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MOF Model to Text Transformation Language, v1.0

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Preface

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OMG

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- CWM
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- CORBA/IIOP
- IDL/Language Mappings
- Specialized CORBA specifications
- CORBA Component Model (CCM).

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- CORBAservices

- CORBAfacilities
- OMG Domain specifications
- OMG Embedded Intelligence specifications
- OMG Security specifications.

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Times/Times New Roman - 10 pt.: Standard body text

Helvetica/Arial - 10 pt. Bold: OMG Interface Definition Language (OMG IDL) and syntax elements.

`Courier - 10 pt. Bold:` Programming language elements.

Helvetica/Arial - 10 pt: Exceptions

Note – Terms that appear in *italics* are defined in the glossary. Italic text also represents the name of a document, specification, or other publication.

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1 Scope

This specification defines the MOF to Text Template Language (Mof2Text), version 1.0. Mof2Text is aligned with UML 2.0, MOF 2.0, and OCL 2.0.

2 Conformance

There are four levels of compliance as shown below. A compliance level is defined in terms of the supported syntax and features.

Syntax Features	Core	Advanced
Abstract	Minimal	Intermediate
Concrete	Basic	Complete

- Abstract syntax compliance: The tool can read and interpret Mof2Text specifications in model form.
- Concrete syntax compliance: The tool can read and execute Mof2Text specifications in concrete syntax form. A tool supporting the concrete syntax also supports the abstract syntax.
- Core feature compliance: The tool supports core language features namely *Template*, *Query*, and *Module*.
- Advanced feature compliance: In addition to the core features, the tool also supports advanced features namely *Module extension, Template Overriding*, *Text mode switching*, and *Macros*.

3 Normative References

The following normative documents contain provisions which, through reference in this text, constitute provisions of this specification. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply.

- MOF 2.0 Core Specification (formal/2006-01-01)
- OCL 2.0 Specification (formal/2006-05-01)
- QVT Specification (ptc/05-11-01)
- UML 2.0 Superstructure Specification (formal/05-07-04)

4 Definitions and Terms

Block

A block groups text producing expressions of a template.

Macro

A Macro provides a way to extend the template language.

Module

A module is a mechanism for structuring transformation specifications.

ProtectedAreaBlock

A protectedAreaBlock identifies the text part that needs to be preserved across model-to-text transformations.

Template

A template specifies a text template with placeholders for data to be extracted from models.

TraceBlock

A trace block associates model elements, for traceability purpose, with a block of text to be generated.

5 Symbols

There are no symbols defined in this specification.

6 Additional Information

6.1 Acknowledgements

The following companies submitted and/or supported parts of this specification:

- Compuware Corporation
- France Telecom
- Interactive Objects Software GmbH
- Mentor Graphics Corporation
- Pathfinder Solutions
- SINTEF
- Softeam
- Tata Consultancy Services

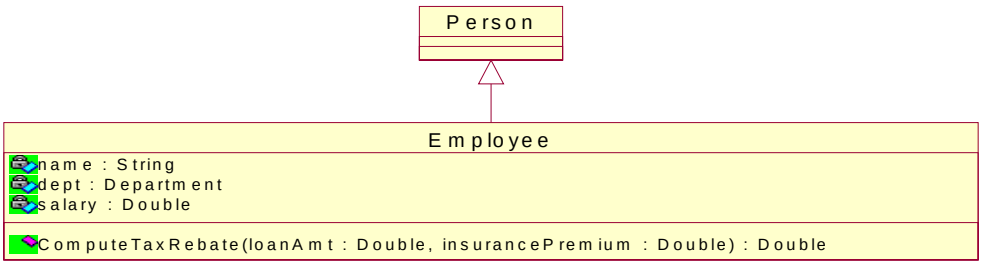
7 Overview

MDA places modeling at the heart of the software development process. Various models are used to capture various aspects of the system in a platform independent manner. Sets of transformations are then applied to these platform independent models (PIM) to derive platform specific models (PSM). These PSMs need to be eventually transformed into software artifacts such as code, deployment specifications, reports, documents, etc. QVT standard addresses the needs of model – to – model transformation (e.g., PIM – to – PIM, PIM – to – PSM and PSM – to – PSM). The MOF Model to Text (mof2text) standard addresses how to translate a model to various text artifacts such as code, deployment specifications, reports, documents, etc. Essentially, the mof2text standard needs to address how to transform a model into a linearized text representation. An intuitive way to address this requirement is a template based approach wherein the text to be generated from models is specified as a set of text templates that are parameterized with model elements.

A template-based approach is used wherein a *Template* specifies a text template with placeholders for data to be extracted from models. These placeholders are essentially expressions specified over metamodel entities with queries being the primary mechanisms for selecting and extracting the values from models. These values are then converted into text fragments using an expression language augmented with a string manipulation library. *Template* can be composed to address complex transformation requirements. Large transformations can be structured into *modules* having public and private parts.

For example, the following *Template* specification generates a Java definition for a UML class.

```
[template public classToJava(c : Class)]
class [c.name/]
{
   // Constructor
   [c.name/]()
   {
   }
}
[/template]
```



For a class ‘Employee’ (shown in the figure above), the following text will be generated:

```
class Employee
{
      // Constructor
      Employee()
      {
      }
}
```

As shown above, the specification has a WYSIWYG character with the output preserving indentation, white spaces, etc. from the specification.

A *Template* can invoke other *Templates*. Invocation of a *Template* is equivalent to *in situ* placement of the text produced by the *Template* being invoked.

```
[template public classToJava(c : Class)]
class [c.name/]
{
   // Attribute declarations
   [attributeToJava(c.attribute)/]

   // Constructor
   [c.name/]()
   {
   }
}
[/template]

[template public attributeToJava(a : Attribute)]
[a.type.name/] [a.name/];
[/template]
```

Template *classToJava* invokes template *attributeToJava* for each attribute of the class and puts ';' as a separator between the text fragments produced by each invocation of *attributeToJava* template.

```
class Employee
{
      // Attribute declarations
      String name;
      Department dept;
      Double salary;

      // Constructor
      Employee()
      {
      }
}
```

Instead of defining two templates separately, a template can iterate over a collection by using the *for* block. Using the *for* block preserves WYSIWYG-ness and improves readability.

For example the *classToJava* template above can use the *for* block as shown below:

```
[template public classToJava(c : Class)]
class [c.name/]
{
   // Attribute declarations
   [for(a : Attribute | c.attribute)]
   [a.type.name/] [a.name/];
   [/for]
```

```
   // Constructor
   [c.name/]()
   {
   }
}
[/template]
```

The for block declares a loop variable '**a**' of type Attribute and produces for each Attribute in the collection **c.attribute** the text between the *[for]* and *[/for]*.

A template can have a guard that decides whether the template can be invoked. For example, the following *classToJava* template is invoked only if the class is concrete.

```
[template public classToJava(c : Class) ? (c.isAbstract = false)]
class [c.name/]
{
   // Attribute declarations
   [attributeToJava(c.attribute)/]

   // Constructor
   [c.name/]()
   {
   }
}
[/template]
```

Complex model navigations can be specified using *queries*. The following example shows use of a query *allOperations* to collect operations of all abstract parent classes of a class in a class hierarchy.

```
[query public allOperations(c: Class) : Set ( Operation ) =
c.operation->union( c.superClass->select(sc|sc.isAbstract=true)-
>iterate(ac : Class;
         os:Set(Operation) = Set{}| os->union(allOperations(ac)))) /]

[template public classToJava(c : Class) ? (c.isAbstract = false)]
class [c.name/]
{
// Attribute declarations
   [attributeToJava(c.attribute)/]
   // Constructor
   [c.name/]()
   {
   }
   [operationToJava(allOperations(c))/]
}

[/template]

[template public operationToJava(o : Operation)]
[o.type.name/] [o.name/] ([for(p:Parameter | o.parameter)
separator(',')] [p.type/] [p.name/] [/for]);
[/template]
```

Testing if a modelelement is of a certain type, and if it is, declaring a variable of that type that is used later in the transformation is supported directly by specifying a let block statement.

```
[template public classToJava(c : Class)]
[let ac : AssociationClass = c ]
class [c.name/]
{
   // Attribute declarations
   [attributeToJava(c.attribute)/]
   // Constructor
   [c.name/]()
   {
   }

   // Association class methods
   [for (t:Type | ac.endType)]
   Attach_[t.name/]([t.name/] p[t.name/])
   {
   // Code for the method here
   }
   [/for]
}
[/let]
[/template]
```

The let block tests whether the actual argument c is of type AssocationClass, and if it is, it declares a variable ac of type AssociationClass that can be used inside the let block.

If the test fails, the let block does not produce any text.

Large transformation specifications can be structured into *Module*s. A *Module* consists of a set of *Templates* and *Queries* and has a public and a private part. Public part exposes *Templates* and *Queries* that can be invoked from other modules. A *Module* can have import dependency on other *Module*s. This allows the importing *Module* to invoke the *Templates* and *Queries* exported by the imported *Module*s.

A transformation (template) can be started by directly invoking a public template with the correct parameters. There is no explicit notion of a main template.

A *Template* can override one or more other *Templates*. A *Module* can extend another *Module* by overriding some of its *Templates*. A Module can extend another module (inheritance) in a sub-super relationship. Only single inheritance is supported. The specializing module inherits all templates from its super and can access or override all public and protected templates.

Overriding is a mechanism to selectively modify the behavior of a *Module*. An overriding template should have the same number of parameters as the overridden template with compatible types. The overriding template is invoked in place of the overridden template when the parameter types match and the guard condition of the former evaluates to true.

7.1 Escape Direction

A template has WYSIWYG nature with the text to be output being specified in exactly the way it should look in the output. In most of the cases, this style of template specification is intuitive where the text producing logic is specified in quoted form i.e., delimited by '[' and ']'. However, there may be cases where the quantity of the text producing logic far outweighs the text being produced. In this case, it is more intuitive to specify the text producing logic without use of special delimiters. This is achieved by setting the escape direction to the required mode i.e., *text-explicit* or *code-explicit* with text-explicit being the default mode.

Syntax for escape direction is similar to java annotations, with possible parameters to control the escape character(s) used:

```
@text-explicit
```

Or

```
@code-explicit
```

Example

```
@text-explicit
[template public classToJava(c : Class)]
class [c.name/]
{
   // Constructor
   [c.name/]()
   {
   }
}
[/template]

@code-explicit
template public classToJava(c : Class)
'class 'c.name '
{
   // Constructor
   'c.name'()
   {
   }
}'
/template
```

In code explicit form, the output text is escaped instead of the transformation (template) code. The characters used to provide escaping in the two different modes has a default value, but may be modified as parameter to the @code/text-explicit annotation.

In code explicit mode, blocks are ended using a slash followed by the block keyword (e.g., for … /for).

```
for(a : Attribute | c.attribute) separator( ',' )
  a.name ' ' a.type.name
/for
```

Some additional examples on code-explicit mode of the previous code snippets are given below:

```
query public allOperations(c: Class) : Set ( Operation ) =
c.operation->union( c.superClass->select(sc|sc.isAbstract=true)->iterate(ac : Class;
        os:Set(Operation) = Set{}| os->union(allOperations(ac))))
/query

template public classToJava(c : Class) ? (c.isAbstract = false)]
‘class [c.name/] ‘
{
   // Attribute declarations
   ‘ attributeToJava(c.attribute)’

   // Constructor
   ‘ c.name ‘()
   {
   }
      ‘operationToJava(allOperations(c))’
}’
/template

template public operationToJava(o : Operation)
o.type.name ‘ ‘ o.name ‘ (‘ for(p:Parameter | o.parameter)
separator(',') p.type ‘ ‘ p.name /for’);’
/template
```

The alternative with a type checking let clause.

```
template public classToJava(c : Class)
let ac : AssociationClass = c
‘class ‘c.name’
{
   // Attribute declarations
   ‘attributeToJava(c.attribute)’

   // Constructor
   ‘c.name’()
   {
   }

   // Association class methods
   ‘for (t:Type | ac.endType)’
   Attach_’t.name’(‘t.name’ p’t.name’)
   {
   // Code for the method here
   }
   ‘/for’
}
‘/let
/template
```

The escape characters

The escape characters for text-explicit and code-explicit has a default representation.

For text-explicit mode, [and] delimiters are used: `TABLE [c.name/] (`

For code-explicit mode, the single quote character is used: ‘TABLE ‘ c.name ‘(

The escape character(s) used can be changed by parameters given to the escape direction annotation property: e.g., @code-explicit (#) – Which defines ‘#’ as the escape character for escaped text. Normally, however, the default escape should be used.

7.2 Traceability

A Trace block relates text that is produced in a block to a set of model elements that are provided as parameters. A Trace block will typically lead to comments in the produced text. Model based code generation is one of the principal applications of model to text transformation. Mof2Text provides support for tracing model elements to text parts. Text parts to be traced must be delimited with special keywords. Additionally, text parts may be marked as protected. Such text parts are preserved and not overwritten by subsequent model-to-text transformations. Information concerning the originating template for text output should also be part of the trace information.

Text parts must be able to relate unambiguously to a set of model elements and must have a unique identification.

```
[template public classToJava(c : Class)]
[trace(c.id()+ '_definition') ]
class [c.name/]
{
   // Constructor
   [c.name/]()
   {
   [protected('user_code')]
   ; user code
   [/protected]

   }
}
[/trace]
[/template]
```

In the example above, the trace block identifies the text to be traced by relating the generated text to model element ‘c’ of type Class. The protected block identifies the text part that needs to be preserved between subsequent model-to-text transformations. It produces delimiters in the output text to clearly identify the protected part. Since such delimiters are specific to a target language, they are not defined in this standard. An implementation tool is responsible for producing the correct delimiters for the desired target language.

7.3 Directing Output to Files

The file block specifies the file to which the generated text should be sent. The file block has three parameters; a uri which denotes the name of the file, a Boolean flag indicating whether the file is to be opened in append mode or not, and an optional unique id, typically derived from modelelement identifiers as in the traceability specification. For instance, a transformation tool can use this id to find a file that was generated in a previous session even when a modelelement was renamed (and the modelelement name was used in the uri of the file) or when the file name has been changed by the

template writer. This will enable protected text parts, if any, to be preserved across transformations. File blocks can be nested with the file associated with the current file block receiving the output. Files may be opened in ‘append’ mode. The default mode of opening files is ‘overwrite.’ This is useful for writing debug information in a log file, for example.

Example

```
[template public classToJava(c : Class)]
[file (‘file:\\’+c.name+’.java’, false, c.id + ‘impl’)]
[file('log.log', true)]processing [class.name/][/file]
class [c.name/]
{
   // Constructor
   [c.name/]()
   {
   }
}
[/file]
[/template]
```

Suppose the above specification was run on a class named ‘cust,’ it would produce Java code in cust.java file and a log entry ‘processing cust’ in log.log file. Suppose after generation, the storage specification was added in the protected area of file cust.sql. Even if the classname is changed later, say to ‘customer,’ a tool will be able to retain the storage specification in the new file customer.sql as the file block takes unique id as a parameter that hasn’t changed (for ‘cust’ object). The uri ‘stdout’ denotes the stdout output stream.

7.4 Macros

Macros provide a way to extend the language. A macro can be used in template specifications.

An example of a macro definition:

```
[macro javaMethod(Type type, String methodName, String resultName, Body body)]
public [typeName(type)/] [methodName/] () {
   [typeName(type)/] [resultName/] = null;
   [body/]
   return [resultName];
}
[/macro]
```

The macro can be invoked as follows:

```
[javaMethod([query.oclExp.type/], query.name, "result")]
    result = [javaocl(query.oclExp)/];
[/javaMethod]
```

A macro must have next to a number of ordinary formal parameters, one parameter of predefined type Body. In the example, the body of the macro call javaMethod is passed to the Body parameter ‘body,’ and the invoked call inserts the body where body is referred. The macro is expanded in the context of the macro call.

Macros can be used to implement comments. The following macro specifies a comment block implementation:

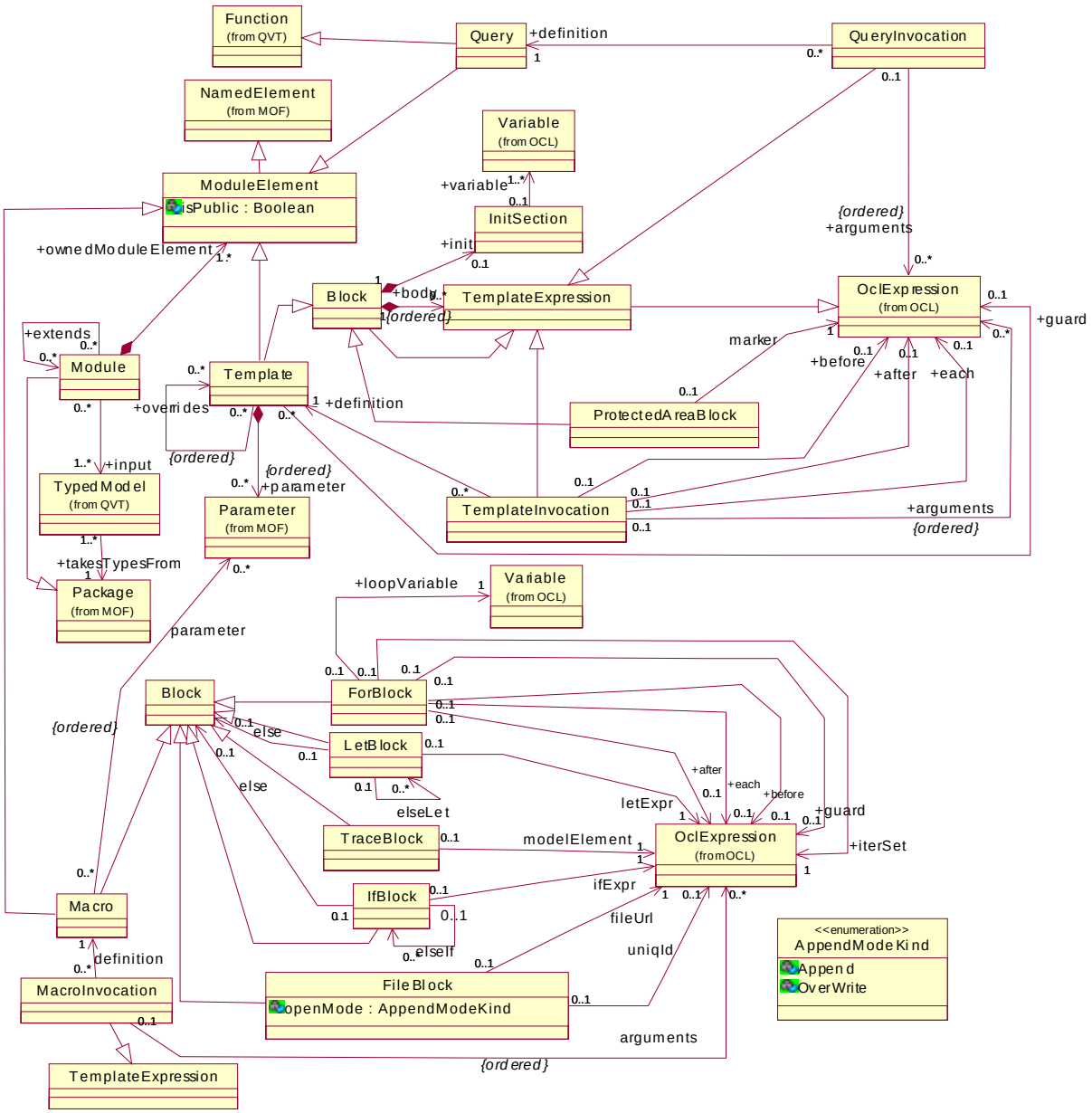
```
[macro comment (Body b)][/macro]
```

The macro can be used as follows:

```
[comment()]
... some code here
[/comment]
```

8 Template Language Specification

8.1 Metamodel



8.1.1 Module

A *module* is a mechanism for structuring transformation specifications. It defines a namespace for the *module elements* it contains. A *module* has a public and a private part. Public part exposes *module elements* that can be used by other modules. A *module* can have import dependency on other modules whose public *module elements* it can use. A *module* can extend one or more other modules by overriding some of their *templates*.

Supertypes

- Package
  A module behaves like a package in providing a namespace for its contents.

Associations

- *input*
  TypedModel containing the model elements to be transformed to text
- *ownedModuleElement*
  A set of contained *module elements*
- *extends*
  A set of modules being extended by this module

8.1.2 ModuleElement

Module element is an abstract class that is specialized by *template* and *query.* A *module element* has a unique name within the containing *module*, and must indicate whether it's public i.e., whether it can be used outside the containing *module*. Input parameters of a *module element* are *Parameters* whose types must be MOF types. These types must be defined in the meta model package specified by the typed model associated with the containing *module*.

Supertypes

- NamedElement

Attributes

- *isPublic : Boolean*
  Specifies whether the *module element* is visible outside the contained *module*.

Associations

- *parameter*
  Input parameters of the *module element*

8.1.3 Template

A *template* specifies a text template with placeholders for data to be extracted from models. These placeholders are expressions specified in terms of metamodel entities and are evaluated over instances of these metamodel entities. *Template* is a specialization of *block*. A *template* can have a *guard* (inherited from *block*) that specifies when it can be invoked. A *template* can override one or more other *templates*. An overriding *template* should have the same number of parameters as the overridden *template* with compatible types. The overriding *template* is invoked in place of the overridden *template* when the parameter types match and the guard condition of the overriding *template* evaluates to true.

In case of a *template* being overridden by multiple *templates*, the *guard* should be specified such that only one of the overriding *templates* is selected. In case of *guards* of more than one overriding *templates* evaluating to true, one of them will get selected arbitrarily.

Consider a *template* T1 with parameter type PT1 being overridden by a *template* T2 with parameter type PT2. If PT2 is the same as PT1, then invocation of T1 will result in invocation of T2. If PT2 is a subtype of PT1, then invocation of T1 with instance of PT2 as an argument will result in invocation of T2 and invocation of T1 with an argument that is an instance of PT1 but not an instance of PT2 will result in invocation of T1.

If PT2 is a supertype of PT1, then invocation of T1 with instance of PT1 or PT2 as an argument will result in invocation of T2. If T1 and T2 have more than one parameter, then if for any of the parameters, the decision is in favor of T1, then T1 is invoked.

An overriding *template* can invoke the overridden *template* from its body using [super/] expression. A template can override one or more templates.

Let's say that T2 overrides T1 and T3. Then T2 may be invoked in three different scenarios:

1. Invocation of T1 resulted in invocation of T2. In this case super points to T1.
2. Invocation of T3 resulted in invocation of T2. In this case super points to T3.
3. T2 is directly invoked. In this case we have ambiguity. This is solved by a default resolution strategy: we choose the first listed template (in this case T1).

It is possible to specify protected sections in the generated text for manual additions. Subsequent applications of the *template* preserve this text.

Supertypes

- Block

Associations

- *guard*
  Guard condition of the *Template*
- *parameter*
  Parameters of the *template*
- *overrides*
  A set of *templates* being overridden by this *template*

8.1.4 Block

A *block* groups text producing expressions of a *template*. A *block* can have *init section* that initializes a set of variables that can be used in its *body.* A *block* can contain other *blocks*.

Supertypes

- TemplateExpression

Associations

- *body*
  An ordered set of *template expressions* specifying the text of the *block*
- *init*
  A set of variable initializations to be used in the *body* of the *block*

8.1.5 InitSection

An *InitSection* contains a set of variable initializations to be used in the *body* of its owning *block*.

Associations

- *body*
  An ordered set of *template expressions* specifying the text of the *block*

8.1.6 TemplateExpression

A *template expression* specializes *ocl expression* for the purpose of text generation. The type of a *template expression* specifying *body* of a *template* must be a *String*.

Supertypes

- OCLExpression

Subtypes

- ProtectedAreaExpression
- TemplateInvocation
- QueryInvocation

8.1.7 ProtectedAreaBlock

A *protected area block* identifies the text part that needs to be preserved across model-to-text transformations. It produces delimiters in the output text to clearly identify the protected part. Changes introduced in the protected part are preserved in subsequent transformations.

Supertypes

- Block

Associations

- *marker*
  Expression for producing the begin and end markers of the delimited section.

8.1.8 ForBlock

A *for block* specifies a text segment that needs to be processed repeatedly over a set of *model elements*. A *for block* can have a guard that specifies when the body of the block can be executed.

Supertype

- Block

Associations

- *iterSet*
  The set over which the loop *body* is processed iteratively.
- *loopVariable*
  The variable that binds to an element of *iterSet*.
- *body*
  Specifies the loop *body* (inherited from *block*).
- *each*
  Expression being evaluated after every iteration except the last
- *before*
  Expression being evaluated before the first iteration.
- *after*
  Expression being evaluated after the last iteration.
- *guard*
  Guard condition of the *For.*

8.1.9 QueryInvocation

A *QueryInvocation* is an expression that specifies invocation of a *Query.*

Associations

- *arguments*

8.1.10 TemplateInvocation

A *template invocation* specifies one or more invocations of a *template*. An argument of a *template invocation* is specified by an expression that could evaluate either to a single value or a set of values. The rules for determining which *template* to invoke and how many times are as follows:

- The types of arguments should match the types of the corresponding parameters. An argument type matches the parameter type when the latter is either the same type or a super type. If the argument is a set and the parameter is a singleton, then the *template* is invoked for each member of the set.
- If the argument is a set and the parameter is a set, then the *template* is invoked once.
- If the argument is a singleton and the parameter is a set, then the *template* is invoked once with the singleton set.

- If the *template* has k singleton parameters and the corresponding arguments are sets, then the *template* is invoked for each member of the cross product of the k sets.
- If a *template* is overridden, then the overriding *template* is invoked as described earlier.

Associations

- *definition*
  The *template* being invoked
- *arguments*
  Expressions evaluating the arguments
- *each*
  Expression being evaluated after each invocation except the last when a *template* is invoked multiple times.
- *before*
  Expression being evaluated before the first invocation of the *template*.
- *after*
  Expression being evaluated after the last invocation of the *template*.

8.1.11 TypedModel

Reused from QVT. A *typed model* specifies candidate input model to be transformed to text. At runtime, a model that is passed to the transformation is constrained to contain only those model elements whose types are specified in the set of model packages associated with the typed model.

Associations

- *takesTypesFrom*
  Package containing the metamodel which provides the types for the model.

8.1.12 Package

Reused from MOF 2.0.

8.1.13 Parameter

Reused from MOF 2.0.

8.1.14 Function

Reused from QVT.

8.1.15 Query

As specified by its supertype *function*, a *query* is a side-effect-free operation. It is owned by a module. A *query* is required to produce the same result each time it is invoked with the same arguments. A *query* is specified by an OCL expression.

Supertypes

- Function, ModuleElement

8.1.16 LetBlock

A let block declares and initializes a variable of type subtype when the cast is successful. Essentially, it can be seen as a test that checks whether the object bound to the supertype variable is actually an instance of the specified subtype and execution of the associated block on success. Multiple such tests can be grouped together in a Let statement on the lines of if-elseif chain.

Supertypes

Block

Associations

- *letExpr*
  The subtype testing and assignment expression
- *elseLet*
  A chain of alternate Let blocks on the lines of if-elseif chain
- *else*
  A block to be executed when none of the let expressions match

8.1.17 FileBlock

A *file block* specifies the file to which the generated text should be sent. The file block has a uri that denotes the name of the file and an optional unique id, typically derived from modelelement identifiers. For instance, a transformation tool can use this id to find a file that was generated in a previous session even when a modelelement was renamed (and the modelelement name was used in the uri of the file) or when the file name has been changed by the template writer. This will enable protected text parts, if any, to be preserved across transformations. A file may be opened in append mode.

Supertypes

- Block

Attributes

- *appendMode : AppendModeKind*
  Mode in which the file is to be opened

Associations

- *fileUrl*
  File to be opened
- *uniqId*
  Unique id associated with the file

8.1.18 TraceBlock

A *trace block* associates model elements, for traceability purpose, with a block of text to be generated.

Supertypes

- Block

Associations

- *modelElement*
  modelelement to be associated with the text block

8.1.19 Macro

A Macro provides a way to extend the language. A macro can be invoked from a template body.

Supertypes

- Block, ModuleElement

Associations

- *parameter*
  Parameters of the macro. The last parameter must be of a special type Body.

8.1.20 MacroInvocation

A *MacroInvocation* is an expression that specifies invocation of a *Macro*.

Supertypes

- TemplateExpression

Associations

- *arguments*
  The last argument must be of special type *TemplateExpression*

8.1.21 IfBlock

An *If block* allows specification of conditional execution of the associated template block. Multiple such conditions can be grouped together in an if-elseif chain.

Supertypes

- Block

Associations

- *ifExpr*
  Conditional expression that needs to evaluate to true for the associated block to be executed.

- *elseIf*
  A chain of conditional blocks.
- *else*
  A block to be executed when none of the conditional expressions evaluate to true.

8.2 Concrete Syntax

The concrete syntax is defined using EBNF.

Text following '//' upto the end-of-line is treated as a comment. Grammar does not specify a rule for comments.

Keywords
module, import, extends, template, query, public, private, protected, guard, init, overrides, each, before, after, for, if, elseif, else, let, elselet, trace, macro, file, mode, text_explicit, code_explicit, super, stdout

Grammar

```
<module> ::= <module_decl> ( <import_decl> )*  [ <queries_section> ] [
<templates_section> ] [ <macros_section> ]

<module_decl> ::= '[module' <PathNameCS> '(' <PathNameCS> ')'
[extends_decl] '/]' |
         'module' <PathNameCS> [extends_decl]

<extends_decl> ::= 'extends' <PathNameCS> ( ',' <PathNameCS> )*

<import_decl> ::= '[import' <PathNameCS> '/]' |
'import' <PathNameCS>

<queries_section> ::= ( <query_defn> | <query_defn_code> )*

<query_defn> ::= '[query' <visibility> <PathNameCS> '(' <arglist> ')' ':' <typeCS>
'=' <OclExpressionCS> '/]'
<query_defn_code> ::= 'query' <visibility> <PathNameCS> '(' <arglist> ')' ':'
<typeCS> '=' <OclExpressionCS>


<visibility> ::= 'public' | 'private'

<arglist> ::= (arg_decl ( ',' arg_decl )* )?

<arg_decl> ::= <SimpleNameCS> ':' <typeCS>

<actualarglist> ::= ( <OclExpressionCS> ( ',' <OclExpressionCS> )* )?

<macros_section> ::= ( <macro_defn> | <macro_defn_code> )*

<templates_section> ::= ( <mode>? <template_defn> )*
```

```
<template_defn>   ::= <template_defn_text> | <template_defn_code>
<template_defn_text> ::= '[template' <signature> ‘]’ <production> '[/template]'
<template_defn_code> ::= template <signature> <production_code> ‘/template’

<signature>  ::= <visibility> <PathNameCS> '(' <arglist> ')' <overrides>? [ <guard> ]
[ <init> ]

<macro_defn> ::= '[macro <PathNameCS> '(' <arglist> ')' ']' <production> '[/macro ]'
<macro_defn_code> ::= 'macro <PathNameCS> '(' <arglist> ')'  <production_code> '/
macro'

<overrides> ::= 'overrides' PathNameCS ( ',' <PathNameCS> )*

<production>::=( <filecmd> | <literal> | <protected> |
<tracecmd> | <forcmd> | <ifcmd> | <letcmd> | '[' <OclExpressionCS> '/]' )*
<production_code>::= (<filecmd_code> | <literal_code> | <protected_code>|
<tracecmd_code> | <forcmd_code> | <ifcmd_code> | <letcmd_code> | <OclExpressionCS>
)*

<guard> ::= '?' '(' <OclExpressionCS> ')'


<init> ::= '{' (  VariableDeclarationCS ';' )+ '}'

<filecmd> ::= '[file' '(' (<OclExpressionCS> | 'stdout' ) [ ‘,’ <OclExpessionCS>] [
‘,’ <OclExpressionCS> ] ')' ']' <production> '[/file]'

<filecmd_code> ::= ‘file’ ‘(' (<OclExpressionCS> | ‘stdout’ ) [ ‘,’ <OclExpessionCS>]
[ ‘,’ <OclExpressionCS> ] ')' <production_code> '/file'


<protected> ::= '[protected' '(' <OclExpressionCS> ')' ']' <production> '[/pro-
tected]'
<protected_code> ::= 'protected' '(' <OclExpressionCS> ')'  <production_code> '/pro-
tected'


<tracecmd> ::= '[trace '(' <OclExpressionCS> ')' ']' <production> '[/trace]'
<tracecmd_code> ::= 'trace '(' <OclExpressionCS> ')'  <production_code> '/trace'


<OclExpressionCS> ::= ( <PropertyCallExpCS> | <VariableExpCS> | <LiteralExpCS> |
<LetExpCS> | <OclMessageExpCS> | <ifExp> |  <invocation> )

<ifExp> ::= <OclExpressionCS> '?' <OclExpressionCS> ':' <OclExpressionCS>

<invocation> ::= ( <PathNameCS> '(' <actualarglist> ')' | 'super' ) [ <before> ] [
<separator> ] [ <after> ]

<before> ::= 'before' '(' <OclExpressionCS> ')'
```

```
<separator> ::= 'separator' '(' <OclExpressionCS> ')'

<after> ::= 'after' '(' <OclExpressionCS> ')'

<forcmd> ::= '[for' '(' <arg_decl> '|' <OclExpressionCS> ')' [ <before> ] [ <separa-
tor> ] [ <after> ] [ <guard> ] [ <init> ] ']' <production> '[/for]'
<forcmd_code> ::= 'for' '(' <arg_decl> '|' <OclExpressionCS> ')' [ <before> ] [ <sep-
arator> ] [ <after> ] [ <guard> ] [ <init> ] <production_code> '/for'


<ifcmd> ::= '[if' '(' <OclExpressionCS> ')' ']' <production> (<elseif>  )* [ <else> ]
'[/if]'
<ifcmd_code> ::= 'if' '(' <OclExpressionCS> ')' <production_code> (<elseif_code>  )*
[ <else_code> ] '/if'


<elseif> ::= '[elseif' '(' <OclExpressionCS> ')' ']' <production> ('[/elseif]')?
<elseif_code> ::= 'elseif' '(' <OclExpressionCS> ')' <production_code> ('/elseif') ?

<else> ::= '[else]' <production> ('[/else]')?
<else_code> ::= 'else' <production_code> ('/else')


<letcmd> ::= '[let' <VariableDeclarationCS> ']' <production> (<elselet>  )* [ <else>
] '[/let]'
<letcmd_code> ::= 'let' <VariableDeclarationCS> <production_code> (<elselet_code>
)* [ <else_code> ] '/let'

<elselet> ::= '[elselet]' <VariableDeclarationCS> <production> '[/elselet]'
<elselet_code> ::= 'elselet' <VariableDeclarationCS> <production_code> '/elselet'

<mode> ::= '@' 'text-explicit' |
     '@' 'code-explicit'

<literal> is a text string not enclosed in quotes
<literal_code> is a text string enclosed in single quotes
```

8.3 Library

The OCL String library has been extended with the following functions. Since OCL understands MOF operations, these functions need to be wrapped as operations of some class not necessarily from the source model being transformed.

8.3.1 String

substitute(String r, String t) : String

Substitutes substring *r* in *self* by substring *t* and returns the resulting string. If there is no occurrence of the substring, it returns the original string.

index(String r) : Integer

Returns the index of substring *r* in *self*, or -1 if *r* is not in *self*.

first(Integer n) : String

Returns first *n* characters of *self*, or *self* if size of *self* is less than *n*.

last(Integer n) : String

Returns last *n* characters of *self*, or *self* if size of *self* is less than *n*.

strstr(String r) : Boolean

Searches for string *r* in *self*. Returns true if found, false otherwise.

toUpper() : String

Creates a copy of *self* with all characters converted to uppercase and returns it.

toLower() : String

Creates a copy of *self* with all characters converted to lowercase and returns it.

strtok(String s1, Integer flag) : String

Breaks the string *self* into a sequence of tokens each of which is delimited by any character in string *s1*. The parameter *flag* should be 0 when *strtok* is called for the first time, 1 subsequently.

strcmp(String s1) : Integer

Returns an integer less than zero, equal to zero, or greater than zero depending on whether *s1* is lexicographically less than, equal to, or greater than *self*.

isAlpha() : Boolean

Returns true if *self* consists only of alphabetical characters, false otherwise.

isAlphanum() : Boolean

Returns true if *self* consists only of alphanumeric characters, false otherwise.

toUpperFirst() : String

Creates a copy of *self* with first character converted to uppercase and returns it.

toLowerFirst() : String

Creates a copy of *self* with first character converted to lowercase and returns it.

8.3.2 Integer

toString(Integer i) : String

Converts the integer *i* to a string.

8.3.3 Real

toString(Real r) : String

Converts the real *r* to a string.

8.4 Whitespace Handling

Text production rules will be easier to understand by viewing the body of a template (or a block expression) as follows:

<block-body> ::= <body-element>*
<body-element> ::= <literalString> | <whitespace> | <expression> | <BOL-indicator>
<whitespace> ::= space | tab | newline
<expression> ::= <stand-alone-block-expression> | <embedded-block-expression> |
<stand-alone-template-invocation> | <embedded-template-invocation> |
<other-expression>
<BOL-indicator> ::= '^'

<stand-alone-block-expression> is a block expression (single or multi-line) that is not surrounded by other body elements on the lines where the block head and the tail occur.

<embedded-block-expression> is a block expression that is surrounded by other non-whitespace body elements on the lines where block head or tail occur.

<stand-alone-template-invocation> is a template invocation expression that stands on a line all by itself.

<embedded-template-invocation> is a template invocation that is surrounded by other body elements on the same line.

<other-expression> refers to all expressions other than the block and template invocation expressions.

Text production rules:

- All body elements produce text
- The text output of a block-body is the sequential concatenation of the text outputs of its body elements
- Rules for identifying starting and ending of block body:
  - template: body starts at the beginning of the next line after the template head, and ends on the last character (excluding the new line) of the line previous to the template tail.
  - multi-line-block: body starts at the beginning of the next line after the block head, and ends on the last character (excluding the new line) of the line previous to the block tail.
  - single-line-block: body starts after the closing bracket of the block head and ends before the starting bracket of the block tail.
- Text outputs of different body elements:
  - A literal string is output as is.
  - A whitespace character is output as is.
  - The text produced by the execution of <other-expression> is output as is.
  - The text produced by the execution of <embedded-block-expression> is output as is.

- The text produced by the execution of <embedded-template-invocation> is output as is.
- <stand-alone-block-expression> needs special handling:
  - Ignore the whitespace characters occurring before the beginning of the head.
  - In the case of a multi-line ‘for block,’ when a separator character is not specified, use ‘new line’ as the default separator between the outputs produced by successive iterations.
- <stand-alone-template-invocation> needs special handling:
  - Add the whitespace preceding the invocation expression before each line of the text produced by the invoked template.
  - In the case of an iterative template invocation (e.g., when the argument is a collection), if a separator character is not specified, use ‘new line’ as the default separator between the outputs produced by successive iterations.

<BOL-indicator> is a special character (‘^’) that marks the beginning of a line – i.e., on the line on which this character appears, the whitespace preceding the character should be excluded from the text output.

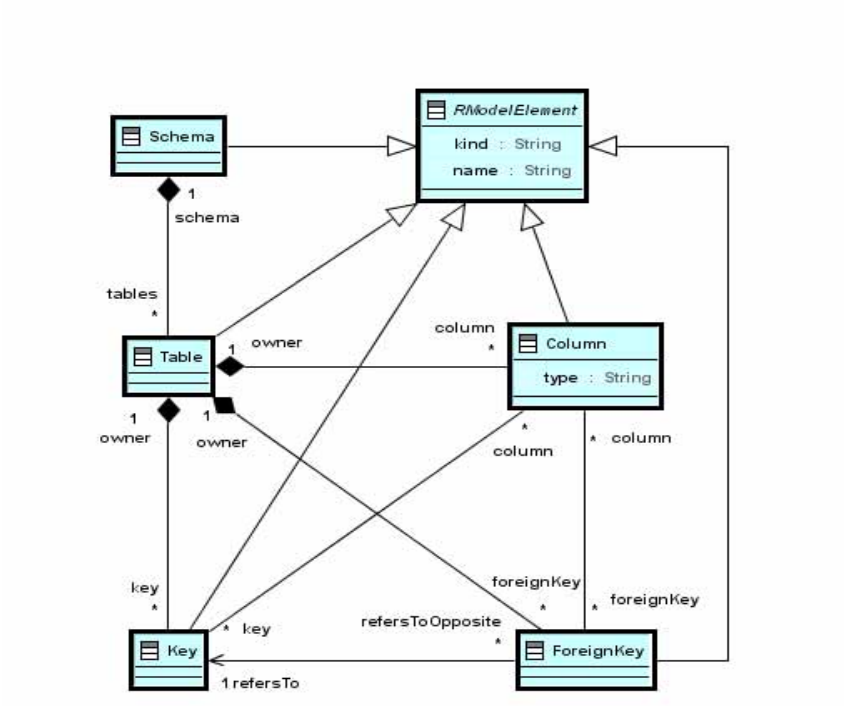
In code-explicit mode, all whitespace must be explicitly specified.

Annex A: Examples

(normative)

A.1 Example 1

The example shows transformation specifications for transforming an RDBMS model to Oracle DDL. A simplified RDBMS metamodel is shown below.




```
[module DDLgen(RDBMS)/]

[template public SchemaToDDL (s: Schema)]
[for (t:Table | s.table)]
[TableToDDL(t)/]
[/for]
[/template]

[template public TableToDDL(t: Table)]
CREATE TABLE [t.name/] (
[for (c:Column|t.column) separator(',')]
[c.name/] [c.type/]
```

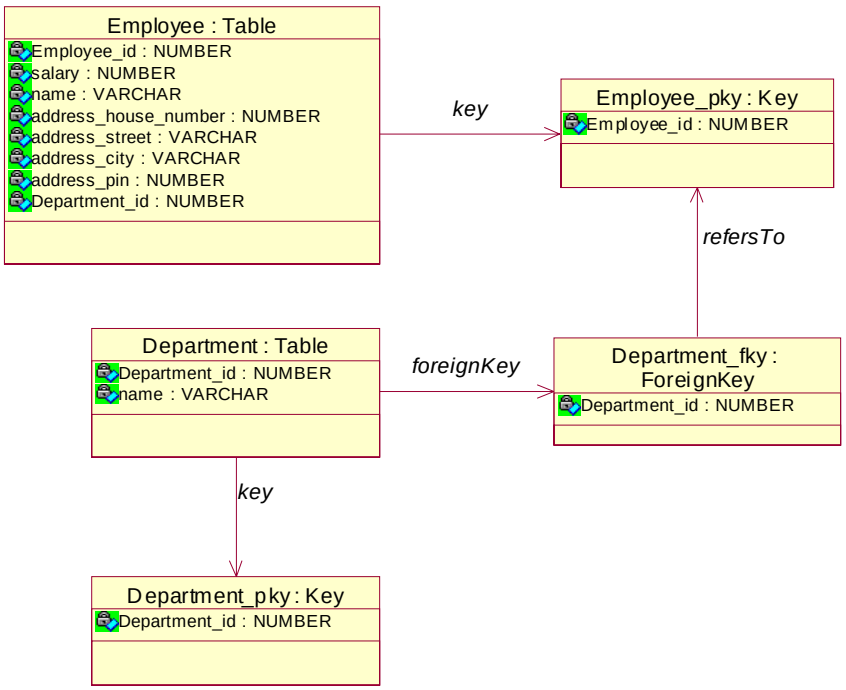
```
[/for]
);
[KeyToDDL(t.key)/]
[foreignKeyToDDL(t.foreignKey)/]
[/template]

[template private KeyToDDL(k:Key)]
ALTER TABLE [k.owner.name/] ADD (
CONSTRAINT [k.name/] PRIMARY KEY ([for (c:Column|k.column) separator(',')]c.name[/
for])
);
[/template]

[template private ForeignKeyToDDL(fk:ForeignKey)]
ALTER TABLE [fk.owner.name] ADD (
CONSTRAINT [fk.name/] FOREIGN KEY ([for (c:Column|fk.column) separator(',')]c.name[/
for])
REFERENCES [fk.refersTo.owner.name/] ([for (c:Column|fk.refersTo.column) separa-
tor(',')]c.name[/for])
ON DELETE CASCADE
);
[/template]

[/module]
```

A sample input model is shown below where Employee and Department are persistent classes.



Generated text is shown below.

```
CREATE TABLE Employee (
   Employee_id NUMBER,
```

```
   salary NUMBER,
   name VARCHAR,
   address_house_number NUMBER,
   address_street VARCHAR,
   address_city VARCHAR,
   address_pin NUMBER,
   Department_id NUMBER
);

ALTER TABLE Employee ADD (
   CONSTRAINT Employee_pky PRIMARY KEY (Employee_id)
);

ALTER TABLE Employee ADD (
   CONSTRAINT Department_fky FOREIGN KEY (Department_id)
      REFERENCES Department (Department_id)
      ON DELETE CASCADE
);

CREATE TABLE Department (
   Department_id NUMBER,
   name VARCHAR
);

ALTER TABLE Department ADD (
   CONSTRAINT Department_pky PRIMARY KEY (Department_id)
);
```

A.2 Example2

Above example in code explicit mode.

```
module DDLgen(RDBMS)

template public SchemaToDDL (s: Schema)
for (t:Table | s.table)
TableToDDL(t)
/for
/template

template public TableToDDL(t: Table)
'CREATE TABLE 't.name ' (
‘  for (c:Column|t.column) separator(',')’
‘c.name ' ' c.type’
‘/for
');'
KeyToDDL(t.key)
foreignKeyToDDL(t.foreignKey)
/template

template private KeyToDDL(k:Key)
'ALTER TABLE 'k.owner.name 'ADD (
CONSTRAINT ' k.name ' PRIMARY KEY (' for(c:Column|k.column) separator(',') c.name /
for ')
);'
/template

template private ForeignKeyToDDL(fk:ForeignKey)
'ALTER TABLE ' fk.owner.name ' ADD (
```

```
CONSTRAINT ' fk.name ' FOREIGN KEY (' for (c:Column|fk.column) separator(',') c.name
/for ')
REFERENCES ' fk.refersTo.owner.name ` ('for (c:Column|fk.refersTo.column) separa-
tor(',') c.name /for ')
ON DELETE CASCADE
);'
/template
/module
```

A.3 Example3

This example shows a template for generating C++ class header from a UML class model. It generates getters and setters for the attributes, a bitvector member to keep track of which attributes have values set and which do not, and a constructor for the class that initializes the bitvector member. User can further modify the constructor body between the generated delimiters.

```
[module class_header_gen /]

[template public class_header(c : Class) { int count = -1; } ]
[file (c.name +'.cpp', false)]
[trace(c.id() +'_header')]

  // Bit vector #definies
  [for(a : Attribute) | c.attribute) { count = count + 1; }]
       #define [a.name/]_BIT [count/]
  [/for]

  class [c.name/] [for(c:Class | c.super) before(':') separator(',')] [c.name/] [/for]
  {
    bool bitVector [‘[‘+c.attribute->size()+’]’/];

    // Attribute declarations
    [for (a : Attribute) | c.attribute)]
      [a.type.name/] [if(isComplexType(a.type)]*[/if] [a.name/];
    [/for]

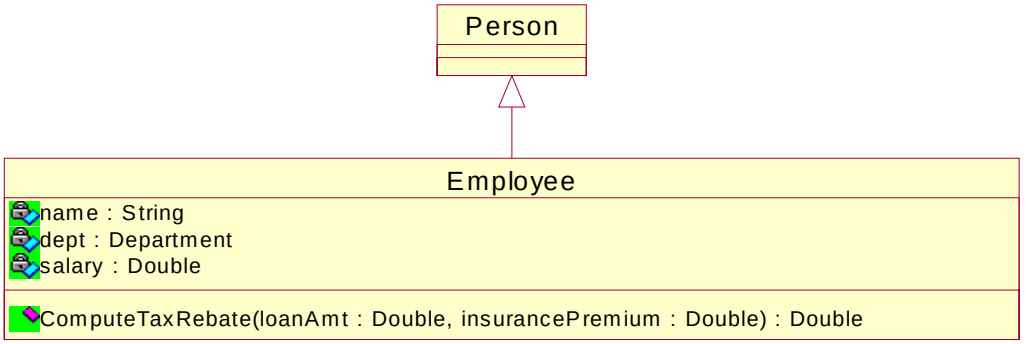
    // Constructor
    [c.name/]()
    {
      // initialize bit vector
      for (int i = 0; i < [c.attribute->size()/]; i++)
      {
        bitVector[‘[i]’] = 0;
      }
      [protected ('user_code')]
           // your code here
      [/protected]
    }

    // Attribute set/get/isSpecified methods
    [for (a : Attribute) | c.attribute)]
    void Set[a.name/] ([a.type.name/] [if(isComplexType(a.type)] * [/if] p[a.name/])
    {
      bitVector[’[‘+a.name+’_BIT]’] = 1;
      [a.name/] = p[a.name/];
    }

    [a.type.name/] Get[a.name/] () {return [a.name/];}
```

```
    bool isSpecified[a.name/]() {return bitVector['['+a.name+'_BIT]'];}
    [/for]

    // Method declarations
    [for (o : Operation) | c.operation) ]
    [o.type.name/] [o.name/] ([for(p:Parameter | o.parameter) separator(',')] [p.type/] [p.name/] [/for]);
    [/for]
  }
[/trace]
[/file]
[/template]
```



Output of the above template for the model shown above is given below:

```
// modelelement$employee_id$_header

#define name_BIT 0
#define dept_BIT 1
#define salary_BIT 2

class Employee : public Person
{
    char bitVector[3];

    // Attribute declarations
    String name;
    Department *dept;
    double salary;

    // Constructor
    Employee()
    {
for (int i = 0; i < 3; i++)
      {
         bitVector[i] = 0;
      }
// protected$user_code$modelelement$employee_id$_header
     // your code here
        // 1$modelelement$employee_id$_header
    }

    // Attribute set/get/isSpecified methods
    void Setname(String pname)
    {
```

```
        bitVector[name_BIT] = 1;
        name = pname;
    }

    String Getname() {return name;}

    bool isSpecifiedname() {return bitVector[name_BIT];}

    void Setdept(Department *pdept)
    {
        bitVector[dept_BIT] = 1;
        dept = pdept;
    }

    Department* Getdept() {return dept;}

    bool isSpecifieddept() {return bitVector[dept_BIT];}

    void Setsalary(double psalary)
    {
        bitVector[salary_BIT] = 1;
        salary = psalary;
    }

    double Getsalary() {return salary;}

    bool isSpecifiedsalary() {return bitVector[salary_BIT];}

    // Method declarations
    double ComputeTaxRebate( double loanAmt, double insurancePremium );
}
```

A.4 Metamodel in XMI

```
<?xml version="1.0" encoding="UTF-8"?>
<emof:Package xmi:version="2.0"
   xmlns:xmi="http://www.omg.org/XMI" xmlns:emof="http://schema.omg.org/spec/mof/2.0/emof.xmi"
xmi:id="metamodel"
   name="metamodel" uri="http:///metamodel.ecore">
  <nestedPackage xmi:id="metamodel.mof" name="mof" uri="http:///metamodel/mof.ecore">
   <ownedType xmi:type="emof:Class" xmi:id="metamodel.mof.Package" name="Package"/>
   <ownedType xmi:type="emof:Class" xmi:id="metamodel.mof.Parameter" name="Parameter"/>
   <ownedType xmi:type="emof:Class" xmi:id="metamodel.mof.NamedElement" name="NamedElement"/>
   <xmi:Extension extender="http://www.eclipse.org/emf/2002/Ecore">
    <nsPrefix>metamodel.mof</nsPrefix>
   </xmi:Extension>
  </nestedPackage>
  <nestedPackage xmi:id="metamodel.mtt" name="mtt" uri="http:///metamodel/mtt.ecore">
   <ownedType xmi:type="emof:Class" xmi:id="metamodel.mtt.TemplateInvocation" name="TemplateInvo-
cation"
     superClass="metamodel.mtt.TemplateExpression">
    <ownedAttribute xmi:id="metamodel.mtt.TemplateInvocation.definition" name="definition" isOr-
dered="false"
      lower="1" type="metamodel.mtt.Template"/>
    <ownedAttribute xmi:id="metamodel.mtt.TemplateInvocation.arguments" name="arguments"
      upper="*" type="metamodel.ocl.OclExpression"/>
    <ownedAttribute xmi:id="metamodel.mtt.TemplateInvocation.before" name="before" isOrdered="false"
      type="metamodel.ocl.OclExpression"/>
    <ownedAttribute xmi:id="metamodel.mtt.TemplateInvocation.each" name="each" type="meta-
```

```
model.ocl.OclExpression" isOrdered="false"/>
    <ownedAttribute xmi:id="metamodel.mtt.TemplateInvocation.after" name="after" isOrdered="false"
      type="metamodel.ocl.OclExpression"/>
  </ownedType>
  <ownedType xmi:type="emof:Class" xmi:id="metamodel.mtt.Template" name="Template"
    superClass="metamodel.mtt.Block metamodel.mtt.ModuleElement">
    <ownedAttribute xmi:id="metamodel.mtt.Template.overrides" name="overrides" upper="*"
      type="metamodel.mtt.Template"/>
    <ownedAttribute xmi:id="metamodel.mtt.Template.parameter" name="parameter" upper="*"
      type="metamodel.mof.Parameter" isComposite="true"/>
    <ownedAttribute xmi:id="metamodel.mtt.Template.guard" name="guard" type="metamodel.ocl.OclEx-
pression" isOrdered="false"/>
  </ownedType>
  <ownedType xmi:type="emof:Class" xmi:id="metamodel.mtt.QueryInvocation" name="QueryInvoca-
tion"
    superClass="metamodel.mtt.TemplateExpression">
    <ownedAttribute xmi:id="metamodel.mtt.QueryInvocation.definition" name="definition" isOr-
dered="false"
      lower="1" type="metamodel.mtt.Query"/>
    <ownedAttribute xmi:id="metamodel.mtt.QueryInvocation.arguments" name="arguments"
      upper="*" type="metamodel.ocl.OclExpression"/>
  </ownedType>
  <ownedType xmi:type="emof:Class" xmi:id="metamodel.mtt.Module" name="Module" super-
Class="metamodel.mtt.Template metamodel.mof.Package">
    <ownedAttribute xmi:id="metamodel.mtt.Module.extends" name="extends" upper="*" isOr-
dered="false"
      type="metamodel.mtt.Module"/>
    <ownedAttribute xmi:id="metamodel.mtt.Module.ownedModuleElement" name="ownedModuleEle-
ment" isOrdered="false"
      lower="1" upper="*" type="metamodel.mtt.ModuleElement" isComposite="true"/>
    <ownedAttribute xmi:id="metamodel.mtt.Module.input" name="input" lower="1" upper="*" isOr-
dered="false"
      type="metamodel.qvt.TypedModel"/>
  </ownedType>
  <ownedType xmi:type="emof:Class" xmi:id="metamodel.mtt.ProtectedAreaBlock" name="ProtectedAr-
eaBlock"
    superClass="metamodel.mtt.Block">
    <ownedAttribute xmi:id="metamodel.mtt.ProtectedAreaBlock.marker" name="marker" isOr-
dered="false"
      lower="1" type="metamodel.ocl.OclExpression"/>
    <ownedAttribute xmi:id="metamodel.mtt.ProtectedAreaBlock.end" name="end" lower="1" isOr-
dered="false"
      type="metamodel.ocl.OclExpression"/>
  </ownedType>
  <ownedType xmi:type="emof:Class" xmi:id="metamodel.mtt.ModuleElement" name="ModuleElement"
    superClass="metamodel.mof.NamedElement">
    <ownedAttribute xmi:id="metamodel.mtt.ModuleElement.isPublic" name="isPublic" isOr-
dered="false">
      <type xmi:type="emof:PrimitiveType" href="http://www.eclipse.org/emf/2002/
Ecore.emof#ecore.EBooleanObject"/>
    </ownedAttribute>
  </ownedType>
  <ownedType xmi:type="emof:Class" xmi:id="metamodel.mtt.TemplateExpression" name="TemplateEx-
pression"
    superClass="metamodel.ocl.OclExpression"/>
  <ownedType xmi:type="emof:Class" xmi:id="metamodel.mtt.InitSection" name="InitSection">
    <ownedAttribute xmi:id="metamodel.mtt.InitSection.variable" name="variable" isOrdered="false"
      lower="1" upper="*" type="metamodel.ocl.Variable"/>
  </ownedType>
  <ownedType xmi:type="emof:Class" xmi:id="metamodel.mtt.Block" name="Block" superClass="meta-
model.mtt.TemplateExpression">
```

```
    <ownedAttribute xmi:id="metamodel.mtt.Block.body" name="body" upper="*" type="meta-
model.mtt.TemplateExpression"
        isComposite="true"/>
    <ownedAttribute xmi:id="metamodel.mtt.Block.init" name="init" type="metamodel.mtt.InitSection"
isOrdered="false"
        isComposite="true"/>
  </ownedType>
  <ownedType xmi:type="emof:Class" xmi:id="metamodel.mtt.ForBlock" name="ForBlock"
      superClass="metamodel.mtt.Block">
    <ownedAttribute xmi:id="metamodel.mtt.ForBlock.loopVariable" name="loopVariable" isOr-
dered="false"
        lower="1" type="metamodel.ocl.Variable"/>
    <ownedAttribute xmi:id="metamodel.mtt.ForBlock.iterSet" name="iterSet" lower="1" isOr-
dered="false"
        type="metamodel.ocl.OclExpression"/>
    <ownedAttribute xmi:id="metamodel.mtt.ForBlock.Variable" name="Variable" upper="*" isOr-
dered="false"
        type="metamodel.ocl.Variable"/>
    <ownedAttribute xmi:id="metamodel.mtt.ForBlock.before" name="before" type="metamodel.ocl.OclEx-
pression" isOrdered="false"/>
    <ownedAttribute xmi:id="metamodel.mtt.ForBlock.after" name="after" type="metamodel.ocl.OclEx-
pression" isOrdered="false"/>
    <ownedAttribute xmi:id="metamodel.mtt.ForBlock.each" name="each" type="metamodel.ocl.OclEx-
pression" isOrdered="false"/>
    <ownedAttribute xmi:id="metamodel.mtt.ForBlock.guard" name="guard" type="metamodel.ocl.OclEx-
pression" isOrdered="false"/>
  </ownedType>
  <ownedType xmi:type="emof:Class" xmi:id="metamodel.mtt.LetBlock" name="LetBlock"
      superClass="metamodel.mtt.ForBlock metamodel.mtt.Block">
    <ownedAttribute xmi:id="metamodel.mtt.LetBlock.elseLet" name="elseLet" upper="*" isOr-
dered="false"
        type="metamodel.mtt.LetBlock"/>
    <ownedAttribute xmi:id="metamodel.mtt.LetBlock.else" name="else" type="metamodel.mtt.Block"
isOrdered="false"/>
    <ownedAttribute xmi:id="metamodel.mtt.LetBlock.ForBlock" name="ForBlock" upper="*" isOr-
dered="false"
        type="metamodel.mtt.ForBlock"/>
    <ownedAttribute xmi:id="metamodel.mtt.LetBlock.letExpr" name="letExpr" lower="1" isOr-
dered="false"
        type="metamodel.ocl.OclExpression"/>
  </ownedType>
  <ownedType xmi:type="emof:Class" xmi:id="metamodel.mtt.NewClass2" name="NewClass2"/>
  <ownedType xmi:type="emof:Class" xmi:id="metamodel.mtt.FileBlock" name="FileBlock"
      superClass="metamodel.mtt.Block">
    <ownedAttribute xmi:id="metamodel.mtt.FileBlock.openMode" name="openMode" type="meta-
model.mtt.AppendModeKind"/>
    <ownedAttribute xmi:id="metamodel.mtt.FileBlock.fileUrl" name="fileUrl" lower="1" isOrdered="false"
        type="metamodel.ocl.OclExpression"/>
    <ownedAttribute xmi:id="metamodel.mtt.FileBlock.uniqId" name="uniqId" type="metamodel.ocl.OclEx-
pression" isOrdered="false"/>
  </ownedType>
  <ownedType xmi:type="emof:Class" xmi:id="metamodel.mtt.TraceBlock" name="TraceBlock"
      superClass="metamodel.mtt.Block">
    <ownedAttribute xmi:id="metamodel.mtt.TraceBlock.modelElement" name="modelElement" isOr-
dered="false"
        lower="1" type="metamodel.ocl.OclExpression"/>
  </ownedType>
  <ownedType xmi:type="emof:Class" xmi:id="metamodel.mtt.Macro" name="Macro" superClass="meta-
model.mtt.Block metamodel.mtt.ModuleElement">
    <ownedAttribute xmi:id="metamodel.mtt.Macro.parameter" name="parameter" upper="*"
        type="metamodel.mof.Parameter"/>
```

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  </ownedType>
  <ownedType xmi:type="emof:Class" xmi:id="metamodel.mtt.MacroInvocation" name="MacroInvocation"
      superClass="metamodel.mtt.TemplateExpression">
    <ownedAttribute xmi:id="metamodel.mtt.MacroInvocation.Macro" name="Macro" lower="1" isOrdered="false"
       type="metamodel.mtt.Macro"/>
    <ownedAttribute xmi:id="metamodel.mtt.MacroInvocation.TemplateExpression" name="TemplateExpression" isOrdered="false"
       upper="*" type="metamodel.mtt.TemplateExpression"/>
    <ownedAttribute xmi:id="metamodel.mtt.MacroInvocation.arguments" name="arguments"
       upper="*" type="metamodel.ocl.OclExpression"/>
  </ownedType>
  <ownedType xmi:type="emof:Class" xmi:id="metamodel.mtt.IfBlock" name="IfBlock"
     superClass="metamodel.mtt.Block">
    <ownedAttribute xmi:id="metamodel.mtt.IfBlock.ifExpr" name="ifExpr" lower="1" isOrdered="false"
       type="metamodel.ocl.OclExpression"/>
    <ownedAttribute xmi:id="metamodel.mtt.IfBlock.else" name="else" type="metamodel.mtt.Block" isOrdered="false"/>
    <ownedAttribute xmi:id="metamodel.mtt.IfBlock.elseIf" name="elseIf" upper="*" isOrdered="false"
       type="metamodel.mtt.IfBlock"/>
  </ownedType>
  <ownedType xmi:type="emof:Enumeration" xmi:id="metamodel.mtt.AppendModeKind" name="AppendModeKind">
    <ownedLiteral xmi:id="metamodel.mtt.AppendModeKind.Append" name="Append"/>
    <ownedLiteral xmi:id="metamodel.mtt.AppendModeKind.OverWrite" name="OverWrite">
      <xmi:Extension extender="http://www.eclipse.org/emf/2002/Ecore">
        <value>1</value>
      </xmi:Extension>
    </ownedLiteral>
  </ownedType>
  <ownedType xmi:type="emof:Class" xmi:id="metamodel.mtt.Query" name="Query" superClass="metamodel.mtt.ModuleElement metamodel.qvt.Function"/>
  <nestedPackage xmi:id="metamodel.mtt.newpackage" name="newpackage" uri="http:///metamodel/mtt/newpackage.ecore">
    <nestedPackage xmi:id="metamodel.mtt.newpackage.newpackage2" name="newpackage2"
       uri="http:///metamodel/mtt/newpackage/newpackage2.ecore">
      <xmi:Extension extender="http://www.eclipse.org/emf/2002/Ecore">
        <nsPrefix>metamodel.mtt.newpackage.newpackage2</nsPrefix>
      </xmi:Extension>
    </nestedPackage>
    <nestedPackage xmi:id="metamodel.mtt.newpackage.qvt_1" name="qvt_1" uri="http:///metamodel/mtt/newpackage/qvt_1.ecore">
      <xmi:Extension extender="http://www.eclipse.org/emf/2002/Ecore">
        <nsPrefix>metamodel.mtt.newpackage.qvt_1</nsPrefix>
      </xmi:Extension>
    </nestedPackage>
    <nestedPackage xmi:id="metamodel.mtt.newpackage.mof_2" name="mof_2" uri="http:///metamodel/mtt/newpackage/mof_2.ecore">
      <xmi:Extension extender="http://www.eclipse.org/emf/2002/Ecore">
        <nsPrefix>metamodel.mtt.newpackage.mof_2</nsPrefix>
      </xmi:Extension>
    </nestedPackage>
    <nestedPackage xmi:id="metamodel.mtt.newpackage.ocl_1" name="ocl_1" uri="http:///metamodel/mtt/newpackage/ocl_1.ecore">
      <xmi:Extension extender="http://www.eclipse.org/emf/2002/Ecore">
        <nsPrefix>metamodel.mtt.newpackage.ocl_1</nsPrefix>
      </xmi:Extension>
    </nestedPackage>
    <xmi:Extension extender="http://www.eclipse.org/emf/2002/Ecore">
      <nsPrefix>metamodel.mtt.newpackage</nsPrefix>
```

```
    </xmi:Extension>
   </nestedPackage>
   <xmi:Extension extender="http://www.eclipse.org/emf/2002/Ecore">
    <nsPrefix>metamodel.mtt</nsPrefix>
   </xmi:Extension>
  </nestedPackage>
  <nestedPackage xmi:id="metamodel.ocl" name="ocl" uri="http:///metamodel/ocl.ecore">
   <ownedType xmi:type="emof:Class" xmi:id="metamodel.ocl.OclExpression" name="OclExpression"/>
   <ownedType xmi:type="emof:Class" xmi:id="metamodel.ocl.Variable" name="Variable"/>
   <xmi:Extension extender="http://www.eclipse.org/emf/2002/Ecore">
    <nsPrefix>metamodel.ocl</nsPrefix>
   </xmi:Extension>
  </nestedPackage>
  <nestedPackage xmi:id="metamodel.qvt" name="qvt" uri="http:///metamodel/qvt.ecore">
   <ownedType xmi:type="emof:Class" xmi:id="metamodel.qvt.TypedModel" name="TypedModel">
    <ownedAttribute xmi:id="metamodel.qvt.TypedModel.takesTypesFrom" name="takesTypesFrom" isOr-
dered="false"
      lower="1" type="metamodel.mof.Package"/>
   </ownedType>
   <ownedType xmi:type="emof:Class" xmi:id="metamodel.qvt.Function" name="Function"/>
   <xmi:Extension extender="http://www.eclipse.org/emf/2002/Ecore">
    <nsPrefix>metamodel.qvt</nsPrefix>
   </xmi:Extension>
  </nestedPackage>
  <xmi:Extension extender="http://www.eclipse.org/emf/2002/Ecore">
   <nsPrefix>metamodel</nsPrefix>
  </xmi:Extension>
</emof:Package>
```

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