Standardizing Common Information Model Implementations – A Test Based Approach

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System Engineering-based Approach

Requirements derived from use cases map to test procedure steps

- Use Cases
  - Southern California Edison (SCE) Use Cases

- Requirements
  - SCE and AMI Enterprise (AMI-ENT) Requirements

- Design and Implement
  - All Vendors

- Test Program
  - Reusable Methodology
  - Allows Additional Tests to be added at any Time
EPRI CIM Part-9 Interoperability Test Cases

5 Major Test Case Areas
- Scheduled Meter Read
- On Demand Meter Read
- Local Area Outage Detected by Meters
- Tampering Detection
- Remote Disconnect/Reconnect

- **Scheduled Meter Reading**
  - Requirement: The interoperable utility system shall be able to command scheduled meter reads.

- **On Demand Meter Reading**
  - Requirement: The interoperable utility system shall be able to command an on-demand meter read.

- **Local Area Outage**
  - Requirement: The interoperable utility system shall be able to detect any outages using "last-gasp" messages from multiple meters.

- **Tampering Detection**
  - Requirement: The interoperable utility system shall be able to notify when a meter has detected a temper attempt.

- **Remote Disconnect-Connect**
  - Requirement: The interoperable utility system shall be able to perform remote reconnections.
  - Requirement: The interoperable utility system shall be able to perform remote disconnections.
Abstract Test Case – Test Description

Test Description:
CIM standard Part-9 meter messages to/from the Meter Data Management System (MDMS) and from/to the Customer Information System (CIS) are verified to be in conformance with the IEC 61968 part 9.

Unit or Systems Under Test (SUTs/UUTs) are the MDMS and CIS or equivalent systems. A scheduled meter disconnect is initiated with the MeterServiceRequest message and the meter reading data is sent in the MeterReadings message. A scheduled meter reconnect is then initiated with the MeterServiceRequest message and the meter reading data is again sent in the MeterReadings message.

As shown in diagram MR 2.09-5, the main test steps are as follows:
1) The MeterServiceRequest messages is sent from the CIS to the MDMS.
2) The EndDeviceControl message is sent from the MDMS to the AMI Head End or similar system.
3) The meter performs a remote disconnect.
4) The MeterReadings message is sent from the MDMS to request meter usage data for the meter.
5) The CreatedMeterReading is sent from the meter/simulator to the MDMS and onto the CIS. The required IEC 61968 part 9 XSD is used to send the CreatedMeterReading message.
6) System error conditions e.g. missing and incomplete data reads are simulated and correct error processing verified.
Test Case Sequence Diagram

**Part 3 Network Operations**
- NO-FLT Fault Detection (OMS)

**Part 9 Meter Operations**
- MR-MOP (MDMS)

**Part 9 Meter Reading**
- MR-RMR (MS)

- CREATED(EndDeviceEvents)
  - validate and/or filter events
  - detect meter events

Creating a sequence diagram illustrates the interaction and flow of events among different network operations and meter operations.
Nominal and Error requirements

Use Case B2 1.050106 AMI-ENT version REQ0224 - Customer representative shall be able to schedule Date and Time for electric service turn On/Off and electric service limiting using AMI back office system(s). See http://www.smartgridipedia.org/images/a/a3/ARCHB2USECASEv12050106.pdf

Use Case B2 ver. 1.050106 AMI-ENT version REQ0231 - The AMI Head End shall periodically send electric service turn off messages to the Meter until the Meter acknowledges that the turn off has been completed successfully

Use Case B2 ver. 1.050106 AMI-ENT version REQ0027 REQ-B2001-Send scheduled turn off notification
Use Case B2 ver. 1.050106 AMI-ENT REQ-B2002-Send scheduled turn off command
Use Case B2 ver. 1.050106 AMI-ENT REQ-B2003-Send scheduled turn off command confirmation
Use Case B2 ver. 1.050106 AMI-ENT REQ-B2004-Send meter read (final)
Use Case B2 ver. 1.050106 AMI-ENT REQ-B2007-Send scheduled turn on command
Use Case B2 ver. 1.050106 AMI-ENT REQ-B2008-Send scheduled turn on command confirmation
Use Case B2 ver. 1.050106 AMI-ENT REQ-B2009-Send meter read (initial)

Off nominal and error requirements

Use Case B1 REQ0201 v1.2 - The Meter Data Unification System shall have the ability to automatically identify and immediately log missing or incomplete data from the previous day.

Use Case B1 REQ0202 v1.2 - The Meter Data Unification System shall have the ability to identify and log Meters that have had missing or incomplete data in the past.

Use Case B1 REQ0203 v1.2 - The Meter Data Unification System shall identify and log Meters where missing or incomplete meter data for the previous day was successfully recovered through the automated on-demand read request.
Test Procedure X-291 Diagram

Systems Under Test

Validate MeterReadings

AMI Network

MR-MRM (MS) Meter System

MR-MDM / MDMS (Optional)

NO-FLT OMS

Item(s) Tested

Item used in test
Semantic Test Harness
Goals

- Lower cost of adopting CIM
- Provide framework for future certification
- Provide extensible framework for additional standards
Lower Cost of Adoption

• Vendor “self service” application
  – Validate outgoing messages
  – Request incoming well formed messages
• Ready to use messages and working examples
• Immediate and exact feedback on success/failure
• Amazon cloud for cost effective hosting
Future Certification

- Extend database logging
- Develop orchestration of related services
Extensible Framework

• Any XML based payload message
  – MultiSpeak
  – OpenADR, openADE
  – SEP 2.0

• Very little coding required – auto generation based on wsdl/xsd/config files

• Simple to support multiple message versions
• Amazon cloud hosting
  – Uses smallest possible instance, very cost effective

• One instance per vendor
  – multiple vendor roles can be configured

• Very simple administration
  – scripted deployment of harness
Under the hood

- Tomcat/Spring/Java
  - Application server
- MySQL
  - database
- Ruby/Rails for UI
  - UI viewer
- SoapUI
  - for working examples
Version 1 support

• Five 61968-9 packages
  – Meter Connect
  – Meter On Demand
  – Meter Scheduled
  – Meter Outage
  – Meter Tamper

• One 61968-6 package
  – Work Request
<table>
<thead>
<tr>
<th>Available Web Services</th>
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</thead>
<tbody>
<tr>
<td><strong>RequestEndDeviceControls_Port</strong></td>
</tr>
<tr>
<td>• CloseEndDeviceControls</td>
</tr>
<tr>
<td>• CancelEndDeviceControls</td>
</tr>
<tr>
<td>• CreateEndDeviceControls</td>
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<td>• CloseMeterReadings</td>
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<td>• CloseMeterServiceRequests</td>
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## Test Status

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<th>CIS</th>
<th>MDMS</th>
<th>AMI</th>
<th>OMS</th>
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<tbody>
<tr>
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<td>Meter Connect</td>
<td>0%</td>
<td>Outage Management</td>
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<tr>
<td>OnDemand Read</td>
<td>0%</td>
<td>OnDemand Read</td>
<td>0%</td>
<td>OnDemand Read</td>
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<tr>
<td>Meter Temper</td>
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<td>Meter Temper</td>
<td>0%</td>
<td>Scheduled Read</td>
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<tr>
<td></td>
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<td></td>
<td></td>
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</table>

**Grid-Interop Phoenix, AZ, Dec 5-8, 2011**

*Reporting UI*
Reporting UI - Package View

EPRI InterOp

Package Status

<table>
<thead>
<tr>
<th>Status</th>
<th>Description</th>
<th>Logs</th>
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<tbody>
<tr>
<td>FAILED</td>
<td>MD_CIS-MDM_Create(MeterServiceRequest)</td>
<td>Logs</td>
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<tr>
<td>No Data</td>
<td>MD_CIS-MDM_Request_Reply(MeterServiceRequest)</td>
<td>Logs</td>
</tr>
<tr>
<td>No Data</td>
<td>MD_CIS-MDM_Request_Updated(MeterServiceRequest)</td>
<td>Logs</td>
</tr>
</tbody>
</table>
Log Entry

ID: 72

create date: 2011-08-01 23:59:40 UTC

address: http://ec2-107-20-45-188.compute-1.amazonaws.com:8080/epriConnect/mdms/cis/send

result code: fail

response code:

http method: POST

header: {accept-encoding=[gzip, deflate], Content-Length=[5389], content-type=[text/xml; charset=UTF-8], host=[ec2-107-20-45-188.compute-1.amazonaws.com:8080], SOAPAction=["http://iec.ch/TC57/2011/MeterServiceRequests/CreatedMeterServiceRequests"], user-agent=[Jakarta Commons-HttpClient/3.1]}

message:

operation: http://iec.ch/TC57/2011/MeterServiceRequests/CreatedMeterServiceRequests

• Provides working examples
• Sending and Receiving
Questions?