Interoperability Test #9 of the Generic Interface Definition (GID) and the Common Information Model (CIM)

The Power of the Common Information Model (CIM) and Generic Interface Definition (GID) to Exchange Power System Data and Provide an Integration Framework

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ABSTRACT

On October 2-6, 2006 in Washington, D.C., software vendors serving the electric utility industry met for the ninth time to test the capability of their software products to exchange data and correctly interpret power system data based on the CCAPI interface standards. In the past, the testing focused exclusively on exchanging power system network models using the CIM (Common Information Model). The fifth test, however, introduced both compliance and interoperability testing of the Generic Interface Definition (GID) standards and the sixth test introduced the exchange of a distribution power system network model. This ninth test continued the tests from prior tests and introduced GES and 61968 Part 3 message testing and continued to test actual implementations of these standards. This report documents the results of this testing.

Both the CIM and the GID were developed by the EPRI CCAPI project. The part of the CIM used for these tests has been approved as an international standard (IEC 61970-301 CIM Base). The GID is currently being progressed as an IEC standard as well and is available as a series of draft standards. Each vendor present was required to exchange files with the other vendors and to demonstrate that their software correctly converted their proprietary representation of a power system model to/from the CIM XML format. In addition, the vendors were invited to stage and test actual field implementations of these standards. Two participants elected to stage and test the standard implementation being delivered at Cleco Energy, LLC (Cleco).

These interoperability tests address an important industry requirement established by NERC to be able to transfer power system model data between Security Coordinators. NERC has mandated the use of the Resource Description Framework (RDF) as the XML schema/syntax for the CIM, which is defined in another CCAPI standard (draft IEC 61970-501 CIM RDF Schema). These tests demonstrated the use of this draft standard for this purpose. Complete model files as well as substation partial model files and incremental updates to existing base model files were exchanged between participants. The GID interfaces were used as part of the project test to provide access to data and exchange messages in a standard method.

Vendors participating in these tests included ABB, EDF, GE, SPTI and SISCO. The project test used the solution being implemented for Cleco. Project Consultants prepared the test procedures, witnessed the test results and prepared this test report for EPRI. Curtis Crews, Michael Nazarek and John Tweedy assisted in witnessing the tests. This is an important milestone in the CCAPI project and is the ninth in a series of planned interoperability tests to demonstrate additional CCAPI capabilities.

PREFACE

The reliability of the North American power grid is an increasingly visible topic in the news today. This is due in large part to the need to operate closer to available transmission capacities than at any time in the history of the electric utility industry. Ever-increasing demand in the face of reduced power plant construction is a major factor.

One way to tackle the reliability issue is to improve the models of the power system used to calculate available transmission capacity, so that calculated capacities more nearly match real world capacities. This permits operation closer to maximum capacity while avoiding unplanned outages. One key to improved models is to have the capability to merge NERC regional models into a combined model. Since these models reside in multiple, proprietary databases in Security Coordination Centers located throughout North America, an information infrastructure that facilitates model exchange is an absolute necessity.

One initiative underway to address this need is based on the Common Information Model (CIM) standards that EPRI helped develop as part of the Control Center Application Program Interface (CCAPI) project. The CIM has been translated into the industry standard eXtensible Markup Language (XML), which permits the exchange of models in a standard format that any EMS can understand using standard Internet and/or Microsoft technologies. The North American Electric Reliability Council (NERC) mandated the use of this standard by Security Coordination Centers (SCCs) to exchange models by September 2001, adding urgency to the deployment of products that support these standards.

Another initiative made possible by the CCAPI project is the establishment of an integration framework based on the CIM, the Generic Interface Definition (GID) standards, and the new CIM-based messaging standards to facilitate the inclusion of the best-of-breed advanced network applications with the existing EMS as well as information exchange between the control center EMS. This makes it possible to upgrade and improve network operations without complete replacement of the existing EMS as well as providing for centralized network model management based on the CIM.

This report presents the results of the ninth interoperability test using these standards to create a model-driven integration architecture. The goal of this report is to raise awareness of the importance and status of this effort and to encourage adoption by additional product suppliers and energy managers.

David L Becker
EPRI
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    5. WAPA – Randy Curtis
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- SISCO – Herb Falk for input into the Project Test procedures and corrections to the rdf files.
- John Tweedy – for his assistance in witnessing and recording the test results.
- Curtis Crews of ERCOT – for his assistance in witnessing and recording the test results.
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- All participants, for providing inputs to the issues and bringing enthusiasm and focused energy with a true spirit of cooperation to Washington, D.C. Their willingness to participate in these tests at their own expense is a testimony to their commitment to support the CIM/GID/XML standards.

In addition, EPRI acknowledges Margaret Goodrich, Project Consultants, who prepared and edited the test plan and procedures, witnessed the tests, recorded the results and wrote this report.

Dave Becker
EPRI

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1 INTRODUCTION

This document reports the results of the ninth CIM/GID/XML interoperability tests, which took place on October 2-6, 2006, in Washington, D.C. Interoperability testing proves that products from different participants can exchange information, interact with the Generic Interface Definition (GID) components and provide the interfacing requirements based on the use of the IEC standards that have been developed as an output of the CCAPI project. These standards include various parts of IEC 61970 and IEC 61968 standards. An additional feature and objective of this and future IOP tests is to verify and validate that changes made to the IEC standards have been implemented and do not prevent or impede data exchange or interaction between the participants. The verification of annual IEC specification updates will be an integral part of the IOP testing process.

This set of interoperability tests focused on four major types of tests:

- Power system model exchanges via file transfer based on CIM XML standards. These tests included complete model transfers, incremental model updates and partial model transfers. The primary purpose of these tests was to validate model exchange using the newly updated CPSM requirements document.
- Project Tests were based on the implementation of the Cleco Energy CIM/GID project that is being implemented by SISCO and SPTI. The project used the following GID services; GDA, HSDA and TSDA.
- GES and 61968 part 3 message tests were also introduced in this IOP. These tests were completed by the SISCO/EDF team.
- EDF provided a CDPSM file that meets the specifications of 61968 Part 13 and that would also be compliant to the CPSM requirements. EDF presented this file to the IOP group to test the premise that a CDPSM file could be used by CPSM tools to perform data exchange and run power flow calculations.

In addition to these tests, the ninth interoperability test also focused on a new version of the UML and RDF files and an updated CPSM standard (Version 3.0).

The UML file was updated based on input from prior IOP tests and WG13. It is envisioned that this file will be used as input to the new release of the CIM standard (Version 11) due to be released in the first half of 2007.

The new RDF file generated using Xpetal resulted in the discovery of several errors and was corrected manually to avoid any delays in the test.

The updated CPSM profile was also tested as part of this IOP. The goal of this testing is to verify that the profile is complete and accurate to achieve true model exchange and is ready to be submitted to the WG13 to progress as a standard. Many corrections and clarifications were added to the document since the last IOP. While significant progress was made, there are still open issues that need to be addressed; however, everyone agreed that this version could be submitted to the IEC for further work.

Use of the load schedule model in the CIM is currently ambiguous. The Load model needs to be examined, clarified, and possibly amended. Until this work is done, it is necessary to define a simplified load model to allow power flow testing with exchanged data. For testing purposes, the pfixed and qfixed attributes of EnergyConsumer were used to contain the real and reactive power injections for each load in the system at a common point in time.

There is also ambiguity in the use of CurveSchedules in the current CIM to define time based schedules. For testing purposes, curves that use the X axis to represent time used values of 0 through 23.99 to represent normalized daily time.

The CIM containment model is currently under discussion. For purposes of this test, the Geographical and Sub-Geographical Regions were used for containment. Host Control Areas and Sub-Control Areas were not used.

This test was the ninth in a series of CIM XML interoperability tests, which began in December 2000. Goals of future tests are described in Section 4.

Objectives and Scope of Interoperability Test

General Test Objectives

The general objectives of the interoperability tests and demonstrations are:

1. Demonstrate interoperability between different products based on the CIM and/or GID. This includes applications from EMS as well as independently developed applications from third party suppliers.
2. Verify compliance with the CIM for those CIM classes/attributes involved in the information exchanges supported by the tests. In particular, a primary objective is to verify that the changes made to the CIM and CPSM since the last IOP were implemented and were functional for data exchange.
3. Demonstrate the exchange of power system models using the CIM with an RDF Schema and XML representation of the model data.
4. Demonstrate message exchange between different vendor products using the services defined in the interface definition standards. This includes the GID services provided by the Common Services, GDA, HSDA, TSDA and GES standards to provide communication interoperability. This was demonstrated using the Project test between SPTI and SISCO the and GES test between SISCO and EDF.

Secondary objectives included the following:

1. Validate the correctness and completeness of IEC draft standards, resulting in higher quality standards by removing discrepancies and clarifying ambiguities.
2. Validate all files used to complete the test including the UML, the RDF and the CIM XML.
3. Exercise and analyze all tools including the RDF generator and the Model Validation tools. Ensure these tools generate accurate results.
4. Validate the contents of the CPSM document.
5. Validate the contents of the models used in the exchange and solution tests.
6. Provide the basis for a more formal interoperability and compliance test suite development for CCAPI standards.

Scope and Specific Interoperability Test 9 Objectives

The scope and specific objectives for the ninth interoperability test fall into four categories:

1. Model exchange, using the test procedures defined below:

- Exchange of a full operational power system network model that includes generation and loads. The full model exchange test will verify that a CIM XML file of a power system model generated by one vendor's application can be used by another vendor's application. The CIM XML file will be based on an RDF/XML version of the CIM. The portion of the CIM that will be tested is defined in the updated NERC Profile for Common Power System Model (CPSM) exchange and will contain the set of CIM classes, attributes and relationships defined by the participants prior to the test. The NERC DEWG Minimum Data Requirements specification will be updated and distributed to all participants prior and will be used to validate the exchanged models. This is the **"full operational model exchange"** test.
- Execution of load flow/power flow applications to verify sufficiency of the model files (in terms of having all necessary elements represented) and correctness of the transformations to/from local representations of the models. This is the "**solution**" test.
- Exchange of incremental updates (i.e., send all changes since the last update or since a specific date/time). This is the "**incremental exchange**" test.
- Exchange of partial models. The test focused on the transfer of complete individual substations and companies. This is the "**partial exchange**" test.

2. GES and IEC 61968 part 3 message tests using message exchange between SISCO and EDF to test the following methods:

- Filtering (message and events)
- Send and receive messages

3. Distribution model exchange as explained below (IEC 61968-13):

- Exchange of a distribution network model. The full distribution network model exchange test will verify that a CIM XML file generated using the CDPSM Profile can be used by the CPSM tools to complete full model exchange. The CIM XML file will be based on an RDF/XML version of the CIM. The portion of the CIM that will be tested is defined in the IEC 61968-13 (CDPSM Profile) for distribution model exchange. This is the **"full distribution model exchange"** test.

4. Project Tests as defined below:

- GDA tests to obtain desired information from the CIM based data via Message Oriented Middleware (MoM).
- Model data formatted using the classes and attributed defined in IEC 61970.

This ninth test provided the opportunity for participants to complete any or all of the tests included in the test procedures generated specifically for this test.

Scope of the CIM Tested

The portions of the CIM that were tested are defined in the following:

- Reference 1 - NERC CPSM Profile for power system model exchange. This profile contains the selected CIM classes, attributes, and relationships defined in the Minimum Data Requirements document produced by the NERC DEWG to model transmission substations, lines, and loads sufficient to run State Estimation and subsequent Power Flow/Contingency Analyses applications. This profile is mostly a subset of the IEC 61970-301 Base CIM standard (see Reference 11).
- IEC 61970 and 61968 standards for the representation of a distribution model. These standards contain the CIM classes, attributes and relationships to model an EMS and DMS system (see References 11 and 16).

Organization of Report

The introductory chapter presents the objectives and scope of these tests. Chapter 2 describes the test plan that was followed and identifies the participants and their products. Chapter 3 presents the test results, beginning with a summary of each test step that was scored. The test scores, which are given as Pass, Pass with Errors, or Not Applicable, are organized in a series of tables. A summary of the significant results achieved is also provided. The first two appendices contain a description of the participant's products used in the tests (Appendix A) and the test configuration data, including specific versions of the CIM in UML and XML/RDF, sample model files, and test tools (Appendix B). Appendix C provides an overview of the GID functionality and the relevant IEC standards for each service. Appendix D contains the detail test approach and descriptions of the model transfer tests.

References

1. IEC 61970 Energy Management System Applications Program Interface (EMS-API) – Part 452: CIM Network Applications Model Exchange Specifications, Rev. 3, 2006-08-29 (commonly known as the CPSM (Common Power System Model) Profile).
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14. Draft IEC 61970: Energy Management System Application Program Interface (EMS-API) – Part 554-4: CIM XML Model Exchange Format, Revision 6, 2005-05-05.
15. UCTE Data Exchange Format for load flow and three-phase short circuit studies (UCTE-DEF) v0.1 – 2003-09-01.
16. Draft IEC 61968: System Interfaces for Distribution Management – Part 13: CIM RDF Model Exchange Format for Distribution, Revision 08, June 2006.

2
THE TEST PLAN

A formal set of test procedures were prepared and used to conduct and score the tests (see Reference 2). These procedures were made available ahead of time and all participants were encouraged to execute as many of these tests as possible prior to coming to Washington, D.C. The goal was to have each participant successfully complete as many tests as possible while in Washington, D.C.

The specific criteria used for evaluation of successful completion of each test was not revealed ahead of time, although the nature of the criteria was discussed.

This section provides an overview of the test plan used for this ninth interoperability test.

Participants and Their Products

The five participants in this test were given the opportunity to spend two full days at the test site in Washington, D.C. Participants brought their own hardware/software to use in the test. The model files used for testing were loaded onto a JumpDrive USB mass storage device for use by each participant. The sample model files and files successfully exported by a participant's product were loaded onto the JumpDrive and each participant could access these files for testing their import/export capability.

Participants were allowed to correct deficiencies or errors found during testing and then, as time permitted, retest. All official testing took place on-site in Washington, D.C. The final test results are recorded in the test matrices provided in Section 3, Test Results.

Each participant was required to use an actual product(s) so that testing would demonstrate interoperability of real products. The participants and their products are listed in Table 2-1 below.

Table 2-1
Participants and Their Products

Vendor	Product Name	Tests
ABB	DE400	1.) Transmission/Distribution Power System Model CIM/XML file transfer (Full & Partial) 2.) Power Flow Solution
ABB	CIM DE Toolkit	1.) Transmission/Distribution Power System Model CIM XML file transfer (Full & Partial)
EDF	CIM Viewer CIM Prao CIM Eurostag	1.) Full Transmission/Distribution power system model CIM/XML file Transfer 2.) Power Flow Solution 3.) GES & 61968 Part 3 Testing
GE	Enterprise Gateway (EG) Transmission Security Management (TSM)	1.) Transmission/Distribution power system model CIM/XML file Transfer (Full, Partial and Incremental) 2.) Power Flow Solution
SPTI	PSS/Odms V5.2.0.4 GDA Adapter HSDA Adapter TSDA Adapter	1.) Transmission/Distribution Power System Model CIM/XML file transfer (Full, Partial & Incremental) 2.) Power Flow Solution 3.) Project Testing
SISCO	GDA Adapter PI Adapter HSDA Adapter TSDA Adapter UIB	1.) Transmission power system model CIM/XML file Import (Full, Partial and Incremental) 2.) GES & 61968 Part 3 Testing 3.) Project Testing

A description of each product used in the tests is contained in Appendix A. These descriptions also explain how the CIM/GID is used in the product and how successful compliance with the CIM/GID standards was demonstrated.

Test Approach

As stated in the Introduction, there were four major categories of tests:

1. Power system model exchange tests based on CIM XML using file transfers
2. GES & IEC 61968 Part 3 Testing
3. CDPSM 61968 Part 13 Exchange Testing
4. Project Tests using GDA and IEC 61970 standards

All Participants were able to perform the exchange tests (items 1 & 3 above). SISCO and EDF performed the GES/61968 Part 3 tests and SISCO and SPTI performed the Project Tests.

Power System Model Exchange Using CIM/XML File Import/Export

To meet the model exchange objectives the same procedures used in prior interoperability tests were used, except that updated draft standards were applied as appropriate. This does not require any special interface capabilities for data exchange – just the ability to read and write a CIM/XML-compliant file to memory. This is sufficient for non-real time exchange of power system models (i.e., initial creation of models and periodic updates). The basis for these tests are the IEC 61970 standards dealing with the CPSM, CIM, CIM RDF Schema, and CIM XML Model Exchange Format (see References 1, 11, 13, and 14, respectively).

For this test, Areva, ABB, EDF and GE provided five transmission files including the European 14 Node file based on the description of the UCTE Data Exchange Format for load flow and three phase short circuit studies (UCTE-DEF, V0.1 - European transmission network exchange).

These tests were similar to those performed in previous interoperability tests, where three types of data transfers involving power system models were tested:

1. Full (complete) model transfers
2. Incremental model updates
3. Partial model transfers
4. Power Flow Solution Tests

A full description of the Full Model Transfers, Incremental Model Updates, Partial Model Transfers and the Power Solution Test approach is provided in Appendix D. The sections below provide an overview of these tests.

Full Model Transfer

Each participant in this test was required to (1) import a model file, (2) generate and export a file that conformed to the standards for the model used[1], and (3) import a file from another vendor's product and correctly interpret the model data contained.

The CIM XML model files used included the Areva 60 bus model file, the WAPA 262 bus model file, the Union for the Coordination of Transmission of Electricity (UCTE) 14 node model file, the EDF 27 node Caplim file and the ABB 40 bus model file. Appendix B provides a full description of the files. These model files, used for the **full operational exchange** tests, contained at least one instance of the CIM classes, attributes and relationships defined in the NERC CPSM profile (see Reference 1).

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[1] Note: Not all participant's products had export capability, in which case this test was not conducted on those products.

Incremental Model Updates

The incremental model update tests were to validate a product's ability to successfully import and merge incremental changes to an existing power system model. Use Cases for these tests are available upon request.

To test this capability, incremental update files were generated by GE using the WAPA262 Bus model as the base model and by SPTI using the EDF 27 node Caplim as the base model. The incremental files used for testing included the modification of device attributes and/or the addition and deletion of devices in a substation.

The updated draft IEC 61970 Part 552-4 contains the standard to define the contents of Incremental Model files.

Partial Model Transfers

These tests were to validate the transfer of a partial model using the existing CIM XML specifications. This is similar to sending an entire power system model, except that only a portion of the entire model is transferred. However, the portion sent is a complete model in and of itself. The test, then, was primarily to ensure sufficient information is transferred to permit the receiving system to merge this model into the existing model. For this to take place without undue manual intervention, the base addresses of all objects in the partial model must be compatible with the existing model.

The scope of this test was limited to the transfer of complete Substation models.

Power Flow Solution Test

The Power Flow Solution test is intended to verify the correct exchange and transformation of power system model files including generation and load through the execution of power flow applications. The following instance data is provided in the model files used in this test:

- Generation values
- Load values
- Measurements
- Transformer settings
- Generator voltage control values
- Device states
- MVAr values for shunt Compensators

To meet the load flow application execution, the ABB40 Bus model file, the WAPA 262 Bus model file, the UCTE 14 node model, or the EDF 27 node Caplim model file was used. In addition, the CDPSM AIGUE model file was used by several participants to prove that a distribution model file could be used as input to a transmission study application (i.e., a power flow application).

Power Flow Applications produce MW and MVAr flows for each line in the model. The MW & Mvar (MVA) flows are a direct function of the voltage difference between the two ends of a line and the resistance of the line. They serve as a check on the transfer of the characteristics of a line (topological connectivity and impedance), but are direct derivatives of the voltage.

As part of the solution, each Power Flow Application produced a table of bus voltage and voltage angle readings for each bus in the model. To evaluate power flow solutions, the tables produced by two different executions of a Participant's Power Flow Application were compared.

If the models used for both executions are identical, then the solutions should be very close, although identical solutions are not expected due to the small effects of conversions between participants. If the models are identical, but different Participant's applications are used, again the table values are not expected to be identical, but should be consistent and within a reasonable range of each other.

It should be kept in mind that the purpose of the test is not to evaluate different Participant's Power Flow Applications, but rather to ensure that the contents and format of the CIM XML documents exchanged are sufficient to permit each Participant's product to converge on a solution.

GES & 61968 Part 3 Testing

The GES testing paired EDF with SISCO to test the GES messaging defined in the GID Service standard. Based upon the definitions and philosophy of the GID, IEC 61970 Part 405 Generic Eventing and Subscription (GES) testing applies primarily to two or more components exchanging standard messages. For this interoperability test, messages defined in draft IEC 61968 Part 3, Network Operation – Outage Management are used. This test document recognizes the need to test the conformance of relevant messaging standards in addition to the interoperability of GES clients and servers.

As a result, testing is divided into two parts:

Conformance testing – dealing with the ability of the GES server to correctly conform to the standard. That is, a GES server must faithfully present one or more hierarchical views of a power system model as well as faithfully present standard message schema for browsing. This test applies only to GES servers.

Interoperability testing – dealing with the ability of a client ability to interoperate with a server. That is, to allow clients to subscribe to messages in the context of a power system model as well as to send and receive standard messages.

Appendix D provides a full description of this test.

CDPSM 61968 Part 13 Model Exchange

The CDPSM exchange tests will include a full distribution model exchange to demonstrate the ability of participants to export/import a distribution model using the tools to exchange a CPSM transmission model. Each participant in this test was required to (1) export the file that conforms to the standards for the model used and/or (2) import a file from another participant's product and correctly interpret the model data contained. The model file used was a model supplied by EDF and was the only model used in this test.

Appendix D provides a full description of this test.

Project Testing

The Project test is intended to show the viability of an implementation of the standards. The project involved using the GID interface services (GDA, HSDA and TSDA) and other products from SISCO (including a Utility Integration Bus (UIB)) and Siemens PTI (including PSS/Odms) to integrate the ICCP data to the network applications provided by SPTI.

The primary focus of this test is to fully implement the functionality of the SISCO and SPTI CIM and GID implementations for Control Center interoperability. In this case the project was to implement a set of network applications into the control center environment while preserving the SCADA and Generation applications from another vendor. The project goals were to incrementally upgrade the legacy EMS within the Control Center and provide the following:

Integration of a message bus middleware platform.

Implement and integrate a set of third party applications (SPTI's PSS/Odms) with the legacy EMS system.

Send and Receive ICCP data to and from the Utility and the ISO or other surrounding utilities.

Appendix D provides a full description of this test.

Test Configuration

The details of the specific files used at the beginning of the testing period are specified in Appendix B. This appendix contains file names for the CIM ROSE model, the RDF schema, RDF syntax definition, and sample model files. As testing progressed and problems were discovered and resolved, updates were generated to some of these files.

3
TEST RESULTS

This section presents the results of the interoperability tests. First, the individual tests that were performed and scored are summarized below. This is followed by the test matrices with scores shown for each test. For details on each test step, including setup required and step-by-step procedures, see the Test Procedures document [2].

Table 3-1
Description of Tests Performed

Step from Test Procedure	Test Description
4.2	***Basic Import/Export***
4.2.2.1	Basic Import - Participant A import sample model file and demonstrate import was done correctly
4.2.3.1	Basic Export - Participant A export model and run validator
4.2.3.2	Re-import Check – Re-import model that was exported in 4.2.3.1
4.2.4.1	Interoperation - Participant B import of Participant A exported CIM XML file.
4.2.5	***Solution Test***
4.2.5.1	Initial Import Document 1, Run Solution, and Export Document 2
4.2.5.2	Interoperability Test Using CIM XML Document 2 from Another Participant
4.3	***Incremental Model Update***
4.3.1	Basic Import Incremental Update File
4.3.3	Export Incremental Update File
4.3.4	Import Incremental Update File and Merge
4.4	***Partial Model Transfer***
4.4.1	**Import Partial Models and Merge**
4.4.1.1	Import sample model with substation(s) missing
4.4.1.3	Import & Merge sample model containing only substation(s)
4.4.2	**Export Merged Model Files**
4.4.2.1	Export merged model - Participant A exports merged model file
4.4.2.2	Re-import merged model - Participant A re-imports exported merged model file
4.4.2.3	Participant B import merged model file from Participant A and validate
4.4.3	**Export Partial Model Pair and Re-Import with Merge**
4.4.3.1	Export Partial Model Pair
4.4.3.2	Re-Import Partial Model Pair and Merge
4.5	***61968 Part 13 Basic Import/Export/Interoperation***
4.5.1.0	Basic Import - Participant A import sample model file and demonstrate import was done correctly
4.5.1.1	Basic Export - Participant A export model and run validator
4.5.1.2	Re-import Check – Re-import model that was exported in 4.5.1.1
4.5.2.1	Interoperation - Participant B import of Participant A exported CIM XML file.

Table 3-1
Description of Tests Performed (Continued)

Step from Test Procedure	*Test Description*
4.6	***GES & 61968 Part 3 Tests***
4.6.1.1	Verify Filtering Off
4.6.1.2	Send Message
4.6.1.3	Verify Message Receipt
4.6.2.1	Event Category Filter
4.6.2.2	Event Area Filter
4.7	***Project Tests***
4.7.1.1	Set-Up Observation Points
4.7.1.2	PSS/Odms Receipt of Simulated Values
4.7.1.3	PSS/Odms Receipt of Manually Overridden Values
4.7.2.1	Obtain Values Using PI SMT
4.7.2.2	Obtain Values Using PI HDA
4.7.2.3	Compare Values Returned – PI SMT
4.7.3.1	Add Points in ODMS – ICCP
4.7.3.2	Add Points in ODMS – HSDA
4.7.3.3	Add Measurement – ICCP Adapter
4.7.3.4	Add Measurement – HDA Adapter
4.7.3.5	Add Measurement – PI Adapter
4.7.3.6	Add Measurement – GDA Change Monitor
4.7.3.7	Delete Measurement in ODMS
4.7.3.8	Delete Measurement in ICCP Adapter
4.7.3.9	Delete Measurement in HDA Adapter
4.7.3.10	Delete Measurement in PI Adapter
4.7.3.11	Delete Measurement in GDA Change Monitor

Summary of Test Results

The following sections report the highlights of the testing. The final results are presented in tables within each section. The entries in each cell of the tables should be interpreted as follows:

- P – Pass. Indicates a successful import of another participant’s exported file. The specific sample model file imported is indicated.
- PE (Passed with Errors) – most aspects of the test were performed successfully.
- VR (Validator Reject) – import file rejected due to errors detected by product internal validator.
- X – No files were exported by this participant, so none available for import or Participant not allowed to use his own files for this test.
- N/A - Product does not have export functionality.
- Blank (no entry) – indicates test was skipped, not witnessed, an exported model file was not available for import, or an exported file was available but had errors that prevented a successful import.

Basic Import/Export and Interoperation

Basic Import and Export

Tables 3-2, 3-3 and 3-4 show the results of the tests on the individual products to determine compliance with the final CIM version 10 XML/RDF standards, which have been approved as an International Standard IEC 61970-301 CIM Base. The primary objective of this test was to successfully import, export and re-import a sample model file based on the CPSM transmission model profile to show compliance.

Highlights of the tests are presented in the following tables. Any issues or explanations for PE results are presented immediately following the tables.

Table 3-2
Basic Import Test of Individual Products

Test Procedure	4.2.2.1 Basic Import				
Test Model Used	**262 Bus Model**	**60 Bus Model**	**40 Bus Model**	**UCTE 14 Node Model**	**EDF 27 Caplim**
ABB – DE400	P	P	P		
ABB – CIM DE Toolkit	P	P	P	P	P
EDF – CIM Viewer	P	P	P	P	P
GE	P	P	P	P	P
SPTI	P		P	P	P
SISCO	P	P	P	P	P

Table 3-3
Basic Export Test of Individual Products

Test Procedure	4.2.3.1 Basic Export				
Test Model Used	**262 Bus Model**	**60 Bus Model**	**40 Bus Model**	**UCTE 14 Node**	**EDF 27 Caplim**
ABB – DE400	PE	P	P		
ABB – CIM DE Toolkit	PE	PE	P	P	P
EDF – CIM Viewer	P	P	P	P	PE
GE	P	PE	PE	PE	PE
SPTI	P		P	P	P

Table 3-4
Re-Import Check of Individual Products

Test Procedure	4.2.3.2 Re-Import Check				
Test Model Used	**262 Bus Model**	**60 Bus Model**	**40 Bus Model**	**UCTE 14 Node**	**EDF 27 Caplim**
ABB – CIM DE Toolkit				P	
GE	P	P	P	P	P

The Pass with Error for the ABB DE400 tool against the 262 Bus model is due to the following:

- ABB, EDF, GE and SPTI were able to successfully run a power flow solution on an imported model file and then export the file. They were also able to import and run a load flow on a model file that had been previously imported and exported by another participant.
- Bottom line: The contents and format of the power system model files exchanged with the CIM XML file representation are adequate for running power flow applications. But more importantly, the running and comparison of power flow solutions is the ultimate validation of the CIM version 10 content and the adequacy of the CIM XML standards for exchanging power system model files.
- The validation process included the review and comparison of the number of islands, the total generation, the total MVar, the total load, the total losses (verified that total loss + load = generation), the number of generators and the number of loads for each solution.

Table 3-6
Solution Test Results

Test Number	1 Import doc-1	2Run PFsol-1	4Import doc-2	5aRun PFsol-2	5bCompare sol-1, sol-2
ABB DE400 w/ABB40 Bus Model	P	P (see Note 1)	P - (w/SPTI export) (see note 2)	P	
EDF CIM Eurostag w/UCTE 14 Bus Model	P	P	P- (w/ABB1 export)	P	P
EDF CIM Eurostag w/UCTE 14 Bus Model	P	P	P - (w/SPTI export)	P	P
EDF CIM Eurostag w/UCTE 14 Bus Model	P	P	P - (w/GE export)	P	P
EDF CIM Eurostag w/aigue CDPSM Model	P	P	P - (w/ABB1 export)	P	P
EDF CIM Eurostag w/aigue CDPSM Model	P	P	P - (w/GE export)	P	P
EDF CIM Eurostag w/27 Caplim	P	P	P - (w/ABB1 export)	P	P
EDF CIM Eurostag w/27 Caplim	P	P	P - (w/SPTI export)	P	P
EDF CIM Eurostag w/27 Caplim	P	P	P - (w/GE export)	P	P
EDF CIM PRAO w/aigue CDPSM Model	P	P			
GE w/WAPA 262 Bus Model	P	P			
GE w/aigue CDPSM Model	P	P			
GE w/ UCTE 14 Bus Model	P	P	P - (w/SPTI export)	P	P
GE w/27 Caplim	P	P	P - (w/ABB1 export)	P	P
GE w/27 Caplim	P	P	P - (w/SPTI export)	P	P
SPTI w/WAPA 262 Bus Model	P	P*	P - (w/EDF export)*	P	P
SPTI w/ABB 40 Bus Model	P	P**			

Table 3-6
Solution Test Results (Continued)

Test Number	1Import doc-1	2Run PF sol-1	4Import doc-2	5aRun PFsol-2	5bCompare sol-1, sol-2
SPTI w/aigue CDPSM Model	P	P			
SPTI w/UCTE 14 Bus Model	P	P			
SPTI w/27 Caplim	P	P	P - (w/GE export)***	P*	P
SPTI w/27 Caplim	P	P	P – (w/ABB1 export)**		

Note 1: The assignment of the slack bus by the ABB Power Flow software needs to be re-accessed.

Note 2: PTI did not have an association between the Line and AC Line Segment so the Line Class was removed from the file by the ABB.

* Had to set the tolerance to a high level to get these models to converge.

** Could not get this model to converge.

*** To get this model to converge, the initial MW for the NINF01_SM units was changed from 99990 to 1950. 1950 is the number that is in the original EDF file and it converges.

Incremental Model Update

This section shows the results of the incremental model update tests. SPTI and GE participated in these tests. Table 3-7 shows the results of the incremental model update testing. The results are grouped according to the type of incremental model update tested: Add, Modify, Delete, or a Combination of adds, modifies, and deletes as would most likely be found in a real-world application of this standard. The entries show the number of incremental update files of each type that were tested.

Table 3-7
Incremental Model Update Testing

Test Procedure	4.3.3 Export Incremental Update				4.3.4 Import Incremental Update			
Incremental Update Type	**Add**	**Modify**	**Delete**	**Combination**	**Add**	**Modify**	**Delete**	**Combination**
GE	P–1	P–1	P–1		P – 2	P – 1		
SPTI				P–1	P – 3		P – 1	

The incremental files prepared for this test are listed in Appendix B.

Export Incremental Updates

GE successfully exported the following incremental update files from the 262 Bus model:

- Add_xfrm.xml
- Mod_xfrm_r.xml
- Del_load.xml

- SPTI successfully exported a combination incremental update file from the EDF 27 Caplim model. The file, names edf27_rev1_rev2.xml, contained a change to the resistance values of a line, a change to the normal open state, it added a line segment with terminals, it moved a breaker to a different connectivity node and it deleted a breaker.

Import Incremental Model Updates and Merge with Existing Base Model

This test required a participant to import an incremental model update file, correctly parse the file for model changes, and apply the changes to a previously stored sample model file. The revised model was reviewed in the importing product to validate the change was correctly interpreted and applied to the existing model. This test validates interoperability using the difference file specification for incremental model updates.

Highlights of this test are as follows:

- SPTI successfully imported four of the update files to the WAPA model and merged them into the existing WAPA 262 bus model stored internally in their product under test.
- GE successfully imported three incremental model update files to the WAPA model and merged them into the existing WAPA 262 bus model stored internally in their product under test.

This test validated that additions, deletions, and modifications to base models can be handled with the incremental update approach, as long a logical sequence of actions are followed. The test also validated the draft specification that defines the approach to creating the difference files used for this test (see Reference 14).

Partial Model Transfer Test

This section shows the results of the partial model testing. Three participants (ABB, Siemens PTI and SISCO) took part in these tests. Table 3-8 and Table 3-9 show the results of these tests.

Table 3-8
Partial Model Testing (Section 4.4.1)

Test Procedure	**4.4.1 Partial Model Import**							
Test Model Used	**Import 262 Bus Model w/o SS**	**Import 262 Bus SS Model**	**Import 27 Node Model w/o SS**	**Import 27 Node SS Model**	**Import 40 Bus Model w/o SS**	**Import 40 Bus SS Model**	**Import 60 Bus Model w/o SS**	**Import 60 Bus SS Model**
ABB – CIM DE Toolkit					P – No Amherst	P – Amherst		
Siemens PTI	P – No Station 4	P – Station			P – No Amherst	P – Amherst	P – No Chenaux P – No Picton	P – Chenaux P – Picton
SISCO			P – No N41	P – N41	P – No Amherst	P – Amherst		

Table 3-9
Partial Model Testing (Section 4.4.2 & 4.4.3)

Test Procedure	**4.4.2 Merged File Export & Import from Another Participant**			**4.4.3 Export New Partial Model Files**	
Test Model Used	**Export Merged Model**	**Re-Import Merge Model**	**Import Merged Model from Another Vendor**	**Export Partial Model Pair**	**Re-Import Partial Model Pair & Merge**
ABB – DE400 (See notes immediately after table for changes to files on export)				P – 262 Bus with SS 4 & 262 Bus w/o Station 4 P – 60 Bus with SS Picton & 60 Bus w/o Picton	
ABB – CIM DE Toolkit				P – 60 Bus w/ SS Chenaux & 60 Bus w/o Chenaux	
Siemens PTI				P – 27 Caplim with N41 & 27 Caplim w/o N41	

The first test (Section 4.4.1) required a participant to import a partial model and merge with a pre-existing base model. The base model had a certain substation removed as shown by the notation (e.g., “No Amherst”, which indicates the Amherst substation was removed from the ABB 40 bus model before importing). ABB, Siemens PTI and SISCO successfully imported and merged at least one substation model with the base model file.

No participant chose to perform the second test (Section 4.4.2).

The third test (Section 4.4.3) was an opportunity for participants to further demonstrate their product’s capability to export partial model files. For this test:

- The ABB DE 400 tool successfully exported two partial model files each comprising one substation from the Areva 60 bus and the GE 262 bus model.
- The ABB CIMDE Toolkit successfully exported a partial model file comprising one substation from the Areva 60 bus model
- Siemens PTI successfully exported a partial model file comprising one substation from the EDF 27 Caplim model.

The ABB tool made one or more of the following changes to the 262 bus files and the 60 bus files during the export:

1. Curve Schedules counts were modified
2. Regulation Schedules counts were modified
3. Terminal were added to support bus bars; original file had 102 and new files have 128
4. Energy Consumer was changed to Equivalent Load
5. Area Load Curve counts were modified

61968 Part 13 Basic Import/Export/Interoperation Tests

ABB, EDF, GE and SPTI participated in the import of the CDPSM file supplied by EDF. ABB, EDF and GE tested the export of this file and EDF, GE and SPTI succeeded in running a power flow solution using the CDPSM file. This file is a distribution file in the CIM XML format that is fully compliant to the 61968 Part 13 standard. The primary objective of this test was to determine if the tools used to exchange and use CPSM transmission files could be used to exchange and use a CDPSM distribution file. The files used by each participant were slightly different and reflected changes that were identified during the test and agreed to by all participants including EDF. Table 3-10 and 3-11 provide the results of these tests.

Table 3-10
CDPSM - Basic Import Test of Individual Products

Test Procedure	4.5.1.0 Basic Import		
Test Model Used	**AIGUE1003.xml**	**AIGUE0809.xml**	**AIGUE1004.xml**
ABB – CIM DE Toolkit	P		
EDF – CIM Viewer		P	
GE			P
SPTI			P

Table 3-11
Basic Export Test of Individual Products

Test Procedure	4.5.1.1 Basic Export		
Test Model Used	**AIGUE1003.xml**	**AIGUE0809.xml**	**AIGUE1004.xml**
ABB – CIM DE Toolkit	P		
EDF – CIM Viewer		P	
GE			P

The ABB CIM DE Toolkit added bus bar sections to each substation, which made the bus bar section and terminal counts mismatch. The tool added 105 bus bar sections and 30 terminals.

The interoperation test was executed by SPTI. This test imported the CDPSM file that was previously exported by ABB. Table 3-12 shows the results of this test.

Table 3-12
Interoperation with Sample Models

Test Procedure	4.5.2.1 Import of 4.5.1.1 CIM XML Exported file
Participant Importing File	**File Exported by ABB**
SPTI	P – AIGUE1003_ABB1_1004.xml

GES & 61968 Part 3 Message Testing

This test was executed by SISCO in conjunction with EDF. With the EDF power system model and messages, the data to be exchanged are Outage Created, Closed, and Changed messages related to business objects modeled in an EDF CDPSM model.

This test includes five tests that include both conformance and interoperability tests. The results of these tests are shown in Table 3-13 below. For additional details about this test, refer to Appendix D of this report.

Table 3-13
GES & 61968 Part 3 Test Results

Test Step	SISCO
4.6.1.1 Verify Filtering Off	**P**
4.6.1.2 Send Message	**P**
4.6.1.3 Verify Message Receipt	**P**
4.6.2.1 Event Category Filter	**P**
4.6.2.2 Event Area Filter	**P**

Project Testing

This section shows the results of the SISCO and SPTI project test. All tests used the Cleco Energy Corporation's model and the data contained therein. SISCO and SPTI participated in these tests and used the UIB Message Bus as the middleware technology. The results of the tests are shown in Table 3-14 below.

Table 3-14
Cleco Project Test Results

Test Step	SISCO	SPTI
4.7.1.1 Set-Up Observation Points	**P**	**P**
4.7.1.2 PSS/Odms Receipt of Simulated Values	**P**	**P**
4.7.1.3 PSS/Odms Receipt of Manually Overridden Values	**P**	**P**
4.7.2.1 Obtain Values Using PI SMT	**P**	**P**
4.7.2.2 Obtain Values Using PI HAD	**P**	**P**
4.7.2.3 Compare Values Returned – PI SMT	**P**	**P**
4.7.3.1 Add Points in ODMS – ICCP	**P**	**P**
4.7.3.2 Add Points in ODMS – HSDA	**P**	**P**
4.7.3.3 Add Measurement – ICCP Adapter	**P**	**P**
4.7.3.4 Add Measurement – HDA Adapter	**P**	**P**
4.7.3.5 Add Measurement – PI Adapter	**P**	**P**
4.7.3.6 Add Measurement – GDA Change Monitor	**P**	**P**
4.7.3.7 Delete Measurement in ODMS	**P**	**P**
4.7.3.8 Delete Measurement in ICCP Adapter	**P**	**P**
4.7.3.9 Delete Measurement in HDA Adapter	**P**	**P**
4.7.3.10 Delete Measurement in PI Adapter	**P**	**P**
4.7.3.11 Delete Measurement in GDA Change Monitor	**P**	**P**

Summary of Issues Identified

Another output of the testing effort was the identification of issues that affect interoperability, either in the CIM documents themselves, in the sample model files, or in the test procedures. Any issues identified prior to or during the test are presented in the sections below.

RDF File Generation

Properties are not referenced to the correct Domain Type.

Model File Issues

There were several issues identified with the model files. Some of these issues were addressed and corrected during the test. The outstanding issues are listed below.

ABB 40 Bus Model

- Original File: Four secondary transformer windings have multiple tap changers (2).
- 40 bus file after export by ABB1: Season.name attribute should reference enumeration type and not be a literal string.
- The filenames do not conform to the length conventions agreed to by IOP9. They are too long.

UCTE 14 Node Model

- Connections between substations are completed via “Terminals” rather than AC Line Segments. While this is allowed in the CIM and CPSM, there is a question surrounding whether it should be.
- Three substations are connected using one transformer; one connectivity node is on the Terminal in Substation A, one is on the Terminal in Substation B and one is on the Terminal in Substation C.

Areva 60 Bus Model

- Attempted import failed for one participant due to duplicate iec61970CIMVersion with duplicate RDF ID. The file was fixed manually so it could be imported by that participant and all others as well.
- File contains character length greater than the agreed upon 60 characters.
- Shunt has measurement on each terminal but the association is to 1 Shunt.
- Load/Generator mismatch create non-convergence for most Power Flow tools.

Validator Issues

The only Validator used in this test was the CIMVT tool developed by Areva. This is due to the following reasons

1. The Langdale CIM Validator had not been updated with the latest RDF/UML.
2. The Mercury tool requires access to the Internet and this was limited at the test site.

No CIMVT Validator Issues were identified during this test.

General Issues

1. The ABB CIM DE Toolkit added bus bar sections and the associated Terminals to the model files based on the needs of the tool. This caused modifications to many of the exported files.
2. There are differences in the way the tools handle some classes. For example, the GE tool does not use bus bar sections and the ABB tool absolutely requires that bus bar sections exist. Therefore, when a file containing bus bar sections is imported by the GE tool, the devices are removed and when a file that has no bus bar sections is imported by the ABB tool, these devices are added. In one instance the original file contained 42 bus bar sections. When the GE tool imported this file these were deleted. When the ABB tool imported the exported GE file, 28 bus bars were added (not 42) and they were placed in different locations. The team needs to determine if this affects the Power Flow or exchange process and should the tests pass when these differences exist.
3. One participant could not solve a Power Flow for any of the ABB 40 bus files (the original or any exports of that file).
4. One participant could not solve a Power Flow for the EDF 27 caplim file after it had been exported from the ABB CIM DE Toolkit.
5. Persistent RDF IDs – In some cases, the RDF IDs for major classes were persistent but some element level (i.e., unit, curve schedule data, etc) RDF IDs are not persistent. This issue needs to be discussed and a resolution or recommendation needs to be presented for review by the appropriate group. There also need to be consensus on whether the RDF ID should be persistent when a model is imported/exported.
6. An agreement needs to be reached concerning the case sensitivity of the XML name and the RDF ID and the validators need to be aligned with the resolution. A discussion will be held and a proposed solution will be drafted and forwarded to the appropriate group.
7. The group wants to extend discussions in the following areas:
    a. The future of UML in the standards process
    b. How to obtain a road map for WG13
    c. How will this group interact with CIM User's Group Testing organization
    d. Need more visibility into WG13 – would be good to have something like the "TISSUES" web site for 61850.

e. Need to decide if we want to transition from RDF and OWL and define a plan to do it. We need to develop an impact statement, analyze what tools are available, the quality of the tools, and the need for an RDF versus OWL validator.

f. Need to decide on Seasonal Limits – will need a Use Case and a proposal on how to model these.

g. Curve Schedules (AKA Time Schedules) – current time schedules will be seasonal – need a full solution from WG13. Create separate file for Time Schedule/Load Model/MVar Capability/Voltage Regulation Schedules. This could be sent with the model or separately. Must be linked to the model they belong to using an ID.

h. RDFIDs need to be persistent and unique within the system that generates them or within the group of files that are exchanged.

i. Need to know if and when Multiple Inheritance will be introduced. Multiple Inheritance means that if a Plant can contain Equipment Container and a class for “Having Furnace” than Plant has Multiple Inheritance. Currently, Multiple Inheritance is not provided in the CIM, but we believe WG13 is moving toward that direction.

4

IMPLEMENTING STANDARDS AT A UTILITY

This report describes how off the shelf products can interoperate via the use of standards. However, the deployment of interoperable products is only one aspect to using and maintaining a standards based infrastructure. Other key issues, which absolutely require a utility's attention include:

- Data engineering: Almost all existing data and systems at a utility do not use a CIM model or the GID interfaces. Consequently, deployment of the standards requires that a utility first analyze how existing data and systems will be modified, wrapped, or replaced. The single largest task is analysis of existing data and mapping that data to the CIM. For example, consider a database containing work orders. The CIM includes a work order related classes and properties. How is a legacy database containing work orders exposed? An analysis needs to occur that describes how legacy database tables relate to the CIM. It is important before embarking on a CIM project to make sure that the task of working through of the data engineering issues is fully planned for.
- System engineering: One of the key benefits in using the CIM is that it rationalizes utility data management. That is, data meaning is more clearly defined and data redundancy is minimized. Central to system engineering is determining "data ownership" - what systems are supplying and/or consuming CIM data. System engineering also includes deciding what GID interface shall be used to expose the data. Frequently, a utility will have redundant data. Careful analysis need to be done to discover who should maintain that data for the rest of the utility and how it will be accessed. Data engineering and system engineering are complementary and should be done at the same time.
- Organizational changes: Experience has shown that the data and system engineering tasks should not be taken lightly. Frequently, dealing with data and system engineering issues will require the establishment of a new organization within a utility for the purpose of overseeing data and system engineering. Typically, this organization will consist of power system engineers who are more familiar with data and IT support engineers who are more familiar with database as well as integration techniques and technology. All engineering need not be done by this group, but it is important to coordinate this activity across the utility. The group needs to work at the outset of any project to plan and manage the maintenance of the CIM data and system architecture.

5
FUTURE INTEROPERABILITY TESTS

Good progress was made during Interop #9 on several fronts. However, additional testing is needed to validate the many resolutions reached as a result of testing, the update of the standards in the future, the issues that still need resolutions. Future interop tests should concentrate on the following areas:

- Resolve the issues surrounding the exchange of models that are changed by the import/export tools.
- Validate all IEC standard changes.
- Power Flow Solutions – Have more participants and test files in order to improve CPSM and CDPSM profiles. If possible, add testing to verify the ability to ***exchange solved power flow solutions***.
- Partial model transfers – validate resolutions on contents of partial model files and test other partial models types such as all devices for a given voltage level, etc.
- GDA - in addition to complete power system model access, need to test more vendors for partial model access, incremental model update, event notification, and add new data access scenarios to retrieve/write other types of data as a formal part of the test.
- GES – test the use of publish/subscribe services provided by the GES specification
- TSDA – include more vendors, test more services and possibly add more communication technologies
- Continue the compliance testing of the IEC 61968 XML message standards defined by IEC TC57 WG14. More participants testing additional message types are needed.
- Start true interoperability testing of the IEC 61968 XML standard messages involving pairs of participants.
- Continue the testing of distribution model exchange (IEC 61968-Part 13).

Future interoperability tests will, of course, still include opportunities for new participants to complete the tests used for this interoperability test or previous tests.

A
PARTICIPANT PRODUCT DESCRIPTIONS

This appendix contains descriptions of the different products used for the interoperability tests. The product descriptions were provided by the individual participants.

ABB Product Descriptions

The following software will be used by ABB. The platforms mentioned below are the ones used during the interoperability tests. The below mentioned software is also available on other platforms.

CIM DE Toolkit

The ABB CIM Data Engineering (DE) Toolkit is a source database maintenance subsystem for the Network Manager System. It is a collection of data engineering tools for maintaining all the data required to configure a working Network Manager EMS, including network model, generation control, training simulator and all SCADA related data.

The portion of the CIM DE Toolkit database related to maintenance of the Network Manager electrical network model and associated applications is based on the IEC Common Information Model (CIM) and the schema of those data structures very closely parallels the schema of the CIM, including object classes, relationships between object classes and attributes.

The CIM DE Toolkit is built using ESRI ArcGIS technology. This software has been used extensively to implement GIS systems but it is actually a general purpose graphical data engineering platform that is well-suited to object-oriented schemas that include the concept of a connected network and a spatial component.

The principal CIM DE Toolkit components include:

- A multi-user, versioned database server with network model schema based on IEC CIM
- A CPSM-compliant CIM/XML importer with automatic substation one-line diagram generation
- Graphical editing environment with custom “CIM-aware” tools
- CIM/XML exporter with user-configurable profiles
- PSS/E and PSLF to CIM/XML converter
- CIM DE to Network Manager exporter

Network Manager SCADA/EMS/DMS

This is a SCADA/EMS/DMS including advanced network applications for both Energy Management System (EMS) and Distribution Management System (DMS) including full graphics GUI WS500. The server system is running on Linux and the WS500 GUI on Microsoft Windows.

Utility Data Warehouse (UDW)

UDW is an Oracle based historian running on Linux.

DE400

DE400 is an Oracle based Data Engineering environment used to configure the SCADA/EMS/DMS server with data and is running on Microsoft Windows.

PCU400

PCU400 is a process communication unit running on Microsoft Windows. The PCU400 has an OPC DA client that is used to connect with external OPC servers.

DAIS2OPC

DAIS2OPC is an OPC DA bridge to the to the SCADA/EMS/DMS server.

GE Product Descriptions

GE used the Enterprise Gateway and the Transmission Security Management software in the IOP. The Enterprise Gateway is for XA/21 transmission network model and CIM/XML exchange (Full, Partial and Incremental) and Transmission Security Management is for Power Flow solution.

Enterprise Gateway

Enterprise Gateway (EG) is GE’s tool for Full, Incremental and Partial CIM model exchange (import and export). Now it is totally redesigned and upgraded to version 3.0, which is self-adaptive to RDFS schema change and XA/21 internal model change. It can manage all the partners of a utility for model exchange and allow multiple users to perform the task simultaneously. EG 3.0 also features a high performance of completing full Export and Import of a CIM/XML model in 1 minute for a moderate power network of around 1000 buses.

Transmission Security Management

XA/21 Transmission Security Management (TSM) is a network analysis application for electric utilities that monitors and controls their high voltage transmission networks. The application provides a powerful set of tools to perform network analysis, contingency analysis, network optimization (SCED, Voltage/VAR Scheduling, Remedial Action, Preventative Action), and fault-level analysis with transmission security management. Control center operators can quickly identify and analyze potential operating problems and formulate preventative strategies. TSM includes real-time applications (State Estimator) for accessing the current state of the power system and study applications for analyzing postulated operating conditions. Real-time applications can be initiated on-demand or based on time or event triggers.

Siemens PTI® Product Descriptions

PSS/Odms is Siemens Power Transmission & Distribution, Inc., Power Technologies International (Siemens PTI) data management and network application suite centered on the international standard, Common Information Model (CIM) and Generic Interface Definition (GID). Siemens PTI's Operational Database Maintenance System (ODMS) and Power System Simulator for Operations (PSS/O) have been integrated to create the PSS/Odms product line, making this product suite one of the most advanced network modeling and application tools. This integration has resulted in a truly CIM-compliant application that is designed to create or install into an enterprise integration platform.

The model management features of PSS/Odms have been specifically developed to create and update Planning and Operations models in rapid fashion with reduced effort never before possible. The PSS/Odms solution and its entire product suite, along with other vendors' software accessing PSS/Odms' open database, provides a core solution that meets the needs of the industry as progression toward reliable deregulation continues.

SISCO'S Product Descriptions

SISCO, Inc. is a private company founded in 1983. SISCO has established itself as a leader in standards-based real-time integration and communications technologies serving the energy and automation industries. SISCO's products are widely used in many mission critical applications from electrical transmission systems to material handling. We work with both end users and OEMs serving those end users. SISCO's ability to partner with other OEMs and integrators allows us to deliver more capabilities at a lower cost resulting in better solutions for you. Today SISCO has demonstrated leadership and capabilities to provide solutions in the following areas:

- Model-driven integration technology based upon advanced publish/subscribe and object oriented technology for enterprise integration of heterogeneous applications in the utility environment.
- Real-time communications and networking based upon open, public, and international standards such as:
  - Inter-control Center Communications Protocol (ICCP) per IEC60870-6 TASE.2 for control center integration and power plant dispatching
  - Utility Communications Architecture (UCA™) per IEC61850 for substation automation

Utility Integration Bus

The Utility Integration Bus (UIB) is a standards-based integration platform designed to significantly reduce the engineering effort required to integrate data in the utility environment. The UIB extends off-the-shelf Enterprise Application Integration (EAI) middleware with utility specific extensions for support of distributed power system models, and standards-based application programming interfaces (API) using XML messaging. The UIB enables you to build a flexible model-driven architecture for application integration and data warehousing to leverage existing power system related application investments.

SISCO’s UIB products include off-the-shelf adapters as well as toolkits for building custom adapters for your own applications. SISCO UIB adapters are currently available for the OSIsoft PI System, ICCP-TASE.2, and any communications protocol or application using an OLE for Process Control (OPC) interface. Our OEM partners have developed adapters for power system model management and advanced power applications like power flow, contingency analysis, state estimators, etc.

The UIB utilizes standards based APIs that are widely supported. This enables the adaptation of many existing off-the-shelf application products from hundreds of suppliers for use in a UIB based system. But, the UIB goes beyond simply supporting the standardized APIs. The UIB also enables these existing products to present their data to other applications on the UIB in the context of the common data exchange model, *even if they haven’t been designed to support a model-driven approach*. SISCO’s UIB adds object mapping and location services to these standard APIs. Object mapping wraps the existing non-model aware data source with a model aware view of the data so that UIB applications do not have to understand how other applications represent data. SISCO’s UIB then adds location services to hide the details of where applications are on the bus. The result is an application integration architecture that provides all data in the context of the model that is independent of how the data source stores data or where it is located. You can then change or move data sources across the bus without affecting all the previous integration work.

The UIB APIs present data in the context of the common data exchange model, which isolates the applications from the internal storage and representation of the data and the location of each data element on the bus. The result is a vastly improved integration architecture that can accommodate existing off-the-shelf programs that support the popular OPC specification without losing any of the benefits of the model driven architecture offered by the UIB. Applications become more like plug‘n’play increasing choices and options for the user and lowering system implementation and maintenance costs.

With traditional approaches, applications must be pre-programmed with tag names in order to access data. Even using a table driven methodology, applications remain dependent on the internal representation and storage of data because the tables need to be maintained. With the model-driven approach of the UIB and its APIs, applications become completely independent of the internal representation and storage of data by other applications. Instead, applications discover the data they need by finding it in the model reducing or eliminating configuration and increasing application reusability.

ICCP-TASE.2 Interface for the Utility Integration Bus

SISCO's Utility Integration Bus (UIB) ICCP-TASE.2 Interface provides integration with remote systems supporting ICCP (IEC60870-6 TASE.2) with control center and enterprise applications using the UIB. The UIB ICCP interface leverages important industry standards such as EPRI's Common Information Model (CIM) and the OMG Data Access for Industrial Systems (DAIS) and Data Access Facility (DAF) standards to provide a unique and powerful solution for ICCP-TASE.2 integration:

- The UIB ICCP Interface provides access to the ICCP data by publishing ICCP data as CIM measurements.
- DAF based client applications (e.g. the DAF browser provided with the UIB) can manage the configuration of the UIB ICCP Interface by adding and deleting CIM measurements.
- DAIS clients can access ICCP data as CIM measurements via a standardized publish/subscribe interface without having to have knowledge of the ICCP point names or configuration.

The result is a powerful standards-based ICCP-TASE.2 integration tool that goes beyond simple ICCP-TASE.2 front-ends or gateways to simplify integration of control center and enterprise applications by eliminating the burden of handling special ICCP configuration and data transformations.

UIB Adapter for the OSIsoft PI System

SISCO's Utility Integration Bus (UIB) adapter for the PI System (PI) from OSIsoft combines the power of the OSIsoft world-leading platform for real-time performance management with the application integration and common information exchange model capabilities of SISCO's UIB. The UIB PI adapter receives modeling information, such as a network connectivity model typically maintained by a network modeling tool, EMS, DMS, or GIS system; and automatically configures the PI Module Database (PI MDB) for those points that are being historized by the PI Server. The UIB Adapter organizes the PI tags within the context of models familiar to the user such as EPRI's Common Information Model (CIM), existing models from other applications like GIS or EMS, or a user-defined power system model. Changes made to the connectivity model are delivered via the UIB to the UIB PI adapter, which automatically creates the PI MDB entries, and PI configuration needed. The UIB and PI System provide a unique cost saving solution for electric utility users that minimizes manual reconfiguration and data handling.

The OSIsoft PI Server organizes data as an array of tags with history. Typically, users have developed their own customized naming strategies as a way of representing the relationship of one tag to another tag. The tag relationships and model information can be conveyed to the user of the information that understands this naming strategy. Relying solely on encoded tag names makes the resulting displays and applications more highly customized to that naming strategy. This can increase the complexity and cost of developing reusable generic displays and applications that make use of the information.

To illustrate this, imagine that a tag for status information associated with a breaker in an AIRPORT substation is given the PI Tag name of AIRPORT_B1_001. Another breaker in the same substation may have a tag name of AIRPORT_B2_003. Even though the tags represent the status of breakers, the unique names create difficulties in developing reusable generic breaker applications and displays.

The PI Module Database (PI MDB) allows model and relationship definitions to be defined, through the use of Modules. The SISCO UIB PI UDS Adapter enhances the capability of the PI MDB through algorithmic and model centric population and maintenance of the PI MDB. The Adapter allows for model relationships based upon class hierarchy (e.g. a breaker is a type of switch) and instance relationships (e.g. a breaker contained within a given substation) to be visualized and maintained as part of the PI MDB.

The benefit, to the user, is that programming based upon prior knowledge is minimized. Consistent algorithms for displaying information (e.g. Status) can be programmed in PI ProcessBook instead of relying on hard coded tag names. This will significantly decrease application life-cycle costs (e.g. development, deployment, and maintenance) because it reduces the number of unique displays and applications that must be supported.

A module has *properties* and *aliases*. Through modularization, object definitions are created for each equipment type (e.g. Breakers). Particular instances of breakers become PI Modules with user assigned names (e.g. Breaker32) and an alias (e.g. Status) that can be referenced to the appropriate PI Tag. Using the alias allows applications to be written generically (e.g. for all breakers) without requiring the prior knowledge of the specific tags. The cross-referencing of the alias to the PI Tag can be done algorithmically resulting in a reusable generic display or application.

SISCO's UIB PI Server Adapter consists of: the adapter itself and a Process Book compatible ActiveX™ Control. The software allows for model creation and maintenance in the PI MDB either manually or automatically. Both of these mechanisms allow for standardized or customer defined models to be used.

Manual model creation and maintenance is performed through the import of eXtensible Markup Language (XML) Resource Description Format (RDF) files whose format has been standardized within the International Electrotechnical Committee (IEC). The two formats that have been standardized allow for schema/model definitions and actual object instance information to be conveyed using XML RDF.

Automatic model creation and maintenance is enabled through the use of SISCO's Utility Integration Bus (UIB). Using the UIB with the PI Server Adapter allows changes made in an external model to be automatically delivered to SISCO's PI Server Adapter and to other non-PI applications as well (e.g. network applications, GIS, EMS, and others). The model repository can contain model information relating to standard models (e.g. CIM, IEC, ISA, …), customer defined models or models residing in other applications such as GIS, EMS, ODMS, and other network modeling applications and tools.

Users of the PI MDB, and other PI MDB related tools, will have the ability to view the relationship between measurements and equipment. The SISCO UIB Adapter creates and maintains the various relationships specified by the model definition. As a result, it is now possible for a PI MDB user to locate a transformer (e.g. TXAP) that is contained within a substation whose name is AIRPORT without having to know the PI tag in advance.

B
TEST CONFIGURATION DATA

Test Procedures

The test procedure for this series of tests was *CIM XML Interoperability Test 9 Test Plan and Procedures*, Revision 1, September 29, 2006 contained in the following file:

- Test procedures: cim_gid interop test 9 plan r1 092906.DOC

CIM Baseline Version for Testing

The version of the CIM to be used for these tests is 10. Specifically, the CIM RDF Schema version of this file will be used. Any file generated or imported will conform to this RDF Schema, although not all classes, attributes, or relations defined need to be included.

The files to be used for the CIM UML and RDF schema at the time of this revision were as follows:

CIM UML file: cim61970_v003_WG13cimissues-CPSM_3.0-16 Aug 2006.mdl

CIM RDF Schema file: CIM-61970-060915 Fixed.rdfs

The namespace for properties and classes to be used in the model files is:

http://iec.ch/TC57/2006/CIM-schema-cim10#

RDF Syntax

The RDF syntax approved for these tests is the Reduced RDF (RRDF) Syntax defined in the draft IEC 61970-552-4 CIM XML Model Exchange Format document [14] and IEC 61970-501 CIM RDF Schema. Files produced may contain syntax definitions beyond the RRDF Syntax, but only the RRDF Syntax will be used to completely express the power system model in the file produced for testing. Participants reading files will be expected to properly interpret the RRDF Syntax definitions contained therein but are not required to interpret and use any definitions beyond the RRDF Syntax.

The specification to be used for the RDF syntax definition at the time of this revision is Reference [13].

Test Files

Each participant was given the opportunity to post a sample model file that they produced using the Reduced RDF Syntax approved for these tests.

The test file for the CIM 10 Validation, Full Model Import/Export and Solution tests is one of the following files (selected by the participant):

1. Areva 60 Bus Model: *Areva60_CPSM3_CIM_20060927.xml*
2. ABB 40 Bus Model: *ABB40bus2006-09-27.xml*
3. EDF UCTE 14 Node file: *utce_14_i3e_20060928.xml*
4. EDF 27 Bus File: *edf27_caplim_20060928.xml*
5. WAPA 262 Bus Model: *wapa262busCPSM.xml*

These filenames may be modified prior to the test and if they are, the revision number will be appended to the end of the filename.

The test file for the 61968 Part 13, Distribution Model Exchange, the EDF aigue0809.xml file was used.

The SISCO/PTI project tests will use a CIM XML file that represents the customer's EMS Network database. This file will be pre-loaded into a CIM-Structured Oracle Database.

The incremental model update test will use one or more of the following files created from the GE WAPA 262 Bus model by GE:

- *add_Line.rdf*
- *add_Load.rdf*
- *add_Xfmr.rdf*
- *mod_Xfrmr_r-etc.rdf*
- *mod_Line_x.rdf*
- *mod_Load-move.rdf*
- *del_Load.rdf*

Other incremental files may be generated during the test and, if so, these will be listed in the incremental test results section of this document. An incremental file that has been generated by participant A may be used by participant A in the exchange tests.

Tools

The tools used for the interoperability testing include:

- CIMVT Validation Tool and documentation developed by Areva is available from the CIM User's Group site (http://sharepoint.ucausersgroup.org/CIM from the Public Documents/CIM Tools folder.)
- RDF Generator (Xpetal) (to convert UML to EFD) and documentation is available at the cimxml egroup site and on the SourceForge web site. The latest version can be obtained from http://www.langdale.com.au/styler/xpetal.

A full description of the CIM Validations tools is provided in the IOP 9 Test Plan and Procedure (Reference 2).

C
GID FUNDAMENTALS

The GID (Generic Interface Definition) provides a set of APIs to be used by software applications for accessing data and for exchanging information with other applications. It builds on existing industry interface standards in common use to provide additional functionality and tailoring to meet the needs of applications dealing with utility operations. Because these APIs are application-independent, they are considered to be generic and common across applications (hence the name GID). By using the GID, the system integrator or software developer is able to create a variety of software components but avoid having to develop software conforming to multiple and potentially conflicting programming models.

The GID development was sponsored by the EPRI CCAPI project. The EPRI GID defines interfaces in the following categories:

- Generic Data Access (GDA): This interface provides a Request/Reply capability which allows data access (read/write) with change notification and browsing (i.e., navigation) based on the CIM without knowledge of logical schema. This interface is based on the OMG Data Access Facility (DAF).
- High Speed Data Access (HSDA): This interface provides both a Request/Reply and Publish/Subscribe capability designed primarily for high volume, efficient, periodic SCADA data transfers. This interface is based on the OPC Foundation Data Access specification.
- Generic Eventing and Subscription (GES): This interface provides a Publish/Subscribe capability which allows a message to be published once with multiple subscribers receiving the message based on topic (i.e., content) filtering. This interface is based upon the OPC Foundation Simple Eventing.
- Time Series Data Access (TSDA): This interface provides both a Request/Reply and Publish/Subscribe capability designed primarily for exchanging time series values. The intended use is for retrieval of historical/archival data.

The GID is being progressed as a part of the IEC 61970 series of standards. In addition to Parts 403, 404, 405, and 407 which apply to the four sets of services above, respectively, Part 401 provides an overview and roadmap to the GID and Part 402 defines a set of common services used by all interfaces, including a naming service for browsing GID server databases.

Compliance with the GID standard requires implementation of the Common Services, Part 402 plus one or more APIs (Parts 403, 404, 405, or 407), although which parts are used for any particular component is a design choice.

Additionally, there are constraints placed upon the GID standards when used in conjunction with the CIM model. These constraints can best be summarized as a definition of a standardized namespace hierarchy as described in Reference 12. Therefore, compliance to the standardized interfaces and namespace definitions were both required in order to claim conformance for these tests.

D
TEST APPROACH AND DESCRIPTIONS

CPSM Full Model Transfer

Figure D-1 shows the process applied by the products under test to export and/or import CIM XML files (also referred to as CIM XML documents). For export, an XML/RDF version of the CIM is used by a product to convert a proprietary representation of one of the sample model files into a standard CIM XML representation of that model. The CIM XML document can then be viewed through a browser using an XSL Style Sheet to format the contents for human readability. Separate XML tools are used to validate the format of the file and the conformance with XML and the RDF Syntax. An XML/RDF Validator tool developed for earlier tests was used during this test to confirm that the CIM XML documents created on export were both well-formed and valid. This tool also provides a count of the number of instances of each CIM class specified in the NERC CPSM Minimum Data Requirements document (see Reference 1)

For import, the application under test converts from the standard CIM XML representation to the product's proprietary internal representation. Product specific tools are used to validate the import was successful.

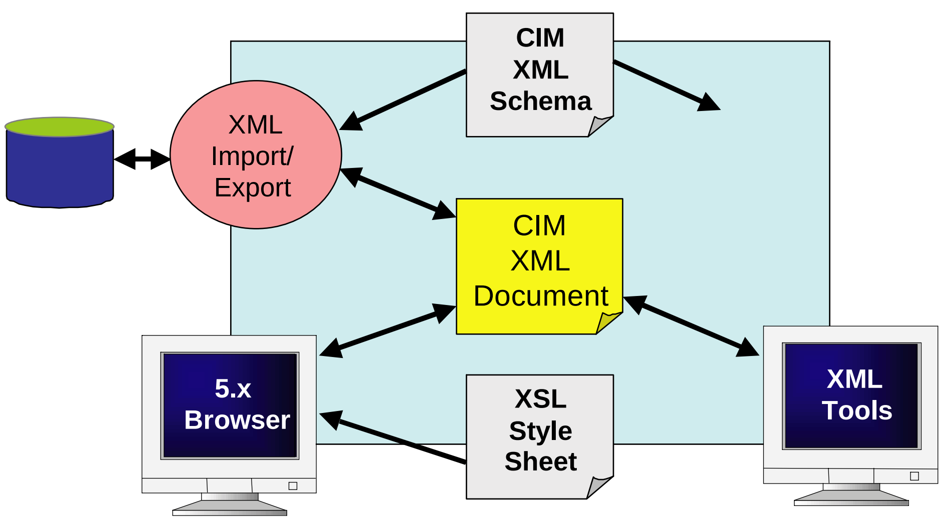

Figure D-1
Export/Import Process Basics

CPSM Interoperability Testing with Complete Power System Models

First, each participant's product had to demonstrate correct import/export from/to the standard CIM XML/RDF format. This showed, to the extent measurable, product *compliance* with the standard. Second, each participant able to successfully export a file to the CIM XML/RDF format then uploaded that file to the JumpDrive to make it available for the other participants to import. When other participants were able to import these files, the *interoperability* of different vendor's products was verified and demonstrated.

The basic steps involved are illustrated in Figure D-2 below. Each participant (Participant A in the figure D-2) was first required to import the CIM XML-formatted test files (CIM XML Doc 1) and demonstrate successful conversion to their product's proprietary format (step 1). If the product had an internal validation capability to check for proper connectivity and other power system relationships, that was used to validate the imported file. If the import was successful, the file was then converted back into the CIM XML format (step 2) to produce CIM XML Doc 2, which should be the same as the original. Participant A was required to demonstrate compliance by running the XML/RDF validator tool on the exported file (step 3). If successful, the exported file was then re-imported to verify that no changes were introduced in the process of converting to the CIM XML format and then back again to the internal product format (Step 4).

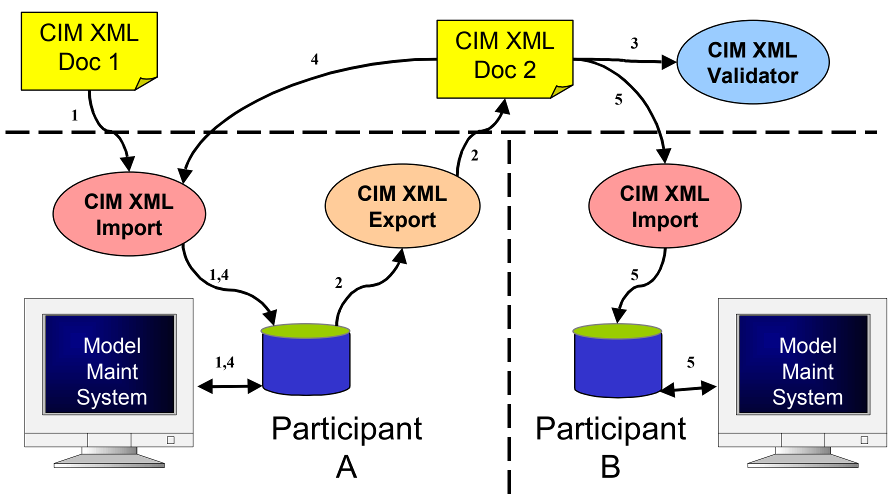

Figure D-2
CIM XML Interoperability Test Process Steps

At this point the exported file was also loaded onto the JumpDrive for another participant (Participant B in Figure D-2) to import and verify that the model imported is in fact the same as the model initially stored in Participant A's application (Step 5). This final step demonstrates interoperability of different vendor's products through use of the CIM XML/RDF standard.

One of the key issues evaluated with these tests is that while all vendors must export and recognize on import the CIM classes specified in the NERC CPSM profile, additional classes exported by one vendor may not be used by the vendor importing the model file, and vice-versa (i.e., one vendor may not export certain classes outside the NERC profile that the importing vendor does use in its internal applications).

Power Flow Solution Test (Using CPSM or CDPSM Model Files)

As stated earlier, the objective of the Power Flow Solution testing was to verify the correct exchange and transformation of power system model files including generation and load through the execution of power flow applications, not the exchange of power flow solutions. Therefore, the test approach involved a round trip exchange of power system model files, with an execution of a power flow initially on Participant A's EMS, then after sending the model file at the Participant B's EMS, and finally after being transferred back to Participant A, executed once more on Participant A's EMS.

Verification was accomplished by a comparison of solutions before and after transformation and model exchange, as illustrated in Figure D-3.

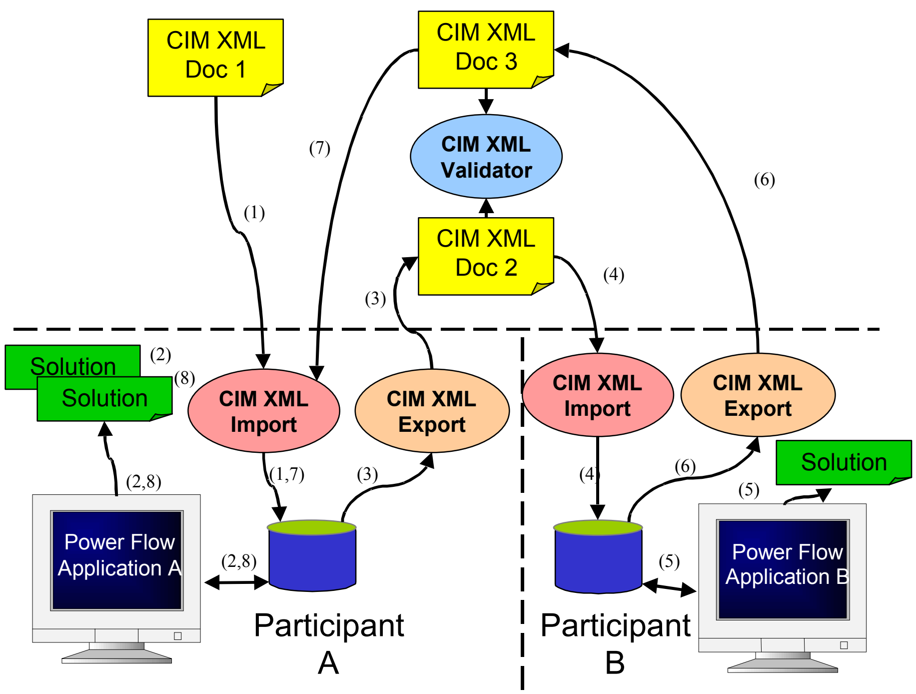

Figure D-3
Solution Test Process

The steps for this process were as follows:

1. Participant A imported a standard power system model file (CIM XML doc 1) and converted to local representation. The imported model in local representation was then validated using participant's display tools.
2. Participant A then ran a power flow and saved the solution.
3. Participant A exported a file, creating CIM XML Doc 2.
4. Participant B imported CIM XML Doc 2 and converted to local representation. The imported model in local representation was then validated using participant's display tools.

5. Participant B then ran a power flow and checked to verify correct operation. Comparison with Participant A's results from step (2) was the first measure of success for this test.
6. Participant B then exported a file, creating CIM XML Doc 3.
7. Participant A imported CIM XML doc 3 and converted to local representation. The imported model in local representation was then validated using participant's display tools.
8. Participant A then ran a power flow and compared results with the solution obtained in step (2) to determine if the solutions matched within a reasonable margin, which was the second measure of a successful test[2].

The reason for a complete round trip is recognition that solutions generated by Power Flow applications from different suppliers may be different and not readily comparable.

CPSM Incremental Model Update

This test used the WAPA 262 bus model file developed for this test as a starting point. Then change files were created to add, delete or modify the model. The format and syntax for this file is described in Reference 14.

Test Process

Once the model was imported by all participants, a difference file was produced and used as an import file by one or more participants. This tested the ability to produce a correctly formed file with correct resource IDs, to interpret the file correctly and to apply it to the internally stored base model file.

Each participant in the incremental model update test followed these steps:

1. import the base model file and validate, then
2. import the difference file, apply the updates to the base model file, and demonstrate correct interpretation of the difference file changes.

CPSM Partial Model Update

The partial model transfer test will demonstrate the ability of products to export and import a subset of a complete model, then stitch this partial model into a base model file.

This test may use several pairs of files to test a substation exchange scenario. Each model contained in the pair will be imported, merged and exported for validation. The scenario includes a partial model that has a substation removed as a starting point and a second partial model that contains a substation to be added. If this test is executed, the participant will first need to generate the partial model files.

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[2] The solutions of multiple runs of a power flow after exporting and re-importing from another participant were expected to result in consistent solutions with reasonable differences that result from model translation to local representation.

The test process below contains the steps for the substation scenario defined above. After execution of this scenario, the model may be imported by another participant for comparison and validation to prove the new file can be exchanged.

Test Process

The steps to process the Substation scenario are as follows:

1. Participant A imports a model with a substation missing (the base model file).
2. Participant A imports a partial model file containing a new substation and merges with the proper base model file. The imported model in local representation is then validated using participant's display tools.
3. Participant A exports the merged model file and validates.
4. Participant B imports the merged model file and validates correctness using display tools.
5. Participant B imports original model file with the substation already merged and compares with newly imported merged file from Participant A.

61968-Part13 CDPSM Full Model Update

The test approach and test process for the CDPSM profile model exchange is the same as for the CPSM profile; therefore, this information is not repeated here. For a full description of these tests, please refer to the CPSM Full Model Update section of this appendix. These tests actually use the same test procedures as those listed in the CPSM section.

Generic Eventing and Subscription (GES) Testing

Based upon the definitions and philosophy of the GID, IEC 61970 Part 405 Generic Eventing and Subscription (GES) testing applies primarily to two or more components exchanging standard messages. For this interoperability test, messages defined in draft IEC 61968 Part 3, Network Operation – Outage Management are used. This test document recognizes the need to test the conformance of relevant messaging standards in addition to the interoperability of GES clients and servers.

As a result, testing is divided into two parts:

- Conformance testing – dealing with the ability of the GES server to correctly conform to the standard. That is, a GES server must faithfully present one or more hierarchical views of a power system model as well as faithfully present standard message schema for browsing. This test applies only to GES servers.
- Interoperability testing – dealing with the ability of a client ability to interoperate with a server. That is, to allow clients to subscribe to messages in the context of a power system model as well as to send and receive standard messages.

Since the IEC 61970 405 GES interface standard is a Platform Independent standard and does not specify a particular architecture or technology to use in an implementation, it is necessary to define this as part of the test to ensure all components can exchange data without any barriers. The figure below provides a sample architecture using components that expose interfaces conforming to the OMG DAIS Alarming and Eventing standard. The exact architectures used during this test are defined in the Conformance and Interoperability sections below.

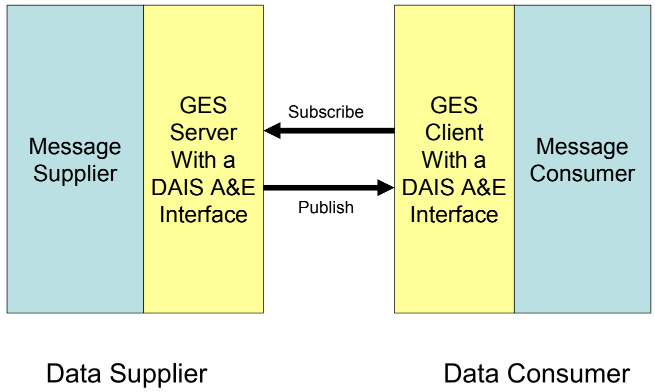
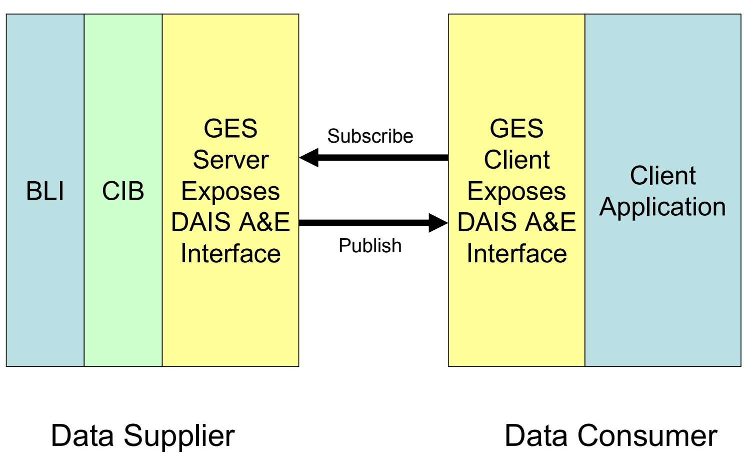


Figure D-4
GES Architecture

With the EDF power system model and messages, the data to be exchanged are Outage Created, Closed, and Changed messages related to business objects modeled in an EDF CDPSM model.

With regard to how this could be deployed at EDF, a component called the "BLI" is the original mechanism on which outage data is exchanged. The BLI is the Software Data Bus used in EDF's Distribution Remote Control Systems. An application is connected to the BLI creates Outage Data and send this data to a component called the "CIB". The CIB generates a compliant 61968-3 Outage Record Message, which can be exchange with in the context of the CIM using a GES interface. Any GES client application can register via GES in order to receive outage messages. The diagram illustrates how the GES Clients and Servers under test could be deployed at EDF.

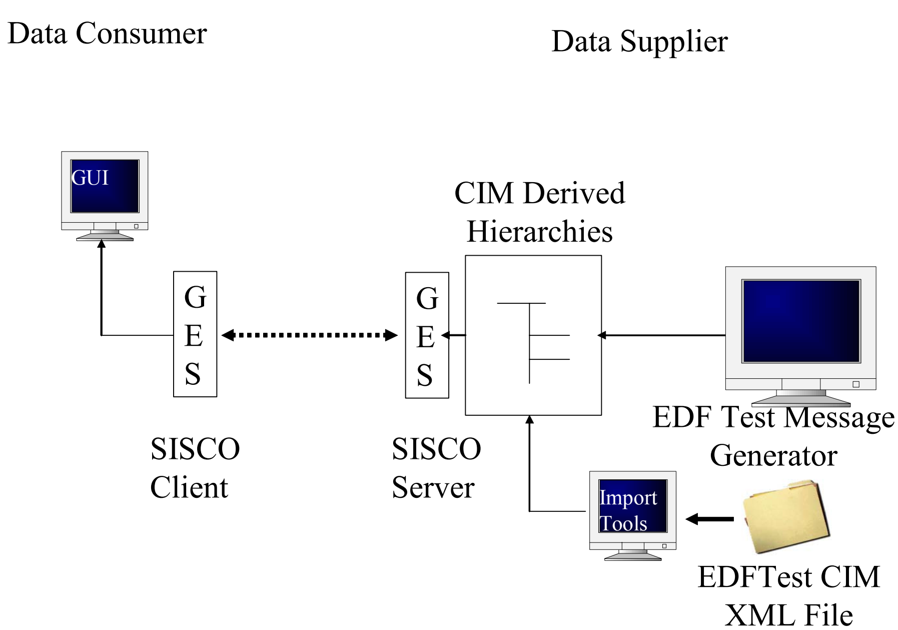


GES Conformance Testing

Conformance testing of GES is primarily a server issue. The main focus of a GES conformance testing is to validate the new requirements imposed on WG 14 message exchange due to subscribing to messages within the context of a CIM NameSpace. The GES functionality to be tested and demonstrated in the server product includes:

- Establishment of a connection by a client to a server.
- CIM based hierarchical browsing and subscription to messages supplied by the server (i.e., the ability to view and subscribe to available data in a CIM-compliant fashion without knowledge of how data is internally organized in the server).
- Data exchange (e.g. publish/receive) where individual WG 14 messages are faithfully transferred.

The Figure below illustrates the test set-up used for conformance testing. A GES client and server were supplied by SISCO's to exchange EDF data within the context of an EDF power system model. EDF supplied a CDPSM schema file, a CDPSM model file, WG 14 message schema, and WG 14 compliant outage messages. SISCO's server under test imported the EDF power system model file and SISCO GES Toolkit was used to populate hierarchical views of the power model. EDF supplied Outage messages containing data related to power system elements described in the model file. This provided the ability for a client to describe what power system elements it was interested in receiving messages about. That is, by using a hierarchical view of a CDPSM file, the client was able to indicate to the server what CIM information it is interested in. The server under test provided the technology for exchange of the selected messages that contained the selected content.



In the diagram above, a client acting as a GES client browses one or more CIM derived hierarchies to select what part of the power system model it is interested in. For example, the client could select a certain geographic region, set of assets (as well as what type of message). The part of the CDPSM model the client is interested in receiving information about is stored in the GES Server. When Outage messages are passed to the GES Server, the Server determines if the client is interested in the message based on whether the client has selected that part of the CDPSM model during subscription. Messages about CIM class instances not selected during the subscription process are not passed to the client.

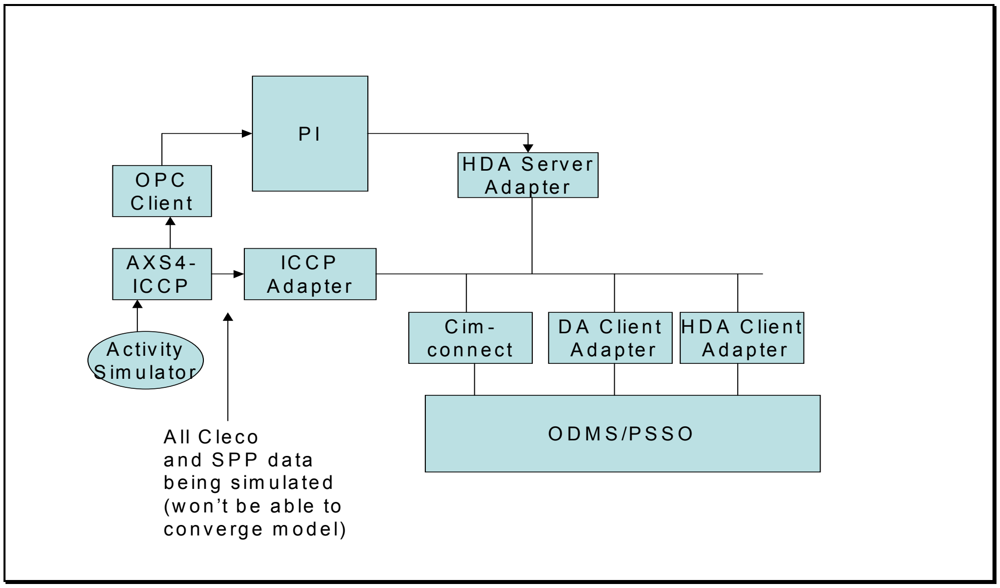
Project Testing

This particular project test will test the IEC 61970 standards as implemented within SISCO's GID Adapters, SISCO's UIB and Siemens PTI's PSS/Odms. When combined together, these components form a complete integration platform.

The primary focus of this test will be to fully explore the functionality of the SISCO and PTI CIM and GID implementations for Control Center interoperability. In this case the project was to implement a set of network applications into the control center environment while preserving the SCADA and Generation applications from another vendor. The project goals were to incrementally upgrade the legacy EMS within the Control Center and provide the following:

- Integration of a message bus middleware platform
- Implement and integrate a set of third party applications (PTI's PSS/Odms) with the legacy EMS system
- Send and Receive ICCP data to and from the Utility and the ISO or other surrounding utilities.

By sharing a common design framework, a message based application integration platform was built. The project involves the integration of network transmission applications using the UIB message bus as the middleware. The diagram below illustrates the project components.



The principle motivation for the project is to facilitate incremental upgrading of the EMS and provide a framework that will allow easy integration of other applications. In this case, the network applications contained within PSS/O are being integrated with the legacy EMS using a CIM based modeling tool called the Operational Database Management System (ODMS). ODMS, a more full featured version of EPRI's CIM Installer, supplies modeling information to the network applications via proprietary mechanisms. ODMS also supplies modeling data for other applications via a CIM/GID interface.

ODMS also supplies a portion of the power system model to the UIB PI Adapter. An application uses the GID to expose information within the context of the CIM. In this case, the PI Adapter imports a small amount of the power model so that it can expose archive data within a CIM context.

Test Process

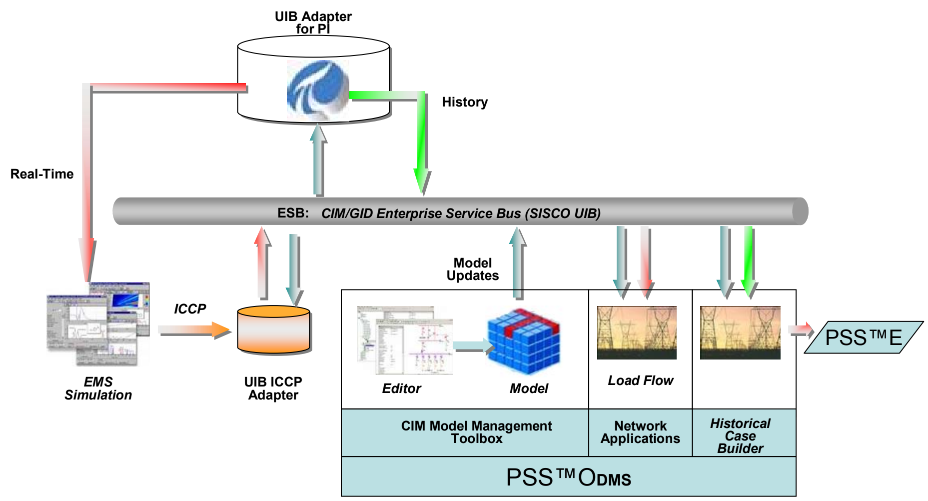


Figure D-5
Logical Information Flow

The purpose of the above configuration is to provide a demonstration of model driven integration based upon CIM/GID standards. The standards and information flow:

- ICCP (IEC 60870-6 TASE.2): This is a protocol that is used to exchange real-time information between EMS and SCADA systems.

  At Cleco, this protocol is used to obtain internal and external (e.g. other utility) EMS/SCADA information. ICCP is converted/mapped into CIM/GID HSDA (High Speed Data Access) through the use of the SISCO UIB ICCP Adapter.

For the demo, OSIsoft PI is being used to simulate the information normally received by the UIB at Cleco via ICCP. This includes simulation of internal and external ICCP Points. The simulation is accomplished through the use of OSIsoft Performance Equations. These PI Tags are then mapped to ICCP Tags. The mappings of these points is shown in Appendix B.

- High Speed Data Access: This is a CIM/GID interface standard that allows “real-time” information to be exchanged.

  For the purposes of the Cleco demo, the UIB Adapter for ICCP acts as the source for the “real-time” measurements for the ESB. Siemens/PTI’s PSS/O subscribes to the HSDA information based upon model driven subscription IDs.

- Time Series Data Access: This is a CIM/GID interface standard that allows historical information to be queried.

  Although Cleco does not currently use this capability, the demo is configured to allow TSDA access (similar to what is being done at LIPA). The repository of the historical information is based upon the simulated points generated within PI.

- Generic Data Access: This is a CIM/GID interface that allows full model and model updates to be conveyed.

  Cleco makes use of Siemens PTI’s ODMS product as the editor and authoritative GDA repository for the UIB. It is used in a similar role in the demo.

There are three major areas that can be tested based upon the demo setup:

- ICCP/HSDA
- TSDA
- GDA Model Updates

Test Approach, Process and Procedures for each of the above areas are provided in the Ninth IOP Test Procedures (Reference 2).