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Preface

About the Object Management Group

OMG

Founded in 1989, the Object Management Group, Inc. (OMG) is an open membership, not-for-profit computer industry standards consortium that produces and maintains computer industry specifications for interoperable, portable and reusable enterprise applications in distributed, heterogeneous environments. Membership includes Information Technology vendors, end users, government agencies and academia.

OMG member companies write, adopt, and maintain its specifications following a mature, open process. OMG's specifications implement the Model Driven Architecture® (MDA®), maximizing ROI through a full-lifecycle approach to enterprise integration that covers multiple operating systems, programming languages, middleware and networking infrastructures, and software development environments. OMG's specifications include: UML® (Unified Modeling Language™); CORBA® (Common Object Request Broker Architecture); CWM™ (Common Warehouse Metamodel); and industry-specific standards for dozens of vertical markets.

More information on the OMG is available at *http://www.omg.org/*.

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1 Scope

1.1 General

This specification adds several new "DDS Security Support" compliance points ("profile") to the DDS Specification. See the compliance levels within the Conformance Clause below.

1.2 Overview of this Specification

This specification defines the Security Model and Service Plugin Interface (SPI) architecture for compliant DDS implementations. The DDS Security Model is enforced by the invocation of these SPIs by the DDS implementation. This specification also defines a set of builtin implementations of these SPIs.

- The specified builtin SPI implementations enable out-of-the box security and interoperability between compliant DDS applications.
- The use of SPIs allows DDS users to customize the behavior and technologies that the DDS implementations use for Information Assurance, specifically customization of Authentication, Access Control, Encryption, Message Authentication, Digital Signing, Logging and Data Tagging.

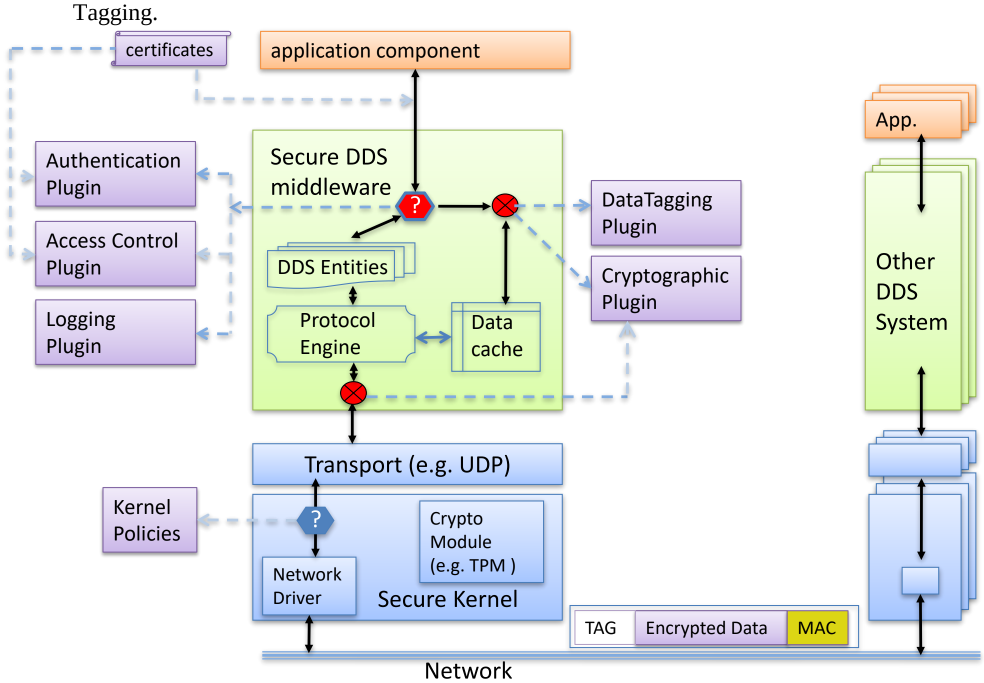

Figure 1 – Overall architecture for DDS Security

This specification defines five SPIs that when combined together provide Information Assurance to DDS systems:

- **Authentication** Service Plugin. Provides the means to verify the identity of the application and/or user that invokes operations on DDS. Includes facilities to perform mutual authentication between participants and establish a shared secret.
- **AccessControl** Service Plugin. Provides the means to enforce policy decisions on what DDS related operations an authenticated user can perform. For example, which domains it can join, which Topics it can publish or subscribe to, etc.
- **Cryptographic** Service Plugin. Implements (or interfaces with libraries that implement) all cryptographic operations including encryption, decryption, hashing, digital signatures, etc. This includes the means to derive keys from a shared secret.
- **Logging** Service Plugin. Supports auditing of all DDS security-relevant events.
- **Data Tagging** Service Plugin. Provides a way to add tags to data samples**.**

2 Conformance

2.1 Conformance points

This specification defines the following conformance points:

(1) Builtin plugin interoperability (mandatory)
(2) Plugin framework (mandatory)
(3) Plugin language APIs (optional)
(4) Logging and Tagging (optional)

Conformance with the “DDS Security” specification requires conformance with all the mandatory conformance points.

2.2 Builtin plugin interoperability (mandatory)

This point provides interoperability with all the builtin plugins with the exception of the Logging plugin. Conformance to this point requires conformance to:

- Clause 7 (the security model and the support for interoperability between DDS Security implementations).
- The configuration of the plugins and the observable wire-protocol behavior specified in Clause 10 (the builtin-plugins), except for sub clause 10.6. This conformance point does not require implementation of the APIs between the DDS implementation and the plugins.

2.3 Plugin framework (mandatory)

This point provides the architectural framework and abstract APIs needed to develop new security plugins and “plug them” into a DDS middleware implementation. Plugins developed using this framework are portable between conforming DDS implementations. However portability for a specific programming language also requires conformance to the specific language API (see 2.4).
Conformance to this point requires conformance to:

- Clause 7 (the security model and the support for interoperability between DDS Security implementations).
- Clause 9 (the plugin model) with the exception of 9.6 and 9.7 (Logging and Data Tagging plugins). The conformance to the plugin model is at the UML level; it does not mandate a particular language mapping.
- Clause 10, the builtin-plugins, except for 10.6 (Builtin Logging Plugin).

In addition it requires the conforming DDS implementation to provide a public API to insert the plugins that conform to the aforementioned sections.

2.4 Plugin Language APIs (optional)

These conformance points provide portability across compliant DDS implementations of the security plugins developed using a specific programming language.
Conformance to any of the language portability points requires conformance to the (mandatory) plugin architecture framework point.
There are 5 “plugin language API” points, each corresponding to a different programming language used to implement the plugins.
Each language point is a separate independent conformance point. Conformance with the “plugin language API” point requires conformance with at least one of the 5 language APIs enumerated below:

- C Plugin APIs. Conformance to sub clauses 11.2 and 11.3

- C++ classic Plugin APIs. Conformance to sub clauses 11.2 and 11.4
- Java classic Plugin APIs. Conformance to sub clauses 11.2 and 11.5
- C++11 Plugin APIs. Conformance to sub clauses 11.2 and 11.6
- Java5+ Plugin APIs. Conformance to sub clauses 11.2 and 11.7

2.5 Logging and Tagging profile (optional)

This point adds support for logging and tagging. Conformance to this point requires conformance to sub clauses 9.6, 9.7, and 10.6.

3 Normative References

DDSSEC12-86 - Secure TypeLookup Built-In Endpoints

- DDS: Data-Distribution Service for Real-Time Systems version 1.4. http://www.omg.org/spec/DDS/1.4
- DDS-RTPS: Data-Distribution Service Interoperability Wire Protocol version 2.5, http://www.omg.org/spec/DDS-RTPS/2.5/
- DDS-XTYPES: Extensible and Dynamic Topic-Types for DDS version 1.3, http://www.omg.org/spec/DDS-XTypes/1.3/
- OMG-IDL: Interface Definition Language (IDL) version 4.2, http://www.omg.org/spec/IDL/4.2
- HMAC: Keyed-Hashing for Message Authentication. H. Krawczyk, M. Bellare, and R.Canetti, IETF RFC 2104, http://tools.ietf.org/html/rfc2104
- Updated Security Considerations for the MD5 Message-Digest and the HMAC-MD5 Algorithms, IETF RFC 6151 https://tools.ietf.org/html/rfc6151
- PKCS #7: Cryptographic Message Syntax Version 1.5. IETF RFC 2315. http://tools.ietf.org/html/rfc2315
- Public-Key Cryptography Standards (PKCS) #1: RSA Cryptography Specifications Version 2.2. IETF RFC 8017. https://tools.ietf.org/html/rfc8017
- XSD: XML Schema Definition Language (XSD) 1.1 Part 2: Datatypes, https://www.w3.org/TR/2012/REC-xmlschema11-2-20120405

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4 Terms and Definitions

For the purposes of this specification, the following terms and definitions apply:

Access Control

Mechanism that enables an authority to control access to areas and resources in a given physical facility or computer-based information system.

Authentication

Security measure(s) designed to establish the identity of a transmission, message, or originator.

Authorization

Access privileges that are granted to an entity; conveying an “official” sanction to perform a security function or activity.

Ciphertext

Data in its encrypted or signed form.

Certification authority

The entity in a Public Key Infrastructure (PKI) that is responsible for issuing certificates, and exacting compliance to a PKI policy.

Confidentiality

Assurance that information is not disclosed to unauthorized individuals, processes, or devices.

Cryptographic algorithm

A well-defined computational procedure that takes variable inputs, including a cryptographic key and produces an output.

Cryptographic key

A parameter used in conjunction with a cryptographic algorithm that operates in such a way that another agent with knowledge of the key can reproduce or reverse the operation, while an agent without knowledge of the key cannot.
Examples include:

1. The transformation of plaintext data into ciphertext.
2. The transformation of ciphertext data into plaintext.
3. The computation of a digital signature from data.
4. The verification of a digital signature.
5. The computation of a message authentication code from data.
6. The verification of a message authentication code from data and a received authentication code.

Data-Centric Publish-Subscribe (DCPS)

The mandatory portion of the DDS specification used to provide the functionality required for an application to publish and subscribe to the values of data objects.

Data Distribution Service (DDS)

An OMG distributed data communications specification that allows Quality of Service policies to be specified for data timeliness and reliability. It is independent of the implementation language.

Data Integrity

Assurance that data has not been altered since creation time.

Data-Origin Authentication

A mechanism providing assurance that a party is corroborated as the source of specified data (it includes data integrity). In this specification it is used to indicate assurance of the `DataWriter` or `DataReader` that originated a message.

Digital signature

The result of a cryptographic transformation of data that, when properly implemented with supporting infrastructure and policy, provides the services of:

1. origin authentication
2. data integrity
3. signer non-repudiation

Extended IDL

Extended Interface Definition Language (IDL) used to describe data types in a way that can be represented in a machine neutral format for network communications. This syntax was introduced as part of the DDS-XTYPES specification [3].

Hashing algorithm

A one-way algorithm that maps an input byte buffer of arbitrary length to an output fixed-length byte array in such a way that:

(a) Given the output it is computationally infeasible to determine the input.
(b) It is computationally infeasible to find any two distinct inputs that map to the same output.

DDSSEC12-90 - Meeting CNSSP-15 security requirements
IETF
The Internet Engineering Task Force (IETF) is a standards organization for the Internet and is responsible for the technical standards that make up the Internet protocol suite.

Information Assurance

The practice of managing risks related to the use, processing, storage, and transmission of information or data and the systems and processes used for those purposes.

Integrity

Protection against unauthorized modification or destruction of information.
DDSSEC12-90 - Meeting CNSSP-15 security requirements

Key derivation function (KDF)

A class of functions that use pseudo-random functions (PRFs) and a pre-shared cryptographic key (the key-derivation key) to generate additional keys [50].

Key establishment

The process by which cryptographic keys are securely established among cryptographic modules [50].

Key agreement

A Key Establishment procedure where the resultant keying material is a function of information contributed by two or more participants, so that no party can predetermine the value of the keying material independently of the other party's contribution used to establish secret keying material [50]. Key agreement typically involves two steps: the use of an appropriate "primitive" to generate an agreed shared secret, and the use of a key derivation function (KDF) to generate one or more keys from the shared secret.

Key management

The handling of cryptographic material (e.g., keys, Initialization Vectors) during their entire life cycle of from creation to destruction.

Message authentication code (MAC)

A cryptographic hashing algorithm on data that uses a symmetric key to detect both accidental and intentional modifications of data.

Message-Origin Authentication

A mechanism providing assurance that a party is corroborated as the source of a specified message. In this specification it is used to indicate assurance of the `DomainParticipant` that originated the message.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

NIST

National Institute of Standards and Technology (NIST) is a US government agency that among other things defines standards relevant to science, engineering, and information technology.

Non-Repudiation

Assurance that the sender of data is provided with proof of delivery and the recipient is provided with proof of the sender's identity, so neither can later deny having received or processed the data.

Public key

A cryptographic key used with a public key cryptographic algorithm that is uniquely associated with an entity and that may be made public. The public key is associated with a private key. The public key may be known by anyone and, depending on the algorithm, may be used to:

1. Verify a digital signature that is signed by the corresponding private key,
2. Encrypt data that can be decrypted by the corresponding private key, or
3. Compute a piece of shared data.

Public key certificate

A set of data that uniquely identifies an entity, contains the entity's public key and possibly other information, and is digitally signed by a trusted party, thereby binding the public key to the entity.

Public key cryptographic algorithm

A cryptographic algorithm that uses two related keys, a public key and a private key. The two keys have the property that determining the private key from the public key is computationally infeasible.

Public Key Infrastructure

A framework that is established to issue, maintain, and revoke public key certificates.

5 Symbols

This specification does not define any symbols or abbreviations.

6 Additional Information

6.1 Changes to Adopted OMG Specifications

This specification does not modify any existing adopted OMG specifications. It reuses and/or adds functionality on top of the current set of OMG specifications.

DDSSEC12-86 - Secure TypeLookup Built-In Endpoints

- **DDS**: This specification does not modify or invalidate any existing DDS profiles or compliance levels. It extends some of the DDS builtin Topics to carry additional information in a compatible way with existing implementations of DDS.
- **DDS-RTPS**: This specification does not require any modifications to RTPS; however, it may impact interoperability with existing DDS-RTPS implementations. In particular, DDS-RTPS implementations that do *not* implement the DDS Security specification will have limited interoperability with implementations that *do* implement the mechanisms introduced by this specification. Interoperability is limited to systems configured to allow "unauthorized" DomainParticipant entities and within those systems, only to Topics configured to be "unprotected."
- **DDS-XTYPES**: This specification depends on the IDL syntax introduced by and the Extended CDR encoding defined in the DDS-XTYPES specification. It does not require any modifications of DDS-XTYPES. Implementations of both this specification and DDS-XTYPES (Basic Network Interoperability Profile) shall include the Builtin Secure TypeLookup Endpoints (see section 7.5.11).
- **OMG IDL**: This specification does not modify any existing IDL-related compliance levels.

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6.2 Acknowledgments

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7 Support for DDS Security

7.1 Security Model

The Security Model for DDS defines the security principals (users of the system), the objects that are being secured, and the operations on the objects that are to be restricted. DDS applications share information on DDS Global Data Spaces (called DDS Domains) where the information is organized into Topics and accessed by means of read and write operations on data-instances of those Topics. Ultimately what is being secured is a specific DDS Global Data Space (domain) and, within the domain, the ability to access (read or write) information (specific Topic or even data-object instances within the Topic) in the DDS Global Data Space.

Securing DDS means providing:

- Confidentiality of the data samples
- Integrity of the data samples and the messages that contain them
- Authentication of DDS writers and readers
- Authorization of DDS writers and readers
- Message-origin authentication
- Data-origin authentication
- (Optional) Non-repudiation of data

To provide secure access to the DDS Global Data Space, applications that use DDS must first be authenticated, so that the identity of the application (and potentially the user that interacts with it) can be established. Once authentication has been obtained, the next step is to enforce access control decisions that determine whether the application is allowed to perform specific actions. Examples of actions are: joining a DDS Domain, defining a new Topic, reading or writing a specific DDS Topic, and even reading or writing specific Topic instances (as identified by the values of key fields in the data). Enforcement of access control shall be supported by cryptographic techniques so that information confidentiality and integrity can be maintained, which in turn requires an infrastructure to manage and distribute the necessary cryptographic keys.

7.1.1 Threats

In order to understand the decisions made in the design of the plugins, it is important to understand some of the specific threats impacting applications that use DDS and DDS Interoperability Wire Protocol (RTPS).

Most relevant are four categories of threats:

1. Unauthorized subscription
2. Unauthorized publication
3. Tampering and replay
4. Unauthorized access to data

These threats are described in the context of a hypothetical communication scenario with six actors all attached to the same network:

- **Alice**. A DDS DomainParticipant who is authorized to publish data on a Topic T.
- **Bob**. A DDS DomainParticipant who is authorized to subscribe to data on a Topic T.
- **Eve**. An eavesdropper. Someone who is **not authorized** to subscribe to data on Topic T. However Eve uses the fact that she is connected to the same network to try to see the data.
- **Trudy**. An intruder. A DomainParticipant who is **not authorized** to publish on Topic T. However, Trudy uses the fact that she is connected to the same network to try to send data.
- **Mallory**. A malicious DDS DomainParticipant. Mallory is authorized to subscribe to data on Topic T but she is **not authorized** to publish on Topic T. However, Mallory will try to use

information gained by subscribing to the data to publish in the network and try to convince Bob that she is a legitimate publisher.

- **Trent**. A trusted service who needs to receive and send information on Topic T. For example, Trent can be a persistence service or a relay service. He is trusted to relay information without having malicious intent. However he is not trusted to see the content of the information.

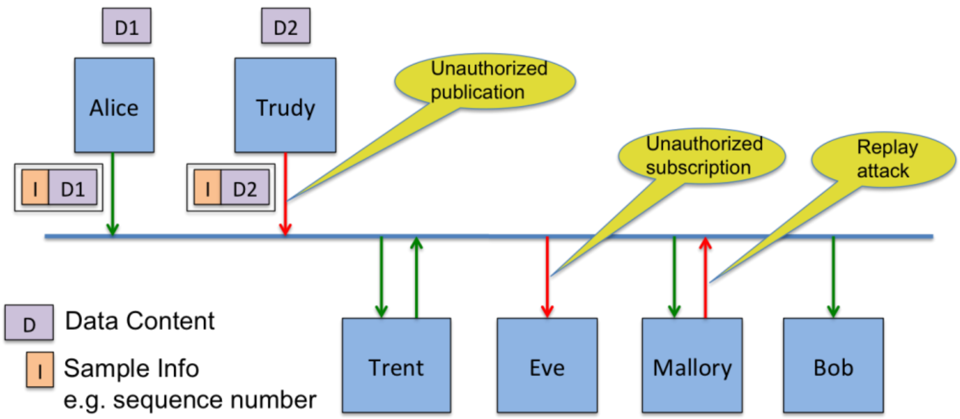

Figure 2 – Threat actors

7.1.1.1 Unauthorized Subscription

The DomainParticipant Eve is connected to the same network infrastructure as the rest of the agents and is able to observe the network packets despite the fact that the messages are not intended to be sent to Eve. Many scenarios can lead to this situation. Eve could tap into a network switch or observe the communication channels. Alternatively, in situations where Alice and Bob are communicating over multicast, Eve could simply subscribe to the same multicast address.

Protecting against Eve is reasonably simple. All that is required is for Alice to encrypt the data she writes using a secret key that is only shared with authorized receivers such as Bob, Trent, and Mallory.

7.1.1.2 Unauthorized Publication

The DomainParticipant Trudy is connected to the same network infrastructure as the rest of the agents and is able to inject network packets with any data contents, headers and destination she wishes (e.g., Bob). The network infrastructure will route those packets to the indicated destination.

To protect against Trudy, Bob, Trent and Mallory need to realize that the data is not originating from Alice. They need to realize that the data is coming from someone not authorized to send data on Topic T and therefore reject (i.e., not process) the packet.

Protecting against Trudy is also reasonably simple. All that is required is for the protocol to require that the messages include either a hash-based message authentication code (HMAC) or digital signature.

- An HMAC creates a message authentication code using a secret key that is shared with the intended recipients. Alice would only share the secret key with Bob, Mallory and Trent so that they can recognize messages that originate from Alice. Since Trudy is not authorized to publish Topic T, Bob and the others will not recognize any HMACs Trudy produces (i.e., they will not recognize Trudy's key).

- A digital signature is based on public key cryptography. To create a digital signature, Alice encrypts a digest of the message using Alice's private key. Everybody (including Bob, Mallory and Trent) has access to Alice's public key. Similar to the HMAC above, the recipients can identify messages from Alice, as they are the only ones whose digital signature can be interpreted with Alice's public key. Any digital signatures Trudy may use will be rejected by the recipients, as Trudy is not authorized to write Topic T.

The use of HMACs versus digital signatures presents tradeoffs that will be discussed further in subsequent sections. Suffice it to say that in many situations the use of HMACs is preferred because the performance to compute and verify them is about 1000 times faster than the performance of computing/verifying digital signatures.

7.1.1.3 Tampering and Replay

Mallory is authorized to subscribe to Topic T. Therefore Alice has shared with Mallory the secret key to encrypt the topic and also, if an HMAC is used, the secret key used for the HMAC.

Assume Alice used HMACs instead of digital signatures. Then Mallory can use her knowledge of the secret keys used for data encryption and the HMACs to create a message on the network and pretend it came from Alice. Mallory can fake all the TCP/UDP/IP headers and any necessary RTPS identifiers (e.g., Alice's RTPS DomainParticipant and DataWriter GUIDs). Mallory has the secret key that was used to encrypt the data so she can create encrypted data payloads with any contents she wants. She has the secret key used to compute HMACs so she can also create a valid HMAC for the new message. Bob and the others will have no way to see that the message came from Mallory and will accept it, thinking it came from Alice.

So if Alice used an HMAC, the only solution to the problem is that the secret key used for the HMAC when sending the message to Mallory cannot be the same as the key used for the HMAC when sending messages to Bob. In other words, Alice must share a **different** secret key for the HMAC with each recipient. Then Mallory will not have the HMAC key that Bob expects from Alice and the messages from Mallory to Bob will not be misinterpreted as coming from Alice.

Recall that Alice needs to be able to use multicast to communicate efficiently with multiple receivers. Therefore, if Alice wants to send an HMAC with a different key for every receiver, the only solution is to append multiple HMACs to the multicast message with some key-id that allows the recipient to select the correct HMAC to verify.

If Alice uses digital signatures to protect the integrity of the message, then this 'masquerading' problem does not arise and Alice can send the same digital signature to all recipients. This makes using multicast simpler. However, the performance penalty of using digital signatures is so high that in many situations it will be better to compute and send multiple HMACs as described earlier.

7.1.1.4 Unauthorized Access to Data by Infrastructure Services

Infrastructure services, such as the DDS Persistence Service or relay services need to be able to receive messages, verify their integrity, store them, and send them to other participants on behalf of the original application.

These services can be trusted not to be malicious; however, often it is not desirable to grant them the privileges they would need to understand the contents of the data. They are allowed to store and forward the data, but not to see inside the data.

Trent is an example of such a service. To support deployment of these types of services, the security model needs to support the concept of having a participant, such as Trent, who is allowed to receive, process, and relay RTPS messages, but is not allowed to see the contents of the data within the message. In other words, he can see the headers and sample information (writer GUID, sequence numbers, keyhash and such) but not the message contents.

To support services like Trent, Alice needs to accept Trent as a valid destination for her messages on topic T and share with Trent only the secret key used to compute the HMAC for Trent, but not the secret key used to encrypt the data itself. In addition, Bob, Mallory and others need to accept Trent as someone who is able to write on Topic T and relay messages from Alice. This means two things: (1) accept and interpret messages encrypted with Alice's secret key and (2) allow Trent to include in his sample information, the information he got from Alice (writer GUID, sequence number and anything else needed to properly process the relayed message).

Assume Alice used an HMAC in the message sent to Trent. Trent will have received from Alice the secret key needed to verify the HMAC properly. Trent will be able to store the messages, but lacking the secret key used for its encryption, will be unable to see the data. When he relays the message to Bob, he will include the information that indicates the message originated from Alice and produce an HMAC with its own secret HMAC key that was shared with Bob. Bob will receive the message, verify the HMAC and see it is a relayed message from Alice. Bob recognizes Trent is authorized to relay messages, so Bob will accept the sample information that relates to Alice and process the message as if it had originated with Alice. In particular, he will use Alice's secret key to decrypt the data.

If Alice had used digital signatures, Trent would have two choices. If the digital signature only covered the data and the sample information he needs to relay from Alice, Trent could simply relay the digital signature as well. Otherwise, Trent could strip out the digital signature and put in his own HMAC. Similar to before, Bob recognizes that Trent is allowed to relay messages from Alice and will be able to properly verify and process the message.

7.2 Cryptographic Algorithm Classes

DDSSEC12-90 - Meeting CNSSP-15 security requirements

The term **Cryptographic Algorithm** is used to refer to well-defined computational procedures that take variable inputs, possibly including a cryptographic key, and produce an output. In the context of this specification, this term refers to any of the cryptographic algorithms used by the SPIs.

Implementations of DDS-Security SPIs rely on cryptographic algorithms to implement authentication, access control, confidentiality, and integrity functionality. The concrete algorithms and how they are used depend on the implementation of the SPIs. However, since the SPIs use well-known algorithms specified by other standard organizations such as NIST and IETF, it is advantageous for DDS-Security to define a common (SPI-independent) mechanism that facilitates reuse of the algorithms across SPI implementations, including the builtin SPIs as well as custom ones.

Following the NIST classification of Cryptographic Algorithms [50], this specification groups the algorithms into the following classes:

- **Digital Signature**: This class of operations are used to prove/verify the integrity and authenticity of a message or a document. In the context of this specification, digital signatures may be used by the SPIs to establish an identity trust chain that validates certificates and to authenticate messages exchanged between two Endpoints.
- **Key Establishment and KeyAgreement**: This class of operations are used to securely establish cryptographic keys among cryptographic modules or communicating endpoints. Key Agreement is a special type of key establishment where the resulting key material is a function of information contributed by two or more participants, so that no party can predetermine the value of the key material independently of the other party's contributions. In the context of this specification, key agreement may be used by the SPIs to generate a shared secret key between two Participants allowing them to exchange information securely.
- **Symmetric Cipher**: This class of operations use a shared secret key for (authenticated) encryption/decryption or to generate/validate Message Authentication Codes (MACs). In the context of this specification, symmetric ciphers may be used by the SPIs to protect the data and

metadata exchanged between two Endpoints. In the NIST classification this group is separated into two: Block-cipher encryption/decryption and message authentication codes. This differentiation is not needed for DDS-Security.

The classes above are intentionally a subset of the ones defined by NIST. It is limited to the types of cryptographic algorithms that the SPIs are expected to be able to configure independently and impact the interoperability between Participants. Other classes of algorithms, such as, Hashing, Random Number Generators, etc. are used but not separately configurable so it is not needed to manage them separately. Future revisions of the specification may separate these as well.
The common set of predefined cryptographic algorithms available for use by the SPIs are defined in Clause 8.

7.3 Types used by DDS Security

The DDS security specification includes extensions to the DDS Interoperability Wire Protocol (DDS-RTPS), as well as, new API-level functions in the form of Security Plugins. The types described in this sub clause are used in these extensions.

7.3.1 Use of IDL and XTYPES notation

DDSSEC12-29 - Specify DDS Security uses XCDR serialization version 1
This specification uses the OMG IDL, including IDL annotations, as a way to define datatypes. Likewise, it uses DDS-XTYPES to define the serialized representation of those data types. See section 3Normative References.
The use of OMG IDL notation and DDS-XTYPES data representation does not imply that implementations of this specification need to also conform to the full OMG IDL or DDS-XTYPES specifications. Rather, the requirement is that the serialized data for types defined/used in the DDS-Security specification the corresponding DDS-XTYPES data representations for those same concrete data types.

7.3.1.1 Type Extensibility

DDSSEC12-29 - Specify DDS Security uses XCDR serialization version 1
DDS-Security leverages the concept of type extensibility as defined in DDS-XTYPES, including the IDL @extensibility annotation, to indicate the possible evolution of the defined data types in future revisions of the specification.
This is done according to the following conventions:

- Types that extend or mimic pre-exiting types in DDS, DDS-XTYPES, or DDS-RTPS use the same extensibility kind as the corresponding base-type.
    - Types representing builtin Topics used for discovery (or secure discovery) of DDS Entities are defined with extensibility MUTABLE.
    - Types representing the Qos of a DDS Entity are defined with extensibility kind MUTABLE.
    - Types representing a Qos Policy of a DDS Entity are defined with extensibility kind APPENDABLE.
    - Other top-level types are defined with extensibility kind APPENDABLE.
- Types used as top-level data types sent for a DDS Topics are defined with either extensibility kind MUTABLE or APPENDABLE.
- Types that appear in sequences or embedded in non-mutable types are defined with extensibility kind FINAL.

7.3.1.2 Data Representation (Serialization)

DDSSEC12-29 - Specify DDS Security uses XCDR serialization version 1

DDS-Security only uses the Extended CDR representation with encoded version 1. Specifically, this means that the serialization of a type with extensibility kind APPENDABLE is the same as if it had been declared to have extensibility kind FINAL. The difference is the expected future evolution of the data type, see 7.3.1.3.

7.3.1.3 Type changes that may appear in future revision of the specification

DDSSEC12-29 - Specify DDS Security uses XCDR serialization version 1

Types defined with extensibility kind FINALare not expected to be modified in future revisions of the DDS-Security specification. If they are, the resulting change will likely not be interoperable with this version of the specification.

Types defined with extensibility kind APPENDABLE may be modified in future revisions of the DDS-Security specification. If they are, the resulting change should be interoperable with this version of the specification.

Vendors may only create vendor-specific extensions to the Types representing builtin Topics used for discovery (or secure discovery) of DDS. These types are all structure types with extensibility kind MULTABLE. The only vendor-specific extension allowed to these types is the addition of new members to these structures. If new members are added:

- The member IDs of these vendor-specific members shall be in the Vendor-specific ParameterId space, defined in DDS-RTPS vesion 2.5, clause 9.4.2.11.2.

The Ignore/Must Understand bit of the memberID/ParameterId must also be set according with the meaning of table 9.6 in that same clause.

7.3.2 Property_t

Section 9.3.2 of the DDS-RTPS specification defines `Property_t` as a data type that holds a pair of strings. One string is considered the property “name” and the other is the property “value” associated with that name.

The DDS Security specification extends the DDS-RTPS definition of `Property_t` to contain the additional boolean attribute “propagate” used to indicate whether a property is intended for local use only or should be propagated by DDS discovery.

The DDS-Security specification uses `Property_t` sequences as a generic data type to configure the security plugins, pass metadata and provide an extensible mechanism for vendors to configure the behavior of their plugins without breaking portability or interoperability.

`Property_t` objects with names that start with the prefix “`dds.sec.`” are reserved by this specification, including future versions of this specification. Plugin implementers can also use this mechanism to pass metadata and configure the behavior of their plugins. In order to avoid collisions with the value of the “name” attribute, implementers shall use property names that start with a prefix to an ICANN domain name they own, in reverse order. For example, the prefix would be “`com.acme.`” for plugins developed by a hypothetical vendor that owns the domain “acme.com”.

The names and interpretation of the expected properties shall be specified by each plugin implementation.

Table 1 – Property_t class

Property_t	
Attributes	
`name`	`String`

value	String
propagate	Boolean

7.3.2.1 IDL Representation for Property_t

The `Property_t` type may be used for information exchange over the network. When a `Property_t` is sent over the network it shall be serialized using Extended CDR format according to the Extended IDL representation [3] below.
DDSSEC12-29 - Specify DDS Security uses XCDR serialization version 1

```
@extensibility(FINAL)
struct Property_t {
   string name;
   string value;
   @non-serialized boolean propagate;
};
typedef sequence< Property_t > PropertySeq;
```

Deleted: APPENDABLE

7.3.3 BinaryProperty_t

`BinaryProperty_t` is a data type that holds a string and an octet sequence. The string is considered the property "name" and the octet sequence the property "value" associated with that name. Sequences of `BinaryProperty_t` are used as a generic data type to configure the plugins, pass metadata and provide an extensible mechanism for vendors to configure the behavior of their plugins without breaking portability or interoperability.
`BinaryProperty_t` also contains the boolean attribute "propagate". Similar to `Property_t` this attribute is used to indicate whether the corresponding binary property is intended for local use only or shall be propagated by DDS discovery.
`BinaryProperty_t` objects with a "name" attribute that start with the prefix "`dds.sec.`" are reserved by this specification, including future versions of this specification.
Plugin implementers may use this mechanism to pass metadata and configure the behavior of their plugins. In order to avoid collisions with the value of the "name", attribute implementers shall use property names that start with a prefix to an ICANN domain name they own, in reverse order. For example, the prefix would be "com.acme." for plugins developed by a hypothetical vendor that owns the domain "acme.com".
The valid values of the "name" attribute and the interpretation of the associated "value" shall be specified by each plugin implementation.

Table 2 – BinaryProperty_t class

BinaryProperty_t	
Attributes	
name	String
value	OctetSeq
propagate	Boolean

7.3.3.1 IDL Representation for BinaryProperty_t

The `BinaryProperty_t` type may be used for information exchange over the network. When a `BinaryProperty_t` is sent over the network, it shall be serialized using Extended CDR format according to the Extended IDL representation [3] below.
DDSSEC12-29 - Specify DDS Security uses XCDR serialization version 1

```
@extensibility(FINAL)
struct BinaryProperty_t {
   string name;
   OctetSeq value;
   @non-serialized boolean propagate;
};
typedef sequence< BinaryProperty_t > BinaryPropertySeq;
```

Deleted: APPENDABLE

DDSSEC12-90 - Meeting CNSSP-15 security requirements

When setting the `BinaryProperty_t value` octet sequence from an ASCII string, the length of the sequence shall be set to the number of characters in the string, counting the NUL terminating character, and each octet in the sequence shall be set to the ASCII value of the corresponding character in the string, including the NUL terminating character.

For example, if an object the string “ECDSA-SHA256” shall result in an octet sequence value with length 13 where the first octet is 0x45 (ASCII code for ‘E’) and the last octet is 0x00.

7.3.4 DataHolder

`DataHolder` is a data type used to hold generic data. It contains various attributes used to store data of different types and formats. `DataHolder` appears as a building block for other types, such as `Token` and `GenericMessageData`.

Table 3 – DataHolder class

DataHolder	
Attributes	
class_id	String
properties	PropertySeq
binary_properties	BinaryPropertySeq

7.3.4.1 IDL representation for DataHolder

The `DataHolder` type may be used for information exchange over the network. When a `DataHolder` is sent over the network, it shall be serialized using Extended CDR format according to the Extended IDL representation [3] below.

DDSSEC12-29 - Specify DDS Security uses XCDR serialization version 1

```
@extensibility(FINAL)
struct DataHolder {
    string            class_id;
    PropertySeq       properties;
    BinaryPropertySeq binary_properties;

};

typedef sequence<DataHolder> DataHolderSeq;
```

Deleted: APPENDABLE

7.3.5 Token

The `Token` class provides a generic mechanism to pass information between security plugins using DDS as the transport. `Token` objects are meant for transmission over the network using DDS either embedded within the builtin topics sent via DDS discovery or via special DDS Topic entities defined in this specification.

The Token class is structurally identical to the DataHolder class and therefore has the same structure for all plugin implementations. However, the contents and interpretation of the Token objects shall be specified by each plugin implementation.
There are multiple specializations of the Token class. They all share the same format, but are used for different purposes. This is modeled by defining specialized classes.

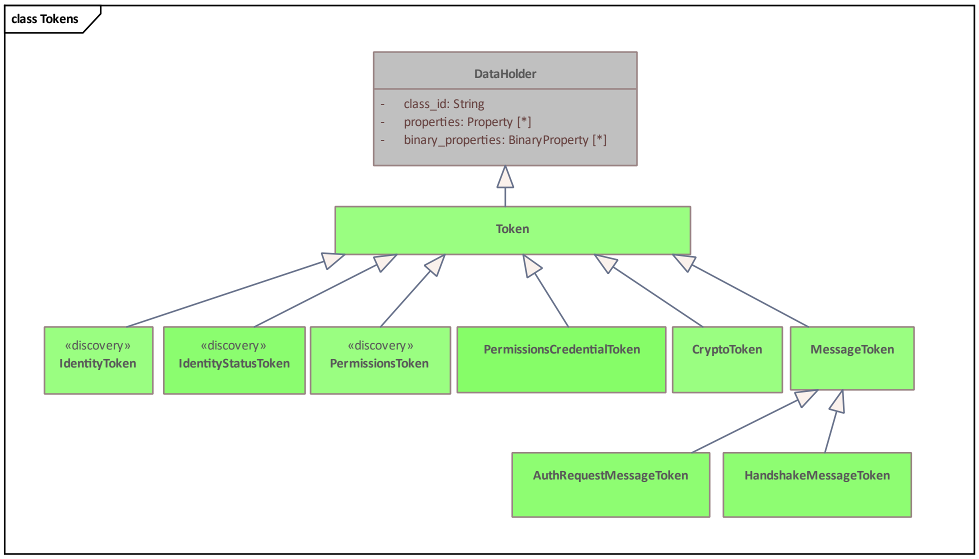

Figure 3 – Token Model

7.3.5.1 Attribute: `class_id`

When used as a Token class, the ***class_id*** attribute in the DataHolder identifies the kind of Token. Strings with the prefix "dds.sec." are reserved for this specification, including future versions of the specification. Implementers of this specification can use this attribute to identify non-standard tokens. In order to avoid collisions, the ***class_id*** they use shall start with a prefix to an ICANN domain name they own, using the same rules specified in 7.3.1 for property names.

7.3.5.2 IDL Representation for Token and Specialized Classes

The Token class is used to hold information exchanged over the network. When a Token is sent over the network, it shall be serialized using Extended CDR format according to the Extended IDL representation below:

```
typedef DataHolder Token;

typedef Token MessageToken;
typedef MessageToken AuthRequestMessageToken;
typedef MessageToken HandshakeMessageToken;

typedef Token IdentityToken;
typedef Token IdentityStatusToken;
typedef Token PermissionsToken;
typedef Token AuthenticatedPeerCredentialToken;
```

```
typedef Token PermissionsCredentialToken;

typedef Token CryptoToken;
typedef Token ParticipantCryptoToken;
typedef Token DatawriterCryptoToken;
typedef Token DatareaderCryptoToken;

typedef sequence<HandshakeMessageToken> HandshakeMessageTokenSeq;
typedef sequence<CryptoToken> CryptoTokenSeq;
typedef CryptoTokenSeq ParticipantCryptoTokenSeq;
typedef CryptoTokenSeq DatawriterCryptoTokenSeq;
typedef CryptoTokenSeq DatareaderCryptoTokenSeq;
```

7.3.5.3 TokenNIL

This name refers to the `Token` object having ***class_id*** set to the empty string, and both ***properties*** and ***binary_properties*** sequences set to the empty sequence.
The `TokenNIL` object is used to indicate the absence of a `Token`.

7.3.6 CryptoAlgorithmName

DDSSEC12-90 - Meeting CNSSP-15 security requirements
The `CryptoAlgorithmName` type provides a common way to identify a Cryptographic Algorithm in contexts where ease of interpretation is the primary consideration and the set of possible algorithms is open ended.
Typical use of the is `CryptoAlgorithmName` is during configuration of the SPIa as well as handshake-type messages sent by the SPIs.
The representation uses a string identifier. The type for `CryptoAlgorithmName` is defined by the IDL below.

```
typedef string<64> CryptoAlgorithmName;
```

See clause 8 for the values of the `CryptoAlgorithmName` used by the SPIs in this specification.

7.3.7 CryptoAlgorithmId

DDSSEC12-90 - Meeting CNSSP-15 security requirements
The `CryptoAlgorithmId` type provides a common way to identify a Cryptographic Algorithm in contexts where a compact, fixed-size representation is required and the set of possible algorithms is open ended.
Typical use of the is `CryptoAlgorithmId` is in message headers that need to identify the type of encryption or message authentication applied to a message.
The representation uses a 1-byte identifier. The type for `CryptoAlgorithmId` is defined by the IDL below.

```
typedef octet CryptoAlgorithmId;
const  CryptoAlgorithmId CRYPTO_ALGORITHM_INVALID_ID=0x00;
```

The value `CRYPTO_ALGORITHM_INVALID_ID` is reserved to indicate the algorithm is undefined or invalid.

- The values in the range 0x01 <= value < 0x80 are reserved for the DDS-Security specification, including future revisions of the specification.

- The values in the range 0x80 <= value <= 0xFF are reserved for implementation-specific algorithms and should be interpreted within the context of the RTPS vendor ID that constructed the object containing that value.

See clause 8 for the values of the `CryptoAlgorithmId` used by the SPIs in this specification.

7.3.8 CryptoAlgorithmBit

DDSSEC12-90 - Meeting CNSSP-15 security requirements

The `CryptoAlgorithmBit` type provides a common way to identify a Cryptographic Algorithm in contexts where there is a need to represent one or more algorithms in a very compact manner and the set of possible algorithms is pre-known and very limited.

Typical use of the is `CryptoAlgorithmBit` is in discovery messages to announce which kinds of algorithms are supported or used.

The representation uses an exact power-of-two integer. This integer is used to test and/or set bits in a `CryptoAlgorithmSet` bitmask, see 7.3.9. The type for `CryptoAlgorithmBit` is defined by the IDL below.

```
typedef uint32 CryptoAlgorithmBit;
const  CryptoAlgorithmBit  CRYPTO_ALGORITHM_COMPATIBILITY_MODE=0x80000000;
```

The range of values for `CryptoAlgorithmBit` is split into 3 sets in order to support defining vendor-specific extensions of the builtin SPIs while allowing future revision of the specification to also define new values:

- The value 0x80000000 is reserved and has a special meaning defined in 7.3.10.1.
- The values in the range 0x00000001 <= value < 0x00010000 are reserved for the DDS-Security specification, including future revisions of the specification.
- The values in the range 0x00010000 <= value < 0x80000000 are reserved for vendor-specific definition and shall only be interpreted within the context of the RTPS vendor ID that constructed the object containing that value.

These rules limit the number of possible algorithms that can be represented in the set to 31, of which 16 are reserved for the DDS-Security specification and future revisions thereof.

See clause 8 for the values of the `CryptoAlgorithmBit` used by the SPIs in this specification.

7.3.9 CryptoAlgorithmSet

DDSSEC12-90 - Meeting CNSSP-15 security requirements

The `CryptoAlgorithmSet` type provides a compact representation a set of cryptographic algorithms belonging to the same class, see 7.2 for the definition of the cryptographic algorithm classes.

The representation uses a bitmask. The inclusion of an algorithm in the set is indicated by setting a specific bit assigned to that algorithm to "1" in the bitmask. This bit may be set using the integer "OR" operation with the `CryptoAlgorithmBit` that represents the algorithm.

The definition of the algorithms and the bit position assigned to each algorithm is defined in clause 8.

The type for `CryptoAlgorithmSet` is defined by the IDL below.

```
typedef uint32  CryptoAlgorithmSet;
const CryptoAlgorithmSet CRYPTO_ALGORITHM_SET_ALL   = 0xffffffff;
const CryptoAlgorithmSet CRYPTO_ALGORITHM_SET_EMPTY = 0x00000000;
```

The highest bit of a `CryptoAlgorithmSet` does not represent an algorithm identifier. Its interpretation is described in 7.3.10.1.

7.3.10 CryptoAlgorithmRequirements

DDSSEC12-90 - Meeting CNSSP-15 security requirements

The `CryptoAlgorithmRequirements` type provides information on the cryptographic algorithms of a single class (e.g. digital signature algorithms) that are supported, required, or used by the SPIs for a specific purpose.

The type for `CryptoAlgorithmRequirements` is defined by the extended IDL below:

```
@extensibility (FINAL)
struct CryptoAlgorithmRequirements {
    CryptoAlgorithmSet  supported_mask;
    CryptoAlgorithmSet  required_mask;
};
```

The ***supported_mask*** represents the set of algorithms of a particular kind that are supported by the SPIs. For example, for digital signature algorithms, it may represent the specific algorithms that are available in the SPIs (e.g., elliptic curve with specific curves and padding, RSA, etc.) so that the SPIs are able to validate signatures (e.g., sent by another Domain Participant) that use those algorithms.

The ***required_mask*** represents the subset of the algorithms in the ***supported_mask*** that the SPI uses when interacting with the corresponding SPIs of another Domain Participant and therefore requires the other participant SPI to support. The compatibility rules are defined in subclause 7.3.10.1 below.

7.3.10.1 CryptoAlgorithmRequirements compatibility

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

DDSSEC12-90 – Meeting CNSSP-15 security requirements

In order for two participants to communicate securely they must be configured with compatible sets of Cryptographic Algorithms.

Define the function `CheckCryptoAlgorithmCompatibility()` as:

```
bool CheckCryptoAlgorithmCompatibility (
    CryptoAlgorithmSet  supported_mask,
    CryptoAlgorithmSet  required_mask)
{
  return
         ( (required_mask & supported_mask ) == required_mask )
    OR
         ( ((required_mask & supported_mask )  != 0 )
            AND ( (required_mask & CRYPTO_ALGORITHM_COMPATIBILITY_MODE) != 0 ))
}
```

The `CryptoAlgorithmRequirements` of the SPIs used by a Participant “P1” are considered compatible with those used by the corresponding SPIs of the other Participant “P2” if and only if the following Boolean expression evaluates to TRUE:

```
     CheckCryptoAlgorithmCompatibility (P2.supported_mask, P1.required_mask)
AND
     CheckCryptoAlgorithmCompatibility (P1.supported_mask, P2.required_mask)
```

The first condition indicates that the algorithms required by P1 are supported by P2. The second condition indicate the reverse, that is, the algorithms used by P2 are supported by P1.

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

`DomainParticipants` with incompatible `CryptoAlgorithmRequirements` may not be able to decrypt messages sent by the other `DomainParticipants`. Likewise they may not be able to validate the message authentication codes included in messages sent by the other `DomainParticipant`.

However, if the encryption/authentication codes do not apply to the whole RTPS message, it may still be able for the two Participants to communicate in certain "unprotected" Topics.

7.3.11 ParticipantSecurityDigitalSignatureAlgorithmInfo

DDSSEC12-90 – Meeting CNSSP-15 security requirements
If the SPIs use digital signature algorithms, then for two participants to authenticate they must be configured with compatible sets.
To support discovering the signature algorithms supported and required by each Participant the information, this specification defines a new parameter IDs for `ParticipantBuiltinTopicData` topic, `PID_PARTICIPANT_SECURITY_DIGITAL_SIGNATURE_ALGORITHM_INFO` (see Section 7.5.1.4). The type for this Parameter IDs is defined by the following extended IDL:

```
@extensibility (APPENDABLE)
struct ParticipantSecurityDigitalSignatureAlgorithmInfo {
    CryptoAlgorithmRequirements trust_chain;
    CryptoAlgorithmRequirements message_auth;
};
```

The ***trust_chain*** contains information about the digital signature algorithms used for the purpose of validating a digitally signed document. Note that in general a digitally signed document may contain one or more digital signatures that "chain" up to a root "authority".

- The ***trust_chain.supported_mask*** shall contain the algorithms the SPIs is able to use to validate the digital signature of documents.
- The ***trust_chain.required_mask*** shall contain all the algorithms that are contained in digitally-signed documents sent by the SPI, where the digital signatures chain up to some trust authority recognized by the SPIs of the Participant. So it provides a requirement on what the SPIs of other participants must support in order to validate the digital signature of those documents.

The ***message_auth*** contains information about the digital signature algorithms used directly (i.e. not chained to a common trust authority) to sign messages or validate message signatures.

- The ***message_auth.supported_mask*** shall contain all the algorithms the SPIs is able to use to validate the digital signature of messages.
- The ***message_auth.required_mask*** shall contain all the algorithms the SPIs will use to sign documents or messages sent to other Participants, so it provides a requirement on what the SPIs of other participant must support in order to interoperate.

7.3.11.1 Compatibility

DDSSEC12-90 – Meeting CNSSP-15 security requirements
The `ParticipantSecurityDigitalSignatureAlgorithmInfo` of two participants is compatible if and only if both the ***trust_chain*** and the ***message_auth*** are compatible according to the compatibility rules for `CryptoAlgorithmRequirements` values defined in subclause 7.3.10.1.
DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
`DomainParticipants` with incompatible `ParticipantSecurityDigitalSignatureAlgorithmInfo` are not able to authenticate with each other. However, they may still be able to communicate with each other if both plugins and configuration allow un-authenticated `DomainParticipants` to communicate.

7.3.11.2 Default value

If the `ParticipantSecurityDigitalSignatureAlgorithmInfo` is not present in `ParticipantBuiltinTopicData` topic received from another Participant, the result shall be the same as if the value received had all `CryptoAlgorithmRequirements` members set to the value:

```
    trust_chain.supported_mask    =   CBIT_RSASSA_PSS_MGF1SHA256_2048_SHA256
                                    | CBIT_RSASSA_PKCS1_V15_2048_SHA256
                                    | CBIT_ECDSA_P256_SHA256

    trust_chain.required_mask     =   CBIT_ECDSA_P256_SHA256

    message_auth.supported_mask   =   CBIT_RSASSA_PSS_MGF1SHA256_2048_SHA256
                                    | CBIT_ECDSA_P256_SHA256

    message_auth.required_mask    =   CBIT_ECDSA_P256_SHA256
```

See subclause 8.2 for the definition of the constants used above.

This default value makes it possible to not send the `ParticipantSecurityDigitalSignatureAlgorithmInfo` in a common configuration that matches previous revisions of the specification.

7.3.12 ParticipantSecurityKeyEstablishmentAlgorithmInfo

DDSSEC12-90 – Meeting CNSSP-15 security requirements

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

If the SPIs establish a secret key, then for two participants to communicate securely they must be configured with compatible sets.

To support discovering the the key establishment algorithm information as part of discovery, this specification defines a new parameter IDs for `ParticipantBuiltinTopicData` topic, `PID_PARTICIPANT_KEY_EXCHANGE_ALGORITHM_INFO` (see Section 7.5.1.4). The type for this Parameter IDs is defined by the following extended IDL:

```
@extensibility (APPENDABLE)
struct ParticipantSecurityKeyEstablishmentAlgorithmInfo  {
    CryptoAlgorithmRequirements shared_secret;
};
```

The ***shared_secret*** contains information about the key establishment algorithms used and supported.

- The ***shared_secret.supported_mask*** shall contain all the algorithms the SPIs is able to use to establish a shared key
- The ***shared_secret.required_mask*** shall contain all the algorithms the SPIs of other participants must support in order to interoperate.

7.3.12.1 Compatibility

DDSSEC12-90 – Meeting CNSSP-15 security requirements

The `ParticipantSecurityKeyEstablishmentAlgorithmInfo` of two participants is compatible if and only if the ***shared_secret*** is compatible according to the compatibility rules for `CryptoAlgorithmRequirements` values defined in subclause 7.3.10.1.

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

`DomainParticipants` with incompatible `ParticipantSecurityKeyEstablishmentAlgorithmInfo` are not able to establish a shared secret using a Key-Agreement protocol. As a consequence, they are also not able to mutually

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authenticate with each other (most mutual authentication algorithms also include a key agreement algorithm). However, they may still be able to communicate with each other if both plugins and configuration allow un-authenticated DomainParticipants to communicate.

7.3.12.2 Default value

DDSSEC12-90 – Meeting CNSSP-15 security requirements

If the ParticipantSecurityKeyEstablishmentAlgorithmInfo is not present in ParticipantBuiltinTopicData topic received from another Participant, the result shall be the same as if the value received had all CryptoAlgorithmRequirements members set to the value:

```
    member.supported_mask  =   CBIT_DHE_MODP_2048_256
                             | CBIT_ECDHE_CEUM_P256

    member.required_mask   =   CBIT_ECDHE_CEUM_P256
```

See subclause 8.3 for the definition of the constants used above.

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This default value makes it possible to not send the ParticipantSecurityKeyEstablishmentAlgorithmInfo in a common configuration that matches previous revisions of the specification.

7.3.13 ParticipantSecuritySymmetricCipherAlgorithmInfo

DDSSEC12-90 – Meeting CNSSP-15 security requirements

If the SPIs use symmetric ciphers for encryption or message authentication, then for two participants to communicate securely they must be configured with compatible sets.

To support propagation of this information as part of discovery, this specification defines a new parameter IDs for ParticipantBuiltinTopicData topic, PID_PARTICIPANT_SECURITY_SYMMETRIC_CIPHER_ALGORITHM_INFO (see Section 7.5.1.4). The type for this Parameter IDs is defined by the following extended IDL:

```
@extensibility (APPENDABLE)

struct ParticipantSecuritySymmetricCipherAlgorithmInfo  {
    CryptoAlgorithmSet   supported_mask;
    CryptoAlgorithmSet   builtin_endpoints_required_mask;
    CryptoAlgorithmSet   builtin_kx_endpoints_required_mask;
    CryptoAlgorithmSet   user_endpoints_default_required_mask;
};
```

The ***supported_mask*** shall contain all the algorithms the SPIs is able to use to decrypt messages or validate authentication tags.

The ***builtin_endpoints_required_mask*** shall contain all the algorithms the the SPIs of other participants must support in order to interoperate with all the builtin endpoints, except for the DCPSParticipantVolatileMessageSecure builtin Topic (see 7.5.4).

The ***builtin_kx_endpoints_required_mask*** shall contain all the algorithms the SPIs of other participants must support in order to interoperate with all the DCPSParticipantVolatileMessageSecure builtin Topic (see 7.5.4). This is the builtin topic used to send cryptographic material.

The ***user_endpoints_default_required_mask*** shall contain all the default algorithms that will be used by user-defined (non-builtin) endpoint. This default applies in case the Endpoint does not directly specify the algorithms it will use.

7.3.13.1 Compatibility

DDSSEC12-90 – Meeting CNSSP-15 security requirements

The ParticipantSecuritySymmetricCipherAlgorithmInfo of two participants P1 and P2 is compatible if and only if:

```
     CheckCryptoAlgorithmCompatibility (
         P2.supported_mask, P1.builtin_endpoints_required_mask)
AND  CheckCryptoAlgorithmCompatibility (
        P2.supported_mask, P1.builtin_kx_endpoints_required_mask)
AND  CheckCryptoAlgorithmCompatibility (
        P1.supported_mask, P2.builtin_endpoints_required_mask)
AND  CheckCryptoAlgorithmCompatibility (
        P1. supported_mask, P2.builtin_kx_endpoints_required_mask)
```

Note that the ***user_endpoints_default_required_mask*** is not considered for compatibility as it may be overridden for specific endpoints.

See subclause 7.3.10.1 for the definition of the CheckCryptoAlgorithmCompatibility function.

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

DomainParticipants with incompatible ParticipantSecuritySymmetricCipherAlgorithmInfo may not be able to decrypt messages sent by the other DomainParticipants. Likewise, they may not be able to validate the message authentication codes included in messages sent by the other DomainParticipant. However, if the encryption/authentication codes do not apply to the whole RTPS message, it may stil be able for the two Participants to communicate in certain “unprotected” Topics.

7.3.13.2 Default value

DDSSEC12-90 – Meeting CNSSP-15 security requirements

If the ParticipantSecuritySymmetricCipherAlgorithmInfo is not present in ParticipantBuiltinTopicData topic received from another Participant, the result shall be the same as if the value received had the members set as follows:

```
    supported_mask                         =   CBIT_AES128_GCM | CBIT_AES256_GCM
    builtin_endpoints_required_mask        =   CBIT_AES256_GCM
    builtin_kx_endpoints_required_mask     =   CBIT_AES256_GCM
    user_endpoints_default_required_mask   =   CBIT_AES256_GCM
```

See subclause 8.1,8.2 for the definition of the constants used above.

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This default value makes it possible to not send the ParticipantSecuritySymmetricCipherAlgorithmInfo in a common configuration that matches previous revisions of the specification.

7.3.14 ParticipantSecurityAlgorithmInfo

DDSSEC12-90 – Meeting CNSSP-15 security requirements

This type aggregates the information about the Cryptographic Algorithms supported and required by the Participant SPIs.

The type is defined by the following extended IDL:

```
@extensibility (APPENDABLE)
struct ParticipantSecurityAlgorithmInfo  {
    ParticipantSecurityDigitalSignatureAlgorithmInfo  digital_signature;
    ParticipantSecurityKeyEstablishmentAlgorithmInfo  key_establishment;
    ParticipantSecuritySymmetricCipherAlgorithmInfo   symmetric_cipher;
};
```

7.3.15 EndpointSecuritySymmetricCipherAlgorithmInfo

DDSSEC12-90 – Meeting CNSSP-15 security requirements

If the SPIs use symmetric ciphers for encryption or message authentication, then for two participants to communicate on a specific Topic the DataWriter and the DataReader of that Topic must be configured with compatible sets of algorithms.

To support propagation of this information as part of discovery, this specification defines a new parameter IDs for `PublicationBuiltinTopicData` and the `SubscriptionBuiltinTopicData` topic, `PID_ENDPOINT_SYMMETRIC_CIPHER_ALGORITHM_INFO` (see Section 7.5.1.5). The type for these Parameter IDs is defined by the following extended IDL:

```
@extensibility (APPENDABLE)
struct EndpointSecuritySymmetricCipherAlgorithmInfo  {
    CryptoAlgorithmSet  required_mask;
    @non_serialized
    CryptoAlgorithmSet  supported_mask;
};
```

The ***required_mask*** shall contain the algorithms the SPIs of other participants must support to interoperate with the Endpoint.

- If the Endpoint is a `DataWriter` then the ***required_mask*** shall contain all the algorithms that are used for encrypting/authenticating the data payload and submessages as well as the protocol-level messages sent to matched DataReaders (e.g. HB and GAP). This corresponds to the algorithms used in the Cryptographic plugin operations ***encode_serialized_payload*** and ***encode_datawriter_submessage*** when applied to that DataWriter.
- If the Endpoint is a `DataReader` then the ***required_mask*** shall contain the algorithms that are used for encrypting/authenticating the protocol-level messages sent to matched writers (e.g. ACKNACKs in the case of reliable DataReaders). This corresponds to the algorithms used in the following Cryptographic plugin ***encode_datareader_submessage*** operation when applied to that DataReader.

The ***supported_mask*** is included in the `PublicationBuiltinTopicData` to make the API more convenient for the user. The member is not serialized and is not included in the data sent with the `PID_ENDPOINT_SYMMETRIC_CIPHER_ALGORITHM_INFO`. The value of this member shall be set by the SPI implementations to match the ***supported_mask*** in the `ParticipantSecuritySymmetricCipherAlgorithmInfo` of the DomainParticipant that contains the Endpoint.

7.3.15.1 Compatibility

The `EndpointSecuritySymmetricCipherAlgorithmInfo` of endpoint E1 belonging to DomainParticipant P1 is compatible with that of endpoint E2 belonging to DomainParticipant P2 if and only if:

```
     CheckCryptoAlgorithmCompatibility (
         P2.symmetric_cipher.supported_mask, E1.required_mask)
AND  CheckCryptoAlgorithmCompatibility (
         P1.symmetric_cipher.supported_mask, E2.required_mask)
```

See subclause 7.3.10.1 for the definition of the `CheckCryptoAlgorithmCompatibility` function.

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7.3.15.2 Default value

If the EndpointSecuritySymmetricCipherAlgorithmInfo is not present in a PublicationBuiltinTopicData or a SubscriptionBuiltinTopicData topic received from another DomainParticipant, the value shall be set to ***symmetric_cipher.user_endpoints_default_required_mask*** of the DomainParticipant that contains the Endpoint (see 7.3.13.2).
This default value makes it possible to not send the EndpointSecuritySymmetricCipherAlgorithmInfo if all the user endpoints use the same symmetric cipher algorithm.

7.3.16 EndpointSecurityAlgorithmInfo

DDSSEC12-90 – Meeting CNSSP-15 security requirements
This type aggregates the information about the Cryptographic Algorithms required by the Endpoint SPIs.
The type is defined by the following extended IDL:

```
@extensibility (APPENDABLE)
struct EndpointSecurityAlgorithmInfo  {
    EndpointSecuritySymmetricCipherAlgorithmInfo    symmetric_cipher;
};
```

7.3.17 CryptoTransformKeyRevision, CryptoTransformKeyRevisionIntHolder

DDSSEC12-122 – Provide mechanism for changing the session keys
The CryptoTransformKeyRevision provides a way to represent changes to Key Material. It is meant to be used withib the CryptoTransformKind class.
The generation of CryptoTransformKeyRevision is implementation-specific, but the format is defined for all implementations as follows:

```
typedef octet CryptoTransformKeyRevision[3];
#define  CRYPTO_TRANSFORM_KEY_REVISION_NONE    {0x00, 0x00, 0x00}
```

The type CryptoTransformKeyRevisionIntHolder provides a normalized way to hold a CryptoTransformKeyRevision as an int32 value.

```
typedef int32 CryptoTransformKeyRevisionIntHolder;
```

The representation of a CryptoTransformKeyRevision ***key_revision_value*** using a CryptoTransformKeyRevisionIntHolder ***int_holder_value*** uses the following encoding:

```
   int_holder_value = 256*256*transformation_key_revision_value[0]
           + 256*key_revision_value[1] + key_revision_value[2]
```

7.3.18 CryptoTransformKind

DDSSEC12-90 – Meeting CNSSP-15 security requirements
The CryptoTransformKind class provides the means to identify the type of cryptographic transformation performed on a applied on a message without an indication of the key material used.
The generation and interpretation of CryptoTransformKind is performed by the security plugins but the format is defined for all Cryptographic plugin implementations as follows:

DDSSEC12-122 – Provide mechanism for changing the session keys

```
@extensibility(FINAL)
struct CryptoTransformKind {
    CryptoTransformKeyRevision       transformation_key_revision;
    CryptoAlgorithmId                transformation_algorithm_id;
};

#define  CRYPTO_TRANSFORM_KIND_INVALID  {{0x00, 0x00, 0x00}, 0x00}
```

The value CRYPTO_TRANSFORM_KIND_INVALID is reserved to indicate an undefined or invalid transformation.

7.3.18.1 Attribute: transformation_key_revision

DDSSEC12-90 – Meeting CNSSP-15 security requirements
DDSSEC12-122 – Provide mechanism for changing the session keys
This attribute is used to support the change of the key material used by a DDS Entity. It is meant to be used in combination with a CryptoTransformKeyId. See 7.3.19 and 7.3.20.

7.3.18.2 Attribute: transformation_algorithm_id

DDSSEC12-90 – Meeting CNSSP-15 security requirements
Identifies the type of cryptographic transformation. That is, the algorithm, mode, padding, etc.
The CryptoAlgorithmId values used for the transformation_algorithm_id shall correspond to those assigned to Symmetric Cipher and MAC algorithms, see clause 8.

7.3.19 CryptoTransformKeyId

DDSSEC12-90 – Meeting CNSSP-15 security requirements
DDSSEC12-122 – Provide mechanism for changing the session keys
The CryptoTransformKeyId class provides a way to identify (lookup) the key material used to perform a cryptographic transformation. The CryptoTransformKeyId is not the key material itself, nor it is derived from the key material. It is simply an opaque value that helps create a unique "lookup" reference that can be associated with the key material that is exchanged by some other means.
The scope for the CryptoTransformKeyId is the DomainParticipant that generated the CryptoTransformKeyId.
When used as part of a CryptoTransformIdentifier, the CryptoTransformKeyId must be combined with the ***transformation_key_revision*** of the associated CryptoTransformKind to uniquely identify the KeyMaterial within the scope of the DomainParticipant GUID that generated it.
The generation of CryptoTransformKeyId is implementation-specific, but the format is defined for all implementations as follows:

```
typedef octet    CryptoTransformKeyId[4];
```

7.3.20 CryptoTransformIdentifier

DDSSEC12-90 – Meeting CNSSP-15 security requirements
The CryptoTransformIdentifier class uniquely identifies the transformation applied on the sending side (encoding) so that the receiver can locate the necessary key material and use the correct cryptographic algorithm, to perform the inverse transformation (decoding).

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The generation and interpretation of `CryptoTransformIdentifier` is performed by the `Cryptographic` plugin.

The structure of the `CryptoTransformIdentifier` is defined for all `Cryptographic` plugin implementations as follows:

```
@extensibility(FINAL)
struct CryptoTransformIdentifier {
    CryptoTransformKind   transformation_kind;
    CryptoTransformKeyId  transformation_key_id;
};
```

7.3.20.1 Attribute: transformation_kind

DDSSEC12-90 – Meeting CNSSP-15 security requirements

DDSSEC12-122 – Provide mechanism for changing the session keys

Identifies the type of cryptographic transformation. See 7.3.18 and provides key revision information. In combination with the ***transformation_key_id*** it allows the receiver to select the right cryptographic algorithm and key material to decode or validate a cryptographically encoded message.

DDSSEC12-122 – Provide mechanism for changing the session keys

The ***transformation_kind*** has two fields:

- transformation_algorithm_id
- transformation_key_revision

The ***transformation_algorithm_id*** identifies the Crytographic Algorithm used by the transformation. It shall contain one of the `CryptoAlgorithmId` values defined in Section 8 (Common Cryptographic Algorithms).

The ***transformation_key_revision*** value (see 7.3.17) shall be combined with the ***transformation_key_id*** attribute to identify the key material within the scope of the DomainParticipant GUID that generated the `CryptoTransformIdentifier`.

7.3.20.2 Attribute: transformation_key_id

DDSSEC12-90 – Meeting CNSSP-15 security requirements

DDSSEC12-122 – Provide mechanism for changing the session keys

Identifies the key material used to perform a cryptographic transformation.

The 3-tuple (***sender_participant_guid***, ***transformation_key_id***, ***transformation_key_revision***) uniquely identifies the Key Material within the scope of all Domain Participants that are communicating in a common DDS Domain. This allows receivers to be robust to dynamic changes in keys and key material: The receiver can either identify the correct key material or else detect that it does not have it.

The 2-tuple (***transformation_key_revision***, ***transformation_key_id***) uniquely identify the Key Material within the scope provided by the DDS `DomainParticipant` that creates the key material.

The values of the `transformation_key_id` are defined by the `Cryptographic` plugin implementation and understood only by that plugin.

7.3.21 PropertyQosPolicy, DomainParticipantQos, DataWriterQos, and DataReaderQos

This specification also introduces an additional Qos policy called `PropertyQosPolicy`, which is defined by the following extended IDL:

```
@extensibility(APPENDABLE)
```

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```
struct PropertyQosPolicy {
   PropertySeq        value;
   BinaryPropertySeq  binary_value;
};
```

The `PropertyQosPolicy` applies to the following DDS entities: `DomainParticipant`, `DataWriter`, and `DataReader`. To allow configuration of this policy from the DDS API the DDS Security specification extends the definitions of the DDS defined types `DomainParticipantQos`, `DataWriterQos`, and `DataReaderQos` with the additional member "property" of type `PropertyQosPolicy` as indicated in the extended IDL snippets below.

This specification also introduces a Qos policy called `DataTagQosPolicy`, defined by the following IDL:

DDSSEC12-29 - Specify DDS Security uses XCDR serialization version 1

```
@extensibility(FINAL)
struct Tag {
    string name;
    string value;
};

typedef sequence<Tag> TagSeq;

@extensibility(APPENDABLE)
struct DataTags {
    TagSeq tags;
};

typedef DataTags DataTagQosPolicy;

@extensibility(MUTABLE)
struct DomainParticipantQos {
   // Existing policies from the DDS specification
   PropertyQosPolicy  property;
};
@extensibility(MUTABLE)
struct DataWriterQos {
   // Existing policies from the DDS specification
   PropertyQosPolicy  property;
   DataTagQosPolicy   data_tags;
};

@extensibility(MUTABLE)
struct DataReaderQos {
   // Existing policies from the DDS specification
   PropertyQosPolicy  property;
   DataTagQosPolicy   data_tags;
};
```

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The `PropertyQosPolicy` shall be propagated via DDS discovery so it appears in the `ParticipantBuiltinTopicData`, `PublicationBuiltinTopicData`, and `SubscriptionBuiltinTopicData` (see 7.5.1.3, 7.5.1.7, and 7.5.1.8). This is used by the plugins to check configuration compatibility. Not all name/value pairs within the underlying `PropertySeq` and `BinaryPropertySeq` are propagated. Specifically only the ones with propagate=TRUE are propagated via DDS discovery and shall appear in the `ParticipantBuiltinTopicData`, `PublicationBuiltinTopicData`, and `SubscriptionBuiltinTopicData`.

7.3.22 ParticipantGenericMessage

This specification introduces additional builtin `DataWriter` and `DataReader` entities used to send generic messages between the participants. To support these entities, this specification uses a general-purpose data type called `ParticipantGenericMessage`, which is defined by the following extended IDL:
DDSSEC12-29 - Specify DDS Security uses XCDR serialization version 1

```
typedef octet[16] GUID_t;
@extensibility(FINAL)
struct MessageIdentity {
   GUID_t source_guid;
   long long sequence_number;
};

typedef string<> GenericMessageClassId;

@extensibility(APPENDABLE)
struct ParticipantGenericMessage {
   /* target for the request. Can be GUID_UNKNOWN */
   MessageIdentity message_identity;
   MessageIdentity related_message_identity;
   GUID_t destination_participant_guid;
   GUID_t destination_endpoint_guid;
   GUID_t source_endpoint_guid;
   GenericMessageClassId   message_class_id;
   DataHolderSeq           message_data;
};
```

The type `GUID_t` refers to the type defined in the DDS-RTPS specification [2]. See clause 7.4.3 for additional details on the `GUID_t`.
DDSSEC12-90 – Meeting CNSSP-15 security requirements

7.3.23 ParticipantSecurityProtectionInfo

This specification introduces a new set of participant security attributes, described in Section 9.4.2.4.
DDSSEC12-90 – Meeting CNSSP-15 security requirements
DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
In order to communicate securely, two participants need to have a compatible configuration for participant security attributes. To support making matching decisions upon discovering a remote participant, this specification defines a new parameter ID for ***ParticipantBuiltinTopicData*** topic, PID_PARTICIPANT_SECURITY_PROTECTION_INFO (see Section 7.5.1.4). The type for that Parameter IDs is defined by the following extended IDL:
DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

```
typedef unsigned long ParticipantSecurityAttributesMask;
typedef unsigned long PluginParticipantSecurityAttributesMask;
struct ParticipantSecurityAttributesMaskExt {
    unsigned short  is_set;
    unsigned short  value;
};
@extensibility (APPENDABLE)
struct ParticipantSecurityProtectionInfo {
  ParticipantSecurityAttributesMask       participant_security_attributes;
  PluginParticipantSecurityAttributesMask
                                  plugin_participant_security_attributes;
```

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```
  ParticipantSecurityAttributesMaskExt
                                   participant_security_optional_attributes;
};
#define  PARTICIPANT_SECURITY_ATTRIBUTES_FLAG_IS_VALID (0x1 << 31)
```

The default value for the info `ParticipantSecurityInfo` sets both masks to zero:

```
#define  PARTICIPANT_SECURITY_ATTRIBUTES_INFO_DEFAULT {0, 0}
```

DDSSEC12-90 – Meeting CNSSP-15 security requirements

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

A compatible configuration is defined as having the same value for the `participant_security_attributes` and the `plugin_participant_security_attributes`, except that when comparing two masks the most significant bit is interpreted in a special manner as described below.

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Deleted: of the attributes in the `ParticipantSecurityProtectionInfo`

The most-significant bit of `PluginParticipantSecurityAttributesMask` and `ParticipantSecurityAttributesMask` is called the ***is_valid*** bit and specifies whether the rest of the mask is valid. If the ***is_valid*** is set to zero on either of the masks, the comparison between the local and remote setting for the `ParticipantSecurityProtectionInfo` shall ignore the attribute. This allows new implementations to be backwards compatible with old implementations by either not sending the `ParticipantSecurityProtectionInfo` (the default value of zero has ***is_valid***=0) or sending it with ***is_valid*** set to 0.

The value of the ***plugin_participant_security_attributes*** shall be defined the security plugin implementation and are opaque to the DDS middleware (other than the ***is_valid*** bit). They allow the middleware to make matching decisions using the `PluginParticipantSecurityAttributesMask` without interpreting it. The definition for the builtin plugins is detailed in clause 10.4.2.3.

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

Two participants that don't have compatible configurations shall not attempt authentication and each participant shall consider the other participant as an "unauthenticated participant." Depending on the configuration these participants can still match each other and communicate with other on a reduced set of Topics that are allowed to be exchange among unauthenticated Participants.

The `participant_security_optional_attributes` encode configuration information about the plugin that does not need to be set consistently for two Participants to authenticate. Therefore, it is not considered as part of the "compatible configuration" definition above. The `participant_security_optional_attributes` contain two masks: The `is_set` mask indicates whether the corresponding bit in the `value` mask is set. The interpretation of each bit is specified in clause 9.4.2.5.

7.3.24 EndpointSecurityProtectionInfo

DDSSEC12-90 - Meeting CNSSP-15 security requirements

This specification defines a plugin-independent endpoint security attributes, described in clause 9.4.2.7. Additionally, plugin implementations can also have their own plugin-specific attributes, see clause 10.4.2.5.

In order to communicate, two endpoints need to have a compatible configuration for endpoint security attributes.

To support making matching decisions upon discovering a remote endpoint, this specification defines a new parameter ID for ***PublicationBuiltinTopicData*** and ***SubscriptionBuiltinTopicData*** topics, `PID_ENDPOINT_SECURITY_PROTECTION_INFO` (see Section 7.5.1.5). The type for that Parameter IDs is defined by the following extended IDL:

```
typedef unsigned long EndpointSecurityAttributesMask;
typedef unsigned long PluginEndpointSecurityAttributesMask;

@extensibility(APPENDABLE)
struct EndpointSecurityProtectionInfo {
  EndpointSecurityAttributesMask       endpoint_security_attributes;
  PluginEndpointSecurityAttributesMask plugin_endpoint_security_attributes;
};
#define  ENDPOINT_SECURITY_ATTRIBUTES_FLAG_IS_VALID (0x1 << 31)
```

The default value for the `EndpointSecurityInfo` is both attributes set to the value zero.

```
#define  ENDPOINT_SECURITY_ATTRIBUTES_INFO_DEFAULT {0, 0}
```

A compatible configuration is defined as having the same value for all of the attributes in the `EndpointSecurityInfo`, except that when comparing two masks the most significant bit is interpreted in a special manner as described below.

The most-significant bit of `PluginEndpointSecurityAttributesMask` and `EndpointSecurityAttributesMask` is called the ***is_valid*** bit and specifies whether the rest of the mask is valid. If the ***is_valid*** is set to zero on either of the masks, the comparison between the local and remote setting for the `EndpointSecurityInfo` shall ignore the attribute. This allows new implementations to be backwards compatible with old implementations by either not sending the `EndpointSecurityInfo` (the default value of zero has ***is_valid***=0) or sending it with ***is_valid*** bit set to zero in one or both attributes.

The value of the ***plugin_endpoint_security_attributes*** shall be defined by the security plugin implementation and is opaque to the DDS middleware (other than the ***is_valid*** bit). It allows the middleware to make matching decisions using the `PluginEndpointSecurityAttributesMask` without interpreting it. The definition for the builtin plugins is detailed in clause 10.4.2.5.

7.3.25 Additional DDS Return Code: NOT_ALLOWED_BY_SECURITY

The DDS specification defines a set of return codes that may be returned by the operations on the DDS API (see sub clause 7.1.1 of the DDS specification).

The DDS Security specification adds an additional return code NOT_ALLOWED_BY_SECURITY, which shall be returned by any operation on the DDS API that fails because the security plugins do not allow it.

7.4 Securing DDS Messages on the Wire

OMG DDS uses the Real-Time Publish-Subscribe (RTPS) on-the-wire protocol [2] for communicating data. The RTPS protocol includes specifications on how discovery is performed, the metadata sent during discovery, and all the protocol messages and handshakes required to ensure reliability. RTPS also specifies how messages are put together.

7.4.1 RTPS Background (Non-Normative)

In a secure system where efficiency and message latency are also considerations, it is necessary to define exactly what needs to be secured. Some applications may require only the data payload to be confidential and it is acceptable for the discovery information, as well as, the reliability meta-traffic (HEARTBEATs, ACKs, NACKs, etc.) to be visible, as long as it is protected from modification. Other applications may also want to keep the metadata (sequence numbers, in-line QoS) and/or the reliability traffic (ACKs, NACKs, HEARTBEATs) confidential. In some cases, the discovery information (who is publishing what and its QoS) may need to be kept confidential as well.

To help clarify these requirements, sub clause 7.4.1 explains the structure of the RTPS `Message` and the different `Submessages` it may contain.

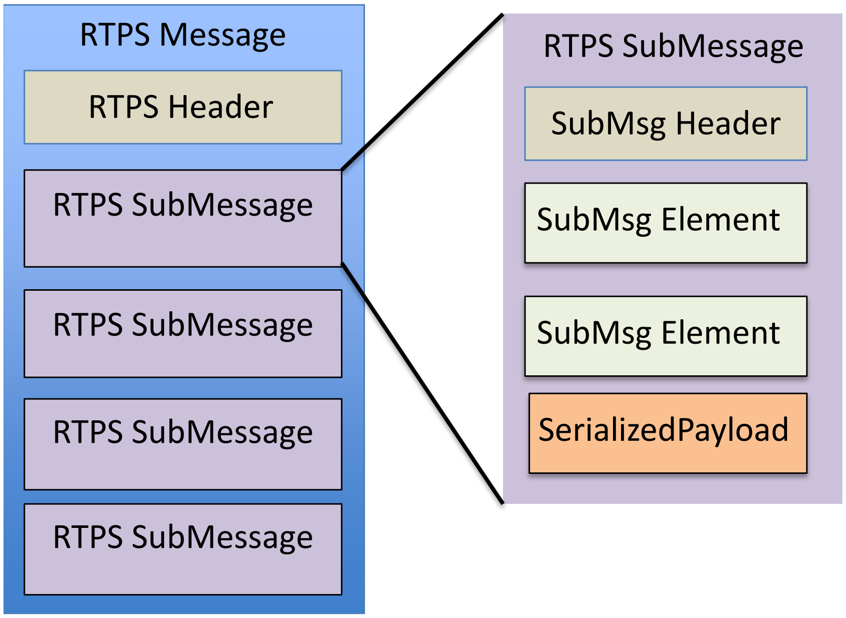

Figure 4 – RTPS message structure

An RTPS Message is composed of a leading RTPS `Header` followed by a variable number of RTPS `Submessages`. Each RTPS `Submessage` is composed of a `SubmessageHeader` followed by a variable number of `SubmessagElements`. There are various kinds of `SubmessageElements` to communicate things like sequence numbers, unique identifiers for DataReader and DataWriter entities, SerializedKeys or KeyHash of the application data, source timestamps, QoS, etc. There is one kind of `SubmessageElement` called `SerializedPayload` that is used to carry the data sent by DDS applications.

For the purposes of securing communications we distinguish three types of RTPS `Submessages`:

1. **DataWriter Submessages**. These are the RTPS submessages sent by a DataWriter to one or more DataReader entities. These include the `Data`, `DataFrag`, `Gap`, `Heartbeat`, and `HeartbeatFrag` submessages.
2. **DataReader Submessages.** These are the RTPS submessages sent by a DataReader to one or more DataWriter entities. These include the `AckNack` and `NackFrag` submessages.
3. **Interpreter Submessages.** These are the RTPS submessages that are destined to the Message Interpreter and affect the interpretation of subsequent submessages. These include all the "`Info`" messages.

The only RTPS submessages that contain application data are the `Data` and `DataFrag`. The application data is contained within the `SerializedPayload` submessage element. In addition to the `SerializedPayload` these submessages contain sequence numbers, inline QoS, the Key Hash, identifiers of the originating DataWriter and destination DataReader, etc.

The Data, and DataFrag submessages contain a ParameterList submessage element called ***inlineQos*** (see section 8.3.7 of the DDS-RTPS specification version 2.2). The ***inlineQos*** holds metadata associated with the submessage. It is encoded as a ParameterList (see section 9.4.2.11 of the DDS-RTPS specification version 2.2). ParameterList is a list of {parameterID, length, value} tuples terminated by a sentinel. One of these parameters is the KeyHash.

The KeyHash parameter may only appear in the Data and DataFrag submessages. Depending on the data type associated with the DataWriter that wrote the data, the KeyHash parameter contains either:

- A serialized representation of the values of all the attributes declared as 'key' attributes in the associated data type, or
- An MD5 hash computed over the aforementioned serialized key attributes.

Different RTPS Submessage within the same RTPS Message may originate on different DataWriter or DataReader entities within the DomainParticipant that sent the RTPS message.

It is also possible for a single RTPS Message to combine submessages that originated on different DDS DomainParticipant entities. This is done by preceding the set of RTPS Submessages that originate from a common DomainParticipant with an InfoSource RTPS submessage.

The RTPS header contains the version of the RTPS protocol composed of a Major Version and Minor Version numbers.

As specified in clause 8.6.1 of the DDS-RTPS specification, changes to the RTPS protocol that do not break interoperability should increase the Minor Version number. These changes include additional submessages, additional builtin-endpoints, and additional parameterIds. The DDS Security specification makes these kinds of changes to the RTPS protocol and therefore must increase the RTPS minor version number.

7.4.2 Secure RTPS Messages

Sub clause 7.1.1 identified the threats addressed by the DDS Security specification. To protect against the "Unauthorized Subscription" threat it is necessary to use encryption to protect the sensitive parts of the RTPS message.

Depending on the application requirements, it may be that the only thing that should be kept confidential is the content of the application data; that is, the information contained in the SerializedPayload RTPS submessage element. However, other applications may also consider the information in other RTPS SubmessageElements (e.g., sequence numbers, KeyHash, and unique writer/reader identifiers) to be confidential. So the entire Data (or DataFrag) submessage may need to be encrypted. Similarly, certain applications may consider other submessages such as Gap, AckNack, Heartbeat, HeartbeatFrag, etc. also to be confidential.

For example, a Gap RTPS Submessage instructs a DataReader that a range of sequence numbers is no longer relevant. If an attacker can modify or forge a Gap message from a DataWriter, it can trick the DataReader into ignoring the data that the DataWriter is sending.

To protect against "Unauthorized Publication" and "Tampering and Replay" threats, messages must be signed using secure hashes or digital signatures. Depending on the application, it may be sufficient to sign only the application data (SerializedPayload submessage element), the whole Submessage, and/or the whole RTPS Message.

To support different deployment scenarios, this specification uses a "message transformation" mechanism that gives the Security Plugin Implementations fine-grain control over which parts of the RTPS Message need to be encrypted and/or signed.

The Message Transformation performed by the Security Plugins transforms an RTPS Message into another RTPS Message. A new RTPS Header may be added and the content of the original RTPS Message may be encrypted, protected by a Secure Message Authentication Code (MAC), and/or signed. The MAC and/or signature can also include the RTPS Header to protect its integrity.

7.4.3 Constraints of the DomainParticipant GUID_t (GUID)

The DDS-RTPS specification [2] states that DDS DomainParticipant entities are identified by a unique 16-byte GUID with type GUID_t. In this DDS-Security specification the type GUID_t refers to the same type defined in clauses 8.4.2.1 and 9.3.1 of the DDS-RTPS specification [2]:

```
// From DDS-RTPS [2] clauses 8.4.2.1 and 9.3.1
typedef octet GuidPrefix_t[12];
struct EntityId_t {
    octet entityKey[3];
    octet entityKind;
};
struct GUID_t {
    GuidPrefix_t prefix;
    EntityId_t   entityId;
};
```

This DomainParticipant GUID is communicated as part of DDS Discovery in the ***SPDPdiscoveredParticipantData*** (see DDS-RTPS specification [2] clauses 8.5.3.2 and 9.3.1.3). Allowing a DomainParticipant to select its GUID arbitrarily would allow hostile applications to perform a “squatter” attack, whereby a DomainParticipant with a valid certificate could announce itself into the DDS Domain with the GUID of some other DomainParticipant. Once authenticated the “squatter” DomainParticipant would preclude the real DomainParticipant from being discovered, because its GUID would be detected as a duplicate of the already existing one.

To prevent the aforementioned “squatter” attack, this specification constrains the GUID that can be chosen by a DomainParticipant, so that it is tied to the Identity of the DomainParticipant. This is enforced by the Authentication plugin.

7.4.4 Mandatory use of the KeyHash for encrypted messages

The RTPS Data and DataFrag submessages can optionally contain the KeyHash as an inline Qos (see sub clause 9.6.3.3, titled “KeyHash (PID_KEY_HASH)”) of the DDS-RTPS specification version 2.3. In this sub clause it is specified that when present, the key hash shall be computed either as the serialized key or as an MD5 on the serialized key.

The key values are logically part of the data and therefore in situations where the data is considered sensitive the key should also be considered sensitive.

For this reason the DDS Security specification imposes additional constraints in the use of the key hash. These constraints apply only to the Data or DataFrag RTPS SubMessages where the SerializedPayload SubmessageElement is encrypted by the operation encode_serialized_payload of the CryptoTransform plugin:

(1) The KeyHash shall be included in the Inline Qos.

(2) The KeyHash shall be computed as the 128 bit MD5 Digest (IETF RFC 1321) applied to the CDR Big- Endian encapsulation of all the Key fields in sequence. Unlike the rule stated in sub clause 9.6.3.3 of the DDS specification, the MD5 hash shall be used regardless of the maximum-size of the serialized key.

These rules accomplish two objectives:

(1) Avoid leaking the value of the key fields in situations where the data is considered sensitive and therefore appears encrypted within the Data or DataFrag submessages.

(2) Enable the operation of infrastructure services without needed to leak to them the value of the key fields (see 7.1.1.4).

Note that the use of the MD5 hashing function for these purposes does not introduce significant vulnerabilities. While MD5 is considered broken as far as resistance to collisions (being able to find two inputs that result in an identical unspecified hash) there are still no known practical preimage attacks on MD5 (being able to find the input that resulted on a given hash).

7.4.5 Immutability of Publisher Partition Qos in combination with non-volatile Durability kind

The DDS specification allows the `PartitionQos` policy of a `Publisher` to be changed after the `Publisher` has been enabled. See sub clause 7.1.3 titled "Supported QoS) of the DDS 1.2 specification.
The DDS Security specification restricts this situation.
The DDS implementation shall not allow a `Publisher` to change `PartitionQos` policy after the `Publisher` has been enabled if it contains any `DataWriter` that meets the following two criteria:
DDSSEC12-49 – Mutability of PartitionQos

(1) The `TopicSecurityAttributes` for the `Topic` associated with the `DataWriter` have ***is_read_protected*** set to TRUE.

(2) The `DataWriter` has the `DurabilityQos` policy kind set to something other than `VOLATILE`.

This rule prevents data that was published while the `DataWriter` had associated a set of `Partitions` from being sent to `DataReaders` that were not matching before the `Partition` change and match after the `Partition` is changed.

7.4.6 Platform Independent Description

7.4.6.1 Change to the RTPS minor version number

Implementations of this specification shall set the RTPS protocol version number present in the RTPS Header. The RTPS Major version number shall be set to 2 and the RTPS Minor version number shall be set to 3. Future revisions of the DDS-RTPS specification shall take this fact into consideration.

7.4.6.2 RTPS Secure Submessage Elements

This specification introduces new RTPS `SubmessageElements` that may appear inside RTPS `Submessages`.

7.4.6.2.1 CryptoTransformIdentifier

DDSSEC12-90 - Meeting CNSSP-15 security requirements
The `CryptoTransformIdentifier` submessage element uniquely identifies the cryptographic transformation performed in the scope of the sending `DomainParticipant`. It contains information about the cryptographic algorithm used to transform an RTPS `Submessage` or an RTPS `SubmessageElement` and also provide a unique identifier of the key material used for the cryptographic transformation.

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The way in which attributes in the CryptoTransformIdentifier are set shall be specified for each Cryptographic plugin implementation. However, all Cryptographic plugin implementations shall be set in a way that allows the operations preprocess_secure_submsg, decode_datareader_submessage, decode_datawriter_submessage, and decode_serialized_payload to uniquely recognize the cryptographic material they shall use to decode the message, or recognize that they do not have the necessary key material.

7.4.6.2.2 CryptoContent

The CryptoContent submessage element is used to wrap a SerializedPayload, an RTPS Submessage, or a complete RTPS Message. It is the result of applying one of the encoding transformations on the CryptoTransform plugin.
The specific format of this shall be defined by each Cryptographic plugin implementation.

7.4.6.2.3 CryptoHeader

The CryptoHeader submessage element is used as prefix to wrap a SerializedPayload, an RTPS Submessage, or a complete RTPS Message. It is the result of applying one of the encoding transformations on the CryptoTransform plugin.
DDSSEC12-90 - Meeting CNSSP-15 security requirements
The CryptoHeader submessage element shall extend the CryptoTransformIdentifier element. Consequently, the leading bytes in the CryptoHeader shall encode the CryptoTransformIdentifier, which in turn contains the CryptoTransformKind containing the CryptoAlgorithmId (see 8), allowing the proper identification of the cryptographic algorithm used. The specific format of this shall be defined by each Cryptographic plugin implementation.

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7.4.6.2.4 CryptoFooter

The CryptoFooter submessage element is used as postfix to wrap a SerializedPayload, an RTPS Submessage, or a complete RTPS Message. It is the result of applying one of the encoding transformations on the CryptoTransform plugin.
The specific format of this shall be defined by each Cryptographic plugin implementation.

7.4.6.3 RTPS Submessage: SecureBodySubMsg

This specification introduces a new RTPS submessage: SecureBodySubMsg. The format of the SecureBodySubMsg complies with the RTPS SubMessage format mandated in the RTPS specification. It consists of the RTPS SubmessageHeader followed by a set of RTPS SubmessageElement elements.
Since the SecureBodySubMsg conforms to the general structure of RTPS submessages, it can appear inside a well-formed RTPS message.

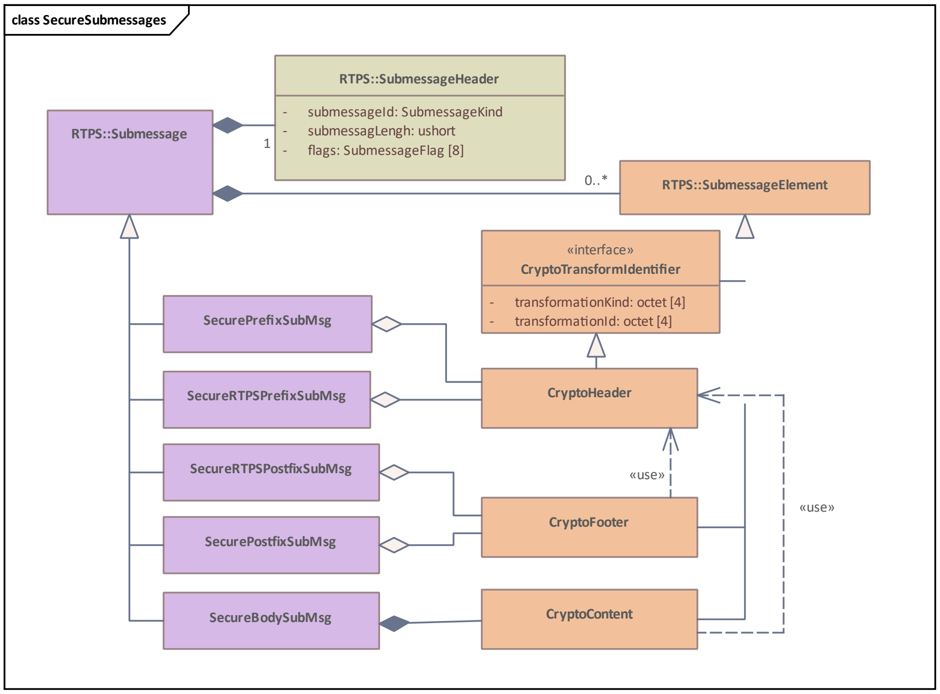

Figure 5 – Secure Submessage and Secured Payload Model

7.4.6.3.1 Purpose

The `SecureBodySubMsg` submessage is used to wrap one or more regular RTPS submessages in such a way that their contents are secured via encryption, message authentication, and/or digital signatures.

7.4.6.3.2 Content

The elements that form the structure of the RTPS `SecureBodySubMsg` are described in the table below.

Table 4 – SecureBodySubMsg class

Element	Type	Meaning
SEC_BODY	SubmessageKind	The presence of this field is common to RTPS submessages. It identifies the kind of submessage. The value indicates it is a SecureBodySubMsg.
submessageLength	ushort	The presence of this field is common to RTPS submessages. It identifies the length of the submessage.
EndianessFlag	SubmessageFlag	Appears in the Submessage header flags. Indicates endianess.
crypto_content	CryptoContent	Contains the result of transforming the original message. Depending on the plugin implementation and configuration, it may contain encrypted content, message access codes, and/or digital signatures.

7.4.6.3.3 Validity

The RTPS `Submessage` is invalid if the ***submessageLength*** in the Submessage header is too small.

7.4.6.3.4 Logical Interpretation

The `SecureBodySubMsg` provides a way to secure content inside a legal RTPS submessage.
A `SecureBodySubMsg` may wrap a single RTPS `Submessage` or a whole RTPS `Message`.

7.4.6.4 RTPS Submessage: SecurePrefixSubMsg

This specification introduces the RTPS submessage: `SecurePrefixSubMsg`. The format of the `SecurePrefixSubMsg` complies with the RTPS `SubMessage` format mandated in the RTPS specification. It consists of the RTPS `SubmessageHeader` followed by a set of RTPS `SubmessageElement` elements.

7.4.6.4.1 Purpose

The `SecurePrefixSubMsg` submessage is used as prefix to wrap an RTPS submessage in such a way that its contents are secured via encryption, message authentication, and/or digital signatures.

7.4.6.4.2 Content

The elements that form the structure of the RTPS `SecurePrefixSubMsg` are described in the table below.

Table 5 – SecurePrefixSubMsg class

Element	Type	Meaning
SEC_PREFIX	SubmessageKind	The presence of this field is common to RTPS submessages. It identifies the kind of submessage. The value indicates it is a SecurePrefixSubMsg.
submessageLength	ushort	The presence of this field is common to RTPS submessages. It identifies the length of the submessage.
EndianessFlag	SubmessageFlag	Appears in the Submessage header flags. Indicates endianess.
transformation_id	CryptoTransformIdentifier	Identifies the kind of transformation performed on the RTPS submessage that follows it.
plugin_crypto_header_extra	octet[]	Provides further information on the transformation performed. The contents are specific to the Plugin Implementation and the value of the transformation_id.

7.4.6.4.3 Validity

The RTPS `Submessage` is invalid if the ***submessageLength*** in the Submessage header is too small.

7.4.6.4.4 Logical Interpretation

The `SecurePrefixSubMsg` provides a way to prefix secure content inside a legal RTPS submessage.
A `SecurePrefixSubMsg` shall be followed by a single RTPS `Submessage` which itself shall be followed by a `SecurePostfixSubMsg`.

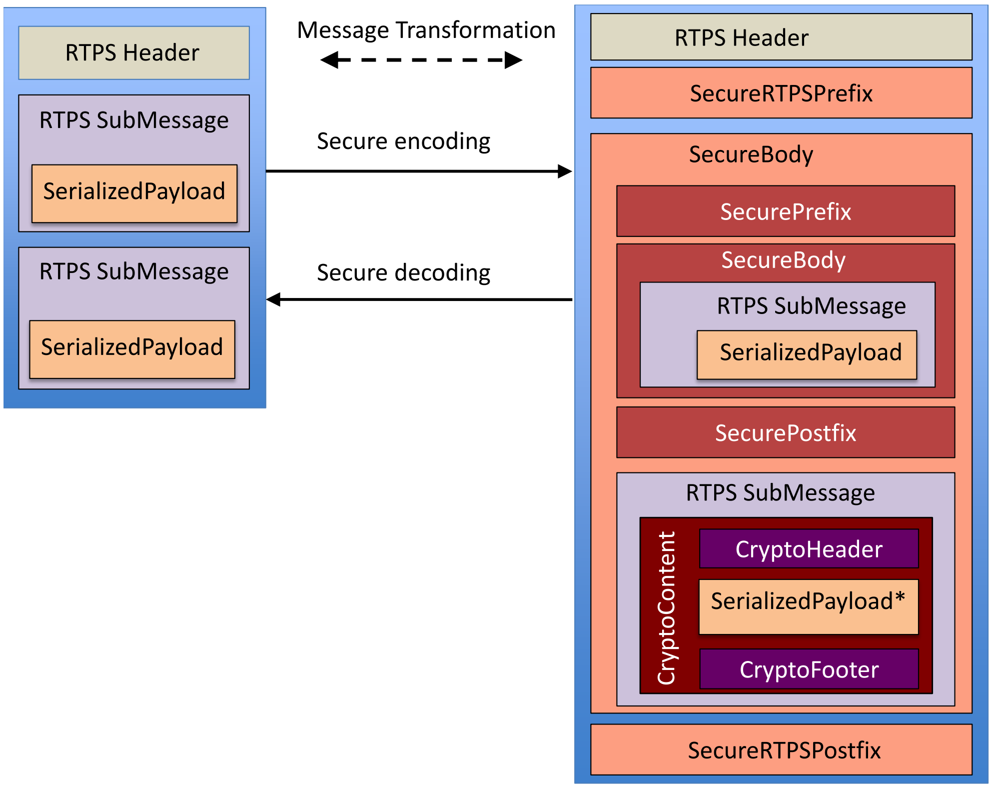

Figure 6 – RTPS message transformations

7.4.6.5 RTPS Submessage: SecurePostfixSubMsg

This specification introduces the RTPS submessage: `SecurePostfixSubMsg`. The format of the `SecurePostfixSubMsg` complies with the RTPS `SubMessage` format mandated in the RTPS specification. As such it consists of the RTPS `SubmessageHeader` followed by a set of RTPS `SubmessageElement` elements.

7.4.6.5.1 Purpose

The `SecurePostfixSubMsg` submessage is used to authenticate the RTPS Submessage that precedes it.

7.4.6.5.2 Content

The elements that form the structure of the RTPS `SecurePostfixSubMsg` are described in the table below.

Table 6 – SecurePostfixSubMsg class

Element	Type	Meaning
SEC_POSTFIX	SubmessageKind	The presence of this field is common to RTPS submessages. It identifies the kind of submessage. The value indicates it is a SecurePostfixSubMsg.
submessageLength	ushort	The presence of this field is common to RTPS submessages. It identifies the length of the submessage.
EndianessFlag	SubmessageFlag	Appears in the Submessage header flags. Indicates endianess.
crypto_footer	CryptoFooter	Provides information on the results of the transformation performed, typically a list of authentication tags. The contents are specific to the Plugin Implementation and the value of the transformation_id contained on the related SecurePrefixSubMsg.

7.4.6.5.3 Validity

The RTPS `Submessage` is invalid if the ***submessageLength*** in the Submessage header is too small. The RTPS `Submessage` is invalid if there is no `SecurePrefixSubMsg`. Immediately before the RTPS submessage that precedes the `SecurePostfixSubMsg`. This `SecurePrefixSubMsg` is referred to as the *related* the `SecurePrefixSubMsg`.

7.4.6.5.4 Logical Interpretation

The `SecurePostfixSubMsg` provides a way to authenticate the validity and origin of the RTPS SubMessage that precedes the `SecurePrefixSubMsg`. The Cryptographic transformation applied is identified in the *related* `SecurePrefixSubMsg`.

7.4.6.6 RTPS Submessage: SecureRTPSPrefixSubMsg

This specification introduces the RTPS submessage: `SecureRTPSPrefixSubMsg`. The format of the `SecurePrefixSubMsg` complies with the RTPS `SubMessage` format mandated in the RTPS specification. It consists of the RTPS `SubmessageHeader` followed by a set of RTPS `SubmessageElement` elements.

7.4.6.6.1 Purpose

The `SecureRTPSPrefixSubMsg` submessage is used as prefix to wrap a complete RTPS message in such a way that its contents are secured via encryption, message authentication, and/or digital signatures.

7.4.6.6.2 Content

The elements that form the structure of the RTPS `SecureRTPSPrefixSubMsg` are described in the table below.
DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

Table 7 – SecureRTPSPrefixSubMsg class

Element	Type	Meaning
SRTPS_PREFIX	SubmessageKind	The presence of this field is common to RTPS submessages. It identifies the kind of submessage. The value indicates it is a SecureRTPSPrefixSubMsg.
submessageLength	ushort	The presence of this field is common to RTPS submessages. It identifies the length of the submessage.
EndianessFlag (E) E = SubmessageHeader.flags & 0x01	SubmessageFlag	Appears in the Submessage header flags. Indicates endianness.
AdditionalAuthenticatedDataFlag (A) A = SubmessageHeader.flags & 0x02	SubmessageFlag	Appears in the Submessage header flags. Indicates that the RTPS Header and HeaderExtension are also protected as "Additional Authenticated Data (AAD)".
PreSharedKeyFlag (P) P = SubmessageHeader.flags & 0x04	SubmessageFlag	Appears in the Submessage header flags. Indicates that the RTPS message is protected using a Pre-Shared-Key
transformation_id	CryptoTransformIdentifier	Identifies the kind of transformation performed on the RTPS submessages that follow up to the SRTPS_POSTFIX submessage.
plugin_crypto_header_extra	octet[]	Provides further information on the transformation performed. The contents are specific to the Plugin Implementation and the value of the transformation_id.

7.4.6.6.3 Validity

The RTPS `Submessage` is invalid if the ***submessageLength*** in the Submessage header is too small.
The `SecureRTPSPrefixSubMsg` shall immediately follow the RTPS Header.

7.4.6.6.4 Logical Interpretation

The `SecureRTPSPrefixSubMsg` provides a way to prefix a list of RTPS Submessages so that they can be secured.
A `SecureRTPSPrefixSubMsg` shall be followed by a list of RTPS `Submessages` which themselves shall be followed by a `SecureRTPSPostfixSubMsg`.

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If the ***AdditionalAuthenticatedDataFlag*** is set the authentication tag(s) present in the `SecureRTPSPostfixSubMsg` include also the RTPS `Header` and RTPS `HeaderExtension` as "Additional Authenticated Data" (AAD).

7.4.6.7 RTPS Submessage: SecureRTPSPostfixSubMsg

This specification introduces the RTPS submessage: `SecureRTPSPostfixSubMsg`. The format of the `SecureRTPSPostfixSubMsg` complies with the RTPS `SubMessage` format mandated in the RTPS specification. As such it consists of the RTPS `SubmessageHeader` followed by a set of RTPS `SubmessageElement` elements.

7.4.6.7.1 Purpose

The `SecureRTPSPostfixSubMsg` submessage is used to authenticate the RTPS Submessages that appear between the preceeding `SecureRTPSPostfixSubMsg` and the `SecureRTPSPostfixSubMsg`.

7.4.6.7.2 Content

The elements that form the structure of the `SecureRTPSPostfixSubMsg` are described in the table below.

Table 8 – SecurePostfixSubMsg class

Element	Type	Meaning
SRTPS_POSTFIX	SubmessageKind	The presence of this field is common to RTPS submessages. It identifies the kind of submessage. The value indicates it is a SecureRTPSPostfixSubMsg.
submessageLength	ushort	The presence of this field is common to RTPS submessages. It identifies the length of the submessage.
EndianessFlag	SubmessageFlag	Appears in the Submessage header flags. Indicates endianess.
crypto_footer	CryptoFooter	Provides information on the results of the transformation performed, typically a list of authentication tags. The contents are specific to the Plugin Implementation and the value of the transformation_id contained on the related SecureRTPSPrefixSubMsg.

7.4.6.7.3 Validity

The RTPS `Submessage` is invalid if the ***submessageLength*** in the Submessage header is too small.
The RTPS `SecureRTPSPostfixSubMsg` is invalid if there is no `SecureRTPSPrefixSubMsg` following the RTPS Header. This `SecureRTPSPrefixSubMsg` is referred to as the *related* `SecureRTPSPrefixSubMsg`.

7.4.6.7.4 Logical Interpretation

The `SecureRTPSPostfixSubMsg` provides a way to authenticate the validity and origin of the list of RTPS Submessages between the related `SecureRTPSPrefixSubMsg` and the `SecureRTPSPrefixSubMsg`. The Cryptographic transformation applied is identified in the *related* `SecureRTPSPrefixSubMsg`.

7.4.7 Mapping to UDP/IP PSM

The DDS-RTPS specification defines the RTPS protocol in terms of a platform-independent model (PIM) and then maps it to a UDP/IP transport PSM (see clause 9, "Platform Specific Model (PSM): UDP/IP" of the DDS-RTPS specification [2]).
Sub clause 7.4.7 does the same thing for the new RTPS submessage elements and submessages introduced by the DDS Security specification.

7.4.7.1 Mapping of the EntityIds for the Builtin DataWriters and DataReaders

DDSSEC12-86 - Secure TypeLookup Built-In Endpoints

Sub clause 7.5 defines the RTPS Built-In Entities added by the DDS Security specification. The corresponding EntityIds used when these endpoints are used on the UDP/IP PSM are given in the table below.

Deleted: a set of builtin Topics and corresponding DataWriter and DataReader entities that shall be present on all compliant implementations of the

Table 9 – EntityId values for secure builtin data writers and data readers

Entity	EntityId_t name	EntityId_t value
SEDPbuiltinPublicationsSecureWriter	ENTITYID_SEDP_BUILTIN_PUBLICATIONS_SECURE_WRITER	{{ff, 00, 03}, c2}
SEDPbuiltinPublicationsSecureReader	ENTITYID_SEDP_BUILTIN_PUBLICATIONS_SECURE_READER	{{ff, 00, 03}, c7}
SEDPbuiltinSubscriptionsSecureWriter	ENTITYID_SEDP_BUILTIN_SUBSCRIPTIONS_SECURE_WRITER	{{ff, 00, 04}, c2}
SEDPbuiltinSubscriptionsSecureReader	ENTITYID_ SEDP_BUILTIN_ SUBSCRIPTIONS_SECURE_READER	{{ff, 00, 04}, c7}
BuiltinParticipantMessageSecureWriter	ENTITYID_P2P_BUILTIN_PARTICIPANT_MESSAGE_SECURE_WRITER	{{ff, 02, 00}, c2}
BuiltinParticipantMessageSecureReader	ENTITYID_P2P_BUILTIN_PARTICIPANT_MESSAGE_SECURE_READER	{{ff, 02, 00}, c7}
BuiltinParticipantStatelessMessageWriter	ENTITYID_P2P_BUILTIN_PARTICIPANT_STATELESS_WRITER	{{00, 02, 01}, c3}
BuiltinParticipantStatelessMessageReader	ENTITYID_P2P_BUILTIN_PARTICIPANT_STATELESS_READER	{{00, 02, 01}, c4}
BuiltinParticipantVolatileMessageSecureWriter	ENTITYID_P2P_BUILTIN_PARTICIPANT_VOLATILE_SECURE_WRITER	{{ff, 02, 02}, c3}
BuiltinParticipantVolatileMessageSecureReader	ENTITYID_P2P_BUILTIN_PARTICIPANT_VOLATILE_SECURE_READER	{{ff, 02, 02}, c4}
SPDPbuiltinParticipantsSecureWriter	ENTITYID_SPDP_RELIABLE_BUILTIN_PARTICIPANT_SECURE_WRITER	{{ff, 01, 01}, c2}
SPDPbuiltinParticipantsSecureReader	ENTITYID_SPDP_RELIABLE _BUILTIN_PARTICIPANT_SECURE_READER	{{ff, 01, 01}, c7}
TypeLookupServiceRequestSecureWriter	ENTITYID_TL_SVC_REQ_SECURE_WRITER	{{ff, 03, 00}, c3}
TypeLookupServiceRequestSecureReader	ENTITYID_TL_SVC_REQ_SECURE_READER	{{ff, 03, 00}, c4}
TypeLookupServiceReplySecureWriter	ENTITYID_TL_SVC_REPLY_SECURE_WRITER	{{ff, 03, 01}, c3}
TypeLookupServiceReplySecureReader	ENTITYID_TL_SVC_REPLY_SECURE_READER	{{ff, 03, 01}, c4}

7.4.7.2 Mapping of the CryptoTransformIdentifier Type

DDSSEC12-90 - Meeting CNSSP-15 security requirements

The UDP/IP PSM maps the `CryptoTransformIdentifier` to the IDL definition in 7.3.20.

7.4.7.3 Mapping of the CryptoHeader SubmessageElement

A `CryptoHeader SubmessageElement` contains the information that identifies a cryptographic transformation. The `CryptoHeader` shall start with the `CryptoTransformIdentifier` and be followed by a plugin-specific ***plugin_crypto_header_extra*** returned by the encoding transformation. The UDP/IP PSM maps the `CryptoHeader` to the following extended IDL structure:

DDSSEC12-29 - Specify DDS Security uses XCDR serialization version 1

```
@extensibility(FINAL)
struct CryptoHeader : CryptoTransformIdentifier  {
    // Extra plugin-specific information added below
    // CryptoHeader   plugin_crypto_header_extra;
};
```

The UDP/IP wire representation for the `CryptoHeader` shall be:

DDSSEC12-90 - Meeting CNSSP-15 security requirements

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Deleted: structure
Deleted: 7.3.207.3.207.3.19
Deleted: :
Deleted: @extensibility(FINAL)¶
struct CryptoTransformIdentifier {¶
octet transformation_kind[4];¶
octet transformation_key_id[4];¶
};
Deleted: APPENDABLE

```
0...2...........8...............16.............24...............32
+---------------+---------------+---------------+---------------+
|               CryptoTransformationKind   transformation_kind  |
+---------------+---------------+---------------+---------------+
+               CryptoTransformKeyId   transformation_key_id    +
+---------------+---------------+---------------+---------------+
|                                                               |
~               octet  plugin_crypto_header_extra[]             ~
|                                                               |
+---------------+---------------+---------------+---------------+
```

Deleted: octet

Deleted: [4]

Deleted: octet

Deleted: [4]

7.4.7.4 Mapping of the CryptoFooter SubmessageElement

A `CryptoFooter` `SubmessageElement` contains the information that authenticates the result of a cryptographic transformation. The `CryptoFooter` contains a plugin-specific ***plugin_crypto_footer*** returned by the encoding transformation.
The UDP/IP wire representation for the `CryptoFooter` shall be:

```
0...2...........8...............16.............24...............32
+---------------+---------------+---------------+---------------+
|                                                               |
~                   octet  plugin_crypto_footer[]               ~
|                                                               |
+---------------+---------------+---------------+---------------+
```

7.4.7.5 SecureBodySubMsg Submessage

7.4.7.5.1 Wire Representation

The UDP/IP wire representation for the `SecureBodySubMsg` shall be:

```
0...2...........8...............16.............24...............32
+---------------+---------------+---------------+---------------+
| SEC_BODY      |X|X|X|X|X|X|X|E|     octetsToNextHeader        |
+---------------+---------------+---------------+---------------+
|                                                               |
+              CryptoContent  crypto_content                    +
|                                                               |
+---------------+---------------+---------------+---------------+
```

7.4.7.5.2 Submessage Id

The `SecureBodySubMsg` shall have the ***submessageId*** set to the value 0x30.

7.4.7.5.3 Flags in the Submessage Header

The `SecureBodySubMsg` only uses the EndiannessFlag.

7.4.7.6 SecurePrefixSubMsg Submessage

7.4.7.6.1 Wire Representation

The UDP/IP wire representation for the SecurePrefixSubMsg shall be:

```
0...2..........8...............16.............24...............32
+---------------+---------------+---------------+---------------+
| SEC_PREFIX    |X|X|X|X|X|X|X|E|      octetsToNextHeader       |
+---------------+---------------+---------------+---------------+
|                                                               |
+               CryptoHeader  crypto_header                     +
|                                                               |
+---------------+---------------+---------------+---------------+
```

7.4.7.6.2 Submessage Id

The SecurePrefixSubMsg shall have the ***submessageId*** set to the value 0x31 and referred by the symbolic name SEC_PREFIX.

7.4.7.6.3 Flags in the Submessage Header

The SecurePrefixSubMsg only uses the EndiannessFlag.

7.4.7.7 SecurePostfixSubMsg Submessage

7.4.7.7.1 Wire Representation

The UDP/IP wire representation for the SecurePostfixSubMsg shall be:

```
0...2..........8...............16.............24...............32
+---------------+---------------+---------------+---------------+
| SEC_POSTFIX   |X|X|X|X|X|X|X|E|      octetsToNextHeader       |
+---------------+---------------+---------------+---------------+
|                                                               |
+               CryptoFooter  crypto_footer                     +
|                                                               |
+---------------+---------------+---------------+---------------+
```

7.4.7.7.2 Submessage Id

The SecurePostfixSubMsg shall have the ***submessageId*** set to the value 0x32 and referred by the symbolic name SEC_POSTFIX.

7.4.7.7.3 Flags in the Submessage Header

The SecurePostfixSubMsg only uses the EndiannessFlag.

7.4.7.8 SecureRTPSPrefixSubMsg Submessage

7.4.7.8.1 Wire Representation

The UDP/IP wire representation for the SecureRTPSPrefixSubMsg shall be:

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

```
0...2..........8...............16.............24...............32
+---------------+---------------+---------------+---------------+
| SRTPS_PREFIX  |X|X|X|X|X|X|P|A|E|      octetsToNextHeader     |
+---------------+---------------+---------------+---------------+
```

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```
|                                                               |
+              CryptoHeader  crypto_header                      +
|                                                               |
+---------------+---------------+---------------+---------------+
```

7.4.7.8.2 Submessage Id

The `SecureRTPSPrefixSubMsg` shall have the ***submessageId*** set to the value 0x33 and referred by the symbolic name `SRTPS_PREFIX`.

7.4.7.8.3 Flags in the Submessage Header

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

The `SecureRTPSPrefixSubMsg` uses three flags:

- **EndiannessFlag** (E): Indicates endianness.
- **AdditionalAuthenticatedDataFlag** (A): Indicates that the RTPS message protection extends to the RTPS Header and RTPS HeaderExtension which are protected as "Additional Authenticated Data (AAD)".
- **PreSharedKeyFlag** (P): Indicates that the RTPS message is protected using a Pre-Shared-Key.

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7.4.7.9 SecureRTPSPostfixSubMsg Submessage

7.4.7.9.1 Wire Representation

The UDP/IP wire representation for the `SecureRTPSPostfixSubMsg` shall be:

```
0...2...........8...............16.............24...............32
+---------------+---------------+---------------+---------------+
| SRTPS_POSTFIX |X|X|X|X|X|X|X|E|     octetsToNextHeader        |
+---------------+---------------+---------------+---------------+
|                                                               |
+         CryptoFooter  crypto_footer                           +
|                                                               |
+---------------+---------------+---------------+---------------+
```

7.4.7.9.2 Submessage Id

The `SecureRTPSPostfixSubMsg` shall have the ***submessageId*** set to the value 0x34 and referred by the symbolic name `SRTPS_POSTFIX`.

7.4.7.9.3 Flags in the Submessage Header

The `SecureRTPSPostfixSubMsg` only uses the EndiannessFlag.

7.5 DDS Support for Security Plugin Information Exchange

In order to perform their function, the security plugins associated with different DDS `DomainParticipant` entities need to exchange information representing things such as Identity and Permissions of the `DomainParticipant` entities, authentication challenge messages, tokens representing key material, etc.

DDS already has several mechanisms for information exchange between `DomainParticipant` entities. Notably the builtin `DataWriter` and `DataReader` entities used by the Simple Discovery Protocol (see sub clause 8.5 of the DDS Interoperability Wire Protocol [2]) and the ***BuiltinParticipantMessageWriter*** and ***BuiltinParticipantMessageReader*** (see sub clause 9.6.2.1 of the DDS Interoperability Wire Protocol [2]).

Where possible, this specification tries to reuse and extend existing DDS concepts and facilities so that they can fulfill the needs of the security plugins, rather than defining entirely new ones. This way, the Security Plugin implementation can be simplified and it does not have to implement a separate messaging protocol.

7.5.1 Secure builtin Discovery Topics

7.5.1.1 Background (Non-Normative)

DDS discovery information is sent using builtin DDS `DataReaders` and `DataWriters`. These are regular DDS `DataReaders` and `DataWriters`, except they are always present in the system and their `Topic` names, associated data types, QoS, and RTPS `EntityIds` are all specified as part of the DDS and RTPS specifications, so they do not need to be discovered.

The DDS specification defines three discovery builtin `Topic` entities: the ***DCPSParticipants*** used to discover the presence of `DomainParticipants`, the ***DCPSPublications*** used to discover `DataWriters`, and the ***DCPSSubscriptions*** used to discover `DataReaders` (see sub clause 8.5 of the DDS Interoperability Wire Protocol [2]).

Much of the discovery information could be considered sensitive in secure DDS systems. Knowledge of things like the `Topic` names that an application is publishing or subscribing to could reveal sensitive information about the nature of the application. In addition, the integrity of the discovery information needs to be protected against tampering, since it could cause erroneous behaviors or malfunctions.

One possible approach to protecting discovery information would be to require that the discovery builtin `Topic` entities always be protected via encryption and message authentication. However, this would entail the problems explained below.

The ***DCPSParticipants*** builtin Topic is used to bootstrap the system, detect the presence of `DomainParticipant` entities, and kick off subsequent information exchanges and handshakes. It contains the bare minimum information needed to establish protocol communications (addresses, port numbers, version number, vendor IDs, etc.). If this `Topic` were protected, the Secure DDS system would have to create an alternative mechanism to bootstrap detection of other participants and gather the same information—which needs to happen prior to being able to perform mutual authentication and exchange of key material. This mechanism would, in essence, duplicate the information in the ***DCPSParticipants*** builtin `Topic`. Therefore, it makes little sense to protect the ***DCPSParticipants*** builtin `Topic`. A better approach is to augment the information sent using the ***DCPSParticipants*** builtin `Topic` with any additional data the Secure DDS system needs for bootstrapping communications (see 7.5.1.3).

Secure DDS systems need to co-exist in the same network and, in some cases, interoperate with non-secure DDS systems. There may be systems built using implementations compliant with the DDS Security specification, which do not need to protect their information. Or there may be systems implemented with legacy DDS implementations that do not support DDS Security. In this situation, the fact that a secure DDS implementation is present on the network should not impact the otherwise correct behavior of the non-secure DDS systems. In addition, even in secure systems not all Topics are necessarily sensitive, so it is desirable to provide ways to configure a DDS Secure system to have Topics that are "unprotected" and be able to communicate with non-secure DDS systems on those "unprotected" Topics.

To allow co-existence and interoperability between secure DDS systems and DDS systems that do not implement DDS security, secure DDS systems must retain the same builtin Topics as the regular DDS systems (with the same GUIDs, topics names, QoS, and behavior). Therefore, to protect the discovery and liveliness information of Topics that are considered sensitive, Secure DDS needs to use additional builtin discovery Topics protected by the DDS security mechanisms.

7.5.1.2 Extending the Data Types used by DDS Discovery

The DDS Interoperability Wire Protocol specifies the serialization of the data types used for the discovery of builtin Topics (***ParticipantBuiltinTopicData***, ***PublicationBuiltinTopicData***, and ***SubscriptionBuiltinTopicData)*** using a representation called a *ParameterList*. Although this description precedes the DDS-XTYPES specification, the serialization format matches the Extended CDR representation defined in DDS-XTYPES for data types declared with MUTABLE extensibility. This allows the data type associated with discovery topics to be extended without breaking interoperability.

Given that DDS-XTYPES formalized the *ParameterList* serialization approach, first defined in the DDS Interoperability and renamed it to “Extended CDR,” this specification will use the DDS Extensible Types notation to define the data types associated with the builtin Topics. This does not imply that compliance to the DDS-XTYPES is required to comply with DDS Security. All that is required is to serialize the specific data types defined here according to the format described in the DDS-XTYPES specification.

7.5.1.3 Reserved RTPS parameter IDs

This specification reserves the RTPS Simple Discovery Protocol ParameterIDs in the range: 0x1000 to 0x1FFF and 0x5000 to 0x5FFF.

The second interval covers the same range of parametersID, except they have the must-understand bit set.

This reserved range applies to RTPS version 2.3 (see 7.4.6.1) and higher minor revisions of RTPS. Future revisions of the DDS-RTPS specification shall take this fact into consideration.

7.5.1.4 Extension to RTPS Standard DCPSParticipants Builtin Topic

The DDS specification specifies the existence of the ***DCPSParticipants*** builtin `Topic` and a corresponding builtin `DataWriter` and `DataReader` to communicate this `Topic`. These endpoints are used to discover `DomainParticipant` entities.

The data type associated with the ***DCPSParticipants*** builtin `Topic` is ***ParticipantBuiltinTopicData***, defined in sub clause 7.1.5 of the DDS specification [1].

The DDS Interoperability Wire Protocol specifies the serialization of ***ParticipantBuiltinTopicData.*** The format used is what the DDS Interoperability Wire Protocol calls a *ParameterList* whereby each member of the ***ParticipantBuiltinTopicData*** is serialized using CDR but preceded in the stream by the serialization of a short ParameterID identifying the member, followed by another short containing the length of the serialized member, followed by the serialized member. See sub clause 8.3.5.9 of the DDS Interoperability Wire Protocol [2]. This serialization format allows the ***ParticipantBuiltinTopicData*** to be extended without breaking interoperability.

This DDS Security specification adds several new members to the ***ParticipantBuiltinTopicData*** structure. The member types and the ***ParameterIDs*** used for the serialization are described below.

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Table 10 – Additional parameter IDs in ParticipantBuiltinTopicData

Member name	*Member type*	*Parameter ID name*	*Parameter ID value*
identity_token	IdentityToken (see 7.3.5)	PID_IDENTITY_TOKEN	0x1001
permissions_token	PermissionsToken (see 7.3.5)	PID_PERMISSIONS_TOKEN	0x1002
property	PropertyQosPolicy	PID_PROPERTY_LIST (See Table 9.12 of DDS-RTPS)	0x0059 (See Table 9.12 of DDS-RTPS)
protection_info	ParticipantSecurityProtectionInfo (see 7.3.23)	PID_PARTICIPANT_SECURITY_PROTECTION_INFO	0x1005
available_builtin_endpoints_ext	AvailableBuiltinEndpointsExtSet_t	PID_AVAILABLE_BUILTIN_ENDPOINTS_EXT	0x1007
digital_signature	ParticipantSecurityDigitalSignatureAlgorithmInfo (see 7.3.11)	PID_PARTICIPANT_SECURITY_DIGITAL_SIGNATURE_ALGORITHM_INFO	0x1010
key_establishment	ParticipantSecurityKeyEstablishmentAlgorithmInfo (see 7.3.12)	PID_PARTICIPANT_SECURITY_KEY_ESTABLISHMENT_ALGORITHM_INFO	0x1011
symmetric_cipher	ParticipantSecuritySymmetricCipherAlgorithmInfo (see 7.3.13)	PID_PARTICIPANT_SECURITY_BUILTIN_EP_SYMMETRIC_CIPHER_ALGORITHM_INFO	0x1012

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DDSSEC12-86 - Secure TypeLookup Built-In Endpoints

```
@extensibility(MUTABLE)
struct ParticipantBuiltinTopicData: DDS::ParticipantBuiltinTopicData {
    @id(0x1001) IdentityToken                              identity_token;
    @id(0x1002) PermissionsToken                           permissions_token;
    @id(0x1005) ParticipantSecurityProtectionInfo          protection_info;
    @id(0x1007)
    AvailableBuiltinEndpointsExtSet_t    available_builtin_endpoints_ext;
    @id(0x1010)
    ParticipantSecurityDigitalSignatureAlgorithmInfo  digital_signature;
    @id(0x1011)
    ParticipantSecurityKeyEstablishmentAlgorithmInfo  key_establishment;
    @id(0x1012)
    ParticipantSecuritySymmetricCipherAlgorithmInfo   symmetric_cipher;
};
```

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DDSSEC12-86 - Secure TypeLookup Built-In Endpoints

If the member ***available_builtin_endpoints_ext*** is not present in the ***ParticipantBuiltinTopic***, the receiver shall interpret the value of the member to be 0x00000000.

If the member ***digital_signature*** is not present in the ***ParticipantBuiltinTopic***, the receiver shall interpret the value of the member to be the default defined in clause 7.3.11.2.

If the member ***key_establishment*** is not present in the ***ParticipantBuiltinTopic***, the receiver shall interpret the value of the member to be the default defined in clause 7.3.13.2.

If the member ***symmetric_cipher*** is not present in the ***ParticipantBuiltinTopic***, the receiver shall interpret the value of the member to be the default defined in clause 7.3.13.2.

Only the `Property_t` and `BinaryProperty_t` elements having the propagate member set to TRUE are serialized. Furthermore, as indicated by the `@non-serialized` annotation the serialization of the `Property_t` and `BinaryProperty_t` elements shall omit the serialization of the ***propagate*** member. That is, they are serialized as if the type definition did not contain the ***propagate*** member. This is consistent with the data-type definition for Property_t that appears in the DDS-RTPS specification (see Table 9.12 of DDS-RTPS). Even if it is not present in the serialized data, the receiver will set the ***propagate*** member to TRUE.

Note that according to DDS-RTPS the PID_PROPERTY_LIST is associated with a single `PropertySeq` rather than the `PropertyQosPolicy`, which is a structure that contains two sequences. This does not cause any interoperability problems because the containing `ParticipantBuiltinTopicData` has mutable extensibility.

The DDS Interoperability Wire Protocol specifies that the ***ParticipantBuiltinTopicData*** shall contain the attribute called ***availableBuiltinEndpoints*** that is used to announce the builtin endpoints that are available in the `DomainParticipant`. See clause 8.5.3.2 of the DDS Interoperability Wire Protocol [2]. The type for this attribute is an array of ***BuiltinEndpointSet_t***. For the UDP/IP PSM the ***BuiltinEndpointSet_t*** is mapped to a bitmap represented as type **long**. Each builtin endpoint is represented as a bit in this bitmap with the bit values defined in Table 9.4 (clause 9.3.2) of the DDS Interoperability Wire Protocol [2].

This DDS Security specification reserves additional bits to indicate the presence of the corresponding built-in end points listed in clause 7.5.8. These bits shall be set on the ***availableBuiltinEndpoints***. The bit that encodes the presence of each individual endpoint is defined in Table 11 below.

Table 11 – Mapping of the additional builtin endpoints added by DDS security to the availableBuiltinEndpoints

Builtin Endpoint	***Bit in the ParticipantBuiltinTopicData availableBuiltinEndpoints***
SEDPbuiltinPublicationsSecureWriter ***SEDPbuiltinPublicationsSecureReader*** See clause 7.5.1.7	(0x00000001 << 16) (0x00000001 << 17)
SEDPbuiltinSubscriptionsSecureWriter ***SEDPbuiltinSubscriptionsSecureReader*** See clause 7.5.1.8	(0x00000001 << 18) (0x00000001 << 19)
BuiltinParticipantMessageSecureWriter ***BuiltinParticipantMessageSecureReader*** See clause 7.5.2	(0x00000001 << 20) (0x00000001 << 21)
BuiltinParticipantStatelessMessageWriter ***BuiltinParticipantStatelessMessageReader*** See clause 7.5.3	(0x00000001 << 22) (0x00000001 << 23)
BuiltinParticipantVolatileMessageSecureWriter ***BuiltinParticipantVolatileMessageSecureReader*** See clause 7.5.4	(0x00000001 << 24) (0x00000001 << 25)
SPDPbuiltinParticipantSecureWriter ***SPDPbuiltinParticipantSecureReader*** See clause 7.5.1.6	(0x00000001 << 26) (0x00000001 << 27)

DDSSEC12-86 - Secure TypeLookup Built-In Endpoints

DDS-Security implementations that support DDS-XTYPES shall advertise the availability of the Secure TypeLookup Built-In Endpoints using the Parameter with ID PID_AVAILABLE_BUILTIN_ENDPOINTS_EXT (see Table 10). Implementations that do not support DDS-XTYPES may omit this parameter. Values of ***available_builtin_endpoints_ext*** are defined in Table below. Use of the Secure TypeLookup Built-In Endpoints is defined in section 7.5.5.

Table 12 – Mapping of the builtin endpoints added by DDS security to the available_builtin_endpoints_ext

Builtin Endpoint	*Bit in the ParticipantBuiltinTopicData available_builtin_endpoints_ext*
TypeLookupServiceRequestSecureWriter ***TypeLookupServiceRequestSecureReader*** See clause 7.5.5	(0x00000001 << 0) (0x00000001 << 1)
TypeLookupServiceReplySecureWriter ***TypeLookupServiceReplySecureReader*** See clause 7.5.5	(0x00000001 << 2) (0x00000001 << 3)

7.5.1.5 Extension to RTPS Standard DCPSPublications and DCPSSubscriptions Builtin Topics

The DDS specification specifies the existence of the ***DCPSPublications*** and ***DCPSSubscriptions*** builtin `Topics` and a corresponding builtin `DataWriters` and `DataReaders` to communicate these `Topics`. These endpoints are used to discover `DataWriter` and `DataReader` entities.

The data type associated with the ***DCPSPublications*** and ***DCPSSubscriptions*** builtin `Topic` are ***PublicationBuiltinTopicData*** and ***SubscriptionBuiltinTopicData***, defined in sub clause 7.1.5 of the DDS specification.

The DDS Interoperability Wire Protocol specifies the serialization of ***PublicationBuiltinTopicData*** and ***SubscriptionBuiltinTopicData***.

The format used is what the DDS Interoperability Wire Protocol calls a `ParameterList` whereby each member of the ***PublicationBuiltinTopicData*** and ***SubscriptionBuiltinTopicData*** is serialized using CDR but preceded in the stream by the serialization of a short `ParameterID` identifying the member, followed by another short containing the length of the serialized member, followed by the serialized member. See sub clause 8.3.5.9 of the DDS Interoperability Wire Protocol [2]. This serialization format allows the ***PublicationBuiltinTopicData*** and ***SubscriptionBuiltinTopicData*** to be extended without breaking interoperability.

This DDS Security specification adds a new member to the ***PublicationBuiltinTopicData*** and ***SubscriptionBuiltinTopicData*** structure. The member types and the `ParameterIDs` used for the serialization are described below.

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Table 13 – Additional parameter IDs in PublicationBuiltinTopicData and SubscriptionBuiltinTopicData

Member name	*Member type*	*Parameter ID name*	*Parameter ID value*
protection_info	EndpointSecurityInfo (See 7.3.24)	PID_ENDPOINT_SECURITY_PROTECTION_INFO	0x1004
symmetric_cipher	EndpointSecuritySymmetricCipherAlgorithmInfo (see 7.3.15)	PID_ENDPOINT_SECURITY_SYMMETRIC_CIPHER_ALGORITHM_INFO	0x1013

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```
@extensibility(MUTABLE)
struct PublicationBuiltinTopicData: DDS::PublicationBuiltinTopicData {
    @id(0x1004) EndpointSecurityProtectionInfo    protection_info;
    @id(0x1013)
    EndpointSecuritySymmetricCipherAlgorithmInfo   symmetric_cipher;
};

@extensibility(MUTABLE)
struct SubscriptionBuiltinTopicData: DDS::SubscriptionBuiltinTopicData {
    @id(0x1004) EndpointSecurityProtectionInfo    protection_info;
    @id(0x1013)
```

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```
    EndpointSecuritySymmetricCipherAlgorithmInfo  symmetric_cipher;
};
```

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If the member ***symmetric_cipher*** is not present in the ***PublicationBuiltinTopic*** or the ***SubscriptionBuiltinTopic*** data, the receiver shall interpret the value of the member to be the default defined in clause 7.3.15.2.

7.5.1.6 New DCPSParticipantSecure Builtin Topic

As described in clause 7.5.1.4, the ***DCPSParticipants*** builtin `Topic` and a corresponding builtin `DataWriter` and `DataReader` are used to discover `DomainParticipant` entities. Implementations of the DDS Security shall use that same ***DCPSParticipants*** builtin `Topic` to announce the `DomainParticipant` information. This is used for bootstrapping authentication and allowing discovery of non-secure applications.

Implementations of the DDS Security specification shall have an additional builtin `Topic` referred to as ***DCPSParticipantsSecure*** and associated builtin `DataReader` and `DataWriter` entities to communicate the `DomainParticipant` information securely.

The `Topic` name for the ***DCPSParticipantsSecure*** `Topic` shall be "DCPSParticipantsSecure".

The data type associated with the ***DCPSParticipantsSecure*** `Topic` shall be ***ParticipantBuiltinTopicDataSecure***, defined to be the same as the ***ParticipantBuiltinTopicData*** defined in clause 7.5.1.4, except the structure has the additional optional member ***identity_status_token*** with the ***ParameterId*** described below.

Table 14 – Additional parameter IDs in ParticipantBuiltinTopicDataSecure

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Member name	*Member type*	*Parameter ID name*	*Parameter ID value*
identity_status_token	IdentityStatusToken	PID_IDENTITY_STATUS_TOKEN	0x1006

```
@extensibility(MUTABLE)
struct ParticipantBuiltinTopicDataSecure: ParticipantBuiltinTopicData {
    @id(0x1006) @optional IdentityStatusToken identity_status_token;
};
```

The QoS associated with the ***DCPSParticipantsSecure*** builtin `Topic` shall be the same as for the ***DCPSPublications*** and ***DCPSSubscriptions*** builtin `Topic`. Note that is not the same as the ***DCPSParticipants*** `Topic`. Among other differences, the ***DCPSParticipantsSecure*** has `ReliabilityQosPolicy` ***kind*** set to RELIABLE.

The builtin `DataWriter` for the ***DCPSParticipantsSecure*** `Topic` shall be referred to as the ***SPDPbuiltinParticipantsSecureWriter***. The builtin `DataReader` for the ***DCPSParticipantsSecure*** `Topic` shall be referred to as the ***SPDPbuiltinParticipantsSecureReader.***

The RTPS `EntityId_t` associated with the ***SPDPbuiltinParticipantsSecureWriter*** and ***SPDPbuiltinParticipantsSecureReader*** shall be as specified in 7.5.8.

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The ***ParticipantBuiltinTopicData*** contains information, such as participant Locators, which may change at run-time. These changes shall be sent using the ***DCPSParticipantsSecure*** builtin `Topic`. The deletion of a DomainParticipant shall also be sent using the ***DCPSParticipantsSecure*** builtin `Topic`.

After authentication has completed successfully a `DomainParticipant` shall ignore any changes to the ***ParticipantBuiltinTopicData*** (including dispose messages) received on the ***DCPSParticipants*** builtin `Topic` from the authenticated `DomainParticipant`. It may, however, rely on these messages to maintain the liveliness of the remote `DomainParticipant`. It should only process

ParticipantBuiltinTopicData messages containing data changes or status changes (dispose or unregister) if they are received over the ***DCPSParticipantsSecure*** builtin Topic.

7.5.1.7 New DCPSPublicationsSecure Builtin Topic

The DDS specification specifies the existence of the ***DCPSPublications*** builtin Topic with topic name "DCPSPublications" and corresponding builtin DataWriter and DataReader entities to communicate on this Topic. These endpoints are used to discover non-builtin DataWriter entities. The data type associated with the ***DCPSPublications*** Topic is ***PublicationBuiltinTopicData***, defined in sub clause 7.1.5 of the DDS specification.

Implementations of the DDS Security shall use that same ***DCPSPublications*** Topic to communicate the DataWriter information for Topic entities that **are not** considered sensitive.

Implementations of the DDS Security specification shall have an additional builtin Topic referred to as ***DCPSPublicationsSecure*** and associated builtin DataReader and DataWriter entities to communicate the DataWriter information for Topic entities that **are** considered sensitive.

The determination of which Topic entities are considered sensitive shall be specified by the AccessControl plugin.

The Topic name for the ***DCPSPublicationsSecure*** Topic shall be "DCPSPublicationsSecure".

The data type associated with the ***DCPSPublicationsSecure*** Topic shall be ***PublicationBuiltinTopicDataSecure***, defined to be the same as the ***PublicationBuiltinTopicData*** structure used by the ***DCPSPublications*** Topic, except the structure has the additional member ***data_tags*** with the ***ParameterId*** described below.

Table 15 – Additional parameter IDs in PublicationBuiltinTopicDataSecure

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Member name	*Member type*	*Parameter ID name*	*Parameter ID value*
data_tags	DataTags	PID_DATA_TAGS	0x1003

```
@extensibility(MUTABLE)
struct PublicationBuiltinTopicDataSecure: PublicationBuiltinTopicData {
    @id(0x1003) DataTags data_tags;
};
```

The QoS associated with the ***DCPSPublicationsSecure*** Topic shall be the same as for the ***DCPSPublications*** Topic.

The builtin DataWriter for the ***DCPSPublicationsSecure*** Topic shall be referred to as the ***SEDPbuiltinPublicationsSecureWriter***. The builtin DataReader for the ***DCPSPublicationsSecure*** Topic shall be referred to as the ***SEDPbuiltinPublicationsSecureReader***.

The RTPS EntityId_t associated with the ***SEDPbuiltinPublicationsSecureWriter*** and ***SEDPbuiltinPublicationsSecureReader*** shall be as specified in 7.5.8.

Deleted: 7.5.87.5.87.5.5

7.5.1.8 New DCPSSubscriptionsSecure Builtin Topic

The DDS specification specifies the existence of the ***DCPSSubscriptions*** builtin Topic with Topic name "DCPSSubscriptions" and corresponding builtin DataWriter and DataReader entities to communicate on this Topic. These endpoints are used to discover non-builtin DataReader entities. The data type associated with the ***DCPSSubscriptions*** is ***SubscriptionBuiltinTopicData*** is defined in sub clause 7.1.5 of the DDS specification.

Implementations of the DDS Security specification shall use that same ***DCPSSubscriptions*** Topic to send the DataReader information for Topic entities that **are not** considered sensitive. The existence and configuration of `Topic` entities as non-sensitive shall be specified by the `AccessControl` plugin.

Implementations of the DDS Security specification shall have an additional builtin `Topic` referred to as ***DCPSSubscriptionsSecure*** and associated builtin `DataReader` and `DataWriter` entities to communicate the `DataReader` information for `Topic` entities that are considered sensitive.

The determination of which `Topic` entities are considered sensitive shall be specified by the `AccessControl` plugin.

The data type associated with the ***DCPSSubscriptionsSecure*** `Topic` shall be ***SubscriptionBuiltinTopicDataSecure*** defined to be the same as the ***SubscriptionBuiltinTopicData*** structure used by the ***DCPSSubscriptions*** `Topic`, except the structure has the additional member ***data_tags*** with the data type and ***ParameterIds*** described below.

Table 16 – Additional parameter IDs in SubscriptionBuiltinTopicDataSecure

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Member name	***Member type***	***Parameter ID name***	***Parameter ID value***
data_tags	DataTags	PID_DATA_TAGS	0x1003

```
@extensibility(MUTABLE)
struct SubscriptionBuiltinTopicDataSecure: SubscriptionBuiltinTopicData {
    @id(0x1003) DataTags data_tags;
};
```

The QoS associated with the ***DCPSSubscriptionsSecure*** `Topic` shall be the same as for the ***DCPSSubscriptions*** `Topic`.

The builtin `DataWriter` for the ***DCPSSubscriptionsSecure*** `Topic` shall be referred to as the ***SEDPbuiltinSubscriptionsSecureWriter***. The builtin `DataReader` for the ***DCPSPublicationsSecure*** `Topic` shall be referred to as the ***SEDPbuiltinSubscriptionsSecureReader***.

The RTPS `EntityId_t` associated with the ***SEDPbuiltinSubscriptionsSecureWriter*** and ***SEDPbuiltinSubscriptionsSecureReader*** shall be as specified in 7.5.8.

Deleted: 7.5.87.5.87.5.5

7.5.2 New DCPSParticipantMessageSecure builtin Topic

The DDS Interoperability Wire Protocol specifies the ***BuiltinParticipantMessageWriter*** and ***BuiltinParticipantMessageReader*** (see sub clauses 8.4.13 and 9.6.2.1 of the DDS Interoperability Wire Protocol[2]). These entities are used to send information related to the LIVELINESS QoS. This information could be considered sensitive and therefore secure DDS systems need to provide an alternative protected way to send liveliness information.

The data type associated with these endpoints is ***ParticipantMessageData*** defined in sub clause 9.6.2.1 of the DDS Interoperability Wire Protocol specification [2].

To support coexistence and interoperability with non-secure DDS applications, implementations of the DDS Security specification shall use the same standard ***BuiltinParticipantMessageWriter*** and ***BuiltinParticipantMessageReader*** to communicate liveliness information on `Topic` entities that **are not** considered sensitive.

Implementations of the DDS Security specification shall have an additional ***DCPSParticipantMessageSecure*** builtin `Topic` and associated builtin `DataReader` and `DataWriter` entities to communicate the liveliness information for `Topic` entities that **are** considered sensitive.

The data type associated with the ***DCPSParticipantMessageSecure*** `Topic` shall be the same as the ***ParticipantMessageData*** structure.

The QoS associated with the ***DCPSParticipantMessageSecure*** `Topic` shall be the same as for the ***DCPSParticipantMessage*** `Topic` as defined in sub clause 8.4.13 of the DDS Interoperability Wire Protocol [2].

The builtin `DataWriter` for the ***DCPSParticipantMessageSecure*** `Topic` shall be referred to as the ***BuiltinParticipantMessageSecureWriter***. The builtin `DataReader` for the ***DCPSParticipantMessageSecure*** `Topic` shall be referred to as the ***BuiltinParticipantMessageSecureReader***.

The RTPS `EntityId_t` associated with the ***BuiltinParticipantMessageSecureWriter*** and ***BuiltinParticipantMessageSecureReader*** shall be as specified in 7.5.8.

Deleted: 7.5.87.5.87.5.5

According to clause 8.7.2.2.3 of DDSI-RTPS [2], if the `DataWriter` `LivelinessQos` policy is `MANUAL_BY_TOPIC_LIVELINESS_QOS`, liveliness is maintained sending data or heartbeats using the same RTPS `DataWriter`. The remaining settings for the `LivelinessQos` policy use the ***DCPSParticipantMessage*** `Topic` to maintain the `DataWriter` liveliness.

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If a `DataWriter` `LivelinessQos` policy is `MANUAL_BY_TOPIC_LIVELINESS_QOS`, implementations compliant with DDS-Security shall use the same RTPS `DataWriter` for the liveliness heartbeats. The liveliness heartbeats shall be protected using the same means as the regular `DataWriter` heartbeats. That is, according to the setting of the `EndpointSecurityConfig` ***is_submessage_protected*** attribute.

Deleted: `EndpointSecurityAttributes`

If the `DataWriter` `LivelinessQos` policy is `AUTOMATIC_LIVELINESS_QOS` or `MANUAL_BY_PARTICIPANT_LIVELINESS_QOS`, implementations compliant with DDS-Security shall send the liveliness heartbeats using either the ***DCPSParticipantMessage*** `Topic` or the ***DCPSParticipantMessageSecure*** `Topic`. The selection shall be done according to the setting of the `TopicSecurityConfig` ***is_liveliness_protected***: It shall use the ***DCPSParticipantMessage*** `Topic` if ***is_liveliness_protected*** is set to **false**, otherwise it shall use the ***DCPSParticipantMessageSecure*** `Topic`.

Deleted: `TopicSecurityAttributes`

7.5.3 New DCPSParticipantStatelessMessage builtin Topic

To perform mutual authentication between DDS `DomainParticipant` entities, the security plugins associated with those participants need to be able to send directed messages to each other. As described in 7.5.3.1 below, the mechanisms provided by existing DDS builtin `Topic` entities are not adequate for this purpose. For this reason, this specification introduces a new ***DCPSParticipantStatelessMessage*** builtin `Topic` and corresponding builtin `DataReader` and `DataWriter` entities to read and write the `Topic`.

7.5.3.1 Background: Sequence Number Attacks (non normative)

DDS has a builtin mechanism for participant-to-participant messaging: the ***BuiltinParticipantMessageWriter*** and ***BuiltinParticipantMessageReader*** (see sub clause 9.6.2.1 of the DDS Interoperability Wire Protocol [2]). However this mechanism cannot be used for mutual authentication because it relies on the RTPS reliability protocol and suffers from the sequence-number prediction vulnerability present in unsecured reliable protocols:

- The RTPS reliable protocol allows a `DataWriter` to send to a `DataReader` `Heartbeat` messages that advance the *first available sequence number* associated with the `DataWriter`. A `DataReader` receiving a `Heartbeat` from a `DataWriter` will advance its *first available sequence number* for that `DataWriter` and ignore any future messages it receives with sequence numbers lower than the *first available sequence number* for the `DataWriter`. The reliable `DataReader` will also ignore duplicate messages for that same sequence number.

- The behavior of the reliability protocol would allow a malicious application to prevent other applications from communicating by sending `Heartbeats` pretending to be from other `DomainParticipants` that contain large values of the *first available sequence number*. All the malicious application needs to do is learn the GUIDs of other applications, which can be done from observing the initial discovery messages on the wire, and use that information to create fake `Heartbeats`.

Stated differently: prior to performing mutual authentication and key exchange, the applications cannot rely on the use of encryption and message access codes to protect the integrity of the messages. Therefore, during this time window, they are vulnerable to this kind of sequence-number attack. This attack is present in most reliable protocols. Stream-oriented protocols such as TCP are also vulnerable to sequence-number-prediction attacks but they make it more difficult by using a random initial sequence number on each new connection and discarding messages with sequence numbers outside the window. This is something that RTPS cannot do given the data-centric semantics of the protocol.

In order to avoid this vulnerability, the Security plugins must exchange messages using writers and readers sufficiently robust to sequence number prediction attacks. The RTPS protocol specifies endpoints that meet this requirement: the RTPS `StatelessWriter` and `StatelessReader` (see 8.4.7.2 and 8.4.10.2 of the DDS Interoperability Wire Protocol [2]) but there are no DDS builtin endpoints that provide access to this underlying RTPS functionality.

7.5.3.2 BuiltinParticipantStatelessMessageWriter and BuiltinParticipantStatelessMessageReader

The DDS Security specification defines two builtin Endpoints: the ***BuiltinParticipantStatelessMessageWriter*** and the ***BuiltinParticipantStatelessMessageReader***. These two endpoints shall be present in compliant implementations of this specification. These endpoints are used to write and read the builtin ***DCPSParticipantStatelessMessage*** `Topic`.

The ***BuiltinParticipantStatelessMessageWriter*** is an RTPS Best-Effort `StatelessWriter` (see sub clause 8.4.7.2 of the DDS Interoperability Wire Protocol [2]).

The ***BuiltinParticipantStatelessMessageReader*** is an RTPS Best-Effort `StatelessReader` (see sub clause 8.4.10.2 of the DDS Interoperability Wire Protocol [2]).

The data type associated with these endpoints is `ParticipantStatelessMessage` defined below (see also 7.3.21):

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```
typedef ParticipantStatelessMessage ParticipantGenericMessage;
```

The RTPS `EntityId_t` associated with the ***BuiltinParticipantStatelessMessageWriter*** and ***BuiltinParticipantStatelessMessageReader*** shall be as specified in 7.5.8.

Deleted: 7.5.87.5.87.5.5

7.5.3.3 Contents of the ParticipantStatelessMessage

The `ParticipantStatelessMessage` is intended as a holder of information that is sent point-to-point from a `DomainParticipant` to another.

The ***message_identity*** uniquely identifies each individual `ParticipantStatelessMessage`:

- The ***source_guid*** field within the ***message_identity*** shall be set to match the `GUID_t` of the ***BuiltinParticipantStatelessMessageWriter*** that writes the message.
- The ***sequence_number*** field within the ***message_identity*** shall start with the value set to one and be incremented for each different message sent by the ***BuiltinParticipantStatelessMessageWriter***.

The ***related_message_identity*** uniquely identifies another ParticipantStatelessMessage that is related to the message being processed. It shall be set to either the tuple {***GUID_UNKNOWN, 0***} if the message is not related to any other message, or else set to match the ***message_identity*** of the related ParticipantStatelessMessage.
The ***destination_participant_guid*** shall contain either the value ***GUID_UNKNOWN*** (see sub clause 9.3.1.5 of the DDS Interoperability Wire Protocol [2]) or else the GUID_t of the destination DomainParticipant.
The ***destination_endpoint_guid*** provides a mechanism to specify finer granularity on the intended recipient of a message beyond the granularity provided by the ***destination_participant_guid***. It can contain either ***GUID_UNKNOWN*** or else the GUID of a specific endpoint within destination DomainParticipant. The targeted endpoint is the one whose Endpoint (DataWriter or DataReader) GUID_t matches the ***destination_endpoint_guid***.
The contents ***message_data*** depend on the value of the ***message_class_id*** and are defined in this specification in the sub clause that introduces each one of the pre-defined values of the GenericMessageClassId. See 7.5.3.5 and 7.5.3.6.

7.5.3.4 Destination of the ParticipantStatelessMessage

If the ***destination_participant_guid*** member is not set to ***GUID_UNKNOWN***, the message written is intended only for the ***BuiltinParticipantStatelessMessageReader*** belonging to the DomainParticipant with a matching Participant Key.
This is equivalent to saying that the ***BuiltinParticipantStatelessMessageReader*** has an implied content filter with the logical expression:

“destination_participant_guid == GUID_UNKNOWN
|| destination_participant_guid == BuiltinParticipantStatelessMessageReader.participant.guid”

Implementations of the specification can use this content filter or some other mechanism as long as the resulting behavior is equivalent to having this content filter.
If the ***destination_endpoint_guid*** member is not set to ***GUID_UNKNOWN***, the message written targets the specific endpoint within the destination DomainParticipant with a matching Endpoint Key.

7.5.3.5 Reserved values of ParticipantStatelessMessage GenericMessageClassId

This specification, including future versions of this specification reserves ***GenericMessageClassId*** values that start with the prefix “dds.sec.” (without quotes) .
The specification defines and uses the following specific values for the ***GenericMessageClassId***:

```
#define GMCLASSID_SECURITY_AUTH_REQUEST             \
             "dds.sec.auth_request"
#define GMCLASSID_SECURITY_AUTH_HANDSHAKE             \
             "dds.sec.auth"
```

Additional values of the ***GenericMessageClassId*** may be defined with each plugin implementation.

7.5.3.6 Format of data within ParticipantStatelessMessage

Each value for the GenericMessageClassId uses different schema to store data within the generic attributes in the ***message_data***.

7.5.3.6.1 Data for message class GMCLASSID_SECURITY_AUTH_HANDSHAKE

If GenericMessageClassId is GMCLASSID_SECURITY_AUTH_HANDSHAKE the ***message_data*** attribute shall contain the HandshakeMessageTokenSeq containing one element.

The specific contents of the HandshakeMessageToken element shall be defined by the Authentication Plugin.
The ***destination_participant_guid*** shall be set to the GUID_t of the destination DomainParticipant.
The ***destination_endpoint_guid*** shall be set to ***GUID_UNKNOWN***. This indicates that there is no specific endpoint targeted by this message: It is intended for the whole DomainParticipant.
The ***source_endpoint_guid*** shall be set to ***GUID_UNKNOWN***.

7.5.3.6.2 Data for message class GMCLASSID_SECURITY_AUTH_REQUEST

If GenericMessageClassId is GMCLASSID_SECURITY_AUTH_REQUEST the ***message_data*** attribute shall contain an AuthRequestMessageTokenSeq containing one element. The specific contents of the AuthRequestMessageToken element shall be defined by the Authentication Plugin.
The ***destination_participant_guid*** shall be set to the GUID_t of the destination DomainParticipant.
The ***destination_endpoint_guid*** shall be set to ***GUID_UNKNOWN***. This indicates that there is no specific endpoint targeted by this message: It is intended for the whole DomainParticipant.
The ***source_endpoint_guid*** shall be set to ***GUID_UNKNOWN***.

7.5.4 New DCPSParticipantVolatileMessageSecure builtin Topic

7.5.4.1 Background (Non-Normative)

In order to perform key exchange between DDS DomainParticipant entities, the security plugins associated with those participants need to be able to send directed messages to each other using a reliable and secure channel. These messages are intended only for Participants that are currently in the system and therefore need a DURABILITY Qos of kind VOLATILE.
The existing mechanisms provided by DDS are not adequate for this purpose:

- The new ***DCPSParticipantStatelessMessage*** is not suitable because it is a stateless best-effort channel not protected by the security mechanisms in this specification and therefore requires the message data to be explicitly encrypted and signed prior to being given to the ***ParticipantStatelessMessageWriter***.
- The new ***DCPSParticipantMessageSecure*** is not suitable because its QoS has DURABILITY kind TRANSIENT_LOCAL (see sub clause 8.4.13 of the DDS Interoperability Wire Protocol [2]) rather than the required DURABILITY kind VOLATILE.

For this reason, implementations of the DDS Security specification shall have an additional builtin Topic ***DCPSParticipantVolatileMessageSecure*** and corresponding builtin DataReader and DataWriter entities to read and write the Topic.

7.5.4.2 BuiltinParticipantVolatileMessageSecureWriter and BuiltinParticipantVolatileMessageSecureReader

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The DDS Security specification defines two new builtin Endpoints: The ***BuiltinParticipantVolatileMessageSecureWriter*** and the ***BuiltinParticipantVolatileMessageSecureReader***. These two endpoints shall be present in compliant implementations of this specification. These endpoints are used to write and read the builtin ***ParticipantVolatileMessageSecure*** Topic and shall have the TopicSecurityConfig and EndpointSecurityConfig set as specified in the tables below.

Deleted: TopicSecurityAttributes
Deleted: EndpointSecurityAttributes

Table 17 – ParticipantVolatileMessageSecure Topic Security Attributes

Attribute	Value
is_read_protected	false
is_write_protected	false
is_discovery_protected	false
is_liveliness_protected	false

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Table 18 – ParticipantVolatileMessageSecure Endpoint Security Attributes (Reader and Writer)

Attribute	Value
is_read_protected	false
is_write_protected	false
is_discovery_protected	false
is_liveliness_protected	false
is_submessage_protected	true
is_payload_protected	false
is_key_protected	false

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The ***BuiltinParticipantVolatileMessageSecureWriter*** is an RTPS Reliable StatefulWriter (see sub clause 8.4.9.2 of the DDS Interoperability Wire Protocol [2]). The DDS `DataWriter` Qos associated with the `DataWriter` shall be as defined in the table below. Any policies that are not shown in the table shall be set corresponding to the DDS defaults.

Table 19 – Non-default Qos policies for BuiltinParticipantVolatileMessageSecureWriter

DataWriter Qos policy	Policy Value
RELIABILITY	kind= RELIABLE
HISTORY	kind= KEEP_ALL
DURABILITY	kind= VOLATILE

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The ***BuiltinParticipantVolatileMessageSecureReader*** is an RTPS Reliable StatefulReader (see sub clause 8.4.11.2 of the DDS Interoperability Wire Protocol [2]). The DDS `DataReader` Qos associated with the `DataReader` shall be as defined in the table below. Any policies that are not shown in the table shall be set corresponding to the DDS defaults.

Table 20 – Non-default Qos policies for BuiltinParticipantVolatileMessageSecureReader

DataReader Qos policy	Policy Value
RELIABILITY	kind= RELIABLE
HISTORY	kind= KEEP_ALL
DURABILITY	kind= VOLATILE

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The data type associated with these endpoints is `ParticipantVolatileMessageSecure` defined as:

```
typedef ParticipantVolatileMessageSecure ParticipantGenericMessage;
```

The RTPS `EntityId_t` associated with the ***BuiltinParticipantVolatileMessageSecureWriter*** and ***BuiltinParticipantVolatileMessageSecureReader*** shall be as specified in 7.5.8.

Deleted: 7.5.87.5.87.5.5

7.5.4.3 Contents of the ParticipantVolatileMessageSecure

The `ParticipantVolatileMessageSecure` is intended as a holder of secure information that is sent point-to-point from a `DomainParticipant` to another.

The ***destination_participant_guid*** shall contain either the value ***GUID_UNKNOWN*** (see sub clause 9.3.1.5 of the DDS Interoperability Wire Protocol [2] or else the `GUID_t` of the destination `DomainParticipant`.

The ***message_identity*** uniquely identifies each individual ParticipantVolatileMessageSecure:

- The ***source_guid*** field within the ***message_identity*** shall be set to match the GUID_t of the ***BuiltinParticipantVolatileMessageSecureWriter*** that writes the message.
- The ***sequence_number*** field within the ***message_identity*** shall start with the value set to one and be incremented for each different message sent by the ***BuiltinParticipantVolatileMessageSecureWriter***.

The ***related_message_identity*** uniquely identifies another ParticipantVolatileMessageSecure that is related to the message being processed. It shall be set to either the tuple {***GUID_UNKNOWN, 0***} if the message is not related to any other message, or else set to match the ***message_identity*** of the related ParticipantVolatileMessageSecure.

The contents ***message_data*** depend on the value of the ***message_class_id*** and are defined in this specification in the sub clause that introduces each one of the defined values of the GenericMessageClassId, see 7.5.4.5.

7.5.4.4 Destination of the ParticipantVolatileMessageSecure

If the ***destination_participant_guid*** member is not set to ***GUID_UNKNOWN***, the message written is intended only for the ***BuiltinParticipantVolatileMessageSecureReader*** belonging to the DomainParticipant with a matching Participant Key.

This is equivalent to saying that the ***BuiltinParticipantVolatileMessageSecureReader*** has an implied content filter with the logical expression:

"destination_participant_guid == GUID_UNKNOWN
|| destination_participant_guid==BuiltinParticipantVolatileMessageSecureReader.participant.guid"

Implementations of the specification can use this content filter or some other mechanism as long as the resulting behavior is equivalent to having this filter.

If the ***destination_endpoint_guid*** member is not set to ***GUID_UNKNOWN*** the message written targets a specific endpoint within the destination DomainParticipant. The targeted endpoint is the one whose Endpoint Key (DataWriter or DataReader GUID_t) matches the ***destination_endpoint_guid***. This attribute provides a mechanism to specify finer granularity on the intended recipient of a message beyond the granularity provided by the ***destination_participant_guid***.

7.5.4.5 Reserved values of ParticipantVolatileMessageSecure GenericMessageClassId

This specification, including future versions of this specification reserves ***GenericMessageClassId*** values that start with the prefix "dds.sec." (without the quotes) .

The specification defines and uses the following specific values for the ***GenericMessageClassId***:

```
#define GMCLASSID_SECURITY_PARTICIPANT_CRYPTO_TOKENS \
            "dds.sec.participant_crypto_tokens"
#define GMCLASSID_SECURITY_DATAWRITER_CRYPTO_TOKENS  \
            "dds.sec.datawriter_crypto_tokens"
#define GMCLASSID_SECURITY_DATAREADER_CRYPTO_TOKENS  \
            "dds.sec.datareader_crypto_tokens"
```

Additional values of the ***GenericMessageClassId*** may be defined with each plugin implementation.

7.5.4.6 Format of data within ParticipantVolatileMessageSecure

Each value for the GenericMessageClassId uses different schema to store data within the generic attributes in the ***message_data***.

7.5.4.6.1 Data for message class GMCLASS_SECURITY_PARTICIPANT_CRYPTO_TOKENS

If `GenericMessageClassId` is `GMCLASSID_SECURITY_PARTICIPANT_CRYPTO_TOKENS`, the ***message_data*** attribute shall contain the `ParticipantCryptoTokenSeq`.

This message is intended to send cryptographic material from one `DomainParticipant` to another when the cryptographic material applies to the whole `DomainParticipant` and not a specific `DataReader` or `DataWriter` within.

The concrete contents of the `ParticipantCryptoTokenSeq` shall be defined by the Cryptographic Plugin (CryptoKeyFactory).

The ***destination_participant_guid*** shall be set to the `GUID_t` of the destination `DomainParticipant`.

The ***destination_endpoint_guid*** shall be set to ***GUID_UNKNOWN***. This indicates that there is no specific endpoint targeted by this message: It is intended for the whole `DomainParticipant`.

The ***source_endpoint_guid*** shall be set to ***GUID_UNKNOWN***.

7.5.4.6.2 Data for message class GMCLASSID_SECURITY_DATAWRITER_CRYPTO_TOKENS

If `GenericMessageClassId` is `GMCLASSID_SECURITY_DATAWRITER_CRYPTO_TOKENS`, the ***message_data*** shall contain the `DatawriterCryptoTokenSeq`.

This message is intended to send cryptographic material from one `DataWriter` to a `DataReader` whom it wishes to send information to. The cryptographic material applies to a specific 'sending' `DataWriter` and it is constructed for a specific 'receiving' `DataReader`. This may be used to send the crypto keys used by a `DataWriter` to encrypt data and sign the data it sends to a `DataReader`.

The concrete contents of the `DatawriterCryptoTokenSeq` shall be defined by the Cryptographic Plugin (CryptoKeyFactory).

The ***destination_endpoint_guid*** shall be set to the `GUID_t` of the `DataReader` that should receive the `CryptoToken` values in the message.

The ***source_endpoint_guid*** shall be set to the `GUID_t` of the `DataWriter` that will be using the `CryptoToken` values to encode the data it sends to the `DataReader`.

7.5.4.6.3 Data for message class GMCLASSID_SECURITY_DATAREADER_CRYPTO_TOKENS

If `GenericMessageClassId` is `GMCLASSID_SECURITY_DATAWRITER_CRYPTO_TOKENS`, the ***message_data*** attribute shall contain the `DatareaderCryptoTokenSeq`.

This message is intended to send cryptographic material from one `DataReader` to a `DataWriter` whom it wishes to send information to. The cryptographic material applies to a specific 'sending' `DataReader` and it is constructed for a specific 'receiving' `DataWriter`. This may be used to send the crypto keys used by a `DataReader` to encrypt data and sign the ACKNACK messages it sends to a `DataWriter`.

The concrete contents of the `DatareaderCryptoTokenSeq` shall be defined by the Cryptographic Plugin (CryptoKeyFactory).

The ***destination_endpoint_guid*** shall be set to the `GUID_t` of the `DataWriter` that should receive the `CryptoToken` values in the message.

The ***source_endpoint_guid*** shall be set to the `GUID_t` of the `DataReader` that will be using the `CryptoToken` values to encode the data it sends to the `DataWriter`.

7.5.5 Secure builtin TypeLookup Service Topics

DDSSEC12-86 - Secure TypeLookup Built-In Endpoints

7.5.5.1 Background

DDSSEC12-86 - Secure TypeLookup Built-In Endpoints

DDS-XTYPES [3] defines two Builtin the `TypeLookup` service Topics: ***TypeLookupServiceRequestTopic*** and ***TypeLookupServiceReplyTopic*** and the four corresponding Built-In Endpoints used to send and receive information on these two Topics: ***TypeLookupServiceRequestWriter***, ***TypeLookupServiceRequestReader***, ***TypeLookupServiceReplyWriter***, and ***TypeLookupServiceReplyReader*** .

These builtin endpoints may be used by a `DomainParticipant` P1 to ask another `DomainParticipant` P2 to send type information associated with Endpoints the second participant P2 has announced via DDS discovery.

Specifically, the `TypeLookup` service interface provides two types of quesries, see [DDS-XTYPES version 1.3 section 7.6.3.3 [3]:

- The TypeObjects associated with the TypeIdentifers provided as an input
- The TypeIdentifiers of types that the type with a givenTypeIdentifier depends on.

Compliance with DDS-XTYPES requires any DomainParticipant that implements the TypeLookup service, to respond to requests for any TypeIdentifier that the DomainParticipant announces (directly or as a dependent type 7.5.6) in the PublicationBuiltinTopicData or SubscriptionBuiltinTopicData.

7.5.5.2 New TypeLookup Service Secure Endpoints

DDSSEC12-86 - Secure TypeLookup Built-In Endpoints

DDS-Security defines the secure versions of TypeLookup Service Endpoints defined in DDS-XTYPES. These consist of four new endpoints: ***TypeLookupServiceRequestSecureWriter***, ***TypeLookupServiceRequestSecureReader***, ***TypeLookupServiceReplySecureWriter***, and ***TypeLookupServiceReplySecureReader***.

The `EntityIds` for the Secure Type Lookup builtin endpoints are defined in Table 9.

The data types and Qos policies of the Secure Type Lookup builtin shall be the same defined for the corresponding (non-secure) endpoint in DDS-XTYPES.

7.5.6 Definition of the Types a DDS Endpoint depends on

DDSSEC12-86 - Secure TypeLookup Built-In Endpoints

Each DDS `Endpoint` (`DataWriter` or `DataReader`) is associated with a DDS `Topic`. The data-type associated with that DDS `Topic` is called the Endpoint's "top-level type" a.k.a. "Topic Type". Some Type definitions make references to other types the defined-type depends on.

For a given `Endpoint`, the collection consisting of the top-level type as well as the transitive closure that includes the types that the top-level type depends (i.e. makes a direct reference in its type definition), shall be referred to as the **types the endpoint depends on.** Stated differently, the "depends-on" relationship is applied recursively starting from the top-level type. The collection of all types that are reached this way defines the "types the endpoint depends on".

Example: Assume a `DataWriter` us writing a `Topic` with the type `AircraftReport` as defined by the IDL below:

```
typedef Latitude  float;
typedef Longitude float;
typedef Altitude  float;

struct Coordinate2D {
    Longitude longitude;
    Latitude  latitude;
```

```
};
typedef sequence<Coordinate2D> Track2D;

struct Coordinate3D : Coordinate2D {
    Altitude altitude;
};
typedef sequence< Coordinate3D> Track3D;

struct Heading {
    float roll;
    float pitch;
    float yaw;
};

struct AircraftReport {
    @key
    string            vehicle_id;
    Coordinate3D      location;
    Heading           heading;
    Track3D           route;
    @unit("minutes")
    int32             remaining_fuel;
};
```

In this case, the **top-level type of DataWriter** is `AircraftReport` and the **types the DataWriter depends on** is the set consisting of the types: `AircraftReport`, `string`, `Coordinate3D`, `Coordinate2D`, `Latitude`, `float`, `Longitude`, `Altitude`, `Heading`, `Track3D`, `sequence<Coordinate3D>`, and `int32`.

7.5.7 Definition of the "RTPS Bootstrapping Messages"

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
Certain RTPS messages need to be protected using separate mechanisms. These may include some messags used during authentication as well as messages used to detect initial presence and lower-level messages used to detect and maintain network connectivity.
An RTPS Messages is called a "RTPS Bootstraooping Messages" if an only if one or more of the following conditions applies:

- It contains RTPS submessages for the builtin topic "DCPSParticipants"
- It contains RTPS submessages for the builtin topic "DCPSParticipantStatelessMessage"
- It contains RTPS submessages for the builtin topic "DCPSParticipantVolatileMessageSecure"
- It is not intended to be processed by a DomainParticipant (e.g. it is a transport-level keep-alive message).

RTPS Messages that are not "RTPS Bootstrapping Messages" are referred to as "RTPS Non-Bootstrapping Messages".
RTPS Bootstrapping Messages are restricted in their content. See 7.5.12.

7.5.8 Definition of the "Builtin Secure Endpoints"

DDSSEC12-86 - Secure TypeLookup Built-In Endpoints
The complete list of builtin Endpoints that are protected by the security mechanism introduced in the DDS Security specification is: ***SPDPbuiltinParticipantsSecureWriter, SPDPbuiltinParticipantsSecureReader, SEDPbuiltinPublicationsSecureWriter, SEDPbuiltinPublicationsSecureReader, SEDPbuiltinSubscriptionsSecureWriter,***

SEDPbuiltinSubscriptionsSecureReader, BuiltinParticipantMessageSecureWriter, BuiltinParticipantMessageSecureReader, BuiltinParticipantVolatileMessageSecureWriter, BuiltinParticipantVolatileMessageSecureReader, TypeLookupServiceRequestWriterSecure, TypeLookupServiceRequestReaderSecure, TypeLookupServiceReplyWriterSecure, and ***TypeLookupServiceReplyReaderSecure.***
This list shall be referred to as the **builtin secure endpoints**.

7.5.9 Definition of the "Builtin Secure Discovery Endpoints"

The "builtin secure discovery endpoints" is the subset the builtin secure endpoints that are used for discovery. They are: ***SPDPbuiltinParticipantsSecureWriter, SPDPbuiltinParticipantsSecureReader, SEDPbuiltinPublicationsSecureWriter, SEDPbuiltinPublicationsSecureReader, SEDPbuiltinSubscriptionsSecureWriter,*** and ***SEDPbuiltinSubscriptionsSecureReader***.
This list shall be referred to as the **builtin secure discovery endpoints**.

7.5.10 Definition of the "Builtin Secure Liveliness Endpoints"

The "builtin secure liveliness endpoints" is the subset the builtin secure endpoints that are used for managing automatic liveliness. They are: ***BuiltinParticipantMessageSecureWriter*** and ***BuiltinParticipantMessageSecureReader***.
This list shall be referred to as the **builtin secure liveliness endpoints**.

7.5.11 Definition of the "Builtin Secure TypeLookup Endpoints"

DDSSEC12-86 - Secure TypeLookup Built-In Endpoints
The "builtin secure type lookup endpoints" is the subset the builtin secure endpoints that are used for the DDS-XTYPES TypeLookup service. They are: ***TypeLookupServiceRequestSecureWriter***, ***TypeLookupServiceRequestSecureReader***, ***TypeLookupServiceReplySecureWriter***, and ***TypeLookupServiceReplySecureReader***.
This list shall be referred to as the **builtin secure type lookup endpoints**.

7.5.12 Constraints in the content of RTPS Bootstrapping Messages

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
In general, the RTPS protocol allows a single RTPS `Message` to contain RTPS `SubMesages` sent by different Entities (`DataReaders` or `DataWriters`) which can be associated with different `Topics`. For example, it is possible to include `Data` sub messages for various `Topics`, including application `Topics` as well as Builtin `Topics`, mix `Data` submessages with `Heartbeat` and `AckNack` submessages, etc.
DDS-Security limits some of these combinations: RTPS Bootstrapping messages (see 7.5.7) shall not contain submessages for any other (non-bootstrapping) builtin topic or application-defined topic.

7.5.13 Securing the "Builtin Secure Endpoints"

DDSSEC12-90 - Meeting CNSSP-15 security requirements
As with application defined Topics, the middleware shall call the operations `get_datawriter_security_config` and `get_datareader_security_config` on the `AccessControl` interface to obtain the `EndpointSecurityConfig` associated with `DataReader` and `DataWriter` entities on all the "Builtin Secure Endpoints". The specific values of the `EndpointSecurityConfig` shall be as shown in the Table below:
DDSSEC12-86 - Secure TypeLookup Built-In Endpoints

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Deleted: get_datawriter_sec_attributes
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Table 21 – EndpointSecurityConfig for all "Builtin Security Endpoints"

Attribute	DCPSParticipantSecure, DCPSPublicationsSecure, DCPSSubscriptionsSecure	DCPSParticipantMessageSecure	DCPSParticipantStatelessMessage	DCPSParticipantVolatileMessageSecure, TypeLookupServiceRequestSecure, TypeLookupServiceReplySecure
is_read_protected	false	false	false	false
is_write_protected	false	false	false	false
is_discovery_protected	N/A	N/A	N/A	N/A
is_liveliness_protected	N/A	N/A	N/A	N/A
is_submessage_protected	Set to match `ParticipantSecurityConfig` ***is_discovery_protected***	Set to match `ParticipantSecurityConfig` ***is_liveliness_protected***	false	true
is_payload_protected	false	false	false	false
is_key_protected	false	false	false	false

The **false** settings for the ***is_read_protected*** and ***is_write_protected*** indicate that these secure builtin endpoints are not protected by the same AccessControl mechanisms as the regular endpoints (i.e., the `AccessControl` plugin is not called). However, they are still protected by the access control mechanism imposed by the `DomainParticipant`. That is, if `ParticipantSecurityConfig` member ***is_access_protected*** is **true**, then access to the secure builtin topics is protected.

For a description of the `ParticipantSecurityConfig`, see clause 9.4.2.4.

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8 Common Cryptographic Algorithms

DDSSEC12-90 - Meeting CNSSP-15 security requirements

This section defines a common set of standard cryptographic algorithms that are available for the SPIs to use.

In addition to the algorithm itself, this section defines the algorithm identifiers that the SPIs may use in different contexts to identify them. The specification uses three identifier representations:

- A `CryptoAlgorithmName` (string) representation. This representation is used to identify a cryptographic algorithm in contexts where ease of interpretation is the primary consideration and a more compact or fixed-size representation isn't required. A typical use is for configuration and inside the `BinaryProperty_t` (see 7.3.3) objects used for SPI handshakes.
- A `CryptoAlgorithmId` (binary) representation (see 7.3.7). This representation is used to identify a type of cryptographic algorithm in contexts where a compact, fixed-size representation is needed, and the possible set of algorithms is open ended. A typical use is within a `CryptoTransformIdentifier` submessage element to identify the type of encryption or message authentication applied to a message.
- A `CryptoAlgorithmBit` (bit) representation (see 7.3.8). This representation is used to identify an algorithm in contexts where there is a need to represent one or more algorithms in a compact manner and the possible set of possible algorithms is pre-known and limited, allowing the algoroithm to be represented as a bit position. A typical use is inside a `CryptoAlgorithmSet` bitmask (7.3.9).

In the case where multiple string identifiers are provided for the same algorithm, they shall all treated as equivalent.

The remaining subclauses define the algorithms currently needed to implement the builtin SPIs. As cryptographic technology and the needs of DDS application evolve the list of algorithms will be extended in future revisions. The list may also be extended to facilitate development of custom SPIs.

8.1 Symmetric Cipher AEAD and MAC Algorithms

DDSSEC12-90 - Meeting CNSSP-15 security requirements

SPIs may use symmetric cipher algorithms for two purposes:

- Authenticated Encryption with Additional Data (AEAD). This uses a symmetric cipher to encrypt (or decrypt) data samples as well as the complete RTPS messages sent over the transport. The AEAD transformation can also provide data/message authentication both on the data that was encrypted as well as on "additional data" that accompanies the encrypted payload.
- Message Authentication Codes. This uses a symmetric cipher to compute (or validate) message authentication codes (MACs, also known as message authentication tags) that ensure message integrity and provide message origin authentication.

As an example, the builtin Cryptographic plugin uses symmetric cipher algorithms in multiple operations, such as ***encode_serialized_payload***, ***encode_datawriter_submessage***, and ***encode_rtps_message***, in order to protect application data as well as metadata such as sequence numbers and timestamps, see 10.5.3

The table below defines the set of key establishment algorithms available to the SPIs.

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

Table 22 – Symmetric Cipher AEAD and MAC Algorithms

CryptoAlgorithm Name7.3.87.3.9	CryptoAlgorithm Id	CryptoAlgorithm Bit	Description
AES128+ GCM	**0x01**	**0x0001 << 0**	Message authentication codes (MACs) computed using Galois MAC (AES-GMAC). The definition of the AES128+GMAC transformations shall be as specified in NIST SP 800-38D [45], specialized to 128-bit AES keys with 96-bit Initialization Vector.
AES128+GCM	**0x02**	**0x0001 << 0** (same bit used for GMAC)	Authenticated Encryption with Additional Data (AEAD) using Advanced Encryption Standard (AES) in Galois Counter Mode (AES-GCM) [45]. The definition of the AES128+GCM transformation shall be as specified in NIST SP 800-38D [45], specialized to 128-bit AES keys with 96-bit Initialization Vector. The most relevant aspects are summarized below.
AES256+ GCM	**0x03**	**0x0001 << 1**	Message authentication codes (MACs) computed using Galois MAC (AES-GMAC). The definition of the AES256+GMAC transformations shall be as specified in NIST SP 800-38D [45], specialized to 256-bit AES keys with 96-bit Initialization Vector.
AES256+GCM	**0x04**	**0x0001 << 1** (same bit used for GMAC)	Authenticated Encryption with Additional Data (AEAD) using Advanced Encryption Standard (AES) in Galois Counter Mode (AES-GCM). The definition of the AES-GCM transformations shall be as specified in NIST SP 800-38D [45], specialized to 256-bit AES keys with 96-bit Initialization Vector. The most relevant aspects are summarized below.

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

Note that the same value of the `CryptoAlgorithmName` and `CryptoAlgorithmBit` is used for the message-authentication-only (MAC-only) variants of the corresponding AEAD algorithms. The reason is that the `CryptoAlgorithmName` and `CryptoAlgorithmBit` are only used to identify the AEAD/MAC algorithm pair and represent the presence of these algorithms in a set (`CryptoAlgorithmSet`) of "supported" or "required" algorithms for the purpose of checking compatibility between the algorithm usage in two different SPIs. In this context it is not necessary to differentiate the authentication-only use/support of the algorithm.

The following symbolic constants are defined to facilitate the use of these algorithms by the SPIs.

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

```
/* Predefined values for CryptoAlgorithmName  */
const string CNAME_AES128_GMAC   =  "AES128+GCM";
```

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```
const string CNAME_AES128_GCM   =  "AES128+GCM";
const string CNAME_AES256_GMAC  =  "AES256+GCM";
const string CNAME_AES256_GCM   =  "AES256+GCM";

/* May be used to indicate the "NULL" transformation */
const CryptoAlgorithmId   CID_INVALID       = 0x00;

/* Predefined values for CryptoAlgorithmId  */
const CryptoAlgorithmId   CID_AES128_GMAC   = 0x01;
const CryptoAlgorithmId   CID_AES128_GCM    = 0x02;
const CryptoAlgorithmId   CID_AES256_GMAC   = 0x03;
const CryptoAlgorithmId   CID_AES256_GCM    = 0x04;

/* Predefined values for CryptoAlgorithmBit  */
const CryptoAlgorithmBit  CBIT_AES128_GMAC  =  1 << 0;
const CryptoAlgorithmBit  CBIT_AES128_GCM   =  1 << 0;
const CryptoAlgorithmBit  CBIT_AES256_GMAC  =  1 << 1;
const CryptoAlgorithmBit  CBIT_AES256_GCM   =  1 << 1;
```

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8.1.1 AEAD with AES-GCM/GMAC

DDSSEC12-90 - Meeting CNSSP-15 security requirements

The essential elements of the AES-GCM authenticated encryption operation are described below, the normative definition can be found in NIST SP 800-38D [45].

AES-GCM is a transformation that takes the four inputs and produces two outputs, symbolically:

```
C, T =  AES-GCM(K, P, AAD, IV)
```

The AES-GCM inputs are described in the table below.

Table 23 – AES-GCM transformation inputs

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Input	Description
K	The 128-bit key to be used with the AES-128 block cipher or the 256-bit key to be used with the AES-256 block cipher.
P	The plaintext. This is the data to encrypt and authenticate. It may be empty in case we only want to authenticate data.
AAD	Additional Authenticated Data. This is data beyond the plaintext that will only be authenticated. I.e. it is not encrypted.
IV	Initialization Vector. This is a 96-bit NONCE that shall not be repeated for the same key.

The AES-GCM transformation outputs are described in the table below.

Table 24 – AES-GCM transformation outputs

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Input	Description
C	Ciphertext. This is the encryption of the plaintext "P".
T	Authentication Tag. This is a Message Authentication Code (MAC) that provides authentication for the Ciphertext (C) and the Additional Authenticated Data (AAD).

AES-GCM uses AES in counter mode with a specific incrementing function called "inc32" used to generate the counter blocks. As recommended in section 5.2.1.1 of NIST SP 800-38D [45] the counter blocks shall be created from the 96-bit Initialization Vector as follows:

- The initial value of the 128-bit counter block is a 128-bit string containing the IV as the leading 96 bits and zeros the remaining right-most 32 bits.

- Incremental values of the 128-bit counter block used to encrypt each block are obtained using the “inc32” function which increments the right-most 32 bits of the string, regarded as the binary representation of a big-endian integer, modulo 2^32. The inc32 operation does not touch the leading 96 bits.

The AES-GMAC transformation is defined as the special case where the plaintext “P” is empty (zero length). This transformation produces only an AuthenticationTag (Message Authentication Code) on the AAD data:

```
T =  AES-GMAC(K, AAD, IV) = AES-GCM(K, “”, AAD, IV)
```

8.2 Digital Signature Algorithms

DDSSEC12-90 - Meeting CNSSP-15 security requirements

SPIs may use digital signature algorithms for signing/validating identity-type certificates and attestation documents. They may also be used to sign messages to prove possession of a private key associated with a public key recognized the other party.

As examples, the builtin Authentication Plugin uses digital signature algorithms for signing/validating Identity Certificates as well as for signing/validating authentication challenge messages, see 10.3.2 and its subclauses. Likewise, the builtin Access Control Plugin uses digital signature algorithms for validating Governance and Permission documents, see 10.4.2 and its subclauses.

The table below defines the set of digital signature algorithms available to the SPIs.

Table 25 – Digital Signature Algorithm identifiers and description

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CryptoAlgorithm Name	*CryptoAlgorithm Id*	*CryptoAlgorithm Bit*	*Description*
RSASSA-PSS-MGF1SHA256+2048+SHA256 **RSA-2048** (deprecated in v 1.2) **RSASSA-PSS-SHA256** (deprecated in v 1.2)	**0x10**	**0x0001 << 0**	2048-bit RSA key [44]. The digital signature shall be computed using the RSASSA-PSS algorithm specified in PKCS #1 [44], using SHA256 as hash function, and MGF1 with SHA256 (mgf1sha256) as mask generation function. The length of the salt is not specified. Plugin implementations may use permissible value. The validation of the signature shall detect the salt length from the signature. Non-normative: In OpenSSL the “auto” option used when verifying a signature causes the salt length to be deduced from the signature itself.
RSASSA-PKCS1-V1_5+2048+SHA256	**0x11**	**0x0001 << 1**	2048-bit RSA key [44]. The digital signature shall be computed using the RSASSA-PKCS1-v1_5 algorithm specified in PKCS #1[44], using SHA256 as hash function.
ECDSA+P256+SHA256 **EC-prime256v1** (deprecated in version 1.2) **ECDSA-SHA256** (deprecated in version 1.2)	**0x12**	**0x0001 << 2**	256-bit Elliptic Curve Key for the secp256r1 curve [57], also known as the prime256v1 curve [41], also known as the NIST P-256 curve [42]. The digital signature shall be computed using the ECDSA-SHA256 algorithm specified in ANSI X9.62-2005 [41].
ECDSA+P384+SHA384	**0x13**	**0x0001 << 3**	384-bit Elliptic Curve Key for the secp384r1 curve [57] also known as the NIST P-384 curve [42]. The digital signature shall be computed using the ECDSA-SHA384 algorithm specified in ANSI X9.62-2005 [41].

The following symbolic constants are defined to facilitate the use of these algorithms by the SPIs.

```
/* Predefined values for CryptoAlgorithmName  */
const string CNAME_RSASSA_PSS_MGF1SHA256_2048_SHA256 =
      "RSASSA-PSS-MGF1SHA256+2048+SHA256";
const string CNAME_RSASSA_PKCS1_V15_2048_SHA256      =
      "RSASSA-PKCS1-V1_5+2048+SHA256";
const string CNAME_ECDSA_P256_SHA256_NAME            =
      "ECDSA+P256+SHA256";
const string CNAME_ECDSA_P384_SHA384                 =
      "ECDSA+P384+SHA384";

/* Predefined values for CryptoAlgorithmId  */
const CryptoAlgorithmId   CID_RSASSA_PSS_MGF1SHA256_2048_SHA256   = 0x10;
const CryptoAlgorithmId   CID_RSASSA_PKCS1_V15_2048_SHA256        = 0x11;
const CryptoAlgorithmId.  CID_ECDSA_P256_SHA256                   = 0x12;
const CryptoAlgorithmId   CID_ECDSA_P384_SHA384                   = 0x13;

/* Predefined values for CryptoAlgorithmBit  */
const CryptoAlgorithmBit  CBIT_RSASSA_PSS_MGF1SHA256_2048_SHA256  = 1 << 0;
const CryptoAlgorithmBit  CBIT_RSASSA_PKCS1_V15_2048_SHA256       = 1 << 1;
const CryptoAlgorithmBit  CBIT_ECDSA_P256_SHA256                  = 1 << 2;
const CryptoAlgorithmBit  CBIT_ECDSA_P384_SHA384                  = 1 << 3;
```

8.3 Key Establishment Algorithms

DDSSEC12-90 - Meeting CNSSP-15 security requirements

SPIs may use key establishment algorithms to establish a shared secret key between two Endpoints which can then be used to exchange point-to-point messages securely.

As an example, the builtin Authentication Plugin uses a key establishment algorithm as part of its authentication handshale to establish a SharedSecret between two Participants, see 10.3.3 and 10.3.4.

The table below defines the set of key establishment algorithms available to the SPIs.

Table 26 – Key Establishment Algorithm identifiers and description

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CryptoAlgorithm Name	*CryptoAlgorithm Id*	*CryptoAlgorithm Bit*	*Description*
DHE+MODP-2048-256 **DH+MODP-2048-256** (deprecated in v 1.2)	**0x20**	**0x0001 << 0**	The Diffie-Hellman Public Key shall be for the 2048-bit MODP Group with 256-bit Prime Order Subgroup, see IETF RFC 5114 [47], section 2.3. ***Non-normative****: The OpenSSL 1.0.2 operation DH_get_2048_256() retrieves the parameters for the 2048-bit MODP Group with 256-bit Prime Order Subgroup.* The Key Agreement Algorithm shall be the "dhEphem, C(2e, 0s, FFC DH) Scheme" defined in section 6.1.2.1 of NIST Special Publication 800-56A Revision 2 [48].
ECDHE-CEUM+P256 **ECDH+prime256v1** (deprecated in v 1.2)	**0x21**	**0x0001 << 1**	The Diffie-Hellman Public Key shall be for the NIST's EC Curve P-256 as defined in appendix D of FIPS 186-4 [42] also known as prime256v1 in ANSI X9.62-2005 [41]. The Key Agreement Algorithm shall be the "(Cofactor) Ephemeral Unified Model, C(2e, 0s, ECC CDH)" defined in section 6.1.2.2 of NIST Special Publication 800-56A Revision 2 [48]. See also section 3.1 "Ephemeral Unified Model" of NIST Suite B Implementer's Guide to NIST SP 800-56A [49].

ECDHE-CEUM+P384	**0x22**	**0x0001 << 2**	The Diffie-Hellman Public Key shall be for the NIST's EC Curve P-384 as defined in appendix D of FIPS 186-4 [42] also known as secp384r1 curve, see IETF 5480 [57]. The Key Agreement Algorithm shall be the "(Cofactor) Ephemeral Unified Model, C(2e, 0s, ECC CDH)" defined in section 6.1.2.2 of NIST Special Publication 800-56A Revision 2 [48]. See also section 3.1 "Ephemeral Unified Model" of NIST Suite B Implementer's Guide to NIST SP 800-56A [49].

DDSSEC12-56 - Encoding of Diffie-Hellman Public Key

A Diffie-Hellman public key may be represented as an OctetSeq for the purposes of including it in a BinaryProperties_t. In this scenario the following format shall be used:

If the public key corresponds to the "DHE+MODP-2048-256" crypto algorithm, then:

- The OctetSeq's value shall contain the big endian representation (an array of bytes) of the DH public key (a big number). Non normative: In OpenSSL 1.1.1, this can be obtained through the BN_bn2bin() API.
- The OctetSeq's length shall contain the size in bytes of the big endian representation of the DH public key. Non normative: In OpenSSL 1.1.1, this can be obtained through the BN_num_bytes() API.

If the public key corresponds to the "ECDHE-CEUM+P256" or "ECDHE-CEUM+P384" crypto algorithms, then:

- The OctetSeq's value shall contain the octet string representation of the ECDHE public key. The octet string representation encoding must conform with Sec. 2.3.3 "Elliptic-Curve-Point-to-Octet-String Conversion" of the SECG SEC 1 ("Elliptic Curve Cryptography") standard [X]. Non normative: In OpenSSL 1.1.1, this can be obtained through the EC_POINT_point2oct() API, passing POINT_CONVERSION_UNCOMPRESSED as the conversion form.
- The OctetSeq's length shall contain the length of the octet string. Non normative: In OpenSSL 1.1.1, this can be obtained as the return value of the EC_POINT_point2oct() API called to obtain the octet string representation.

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The following symbolic constants are defined to facilitate the use of these algorithms by the SPIs.

```
/* Predefined values for CryptoAlgorithmName  */
const string CNAME_DHE_MODP_2048_256   = "DHE+MODP-2048-256";
const string CNAME_ECDHE_CEUM_P256     = "ECDHE-CEUM+P256";
const string CNAME_ECDHE_CEUM_P384     = "ECDHE-CEUM+P384";

/* Predefined values for CryptoAlgorithmId  */
const CryptoAlgorithmId CID_DHE_MODP_2048_256     = 0x20;
const CryptoAlgorithmId CID_ECDHE_CEUM_P256       = 0x21;
const CryptoAlgorithmId CID_ECDHE_CEUM_P384       = 0x22;

/* Predefined values for CryptoAlgorithmBit  */
const CryptoAlgorithmBit CBIT_DHE_MODP_2048_256   =  1 << 0;
const CryptoAlgorithmBit CBIT_ECDHE_CEUM_P256     =  1 << 1;
const CryptoAlgorithmBit CBIT_ECDHE_CEUM_P384     =  1 << 2;
```

9 Plugin Architecture

9.1 Introduction

9.1.1 Service Plugin Interface Overview

There are five plugin SPIs: Authentication, Access-Control, Cryptographic, Logging, and Data Tagging.

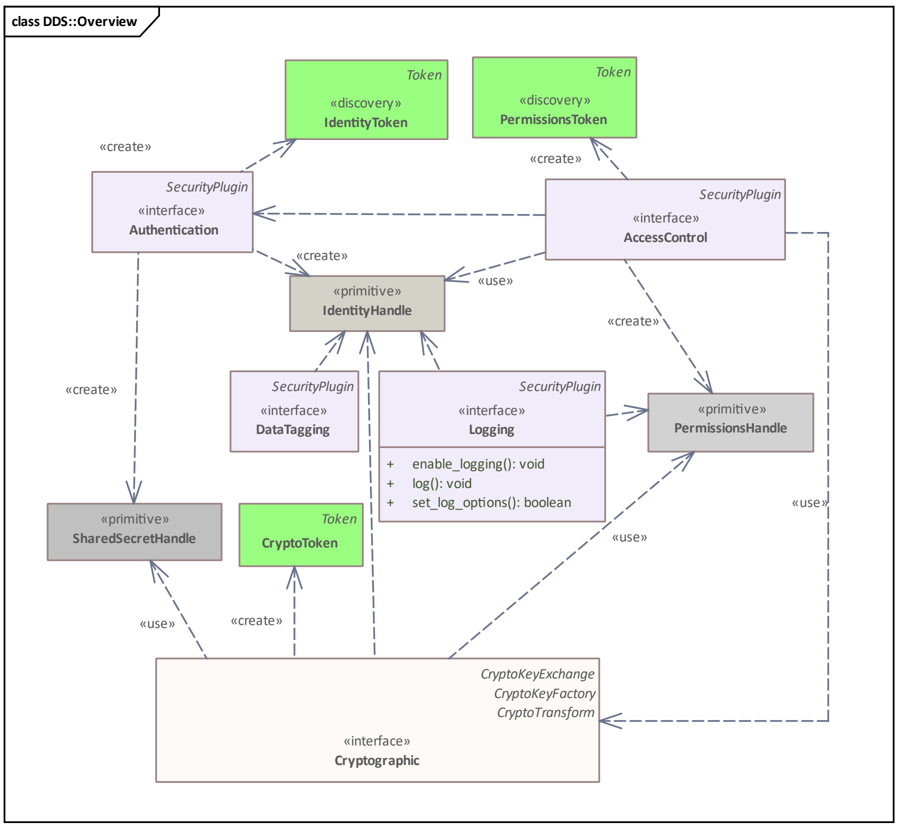

Figure 7 – Plugin Architecture Model

The responsibilities and interactions between these Service Plugins are summarized in the table below and detailed in the sections that follow.

Table 27 – Purpose of each Security Plugin

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Service Plugin	*Purpose*	*Interactions*
`Authentication`	Authenticate the principal that is joining a DDS Domain. Support mutual authentication between participants and establish a shared secret.	The principal may be an application/process or the user associated with that application or process.
`AccessControl`	Decide whether a principal is allowed to perform a protected operation.	Protected operations include joining a specific DDS domain, creating a Topic, reading a Topic, writing a Topic, etc.
`Cryptography`	Generate keys. Perform Key Exchange. Perform the encryption and decryption operations. Compute digests, compute and verify Message Authentication Codes. Sign and verify signatures of messages.	This plugin implements 3 complementary interfaces: CryptoKeyFactory, CryptoKeyExchange, and CryptoTransform.
`Logging`	Log all security relevant events.	This plugin is accessible to all other plugins such that they can log the relevant events.
`DataTagging`	Add a data tag for each data sample.	

9.1.2 Plugin Instantiation

The Security Plugins shall be configurable separately for each `DomainParticipant` even when multiple DomainParticipants are constructed within the same Operating System Process and share the same Address Space.

A collection of the 5 SPIs intended to be used with the same `DomainParticipant` is referred to as a DDS-Security Plugin Suite.

The mechanism used to instantiate the security Service Plugins and associate them with each `DomainParticipant` is not defined by the DDS-Security specification.

Implementations of this specification may use vendor-specific configurations to facilitate linking the Plugin Suite, including providing dynamic loading and linking facilities as well as initializing the Plugin Suite.

Likewise implementations of this specification may use vendor-specific configurations to bind a Plugin Suite to the `DomainParticipant.` However it is required for the Plugin Suite to be initialized and bound by the time the `DomainParticipant` is enabled. Therefore this process shall complete either during the `DomainParticipantFactory` `create_domain_participant` or else during the `DomainParticipant` `enable` operations defined in [1]. Note that some of the Plugin Suite Authentication and AccessControl operations shall also be called during `create_domain_participant` or during `enable`.

9.2 Common Types

9.2.1 Security Exception

`SecurityException` is a data type used to hold error information. `SecurityException` objects are potentially returned from many of the calls in the Security plugins. They are used to return an error code and message.

Table 28 – SecurityException class

SecurityException	
Attributes	
message	String
code	long
minor_code	long

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9.3 Authentication Plugin

The Authentication Plugin SPI defines the types and operations necessary to support the authentication of DDS DomainParticipants.

9.3.1 Background (Non-Normative)

Without the security enhancements, any DDS DomainParticipant is allowed to join a DDS Domain without authenticating. However, in the case of a secure DDS system, every DDS participant will be required to authenticate to avoid data contamination from unauthenticated participants.
The DDS protocol uses its native discovery mechanism to detect when participants enter the DDS Domain.
The discovery mechanism that registers participants with the DDS middleware is enhanced with an authentication protocol. For protected DDS Domains a DomainParticipant that enables the authentication plugin will only communicate with another DomainParticipant that has the authentication plugin enabled.
The plugin SPI is designed to support multiple implementations with varying numbers of message exchanges. The message exchanges may be used by two DomainParticipant entities to challenge each other so that their identity can be authenticated. Often a shared secret is also derived from a successful authentication message exchange. The shared secret can be used to exchange cryptographic materal in support of encryption and message authentication.

9.3.2 Authentication Plugin Model

The Authentication Plugin model is presented in the figure below.
DDSSEC12-90 - Meeting CNSSP-15 security requirements

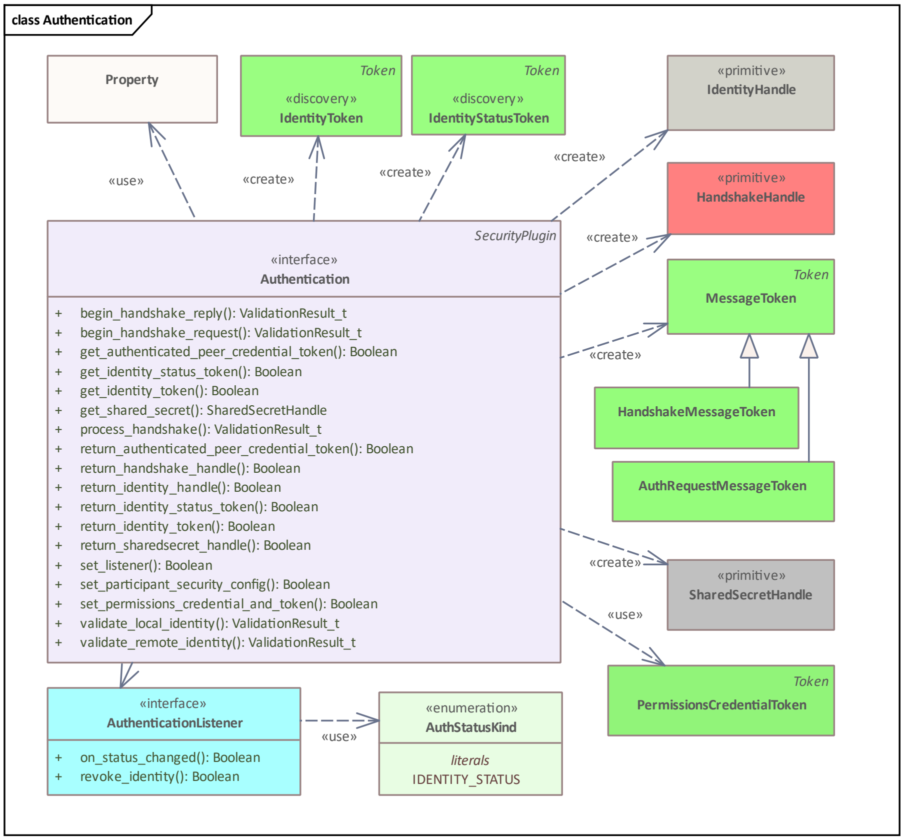

Figure 8 – Authentication plugin model

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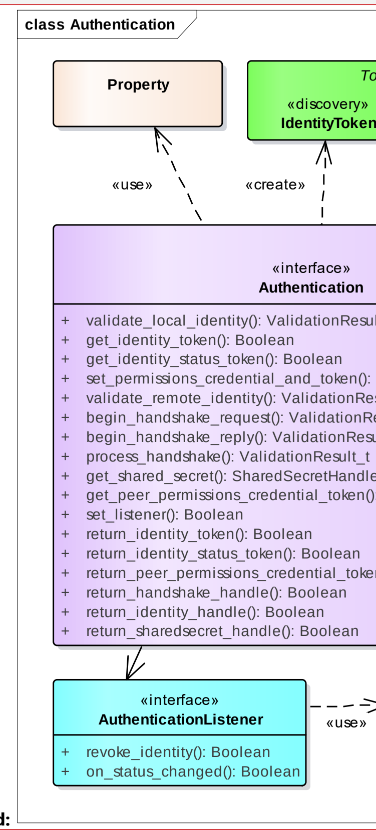

9.3.2.1 IdentityToken

An `IdentityToken` contains summary information on the identity of a `DomainParticipant` in a manner that can be externalized and propagated via DDS discovery. The specific content of the `IdentityToken` shall be defined by each `Authentication` plugin specialization. The intent is to provide only summary information on the permissions or derived information such as a hash.

9.3.2.2 IdentityStatusToken

An `IdentityStatusToken` contains authentication information of a `DomainParticipant` in a manner that can be externalized and propagated via the ***DCPSParticipantSecure*** builtin `Topic`. The specific content of the `IdentityStatusToken` shall be defined by each `Authentication` plugin. The intent is to provide a mechanism that can be used to securely send information to other participants that are already mutually authenticated. It could be used, for example, to provide an updated certificate in case the current one has expired.
The information shall be retrieved from the `Authentication` plugin by calling the operation `get_identity_status_token`. And included in the ***DCPSParticipantSecure*** builtin `Topic`.

The Authentication plugin can use the operation on_status_changed on the AuthenticationListener to notify that there is an updated IdentityStatusToken.

9.3.2.3 IdentityHandle

An IdentityHandle is an opaque local reference to internal state within the Authentication plugin, which uniquely identifies a DomainParticipant. It is understood only by the Authentication plugin and references the authentication state of the DomainParticipant. This object is returned by the Authentication plugin as part of the validation of the identity of a DomainParticipant and is used whenever a client of the Authentication plugin needs to refer to the identity of a previously identified DomainParticipant.

9.3.2.4 HandshakeHandle

A HandshakeHandle is an opaque local reference used to refer to the internal state of a possible mutual authentication or handshake protocol.

9.3.2.5 AuthRequestMessageToken

The AuthRequestMessageToken encodes plugin-specific information that the Authentication plugins associated with two DomainParticipant entities exchange to bootstrap the mutual authentication handshake. The AuthRequestMessageToken is understood only by the AuthenticationPlugin implementations on either side of the handshake. The AuthRequestMessageToken is sent and received by the DDS implementation under the direction of the AuthenticationPlugins.
The AuthRequestMessageToken has ***class_id*** set to GMCLASSID_SECURITY_AUTH_REQUEST (see 7.5.3.5).

9.3.2.6 HandshakeMessageToken

A HandshakeMessageToken encodes plugin-specific information that the Authentication plugins associated with two DomainParticipant entities exchange as part of the mutual authentication handshake. The HandshakeMessageToken is understood only by the AuthenticationPlugin implementations on either side of the handshake. The HandshakeMessageToken is sent and received by the DDS implementation under the direction of the AuthenticationPlugins.
The HandshakeMessageToken has ***class_id*** set to GMCLASSID_SECURITY_AUTH_HANDSHAKE (see 7.5.3.5).

9.3.2.7 AuthenticatedPeerCredentialToken

An AuthenticatedPeerCredentialToken encodes plugin-specific information that the Authentication plugin obtains from a remote DomainParticipant during the authentication process that is of interest to the AccessControlPlugin. This information is accessible via the operation get_authenticated_peer_credential_token.

9.3.2.8 SharedSecretHandle

A SharedSecretHandle is an opaque local reference to internal state within the AuthenticationPlugin containing a secret that is shared between the AuthenticationPlugin implementation and the peer AuthenticationPlugin implementation associated with a remote DomainParticipant. It is understood only by the two

AuthenticationPlugin implementations that share the secret. The shared secret is used to encode Tokens, such as the CryptoToken, such that they can be exchanged between the two DomainParticipants in a secure manner.

9.3.2.9 Authentication interface

DDSSEC12-90 - Meeting CNSSP-15 security requirements

This interface is the starting point for all the security mechanisms. When a DomainParticipant is either locally created or discovered, it needs to be authenticated in order to be able to communicate in a DDS Domain.

The interaction between the DDS implementation and the Authentication plugin has been designed in a flexible manner so it is possible to support various authentication mechanisms, including those that require a handshake and/or perform mutual authentication between participants. It also supports establishing a shared secret. This interaction is described in the state machine illustrated in the figure below.

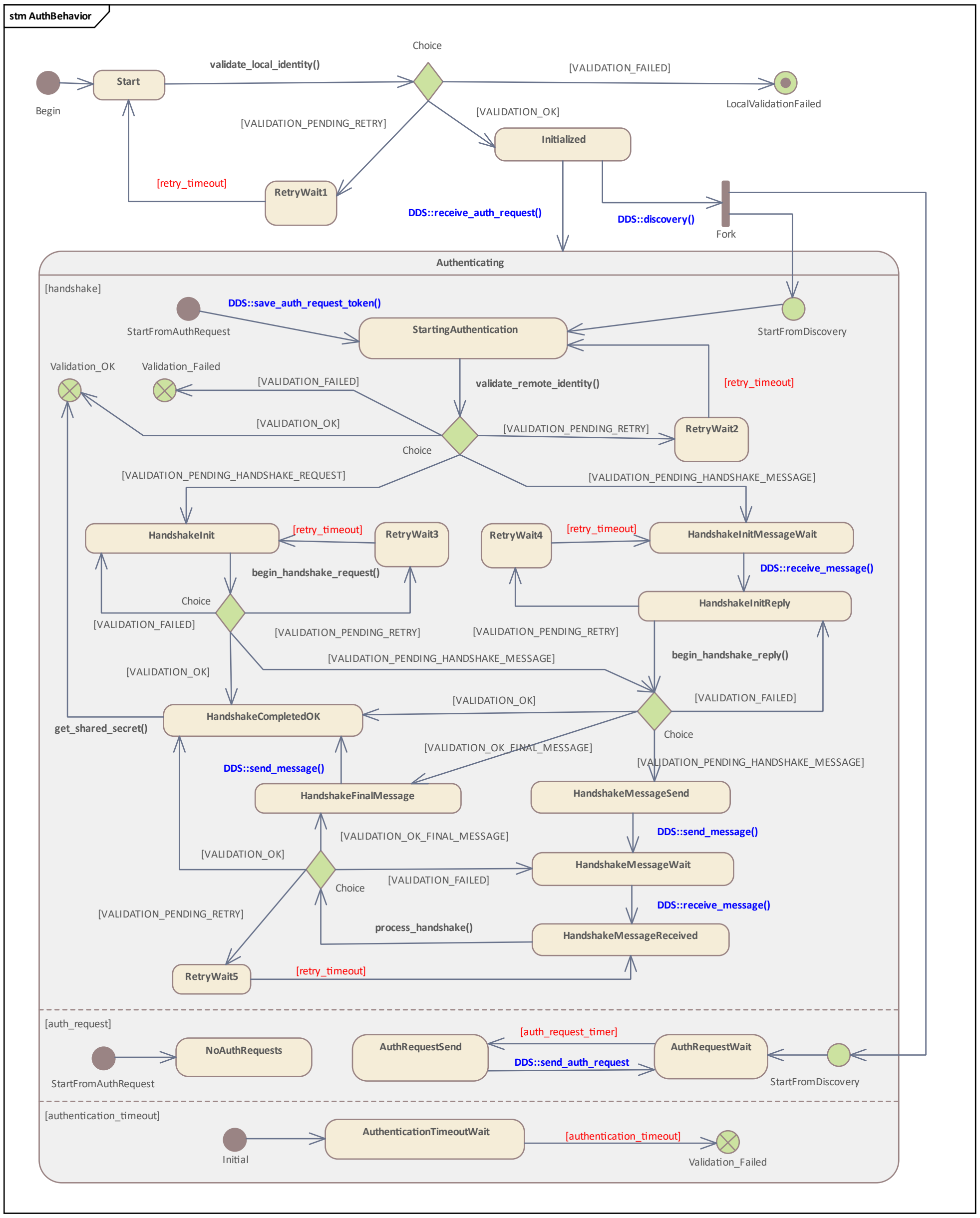

Figure 9 – Authentication plugin interaction state machine

9.3.2.9.1 Reliability of the Authentication Handshake

In order to be sufficiently robust to avert sequence number attacks (7.5.3.1), the Authentication Handshake uses the ***BuiltinParticipantStatelessMessageWriter*** and ***BuiltinParticipantStatelessMessageReader*** endpoints (7.5.3) with `GenericMessageClassId` set to GMCLASSID_SECURITY_AUTH_REQUEST or GMCLASSID_SECURITY_AUTH_HANDSHAKE (7.5.3.5). These stateless endpoints send messages best-effort without paying attention to any sequence number information to remove duplicates or attempt ordered delivery. Despite this, the Authentication Handshake needs to be able to withstand the message loss that may occur on the network.

In order to operate robustly in the presence of message loss and sequence number attacks DDS Security implementations shall follow the rules below:

1. The DDS security implementation shall pass to the AuthenticationPlugin any message received by the ***BuiltinParticipantStatelessMessageReader*** that has a `GenericMessageClassId` set to GMCLASSID_SECURITY_AUTH_REQUEST or GMCLASSID_SECURITY_AUTH_HANDSHAKE.
2. Any time the state-machine indicates that a message shall be sent using the ***BuiltinParticipantStatelessMessageWriter*** and a reply message needs to be received by the ***BuiltinParticipantStatelessMessageReader***, the DDS implementation shall cache the message that was sent and set a timer. If a correct reply message is not received when the timer expires, the state-machine shall send the same message again. This process shall be repeated multiple times until a correct message is received.
3. Whenever a message is sent using the ***BuiltinParticipantStatelessMessageWriter,*** a reply message is received by the ***BuiltinParticipantStatelessMessageReader***. The reply is then passed to the AuthenticationPlugin. If the plugin operation returns VALIDATION_NOT_OK, the implementation transitions back to the previous state that caused the message to be sent and resends the same message.

Rule #2 makes authentication robust to message loss.

Rule #3 makes authentication robust to an attacker trying to disrupt an authentication exchange by sending bad replies.

Example application of rule #2: Assume the DDS implementation transitioned to the *HandshakeMessageSend* state, sent the message M1 and is now in the *HandshakeMessageWait* state waiting for the reply. If no reply is received within an implementation-specific retry-time, the same message M1 shall be sent again and the process repeated until either a reply is received or an implementation-specific timeout elapses (or a maximum number of retries is reached).

Example application of rule #3: Assume the DDS implementation transitioned to the *HandshakeMessageSend* state, sent the message M2, transitions to *HandshakeMessageWait*, receives the reply, transitions to *HandshakeMessageReceived*, calls process_handshake() and the operation returns VALIDATION_NOT_OK. In this situation the DDS implementation shall transition back to *HandshakeMessageSend* and resent M2 again.

9.3.2.10 Unauthenticated DomainParticipant entities

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

The term "Unauthenticated" `DomainParticipant` entity refers to a discovered `DomainParticipant` that cannot be authenticated by the Authentication plugin. This can be either because they lack support for the `Authentication` plugin being used, have incompatible plugins, incompatible plugin configurations, or simply fail the authentication protocol.

All these cases shall be treated the same. Regardless of the reason, each particicipant shall treat the other as an “unauthenticated” participant and behave towards it according to what its own configuration specifies with respect to unauthenticated participants. See 9.8.3.

9.3.2.11 Authentication plugin interface

The `Authentication` plugin shall have the operations shown in the table below.
DDSSEC12-90 - Meeting CNSSP-15 security requirements

Table 29 – Authentication plugin interface

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Authentication		
No Attributes		
Operations		
`validate_local_identity`		`ValidationResult_t`
	`out: local_identity_handle`	`IdentityHandle`
	`out: adjusted_participant_guid`	`GUID_t`
	`domain_id`	`DomainId_t`
	`participant_qos`	`DomainParticipantQos`
	`candidate_participant_guid`	`GUID_t`
	`out: exception`	`SecurityException`
`get_identity_token`		`Boolean`
	`out: identity_token`	`IdentityToken`
	`handle`	`IdentityHandle`
	`out: exception`	`SecurityException`
`get_identity_status_token`		`Boolean`
	`out: identity_status_token`	`IdentityStatusToken`
	`handle`	`IdentityHandle`
	`out: exception`	`SecurityException`
`set_participant_security_config`		`Boolean`
	`out: adjusted_algorithm_info`	`ParticipantSecurityAlgorithmInfo`
	`handle`	`IdentityHandle`
	`participant_security_config`	`ParticipantSecurityConfig`
	`out: exception`	`SecurityException`

set_permissions_credential_and_token		Boolean
	handle	IdentityHandle
	permissions_credential_token	PermissionsCredentialToken
	permissions_token	PermissionsToken
	out: exception	SecurityException
validate_remote_identity		ValidationResult_t
	out: remote_identity_handle	IdentityHandle
	out: local_auth_request_token	AuthRequestMessageToken
	remote_auth_request_token	AuthRequestMessageToken
	local_identity_handle	IdentityHandle
	remote_identity_token	IdentityToken
	remote_participant_guid	GUID_t
	out: exception	SecurityException
begin_handshake_request		ValidationResult_t
	out: handshake_handle	HandshakeHandle
	out: handshake_message	HandshakeMessageToken
	initiator_identity_handle	IdentityHandle
	replier_identity_handle	IdentityHandle
	serialized_local_participant_data	octet[]
	out: exception	SecurityException
begin_handshake_reply		ValidationResult_t
	out: handshake_handle	HandshakeHandle
	out: handshake_message_out	HandshakeMessageToken
	handshake_message_in	HandshakeMessageToken
	initiator_identity_handle	IdentityHandle
	replier_identity_handle	IdentityHandle
	serialized_local_participant_data	octet[]
	out: exception	SecurityException
process_handshake		ValidationResult_t
	out: handshake_message_out	HandshakeMessageToken
	handshake_message_in	HandshakeMessageToken
	handshake_handle	HandshakeHandle
	out: exception	SecurityException
get_shared_secret		SharedSecretHandle
	handshake_handle	HandshakeHandle
	out: exception	SecurityException
get_authenticated_peer_credential_token		Boolean
	out: peer_credential_token	AuthenticatedPeerCredentialToken
	handshake_handle	HandshakeHandle
	out: exception	SecurityException
set_listener		Boolean
	listener	AuthenticationListener
	out: exception	SecurityException
return_identity_token		Boolean
	token	IdentityToken
	out: exception	SecurityException
return_identity_status_token		Boolean
	token	IdentityStatusToken
	out: exception	SecurityException
return_authenticated_peer_credential_token		Boolean
	peer_credential_token	AuthenticatedPeerCredentialToken
	out: exception	SecurityException
return_handshake_handle		Boolean
	handshake_handle	HandshakeHandle

	out: exception	SecurityException
return_identity_handle		Boolean
	identity_handle	IdentityHandle
	out: exception	SecurityException
return_sharedsecret_handle		Boolean
	sharedsecret_handle	SharedSecretHandle
	out: exception	SecurityException

9.3.2.11.1 Type: ValidationResult_t

Enumerates the possible return values of the `validate_local_identity` and `validate_remote_identity` operations.

Table 30 – Values for ValidationResult_t

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ValidationResult_t	
`VALIDATION_OK`	Indicates the validation has succeeded
`VALIDATION_FAILED`	Indicates the validation has failed
`VALIDATION_PENDING_RETRY`	Indicates that validation is still proceeding. The operation shall be retried at a later point in time.
`VALIDATION_PENDING_HANDSHAKE_REQUEST`	Indicates that validation of the submitted `IdentityToken` requires sending a handshake message. The DDS Implementation shall call the operation `begin_handshake_request` and send the `HandshakeMessageToken` obtained from this call using the ***BuiltinParticipantMessageWriter*** with `GenericMessageClassId` set to GMCLASSID_SECURITY_AUTH_HANDSHAKE.
`VALIDATION_PENDING_HANDSHAKE_MESSAGE`	Indicates that validation is still pending. The DDS Implementation shall wait for a message on the ***BuiltinParticipantMessageReader*** and, once this is received, call `process_handshake` to pass the information received in that message.
`VALIDATION_OK_FINAL_MESSAGE`	Indicates that validation has succeeded but the DDS Implementation shall send a final message using the ***BuiltinParticipantMessageWriter*** with `GenericMessageClassId` set to GMCLASSID_SECURITY_AUTH_HANDSHAKE.

9.3.2.11.2 Operation: `validate_local_identity`

Validates the identity of the local `DomainParticipant`. The operation returns as an output parameter the `IdentityHandle`, which can be used to locally identify the local Participant to the `Authentication Plugin`.

In addition to validating the identity, this operation also returns the `DomainParticipant` `GUID_t` that shall be used by the DDS implementation to uniquely identify the `DomainParticipant` on the network.

This operation shall be called before the `DomainParticipant` is enabled. It shall be called either by the implementation of `DomainParticipantFactory` `create_domain_participant` or `DomainParticipant` `enable` [1].

If an error occurs, this method shall return VALIDATION_FAILED and fill the `SecurityException`.

The method shall return either VALIDATION_OK if the validation succeeds, or VALIDATION_FAILED if it fails, or VALIDATION_PENDING_RETRY if the verification has not finished.

If VALIDATION_PENDING_RETRY has been returned, the operation shall be called again after a configurable delay to check the status of verification. This shall continue until the operation returns either VALIDATION_OK (if the validation succeeds), or VALIDATION_FAILED. This approach allows non-blocking interactions with services whose verification may require invoking remote services.

Parameter (out) local_identity_handle: A handle that can be used to locally refer to the Authenticated Participant in subsequent interactions with the `Authentication` plugin. The nature of the handle is specific to each `Authentication` plugin implementation. The handle will only be meaningful if the operation returns VALIDATION_OK.

Parameter (out) adjusted_participant_guid: The `GUID_t` that the DDS implementation shall use to uniquely identify the `DomainParticipant` on the network. The returned ***adjusted_participant_guid*** shall be the one that eventually appears in the ***participant_guid*** attribute of the `ParticipantBuiltinTopicData` sent via discovery.

Parameter domain_id: The DDS Domain Id of the `DomainParticipant`.

Parameter participant_qos: The `DomainParticipantQos` of the `DomainParticipant`.

Parameter candidate_participant_guid: The `GUID_t` that the DDS implementation would have used to uniquely identify the `DomainParticipant` if the Security plugins were not enabled.

Parameter exception: A `SecurityException` object.

Return: The operation shall return

- VALIDATION_OK if the validation was successful.
- VALIDATION_FAILED if it failed.
- VALIDATION_PENDING_RETRY if verification has not completed and the operation should be retried later.

9.3.2.11.3 Operation: `validate_remote_identity`

Initiates the process of validating the identity of the discovered remote `DomainParticipant`, represented as an `IdentityToken` object. The operation returns the `ValidationResult_t` indicating whether the validation succeeded, failed, or is pending a handshake. If the validation succeeds, an `IdentityHandle` object is returned, which can be used to locally identify the remote `DomainParticipant` to the `Authentication` plugin.

If the validation can be performed with the information passed and succeeds, the operation shall return VALIDATION_OK. If it can be performed with the information passed and it fails, it shall return VALIDATION_FAILED.

The validation of a remote participant might require the remote participant to perform a handshake. In this situation, the `validate_remote_identity` operation shall return VALIDATION_PENDING_HANDSHAKE_REQUEST or VALIDATION_PENDING_HANDSHAKE_MESSAGE.

If the operation returns VALIDATION_PENDING_HANDSHAKE_REQUEST, then the DDS implementation shall call the operation `begin_handshake_request` to continue the validation process.

If the operation returns VALIDATION_PENDING_HANDSHAKE_MESSAGE, then the DDS implementation shall wait until it receives a `ParticipantStatelessMessage` from the remote participant identified by the ***remote_participant_guid*** using the contents described in 9.3.2.11.5 and then call the operation `begin_handshake_reply`.

If an error occurs, this method shall return VALIDATION_FAILED and fill the `SecurityException`.

Parameter (out) remote_identity_handle: A handle that can be used to locally refer to the remote Authenticated Participant in subsequent interactions with the `AuthenticationPlugin`. The nature of the **remote_identity_handle** is specific to each `AuthenticationPlugin` implementation. The handle will only be provided if the operation returns something other than VALIDATION_FAILED.

Parameter (out) local_auth_request_token: An `AuthRequestMessageToken` to be sent using the ***BuiltinParticipantStatelessMessageWriter***. The contents shall be specified by each plugin

implementation. If the returned token is TokenNIL (see 7.3.5.3), the AuthRequestMessageToken shall not be sent.
Parameter remote_auth_request_token: The AuthRequestMessageToken received from the remote DomainParticipant that caused the authentication to begin. This token shall be NIL if the authentication was not initiated by the reception of an AuthRequestMessageToken.
Parameter remote_identity_token: A token received as part of ParticipantBuiltinTopicData, representing the identity of the remote DomainParticipant.
Parameter remote_participant_guid: GUID_t uniquely identifying the remote participant.
Parameter exception: A SecurityException object.
Return: The operation shall return:

- VALIDATION_OK if the validation was successful.
- VALIDATION_FAILED if it failed.
- VALIDATION_PENDING_HANDSHAKE_REQUEST if validation has not completed. If this is returned, the DDS implementation shall call begin_handshake_request, to continue the validation.
- VALIDATION_PENDING_HANDSHAKE_MESSAGE if validation has not completed. If this is returned, the DDS implementation shall wait for a message on the ***BuiltinParticipantMessageReader*** with the ***message_identity*** containing a ***source_guid*** that matches the ***remote_participant_guid*** and a ***message_class_id*** set to GMCLASSID_SECURITY_AUTH_HANDSHAKE.
- VALIDATION_PENDING RETRY if the validation has not completed. If this is returned, the operation should be called again at a later point in time to check the validation status.

9.3.2.11.4 Operation: begin_handshake_request

This operation is used to initiate a handshake. It shall be called by the DDS middleware solely as a result of having a previous call to validate_remote_identity returning VALIDATION_PENDING_HANDSHAKE_REQUEST.
This operation returns a HandshakeMessageToken that shall be used to send a handshake to the remote participant identified by the ***replier_identity_handle***.
The contents of the HandshakeMessageToken are specified by the plugin implementation.
If an error occurs, this method shall return VALIDATION_FAILED and fill the SecurityException.
Parameter (out) handshake_handle: A handle returned by the Authentication plugin used to keep the state of the handshake. It is passed to other operations in the Authentication plugin.
Parameter (out) handshake_message_token: A HandshakeMessageToken to be sent using the ***BuiltinParticipantMessageWriter***. The contents shall be specified by each plugin implementation.
Parameter initiator_identity_handle: Handle to the local participant that originated the handshake.
Parameter replier_identity_handle: Handle to the remote participant whose identity is being validated.
Parameter serialized_local_participant_data: CDR Big Endian Serialization for the ParticipantBuiltInTopicDataSecure object associated with the local DomainParticipant.
Parameter exception: A SecurityException object.
Return: The operation shall return:

- VALIDATION_OK if the validation was successful.
- VALIDATION_FAILED if it failed.

- VALIDATION_PENDING_HANDSHAKE_MESSAGE if validation has not completed. If this is returned, the DDS implementation shall send the ***handshake_message_out*** using the ***BuiltinParticipantMessageWriter*** and then wait for the reply message on the ***BuiltinParticipantMessageReader***. The DDS implementation shall set the `ParticipantStatelessMessage participantGuidPrefix` message_class_id to GMCLASSID_SECURITY_AUTH_HANDSHAKE and fill the ***message_data*** with the ***handshake_message*** `HandshakeMessageToken` and set the ***destination_participant_guid*** to match the DDS `GUID_t` of the destination `DomainParticipant`. When the reply message is received the DDS implementation shall call the operation `begin_handshake_reply`, to continue the validation.
- VALIDATION_OK_FINAL_MESSAGE if the validation succeeded. If this is returned, the DDS implementation shall send the returned ***handshake_message*** using the ***BuiltinParticipantMessageReader***.
- VALIDATION_PENDING RETRY if the validation has not completed. If this is returned, the DDS implementation shall call the operation again at a later point in time to check the validation status.

In the cases where the return code indicates that a message shall be sent using the ***BuiltinParticipantMessageWriter***, the DDS implementation shall set the `ParticipantStatelessMessage` as follows:

- The ***message_class_id*** shall be set to `GMCLASSID_SECURITY_AUTH_HANDSHAKE`.
- The ***destination_participant_guid*** shall be set to match the DDS `GUID_t` of the destination `DomainParticipant`.
- The ***message_identity*** shall be set to have the ***source_guid*** matching the DDS `GUID_t` of the `DomainParticipant` that is sending the message and the ***sequence_number*** to the value in the previous message sent by the ***BuiltinParticipantMessageWriter***, incremented by one.
- The ***related_message_identity*** shall be set with ***source_guid*** as ***GUID_UNKNOWN*** and ***sequence_number*** to zero.
- The ***message_data*** shall be filled with the ***handshake_message*** `HandshakeMessageToken`.

9.3.2.11.5 Operation: `begin_handshake_reply`

This operation shall be invoked by the DDS implementation in reaction to the reception of the initial handshake message that originated on a `DomainParticipant` that called the `begin_handshake_request` operation. It shall be called by the DDS implementation solely as a result of having a previous call to `validate_remote_identity` returns VALIDATION_PENDING_HANDSHAKE_MESSAGE and having received a message on the ***BuiltinParticipantMessageReader*** with attributes set as follows:

- ***message_class_id*** `GMCLASSID_SECURITY_AUTH_HANDSHAKE`
- ***message_identity source_guid*** matching the `GUID_t` of the `DomainParticipant` associated with the ***initiator_identity_handle***
- ***destination_participant_guid*** matching the `GUID_t` of the receiving `DomainParticipant`

This operation generates a ***handshake_message_out*** in response to a received ***handshake_message_in***. Depending on the return value of the operation, the DDS implementation shall send the ***handshake_message_out*** using the ***BuiltinParticipantMessageWriter*** to the participant identified by the ***initiator_identity_handle***.
The contents of the ***handshake_message_out*** `HandshakeMessageToken` are specified by the plugin implementation.

If an error occurs, this method shall return VALIDATION_FAILED and fill the `SecurityException`.

Parameter (out) handshake_handle: A handle returned by the Authentication Plugin used to keep the state of the handshake. It is passed to other operations in the Plugin.

Parameter (out) handshake_message_out: A `HandshakeMessageToken` containing a message to be sent using the ***BuiltinParticipantMessageWriter***. The contents shall be specified by each plugin implementation.

Parameter handshake_message_in: A `HandshakeMessageToken` containing a message received from the ***BuiltinParticipantMessageReader***. The contents shall be specified by each plugin implementation.

Parameter initiator_identity_handle: Handle to the remote participant that originated the handshake.

Parameter replier_identity_handle: Handle to the local participant that is initiating the handshake response.

Parameter serialized_local_participant_data: CDR Big Endian Serialization for the `ParticipantBuiltInTopicDataSecure` object associated with the local `DomainParticipant`.

Parameter exception: A `SecurityException` object.

Return: The operation shall return:

- VALIDATION_OK if the validation was successful.
- VALIDATION_FAILED if it failed.
- VALIDATION_PENDING_HANDSHAKE_MESSAGE if validation has not completed. If this is returned, the DDS implementation shall send the ***handshake_message_out*** using the ***BuiltinParticipantMessageWriter*** and then wait for a reply message on the ***BuiltinParticipantMessageReader*** from that remote `DomainParticipant`.
- VALIDATION_OK_FINAL_MESSAGE if the validation succeeded. If this is returned, the DDS implementation shall send the returned ***handshake_message_out*** using the ***BuiltinParticipantMessageWriter***.
- VALIDATION_PENDING RETRY if the validation has not completed. If this is returned, the DDS implementation shall call the operation again at a later point in time to check the validation status.

In cases where the return code indicates that a message shall be sent using the ***BuiltinParticipantMessageWriter***, the DDS implementation shall set the `ParticipantStatelessMessage` as follows:

- The ***message_class_id*** shall be set to `GMCLASSID_SECURITY_AUTH_HANDSHAKE`.
- The ***destination_participant_guid*** shall be set to match the DDS `GUID_t` of the destination `DomainParticipant`.
- The ***message_identity*** shall be set to have the ***source_guid*** matching the DDS `GUID_t` of the `DomainParticipant` that is sending the message and the ***sequence_number*** to the value in the previous message sent by the ***BuiltinParticipantMessageWriter***, incremented by one.
- The ***related_message_identity*** shall be set to match the ***message_identity*** of the `ParticipantStatelessMessage` received that triggered the execution of the `begin_handshake_reply` operation.
- The ***message_data*** shall be filled with the ***handshake_message_out*** `HandshakeMessageToken`.

9.3.2.11.6 Operation: `process_handshake`

This operation is used to continue a handshake. It shall be called by the DDS middleware solely as a result of having a previous call to ***begin_handshake_request*** or ***begin_handshake_reply*** that returned VALIDATION_PENDING_HANDSHAKE_MESSAGE and having also received a

ParticipantStatelessMessage on the ***BuiltinParticipantMessageReader*** with attributes set as follows:

- ***message_class_id*** GMCLASSID_SECURITY_AUTH_HANDSHAKE
- ***message_identity source_guid*** matching the GUID_t of the peer DomainParticipant associated with the ***handshake_handle***
- ***related_message_identity*** matching the ***message_identity*** of the last ParticipantStatelessMessage sent to the peer DomainParticipant associated with the ***handshake_handle***.
- ***destination_participant_guid*** matching the GUID_t of the receiving DomainParticipant.

This operation generates a ***handshake_message_out*** HandshakeMessageToken in response to a received ***handshake_message_in*** HandshakeMessageToken. Depending on the return value of the function the DDS implementation shall send the ***handshake_message_out*** using the ***BuiltinParticipantMessageWriter*** to the peer participant identified by the ***handshake_handle***.
The contents of the ***handshake_message_out*** HandshakeMessageToken are specified by the plugin implementation.
If an error occurs, this method shall return VALIDATION_FAILED and fill the SecurityException.
Parameter (out) handshake_message_out: A HandshakeMessageToken containing the ***message_data*** that should be placed in a ParticipantStatelessMessage to be sent using the ***BuiltinParticipantMessageWriter***. The contents shall be specified by each plugin implementation.
Parameter handshake_message_in: The HandshakeMessageToken contained in the ***message_data*** attribute of the ParticipantStatelessMessage received**.** The interpretation of the contents shall be specified by each plugin implementation.
Parameter handshake_handle: Handle returned by a corresponding previous call to ***begin_handshake_request*** or ***begin_handshake_reply***.
Parameter exception: A SecurityException object.
Return: The operation shall return:

- VALIDATION_OK if the validation was successful.
- VALIDATION_FAILED if it failed.
- VALIDATION_PENDING_HANDSHAKE_MESSAGE if validation has not completed. If this is returned, the DDS implementation shall send a ParticipantStatelessMessage continuing the returned ***handshake_message_out*** using the ***BuiltinParticipantMessageWriter*** and then wait for a reply message on the ***BuiltinParticipantMessageReader*** from that remote DomainParticipant.
- VALIDATION_OK_FINAL_MESSAGE if the validation succeeded. If this is returned, the DDS implementation shall send a ParticipantStatelessMessage containing the returned ***handshake_message_out*** using the ***BuiltinParticipantMessageWriter*** but not wait for any replies**.**
- VALIDATION_PENDING RETRY if the validation has not completed. If this is returned, the DDS implementation shall call the operation again at a later point in time to check the validation status.

In the cases where the return code indicates that a ParticipantStatelessMessage shall be sent using the ***BuiltinParticipantMessageWriter*** the DDS implementation shall set the fields of the ParticipantStatelessMessage as follows:

- The ***message_class_id*** shall be set to GMCLASSID_SECURITY_AUTH_HANDSHAKE.
- The ***destination_participant_guid*** shall be set to match the DDS GUID_t of the destination DomainParticipant.

- The ***message_identity*** shall be set to have the ***source_guid*** matching the DDS GUID_t of the DomainParticipant that is sending the message and the ***sequence_number*** to the value in the previous message sent by the ***BuiltinParticipantMessageWriter***, incremented by one.
- The ***related_message_identity*** shall be set to match the ***message_identity*** of the ParticipantStatelessMessage received that triggered the execution of the begin_handshake_reply operation.
- The ***message_data*** shall be filled with the ***handshake_message_out*** HandshakeMessageToken.

9.3.2.11.7 Operation: get_shared_secret

Retrieves the SharedSecretHandle resulting with a successfully completed handshake.
This operation shall be called by the DDS middleware on each HandshakeHandle after the handshake that uses that handle completes successfully, that is after the last 'handshake' operation called on that handle (begin_handshake_request, begin_handshake_reply, or process_handshake) returns VALIDATION_OK or VALIDATION_OK_FINAL_MESSAGE.
The retrieved SharedSecretHandle shall be used by the DDS middleware in conjunction with the CryptoKeyExchange interface of the Cryptographic Plugin to exchange cryptographic key material with other DomainParticipant entities.
If an error occurs, this method shall return the NILHandle and fill the SecurityException.
Parameter handshake_handle: Handle returned by a corresponding previous call to ***begin_handshake_request*** or ***begin_handshake_reply***, which has successfully completed the handshake operations.
Parameter exception: A SecurityException object.

9.3.2.11.8 Operation: get_authenticated_peer_ credential_token

Retrieves the AuthenticatedPeerCredentialToken resulting with a successfully completed authentication of a discovered DomainParticipant.
This operation shall be called by the DDS middleware on each HandshakeHandle after the handshake that uses that handle completes successfully, that is after the last 'handshake' operation called on that handle (begin_handshake_request, begin_handshake_reply, or process_handshake) returns VALIDATION_OK or VALIDATION_OK_FINAL_MESSAGE.
If an error occurs, this method shall return false and fill the SecurityException.
Parameter peer_credential_token (out): A placeholder for the returned AuthenticatedPeerCredentialToken.
Parameter handshake_handle: HandshakeHandle returned by a corresponding previous call to begin_handshake_request or begin_handshake_reply, which has successfully completed the handshake operations.
Parameter exception: A SecurityException object.

9.3.2.11.9 Operation: get_identity_token

Retrieves an IdentityToken used to represent on the network the identity of the DomainParticipant identified by the specified IdentityHandle.
Parameter identity_token (out): The returned IdentityToken.
Parameter handle: The handle used to locally identify the DomainParticipant for which an IdentityToken is desired. The handle must have been returned by a successful call to validate_local_identity, otherwise the operation shall return false and fill the SecurityException.
Parameter exception: A SecurityException object.

Return: If an error occurs, this method shall return `false` and fill the `SecurityException`. Otherwise it shall return the `IdentityToken`.

9.3.2.11.10 Operation: get_identity_status_token

Retrieves an `AuthenticationToken` used to represent on the network the authentication state of the `DomainParticipant` identified by the specified `IdentityHandle`.
Parameter identity_token (out): The returned `IdentityStatusToken`.
Parameter handle: The handle used to locally identify the `DomainParticipant` for which an `IdentityStatusToken` is desired. The handle must have been returned by a successful call to `validate_local_identity`, otherwise the operation shall return false and fill the `SecurityException`.
Parameter exception: A `SecurityException` object.
Return: If an error occurs, this method shall return `false` and fill the `SecurityException`. Otherwise it shall return the `IdentityStatusToken`.

9.3.2.11.11 Operation: set_participant_security_config

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Configures various aspects of the Authentication algorithm used by the `Authentication` plugin and retrieves an updated `ParticipantSecurityAlgorithmInfo` that contains the cryptographic algorithms used and supported by the `Authentication` plugin.
The operation shall be called by the middleware after calling `validate_local_identity` on the `Authentication` plugin and calling the `get_participant_security_config` on the `AccessControl` plugin, `AccessControl` interface.
The `Authentication` plugin shall configure itself according to the content of the *participant_security_config* parameter, including limiting the cryptographic algorithms used to those that appear in the *supported_mask* of the *participant_security_config* parameter field *algorithm_info* of type `ParticipantSecurityAlgorithmInfo` (see 7.3.14).
For instance, the `Authentication` plugin shall limit the Key Establishment algorithms used to those that appear in the member *algorithm_info.key_establishment_info. supported_mask* and likewise for the other kinds of cryptographic algorithms.
If the `Authentication` plugin is not able to restrict the algorithms used as specified in the *participant_security_config.algorithm_info* the operation shall fail and return an exception.
The `ParticipantSecurityAlgorithmInfo` returned in the *adjusted_algorithm_info* (output) parameter shall be used to configure the fields of the `ParticipantBuiltinTopicData` sent using the `DCPSParticipants` builtin Topic.
Parameter handle: The handle used to locally identify the `DomainParticipant`. The handle must have been returned by a successful call to `validate_local_identity`, otherwise the operation shall return false and fill the `SecurityException`.
Parameter adjusted_algorithm_info (out): The parameter shall be shall be initialized with a copy of the *participant_security_config.algorithm_info* (input) parameter. Subsequently the operation shall:
Add any cryptographic algorithm that may be used by the plugin to the *required_mask* for the corresponding algorithm kind. For example it shall add any algorithm it used for Key Establismment to the *adjusted_algorithm_info.key_establishment_info.required_mask.*
Remove any cryptographic algorithm not supported by the plugin from the *supported_mask* for the corresponding algorithm kind. For example it shall remove Key Establismment algorithms it does not support from the *adjusted_algorithm_info.key_establishment_info.supported_mask.*

Parameter participant_security_config (in): This parameter shall match the value of the ***participant_security_config*** parameter returned from calling `get_participant_security_config` on the AccessControl plugin, `AccessControl` interface.
Parameter exception: A `SecurityException` object.
Return: If an error occurs, this method shall return `false` and fill the `SecurityException`. Otherwise it shall fill the **adjusted_algorithm_info**.

9.3.2.11.12 Operation: `set_permissions_credential_and_token`

Associates the `PermissionsCredentialToken` (see 9.4.2.2) returned by the `AccessControl` plugin operation `get_permissions_credential_token` with the local `DomainParticipant` identified by the `IdentityHandle`.
This operation shall be called by the middleware after calling `validate_local_identity` and prior to any calls to `validate_remote_identity`.
Parameter handle: The handle used to locally identify the `DomainParticipant` whose `PermissionsCredential` is being supplied. The handle must have been returned by a successful call to ***validate_local_identity***, otherwise the operation shall return false and fill the `SecurityException`.
Parameter permissions_credential_token: The `PermissionsCredentialToken` associated with the `DomainParticipant` identified by the `IdentityHandle`. The ***permissions_credential_token*** must have been returned by a successful call to `get_permissions_credential_token`, on the `AccessControl` plugin. Otherwise the operation shall return false and fill the `SecurityException`.
Parameter exception: A `SecurityException` object.
Return: If an error occurs, this method shall return `false`, otherwise it shall return `true`.

9.3.2.11.13 Operation: set_listener

Sets the `AuthenticationListener` that the `Authentication` plugin will use to notify the DDS middleware infrastructure of events relevant to the Authentication of DDS Participants.
If an error occurs, this method shall return `false` and fill the `SecurityException`.
Parameter listener: An `AuthenticationListener` object to be attached to the `Authentication` object. If this argument is `nil`, it indicates that there shall be no listener.
Parameter exception: A `SecurityException` object, which provides details in case the operation returns `false`.

9.3.2.11.14 Operation: return_identity_token

Returns the `IdentityToken` object to the plugin so it can be disposed of.
Parameter token: An `IdentityToken` issued by the plugin on a prior call to `get_identity_token`.
Parameter exception: A `SecurityException` object, which provides details in the case this operation returns `false`.

9.3.2.11.15 Operation: return_identity_status_token

Returns the `IdentityStatusToken` object to the plugin so it can be disposed of.
Parameter token: An `IdentityStatusToken` issued by the plugin on a prior call to `get_identity_status_token`.

Parameter exception: A `SecurityException` object, which provides details in the case this operation returns `false`.

9.3.2.11.16 Operation: return_authenticated_peer_credential_token

Returns the `AuthenticatedPeerCredentialToken` object to the plugin so it can be disposed of.
Parameter peer_credential_token: An `AuthenticatedPeerCredentialToken` issued by the plugin on a prior call to `get_authenticated_peer_credential_token`.
Parameter exception: A `SecurityException` object, which provides details in the case this operation returns `false`.

9.3.2.11.17 Operation: return_handshake_handle

Returns the `HandshakeHandle` object to the plugin so it can be disposed of.
Parameter handshake_handle: A `HandshakeHandle` issued by the plugin on a prior call to ***begin_handshake_request*** or ***begin_handshake_reply***.
Parameter exception: A `SecurityException` object, which provides details in the case this operation returns `false`.

9.3.2.11.18 Operation: return_identity_handle

Returns the `IdentityHandle` object to the plugin so it can be disposed of.
Parameter identity_handle: An `IdentityHandle` issued by the plugin on a prior call to ***validate_local_identity*** or ***validate_remote_identity***.
Parameter exception: A `SecurityException` object, which provides details in the case this operation returns `false`.

9.3.2.11.19 Operation: return_sharedsecret_handle

Returns the `SharedSecretHandle` object to the plugin so it can be disposed of.
Parameter sharedsecret_handle: An `IdentityHandle` issued by the plugin on a prior call to ***get_shared_secret***.
Parameter exception: A `SecurityException` object, which provides details in the case this operation returns `false`.

9.3.2.12 AuthenticationListener

The `AuthenticationListener` provides the means for notifying the DDS middleware infrastructure of events relevant to the authentication of DDS `DomainParticipant` entities. For example, identity certificates can expire; in this situation, the `AuthenticationPlugin` shall call the `AuthenticationListener` to notify the DDS implementation that the identity of a specific `DomainParticipant` is being revoked.

Table 31 – Authentication listener class

Deleted: 313130

AuthenticationListener		
No Attributes		
Operations		
`on_revoke_identity`		`Boolean`
	`plugin`	`Authentication`
	`handle`	`IdentityHandle`
	`out: exception`	`SecurityException`
`on_status_changed`		`void`
	`plugin`	`Authentication`

	handle	IdentityHandle
	status_kind	AuthStatusKind
	out: exception	SecurityException

9.3.2.12.1 Enumeration: AuthStatusKind

The AuthStatusKind enumerates the kind of changes to the status of the Authentication plugin or underlying Identity that are notified via the AuthenticationListener operation on_status_changed. The possible values are described in the table below:

Table 32 – Description of the AuthStatusKind values

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Value	Meaning
IDENTITY_STATUS	Indicates a change to an identity status. Identity Status changes are represented externally to the Authentication plugin with an IdentityStatusToken that can be retrieved via the operation get_identity_status_token on the Authentication interface. The changed IdentityStatusToken shall be propagated by the DDS implementation to the other DomainParticipants using the ***DCPSParticipantsSecure*** builtin Topic.

9.3.2.12.2 Operation: on_revoke_identity

Revokes the identity of the participant identified by the IdentityHandle. The corresponding IdentityHandle becomes invalid. As a result of this, the DDS middleware shall terminate any communications with the DomainParticipant associated with that handle.

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The DDS middleware shall create a new revision of any Key Material that it had shared with the DomainParticipant identified by the IdentityHandle and send the revised Key Material to the remaining DomainParticipant entities (those whose identity has not been revoked) and had the previous revision of the Key Material. In other words, the DomainParticipant entities that are still authenticated and have the appropriate permissions to access the information protected by the regenerated Key Material.

The DDS middleware shall use the revised Key Material such that DomainParticipant that have not received the revision (e.g. the one whose identity has been revoked) are not able to decode the messages, even if they were to accidentally receive those messages (e.g. via multicast).

The DDS middleware may delay switching to the use of the revised Key Material until the other DomainParticipant entities have confirmed reception or sufficient time has elapsed.

To minimize the need for DataWriters to re-encrypt data stored in their caches, DataReaders with DURABILITY kind different from VOLATILE shall retail at least the last 8 revisions of the Key Material. Likewise, DataWriters shall not send messages that use KeyMaterial that is more than 7 revisions earlier than the current.

If an error occurs, this method shall return false.

Parameter plugin: An Authentication plugin object that has this listener allocated.

Parameter handle: An IdentityHandle object that corresponds to the Identity of a DDS Participant whose identity is being revoked.

9.3.2.12.3 Operation: on_status_changed

Informs the DomainParticipant that a status associated with the Authentication plugin or an Identity managed by the plugin has changed.

Depending on the kind of status the DDS implementation may need to take specific actions to retrieve information on the changed status and propagate it to other `DomainParticipant` entities. The actions that shall be taken for each kind of status are described in clause 9.3.2.12.1.

9.4 Access Control Plugin

The Access Control Plugin API defines the types and operations necessary to support an access control mechanism for DDS `DomainParticipants`.

9.4.1 Background (Non-Normative)

Once a `DomainParticipant` is authenticated, its permissions need to be validated and enforced. Permissions or access rights are often described using an access control matrix where the rows are subjects (i.e., users), the columns are objects (i.e., resources), and a cell defines the access rights that a given subject has over a resource. Typical implementations provide either a column-centric view (i.e., access control lists) or a row-centric view (i.e., a set of capabilities stored with each subject). With the proposed `AccessControl` SPI, both approaches can be supported.
Before we can describe the access control plugin SPI, we need to define the permissions that can be attached to a `DomainParticipant`. Every DDS application uses a `DomainParticipant` to access or produce information on a `Domain`; hence the `DomainParticipant` has to be allowed to run in a certain `Domain`. Moreover, a `DomainParticipant` is responsible for creating `DataReaders` and `DataWriters` that communicate over a certain `Topic`. Hence, a `DomainParticipant` has to have the permissions needed to create a `Topic`, to publish through its `DataWriters` certain `Topics`, and to subscribe via its `DataReaders` to certain `Topics`. There is a very strong relationship between the `AccessControl` plugin and the `Cryptographic` plugin because encryption keys need to be generated for `DataWriters` based on the `DomainParticipant`’s permissions.

9.4.2 AccessControl Plugin Model

The `AccessControl` plugin model is presented in the figure below.
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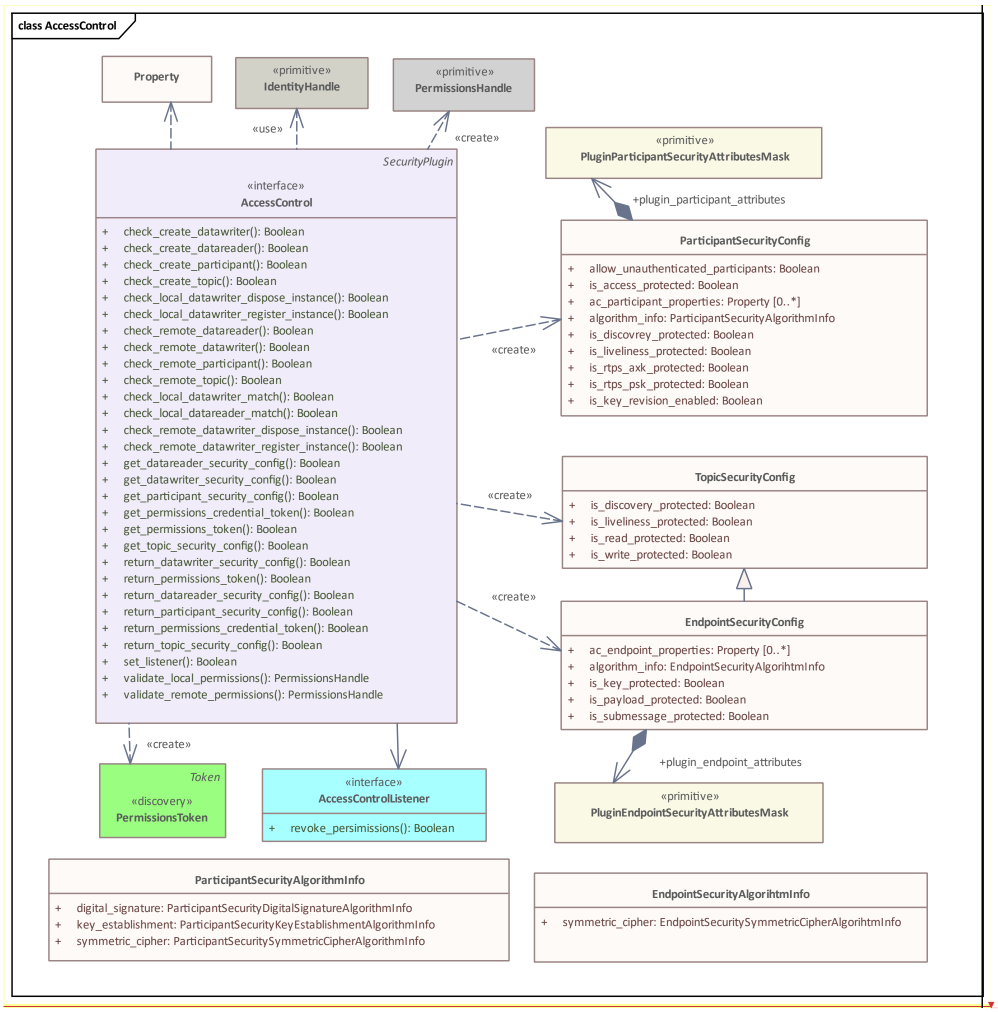

Figure 10 – AccessControl Plugin Model

9.4.2.1 PermissionsToken

A `PermissionsToken` contains summary information on the permissions for a `DomainParticipant` in a manner that can be externalized and propagated over DDS discovery. The specific content of the `PermissionsToken` shall be defined by each `AccessControlPlugin` specialization. The intent is to provide only summary information on the permissions or derived information such as a hash.

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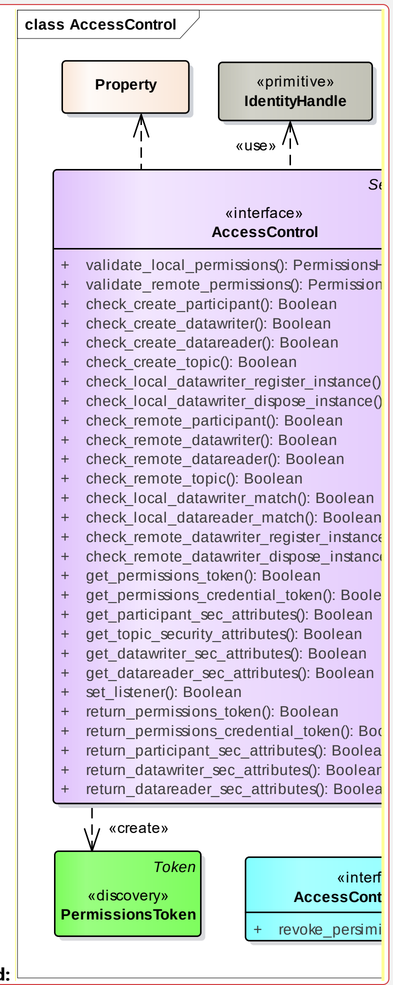

9.4.2.2 PermissionsCredentialToken

A `PermissionsCredentialToken` encodes the permissions and access information for a `DomainParticipant` in a manner that can be externalized and sent over the network. The `PermissionsCredential` is used by the `AccessControl` plugin to verify the permissions of a peer `DomainParticipant` and perform all the access-control decisions related to that peer `DomainParticipant`, including determining whether it can join a domain, match specific local `DataWriters` or `DataReaders`, etc.

The `PermissionsCredentialToken` is intended for dissemination during the authentication handshake. The specific content of the `PermissionsCredentialToken` shall be defined by each `AccessControl` plugin specialization and it may not be used by some `AccessControl` plugin specializations.

9.4.2.3 PermissionsHandle

A `PermissionsHandle` is an opaque local reference to internal state within the `AccessControl` plugin. It is understood only by the `AccessControl` plugin and characterizes the permissions associated with a specific `DomainParticipant`. This object is returned by the `AccessControl` plugin as part of the validation of the permissions of a `DomainParticipant` and is used whenever a client of the `AccessControl` plugin needs to refer to the permissions of a previously validated `DomainParticipant`.

9.4.2.4 ParticipantSecurityConfig

Deleted: ParticipantSecurityAttributes

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The `ParticipantSecurityConfig` describe how the middleware should protect the `DomainParticipant`. This is a structured type with the following IDL representation, whose members are described in Table 33 below:

Deleted: `ParticipantSecurityAttributes`

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DDSSEC12-122 – Provide mechanism for changing the session keys

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

```
@extensibility (APPENDABLE)
struct ParticipantSecurityConfig {
    boolean                                allow_unauthenticated_participants;
    boolean                                is_access_protected;
    boolean                                is_rtps_axk_protected;
    boolean                                is_rtps_psk_protected;
    boolean                                is_discovery_protected;
    boolean                                is_liveliness_protected;
    boolean                                is_key_revision_enabled;
    PluginParticipantSecurityAttributesMask plugin_participant_attributes;
    PropertySeq                            ac_endpoint_properties;
    ParticipantSecurityAlgorithmInfo       algorithm_info;
};
```

DDSSEC12-90 - Meeting CNSSP-15 security requirements

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

Table 33 – Description of the ParticipantSecurityConfig

Deleted: ParticipantSecurityAttributes

Member	Type	Meaning
allow_unauthenticated_participants	Boolean	Indicates whether the matching of the DomainParticipant with a remote DomainParticipant requires successful authentication.

		If ***allow_unauthenticated_participants*** is TRUE, the DomainParticipant shall allow matching other DomainParticipants—even if the remote DomainParticipant cannot authenticate—as long as there is not already a valid authentication with the same DomainParticipant's GUID. Additionally, a DomainParticipant that later authenticates would kick out the unauthenticated DomainParticipant if it has the same GUID. If ***allow_unauthenticated_participants*** is FALSE, the DomainParticipant shall enforce the authentication of remote DomainParticipants and disallow matching those that cannot be successfully authenticated.
is_access_protected	Boolean	Indicates whether the matching of the DomainParticipant with a remote DomainParticipant requires authorization by the AccessControl plugin. If ***is_access_protected*** is TRUE, then the DDS middleware shall call and `get_authenticated_peer_credential_token`, `validate_remote_permissions`, and `check_remote_participant` operations on the matched and authenticated remote DomainParticipant. Any failure in these calls will result in failing to authorize the remote participant, which shall be removed by the local participant. If ***is_access_protected*** is FALSE, then the DDS middleware shall call `get_authenticated_peer_credential_token` and `validate_remote_permissions` operations on the matched and authenticated remote DomainParticipant. However, a HandleNIL return from these operations will not prevent authorization.
is_rtps_axk_protected	Boolean	Indicates whether RTPS Non-Bootstrapping Messages (7.5.7) should be protected with a Participant Key created by the sending `DomainParticipant` and exchanged post-authentication. This "Autenticated Partcipant Exchanged Key" is generated and shared by the sending participant. If ***is_rtps_axk_protected*** is TRUE then: (1) ***allow_unauthenticated_participants*** must be FALSE. (2) The DDS middleware shall call the operations on the CryptoKeyFactory for the local DomainParticipant. (3) The DDS middleware shall call the operations on the CryptoKeyExchange for matched DomainParticipants that have been authenticated. (4) All RTPS non-bootstrapping messages sent by the DomainParticipant to matched DomainParticipants shall be transformed using the CryptoTransform operation `encode_rtps_message`. (5) All RTPS non-bootstrapping messages received shall be transformed using the CryptoTransform operation `decode_rtps_message`.
is_rtps_psk_protected	Boolean	Indicates whether all RTPS Messages (including RTPS Bootstrapping Messages) should be protected: RTPS Messages that are not otherwise protected by an "Authenticated Partcipant Exchanged Key" will be protected with a Pre-Shared Key. • If ***is_rtps_psk_protected*** is FALSE the RTPS Bootstrapping Messages messages will not be cryptographically protected even if ***is_rtps_axk_protected*** is set to TRUE. • If ***is_rtps_psk_protected*** is TRUE all RTPS messages will be cryptographically protected by either a pre-shared key or a "Autenticated Partcipant Exchanged Key." If ***is_rtps_psk_protected*** is TRUE, then: (1) The DDS middleware shall call the operations on the `CryptoKeyFactory` for the local `DomainParticipant`.

Deleted: Indicates whether the whole RTPS Message needs to be transformed by the CryptoTransform operation encode_rtps_message.¶

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Deleted: , except for RTPS messages that contain submessages for any of the following builtin topics ***"DCPSParticipants"***, ***"DCPSParticipantStatelessMessage"***, or ***"DCPSParticipantVolatileMessageSecure"***. These RTPS messages shall not be transformed by `encode_rtps_message`/`decode_rtps_message` operations.¶
(5) RTPS messages that contain submessages for the builtin topics ***"DCPSParticipants"***, ***"DCPSParticipantStatelessMessage"***, or ***"DCPSParticipantVolatileMessageSecure"*** cannot contain submessages for any other builtin topic or application-defined topic.¶
If ***is_rtps_protected*** is FALSE, then the above actions shall not be taken.

		(2) The DDS middleware shall call the operations on the `CryptoKeyExchange` for matched `DomainParticipants` (authenticated or not). (3) All RTPS messages sent shall be transformed using the `CryptoTransform` operation `encode_rtps_message` (4) All RTPS messages received shall be transformed using the `CryptoTransform` operation `decode_rtps_message`. If ***is_rtps_psk_protected*** is FALSE, then: (1) RTPS Bootstrapping Messages sent **shall NOT** be transformed using the `CryptoTransform` operation `encode_rtps_message` (2) RTPS Bootstrapping Messages received **shall NOT** be transformed using the `CryptoTransform` operation `decode_rtps_message`.
is_discovery_protected	Boolean	Indicates the DDS middleware shall call the operations on the `CryptoKeyFactory`, `CryptoKeyExchange`, and `CryptoTransform` for the ***DCPSPublicationsSecure*** and ***DCPSSubscriptionsSecure*** entities: If ***is_discovery_protected*** is TRUE, then the `CryptoKeyFactory`, `CryptoKeyExchange` operations shall be called for the ***DCPSPublicationsSecure*** and ***DCPSSubscriptionsSecure*** entities to create the associated cryptographic material and send it to the matched entities. If ***is_discovery_protected*** is FALSE, then the `CryptoKeyFactory`, `CryptoKeyExchange` and `CryptoTransform` operations will not be called. If ***is_discovery_protected*** is TRUE, the submessages sent by the ***DCPSPublicationsSecure*** and ***DCPSSubscriptionsSecure*** `DataWriters` shall be transformed using the `CryptoTransform` operation `encode_datawriter_submessage` and the messages received from the matched `DataReaders` shall be transformed using the `CryptoTransform` operation `decode_datareader_submessage`. If ***is_discovery_protected*** is TRUE, the submessages sent by the ***DCPSPublicationsSecure*** and ***DCPSSubscriptionsSecure*** DataReaders shall be transformed using the `CryptoTransform` operation `encode_datareader_submessage` and the messages received from the matched `DataWriters` shall be transformed using the `CryptoTransform` operation `decode_datawriter_submessage`. Independent of the setting of ***is_discovery_protected***, the `CryptoTransform` operations `encode_serialized_payload` and `decode_serialized_payload` shall never be called for the ***DCPSPublicationsSecure*** and ***DCPSSubscriptionsSecure*** entities.
is_liveliness_protected	Boolean	Indicates the DDS middleware shall call the operations on the `CryptoKeyFactory`, `CryptoKeyExchange`, and `CryptoTransform` for the ***BuiltinParticipantMessageSecure*** entities: If ***is_liveliness_protected*** is TRUE, then the `CryptoKeyFactory`, `CryptoKeyExchange` operations shall be called for the ***BuiltinParticipantMessageSecure*** entities to create the associated cryptographic material and send it to the matched entities. If ***is_liveliness_protected*** is FALSE, then the `CryptoKeyFactory`, ***CryptoKeyExchange*** and `CryptoTransform` operations will not be called. If ***is_liveliness_protected*** is TRUE, the submessages sent by the ***BuiltinParticipantMessageSecure*** `DataWriter` shall be transformed using the `CryptoTransform` operation `encode_datawriter_submessage` and

		the messages received from the matched `DataReaders` shall be transformed using the `CryptoTransform` operation `decode_datareader_submessage`. If ***is_liveliness_protected*** is TRUE, the submessages sent by the ***BuiltinParticipantMessageSecure*** `DataReader` shall be transformed using the `CryptoTransform` operation `encode_datareader_submessage` and the messages received from the matched `DataWriters` shall be transformed using the `CryptoTransform` operation `decode_datawriter_submessage`. Independent of the setting of ***is_liveliness_protected***, the `CryptoTransform` operations `encode_serialized_payload` and `decode_serialized_payload` shall never be called for the ***BuiltinParticipantMessageSecure*** entities.
is_key_revision_enabled	Boolean	Indicates the DDS middleware will revise Key Material for its entities when certain events are encountered (e.g. the identity of a matched DomainParticipant is revoked).
plugin_participant_attributes	PluginParticipantSecurityAttributesMask	This field is a holder for plugin-specific information that is propagated via discovery as part of the ParticipantSecurityInfo (see 7.3.23). The definition for the builtin plugins can be found in clause 10.4.2.4.
ac_participant_properties	PropertySeq	Additional properties to add to the ***participant_properties*** parameter passed to the `CryptoKeyFactory` operation `register_local_participant`. See 9.5.1.8.1. The returned ***ac_participant_properties*** and their interpretation shall be specified by each plugin implementation.
algorithm_info	ParticipantSecurityAlgorithmInfo	Cryptographic algorithms used and supported by the participant. See 7.3.14.

9.4.2.5 Definition of the ParticipantSecurityAttributesMask

DDSSEC12-90 - Meeting CNSSP-15 security requirements

The `ParticipantSecurityAttributesMask` is used to encode selected fields from the `ParticipantSecurityConfig` in a compact way such that it can be included in the `ParticipantSecurityInfo`, see 7.3.24.

This type has the following IDL representation:

```
typedef unsigned long ParticipantSecurityAttributesMask;
```

The mapping of the selected fields of the `ParticipantSecurityConfig` to `ParticipantSecurityAttributesMask` shall be as follows:

DDSSEC12-90 - Meeting CNSSP-15 security requirements

DDSSEC12-122 – Provide mechanism for changing the session keys

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

Table 34 – Mapping of fields ParticipantSecurityConfig to bits in ParticipantSecurityAttributesMask

Field in `ParticipantSecurityConfig`	Corresponding bit in the `ParticipantSecurityAttributesMask`
allow_unauthenticated_participants	No mapping
is_access_protected	No mapping
is_rtps_axk_protected	#define PARTICIPANT_SECURITY_ATTRIBUTES_FLAG_IS_RTPS_AXK_PROTECTED (0x00000001 << 0)

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is_discovery_protected	#define PARTICIPANT_SECURITY_ATTRIBUTES_FLAG_IS_DISCOVERY_PROTECTED (0x00000001 << 1)|
is_liveliness_protected	#define PARTICIPANT_SECURITY_ATTRIBUTES_FLAG_IS_LIVELINESS_PROTECTED (0x00000001 << 2)
is_key_revision_enabled	#define PARTICIPANT_SECURITY_ATTRIBUTES_FLAG_IS_KEY_REVISION_ENABLED (0x00000001 << 3)
is_rtps_psk_protected	#define PARTICIPANT_SECURITY_ATTRIBUTES_FLAG_IS_RTPS_PSK_PROTECTED (0x00000001 << 4)
is_valid	#define PARTICIPANT_SECURITY_ATTRIBUTES_FLAG_IS_VALID (0x00000001 << 31)|

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
DDSSEC12-122 – Provide mechanism for changing the session keys

Table 35 – Mapping of fields ParticipantSecurityConfig to bits in ParticipantSecurityOptionalAttributesMask

Field in `ParticipantSecurityConfig`	Corresponding bit in the `ParticipantSecurityOptionlAttributesMask` (applies to both `is_set` and `value` fields)
allow_unauthenticated_participants	#define PARTICIPANT_SECURITY_OPT_ATTRIBUTES_FLAG_ALLOW_UNAUTHENTICATED_PARTICIPANTS (0x0001 << 0)
is_access_protected	#define PARTICIPANT_SECURITY_OPT_ATTRIBUTES_FLAG_IS_ACCESS_PROTECTED (0x0001 << 1)
is_rtps_axk_protected	No mapping.
is_discovery_protected	No mapping.
is_liveliness_protected	No mapping.
is_key_revision_enabled	No mapping.
is_rtps_psk_protected	No mapping.
is_valid	No mapping.

9.4.2.6 TopicSecurityConfig

DDSSEC12-90 - Meeting CNSSP-15 security requirements

The `TopicSecurityConfig` describe how the middleware shall protect the Entity. This is a structured type with the following IDL representation, whose members are described in
DDSSEC12-90 - Meeting CNSSP-15 security requirements
DDSSEC12-86 - Secure TypeLookup Built-In Endpoints
Table 36 below:

```
@extensibility (APPENDABLE)
struct TopicSecurityConfig {
    boolean  is_read_protected;
    boolean  is_write_protected;
    boolean  is_discovery_protected;
    boolean  is_liveliness_protected;
};
```

DDSSEC12-90 - Meeting CNSSP-15 security requirements
DDSSEC12-86 - Secure TypeLookup Built-In Endpoints

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DDSSEC12-86 - Secure TypeLookup Built-In Endpoints¶
Table 36DDSSEC12-90 - Meeting CNSSP-15 security requirements¶
DDSSEC12-86 - Secure TypeLookup Built-In Endpoints¶
Table 36Table 34

Table 36 – Description of the TopicSecurityConfig

Member	Type	Meaning
is_read_protected	Boolean	Indicates if read access to the `Topic` is protected. If ***is_read_protected*** is FALSE, then local `DataReader` creation and remote `DataReader` matching can proceed without further access-control mechanisms imposed. Otherwise, they shall be checked using the `AccessControl` operations.
is_write_protected	Boolean	Indicates if read access to the `Topic` is protected. If ***is_write_protected*** is FALSE, then local `DataWriter` creation and remote `DataWriter` matching can proceed without further access-control mechanisms imposed. Otherwise, they shall be checked using the `AccessControl` operations.
is_discovery_protected	Boolean	Indicates if the discovery information for the entity shall be sent using a secure builtin discovery topics or the regular builtin discovery topics. If ***is_discovery_protected*** is TRUE, then discovery information for that entity shall be sent using the ***SEDPbuiltinPublicationsSecureWriter SEDPbuiltinSubscriptionsSecureWriter***. If ***is_discovery_protected*** is FALSE, then discovery information for that entity shall be sent using the ***SEDPbuiltinPublicationsWriter*** or ***SEDPbuiltinSubscriptionsWriter***. Also impacts which Types can be looked-up using the regular (non-secure) Builtin TypeLookup Endpoints and which require use of the Builtin Secure TypeLookup Endpoints (7.5.5): • If a type **belongs** to the set of "types an Endpoint depends on" for an Endpoint that has ***is_discovery_protected*** = FALSE, then information about the type's TypeObject and types it depends on can be looked up using the regular (non-secure) Builtin TypeLookup Endpoints as well as using the Secure Builtin TypeLookup Endpoints. • Otherwise, the information about the type's TypeObject and the and types it depends on can only be looked-up using the Secure Builtin TypeLookup Endpoints. See 7.5.6 for the definition of the "types an Endpoint depends on".
is_liveliness_protected	Boolean	The value of this attribute matters only if the `DataWriter LivelinessQos` policy is AUTOMATIC_LIVELINESS_QOS or MANUAL_BY_PARTICIPANT_LIVELINESS_QOS. In this case it indicates whether the liveliness information for the entity shall be sent using the ***BuiltinParticipantMessage*** or the ***BuiltinParticipantMessageSecure*** builtin `Topic`. If ***is_liveliness_protected*** is TRUE then the liveliness heartbeats are sent using the ***BuiltinParticipantMessageSecure*** builtin `Topic`. Otherwise they are sent using the ***BuiltinParticipantMessage*** builtin `Topic`.

9.4.2.7 EndpointSecurityConfig

DDSSEC12-90 - Meeting CNSSP-15 security requirements

The `EndpointSecurityConfig` describe how the middleware shall protect the Entity. This is a structured type, derived from TopicSecurityConfig, with the following IDL representation, whose members are described in Table 37 below:

```
@extensibility (APPENDABLE)
struct EndpointSecurityConfig : TopicSecurityConfig {
    boolean                             is_submessage_protected;
    boolean                             is_payload_protected;
    boolean                             is_key_protected;
    PluginEndpointSecurityAttributesMask  plugin_endpoint_attributes;
    PropertySeq                         ac_endpoint_properties;
    EndpointSecurityAlgorithmInfo       algorithm_info;
```

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};

Table 37 – Description of the EndpointSecurityConfig

Member	Type	Meaning
is_submessage_protected	Boolean	Indicates the DDS middleware shall call the operations on the CryptoKeyFactory, CryptoKeyExchange, and CryptoTransform for the entity: If ***is_submessage_protected*** is TRUE, then the CryptoKeyFactory, CryptoKeyExchange operations shall be called for that entity to create the associated cryptographic material and send it to the matched entities. If ***is_submessage_protected*** is FALSE, then the CryptoKeyFactory, CryptoKeyExchange and CryptoTransform operations are called only if is_payload_protected is TRUE. If ***is_submessage_protected*** is TRUE and the entity is a DataWriter, the submessages sent by the DataWriter shall be transformed using the CryptoTransform operation encode_datawriter_submessage and the messages received from the matched DataReaders shall be transformed using the CryptoTransform operation decode_datareader_submessage. If ***is_submessage_protected*** is TRUE, and the entity is a DataReader, the submessages sent by the DataReader shall be transformed using the CryptoTransform operation encode_datareader_submessage and the messages received from the matched DataWriters shall be transformed using the CryptoTransform operation decode_datawriter_submessage.
is_payload_protected	Boolean	Indicates the DDS middleware shall call the operations on the CryptoKeyFactory, CryptoKeyExchange, and CryptoTransform for the entity. If ***is_payload_protected*** is TRUE, then the CryptoKeyFactory, CryptoKeyExchange operations shall be called for that entitity to create the associated cryptographic material and send it to the matched entities. If ***is_payload_protected*** is FALSE, then the CryptoKeyFactory, CryptoKeyExchange and CryptoTransform operations are called only if is_payload_protected is TRUE. If ***is_ payload_protected*** is TRUE and the entity is a DataWriter, the serialized data sent by the DataWriter shall be transformed by calling encode_serialized_payload. If ***is_ payload_protected*** is TRUE and the entity is a DataReader, the serialized data received by the DataReader shall be transformed by calling decode_serialized_payload
is_key_protected		Indicates that the content of the Instance Key is sensitive. If ***is_key_protected*** is TRUE, then the DDS middleware shall compute the KeyHash for the Instance Key as described in section 7.4.4. If ***is_key_protected*** is FALSE, then the DDS middleware should the compute the KeyHash for the Instance Key as described in clause 9.6.3.3 of the DDS-RTPS specification [2].
plugin_endpoint_attributes	PluginEndpointSpecificAttributesMask	This field is a holder for plugin-specific information that is propagated via discovery as part of the EndpointSecurityInfo (see 7.3.24). The definition for the builtin plugins can be found in 10.4.2.6.
ac_endpoint_properties	PropertySeq	Additional properties to add to the ***datawriter_properties*** or ***datareader_properties*** passed to the `CryptoKeyFactory` operations `register_local_datawriter` and `register_local_datareader`.

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		The returned ***ac_endpoint_properties*** and their interpretation shall be specified by each plugin implementation.
algorithm_info	EndpointSecurityAlgorithmInfo	Cryptographic algorithms required to interoperate with the endpoint. See 7.3.16.

9.4.2.8 Definition of the EndpointSecurityAttributesMask

DDSSEC12-90 - Meeting CNSSP-15 security requirements

The `EndpointSecurityAttributesMask` is used to encode the value of the `EndpointSecurityConfig` in a compact way such that it can be included in the `EndpointSecurityInfo`, see 7.3.24.

The mapping of the `EndpointSecurityConfig` to `EndpointSecurityAttributesMask` shall be as defined in the table below:

Table 38 – Mapping of fields EndpointSecurityConfig to bits in EndpointSecurityAttributesMask

Field in EndpointSecurityConfig	Corresponding bit in the `EndpointSecurityAttributesMask`
is_read_protected	#define ENDPOINT_SECURITY_ATTRIBUTES_FLAG_IS_READ_PROTECTED (0x00000001 << 0)
is_write_protected	#define ENDPOINT_SECURITY_ATTRIBUTES_FLAG_IS_WRITE_PROTECTED (0x00000001 << 1)
is_discovery_protected	#define ENDPOINT_SECURITY_ATTRIBUTES_FLAG_IS_DISCOVERY_PROTECTED (0x00000001 << 2)
is_submessage_protected	#define ENDPOINT_SECURITY_ATTRIBUTES_FLAG_IS_SUBMESSAGE_PROTECTED (0x00000001 << 3)
is_payload_protected	#define ENDPOINT_SECURITY_ATTRIBUTES_FLAG_IS_PAYLOAD_PROTECTED (0x00000001 << 4)
is_key_protected	#define ENDPOINT_SECURITY_ATTRIBUTES_FLAG_IS_KEY_PROTECTED (0x00000001 << 5)
is_liveliness_protected	#define ENDPOINT_SECURITY_ATTRIBUTES_FLAG_IS_LIVELINESS_PROTECTED (0x00000001 << 6)
is_valid	#define ENDPOINT_SECURITY_ATTRIBUTES_FLAG_IS_VALID (0x00000001 << 31)

9.4.2.9 AccessControl interface

DDSSEC12-90 - Meeting CNSSP-15 security requirements

Table 39 – AccessControl Interface

AccessControl		
No Attributes		
Operations		
`validate_local_permissions`		`PermissionsHandle`
	`auth_plugin`	`AuthenticationPlugin`
	`identity`	`IdentityHandle`
	`domain_id`	`DomainId_t`
	`participant_qos`	`DomainParticipantQos`

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	out: exception	SecurityException
validate_remote_permissions		PermissionsHandle
	auth_plugin	AuthenticationPlugin
	local_identity_handle	IdentityHandle
	remote_identity_handle	IdentityHandle
	remote_permissions_token	PermissionsToken
	remote_credential_token	AuthenticatedPeerCredentialToken
	out: exception	SecurityException
check_create_participant		Boolean
	permissions_handle	PermissionsHandle
	domain_id	DomainId_t
	qos	DomainParticipantQoS
	out: exception	SecurityException
check_create_datawriter		Boolean
	permissions_handle	PermissionsHandle
	domain_id	DomainId_t
	topic_name	String
	qos	DataWriterQoS
	partition	PartitionQosPolicy
	data_tag	DataTag
	out: exception	SecurityException

check_create_datareader		Boolean
	permissions_handle	PermissionsHandle
	domain_id	DomainId_t
	topic_name	String
	qos	DataReaderQoS
	partition	PartitionQosPolicy
	data_tag	DataTag
	out: exception	SecurityException
check_create_topic		Boolean
	permissions_handle	PermissionsHandle
	domain_id	DomainId_t
	topic_name	String
	qos	TopicQoS
	out: exception	SecurityException
check_local_datawriter_ register_instance		Boolean
	permissions_handle	PermissionsHandle
	writer	DataWriter
	key	DynamicData
	out: exception	SecurityException
check_local_datawriter_ dispose_instance		Boolean
	permissions_handle	PermissionsHandle
	writer	DataWriter
	key	DynamicData
	out: exception	SecurityException
check_remote_participan t		Boolean
	permissions_handle	PermissionsHandle
	domain_id	DomainId_t
	participant_data	ParticipantBuiltinTopicDataSecure
	out: exception	SecurityException
check_remote_datawriter		Boolean
	permissions_handle	PermissionsHandle
	domain_id	DomainId_t
	publication_data	PublicationBuiltinTopicDataSecure
	out: exception	SecurityException
check_remote_datareader		Boolean
	permissions_handle	PermissionsHandle
	domain_id	DomainId_t
	subscription_data	SubscriptionBuiltinTopicDataSecur e
	out: relay_only	Boolean
	out: exception	SecurityException
check_remote_topic		Boolean
	permissions_handle	PermissionsHandle
	DomainId_t	domain_id
	topic_data	TopicBuiltinTopicData
	out: exception	SecurityException
check_local_datawriter_ match		Boolean
	writer_permissions_ handle	PermissionsHandle
	reader_permissions_ handle	PermissionsHandle
	publication_data	PublicationBuiltInTopicDataSecure
	subscription_data	PublicationBuiltinTopicDataSecure
	out: exception	SecurityException
		Boolean

check_local_datareader_ match	reader_permissions_ handle	PermissionsHandle
	writer_permissions_ handle	PermissionsHandle
	subscriber_partitio n	PartitionQosPolicy
	publication_data	PublicationBuiltInTopicDataSecure
	subscription_data	PublicationBuiltinTopicDataSecure
	out: exception	SecurityException

check_remote_datawriter_register_instance		Boolean
	permissions_handle	PermissionsHandle
	reader	DataReader
	publication_handle	InstanceHandle_t
	key	DynamicData
	instance_handle	InstanceHandle_t
	out: exception	SecurityException
check_remote_datawriter_dispose_instance		Boolean
	permissions_handle	PermissionsHandle
	reader	DataReader
	publication_handle	InstanceHandle_t
	key	DynamicData
	out: exception	SecurityException
get_permissions_token		Boolean
	out: permissions_token	PermissionsToken
	handle	PermissionsHandle
	out: exception	SecurityException
get_permissions_credential_token		Boolean
	out: permissions_credential_token	PermissionsCredentialToken
	handle	PermissionsHandle
	out: exception	SecurityException
set_listener		Boolean
	listener	AccessControlListener
	out: exception	SecurityException
return_permissions_token		Boolean
	token	PermissionsToken
	out: exception	SecurityException
return_permissions_credential_token		Boolean
	permissions_credential_token	PermissionsCredentialToken
	out: exception	SecurityException

get_participant_security_config		Boolean
	permissions_handle	PermissionsHandle
	out: participant_security_config	ParticipantSecurityConfig
	out: exception	SecurityException
get_topic_security_config		Boolean
	permissions_handle	PermissionsHandle
	topic_name	string
	out: topic_security_config	TopicSecurityConfig
	out: exception	SecurityException
get_datawriter_security_config		Boolean
	permissions_handle	PermissionsHandle
	topic_name	string
	partition	PartitionQosPolicy
	data_tag	DataTagQosPolicy
	out: endpoint_security_config	EndpointSecurityConfig
	out: exception	SecurityException
get_datareader_security_config		Boolean
	permissions_handle	PermissionsHandle
	topic_name	string
	partition	PartitionQosPolicy
	data_tag	DataTagQosPolicy
	out: endpoint_security_config	EndpointSecurityConfig
	out: exception	SecurityException
return_participant_security_config		Boolean
	config	ParticipantSecurityConfig
	out: exception	SecurityException
return_topic_security_config		Boolean
	config	TopicSecurityConfig
	out: exception	SecurityException
return_datawriter_security_config		Boolean
	config	EndpointSecurityConfig
	out: exception	SecurityException
return_datareader_security_config		Boolean
	config	EndpointSecurityConfig
	out: exception	SecurityException

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9.4.2.9.1 Operation: validate_local_permissions

Validates the permissions of the local DomainParticipant. The operation returns a PermissionsHandle object, if successful. The PermissionsHandle can be used to locally identify the permissions of the local DomainParticipant to the AccessControl plugin.

This operation shall be called before the DomainParticipant is enabled. It shall be called either by the implementation of DomainParticipantFactory create_domain_participant or DomainParticipant enable [1].

If an error occurs, this method shall return HandleNIL.

Parameter auth_plugin: The Authentication plugin, which validated the identity of the local DomainParticipant. If this argument is nil, the operation shall return HandleNIL.

Parameter identity: The IdentityHandle returned by the authentication plugin from a successful call to validate_local_identity.

Parameter domain_id: The DDS Domain Id of the DomainParticipant.

Parameter participant_qos: The DomainParticipantQos of the DomainParticipant.

Parameter exception: A SecurityException object, which provides details, in case this operation returns HandleNIL.

9.4.2.9.2 Operation: validate_remote_permissions

Validates the permissions of the previously authenticated remote DomainParticipant, given the PermissionsToken object received via DDS discovery and the PermissionsCredentialToken obtained as part of the authentication process. The operation returns a PermissionsHandle object, if successful.

If an error occurs, this method shall return HandleNIL.

Parameter auth_plugin: The Authentication plugin, which validated the identity of the remote DomainParticipant. If this argument is nil, the operation shall return HandleNIL.

Parameter local_identity_handle: The IdentityHandle returned by the authentication plugin.

Parameter remote_identity_handle: The IdentityHandle returned by a successful call to the validate_remote_identity operation on the Authentication plugin.

Parameter remote_permissions_token: The PermissionsToken of the remote DomainParticipant received via DDS discovery inside the ***permissions_token*** member of the ***ParticipantBuiltinTopicData***. See 7.5.1.3.

Parameter remote_credential_token: The AuthenticatedPeerCredentialToken of the remote DomainParticipant returned by the operation get_authenticated_peer_credential_token on the Authentication plugin.

Parameter exception: A SecurityException object, which provides details, in case this operation returns HandleNIL.

9.4.2.9.3 Operation: check_create_participant

Enforces the permissions of the local DomainParticipant. When the local DomainParticipant is created, its permissions must allow it to join the DDS Domain specified by the ***domain_id***. Optionally the use of the specified value for the DomainParticipantQoS must also be allowed by its permissions. The operation returns a Boolean value.

This operation shall be called before the DomainParticipant is enabled. It shall be called either by the implementation of DomainParticipantFactory create_domain_participant or DomainParticipant enable [1].

DDSSEC12- 62 Indicate that AccessControl operations need to be called on a set_qos

This operation shall also be called when the application calls the operation `set_qos()` on the to check if the `DomainParticipant` has the permissions needed for the updated `DomainParticipant` Qos configuration. The check performed shall be the same as the one performed when the `DomainParticipant` is first created, but using the new Qos specified in the `set_qos()`. If the `check_create_participant` does not succeed (return true), the `set_qos` operation shall fail with the NOT_ALLOWED_BY_SECURITY error.

If an error occurs, this method shall return `false`.

Parameter permissions_handle: The `PermissionsHandle` object associated with the local `DomainParticipant`. If this argument is `nil`, the operation shall return `false`.

Parameter domain_id: The domain id where the local `DomainParticipant` is about to be created. If this argument is `nil`, the operation shall return `false`.

Parameter qos: The QoS policies of the local `DomainParticipant`. If this argument is nil, the operation shall return `false`.

Parameter exception: A `SecurityException` object, which provides details in case this operation returns `false`.

9.4.2.9.4 Operation: `check_create_datawriter`

Enforces the permissions of the local `DomainParticipant`. When the local `DomainParticipant` creates a `DataWriter` for `topic_name` with the specified `DataWriterQos` associated with the `data_tag`, its permissions must allow this. The operation returns a `Boolean` object.

DDSSEC12- 62 Indicate that AccessControl operations need to be called on a set_qos

This operation shall also be called when the application calls the operation `set_qos()` on a `DataWriter` to check if the `DomainParticipant` has the permissions needed for the updated `DataWriter` Qos configuration. The check performed shall be the same as the one performed when the `DataWriter` is first created, but using the new Qos specified in the `set_qos()`. If the `check_create_datawriter` does not succeed (return true), the `set_qos` operation shall fail with the NOT_ALLOWED_BY_SECURITY error.

If an error occurs, this method shall return `false`.

Parameter permissions_handle: The `PermissionsHandle` object associated with the local `DomainParticipant`. If this argument is `nil`, the operation shall return `false`.

Parameter domain_id: The `DomainId_t` of the local `DomainParticipant` to which the local `DataWriter` will belong.

Parameter topic_name: The topic name that the `DataWriter` is supposed to write. If this argument is `nil`, the operation shall return `false`.

Parameter qos: The QoS policies of the local `DataWriter`. If this argument is nil, the operation shall return `false`.

Parameter partition: The `PartitionQosPolicy` of the local `Publisher` to which the `DataWriter` will belong.

Parameter data_tag: The data tags that the local `DataWriter` is requesting to be associated with its data. This argument can be `nil` if it is not considered for access control.

Parameter exception: A `SecurityException` object, which provides details in case this operation returns `false`.

9.4.2.9.5 Operation: `check_create_datareader`

Enforces the permissions of the local `DomainParticipant`. When the local `DomainParticipant` creates a `DataReader` for a `Topic` for `topic_name` with the specified `DataReaderQos` qos associated with the `data_tag`, its permissions must allow this. The operation returns a `Boolean` value.

DDSSEC12- 62 Indicate that AccessControl operations need to be called on a set_qos

This operation shall also be called when the application calls the operation `set_qos()` on a `DataReader` to check if the `DomainParticipant` has the permissions needed for the updated `DataReader` Qos configuration. The check performed shall be the same as the one performed when the `DataReader` is first created, but using the new Qos specified in the `set_qos()`. If the `check_create_datareader` does not succeed (return true), the `set_qos` operation shall fail with the NOT_ALLOWED_BY_SECURITY error.

If an error occurs, this method shall return `false`.

Parameter permissions_handle: The `PermissionsHandle` object associated with the local `DomainParticipant`. If this argument is `nil`, the operation shall return `false`.

Parameter domain_id: The `DomainId_t` of the local `DomainParticipant` to which the local `DataReader` will belong.

Parameter topic_name: The topic name that the `DataReader` is supposed to read. If this argument is `nil`, the operation shall return `false`.

Parameter qos: The QoS policies of the local `DataReader`. If this argument is nil, the operation shall return `false`.

Parameter partition: The `PartitionQosPolicy` of the local `Subscriber` to which the `DataReader` will belong.

Parameter data_tag: The data tags that the local `DataReader` is requesting read access to. This argument can be `nil` if it is not considered for access control.

Parameter exception: A `SecurityException` object, which provides details in case this operation returns `false`.

9.4.2.9.6 Operation: `check_create_topic`

Enforces the permissions of the local `DomainParticipant`. When an entity of the local `DomainParticipant` creates a `Topic` with `topic_name` and `TopicQos qos` its permissions must allow this. The operation returns a `Boolean` value.

DDSSEC12- 62 Indicate that AccessControl operations need to be called on a set_qos

This operation shall also be called when the application calls the operation `set_qos()` on the `Topic` to check if the `DomainParticipant` has the permissions needed for the new Qos configuration. The check performed shall be the same as the one performed when the `Topic` is first created, but using the new Qos specified in the `set_qos()`. If the `check_create_topic` does not succeed (return true), the `set_qos` operation shall fail with the NOT_ALLOWED_BY_SECURITY error.

If an error occurs, this method shall return `false`.

Parameter permissions_handle: The `PermissionsHandle` object associated with the local `DomainParticipant`. If this argument is `nil`, the operation shall return `false`.

Parameter domain_id: The `DomainId_t` of the local `DomainParticipant` that creates the Topic.

Parameter topic_name: The topic name to be created. If this argument is `nil`, the operation shall return `false`.

Parameter qos: The QoS policies of the local `Topic`. If this argument is nil, the operation shall return `false`.
Parameter exception: A `SecurityException` object, which provides details in case this operation returns `false`.

9.4.2.9.7 Operation: `check_local_datawriter_register_instance`

Enforces the permissions of the local `DomainParticipant`. In case the access control requires a finer granularity at the instance level, this operation enforces the permissions of the local `DataWriter`. The `key` identifies the instance being registered and permissions are checked to determine if registration of the specified instance is allowed. The operation returns a `Boolean` value. If an error occurs, this method shall return `false`.
Parameter permissions_handle: The `PermissionsHandle` object associated with the local `DomainParticipant`. If this argument is `nil`, the operation shall return `false`.
Parameter writer: `DataWriter` object that registers the instance. If this argument is `nil`, the operation shall return `false`.
Parameter key: The `key` of the instance for which the registration permissions are being checked. If this argument is `nil`, the operation shall return `false`.
Parameter exception: A `SecurityException` object, which provides details in case this operation returns `false`.

9.4.2.9.8 Operation: `check_local_datawriter_dispose_instance`

Enforces the permissions of the local `DomainParticipant`. In case the access control requires a finer granularity at the instance level, this operation enforces the permissions of the local `DataWriter`. The `key` has to match the permissions for disposing an instance. The operation returns a `Boolean` object.
If an error occurs, this method shall return `false`.
Parameter permissions_handle: The `PermissionsHandle` object associated with the local `DomainParticipant`. If this argument is `nil`, the operation shall return `false`.
Parameter writer: `DataWriter` object that registers the instance. If this argument is `nil`, the operation shall return `false`.
Parameter key: The `key` identifies the instance being registered and the permissions are checked to determine if disposal of the specified instance is allowed. If this argument is `nil`, the operation shall return `false`.
Parameter exception: A `SecurityException` object, which provides details in case this operation returns `nil`.

9.4.2.9.9 Operation: `check_remote_participant`

Enforces the permissions of the remote `DomainParticipant`. When the remote `DomainParticipant` is discovered, the domain_id and, optionally, the `DomainParticipantQoS` are checked to verify that joining that DDS Domain and using that QoS is allowed by its permissions. The operation returns a `Boolean` result.
DDSSEC12- 62 Indicate that AccessControl operations need to be called on a set_qos
This operation shall also be called whenever a `DomainParticipant` detects a QoS change for a different (peer) `DomainParticipant` that is matched with a local `DomainParticipant`.

If the check_remote_participant does not succeed (return true), the remote participant shall be considered invalid. This shall result in un-matching the remote DomainParticipant if it was previously matched.

If an error occurs, this method shall return false.

Parameter permissions_handle: The PermissionsHandle object associated with the remote DomainParticipant. If this argument is nil, the operation shall return false.

Parameter domain_id: The domain id where the remote DomainParticipant is about to be created. If this argument is nil, the operation shall return false.

Parameter participant_data: The ParticipantBuiltInTopicDataSecure object associated with the remote DomainParticipant. If this argument is nil, the operation shall return false.

Parameter exception: A SecurityException object, which provides details in case this operation returns nil.

9.4.2.9.10 Operation: check_remote_datawriter

Enforces the permissions of a remote DomainParticipant.

This operation shall be called by a DomainParticipant prior to matching a local DataReader belonging to that DomainParticipant with a DataWriter belonging to a different (peer) DomainParticipant.

This operation shall also be called whenever a DomainParticipant detects a QoS change for a DataWriter belonging to a different (peer) DomainParticipant that is matched with a local DataReader.

This operation verifies that the peer DomainParticipant has the permissions necessary to publish data on the DDS Topic with name ***topic_name*** using the DataWriterQoS that appears in ***publication_data***. The operation returns a Boolean value.

If an error occurs, this method shall return false.

Parameter permissions_handle: The PermissionsHandle object associated with the remote DomainParticipant. If this argument is nil, the operation shall return false.

Parameter domain_id: The domain id of the DomainParticipant to which the remote DataWriter belongs.

Parameter publication_data: The PublicationBuiltInTopicDataSecure object associated with the remote DataWriter. If this argument is nil, the operation shall return false.

Parameter exception: A SecurityException object, which provides details in case this operation returns false.

9.4.2.9.11 Operation: check_remote_datareader

Enforces the permissions of a remote DomainParticipant.

This operation shall be called by a DomainParticipant prior to matching a local DataWriter belonging to that DomainParticipant with a DataReader belonging to a different (peer) DomainParticipant.

This operation shall also be called whenever a DomainParticipant detects a QoS change for a DataReader belonging to a different (peer) DomainParticipant that is matched with a local DataWriter.

This operation verifies that the peer DomainParticipant has the permissions necessary to subscribe to data on the DDS Topic with name ***topic_name*** using the DataReaderQoS that appears in ***subscription_data***. The operation returns a Boolean value and also sets the ***relay_only*** output parameter.

If the operation returns `true`, the DDS middleware shall allow the local `DataWriter` to match with the remote `DataReader`, if it returns `false`, it shall not allow it.
If the operation returns `true`, the ***relay_only*** parameter shall be remembered by the DDS middleware and passed to the `register_matched_remote_datareader` operation on the `CryptoKeyFactory`.
If an error occurs, this method shall return `false`.
Parameter permissions_handle: The `PermissionsHandle` object associated with the local `DomainParticipant`. If this argument is `nil`, the operation shall return `false`.
Parameter domain_id: The domain id of the `DomainParticipant` to which the remote `DataReader` belongs.
Parameter subscription_data: The `SubscriptionBuiltInTopicDataSecure` object associated with the remote `DataReader`. If this argument is `nil`, the operation shall return `false`.
Parameter (out) relay_only: Boolean indicating whether the permissions of the remote `DataReader` are restricted to relaying the information (understanding sequence numbers and other `SubmessageHeader` information) but not decoding the data itself. This parameter is only meaningful if the operation returns `true`.
Parameter exception: A `SecurityException` object, which provides details in case this operation returns `false`.

9.4.2.9.12 Operation: check_remote_topic

Enforces the permissions of the remote `DomainParticipant`. When the remote `DomainParticipant` creates a certain topic, the ***topic_name*** and optionally the `TopicQoS` extracted from the ***topic_data*** are verified to ensure the remote `DomainParticipant` permissions allow it to create the DDS `Topic` with the specified QoS. The operation returns a `Boolean` value.
If an error occurs, this method shall return `false`.
Parameter permissions_handle: The `PermissionsHandle` object associated with the remote `DomainParticipant`. If this argument is `nil`, the operation shall return `false`.
Parameter topic_data: The `TopicBuiltInTopicData` object associated with the `Topic`. If this argument is `nil`, the operation shall return `false`.
Parameter exception: A `SecurityException` object, which provides details in case this operation returns `false`.

9.4.2.9.13 Operation: check_local_datawriter_match

Provides the means for the `AccessControl` plugin to enforce access control rules that are based on the `DataTag` associated with `DataWriter` and a matching `DataReader`.
The operation shall be called for any local `DataWriter` that matches a `DataReader`. The operation shall be called after the operation `check_local_datawriter` has been called on the local `DataWriter` and either `check_local_datareader` or `check_remote_datareader` has been called on the `DataReader`.
DDSSEC12- 62 Indicate that AccessControl operations need to be called on a set_qos.
This operation shall also be called when a local `DataWriter`, matched with a `DataReader`, detects a change on the Qos of the local `DataWriter` or the matched `DataReader`.
The operation shall be called only if the aforementioned calls to `check_local_datawriter` and `check_local_datareader` or `check_remote_datareader` are returned successfully.
The operation returns a `Boolean` value. If an error occurs, this method shall return `false` and the `SecurityException` filled.

Parameter writer_permissions_handle: The PermissionsHandle object associated with the DomainParticipant that contains the local DataWriter. If this argument is nil, the operation shall return false.
Parameter reader_permissions_handle: The PermissionsHandle object associated with the remote DomainParticipant. If this argument is nil, the operation shall return false.
Parameter publication_data: The PublicationBuiltInTopicDataSecure object associated with the local DataWriter. If this argument is nil, the operation shall return false.
Parameter subscription_data: The SubscriptionBuiltInTopicDataSecure object associated with the matched DataReader. If this argument is nil, the operation shall return false.
Parameter exception: A SecurityException object, which provides details in case this operation returns false.

9.4.2.9.14 Operation: check_local_datareader_match

Provides the means for the AccessControl plugin to enforce access control rules that are based on the DataTag associated with a DataReader and a matching DataWriter.
The operation shall be called for any local DataReader that matches a DataWriter. The operation shall be called after the operation check_local_datareader has been called on the local DataReader and either check_local_datawriter or check_remote_datawriter has been called on the DataWriter.
DDSSEC12- 62 Indicate that AccessControl operations need to be called on a set_qos.
This operation shall also be called when a local DataReader, matched with a DataWriter, detects a change on the Qos of the local DataReader or the matched DataWriter.
The operation shall be called only if the aforementioned calls to check_local_datareader and check_local_datawriter or check_remote_datawriter are returned successfully.
The operation returns a Boolean value. If an error occurs, this method shall return false and the SecurityException filled.
Parameter writer_permissions_handle: The PermissionsHandle object associated with the DomainParticipant that contains the local DataReader. If this argument is nil, the operation shall return false.
Parameter reader_permissions_handle: The PermissionsHandle object associated with the remote DomainParticipant. If this argument is nil, the operation shall return false.
Parameter subscription_data: The SubscriptionBuiltInTopicDataSecure object associated with the local DataReader. If this argument is nil, the operation shall return false.
Parameter publication_data: The PublicationBuiltInTopicDataSecure object associated with the matched DataWriter. If this argument is nil, the operation shall return false.
Parameter exception: A SecurityException object, which provides details in case this operation returns false.

9.4.2.9.15 Operation: check_remote_datawriter_register_instance

Enforces the permissions of the remote DomainParticipant. In case the access control requires a finer granularity at the instance level, this operation enforces the permissions of the remote DataWriter. The key has to match the permissions for registering an instance. The operation returns a Boolean value.
If an error occurs, this method shall return false.
Parameter permissions_handle: The PermissionsHandle object associated with the remote DomainParticipant. If this argument is nil, the operation shall return false.

Parameter reader: The local DataReader object that is matched to the remote DataWriter that registered an instance.
Parameter publication handle: Handle that identifies the remote DataWriter.
Parameter key: The key of the instance that needs to match the permissions for registering an instance. If this argument is nil, the operation shall return false.
Parameter exception: A SecurityException object, which provides details in case this operation returns false.

9.4.2.9.16 Operation: check_remote_datawriter_dispose_instance

Enforces the permissions of the remote DomainParticipant. In case the access control requires a finer granularity at the instance level, this operation enforces the permissions of the remote DataWriter. The key has to match the permissions for disposing an instance. The operation returns a Boolean value.
If an error occurs, this method shall return false.
Parameter permissions_handle: The PermissionsHandle object associated with the remote DomainParticipant. If this argument is nil, the operation shall return false.
Parameter reader: The local DataReader object that is matched to the Publication that disposed an instance.
Parameter publication handle: Handle that identifies the remote Publication.
Parameter key: The key of the instance that needs to match the permissions for disposing an instance. If this argument is nil, the operation shall return false.
Parameter exception: A SecurityException object, which provides details in case this operation returns false.

9.4.2.9.17 Operation: get_permissions_token

Retrieves a PermissionsToken object. The PermissionsToken is propagated via DDS discovery to summarize the permissions of the DomainParticipant identified by the specified PermissionsHandle.
If an error occurs, this method shall return false.
Parameter permissions_token (out): The returned PermissionsToken.
Parameter handle: The handle used to locally identify the permissions of the DomainParticipant for which a PermissionsToken is desired. If this argument is nil, the operation shall return nil.
Parameter exception: A SecurityException object, which provides details in case this operation returns false.

9.4.2.9.18 Operation: get_permissions_credential_token

Retrieves a PermissionsCredentialToken object that can be used to represent on the network the permissions of the DomainParticipant identified by the specified PermissionsHandle.
If an error occurs, this method shall return false.
Parameter permissions_credential_token (out): The returned PermissionsCredentialToken.
Parameter handle: The PermissionsHandle used to locally identify the permissions of the DomainParticipant for which a PermissionsCredentialToken is desired. If this argument is nil, the operation shall return nil.
Parameter exception: A SecurityException object, which provides details in case this operation returns false.

9.4.2.9.19 Operation: `set_listener`

Sets the listener for the `AccessControl` plugin.
If an error occurs, this method shall return `false`.
Parameter listener: An `AccessControlListener` object to be attached to the `AccessControl` plugin. If this argument is `nil`, the operation returns `false`.
Parameter exception: A `SecurityException` object, which provides details in case this operation returns `false`.

9.4.2.9.20 Operation: `return_permissions_token`

Returns the `PermissionsToken` to the plugin for disposal.
Parameter token: A `PermissionsToken` to be disposed of. It should correspond to the `PermissionsToken` returned by a prior call to `get_permissions_token` on the same plugin.
Parameter exception: A `SecurityException` object, which provides details in case this operation returns `false`.

9.4.2.9.21 Operation: `return_permissions_credential_token`

Returns the `PermissionsCredentialToken` to the plugin for disposal.
Parameter permissions_credential_token: A `PermissionsCredentialToken` to be disposed of. It should correspond to the `PermissionsCredentialToken` returned by a prior call to `get_permissions_credential_token` on the same plugin.
Parameter exception: A `SecurityException` object, which provides details in case this operation returns `false`.

9.4.2.9.22 Operation: get_participant_security_config

DDSSEC12-90 - Meeting CNSSP-15 security requirements
This operation shall be called by the DDS middleware as part of the creation or enabling of the DDS `DomainParticipant`.
The operation retrieves the `ParticipantSecurityConfig`, which describe how the DDS middleware should enforce the security and integrity of the information produced and consumed via the DomainParticipant.
The value of the on the `ParticipantSecurityConfig` member ***security_info*** of type `ParticipantSecurityAlgorithmInfo` (see 7.3.14) contains information about the cryptographic algorithms the security plugins may use to perform their function which may restrict the set of algorithms that the plugins could otherwise use.
The returned `ParticipantSecurityConfig` shall be used to call the operation `set_participant_security_config` on the `Authentication` plugin and the operation `register_local_participant` on the `Cryptographic` plugin. .
If an error occurs, this method shall return `false`.
Parameter permissions_handle: The `PermissionsHandle` object associated with the local `DomainParticipant`. If this argument is `nil`, the operation shall return `false`.
Parameter (out) attributes: The returned `ParticipantSecurityConfig` contains attributes that indicate how the different building topics shall be protected and the kinds of cryptographic algorithms that may be used by the plugins. This return value is intended to be used to call the operation `set_participant_security_config` on each of other plugins so that they can configure themselves accordingly.
Parameter exception: A `SecurityException` object, which provides details in case this operation returns `false`.

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9.4.2.9.23 Operation: get_topic_security_config

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DDSSEC12-90 - Meeting CNSSP-15 security requirements

Retrieves the `TopicSecurityConfig`, which describes how the DDS middleware should enforce the security and integrity of the information related to the DDS `Topic`.

Deleted: `TopicSecurityAttributes`

This operation shall be called by the DDS middleware as part of the creation or enabling of a DDS Topic. The operation shall be called before calling `check_create_topic`, `check_create_datawriter`, `check_create_datareader`, `check_remote_datawriter`, `check_remote_datareader`, `check_remote_datawriter_match`, or `check_remote_datareader_match`.

If an error occurs, this method shall return `false`.

Parameter permissions_handle: The `PermissionsHandle` object associated with the local `DomainParticipant`. If this argument is nil, the operation shall return false.

Parameter topic_name: The name of the `Topic`. If this argument is nil, the operation shall return false.

Parameter (out) attributes: The returned `TopicSecurityConfig`.

Deleted: `TopicSecurityAttributes`

Parameter exception: A `SecurityException` object, which provides details in case this operation returns false.

9.4.2.9.24 Operation: get_datawriter_security_config

Deleted: _sec_attributes

DDSSEC12-90 - Meeting CNSSP-15 security requirements

Retrieves the `EndpointSecurityConfig`, which describes how the DDS middleware should enforce the security and integrity of the information related to the DDS `DataWriter` endpoint.

Deleted: `EndpointSecurityAttributes`

This operation shall be called by the DDS middleware as part of the creation or enabling of a DDS `DataWriter`. The operation shall be called after calling `check_create_datawriter`.

The value of the on the `EndpointSecurityConfig` members shall be used to configure the `DCPSPublications` builtin Topic, specifically the `PublicationsBuiltinTopicData` members ***security_info*** and ***symmetric_cipher*** members, see 7.5.1.5.

If an error occurs, this method shall return `false`.

Parameter permissions_handle: The `PermissionsHandle` object associated with the local `DomainParticipant`. If this argument is `nil`, the operation shall return `false`.

Parameter topic_name: The name of the `Topic` associated with the `DataWriter`. If this argument is `nil`, the operation shall return `false`.

Parameter partition: The `PartitionQosPolicy` of the local `Publisher` to which the `DataWriter` belongs.

Parameter data_tag: The `DataTagQosPolicy` associated with the `DataWriter`. This argument can be `nil`.

Parameter (out) attributes: The returned `EndpointSecurityConfig`.

Deleted: `EndpointSecurityAttributes`

Parameter exception: A `SecurityException` object, which provides details in case this operation returns `false`.

9.4.2.9.25 Operation: get_datareader_security_config

Deleted: get_datareader_sec_attributes

DDSSEC12-90 - Meeting CNSSP-15 security requirements

Retrieves the `EndpointSecurityConfig`, which describes how the DDS middleware should enforce the security and integrity of the information related to the DDS `DataReader` endpoint.

Deleted: `EndpointSecurityAttributes`

This operation shall be called by the DDS middleware as part of the creation or enabling of a DDS `DataReader`. The operation shall be called after calling `check_create_datareader`.

The value of the on the `EndpointSecurityConfig` members shall be used to configure the `DCPSPublications` builtin Topic, specifically the `PublicationBuiltinTopicData` members ***security_info*** and ***symmetric_cipher*** members, see 7.5.1.5.

If an error occurs, this method shall return `false`.
Parameter permissions_handle: The `PermissionsHandle` object associated with the local `DomainParticipant`. If this argument is `nil`, the operation shall return `false`.
Parameter topic_name: The name of the `Topic` associated with the `DataReader`. If this argument is `nil`, the operation shall return `false`.
Parameter partition: The `PartitionQosPolicy` of the local `Subscriber` to which the `DataReader` belongs.
Parameter data_tag: The data tag associated with the `DataReader`. This argument can be `nil`.
Parameter (out) attributes: The returned `EndpointSecurityConfig`.
Deleted: `EndpointSecurityAttributes`
Parameter exception: A `SecurityException` object, which provides details in case this operation returns `false`.

9.4.2.9.26 Operation: return_participant_security_config

Deleted: return_participant_sec_attributes

DDSSEC12-90 - Meeting CNSSP-15 security requirements
Returns the `ParticipantSecurityConfig` to the plugin for disposal.
Deleted: `ParticipantSecurityAttributes`
Parameter attributes: The `ParticipantSecurityConfig` to return.
Deleted: `ParticipantSecurityAttributes`
Parameter exception: A `SecurityException` object, which provides details in case this operation returns false.

9.4.2.9.27 Operation: return_topic_security_config

DDSSEC12-90 - Meeting CNSSP-15 security requirements
Returns the `TopicSecurityConfig` to the plugin for disposal.
Parameter attributes: The `TopicSecurityConfig` to return.
Parameter exception: A `SecurityException` object, which provides details in case this operation returns false.

9.4.2.9.28 Operation: return_datawriter_security_config

Deleted: _sec_attributes

DDSSEC12-90 - Meeting CNSSP-15 security requirements
Returns the `EndpointSecurityConfig` to the plugin for disposal.
Deleted: `EndpointSecurityAttributes`
Parameter attributes: The `EndpointSecurityConfig` to return.
Deleted: `EndpointSecurityAttributes`
Parameter exception: A `SecurityException` object, which provides details in case this operation returns false.

9.4.2.9.29 Operation: return_datareader_security_config

Deleted: _sec_attributes

DDSSEC12-90 - Meeting CNSSP-15 security requirements
Returns the `EndpointSecurityConfig` to the plugin for disposal.
Deleted: `EndpointSecurityAttributes`
Parameter attributes: The `EndpointSecurityConfig` to return.
Deleted: `EndpointSecurityAttributes`
Parameter exception: A `SecurityException` object, which provides details in case this operation returns false.

9.4.2.10 AccessControlListener interface

The purpose of the `AccessControlListener` is to be notified of all status changes for different identities. For example, permissions can change; hence, the `AccessControlListener` is notified and enforces the new permissions.

Table 40 – AccessControlListener interface

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AccessControlListener		
No Attributes		
Operations		
on_revoke_permissions		Boolean
	plugin	AccessControl
	handle	PermissionsHandle

9.4.2.10.1 Operation: on_revoke_permissions

`DomainParticipants`' Permissions can be revoked/changed. This listener provides a callback for permission revocation/changes.
If an error occurs, this method shall return `false`.
Parameter plugin: The correspondent `AccessControl` object.
Parameter handle: A `PermissionsHandle` object that corresponds to the Permissions of a DDS Participant whose permissions are being revoked.

9.5 Cryptographic Plugin

The `Cryptographic` plugin defines the types and operations necessary to support encryption, digest, message authentication codes, and key exchange for DDS `DomainParticipants`, `DataWriters` and DDS `DataReaders`.
Users of DDS may have specific cryptographic libraries they use for encryption, as well as, specific requirements regarding the algorithms for digests, message authentication, and signing. In addition, applications may require having only some of those functions performed, or performed only for certain DDS `Topics` and not for others. Therefore, the plugin API has to be general enough to allow flexible configuration and deployment scenarios.

9.5.1 Cryptographic Plugin Model

The `Cryptographic` plugin model is presented in the figure below. It combines related cryptographic interfaces for key creation, key exchange, encryption, message authentication, hashing, and signature.

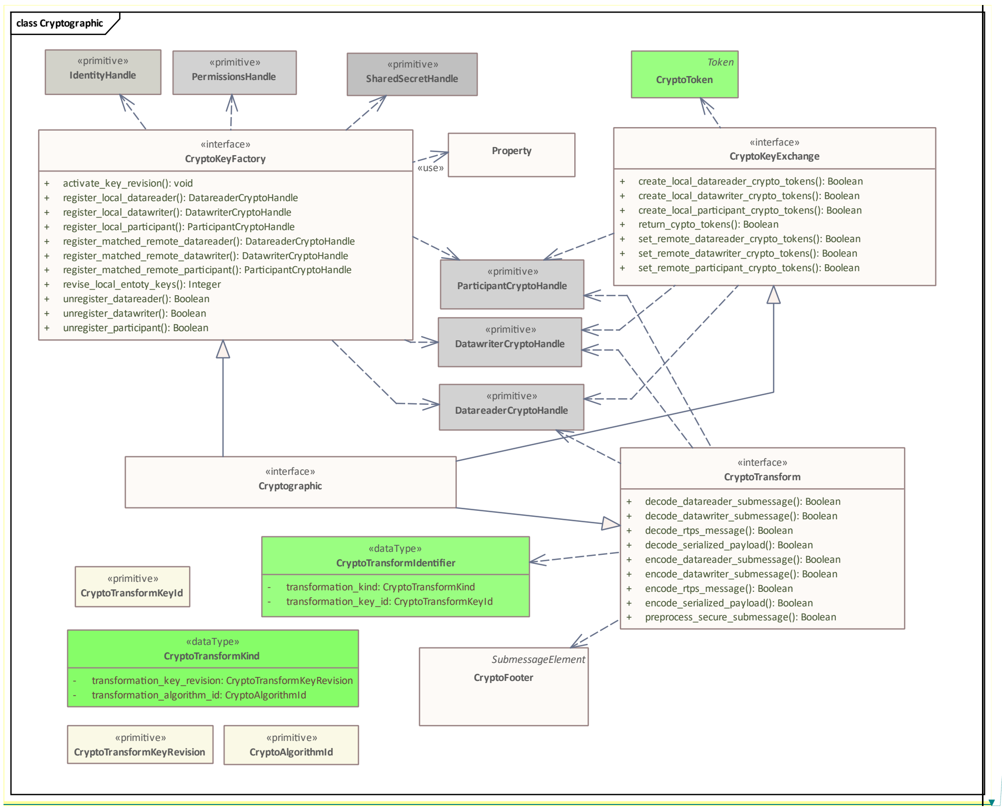

Figure 11 – Cryptographic Plugin Model

9.5.1.1 CryptoToken

This class represents a generic holder for key material. A `CryptoToken` object contains all the information necessary to construct a set of keys to be used to encrypt and/or sign plain text transforming it into cipher-text or to reverse those operations.

The format and interpretation of the `CryptoToken` depends on the implementation of the Cryptographic plugin. Each plugin implementation shall fully define itself, so that applications are able to interoperate. In general, the `CryptoToken` will contain one or more keys and any other necessary material to perform crypto-transformation and/or verification, such as, initialization vectors (IVs), salts, etc.

9.5.1.2 ParticipantCryptoHandle

The `ParticipantCryptoHandle` object is an opaque local reference that represents the key material used to encrypt and sign whole RTPS Messages. It is used by the operations `encode_rtps_message` and `decode_rtps_message`.

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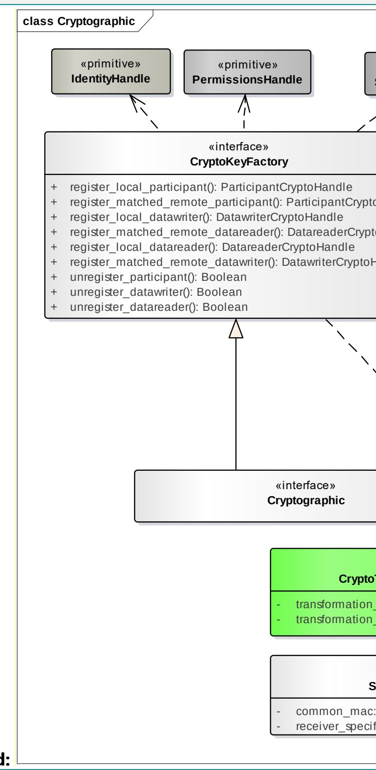

9.5.1.3 DatawriterCryptoHandle

The `DatawriterCryptoHandle` object is an opaque local reference that represents the key material used to encrypt and sign RTPS submessages sent from a DataWriter. This includes the RTPS submessages `Data`, `DataFrag`, `Gap`, `Heartbeat`, and `HeartbeatFrag`, as well as, the `SerializedPayload` submessage element that appears in the `Data` and `DataFrag` submessages.
It is used by the operations `encode_datawriter_submessage`, `decode_datawriter_submessage`, `encode_serialized_payload`, and `decode_serialized_payload`.

9.5.1.4 DatareaderCryptoHandle

The `DatareaderCryptoHandle` object is an opaque local reference that represents the key material used to encrypt and sign RTPS `Submessages` sent from a `DataReader`. This includes the RTPS Submessages `AckNack` and `NackFrag`.
It is used by the operations `encode_datareader_submessage`, `decode_datareader_submessage`.

9.5.1.5 CryptoTransformIdentifier

The `CryptoTransformIdentifier` object used to uniquely identify the transformation applied on the sending side (encoding) so that the receiver can locate the necessary key material to perform the inverse transformation (decoding). The generation of `CryptoTransformIdentifier` is performed by the `Cryptographic` plugin.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

To enable interoperability and avoid misinterpretation of the key material, the structure of the `CryptoTransformIdentifier` is defined for all `Cryptographic` plugin implementations.
The definition and interpretation is provided in 7.3.20.

9.5.1.6 Key Revision: CryptoTransformKeyRevision and associated CryptoTransformIdentifier

DDSSEC12-122 – Provide mechanism for changing the session keys

Key Revision creates a new version of existing `KeyMaterial`.
The revised (updated) the `KeyMaterial` is basically new key material which should not share any cryptographic material (e.g. keys and initialization vectors) with the previous revision. What makes it as "revision" is its intended use as a replacement for already existing (and shared) `KeyMaterial` so there is the intent to eventually remove the `KeyMaterial` corresponding to earlier revisions.
The `CryptoTransformIdentifier` for the "revised" key material shall have:

- The same value of the ***transformation_key_id***.
- The same value for the ***transformation_kind***'s member ***transformation_algorithm_id***
- An updated (incremented) value for the ***transformation_kind***'s member ***transformation_key_revision***.

The fact that the ***transformation_key_id*** remains constant allows receivers of the `CryptoTransformIdentifier` to detect that the associated `KeyMaterial` replaces existing `KeyMaterial` and identify the material being replaced. This allows the resurces for the replaced Key Material to be reclaimed when it is safe to do so.

9.5.1.7 SecureSubmessageCategory_t

Enumerates the possible categories of RTPS submessages.

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```
typedef octet CryptoTransformKind[4];¶
typedef octet CryptoTransformKeyId[4];¶
struct CryptoTransformIdentifier {¶
    CryptoTransformKind transformation_kind;¶
    CryptoTransformKeyId transformation_key_id;¶
};¶
```
Table 34 – CryptoTransformIdentifier class¶
CryptoTransformIdentifier ...

Table 41 – SecureSubmessageCategory_t

SecureSubmessageCategory_t	
INFO_SUBMESSAGE	Indicates an RTPS Info submessage: InfoSource, InfoDestination, or InfoTimestamp.
DATAWRITER_SUMBESSAGE	Indicates an RTPS submessage that was sent from a DataWriter: Data, DataFrag, HeartBeat, Gap.
DATAREADER_SUMBESSAGE	Indicates an RTPS submessage that was sent from a DataReader: AckNack, NackFrag.

9.5.1.8 CryptoKeyFactory interface

This interface groups the operations related to the creation of keys used for encryption and digital signing of both the data written by DDS applications and the RTPS submessage and message headers, used to implement the discovery protocol, distribute the DDS data, implement the reliability protocol, etc.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

DDSSEC12-122 – Provide mechanism for changing the session keys

Table 42 – CryptoKeyFactory Interface

CryptoKeyFactory		
No Attributes		
Operations		
register_local_participant		ParticipantCryptoHandle
	out: adjusted_algorithm_info	ParticipantSecurityAlgorithmInfo
	participant_identity	IdentityHandle
	participant_permissions	PermissionsHandle
	participant_properties	PropertySeq
	participant_security_config	ParticipantSecurityConfig
	out: exception	SecurityException
register_matched_remote_participant		ParticipantCryptoHandle
	local_participant_crypto_handle	ParticipantCryptoHandle
	remote_participant_identity	IdentityHandle
	remote_participant_permissions	PermissionsHandle
	shared_secret	SharedSecretHandle
	out: exception	SecurityException
register_local_datawriter		DatawriterCryptoHandle
	out: adjusted_algorithm_info	EndpointSecurityAlgorithmInfo
	participant_crypto	ParticipantCryptoHandle
	datawriter_properties	PropertySeq

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	datawriter_security_config	EndpointSecurityConfig
	endpoint_guid	GUID_t
	out: exception	SecurityException

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register_matched_remote_datareader		DatareaderCryptoHandle
	local_datawriter_crypto_handle	DatawriterCryptoHandle
	remote_participant_crypto	ParticipantCryptoHandle
	shared_secret	SharedSecretHandle
	relay_only	Boolean
	out: exception	SecurityException
register_local_datareader		DatareaderCryptoHandle
	out: adjusted_algorithm_info	EndpointSecurityAlgorithmInfo
	participant_crypto	ParticipantCryptoHandle
	datareader_properties	PropertySeq
	datareader_security_config	EndpointSecurityConfig
	endpoint_guid	GUID_t
	out: exception	SecurityException
register_matched_remote_datawriter		DatawriterCryptoHandle
	local_datareader_crypto_handle	DatareaderCryptoHandle
	remote_participant_crypt	ParticipantCryptoHandle
	shared_secret	SharedSecretHandle
	out: exception	SecurityException
revise_local_entity_keys		CryptoTransformKeyRevisionIntHolder
	participant_crypto_handle	ParticipantCryptoHandle
	out: exception	SecurityException
activate_key_revision		Boolean
	local_participant_crypto_handle	ParticipantCryptoHandle
	key_revision	CryptoTransformKeyRevisionIntHolder
	out: exception	SecurityException
unregister_participant		Boolean
	participant_crypto_handle	ParticipantCryptoHandle
	out: exception	SecurityException
unregister_datawriter		Boolean
	datawriter_crypto_handle	DatawriterCryptoHandle
	out: exception	SecurityException
unregister_datareader		Boolean
	datareader_crypto_handle	DatareaderCryptoHandle
	out: exception	SecurityException

Deleted: EndpointSecurityAttributes

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9.5.1.8.1 Operation: register_local_participant

Registers a local DomainParticipant with the Cryptographic Plugin. The DomainParticipant must have been already authenticated and granted access to the DDS Domain. The operation shall create any necessary key material that is needed to Encrypt and Sign secure messages that are directed to other DDS DomainParticipant entities on the DDS Domain.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

Configures the cryptographic algorithms that may be used by the Cryptographic plugin and retrieves an updated ParticipantSecurityAlgorithmInfo that incorporates the information of the algorithms supported, required, or used by the Cryptographic plugin.

This operation shall be called by the middleware after calling get_participant_security_config on the AccessControl plugin.

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

If successful, this operation shall return a ParticipantCryptoHandle used to locally identify the DomainParticipant to the Cryptographic Plugin. Otherwise it shall return HandleNIL and fill the SecurityException.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

Parameter adjusted _algorithm_info (out): An updated ParticipantSecurityAlgorithmInfo. The value is obtained by starting from the value passed in the **participant_security_config.algorithm_info** (in) parameter, adding to the "required" sets any algorithms that are used by the Cryptographic plugin and removing from the "supported" sets any algorithms of the types that would be used in the Cryptographic plugin operations that are supported by the plugin.

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

Parameter **participant_identity**: An IdentityHandle returned by a prior call to validate_local_identity. If this argument is nil, the operation returns HandleNIL.

Parameter **participant_permissions**: A PermissionsHandle returned by a prior call to validate_local_permissions. If this argument is nil, the operation returns HandleNIL.

Parameter **participant_properties**: This parameter shall contain all the properties in the PropertyQosPolicy of the local DomainParticipant whose name has the prefix "dds.sec.crypto." The purpose of this parameter is to allow configuration of the Cryptographic Plugin by the DomainParticipant, e.g., selection of the cryptographic algorithm, key size, or even setting of the key. The use of this parameter depends on the particular implementation of the plugin and shall be specified for each implementation. Properties not understood by the plugin implementation shall be silently ignored.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

Parameter **participant_security_config**: The ParticipantSecurityConfig returned by the AccessControl get_participant_security_config operation.

Parameter **exception**: A SecurityException object, which provides details in case this operation returns HandleNIL.

Deleted: **Parameter handle**: The handle used to locally identify the DomainParticipant. The handle must have been returned by a successful call to register_local_participant, otherwise the operation shall return false and fill the SecurityException.¶

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Deleted: get_participant_sec_attributes

9.5.1.8.2 Operation: register_matched_remote_participant

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Registers a remote DomainParticipant with the Cryptographic Plugin. The remote DomainParticipant must have been already Authenticated and granted Access to the DDS Domain. The operation performs two functions:

1. It shall create any necessary key material needed to decrypt and verify the signatures of messages received from that remote `DomainParticipant` and directed to the local `DomainParticipant`.
2. It shall create any necessary key material that will be used by the local `DomainParticipant` when encrypting or signing messages that are intended only for that remote `DomainParticipant`.

Parameter **local_participant_crypto_handle**: A `ParticipantCryptoHandle` returned by a prior call to `register_local_participant`. If this argument is `nil`, the operation returns `false`.
Parameter **remote_participant_identity**: An `IdentityHandle` returned by a prior call to `validate_remote_identity`. If this argument is `nil`, the operation returns `nil`.
Parameter **participant_permissions**: A `PermissionsHandle` returned by a prior call to `validate_remote_permissions`. If this argument is `nil`, the operation returns `nil`.
Parameter **shared_secret**: The `SharedSecretHandle` returned by a prior call to `get_shared_secret` as a result of the successful completion of the Authentication handshake between the local and remote `DomainParticipant` entities.
Parameter **exception**: A `SecurityException` object, which provides details in case this operation returns `false`.

9.5.1.8.3 Operation: register_local_datawriter

Registers a local `DataWriter` with the `Cryptographic` Plugin. The fact that the `DataWriter` was successfully created indicates that the `DomainParticipant` to which it belongs was authenticated, granted access to the DDS Domain, and granted permission to create the `DataWriter` on its `Topic`.
This operation shall create the cryptographic material necessary to encrypt and/or sign the data written by the `DataWriter` and returns a `DatawriterCryptoHandle` to be used for any cryptographic operations affecting messages sent or received by the `DataWriter`.
If an error occurs, this method shall return false. If it succeeds, the operation shall return an opaque handle that can be used to refer to that key material.
DDSSEC12-90 - Meeting CNSSP-15 security requirements
Parameter adjusted _algorithm_info (out): An updated `EndpointSecurityAlgorithmInfo`. The value is obtained by starting from the value passed in the **datawriter_security_config** (in) parameter, adding to the "required" sets any algorithms that are used by the Cryptographic plugin and removing from the "supported" sets any algorithms of the types that would be used in the Cryptographic plugin operations that are supported by the plugin.
Parameter handle: The handle used to locally identify the `DomainParticipant`. The handle must have been returned by a successful call to `register_local_participant`, otherwise the operation shall return false and fill the `SecurityException`.
Parameter **participant_crypto**: A `ParticipantCryptoHandle` returned by a prior call to `register_local_participant`. It shall correspond to the `ParticipantCryptoHandle` of the `DomainParticipant` to which the `DataWriter` belongs. If this argument is `nil`, the operation returns `false`.
Parameter **local_datawriter_properties**: This parameter shall contain all the properties in the `PropertyQosPolicy` of the local `DataWriter` whose name has the prefix "`dds.sec.`crypto." The purpose of this parameter is to allow configuration of the `Cryptographic` Plugin by the `DataWriter`, e.g., selection of the cryptographic algorithm, key size, or even setting of the key. The

use of this parameter depends on the particular implementation of the plugin and shall be specified for each implementation. Properties not understood by the plugin implementation shall be silently ignored.

Parameter **datawriter_security_config**: The EndpointSecurityConfig returned by the AccessControl get_datawriter_security_config operation.

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Parameter **algorithm_support**: A EndpointCryptographicAlgorithmSupport object describing the algorithms that are used and required by the DataWriter.

Parameter **exception**: A SecurityException object, which provides details in case this operation returns false.

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9.5.1.8.4 Operation: register_matched_remote_datareader

Registers a remote DataReader with the Cryptographic Plugin. The remote DataReader shall correspond to one that has been granted permissions to match with the local DataWriter.

This operation shall create the cryptographic material necessary to encrypt and/or sign the RTPS submessages (Data, DataFrag, Gap, Heartbeat, HeartbeatFrag) sent from the local DataWriter to that DataReader. It shall also create the cryptographic material necessary to process RTPS Submessages (AckNack, NackFrag) sent from the remote DataReader to the DataWriter.

The operation shall associate the value of the ***relay_only*** parameter with the returned DatawriterCryptoHandle. This information shall be used in the generation of the KeyToken objects to be sent to the DataReader.

Parameter **local_datawriter_crypto_handle**: A DatawriterCryptoHandle returned by a prior call to register_local_datawriter. If this argument is nil, the operation returns HandleNIL.

Parameter **remote_participant_crypto**: A ParticipantCryptoHandle returned by a prior call to register_matched_remote_participant. It shall correspond to the ParticipantCryptoHandle of the DomainParticipant to which the remote DataReader belongs. If this argument is nil, the operation returns HandleNIL.

Parameter **shared_secret**: The SharedSecretHandle returned by a prior call to get_shared_secret as a result of the successful completion of the Authentication handshake between the local and remote DomainParticipant entities.

Parameter relay_only: Boolean indicating whether the cryptographic material to be generated for the remote DataReader shall contain everything, or only the material necessary to relay (store and forward) the information (i.e., understand the SubmessageHeader) without being able to decode the data itself (i.e., decode the SecureData).

Parameter **exception**: A SecurityException object, which provides details in case this operation returns HandleNIL.

9.5.1.8.5 Operation: register_local_datareader

Registers a local DataReader with the Cryptographic Plugin. The fact that the DataReader was successfully created indicates that the DomainParticipant to which it belongs was authenticated, granted access to the DDS Domain, and granted permission to create the DataReader on its Topic.

This operation shall create the cryptographic material necessary to encrypt and/or sign the messages sent by the DataReader when the encryption/signature is independent of the targeted DataWriter.

If successful, the operation returns a `DatareaderCryptoHandle` to be used for any cryptographic operations affecting messages sent or received by the `DataWriter`.

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Parameter **adjusted _algorithm_info (out)**: An updated `EndpointSecurityAlgorithmInfo`. The value is obtained by starting from the value passed in the **datareader_security_config** (in) parameter, adding to the "required" sets any algorithms that are used by the Cryptographic plugin and removing from the "supported" sets any algorithms of the types that would be used in the Cryptographic plugin operations that are supported by the plugin.

Parameter **handle**: The handle used to locally identify the `DomainParticipant`. The handle must have been returned by a successful call to `register_local_participant`, otherwise the operation shall return false and fill the `SecurityException`.

Parameter **participant_crypto**: A `ParticipantCryptoHandle` returned by a prior call to `register_local_participant`. It shall correspond to the `ParticipantCryptoHandle` of the `DomainParticipant` to which the `DataReader` belongs. If this argument is `nil`, the operation returns `HandleNIL`.

Parameter **local_datareader_properties**: This parameter shall contain all the properties in the `PropertyQosPolicy` of the local `DataReader` whose name has the prefix "`dds.sec.`crypto." The purpose of this parameter is to allow configuration of the `Cryptographic` Plugin by the `DataReader`, e.g., selection of the cryptographic algorithm, key size, or even setting of the key. The use of this parameter depends on the particular implementation of the plugin and shall be specified for each implementation. Properties not understood by the plugin implementation shall be silently ignored.

Parameter **datareader_security_config**: The `EndpointSecurityConfig` returned by the `AccessControl` `get_datareader_security_config` operation.

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Parameter **algorithm_support**: A `EndpointCryptographicAlgorithmSupport` object describing the algorithms that are used and required by the DataReader.

Parameter **exception**: A `SecurityException` object, which provides details in case this operation returns `HandleNIL`.

9.5.1.8.6 Operation: register_matched_remote_datawriter

Registers a remote `DataWriter` with the `Cryptographic` Plugin. The remote `DataWriter` shall correspond to one that has been granted permissions to match with the local `DataReader`. This operation shall create the cryptographic material necessary to decrypt and/or verify the signatures of the RTPS submessages (`Data`, `DataFrag`, `Heartbeat`, `HeartbeatFrag`, `Gap`) sent from the remote `DataWriter` to the `DataReader`. The operation shall also create the cryptographic material necessary to encrypt and/or sign the RTPS submessages (`AckNack`, `NackFrag`) sent from the local `DataReader` to the remote `DataWriter`.

Parameter **local_datareader_crypto_handle**: A `DatareaderCryptoHandle` returned by a prior call to `register_local_datareader`. If this argument is `nil`, the operation returns `nil`.

Parameter **remote_participant_crypto**: A `ParticipantCryptoHandle` returned by a prior call to `register_matched_remote_participant`. It shall correspond to the `ParticipantCryptoHandle` of the `DomainParticipant` to which the remote `DataWriter` belongs. If this argument is `nil`, the operation returns `nil`.

Parameter **shared_secret**: The `SharedSecretHandle` returned by a prior call to `get_shared_secret` as a result of the successful completion of the Authentication handshake between the local and remote `DomainParticipant` entities.

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Parameter **exception**: A SecurityException object, which provides details in case this operation returns HandleNIL.

9.5.1.8.7 Operation: revise_local_entity_keys

DDSSEC12-122 – Provide mechanism for changing the session keys

Creates a revision of the KeyMaterial used by the local DomainParticipant and its contained DataReader and DataWriter entities. See 9.5.1.6 for a description of the concept of Key Revision.

This operation shall only update the KeyMaterial that is intended to be shared with multiple DomainParticipant, not the key material that, by its very nature, is shared with a single matched DomainParticipant or DataReader and DataWriter. For example, receiver-specific Keys (see 9.5.1.10.2) or the Participant to Participant keys used in the BuiltinParticipantVolatileMessageSecureWriter and BuiltinParticipantVolatileMessageSecureReader (see 9.8.9.1) shall not be updated.

The specific key material that is revised shall be specified for each specific Cryptographic plugin.

This operation shall be called by the middleware whenever it needs to update the Key Material because a matched DomainParticipant is no longer trusted or has lost access rights to some matched Topics that it previously had access to.

If successful, this operation shall return an CryptoTransformKeyRevisionIntHolder containing the CryptoTransformKeyRevision (see 7.3.17).

If not successful it shall return -1 and fill the SecurityException.

Returning a ***key_revision*** value of "0" indicates the Plugin does not support Key Revisions and no Key Material has been updated. In this case there is no need to get the new CryptoTokens, distribute them, and call .activate_key_revision.

If the returned ***key_revision*** value is strictly greated than "0", subsequent "create crypto tokens" calls on the CryptoKeyExchange interface shall return the CryptoTokens that correspond to the.updated Key Material. Otherwise the CryptoTokens returned should be the same as if this operation was never called.

Parameter **participant_crypto_handle**: A ParticipantCryptoHandle returned by a prior call to register_local_participant. If this argument is nil, the operation returns FALSE.

Parameter **exception**: A SecurityException object, which provides details in case this operation returns -1.

9.5.1.8.8 Operation: activate_key_revision

DDSSEC12-122 – Provide mechanism for changing the session keys

Configures the plugin to start using the KeyMaterial that corresponds to a Key Revision created by a previous call to the operation revise_local_entity_keys.

This operation shall only be called by the middleware if the most recent call to revise_local_entity_keys returned a ***key_revision*** strictly greater than zero.

This operation shall be called by the middleware after calling `revise_local_entity_keys`, after obtaining the `CrytoTokens` that correspond to the revised key material, after sending the appropriate `CryptoTokens` to the authorized `DomainParticipant` entities and getting a confirmation that the `CryptoTokens` have been received. Alternatively it may be called by the middleware after sufficient time has elapsed since the `CryptoTokens` that correspond to the revised Key Material have been sent.

If successful, this operation shall return `true` and any subsequent "encode" calls to the `CryptoTranform` interface shall use the `KeyMaterial` that corresponds to the latest (now current) revision.
If unsuccessful the operation shall return `false` and subsequent "encode" calls to the `CryptoTranform` interface shall keep using the same the `KeyMaterial` used before the call.

Parameter **participant_crypto_handle**: A `ParticipantCryptoHandle` returned by a prior call to `register_local_participant`. If this argument is `nil`, the operation shall return `false`.
Parameter **exception**: A `SecurityException` object, which provides details in case this operation returns `false`.

Parameter **key_revision**: The `CryptoTransformKeyRevisionIntHolder` value returned by a prior call to `revise_local_entity_keys`. If this argument does not correspond to a value returned by `revise_local_entity_keys`, the operation shall return `false`.

Parameter **exception**: A `SecurityException` object, which provides details in case this operation returns `false`.

9.5.1.8.9 Operation: unregister_participant

Releases the resources, associated with a `DomainParticipant` that the Cryptographic plugin maintains. After calling this function, the DDS Implementation shall not use the `participant_crypto_handle` anymore.
The DDS Implementation shall call this function when it determines that there will be no further communication with the DDS DomainParticipant associated with the `participant_crypto_handle`. Specifically, it shall be called when the application deletes a local DomainParticipant and also when the DDS Discovery mechanism detects that a matched DomainParticipant is no longer in the system.
Parameter **participant_crypto_handle**: A `ParticipantCryptoHandle` returned by a prior call to `register_local_participant`, or `register_matched_remote_participant` if this argument is `nil`, the operation returns `false`.
Parameter **exception**: A `SecurityException` object, which provides details in case this operation returns `false`.

9.5.1.8.10 Operation: unregister_datawriter

Releases the resources, associated with a `DataWriter` that the Cryptographic plugin maintains. After calling this function, the DDS Implementation shall not use the `datawriter_crypto_handle` anymore.
The DDS Implementation shall call this function when it determines that there will be no further communication with the DDS `DataWriter` associated with the `datawriter_crypto_handle`.

Specifically it shall be called when the application deletes a local DataWriter and also when the DDS Discovery mechanism detects that a matched DataWriter is no longer in the system.

Parameter **datawriter_crypto_handle**: A ParticipantCryptoHandle returned by a prior call to register_local_datawriter, or register_matched_remote_datawriter if this argument is nil, the operation returns false.

Parameter **exception**: A SecurityException object, which provides details in case this operation returns false.

9.5.1.8.11 Operation: unregister_datareader

Releases the resources, associated with a DataReader, that the Cryptographic plugin maintains. After calling this function, the DDS Implementation shall not use the datareader_crypto_handle anymore.

The DDS Implementation shall call this function when it determines that there will be no further communication with the DDS DataReader associated with the datareader_crypto_handle. Specifically it shall be called when the application deletes a local DataReader and also when the DDS Discovery mechanism detects that a matched DataReader is no longer in the system.

Parameter **datareader_crypto_handle**: A ParticipantCryptoHandle returned by a prior call to register_local_datareader, or register_matched_remote_datareader if this argument is nil, the operation returns false.

Parameter **exception**: A SecurityException object, which provides details in case this operation returns false.

9.5.1.9 CryptoKeyExchange Interface

The key exchange interface manages the creation of keys and assist in the secure distribution of keys and key material.

DDSSEC12-122 – Provide mechanism for changing the session keys

Table 43 – CryptoKeyExchange Interface

CryptoKeyExchange		
No Attributes		
Operations		
create_local_participant_crypto_tokens		Boolean
	out: local_participant_crypto_tokens	ParticipantCryptoTokenSeq
	local_participant_crypto	ParticipantCryptoHandle
	remote_participant_crypto	ParticipantCryptoHandle
	key_revision	int32
	out: exception	SecurityException
set_remote_participant_crypto_tokens		Boolean
	local_participant_crypto	ParticipantCryptoHandle
	remote_participant_crypto	ParticipantCryptoHandle
	remote_participant_tokens	ParticipantCryptoTokenSeq
	out: exception	SecurityException
create_local_datawriter_crypto_tokens		Boolean
	out: local_datawriter_crypto_tokens	DatawriterCryptoTokenSeq
	local_datawriter_crypto	DatawriterCryptoHandle
	remote_datareader_crypto	DatareaderCryptoHandle
	key_revision	int32
	out: exception	SecurityException
set_remote_datawriter_crypto_tokens		Boolean
	local_datareader_crypto	DatareaderCryptoHandle
	remote_datawriter_crypto	DatawriterCryptoHandle
	remote_datawriter_tokens	DatawriterCryptoTokenSeq
	out: exception	SecurityException
create_local_datareader_crypto_tokens		Boolean
	out: local_datareader_crypto_tokens	DatareaderCryptoTokenSeq
	local_datareader_crypto	DatareaderCryptoHandle
	remote_datawriter_crypto	DatawriterCryptoHandle

	key revision	int32
	out: exception	SecurityException
set_remote_datareader_crypto_tokens		Boolean
	local_datawriter_crypto	DatawriterCryptoHandle
	remote_datareader_crypto	DatareaderCryptoHandle
	remote_datareader_tokens	DatareaderCryptoTokenSeq
	out: exception	SecurityException
return_crypto_tokens		Boolean
	crypto_tokens	CryptoTokenSeq
	out: exception	SecurityException

9.5.1.9.1 Operation: create_local_participant_crypto_tokens

This operation creates a sequence of `CryptoToken` tokens containing the information needed to correctly interpret cipher text encoded using the ***local_participant_crypto***. That is, the `CryptoToken` sequence contains the information needed to decrypt any data encrypted using the ***local_participant_crypto***, as well as, verify any signatures produced using the ***local_participant_crypto***.

The returned `CryptoToken` sequence contains opaque data, which only the plugins understand. The returned `CryptoToken` sequence is intended for transmission in "clear text" to the remote `DomainParticipant` associated with the ***remote_participant_crypto*** so that the remote `DomainParticipant` has access to the necessary key material. For this reason, the `CryptoKeyExchange` plugin implementation may encrypt the sensitive information inside the `CryptoToken` using shared secrets and keys obtained from the ***remote_participant_crypto***. The specific ways in which this is done depend on the plugin implementation.

The DDS middleware implementation shall call this operation for each remote `DomainParticipant` that matches a local `DomainParticipant`. That is, remote participants that have been successfully authenticated and granted access by the AccessControl plugin.

DDSSEC12-122 – Provide mechanism for changing the session keys

The DDS middleware implementation shall also call this operation after calling `revise_local_entity_keys` since this operation will generate new key material for all the local entities in the `DomainParticipant`.

The returned `ParticipantCryptoTokenSeq` shall be sent to the remote `DomainParticipant` using the ***BuiltinParticipantVolatileMessageSecureWriter*** with kind set to `GMCLASSID_SECURITY_PARTICIPANT_CRYPTO_TOKENS` (see 7.5.3.5). The returned `ParticipantCryptoTokenSeq` sequence shall appear in the ***message_data*** attribute of the `ParticipantVolatileMessageSecure` (see 7.5.4).

Parameter local_participant_crypto_tokens (out): The returned `ParticipantCryptoTokenSeq`.

Parameter local_participant_crypto: A `ParticipantCryptoHandle`, returned by a previous call to `register_local_participant`, which corresponds to the `DomainParticipant` that will be encrypting and signing messages.

Parameter remote_participant_crypto: A `ParticipantCryptoHandle`, returned by a previous call to `register_matched_remote_participant`, that corresponds to the `DomainParticipant` that will be receiving the messages from the local `DomainParticipant` and will be decrypting them and verifying their signature.

DDSSEC12-122 – Provide mechanism for changing the session keys

Parameter key_revision: An integer that selects the revision of the Key Material that is encoded into the returned CryptoTokenSeq. The ***key_revision*** shall correspond to one returned by a prior call to revise_local_entity_keys, otherwise the operation shall return false and set the SecurityException object.
Parameter exception: A SecurityException object, which provides details in case this operation returns false.

9.5.1.9.2 Operation: set_remote_participant_crypto_tokens

This operation shall be called by the DDS implementation upon reception of a message on the ***BuiltinParticipantVolatileMessageSecureReader*** with kind set to GMCLASSID_SECURITY_PARTICIPANT_CRYPTO_TOKENS (see 7.5.3.5).
The operation configures the Cryptographic plugin with the key material necessary to interpret messages encoded by the remote DomainParticipant associated with the ***remote_participant_crypto*** and destined to the local DomainParticipant associated with the ***local_participant_crypto***. The interpretation of the CryptoToken sequence is specific to each Cryptographic plugin implementation. The CryptoToken sequence may contain information that is encrypted and/or signed. Typical implementations of the Cryptographic plugin will use the previously configured shared secret associated with the local and remote ParticipantCryptoHandle to decode the CryptoToken sequence and retrieve the key material within.
Parameter remote_participant_crypto: A ParticipantCryptoHandle, returned by a previous call to register_matched_remote_participant, that corresponds to the DomainParticipant that will be sending the messages from the local DomainParticipant and will be encrypting/signing them with the key material encoded in the CryptoToken sequence.
Parameter local_participant_crypto: A ParticipantCryptoHandle, returned by a previous call to register_local_participant, that corresponds to the DomainParticipant that will be receiving messages from the remote DomainParticipant and will need to decrypt and/or verify their signature.
Parameter remote_participant_tokens: A ParticipantCryptoToken sequence received via the ***BuiltinParticipantVolatileMessageSecureReader***. The CryptoToken sequence shall correspond to the one returned by a call to create_local_participant_crypto_tokens performed by the remote DomainParticipant on the remote side.
Parameter exception: A SecurityException object, which provides details in case this operation returns false.

9.5.1.9.3 Operation: create_local_datawriter_crypto_tokens

This operation creates a DatawriterCryptoTokenSeq containing the information needed to correctly interpret cipher text encoded using the local_datawriter_crypto. That is, the CryptoToken sequence contains that information needed to decrypt any data encrypted using the ***local_datawriter_crypto*** as well as verify any signatures produced using the ***local_datawriter_crypto***.
The returned CryptoToken sequence contains opaque data, which only the plugins understand. The returned CryptoToken sequence shall be sent to the remote DataReader associated with the remote_datareader_crypto so that the remote DataReader has access to the necessary key material.
The operation shall take into consideration the value of the ***relay_only*** parameter associated with the DatawriterCryptoHandle (see 9.5.1.8.4) this parameter shall control whether the Tokens

returned contain all the cryptographic material needed to decode/verify both the RTPS SubMessage and the CryptoContent submessage element within or just part of it.

If the value of the ***relay_only*** parameter was FALSE, the Tokens returned contain all the cryptographic material.

If the value of the ***relay_only*** parameter was TRUE, the Tokens returned contain only the cryptographic material needed to verify and decode the RTPS SubMessage but not the CryptoContent submessage element within.

The DDS middleware implementation shall call this operation for each remote `DataReader` that matches a local `DataWriter`.

DDSSEC12-122 – Provide mechanism for changing the session keys

The DDS middleware implementation shall also call this operation after calling `revise_local_entity_keys` since this operation will generate new key material for all the local `DataWriter` entities in the `DomainParticipant`.

The returned `CryptoToken` sequence shall be sent by the DDS middleware to the remote `DataReader` using the ***BuiltinParticipantVolatileMessageSecureWriter*** with kind set to `GMCLASSID_SECURITY_DATAWRITER_CRYPTO_TOKENS` (see 7.5.3.5). The returned `DatawriterCryptoToken` shall appear in the ***message_data*** attribute of the ***ParticipantVolatileMessageSecure*** (see 7.5.4.2). The ***source_endpoint_guid*** attribute shall be set to the `GUID_t` of the local `DataWriter` and the ***destination_endpoint_guid*** attribute shall be set to the `GUID_t` of the remote `DataReader`.

Parameter local_datawriter_crypto_tokens: The returned `DatawriterCryptoTokenSeq`.

Parameter local_datawriter_crypto: A `DatawriterCryptoHandle`, returned by a previous call to `register_local_datawriter` that corresponds to the `DataWriter` that will be encrypting and signing messages.

Parameter remote_datareader_crypto: A `DatareaderCryptoHandle`, returned by a previous call to `register_matched_remote_datareader`, that corresponds to the `DataReader` that will be receiving the messages from the local `DataWriter` and will be decrypting them and verifying their signature.

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Parameter key_revision: An integer that selects the revision of the `Key Material` that is encoded into the returned `CryptoTokenSeq`. The ***key_revision*** shall correspond to one returned by a prior call to `revise_local_entity_keys`, otherwise the operation shall return false and set the `SecurityException` object.

Parameter exception: A `SecurityException` object, which provides details in case this operation returns `false`.

9.5.1.9.4 Operation: set_remote_datawriter_crypto_tokens

This operation shall be called by the DDS implementation upon reception of a message on the ***BuiltinParticipantVolatileMessageSecureReader*** with kind set to `GMCLASSID_SECURITY_DATAWRITER_CRYPTO_TOKENS` (see 7.5.3.5).

The operation configures the `Cryptographic` plugin with the key material necessary to interpret messages encoded by the remote `DataWriter` associated with the `remote_datawriter_crypto` and destined to the local `DataReader` associated with the `local_datareader_crypto`. The interpretation of the `DatawriterCryptoTokenSeq` sequence is specific to each `Cryptographic` plugin implementation. The `CryptoToken` sequence may contain information that is encrypted and/or signed. Typical implementations of the `Cryptographic` plugin will use the previously configured shared secret associated with the remote

DatawriterCryptoHandle and local DatareaderCryptoHandle to decode the CryptoToken sequence and retrieve the key material within.

Parameter remote_datawriter_crypto: A DatawriterCryptoHandle, returned by a previous call to register_matched_remote_datawriter, that corresponds to the DataWriter that will be sending the messages to the local DataReader and will be encrypting/signing them with the key material encoded in the CryptoToken.

Parameter local_datareader_crypto: A DatareaderCryptoHandle, returned by a previous call to register_local_datareader, that corresponds to the DataReader that will be receiving messages from the remote DataWriter and will need to decrypt and/or verify their signature.

Parameter remote_datawriter_tokens: A CryptoToken sequence received via the ***BuiltinParticipantVolatileMessageSecureReader***. The DatawriterCryptoToken shall correspond to the one returned by a call to create_local_datawriter_crypto_tokens performed by the remote DataWriter on the remote side.

Parameter exception: A SecurityException object, which provides details in case this operation returns false.

9.5.1.9.5 Operation: create_local_datareader_crypto_tokens

This operation creates a DatareaderCryptoTokenSeq containing the information needed to correctly interpret cipher text encoded using the ***local_datareader_crypto***. That is, the CryptoToken sequence contains that information needed to decrypt any data encrypted using the ***local_datareader_crypto*** as well as verify any signatures produced using the ***local_datareader_crypto***.

The returned CryptoToken sequence contains opaque data, which only the plugins understand. The returned CryptoToken sequence shall be sent to the remote DataWriter associated with the ***remote_datawriter_crypto*** so that the remote DataWriter has access to the necessary key material.

For this reason, the CryptoKeyExchange plugin implementation may encrypt the sensitive information inside the CryptoToken sequence using shared secrets and keys obtained from the ***remote_datawriter_crypto***. The specific ways in which this is done depend on the plugin implementation.

The DDS middleware implementation shall call this operation for each remote DataWriter that matches a local DataReader.

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The DDS middleware implementation shall also call this operation after calling revise_local_entity_keys since this operation will generate new key material for all the local DataReader entities in the DomainParticipant.

The returned DatareaderCryptoTokenSeq shall be sent by the DDS middleware to the remote DataWriter using the ***BuiltinParticipantVolatileMessageSecureWriter*** with kind set to GMCLASSID_SECURITY_DATAREADER_CRYPTO_TOKENS (see 7.5.4.2). The returned DatareaderCryptoTokenSeq shall appear in the ***message_data*** attribute of the ParticipantVolatileMessageSecure (see 7.5.4.2). The ***source_endpoint_guid*** attribute shall be set to the GUID_t of the local DataReader and the ***destination_endpoint_guid*** attribute shall be set to the GUID_t of the remote DataWriter.

Parameter local_datareader_crypto_tokens (out): The returned DatareaderCryptoTokenSeq.

Parameter local_datareader_crypto: A DatareaderCryptoHandle, returned by a previous call to register_local_datareader, that corresponds to the DataReader that will be encrypting and signing messages.

Parameter remote_datawriter_crypto: A `DatawriterCryptoHandle`, returned by a previous call to `register_matched_remote_datawriter`, that corresponds to the `DataWriter` that will be receiving the messages from the local `DataReader` and will be decrypting them and verifying their signature.

DDSSEC12-122 – Provide mechanism for changing the session keys

Parameter key_revision: An integer that selects the revision of the `Key aterial` that is encoded into the returned `CryptoTokenSeq`. The ***key_revision*** shall correspond to one returned by a prior call to `revise_local_entity_keys`, otherwise the operation shall return false and set the `SecurityException` object.

Parameter exception: A `SecurityException` object, which provides details in case this operation returns `false`.

9.5.1.9.6 Operation: set_remote_datareader_crypto_tokens

This operation shall be called by the DDS implementation upon reception of a message on the ***BuiltinParticipantVolatileMessageSecureReader*** with kind set to `GMCLASSID_SECURITY_DATAREADER_CRYPTO_TOKENS` (see 7.5.4.2).

The operation configures the `Cryptographic` plugin with the key material necessary to interpret messages encoded by the remote `DataReader` associated with the ***remote_datareader_crypto*** and destined to the local `DataWriter` associated with the ***local_datawriter_crypto***. The interpretation of the `DatareaderCryptoTokenSeq` is specific to each `Cryptographic` plugin implementation.

The `CryptoToken` sequence may contain information that is encrypted and/or signed. Typical implementations of the `Cryptographic` plugin will use the previously configured shared secret associated with the remote `DatareaderCryptoHandle` and local `DatawriterCryptoHandle` to decode the `CryptoToken` sequence and retrieve the key material within.

Parameter remote_datareader_crypto: A `DatareaderCryptoHandle`, returned by a previous call to `register_matched_remote_datareader`, that corresponds to the `DataReader` that will be sending the messages to the local `DataWriter` and will be encrypting/signing them with the key material encoded in the `CryptoToken` sequence.

Parameter local_datawriter_crypto: A `DatawriterCryptoHandle` returned by a previous call to `register_local_datawriter`, that corresponds to the `DataWriter` that will be receiving messages from the remote `DataReader` and will need to decrypt and/or verify their signature.

Parameter remote_datareader_tokens: A `CryptoToken` sequence received via the ***BuiltinParticipantVolatileMessageSecureReader***. The `DatareaderCryptoToken` shall correspond to the one returned by a call to `create_local_datareader_crypto_tokens` performed by the remote `DataReader` on the remote side.

Parameter exception: A `SecurityException` object, which provides details in case this operation returns `false`.

9.5.1.9.7 Operation: return_crypto_tokens

Returns the tokens in the `CryptoToken` sequence to the plugin so the plugin can release any information associated with it.

Parameter crypto_tokens: Contains `CryptoToken` objects issued by the plugin on a prior call to one of the following operations:

- create_local_participant_crypto_tokens
- create_local_datawriter_crypto_tokens
- create_local_datareader_crypto_tokens

Parameter exception: A SecurityException object, which provides details in case this operation returns false.

9.5.1.10 CryptoTransform interface

This interface groups the operations related to encrypting/decrypting, as well as, computing and verifying both message digests (hashes) and Message Authentication Codes (MAC).
MACs may be used to verify both the (data) integrity and the authenticity of a message. The computation of a MAC (also known as a keyed cryptographic hash function), takes as input a secret key and an arbitrary-length message to be authenticated, and outputs a MAC. The MAC value protects both a message's data integrity, as well as, its authenticity by allowing verifiers (who also possess the secret key) to detect any changes to the message content.
A Hash-based Message Authentication Code (HMAC) is a specialized way to compute MACs. While an implementation of the plugin is not forced to use HMAC, and could use other MAC algorithms, the API is chosen such that plugins can implement HMAC if they so choose.
The operations in the CryptoTransform Plugin are defined to be quite generic, taking an input byte array to transform and producing the transformed array of bytes as an output. The DDS implementation is only responsible for calling the operations in the CryptoTransform plugin at the appropriate times as it generates and processes the RTPS messages, substitutes the input bytes with the transformed bytes produced by the CryptoTransform operations, and proceeds to generate/send or process the RTPS message as normal but with the replaced bytes. The decision of the kind of transformation to perform (encrypt and/or produce a digest and/or a MAC and/or signature) is left to the plugin implementation.
DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

Table 44 – CryptoTransform interface

CryptoTransform		
No Attributes		
Operations		
encode_serialized_payload		Boolean
	out: encoded_buffer	octet[]
	out: extra_inline_qos	octet[]
	plain_buffer	octet[]
	sending_datawriter_crypto	DatawriterCryptoHandle
	out: exception	SecurityException
encode_datawriter_submessage		Boolean
	out: encoded_rtps_submessage	octet[]
	plain_rtps_submessage	octet[]
	sending_datawriter_crypto	DatawriterCryptoHandle
	receiving_datareader_crypto_list	DatareaderCryptoHandle[]
	inout: receiving_datareader_crypto_list_index	long
	out: exception	SecurityException
encode_datareader_submessage		Boolean
	out: encoded_rtps_submessage	octet[]
	plain_rtps_submessage	octet[]
	sending_datareader_crypto	DatareaderCryptoHandle
	receiving_datawriter_crypto_list	DatawriterCryptoHandle[]

	out: exception	SecurityException

encode_rtps_message		Boolean
	out: encoded_rtps_message	octet[]
	plain_rtps_message	octet[]
	sending_participant_crypto	ParticipantCryptoHandle
	receiving_participant_crypto_list	ParticipantCryptoHandle[]
	inout: receiving_participant_crypto_list_index	long
	transform with psk	Boolean
	out: exception	SecurityException
decode_rtps_message		Boolean
	out: plain_buffer	octet[]
	encoded_buffer	octet[]
	receiving_participant_crypto	ParticipantCryptoHandle
	sending_participant_crypto	ParticipantCryptoHandle
	out: exception	SecurityException
preprocess_secure_submsg		Boolean
	out: datawriter_crypto	DatawriterCryptoHandle
	out: datareader_crypto	DatareaderCryptoHandle
	out: secure_submessage_category	DDS_SecureSumessageCategory_t
	in: encoded_rtps_submessage	octet[]
	receiving_participant_crypto	ParticipantCryptoHandle
	sending_participant_crypto	ParticipantCryptoHandle
	out: exception	SecurityException

decode_datawriter_submessage		Boolean
	out: plain_rtps_submessage	octet[]
	encoded_rtps_submessage	octet[]
	receiving_datareader_crypto	DatareaderCryptoHandle
	sending_datawriter_crypto	DatawriterCryptoHandle
	out: exception	SecurityException
decode_datareader_submessage		Boolean
	out: plain_rtps_submessage	octet[]
	encoded_rtps_submessage	octet[]
	receiving_datawriter_crypto	DatawriterCryptoHandle
	sending_datareader_crypto	DatareaderCryptoHandle
	out: exception	SecurityException
decode_serialized_payload		Boolean
	out: plain_buffer	octet[]
	encoded_buffer	octet[]
	inline_qos	octet[]

	receiving_datareader_crypto	DatareaderCryptoHandle
	sending_datawriter_crypto	DatawriterCryptoHandle
	out: exception	SecurityException

9.5.1.10.1 Operation: encode_serialized_payload

This operation shall be called by the DDS implementation as a result of the application calling the write operation on the DataWriter associated with the `DatawriterCryptoHandle` specified in the ***sending_datawriter_crypto*** parameter.

The operation receives the data written by the `DataWriter` in serialized form wrapped inside the RTPS `SerializedPayload` submessage element and shall output an RTPS `CryptoContent` submessage element and a ***extra_inline_qos*** containing InlineQos formatted as a `ParameterList`, see section 7.4.1.

If the returned ***extra_inline_qos*** is not empty, the parameters contained shall be added to the list of ***inlineQos*** parameters present in the (`Data` or `DataFrag`) submessage. If the (`Data` or `DataFrag`) submessage did not already have an ***inlineQos***, then the ***inlineQos*** submessage element shall be added and the submessage flags modified accordingly.

The DDS implementation shall call this operation for all outgoing RTPS Submessages with submessage kind `Data` and `DataFrag`. The DDS implementation shall substitute the `SerializedPayload` submessage element within the aforementioned RTPS submessages with the `CryptoContent` produced by this operation.

The implementation of `encode_serialized_payload` can perform any desired cryptographic transformation of the `SerializedPayload` using the key material in the `sending_datawriter_crypto`, including encryption, addition of a MAC, and/or signature. The `encode_serialized_payload` shall include in the ***extra_inline_qos*** or the `CryptoContent` the `CryptoTransformIdentifier` and the additional information needed to identify the key used and decode the `CryptoContent` submessage element.

If an error occurs, this method shall return `false`.

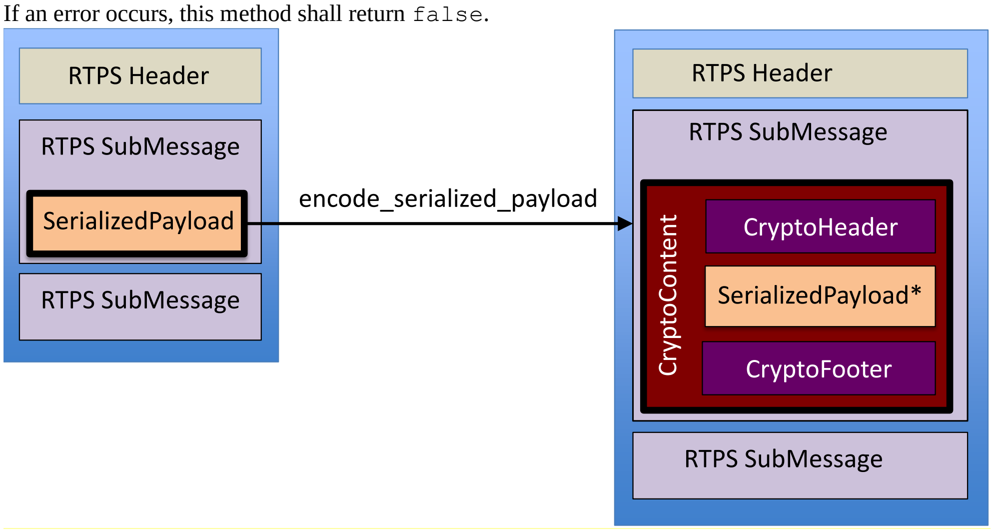

Figure 12 – Effect of encode_serialized_payload within an RTPS message

Parameter ***encoded_buffer***: The output containing the CryptoContent RTPS submessage element, which shall be used to replace the input ***plain_buffer***.
Parameter ***extra_inline_qos***: The output containing additional parameters to be added to the inlineQos `ParamaterList` in the submessage.
Parameter **plain_buffer**: The input containing the `SerializedPayload` RTPS submessage element.
Parameter **sending_datawriter_crypto**: The `DatawriterCryptoHandle` returned by a previous call to `register_local_datawriter` for the `DataWriter` that wrote the `SerializedPayload`.
Parameter **exception**: A `SecurityException` object, which provides details in case this operation returns `false`.

9.5.1.10.2 Operation: encode_datawriter_submessage

This operation shall be called by the DDS implementation whenever it has constructed an RTPS submessage of kind `Data`, `DataFrag`, `Gap`, `Heartbeat`, or `HeartbeatFrag`.
The operation receives the `DatawriterCryptoHandle` of the `DataWriter` that is sending the submessage, as well as, a list of `DatareaderCryptoHandle` corresponding to all the `DataReader` entities to which the submessage is being sent.
In the case of ***BuiltinParticipantVolatileMessageSecureWriter*** (identified through the `DatawriterCryptoHandle`), the `DatareaderCryptoHandle` list has ONE element containing `KxKey` material derived from the `SharedSecret` as described in 10.5.2.1.2.
The operation receives the complete RTPS submessage as it would normally go onto the wire in the parameter ***rtps_submessage*** and shall output one or more RTPS `Submessages` in the output parameter ***encoded_rtps_submessage***. The DDS implementation shall substitute the original RTPS submessage that was passed in the ***rtps_submessage*** with the RTPS `Submessages` returned in the ***encoded_rtps_submessage*** output parameter in the construction of the RTPS message that is eventually sent to the intended recipients.
The implementation of `encode_datawriter_submessage` can perform any desired cryptographic transformation of the RTPS `Submessage` using the key material in the ***sending_datawriter_crypto***; it can also add one or more MACs and/or signatures. The fact that the cryptographic material associated with the list of intended `DataReader` entities is passed in the parameter ***receiving_datareader_crypto_list*** allows the plugin implementation to include MACs that may be computed differently for each `DataReader`.
The implementation of `encode_datawriter_submessage` shall include, within the RTPS `Submessages`, the `CryptoTransformIdentifier` containing any additional information necessary for the receiving plugin to identify the `DatawriterCryptoHandle` associated with the DataWriter that sent the message, as well as, the `DatareaderCryptoHandle` associated with the DataReader that is meant to process the submessage. How this is done depends on the plugin implementation.
A typical implementation of `encode_datawriter_submessage` may output a `SecurePrefixSubMsg` followed by a `SecureBodySubMsg`, followed by a `SecurePostfixSubMsg`.
If an error occurs, this method shall return `false`.

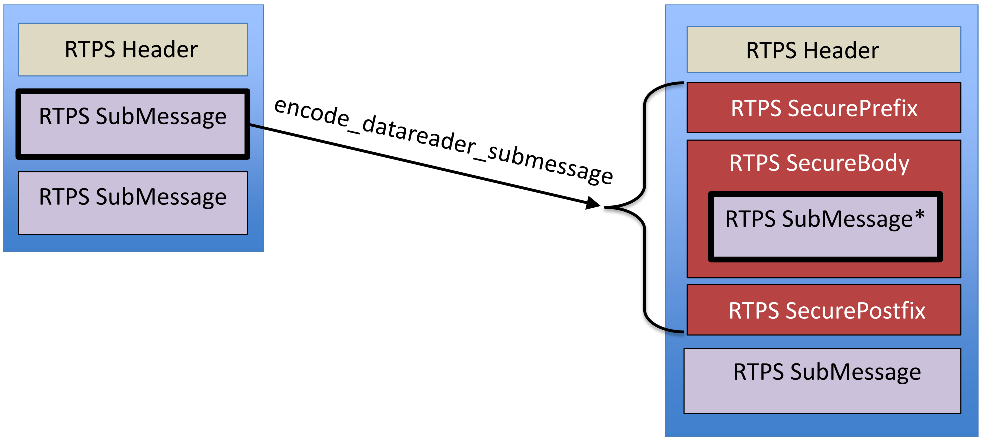

Figure 13 – Effect of encode_datawriter_submessage within an RTPS message

Parameter **encoded_rtps_submessage**: The output containing one or more RTPS submessages, which shall be used to replace the input ***rtps_submessage***.

Parameter **plain_rtps_submessage**: The input containing the RTPS submessage created by a DataWriter. This submessage will be one of following kinds: `Data`, `DataFrag`, `Gap`, `Heartbeat`, and `HeartbeatFrag`.

Parameter **sending_datawriter_crypto**: The `DatawriterCryptoHandle` returned by a previous call to register_local_datawriter for the DataWriter whose GUID is inside the `rtps_submessage`.

Parameter **receiving_datareader_crypto_list**: The list of `DatareaderCryptoHandle` returned by previous calls to `register_matched_remote_datareader` for the DataReader entities to which the submessage will be sent.

Parameter **receiving_datareader_crypto_list_index**: Index to the first element of the ***receiving_datareader_crypto_list*** that should be used. This parameter allows the `encode_datawriter_submessage` operation to be invoked multiple times for a given ***plain_rtps_submessage***, iterating over elements in the receiving***_datawriter_crypto_list***. Each iteration prepares the ***encoded_rtps_submessage*** for a different set of data readers and advances the ***receiving_datareader_crypto_list_index***.

The ***receiving_datareader_crypto_list_index*** shall be set to 0 to start the iteration on a ***plain_rtps_submessage***. Subsequent calls may use a non-zero value of the index. If the index is non-zero, then the ***plain_rtps_submessage*** shall be set to the empty sequence and the ***encoded_rtps_submessage*** shall be the one returned by a previous call to the `encode_datawriter_submessage`. The calls with non-zero values of the ***receiving_datareader_crypto_list_index*** modify the ***encoded_rtps_submessage***, replacing the receiver-specific parts of the ***encoded_rtps_submessage***.

The operation fills the ***receiving_datawriter_crypto_list_index*** with the next index to use in subsequent calls to `encode_datawriter_submessage`. The value ***receiving_datawriter_crypto_list_index*** = Length(***receiving_datawriter_crypto_list***) indicates that the iteration over the ***receiving_datawriter_crypto_list*** is complete.

Parameter **exception**: A `SecurityException` object, which provides details in case this operation returns `false`.

9.5.1.10.3 Operation: encode_datareader_submessage

This operation shall be called by the DDS implementation whenever it has constructed an RTPS submessage of kind `AckNack` or `NackFrag`.

The operation receives the `DatareaderCryptoHandle` of the DataReader that is sending the submessage, as well as, a list of `DatawriterCryptoHandle` corresponding to all the DataWriter entities to which the submessage is being sent.

In the case of ***BuiltinParticipantVolatileMessageSecureReader*** (identified through the `DatawriterCryptoHandle`), the `DatawriterCryptoHandle` list has ONE element containing `KxKey` material derived from the `SharedSecret` as described in 10.5.2.1.2.

The operation receives the complete RTPS submessage as it would normally go onto the wire in the parameter ***rtps_submessage*** and shall output one or more RTPS `Submessages` in the output parameter ***encoded_rtps_submessage***. The DDS implementation shall substitute the original RTPS submessage that was passed in the ***rtps_submessage*** with the `Submessages` returned in the ***encoded_rtps_submessage*** output parameter in the construction of the RTPS message that is eventually sent to the intended recipients.

The implementation of `encode_datareader_submessage` can perform any desired cryptographic transformation of the RTPS Submessage using the key material in the `sending_datareader_crypto`, it can also add one or more MACs, and/or signatures. The fact that the cryptographic material associated with the list of intended `DataWriter` entities is passed in the parameter `receiving_datawriter_crypto_list` allows the plugin implementation to include one of MAC that may be computed differently for each `DataWriter`.

The implementation of `encode_datareader_submessage` shall include within the ***encoded_rtps_submessage*** the `CryptoTransformIdentifier` containing any additional information necessary for the receiving plugin to identify the `DatareaderCryptoHandle` associated with the DataReader that sent the message as well as the `DatawriterCryptoHandle` associated with the DataWriter that is meant to process the submessage. How this is done depends on the plugin implementation.

A typical implementation of `encode_datareader_submessage` may output a `SecurePrefixSubMsg` followed by a `SecureBodySubMsg`, followed by a `SecurePostfixSubMsg`.

If an error occurs, this method shall return `false`.

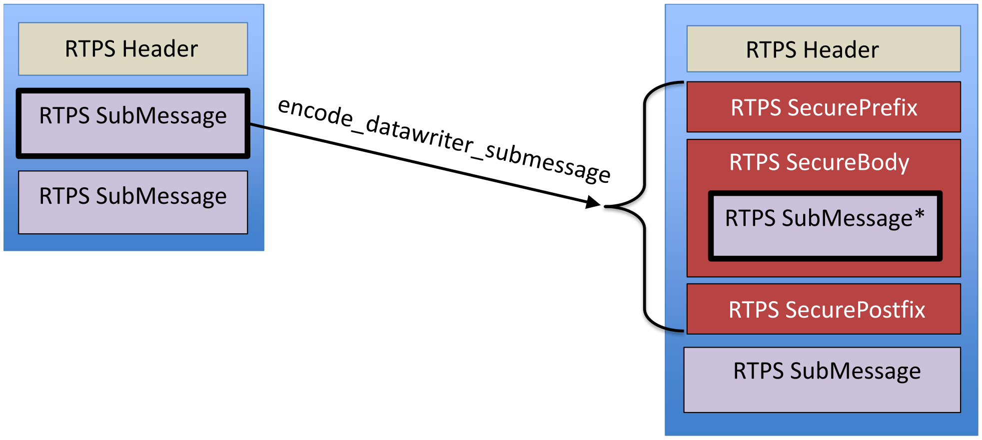

Figure 14 – Effect of encode_datareader_submessage within an RTPS message

Parameter **encoded_rtps_submessage**: The output containing one or more RTPS submessages, which shall be used to replace the input `rtps_submessage`.
Parameter **plain_rtps_submessage**: The input containing the RTPS submessage created by a DataReader. This submessage will be one of following kinds: `AckNack`, `NackFrag`.
Parameter **sending_datareader_crypto**: The `DatareaderCryptoHandle` returned by a previous call to register_local_datareader for the DataReader whose GUID is inside the `rtps_submessage`.
Parameter **receiving_datawriter_crypto_list**: The list of `DatawriterCryptoHandle` returned by previous calls to `register_matched_remote_datawriter` for the DataWriter entities to which the submessage will be sent.
Parameter **exception**: A `SecurityException` object, which provides details in case this operation returns `false`.

9.5.1.10.4 Operation: encode_rtps_message

This operation shall be called by the DDS implementation whenever it has constructed an RTPS message prior to sending it on the wire.
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The operation receives the `ParticipantCryptoHandle` of the DomainParticipant that is sending the message, as well as, a list of `ParticipantCryptoHandle` corresponding to all the DomainParticipant entities to which the message is being sent.
The operation receives the complete RTPS message as it would normally go onto the wire in the parameter ***plain_rtps_message*** and shall also output an RTPS message in the output parameter ***encoded_rtps_message***. The DDS implementation shall substitute the original RTPS message that was passed in the ***plain_rtps_message*** with the ***encoded_rtps_message*** returned by this operation and proceed to send it to the intended recipients.
This operation may optionally not perform any transformation of the input RTPS message. In this case, the operation shall return false but not set the `exception` object. In this situation the DDS implementation shall send the original RTPS message.
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The implementation of `encode_rtps_message` may perform any desired cryptographic transformation of the whole RTPS Message using the key material in the `sending_participant_crypto`, it can also add one or more MACs, and/or signatures. The fact that the cryptographic material associated with the list of intended DataWriter entities is passed in the parameter `receiving_participant_crypto_list` allows the plugin implementation to include MACs that may be computed differently for each destination `DomainParticipant`.
The implementation of `encode_rtps_message` shall include within the ***encoded_rtps_message*** the `CryptoTransformIdentifier` containing any additional information beyond the one shared via the `CryptoToken` that would be needed to identify the key used and decode the ***encoded_rtps_message*** back into the original RTPS message.
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The details of the transformation shall be defined for each specific `Cryptographic` plugin implementation:

- A typical implementation of `encode_rtps_message` to provide authentication only may output the `RTPS Header` (and optionally a `HeaderExtension`), followed by a `SecureRTPSPrefixSubMsg`, followed by the submessages included in the input ***plain_rtps_message***, followed by a `SecureRTPSPostfixSubMsg`. An additional

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InfoSourceSubMsg duplicating the information in the RTPS Header may be inserted after the SecureRTPSPrefixSubMsg when additional authenticated data is not enabled.

- A typical implementation of encode_rtps_message to provide authenticated encryption may output the RTPS Header (and optionally a HeaderExtension), followed by a SecureRTPSBodySubMsg containing the result of transforming the remining messages included in the input ***plain_rtps_message*** followed by a SecureRTPSPrefixSubMsg, followed by a SecureRTPSBodySubMsg containing the result of transforming the non-header submessages in the input ***plain_rtps_message***, followed by a SecureRTPSPostfixSubMsg. An additional InfoSourceSubMsg duplicating the information in the RTPS Header may be inserted prior to doing the transformation when additional authenticated data is not enabled.

If an error occurs, this method shall return false and set the exception object.

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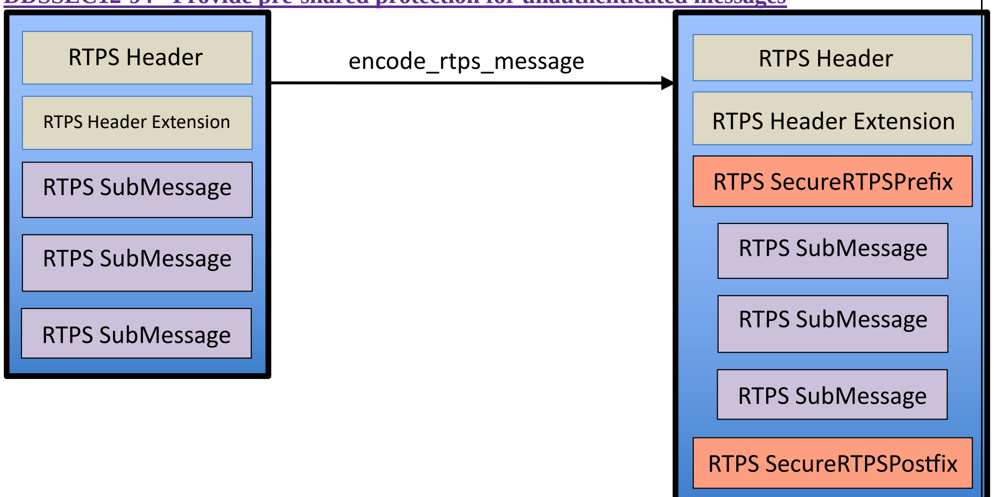

Figure 15 – Possible effect of encode_rtps within an RTPS message providing authentication only

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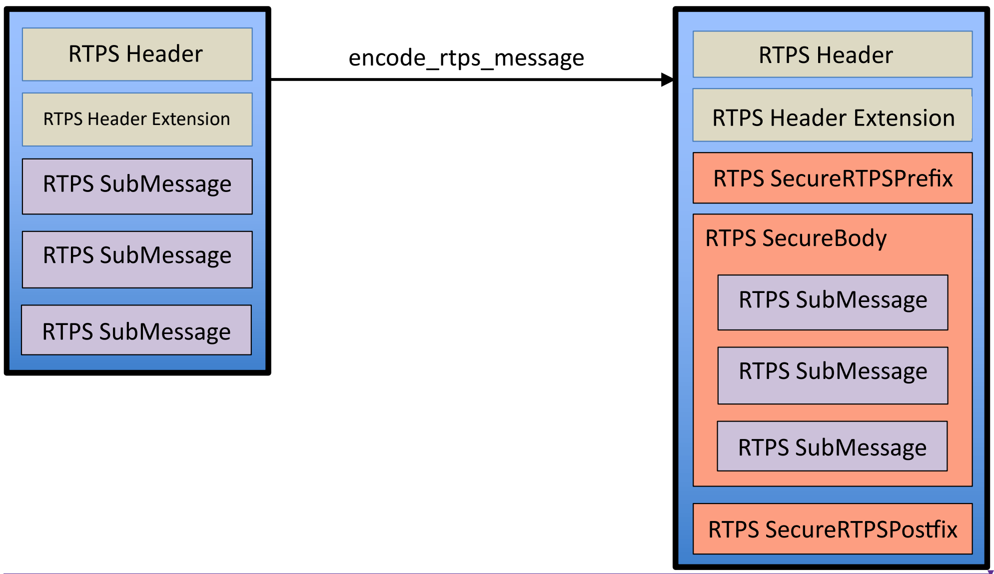

Figure 16 – Possible effect of encode_rtps within an RTPS message providing authenticated encryption

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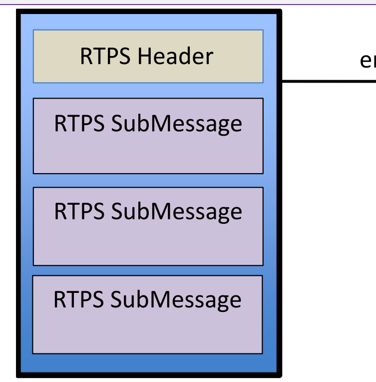

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Parameter **encoded_rtps_message**: The output containing the encoded RTPS message.

Parameter **plain_rtps_message**: The input containing the RTPS messages the DDS implementation intended to send.

Parameter **sending_participant_crypto**: The `ParticipantCryptoHandle` returned by a previous call to register_local_participant for the DomainParticipant whose GUID is inside the RTPS Header.

Parameter **receiving_participant_crypto_list**: The list of `ParticipantCryptoHandle` returned by previous calls to `register_matched_remote_participant` for the DomainParticipant entities to which the message will be sent.

Parameter **receiving_participant_crypto_list_index**: Index to the first element of the ***receiving_participant_crypto_list*** that should be used. This parameter allows the `encode_rtps_message` operation to be invoked multiple times for a given ***plain_rtps_message***, iterating over elements in the receiving_***receiving_participant_crypto_list***. Each iteration prepares the ***encoded_rtps_message*** for a different set of receiving domain participants and advances the ***receiving_participant_crypto_list_index***.

The ***receiving_participant_crypto_list_index*** shall be set to 0 to start the iteration on a ***plain_rtps_message***. Subsequent calls may use a non-zero value of the index. If the index is non-zero, then the ***plain_rtps_message*** shall be set to the empty sequence and the ***encoded_rtps_message*** shall be the one returned by a previous call to the `encode_rtps_message`. The calls with non-zero values of the ***receiving_participant_crypto_list_index*** modify the ***encoded_rtps_message***, replacing the receiver-specific parts of the ***encoded_rtps_message***.

The operation fills the ***receiving_participant_crypto_list_index*** with the next index to use in subsequent calls to `encode_rtps_message`. The value ***receiving_participant_crypto_list_index*** = Length(***receiving_participant_crypto_list***) indicates that the iteration over the ***receiving_participant_crypto_list*** is complete.

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

Parameter **transform_with_psk**: If `false`, indicates that the RTPS message shall be transformed using the cryptographic material that the sending Participant created and exchanged with the matched authenticated Participants. If `true`, indicates that the RTPS message shall be protected using the sending Participant's pre-shared key. This shall result in the RTPS `SecureRTPSPRefix's PreSharedKeyFlag` (see 7.4.7.8.3) to be set for the outgoing encoded_RTPS_message).

Parameter **exception**: A `SecurityException` object, which provides details in case this operation returns `false`.

9.5.1.10.5 Operation: decode_rtps_message

This operation shall be called by the DDS implementation whenever it receives an RTPS message prior to parsing it.

This operation shall reverse the transformation performed by the `encode_rtps_message` operation, decrypting the content if appropriate and verifying any MACs or digital signatures that were produced by the `encode_rtps_message` operation.

If an error occurs, this method shall return an exception.

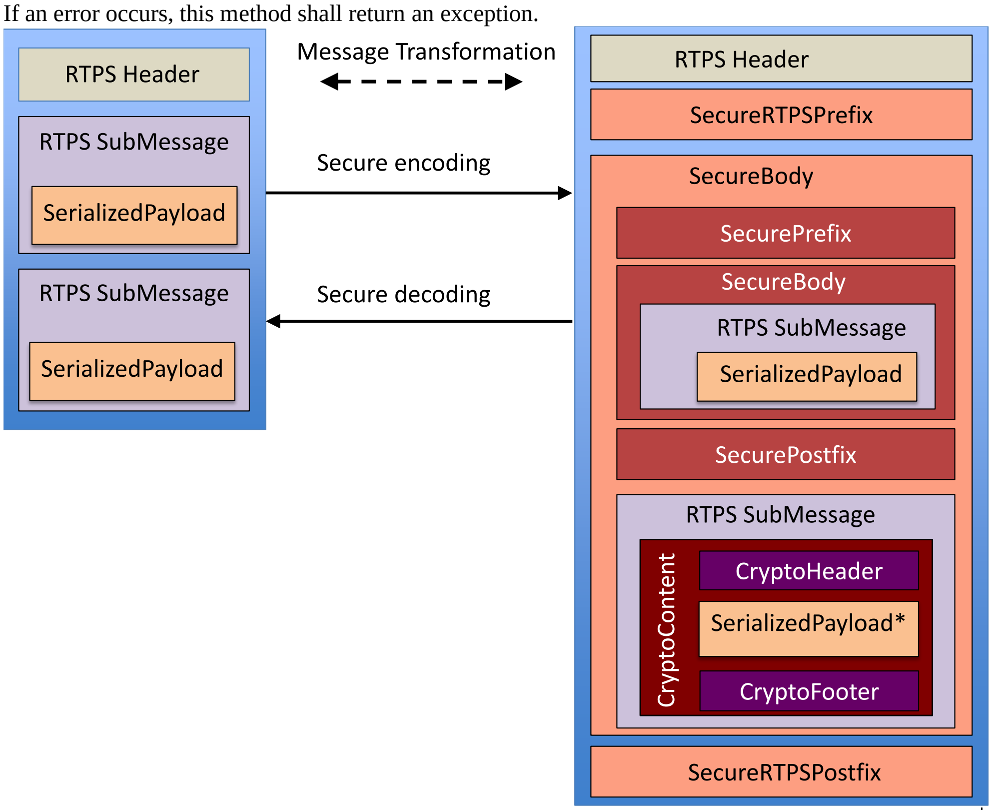

Figure 17 – Possible effect of decode_rtps within an RTPS message

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Parameter **plain_rtps_message**: The output containing the decoded RTPS message. The output message shall contain the original RTPS message.

Parameter **encoded_rtps_message**: The input containing the encoded RTPS message the DDS implementation received.
Parameter **receiving_participant_crypto**: The `ParticipantCryptoHandle` returned by previous calls to `register_local_participant` for the `DomainParticipant` entity that received the RTPS message.
Parameter **sending_participant_crypto**: The `ParticipantCryptoHandle` returned by a previous call to `register_matched_remote_participant` for the `DomainParticipant` that sent the RTPS message whose GUID is inside the RTPS Header.
Parameter **exception**: A `SecurityException` object, which provides details in case this operation returns `false`.

9.5.1.10.6 Operation: preprocess_secure_submsg

This operation shall be called by the DDS implementation as a result of a `DomainParticipant` receiving an RTPS.
The purpose of the operation is to determine whether the secure submessage was produced as a result of a call to `encode_datawriter_submessage` or a call to `encode_datareader_submessage`, and to retrieve the appropriate `DatawriterCryptoHandle` and `DatareaderCryptoHandle` needed to decode the submessage.
If the operation returns successfully, the DDS implementation shall call the appropriate decode operation based on the returned `SecureSubmessageCategory_t`:

- If the returned `SecureSubmessageCategory_t` equals DATAWRITER_SUBMESSAGE, then the DDS Implementation shall call `decode_datawriter_submessage`.
- If the returned `SecureSubmessageCategory_t` equals DATAREADER_SUBMESSAGE, then the DDS Implementation shall call `decode_datareader_submessage`.
- If the returned `SecureSubmessageCategory_t` equals INFO_SUBMESSAGE, then the DDS Implementation proceeds normally to process the submessage without further decoding.

Parameter **secure_submessage_category**: Output `SecureSubmessageCategory_t`. It shall be set to `DATAWRITER_SUBMESSAGE` if the `SecurePrefixSubMsg` was created by a call to `encode_datawriter_submessage` or set to `DATAREADER_SUBMESSAGE` if the `SecurePrefixSubMsg` was created by a call to `encode_datareader_submessage`. If none of these conditions apply, the operation shall return false.
Parameter **datawriter_crypto**: Output `DatawriterCryptoHandle`. The setting depends on the returned value of `secure_submessage_category`:

- If `secure_submessage_category` is `DATAWRITER_SUBMESSAGE`, the `datawriter_crypto` shall be the `DatawriterCryptoHandle` returned by a previous call to `register_matched_remote_datawriter` for the DataWriter that wrote the RTPS Submessage.
- If `secure_submessage_category` is `DATAREADER_SUBMESSAGE`, the `datawriter_crypto` shall be the `DatawriterCryptoHandle` returned by a previous call to `register_local_datawriter` for the DataWriter that is also the destination of the RTPS Submessage.

Parameter **datareader_crypto**: Output `DatareaderCryptoHandle`. The setting depends on the returned value of `secure_submessage_category`:

- If secure_submessage_category is DATAWRITER_SUBMESSAGE, the datareader_crypto shall be the DatareaderCryptoHandle returned by a previous call to register_local_datareader for the DataReader that is the destination of the RTPS Submessage.
- If secure_submessage_category is DATAREADER_SUBMESSAGE, the datareader_crypto shall be the DatareaderCryptoHandle returned by a previous call to register_matched_remote_datareader for the DataReader that wrote the RTPS Submessage.

Parameter **encoded_rtps_message**: The input containing the received RTPS message.
Parameter **receiving_participant_crypto**: The ParticipantCryptoHandle returned by previous calls to register_local_participant for the DomainParticipant that received the RTPS message.
Parameter **sending_participant_crypto**: The ParticipantCryptoHandle returned by a previous call to register_matched_remote_participant for the DomainParticipant whose GUID is inside the RTPS Header.
Parameter **exception**: A SecurityException object, which provides details in case this operation returns false.

9.5.1.10.7 Operation: decode_datawriter_submessage

This operation shall be called by the DDS implementation as a result of receiving a SecurePrefixSubMsg whenever the preceding call to preprocess_secure_submessage identified the SecureSubmessageCategory_t as DATAWRITER_SUBMESSAGE.
This operation shall reverse the transformation performed by the encode_datawriter_submessage operation, decrypting the content if appropriate and verifying any MACs or digital signatures that were produced by the encode_datawriter_submessage operation.
The DDS implementation shall substitute the RTPS SecurePrefixSubMsg and any associated submessages following (for example, SecureBodySubMsg and SecurePostfixSubMsg) within the received submessages with the RTPS Submessage produced by this operation.
If an error occurs, this method shall return false.

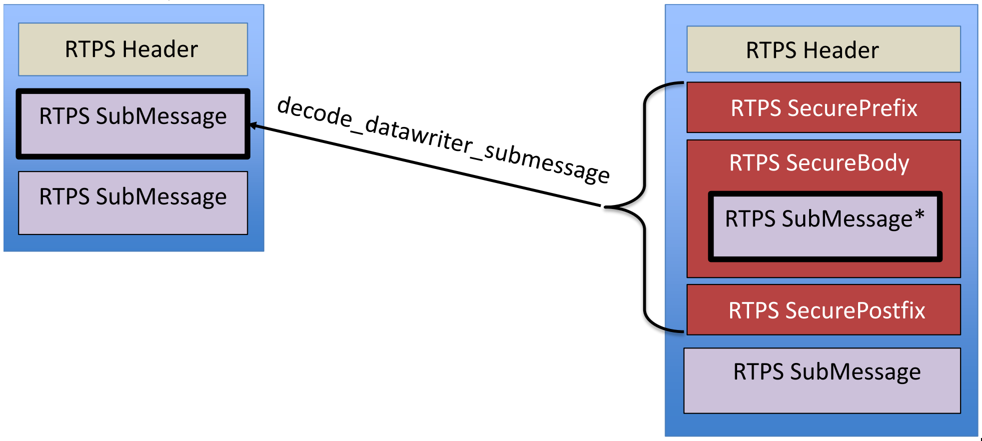

Figure 18 – Effect of decode_datawriter_submessage within an RTPS message

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Parameter **plain_rtps_submessage**: The output containing the RTPS submessage created by a DataWriter. This submessage will be one of following kinds: Data, DataFrag, Gap, Heartbeat, and HeartbeatFrag.

Parameter **encoded_rtps_submessage**: The input containing the RTPS SecurePrefixSubMsg and any associated submessages following (for example, SecureBodySubMsg and SecurePostfixSubMsg), which were created by a call to encode_datawriter_submessage.

Parameter **receiving_datareader_crypto**: The DatareaderCryptoHandle returned by the preceding call to preprocess_secure_submessage performed on the received SecurePrefixSubMsg. It shall contain the DatareaderCryptoHandle corresponding to the DataReader that is receiving the RTPS Submessage.

Parameter **sending_datawriter_crypto**: The DatawriterCryptoHandle returned by the preceding call to preprocess_secure_submsg performed on the received SecurePrefixSubMsg. It shall contain the DatawriterCryptoHandle corresponding to the DataWriter that is sending the RTPS Submessage.

Parameter exception: A SecurityException object, which provides details in case this operation returns false.

9.5.1.10.8 Operation: decode_datareader_submessage

This operation shall be called by the DDS implementation as a result of receiving a SecurePrefixSubMsg whenever the preceding call to preprocess_secure_submessage identified the SecureSubmessageCategory_t as DATAREADER_SUBMESSAGE.

This operation shall reverse the transformation performed by the encode_datareader_submessage operation, decrypting the content if appropriate and verifying any MACs or digital signatures that were produced by the encode_datareader_submessage operation.

The DDS implementation shall substitute the RTPS SecurePrefixSubMsg and any associated submessages following (for example, SecureBodySubMsg and SecurePostfixSubMsg) within the received submessages with the RTPS Submessage produced by this operation.

If an error occurs, this method shall return false.

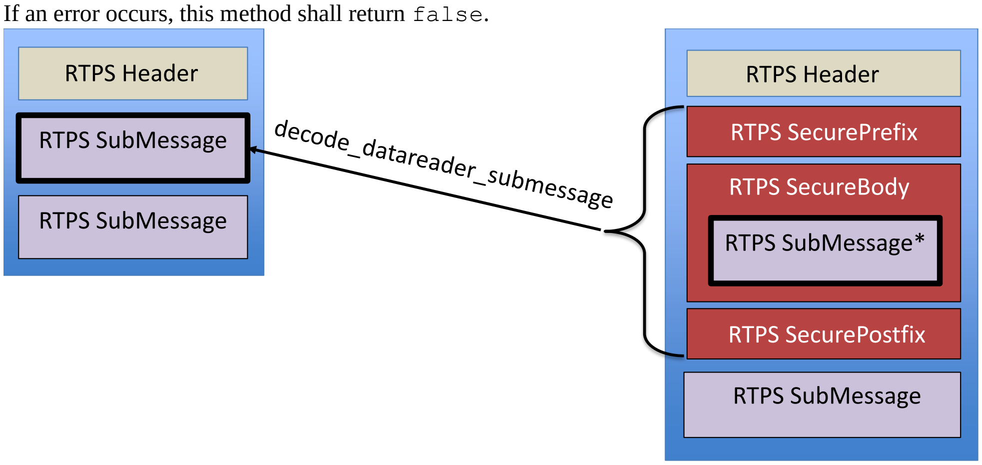

Figure 19 – Effect of decode_datawriter_submessage within an RTPS message

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Parameter **plain_rtps_submessage**: The output containing the RTPS submessage created by a DataReader. This submessage will be one of the following kinds: `AckNack`, `NackFrag`.
Parameter **encoded_rtps_submessage**: The input containing the RTPS `SecurePrefixSubMsg` and any associated submessages following (for example, `SecureBodySubMsg` and `SecurePostfixSubMsg`), which was created by a call to `encode_datareader_submessage`.
Parameter **receiving_datawriter_crypto**: The `DatawriterCryptoHandle` returned by the preceding call `to preprocess_secure_subessage` performed on the received `SecurePrefixSubMsg`. It shall contain the `DatawriterCryptoHandle` corresponding to the DataWriter that is receiving the RTPS Submessage.
Parameter **sending_datareader_crypto**: The `DatareaderCryptoHandle` returned by the preceding call to `preprocess_secure_submessage` performed on the received `SecurePrefixSubMsg`. It shall contain the `DatareaderCryptoHandle` corresponding to the DataReader that is sending the RTPS Submessage.

9.5.1.10.9 Operation: decode_serialized_payload

This operation shall be called by the DDS implementation as a result of a DataReader receiving a `Data` or `DataFrag` submessage containing a `CryptoContent` RTPS submessage element (instead of the normal `SerializedPayload`).
The operation shall receive in the ***inline_qos*** parameter the InlineQos RTPS `SubmessageElement` that appeared in the RTPS `Data` submessage that carried the `SerializedPayload`.
The DDS implementation shall substitute the `CryptoContent` submessage element within the received submessages with the `SerializedPayload` produced by this operation.
The implementation of `decode_serialized_payload` shall undo the cryptographic transformation of the `SerializedPayload` that was performed by the corresponding call to `encode_serialized_payload` on the DataWriter side. The DDS implementation shall use the available information on the remote DataWriter that wrote the message and the receiving DataReader to locate the corresponding `DatawriterCryptoHandle` and `DatareaderCryptoHandle` and pass them as parameters to the operation. In addition, it shall use the `CryptoTransformIdentifier` present in the `CryptoContent` to verify that the correct key is available and obtain any additional data needed to decode the `CryptoContent`.

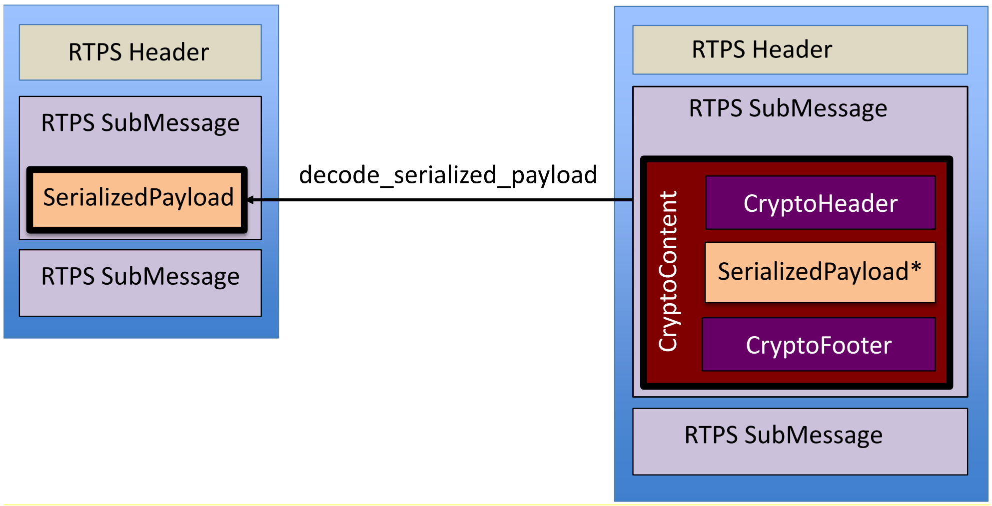

Figure 20 – Effect of decode_serialized_payload within an RTPS message

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If an error occurs, this method shall return `false`.

Parameter **plain_buffer**: The output containing the `SerializedPayload` RTPS submessage element, which shall be used to replace the input plain_buffer.

Parameter **encoded_buffer**: The input containing the `CryptoContent` RTPS submessage element.

Parameter **receiving_reader_crypto**: The `DatareaderCryptoHandle` returned by a previous call to `register_local_datareader` for the `DataReader` that received the Submessage containing the `CryptoContent`.

Parameter **sending_datawriter_crypto**: The `DatawriterCryptoHandle` returned by a previous call to `register_matched_remote_datawriter` for the `DataWriter` that wrote the `CryptoContent`.

Parameter exception: A `SecurityException` object, which provides details in case this operation returns `false`.

9.6 The Logging Plugin

The Logging Control Plugin API defines the types and operations necessary to support logging of security events for a DDS `DomainParticipant`.

9.6.1 Background (Non-Normative)

The `Logging` plugin provides the capability to log all security events, including expected behavior and all security violations or errors. The goal is to create security logs that can be used to support audits. The rest of the security plugins will use the logging API to log events.

The `Logging` plugin will add an ID to the log message that uniquely specifies the `DomainParticipant`. It will also add a time-stamp to each log message.

The `Logging` API has two options for collecting log data. The first is to log all events to a local file for collection and storage. The second is to distribute log events securely over DDS.

9.6.2 Logging Plugin Model

The logging model is shown in the figure below.

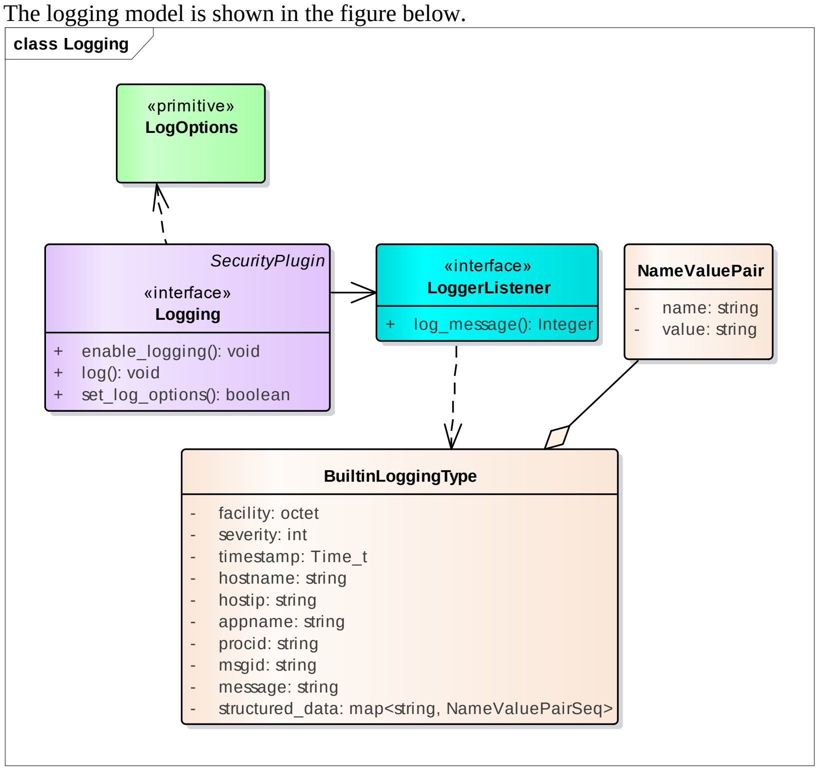

Figure 21 – Logging Plugin Model

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9.6.2.1 LogOptions

The `LogOptions` let the user control the ***log level*** and where to log. The options must be set before logging starts and may not be changed at run-time after logging has commenced. This is to ensure that an attacker cannot temporarily suspend logging while they violate security rules, and then start it up again.

The options specify if the messages should be logged to a file and, if so, the file name. The `LogOptions` also specify whether the log messages should be distributed to remote services or only kept locally.

Table 45 – LogOptions values

LogOptions	
Attributes	
`log_level`	`Long`
`log_file`	`String`
`distribute`	`Boolean`

9.6.2.1.1 Attribute: log_level

Specifies what level of log messages will be logged. Messages at or below the ***log_level*** are logged. The levels are as follows, from low to high:

- FATAL_LEVEL – security error causing a shutdown or failure of the Domain Participant
- SEVERE_LEVEL – major security error or fault
- ERROR_LEVEL – minor security error or fault
- WARNING_LEVEL – undesirable or unexpected behavior
- NOTICE_LEVEL – important security event
- INFO_LEVEL – interesting security event
- DEBUG_LEVEL – detailed information on the flow of the security events
- TRACE_LEVEL – even more detailed information

9.6.2.1.2 Attribute: log_file

Specifies the full path to a local file for logging events. If the file already exists, the logger will append log messages to the file. If it is NULL, then the logger will not log messages to a file.

9.6.2.1.3 Attribute: distribute

Specifies whether the log events should be distributed over DDS. If it is TRUE, each log message at or above the `log_level` is published as a DDS `Topic`.

9.6.2.2 Logging

Table 46 – Logging Interface

Logging		
No Attributes		
Operations		
`set_log_options`		`Boolean`
	`options`	`LogOptions`
	`out: exception`	`SecurityException`

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log		void
	log_level	long
	message	String
	category	String
	out:exception	SecurityException
enable_logging		void
	out: exception	SecurityException
set_listener		Boolean
	listener	LoggerListener
	out: exception	SecurityException

9.6.2.2.1 Operation: set_log_options

Sets the options for the logger. This must be called before `enable_logging`; it is an error to set the options after logging has been enabled.
If the options are not successfully set, then the method shall return `false`.
Parameter options: the `LogOptions` object with the required options.
Parameter exception: A `SecurityException` object, which provides details in case this operation returns `false`.

9.6.2.2.2 Operation: log

Log a message. The logger shall log the message if its `log_level` is at or above the level set in the `LogOptions`. The Logger shall add to the message the RTPS GUID of the `DomainParticipant` whose operations are being logged.
The `Logger` shall populate the ***facility***, ***severity***, and ***timestamp***, fields. The `Logger` may populate the ***hostname***, ***hostip***, ***appname***, ***procid*** fields as appropriate. The `Logger` shall add an entry to the ***structured_data*** field with the key "DDS". This `NameValuePair` sequence shall include the following name-value pairs:

Table 47 – Logger structured_data entries

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Name	Value
guid	RTPS GUID of the DDS entity that triggered the log message
domain_id	Domain Id of the DomainParticipant that triggered the log message
plugin_class	Identifier of the type of security plugin: Authentication, AccessControl, Cryptographic, etc.
plugin_method	Security plugin method name that triggered the log message

The Logger may add more entries as appropriate for the error condition.

Parameter log_level: The level of the log message. It must correspond to one of the levels defined in 9.6.2.1.1.
Parameter message: The log message.
Parameter category: A category for the log message. This can be used to specify which security plugin generated the message.
Parameter exception: A `SecurityException` object that will return an exception if there is an error with logging.

9.6.2.2.3 Operation: enable_logging

Enables logging. After this method is called, any call to log shall log the messages according to the options. After this method is called, the options may not be modified. This is to ensure that the logger cannot be temporarily suspended to cover up an attack.
If the options are not successfully set, then the method shall return `false`.
Parameter options: the `LogOptions` object with the required options.

Parameter exception: A SecurityException object, which provides details in case this operation returns false.

9.6.2.2.4 Operation: set_listener

Sets the LoggerListener that the Logger plugin will use to notify the application of log events. If an error occurs, this method shall return false and fill the SecurityException.
Parameter listener: A LoggerListener object to be attached to the Logger object. If this argument is NIL, it indicates that there shall be no listener.
Parameter exception: A SecurityException object, which provides details in case the operation returns FALSE.

9.7 Data Tagging

Data tagging is the ability to add a security label or tag to data. This is often used to specify a classification level of the data including information about its releasability. In a DDS context, it could have several uses:

- It can be used for access control – access control would be granted based on the tag.
- It could be used for message prioritization.
- It could not be used by the middleware, and instead used by the application or other service.

9.7.1 Background (Non-Normative)

There are four different approaches to data tagging:

1. `DataWriter` tagging: data received from a certain `DataWriter` has the tag of the `DataWriter`. This solution does not require the tag to be added to each individual sample.
2. Data instance tagging: each instance of the data has a tag. This solution does not require the tag to be added to each individual sample.
3. Individual sample tagging: every DDS sample has its own tag attached.
4. Per-field sample tagging: very complex management of the tags.

This specification supports `DataWriter` tagging. This was considered the best choice as it meets the majority of use cases. It fits into the DDS paradigm, as the metadata for all samples from a `DataWriter` is the same. It is also the highest performance, as the tag only needs to be exchanged once when the `DataWriter` is discovered, not sent with each sample.

This approach directly supports typical use cases where each application or `DomainParticipant` writes data on a `Topic` with a common set of tags (e.g., all at the same specified security level). For use cases where an application creates data at different classifications, that application can create multiple `DataWriters` with different tags.

9.7.2 DataTagging Model

The `DataWriter` tag will be associated with every sample written by the `DataWriter`. The `DataWriter` DataTag is implemented as an immutable `DataWriterQos`. The `DataWriter` DataTag shall be propagated in the `PublicationBuiltinTopicData` as part of the DDS discovery protocol.

The `DataReader` DataTag is implemented as an immutable `DataReaderQos`. The `DataReader` DataTag shall be propagated in the `SubscriptionBuiltinTopicData` as part of the DDS discovery protocol.

9.8 Security Plugins Behavior

In the previous sub clauses, the functionality and APIs of each plugin have been described. This sub clause provides additional information on how the plugins are integrated with the middleware.

9.8.1 Authentication and AccessControl behavior with local DomainParticipant

The figure below illustrates the functionality of the security plugins with regards to a local `DomainParticipant`.

In this sub clause the term *"DDS application"* refers to the application code that calls the DDS API. The term "*DDS middleware*" refers to a DDS Implementation that complies with the DDS Security specification.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

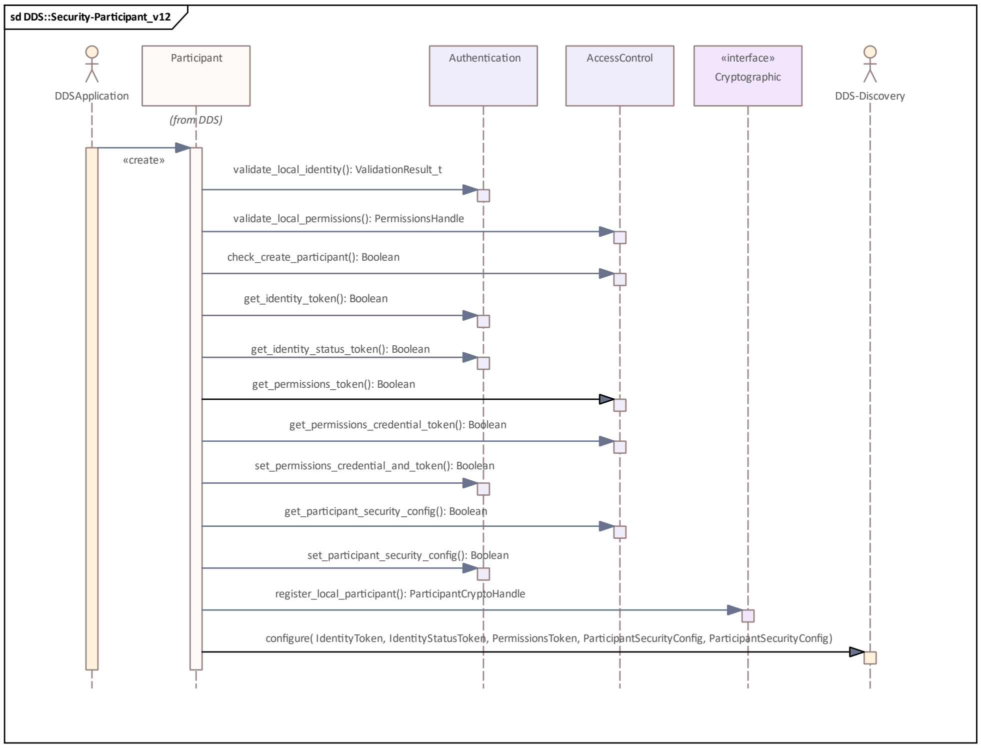

Figure 22 – Authentication and AccessControl sequence diagram with local DomainParticipant

This behavior sequence is triggered when the DDS application initiates the creation of a local `DomainParticipant` by calling the `create_participant` operation on the `DomainParticipantFactory`. The following are mandatory steps that the DDS middleware shall perform prior to creating the `DomainParticipant`. The steps need not occur exactly as described as long as the observable behavior matches the one described below.

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1. The DDS middleware shall validate the identity of the application attempting to create the `DomainParticipant` by calling the `Authentication::validate_local_identity` operation, passing the `domain_id`, the `DomainParticipantQos`, and a ***candidate_participant_guid***. The `Authentication` plugin validates the identity of the local `DomainParticipant` and returns an `IdentityHandle` for the holder of the identity (`DomainParticipant`), which will be necessary for interacting with the access control plugin. The `validate_local_identity` operation also returns an adjusted_participant_guid. If the identity is not successfully validated, the DDS middleware shall not create the `DomainParticipant` and the `create_participant` operation shall return NIL and set the return code to NOT_ALLOWED_BY_SECURITY.

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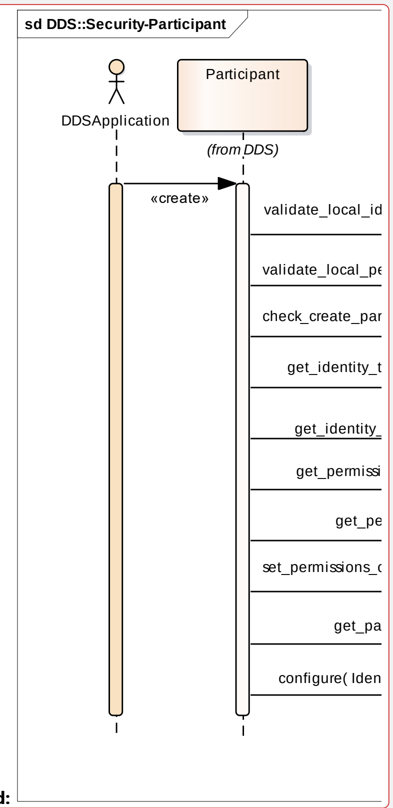

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2. The DDS middleware shall validate that the DDS application has the necessary permissions to join DDS domains by calling the `AccessControl::validate_local_permissions` operation. The Access Control plugin shall validate the permissions and issue a signed `PermissionsHandle` for the holder of the identity (`DomainParticipant`). If the permissions are not validated, the `DomainParticipant` shall not be created, the `create_participant` operation shall return NIL and set the return code to NOT_ALLOWED_BY_SECURITY.
3. The DDS middleware shall verify that the DDS application has the necessary permissions to join the specific Domain identified by the `domainId` by calling the operation `AccessControl::check_create_participant`. If this operation returns FALSE, the `DomainParticipant` shall not be created, the `create_participant` operation shall return NIL and set the return code to NOT_ALLOWED_BY_SECURITY.
4. The DDS middleware shall call the `get_identity_token` operation to obtain the `IdentityToken` object corresponding to the received `IdentityHandle`. The `IdentityToken` object shall be placed in the ParticipantBuiltinTopicData sent via discovery, see 7.5.1.3.
5. The DDS middleware shall call the `get_identity_status_token` operation to obtain the `IdentityStatusToken` object corresponding to the received `IdentityHandle`. If the returned `IdentityStatusToken` object is different than `TokenNIL`, it shall be placed in the ***ParticipantBuiltinTopicDataSecure*** sent via secure discovery, see 7.5.1.6.
6. The middleware shall call the `get_permissions_token` operation on the AccessControl plugin to obtain the `PermissionsToken` object corresponding to the received `PermissionsHandle`. The `PermissionsToken` shall be placed in the ParticipantBuiltinTopicData sent via discovery, see 7.5.1.3.
7. The middleware calls the `get_permissions_credential_token` operation on the `AccessControl` plugin, which returns the `PermissionsCredentialToken` object corresponding to the received `PermissionsHandle`. The `PermissionsCredentialToken` object is necessary to configure the `Authentication` plugin.
8. The middleware calls the `set_permissions_credential_and_token` operation on the `Authentication` plugin such that it can be sent during the authentication handshake.
9. The middleware calls the `get_participant_security_config` operation on the `AccessControl` plugin to obtain the `ParticipantSecurityConfig` to configure various behavioral aspects including how to handle unauthenticated participants, how the builtin topics should be protected, and the cryptographic algorithms the plugins are allowed to use.
10. The middleware calls the `set_participant_security_config` operation on the `Authentication` plugin passing the `ParticipantSecurityConfig` returned by the call to `get_participant_security_config`. Calling `set_participant_security_config` configures the `Authentication` plugin including the algorithms it may use and gets an output `ParticipantSecurityAlgorithmInfo` with information on the cryptographic algorithms supported and used by the `Authentication` plugin.

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11. The middleware calls the `register_local_participant` operation on the `Cryptographic` plugin passing the `ParticipantSecurityConfig` returned by the call to `get_participant_security_config` this configures the `Cryptographic` plugin and gets an output `ParticipantSecurityAlgorithmInfo` with information on cryptographic the algorithms supported and used by the `Cryptographic` plugin.
12. This `configure` operation is internal to the DDS implementation and therefore this API is not specified by the DDS Security specification. It is mentioned here to provide guidance to implementers. The `DomainParticipant`'s `IdentityToken`, the `PermissionsToken`, the `ParticipantSecurityConfig` returned by `get_participant_security_config` and the `ParticipantSecurityAlgorithmInfo` values returned by the two calls to `set_participant_security_config` are used to configure DDS discovery and also impact the information propagated inside the ***ParticipantBuiltinTopicData*** and ***ParticipantBuiltinTopicDataSecure:***
    - Information propagated in the ***ParticipantBuiltinTopicData*** members:
        1. `IdentityToken` is used to set the ***identity_token*** .
        2. `PermissionsToken` is used to set the ***permissions_token***
        3. The `ParticipantSecurityConfig` is used to set the ***security_info***
        4. The two `ParticipantSecurityAlgorithmInfo` are combined and used to set the ***digital_signature***, ***key_establishment***, and ***symmetric_cipher***.
    - Information propagated in the ***ParticipantBuiltinTopicDataSecure*** members:
        1. The `IdentityStatusToken`, is used to set the ***identity_status_token*** .

9.8.2 Compatibility of Participant Security Plugins

DDSSEC12-90 - Meeting CNSSP-15 security requirements

Discovered `DomainParticipant` entities may not implement the DDS Security specification of may be configured with incompatible Security Plugins. For this reason, whenever a (local) `DomainParticipant` discovers a (remote) `DomainParticipant` the first step is to check the information present in the `ParticipantBuiltinTopicData` of the remote `DomainParticipant` to determine security plugin compatibility. The check examines the following members: ***identity_token***, ***permissions_token***, ***security_protection_info, digital_signature, key_establishment, symmetric_cipher.***

9.8.3 Authentication behavior with discovered DomainParticipant

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Depending on the `ParticipantSecurityConfig` returned by the `AccessControl` operation `get_participant_security_config` the `DomainParticipant` may allow remote `DomainParticipants` that lack the ability to authenticate (e.g., do not implement DDS Security) to match.

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9.8.3.1 Behavior when `allow_unauthenticated_participants` is set to TRUE

DDSSEC12-90 - Meeting CNSSP-15 security requirements

If the `ParticipantSecurityConfig` returned by the operation `get_participant_security_config` has the member

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Deleted: `get_participant_sec_attributes` allow_unauthenticated_participants set to TRUE, the DomainParticipant shall allow matching remote DomainParticipant entities that are not able to authenticate. Specifically:

- Discovered DomainParticipant entities that do *not* implement the DDS Security specification or do not contain compatible Security Plugins shall be matched without the DomainParticipant attempting to authenticate them and shall be treated as "Unauthenticated" DomainParticipant entities.
- Discovered DomainParticipant entities that *do* implement the DDS Security specification and declare compatible Security Plugins but fail the Authentication protocol shall be matched and treated as "Unauthenticated" DomainParticipants entities.

For any matched "Unauthenticated" DomainParticipant entities, the DomainParticipant shall **match only** the regular builtin Endpoints (***ParticipantMessage***, ***DCPSParticipants***, ***DCPSPublications***, ***DCPSSubscriptions***) **and not** the builtin secure Endpoints (see 7.5.8 for the complete list).

For any matched authenticated DomainParticipant entities, the DomainParticipant shall match all the builtin endpoints.

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9.8.3.2 Behavior when allow_unauthenticated_participants is set to FALSE

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If the ParticipantSecurityConfig has the member allow_unauthenticated_participants set to FALSE, the DomainParticipant shall reject remote DomainParticipant entities that are not able to authenticate. Specifically:

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- Discovered DomainParticipant entities that do not implement the DDS Security specification or do not contain compatible Security Plugins shall be rejected without the DomainParticipant attempting to authenticate them.
- Discovered DomainParticipant entities that do implement the DDS Security specification, declare compatible Security Plugins but fail the Authentication protocol shall be rejected.
- Discovered DomainParticipant entities that do implement the DDS Security specification and declare compatible Security Plugins automatically "match" the ***ParticipantStatelessMessage*** builtin endpoints to allow the authentication handshake to proceed.
- Discovered DomainParticipant entities that do implement the DDS Security specification, declare compatible Security Plugins, and pass the Authentication protocol successfully shall be matched and the DomainParticipant shall also match all the builtin endpoints of the discovered DomainParticipant, except for the ***ParticipantStatelessMessage*** builtin endpoints, which were already matched prior to the Authentication protocol.

The figure below illustrates the behavior of the security plugins with regards to a discovered DomainParticipant that also implements the DDS Security specification and announces compatible security plugins. The exact operations depend on the plugin implementations. The sequence diagram shown below is just indicative of one possible sequence of events and matches what the builtin DDS:Auth:PKI-DH plugin (see 10.3.3) does.

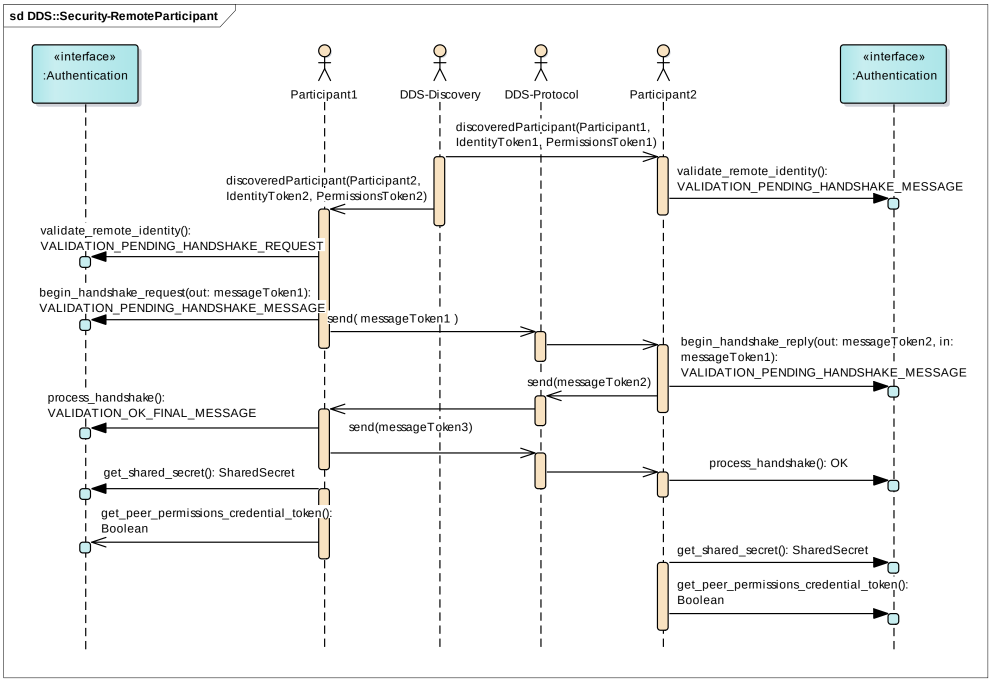

Figure 23 – Authentication sequence diagram with discovered DomainParticipant

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1. Participant2 discovers Participant1via the discovery protocol. The `BuiltinParticipantTopicData` contains the `IdentityToken` and `PermissionsToken` of Participant1.
2. Participant2 calls the `validate_remote_identity` operation to validate the identity of Participant1 passing the local `IdentityHandle` of Participant2 and the remote `IdentityToken` and `GUID_t` of Participant1 received via discovery and obtains an `IdentityHandle` for Participant1, needed for further operations involving Participant1. The operation returns VALIDATION_PENDING_HANDSHAKE_MESSAGE indicating that further handshake messages are needed to complete the validation and that Participant2 should wait for a `HandshakeMessageToken` to be received from Participant1. Participant2 waits for this message.
3. Participant1 discovers Participant2 via the DDS discovery protocol. The `BuiltinParticipantTopicData` contains the `IdentityToken` and `PermissionsToken` of Participant2.
4. Participant1 calls the operation `validate_remote_identity` to validate the identity of Participant2 passing the `IdentityToken` and `PermissionsToken` of Participant2 received via discovery and obtains an `IdentityHandle` for Participant2, needed for further operations involving Participant2. The operation returns VALIDATION_PENDING_HANDSHAKE_REQUEST indicating further handshake messages are needed and Participant1 should initiate the handshake.

5. Participant1 calls `begin_handshake_request` to begin the requested handshake. The operation outputs a `HandshakeHandle` and a `HandshakeMessageToken` (messageToken1). The operation returns VALIDATION_PENDING_HANDSHAKE_MESSAGE indicating authentication is not complete and the returned messageToken1 needs to be sent to Participant2 and a reply should be expected.
6. Participant1 sends the `HandshakeMessageToken` (messageToken1) to Participant2 using the ***BuiltinParticipantMessageWriter***.
7. Participant2 receives the `HandshakeMessageToken` (messageToken1) on the ***BuiltinParticipantMessageReader***. Participant2 determines the message originated from a remote `DomainParticipant` (Participant1) for which it had already called `validate_remote_identity` where the function had returned VALIDATION_PENDING_HANDSHAKE_REPLY.
8. Participant2 calls `begin_handshake_reply` passing the received `HandshakeMessageToken` (messageToken1). The `Authentication` plugin processes the `HandshakeMessageToken` (messageToken1) and outputs a `HandshakeMessageToken` (messageToken2) in response and a `HandshakeHandle`. The operation `begin_handshake_reply` returns VALIDATION_PENDING_HANDSHAKE_MESSAGE, indicating authentication is not complete and an additional message needs to be received.
9. Participant2 sends the `HandshakeMessageToken` (messageToken2) back to Participant1 using the ***BuiltinParticipantMessageWriter***.
10. Participant1 receives the `HandshakeMessageToken` (messageToken2) on the ***BuiltinParticipantMessageReader***. Participant1 determines this message originated from a remote `DomainParticipant` (Participant2) for which it had already called `validate_remote_identity` where the function had returned VALIDATION_PENDING_HANDSHAKE_REQUEST.
11. Participant1 calls `process_handshake` passing the received `HandshakeMessageToken` (messageToken2). The Authentication plugin processes messageToken2, verifies it is a valid reply to the messageToken1 it had sent and outputs the `HandshakeMessageToken` messageToken3 in response. The `process_handshake` operation returns VALIDATION_OK_FINAL_MESSAGE, indicating authentication is complete but the returned `HandshakeMessageToken` (messageToken3) must be sent to Participant2.
12. Participant1 sends the `HandshakeMessageToken` (messageToken3) to Participant2 using the ***BuiltinParticipantMessageWriter***.
13. Participant2 receives the `HandshakeMessageToken` (messageToken3) on the ***BuiltinParticipantMessageReader***. Participant2 determines this message originated from a remote `DomainParticipant` (Participant1) for which it had already called the operation `begin_handshake_reply` where the call had returned VALIDATION_PENDING_HANDSHAKE_MESSAGE.
14. Participant2 calls the `process_handshake` operation, passing the received `HandshakeMessageToken` (messageToken3). The Authentication plugin processes the messageToken2, verifies it is a valid reply to the messageToken2 it had sent and returns OK, indicating authentication is complete and no more messages need to be sent or received.

15. Participant1, having completed the authentication of Participant2, calls the operation `get_shared_secret` to retrieve the `SharedSecret`, which is used with the other Plugins to create `Tokens` to exchange with Participant2.
16. Participant1, having completed the authentication of Participant2, calls the operation `get_authenticated_peer_credential_token` to retrieve the `AuthenticatedPeerCredentialToken` associated with Participant2, which is used with the `AccessControl` plugin to determine the permissions that Participant1 will grant to Participant2.
17. Participant2, having completed the authentication of Participant1, calls the operation `get_shared_secret` to retrieve the `SharedSecret`, which is used with the other Plugins to create `Tokens` to exchange with Participant1.
18. Participant2, having completed the Authentication of Participant1, calls the operation `get_authenticated_peer_credential_token` to retrieve the `AuthenticatedPeerCredentialToken` associated with Participant2 which is used with the `AccessControl` plugins to determine the permissions that Participant2 will grant to Participant1.

9.8.4 DDS Entities impacted by the AccessControl operations

There are six types of `DDS Entities`: `DomainParticipant`, `Topic`, `Publisher`, `Subscriber`, `DataReader`, and `DataWriter`. All these except the `DomainParticipant` are defined as the `DDS Domain Entities` (subclause 2.2.2.1.2 of DDS [1]).

The `Domain Entities` created by a `DomainParticipant` can be grouped into four categories:

1. DDS-RTPS Protocol [2] Builtin Entities. These are domain entities used to read and write the four builtin Topics: ***DCPSParticipants***, ***DCPSTopics***, ***DCPSPublications***, ***DCPSSubscriptions***.
2. Builtin Secure Entities. These are the `Domain Entities` related to the Builtin Secure Endpoints defined in Section 7.5.8. These `Entities` are used to read and write the four builtin secure topics: ***DCPSPublicationsSecure***, ***DCPSSubscriptionsSecure***, ***DCPSParticipantMessageSecure***, and ***DCPSParticipantVolatileMessageSecure***.
3. Other builtin `Entities` defined by the DDS-Security specification not included in the "Builtin Secure Endpoints". These are the ***BuiltinParticipantStatelessMessageWriter*** and the ***BuiltinParticipantStatelessMessageReader***.
4. Application-defined `Entities`. These are any non-builtin `Domain Entities`.

The `AccessControl` plugin shall impact only the Builtin Secure Entities and the application-defined Entities. It shall not impact the builtin entities defined by the DDS-RTPS Protocol specification nor the ***BuiltinParticipantStatelessMessageWriter*** or the ***BuiltinParticipantStatelessMessageReader***.

`AccessControl` plugin operations can be grouped into 5 groups:

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1. Group1. Operations related to `DomainParticipant`. These are: validate_local_permissions, validate_remote_permissions, check_create_participant, get_permissions_token, get_permissions_credential_token, set_listener, return_permissions_token, return_permissions_credential_token, get_participant_security_config, return_participant_security_config.
2. Group2. Operations related to the creation of local `Domain Entities`. These are: check_create_topic, check_create_datawriter, check_create_datareader,

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Deleted: return_participant_sec_attributes get_datawriter_security_config, get_datareader_security_config, return_datawriter_security_config, return_datareader_security_config.

3. Group3. Operations related to write activities of local `Domain Entities`. These are: check_local_datawriter_register_instance and check_local_datawriter_dispose_instance.
4. Group4. Operations related to discovery and match of remote `Domain Entities`. These are: check_remote_topic, check_remote_datawriter, check_remote_datareader, check_local_datawriter_match, and check_local_datareader_match.
5. Group5. Operations related to the write activities of remote `Domain Entities`. These are: check_remote_datawriter_register_instance and check_remote_datawriter_dispose_instance.

Table 48 below summarizes the DDS `Entities` affected by each operation group.

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Table 48 – Impact of Access Control Operations to the DDS Builtin and Application-defined Entities

Entity Category	*Entity*	*Impact by AccessControl operation in group*				
		Group1	*Group2*	*Group3*	*Group4*	*Group5*
DomainParticipant	All created	Yes	No	No	No	No
DDS-RTPS Protocol Builtin Entities	See RTPS Protocol specification [2]	Yes, indirectly	No	No	No	No

Builtin Secure Entities	SEDPbuiltinPublicationsSecureWriter SEDPbuiltinPublicationsSecureReader SEDPbuiltinSubscriptionsSecureWriter SEDPbuiltinSubscriptionsSecureReader BuiltinParticipantMessageSecureWriter BuiltinParticipantMessageSecureReader BuiltinParticipantVolatileMessageSecureWriter BuiltinParticipantVolatileMessageSecureReader	Yes, indirectly	Only get_datawriter_security_config and get_datareader_security_config	No	No	No
Other builtin Entities defined by DDS-Security	BuiltinParticipantStatelessMessageWriter BuiltinParticipantStatelessMessageReader	Yes, indirectly	No	No	No	No
Application-defined Domain Entities	Publisher, Subscriber	Yes, indirectly	Yes, indirectly	No	Yes, indirectly	No
	Topic, DataWriter, DataReader	Yes, indirectly	Yes	Yes	Yes	Yes

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The `DomainParticipant` entities are only impacted by `AccessControl` plugin operations in Group1. The `DomainParticipant` is not created unless allowed by the `AccessControl` plugin. Also the matching of a remote `DomainParticipant` must be allowed by the `AccessControl` plugin. The full interaction is described in sub clauses 9.8.1 and 9.8.7.

The DDS-RTPS Builtin Entities are impacted indirectly by `AccessControl` plugin operations in Group1 in the sense that if the sense that the creation of the `Entities` is dependent on the successful creation of the local `DomainParticipant` which is controlled by the Group1 operations. Likewise the match of the remote entities is dependent on the successful match of a remote `DomainParticipant`, which is also controlled by the Group1 operations.

The DDS-RTPS Builtin Entities shall not be impacted by any of the operations in Group2, Group3, Group4, or Group5.

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The Secure Builtin Entities are impacted indirectly by `AccessControl` plugin operations in Group1 in the same way as the DDS-RTPS Builtin Entities.

The Secure Builtin Entities are impacted only by the `get_datawriter_security_config` and `get_datareader_security_config` operations in Group2. They shall not be impacted by any other Group2 operations. This means that the Secure Builtin Entities shall be created unconditionally when the DomainParticipant is created. During the creation process of DataWriter entities the `get_datawriter_security_config` shall be called and likewise during the creation process of DataReader entities the `get_datareader_security_config` shall be called. The purpose of calling these `get_xxx_security_config` operations is to obtain the information necessary to call the Cryptographic plugin operations on these endpoints.

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Deleted: `get_xxx_sec_attributes`

The ***BuiltinParticipantStatelessMessageWriter*** and ***BuiltinParticipantStatelessMessageReader*** are only indirectly impacted by the Group2 operations in that they are tied to the successful creation of the `DomainParticipant`. They are not impacted by the successful match of remote entities not any other `AccessControl` plugin operations in any Group. DDS Secure implementations shall create these endpoints unconditionally for all created DomainParticipant. Being stateless these endpoints are not "matched" to remote endpoints in the sense of being aware and maintaining the state and presence of the remote endpoints. Nevertheless they are able to send exchange information in a stateless, best-efforts manner.

The Application-defined Publisher and Subscriber Entities are impacted indirectly by AccessControl plugin operations in Group1 only by the fact that they depend on the successful creation of the DomainParticipant. They are impacted indirectly by operations in Group2 by the fact that the PartitionQos settings of the Publisher (or Subscriber) may cause the AccessControl plugin to prevent the creation of DataWriter (or DataReader) entities belonging to them. Likewise they are impacted indirectly by operations in Group4 in that the PartitionQos settings of the remote Publisher (or Subscriber) may cause the AccessControl plugin to prevent matching of remote DataWriter (or DataReader) entities. They are not impacted by operations in Group3 or Group5.

The Application-defined Topic, DataWriter and DataReader entities are impacted indirectly by AccessControl plugin operations in Group1 the same way the The DDS-RTPS Builtin Entities are. These Entities are impacted by the AccessControl plugin operations in Group2, Group3, Group4, and Group5. This is described in subclauses 9.8.6 and 9.8.8.

9.8.5 AccessControl behavior with local participant creation

The functionality of the AccesControl plugin with regards to the creation of local DDS DomainParticipant entities was illustrated in Figure 22 and described in 9.8.1. Subclause 9.8.1 covered Authentication and AccessControl plugin behavior simultanepusly because these two plugins interact with each other.

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9.8.6 AccessControl behavior with local domain entity creation

The figure below illustrates the functionality of the security plugins with regards to the creation of local DDS domain entities: Topic, DataWriter, and DataReader entities.

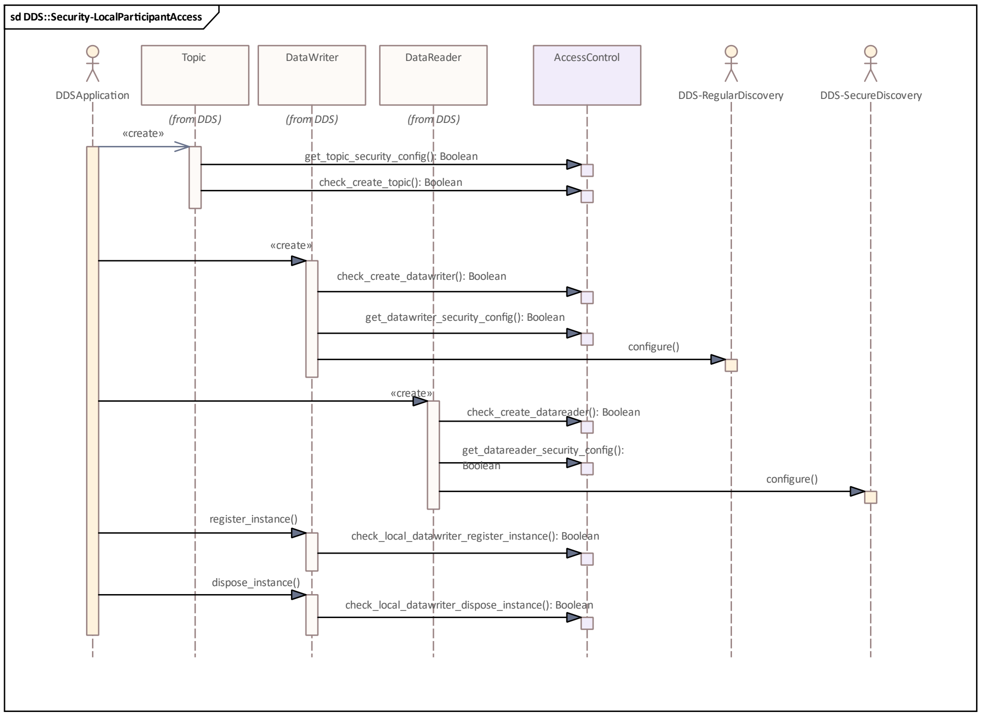

Figure 24 – AccessControl sequence diagram with local entities

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1. The DDS application initiates the creation of a new `Topic` for the `DomainParticipant`.
2. The middleware calls `AccessControl::get_topic_security_config` to obtain the `TopicSecurityConfig` for the `Topic` being created.

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3. The middleware verifies the `DomainParticipant` is allowed to create a Topic with name `topicName`. Operation `AccessControl::check_create_topic()` is called for this verification. If the verification fails, the Topic object is not created.
4. The DDS application initiates the creation of a local `DataWriter`.
5. The middleware verifies that the `DataWriter` has the right permissions to publish on Topic `topicName`. Operation `AccessControl::check_create_datawriter()` is called for this verification. As an optional behavior, `check_create_datawriter` () can also verify if the `DataWriter` is allowed to tag data with `dataTag`. If the verification doesn't succeed, the `DataWriter` is not created. As an optional behavior, `check_create_datawriter()` can also check the QoS associated with the `DataWriter` and grant permissions taking that into consideration.
6. The middleware calls `AccessControl::get_datawriter_security_config` to obtain the `EndpointSecurityConfig` for the created `DataWriter`.

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7. This sequence diagram illustrates the situation where the `TopicSecurityConfig` for the created `DataWriter` has the ***is_discovery_protected*** attribute set to FALSE. In this

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situation the middleware configures Discovery to use regular (not secure) publications discovery endpoint (***DCPSPublications***) to propagate the `PublicationBuiltinTopicData` for the created `DataWriter`.

8. The DDS application initiates the creation of a local `DataReader`.
9. The middleware verifies that the `DataReader` has the right permissions to subscribe on Topic `topicName`. Operation `AccessControl::check_create_datareader()` is called for this verification. As an optional behavior, `check_create_datareader()` can also verify if the `DataReader` is allowed to receive data tagged with `dataTag`. If the verification doesn't succeed, the `DataReader` is not created. As an optional behavior `check_create_datareader()` can also check the QoS associated with the `DataReader` and grant permissions taking that into consideration.
10. The middleware calls the operation `AccessControl::get_datareader_security_config` to obtain the `EndpointSecurityConfig` for the created `DataReader` entity.
11. This sequence diagram illustrates the situation where the `TopicSecurityConfig` for the topic (a different topic than in the earlier steps) has the ***is_discovery_protected*** attribute set to TRUE. In this situation the middleware configures Discovery to use the secure subscriptions discovery endpoint (***DCPSSecureSubscriptions***) to propagate the `SubscriptionBuiltinTopicData` for the created `DataReader`.
12. The DDS application initiates the registration of a data instance on the `DataWriter`.
13. The middleware verifies that the `DataWriter` has the right permissions to register the instance. The operation `AccessControl::check_local_datawriter_register_instance()` is called for this verification. If the verification doesn't succeed, the instance is not registered.
14. The DDS application initiates the disposal of an instance of the `DataWriter`.
15. The middleware verifies that the `DataWriter` has the right permissions to dispose the instance. The operation `AccessControl::check_local_datawriter_dispose_instance()` is called for this verification. If the verification doesn't succeed, the instance is not disposed.

9.8.7 AccessControl behavior with remote participant discovery

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If the `ParticipantSecurityConfig` object returned by the `AccessControl` operation `get_participant_security_config` has the ***allow_unauthenticated_participants*** attribute set to TRUE, the `DomainParticipant` may discover DomainParticipants that cannot be authenticated because they either lack support for the authentication protocol or they fail the authentication protocol. These "Unauthenticated" `DomainParticipant` entities shall be matched and considered "Unauthenticated" DomainParticipant entities. Local `DomainParticipant` will not perform any further participant AccessControl validation with unauthenticated participants (i.e., `validate_remote_permissions` and `check_remote_participant` will not be called).

If the `DomainParticipant` discovers a DomainParticipant entity that it can authenticate successfully, and ***is_access_protected*** is TRUE, then it shall validate with the AccessControl plugin that it has the permissions necessary to join the DDS domain. This is done by successfully calling to `get_authenticated_peer_credential_token` on the `Authentication` plugin, then to `validate_remote_permissions` and `check_remote_participant` in the `AccessControl` plugin:

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- If the validation succeeds, the discovered DomainParticipant shall be considered “Authenticated” and all the builtin Topics automatically matched.
- If the validation fails, the discovered DomainParticipant shall be considered ignored and all the builtin Topics should not be matched.

If the `DomainParticipant` discovers a `DomainParticipant` entity that it can authenticate successfully, and ***is_access_protected*** is FALSE, then validation will succeed with no access control checking. In this case, only `get_authenticated_peer_credential_token` and `validate_remote_permissions` are called, and a HandleNIL return will not impact the validation result.
The figure below illustrates the functionality of the security plugins with regards to the discovery of remote `DomainParticipant` entity that has been successfully authenticated by the Authentication plugin.

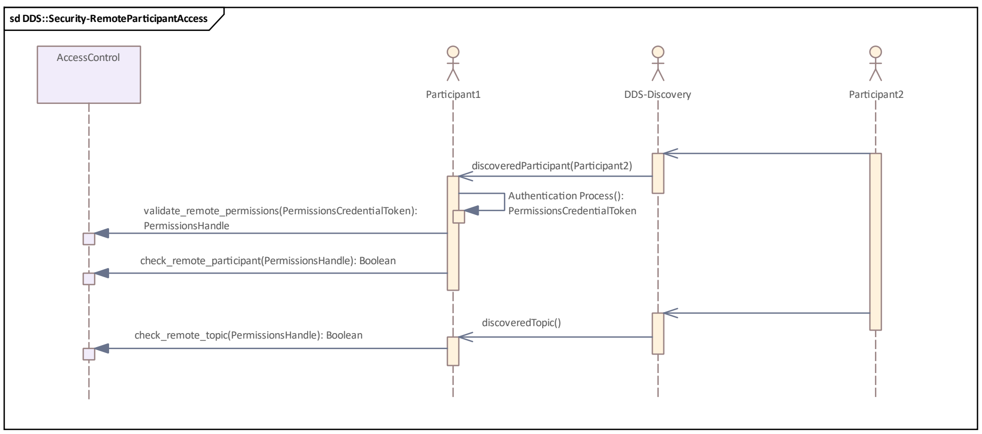

Figure 25 – AccessControl sequence diagram with discovered DomainParticipant

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1. The `DomainParticipant` Participant1 discovers the `DomainParticipant` (Participant2) via the discovery protocol and successfully authenticates Participant2 and obtains the `AuthenticatedPeerCredentialToken` as described in 9.8.3.
2. Participant1 calls the operation `validate_remote_permissions` to validate the permissions of Participant2, passing the `PermissionsToken` obtained via discovery from Participant2 and the `AuthenticatedPeerCredentialToken` returned by the operation `get_authenticated_peer_credential_token` on the `Authentication` plugin. The operation `validate_remote_permissions` returns a `PermissionsHandle`, which the middleware will use whenever an access control decision must be made for the remote `DomainParticipant`.
3. Participant1 calls the operation `check_remote_participant` to verify the remote `DomainParticipant` (Participant2) is allowed to join the DDS domain with the specified `domainId`, passing the `PermissionsHandle` returned by the `validate_remote_permissions` operation. If the verification fails, the remote `DomainParticipant` is ignored and all the endpoints corresponding to the builtin Topics are unmatched.

4. Participant1 discovers that DomainParticipant (Participant2) has created a new DDS Topic.
5. Participant1 verifies that the remote DomainParticipant (Participant2) has the permissions needed to create a DDS Topic with name topicName. The operation check_remote_topic is called for this verification. If the verification fails, the discovered Topic is ignored.

9.8.8 AccessControl behavior with remote domain entity discovery

This sub clause describes the functionality of the AccessControl plugin relative to the discovery of remote domain entities, that is, Topic, DataWriter, and DataReader entities.

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If the ParticipantSecurityConfig object returned by the AccessControl operation get_participant_security_config has the is_access_protected attribute set to FALSE, the DomainParticipant may have matched a remote "Unauthenticated" DomainParticipant, i.e., a DomainParticipant that has not authenticated successfully and may therefore discover endpoints via the regular (non-secure) discovery endpoints from an "Unauthenticated" DomainParticipant.

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9.8.8.1 AccessControl behavior with discovered endpoints from "Unauthenticated" DomainParticipant

If the DomainParticipant discovers endpoints from an "Unauthenticated" DomainParticipant it shall:

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- Reject (do not try to match) local endpoints for which the related TopicSecurityConfig have the attribute ***is_read_protected*** or ***is_write_protected*** set to TRUE.
- Proceed to try matching without checking with the AccessControl plugin the local DataWriter endpoints for which the related TopicSecurityConfig object returned by the operation get_topic_security_config have the attribute ***is_read_protected*** set to FALSE.
- Proceed to try matching without checking with the AccessControl plugin the local DataReader endpoints for which the related TopicSecurityConfig object returned by the operation get_topic_security_config have the attribute ***is_write_protected*** set to FALSE.

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9.8.8.2 AccessControl behavior with discovered endpoints from "Authenticated" DomainParticipant

If the DomainParticipant discovers endpoints from an "authenticated" DomainParticipant it shall:

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- Perform the AccessControl checks for discovered endpoints that would match local DataWriters for whom the ***is_read_protected*** attribute is set to TRUE, and only proceed to try matching the discovered endpoints for whom the access control checks succeed.
- Perform the AccessControl checks for discovered endpoints that would match local DataReader for whom the ***is_write_protected*** attribute is set to TRUE, and only proceed to try matching the discovered endpoints for whom the access control checks succeed.
- Proceed to try matching without checking with the AccessControl plugin the local DataWriters for whom the related TopicSecurityConfig object returned by the operation get_topic_security_config has the ***is_read_protected*** attribute set to FALSE.

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- Proceed to try matching without checking with the AccessControl plugin the local DataReaders for whom the related TopicSecurityConfig object returned by the operation get_topic_security_config has the ***is_write_protected*** attribute set to FALSE.

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The figure below illustrates the behavior relative to discovered endpoints coming from an “Authenticated” DomainParticipant that would match local endpoints for which the ***is_read_protected*** and ***is_write_protected*** attributes are set to FALSE.

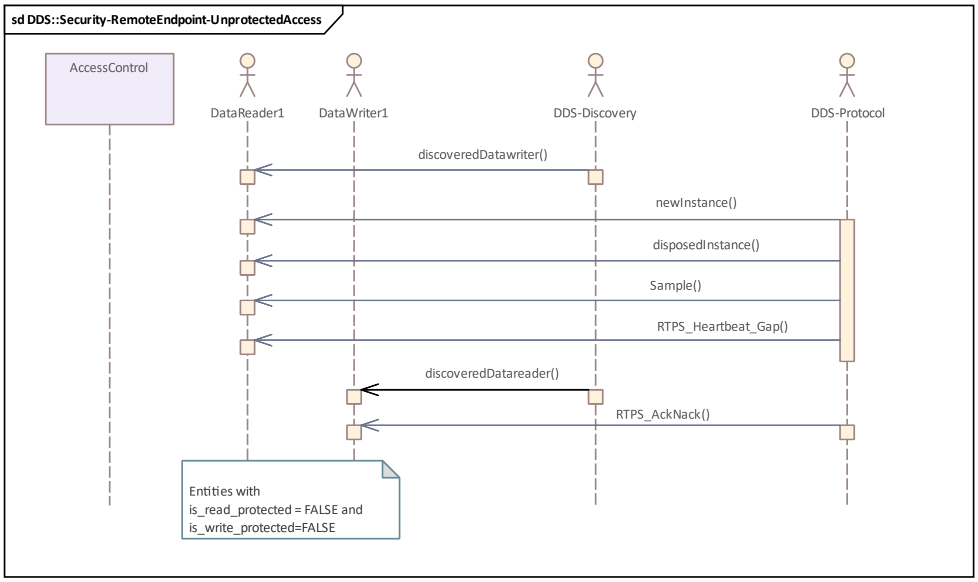

Figure 26 – AccessControl sequence diagram with discovered entities when is_read_protected and is_write_protected are both FALSE

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1. DataReader1 discovers via the discovery protocol that a remote DataWriter (DataWriter2) on a Topic with name ***topicName***. The DataReader1 shall not call any operations on the AccessControl plugin and shall proceed to match DataWriter2 subject to the matching criteria specified in the DDS and DDS-XTypes specifications.
2. DataReader1 receives a Sample from DataWriter2 with DDS ViewState NEW, indicating this is the first sample for that instance received by the DataReader. This sample shall be processed according to the DDS specification without any calls to the AccessControl plugin.
3. DataReader1 receives a Sample from DataWriter2 with DDS InstanceState NOT_ALIVE_DISPOSED, indicating the remote DataWriter disposed an instance. This sample shall be processed according to the DDS specification without any calls to the AccessControl plugin.
4. DataReader1 receives a Sample from DataWriter2 with DDS ViewState NOT_NEW. DataReader1 shall operate according to the DDS and DDS-RTPS specifications without any calls to the AccessControl plugin.

5. DataReader1 receives an RTPS `HeartBeat` message or an RTPS `Gap` message from DataWriter2. In both these cases DataReader1 shall operate according to the DDS and DDS-RTPS specifications without any calls to the `AccessControl` plugin.
6. DataWriter1 discovers via the discovery protocol that a remote `DataReader` (DataReader2) on a `Topic` with name ***topicName***. DataWriter1 shall not call any operations on the `AccessControl` plugin and shall match DataReader2 subject to the matching criteria specified in the DDS and DDS-XTypes specifications.
7. DataWriter1 receives an RTPS AckNack message from DataReader2. DataWriter1 shall operate according to the DDS and DDS-RTPS specifications without any calls to the `AccessControl` plugin.

The figure below illustrates the behavior relative to discovered endpoints coming from an "Authenticated" `DomainParticipant` that would match local endpoints for which both ***is_read_protected*** and ***is_write_protected*** attributes are set to TRUE.

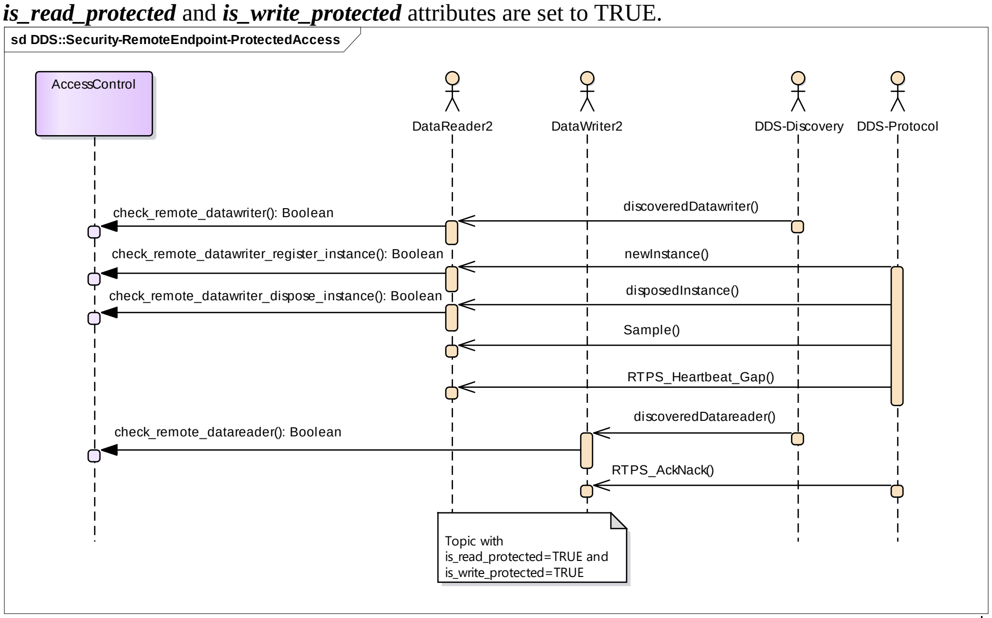

Figure 27 – AccessControl sequence diagram with discovered entities when is_read_protected==TRUE and is_write_protected==TRUE

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1. DataReader1 discovers via the discovery protocol a remote `DataWriter` (DataWriter2) on a `Topic` with name ***topicName*** that matches the DataReader1 `Topic` ***topicName***.
2. DataReader1 shall call the operation `check_remote_datawriter` to verify that Participant2 (the `DomainParticipant` to whom DataWriter2 belongs) has the permissions needed to publish the DDS `Topic` with name ***topicName***. As an optional behavior, the same operation can also verify if the DataWriter2 is allowed to tag data with `dataTag` that are associated with it.
   1. If the verification doesn't succeed, the DataWriter2 is ignored.
   2. If the verification succeeds, DataReader1 shall proceed to match DataWriter2 subject to the matching criteria specified in the DDS and DDS-XTypes specifications.

3. DataReader1 receives a Sample from DataWriter2 with DDS ViewState NEW, indicating this is the first sample for that instance received by the `DataReader`. This sample shall be processed according to the DDS specification without any calls to the `AccessControl` plugin.
4. DataReader1 shall call the operation `check_remote_datawriter_register_instance` to verify that Participant2 has the permissions needed to register the instance. If the verification doesn't succeed, the sample shall be ignored.
5. DataReader1 receives a Sample from DataWriter2 with DDS `InstanceState` NOT_ALIVE_DISPOSED, indicating the remote `DataWriter` disposed an instance.
6. DataReader1 shall call the operation `check_remote_datawriter_dispose_instance` to verify that Participant2 has the permissions needed to dispose the instance. If the verification doesn't succeed, the instance disposal shall be ignored.
7. DataReader1 receives a Sample from DataWriter2 with DDS `ViewState` NOT_NEW, indicating this DataReader1 already received samples on that instance. This sample shall be processed according to the DDS specification without any calls to the `AccessControl` plugin.
8. DataReader1 receives an RTPS HeartBeat message or an RTPS `Gap` message from DataWriter2. In both these cases DataReader1 shall operate according to the DDS and DDS-RTPS specifications without any calls to the `AccessControl` plugin.
9. DataWriter1 discovers via the discovery protocol a remote `DataReader` (DataReader2) on a `Topic` with name ***topicName*** that matches the DataReader1 `Topic` ***topicName***.
10. DataWriter1 shall call the operation `check_remote_datareader` to verify that Participant2 (the DomainParticipant to whom DataReader2 belongs) has the permissions needed to subscribe the DDS `Topic` with name ***topicName***. As an optional behavior, the same operation can also verify if the DataReader2 is allowed to read data with `dataTag` that are associated with DataWriter1.
    1. If the verification doesn't succeed, DataReader2 is ignored.
    2. If the verification succeeds, DataWriter1 shall proceed to match DataReader2 subject to the matching criteria specified in the DDS and DDS-XTypes specifications.
11. DataWriter1 receives an RTPS `AckNack` message from DataReader2. DataWriter1 shall operate according to the DDS and DDS-RTPS specifications without any calls to the `AccessControl` plugin.

9.8.9 Cryptographic Plugin key generation behavior

Key Generation is potentially needed for:

- The `DomainParticipant` as a whole
- Each `DomainParticipant` match pair
- Each builtin secure endpoint (`DataWriter` or `DataReader`)
- Each builtin secure endpoint match pair
- Each application secure endpoint (`DataWriter` or `DataReader`)
- Each application secure endpoint match pair

9.8.9.1 Key generation for the BuiltinParticipantVolatileMessageSecureWriter and BuiltinParticipantVolatileMessageSecureReader

The ***BuiltinParticipantVolatileMessageSecureWriter*** and ***BuiltinParticipantVolatileMessageSecureReader*** endpoints are special in that they are the ones used to securely send the Crypto Tokens. Therefore the key material needed to secure this channel has to be derivable from the `SharedSecret` without having access to Crypto Tokens returned by the `create_local_datawriter_crypto_tokens` or `create_local_datareader_crypto_tokens`. Effectively this means the key material used for key-exchange is always derived from the `SharedSecret`.

For the ***BuiltinParticipantVolatileMessageSecureWriter*** the creation of the key material necessary to communicate with a matched ***BuiltinParticipantVolatileMessageSecureReader*** shall complete during the operation `register_matched_remote_datareader` and the DDS middleware shall not call the operation `create_local_datawriter_crypto_tokens` or the operation `set_remote_datareader_crypto_tokens` on the CryptoKeyExchange.

For the ***BuiltinParticipantVolatileMessageSecureReader*** the creation of the key material necessary to communicate with a matched ***BuiltinParticipantVolatileMessageSecureWriter*** shall complete during the operation `register_matched_remote_datawriter` and the DDS middleware shall not call the operation `create_local_datareader_crypto_tokens` or the operation `set_remote_datawriter_crypto_tokens` on the CryptoKeyExchange.

The DDS implementation shall add a property with name "`dds.sec.`builtin_endpoint_name" and value "BuiltinParticipantVolatileMessageSecureWriter" to the `Property_t` passed to the operation `register_local_datawriter` when it registers the ***BuiltinParticipantVolatileMessageSecureWriter*** with the CryptoKeyFactory.

The DDS implementation shall add a property with name "`dds.sec.`builtin_endpoint_name" and value "BuiltinParticipantVolatileMessageSecureReader" to the `Property_t` passed to the operation `register_local_datareader` when it registers the ***BuiltinParticipantVolatileMessageSecureReader*** with the CryptoKeyFactory.

Setting the `Property_t` as described above allows the CryptoKeyFactory to recognize the ***BuiltinParticipantVolatileMessageSecureWriter*** and the ***BuiltinParticipantVolatileMessageSecureReader.***

9.8.9.2 Key generation for the DomainParticipant

For each local `DomainParticipant` that is successfully created the DDS implementation shall call the operation `register_local_participant` on the `KeyFactory`.

For each discovered `DomainParticipant` that has successfully authenticated and has been matched to the local `DomainParticipant` the DDS middleware shall call the operation `register_matched_remote_participant` on the `KeyFactory`. Note that this operation takes as one parameter the SharedSecret obtained from the Authentication plugin.

9.8.9.3 Key generation for the builtin endpoints

For each `DataWriter` belonging to the list of "Builtin Secure Endpoints", see 7.5.8, with the exception of the ***BuiltinParticipantVolatileMessageSecureWriter***, the DDS middleware shall call the operation `register_local_datawriter` on the `KeyFactory` to obtain the `DatawriterCryptoHandle` for the builtin `DataWriter`.

For each `DataReader` belonging to the list of "Builtin Secure Endpoints", see 7.5.8, with the exception of the ***BuiltinParticipantVolatileMessageSecureReader***, the DDS middleware shall call the

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operation `register_local_datareader` on the `KeyFactory` to obtain the `DatareaderCryptoHandle` for the corresponding builtin `DataReader`.

For each discovered `DomainParticipant` that has successfully authenticated and has been matched to the local `DomainParticipant` the DDS middleware shall:

1. Call the operation `KeyFactory::register_matched_remote_datawriter` for each local `DataWriter` belonging to the "Builtin Secure Endpoints" passing it the local `DataWriter` and the corresponding remote `DataReader` belonging to the "Builtin Secure Endpoints" of the discovered `DomainParticipant`.
2. Call the operation `KeyFactory::register_matched_remote_datareader` for each local `DataReader` belonging to the "Builtin Secure Endpoints" passing it the local `DataReader` , the corresponding remote `DataWriter` belonging to the "Builtin Secure Endpoints" of the discovered `DomainParticipant`, and the `SharedSecret` obtained from the Authentication plugin.

9.8.9.4 Key generation for the application-defined endpoints

DDSSEC12-90 - Meeting CNSSP-15 security requirements

Recall that for each application-defined (non-builtin) `DataWriter` and `DataReader` successfully created by the DDS Application the DDS middleware has an associated `EndpointSecurityConfig` object which is the one returned by the `AccessControl::get_datawriter_security_config` or `AccessControl::get_datareader_security_config`.

For each non-builtin `DataWriter` for whom the associated `EndpointSecurityConfig` object has either the member ***is_submessage_protected*** or the member ***is_payload_protected*** set to TRUE, the DDS middleware shall:

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Deleted: `get_datawriter_sec_attributes`

Deleted: `get_datareader_sec_attributes`

Deleted: `EndpointSecurityAttributes`

1. Call the operation `register_local_datawriter` on the `KeyFactory` to obtain the `DatawriterCryptoHandle` for the `DataWriter`.
2. Call the operation `register_matched_remote_datareader` for each discovered `DataReader` that matches the `DataWriter`.

For each non-builtin `DataReader` for whom the associated `EndpointSecurityConfig` object has either the member ***is_submessage_protected*** or the member ***is_payload_protected*** set to TRUE, the DDS middleware shall:

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1. Call the operation `register_local_datareader` on the `KeyFactory` to obtain the `DatareaderCryptoHandle` for the `DataReader`.
2. Call the operation `register_matched_remote_datawriter` for each discovered `DataWriter` that matches the `DataReader`.

9.8.9.5 Key revision for local participant and contained endpoints

DDSSEC12-122 – Provide mechanism for changing the session keys

DDS-Security uses key revisions (see 9.5.1.6) to invalidate `KeyMaterial` that has been shared with remote Participants that are no longer trusted or have lost the authorization they previously had to receive the `KeyMaterial`.

DDS- Security does not use key revisions to simply rotate the `KeyMaterial` because it has been used too long, or used to protect too much data. Key Rotation for those purposes should be implemented internally by the Security Plugins. For example, see 10.5.3.3.4

To perform a Key Revision the DDS middlewre shall:

1. Call the operation `revise_local_entity_keys` on the `KeyFactory` to cause the `Cryptographic` plugin to genertate new `Key Material` for a local `DomainParticipant` and all the endpoints it contains.
   a. This operation receives the local `ParticipantCryptoHandle`.
   b. The `Cryptographic` plugin shall be able to navigate from that to the Crypto Handles of all the endpoints that belong to that `DomainParticipant` such that the associated `KeyMaterial` can be updated.
   c. The returned ***key_revision*** value used to identify the revision of Key Material.
2. Call the operation `create_local_participant_crypto_tokens` passing the `ParticipantCryptoHandle` and the previously-obtained ***key_revision***.
   a. This operation shall retrieve the CryptoTokens that are associated with the `DomainParticipant` for the indicated ***key_revision***.
3. Call the operation `create_local_datawriter_crypto_tokens` for each local `DataWriter` belonging to the `DomainParticipant` passing the `DatawriterCryptoHandle` and the ***key_revision***.
   a. This operation shall retrieve the CryptoTokens that are associated with the `DataWriter` for the indicated ***key_revision***.
4. Call the operation `create_local_datareader_crypto_tokens` for each local `DataReader` belonging to the `DomainParticipant` passing the `DatareaderCryptoHandle` and the ***key_revision***.
   a. This operation shall retrieve the CryptoTokens that are associated with the `DataReader` for the indicated ***key_revision***.
5. Send the `CryptoTokens` to the matched, authenticated, DomainParticipants that should have access to them using the same Key Exchange process that was used to send the original CryptoTokens prior to creating the Key Revision.
6. Wait until all the matched Authenticated `DomainParticipant` have acknowledged receiving the `CryptoTokens` or else until sufficient time has elapsed.
7. Call `activate_key_revision` to configure the `Cryptographic` plugin to use the specified ***key_revision*** for subsequent “encode” calls on the `CryptoTransform` interface.

9.8.9.6 Limiting message-size overhead caused by receiver specific key material

The use of receiver-specific key material increases the message size in situations where the same encoded message is sent to multiple receivers. For example, when using a multicast transport. In the presence of large numbers or receivers this "per-receiver" overhead may cause a single RTPS submessage with all the receiver-specific authentication codes to exceed the maximum transport MTU. This would cause problems, as RTPS submessages cannot be fragmented.

To overcome this kind of situation implementations may use different strategies.

1. An implementation may limit the number of different receiver-specific key material it generates. For example, it may reuse the same receiver-specific key for multiple receivers. This would limit the overhead at the cost of weakening the origin authentication.
2. An implementation may impose a limit on the number of receiver-specific macs attached to a single message. This would require DDS implementations to construct multiple messages, each with a different set of receiver-specific authentication codes. This use-case is facilitated by the encode_datawriter_submessage and encode_rtps_message CryptoTransform operations.

The selection between and configuration of these choices is implementation specific, as it does not affect interoperability.

9.8.10 Cryptographic Plugin key exchange behavior

Cryptographic key exchange is potentially needed for:

- Each `DomainParticipant` match pair.
- Each builtin secure endpoint match pair.
- Each application secure endpoint match pair.

9.8.10.1 Key Exchange with discovered DomainParticipant

Cryptographic key exchange shall occur between each `DomainParticipant` and each discovered `DomainParticipant` that has successfully authenticated. This key exchange propagates the key material related to encoding/signing/decoding/verifying the whole RTPS message. In other words the key material needed to support the `CryptoTransform` operations `encode_rtps_message` and `decode_rtps_message`.

Given a local DomainParticipant the DDS middleware shall:

1. Call the operation `create_local_participant_crypto_tokens` on the `KeyFactory` for each discovered `DomainParticipant` that has successfully authenticated and has been matched to the local `DomainParticipant`. This operation takes as parameters the local and remote `ParticipantCryptoHandle`.
2. Send the `ParticipantCryptoTokenSeq` returned by operation `create_local_participant_crypto_tokens` to the discovered `DomainParticipant` using ***BuiltinParticipantVolatileMessageSecureWriter***.

The discovered `DomainParticipant` shall call the operation `set_remote_participant_crypto_tokens` passing the `ParticipantCryptoTokenSeq` received by the ***BuiltinParticipantVolatileMessageSecureReader***.

The figure below illustrates the functionality of the Cryptographic KeyExchange plugins with regards to the discovery and match of an authenticated remote `DomainParticipant` entity.

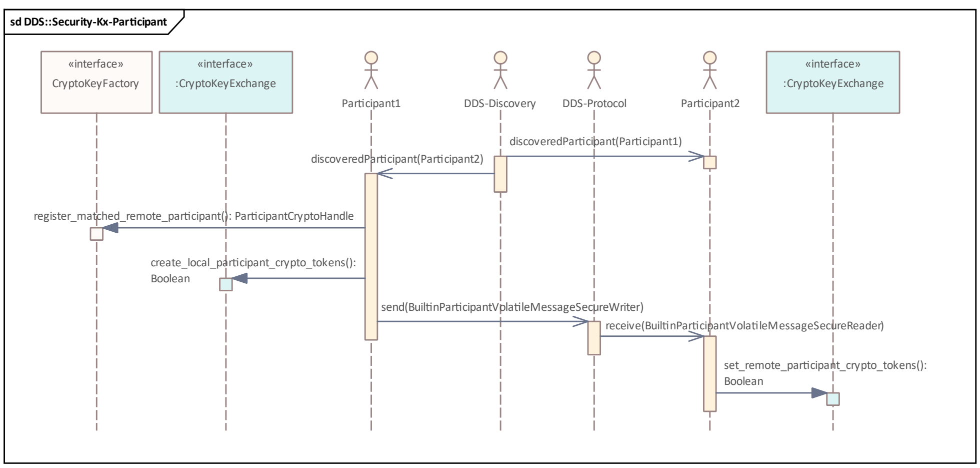

Figure 28 – Cryptographic KeyExchange plugin sequence diagram with discovered DomainParticipant

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1. Participant2 discovers the `DomainParticipant` (Participant1) via the DDS discovery protocol. This sequence is not described here as it is equivalent to the sequence that Participant1 performs when it discovers Participant2.
2. Participant1 discovers the `DomainParticipant` (Participant2) via the DDS discovery protocol. Participant2 is authenticated and its permissions are checked as described in 9.8.3 and 9.8.7. This is not repeated here. The authentication and permissions checking resulted in the creation of an `IdentityHandle`, a `PermissionsHandle`, and a `SharedSecretHandle` for Participant2.
3. Participant1 calls the operation `register_matched_remote_participant` on the `Cryptographic` plugin (`CryptoKeyFactory` interface) to store the association of the remote identity and the SharedSecret.
4. Participant1 calls the operation `create_local_participant_crypto_tokens` on the `Cryptographic` plugin (`CryptoKeyExchange` interface) to obtain a collection of `CriptoToken` (cryptoTokensParticipant1ForParticipant2) to send to the remote `DomainParticipant` (Participant2).
5. Participant1 sends the collection of `CryptoToken` objects (cryptoTokensParticipant1ForParticipant2) to Participant2 using the ***BuiltinParticipantVolatileMessageSecureWriter***.
6. Participant2 receives the `CryptoToken` objects (cryptoTokensParticipant1ForParticipant2) and calls the operation `set_remote_participant_crypto_tokens()` to register the `CryptoToken` sequence with the `DomainParticipant`. This will enable the `Cryptographic` plugin on Participant2 to decode and verify MACs on the RTPS messages sent by Participant1 to Participant2.

9.8.10.2 Key Exchange with remote DataReader

Cryptographic key exchange shall occur between each builtin secure `DataWriter` and the matched builtin secure `DataReader` entities of authenticated matched `DomainParticipant` entities, see 7.5.8, with the exception of the ***BuiltinParticipantVolatileMessageSecureReader***.

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DDSSEC12-90 - Meeting CNSSP-15 security requirements

Cryptographic key exchange shall also occur between each application `DataWriter` whose `EndpointSecurityConfig` object has either the ***is_submessage_protected*** or the ***is_payload_protected*** members set to TRUE, and each of its matched `DataReader` entities.

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Given a local `DataWriter` that is either a builtin secure `DataWriter` or an application `DataWriter` meeting the condition stated above the DDS middleware shall:

1. Call the operation `create_local_datawriter_crypto_tokens` on the `KeyFactory` for each matched `DataReader`. This operation takes as parameters the local `DatawriterCryptoHandle` and the remote `DatareaderCryptoHandle`.
2. Send the `DatawriterCryptoTokenSeq` returned by operation `create_local_datawriter_crypto_tokens` to the discovered `DomainParticipant` using ***BuiltinParticipantVolatileMessageSecureWriter***.

The matched `DataReader` shall call the operation `set_remote_datawriter_crypto_tokens` passing the `DatawriterCryptoTokenSeq` received by the ***BuiltinParticipantVolatileMessageSecureReader***.

The figure below illustrates the functionality of the Cryptographic `KeyExchange` plugin with regards to the discovery and match of a local secure `DataWriter` and a matched `DataReader`.

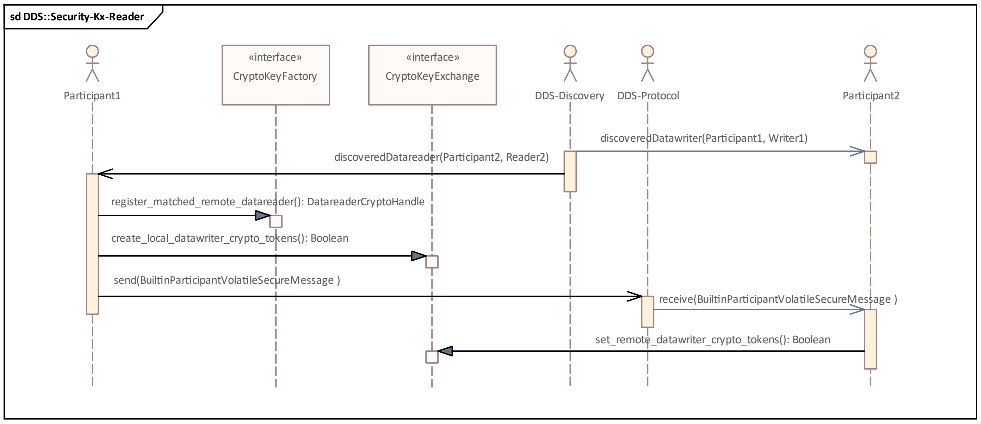

Figure 29 – Cryptographic KeyExchange plugin sequence diagram with discovered DataReader

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1. Participant2 discovers a `DataWriter` (Writer1) belonging to Participant1 that matches a local DataReader (Reader2) according to the constraints in the DDS security specification.
2. Participant1 discovers a `DataReader` (Reader2) belonging to Participant2 that matches a local DataWriter (Writer1) according to the constraints in the DDS security specification.
3. Participant1 calls the operation `register_matched_remote_datareader` as stated in 9.8.9.
4. Participant1 calls the operation `create_local_datawriter_crypto_tokens` on the `CryptoKeyExchange` to obtain a collection of `CriptoToken` objects (cryptoTokensWriter1ForReader2).
5. Participant1 sends the collection of `CryptoToken` objects (cryptoTokensWriter1ForReader2) to Participant2 using the ***BuiltinParticipantVolatileMessageSecureWriter***.
6. Participant2 receives the `CryptoToken` objects (cryptoTokensWriter1ForReader2) and calls the operation `set_remote_ datawriter_crypto_tokens()` to register the `CryptoToken` sequence with the `DataWriter (`Writer1`)`. This will enable the `Cryptographic` plugin on Participant2 to decode and verify MACs on the RTPS submessages and data payloads sent from Writer1to Reader2.

9.8.10.3 Key Exchange with remote DataWriter

Cryptographic key exchange shall occur between each builtin secure `DataReader` and the matched builtin secure `DataWriter` entities of authenticated matched `DomainParticipant` entities, see 7.5.8, with the exception of the ***BuiltinParticipantVolatileMessageSecureReader***.

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DDSSEC12-90 - Meeting CNSSP-15 security requirements

Cryptographic key exchange shall also occur between each application `DataReader` whose `EndpointSecurityConfig` object has the ***is_submessage_protected*** member set to TRUE, and each of its matched `DataWriter` entities.

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Given a local `DataReader` that is either a builtin secure `DataReader` or an application `DataReader` meeting the condition stated above the DDS middleware shall:

1. Call the operation `create_local_datareader_crypto_tokens` on the `KeyFactory` for each matched `DataWriter`. This operation takes as parameters the local `DatareaderCryptoHandle` and the remote `DatawriterCryptoHandle`.
2. Send the `DatareaderCryptoTokenSeq` returned by operation `create_local_datareader_crypto_tokens` to the discovered `DomainParticipant` using ***BuiltinParticipantVolatileMessageSecureWriter***.

The matched `DataWriter` shall call the operation `set_remote_datareader_crypto_tokens` passing the `DatareaderCryptoTokenSeq` received by the ***BuiltinParticipantVolatileMessageSecureReader***.
The figure below illustrates the functionality of the Cryptographic `KeyExchange` plugin with regards to the discovery and match of a local secure `DataReader` and a matched `DataWriter`.
DDSSEC12-90 - Meeting CNSSP-15 security requirements
Cryptographic key exchange shall occur between each `DataReader` whose `EndpointSecurityConfig` has the ***is_submessage_protected*** members set to TRUE and each of its matched `DataWriter` entities.

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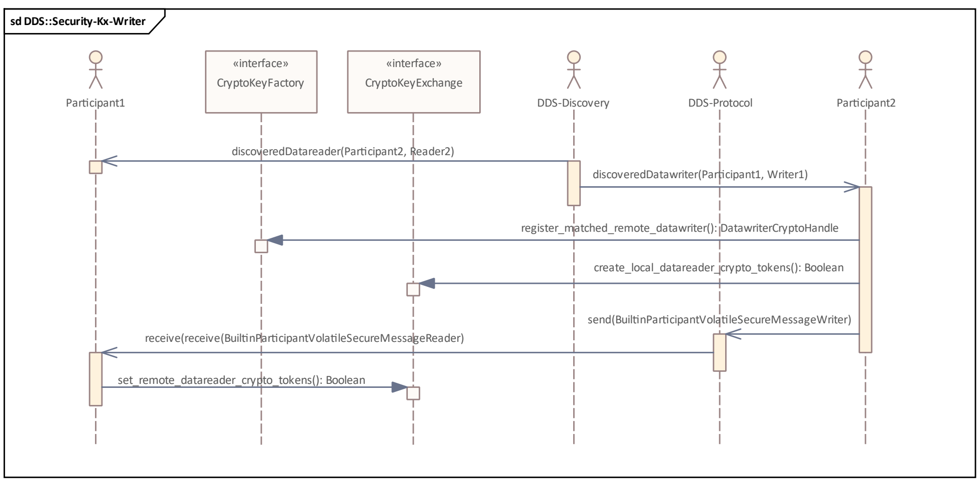

Figure 30 – Cryptographic KeyExchange plugin sequence diagram with discovered DataWriter

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1. Participant1 discovers a `DataReader` (Reader2) belonging to Participant2 that matches a local DataWriter (Writer1) according to the constraints in the DDS security specification.
2. Participant2 discovers a `DataWriter` (Writer1) belonging to Participant1 that matches a local DataReader (Reader2) according to the constraints in the DDS security specification.
3. Participant2 calls the operation `register_matched_remote_datawriter` as stated in 9.8.9.
4. Participant2 calls the operation `create_local_datareader_crypto_tokens` on the `CryptoKeyExchange` to obtain a collection of `CriptoToken` objects (cryptoTokensReader2ForWriter1).
5. Participant2 sends the collection of `CryptoToken` objects (cryptoTokensReader2ForWriter1) to Participant1 using the ***BuiltinParticipantVolatileMessageSecureWriter***.

6. Participant1 receives the CryptoToken objects (cryptoTokensReader2ForWriter1) and calls the operation set_remote_ datareader_crypto_tokens() to register the CryptoToken sequence with the DataWriter (Writer1). This will enable the Cryptographic plugin on Participant1 to decode and verify MACs on the RTPS submessages sent from Reader2 to Writer1.

9.8.10.4 Key Revision Exchange for DomainParticipant and contained DataWriter and DataReaders

DDSSEC12-122 – Provide mechanism for changing the session keys

The DDS middleware may call the operation revise_local_entity_keys (see 9.5.1.8.7) to create new Key Material for all DDS Entities in the DominParticipant. This opertion returns an integer that is used to represent the new CrytoTransformKeyRevision.

Following the call to revise_local_entity_keys the DDS middleware shall call the operation create_local_participant_crypto_tokens (see 9.5.1.9.1) to retrieve the CryptoTokens associated with the new Key Material.

The DDS middleware shall subsequently send those CryptoTokens to all Authenticated, matched DominParticipant entities using the same mechanism used for Discovered DomainParticipants, see 9.8.10.1),

Following the call to revise_local_entity_keys, the DDS middleware shall also call create_local_datawriter_crypto_tokens (see 9.5.1.9.3) to retrieve the CryptoTokens containing the new Key Material for each DataWriter .
The DDS middleware shall send those CryptoTokens to all Authenticated, Authorized, matched DataReader entities that according using the same mechanisms described in 9.8.10.2.

Following the call to revise_local_entity_keys, the DDS middleware shall also call create_local_datareader_crypto_tokens (see 9.5.1.9.5) to retrieve the CryptoTokens containing the new Key Material for each DataReader.
The DDS middleware shall send those CryptoTokens to all Authenticated, Authorized, matched DataWriter entities that according using the same mechanisms described in 9.8.10.3

The DDS middleware shall wait until the above CryptoTokens have been received or else a “sufficient” time has elapsed. After this it shall call activate_key_revision (see 9.5.1.8.8) to cause the Cryptographic plugin to start using the Key Material associated with the Key Revision.

9.8.11 Cryptographic Plugins encoding/decoding behavior

This sub clause describes the behavior of the DDS implementation related to the CryptoTransform interface.
This specification does not mandate a specific DDS implementation in terms of the internal logic or timing when the different operations in the CryptoTransform plugin are invoked. The sequence charts below just express the requirements in terms of the operations that need to be called and their interleaving. This specification only requires that by the time the RTPS message appears on the wire the proper encoding operations have been executed first on each SerializedPayload submessage element, then on the enclosing RTPS Submessage, and finally on the RTPS Message. Similarly by the time a received RTPS Message is interpreted the proper decoding operations are executed on the reverse order. First on the encoded RTPS Message, then on each set of secured submessages starting

with either a SecureRTPSPrefixSubMsg or SecurePrefixSubMsg, and finally on each CryptoContent submessage element.

9.8.11.1 Encoding/decoding of a single writer message on an RTPS message

The figure below illustrates the functionality of the security plugins with regard to encoding the data, Submessages and RTPS messages in the situation where the intended RTPS Message contains a single writer RTPS Submessage.

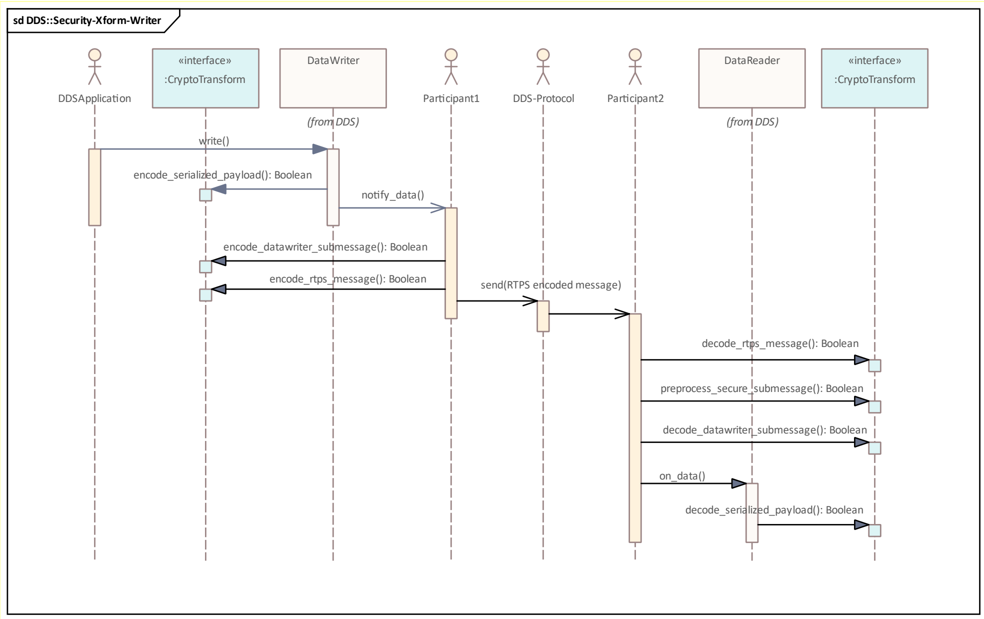

Figure 31 – Cryptographic CryptoTransform plugin sequence diagram for encoding/decoding a single DataWriter submessage

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DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

1. The application writes data using a DataWriter belonging to Participant1. The DDS implementation serializes the data.
2. The DataWriter in Participant1 constructs the SerializedPayload RTPS submessage element and calls the operation encode_serialized_payload. This operation creates an RTPS SecData that protects the SerializedPayload potentially encrypting it, adding a MAC and/or digital signature.
3. This step is notional; the specific mechanism depends on the DDS Implementation. Participant1 realizes it is time to send the data written by the DataWriter to a remote DataReader in Participant2.
4. Participant1 constructs the RTPS Data Submessage to send to the DataReader and calls the operation encode_datawriter_submessage to transform the original Data submessage to a set of secure submessages (SecurePrefixSubMsg, original plain text submessage or SecureBodySubMsg, and optional SecurePostfixSubMsg). This same transformation would be applied to any DataWriter submessage (Data, Gap,

Heartbeat, DataFrag, HeartbeatFrag). The encode_datawriter_submessage receives as parameters the DatawriterCryptoHandle of the DataWriter and a list of DatareaderCryptoHandle for all the DataReader entities to which the message will be sent. Using a list allows the same set of secure submessages to be sent to all those DataReader entities.

5. Participant1 constructs the RTPS Message it intends to send to the DataReader (or readers). It then calls encode_rtps_message to transform the original RTPS Message into a new "encoded" RTPS Message with the same RTPS header and a set of secure submessages protecting the contents of the original RTPS Message. The encode_rtps_message receives as parameters the ParticipantCryptoHandle of the sending DomainParticipant (Participant1) and a list of ParticipantCryptoHandle for all the DomainParticipant entities to which the message will be sent (Participant2). Using a list enables the DomainParticipant to send the same message (potentially over multicast) to all those DomainParticipant entities.
6. Participant1 sends the new "encoded" RTPS Message obtained as a result of the previous step to Participant2.
7. Participant2 receives the "encoded" RTPS Message. Participant2 parses the message and detects a SecureRTPSPrefixSubMsg. This indicates it shall call the operation decode_rtps_message to process the prefix, body and optional postfix submessage. If decode_rtps_message is successful, the result is an RTPS Message that can be processed further.
8. Participant2 parses the RTPS Message resulting from the previous step and encounters an RTPS SecurePrefixSubMsg. This indicates it shall call the operation preprocess_rtps_submessage to determine whether this is a Writer submessage or a Reader submessage and obtain the DatawriterCryptoHandle and DatareaderCryptoHandle handles it needs to decode the message. This function determines it is a Writer submessage.
9. Participant2 calls the operation decode_datawriter_submessage passing in a data stream that includes the SecurePrefixSubMsg, a plain text submessage or a SecureBodySubMsg, and an optional SecurePostfixSubMsg. The decode_datawriter_submessage operation also requires the DatawriterCryptoHandle and DatareaderCryptoHandle obtained in the previous step. The operation, if successful, will return the original Data submessage that was input to encode_datawriter_submessage on the DataWriter side. From the Data submessage the DDS implementation extracts the CryptoContent submessage element.
10. This step is notional; the specific mechanism depends on the DDS Implementation. Participant2 realizes it is time to notify the DataReader and retrieve the actual data sent by the DataWriter.
11. Participant2 calls decode_serialized_payload passing in the RTPS CryptoContent and obtains the original SerializedPayload submessage element was the input to the encode_serialized_payload on the DataWriter side. This operation takes as arguments the DatawriterCryptoHandle and DatareaderCryptoHandle obtained in step 8.

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9.8.11.2 Encoding/decoding of multiple writer messages on an RTPS message

The figure below illustrates the functionality of the security plugins in the situation where the intended RTPS message contains a multiple `DataWriter` RTPS `Submessages`, which can represent multiple samples, from the same `DataWriter` or from multiple DataWriter entities, as well as, a mix of `Data`, `Heartbeat`, `Gap`, and any other `DataWriter` RTPS `Submessage` as defined in 7.4.1.

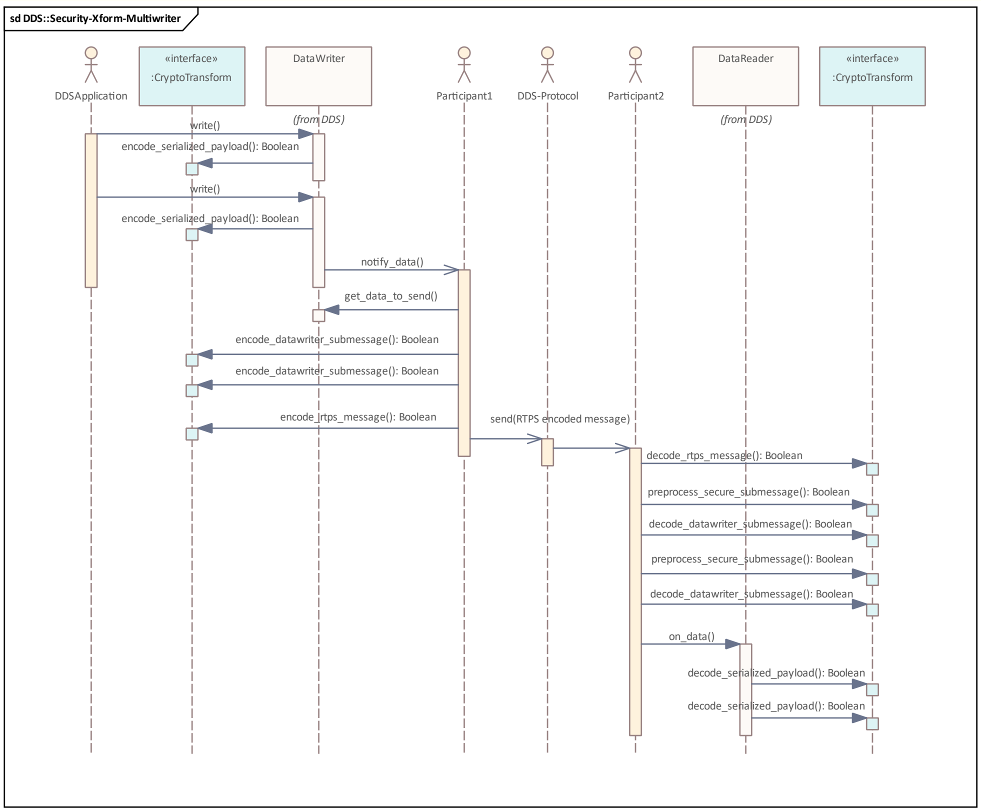

Figure 32 – Cryptographic CryptoTransform plugin sequence diagram for encoding/decoding multiple DataWriter submessages

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The steps followed to encode and decode multiple DataWriter Submessages within the same RTPS message are very similar to the ones used for a single Writer message. The only difference is that the writer side can create multiple RTPS Submessages. In this case, Participant1 creates two Data Submessages and a Heartbeat Submessage, transforms each separately using the `encode_datawriter_submessage`, places them in the same RTPS message and then transforms the RTPS Message containing all the resulting secured submessages using `encode_rtps_message`.

The steps followed to decode the message are the reverse ones.

Note that the DataWriter entities that are sending the submessages and/or the DataReader entities that are the destination of the different Submessages may be different. In this situation each call to `encode_serialized_payload()`, `encode_datawriter_submessage()`, decode_datawriter_submessage(), and encode_serialized_payload(), shall receive the proper DatawriterCryptoHandle and DatareaderCryptoHandle handles.

9.8.11.3 Encoding/decoding of multiple reader messages on an RTPS message

The figure below illustrates the functionality of the security plugins in the situation where the intended RTPS message contains multiple DataReader RTPS submessages from the same DataReader or from multiple DataReader entities. These include AckNack and NackFrag RTPS Submessages as defined in 7.4.1.

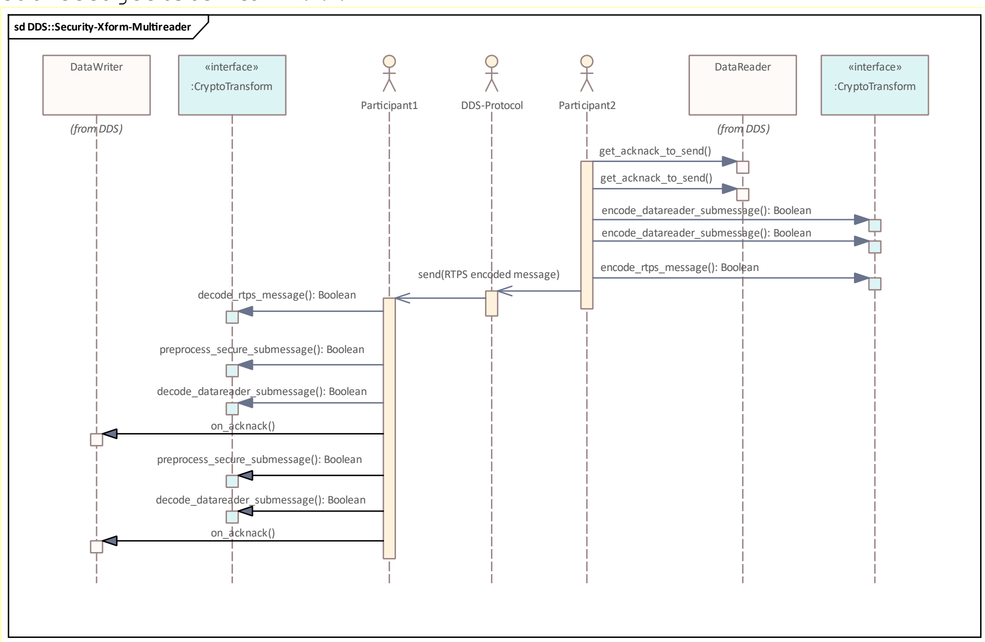

Figure 33 -- Cryptographic CryptoTransform plugin sequence diagram for encoding/decoding multiple DataReader submessages

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1. This step is notional; the specific mechanism depends on the DDS Implementation. Participant2 realizes it is time to send an AckNack or NackFrag submessage from DataReader to a remote DataWriter.
2. Participant2 constructs the AckNack (or any other DataReader RTPS Submessage) and calls the operation encode_datareader_submessage. This operation creates multiple submessages: a SecurePrefixSubMsg, a plain text submessage or a SecureBodySubMsg, and optionally a SecurePostfixSubMsg. This operation shall receive as parameter the DatareaderCryptoHandle of the DataReader that sends the submessage and a list of DatawriterCryptoHandle handles of all the DataWriter entities to which the Submessage will be sent.
3. Step 2 may be repeated multiple times constructing various secured submessages from different DataReader RTPS Submessages. Different submessages may originate on different DataReader entities and/or be destined for different DataWriter entities. On each case the encode_datareader_submessage operation shall receive the

DatareaderCryptoHandle and list of DatawriterCryptoHandle that correspond to the source and destinations of that particular Submessage.

4. Participant2 constructs the RTPS Message that contains the submessages obtained as a result of the previous steps. It shall then call encode_rtps_message to transform the "original" RTPS Message into a SecureRTPSPrefixSubMsg followed by either 1) an INFO_SRC SubMsg and the contents of the RTPS Message or 2) a SecureBodySubMsg (with INFO_SRC and encoded content), and finally a SecureRTPSPostfixSubMsg.
5. Participant2 sends the "encoded" RTPS Message to Participant1 (and any other destination DomainParticipant).
6. Participant1 receives the "encoded" RTPS Message. Participant parses the message and detects an RTPS SecureRTPSPrefixSubMsg. This indicates it should call the operation decode_rtps_message to process the prefix, body and optional postfix submessage. If decode_rtps_message is successful, the result is an RTPS Message that can be processed further.
7. Participant1 parses the RTPS Message resulting from the previous step and encounters an RTPS SecurePrefixSubMsg. This indicates it shall call the operation preprocess_secure_submessage to determine whether this is a Writer submessage or a Reader submessage and obtain the DatawriterCryptoHandle and DatareaderCryptoHandle handles it needs to decode the message. This function determines it is a DataReader submessage.
8. Participant1 calls decode_datareader_submessage passing in a data stream that includes the SecurePrefixSubMsg, a plain text submessage or a SecureBodySubMsg, and an optional SecurePostfixSubMsg. The decode_datareader_submessage operation also requires the DatawriterCryptoHandle and DatareaderCryptoHandle obtained in the previous step. The operation, if successful, will return the original AckNack (or proper DataReader submessage) submessage that was input to encode_datareader_submessage on the DataReader side.
9. This step is notional; the specific mechanism depends on the DDS Implementation. Participant1 realizes it is time to notify the DataReader of the Acknowledgment, negative acknowledgment or whatever the DataReader Submessage indicated.
10. Each RTPS SecurePrefixSubMsg encountered within the RTPS Message is processed in this same way. The operation preprocess_rtps_submessage is first invoked and if it indicates it is a DataReader submessage, Participant1 shall call decode_datareader_submessage() on the submessage.

9.8.11.4 Encoding/decoding of reader and writer messages on an RTPS message

The figure below illustrates the functionality of the security plugins with regard to encoding the data, Submessages and RTPS messages in the situation where the intended RTPS message contains multiple RTPS Submessages which can represent a mix of different kinds of DataWriter and DataReader submessages such as Data, Heartbeat, Gap, AckNack, NackFrag and any other RTPS Submessage as defined in 7.4.1.

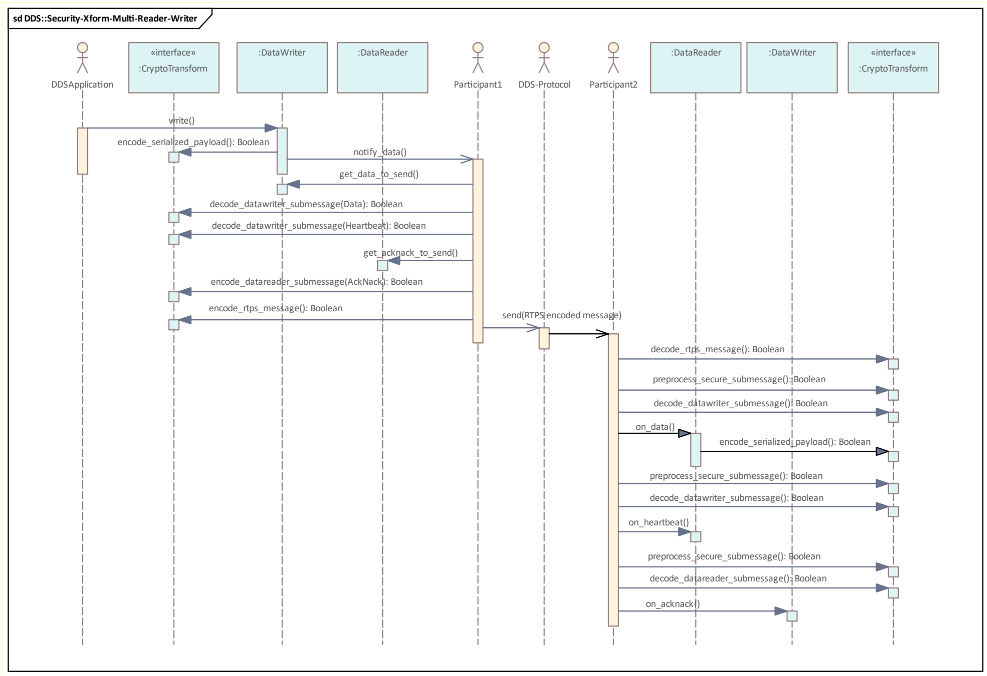

Figure 34 – Cryptographic CryptoTransform plugin sequence diagram for encoding/decoding multiple DataWriter and DataReader submessages

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1. The application writes data using a `DataWriter` belonging to Participant1. The DDS implementation serializes the data.
2. The `DataWriter` in Participant1 constructs the `SerializedPayload` RTPS submessage element and calls the operation `encode_serialized_payload`. This operation creates an RTPS `SecData` that protects the `SerializedPayload` potentially encrypting it, adding a MAC and/or digital signature.
3. This step is notional; the specific mechanism depends on the DDS Implementation. Participant1 realizes it is time to send the data written by the `DataWriter` to a remote `DataReader`.
4. Participant1 constructs the RTPS `Data` Submessage that it will send to the `DataReader` and calls the operation `encode_datawriter_submessage` to transform the original `Data` submessage to a set of secured submessages.
5. This step is notional. The specifics will depend on the DDS Implementation. Participant1 decides it needs to send a `Heartbeat` submessage along with the `Data` submessage. It constructs the RTPS `Heartbeat` submessage and calls the operation `encode_datawriter_submessage()` to transform the original `Heartbeat` submessage to a set of secured submessages.
6. This step is notional. The specific mechanism depends on the DDS Implementation. Participant1 decides it also wants to include an RTPS `AckNack` submessage from a DataReader that also belongs to Participant1 into the same RTPS Message because it is destined to the same Participant2.

7. Participant1 constructs the RTPS `AckNack` submessage and calls `encode_datareader_submessage` to transform the original `AckNack` submessage to a set of secured submessages.
8. Participant1 constructs the RTPS Message that contains the submessages obtained as a result of the previous steps. It shall then call `encode_rtps_message`. To transform the "original" RTPS Message into `SecureRTPSPrefixSubMsg` followed by either 1) an `INFO_SRC` SubMsg and the contents of the RTPS `Message` or 2) a `SecureBodySubMsg` (with `INFO_SRC` and encoded content), and finally a `SecureRTPSPostfixSubMsg`.
9. Participant1 sends the "encoded" RTPS `Message` to Participant2 (and any other destination DomainParticipant).
10. Participant2 receives the "encoded" RTPS Message. Participant2 parses the message and detects an RTPS `SecureRTPSPrefixSubMsg`. This indicates it should call the operation `decode_rtps_message` to process the prefix, body and optional postfix submessage. If `decode_rtps_message` is successful, the result is an RTPS Message that can be processed further.
11. Participant2 parses the RTPS Message resulting from the previous step and encounters an RTPS `SecurePrefixSubMsg`. This indicates it shall call `preprocess_secure_submessage` to determine whether this is a `Writer` submessage or a `Reader` submessage and obtain the `DatawriterCryptoHandle` and `DatareaderCryptoHandle` handles it needs to decode the message. This function determines it is a `DataWriter` submessage.
12. Participant1 calls the operation `decode_datawriter_submessage`, passing in a data stream that includes the `SecurePrefixSubMsg`, a plain text submessage or a `SecureBodySubMsg`, and an optional `SecurePostfixSubMsg`. The `decode_datawriter_submessage` operation also requires the `DatawriterCryptoHandle` and `DatareaderCryptoHandle` obtained in the previous step. The operation, if successful, will return the original DataWriter submessage that was input to `encode_datawriter_submessage` on the Participant1 side.
13. This step is notional; the specific mechanism depends on the DDS Implementation. The Participant2 realizes it is time to notify the `DataReader` of the arrival of data.
14. Participant2 calls `decode_serialized_payload` passing in the RTPS `CryptoContent` and obtains the original `SerializedPayload` submessage element was the input to the `encode_serialized_payload` on the Participant1 side. This operation takes as arguments the `DatawriterCryptoHandle` and `DatareaderCryptoHandle` obtained in the step 11.
15. Step 11 is repeated. It is again determined that the next set of secured submessages are a `DataWriter` submessage and the proper `DatawriterCryptoHandle` and `DatareaderCryptoHandle` handles are retrieved.
16. Step 12 is repeated. Participant2 calls `decode_datawriter_submessage` passing in a data stream that includes the `SecurePrefixSubMsg`, a plain text submessage or a `SecureBodySubMsg`, and an optional `SecurePostfixSubMsg`. This transforms the submessages into the original `Heartbeat` submessage.
17. This step is notional; the specific mechanism depends on the DDS Implementation. Participant2 notifies DataReader of the `Heartbeat`.

18. Step 11 is repeated. It is determined that the next set of submessages are a DataReader submessage and the proper `DatawriterCryptoHandle` and `DatareaderCryptoHandle` handles are retrieved.
19. Participant2 calls `decode_datareader_submessage` passing in a data stream that includes the `SecurePrefixSubMsg`, a plain text submessage or a `SecureBodySubMsg`, and an optional `SecurePostfixSubMsg`. The result of this operation is the original `AckNack` submessage that was the input to the `encode_datareader_submessage` on Participant1. This operation takes as arguments the `DatawriterCryptoHandle` and `DatareaderCryptoHandle` obtained in the previous step.
20. This step is notional; the specific mechanism depends on the DDS Implementation. Participant2 notifies `DataWriter` of the `AckNack`.

10 Builtin Plugins

10.1 Introduction

This specification defines the behavior and implementation of at least one builtin plugin for each kind of plugin. The builtin plugins provide out-of-the-box interoperability between implementations of this specification.
The builtin plugins are summarized in the table below:
DDSSEC12-90 - Meeting CNSSP-15 security requirements

Table 49 – Summary of the Builtin Plugins

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SPI	*Plugin Name*	*Description*
Authentication	DDS:Auth:PKI-DH	Uses PKI with a pre-configured shared Certificate Authority. ECDSA or RSA as the digital signature algorithms, and Elliptic-Curve Diffie-Hellman (ECDH) or Diffie-Hellman (DH) as the key establishment algorithm.
AccessControl	DDS:Access:Permissions	Permissions document signed by shared Certificate Authority
Cryptography	DDS:Crypto:AES-GCM-GMAC	AES-GCM (AES using Galois Counter Mode) for encryption. AES-GMAC for message authentication.
DataTagging	DDS:Tagging:DDS_Discovery	Send Tags via Endpoint Discovery
Logging	DDS:Logging:DDS_LogTopic	Logs security events to a dedicated DDS Log Topic

Deleted: RSA or DSA and Diffie-Hellman for authentication and key exchange

10.2 Requirements and Priorities (Non-Normative)

The selection of the builtin plugins was driven by several functional, as well as, non-functional requirements, as described below.
Most DDS users surveyed consider the following functional requirements as essential elements of a secure DDS middleware:

- Authentication of applications (DDS Domain Participants) joining a DDS Domain.
- Access control of applications subscribing to specific data at the Domain and Topic level.
- Message integrity and data-origin authentication.
- Encryption of a data sample using different encryption keys for different Topics.

In addition to these essential needs, many users also required that secure DDS middleware should provide for:

- Sending digitally signed data samples.
- Sending data securely over multicast.
- Tagging data.
- Integrating with open standard security plugins.

Other functional requirements which are considered useful but less common were:

- Access control to certain samples within a Topic but not others, with access rights being granted according to the data-sample contents or the data-sample key.
- Access control to certain attributes within a data sample but not others, such that certain DataReader entities can only observe a subset of the attributes as defined by their permissions.
- Permissions that control which QoS might be used by a specific DDS Entity: DomainParticipant, Publisher, DataWriter, Subscriber, or DataReader.

The primary non-functional requirements that informed the selection of the builtin plugins are:

- Performance and Scalability.

- Robustness and Availability.
- Fit to the DDS Data-Centric Information Model.
- Leverage and reuse of existing security infrastructure and technologies.
- Ease of use while supporting common application requirements.

10.2.1 Performance and Scalability

DDS is commonly deployed in systems that demand high performance and need to scale to large numbers of processes and computers. Different applications vary greatly in the number of processes, Topics, and/or data-objects belonging to each Topic.

The policy enforcement/decision points as well as the transformations (cipher, decipher, hash) performed by the plugins should not adversely degrade system performance and scalability beyond what is tolerable and strictly needed. In practice this means several things for the builtin plugins:

- The use of Asymmetric Key Cryptography shall be limited to the discovery, authentication, session and shared-secret establishment phase (i.e., when a Participant discovers another Participant, a DataReader and matching DataWriter). To the extent possible it shall not be used in the critical path of data distribution.
- The use of ciphers, HMACs, or digital signatures shall be selectable on a per stream (Topic) basis. In case of encryption, symmetric ciphers should be used for the application data.
- It shall be possible to provide integrity via HMAC techniques without also requiring the data to be ciphered.
- Multicast shall be supported even for ciphered data.

10.2.2 Robustness and Availability

DDS is deployed in mission-critical systems, which must continue to operate 24/7 despite partial system malfunction. DDS also operates in fielded environments where specific components or systems may be subject to accidental failure or active attack. DDS provides a highly robust infrastructure due to the way the communication model and protocols are defined as they can be (and commonly are) implemented in a peer-to-peer fashion without any centralized services. For this reason, many DDS implementations have no single points of failure.

The builtin plugins should not negate these desirable properties present in the underlying DDS middleware infrastructure.

In practice, this means that:

- Centralized policy decision points or services should be avoided.
- The individual DDS DomainParticipant components should be self-contained and have what they need to operate securely even in the presence of system partitions.
- Multi-party key agreement protocols shall be avoided because they can be easily disrupted by disrupting just one party.
- Security tokens and keys should be compartmentalized as much as possible such that compromise of an application component is contained to that component itself. For example, selection of a system-wide secret key for the whole Domain or even for a Topic should be avoided.

10.2.3 Fitness to the DDS Data-Centric Model

Application developers that use DDS think in terms of the data-centric elements that DDS provides. That is, they think first and foremost about the Domains (global data spaces) the application must join and the Topics that the application needs to read and write. Therefore, the builtin plugins should offer the possibility to control access with this level of granularity.

Users of DDS also think about the data objects (keyed instances) they read and write, the ability to dispose instances, filter by content, set QoS, and so forth. While it may be useful to offer ways to provide access controls to this as well, it was considered of lesser priority and potentially conflicting with the goal of ease of configurability and maintainability.

The semantics of DDS communications require that individual samples can be consumed independently of each other. Depending on the QoS policy settings samples written by a single DataWriter may be received and processed out of order relative to the order sent, or may be received with intermediate gaps resulting from best-effort communication (if selected), or may be filtered by content, time, or history, etc. For this reason, any encryption and/or digital signature applied to a sample should be able to be processed in isolation, without requiring the receiver to maintain a specific context reconstructed from previous samples.

10.2.4 Leverage and Reuse of Existing Security Infrastructure and Technologies

To the extent possible, it is desirable that the builtin plugins leverage and reuse existing IA technology and tools. This not only reduces the barrier of entry for implementers of the specification, but also more importantly enhances the quality of the result by allowing the use of proven, peer-reviewed, and/or already certified approaches. The builtin plugins leverage existing standards and tools for PKI, ciphers, hashing and digital signing. To the extent possible, ideas and approaches from existing protocols for key management and secure multicast are also leveraged, although where appropriate they have been adapted to the data-centric communications model of DDS and the DDS-RTPS wire protocol.

10.2.5 Ease-of-Use while Supporting Common Application Requirements

It is anticipated that specialized applications may need to develop their own security plugins to either integrate existing security infrastructure or meet specialized requirements. Therefore the primary consumers of the builtin plugins will be users who want to secure their systems but not have complex needs or significant legacy components. Under these conditions, ease-of-use is essential. A security infrastructure that is too hard to configure or too complex to understand or maintain is less likely to be used, or may be used wrongly, resulting in systems that are less secure overall.

The builtin plugins balance rich functionality and ease-of-use, providing for the most common use cases, in a manner that is easy to understand and use correctly.

10.3 Builtin Authentication: DDS:Auth:PKI-DH

This builtin authentication plugin is referred to as the "DDS:Auth:PKI-DH".

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The DDS:Auth:PKI-DH plugin implements authentication using a trusted `Certificate Authority` (CA). It performs mutual authentication between discovered participants using standard **Digital Signature Algorithms** (e.g. ECDSA [11]) to establish an identity trust chain and to sign authentication messages. It establishes a shared secret to create a peer-to-peer secure channel using standard **Key Establishment Algorithms** (e.g. ECDH [12]). See clause 8.

Deleted: the RSA or ECDSA Digital Signature Algorithms [11] and establishes a shared secret using Diffie-Hellman (DH) or Elliptic Curve Diffie-Hellman (ECDH) Key Agreement Methods [12].

The CA could be an existing one. Or a new one could be created for the purpose of deploying applications on a DDS `Domain`. The nature or manner in which the CA is selected is not important because the way it is used enforces a shared recognition by all participating applications.

Prior to a `DomainParticipant` being enabled the DDS:Auth:PKI-DH plugin associated with the `DomainParticipant` must be configured with three things:

1. The `X.509 Certificate` that defines the `Shared Identity CA`. This certificate contains the `Public Key` of the CA.

2. The Private Key of the DomainParticipant.
3. An X.509 Certificate that chains up to the Shared Identity CA, that binds the Public Key of the DomainParticipant to the Distinguished Name (subject name) for the DomainParticipant.

10.3.1 Configuration

The builtin authentication plugin shall be configured using the PropertyQosPolicy of the DomainParticipantQos. The specific properties used are described in Table 50 below.
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Table 50 – Properties used to configure the builtin Authentication plugin

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Property Name (all properties have "dds.sec.auth" prefix)	***Property Value (all these properties shall have propagate set to FALSE)*** ***URI syntax follows IETF RFC 3986.*** ***URI "data" schema follows IETF RFC 2397*** ***URI "pkcs11" schema follows IETF RFC 7512*** ***Vendors may support additional schemas***
identity_ca	URI to the X509 certificate [39] of the Identity CA. Supported URI schemes: file, data, pkcs11 The **file** and **data** schemas shall refer to a X.509 v3 certificate (see X.509 v3 ITU-T Recommendation X.509 (2005) [39]) in PEM format. Examples: file:identity_ca.pem file:/home/myuser/identity_ca.pem data:,-----BEGIN CERTIFICATE----- MIIC3DCCAcQCCQCWE5x+Z ... PhovK0mp2ohhRLYI0ZiyYQ== -----END CERTIFICATE----- pkcs11:object=MyIdentityCACert;type=cert
private_key	URI to access the private Private Key for the DomainParticipant Supported URI schemes: file, data, pkcs11 pkcs11 URI follows IETF RFC 7512 "The PKCS #11 URI Scheme" Examples: file:identity_ca_private_key.pem file:/home/myuser/identity_ca_private_key.pem file:identity_ca_private_key.pem?password=OpenSesame data:,-----BEGIN RSA PRIVATE KEY----- MIIEpAIBAAKCAQEA3HIh...AOBaaqSV37XBUJg== -----END RSA PRIVATE KEY----- pkcs11:object=MyParticipantPrivateKey;type=private?pin-value=OpenSesame
password	A password used to decrypt the private_key. The value of the password property shall be interpreted as the Base64 encoding of the AES-128 key that shall be used to decrypt the private_key using AES128-CBC. If the password property is not present, then the value supplied in the private_key property must contain the unencrypted private key.

	The password property is only used if the private_key is provided with a "file:" or a "data:" URI. It does not apply to private keys supplied with the "pkcs11:" URI.
identity_certificate	URI to a X509 certificate signed by the IdentityCA in PEM format containing the signed public key for the DomainParticipant Supported URI schemes: file, data, pkcs11 Examples: file:participant1_identity_cert.pem data:,-----BEGIN CERTIFICATE----- MIIDjjCCAnYCCQDCEu9...6rmT87dhTo= -----END CERTIFICATE----- pkcs11:object=MyParticipantIdentityCert;type=cert
key_establishment_algorithm (The presence of this property is optional)	The string "AUTO" or one of the `CryptoAlgorithmName` strings shown in Table 26 that identifies a Key Establishment Algorithm.

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10.3.1.1 Identity CA Certificate

The certificate used to configure the public key of the Identity CA.
The certificate shall be the X.509 v3 Certificate [39] of the issuer of the Identity Certificates in section 10.3.1.3. The certificate can be self-signed if it is a root CA or signed by some other CA public key if it is a subordinate CA. Regardless of this the Public Key in the Certificate shall be accepted as the one for the Identity CA trusted to sign `DomainParticipant` Identity Certificates, see 10.3.1.3.

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The algorithm of the public key of the CA shall be one of the algorithms defined in 8.2.

Deleted: 8.28.28.1.2

Deleted: The public key of the CA shall be either a 2048-bit RSA key [44] or else a 256-bit Elliptic Curve Key for the prime256v1 curve [41], also known as the NIST P-256 curve [42].…

The Identity CA Certificate shall be provided to the plugins using the `PropertyQosPolicy` on the `DomainParticipantQos` as specified in Table 50.

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10.3.1.2 Private Key

DDSSEC12-90 - Meeting CNSSP-15 security requirements

The Private Key associated with the `DomainParticipant`. The algorithm of the private key of the CA shall be one of the algorithms defined in 8.2.

Deleted: 8.28.28.1.2

Deleted: It may be either a 2048-bit RSA private key or a 256-bit Elliptic Curve Key for use with the prime256v1 curve [41]…

The Private Key shall be provided to the plugins using the `PropertyQosPolicy` on the `DomainParticipantQos` as specified in Table 50.

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10.3.1.3 Identity Certificate

An X.509 v3 Certificate [39] that chains up to the Identity CA (see 10.3.1.1). The Identity Certificate binds the Public Key of the `DomainParticipant` to the Distinguished Name (subject name) for the `DomainParticipant`.

10.3.1.4 Key Establishment Algorithm

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The Key Establishment Algorithm that the `DomainParticipant` will use in the situations when the `DomainParticipant` initiates the Authentication handshake. The algorithm shall be one of the algorithms defined in 8.2.

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The Key Establishment Algorithm should be provided to the plugins using the `PropertyQosPolicy`, property ***key_establishment_algorithm*** on the `DomainParticipantQos` as specified in Table 50.

The ***key_establishment_algorithm*** property may be omitted or may have the value set to "AUTO". In both these cases, the selection of the algorithm will be left to the `Authentication` plugin.

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10.3.2 DDS:Auth:PKI-DH Types

This sub clause specifies the content and format of the `Credential` and `Token` objects used by the DDS:Auth:PKI-DH plugin.

`Credential` and `Token` attributes left unspecified in this specification shall be understood to not have any required values in this specification. These attributes shall be handled according to the following rules:

- Plugin implementations may place data in these attributes as long as they also include a property attribute that allows the implementation to unambiguously detect the presence and interpret these attributes.
- Attributes that are not understood shall be ignored.
- `Property_t` and `BinaryProperty_t` names shall comply with the rules defined in 7.3.1 and 7.3.3, respectively.

The content of the `Handle` objects is not specified as it represents references to internal state that is only understood by the plugin itself. The DDS Implementation only needs to hold a reference to the returned `Handle` objects returned by the plugin operations and pass these `Handle` references to other operations.

10.3.2.1 DDS:Auth:PKI-DH IdentityToken

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

The DDS:Auth:PKI-DH plugin shall set the attributes of the `IdentityToken` object as specified in the tables below:

- The settings in Table 51 shall be used in the general situation where a DomainParticipant needs authenticate and be authenticated by other DomainParticipants. This is the only setting that allows a Participant to have an Identity and associated Permissions file.
- The settings in Table 52 shall only be used in situations where a DomainParticipant does not intent to Authenticate and will therefore be treated as an "Unauthenticated Participant" by the other DomainParticipants.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

Table 51 – IdentityToken class for the builtin Authentication plugin – general case

Attribute name	*Attribute value*	
class_id	"DDS:Auth:PKI-DH:1.2"	
properties (The presence of each of properties is optional)	*name*	*value*
	dds.cert.sn	The subject name of the Identity Certificate.
	dds.cert.algo	One of the CryptoAlgorithmName string identifiers for digital signature algorithms defined in Table 25.
	dds.ca.sn	The subject name of the Identity CA Certificate.

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	dds.ca.algo	One of the CryptoAlgorithmName string identifiers for digital signature algorithms defined in Table 25

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DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

Table 52 – IdentityToken class for the builtin Authentication plugin – when only using pre-shared key

Attribute name	*Attribute value*	
class_id	"DDS:Auth:PSK:1.2"	
properties	*name*	*value*
(The presence of this of properties is optional)	dds.psk.algo	One of the CryptoAlgorithmName string identifiers for Symmetric Cipher AEAD and MAC Algorithms cypher algorithms defined in Table 22

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The value of the ***class_id*** shall be interpreted as composed of three parts: a ***PluginClassName***, a ***MajorVersion*** and a ***MinorVersion*** according to the following format: `<PluginClassName>:<MajorVersion>.<MinorVersion>`. The ***PluginClassName*** is separated from the ***MajorVersion*** by the last ':' character in the class_id. The ***MajorVersion*** and ***MinorVersion*** are separated by a '.' character. Accordingly this version of the specification has ***PluginClassName*** equal to "DDS:Auth:PKI-DH", ***MajorVersion*** set to 1, and ***MinorVersion*** set to 0.

10.3.2.2 DDS:Auth:PKI-DH IdentityStatusToken

The DDS:Auth:PKI-DH plugin shall set the attributes of the `IdentityStatusToken` object as specified in the table below:
DDSSEC12-110 – Corrections to tables describing IdentityStatusToken …

Table 53 – IdentityStatusToken class for the builtin Authentication plugin

Attribute name	*Attribute value*	
class_id	"DDS:Auth:PKI-DH:1.0"	
binary_properties	*name*	*value*
(The presence of each of properties is optional)	ocsp_status	A DER-encoded OCSP response (using the ASN.1 type OCSPResponse defined in clause 4.2.1 of RFC 2560 [54]) that provides the status of the identity certificate of the DomainParticipant.

10.3.2.3 DDS:Auth:PKI-DH AuthenticatedPeerCredentialToken

The DDS:Auth:PKI-DH plugin shall set the attributes of the `AuthenticatedPeerCredentialToken` object as specified in the table below:
DDSSEC12-110 – Corrections to tables describing IdentityStatusToken …

Table 54 – AuthenticatedPeerCredentialToken class for the builtin Authentication plugin

Attribute name	*Attribute value*	
class_id	"DDS:Auth:PKI-DH:1.0"	
binary_properties	*name*	*value*
	c.id	Contents of the certificate signed by IdentityCA that was received from the peer DomainParticipant as part of the authentication process. Corresponds to the property with the same name received in the HandskaheRequestMessageToken or HandskaheReplyMessageToken.
	c.perm	Contents of the permissions document signed by the PermissionCA that that was received from the peer DomainParticipant as part of the authentication process. Corresponds to the property with the same name received in the HandskaheRequestMessageToken or HandskaheReplyMessageToken.

10.3.2.4 DDS:Auth:PKI-DH AuthRequestMessageToken

The DDS:Auth:PKI-DH plugin shall set the attributes of the `AuthRequestMessageToken` object as specified in the table below:
DDSSEC12-110 – Corrections to tables describing IdentityStatusToken …

Table 55 – AuthRequestMessageToken class for the builtin Authentication plugin

Attribute name	*Attribute value*	
class_id	"DDS:Auth:PKI-DH:1.0+AuthReq"	
binary_properties	*name*	*value*
	future_challenge	A 256-bit NONCE generated by the Participant, compliant with Section 8.6.7 of NIST Recommendation for Random Number Generation Using Deterministic Random Bit Generators [46]. The value shall match what will be sent on the ***challenge1*** property of the `HandshakeRequestMessageToken` or the ***challenge2*** property of the `HandshakeReplyMessageToken`.

10.3.2.5 DDS:Auth:PKI-DH HandshakeMessageToken

The DDS:Auth:PKI-DH plugin uses several `HandshakeMessageToken` object formats:

- `HandshakeRequestMessageToken` objects
- `HandshakeReplyMessageToken` objects
- `HandshakeFinalMessageToken` objects

10.3.2.5.1 HandshakeRequestMessageToken objects

The attributes in `HandshakeRequestMessageToken` objects shall be set as specified in the table below. References to the `DomainParticipant` within the table refer to the `DomainParticipant` that is creating the `HandshakeRequestMessageToken`.
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Table 56 – HandshakeRequestMessageToken for the builtin Authentication plugin

Attribute name	*Attribute value*	
class_id	"DDS:Auth:PKI-DH:1.0+Req"	
binary_properties	***name***	***value***
	c.id	Contents of the certificate signed by IdentityCA that was configured using the Participant PropertyQosPolicy with name "dds.sec.auth.identity_certificate"
	c.perm	Contents of the permissions document signed by the PermissionCA that was configured using the Participant PropertyQosPolicy with name "dds.sec.access.permissions"
	c.pdata	The CDR Big Endian Serialization of the ParticipantBuiltinTopicData
	c.dsign_algo	Digital signature algorithm identifier. One of the CryptoAlgorithmName unique string identifiers defined in Table 25.
	c.kagree_algo	Key agreement algorithm identifier. One of the CryptoAlgorithmName string identifiers defined in Table 26. The string identifier shall correspond to the Key Establishment algorithm chosen by the initiator Participant.
	hash_c1	SHA-256 hash of the CDR Big Endian serialization of a BinaryPropertySeq object containing all the properties above that start with "c." placed in the same order as they appear above. Inclusion of the ***hash_c1*** property is optional. Its only purpose is to facilitate troubleshoot interoperability problems.
	dh1	The Key Agreement Public Key chosen by the Participant. This will be used for key establishment between the two involved Participants. The algorithm of this Public Key shall be one of the algorithms defined in Table 26.
	challenge1	A 256-bit NONCE generated by the Participant, compliant with Section 8.6.7 of NIST Recommendation for Random Number Generation Using Deterministic Random Bit Generators [46]. If the `validate_remote_identity` returned a non-NIL `AuthRequestMessageToken`, then the value shall match what was sent on the `AuthRequestMessageToken` ***future_challenge*** property.
	ocsp_status	Inclusion of this property is optional. A DER-encoded OCSP response (using the ASN.1 type OCSPResponse defined in clause 4.2.1 of RFC 2560 [54]) that provides the status of the identity certificate in the **c.id** property.

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The encoding of the Key Agreement Public Key into the octet sequence that holds the value of a binary property depends on the type of Key Agreement key and is described in clause 8.3. This convention applies to the setting of the binary property value for the property "dh1".

Plugin implementations may add extra properties as long as the names comply with the rules defined in in 7.3.1. Plugin implementations shall ignore any properties they do not understand.

10.3.2.5.2 HandshakeReplyMessageToken

The attributes in the `HandshakeReplyMessageToken` objects are set as specified in the table below. References to the `DomainParticipant` within the table refer to the `DomainParticipant` that is creating the `HandshakeReplyMessageToken`.

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Table 57 – HandshakeReplyMessageToken for the builtin Authentication plugin

Attribute name	*Attribute value*	
class_id	"DDS:Auth:PKI-DH:1.0+Reply"	
binary_properties	***name***	***value***

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Either "DH+MODP-2048-256" or "ECDH+prime256v1-CEUM"

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If the Participant Identity uses a RSA Public Key, then the ***c.dsign_algo*** shall be "RSASSA-PSS-SHA256".¶
If the Participant Identity uses a EC Public Key, then the ***c.dsign_algo*** shall be "ECDSA-SHA256".

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	c.id	Contents of the certificate signed by IdentityCA that was configured using the Participant PropertyQosPolicy with name “dds.sec.auth.identity_certificate”
	c.perm	Contents of the permissions document signed by the PermissionCA that was configured using the Participant PropertyQosPolicy with name “dds.sec.access.permissions”
	c.pdata	The CDR Big Endian Serialization of the ParticipantBuiltinTopicData
	c.dsign_algo	Digital signature algorithm identifier. One of the CryptoAlgorithmName string identifiers defined in Table 25
	c.kagree_algo	Key agreement algorithm identifier. One of the CryptoAlgorithmName string identifiers defined in Table 26. The string identifier shall correspond to the Key Establishment algorithm chosen by the initiator Participant.
	hash_c2	SHA-256 hash of the CDR Big Endian serialization of a BinaryPropertySeq object containing all the properties above that start with “c.” placed in the same order as they appear above. Inclusion of the ***hash_c2*** property is optional. Its only purpose is to facilitate troubleshoot interoperability problems.
	dh2	The Key Agreement Public Key chosen by the Participant. This will be used for key establishment between the two involved Participants. The algorithm of this Public Key shall be one of the algorithms defined in Table 26.
	hash_c1	The value of the related HandshakeRequestMessageToken property hash_c1. Inclusion of the hash_c1 property is optional. Its only purpose is to facilitate troubleshoot interoperability problems.
	dh1	The value of the related HandshakeRequestMessageToken property dh1. Inclusion of the dh1 property is optional. Its only purpose is to facilitate troubleshoot interoperability problems.
	challenge1	Value of the related HandshakeRequestMessageToken property challenge1.
	challenge2	A 256-bit NONCE generated by the Participant, compliant with Section 8.6.7 of NIST Recommendation for Random Number Generation Using Deterministic Random Bit Generators [46]. If the `validate_remote_identity` returned a non-NIL `AuthRequestMessageToken`, then the value shall match what was sent on the `AuthRequestMessageToken` ***future_challenge*** property.
	ocsp_status	Inclusion of this property is optional. A DER-encoded OCSP response (using the ASN.1 type OCSPResponse defined in clause 4.2.1 of RFC 2560 [54]) that provides the status of the identity certificate in the **c.id** property.
	signature	The Digital Signature of the CDR Big Endian serialization of a BinaryPropertySeq object containing the properties: hash_c2, challenge2, dh2, challenge1, dh1, and hash_c1, placed in that order. All the aforementioned properties shall appear within the signature even if some of the optional properties do not appear separately as properties in the HandshakeReplyMessageToken.

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The encoding of the Key Agreement Public Key into the octet sequence that holds the value of a binary property depends on the type of Key Agreement key and is described in clause 8.3. This convention applies to the setting of the binary property value for the properties “dh1” and “dh2”.

Plugin implementations may add extra properties as long as the names comply with the rules defined in 7.5.3.5. Plugin implementations shall ignore any properties they do not understand.

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Regardless of the key agreement algorithm, the `SharedSecret` (see REF _Ref357403335 \h DDSSEC12-90 - Meeting CNSSP-15 security requirements
Table 60) shall be computed as the SHA256 hash of the derived shared secret computed by the key agreement algorithm. [Non-normative: This is done to accommodate the use of cryptographic libraries that do not provide direct access to the derived shared secret and only allow retrieval of the SHA256 of the shared secret.]

The digital signature shall be computed using the Private Key associated with the DomainParticipant, which corresponds to the Public Key that appears in the Identity Certificate.

10.3.2.5.3 HandshakeFinalMessageToken

`HandshakeFinalMessageToken` objects are used to finish an authentication handshake.

The attributes in the `HandshakeFinalMessageToken` objects shall be set as specified in the table below.

References to the `DomainParticipant` within the table refer to the `DomainParticipant` that is creating the `HandshakeFinalMessageToken`.

Table 58 – HandshakeFinalMessageToken for the builtin Authentication plugin

Attribute name	*Attribute value*	
class_id	"DDS:Auth:PKI-DH:1.0+Final".	
binary_properties	***name***	***value***
	hash_c1	The value of the related HandshakeRequestMessageToken property hash_c1. Inclusion of the hash_c1 property is optional. Its only purpose is to facilitate troubleshoot interoperability problems.
	hash_c2	The value of the related HandshakeReplyMessageToken property hash_c2. Inclusion of the hash_c2 property is optional. Its only purpose is to facilitate troubleshoot interoperability problems.
	dh1	The value of the related HandshakeRequestMessageToken property dh1. Inclusion of the dh1 property is optional. Its only purpose is to facilitate troubleshoot interoperability problems.
	dh2	The value of the related HandshakeReplyMessageToken property dh2. Inclusion of the dh2 property is optional. Its only purpose is to facilitate troubleshoot interoperability problems.
	challenge1	Value of HandshakeRequestMessageToken property challenge1
	challenge2	Value of HandshakeReplyMessageToken property challenge2
	signature	The Digital Signature of the CDR Big Endian serialization of a BinaryPropertySeq object containing the properties: hash_c1, challenge1, dh1, challenge2, dh2, and hash_c2, placed in that order. All the aforementioned properties shall appear within the signature even if some of the optional properties do not appear separately as properties in the HandshakeFinalMessageToken.

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The Key Agreement public key shall be for the same algorithm and Domain Parameters that were used for the `HandshakeRequestMessageToken` key received as value of the ***dh2*** property. The parameters and algorithm shall be determined based on the value of the `HandshakeRequestMessageToken` parameter with key ***c.kagree_algo***. In other words, it is the Participant that creates the `HandshakeRequestMessageToken` the one that controls the key agreement algorithm used.

The digital signature shall be computed using the Private Key associated with the DomainParticipant, which corresponds to the Public Key that appears in the Identity Certificate.

Deleted: If the value of the *c. kagree_algo* property is "DH+MODP-2048-256", then:¶
The Diffie-Hellman Public Key shall be for the 2048-bit MODP Group with 256-bit Prime Order Subgroup, see IETF RFC 5114 REF _Ref316671709 \r \h [47], section 2.3.¶
The Key Agreement Algorithm shall be the "dhEphem, C(2e, 0s, FFC DH) Scheme" defined in section 6.1.2.1 of NIST Special Publication 800-56A Revision 2 REF _Ref316672077 \r \h [48].¶
Non-normative note: The OpenSSL 1.0.2 operation DH_get_2048_256() retrieves the parameters for the 2048-bit MODP Group with 256-bit Prime Order Subgroup.¶
If the value of the *c.kagree_algo* property is "ECDH+prime256v1-CEUM", then:¶
The Diffie-Hellman Public Key shall be for the NIST's EC Curve P-256 as defined in appendix D of FIPS 186-4 REF _Ref315698447 \r \h [42] also known as prime256v1 in ANSI X9.62-2005 REF _Ref315698414 \r \h [41].¶
The Key Agreement Algorithm shall be the "(Cofactor) Ephemeral Unified Model, C(2e, 0s, ECC CDH)" defined in section 6.1.2.2 of NIST Special Publication 800-56A Revision 2 REF _Ref316672077 \r \h [48]. See also section 3.1 "Ephemeral Unified Model" of NIST Suite B Implementer's Guide to NIST SP 800-56A REF _Ref316672299 \r \h [49].¶

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Table 60DDSSEC12-90 - Meeting CNSSP-15 security requirements¶
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If the Participant Private Key is a RSA key, then:¶
The value of the *c.dsign_algo* property shall be "RSASSA-PSS-SHA256". ¶
The digital signature shall be computed using the RSASSA-PSS algorithm specified in PKCS #1 (IETF 3447) RSA Cryptography Specifications Version 2.1 [44], using SHA256 as hash function, and MGF1 with SHA256 (mgf1sha256) as mask generation function.¶
If the Participant Private Key is an EC key, then:¶
The value of the *c.dsign_algo* shall be "ECDSA-SHA256".¶
The digital signature shall be computed using the ECDSA-SHA256 algorithm specified in ANSI X9.62-2005 [41].

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If the Participant Participant Private Key is an EC key, then the digital signature shall be computed using the ECDSA-SHA256 algorithm specified in ANSI X9.62-2005 [41].

10.3.3 DDS:Auth:PKI-DH plugin behavior

The table below describes the actions that the DDS:Auth:PKI-DH plugin performs when each of the plugin operations is invoked.

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Table 59 – Actions undertaken by the operations of the builtin Authentication plugin

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`validate_local_identity`	This operation shall receive the ***participant_guid*** associated with the local `DomainParticipant` whose identity is being validated. The operation shall receive the `DomainParticipantQos` with a `PropertyQosPolicy` containing the properties defined in 10.3.1. The operation shall verify the validity of the X509 certificate associated with the property named ***dds.sec.auth.identity_certificate*** using the CA configured by the ***dds.sec.auth.identity_ca*** property. The operation shall check a CRL and/or an OCSP (RFC 2560 [54]) responder. This includes checking the expiration date of the certificate. If the above check fails, the operation shall return VALIDATION_FAILED. The operation shall fill the ***handle*** with an implementation-dependent reference that allows the implementation to retrieve at least the following information: 1. The private key associated with the ***identity_credential*** 2. The public key associated with the ***identity_credential*** 3. The ***participant_guid*** The operation shall return the 16-byte ***adjusted_participant_guid*** GUID consisting of the same EntityId_t and a GuidPrefix_t computed as follows: • The first bit (bit 0) shall be set to 1. • The 47 bits following the first bit (bits 1 to 47) shall be set to the 47 first bits of the SHA-256 hash of the ASN.1 DER encoding of the SubjectName [40] appearing on the ***identity_credential***. • The following 48 bits (bits 48 to 95) shall be set to the first 48 bits of the SHA-256 hash of the ***candidate_participant_guid***. If successful, the operation shall return VALIDATION_OK.
`get_identity_token`	The operation shall receive the ***handle*** corresponding to the one returned by a successful previous call to ***validate_local_identity***. If the above condition is not met, the operation shall return the exception DDS_SecurityException_PreconditionError. This operation shall return an `IdentityToken` object with the content specified in 10.3.2.1.
`get_identity_status_token`	This operation shall receive the ***handle*** corresponding to the one returned by a successful previous call to ***validate_local_identity***. If the above condition is not met, the operation shall return the exception DDS_SecurityException_PreconditionError. This operation shall return an `IdentityToken` object with the content specified in 10.3.2.2.
`set_participant_security_config`	This operation shall perform the following checks based on the value of the members of the ***participant_security_config*** (in) parameter Check that the ***digital_signature.trust_chain.supported_mask*** includes at least one algorithm that is supported by the AUTH plugin. Fail otherwise. Check that the ***digital_signature.message_auth.supported_mask*** includes at least one algorithm that is supported by the AUTH plugin. Fail otherwise. Check that the ***key_establisment.shared_secret.supported_mask*** includes at least one algorithm that is supported by the AUTH plugin. Fail otherwise. The operation shall set the ***adjusted_algorithm_info*** (out) parameter according to the following steps: Initialize ***adjusted_algorithm_info*** as a copy of ***participant_security_config.algorithm_info***

	Remove any unsupported algorithms from the ***digital_signature.trust_chain.supported_mask***, the ***digital_signature.message_auth.supported_mask*** , and the ***key_establisment.shared_secret.supported_mask*** Add the algorithms that appear in the Identity Certificate to the ***digital_signature.trust_chain.required_mask***. Add the algorithm that corresponds to the public key in the Identity Certificate to the ***digital_signature.message_auth.required_mask***. Check that this algorithm is present in thee ***digital_signature.trust_chain.supported_mask***, fail otherwise. Add the algorithm that will be used for the Key Agreement protocol if the Participant initiates authentication to the the ***key_establisment.shared_secret.required_mask***. Check that this algorithm is present in the the ***key_establisment.shared_secret.supported_mask***, fail otherwise. The operation shall configure the AUTH plugin to only accept the resulting set of supported algorithms in the ***adjusted_algorithm_info***.
`set_permissions_credential_and_token`	This operation shall store the `PermissionsCredentialToken` and the `PermissionsToken` internally to the plugin and associate them with the `DomainParticipant` represented by the IdentityHandle.
`validate_remote_identity`	The operation shall receive the `IdentityToken` of the remote participant in the argument ***remote_identity_token***. The contents of the `IdentityToken` shall be identical to what would be returned by a call to `get_identity_token` on the `Authentication` plugin of the remote `DomainParticipant` associated with the ***remote_participant_guid***. The operation shall compare the ***class_id*** of the ***local identity_token*** with that of the ***remote_identity_token***. If the P***luginClassName*** or the ***MajorVersion*** are different, it shall return VALIDATION_FAILED. If the ***remote_auth_request_token*** is `NIL`, the operation shall generate a ***local_auth_request_token*** `AuthRequestMessageToken` (see 10.3.2.4), otherwise the ***local_auth_request_token*** shall be set to `TokenNIL`. Note that a ***local_auth_request_token*** is returned as an out parameter. The operation shall compare lexicographically the ***remote_participant_guid*** with the participant key obtained from the ***local_identity_handle***. If the ***remote_participant_guid*** > ***local_participant_guid***, the operation shall return VALIDATION_PENDING_HANDSHAKE_REQUEST. If the ***remote_participant_guid*** < ***local_participant_guid***, the operation shall return VALIDATION_PENDING_HANDSHAKE_MESSAGE. In both scenarios the ***remote_identity_handle*** shall be filled with a reference to internal plugin information that identifies the remote participant and associates it to the contents of the ***remote_identity_token,*** the ***local_auth_request_token***, the ***remote_auth_request_token*** and any additional information required for the challenge protocol.
`begin_handshake_request`	The operation shall receive the ***initiator_identity_handle*** corresponding to the ***local_identity_handle*** of a previous invocation to the ***validate_remote_identity*** operation that returned VALIDATION_PENDING_HANDSHAKE_REQUEST. The operation shall also receive the ***replier_identity_handle*** corresponding to the ***remote_identity_handle*** returned by that same invocation to the ***validate_remote_identity*** operation. The operation shall also receive the ***serialized_local_participant_data*** associated with the local `DomainParticipant`. This will be used to set the value of the property named "c.pdata". The operation shall return the ***handshake_message*** containing a `HandshakeRequestMessageToken` object with contents as defined in 10.3.2.5.1 The operation shall check the content of the ***local_auth_request_token*** associated with the ***remote_identity_handle***. If the token was different from `TokenNIL`, the operation shall use the value of property named "`future_challenge`" found in

	the ***local_auth_request_token*** to fill the property named "`challenge1`" of the ***handshake_message*** returned. The operation shall fill the ***handshake_handle*** with an implementation-dependent reference that allows the implementation to retrieve at least the following information: 1. The ***local_identity_handle*** 2. The ***remote_identity_handle*** 3. The value attribute of the ***handshake_message*** returned The operation shall return VALIDATION_PENDING_HANDSHAKE_MESSAGE.
`begin_handshake_reply`	The operation shall receive the ***replier_identity_handle*** corresponding to ***local_identity_handle*** of a previous invocation to the ***validate_remote_identity*** operation that returned VALIDATION_PENDING_HANDSHAKE_MESSAGE. The operation shall also receive the ***initiator_identity_handle*** corresponding to the ***remote_identity_handle*** returned by that same invocation to the `validate_remote_identity` operation. The operation shall also receive the ***serialized_local_participant_data*** associated with the local `DomainParticipant`. This will be used to set the value of the property named "c.pdata". If any of the above conditions is not met, the operation shall return the exception DDS_SecurityException_PreconditionError. The operation shall check the content of the ***remote_auth_request_token*** associated with the ***remote_identity_handle***. If the token was different from `TokenNIL`, the operation shall verify that the property named "`future_challenge`" found in that token is the same value as the property named "`challenge1`" found in the ***handshake_message_in*** `HandshakeRequestMessageToken`. If the condition is not met, the operation shall return VALIDATION_FAILED. The operation shall check the content of the ***local_auth_request_token*** associated with the ***remote_identity_handle***. If the token was different from `TokenNIL`, the operation shall use the value of property named "`future_challenge`" found in the ***local_auth_request_token*** to fill the property named "`challenge2`" of the ***handshake_message*** returned. The operation shall verify the validity of the `IdentityCredential` contained in the property named "`c.id`" found in the ***handshake_message_in*** `HandshakeRequestMessageToken`. This verification shall be done using the locally configured CA in the same manner as the `validate_local_identity` operation. If the ***handshake_message_in*** does not contain the aforementioned property or the verification fails, then the operation shall fail and return ValidationResult_Fail. If the property **ocsp_status** is present, the operation shall verify that the OCSP response included in the property corresponds to the identity in the **c.id** property. The operation shall use the OCSP response to verify the status of the `IdentityCredential`. If that status is good and the validity interval has not been exceeded it shall accept that as proof that the IdentityCredential is still valid. If the status is revoked, the operation shall fail and return ValidationResult_Fail. If the status is different from the aforementioned ones it shall behave as if the **ocsp_status** property was not present. If the property **ocsp_status** is not present, the operation shall use its own means to determine the status of the `IdentityCredential`. This may performing an OCSP query or consulting a CRL list. The specific behavior is implementation specific. The operation shall verify that the first bit of the ***participant_guid*** of the ParticipantBuiltinTopic data inside the "`c.pdata`" is set to 1 and that the following 47 bits match the first 47 bits of the SHA-256 hash of the SubjectName appearing in the `IdentityCredential`. If this verification fails, the operation shall fail and return ValidationResult_Fail.

	The operation shall fill the ***handshake_message_out*** with a `HandshakeReplyMessageToken` object with the content specified in 10.3.2.5.2. The operation shall fill the ***handshake_handle*** with an implementation-dependent reference that allows the implementation to retrieve at least the following information: 1. The ***replier_identity_handle*** 2. The ***initiator_identity_handle*** 3. The value attribute of the ***challenge_message*** returned 4. The property with name "dds.sec.permissions" found within the ***handshake_message_in*** if present The operation shall return VALIDATION_PENDING_HANDSHAKE_MESSAGE.
`process_handshake` on a ***handshake_handle*** created by `begin_handshake_request`	The operation shall be called with the ***handshake_handle*** returned by a previous call to ***begin_handshake_request*** that returned VALIDATION_PENDING_HANDSHAKE_MESSAGE. The ***handshake_message_in*** shall correspond to a `HandshakeReplyMessageToken` object received as a reply to the ***handshake_message*** `HandshakeRequestMessageToken` object associated with the ***handshake_handle***. If any of the above conditons are not met, the operation shall return the exception DDS_SecurityException_PreconditionError. The operation shall verify that the contents of the ***handshake_message_in*** correspond to a `HandshakeReplyMessageToken` as described in 10.3.2.5.2. The operation shall check the content of the ***remote_auth_request_token*** associated with the ***remote_identity_handle***. If the token was different from `TokenNIL`, the operation shall verify that the property named "`future_challenge`" found in that token is the same value as the property named "`challenge2`" found in the ***handshake_message_in*** `HandshakeReplyMessageToken`. If the condition is not met, the operation shall return VALIDATION_FAILED. The operation shall verify the validity of the `IdentityCredential` contained in the property named "`c.id`" found in the ***handshake_message_in*** `HandshakeReplyMessageToken`. This verification shall be done using the locally configured CA in the same manner as the ***validate_local_identity*** operation. If the ***handshake_message_in*** does not contain the aforementioned property or the verification fails, then the operation shall fail and return ValidationResult_Fail. If the property **ocsp_status** is present, the operation shall verify that the OCSP response included in the property corresponds to the identity in the **c.id** property. The operation shall use the OCSP response to verify the status of the `IdentityCredential`. If that status is good and the validity interval has not been exceeded, it shall accept that as proof that the IdentityCredential is still valid. If the status is revoked, the operation shall fail and return ValidationResult_Fail. If the status is different from the aforementioned ones, it shall behave as if the **ocsp_status** property was not present. If the property **ocsp_status** is not present, the operation shall use its own means to determine the status of the `IdentityCredential`. This may performing an OCSP query or consulting a CRL list. The specific behavior is implementation specific. The operation shall check that the challenge1 matches the one that was sent on the `HandshakeRequestMessageToken.` The operation shall validate the digital signature in the "`signature`" property, according to the algorithm described in 8.2. If the specified checks do not succeed, the operation shall return VALIDATION_FAILED. The operation shall create a `HandshakeFinalMessageToken` object as described in 10.3.2.5.3. The operation shall fill the ***handshake_message_out*** with the created `HandshakeFinalMessageToken` object.

	The operation shall store the ***value*** of property with ***name*** "`dds.sec.`" found within the ***handshake_message_in***, if present and associate it with the ***handshake_handle*** as the `PermissionsCertificate` of remote `DomainParticipant`. The operation shall use the Key Agreement Public Key in the "`dh2`" property in combination with the Key Agreement Private Key it used to compute the `HandshakeFinalMessageToken` "`dh1`" property to compute the shared secret. The algorithm shall be as described in 8.3. On success the operation shall return VALIDATION_OK_FINAL_MESSAGE.
`process_handshake` on a ***handshake_handle*** created by `begin_handshake_reply`	The operation shall be called with the ***handshake_handle*** returned by a previous call to ***begin_handshake_reply*** that returned VALIDATION_PENDING_HANDSHAKE_MESSAGE. The ***handshake_message_in*** shall correspond to the one received as a reply to the ***handshake_message_out*** associated with the ***handshake_handle***. If any of the above conditions is not met, the operation shall return the exception DDS_SecurityException_PreconditionError. The operation shall verify that the contents of the ***handshake_message_in*** correspond to a `HandshakeFinalMessageToken` object as described in 10.3.2.5.3. The operation shall check that the challenge1 and challenge2 match the ones that were sent on the `HandshakeReplyMessageToken.` The operation shall validate the digital signature in the "`signature`" property, according to the expected contents and algorithm described in 8.2. The operation shall use the Key Agreement Public Key in the "`dh1`" property in combination with the Key Agreement Private Key it used to compute the `HandshakeReplyMessageToken` "`dh2`" property to compute the shared secret. The algorithm shall be as described in 8.3. On success the operation shall return VALIDATION_OK.
`get_shared_secret`	This operation shall be called with the ***handshake_handle*** that was previously used to call either ***process_handshake*** and for which the aforementioned operation returned VALIDATION_OK_FINAL_MESSAGE or VALIDATION_OK. If the above conditon is not met, the operation shall return the exception DDS_SecurityException_PreconditionError. The operation shall return a `SharedSecretHandle` that is internally associated with the SharedSecret established as part of the handshake. On failure the operation shall return nil.
`get_authenticated_peer_credential_token`	This operation shall be called with the ***handshake_handle*** that was previously used to call either ***process_handshake*** and for which the aforementioned operation returned VALIDATION_OK_FINAL_MESSAGE or VALIDATION_OK. If the above conditon is not met, the operation shall return the exception DDS_SecurityException_PreconditionError. The operation shall return the `AuthenticatedPeerCredentialToken` of the peer `DomainParticipant` associated with the ***handshake_handle***. If the `DomainParticipant` initiated the handshake, then the peer `AuthenticatedPeerCredentialToken` is constructed from the `HandshakeReplyMessageToken`, otherwise it is constructed from the `HandshakeRequestMessageToken`. See 10.3.2.3. On failure the operation shall return nil.
`set_listener`	This operation shall save a reference to the listener object and associate it with the specified `IdentityHandle`.
`return_identity_token`	This operation shall behave as specified in 9.3.2.11.14.
`return_identity_status_token`	This operation shall behave as specified in 9.3.2.11.15.

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return_authenticated_peer_credential_token	This operation shall behave as specified in 9.3.2.11.16.
return_handshake_handle	This operation shall behave as specified in 9.3.2.11.17.
return_identity_handle	This operation shall behave as specified in 9.3.2.11.18.
return_sharedsecret_handle	This operation shall behave as specified in 9.3.2.11.19.

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10.3.4 DDS:Auth:PKI-DH plugin authentication protocol

The operations the Secure DDS implementation executes on the Authentication plugin combined with the behavior of the DDS:Auth:PKI-DH result in an efficient 3-message protocol that performs mutual authentication and establishes a shared secret.
The rest of this sub clause describes the resulting protocol.
The authentication protocol is symmetric, that is there are no client and server roles. But only one DomainParticipant should initiate the protocol. To determine which of the two DomainParticipant entities shall initiate the protocol, each DomainParticipant compares its own GUID with that of the other DomainParticipant. The DomainParticipant with the lower GUID (using lexicographical order) initiates the protocol.

10.3.4.1 Terms and notation

The table below summarizes the terms used in the description of the protocol.
DDSSEC12-90 - Meeting CNSSP-15 security requirements

Table 60 – Terms used in the description of the builtin authentication protocol

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Term	*Meaning*
Participant1	The DomainParticipant that initiates the handshake protocol. It calls begin_handshake_request, sends the HandshakeRequestMessageToken, receives the HandshakeReplyMessageToken, and sends the HandshakeFinalMessageToken).
Participant2	The DomainParticipant that does not initiate the handshake protocol. It calls begin_handshake_reply, receives the HandshakeRequestMessageToken, sends the HandshakeReplyMessageToken, and receives the HandshakeFinalMessageToken).
PubK_1	The Public Key of Participant1.
PubK_2	The Public Key of Participant2.
PrivK_1	The Private Key of Participant1.
PrivK_2	The Private Key of Participant2.
Cert1	The IdentityCertificate (signed by the shared CA) of Participant A. It contains PubK_1.
Cert2	The IdentityCertificate (signed by the shared CA) of Participant 2. It contains PubK_2.
Perm1	Permissions document of Participant1 (signed by Permissions CA).
Perm2	Permissions document of Participant2 (signed by Permissions CA).
Pdata1	ParticipantBuiltinTopicData of Participant1.
Pdata2	ParticipantBuiltinTopicData of Participant2.
Dsign_algo1	Token identifying the Digital Signature Algorithm for Participant1.
Dsign_algo2	Token identifying the Digital Signature Algorithm for Participant2.
Kagree_algo1	Token identifying the Key Agreement Algorithm selected by Participant1 that shall be used to establish the shared secret.
Kagree_algo2	Token identifying the Key Agreement Algorithm used by Participant2. It shall be set to match the one received from Participant1 in Kagree_algo1and used to establish the shared secret.
Challenge1	The challenge created by Participant1.

Challenge2	The challenge created by Participant2.
DH1	Key Agreement Public Key generated by Participant1.
DH2	Key Agreement Public Key generated by Participant2.
DHSharedSecret	The shared secret computed combining DH1 and DH2 with the DH secret key each participant has.
SharedSecret	The SHA256 Hash of the DHSharedSecret.
C1	A shortcut for the list: Cert1, Perm1, Pdata1, Dsign_algo1, Kagree_algo1.
C2	A shortcut for the list: Cert2, Perm2, Pdata2, Dsign_algo2, Kagree_algo2.

The table below summarizes the notation and transformation functions used in the description of the protocol:

Table 61 – Notation of the operations/transformations used in the description of the builtin authentication protocol

Function / notation	*meaning*
Sign(data)	Signs the 'data' argument using the Participant Private Key.
Hash(data)	Hashes the 'data' argument using SHA-256.
data1 | data2	The symbol '|' is used to indicate byte concatenation.

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10.3.4.2 Protocol description

The table below describes the resulting 3-way protocol that establishes authentication and a shared secret between Participant_A and Participant_B.

Table 62 – Description of built-in authentication protocol

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Participant A	Participant B
Is configured with PrivK_1 and C1 where C1 = Cert1, Perm1, Pdata1, Dsign_algo1, Kagree_algo1 Generates a random Challenge1. Generates DH1. Sends: `HandshakeRequestMessageToken: (C1, Hash(C1), Challenge1, DH1)` Note: In the above message Hash(C1) may be omitted.	Is configured with PrivK_2 and C2 where C2 = Cert2, Perm2, Pdata2, Dsign_algo2, Kagree_algo2

	Receives `HandshakeRequestMessageToken`
	
	Verifies Cert1 with the configured Identity CA
	Verifies Hash(C1)
	Generates a random Challenge2
	Generates DH2
	Sends:
	`HandshakeReplyMessageToken:`
	`(C2, Hash(C2),`
	`Challenge1, Challenge2,`
	`DH2, Hash(C1), DH1,`
	`Sign(Hash(C2) | Challenge2`
	`| DH2 | Challenge1 | DH1`
	`| Hash(C1)) )`
	Note: In the above message Hash(C2) , Hash(C1) and DH1 may be omitted outside the signature.

Receives `HandshakeReplyMessageToken`
Verifies Cert2 with the configured Identity CA
Verifies signature against PubK2
Computes shared secret from DH2 and the DH private key used for DH1
Sends:
`HandshakeFinalMessageToken:`
`( Hash(C1), Hash(C2), DH1, DH2,`
`  Challenge1, Challenge2,`
`  Sign( Hash(C1) | Challenge1 | DH1`
`        | Challenge2 | DH2`
`        | Hash(C2)) )`	

Note: In the above message Hash(C1) , Hash(C2), DH1, and DH2 may be omitted outside the signature.	Receives `HandshakeFinalMessageToken` Checks Hash(C1) matches the `HandshakeRequestMessageToken` Verifies the signature in `HandshakeFinalMessageToken` against PubK_1 Computes shared secret from DH1 and the DH private key used for DH2

10.4 Builtin Access Control: DDS:Access:Permissions

This builtin `AccessControl` plugin is referred to as the "DDS:Access:Permissions" plugin.
The DDS:Access:Permissions implements the `AccessControl` plugin API using a permissions document signed by a shared Certificate Authority (CA).
The shared CA could be an existing one (including the same CA used for the `Authentication` plugin), or a new one could be created for the purpose of assigning permissions to the applications on a DDS Domain. The nature or manner in which the CA is selected is not important because the way it is used enforces a shared recognition by all participating applications.
Each `DomainParticipant` has an associated instance of the DDS:Access:Permissions plugin.

10.4.1 Configuration

The DDS:Access:Permissions plugin is configured with three documents:

1. The Permissions CA certificate
2. The Domain governance signed by the Permissions CA
3. The DomainParticipant permissions signed by the Permissions CA

The configuration of the builtin access control plugin shall be done using the `PropertyQosPolicy` of the `DomainParticipantQos`. The specific properties used are described in Table 63 below.

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Table 63 – Properties used to configure the builtin AccessControl plugin

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Property Name (all properties have "dds.sec.access" prefix)	***Property Value (all these properties shall have propagate set to FALSE)*** ***URI syntax follows IETF RFC 3986.*** ***URI "data" schema follows IETF RFC 2397*** ***Vendors may support additional schemas***
permissions_ca	URI to a X509 certificate for the PermissionsCA in PEM format. Supported URI schemes: file, data, pkcs11 The **file** and **data** schemas shall refer to a X.509 v3 certificate (see X.509 v3 ITU-T Recommendation X.509 (2005) [39]) in PEM format.

	Examples: file:permissions_ca.pem file:/home/myuser/ permissions_ca.pem data:,-----BEGIN CERTIFICATE----- MIIC3DCCAcQCCQCWE5x+Z ... PhovK0mp2ohhRLYI0ZiyYQ== -----END CERTIFICATE----- pkcs11:object= MyPermissionsCACert;type=cert
governance	URI to the shared Governance Document signed by the Permissions CA in S/MIME format URI schemes: file, data Example file URIs: file:governance.smime file:/home/myuser/governance.smime Example data URI: data:,MIME-Version: 1.0 Content-Type: multipart/signed; protocol="application/x-pkcs7-signature"; micalg="sha-256"; boundary="----F9A8A198D6F08E1285A292ADF14DD04F" This is an S/MIME signed message ------F9A8A198D6F08E1285A292ADF14DD04F <?xml version="1.0" encoding="UTF-8"?> <dds xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noNamespaceSchemaLocation="omg_shared_ca_governance.xsd"> <domain_access_rules> ... </domain_access_rules> </dds> ... ------F9A8A198D6F08E1285A292ADF14DD04F Content-Type: application/x-pkcs7-signature; name="smime.p7s" Content-Transfer-Encoding: base64 Content-Disposition: attachment; filename="smime.p7s" MIIDuAYJKoZIhv ...al5s= ------F9A8A198D6F08E1285A292ADF14DD04F—
permissions	URI to the DomainParticipant permissions document signed by the Permissions CA in S/MIME format URI schemes: file, data Example file URIs: file:participant1_permissions.smime file:/home/myuser/participant1_permissions.smime

10.4.1.1 Permissions CA Certificate

This is an X.509 certificate that contains the Public Key of the CA that will be used to sign the Domain Governance and Domain Permissions document. The certificate can be self-signed or signed by some other CA. Regardless of this the Public Key in the Certificate shall be trusted to sign the aforementioned Governance and Permissions documents (see 10.4.1.2 and 10.4.1.5).

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The Permissions CA Certificate shall be provided to the plugins using the `PropertyQosPolicy` on the `DomainParticipantQos` as specified in Table 63.

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10.4.1.2 Domain Governance Document

The domain governance document is an XML document that specifies how the domain should be secured.

The domain governance document shall be signed by the Permissions CA. The signed document shall use S/MIME version 3.2 format as defined in IETF RFC 5761 using SignedData Content Type (section 2.4.2 of IETF RFC 5761) formatted as multipart/signed (section 3.4.3 of IETF RFC 5761). This corresponds to the mime-type application/pkcs7-signature. Additionally the signer certificate shall be included within the signature.

The signed governance document shall be provided to the plugins using the `PropertyQosPolicy` on the `DomainParticipantQos` as specified in Table 63.

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The governance document specifies which DDS domain IDs shall be protected and the details of the protection. Specifically, this document configures the following aspects that apply to the whole domain:

DDSSEC12-90 - Meeting CNSSP-15 security requirements

- The cryptographic algorithms that can be used by the Participants and Endpoints in the Domain.
- Whether the discovery information should be protected and the kind of protection: only message authentication codes (MACs) or encryption followed by MAC.
- Whether the whole RTPS message should be protected and the kind of protection. This is in addition to any protection that may occur for individual submessages and for submessage data payloads.
- Whether the liveliness messages should be protected.
- Whether a discovered DomainParticipant that cannot authenticate or fail the authentication should be allowed to join the domain and see any discovery data that are configured as 'unprotected' and any Topics that are configured as 'unprotected'.
- Whether any discovered DomainParticipant that authenticates successfully should be allowed to join the domain and see the discovery data without checking the access control policies.

In addition, the domain governance document specifies how the information on specific Topics within the domain should be treated. Specifically:

- Whether the discovery information on specific Topics should be sent using the secure (protected) discovery writers or using the regular (unprotected) discovery writers.
- Whether read access to the Topic should be open to all or restricted to the DomainParticipants that have the proper permissions.
- Whether write access to the Topic should be open to all or restricted to the DomainParticipants that have the proper permissions.
- Whether the metadata information sent on the Topic (sequence numbers, heartbeats, key hashes, gaps, acknowledgment messages, etc.) should be protected and the kind of protection (MAC or Encrypt then MAC).
- Whether the payload data sent on the Topic (serialized application level data) should be protected and the kind of protection (MAC or Encrypt then MAC).

10.4.1.2.1 Basic Protection Kinds

The domain governance document provides a means for the application to configure the kinds of cryptographic transformation applied to the complete RTPS Message, certain RTPS SubMessages, and the SerializedPayload RTPS submessage element that appears within the `Data` and `DataFrag` submessages.

The configuration allows specification of three protection levels: NONE, SIGN, ENCRYPT.

NONE indicates no cryptographic transformation is applied.

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SIGN indicates the cryptographic transformation shall be purely a message authentication code (MAC), that is, no encryption is performed. Therefore the resulting `CryptoTransformIdentifier` for the output of the "encode" transformations shall have the ***transformation_kind*** attribute member ***transformation_algorithm_id*** set to the `CryptoAlgorithmId` that corresponds to the selected MAC algorithm (e.g. `CID_AES256_GMAC`), see 8.1.

Deleted: `CRYPTO_TRANSFORMATION_KIND` variants `AES_128_GMAC` or `AES_256_GMAC`.

ENCRYPT indicates the cryptographic transformation shall be an encryption followed by a message authentication code (MAC) computed on the ciphertext, also known as Encrypt-then-MAC. Therefore the resulting `CryptoTransformIdentifier` for the output of the "encode" transformations shall have the ***transformation_kind*** attribute member ***transformation_algorithm_id*** set to the `CryptoAlgorithmId` that corresponds to the selected AEAD algorithm (e.g. `CID_AES256_GCM`), see 8.1.

Deleted: `CRYPTO_TRANSFORMATION_KIND` variants `AES_128_GCM` or `AES_256_GCM`

10.4.1.2.2 Protection Kinds

This configuration allows specification of two protection levels beyond the ones provided by the Basic Protection Kind (10.4.1.2.1): SIGN_WITH_ORIGIN_AUTHENTICATION and ENCRYPT_WITH_ORIGIN_AUTHENTICATION.

SIGN_WITH_ORIGIN_AUTHENTICATION indicates the cryptographic transformation shall be purely a set of message authentication codes (MAC), that is, no encryption is performed. This cryptographic transformation shall create a first "common authenticationcode" similar to the case where Protection Kind is SIGN. In addition, the cryptographic transformation shall create additional authentication codes, each produced with a different secret key. Each of these additional secret keys shall be shared only with a subset of the receivers. In the limit case each secret key is shared with only one receiver. The additional MACs prove to the receiver that the sender originated the message, preventing other receivers from impersonating the sender.

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The resulting `CryptoTransformIdentifier` for the output of the "encode" transformations shall have the ***transformation_kind*** attribute member ***transformation_algorithm_id*** set to the `CryptoAlgorithmId` that corresponds to the selected MAC algorithm (e.g. `CID_AES256_GMAC`), see 8.1.

Deleted: `CRYPTO_TRANSFORMATION_KIND` variants `AES_128_GMAC` or `AES_256_GMAC`

ENCRYPT_WITH_ORIGIN_AUTHENTICATION indicates the cryptographic transformation shall be an encryption followed by a message authentication code (MAC) computed on the ciphertext, followed by additional authentication codes. Each of the additional authentication codes shall use a different secret key. The encryption and first (common) authentication code is similar to ones produced when the Protection Kind is ENCRYPT. The additional authentication codes are similar to the ones produced when the Protection Kind is **SIGN_WITH_ORIGIN_AUTHENTICATION**.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

The resulting `CryptoTransformIdentifier` for the output of the "encode" transformations shall have the ***transformation_kind*** attribute member ***transformation_algorithm_id*** set to the `CryptoAlgorithmId` that corresponds to the selected AEAD algorithm (e.g. `CID_AES256_GCM`), see 8.1.

Deleted: `CRYPTO_TRANSFORMATION_KIND` variants `AES_128_GCM` or `AES_256_GCM`

10.4.1.2.3 Domain Governance document format

The format of this document defined using the following XSD:

DDSSEC12-122 – Provide mechanism for changing the session keys

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

DDSSEC12-101 – Add specification of domainTag tp governance and permissions

```
<?xml version="1.0" encoding="UTF-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
    elementFormDefault="qualified" attributeFormDefault="unqualified">

    <xs:element name="dds" type="DomainAccessRulesNode" />

    <xs:complexType name="DomainAccessRulesNode">
        <xs:sequence minOccurs="1" maxOccurs="1">
            <xs:element name="domain_access_rules"
                        type="DomainAccessRules" />
        </xs:sequence>
    </xs:complexType>

    <xs:complexType name="DomainAccessRules">
        <xs:sequence minOccurs="1" maxOccurs="unbounded">
            <xs:element name="domain_rule" type="DomainRule" />
        </xs:sequence>
    </xs:complexType>

    <xs:complexType name="DomainRule">
        <xs:sequence minOccurs="1" maxOccurs="1">
            <!-- DDSSEC12-101 -->
            <xs:element name="domains" type="DomainSet" />
            <xs:element name="allow_unauthenticated_participants"
                        type="xs:boolean" />
            <xs:element name="enable_join_access_control"
                        type="xs:boolean" />
            <xs:element name="enable_key_revision"
                        type="xs:boolean" />
            <xs:element name="discovery_protection_kind"
                        type="ProtectionKind" />
            <xs:element name="liveliness_protection_kind"
                        type="ProtectionKind" />
            <xs:element name="rtps_protection_kind"
                        type="ProtectionKind" />
            <!-- DDSSEC12-94 -->
            <xs:element name="rtps_psk_protection_kind"
                        type="BasicProtectionKind" />
            <xs:element name="topic_access_rules"
                        type="TopicAccessRules" />
            <!--  DDSSEC12-90  -->
            <xs:element name="allowed_crypto_algorithms"
                        type="AllowedCryptoAlgorithms" minOccurs="0"/>
        </xs:sequence>
    </xs:complexType>

    <!-- DDSSEC12-101 -->
    <xs:complexType name="DomainSet">
```

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```
        <xs:sequence>
            <xs:choice minOccurs="1" maxOccurs="unbounded">
                <xs:element name="id" type="DomainId" />
                <xs:element name="id_range" type="DomainIdRange" />
            </xs:choice>
            <xs:choice minOccurs="0" maxOccurs="unbounded">
                <xs:element name="tag" type="DomainTag" />
                <xs:element name="tag_expression"
                            type="DomainTagExpression" />
            </xs:choice>
        </xs:sequence>
    </xs:complexType>

    <xs:simpleType name="DomainId">
        <xs:restriction base="xs:nonNegativeInteger" />
    </xs:simpleType>

    <xs:complexType name="DomainIdRange">
        <xs:choice>
            <xs:sequence/>
                <xs:element name="min" type="DomainId" />
                <xs:element name="max" type="DomainId" minOccurs="0" />
            </xs:sequence/>
            <xs:element name="max" type="DomainId" />
        </xs:choice>
    </xs:complexType>

    <!-- DDSSEC12-101 -->
    <xs:simpleType name="DomainTag">
        <xs:restriction base="xs:string" />
    </xs:simpleType>
    <xs:simpleType name="DomainTagExpression">
        <xs:restriction base="xs:string" />
    </xs:simpleType>

    <xs:simpleType name="ProtectionKind">
        <xs:restriction base="xs:string">
            <xs:enumeration value="ENCRYPT_WITH_ORIGIN_AUTHENTICATION" />
            <xs:enumeration value="SIGN_WITH_ORIGIN_AUTHENTICATION" />
            <xs:enumeration value="ENCRYPT" />
            <xs:enumeration value="SIGN" />
            <xs:enumeration value="NONE" />
        </xs:restriction>
    </xs:simpleType>

    <xs:simpleType name="BasicProtectionKind">
        <xs:restriction base="ProtectionKind">
            <xs:enumeration value="ENCRYPT" />
            <xs:enumeration value="SIGN" />
            <xs:enumeration value="NONE" />
        </xs:restriction>
    </xs:simpleType>

    <xs:complexType name="TopicAccessRules">
```

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```
    <xs:complexType
name="DomainIdSet">¶
        <xs:choice minOccurs="1"
maxOccurs="unbounded">¶
            <xs:element name="id"
type="DomainId" />¶
            <xs:element name="id_range"
type="DomainIdRange" />¶
        </xs:choice>¶
    </xs:complexType>¶
```

```
        <xs:sequence minOccurs="1" maxOccurs="unbounded">
            <xs:element name="topic_rule" type="TopicRule" />
        </xs:sequence>
    </xs:complexType>

    <xs:complexType name="TopicRule">
        <xs:sequence minOccurs="1" maxOccurs="1">
            <xs:element name="topic_expression" type="TopicExpression" />
            <xs:element name="enable_discovery_protection"
                        type="xs:boolean" />
            <xs:element name="enable_liveliness_protection"
                        type="xs:boolean" />
            <xs:element name="enable_read_access_control"
                        type="xs:boolean" />
            <xs:element name="enable_write_access_control"
                        type="xs:boolean" />
            <xs:element name="metadata_protection_kind"
                        type="ProtectionKind" />
            <xs:element name="data_protection_kind"
                        type="BasicProtectionKind" />
        </xs:sequence>
    </xs:complexType>

    <xs:simpleType name="TopicExpression">
        <xs:restriction base="xs:string" />
    </xs:simpleType>

    <!--  DDSSEC12-90  -->
    <xs:complexType name="AllowedCryptoAlgorithms">
        <xs:sequence minOccurs="1" maxOccurs="1">
            <xs:element name="digital_signature"
                        type="DigitalSignatureAlgorithms"/>
            <xs:element name="digital_signature_identity_trust_chain"
                        type="DigitalSignatureAlgorithms" minOccurs="0" />
            <xs:element name="key_establishment"
                        type="KeyEstablishmentAlgorithms"/>
            <xs:element name="symmetric_cipher"
                        type="SymmetricCipherAlgorithms"/>
        </xs:sequence>
    </xs:complexType>

    <!--  DDSSEC12-90  -->
    <xs:complexType name="DigitalSignatureAlgorithms">
        <xs:sequence minOccurs="1" maxOccurs="unbounded">
            <xs:element name="algorithm" type="DigitalSignatureKind" />
        </xs:sequence>
    </xs:complexType>

    <!--  DDSSEC12-90  -->
    <xs:complexType name="KeyEstablishmentAlgorithms">
        <xs:sequence minOccurs="1" maxOccurs="unbounded">
            <xs:element name="algorithm" type="KeyEstablishmentKind" />
        </xs:sequence>
    </xs:complexType>
```

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```
    <!--  DDSSEC12-90  -->
    <xs:complexType name="SymmetricCipherAlgorithms">
        <xs:sequence minOccurs="1" maxOccurs="unbounded">
            <xs:element name="algorithm" type="SymmetricCipherKind" />
        </xs:sequence>
    </xs:complexType>

    <!--  DDSSEC12-90  -->
    <xs:simpleType name="DigitalSignatureKind">
        <xs:restriction base="xs:string">
            <xs:enumeration value="RSASSA-PSS-MGF1SHA256+2048+SHA256" />
            <xs:enumeration value="RSASSA-PKCS1-V1_5+2048+SHA256" />
            <xs:enumeration value="ECDSA+P256+SHA256" />
            <xs:enumeration value="ECDSA+P384+SHA384" />
        </xs:restriction>
    </xs:simpleType>

    <!--  DDSSEC12-90  -->
    <xs:simpleType name="KeyEstablishmentKind">
        <xs:restriction base="xs:string">
            <xs:enumeration value="DHE+MODP-2048-256" />
            <xs:enumeration value="ECDHE-CEUM+P256" />
            <xs:enumeration value="ECDHE-CEUM+P384" />
        </xs:restriction>
    </xs:simpleType>

    <!--  DDSSEC12-90  -->
    <xs:simpleType name="SymmetricCipherKind">
        <xs:restriction base="xs:string">
            <xs:enumeration value="AES128+GCM" />
            <xs:enumeration value="AES256+GCM" />
        </xs:restriction>
    </xs:simpleType>
</xs:schema>
```

10.4.1.2.4 Domain Access Rules Section

The XML domain governance document is delimited by the <dds> XML element tag and contains a single domain access rules Section delimited by the <domain_access_rules> XML element tag. The domain access rules Section contains a set of domain rules each delimited by the <domain_rule> XML element tag.

10.4.1.2.5 Domain Rules

Each domain rule appears within the domain access rules Section delimited by the <domain_rule> XML element tag.

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DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

Each domain rule contains the following elements and sections:

1. Domains element
2. Allow Unauthenticated Participants element
3. Enable Join Access Control element

4. Discovery Protection Kind element
5. Liveliness Protection Kind element
6. RTPS Protection Kind element
7. RTPS PSK Protection Kind element
8. Allowed Algorithms Section
9. Topic Access Rules Section

The contents and delimiters of each Section are described below.

The domain rules shall be evaluated in the same order as they appear in the document. A rule only applies to a particular `DomainParticipant` if the domain Section matches the DDS domain_id to which the `DomainParticipant` belongs. If multiple rules match, the first rule that matches is the only one that applies.

10.4.1.2.5.1 Domains element

This element is delimited by the XML element **<domains>**.

The value in this element identifies the collection of DDS `domain_id` values to which the rule applies.

DDSSEC12-101 – Add specification of domainTag tp governance and permissions

The value in this element identifies the DDS domains to which the rule applies. DDS domains are identified by their `DomainId` (an integer) and a `DomainTag` (a string). One or more `DomainId` values (or ranges) must always be specified. In addition, one or more `DomainTag` values or `DomainTagExpression` values may be optionally specified.

If no `DomainTag` and `DomainTagExpression` is specified, then it shall be treated as if the empty `string` ("") was specified as the only `DomainTag` value.

Note: The empty `DomainTag` ("") is the value for the `DomainTag` that is applied to any `DomainParticipant` that does not explicitly specify a `DomainTag` value. This `DomainTag` value is interoperable with earlier versions of the DDS implementations that did not support domain tags.

The **<domains>** element can contain a single domain ID, for example:

```
<domains>
    <id>0</id>
</domains>
```

Or it can contain a range of domain IDs, for example:

```
<domains>
    <id_range>
        <min>10</min>
        <max>20</max>
    </id_range>
</domains>
```

Or it can contain a list of domain IDs and domain ID ranges, for example:

```
<domains>
    <id>0</id>
    <id_range>
        <min>10</min>
        <max>20</max>
    </id_range>
    <id>25</id>
    <id>27</id>
    <id_range>
        <min>40</min>
```

```
            <max>55</max>
        </id_range>
    </domains>
```

DDSSEC12-101 – Add specification of domainTag tp governance and permissions

Or it can specify both domain IDs and domain Tags, and/or domain tag expressions, for example:

```
    <domains>
        <id>0</id>
        <id_range>
        <min>10</min>
        <max>20</max>
        </id_range>
        <tag>Robot15</tag>
        <tag_expression>AGVS/*</tag_expression>
    </domains>
```

10.4.1.2.5.2 Allow Unauthenticated Participants element

This element is delimited by the XML element **<allow_unauthenticated_participants>**.
This element may take the binary values TRUE or FALSE.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

If the value is set to FALSE, the `ParticipantSecurityConfig` returned by the `get_participant_security_config` operation on the `AccessControl` shall have the ***allow_unauthenticated_participants*** member set to FALSE.

If the value is set to TRUE, the `ParticipantSecurityConfig` returned by the `get_participant_security_config` operation on the `AccessControl` shall have the ***allow_unauthenticated_participants*** member set to TRUE.

Deleted: `ParticipantSecurityAttributes`
Deleted: `get_participant_sec_attributes`
Deleted: `ParticipantSecurityAttributes`
Deleted: `get_participant_sec_attributes`

10.4.1.2.5.3 Enable Join Access Control element

This element is delimited by the XML element **<enable_join_access_control>**.
This element may take the binary values TRUE or FALSE.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

If the value is set to FALSE, the `ParticipantSecurityConfig` returned by the `get_participant_security_config` operation on the `AccessControl` shall have the ***is_access_protected*** member set to FALSE.

If the value is set to TRUE, the `ParticipantSecurityConfig` returned by the `get_participant_security_config` operation on the `AccessControl` shall have the ***is_access_protected*** member set to TRUE.

Deleted: `ParticipantSecurityAttributes`
Deleted: `get_participant_sec_attributes`
Deleted: `ParticipantSecurityAttributes`
Deleted: `get_participant_sec_attributes`

10.4.1.2.5.4 Enable Key Revision element

DDSSEC12-122 – Provide mechanism for changing the session keys

This element is delimited by the XML element **<enable_key_revision>**.
This element may take the binary values TRUE or FALSE.

If the value is set to FALSE, the `ParticipantSecurityConfig` returned by the `get_participant_security_config` operation on the `AccessControl` shall have the ***is_key_revision_enabled*** member set to FALSE.

If the value is set to TRUE, the `ParticipantSecurityConfig` returned by the `get_participant_security_config` operation on the `AccessControl` shall have the ***is_key_revision_enabled*** member set to TRUE.

10.4.1.2.5.5 Discovery Protection Kind element

This element is delimited by the XML element **<discovery_protection_kind>**.
The discovery protection element specifies the protection kind (see 10.4.1.2.2) used for the secure builtin `DataWriter` and `DataReader` entities used for discovery: ***SPDPbuiltinParticipantsSecureWriter, SEDPbuiltinPublicationsSecureWriter***, ***SEDPbuiltinSubscriptionsSecureWriter, SPDPbuiltinParticipantsSecureReader, SEDPbuiltinPublicationsSecureReader***, ***SEDPbuiltinSubscriptionsSecureReader***.
The discovery protection kind element may take five possible values: NONE, SIGN, ENCRYPT, SIGN_WITH_ORIGIN_AUTHENTICATION, or ENCRYPT_WITH_ORIGIN_AUTHENTICATION. The resulting behavior for the aforementioned builtin discovery secure entities shall be as specified in 10.4.1.2.2 with regards to the RTPS SubMessages.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

This setting controls the contents of the `ParticipantSecurityConfig` and `PluginParticipantSecurityAttributes` returned by the `AccessControl::get_participant_security_config` operation on the `DomainParticipant`. Specifically:

- The attribute ***is_discovery_protected*** attribute in the `ParticipantSecurityConfig` shall be set to FALSE if the value specified in the **<discovery_protection_kind>** element is NONE and to TRUE otherwise.
- The attribute ***is_discovery_encrypted*** in the `PluginParticipantSecurityAttributes` (see 10.4.2.5) shall be set to TRUE if the value specified in the **<discovery_protection_kind>** is ENCRYPT or ENCRYPT_WITH_ORIGIN_AUTHENTICATION and to FALSE otherwise.
- The attribute ***is_discovery_origin_authenticated*** in the `PluginParticipantSecurityAttributes` (see 10.4.2.5) shall be set to TRUE if the value specified in the **<discovery_protection_kind>** is SIGN_WITH_ORIGIN_AUTHENTICATION or ENCRYPT_WITH_ORIGIN_AUTHENTICATION and to FALSE otherwise.

Deleted: ParticipantSecurityAttributes

Deleted: get_participant_sec_attributes

Deleted: ParticipantSecurityAttributes

10.4.1.2.5.6 Liveliness Protection Kind element

This element is delimited by the XML element **<liveliness_protection_kind>**.
The liveliness protection element specifies the protection kind (see 10.4.1.2.2) used for builtin `DataWriter` and `DataReader` associated with the ***ParticipantMessageSecure*** builtin Topic (see 7.5.2): ***BuiltinParticipantMessageSecureWriter*** and ***BuiltinParticipantMessageSecureReader.***
The liveliness protection kind element may five three possible values: NONE, SIGN, ENCRYPT, SIGN_WITH_ORIGIN_AUTHENTICATION, or ENCRYPT_WITH_ORIGIN_AUTHENTICATION.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

This setting controls the contents of the `ParticipantSecurityConfig` and `PluginParticipantSecurityAttributes` returned by the `AccessControl::get_participant_security_config` operation on the `DomainParticipant`. Specifically:

- The attribute ***is_liveliness_protected*** in the `ParticipantSecurityConfig` shall be set to FALSE if the value specified in the **<liveliness_protection_kind>** element is NONE and to TRUE otherwise.

Deleted: ParticipantSecurityAttributes

Deleted: get_participant_sec_attributes

Deleted: ParticipantSecurityAttributes

- The attribute ***is_liveliness_encrypted*** in the `PluginParticipantSecurityAttributes` (see 10.4.2.5) shall be set to TRUE if the value specified in the **< liveliness_protection_kind>** is ENCRYPT or ENCRYPT_WITH_ORIGIN_AUTHENTICATION and to FALSE otherwise.
- The attribute ***is_liveliness_origin_authenticated*** in the `PluginParticipantSecurityAttributes` (see 10.4.2.5) shall be set to TRUE if the value specified in the **< liveliness_protection_kind>** is SIGN_WITH_ORIGIN_AUTHENTICATION or ENCRYPT_WITH_ORIGIN_AUTHENTICATION and to FALSE otherwise.

10.4.1.2.5.7 RTPS Protection Kind element

This element is delimited by the XML element **<rtps_protection_kind>**.
The RTPS protection kind element specifies the protection kind (see 10.4.1.2.2) used for the whole RTPS message.
The RTPS protection kind element may take five possible values: NONE, SIGN, ENCRYPT, SIGN_WITH_ORIGIN_AUTHENTICATION, or ENCRYPT_WITH_ORIGIN_AUTHENTICATION. The resulting behavior for the RTPS message cryptographic transformation shall be as specified in 10.4.1.2.2.
DDSSEC12-90 - Meeting CNSSP-15 security requirements
This setting controls the contents of the `ParticipantSecurityConfig` and `PluginParticipantSecurityAttributes` returned by the `AccessControl::get_participant_security_config` operation on the `DomainParticipant`. Specifically:
DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

- The attribute ***is_rtps_axk_protected*** attribute in the `ParticipantSecurityConfig` shall be set to FALSE if the value specified in the **<rtps_protection_kind>** element is NONE and to TRUE otherwise.
- The attribute ***is_rtps_axk_encrypted*** in the `PluginParticipantSecurityAttributes` (see 10.4.2.5) shall be set to TRUE if the value specified in the **< rtps_protection_kind>** is ENCRYPT or ENCRYPT_WITH_ORIGIN_AUTHENTICATION and to FALSE otherwise.
- The attribute ***is_rtps_origin_authenticated*** in the `PluginParticipantSecurityAttributes` (see 10.4.2.5) shall be set to TRUE if the value specified in the **<rtps_protection_kind>** is SIGN_WITH_ORIGIN_AUTHENTICATION or ENCRYPT_WITH_ORIGIN_AUTHENTICATION and to FALSE otherwise.

10.4.1.2.5.8 RTPS PSK Protection Kind element

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
This element is delimited by the XML element **<rtps_psk_protection_kind>**.
The RTPS protection kind element specifies the protection kind (see 10.4.1.2.2) used for RTPS `Messages` that are not otherwise protected by an "Authenticated Participant Exchanged Key". This includes the RTPS `Bootstrapping Messages` (see 7.5.7). PSK protection, if enabled, protects the whole RTPS message using a Pre-Shared Key.
The RTPS PSK Protection Kind element may take three possible values: `NONE`, `SIGN`, or `ENCRYPT`. The resulting behavior for the RTPS message cryptographic transformation shall be as specified in 10.4.1.2.2.
This setting controls the contents of the `ParticipantSecurityConfig` and `PluginParticipantSecurityAttributes` returned by the

Deleted: ParticipantSecurityAttributes
Deleted: get_participant_sec_attributes
Deleted: ParticipantSecurityAttributes

AccessControl::get_participant_security_config operation on the DomainParticipant. Specifically:

- The attribute ***is_rtps_psk_protected*** attribute in the ParticipantSecurityConfig shall be set to FALSE if the value specified in the **<rtps_psk_protection_kind>** element is NONE and to TRUE otherwise.
- The attribute ***is_rtps_psk_encrypted*** in the PluginParticipantSecurityAttributes (see 10.4.2.5) shall be set to TRUE if the value specified in the **<rtps_psk_protection_kind>** is ENCRYPT and to FALSE otherwise.

10.4.1.2.5.9 Allowed Algorithms Section

DDSSEC12-90 - Meeting CNSSP-15 security requirements

This section is delimited by the XML element **<allowed_crypto_algorithms>.**

The Allowed Algorithms section defines rules that control the cryptographic algorithms that may be used in the domain. It contains the following elements:

1. Digital Signature element
2. Digital Signature Trust Chain element
3. Key Establishment element
4. Symmetric Cipher element

These elements are described below.

10.4.1.2.5.9.1 Digital Signature Element

DDSSEC12-90 - Meeting CNSSP-15 security requirements

This element is delimited by the XML element <**digital_signature**>.

The Digital Signature element defines the digital signature algorithms allowed to be used in the Domain for the purpose of signing messages with the Private Key associated with a Participant Identity Certificate. This also limits the type of Public Key that may be used in the Participant Identity to those compatible with the algorithms allowed.

The <**digital_signature**> element contains a sequence of **<algorithm>** elements, each identifying an allowed digital signature algorithm. Each **<algorithm>** element shall contain the CryptoAlgorithmName string identifier of the algorithm as defined in clause 8.2.

If the <**digital_signature**> element is not present the Participant may use any of the algorithms defined in clause 8.2.

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Deleted: 8.28.28.1.2

10.4.1.2.5.9.2 Digital Signature Trust Chain Element

DDSSEC12-90 - Meeting CNSSP-15 security requirements

This element is delimited by the XML element <**digital_signature_trust_chain**>.

The Digital Signature Trust Chain element defines the digital signature algorithms allowed to be used by the SPIs for the purpose of signing Identity Certificates, Governance Documents, and Permission Documents. This also limits the type of Public Keys that may be used by the Certificate Authorities that sign the aforementioned documents as they must be compatible with the algorithms allowed.

The <**digital_signature_trust_chain**> element contains a sequence of **<algorithm>** elements, each identifying an allowed digital signature algorithm. Each **<algorithm>** element shall contain the CryptoAlgorithmName string identifier of the algorithm as defined in clause 8.2.

If the <**digital_signature_trust_chain**> element is not present then the allowed algorithms are the same specified by the <**digital_signature**> element, if present. If the <**digital_signature**> element is also not present, the Participant may use any of the algorithms defined in clause 8.2.

Deleted: 8.28.28.1.2

Deleted: 8.28.28.1.2

10.4.1.2.5.9.3 Key Establishment Element

DDSSEC12-90 - Meeting CNSSP-15 security requirements

This element is delimited by the XML element <**key_establishment**>.
The Key Establishment element defines the Key Agreement algorithms allowed to be used by the Authentication Plugin to compute a SharedSecret between Participants.
The <**key_establishment**> element contains a sequence of **<algorithm>** elements each identifying an allowed key establishment algorithm. Each **<algorithm>** element shall contain the `CryptoAlgorithmName` string identifier of the algorithm as defined in clause 8.2.
If the <**key_establishment**> is not present, the Participant may use any of the algorithms defined in clause 8.2.

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Deleted: 8.28.28.1.2

10.4.1.2.5.9.4 Symmetric Cipher Element

DDSSEC12-90 - Meeting CNSSP-15 security requirements

This element is delimited by the XML element <**symmetric_cipher**>.
The Symmetric Cipher element defines the algorithms allowed to be used by the SPIs to encrypt and/or compute message authentication codes on data and messages.
The <**symmetric_cipher**> element contains a sequence of **<algorithm>** elements, each representing an allowed symmetric cipher. Each **<algorithm>** element shall contain the `CryptoAlgorithmName` string identifier of the algorithm as defined in clause 8.1.
If the <**symmetric_cipher**> element is not present, the Participant may use any of the algorithms defined in clause 8.1.

10.4.1.2.5.10 Topic Access Rules Section

This section is delimited by the XML element **<topic_access_rules>** and contains a sequence of topic rule elements.

10.4.1.2.6 Topic Rule Section

This section is delimited by the XML element **<topic_rule>** and appears within the domain rule Section.
Each topic rule Section contains the following elements:

1. Topic expression
2. Enable Discovery protection
3. Enable Liveliness protection
4. Enable Read Access Control element
5. Enable Write Access Control element
6. Metadata protection Kind
7. Data protection Kind

The contents and delimiters of each Section are described below.
The topic expression element within the rules selects a set of Topic names. The rule applies to any DataReader or DataWriter associated with a Topic whose name matches the Topic expression name.
The topic access rules shall be evaluated in the same order as they appear within the **<topic_access_rules>** Section. If multiple rules match the first rule that matches is the only one that applies.

10.4.1.2.6.1 Topic expression element

This element is delimited by the XML element **<topic_expression>**.
The `value` in this element identifies the set of DDS `Topic` names to which the rule applies. The rule will apply to any `DataReader` or `DataWriter` associated with a `Topic` whose name matches the value.
The Topic name expression syntax and matching shall use the syntax and rules of the POSIX `fnmatch()` function as specified in POSIX 1003.2-1992, Section B.6 [38].

10.4.1.2.6.2 Enable Discovery protection element

This element is delimited by the XML element **<enable_discovery_protection>**.
This element may take the boolean values TRUE or FALSE.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

The setting controls the contents of the `TopicSecurityConfig` returned by the `AccessControl::get_topic_security_config` on a `Topic` whose associated `Topic` name matches the rule's topic expression. Specifically the ***is_discovery_protected*** attribute in the `TopicSecurityConfig` shall be set to the boolean value specified in the **<enable_discovery_protection>** element.

Deleted: `TopicSecurityAttributes`
Deleted: `_sec_attributes`
Deleted: `TopicSecurityAttributes`

10.4.1.2.6.3 Enable Liveliness Protection element

This element is delimited by the XML element **<enable_liveliness_protection>**.
This element may take the boolean values TRUE or FALSE.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

The setting controls the contents of the `TopicSecurityConfig` returned by the `AccessControl::get_topic_security_config` operation on a `Topic` whose associated `Topic` name matches the rule's topic expression. Specifically the ***is_liveliness_protected*** attribute in the `TopicSecurityConfig` shall be set to the boolean value specified in the **<enable_liveliness_protection>** element.

Deleted: `TopicSecurityAttributes`
Deleted: `_sec_attributes`
Deleted: `TopicSecurityAttributes`

10.4.1.2.6.4 Enable Read Access Control element

This element is delimited by the XML element **<enable_read_access_control>**.
This element may take the boolean values TRUE or FALSE.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

The setting shall control the contents of the `TopicSecurityConfig` returned by the `AccessControl::get_topic_security_config` operation on any `Topic` whose associated `Topic` name matches the rule's topic expression. Specifically the ***is_read_protected*** attribute in the `TopicSecurityConfig` shall be set to the boolean value specified in the **<enable_read_access_control>** element.

Deleted: `TopicSecurityAttributes`
Deleted: `_sec_attributes`
Deleted: `TopicSecurityAttributes`

In addition, this element shall control the `AccessControl::check_create_datareader` operation on any `DataReader` entity whose associated `Topic` name matches the rule's topic expression. Specifically:

- If the value of **<enable_write_access_control>** element is FALSE, the operation `check_create_datareader` shall return TRUE without further checking the Permissions document.
- If the value of **<enable_write_access_control>** element is TRUE, the operation `check_create_datareader` shall return a value according to what is specified in the Permissions document, see 10.4.1.5.

Deleted: 10.4.1.510.4.1.510.4.1.3

10.4.1.2.6.5 Enable Write Access Control element

This element is delimited by the XML element **<enable_write_access_control>**.
This element may take the boolean values TRUE or FALSE.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

The setting shall control the contents of the `TopicSecurityConfig` returned by the `AccessControl::get_topic_security_config` operation on any `Topic` whose associated `Topic` name matches the rule's topic expression. Specifically the ***is_write_protected*** attribute in the `TopicSecurityConfig` shall be set to the binary value specified in the **<enable_write_access_control>** element.

Deleted: `TopicSecurityAttributes`
Deleted: `_sec_attributes`
Deleted: `TopicSecurityAttributes`

In addition, this element shall control the `AccessControl::check_create_datawriter` operation on any `DataWriter` entity whose associated `Topic` name matches the rule's topic expression. Specifically:

- If the value of **<enable_write_access_control>** element is FALSE, the operation `check_create_datawriter` shall return TRUE without further checking the Permissions document.
- If the value of **<enable_write_access_control>** element is TRUE, the operation `check_create_datawriter` shall return a value according to what is specified in the Permissions document, see 10.4.1.5.

Deleted: 10.4.1.510.4.1.510.4.1.3

10.4.1.2.6.6 Metadata Protection Kind element

This element is delimited by the XML element **<metadata_protection_kind>**.
This element may take the Protection Kind values NONE, SIGN, ENCRYPT, SIGN_WITH_ORIGIN_AUTHENTICATION, or ENCRYPT_WITH_ORIGIN_AUTHENTICATION.
The setting of this element shall specify the protection kind (see 10.4.1.2.2) used for the RTPS `SubMessages` sent by any `DataWriter` and `DataReader` whose associated `Topic` name matches the rule's topic expression.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

The setting of this element shall also control the contents of the `EndpointSecurityConfig` and `PluginEndpointSecurityAttributes` returned by the `AccessControl::get_datawriter_security_config` and `AccessControl::get_datareader_security_config` operation on any `DataWriter` or `DataReader` entity whose associated `Topic` name matches the rule's topic expression. Specifically:

- The attribute ***is_submessage_protected*** in the `EndpointSecurityConfig` shall be set to FALSE if the value specified in the **<metadata_protection_kind>** is NONE and shall be set to TRUE otherwise.
- The attribute ***is_submessage_encrypted*** in the `PluginEndpointSecurityAttributes` (see 10.4.2.5) shall be set to TRUE if the value specified in the **<metadata_protection_kind>** is ENCRYPT or ENCRYPT_WITH_ORIGIN_AUTHENTICATION and to FALSE otherwise.
- The attribute ***is_submessage_origin_authenticated*** in the `PluginEndpointSecurityAttributes` (see 10.4.2.5) shall be set to TRUE if the value specified in the **<metadata_protection_kind>** is SIGN_WITH_ORIGIN_AUTHENTICATION or ENCRYPT_WITH_ORIGIN_AUTHENTICATION and to FALSE otherwise.

Deleted: `EndpointSecurityAttributes`

Deleted: `get_datawriter_sec_attributes`

Deleted: `get_datareader_sec_attributes`

Deleted: `EndpointSecurityAttributes`

10.4.1.2.6.7 Data Protection Kind element

This element is delimited by the XML element **<data_protection_kind>**.
This element may take the Basic Protection Kind values: NONE, SIGN, or ENCRYPT.
The setting of this element shall specify the basic protection kind (see 10.4.1.2.1) used for the RTPS `SerializedPayload` submessage element sent by any `DataWriter` whose associated `Topic` name matches the rule's topic expression.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

The setting shall control the contents of the `EndpointSecurityConfig` and `PluginEndpointSecurityAttributes` returned by the `AccessControl::get_datawriter_security_config` operation on any `DataWriter` entity whose associated `Topic` name matches the rule's topic expression. Specifically the `PluginEndpointSecurityAttributes` attributes ***is_payload_protected*** and ***is_key_protected***,

Deleted: `EndpointSecurityAttributes`

Deleted: `get_datawriter_sec_attributes` as well as the `PluginEndpointSecurityAttributes` attribute ***is_payload_encrypted*** (see 10.4.2.6):

- If the value specified in the **<data_protection_kind>** element is NONE, then ***is_payload_protected, is_key_protected*** and ***is_payload_encrypted*** shall be set to FALSE.
- If the value specified in the **<data_protection_kind>** element is SIGN, then ***is_payload_protected*** shall be set to TRUE. The attributes ***is_key_protected*** and ***is_payload_encrypted*** shall be set to FALSE.
- If the value specified in the **<data_protection_kind>** element is ENCRYPT, then ***is_payload_protected***, ***is_key_protected***, and ***is_payload_encrypted*** shall be set to TRUE.

10.4.1.2.7 Application of Domain and Topic Rules

DDSSEC12-101 – Add specification of domainTag tp governance and permissions

For a given `DomainParticipant` the Domain Rules shall be evaluated in the same order they appear in the Governance document. The first Domain Rule having a **<domains>** element whose value matches the `DomainParticipant`'s `Domain` shall be the one applied to the `DomainParticipant`.

DDSSEC12-101 – Add specification of domainTag tp governance and permissions

For the `DomainParticipant` `Domain` to be matched, both the `DomainParticipant`'s `DomainId` and the `DomainParticipant`'s `DomainTag` must match one of the ones that appear in the rule:

- To match the `DomainId`, the value must be specified in using the **<id>** element, or else fall within one of the ranges specified using the **<id_range>** element.
- To match the `DomainTag`, the value must be specified in using the **<tag>** element, or else match one of expressions specified using the **<tag_expression>** element.
    - If a `DomainParticipant` does not specify a `DomainTag` it is considered to have the empty tag ""
    - If the **<domains>** element does not specify any **<tag>** or **<tag_expression>** elements, it is considered to have specified a single **<tag>** containing the empty string.

The tag expression syntax and matching shall use the syntax and rules of the POSIX fnmatch() function as specified in POSIX 1003.2-1992, Section B.6 [38].

If no Domain Rule matches the `DomainParticipant` domain_id the operation under consideration shall fail with a suitable "permissions error". If desired, to avoid this situation, a "default" Domain Rule can be added to the end using the expression:

DDSSEC12-101 – Add specification of domainTag tp governance and permissions

```
<domains>
    <id_range>
        <min>0</min>
    </id_range>
    <tag_expression>*</tag_expression>
</domains>
```

This rule will match any domain_id not matched by the rules that appear before.

For a given `Topic`, `DataWriter` or `DataReader` DDS `Entity` belonging to a `DomainParticipant` the Topic Rules appearing within the Domain Rule that applies to that `DomainParticipant` shall be evaluated in the same order they appear in the Governance document. The first Topic Rule having a **<topic_expression>** element whose value matches the topic name associated with the `Entity` shall be the one applied to the `Entity`.

If no Topic Rule matches the `Entity` topic name the operation under consideration shall fail with a suitable "permissions error". If desired, to avoid this situation, a "default" Topic Rule can be added to the end using the expression **<topic_expression>*</ topic_expression** >. This rule will match any topic name not matched by the rules that appear before.

10.4.1.3 Governance Document Extensibility

DDSSEC12-29 - Specify DDS Security uses XCDR serialization version 1

Future revisions of the DDS-Security specification may include additional information in the Governance document. Likewise, plugin implementations may also include implementation-specific or vendor-specific information into the Governance document.

Extensions to the Governance document shall follow the rules below. These ensures the extension will be properly interpreted (or ignored) and not break compatibility with DDS-systems built with SPIs that do not understand the extension.

- The extended governance document shall be a well-formed XML document according to the XML 1.1 standard [59].
- Extensions shall be done by means of adding new XML elements which may recursively contain nested elements or text,
    - The added elements shall not contain mixed content, that is, the direct content can either be empty, text data or (children) XML elements. However, any specific element shall not contain both text data and children XML elements.
    - The added elements shall have an optional attribute called must_interpret that can take the values "true", "false", "TRUE, or "FALSE".

Definitions:

- Any XML element that is not recognized, i.e., does not appear in the XSD defined in clause 10.4.1.2.3 shall be considered a "governance extension element."
- Any XML unrecognized XML attribute that appears in an otherwise recognized XML element, i.e. the element appears in the XSD defined in clause 10.4.1.2.3 but the attribute does not shall be considered a "governance extension attribute."
- Any XML unrecognized value for an XML attribute that appears in otherwise recognized XML element and attribute, i.e., the element and attribute appear in the XSD defined in clause 10.4.1.2.3 but the attribute value is not valid according to the XSD shall be considered a "governance extension attribute value."

The processing of the Governance document by the Access Control plugin shall follow the rules below:

- If an XML element does not have the **must_interpret** attribute it shall be treated as if it had must_interpret="TRUE".
- If a governance extension element has the **must_interpret** attribute set to "false" or "FALSE", then the extension element shall be ignored, and the processing shall skip to the closing of the extension element.
    - Ignoring an extension element recursively ignores any children of the extension element independently of the presence or value of the regardless of the **must_interpret** attribute in the children.
- If a governance extension element has the **must_interpret** attribute set to "true" or "TRUE", then the governance document shall be considered invalid, and an error shall be raised.

- If a governance extension attribute appears in an element that also has the **must_interpret** attribute set to "false" or "FALSE", then the extension attribute shall be ignored and the processing shall continue with the next attribute, if any.
    - Ignoring an extension attribute is localized to the attribute itself. It does not cause the other attributes to be ignored, it also does not cause the children of the element to be ignored.
- If a governance extension attribute appears in an element that also has the **must_interpret** attribute set to "true" or "TRUE", then the governance document shall be considered invalid, and an error shall be raised.
- If a governance extension attribute value appears in an element that also has the **must_interpret** attribute set to "false" or "FALSE", then the attribute shall be ignored and the processing shall continue with the next attribute, if any.
    - Ignoring an extension attribute value is localized to the attribute itself. It does not cause the other attributes to be ignored, it also does not cause the children of the element to be ignored.
- If a governance extension attribute value appears in an element that also has the **must_interpret** attribute set to "true" or "TRUE", then the governance document shall be considered invalid, and an error shall be raised.

These rules allow the addition of elements to a Governance document without making them incompatible with SPIs that do not understand the added element.
The rules also provide a way to mark extensions that must be interpreted. This is done with the **must_interpret** attribute. This extension will make the new document incompatible with SPIs that don’t understand it.

10.4.1.4 Example Domain Governance document (non normative)

Following is an example permissions document that is written according to the XSD described in 10.4.1.2.3.
DDSSEC12-122 – Provide mechanism for changing the session keys
DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
DDSSEC12-101 – Add specification of domainTag tp governance and permissions

```
<?xml version="1.0" encoding="utf-8"?>
<dds xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:noNamespaceSchemaLocation="http://www.omg.org/spec/DDS-
Security/20170801/omg_shared_ca_domain_governance.xsd">
    <domain_access_rules>
        <domain_rule>
            <domains>
                <id>0</id>
                <id_range>
                    <min>10</min>
                    <max>20</max>
                <id_range>
                <!--  DDSSEC12-101  -->
                <tag>Robot15</tag>
                <tag_expression>AGV/*</tag_expression>
            </domains>
            <allow_unauthenticated_participants>false
            </allow_unauthenticated_participants>
            <enable_join_access_control>true</enable_join_access_control>
            <enable_key_revision>true</enable_key_revision>
```

Deleted: FALSE

Deleted: TRUE

Deleted: TRUE

```
        <rtps_protection_kind>SIGN</rtps_protection_kind>
        <!--  DDSSEC12-94  -->
        <rtps_psk_protection_kind>ENCRYPT</rtps_psk_protection_kind>
        <discovery_protection_kind>ENCRYPT</discovery_protection_kind>
        <liveliness_protection_kind>SIGN</liveliness_protection_kind>

        <topic_access_rules>
            <topic_rule>
                <topic_expression>Square*</topic_expression>
                <enable_discovery_protection>true
                </enable_discovery_protection>
                <enable_read_access_control>true
                </enable_read_access_control>
                <enable_write_access_control>true
                </enable_write_access_control>
                <metadata_protection_kind>ENCRYPT
                </metadata_protection_kind>
                <data_protection_kind>ENCRYPT
                </data_protection_kind>
            </topic_rule>

            <topic_rule>
                <topic_expression>Circle</topic_expression>
                <enable_discovery_protection>true
                </enable_discovery_protection>
                <enable_read_access_control>false
                </enable_read_access_control>
                <enable_write_access_control>true
                </enable_write_access_control>
                <metadata_protection_kind>ENCRYPT
                </metadata_protection_kind>
                <data_protection_kind>ENCRYPT
                </data_protection_kind>
            </topic_rule>

            <topic_rule>
                <topic_expression>Triangle
                </topic_expression>
                <enable_discovery_protection>false
                </enable_discovery_protection>
                <enable_read_access_control>false
                </enable_read_access_control>
                <enable_write_access_control>true
                </enable_write_access_control>
                <metadata_protection_kind>NONE
                </metadata_protection_kind>
                <data_protection_kind>NONE
                </data_protection_kind>
            </topic_rule>

            <topic_rule>
                <topic_expression>*</topic_expression>
                <enable_discovery_protection>true
                </enable_discovery_protection>
```

Deleted: TRUE

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Deleted: FALSE

Deleted: TRUE

Deleted: FALSE

Deleted: FALSE

Deleted: TRUE

Deleted: TRUE

```
                <enable_read_access_control>true
                </enable_read_access_control>
                <enable_write_access_control>true
                </enable_write_access_control>
                <metadata_protection_kind>ENCRYPT
                </metadata_protection_kind>
                <data_protection_kind>ENCRYPT
                </data_protection_kind>
            </topic_rule>
        </topic_access_rules>
        <!-- DDSSEC-12-90 -->
        <allowed_crypto_algorithms>
            <digital_signature>
                <algorithm>RSASSA-PSS-MGF1SHA256+2048+SHA256
                </algorithm>
                <algorithm>ECDSA+P256+SHA256</algorithm>
                <algorithm>ECDSA+P384+SHA384</algorithm>
            </digital_signature>

            <digital_signature_identity_trust_chain>
                <algorithm>ECDSA+P256+SHA256</algorithm>
                <algorithm>ECDSA+P384+SHA384</algorithm>
            </digital_signature_identity_trust_chain>

            <key_establishment>
                <algorithm>DHE+MODP-2048-256</algorithm>
                <algorithm>ECDHE-CEUM+P256</algorithm>
                <algorithm>ECDHE-CEUM+P384</algorithm>
            </key_establishment>

            <symmetric_cipher>
                <algorithm>AES128+GCM</algorithm>
                <algorithm>AES256+GCM</algorithm>
            </symmetric_cipher>
        </allowed_crypto_algorithms>
    </domain_rule>
  </domain_access_rules>
</dds>
```

Deleted: TRUE

Deleted: TRUE

10.4.1.5 DomainParticipant Permissions Document

The permissions document is an XML document containing the permissions of the domain participant and binding them to the distinguished name of the `DomainParticipant` as defined in the DDS:Auth:PKI-DH authentication plugin.

The permissions document shall be signed by the Permissions CA. The signed document shall use S/MIME version 3.2 format as defined in IETF RFC 5761 using SignedData Content Type (section 2.4.2 of IETF RFC 5761) formatted as multipart/signed (section 3.4.3 of IETF RFC 5761). This corresponds to the mime-type application/pkcs7-signature. Additionally, the signer certificate shall be included within the signature.

The signed permissions document shall be provided to the plugins using the `PropertyQosPolicy` on the `DomainParticipantQos` as specified in Table 63.

Deleted: Table 63Table 63Table 60

10.4.1.5.1 Permissions document format

DDSSEC12-3 – Add mechanism to extend Governance and Permissions document

DDSSEC12-91 - How are 'subject_name' fields compared?

The format of this document is defined using the following XSD.

DDSSEC12-101 – Add specification of domainTag tp governance and permissions

```
<?xml version="1.0" encoding="utf-8"?>
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
    elementFormDefault="qualified" attributeFormDefault="unqualified">

    <xs:element name="dds" type="PermissionsNode" />
    <xs:complexType name="PermissionsNode">
        <xs:sequence minOccurs="1" maxOccurs="1">
            <xs:element name="permissions" type="Permissions" />
        </xs:sequence>
    </xs:complexType>

    <xs:complexType name="Permissions">
        <xs:sequence minOccurs="1" maxOccurs="unbounded">
            <xs:element name="grant" type="Grant" />
        </xs:sequence>
    </xs:complexType>
    <xs:complexType name="Grant">
        <xs:sequence minOccurs="1" maxOccurs="1">
            <!— DDSSEC12-91 -->
            <xs:choice minOccurs="1" maxOccurs="1">
              <xs:element name="subject_name" type="xs:string" />
              <xs:element name="subject_name_expression"
                            type="xs:string" />
            </xs:choice>
            <xs:element name="validity" type="Validity" />
            <xs:sequence minOccurs="1" maxOccurs="unbounded">
              <xs:choice minOccurs="1" maxOccurs="1">
                <xs:element name="allow_rule" minOccurs="0" type="Rule" />
                <xs:element name="deny_rule" minOccurs="0" type="Rule" />
              </xs:choice>
            </xs:sequence>
            <xs:element name="default" type="DefaultAction" />
        </xs:sequence>
        <xs:attribute name="name" type="xs:string" use="required" />
    </xs:complexType>

    <xs:complexType name="Validity">
        <xs:sequence minOccurs="1" maxOccurs="1">
            <xs:element name="not_before" type="xs:dateTime" />
            <xs:element name="not_after" type="xs:dateTime" />
        </xs:sequence>
    </xs:complexType>

    <xs:complexType name="Rule">
        <xs:sequence minOccurs="1" maxOccurs="1">
            <!-- DDSSEC12-101 -->
            <xs:element name="domains" type="DomainSet" />
```

Deleted: Id

```
            <xs:sequence minOccurs="0" maxOccurs="unbounded">
                <xs:element name="publish" type="Criteria" />
            </xs:sequence>
            <xs:sequence minOccurs="0" maxOccurs="unbounded">
                <xs:element name="subscribe" type="Criteria" />
            </xs:sequence>
             <xs:sequence minOccurs="0" maxOccurs="unbounded">
                <xs:element name="relay" type="Criteria" />
            </xs:sequence>
        </xs:sequence>
    </xs:complexType>

    <!-- DDSSEC12-101 -->
    <xs:complexType name="DomainSet">
        <xs:sequence>
            <xs:choice minOccurs="1" maxOccurs="unbounded">
                <xs:element name="id" type="DomainId" />
                <xs:element name="id_range" type="DomainIdRange" />
            </xs:choice>
            <xs:choice minOccurs="0" maxOccurs="unbounded">
                <xs:element name="tag" type="DomainTag" />
                <xs:element name="tag_expression"
                            type="DomainTagExpression" />
            </xs:choice>
        </xs:sequence>
    </xs:complexType>

    <xs:simpleType name="DomainId">
        <xs:restriction base="xs:nonNegativeInteger" />
    </xs:simpleType>

    <xs:complexType name="DomainIdRange">
        <xs:choice>
            <xs:sequence>
                <xs:element name="min" type="DomainId" />
                <xs:element name="max" type="DomainId" minOccurs="0" />
            </xs:sequence>
            <xs:element name="max" type="DomainId" />
        </xs:choice>
    </xs:complexType>

    <!-- DDSSEC12-101 -->
    <xs:simpleType name="DomainTag">
        <xs:restriction base="xs:string" />
    </xs:simpleType>
    <xs:simpleType name="DomainTagExpression">
        <xs:restriction base="xs:string" />
    </xs:simpleType>

    <xs:complexType name="Criteria">
        <xs:all minOccurs="1">
            <!--  DDSSEC11-56  -->
            <xs:element name="topics" minOccurs="1"
                        type="TopicExpressionList" />
```

Deleted:
```
    <xs:complexType name="DomainIdSet">¶
        <xs:choice minOccurs="1" maxOccurs="unbounded">¶
            <xs:element name="id" type="DomainId" />¶
            <xs:element name="id_range" type="DomainIdRange" />¶
        </xs:choice>¶
    </xs:complexType>¶
```

```
            <xs:element name="partitions" minOccurs="0"
                        type="PartitionExpressionList" />
            <xs:element name="data_tags" minOccurs="0" type="DataTags" />
        </xs:all>
    </xs:complexType>

    <xs:complexType name="TopicExpressionList">
        <xs:sequence minOccurs="1" maxOccurs="unbounded">
            <xs:element name="topic" type="TopicExpression" />
        </xs:sequence>
    </xs:complexType>

    <xs:complexType name="PartitionExpressionList">
        <xs:sequence minOccurs="1" maxOccurs="unbounded">
            <xs:element name="partition" type="PartitionExpression" />
        </xs:sequence>
    </xs:complexType>

    <xs:simpleType name="TopicExpression">
        <xs:restriction base="xs:string" />
    </xs:simpleType>

    <xs:simpleType name="PartitionExpression">
        <xs:restriction base="xs:string" />
    </xs:simpleType>

    <xs:complexType name="DataTags">
        <xs:sequence minOccurs="1" maxOccurs="unbounded">
            <xs:element name="tag" type="TagNameValuePair" />
        </xs:sequence>
    </xs:complexType>
    <xs:complexType name="TagNameValuePair">
        <xs:sequence minOccurs="1" maxOccurs="unbounded">
            <xs:element name="name" type="xs:string" />
            <xs:element name="value" type="xs:string" />
        </xs:sequence>
    </xs:complexType>

    <xs:simpleType name="DefaultAction">
        <xs:restriction base="xs:string">
            <xs:enumeration value="ALLOW" />
            <xs:enumeration value="DENY" />
        </xs:restriction>
    </xs:simpleType>
</xs:schema>
```

10.4.1.5.2 Permissions Section

The XML permissions document contains a permissions Section. This is the portion of the XML document delimited by the <permissions> XML element tag.
The permissions Section contains a set of grant sections.

10.4.1.5.3 Grant Section

The grant sections appear within the permissions Section delimited by the **<grant>** XML element tag.

Each grant Section contains three sections:

DDSSEC12-91 - How are 'subject_name' fields compared?

1. Either a Subject name Section (subject_name element) or a Subject name expression Section (subject_name_expression element)
2. Validity Section (validity element)
3. Rules Section (allow, deny and default elements)

The contents and delimiters of each Section are described below.

10.4.1.5.3.1 Subject name Section

This Section is delimited by the XML element **<subject_name>**.

The subject name Section identifies the DomainParticipant to which the permissions apply. Each subject name can only appear in a single **<permissions>** Section within the XML Permissions document.

The contents of the **<subject_name>** element shall be the x.509 subject name for the `DomainParticipant` as is given in its Authorization Certificate. A permissions Section with a subject name that does not match the subject name given in the corresponding Authorization certificate shall be ignored.

DDSSEC12-91 - How are 'subject_name' fields compared?

The X.509 subject name is a set of attribute-value assertions. The format of x.509 subject name shall be the string representation of the X.509 certificate Subject name as defined in IETF RFC 4514 "Lightweight Directory Access Protocol (LDAP): String Representation of Distinguished Names" [53], with additional restrictions.

Deleted: name-value pairs

From IETF RFC 4514:

- Each attribute-value assertion is separated using the comma (',' U+002C) character.
- For each assertion, the attribute name is separated from the value using the equals ('=' U+003D) character.

Additional restrictions:

- Attribute names shall start with a letter and contain only alphanumeric characters and dot characters ('.', U+002E). Specifically, names cannot have whitespace.
- Attribute values shall contain only alphanumeric characters, whitespace, and the characters ".", "/", ";", ":", "+", "@", "&", "|" .
- Attribute values are not allowed to have whitespace at the beginning and the end.
- Whitespace at the beginning and end of the attribute-value pair as well as surrounding the "=" character is not incorporated into the attribute name or value and is silently ignored.

For example:

DDSSEC12-91 - How are 'subject_name' fields compared?

```
<subject_name>emailAddress=cto@acme.com, CN=AGV/agv1, OU=CTO Office, O=ACME
Inc., L=Sunnyvale, ST=CA, C=US</subject_name>
```

Deleted: `DDS Shapes Demo`

10.4.1.5.3.1.1 Subject name matching

DDSSEC12-91 - How are 'subject_name' fields compared?

Two subject names match if an only if the following conditions are met:

- They contain the same attribute names
- For each attribute name, the corresponding attribute values are identical strings:

Per the above rules the order of the atributes does not affect the matching.

10.4.1.5.3.2 Subject name expression Section

DDSSEC12-91 - How are 'subject_name' fields compared?

This Section is delimited by the XML element <**subject_name_expression**>.

The subject name expression Section identifies a set of DomainParticipants to which the permissions apply. It shall be matched against the x.509 subject name for the DomainParticipant as is given in its Authorization Certificate.

The <**subject_name_expression**> element shall contain the same type of attribute-value assertions as the <**subject_name** > element (see 10.4.1.5.3.1), except that the attribute values may also contain the special "pattern" characters '*', '?', "[", "]", "!", "-".

Deleted: 10.4.1.5.3.110.4.1.5.3.110.4.1.3.2.1

For example:

```
<subject_name>emailAddress=cto@acme.com, CN=AGV/*, OU=CTO Office, O=ACME
Inc., L=Sunnyvale, ST=CA, C=US</subject_name>
```

10.4.1.5.3.2.1 Subject name expression matching

DDSSEC12-91 - How are 'subject_name' fields compared?

A subject name matches a subject name expression if an only if the following conditions are met:

- They contain the same attribute names
- For each attribute name, the corresponding attribute values ***subject_attr_val*** and ***subject_expression_attr_val*** match according to the POSIX fnmatch() function (see in POSIX 1003.2-1992, Section B.6 [38], with flags: FNM_PATHNAME=TRUE, FNM_PERIOD=FALSE, and FNM_NOESCAPE=TRUE. Note that it is a case-sensitive match.

Per the above rules the order of the atributes does not affect the matching.

10.4.1.5.3.3 Validity Section

This Section is delimited by the XML element <**validity**>. The contents of this element reflect the valid dates for the permissions. It contains both the starting date and the end date using the format defined by `dateTime` data type as specified in sub clause 3.3.7 of [XSD]. Time zones that aren't specified are considered UTC.

A permissions Section with a validity date that falls outside the current date at which the permissions are being evaluated shall be ignored.

10.4.1.5.3.4 Rules Section

This Section contains the permissions assigned to the `DomainParticipant`. It is described as a set of rules.

The rules are applied in the same order that appear in the document. If the criteria for the rule matches the `domain_id` join and/or publish or subscribe operation that is being attempted, then the allow or deny decision is applied. If the criteria for a rule does not match the operation being attempted, the evaluation shall proceed to the next rule. If all rules have been examined without a match, then the decision specified by the "default" rule is applied.

DDSSEC12-79 – Built-in Access Control: interpretation of enable_read/write_access_control

The default rule shall always be present and must appear after all allow and deny rules. However, in DDS-Security 1.1 and earlier versions the presence of the default rule was optional. To allow implementations that comply with later revisions to still process the older permissions files the absence of the default rule shall be treated as a <default>DENY</default>.

Deleted: The default rule, if present, must appear after all allow and deny rules. If the default rule is not present, the implied default decision is DENY.

The matching criteria for each rule specify the `domain_id`, topics (published and subscribed), the partitions (published and subscribed), and the data-tags associated with the `DataWriter` and `DataReader`.

For the grant to match there shall be a match of the topics, partitions, and data-tags criteria. This is interpreted as an AND of each of the criteria. For a specific criterion to match (e.g., **<topics>**) it is enough that one of the topic expressions listed matches (i.e., an OR of the expressions with the **<topics>** section).

10.4.1.5.3.4.1 Format of the allow rules

Allow rules appear inside the **<allow_rule>** XML Element. Each rule contains a Domains Section; (10.4.1.5.3.4.1.1), followed by a set of allowed actions. There are three kinds of allowed actions: publish, subscribe and relay.

Deleted: 10.4.1.5.3.4.1.110.4.1.5.3.4.1.110.4.1.3.1.3.1.1

10.4.1.5.3.4.1.1 Domains Section

This Section is delimited by the XML element **<domains>**.
The value in this element identifies the collection of DDS domain_id values to which the rule applies. The syntax is the same as for the domain section of the Governance document. See subclause 10.4.1.2.5.1.
For example:

Deleted: 10.4.1.2.5.110.4.1.2.5.110.4.1.2.1.1

DDSSEC12-101 – Add specification of domainTag tp governance and permissions

```
<domains>
    <id>0</id>
    <tag>Robot15</tag>
</domains>
```

Deleted: ¶

10.4.1.5.3.4.1.2 Format of the Allowed Actions sections

The sections for each of the three action kinds have similar format. The only difference is the name of the XML element used to delimit the action:

- The **Allow Publish** Action is delimited by the **<publish>** XML element
- The **Allow Subscribe** Action is delimited by the **<subscribe>** XML element
- The **Allow Relay** Action is delimited by the **<relay>** XML element

Each allowed action logically contains three orthogonal conditions. These cover the topic name, partitions, and data-tags. All these conditions must be met for the allowed action to apply. Note that some of these conditions may not appear explicitly in the XML file. In this case a specified default value is assumed and applied as if the condition had been explicitly listed.

Each of these three conditions appears in a separate section:

- Allowed Topics Condition section
- Allowed Partitions Condition section
- Allowed Data Tags Condition section

Example:

```
<publish>         <!— delimits the publish action  -->
    <topics>      <!— delimits the topic condition -->
        <topic>Square</topic>
    </topics>
    <partitions>  <!— delimits the partition condition -->
        <partition>A_partition</partition>
    </partitions>
```

```
                  <!— data tags condition absent so use default -->
</publish>
```

10.4.1.5.3.4.1.3 Allowed Topic condition section

The ***topic condition section*** is delimited by the **<topics>** XML element. It defines the DDS Topic names that must be matched for the allow rule to apply. Topic names may be given explicitly or by means of Topic name expressions. Each topic name or topic-name expression appears separately in a **<topic>** sub-element within the **<topics>** element.

The Topic name expression syntax and matching shall use the syntax and rules of the POSIX fnmatch() function as specified in POSIX 1003.2-1992, Section B.6 [38].

In order for an action (e.g., a publish action) to be allowed it must meet the ***topic condition.*** For this to happen the Topic name associated with the intended action must match one the topics or topic expressions explicitly listed in the ***topic condition section***.

The ***topic condition section*** must always be present; therefore there is no default specfied.

Example (appearing within a <allow_rule> and within a publish, subscribe, or relay action):

```
    <topics>
        <topic>Square</topic>
        <topic>B*</topic>
    </topics>
```

The above topic condition would match Topic “Square” and any topic that starts with a “B”.

10.4.1.5.3.4.1.4 Allowed Partitions condition section

The ***allowed partitions condition section*** is delimited by the **<partitions>** XML element. It limits the set DDS Partitions names that may be associated with the (publish, subscribe, relay) action for the rule to apply. Partition names may be given explicitly or by means of Partition name expressions. Each partition name or partition-name expression appears separately in a **<partition>** sub-element within the **<partitions>** element.

The Partition name expression syntax and matching shall use the syntax and rules of the POSIX fnmatch() function as specified in POSIX 1003.2-1992, Section B.6 [38].

In order for an action (e.g., a publish action) to meet the ***allowed partitions condition*** that appears within an allow rule, the set of the Partitions associated with the DDS entity (DataWriter or DataReader) attempting the (publish, subscribe, or relay) action must be contained in the set of partitions defined by the ***allowed partitions condition section***.

If there is no **<partitions>** Section within an allow rule, then the default "empty string" partition is assumed. See PARTITION QosPolicy entry in Qos Policies table of section 2.2.3 (Supported Qos) of the DDS Specification version 1.4. This means that the allow rule (e.g., publish) would only allow a DataWriter to publish on the “empty string” partition.

Example (appearing within a <allow_rule> and within a <publish> action):

```
    <partitions>
        <partition>A</partition>
        <partition>B</partition>
    </partitions>
```

The above ***allowed partitions condition*** would be matched if the partitions associated with the DDS Entity attempting to perform the action (e.g., publish action) is a subset of the set {A, B}. So it would be OK to publish in partition A, in B, or in {A, B} but not in {A, B, C}.

For legacy reasons DDS-Security implementations shall provide a way to select an alternative “legacy matching” behavior. The “legacy matching behavior” shall match the ***allowed partitions condition*** condition as long as one or more of the Partitions associated with DDS Entity attempting to perform the action (e.g., DataWriter for a publish action) matches one of the partitions in the ***allowed partitions condition***. The same ***allowed partitions condition section*** above would be matched if the partitions associated with the DDS DataWriter include A or B. So it would be OK to publish in A, in B, or in {A, B} and also in {A, B, C}.

10.4.1.5.3.4.1.5 Allowed Data tags condition section

The ***allowed data tags condition section*** is delimited by the **< data_tags>** XML element. It limits the set DDS Data Tags that may be associated with the (publish, subscribe, relay) action for the rule to apply. The **<data_tags>** XML Element contain a set of tags.
In order for an action (e.g., a publish action) to meet the ***allowed data tags condition*** the set of the Data Tags associated with the DDS Entity performing the action (e.g., a DataWriter for a publish action) must be contained in the set of data tags defined by the ***allowed data tags condition section***.
If there is no **<data_tags>** section then the default empty set is assumed. This means that the allow action (e.g., publish action) would only allow publishing if there are no data tags associated with the DDS Endpoint (DataWriter for a publish action).
Example (appearing within a <allow_rule> and within a <publish> action):

```
<data_tags>
    <tag>
        <name>aTagName1</name>
        <value>aTagValue1</value>
    </tag>
</data_tags>
```

The above ***allowed data tags condition*** would be matched if the data tags associated with the DDS Entity performing the action (e.g., DataWriter for publish action) are a subset of the set { (aTagName1, aTagValue)} } . So it would be OK to publish using a DataWriter with no associated data-tags, or a DataWriter with a single tag with name “aTagName1” and value “aTagValue1”.

10.4.1.5.3.4.1.6 Example allow rule

```
<allow_rule>
        <domains>
            <id>0</id>
        </domains>
        <publish>
            <topics>
                <topic>Cir*</topic>
            </topics>
            <data_tags>
                <tag>
                    <name>aTagName1</name>
                    <value>aTagValue1</value>
                </tag>
            </data_tags>
        </publish>
        <subscribe>
            <topics>
                <topic>Sq*</topic>
            </topics>
            <data_tags>
                <tag>
                    <name>aTagName1</name>
                    <value>aTagValue1</value>
```

```
                </tag>
                <tag>
                    <name>aTagName2</name>
                    <value>aTagValue2</value>
                </tag>
            </data_tags>
        </subscribe>
        <subscribe>
            <topics>
                <topic>Triangle</topic>
            </topics>
            <partitions>
                <partition>P*</partition>
            </partitions>
        </subscribe>
    </allow_rule>
```

10.4.1.5.3.4.2 Format for deny rules

Deny rules appear inside the **<deny_rule>** XML Element. Each rule contains a Domains Section; (10.4.1.5.3.4.1.1), followed by a set of denied actions. There are three kinds of denied actions: publish, subscribe and relay.

Deleted: 10.4.1.5.3.4.1.110.4.1.5.3.4.1.110.4.1.3.1.3.1.1

Deny rules have the same format as the allow rules. The only difference is how they are interpreted. If the criteria in the deny rule matches the operation being performed, then the decision is to deny the operation.

10.4.1.5.3.4.2.1 Domains Section

This Section is delimited by the XML element **<domains>**. The value in this element identifies the collection of DDS domain_id values to which the rule applies. The syntax is the same as for the domain section of the Governance document. See subclause 10.4.1.2.5.1.

Deleted: 10.4.1.2.5.110.4.1.2.5.110.4.1.2.1.1

For example:

```
<domains>
    <id>0</id>
</domains>
```

10.4.1.5.3.4.2.2 Format of the Denied Actions sections

The sections for each of the three action kinds have similar format. The only difference is the name of the XML element used to delimit the action:

- The **Deny Publish** Action is delimited by the **<publish>** XML element.
- The **Deny Subscribe** Action is delimited by the **<subscribe>** XML element.
- The **Deny Relay** Action is delimited by the **<relay>** XML element.

Each denied action logically contains three orthogonal deny conditions. These cover the topic name, partitions, and data-tags. All these conditions must be met for the denied action to apply. Note that some of these conditions may not appear explicitly in the XML file. In this case a specified default value is assumed and applied as if the condition had been explicitly listed.

Each of these three conditions appears in a separate section:

- Denied Topics Condition section.

- Denied Partitions Condition section.
- Denied Data Tags Condition section.

Example (appearing within a <deny_rule>):

```
<publish>         <!— delimits the publish action  -->
    <topics>      <!— delimits the topic condition -->
        <topic>Square</topic>
    </topics>
    <partitions>  <!— delimits the partition condition -->
        <partition>A_partition</partition>
    </partitions>
                  <!— data tags condition absent so use default -->
</publish>
```

10.4.1.5.3.4.2.3 Denied Topic condition section

The ***denied topic condition section*** is delimited by the **<topics>** XML element. It has the same format and interpretation as the ***allowed topic condition section*** for the allowed actions, see 10.4.1.5.3.4.1.3. In order for an action (e.g., a publish action) to be denied it must meet the ***denied topic condition.*** For this to happen the Topic name associated with the intended action must match one the topics or topic expressions explicitly listed in the ***denied topic condition section***.

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10.4.1.5.3.4.2.4 Denied Partitions condition section

The ***denied partitions condition section*** is delimited by the **<partitions>** XML element. It defines the DDS Partitions names that when associated with the (publish, subscribe, relay) cause the deny action for the rule to apply. Partition names may be given explicitly or by means of Partition name expressions. Each partition name or partition-name expression appears separately in a **<partition>** sub-element within the **<partitions>** element.
In order for an action (e.g., a publish action) to be denied it must meet the ***denied partitions condition.*** For this to happen one of more of the partition names associated with the DDS Entity performing the action (e.g., a DataWriter for the publish action) must match one the partitions or partition expressions explicitly listed in the ***partitions condition section***.
If there is no **<partitions>** section then the "*" partition expression is assumed. This means that the deny action (e.g., deny publish action) would apply independent of the partition associated with the DDS Endpoint (DataWriter for the publish action).
Example (appearing within a <deny_rule> and within a <publish> action):

```
    <partitions>
        <partition>A</partition>
        <partition>B</partition>
    </partitions>
```

The above ***denied partitions condition*** would be matched if the partitions associated with the DDS Entity performing the action (e.g., DataWriter for a publish action) intersect the set {A, B}. So it would be OK to publish in C, but not in {A}, {A, B}, or {A, B, C}.

10.4.1.5.3.4.2.5 Data tags condition section

The ***denied data tags condition section*** is delimited by the **<data_tags>** XML element. It defines the DDS tags names and values that when associated with the (publish, subscribe, relay) cause the deny action for the rule to apply.

In order for an action (e.g., a publish action) to be denied it must meet the ***denied data tags condition.*** For this to happen the DDS Entity associated with the action (e.g., DataWriter for a publish action) must have a data tag name and value pair associated that matches one the data tags explicitly listed in the ***denied data tags condition section***.

If there is no **<data_tags>** section then the “set of all possible tags” set is assumed as default. This means that the deny action (e.g., deny publish action) would apply independent of the data tags associated with the DDS Endpoint (e.g., DataWriter for a publish action).

Example (appearing within a <deny_rule> and within a <publish> action):

```
<data_tags>
    <tag>
        <name>aTagName1</name>
        <value>aTagValue1</value>
    </tag>
</data_tags>
```

The above ***denied data tags condition*** would be matched if the data tags associated with the DDS Entity performing the action (e.g., DataWriter for a publish action) intersect the set { (aTagName1, aTagValue1) }. So it would not deny publishing using a DataWriter with no associated data-tags, or a DataWriter with a single tag with name “aTagName2”, or a DataWriter with a single tag with name “aTagName1” and value “aTagValue2”. But it would deny publishing using a DataWriter with with two associated data-tags { (aTagName1, aTagValue1), (aTagName2, aTagValue2)}.

10.4.1.5.3.4.2.6 Example deny rule

```
<allow_rule>
        <domains>
            <id>0</id>
        </domains>
        <publish>
            <topics>
                <topic>Cir*</topic>
            </topics>
            <data_tags>
                <tag>
                    <name>aTagName1</name>
                    <value>aTagValue1</value>
                </tag>
            </data_tags>
        </publish>
        <subscribe>
            <topics>
                <topic>Sq*</topic>
            </topics>
            <data_tags>
                <tag>
                    <name>aTagName1</name>
                    <value>aTagValue1</value>
                </tag>
                <tag>
                    <name>aTagName2</name>
                    <value>aTagValue2</value>
                </tag>
            </data_tags>
```

```
        </subscribe>
        <subscribe>
            <topics>
                <topic>Triangle</topic>
            </topics>
            <partitions>
                <partition>P*</partition>
            </partitions>
        </subscribe>
</allow_rule>
```

10.4.1.5.3.4.2.7 Example deny rule

```
 <deny_rule>
         <domains>
             <id>0</id>
         </domains>
         <publish>
             <topics>
                 <topic>Circle1</topic>
             </topics>

         </publish>
         <publish>
             <topics>
                 <topic>Square</topic>
             </topics>
             <partitions>
                 <partition>A_partition</partition>
             </partitions>
         </publish>
         <subscribe>
             <topics>
                 <topic>Square1</topic>
             </topics>
         </subscribe>
         <subscribe>
             <topics>
                 <topic>Tr*</topic>
             </topics>
             <partitions>
                 <partition>P1*</partition>
             </partitions>
             <data_tags>
                 <tag>
                     <name>aTagName1</name>
                     <value>aTagValue1</value>
                 </tag>
                 <tag>
                     <name>aTagName2</name>
                     <value>aTagValue2</value>
                 </tag>
             </data_tags>
         </subscribe>
</deny_rule>
```

10.4.1.6 Permissions Document Extensibility

DDSSEC12-3 – Add mechanism to extend Governance and Permissions document

Future revisions of the DDS-Security specification may include additional information in the Permissions document. Likewise, plugin implementations may include implementation-specific or vendor-specific information into the Permissions document.

DDS-Security provides a specific mechanism to allow making these kinds of extensions to the Permissions document without breaking compatibility with DDS-systems built with SPIs that do not understand the extension.

The approach is the same used for extending the Governance document, see 10.4.1.3. The same rules described there apply to the extension mechanism as well as how the Permissions plugin shall process the Permissions document in the presence of extension elements, attributes, and attribute values that are not recognized.

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10.4.1.7 DomainParticipant example permissions document (non normative)

Following is an example permissions document that is written according to the XSD described in 10.4.1.5.

```
<?xml version="1.0" encoding="UTF-8"?>
<dds xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:noNamespaceSchemaLocation="http://www.omg.org/spec/DDS-Security/20170801/omg_shared_ca_permissions.xsd">
  <permissions>
    <grant name="ShapesPermission">
      <subject_name>emailAddress=cto@acme.com, CN=DDS Shapes Demo, OU=CTO Office, O=ACME Inc., L=Sunnyvale, ST=CA, C=US</subject_name>
      <validity>
        <!-- Format is CCYY-MM-DDThh:mm:ss[Z|(+|-)hh:mm] The time zone may
             be specified as Z (UTC) or (+|-)hh:mm. Time zones that aren't
             specified are considered UTC.
         -->
        <not_before>2024-03-26T00:00:00</not_before>
        <not_after>2034-03-26T22:45:30</not_after>
      </validity>
      <allow_rule>
        <domains>
          <id>0</id>
          <!--  DDSSEC12-101 -->
          <tag>Robot15</tag>
        </domains>
      </allow_rule>
      <deny_rule>
        <domains>
          <id>0</id>
        </domains>
        <publish>
          <topics>
            <topic>Circle1</topic>
          </topics>
        </publish>
        <publish>
          <topics>
            <topic>Square</topic>
          </topics>
          <partitions>
            <partition>A_partition</partition>
          </partitions>
        </publish>
        <subscribe>
          <topics>
            <topic>Square1</topic>
          </topics>
        </subscribe>
        <subscribe>
          <topics>
            <topic>Tr*</topic>
          </topics>
```

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```
      <partitions>
        <partition>P1*</partition>
      </partitions>
    </subscribe>
  </deny_rule>
  <allow_rule>
    <domains>
      <id>0</id>
    </domains>
    <publish>
      <topics>
        <topic>Cir*</topic>
      </topics>
      <data_tags>
        <tag>
          <name>aTagName1</name>
          <value>aTagValue1</value>
        </tag>
      </data_tags>
    </publish>
    <subscribe>
      <topics>
        <topic>Sq*</topic>
      </topics>
      <data_tags>
        <tag>
          <name>aTagName1</name>
          <value>aTagValue1</value>
        </tag>
        <tag>
          <name>aTagName2</name>
          <value>aTagValue2</value>
        </tag>
      </data_tags>
    </subscribe>
    <subscribe>
      <topics>
        <topic>Triangle</topic>
      </topics>
      <partitions>
        <partition>P*</partition>
      </partitions>
      <data_tags>
        <tag>
          <name>aTagName1</name>
          <value>aTagValue1</value>
        </tag>
      </data_tags>
    </subscribe>
    <relay>
      <topics>
        <topic>*</topic>
      </topics>
```

```
        <partitions>
          <partition>aPartitionName</partition>
        </partitions>
      </relay>
    </allow_rule>
    <default>DENY</default>
  </grant>
</permissions>
</dds>
```

10.4.2 DDS:Access:Permissions Types

This sub clause specifies the content and format of the `Credential` and `Token` objects used by the DDS:Access:Permissions plugin.

10.4.2.1 DDS:Access:Permissions PermissionsCredentialToken

The DDS:Access:Permissions plugin shall set the attributes of the `PermissionsCredentialToken` object as specified in the table below.

Table 64 – PermissionsCredentialToken class for the builtin AccessControl plugin

Attribute name	*Attribute value*	
class_id	"DDS:Access:PermissionsCredential"	
properties	*name*	*value*
	dds.perm.cert	Contents of the permissions document signed by the PermissionCA that was configured using the Participant PropertyQosPolicy with name "dds.sec.access.permissions"

10.4.2.2 DDS:Access:Permissions PermissionsToken

The DDS:Access:Permissions plugin shall set the attributes of the `PermissionsToken` object as specified in the table below:

DDSSEC12-90 - Meeting CNSSP-15 security requirements

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

Table 65 – PermissionsToken class for the builtin AccessControl plugin

Attribute name	*Attribute value*	
class_id	"DDS:Access:Permissions:1.2"	
properties (The presence of each of these properties is optional)	*name*	*value*
	dds.perm_ca.sn	The subject name of Permissions CA
	dds.perm_ca.algo	One of the CryptoAlgorithmName string identifiers for digital signature algorithms defined in clause 8.2, Table 25.

The value of the ***class_id*** shall be interpreted as composed of three parts: a ***PluginClassName***, a ***MajorVersion*** and a ***MinorVersion*** according to the same format described in 10.3.2.1. Accordingly this version of the specification has ***PluginClassName*** equal to "DDS:Access:Permissions", ***MajorVersion*** set to 1, and ***MinorVersion*** set to 0.

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If the ***MajorVersion*** and ***MinorVersion*** are missing from the class_id, it shall be interpreted as being ***MajorVersion*** 1 and ***MinorVersion*** 0.

10.4.2.3 PluginParticipantSecurityAttributes

The `PluginParticipantSecurityAttributes` describe plugin-specific behavior of the builtin DDS:Crypto:AES:GCM-GMAC Crypto affecting the key material and transformations for the RTPS messages and the RTPS submessages related to the builtin Topics.
This is a structured type, whose members are described in the table below:
DDSSEC12-90 - Meeting CNSSP-15 security requirements
DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

Table 66 – Description of the PluginParticipantSecurityAttributes

Member	Type	Meaning
is_rtps_axk_encrypted	Boolean	This field is only used if the ParticipantSecurityConfig field ***is_rtps_axk_protected*** is TRUE. Otherwise it has no effect and it shall be set to FALSE. This field indicates to the DDS:Crypto:AES:GCM-GMAC plugin whether the RTPS messages protected with an"Authenticated Participant Exchanged Key" shall be protected using authenticated encryption or only an authentication code. If ***is_rtps_axk_encrypted*** is TRUE, the CryptoKeyFactory `register_local_participant` operation shall create key material for performing a GCM authenticated encryption. If ***is_rtps_axk_encrypted*** is TRUE, the the CryptoTransform `encode_rtps_message` operation, when invoked with parameter ***transform_with_psk***=FALSE, shall apply the GCM authenticated encryption transformation. If ***is_rtps_axk_encrypted*** is FALSE, the `register_local_participant` operation shall create key material for performing a GMAC authentication and the CryptoTransform `encode_rtps_message` operation, when invoked with parameter ***transform_with_psk***=FALSE, shall apply the GMAC authentication transformation.
is_rtps_psk_encrypted	Boolean	This field is only used if the ParticipantSecurityConfig field ***is_rtps_psk_protected*** is TRUE. Otherwise it has no effect and it shall be set to FALSE. This field indicates to the DDS:Crypto:AES:GCM-GMAC plugin whether the RTPS messages protected with.a pre-shared key shall be protected using authenticated encryption or only an authentication code. If ***is_rtps_psk_encrypted*** is TRUE, the CryptoKeyFactory `register_local_participant` operation shall use the pre-shared-key to create key material for performing a GCM authenticated encryption using the pre-shared key. If ***is_rtps_psk_encrypted*** is TRUE the CryptoTransform `encode_rtps_message` operation, when invoked with parameter ***transform_with_psk***=TRUE, shall apply the GCM authenticated encryption transformation using the pre-shared key. If ***is_rtps_psk_encrypted*** is FALSE, the `register_local_participant` operation shall use the pre-shared-key to create key material for performing a GMAC authentication and the CryptoTransform `encode_rtps_message` operation, when invoked with parameter ***transform_with_psk***=TRUE, shall apply the GMAC authentication transformation.
is_discovery_encrypted	Boolean	This field is only used if the ParticipantSecurityConfig field ***is_discovery_protected*** is TRUE. Otherwise it has no effect and it shall be set to FALSE. This field indicates to the DDS:Crypto:AES:GCM-GMAC plugin whether the submessages related to the **builtin secure discovery endpoints** (see 7.5.9) shall be protected using authenticated encryption or only an authentication code. If ***is_discovery_encrypted*** is TRUE, the CryptoKeyFactory `register_local_datawriter` (in the case of a DataWriter endpoint) or `register_local_datareader` (in the case of a DataReader endpoint) operation for the **builtin secure discovery endpoints** shall create key material for performing a GCM authenticated encryption and the CryptoTransform `encode_datawriter_submessage` and

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		`encode_datareader_submessage` operations shall apply the GCM authenticated encryption transformation. If ***is_discovery_encrypted*** is FALSE, the aforementioned operations shall create key material for performing a GMAC authentication and the CryptoTransform `encode_rtps_submessage` and `encode_datawriter_submessage` operations shall apply the GMAC authentication transformation.
is_liveliness_encrypted	Boolean	This field is only used if the ParticipantSecurityConfig field ***is_liveliness_protected*** is TRUE. Otherwise it has no effect and it shall be set to FALSE. This field indicates to the DDS:Crypto:AES:GCM-GMAC plugin whether the submessages related to the **builtin secure liveliness endpoints** (see 7.5.10) shall be protected using authenticated encryption or only an authentication code. If ***is_liveliness_encrypted*** is TRUE, the CryptoKeyFactory `register_local_datawriter` (in the case of a DataWriter endpoint) or `register_local_datareader` (in the case of a DataReader endpoint) operation for the **builtin secure liveliness endpoints** shall create key material for performing a GCM authenticated encryption and the CryptoTransform `encode_datawriter_submessage` and `encode_datareader_submessage` operations shall apply the GCM authenticated encryption transformation. If ***is_liveliness_encrypted*** is FALSE, the aforementioned operations shall create key material for performing a GMAC authentication and the CryptoTransform `encode_datawriter_submessage` and `encode_datareader_submessage` operations shall apply the GMAC authentication transformation.
is_rtps_origin_authenticated	Boolean	This field is only used if the ParticipantSecurityConfig field ***is_rtps_axk_protected*** is TRUE. Otherwise it has no effect and it shall be set to FALSE. This field indicates to the DDS:Crypto:AES:GCM-GMAC plugin whether the RTPS messages shall have additional authentication codes constructed using receiver-specific keys. If ***is_rtps_origin_authenticated*** is TRUE, the CryptoKeyFactory `register_matched_remote_participant` operation shall create additional receiver-specific key material for performing a GMAC authentication. The CryptoTransform `encode_rtps_message` operation shall add additional GMAC authentication codes using the receiver-specific key material. If ***is_rtps_origin_authenticated*** is FALSE, the aforementioned operations shall not create additional key material and the CryptoTransform `encode_rtps_message` shall not add additional GMAC authentication codes.

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is_discovery_origin_authenticated	Boolean	This field is only used if the ParticipantSecurityConfig field ***is_discovery_protected*** is TRUE. Otherwise it has no effect and it shall be set to FALSE. This field indicates to the DDS:Crypto:AES:GCM-GMAC plugin whether the RTPS submessage from or to the **builtin secure discovery endpoints** shall have additional authentication codes constructed using receiver-specific keys. If ***is_discovery_origin_authenticated*** is TRUE, the CryptoKeyFactory `register_matched_datareader` (in the case of a DataWriter endpoint) or `register_matched_datawriter` (in the case of a DataReader endpoint) operation shall create additional receiver-specific key material for performing a GMAC authentication. The CryptoTransform `encode_datawriter_submessage` and `encode_datareader_submessage` operations shall add additional GMAC authentication codes using the receiver-specific key material. If ***is_discovery_origin_authenticated*** is FALSE, the aforementioned operations shall not create additional key material and the CryptoTransform `encode_datawriter_submessage` and `encode_datareader_submessage` operations shall not add additional GMAC authentication codes.
is_liveliness_origin_authenticated	Boolean	This field is only used if the ParticipantSecurityConfig field ***is_liveliness_protected*** is TRUE. Otherwise it has no effect and it shall be set to FALSE. This field indicates to the DDS:Crypto:AES:GCM-GMAC plugin whether the RTPS submessage from or to the **builtin secure liveliness endpoints** shall have additional authentication codes constructed using receiver-specific keys. If ***is_liveliness_origin_authenticated*** is TRUE, the CryptoKeyFactory `register_matched_datareader` (in the case of a DataWriter endpoint) or `register_matched_datawriter` (in the case of a DataReader endpoint) operation shall create additional receiver-specific key material for performing a GMAC authenticatication. The CryptoTransform `encode_datawriter_submessage` and `encode_datareader_submessage` operations shall add additional GMAC authentication codes using the receiver-specific key material. If ***is_liveliness_origin_authenticated*** is FALSE, the aforementioned operations shall not create additional key material and the CryptoTransform `encode_datawriter_submessage` and `encode_datareader_submessage` operations shall not add additional GMAC authentication codes.

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10.4.2.4 Definition of the PluginParticipantSecurityAttributesMask

The `PluginParticipantSecurityAttributesMask` is used to encode the value of the `PluginParticipantSecurityAttributes` in a compact way such that it can be included in the `ParticipantSecurityInfo`, see 7.3.23.

As described in section 7.3.23, in order to communicate, two DomainParticipants need to have the same `ParticipantSecurityInfo`. As as consequence the `PluginParticipantSecurityAttributesMask` must also be the same.

The default value for the mask is:

```
#define  PLUGIN_PARTICIPANT_SECURITY_ATTRIBUTES_MASK_DEFAULT 0
```

The mapping of the `PluginParticipantSecurityAttributes` to `PluginParticipantSecurityAttributesMask` is as follows:

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

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Table 67 – Mapping of PluginParticipantSecurityAttributes to the PluginParticipantSecurityAttributesMask

Field in PluginParticipantSecurityAttributes	Corresponding bit in the `PluginParticipantSecurityAttributesMask`
is_rtps_axk_encrypted	`#define PLUGIN_PARTICIPANT_SECURITY_ATTRIBUTES_FLAG_IS_RTPS_AXK_ENCRYPTED (0x00000001 << 0)`
is_discovery_encrypted	`#define PLUGIN_PARTICIPANT_SECURITY_ATTRIBUTES_FLAG_BUILTIN_IS_DISCOVERY_ENCRYPTED (0x00000001 << 1)`
is_liveliness_encrypted	`#define PLUGIN_PARTICIPANT_SECURITY_ATTRIBUTES_FLAG_IS_LIVELINESS_ENCRYPTED (0x00000001 << 2)`
is_rtps_origin_authenticated	`#define PLUGIN_PARTICIPANT_SECURITY_ATTRIBUTES_FLAG_IS_RTPS_ORIGIN_AUTHENTICATED (0x00000001 << 3)`
is_discovery_origin_authenticated	`#define PLUGIN_PARTICIPANT_SECURITY_ATTRIBUTES_FLAG_IS_DISCOVERY_ORIGIN_AUTHENTICATED (0x00000001 << 4)`
is_liveliness_origin_authenticated	`#define PARTICIPANT_SECURITY_ATTRIBUTES_FLAG_IS_LIVELINESS_ORIGIN_AUTHENTICATED (0x00000001 << 5)`
is_rtps_psk_encrypted	`#define PLUGIN_PARTICIPANT_SECURITY_ATTRIBUTES_FLAG_IS_RTPS_PSK_ENCRYPTED (0x00000001 << 6)`

10.4.2.5 PluginEndpointSecurityAttributes

The `PluginEndpointSecurityAttributes` describe plugin-specific behavior of the builtin DDS:Crypto:AES:GCM-GMAC Crypto affecting the key material and transformations for endpoints (DataWriters and DataReaders) submessages and submessage payloads.

This is a structured type, whose members are described in the table below:

DDSSEC12-90 - Meeting CNSSP-15 security requirements

Table 68 – Description of the PluginEndpointSecurityAttributes

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Member	Type	Meaning
is_submessage_encrypted	Boolean	This field is only used if the EndpointSecurityConfig field ***is_submessage_protected*** is TRUE. Otherwise it has no effect and it shall be set to FALSE. This field indicates to the DDS:Crypto:AES:GCM-GMAC plugin whether the submessage shall be protected using authenticated encryption or only an authentication code. If ***is_submessage_encrypted*** is TRUE, the CryptoKeyFactory `register_local_datawriter` (in the case of a `DataWriter` endpoint) or `register_local_datareader` (in the case of a `DataReader` endpoint) operation shall create key material for performing a GCM authenticated encryption and the CryptoTransform operation `encode_datawriter_submessage` (in the case of a `DataWriter` endpoint) or `encode_datareader_submessage` (in the case of a `DataReader`) shall apply the GCM authenticated encryption transformation. If ***is_submessage_encrypted*** is FALSE, the aforementioned operations shall create key material for performing a GCM authenticated encryption and the CryptoTransform operation `encode_datawriter_submessage` (in the case of a `DataWriter` endpoint) or `encode_datareader_submessage` (in the case of a `DataReader`) shall apply the GCM authenticated encryption transformation.
is_submessage_origin_authenticated	Boolean	This field is only used if the EndpointSecurityConfig field ***is_submessage_protected*** is TRUE. Otherwise it has no effect and it shall be set to FALSE. This field indicates to the DDS:Crypto:AES:GCM-GMAC plugin whether the submessage shall have additional authentication codes constructed using receiver-specific keys. If ***is_submessage_origin_authenticated*** is TRUE, the CryptoKeyFactory `register_matched_datareader` (in the case of a DataWriter endpoint) or `register_matched_datawriter` (in the case of a DataReader endpoint) operation shall create additional receiver-specific key material for performing a GMAC authenticatication. The CryptoTransform operation `encode_datawriter_submessage` (in the case of a `DataWriter` endpoint) or `encode_datareader_submessage` (in the case of a `DataReader`) shall add additional GMAC authentication codes using the receiver-specific key material. If ***is_submessage_origin_authenticated*** is FALSE, the aforementioned operations shall not create additional key material and the CryptoTransform operation `encode_datawriter_submessage` (in the case of a `DataWriter` endpoint) or

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		`encode_datareader_submessage` (in the case of a `DataReader`) shall not add additional GMAC authentication codes.
is_payload_encrypted	Boolean	This field is only used if the EndpointSecurityConfig field ***is_payload_protected*** is TRUE. Otherwise it has no effect and it shall be set to FALSE. This field indicates to the DDS:Crypto:AES:GCM-GMAC plugin whether the payload shall be protected using authenticated encryption or only an authentication code. If ***is_payload_encrypted*** is TRUE, the CryptoKeyFactory `register_local_datawriter` (in the case of a DataWriter endpoint) or `register_local_datareader` (in the case of a DataReader endpoint) operation shall create key material for performing a GCM authenticated encryption and the CryptoTransform `encode_serialized_payload` operation shall apply the GCM authenticated encryption transformation. If ***is_payload_encrypted*** is FALSE, the aforementioned operations shall create key material for performing a GCM authenticated encryption and the CryptoTransform `encode_serialized_payload` operation shall apply the GCM authenticated encryption transformation.

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10.4.2.6 Definition of the PluginEndpointSecurityAttributesMask

The `PluginEndpointSecurityAttributesMask` is used to encode the value of the `PluginEndpointSecurityAttributes` in a compact way such that it can be included in the `EndpointSecurityInfo`, see 7.3.24.
As described in section 7.3.24, in order to communicate, two endpoints need to have the same `EndpointSecurityAttributesMask`. As as consequence the `PluginEndpointSecurityAttributesMask` must also be the same.
The default value for the mask is:

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```
#define  PLUGIN_ENDPOINT_SECURITY_ATTRIBUTES_MASK_DEFAULT 0
```

The mapping of the `PluginEndpointSecurityAttributes` to `PluginEndpointSecurityAttributesMask` is as follows:

Table 69 – Mapping of fields PluginEndpointSecurityAttributes to the PluginEndpointSecurityAttributesMask

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Field in `PluginEndpointSecurityAttributes`	Corresponding bit in the `PluginEndpointSecurityAttributesMask`
is_submessage_encrypted	#define PLUGIN_ENDPOINT_SECURITY_ATTRIBUTES_FLAG_IS_SUBMESSAGE_ENCRYPTED (0x00000001 << 0)
is_payload_encrypted	#define PLUGIN_ENDPOINT_SECURITY_ATTRIBUTES_FLAG_IS_PAYLOAD_ENCRYPTED (0x00000001 << 1)
is_submessage_origin_authenticated	#define PLUGIN_ENDPOINT_SECURITY_ATTRIBUTES_FLAG_IS_SUBMESSAGE_ORIGIN_AUTHENTICATED (0x00000001 <<2)

10.4.3 DDS:Access:Permissions plugin behavior

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

The DDS:Access:Permissions shall be initialized to have access to the Permissions CA public key. As this is a builtin plugin the mechanism for initialization is implementation dependent.

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The table below describes the actions that the DDS:Access:Permissions plugin performs when each of the plugin operations is invoked.

DDSSEC12-90 - Meeting CNSSP-15 security requirements
DDSSEC12-79 - Built-in Access Control: interpretation of enable_read/write_access_control
DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

Table 70 – Actions undertaken by the operations of the builtin AccessControl plugin

`check_create_participant`	This operation shall use the ***permissions_handle*** to retrieve the cached Permissions and Governance information. As a precondition, the Permissions document must contain a **Grant** for the DomainParticipant (otherwise, validate_local_permissions would have failed). If the `ParticipantSecurityConfig` has ***is_access_protected*** set to FALSE, then the operation shall succeed and return TRUE. If the Grant's first matching rule for the DomainParticipant's domain is an **allow** rule, then the operation shall succeed and return TRUE. If the Grant's first matching rule for the DomainParticipant's domain is a **deny** rule with no publish or subscribe rules, then the operation shall fail and return FALSE. If none of the previous conditions are true, then the operation shall return TRUE if the default is ALLOW and return FALSE otherwise.
`check_create_datawriter`	This operation shall use the ***permissions_handle*** to retrieve the cached Permissions and Governance information. If the Governance specifies a topic or topic-expression on the `DomainParticipant` ***domain_id*** matching the `DataWriter` topic with ***enable_write_access_control*** set to FALSE, then the operation shall succeed and return TRUE. If the Permissions document contains a Grant for the `DomainParticipant` allowing it to publish the `Topic` with specified ***topic_name*** on all the `Publisher`'s `PartitionQosPolicy` names and with all the tags in the `DataWriter DataTagQosPolicy`, then the operation shall succeed and return TRUE. Otherwise the operation shall return FALSE.
`check_create_datareader`	This operation shall use the ***permissions_handle*** to retrieve the cached Permissions and Governance information. If the Governance specifies a topic or topic-expression on the `DomainParticipant` ***domain_id*** matching the `DataReader` topic with ***enable_read_access_control*** set to FALSE, then the operation shall succeed and return TRUE. If the Permissions document contains a Grant for the `DomainParticipant` allowing it to subscribe the `Topic` with specified ***topic_name*** on all the `Subscriber`'s `PartitionQosPolicy` names and with all the tags in the `DataReader DataTagQosPolicy`, then the operation shall succeed and return TRUE. Otherwise the operation shall return FALSE.
`check_create_topic`	This operation shall use the ***permissions_handle*** to retrieve the cached Permissions and Governance information. If the Governance specifies a topic or topic-expression on the `DomainParticipant` ***domain_id*** matching the `Topic` name with ***enable_read_access_control*** set to FALSE or with ***enable_write_access_control*** set to FALSE, then the operation shall succeed and return TRUE. If the Permissions document contains a Grant for the `DomainParticipant` allowing it to publish the `Topic` with specified ***topic_name***, then the operation shall succeed and return TRUE. If the Permissions document contains a Grant for the `DomainParticipant` allowing it to subscribe the `Topic` with specified ***topic_name***, then the operation shall succeed and return TRUE. Otherwise the operation shall return FALSE.

Deleted: If the Governance specifies any topics on the `DomainParticipant` ***domain_id*** with ***enable_read_access_control*** set to FALSE or with ***enable_write_access_control*** set to FALSE, then the operation shall succeed and return TRUE.¶

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`check_local_datawriter_register_instance`	This operation shall return TRUE.
`check_local_datawriter_dispose_instance`	This operation shall return TRUE.
`check_remote_participant`	This operation shall use the ***permissions_handle*** to retrieve the cached local `DomainParticipant` Governance and the remote `DomainParticipant` Permissions information. As a precondition, the remote Permissions document must contain a Grant for the remote DomainParticipant (otherwise, validate_remote_permissions would have failed). If the `ParticipantSecurityConfig` has ***is_access_protected*** set to FALSE, then the operation shall succeed and return TRUE. If the ***PluginClassName*** or the ***MajorVersion*** of the ***local permissions_token*** differ from those in the ***remote_permissions_token***, the operation shall return FALSE. If the Grant's first matching rule for the remote DomainParticipant's domain is an **allow** rule, then the operation shall succeed and return TRUE. If the Grant's first matching rule for the remote DomainParticipant's domain is a **deny** rule with no publish or subscribe rules, then the operation shall fail and return FALSE. If none of the previous conditions are true, then the operation shall return TRUE if the default is ALLOW and return FALSE otherwise.
`check_remote_datawriter`	This operation shall use the ***permissions_handle*** to retrieve the cached local `DomainParticipant` Governance and the remote `DomainParticipant` Permissions information. If the Governance specifies a topic or topic-expression on the `DomainParticipant` ***domain_id*** matching the remote `DataWriter` topic with ***enable_write_access_control*** set to FALSE, then the operation shall succeed and return TRUE. If the ***PluginClassName*** or the ***MajorVersion*** of the ***local permissions_token*** differ from those in the ***remote_permissions_token***, the operation shall return FALSE. If the remote `DomainParticipant` Permissions document contains a Grant allowing it to publish the `DataWriter`'s ***topic_name*** on all the remote `Publisher`'s `PartitionQosPolicy` names and with all the tags in the remote `DataWriter DataTagQosPolicy`, then the operation shall succeed and return TRUE. Otherwise the operation shall return FALSE.
`check_remote_datareader`	This operation shall use the ***permissions_handle*** to retrieve the cached local `DomainParticipant` Governance and the remote `DomainParticipant` Permissions information. If the Governance specifies a topic or topic-expression on the `DomainParticipant` ***domain_id*** matching the remote `DataReader` topic with ***enable_read_access_control*** set to FALSE, then the operation shall succeed, set the 'allow_relay_only' output parameter to FALSE, and return TRUE. If the ***PluginClassName*** or the ***MajorVersion*** of the ***local permissions_token*** differ from those in the ***remote_permissions_token***, the operation shall return FALSE. If the Permissions document contains a Grant for the remote `DomainParticipant` allowing it to subscribe the `DataReader`'s ***topic_name*** on all the `Subscriber`'s `PartitionQosPolicy` names and with all the tags in the `DataReader DataTagQosPolicy`, then

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If the Permissions document contains a Grant for the remote `DomainParticipant` and the Grant contains an allow rule on the `DomainParticipant` ***domain_id***, then the operation shall succeed and return TRUE.¶
Otherwise the operation shall return FALSE.

	the operation shall succeed, set the ‘allow_relay_only’ output parameter to FALSE, and return TRUE. If the Permissions document contains a Grant for the remote `DomainParticipant` allowing it to ‘relay’ the `DataReader`’s ***topic_name***, the operation shall return TRUE and also set the ‘allow_relay_only’ output parameter to TRUE. Otherwise the operation shall return FALSE.
`check_remote_topic`	This operation shall use the ***permissions_handle*** to retrieve the cached local `DomainParticipant` Governance and the remote `DomainParticipant`Permissions information. If the Governance specifies a topic or topic-expression on the `DomainParticipant` ***domain_id*** matching the `Topic` name with ***enable_read_access_control*** set to FALSE or with ***enable_write_access_control*** set to FALSE, then the operation shall succeed and return TRUE. If the ***PluginClassName*** or the ***MajorVersion*** of the ***local permissions_token*** differ from those in the ***remote_permissions_token***, the operation shall return FALSE. If the Permissions document contains a Grant for the `DomainParticipant` allowing it to publish the `Topic` with specified ***topic_name***, then the operation shall succeed and return TRUE. If the Permissions document contains a Grant for the `DomainParticipant` allowing it to subscribe the `Topic` with specified ***topic_name***, then the operation shall succeed and return TRUE. Otherwise the operation shall return FALSE.
`check_local_datawriter_match`	This operation shall return TRUE.
`check_local_datareader_match`	This operation shall return TRUE.
`check_remote_datawriter_register_instance`	This operation shall return TRUE.
`check_remote_datawriter_dispose_instance`	This operation shall return TRUE.
`get_permissions_token`	This operation shall return the `PermissionsToken` formatted as described in 10.4.2.2.
`get_permissions_credential_token`	This operation shall return the `PermissionsToken` formatted as described in 10.4.2.1
`set_listener`	This operation shall save a reference to the listener object and associate it with the specified `PermissionsHandle`.
`return_permissions_token`	This operation shall behave as specified in 9.4.2.9.20
`return_permissions_credential_token`	This operation shall behave as specified in 9.4.2.9.21
`validate_local_permissions`	This operation shall receive the DomainId and `DomainParticipantQos` from which it can access the Identity

	Certificate, Signed Domain Governance and Signed Permissions document. The operation shall check the subject name in the Identity Certificate matches the one from the Signed Permissions document. The operation shall verify the signature of the Signed Domain Governance and Signed Permissions document by the configured Permissions CA. If all of these succeed, the operation shall cache the Permissions (see 10.4.1.5.2) from the certificate and return an opaque handle that the plugin can use to refer to the saved information. Otherwise the operation shall return an error.
`validate_remote_permissions`	This operation shall invoke the operation `get_authenticated_peer_credential_token` on the ***auth_plugin*** passing the ***remote_identity_handle*** to retrieve the `AuthenticatedPeerCredentialToken` (see 10.3.2.3) for the remote `DomainParticipant`. The `AuthenticatedPeerCredentialToken` contains both the Identity Certificate and the Signed Permissions Document obtained from the remote DomainParticipant during the Authentication. The operation shall check the subject name in the Signed Permissions Document matches the one in the Identity Certificate. The operation shall verify the signature of the Signed Permissions Document by the configured Permissions CA. If all of these succeed, the operation shall cache the Permission Section from the Signed Permissions Document and return an opaque handle that the plugin can use to refer to the saved information. Otherwise the operation shall return an error.
`get_participant_security_config`	This operation shall use the ***permissions_handle*** to retrieve the cached Permissions and Governance information. Based on the Governance document rules for the `DomainParticipant` ***domain_id*** the operation shall fill the ***attributes*** output parameter. The fields of the `ParticipantSecurityConfig` ***attributes*** shall be set according to the following rules: If the Governance document has the element ***allow_unauthenticated_participants*** set to FALSE, the ***attributes*** field ***allow_unauthenticated_participants*** shall be set to FALSE. Otherwise the field shall be set to TRUE. If the Governance document has the element ***enable_join_access_control*** set to FALSE, the ***attributes*** field ***is_access_protected*** shall be set to FALSE. Otherwise the field shall be set to TRUE. If the Governance document has the element ***rtps_protection_kind*** set to NONE, the ***attributes*** field ***is_rtps_axk_protected*** shall be set to FALSE. Otherwise the field shall be set to TRUE. If the Governance document does not have the XML element <***allowed_crypto_algorithms***> the ***algorithm_info*** shall have the "supported_mask" field corresponding each of the algorithm types set to CRYPTO_ALGORITHM_SET_ALL defined in 7.3.9, representing that there are no constraints on the supported algorithms. If the Governance document has the XML element <***key_establishment***>, the ***algorithm_info*** shall have the ***key_establishment.supported_mask*** field set field set according to the algorithms that appear in the XML element. Otherwise the mask shall be set to CRYPTO_ALGORITHM_SET_ALL. If the Governance document has the XML element <***symmetric_cipher***>, the ***algorithm_info*** shall have the ***symmetric_cipher.supported_mask*** field set set according to the algorithms that appear in the XML element. Otherwise mask shall be set to CRYPTO_ALGORITHM_SET_ALL.

	If the Governance document has the XML element <***digital_signature***>, the ***algorithm_info*** shall have the ***digital_signature.message_auth.supported_mask*** field set according to the algorithms that appear in the XML element. Otherwise the mask shall be set to CRYPTO_ALGORITHM_SET_ALL. If the Governance document has the XML element <***digital_signature_identity_trust_chain***>, the ***algorithm_info*** shall have the ***digital_signature.trust_chain.supported_mask*** field set according to the algorithms that apear in the XML element. Otherwise the mask shall be set to the same value as the ***digital_signature.message_auth.supported_mask***. The ***digital_signature.trust_chain.required_mask*** shall be set to represent the set of digital signature algorithms that appear in the Identity Certificate and the CRYPTO_ALGORITHM_COMPATIBILITY_MODE bit shall be set if there are 2 or more algorithms. If any of the algorithms in the ***digital_signature.trust_chain.required_mask*** is not present in the ***digital_signature.trust_chain.supported_mask*** the opearion shall return an error. The ***digital_signature.message_auth.required_mask*** shall be set to CRYPTO_ALGORITHM_SET_EMPTY. The ***key_establishment.required_mask*** and ***symmetric_cipher.required_mask*** and shall both be set to CRYPTO_ALGORITHM_SET_EMPTY.
`return_participant_security_config`	This operation shall behave as specified in 9.4.2.9.26.
`return_topic_security_config`	This operation shall behave as specified in 9.4.2.9.27
`return_datawriter_security_config`	This operation shall behave as specified in 9.4.2.9.28.
`return_datareader_security_config`	This operation shall behave as specified in 9.4.2.9.29.

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10.5 Builtin Crypto: DDS:Crypto:AES-GCM-GMAC

DDSSEC12-90 - Meeting CNSSP-15 security requirements

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

This builtin `Cryptographic` plugin is referred to as "DDS:Crypto:AES-GCM-GMAC" plugin. This plugin does Authenticated Encryption with Associated Data (AEAD) using Advanced Encryption Standard with Galois Counter Mode (AES-GCM/GMAC), see 8.1 for more details.

The use of (Galois) counter mode allows authenticated decryption of blocks in arbitrary order. All that is needed to decrypt and validate the authentication tag are the Key and the Initialization Vector. This is very important for DDS because a `DataReader` may not receive all the samples written by a matched `DataWriter`. The use of DDS `ContentFilteredTopics` as well as DDS QoS policies such as `History` (with KEEP_LAST kind), `Reliability` (with BEST_EFFORTS kind), `Lifespan`, and `TimeBasedFilter`, among others, can result in a `DataReader` receiving a subset of the samples written by a `DataWriter`.

The AES-GCM transformation produces both the ciphertext and a message authentication code (MAC) using the same secret key. This is sufficient to protect the plaintext and ensure integrity. However, there are situations where multiple MACs are required. For example, when a DataWriter shares the same Key with multiple DataReaders and, in spite of this, the DataWriter needs to ensure message-origin authentication. In this situation the DataWriter should create a separate "reader-specific key" used only for authentication and append additional reader-specific MACs, each computed with one of the reader-specific keys.

10.5.1 Configuration

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The DDS:Crypto:AES-GCM-GMAC plugin shall be configured using the `PropertyQosPolicy` of the `DomainParticipantQos`, `DataWriterQos`, or `DataReaderQos`. The specific properties used are described in Table 50 below.

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Table 71 – Properties used to configure the builtin Crypto plugin

Property Name *(all properties have "dds.sec.crypto." prefix)*	***Property Value*** *(all these properties shall have propagate set to FALSE)*	***Applicable Entities***
symmetric_cipher_algorithm (the presence of this property is optional)	The string "AUTO" or one of the `CryptoAlgorithmName` strings shown in Table 22 that identifies a Symmetric Cipher AEAD and MAC Algorithm. If not specified it is treated as if it was specified to be "AUTO". If "AUTO" is specified it is treated as if it was specified to be "AES256-GCM". This property must be configured consistently on all the DomainParticipants that join a DDS Domain.	DomainParticipant DataWriter DataReader

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¶
The definition of the AES-GCM and AES-GMAC transformations shall be as specified in NIST SP 800-38D [45] specialized to 128-bit and 256-bit AES keys with 96-bit Initialization Vector. The most relevant aspects are summarized below.¶
¶
The AES-GCM authenticated encryption operation is a transformation that takes the four inputs and produces two outputs, symbolically:¶
`C, T = AES-GCM(K, P, AAD, IV)`¶
The AES-GCM inputs are described in Table 64 below.¶
Table 64 – AES-GCM transformation inputs¶
Input ...

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rtps_psk_symmetric_cipher_algorithm (the presence of this property is optional)	The string "AUTO" or one of the `CryptoAlgorithmName` strings shown in Table 22 that identifies a pair of Symmetric Cipher AEAD and MAC Algorithms. If not specified it is treated as if it was specified to be "AUTO". If "AUTO" is specified it is treated as if it was specified to be "AES256-GCM". This property must be configured consistently on all the DomainParticipants that join a DDS Domain.	DomainParticipant

rtps_psk_secret_passphrase
 	
(the presence of this property is optional)
	Setting this property enables pre-shared-key (PSK) protection. See 10.4.1.2.5.8.
	
	The property specifies the URI to access the ***passphrase_id*** and ***passphrase*** that is used to protect RTPS messages using a pre-shared key..
	
	The ***passphrase_id*** shall be a number between 0 and 2^{32}-1 represented as a decimal string. The ***passphrase_id*** shall immediately follow the URI schema, after the character(s) used to delimit the URI schema, e.g. ':' or ':,'.
	
	The range of ***passphrase_id*** that verify ***passphrase_id* && 0xFF== 0xFF** is reserved and shall not be used.
	
	The ***passphrase*** shall contain up to 512 ASCII printable characters (character codes 32 to 126, both included), except that the first and last characters of the ***passphrase*** shall not be the space character (character codes 32)
	The ***passphrase*** shall follow the ***passphrase_id*** be and separated from it by the ':' character.
	
	The ***passphrase_id*** and ***passphrase*** must be configured consistently on all the DomainParticipants that join the DDS Domain.
	
	Supported URI schemas are: "file" and "data".
	
	Examples:
	`file:myfile.txt`
	`file:/home/myuser/myfile.txt`
	
	`data:,5612:Open Sesame`
	
	Here the ***passphrase_id*** is 5612 and the ***passphase*** is "Open Sesame"
	
	In the above example, in order to specify the same configuration, the content of the file **myfile.txt** should be the string:
	`5612:Open Sesame`
		DomainParticipant

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rtps_psk_secret_passphrase_extra
 	
(the presence of this property is optional. This property is ignored is the rtps_psk_secret_passphrase is not present)
	URI to access a list of additional ***passphrase id*** and ***passphrase*** values that are also accepted during decoding. This is intended to allow replacing the pre-shared keys system-wide while the system remains in operation.
	
	The URIs accepted are the same used for the `rtps_psk.secret_passphrase` property.
	
	If multiple passphrases are provided each ***secret passphrase id*** and ***passphrase*** tuple shall be separated from the next using the LineFeed (\n, character 10), the CarryReturn (\r, character 13), or both.
	For example:
	`data:,5613:ExtraSecretPassphase`
	`5614:AnotherSecretPassphase`
	`5615:YetAnotherSecretPassphase`
		DomainParticipant

10.5.1.1 Symmetric Cipher Algorithm

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If used in the `DomainParticipantQos`, it configures multiple things:

- The Symmetric Cipher Algorithm Pair that the `DomainParticipant` will use to protect the secure builtin endpoints (with the exception of the SecureVolatile).
- The default Symmetric Cipher Algorithm Pair used by `DataWriters` and `DataReaders` in the `DomainParticipant` that will be used unless it is overridden by a configuration in a specific `DataWriterQos` or `DataReaderQos`.
- The default Symmetric Cipher Algorithm Pair used by for RTPS Message Protection, assuming it is enabled.
- The default Symmetric Cipher Algorithm Pair used by for RTPS PSK Message Protection, assuming it is enabled.

If used in a `DataWriterQos` or `DataReaderQos` it configures the symmetric cipher used by that specific `DataWriter` or `DataReader`, overriding any default configuration that may have been set on the `DomainParticipantQos`. If the property is omitted or set to AUTO on the `PropertyQosPolicy` of a `DataWriterQos` or `DataReaderQos` the default specified for the `DomainParticipant` will apply to the corresponding `DataWriter` or `DataReader`.
The Symmetric Cipher Algorithm shall be one of the algorithms defined in 8.1.

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Deleted: If the ***symmetric_cipher_algorithm*** property is omitted or has its value set to "AUTO" in the `PropertyQosPolicy` of the `DomainParticipantQos`, the selection of the symmetric cipher algorithm used will be left to the `Cryptographic` plugin implementation.¶

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10.5.1.2 PSK Symmetric Cipher Algorithm

DDSSEC12-94 – Provide Pre-Shared Key Protection

Configures the Cipher Algorithm Pair that the `DomainParticipant` will use to protect RTPS Messages with a pre-shared Key.
The algorithm selected will be reflected in the ***transformation_algorithm_id*** field that appears in the `CryptoTransformIdentifier` of the protected RTPS Messages.

10.5.1.3 PSK Secret Passphrase

DDSSEC12-94 – Provide Pre-Shared Key Protection

Configures the KeyMaterial and CryptoTransformKeyId and CryptoTransformKeyRevision used by the operation encode_rtps_message when the parameter **transform_with_psk** is set to true. Note that the CryptoTransformKeyId and CryptoTransformKeyRevision both appear within the CryptoTransformIdentifier.

The same KeyMaterial shall also be used to by the operation decode_rtps_message when the CryptoHeader indicates it has been protected with a pre-shared key when the CryptoTransformIdentifier contains matching values for the CryptoTransformKeyId and CryptoTransformKeyRevision.

The derivation of the CryptoTransformKeyId, CryptoTransformKeyRevision and KeyMaterial from the secret passphrase shall be as specified in 10.5.2.1.3.

10.5.1.4 PSK Secret Passphrase Alternative

DDSSEC12-94 – Provide Pre-Shared Key Protection

Configures alternative values for the KeyMaterial, CryptoTransformKeyId and CryptoTransformKeyRevision used to decrypt/authenticate received RTPS Messages protected with a pre-shared Key. That is the transformation performed by the operation decode_rtps_message when the context indicates they have been protected with a pre-shared key.

The derivation of the CryptoTransformKeyId, CryptoTransformKeyRevision and KeyMaterial from the secret passphrase alternative shall be as specified in 10.5.2.1.3.

10.5.2 DDS:Crypto:AES-GCM-GMAC Types

The Cryptographic plugin defines a set of generic data types to be used to initialize the plugin and to externalize the properties and material that must be shared with the applications that need to decode the cipher material, verify signatures, etc.

Each plugin implementation defines the contents of these types in a manner appropriate for the algorithms it uses. All "Handle" types are local opaque handles that are only understood by the local plugin objects that create or use them. The remaining types shall be fully specified so that independent implementations of DDS:Crypto:AES-GCM-GMAC can interoperate.

10.5.2.1 DDS:Crypto:AES-GCM-GMAC CryptoToken

The DDS:Crypto:AES-GCM-GMAC plugin shall set the attributes of the CryptoToken object as specified in the table below:

Table 72 – CryptoToken class for the builtin Cryptographic plugin

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Attribute name	*Attribute value*	
class_id	"DDS:Crypto:AES_GCM_GMAC"	
binary_properties	*name*	*value*
	dds.cryp.keymat	The Big Endian CDR Serialization of the KeyMaterial_AES_GCM_GMAC structure defined below.

10.5.2.1.1 KeyMaterial_AES_GCM_GMAC structure

The contents and serialization of the KeyMaterial_AES_GCM_GMAC structure are described by the Extended IDL below.

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Note: The types `CryptoTransformKind` and `CryptoTransformKeyId` were defined in 7.3.18 and 7.3.19. The acceptable values for `CryptoAlgorithmId` are defined in 8.1.

```
@extensibility(FINAL)
struct KeyMaterial_AES_GCM_GMAC {
    CryptoTransformKind  transformation_kind;
    sequence<octet, 32>  master_salt;

    CryptoTransformKeyId sender_key_id;
    sequence<octet, 32>  master_sender_key;

    CryptoTransformKeyId receiver_specific_key_id;
    sequence<octet, 32>  master_receiver_specific_key;
};

typedef
sequence<KeyMaterial_AES_GCM_GMAC> KeyMaterial_AES_GCM_GMAC_Seq;
```

A zero value for ***receiver_specific_key_id*** indicates there is no receiver-specific authentication tags and shall occur if and only if the length of the ***master_receiver_specific_key*** is also zero.

10.5.2.1.2 Key material used by the BuiltinParticipantVolatileMessageSecureWriter and BuiltinParticipantVolatileMessageSecureReader

The Key Material used by the ***BuiltinParticipantVolatileMessageSecureWriter*** and ***BuiltinParticipantVolatileMessageSecureReader*** shall be derived from the `SharedSecret` obtained as part of the authentication process. The attributes of the `KeyMaterial_AES_GCM_GMAC` shall be set as described in Table 73 below. This uses HMAC-Based Key Derivation (HKDF) recommended in IETF RFC 5869 [50].

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Table 73 – KeyMaterial_AES_GCM_GMAC for BuiltinParticipantVolatileMessageSecureWriter and BuiltinParticipantVolatileMessageSecureReader

Attribute name	*Attribute value*
transformation_kind	Set transformation_algorithm_id to CRYPTO_ALGORITHM_ID_AES256_GCM
master_salt	HMACsha256 (sha256(Challenge1 | KxSaltCookie | Challenge2) , SharedSecret) The parameters to the above functions are defined in Table 74 In the case where transformation_kind. member transformation_algorithm_id is CRYPTO_ALGORITHM_ID_AES128_GCM this is truncated to the first 128 bits.
sender_key_id	0
master_sender_key	HMACsha256 (sha256(Challenge2 | KxKeyCookie | Challenge1) , SharedSecret) The parameters to the above functions are defined in Table 74 In the case where transformation_kind member transformation_algorithm_id is CRYPTO_ALGORITHM_ID_AES128_GCM this is truncated to the first 128 bits.
receiver_specific_key_id	0
master_receiver_specific_key	Zero-length sequence

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Table 74 – Terms used in KxKey and KxMacKey derivation formula for the builtin Cryptographic plugin

Term	*Meaning*
Challenge1	The challenge that was sent in the ***challenge1*** attribute of the `HandshakeRequestMessageToken` as part of the Authentication protocol. This information shall be accessible from the `SharedSecretHandle`.

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```
/* Valid values for CryptoTransformKind */

/* No encryption, no authentication tag */
#define CRYPTO_TRANSFORMATION_KIND_NONE {0, 0, 0, 0}

/* No encryption.
   One AES128-GMAC authentication tag using the sender_key
   Zero or more AES128-GMAC auth. tags with receiver keys */
#define CRYPTO_TRANSFORMATION_KIND_AES128_GMAC {0, 0, 0, 1}

/* Authenticated Encryption using AES-128 in Galois Counter Mode
   (GCM) using the sender key.
   The authentication tag using the sender_key obtained from GCM
   Zero or more AES128-GMAC auth. tags with receiver keys */
#define CRYPTO_TRANSFORMATION_KIND_AES128_GCM {0, 0, 0, 2}

/* No encryption.
   One AES256-GMAC authentication tag using the sender_key
   Zero or more AES256-GMAC auth. tags with receiver keys */
#define CRYPTO_TRANSFORMATION_KIND_AES256_GMAC {0, 0, 0, 3}

/* Authenticated Encryption using AES-256 in Galois Counter Mode
   (GCM) using the sender key.
   The authentication tag using the sender_key obtained from GCM
   Zero or more AES256-GMAC auth. tags with receiver keys */
#define CRYPTO_TRANSFORMATION_KIND_AES256_GCM {0, 0, 0, 4}
```

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Challenge2	The challenge that was sent in the ***challenge2*** attribute of the `HandshakeReplyMessageToken` as part of the Authentication protocol. This information shall be accessible from the `SharedSecretHandle`.
SharedSecret	The shared secret established as part of the key agreement protocol. This information shall be accessible from the `SharedSecretHandle`.
KxKeyCookie	The 16 bytes in the string "key exchange key"
KxSaltCookie	The 16 bytes in the string "keyexchange salt"
data1 | data2 | data3	The symbol '|' is used to indicate byte string concatenation
HMACsha256(key, data)	Computes the hash-based message authentication code on 'data' using the key specified as first argument and a SHA256 hash as defined in [27]. When the 'data' is a string, it is passed to the function a the raw array of characters treted as bytes without any leading "length" or terminating "nul" character.

10.5.2.1.3 Key material used by the RTPS Pre-Shared Key (PSK) Protection

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

The `KeyMaterial` used by the RTPS PSK Protection (ParticipantPSKMaterial) shall be derived from the Pre-Shared Secret (a.k.a. Pre-Shared-Key) configured for the Participant.

The attributes of the `KeyMaterial_AES_GCM_GMAC` shall be set as described in Table 75 and Table 76 below. This uses HMAC-Based Key Derivation (HKDF) recommended in IETF RFC 5869 [52].

Table 75 – KeyMaterial_AES_GCM_GMAC for RTPS Pre Shared Key (PSK) Protection

Attribute name	*Attribute value*

transformation_kind
 	
nested attribute:
transformation_algorithm_id
	Set the ***transformation_algorithm_id*** to one of the following `CryptoAlgorithmId` values (see section 8.1):
	`CRYPTO_ALGORITHM_ID_NONE`
	`CRYPTO_ALGORITHM_ID_AES128_GMAC`
	`CRYPTO_ALGORITHM_ID_AES128_GCM`
	`CRYPTO_ALGORITHM_ID_AES256_GMAC`
	`CRYPTO_ALGORITHM_ID_AES256_GCM`
	The `CryptoAlgorithmId` variants containing AES128 in their name indicate that the encryption and/or authentication use AES with 128-bit key as the underlaying cryptographic engine. These variants shall have ***master_sender_key*** with 16 octets in length.
	The variants containing AES256 in their name indicate that the encryption and/or authentication use AES with 256-bit key as the underlaying cryptographic engine. These variants shall have ***master_sender_key*** with 32 octets in length.
	The variants with name ending with GCM indicate that the transformation is the standard authenticated encryption operation known as AES-GCM (AES using Galois Counter Mode) where the plaintext is encrypted and followed by an authentication tag computed using the same secret key.
	The variants ending in GMAC indicate that there is no encryption (i.e., the ciphertext matches the input plaintext) and there is an authentication tag computed using the sender key that is shared with all the readers.

transformation_kind nested attribute: transformation_key_revision	**PassphraseKeyId** This value is defined in Table 76.
master_salt	**HMACsha256(HMACsha256(**"PSK-SALT" | **SenderKeyId** | "RTPS" | **ProtocolVersion | VendorId | GuidPrefix, PreSharedSecret), "**master salt derivation" | **0x01)** The parameters to the above functions are defined in Table 76.

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	In the case where transformation_kind member transformation_algorithm_id is CRYPTO_ALGORITHM_ID_AES128_GMAC or CRYPTO_ALGORITHM_ID_AES128_GCM this is truncated to the first 128 bits.
sender_key_id	**SenderKeyId** This value is defined in Table 76.
master_sender_key	**HMACsha256(HMACsha256(**"PSK-SKEY" **| SenderKeyId |** "RTPS" **| ProtocolVersion | VendorId | GuidPrefix, PreSharedSecret), "**master sender key derivation"**| 0x01)** The parameters to the above functions are defined in Table 76. In the case where transformation_kind member transformation_algorithm_id is CRYPTO_ALGORITHM_ID_AES128_GMAC or CRYPTO_ALGORITHM_ID_AES128_GCM this is truncated to the first 128 bits.
receiver_specific_key_id	0
master_receiver_specific_key	Zero-length sequence

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Table 76 – Terms used in the RTPS PSK Protection derivation formula for the builtin Cryptographic plugin

Term	*Meaning*
"ASCII TEXT"	Well-known text string.
Sha256(data)	Computes the hash on 'data' using the SHA256 hash as defined in [27]. When the 'data' is a string, it is passed to the function as a byte buffer, one ASCII character per byte, without any leading "length" or terminating "nul" character.
HMACsha256(key, data)	Computes the hash-based message authentication code on 'data' using the key specified as first argument and a SHA256 hash as defined in [27]. When the 'data' is a string, it is passed to the function as a byte buffer, one ASCII character per byte, without any leading "length" or terminating "nul" character.
data1 | data2 | data3	The symbol '|' is used to indicate byte string concatenation
DomainId	The decimal string representation of the DDS DomainId for the DomainParticipant.
DomainTag	The string containing the DDS DomainTag of the DomainParticipant. Note the special case where DomainTag is the emtpy string is allowed.
GuidPrefix	12 bytes matching the GUID Prefix that will appear in the RTPS Header of the RTPS messages protected with the derived key material.
PassphraseId	The integer value resulting from interpreting the ***passphrase_id*** configured in the property ***dds.sec.crypto.psk.secret_passphrase*** as decimal integer. For example,e if the property is set to `data:,5612:Open Sesame` The **PassphaseId** would be the integer 5612.
PassphraseKeyId	Single byte computed as specified below: **PassphraseKeyId** = **PassphraseId** & 0xFF

PassphraseKeyRevision	The CryptoTransformKeyRevision (7.3.17) value computed as specified below:
	`PassphraseRevision[0] = (PassphraseId >> 24) & 0xFF`
	`PassphraseRevision[1] = (PassphraseId >> 16) & 0xFF`
	`PassphraseRevision[2] = (PassphraseId >>  8) & 0xFF`

PassphraseSecret	**Text string:** The pre-shared secret (a.k.a. PSK or passphrase) configured on all DomainParticipants intended to join the same PSK-protected Domain. This string shall match the ***passphrase*** configured on the Cryptographic plugin using the property "***dds.sec.crypto.psk.secret_passphrase***" , see 10.5.1 When the string is passed to a function that expects an array of octets, it is treated as. an array of characters without any leading "length" or terminating "nul" character. For example if the ***dds.sec.crypto.psk.secret_passphrase*** property is set to `data:,5612:Open Sesame`

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	The **PassphaseSecret** would be the string "Open Sesame"
ProtocolVersion	2 bytes matching the Protocol Version that will appear in the RTPS Header of the RTPS messages being protected with the derived key material.
SenderKeyId	Four-byte array. The first 3 bytes are the first 3 bytes resulting from the **Sha256("**DomainId=" **| DomainId |** ";DomainTag=" **| DomainTag)** The last byte is set to the **PassphraseKeyId**.
VendorId	2 bytes matching the Vendor Id that will appear in the RTPS Header of the RTPS messages protected with the derived key material.

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Example derivation of the Key Material from a pre-shared secret:

dds.sec.crypto.psk.secret_passphrase=data:,5632:castle super radar denial swing lunar kind swarm wet toilet output harbor basic begin margin huge year visit

INPUTS:

```
    Property dds.sec.crypto.psk.secret_passphrase =
data:,5632:castle super radar denial swing lunar kind swarm wet toilet
output harbor basic begin margin huge year visit
    DomainId = 201
    DomainTag =""
    ProtocolVersion = {0x02, 0x05}
    VendorId = {0x01, 0x01}
    GuidPrefix = {DF, CD, 91, E1, 68, 68, 04, 51, 6C, B1, B6, 0E}
```

OUTPUTS:

```
  PassphraseSecret = "castle super radar denial swing lunar kind swarm wet
toilet output harbor basic begin margin huge year visit"

  PassphraseId     = 5632 = 0x1600
  PassphraseKeyId = 5632 & 0xFF = 0x1600 & 0XFF = 0x00
  PassphraseKeyRevision = {0x00, 0x00, 0x16} = {0, 0, 22}

  SenderKeyId:
    sha256("DomainId=201;DomainTag=") =
           61c853ac1adb0af119364e30f74271fc16a57608e2aca13f74bcd343e9ec5a2a
  SenderKeyId = {{0x61, 0xC8, 0x53}, PassphraseKeyId}
  SenderKeyId = {0x61, 0xC8, 0x53, 0x00}

  master_salt =
    HMACsha256(
      HMACsha256(
        "PSK-SALT" | SenderKeyId | "RTPS" | ProtocolVersion | VendorId |
GuidPrefix,
        PassphraseSecret),
      "master salt derivation" | 0x01 )

  master_salt =
    HMACsha256(
      HMACsha256(
```

```
        50 53 4B 2D 53 41 4C 54 | 61 C8 53 00 | 52 54 50 53 | 02 05 | 01 01
| DF CD 91 E1 68 68 04 51 6C B1 B6 0E,
        63 61 73 74 6C 65 20 73 75 70 65 72 20 72 61 64 61 72 20 64 65 6E
69 61 6C 20 73 77 69 6E 67 20 6C 75 6E 61 72 20 6B 69 6E 64 20 73 77 61 72
6D 20 77 65 74 20 74 6F 69 6C 65 74 20 6F 75 74 70 75 74 20 68 61 72 62 6F
72 20 62 61 73 69 63 20 62 65 67 69 6E 20 6D 61 72 67 69 6E 20 68 75 67 65
20 79 65 61 72 20 76 69 73 69 74),
        6D 61 73 74 65 72 20 73 61 6C 74 20 64 65 72 69 76 61 74 69 6F 6E |
01)

  master_salt =
a4ebff5738dc6826c8d3f5e55a24bb96d9e80147b51c4e49a0927c4fa2cfec8c

  master_sender_key =
    HMACsha256(
      HMACsha256(
        "PSK-SKEY" | SenderKeyId | "RTPS" | ProtocolVersion | VendorId |
GuidPrefix,
        PassphraseSecret),
      "master sender key derivation" | 0x01 )

  master_sender_key =
    HMACsha256(
      HMACsha256(
        50 53 4B 2D 53 4B 45 59 | 61 C8 53 00 | 52 54 50 53 | 02 05 | 01 01
| DF CD 91 E1 68 68 04 51 6C B1 B6 0E,
        63 61 73 74 6C 65 20 73 75 70 65 72 20 72 61 64 61 72 20 64 65 6E
69 61 6C 20 73 77 69 6E 67 20 6C 75 6E 61 72 20 6B 69 6E 64 20 73 77 61 72
6D 20 77 65 74 20 74 6F 69 6C 65 74 20 6F 75 74 70 75 74 20 68 61 72 62 6F
72 20 62 61 73 69 63 20 62 65 67 69 6E 20 6D 61 72 67 69 6E 20 68 75 67 65
20 79 65 61 72 20 76 69 73 69 74),
        6D 61 73 74 65 72 20 73 65 6E 64 65 72 20 6B 65 79 20 64 65 72 69
76 61 74 69 6F 6E | 01)

  master_sender_key =
4708460adc6bb886521fbdc4b3a9d34e27eed36c162ccdf4fb7427a7f347738b
```

10.5.2.2 DDS:Crypto:AES-GCM-GMAC CryptoTransformIdentifier

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DDSSEC12-90 - Meeting CNSSP-15 security requirements

The DDS:Crypto:AES-GCM-GMAC shall set the `CryptoTransformIdentifier` attributes as specified in the table below:

DDSSEC12-122 – Provide mechanism for changing the session keys

Table 77 – CryptoTransformIdentifier class for the builtin Cryptographic plugin

Attribute	*Value*

`transformation_kind`	Set the ***transformation_algorithm*** field to one of the following values (see section 8.1):
	`CRYPTO_ALGORITHM_ID_NONE`
	`CRYPTO_ALGORITHM_ID_AES128_GMAC`
	`CRYPTO_ALGORITHM_ID_AES128_GCM`
	`CRYPTO_ALGORITHM_ID_AES256_GMAC`
	`CRYPTO_ALGORITHM_ID_AES256_GCM`

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	The variants containing AES128 in their name indicate that the encryption and/or authentication use AES with 128-bit key as the underlaying cryptographic engine. These variants shall have ***master_sender_key*** with 16 octets in length and ***master_receiver_specific_key*** with either zero or 16 octets in length. The variants containing AES256 in their name indicate that the encryption and/or authentication use AES with 256-bit key as the underlaying cryptographic engine. These variants shall have ***master_sender_key*** with 32 octets in length and ***master_receiver_specific_key*** with either zero or 32 octets in length. The variants with name ending with GCM indicate that the transformation is the standard authenticated encryption operation known as AES-GCM (AES using Galois Counter Mode) where the plaintext is encrypted and followed by an authentication tag computed using the same secret key. These variants may contain zero or more receiver-specific authentication tags. If ***receiver_specific_key_id*** is set to zero there shall be no receiver-specific tags otherwise there shall be one or more receiver-specific tags. The variants ending in GMAC indicate that there is no encryption (i.e., the ***ciphertext*** matches the input ***plaintext***) and there is an authentication tag computed using the sender key that is shared with all the readers. These variants may contain zero or more receiver-specific authentication tags. If ***receiver_specific_key_id*** is set to zero there shall be no receiver-specific tags otherwise there shall be one or more receiver-specific tags. Set the ***transformation_key_revision*** field to the value {0, 0, 0} the first time Key Material is produced for a specific value of the `transformation_key_id`. Subsequent generation of the Key Material for that same `transformation_key_id` should increment the ***transformation_key_revision***, starting from the last Byte, as in {0x00, 0x00, 0x01}, {0x00, 0x00, 0x02}, etc. until {0xFF, 0xFF, 0xFF} and then roll-over to {0x00, 0x00, 0x01} again.
`transformation_key_id`	This is set to a different value each time new Key Material is produced by a `DomainParticipant`. The algorithm used is implementation specific but it shall avoid repeating the values for the same `DomainParticipant`. This value is not modified for the Key Material created by the `revise_local_entity_keys` operation..

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10.5.2.3 DDS:Crypto:AES-GCM-GMAC CryptoHeader

The DDS:Crypto:AES-GCM-GMAC `CryptoTransform` interface has several operations that transform `plain` text into `cipher` text. The cipher-text created by these "encode" operations contains a `CryptoHeader` that is interpreted by the corresponding "decode" operations on the receiving side.

The `CryptoHeader` structure is described by the Extended IDL below:

```
// Serialized as Big Endian
@extensibility(FINAL)
struct CryptoHeader {
    CryptoTransformIdentifier transform_identifier;
    octet                     session_id[4];
    octet                     initialization_vector_suffix[8];
};
```

As indicated by the IDL above, the ***plugin_crypto_header_extra*** attribute introduced in 7.4.6.4.2 consists of the ***session_id*** and the ***initialization_vector_suffix***.

The ***transformation_indentifier*** combined with the identity of the sending `DomainParticipant` uniquely identifies the `KeyMaterial` used to transform the plaintext into the `cipher` text.

The ***session_id*** combined with the `KeyMaterial` uniquely identifies the cryptographic keys used for the encryption and MAC operations.

The ***initialization_vector_suffix*** combined with the ***session_id*** uniquely identifies the `Initialization Vector` used as part of the AES-GCM and AES-GMAC transformations.
The `CryptoHeader` structure shall be serialized using Big Endian serialization (a.k.a. network byte order).

10.5.2.4 DDS:Crypto:AES-GCM-GMAC CryptoContent

The DDS:Crypto:AES-GCM-GMAC `CryptoTransform` interface has operations that transform plaintext into `cipher` text. The cipher-text created by some of these "encode" operations contains a `CryptoContent` submessage element (see 7.4.6.2) that is interpreted by the corresponding "decode" operations on the receiving side.
The `CryptoContent` structure is described by the Extended IDL below:

```
// Serialized as Big Endian
@extensibility(FINAL)
struct CryptoContent  {
    sequence<octet>     crypto_content;
};
```

The `CryptoContent` structure shall be serialized using Big Endian serialization (a.k.a. network byte order).

10.5.2.5 DDS:Crypto:AES-GCM-GMAC CryptoFooter

The DDS:Crypto:AES-GCM-GMAC `CryptoTransform` interface has several operations that transform plaintext into `cipher` text. The cipher-text created by these "encode" operations contains a `CryptoFooter` that is interpreted by the corresponding "decode" operations on the receiving side.
The `CryptoFooter` structure is described by the Extended IDL below:

```
// Serialized as Big Endian
@extensibility(FINAL)
struct ReceiverSpecificMAC {
    CryptoTransformKeyId  receiver_mac_key_id;
    octet                 receiver_mac[16];
};

// Serialized as Big Endian
@extensibility(FINAL)
struct CryptoFooter {
    octet                          common_mac[16];
    sequence<ReceiverSpecificMAC>  receiver_specific_macs;
};
```

As indicated by the IDL above, the ***crypto_footer*** attribute introduced in 7.4.6.5 consists of the ***common_mac*** and the ***receiver_specific_macs***.
The receiver-specific Message Authentication Codes (MACs) are computed with a secret key that the sender shares only with one receiver. The receiver-specific MACs provide message-origin authentication to the receiver even when the sender is communicating with multiple receivers via multicast and shares the same encryption key will all of them.
The `ReceiverSpecificMAC` and `CryptoFooter` structures shall be serialized using Big Endian serialization (a.k.a. network byte order).

10.5.3 DDS:Crypto:AES-GCM-GMAC plugin behavior

This plugin implements three interfaces: `CryptoKeyFactory`, `CryptoKeyExchange`, and `CryptoTransform`. Each is described separately.

10.5.3.1 CryptoKeyFactory for DDS:Crypto:AES-GCM-GMAC

The table below describes the actions that the DDS:Crypto:AES-GCM-GMAC when each of the `CryptoKeyFactory` plugin operations is invoked.

DDSSEC12-90 - Meeting CNSSP-15 security requirements

DDSSEC12-122 – Provide mechanism for changing the session keys

Table 78 – Actions undertaken by the operations of the builtin Cryptographic CryptoKeyFactory plugin

`register_local_participant`	This operation shall create a new `KeyMaterial_AES_GCM_GMAC` object and return a handle that the plugin can use to access the created object. We will refer to this object by the name: `ParticipantKeyMaterial`. The ***transformation_kind*** member ***transformation_algorithm_id*** for the `ParticipantKeyMaterial` object determines whether the transformation performs authentication only (GMAC) or authenticated encryption (GCM). The selection between these two options shall be done according to the setting of the RTPS Protection Kind (see 10.4.1.2.5.7). The ***transformation_kind*** member ***transformation_algorithm_id*** also determines whether the encryption and/or authentication uses 128-bit or 256-bit keys. This aspect shall be configurable but the configuration mechanism is not specified. The operation shall store in the internal state of the plugin the value for ***particiant_security_config.algorithm_info.symmetric_cipher.supported_mask.*** This operation shall fill the ***adjusted_algorithm_info*** output parameter as follows: • The member ***symmetric_cipher.supported_mask*** shall be initialized with all the `CryptoAlgorithmBit` that correspond to the algorithms that can be used to protect the RTPS messages, RTPS submessages, and the data in application level (non built-in) Topics. • The member ***symmetric_cipher.builtin_kx_endpoints_required_mask*** shall be initialized with `CryptoAlgorithmBit` that corresponds to the algorithm that will be used to protect the `DCPSParticipantVolatileMessageSecure` builtin Topic. • The member ***symmetric_cipher.builtin_endpoints_required_mask*** shall be initialized with all the `CryptoAlgorithmBit` that correspond to the algorithms that will be used to protect he remaining buitin Topics, other than the `DCPSParticipantVolatileMessageSecure` builtin Topic. • All other members of ***adjusted_algorithm_info*** shall be set to zero. The operation shall configure the Crypto plugins to only accept the resulting set of supported algorithms in the ***adjusted_algorithm_info***.
`register_matched_remote_participant`	This operation shall associate the `SharedSecret` received as an argument with the local and remote `ParticipantCryptoHandle`. This operation shall create a new `KeyMaterial_AES_GCM_GMAC` object and associate it with the local and remote `ParticipantCryptoHandle` pair. We will refer to this object by the name: `Participant2ParticipantKeyMaterial`. The `Participant2ParticipantKeyMaterial` ***transformation_kind***, ***master_salt***, and ***master_sender_key, and sender_key_id*** shall match those of the `ParticipantKeyMaterial`. If the RTPS Protection Kind (see 10.4.1.2.5.7) does not specify the use of origin authentication, then the ***receiver_specific_key_id*** shall be set to zero and the ***master_receiver_specific key*** shall be set to the empty sequence. If the RTPS Protection Kind (see 10.4.1.2.5.7) specifies the use of origin authentication, then a new secret key

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	(MasterReceiverParticipantSpecificKey) shall be created, the ***receiver_specific_key_id*** shall be set to identify this new key, and the ***master_receiver_specific key*** field shall contain MasterReceiverParticipantSpecificKey. The Participant2ParticipantKeyMaterial shall be used to transform and authenticate the RTPS messages. The Participant2ParticipantKeyMaterial shall be sent to the remote DomainParticipant using the operations of the CryptoKeyExchange. This operation also creates a KeyMaterial_AES_GCM_GMAC object derived from the SharedSecret passed as a parameter. This key material shall be associated with the local and remote ParticipantCryptoHandle pair. We will refer to this key material as the Participant2ParticipantKxKeyMaterial. It is used to exchange key material between DomainParticipant entities.
register_local_datawriter	This operation shall create a new KeyMaterial_AES_GCM_GMAC_Seq object and returns a handle that the plugin can use to access the created object. We will refer to this object by the name: WriterKeyMaterialSeq. The sequence may contain one or two elements depending on the settings of the Metadata Protection Kind (see 10.4.1.2.6.6) and Data Protection Kind (see 10.4.1.2.6.7). If the Metadata Protection Kind is different from NONE, then the operation shall create a KeyMaterial_AES_GCM_GMAC to use for the encode_datawriter_submessage operation. In addition, this key material shall appear as the first element in the KeyMaterial_AES_GCM_GMAC_Seq. If the Data Protection Kind is different from NONE, then the operation shall create a KeyMaterial_AES_GCM_GMAC to use for the encode_serialized_payload operation. In the case where both meta-data protection and data protection are the same, it is allowed for an implementation to reuse the same key material for both. In this case the KeyMaterial_AES_GCM_GMAC_Seq would contain only one element. This “key reuse” aspect shall be configurable but the configuration mechanism is not specified. The ***transformation_kind*** member ***transformation_algorithm_id*** for the KeyMaterial_AES_GCM_GMAC objects determines whether the transformation performs authentication only (GMAC) or encryption followed by authentication (GCM). The selection between these two options for each created KeyMaterial_AES_GCM_GMAC object shall be done according to the setting of corresponding Protection Kind. The ***transformation_kind*** member ***transformation_algorithm_id*** for the KeyMaterial_AES_GCM_GMAC objects also determines whether the encryption and/or authentication uses 128-bit or 256-bit keys. This aspect shall be configurable but the configuration mechanism is not specified. This operation shall fill the ***adjusted_algorithm_info*** output parameter as follows: • The member ***adjusted_algorithm_info. symmetric_cipher.supported_mask*** shall be initialized with the same value set in the register_local_participant operation. • The member ***adjusted_algorithm_info. symmetric_cipher.required_mask*** shall be initialized with CryptoAlgorithmBit that corresponds to the algorithm that will be used to protect the application data and the RTPS submessages sent by the DataWriter. All other members of ***adjusted_algorithm_info*** shall be set to zero.
register_matched_remote_datareader	This operation shall create a new KeyMaterial_AES_GCM_GMAC_Seq object and associate it with the local DatawriterCryptoHandle and remote DatareaderCryptoHandle pair. We will refer to this object by the name: Writer2ReaderKeyMaterialSeq. The first elements of the Writer2ReaderKeyMaterialSeq shall contain the elements of the WriterKeyMaterialSeq. Additional elements depend on whether the Metadata Protection Kind (see 10.4.1.2.6.6) specified the use of origin authentication.

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	If the Metadata Protection Kind (see 10.4.1.2.6.6) specified the use of origin authentication, the first element of the `Writer2ReaderKeyMaterialSeq` shall contain a non-zero ***receiver_specific_key_id*** that identifies a new key created by this operation. The new key (`MasterReceiverREndpointSpecificKey`) shall be stored in the ***master_receiver_specific_key***. This ***master_receiver_specific_key*** shall be shared only with that one specific remote `DataReader` so that it can be used to authenticate the `DataWriter` that originated the message. The `Writer2ReaderKeyMaterialSeq` shall be sent to the remote DataReader such that it can process the `CryptoTransform` encoded from the `DataWriter`.

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`register_local_datareader`	This operation shall create a new `KeyMaterial_AES_GCM_GMAC` object and return a handle that the plugin can use to access the created object. We will refer to this object by the name: `ReaderKeyMaterial`. The ***transformation_kind***. member ***transformation_algorithm_id*** for the `ReaderKeyMaterial` object determines whether the transformation performs authentication only (GMAC) or encryption followed by authentication (GCM). The selection between these two options shall be done according to the setting of the Data Protection Kind (see 10.4.1.2.6.7). The ***transformation_kind***. member ***transformation_algorithm_id*** also determines whether the encryption and/or authentication uses 128-bit or 256-bit keys. This aspect shall be configurable but the configuration mechanism is not specified. This operation shall fill the ***adjusted_algorithm_info*** output parameter as follows: • The member ***adjusted_algorithm_info. symmetric_cipher.supported_mask*** shall be initialized with the same value set in the `register_local_participant` operation. • The member ***adjusted_algorithm_info. symmetric_cipher.required_mask*** shall be initialized with `CryptoAlgorithmBit` that corresponds to the algorithm that will be used to protect the the RTPS submessages sent by the `DataReader`. All other members of ***adjusted_algorithm_info*** shall be set to zero.
`register_matched_remote_datawriter`	This operation shall create a new `KeyMaterial_AES_GCM_GMAC` object and associate it with the local `DatareaderCryptoHandle` and remote `DatawriterCryptoHandle` pair. We will refer to this object by the name: `Reader2WriterKeyMaterial`. The ***transformation_kind***, ***master_salt***, and ***master_sender_key, and sender_key_id*** for the `Reader2WriterKeyMaterial` object shall match those in the `DataReader ReaderKeyMaterial`. If the Metadata Protection Kind (see 10.4.1.2.6.6) does not specify the use of origin authentication, then the ***receiver_specific_key_id*** shall be set to zero and the ***master_receiver_specific key*** shall be set to the empty sequence. If the Metadata Protection Kind (see 10.4.1.2.6.6) specifies the use of origin authentication, then a new secret key (`MasterReceiverWEndpointSpecificKey`) shall be created, the ***receiver_specific_key_id*** shall be set to identify this new key, and the ***master_receiver_specific key*** field shall contain `MasterReceiverWEndpointSpecificKey`. The `Reader2WriterKeyMaterial` shall be sent to the remote `DataWriter` such that it can process the `ciphetext` from the `DataReader`.

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revise_local_entity_keys	This operation shall create new Key Material for all the Entities in the DomainParticipant with the exceptions noted below. The Key Material should be associated with the new key revision value returned by the operation. See 9.5.1.6. The new Key Material created by this operation shall be related to the existing material in that: The ***transformation_kind*** shall only change the key_revision member. The ***master_salt*** shall be entirely new. The ***sender_key_id*** shall remain the same. The ***master_sender_key*** shall be entirely new. The ***receiver_specific_key*** shall remain the same. The ***master_receiver_specific_key*** shall remain the same. This operation shall not create new Key Material for the ***BuiltinParticipantVolatileMessageSecureWriter*** and ***BuiltinParticipantVolatileMessageSecureReader***. This operation shall not create new Key Material for any Key Material derived from. Pre-shared key.
activate_key_revision	This operation shall cause the CryptoTransform API "encode" operations that do not use a preshared key (i.e. not the encode_rtps_message called with ***transform_with_psk*** = true) to use the Key Material associated with the specified ***key_revision***. Note that the KeyMaterial being revised/activated is subject to the limitations described in 9.5.1.8.7 regarding the fact that they only impact KeyMaterial that is potentially shared with multiple Participants.
unregister_participant	Releases any resources allocated on the corresponding call to register_local_participant, or register_matched_remote_participant.
unregister_datawriter	Releases any resources allocated on the corresponding call to register_local_datawriter, or register_matched_remote_datawriter.
unregister_datareader	Releases any resources allocated on the corresponding call to register_local_datareader, or register_matched_remote_datareader.

10.5.3.2 CryptoKeyExchange for DDS:Crypto:AES-GCM-GMAC

The table below describes the actions that the DDS:Crypto:AES-GCM-GMAC when each of the CryptoKeyExchange plugin operations is invoked.

Table 79 – Actions undertaken by the operations of the builtin Cryptographic CryptoKeyExchange plugin

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create_local_participant_crypto_tokens	Creates a DDS:Crypto:AES-GCM-GMAC CryptoToken object and returns it in the output sequence. The CryptoToken contains the Participant2ParticipantKeyMaterial created on the call to register_matched_remote_participant for the remote_participant_crypto.
set_remote_participant_crypto_tokens	Shall receive the sequence containing one CryptoToken object that was created by the corresponding call to create_local_participant_crypto_tokens on the remote side.
create_local_datawriter_crypto_tokens	Creates a DDS:Crypto:AES-GCM-GMAC CryptoToken object and returns it in the output sequence. The CryptoToken contains the Writer2ReaderKeyMaterial created on the call to register_matched_remote_datareader for the remote_datareader_crypto.

set_remote_datawriter_crypto_tokens	Shall receive the sequence containing one CryptoToken object that was created by the corresponding call to create_local_datawriter_crypto_tokens on the remote side.
create_local_datareader_crypto_tokens	Creates a DDS:Crypto:AES-GCM-GMAC CryptoToken object and returns it in the output sequence. The CryptoToken contains the Reader2WriterKeyMaterial created on the call to register_matched_remote_datawriter for the remote_datawriter_crypto.
set_remote_datareader_crypto_tokens	Shall receive the sequence containing one CryptoToken object that was created by the corresponding call to create_local_datareader_crypto_tokens on the remote side.
return_crypto_tokens	Releases the resources associated with the CryptoToken objects in the sequence.

10.5.3.3 CryptoKeyTransform for DDS:Crypto:AES-GCM-GMAC

10.5.3.3.1 Overview

The table below describes the actions that the DDS:Crypto:AES-GCM-GMAC when each of the CryptoKeyTransform plugin operations is invoked.

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Table 80 – Actions undertaken by the operations of the builtin Cryptographic CryptoKeyTransform plugin

encode_serialized_payload	Uses the WriterKeyMaterial associated with the sending_datawriter_crypto to encrypt and/or sign the input SerializedPayload RTPS SubmessageElement (see 7.4.1). If the ***transformation_kind*** indicates that encryption is performed, then the output shall be the three RTPS Submessage elements: CryptoHeader, CryptoContent, and CryptoFooter (see 10.4.2.5 and 10.5.3.3.4.4). If the ***transformation_kind*** indicates that only authentication is performed, then the output shall be the three RTPS Submessage elements: CryptoHeader, SerializedPayload, and CryptoFooter. Where SerializedPayload is the serialized payload passed as an input to the operation. This operation shall always set the ***receiver_specific_macs*** attribute in the CryptoFooter to the empty sequence.
encode_datawriter_submessage	Uses the WriterKeyMaterial associated with the sending_datawriter_crypto and the Writer2ReaderKeyMaterial associated with the sending_datawriter_crypto and each of the receiving_datareader_crypto handles to encrypt and/or sign the input RTPS Submessage. If the ***transformation_kind*** indicates that encryption is performed, then the output shall be the three RTPS Submessages: SecurePrefixSubMsg, SecureBodySubMsg, and SecurePostfixSubMsg. See 7.4.7.6, 7.4.7.5, and 7.4.7.7. If the ***transformation_kind*** indicates that only authentication is performed, then the output shall be the three RTPS Submessages: SecurePrefixSubMsg, InputSubmessage, and SecurePostfixSubMsg. Where InputSubmessage indicates the submessage that was passed as input to the operation. The transformations shall be computed using the WriterKeyMaterial associated with the sending_datawriter_crypto. Depending on the configuration the operation may compute and set the ***common_mac*** and the ***receiver_specific_macs*** attributes within the SecurePostfixSubMsg. The ***common_mac*** shall be computed using the WriterKeyMaterial associated with the sending_datawriter_crypto.

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	If computed, the ***receiver_specific_macs*** shall be computed using the `Writer2ReaderKeyMaterial` associated with the pair composed of the `sending_datawriter_crypto` and each of the corresponding `receiving_datareader_crypto`. In the case of ***BuiltinParticipantVolatileMessageSecureWriter***, the ***receiving_datareader_crypto_list*** has ONE element containing `KxKey` material derived from the `SharedSecret` as described in 10.5.2.1.2.
`encode_datareader_submessage`	Uses the `ReaderKeyMaterial` associated with the `sending_datareader_crypto` and the `Reader2WriterKeyMaterial` associated with the `sending_datareader_crypto` and each of the `receiving_datareader_crypto` handles to encrypt and/or sign the input RTPS Submessage. If the ***transformation_kind*** indicates that encryption is performed, then the output shall be the three RTPS Submessages: `SecurePrefixSubMsg`, `SecureBodySubMsg`, and `SecurePostfixSubMsg`. See 7.4.7.6, 7.4.7.5, and 7.4.7.7. If the ***transformation_kind*** indicates that only authentication is performed, then the output shall be the three RTPS Submessages: `SecurePrefixSubMsg`, `InputSubmessage`, and `SecurePostfixSubMsg`. Where `InputSubmessage` indicates the submessage that was passed as input to the operation. The transformations shall be computed using the `ReaderKeyMaterial` associated with the `sending_datareader_crypto`. Depending on the configuration the operation may compute and set the common_digest or the additional_digests. The ***common_mac*** shall be computed using the `ReaderKeyMaterial` associated with the `sending_datareader_crypto`. If computed, the ***receiver_specific_macs*** shall be computed using the `Reader2WriterKeyMaterial` associated with the pair composed of the `sending_datareader_crypto` and each of the corresponding `receiving_datawriter_crypto`. In the case of ***BuiltinParticipantVolatileMessageSecureReader***, the ***receiving_datawriter_crypto_list*** has ONE element containing `KxKey` material derived from the `SharedSecret` as described in 10.5.2.1.2.

`encode_rtps_message`	Transforms the input RTPS Message into an output RTPS Message that contains the original RTPS Header and, if present, the original HeaderExtension, followed by the `SecureRTPSPrefixSubMsg`, one or more RTPS SubMessages, and the `SecureRTPSPostfixSubMsg`. If this operation is called with the parameter ***transform_with_psk***=TRUE, then it shall use the pre-shared key material defined in section 10.5.2.1.3, otherwise the transformation shall use the `ParticipantKeyMaterial` associated with the `sending_participant_crypto` and `Participant2ParticipantKeyMaterial` and each of the `receiving_participant_crypto` handles. **1) Transformation when "Additional Authenticated Data (AAD)" is disabled** Let `RTPSMessage{RTPSHdr-> InfoSourceSubMsg}` represent the input RTPS `Message` transformed so that the RTPS `Header` is replaced with an RTPS InfoSourceSubMsg containing the same information as the RTPS Header and the remaining submessages remain the same. **1.1)** If the ***transformation_kind*** indicates that encryption is performed, then the output shall be the three RTPS Submessages: `SecureRTPSPrefixSubMsg`, `SecureBodySubMsg`, and `SecureRTPSPostfixSubMsg`. The `SecureRTPSPrefixSubMsg` flag `AuthenticatedDataFlag` shall be unset. The `SecureRTPSPrefixSubMsg` `PreSharedKeyFlag` shall be set if `encode_rtps_message` was called with ***transform_with_psk***=TRUE. The `SecureBodySubMsg` shall contain the result of encrypting the `RTPSMessage{RTPSHdr-> InfoSourceSubMsg}`. The `SecureRTPSPostfixSubMsg` shall contain the authentication tags computed on the `SecureBodySubMsg`. **1.2)** If the ***transformation_kind*** indicates that only authentication is performed then the output shall be the RTPS Submessages: `SecureRTPSPostfixSubMsg`, `RTPSMessage{RTPSHdr-> InfoSourceSubMsg}`, and `SecureRTPSPostfixSubMsg`. The `SecureRTPSPostfixSubMsg` shall contain the authentication tags computed on the `RTPSMessage{RTPSHdr-> InfoSourceSubMsg}`. Depending on the configuration the operation may contain only the ***common_mac*** and a non-zero length ***receiver_specific_macs.*** The ***common_mac*** shall be computed using the `ParticipantKeyMaterial` associated with the `sending_participant_crypto`. If present, the ***receiver_specific_macs*** shall be computed using the `Participant2ParticipantKeyMaterial` associated with the pair composed of the `sending_participant_crypto` and each of the corresponding `receiving_participant_crypto`. **2) Transformation when "Additional Authenticated Data (AAD)" is enabled** Let `RTPSMessage{Body}` represent the input RTPS `Message` excluding the RTPS `Header` and `HeaderExtension`. This case shall not insert an `InfoSourceSubMsg` on the resulting output. **2.1)** If the ***transformation_kind*** indicates that encryption is performed, then the output shall be the original `RTPS Header` and (if present) the (adjusted) `HeaderExtension` (see bullet (3)), plus three RTPS Submessages: `SecureRTPSPrefixSubMsg`, `SecureBodySubMsg`, and `SecureRTPSPostfixSubMsg`. The `SecureRTPSPrefixSubMsg` flag `AdditionlAuthenticatedDataFlag` shall be set. The `SecureRTPSPrefixSubMsg` flag `PreSharedKeyFlag` shall be set if `encode_rtps_message` was called with ***transform_with_psk***=TRUE.

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	The `SecureBodySubMsg` shall contain the result of encrypting the `RTPSMessage{Body}`. The `SecureRTPSPostfixSubMsg` shall contain the authentication tags computed on the `SecureBodySubMsg` with both the RTPS `Header` and (if present) the (adjusted) `HeaderExtension` as AAD, see bullet (3). **2.2)** If the ***transformation_kind*** indicates that only authentication is performed then the output shall be: the original RTPS `Header` and (if present) the (adjusted) `Header Extension` (see bullet (3)), followed by the `SecureRTPSPostfixSubMsg`, `RTPSMessage{Body}`, and `SecureRTPSPostfixSubMsg`. The `SecureRTPSPostfixSubMsg` shall contain the authentication tags computed on the `RTPSMessage{Body}` with both the RTPS `Header` and (if present) the (adjusted) `Header Extension` as AAD, see bullet (3). Depending on the configuration the operation may contain only the ***common_mac*** and a non-zero length ***receiver_specific_macs***. The ***common_mac*** shall be computed using the `ParticipantKeyMaterial` associated with the ***sending_participant_crypto***. If present, the ***receiver_specific_macs*** shall be computed using the `Participant2ParticipantKeyMaterial` associated with the pair composed of the ***sending_participant_crypto*** and each of the corresponding ***receiving_participant_crypto.*** 3) In both cases: ***transformation_kind*** indicating encryption or only authentication, the `HeaderExtension`, if present, shall be adjusted as follows: 3.1) The `HeaderExtension` used as input to the AAD shall have the `messageLength` element, if present, set to zero. 3.2) The `HeaderExtension` used as input to the AAD shall have the `messageChecksum` element, if present, set to zero. 3.3) After computing the `SecureRTPSPrefixSubMsg`, `SecureBodySubMsg`, and `SecureRTPSPostfixSubMsg`. The `HeaderExtension` shall be adjusted setting the appropriate values of the `messageLength` and `messageChecksum` elements, if originally present, to correspond to the transformed (encoded) RTPS message.

`decode_rtps_message`	Examines the `SecureRTPSPrefixSubMsg` to determine the ***transformation_kind*** matches the one the receiving DomainParticipant is expecting both in terms of the type of algorithm as well as the protection (encrypt, authentication, origin authentication, etc.). If the kind is not the expected one, the operation shall fail with an exception. **1) If SecureRTPSPrefixSubMsg's PreSharedKeyFlag is not set:** Uses source `DomainParticipant` GUIDs in the RTPS Header to locate the `sending_participant_crypto` and `receiving_participant_crypto`. Then looks whether the ***transformation_key_id*** attribute in the `CryptoTransformIdentifier` is associated with those `ParticipantCryptoHandles`. If the association is not found, the operation shall fail with an exception. If the ***transformation_kind*** indicates the use of authenticated encryption, it uses the RemoteParticipantKeyMaterial to decode the encoded input RTPS message. Uses the `RemoteParticipantKeyMaterial` and the `RemoteParticipant2ParticipantKeyMaterial` associated with the retrieved `ParticipantCryptoHandles` to validate the authentication tags contained in the `SecureRTPSPostfixSubMsg`. If the `RemoteParticipant2ParticipantKeyMaterial` specified a ***receiver_specific_key_id*** different from zero, the operation shall check that the received `SecureRTPSPostfixSubMsg` contains a ***receiver_specific_macs*** element containing the ***receiver_specific_key_id*** associated with local and remote `CryptoHandles` and use it to verify the submessage. If the ***receiver_specific_key_id*** is missing or the verification fails the operation shall fail with an exception. **2) If SecureRTPSPrefixSubMsg's PreSharedKeyFlag is set:** Uses content of the RTPS Header, the pre-shared secret and SenderKeyId to compute (or locate a previously computed) PSK Key Material associated with the sending Participant (see 10.5.2.1.3). If the ***transformation_kind*** indicates the use of authenticated encryption, it uses the PSK KeyMaterial to decode the encoded input RTPS message. Uses the PSK KeyMaterial to validate the authentication tags contained in the SecureRTPSPostfixSubMsg. **3) If the SecureRTPSPrefixSubMsg's AdditionalAuthenticatedDataFlag is set:** The validation of the tag present in the `SecureRTPSPostfixSubMsg` shall pass the RTPS `Header` and (if present) the (adjusted) `HeaderExtension` as AAD. 3.1) The (adjusted) `HeaderExtension` used as input to the AAD validation shall have the `messageLength` element, if present, set to zero and the `messageChecksum` element, if present, also set to zero. **4) Finally:** The `HeaderExtension`, if present, shall have the `messageLength` element, if present and the `messageChecksum` element, if present, adjusted such that they correspond to the values passed as input to the `encode_rtps_message` operation. Upon success the returned RTPS Message shall match the input to the `encode_rtps_message` operation on the DomainParticipant that sent the message.
`preprocess_secure_submsg`	Examines the RTPS SecureSubmessage to: 1. Determine whether the `CryptoTransformIdentifier` the ***transformation_kind*** matches one of the recognized kinds. 2. Classify the RTPS Submessage as a Writer or Reader Submessage.

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	3. Retrieve the DatawriterCryptoHandle and DataReaderCryptoHandle handles associated with the `CryptoTransformIdentifier` ***transformation_key_id***.
`decode_datawriter_submessage`	Uses the `RemoteDatawriterKeyMaterial` and the `RemoteDatawriter2DatareaderKeyMaterial` associated with the CryptoHandles returned by the `preprocess_secure_submessage` to verify and decrypt the RTPS SubMessage that follows the `SecurePrefixSubMsg`, using the authentication tags in the `SecurePostfixSubMsg`. If the verification or decryption fails, the operation shall fail with an exception. If the `RemoteDatawriterKeyMaterial` specified a ***transformation_kind*** different from CRYPTO_ALGORITHM_ID_NONE, then the operation shall check that the received `SecurePostfixSubMsg` contains a ***common_mac*** and use it to verify the RTPS SubMessage that follows the `SecurePrefixSubMsg`. If the ***common_mac*** is missing or the verification fails the operation shall fail with an exception. If the `RemoteDatawriter2DatareaderKeyMaterial` specified a ***receiver_specific_key_id*** different from zero, then the operation shall check that the received `SecurePostfixSubMsg` contains a non-zero length ***receiver_specific_macs*** element containing the ***receiver_specific_key_id*** that is associated with local and remote CryptoHandles and use it to verify the submessage. If the ***receiver_mac_key_id*** is missing or the verification fails, the operation shall fail with an exception. If the `RemoteDatawriterKeyMaterial` specified a ***transformation_kind*** that performs encryption the operation shall use the `RemoteDatawriterKeyMaterial` to decode the data in the `SecureBodySubMsg`, obtain an RTPS SubMessage and return it. Otherwise the RTPS Submessage that follows the `SecurePrefixSubMsg` is returned. Upon success the returned RTPS SubMessage shall match the input to the `encode_datawriter_message` operation on the DomainParticipant that sent the message. In the case of ***BuiltinParticipantVolatileMessageSecureReader***, the ***sending_datawriter_crypto*** contains the `KxKey` material derived from the `SharedSecret` as described in 10.5.2.1.2
`decode_datareader_submessage`	Uses the `RemoteDatareaderKeyMaterial` and the `RemoteDatareader2DatawriterKeyMaterial` associated with the CryptoHandles returned by the `preprocess_secure_submessage` to verify and decrypt the RTPS SubMessage that follows the `SecurePrefixSubMsg`, using the authentication tags in the `SecurePostfixSubMsg`. If the verification or decryption fails, the operation shall fail with an exception. If the `RemoteDatareaderKeyMaterial` specified a ***transformation_kind*** different from CRYPTO_ALGORITHM_ID_NONE, then the operation shall check that the received `SecurePostfixSubMsg` contains a ***common_mac*** and use it to verify the RTPS SubMessage that follows the `SecurePrefixSubMsg`. If the ***common_mac*** is missing or the verification fails, the operation shall fail with an exception. If the `RemoteDatareader2DatawriterKeyMaterial` specified a ***receiver_specific_key_id*** different from zero, then the operation shall check that the received `SecurePostfixSubMsg` contains a non-zero length ***receiver_specific_macs*** element containing the ***receiver_specific_key_id*** that is associated with local and remote CryptoHandles and use it to verify the submesage. If the ***receiver_specific_key_id*** is missing or the verification fails, the operation shall fail with an exception. If the `RemoteDatareaderKeyMaterial` specified a ***transformation_kind*** that performs encryption the operation shall use the `RemoteDatareaderKeyMaterial` to decode the data in the `SecureBodySubMs`, obtain an RTPS SubMessage and return it. Otherwise the RTPS Submessage that follows the `SecurePrefixSubMsg` is returned.

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	Upon success the returned RTPS SubMessage shall match the input to the `encode_datareader_message` operation on the DomainParticipant that sent the message. In the case of ***BuiltinParticipantVolatileMessageSecureWriter***, the ***sending_datareader_crypto*** contains the `KxKey` material derived from the `SharedSecret` as described in 10.5.2.1.2
`decode_serialized_payload`	Uses writerGUID and the readerGUID in the RTPS SubMessage to locate the `sending_datawriter_crypto` and `receiving_datareader_crypto`. Then looks whether the ***transformation_key_id*** attribute in the `CryptoTransformIdentifier` in the `CryptoHeader` SubmessageElement is associated with those CryptoHandles. If the association is not found, the operation shall fail with an exception. Uses the `RemoteDatawriterKeyMaterial` associated with the retrieved CryptoHandles to verify the ***common_mac*** and decrypt the RTPS SecureData SubmessageElement. If the verification or decryption fails, the operation shall fail with an exception. If the `RemoteDatawriterKeyMaterial` specified a ***receiver_specific_key_id*** different from zero, then the operation shall check that the received SecureData SubmessageElement contains a non-zero length ***receiver_specific_macs*** element containing the ***receiver_specific_key_id*** that is associated with the local and remote CryptoHandles. If the ***receiver_specific_key_id*** is missing or the verification fails, the operation shall fail with an exception. If the `RemoteDatawriterKeyMaterial` specified a ***transformation_kind*** that performs encryption, the operation shall use the `RemoteDatawriterKeyMaterial` to decode the data in the `CryptoContent`, obtain a `SerializedPayload` and return it. Otherwise the RTPS Submessage Element that follows the `CryptoHeader` is returned as `SerializedPayload`. Upon success the returned RTPS `SerializedPayload` shall match the input to the `encode_serialized_payload` operation on the DomainParticipant that sent the message.

10.5.3.3.2 Encode/decode operation virtual machine

The logical operation of the DDS:Crypto:AES-GCM-GMAC is described in terms of a virtual machine as it performs the encrypt message digest operations. This is not intended to mandate implementations should follow this approach literally, simply that the observable results for any plaintext are the same as the virtual machine described here.
For any given cryptographic session the operation of the DDS:Crypto:AES-GCM-GMAC transforms plaintext into ciphertext can be described in terms of a virtual machine that maintains the following state:
DDSSEC12-53 Clarify meaning of "bit array" and specify number of constant …

Table 81 – Terms used in Key Computation and cryptographic transformations formulas for the builtin cryptographic plugin

State variable	*Type*	*Meaning*
MasterKey	octet[16] for AES128 octet[32] for AES256	The master key from which session salts, session keys and session hash keys are derived.
MasterSalt	octet[16] for AES128 octet[32] for AES256	A random vector used in connection with the MasterKey to create the SessionKey.
MasterKeyId	octet[4]	A NONCE value associated with the master key when it is first created used to tag the ciphertext to ensure the correct key is being used during decryption. It may be used also for the purposes of re-keying.

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Deleted: 128 bit array
Deleted: 256 bit array

MasterReceiverSpecificKey	octet[16] for AES128 octet[32] for AES256	The master key from which SessionReceiverSpecificKey keys are derived.
InitializationVectorSuffix	octet[8]	An initially random NONCE used to create the Initialization Vector needed by the cryptographic operations. This value shall be changed each time an encryption or MAC operation is performed using the same key.
SessionId	octet[4]	An initially random value used to create the current SessionKey, and SessionReceiverSpecificKey from the MasterKey, MasterReceiverSpecificKey, and Master salts. The SessionId is incremented each time a new SessionKey is needed and then used to derive the new SessionKey and SessionReceiverSpecificKey from the MasterKey and MasterReceiverSpecificKey. Knowledge of the MasterKey, MasterSalt, and the SessionId is sufficient to create the SessionKey. Knowledge of the MasterReceiverSpecificKey, MasterSalt, and the SessionId is sufficient to create the SessionReceiverSpecificKey.
SessionKey	octet[16] for AES128 octet[32] for AES256	The current key used for creating the ciphertext and/or the common_mac. It is constructed from the MasterKey, MasterSalt, and SessionId.
SessionReceiverSpecificKey	octet[16] for AES128 octet[32] for AES256	The current key used for creating the receiver_specific_mac.
session_block_counter	64 bit integer	A counter that counts the number of blocks that have been ciphered with the current SessionKey.
max_blocks_per_session	64 bit integer	A configurable property that limits the number of blocks that can be ciphered with the same SessionKey. If the ***session_block_counter*** exceeds this value, a new SessionKey and SessionReceiverSpecificKey are computed and the ***session_block_counter*** is reset to zero.

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All the key material with a name that starts with "Master" corresponds to the `KeyMaterial_AES_GCM_GMAC` objects that were created by the `CryptoKeyFactory` operations. This key material is not used directly to encrypt or compute MAC of the plaintext. Rather it is used to create "Session" Key material by means of the algorithms described below. This has the benefit that the 'session' keys used to secure the data stream data can be modified as needed to maintain the security of the stream without having to perform explicit rekey and key-exchange operations.

10.5.3.3.3 Computation of SessionKey and SessionReceiverSpecificKey

The `SessionKey` and `SessionReceiverSpecificKey` are computed from the `MasterKey`, `MasterSalt` and the `SessionId`:

```
SessionKey := HMAC256(MasterKey,"SessionKey" | MasterSalt | SessionId)
SessionReceiverSpecificKey
    := HMAC256(MasterReceiverSpecificKey,
               "SessionReceiverKey" | MasterSalt | SessionId)
```

HMAC256 is a HMAC-SHA256. In case a 128 key is desired the 256 bit HMAC is truncated to the first 128 bits.

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In the above expressions the symbol '|' indicates concatenation. When constructing the input to the HMAC256 function, the strings should be treated as arrays of octets, each octet being the ASCII representation of a character, and there should be no NUL termination of the string, that is, the last character of the string is immediately followed by the bytes concatenated after the string.

10.5.3.3.4 Computation of ciphertext from plaintext

The ciphertext is computed from the plain text using AES in Galois Counter Mode (AES-GCM). The encryption transforms the plaintext input into ciphertext by performing an encryption operation using the AES-GCM algorithm in counter mode using the SessionKeys associated with the specified KeyHandle. The encryption transformation is described in detail in the sections that follow.
The encryption operation uses a 96-bit initialization vector constructed as:

```
InitializationVector =  SessionId | InitializationVectorSuffix
```

In the above expression '|' indicates the concatenation of bit strings.
The same ***InitializationVector*** is associated with all the session keys (***SessionKey*** and all ***SessionReceiverSpecificKeys***) associated with a specific Sender. It shall be incremented each time any of those keys are used to encrypt and/or create a MAC.
The ***session_block_counter*** is an internal counter that keeps track of the number of blocks encrypted with the same session key. The purpose is to ensure that a single session key is not used to encrypt more than the configured ***max_blocks_per_session***. The ***session_block_counter*** and the size of the plain text shall be used by implementations of the `Crypto` encode operations to ensure that ***max_blocks_per_session*** will not be exceeded during the encode operation. If the operation detects that the counter would exceed the maximum then it should modify the ***SessionId*** and derive new session keys prior to transforming any of the input plain text. The change in the ***SessionId*** creates new session keys and thus resets the ***session_block_counter***. This approach ensures that all ciphertext returned by the operation is encrypted with the same session keys.
The resulting ciphertext will be preceded by a `CryptoHeader` that indicates the ***SessionId*** and ***InitializationVectorSuffix***.
The resulting block of bytes from the "encode" operations (`encode_serialized_payload`, `encode_datawriter_submessage`, `encode_datareader_submessage`, and `encode_rtps_message`) is illustrated in the sections that follow:

10.5.3.3.4.1 Format of the CryptoHeader Submessage Element

The `CryptoHeader` submessage element generated by the DDS:Crypto:AES-GCM-GMAC shall take the form:

```
0...2...........8...............16.............24...............32
+---------------+---------------+---------------+---------------+
+ CryptoHeader:                                                 +
+    CryptoTransformIdentifier  transformation_id               +
|       octet[4]  transformation_id.transformation_kind         |
|       octet[4]  transformation_id.transformation_key_id       |
+    - - - - - - - - - - - - - - - - - - - - - - - - - - -      +
+    plugin_sec_prefix:                                         +
|       octet[4]  plugin_sec_prefix.session_id                  |
~       octet[8]  plugin_sec_prefix.init_vector_suffix          ~
+---------------+---------------+---------------+---------------+
```

Note that as specified in 10.5.2.3 the CryptoHeader shall be serialized using Big Endian representation.

10.5.3.3.4.2 Format of the CryptoContent Submessage Element

The `CryptoContent` submessage element generated by the DDS:Crypto:AES-GCM-GMAC shall take the form:

```
0...2...........8...............16.............24...............32
+---------------+---------------+---------------+---------------+
+ CryptoContent:                                                +
|      long crypto_content.length = N                           |
+      - - - - - - - - - - - - - - - - - - - - - - - - - - - -  +
|crypto_ct[0]   |crypto_ct[1]   |crypto_ct[2]   |crypto_ct[3]   |
~                   . . .                                       ~
|crypto_ct[N-4] |crypto_ct[N-3] |crypto_ct[N-2] |crypto_ct[N-1] |
+---------------+---------------+---------------+---------------+
```

Note that the cipher operations have 16-byte block-size and add padding when needed. Therefore the ***secure data.length*** ("N") will always be a multiple of 16.

Note that as specified in 10.5.2.4 the ***secure data.length*** shall be serialized using Big Endian representation.

10.5.3.3.4.3 Format of the CryptoFooter Submessage Element

The `CryptoFooter` submessage element generated by the DDS:Crypto:AES-GCM-GMAC shall take the form:

```
0...2...........8...............16.............24...............32
+---------------+---------------+---------------+---------------+
+ CryptoFooter ( = plugin_sec_tag):                             +
~    octet[16] plugin_sec_tag.common_mac                        ~
+    - - - - - - - - - - - - - - - - - - - - - - - - - -        +
+    plugin_sec_tag.receiver_specific_macs:                     +
|      long    plugin_sec_tag.receiver_specific_macs.length = N |
|      - - - - - - - - - - - - - - - - - - - - - - - - - - - -  |
|      octet[4]  receiver_specific_macs[0].receiver_mac_key_id  |
|      octet[16] receiver_specific_macs[0].receiver_mac         ~
+      - - - - - - - - - - - - - - - - - - - - - - - - - -      +
+      . . .                                                    +
+      - - - - - - - - - - - - - - - - - - - - - - - - - -      +
|      octet[4]  receiver_specific_macs[N-1].receiver_mac_key_id|
~      octet[16] receiver_specific_macs[N-1].receiver_mac       ~
+---------------+---------------+---------------+---------------+
```

Note that as specified in 10.5.2.5 the CryptoFooter shall be serialized using Big Endian representation.

10.5.3.3.4.4 Result from encode_serialized_payload

The input to this operation is a SerializedPayload submessage element:

```
0...2...........8...............16.............24...............32
+---------------+---------------+---------------+---------------+
~       SerializedPayload                                       ~
+---------------+---------------+---------------+---------------+
```

The output in case the transformation performs authentication only shall be:

```
0...2...........8...............16.............24...............32
+---------------+---------------+---------------+---------------+
~       CryptoHeader                                            ~
```

```
+--------------+--------------+--------------+--------------+
~       SerializedPayload    (unchanged from input)          ~
+--------------+--------------+--------------+--------------+
~       CryptoFooter                                         ~
+--------------+--------------+--------------+--------------+
```

The ***common_mac*** in the `CryptoFooter` is the authentication tag generated by the AES-GMAC transformation using the ***SessionKey*** and the ***InitializationVector*** operating on the `SerializedPayload`.

The ***receiver_specific_macs*** in the `CryptoFooter` are the AES-GMAC tags computed on the ***common_mac*** using each of the ***SessionReceiverSpecificKey*** and the same ***InitializationVector***.

The output in case the transformation performs encryption and authentication shall be:

```
0...2...........8...............16.............24...............32
+--------------+--------------+--------------+--------------+
~       CryptoHeader                                         ~
+--------------+--------------+--------------+--------------+
~       CryptoContent                                        ~
|            crypto_content =  Encrypt(SerializedPayload)       |
+--------------+--------------+--------------+--------------+
~       CryptoFooter                                         ~
+--------------+--------------+--------------+--------------+
```

In the above Encrypt indicates the cryptographic transformation performed with AES-GCM using the ***SessionKey*** and the ***InitializationVector*** operating on the `SerializedPayload`.

The ***common_mac*** in the `CryptoFooter` is the authentication tag generated by the same AES-GCM where the Additional Authenticated Data is empty.

The ***receiver_specific_macs*** in the `CryptoFooter` are the AES-GMAC tags computed on the ***common_mac*** using each of the ***SessionReceiverSpecificKey*** and the same ***InitializationVector***.

10.5.3.3.4.5 Result from encode_datawriter_submessage and encode_datareader_submessage

The input to this operation is an RTPS submessage:

```
0...2...........8...............16.............24...............32
+--------------+--------------+--------------+--------------+
|                                                              |
~     RTPS SubMessage                                          ~
|                                                              |
+--------------+--------------+--------------+--------------+
```

The output in case the transformation performs authentication only shall be:

```
0...2...........8...............16.............24...............32
+--------------+--------------+--------------+--------------+
| SEC_PREFIX    | (flags)      E|     short octetsToNextSubMsg  |
+--------------+--------------+--------------+--------------+
~     CryptoHeader                                             ~
+--------------+--------------+--------------+--------------+
+--------------+--------------+--------------+--------------+
|                                                              |
~     RTPS SubMessage        (unchanged from input)           ~
|                                                              |
+--------------+--------------+--------------+--------------+
```

```
+---------------+---------------+---------------+---------------+
| SEC_POSTFIX   | (flags)      E|     short octetsToNextSubMsg  |
+---------------+---------------+---------------+---------------+
~       CryptoFooter                                            ~
+---------------+---------------+---------------+---------------+
```

The ***common_mac*** in the `CryptoFooter` is the authentication tag generated by the AES-GMAC transformation using the ***SessionKey*** and the ***InitializationVector*** operating on the RTPS `Submessage`.

The ***receiver_specific_macs*** in the `CryptoFooter` are the AES-GMAC tags computed on the ***common_mac*** using each of the ***SessionReceiverSpecificKey*** and the same ***InitializationVector***.

The output in case the transformation performs encryption and authentication shall be:

```
0...2...........8...............16.............24...............32
+---------------+---------------+---------------+---------------+
| SEC_PREFIX    | (flags)      E|     short octetsToNextSubMsg  |
+---------------+---------------+---------------+---------------+
~     CryptoHeader                                              ~
+---------------+---------------+---------------+---------------+
+---------------+---------------+---------------+---------------+
| SEC_BODY      |  (flags)     E|     short octetsToNextSubMsg  |
+---------------+---------------+---------------+---------------+
~       CryptoContent                                           ~
|           crypto_content = Encrypt( RTPS SubMsg )             |
+---------------+---------------+---------------+---------------+
+---------------+---------------+---------------+---------------+
| SEC_POSTFIX   | (flags)      E|     short octetsToNextSubMsg  |
+---------------+---------------+---------------+---------------+
~       CryptoFooter                                            ~
+---------------+---------------+---------------+---------------+
```

In the above Encrypt indicates the cryptographic transformation performed with AES-GCM using the ***SessionKey*** and the ***InitializationVector*** operating on the input RTPS `Submessage`.

The ***common_mac*** in the ***CryptoFooter*** is the authentication tag generated by the same AES-GCM transformation where the Additional Authenticated Data is empty.

The ***receiver_specific_macs*** in the CryptoFooter are the AES-GMAC tags computed on the ***common_mac*** using each of the ***SessionReceiverSpecificKey*** and the same ***InitializationVector***.

10.5.3.3.4.6 Result from encode_rtps_message

The input to this operation is an RTPS message:

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

```
+---------------+---------------+---------------+---------------+
~       RTPSHdr                                                 ~
+---------------+---------------+---------------+---------------+
~       RTPSHdrExt  (optional)                                  ~
+---------------+---------------+---------------+---------------+
~       SubMsg1 submessage                                      ~
+---------------+---------------+---------------+---------------+
~       SubMsg2 submessage                                      ~
```

```
+---------------+---------------+---------------+---------------+
|       . . .                                                   |
+---------------+---------------+---------------+---------------+
~       SubMsgN submessage                                      ~
+---------------+---------------+---------------+---------------+
```

10.5.3.3.4.6.1 Authentication only with AAD enabled

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

The output in case the transformation performs authentication only and Additional Authenticated Data (AAD)" is enabled shall be:

```
0...2...........8...............16.............24...............32
+---------------+---------------+---------------+---------------+
~       RTPSHdr  (unchanged from input)                         ~
+---------------+---------------+---------------+---------------+
~       RTPSHdrExt  (optional, unchanged from input)            ~
+---------------+---------------+---------------+---------------+
+---------------+---------------+---------------+---------------+
| SRTPS_PREFIX  | (flags)    A E|      short octetsToNextSubMsg  |
+---------------+---------------+---------------+---------------+
~       CryptoHeader                                            ~
+---------------+---------------+---------------+---------------+
+---------------+---------------+---------------+---------------+
~       RTPSMessage{ Body }                                     ~
+---------------+---------------+---------------+---------------+
+---------------+---------------+---------------+---------------+
| SRTPS_POSTFIX |    flags     E|      short octetsToNextSubMsg  |
+---------------+---------------+---------------+---------------+
~       CryptoFooter                                            ~
+---------------+---------------+---------------+---------------+
```

The ***common_mac*** in the `CryptoFooter` is the authentication tag generated by the AES-GMAC transformation using the ***SessionKey*** and the ***InitializationVector*** operating on the `RTPSMessage{ Body }` where the Additional Authenticated Data is set to the RTPS `Header` and RTPS `HeaderExtension`.

`RTPSMessage{ Body }`. Represents the original RTPS Message where the RTPS Header and HeaderExtension are removed.

The ***receiver_specific_macs*** in the `CryptoFooter` are the AES-GMAC tags computed on the ***common_mac*** using each of the ***SessionReceiverSpecificKey*** and the same ***InitializationVector***.

10.5.3.3.4.6.2 Authentication only with AAD not enabled

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

The output in case the transformation performs authentication only and Additional Authenticated Data (AAD)" is not enabled shall be:

```
0...2...........8...............16.............24...............32
+---------------+---------------+---------------+---------------+
~       RTPSHdr  (unchanged from input)                         ~
+---------------+---------------+---------------+---------------+
~       RTPSHdrExt  (optional, unchanged from input)            ~
```

```
+---------------+---------------+---------------+---------------+
+---------------+---------------+---------------+---------------+
| SRTPS_PREFIX  | (flags)      E|      short octetsToNextSubMsg  |
+---------------+---------------+---------------+---------------+
~       CryptoHeader                                            ~
+---------------+---------------+---------------+---------------+
+---------------+---------------+---------------+---------------+
~       RTPSMessage{ RTPSHdr+RTPSHdrExt? -> InfoSourceSubMsg }  ~
+---------------+---------------+---------------+---------------+
+---------------+---------------+---------------+---------------+
| SRTPS_POSTFIX |    flags     E|      short octetsToNextSubMsg  |
+---------------+---------------+---------------+---------------+
~       CryptoFooter                                            ~
+---------------+---------------+---------------+---------------+
```

The ***common_mac*** in the `CryptoFooter` is the authentication tag generated by the AES-GMAC transformation using the ***SessionKey*** and the ***InitializationVector*** operating on the `RTPSMessage{ RTPSHdr -> InfoSourceSubMsg}`.

`RTPSMessage{ RTPSHdr -> InfoSourceSubMsg}`. Represents the original RTPS Message where the RTPS Header is repaced with an InfoSourceSubMsg with equivalent content.

The ***receiver_specific_macs*** in the `CryptoFooter` are the AES-GMAC tags computed on the ***common_mac*** using each of the ***SessionReceiverSpecificKey*** and the same ***InitializationVector***.

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

If Additional Authenticated Data (AAD)" is not enabled the inout RTPS Message cannot contain an RTPS `Header Extension`. Preventing this configuration is implementation specific.

10.5.3.3.4.6.3 Authenticated Encryption with AAD enabled

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

The output in case the transformation performs authenticated encryption and has Additional Authenticated Data enabled shall be:

```
+---------------+---------------+---------------+---------------+
~       RTPSHdr  (unchanged from input)                         ~
+---------------+---------------+---------------+---------------+
~       RTPSHdrExtension  (optional, unchanged from input)      ~
+---------------+---------------+---------------+---------------+
+---------------+---------------+---------------+---------------+
| SRTPS_PREFIX  | (flags)    A E|      short octetsToNextSubMsg  |
+---------------+---------------+---------------+---------------+
~       CryptoHeader                                            ~
+---------------+---------------+---------------+---------------+
+---------------+---------------+---------------+---------------+
| SEC_BODY      |  (flags)     E|      short octetsToNextSubMsg  |
+---------------+---------------+---------------+---------------+
~       CryptoContent                                           ~
|         crypto_content =                                      |
|           Encrypt( RTPSMessage{Body} )                        |
+---------------+---------------+---------------+---------------+
+---------------+---------------+---------------+---------------+
| SRTPS_POSTFIX |    flags     E|      short octetsToNextSubMsg  |
+---------------+---------------+---------------+---------------+
~       CryptoFooter                                            ~
```

Deleted:

```
+---------------+---------------+---------------+---------------+
```

In the above Encrypt indicates the cryptographic transformation performed with AES-GCM using the ***SessionKey*** and the ***InitializationVector*** operating on the `RTPSMessage{ Body }`.

The ***common_mac*** in the ***CryptoFooter*** is the authentication tag generated by the same AES-GCM transformation where the Additional Authenticated Data is set to the RTPS `Header` and RTPS `Header Extension`.

The ***receiver_specific_macs*** in the CryptoFooter are the AES-GMAC tags computed on the ***common_mac*** using each of the ***SessionReceiverSpecificKey*** and the same ***InitializationVector***

10.5.3.3.4.6.4 Authenticated Encryption with AAD not enabled

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

The output in case the transformation performs encryption and authentication shall be:

```
+---------------+---------------+---------------+---------------+
~       RTPSHdr  (unchanged from input)                         ~
+---------------+---------------+---------------+---------------+
+---------------+---------------+---------------+---------------+
| SRTPS_PREFIX  | (flags)      E|     short octetsToNextSubMsg  |
+---------------+---------------+---------------+---------------+
~       CryptoHeader                                            ~
+---------------+---------------+---------------+---------------+
+---------------+---------------+---------------+---------------+
| SEC_BODY      |  (flags)     E|     short octetsToNextSubMsg  |
+---------------+---------------+---------------+---------------+
~       CryptoContent                                           ~
|         crypto_content =                                      |
|           Encrypt( RTPSMessage{RTPSHdr -> InfoSourceSubMsg} ) |
+---------------+---------------+---------------+---------------+
+---------------+---------------+---------------+---------------+
| SRTPS_POSTFIX |    flags     E|     short octetsToNextSubMsg  |
+---------------+---------------+---------------+---------------+
~       CryptoFooter                                            ~
+---------------+---------------+---------------+---------------+
```

In the above Encrypt indicates the cryptographic transformation performed with AES-GCM using the ***SessionKey*** and the ***InitializationVector*** operating on the `RTPSMessage{ RTPSHdr -> InfoSourceSubMsg}`.

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

The ***common_mac*** in the ***CryptoFooter*** is the authentication tag generated by the same AES-GCM transformation where the Additional Authenticated Data is empty.

The ***receiver_specific_macs*** in the CryptoFooter are the AES-GMAC tags computed on the ***common_mac*** using each of the ***SessionReceiverSpecificKey*** and the same ***InitializationVector***.

If Additional Authenticated Data (AAD)" is not enabled the input RTPS Message cannot contain an RTPS `Header Extension`. Preventing this configuration is implementation specific.

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10.5.3.3.5 Computation of plaintext from ciphertext

The decrypt operation first checks that the `CryptoTransformIdentifier` attribute in the `CryptoHeader` has the proper `transformation_kind` and also uses the `CryptoTransformIdentifier` `transformation_key_id` to locate the `MasterKey`, and `MasterSalt`. In case of a re-key the crypto handle (`ParticipantCryptoHandle`, `DatawriterCryptoHandle`, or `DatareaderCryptoHandle`) may be associated with

multiple `MasterKeyId` and this parameter allows selection of the correct one. If the `MasterKeyId` is not found associated with the crypto handle the operation shall fail.
The session_id attribute within the `CryptoHeader` is used to obtain the proper `SessionReceiverSpecificKeys` and `SessionKey`. Note that this only requires a re-computation if it has changed from the previously received `SessionId` for that crypto handle.
Given the `InitializationVector` from the `CryptoHeader` and the `SessionKey` the transformation performed to recover the plaintext from the ciphertext is identical to the one performed to go plaintext to ciphertext.

10.5.3.3.6 Computation of the message authentication codes

The message digest is computed on the crypto_header and the ciphertext.
There are two types of message authentication codes (MACs) that may appear.

- The first stored in the ***common_mac*** uses the SessionKey. This MAC may be verified by all the receivers of the message.
- The second type, stored in the ***receiver_specific_macs*** contains MACs that use different `SessionReceiverSpecificKey` whose CryptoTransformIdentifier appears explicitly in the ***receiver_specific_macs***. These MACs use receiver-specific keys that are shared with only one receiver. The key material for these MACs is derived from the `RemoteParticipant2ParticipantKeyMaterial`, the `RemoteWriter2ReaderKeyMaterial`, or the `RemoteReader2WriterKeyMaterial`.

10.6 Builtin Logging Plugin

The builtin Logging Plugin is known as the DDS:Logging:DDS_LogTopic.
The DDS:Logging:DDS_LogTopic implements logging by publishing information to a DDS `Topic` `BuiltinLoggingTopic` defined below.
DDSSEC12-108 – secure log topic has a year 2038 issue
The `BuiltinLoggingTopic` shall have the Topic name "`DDS:Security:LogTopicV2`".
The `BuiltinLoggingTopic` shall have the Type `BuiltinLoggingTypeV2` defined in the IDL below.
DDSSEC12-108 – secure log topic has a year 2038 issue
Prior versions of DDS-Security (1.1 and earlier) published a topic with name "DDS:Security:LogTopic" and type BuiltinLoggingType also shown in the IDL below. Implementors of DDS-Security 1.2 may optionally provide mechanisms that configure a DomainParticipant to publish the legacy BuiltinLoggingTopic, that is, topic name "DDS:Security:LogTopic" and type "BuiltinLoggingType". Implementors may optionally provide mechanisms that configure a DomainParticipant to publish both the legacy "DDS:Security:LogTopic" as well as the new "DDS:Security:LogTopicV2". Note that publishing both Topics requires two separate DataWriters.
Users of DDS-Security 1.2 that want to receive the secure log messages shall create a DataReader for topic "DDS:Security:LogTopicV2" with type BuiltinLoggingTypeV2. Users that want to receive messages from applications that are using the "legacy" Log Topic may create an additional DataReader for "DDS:Security:LogTopic" with type BuiltinLoggingType. Users may subscribe to both Topics, using two different DataReaders.

```
enum LoggingLevel {
    EMERGENCY_LEVEL, // System is unusable. Should not continue use.
    ALERT_LEVEL,     // Should be corrected immediately
    CRITICAL_LEVEL,  // A failure in primary application.
```

```
    ERROR_LEVEL,     // General error conditions
    WARNING_LEVEL,   // May indicate future error if action not taken.
    NOTICE_LEVEL,    // Unusual, but nor erroneous event or condition.
    INFORMATIONAL_LEVEL, // Normal operational. Requires no action.
    DEBUG_LEVEL
};

@extensibility(FINAL)
struct NameValuePair {
    string name;
    string value;
};
typedef sequence<NameValuePair> NameValuePairSeq;
```

DDSSEC12-108 – secure log topic has a year 2038 issue

```
struct LegacyTime_t {
    long sec;
    unsigned long nanosec;
};

struct Time_t {
    long long sec;
    unsigned long nanosec;
};
```

DDSSEC12-29 - Specify DDS Security uses XCDR serialization version 1

```
@extensibility(APPENDABLE)
struct BuiltinLoggingType {
    octet  facility;  // Set to 0x0A (10). Indicates sec/auth msgs
    LoggingLevel severity;
    LegacyTime_t timestamp; // Since epoch 1970-01-01 00:00:00 +0000 (UTC)
    string hostname;  // IP host name of originator
    string hostip;    // IP address of originator
    string appname;   // Identify the device or application
    string procid;    // Process name/ID for syslog system
    string msgid;     // Identify the type of message
    string message;   // Free-form message

    // Note that certain string keys (SD-IDs) are reserved by IANA
    map<string, NameValuePairSeq>  structured_data;
};

@extensibility(APPENDABLE)
struct BuiltinLoggingTypeV2 {
    octet  facility;  // Set to 0x0A (10). Indicates sec/auth msgs
    LoggingLevel severity;
    Time_t timestamp; // Since epoch 1970-01-01 00:00:00 +0000 (UTC)
    string hostname;  // IP host name of originator
    string hostip;    // IP address of originator
    string appname;   // Identify the device or application
    string procid;    // Process name/ID for syslog system
    string msgid;     // Identify the type of message
    string message;   // Free-form message

    // Note that certain string keys (SD-IDs) are reserved by IANA
    map<string, NameValuePairSeq>  structured_data;
```

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};

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

Knowledge of the BuiltinLoggingTopic shall be builtin into the DDS:Access:Permissions AccessControl plugin and it shall be treated according to the following topic rule:

```
    <topic_rule>
  <topic_expression> DDS:Security:LogTopic</topic_expression>
  <enable_discovery_protection>FALSE</enable_discovery_protection>
  <enable_read_access_control>TRUE</enable_read_access_control>
  <enable_write_access_control>FALSE</enable_write_access_control>
  <metadata_protection_kind>SIGN</metadata_protection_kind>
  <data_protection_kind>ENCRYPT</data_protection_kind>
</topic_rule>
```

The above rule states that any DomainParticipant with permission necessary to join the DDS Domain shall be allowed to write the BuiltinLoggingTopic but in order to read the BuiltinLoggingTopic the DomainParticipant needs to have a grant for the BuiltinLoggingTopic in its permissions document.

10.6.1 DDS:Logging:DDS_LogTopic plugin behavior

The table below describes the actions that the DDS:Logging:DDS_LogTopic plugin performs when each of the plugin operations is invoked.

Table 82 – Actions undertaken by the operations of the builtin Logging plugin

set_log_options	Controls the configuration of the plugin. The LogOptions parameter shall be used to take the actions described below: If the ***distribute*** parameter is set to TRUE, the DDS:Logging:DDS_LogTopic shall create a DataWriter to send the BuiltinLoggingTopic if it is FALSE, it shall not. The plugin shall open a file with the name indicated in the ***log_file*** parameter. The plugin shall remember the value of the ***log_level*** so that it can be used during the log operation.

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`log`	This operation shall check if logging was enabled by a prior call to `enable_logging` and if not it shall return without performing any action. If logging was enabled, it shall behave as described below: The operation shall compare the value of the the ***log_level*** parameter with the value saved during the `set_log_options` operation. If the ***log_level*** parameter value is greater than the one saved by the `set_log_options` operation, the operation shall return without performing any action. If the ***log_level*** parameter value is less than or equal to the one saved, the `log` operation shall perform two actions: • It shall append a string representation of the parameters passed to the log operation to the end of the file opened by the `set_log_options` operation. • If the value of the ***distribute*** option was set on the call to `set_log_options`, the plugin shall fill an object of type `BuiltinLoggingType` with the values passed as arguments to the `log` operation and publish it using the `DataWriter` associated with the `BuiltinLoggingTopic` created by the `set_log_options` operation.
`enable_logging`	This operation shall save the fact that logging was enabled such that the information can be used by the `log` operation.
`set_listener`	This operation shall save a reference to the LoggerListener such that the listener is be notified each time a log message is produced.

10.7 Builtin Authentication: DDS:Auth:PSK

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

This builtin authentication plugin is referred to as the “DDS:Auth:PSK”. ”. It is intended to be used in conjunction with the “DDS:Access:PSK” and “DDS:Crypto:PSK.

The DDS:Auth:PSK plugin is mostly a “NOOP” plugin that constructs an IdentityHandle with the information the information the “DDS:Access:PSK” and “DDS:Crypto:PSK need.

The DDS:Auth:PSK plugin does not do any Authentication treating all participants it discovers as “Unauthenticated” Participants. However, provided it is used with the “DDS:Crypto:PSK” plugin, any discovered DDS `DomainParticipant` must have access to the same pre-shared secret key.

10.7.1 Configuration

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

This plugin does not require any configuration beyond selecting it to be used. The mechanism for selecting which plugins are active is implementation specific.

10.7.2 DDS:Auth:PSK Types

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

This sub clause specifies the content and format of the `Credential` and `Token` objects used by the DDS:Auth:PSK plugin.

`Credential` and `Token` attributes left unspecified in this section shall be understood to not have any required values for the plugin. These attributes shall be handled according to the following rules:

- Plugin implementations may place data in these attributes as long as they also include a property attribute that allows the implementation to unambiguously detect the presence and interpret these attributes.
- Attributes that are not understood shall be ignored.

- Property_t and BinaryProperty_t names shall comply with the rules defined in 7.3.1 and 7.3.3, respectively.

The content of the Handle objects is not specified as it represents references to internal state that is only understood by the plugin itself. The DDS Implementation only needs to hold a reference to the returned Handle objects returned by the plugin operations and pass these Handle references to other operations.

10.7.2.1 DDS:Auth:PSK IdentityToken

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
The DDS:Auth:PSK plugin shall set the ***class_id*** attribute of the IdentityToken object to "DDS:Auth:PSK:1.2" no other attributes are specified or required.
The value of the ***class_id*** shall be interpreted as composed of three parts: a ***PluginClassName***, a ***MajorVersion*** and a ***MinorVersion*** according to the following format: <PluginClassName>:<MajorVersion>.<MinorVersion>. The ***PluginClassName*** is separated from the ***MajorVersion*** by the last ':' character in the class_id. The ***MajorVersion*** and ***MinorVersion*** are separated by a '.' character. Accordingly this version of the specification has ***PluginClassName*** equal to "DDS:Auth:PSK", ***MajorVersion*** set to 1, and ***MinorVersion*** set to 2.

10.7.2.2 DDS:Auth:PSK IdentityStatusToken

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
The DDS:Auth:PSK plugin does not use this Token. There is no value specified for it.

10.7.2.3 DDS:Auth:PSK AuthenticatedPeerCredentialToken

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
The DDS:Auth:PSK plugin does not use this Token. There is no value specified for it.

10.7.2.4 DDS:Auth:PSK AuthRequestMessageToken

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
The DDS:Auth:PSK plugin does not use this Token. There is no value specified for it.

10.7.2.5 DDS:Auth:PSK HandshakeMessageToken

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
There is no value specified for it.

10.7.2.5.1 HandshakeRequestMessageToken objects

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
The DDS:Auth:PSK plugin does not use this Token. There is no value specified for it.

10.7.2.5.2 HandshakeReplyMessageToken

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
The DDS:Auth:PSK plugin does not use this Token. There is no value specified for it.

10.7.2.5.3 HandshakeFinalMessageToken

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

There is no value specified for it.

10.7.3 DDS:Auth:PSK plugin behavior

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

The table below describes the actions that the DDS:Auth:PSK plugin performs when each of the plugin operations is invoked.

Table 83 – Actions undertaken by the operations of the builtin DDS:Auth:PSK plugin

`validate_local_identity`	This operation shall receive the ***participant_guid*** associated with the local `DomainParticipant` whose identity is being validated. The operation shall always return VALIDATION_OK. The operation shall set the output 16-byte ***adjusted_participant_guid*** GUID to the same value as the input ***participant_guid***.
`get_identity_token`	This operation returns the Token specified in 10.7.2.1
`get_identity_status_token`	This operation shall return TokenNIL.
`set_participant_security_config`	This operation shall do nothing and return TRUE.
`set_permissions_credential_and_token`	This operation shall do nothing and return TRUE.
`validate_remote_identity`	The operation shall always return VALIDATION_FAILED.
`begin_handshake_request`	This operation does not need to be implemented. It will not be called on the plugin given that `validate_remote_identity` always returns VALIDATION_FAILED.
`begin_handshake_reply`	This operation does not need to be implemented. It will not be called on the plugin given that `validate_remote_identity` always returns VALIDATION_FAILED
`process_handshake`	This operation does not need to be implemented. It will not be called on the plugin given that `validate_remote_identity` always returns VALIDATION_FAILED
`get_shared_secret`	This operation does not need to be implemented. It will not be called on the plugin given that `validate_remote_identity` always returns VALIDATION_FAILED.
`get_authenticated_peer_credential_token`	This operation does not need to be implemented. It will not be called on the plugin given that `validate_remote_identity` always returns VALIDATION_FAILED.
`set_listener`	This operation shall save a reference to the listener object and associate it with the specified `IdentityHandle`.
`return_identity_token`	This operation shall behave as specified in 9.3.2.11.14.
`return_identity_status_token`	This operation shall behave as specified in 9.3.2.11.15.
`return_authenticated_peer_credential_token`	This operation does not need to be implemented. It will not be called on the plugin given that `validate_remote_identity` immediately fails
`return_handshake_handle`	This operation does not need to be implemented. It will not be called on the plugin given that `begin_handshake_request` and `begin_handshake_reply` are never called.

`return_identity_handle`	This operation shall behave as specified in 9.3.2.11.18.
`return_sharedsecret_handle`	This operation does not need to be implemented. It will not be called on the plugin given that `validate_remote_identity` always returns VALIDATION_FAILED.

10.8 Builtin Access Control: DDS:Access:PSK

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

This builtin plugin is referred to as the "DDS:Access:PSK". It is intended to be used in conjunction with the DDS:Auth:PSK and the DDS:Crypto:PSK.

The plugin implements the `AccessControl` plugin API granting all permissions. Specifically:

- It allows the local application to join any DDS domain, as well as publish and subscribe to any DDS `Topic` in that domain.
- It allows a remote `DomainParticipant` to join any DDS domain, as well as publish and subscribe to any DDS Topic in that domain.

Provided it is used with the DDS:Crypto:PSK, the broad permissions are granted on the basis that any discovered DDS `DomainParticipant` must have access to the same pre-shared secret key.

10.8.1 Configuration

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

The configuration of the DDS:Access:PSK access control plugin shall be done using the `PropertyQosPolicy` of the `DomainParticipantQos`. The specific properties used are described in Table 84 below.

Table 84 – Properties used to configure the builtin DDS:Access:PSK plugin

Property Name ***(all properties have "dds.sec.access." prefix)***	***Property Value*** ***(all these properties shall have propagate set to FALSE)***	***Applicable Entities***
rtps_psk_protection_kind (the presence of this property is optional)	One of the following 3 string options: "NONE", "SIGN", or "ENCRYPT". Note that use of "NONE" will disable all protection. If not specified it is treated as if it was specified to be "ENCRYPT". This property must be configured consistently on all the DomainParticipants that join a DDS Domain.	DomainParticipant

10.8.2 DDS:Access:PSK Types

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

This sub clause specifies the content and format of the `Credential` and `Token` objects used by the DDS:Access:PSK plugin.

10.8.2.1 DDS:Access:PSK PermissionsCredentialToken

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

The DDS:Access:PSK plugin does not interpret the value of this Token. For this reason the value is implementation specific.

10.8.2.2 DDS:Access:PSK PermissionsToken

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
The DDS:Access:PSK plugin shall set the ***class_id*** attributes to "DDS:Access:PSK:1.2". No other attributes need to be set.

10.8.2.3 DDS:Access:PSKPluginParticipantSecurityAttributes

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
The `PluginParticipantSecurityAttributes` describe plugin-specific behavior of the associated cryptographic plugin affecting the key material and transformations for the RTPS messages

10.8.2.4 DDS:Access:PSK PluginParticipantSecurityAttributesMask

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
The `PluginParticipantSecurityAttributesMask` is used to encode the value of the `PluginParticipantSecurityAttributes` in a compact way such that it can be included in the `ParticipantSecurityInfo`.

10.8.2.5 DDS:Access:PSK PluginEndpointSecurityAttributes

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
The `PluginEndpointSecurityAttributes` describe plugin-specific behavior of the associated cryptographic plugin affecting the key material and transformations for `DataWriter` and `DataReader` messages.

10.8.2.6 DDS:Access:PSK PluginEndpointSecurityAttributesMask

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
The `PluginEndpointSecurityAttributesMask` is used to encode the value of the `PluginEndpointSecurityAttributes`

10.8.3 DDS:Access:PSK plugin behavior

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
The table below describes the actions that the DDS:Access:PSK plugin performs when each of the plugin operations is invoked.

Table 85 – Actions undertaken by the operations of the builtin AccessControl plugin

`check_create_participant`	This operation shall return TRUE.
`check_create_datawriter`	This operation shall return TRUE.
`check_create_datareader`	This operation shall return TRUE.
`check_create_topic`	This operation shall return TRUE.
`check_local_datawriter_register_instance`	This operation shall return TRUE.
`check_local_datawriter_dispose_instance`	This operation shall return TRUE.
`check_remote_participant`	This operation shall return TRUE.

check_remote_datawriter	This operation shall return TRUE.
check_remote_datareader	This operation shall return TRUE.
check_remote_topic	This operation shall return TRUE.
check_local_datawriter_match	This operation shall return TRUE.
check_local_datareader_match	This operation shall return TRUE.
check_remote_datawriter_register_instance	This operation shall return TRUE.
check_remote_datawriter_dispose_instance	This operation shall return TRUE.
get_permissions_token	This operation shall return the `PermissionsToken` formatted as described in 10.8.2.2.
get_permissions_credential_token	This operation shall return the `PermissionsToken` formatted as described in 10.8.2.1
set_listener	This operation shall save a reference to the listener object and associate it with the specified `PermissionsHandle`.
return_permissions_token	This operation shall behave as specified in 9.4.2.9.20
return_permissions_credential_token	This operation shall behave as specified in 9.4.2.9.21
validate_local_permissions	This operation shall succeedand return an opaque handle that the plugin can use to refer to any implementation-specific saved information.
validate_remote_permissions	This operation shall succeedand return an opaque handle that the plugin can use to refer to any implementation-specific saved information.
get_participant_security_config	This operation shall use the ***permissions_handle*** to retrieve the cached information resulting from the configuration of the plugin. The fields of the `ParticipantSecurityConfig` ***attributes*** shall be set according to the following rules: The field ***allow_unauthenticated_participants*** shall be set to TRUE. The field ***is_access_protected*** shall be set to FALSE. The field ***is_rtps_axk_protected*** shall be set to FALSE. The field ***is_rtps_psk_protected*** shall be set to TRUE if the `DomanParticipant` was configured with the `PropertyQos` property ***dds.sec.access.rtps_psk_protection_kind*** set to "ENCRYPT" or "SIGN". It shall be set to FALSE if it was configured with the property set to "NONE". The field ***is_discovery_protected*** shall be set to FALSE. The field ***is_liveliness_protected*** shall be set to FALSE. The field ***plugin_participant_mask*** shall have the PLUGIN_PARTICIPANT_SECURITY_ATTRIBUTES_FLAG_IS_RTPS_PSK_ENCRYPTED set if and only if the `DomanParticipant` was configured with the `PropertyQos` property ***dds.sec.access.rtps_psk_protection_kind*** set to "ENCRYPT" All other flags should be unset. The field ***algorithm_info*** shall have its nested fields set as follows: • All the "***supported_mask***" nested fields corresponding each of the algorithm types shall be set to

	CRYPTO_ALGORITHM_SET_ALL defined in 7.3.9, indicating that there are no constraints on the supported algorithms. • All the "***required_mask***" nested fields corresponding each of the algorithm types shall be set to CRYPTO_ALGORITHM_SET_EMPTY indicating that there are no required algorithms.
`get_topic_security_config`	The fields of the `TopicSecurityConfig` ***attributes*** shall all be set to FALSE.
`get_datawriter_security_config`	The boolean fields of the `DatawriterSecurityConfig` ***attributes*** shall all be set to FALSE. The ***plugin_endpoint_attributes*** shall be set to the empty mask. The setting of the ***ac_endpoint_properties*** is implementation specific. The field ***algorithm_info*** shall have its nested fields set as follows: • All the "***supported_mask***" nested fields corresponding each of the algorithm types shall be set to CRYPTO_ALGORITHM_SET_ALL defined in 7.3.9, indicating that there are no constraints on the supported algorithms. • All the "***required_mask***" nested fields corresponding each of the algorithm types shall be set to CRYPTO_ALGORITHM_SET_EMPTY indicating that there are no required algorithms.
`get_datareader_security_config`	The boolean fields of the `DatareaderSecurityConfig` ***attributes*** shall all be set to FALSE. The ***plugin_endpoint_attributes*** shall be set to the empty mask. The setting of the ***ac_endpoint_properties*** is implementation specific. The field ***algorithm_info*** shall have its nested fields set as follows: • All the "***supported_mask***" nested fields corresponding each of the algorithm types shall be set to CRYPTO_ALGORITHM_SET_ALL defined in 7.3.9, indicating that there are no constraints on the supported algorithms. • All the "***required_mask***" nested fields corresponding each of the algorithm types shall be set to CRYPTO_ALGORITHM_SET_EMPTY indicating that there are no required algorithms.
`return_participant_security_config`	This operation shall behave as specified in 9.4.2.9.26
`return_topic_security_config`	This operation shall behave as specified in 9.4.2.9.27
`return_datawriter_security_config`	This operation shall behave as specified in 9.4.2.9.28.
`return_datareader_security_config`	This operation shall behave as specified in 9.4.2.9.29.

10.9 Builtin Crypto: DDS:Crypto:PSK

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

This builtin `Cryptographic` plugin is referred to as the "DDS:Crypto:PSK" plugin. This plugin does Authenticated Encryption with Associated Data (AEAD) using Advanced Encryption Standard with Galois Counter Mode (AES-GCM/GMAC), see 8.1 for more details.
The algorithms used are the same described in 10.5.

The DDS:Crypto:PSK plugin is intended to be used in connection with the DDS:Auth:PSK and the DDS:Access:PSK.

10.9.1 Configuration

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
The DDS:Crypto:PSK plugin shall be configured using the `PropertyQosPolicy` of the `DomainParticipantQos`. The specific properties used are described in Table 86 below.

Table 86 – Properties used to configure the builtin DDS:Crypto:PSK plugin

Property Name ***(all properties have "dds.sec.crypto." prefix)***	***Property Value*** ***(all these properties shall have propagate set to FALSE)*** ***URI syntax follows IETF RFC 3986.*** ***URI "data" schema follows IETF RFC 2397*** ***Vendors may support additional schemas***	***Applicable Entities***

rtps_psk_symmetric_cipher_algorithm (the presence of this property is optional)	The string "AUTO" or one of the `CryptoAlgorithmName` strings shown in Table 22 that identifies a pair of Symmetric Cipher AEAD and MAC Algorithms. If not specified it is treated as if it was specified to be "AUTO". If "AUTO" is specified it is treated as if it was specified to be "AES256-GCM". This property must be configured consistently on all the `DomainParticipants` that join the same DDS Domain.	DomainParticipant

rtps_psk_secret_passphrase (the presence of this property is mandatory)	Specifying this property enables pre-shared-key (PSK) protection. See 10.4.1.2.5.8.
	
	The property specifies the URI to access the ***passphrase_id*** and ***passphrase*** that is used to protect RTPS messages using a pre-shared key.
	
	The ***passphrase_id*** shall be a number between 0 and 2^{32}-1 represented as a decimal string. The ***passphrase_id*** shall immediately follow the URI schema, after the character(s) used to delimit the URI schema, e.g. ':' or ':,'.
	
	The range of ***passphrase_id*** that verify ***passphrase_id* && 0xFF== 0xFF** is reserved and shall not be used.
	
	The ***passphrase*** shall contain up to 512 ASCII printable characters (character codes 32 to 126, both included), except that the first and last characters of the ***passphrase*** shall not be the space character (character codes 32)
	The ***passphrase*** shall follow the ***passphrase_id*** be and separated from it by the ':' character.
	
	The ***passphrase_id*** and ***passphrase*** must be configured consistently on all the DomainParticipants that join the DDS Domain.
	
	Supported URI schemas are: "file" and "data".
	
	Examples:
	`file:myfile.txt`
	`file:/home/myuser/myfile.txt`
	
	`data:,5612:Open Sesame`
	
	Here the ***passphrase_id*** is 5612 and the ***passphrase*** is "Open Sesame"
	
	In the above example, in order to specify the same configuration, the content of the file **myfile.txt** should be the string:
	`5612:Open Sesame`
		DomainParticipant

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rtps_psk_secret_passphrase_alt (the presence of this property is optional)	URI to access a list of additional ***passphrase id*** and ***passphase*** values that are also accepted during decoding. This is intended to allow replacing the pre-shared keys system-wide while the system remains in operation.
	
	The URIs accepted are the same used for the `rtps_psk.secret_passphrase` property.
	
	If multiple passphrases are provided each ***secret passphrase id***, and ***passphrase*** tuple shall be separated from the next using the LineFeed (\n, character 10), the CarryReturn (\r, character 13), or both.
	For example:
	`data:,5613:ExtraSecretPassphase`
	`5614:AnotherSecretPassphase`
	`5615:YetAnotherSecretPassphase`
		DomainParticipant

10.9.2 DDS:Crypto:PSK Types

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

The `Cryptographic` plugin defines a set of generic data types that are used to externalize the properties and material that must be shared with the applications that need to decode the cipher material.

The types defined are the same as the corresponding ones for the DDS:Crypto:AES-GCM-GMAC plugin, see 10.5.2.

10.9.2.1 DDS:Crypto:PSK CryptoToken

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

This type is defined the same way as the DDS:Crypto:AES-GCM-GMAC CryptoToken, see 10.5.2.1.

This type is not strictly needed as the pre-shared Keys are not sent over the network. However, it may still be useful to plugin implementations in order to hold the key material and pass it between functions.

The Key Material used by the plugin shall be derived from the DomainParticipant configuration properties defined in 10.9.1 using the same algorithm described in 10.5.2.1.3.

10.9.2.2 DDS:Crypto:PSK CryptoTransformIdentifier

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

This type is defined the same wasy as the DDS:Crypto:AES-GCM-GMAC CryptoTransformIdentifier, see 10.5.2.2.

10.9.2.3 DDS:Crypto:PSK CryptoHeader

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

This type is defined the same wasy as the DDS:Crypto:AES-GCM-GMAC CryptoHeader, see 10.5.2.3.

10.9.2.4 DDS:Crypto:PSK CryptoContent

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages

This type is defined the same wasy as the DDS:Crypto:AES-GCM-GMAC CryptoContent, see 10.5.2.4.

10.9.2.5 DDS:Crypto:PSK CryptoFooter

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
This type is defined the same wasy as the DDS:Crypto:AES-GCM-GMAC CryptoFooter, ee 10.5.2.5.

10.9.3 DDS:Crypto:PSK plugin behavior

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
This plugin implements three interfaces: `CryptoKeyFactory`, `CryptoKeyExchange`, and `CryptoTransform`. Each is described separately.

10.9.3.1 CryptoKeyFactory for DDS:Crypto:PSK

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
The table below describes the actions that the DDS:Crypto:PSK when each of the `CryptoKeyFactory` plugin operations is invoked.
DDSSEC12-122 – Provide mechanism for changing the session keys

Table 87 – Actions undertaken by the operations on the DDS:Crypto:PSK CryptoKeyFactory plugin

`register_local_participant`	This operation shall create a new `KeyMaterial_AES_GCM_GMAC` object and return a handle that the plugin can use to access the created object. We will refer to this object by the name: `ParticipantKeyMaterial`. The ***transformation_kind*** member ***transformation_algorithm_id*** for the `ParticipantKeyMaterial` object determines whether the transformation performs authentication only (GMAC) or authenticated encryption (GCM). The selection between these two options shall be done according to the setting of the RTPS Protection Kind (see 10.4.1.2.5.7). The ***transformation_kind*** member ***transformation_algorithm_id*** also determines whether the encryption and/or authentication uses 128-bit or 256-bit keys. This aspect shall be configurable but the configuration mechanism is not specified. The operation shall store in the internal state of the plugin the value for ***particiant_security_config.algorithm_info.symmetric_cipher.supported_mask.*** This operation shall fill the ***adjusted_algorithm_info*** output parameter as follows: • The member ***symmetric_cipher.supported_mask*** shall be initialized with the `CryptoAlgorithmBit` that correspond to the algorithm that will be used to protect the RTPS messages. That is, the algorithm configured using the property `rtps_psk_symmetric_cipher_algorithm`, see 10.9.1. • The member ***symmetric_cipher.required_mask*** shall be initialized with the same value as the ***symmetric_cipher.supported_mask***. • The member ***symmetric_cipher.builtin_kx_endpoints_required_mask*** shall be initialized with `CRYPTO_ALGORITHM_SET_EMPTY`. • The member ***symmetric_cipher.builtin_endpoints_required_mask*** shall be initialized with `CRYPTO_ALGORITHM_SET_EMPTY`. • All other members of ***adjusted_algorithm_info*** shall be set to zero. Note that a zero value for a mask corresponds to the constant value CRYPTO_ALGORITHM_SET_EMPTY. The operation shall configure the Crypto plugins to only accept the resulting set of supported algorithms in the ***adjusted_algorithm_info***.
`register_matched_remote_participant`	This operation shall do nothing and return dummy Handle.
`register_local_datawriter`	This operation shall do nothing and return dummy Handle.

register_matched_remote_datareader	This operation shall do nothing and return dummy Handle.
register_local_datareader	This operation shall do nothing and return dummy Handle.
register_matched_remote_datawriter	This operation shall do nothing and return dummy Handle.
revise_local_entity_keys	This operation shall do nothing and return dummy Handle.
activate_key_revision	This operation shall do nothing and return FALSE.
unregister_participant	Releases any resources allocated on the corresponding call to register_local_participant, or register_matched_remote_participant.
unregister_datawriter	Releases any resources allocated on the corresponding call to register_local_datawriter, or register_matched_remote_datawriter.
unregister_datareader	Releases any resources allocated on the corresponding call to register_local_datareader, or register_matched_remote_datareader.

10.9.3.2 CryptoKeyExchange for DDS:Crypto:PSK

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
The table below describes the actions that the DDS:Crypto:PSK when each of the `CryptoKeyExchange` plugin operations is invoked.

Table 88 – Actions undertaken by the operations of the builtin DDS CryptoKeyExchange plugin

create_local_participant_crypto_tokens	This operation shall do nothing and return FALSE.
set_remote_participant_crypto_tokens	This operation shall do nothing and return FALSE.
create_local_datawriter_crypto_tokens	This operation shall do nothing and return FALSE.
set_remote_datawriter_crypto_tokens	This operation shall do nothing and return FALSE.
create_local_datareader_crypto_tokens	This operation shall do nothing and return FALSE.
set_remote_datareader_crypto_tokens	This operation shall do nothing and return FALSE.
return_crypto_tokens	Releases the resources associated with the `CryptoToken` objects in the sequence.

10.9.3.3 CryptoKeyTransform for DDS:Crypto:PSK

10.9.3.3.1 Overview

DDSSEC12-94 - Provide pre-shared protection for unauthenticated messages
The table below describes the actions that the DDS:Crypto:AES-GCM-GMAC when each of the `CryptoKeyTransform` plugin operations is invoked.

Table 89 – Actions undertaken by the operations of the builtin Cryptographic CryptoKeyTransform plugin

encode_serialized_payload	This operation shall do nothing and return FALSE.
encode_datawriter_submessage	This operation shall do nothing and return FALSE.

encode_datareader_submessage	This operation shall do nothing and return FALSE.
encode_rtps_message	Transforms the input RTPS Message into an output RTPS Message that contains the original RTPS Header and, if present, the original HeaderExtension, followed by the SecureRTPSPrefixSubMsg, one or more RTPS SubMessages, and the SecureRTPSPostfixSubMsg. The operation checks that the parameter ***transform_with_psk***=TRUE. If this is not the case the operation shall fail and return FALSE. The operation checks that the parameter ***receiver_specific_macs*** contains an empty list. If this is not the case the operation shall fail and return FALSE. The transformation uses the ParticipantKeyMaterial associated with the sending_participant_crypto. Let RTPSMessage{Body} represent the input RTPS Message excluding the RTPS Header and HeaderExtension. **1)** If the ***transformation_kind*** indicates that encryption is performed, then the output shall be the original RTPS_Header and (if present) the (adjusted) HeaderExtension (see bullet (3)), plus three RTPS Submessages: SecureRTPSPrefixSubMsg, SecureBodySubMsg, and SecureRTPSPostfixSubMsg. The SecureRTPSPrefixSubMsg flag AdditionalAuthenticatedDataFlag shall be set. The SecureRTPSPrefixSubMsg flag PreSharedKeyFlag shall be set. The SecureBodySubMsg shall contain the result of encrypting the RTPSMessage{Body}. The SecureRTPSPostfixSubMsg shall contain the authentication tags computed on the SecureBodySubMsg with both the RTPS Header and (if present) the (adjusted) HeaderExtension as AAD, see bullet (3). **2)** If the ***transformation_kind*** indicates that only authentication is performed then the output shall be: the original RTPS Header and (if present) the (adjusted) Header Extension (see bullet (3)), followed by the SecureRTPSPostfixSubMsg, RTPSMessage{Body}, and SecureRTPSPostfixSubMsg. The SecureRTPSPostfixSubMsg shall contain the authentication tags computed on the RTPSMessage{Body} with both the RTPS Header and (if present) the (adjusted) Header Extension as AAD, see bullet (3). The ***common_mac*** shall be computed using the ParticipantKeyMaterial associated with the ***sending_participant_crypto***. 3) In both cases: ***transformation_kind*** indicating encryption or only authentication, the HeaderExtension, if present, shall be adjusted as follows: 3.1) The HeaderExtension used as input to the AAD shall have the messageLength element, if present, set to zero. 3.2) The HeaderExtension used as input to the AAD shall have the messageChecksum element, if present, set to zero. 3.3) After computing the SecureRTPSPrefixSubMsg, SecureBodySubMsg, and SecureRTPSPostfixSubMsg. The HeaderExtension shall be adjusted setting the appropriate values of the messageLength and messageChecksum elements, if originally present, to correspond to the transformed (encoded) RTPS message.

decode_rtps_message	Examines the SecureRTPSPrefixSubMsg to determine the ***transformation_kind*** matches the one the receiving DomainParticipant is expecting both in terms of the type of algorithm as well as the protection (encrypt, authentication,, etc.). If the kind is not the expected one, the operation shall fail with an exception. The operation checks that the parameter ***transform_with_psk***=TRUE. If this is not the case the operation shall fail and return FALSE. **1) Uses content of the RTPS Header, the pre-shared secret and SenderKeyId** to compute (or locate a previously computed) PSK Key Material associated with the sending Participant (see 10.5.2.1.3). If the ***transformation_kind*** indicates the use of authenticated encryption, it uses the PSK KeyMaterial to decode the encoded input RTPS message. Uses the PSK KeyMaterial to validate the authentication tags contained in the SecureRTPSPostfixSubMsg. **2) Checks the SecureRTPSPrefixSubMsg's AdditionalAuthenticatedDataFlag.** If this flag is not set, the decode operation shall fail. If the flag is set, the decode shall validate the tag present in the SecureRTPSPostfixSubMsg passing the RTPS Header and (if present) the (adjusted) HeaderExtension as AAD. 2.1) The (adjusted) HeaderExtension used as input to the AAD validation shall have the messageLength element, if present, set to zero and the messageChecksum element, if present, also set to zero. **3) Finally:** The HeaderExtension, if present, shall have the messageLength element, if present and the messageChecksum element, if present, adjusted such that they correspond to the values passed as input to the encode_rtps_message operation. Upon success the returned RTPS Message shall match the input to the encode_rtps_message operation on the DomainParticipant that sent the message.
preprocess_secure_submsg	This operation shall do nothing and return FALSE.
decode_datawriter_submessage	This operation shall do nothing and return FALSE.
decode_datareader_submessage	This operation shall do nothing and return FALSE.
decode_serialized_payload	This operation shall do nothing and return FALSE.

11 Plugin Language Bindings

11.1 Introduction

Clause 9 defines the plugin interfaces in a programming-language independent manner using UML. Using the terminology of the DDS specification this UML definition could be considered a Platform Independent Model (PIM) for the plugin interfaces. The mapping to each specific programming languages platform could therefore be considered a Platform Specific Model (PSM) for that programming language.

The mapping of the plugin interfaces to specific programming languages is defined by first defining the interfaces using OMG-IDL version 3.5 with the additional syntax defined in the DDS-XTYPES specification and subsequently applying the IDL to language mapping to the target language.

IDL Types lacking the DDS-XTYPES `@extensibility` annotation shall be interpreted as having the extensibility kind APPENDABLE. This matches the DDS-XTYPES specification implied extensibility of un-annotated types.

For consistency with the DDS specification, the DDS security specification defines language bindings to each of the language PSMs specified for DDS, namely:

- C as derived from the IDL to C mapping
- C++ classic, as derived from the IDL to C++ mapping
- Java classic, as derived from the IDL to Java mapping
- C++ modern, aligned with the DDS-STDC++ specification, this is derived from the IDL to C++11 mapping
- Java modern with the DDS-JAVA5+ specification

11.2 IDL representation of the plugin interfaces

For consistency in the resulting APIs, the mapping from the plugin interfaces defined in clause 9 and the OMG IDL follows the same PIM to PSM mapping rules as the OMG DDS specification (see sub clause 7.2.2 of the DDS specification version 1.2 [1]). A relevant subset of these rules is repeated here. In these rules "PIM" refers to the UML description of the interfaces in clause 9 and PSM refers to the OMG-IDL description of the interfaces that appears in the associated **dds_security.idl** file.

- The PIM to PSM mapping maps the UML interfaces and classes into IDL interfaces. Plain data types are mapped into structures.
- 'Out' parameters in the PIM are conventionally mapped to 'inout' parameters in the PSM in order to minimize the memory allocation performed by the Service and allow for more efficient implementations. The intended meaning is that the caller of such an operation should provide an object to serve as a "container" and that the operation will then "fill in" the state of that objects appropriately.

The resulting IDL representation of the plugin interfaces appears in the file **dds_security.idl** which shall be considered part of the DDS Security specification.

11.3 C language representation of the plugin interfaces

The C language representation of the plugin interfaces shall be obtained applying the IDL to C mapping [5] to the **dds_security.idl** file.

11.4 C++ classic representation of the plugin interfaces

The C++ classic (without the use of the C++ standard library) language representation of the plugin interfaces shall be obtained using the IDL2C++ mapping [7] to the **dds_security.idl** file.

11.5 Java classic

The Java classic language representation of the plugin interfaces shall be obtained using the IDL2Java mapping [6] to the **dds_security.idl** file.

11.6 C++11 representation of the plugin interfaces

This representation is aligned with the DDS-STDC++ PSM.

The C++ classic language representation of the plugin interfaces shall be obtained using the IDL2C++11 mapping [8] to the **dds_security.idl** file with the following exceptions:

1. The IDL module DDS shall be mapped to the C++ namespace **dds** so it matches the namespace used by the DDS-STD-C++ PSM.
2. The mapping shall not use any C++11-only feature of the language or the library (e.g., move constructors, noexcept, override, std::array).
3. Arrays shall map to the `dds::core::array` template defined in the DDS-STD-C++ PSM.
4. The enumerations shall map to the dds::core::safe_enum template defined in the DDS-STD-C++ PSM.
5. The IDL DynamicData native type shall be mapped to the C++ type `dds::code::xtypes::DynamicData` defined in the DDS-STDC++ PSM.

11.7 Java modern aligned with the DDS-JAVA5+ PSM

The Java classic language representation of the plugin interfaces shall be obtained using the IDL2Java mapping [6] to the **dds_security.idl** file with the following exceptions:

1. The IDL module DDS shall be mapped to the Java namespace **org.omg.dds** so it matches the namespace used by the DDS-JAVA5+ PSM.
2. The IDL DynamicData native type shall be mapped to the type `org.omg.dds.type.dynamic.DynamicData` defined in the DDS-JAVA5+ PSM.

Annex A – References

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