

Welcome to the CIM University

New Orleans,
Louisiana, USA
22 October 2012

CIM Standards Overview and CIM's Role in the Utility Enterprise – Part 1

CIM Users Group
New Orleans,
Louisiana, USA
22 October 2012
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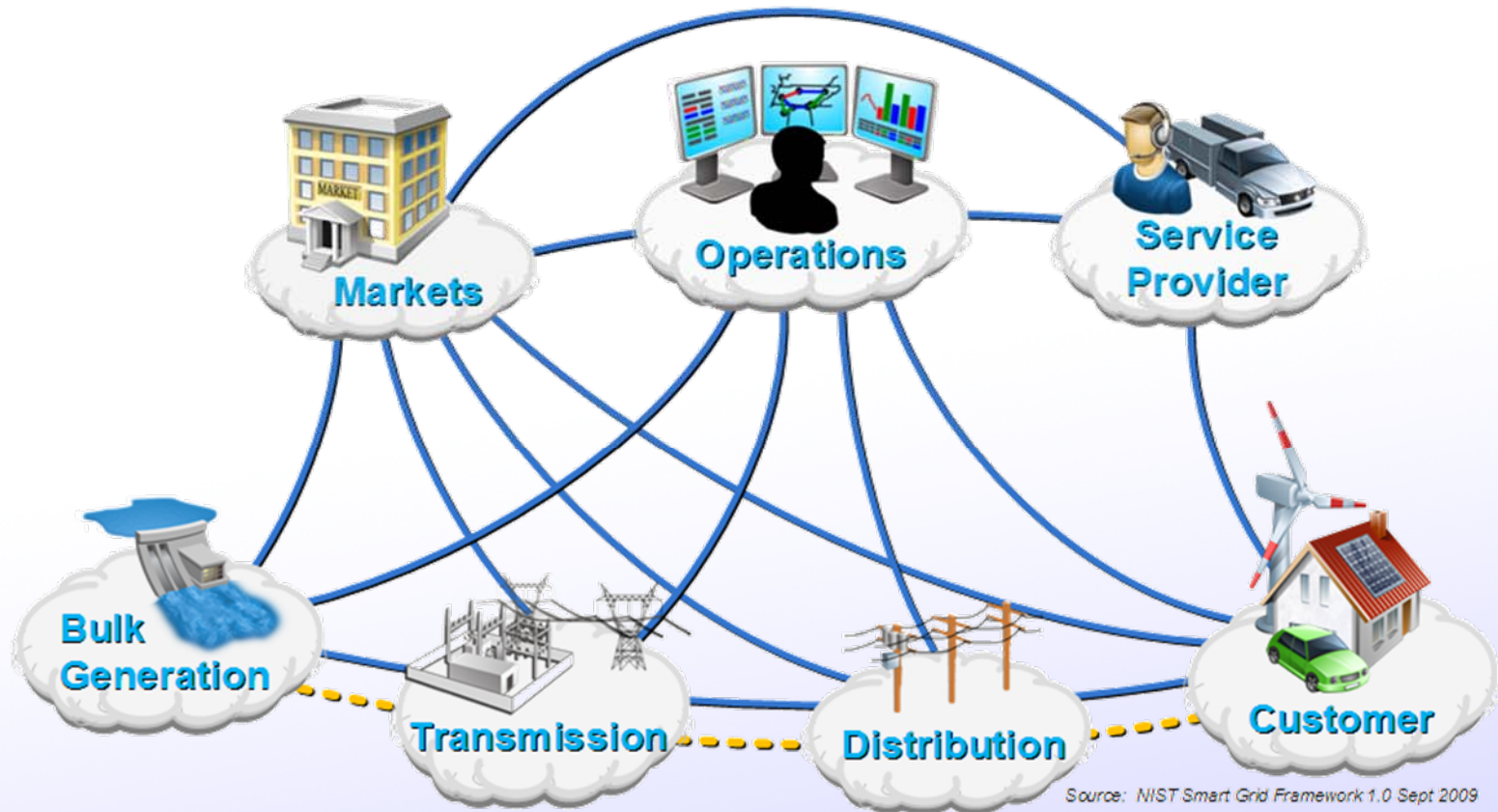
Presentation Contents

- Background
- What is the CIM
- How the CIM is used in the Utility Enterprise
- Three Layer Architecture for Using the CIM Standards
- CIM UML model
- Profiles for business context
- Implementation syntax
- IEC CIM Working Groups and Standards
- CIM as Basis for Enterprise Semantic Model (ESM)
- Case studies
- Where to get CIM information

The IEC Common Information Model (CIM) - What Is It?

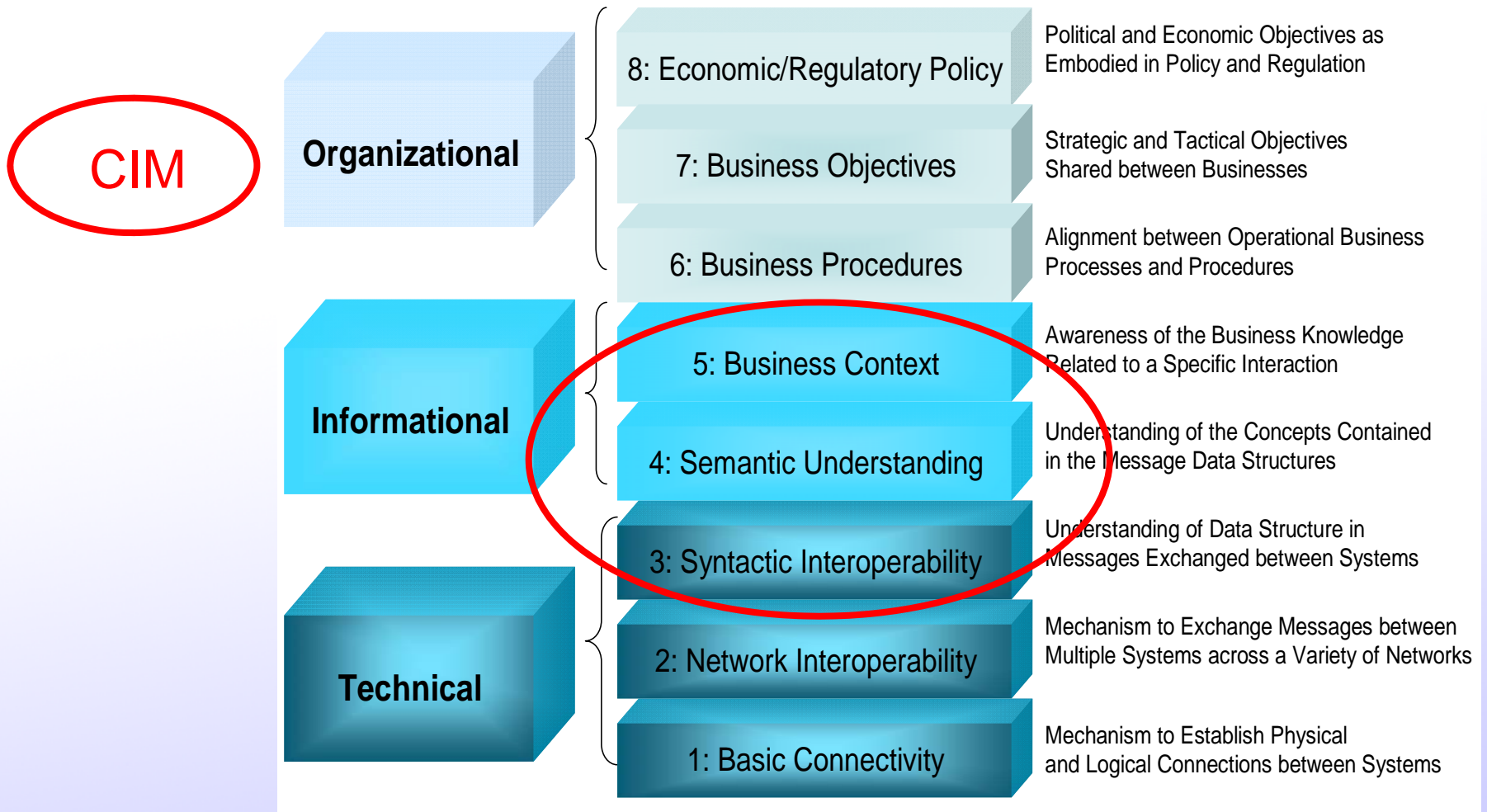
- A set of standards in enable system integration and information exchange based on a common information model
 - Provides a general information model and message/file schemas for messages/files exchanged between systems
- A key differentiator: The CIM standards are based on a Unified Modeling Language (UML) based information model representing real-world objects and information entities exchanged within the value chain of the electric power industry
 - Provides common semantics for all information exchanges
 - Referred to as Model-Driven Integration (MDI)
 - Not tied to a particular application's view of the world
 - But permits same model to be used by all applications to facilitate information sharing between applications
 - Maintained by IEC in Sparx Enterprise Architect modeling tools
 - Many tools available generating design artifacts and documentation
 - Enable data access to enterprise data warehouse in a standard way

Conceptual Model

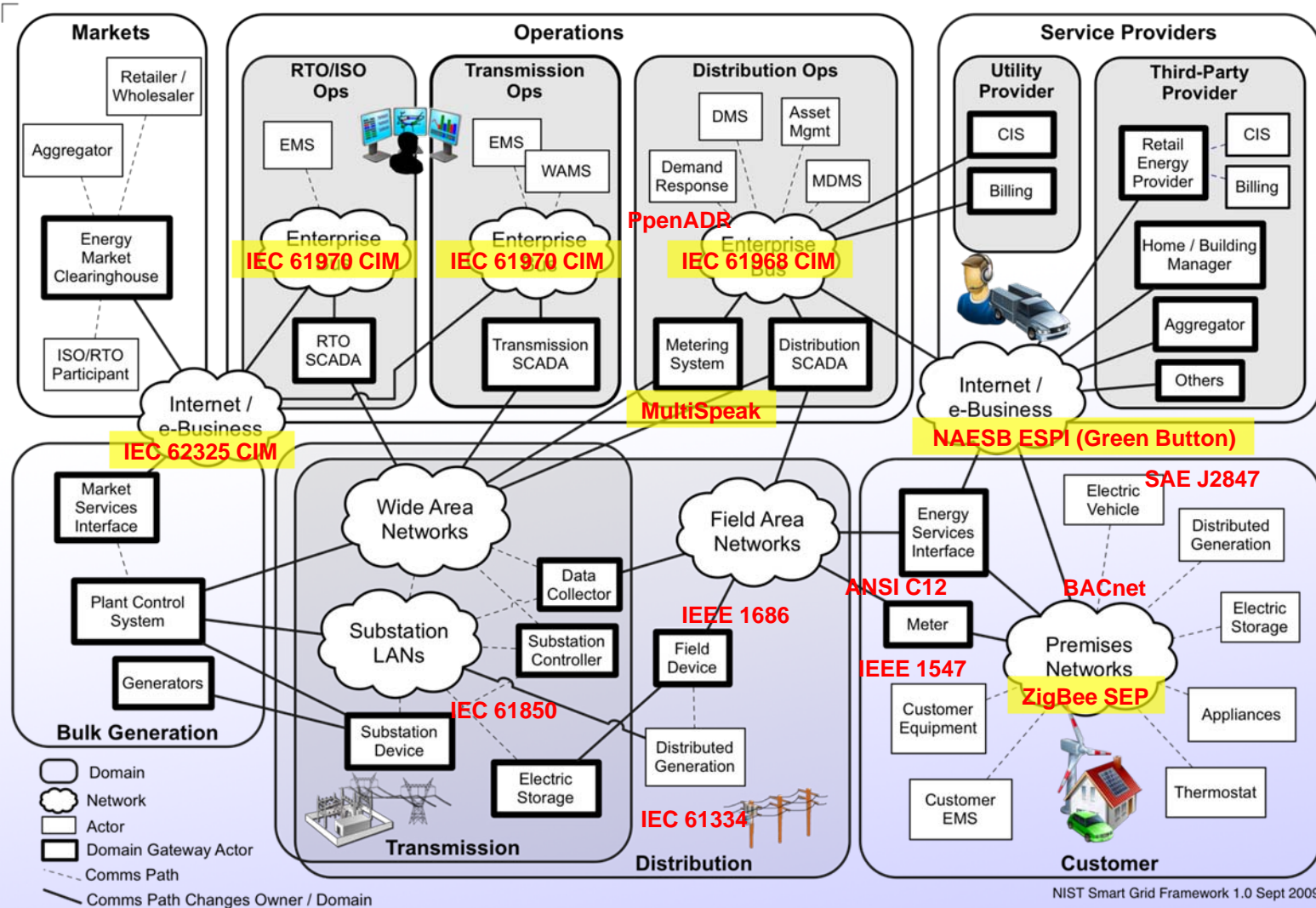


GWAC Stack and the CIM Standards

Interoperability Categories



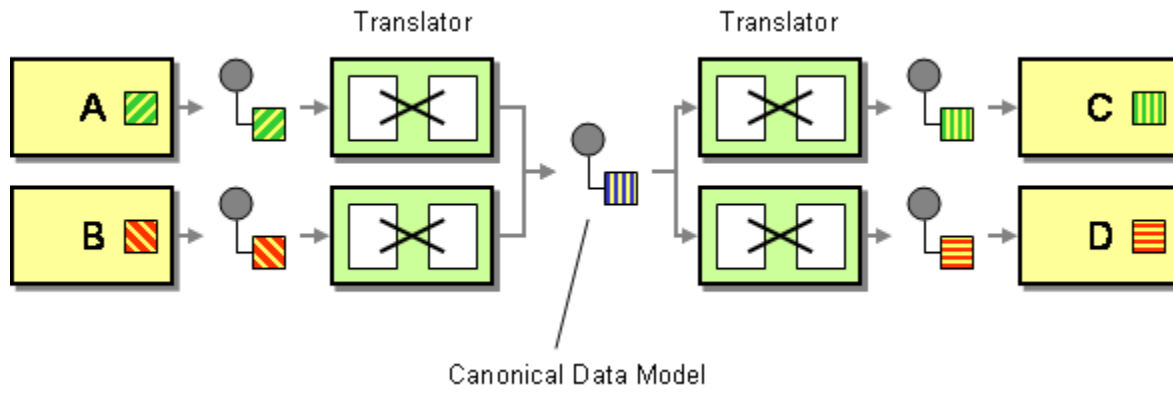
Smart Grid Conceptual Model - Diving Deeper



Role of CIM in Smart Grid Architecture

- CIM standards aim to simplify integration of components and expand options for supply of components by standardizing information exchanges
 - Reduce complexity with clear consistent semantic modeling across the enterprise
 - Data sources: achieve a clear picture of data mastership in the enterprise
 - Data consumers: make 'data of record' available on demand to qualified users
- CIM employs a *canonical data model* (CDM) strategy for standardizing interfaces in the power system operations and planning domain.

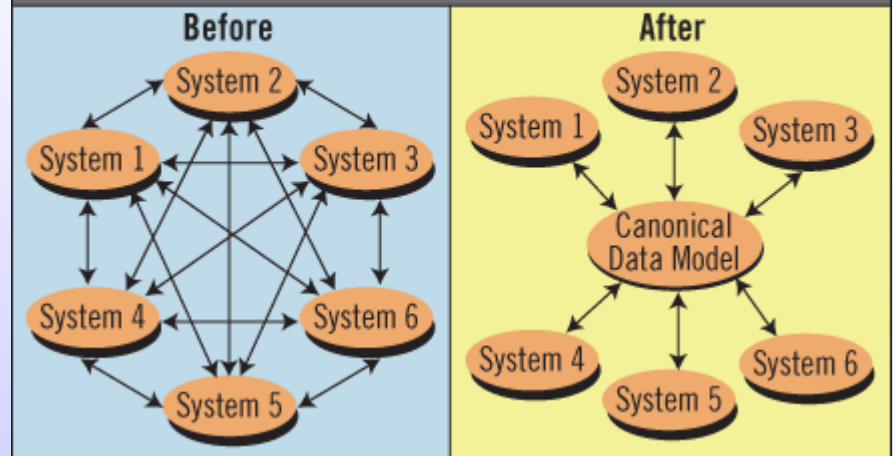
What is a Canonical Data Model?



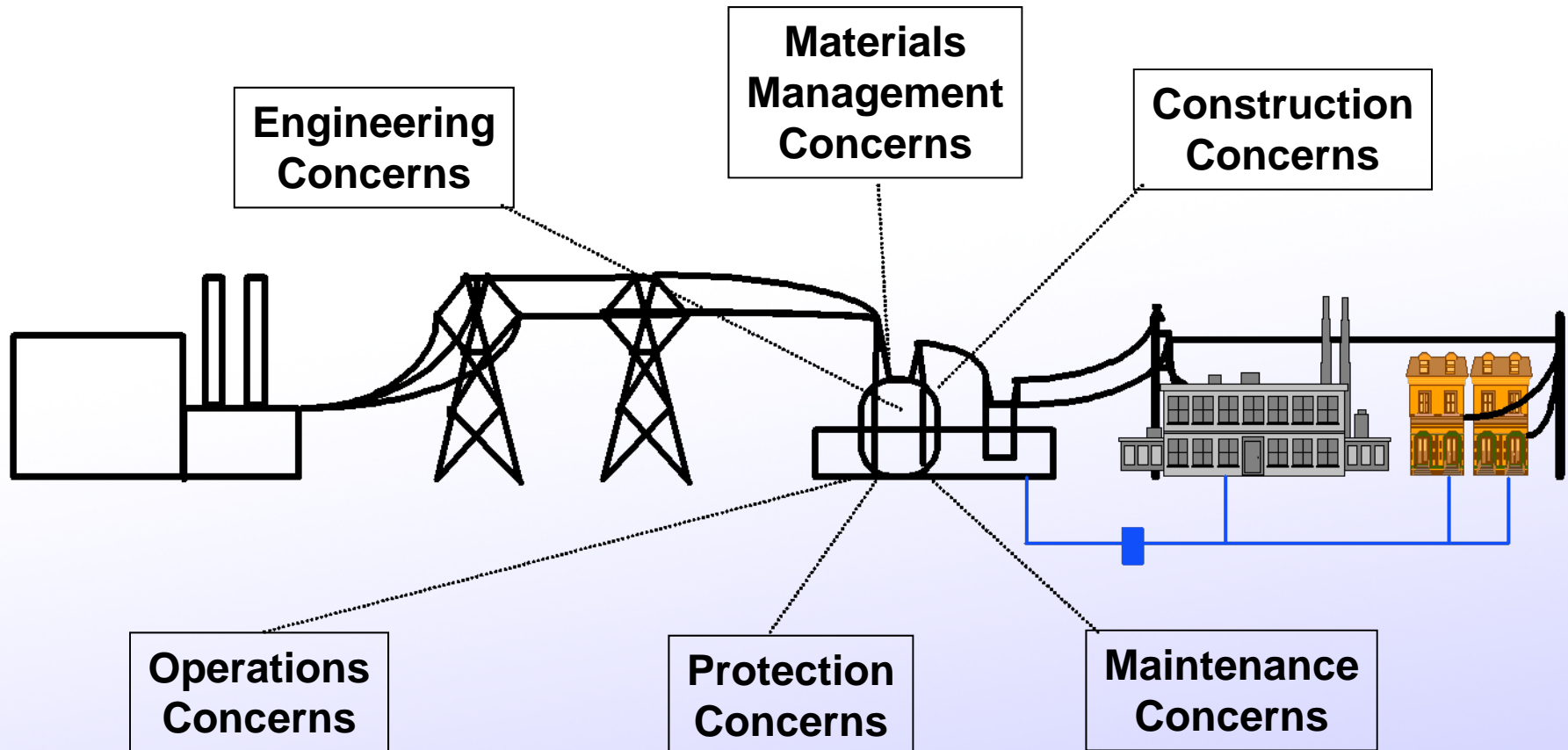
A common language, like use of English in International IEC standards

A common vocabulary or set of semantics for creating understanding

Figure 1: Simplified Example of the Use of a Canonical Data Model Before and After



The *Common Language* Should Provide Relevant Information To A User Regardless of Source



The *Common Language* Should Provide Relevant Information To A User Regardless of Source

Engineering Concerns

The logical view of how the type of equipment fits (will fit) in the electrical network. Nominal configuration of “as-built” and “future” states.

- Field Name
- Spatial Location
- Version
- Physical Connectivity
- Load Projections
- Capacity Requirements
- Compatible Unit
- Equipment Ratings

Materials Management Concerns

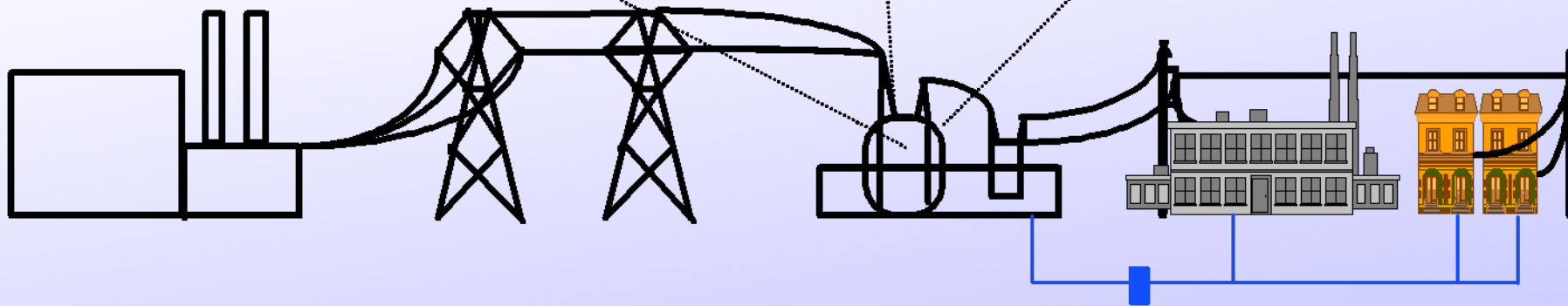
Planning and tracking material requirements for construction and maintenance. Information about physical pieces of equipment.

- Asset Identifier
- Compatible Unit
- Equipment Component Type
- Equipment Manufacturer/Model
- Serial Number
- Location
- Equipment Location History
- Manufacturer Specifications

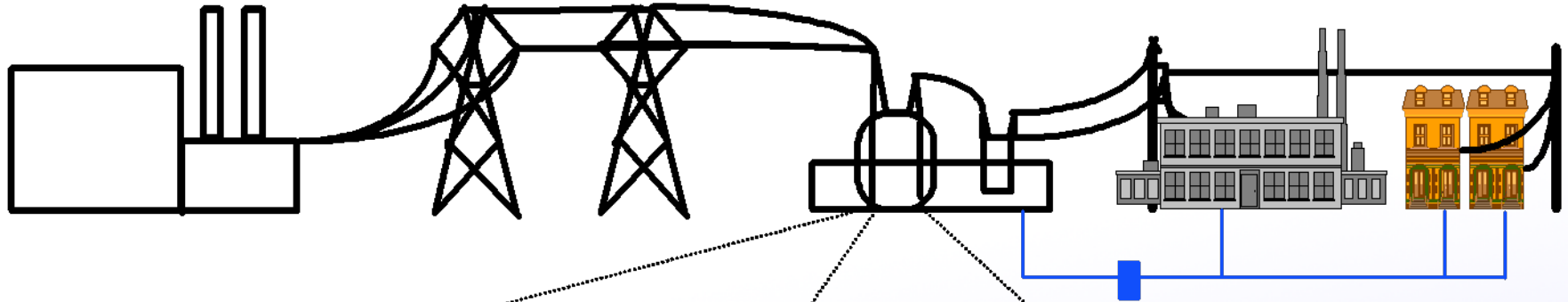
Construction Concerns

Lifecycle information regarding when and how to install equipment:

- Field Name
- Location
- Equipment Manufacturer/Model
- Compatible Unit
- Equipment Ratings
- Work Order
- Work Design
- Installation Schedule & Budget
- Permits
- Manufacturer Specifications
- Safety Requirements



The Needs of Various Users - Some Same, Some Different (continued)



Operations Concerns

Real-time condition of equipment and electrical network necessary to maintain reliable network operation:

- Field Name
- Schematics & Spatial Location
- Electrical Connectivity
- Operational Limits (dynamic)
- Equipment Status
- Clearances
- Network Measurements (voltage, current, frequency)
- Equipment Faults
- Weather Measurements
- Operational Restrictions

Protection Concerns

Setting and configuring relays based on equipment and network protection requirements:

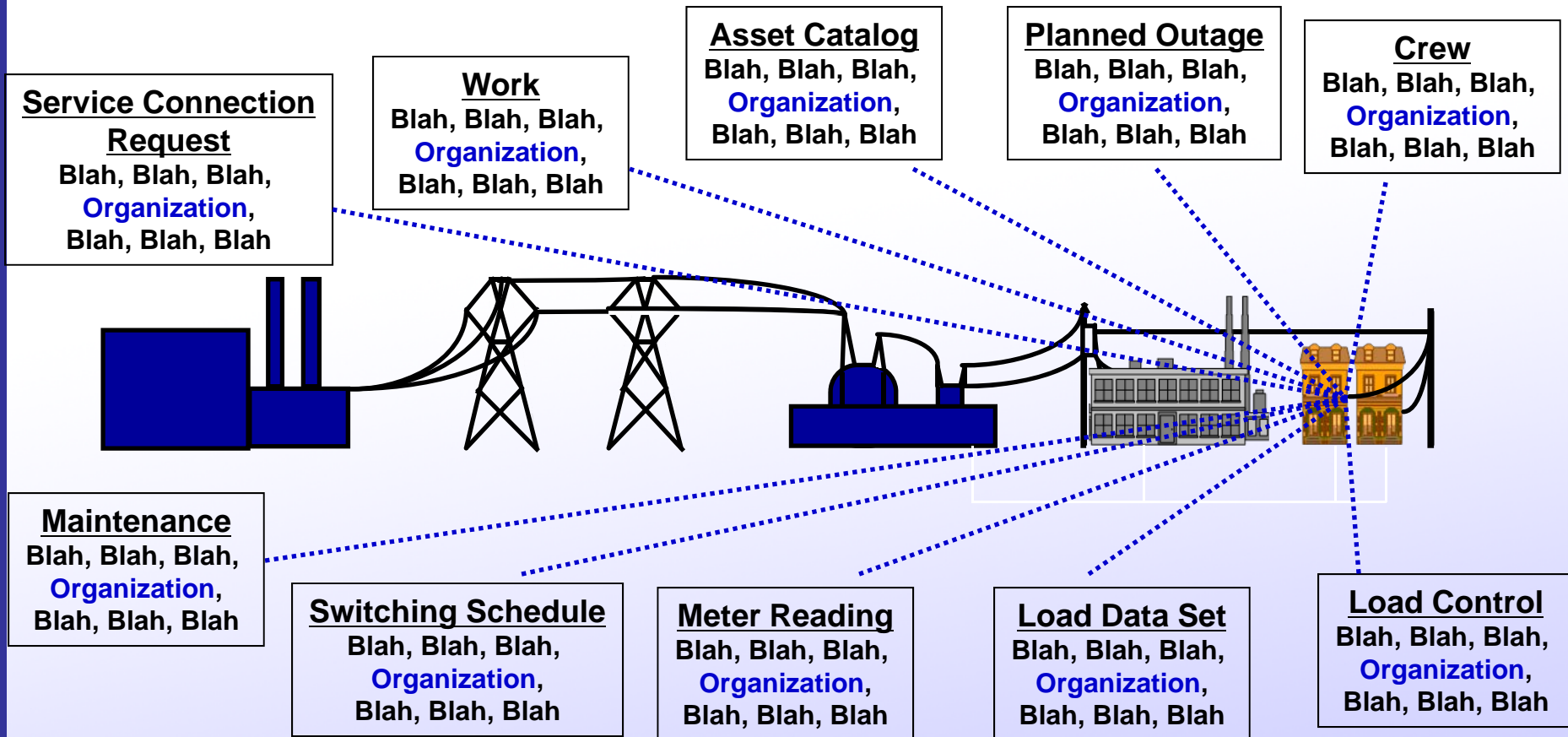
- Field Name
- Schematics
- Electrical Connectivity
- Maximum Capacity
- Zones Of Protection
- Equipment Status
- Clearances
- Network Measurements (voltage, current, frequency, transients)
- Equipment Faults

Maintenance Concerns

Lifecycle information regarding when and how equipment is maintained:

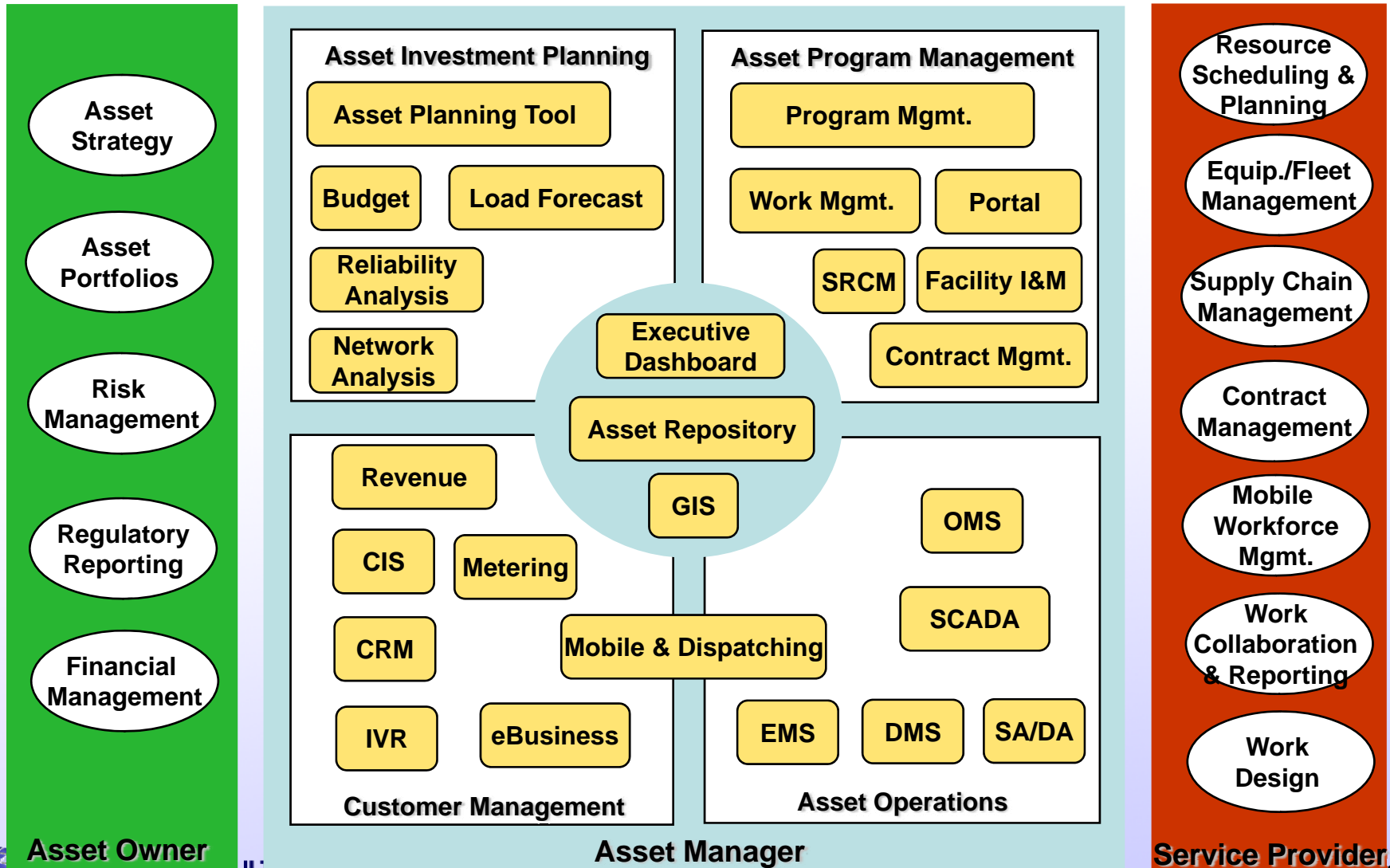
- Field Name
- Location
- Equipment Manufacturer/Model
- Equipment Ratings
- Routine Maintenance
- Testing & Diagnostics Procedures
- Equipment Condition
- Inspection Schedule
- Equipment Repair Records
- Site Service Records
- Maintenance Budget
- Safety Requirements

Exchanging Common Language Messages Among Systems Should Provide Relevant Information To Each System That Is *Harmonious With All Other Systems' Information*



For example, in each of the message exchanges depicted above, the same Organization is referenced for different reasons. There should be NO inconsistencies about this Organization in them!

For example, a common language-based logical infrastructure facilitates collaboration among the many applications involved in Asset Management



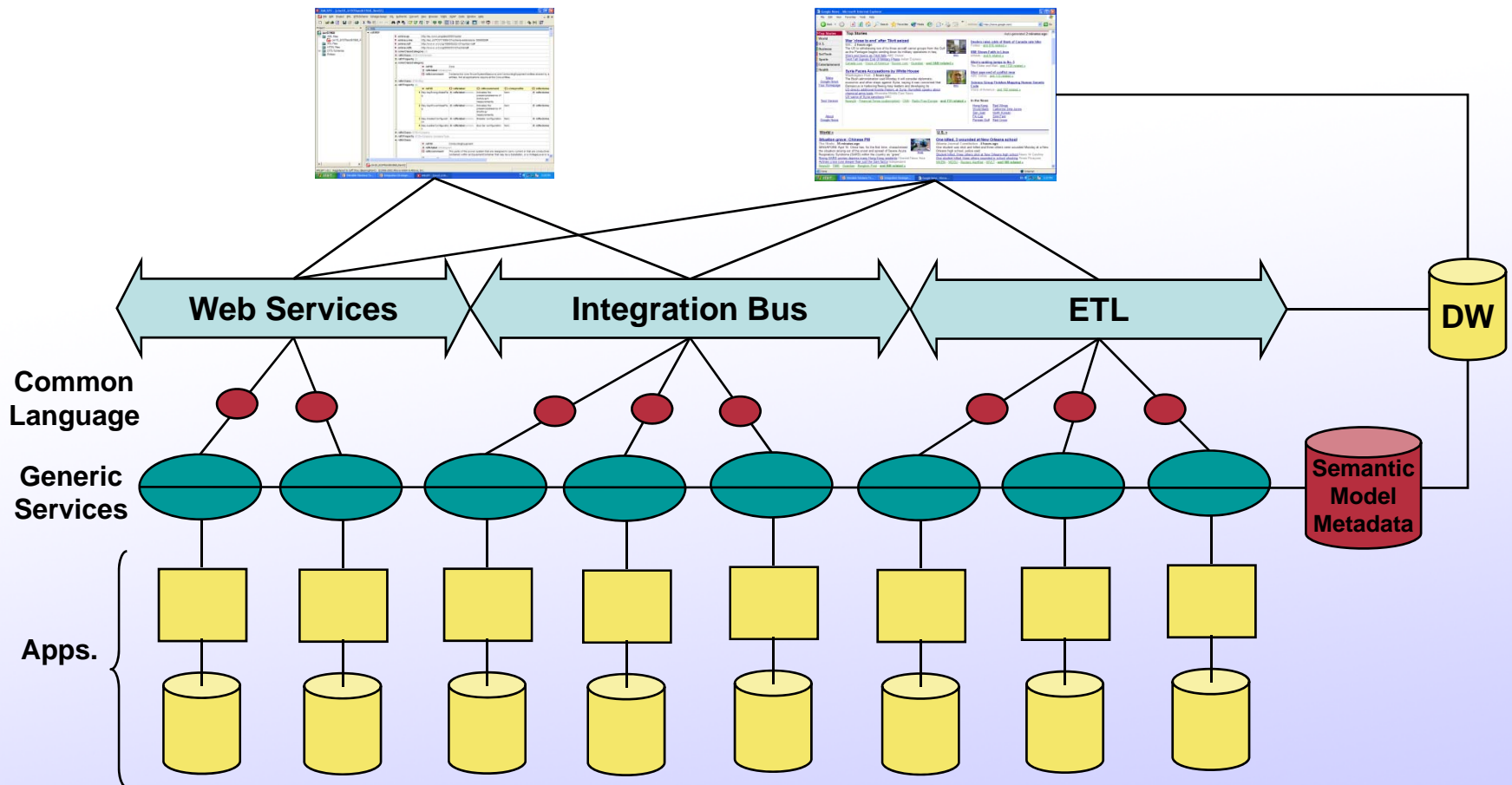
Using A Semantic Model To Simplify & Scale Up The Mapping Process

- What is a Semantic Model?
 - The key ingredients that make up a semantic model are a vocabulary of basic terms, a precise specification of what those terms mean and how they relate to each other.
- How is it used?
 - Before making mappings, a model (or an ontology) of a given business domain is defined.
 - The model is expressed in a knowledge representation language and it contains business concepts, relationships between them and a set of rules.
 - By organizing knowledge in a discrete layer for use by information systems, semantic models enable communication between computer systems in a way that is independent of the individual system technologies, information architectures and applications.
 - Compared to one-to-one mappings, mapping data sources to a common semantic model offer a much more scaleable and maintainable way to manage and integrate enterprise data.

The CIM Semantic Model Provides a Semantic Layer in an Enterprise Architecture

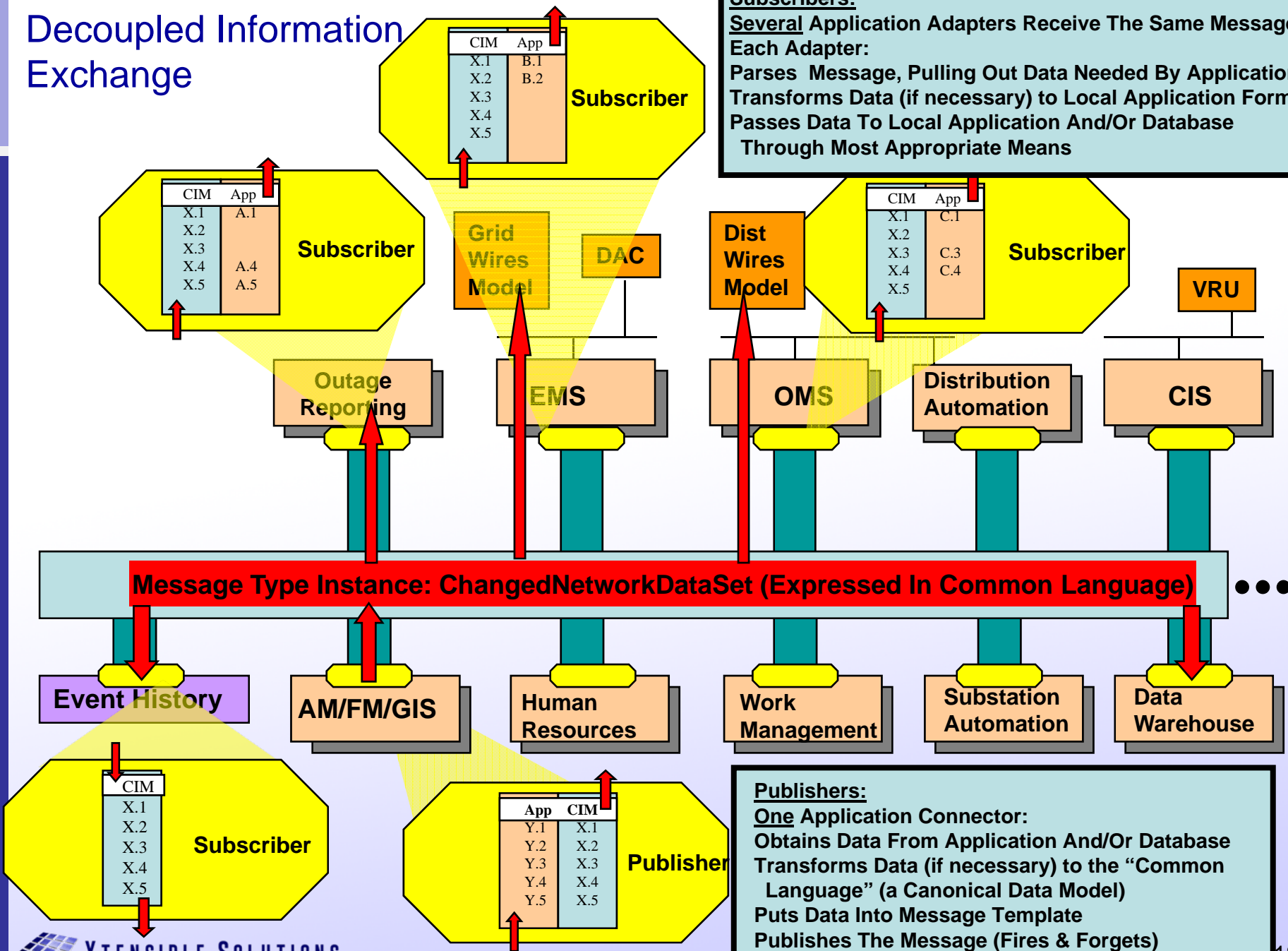
Composite Applications

Business Intelligence



Decoupled Information Exchange

Subscribers:
Several Application Adapters Receive The Same Message Each Adapter:
Parses Message, Pulling Out Data Needed By Application
Transforms Data (if necessary) to Local Application Format
Passes Data To Local Application And/OR Database Through Most Appropriate Means



Publishers:
One Application Connector:
Obtains Data From Application And/OR Database
Transforms Data (if necessary) to the "Common Language" (a Canonical Data Model)
Puts Data Into Message Template
Publishes The Message (Fires & Forgets)

The CIM and Related Standards

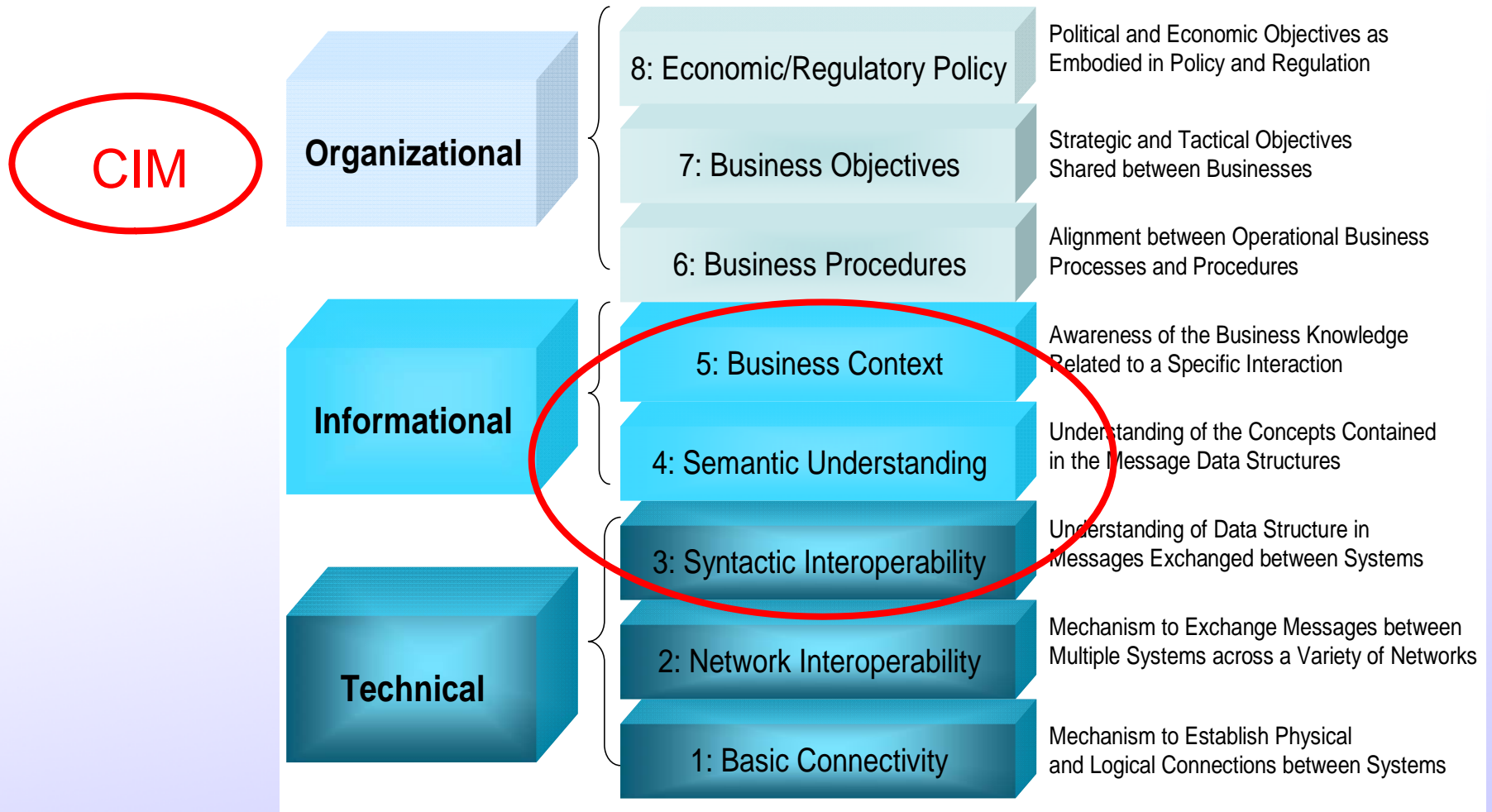
- The CIM standards are more than just an abstract **information model** (or CDM) expressed in UML
- **Profiles** for specifying a subset of the CIM classes and attributes for a specific business context at a specific system interface or system interaction
- **Implementation models**
 - Use of XML to create serialized files and messages
 - RDF Schema-based standards for power system model exchange
 - XML Schema-based standards for information message payloads
 - ETL based on CIM for data base access
 - DDLs for data tables

We Need An Organizing Framework

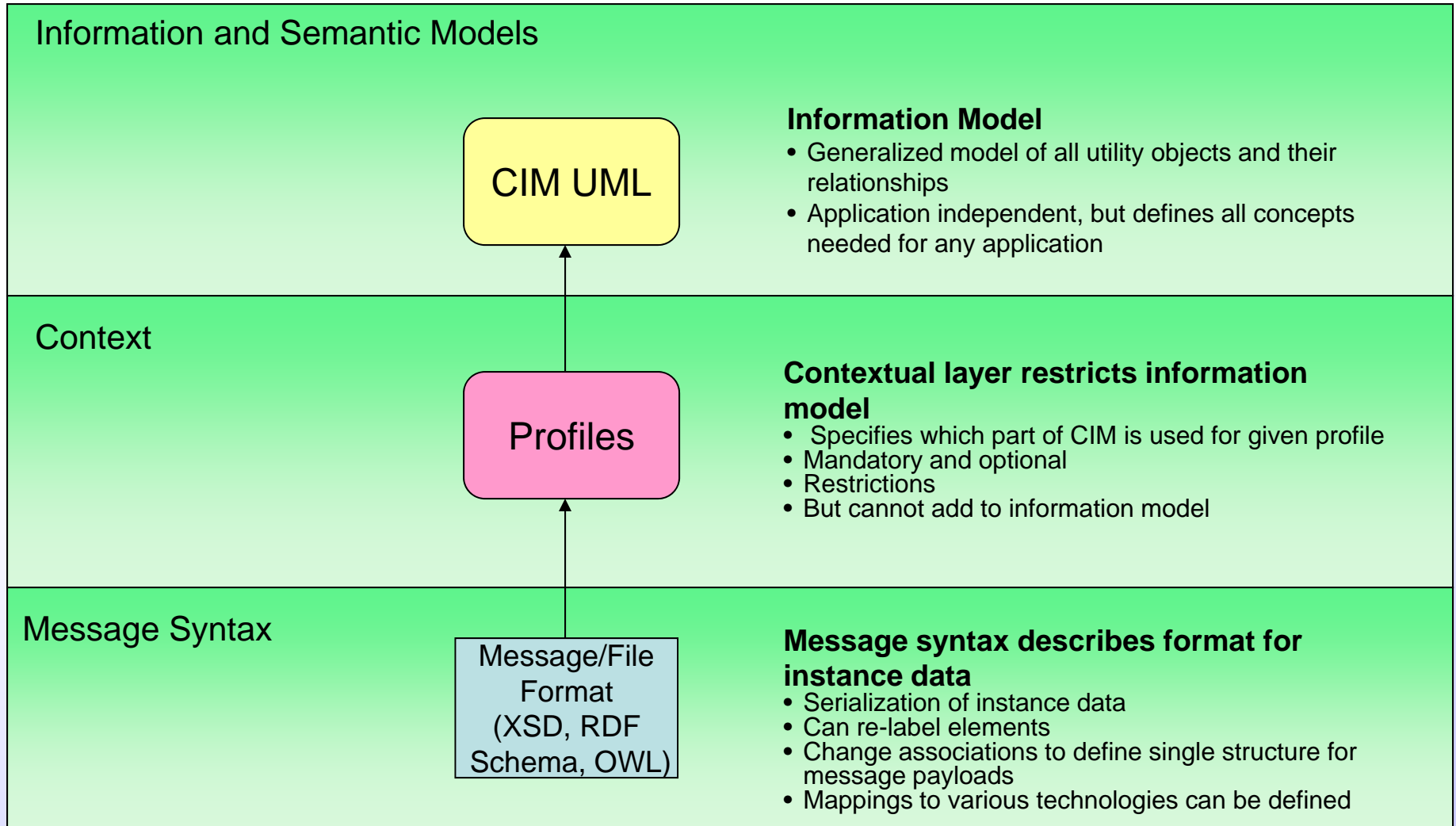
- Layered Reference Architecture for TC57
 - See 62357-1: Reference Architecture for Power System Information Exchange, First Edition
- Based on UN/CEFACT
 - Information Model
 - Contextual Model
 - Message Syntax
 - Rules for Message Assembly

GWAC Stack - Not an IT Architecture for the CIM Standards

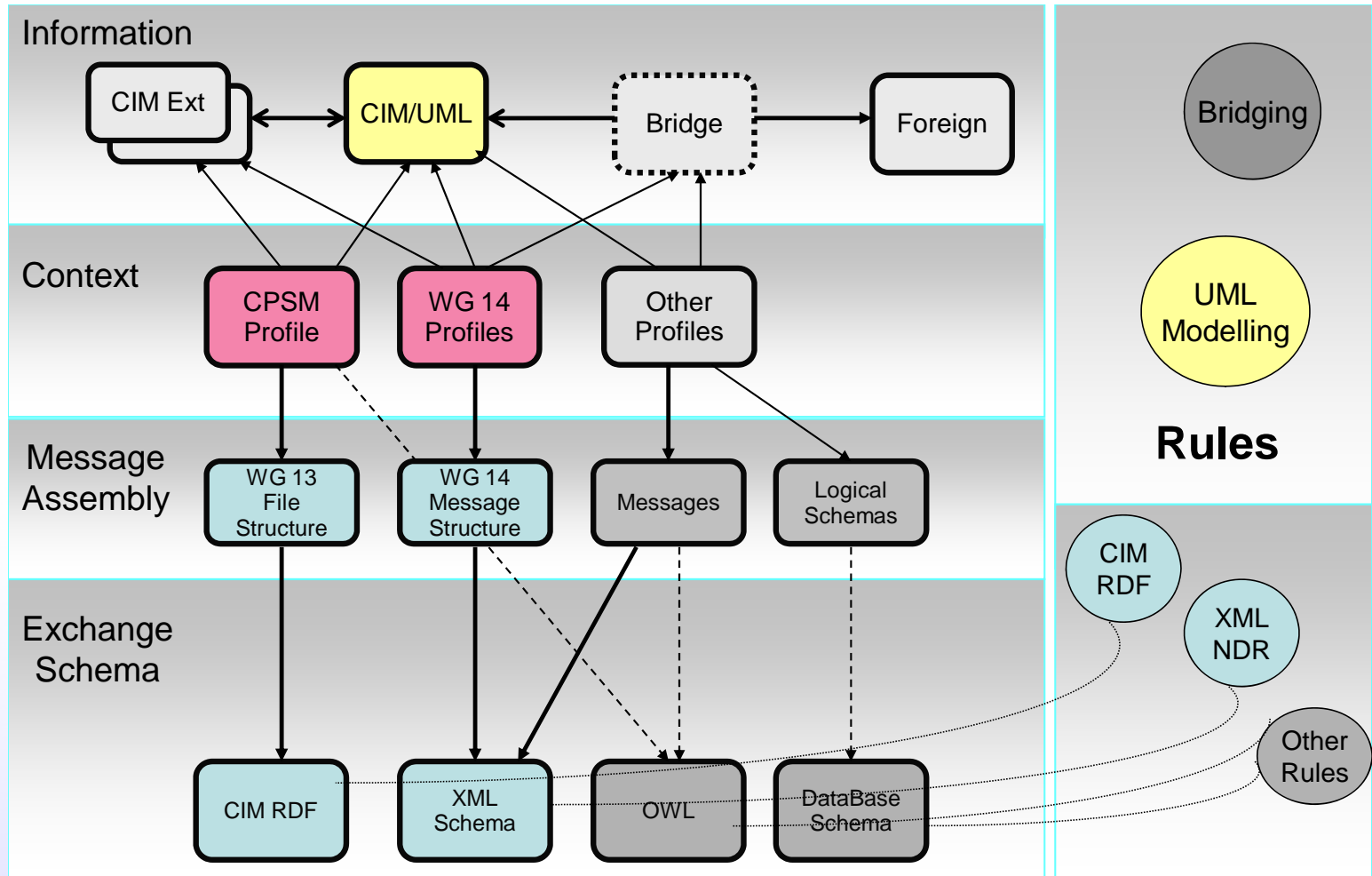
Interoperability Categories



CIM Layered Architecture



Layered Architecture for CIM Standards



From Information Model to Syntactic Model

UML World

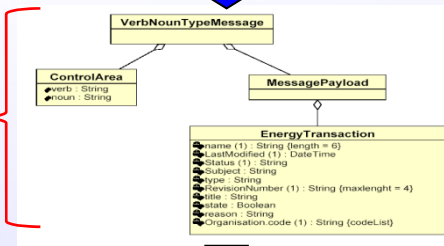
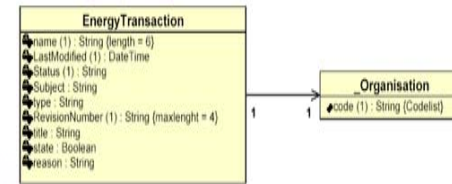
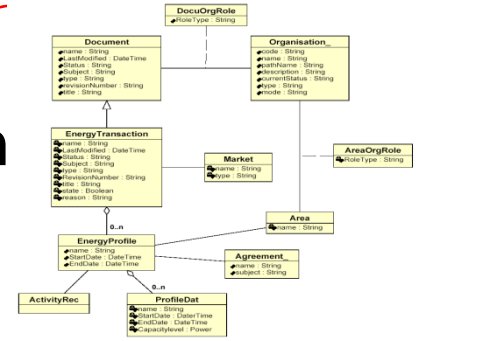
XML Syntactic World

Information Semantic Model

Context/ Profiles

Message Assembly

Message Syntax



```

<?xml version="1.0" encoding="UTF-8"?>
<xsd:element
name=« MT_EnergyTransaction»
<xsd:sequence>
  <xsd:element
name=« EnergyTransaction"/>
  <xsd:sequence>
    <xsd:element name=« Name"/>
    <xsd:element name=« Type"/>
  </xsd:sequence>
</xsd:element>
  
```

Abstract Model

Syntactic Model

Information/Semantic Model Expressed in UML (Unified Modeling Language) Notation

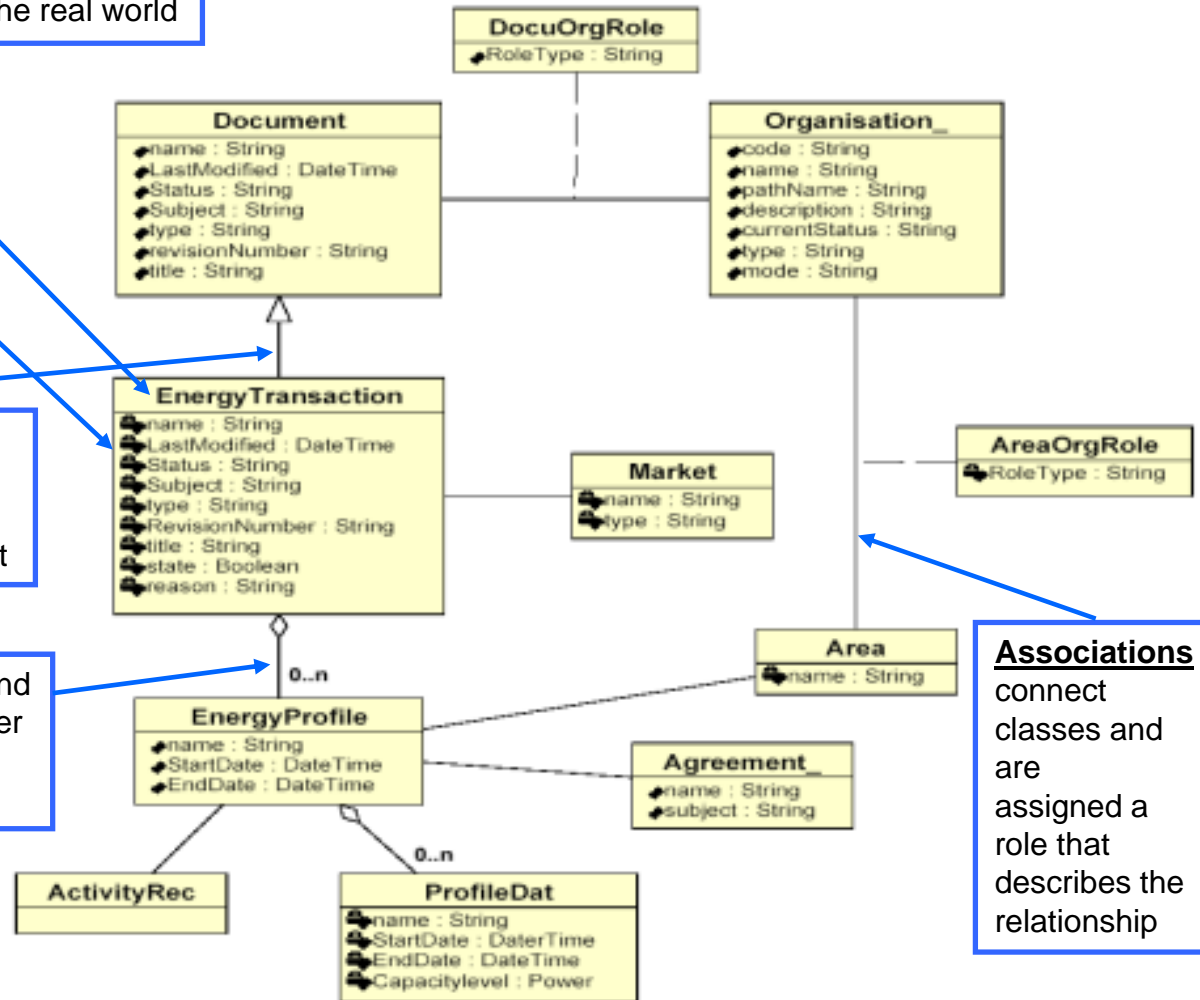
Class Name usually describes things in the real world

Class Attributes describe significant aspects about the thing

This **Specialization** indicates that an "EnergyTransaction" is a type of "Document." "EnergyTransaction" inherits all of the attributes from Document

Aggregation is a variant of Association and indicates a class is a collection or container of other classes, but if the container is destroyed, its contents are not.

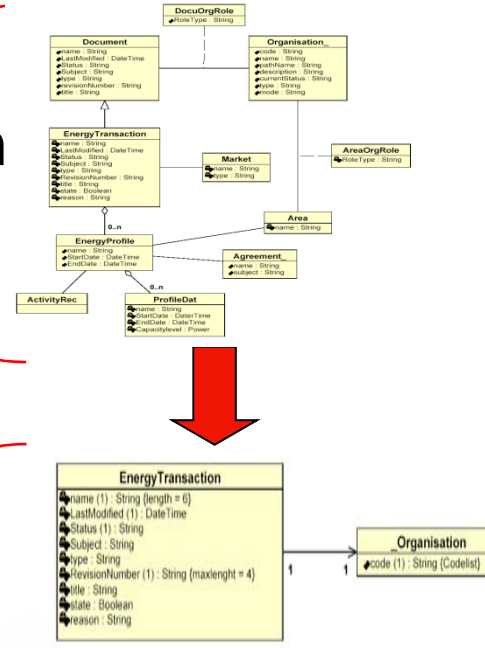
Associations connect classes and are assigned a role that describes the relationship



From Information Model to Syntactic Model

Information Semantic Model

Context/Profiles



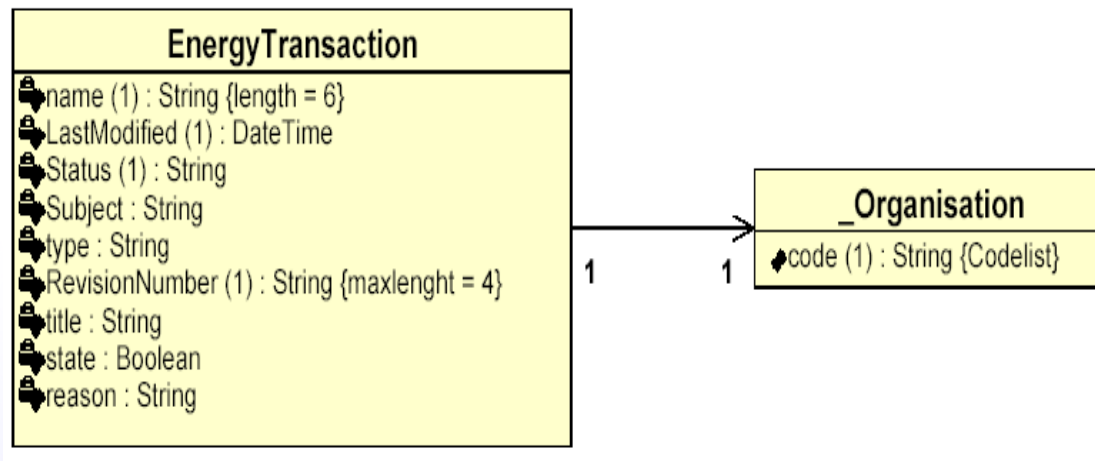
Abstract Model

UML World

XML Syntactic World

Syntactic Model

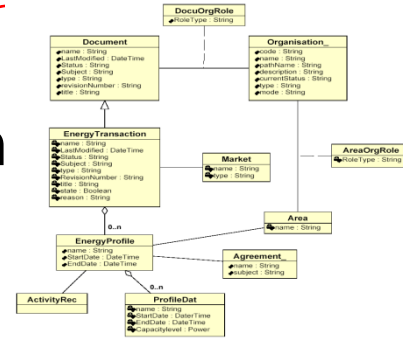
Context/Profiles



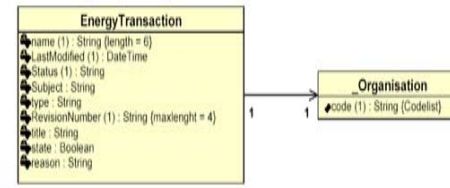
From Information Model to Syntactic Model

UML World

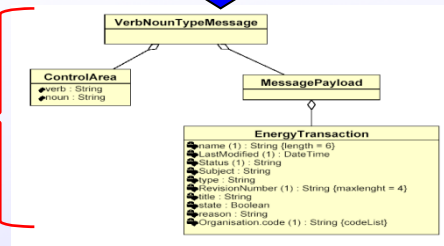
Information Semantic Model



Context/Profiles



Message Assembly



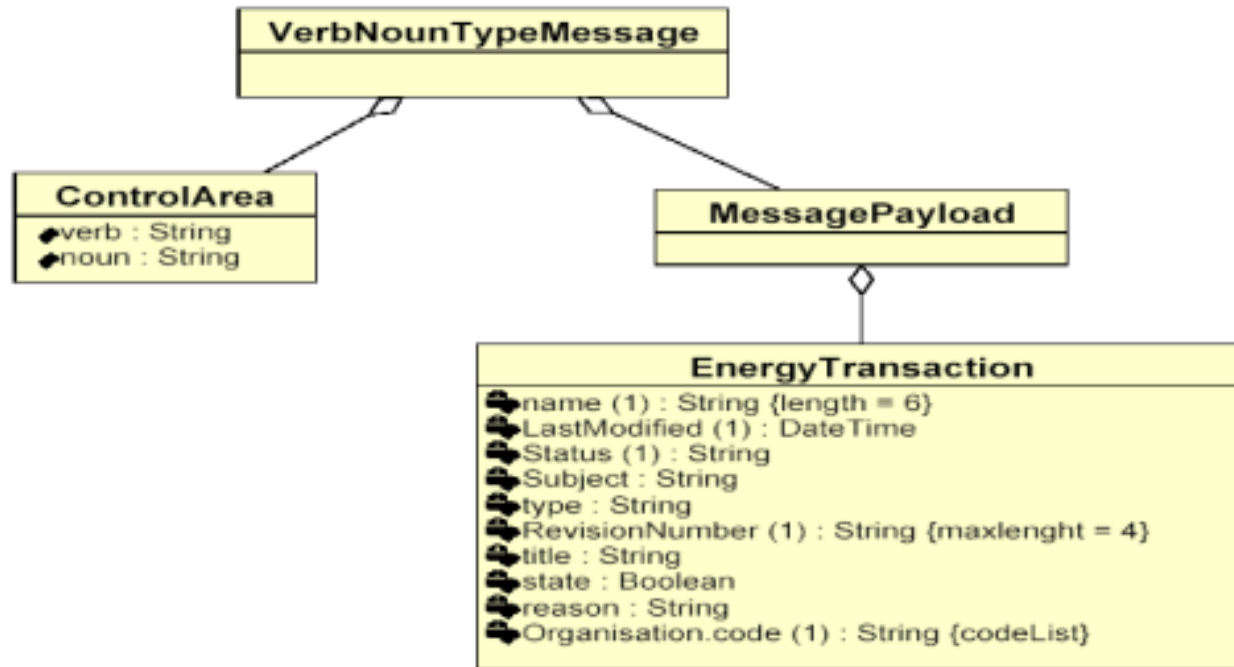
Abstract Model



Syntactic Model

XML Syntactic World

Message Assembly



From Information Model to Syntactic Model

UML World

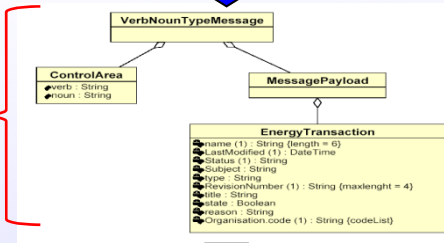
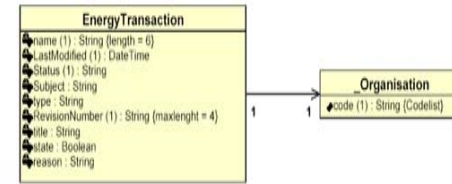
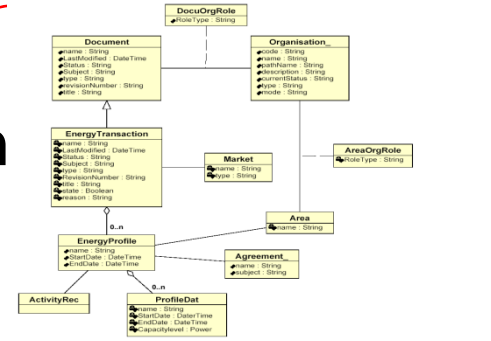
XML Syntactic World

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<xsd:sequence>
  <xsd:element
name=« EnergyTransaction"/>
  <xsd:sequence>
    <xsd:element name=« Name"/>
    <xsd:element name=« Type"/>
  </xsd:sequence>
</xsd:element>
  
```

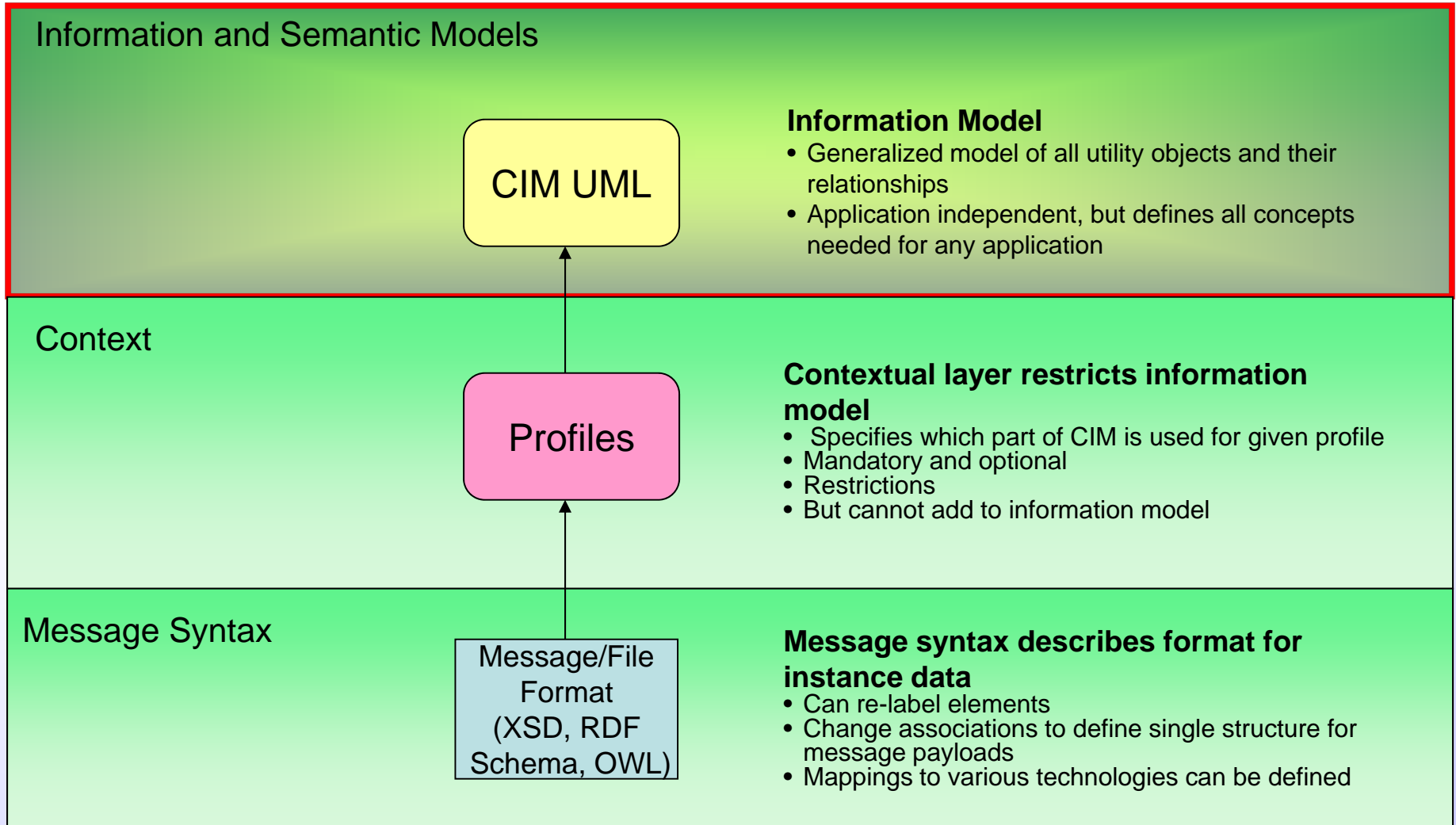
Abstract Model

Syntactic Model

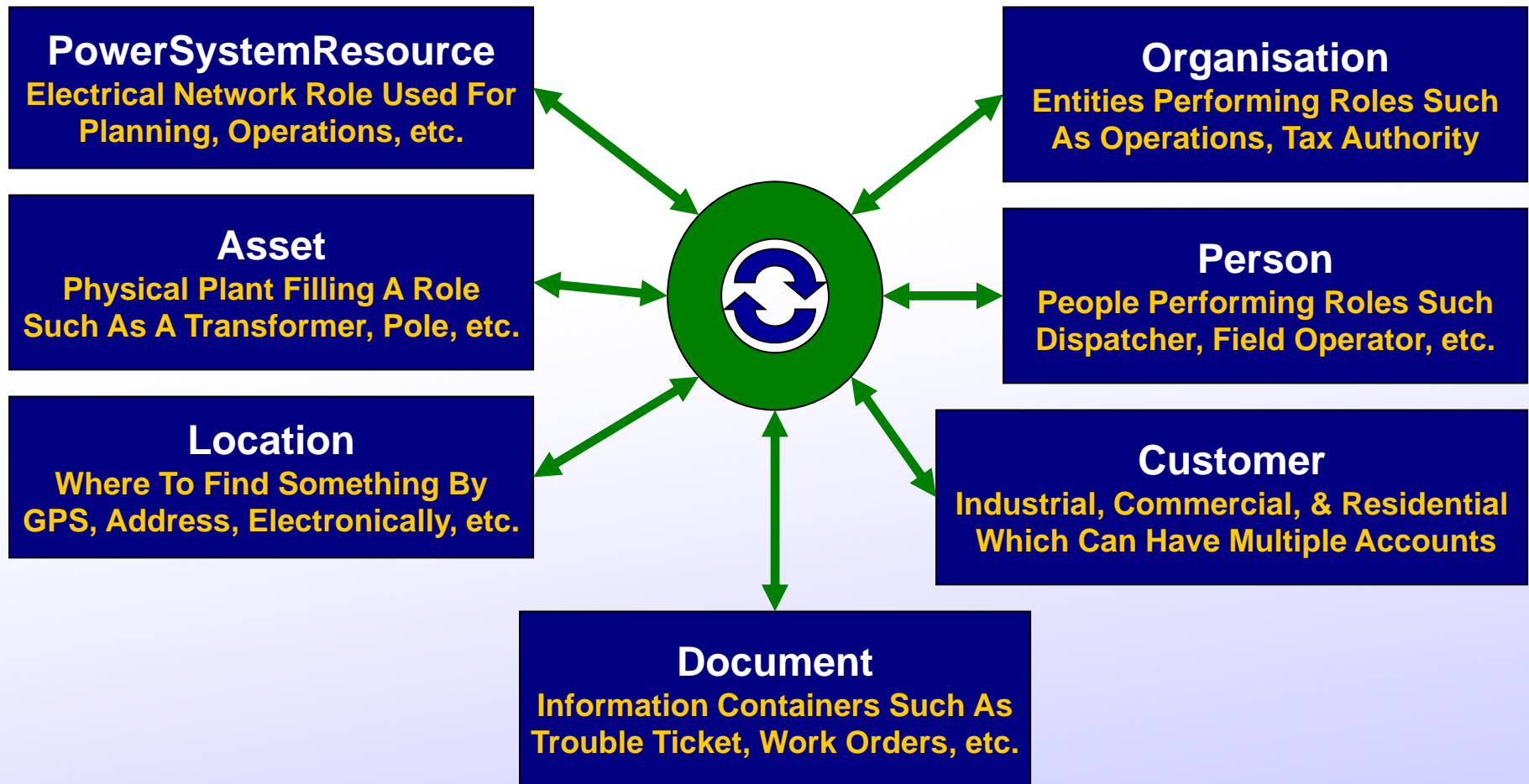
To Summarize

- The CIM is an abstract **information model** standard expressed in UML.
- **Profiles** specifying a subset of the CIM classes and attributes for specific business context
- **Implementation technologies**, 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

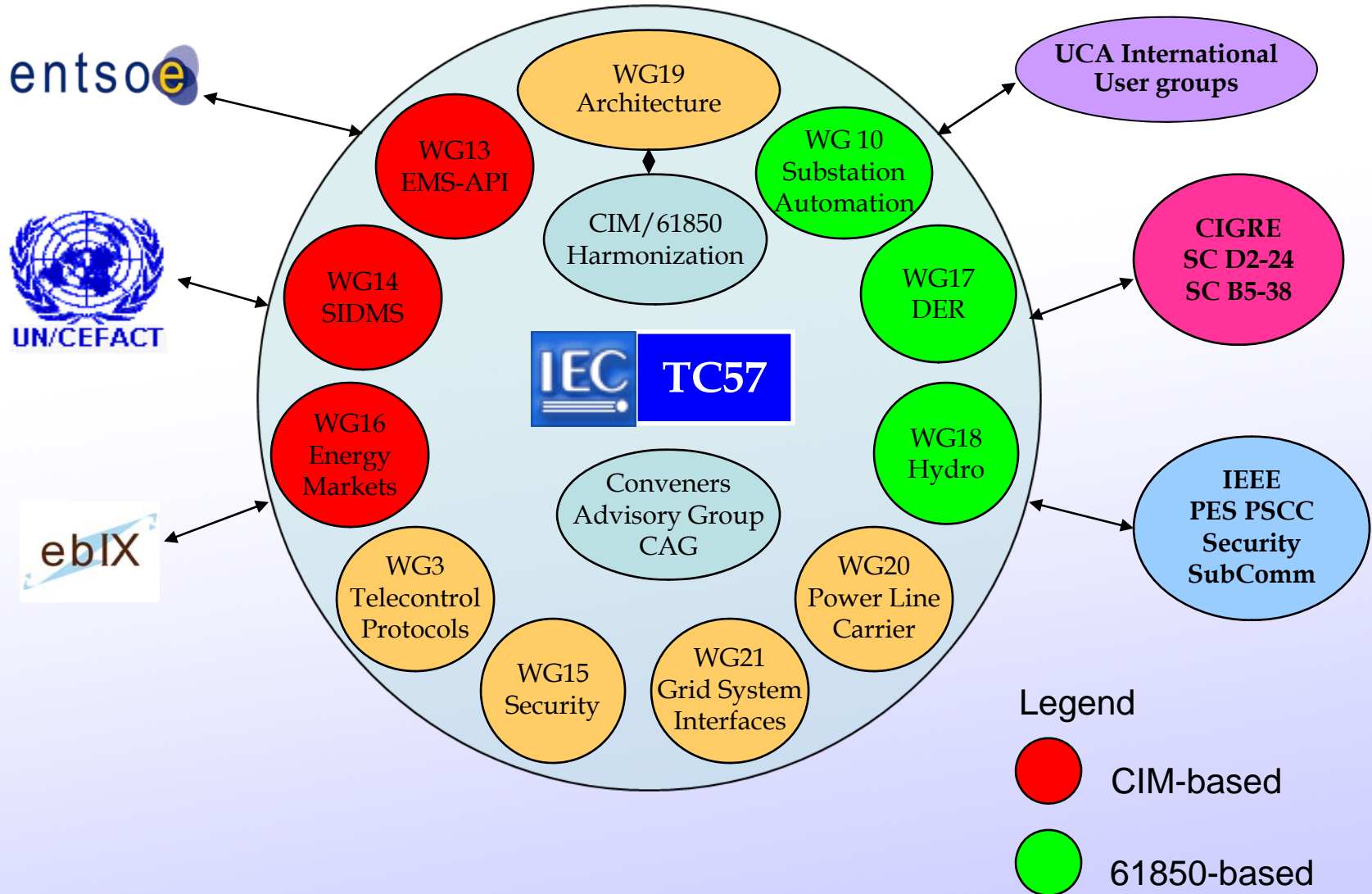
Let's look at each layer of the CIM standards



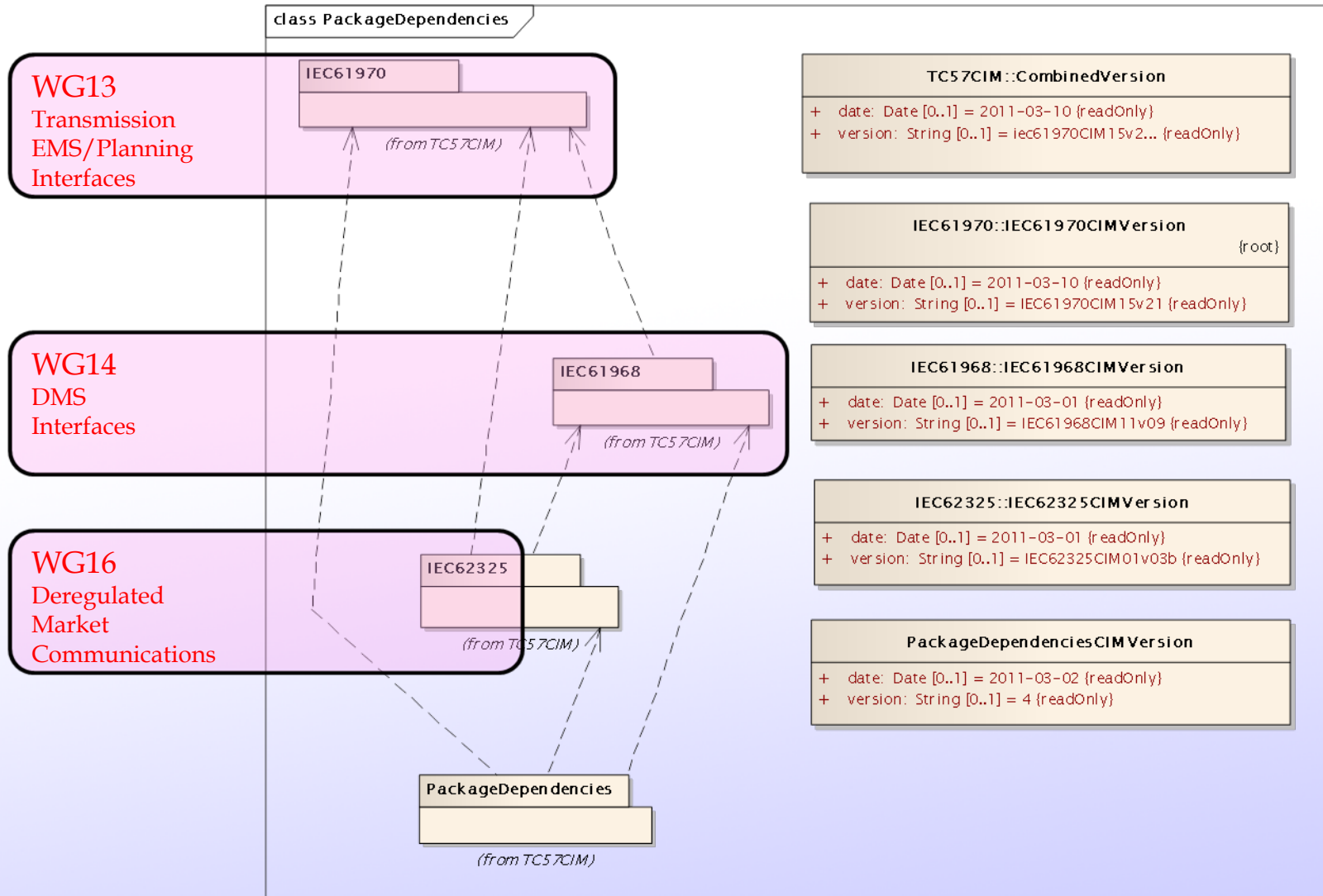
Foundational Relationships Of The CIM



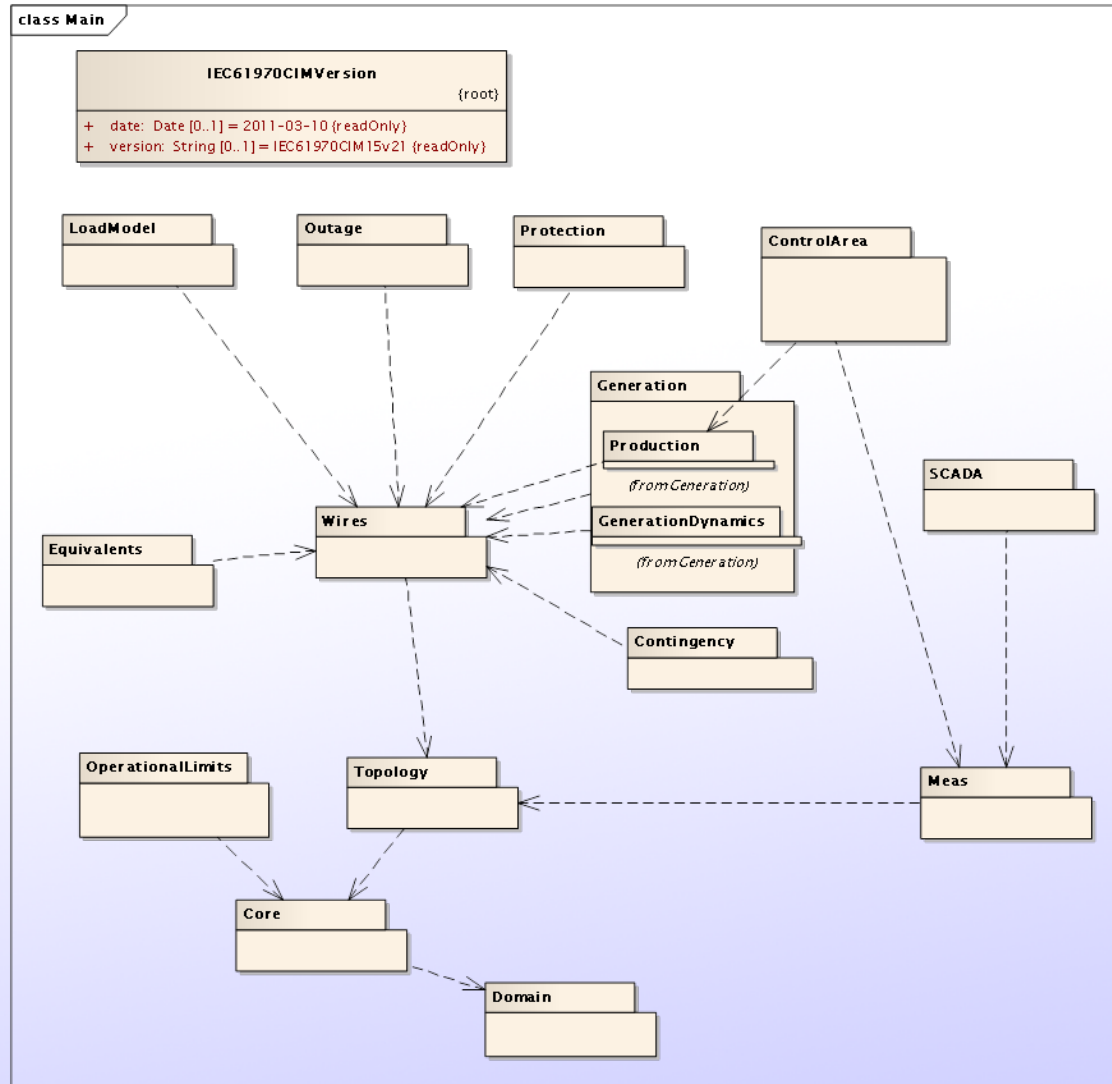
TC 57 Organization and Formal Liaisons



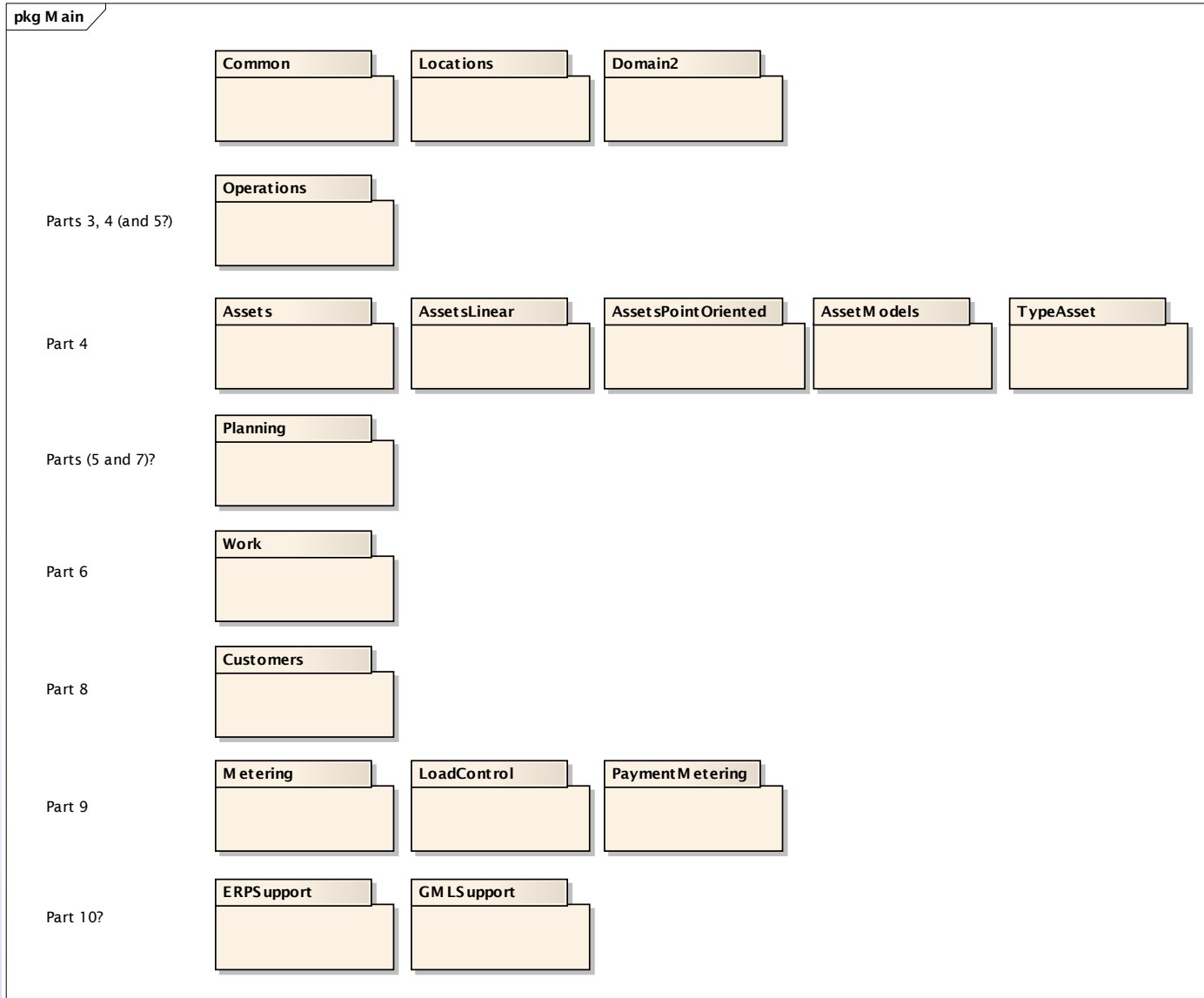
IEC TC57 CIM Packages



WG13 CIM Packages - 61970



WG14 CIM Packages - 61968



WG16 CIM Market Extensions

pkg IEC62325

IEC62325CIMVersion

- + date: Date [0..1] = 2011-03-01
- + version: String [0..1] = IEC62325CIM01v03b

MarketOperations

- + CongestionRevenueRights
- + Domain
- + InterchangeSchedule
- + MarketPlan
- + MarketQualitySystem
- + MarketSystem
- + ParticipantInterfaces
- + ReferenceData

Financial

- + ControlAreaOperator
- + CustomerConsumer
- + GenerationProvider
- + IntSchedAgreement
- + Market
- + OpenAccessProduct
- + TransmissionProduct
- + TransmissionProvider

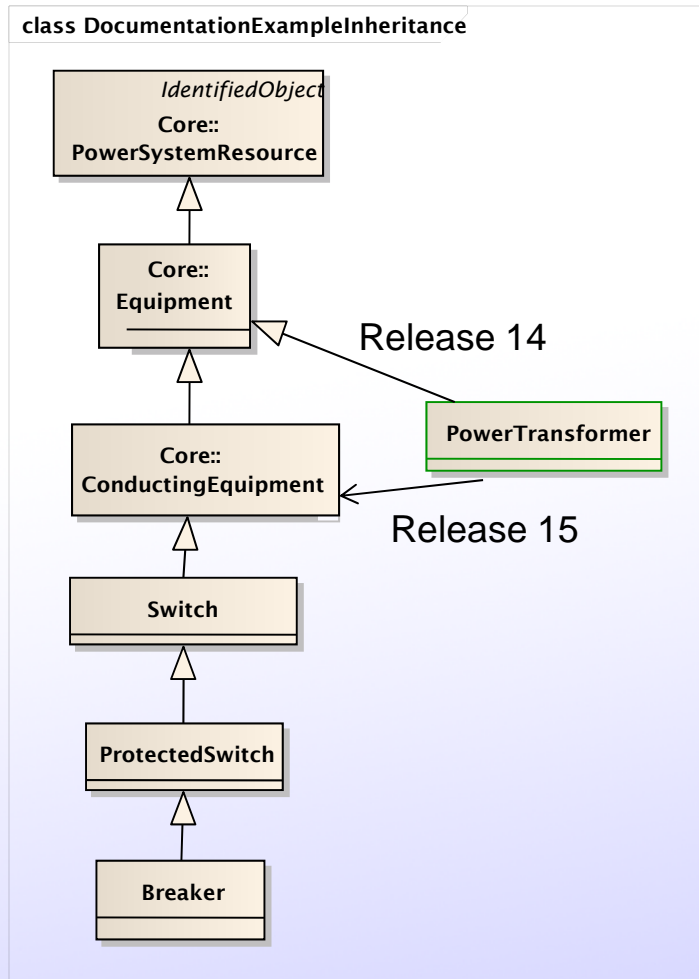
Reservation

- + ServicePoint
- + TiePoint
- + TransmissionPath

EnergyScheduling

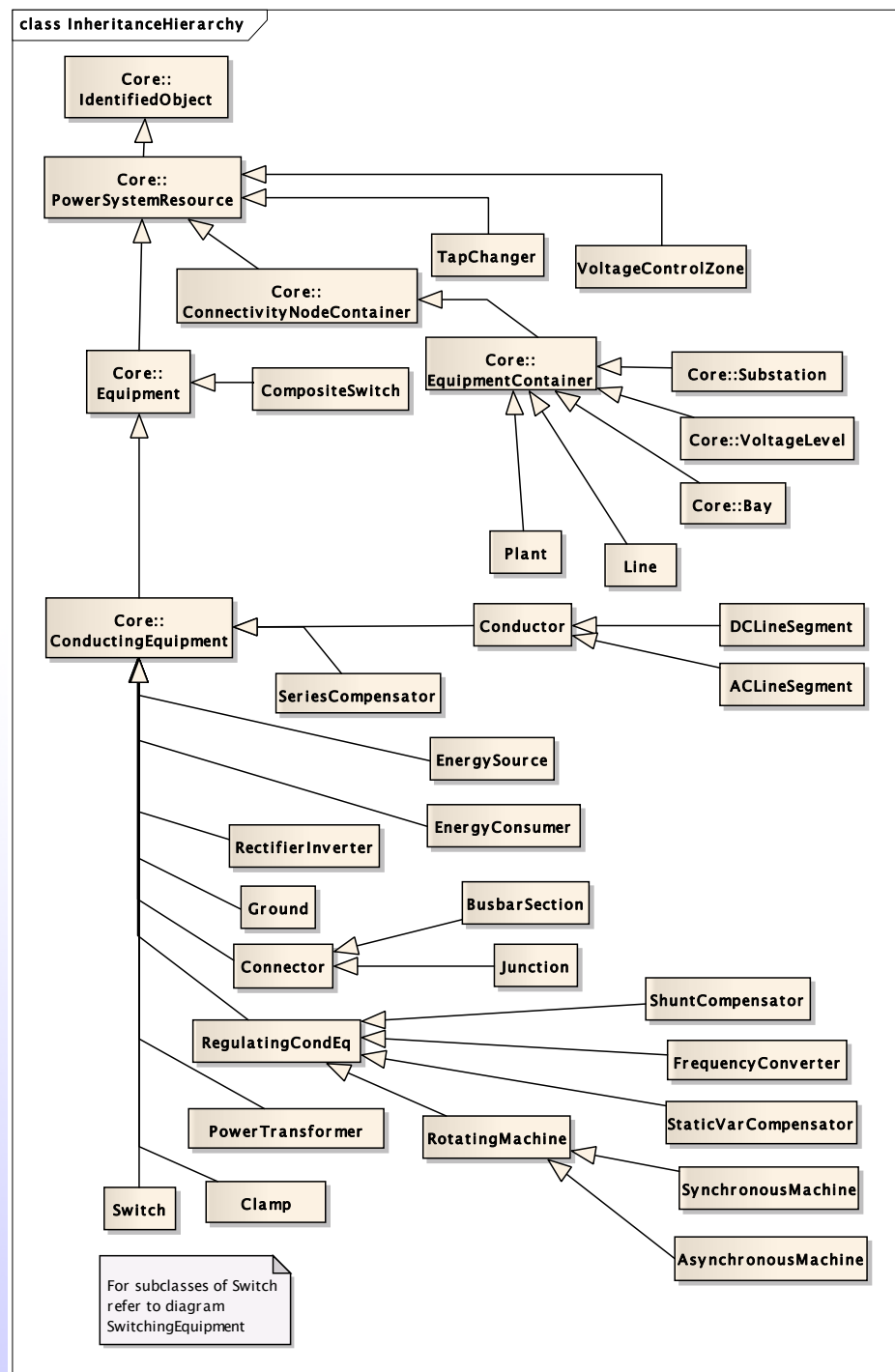
- + AreaReserveSpec
- + CurrentEmergencyScheduledInterchange
- + CurrentScheduledInterchange
- + CurtailmentProfile
- + DynamicSchedule
- + EnergyProduct
- + EnergyProfile
- + EnergyTransaction
- + HostControlArea
- + HostControlAreaSolutionData
- + InadvertentAccount
- + InternalControlArea
- + LossProfile
- + Profile
- + ProfileData
- + SubControlArea
- + TieLine
- + TransmissionCorridor
- + TransmissionReservation
- + TransmissionRightOfWay

Concepts: Generalization/Inheritance



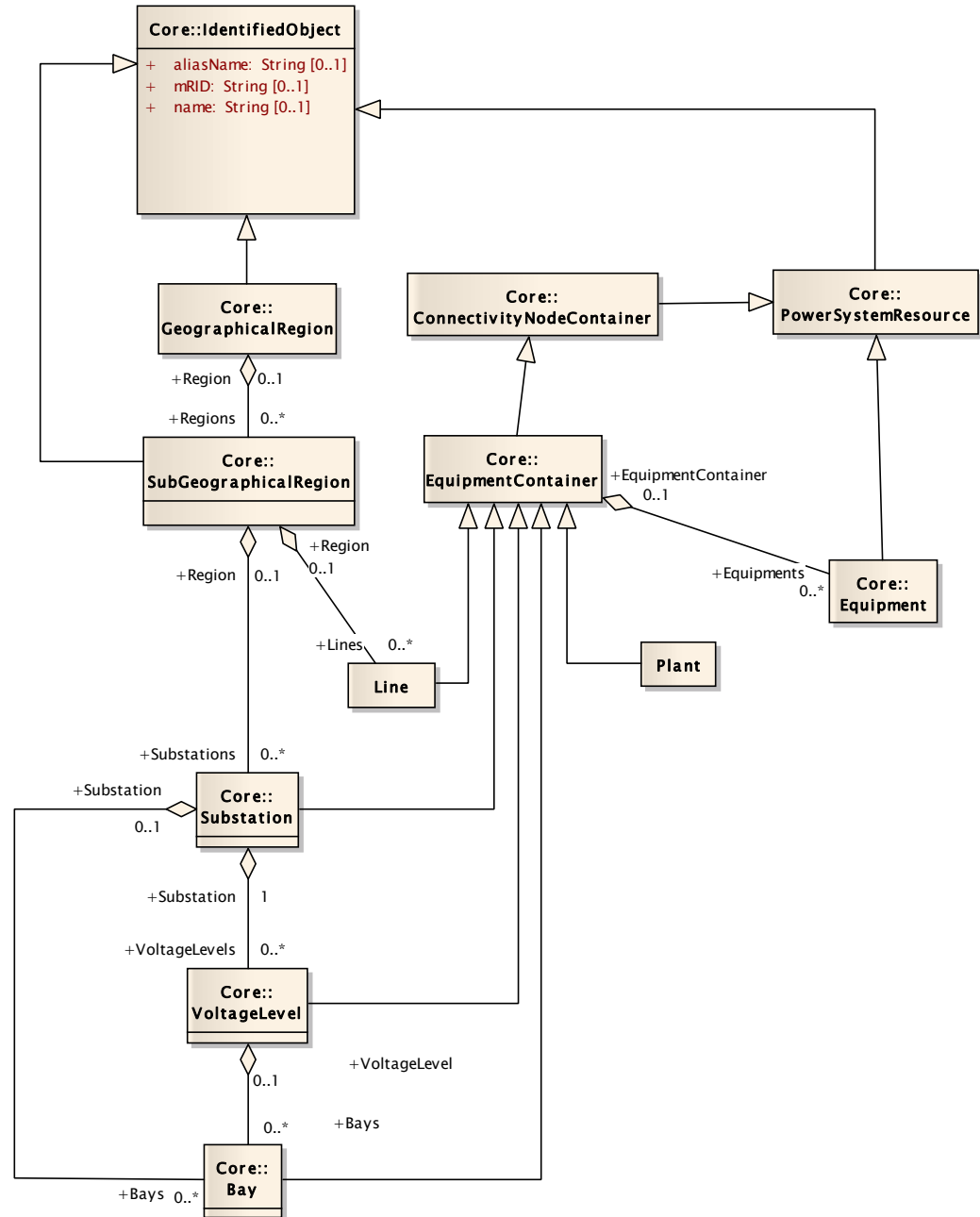
- Breaker: Specialization of ProtectedSwitch
- ProtectedSwitch: Specialization of Switch
- Switch: Specialization of Conducting Equipment
- ConductingEquipment: Specialization of Equipment
- Equipment: Specialization of PowerSystem Resource

Equipment Inheritance Hierarchy



Naming Hierarchy 1

class NamingHierarchyPart1

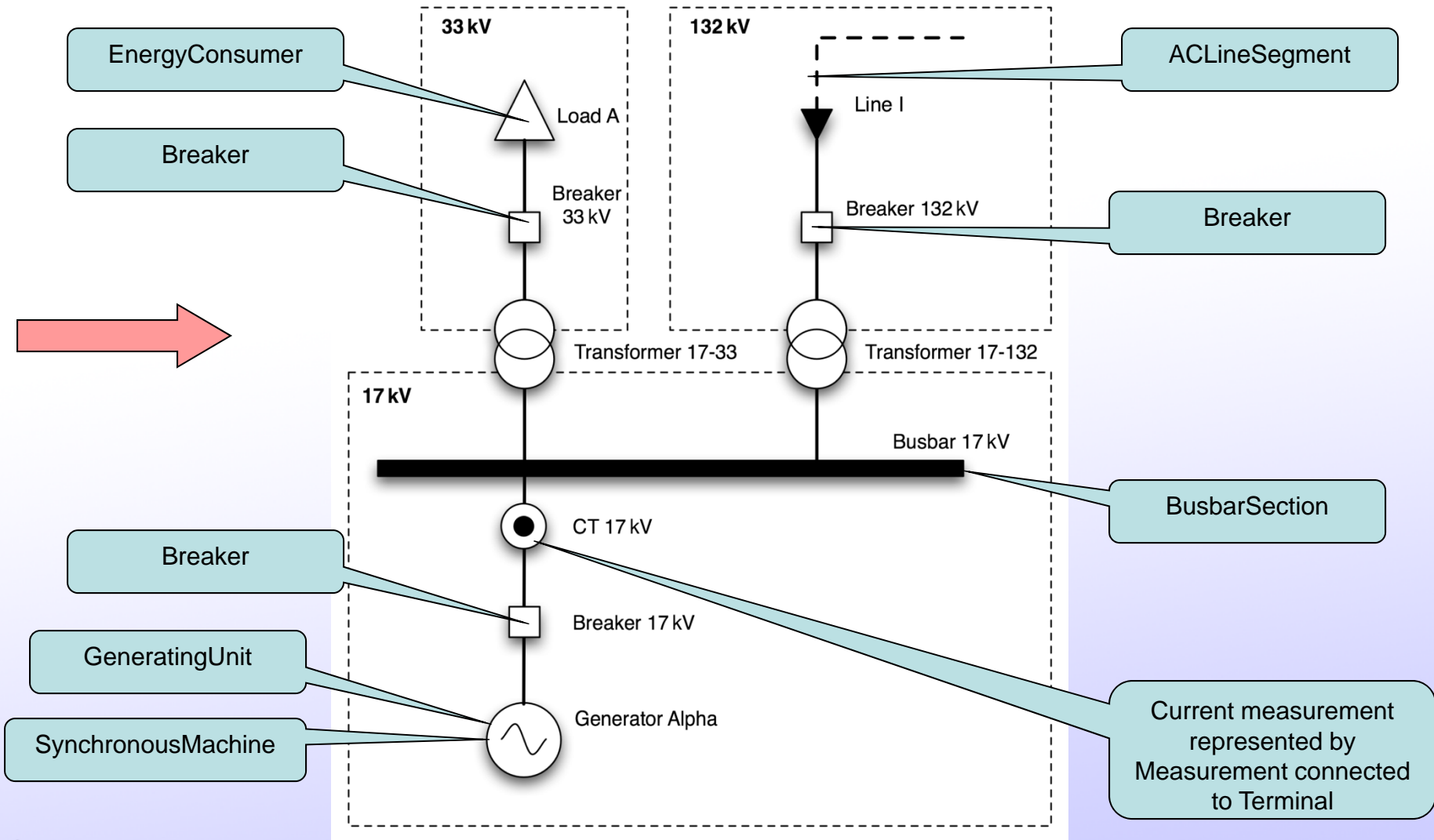


Converting a Circuit to CIM Objects

- Example to show how voltage levels, current transformers, power transformers and generators are modelled
- Circuit contains a single generating source, load, line and busbar. The circuit also contains two power transformers resulting in three voltage levels of 17kV, 33kV and 132kV

Taken from Alan McMorran, *Common Information Model Primer: First Edition.*, EPRI, Palo Alto, CA: 2011, 1024449

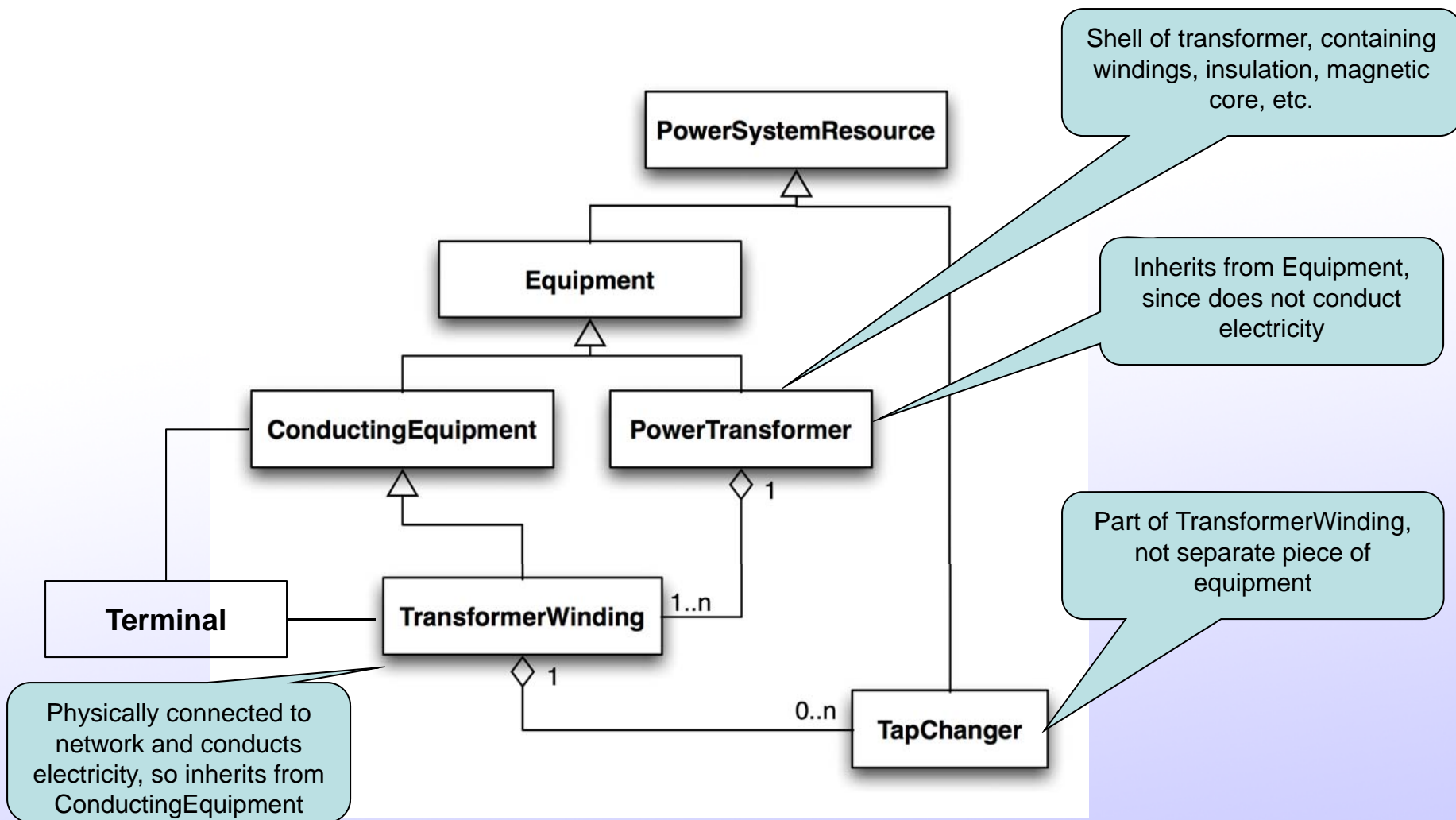
Example Circuit as a Single Line Diagram



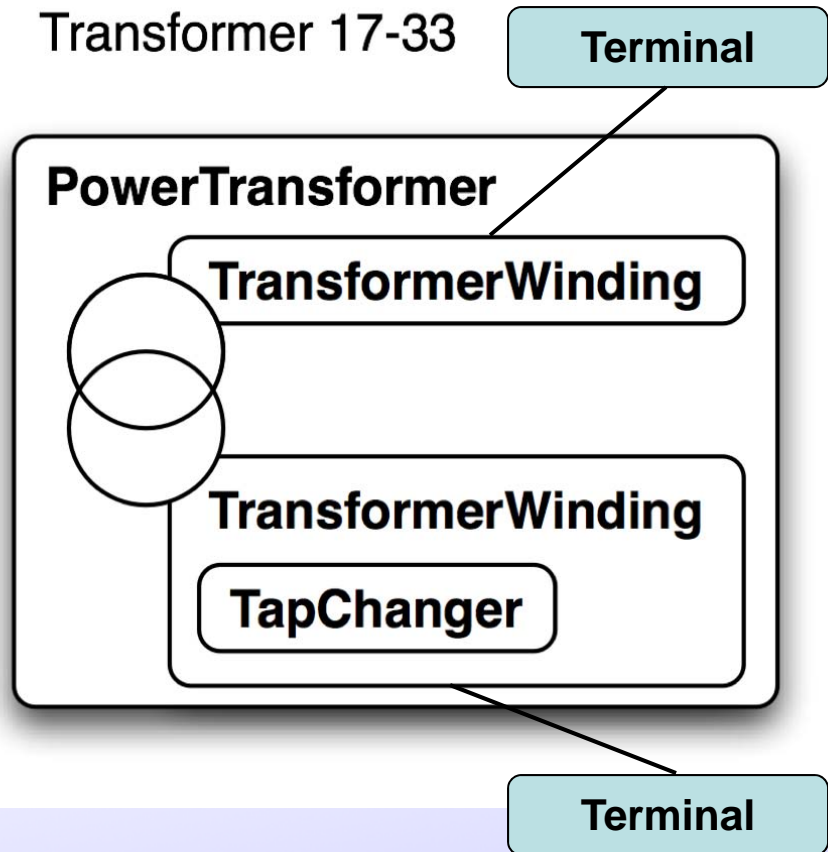
Representing a Power Transformer as CIM Objects

- A power transformer is not mapped to a single CIM class
 - Represented by a number of classes
 - Two-winding power transformer becomes two TransformerWinding objects within a PowerTransformer container
- If a tap changer is present to control one of the windings
 - An instance of the TapChanger class is associated with that particular winding
 - Also contained within the PowerTransformer instance

Transformer Class Diagram pre-CIM Release 15



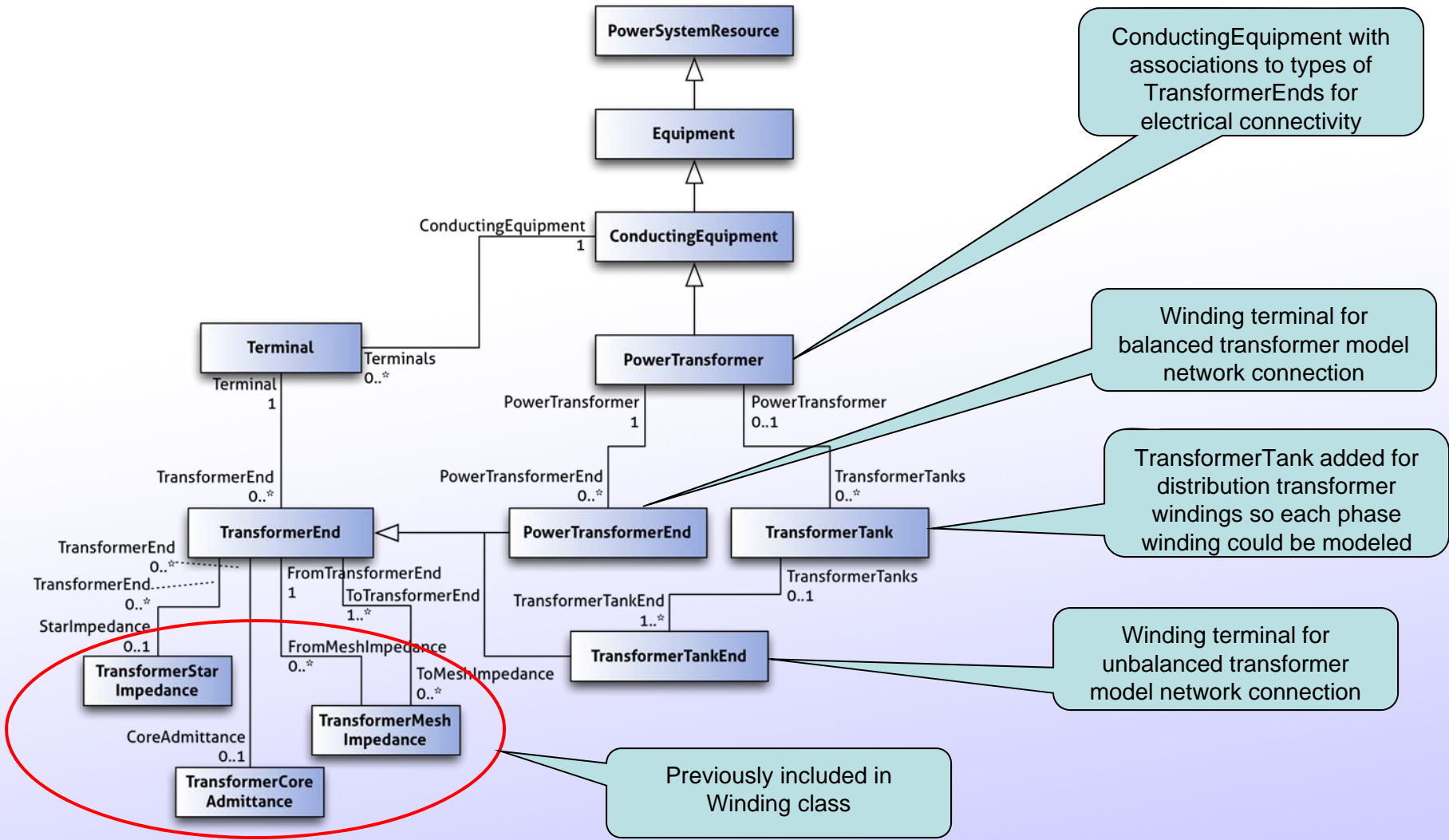
Transformer Instance for Transformer 17-33 pre-Release 15



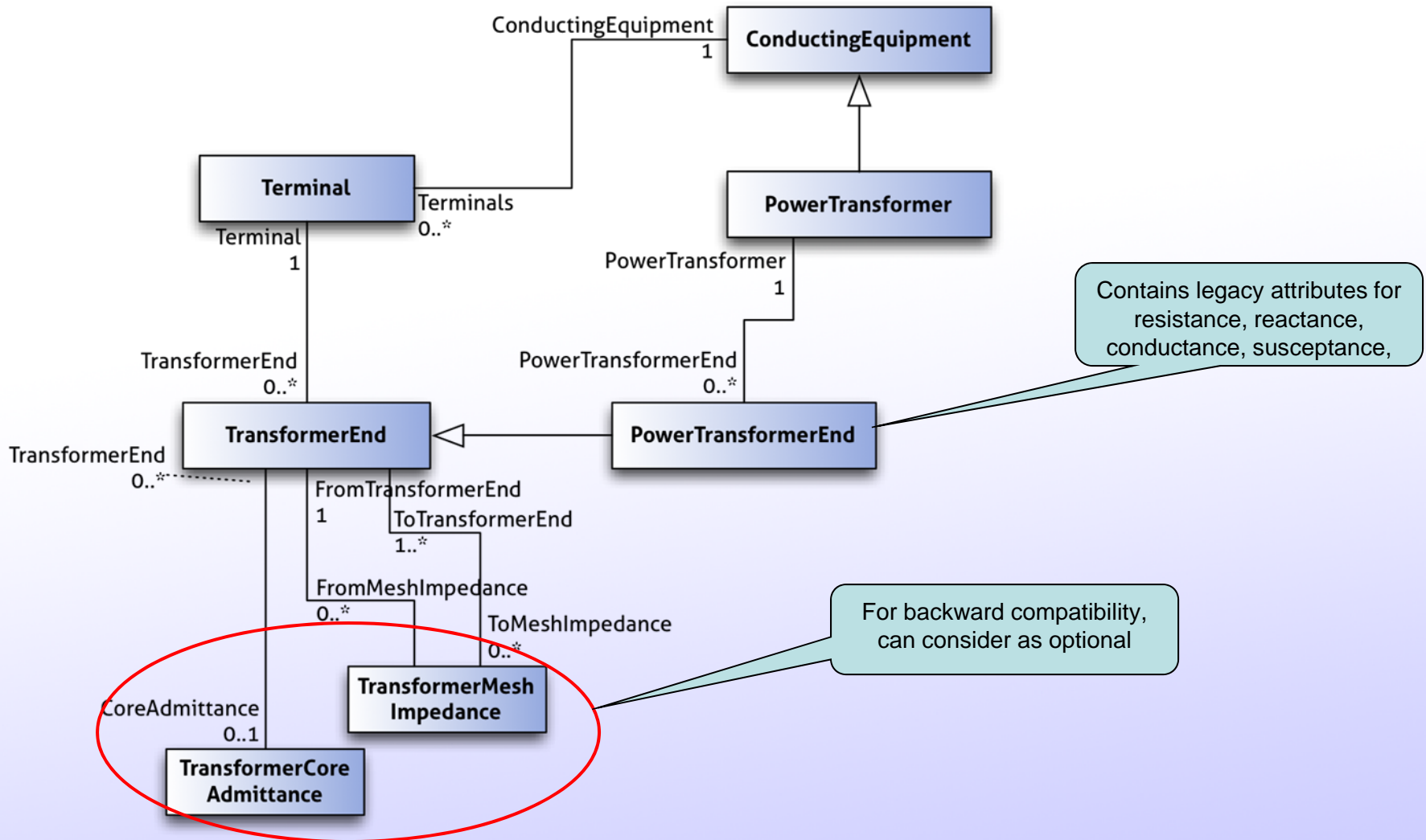
- Transformer 17-33 is represented as four CIM objects
- Connections from the transformer to the network are made from the windings via Terminal

Transformer Class Diagram

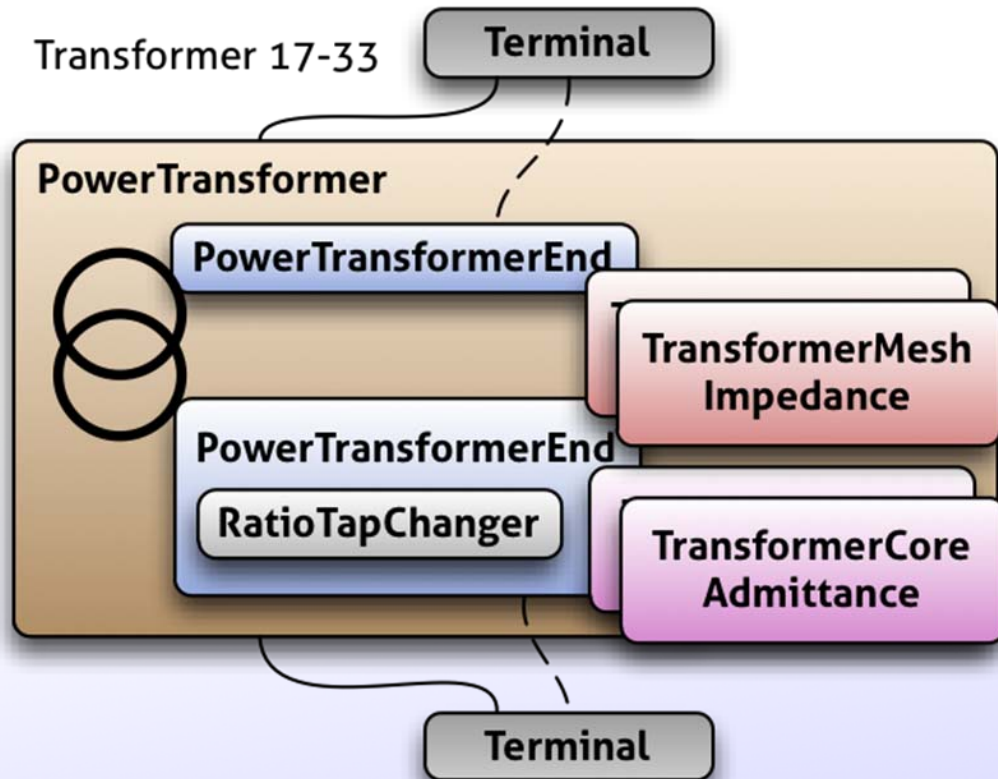
CIM Release 15



Balanced Transformer Model

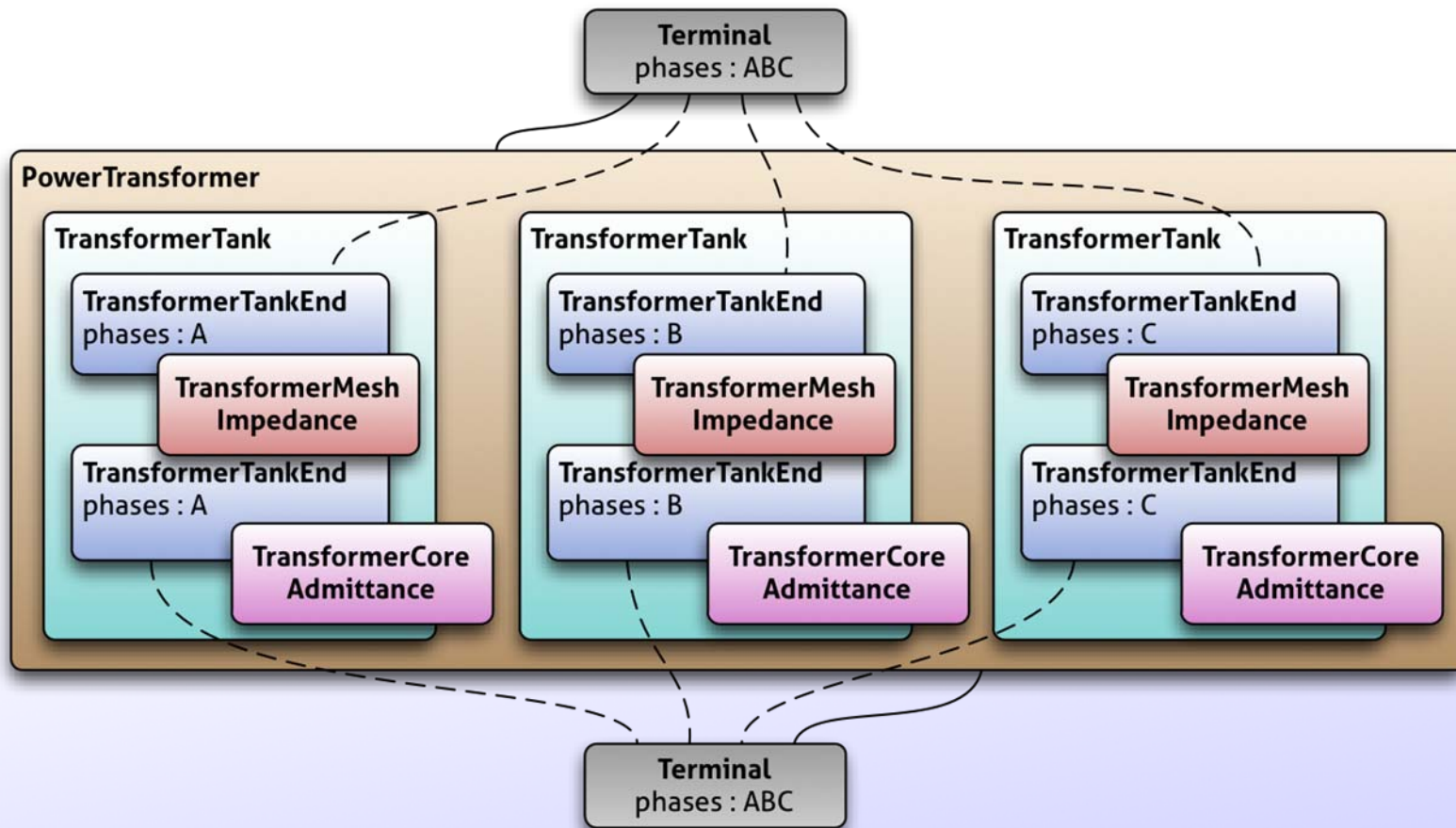


Balanced Transformer Instance for Transformer 17-33 - Release 15

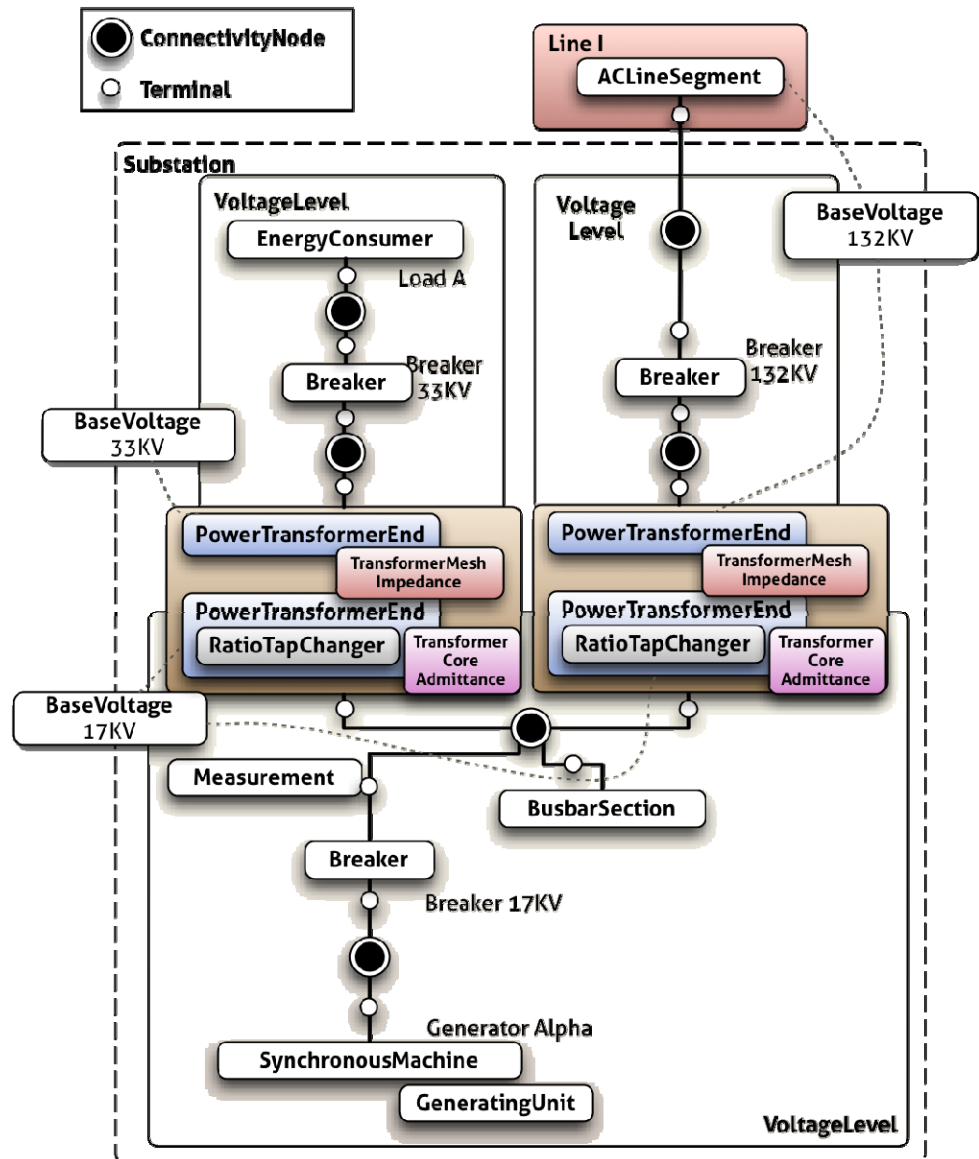


Transformer 17-33 is represented as four CIM objects plus optional objects
Connections from the transformer to the network are made directly from the PowerTransformer via association to PowerTransformerEnd

Unbalanced Distribution Transformer with Multiple Tanks Instance Example

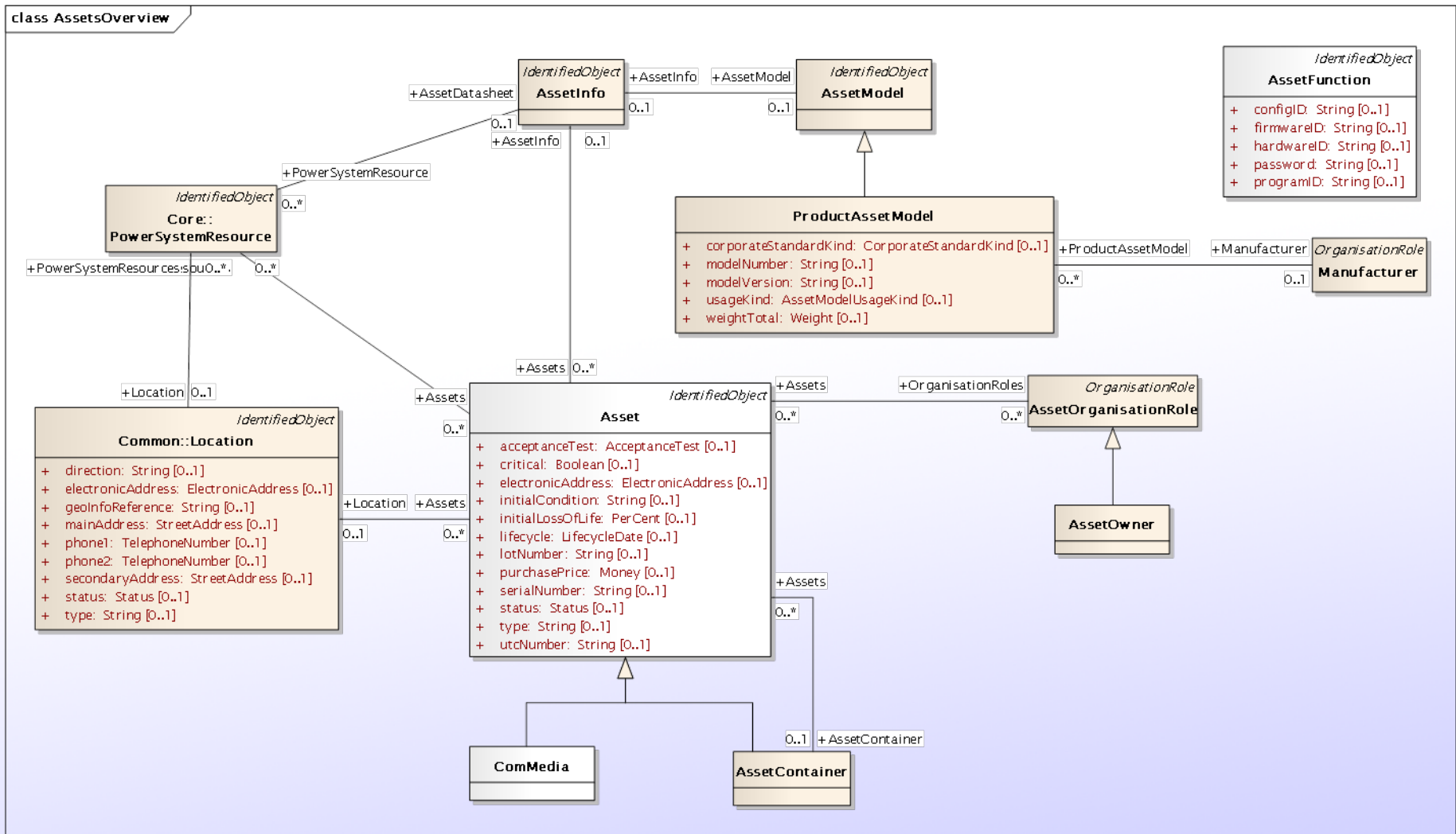


Example Circuit with Full CIM Mappings

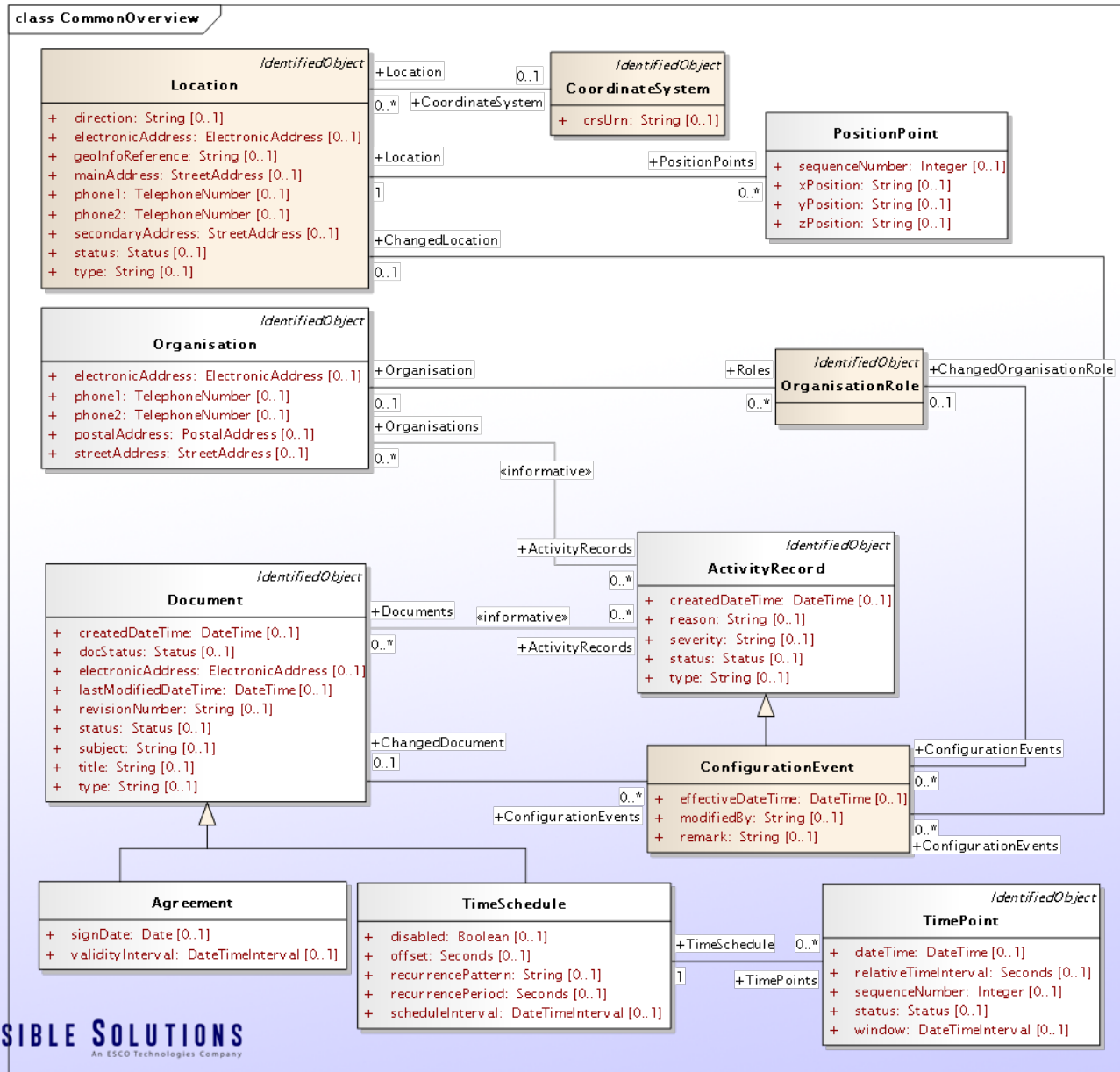


- Maps to
 - 17 CIM classes
 - 45 CIM objects
- Could be extended further with addition of objects for
 - control areas
 - equipment owners
 - measurement units
 - generation and load curves
 - asset data

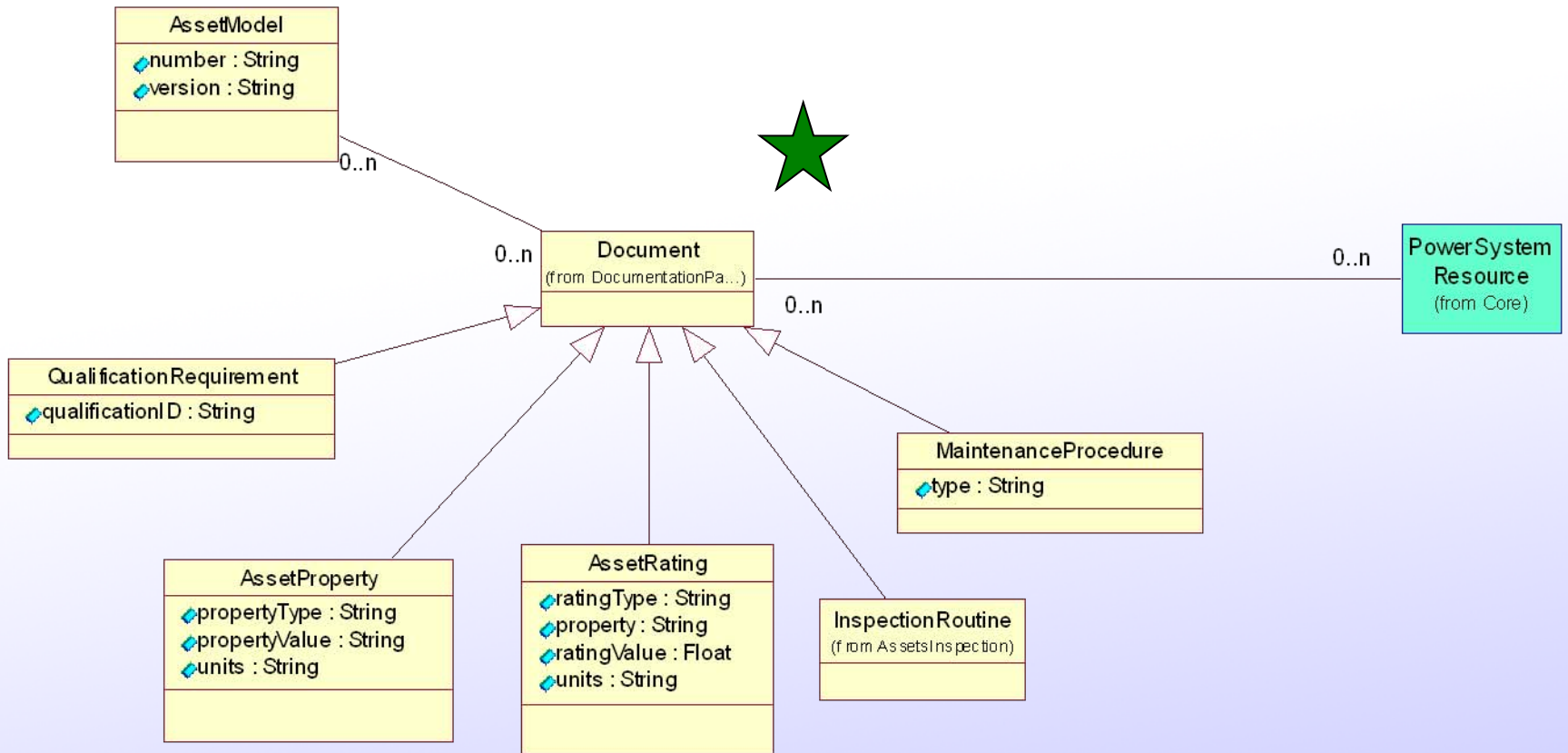
How The CIM Handles Location For Logical Devices And/Or The Physical Asset Performing The Device's Role



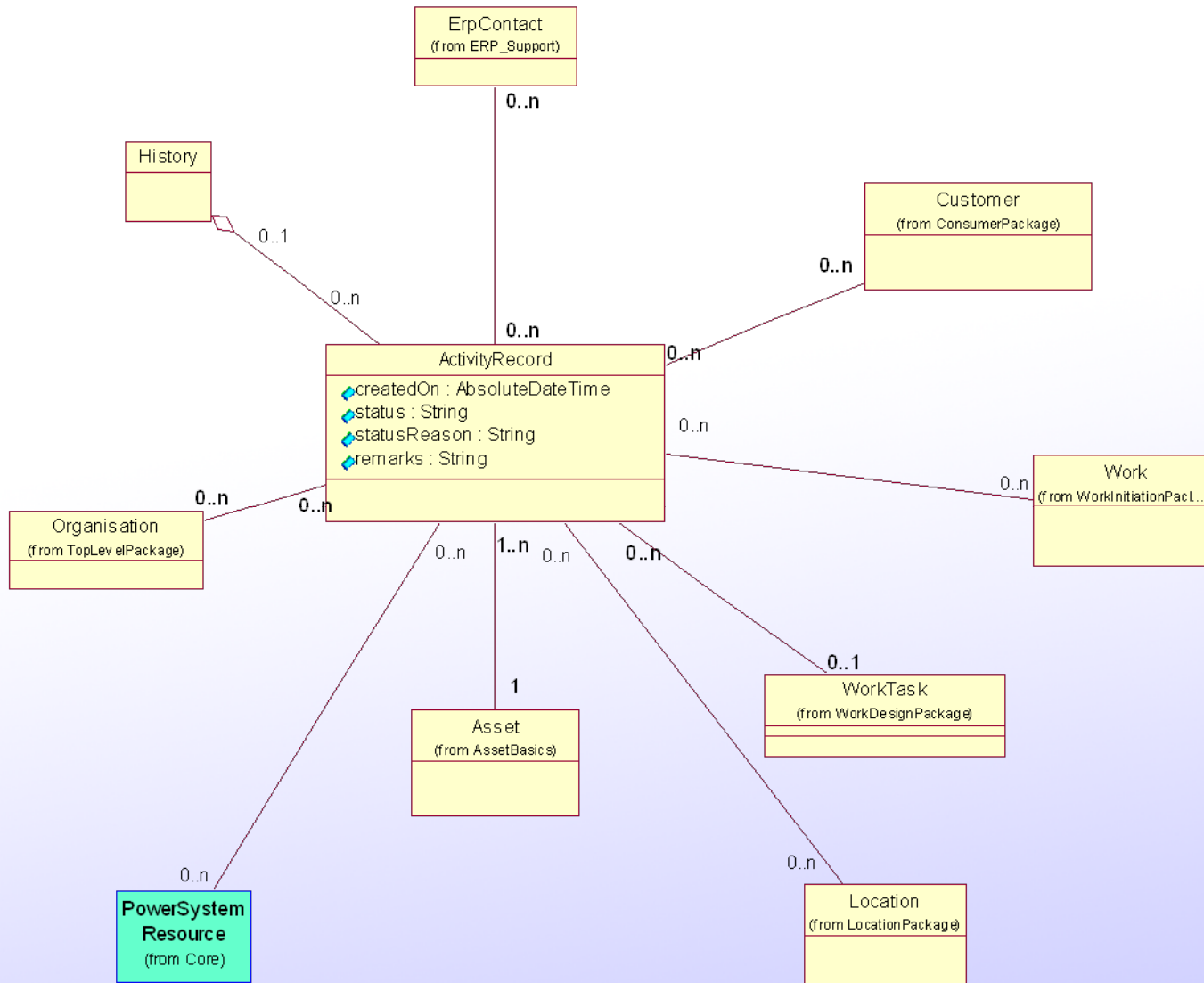
Common Concepts in 61968 CIM



Types Of Document Relationship Inherited By All Assets



Activity Records



CIM UML Release Cycles

- 61970 CIM UML tries for annual release cycle
 - Basis for IEC 61970-301 CIM Base Fifth Edition
 - Word document auto-generated from the UML electronic model
 - Information system and Profile documents are synchronized with UML model release
- 61968 CIM UML different update cycles
 - Basis for IEC 61968-11 CIM Distribution Information Exchange Model
- 62325 CIM UML on another update cycle
 - Basis for IEC 62325-301 CIM for Deregulated Markets
- Complete CIM UML available as a combined model on CIMug Sharepoint site:
 - **Title:** draft CIM16 + DCIM12 + MCIM02
 - **Name:** [iec61970cim16v13_iec61968cim12v05_iec62325cim02v05](#)

CIM UML in Enterprise Architect

- The CIM UML model is maintained in Sparx Enterprise Architect (EA)
- Current Official CIM Release 15 UML Model
 - `iec61970cim15v33_iec61968cim11v13_iec62325cim01v07`
- Go to UML model in EA

- End of presentation