EPRI

Report on the Common Information Model (CIM) Extensible Markup Language (XML) Interoperability Test #4

The Power of the CIM to Exchange Power System Models

Technical Report

Report on the
Common Information Model (CIM) Extensible Markup Language (XML) Interoperability Test #4

The Power of the CIM
to Exchange Power System Models

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REPORT SUMMARY

The Control Center Application Program Interface (CCAPI) and Common Information Model (CIM) translated into Extensible Markup Language (XML) provide an important standard for exchanging power system models. Previous interoperability tests validated the use and acceptance of this standard by suppliers who provide products to the electric utility industry. A fourth set of interoperability tests, conducted July 2002, extended this validation by testing new proposed standards for incremental model updates and partial model transfers. These tests also confirmed the capability of participants to transfer Inter-Control Center Communication Protocol (ICCP) configuration data. This report presents results of the fourth set of interoperability tests.

Background

EPRI spearheaded an industrywide CCAPI effort to develop open, interoperable applications for Energy Management Systems (EMS) in energy control centers through use of standardized interfaces. Central to the CCAPI concept is CIM, which defines the essential data structure of a power system model. The North American Electric Reliability Council had been searching for the best way to exchange power system models electronically. CIM—using the industry standard language XML—offered the best solution. The CCAPI project initiated an effort to map CIM into XML, which is supported by all major software platforms. Use of the Resource Description Framework (RDF) schema and syntax to organize XML was also adopted. To validate the XML and RDF standards for model exchange, EPRI planned a series of interoperability tests between products from different suppliers.

Objective

To report results of the fourth set of interoperability tests performed in San Francisco, California, July 15-17, 2002.

Approach

The project team prepared a formal set of test procedures to test the ability of vendor products to correctly import and export sample power system model files. After a period of preparation and preliminary testing, four vendors gathered in San Francisco to have an impartial observer test their products. Several sample model files were available for this test based on the ABB 40 bus and Siemens 100 bus models. In addition, real-life large-scale models from Duke Energy (1700 substations) and California Independent System Operator (CAISO) (approximately 2500 substations) used in previous tests were available. Incremental updates and partial models were exchanged and checked to validate proper merging with model files.

Results

This report summarizes the process and results for the fourth series of interoperability tests in five categories, as follows:

- Basic import/export of model files—Tests an individual product's ability to correctly import and export power system model files based on CIM XML standards
- Interoperability test and transfer of ICCP configuration data—Tests the ability of one vendor's product to correctly import a sample model previously exported by another vendor's product using CIM XML standards
- Incremental model update—Validates use of the new standards in sending different model files
- Partial model transfer set of tests—Requires a participant to import a partial model and merge it with a preexisting model from the same vendor
- Solution test—Verifies correct content of power system model files as well as exchange and transformation of files, including generation and load-through execution of power flow applications

EPRI Perspective

CCAPI compliance offers control center managers the flexibility to combine—on one or more integrated platforms—software that best meets their energy company's needs for system economy and reliability. This compatibility allows managers to upgrade, or migrate, their EMS incrementally and quickly, while preserving prior utility investments in custom software. Migration reduces upgrade costs by 40 percent or more and enables energy companies to gain strategic advantages by using new applications as they become available.

CCAPI/CIM-enhanced EMS foster an interdisciplinary approach to conducting business by enabling interdepartmental teams to access a range of needed information via open systems. Hence, in innovative applications, energy companies are planning to implement CCAPI and CIM outside the control center to reduce costs and improve customer service and staff productivity. EPRI continues to sponsor collaborative efforts to advance CCAPI and CIM capabilities for greater information systems integration solutions—in the control center and beyond.

Keywords

Application Program Interface
Energy Management Systems
Data Exchange
Common Information Model (CIM)
Extensible Markup Language (XML)

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 - evidence the recent rolling blackouts in California.

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 Center EMSs 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) recently 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.

This report presents the results of the fourth interoperability tests using these standards to exchange power system models between products from different vendors. The goal of this report is to raise awareness of the importance and status of this effort to encourage early adoption by additional product suppliers and energy managers.

David L Becker
EPRI
September 2002

ABSTRACT

On July 15-17, 2002 in San Francisco, California, software vendors serving the electric utility industry met for the fourth time to continue testing the capability of their software products to exchange and correctly interpret power system model data based on the CIM (Common Information Model). The CIM was 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). 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.

These interoperability tests address an important industry requirement established by NERC to be able to transfer power system model data (including ICCP configuration 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 and for any other application where a standard way of representing power system models is needed, such as combining multiple, proprietary-formatted power system models into a single merged internal model for an RTO.

New for this fourth test was the validation of new specifications for incremental model update to transfer only changes to an existing power system model. In addition, partial models were successfully transferred, translated, and merged using the existing specifications.

Vendors participating in these tests included ABB, GE Network Solutions, Langdale Consultants, and PTI (formerly PsyCor). KPMG Consulting prepared the test procedures, witnessed the test results, and prepared this test report for EPRI. This is an important milestone in the CCAPI project and is the fourth in a series of planned interoperability tests to demonstrate additional CCAPI capabilities.

ACKNOWLEDGMENTS

EPRI wishes to thank the many people who worked hard to make this fourth CIM XML interoperability test a success. Not all people who contributed can be named here. However, EPRI would like to give special recognition to the following vendors and contractors:

- Arnold deVos, Langdale Consultants, for preparation of the specifications used for the incremental model update and for his participation in these tests.
- Jerry Tennison, PTI, for provision of the LAN server for model management during the tests and execution of the interoperability tests for PTI, and Margaret Goodrich who assisted with the PTI tests.
- Dejan Miljkovic and Mostafa Khadem, ABB, for preparation of the incremental model test files and partial model test files based on the 40 bus model, and for participating in the testing.
- Ron Larson and Xiaofeng Wang, GE Network Solutions, for participation in the testing.
- Kurt Hunter, Siemens, for preparation of the Siemens 100 bus model and partial model test files based on this model.
- Enamul Haq, CAISO, for providing incremental model update examples.
- David Ambrose, WAPA, for assistance in witnessing and recording the test results as well as contributing to the testing approaches and ICCP configuration data needs of NERC.
- All participants, for bringing enthusiasm and focused energy with a true spirit of cooperation to San Francisco to make these tests a success. Their willingness to participate in these tests at their own expense is a testimony to their commitment to support the CIM standards and the utility industry's need for products to exchange power system models in a reliable, consistent fashion.

In addition, EPRI acknowledges Terry Saxton, KPMG Consulting, who prepared the test plan and procedures, witnessed the tests and recorded the results, and wrote this report.

Dave Becker
EPRI

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1
INTRODUCTION

This document reports the results of the fourth CIM XML interoperability tests, which took place on July 15-17, 2002, in San Francisco, California. Interoperability testing proves that products from different vendors can exchange information and request services based on the use of the IEC standards that have been developed as an output of the CCAPI project.

The test required that participating products conform to the IEC 61970-301 CIM Base standard, which is based on the CIM model file cimu10.mdl, the future IEC 61970-501 CIM RDF Schema Version 4, and a new incremental model update specification.

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

Objectives of Interoperability Test

The objectives of the interoperability tests and demonstrations were to:

1. Demonstrate interoperability between different vendor products based on the CIM. 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.

3. Demonstrate the exchange of power system models using the CIM and an RDF Schema and XML representation of the model data.

4. Demonstrate the ability of vendor products and XML tools to handle real-world, large scale power system models.

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. Provide the basis for a more formal interoperability and compliance test suite development for CCAPI standards. This would eventually become part of set of UCA 2 test procedures and facilities currently being developed by EPRI.

Specific objectives for the fourth interoperability test fell into three categories:

1. Test the transfer of incremental model updates (i.e., send all changes since the last update or since a specific date/time).
2. Test the partial transfers of models (i.e., condition-based using "where is …" type reasoning.) The tests focused on the transfer of complete individual substations.
3. Exchange of ICCP Object ID Configuration data.

This fourth test also provided the opportunity for more participants to complete the tests used for previous interoperability tests.

Scope of Interoperability Test 4

This fourth interoperability test involved CIM XML model files similar to those used in the first tests. However, the emphasis on the fourth test was the transfer of incremental model updates and partial model files as well as the transfer of ICCP configuration data.

The scope for these tests is described in use cases prepared for this test. The use cases are contained in Appendix: Use Cases.

In addition, this test also included a continuation of the tests defined for the third interoperability test for those vendors that did not participate at the time the third test was performed. Reference 5 contains a description of these tests.

Incremental Model Updates

The incremental model update tests were to validate the new specification developed by Arnold deVos for transferring changes to existing power system models. The specification is titled "RDF Difference Models – Representing the Difference Between Two RDF Models" and is available as file DifferenceModelsR05.pdf at the cimxml Yahoo Web site in the files folder "Most Current CIM Models, Schemas, and Syntax."

To test this capability, the incremental update examples provided by Enamul Haq from CAISO contained in Appendix: Incremental Model Update Examples. These examples were translated into equivalent types of changes in the existing sample model test files by the test participants.

The use case titled "Incremental Model Update" in Appendix D describes this capability.

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 use case titled “Partial Model Transfer” in Appendix D describes this capability.

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

ICCP Configuration Data Transfer

This test was to validate the proposed approach for transferring ICCP configuration data. This approach is described in the use case contained in Appendix D titled “Power System Model Exchange with ICCP/TASE.2 Linkage.”

The purpose of this capability is to send the information needed to be able to correlate the real-time SCADA point values transferred via ICCP with the proper measurements in the power system model.

Existing CIM attributes were used for the configuration data, so no changes to the CIM were required.

Scope of the CIM Tested

The portion of the CIM that was tested is defined in the NERC 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 (see Reference 1).

Organization of Report

This report presents results of the fourth CIM XML interoperability tests held in San Francisco.

The introductory chapter presents the objectives and scope of these tests. Chapter 2 describes the test plan that was followed and identifies the participating vendors 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 are also provided. The first three appendices contain a description of the participant’s products used in the tests (Appendix A); the test configuration data, including specific versions of the CIM in UML and XML/RDF, sample model files, and test tools (Appendix B); and issues and resolutions that arose during the tests (Appendix C). The remaining appendices contain the use cases that define the capabilities being tested (Appendix D) and examples of incremental model updates (Appendix E).

References

1. CPSM (Common Power System Model) Minimum Data Requirements in Terms of the EPRI CIM, version 1.8, March 2002.

2. *CIM XML Interoperability Test 4*, Test Plan and Procedures, Revision 1, July 14, 2002.

3. *Report on the First Common Information Model (CIM) Extensible Markup Language (XML) Interoperability Test*, The Power of the CIM to Exchange Power System Models, Product Number 1006161, Final Report, February 2001.

4. *Report on the Common Information Model (CIM) Extensible Markup Language (XML) Interoperability Test #2*, The Power of the CIM to Exchange Power System Models, Product Number 1006216, Technical Progress, October 2001.

5. *Report on the Common Information Model (CIM) Extensible Markup Language (XML) Interoperability Test #3*, The Power of the CIM to Exchange Power System Models, EPRI, Palo Alto, CA: 2001. 1006217.

2
THE TEST PLAN

Each application participating in this test was required to (1) generate and export a file that conformed to the standards for the specific model data defined for the test and/or (2) import a file from another vendor's product and correctly interpret the model data contained. A formal set of test procedures were prepared and used to conduct and score the tests (see Reference 2). In addition, participants were also given the opportunity to run power flow solutions on the imported files as another way to validate the proper handling of imported models.

Participating Vendors and Their Products

Each participating vendor was required to use an actual product so that testing would demonstrate interoperability of real products. The participating vendors and their products are listed in Table 2-1 below. Table 2-1 also describes the hardware platform and operating system used.

Table 2-1
Participating Vendors and their Products

Vendor	Product Name	Platform	OS
ABB	SABLE – Open technology system for implementation of Business Management and Energy Information systems.	COMPAQ Alpha server DS10, 600 MHZ	UNIX 5.0F
GE Network Solutions (1)	XA21	Sun Blade 100, 1 GB RAM	Solaris 2.8
GE Network Solutions (2)	Enterprise Gateway	IBM-compatible PC, 512 MB RAM	Windows 2000
Langdale Consulting	CIMBuilder – Knowledge Representation tool for managing CIM models.	X86-based PC. (Test unit configured with 700Mhz PIII, 196MB.)	Windows 2000
PTI	ODMS – Data Repository and Data Management System	IBM-compatible Laptop PC	Windows 2000

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

Test Approach

As stated in the Introduction, there were three major categories of new tests – incremental model update, partial model transfer, and ICCP configuration data. Participants were encouraged to perform either one, two, or all three of these tests.

These tests were performed by participants with the same class of products used in Interop Test 3 (i.e., modeling or browser tools along with the CIM validator tool were sufficient to demonstrate correct operation.)

For those participants performing the tests conducted in the third interoperability test, there were another three categories of tests – a CIM 10 Validation test, a Scalability test, and a Solution test. Participants were encouraged to perform either one, two, or all three of these tests if not already completed. The CIM 10 Validation and Scalability tests were performed by participants with the same class of products described above, but the Solution test required the use of power flow applications to operate on the power system models to calculate power flow solutions. Solutions obtained were used to validate the correct transfer and transformation of model files between participants. The Solution tests used the same model files as the CIM 10 Validation tests to create confidence that the appropriate information is being exchanged and interpreted correctly, thus avoiding performance issues associated with large models, whose solutions can be checked in future tests. Since these tests were described in the Third Interoperability Test Report (see Reference 5), they are not discussed any further in Section 2.

Incremental Model Update

This test used the updated sample model files from Siemens and ABB as a starting point, since these files have the X base addressing required for consistent resource IDs. Then the types of changes described in the incremental_update_example.doc file described earlier were used to create a difference file containing these changes.

Test Process

A difference file produced by one participant was imported by another. This tested the ability of the first participant to produce a correctly formed file with correct resource IDs, and tested the second participant to interpret this file correctly and apply it to the internally stored base model file.

Each system participating in the incremental model update test followed these steps:

1. import the base small 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.

Partial Model Transfer

The partial model transfer test demonstrates 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 used the sample model files from Siemens that had a substation removed. Then a substation partial model file was exported and imported, the partial model merged with the base file, and the merged model exported for validation.

Test Process

The steps for this process were as follows (the same process applies to the ABB model with substation Troy):

1. Participant A imported the “Siemens100 Less Port” base model file that did not contain Substation Port.
2. Participant A imported a partial model file containing a new substation Port and merged it with the base model file, to create a new model “Siemens100 Plus Port”. The imported model in local representation was then validated using participant’s display tools.
3. Participant A compared this new model “Siemens100 Plus Port” with previously imported sample model file “Siemens100” that already contained Substation Port.
4. Participant A exported the merged model file “Siemens100 Plus Port” and validated it.
5. Participant B imported the merged model file “Siemens100 Plus Port” and validated correctness using display tools.
6. Participant B imported original base model file “Siemens100” and compared with newly imported merged file “Siemens100 Plus Port” from Participant A.
7. Extra credit was offered for creating and exporting a new partial model file that is demonstrated to be correct by validation and import by another participant.

ICCP Configuration Data Transfer

The ICCP configuration data transfer test demonstrated that ICCP configuration data prepared by one participant was imported and correctly interpreted by another participant.

The test used the small model files from Interop Test #3 with instance data for 20 ICCP points included.

Test Process

The steps for this test were as follows:

1. Participant A added ICCP configuration instance data and exported sample model file.

2. Participant B imported the file exported by Participant A and validated the contents of the ICCP configuration data.

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 (Reference 2).

Table 3-1
Description of Tests Performed

Step from Test Plan	Test Description
	Basic Import/Export
3.1.1	*Basic Import*
-1	Participant A import 40 bus model and demonstrate import was done correctly
-2	Participant A import 100 model and demonstrate import was done correctly
3.1.2	*Basic Export*
-1	Participant A export 40 bus model and run validator
-2	Participant A export 100 bus model and run validator
3.1.3	*Interoperation* - Participant B import of Participant An exported CIM XML file.
	Incremental Model Update
3.1.4	*Export Incremental Update File*
3.1.5	*Import Incremental Update File and Merge*
	Partial Model Transfer
3.2.1	*Import Partial Models and Merge*
3.2.1.1	Import sample model with substation removed
3.2.1.2	Import sample model for single substation
3.2.1.3	Merge model files
3.2.2	*Exchange Merged Model Files*
3.2.2.1	*Export merged model - Participant A exports merged model file*
3.2.2.2	Re-import merged model - Participant A re-imports exported merged model file
3.2.2.3	Participant B import merged model file from Participant A and validate
3.2.3	*Export Partial Model File*
	ICCP Configuration Data Transfer
3.3	*Import of previously exported model file with ICCP data*

Summary of Test Results

The following sections report the highlights of the testing.

Basic Import/Export and Interoperation and ICCP Configuration Data Transfer

Basic Import and Export

Table 3-2 shows 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 and export one of the sample model files to show compliance, although all sample model files were available for further demonstration of interoperability. All of the participants were able to pass this test. Highlights of the tests are as follows:

- All participants were able to successfully import and export the Siemens 100 bus model file correctly converting from the CIM XML format to their internal proprietary format. PTI's export was successful except for omitting several classes with their values.
- GE Network Solutions successfully imported the ABB 40 bus model with some errors.

Table 3-2
Basic Import/Export Test of Individual Products

Test Procedure	3.1.1 Basic Import		3.1.2 Basic Export	
Test Number	1 40 Bus Model	2 100 Bus Model	1 40 Bus Model	2 100 Bus Model
ABB	P	P	P	P
GE Network Solution	PE	P		PE[1]
Langdale		P		P[2]
PTI		P		P

Notes:
P (Passed) – all aspects of the test were performed successfully
PE (Passed with Errors) – most aspects of the test were performed successfully
O – Originator of model (Model originators did not import or export their own models in this test step.)
Blank entry – indicates test was either skipped or not witnessed
N/A (Not Applicable) – product does not support the functionality to perform this test

[1] Export contained extra switch, breaker was changed to switch on export, measurements and terminals were lost in export, but model was valid.

[2] Validator was not run.

Interoperation and ICCP Configuration Data Transfer

This section documents the pairs of vendors that were able to demonstrate interoperation via the CIM XML formatted-model file. Though the CIM XML documents are from different parties, the test verification for import and export followed the same pattern as done on the tests of individual products above. This section also documents the results of the ICCP configuration data transfer.

These tests demonstrate true interoperability by exchanging CIM XML documents produced by different participants. A Pass indicates that a pair of vendors successfully demonstrated the exchange of a power system model file using the CIM XML format. The specific model file exchanged is also identified.

Highlights of the tests are as follows:

- GE Network Systems and Langdale successfully imported the Siemens 100 bus model exported by PTI.
- PTI successfully imported the Siemens 100 bus model exported by GE Network Systems.
- ABB and Langdale successfully imported the ICCP configuration data contained in the Siemens 100 bus model file.

Incremental Model Update

This section shows the results of the incremental model update file exchanges. ABB and Langdale participated in these tests.

The first test required a participant to make incremental changes to a sample model file and export those changes as a difference file. Highlights of this test are as follows:

- ABB removed an energy consumer and successfully exported the difference file
- ABB added an energy consumer and successfully exported the difference file
- Langdale changed a substation name and successfully exported the difference file
- Langdale changed a substation name and deleted a circuit breaker and successfully exported the difference file

The second test required a participant to import an incremental model update file exported by another participant, correctly parse the file for model changes, and apply the changes to a previously stored sample model file. This test validates interoperability using the difference file specification for incremental model updates.

Highlights of this test are as follows:

- ABB successfully imported the Langdale incremental model update file with changes to the Siemens 100 bus model and merged with the existing Siemens 100 bus model already stored.

Partial Model Transfer

This section shows the results of the partial model testing. ABB, Langdale, and PTI participated in these tests.

The first test required a participant to import a partial model and merge with a pre-existing model from the same vendor. Highlights of this test are as follows:

- ABB successfully imported and merged the Siemens Port substation model with the Siemens 100 bus model (without the Port substation).
- Langdale successfully imported and merged the ABB Troy substation model with the ABB 40 bus model (without the Troy substation).
- PTI used a slightly different approach. They merged the Siemens Port substation XML model with the Siemens 100 bus XML model without the Port substation while still in XML, then imported the merged model. While this demonstrates the capability to merge XML models, it does not demonstrate the capability of the main application under test to accept a partial model and merge it with a model already resident in the application. This was due to a current limitation in the application under test which will be updated in the near future.

The second test required a participant to export a merged model file and to also import a merged model file from another participant, as a way to validate the contents and format of the merged files. Highlights of this test are as follows:

- ABB successfully exported the merged Siemens 100 bus with Port model file.
- ABB successfully imported a merged ABB 40 bus with Troy model previously merged and exported by Langdale.
- Langdale successfully exported the merged ABB 40 bus with Troy model file, with only the CIM Version class missing in the export.

Solution Test

This was a test first defined and conducted by a number of participants at the second interoperability test and also repeated at the third test. This test required a participant to run a power flow application on an imported model file. Details of this test are documented in the third interoperability test report (see Reference 5). Only GE Network Solutions elected to perform this test at the fourth interoperability test.

It should be kept in mind that the purpose of the test was 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.

Highlights of the Solution test are as follows:

- GE Network Solutions successfully imported and ran a power flow solution (with convergence after 4 iterations) on the Siemens 100 bus model as exported by PTI. This validates both the correct import as well the export by PTI.

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. Every attempt was made to resolve issues during testing so that a common resolution could be adopted and implemented by each participant, followed by a retest.

Only one issue was documented during the test:

- For partial model transfers, an issue arises with associations that have a many: many multiplicity regarding how to handle deletions or additions. For example, a single MVARCapabilityCurve class can apply to synchronous machines in multiple substations. So when a substation is added that needs an association to this existing curve, that association has to be recognized and added as part of the substation partial model. It was missing in some merged files. A suggested resolution is to send all needed curves with the partial model file, and leave it to the application performing the merge to recognize and eliminate redundancy. An alternative is to send a subsequent incremental update to add the association between the MVARCapabilityCurve class and the synchronous machines added with the partial model transfer.

4
FUTURE INTEROPERABILITY TESTS

Plans for future interoperability tests need to be defined. The NERC Data Exchange Working Group (DEWG) has determined that in addition to the tests included in this fourth test, the SCCs would like to be able to transfer a snapshot of the network at a point in time (i.e., include Measurement values only – not the model). This is the same data sent with model to run power flows. In addition, they would like to be able to handle other types of partial model file transfers using condition-based “where is …” type reasoning (for example, all substation equipment with VoltageLevel greater than or equal to 200KV).

Other possible interoperability tests could include the following:

1. Opportunities for more participants to complete the tests used for this fourth interoperability test or previous tests.

2. *Duke Energy model and/or CAISO model with Powerflow Applications:* Run Powerflow applications using a large scale model. Participants can run their Power Flow applications and demonstrate other applications (e.g., OPF and State Estimator), as available. This will test larger models with loads.

3. *Additional applications:* Run additional applications of exchanged model files, such as State Estimator and Optimal Power Flow.

4. *Exchange of solved power flow solutions:* This is an existing need that will be tested once a solution is defined.

Another possibility is to expand the testing to validate standard Application Program Interfaces (APIs) based on CCAPI-based standards to exchange the XML documents created with the CIM SML specifications. All exchanges during these interoperability tests have been handled as file transfers.

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 SABLE

The test procedures related to CIM XML model exchange will be performed against the ABB SABLE product, ABB's open technology system for implementation of Business Management and Energy Information systems. SABLE runs on an Alphaserver DS10, 600 MHZ.

The CIM schema has been implemented in an Oracle database. This CIM Oracle database will be used for both import and export processes.

During the import process, data from the CIM database will be imported to SABLE. During the export process, data from SABLE will be exported to the CIM database.

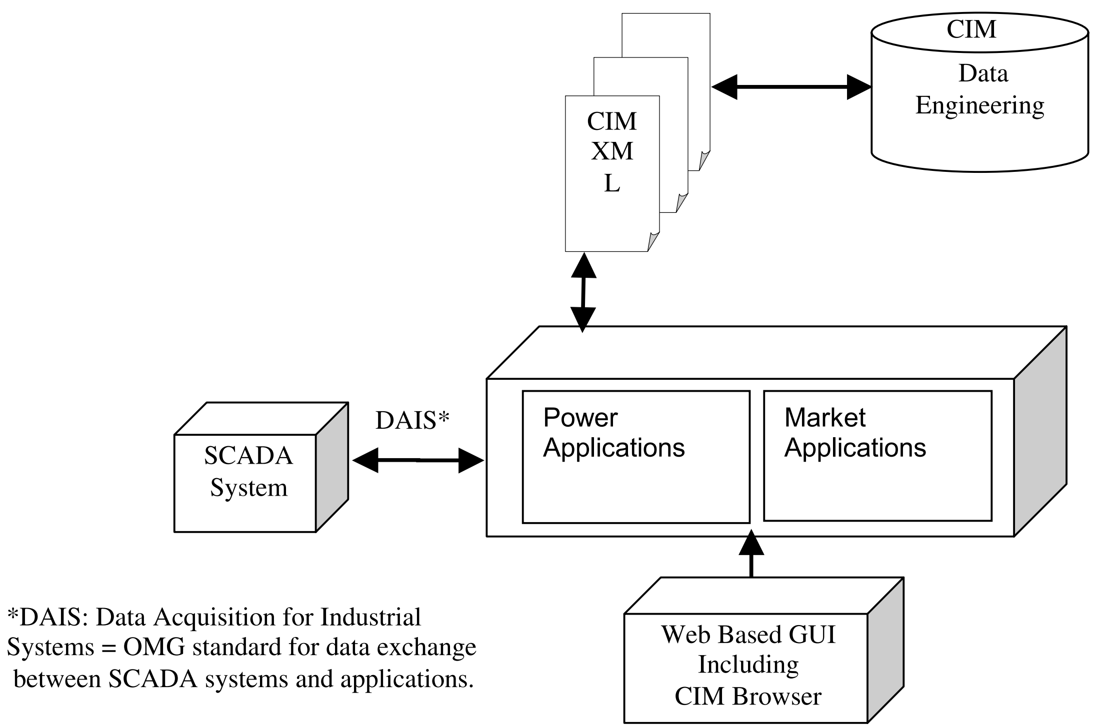

Figure A-1
ABB's SABLE

GE Network Solutions XA21 and Enterprise Gateway Platform

XA21 is a high performance distributed control solution that provides electric utilities worldwide with the capability to monitor, control, and optimize the operation of geographically-dispersed assets in real-time. Scalable from a single node, non-redundant system upward to geographically-dispersed systems containing dozens of interconnected processing nodes, XA/21 is a common computing foundation that is fully configurable and can be tailored for specific functions.

The Enterprise Gateway provides a software package that can import and export the NERC defined profile of data from XA21 internal power system network model to and from the CIM.

- The import process takes CIM/XML document and generates internal models for power application study cases as well as XA21 database batch in files.
- The export process generates CIM/XML documents from XA21 internal data models.

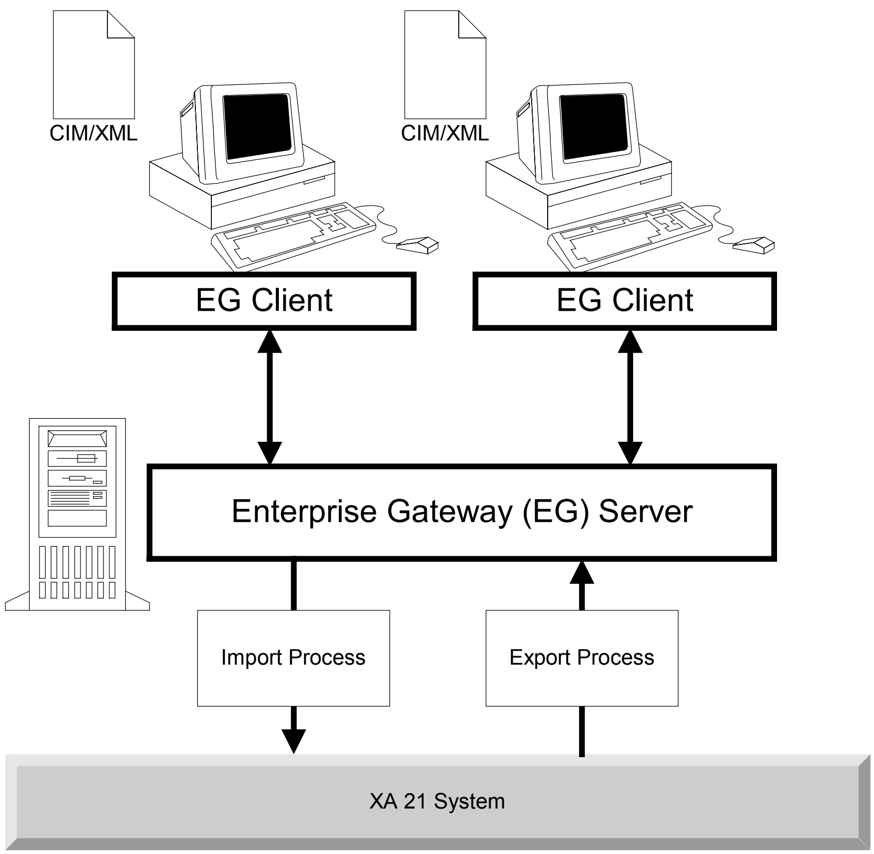

Figure A-2
GE Network Solutions XA21 and Enterprise Gateway Platform

Langdale Consultants CIMBuilder

The CIMBuilder product was used for all tests in which Langdale participated. The tests exercised a subset of built-in CIMBuilder capabilities.

Summary of Capabilities

CIMBuilder is a general purpose tool to help utility engineers to manage, exchange and edit CIM models.

- For managing models, CIMBuilder provides facilities to view, compare, merge, split, validate and transform models. It can manipulate complete or partial models and link them with proprietary model information or CIM extensions.
- For exchanging models, CIMBuilder provides DAF and CIM/XML interfaces. It can export and import standard full, partial and incremental CIM/XML models via the local file system or HTTP. It can exchange model information with other systems in both directions via DAF interfaces as a client and server.

PTI Operational Database Maintenance System (ODMS)

The test procedures related to the CIM XML model exchange will be performed against the PTI Operational Database Maintenance System (ODMS). As configured for the interoperability tests, the ODMS Data Repository and the ODMS Viewer/Editor products will be used for CIM XML model exchange and data representation.

The ODMS is an established product that is designed to import model data from diverse EMS systems and to merge or replace these models in the ODMS client's native EMS model. An overview of the ODMS data management facilities is presented in Figure A-3.

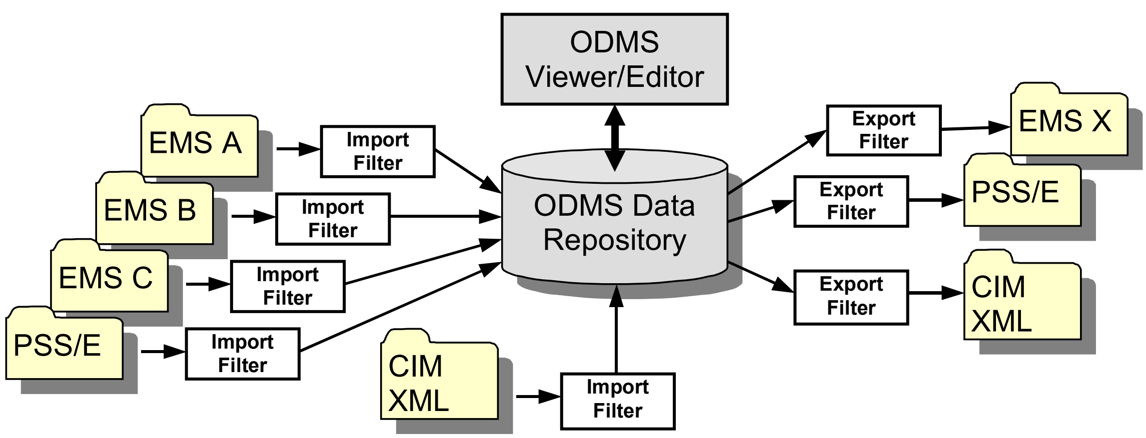

Figure A-3
PTI's Operational Database Maintenance System

Until the CIM XML process became available, PTI developed import “filters” that operated on vendor-specific data formats and converted the data from the various EMS systems into the CIM – which PTI calls the ODMS Data Repository. The ODMS Data Repository is based on the CIM and is provided on either an MS Access or an Oracle (8i+) database platform. Having translated and expressed all EMS models in the CIM, the models are then manipulated in this common environment. PTI also developed export “filters” that allow the contents of the ODMS Data Repository to be exported into a vendor-specific format.

PTI is modifying its product line to use CIM XML import and export filters along with their existing EMS vendor-specific filters. The CIM XML filters are not yet comprehensive enough to provide all of the information useful to the ODMS model merge process. However, as the CIM XML data exchange standard adds model details, PTI’s hopes are that the need for individual filters for each EMS system will no longer be required.

The ODMS Viewer/Editor provides a full-graphics interface to the underlying ODMS Data Repository for adding, deleting, and/or editing the model data. The ODMS Viewer/Editor will automatically generate specified station one-lines and world views based on only the data contained in the ODMS Data Repository. As changes are made to the data, a rich set of data validation constraints is applied. These validations not only guarantee that the change will maintain CIM integrity, but that reasonable power systems data entries have been made.

The ODMS has extensive data validation processes it uses during data import. For the Interoperability Tests, the ODMS was configured to perform full validation on each incoming CIM XML file to assure that the file was first CIM XML compliant, and second, that the file represented a valid CIM model. The intention of the NERC data exchange is to exchange only working network models. Therefore, imports of invalid models - either due to CIM violations or network model violations - were not allowed into the ODMS CIM Data Repository.

B
TEST CONFIGURATION DATA

Test Procedures

The test procedure for this series of tests was *CIM XML Interoperability Test 4 Test Plan and Procedures*, Revision 1, July 14, 2002 contained in the following file:

- Test procedures: cimxml test 4 plan rev1.DOC

CIM Baseline Version for Testing

The version of the CIM used for these tests was 10. Specifically, the CIM RDF Schema version of this file was used. Any file generated or imported was required to conform to this RDF Schema, although only the classes, attributes, and relations defined in the NERC CPSM profile needed to be included.

The files used for the CIM UML and RDF schema were as follows:

- CIM ROSE UML file: cim10_011015.mdl
- CIM RDF Schema file: cim10_011015.rdf

The namespace for properties and classes used in the model files was:

  – http://iec.ch/TC57/2001/CIM-schema-cim10#

RDF Syntax

The RDF syntax approved for these tests is the Reduced RDF (RRDF) Syntax defined by Arnold deVos. Files produced may contain syntax definitions beyond the RRDF Syntax, but only the RRDF Syntax was used to completely express the power system model in the file produced for testing. Participants reading files were expected to properly interpret the RRDF Syntax definitions contained therein but were not required to interpret and use any definitions beyond the RRDF Syntax.

The file used for the RDF syntax definition was as follows:

- CIM XML syntax definition: Simplified RDF Syntax 6.pdf

Test Files

Each participant was requested to post a sample model file that they have produced using the Reduced RDF Syntax approved for these tests. Each such sample file was accompanied by a one-line schematic diagram illustrating at least parts of the power system model defined in the file.

The test files provided for the sample models were as follows (final updates were made during the test):

ABB

- ABB 40 bus model:
  ABB40_06-10-02.rdf
- ABB 40 bus model without the Troy substation:
  ABB40_06-10-02_no_TROY.rdf
- Troy substation model:
  ABB40_06-10-02_TROY.rdf
- Incremental update to add an energy consumer:
  ABB40_06-10-02_add_EnergyConsumer.rdf
- Incremental update to remove an energy consumer:
  ABB40_06-10-02_reomve_EnergyConsumer.rdf

Siemens

- Siemens 100 bus model: siemens100_04-02-02.rdf
- Siemens 100 bus model without Port substation: siemens100_no_PORT.rdf
- Port substation model: siemens100_PORT.rdf

The Duke Energy and CAISO models used are available only on a restricted basis, after signing a non-disclosure agreement.

Tools

The tools used for the interoperability testing are described in the draft IEC 61970-503 CIM XML Format document as follows:

- CIM XML Document Validator and documentation for both a GUI and command line interface 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/validate/download/CIMValidate-20010909a.jar.
- RDF Generator (Xpetal) (to convert UML to RDF) and documentation is available at the cimxml egroup site and on the SourceForge web site.

File Transfer

Sharing and transferring files between participant's systems was accomplished using a shared file server and connected to by all participants through a LAN switch.

C

TEST ISSUES AND RESOLUTIONS

This appendix contains a list of the issues identified during the CIM XML interoperability testing organized by category. The other issues are noted as notes under the test report tables in the main body of this report. The status of the resolutions reached during the testing period are also reported. The open issues will be addressed within the CCAPI Task Force and IEC Working Group 13.

The issue categories include the following:

- CIM – issues dealing with the CIM model
- NERC CPSM Profile – issues with the format or content of the NERC CPSM profile definition of classes, attributes, and associations to be included in the sample model files, or the way the profile definitions are handled in UML or XML/RDF
- Products in Test – issues concerned with the specific product under test
- Tools – issues with the CIM XML validator tool

No.	Submitter	Category	Problem Statement	Suggested Resolution	Final Resolution and Status
1	D. Miljkovic	User Convention for Partial Model Transfers	For partial model transfers, an issue arises with associations that have a many: many multiplicity regarding how to handle deletions or additions. For example, a single MVARCapabilityCurve class can apply to synchronous machines in multiple substations. So when a substation is added that needs an association to this existing curve, that association has to be recognized and added as part of the substation partial model. It was missing in some merged files.	1. Send all needed curves with the partial model file, and leave it to the application performing the merge to recognize and eliminate redundancy. 2. An alternative is to send a subsequent incremental update to add the association between the MVARCapabilityCurve class and the synchronous machines added with the partial model transfer.	Open
2	T. Saxton	Test Model	The Siemens 100 bus model is missing an association with VoltageLevel, as required by the current version of the NERC CPSM specification	Update the model file with a later version that complies with the current CPSM specification	New version contains suggested resolution

D
USE CASES

This appendix contains the three use cases describing the major objectives for the fourth interoperability tests:

1. Incremental Model Update

2. Partial Model Transfer

3. Power System Model Exchange with ICCP/TASE.2 Linkage

Use Case

Name: Incremental Model Update

Summary:

Periodically or on demand, transfer all changes to a power system model since some point in time or since the last update.

Actor(s):

Name	Role Description
Security Coordinator (SC)/ Advanced Applications Engineer at WAPA	Needs current updates from other SCs in the Western Region to run advanced apps (e.g., contingency analysis, state estimation, power flow, etc.) on boundary security coordination area. This requires any changes made to substation models in California, for instance, since the original model or any previous update was received.
SCADA Manager in California, Bonneville	Receive and approve request, then initiate export of changes to requestor.

Probable Participating Systems:

System	Services or Information Provided
Security Coordination system in California (ABB) and Bonneville (ESCA)	Receive request for incremental model update, interpret, prepare model changes for transfer, and initiate the model update transfer. Also responsible for notification of updates when changes are made.
ODMS from PTI	Receive model and perform model merge with existing model, export to GE SCADA system
Loveland SCADA with advanced apps	Import merged model, run advanced apps to evaluate contingencies, calculate available capacity, ensure reliable operation, etc.

Pre-conditions:

There is an existing power system model at both Loveland and California based on CIM.

Assumptions/Design Considerations:

- These same systems will also be involved in partial model transfers and network snapshot use cases.
- Unique identifiers are required, as well as consistent naming between partial model received and existing models, and subsequent updates.
- Sufficient model data is needed to unequivocally identify where model has changed.

- Real time network data (e.g., status, generation, load) needed for running advanced apps (e.g., contingency analysis, power flow) will be obtained via the Network Snapshot Transfer use case or via ICCP.

Examples of partial model updates:

- Add new substation
- Replace existing transformer with a new transformer with different ratings
- Add new line or delete existing line
- Change rating or setting

State any known assumptions, limitations, constraints, or variations that may affect this use case. Consider:

- Timing requirements – no real-time. Want changes immediately if already energized. Otherwise, for a new substation, want substation model transferred approximately 2 weeks before energized, and then notification when energized. However, NERC should probably specify the timing requirements for the ISN case.
- Frequency of use – whenever there is a change.
- Sizing characteristics, etc.???

Normal Sequence:

Use Case Step	Description	From–To	Information Content
Step 1	Security Coordinator makes request for incremental update. This becomes a standing request (or persistent query) for any updates	(from) SC (to) Calif. System SC	Qualifiers for that portion of network of interest
Step 2	California system accepts input parameters, prepare incremental update, prepare XML document, and export to WAPA ODMS.	(from) Calif. SC system (to) ODMS	*CIM/XML model file containing incremental model updates. Need sufficient info to uniquely identify where updates fit in overall model.*
Step 3	Verify scope and merge. After merging, ODMS exports updated network model to WAPA SCADA system	(from) ODMS (to) WAPA SCADA system	Complete merged model file
Step 4	Test update in offline EMS.	SCADA system	
Step 5	Notify the update is now in service	(from) Calif. SC system (to) WAPA SCADA system	Update notification, timestamp, time of activation, reference to specific update file
Step 6	Apply the update to online system	SDADA system	

Exceptions/Alternate Sequences:

Describe any alternative actions that may be required that deviate from the normal course of activities. Should the alternate sequence require detailed descriptions, consider creating a new Use Case.

Since updates are supplied in advance of commissioning, several may be outstanding at one time. Furthermore, updates could be issued in one order and notified in another, i.e., for two updates X and Y, the steps could be: issue X; issue Y; notify Y in service; notify X in service.

Post-conditions:

Complete and error-free transfer. A model merge is required before model will used. Any unnecessary (e.g., duplicate data or data outside scope of merged model) model data received will be discarded.

Integration Scenario

Insert Visio diagram showing interactions between systems/business function/databases with each interaction labeled with use case step and short descriptive title.

References:

Use Cases referenced by this use case, or other documentation that clarifies the requirements or activities described.

- Incremental Model Update Use Case
- Network Snapshot Use Case

Issues:

ID	Description	Status
1.		

Revision History:

No	Date	Author	Description
0.	3/18/2002	T. Saxton	Initial version

Use Case Diagram:

Use Case

Name: Partial Model Transfer

Summary:

Transfer a portion of a power system model network using "where is" type reasoning to define the portion of the network of interest (for example, all substation equipment with VoltageLevel greater than or equal to 200KV). Assmption is that this is for coordination between NERC Security Coordinators. Complete models are not needed.

Actor(s):

Name	Role Description
Security Coordinator (SC)/Advanced Applications Engineer at WAPA	Needs data from other SCs in the Western Region to run advanced apps (e.g., contingency analysis, state estimation, power flow, etc.) on boundary security coordination area. This requires substation model data from California. Need partial model transfer, merge models, and then get real time data from Calif. for those substations. Need sufficient data to permit model merge.
SCADA Manager in California, Bonneville	Receive request, input data to SCADA EMS system.

Probable Participating Systems:

System	Services or Information Provided
Security Coordination system in California (ABB) and Bonneville (ESCA)	Receive manual request for partial model transfer, interpret, prepare partial model for transfer, and initiate the model transfer. Also responsible for notification of updates when changes are made.
ODMS from PTI	Receive model and perform model merge with existing model, export to GE SCADA system
Loveland SCADA EMS with advanced apps	Import merged model, run advanced apps to evaluate contingencies, calculate available capacity, ensure reliable operation, etc.

Pre-Conditions:

There is an existing power system model at both Loveland and California based on CIM.

Assumptions/Design Considerations:

- These same systems will also be involved in incremental model update and network snapshot use cases.
- Unique identifiers are required, as well as consistent naming between partial model received and existing models, and subsequent updates.

- Sufficient model data is needed to permit a model merge. For example, if we decide to go for partial model exchange based on voltage level, then it may be best to do that on area basis. For example - give all the equipments of SDGE where the voltage is above 230KV. We need to specify whether we want to represent the network components below the cut voltage by an equivalent component (may be by an injection) or simply don't include them in the partial model.
- Real time network data (e.g., status, generation, load) needed for running advanced apps (e.g., contingency analysis, power flow) will be obtained via the Network Snapshot Transfer use case or via ICCP.

Examples of partial model updates:

- Voltage cut plane (i.e., all equipment in substations including step down/up transformer and above a set voltage, such as 345 KV)
- Enumerated substation list (i.e., all equipment in substation including connecting lines with identification of destination substation for each line)
- Geographic cut plane (i.e., all power system model North of Path 15.)

State any known assumptions, limitations, constraints, or variations that may affect this use case. Consider:

- Timing requirements – no real-time. Want changes immediately if already energized. Otherwise, for a new substation, want substation model transferred approximately 2 weeks before energized, and then notification when energized. However, NERC should probably specify the timing requirements for the ISN case.
- Frequency of use - Once initially, then whenever there is a change.
- Sizing characteristics, etc. – Initial large (thousand buses at 345kv for all California), to single substations when adding a new one.
- Some requests for partial models may not be supported by the system receiving the request. For example, a request for a geographic cut plane cannot be supported by CAISO, since they do not maintain geographic information with the network model. Therefore it seems likely that the request would have to be done manually between the Security Coordinator (SC)/ Advanced Applications Engineer making the request and the SCADA Manager receiving the request. The standard for partial model transfer would apply only to the sending of the partial model, not the request.

Normal Sequence:

Use Case Step	Description	From–To	Information Content
Step 1	Security Coordinator makes request for partial model transfer. Initially will be done off-line. This becomes a standing request (or persistent query) for any updates to that portion of the model that has changed.	(from) SC (to) Calif. System SC	Qualifiers for that portion of network requested
Step 2	California system accepts input parameters, prepare partial model, prepare XML document, and export to WAPA ODMS.	(from) Calif. SC system (to) ODMS	*Complete CIM/XML model file for requested portion of network model. Need sufficient info to uniquely identify where partial model fits in overall model. For substation list, want connecting lines and identification of connected substation. Also need ICCP Conf data for all measured points.*
Step 3	After merging models, ODMS exports updated network model to WAPA SCADA EMS system	(from) ODMS (to) WAPA SCADA EMS system	Complete merged model file
Step 4	Populate EMS database tables and generate the updated database. Run application in test environment off-line. If the results are ok, the transfer the new database into the production system	EMS system	
Step 4	California system initiate transfer of any changes to the partial models previously asked. This would be done with Incremental Model Update use case on partial model.		All changes to the partial model previously defined.
Step N	Step N details		

Exceptions/Alternate Sequences:

Describe any alternative actions that may be required that deviate from the normal course of activities. Should the alternate sequence require detailed descriptions, consider creating a new Use Case.

An alternate approach would automate the request as well as reply, but this would require a protocol to identify the request. One approach would be to use DAF concepts to serialize partial model queries. An XML version of DAF that uses CIM XML as its payload could minimize the amount of development effort.

Given growing acceptance of web services and SOAP, it might also make sense to see how this technology could be leveraged.

Post-Conditions:

Complete and error-free transfer. A model merge is required before model will be used. Any unnecessary (e.g., duplicate data or data outside scope of merged model) model data received will be discarded.

Integration Scenario

Insert Visio diagram showing interactions between systems/business function/databases with each interaction labeled with use case step and short descriptive title.

References:

Use Cases referenced by this use case, or other documentation that clarifies the requirements or activities described.

- Incremental Model Update Use Case
- Network Snapshot Use Case

Issues:

ID	Description	Status
2.		

Revision History:

No.	Date	Author	Description
0.	2/27/2002	T. Saxton/D. Ambrose	Initial version
1	3/18/2002	T. Saxton	Incorporated suggestions by Enamul, John, Arnold

Use Case Diagram:

Use Case

Name: Power System Model Exchange with ICCP/TASE.2 Linkage

Summary:

Exchange of power system models with linkage to ICCPTASE.2 measurements.

Actor(s):

Name	Role Description
EMS A Data Engineer	Maintains EMS A power system model. Adds ICCPTASE.2 linkage data to power system model
EMS B Data Engineer	Maintains EMS B power system model. Makes mapping between ICCPTASE.2 Object ID in received model and measurements received via ICCPTASE.2 link

Probable Participating Systems:

System	Services or Information Provided
EMS A	Converts an internal representation of a power system model to CIM XML format and sends to EMS B. Also sends real-time ICCPTASE.2 SCADA points via an ICCPTASE.2 link to EMS B.
EMS B	Receives power system model from EMS A as a CIM XML formatted file and converts to internal model representation of EMS B. Also receives real-time measurement data from EMS A via an ICCPTASE.2 link.

Pre-conditions:

1. A unique local SCADA Reference ID has been locally assigned to each measurement value by EMS A data engineer to be included in the power system model transferred from EMS A to EMS B.

2. An ICCPTASE.2 link is already established and an ICCPTASE.2 Object ID has been assigned to at least some of the measurement values available for transfer to intended receiver.

3. A CIM-compatible representation of the power system model at both EMS A and B exists.

4. A bilateral table is already established for SCADA points available at EMS A for EMS B to receive.

Assumptions/Design Considerations:

[State any known assumptions, limitations, constraints, or variations that may affect this use case. Consider:

- *Timing requirements*
- *Frequency of use*
- *Sizing characteristics, etc.]*

Normal Sequence:

Use Case Step	Description
Step 1	EMS A data engineer adds ICCPTASE.2 Object ID to each measurement value in the power system model that is available for transfer to EMS B. The ICCPTASE.2 Object ID must be exactly the same as the ICCPTASE.2 Object ID that is used with the real-time data transfers via ICCPTASE.2 link. In CIM MeasurementValue class: a. store SCADA ID in MeasurementValue.name attribute b. store ICCPTASE.2 Object ID in MeasurementValue.aliasName attribute. In CIM MeasurementValueSource class: a. store “ICCPCC Link” in MeasurementValueSource.name to indicate data is supplied by an ICCPTASE.2 link b. store “EMS A” in MeasurementValueSource.pathName to give specific instance of control center providing the ICCPTASE.2 data
Step 2	EMS A converts power system model to CIM XML format and transfers file to EMS B.
Step 3	EMS B receives EMS A power system model in CIM XML format and converts to internal model format.
Step 4	EMS B Data Engineer merges the power system model from EMS A into the EMS B power system model. This requires configuring EMS B software to correlate each measurement value in the EMS A power system model and the real-time SCADA points received via the ICCPTASE.2 link. Recommendation: Using the CIM SCADA package, the MeasurementValue and MeasurementValueSource instances received from EMS A should be stored at EMS B as remote measurements. This should be done by modeling the EMS A control center as a RemoteUnit and all the MeasurementValues as RemotePoints. This requires the following mapping: a. MeasurementValueSource.name to RemoteUnit.name b. MeasurementValueSource.pathName to RemoteUnit.pathName c. MeasurementValue.name to RemotePoint.name d. MeasurementValue.aliasName to RemotePoint.aliasName

Exceptions/Alternate Sequences:

1. An ICCPTASE.2 SCADA point is available via ICCPTASE.2 link and there is no corresponding measurement value in the CIM power system model. This will require manual intervention to update the power system model ICCPTASE.2 linkage data for that point and perhaps a resend of the model (or an incremental update if available).
2. The converse: There is a measurement value in the CIM model with an ICCPTASE.2 source and ICCPTASE.2 Object ID, but there is no real-time data received from the EMS A over the ICCPTASE.2 link for that point. This is not necessarily a problem. It is up to the EMS B, as an ICCPTASE.2 client, to request all ICCPTASE.2 SCADA points available to it from EMS A. It may require a revision to the bilateral table as well.

Post-conditions:

A mapping is established at EMS B between each ICCPTASE.2 Object ID received and a measurement value in its power system model. This is needed, for example, to run power flow and state estimator applications and for displaying real-time measurement data on one-line displays.

Note that it is possible to have a complete round-trip transfer of the model from EMS A through EMS B and then back to EMS A with the RemoteUnit and RemotePoint model information added at EMS B so that EMS A can verify completeness/correctness of the transfer.

References:

Issues:

ID	Description	Status
1.		

Revision History:

No	Date	Author	Description
0.	6/6/2001	T. Saxton	Initial
1	7/16/01	T. Saxton	Added SCADA reference ID as well as ICCPTASE.2 Object ID as part of power system model transfer, and also added specific recommended use of CIM to transfer this information
2	7/24/01	T. Saxton	Changed attributes in MeasurementValueSource used to indicate ICCPTASE.2 data and name of control center supplying ICCPTASE.2 data, changed “ICCPTASE.2 ID” to “ICCPTASE.2 Object ID” to match NERC’s terminology, clarified text in Step 4, minor editing improvements
3	4/5/02	T. Saxton	Changed “ICCP” to “TASE.2”. Changed MeasurementValueSource from “ICCP” to “CC Link” to be inclusive of other CC protocols that may be used for other applications of this use case.

Use Case Diagram:

E

INCREMENTAL MODEL UPDATE EXAMPLES

This appendix contains examples of the types of incremental model updates that frequently occur in transmission power system models. Exchanging entire power system models to communicate these changes is not feasible. Transferring them as incremental changes in a difference file was the subject of one set of tests.

These examples were provided complements of Enamul Haq, CAISO.

Changes Related to Lines

Difference in Line Impedance

Line Name	: KESWICK_OBANION
From Substation	: KESWICK From KV: 230
To Substation	: OBANION To KV: 230

Old Values	**New Values**
Rpu = 0.0282	Rpu = 0.0646
Xpu = 0.1972	Xpu = 0.5961
Bpu = 0.4062	Bpu = 0.4066

Difference in Line Ratings

Line Name	:	PITSBURG_SANMATEO
From Substation	:	PITSBURG From KV: 230
To Substation	:	SANMATEO To KV: 230

Old MVA Ratings	**New MVA Ratings**
1st Rating = 295.6	1st Rating = 398
2nd Rating = 388.6	2nd Rating = 463
3rd Rating = 398.4	3rd Rating = 488
	4th Rating = 518

Difference in Line Status

// This line was in service in the previous update
// This line is out of service in the new update

Line Name	: EL PECO_BIOLA
From Substation	: EL PECO From KV: 70
To Substation	: BIOLA To KV: 70

Old Status	**New Status**
In Service	Out of Service

// This line was out of service in the previous update
// This line is in service in the new update

Line Name	: DRHM JCB_ESQUON
From Substation	: DRHM JCB From KV: 60
To Substation	: ESQUON To KV: 60

Old Status	**New Status**
Out of Service	In Service

Addition of a new Line

A new line has been added between Substation “AAAA” and Substation “BBBB”.

Increased the # of Series Capacitor Sections from 2 to 3 of the Line “AAA_BBB” at a Substation

Added a new section of series capacitor section with line “AAA_BBB” at the substation “AAA”.

Changes Related to Transformers

Difference in Transformer Impedance

Transformer Name: GOLDHILL 115/230KV

Old Value		**New Value**
Rpu	0.0021	0.0024
Xpu	0.0584	0.064
Bmag	-0.006	-0.0028

Difference in Transformer Ratings

Transformer Name: TESLA 500/230 KV

Old MVA Ratings		**New MVA Ratings**
1st Rating	940	981
2nd Rating	1073	1092

Missing Transformer

Transformer DIAB 25/500 KV is no longer in service.

Addition of a New Transformer

Added a new 2-winding transformer at Substation AAA
Added a new 3-winding transformer at Substation BBB

Transformer Regulating Schedule has changed

The regulating schedule of transformer “TTTT” at Substation “HHHH” has been changed.

Changes Related to Loads (Energy Consumer)

Load value has changed

Load value has changed from the previous update.

Location of the load has changed

The location of the load “AAAA” at Substation “CCCC” has changed from 230KV bus to 69KV bus.

Load has been removed

The load “DDDD” from substation “TTTT” has been removed.

A new Load has been added

The load “PPPP” is added at 69KV bus at Substation “RRRR”

Change in Load Status

The nonconforming load “LLLL5” at Substation “YYYY”:

Old status	**New Status**
Out of Service	In Service

The nonconforming load “LLLL6” at Substation “YYYY”:

Old status	**New Status**
In Service	Out of Service

Changes Related to Generators

Addition of a new Generator

A new generator "GGG1" is added at Substation "SSSS"

Removal of a Generator

The generator "GGG2" from Substation "SSSS" has been removed.

Changes in Generator Status

The generator "GGG5" at Substation "YYYY":

Old status	**New Status**
Out of Service	In Service

The generator "GGG6" at Substation "YYYY":

Old status	**New Status**
In Service	Out of Service

Changes Related to Reactive Devices

Added New Reactive Devices

Added a new capacitor bank at Substation "LLLL"
Added a new reactor bank at Substation "LLLL"

Changes in status of Reactive Devices

The Status of the Reactive Device "RRRR1" at Substation "HHHH"

Old status	**New Status**
In Service	Out of Service

The Status of the Reactive Device "RRRR2" at Substation "HHHH"

Old status	**New Status**
In Service	Out of Service

Other Examples

1. A new capacitor bank was added to a previously unused transformer tertiary.

2. A new substation was built near the middle of an existing transmission line.

3. A large industrial company purchased all (or part) of a substation from a transmission provider and renamed it.

4. A load (or generator) was previously modeled as an aggregate and was split up into component parts to more accurately model the physical situation.

5. A bus was sectionalized and a new bus name was created. Existing equipment was divided between the two buses.

6. A second (or third) parallel conductor was added with the same from and to buses of an existing line.

Types of Changes

The changes can be categorized as follows:

1. Changes in topology of the network model (addition/deletion/reconfiguration of the physical devices.)

2. Changes in values (ratings, parameters etc.)

3. Status changes (in service/out of service).

Note:

1. WSCC model does not contain any information on station switches and as such no change information is mentioned in the examples. When utilities will exchange detailed station models, there will be changes in CBs, Switches and Bus Bars.

Targets:
Grid Operations and Management
Grid Planning and Development
Enterprise Infrastructure Security (EIS)

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