IDA

The Best of All Possible Worlds: Applying the Model Driven Architecture Approach to a JC3IEDM OWL Ontology Modeled in UML

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Background

- Traditional information modeling – as exemplified by data modeling for database implementations – is focused on *processes*, which generally leads to a tight coupling between the resulting model and how an organization uses information to support its operations
- These models are driven by the current state of how things are done, instead of expressing what the objects involved are
  - This causes data interoperability problems due to procedural variability – there are many ways to skin the *procedural cat*
- A modeling approach that emphasizes the what – the nature of the objects in the domain being modeled – can better support information models with constructs of broader applicability and durability across the enterprise

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Desired Capability

- Ability to model information more flexibly than with standard ER notation, and, at the same time, be able to leverage the gains provided by the application of the Model Driven Architecture (MDA) approach
- Issue:
  - Semantic modeling well supported with OWL but MDA requires UML
- Approach investigated:
  - Use Ontology Definition Metamodel (ODM) to model OWL in UML
  - Treat resulting model as an MDA Platform Independent Model (PIM)
  - Apply the MDA tool set (i.e., Query-View-Transformation language) to the OWL PIM to automatically generate desired MDA Platform Specific Model (PSM)
  - Use standard CASE tool capabilities to automatically produce executable code

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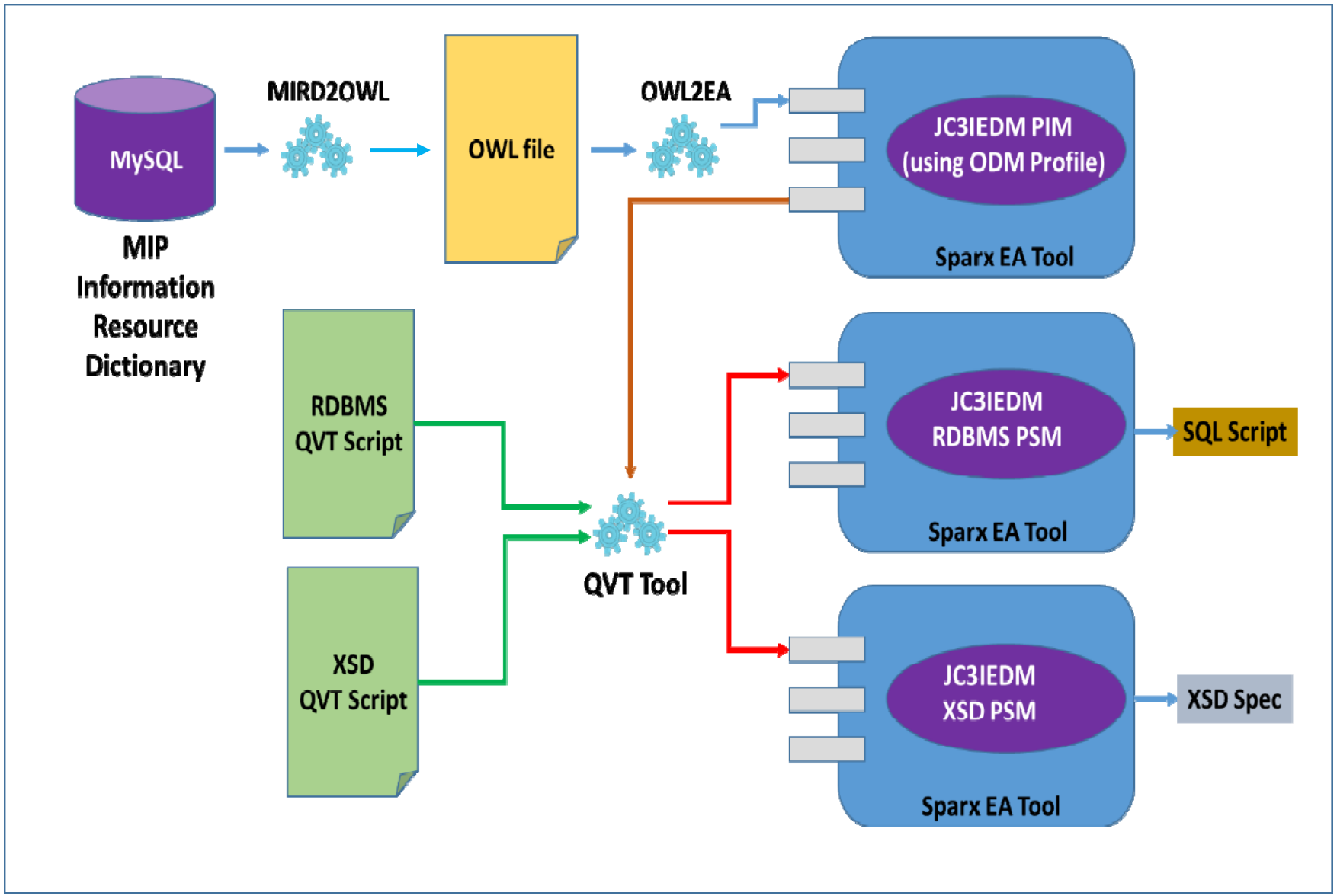
Proposed Approach



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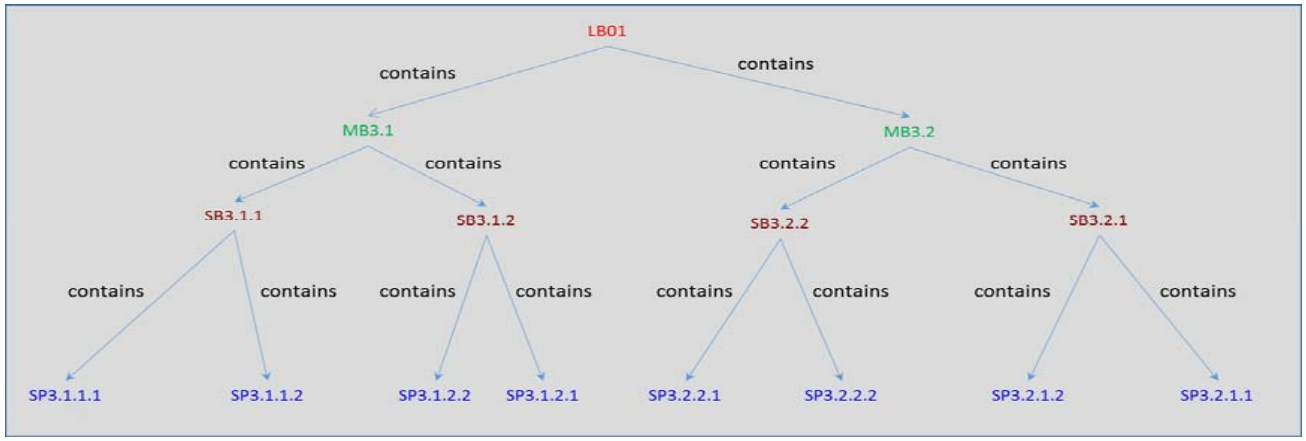
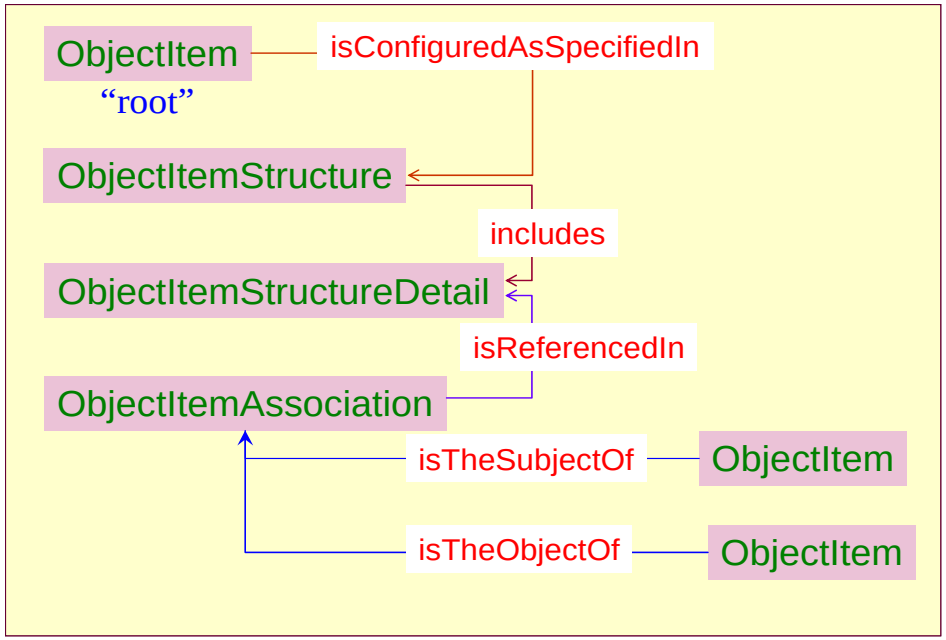
RDBMS Use Case

Task: Capture a tree-like decomposition of container contents

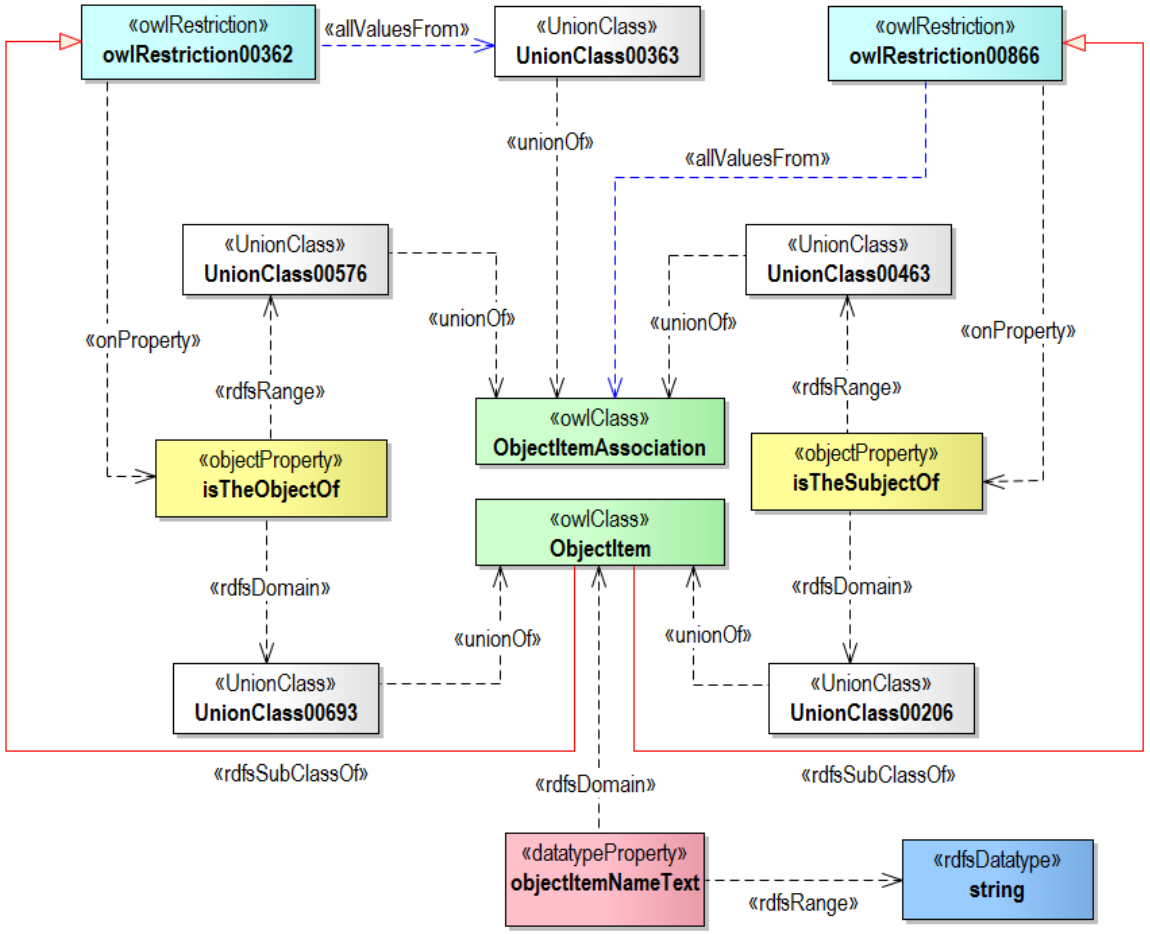


Conceptual Model



RDBMS Use Case

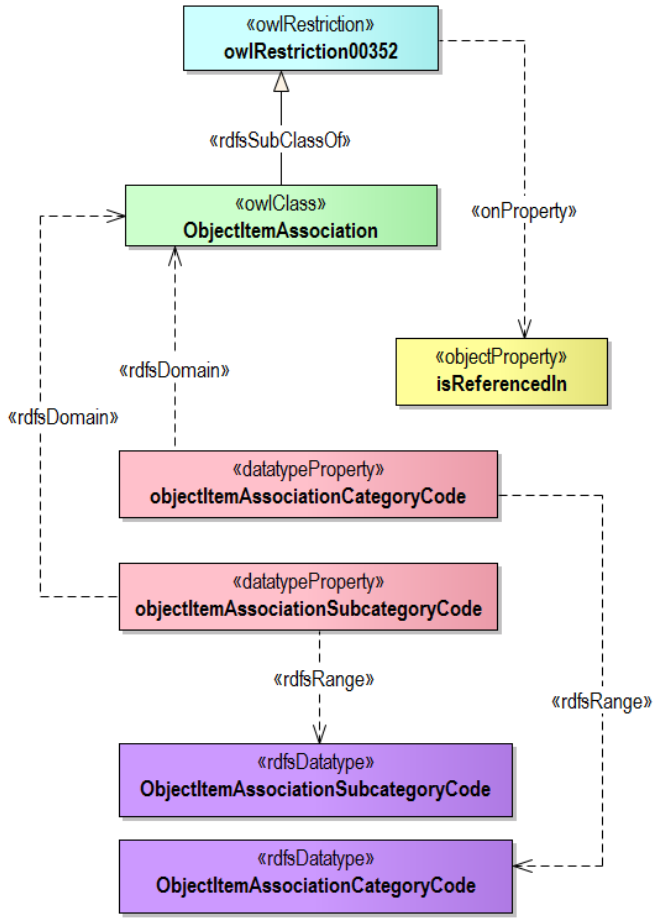
OWL Modeling
ObjectItemAssociation Subview



OWL UML PIM

RDBMS Use Case

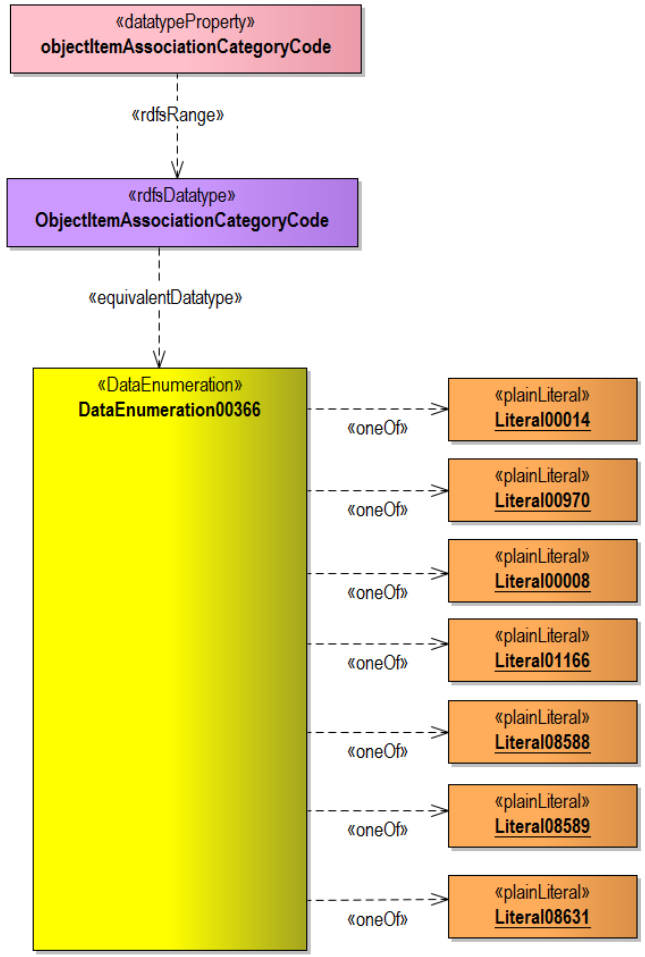
OWL Modeling
objectProperties for ObjectItemAssociation subview



OWL UML PIM

RDBMS Use Case

OWL Modeling
dataTypeProperties for ObjectItemAssociation subview



OWL UML PIM

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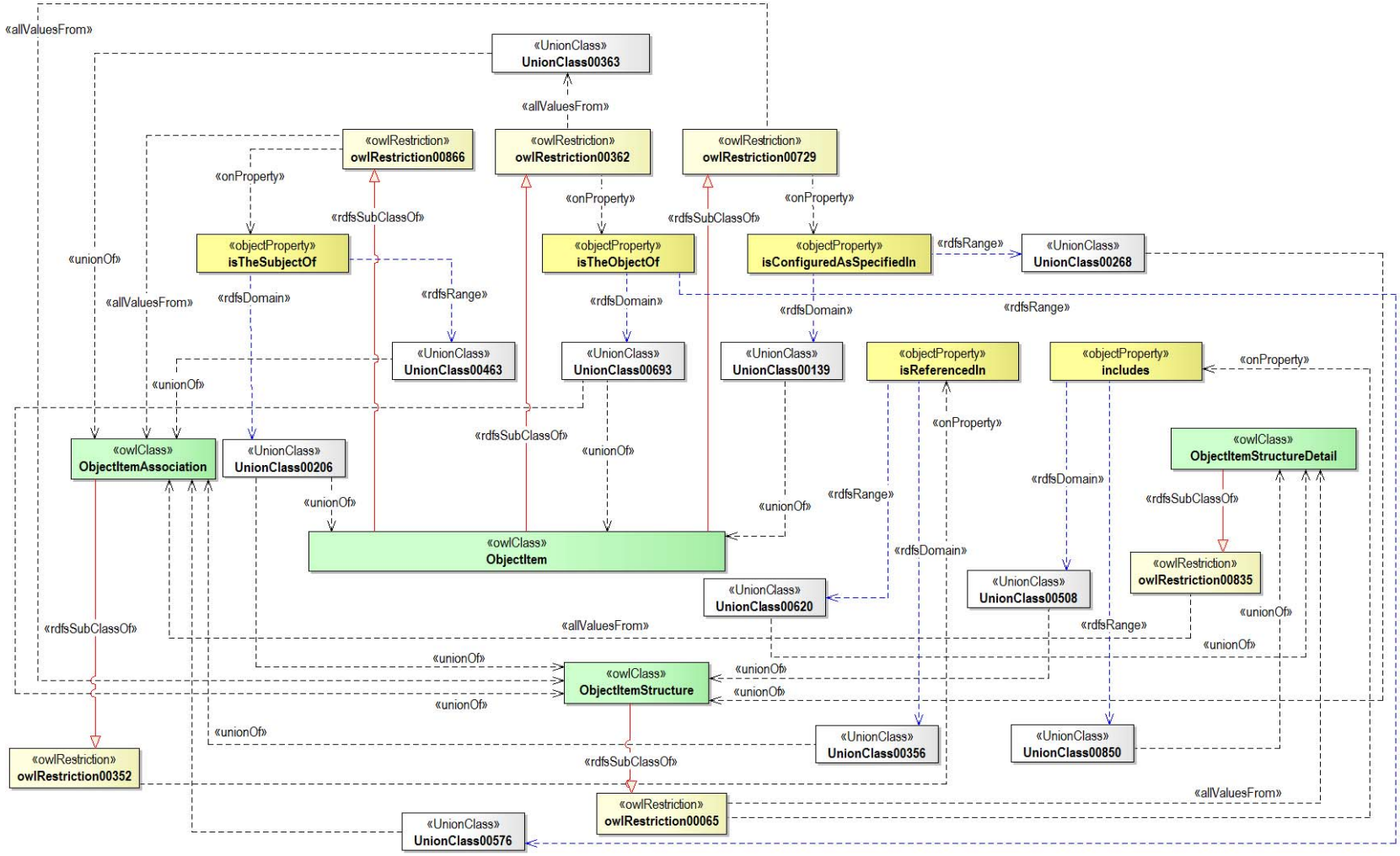
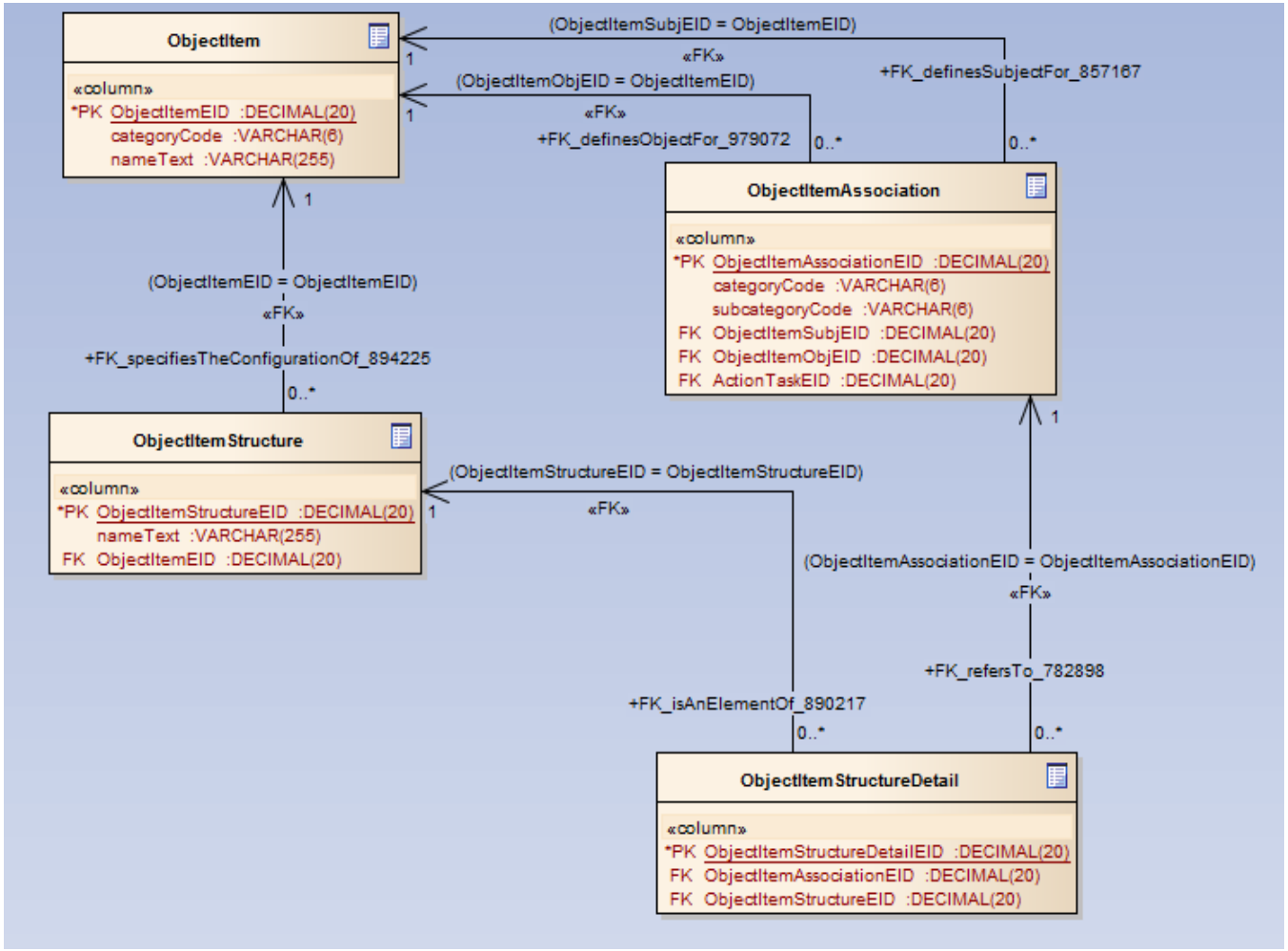
RDBMS Use Case



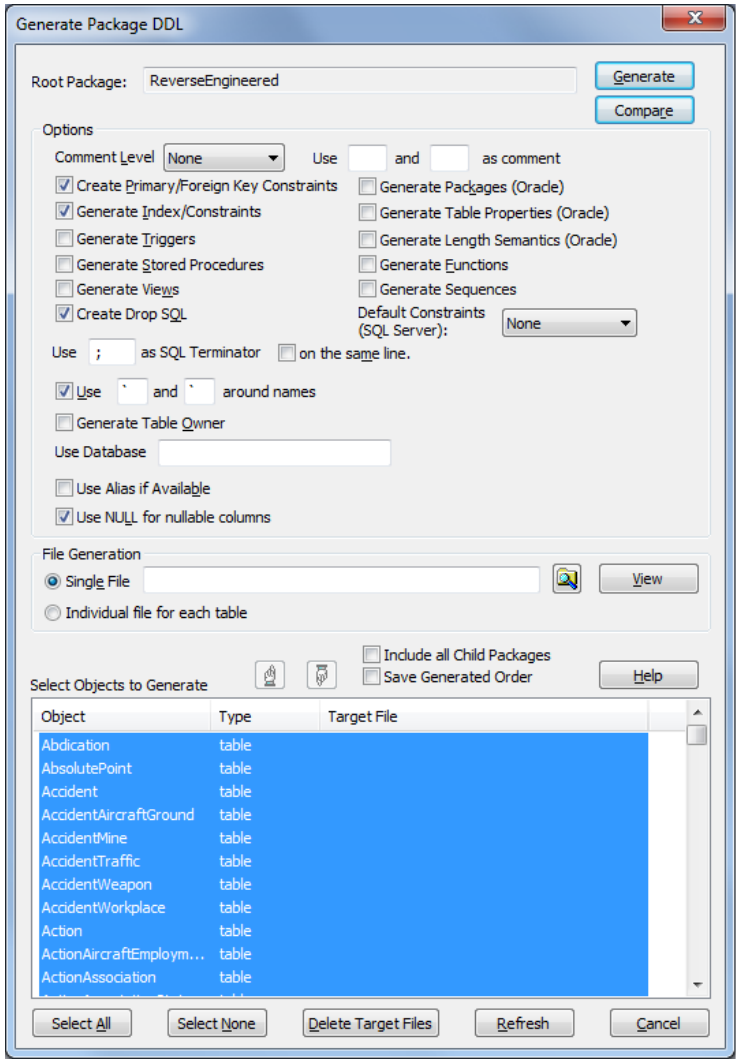
OWL UML PIM Finalized

RDBMS Use Case

Resulting RDBMS PSM after QVT Transformation



RDBMS Use Case



CASE Tool Generation Capability

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RDBMS Use Case

```
SET FOREIGN_KEY_CHECKS=0;



DROP TABLE IF EXISTS `ObjectItem` CASCADE
;
DROP TABLE IF EXISTS `ObjectItemAssociation` CASCADE
;
DROP TABLE IF EXISTS `ObjectItemStructure` CASCADE
;
DROP TABLE IF EXISTS `ObjectItemStructureDetail` CASCADE
;

CREATE TABLE `ObjectItem`
(
    `ObjectItemEID` DECIMAL(20) NOT NULL,
    `categoryCode` VARCHAR(6) NULL,
    `nameText` VARCHAR(255) NULL,
    PRIMARY KEY (`ObjectItemEID`)

) TYPE=InnoDB
;


CREATE TABLE `ObjectItemAssociation`
(
    `ObjectItemAssociationEID` DECIMAL(20) NOT NULL,
    `categoryCode` VARCHAR(6) NULL,
    `subcategoryCode` VARCHAR(6) NULL,
    `ObjectItemSubjEID` DECIMAL(20) NULL,
    `ObjectItemObjEID` DECIMAL(20) NULL,
    `ActionTaskEID` DECIMAL(20) NULL,
    PRIMARY KEY (`ObjectItemAssociationEID`),
    INDEX `ObjectItemObjEID` (`ObjectItemObjEID` ASC),
    INDEX `ObjectItemSubjEID` (`ObjectItemSubjEID` ASC),
    INDEX `ActionTaskEID` (`ActionTaskEID` ASC)

) TYPE=InnoDB
;


CREATE TABLE `ObjectItemStructure`
(
    `ObjectItemStructureEID` DECIMAL(20) NOT NULL,
    `nameText` VARCHAR(255) NULL,
    `ObjectItemEID` DECIMAL(20) NULL,
    PRIMARY KEY (`ObjectItemStructureEID`),
    INDEX `ObjectItemEID` (`ObjectItemEID` ASC)

) TYPE=InnoDB
;

```

Executable SQL Script

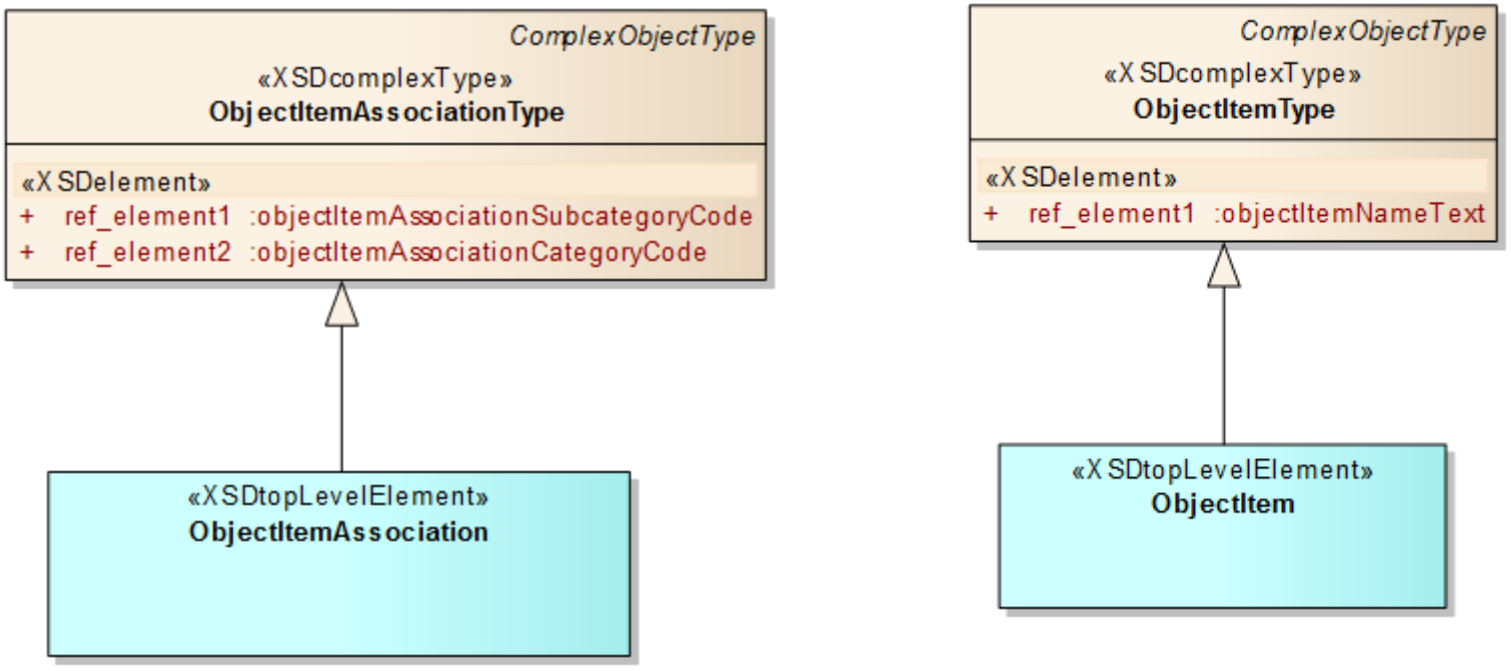
XML/XSD Use Case

Goals

- Support interoperability among DoD systems
- Improve information consistency and correctness
- Demonstrate the value of Model Driven Architecture in XML-based message exchange

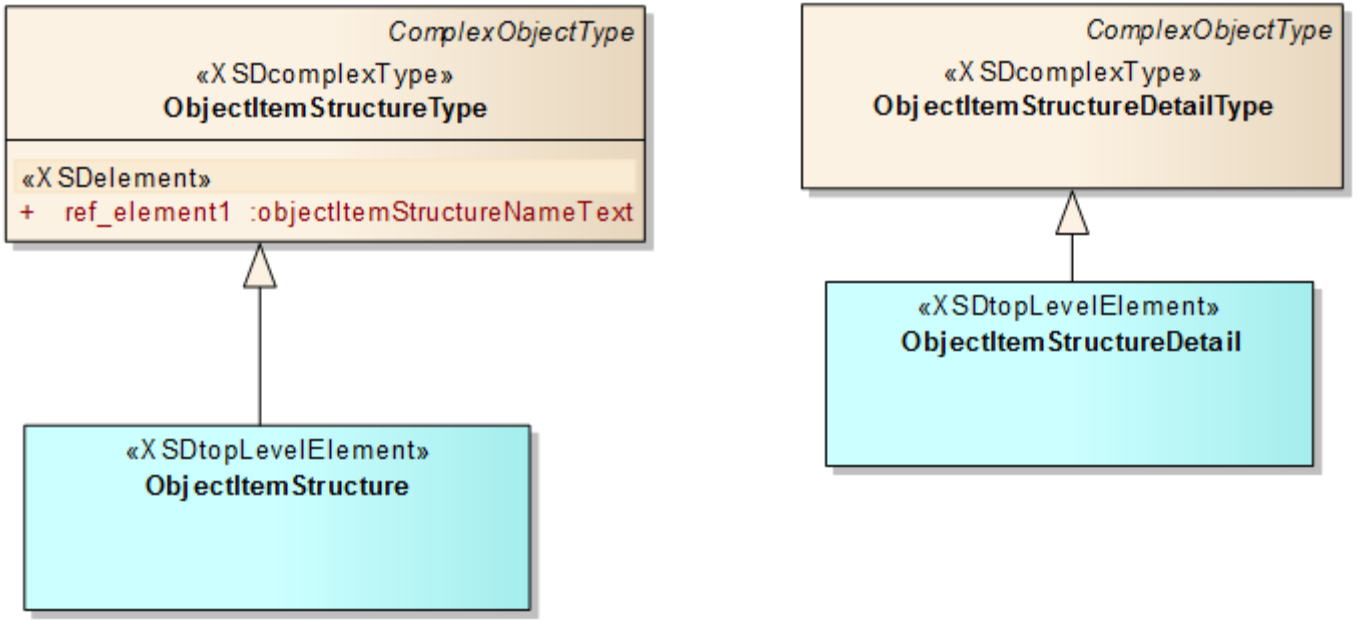
XML/XSD Use Case

Resulting XSD Model after QVT Transformation



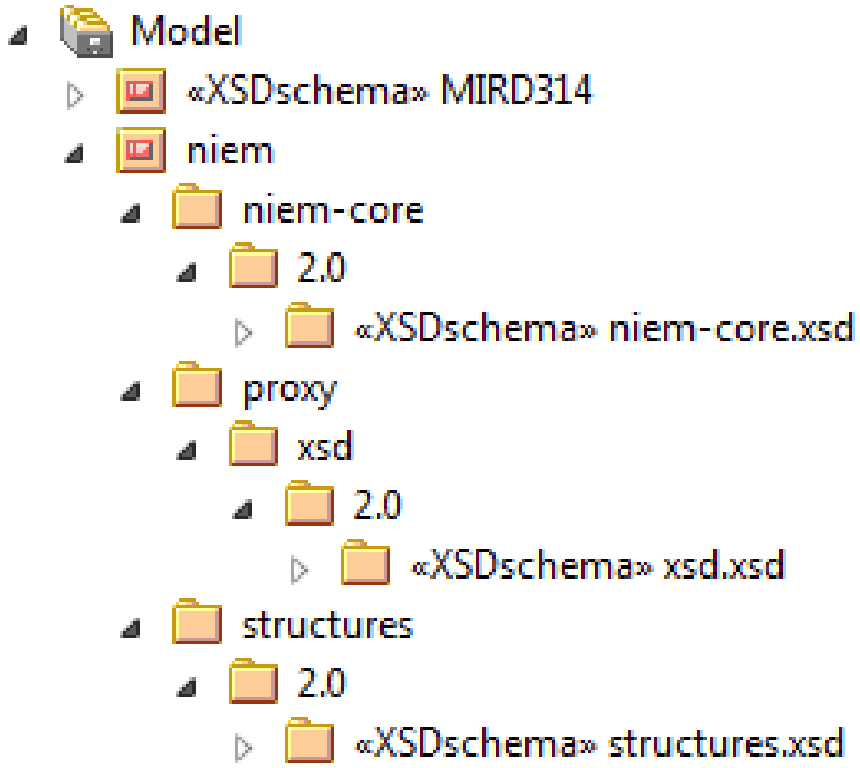
XML/XSD Use Case

Resulting XSD Model after QVT Transformation



XML/XSD Use Case

Package hierarchy generated by the QVT transformation



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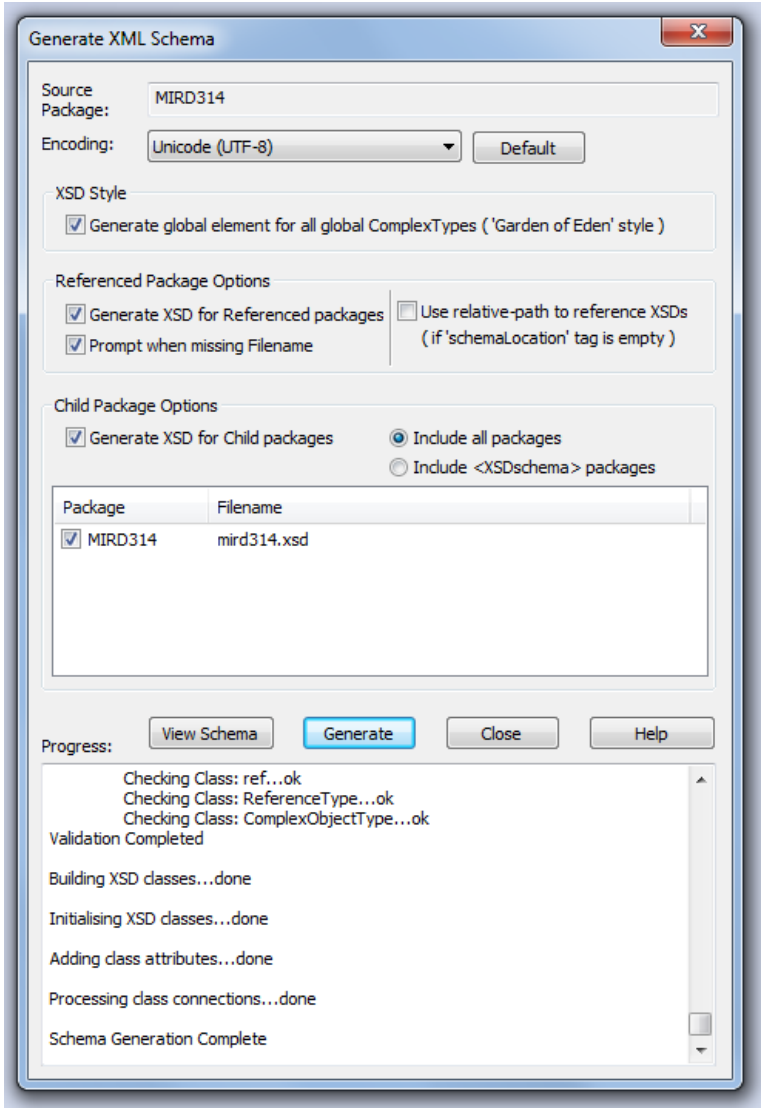
XML/XSD Use Case



CASE Tool Generation Capability

XML/XSD Use Case

```
<xs:element name="ObjectItemAssociation"
type="mird:ObjectItemAssociationType">
    <xs:annotation>
        <xs:documentation>A relationship of an
        Object Item as a subject with another
        Object Item as an object.</xs:documentation>
    </xs:annotation>
</xs:element>
```

Generated XSD

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XML/XSD Use Case

```
<xs:complexType name="ObjectItemStructureDetailType">
    <xs:annotation>
        <xs:documentation>The identification of a
        specific Object Item Association as an
        element in a specific Object Item Structure.
        </xs:documentation>
    </xs:annotation>
    <xs:complexContent>
        <xs:extension base="s:ComplexObjectType">
            <xs:sequence/>
        </xs:extension>
    </xs:complexContent>
</xs:complexType>
<xs:element name="ObjectItemStructureDetail"
type="mird:ObjectItemStructureDetailType">
    <xs:annotation>
        <xs:documentation>The identification of a
        specific Object Item Association as an
        element in a specific Object Item Structure.
        </xs:documentation>
    </xs:annotation>
</xs:element>
```

Generated XSD

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Conclusions

- The ODM profile enables use of UML for OWL modeling of business domains, e.g., C2
- Resulting OWL UML model can be treated as a PIM
- MDA approach can be applied to generate PSMs
- Current CASE tool capabilities adequately support generation of executable code for a number of implementations of general use: RDBMS, XML/XSD
- Other implementations may require development of appropriate UML profiles which, although not trivial, are technically feasible