ABB Experiences Implementing CIM
Experiences Implementing CIMXML

- Presentation given by
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  - At EPCC Dublin 2009 June 15

- The presentation contains
  - Brief overview of CIM and CIMXML
  - UCTE use of CIM
  - ABB experiences implementing CIM and CIMXML
  - Conclusion
Brief overview of CIM and CIMXML

- Common Information Model (CIM) for the Utility industry
  - A standard from IEC TC57
  - A data model described in UML
    - IEC61970-301 Core information model
    - IEC61970-501 RDF Schema version of the UML
  - Data exchange profiles as subsets of the core model
    - IEC61970-452 Network model exchange profile
    - IEC61970-456 Network solution profile (coming)
- CIMXML the data exchange format
  - IEC61970-552-4 XML encoding
CIM History

- Originated as an EPRI project 1994
- EPRI report TR-106324 June 1996
- IEC TC57/WG13 formed September 1996
- UML used to describe the data model in 1998
- First interoperability test December 2000
- DMS extensions added in 2003
- CIM Market extensions (CME) created 2004
- ETSO scheduling system added late 2004
- CIM for planning added in 2007
- CIM usage in UCTE DACF evaluation started 2007
- CIM for dynamics stated 2008
ABB Support Of CIM

- ABB actively participate in standards work
- ABB Network Manager EMS/MMS products
- ABB participated in interoperability tests since the start
  - First test December 2000
  - ABB40bus test network used in tests
- Follow CIM development and supports latest versions
  - CIM13 latest version
  - CIM14 coming fall 2009
CIM14 Latest CIM Developments

- Network data model extended for UCTE needs
- New topology solution exchange file (new)
- New load flow solution exchange file (new)
- Interoperability test coming up October 2009
UCTE Day Ahead Congestion Forecast (DACF)

- Schedules from MMS to TSO
- Model & LF solutions from TSO to Ctrl Block Resp TSO
- UCTE-DEF for CIM14

UCTE-DEF:
- 4 times/day
- CIM14
- 24 times/day
UCTE Use Of CIM

- Passed
  - UCTE evaluates CIM November 2007
  - IEC-UCTE TF formed at CIMug in Västerås June 2008
  - UCTE CIM Profile draft ready December 2008
  - Training on UCTE CIM January 2009
  - UCTE-DEF CIM converter tested March 2009
  - Proof of concept in Interoperability test March 2009

- Future
  - IEC TC57/WG13 Incorporates UCTE profile June 2009
  - Start use CIM in DACF September 2009
  - End of UCTE-DEF CIM converter usage December 2010
Implementing CIM

- Preconditions and assumptions
  - The CIM is an interface model, not a database schema
  - Legacy software implementing a network model exists
  - Legacy software use CIMXML for data exchange
  - CIMXML import/export adapters is to be developed

- CIMXML is the data exchange format described in IEC61970-552-4
The CIM Is An Interface Model

- Adapting application code directly to a CIM “schema”
  - May make conversion of existing software expensive.
  - Makes the implementation vulnerable to CIM model changes.
  - Makes maintenance expensive as the CIM evolve.
CIMXML Data Exchange Architecture

CIM -> Definition of mapping -> Legacy Software Data model

Definition of mapping:
- Export mapping
- Import mapping

CIMXML file -> CIMXML Export

CIMXML Import -> Legacy software
Describing Data Model Semantics

- CIM
  - UML
- Legacy software
  - UML
  - Tabular, e.g. spread sheet
  - Data dictionary
  - Text documents
  - Source code
CIMXML Model Exchange Example

```xml
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:cim="http://iec.ch/TC57/2008/CIM-schema-cim13#">
  <cim:IEC61970CIMVersion rdf:ID="_301">
    <cim:IEC61970CIMVersion.version>CIM13v12</cim:IEC61970CIMVersion.version>
    <cim:IEC61970CIMVersion.date>2008-09-26</cim:IEC61970CIMVersion.date>
  </cim:IEC61970CIMVersion>
  <cim:ACLineSegment rdf:ID="_03F929948E2B410AB3112811F0DE521D">
    <cim:Conductor.gch>0</cim:Conductor.gch>
    <cim:Conductor.bch>.0003938</cim:Conductor.bch>
    <cim:Conductor.r>4.621</cim:Conductor.r>
    <cim:Conductor.x>37.6</cim:Conductor.x>
    <cim:Conductor.length>0</cim:Conductor.length>
    <cim:IdentifiedObject.name>MARC400LANSTIE</cim:IdentifiedObject.name>
    <cim:IdentifiedObject.localName>SEG1</cim:IdentifiedObject.localName>
    <cim:ConductingEquipment.BaseVoltage
      rdf:resource="#_7BF23942C2EF4E18A90862795F455172"/>
    <cim:Equipment.MemberOf_EquipmentContainer
      rdf:resource="#_51D9E7DE58344856A860EEA051027F48"/>
  </cim:ACLineSegment>
  ...
</rdf:RDF>
```
CIM UML To CIMXML Mapping

- Mappings described in IEC 61970-552-4

```xml
<cim:TopologicalTerminal rdf:ID="TT1">
    <cim:TopologicalTerminal.TopologicalNode rdf:resource="#TN1"/>
    <cim:TopologicalTerminal.connected>true</cim:TopologicalTerminal.connected>
    <cim:TopologicalTerminal.Terminal rdf:resource="#T1"/>
</cim:TopologicalTerminal>
```
Mappings

- One to one
  - Identical, names the same
  - Structurally the same, names differs
- One to many
  - Structurally different
  - Common data represented by a type
  - Instances represented by attributes
One To One Substation Example

- CIM and implementation
  - Structurally identical
  - Names need translation

<table>
<thead>
<tr>
<th>cim:Substation</th>
<th>1</th>
<th>.impl:Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>- name</td>
<td></td>
<td>- userId</td>
</tr>
<tr>
<td>- mRID</td>
<td></td>
<td>- guid</td>
</tr>
<tr>
<td>- ...</td>
<td></td>
<td>- ...</td>
</tr>
</tbody>
</table>
One To One Switch Example

- CIM Switch is sub typed
- Implementation switch is not sub typed
One To Many Two Winding Transformer Example

- CIM TransformerWinding
  - Only one winding used for ratings
  - Both windings needed for connectivity
- Implementation Tran2wType
  - CIM instances may have ratings for multiple instances
One To Many Three Winding Transformer Example

- CIM TransformerWinding
  - All three windings have ratings and connectivity
- Implementation Tran3wType
  - CIM instances ratings mapped as attributes
  - CIM instances may have ratings for multiple instances

```
cim:PowerTransformer    1 1
  - ...                   
    1                   1
    3

impl:Tran3w
  - ...               * 1

impl:Tran3wType
  - rp
  - rs
  - rt
  - g
  - ratedSp
  - ...  
```
Legacy Software Implementation And Interfaces

- RDBMS
- File format
- Direct application
  - Java
  - C/C++
  - C#
  - FORTRAN
Implementation Technologies

- Apache foundation (http://www.apache.org)
  - Xerces XML parser supporting DOM, SAX, JAXP …
  - Xalan XSLT processor
  - Many more …
- Microsoft (http://msdn.microsoft.com/xml)
  - MSXML parser supporting DOM, SAX, …
  - .NET for integration with MS .NET languages
  - Visual studio XML editors
- Oracle (http://www.oracle.com)
  - RDBMS built in XML support and XML database
- XMLSpy XML editor (http://www.altova.com)
- Many more …
Performance Considerations

- Simple file scan with XSLT is fast
- Resolving associations in XSLT is CPU intensive
  - $element[attribute/@rdf:resource = rdf:ID]
- Resolve associations in application or database
  - Use hash tables in application
  - Use indices in database
Conclusions

- CIM is close to data models in ABB Network Manager
  - The mapping is simple
- CIM changes and will continue do so
  - An isolating mapping layer is valuable and save costs
- Performance and scalability is always an issue
  - CIMXML file size need consideration
  - Large networks, e.g. continental Europe and UCTE
- UCTE IOP March 2009 proved working CIMXML implementations can be developed in short time
- CIM interoperability is steadily increasing