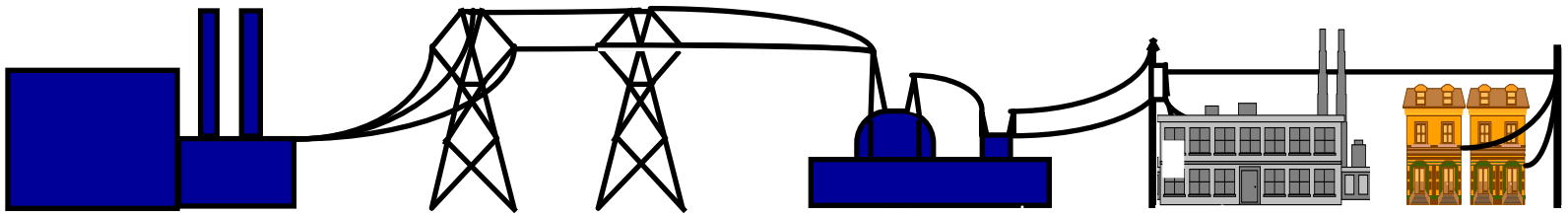
Message Generation Based on the CIM

CIM User Group Meeting
Vasteras, Sweden
10 June 2008



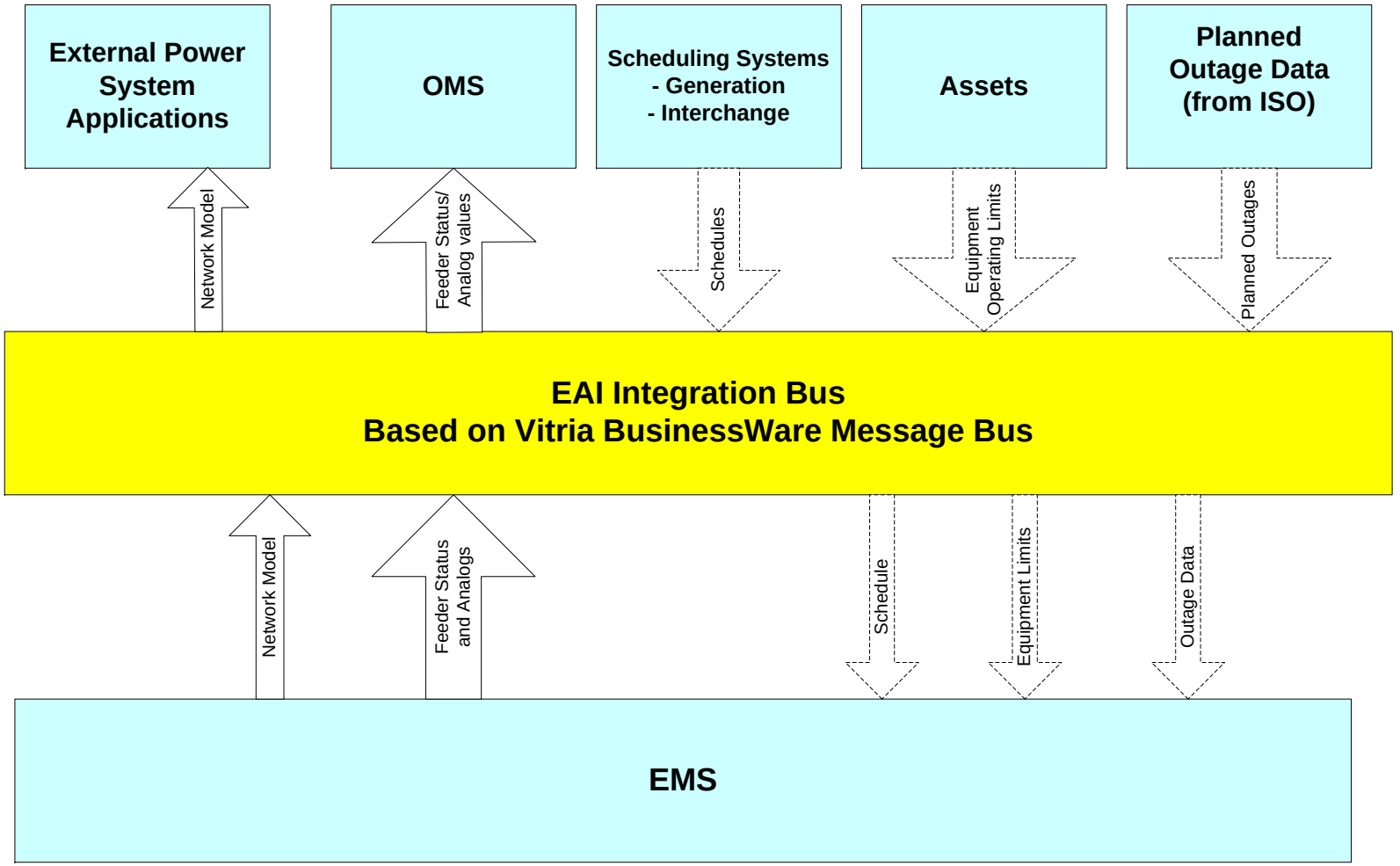
Acknowledgements

- Alan McMorran, “An Introduction to IEC 61970-301 & 61968-11: The Common Information Model”, University of Strathclyde, Glasgow, UK
- Jean-Luc Sanson, EDF and Xiaofeng Wang, Xtensible Solutions, “Information Model and Message Modeling”
- Arnold deVos, “UN/CEFACT Modeling and Messaging Framework”

Message Generation Based on the CIM

- Initial Take
  - Generating a message based on the CIM standards
- Second Take
  - How do you incorporate business constraints and restrictions to the CIM standard
  - How do you use the 61968 message standards
- Third Take
  - How do you incorporate other information meta models into your enterprise semantic model in addition to the CIM standard
- Fourth Take
  - How do you test for compliance

EMS Replacement with MDI for External Interfaces



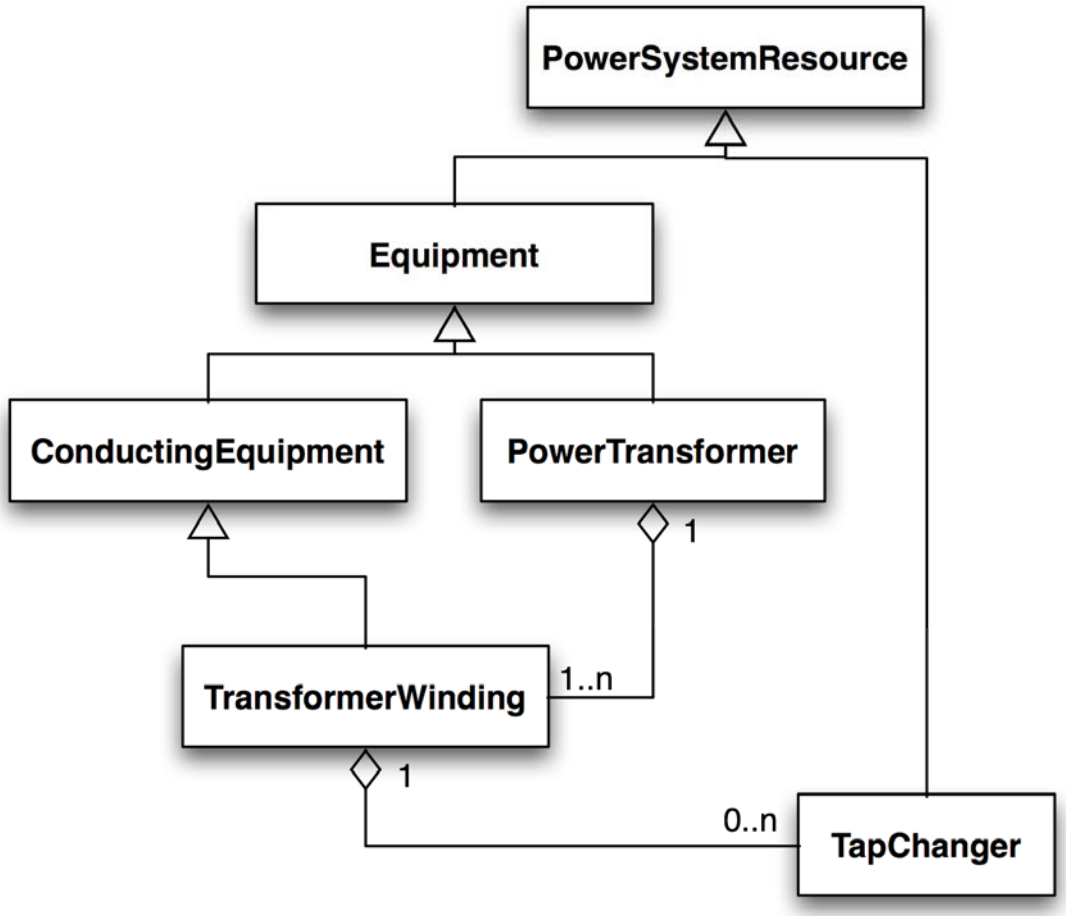
EMS Replacement Project

- Goal was to implement MDI (Model Driven Integration)
- Decision to use Web Services over Vitria BusinessWare EAI platform
- Delivered XML message schemas and WSDLs for
  - Status and analog measurements
  - Outage schedules
  - Interchange schedules
  - Generation schedules
  - Line operating limits
  - Transformer operating limits
  - Generic events for log
- Interesting paradigm shift

Mapping EMS Interfaces to the CIM – User access to transformer data

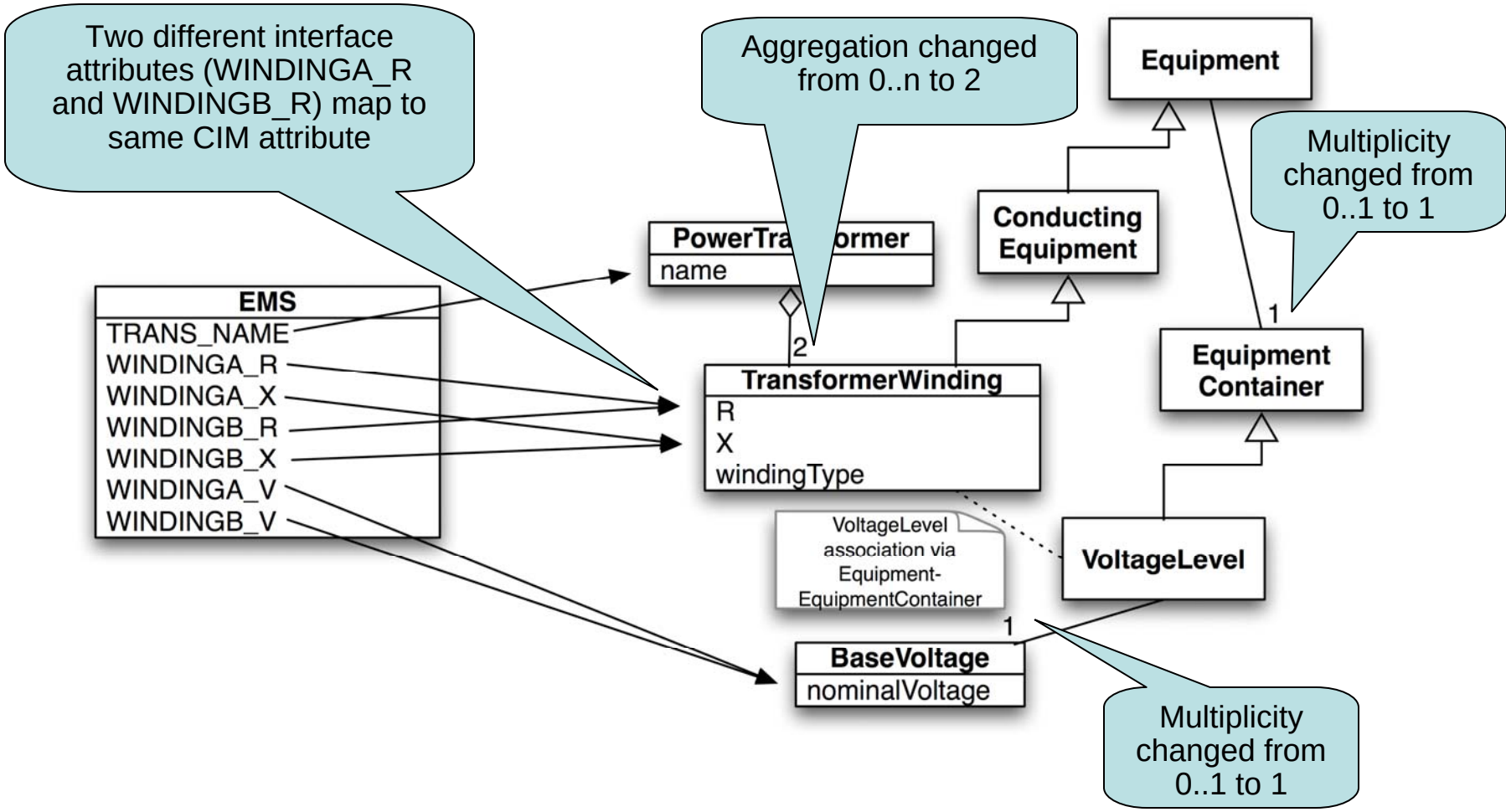
- Interface attributes:
  - TRANS_NAME – The Transformer's name
  - WINDINGA_R – The Transformer's primary winding resistance
  - WINDINGA_X – The Transformer's primary winding reactance
  - WINDINGB_R – The Transformer's secondary winding resistance
  - WINDINGB_X – The Transformer's secondary winding reactance
  - WINDINGA_V – The Transformer's primary winding voltage
  - WINDINGB_V – The Transformer's secondary winding voltage

Transformer Class Diagram

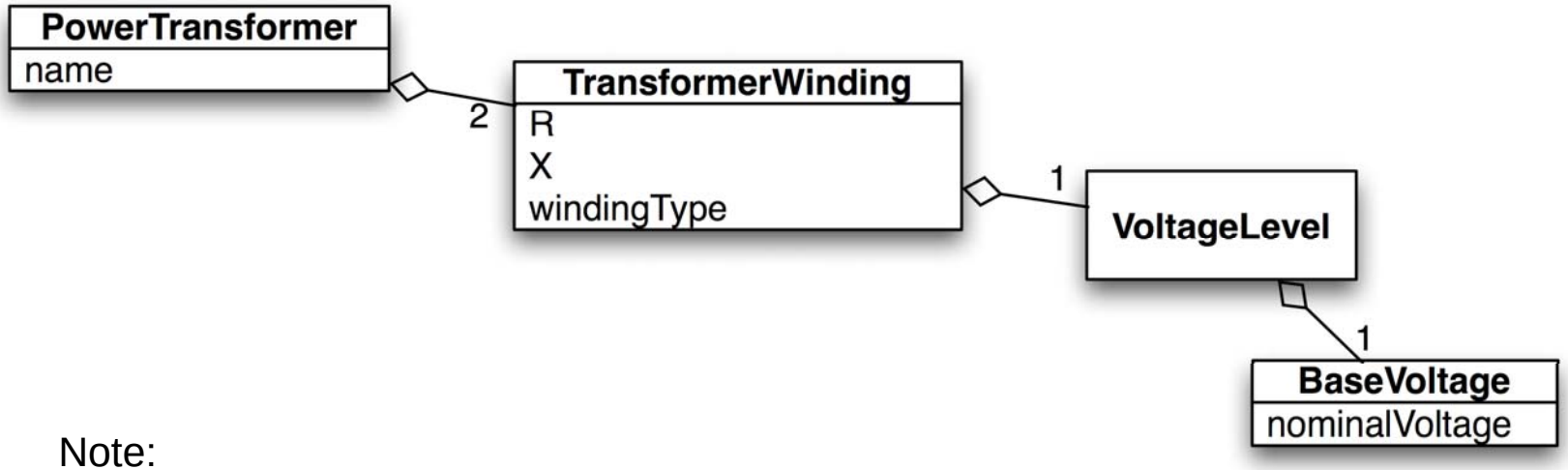


CIM Interface Mapping

- Beginnings of Message Payload Definition



Message Payload in UML



Note:

- Associations changed to aggregations
- Parent classes removed
  - Not required in actual message content
  - Parent classes already known by both sender and receiver
    - Corollary: Only those parts of the CIM used in message exchange need to be supported by interface applications
- End result – modified class structure
  - Example of application of business context to information model

XML Schema for Transformer Message

```
<xs:schema xmlns:cim="cimBase" xmlns:xs="http://www.w3.org/2001/XMLSchema">

<xs:element minOccurs="1" maxOccurs="1" name="PowerTransformer">
 <xs:complexType>
  <xs:complexContent>
   <xs:extension base="cim:PowerTransformer">
    <xs:sequence>
     <xs:element minOccurs="1" maxOccurs="1"
         name="Naming.name" type="xs:string"/>
     <xs:element minOccurs="2" maxOccurs="2"
         name="PowerTransformer.Contains_TransformerWindings">
      <xs:complexType>
       <xs:complexContent>
        <xs:extension base="cim:TransformerWinding">
         <xs:sequence>
          <xs:element minOccurs="1" maxOccurs="1"
              name="TransformerWinding.r" type="xs:float"/>
          <xs:element minOccurs="1" maxOccurs="1"
              name="TransformerWinding.x" type="xs:float"/>
          <xs:element minOccurs="1" maxOccurs="1"
              name="TransformerWinding.windingType" type="cim:WindingType"/>
          <xs:element minOccurs="1" maxOccurs="1"
              name="TransformerWinding.MemberOf_EquipmentContainer">
           <xs:complexType>
            <xs:complexContent>
             <xs:extension base="cim:VoltageLevel">
              <xs:sequence>
               <xs:element minOccurs="1" maxOccurs="1"
                   name="VoltageLevel.BaseVoltage">
                <xs:complexType>
                 <xs:complexContent>
                  <xs:extension base="cim:BaseVoltage">
                   <xs:sequence>
                    <xs:element minOccurs="1" maxOccurs="1"
                        name="BaseVoltage.nominalVoltage" type="xs:float"/>
                   </xs:sequence>
                  <xs:extension>
                 </xs:complexContent>
                 </xs:complexType>
                </xs:element>
              </xs:sequence>
             </xs:extension>
            </xs:complexContent>
           </xs:complexType>
          </xs:element>
         </xs:sequence>
        </xs:extension>
       </xs:complexContent>
      </xs:complexType>
     </xs:element>
    </xs:sequence>
   </xs:extension>
  </xs:complexContent>
 </xs:complexType>
</xs:element>

</xs:schema>
```

Transformer Interface Message Payload in XML

```
<cim:PowerTransformer>
  <cim:Naming.name>Transformer SGT1</cim:Naming.name>
  <cim:PowerTransformer.Contains_TransformerWindings>
    <cim:TransformerWinding.r>0.23</cim:TransformerWinding.r>
    <cim:TransformerWinding.x>0.78</cim:TransformerWinding.x>
    <cim:TransformerWinding.windingType>WindingType.primary
         </cim:TransformerWinding.windingType>
    <cim:Equipment.MemberOf_EquipmentContainer>
      <cim:VoltageLevel.BaseVoltage>
        <cim:BaseVoltage.nominaVoltage>400
          </cim:BaseVoltage.nominalVoltage>
      </cim:VoltageLevel.BaseVoltage>
    </cim:Equipment.MemberOf_EquipmenContainer>
  </cim:PowerTransformer.Contains_TransformerWindings>
  <cim:PowerTransformer.Contains_TransformerWindings>
    <cim:TransformerWinding.r>0.46</cim:TransformerWinding.r>
    <cim:TransformerWinding.x>0.87</cim:TransformerWinding.x>
    <cim:TransformerWinding.windingType>WindingType.secondary
         </cim:TransformerWinding.windingType>
    <cim:Equipment.MemberOf_EquipmentContainer>
      <cim:VoltageLevel.BaseVoltage>
        <cim:BaseVoltage.nominaVoltage>275
             </cim:BaseVoltage.nominalVoltage>
      </cim:VoltageLevel.BaseVoltage>
    </cim:Equipment.MemberOf_EquipmenContainer>
  </cim:PowerTransformer.Contains_TransformerWindings>
</cim:PowerTransformer>
```

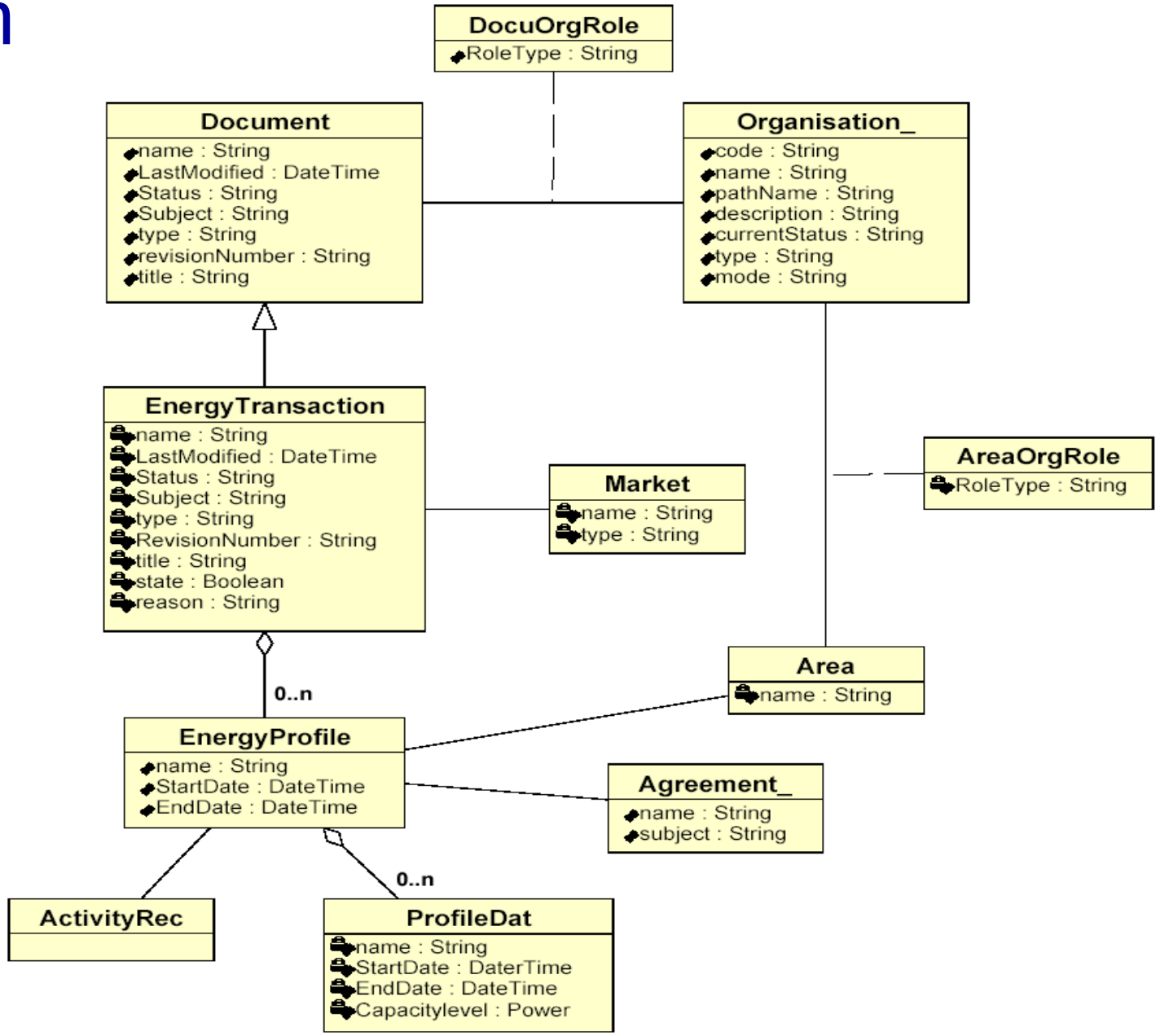
How can we generate a Message from an Information Model?

- First we are define a context : use case, business process analysis…
- At the end of this analysis some exchanges are defined that are realized by message exchange
- Message description must state :
  - What are the classes involved in the exchange?
  - What are the class properties necessary for the exchange?
  - What kind of constraints should be applied on the properties type?
  - What is the principal class involved in the exchange?
- In fact what we are doing is defining a view of the information Model

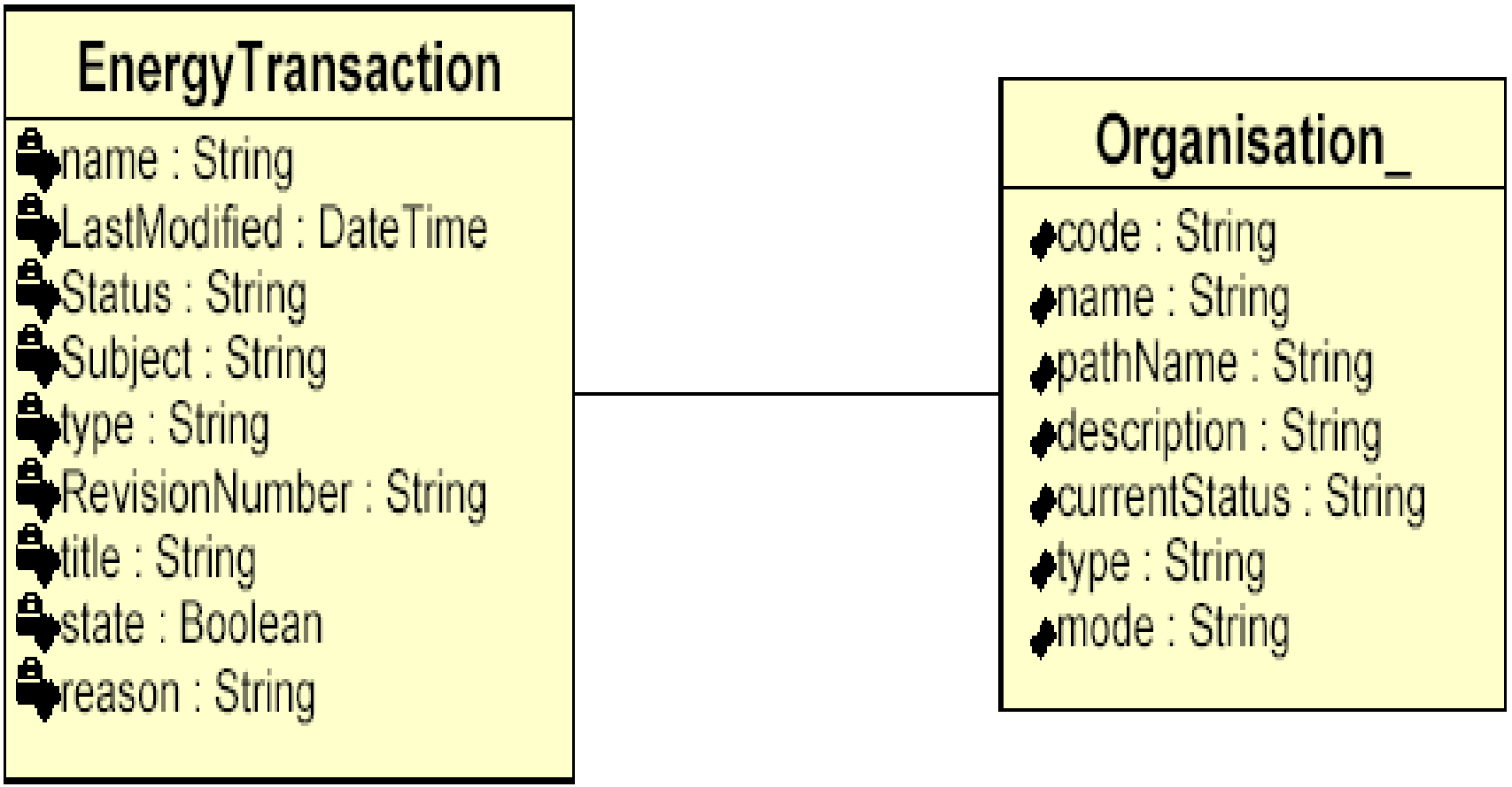
Information Model

- An Information Model is a model that represents all classes with :
  - all their possible properties
  - all their possible associations
- This has some consequences :
  - All properties are described as optional
  - A lot of associations are left optional
  - All associations are bidirectional ones (except for specialized ones like inheritance and aggregation)
  - This means that there is no hierarchy
  - dataTyping is kept as generic as possible
- An Information Model is context independant
- The CIM model is based on this philosophy

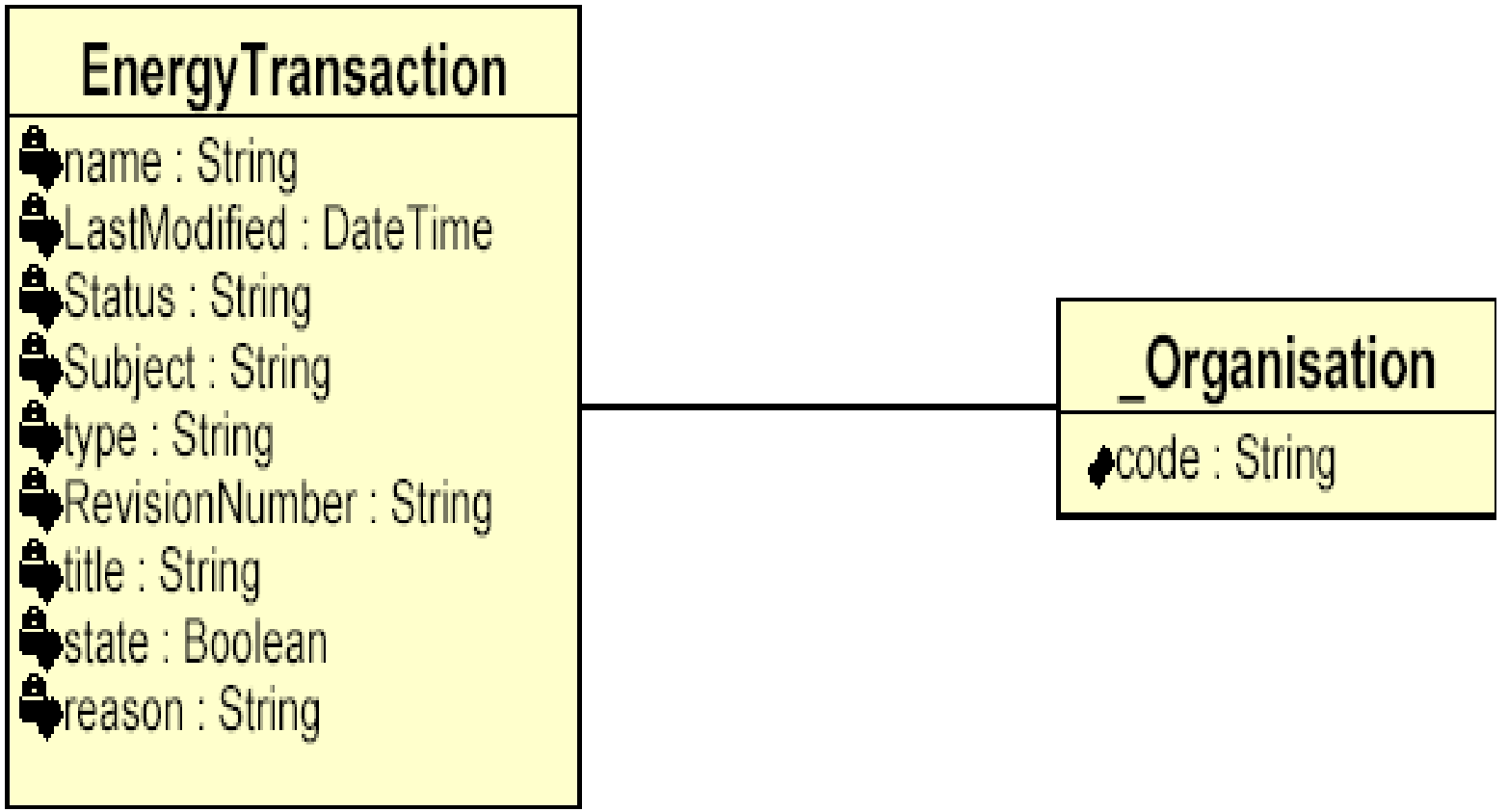
Information Model (Abstract Model) Business Class



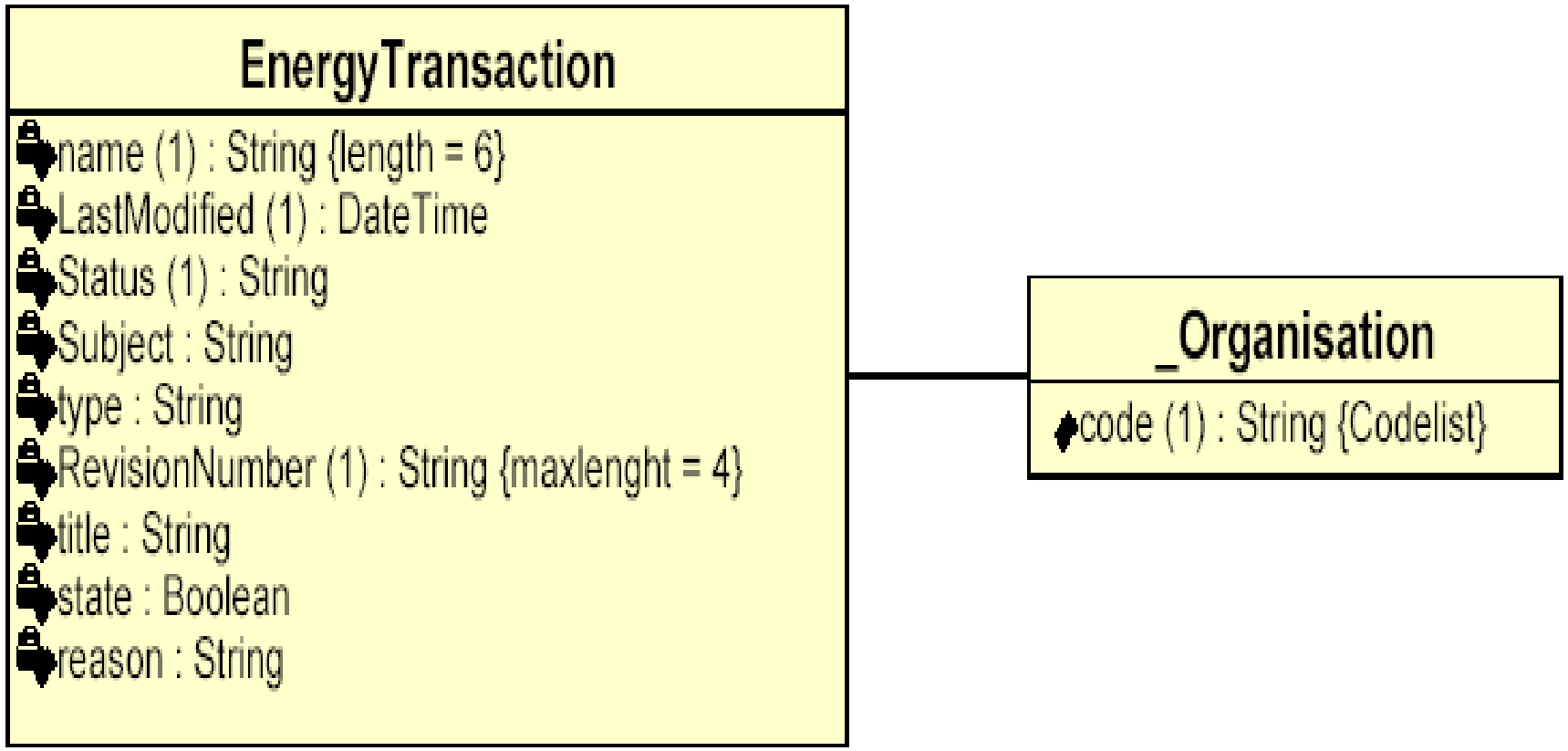
Step 1: Selecting Classes involved in the exchange



Step 2: Select class properties involved in the exchange:



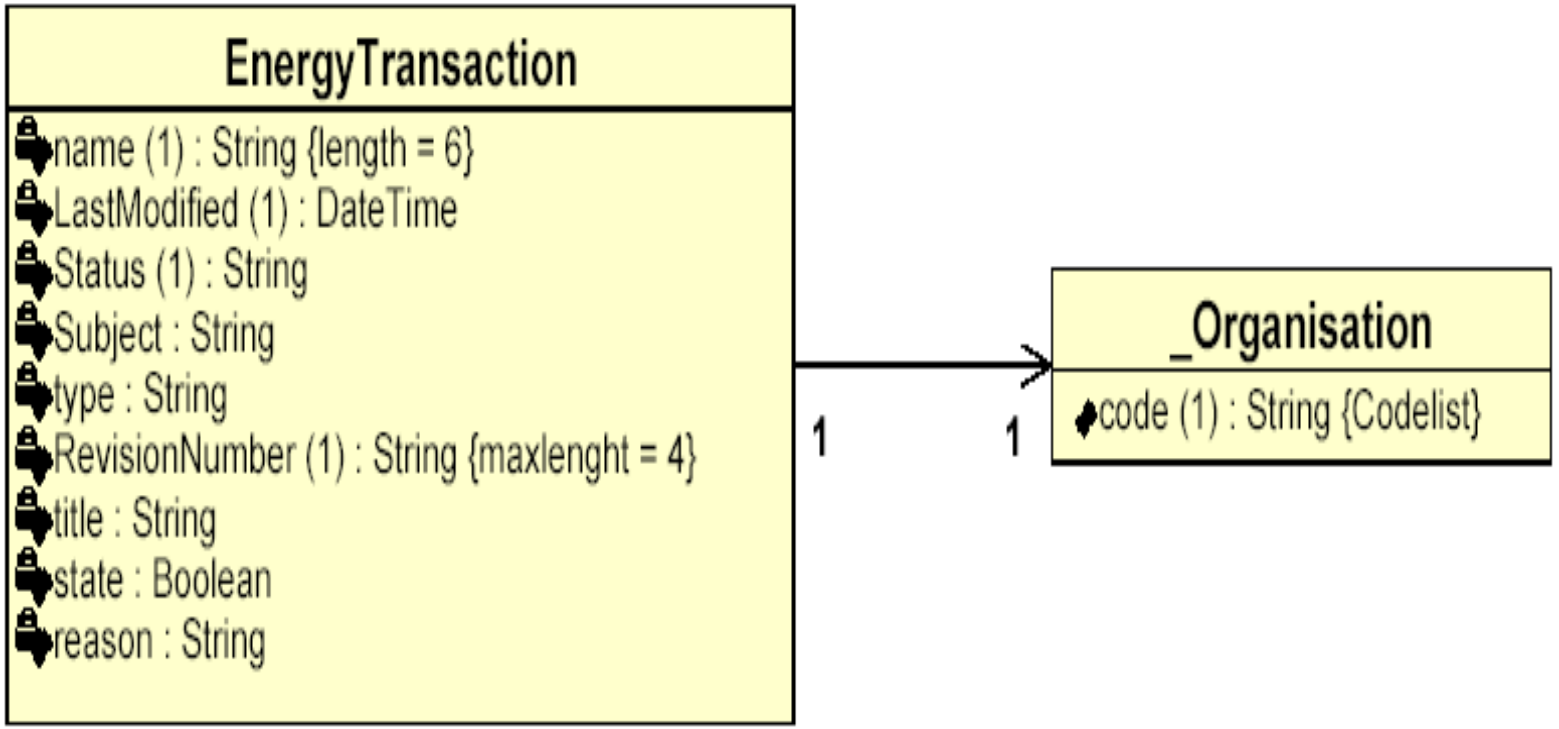
Step 3: Define Properties DataTypes and constraints



➔ Need for a constraint language

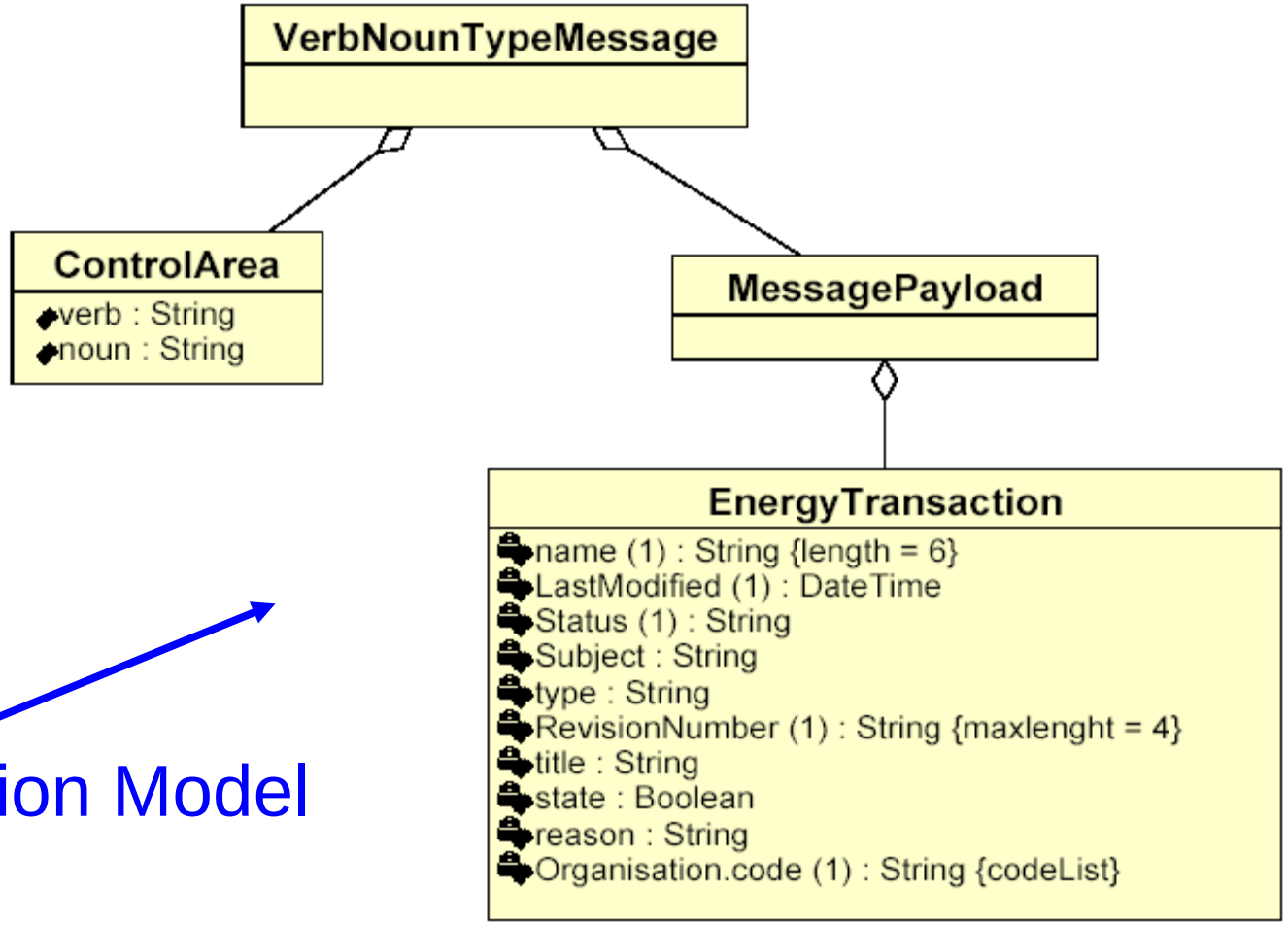
Step 4: Define main classes (and hierarchy)

Root Element



➔ Contextual Model Definition

Define Message Model according to standard assembly rules



➔Implementation Model level

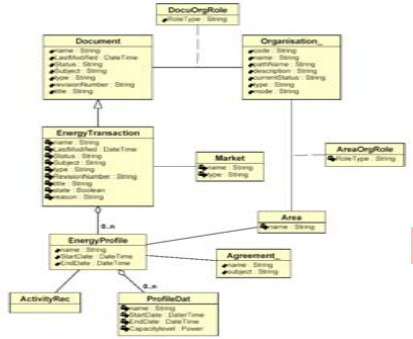
➔Assembly Rules

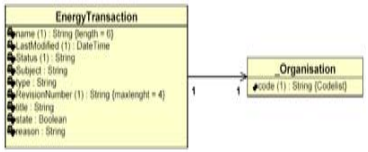
Define Syntactic Message Model according to transformation rules

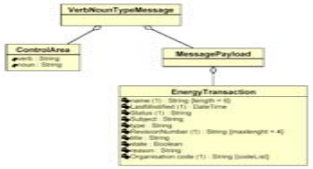
XML Syntax

```
<?xml version="1.0" encoding="UTF-8"?>
<xsd:element name=« VerbNounMessageType">
<xsd:sequence>
    <xsd:element name=« ControlArea"/>
      <xsd:sequence>
        <xsd:element name=« Verb"/>
          <xsd:element name=« Noun"/>
      </xsd:sequence>
     </xsd:element>
```

From Information Model to Syntactic Model







Abstract Model

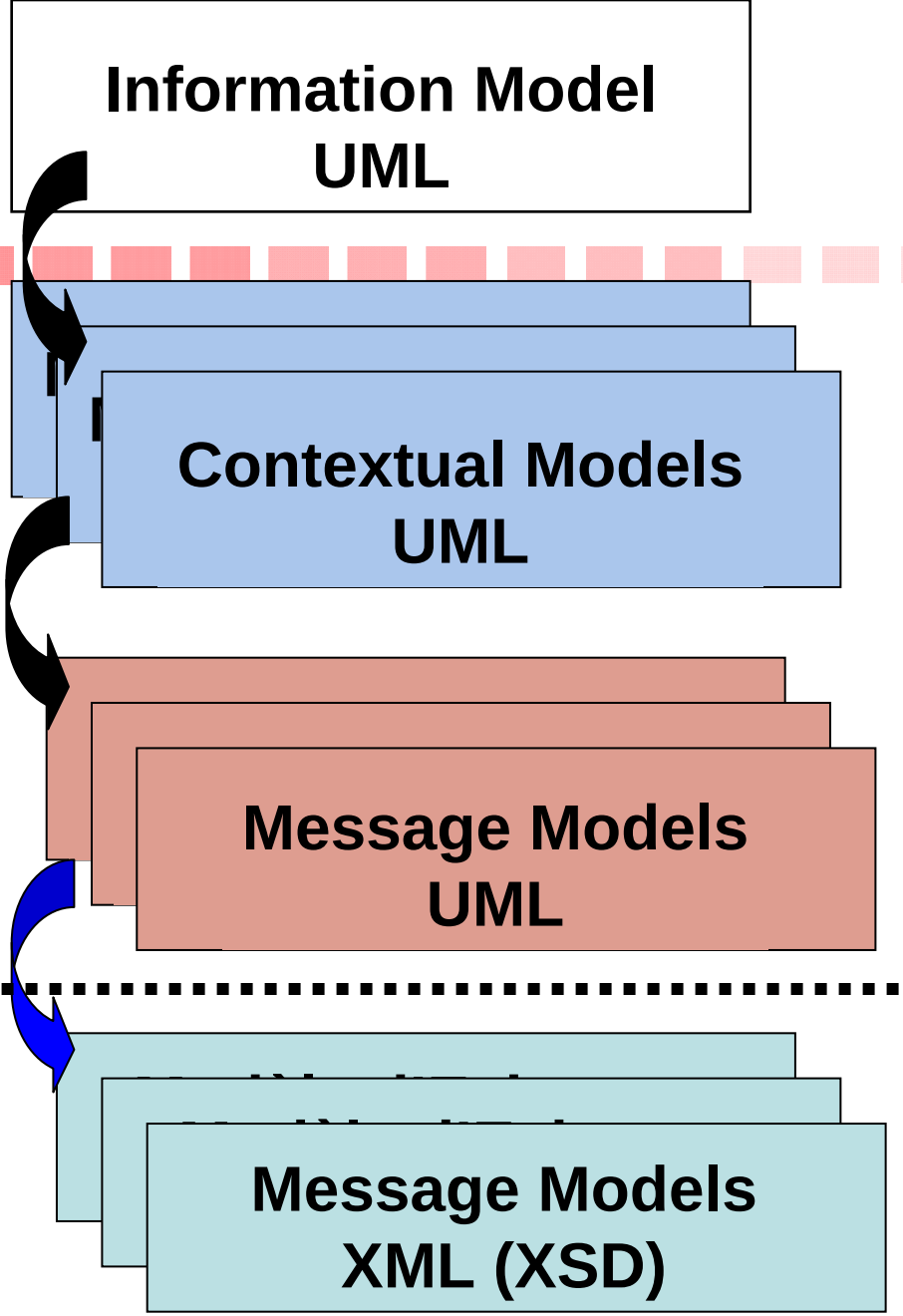
UML World

XML Syntactic World

```
<?xml version="1.0" encoding="UTF-8"?>
<xsd:element name="MSG">
<xsd:sequence>
    <xsd:element name="EnTête"/>
      <xsd:sequence>
        <xsd:element name="Source"/>
          <xsd:element name="Creation"/>
      </xsd:sequence>
    </xsd:element>
```

Syntactic Model

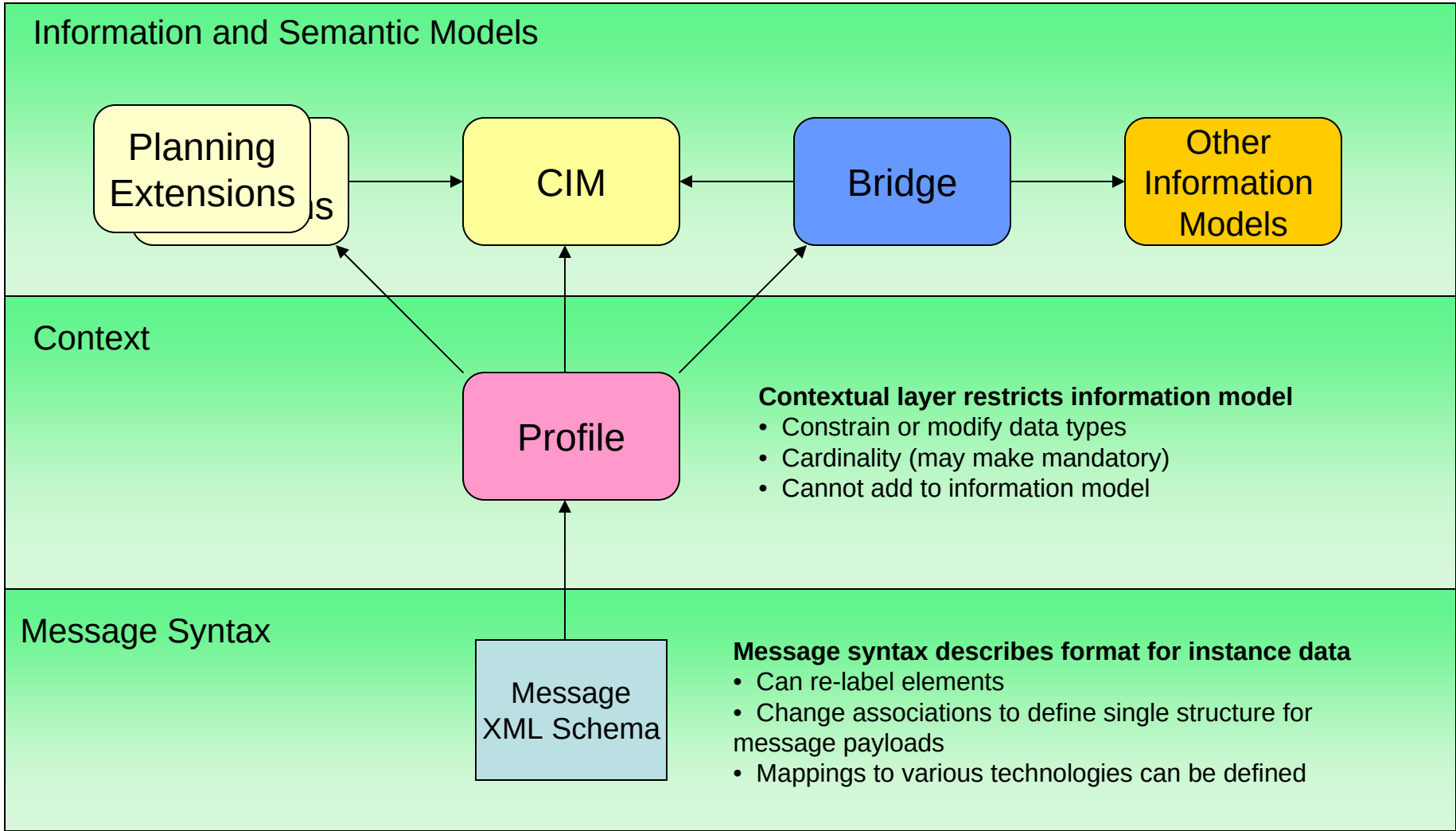
UML/XML Modelling layers



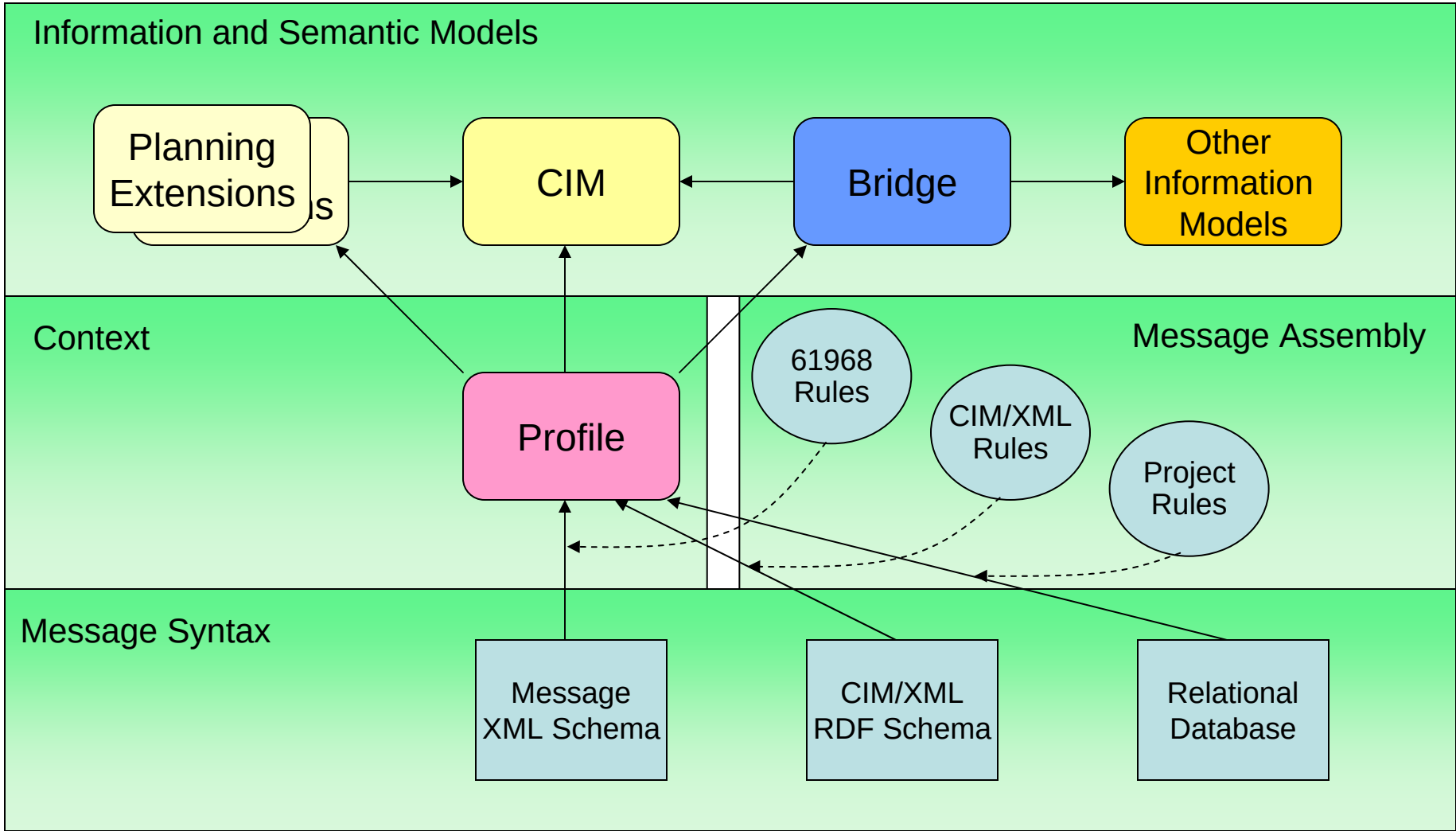
We Need An Organizing Framework

- Layered Reference Architecture for TC57
- Based on UN/CEFACT
  - Information Model
  - Contextual Model
  - Message Syntax
    - Rules for Message Assembly

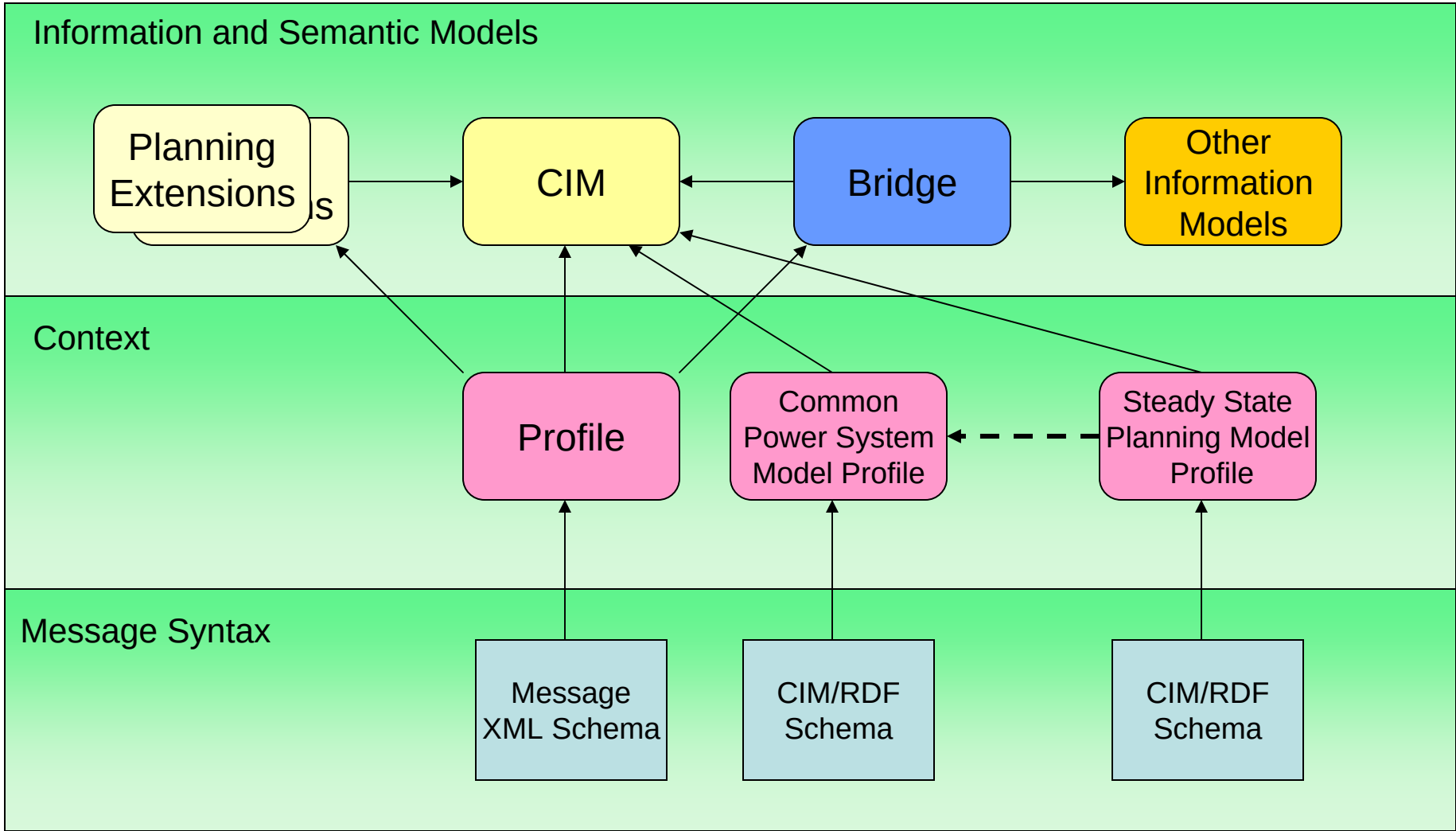
Semantic Models and Profiles



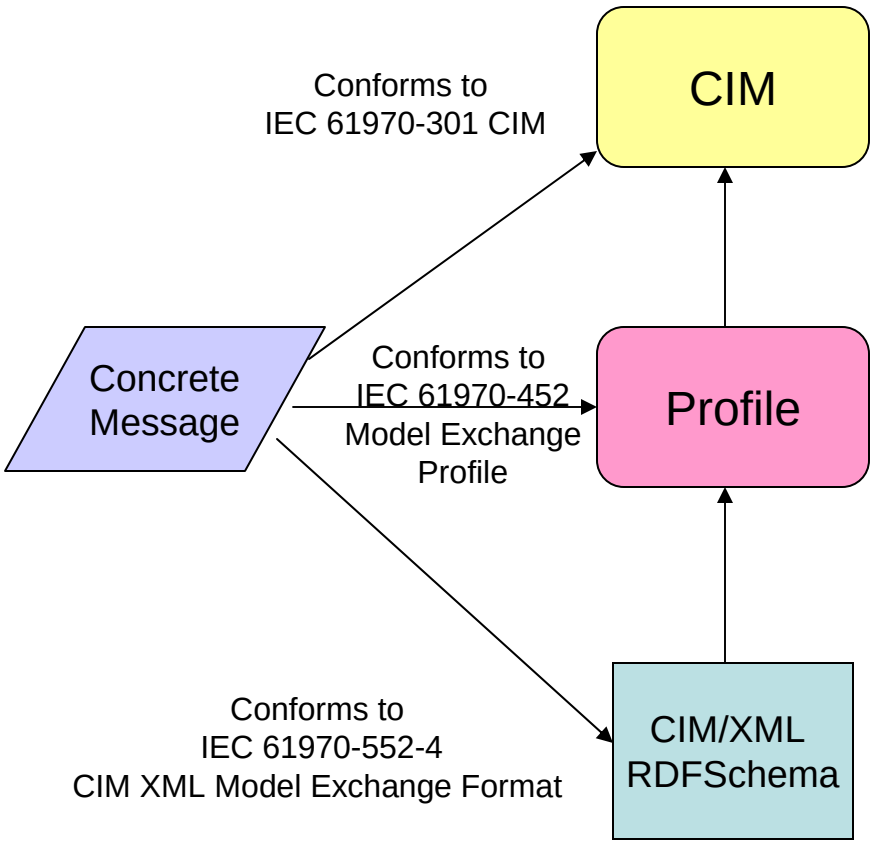
Semantic Models and Profiles



Semantic Models and Profiles



Ex: Power Flow Network Model Exchange



Information Model
- Defines all concepts needed for planning
  - Reused parts
  - New extensions

Contextual layer restricts information model
- Specifies which part of CIM is used for static model exchange
- Mandatory and optional
- Restrictions
- But cannot add to information model

File syntax
- Can re-label elements
- Change associations to define single structure for message payloads
- Mappings to various technologies can be defined

To Summarize

- The CIM is an abstract **information model** standard expressed in UML.
  - But it is more than an information model
- **Profiles** specifying a subset of the CIM classes and attributes for specific business context
- **Implementation models**, such as use of XML to create serialized files and messages
  - Standards for power system models
  - Standards for information message payloads
- Also, the CIM UML can be extended
  - Standard extensions for new functional areas
  - Private extensions for specific utility requirements

CIM Compliance

- What is CIM Compliance
- How do you specify the use of the CIM
- How do you test for compliance

What Does CIM Compliance Mean?

- CIM compliance means that at the public interface the data representation complies with the CIM in terms of:
- General principles:
  - Semantics – naming and meaning of data
  - Syntax – data type
- A specific profile that specifies which parts of the CIM are in view
- Specific services
- Specific XML schemas for messages
- Specific RDF schemas files to be exchanged
- Good practices in the use of the CIM – project guidelines document
- Bottom line: Compliance deals with message/data exchanged at an interface

What CIM Compliance Does Not Mean

- There is a database organized exactly like the CIM class diagrams
- All aspects of the CIM are included in an implementation
  - Profiles can be defined for compliance purposes
    - NERC has defined a Common Power System Model (CPSM) with mandatory and optional conformance points (i.e., classes, attributes, associations)
    - EDF has defined a Distribution Network Model profile
    - Other profiles can be defined and added to the CIM model as well
  - Message standards define a subset of the CIM for a specific information exchange
    - Defines which parts of CIM are used, and which are mandatory or optional
  - A specific system interface may only support a subset of a message standard
    - Ex: A multi-step transaction may involve several systems, each of which supports only a part of the total message standard
- Real-world interfaces will also include private extensions

How to Specify the Use of the CIM

- Need to be specific in what is asked for
  - Specific profiles or message schemas
- Or spell out the process to be followed
  - Map all interfaces to the CIM with extensions added as necessary to create an enterprise information model
  - May be other models to also be included
  - Type of interface envisioned
    - Use of middleware
    - Use of the GID
    - Use of Web services
  - Responsibility for adapters
    - Part of vendor responsibility or system integrator

How to Test for Compliance

- Compliance testing vs. interoperability testing
- Rely on previous interoperability tests
  - Witnessed test results for vendors that participate
  - Documented in EPRI technical reports
- Validation tools
  - CIM/XML with RDF schema for power system model transfer – used in interop tests
  - XML schema validation for messages
- Subject of one of the CIMug WGs
  - Need for a compliance test suite

Questions?