Approaches to integrating MultiSpeak® and CIM

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NIST Framework and Roadmap

- Revised version Jan 19, 2010
- 75 key standards identified
  - IEC 61968, IEC 61970, MultiSpeak® ...
- 16 Priority Action Plans to fill gaps (one completed)
  - PAP8: Develop strategies to integrate and expand IEC 61970-301, IEC 61968, MultiSpeak and IEC 61850 for Smart Grid applications
  - PAP14: Develop strategies to expand and integrate MultiSpeak, IEC 61850, IEC 61968, IEC 61970, IEEE PC37.237 (Time Tagging), IEEE PC37.239 (COMFEDE) and the future IEEE Common Settings file format for Smart Grid Applications
  - PAP Outputs related to CIM and MultiSpeak integration:
    - MultiSpeak UML model
    - MultiSpeak–CIM model mapping (in process)
    - CIMTool enhancement to enable profiling MultiSpeak model (proposal)
MultiSpeak®

- Initiative to develop and document software data exchange interfaces and service-enabled application integration
- Developed by National Rural Cooperatives Association (NRECA) in collaboration with key industry vendors
- Currently covers applications of interest to distribution utilities and to the distribution portion of vertically integrated utilities, moving towards support for transmission
- Many of the back-office functions supported overlap with CIM
Context for MultiSpeak® specification

• Rural Distribution Co-operatives:
  – have few or no IT staff, and thus depend on vendors to integrate
  – have no rich messaging infrastructure

• This drove a need to use vernacular integration technologies and approaches and a focus on functions rather than applications
CIM scope and layering

IEC 61968-1 Interface Reference Model and applications
<table>
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<tr>
<th>Business Functions</th>
<th>Business Sub-functions</th>
<th>Abstract Components</th>
<th>MultiSpeak Functions</th>
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<td>Meter and Control (MR)</td>
<td>Metering Systems (MS)</td>
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<td>End point controls</td>
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<td>Disconnect/reconnect</td>
<td>CD</td>
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<td>Demand reset</td>
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<td>Point of sale</td>
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<td>Outage detection and restoration verification</td>
<td>MR</td>
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<td>Power reliability and quality events</td>
<td>MR</td>
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<td>Metering system events</td>
<td>MR</td>
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<tr>
<td>Meter Maintenance and Asset</td>
<td>End point install, configure,</td>
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<td>MR/CD</td>
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<tr>
<td>Management</td>
<td>remove, repair, disconnect,</td>
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<td></td>
<td>reconnect</td>
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<td>MR</td>
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<td></td>
<td>End point asset history</td>
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<td>End point reconfiguration</td>
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<td>MR</td>
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<td>Special read</td>
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<td>MR</td>
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<td>Meter service request</td>
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<td>MR</td>
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<td>Tariffs</td>
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<td>MR</td>
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<td>Meter Data Management (MDM)</td>
<td>Meter data repository</td>
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<td>Usage history</td>
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<td>Validation, estimation, &amp;</td>
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<td>Load control</td>
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<td>Demand response</td>
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<td>DR</td>
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</table>
CIM layering and GWAC Stack

Interoperability Categories

Organizational
- 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

Informational
- Political and Economic Objectives as Embodied in Policy and Regulation
- Strategic and Tactical Objectives Shared between Businesses
- Alignment between Operational Business Processes and Procedures
- Awareness of the Business Knowledge Related to a Specific Interaction
- Understanding of the Concepts Contained in the Message Data Structures
- Understanding of Data Structure in Messages Exchanged between Systems
- Mechanism to Exchange Messages between Multiple Systems across a Variety of Networks
- Mechanism to Establish Physical and Logical Connections between Systems

Technological
- Mechanism to Establish Physical and Logical Connections between Systems

Message Assembly
- Resource identification
- Time-Synchronization
- Security & Privacy
- Transaction & State Management
- System Presentation
- Performance & Reliability
- Scalability

Message Syntax
- CIM/XML Schema
- Message XML Schema
- XML Schema
- Relational Database Schema

Contextual
- CIM Ext.
- Profile
- Common Profile

Information
- CIM
- Bridge
- Foreign

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# CIM Layering and MDA

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<th>Model Defined Architecture</th>
<th>Platform Independent Model</th>
<th>Mapping</th>
<th>Platform Specific Model</th>
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<tr>
<td>Information</td>
<td>Contextual</td>
<td>Message Syntax</td>
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<tr>
<td>CIM Ext.</td>
<td>CPSM Profile</td>
<td>CIM/XML Schema</td>
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<tr>
<td>CIM</td>
<td>Profile</td>
<td>Message XML Schema</td>
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<tr>
<td>Bridge</td>
<td>Common Profile</td>
<td>CIM/XML Schema</td>
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<tr>
<td>Foreign</td>
<td>W614 Rules</td>
<td>XML Schema</td>
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<td></td>
<td>Project Rules</td>
<td>Relational Database Schema</td>
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</tbody>
</table>

CIM Layering

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MultiSpeak – CIM integration challenge

- Overlap in content and domain functionality supported
- Context for use of IEC 61968 is sufficiently different that MultiSpeak users require different
  - schema
  - rules for schema formats
  - profiles
  - (possibly) CDM/PIM
- How to integrate this with CIM

This is what we explored
Goals of the Integration

• Map MultiSpeak® to CIM while serving needs of MS users

• Mapping should be:
  – Flexible enough to allow use of current data exchange format styles
  – Suitable for web publication
  – Unambiguous
  – Machine readable
  – Have a standard form, preferably with multivendor or open source tool support
  – Support automated translation of data between standard formats
Two architectures

- We explored a number of alternative approaches and all used one of two basic architectures:

  1. A single *unified* Canonical Data Model was used with expressive mappings to exchange models allowing coexistence diverse naming and design rules

  2. Two Canonical Data Models were employed with mappings between to *harmonize* their areas of overlap

*Unified* and *Harmonized* models are terms used by the SGIP Architecture Committee (SGAC) to describe approaches for relating semantic models. See Semantic Summit slides: [http://collaborate.nist.gov/twiki-sggrid/pub/SmartGrid/SGIPMinutesSGAC/SemanticSummit20100915.pptx](http://collaborate.nist.gov/twiki-sggrid/pub/SmartGrid/SGIPMinutesSGAC/SemanticSummit20100915.pptx)
Approach 1: Proprietary tool

- Architecture: Unified Model
- Attributes:
  - Supports flexible variation in exchange format styles
  - Has excellent tool support (although from a single vendor)
  - Has no publishable machine readable form for the mappings (though MDMI was suggested as a future possibility)
  - Supports automatic translation
  - Tool deployed and in use within other standards communities supporting data exchange specification suites

MDMI – Model Driven Message Interoperability
Approach 2: off-the-shelf tool integration

- **Architecture: Harmonized Models**
- **Attributes:**
  - Assumes certain patterns of mapping between CDM and exchange form
  - Combination of off-the-shelf tools and single vendor software, but established techniques were employed (such as Rete rule execution) that could be adapted to other tools and environments
  - Model to model mapping described using UML diagrams, making it understandable but not in a standard mapping language
  - Mappings are declarative
  - Approach has been used for other inter-specification mappings but would need some adaptation to this use case
  - Conversion performance is research grade
  - Uses UML models (and mappings) from MagicDraw rather than EnterpriseArchitect
Approach 3: semantic mediation

- **Architecture:** Unified Model
- **Attributes:**
  - Allows flexible variation in exchange format styles
  - Uses research grade tools that need updating
  - Mapping is described with a mapping language defined by a researcher using OWL (i.e. OWL was used to create the metamodel describing the language)
  - The mappings are web publishable in a standard format (OWL), though not in a standard mapping language
  - Mappings are declarative
  - The unified model must be defined in OWL rather than directly in UML (though the OWL could be generated from UML with CIMTool)
Approach 4: EMF and QVTo

• Architecture: Harmonized Models
• Attributes:
  – Allows flexible variation in exchange format styles
  – Uses Eclipse Modeling Framework open source community tools
  – Model to model mapping is described using an open standard mapping language: MOF Query/View/Transformation operational (QVTo)¹ form
  – The QVTo tool for transformations was contributed to EMF by Borland and is attracting considerable interest
  – Mappings are web publishable in a standard format
  – The mappings are imperative
  – eCore renderings of the UML models are referenced by the mappings
  – Transformations are automated with good performance

¹ Meta Object Facility (MOF) 2.0 Query/View/Transformation, V1.0 http://www.omg.org/spec/QVT/1.0/
The winner

Option 4
- Used most mature languages and tools
- Met key criteria for publishable mappings
- Included a CDM for MultiSpeak
Future plans

• NIST plans to research option 3 for Semantic Mediation and Testing
• Proposal in place to define mappings for portions of CIM and MultiSpeak using EMF and QVT
• Proposal to enhance CIMTool to support MS naming and design rules, enabling a simpler UML model for MS
Future architecture

MS UML model

CIMTool Profile

CIMTool generates

XML Schema For MultiSpeak

conformsTo

MS instance data

Eclipse module transformations

conformsTo

CIM instance data

CIM UML model

CIMTool Profile

CIMTool generates

XML Schema or cim/xml for CIM

instanceOf

describes

QVTo Mapping

instanceOf
Supplemental Slides
Eclipse EMF screenshot
`modeltype` MS “strict” uses ‘http://www.multispeak.org/Version_3.0’;

`transformation` cdpsmToMultispeakv3 (in cim : CIM, out ms : MS);

`main` () {
    `var` message : MultiSpeak := object MultiSpeak{}:
    ...
    `log` ("Substations: “+cim.objects() [CIM::IEC61970::Core::Substation]->size().toString());
    cimobjects()[CIM::IEC61970::Core::Substation].map substation();
    ...
} ...

`mapping` CIM::IEC61970::Core::Substation substation() : MS::Substation
    inherits CIM::IEC61970::Core::PowerSystemResource::psr {
        mapLocation := `self`.GeoLocation.map pointLocation();
    }
    ...