Lecture 16
Common Information Model
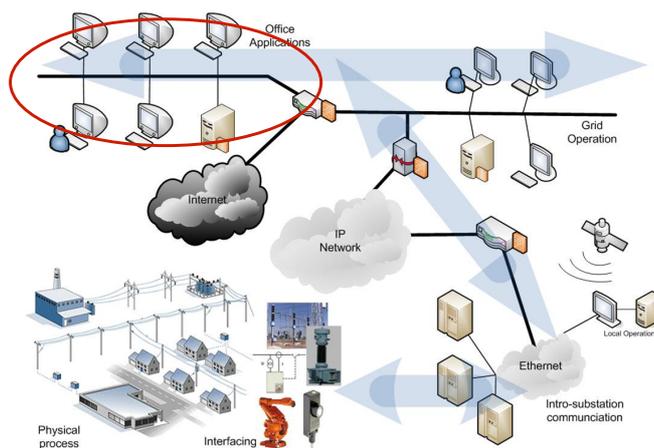
ROYAL INSTITUTE
OF TECHNOLOGY

Course Map

ROYAL INSTITUTE
OF TECHNOLOGY

Office
Applications

Grid
Operation

Internet

IP
Network

Local Operation

Ethernet

Physical
process

Interfacing

Intro-substation
communciation

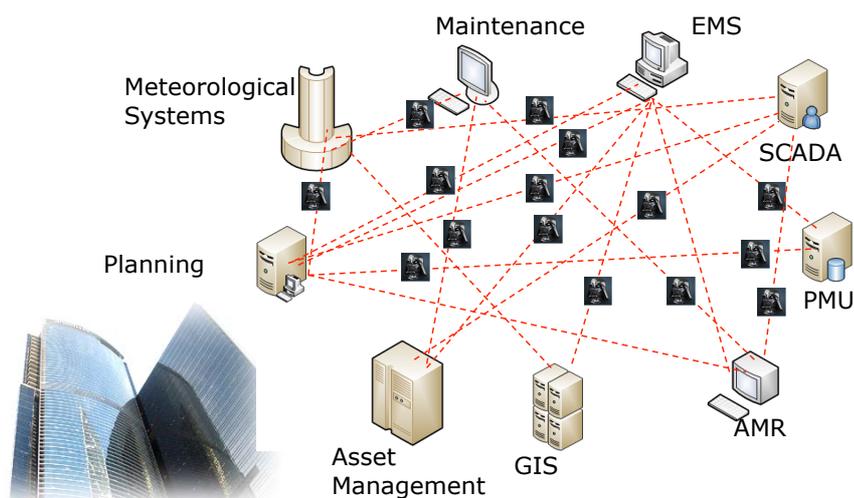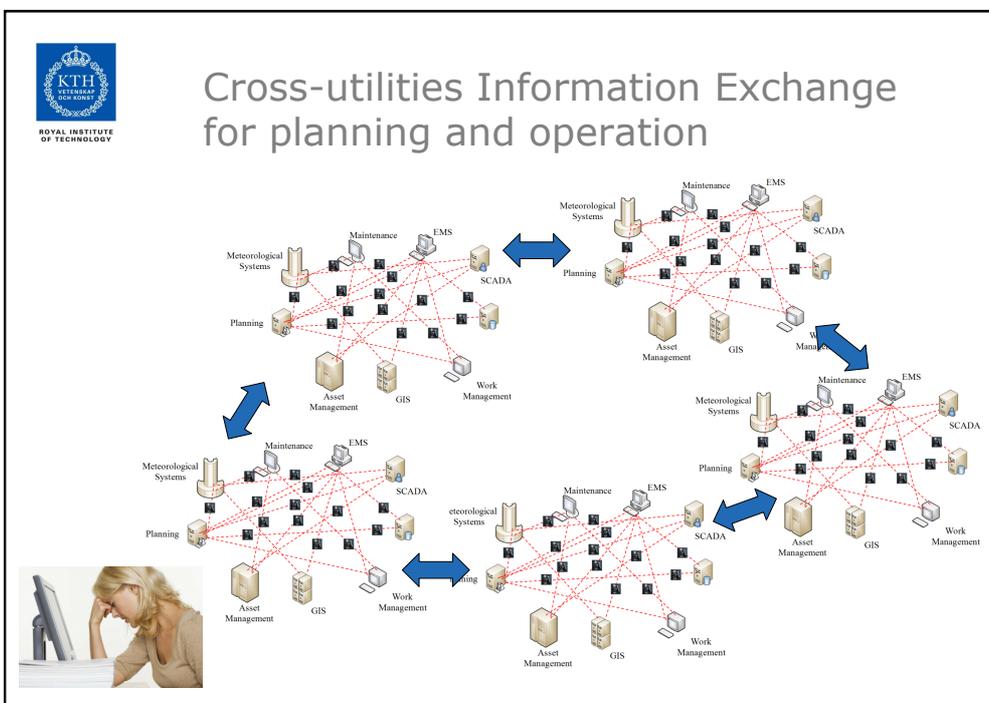# Contents

- Information Modelling in Power Industry
  - Information Exchange Need
  - Information modeling

- Common Information Model-CIM
  - Background
  - CIM based Modeling of Power Systems
  - How CIM information is exchanged

Intra-utility Information Exchange

Deregulated Power Industry

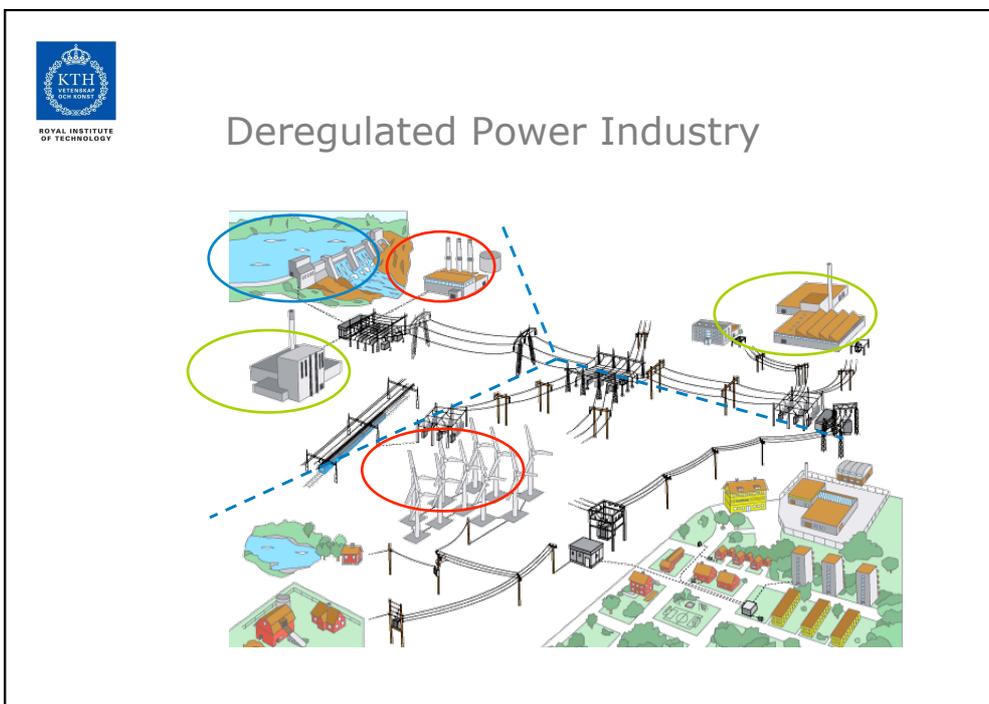Cross-utilities Information Exchange for planning and operation

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Classes, Objects and Attributes

- Object-Oriented modelling
- UML class diagrams
- Object diagram

Classes, Objects and Attributes
Object-oriented programming

- Object
  - Data structure
    - Data fields
    - Methods
  - Often used to represent real-world "thing"

Classes, Objects and Attributes
Object-oriented programming II

- Class
  - Template for an object - blueprint
- Instance
  - Actual object created at run-time
- Method
  - Set of procedural statements for achieving a result
- Message passing
  - Interfacing – an object sends data or invokes a method
- Abstraction
  - Grouping of common behaviours - *inheritance*
- Encapsulation
  - Conceal the functional details of a class from other objects that send messages to it

Classes, Objects and Attributes
UML – Class diagrams I
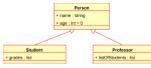
- Class
  - Name
  - Attributes
  - Methods/Functions/Operations

BankAccount

owner : String
balance : Dollars = 0

deposit (amount : Dollars)
withdrawl (amount : Dollars)

- Attributes have data types can be assigned default values

- Methods have parameters and the parameters also have data types
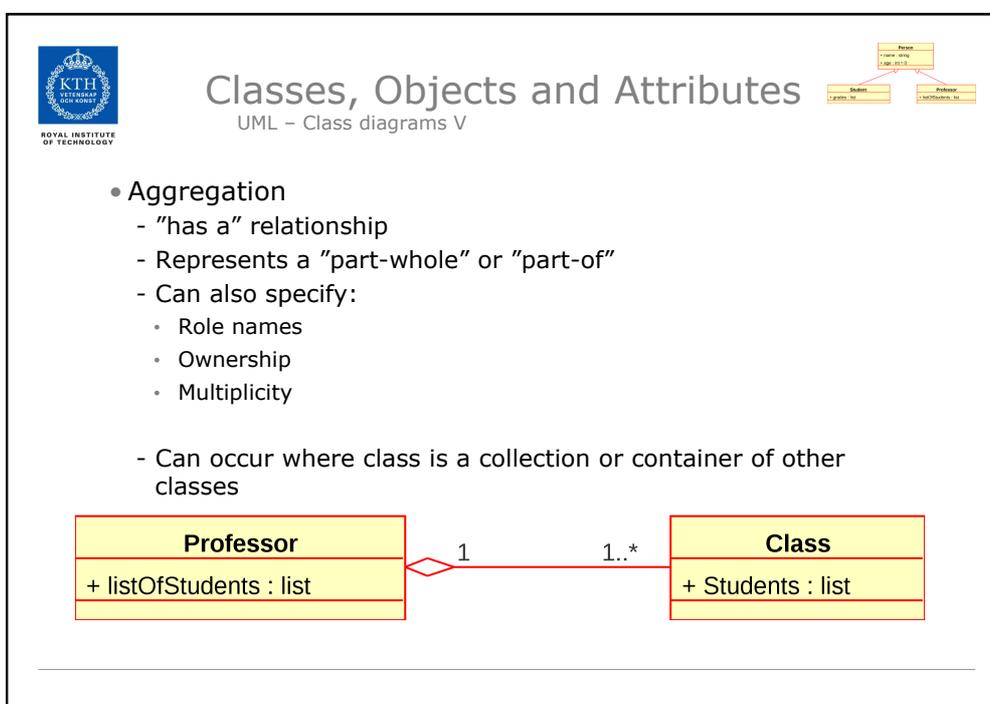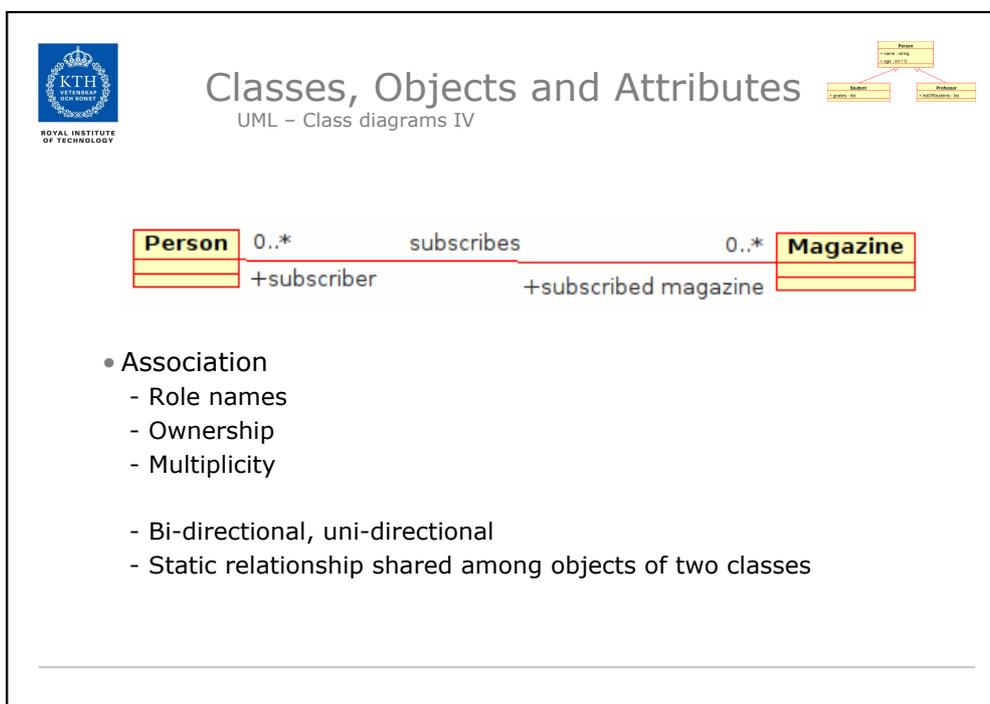
Classes, Objects and Attributes
UML – Class diagrams III

- Class
  - Name
  - Attributes
  - Methods/Functions/Operations

  - Visibility
    - Public
    - Private
    - Protected
    - Package
    - Derived
    - Static

BankAccount

owner : String
balance : Dollars = 0

deposit (amount : Dollars)
withdrawl (amount : Dollars)

Classes, Objects and Attributes
UML – Class diagrams IV

Person	0..*	subscribes	0..*	Magazine
	+subscriber		+subscribed magazine	

- Association
  - Role names
  - Ownership
  - Multiplicity

  - Bi-directional, uni-directional
  - Static relationship shared among objects of two classes

Classes, Objects and Attributes
UML – Class diagrams V

- Aggregation
  - "has a" relationship
  - Represents a "part-whole" or "part-of"
  - Can also specify:
    · Role names
    · Ownership
    · Multiplicity

  - Can occur where class is a collection or container of other classes

Professor		1	1..*	Class	
+ listOfStudents : list				+ Students : list	

Classes, Objects and Attributes
UML – Class diagrams VI

Car ◆ 0..1 ─── 1..1 Carburetor

- Composition
  - "owns a" relationship
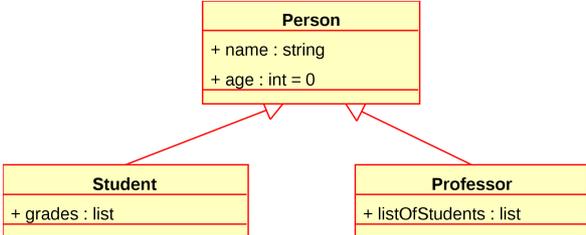 - Strong object life-cycle dependency

Classes, Objects and Attributes
UML – Class diagrams VII

- Generalization
  - "is a" relationship
  - One class is a sub-type of specialized form of the parent class
  - Also known as inheritance
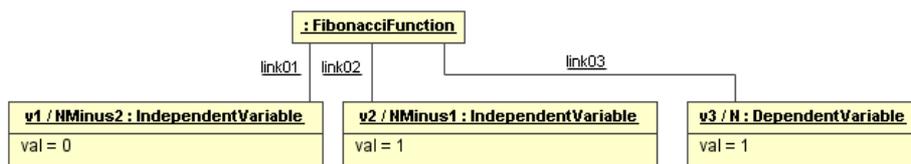 - Sub-type is "child" class and super-type is the "parent" class

Person
+ name : string
+ age : int = 0

Student
+ grades : list

Professor
+ listOfStudents : list

Classes, Objects and Attributes
Object diagram

: FibonacciFunction

link01   link02   link03

v1 / NMinus2 : IndependentVariable
val = 0

v2 / NMinus1 : IndependentVariable
val = 1

v3 / N : DependentVariable
val = 1
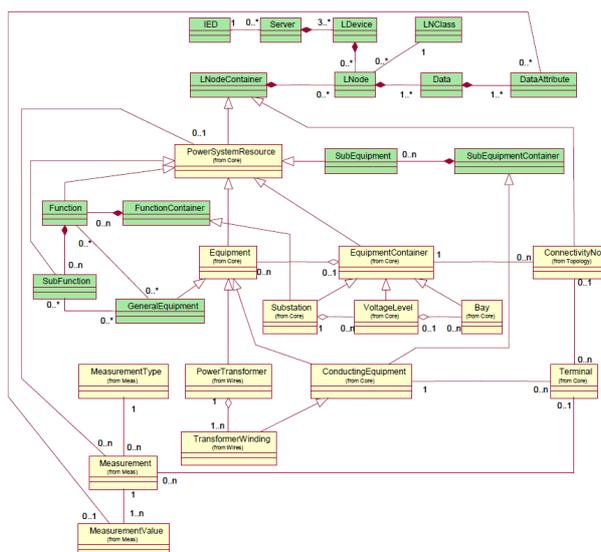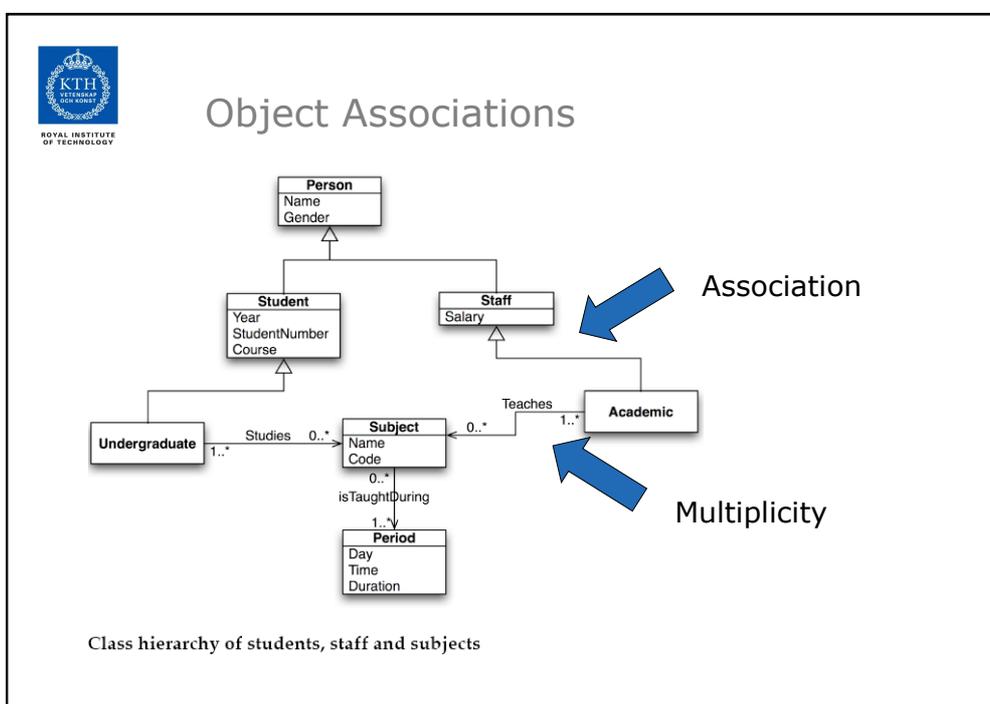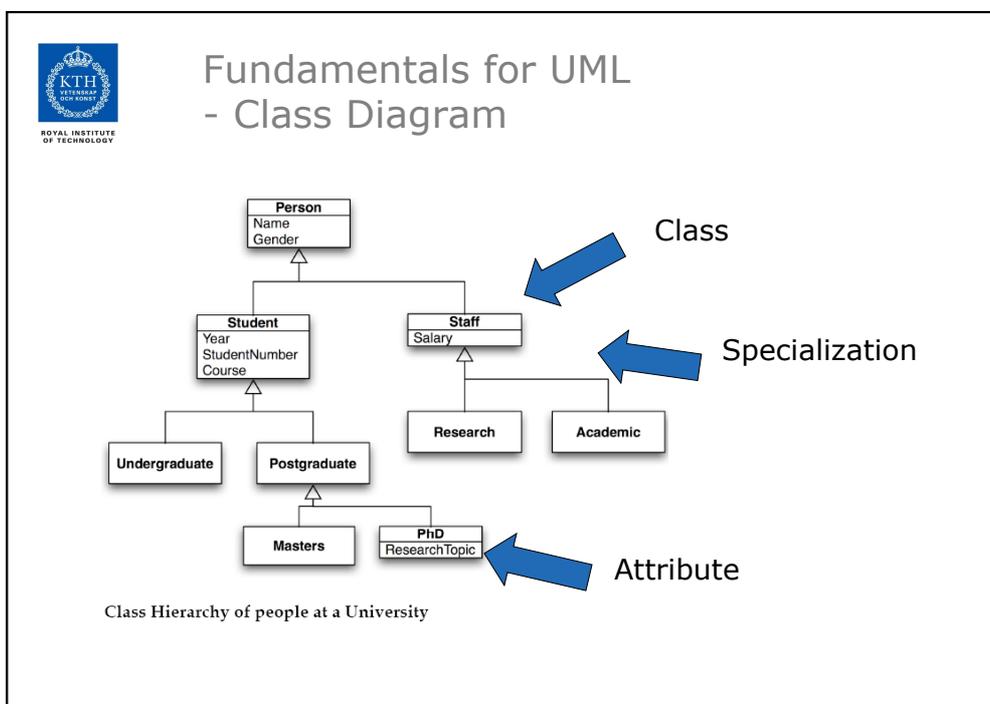
- Instance specification
  - Instance name
  - "Link" represents an *instance* of an association
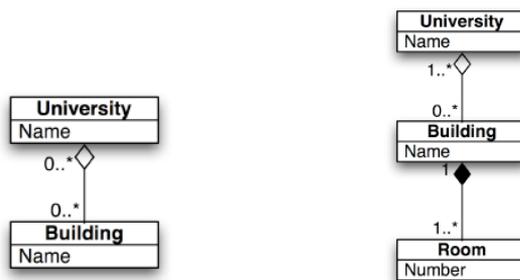 - "Slots" represent attributes and may specify a value

Information modelling of power systems

Fundamentals for UML
- Class Diagram

Class Hierarchy of people at a University

Object Associations

Class hierarchy of students, staff and subjects
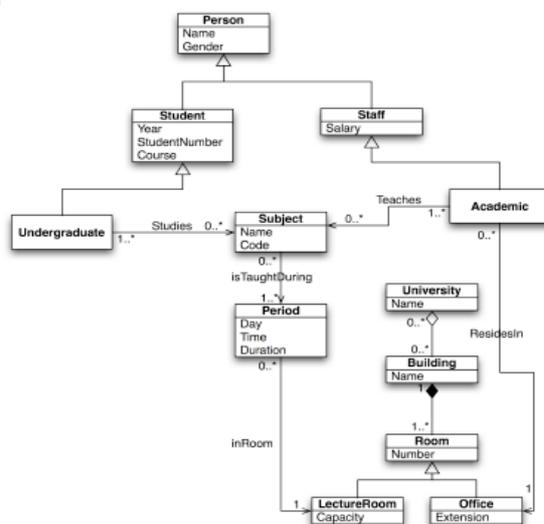
Aggregation and Composition (Association)

Aggregation   Composition

Classes, Associations, Aggregations and Compositions

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Background

- International Electrotechnical Commission is the main international body for electrotechnical standardization
- Technical Committee number 57 works in the area of "Power System Management and related Information Exchange"
- The working groups within TC57 specifies:
  - Communication protocols for wide area communication
  - Information models for substations, Distributed Energy Resources and hydropower stations
  - Security and management profiles for protocols
- And the Common Information Model – the CIM

What is the CIM?

- 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
- A tool to enable integration and information exchange to enable data access in a standard way
- A common language to navigate and access complex data structures in any database
- It is not tied to a particular vendor's view of the world
- It also provides consistent view of the world by operators regardless of which application user interface they are using

Courtesy of T.Saxton TC57 WG13 chairman

We could achieve....

- Information modelling without mapping
  - the value (data typr, e.g., floating point)
  - the scale (offset and factor- if applicable)
  - the enginneering unit (e.g. SI unit)
  - names of the aforementioned items

- Information exchange without mapping
  - service to access data
  - addressing for information
  - the encoding of the information while "on the wire"

IEC 61970-301

- Semantic model that describes the components of a power system and the relationships between each component

- Exchange of data between transmission system operators

- Enabling power flow calculation/state estimation on neighbouring transmission systems
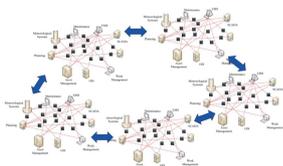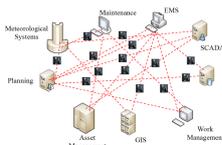

Not yet for dynamic calculations

IEC 61968-11

- Extend the semantic model to cover other aspects of power system software data exchange (such asdistribution level assets, asset management, metering, planning…)

- Focus on intra-utility information exchange and integration of distribution management systems
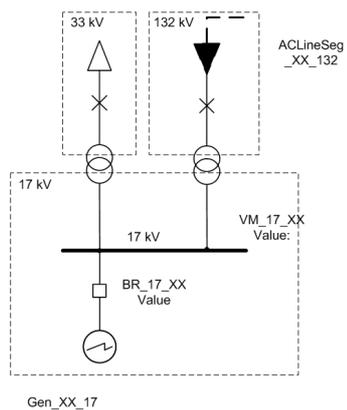
- Specification of message exchange

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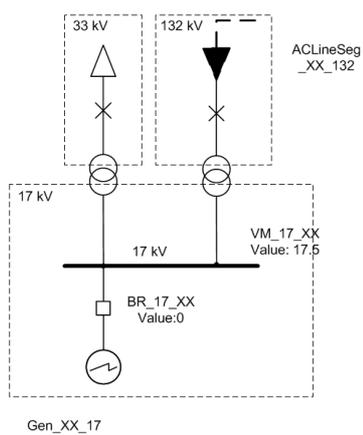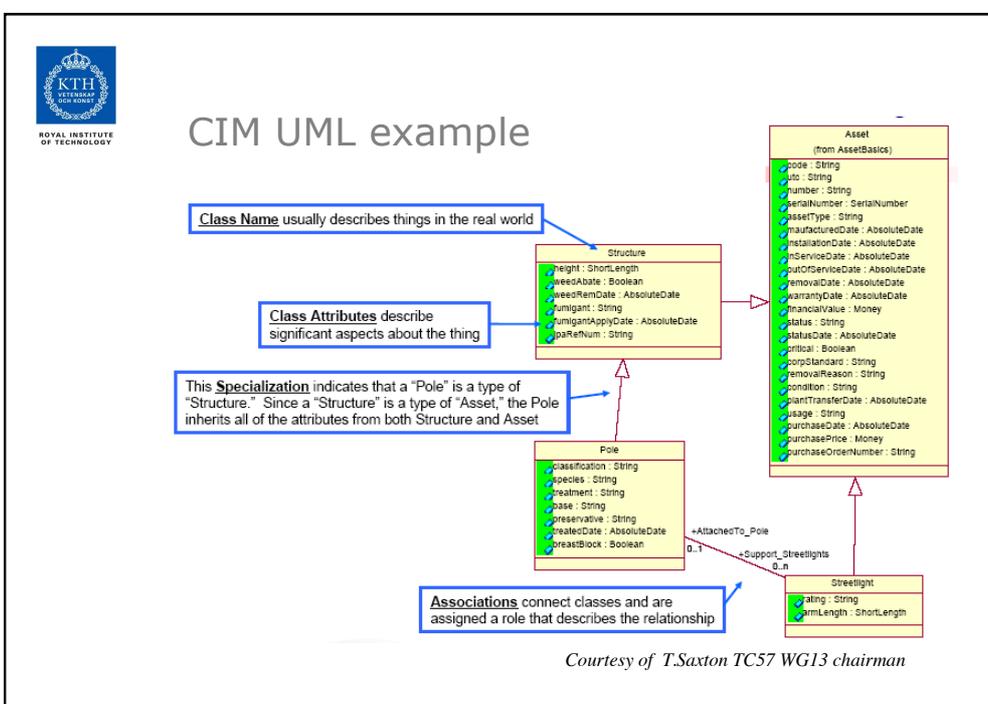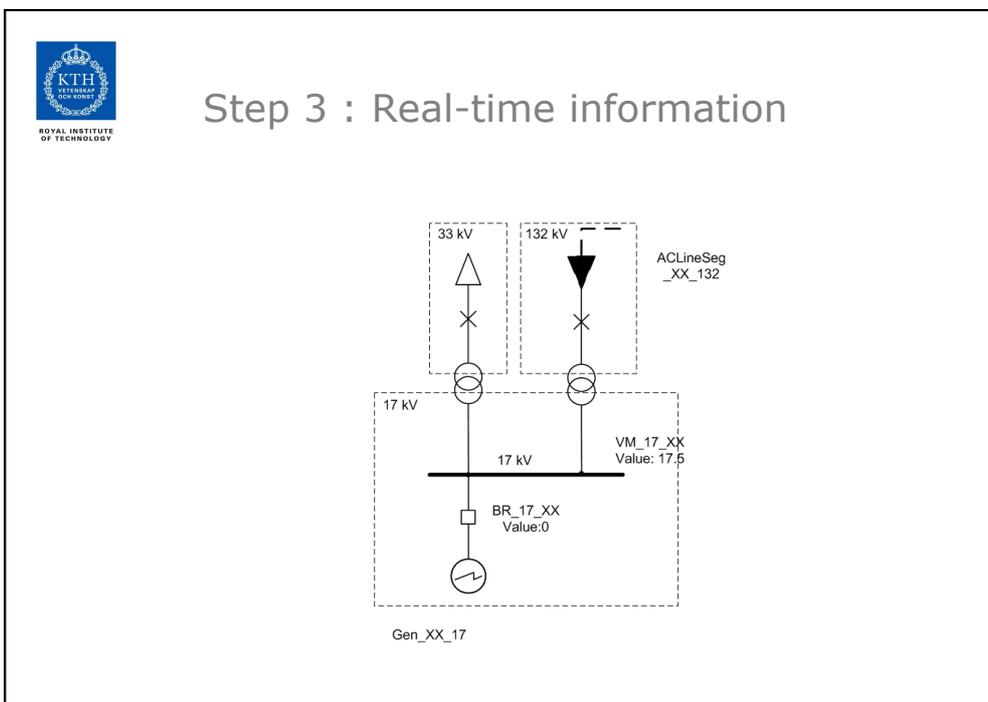 - How CIM information is exchanged

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The Role of the 61970 CIM- Example

Power system model transfer between TSOs

Step 1: (Static Model)
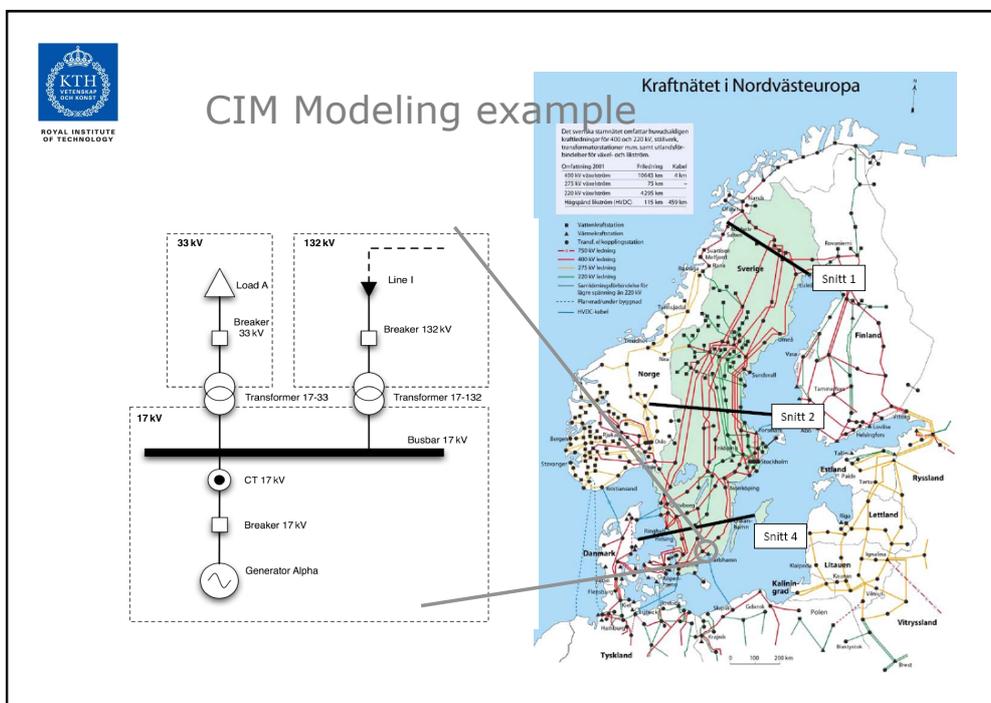

Step 2: Schedules (fixed values)

Step 3 : Real-time information

CIM UML example

Class Name usually describes things in the real world

Class Attributes describe significant aspects about the thing

This Specialization indicates that a "Pole" is a type of "Structure." Since a "Structure" is a type of "Asset," the Pole inherits all of the attributes from both Structure and Asset

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

Courtesy of T.Saxton TC57 WG13 chairman

Example Hierarchy in the Breaker Class

Conducting Equipment and Connectivity

Conducting Equipment and Connectivity class diagram

Packages in CIM

CIM Modeling example

Modeling the real-world

Representing transformers

Note: Use this
Modelling
Convention
For
Assignment

Contents
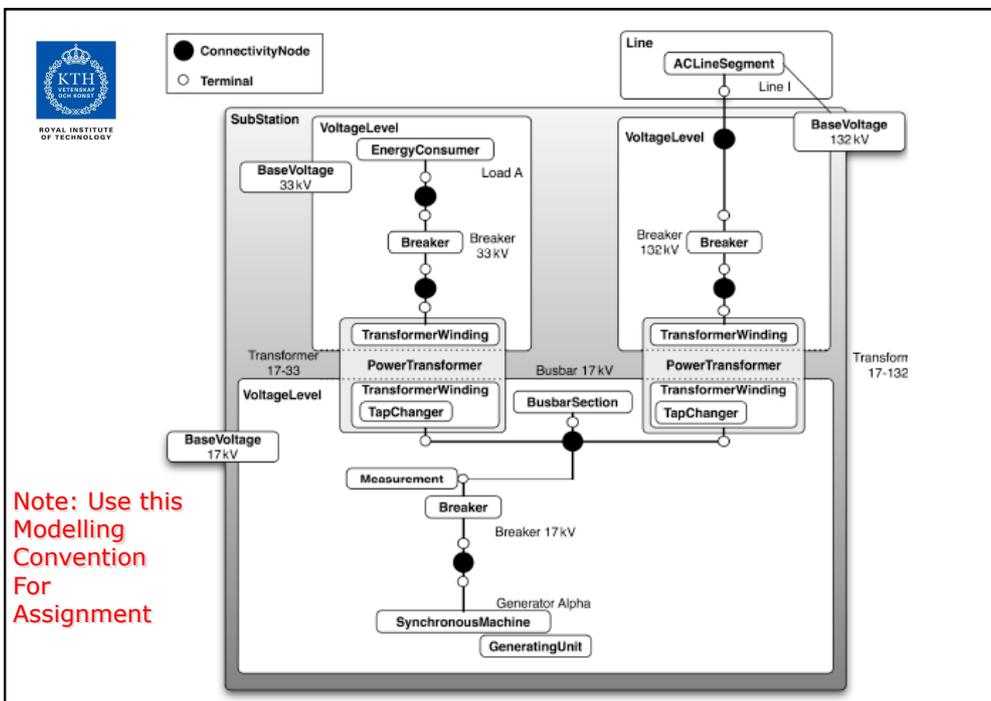
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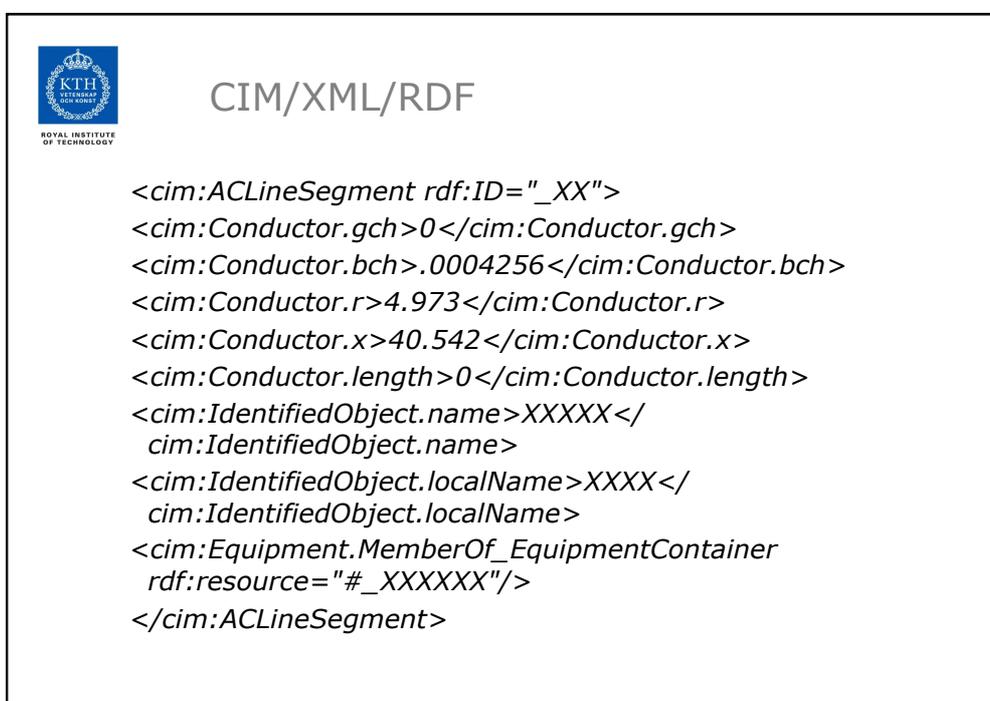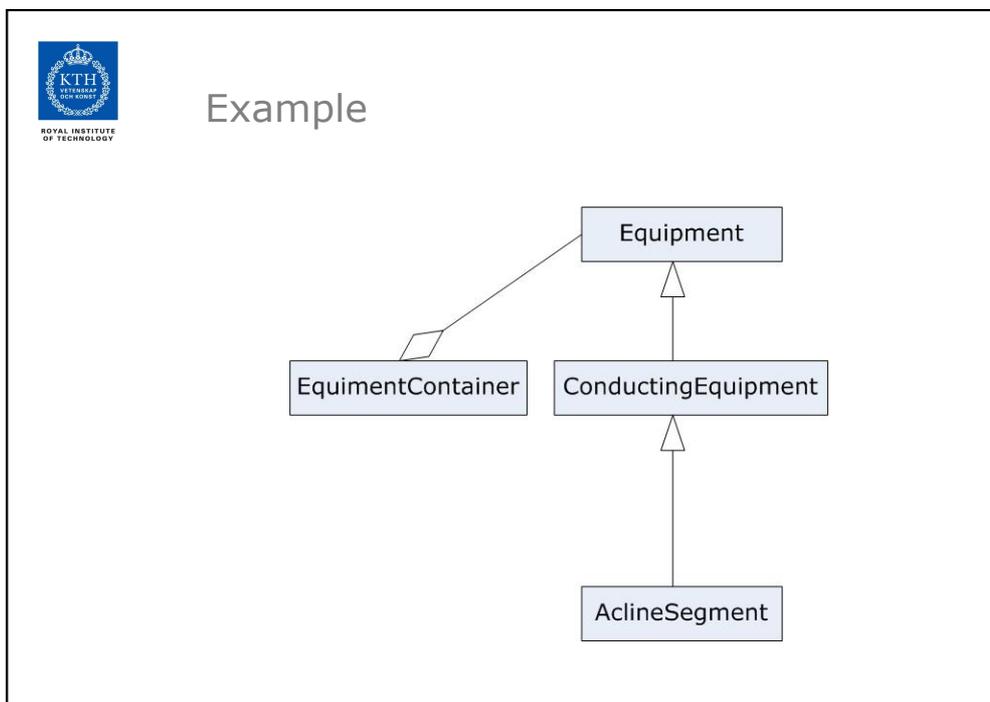Power system model transfer between TSOs

Serialisation of the Data model

- To transfer information between two systems, the data needs to be converted into some type of file.

- XML (just as is used in 61850) is a suitable type of file

- XML file structure recap

   <tag>…contained data…</tag>

- CIM serialisations are exchanged using files that are formated according to the CIM RDF schema.

RDF : Recourse Document Framework

With a XML document there is no way to denote a link between two elements besides the relationship of *Generalization*. **RDF is the language used for expressing the metadata that machines can process simply.** RDF is expressed as a special kind of XML document. It is used to provide a framework for data in an XML format by allowing relationships to be defined between XML nodes. Each element can be assigned a unique ID attribute under the RDF namespace. Adding a resource attribute to an element allows references to be made between elements by having its value refer to another element's ID.

Example

CIM/XML/RDF

```
<cim:ACLineSegment rdf:ID="_XX">
<cim:Conductor.gch>0</cim:Conductor.gch>
<cim:Conductor.bch>.0004256</cim:Conductor.bch>
<cim:Conductor.r>4.973</cim:Conductor.r>
<cim:Conductor.x>40.542</cim:Conductor.x>
<cim:Conductor.length>0</cim:Conductor.length>
<cim:IdentifiedObject.name>XXXXX</
 cim:IdentifiedObject.name>
<cim:IdentifiedObject.localName>XXXX</
 cim:IdentifiedObject.localName>
<cim:Equipment.MemberOf_EquipmentContainer
 rdf:resource="#_XXXXX"/>
</cim:ACLineSegment>
```

Questions