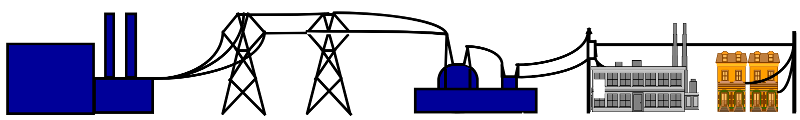
Introduction to CIM

Acknowledgment: These slides were downloaded from CIM user group web site at http://cimug.ucaiug.org/. They are authored by Xtensible Solutions, with modifications for being used in class.



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Presentation Contents

- Background
- What is the CIM
- How the CIM is used in the Utility Enterprise
  - As a semantic model for information exchange
- Three Layer Architecture for Using the CIM Standards
- CIM UML model
- Profiles for business context
- Implementation syntax
  - XML Schema – for messaging
  - RDF Schema - for model exchange
- Where to get CIM information

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CIM History

- 1992 – Unified Information turned over a data model based on the EPRI OTS to the CCAPI Task Force with the understanding it would be turned into an industry standard model
- 1993 to 1996 - The CCAPI task force expanded the data model with a primary goal of enabling use of plug compatible applications to help protect utility investment in applications
  - Entity Relationship Visio Diagram with MS Access database
- 1996 – The CIM was turned over to IEC Technical Committee 57, Working Group 13&14, where it is advancing through the standards process. It covers both electric utility transmission and distribution business operations
  - Converted to UML and initially maintained in Rational Rose
- 2000 – NERC mandates CIM and first IOP test
- 2003 – ISO/RTO Council and EPRI sponsored an initiative to expand CIM into Market Operations, a.k.a. CME, followed by extensions for Planning and Dynamics
- 2005 – First edition of IEC 61970-301 CIM Base
- 2005 – CIM Users Group established under UCA Users Group
- 2008 – CIM adopted by UCTE
- 2009 – NIST identifies CIM as key standard for Smart Grid interoperability
- 2010 – ENTSO-E migrates to CIM and holds first IOP test

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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

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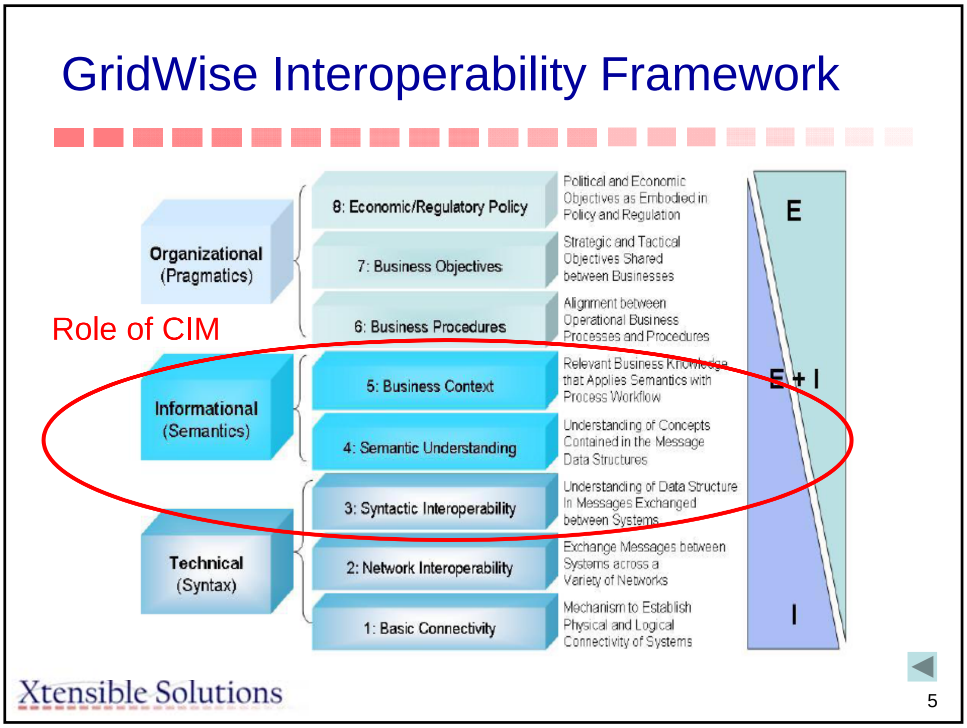
GridWise Interoperability Framework
Organizational (Pragmatics)
Informational (Semantics)
Technical (Syntax)
Role of CIM
8: Economic/Regulatory Policy
7: Business Objectives
6: Business Procedures
5: Business Context
4: Semantic Understanding
3: Syntactic Interoperability
2: Network Interoperability
1: Basic Connectivity
Political and Economic Objectives as Embodied in Policy and Regulation
Strategic and Tactical Objectives Shared between Businesses
Alignment between Operational Business Processes and Procedures
Relevant Business Knowledge that Applies Semantics with Process Workflow
Understanding of Concepts Contained in the Message Data Structures
Understanding of Data Structure in Messages Exchanged between Systems
Exchange Messages between Systems across a Variety of Networks
Mechanism to Establish Physical and Logical Connectivity of Systems
E
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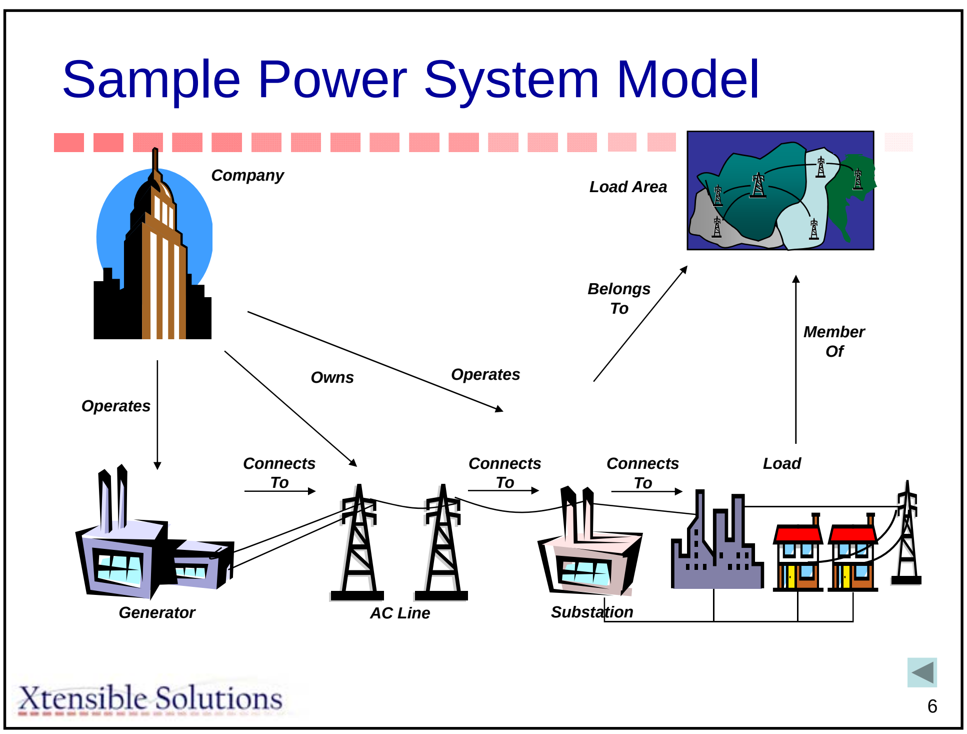
Sample Power System Model
Company
Load Area
Belongs To
Member Of
Owns
Operates
Operates
Connects To
Connects To
Connects To
Load
Generator
AC Line
Substation
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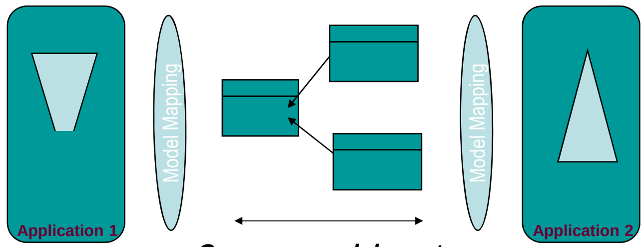
Application of Information Model



Common model creates understanding

SISCO SYSTEMS

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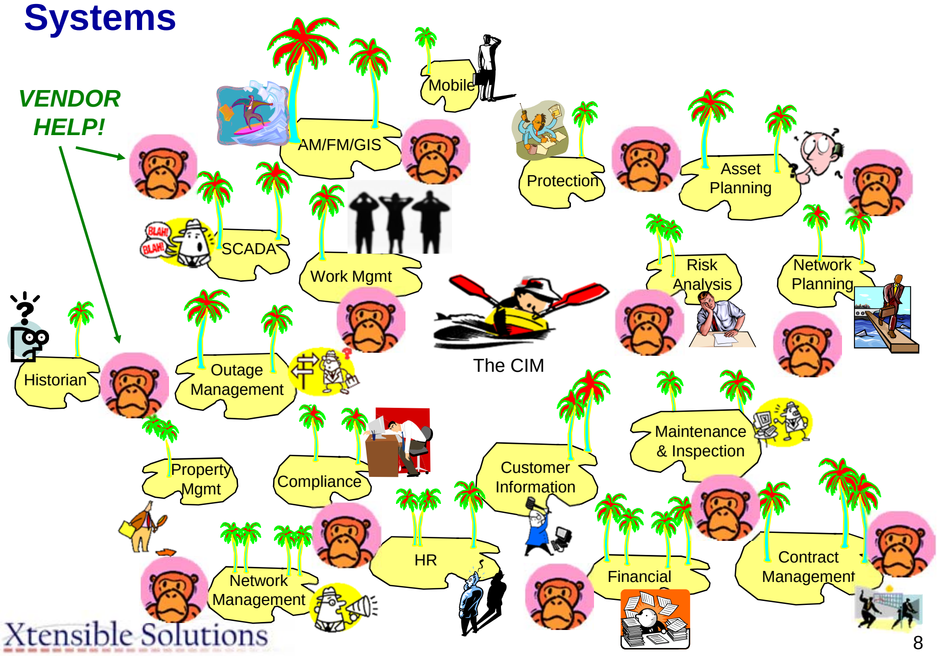
Information is Needed From Many Individual Systems



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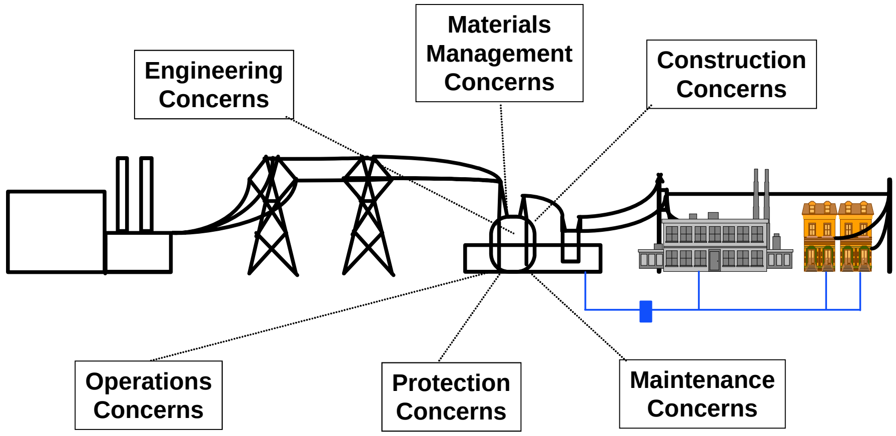
The *Common Language* Should Provide Relevant Information To A User Regardless of Source



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The Needs of Various Users – Some Same, Some Different

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.

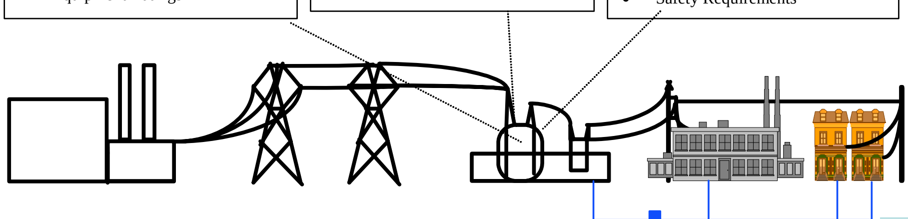
- Field Name
- Spatial Location
- Version
- Physical Connectivity
- Load Projections
- Capacity Requirements
- Compatible Unit
- Equipment Ratings

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



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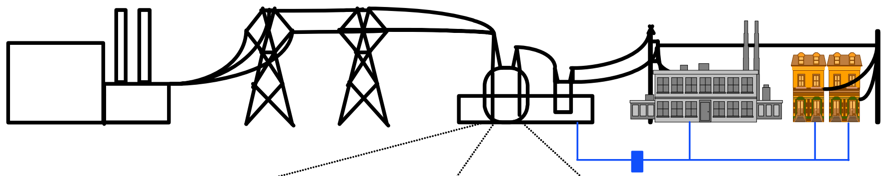
The Needs of Various Users – Some Same, Some Different (continued)



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

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

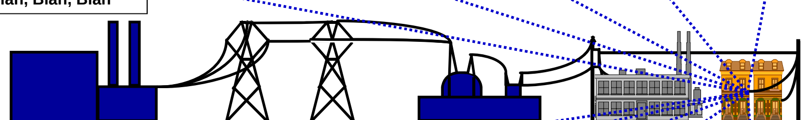
Service Connection Request
Blah, Blah, Blah, **Organization**, Blah, Blah, Blah

Work
Blah, Blah, Blah, **Organization**, Blah, Blah, Blah

Asset Catalog
Blah, Blah, Blah, **Organization**, Blah, Blah, Blah

Planned Outage
Blah, Blah, Blah, **Organization**, Blah, Blah, Blah

Crew
Blah, Blah, Blah, **Organization**, Blah, Blah, Blah



Maintenance
Blah, Blah, Blah, **Organization**, Blah, Blah, Blah

Switching Schedule
Blah, Blah, Blah, **Organization**, Blah, Blah, Blah

Meter Reading
Blah, Blah, Blah, **Organization**, Blah, Blah, Blah

Load Data Set
Blah, Blah, Blah, **Organization**, Blah, Blah, Blah

Load Control
Blah, Blah, Blah, **Organization**, Blah, Blah, Blah

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!

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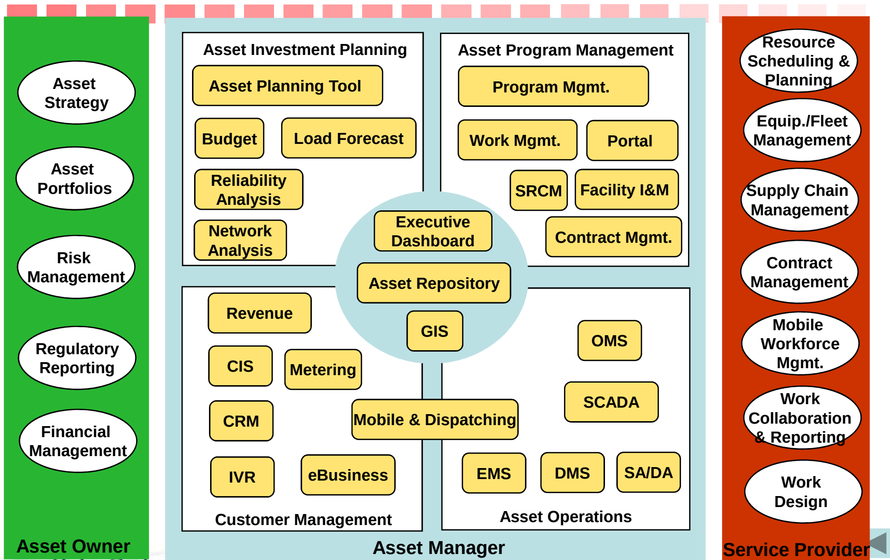
For example, a common language-based logical infrastructure facilitates collaboration among the many applications involved in Asset Management



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[source: DistribuTECH 2003 paper by Zhou & Robinson]

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Application To Common Language Mapping – The Typical Field to Field Process Is Cumbersome

- Individual fields of data models from data sources are mapped to each other
- Approach <u>does not scale well</u> as the number of maps grows exponentially with each new data source
- Mapping is a challenge as 'mappers' must have an in depth understanding of all relevant data sources – a tall order!

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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.

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[source: TopQuadrant Technology Briefing, July 2003]

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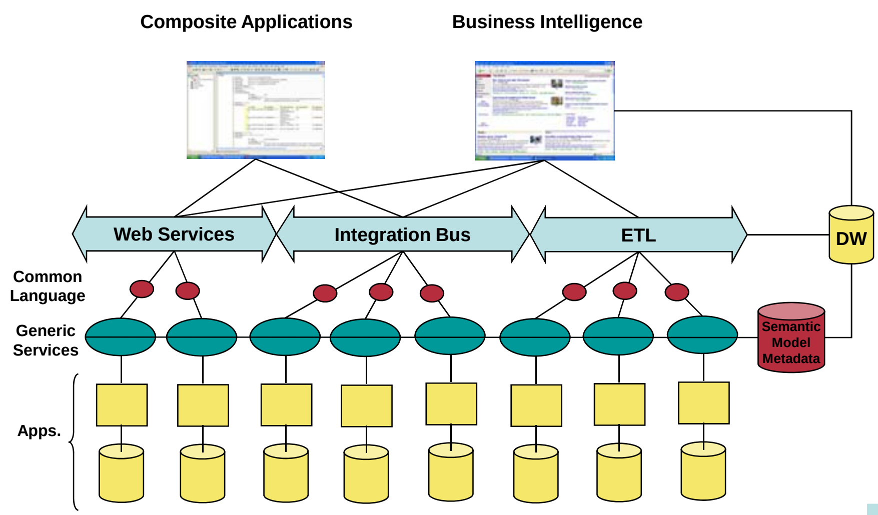
The CIM Provides a Semantic Layer in an Enterprise Architecture



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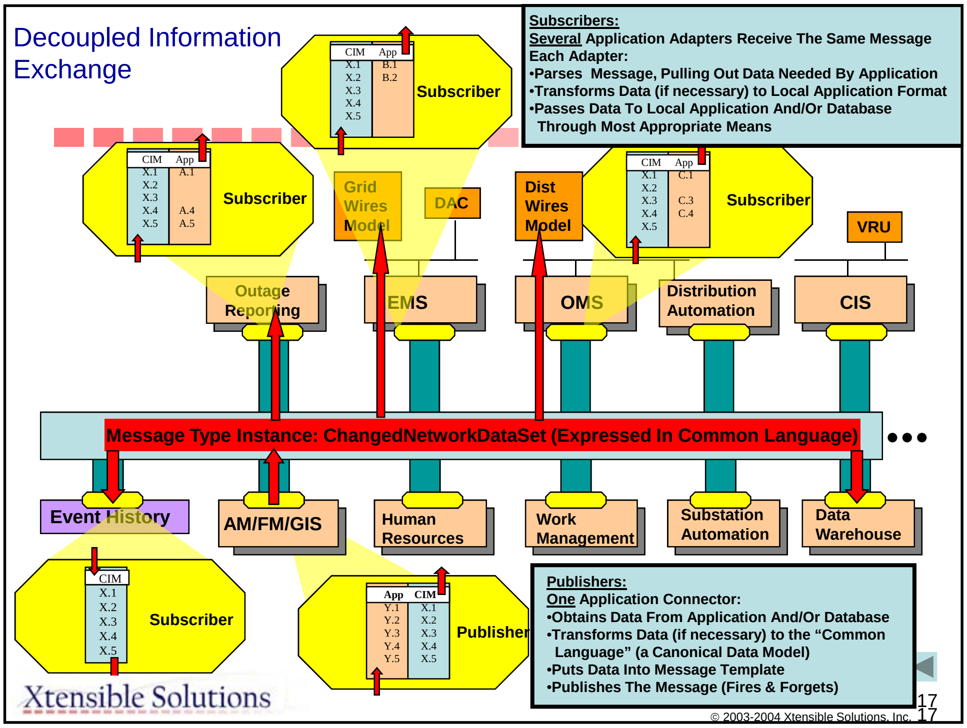

The CIM and Related Standards

- But the CIM standards are more than just an abstract **information model** 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

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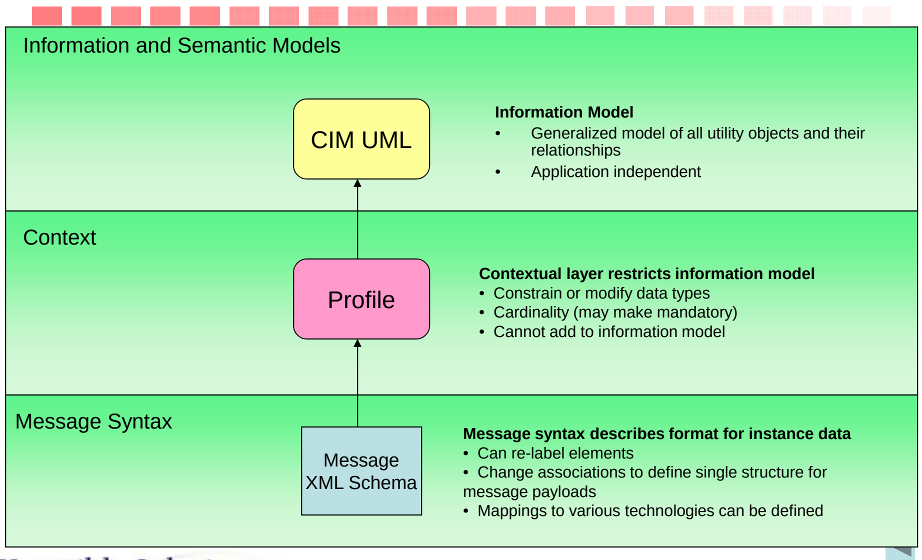
TC57 Layered Architecture



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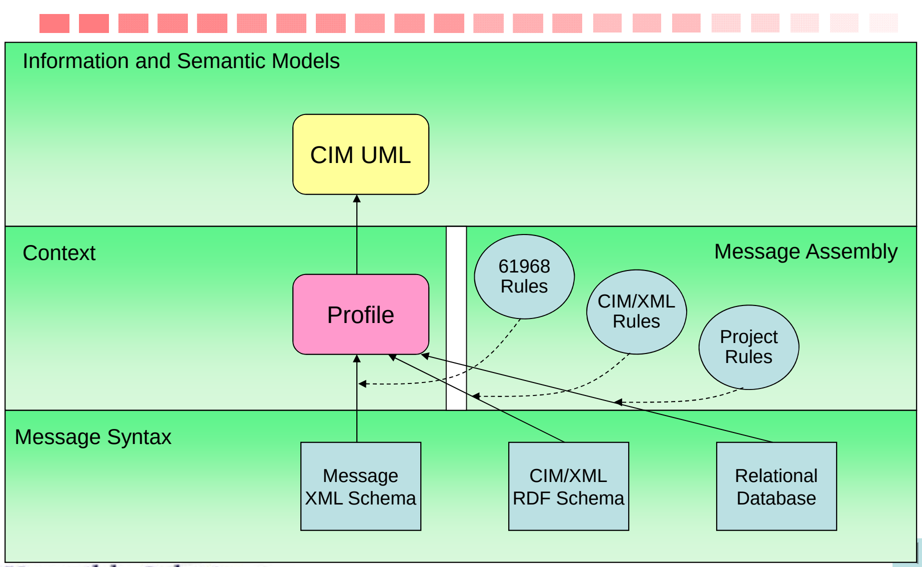
Semantic Models and Profiles



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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

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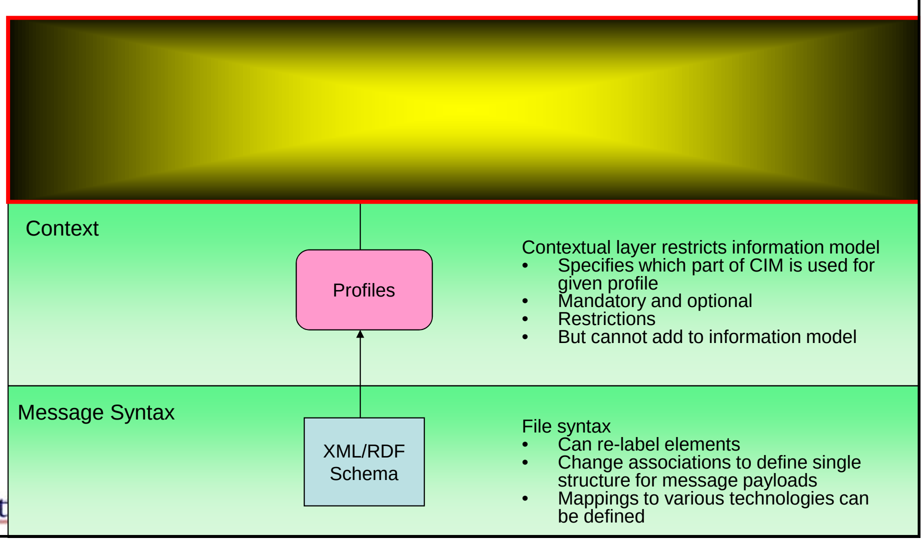
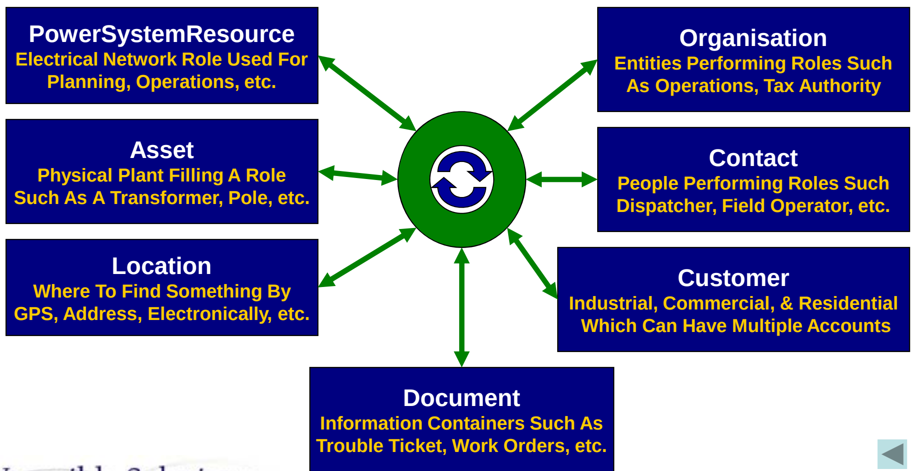
Let’s Look at each Layer of the CIM



Foundational Relationships Of The CIM



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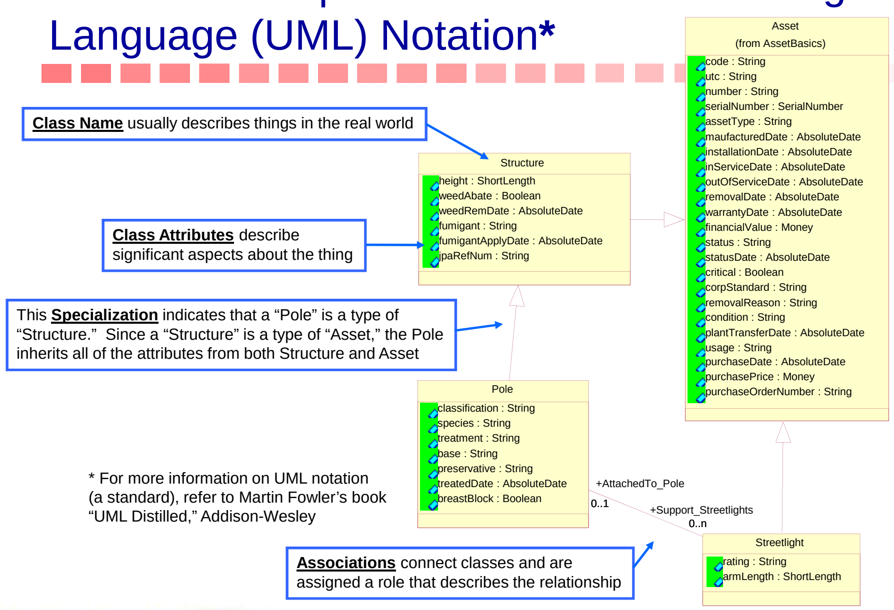
The CIM Is Expressed In Unified Modeling Language (UML) Notation*



* For more information on UML notation (a standard), refer to Martin Fowler's book "UML Distilled," Addison-Wesley

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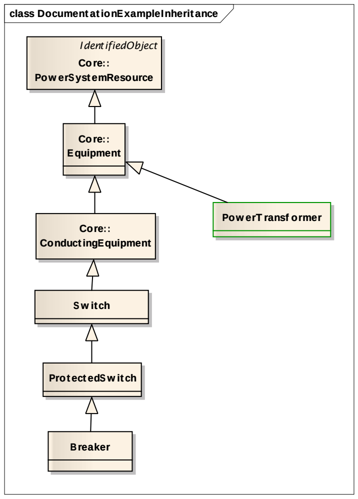
Concepts: Generalization/Inheritance



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

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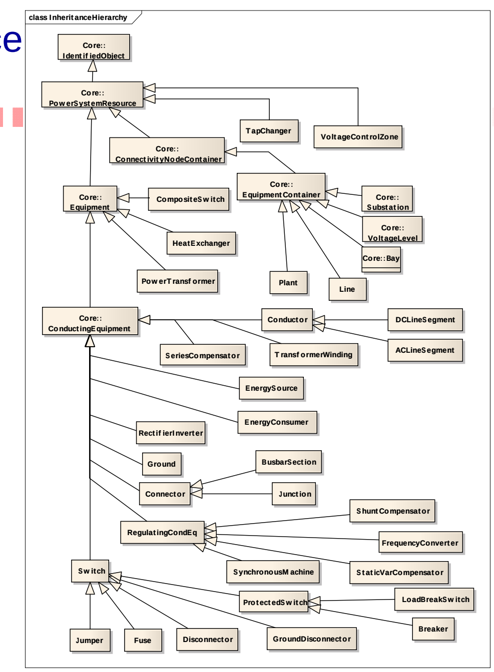
Equipment Inheritance Hierarchy



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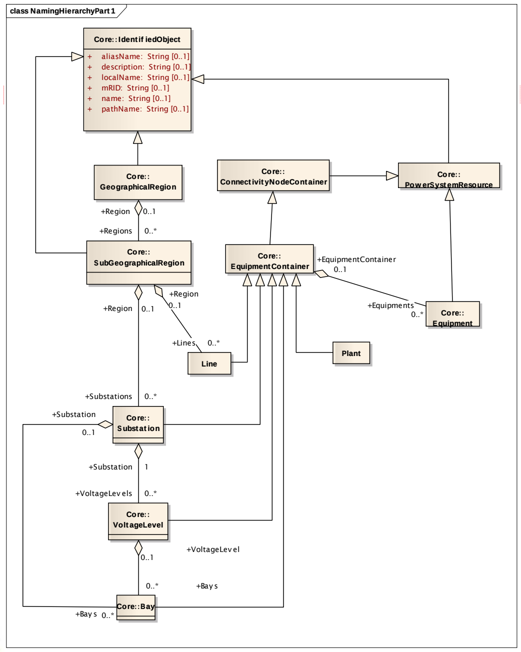
Naming Hierarchy 1



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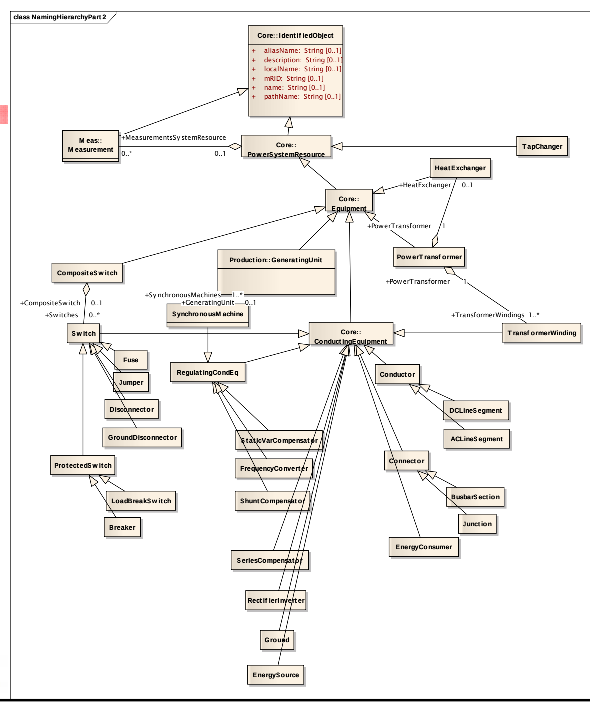
Naming Hierarchy 2



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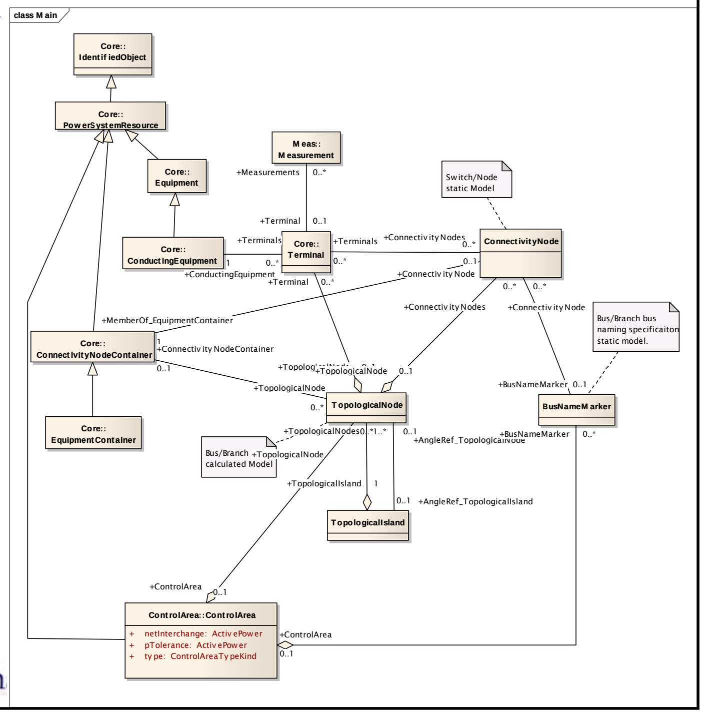
Connectivity and Topology Model



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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 McMorran, “An Introduction to IEC 61970-301 & 61968-11: The Common Information Model”, University of Strathclyde, Glasgow, UK

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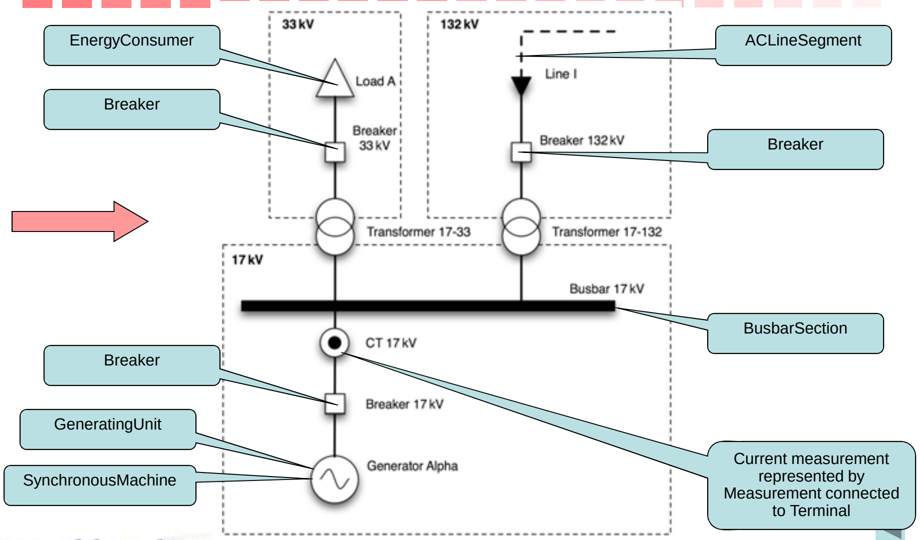
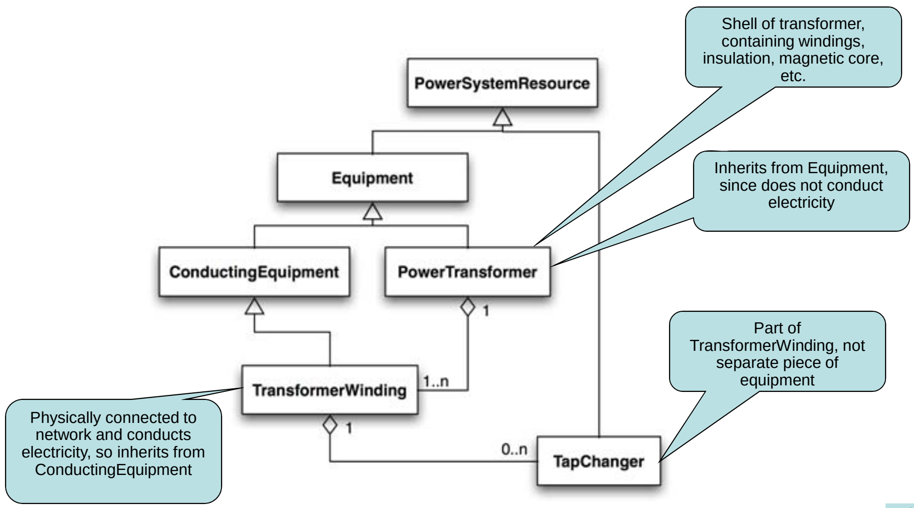
Example Circuit as a Single Line Diagram



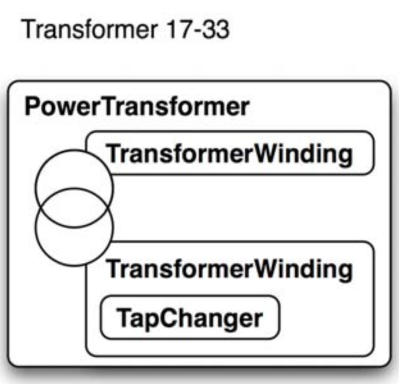
Representing a Power Transformer as CIM Objects

- A power transformer is not mapped to a single CIM class
  - Represented by a number of components with a single PowerTransformer container class
  - 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

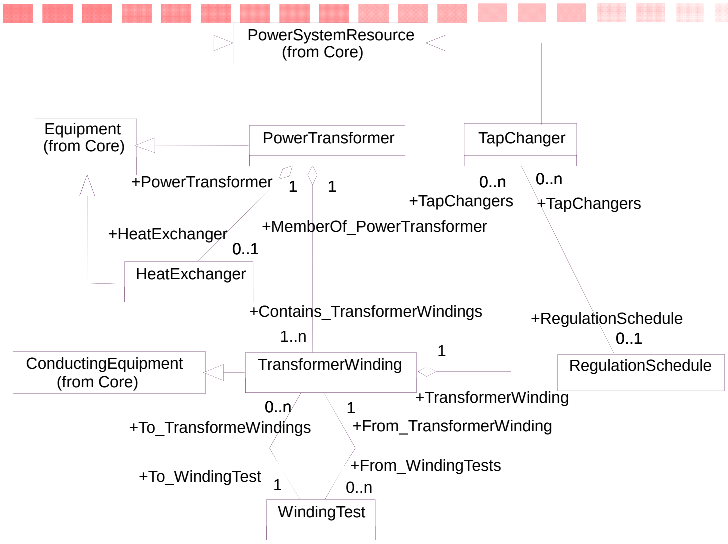


CIM Mapping for Transformer 17-33



- Transformer 17-33 is represented as four CIM objects

Transformer Model Diagram from 61970-301CIM Base



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Transformer Winding Attributes

Transformer Winding

- b: Susceptance
- insulationKV: Voltage
- connectionType: WindingConnection
- emergencyMVA : ApparentPower
- g: Conductance
- grounded: Boolean
- r: Resistance
- r0: Resistance
- ratedKV: Voltage
- rated MVA: ApparentPower
- rground: Resistance
- shortTermMVA: ApparentPower
- windingType: WindingType
- x: Reactance
- x0: Reactance
- xground: Reactance

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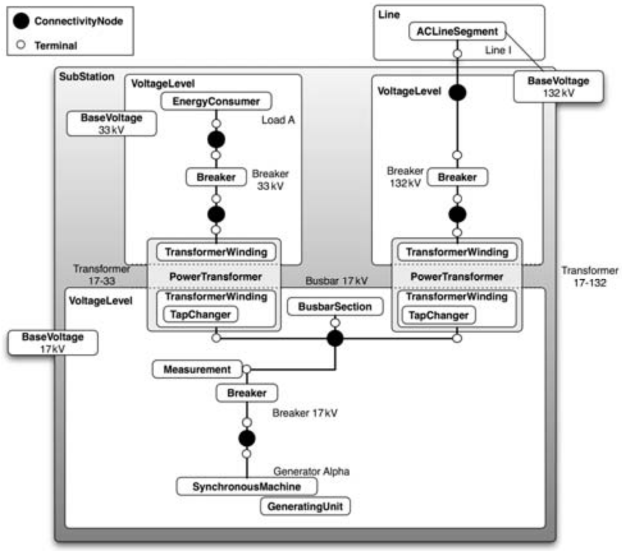
Example Circuit with Full CIM Mappings



- 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

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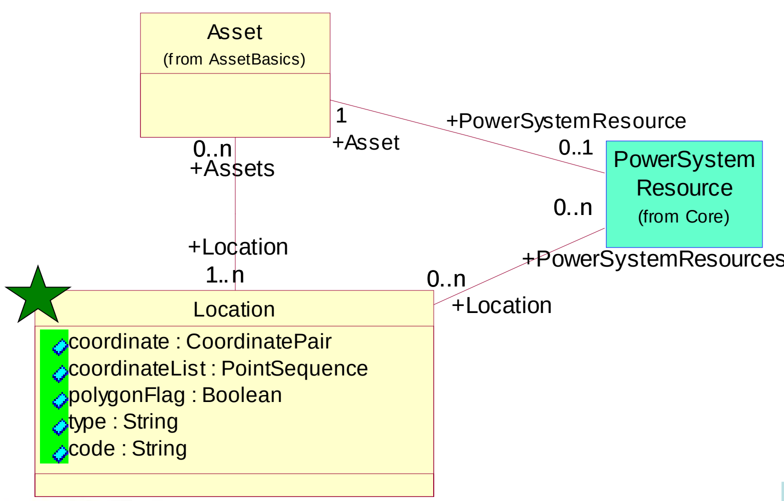
How The CIM Handles Location For Logical Devices And/Or The Physical Asset Performing The Device's Role



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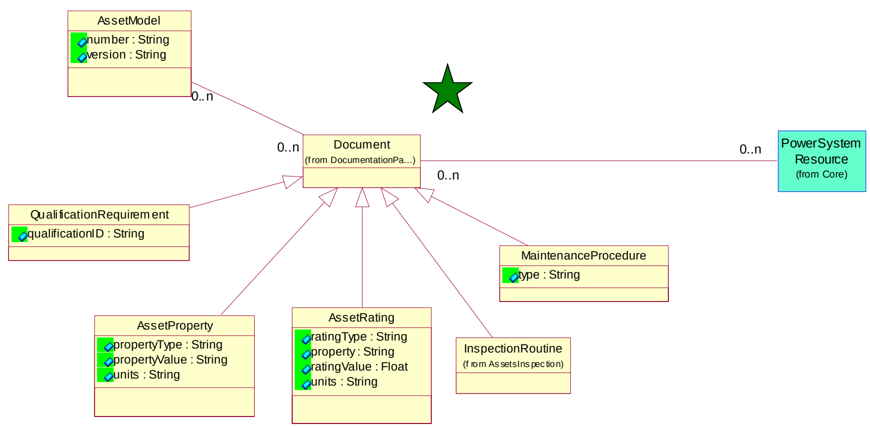
Types Of Document Relationship Inherited By All Assets



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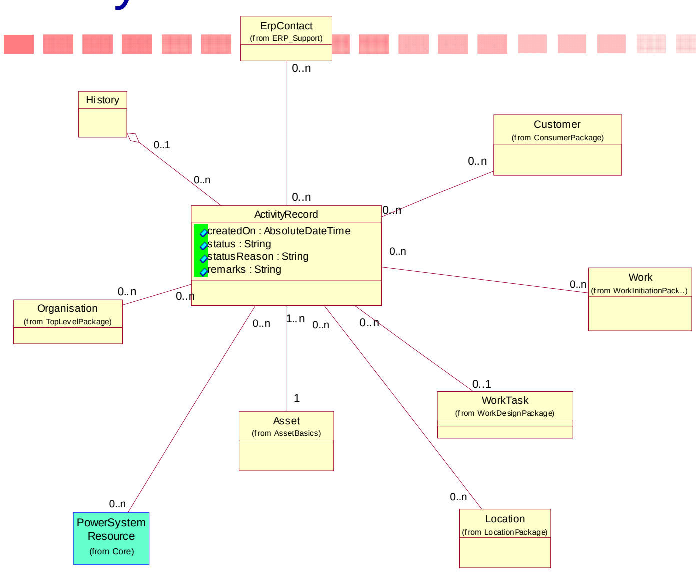
Activity Records



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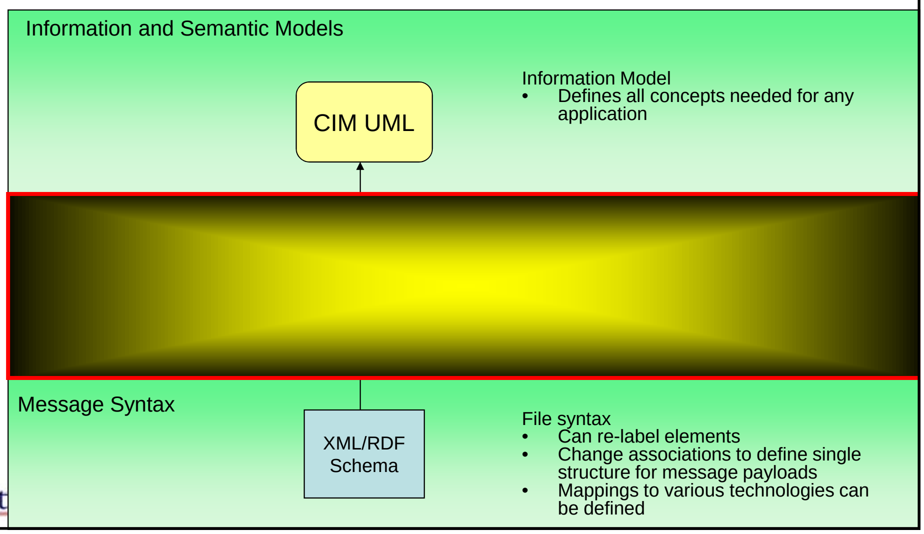
Let's Look at each Layer of the CIM



Common Power System Model (CPSM) Profile

- IEC 61970-452 specifies the specific profile (or subset) of the CIM for exchange of static power system data between utilities, security coordinators and other entities participating in a interconnected power system
- All parties have access to the modeling of their neighbor's systems that is necessary to execute state estimation or power flow applications
- A companion standard, IEC 61970-552, defines the CIM XML Model Exchange Format based on the Resource Description Framework (RDF) Schema specification language which can be used to transfer power system model data for a particular profile
- Interoperability tests have validated several vendor's products for exchanging complete power system models, partial models, and incremental updates

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61970-452 CPSM Profile TOC Snippet

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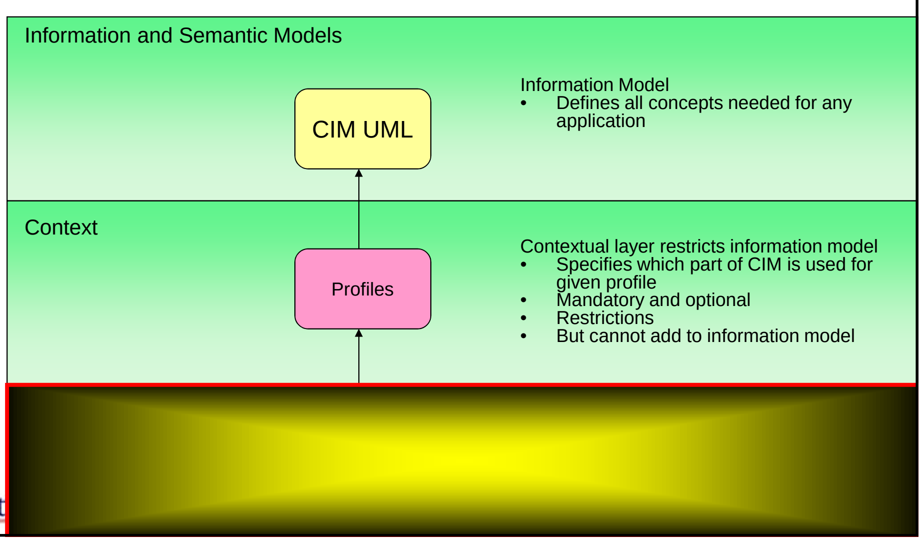
Let's Look at each Layer of the CIM



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XML Implementation Technologies

- XML Schema
  - Used for generation of message payloads for system interfaces in system integration use cases
- RDF Schema
  - Used for exchange of power system models

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What is XML?

- eXtensible Markup Language
  - A text-based tag language, similar in style to HTML but with user-definable tags
    - Similar in use of ASCII text and tags
  - Based on Standard Generalized Markup Language (SGML), which is ISO 8879.
- Self-describing
- Open industry standard - W3C Recommendation (spec)
  - Broad usage across industries (many XML tools available)
- Cross-platform and vendor-neutral standard
- Easy to use, easy to implement

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Basic Syntax

- Starts with XML declaration
  <?xml version="1.0"?>
- Rest of document inside the "root element"
  <TEI.2>…</TEI.2>
- Tags are used to provide information about the document content (metadata)
- Start and end tags must match exactly

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What is an XML Element?

- An XML element is everything from (including) the element's start tag to (including) the element's end tag.
- An element can contain other elements, simple text or a mixture of both. Elements can also have attributes.
- ```
  <bookstore>
   <book category="CHILDREN">
    <title>Harry Potter</title>
    <author>J K. Rowling</author>
    <year>2005</year>
    <price>29.99</price>
   </book>
   <book category="WEB">
    <title>Learning XML</title>
    <author>Erik T. Ray</author>
    <year>2003</year>
    <price>39.95</price>
   </book>
  </bookstore>
  ```
- In the example above, <bookstore> and <book> have **element contents**, because they contain other elements. <author> has **text content** because it contains text.
- In the example above only <book> has an **attribute** (category="CHILDREN").

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Implementation Syntax – XML Schema

- Example of use of XML Schema
- Mapping Proprietary EMS Interfaces to the CIM
  - Provide enterprise system access to transformer data

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

- EMS Native 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

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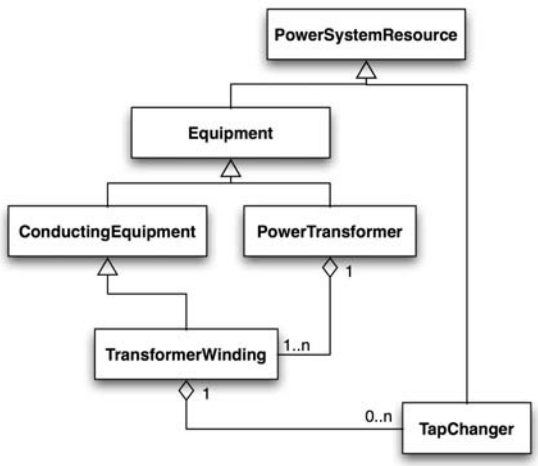
Transformer Class Diagram in CIM



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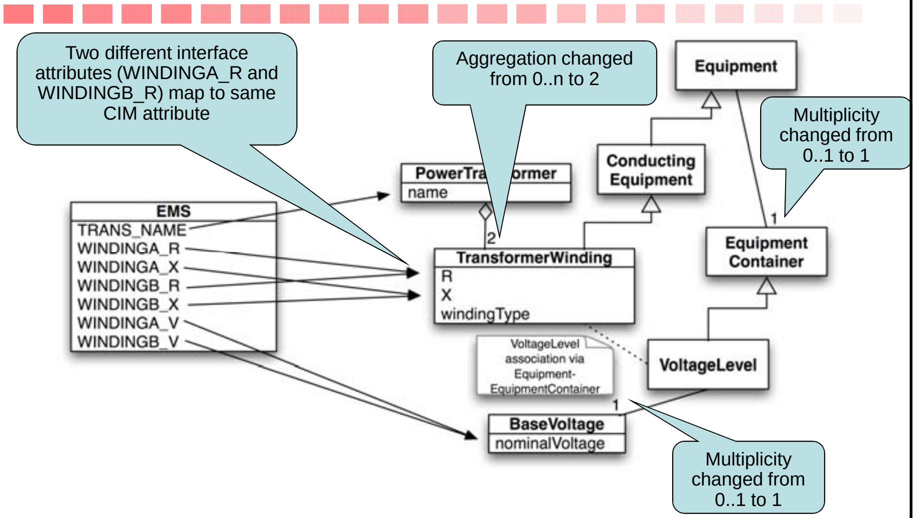
CIM Interface Mapping

- Beginnings of Profile/Message Payload Definition



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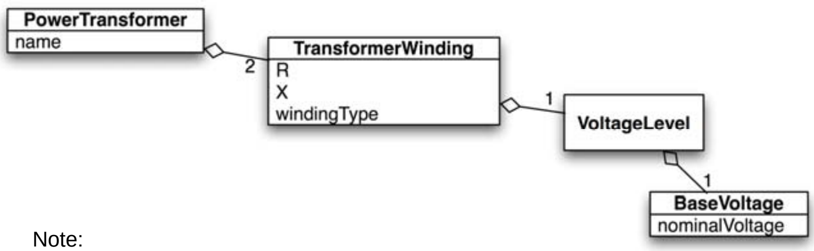
Message Payload in UML



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

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Schemas – Meta Data

- A Schema is a description or definition of the structure of a database or other data source. It provides:
  - Allowable content or structure of data of a variety of types
  - Abstract definition of the relationships and characteristics of a class of objects or pieces of data
- Database Schema
  - Defines the table names and columns, describes the relationships between tables (via keys), and acts as a repository for triggers and stored procedures.
- XML Schema
  - Describes the ordering and inter-relationship of
    - XML elements (i.e., sequence and nesting of tags) and
    - Attributes (i.e., values, types, defaults) in the class of XML documents to which the schema applies.

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(source: "Professional XML Meta Data," by Kal Ahmed, et al.)

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XML Schema of CIM

- An XML Schema of the CIM can be generated with XML tools
- The CIM classes and attributes are used to define tags
- Then the CIM can be shown in XML as well as UML
- Example is PowerTransformer

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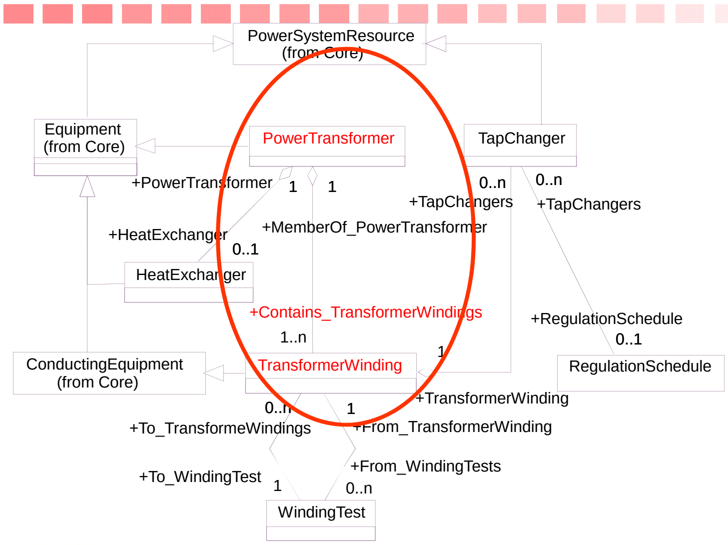
Transformer Model Diagram from 61970-301CIM Base



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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>
```

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Sample 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>
```

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XML Implementation Technologies

- XML Schema
  – Used for generation of message payloads for system interfaces in system integration use cases
- RDF Schema
  – Used for exchange of power system models

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Big Issue

- "Although we can swap our documents with each other through XML, we still haven't a clue what they mean."
  » ("Professional XML Meta Data," by Kal Ahmed, et al.)
- Resource Description Framework (RDF) Is W3C's Means To Resolve This.

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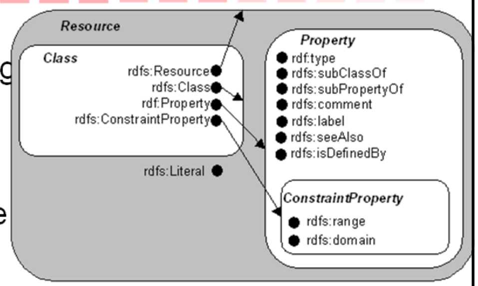
RDF Schema

- RDF Schema mechanism is a set of RDF resources (including properties) and constraints on their relationships
- Defines application-specific RDF vocabularies, for example CIM vocabulary
- RDF Schema URI unambiguously identifies a single version of a schema



[Courtesy Of Leila Schneburger]

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Technical Approach

- RDF (Resource Description Framework)

  - Defines mechanism for describing resources that makes no assumptions about a particular application domain, nor defines the semantics of any application domain. The definition of the mechanism is domain neutral, yet the mechanism is suitable for describing information about any domain:
  - For more information: http://www.w3.org/RDF
  - Status: W3C Recommendation 22 February 1999
    - http://www.w3.org/TR/REC-rdf-syntax/
- RDF Schema

  - Defines a schema specification language. Provides a basic type system for use in RDF models. It defines resources and properties such as Class and subClassOf that are used in specifying application-specific schemas:
  - Status: W3C Proposed Recommendation 03 March 1999
    - http://www.w3.org/TR/PR-rdf-schema/

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Technical Approach (Cont.)

- Namespaces

  - provide a simple method for qualifying element and attribute names used in XML documents by associating them with namespaces identified by URI references:
  - Status: WC3 Recommendation 14-January-1999
    - http://www.w3.org/TR/REC-xml-names/
- URI (Uniform Resource Identifiers)

  - provide a simple and extensible means for identifying a resource:
  - Status: Internet RFC August 1998
    - ftp://ftp.isi.edu/in-notes/rfc2396.txt

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CIM UML=>RDF Schema=>RDBMS

UML.	RDF	Relational Model
Object	Resource	Tuple (i.e. row)
Attribute or association	Property	Attribute (i.e. column) or foreign key
Class	Class	Relation (i.e. table)
	Resource Description	Tuple value
	URI	Key value
	Value	Field value

[Courtesy Of Leila Schneburger]

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Siemens 100 Bus Network Model in RDF

Top of RDF Schema version of Siemens 100 bus model


```xml
<?xml version="1.0" encoding="UTF-8"?>
<rdf:RDF xml:base="siemens" xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:cim="http://iec.ch/TC57/2001/CIM-schema-cim10#"><cim:ACLineSegment rdf:ID="_
6B1DD5C2CB934E86AC53FFD886E2D1B3"><cim:Naming.name>BBD-RSK2</cim:Naming.name><cim:Conductor.bch>2.79
</cim:Conductor.bch><cim:Conductor.x>4.3378</cim:Conductor.x><cim:Conductor.r>0.4761</cim:Conductor.r>
</cim:ACLineSegment><cim:Terminal rdf:ID="_EB6085D9DF364DA78A884D4D0A571371"><cim:Naming.name>T2</cim:Naming.name>
<cim:Terminal.ConnectivityNode rdf:resource="#_CC312D30C85C4236948A4129AEE3B5F7"/>
<cim:Terminal.ConductingEquipment rdf:resource="#_6B1DD5C2CB934E86AC53FFD886E2D1B3"/></cim:Terminal><cim:Terminal
rdf:ID="_7C8354E0DA247DBB3611E2E8BF8A86D"><cim:Naming.name>T1</cim:Naming.name><cim:Terminal.ConnectivityNode
rdf:resource="#_D16FD63501444AECBF8157D1E4764E38"/><cim:Terminal.ConductingEquipment rdf:resource="#_
6B1DD5C2CB934E86AC53FFD886E2D1B3"/></cim:Terminal><cim:ACLineSegment rdf:ID="_E83B07FE54A945539A95FD2DB2CDD4FC">
<cim:Naming.name>BKR-TUR</cim:Naming.name><cim:Conductor.bch>0.39</cim:Conductor.bch><cim:Conductor.x>4.1262
</cim:Conductor.x><cim:Conductor.r>1.0051</cim:Conductor.r></cim:ACLineSegment><cim:Terminal
rdf:ID="_E273D9258F9D42FCA018B274BE6F5FA6"><cim:Naming.name>T2</cim:Naming.name><cim:Terminal.ConnectivityNode
rdf:resource="#_576B6D171B174B8BACB7AFF7289D0434"/><cim:Terminal.ConductingEquipment
rdf:resource="#_E83B07FE54A945539A95FD2DB2CDD4FC"/></cim:Terminal><cim:Terminal
rdf:ID="_B23175B9692441AFBD2C581E86300550"><cim:Naming.name>T1</cim:Naming.name><cim:Terminal.ConnectivityNode
rdf:resource="#_A69ED82F4EB4B65A8840CDD1E064887"/><cim:Terminal.ConductingEquipment
rdf:resource="#_E83B07FE54A945539A95FD2DB2CDD4FC"/></cim:Terminal><cim:Unit rdf:ID="_
5EAAD38A446E429E9905FAC32070D6FC"><cim:Naming.name>Amperes</cim:Naming.name></cim:Unit><cim:ACLineSegment
rdf:ID="_329884C01F6B4DC08492F711088538D6"><cim:Naming.name>CRS-ANY1</cim:Naming.name><cim:Conductor.bch>5.03
</cim:Conductor.bch><cim:Conductor.x>12.90761</cim:Conductor.x><cim:Conductor.r>1.2696</cim:Conductor.r></
```


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CIM Usage

- Many EMS vendors support power system model exchange using CIM/RDF/XML, some with CIM-based databases behind the scenes
- EPRI has sponsored 12 interoperability tests for transmission model exchange and service validation and more recently for planning and distribution
- Utilities have implemented CIM-based integration using EAI technologies
  - Utilities have used the CIM as the basis for developing common messages for integration
- Asset and work management vendors as well as GIS application vendors are supporting CIM/XSD standards
- AMI (Smart Meter) projects use IEC 61968 Part 9 for meter related information exchange
- CIM has been extended into the power market, planning, and dynamic model exchange
- CIM provides a foundation for Service-Oriented Architecture (SOA) and Web service implementations
- Vendors have developed tools to build CIM-based information exchange messaging, ESB and OPC interfaces, and repository applications that can process CIM-aware data
- MultiSpeak is converting to CIM-based UML models and XML
- ENTSO_E is converting power model exchanges and day-ahead forecasts for planning/operational applications to CIM based format
  - Second IOP conducted in July 2010 (first was UCTE IOP in March 2009)
- Many Smart Grid-related activities based on CIM
  - Separate presentations during week

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Concluding Remarks

- Bottom line: CIM standards are different and much more powerful
  - Can be applied in many ways
  - Support many types of functions/applications through combination of reuse and extension
  - Architecture supports future, unknown applications

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