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CAMEO DATA MODELER PLUGIN

18.5

user guide

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GETTING STARTED

Introduction

Cameo Data Modeler plugin provides data-related modeling for MagicDraw. It includes entity-relationship, database and XML schema modeling features.

This plugin enables you to draw entity-relationship diagrams (using the crow's foot notation). This is a full-featured variant of ER diagram (including extended entity-relationship concepts - like generalization), providing a spectrum of capabilities for logical data modeling.

This plugin provides SQL database modeling / diagramming and DDL script generation / reverse features. It supports 11 flavors of databases (including Standard SQL, Oracle, DB2, Microsoft SQL Server, MySQL, PostgreSQL), has separate type libraries for them, carries additional modeling extensions for Oracle databases, Transformations from / to plain UML models and from ER models are provided.

This plugin provides XML schema modeling / diagramming and schema file (*.xsd) generation / reversing features. Transformations from / to plain UML models are provided.

NOTES	
	• Cameo Data Modeler plugin is a separately purchasable add-on for MagicDraw Standard, Professional, and Architect Editions, and it is free of charge for MagicDraw Enterprise Edition. • Cameo Data Modeler plugin replaces previous (free) Data Modeling Notations plugin that supported the business entity-relationship diagram, a simplified version of entity-relationship diagram, usable for high level, abstract domain data modeling. • This plugin repackages database and XML schema modeling functionality, which was previously available only in MagicDraw Architect and Enterprise editions.

Installing Cameo Data Modeler Plugin

To install Cameo Data Modeler plugin

1. From the **Help** menu, select **Resource/Plugin Manager**.
2. Select **Cameo Data Modeler** plugin to download and install it.
3. Restart MagicDraw to activate Cameo Data Modeler plugin.

Note that when you install the plugin, you get an evaluation key automatically. This key is good for 7 days. Afterwards you need to purchase a license for a plugin to work on diagrams provided by the plugin (when initial license expires, diagrams are switched to the read-only mode).

For more information on how to work with the **Resource/Plugin Manager** dialog, see *MagicDraw User's Manual.pdf*.

ENTITY-RELATIONSHIP (ER) MODELING AND DIAGRAMS

Introduction

Cameo Data Modeler plugin brings in the following:

- Entity Relationship profile.
- Entity Relationship diagram.
- Template for new ER project creation.
- Sample, demonstrating ER modeling features.
- ER to SQL (Oracle and Generic) transformation and accompanying traceability features.
- Entity-Relationship and SQL report.

Entity-Relationship diagram, as the name suggests, allows specifying entities and relationships between them. It is useful for the abstract domain modeling - to provide structure for data in the domain. It is much more abstract and implementation-independent than the SQL diagram, which shows the concrete implementation of the data structure in the database.

Basic Concepts

An entity is any thing that is capable of an existence. An entity usually refers to some aspect of the real world, which can be distinguished from other aspects of the real world (a person, place, customer transaction, order...).

An entity is represented by a box shape on the diagram. An entity has two compartments where properties (columns) of the entity can be specified. The upper compartment holds primary key properties of the entity; lower - other properties.

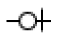
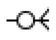
A relationship between entities describes how entities are associated. Relationships are represented by lines, connecting entities. Relationship end adornments indicate multiplicities of these ends. Multiplicity is the number of entity instances that can be associated with a number of another entity instances. Relationship multiplicity is represented by three symbols (so called "crow's foot notation" or "Information Engineering notation" - see Table 1 on page 7).

TABLE 1. **Symbols of the relationship multiplicity**

Name	Value	Notation
Zero	Zero	○
Vertical	One	|
Crow's foot	Many	<

Multiplicity lower bounds and upper bounds are paired into one adornment - see the possible pairings in Table 2 on page 8. Note that any lower bound, which is more that 0 is treated as 1 (this also includes lower bounds greater than 1 - such as e.g. 2). Also, any upper bound which is greater than 1 is treated as Many (this also includes upper bounds less than unlimited - such as e.g. 7).

TABLE 2. **Multiplicity bound pairings**

Min	Max	Read As	Figure
0	1	One (optional)	
1	1	One (mandatory)	
0	Many	Many (optional)	
1	Many	Many (mandatory)	

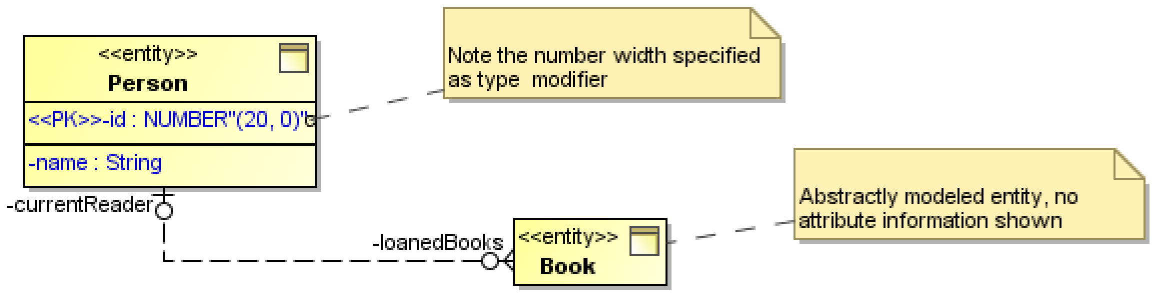

<<entity>>
Person
<<PK>>-id : NUMBER"(20, 0)"
-name : String
Note the number width specified as type modifier
-currentReader
-loanedBooks
<<entity>>
Book
Abstractly modeled entity, no attribute information shown

Figure 1 -- Basic ER diagram example

NOTES

- Some authors use **Entity Type** term to signify the description of a set of entities and **Entity Instance** term to signify concrete exemplar from that set. **Entity** term used in this manual corresponds to **Entity Type**.
- Data modeling world frequently uses term Cardinality to denote the allowable numbers of entity instances, which can be associated. But with the rise of the UML, the more correct term **Multiplicity** was introduced and term **Cardinality** is only used to denote concrete numbers of entity instances, which are associated. Hence in the example Person [0..1]-------[0..*] Book, the ranges [0..1] and [0..*] are called multiplicities. And if we have person “John Doe” associated with books “Moby Dick” and “Origin of Species”, we have a cardinality of 2 for loaned books role (and 1 on an opposite end - current reader role). Note that cardinality is always concrete number while multiplicity denotes range of possible cardinalities.

Business Entity-Relationship Diagrams

There is a flavor of the ER diagrams, called Business ER diagrams - this is a simplified flavor of the ER diagram. This diagram only shows entities as boxes (without structure) and relationships between them. It is useful for high-level, abstract domain modeling - provide a structure for business data, or define business terminology.

These diagrams can be draw using the same ER diagram simply by suppressing both primary key and column compartments on all the entities. Convenient way to do this is to multiselect all the entities (hold down ALT and click any entity) and use the **Suppress All** button in the Shape Editing toolbar of the diagram.

Identifying Relationships and Dependent Entities

One-to-many (and, very rarely, one-to-one) relationship can be declared identifying. Identifying relationship is a “stronger” version of the relationship, indicating that the one entity (the one at the multiple end of the relationship) can not exist without the entity on the other end.

You can create such relationships using buttons on a diagram pallet. You can also turn an existing relationship into identifying and back again. For this you can choose to do one of the following: either change the **Is Identifying** property value in the relationship Specification window or select the appropriate check box on its shortcut menu.

Identifying relationship is drawn as solid line. Non-identifying relationships use heavy dashes.

Closely related concept is dependent / independent entities. Dependent entities are those, which are at the multiple end of the identifying relationship. They cannot exist without the independent entity at the other end. In addition every inherited entity (if you are doing EER modeling) is considered to be dependent.

Dependent entity's primary key includes the other entity's key as part (this is implied, not shown in the model).

Dependent entities are automatically recognized and drawn with rounded corners.

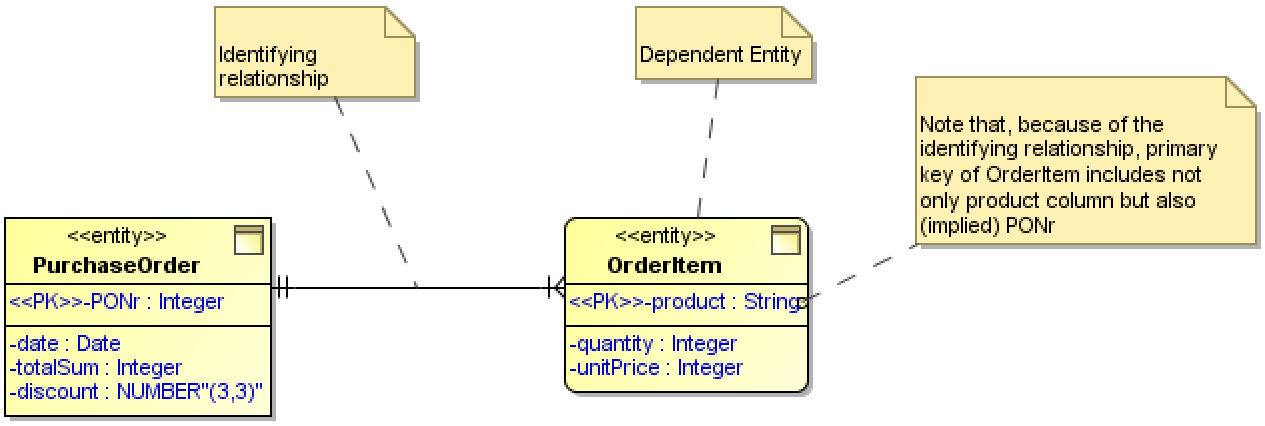


Figure 2 -- Example of identifying relationship and dependent entity in ER diagram

Constraints between Relationships

You can place XOR constraints (there is also a rarely used OR constraint) between relationships using a corresponding toolbar button. Note that constraint must join relationships, that have at least one common end - not any arbitrary relationships.

Current implementation of constraints does not allow placing a constraint on more than 2 relationships.

Generalization and Specialization

ER diagram has a support for generalization / specialization modeling. Generalization and Specialization is really the same relationship, just the different direction of classification (generalization is bottom-up, specialization is top-down). Hence they use the same model element.

Generalizations can be joined into generalization sets (trees of generalizations), which allow specifying additional properties on a group of generalizations - such as disjointness and completeness constraints.

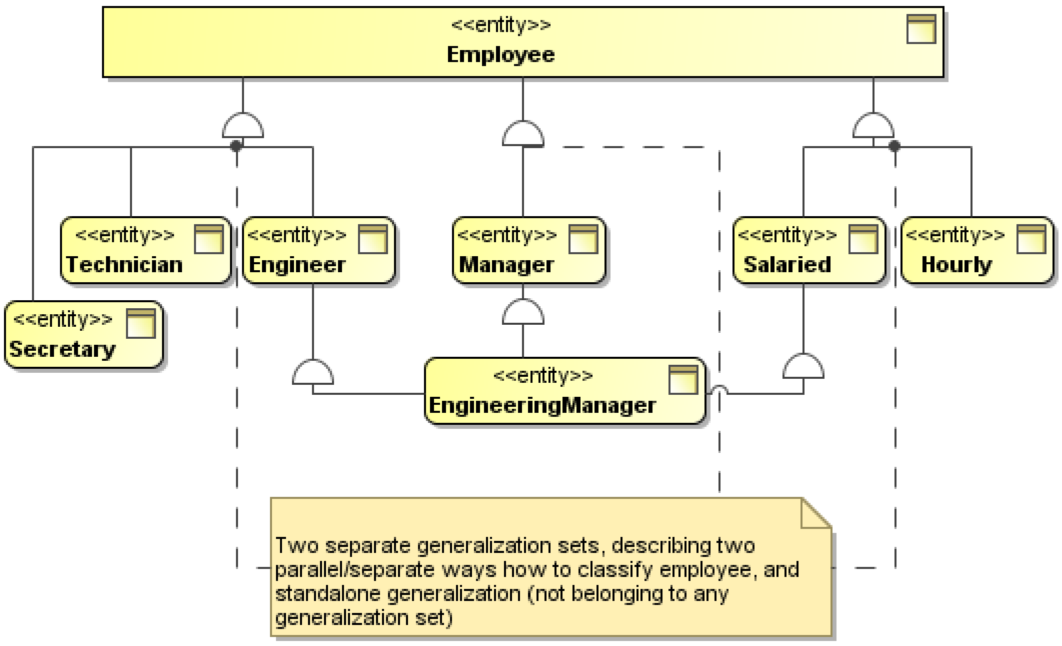

<<entity>> Employee
<<entity>> Technician
<<entity>> Engineer
<<entity>> Manager
<<entity>> Salaried
<<entity>> Hourly
<<entity>> Secretary
<<entity>> EngineeringManager
Two separate generalization sets, describing two parallel/separate ways how to classify employee, and standalone generalization (not belonging to any generalization set)

Figure 3 -- Example of generalization in ER diagram

Disjointness and completeness constraints are specified using the **Is Disjoint** (*true* for disjoint, *false* for overlapping specialization) and **Is Covering** (*true* for total, *false* for partial specialization) properties. They can be set via the relationship shortcut menu or in the Specification window.

Hence there are 4 combinations of these two settings. The “breadloaf” symbol joining generalizations into a tree shows these 4 variations - see the following figures.

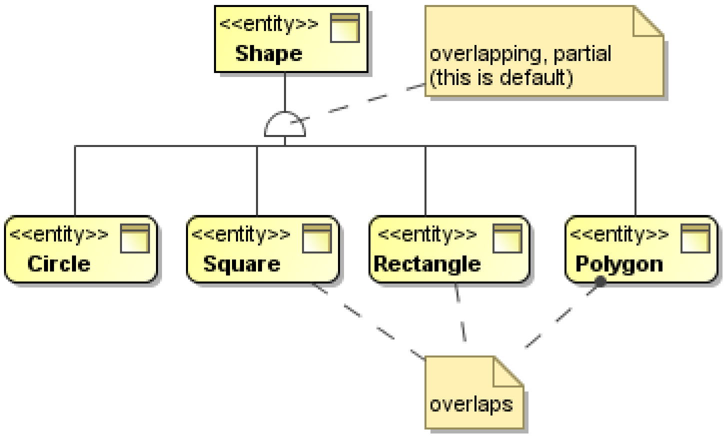


Figure 4 -- Example of overlapping and partial specialization in ER diagram

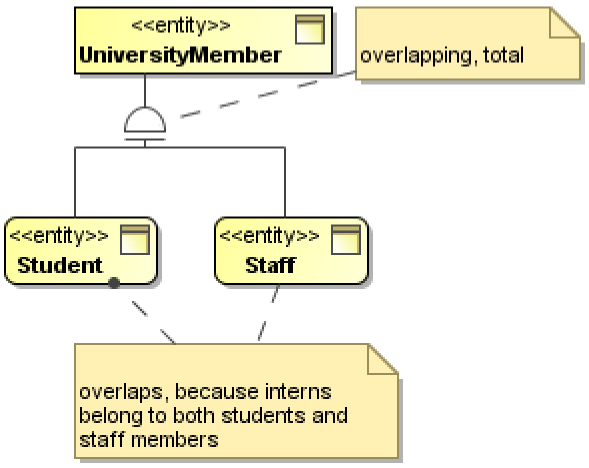


Figure 5 -- Example of overlapping and total specialization in ER diagram

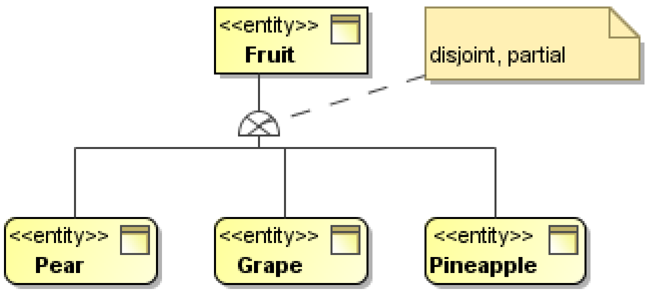


Figure 6 -- Example of disjoint and partial specialization in ER diagram

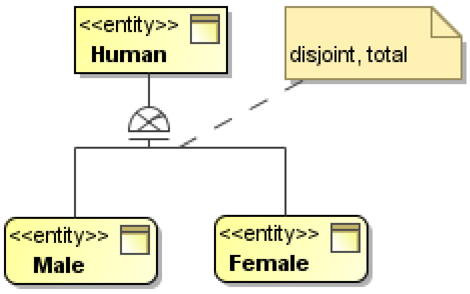


Figure 7 -- Example of disjoint and total specialization in ER diagram

NOTE UML terminology (covering / not covering) is used for completeness property name in Specification window. Other names, more familiar for data modelers, are total / partial and complete / incomplete. These terms are analogous and can be used interchangeably.

In the specialization hierarchies, there can be several ways how entity instance is assigned to specific entity subtype. It can be determined by the user - when user himself decides to which subtype given instance belongs (user-defined specialization). Or it can be determined by actual data values of entity instance (attribute-defined specialization). The latter case can be further subdivided into two subcases - simple attribute-based discrimination (when discrimination is performed by doing simple attribute value comparison) and more complex predicate-based discrimination (when discrimination is specified using more complex, explicitly specified conditions).

Examples of these two cases are shown in the following figures.

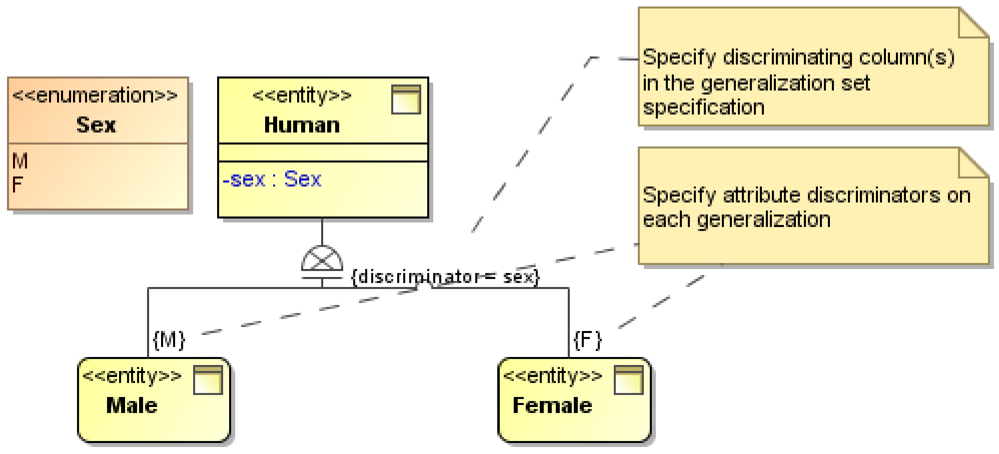

<<enumeration>>
Sex
M
F
<<entity>>
Human
-sex : Sex
Specify discriminating column(s) in the generalization set specification
Specify attribute discriminators on each generalization
{discriminator= sex}
{M}
{F}
<<entity>>
Male
<<entity>>
Female

Figure 8 -- Example of attribute-based discriminator in ER diagram

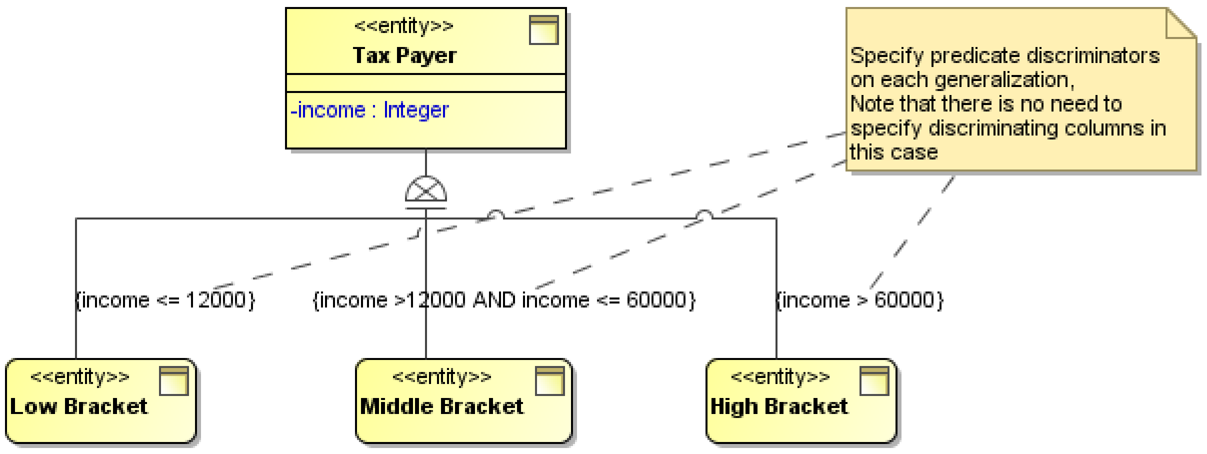

<<entity>>
Tax Payer
-income : Integer
Specify predicate discriminators on each generalization, Note that there is no need to specify discriminating columns in this case
{income <= 12000}
{income >12000 AND income <= 60000}
{income > 60000}
<<entity>>
Low Bracket
<<entity>>
Middle Bracket
<<entity>>
High Bracket

Figure 9 -- Example of predicate-based discriminator in ER diagram

Discriminators are modeled as special constraints, placed on individual generalization relationships. The easiest way to access them is from the shortcut menu of the generalization.

Predicate-based discriminator is simpler - you just fill in the **Specification** field of the predicate with an appropriate expression text.

Attribute-based discriminator is more complex. First you have to specify columns, by which you will discriminate the entities into the corresponding subclasses. This is done by filling in the **Discriminator** field of the generalization set (you can specify one or several columns there). Then you have to fill in the **Template** field of the predicate. This template field holds an instance specification, which is used as template or etalon to differentiate the entity instances into appropriate subclasses. Fill in the slots for the same columns that you indicated on the generalization set.

NOTE	Category (also know as union) concept is currently not explicitly supported. Total (but not partial) categories can be “simulated” using the total specialization tree, just visually reversed.

Key Modeling

Keys of the entity are marked by applying the corresponding stereotype («PrimaryKey», «AlternativeKey») on the necessary column(s). This can be done from the shortcut menu of the column.

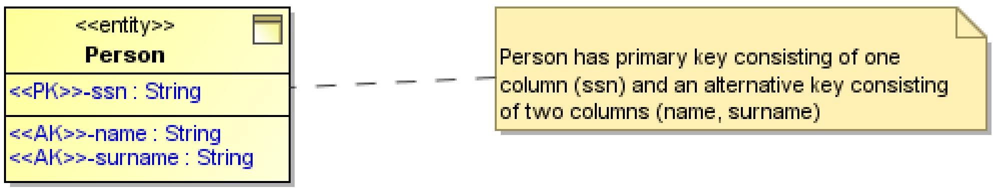

<<entity>>
Person
<<PK>>-ssn : String
<<AK>>-name : String
<<AK>>-surname : String
Person has primary key consisting of one column (ssn) and an alternative key consisting of two columns (name, surname)

Figure 10 -- Example of key usage in ER diagram

Primary key columns are grouped into a separate compartment. When the «PrimaryKey» stereotype is applied / unapplied, the column migrates between the two compartments.

In rare cases there is a need to specify several alternative keys on the same entry. This can be done, by filling the “Id” tag field of the key column with key identifier(s). Columns, having the same Id are considered to be belonging to the same key. Overlapping alternative keys can be specified in the same manner (column can have several ids specified).

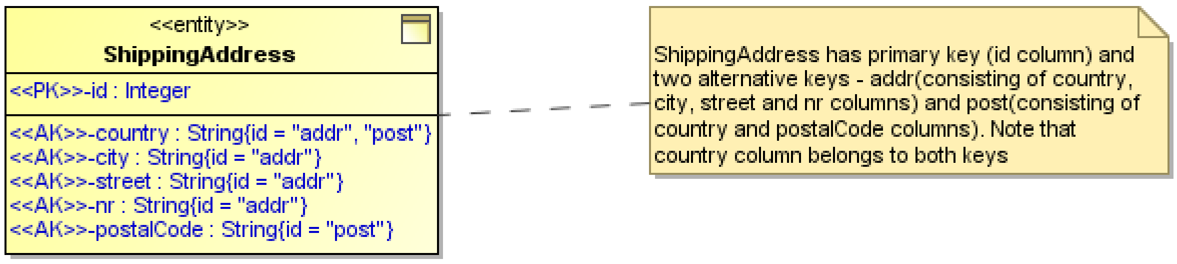

<<entity>>
ShippingAddress
<<PK>>-id : Integer
<<AK>>-country : String{id = "addr", "post"}
<<AK>>-city : String{id = "addr"}
<<AK>>-street : String{id = "addr"}
<<AK>>-nr : String{id = "addr"}
<<AK>>-postalCode : String{id = "post"}
ShippingAddress has primary key (id column) and two alternative keys - addr(consisting of country, city, street and nr columns) and post(consisting of country and postalCode columns). Note that country column belongs to both keys

Figure 11 -- Example of multiple overlapping alternative keys in ER diagram

Inversion entries are specified analogously. Inversion entry is a non-unique (combination of) column(s), which nevertheless is used frequently to search for the entity. Marking columns as IE gives hints to database implementers about which indexes to specify.

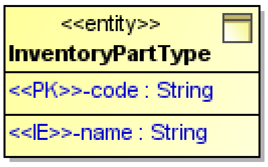


Figure 12 -- Example of inversion entry in ER diagram

NOTE Though ER profile carries the «ForeignKey» stereotype, this stereotype is currently unused. It is reserved for future - for automatic foreign key derivation functionality. Users should not specify FK columns explicitly on their entities (FKs are implied), unless needed for some specific purpose - use at your own risk.

Virtual Entities

Virtual entities are entities that can be derived from information in other entities. They are marked with keyword «virtual» on the diagrams. Otherwise they can be handled in the same manner as other entities.

Virtual entities roughly correspond to views in databases.

If you need to specify exact way how virtual entities are derived from other entities, you can use Abstraction relationships from UML; derivation expression can be specified in the Mapping field.

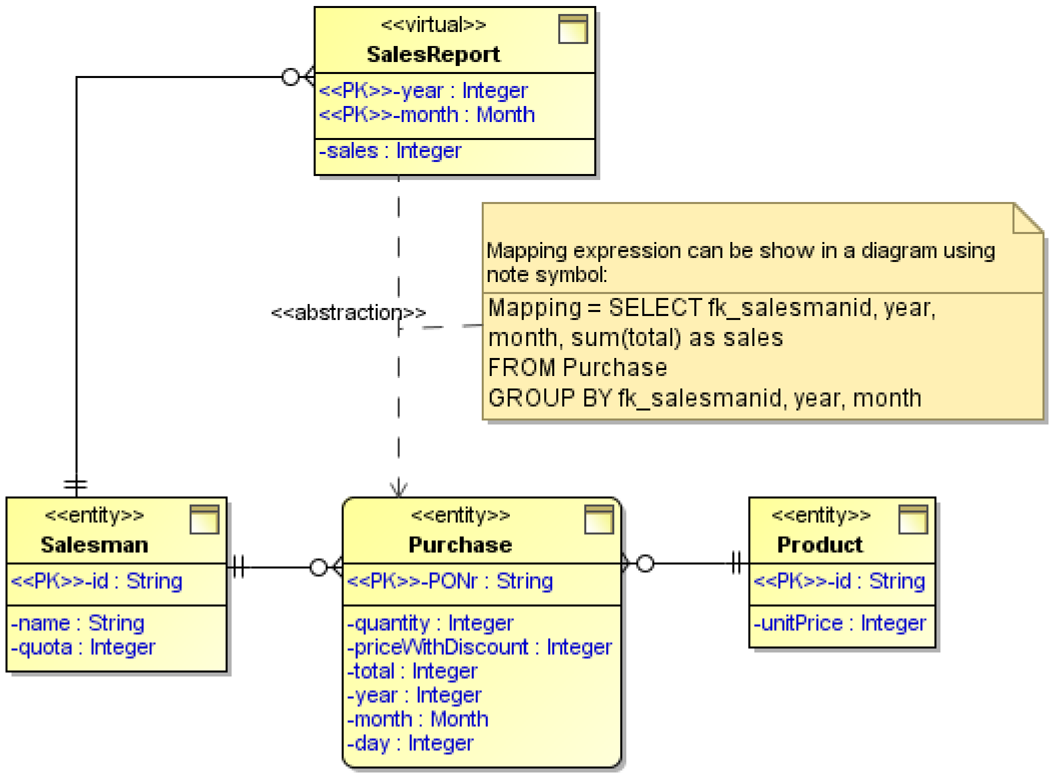


Figure 13 -- Example of virtual entity usage in ER diagram

Importing CA ERwin® Data Modeler Projects

Cameo Data Modeler Plugin for MagicDraw provides import functionality for data models created using CA ERwin® Data Modeler (henceforth will be referred as ERwin). ERwin is one of the leaders in the data modeling tools market.

Data models produced in ERwin have a two-layer structure consisting of logical and physical layers that are tightly synchronized. The physical layer semantically corresponds to the SQL modeling / diagramming / generation functionality in MagicDraw. The logical layer corresponds to ER diagrams, implemented by Cameo Data Modeler Plugin.

The import functionality only imports logical layer data from ERwin into ER diagrams / data model in MagicDraw. Cameo Data Modeler Plugin does not yet support import of physical layer data.

Importing Data Models

Cameo Data Modeler supports model files produced in ERwin version 7.x. It is recommended that the newest v7.3 should be used since it has been heavily tested. Data models in ERwin must be saved in the *.xml format (choose the **XML Standard File** option in the **Save As** dialog).

To import an ERwin model

1. Start MagicDraw.
2. Click **File** > **Import From** > **CA ERwin Data Modeler v7.x**. The **Open file** dialog will open.
3. Select an ERwin model file (*.xml). A new MagicDraw project will be created and logical model will be imported from the ERwin model file into that project.

After successful import, you can proceed to edit or manage the model using MagicDraw features.

If you want to include the ER model as part of a larger project in MagicDraw, you can use either module linking functionality (click **File** > **Use Module**) to attach the ER model to your main project model or project import functionality (click **File** > **Import From** > **Another MagicDraw Project**) to transfer the contents of this ER model to your main project model.

If you want to update an imported and edited ER model, for example, you have made changes to the ERwin model and want to import those changes into MagicDraw again, you can use the merge functionality (click **Tools** > **Project Merge**) to import the ERwin model into a new ER model and merge it with the model you have imported earlier.

Imported Elements

TABLE 3. **Import Mapping Reviews and Notes**

ERwin	**Cameo Data Modeler**	**Comments**
Any element	Any Element	● For each element, it's name, definition, and notes are imported. ● Definitions are imported as MagicDraw documentation (special UML comments) and notes are imported as UML comments.
Entity	Entity	
Attribute	Attribute	● The **Null** / **Not Null** setting is imported as UML multiplicities [0..1] / [1]. ● Attribute constraints and default value information is imported. ● Domain information is not imported because domains are not supported. ● Attribute type information is imported - the standard primitive types are mapped to the UML primitive types. ● Other types (which are not found in the model) are created on the fly.
Key	Key Marking on Attributes	● There is no separate standalone model element for a key in the Cameo Data Modeler ER diagrams. Instead, attributes belonging to a key are marked by applying a stereotype to them (PK, AK, or IE) as necessary.
Relationship	Association relationship	● Simple relationships are mapped to UML associations. ● Verb phrases are mapped to role names. ● Cardinality and null / not null settings are mapped to UML multiplicities ([0..1], [1], [0..*], [1..*]). ● Referential integrity information is stored in a special stereotype / tag. ● Key information is not imported since the current ER diagrams do not support FK modeling.

ERwin	**Cameo Data Modeler**	**Comments**
	Generalization relationship	• ERwin relationships, which are participating in the generalization tree, are mapped to UML generalizations. • Generalizations are joined into generalization trees. • Complete / incomplete and overlapping / exclusive settings are imported / supported. • Discriminating columns are imported / supported. • Referential integrity information is stored in a special stereotype / tag. • Verb phrase information is not imported.
Default Value	Instance Specification	• A standalone UML instance specification is created to hold value definition. This instance specification is (or can be) then referenced from attributes, default value fields.
Domain	-	• Domains are not yet supported in Cameo Data Modeler.
Validation Rule	Constraint	• The Validation rule is stored as constraint body text.
Display	ER diagram	• Due to geometric constraints and element size changes, the diagram layout will be slightly different. • Paths between elements can be re-routed.
User Defined Properties Dictionary	Profile / Stereotypes / Tags	• A custom UML profile is created for the user's property definitions.
User Defined Properties	Tag Values	• A custom profile generated from the UDP dictionary is applied and user property information is stored in the tag values of the applied custom stereotypes.

DATABASE SUPPORT

Introduction

Cameo Data Modeler plugin brings the following:

- IMM Relational profile for SQL modeling support (the profile is named according to the OMG working group name).
- Extension profile for Oracle.
- SQL diagram, Oracle SQL diagram and customizations for profile.
- Code engineering (generation / reverse) features for working with database generation scripts.
- Primitive type libraries for database flavors.
- Template for new Database project creation.
- Sample, demonstrating database modeling features.
- UML / ER to SQL (Oracle and generic) and SQL to UML transformations and accompanying traceability features.
- Entity-Relationship and SQL report.
- Helper functionality for SQL diagrams - notation switch.

Cameo Data Modeler plugin provides support for database modeling and code engineering. It supports modeling of the database concepts at the level of SQL:1999 (SQL3) standard. A few rarely used concepts (like collation, translation) are not supported.

IMPORTANT! A BIG DISCLAIMER UPFRONT. In v17.0.1 SQL **modeling** was significantly extended and reworked. The new profile for SQL modeling covers more SQL concepts than the old Generic DDL and Oracle DDL profiles, that were previously used for SQL modeling. However the **code engineering** features (script generation and reverse engineering) were not upgraded yet - code engineering capabilities are almost the same as in v17.0. There is currently a skew between the modeling and code engineering features. Some things that can be modeled with the help of the current profile can not yet be not generated / reversed to / from database script.

SQL Diagrams

Cameo Data Modeler provides a specialized diagram for database modeling. This diagram is called **SQL Diagram** and is located under **Data Modeling** diagram subgroup. This diagram provides means for creating and depicting various SQL elements.

In addition to the main SQL diagram, there is a slightly modified diagram for Oracle databases. It is called **Oracle SQL Diagram** and is located under the same **Data Modeling** diagram subgroup. This diagram is only slightly modified - it has an additional diagram button for the Materialized View modeling. Otherwise than that, it is identical to the main SQL diagram. If you are not modeling materialized views, you can freely use the generic diagram type instead of specialized one for Oracle modeling.

Crow’s Foot Notation in SQL Diagrams

Once Cameo Data Modeler plugin is applied to MagicDraw you can display the crow’s foot notation or use standard UML notation of associations (displaying multiplicities in text format) in the SQL diagram.

To display Multiplicities or crow’s foot notation in a SQL diagram

1. Create the SQL diagram.
2. Draw two tables.
3. Create columns for the tables and some of them as primary keys.
4. Connect the table elements with the Foreign Key relationship.
5. Define **Name**, **PK**, and **FK** in the open **Foreign Key** dialog box.
6. Open the **Project Options** dialog box.
7. Select the **General project options** branch.
8. Change the **Show relationship ends as** property correspondingly to either **No special notation** or **Crow’s feet.** Multiplicities (Figure 14 on page 18) or crow’s foot notation (Figure 15 on page 18) will then be displayed on the Foreign Key ends.

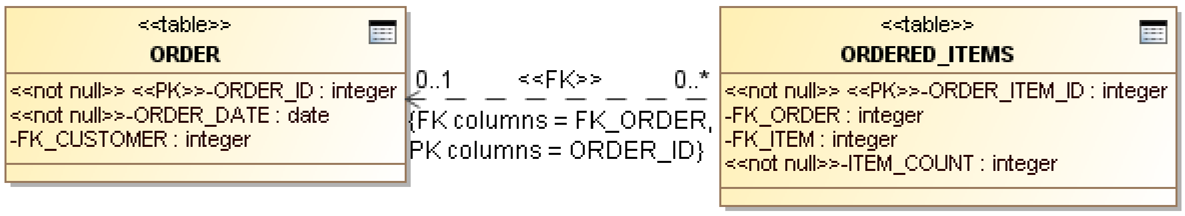


Figure 14 -- Multiplicities on Foreign Key relationship in SQL diagram

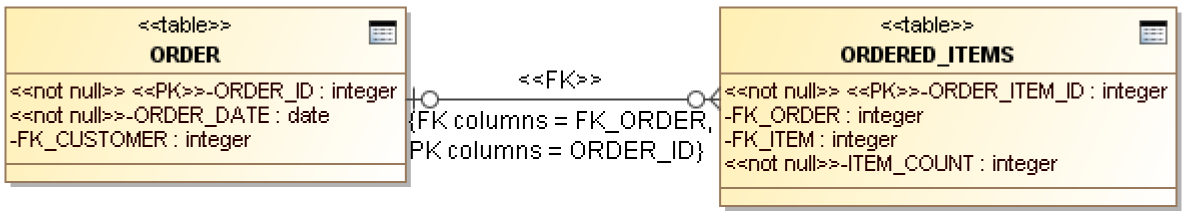


Figure 15 -- Crow’s foot notation for Foreign Key relationship in SQL diagram

Database Modeling

This chapter covers modeling of various SQL elements - in detail and with examples.

Common SQL Element Properties

These properties are common and available for all SQL model elements in their Specification windows.

Property name	**Description**
Name	Name of this SQL model element.
Label	Label of SQL model element. Can be used for various referring purposes (both human and code referral).
Description	Longer text, describing this SQL element in more detail.

Property name	Description
TODO	Additional remarks about the further modifications, necessary for this element

In addition to these SQL properties, some common, useful UML model properties are shown in the Specification windows (only in the Expert mode).

Property name	Function
Qualified Name	Fully qualified name of this model element - names of all owning parent elements and this element, concatenated using “::” separators.
Owner	Model element, directly owning this element.
Applied Stereotype	Stereotypes, applied on this model element, extending element data over and above the standard UML functionality. SQL extension stereotypes can be seen here (implementing SQL model features, described in this document) as well as any additional extensions.
Image	Custom image can be set on each model element if necessary.

Top Level Elements

There are several top-level model elements, that serve as the containers for other model elements of the database model. Those are: Database, Schema, Catalog.

Top level elements are not strictly necessary to begin database modeling. You can start modeling database elements (like tables) in the standard UML package (even directly under root ‘Data’ model element). But top level elements help to provide context for those other elements and their naming and positioning in the database. So, at least one top level element should be present - either Schema element or Database element. Optimally both Database and Schema element should be present in the model (Schema package inside the Database package). Catalog modeling is less important, it can be skipped. Not all databases have support for catalogs.

When top-level element is created (either on the diagram or in the containment tree), a special dialog is shown for selecting database flavor.

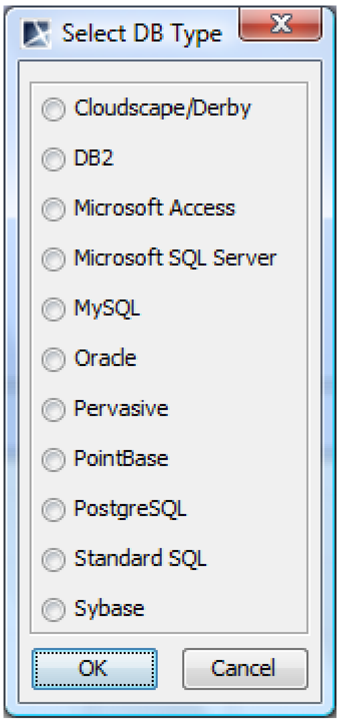


Figure 16 -- Database flavor selection dialog

When DB flavor is chosen, the necessary profile for that DB flavor is attached to the project (providing standard data types for that DBMS and / or additional stereotypes for modeling extensions of that DB flavor). Then profile application relationship is created from the package that is being created (Database, Schema) to the attached DB profile. This marks the top level element as belonging to this DB flavor, Other DB elements, created under that top level element will be automatically considered as belonging to this DB flavor.

If you would like to switch database flavor after creating a top level element, you can do this in the following way.

To switch database flavor after creating a top level element

IMPORTANT!	You must have the necessary module attached to your project (use **File>Use Module** menu, choose the necessary module from your **<install.root>\profiles** predefined location)

1. Right-click the top level element.
2. From the shortcut menu, select **Apply Profiles**.
3. Select the check box near the needed profile and clear the check box near the old profile.
4. Click **Apply**.

Top level elements can be explicitly drawn, on the diagram.

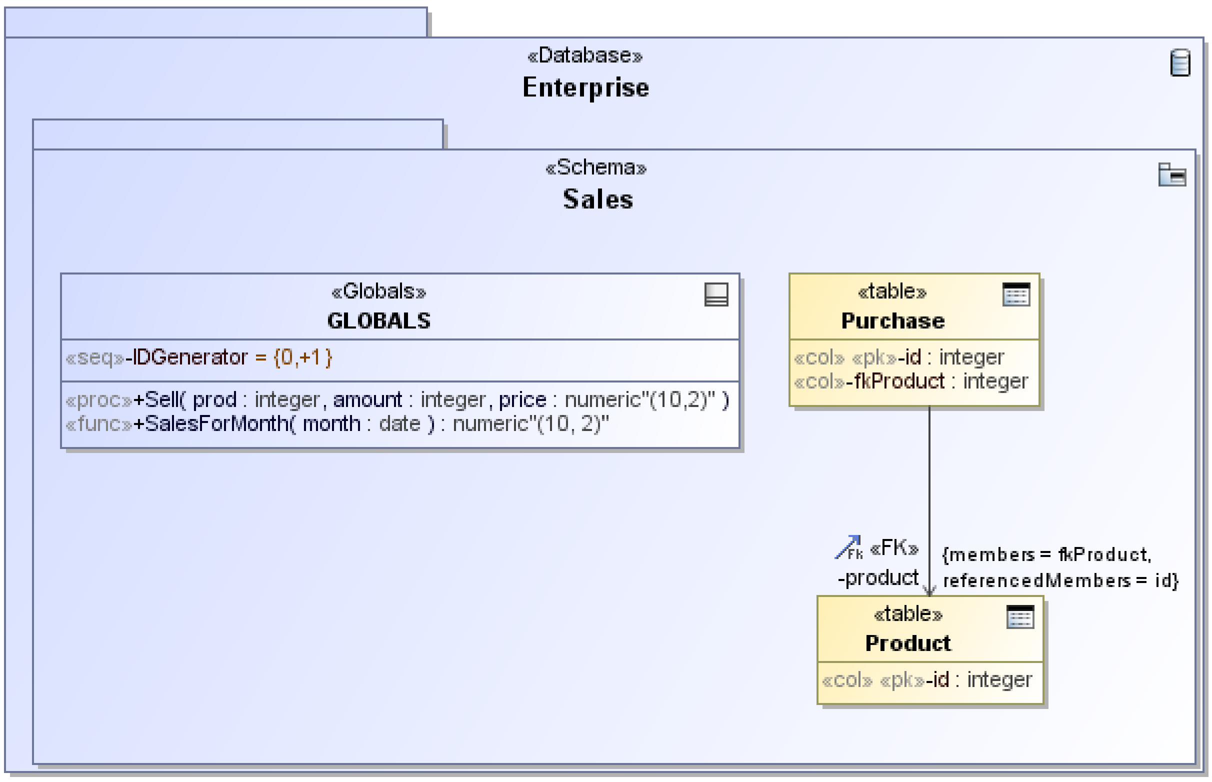

«Database»
Enterprise
«Schema»
Sales
«Globals»
GLOBALS
«seq»-IDGenerator = {0,+1}
«proc»+Sell(prod : integer, amount : integer, price : numeric"(10,2)")
«func»+SalesForMonth(month : date) : numeric"(10, 2)"
«table»
Purchase
«col» «pk»-id : integer
«col»-fkProduct : integer
«FK»
-product
{members = fkProduct, referencedMembers = id}
«table»
Product
«col» «pk»-id : integer

Figure 17 -- Database top level containers (Database and Schema) on diagram pane

However, showing top level elements on the diagram, and nesting their contents inside them is often clumsy, and consumes valuable diagram space. Showing them on the diagram pane is not necessary; it is enough to create them in the Containment tree (using the **New Element** command on the shortcut menu). Then, place your diagram inside the created containers, and the elements that you will be creating in your diagram, will go into the necessary container. See the following figure (logically equivalent to the previous one), showing a top level element just in the Containment tree and not displayed on the diagram pane.

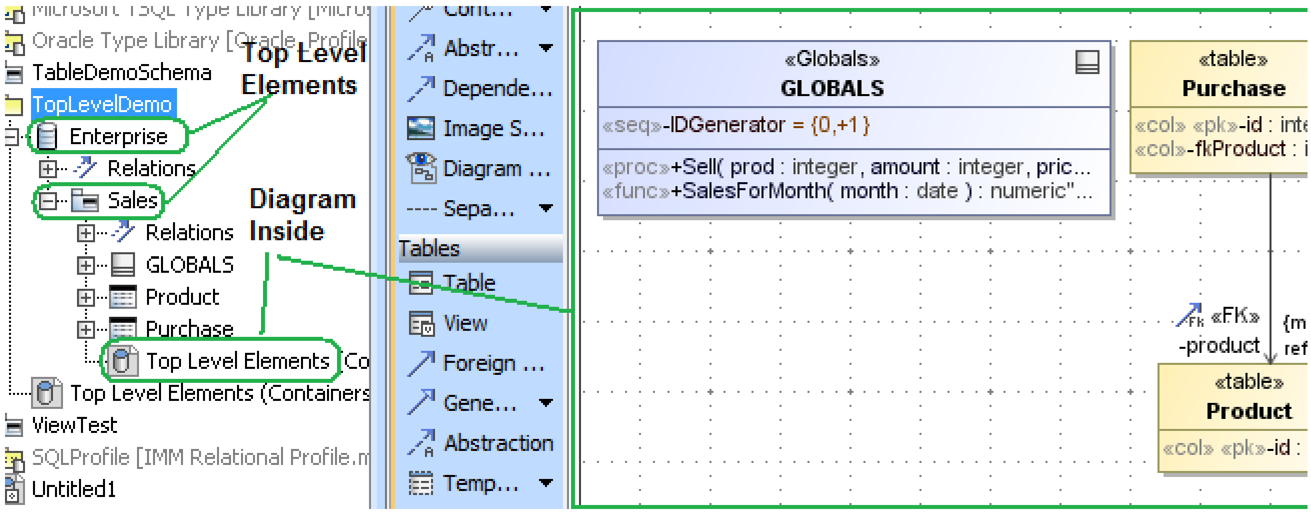


Figure 18 -- Database top level containers (Database and Schema) in Containment tree, but not on diagram pane

There is also one additional complication, steming from the limitations of UML. UML does not allow placing UML properties (which are used for SQL sequence modeling), or operations (which are used for SQL stored procedure & function modeling) directly into packages. Properties and operations can only occur in classes. A special model element was introduced to work around this limitation - GLOBALS element (based on UML class). This intermediate element can be placed directly inside the top level element (usually Schema, but can also be placed under Database) and then the necessary database elements - sequences, stored procedures can be placed inside it.

Database

NOTE	Database is modeled as UML Package with Database stereotype applied.

Database is a top level element, representing entire database within DBMS.

Besides the standard SQL element properties, database has the following properties available in the Specification window:

Property name	Description
Vendor	Specifies the vendor and the version of the database software. These fields are used for information purposes only. They do not affect the generation or further modeling.
Version	

Schema

NOTE	SQL Schema is modeled as UML Package with Schema stereotype applied.

Schema element represents a collection of database elements - tables, indexes, stored procedures, etc. - grouped for particular purpose (such as data structures for some particular application).

Catalog

NOTE	SQL Catalog is modeled as UML Package with Catalog stereotype applied.

Catalog element represents intermediate grouping level between database and schema. Catalogs are also reused for Oracle DB modeling - to implement Oracle packages.

GLOBALS

NOTE	GLOBALS is modeled as UML Class with the «Globals» stereotype applied.

GLOBALS element is a special intermediate element to work around limitation of UML. UML does not allow placing UML properties (which are used for SQL sequence modeling), or UML operations (which are used for SQL stored procedure & function modeling) directly into packages. Properties and operations can only occur in classes.

To work around this limitation, GLOBALS element (based on UML class) was introduced. This intermediate element can be placed directly inside the top level element (usually Schema, but can also be placed under Database) and then the necessary database elements - sequences, stored procedures and functions can be placed inside it.

Name of GLOBALS model element is not important, but for the sake of tidiness it should be named "GLOBALS". There should be at most one such element per the container (Schema, Database, Package). This model element does not carry any additional useful properties; it serves just as a carrier of inner elements - sequences and routines.

Tables, Columns, and Views

Tables and their constituent columns are the main elements for describing database data structures. Table stores multiple rows of data each consisting of several columns. Each cell holds one data value (or is empty). All values of one column are of the same type. Correspondingly each table description consists of the table name and a set of column descriptions. Additionally there are various kinds of constraints (including the all-important primary key and foreign key constraints), that can be applied on tables and triggers, specifying additional actions to be performed during data manipulation.

See “Constraints” on page 36 for constraints and “Triggers” on page 44 for triggers.

There can be various kinds of tables

- Normal persistent tables
- Temporary tables
- Views (derived tables)

The following figure illustrates various kinds of tables that can be modeled on the diagram.

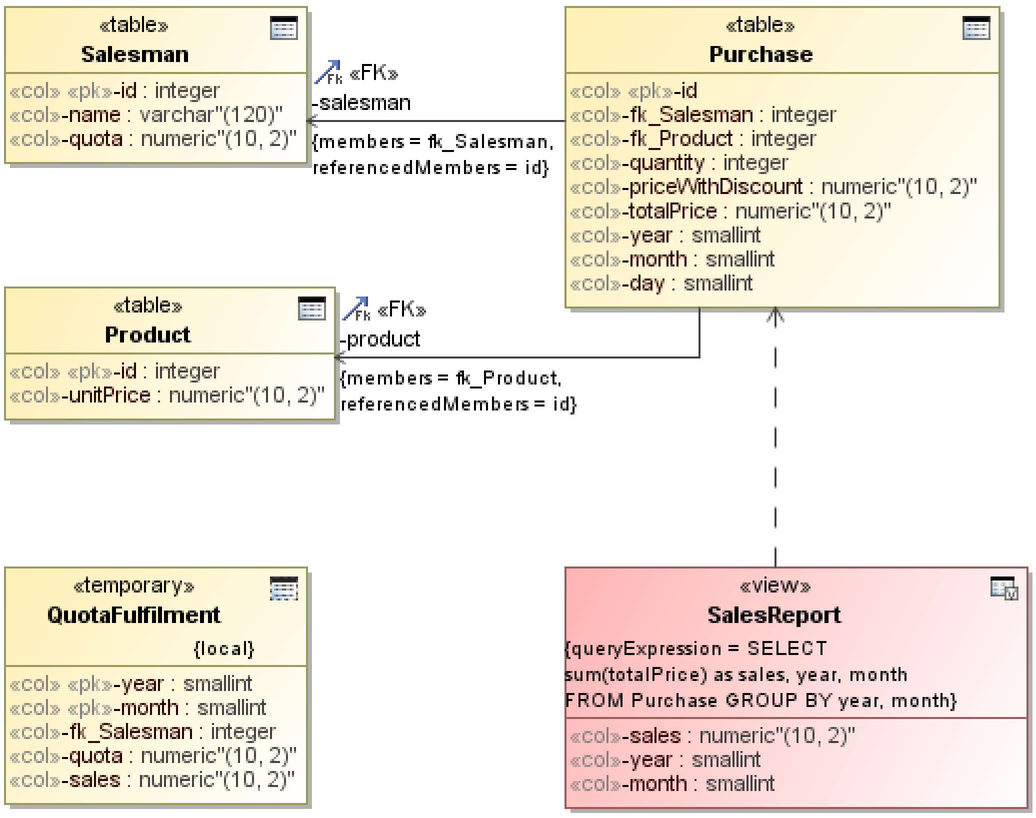

«table»
Salesman
«col» «pk»-id : integer
«col»-name : varchar"(120)"
«col»-quota : numeric"(10, 2)"
«FK»
-salesman
{members = fk_Salesman, referencedMembers = id}
«table»
Purchase
«col» «pk»-id
«col»-fk_Salesman : integer
«col»-fk_Product : integer
«col»-quantity : integer
«col»-priceWithDiscount : numeric"(10, 2)"
«col»-totalPrice : numeric"(10, 2)"
«col»-year : smallint
«col»-month : smallint
«col»-day : smallint
«table»
Product
«col» «pk»-id : integer
«col»-unitPrice : numeric"(10, 2)"
«FK»
-product
{members = fk_Product, referencedMembers = id}
«temporary»
QuotaFulfilment
{local}
«col» «pk»-year : smallint
«col» «pk»-month : smallint
«col»-fk_Salesman : integer
«col»-quota : numeric"(10, 2)"
«col»-sales : numeric"(10, 2)"
«view»
SalesReport
{queryExpression = SELECT sum(totalPrice) as sales, year, month FROM Purchase GROUP BY year, month}
«col»-sales : numeric"(10, 2)"
«col»-year : smallint
«col»-month : smallint

Figure 19 -- Various kinds of tables: persistent tables, temporary tables, and views

Tables can have generalization relationships between them. These relationships correspond to the following SQL syntax in the create table statement:

```
CREATE TABLE <name> OF <UDT name> [UNDER <supertable>]
```

There can be at most 1 outgoing generalization. Generalizations are not widely supported in database management systems. As of v17.0.1 Cameo Data Modeler supports modeling of these structures. Generation of corresponding script code is not supported yet.

Persistent Table

NOTE	SQL Persistent Table is modeled as UML Class with the «Persistent-Table» stereotype applied. For the sake of compactness, these tables are displayed with the «table» keyword (instead of the long form - «PersistentTable») on the diagram.

Persistent table is the most often used kind of table.

Besides the standard SQL element properties, persistent table has the following properties available in the Specification window (these properties are only available in Expert mode).

Property name	Description
User-defined type	Points to structured user defined type, which serves as a base for the row type of the table.
Supertable	Points to the parent (base) table. Can only be used together with user-defined type.
Self Ref Column Generation	Describes the self-referencing column generation options. Can only be used together with user-defined type. Corresponds to the following subclause of SQL create table statement: `REF IS <column name> [SYSTEM GENERATED|USER GENERATED|DERIVED]`
Referencing Foreign Keys	This is back reference from foreign keys, referencing this table. This field is for information purposes only. If you want to change it, change **Referenced Table** field of the foreign key instead.
Insertable	These are two derived (non editable) fields, describing table data editing capabilities. At the moment calculation of these properties is not implemented - they are always set to false
Updatable	

Temporary Table

NOTE	SQL Temporary Table is modeled as UML Class with the «Temporar-yTable» stereotype applied. For the sake of compactness, these tables are displayed with the «temporary» keyword (instead of the long form - «TemporaryTable») on the diagram.

Temporary table is a kind of table, where data is held only temporary. There are two kinds of temporary tables. Local temporary table persists for the duration of user session and is visible only for the creator user. Global temporary table is long lived and visible for all users. Note that **data** in the global temporary table is different for different users and does not persist throughout user sessions (only global table definition persists).

Temporary tables are created using SQL create table statement (using TEMPORARY option):

```
CREATE (GLOBAL | LOCAL) TEMPORARY TABLE <table name> ...
[ON COMMIT (PRESERVE | DELETE) ROWS]
```

Besides the standard SQL element properties and persistent table properties (see section above), temporary table has the following properties available in the Specification window.

Property name	Description
Local	Marks the table as local or global temporary table.
Delete On Commit	Regulates whether data is deleted or retained on commit.

View

NOTE	SQL View is modeled as UML Class with the «ViewTable» stereotype applied. For the sake of compactness, views are displayed with the «view» keyword (instead of the long form - «ViewTable») on the diagram.

View is a table, whose data is derived from data of other tables (by applying some SQL query).

Views are created using SQL create view statement:

```
CREATE VIEW <name> [<view column list>]
AS <query expression>
[ WITH [ CASCADED | LOCAL ] CHECK OPTION ]
```

Note that since column definition list is optional in SQL syntax, specifying column definitions in the view is also optional (columns can be inferred from query expression of the view). However it is often a good idea to include column definitions, since this allows to see view data structure on the diagram / in the model at a glance, without parsing the query expression text.

Besides the standard SQL element properties and persistent table properties (see section above), view has the following properties available in the Specification window

Property name	Description
Query Expression	A query expression, defining how data is calculated / retrieved for this view. This is an SQL SELECT statement.
Check Type	Describes how check is performed on the data update through the view. Only meaningful for updateable views (which is rare).

Query expression of the view modeling deserves a special attention. Query expression, defining the view, is not just a simple string, but a (stereotyped) UML model element. By default query expression model object is stored within the view definition itself. There is a special constraint, automatically created inside the view, to hold this expression. When the view is created, **Query Expression** field (which is a tag of stereotype, applied on the view) is automatically pointed to this expression.

So by default you just need to fill in the **Body** text of the expression. To do that you need to double-click on the **Query Expression** field. This opens Specification window for the expression itself, where **Body** can be filled in. This is the default, no-hassle way to specify view. It is easy. But it has one deficiency. Views created this way do not have any model references to the underlying table model elements. This may be undesirable from the dependency tracking standpoint (in the dependency analysis). To remedy this, you can draw an additional **Dependency** relationships between the view and base tables.

There is also another way to model the query expression, defining the view. If you click on the **...** button of the **Query Expression** field, this action opens the element selection dialog, allowing to retarget the **Query Expression** pointer choose another expression object, located somewhere else in the model. For example view definition expression can be located inside the **Abstraction** relationship, drawn from the view to the base table (**Mapping** field of the **Abstraction**).

To model view queries using abstractions

1. Draw an abstraction relationship between a View and a Table.
2. In the abstraction's Specification window, fill in the **Mapping** cell. This will be an inner UML OpaqueExpression model element with language and body cells. Set language to "SQL" and fill in the body with the necessary "SELECT ..." expression text.
3. Further open the Specification window of the mapping expression, and apply the «QueryExpressionDefault» stereotype.

4. Open the Specification window of the view. Click the **...** button in the **Query Expression** cell. In the element Selection dialog navigate to the abstraction relationship and select the expression inside of it.

This way to model view query expressions is rather tedious - so it is not recommended for modeling novices. But it has an advantage of capturing the real relationship in the model between the view and the constituent table(s). Also query expression can be shown on the abstraction relationship (using note mechanism) instead of showing expression on the view.

In the following figure you can see a diagram that illustrates the alternative way of view modeling.

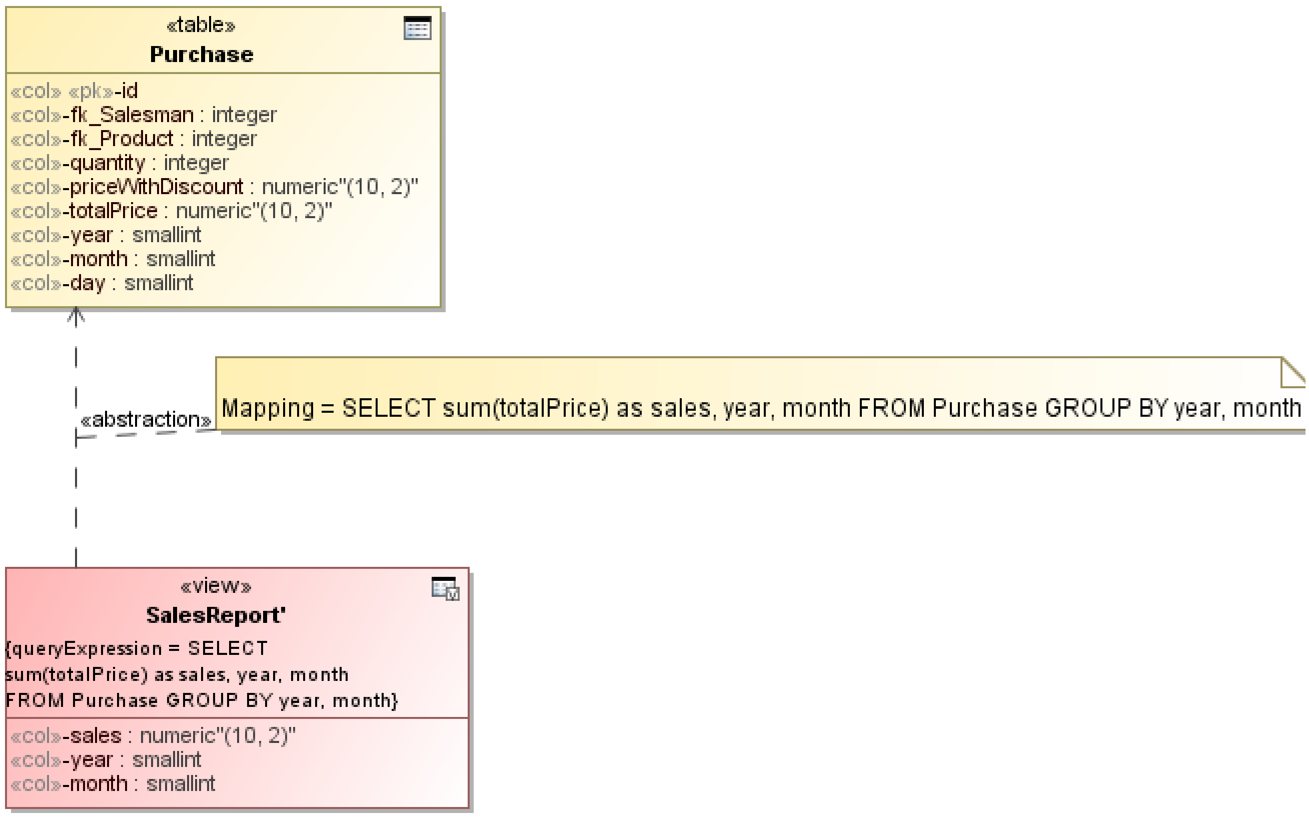

«table»
Purchase
«col» «pk»-id
«col»-fk_Salesman : integer
«col»-fk_Product : integer
«col»-quantity : integer
«col»-priceWithDiscount : numeric"(10, 2)"
«col»-totalPrice : numeric"(10, 2)"
«col»-year : smallint
«col»-month : smallint
«col»-day : smallint
«abstraction»
Mapping = SELECT sum(totalPrice) as sales, year, month FROM Purchase GROUP BY year, month
«view»
SalesReport'
{queryExpression = SELECT sum(totalPrice) as sales, year, month FROM Purchase GROUP BY year, month}
«col»-sales : numeric"(10, 2)"
«col»-year : smallint
«col»-month : smallint

Figure 20 -- Alternative notation for modeling view derivation from tables

Column

NOTE	SQL Column is modeled as UML Property with «Column» stereotype applied. For the sake of compactness, columns are displayed with the «col» keyword (instead of the long form - «Column») on the diagram.

Column model element describes one column of the table. In the most frequent case it's just a name of the column and a type. Additionally column can carry default value specification, column constraints.

Column definition syntax in SQL (in CREATE TABLE, ADD COLUMN statements):

```
<column name> [ <data type> ]
[ DEFAULT <value expression> |
  GENERATED { ALWAYS | BY DEFAULT } AS IDENTITY
      [ '(' <sequence options> ')' ] |
  GENERATED ALWAYS AS <expression>]
[ <column constraint definition>... ]
```

Besides the standard SQL element properties, column has the following properties available in the Specification window.

Property name	Description
Type	Collectively these two fields describe the type of the column. Type could be any of the primitive types from the library or user defined type. Modifier provides additional parameters for the type - such as width of the character type (when type=varchar and modifier=”(20)” - column is of varchar(20) type). See Type Usage section for details.
Type Modifier	
Nullable	Marks column as nullable or not. Basically this is an in-line nullability constraint. See Constraints section for details.
Default Value	Carries the default value of the column. This is normally an opaque expression, allowing to specify the value of the column. However it can be switched to Identity Specifier. In this case it describes the autoincrement options of the column. See Sequences section.
Is Derived	Standard UML field, used to mark the column as derived (GENERATED ALWAYS AS <expression>). It works together with Default Value field.
Scope Check	Marks this column as scope checked to a particular table and allows choosing particular referential integrity ensuring action (RESTRICT CASCADE, etc).
Scope Checked	
Implementation Dependent	Marks this column as implementation dependent.

Modeling Types

Cameo Data Modeler provides the standard type libraries as well as ability to model user defined types (structured user defined types and composites - multiset, array data types). The types can then be used to specify columns of the tables and / or parameters of procedures and functions. There is also a special mechanism for using types with modifiers. This mechanism is common in the MagicDraw, however some explanation is necessary on how to use it in database modeling.

Predefined Type Libraries

Cameo Data Modeler provides predefined type libraries for database flavors it supports. Besides the standard SQL type library, there are type libraries for Oracle, DB2, MS SQL, MySQL, PostgreSQL, Sybase, Cloudscape (Derby), Pervasive, MS Access and Pointbase. The standard SQL type library is the main type library, and type libraries for each flavor import (a subset of) types from it and define additional types, specific for that flavor.

The necessary type library is imported when you create the Database or Schema element in your model and choose a flavor for it (See Database flavor selection dialog: “Database flavor selection dialog” on page 20).

Type Usage

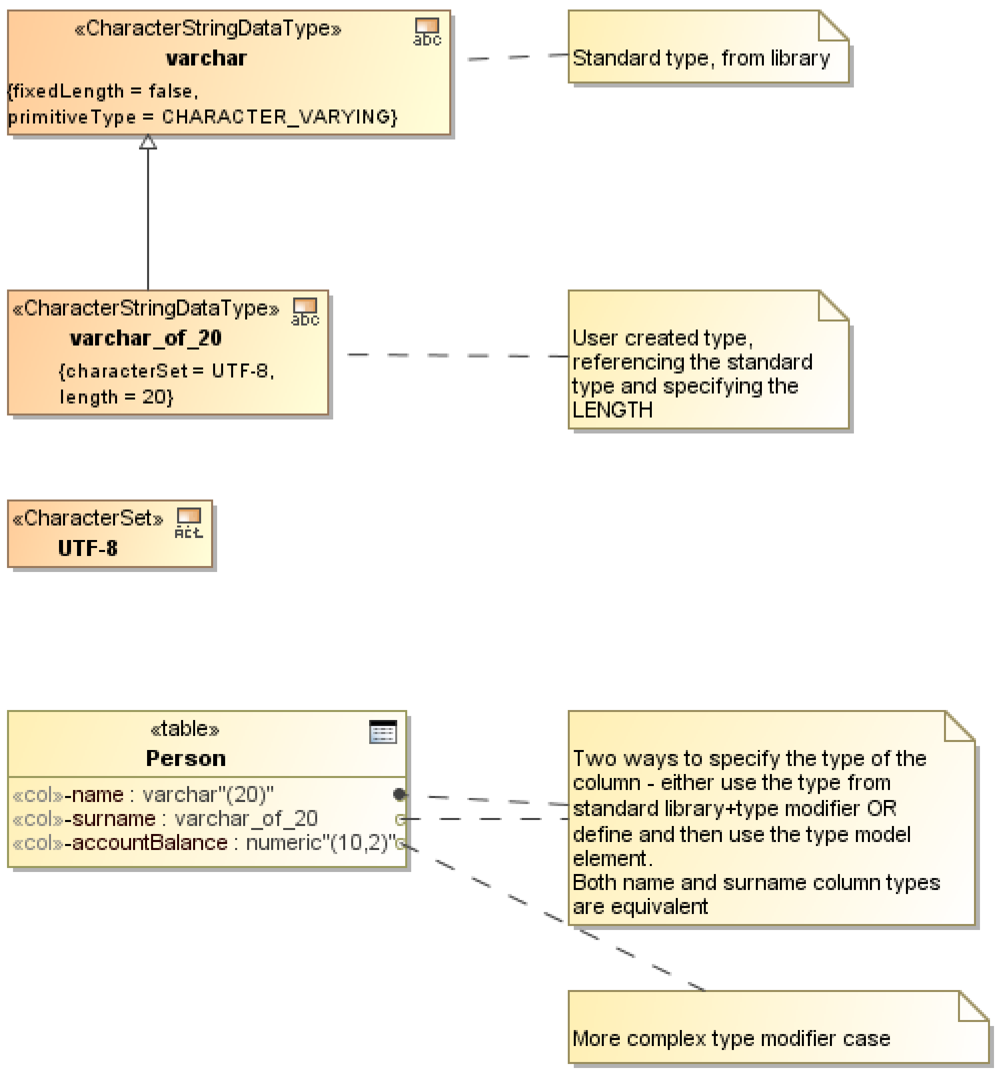

«CharacterStringDataType»
varchar
{fixedLength = false,
primitiveType = CHARACTER_VARYING}
Standard type, from library
«CharacterStringDataType»
varchar_of_20
{characterSet = UTF-8,
length = 20}
User created type, referencing the standard type and specifying the LENGTH
«CharacterSet»
UTF-8
«table»
Person
«col»-name : varchar"(20)"
«col»-surname : varchar_of_20
«col»-accountBalance : numeric"(10,2)"
Two ways to specify the type of the column - either use the type from standard library+type modifier OR define and then use the type model element.
Both name and surname column types are equivalent
More complex type modifier case

Figure 21 -- Type specifying. Library type and modifier vs. separately modeled type

Usage of a simple SQL type, such as **boolean**, is very simple. If you want to set it as a type of a column or operation parameter, you just need to specify it in the **type** field. However there are types (such as **varchar** or **numeric**) in SQL, which require additional data. There are two mechanisms to specify these kinds of types: either use the library type+ type modifier mechanism or create your own type element.

Lets take the standard **varchar** type as an example. It must have the maximum length data provided at each usage. Semantically there are many different types, one for each length limit - **varchar(20)**, **varchar(53)**, **varchar(255)** etc. Now the standard type library can not provide myriad of different **varchar** types. Library only provides the **varchar** type definition.

To specify that column is of **varchar(20)**

1. Set the **type** field of the column to **varchar** type from the library.
2. Set the **type modifier** field of the column to “**(20)**” (no quotes). Note that type modifier is a simple string - whatever is entered in this field, will be used in script generation verbatim, without additional checks. An example of more complex type modifier would be “**(10, 2)**” type modifier for **numeric** data type.

Alternative way to specify that column is of **varchar(20)** is to explicitly create a separate type in the model.

To specify that column is of varchar(20) in the alternative way

1. Create the necessary type (use one of the buttons in the SQL diagram, Primitive Types toolbar) - character string, fixed precision, integer, approximate, boolean, binary, date or XML types. In our case this would be character string type.
2. Set the length data in the dedicated tag (look up the **length** tag in the **Tags** section of the Specification window). Note that this is numeric field - you need to input number 20, and not the “(20)” string as was the case with type modifiers.
3. The name of your type can be whatever you like. For example **varchar_of_20**. The name is not important.
4. Inherit (draw generalization relationship) your type from the appropriate type from the type library. In this case, inherit **varchar_of_20** from **varchar** form the library. This information will be used for determining the proper type name during script generation (so, in the generated script you will see the proper type reference - **varchar(20)**).
5. This created type can now be specified in the **type** field of the column(s).

There would be one type in the model for each **varchar** length that you use in your database.

The second way is more tedious - you need to create quite a few types. So by default the first way is used. But the second way has several advantages, that may outweight it’s deficiencies. First - there is one spot where parameters of the type can be changed. You can easily widen the varchar(20) fields to varchar(40) by editing just one place in the model. Secondly, you can define some additional parameters of the type - such as character set.

User Defined Types

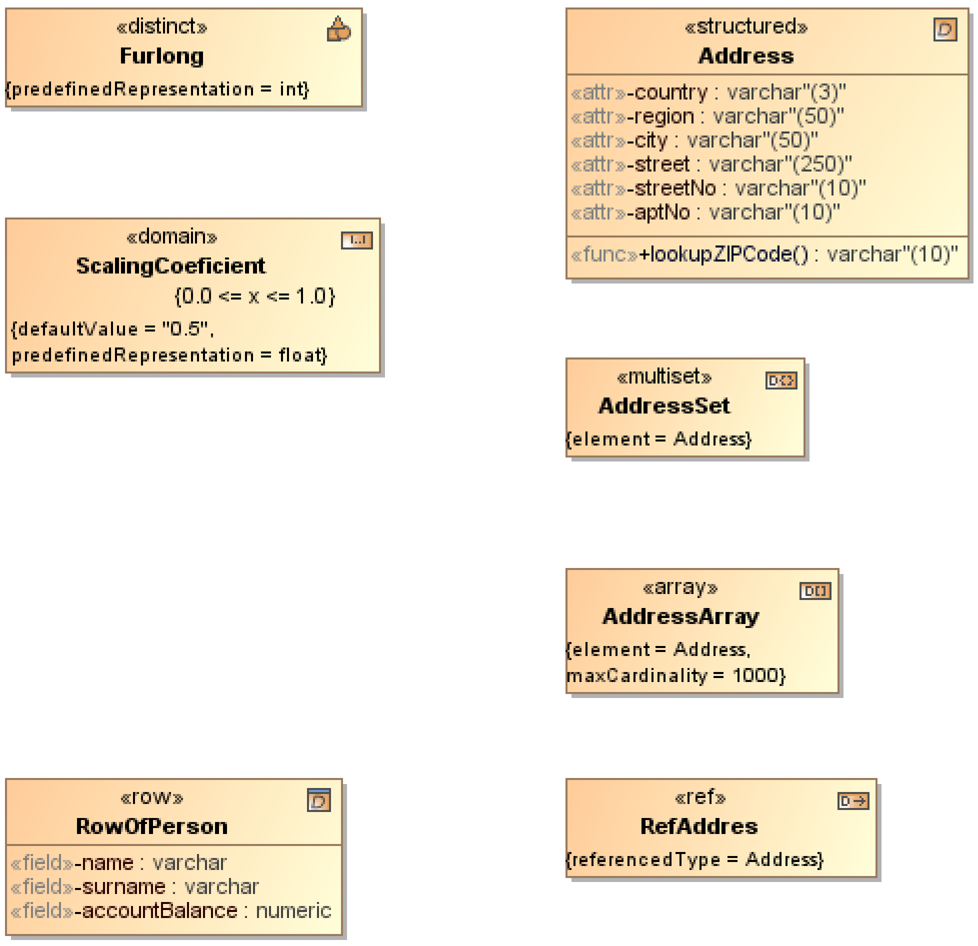

«distinct»
Furlong
{predefinedRepresentation = int}
«structured»
Address
«attr»-country : varchar"(3)"
«attr»-region : varchar"(50)"
«attr»-city : varchar"(50)"
«attr»-street : varchar"(250)"
«attr»-streetNo : varchar"(10)"
«attr»-aptNo : varchar"(10)"
«func»+lookupZIPCode() : varchar"(10)"
«domain»
ScalingCoeficient
{0.0 <= x <= 1.0}
{defaultValue = "0.5", predefinedRepresentation = float}
«multiset»
AddressSet
{element = Address}
«array»
AddressArray
{element = Address, maxCardinality = 1000}
«row»
RowOfPerson
«field»-name : varchar
«field»-surname : varchar
«field»-accountBalance : numeric
«ref»
RefAddres
{referencedType = Address}

Figure 22 -- Examples of user defined types

Besides the primitive / built-in types of the database, user can define additional types for his own schema.

Distinct Type

NOTE	SQL Distinct type is modeled as UML DataType with «DistinctUserDefinedType» stereotype applied. For the sake of compactness, references are displayed with the «distinct» keyword (instead of the long form - «DistinctUserDefinedType») on the diagram.

Distinct type definition allows to redefine some primitive type in order to enforce the non-assignability rules. For example, two distinct types **Meters** and **Yards** can be defined on the base primitive type **float**. With this definition, system would enforce checks that yard fields / columns are not assigned to meter fields / columns without a conversion (explicit cast).

Besides the standard SQL element properties, distinct type has the following properties available in the Specification window.

Property name	Description
Predefined Representation	Points to some base primitive type.

Domain

NOTE	SQL Domain is modeled as UML DataType with «Domain» stereotype applied. For the sake of compactness, domains are displayed with the «domain» keyword on the diagram.

Domain allows to define a more narrow set of values than the base primitive type allows. This narrowing is done by assigning additional constraints on the domain. Columns, whose types are set to the domain, can only assume values from this more narrow subset.

Besides the standard SQL element properties, domain has the following properties available in the Specification window.

Property name	Description
Predefined Representation	Points to some base primitive type.
Default Value	Default value for the column if no value is specified.

Structured User Defined Type

NOTE	SQL Structured User Defined Type is modeled as UML DataType with «StructuredUserDefinedType» stereotype applied. For the sake of compactness, domains are displayed with the «structured» keyword (instead of the long form - «StructuredUserDefinedType»)on the diagram.

Structured UDT defines a composite datatype. Each value of this type is a tuple of several values; each position in a tuple has a name. Structured UDT value is analogous to one row of the table. Structured UDTs allow single inheritance (multiple inheritance is not supported). Inheritance (subtype-supertype relationship) can be modeled using UML Generalization relationships

Besides the standard SQL element properties, structured UDT has the following properties available in the Specification window.

Property name	Description
Instantiable	Defines
Final	Default value for the column if no value is specified.
Super	Shows base data types. This is a derived field, it is not editable. To make changes, use UML Generalization relationships.

Parts of the structured UDT (properties) are called attributes (compare - parts of the table definition are called columns). Attributes of structured UDT are created like columns of the table, that is, via the **Attribute Definitions** tab in the structured UDT Specification window or using an appropriate smart manipulation button on its shape.

Besides the standard SQL element properties, attribute has the following properties available in the Specification window.

Property name	Description
Type	Collectively these two fields describe the type of the attribute. The same considerations as for column type modeling apply.
Type Modifier	
Default Value	Carries the default value of the attribute.
Scope Check	Marks this attribute as scope checked to a particular table and allows choosing particular referential integrity ensuring action (RESTRICT CASCADE, etc).
Scope Checked	

Besides attributes, Structured UDTs have a collection of methods - operations, performing actions on values of this type. Methods are covered in a separate section with stored procedures and functions (see Routines section).

Array Type

NOTE	SQL Array type is modeled as UML DataType with «ArrayDataType» stereotype applied. For the sake of compactness, arrays are displayed with the «array» keyword (instead of the long form - «ArrayDataType») on the diagram.

Array type defines an array (that is, list of values, with the indexed, O(1) access to the n-th element) of the values of elementary type.

Besides the standard SQL element properties, array type has the following properties available in the Specification window.

Property name	Description
Element	The elementary type of the set elements.
Max Cardinality	The size limit of the array.

Multiset Type

NOTE	SQL Multiset type is modeled as UML DataType with «MultisetDataType» stereotype applied. For the sake of compactness, multisets are displayed with the «multiset» keyword (instead of the long form - «MultisetDataType») on the diagram.

Multiset type defines a set of elements of the elementary type.

Besides the standard SQL element properties, multiset has the following properties available in the Specification window.

Property name	Description
Element	The elementary type of the set elements.

Reference Types

NOTE	SQL Reference type is modeled as UML DataType with «Reference-DataType» stereotype applied. For the sake of compactness, refer-ences are displayed with the «ref» keyword (instead of the long form - «ReferenceDataType») on the diagram.

Reference type defines a pointer to the data of the referred type.

Besides the standard SQL element properties, reference type has the following properties available in the Specification window:

Property name	Description
Referenced Type	The type of the data that is being referenced.
Scope Table	Limit the references to the data of the particular table.

Row Type

NOTE	SQL Row Data Type is modeled as UML DataType with «RowDataType» stereotype applied. For the sake of compactness, row data types are displayed with the «row» keyword (instead of the long form - «RowDataType») on the diagram.

Represents one row of the table. The difference from structured UDT is that row type represents a value stored in the table, while structured UDT represents “free-floating” value during computation. For example it is meaningful to take address for the row., but not of the structured UDT value.

Parts of the row data type (properties) are called fields (compare - parts of the table definition are called columns). Fields for row data type are created like columns of the table, that is, via the **Fields** tab in the row data type Specification window or using an appropriate smart manipulation button on its shape.

Besides the standard SQL element properties, field has the following properties available in the Specification window.

Property name	Description
Type	Collectively these two fields describe the type of the field. The same considerations as for column type modeling apply.
Type Modifier	

Property name	Description
Scope Check	Marks this field as scope checked to a particular table and allows choosing particular referential integrity ensuring action (RESTRICT CASCADE, etc).
Scope Checked	

Sequences and Autoincrement Columns

NOTES

- SQL Sequence is modeled as UML Property with «Sequence» stereotype applied. For the sake of compactness, sequences are displayed with the «seq» keyword (instead of the long form - «Sequence») on the diagram.
- Autoincrement parameters (start value, increment, etc.) data is stored as a separate model element - UML OpaqueExpression, with «IdentitySpecifier» stereotype applied. This element is set as **defaultValue** of the Property - either sequence property (when standalone sequences are modeled) or column property (when autoincrement table columns are modeled).

SQL has facilities to generate sequences of numbers (0, 1, 2, 3, ...). These sequences are often used to fill in values for identifier columns - to uniquely number the row data in the table. There are 2 separate facilities:

- Standalone sequence object. This generator is not tied to any other object. Programer must explicitly query it to get the next value from the sequence and then use the retrieved value appropriately (usually in the INSERT statement to insert value for id column). Usually there are separate sequences for each table; sometimes the same sequence is reused for several columns.
- Autoincrement columns. Column of the table can be designated as autoincrement. When row is inserted into the table, if value of such column is not explicitly provided, one is generated automatically.

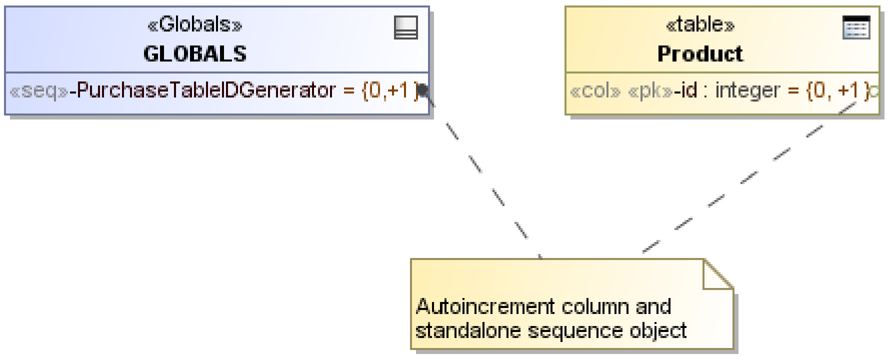

«Globals»
GLOBALS
«seq»-PurchaseTableIDGenerator = {0,+1}
«table»
Product
«col» «pk»-id : integer = {0, +1}
Autoincrement column and standalone sequence object

Figure 23 -- Example of sequence and autoincrement column modeling

Cameo Data Modeler has modeling support for both kinds of sequences.

To create a standalone sequence

Do one of the following:

- Select the GLOBALS element shape on a diagram pane and click an appropriate smart manipulation button.

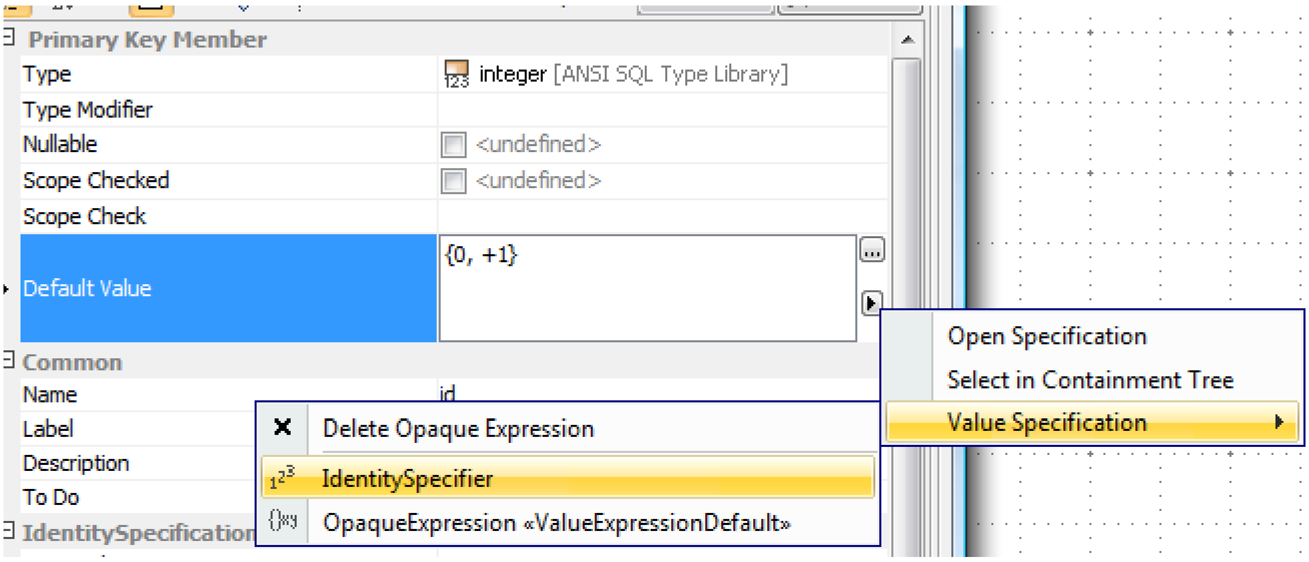
- Right-click the GLOBALS element in the Containment tree and on its shortcut menu, select **New Element** > **Sequence**.

NOTE	Since a standalone sequence is modeled as a UML Property, it can not be placed directly into the Schema package.

Autoincrement columns are also supported. To mark a column as autoincrement, you must switch the **Default Value** property value type from value expression to identity specifier.

To mark a column as autoincrement

1. Open the column Specification window.
2. Select the **Default Value** property.
3. Click the black-arrowed button next to the property value and select **Value Specification** > **IdentitySpecifier** as shown in the following figure.



Primary Key Member

Type	integer [ANSI SQL Type Library]
Type Modifier	
Nullable	<undefined>
Scope Checked	<undefined>
Scope Check	
Default Value	{0, +1}

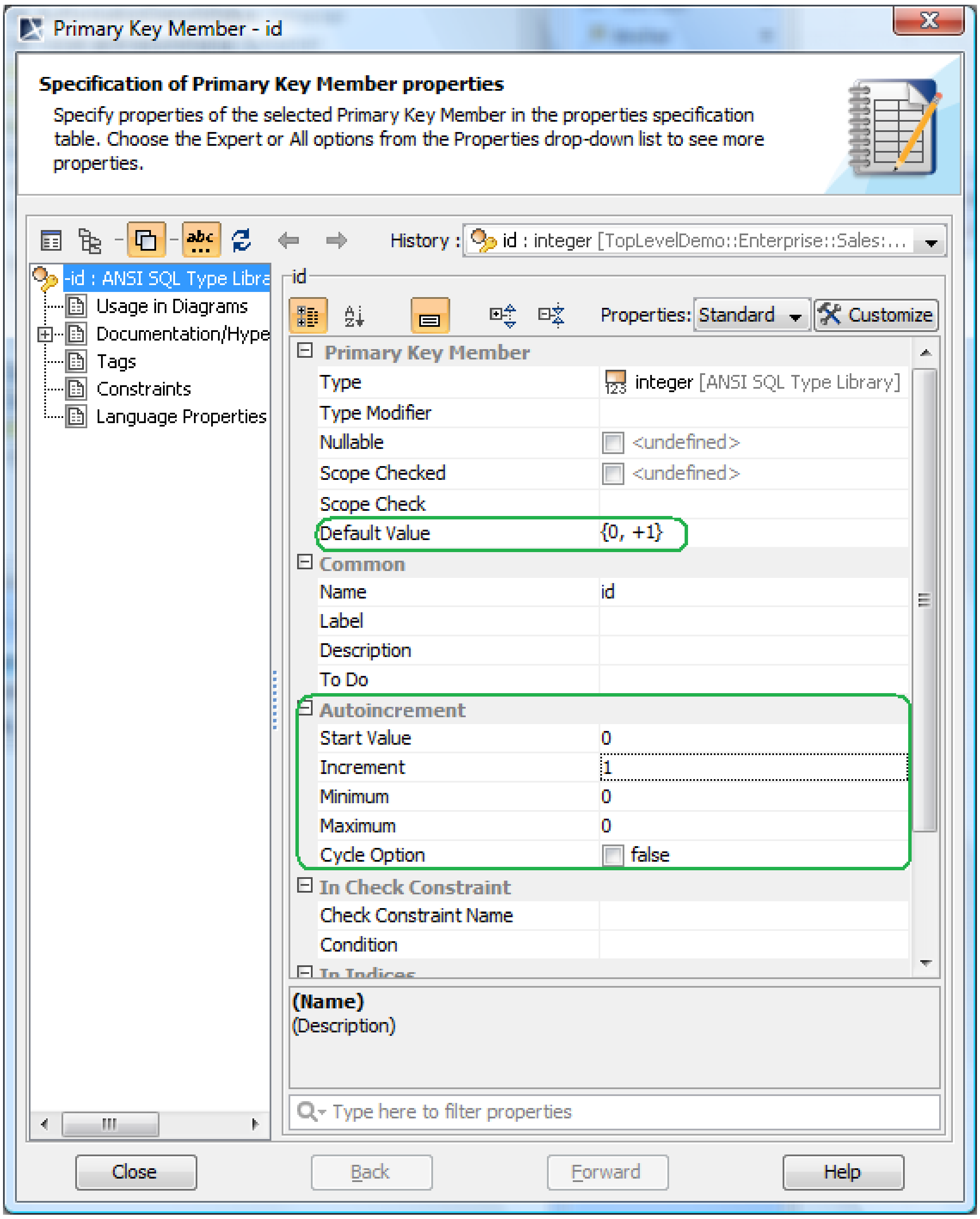
Common

Name	id
Label	
Description	
To Do	

IdentitySpecification

Figure 24 -- Marking column as autoincrement

After the switching, the **Autoincrement** property group appears in the Specification window of the column allowing to specify autoincrement data (start value, increment, etc.).


Primary Key Member - id

Specification of Primary Key Member properties

Specify properties of the selected Primary Key Member in the properties specification table. Choose the Expert or All options from the Properties drop-down list to see more properties.

History : id : integer [TopLevelDemo::Enterprise::Sales:...

Properties: Standard

Primary Key Member	
Type	integer [ANSI SQL Type Library]
Type Modifier	
Nullable	<undefined>
Scope Checked	<undefined>
Scope Check	
Default Value	{0, +1}
Common	
Name	id
Label	
Description	
To Do	
Autoincrement	
Start Value	0
Increment	1
Minimum	0
Maximum	0
Cycle Option	false
In Check Constraint	
Check Constraint Name	
Condition	

Figure 25 -- Additional properties in autoincrement column's Specification window

Besides the standard SQL element properties and sequences, an autoincrement column has the following properties available in the **Autoincrement** property group of the Specification window.

Property name	Description
Start Value	Starting value of the sequence counter.
Increment	Delta value of the sequence counter (can be negative - to count down).
Minimum	Lower bound of the counter (if any).

Property name	Description
Maximum	Upper bound of the counter (if any)
Cycle Option	The counter can “wrap around” when it reaches the maximum (or minimum - for downwards counters)

Additionally sequence has an **Identity** field and column has the **Default Value** field, where textual representation of the counter options can be entered. This feature can be used for nice displaying of the counter configuration in the diagrams (the start, inc, min, max field data is normally not visible in the diagram). Some notation convention should be adopted how to map the counter data into the text representation. For example it could be: {<start>, <inc>, <min>-<max>, <c>}. Then the counter from 0 with +1 increment, min max of 0 and 1000 and cycle option would be displayed as “{0, +1, 0-1000, C}” string. At the moment this text representation is not automatically connected to the counter field values, so synchronization has to be done by hand.

Constraints

Tables have a multitude of constraints between them. These constraints enforce the proper business semantics for the data in the database tables (relationships between data in different tables, semantical constraints of the data in the table). There are these available constraint types:

- Primary key constraints - specifying column (or a combination of columns), which uniquely identify the row in the table.
- Unique constraints. They are very similar to primary key constraints - uniquely identify the row in the table. One of the unique constraints of the table is designated as primary.
- Foreign key constraints, which establish relationships between two tables.
- Nullability constraints (NOT NULL constraint) - a simple constraint on the column, indicating that column must have value
- Check constraints establish additional checking conditions on values in the column / table.
- Assertions provide more global check than a check constraint - spanning multiple tables
- indexes are not constraints per se, but they are covered in this section because they are modeled similarly.

The primary keys, unique and check constraints, indexes can be modeled in two ways. One way is easy and simple but does not cover all the options provided by SQL. Another way is tedious, but provides full SQL coverage.

Implicit Primary Key, Unique, Check Constraint, and Index Modeling

NOTES	• SQL Primary Key (when implicitly modeled) is modeled as an additional «PrimaryKeyMember» stereotype applied on the SQL column. This variant is shown in the diagram as an additional «pk» keyword on the column in the diagram. • SQL Unique Constraint (when implicitly modeled) is modeled as an additional «UniqueMember» stereotype applied on the SQL column. This variant is shown in the diagram as an additional «unique» keyword on the column in the diagram. • SQL Check Constraint (when implicitly modeled) is modeled as an additional «CheckMember» stereotype applied on the SQL column. This variant is shown in the diagram as an additional «chk» keyword on the column in the diagram. • SQL Index (when implicitly modeled) is modeled as an additional «IndexMember» stereotype applied on the SQL column. This variant is shown in the diagram as an additional «idx» keyword on the column in the diagram.

An easy way of modeling this kind of constraint is applying the «PrimaryKeyMember», «UniqueMember», «CheckMember», or «IndexMember» stereotype on the necessary column. PK, unique, and index markers can be applied on the column via its shortcut menu as shown in the following figure.

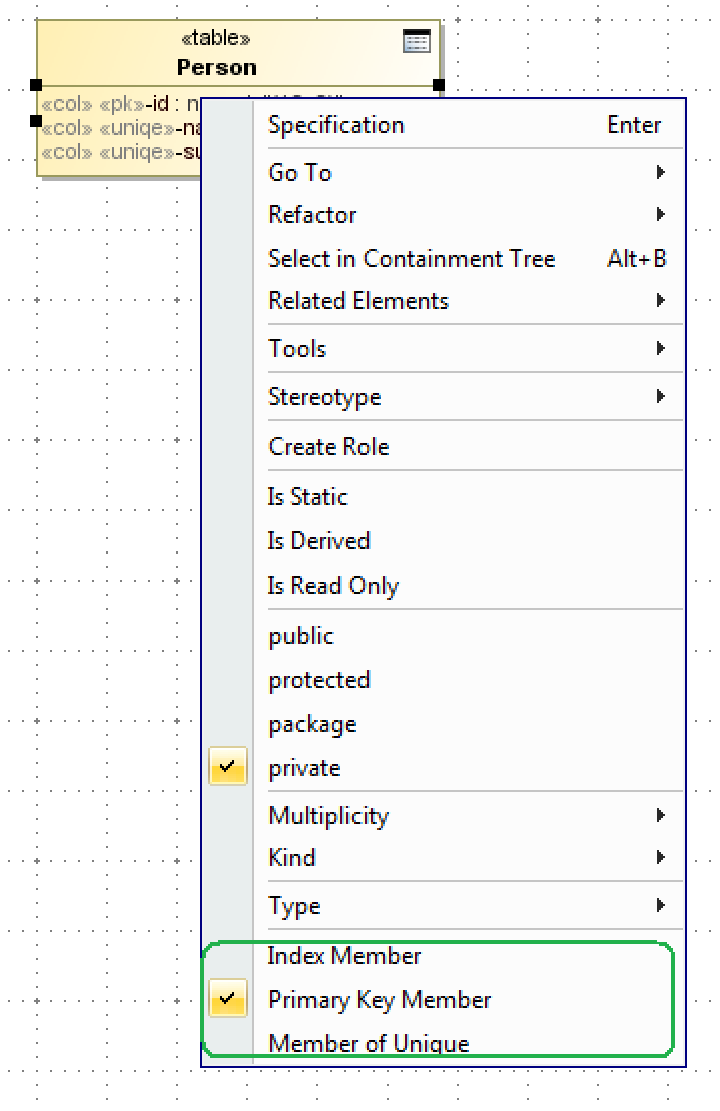


Figure 26 -- Quick application of PK, Unique, and Index markers

To apply a check constraint marker on a column

1. Open the Specification window of the column.
2. Define the **Condition** property value in the **In Check Constraint** property group.

Thusly marked column is considered as a member of one-column constraint, specified in-line. It is by default an unnamed constraint. To specify its name, you need to define the **Primary Key Name**, the **Unique Key Names**, the **Check Name**, or the **Index Names** property value in the column Specification window.

In the SQL script (in CREATE TABLE, ADD COLUMN statements) this would correspond to the following part of the column specification:

```
<column name> [ <data type> ] ...
[ [<constraint name>] <constraint>... ]
<constraint> ::=
| UNIQUE| PRIMARY KEY
| CHECK '('<condition>')'
```

If primary key, unique constraint or index must span several columns (in this case constraint is not in-line, near the column definition, but as a separate definition at the bottom of the table definition), all the columns must be marked with the appropriate «UniqueMember» / «IndexMember» stereotype and all must have the same name. Column can participate in several unique or

Various cases of quick constraint modeling are depicted in the following figure.

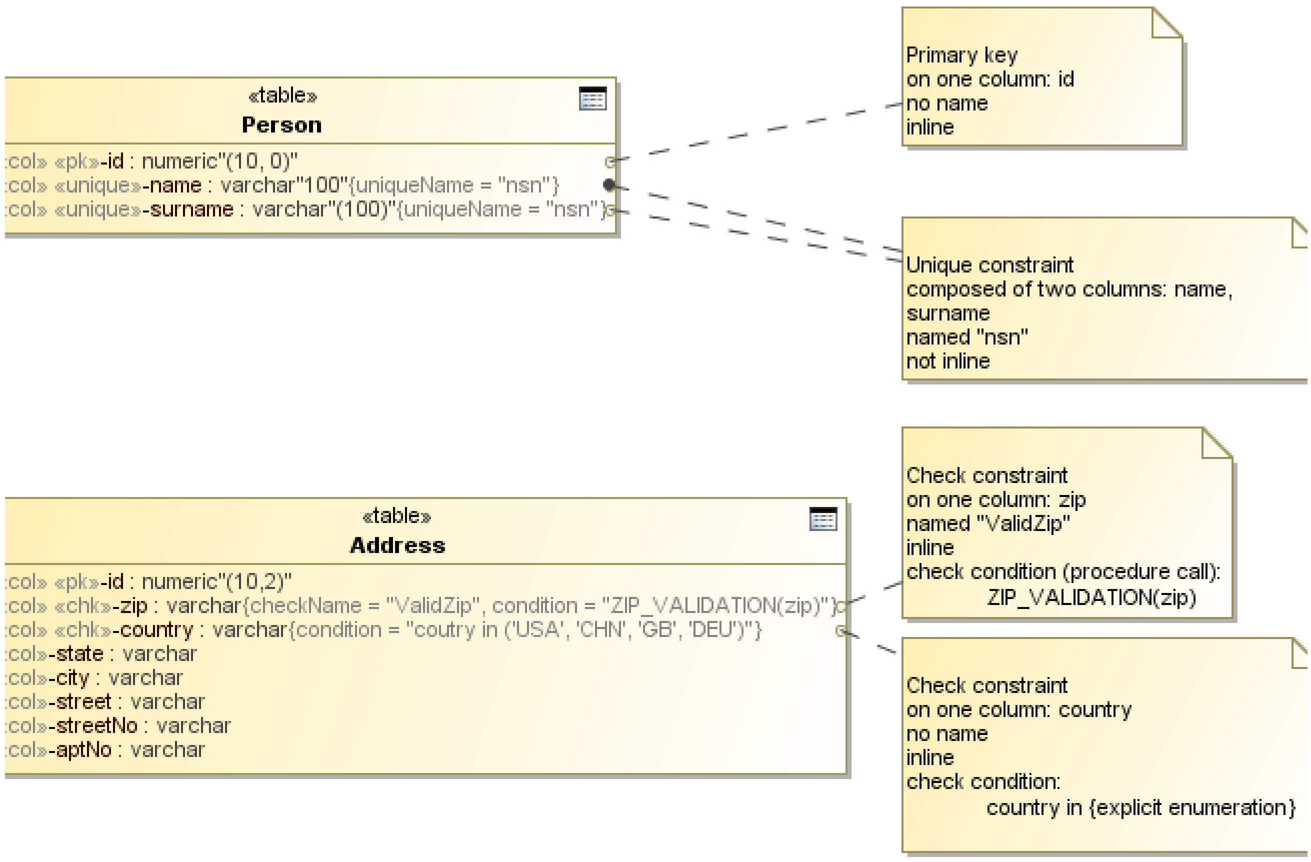

«table»
Person
«col» «pk»-id : numeric"(10, 0)"
«col» «unique»-name : varchar"100"{uniqueName = "nsn"}
«col» «unique»-surname : varchar"(100)"{uniqueName = "nsn"}
Primary key
on one column: id
no name
inline
Unique constraint
composed of two columns: name, surname
named "nsn"
not inline
«table»
Address
«col» «pk»-id : numeric"(10,2)"
«col» «chk»-zip : varchar{checkName = "ValidZip", condition = "ZIP_VALIDATION(zip)"}
«col» «chk»-country : varchar{condition = "coutry in ('USA', 'CHN', 'GB', 'DEU')"}
«col»-state : varchar
«col»-city : varchar
«col»-street : varchar
«col»-streetNo : varchar
«col»-aptNo : varchar
Check constraint
on one column: zip
named "ValidZip"
inline
check condition (procedure call):
ZIP_VALIDATION(zip)
Check constraint
on one column: country
no name
inline
check condition:
country in {explicit enumeration}

Figure 27 -- Various situations, modeled with quick constraint notation

Explicit Primary Key, Unique, Check Constraint, and Index Modeling

NOTES	
	● SQL Unique Constraint (when explicitly modeled) is modeled as UML Constraint with «UniqueConstraint» stereotype applied. ● SQL Check Constraint (when explicitly modeled) is modeled as UML Constraint with «CheckConstraint» stereotype applied. ● SQL Index (when explicitly modeled) is modeled as UML Constraint with «Index» stereotype applied.

The quick, implicit way to model constraints does not cover some cases, allowed by SQL. Constraints in SQL can be marked as DEFERABLE, INITIALY DEFERRED; constraint in the database can be in active state (enforced) or disabled. Indexes have various configuration parameters.

Modeling with the help of «XYZMember» stereotypes does not allow to specify this additional information. In this case modeling with explicit constraint model elements is necessary. This can be done from the Specification window of table. There are separate tabs for creating these constraint elements: **Unique Constrains** (allows creating both primary keys and unique constraints), **Check Constraints**, **Indices**. Once created, additional properties of the constraints can be specified.

Besides the standard SQL element properties, primary key and unique constraint have following properties available in the Specification window.

Property name	Description
Members	Columns, constrained by this constraint (must come from the same table where constraint is located)
Inline	Whether constraint is defined near the column definition, or separately, at the bottom of the bale definition. Only one-column constraints can be inline.
Deferable	Marks the constraint as deferrable.
Initially Deferred	Marks the constraint as initially deferred.
Enforced	Whether constraint is actively checked in the database (can be changed with the SQL statements).

Check constraints have the same properties as primary key and unique constraints, and additionally have following properties available in the Specification window.

Property name	Description
Condition	Condition to be checked

Besides the standard SQL element properties, index has the following properties available in the Specification window.

Property name	Description
Members	Member columns of this index
Member Increment Type	For each member column, ASC or DESC ordering direction
Unique	Index is used to enforce uniqueness
System Generated	Index is system-generated.

Property name	Description
Clustered	The index is clustered. Only one index per table can be clustered. Non-clustered indexes are stored separately and do not affect layout of the data in the table. Clustered index governs the table data layout (table data pages are leafs of the index tree).
Fill Factor	Hash table fill factor of the index
Included Members	Additional member columns of the index. No sorting is done by these columns, however their data is included into index - this provides fast retrieval. This feature is very database-specific (AFAIK only MS SQL Server has those).
Included Member Increment Type	

Foreign Keys

NOTES

- SQL Foreign Key (when modeled with UML Association relationship) is modeled as UML Association with the «FK» stereotype applied.on the end of the association (UML Property), which points to the referenced table
- SQL Foreign Key (when modeled with UML Constraint) is modeled as UML Constraint with «ForeignKey» stereotype applied.

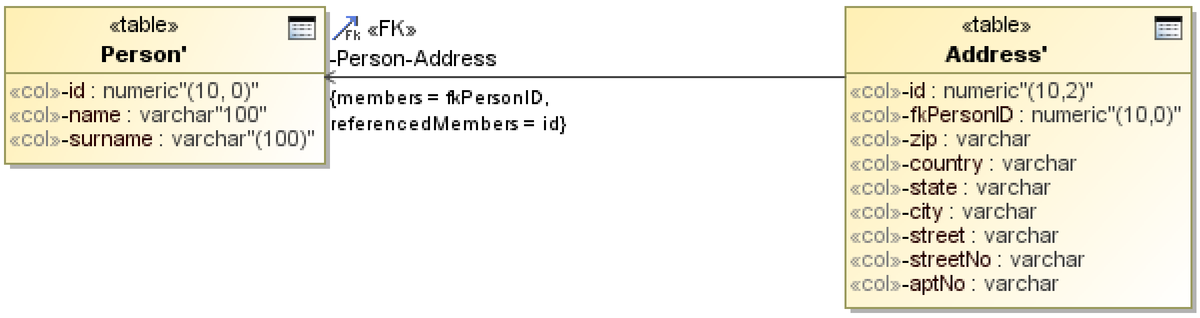


Figure 28 -- Foreign key example

Foreign keys describe relationships between two tables. At the detailed understanding level, foreign key is a constraint on the (group of) columns in the source / referencing table, such that for each row in the source table their value combination (tuple) is equal to the value combination (tuple) of the (group of) columns for some row in the target / referenced table.

Foreign keys also have the two ways to be modeled. The main way is described below.

The main way to model foreign keys is to draw association relationship from the referencing table to the referenced table. The relationship can be simply draw in the diagram from the smart manipulator or from the button in the diagram toolbar.

When the FK association is draw, the following dialog pops up:

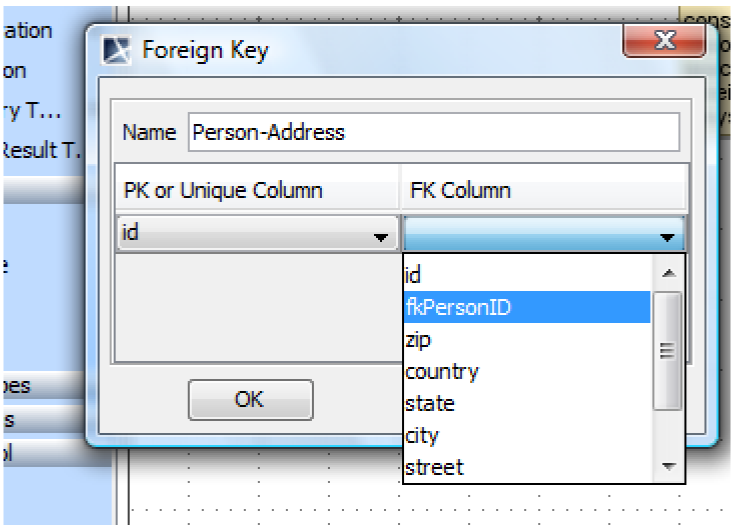


Figure 29 -- Foreign Key dialog

Note that you have to have the necessary columns in the tables (PK or unique columns in target table, referencing FK columns in the source table) before drawing the FK relationship. In this dialog, select the referenced columns (of the target table) in the first column of the table, and corresponding referencing columns (of the source table). Additionally, foreign key name can be specified.

When dialog is OK'd, foreign key association is created; «FK» stereotype is applied on the referencing association end and the selected column information is stored in tags.

If foreign key information has to be changes, this is done in the Specification window of the FK property. Besides the standard SQL element properties foreign key has the following properties available in the Specification window.

Property name	Description
Inline	The same functionality as for the explicitly modeled PK, unique constraints
Deferable	
Initially Deferred	
Enabled	
Match	Specifies how the columns in the referenced table and columns in the referencing table are matched (SIMPLE, FULL, PARTIAL match).
On Delete	Referential integrity enforcement action that is performed when the data in the referenced table is deleted (NO ACTION, RESTRICT, CASCADE, SET NULL, SET DEFAULT)
On Update	Referential integrity enforcement action that is performed when the data in the referenced table is updated (NO ACTION, RESTRICT, CASCADE, SET NULL, SET DEFAULT)
Referencing Members	Member columns of the constraint (from the same table where constraint is located). FK constrains values of these columns to point to the data in the referenced tables

Property name	Description
Referenced Members	The set of the columns in the referenced (target) table, to which referencing columns are matched. There are 6 ways to specify this set - choose one. Referenced Members field explicitly lists the target columns. Referenced Unique Constraint / Index points to the constraint or index in the target table, and referenced member columns are members of this constraint / index. (by Name) option is used when constraint / index is no explicitly modeled with model element but is just a marking on the column Referenced Table always points to the target table of the FK (field is not editable, to change it, reconnect the association). If the referenced members column list is not specified in any other way, then referenced columns are taken from the PK of the referenced table
Referenced Table	
Referenced Unique Constraint	
Referenced (by Name) Unique Constraint	
Referenced Unique Index	
Referenced (by Name) Unique Index	

The alternative way of modeling a foreign key is creating a UML constraint with the «ForeignKey» stereotype applied. This way is less desired than the main way, because it does not visualize relationship between tables. It is just a constraint in the table. This method may be used when human-readability is not critical, e.g., when database layout is generated with some custom automated script / transformation in the model.

To create a constraint with the «ForeignKey» stereotype

1. Select a table in the Containment tree.
2. Do one of the following:
    - Right-click the selected element and from its shortcut menu select **New Element** > **Explicit Foreign Key**.
    - Open the **Explicit Foreign Keys** tab in the table's Specification window.

Besides the standard SQL element properties and properties that are available for other explicit constraints (that is, PK, unique, check constraints), explicit foreign key has the following properties available in the Specification window.

Property name	Description
Match	Specifies how the columns in the referenced table and columns in the referencing table are matched (SIMPLE, FULL, PARTIAL match).
On Delete	Referential integrity enforcement action that is performed when the data in the referenced table is deleted (NO ACTION, RESTRICT, CASCADE, SET NULL, SET DEFAULT)
On Update	Referential integrity enforcement action that is performed when the data in the referenced table is updated (NO ACTION, RESTRICT, CASCADE, SET NULL, SET DEFAULT)
Referencing Members	Member columns of the constraint (from the same table where constraint is located). FK constrains values of these columns to point to the data in the referenced tables

Property name	Description
Referenced Members	The set of the columns in the referenced (target) table, to which referencing columns are matched. There are 6 ways to specify this set - choose one. Referenced Members field explicitly lists the target columns. Referenced Table field just specifies the target table, referenced columns are then taken from the PK of the table Referenced Unique Constraint / Index points to the constraint or index in the target table, and referenced member columns are members of this constraint / index. (by Name) option is used when constraint / index is no explicitly modeled with model element but is just a marking on the column
Referenced Table	
Referenced Unique Constraint	
Referenced (by Name) Unique Constraint	
Referenced Unique Index	
Referenced (by Name) Unique Index	

Nullability Constraint

NOTE	SQL NOT NULL constraint (if modeled explicitly, which is rare!) is modeled as UML Constraint with «NotNullConstraint» stereotype applied.

Nullability, or NOT NULL constraint forces the condition that the column must have value. Implicit NOT NULL constraint is modeled with the **nullable** field of the column (set nullable=false to specify NOT NULL). This is an usual and quick way to model these constraints.

Usually there is no need to model these constraints explicitly - create a separate model element for them. But in the more complex cases these constraints can be created by hand and the «NotNullConstraint» stereotype applied on them. This allows specifying non-inline constraints, or named constraints, or deferred constraints or inactive constrains.

NOT NULL constraint does not have any additional properties in the Specification window besides the properties that all table constraints have.

Assertion

NOTE	SQL Assertion is modeled as UML Constraint with «Assertion» stereotype applied.

Assertion constraints are very similar to check constraints, but instead of being local to the table, they are global to the database. Assertions check some condition that must hold through several tables. Assertions are modeler as explicit constraints; there is no shorthand modeling form - assertion is always an explicit UML constraint.

To create an assertion

1. Select a schema or a database element in the Containment tree.
2. Right-click the selected element and from its shortcut menu select **New Element** > **Assertion**.

Besides the standard SQL element properties assertion has the following properties available in the Specification window.

Property name	Description
Search Condition	The assertion body condition
Constrained Tables	List of the tables on which assertion runs

Triggers

NOTE	SQL Trigger is modeled as UMLOpaqueBehavior with the «Trigger» stereotype applied.

Trigger describes some action that must be performed when some particular data manipulation action is being performed in the database table. Trigger can be fired when data is added, deleted or changed in the table and perform some action (update some other table, calculate additional values, validate data being updated or even change the data that is being updated).

Trigger is always defined for some table. You can define triggers in the **Triggers** tab of the table Specification window. Trigger has an event type (on what actions trigger is fired, that is, on insert, on update, or on delete), action time (before, after, instead of), and an actual body describing the actions.

Besides the standard SQL element properties, trigger has the following properties available in the Specification window.

Property name	Description
Action Time	Specifies moment of time when trigger action is performed (before the specified event, after event, insteadof event).
On Insert	The event that causes trigger firing.
On Update	
On Delete	
Trigger Column	List of columns, which cause trigger fire on update (must be from the same table as trigger is located). Used with On Update triggers to specify that only some column updates cause trigger fire.
Language	Trigger implementation language (should be SQL).
Body	Trigger body text (operations that are performed on trigger fire)
Time Stamp	Trigger creation timestamp
Action Granularity	Specifies whether trigger fires once per executed statement, or once per each affected row
When	Specifies additional precondition for trigger firing
New Row	These fields can be used for defining variable names for holding new row / table values and old row / table values - for referencing in trigger body. REFERENCING ((NEW|OLD) (TABLE|ROW) AS <name>)+
New Table	
Old Row	
Old Table	
Additional Actions	Additional action statements. This option is rarely used - it is non-standard and supported only by some databases. Usually triggers have just one body.

Routines

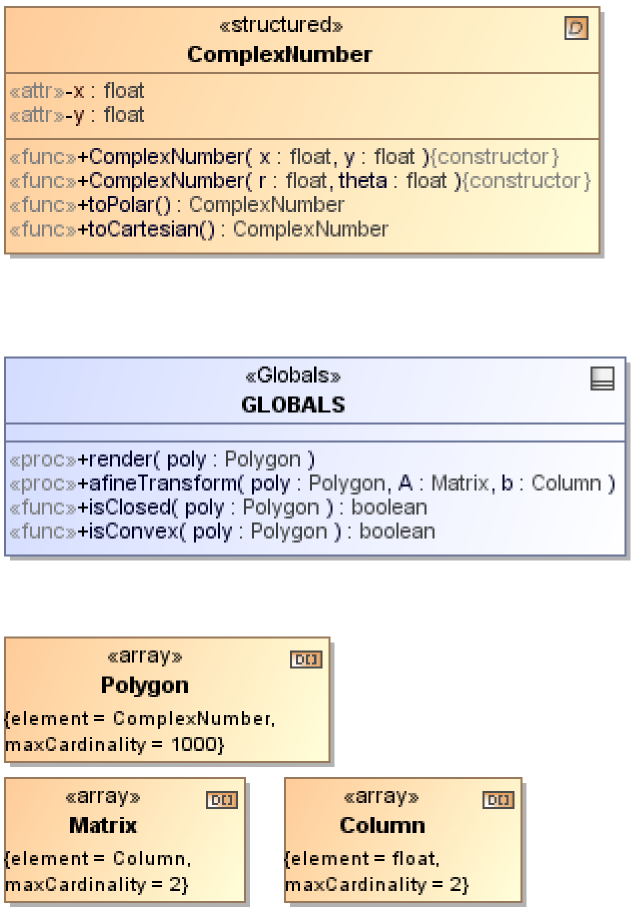

«structured»
ComplexNumber
«attr»-x : float
«attr»-y : float
«func»+ComplexNumber(x : float, y : float){constructor}
«func»+ComplexNumber(r : float, theta : float){constructor}
«func»+toPolar() : ComplexNumber
«func»+toCartesian() : ComplexNumber
«Globals»
GLOBALS
«proc»+render(poly : Polygon)
«proc»+afineTransform(poly : Polygon, A : Matrix, b : Column)
«func»+isClosed(poly : Polygon) : boolean
«func»+isConvex(poly : Polygon) : boolean
«array»
Polygon
{element = ComplexNumber,
maxCardinality = 1000}
«array»
Matrix
{element = Column,
maxCardinality = 2}
«array»
Column
{element = float,
maxCardinality = 2}

Figure 30 -- Routines example

SQL supports several different kinds of routines. There are global routines, that are not bound to a particular type but belongs to the schema. There are two kinds of these routines - Procedures and Functions. And there are routines, that are bound to a particular structured user defined type - Methods. Each routine kind can have several parameters. Parameters have type and direction (**in**, **out**, **inout**). Functions and methods in SQL have return types - this is formalized in UML models by having an additional parameter with **return** direction kind.

There is an UML limitation, that UML does not allow to place UML operations (which are used to model SQL procedures and functions) directly in the UML packages (which are used to model SQL schemas). For this reason global routines are placed into a special container class - GLOBALS (see “GLOBALS” on page 22).

Routines can be external (written in some other languages and attached to database engine) or SQL routines. In the latter case, body of the routine can be specified in the model. Due to UML specifics, there are two ways to specify the routine body - by filling the UML **method** field or by filling the UML **bodyCondition** field of the operation. These two ways are visible in the Specification window under the field names **Source (as method)** and **Source (as body condition)**. When specifying routine body, specify only one of these fields.

To use “as method” way

1. Right-click the GLOBALS element in the Containment tree and from its shortcut menu select **New Element** > **Source**. A source element (a UML OpaqueBehavior with the «Source» stereotype applied) under the GLOBALS element will be created in your schema.
2. In the Specification window of routine, edit the **Source (as method)** property value and in the opened dialog select the source element you’ve just created.

To use “as body condition” way, you simply have to fill the field. The routine body model element (in this caseUML Constraint - holding UML OpaqueExpression) shall be created under your routine model element.

Besides the standard SQL element properties, all 3 kinds of routines have the following properties available in the Specification window.

Property name	Description
Specific Name	Additional name for the routine, uniquely identifying it throughout the system.
Deterministic	Specifies whether routine is deterministic (always gives the same output with the same data input)
Parameter Style	SQL or GENERAL
SQL Data Access	Specifies how routine accesses SQL data (NO SQL | CONTAINS SQL | READS SQL DATA | MODIFIES SQL DATA)
Source(as method)	Fields holding routine body text (chose only one).
Source (as body condition	
Creation TS	Routine creation and last edit timestamps
Last Altered TS	
Authorization ID	Authorization identifier which owns this routine (owner of the schema at routine creation time)
Security	Determines the authorization identifier under which this routine runs. Tipically set to “INVOKER”, “DEFINER”, “IMPLEMENTATION DEPENDENT”
External Name	The name of the external language routine implementation method (if routine is non-SQL routine)

Procedure

NOTE SQL Procedure is modeled as UML Operation with «Procedure» stereotype applied. For the sake of compactness, procedures are displayed with the «proc» keyword (instead of the long form - «Procedure») on the diagram.

Procedure is an operation that can be SQL-invoked and performs some actions depending on the parameters supplied. Procedures are global for schema - they are created under the GLOBALS model element.

Besides the standard properties of SQL routines (see “Routines” on page 45), procedure has the following properties available in the Specification window.

Property name	Description
Max Result Sets	If result set count returned by procedure is dynamic, this value limits count thereof (DYMANIC RESULT SETS <max> clause)
Old Save Point	Savepoint level indicator for procedure (false means that new savepoint must be established before the procedure is run)

Function

NOTE	SQL Function is modeled as UML Operation with «Function» or «BuiltInFunction» or «UserDefinedFunction» stereotype applied. By default the «UserDefinedFunction» is used, however if another kind can be freely used if it is necessary for modeling needs (e.g. if we are modeling some built in library and want to specify that functions are built-in and not user defined). For the sake of compactness, functions are displayed with the «func» keyword (instead of the long form) on the diagram.

Function describes some operation that calculates and returns some value depending on the parameters supplied. Functions are global for schema - they are created under the GLOBALS model element.

Besides the standard properties of SQL routines (see section above), function has the following properties available in the Specification window.

Property name	Description
Null Call	Specifies that function returns NULL when called with NULL parameter value (RETURNS NULL ON NULL INPUT clause)
Type Preserving	Specifies that function does not change the type of the supplied parameter (returns the same object)
Transform Group	Allows to specify TRANSFORM GROUP <groups> clause - single or multiple.

Method

NOTE	SQL Method is modeled as UML Operation with «Method» stereotype applied. For the sake of compactness, methods are displayed with the «func» keyword (instead of the long form - «Method») on the diagram.

Method is a function of the structured user defined type. It is created inside the structured UDT.

Besides the properties of SQL functions (see section above), method has the following properties available in the Specification window.

Property name	Description
Constructor	Specifies that function is a constructor (that is, it is used to construct values of the enclosing structured UDT).
Overriding	Specifies that function is overriding the same-named function from the parent structured UDT

Parameter

NOTE	SQL Parameter is modeled as UML Parameter with «Parameter» stereotype applied.

This model element specifies data inputs / outputs into routine calculations. Parameter has a type, direction (in / out / inout for usual parameters and a single parameter with direction return for functions) and default value.

Besides the standard SQL element properties, parameter has the following properties available in the Specification window.

Property name	Description
Type	Type of the parameter
Type Modifier	
Default Value	Default value (used when value is not supplied during routine invocation).
Direction	Direction of data flow through the parameter (into the routine, out of the routine or both)
Locator	AS LOCATOR modifier of the type. Specifies that instead of value, means to locate value are transferred
String Type Option	Only valid when parameter type is XML type. Specifies underlying string datatype.
Cast Type	Additional options, specifying that return parameter is cast from another type (possibly with locator indication).
Cast Locator	

Cursor and Routine Result Table

NOTE	SQL Cursor is modeled as UML Parameter with the «Cursor» stereotype applied.

When routine does not return a scalar value but a collection of the table values, cursor is used, instead of the parameter. Cursor has a type. This type must be some table type instead of the scalar types used for parameters. It can be an actual table / view from the model, if cursor returns values from that table, or (if cursor returns data from some SELECT statement) can be a synthetic table. A Routine Result Table model element is used for this purpose (UML Class with «RoutineResultTable» stereotype applied). It’s modeling is exactly the same as the normal tables - this is just an ephemeral table.

Besides the standard SQL element properties, cursor has the following properties available in the Specification window:

Property name	Description
Type	Type of the cursor. Should point to the routine result table.
Type Modifier	
Direction	Direction of data flow through the parameter (into the routine, out of the routine, routine result)

Access Control

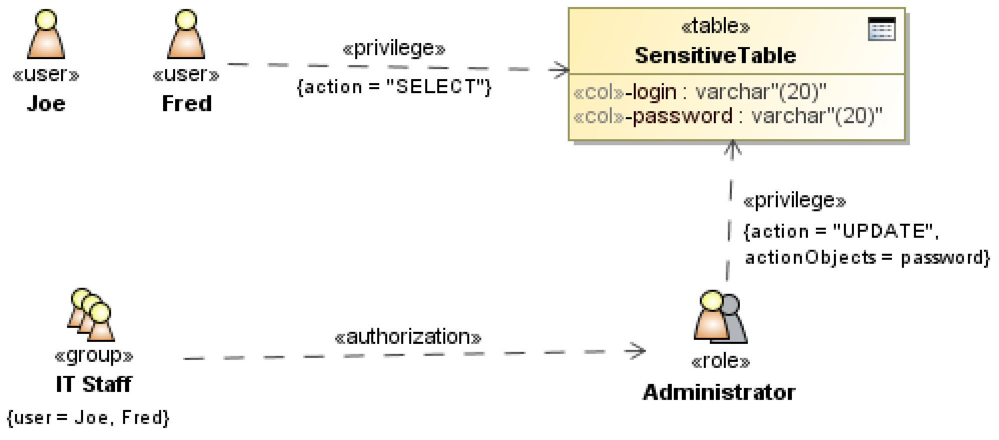


Figure 31 -- Access control example

SQL has means to specify and control the rules of access to various data objects. This subset of SQL language is sometimes called Data Control Language. The relevant concepts are: User, Group, Role (3 different kinds of authorization subjects), Permission and Role Authorization (2 kinds of access control rules). Possible object types for access control varies depending on database flavor, but usually Tables, User-defined Types, Domains, Routines, Sequences can be specified as the target objects of access control.

User

NOTE	SQL User is modeled as UML Actor with the «User» stereotype applied.

User object represents the single user person in the system, User is subject to access control rules.

Besides the standard SQL element properties, user has the following properties available in the Specification window.

Property name	Description
Owned Schema	Schemas that are owned by this user,

Group

NOTE	SQL Group is modeled as UML Actor with the «Group» stereotype applied.

Group object represents a collection of Users. Group is subject to access control rules, and allows specifying access control rules on several users simultaneously.

Besides the standard SQL element properties, group has the following properties available in the Specification window.

Property name	Description
User	Collection of users the group is made of.
Owned Schema	Schemas that are owned by this group,

Role

NOTE	SQL Role is modeled as UML Actor with the «Role» stereotype applied.

Role object represents a specific role (typical activities) that can be played by users. Role is subject to access control rules, and allows specifying access control rules for all subjects, playing this role.

Besides the standard SQL element properties, role has the following properties available in the Specification window.

Property name	Description
Owned Schema	Schemas that are owned by this role,

Privilege

NOTE	SQL Privilege is modeled as UML Dependency with the «Privilege» stereotype applied.

Privilege relationship expresses the fact that the permission to perform specified action on specified object (relationship target) is granted to specified grantee (relationship source). Grantee can be any authorization subject - Use, Group or another Role. Object can by another SQL object (the precise list of object types, that can be targeted by privileges, varies by database type).

Privilege corresponds to SQL grant privilege statement:

```
GRANT <action>[(<column list>)] ON <object> TO <grantee> [WITH HIERARCHY
OPTION][WITH GRANT OPTION]
```

Besides the standard SQL element properties, privilege has the following properties available in the Specification window.

Property name	Description
Action	Specifies action that is being granted (such as SELECT or UPDATE).
Action Objects	Specifies additional more narrow subobject list, on which the specified action is permitted (usually column list for SELECT or UPDATE).
Grantable	Specifies that this privilege can be further re-granted to other subjects by the recipients. Corresponds to WITH GRANT OPTION part of GRANT statement.
With Hierarchy	Specifies that this privilege applies to subobjects (subtables). Corresponds to WITH HIERARCHY OPTION part of the GRANT statement.
Grantor	Subject, who grants this privilege to the grantees.

Role Authorization

NOTE	SQL Role Authorization is modeled as UML Dependency with «RoleAuthorization» stereotype applied.

Role authorization relationship expresses the fact that the specified role (relationship target) is granted to specified grantee (relationship source). Grantee can be any authorization subject - Use, Group or another Role.

Role authorization corresponds to SQL grant role statement:

```
GRANT <role> TO <grantee> [WITH ADMIN OPTION]
```

Besides the standard SQL element properties, role authorization has the following properties available in the Specification window.

Property name	Description
Grantable	Specifies that this role can be further re-granted to other subjects by the recipients. Corresponds to WITH ADMIN OPTION part of GRANT statement.
Grantor	Subject, who grants this role to the grantees.

Oracle Database Modeling Extensions

When the Oracle flavor is chosen for database top level element (schema or database), additional Oracle extensions are brought in. Elements that are in the scope of this schema or database element obtain additional Oracle-specific properties in the Specification windows (under the separate **Oracle** property group). These properties carry an additional information, that is then used when generating DDL scripts for Oracle.

Most often there is just one **Additional Properties** property - allowing entering free-form text that is then used when generating (this can be used to specify any extension texts - such as tablespace options for tables).

Oracle extensions provide means to model synonyms. Synonym is mapped as follows:

- Element of the same type (that is, table, materialized view, stored procedure, sequence) as the one being aliased is created. It is stereotyped as appropriate, but have no other data - just it's name is important.
- Additionally, stereotype «OraSynonym» will be applied on the element. It has ref:Element[1] tag for pointing to the element being aliased. Synonyms of synonyms are handled in the same way.

Oracle extensions provide means to model materialized views. Materialized view can be created from Oracle SQL diagram. It is an ordinary SQL view, but with the additional «OraMaterializedView» stereotype applied (in diagrams, a shortened keyword «materialized» is used for the sake of compactness).

Database Code Engineering

Cameo Data Modeler provides code engineering capabilities database script generation and reverse engineering. Database model can be generated in to the DDL script, which can then be run on the database engine to create database structures. And conversely database engine can export database structures into the DDL script, which can then be reverse-engineered into the database model. In addition to that Cameo Data Modeler provides reverse engineering directly from live database through **JDBC** connection.

Cameo Data Modeler code engineering supports the following database dialects for script generation and reversing:

- Standard SQL
- Oracle
- MS SQL Server
- DB2
- MySQL
- PostgreSQL
- Sybase

- Pervasive
- Cloudscape / Derby
- MS Access
- Pointbase

As was mentioned earlier, database modeling was significantly extended in the version v17.0.1. But database code engineering has remained at the same level as before. Hence currently not all database concepts, that can be modeled, can be subsequently generated or reverse engineered. This situation will be amended in the future.

Code Engineering Set

Code engineering set for database scripts can be created in the same manner as CE sets for other code types (see “Code Engineering Sets” in *MagicDraw CodeEngineering UserGuide.pdf*). Right-click the Code engineering Sets, New, DDL, and then the appropriate database flavor. When the CE set is created, database model elements can be added to it and then DDL script file(s) can be generated OR the script files can be added to the CE set and then reverse-engineered into the database models. In addition to reversing from files, there is Reverse from DB radio button. Once it is switched, the options for JDBC connection configuring appear, allowing to set up connection to the live database.

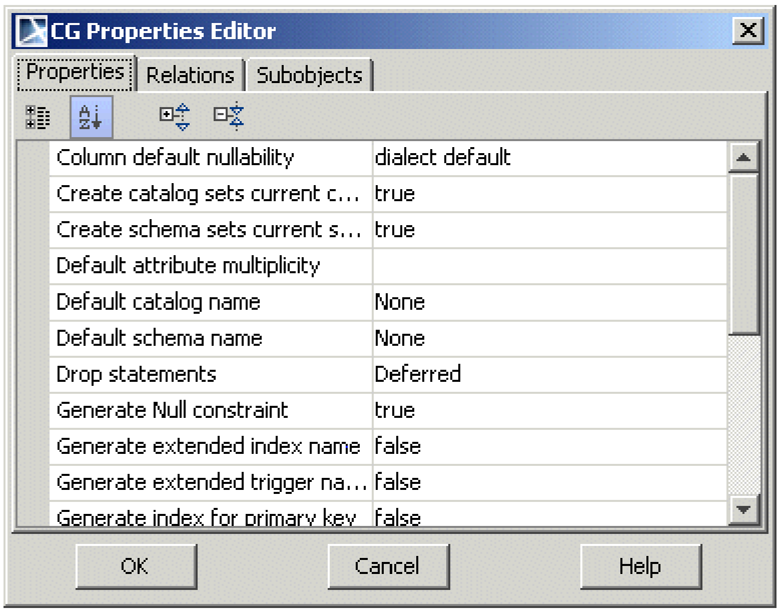
Box name	Description
Recently Used	Contains the list of the recently used reverse templates. Choose the one you need and click **Apply**.
DB Connection URL	The connection URL for the selected profile.
Driver Files	Contains .jar and .zip files or directories with JDBC driver’s classes. To choose the files or directories you want to add or remove, click the **...** button. The **Select Files and/or Directories** dialog appears. **NOTE** If the driver file is empty, Driver Class is searched from the classpath.
Driver Class	Contains the connection driver class. Click the **...** button and the list of available driver classes that are available in the selected driver files is displayed. **NOTE** Only in the files that are selected in the **Driver Files** list, the system searches for driver classes.
Username	Type the username to connect to the database.
Password	Type the password to connect to the database.
Catalog	Contains a name of the selected Catalog. To retrieve the list of available Catalogs from the database, click the **...** button and select the catalog. The catalog name appears in the **Catalog** text box. **NOTE** Only when all other properties in this dialog box are correctly defined, the list of catalogs can be retrieved.
Schema	Contains a name of the selected Schema. To retrieve the list of available Schemas from the database, click the **...** button and select the schema. The schema name appears in the **Schema** text box. **NOTE** Only when all other properties in this dialog box are correctly defined, the list of schemas can be retrieved.

Box name	Description
Property Name	The name of the JDBC driver property. **NOTE:** If using Oracle drivers, while retrieving db info from Oracle db: • To retrieve comments on table and column, set property as remarks=true. • To connect to a db as sysdba, set property as internal_logon=sysdba.
Debug JDBC Driver	If selected, all output from a JDBC driver will be directed to Message Window.
Reload Driver	By default, the **Reload Driver** check box is selected. If you want that driver to not be reloaded, clear the check box.

Properties of Code Engineering Set for DDL

There are two separate properties sets, stored as properties of code engineering set for DDL:

- Properties for DDL script generation
- Properties for DDL script reverse engineering



Column default nullability	dialect default
Create catalog sets current c...	true
Create schema sets current s...	true
Default attribute multiplicity	
Default catalog name	None
Default schema name	None
Drop statements	Deferred
Generate Null constraint	true
Generate extended index name	false
Generate extended trigger na...	false
Generate index for primary key	false

Figure 32 -- DDL properties in CG Properties Editor dialog

Property name	Value list	Description
Properties for DDL generation		
Default attribute multiplicity	**0**, **0..1**, any entered by user	If the attribute multiplicity is not specified, the value of this property is used.
Generate Null constraint	**True**, **false** (default)	If true, generates NULL constraint for column attribute with [0..1] multiplicity. If DBMS, you use, support NULL, you can enable this to generate NULL constrains. See also: GenerateNotNullConstraint, AttributeDefaultMultiplicity

Property name	Value list	Description
Generate extended index name	**True**, **false** (default)	If true, generates index name of the form: TableName_IndexName.
Generate extended trigger name	**True**, **false** (default)	If true, generates trigger name of the form: TableName_TriggerName.
Generate index for primary key	**True** (default), **false**	If the DBMS, you use, requires explicit indexes for primary key, you may enable explicit index creation using this flag. See also: GenerateIndexForUnique
Generate index for unique	**True** (default), **false**	If the DBMS, you use, requires explicit indexes for primary key or unique columns, may enable explicit index creation using this flag. See also: GenerateIndexForPK
Generate not Null constraint	**True** (default), **false**	If true, generates NOT NULL constraint for column attribute with [1] multiplicity. If you set GenerateNullConstraint, you may wish to do not generate NOT NULL constrain. See also: GenerateNullConstraint, AttributeDefaultMultiplicity
Generate qualified names	**True** (default), **false**	If value of Generate Qualified Names check box is true, package name is generated before the table or view name. For example: «Database» package “MQOnline” includes «Table» class “libraries”. Then check box Generate Qualified Names is selected as true in generated source would be written: CREATE TABLE MQOnline.libraries; Then check box Generate Qualified Names is selected as false, in generated source would be written: CREATE TABLE libraries;
Generate quoted identifiers	**True**, **false** (default)	Specifies whether DDL code generator should generate quoted names of identifiers.
Object creation mode	The Object Creation Mode combo box has the following options: only CREATE statements DROP & CREATE statements CREATE OR REPLACE statements (only for Oracle dialect; default for this dialect) DROP IF EXISTS & CREATE statements (only for MySQL dialect; default for this dialect).	
Properties for DDL script reverse engineering		

Property name	Value list	Description
Column default nullability	**Dialect default** (default), **not specified**, **NULL**, **NOT NULL**	If column has no NULL or NOT NULL constraint specified, the value of this property is used.
Create catalog sets current catalog	**True** (default), **false**	Specifies whether create catalog statement changes current catalog name.
Create schema sets current schema	**True** (default), **false**	Specifies whether create schema statement changes current schema name.
Default catalog name	**DefaultCatalogNone** (default), **DefaultCatalogPackage**, any entered by the user	Specifies current database name. Used when DDL script does not specify database name explicitly.
Default schema name	**DefaultSchemaNone** (default), **DefaultSchemaPackage**, any entered by the user	Specifies current schema name. Used when DDL script does not specify schema name explicitly.
Drop statements	**Deferred** (default), **Immediate**, **Ignored**	Specifies whether execution of drop statements may be deferred, or must be executed, or must be ignored. Deferred drop may be enabled if elements are recreated later. This will save existing views. Attribute stereotypes, multiplicity and default value always are not dropped immediately.
Map Null / not Null constraints to	**Stereotypes** (default), **Multiplicity**	When parsing DDLs, the null / not null constraints are modeled as either stereotype tag values or multiplicity.
Map foreign keys	**True** (default), **false**	An association with «FK» stereotype on the association end is created, to represent Foreign Key.
Map indexes	**True** (default), **false**	A constraint with «Index» stereotype is added into table, to represent index.
Map triggers	**True** (default), **false**	An opaque behavior with «Trigger» stereotype is added into table to represent trigger.
Map views	**True** (default), **false**	A class with «ViewTable» stereotype is created to represent view.

Supported SQL Statements

This section lists SQL statements that are supported in the Cameo Data Modeler plugin. They are parsed and mapped into model constructs.

The following table provides SQL2 SQL schema statements and their support status in the Cameo Data Modeler plugin (**Yes** means that a statement can be generated into DLL script from model constructs and reverse engineered from script into model constructs).

SQL schema statement	Supported	(Yes / No)
SQL schema definition statement	Schema definition	Yes
	Table definition	Yes
	View definition	Yes
	Alter table statement	Yes
	Grant statement	No
	Domain definition	No
	Assertion definition	No
	Character set definition	No
	Collation definition	No
	Translation definition	No
SQL schema manipulation statement	Drop table statement	Yes
	Drop view statement	Yes
	Revoke statement	No
	Alter domain statement	No
	Drop assertion statement	No
	Drop domain statement	No
	Drop character set statement	No
	Drop collation statement	No
	Drop translation statement	No

Some SQL schema statements (e.g. schema definition, table definition) allow implicit catalog name and unqualified schema name. In addition to SQL schema statements, the following SQL session statements must be supported:

- Set catalog statement - sets the current default catalog name.
- Set schema statement - sets the current default unqualified schema name.

Cameo Data Modeler supports the following widely used by dialects statements that are not the part of SQL2:

- Database definition statement (CREATE DATABASE) that creates database
- Index statements (CREATE INDEX, DROP INDEX) that create an index on table and remove it
- Trigger statements (CREATE TRIGGER, DROP TRIGGER) that create a trigger on table and remove it.

The following table provides details on mapping on the supported SQL schema manipulation statements into SQL constructs.

DDL Statement or Concept	Action, model Item	Description	Visible
Alter table statement	Modify class	Elements: table name and alter table action. Alter table action – one of: add column, add table constraint, alter column, drop table constraint, drop column.	Yes

DDL Statement or Concept	Action, model Item	Description	Visible
Add column definition	Define attribute	Elements: column definition.	Yes
Add table constraint definition	Define method	Elements: table constraint definition.	Yes
Alter column definition	Modify attribute	Elements: mandatory column name, default clause (for add default statement only).	Yes
Drop table constraint definition	Delete method	Elements: constraint name, drop behavior	Yes
Drop column definition	Delete attribute	Elements: column name, drop behavior	Yes
Drop schema statement	Delete package	Elements: schema name, drop behavior	Yes
Drop table statement	Delete class	Elements: table name, drop behavior	Yes
Drop view statement	Delete class	Elements: table name, drop behavior	Yes
Drop behavior	Action property	Modifiers: CASCADE, RESTRICT	No

DDL Dialects

This section reviews Cameo Data Modeler support for DDL script flavors from different vendors.

Standard SQL2

For SQL2 statements supported by Cameo Data Modeler see Section Supported SQL Statements, “Supported SQL Statements”, on page 55.

MagicDraw UML schema package is located within a database package. Database definition statement is not the part of the SQL2 standard - it is an analogue of a Database (a Catalog).

NOTE	A Catalog has no explicit definition statement. If a database package for a Catalog does not exist, it should be created (when it is referred for the first time).

Oracle

Cameo Data Modeler Oracle DDL script generation is based on the Velocity engine. This provides ability to change generated DDL script by changing velocity template. In this chapter we will introduce how Oracle DDL generation works in MagicDraw, how to change template for some specific things.

Knowledge of the Velocity Template Language is necessary for understanding, editing, or creating templates. Velocity documentation can be downloaded from: http://click.sourceforge.net/docs/velocity/Velocity-UsersGuide.pdf.

For more information about Oracle DDL generation and customization, see *MagicDraw OpenAPI UserGuide.pdf*.

Oracle dialect

For more information about Oracle DDL 11g, see http://download.oracle.com/docs/cd/B28359_01/ server.111/ b28286/toc.htm

Oracle dialect has CREATE DATABASE, CREATE INDEX, and CREATE TRIGGER statements that are not the part of SQL2 standard but that are taken into account while reversing DDL script of this dialect.

This dialect has some syntax differences from SQL2 standard because of extensions (e.g. some schema definition statements can have STORAGE clause). These extensions are ignored while reversing.

Code engineering features for Oracle dialect are more extensive that code engineering for other dialects. In addition to the concepts, supported by Standard SQL generation, Oracle generation supports generation and reverse of:

- Sequences
- Synonym
- Structured user-defined types (with methods, map & order functions)
- Function and Procedure
- Users, Roles Grants
- Materialized Views

Cloudscape

Informix Cloudscape v3.5 dialect has no database definitions statement. A database package with the name specified by CurrentDatabaseName property is used.

This dialect has CREATE INDEX and CREATE TRIGGER statements that are not the part of a SQL2 standard but that should be taken into account while reversing DDL script of this dialect.

This dialect has some syntax differences from SQL2 standard because of extensions (e.g. some schema definition statements can have PROPERTIES clause). These extensions are ignored while reversing.

TRANSFORMATIONS

Introduction

NOTE	Transformation engine implementation code is available from the MagicDraw Standard Edition upwards. However, there are just a couple of transformations in the MagicDraw (Any-to-Any and Profile Migration transformations). The Cameo Data Modeler plugin brings in a set of transformations between various kinds of data models.

The Cameo Data Modeler plugin for MagicDraw provides a set of transformation for transforming between various kinds of data models. There are transformations for transforming:

- UML models to SQL models (2 flavors - generic and Oracle)
- ER models to SQL models (2 flavors - generic and Oracle)
- SQL models to UML models (suitable for all flavors of databases)
- UML models to XML schema models
- XML schema models to UML models

After the transformation, user can further refine the resulting model as necessary, and generate the artifact files from those models. Actual DDL scripts, XML schema files can be generated using the code engineering facilities.

Since the Cameo Data Modeler plugin provides more powerful modeling and generation features for Oracle database flavor (there are Oracle-specific modeling extensions, and code engineering features for Oracle database scripts cover more features), there are two separate transformation flavors as well - “ER to SQL (Generic)” and “ER to SQL (Oracle)”.

NOTE	As of version 17.0.1 the Generic-Oracle DDL(SQL) transformation is no longer available in MagicDraw. The transformation is no longer needed, because of unification of previously separate profiles for generic SQL and Oracle SQL modeling.

Functionality of performing model transformations in MagicDraw is accessible by the **Model Transformations Wizard**. The wizard is used for creating new transformations.

To open the **Model Transformations Wizard**

Do one of the following:

- From the **Tools** menu, choose **Model Transformations**.
- Select one or more packages. From the shortcut menu, choose **Tools** > **Transform**.

NOTE	For more information about this wizard, see “Model Transformation Wizard” in *MagicDraw UserManual.pdf*.

Each transformation has its own default type map for replacing data types from the source domain into the appropriate data types of the result domain. If this type map is not suitable, the default type map can be modified or an entirely different type map can be provided if necessary.

NOTE	• For more information on how to create your own transformation rules or change mapping behavior, see "Transformation Type Mapping" in the *MagicDraw UserManual.pdf*. • For more information on how to set up the mapping, watch the "Transformations" online demo at http://www.nomagic.com/support/demos.html.

UML to SQL Transformation

There are two very similar UML to DDL transformations:

1. UML to SQL (Generic)
2. UML to SQL (Oracle)

These transformations convert the selected part of a UML model with class diagrams into Generic or Oracle SQL models with Oracle SQL diagrams respectively.

Transformation Procedure

UML to SQL (Generic / Oracle) transformation is based on the same copy mechanism as the other transformations are. It copies the source model part to the destination (unless the in-place transformation is performed), remaps types, and then performs model reorganization to turn the model into an SQL model.

To transform a UML model to SQL

1. Open the UML model you want to transform or create a new one.
2. Open the **Model Transformation Wizard**. Do one of the following:
   - On the main menu, click **Tools** > **Model Transformations**.
   - Select the package in the Model Browser and click **Tools** > **Transform** on it's shortcut menu.
3. Perform the steps of the wizard:

   3.1 Select the transformation type.

   3.2 Select the transformation source and specify the location wherein the output should be placed. If you open the wizard from the shortcut menu of a package, this package and all it's content will be automatically selected as the source.

   3.3 Check type mappings. You can select the transformation type map profile in this step.

   3.4 Specify transformation details.
4. Click **Finish** when you are done.

Conversion of Classes

UML classes from the source model are converted into tables.

Each property of the source class becomes a column in the result table. If a property in the UML model had the explicit multiplicity specified, nullable=true (for [0..1] multiplicity in source property) and nullable=false (for [1] multiplicity in source property) marking is applied on result columns.

Operations contained in the source class are not copied into the result table.

Primary Keys Autogeneration

If a UML class in the source model had no primary key (it is declared by applying an appropriate stereotype), an ID column is generated and marked as the primary key (PK).

TIP!	You can turn off the automatic generation of PKs during the model transformation. For this, click to clear the **Autogenerate PK** check box in the **Transformation Details** pane (the 4th step of the **Model Transformation Wizard**) In this case you must specify PKs and FKs manually after the model transformation!

The **Autogenerated PK name template** transformation property governs the name of the generated ID column. The %t pattern in the name template is expanded to the current table name.

The **Autogenerated PK type** transformation property determines the type of the ID column. The default type is integer.

Sequence Autogeneration

NOTE	This feature is only available in UML to SQL (Oracle) transformations. Generic SQL models do not have sequence support yet.

For each single-column PK in the destination a sequence object can be generated.

The **Autogenerate Sequences** transformation property governs the sequence autogeneration. Possible choices for setting the property value are as follows:

1. **Do not generate sequences** choice switches sequence generation off.
2. **Generate sequences for all single-column PKs** choice switches sequence generation on.
3. **Generate sequences for all autogenerated PKs** choice switches sequence generation on but only for those PKs that there automatically generated by the tool (but not for PKs which were declared by the user).

Conversion of Associations

One-to-one and one-to-many associations between classes in the source UML model are converted to foreign key relationships and to foreign key columns in the table, which is at the multiple end.

The **Autogenerated FK column name template** transformation property governs the name of the generated FK column. A name template can use the following patterns:

- %t is replaced by the name of the table, the foreign key is pointing to.
- %k is replaced by the key name, this foreign key is pointing to.
- %r is replaced by the name of the relationship role, which is realized by this foreign key.

Note that the type of the FK column matches the type of the PK column, to which this key is pointing.

Many-to-Many associations are transformed into the intermediate table. An intermediate table is generated for an association and has two FK relationships pointing to the tables at association ends. FK are generated in the same way as for one-to-many associations.

The **Autogenerated table name template** transformation property governs the name of the generated intermediate table (%t1 and %t2 are replaced by the names of the tables at relationship ends).

You can create your own **Autogenerated FK constraint name template**. It makes easier to find FKs in the generated code. Also it is helpful if you have some naming convention at your company.

You can use the same described patterns to specify the FK name template. For example, if you define the FK constraint name template as “fk_%r”, appropriate relations in the model will look like it is depicted in the following figure.

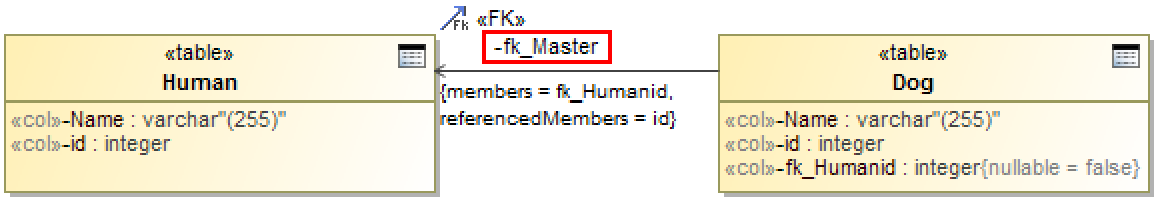


Figure 33 -- Example of transformation when FK name template is used

The same sample in the, for example, SQL code will look as follows:

```
CREATE SEQUENCE pets.Dog_SEQ;

CREATE SEQUENCE pets.Human_SEQ;

CREATE TABLE pets.Human
(
     Name varchar (255),
     id integer,
     PRIMARY KEY(id)
);

CREATE TABLE pets.Dog
(
     Name varchar (255),
     id integer,
     fk_Humanid integer NOT NULL,
     PRIMARY KEY(id),
     CONSTRAINT fk_Master FOREIGN KEY(fk_Humanid) REFERENCES pets.Human (id)
);
```

To create the FK constraint name template

1. In the **Transformation Details** (the 4th step of the **Model Transformation Wizard**), click the **Autogenerated FK constraint name template** specification cell. The Edit button appears.
2. Click the Edit button and, in the opened **Autogenerated FK constraint name template** dialog, define the FK name template. You can use specific names and patterns, such as %t (a table name) or %r (a relationship role) in the name template definition.
3. Click **OK** when you are done and continue the transformation setup process.

Conversion of Identifying Associations

Some relationships in the source model are treated as identifying relationships. In case of identifying a relationship, the objects of the class, which is at the multiple end of the association, are not independent, that is, they can exist only in association with the objects at the singular end of the association. In the resulting SQL model, the FK of these relationships is included into the PK of the table.

The PK of the dependent table is composite and contains two columns as a result:

1. ID column of the table
2. FK to the independent table

Unfortunately UML models lack model data and notation to specify, which associations are identified. Hence transformation has to guess this. It uses the following heuristics - the composite associations are treated as identifying, while the other associations are not.

The **Treat composition relationships as identifying** transformation property governs these heuristics. If this property set to false, all associations are treated as not identifying.

Conversion of Multivalued Properties

In UML models, properties can be multi-valued (e.g. [0..7], [2..*]). However in databases columns they can be only single-valued. Transformation uses two strategies to handle multi-valued properties in the source model.

If the upper multiplicity limit is small and fixed, e.g., [0..3], then columns are simply multiplied the necessary number of times. The result table will have multiple columns with sequence numbers appended to their names (like “phone1”, “phone2”, and “phone3” columns in the result for a single phone[0..3] property in the source).

The **Max Duplicated Columns** transformation property governs the maximum number of columns, that are generated using this strategy.

If the upper multiplicity upper bound is larger than this limit or unlimited, then an auxiliary value table is generated for such multi-valued properties. This table is FK-related to the main table of the class, and holds a “value” column for storing property values.

The **Value table name** transformation property governs the name of the generated table (%t in this property is replaced by the name of the table and %r - by the property name). So, the table name template “%t_%r_VALUES” gives a “Person_Phone_VALUES” table name for the Person::phone property).

Conversion of Generalizations

In UML, generalizations are used extensively, while SQL domain lacks the concept of generalizations. Hence during the transformation, generalization trees are transformed into different concepts to simulate the generalization approximately.

There are three different strategies for simulating generalizations in the result domain:

1. **Multiple Tables, Decomposed Object** strategy.
2. **Multiple Tables, Copy Down** strategy.
3. **One Table, Merged** strategy.

Specify the strategy for converting generalization trees in the **Generalization Tree transformation strategy** transformation property.

Multiple Tables, Decomposed Object strategy

This strategy consists of the following actions:

1. Each class is converted to a separate table.
2. Direct (not inherited) properties of the class are converted to the columns of the table.
3. A foreign key to the table of the base class is created. The table of the base class carries the inherited columns.
4. Primary keys of all the classes participating in a hierarchy tree are the same (there can be several hierarchy trees in the same transformation source, and each one is handled separately). PK of the specific tables is also a FK to the parent table.

This strategy is the closest one to UML and fits nicely from theoretical standpoint since there is no data duplication. The only problem of this approach is the performance of data retrieval and storage. During the storing operation, objects are decomposed into several parts, each stored in a different table (that is why the strategy is called Decomposed Object strategy), and for retrieving the object you have to query several tables (with resulting multi-level joins).

Multiple Tables, Copy Down strategy

This strategy consists of the following actions:

1. Each class is converted to a separate table.
2. The table of each class holds columns for properties of that class AND all the columns, copied from the base class (that is why this strategy is called Copy Down strategy).

As a result each table possesses the complete column set to carry data about an object of particular type. All the data of the object is stored in one table.

The weak point of this strategy is that the association relationships between tables are copied down also. Hence each association in the source can produce many foreign keys in the target. Writing SQL queries against this database layout is not very convenient. Also, if you want to retrieve all the objects of the particular class, you have to query several tables and union the results.

One Table, Merged strategy

This strategy consists of the following actions:

1. All the classes in the generalization hierarchy are folded into one large table.
2. All the properties of all the classes become table columns (note that columns that were mandatory in the specific classes become optional in the merged table).
3. A separate selector column is generated, which indicates the type of the object carried by the particular line.

The **Selector Column Name**, **Selector Column Type** and **Selector Column Type Modifier** transformation properties determine the selector column format.

This strategy is suitable for very small hierarchies usually of just one hierarchy level with a couple of specialization classes, each adding a small number of properties to the base class. E.g., general class “VehicleRegistration” and a couple of subclasses: “CarRegistration” and “TruckRegistration”.

This strategy suites simple cases well. It is simple and fast. However it does not scale for larger hierarchies and produces sparse tables (tables with many null values in the unused columns) in this case.

Conclusions and future improvements

Note that all hierarchies from the transformation source are converted using the same method. You cannot choose different strategies for each particular case of the generalization tree. This is considered as a future improvement for the transformations.

Conversion of DataTypes

You can choose two strategies to transform datatype of data to SQL:

- To transform datatypes to **structured user defined types**. This is a default case.

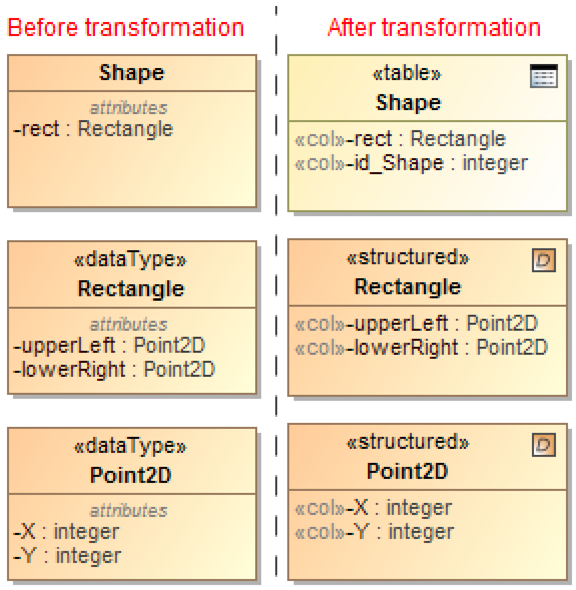


Figure 34 -- Example of datatype transformation to structured user defined types

The same sample in the, for example, Oracle SQL code will look as follows:

```
CREATE SEQUENCE Shapes.Shape_SEQ;

CREATE OR REPLACE TYPE Shapes.integer AS OBJECT NOT FINAL INSTANTIABLE;
/
CREATE OR REPLACE TYPE Shapes.Point2D AS OBJECT
     (
     X integer,
     Y integer
     ) NOT FINAL INSTANTIABLE;
/
CREATE OR REPLACE TYPE Shapes.Rectangle AS OBJECT
     (
     upperLeft Point2D,
     lowerRight Point2D
     ) NOT FINAL INSTANTIABLE;
/
CREATE TABLE Shapes.Shape
(
     rect Rectangle,
     id integer,
     PRIMARY KEY(id)
);
```

- To expand datatypes into **separate columns** at the point of usage. Each property of a class having a datatype as a type is expanded into a set of columns—one column per each attribute of the datatype (including inherited attributes). Column types are copied from the source datatype attribute types (modulo the transformation type mapping). If the original datatype attribute is multivalued, the resulting column is further modified in the same manner as multivalued class attributes. The datatype expansion is recursive.

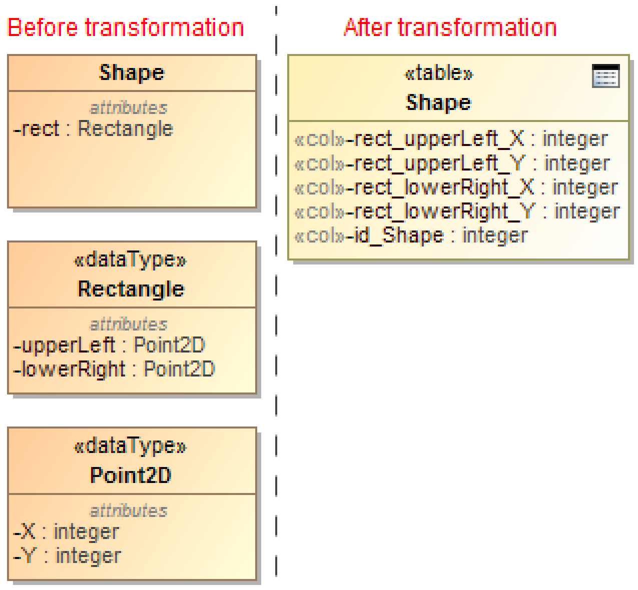


Figure 35 -- Example of DataType transformation to separate columns

The same sample in the, for example, Oracle SQL code will look as follows:

```
CREATE TABLE Shapes.Shape
(
     X_upperLeft_rect integer,
     Y_upperLeft_rect integer,
     X_lowerRight_rect integer,
     Y_lowerRight_rect integer,
     id integer,
     PRIMARY KEY(id)
);
```

On the conversion of DataTypes into separate columns at the point of usage, you can define names of the columns. By default, the format “%r_%a” is used, where %r is a name of a class attribute and %a is a name of a DataType attribute. In the example depicted in the preceding figure, column names are constructed according to the default template, like rect_upperLeft_X, rect_lowerRight_Y and so on.

To select a strategy for the DataType transformation

1. In the **Transformation Details** (the 4th step of the **Model Transformation Wizard**), set the **Expand datatypes** value to:
   - *False* to transform datatypes to structured user defined types.
   - *True* to expand datatypes into separate columns at the point of usage
2. Continue the transformation setup process.

To define a template name for columns

1. In the **Transformation Details** (the 4th step of the **Model Transformation Wizard**), click the **Expanded datatype column name template** specification cell. The Edit button appears.
2. Click the Edit button and, in the opened **Expanded datatype column name template** dialog, define the column name. In the column name definition, you can use specific convenient names and the following patterns:
   - %r - a name of a class attribute
   - %a - a name of a datatype attribute
   - %t - a name of table

3. Click OK when you are done and continue the transformation setup process.

The column name template is defined in the **Expanded datatype column name template** property.

Conversion of Enumerations

When transforming enumerations, you can choose two strategies:

- To transform the enumeration to **check constraints** at the point of usage. This is the default case. Every class attribute of the enumeration type in the transformation source is transformed to the table column of a char type.

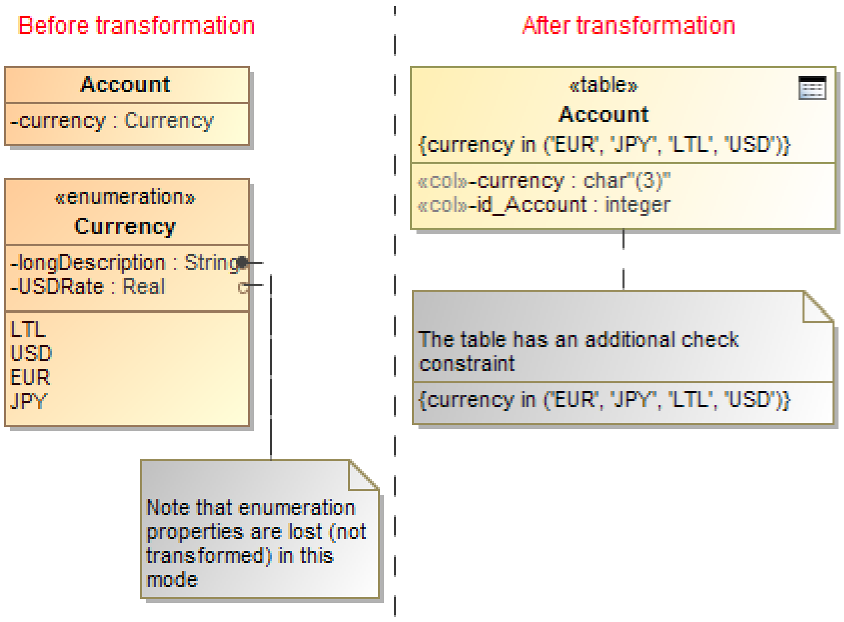

Before transformation
After transformation
Account
-currency : Currency
«enumeration»
Currency
-longDescription : String
-USDRate : Real
LTL
USD
EUR
JPY
Note that enumeration properties are lost (not transformed) in this mode
«table»
Account
{currency in ('EUR', 'JPY', 'LTL', 'USD')}
«col»-currency : char"(3)"
«col»-id_Account : integer
The table has an additional check constraint
{currency in ('EUR', 'JPY', 'LTL', 'USD')}

Figure 36 -- Example of enumeration transformation to check constraints

The same sample in the, for example, SQL code will look as follows:

```
CREATE TABLE Enumeration_CheckConstraint.Account
(
     currency char (3),
     id_Account integer,
     CHECK(currency in ('EUR', 'JPY', 'LTL', 'USD')),
     PRIMARY KEY(id_Account)
);
```

- To transform enumerations to **lookup tables**. This strategy can handle the more complex enumerations, for example, enumerations having their own attributes. The lookup table is automatically populated with enumeration literal values, and INSERT statements are generated during the SQL code generation. For each attribute that enumeration source has (including inherited attributes) the column in the target table is created. Attributes are transformed using the normal transformation rules for class attributes (including the type mapping, data type expansion, if requested, and multivalue-attribute expansion). The **name** column is added to the lookup table and the primary key is automatically generated, see “Primary Keys Autogeneration” on page 61. Every class attribute of the enumeration type in the transformation source is transformed to the foreign key.

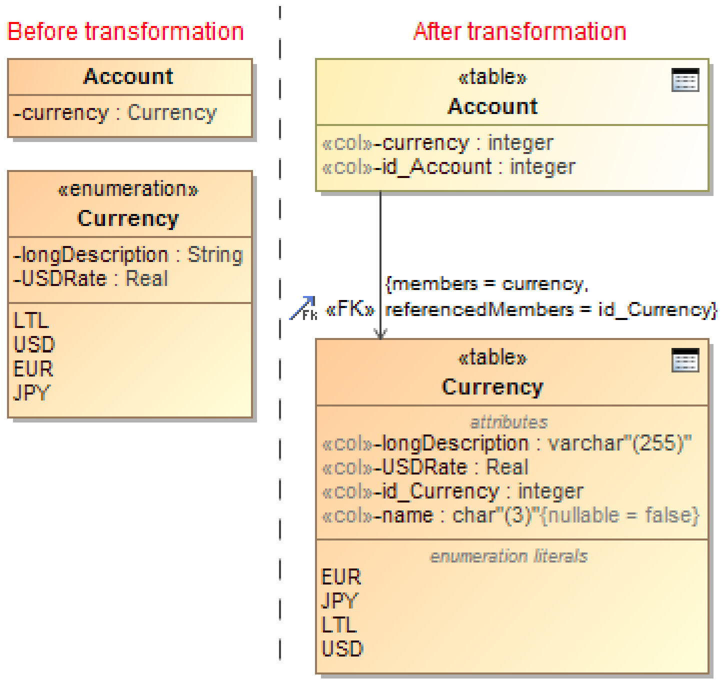


Figure 37 -- Example of enumeration transformation to lookup tables

The same sample in the, for example, SQL code will look as follows:

```
CREATE TABLE Enumeration_LookupTables.Currency
(
     longDescription varchar (255),
     USDRate,
     id_Currency integer,
     name char (3) NOT NULL,
     PRIMARY KEY(id_Currency)
);
INSERT INTO Enumeration_LookupTables.Currency(id_Currency, name) VALUES(0, 'EUR');
INSERT INTO Enumeration_LookupTables.Currency(id_Currency, name) VALUES(1, 'JPY');
INSERT INTO Enumeration_LookupTables.Currency(id_Currency, name) VALUES(2, 'LTL');
INSERT INTO Enumeration_LookupTables.Currency(id_Currency, name) VALUES(3, 'USD');


CREATE SEQUENCE Enumeration_LookupTables.Currency_SEQ;

CREATE SEQUENCE Enumeration_LookupTables.Account_SEQ;

CREATE TABLE Enumeration_LookupTables.Account
(
     currency integer,
     id_Account integer,
     PRIMARY KEY(id_Account),
     FOREIGN KEY(currency) REFERENCES Enumeration_LookupTables.Currency
(id_Currency)
);
```

To select a strategy for the Enumeration transformation

1. In the **Transformation Details** (the 4th step of the **Model Transformation Wizard**), click the **Enumeration transformation strategy** specification cell. The list of available strategies appears. Select one of the following:
   - **Check Constraints** to transform the enumeration to check constraints at the point of usage.

- **Lookup Table** to transform enumeration to lookup tables.

2. Continue the transformation setup process.

Package Hierarchy Reorganization

UML models usually have a moderately deep package nesting organization, while SQL models can have at most one package level - the schemas. Hence during the transformation, packages should be reorganized.

The **Change package hierarchy** transformation property governs the package reorganization. Possible choices for setting the property value are as follows:

1. **Leave intact** choice switches reorganization off.
2. **Flatten packages** choice forces flattening of the packages of the source, leaving only the top level packages in the destination.
3. **Strip packages** choice removes all packages of the source.

Naming of Transformed Elements

While transforming your UML models to SQL, you can modify names of the transformed elements according to given naming rules. There are several predefined rules:

- Replace spaces or special characters in the element name with the underscore sign “_”. For example, the name in source “Customer Profile” and “Terms&Conditions” could be transformed as “Customer_Profile” and “Terms_Conditions” accordingly.
- Capitalize element names after the transformation. For example, the name in source “Customer” could be transformed as “CUSTOMER”.
- Pluralize element names after transformation. For example, the name in source “Customer” could be transformed as “Customers”.
- Detect the camel case edge in element names on transformation. For example, the name in source “CustomerProfile” could be transformed as “Customer_Profile”.

To select a naming rule

1. In the **Transformation Details** (this is the last step of the **Model Transformation Wizard**), click the **Name conversion rules** specification cell. The cell expands and the Edit button appears.
2. Click the Edit button. The **Select Opaque Behavior «Naming Rule»** dialog opens.
3. In the opened dialog, select naming rules you want to use in transforming element names. You may select more than one rule.

NOTE	
	• Be sure the search includes auxiliary resources! To turn on the appropriate search mode, click **Include elements from modules into search results**. • To select several naming rules, click the **Multiple Selection** button.

Naming rules are as follows:

Rule name	Description	Example
CamelCaseSeparator	Detects all the occurrences in the original name of the situation where lower case letter is followed by upper case letter and insert the underscore sign '_' character between.	CustomerProfile > Customer_Profile

Rule name	Description	Example
LowerCase	All Unicode letter characters in the source name are converted to their lower case version in the result name. Other character are passed through unchanged.	CUSTOMER 1 > customer 1
Pluralization	All original names that do not end with character 'S' or 's' will have the 's' character appended.	Customer > Customers
SpecialCharacterEscape	All Unicode characters in the source name that are not letters and not numbers are converted to an underscore sign '_' in the result name. Other character are passed through unchanged.	Terms&Conditions > Terms_Conditions
UpperCase	All Unicode letter characters in the source name are converted to their upper case version in the result name. Other character are passed through unchanged.	Customer 1 > CUSTOMER 1
WhitespaceEscape	All Unicode whitespace characters in the source name are converted to an underscore sign '_' in the result name. Other character are passed through unchanged.	Customer 1 > Customer_1

For more information about selecting elements, see “Selecting an Element” in *MagicDraw UserManual.pdf*.

4. Click **OK** when you are done.

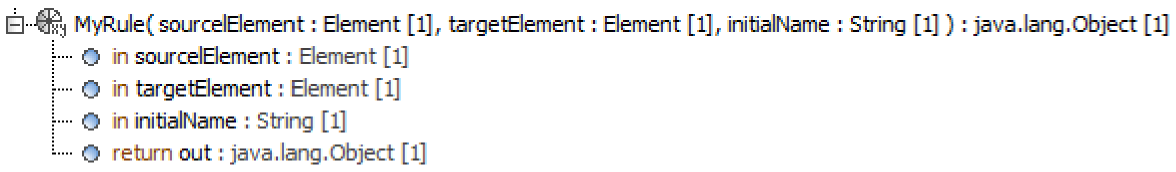
You can also create your custom naming rules using structured expressions or various scripts. The naming rule is an executable opaque behavior. For more information about executable opaque behaviors, see “Creating executable opaque behaviors” in *MagicDraw UserManual.pdf*. The following procedure describes one of the possible ways to create a custom naming rule.

To create a custom naming rule

1. Create a package for the naming rule data.
2. In this package, create an Opaque Behavior with the following parameters exactly in the same order as follows:

   - sourceElement : Element
   - targetElement : Element
   - initialName : String

   The return parameter is of a java.lang.Object type.


MyRule(sourcelElement : Element [1], targetElement : Element [1], initialName : String [1]) : java.lang.Object [1]
in sourcelElement : Element [1]
in targetElement : Element [1]
in initialName : String [1]
return out : java.lang.Object [1]

3. Use the **Model Transformation Profile.mdzip** module. On the main menu, click **File** > **Use Module**. The required module is located in the <install.root>\profiles\Model_Transformation_Profile.mdzip. Click **Finish** after you have selected the module.
4. In the Model Browser, select the Opaque Behavior you have created and apply the «NamingRule» stereotype on it. Open the opaque behavior’s shortcut menu and click **Stereotype**. In the opened **Select Stereotype** list, select the «NamingRule» stereotype and click **Apply**.
5. Open the opaque behavior’s Specification window and specify the **Body and Language** property. Actually, this is a property where you define your custom naming rule. Click property specification cell and then click the Edit button.

6. In the opened **Body and Language** dialog, select a language for defining your naming rule and create the rule's body.

NOTE	● The SQL language is not suitable for defining naming rules. ● If you choose the Structured Expression language, turn on the Expert mode to get the all list of possible operations.

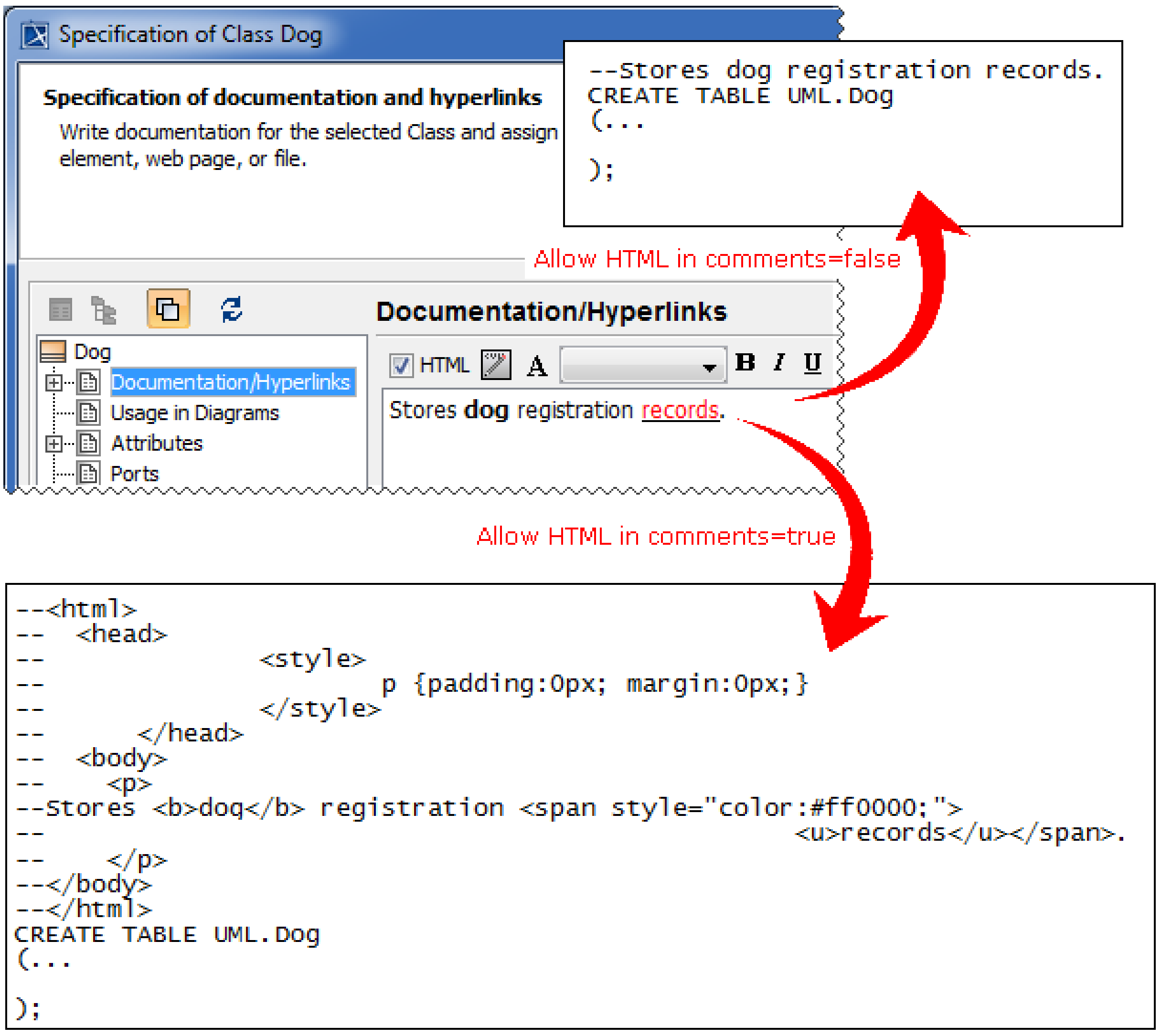
7. Click **OK** when you are done. The naming rule you have created appears in the **Name conversion rules** selection list.

Transforming documentation

Documentation can be copied either with or without HTML formatting information. If you need to retain the formatting information, click to select the **Allow HTML in comments** check box in the **Transformation Details** pane (the 4th step of the **Model Transformation Wizard**).

The model element documentation is turned into SQL comments during the DDL script generation.

TIP!	You can turn off the comment generation. For this, do the following: 1. From the **Options** menu, select **Project**. The **Project Options** dialog opens. 2. Select **DDL Language Options** on the left (you may need to expand the **Code Engineering** node). The appropriately named pane opens on the right. 3. Click to clear the **Generate documentation** check box. 4. Click **OK**.


Specification of Class Dog
Specification of documentation and hyperlinks
Write documentation for the selected Class and assign
element, web page, or file.
Allow HTML in comments=false
Documentation/Hyperlinks
Dog
Documentation/Hyperlinks
Usage in Diagrams
Attributes
Ports
HTML
Stores dog registration records.
Allow HTML in comments=true

```
--Stores dog registration records.
CREATE TABLE UML.Dog
(...

);
```

```
--<html>
--  <head>
--              <style>
--                      p {padding:0px; margin:0px;}
--              </style>
--      </head>
--  <body>
--    <p>
--Stores <b>dog</b> registration <span style="color:#ff0000;">
--                                                 <u>records</u></span>.
--    </p>
--</body>
--</html>
CREATE TABLE UML.Dog
(...

);
```

Figure 38 -- SQL comments with and without HTML formatting information

Excluding elements from transformation

Elements can be excluded from the transformation in one of the following ways:

- By deselecting these elements in the 2nd step of the **Model Transformation Wizard**.
- By specifying rules for the automatic exclusion of elements in the 4th step of the wizard. These rules must be defined as executable opaque behaviors.

To define a rule for automatic elements' exclusion

1. Create an executable opaque behavior.

   For more information, see "Creating executable opaque behaviors" in *MagicDraw UserManual.pdf.*
2. Create an input parameter, whose type is *Element,* the abstract UML metaclass, and multiplicity is [1].
3. Create a return parameter, whose type is java.lang.Object and multiplicity is [1].
4. Specify the **Language and Body** property value for the new opaque behavior.

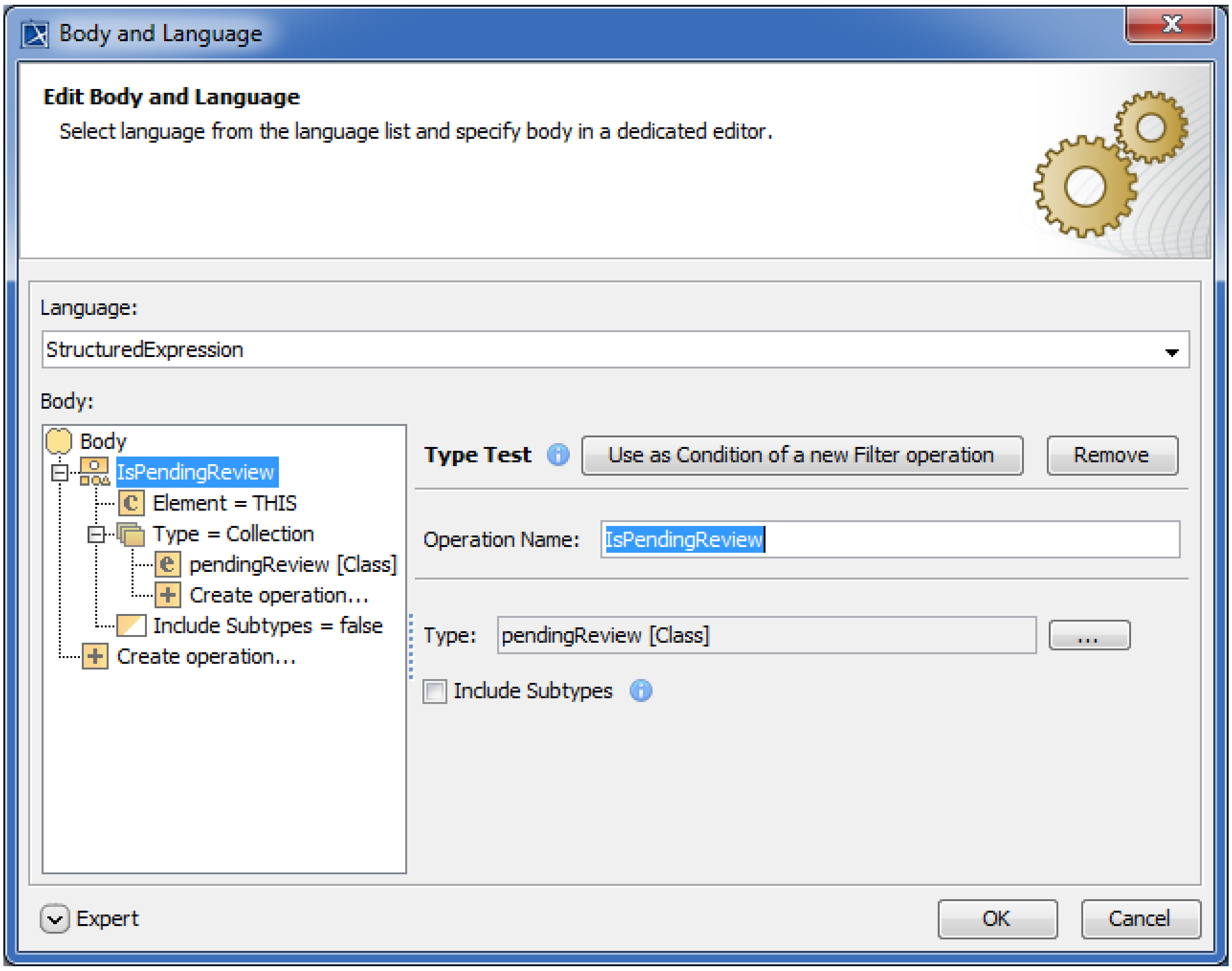
EXAMPLE

Let's say we need to exclude from the transformation all the classes with the «pendingReview» stereotype applied.

For this, we must do the following:

1. Select **StructuredExpression** as language of the opaque behavior body.
2. Define the body by creating a TypeTest operation, which takes the collection of elements and returns only the ones with the «pendingReview» stereotype applied (see the following figure).

For more information about the TypeTest operation, see "Calling operations from the model" in *MagicDraw UserManual.pdf.*


Body and Language

Edit Body and Language

Select language from the language list and specify body in a dedicated editor.

Language: StructuredExpression

Body:

- Body
  - IsPendingReview
    - Element = THIS
    - Type = Collection
      - pendingReview [Class]
      - Create operation...
    - Include Subtypes = false
  - Create operation...

Type Test | Use as Condition of a new Filter operation | Remove

Operation Name: IsPendingReview

Type: pendingReview [Class] ...

☐ Include Subtypes

Expert | OK | Cancel

To specify the rules for the automatic elements' exclusion from the transformation

1. In the **Transformation Details** pane (the 4th step of the **Model Transformation Wizard**), click the **Elements exclusion rules** specification cell. The Edit button appears.
2. Click the button and select one or more rules in the **Select Opaque Behavior** dialog.
3. Click **OK** when you are done and continue the transformation setup process.

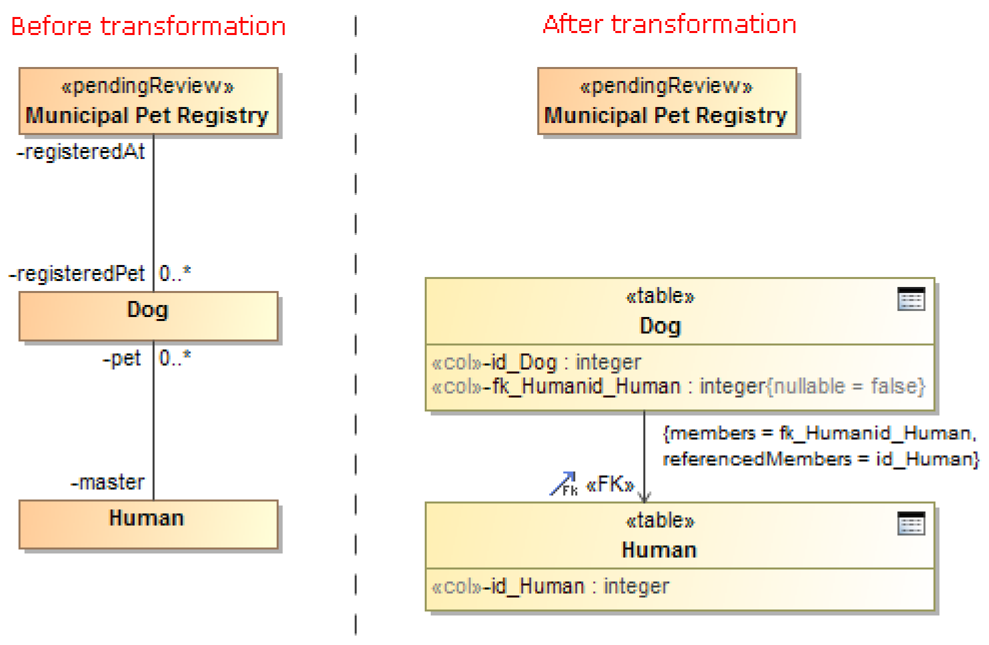


Figure 39 -- Example of transformation with excluded class

Type Mapping

Default type maps of the UML to SQL (Generic / Oracle) transformations remap the types that are commonly used in the UML modeling domain (such as String) into types that are suitable for SQL domain (such as varchar).

UML to SQL Type Map

The default type map for these transformations is stored in the **UML to SQL Type Map** profile and automatically gets attached to your project at the 3rd step (the type mapping step) of the transformation wizard. If necessary it can be changed.

The Default map carries the following type conversions.

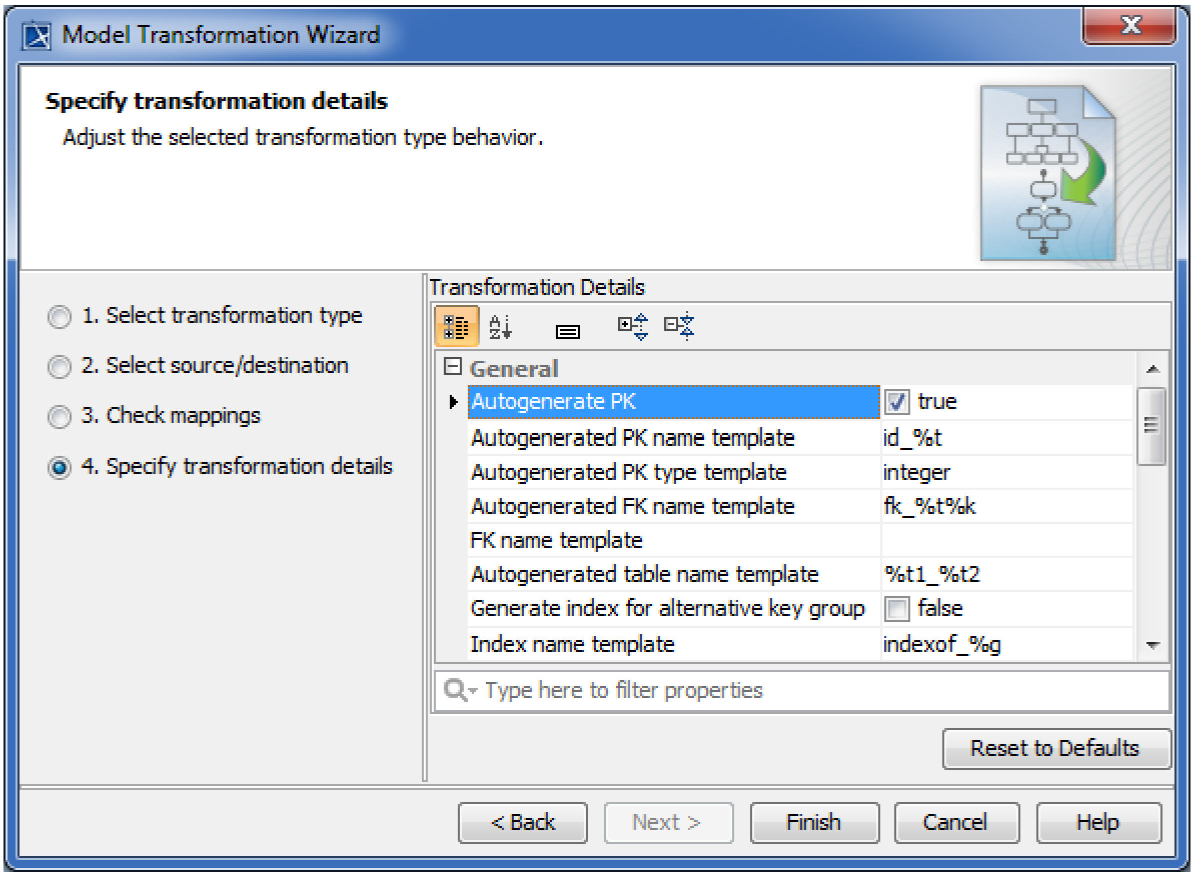
Source Type	Result Type
String	varchar (default) varchar2 char varying character varying nvarchar nvarchar2 nchar varying national char varying national character varying longvarchar long varchar char character nchar national char national character long char
short	smallint
long	number(20)
Integer	integer
int	int
float	float
double	double precision
date	date
char	char(default) character nchar national char national character
byte	number(3)
boolean	number(1)

If you have a situation when one type map imports another type map, you can specify another default mapping rule. Such situation appears, for example, in the Oracle type map, inheriting from the Standard type map where the Oracle mapping rule String-->varchar2 overrides the base mapping rule String-->varchar. For more information about the type mapping, see “Transformation Type Mapping” and “Controlling Type Mapping Rule Behavior” in *MagicDraw UserManual.pdf.*

NOTE	This feature is available with MagicDraw 18.0 SP1 or later.

Transformation Properties

This is the complete list of properties available in UML to SQL(Generic / Oracle) transformation in the **Model Transformation Wizard** (for more information about this wizard, see “Model Transformation Wizard” in *MagicDraw UserManual.pdf*).


Model Transformation Wizard
1. Select transformation type
2. Select source/destination
3. Check mappings
4. Specify transformation details
Reset to Defaults
< Back
Next >
Finish
Cancel
Help

Specify transformation details
Adjust the selected transformation type behavior.

Transformation Details

Type here to filter properties

General	
Autogenerate PK	✓ true
Autogenerated PK name template	id_%t
Autogenerated PK type template	integer
Autogenerated FK name template	fk_%t%k
FK name template	
Autogenerated table name template	%t1_%t2
Generate index for alternative key group	false
Index name template	indexof_%g

Figure 40 -- Model Transformation Wizard for UML to SQL (Generic / Oracle) transformation. Specify Transformation Details wizard step

Property name	Description
Autogenerated PK name template	If the class has no PK column in the ER model, this transformation parameter for the autogenerated column name will generate the PK. You may specify the pattern for the PK name. Default "id_%t", where %t is replaced by the name of the table.
Autogenerated PK type template	Specifies the type of the autogenerated PKs. Default: integer.
Autogenerated FK name template	The foreign keys are automatically generated to implement the relationships between classes. This transformation parameter autogenerates a FK name. You may specify the pattern for the name. Default: "fk_%t%k%r", where %t is replaced by the name of the table, the foreign key is pointing. The %k is replaced by the key name, to which this foreign key points. The %r is replaced by the name of the relationship, which is realized with this foreign key.
Autogenerated table name template	This transformation parameter autogenerates table name. You may specify the pattern for the name. Default "%t1_%t2", where %t1 is replaced by the name of the first table, %t2 - second table. The %r pattern (name of relationship) is also supported.

Property name	Description
Generated index for alternative keys	If *true*, generates index for «AK». Default: false
Index name template	If the above option is set to *true*, you may choose the template for the index name. Template may contain %g pattern, which will be replaced with AK group name. Default: indexof_%g
Change package hierarchy	Choose option for packages from transformation source: to strip all the package hierarchy, or flatten the package hierarchy down to the first level where each package is transformed into the schema. Default: Flatten packages
Treat composition relationship as identifying	If this option is set to *true*, the composition associations are treated as if the «identifying» stereotype were applied to them. Default: true
Default association end multiplicity	If multiplicity was not specified in model, defined multiplicity will be set after transformation. Default: 1
Generalization Tree transformation strategy	Selects the strategy to be used for converting generalization trees. Default: Multiple Values, Decomposed Object
Selector Column Name	Name of selector column for the merged table strategy of generalization conversion Default: typeSelector Note: together with selector type and type modifier this gives typeSelector:char(255) column.
Selector Column Type	Type of the selector column for the merged table strategy of generalization conversion. Default: char
Selector Column Type Modifier	Type modifier of the selector column for the merged table strategy of generalization conversion Default: 255
Max Duplicated Columns	Threshold for multivalue property conversion strategies - maximum number of columns for which the column duplication strategy is used. If exceeded, auxiliary value table is used. Default:3
Value Table Name	Name of the value table (to be generated when converting multivalue properties). %t pattern is expanded to table name, %r - name of the original property. Default: %t_%r_VALUES (e.g Person_phone_VALUES table will be generated for Person::phone[0..5] property in the source)
Autogenerate Sequences*	Selects wherever and when sequences are generated for PKs Default: Generate sequences for all single-column PKs
Autogenerated Sequence Name*	Name of the generated sequences. %t pattern is expanded to table name. Default: %t_SEQ
Autogenerate PK	If *true*, primary keys are generated automatically. For more information, “Primary Keys Autogeneration” on page 61.

Property name	Description
Enumeration transformation strategy	For more information, see “Conversion of Enumerations” on page 67.
Expand datatypes	For more information, see “Conversion of DataTypes” on page 64.
Expanded datatype column name template	For more information, see “Conversion of DataTypes” on page 64.
Name conversion rules	One or more rules for element name conversion. For more information, see “Naming of Transformed Elements” on page 69.
FK name template	An FK name template definition. You can use specific names and patterns, such as %t (a table name) or %r (a relationship role). For more information, see “Conversion of Associations” on page 61.
Elements exclusion rules	One or more rules for elements’ exclusion from the transformation. For more information, see “Excluding elements from transformation” on page 72.
Allow HTML in comments	If *true*, SQL comments in DDL script retain HTML formatting information. For more information, see “Transforming documentation” on page 71.

* - These properties are available only for UML to SQL (Oracle) transformation.

ER to SQL (Generic / Oracle) Transformations

Both generic and Oracle transformation flavors are very similar, so they will be described together. Furthermore, these transformations are based on and very similar to the UML to SQL(Generic / Oracle) transformations with several extensions, relevant to ER modeling.

Hence this chapter only describes this extended behavior of ER to SQL(Generic / Oracle) transformation. To see the full transformation feature set (which includes conversion of many-to-many relationships into an intermediate table, three different methods of transforming generalizations into table layouts, autogenerating primary keys, unique constraints and indexes, generating additional tables for multivalue attributes, type remapping between UML and database worlds, sequence generation, and package hierarchy flattening), please, see “UML to SQL Transformation” on page 60.

NOTE	Please note that the SQL model, produced by the transformation, is usually not optimal (e.g. all the generalizations are transformed using the same chosen strategy, while usually different strategies are chosen for each particular case - at the discretion of DBA). Hence it is frequently advisable to refine / edit the produced model after the transformation.

Identifying Relationships

Identifying relationships are transformed in the same way as in the UML to SQL transformation, that is, the foreign key of the transformation gets to be included into the primary key of the dependent entity (the one at the multiple end of the relationship). The difference in ER to SQL transformation case is that the ER model eliminates guessing, which relationships are identifying and which ones are not. UML to SQL transformation guesses, which UML associations should be identifying, by using a heuristic method - composition associations are treated as identifying (this heuristic is controlled by the **Treat compositions as identifying** transformation property). In ER models, identifying relationships are explicitly marked as such, hence there is no need to guess (“Identifying Relationships and Dependent Entities” on page 9 specifies how identifying relationships are modeled).

Key Transformation

Keys in ER models are transformed into constraints in a DDL model.

These are the rules for key transformations into DDL constraints:

1. The Primary key of the entity in the ER model is transformed into a primary key constraint in the SQL model.
2. The Alternative keys of the entities in the ER model are transformed into unique constraints in the SQL model.
3. The Inversion entries of the entities in the ER model are transformed into indexes in the SQL model.
4. If key or entry in ER model has a name (**identifier** tag), this information is preserved in the SQL model. The corresponding key / index will also have a name in the SQL model.

Lets review an example of key modeling, which has been described in “Key Modeling” on page 13. After the transformation, the three entities of the ER model are transformed into the three tables of the SQL model respectively.

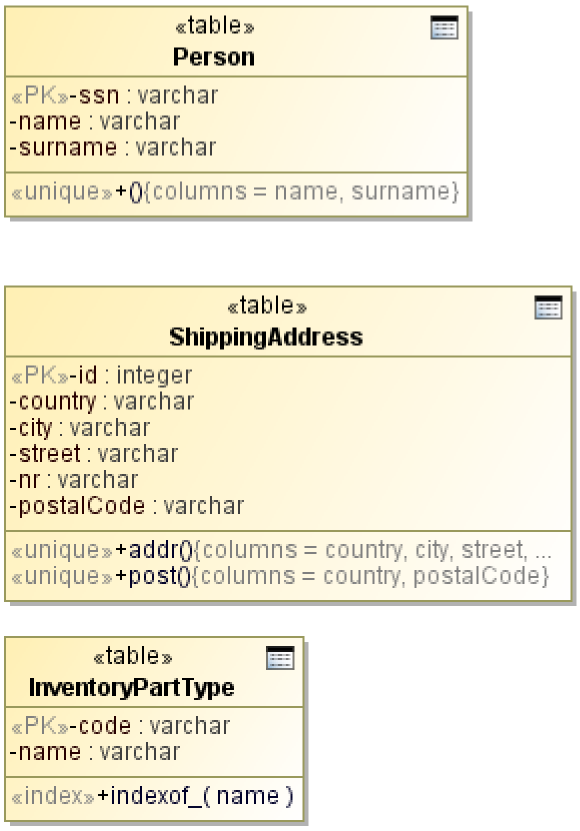


Figure 41 -- TBD Screenshot Example of key transformation results

Virtual Entity Transformation

Virtual entities of ER models can be transformed into different elements of SQL models:

- Tables (just as ordinary, non-virtual entities).
- SQL views (ER to SQL(Oracle) transformation has an additional choice of simple views or materialized views).

The choice is controlled by the **Virtual Entities Transformed To** transformation property.

Tracing between Data Model Layers

After the transformation, a relationship is established between the logical data model layer, which is represented by the ER model, and the physical data model layer, which is represented by a SQL model respectively. It is possible to navigate between the connected elements in the forward (ER -> SQL) and backward (SQL -> ER) directions using the dedicated submenu - **Go To** - on the element's shortcut menu.

To go to the corresponding element in the forward direction

1. Right-click the element.
2. On it's shortcut menu, click **Go To** > **Traceability** > **Model Transformations** > **Transformed To**.

To go to the corresponding element in the backward direction

1. Right-click the element.
2. On it's shortcut menu, click **Go To** > **Traceability** > **Model Transformations** > **Transformed From**.

The same tracing information is visible in the element's Specification window and **Properties** panel under the **Traceability** tab. This information is also reflected in the Entity-Relationship and SQL Report using navigable references between the report section. Traceability information can also be depicted in a relation map or in a tabular format using the capabilities of the custom dependency matrix feature.

SQL to UML Transformation

The SQL models and diagrams will be transformed into the platform-independent UML models and UML class diagrams. SQL to UML transformation can be applied to SQL models of any database flavor.

Type Mapping

If there are types specified in the SQL model for elements, after transformation SQL types should be converted to UML types. Because of that, there is a type mapping from SQL types to UML types.

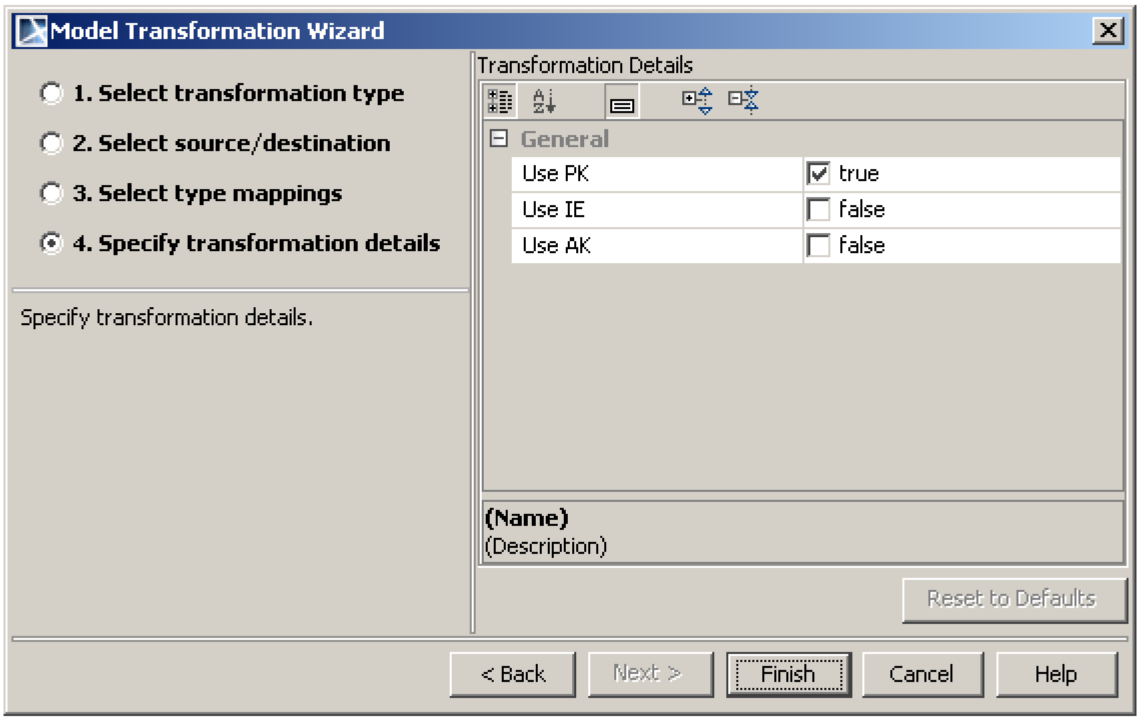
Mapping rules are based on dependencies, which contains the **SQL to UML Type Map** profile. This profile is automatically attached, when SQL to UML transformation is performed.

Transformation Results

The SQL stereotypes are discarded from tables, views, fields, and associations (except the PK stereotype).

Views are discarded in transformed class diagram.

There are additional properties to choose for SQL to UML transformation in the **Model Transformation Wizard** (for more information about the wizard, see "Model Transformations Wizard" in MagicDraw UserManual.pdf.)


Model Transformation Wizard
1. Select transformation type
2. Select source/destination
3. Select type mappings
4. Specify transformation details
Specify transformation details.
Transformation Details
General
(Name)
(Description)
Reset to Defaults
< Back
Next >
Finish
Cancel
Help

Use PK	[✓] true
Use IE	[ ] false
Use AK	[ ] false

Figure 42 -- Model Transformation Wizard for SQL to UML transformation. Specify Transformation Details wizard step

Option name	Type	Description
Use PK	**Check box**	If set to "true", appropriate columns with the primary key stereotype are marked after transformation.
Use IE	**Check box**	If set to "true", indexed columns with the inverted entity stereotype are marked after transformation.
Use AK	**Check Box**	If set to "true", unique columns with the alternative key stereotype are marked after transformation.

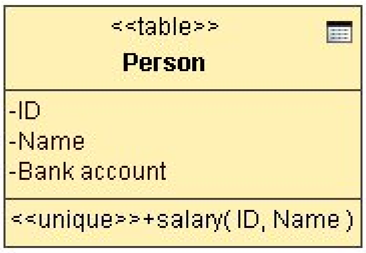
The «IE» stereotype is applied to the columns in the UML model from *indexes* in the SQL.

The «AK» stereotypes are applied to the columns in the UML model from *unique* constraints in the SQL.

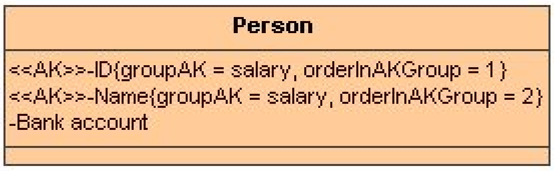
If the *unique* or *index* of the SQL contains more than one column, the **group** tag is created on the corresponding columns. The value of the tag is the name of the *unique / index*.

If the PK, *unique* constraint or *index* of the SQL contains more than one column, the **orderInXXGroup** tag is created on the corresponding columns. The value of the tag is the place number of the column in the PK, unique constraint or index (first column gets tag value=1, second column - 2, etc).

Example TBD 3 SQL screenshotsBefore transformation:



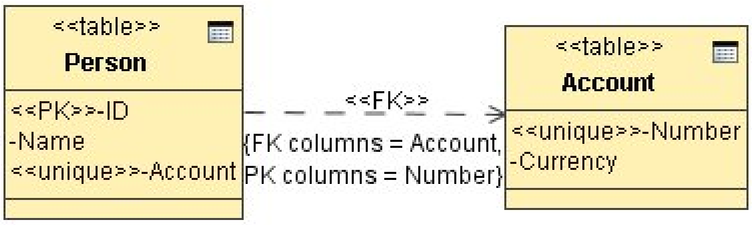
After transformation:


Person
<<AK>>-ID{groupAK = salary, orderInAKGroup = 1}
<<AK>>-Name{groupAK = salary, orderInAKGroup = 2}
-Bank account

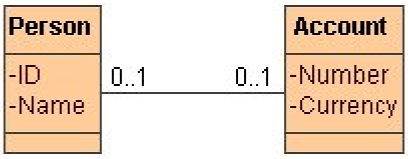
There are some foreign key cases, when after transformation, association with multiplicities are created in class diagram:

Transforming foreign key, when the «unique» stereotype is set

Before transformation:

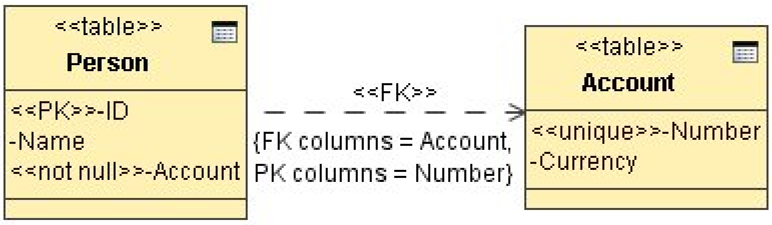


After transformation:

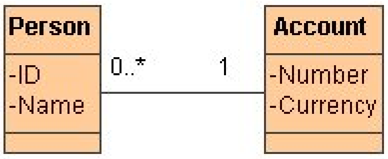


Transforming foreign key, when the «not null» stereotype is set

Before transformation:

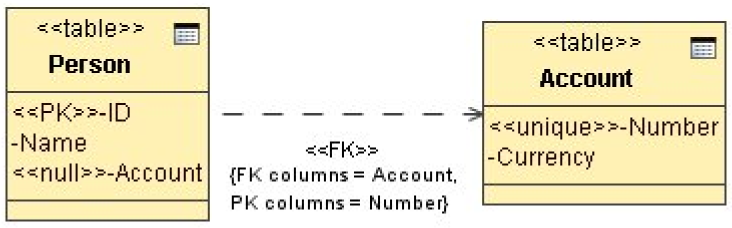


After transformation:

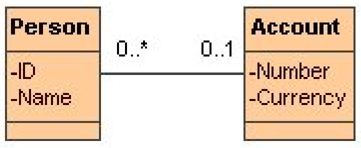


Transforming foreign key, when the «null» stereotype is set

Before transformation:

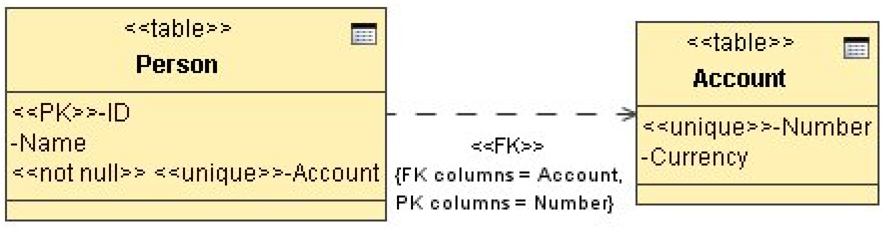


After transformation:

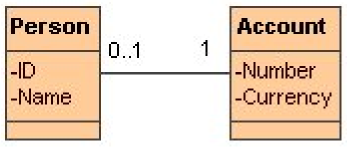


Transforming foreign key, when the «unique» and the «not null» stereotypes are set

Before transformation:



After transformation:



UML to XML Schema Transformation

The UML to XML Schema transformation helps to create the equivalent XML schema model from the given UML model.

Basically this transformation is the copying of a source UML model, and then applying the necessary stereotypes according to the XML schema modeling rules.

Type Mapping

This type map stores mapping between primitive UML data types and primitive XML Schema data types.

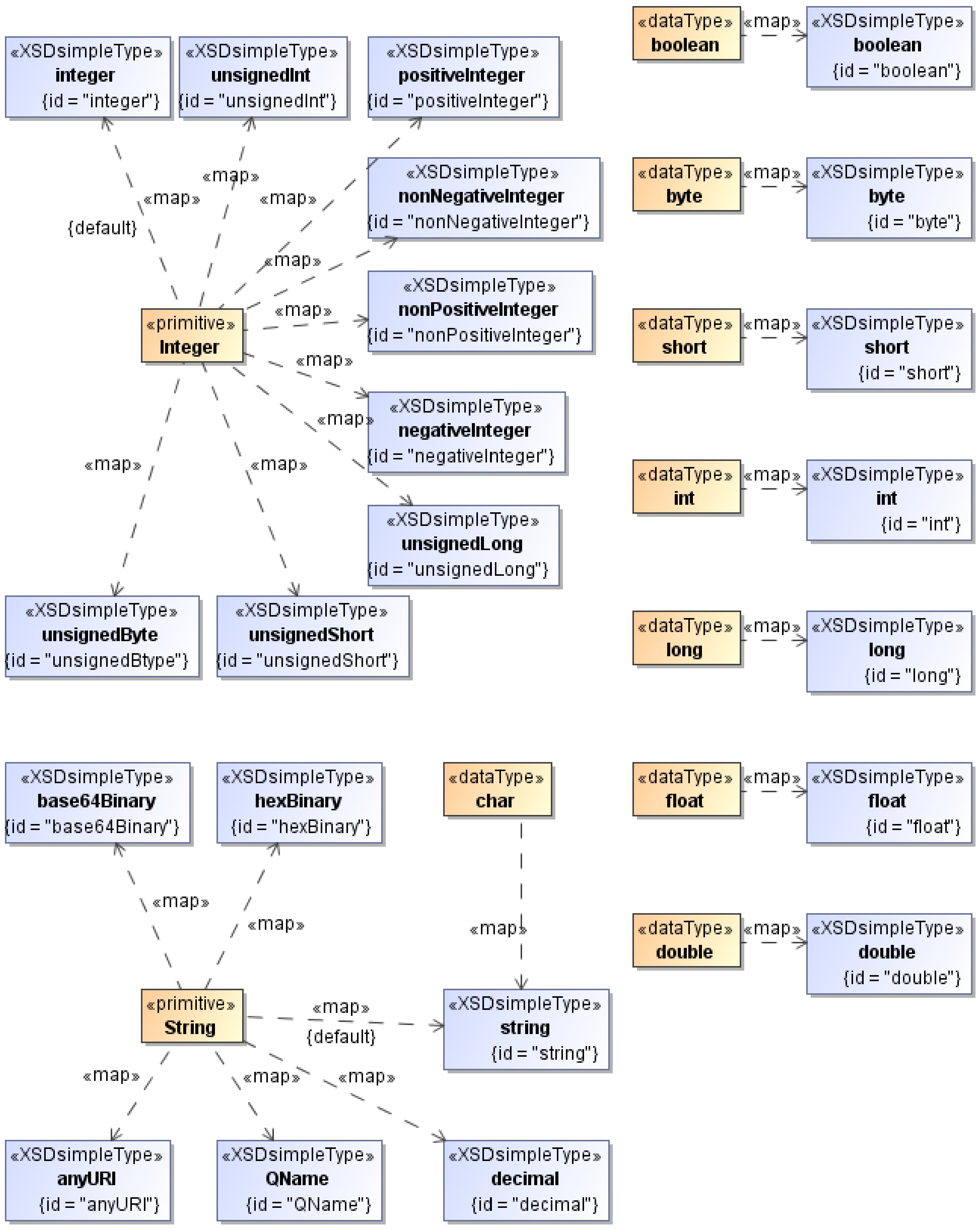

«XSDsimpleType» integer {id = "integer"}
«XSDsimpleType» unsignedInt {id = "unsignedInt"}
«XSDsimpleType» positiveInteger {id = "positiveInteger"}
«dataType» boolean
«map»
«XSDsimpleType» boolean {id = "boolean"}
«XSDsimpleType» nonNegativeInteger {id = "nonNegativeInteger"}
«dataType» byte
«map»
«XSDsimpleType» byte {id = "byte"}
«map»
{default}
«XSDsimpleType» nonPositiveInteger {id = "nonPositiveInteger"}
«primitive» Integer
«dataType» short
«XSDsimpleType» short {id = "short"}
«XSDsimpleType» negativeInteger {id = "negativeInteger"}
«dataType» int
«XSDsimpleType» int {id = "int"}
«XSDsimpleType» unsignedLong {id = "unsignedLong"}
«XSDsimpleType» unsignedByte {id = "unsignedBtype"}
«XSDsimpleType» unsignedShort {id = "unsignedShort"}
«dataType» long
«XSDsimpleType» long {id = "long"}
«XSDsimpleType» base64Binary {id = "base64Binary"}
«XSDsimpleType» hexBinary {id = "hexBinary"}
«dataType» char
«dataType» float
«XSDsimpleType» float {id = "float"}
«dataType» double
«XSDsimpleType» double {id = "double"}
«primitive» String
«XSDsimpleType» string {id = "string"}
«XSDsimpleType» anyURI {id = "anyURI"}
«XSDsimpleType» QName {id = "QName"}
«XSDsimpleType» decimal {id = "decimal"}

Figure 43 -- UML to XML schema type map (1)

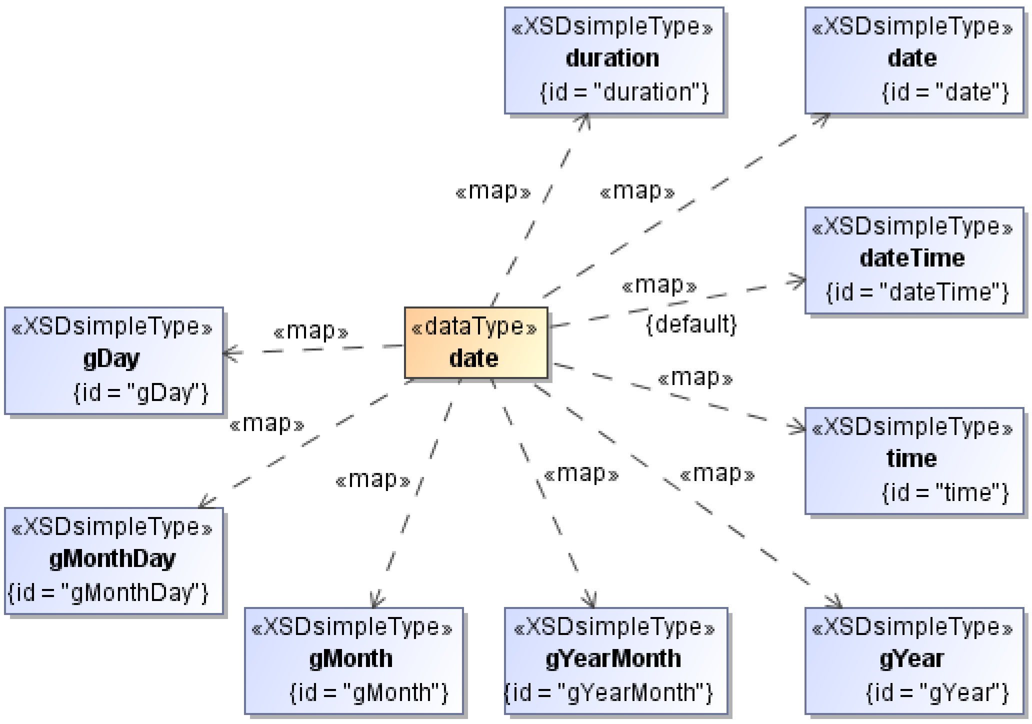

«XSDsimpleType» duration {id = "duration"}
«XSDsimpleType» date {id = "date"}
«XSDsimpleType» dateTime {id = "dateTime"}
«dataType» date
«XSDsimpleType» gDay {id = "gDay"}
«XSDsimpleType» time {id = "time"}
«XSDsimpleType» gMonthDay {id = "gMonthDay"}
«XSDsimpleType» gMonth {id = "gMonth"}
«XSDsimpleType» gYearMonth {id = "gYearMonth"}
«XSDsimpleType» gYear {id = "gYear"}
«map»
{default}

Figure 44 -- UML to XML schema type map (2)

Transformation Results

For each class in the transformation destination set, the «XSDcomplexType» stereotype is applied, unless this class is derived from the simple XML type (that is, one of the basic types, or type, stereotyped with XSDsimpleType). In that case a «XSDsimpleType» stereotype is applied.

If the class is derived from another class, which is stereotyped as «XSDcomplexType», additionally the «XSDcomplexContent» stereotype is applied on this class with «XSDextension» on the corresponding generalization relationship.

If the class is derived from another class, which is stereotyped as «XSDsimpleType», additionally the «XSDrestriction» stereotype is applied on the corresponding generalization relationship.

If the class is not derived from anything, and has attributes with the **XSDelement** tag, the «XSDcomplexContent» stereotype is applied on this class.

If the class is not derived from anything, and has no attributes with the **XSDelement** tag, no «XXXXContent» stereotype is applied on this class - the class has an empty content.

The UML datatypes in the transformation source set are transformed into the classes with the «XSDsimpleType» stereotype - unless after the type map this class appears to be derived from a class with the «XSDcomplexType» stereotype. Then the «XSDcomplexType» stereotype is used.

For each attribute of the class, which is NOT of the simple XML type (that is, one of the basic types, or type, stereotyped with the «XSDsimpleType») or has a multiplicity > 1, the «XSDelement» stereotype is applied.

For each composition association, linking 2 classes stereotyped as XML schema types, the stereotype on the association end is applied, the same as the rules for attributes.

Enumerations in the UML model are transformed into the enumerations in the XML Schema model (classes with the «XSDsimpleType» stereotype are derived by restriction from the XML string type, where all the elements of the original enumeration are converted into the attributes with an «XSDenumeration» stereotype).

For each package in the transformation set, the «XSDnamespace» stereotype is applied.

In each package, one additional class for the XML schema is created. The name of the schema class is constructed by taking the name of the package and then appending the .xsd to it (e.g. if the package in the source model set is named "user", then name the schema class "user.xsd" in the destination package).

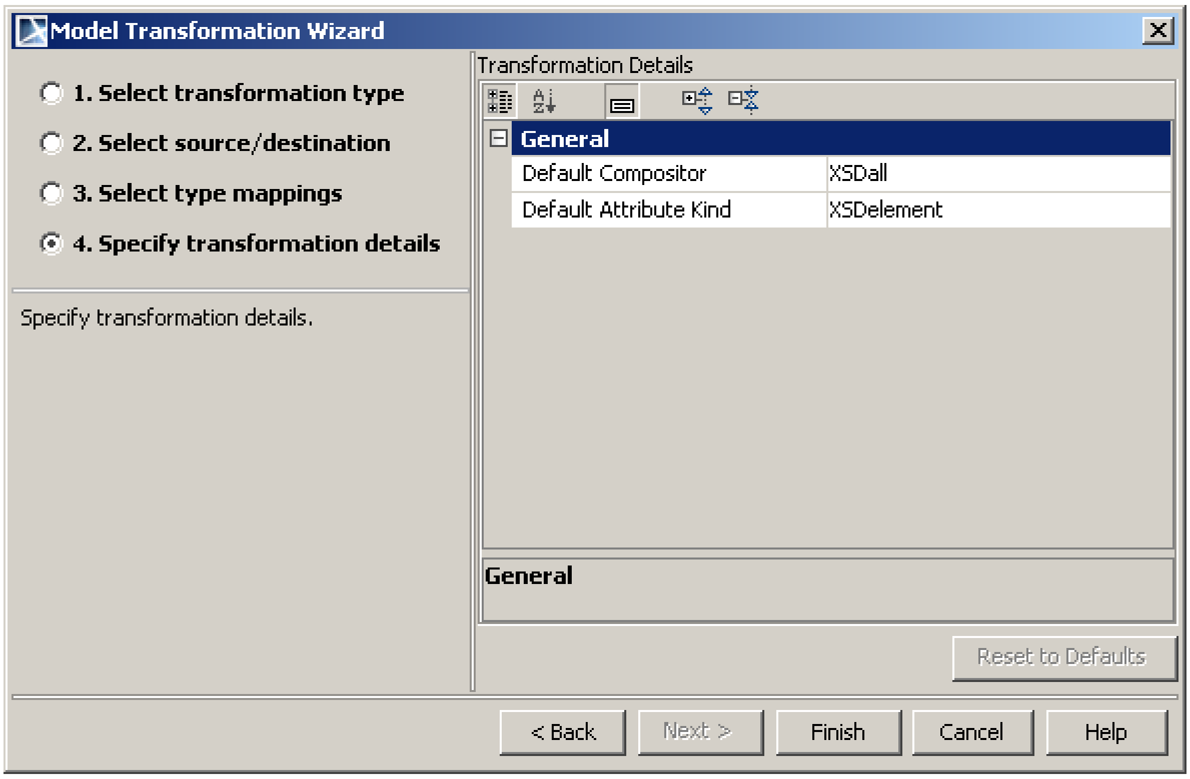
The targetNamespace value is added to the schema class, with the name of it's parent (e.g. if the schema is placed in the "http://magicdraw.com/User" package, the targetNamespace=" http://magicdraw.com/User" is set on the schema class).

Schema class and the namespaces http://www.w3c.org/2001/XMLSchema [XML Schema profile] and its target namespace are linked using the xmlns relationships. The names of these links are: the same as target namespace, for the link to target namespace; "xs" for the XML Schema namespace.

Class diagrams are transformed into XML Schema diagrams.

The model elements, which have no meaning in the XML schemas, are discarded. This includes (without limitation) behavioral features of classes, interfaces, actors, use cases, states, activities, objects, messages, stereotypes and tag definitions.

There are additional properties to choose for UML to XML Schema transformation in the **ModelTransformation Wizard** (for more information about the wizard, see “Model Transformations” in *MagicDraw UserManual.pdf*.)


Model Transformation Wizard
1. Select transformation type
2. Select source/destination
3. Select type mappings
4. Specify transformation details
Transformation Details
General
Reset to Defaults
< Back
Next >
Finish
Cancel
Help

Specify transformation details.

Default Compositor	XSDall
Default Attribute Kind	XSDelement

Figure 45 -- Model Transformation Wizard for UML to XML Schema transformation. Specify Transformation Details

Option name	Type	Description
Default Compositor	**Combo box**	Possible choices: XSDall, XSDchoice, XSDsequence Determines element grouping in complex types of XML Schema. Default: XSDall
Default Attribute Kind	**Combo box**	Determines to what attribute kind, XSDelement or XSDattribute UML attribute will be mapped. Default: XSDelement

XML Schema to UML Transformation

The XML Schema to UML transformation helps to extract the abstract UML model from the XML schema model.

Type Mapping

Type maps store mapping between primitive UML data types and primitive XML Schema data types, the same applies for UML to XML Schema Transformation just in reversed order. For XML Schema to UML element type mapping diagram, see “Type Mapping” on page 84.

Transformation Results

The XML Schema diagrams are transformed to the Class diagrams.

Unnecessary stereotypes (XSDxxxx) are discarded from the classes.

Attributes of the classes are gathered if they were spread into several different classes.

Attributes of the classes may be realized as associations. In this case the main class gathers all the associations of the members.

The same principle is applied when elements are in a group, shared by two or more classes. Elements (attributes) are copied into both destination classes.

The attributes with the «XSDgroupRef» stereotype are treated as if the group relationship has been drawn and transformed accordingly - discarded in the UML model, and the group content (elements / attributes) placed in their place.

Simple XML schema types (classes with the «XSDsimpleType» stereotype), which after copying and type remap happen to be derived from any data type (UML DataType) or not derived from anything and are transformed into the UML data types.

Simple XML schema types, which are derived by restriction from string and are restricted by enumerating string values and are converted into enumerations in the UML diagrams.

The classes with the «XSDschema» stereotype are not copied into a destination model.

The «XDSkey», «XSDkeyref», and «XSDunique» stereotyped attributes are not copied into a destination model.

The «XDSany», «XSDanyAttribute» stereotyped attributes are not copied into a destination model.

The «XDSnotation» stereotyped attributes are not copied into a destination model.

The «XDSlength», «XDSminLength», «XDSmaxLength», «XSDpattern», «XSDfractionDigits», «XSDtotalDigits», «XDSmaxExclusive», «XDSmaxInclusive», «XDSminExclusive», and «XDSminInclusive» stereotyped attributes are not copied into a destination model.

The XML schemas (classes with the «XSDschema» stereotype) should not be transformed, but they may contain inner classes (anonymous types of schema elements). These inner classes are transformed using usual rules for UML type transformation - as if they were not inner classes but normal XML schema types.

ENTITY-RELATIONSHIP AND SQL REPORT

MagicDraw provides a report template for generating reports of the data models. The report template is suitable for reporting both ER and SQL models. If your project contains both ER and SQL models, a unified report covering both models can be produced.

The report can be generated using the Report Wizard feature.

To generate a report

1. On the **Tools** menu, click **Report Wizard**.
2. In the **Select Template** area, select **Data Modeling** > **Entity-Relationship and DDL Report** and then click **Next >**.
3. Click **Next >** again.

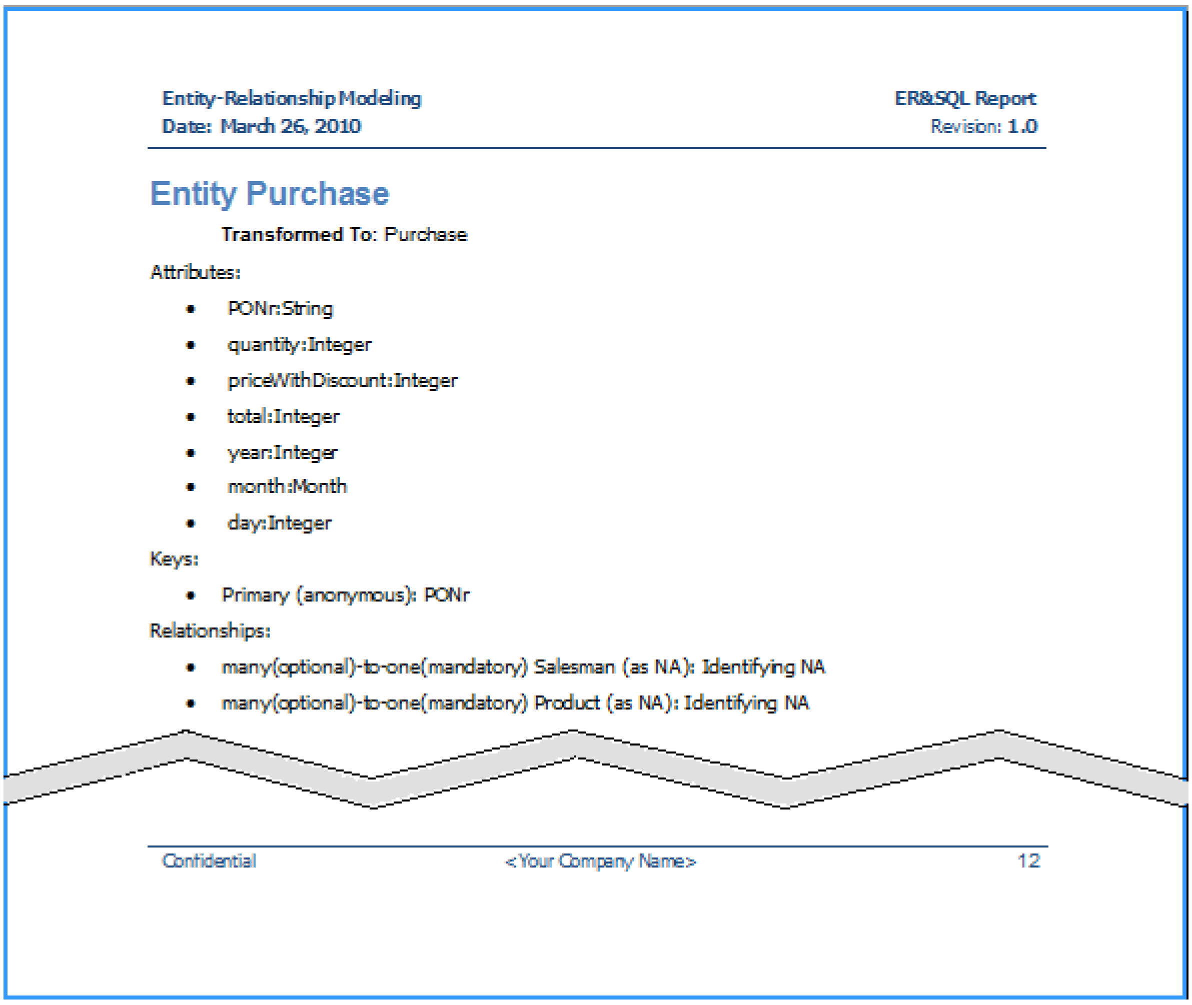
NOTE	In this step, you can edit report variables. To start editing variables, click the **Variable** button.

4. In the **Select Element Scope** area, define the scope for the report, using the buttons placed between the two lists, and then click **Next >**.
5. In the **Output Options** area, define the appropriate options.
6. Click **Generate**. Wait a moment while the report is generated (generation time depends on the selected scope).

The Report Wizard produces an .rtf file. This file contains sections for each reported model entity, its attributes, relationships with other entities (both simple relationships and generalization / specialization relationships), and keys. The SQL part of the file contains sections for each table (with its columns, constraints, indexes, and triggers), each standalone sequence, each global procedure or function, each user defined type (with its attributes and methods), and each authorization identifier (users, groups, roles, and permissions).

The report has a boilerplate beginning and includes a cover page, table of contents, and a table of figures. Sections such as “Purpose”, “Scope”, “Overview”, and “Revision History” can be customized by changing the predefined report variables (see the 3rd step of the report generation procedure, described above). The report also has an appendix containing all the diagrams in your model.

If the model contains both ER and SQL models and is linked by traceability references, the report will link (with active references) the appropriate report sections of entities and tables that are traceable in the model.



Entity-Relationship Modeling
Date: March 26, 2010

ER&SQL Report
Revision: 1.0

Entity Purchase

Transformed To: Purchase

Attributes:

- PONr:String
- quantity:Integer
- priceWithDiscount:Integer
- total:Integer
- year:Integer
- month:Month
- day:Integer

Keys:

- Primary (anonymous): PONr

Relationships:

- many(optional)-to-one(mandatory) Salesman (as NA): Identifying NA
- many(optional)-to-one(mandatory) Product (as NA): Identifying NA

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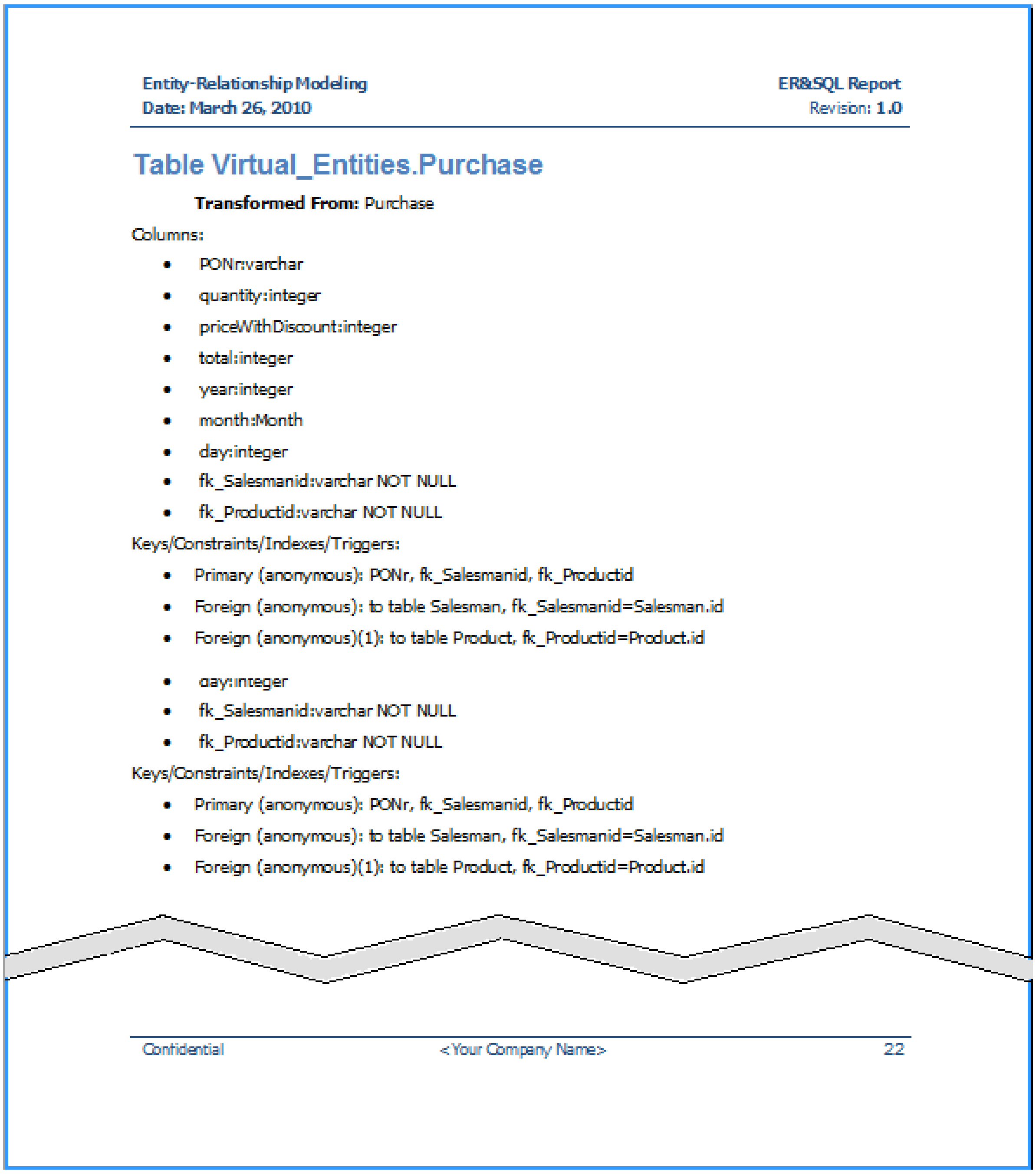
Figure 46 -- Fragment of ER model report example



Entity-Relationship Modeling
Date: March 26, 2010

ER&SQL Report
Revision: 1.0

Table Virtual_Entities.Purchase

Transformed From: Purchase

Columns:

- PONr:varchar
- quantity:integer
- priceWithDiscount:integer
- total:integer
- year:integer
- month:Month
- day:integer
- fk_Salesmanid:varchar NOT NULL
- fk_Productid:varchar NOT NULL

Keys/Constraints/Indexes/Triggers:

- Primary (anonymous): PONr, fk_Salesmanid, fk_Productid
- Foreign (anonymous): to table Salesman, fk_Salesmanid=Salesman.id
- Foreign (anonymous)(1): to table Product, fk_Productid=Product.id

- day:integer
- fk_Salesmanid:varchar NOT NULL
- fk_Productid:varchar NOT NULL

Keys/Constraints/Indexes/Triggers:

- Primary (anonymous): PONr, fk_Salesmanid, fk_Productid
- Foreign (anonymous): to table Salesman, fk_Salesmanid=Salesman.id
- Foreign (anonymous)(1): to table Product, fk_Productid=Product.id

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Figure 47 -- Fragment of SQL model report example

XML SCHEMAS

Introduction

Reference: http://www.w3.org/TR/xmlschema-2/

XML Schema Mapping to UML Elements

Defined stereotypes

Stereotype name	Base Stereotype	Applies on	Defined TagDefinitions
XSDcomponent		Class Attribute AssociationEnd Binding Generalization Comment Component	id – string Details: The base and abstract stereotype for all XML Schema stereotypes used in UML profile
XSDattribute	XSDcomponent	Attribute	fixed – some fixed element value form – (*qualified* | *unqualified*) refString – string representation of reference to other attribute. ref – actual reference to other attribute use – (*optional* | *prohibited* | *required*) : optional
XSDelement	XSDcomponent	Attribute AssociationEnd	abstract – (true | false) block - (extension | restriction | substitution) final - (extension | restriction) fixed – some fixed element value form - (*qualified* | *unqualified*) nillable – (true | false) refString – string representation of reference to other attribute. ref – actual reference to other attribute substitutionGroup – actual reference to UML ModelElement substitutionGroupString – string representation of substitution group key_unique_keyRef – a list of referenced UML Attributes sequenceOrder – a number in sequence order
XSDcomplexType	XSDcomponent	Class	block – (*extension* | *restriction)* final – (*extension* | *restriction*) mixed – (true | false)
XSDsimpleContent		Class	simpleContentId – string
XSDcomplexContent		Class	complexContentId – string complexContentMixed
XSDgroup	XSDcomponent	Class	

Stereotype name	Base Stereotype	Applies on	Defined TagDefinitions
XSDgroupRef	XSDcomponent	Attribute AssociationEnd	sequenceOrder – a number in sequence order
XSDall		Class	allId – string maxOccurs minOccurs
XSDchoice		Class	choiceId – string maxOccurs minOccurs sequenceOrder – a number in sequence order
XSDsequence		Class	sequenceId – string maxOccurs minOccurs sequenceOrder – a number in sequence order
XSDrestriction	XSDcomponent	Generalization	
XSDextension	XSDcomponent	Generalization	
XSDattributeGroup	XSDcomponent	Class	
XSDsimpleType	XSDcomponent	Class	final - (#all | (list | union | restriction))
XSDlist	XSDcomponent	Class	listId - string
XSDunion	XSDcomponent	Class	unionId - string
XSDannotation	XSDcomponent	Comment	appInfoSource appInfoContent source xml:lang
XSDany	XSDcomponent	Attribute	namespace – string processContents - (lax | skip | strict); default strict sequenceOrder – a number in sequence order
XSDanyAttribute	XSDcomponent	Attribute	namespace – string processContents - (lax | skip | strict); default strict
XSDschema	XSDcomponent	Class	attributeFormDefault blockDefault elementFormDefault finalDefault targetNamespace – reference to some ModelPackage version xml:lang

Stereotype name	Base Stereotype	Applies on	Defined TagDefinitions
XSDnotation	XSDcomponent	Attribute	public system
XSDredefine	XSDcomponent	Class	
XSDimport	XSDcomponent «import»	Permision	schemaLocation
XSDinclude	XSDcomponent	Component	
XSDminExclusive	XSDcomponent	Attribute	fixed = boolean : false
XSDminInclusive	XSDcomponent	Attribute	fixed = boolean : false
XSDmaxExclusive	XSDcomponent	Attribute	fixed = boolean : false
XSDmaxInclusive	XSDcomponent	Attribute	fixed = boolean : false
XSDtotalDigits	XSDcomponent	Attribute	fixed = boolean : false
XSDfractionDigits	XSDcomponent	Attribute	fixed = boolean : false
XSDlength	XSDcomponent	Attribute	fixed = boolean : false
XSDminLength	XSDcomponent	Attribute	fixed = boolean : false
XSDmaxLength	XSDcomponent	Attribute	fixed = boolean : false
XSDwhiteSpace	XSDcomponent	Attribute	fixed = boolean : false value
XSDpattern	XSDcomponent	Attribute	
XSDenumeration	XSDcomponent	Attribute	
XSDunique		Attribute	selector field
XSDkey		Attribute	selector field
XSDkeyref		Attribute	selector field refer – UML Attribute referString - String
XSDnamespace		ModelPackage	
xmlns		Permission	

attribute

- XML schema attribute maps to UML Attribute with stereotype *XSDattribute*.
- *default* maps to initial UML Attribute or AssociationEnd value.
- annotation – to UML Attribute or AssociationEnd documentation.
- name – to UML Attribute or AssociationEnd name.
- type or content simpleType – to UML Attribute or AssociationEnd type.

Other attributes or elements maps to corresponding tagged values.

```
<attribute
  default = string
  fixed = string
  form = (qualified    | unqualified    )
  id = ID
  name = NCName
  ref = QName
  type = QName
  use = (optional    | prohibited    | required   ) : optional
  {any attributes with non-schema namespace . . .}              >
  Content:   (annotation?, (simpleType?))
</attribute>
```

Example:

<xs:attribute name="age" type="xs:positiveInteger" use="required"/>

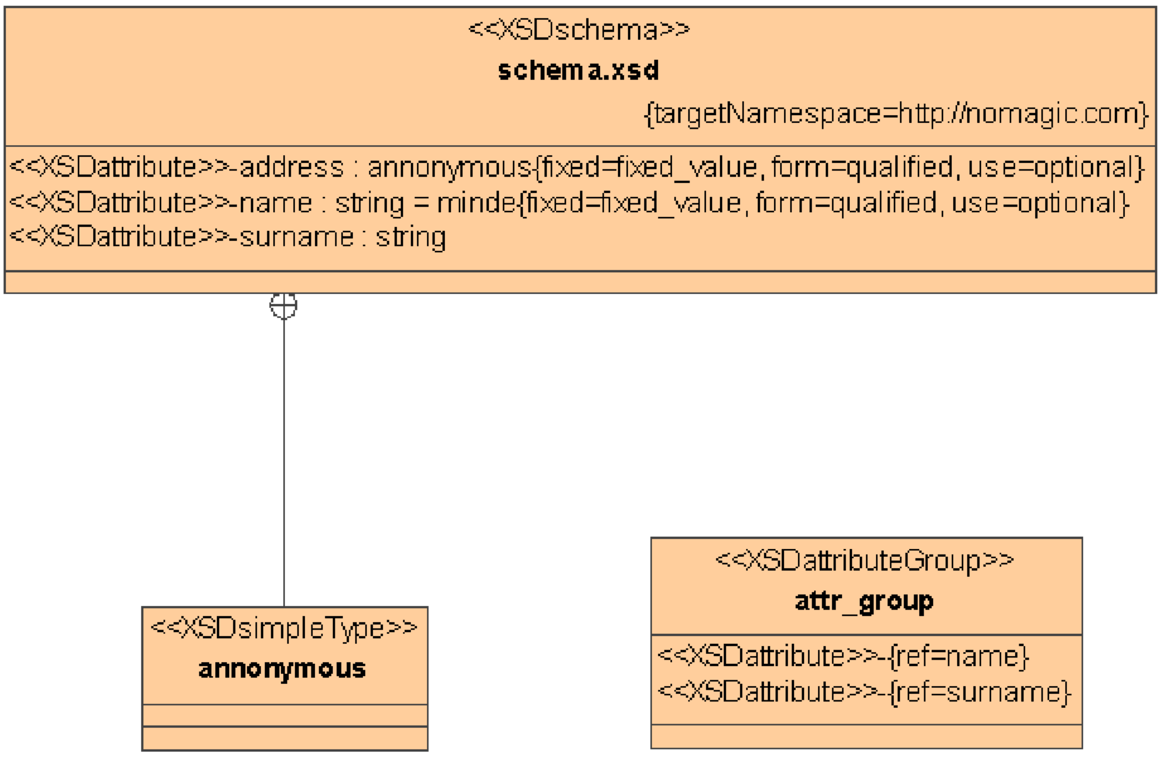
ref value is generated from ref or refString TaggedValue.

One of ref or name must be present, but not both.

If ref is present, then all of <simpleType>, form and type must be absent.

type and <simpleType> must not both be present.

attribute UML Model example:


<<XSDschema>>
schema.xsd
{targetNamespace=http://nomagic.com}
<<XSDattribute>>-address : annonymous{fixed=fixed_value, form=qualified, use=optional}
<<XSDattribute>>-name : string = minde{fixed=fixed_value, form=qualified, use=optional}
<<XSDattribute>>-surname : string
<<XSDsimpleType>>
annonymous
<<XSDattributeGroup>>
attr_group
<<XSDattribute>>-{ref=name}
<<XSDattribute>>-{ref=surname}

<xs:schema xmlns:nm = "http://nomagic.com" xmlns:xs = "http://www.w3.org/2001/XMLSchema" targetNamespace = "http://nomagic.com"

```
      <xs:attribute name = "name" type = "xs:string" default = "minde"
fixed = "fixed_value" form = "qualified" use = "optional" >
            <xs:annotation >
                  <xs:documentation >name attribute
documentation</xs:documentation>
            </xs:annotation>
      </xs:attribute>
      <xs:attribute name = "address" fixed = "fixed_value" form =
"qualified" use = "optional" >
            <xs:annotation >
                  <xs:documentation >surname attribute
documentation</xs:documentation>
            </xs:annotation>
            <xs:simpleType >
                  <xs:restriction base = "xs:string" />
            </xs:simpleType>
      </xs:attribute>
      <xs:attribute name = "surname" type = "xs:string" />
      <xs:attributeGroup name = "attr_group" >
            <xs:attribute ref = "nm:name" >
                  <xs:annotation >
                        <xs:documentation >reference
documentation</xs:documentation>
                  </xs:annotation>
            </xs:attribute>
            <xs:attribute ref = "nm:surname" />
      </xs:attributeGroup>
</xs:schema>
```

element

Maps to UML Attribute or UML AssociationEnd with stereotype *XSDelement*.

- annotation – to UML Attribute or UML AssociationEnd documentation.
- default - to initial UML Attribute or UML AssociationEnd value.
- maxOccurs - to multiplicity upper range. Value unbounded maps to asterisk in UML.
- minOccurs – to multiplicity lower range.
- name – to UML Attribute or UML AssociationEnd name.
- type or content (simpleType | complexType) – to UML Attribute or UML AssociationEnd type.

Other properties maps to corresponding tagged values.

XML Representation Summary: element Element Information Item

```
<element
  abstract = boolean : false
  block = (#all | List of (extension | restriction | substitution))
  default = string
  final = (#all | List of (extension | restriction))
  fixed = string
  form = (qualified | unqualified)
  id = ID
  maxOccurs = (nonNegativeInteger | unbounded)  : 1
  minOccurs = nonNegativeInteger : 1
  name = NCName
  nillable = boolean : false
  ref = QName
  substitutionGroup = QName
  type = QName
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?, ((simpleType | complexType)?, (unique | key | keyr
</element>
```

ref value is generated from ref or refString TaggedValue.

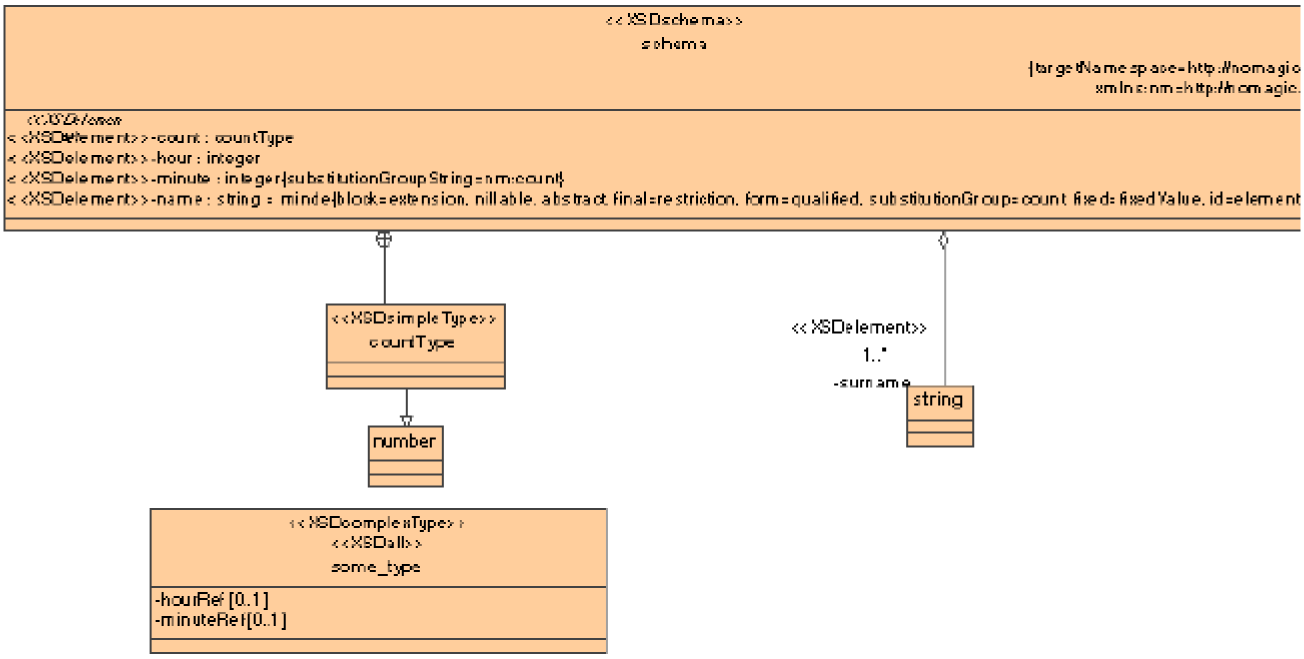
One of ref or name must be present, but not both.

If ref is present, then all of <complexType>, <simpleType>, <key>, <keyref>, <unique>, nillable, default, fixed, form, block and type must be absent, i.e. only minOccurs, maxOccurs, id are allowed in addition to ref, along with <annotation>

Example:

```
<xs:element name="PurchaseOrder" type="PurchaseOrderType"/>

<xs:element name="gift">
 <xs:complexType>
  <xs:sequence>
   <xs:element name="birthday" type="xs:date"/>
   <xs:element ref="PurchaseOrder"/>

 </xs:complexType>
</xs:element>
```

element UML Model example:



<<XSDschema>>
schema
{targetNamespace=http://nomagic
xmlns:nm=http://nomagic.
<<XSDelemen
<<XSDelement>>-count : countType
<<XSDelement>>-hour : integer
<<XSDelement>>-minute : integer{substitutionGroupString=nm:count}
<<XSDelement>>-name : string = minde{block=extension, nillable, abstract, final=restriction, form=qualified, substitutionGroup=count, fixed=fixedValue, id=element
<<XSDsimpleType>>
countType
number
<<XSDelement>>
1..*
-surname
string
<<XSDcomplexType>>
<<XSDall>>
some_type
-hourRef [0..1]
-minuteRef [0..1]

```
<xs:schema xmlns:nm = "http://nomagic.com" xmlns:xs =
"http://www.w3.org/2001/XMLSchema" targetNamespace = "http://nomagic.com" >
      <xs:element name = "name" type = "xs:string" default = "minde" id = "elementID"
abstract = "true" block = "extension" final = "restriction" fixed = "fixedValue" form =
"qualified" nillable = "true" substitutionGroup = "nm:count" >
            <xs:annotation >
                  <xs:documentation >element name documentation</xs:documentation>
            </xs:annotation>
      </xs:element>
      <xs:element name = "count" >
            <xs:annotation >
                  <xs:documentation >element count documenation</xs:documentation>
            </xs:annotation>
            <xs:simpleType >
                  <xs:restriction base = "xs:number" />
            </xs:simpleType>
      </xs:element>
      <xs:element name = "hour" type = "xs:integer" />
      <xs:element name = "minute" type = "xs:integer" substitutionGroup = "nm:count" />
      <xs:element name = "surname" type = "xs:string" minOccurs = "1" maxOccurs =
"unbounded" />
      <xs:complexType name = "some_type" >
            <xs:all >
                  <xs:element ref = "nm:hour" minOccurs = "0" maxOccurs = "1" >
                        <xs:annotation >
                              <xs:documentation >hour ref
documentatuion</xs:documentation>
                        </xs:annotation>
                  </xs:element>
                  <xs:element ref = "nm:minute" minOccurs = "0" maxOccurs = "1" />
            </xs:all>
      </xs:complexType>
```

complexType

Complex type maps to UML Class with stereotype XSDcomplexType.

- abstract - to UML Class abstract value(true | false).
- annotation - to UML Class documentation.
- attribute – to inner UML Class Attribute or UML Association End.
- attributeGroup – to UML AssociationEnd or UML Attribute with type XSDattributeGroup.

name – to UML Class name.

This class also can have stereotypes XSDsimpleContent, XSDcomplexContent, XSDall, XSDchoice, XSDsequence.

No stereotype – the same as “XSDsequence”.

Generalization between complex type and other type has stereotype XSDrestriction or XSDextension. We assume stereotype XSDextension if generalization do not have stereotype.

Some complex mapping:

- complexType with simpleContent – to UML Class. This class must be derived from other class and can must have stereotype XSDsimpleContent.
- complexType with complexContent – to UML Class. This class must be derived from other class and must have stereotype XSDcomplexContent.

complexType with group, all, choice or sequence – to UML class with appropriate stereotype.

```
<complexType
  abstract = boolean : false
  block = (#all | List of (extension | restriction))
  final = (#all | List of (extension | restriction))
  id = ID
  mixed = boolean : false
  name = NCName
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?, (simpleContent | complexContent | ((group | al
((attribute | attributeGroup)*, anyAttribute?))))
</complexType>
```

When the <simpleContent> alternative is chosen, the following elements are relevant, and the remaining property mappings are as below. Note that either <restriction> or <extension> must be chosen as the content of <simpleContent>

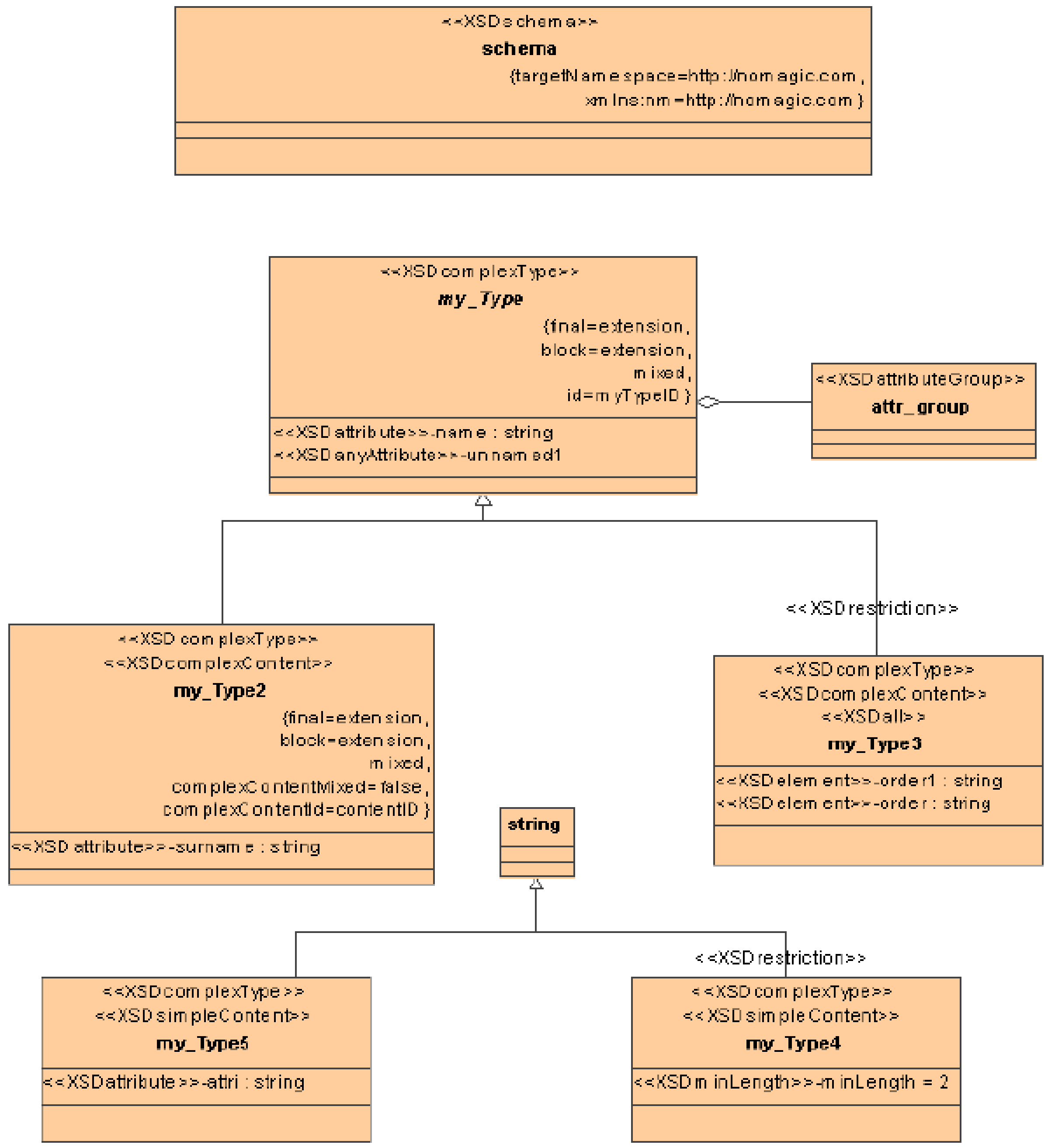
```
<simpleContent
  id = ID
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?, (restriction | extension))
</simpleContent>
<restriction
  base = QName
  id = ID
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?, (simpleType?, (minExclusive | minInclusive | maxE
maxInclusive | totalDigits | fractionDigits | length | minLength | maxLeng
whiteSpace | pattern)*)?, ((attribute | attributeGroup)*, anyAttribute?))
</restriction>
<extension
  base = QName
  id = ID
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?, ((attribute | attributeGroup)*, anyAttribute?))
</extension>
<attributeGroup
  id = ID
  ref = QName
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</attributeGroup>
<anyAttribute
```

When the <complexContent> alternative is chosen, the following elements are relevant (as are the <attributeGroup> and <anyAttribute> elements, not repeated here), and the additional property mappings are as below. Note that either <restriction> or <extension> must be chosen as the content of <complexContent>, but their content models are different in this case from the case above when they occur as children of <simpleContent>.

The property mappings below are also used in the case where the third alternative (neither <simpleContent> nor <complexContent>) is chosen. This case is understood as shorthand for complex content restricting the **ur-type definition**, and the details of the mappings should be modified as necessary.

```
<complexContent
  id = ID
  mixed = boolean
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?, (restriction | extension))
</complexContent>
<restriction
  base = QName
  id = ID
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?, (group | all | choice | sequence)?, ((attribute |
attributeGroup)*, anyAttribute?))
</restriction>
<extension
  base = QName
  id = ID
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?, ((group | all | choice | sequence)?, ((attribute
attributeGroup)*, anyAttribute?)))
</extension>
```

complexType UML Model example:



```
<?xml version='1.0' encoding='Cp1252'?>
<xs:schema xmlns:nm = "http://nomagic.com" xmlns:xs =
"http://www.w3.org/2001/XMLSchema" targetNamespace = "http://nomagic.com" >
      <xs:complexType name = "my_Type2" block = "extension" final =
"extension" mixed = "true" >
            <xs:annotation >
                  <xs:documentation >my_type2
documentation</xs:documentation>
            </xs:annotation>
            <xs:complexContent id = "contentID" mixed = "false" >
                  <xs:extension base = "nm:my_Type" >
                        <xs:attribute name = "surname" type = "xs:string" />
                  </xs:extension>
            </xs:complexContent>
      </xs:complexType>
      <xs:complexType name = "my_Type3" >
            <xs:complexContent >
                  <xs:restriction base = "nm:my_Type" >
                        <xs:all >
                              <xs:element name = "order" type = "xs:string"
/>
                              <xs:element name = "order1" type = "xs:string"
/>
                        </xs:all>
                  </xs:restriction>
            </xs:complexContent>
      </xs:complexType>
      <xs:complexType name = "my_Type4" >
            <xs:simpleContent >
                  <xs:restriction base = "xs:string" >
                        <xs:minLength value = "2" />
                  </xs:restriction>
            </xs:simpleContent>
      </xs:complexType>
      <xs:complexType name = "my_Type5" >
            <xs:simpleContent >
                  <xs:extension base = "xs:string" >
                        <xs:attribute name = "attri" type = "xs:string" />
                  </xs:extension>
            </xs:simpleContent>
      </xs:complexType>
      <xs:complexType name = "my_Type" abstract = "true" block = "extension"
final = "extension" id = "myTypeID" mixed = "true" >
            <xs:annotation >
                  <xs:documentation >my_type
documentation</xs:documentation>
            </xs:annotation>
            <xs:attribute name = "name" type = "xs:string" />
            <xs:attributeGroup ref = "nm:attr_group" />
            <xs:anyAttribute />
      </xs:complexType>
      <xs:attributeGroup name = "attr_group" />
</xs:schema>
```

attributeGroup

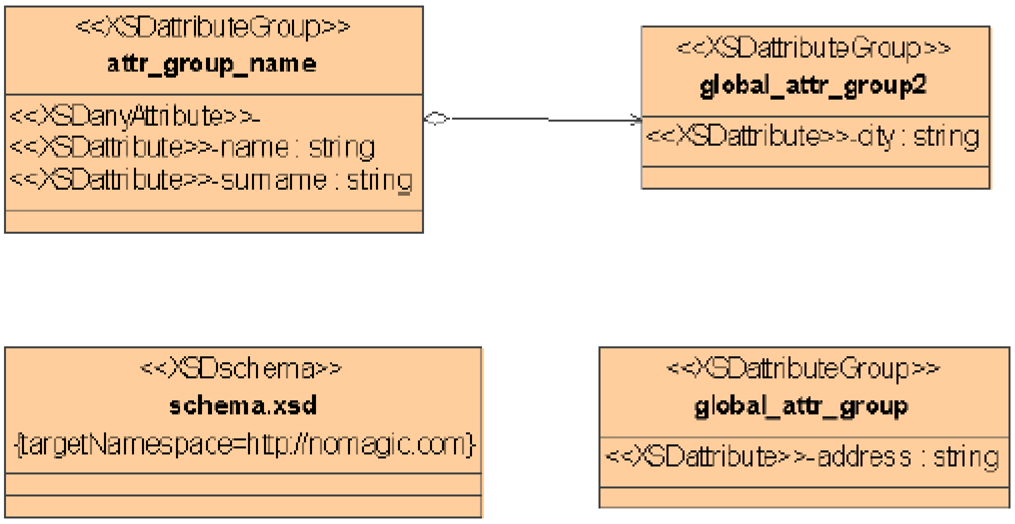
attributeGroup maps to simple UML Class with stereotype XSDattributeGroup.

- name – to UML Class name
- annotation – to UML Class documentation
- attribute – to inner UML Attribute or AssociationEnd with XSDattribute
- stereotype.
- attributeGroup - inner attributeGroup always must be just reference. Such reference maps to Attribute or AssociationEnd with type of referenced attributeGroup. The opposite Association End kind must be aggregated and it must be navigable.
- anyAttribute – to inner UML Attribute with stereotype *XSDanyAttribute*.

If reference is generated, name is not generated.

When an **<attributeGroup>** appears as a daughter of **<schema>** or **<redefine>**, it corresponds to an attribute group definition as below. When it appears as a daughter of **<complexType>** or **<attributeGroup>**, it does not correspond to any component as such.

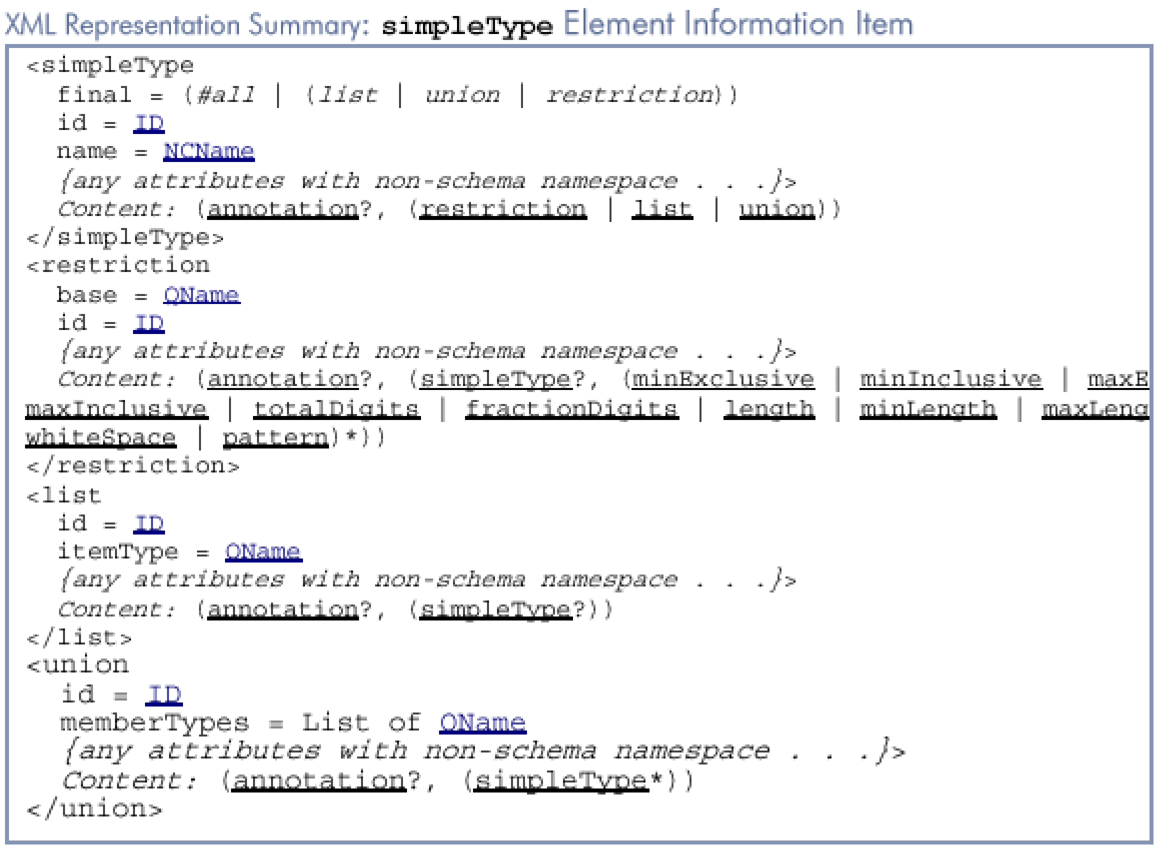
attributeGroup UML Model example:


<<XSDattributeGroup>>
attr_group_name
<<XSDanyAttribute>>-
<<XSDattribute>>-name : string
<<XSDattribute>>-surname : string
<<XSDattributeGroup>>
global_attr_group2
<<XSDattribute>>-city : string
<<XSDschema>>
schema.xsd
{targetNamespace=http://nomagic.com}
<<XSDattributeGroup>>
global_attr_group
<<XSDattribute>>-address : string

```
<xs:schema xmlns:nm = "http://nomagic.com" xmlns:xs =
"http://www.w3.org/2001/XMLSchema" targetNamespace = "http://nomagic.com"
>
      <xs:attributeGroup name = "global_attr_group" >
            <xs:attribute name = "address" type = "xs:string" />
      </xs:attributeGroup>
      <xs:attributeGroup name = "attr_group_name" >
            <xs:annotation >
                  <xs:documentation >attribute group
documentation</xs:documentation>
            </xs:annotation>
            <xs:attribute name = "surname" type = "xs:string" />



             <xs:attribute name = "name" type = "xs:string" >
                   <xs:annotation >
                         <xs:documentation >name attribute
 documentation</xs:documentation>
                   </xs:annotation>
             </xs:attribute>
             <xs:attributeGroup ref = "nm:global_attr_group2" >
                   <xs:annotation >
                         <xs:documentation >reference
 documentation</xs:documentation>
                   </xs:annotation>
             </xs:attributeGroup>
             <xs:anyAttribute />
       </xs:attributeGroup>
       <xs:attributeGroup name = "global_attr_group2" >
             <xs:attribute name = "city" type = "xs:string" />
       </xs:attributeGroup>
 </xs:schema>
```

simpleType

Maps to UML Class with stereotype *XSDsimpleType*.


XML Representation Summary: `simpleType` Element Information Item

```
<simpleType
  final = (#all | (list | union | restriction))
  id = ID
  name = NCName
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?, (restriction | list | union))
</simpleType>
<restriction
  base = QName
  id = ID
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?, (simpleType?, (minExclusive | minInclusive | maxE
maxInclusive | totalDigits | fractionDigits | length | minLength | maxLeng
whiteSpace | pattern)*))
</restriction>
<list
  id = ID
  itemType = QName
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?, (simpleType?))
</list>
<union
  id = ID
  memberTypes = List of QName
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?, (simpleType*))
</union>
```

Example:

```
<xs:simpleType name="farenheitWaterTemp">
 <xs:restriction base="xs:number">
  <xs:fractionDigits value="2"/>
  <xs:minExclusive value="0.00"/>
  <xs:maxExclusive value="100.00"/>
 </xs:restriction>
</xs:simpleType>
```

The XML representation of a simple type definition.

restriction

To specify restriction generalization must be used between this class and super class. This generalization has or do not have *XSDrestriction* stereotype. Restriction id and annotation maps to Generalization properties.

In order to have inner simpleType element, parent of this Generalization must be inner Class of outer UML Class.

list

UML Class must have additional stereotype *XSDlist*.

Binding between this class and XSD:list must be provided.

“itemsType” maps to UML TemplateArgument from Binding.

union

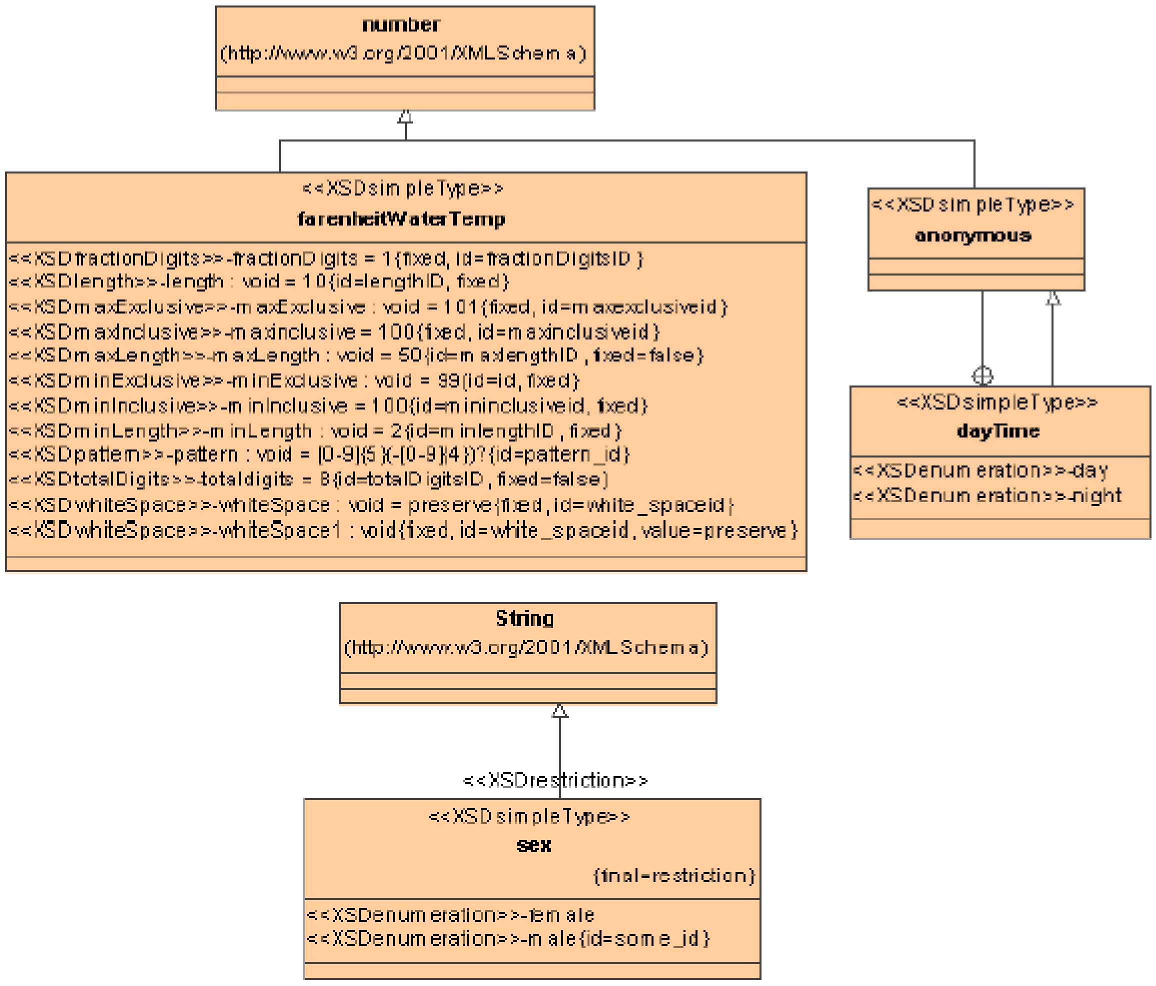
UML Class must have additional stereotype *XSDunion*.

“memberTypes” and inner simpleTypes maps to several UML Generalizations between this simple type and members types.

In order to have inner simpleType element, parent of this Generalization must be inner Class of outer UML Class.

Example:

Restriction example


number
(http://www.w3.org/2001/XMLSchema)
<<XSDsimpleType>>
farenheitWaterTemp
<<XSDfractionDigits>>-fractionDigits = 1{fixed, id=fractionDigitsID}
<<XSDlength>>-length : void = 10{id=lengthID, fixed}
<<XSDmaxExclusive>>-maxExclusive : void = 101{fixed, id=maxexclusiveid}
<<XSDmaxInclusive>>-maxinclusive = 100{fixed, id=maxinclusiveid}
<<XSDmaxLength>>-maxLength : void = 50{id=maxlengthID, fixed=false}
<<XSDminExclusive>>-minExclusive : void = 99{id=id, fixed}
<<XSDminInclusive>>-minInclusive = 100{id=mininclusiveid, fixed}
<<XSDminLength>>-minLength : void = 2{id=minlengthID, fixed}
<<XSDpattern>>-pattern : void = [0-9]{5}(-[0-9]{4})?{id=pattern_id}
<<XSDtotalDigits>>-totaldigits = 8{id=totalDigitsID, fixed=false}
<<XSDwhiteSpace>>-whiteSpace : void = preserve{fixed, id=white_spaceid}
<<XSDwhiteSpace>>-whiteSpace1 : void{fixed, id=white_spaceid, value=preserve}
<<XSDsimpleType>>
anonymous
<<XSDsimpleType>>
dayTime
<<XSDenumeration>>-day
<<XSDenumeration>>-night
String
(http://www.w3.org/2001/XMLSchema)
<<XSDrestriction>>
<<XSDsimpleType>>
sex
{final=restriction}
<<XSDenumeration>>-female
<<XSDenumeration>>-male{id=some_id}

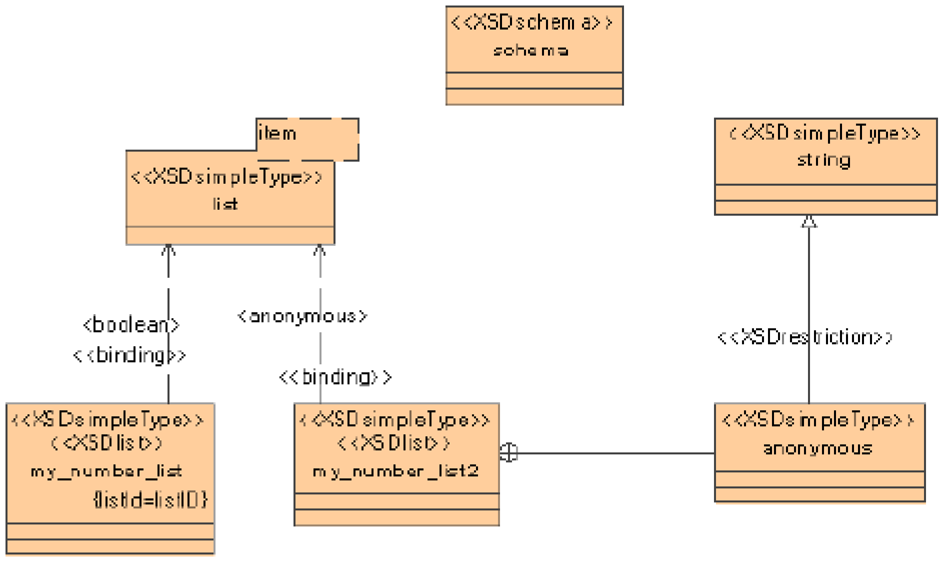
```
<xs:schema xmlns:nm = "http://nomagic.com" xmlns:xs =
"http://www.w3.org/2001/XMLSchema" targetNamespace = "http://nomagic.com" >
      <xs:simpleType name = "farenheitWaterTemp" >
            <xs:annotation >
                  <xs:documentation >documentation of simple
type</xs:documentation>
            </xs:annotation>
            <xs:restriction base = "xs:number" >
                  <xs:annotation >
                        <xs:documentation >documentation of
restriction</xs:documentation>
                  </xs:annotation>
                  <xs:pattern id = "pattern_id" value = "[0-9]{5}(-[0-
9]{4})?" >
                        <xs:annotation >
                              <xs:documentation >pattern
doc</xs:documentation>
```

```
                    </xs:annotation>
               </xs:pattern>
               <xs:whiteSpace id = "white_spaceid" fixed = "true" value =
"preserve" >
                    <xs:annotation >
                         <xs:documentation >white space
doc</xs:documentation>
                    </xs:annotation>
               </xs:whiteSpace>
               <xs:whiteSpace id = "white_spaceid" fixed = "true" value =
"preserve" >
                    <xs:annotation >
                         <xs:documentation >white space
doc</xs:documentation>
                    </xs:annotation>
               </xs:whiteSpace>
               <xs:maxLength id = "maxlengthID" fixed = "false" value =
"50" >
                    <xs:annotation >
                         <xs:documentation >max length
documentation</xs:documentation>
                    </xs:annotation>
               </xs:maxLength>
               <xs:minLength id = "minlengthID" fixed = "true" value =
"2" >
                    <xs:annotation >
                         <xs:documentation >min length
documentation</xs:documentation>
                    </xs:annotation>
               </xs:minLength>
               <xs:length id = "lengthID" fixed = "true" value = "10" >
                    <xs:annotation >
                         <xs:documentation >length
documentation</xs:documentation>
                    </xs:annotation>
               </xs:length>
               <xs:fractionDigits id = "fractionDigitsID" fixed = "true"
value = "1" >
                    <xs:annotation >
                         <xs:documentation >fraction digits
documentation</xs:documentation>
                    </xs:annotation>
               </xs:fractionDigits>
               <xs:totalDigits id = "totalDigitsID" fixed = "false" value
= "8" >
                    <xs:annotation >
                         <xs:documentation >total digits
id</xs:documentation>
                    </xs:annotation>
               </xs:totalDigits>
               <xs:maxInclusive id = "maxinclusiveid" fixed = "true"
value = "100" >
                    <xs:annotation >
                         <xs:documentation >max inclusive
documentation</xs:documentation>
                    </xs:annotation>
               </xs:maxInclusive>
               <xs:minInclusive id = "mininclusiveid" fixed = "true"
value = "100" >
```

```
                        <xs:annotation >
                              <xs:documentation >min inclusive
documentation</xs:documentation>
                        </xs:annotation>
                  </xs:minInclusive>
                  <xs:maxExclusive id = "maxexclusiveid" fixed = "true"
value = "101" >
                        <xs:annotation >
                              <xs:documentation >max exclusive
documentation</xs:documentation>
                        </xs:annotation>
                  </xs:maxExclusive>
                  <xs:minExclusive id = "id" fixed = "true" value = "99" >
                        <xs:annotation >
                              <xs:documentation >min exclusive
documentation</xs:documentation>
                        </xs:annotation>
                  </xs:minExclusive>
            </xs:restriction>
      </xs:simpleType>
      <xs:simpleType name = "dayTime" >
            <xs:annotation >
                  <xs:documentation >day time
documentation</xs:documentation>
            </xs:annotation>
            <xs:restriction >
                  <xs:annotation >
                        <xs:documentation >restriction
documentation</xs:documentation>
                  </xs:annotation>
                  <xs:simpleType >
                        <xs:restriction base = "xs:number" />
                  </xs:simpleType>
                  <xs:enumeration value = "day" >
                        <xs:annotation >
                              <xs:documentation >day
value</xs:documentation>
                        </xs:annotation>
                  </xs:enumeration>
                  <xs:enumeration value = "night" >
                        <xs:annotation >
                              <xs:documentation >night
value</xs:documentation>
                        </xs:annotation>
                  </xs:enumeration>
            </xs:restriction>
      </xs:simpleType>
      <xs:simpleType name = " sex" final = "restriction" >
            <xs:annotation >
                  <xs:documentation >documentation of simple type
restriction</xs:documentation>
            </xs:annotation>
            <xs:restriction base = "xs:string" >
                  <xs:enumeration id = "some_id" value = "male" />
                  <xs:enumeration value = "female" >
                        <xs:annotation >
                              <xs:documentation >female
value</xs:documentation>
```

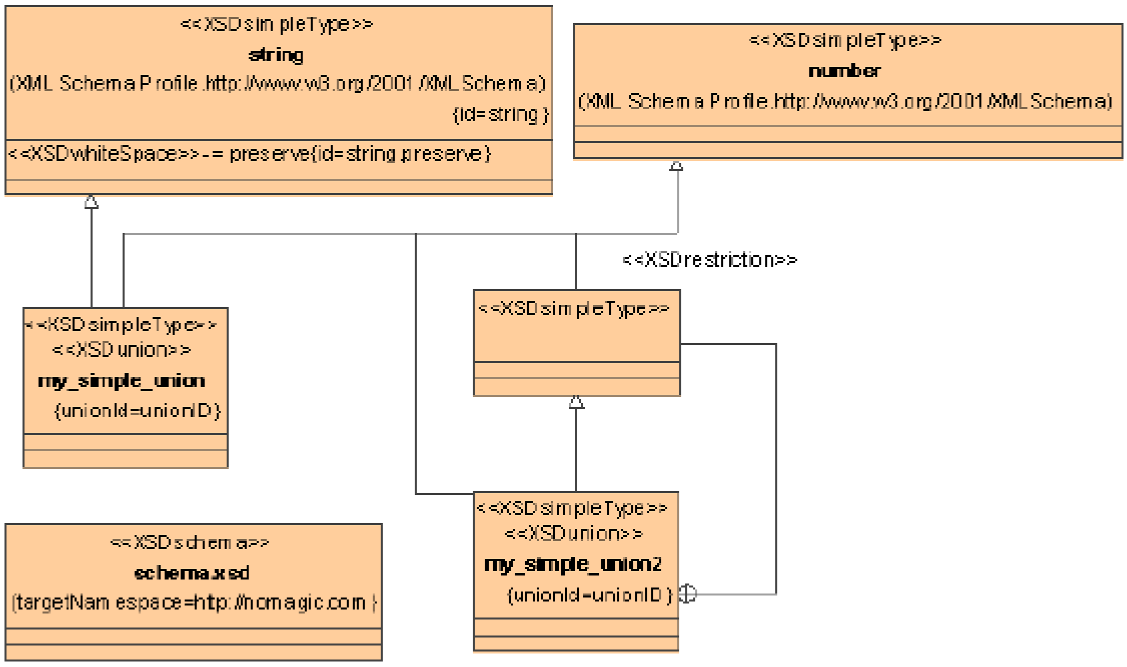
```
                        </xs:annotation>
                    </xs:enumeration>
                </xs:restriction>
            </xs:simpleType>
        </xs:schema>
```

list example



```
<?xml version='1.0' encoding='UTF-8'?>

<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema" >
      <xs:simpleType name="my_number_list2" >
            <xs:list >
                  <xs:simpleType >
                        <xs:restriction base="xs:string" />
                  </xs:simpleType>
            </xs:list>
      </xs:simpleType>
      <xs:simpleType name="my_number_list" >
            <xs:annotation >
                  <xs:documentation >my list
documentation</xs:documentation>
            </xs:annotation>
            <xs:list itemType="xs:boolean" />
      </xs:simpleType>
</xs:schema>
```

union example

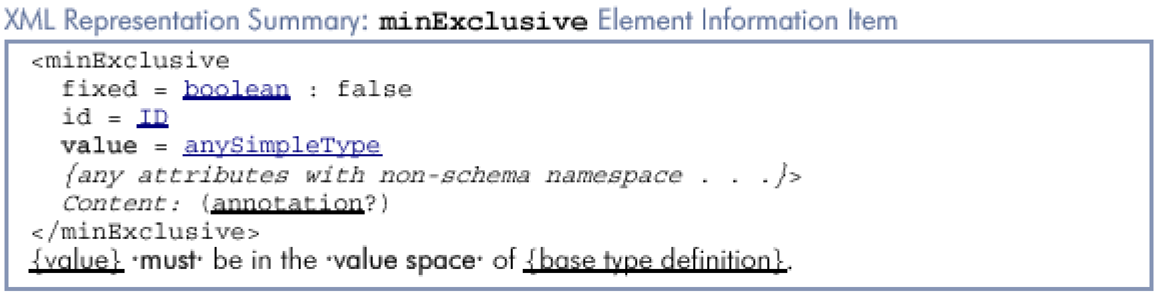


```
<xs:schema xmlns:nm = "http://nomagic.com" xmlns:xs =
"http://www.w3.org/2001/XMLSchema" targetNamespace = "http://nomagic.com" >
      <xs:simpleType name = "my_simple_union" >
            <xs:union id = "unionID" memberTypes = "xs:string xs:number" />
      </xs:simpleType>
      <xs:simpleType name = "my_simple_union2" >
            <xs:annotation >
                  <xs:documentation >very important
documentation</xs:documentation>
            </xs:annotation>
            <xs:union id = "unionID" memberTypes = "xs:number" >
                  <xs:simpleType >
                        <xs:restriction base = "xs:number" />
                  </xs:simpleType>
            </xs:union>
      </xs:simpleType>
</xs:schema>
```

minExclusive

Maps to UML Attribute with stereotype *XSDminExclusive*. Name and type of such attribute does not make sence.

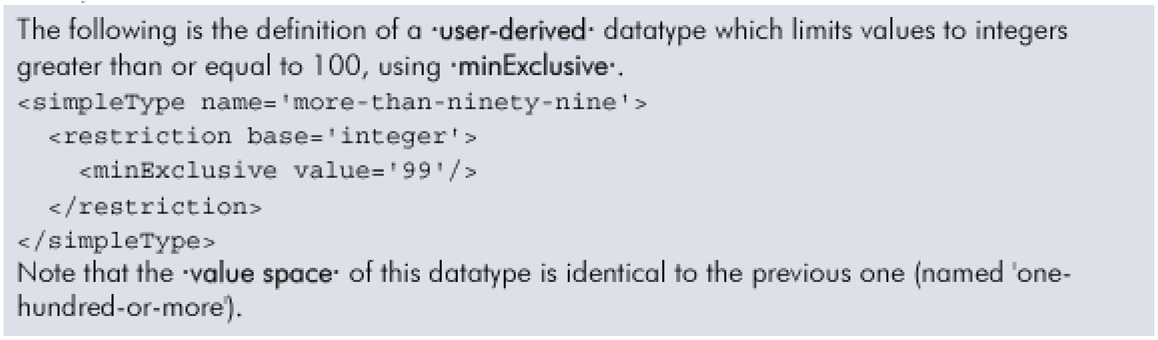
- value – to Attribute initial value.


XML Representation Summary: **minExclusive** Element Information Item

```
<minExclusive
  fixed = boolean : false
  id = ID
  value = anySimpleType
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</minExclusive>
```

{value} ·must· be in the ·value space· of {base type definition}.

Example:


The following is the definition of a ·user-derived· datatype which limits values to integers greater than or equal to 100, using ·minExclusive·.

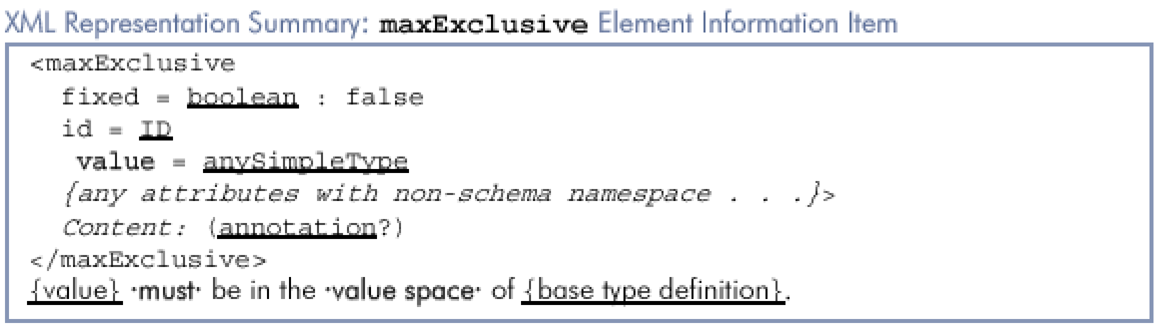
```
<simpleType name='more-than-ninety-nine'>
  <restriction base='integer'>
    <minExclusive value='99'/>
  </restriction>
</simpleType>
```

Note that the ·value space· of this datatype is identical to the previous one (named 'one-hundred-or-more').

maxExclusive

Maps to UML Attribute with stereotype *XSDmaxExclusive*. Name and type of such attribute does not make sence.

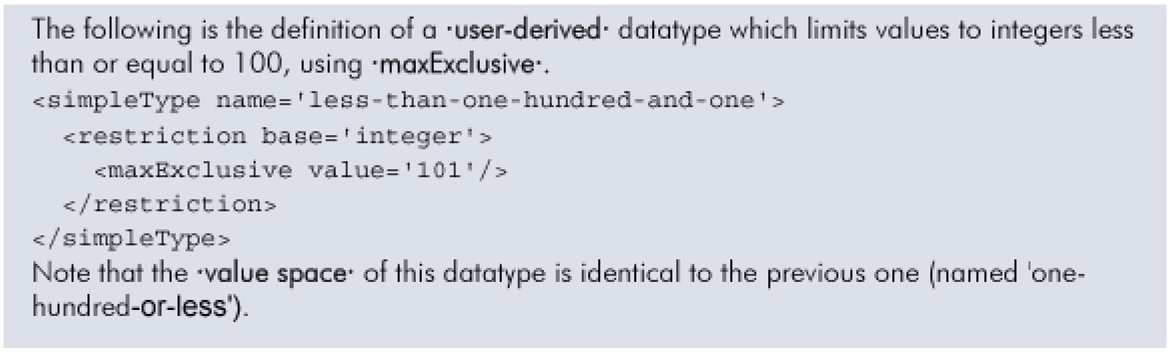
- value – to Attribute initial value.


XML Representation Summary: **maxExclusive** Element Information Item

```
<maxExclusive
  fixed = boolean : false
  id = ID
   value = anySimpleType
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</maxExclusive>
```

{value} ·must· be in the ·value space· of {base type definition}.

Example:


The following is the definition of a ·user-derived· datatype which limits values to integers less than or equal to 100, using ·maxExclusive·.

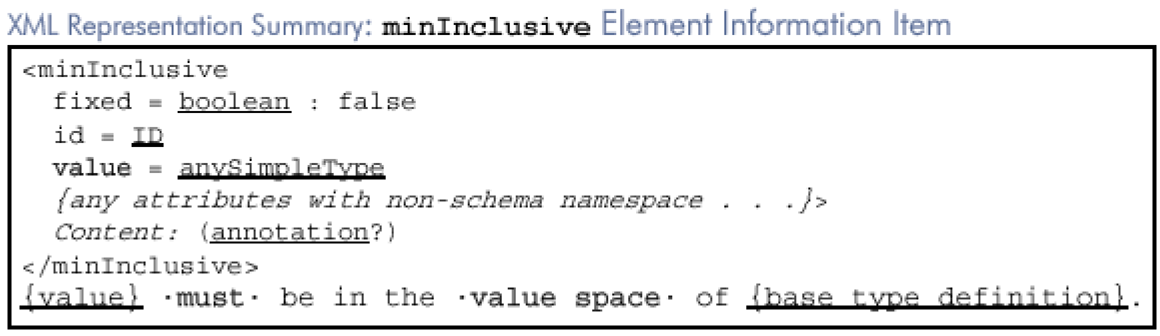
```
<simpleType name='less-than-one-hundred-and-one'>
  <restriction base='integer'>
    <maxExclusive value='101'/>
  </restriction>
</simpleType>
```

Note that the ·value space· of this datatype is identical to the previous one (named 'one-hundred-or-less').

minInclusive

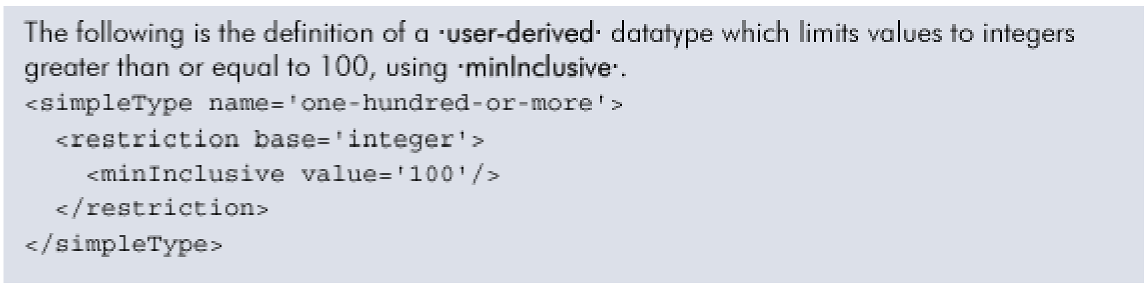
Maps to UML Attribute with stereotype *XSDminInclusive*. Name and type of such attribute does not make sence.

- value – to Attribute initial value.


XML Representation Summary: **minInclusive** Element Information Item

```
<minInclusive
  fixed = boolean : false
  id = ID
  value = anySimpleType
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</minInclusive>
{value} ·must· be in the ·value space· of {base type definition}.
```

Example:

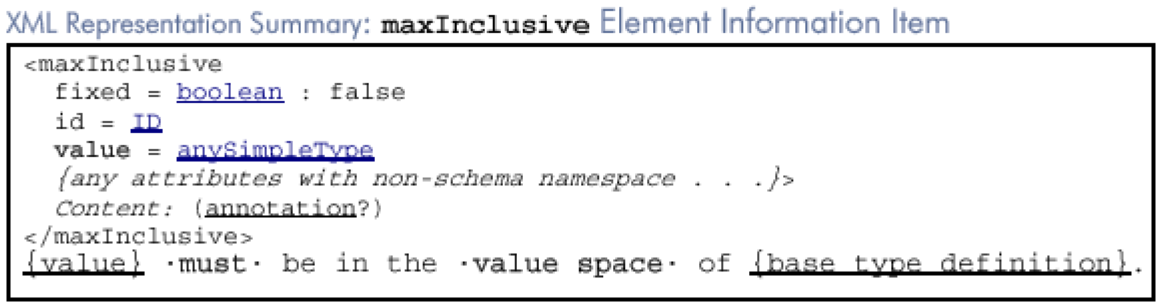

The following is the definition of a ·user-derived· datatype which limits values to integers greater than or equal to 100, using ·minInclusive·.

```
<simpleType name='one-hundred-or-more'>
  <restriction base='integer'>
    <minInclusive value='100'/>
  </restriction>
</simpleType>
```

maxInclusive

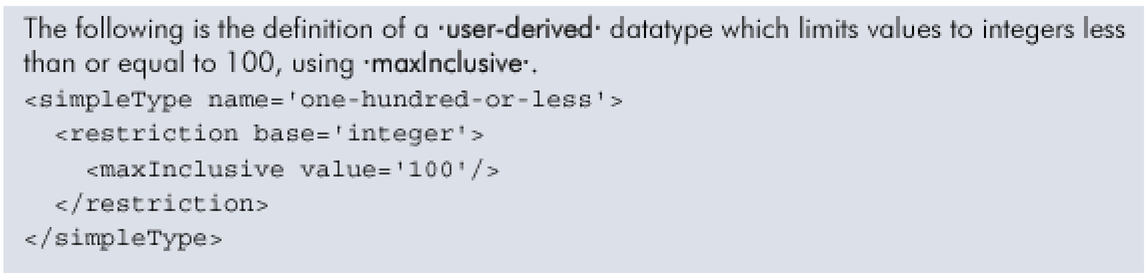
Maps to UML Attribute with stereotype *XSDmaxInclusive*. Name and type of such attribute does not make sence.

- value – to Attribute initial value.


XML Representation Summary: **maxInclusive** Element Information Item

```
<maxInclusive
  fixed = boolean : false
  id = ID
  value = anySimpleType
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</maxInclusive>
{value} ·must· be in the ·value space· of {base type definition}.
```

Example:

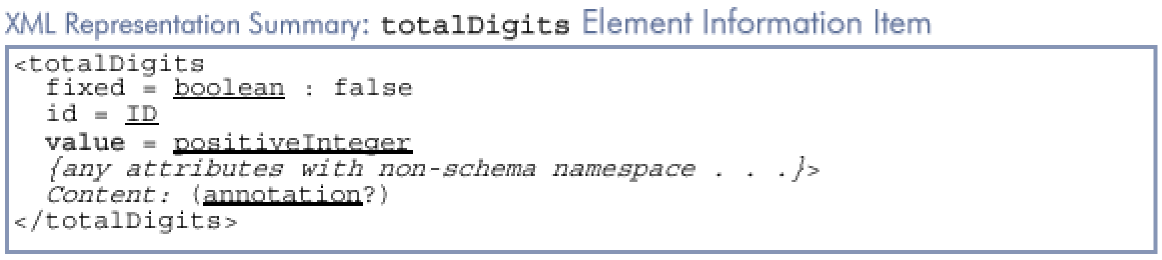

The following is the definition of a ·user-derived· datatype which limits values to integers less than or equal to 100, using ·maxInclusive·.

```
<simpleType name='one-hundred-or-less'>
  <restriction base='integer'>
    <maxInclusive value='100'/>
  </restriction>
</simpleType>
```

totalDigits

Maps to UML Attribute with stereotype *XSDtotalDigits*. Name and type of such attribute does not make sence.

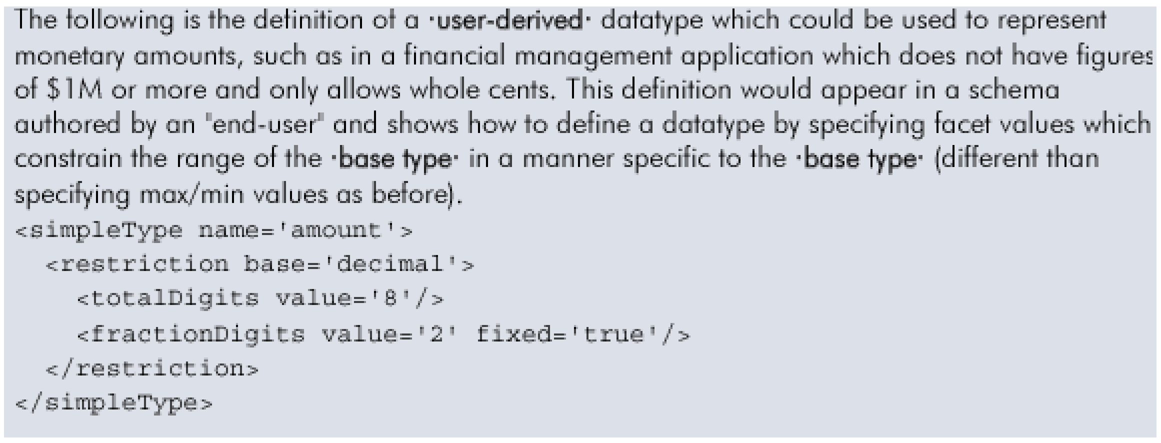
- value – to Attribute initial value.



XML Representation Summary: `totalDigits` Element Information Item

```
<totalDigits
  fixed = boolean : false
  id = ID
  value = positiveInteger
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</totalDigits>
```

Example



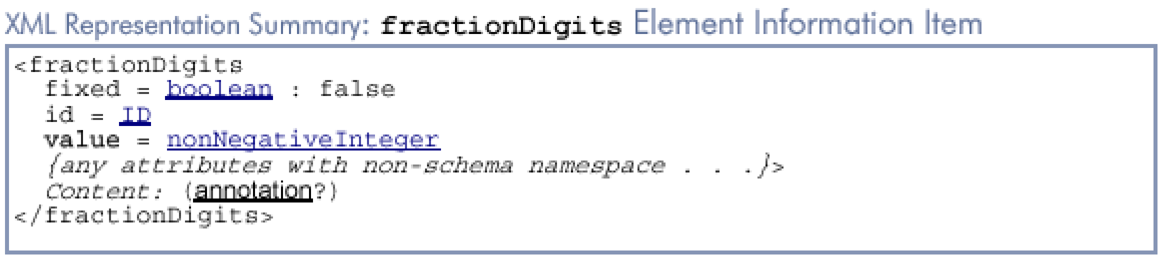
The following is the definition of a ·user-derived· datatype which could be used to represent monetary amounts, such as in a financial management application which does not have figures of $1M or more and only allows whole cents. This definition would appear in a schema authored by an "end-user" and shows how to define a datatype by specifying facet values which constrain the range of the ·base type· in a manner specific to the ·base type· (different than specifying max/min values as before).

```
<simpleType name='amount'>
  <restriction base='decimal'>
    <totalDigits value='8'/>
    <fractionDigits value='2' fixed='true'/>
  </restriction>
</simpleType>
```

fractionDigits

Maps to UML Attribute with stereotype *XSDfractionDigits*. Name and type of such attribute does not make sence.

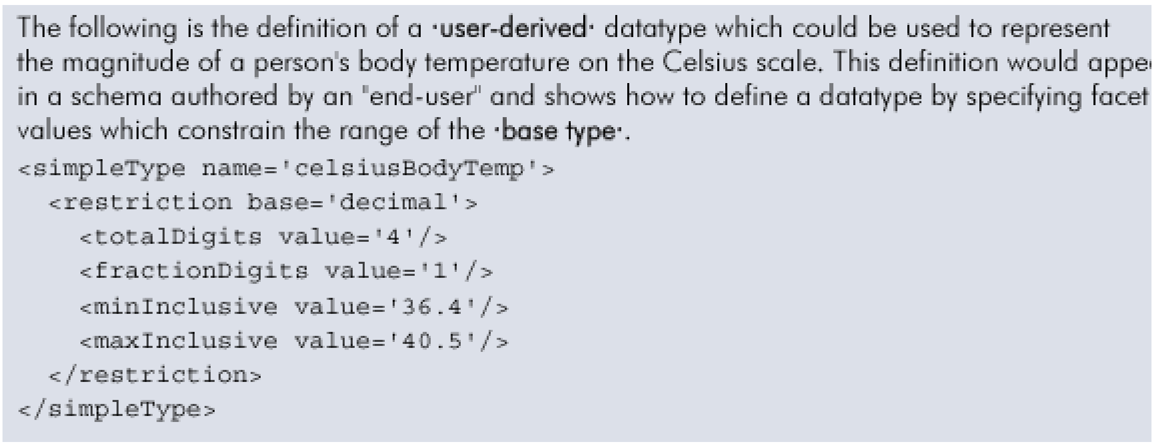
- value – to Attribute initial value.



XML Representation Summary: `fractionDigits` Element Information Item

```
<fractionDigits
  fixed = boolean : false
  id = ID
  value = nonNegativeInteger
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</fractionDigits>
```

Example

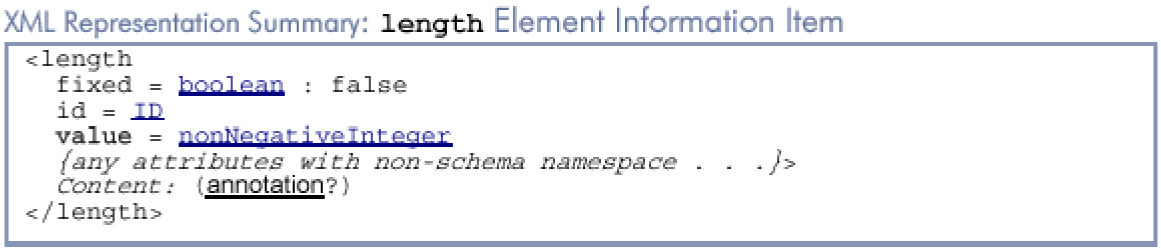

The following is the definition of a ·**user-derived**· datatype which could be used to represent the magnitude of a person's body temperature on the Celsius scale. This definition would appe in a schema authored by an "end-user" and shows how to define a datatype by specifying facet values which constrain the range of the ·**base type**·.

```
<simpleType name='celsiusBodyTemp'>
  <restriction base='decimal'>
    <totalDigits value='4'/>
    <fractionDigits value='1'/>
    <minInclusive value='36.4'/>
    <maxInclusive value='40.5'/>
  </restriction>
</simpleType>
```

lenght

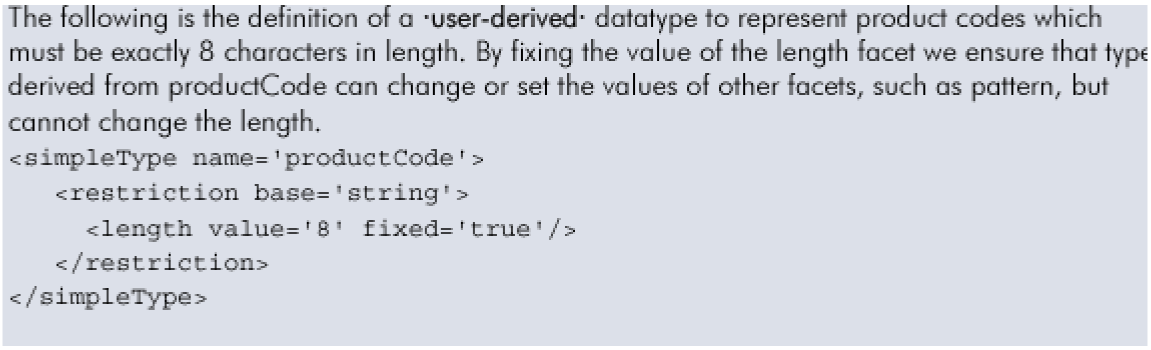
Maps to UML Attribute with stereotype *XSDlength*. Name and type of such attribute does not make sence.

- value – to Attribute initial value.


XML Representation Summary: `length` Element Information Item

```
<length
  fixed = boolean : false
  id = ID
  value = nonNegativeInteger
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</length>
```

Example

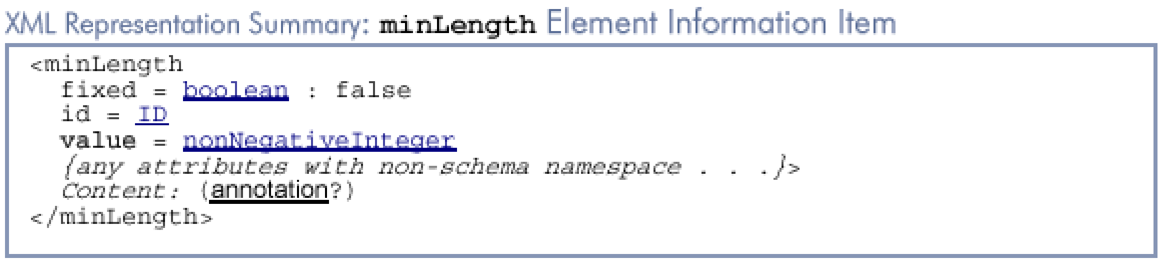

The following is the definition of a ·**user-derived**· datatype to represent product codes which must be exactly 8 characters in length. By fixing the value of the length facet we ensure that type derived from productCode can change or set the values of other facets, such as pattern, but cannot change the length.

```
<simpleType name='productCode'>
   <restriction base='string'>
     <length value='8' fixed='true'/>
   </restriction>
</simpleType>
```

minLength

Maps to UML Attribute with stereotype *XSDminLength*. Name and type of such attribute does not make sence.

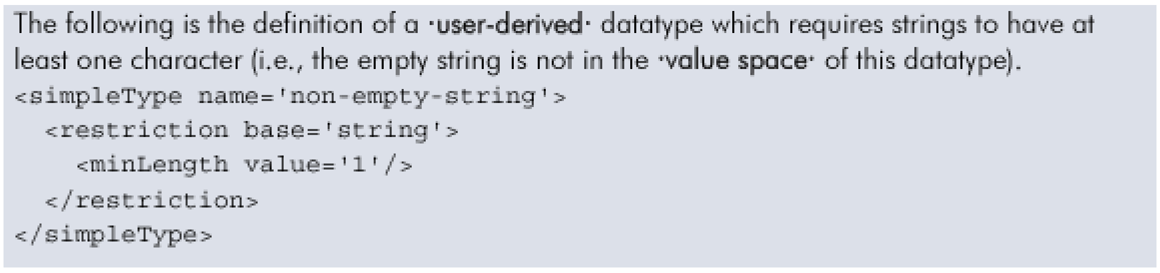
- value – to Attribute initial value.



XML Representation Summary: `minLength` Element Information Item

```
<minLength
  fixed = boolean : false
  id = ID
  value = nonNegativeInteger
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</minLength>
```

Example



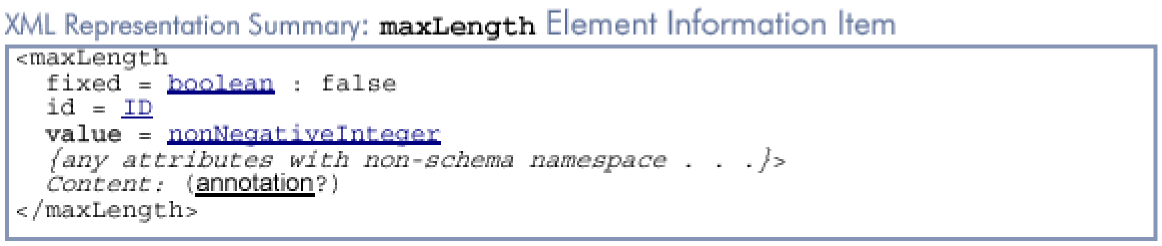
The following is the definition of a ·**user-derived**· datatype which requires strings to have at least one character (i.e., the empty string is not in the ·**value space**· of this datatype).

```
<simpleType name='non-empty-string'>
  <restriction base='string'>
    <minLength value='1'/>
  </restriction>
</simpleType>
```

maxLength

Maps to UML Attribute with stereotype *XSDmaxLength*. Name and type of such attribute does not make sence.

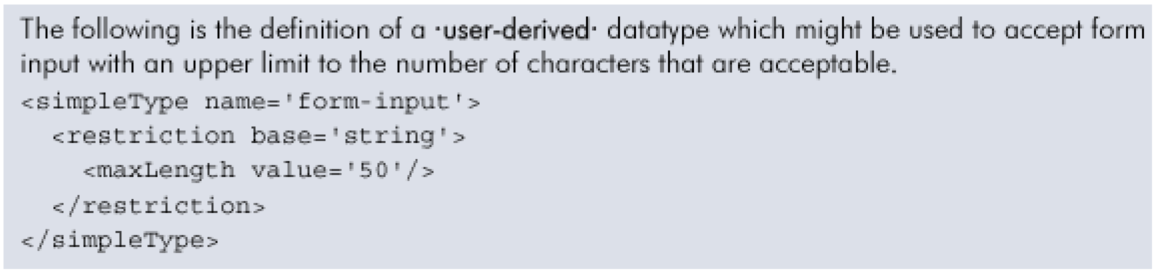
- value – to Attribute initial value.



XML Representation Summary: `maxLength` Element Information Item

```
<maxLength
  fixed = boolean : false
  id = ID
  value = nonNegativeInteger
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</maxLength>
```

Example



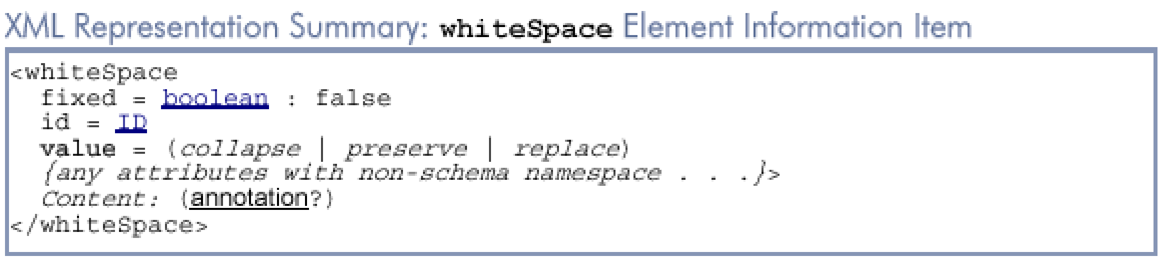
The following is the definition of a ·**user-derived**· datatype which might be used to accept form input with an upper limit to the number of characters that are acceptable.

```
<simpleType name='form-input'>
  <restriction base='string'>
    <maxLength value='50'/>
  </restriction>
</simpleType>
```

whiteSpace

Maps to UML Attribute with stereotype *XSDwhiteSpace*. Name and type of such attribute does not make sence.

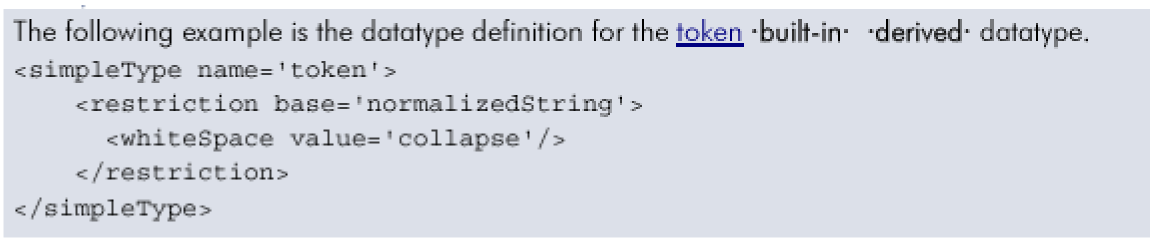
- value – to Attribute initial value.



XML Representation Summary: `whiteSpace` Element Information Item

```
<whiteSpace
  fixed = boolean : false
  id = ID
  value = (collapse | preserve | replace)
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</whiteSpace>
```

Example



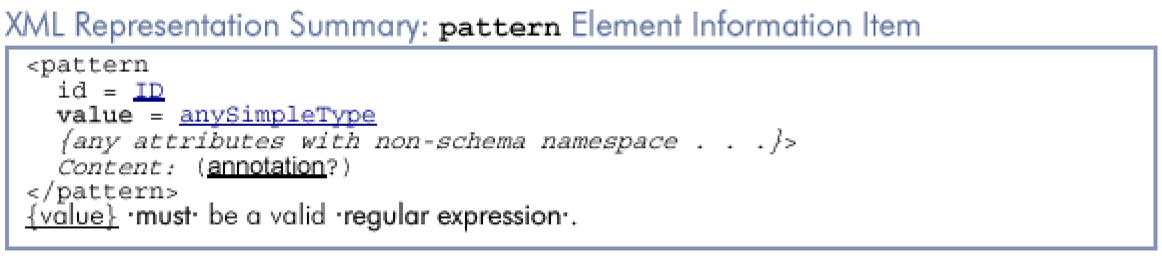
The following example is the datatype definition for the token ·built-in· ·derived· datatype.

```
<simpleType name='token'>
    <restriction base='normalizedString'>
      <whiteSpace value='collapse'/>
    </restriction>
</simpleType>
```

pattern

Maps to UML Attribute with stereotype *XSDpattern*. Name and type of such attribute does not make sence.

- value – to Attribute initial value or TaggedValue with name ‘value’.

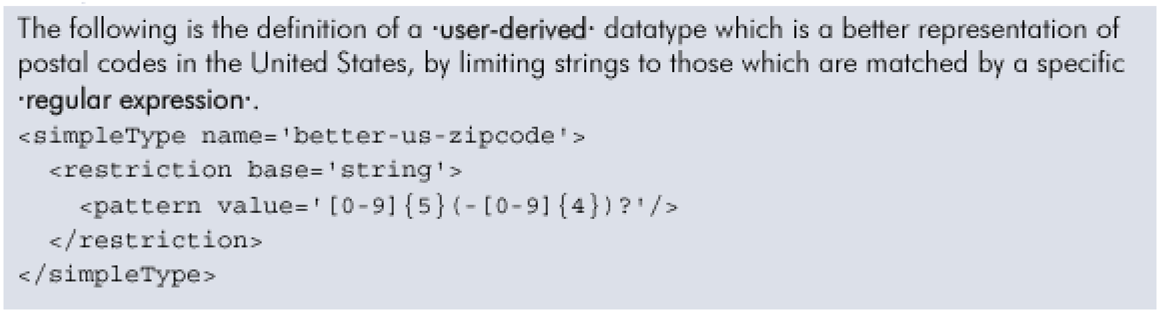


XML Representation Summary: `pattern` Element Information Item

```
<pattern
  id = ID
  value = anySimpleType
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</pattern>
```

{value} ·must· be a valid ·regular expression·.

Example



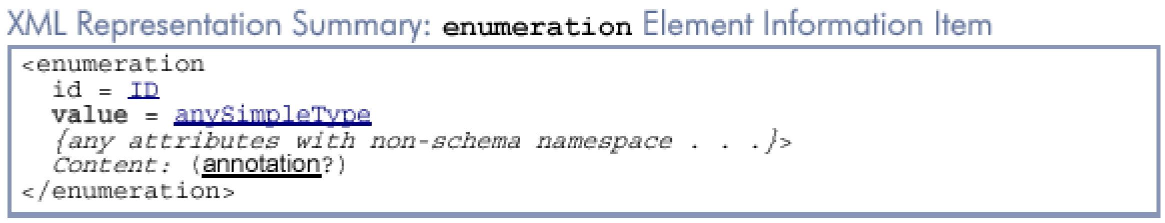
The following is the definition of a ·user-derived· datatype which is a better representation of postal codes in the United States, by limiting strings to those which are matched by a specific ·regular expression·.

```
<simpleType name='better-us-zipcode'>
  <restriction base='string'>
    <pattern value='[0-9]{5}(-[0-9]{4})?'/>
  </restriction>
</simpleType>
```

enumeration

Maps to UML Attribute with stereotype XSDenumeration.

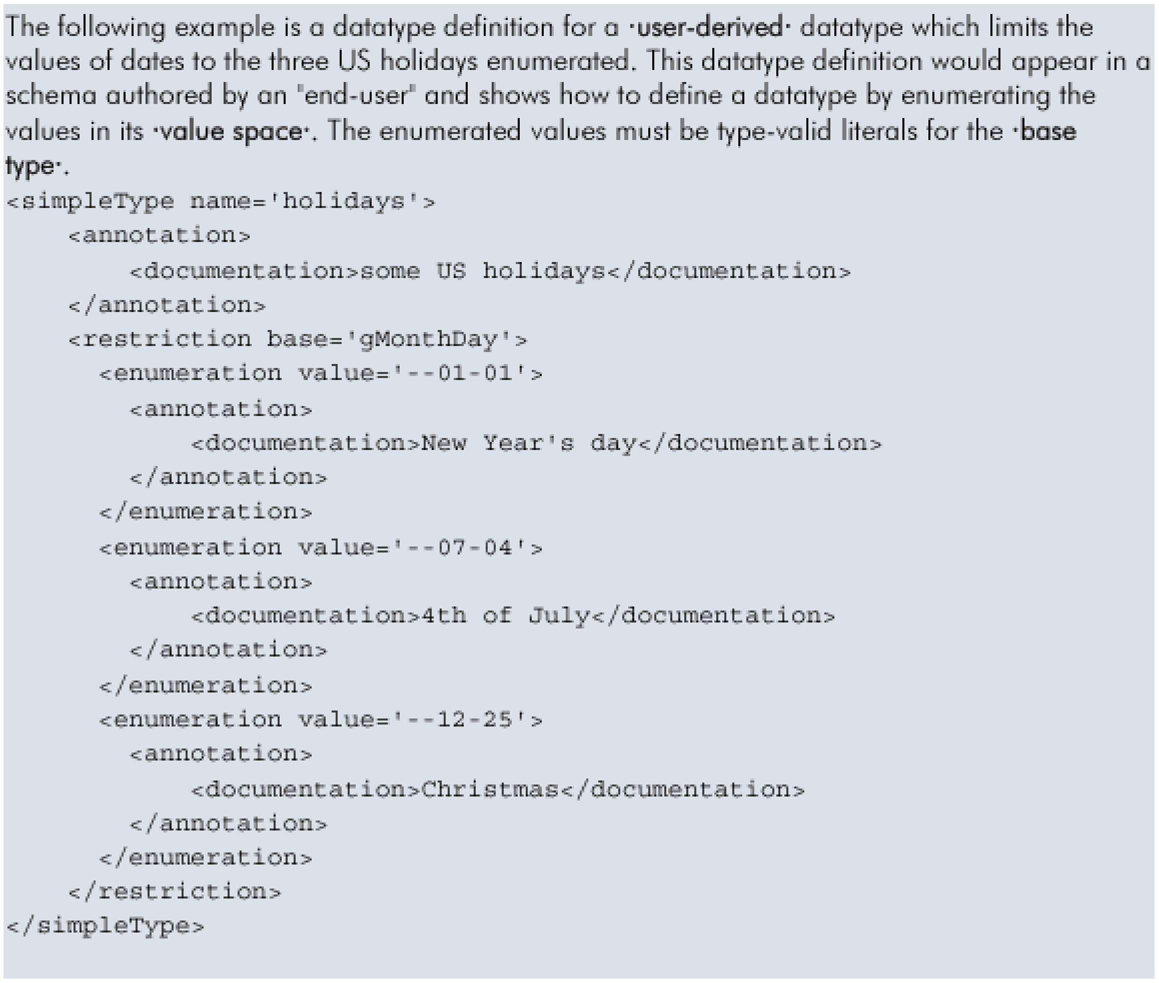
- value – to Attribute name.



XML Representation Summary: `enumeration` Element Information Item

```
<enumeration
  id = ID
  value = anySimpleType
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</enumeration>
```

Example

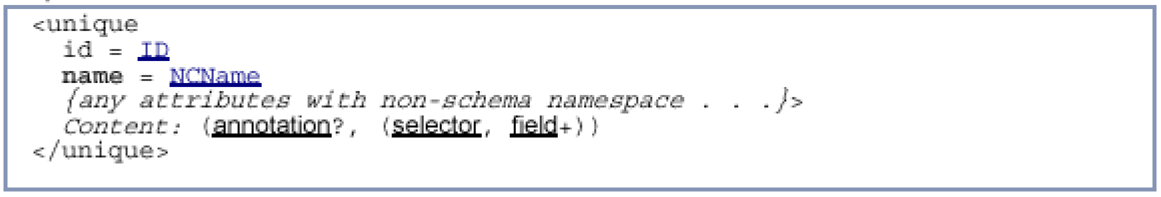


The following example is a datatype definition for a ·**user-derived**· datatype which limits the values of dates to the three US holidays enumerated. This datatype definition would appear in a schema authored by an "end-user" and shows how to define a datatype by enumerating the values in its ·**value space**·. The enumerated values must be type-valid literals for the ·**base type**·.

```
<simpleType name='holidays'>
    <annotation>
        <documentation>some US holidays</documentation>
    </annotation>
    <restriction base='gMonthDay'>
      <enumeration value='--01-01'>
        <annotation>
            <documentation>New Year's day</documentation>
        </annotation>
      </enumeration>
      <enumeration value='--07-04'>
        <annotation>
            <documentation>4th of July</documentation>
        </annotation>
      </enumeration>
      <enumeration value='--12-25'>
        <annotation>
            <documentation>Christmas</documentation>
        </annotation>
      </enumeration>
    </restriction>
</simpleType>
```

unique

Maps to UML Attribute added into some UML Class.



```
<unique
  id = ID
  name = NCName
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?, (selector, field+))
</unique>
```

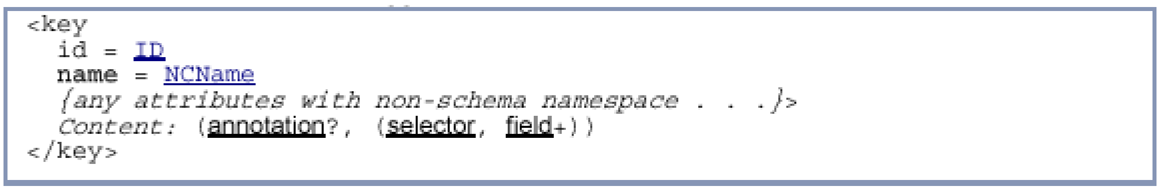
unique UML Model example

For an example, see “keyref UML Model example” on page 121

key

Maps to UML Attribute added into some UML Class.

- name – to Attribute name.
- id – to TaggedValue.



```
<key
  id = ID
  name = NCName
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?, (selector, field+))
</key>
```

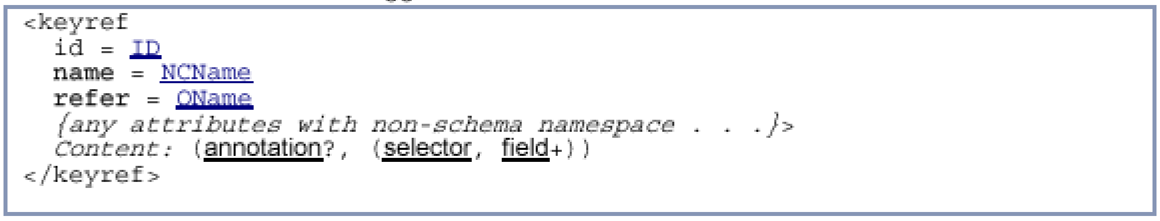
key UML Model example

For an example, see “keyref UML Model example” on page 121

keyref

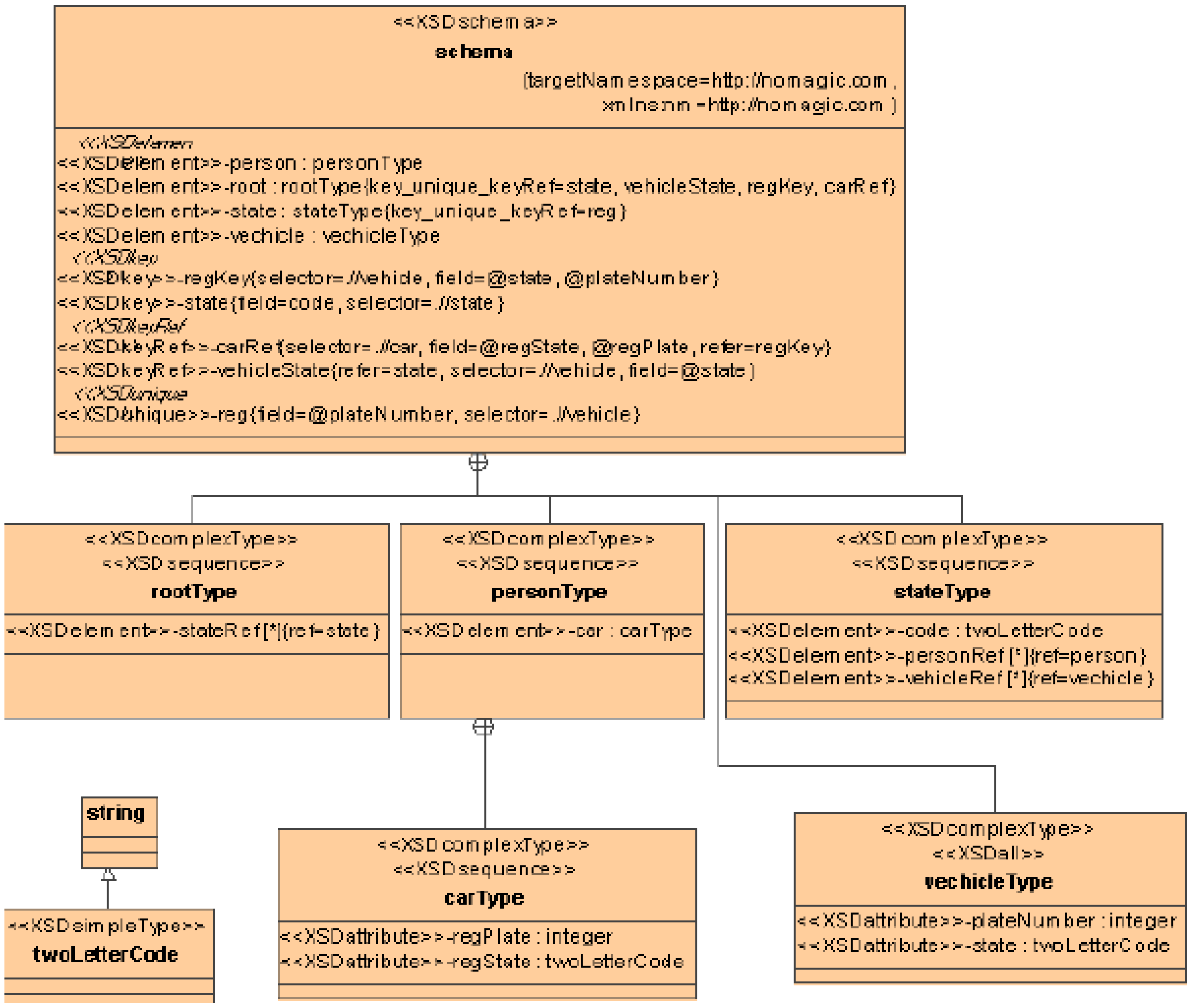
Maps to UML Attribute added into some UML Class.

- refer – to value of “refer” or “referString” TaggedValue.
- name – to Attribute name.
- id – to TaggedValue.



```
<keyref
  id = ID
  name = NCName
  refer = QName
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?, (selector, field+))
</keyref>
```

keyref UML Model example



<<XSDschema>>
schema
{targetNamespace=http://nomagic.com ,
xmlns:nm =http://nomagic.com }
<<XSDelement>>
<<XSDelement>>-person : personType
<<XSDelement>>-root : rootType{key_unique_keyRef=state, vehicleState, regKey, carRef}
<<XSDelement>>-state : stateType{key_unique_keyRef=reg}
<<XSDelement>>-vechicle : vechicleType
<<XSDkey>>
<<XSDkey>>-regKey{selector=.//vehicle, field=@state, @plateNumber}
<<XSDkey>>-state{field=code, selector=.//state}
<<XSDkeyRef>>
<<XSDkeyRef>>-carRef{selector=.//car, field=@regState, @regPlate, refer=regKey}
<<XSDkeyRef>>-vehicleState{refer=state, selector=.//vehicle, field=@state}
<<XSDunique>>
<<XSDunique>>-reg{field=@plateNumber, selector=.//vehicle}
<<XSDcomplexType>>
<<XSDsequence>>
rootType
<<XSDelement>>-stateRef[*]{ref=state}
<<XSDcomplexType>>
<<XSDsequence>>
personType
<<XSDelement>>-car : carType
<<XSDcomplexType>>
<<XSDsequence>>
stateType
<<XSDelement>>-code : twoLetterCode
<<XSDelement>>-personRef[*]{ref=person}
<<XSDelement>>-vehicleRef[*]{ref=vechicle}
string
<<XSDsimpleType>>
twoLetterCode
<<XSDcomplexType>>
<<XSDsequence>>
carType
<<XSDattribute>>-regPlate : integer
<<XSDattribute>>-regState : twoLetterCode
<<XSDcomplexType>>
<<XSDall>>
vechicleType
<<XSDattribute>>-plateNumber : integer
<<XSDattribute>>-state : twoLetterCode

```
<xs:schema xmlns:nm = "http://nomagic.com" xmlns:xs =
"http://www.w3.org/2001/XMLSchema" targetNamespace = "http://nomagic.com" >
      <xs:element name = "vechicle" >
            <xs:complexType >
                  <xs:all />
                  <xs:attribute name = "plateNumber" type = "xs:integer" />
                  <xs:attribute name = "state" type = "nm:twoLetterCode" />
            </xs:complexType>
      </xs:element>
      <xs:element name = "state" >
            <xs:complexType >
                  <xs:sequence >
                        <xs:element name = "code" type = "nm:twoLetterCode" />
                        <xs:element ref = "nm:vechicle" maxOccurs =
"unbounded" />
                        <xs:element ref = "nm:person" maxOccurs =
"unbounded" />
                  </xs:sequence>
            </xs:complexType>
            <xs:unique name = "reg" >
                  <xs:annotation >
                        <xs:documentation >unique
documentation</xs:documentation>
                  </xs:annotation>
                  <xs:selector xpath = ".//vehicle" />
                  <xs:field xpath = "@plateNumber" />
            </xs:unique>
      </xs:element>
      <xs:element name = "person" >
            <xs:complexType >
                  <xs:sequence >
                        <xs:element name = "car" >
                              <xs:complexType >
                                    <xs:sequence />
                                    <xs:attribute name = "regPlate" type =
"xs:integer" />
                                    <xs:attribute name = "regState" type =
"nm:twoLetterCode" />
                              </xs:complexType>
                        </xs:element>
                  </xs:sequence>
            </xs:complexType>
      </xs:element>
      <xs:element name = "root" >
            <xs:complexType >
                  <xs:sequence >
                        <xs:element ref = "nm:state" maxOccurs = "unbounded"
/>
                  </xs:sequence>
            </xs:complexType>
            <xs:key name = "state" >
                  <xs:selector xpath = ".//state" />
                  <xs:field xpath = "code" />
            </xs:key>
            <xs:keyref name = "vehicleState" refer = "nm:state" >
                  <xs:selector xpath = ".//vehicle" />
                  <xs:field xpath = "@state" />
            </xs:keyref>
            <xs:key name = "regKey" >
                  <xs:annotation >
                        <xs:documentation >key
documentation</xs:documentation>
                  </xs:annotation>
                  <xs:selector xpath = ".//vehicle" />
                  <xs:field xpath = "@state" />
                  <xs:field xpath = "@plateNumber" />
            </xs:key>
            <xs:keyref name = "carRef" refer = "nm:regKey" >
                  <xs:annotation >
                        <xs:documentation >key ref
documentation</xs:documentation>
```

```
                </xs:annotation>
                <xs:selector xpath = ".//car" />
                <xs:field xpath = "@regState" />
                <xs:field xpath = "@regPlate" />
            </xs:keyref>
        </xs:element>
        <xs:simpleType name = "twoLetterCode" >
            <xs:restriction base = "xs:string" />
        </xs:simpleType>
</xs:schema>
```

selector and field

Maps to UML TaggedValues named “selector” and “field” of UML Attribute representing key,keyRef or unique. “selector” tag has value representing “xpath” and “field” - list of valuesrepresenting field “xpath”. ID values shall be skipped and annotation documentation will beapplied to tagged value according to annotation rule (see:annotation). For field valuesannotation documentation shall be merged in one.

```
<selector
  id = ID
  xpath = a subset of XPath expression, see below
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</selector>
<field
  id = ID
  xpath = a subset of XPath expression, see below
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</field>
```

Example

```
<xs:key name="fullName">
 <xs:selector xpath=".//person"/>
 <xs:field xpath="forename"/>
 <xs:field xpath="surname"/>
</xs:key>

<xs:keyref name="personRef" refer="fullName">
 <xs:selector xpath=".//personPointer"/>
 <xs:field xpath="@first"/>
 <xs:field xpath="@last"/>
</xs:keyref>

<xs:unique name="nearlyID">
 <xs:selector xpath=".//*"/>
 <xs:field xpath="@id"/>
</xs:unique>
```

XML representations for the three kinds of identity-constraint definitions

Example

```
<xs:element name="state">
 <xs:complexType>
  <xs:sequence>
   <xs:element name="code" type="twoLetterCode"/>
   <xs:element ref="vehicle" maxOccurs="unbounded"/>
   <xs:element ref="person" maxOccurs="unbounded"/>
  </xs:sequence>
 </xs:complexType>

 <xs:key name="reg"> <!-- vehicles are keyed by their plate within states
-->
  <xs:selector xpath=".//vehicle"/>
  <xs:field xpath="@plateNumber"/>
 </xs:key>
</xs:element>

<xs:element name="root">
 <xs:complexType>
  <xs:sequence>
   . . .
   <xs:element ref="state" maxOccurs="unbounded"/>
   . . .
  </xs:sequence>
 </xs:complexType>

 <xs:key name="state"> <!-- states are keyed by their code -->
  <xs:selector xpath=".//state"/>
  <xs:field xpath="code"/>
 </xs:key>

 <xs:keyref name="vehicleState" refer="state">
  <!-- every vehicle refers to its state -->
  <xs:selector xpath=".//vehicle"/>
  <xs:field xpath="@state"/>
 </xs:keyref>

 <xs:key name="regKey"> <!-- vehicles are keyed by a pair of state and pla
-->
  <xs:selector xpath=".//vehicle"/>
  <xs:field xpath="@state"/>
  <xs:field xpath="@plateNumber"/>
 </xs:key>

 <xs:keyref name="carRef" refer="regKey"> <!-- people's cars are a
reference -->
  <xs:selector xpath=".//car"/>
  <xs:field xpath="@regState"/>
  <xs:field xpath="@regPlate"/>
 </xs:keyref>

</xs:element>
```

```
<xs:element name="person">
 <xs:complexType>
  <xs:sequence>
   . . .
   <xs:element name="car">
    <xs:complexType>
     <xs:attribute name="regState" type="twoLetterCode"/>
     <xs:attribute name="regPlate" type="xs:integer"/>
    </xs:complexType>
   </xs:element>
  </xs:sequence>
 </xs:complexType>
</xs:element>
```

A *state* element is defined, which contains a *code* child and some *vehicle* and *person* children. A *vehicle* in turn has a *plateNumber* attribute, which is an integer, and a *state* attribute. State's *code* s are a key for them within the document. Vehicle's *plateNumber* s are a key for them within states, and *state* and *plateNumber* is asserted to be a key for *vehicle* within the document as a whole. Furthermore, a *person* element has an empty car child, with *regState* and *regPlate* attributes, which are then asserted together to refer to *vehicles* via the *carRef* constraint. The requirement that a *vehicle's state* match its containing *state's code* is not expressed here.

selector and field UML Model example

For an example, see “keyref UML Model example” on page 121

annotation

Maps to UML Comment with or without stereotype XSDannotation.

Documentation’s content maps to UML Comment body(name).

“documentation” maps as UML comment:

- “content” value shall be comment name
- “xml:lang” value – tag “xml:lang” value
- source value – tag ”source” value

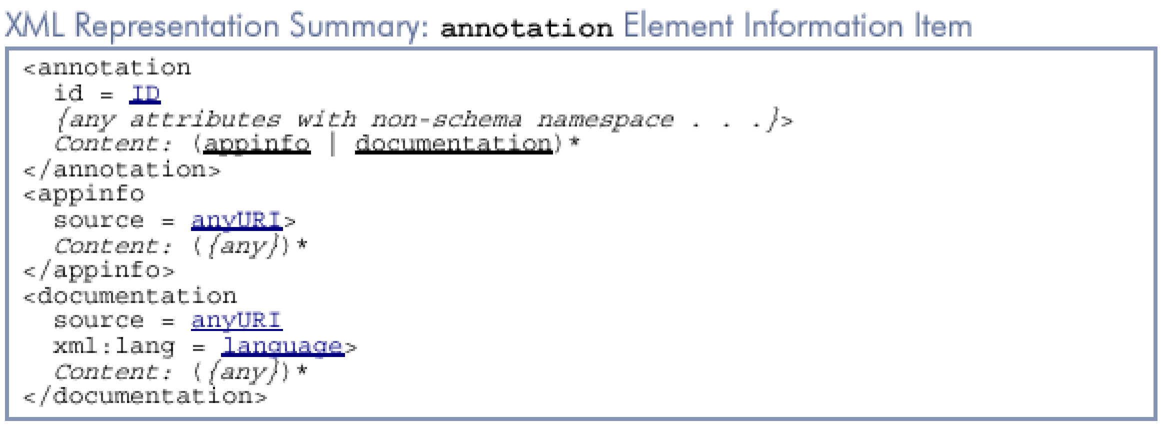
“appinfo” maps as tag value with name “appInfoSource”:

- “source” value will be tag value
- “content” will be documentation for tagged value

Appearing several annotation nodes on one element node, mapping shall be done in following way:

- “documentation” text shall be merged into one UML comment with merged content, but “content” and “xml:lang” tag values shall represent only first matched values

- “appInfo” shall have: “content” merged into one tag “appInfoSource” comment, but tag value shall represent first matched “appinfo”



XML Representation Summary: `annotation` Element Information Item

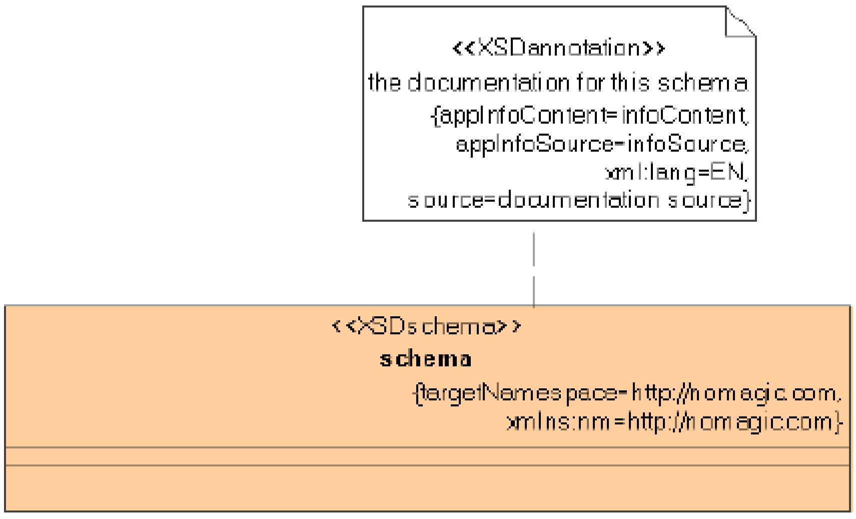
```
<annotation
  id = ID
  {any attributes with non-schema namespace . . .}>
  Content: (appinfo | documentation)*
</annotation>
<appinfo
  source = anyURI>
  Content: ({any})*
</appinfo>
<documentation
  source = anyURI
  xml:lang = language>
  Content: ({any})*
</documentation>
```

Example

```
<xs:simpleType fn:note="special">
  <xs:annotation>
   <xs:documentation>A type for experts only</xs:documentation>
   <xs:appinfo>
    <fn:specialHandling>checkForPrimes</fn:specialHandling>
   </xs:appinfo>
  </xs:annotation>
```

XML representations of three kinds of annotation.

annotation UML Model example


<<XSDannotation>>
the documentation for this schema
{appInfoContent=infoContent,
appInfoSource=infoSource,
xml:lang=EN,
source=documentation source}
<<XSDschema>>
schema
{targetNamespace=http://nomagic.com,
xmlns:nm=http://nomagic.com}

```
<xs:schema xmlns:nm = "http://nomagic.com" xmlns:xs =
"http://www.w3.org/2001/XMLSchema" targetNamespace = "http://nomagic.com" >
      <xs:annotation >
            <xs:appinfo source = "infoSource" >infoContent</xs:appinfo>
```

```
              <xs:documentation source = "documentation source" xml:lang =
"EN" >the documentation for this schema</xs:documentation>
        </xs:annotation>
</xs:schema>
```

compositors

Complex type maps to UML Class with stereotype XSDcomplexType. In order to have some group in complex type, the same UML Class also must have XSDall, XSDchoice or XSDsequence stereotype.

UML model can have ModelClass just with single stereotype XSDall, XSDchoice or XSDsequence. In this case such class maps to inner part of other group.

Elements order in sequence group is very important. Such elements are ordered according values of TaggedValue sequenceOrder.

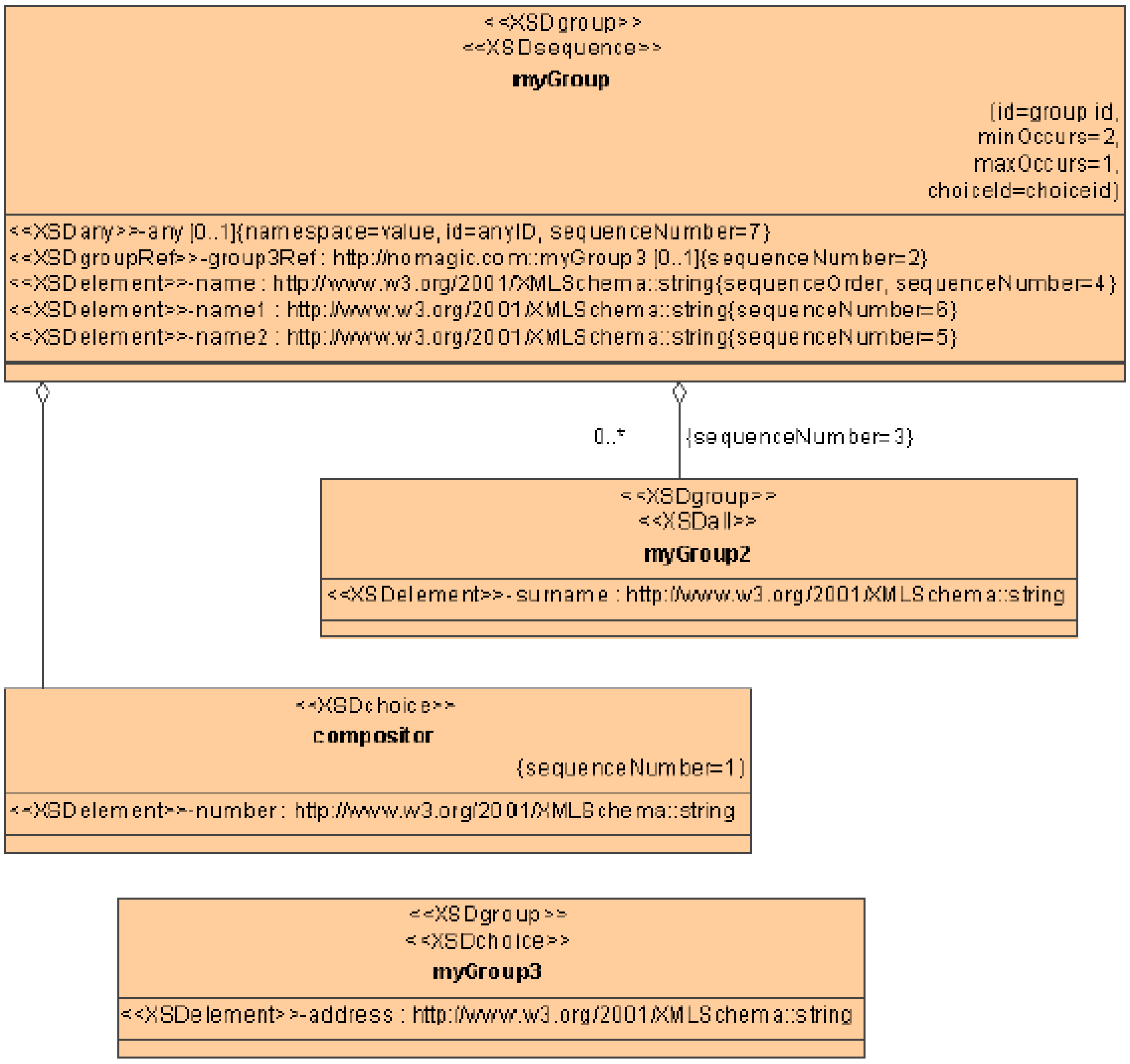
```
<all
  id = ID
  maxOccurs = 1 : 1
  minOccurs = (0 | 1) : 1
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?, element*)
</all>
<choice
  id = ID
  maxOccurs = (nonNegativeInteger | unbounded)  : 1
  minOccurs = nonNegativeInteger : 1
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?, (element | group | choice | sequence | any)*)
</choice>
<sequence
  id = ID
  maxOccurs = (nonNegativeInteger | unbounded)  : 1
  minOccurs = nonNegativeInteger : 1
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?, (element | group | choice | sequence | any)*)
</sequence>
```

Example

```
<xs:all>
 <xs:element ref="cats"/>
 <xs:element ref="dogs"/>
</xs:all>

<xs:sequence>
 <xs:choice>
  <xs:element ref="left"/>
  <xs:element ref="right"/>
 </xs:choice>
 <xs:element ref="landmark"/>
</xs:sequence>
```

XML representations for the three kinds of model group, the third nested inside the second.

compositors UML Model example


<<XSDgroup>>
<<XSDsequence>>
myGroup
{id=group id,
minOccurs=2,
maxOccurs=1,
choiceId=choiceid}
<<XSDany>>-any [0..1]{namespace=value, id=anyID, sequenceNumber=7}
<<XSDgroupRef>>-group3Ref : http://nomagic.com::myGroup3 [0..1]{sequenceNumber=2}
<<XSDelement>>-name : http://www.w3.org/2001/XMLSchema::string{sequenceOrder, sequenceNumber=4}
<<XSDelement>>-name1 : http://www.w3.org/2001/XMLSchema::string{sequenceNumber=6}
<<XSDelement>>-name2 : http://www.w3.org/2001/XMLSchema::string{sequenceNumber=5}
0..*
{sequenceNumber=3}
<<XSDgroup>>
<<XSDall>>
myGroup2
<<XSDelement>>-surname : http://www.w3.org/2001/XMLSchema::string
<<XSDchoice>>
compositor
{sequenceNumber=1}
<<XSDelement>>-number : http://www.w3.org/2001/XMLSchema::string
<<XSDgroup>>
<<XSDchoice>>
myGroup3
<<XSDelement>>-address : http://www.w3.org/2001/XMLSchema::string

```
<?xml version='1.0' encoding='Cp1252'?>

<xs:schema xmlns:nm = "http://nomagic.com" xmlns:xs =
"http://www.w3.org/2001/XMLSchema" targetNamespace = "http://nomagic.com" >
      <xs:group name = "myGroup" >
            <xs:annotation >
                  <xs:documentation >my group
documentation</xs:documentation>
            </xs:annotation>
            <xs:sequence minOccurs = "2" maxOccurs = "1" >
                  <xs:choice >
                        <xs:element name = "number" type = "xs:string" />
                  </xs:choice>
                  <xs:group ref = "nm:myGroup3" minOccurs = "0" maxOccurs =
"1" >
                        <xs:annotation >
```

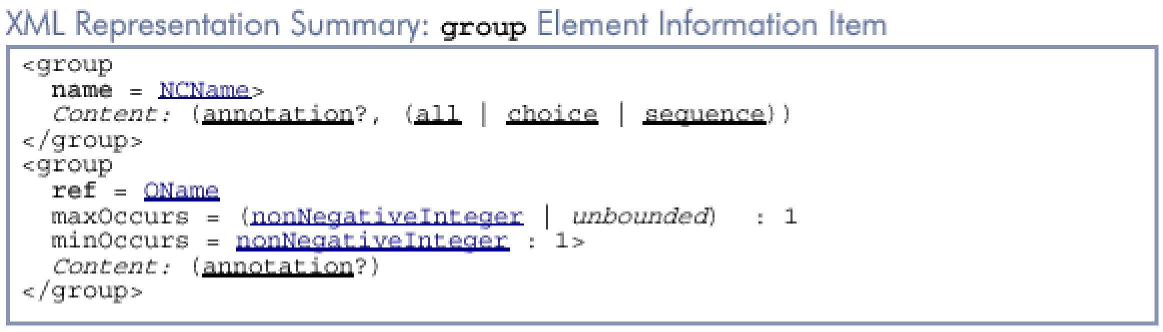
```
                              <xs:documentation >ref
documentation</xs:documentation>
                        </xs:annotation>
                  </xs:group>
                  <xs:group ref = "nm:myGroup2" minOccurs = "0" maxOccurs =
"unbounded" >
                        <xs:annotation >
                              <xs:documentation >another ref
documentation</xs:documentation>
                        </xs:annotation>
                  </xs:group>
                  <xs:element name = "name" type = "xs:string" />
                  <xs:element name = "name2" type = "xs:string" />
                  <xs:element name = "name1" type = "xs:string" />
                  <xs:any id = "anyID" namespace = "value" minOccurs = "0"
maxOccurs = "1" />
            </xs:sequence>
      </xs:group>
      <xs:group name = "myGroup3" >
            <xs:choice >
                  <xs:element name = "address" type = "xs:string" />
            </xs:choice>
      </xs:group>
      <xs:group name = "myGroup2" >
            <xs:all >
                  <xs:element name = "surname" type = "xs:string" />
            </xs:all>
      </xs:group>
</xs:schema>
```

group

Maps to UML Class with stereotype *XSDgroup*.

This class also may have stereotype *XSDall*, *XSDsequence* or *XSDchoice*.

If group has ref attribute, such group definition maps to UML Attribute or UML Association End. UML Attribute must have *XSDgroupRef* stereotype. This stereotype may be omitted for AssociationEnd.


XML Representation Summary: group Element Information Item

```
<group
  name = NCName>
  Content: (annotation?, (all | choice | sequence))
</group>
<group
  ref = QName
  maxOccurs = (nonNegativeInteger | unbounded)  : 1
  minOccurs = nonNegativeInteger : 1>
  Content: (annotation?)
</group>
```

Example

```
<xs:group name="myModelGroup">
 <xs:sequence>
  <xs:element ref="someThing"/>
  . . .
 </xs:sequence>
</xs:group>

<xs:complexType name="trivial">
 <xs:group ref="myModelGroup"/>
 <xs:attribute .../>
</xs:complexType>

<xs:complexType name="moreSo">
 <xs:choice>
  <xs:element ref="anotherThing"/>
  <xs:group ref="myModelGroup"/>
 </xs:choice>
 <xs:attribute .../>
</xs:complexType>
```

group UML Model example

For an example, see “compositors UML Model example” on page 127

any and anyAttribute

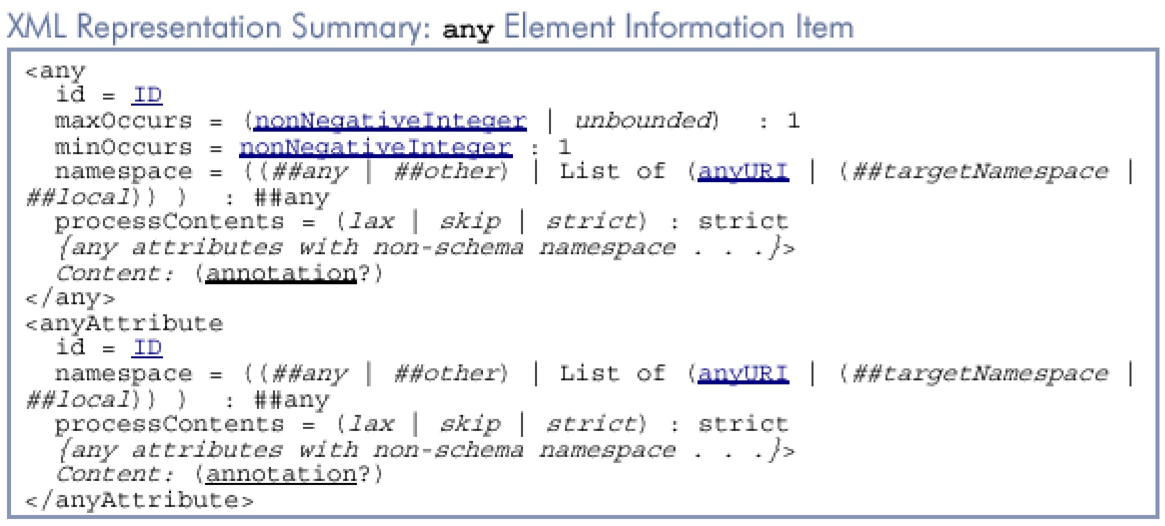
Maps to UML Attribute with stereotype *XSDany* or *XSDanyAttribute*.

maxOccurs - to multiplicity upper range. Value unbounded maps to asterisk in UML.

minOccurs – to multiplicity lower range.

annotation maps to Attribute documentation

Other properties to TaggedValues.



XML Representation Summary: **any** Element Information Item

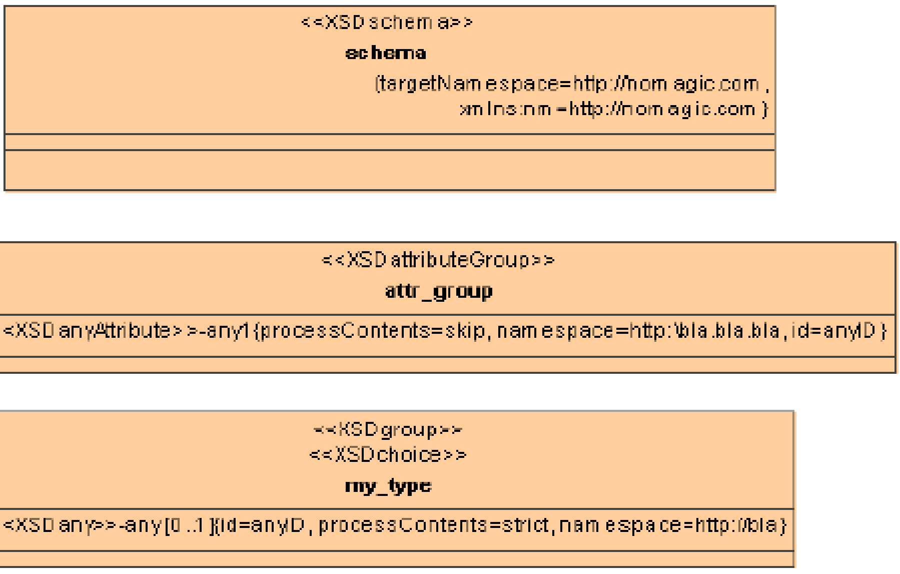
```
<any
  id = ID
  maxOccurs = (nonNegativeInteger | unbounded)  : 1
  minOccurs = nonNegativeInteger : 1
  namespace = ((##any | ##other) | List of (anyURI | (##targetNamespace |
##local)) )  : ##any
  processContents = (lax | skip | strict) : strict
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</any>
<anyAttribute
  id = ID
  namespace = ((##any | ##other) | List of (anyURI | (##targetNamespace |
##local)) )  : ##any
  processContents = (lax | skip | strict) : strict
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</anyAttribute>
```

Example

```
<xs:any processContents="skip"/>

<xs:any namespace="##other" processContents="lax"/>

<xs:any namespace="http://www.w3.org/1999/XSL/Transform"/>

<xs:any namespace="##targetNamespace"/>

<xs:anyAttribute namespace="http://www.w3.org/XML/1998/namespace"/>
```

XML representations of the four basic types of wildcard, plus one attribute wildcard.

any and anyAttribute UML Model example


<<XSDschema>>
schema
{targetNamespace=http://nomagic.com ,
xmlns:nm =http://nomagic.com }
<<XSDattributeGroup>>
attr_group
<<XSDanyAttribute>>-any1{processContents=skip, namespace=http:\bla.bla.bla, id=anyID}
<<XSDgroup>>
<<XSDchoice>>
my_type
<<XSDany>>-any[0..1]{id=anyD, processContents=strict, namespace=http://bla}

```
<?xml version='1.0' encoding='Cp1252'?>

<xs:schema xmlns:nm = "http://nomagic.com" xmlns:xs =
"http://www.w3.org/2001/XMLSchema" targetNamespace = "http://nomagic.com"
>
      <xs:group name = "my_type" >
            <xs:choice >
                  <xs:any id = "anyID" namespace = "http://bla"
processContents = "strict" minOccurs = "0" maxOccurs = "1" >
                        <xs:annotation >
                              <xs:documentation >any
documentation</xs:documentation>
                        </xs:annotation>
                  </xs:any>
            </xs:choice>
      </xs:group>
      <xs:attributeGroup name = "attr_group" >
            <xs:anyAttribute id = "anyID" namespace = "http:\bla.bla.bla"
processContents = "skip" >
                  <xs:annotation >
```

```
                              <xs:documentation >any attribute
documentation</xs:documentation>
                         </xs:annotation>
                    </xs:anyAttribute>
               </xs:attributeGroup>
</xs:schema>
```

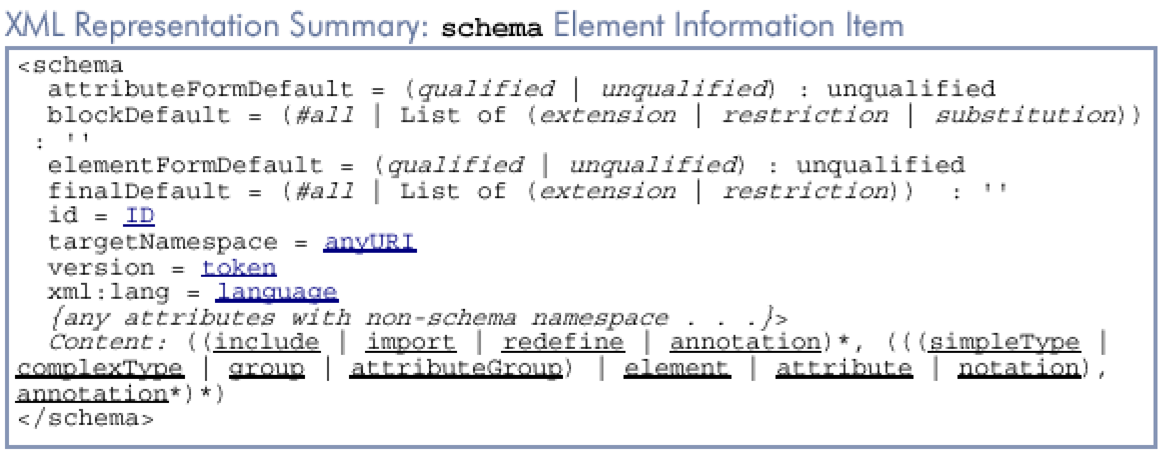
schema

Maps to UML Class with stereotype *XSDschema*.

All schema global attributes and elements are mapped to UML Attributes of this class.

Name of this class should match file name or must be assigned to the component, which represents file.

“xmlns” xml tags maps to an permission link with stereotype «xmlns» and name, representing given prefix. Permission client is schema class and supplier package with name equal to the “xmlns” value.



XML Representation Summary: `schema` Element Information Item

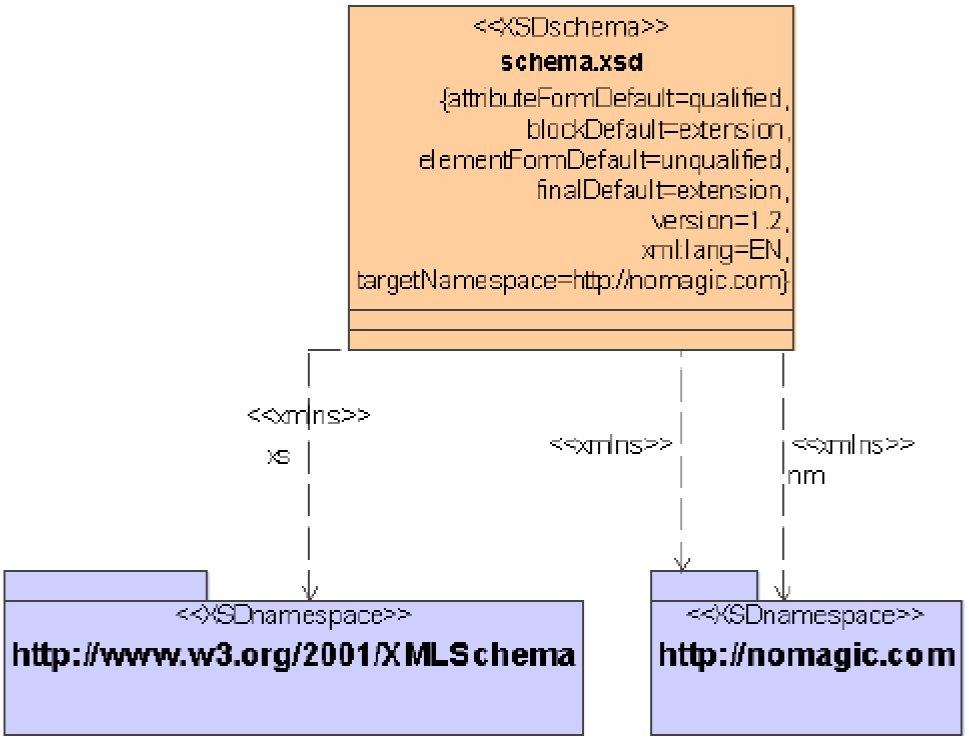
```
<schema
  attributeFormDefault = (qualified | unqualified) : unqualified
  blockDefault = (#all | List of (extension | restriction | substitution))
 : ''
  elementFormDefault = (qualified | unqualified) : unqualified
  finalDefault = (#all | List of (extension | restriction))  : ''
  id = ID
  targetNamespace = anyURI
  version = token
  xml:lang = language
  {any attributes with non-schema namespace . . .}>
  Content: ((include | import | redefine | annotation)*, (((simpleType |
complexType | group | attributeGroup) | element | attribute | notation),
annotation*)*)
</schema>
```

Example

```
<xs:schema
    xmlns:xs="http://www.w3.org/2001/XMLSchema"
    targetNamespace="http://www.example.com/example">
  . . .
</xs:schema>
```

The XML representation of the skeleton of a schema.

schema UML Model example



```
<xs:schema xmlns:nm = "http://nomagic.com"
xmlns:xs = "http://www.w3.org/2001/XMLSchema"
xmlns = "http://nomagic.com"
attributeFormDefault = "qualified"
blockDefault = "extension"
elementFormDefault = "unqualified"
finalDefault = "extension"
targetNamespace = "http://nomagic.com"
version = "1.2"
xml:lang = "EN" />
```

notation

Maps to UML Attribute with stereotype *XSDnotation*. This attribute must be added into UML class with stereotype *XSDschema*.

- name maps to UML Attribute name
- annotation maps to UML Attribute documentation.

XML Representation Summary: `notation` Element Information Item

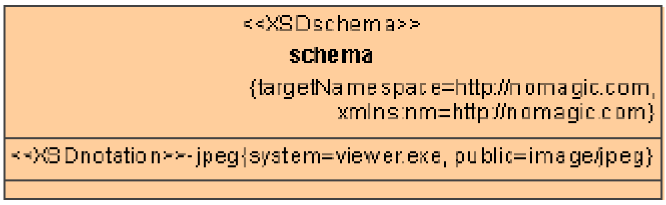
```
<notation
  id = ID
  name = NCName
  public = anyURI
  system = anyURI
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</notation>
```

Example

```
<xs:notation name="jpeg" public="image/jpeg" system="viewer.exe">
```

The XML representation of a notation declaration.

notation UML Model example


<<XSDschema>>
schema
{targetNamespace=http://nomagic.com,
xmlns:nm=http://nomagic.com}
<<XSDnotation>>-jpeg{system=viewer.exe, public=image/jpeg}

```
<xs:schema xmlns:nm = "http://nomagic.com"
xmlns:xs = "http://www.w3.org/2001/XMLSchema"
targetNamespace = "http://nomagic.com" >
      <xs:notation name = "jpeg" public = "image/jpeg" system = "viewer.exe"
/>
</xs:schema>
```

redefine

Maps to UML Class with stereotype *XSDredefine*. This class has inner UML Classes as redefined elements. Every redefined element must be derived from other UML class with stereotype *XSDsimpleType*, *XSDcomplexType*, *XSDgroup*, *XSDattributeGroup*. The name of this class shall match “schemaLocation” value.

If two “redefine” with the same schema location appears, they shall be merged to the one and the same class with a name “schemaLocation”.

Redefine Class must be inner class of XSDschema Class.

- annotation - to *XSDredefine* UML Class documentation
- schemaLocation – to XSDredefine UML Class name.

XML Representation Summary: `redefine` Element Information Item

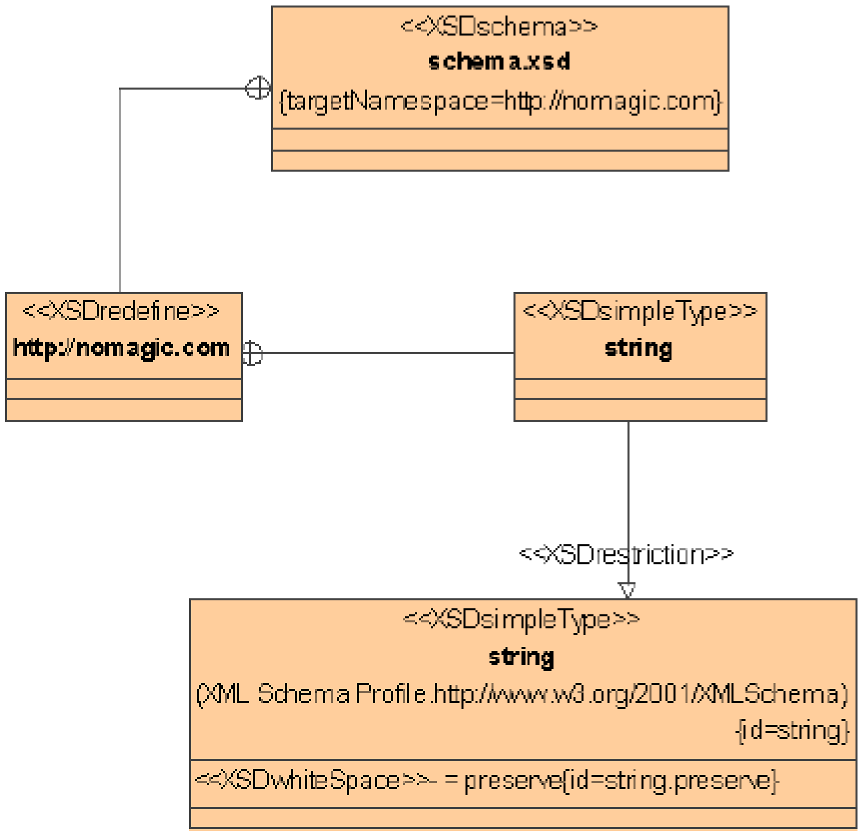
```
<redefine
  id = ID
  schemaLocation = anyURI
  {any attributes with non-schema namespace . . .}>
  Content: (annotation | (simpleType | complexType | group |
attributeGroup))*
</redefine>
```

Example

```
v1.xsd:
 <xs:complexType name="personName">
  <xs:sequence>
   <xs:element name="title" minOccurs="0"/>
   <xs:element name="forename" minOccurs="0" maxOccurs="unbounded"/>
  </xs:sequence>
 </xs:complexType>

 <xs:element name="addressee" type="personName"/>

v2.xsd:
 <xs:redefine schemaLocation="v1.xsd">
  <xs:complexType name="personName">
   <xs:complexContent>
    <xs:extension base="personName">
     <xs:sequence>
      <xs:element name="generation" minOccurs="0"/>
     </xs:sequence>
    </xs:extension>
   </xs:complexContent>
  </xs:complexType>
 </xs:redefine>

 <xs:element name="author" type="personName"/>
```

The schema corresponding to *v2.xsd* has everything specified by *v1.xsd* , with the *personName* type redefined, as well as everything it specifies itself. According to this schema, elements constrained by the *personName* type may end with a *generation* element. This includes not only the *author* element, but also the *addressee* element.

redefine UML Model example

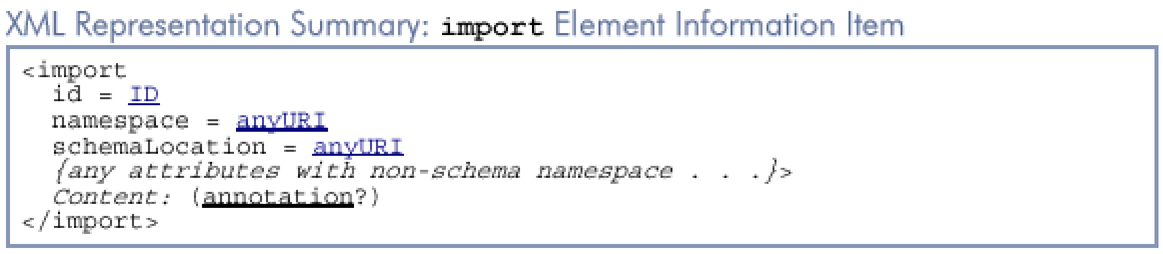

<<XSDschema>>
schema.xsd
{targetNamespace=http://nomagic.com}
<<XSDredefine>>
http://nomagic.com
<<XSDsimpleType>>
string
<<XSDrestriction>>
<<XSDsimpleType>>
string
(XML Schema Profile.http://www.w3.org/2001/XMLSchema)
{id=string}
<<XSDwhiteSpace>>- = preserve{id=string.preserve}

```
<?xml version='1.0' encoding='UTF-8'?>

<xs:schema xmlns:nm="http://nomagic.com"
xmlns:xs="http://www.w3.org/2001/XMLSchema"
targetNamespace="http://nomagic.com" >
      <xs:redefine schemaLocation="http://nomagic.com" >
            <xs:simpleType name="string" >
                  <xs:annotation >
                        <xs:documentation >my
documentation</xs:documentation>
                  </xs:annotation>
                  <xs:restriction base="xs:string" />
            </xs:simpleType>
      </xs:redefine>
</xs:schema>
```

import

Maps to UML Permission with stereotype *XSDimport*. Permission client must be schema class stereotypes *«XSDschema»* Component, supplier namespace Package *XSDnamespace*.

- namespace maps to supplier name.
- annotation maps to UML Attribute documentation.
- schemaLocation maps to TaggedValue.


XML Representation Summary: `import` Element Information Item

```
<import
  id = ID
  namespace = anyURI
  schemaLocation = anyURI
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</import>
```

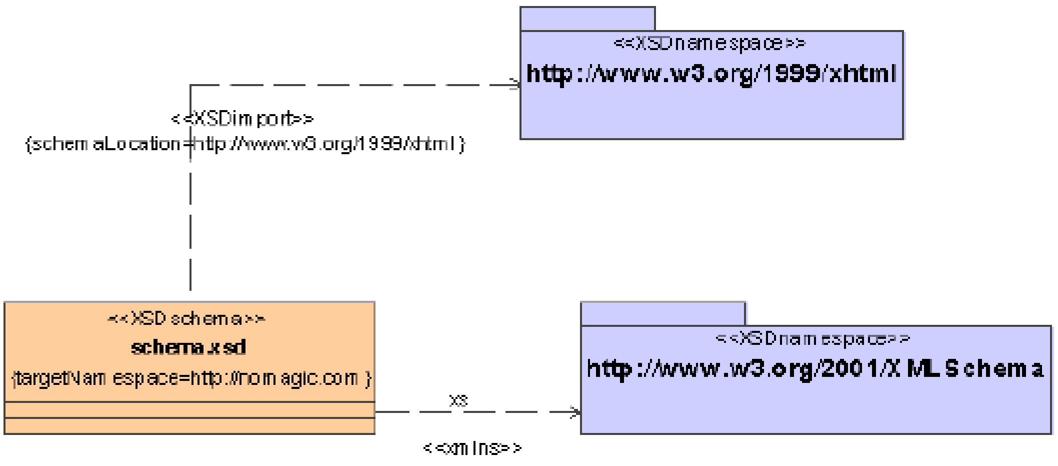
Example

The same namespace may be used both for real work, and in the course of defining schema components in terms of foreign components:

```
<schema xmlns="http://www.w3.org/2001/XMLSchema"
        xmlns:html="http://www.w3.org/1999/xhtml"
        targetNamespace="uri:mywork" xmlns:my="uri:mywork">

 <import namespace="http://www.w3.org/1999/xhtml"/>

 <annotation>
  <documentation>
   <html:p>[Some documentation for my schema]</html:p>
  </documentation>
 </annotation>

 . . .

 <complexType name="myType">
  <sequence>
   <element ref="html:p" minOccurs="0"/>
  </sequence>
  . . .
 </complexType>

 <element name="myElt" type="my:myType"/>
</schema>
```

The treatment of references as ·**QNames**· implies that since (with the exception of the schema for schemas) the target namespace and the XML Schema namespace differ, without massive redeclaration of the default namespace either internal references to the names being defined in a schema document or the schema declaration and definition elements themselves must be explicitly qualified. This example takes the first option -- most other examples in this specification have taken the second.

import UML Model example

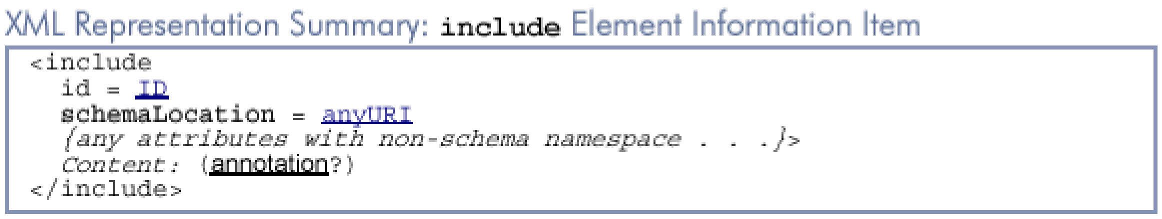

<<XSDnamespace>>
http://www.w3.org/1999/xhtml
<<XSDimport>>
{schemaLocation=http://www.w3.org/1999/xhtml}
<<XSDschema>>
schema.xsd
{targetNamespace=http://nomagic.com}
xs
<<xmlns>>
<<XSDnamespace>>
http://www.w3.org/2001/XMLSchema

```
<xs:schema xmlns:nm = "http://nomagic.com" xmlns:xs =
"http://www.w3.org/2001/XMLSchema" targetNamespace = "http://nomagic.com" >
      <xs:import namespace = "http://www.w3.org/1999/xhtml" schemaLocation
= "http://www.w3.org/1999/xhtml" />
</xs:schema>
```

include

Maps to UML Component with stereotype XSDinclude. Component must be added into xsd file component.

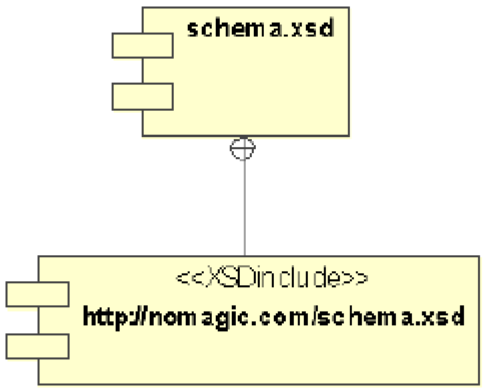
- annotation maps to UML Component documentation
- schemaLocation maps to UML Component name.



XML Representation Summary: `include` Element Information Item

```
<include
  id = ID
  schemaLocation = anyURI
  {any attributes with non-schema namespace . . .}>
  Content: (annotation?)
</include>
```

include UML Model example



```
<xs:schema xmlns:nm = "http://nomagic.com" xmlns:xs =
"http://www.w3.org/2001/XMLSchema" targetNamespace = "http://nomagic.com"
>
      <xs:include schemaLocation = "http://nomagic.com/schema.xsd" />
</xs:schema>
```

XML schema namespaces

Maps to UML Package with stereotype *XSDnamespace*. In order to define “xmlns” attribute in the schema file, Permission between XSDnamespace package and XSDschema class must be added into the model.

- The Permission name maps to namespace shortcut.

Example:

```
<xs:schema
    xmlns:xs="http://www.w3.org/2001/XMLSchema"
xmlns="http://www.w3.org/2001/XMLSchema"
    targetNamespace="http://www.example.com/example">
  . . .
</xs:schema>
```

The XML representation of the skeleton of a schema.

In order to generate such namespaces:

- UML model must have Package with name *“http://www.w3.org/2001/XMLSchema”*
- UML model must have Package with name *“http://www.example.com/example”*

- Permission with name “xs” must be added into model between XMLSchema Class and Package *“http://www.w3.org/2001/XMLSchema”.*
- Permission without name must be added into model between XMLSchema Class and Package *“http://www.w3.org/2001/XMLSchema”*.

XML schema namespaces UML Model example

For an example, see “schema UML Model example” on page 133.