ELECTRIC POWER RESEARCH INSTITUTE

Interoperation Test #8 of the Generic Interface Definition (GID) Standards and the Common Information Model (CIM)

The Power of the CIM and GID to Exchange Power System Data and Provide an Integration Framework

Technical Report

Interoperation Test #8 of the Generic Interface Definition (GID) Standards and the Common Information Model (CIM)

The Power of the CIM and GID to Exchange Power System Data and Provide an Integration Framework

1013295

Final Report, June 2006

EPRI Project Manager
D. Becker

ELECTRIC POWER RESEARCH INSTITUTE
3420 Hillview Avenue, Palo Alto, California 94304-1395 • PO Box 10412, Palo Alto, California 94303-0813 • USA
800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com

DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITIES

ORGANIZATION(S) THAT PREPARED THIS DOCUMENT

Project Consultants, LLC

NOTE

Requests for copies of this report should be directed to EPRI Orders and Conferences, 1355 Willow Way, Suite 278, Concord, CA 94520, (800) 313-3774.

CITATIONS

This report was prepared by

Project Consultants, LLC
P.O. Box 2106
154 Bayside Circle
Malakoff, TX 75148

Author
M. Goodrich

This report describes research sponsored by the Electric Power Research Institute (EPRI).

The report is a corporate document that should be cited in the literature in the following manner:

Interoperation Test #8 of the Generic Interface Definition (GID) Standards and the Common Information Model (CIM): The Power of the CIM and GID to Exchange Power System Data and Provide an Integration Framework. EPRI, Palo Alto, CA: 2006. 1013295.

REPORT SUMMARY

The EPRI Control Center Application Program Interface (CCAPI) project has produced a number of international standards, including the Common Information Model (CIM) and Generic Interface Definition (GID) specifications. These standards provide the basis for model-driven information exchange both within and between control centers and other systems involved in utility operations. Previous interoperability tests validated the use and acceptance of the CIM standard translated into eXtensible Markup Language XML. This report describes the eighth set of interoperability tests, which demonstrated the exchange of complete and incremental power system models. This series also staged and tested an actual implementation using one of the GID interfaces with a model representation of CIM as defined in both the International Electrotechnical Commission (IEC) 61970 and 61968 standards.

Background
EPRI spearheaded an industrywide CCAPI effort to develop open, interoperable applications for energy management systems (EMS) in energy control centers through the use of standardized interfaces (now part of the IEC 61970 series of international standards). Central to the CCAPI concept is CIM, which defines the essential data structure of a power system model. The North American Electric Reliability Council (NERC) sought the best way to exchange power system models electronically. As a result, the CCAPI project initiated an effort to map CIM into XML using resource description framework (RDF) schema and syntax to organize XML. To validate XML and RDF for model exchange, a series of interoperability tests between products from different suppliers was planned and carried out. These tests have not been expanded to include all portions of IEC 61970 and 61968 standards.

Objectives
To report results of the eighth set of interoperability tests performed in San Francisco, California, on March 30-31, 2006.

Approach
The project team prepared a formal set of test procedures to test the ability of participant products to conform to IEC 61970 (CIM/XML) standards. After a period of preparation and preliminary testing, five participants (ABB, Areva, Siemens PTI, SISCO, and SNC Lavalin) gathered in San Francisco to have an impartial observer test their products.

Results
Each of the five participants was able to successfully import at least one power system model, correctly converting from CIM XML format to their internal proprietary format. Four pairs of vendors also were able to interoperate successfully by exchanging at least one sample model file between them.

Siemens PTI (SPTI), SNC Lavalin (SNC), and Areva were able to successfully run a power flow solution on an imported transmission model file and then export the file, providing further validation of the content and correct translation between proprietary formats and CIM.

Incremental model update testing verifies correct update of a base model with incremental updates using the XML difference file format. Both SPTI and SNC successfully imported multiple incremental model update files and merged them into an existing base model. In addition, SNC produced several incremental files for use by other participants.

The project test verified that the actual implementation of CIM/GID standards within a utility environment produces the desired functionality and provides an integration platform. SISCO, the only participant in this test, successfully demonstrated the use of the Global Digital Alliance (GDA) interface as defined in the IEC 61970-402 standard. Using the GDA interface, queries were executed against a CIM repository based on IEC 61970 and 61968 standards and the results were verified.

EPRI Perspective

The changing business environment has increased the need for greater business and operating flexibility in the energy industry. CCAPI compliance offers operations center managers the flexibility to combine on one or more integrated platforms and software that best meets their energy company's needs for system economy and reliability. This compatibility allows managers to upgrade, or migrate, their energy management system (EMS) or other operations systems incrementally, thus preserving prior utility investments in custom software and enabling the use of new applications as they become available. Migration can reduce upgrade costs by 40 percent or more.

CCAPI-enhanced integration architectures based on the CIM model, GID interfaces, and standard XML messages enable interdepartmental teams to access a range of needed information via open systems. Hence, in innovative applications, energy companies are planning to implement CCAPI/CIM/GID/XML outside the control center to reduce costs and improve customer service and staff productivity. EPRI continues to sponsor collaborative efforts to advance these CCAPI-based integration strategies for greater information systems integration solutions—in the control center and beyond.

Keywords

Application program interface
Common information model (CIM)
Control center
Energy management systems
Generic interface definition (GID)
eXtensible markup language (XML)

ABSTRACT

On March 30-31, 2006 in San Francisco, California, software vendors serving the electric utility industry met for the eighth 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 eighth test continued the tests from prior tests and introduced project testing to evaluate 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. One participant elected to stage and test the standard implementation that is being delivered at Long Island Power Authority (LIPA).

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 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. Complete model files as well as incremental updates to existing base model files were exchanged between participants. The GID GDA interface was used as part of the project test to provide access to data residing on a server based only on the CIM rather than the internal logical database schema where the model data is stored.

Vendors participating in these tests included ABB, Areva, SPTI, SNC, and SISCO. The project test used the solution being implemented for the Long Island Power Authority (LIPA). Project Consultants prepared the test procedures, witnessed the test results and prepared this test report for EPRI. John Tweedy assisted in witnessing the tests. This is an important milestone in the CCAPI project and is the eighth in a series of planned interoperability tests to demonstrate additional CCAPI capabilities.

ACKNOWLEDGEMENTS

EPRI wishes to thank the many people who worked hard to make this eighth CIM/GID/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 utilities, vendors and contractors:

- The following Companies and Personnel for preparation of the test files:
- ABB – Lars-Ola Osterlund
- Areva – Robert Adams and Lucy Wu
- SNC Lavalin – David Brown
- EDF – Fei Wu
- GE - Feng Chen and Bruce Lifter
- WAPA – Randy Curtis
- Areva - Jun Zhu for generation of the CIMVT validation tool used to validate the model files.
- Langdale – Arnold deVos for the generation of the updated rdf files used in the test and for the CIMXML validator.
- Siemens – Kurt Hunter for the updates to the UML and the Common Power System Model (CPSM) document.
- Alan McMorran – for the generation of the Mercury validator used to validate the model files against the CPSM document.
- SISCO – Wanda Ongaro for her input into the Project Test procedures.
- John Tweedy – for his assistance in witnessing and recording the test results. His knowledge of Power Flow solutions was a tremendous help.
- All participants, for providing inputs to the issues and 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/GID/XML standards and the utility industry’s need for products to exchange power system models in a reliable, consistent fashion.

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

Dave Becker
EPRI

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 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) 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 eighth 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
April 2006

CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

This document reports the results of the eighth CIM/GID/XML interoperability tests, which took place on March 30-31, 2006, in San Francisco, California. 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.

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

- Power system model exchanges via file transfer based on CIM XML standards. These tests included complete model transfers and incremental model updates. 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 LIPA CIM/GID project that is being implemented by SISCO and SPTI. The project used a GDA Client to access the Asset portions of the CIM standard. A CIM RDF file was used to define the schema used by a GDA Server to expose the legacy data.

In addition to these tests, the eighth interoperability test also focused on the testing of two new CIM Validators, a new version of the UML and RDF files, and a new Model file developed by the Western Area Power Authority (WAPA).

While the Langdale CIM XML Validator provided valuable analysis of the CIM XML file, it lacked the logic to validate the file in terms of the CPSM document. The class and attribute checking was inadequate and multiplicity was not checked. The new CIM Validators expand the validation checking of the model files to include these elements. The two new tools included one online validation tool and one standalone tool, which had to be installed on each participant's workstation.

The new model file developed by WAPA is a 262 bus model that was extracted from the WECC model. This model was developed in response to the need of the industry to use actual models in any compliance or interoperability test. It is hoped that this model will become the accepted standard to use for model exchange in the future. The IOP group will continue to exercise this model to ensure its accuracy and completeness. Once this is complete, this model will become part of the test tool suite to use in all future interoperability and compliance tests.

The UML file was updated based on input from prior IOP tests and WG13. It is envisioned that this file will be updated again prior to the September tests.

The new RDF file generated using Xpetal resulted in the discovery of an error in the generation process or the Xpetal tool itself. The RDF file was corrected manually to avoid any delays in the test. However, the IOP group will continue its review of the file and the Xpetal tool to correct any deficiencies and ensure a valid RDF file is generated for the September tests.

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 before this is ready to be submitted to the IEC.

Use of the load schedule model in the CIM is currently ambiguous. This 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, each Substation must be contained by a SubControlArea and each SubControlArea must be contained by a HostControlArea.

This test was the eighth 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

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.
3. Demonstrate the exchange of power system models using the CIM and 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, HSDA and TSDA standards to provide communication interoperability.

5. Demonstrate the use of the standards to produce an integration framework and expose legacy data via a GDA Client layer. Specifically, the test demonstrated a portion of an actual field implementation using the CIM compliant GDA interface and a CIM-based rdf model.

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.

Specific Interoperability Test 8 Objectives

Specific objectives for the eighth interoperability test fall into two 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.
2. 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 and 61968.

This eighth 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 Interoperability Test 8

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. Similar to prior tests, we demonstrated and validated a product's ability to successfully import and/or export a complete model file and apply incremental updates using standard file operations. 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 CIM, CIM RDF Schema, and CIM XML Model Exchange Format (see References 10, 12, and 13, respectively).

For this test, Areva, ABB, EDF and WAPA provided four 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).

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 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 profile (see Reference 1).

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 SNC Lavalin using the WAPA262 Bus model 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.

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

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, either the Areva 60 Bus model file, the WAPA 262 Bus model file or the UCTE 14 node model files were used.

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.

Project Testing

The Project test is intended to show the viability of an implementation of the standards. The project involved using a Virtual Database Warehouse (VDW) and other products from SISCO including a Utility Integration Bus (UIB), and several GID service interfaces (GDA, HSDA and TSDA) to integrate all of the major Asset and Control Center applications including ODMS from SPTI.

This test will focus on the VDW section of the project and will test the GDA Client access of the Asset portions of the CIM standard. Specifically, the CIM RDF file is used to define the schema by which the legacy data is exposed by the GDA server over the UIB. The legacy data is accessed from its original data store, mapped to the CIM schema and presented as CIM data by the GDA server, without requiring the creation of new data stores. The CIM data is then made available by the VDW GDA Client layer via ODBC queries.

A comparison of the results of the queries to the legacy database was observed to verify the GDA accurately exposed the data.

Model Files

Just prior to the beginning of IOP 7, a general Data Exchange Workshop was held at CAISO to discuss the CIM standards and data exchange. Several Utilities that have implemented the standards were asked to give presentations surrounding their projects and list any open issues or lessons learned as a result of their efforts. Several of the Utilities discussed the need to use real model from the industry as part of the IOP tests to obtain more reliable results and to have some independence from the vendor models.

To address this issue, Dave Ambrose and Randy Curtis of Western Area Power Authority (WAPA), in conjunction with their vendor, created an excerpt of their model that could be used in all future IOP tests. This model was slightly modified to protect the security interests of their members and to reduce the size of the model to something that would be manageable for an interoperability test. Otherwise, the model was a real–world extract of the WAPA model. This model was introduced into this test to use in the exchange and solution tests. While some issues were identified and will need to be corrected or addressed, all participants were able to successfully use this model. It is anticipated that this model and others like it will be used in future tests and will become the standard for input to future interoperability and compliance testing.

Validation Tools

While the Langdale validator has been very useful in past tests, the utilities from the CAISO Data Exchange Workshop expressed concern that this tool was not complete enough to ensure the model files were accurate and fully met the standards. The CIMValidate command within the Langdale tool validates an RDF model against a schema or summarizes an RDF model. Both model and schema are read from XML documents conforming to the W3C RDF Model and Syntax Recommendation. While it is required that this be checked, everyone, including the vendor participants expressed a desire to generate a new tool that would also check the class and attributes of the CIM as well as the multiplicity defined in the standard.

To meet this need, two additional validation tools were created for use in this IOP. The first, CIMVT, was developed by Areva personnel and the second, Mercury, was developed by Alan McMorran, a graduate student from the University of Strathclyde.

The CIM Validation Tool (CIMVT) is a schema-driven validation tool designed to:

- Validate CIM/XML against the governing RDF/OWL schema
- Validate extended CIM/XML against the user-provided extended CIM schema
- Check whether the CIM/XML is CPSM-compliant

CIMVT was initiated by the CIMug Validation Task Force and it is intended to be released as an open source to benefit the CIM communities. This tool can be installed on any computer that has Java installed.

The Mercury CIM XML Online Validator is part of the University of Strathclyde's Mercury CIM Toolkit

The model validation tool within the Mercury CIM Toolkit allows a user to validate a power system model in CIM format against a pre-defined profile. Currently these profiles includes the CPSM Minimum Data Requirements version 2.0 (as of March 2006), including all conditional rules for defining minimum attributes and association cardinality. The validation process takes place in two steps: The first stage takes place during the import of the CIM XML file and checks the file for CIM compliance and flags any unsupported classes, attributes and associations (this provides a level of validation equivalent to the CIMValidate tool); the second stage uses the separate Model Validator to validate the CIM power system model against a profile and provides the user with details on which instances failed to validate and the rules that were not met. The toolkit is a web application and thus requires only an internet connection and a standard compliant browser to be accessed.

Scope of the CIM Tested

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

- Reference 1 - 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. This profile is mostly a subset of the IEC 61970-301 Base CIM standard (see Reference 10).
- IEC 61970 and 61968 standards for the representation of the asset model. These standards contain the CIM classes, attributes and relationships to model an EMS and DMS system including the Asset Management classes to model an asset management system (see references 10 and 15)

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. Appendix E contains a description and the results of all off-site tests.

References

1. CPSM (Common Power System Model) Minimum Data Requirements in Terms of the IEC CIM, version 2.0, March 7, 2006.
2. CIM XML Interoperability Test 8, Test Plan and Procedures, Revision 1, March 28, 2006.
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, EPRI, Palo Alto, CA: 2001. 1006161.
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, EPRI, Palo Alto, CA: 2001. 1006216.
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.
6. Report on the Common Information Model (CIM) Extensible Markup Language (XML) Interoperability Test #4: The Power of the CIM to Exchange Power System Models, EPRI, Palo Alto, CA: 2002. 1007351.
7. Testing of the Generic Interface Definition (GID Standards and the Common Information Model (CIM) Extensible Markup Language (XML) Interoperability Test #5: The Power of the Common Information Model (CIM) and the Generic Interface Definition (GID) to Exchange Power System Data, EPRI, Palo Alto, CA: 2004. 1009404.
8. Report on the Sixth Control Center Application Program Interface (CCAPI) Interoperability Test, EPRI, Palo Alto, CA: 2004. 1010117.
9. Interoperability Test No. 7 of the Generic Interface Definition (GID) Standards and the Common Information Model (CIM), EPRI, Palo Alto, CA: 2005. 1012990.
10. IEC 61970 Energy Management System Application Program Interface (EMS-API) - Part 301: Common Information Model (CIM) Base, Edition 1, based on cim10_030501.mdl
11. Draft IEC 61970: Energy Management System Application Program Interface (EMS-API) – Part 402: Common Services, Draft Revision 8, 1 July 2005
12. Draft IEC 61970: Energy Management System Application Program Interface (EMS-API) – Part 501: CIM RDF Schema, Revision 4, 2004-02-25
13. Draft IEC 61970-554-4: Energy Management System Application Program Interface (EMS-API) – Part 554-4: CIM XML Model Exchange Format, Revision 6, 2005-05-05
14. UCTE Data Exchange Format for load flow and three phase short circuit studies (UCTE-DEF) v0.1 – 2003-09-01.
15. Draft IEC 61968: System Interfaces for Distribution Management – CIM Extensions.

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 San Francisco. The goal was to have each participant successfully complete as many tests as possible while in San Francisco.

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 eighth 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 San Francisco, California. 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. Most official testing took place on-site in San Francisco. However, due to an illness, ABB was not able to participate in the on-site test. An attempt was made to allow remote participation but the internet and facilities at the test site were not sufficient to provide the proper access. A decision was made to allow ABB to execute these tests remotely during the weeks following this test. The off-site tests that were completed by ABB and the results are described in Appendix E.

The final test results achieved during the test at the test site are recorded in the test matrices provided in Section 3, Test Results. The results from the off-site testing are recorded in Appendix E of this document.

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
Areva	e-Terra-Platform	1.) Transmission/Distribution Power System Model CIM/XML file transfer 2.) Power Flow Solution
SPTI	PSS/Odms V5.2.0.4	3.) Transmission/Distribution Power System Model CIM/XML file transfer 4.) Incremental file transfer 5.) Power Flow Solution
SISCO	VDW, GDA Client/Server and UIB	1) Transmission power system model CIM/XML file Import 2) Project Testing
SNC	GENe EMS	6.) Transmission/Distribution Power System Model CIM/XML file transfer 7.) Incremental file transfer 8.) Power Flow Solution

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 two major categories of tests:

- Power system model and data exchange tests based on CIM XML using file transfers
- Project Tests using GDA, IEC 61970 and 61968 standards

All Participants were able to perform the exchange tests. SISCO performed the Project Tests.

Model, Data Exchange and Solution Tests

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

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

A full description of the Full Model Transfers, Incremental Model Updates and the Power Solution Test approach is provided in Appendix D

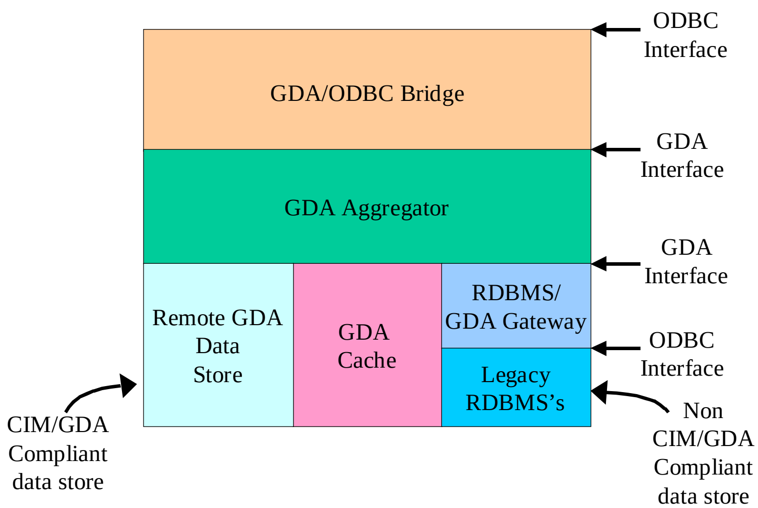
Project Tests

This particular project test will test the IEC 61970 and 61968 standards as implemented within SISCO's VDW and UIB. The primary focus of this test will be to fully explore the functionality of the VDW as a platform for asset analysis.

By sharing a common design framework, a message based application integration and data mining solution was built simultaneously. This approach reused shared application wrappers without requiring all the data to be copied to a data warehouse. By exposing application wrappers directly to the VDW without an intervening copy of all the data in a warehouse, flexibility was maximized.

The databases are exposed as CIM data by the VDW and made available on the UIB. This architecture highlights one of the advantages of using a transport neutral interface such as GDA. In this architecture, links are optimized to meet project goals while still enabling a single standard off-the-shelf wrapper for applications. Besides the VDW, asset analysis in this use case includes deployment of an off-the-shelf CIM/GID compliant message bus called the UIB.

Data presented by the VDW is aggregated from data presented by CIM compliant GDA Servers as shown below.



VDW Architecture

The database server transforms data in the legacy databases to GDA compliant data mapped to the CIM model. In particular, the following databases are mapped to the following CIM packages:

Legacy Data	CIM Package
MMWADMIN Asset Data	CIM Assets Package
WAREHSE Events Data	CIM Events Package*
MMWADMIN Substation, Zone Data	CIM Location Package
MMWADMIN TOTS Outage Data	CIM Outage Package
MMWADMIN Performance Data	CIM Performance Package*
MAXTRPTP Maximo T&D Work Management Data	CIM Work Package
MAXGRPTP Maximo Generation Work Management Data	CIM Work Package

*CIM extensions used to expose data currently in use

The following table shows the CIM class to legacy database table/view mapping:

CIM Classes	Database Table / View
ACLineSegmentAsset	CIM_ACLINESEGMENTASSET_V
AssetList	CIM_MRAGROUP_V
AssetPerfModel	CIM_CIRESULT_V
BreakerAsset	CIM_BREAKERASSET_V
BreakerOutageEvent	CIM_TOTSBREAKER_V
BusbarSectionAsset	CIM_BUSBARSECTIONASSET_V
ErpContact	CIM_ERPCONTACT
ErpProjectAccounting	CIM_ERPPROJECTACCOUNTING
Event	CIM_EVENTS_V
LineAsset	CIM_LINEASSET_V
Organisation	CIM_ORGANIZATION
OutageRecord	CIM_TOTSMASTER_V
OutageStep	CIM_TOTSEQUIP_V
PerfModelResultOutput	CIM_PERFMODELRESULT_V
PowerTransformerAsset	CIM_POWERTRANSFORMERASSET_V
Project	CIM_PROJECT
ResultParam	CIM_RESULTPARAM_V
Schedule	CIM_SCHEDULE
Site	CIM_SITE_V
Work	CIM_WORK
WorkFlow	CIM_WORKFLOW
WorkTask	CIM_WORKTASK_V
Zone	CIM_ZONE_V

Test Process

Two basic tests, Data Access and SQL Execution, were executed to validate the data returned by the VDW for correctness and completeness. This was accomplished using Select Queries. Three classes were selected for this test; Outage Report, Work and Site. Each class was mapped to a table and a query was issued using an ODBC client. The Oracle tool Toad was used to view the results from the legacy database and compare the results to the data returned by the VDW.

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).

Note: the Partial Model Update sections of the Test Procedure are not presented in the table since these tests were not executed by any participant.

Table 3-1
Description of Tests Performed

Step From Test Procedure	Test Description
4.2	***Basic Import/Export***
4.2.1	Basic Import - Participant A import sample model file and demonstrate import was done correctly
4.2.2	Basic Export - Participant A export 100 bus model and run validator
4.2.3	Interoperation - Participant B import of Participant A exported CIM XML file.
4.2.4	***Solution Test***
4.2.4.1	Initial Import Document 1, Run Solution, and Export Document 2
4.2.4.2	Interoperability Test Using CIM XML Document 2 from Another Participant
4.3	***Incremental Model Update***
4.3.3	Export Incremental Update File
4.3.4	Import Incremental Update File and Merge
4.5	***Project Tests***
4.5.1.1	Data Access – Outage Record
4.5.1.2	Data Access – Site
4.5.1.3	Data Access – Work
4.5.2.1	Selection of Named Attributes (5 types of Equipment)
4.5.2.2	Select With Where Clause
4.5.2.3	Select With Order By
4.5.2.4	Select With Group By
4.5.2.5	Select of Joined Data
4.5.2.6	Use of SQL Functions

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
- 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. It should be noted that to pass the export test successfully, the exported model file had to be re-imported correctly. So all participants that passed the export test also demonstrated a successful re-import of the exported file.

All of the participants were able to pass this test. Highlights of the tests are presented in the following tables.

Table 3-2
Basic Import Test of Individual Products

Test Procedure	4.2.1.1 Basic Import			
Test Model Used	**262 Bus Model**	**60 Bus Model**	**40 Bus Model**	**UCTE 14 Node Model**
Areva	P	P	P	P
SNC	P	P	P	P
SPTI	P	P	P	P
SISCO UIB Store	P	P	P	P

Table 3-3
Basic Export Test of Individual Products

Test Procedure	4.2.2.1 Basic Export			
Test Model Used	**262 Bus Model**	**60 Bus Model**	**40 Bus Model**	**UCTE 14 Node**
Areva	P	P	P	P
SNC	P	P	P	P
SPTI	P	P	P	P

Table 3-4
Re-Import Check of Individual Products

Test Procedure	4.2.2.2 Re-Import Check			
Test Model Used	**262 Bus Model**	**60 Bus Model**	**40 Bus Model**	**UCTE 14 Node**
Areva	P	P	P	P
SNC	P	P	PE*	P
SPTI	P	P	P	P

*** The pass with errors was noted due to some missing regulation measurements. SNC Lavalin offers the following explanation for this event:**

GEN-e 'dropped' some regulation measurements. This occurs when there is more than one device regulating the same bus (i.e. ConnectivityNode). It should be noted, however, that the GEN-e re-exported model remained electrically true to the original model: the regulating devices were linked to the same Connectivity nodes (This should have no impact on power flow results). This difference highlights the different ways one can model regulation in CIM and the NERC profile. Specifically,

1:1 1:1 1:1

The original model was PSR -> Measurement -> Terminal -> ConnectivityNode.

n:1 1:1 1:1

The GEN-e model was PSR -> Measurement -> Terminal -> ConnectivityNode.

Basically SNC-LAvalin's GEN-e the dropped duplicate regulation measurements, using only one to associate the regulating PSR to the same ConnectivityNode. This is valid modeling as defined in the CIM model (http://www.cimuser.org/Model/CIM10r7/cat350319f0014c/cat40192ef20048/cat379a700e0134/dgm379a751d006e.htm)

Interoperation

This section documents the pairs of vendors that were able to demonstrate interoperation via the CIM XML formatted-model file.

Table 3-5 shows the results for the interoperability testing. The primary objective of this test was for a participant to successfully import a power system model exported by another participant. The rows show the results of the interoperability test for each participant. Each column represents a file available for testing. These files were previously exported as part of the Basic Export test above (See Table 3-3).

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.

All participants with functionality to export a file did so and then made that file available for other participants to import.

Highlights of the tests are as follows:

- Nine pairs of vendors were able to interoperate successfully by exchanging at least one sample model file.

Table 3-5
Interoperation With Sample Models

Test Procedure	4.2.3 Import of 4.2.2.1 CIM XML Exported File		
Participant Importing File	**File Exported by Areva**	**File Exported by SPTI**	**File Exported by SNC**
Areva	X	P – 262 Bus P – UCTE14 P – 40 Bus P – 60 Bus	P – 262 Bus P – 60 Bus P – UCTE14
SNC	P – 262 Bus	P – UCTE14 P – 60 Bus	X
SPTI	P – 60 Bus P – 40 Bus P – 262 Bus P – UCTE14	X	P – 60 Bus P – 40 Bus P – 262 Bus P – UCTE14
SISCO	P – 262 Bus	P – 60 Bus P – 40 Bus	P – UCTE14

Power Flow Solution Testing

Areva, SPTI and SNC participated in these tests using the WAPA 262 bus model, the Areva 60 bus model and the UCTE 14 Node model. Table 3-6 shows the results of each of the steps as defined in Appendix D. Highlights of the Solution test are as follows:

- Areva, SPTI and SNC 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	2 Run PF sol-1	3 Export Doc-2	4 Import Doc-2	5a Run PF sol-2	5b Compare sol-1, sol-2
SPTI w/WAPA 262 Bus Model	P	P	P	P (w/Areva export)	P	P
SPTI w/UCTE 14 Bus Model	P	P	P	P (w/Areva export)	P	P
SPTI w/UCTE 14 Bus Model	P	P	P	P (w/SNC export)	P	P
SPTI w/Areva 60 Bus Model	P	P	P	P (w/SNC export)**		
SNC w/WAPA 262 Bus Model	P	P	P	P (w/Areva export)	P	P
SNC w/UCTE 14 Bus Model	P	P	P	P (w/SPTI export)	P	P
SNC w/Areva 60 Bus Model	P	P	P	P (w/SPTI export)	P	P
Areva w/WAPA 262 Bus Model	P	P	P	P (w/SPTI export)	P	P
Areva w/UCTE 14 Bus Model	P	P	P	P (w/SPTI export)	P	P
Areva w/Areva 60 Bus Model	P	P	P	P (w/SNC export)**		
Areva w/UCTE 14 Bus Model	P	P	P	P (w/SNC export)	P	P

**An issue arose with the SNC Lavalin exports of the AREVA 60 bus and WAPA 262 bus models. While these exports passed all the validation tools, and Areva and SPTI were both able to import the SNC Lavalin exports, the Areva and SPTI imports nevertheless did not define solvable power flow cases. The source of the problem seemed to be differing valid interpretations of load hierarchy modeling. In the case of the Areva 60 bus model, three additional load areas were contained in the SNC exported model. Since the hierarchy issues and the Load Area issues of the CPSM have not been resolved, SNC was given a Pass for these files and the Power Flow Solution tests using these files was halted.

Incremental Model Update

This section shows the results of the incremental model update tests. SPTI and SNC Lavalin 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.

SNC Lavalin prepared the following files for this IOP test using the WAPA 262 bus model:

- *co-AddACLine-SNC.xml* (add an AC Line to the model)
- *co-AddLoad-SNC.xml* (add a Load to the model)
- *co-AddPt-SNC.xml* (add a Power Transformer to the model)
- *Co-ModPt-r-SNC.xml* (modify the r value on the Power Transformer)
- *Co-ModACLine-x-SNC.xml* (modify the x value on the AC Line)
- *Co-ModLoad-move-SNC.xml* (Modify - move the Load)
- *Co-DelLoad-SNC.xml* (delete the load added above)

Export Incremental Updates

The first test required a participant to make incremental changes to the UCTE 14 node model and export those changes as an incremental update (i.e., a difference file). SNC Lavalin successfully exported the following incremental update files:

- Co_addbs.xml
- Co_addload.xml
- Co_addgn.xml
- Co_modtftap.xml
- Co_addsw.xml

Import Incremental Model Updates and Merge With Existing Base Model

The second 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 all 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.
- SNC successfully imported all 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 13).

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	Combi-nation	Add	Modify	Delete	Combi-nation
SNC	P - 4	P - 1			P – 3	P – 3	P - 1	
SPTI					P – 3	P – 3	P - 1	

Project Testing

This section shows the results of the SISCO project testing. All tests used the modified LIPA model named CIM10_61970and 61968_LIPA_20051005.rdf and the data contained therein. SISCO participated in these tests and used the UIB Message Bus as the middleware technology. The results of the tests are shown in Table 3-8 below.

The highlights of these tests were as follows:

- The rdf file defined above was used by the VDW to expose the legacy data via the GDA over the UIB.
- The GDA client layer exposed the data via ODBC Queries
- The queries extracted Asset data for Outage Records, Site Records and Work Records.
- The queries extracted data for named attributes for the following Asset Types:
- AC Line Segment
- Breaker
- Bus Bar Section
- Line
- Power Transformer

Table 3-8
LIPA Project Test Results (Data Access and SQL Execution)

Test Step	SISCO
4.5.1.1 Data Access – Outage Record	P
4.5.1.2 Data Access – Site Record	P
4.5.1.3 Data Access – Work Record	P
4.5.2.1 Selection of Named Attributes – 5 Types Tested	P
4.5.2.2 Select With Where Clause	P
4.5.2.3 Select With Order By	P
4.5.2.4 Select With Group By	P
4.5.2.5 Select of Joined Data	P
4.5.2.6 Use of SQL Functions	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

During this test, an issue with the correct generation of the rdf files was identified. The Host Control Area was not included in the RDF files. The participants added this to the file manually as a work around. This will need to be addressed as part of the overall review of the RDF tool.

The other RDF issues identified prior to the test included the Version identifier and the CIM Namespace designator. It was decided that the Version would use IEC 61970 as the name and use the date from the CPSM document notes section. The CIM namespace would use the same designator as in prior tests except the data would be changed from 2003 to 2005.

To avoid delays in the testing, it was decided to correct any deficiencies in the rdf files manually and proceed with the testing. However, these issues will be addressed by the IOP group after the test. It is believed that a problem exists with the RDF generation tool. A full description of the problems/issues will be forwarded to the appropriate groups for review and correction. The IOP group will follow-up with this issue and verify the accuracy of the rdf files at the next IOP test to be held in September.

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

- There are three transformers that have 2 tap changers on one winding
- Measurement is on a terminal of an AC Line segment but the member of PSR points to an instance of a line. Need to correct the mismatch.
- All participants attempted to use the ABB 40 bus model as an input to the Power Flow Solution test but all attempts were unsuccessful. The model would not converge.
- Langdale and Mercury reported an invalid enumeration for GenControlSource, among others.
- The model file contains “bad” load and regulation schedule data.
- Version and CIM Namespace has to be corrected.
- Rev 3 of the model had errors that were not present in the previous revision: 1) MeasurementValueSources – Mercury has 2 and the model has 5; 2) Substation attributes cause errors to be reported in Mercury; 3) 3 synchronous machines have a regulation schedule without a measurement; and 4) two terminals do not have connectivity nodes.

WAPA 262 Bus Model

- Measurement issues – measurement must be associated to a PSR and the PSR is a Voltage level but the terminal is on a switch NOT the PSR. Need to make the Member of PSR point to the switch that has the terminal that the measurement is associated to rather than the voltage level
- Energy Consumer Pfix and Qfix had charging values that are too high on the lines to allow the Power Flow to solve. These were corrected manually and the file was used.

UCTE 14 Node Model

- Mercury tool reported that Minimum operating MVar is not in the UCTE file

Areva 60 Bus Model

- Version header was corrected

Validator Issues

Issues surrounding each of the Validators used are presented in the following sections.

Langdale Validator

1. The schema does not have Host Control Area, Control Area, business unit, etc. and this causes the tool to issue errors for these instances.
2. Reports the enumerated type “unavailable” on gencontrolsource as an error. This is not a valid error, the error is in the RDF schema file; i.e., “unavailable” is missing in the file. The other validators are not catching this as an error because it is optional in the CPSM.

Areva Validator

1. The tools needs to be updated to match the new UML. This will be required anytime the UML is changed. In this case, MeasurementValue.MemberOf_Measurement is no longer in the CIM. The CIM/OWL definition needs to be updated to use the latest UML. Instead of MeasurementValue.MemberOf_Measurement, it should be AnalogValue.MemberOf_Measurement
2. This tool needs a better User Interface!
3. An RDF ID or an XML Name cannot start with a numeric.
4. Should the tool include enumerated types that are optional in the CPSM?
5. The invalid enumeration types in the ABB40 bus model were not reported.

Mercury Validator

1. Since this is an online tool, the upload time for some files may make the use of this tool prohibitive. The ability to upload zip files did help but if a very large model is very used, this tool will not be the tool of choice.
2. The tool will need to be converted to a stand-alone product (not a web-based tool) for use in full compliance testing where proprietary files might be used.
3. The tool should either ignore other namespaces or provide a method to include other namespaces. Most of the vendor tools will have additional namespaces added if they add any elements to the files at export.
4. Should the tool include enumerated types that are optional in the CPSM?
5. Mercury is improperly flagging a valid enumeration type in the UCTE file. Active Power is a valid enumeration type.
6. Mercury erroneously requires that a synchronous machine must have a generating unit. A synchronous machine can be operated as a condenser only.

General Issues

1. One participant could import and solve the original WAPA model but could not import and solve the WAPA model that was exported by SNC Lavalin.
2. 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 needs to be discussed and a resolution or recommendation needs to be presented for review by the appropriate group.
3. 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.
4. All Validation tools need to allow additional associations than what is in the CPSM as long as it is valid per the CIM standard. For example, a substation can have an association to either a MemberOf_SubControlArea or a Load Area or both. That means the CIM XML file can have either or both and the validation tool should pass it.
5. The CPSM should clarify that Condensers do not require a generating unit.

4
IMPLEMENTING STANDARDS AT A UTILITY

This report describes the 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 #8 on several fronts. However, additional testing is needed to validate the many resolutions reached as a result of testing and vendor consultations to reach agreement. Future interop tests should concentrate on the following areas:

- 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. Much of this testing was begun during IOP 6 but this time no GDA tests were performed other than the SISCO project test. Also need to include more vendors.
- 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) begun during IOP 7.

Hopefully, future testing will also be possible off-line using a conformance test suite (yet to be developed) with official observation, evaluation, and documentation of results.

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
APPENDIX: 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.

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.

Areva e-Terra Platform(TM)

The interop tests were executed for e-terraplatform(TM). This is AREVA T&D Automation's solution for Energy Management Systems.

AREVA's data modeling component, called e-terramodeler(TM), is responsible for import / export of CIM compliant files.

For more information, contact a local Areva T&D representative or log onto www.areva-td.com.

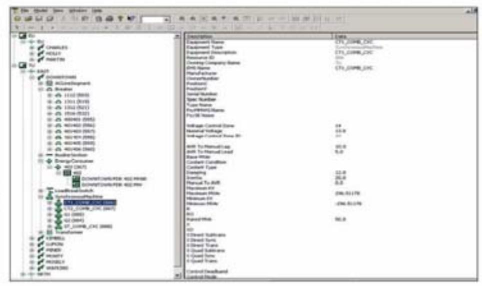
Siemens PTI® Product Descriptions

PSS/ODMS™

PSS/ODMS is Siemens Power Transmission & Distribution, Inc., Power Technologies International (Siemens PTI) data management and network applications 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 into the PSS/ODMS product line, making this product suite one of the most advanced network modeling and applications tools. This integration has resulted in a CIM based application that is designed to create or install into a CIM environment, and optionally to either create or install into a GID-based enterprise platform.

Features and Benefits of PSS/ODMS:

- PSS/ODMS access by system operators in both a real-time mode and a study mode, by simple windows pull-down menus.
- Replication of the real-time network model schema currently in use in the online system for model maintenance and expansion and for Operational Planning. This provides the ability to validate and run network analysis on these models in a stand-alone mode without impacting real-time operations.
- Ability to construct future models in an online environment and validate these models with existing current telemetry without impacting real-time operations and without a need for a system shutdown/fail-back.



- Ability to revert to any defined schema model in the CIM-Compliant database, in case the model becomes corrupted, by simple point and click procedures – without impacting real-time operations.
- CIM model data available from the PSS/ODMS Data Repository via ODBC, OLEDB, ADO, OCI and most off-the-shelf third party DB interfaces.
- Fault tolerant solution. The PSS/ODMS software is distributed to all users running the application, and local disk save cases are only limited by the disk storage size on each desktop or laptop. In the event of communication failure, state estimator results can be reloaded from the last save case instantaneously.
- Ability to aggregate Planning and Operations models into a single model domain.
- Ability to construct piece-wise historical models for the state estimator and PSS/E™ based on historical network configuration and measurements collected in the SCADA historian.
- Ability to export operational models to PSS/E while preserving PSS/E bus numbers and names to those used by planning.
- Ability to export any of the defined models in CIM XML.

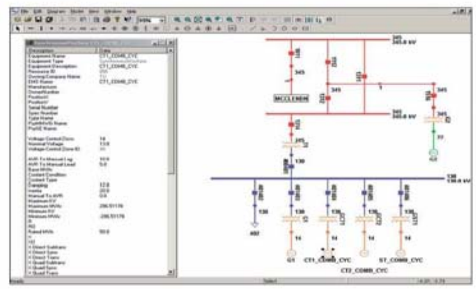
The PSS/ODMS Solution Set

Siemens PTI acquired PsyCor International Inc.'s Operation Database Maintenance System (ODMS) and its accompanying products and services. This product has been improved and incorporated into PSS/ODMS.

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.

PSS/ODMS was initially developed under the guidance of five of the major utility organizations charged with maintaining the reliability of the transmission system in North America. The original objective of the model management facilities was to provide regional coordinators and large utilities the ability to accept and combine or merge data models from many and varied EMS systems and planning models into a central data repository for manipulation and subsequent export into the native EMS system or to planning. Siemens PTI is the only known company to successfully provide this data translation, model merging and data warehousing across EMS and planning systems.

The process implemented by Siemens PTI in the PSS/ODMS product line is designed to assemble, and equally important to maintain, the central data repository for operations and planning data. The use of the CIM-based schema and PSS/ODMS' use of ODBC and SQL interfaces provides tremendous versatility in the use of the data repository. Depending on the modules and filters purchased, the PSS/ODMS filters export the data from the data repository to the native EMS system, to others' EMS systems via CIM XML format, and to planning formats such as the industry recognized PSS/E system planning package. This open, versatile architecture provides the ability for other applications to easily share and mine the data.

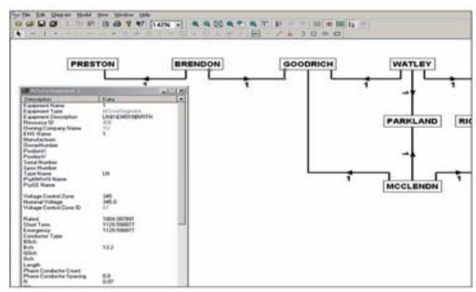


The CIM is an international industry standard data-relationship definition for the representation of utility data. The CIM originated from an EPRI program to standardize EMS data and to open EMS systems to allow multi-vendor supply of subsystems. Siemens PTI, one of the original CIM implementers, has used the CIM to provide a toolset that allows systems to freely exchange data.

The PSS/OneLine software is an automatic one-line and world map graphics generator that creates well-drawn graphics based solely on the network data provided in the underlying CIM database. This PSS/ODMS module presents visual alerts of potential errors in the database. PSS/OneLine also provides for exporting the one-line diagrams to the EMS system in several popular graphic formats. Our clients have provided a rich set of business rules for automatically generating drawings that can be easily tuned using the CAD-like toolset provided in PSS/OneLine.

PSS/ODMS Measurable Benefits

PSS/ODMS provides both short and long-term benefits and value by providing model-building capability that allows for rapid model creation and updates, while providing tools that lead to improved accuracy of the transmission system model. Specifically the PSS/ODMS product suite:



- **Saves Time in Creating the Network Model –** Our experience indicates that building a large network model from basic components would require up to 50,000 man-hours. Even starting from existing models requires an inordinate amount of time to eliminate the model duplication and merge these into a further customized data set to fill our client's needs. PSS/ODMS provides the capability to integrate diverse models and customize the result for the final operational model. The PSS/ODMS model exchange capability provides even more savings by allowing model updates directly from other reliability entities that have spent many man-hours building their network models.

- **Saves Time in Maintaining the Network Model** – To incorporate changes manually into the network model could require a substantial full-time staff. PSS/ODMS offers the ability to update the model in a fraction of the time required using manual processes. Additionally, by visually identifying the areas that require modeling attention, efficiencies are further optimized. Updates can include either entire company models, models for only those substations that have changed since the last model update, or disparate sets of data changes reducing tedious manual data entry even more.
- **Conspicuously Identifies Errors and Reduces Time for One-Line Generation** – All reliability organizations have one-line drawings of major facilities on paper that can be used for data checking and for display generation. However, PSS/OneLine provides a tool that will quickly generate a substation one-line drawing that conforms exactly to the underlying data in the PSS/ODMS CIM Data Repository. From the PSS/OneLine screens, connectivity errors are quickly identified, the data edited directly, and the drawings and edited data are saved. Existing PSS/OneLine clients have indicated time savings ranging from 50-75% resulting from their use of the PSS/OneLine as a data-editing environment that also meets their graphics needs.
- **Increases Transmission Asset Utilization** – Appreciating that the PSS/ODMS assists in developing an accurate model, one would expect more accurate calculations, and thereby increased asset utilization. The potential for accurately assessing system performance and allowing additional capacity to be used can result in millions of dollars of increased revenue. Conversely, selling transmission service that isn't available could result in unnecessary curtailments, and equally costly consequences. All energies are focused on improving the system model that leads to more accurate determination of the state of the system. PSS/ODMS provides much needed tools to improve the model accuracy.
- **Improves Operations Planning Capabilities** – A more accurate model when analyzing generation unit operation can better predict when a unit is needed for transmission system support or when a unit may be a detriment to the operation of the transmission system. PSS/ODMS also exports the operations model in PSS/E format using controlled bus numbers and names specified by the user so the resulting model is familiar to the planning staff, further eliminating errors and expediting study activities when conducting off-line PSS/E work.
- **Allows for Better Staff Utilization** – The modeling automation provided within the PSS/ODMS allows technical staff to be more efficient in their data modeling efforts. High-powered personnel can spend their time making decisions instead of performing tedious data entry.

For more information about the NERC Model Exchange requirements and the PSS/ODMS Product Suite, please contact:

Operational Product Sales
Siemens Power Transmission & Distribution, Inc.
Power Technologies International
1482 Erie Boulevard, P.O. Box 1058
Schenectady, New York 12301-1058 USA
+1 518-395-5000
pti-software-services.ptd@siemens.com

Visit our website:
www.pti-us.com

SIEMENS

07/05

SS700

SISCO'S Virtual Data Warehouse

The **VDW** (**V**irtual **D**ata **W**arehouse) is a flexible tool that exposes legacy data as CIM compliant data. It allows multiple legacy databases containing vastly different data to be aggregated and presented as a single CIM data store. This can prevent the duplication of data and bring together data that had been isolated within departments. It represents a step forward in the quest for plug-and-play software applications for the power industry. Legacy data is transformed into CIM data on the fly without the need to build and manage new data warehouses.

Benefits of the CIM based VDW include:

The VDW architecture is based entiirely on standardized interfaces, playing a role in the move towards non-biased standardized best practices.

Open standard architecture in which major components are individually interoperable. Decreased development cost, together with competition and reuse of analysis applications, will help drive down prices.

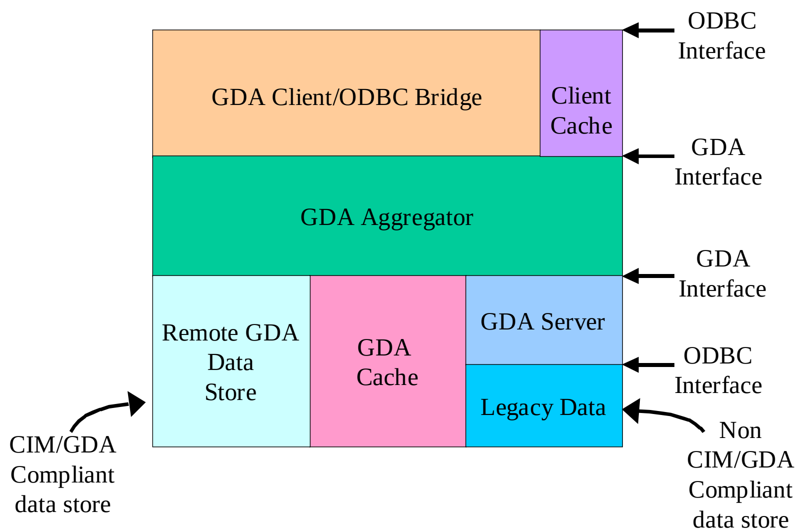
Avoids the cost of developing new data warehouses.

The VDW facilitates inclusion of unstructured data and avoids preordaining how data will be analyzed. This approach provides a flexible approach for the future.

The VDW allows a staged approach. You can start with one existing data warehouse as a source for the VDW, increasing the scope of the VDW incrementally until, eventually, all data are all available via unified CIM views. In this manner, the VDW delivers incremental value with staged effort throughout the process.

The VDW contains a GDA server component that exposes the legacy data via CIM GDA. The legacy data is mapped to the CIM schema via an easy to use mapping tool. The top layer is a GDA client that exposes the CIM data via ODBC. Because there is a CIM GDA layer in the middle, the legacy data is available to GDA client applications from other vendors. Similarly, the VDW GDA client layer can aggregate CIM GDA data from other vendors to join previously isolated data.

The architecture of the VDW is shown below:



VDW Architecture

CIM GDA Server

The legacy data is mapped to the CIM model via an easy to use configuration tool. Modifications to the CIM schema and the legacy database schemas are supported via load and synch technology. The GDA server exposes the legacy data as CIM GDA data on the UIB bus. This data is then available to all GDA client applications, including applications from other vendors.

The GDA server supports GDA Model Change Events so that changes in the underlying data can be broadcast to GDA applications so that they can update their model on the fly.

CIM GDA Cache

Data caching at both the system and user level is supported for optimal performance. At the system level, the system administrator can select which data is to be cached. Data from multiple GDA servers may be cached. An additional cache is available for each user. Each user may select the GDA to ODBC results to be cached.

CIM GDA Aggregator

Data aggregation shields the user from the complexity of dealing with multiple data sources. Client applications should operate as if there is a single unified relational database in which all CIM data has been aggregated. The VDW allows this by aggregating CIM data presented by multiple GDA Servers, including those from other vendors, as a single CIM data store. This allows, for example, legacy asset data exposed by one GDA server to be joined with PSR operating limits exposed by another GDA server.

CIM GDA Client/ODBC Server Bridge

The top layer of the VDW is a GDA Client and exposes the CIM data via ODBC for use by common data analysis tools. The VDW allows standard ODBC client to query and retrieve CIM related data such as assets and power system resources. The CIM data may be joined across multiple CIM classes as well as ordered and grouped. Most major SQL commands are supported by the VDW. The top layer of the VDW allows users to create views and to selectively cache data and results that the user uses often.

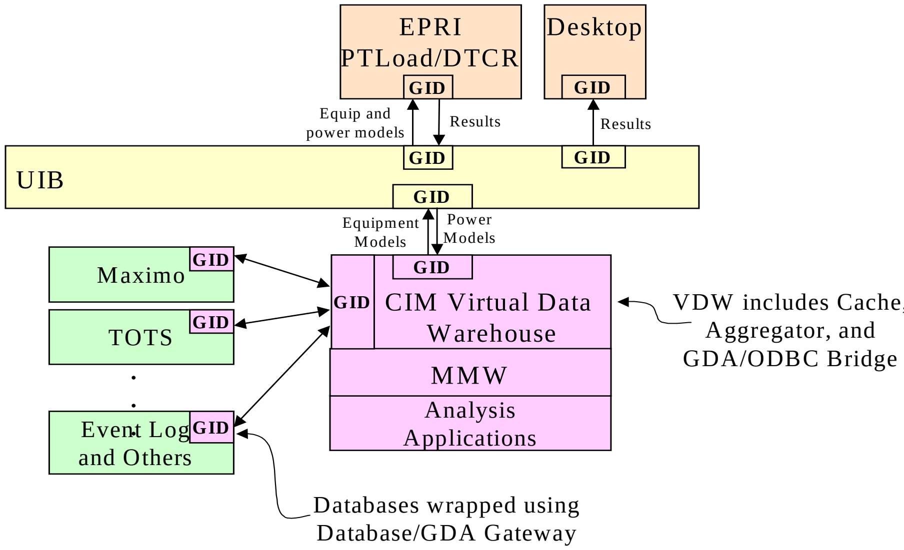
Example Application

This section describes how a deployment of the VDW can be used to create a platform for asset analysis2. In this case, we consider two projects with apparently different goals. The projects are:

- Development of substation focused asset analysis applications. These application require:
  - Asset/Equipment data
  - Historical measurement information
  - Power system network models
  - Data mining oriented and message bus oriented interaction
- Control center project to incrementally upgrade the legacy EMS
  - Integration of third party archive
  - New state estimator
  - CIM based power system modeling environment

By sharing a common design framework, a message based application integration and data mining solution can be built simultaneously. This approach reuses shared application wrappers to leverage the investment in each without requiring all data to be copied to a data warehouse. Separately, the cost of developing individual wrappers for data warehousing and for application integration can be prohibitive. By exposing application wrappers directly to the VDW without an intervening copy of all the data in a warehouse, flexibility is maximized while costs are minimized. The diagram below illustrates the asset analysis project components.

2 Based on EPRI VDW project at LIPA

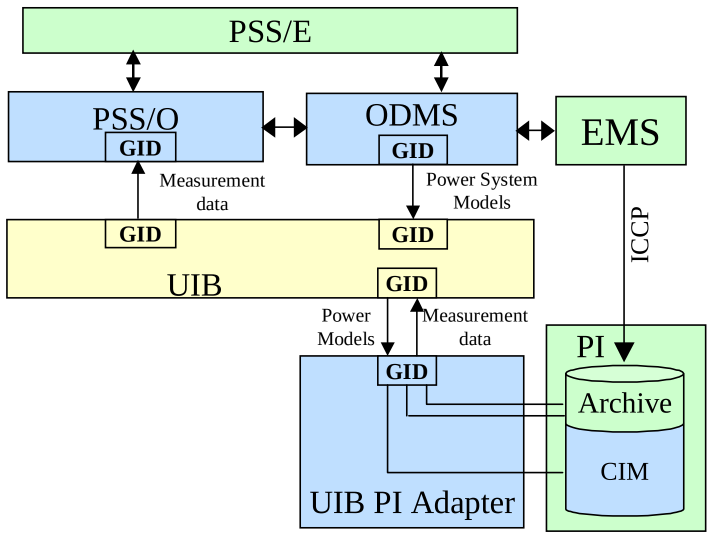


Asset Analysis Project

In this diagram, a collection of databases including Maximo, Transformer Outage (TOTS), transmission breaker change events (Event Log), and others are integrated using the RDBMS/GDA Gateway. The databases are aggregated with power system modeling data supplied by the Utility Integration Bus (UIB). The databases are tied directly to the VDW and not to the UIB for performance. By avoiding the XML messaging required by the UIB and only using the binary interface-to-interface remote procedure calls, query performance of the VDW is maximized. This architecture highlights one of the advantages of using a transport neutral interface such as GDA. In this architecture, links are optimized to meet project goals while still enabling a single standard off-the-shelf wrapper for applications. Application vendors can supply a single standard wrapper for data warehousing and message based application integration.

Besides the VDW, asset analysis in this use case includes deployment of an off-the-shelf CIM/GID compliant message bus called the Utility Integration Bus (UIB), and a transformer thermal analysis program called PTLoad. Rather than run on top of a specific analysis platform such as MMW, PTLoad connects directly into the CIM/GID integration infrastructure using the GID interfaces. Periodically, PTLoad examines current transformer loading and temperatures and after running calculations, publishes results on to the bus. PTLoad obtains required asset and power system information about equipment from the UIB GDA server.

The control center project involves the integration of transmission related applications using the UIB as shown below:

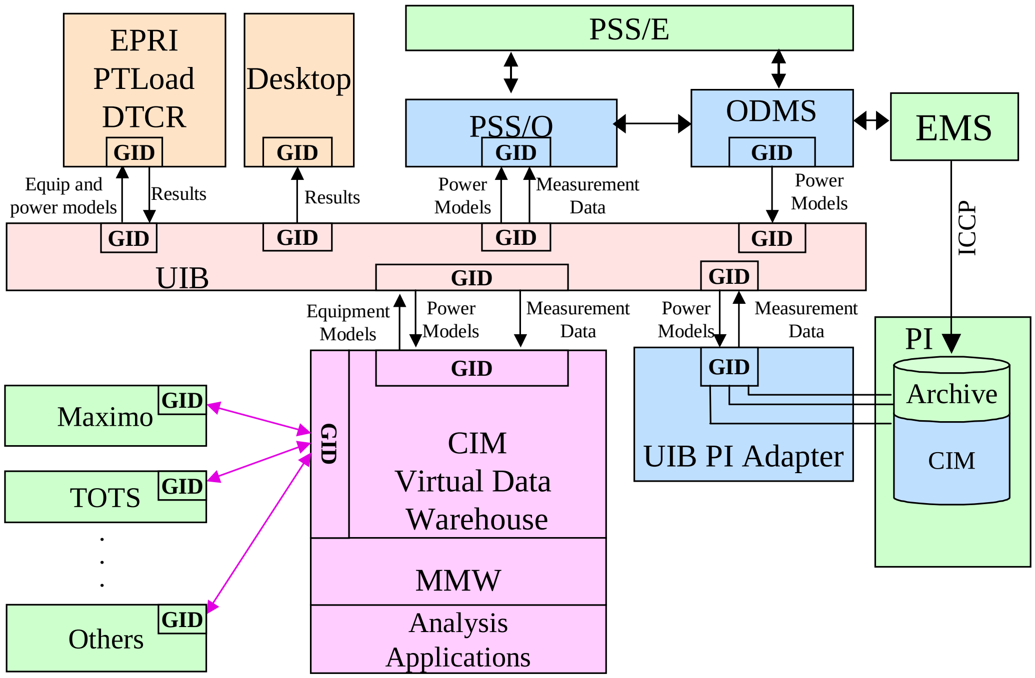


Control Center Project

As mentioned above, the principle motivation for the control center project is to facilitate incremental upgrading of the EMS. In this case, a new state estimator (PSS/O) and power flow application (PSS/E) are being integrated with the legacy EMS using a CIM based modeling tool called Operational Data Management System (ODMS). ODMS, a more full featured version of EPRI's CIM Installer, supplies modeling information to the new state estimator and power flow application via proprietary mechanisms. ODMS also supplies modeling data to the asset analysis applications via a CIM/GID interface.

ODMS also supplies a portion of the power system model to the UIB PI Adapter. As discussed previously, 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.

The diagram below depicts the combined system.

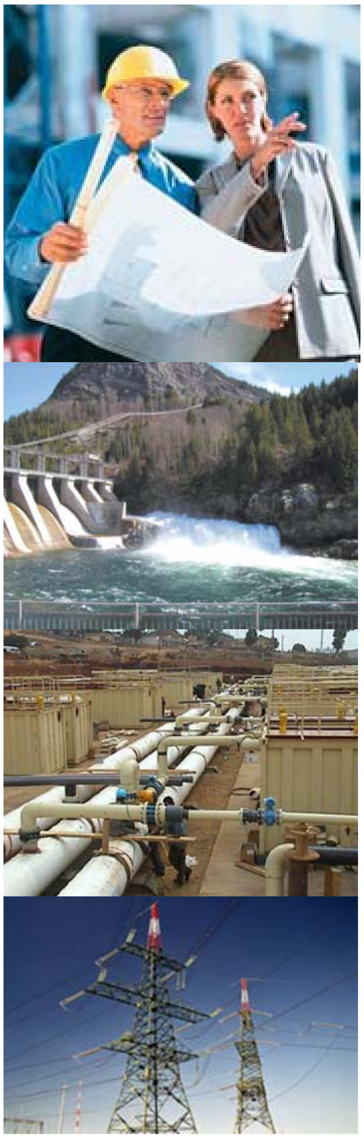


Combined Architecture

SNC Lavalin Product Descriptions

SNC-LAVALIN INC.

INTRODUCTION



SNC-Lavalin is one of the leading groups of engineering and construction companies in the world, and a key player in the ownership and management of infrastructure. In business since 1911, SNC-Lavalin companies are active across Canada, in the United States, and in 30 other countries worldwide. They are currently working on projects in approximately 100 countries.

SNC-Lavalin provides engineering, procurement, construction, project management and project financing services to a variety of industry sectors, including power, mining and metallurgy, infrastructure, chemicals and petroleum, pharmaceuticals, environment, agrifood, agriculture, mass transit, defence, and telecommunications.

SNC-Lavalin business units have the autonomy and global resources to assume total responsibility for every aspect of a project, on a fee-for-services, turnkey or concession basis, on their own or in partnership. Multidisciplinary teams of engineers, technical specialists and project management personnel work together in integrated task forces, committed to the prime objective of satisfying the client's needs.

The financing branches of SNC-Lavalin arrange financing solutions including traditional export credit and foreign component commercial credits, for all SNC-Lavalin business units in and outside Canada, as well as for third parties. This specialized expertise optimizes its position to secure the best financing conditions for a project, and to participate in the growing spheres of build-own-operate-transfer projects and public-private partnerships.

SNC-Lavalin is committed to maintaining high standards for health, safety and the environment and is committed to delivering projects within cost and on schedule. The quality management system of most of SNC-Lavalin business units are certified ISO 9001:2000. Recognizing the importance of integrating projects into their surroundings, SNC-Lavalin relies on its international network to provide first-hand knowledge of diverse geographical regions with respect to local cultures, traditions and customs of the countries in which it works.

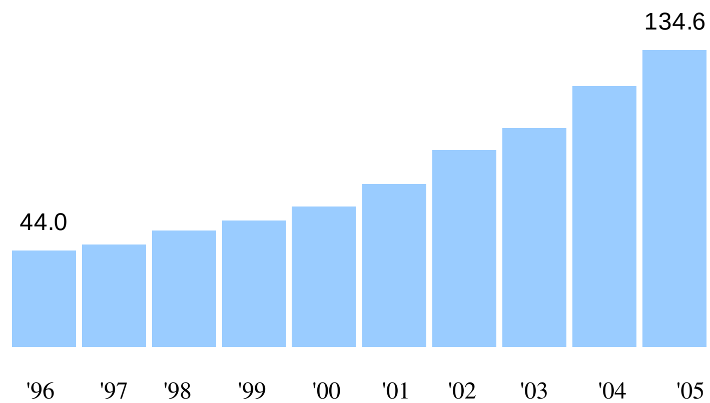
FINANCIAL HIGHLIGHTS

The ability to win contracts around the world is a good indicator of a successful business strategy. SNC-Lavalin has won significant contracts in all its sectors of activity, and is working on projects of all sizes worldwide. Our business strategy draws upon our diverse revenue base, our complementary pool of expertise, and our ability to adapt to evolving market needs.

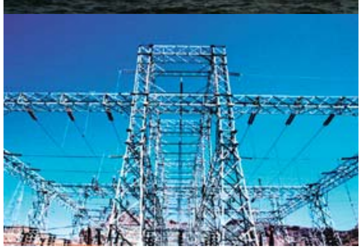
Our three revenue categories—services, packages and concessions—also complement each other. Each one is an integral part of our business and together they enhance it even further.

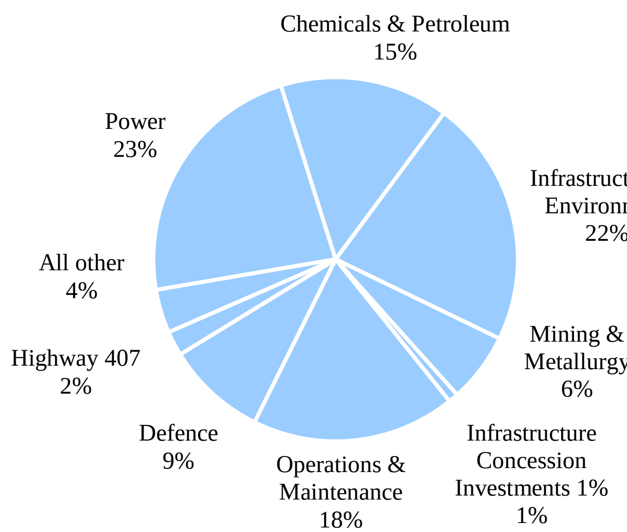
In 2005, SNC-Lavalin's net income continued to rise for the 14th consecutive year with revenues of CA $3.8 billion in 2005. The confidence of our clients worldwide was expressed in the numerous projects awarded to SNC-Lavalin in 2005, which allowed us to compile a backlog of CA $8.1 billion at the start of 2006.

SNC-Lavalin's Net Income excluding Highway 407
(In millions of Canadian $)



Breakdown by Sector of Activity





Power Division

SNC-Lavalin's Power division has over 90 years of experience in over 120 countries. SNC-Lavalin's power projects represent an installed capacity of nearly 240,000 MW, more than 90,000km of transmission and distribution lines, and some 1,500 substations. SNC-Lavalin also owns and operates several generation and transmission facilities, a number of which it designed, built and financed. SNC-Lavalin's Power division is recognized internationally as a leader in engineering and construction in the fields of hydroelectric, nuclear, and thermal power generation, power system studies, power sector reform, transmission and distribution projects, energy control systems, training, and technology transfer.

SNC-Lavalin's Power division operates in the following areas:

1. Energy Control Systems;
2. Thermal Power Plants;
3. Hydro Power Plants;
4. Nuclear Power Plants;
5. Substations and Power Lines;
6. Power Reform and Restructuring.

SNC-LAVALIN ENERGY CONTROL SYSTEMS

INTRODUCTION

SNC-Lavalin Energy Control Systems specializes in the design, supply, installation, and commissioning of Supervisory Control and Data Acquisition (SCADA) systems, Distribution Management Systems (DMS), Energy Management Systems (EMS), and Generation Management Systems (GMS). Together with the other divisions of SNC-Lavalin and its network of partners and suppliers, it provides complete turnkey solutions to the power sector including consulting, feasibility studies, design, infrastructure construction, customized energy control systems, telecommunications, remote terminal units, distribution automation, substation automation, training and technology transfer.

SNC-Lavalin Energy Control Systems has been supplying SCADA, DMS, EMS and GMS real-time control systems to the power sector for almost 40 years, with systems installed in six continents. It has successfully installed energy control systems in countries and regions such as Argentina, Australia, Canada, China, Egypt, Finland, Iceland, Slovenia, Taiwan, Thailand, United States, and Venezuela. Through state-of-the-art software and hardware, these systems are helping utilities manage generating stations, high-voltage transmission networks, as well as medium and low voltage distribution networks.

With its extensive experience in managing large and complex projects, as well as its solutions-oriented approach, its multicultural team, and its flexibility, SNC-Lavalin Energy Control Systems is able to offer global solution for small, medium, or large projects and to quickly adapt to changing market needs.

The Energy Control System business unit is located at 2425 Pitfield, Montréal, Québec. This 65,000-sq.ft. location is fully product-dedicated, providing a high-tech environment for the development of GENe software solutions. At any given time, several customer personnel and consultants are working with the GENe product team, participating in system integration, factory testing, and on-the-job training programs.

Certified ISO 9001

The quality management system of SNC-Lavalin Energy Control Systems is certified ISO 9001:2000.

SNC-Lavalin ECS continues to be an international leader in SCADA, DMS, EMS, and GMS systems. This is achieved through the know-how of its people, a continuous investment in the improvement of its products, and by contributing to the success of its clients through value-added products and services.

PRODUCT OVERVIEW

With the ever-increasing demand for power, utilities need powerful, expandable, and reliable tools to monitor and control their network assets. The competitive business environment created by deregulation means reliability of service is an important issue for all utilities.

In February 2006, SNC-Lavalin ECS launched GENe, the “Enterprise” version of the product, which provides enormous flexibility for utilities managing multiple assets, such as electricity, gas and water. GENe is the next step in the evolution of the GEN-3 and GEN-4 products, and will support applications for natural gas distribution as well as water distribution networks. GENe also features enhancements in cyber security, GIS interfaces, storage area networks, and more.

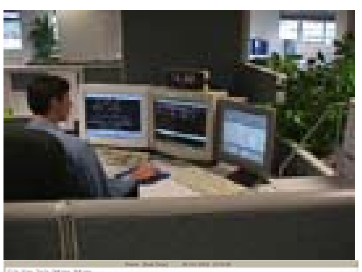
SNC-Lavalin ECS products are mature, field-proven products based on an open, distributed architecture that provides superior performance, enhanced graphics, fault tolerance, and high availability. GENe products provide an integrated suite of electricity, gas and water applications running on the same software platform, and are suitable for small, medium, large, and very large systems.

At SNC-Lavalin, we understand that data is an important corporate asset. We have designed our products to ensure that all data is securely available through a standard interfaces for display on corporate web pages, exchange with corporate applications or integration with productivity software such as Microsoft® Excel®, Microsoft® Access®, and commercial reporting packages.

DEDICATED CUSTOMER SERVICE

SNC-Lavalin has a dedicated Customer Services support team which offers 24x7 support to customers around the world. Various levels of support are available including upgrade options to keep systems up-to-date with the latest software and hardware developments.

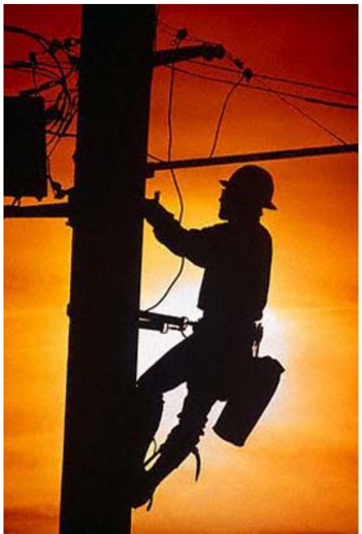
GENe SCADA

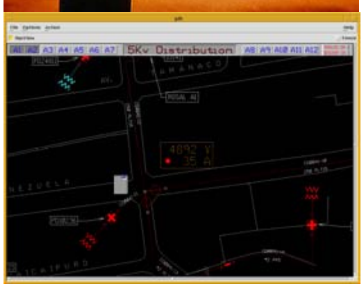


The GENe SCADA product supports a wide range of industry-standard and legacy protocols, including DNP3, IEC-60870-5, TASE.2 ICCP, ELCOM-90, and DL-476-92. It is fully integrated with our DMS, EMS and GMS products for real-time network analysis, and can be used in substation automation and pipeline management projects. Its features include:

1. IP-based redundant front-end processors;
2. Support of bit-oriented, synchronous, and asynchronous protocols;
3. Availability of a large library of legacy RTU protocols;
4. RDBMS-based database management facility;
5. Online database edits with audit trail;
6. Fully internationalized user interface with secure access control;
7. Automatic generation of substation and RTU tabular displays;
8. Large library of dynamic symbol objects for graphic displays;
9. Powerful calculated points engine;
10. Rich scripting language for real-time automatic process control;
11. Replicated real-time database for superior performance;
12. Historical data collection by exception;
13. ODBC/SQL access to real-time and historical data;
14. Web-based access to SCADA data and displays.

GENe Distribution Management System (DMS)

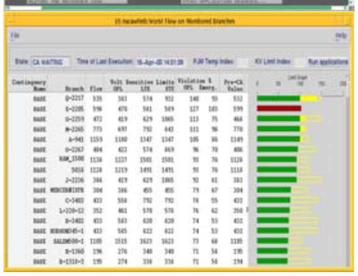




The GENe DMS product provides utilities with a comprehensive suite of applications and tools for efficient, reliable, and cost-effective management of distribution networks. Its sophisticated network model supports three-phase unbalanced networks, and is the basis for all of the DMS applications. The DMS product provides an interface to most major GIS systems for initial population and online incremental updates of the network model and operating displays. The DMS applications are fully integrated with the GENe SCADA and EMS products and use a common real-time database, so analysis and recommendations are based on the real-time state of the network. Most DMS applications are available in both real-time and study mode.

1. GIS Interface;
2. Network Connectivity Analysis;
3. Feeder Colouring;
4. Feeder Tracing, Cuts, Grounds, and Jumpers;
5. Load Forecast and Load Estimation;
6. Three-phase Unbalanced Power Flow;
7. Fault Level Analysis;
8. Fault Detection, Isolation, and Restoration;
9. Load Shedding and Restoration;
10. Loss Minimization and Load Balancing;
11. Contingency Load Transfer;
12. Volt-var Control;
13. Intelligent Switching Management;
14. Trouble Call and Outage Management;
15. Dispatcher Training Simulator.

GENe Energy Management System (EMS)

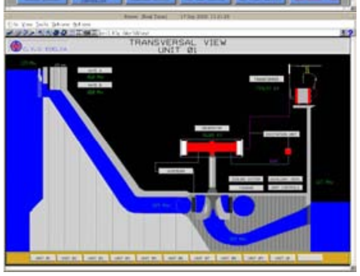


The GENe EMS product includes a full suite of transmission network security analysis applications that use state-of-the-art algorithms. The EMS applications are fully integrated with the other GENe products and use a common real-time database. As a result, the displays used for real-time SCADA operations can also be used to display network security analysis results. The following is a list of the main GENe EMS applications:

1. Load Forecast;
2. Bus Scheduler;
3. Network Topology Processor;
4. State Estimator;
5. Dispatcher Power Flow;
6. Pre-switching Validation;
7. Transmission Loss Penalty Factor;
8. Reactive Reserve Monitor;
9. Contingency Analysis;
10. Contingency Remedial Action;
11. Optimal Power Flow;
12. Volt-VAr Control;
13. Security-constrained Dispatch;
14. Fault Level Calculation;
15. Switching Management;
16. Real-time Market Applications;
17. Dynamic/Transient Stability Analysis;
18. Equipment Outage Scheduler;
19. Interchange Transaction Scheduler;
20. Network Operations Scheduling;
21. Dispatcher Training Simulator.

The GENe EMS supports full and incremental CCAPI-CIM Model Import/Export per IEC61870-301 and NERC CPSM Profile standards.

GENe GENERATION MANAGEMENT SYSTEM (GMS)



SNC-Lavalin has extensive experience in supplying plant control systems for some of the largest hydroelectric installations in the world. GMS applications can also be included with EMS systems for centralized dispatch of multiple generating plants. These systems are based on the GENe SCADA product and the following Operations Planning and Generation Management applications:

1. Load Forecast;
2. Unit Commitment;
3. Hydro Flow Simulation;
4. Hydro Generation Scheduling;
5. Hydro-thermal Co-ordination;
6. Automatic Generation Control;
7. Economic Dispatch;
8. Reserve Monitor;
9. AGC Performance Monitor (per NERC standards);
10. Production Costing;
11. Automatic Voltage Control;
12. Spillway Gate Control;
13. Network Topology Processor;
14. Dispatcher Training Simulator.

B
APPENDIX: TEST CONFIGURATION DATA

Test Procedures

The test procedure for this series of tests was CIM XML Interoperability Test 8 Test Plan and Procedures, Revision 1, March 28, 2006 contained in the following file:

- Test procedures: cim_gid interop test 8 plan r1 032806.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_2.0.mdl

CIM RDF Schema file: 61970NERC.rdfs

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

http://iec.ch/TC57/2005/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 (Reference 13) 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 12.

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_2006-03-27.xml
2. ABB 40 Bus Model: ABB40busCPSM2.rdf
3. EDF UCTE 14 Node file: utce_14_i3e_20060328_2.xml
4. WAPA 262 Bus Model: wapa262cim.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 exact revision used in the test will be noted in the final test report.

The SISCO 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:

- *co-AddACLine-SNC.xml*
- *co-AddLoad-SNC.xml*
- *co-AddPt-SNC.xml*
- *Co-ModPt-r-SNC.xml*
- *Co-ModACLine-x-SNC.xml*
- *Co-ModLoad-move-SNC.xml*
- *Co-DelLoad-SNC.xml*

An incremental file that has been generated by a participant may also be used by another participant.

Tools

The tools to be used for the interoperability testing at the time of this revision are:

- CIM XML 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.)
- Mercury CIM XML Online Validator provided by the University of Strathclyde's Mercury CIM Toolkit. To use this tool, register at http://monaco.eee.strath.ac.uk/mercury

- 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.
- 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 XML Validators is provided in the IOP 8 Test Plan and Procedure (reference 2).

C
APPENDIX: 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 11. Therefore, compliance to the standardized interfaces and namespace definitions were both required in order to claim conformance for these tests.

D
APPENDIX: TEST APPROACH AND DESCRIPTIONS

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.

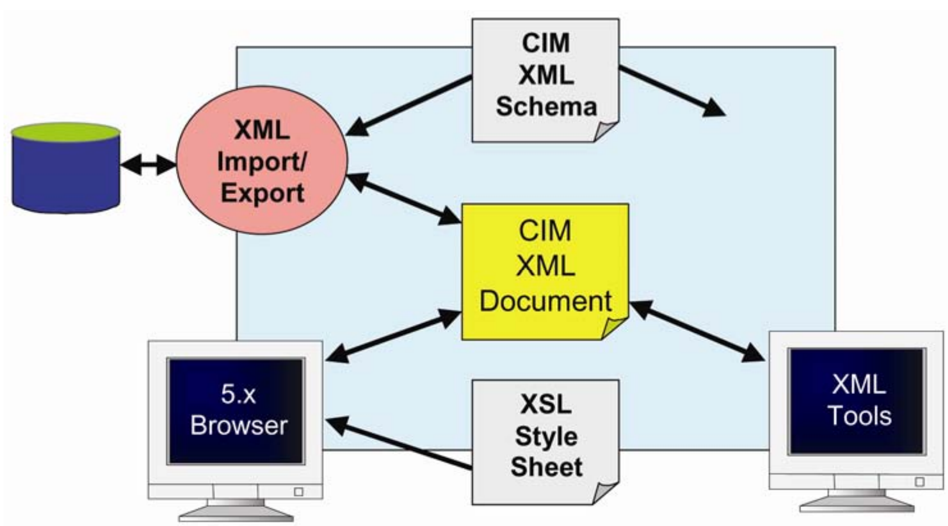


Figure D-1
Export/Import Process Basics

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).

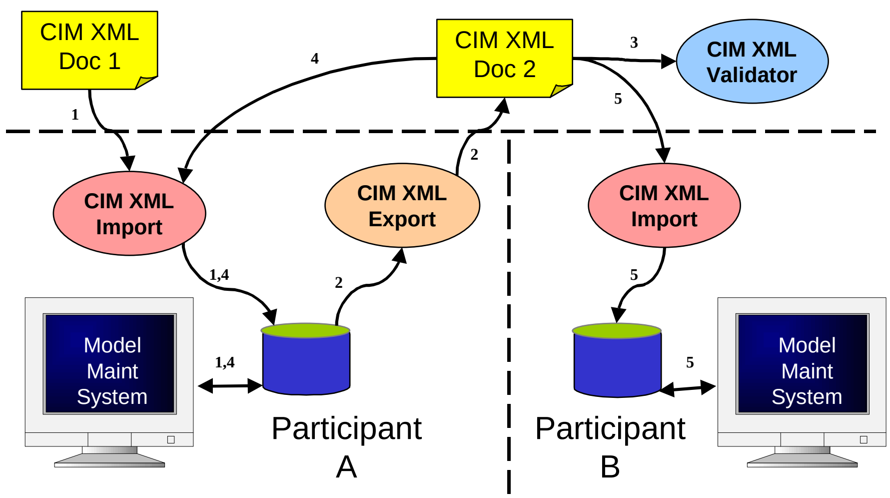


Figure D-2
CIM XML Interoperability Test Process Steps

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

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.

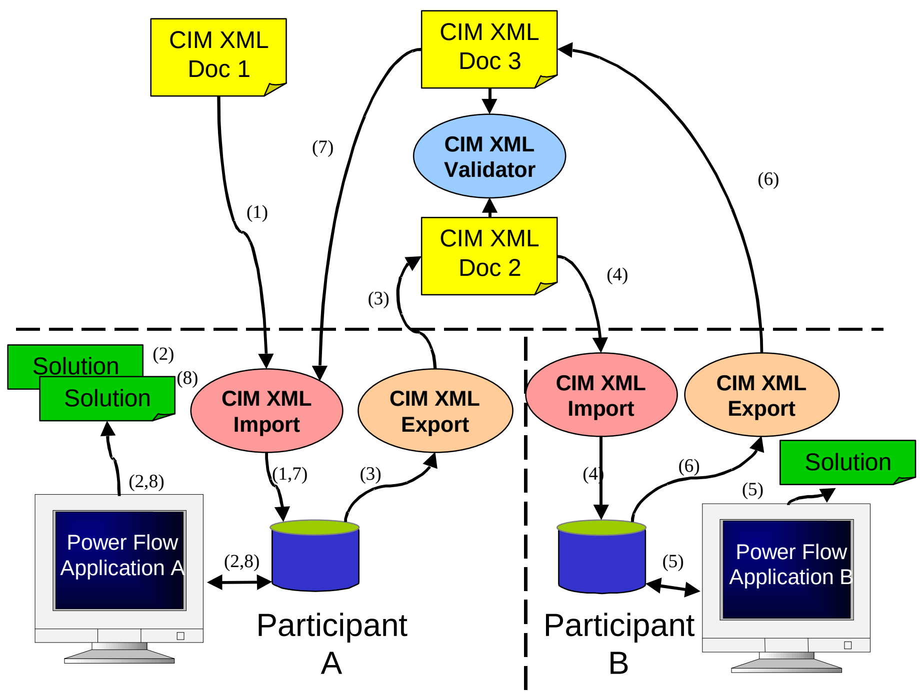


Figure D-3
Solution Test Process

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[3].

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.

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 13.

Test Process

Once the WAPA 262 bus 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.

3 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.

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.

E

APPENDIX: OFF-SITE TEST DESCRIPTION AND RESULTS

The off-site testing included the ABB import and export tests. This section defines the tests that were performed, the files that were used and the results.

Executed Tests

The exchange tests included the Basic Import and Basic Export. In addition, ABB also created two pairs of Partial files; one pair from the Areva 60 bus and one pair from the ABB 40 bus.

The files used in the Basic Import test included:

- AREVA60-2006-03-27_ABB.rdf
- WAPA262CIM_ABB.rdf
- ABB40busCPSM2_2006-04-28.rdf

The only file used in the Basic Export test was the AREVA60-2006-03-27_ABB-adj-rexported.rdf.

The partial files created included the following:

- AREVA60-2006-03-27_ABB-adj-rexported_WO_Brighton.rdf
- AREVA60-2006-03-27_ABB-adj-rexported_Brighton.rdf
- ABB40busCPSM2_2006-04-28_WO-Amherst.rdf
- ABB40busCPSM2_2006-04-28-Amherst.rdf

The files were validated using Mercury validator. In addition, specific attribute values were requested from the models and screen shots were provided showing these attributes and the values contained in the model. These screens are contained in the Results section.

Test Results

Basic Import and Export

The tables below show the results of the ABB import and export tests. The primary objective of this test was to successfully import and export a sample model file based on the CPSM transmission model profile to show compliance.

Basic Import Test of ABB's Product

Test Procedure	4.2.1.1 Basic Import		
Test Model Used	**262 Bus Model**	**60 Bus Model**	**40 Bus Model**
ABB	P	P	P

To verify the Areva 60 bus model and the WAPA 262 bus file were correctly imported, the observer requested the following information from ABB.

For the Areva60 bus, Chenaux Substation, the X and R values for the two windings on Transformer GI was requested. In addition, the Initial MW and Max/Min MVA on the generating unit in the same substation was requested.

For the WAPA262 bus, the total number of AC Line Segments, Breakers, Energy Consumers, Substations and Synchronous Machines contained in the model was requested.

The response to these inquiries is contained in the screen shots presented in the section below.

Basic Export Test of ABB's Product

Test Procedure	4.2.2.1 Basic Export
Test Model Used	**60 Bus Model**
ABB	P

Partial Model Pair Creation

ABB created two sets of partial model pairs. However, since no other participant tested partial models for this test, there was no way to verify if the pairs were valid files.

ABB Screen Shots

The following screen shots were produced to provide the data required to pass the basic export test above.

Areva Re-exported Transformer CHENAUX-XFMR-G1 1


```
<cim:PowerTransformer rdf:ID="_197634201">
    <cim:PowerTransformer.transformerType rdf:resource="http://iec.ch/TC57/2005/CIM-schema-cim10#TransformerType.voltageControl"/>
    <cim:Naming.name>CHENAUXG1</cim:Naming.name>
    <cim:Naming.pathName>CHENAUXG1</cim:Naming.pathName>
    <cim:Naming.aliasName>CO-ECARDV-ECARST-CHENAUX-XFMR-G1</cim:Naming.aliasName>
    <cim:Naming.description>CHENAUXG1</cim:Naming.description>
    <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#_197070201"/>
</cim:PowerTransformer>


<cim:TapChanger rdf:ID="_198046201">
    <cim:TapChanger.highStep>16</cim:TapChanger.highStep>
    <cim:TapChanger.lowStep>-16</cim:TapChanger.lowStep>
    <cim:TapChanger.neutralKV>345</cim:TapChanger.neutralKV>
    <cim:TapChanger.neutralStep>0</cim:TapChanger.neutralStep>
    <cim:TapChanger.normalStep>0</cim:TapChanger.normalStep>
    <cim:TapChanger.stepVoltageIncrement>1.72499990463257</cim:TapChanger.stepVoltageIncrement>
    <cim:TapChanger.tculControlMode rdf:resource="http://iec.ch/TC57/2005/CIM-schema-cim10#TransformerControlMode.off"/>
    <cim:Naming.name>ACHENAUXG1G10001</cim:Naming.name>
    <cim:Naming.pathName>ACHENAUXG1G10001</cim:Naming.pathName>
    <cim:Naming.aliasName>CO-ECARDV-ECARST-CHENAUX-XFMR-G1XF-G10001TAPTY-2</cim:Naming.aliasName>
    <cim:Naming.description>A0001</cim:Naming.description>
    <cim:TapChanger.TransformerWinding rdf:resource="#_197634307"/>
</cim:TapChanger>
```


ABB Automation

ABB Automation Systems/Utilities
Industrial IT standardization 10

Areva Re-exported Transformer CHENAUX-XFMR-G1 **2**


```xml
<cim:TransformerWinding rdf:ID="_197634307">
    <cim:TransformerWinding.g>.000100819155639572005881117412308338584</cim:TransformerWinding.g>
    <cim:TransformerWinding.b>.000663726107960513085486242386053350137</cim:TransformerWinding.b>
    <cim:TransformerWinding.r>0</cim:TransformerWinding.r>
    <cim:TransformerWinding.ratedKV>345</cim:TransformerWinding.ratedKV>
    <cim:TransformerWinding.ratedMVA>3768.12</cim:TransformerWinding.ratedMVA>
    <cim:TransformerWinding.connectionType rdf:resource="http://iec.ch/TC57/2005/CIM-schema-cim10#WindingConnection.Y"/>
    <cim:TransformerWinding.windingType rdf:resource="http://iec.ch/TC57/2005/CIM-schema-cim10#WindingType.primary"/>
    <cim:TransformerWinding.x>21.543525695800796535</cim:TransformerWinding.x>
    <cim:Naming.name>CHENAUXG1_1</cim:Naming.name>
    <cim:Naming.pathName>CHENAUXG1_1</cim:Naming.pathName>
    <cim:Naming.description>CHENAUXG1_1</cim:Naming.description>
    <cim:TransformerWinding.MemberOf_PowerTransformer rdf:resource="#_197634201"/>
    <cim:ConductingEquipment.BaseVoltage rdf:resource="#_345302"/>
</cim:TransformerWinding>

<cim:TransformerWinding rdf:ID="_197634308">
    <cim:TransformerWinding.g>0</cim:TransformerWinding.g>
    <cim:TransformerWinding.b>0</cim:TransformerWinding.b>
    <cim:TransformerWinding.r>0</cim:TransformerWinding.r>
    <cim:TransformerWinding.ratedKV>13.8000001907349</cim:TransformerWinding.ratedKV>
    <cim:TransformerWinding.ratedMVA>3768.12</cim:TransformerWinding.ratedMVA>
    <cim:TransformerWinding.connectionType rdf:resource="http://iec.ch/TC57/2005/CIM-schema-cim10#WindingConnection.Y"/>
    <cim:TransformerWinding.windingType rdf:resource="http://iec.ch/TC57/2005/CIM-schema-cim10#WindingType.secondary"/>
    <cim:TransformerWinding.x>0</cim:TransformerWinding.x>
    <cim:Naming.name>CHENAUXG1_2</cim:Naming.name>
    <cim:Naming.pathName>CHENAUXG1_2</cim:Naming.pathName>
    <cim:Naming.description>CHENAUXG1_2</cim:Naming.description>
    <cim:TransformerWinding.MemberOf_PowerTransformer rdf:resource="#_197634201"/>
    <cim:ConductingEquipment.BaseVoltage rdf:resource="#_14102"/>
</cim:TransformerWinding>
```


ABB Automation

ABB Automation Systems/Utilities
Industrial IT standardization 11

Comparing Original & Re-exported Areva60bus

Original

- ACLineSegment (47)
- Analog (145)
- AreaLoadCurve (1)
- BaseVoltage (11)
- Breaker (350)
- Company (2)
- Compensator (19)
- ConnectivityNode (393)
- ControlAreaOperator (4)
- CurveSchedData (40)
- DayType (40)
- EquivalentLoad (57)
- HostControlArea (4)
- IEC61970Version (1)
- Limit (318)
- LimitSet (106)
- Line (47)
- LoadArea (1)
- MeasurementType (8)
- PowerTransformer (59)
- RegulationSchedule (39)
- Season (4)
- SubControlArea (4)
- Substation (30)
- SynchronousMachine (24)
- TapChanger (49)
- Terminal (1012)
- ThermalGeneratingUnit (24)
- TransformerWinding (118)
- Unit (11)
- VoltageLevel (69)

Re-exported

- ACLineSegment (47)
- Analog (145)
- BasePower (1)
- BaseVoltage (10)
- Breaker (350)
- Compensator (19)
- ConnectivityNode (393)
- DayType (5)
- Discrete (350)
- EquivalentLoad (57)
- HostControlArea (4)
- IEC61970Version (1)
- Limit (318)
- LimitSet (106)
- Line (47)
- LoadArea (1)
- MeasurementType (8)
- MeasurementValueSource (2)
- PowerTransformer (59)
- Season (4)
- SubControlArea (4)
- Substation (30)
- SynchronousMachine (24)
- TapChanger (49)
- Terminal (1012)
- ThermalGeneratingUnit (24)
- TransformerWinding (118)
- Unit (11)
- VoltageLevel (69)

Comments
- schedules still missing in re-export
- the hierarchy above substation has problems
- voltage BV-200 not used in original hence excluded in re-export

ABB Automation

ABB Automation Systems/Utilities
Industrial IT standardization 12

Wapa Substations In DE400

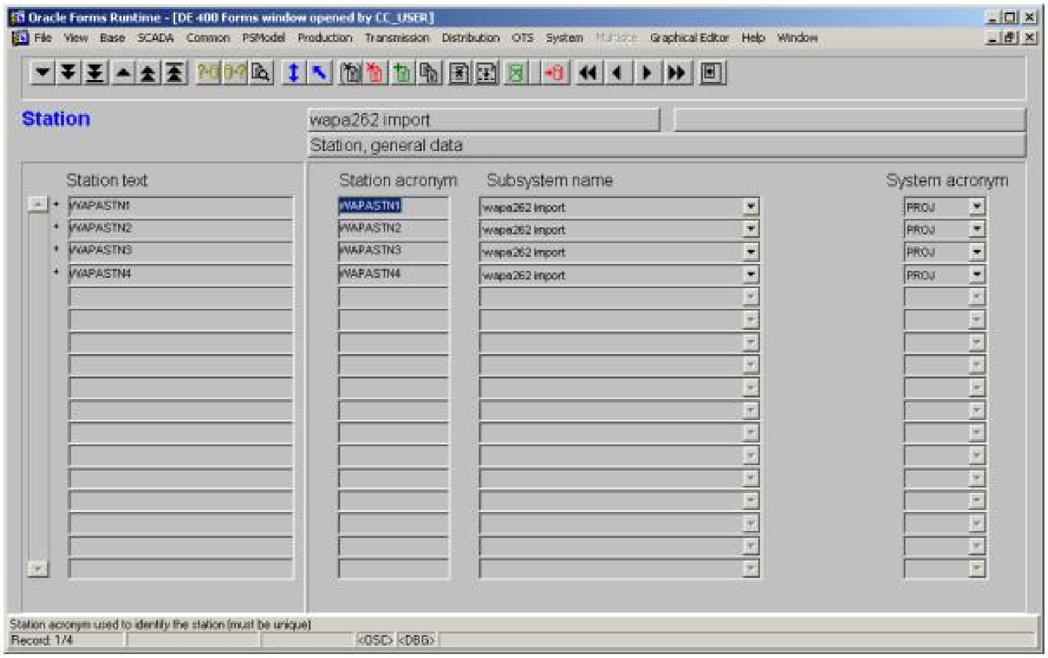


ABB Automation

ABB Automation Systems/Utilities
Industrial IT standardization 13

Comparing Original & Re-exported Wapa262

Original	Re-exported
ACLineSegment (234)	ACLineSegment (234)
Analog (774)	Analog (736)
AreaLoadCurve (4)	BasePower (1)
BaseVoltage (10)	BaseVoltage (10)
Breaker (998)	Breaker (998)
Compensator (36)	Compensator (36)
ConnectivityNode (1260)	ConnectivityNode (1260)
CurveSchedData (208)	DayType (5)
EnergyConsumer (152)	Discrete (998)
GeneratingUnit (13)	EquivalentLoad (152)
HostControlArea (4)	HostControlArea (4)
IEC61970Version (1)	IEC61970Version (1)
Limit (2118)	Limit (2112)
LimitSet (719)	LimitSet (717)
LoadArea (4)	Line (234)
MVArCapabilityCurve (55)	LoadArea (4)
MeasurementType (7)	MeasurementType (8)
MeasurementValueSource (2)	MeasurementValueSource (2)
PowerTransformer (105)	PowerTransformer (105)
RegulationSchedule (94)	Season (4)
Season (4)	SubControlArea (4)
SubControlArea (4)	Substation (4)
Substation (4)	SynchronousMachine (55)
SynchronousMachine (55)	TapChanger (105)
TapChanger (105)	Terminal (2918)
Terminal (2918)	ThermalGeneratingUnit (55)
ThermalGeneratingUnit (42)	TransformerWinding (210)
TransformerWinding (210)	Unit (11)
Unit (7)	VoltageLevel (262)
VoltageLevel (262)	

Comments
- schedules still missing in re-export
- the hierarchy above substation has problems
- wapa use both ThermalGeneratingUnit and GeneratingUnit (illegal). I export all as ThermalGeneratingUnits
- there are some problems with analogs in wapa so all doesnt get imported will look into that.

ABB Automation
ABB Automation Systems/Utilities
Industrial IT standardization 14

ABB

Areva Original Unit CHENAUXKV-14


```xml
<cim:SynchronousMachine rdf:ID="CO-ECARDV-ECARST-CHENAUXKV-14SMUN-1">
    <cim:Naming.name>1</cim:Naming.name>
    <cim:Naming.aliasName>1</cim:Naming.aliasName>
    <cim:Naming.pathName>SynchronousMachine</cim:Naming.pathName>
    <cim:SynchronousMachine.maximumKV>13.8000001907349</cim:SynchronousMachine.maximumKV>
    <cim:SynchronousMachine.maximumMVAr>145.785995483398</cim:SynchronousMachine.maximumMVAr>
    <cim:SynchronousMachine.minimumKV>13.8000001907349</cim:SynchronousMachine.minimumKV>
    <cim:SynchronousMachine.minimumMVAr>-135.951995849609</cim:SynchronousMachine.minimumMVAr>
    <cim:SynchronousMachine.operatingMode rdf:resource="http://iec.ch/TC57/2005/CIM-schema-cim10#SynchronousMachineOperatingMode.generator"/>
    <cim:SynchronousMachine.ratedMVA>1300</cim:SynchronousMachine.ratedMVA>
    <cim:SynchronousMachine.type rdf:resource="http://iec.ch/TC57/2005/CIM-schema-cim10#SynchronousMachineType.generator_or_condenser"/>
    <cim:SynchronousMachine.MemberOf_GeneratingUnit rdf:resource="#CO-ECARDV-ECARST-CHENAUXKV-14UN-1"/>
    <cim:RegulatingCondEq.Measurement rdf:resource="#MEAS-CO-ECARDV-ECARST-CHENAUXKV-14UN-1"/>
    <cim:RegulatingCondEq.RegulationSchedule rdf:resource="#TY-REGSK-SKD-RGSKUN20"/>
    <cim:ConductingEquipment.BaseVoltage rdf:resource="#BV-13.8"/>
    <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#CO-ECARDV-ECARST-CHENAUXKV-14"/>
    <cim:PowerSystemResource.OperatedBy_Companies rdf:resource="#CO-ECAR"/>
</cim:SynchronousMachine>

<cim:ThermalGeneratingUnit rdf:ID="CO-ECARDV-ECARST-CHENAUXKV-14UN-1">
    <cim:Naming.name>14UN11</cim:Naming.name>
    <cim:Naming.aliasName>1</cim:Naming.aliasName>
    <cim:GeneratingUnit.genControlSource rdf:resource="http://iec.ch/TC57/2005/CIM-schema-cim10#GeneratorControlSource.onAGC"/>
    <cim:GeneratingUnit.initialMW>341.287994384766</cim:GeneratingUnit.initialMW>
    <cim:GeneratingUnit.maximumOperatingMW>1300</cim:GeneratingUnit.maximumOperatingMW>
    <cim:GeneratingUnit.minimumOperatingMW>50</cim:GeneratingUnit.minimumOperatingMW>
    <cim:GeneratingUnit.normalPF>1.29999995231628</cim:GeneratingUnit.normalPF>
    <cim:GeneratingUnit.SubControlArea rdf:resource="#AREA-ECARDV-ECARAREA-ECAR"/>
    <cim:Equipment.MemberOf_EquipmentContainer rdf:resource="#CO-ECARDV-ECARST-CHENAUXKV-14"/>
    <cim:PowerSystemResource.OperatedBy_Companies rdf:resource="#CO-ECAR"/>
</cim:ThermalGeneratingUnit>
```


ABB Automation
ABB Automation Systems/Utilities
Industrial IT standardization 2

Areva Substation CHENAUXKV-14 In DE400

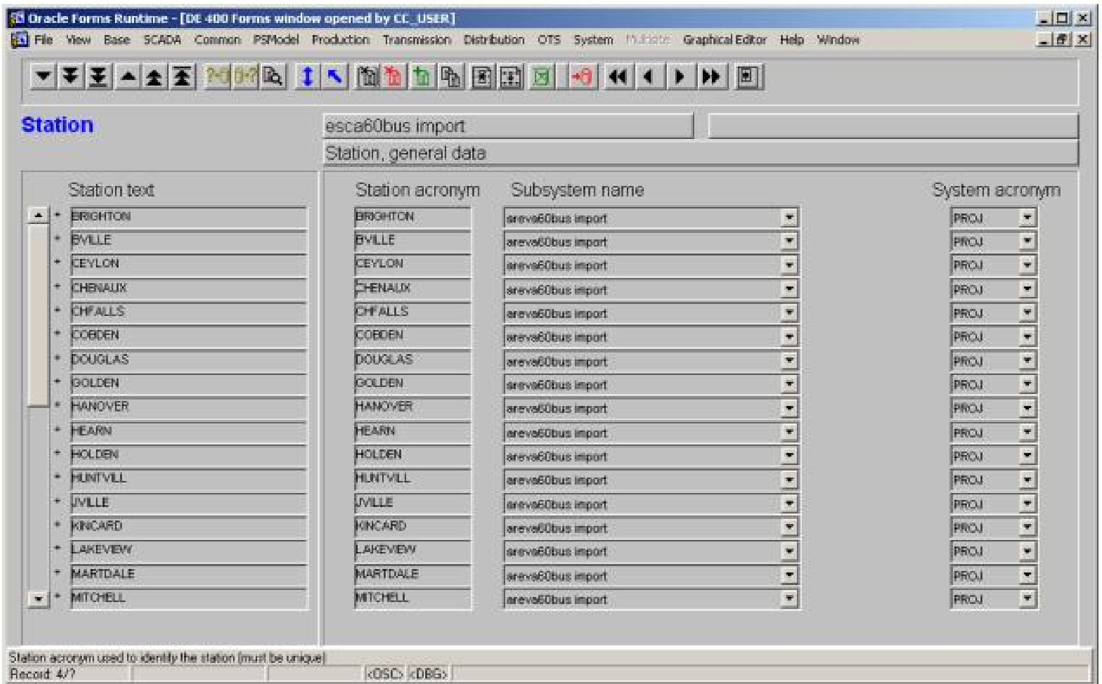
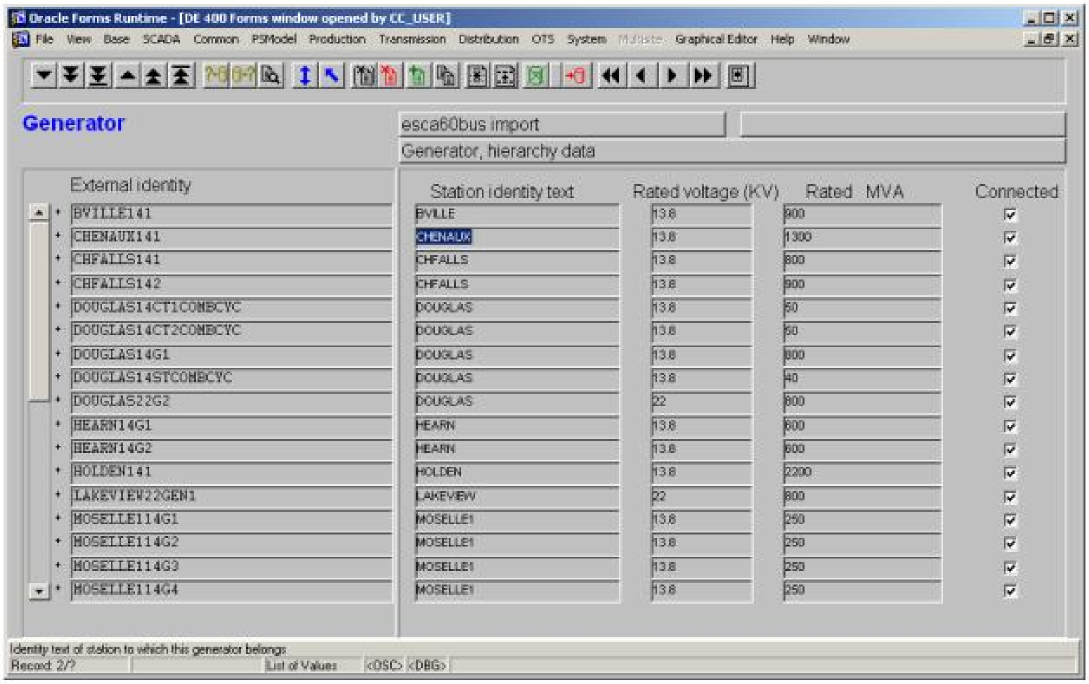


ABB Automation
ABB Automation Systems/Utilities
Industrial IT standardization 3

Areva Unit CHENAUXKV-14 In **DE400**

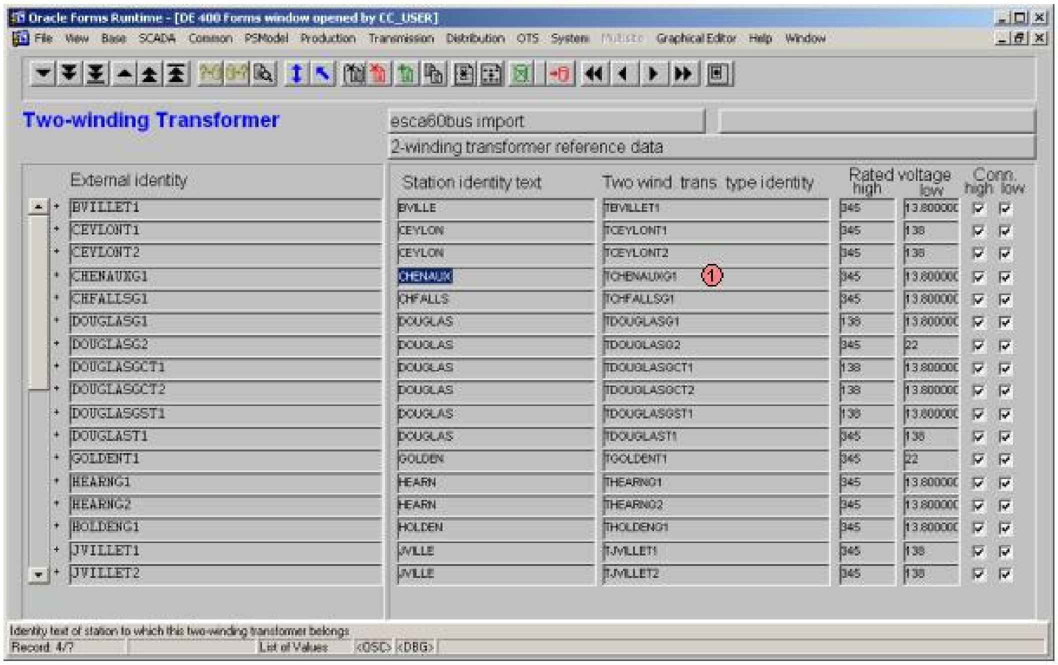


External identity	Station identity text	Rated voltage (KV)	Rated MVA	Connected
BVILLE141	BVILLE	13.8	900	✓
CHENAUX141	CHENAUX	13.8	1300	✓
CHFALLS141	CHFALLS	13.8	800	✓
CHFALLS142	CHFALLS	13.8	900	✓
DOUGLAS14CT1COMBCYC	DOUGLAS	13.8	50	✓
DOUGLAS14CT2COMBCYC	DOUGLAS	13.8	50	✓
DOUGLAS14G1	DOUGLAS	13.8	800	✓
DOUGLAS14STCOMBCYC	DOUGLAS	13.8	40	✓
DOUGLAS22G2	DOUGLAS	22	800	✓
HEARN14G1	HEARN	13.8	600	✓
HEARN14G2	HEARN	13.8	600	✓
HOLDEN141	HOLDEN	13.8	2200	✓
LAKEVIEW22GEN1	LAKEVIEW	22	800	✓
MOSELLE114G1	MOSELLE1	13.8	250	✓
MOSELLE114G2	MOSELLE1	13.8	250	✓
MOSELLE114G3	MOSELLE1	13.8	250	✓
MOSELLE114G4	MOSELLE1	13.8	250	✓

Identity text of station to which this generator belongs
Record: 2/? List of Values <OSC> <DBG>

ABB Automation
ABB Automation Systems/Utilities
Industrial IT standardization 4

Areva Transformer CHENAUX-XFMR-G1 In **DE400 1**

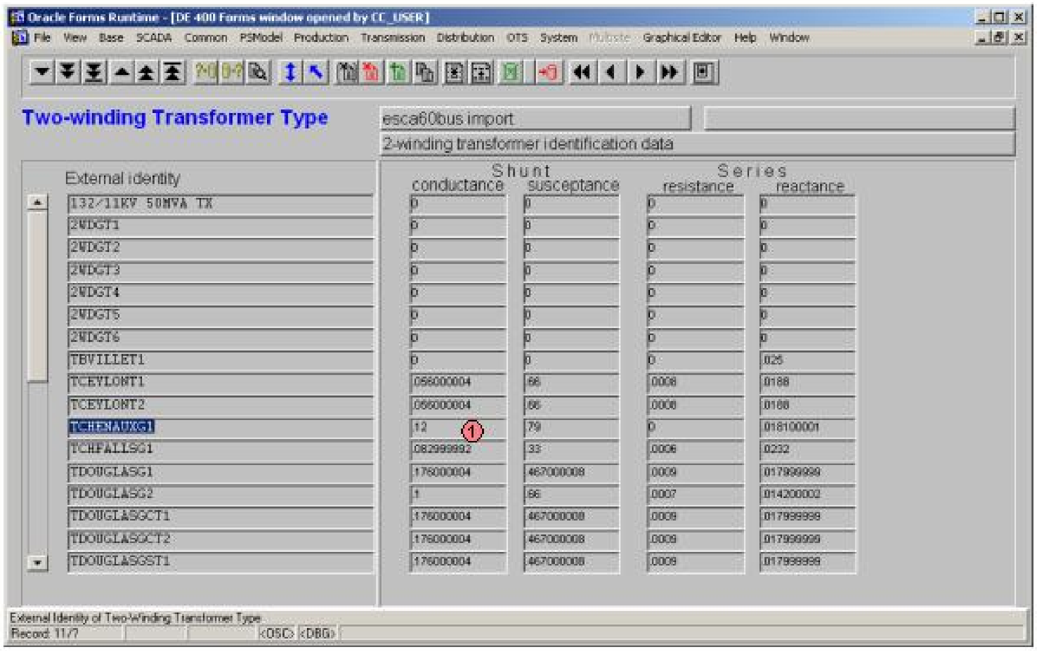


External identity	Station identity text	Two wind. trans. type identity	Rated voltage high	Rated voltage low	Conn. high	Conn. low
BVILLET1	BVILLE	TBVILLET1	345	13.80000	☑	☑
CEYLONT1	CEYLON	TCEYLONT1	345	138	☑	☑
CEYLONT2	CEYLON	TCEYLONT2	345	138	☑	☑
CHENAUXG1	CHENAUX	TCHENAUXG1 (1)	345	13.80000	☑	☑
CHFALLSG1	CHFALLS	TCHFALLSG1	345	13.80000	☑	☑
DOUGLASG1	DOUGLAS	TDOUGLASG1	138	13.80000	☑	☑
DOUGLASG2	DOUGLAS	TDOUGLASG2	345	22	☑	☑
DOUGLASGCT1	DOUGLAS	TDOUGLASGCT1	138	13.80000	☑	☑
DOUGLASGCT2	DOUGLAS	TDOUGLASGCT2	138	13.80000	☑	☑
DOUGLASGST1	DOUGLAS	TDOUGLASGST1	138	13.80000	☑	☑
DOUGLAST1	DOUGLAS	TDOUGLAST1	345	138	☑	☑
GOLDENT1	GOLDEN	TGOLDENT1	345	22	☑	☑
HEARNG1	HEARN	THEARNG1	345	13.80000	☑	☑
HEARNG2	HEARN	THEARNG2	345	13.80000	☑	☑
HOLDENG1	HOLDEN	THOLDENG1	345	13.80000	☑	☑
JVILLET1	JVILLE	TJVILLET1	345	138	☑	☑
JVILLET2	JVILLE	TJVILLET2	345	138	☑	☑

1) Note, impedance parameters in type data, see next slide

ABB Automation
ABB Automation Systems/Utilities
Industrial IT standardization 8

Areva Transformer CHENAUX-XFMR-G1 In **DE400 2**


Oracle Forms Runtime - [DE 400 Forms window opened by CC_USER]

File View Base SCADA Common PSModel Production Transmission Distribution OTS System Multisite Graphical Editor Help Window

Two-winding Transformer Type

esca60bus import

2-winding transformer identification data

External identity	Shunt conductance	Shunt susceptance	Series resistance	Series reactance
132/11KV 50MVA TX	0	0	0	0
2WDGT1	0	0	0	0
2WDGT2	0	0	0	0
2WDGT3	0	0	0	0
2WDGT4	0	0	0	0
2WDGT5	0	0	0	0
2WDGT6	0	0	0	0
TBVILLET1	0	0	0	.025
TCEYLONT1	.056000004	.66	.0008	.0188
TCEYLONT2	.056000004	.66	.0008	.0188
TCHENAUXG1	.12 (1)	.79	0	.018100001
TCHFALLSG1	.082999992	.33	.0006	.0232
TDOUGLASG1	.176000004	.467000008	.0009	.017999999
TDOUGLASG2	.1	.66	.0007	.014200002
TDOUGLASGCT1	.176000004	.467000008	.0009	.017999999
TDOUGLASGCT2	.176000004	.467000008	.0009	.017999999
TDOUGLASGST1	.176000004	.467000008	.0009	.017999999

External Identity of Two-Winding Transformer Type

Record: 11/? <OSC> <DBG>

1) Note, impedance parameters in per unit

ABB Automation

ABB Automation Systems/Utilities

Industrial IT standardization 9

Export Control Restrictions

Access to and use of EPRI Intellectual Property is granted with the specific understanding and requirement that responsibility for ensuring full compliance with all applicable U.S. and foreign export laws and regulations is being undertaken by you and your company. This includes an obligation to ensure that any individual receiving access hereunder who is not a U.S. citizen or permanent U.S. resident is permitted access under applicable U.S. and foreign export laws and regulations. In the event you are uncertain whether you or your company may lawfully obtain access to this EPRI Intellectual Property, you acknowledge that it is your obligation to consult with your company's legal counsel to determine whether this access is lawful. Although EPRI may make available on a case-by-case basis an informal assessment of the applicable U.S. export classification for specific EPRI Intellectual Property, you and your company acknowledge that this assessment is solely for informational purposes and not for reliance purposes. You and your company acknowledge that it is still the obligation of you and your company to make your own assessment of the applicable U.S. export classification and ensure compliance accordingly. You and your company understand and acknowledge your obligations to make a prompt report to EPRI and the appropriate authorities regarding any access to or use of EPRI Intellectual Property hereunder that may be in violation of applicable U.S. or foreign export laws or regulations.

Printed on recycled paper in the United States of America

The Electric Power Research Institute (EPRI)

The Electric Power Research Institute (EPRI), with major locations in Palo Alto, California, and Charlotte, North Carolina, was established in 1973 as an independent, nonprofit center for public interest energy and environmental research. EPRI brings together members, participants, the Institute's scientists and engineers, and other leading experts to work collaboratively on solutions to the challenges of electric power. These solutions span nearly every area of electricity generation, delivery, and use, including health, safety, and environment. EPRI's members represent over 90% of the electricity generated in the United States. International participation represents nearly 15% of EPRI's total research, development, and demonstration program.

Together...Shaping the Future of Electricity

Program:

Grid Operations and Planning

1013295

ELECTRIC POWER RESEARCH INSTITUTE

3420 Hillview Avenue, Palo Alto, California 94304-1395 • PO Box 10412, Palo Alto, California 94303-0813 USA

800.313.3774 • 650.855.2121 • askepri@epri.com • www.epri.com