Report on the CDPSM 2011 CIM-XML Interoperability Test

The Power of the Common Information Model (CIM) to Exchange Power System Data

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EXECUTIVE SUMMARY

On March 28 – April 1, 2011 in EDF Research and Development Division, Clamart, France, software vendors serving the electric utility industry met to test the capability of their software products to exchange data and correctly interpret power system data based on the latest CIM version. Previous interoperability tests validated the use and acceptance of the CIM standard translated into CIM/XML and transfer of data via the standard interfaces. This round of testing focused on three areas: 1) exchanging power system network models using the CIM (Common Information Model); 2) compliance and interoperability testing of a GIS model; and, 3) the exchange of incremental model updates. This report documents the results of this testing.

The tests were designed to demonstrate and verify that the participants were able to successfully exchange power system network models using the draft IEC 61968-13: CIM Network Application Model Exchange Specification (Common Distribution Power System Model), the IEC 61970-501 CIM RDF Schema, Rev. 5, 2004-12-14, the future IEC 61970-552-4 CIM XML Model Exchange Format and the future IEC 61968-Part 4 Network Data Set. In addition, the standards tested as part of these tests included the portions of the IEC 61970 and IEC 61968 set of standards, specifically, the CDPSM Profile Group and the CIM UML for CIM as specified in iec61970cim15v19_iec61968cim11v09_iec62325cim01v03b.eap.

These interoperability tests address an important industry requirement that has been identified by NERC and many ISOs, RTOs and industry Utilities. NERC has mandated the use of the Resource Description Framework (RDF) as the XML schema/syntax for the CIM, which is defined in another IEC standard (IEC 61970-501 CIM RDF Schema). These tests demonstrated the use of this standard for this purpose. Full Distribution Model exchange tests, Power Flow Solution tests, Incremental Exchange tests and GIS Exchange tests, as well as unstructured testing were conducted by test participants.

Results and Findings

To start the test, participants submitted test models (that is, files in CIM/XML format). Two Validation Tools (CIMTool and CIMphony) were used to validate the correct formation of these models according to the standard. Each participant then attempted to import and then export these models in conformance with the full and incremental standard. Following the import stage, participants would demonstrate to observers, using their own internal modeling and/or power flow applications, that the imported models indeed matched the submitted CIM/XML models.

For 2011 IOP, ten initial models were provided for the tests. Eight vendors performed the basic import test of one or more models successfully. Six vendors performed the basic export test of one of more models successfully. Eight vendors successfully imported GIS Models. Nine vendors imported model files exported by other vendors, and five vendors demonstrated

incremental model updating. Four vendors performed the Power Flow Solution testing successfully.

Challenges and Objectives

This report is of interest to any utility professional that is preparing to implement products from multiple vendors to exchange or use information from different applications. The data contained in this report provides an overview of the functionality that can be purchased from the various vendors. It also explains the issues surrounding the use and implementation of the standards and the level to which these standards have been implemented by the vendors.

The implementation and general exchange issues discussed in the report will provide data to assist the utility professional in budgeting and scheduling integration projects using these standards.

As the standards progress, this type of activity becomes increasingly important to provide all players with an in-depth understanding of the standards and the areas that need to be extended to ensure these standards can be implemented in a cost effective manner.

Our primary challenge in the future is to extend the standard beyond the Control Center and prove that the standard is stable and fully implementable.

Applications, Values, and Use

Once the standard is extended, it will allow full data management and data exchange between the Transmission, Distribution, Planning and Generation areas of the enterprise. Especially urgent at the present time is to move the standard into the newest area of SmartGrid, Automated Meter Infrastructure (AMI), Real Time Pricing (RTP) and Premise Area Network (PAN). Once we have these areas standardized and can tap into the new data provided by these systems, the Utilities will be able to maximize the return on investment and achieve efficiencies that will lower the cost of future system upgrades and integration.

UCAIug Perspective

The changing business environment has increased the need for greater business and operating flexibility in the energy industry. The IEC standards and vendor compliance with the standards offers the energy industry the tools to integrate, upgrade or migrate their systems to meet the industry's changing demands. Interoperability testing provides validation of the standards and the products, and provides the industry professionals with the confidence needed to address their changing demands. UCAIug is committed to ensure this need can be met in the area of messaging and data management. These interoperability tests provide a mechanism to ensure compliance with the IEC standards and integration architectures.

Integration architectures based on the CIM model 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 CIM/GID/XML outside the control center to reduce costs and improve customer service and staff productivity. UCAIug continues to sponsor collaborative efforts to advance these integration strategies for greater information systems integration solutions—in the control center and beyond.

Approach

The goals of the Interoperability test were to show that the participants could exchange models using the IEC Interface Standards. The project team prepared a formal set of test procedures to test the ability of the participant's products to conform to the IEC 61970/61968 (CIM/XML) standards. After a period of preparation and preliminary testing, ten vendors gathered in Clamart, at EDF research R&Development division, France to test their products. Alstom Grid, EDF, GE Energy, EPRI/OpenDSS, Open Grid Systems, Oracle, Siemens, SISCO, Supelec and TIBCO all participated. Personnel from SISCO prepared the test procedures, volunteers from IIE, ENEL, Alcatel-Lucent, and the Austrian Institute of Technology witnessed the test results and, personnel from SISCO prepared this test report for UCAIug.

Keywords

Application Program Interface
Common Information Model (CIM)
Control Center
Distribution Management Systems
eXtensible Markup Language (XML)

PREFACE

The reliability of the European and North American power grids 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 address 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 regional models into a combined model. Since these models reside in multiple, proprietary databases in Security Coordination Centers located throughout Europe and North America, an information infrastructure that facilitates model exchange is an absolute necessity.

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. 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.

This report presents the results of the 2011 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.

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1. Michel Barberis and EDF R&D for hosting and providing lunches for the test
2. Arnold deVos of Langdale Consultants – Provided CIMTool, to generate the RDF Schema file for use by the participants and provide CIM XML/RDF file validation.
3. Tatjana Kostic of ABB – Provided the CIM UML revisions and maintenance
4. Alan McMorran OpenGridSystems – Provided the CDPSM Profiles and CIMphony, a CIM XML/RDF validation tool.
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10. Bruce Scovill of GE Energy, Part 4 Chair, for organizing and running the vendor meetings leading up to the interoperability test

UCAIug would also like to give recognition to the following people who reviewed and assisted in the completion of this test report, as they firmly believe it can help our industry to progress on this topic:

1. Eric Lambert of EDF R&D
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4. Tom McDermott of Meltran
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1 INTRODUCTION

This document reports the results of the CDPSM 2011 CIM/XML interoperability tests, which took place on March 28 – April 1, 2011 in Clamart, at EDF Research and Development Division, France. According to the Gridwise Architecture Council, interoperability testing proves "…the capability of systems, products and units to provide and receive services and information between each other, and to use the services and information exchanged to operate effectively together in predictable ways without significant user intervention..."[1] The standards for this test included various IEC 61968 Part 4 and Part 13 of the standards. An additional feature and objective of this and future IOP tests is to verify and validate that changes made to the IEC standards have been implemented and do not prevent or impede data exchange or interaction between the participants. The verification of annual IEC specification updates is an integral part of the IOP testing process.

This set of interoperability tests focused on data exchange tests that addressed the following specific objectives:

- Exchange of a full distribution 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 files will be based on an RDF/XML version of the CIM. The portion of the CIM that will be tested is defined in one of the CDPSM Profile Group for power system model exchanges and will contain the set of CIM classes, attributes and relationships defined by the IEC 61968-Part 13 profile document and the participants prior to the test. The CDPSM Profile Group schemas will be updated and distributed to all participants prior and will be used to validate the exchanged models. This is the **"full distribution 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. This test will be executed on the Balanced, Unbalanced and Connectivity models used in the test.

- Exchange of GIS Profiles. This is the **"GIS exchange"** test.

1 As defined in the GWAC Interoperability Checklist 1.0, http://www.gridwiseac.org/pdfs/gwac_decisionmakerchecklist.pdf

This test is part of a series of CIM XML interoperability tests, which began in December 2000. Goals of future tests are described in Section 6.

Objectives and Scope of Interoperability Test

General Test Objectives

The general objectives of the interoperability tests and demonstrations are:

1. Demonstrate interoperability between different products based on the latest CIM version. This includes applications from DMS and GIS 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. Validate that the CDPSM Profile Group is correct, complete and ready to be implemented as a Standard. This test includes six separate profiles in the Profile Group:
    - Asset
    - Electrical Properties
    - Functional
    - Geographical
    - State Variables
    - Topology

   Each of these profiles will be used for exchange of full and incremental models for balanced and unbalanced networks. The Profile Group provides sufficient information for the successful execution of a Power Flow and for GIS system operations. The Asset, Functional and Geographical profiles will be used by the GIS and sent to the DMS to show the interoperability of a GIS and a DMS system.
4. Demonstrate the exchange of power system models using the CIM and an RDF Schema and XML representation of the model data.

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 the test Models, the UML and the RDF files created for the test. These files will be the basis for future compliance testing.
3. Validate the tools including the RDF generation tools and the model validation tools. These will be used in the future for compliance and interoperability testing.

Scope of the CIM-CDPSM 2011 Interoperability Test

To meet the model exchange objectives, similar procedures to those used in prior CDPSM interoperability tests were used. Changes were made based on the needs of the updated distribution and GIS models and software under test. A full set of instance files for the Profile

Group generated by Didier Ilhat of EDF were used for DMS exchange files. Mike Stanislawski of GE generated Asset and Functional instance profiles for use in the GIS to DMS exchange tests. For incremental model updates, the draft IEC 61970-552-4 specification was used. For incremental instance files presented during the test, they were used for the Incremental exchange files.

To meet the load flow application execution, the EDF instance files were used.

All the above models are complete models that contain generation and loads. This interoperability test sought to validate the exchange of power system model data based on an RDF/XML version of the CIM. This test validated that the CIM XML file of power system model data generated by one vendor's application can be used by another vendor's application. The CIM XML format definition was the common interface being employed.

Organization of Report

This report is organized into the following Chapters:

- Chapter 1 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.
- Chapter 4 provides a summary of the issues encountered an identified during the test.
- Chapter 5 discusses the implementation of Standards.
- Chapter 6 describes what tests should be included in future IOP tests.
- Appendix A contains a description of the participant's products used in the tests, including the CIM based test tools.
- Appendix B contains the detail test approach and descriptions of the model transfer tests that were performed.

References

1. IEC 61968 Application Integration at Electric Utilities Systems Interfaces for Distribution Management – Part 13: CIM RDF Model Exchange Format for Distribution, (Commonly known as the CDPSM Profile)
2. IEC 61968-11 Ed. 1: Application integration at electric utilities- System Interfaces for Distribution Management – Part 11: Common Information Model (CIM) Extensions for Distribution, based on the UML specified in iec61970cim15v19_iec61968cim11v09_iec62325cim01v03b.eap.

3. IEC 61970 Energy Management System Application Program Interface (EMS-API) - Part 301: Common Information Model (CIM) Base, Edition 2, based on the UML specified in iec61970cim15v19_iec61968cim11v09_iec62325cim01v03b.eap.
4. Draft IEC 61970: Energy Management System Application Program Interface (EMS-API) – Part 501: CIM RDF Schema, Revision 5, 2004-12-14
5. Draft IEC 61970: Energy Management System Application Program Interface (EMS-API) – Part 552-4: CIM XML Model Exchange Format, Revision 7, 2007-10-16
6. IEC 61968-4 and 61968-13 (CDPSM) 2011 Interoperability Test – Test Plan and Procedures, Revision 0, March 28, 2011.

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TEST PARTICIPANTS AND TEST APPROACH

A formal set of test procedures was prepared and used to conduct and score the tests (see Reference 6). 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 the EDF R&D site in Clamart, France.

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

This section provides an overview of the test approach used for the CDPSM 2011 interoperability test. For a description of the test process that was used, refer to Appendix B.

Participants and Their Products

All participants in this test were given the opportunity to spend five full days at the test site in France. Participants brought their own hardware/software to use in the test. The model files used for testing were loaded onto an EDF provided file server for use by each participant. The sample model files and files successfully exported by a participant's product were loaded onto the file server under each participant's public folder so all other participants could access these files for testing their import/export capability.

Participants were allowed to correct deficiencies or errors found during testing and then, as time permitted, retest. All official testing took place on-site at the EDF R&D facility in Clamart, France, a suburb of Paris, France.

The final test results are recorded in the test matrices provided in Section 3, Test Results.

Each participant was required to use an actual product(s) so that testing would demonstrate interoperability of real products. The participants and their products are listed in Table 2-1 below. The version and status of the vendor's product is also provided in the table.

Table 2-1 Participants and Their Products

Vendor	Product Name
Alstom	e-terraSource 2.0.1
EDF	PRAO (MV planning Tool), Matlab-PSAT CIM API (MV DMS loadflow), GEDEON (EDF R&D CIM Database)
GE Energy	Electric Office 4.2 and Smallworld GIS Adapter
EPRI	OpenDSS
Open Grid Systems	CIMPHONY
Oracle	
Siemens	Spectrum Power IMM 2.20 / Spectrum Power DNA 1.10
SISCO	Utility Integration Bus for OSIsoft PI System
SUPELEC	CIMCLIPSE 1.0 [BETA VERSION]
TIBCO	IntelliEDGE for CIM

A description of each product used in the tests is contained in Appendix A. For brevity, the vendor names may be shortened as follows: Alstom Grid will be referred to as Alstom; GE Energy will be referred to as GE; Siemens EDEASOL will be referred to as Siemens; and Open Grid Systems will be referred to as OGS.

Test Approach

As stated in the Introduction there were three types of model exchange 1) CDPSM full model data exchange tests using CIM XML-RDF files; 2) CDPSM Incremental model data exchange tests using CIM XML-RDF Incremental files; and, 3) CDPSM full GIS model data for exchange with a DMS system. Participants could perform one, two or all three of these exchange tests. Full and Incremental models are sufficient to allow a Power Flow solution to be executed.

The CDPSM data exchange tests could be performed by participants with exchange adapters and some type of display (tabular or graphical) to show the completion of the import. However, the Solution tests required the use of power flow applications to operate on the power system models to calculate power flow solutions. These solutions were used to validate the correct transfer and transformation of model files between participants. The Solution tests could use the same model files as the other model and data exchange tests.

Full Distribution Model Exchange Test

Each participant in this test was required to (1) generate and export a file that conformed to the standards for the model used and/or (2) import a file from another vendor's product and correctly interpret the model data contained. The model files used were the EDF and GE model instance files prepared by the participants. These models were available before the formal testing began in order to allow the participants to checkout and debug their software as well as to discover any discrepancies or errors in the files themselves.

Product specific tools were used to validate the success of the import while separate XML tools were used to validate the export of the model files.

Incremental Exchange Test

The incremental model update test demonstrated the ability of products to accept small changes to existing model files, rather than sending a complete replacement model file.

The participants in this test were able to use either the GE or EDF instance files, depending on the incremental files used. The Test Participants could also generate incremental files themselves and use those for this test. The files were provided on a Windows file server provided by EDF. The format and syntax for these files are described in IEC 61970, Part 552-4: CIM XML Model Exchange Format.

Power Flow Solution Test

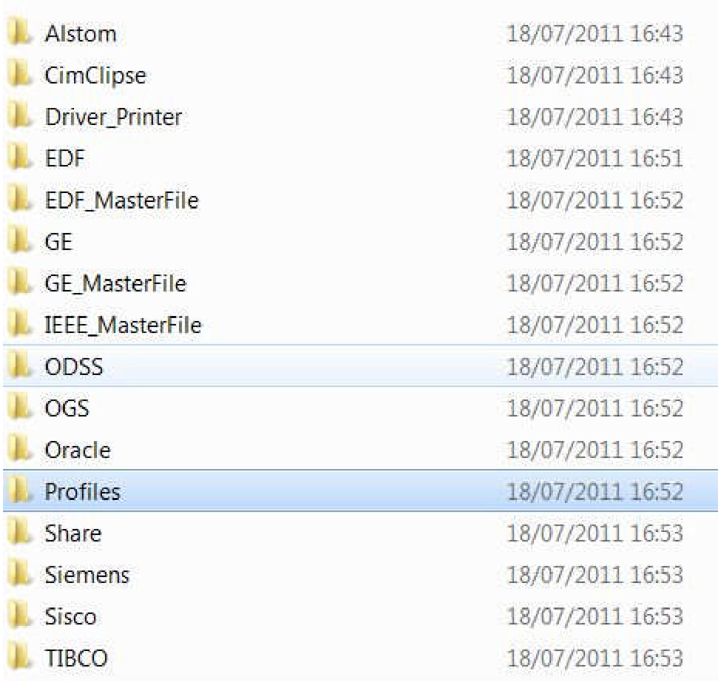
The Power Flow Solution test verified the correct exchange and transformation of power system model files including generation and load through the execution of power flow applications. Verification was accomplished by a comparison of solutions before and after transformation and model exchange.

GIS Exchange Test

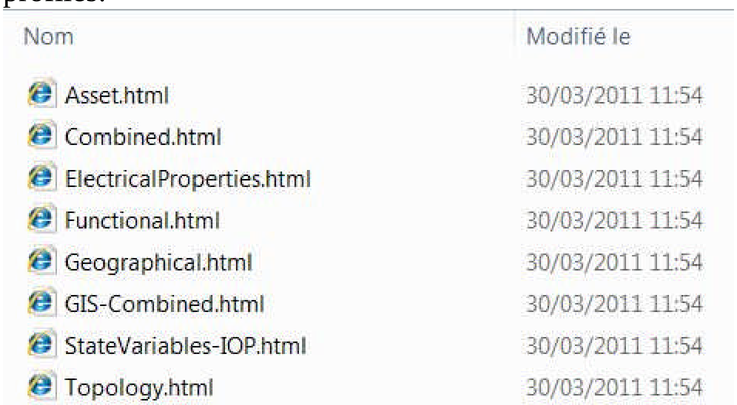
The GIS exchange model test verified the ability of the GIS system to produce a connectivity model and the DMS system to import and correctly apply the model.

The test used the GE connectivity model.

A server was set up at EDF were all participants could put their results and access profiles and data sets. The following picture describes the different folders:



The profiles tested were put in Profile folder. The following picture presents the different profiles:



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CIM/XML INTEROPERABILITY TEST RESULTS

This section presents the results of the interoperability tests. First, the individual tests that were performed and scored are summarized in the tables 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 6).

Table 3-1 All Participant Test Procedures

Step from Test Procedure	Test Description
4.2.1.1	Basic Import – Full Model
4.2.1.2	Network Product Validation – uses XML software tool to check
4.2.2.1	Power Flow solution
4.2.3.1	Export Sample Model
4.2.3.2	Re-import Check – Re-import model that was exported in 4.2.3.1
4.2.4.1.1	Interoperation - Participant B import of Participant A exported CIM XML file (Document 2).
4.2.4.1.2	Network Product Validation – uses XML software tool to check Document 2
4.2.4.2	Power Flow Solution – produce and compare results (Solution 2)
4.3.1	Basic Import – Full GIS Model
4.3.2	Network Product Validation – uses XML software tool to check
4.4.1	Export incremental update file
4.4.2	Import incremental update file
4.4.3	Create incremental file – change power flow
4.4.4	Re-import model – file from 4.2.1 or 4.3.1
4.4.5	Import incremental update – change power flow
4.4.6	Power Flow solution
4.5	Unstructured Testing

The tests in the above table were executed by one or more participants using the files produced EDF, GE or other test participants.

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
- X – No files were exported by this participant or Participant is not allowed to use his own files for this test.
- N/A - Product does not have export functionality
- Blank (no entry) – indicates test was skipped, not witnessed, an exported model file was not available for import, or an exported file was available but had errors that prevented a successful import.

Basic Import/Export (Full Models) and Interoperation

Basic Import and Export

Tables 3-2 through 3-5 show the results of the tests on the individual products to determine compliance with the IEC 61968-Part 13 profile document, including GIS Model imports. The primary objective of this test was to successfully import, export and re-import a sample model file based on the CDPSM Profile Group for power system model exchanges to show compliance.

Highlights of the tests are presented in the following tables. Many models were imported or exported by the participants. The tables below show a "P" to indicate that the participant was able to import one or more models. A full list of the models that were imported or exported by the participants is listed on the CIMug Web Site. Any issues or explanations for PE results are presented immediately following the tables. In addition, any issues or notes concerning the tests are presented in the sections following the tables.

The files provided by EDF and GE for basic imports are abbreviated as follows:

- AIGUE for AIGUE_EDF_V1-1-C15
  This network is a MV network.

ACLineSegment	280
Asset	1
BaseVoltage	2
Bay	8
Breaker	8
BusbarSection	2
ConnectivityNode	394
CoordinateSystem	1
EnergyConsumer	101
EnergySource	1
GeneratingUnit	4
GeographicalRegion	1

IEC61970CIMVersion	1
Junction	75
Line	226
LoadBreakSwitch	107
Location	762
Name	226
NameType	3
NameTypeAuthority	1
PSRType	7
PositionPoint	1303
PowerTransformer	1
PowerTransformerEnd	2
ShuntCompensator	1
SubGeographicalRegion	1
Substation	276
SynchronousMachine	4
Terminal	976
TransformerEndInfo	2
VoltageLevel	277
WireInfo	280

Two others files related to "AIGUE" were provided by EDF : the AIGUE LV network, and the AIGUE combined MV and LV Network. This was the first time that EDF provided CIM LV Networks.

IOP2011-EDF-AIGUE-LV-V1.xml	31/03/2011 09:49
IOP2011-EDF-AIGUE-MV+LV-V1.xml	31/03/2011 10:05

- C10 for C10_EDF_V1-1-C15

ACLineSegment	112
Asset	4
BaseVoltage	2
Bay	23
Breaker	23
BusbarSection	4
ConnectivityNode	172
CoordinateSystem	1
EnergyConsumer	52
EnergySource	2
GeneratingUnit	2
GeographicalRegion	1
IEC61970CIMVersion	1
Junction	45
Line	97
LoadBreakSwitch	34
Location	393
Name	133
NameType	3
NameTypeAuthority	1
PSRType	7
PositionPoint	765
PowerTransformer	4
PowerTransformerEnd	8
ShuntCompensator	6
SubGeographicalRegion	1
Substation	106
SynchronousMachine	2

Terminal	457
TransformerEndInfo	8
VoltageLevel	108
WireInfo	112

- RURAL for RURAL_EDF_V1-1-C15

ACLineSegment	3550
Asset	8
BaseVoltage	2
Bay	57
Breaker	50
BusbarSection	8
ConnectivityNode	4895
CoordinateSystem	1
EnergyConsumer	1093
EnergySource	4
GeneratingUnit	2
GeographicalRegion	1
IEC61970CIMVersion	1
Junction	1844
Line	3329
LoadBreakSwitch	1338
Location	11026
Name	2252
NameType	3
NameTypeAuthority	1
PSRType	7
PositionPoint	25074
PowerTransformer	8
PowerTransformerEnd	16
ShuntCompensator	4
SubGeographicalRegion	1
Substation	3492
SynchronousMachine	2
Terminal	12847
TransformerEndInfo	16
VoltageLevel	3496
WireInfo	3550

- URBAN for URBAN_EDF_V1-1-C15

ACLineSegment	4703
Asset	13
BaseVoltage	3
Bay	123
Breaker	124
BusbarSection	16
ConnectivityNode	7967
CoordinateSystem	1
EnergyConsumer	2056
EnergySource	5
GeographicalRegion	1
IEC61970CIMVersion	1
Junction	913
Line	3338
LoadBreakSwitch	3234

Location	13089
Name	4245
NameType	3
NameTypeAuthority	1
PSRType	7
PositionPoint	41302
PowerTransformer	13
PowerTransformerEnd	26
ShuntCompensator	5
SubGeographicalRegion	1
Substation	4601
Terminal	19143
TransformerEndInfo	26
VoltageLevel	4606
WireInfo	4703

- CIRC for CIRC_Combined_50204_2011_03_29_1752_50
- CIRC-A for CIRC_Asset_50204_2011_03_29_1432_15
- CIRC-F for CIRC_Functional_50204_2011_03_29_1432_15
- IOP2011 for IOP2011-EDF-GIS-AIGUE-V1

ACLineSegment	396
Analog	12
Asset	1164
AssetInfo	78
BaseVoltage	22
Bay	138
Breaker	11
BusbarSection	121
BusbarSectionInfo	2
CableInfo	11
ConnectivityNode	688
CoordinateSystem	1
Disconnector	5
EnergyConsumer	77
EnergySource	1
FaultIndicator	42
Fuse	9
GeneratingUnit	6
GeographicalRegion	1
Junction	198
Line	5
LoadBreakSwitch	157
Location	668
Manufacturer	22
Name	2796
NameType	5
NameTypeAuthority	1
Organisation	37
OverheadWireInfo	10
PSRType	94
PerLengthSequenceImpedance	21
PositionPoint	1508
PowerTransformer	97
PowerTransformerEnd	194
ProductAssetModel	77

RatioTapChanger	86
ShuntCompensator	1
SubGeographicalRegion	3
Substation	322
SurgeProtector	69
SwitchInfo	14
SynchronousMachine	6
Terminal	1754
VoltageLevel	120

- IEEE3-M for OpenDSS_IEEE3_MTX
- IEEE3-A for OpenDSS_IEEE3_ASSETS

Table 3-2 Basic Import Test of Individual Products

Test Procedure	4.2.1.1 Basic Import				
Test Model Used	***AIGUE***	***C10***	**RURAL**	**URBAN**	**IOP2011**
Alstom	P	P	P	P	
EDF	P	P	P	P	P
OpenDSS	P	P	P	P	
OGS*	P	P	P	P	P
Oracle	P	P	P	P	P
Siemens		P			
SISCO	P	P	P	P	P
Supelec	P				
TIBCO	P				

** OGS imported both the combined and multiple individual files shown in this test table.

Table 3-3 Basic Import Test of Individual Products - continued

Test Procedure	4.2.1.1 Basic Import - continued				
Test Model Used	**IEEE3 - M**	**IEEE3 - A**			
OGS	P	P			

Table 3-4 Basic Model Export

Test Procedure	4.2.3.1 Export							
Test Model Used	AIGUE	C10	RURAL	URBAN	CIRC	CIRC-A	CIRC-F	IOP2011
Alstom	PE							
EDF	P	P	P	P	P			P
GE						P	P	
OGS**	P	P	P	P				P
Siemens		P						
Supelec		P					P	

** OGS exported both the combined and multiple individual files shown in this test table

GIS Full Import

Table 3-5 shows the results for the importation of GIS instance files which were provided by GE. The files imported had passed one or more validations and were believed to have good integrity. The GIS instance files contained at least one occurrence of each CIM class and attribute contained in the CDPSM profiles used by the GIS system.

Table 3-5 Full Import – GIS Model

Test Procedure	4.3.1 GIS Model Import		
Test Model Used	CIRC	CIRC-A	CIRC-F
Alstom	P		P
EDF	P	P	
OpenDSS	P		
OGS	P	P	P
Oracle	P		
Siemens	P		
SISCO	P	P	P

Test Procedure	4.3.1 GIS Model Import		
Test Model Used	CIRC	CIRC-A	CIRC-F
Supelec			P

Interoperation

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

Table 3-6 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 3-4).

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.

The table below shows the vendor pairs that were able to interoperate successfully by exchanging at least one sample model file.

Table 3-6 Interoperation (CIM XML Document 2)

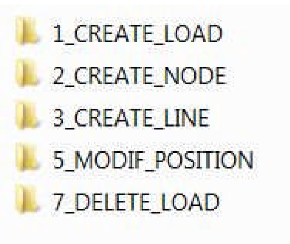
Test Procedure	4.2.4.1.1 Import CIM XML Exported file				
Participant Importing File	Alstom Exports	EDF Exports	GE Exports	Supelec Exports	OGS Exports
Alstom					P-AIGUE
EDF			P-CIRC-F	P-AIGUE	P-C10 P-AIGUE
OpenDSS					P-AIGUE P-C10 P-URBAN P-RURAL
OGS	P-AIGUE P-URBAN			P-CIRC-F	

Test Procedure	4.2.4.1.1 Import CIM XML Exported file				
Participant Importing File	**Alstom Exports**	**EDF Exports**	**GE Exports**	**Supelec Exports**	**OGS Exports**
Oracle	P-AIGUE P-URBAN	P-AIGUE P-C10 P-URBAN P-IOP2011 P-RURAL P-CIRC		P-AIGUE	P-AIGUE P-C10 P-URBAN P-IOP2011 P-RURAL
Siemens	P-AIGUE				
SISCO	P-AIGUE	P-CIRC		P-C10_OGS	
Supelec					P-C10
TIBCO	P-AIGUE				P-AIGUE

Incremental Model Update

This section shows the results of the incremental model update tests. Alstom, OGS, EDF, SISCO, and Supelec 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 a Substation (which does not change the Power Flow) and Modify the model sufficiently that the Power Flow is changed. These are real-world applications of the CIM/XML Incremental standard.

EDF provided CIM files that could be used for incremental updates, based on AIGUE



Import/Export Incremental Updates and Merge with Existing Base Model

Alstom, OGS, and Supelec each successfully exported incremental update files. At least one of the files added a substation in the middle of a line and at least one of the files modified the model in such a way as to cause the Power Flow Solution to change. These files were used by other participants in this IOP.

Half of the participants successfully imported one or more incremental update files. The import 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 imported and stored base 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.

The test validated that additions, deletions, and modifications to base models can be handled with the incremental update approach, as long as a logical sequence of actions are followed.

Table 3-7 Incremental Model Update Testing

Test Procedure	4.4.1/3 Export Incremental Update		4.4.2/5 Import Incremental Update	
Incremental Update Type	Substation or No Chg. To Power Flow	Change Power Flow	Substation or No Chg. To Power Flow	Change Power Flow
ALSTOM	P-AIGUE	P-AIGUE	P-AIGUE_OGS	P-AIGUE_OGS
EDF			PE-C10_Supelec P-AIGUE_OGS	P-AIGUE_Supelec P-AIGUE_OGS
OGS	P-AIGUE	P-AIGUE	P-C10_Supelec	P-C10_Supelec
SISCO			P-C10_Supelec	P-C10_Supelec P-C10_OGS
Supelec	P-C10	P-C10	P-AIGUE_OGS	P-C10_Supelec

Power Flow Solution Testing

Alstom, EDF, OpenDSS, and Siemens executed Power Flow using EDF's C10 or AIGUE files. EDF and Open DSS were also able to import and run a load flow on a model file that had been previously imported and exported by another participant.

The contents and format of the power system model files exchanged with the CIM XML file representation are adequate for running power flow applications; however, there is a need for more definition and conventions before the Power Flow solutions will match closely enough to be considered a validation of the file exchange.

During these tests, the following conventions were written:

CIM IOP Test 2011

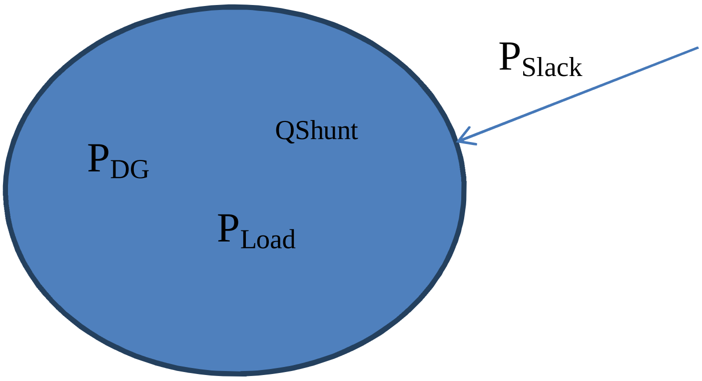
Definition of PowerFlow Parameters:

P_{Slack_i} [MVA] = Power at the Transmission Network (Slack) interconnection point to the distribution network

P_{DG_i} [MVA]= Power generated from one distributed generator inside the distribution network

P_{Loss} [MVA] = Sum of all loads (active power) in the distribution network

Total Generation = $\sum P_{Slack\_i} + \sum P_{DG\_i}$
Total Load = $P_{Load} + P_{Losses}$
Total Shunt
Total Losses
$P_{Slack} = \sum P_{Load\_i} - \sum P_{DG\_i} + P_{Losses}$
$Q_{Slack} = \sum Q_{Load\_i} - \sum Q_{DG\_i} + Q_{Losses}$



PowerFlow Result from C10_EDF_V1-1-C15 with PSAT

	active [MW]	reactive [Mvar]
Total Generation	29,494	16,188
Power_Slack	28,593	6,434
Power_DG	0,901	0,360
Total Losses	0,149	2,294
Total Shunt	0,000	9,394
Total Load	29,494	16,188

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 3-8 Solution Test Results

Test Number	4.2.1.1 Import doc-1	4.2.2.1 Run PF sol-1	4.2.4.1 Import doc-2	4.2.4.2 Run PF sol-2
ALSTOM	P-AIGUE P-URBAN P-RURAL P-CIRC-F P-C10	P-AIGUE P-C10_EDF	P-AIGUE_OGS	P-AIGUE_OGS
EDF	P-C10	P-C10	P-AIGUE_OGS	P-AIGUE_OGS

Test Number	4.2.1.1 Import doc-1	4.2.2.1 Run PF sol-1	4.2.4.1 Import doc-2	4.2.4.2 Run PF sol-2
OpenDSS	P-AIGUE P-C10 P-URBAN P-RURAL	P-AIGUE P-C10 P-URBAN P-RURAL	P-AIGUE_OGS P-C10_OGS P-URBAN_OGS P-RURAL_OGS	P-AIGUE_OGS P-C10_OGS P-URBAN_OGS P-RURAL_OGS
OGS			P-AIGUE_ALSTOM P-CIRC_Supelec P-URBAN	
Oracle			P-AIGUE_ALSTOM P-URBAN_ALSTOM P-AIGUE_OGS P-C10_OGS P-URBAN_OGS P-IOP2011_OGS P-RURAL_OGS P-AIGUE_EDF P-C10_EDF P-URBAN_EDF P-IOP2011_EDF P-RURAL_EDF P-AIGUE_Supelec P-CIRC_EDF	
Siemens	P-C10	P-C10		
SISCO			P-C10_OGS_Supelec P-AIGUE_ALSTOM P-CIRC_EDF	
Supelec			P-C10_OGS	
TIBCO	P-AIGUE		P-AIGUE_OGS P-AIGUE_ALSTOM	

Unstructured Tests Procedures & Results

Two participants executed unstructured tests – Open Grid Systems (OGS) and EDF R&D. The section below describes the tests that were executed. If the test used a current test procedure, that procedure is referenced. If the test is for an entirely new procedure, the procedure steps are included with the results.

There are two unstructured tests completed by OGS. The first test proved that OGS can adequately combine multiple Profile files into a single combined Profile file for each type of file needed. The second test imported a Graphics Display Profile and used it to generate displays.

The unstructured test provided by EDF was the use of state variable profile (61970-456) to export load flow calculation.

Unstructured Test 1

OGS performed the following unstructured test sequences to combine multiple files into a single Profile:

1. Create a combined model instance file using:
    a. C10_EDF_V1-1-C15_Asset
    b. C10_ EDF_V1-1-C15_ElectricalProperties
    c. C10_ EDF_V1-1-C15_Functional
    d. C10_EDF_V1-1-C15_Geographical

Which resulted in the C10.XML file

2. Create a combined model instance file using:
    a. C10.XML
    b. C10_EDF_V1-1-C15-Topology

    This resulted in the C10_TOP.XML file.

3. Created a combined model instance file using:
    a. C10_TOP
    b. C10_EDF_V1-1-C15_StateVariables-IOP

    This resulted in the C10_TOP_SV.XML

4. Used the above model instance files to derive the State Variable values and the topology values for the SV and TP instance files:
    a. 128 SV INJECTION,
    b. 156 SV POWERFLOW,
    c. 128 SV VOLTAGE
    d. Each topology node has now voltage and angle, discovered on terminals P & Q values

    NOTE: C10_TOP_SV_OGS.XML is on the server + screenshots

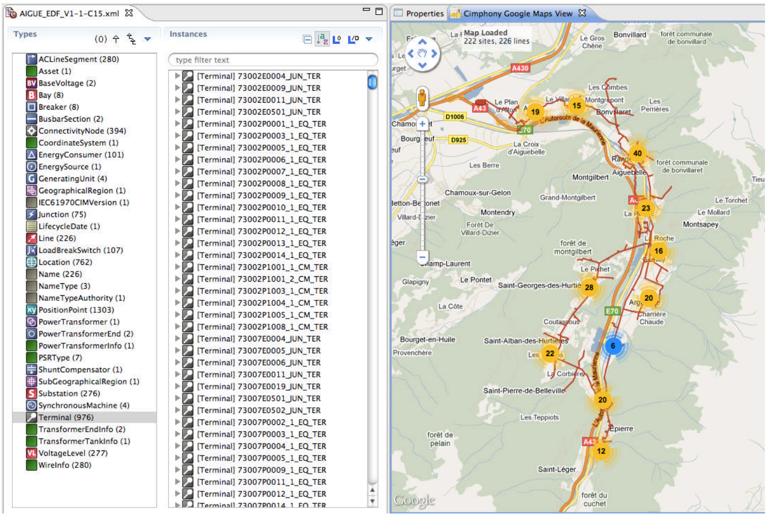
Unstructured Test 2

OGS performed a second unstructured test sequence to demonstrate the Geographical Profile:

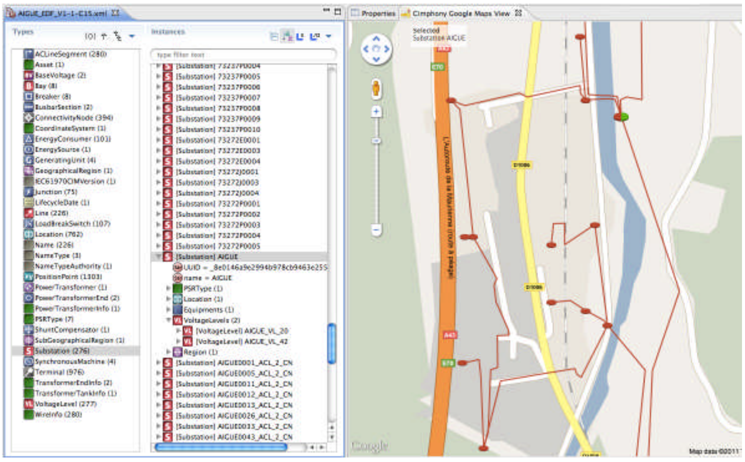
1. Imported a Geographical Profile from the AIGUE_EDF_V1-1-C15.xml model.

(The graphics profile of EDF files are imported on EDF Tools Prao, and MatlabPsat, see EDF annex)

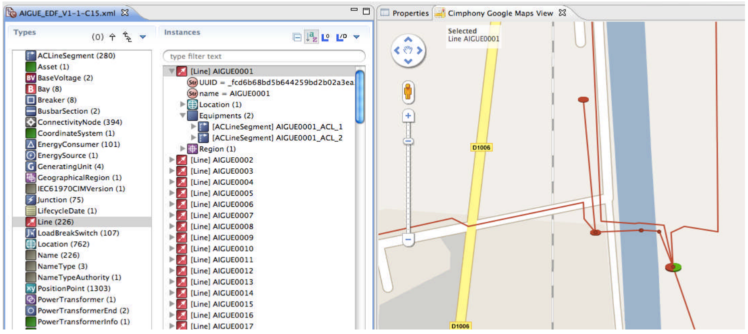
2. Demonstrated Geographical View.



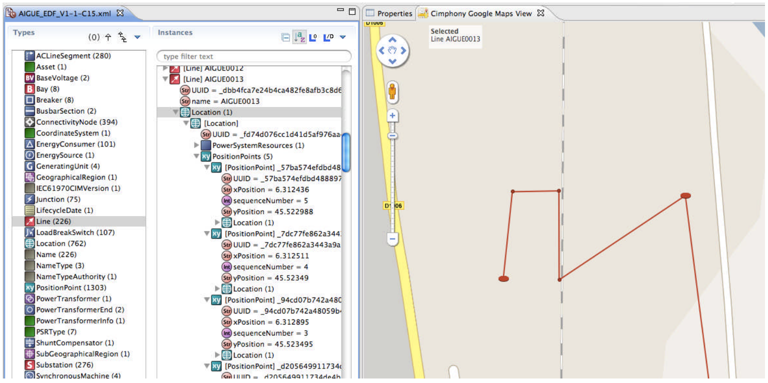
3. Selected main MV/LV Substation on Map and showed linkage to corresponding AIGUE Substation using CIMphony browser.



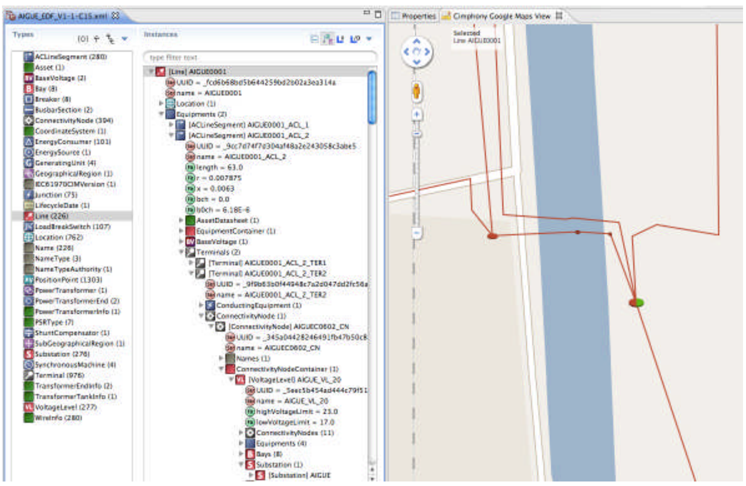
4. Selected first line connected to AIGUE substation, identified as being AIGUE001 Line in CIM data, containing two ACLineSegents in CIM data



5. Selected line AIGUE0013, indicating 5 PositionPoints and rendering a start point, end point and three intermediary points corresponding to CIM data.



6. Selected line AIGUE001, then ACLineSegments->Terminal->ConnectivityNode->ConnectivityNodeContainer->Substation following associations to within the AIGUE Substation. This was highlighted by the AIGUE substation icon (dual-color) bouncing in the view when selected in CIM data.



Unstructured Test 3

The intention of this test is to reuse a profile newly defined by IEC TC57 for transmission purposes. After the CIM import, a load flow is run, and the load flow results are exported in a StateVariable profile.

A snippet of the instance file using state variable profile is provided here after:


```
  <?xml version="1.0" encoding="ISO-8859-1" ?>
- <rdf:RDF xmlns:cim="http://iec.ch/TC57/2010/CIM-schema-cim15#" xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#">
  - <cim:TopologicalIsland rdf:ID="#_SIMUMAT_TI">
      <cim:TopologicalIsland.AngleRef_TopologicalNode rdf:resource="#_ND_BILAN_TN" />
    </cim:TopologicalIsland>
  - <cim:SvVoltage rdf:ID="_42095E0004_TN_SVV">
      <cim:SvVoltage.angle>-0.09711</cim:SvVoltage.angle>
      <cim:SvVoltage.v>19.6481</cim:SvVoltage.v>
      <cim:SvVoltage.TopologicalNode rdf:resource="#_42095E0004_TN" />
    </cim:SvVoltage>
  - <cim:SvInjection rdf:ID="_42095E0004_TN_SVI">
      <cim:SvInjection.pNetInjection>0</cim:SvInjection.pNetInjection>
      <cim:SvInjection.qNetInjection>0</cim:SvInjection.qNetInjection>
      <cim:SvInjection.TopologicalNode rdf:resource="#_42095E0004_TN" />
    </cim:SvInjection>
  - <cim:SvVoltage rdf:ID="_42095E0008_TN_SVV">
      <cim:SvVoltage.angle>-0.09683</cim:SvVoltage.angle>
      <cim:SvVoltage.v>19.6639</cim:SvVoltage.v>
      <cim:SvVoltage.TopologicalNode rdf:resource="#_42095E0008_TN" />
    </cim:SvVoltage>
  - <cim:SvInjection rdf:ID="_42095E0008_TN_SVI">
      <cim:SvInjection.pNetInjection>0</cim:SvInjection.pNetInjection>
      <cim:SvInjection.qNetInjection>0</cim:SvInjection.qNetInjection>
      <cim:SvInjection.TopologicalNode rdf:resource="#_42095E0008_TN" />
    </cim:SvInjection>
  - <cim:SvVoltage rdf:ID="_42095E0018_TN_SVV">
      <cim:SvVoltage.angle>-0.09722</cim:SvVoltage.angle>
      <cim:SvVoltage.v>19.6198</cim:SvVoltage.v>
      <cim:SvVoltage.TopologicalNode rdf:resource="#_42095E0018_TN" />
    </cim:SvVoltage>
  - <cim:SvInjection rdf:ID="_42095E0018_TN_SVI">
      <cim:SvInjection.pNetInjection>0</cim:SvInjection.pNetInjection>
      <cim:SvInjection.qNetInjection>0</cim:SvInjection.qNetInjection>
      <cim:SvInjection.TopologicalNode rdf:resource="#_42095E0018_TN" />
    </cim:SvInjection>
  - <cim:SvVoltage rdf:ID="_42095E0019_TN_SVV">
```

4 SUMMARY OF IDENTIFIED ISSUES

One of the primary objectives of the Interoperability tests is the identification of any issues with the Standards, the CIM XML messages, or the Test Procedures themselves. The vendor products tested in the 2011 IOP exposed no interoperability issues among the eight products tested. The success of this test effort reflects vendors support for the standards, the standards activities, their careful implementation and the careful planning of the tests by the 2011 IOP Part 4 and 13 Test Team.

No outstanding issues surrounding the test models, the standards or the vendor tools were identified during this test. Nevertheless more time would have been necessary to run load-flow calculations. Some issues were found regarding Mandatory/optional attributes, depending on the applications. Thus some applications require some data value for some attributes, and default values can conduct to wrong results.

5 IMPLEMENTING STANDARDS AT A UTILITY

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

- Data engineering: Almost all existing data and systems at a utility do not use a CIM model or the GID interfaces. Consequently, deployment of the standards requires that a utility first analyze how existing data and systems will be modified, wrapped, or replaced. The single largest task is analysis of existing data and mapping that data to the CIM. For example, consider a database containing work orders. The CIM includes a work order related classes and properties. How is a legacy database containing work orders exposed? An analysis needs to occur that describes how legacy database tables relate to the CIM. It is important before embarking on a CIM project to make sure that the task of working through of the data engineering issues is fully planned for.
- System engineering: One of the key benefits in using the CIM is that it rationalizes utility data management. That is, data meaning is more clearly defined and data redundancy is minimized. Central to system engineering is determining "data ownership" - what systems are supplying and/or consuming CIM data. System engineering also includes deciding what GID interface shall be used to expose the data. Frequently, a utility will have redundant data. Careful analysis needs 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.

There are several other key elements that should be taken into consideration when implementing the IEC standards across the enterprise. These include, but are not limited to:

(1) Do not attempt to implement the standard across the entire enterprise in a single project. Plan a full vision that includes the full enterprise and have a schedule and budget plan that will provide the foundation for this effort.

(2) After the vision is defined, break it into project phases that can be completed in a single budget cycle and that will bring value to the organization.

(3) Be prepared to modify or create new Business Processes to embrace and enhance the new architecture and software that is implemented.

6

FUTURE INTEROPERABILITY TESTS

Good progress was made during the CDPSM 2011 Interoperability Test on several fronts. However, additional testing is needed to validate the many resolutions reached as a result of testing, the update of the standards in the future and the issues that still need resolutions. Future Interop tests should concentrate on the following areas:

- Validation of all IEC standard changes.
- Testing Solution Exchange only (State Variables Profile)
- Add State Estimation exchange tests.
- Work to generate a single profile that will work for Balanced and Unbalanced models in the Transmission and Distribution space.
- Exchange and Test other Profiles.
- Work on defined test models including defined test results in order to allow easier comparison of the results. Those test models should of course be available ahead of the IOP schedule.

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.

Alstom Grid e-terraSource

For the 2010 Interop, Alstom Grid tested a pre-release version of **e-terra***source* version 2.0, which is the model management product that will support CIM model exchange in Alstom Grid deliveries going forward.

Product Summary

Both the utility industry and the IT industry have changed considerably in the last decade. These changes drive the need to redefine how model management is carried out in utility operations. On the utility business side, security and market analytical functions (state estimation, contingency analysis and others) are now mission critical functions because of deregulation. These functions will not operate to required levels without high-quality large-scale regional network models, which are very challenging to assemble and maintain. On the IT side, enterprise integration is now a dominant trend, and one of its goals is consolidation of modeling such that any given item of data is entered only once within the enterprise.

The **e-terra***source* product is a totally redesigned and rebuilt master modeling system that responds to these trends. It performs all the traditional model management functions for Alstom Grid's EMS offering, but includes the following new scope:

- **CIM information model.** Conforms to CIM interface standards and maintains full information equivalency with CIM structures.
- **Multi-user environment.** Concurrent, independent activity by any number of modeling persons in dispersed locations is supported.
- **Graphical edit.** User interface includes viewing and editing of the model in schematic form.
- **Schematic displays.** Power system schematic displays for EMS may be maintained as part of the modeling process.
- **Effective dating and future models.** Plans and proposed changes may be captured in work projects and scheduled in time. Models can be generated for any point in time.
- **Model authorities and model exchange.** Support is included for CIM model exchange and for the new CIM model authority processes for cooperative modeling of an interconnection by its constituents.
- **Multiple target systems.** The product is designed as a common modeling source – thus EMS, Market and Planning systems, for example, can be supported from a single model.
- **On-line model change.** Interfaces are provided for support of on-line model update within target systems such as EMS.
- **Metadata driven.** The product implementation is metadata driven so that the core CIM models may be extended without requiring a new product release.
- **Multiple names.** Remembers names when different targets use different names.
- **Work management.** Status of work projects can be tracked through stages of development, approval and installation. Full audit trails of modeling and installation activity are provided.

NETWORK MANAGEMENT SOLUTIONS

e-terra*source*

The power to model

ALSTOM Grid's worldwide transmission Network Management Solution: The CIM power system modeler for EMS

e-terra*source* provides:

- A single, enterprise view of the power system, appropriate for transmission, distribution, generation and market systems, in past, present and future time contexts.
- A modeling tool designed with participation by real users, reflecting the best modeling practices and productivity features.
- A new and innovative RDBMS approach based on CIM standards from TC57.
- An integration-ready design compatible with CIGRE D2.24 information architecture concepts.

Business challenges

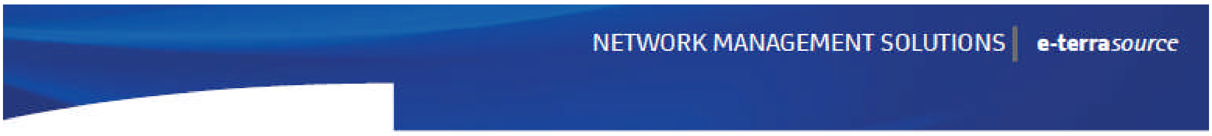
e-terra*source* is a new tool for power system modeling, where utilities are facing increasingly complex data management issues:

- System models are very large and complex power systems that are difficult and expensive to produce, debug and keep up to date.
- Accurate analysis demands accurate models. Appropriate situational awareness cannot be achieved without quality models.
- Evolving system models are needed to support real-time, forward planning and post mortem time contexts, at both the transmission and distribution levels.
- System models should be shared between different applications to save labor and minimize discrepancies in the models.

Customer Profiles

- Transmission and Distribution System Operations and Planning
- Regional Transmission Organizations
- Market and Generation Operations
- Utility IT Integration & Architecture Departments

GRID | ALSTOM | *we are shaping the future*



Use cases for Alstom Grid's new e-terra*source* modeler:

Traditional modeling for EMS takes a big step forward

If you are a utility considering buying an Alstom Grid EMS or upgrading to a new version of an Alstom Grid EMS, you may only be looking at modeling in its traditional support role.

e-terra*source* is the modeling application that will be supplied with all new Alstom Grid systems. It provides state of the art modeling features that will improve your ability to develop and maintain the complex power system models that are required for operational success. Some of the particularly useful new features include:

- the ability to edit the model schematically
- the multi-user work environment
- the ability to manage the evolution of the model over time

Coordinated transmission models for an interconnection

If you are part of an interconnection populated by many transmission owners, as is the case with most major utilities and regional security organizations, then you share the problem that your analytical models must cover not only your territory, but also the territory of other entities in the interconnection. Model data exchange becomes a key requirement of your operation process.

The IEC CIM standards organizations have developed a solution to this problem that can be implemented in any interconnection for either operations or planning or both, consolidated. Thanks to the Model Authority Set concepts originating from its CIM design, **e-terra***source* supports natively CIM based model exchanges and model merges with any kind of CIM compliant systems.

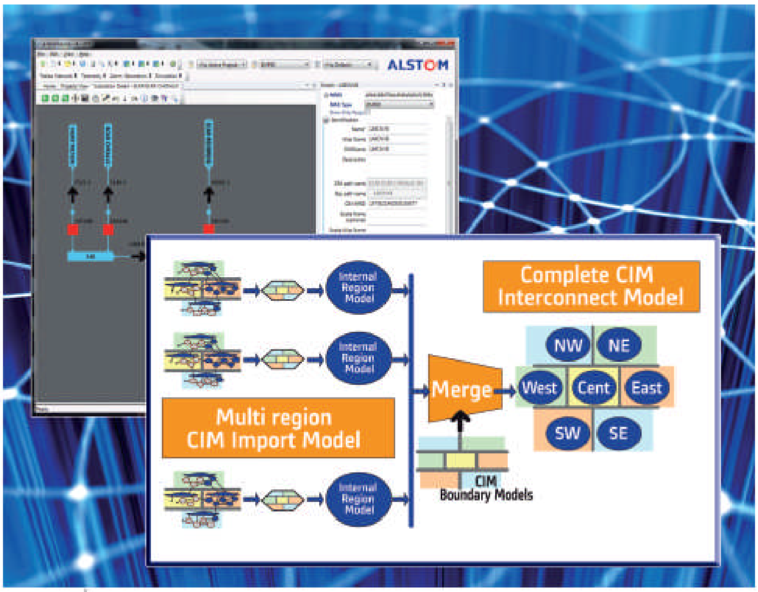


Figure 1 | In the graphical modeling environment of **e-terra***source*, new structures of the model are added and connected via convenient visual editing facilities.

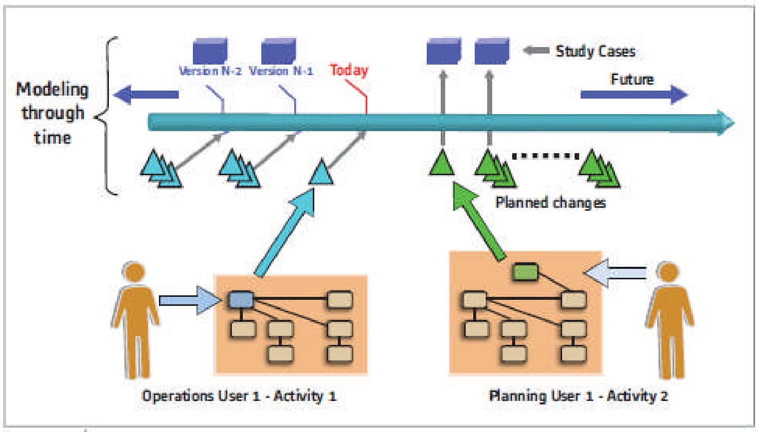


Figure 2 | Past, present and future views of the power system can be managed concurrently thanks to the advanced temporal modeling in **e-terra***source*.

Modeling as a focal point of IT integration

If you are a utility embarking on Smart Grid enterprise architecture, there are a few concepts that you may be thinking about:

- Enterprise message bus
- Webservices
- Canonical data models for semantic consistency
- The IEC TC57 CIM standards
- The CIGRE D2.24 reference architecture
- Data mastership and enterprise information flow

As a long-time player in the power system space, Alstom Grid has been at the center of efforts like CIM and CIGRE D2.24. We understand these efforts and we have designed the **e-terra***source* product for these standards. In particular, **e-terra***source* is designed to serve as a central enterprise component for collecting and distributing a common view of the power system (past, present or future) in standard CIM form. This enables applications to exchange business information about the power system using a common reference point.

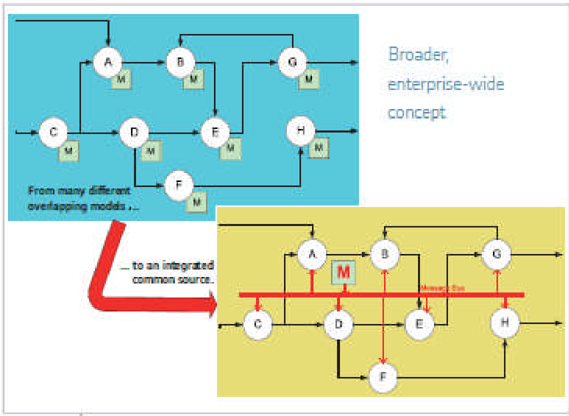
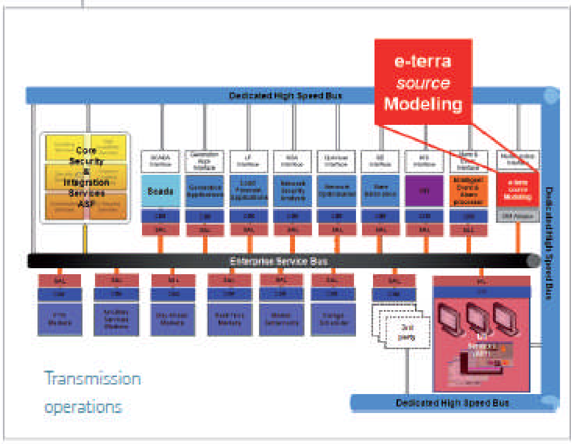


Figure 3:
e-terra*source*
from multiple
to single source modeling
in **e-terra** D2.24 system architecture

Extending models via e-terra*source* meta-data driven schema

In almost any situation where you use a modeler, you may have the need to extend the kinds of data being managed beyond what is required by the Alstom Grid EMS, or beyond what is defined in the current CIM standard. If so, you will need to be able to extend the schema of the data that **e-terra***source* is managing. We have designed **e-terra***source* to make this a straightforward non-programming operation, thanks to its meta-data driven schema.



NETWORK MANAGEMENT SOLUTIONS | **e-terra***source*

e-terra*source* product summary

Key Concepts:

- A model is a representation of some real world system, such as a power system, maintained over time – i.e. past, present and future views are available.
- A project is an annotated, dated collection of changes to a model. Projects create easy to use audit trails of activity and, when specified in the future, provide documentation of plans.
- Multiple workspaces support concurrent independent work by multiple users.
- A full model may be divided into non-overlapping model authority sets maintained by different parties.

The model repository

- **e-terra***source* is a database application supported in Oracle and SQLServer.
- Supports a versioned storage of multiple models obeying multiple schemas.
- Schemas for models are configurable via metadata.

Viewing and editing

- Graphic edit provides a schematic representation of power system objects and supports graphical insert, delete and connection operations.
- Trees provide configurable navigation through hierarchies of model objects.
- Grids provide tabular views with configurable filtering and sorting on columns.
- Property sheets show individual objects in full detail.
- Templates allow convenient insertion of common patterns of objects.
- Project views show the operations encapsulated by a project.

Import and export / Integration

- **e-terra***source* cooperates with other modeling sources via CIM standard import / export.
- **e-terra***source* supplies extended CIM models for deployment to target systems.

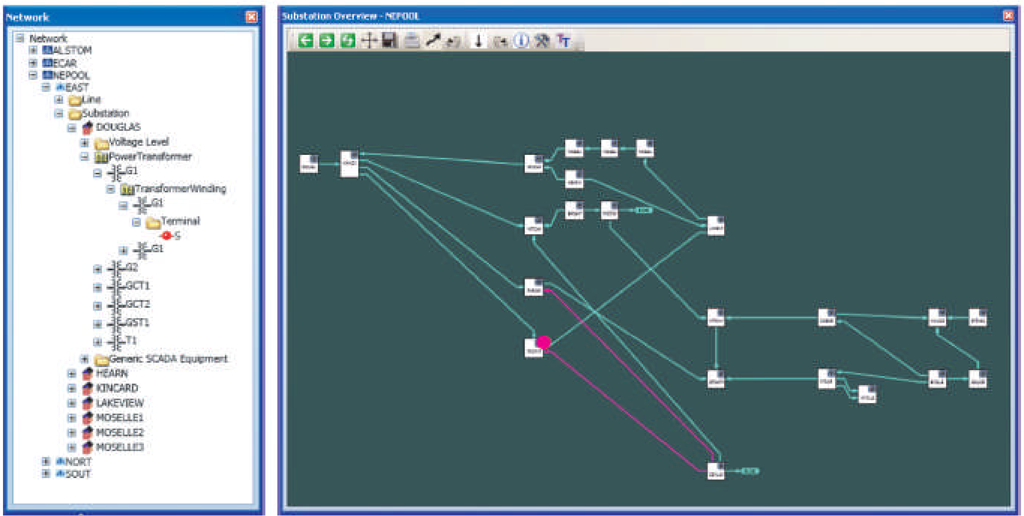


Figure 4 | A variety of navigational facilities simplify model building and browsing activities in **e-terra***source*.

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GRID | ALSTOM

EDF

EDF R&D participated with three products (Gedeon, Prao, CIM API for Advanced DMS function implemented using Matlab-Psat) described hereafter.

GEDEON Database

Gedeon is an CIM Oracle Database which is used by EDF R&D in order to test the implementation of CIM model in a relational Database, from CIM UML model exported from Entreprise Architect.

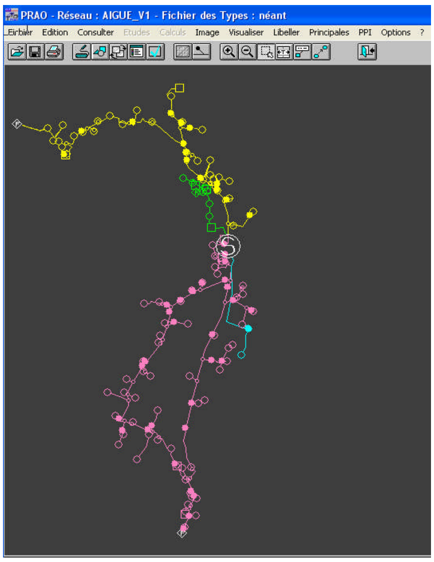
Gedeon is used to import, export CIM instances files in global mode, import incremental files and apply it to a global database already created from an import.

Gedeon as also an export facility which allow it to compare two versions of databases and to export their differences in an incremental file.

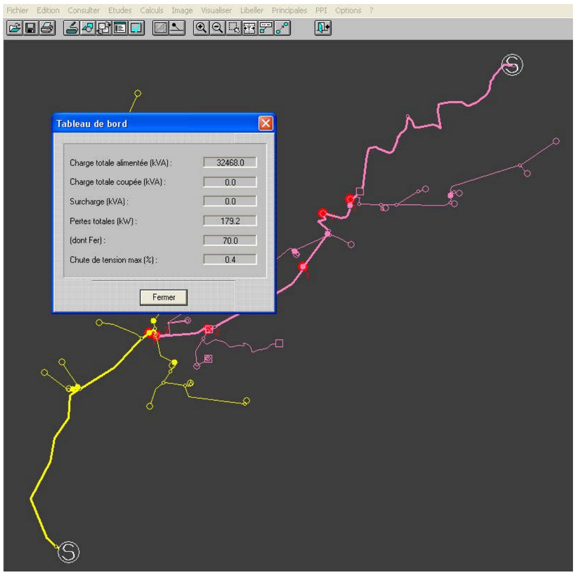
Version of Gedeon : v1.1
Version of Oracle : v10

PRAO Planning Tool

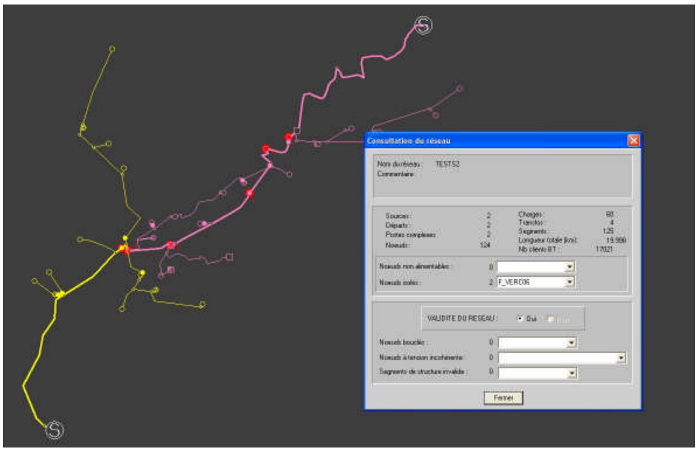
PRAO is the ERDF MV planning tool.
Version of PRAO : 2.7



AIGUE Import



C10 Import with load flow



C10 Import with other load flow information

Load Flow results from Prao can be exported in an excel sheet. A snippet is given below:

RESEAU : C10 STRATEGIE : test ANNEE : 0/30
DATE : 1/04/2011 HEURE : 15:35:33

Schéma normal calculé à P*max
Coefficient pondérateur IMAP souterrain : 0.825

DEPARTS_DETAILLES

Nom du Départ	Libellé	Marge Transit Min. sur la Principale (kVA)	Segment à Marge Transit Min. sur la Principale	Long. Totale en contrainte I (m)	Long. Ossature en contrainte I (m)	Long. Autre en contrainte I (m)	Long. Totale en contrainte U (m)	Capacitif (nF)	Nb. points teleco.	Nb. organes teleco.	Nb. points Ossature	Nb. organes Ossature teleco.	Nb. départs en bouclage	Nb. Bouclages avec	Nb. Bouclages avec autres départ
'F_VERC0014	'ST FER	4249.48	'F_VER0049	0	0	0	0	1823.76	2	2	2	2	1	0	1
'P_SALC0010	'FIRMIN	4564.37	'P_SAL0016	0	0	0	0	120.289	0	0	0	0	1	0	1

Schéma normal calculé à P*max
Coefficient pondérateur IMAP souterrain : 0.825

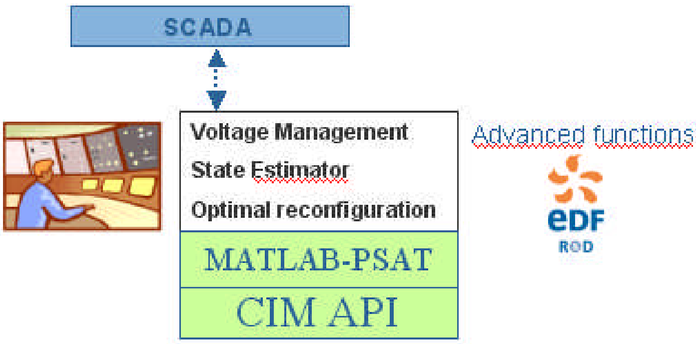
DEPARTS

Nom du Départ	Libellé	Source	Transformateur HTB/HTA	3I0 (A)	Cosinus Phi	Transit (kVA)	Longueur (km)	Longueur Aérien (km)	Nb Clients BT	Nb Clients HTA	Ps HTA (kW)	Surcharge (kVA)	Pertes J. (kW)	Pertes Fer (kW)	Marge Min. (kVA)	Ouvrage de Marge min.	Chute de T. Max. (%)	Ouvrage de Chute max.
'F_VERC0014	'ST FER	'F_VERBHT00	'F_VERY0312	19.8476	0.894427	1525,0	11.289000	0.000000	804	4	0.000000	0.000000	3.117738	0.000000	4227.123047	'F_VER0042	0.374335	'43184P0003
'P_SALC0010	'FIRMIN	'P_SALBHT00	'P_SALY0311	1.309084	0.949629	507.566772	8.349000	0.000000	264	0	0.000000	0.000000	0.816406	0.000000	4311.897461	'P_SAL0019	0.224621	'43184P0019

Pertes J. (kW)	Pertes Fer (kW)	Marge Min. (kVA)	Ouvrage de Marge min.	Chute de T. Max. (%)	Ouvrage de Chute max.	Icc Min (Bi) vu du départ (A)	NoeudIccMin (Bi) Regime Normal	Tension (kV)	Long. Souterraine (m)	Long. Torsadé (m)	Long. Totale Ossature (m)	Long. Souterraine Ossature (m)	Long. Aerienne Ossature (m)	Autoproducteurs
3.117738	0.000000	4227.123047	'F_VER0042	0.374335	'43184P0003	2263,00	'43184E0007	20.000000	0.000000	0.000000	4951.000000	0.000000	0.000000	non
0.816406	0.000000	4311.897461	'P_SAL0019	0.224621	'43184P0019	1803,00	'43184P0012	20.000000	0.000000	0.000000	2722.000000	0.000000	0.000000	non

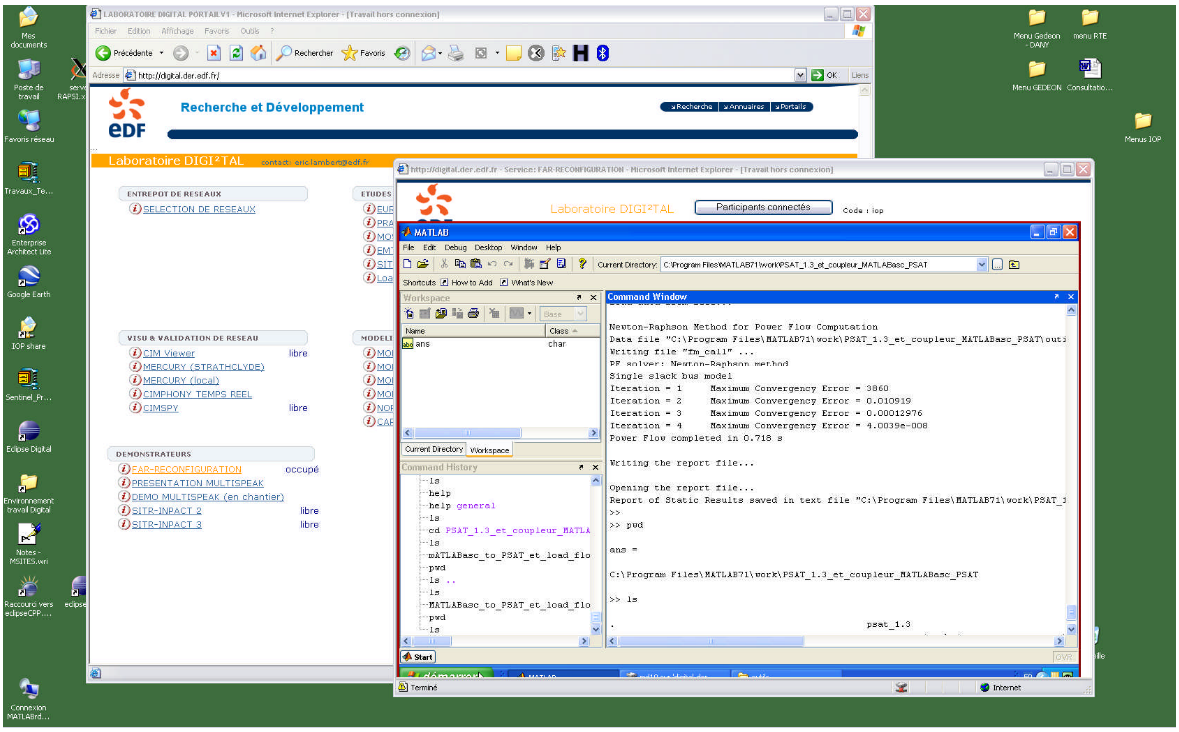
CIM API for MATLAB-PSAT

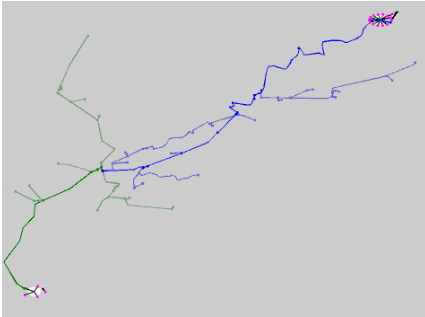
EDF R&D has developed a set of Distribution Automation advanced functions in the context of EDF R&D Distribution Challenge 2015. These advanced functions are connected to a Scada System. These functions are developed using MATLAB software and a CIM API has been developed to MATLAB in order to configure theirs data using CIM CDPSM profile.
The following picture describe the architecture :



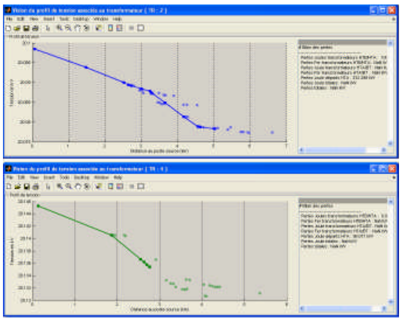
The MATLAB CIM-API is demonstrated during this IOP test through the EDF R&D Digi²tal (DistrIbution Grid Intellingent InTegrAtion Laboratory) platform where the MATLAB-PSAT prototype has been installed.
This CIM API is used during IOP test for test of the imports of C10, AIGUE files and to run a load flow in order to compare the results with other products.

The following picture describes Digital and Matlab-PSAT product:

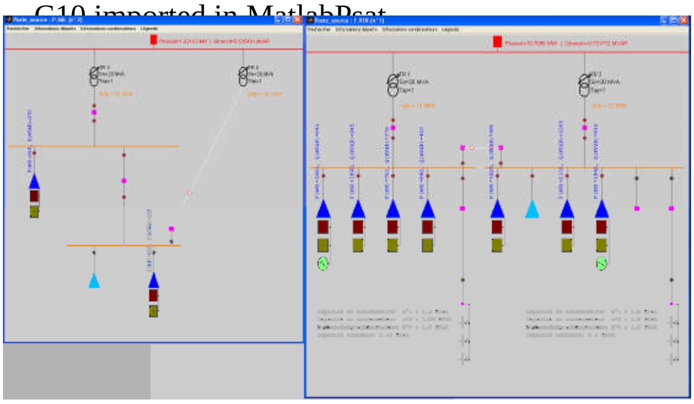




C10 imported in MatlabPsat



C10 voltage plan result



C10 primary substation

The MATLAB CIM-API allows to import CIM files and to run loadflow. EDF recommended to use C10 which is a small MV network in order to be able to compare loadflow results between tools.

Here after are shown a snippet the C10 Matlab-Psat loadflow calculation results.

POWER FLOW REPORT
P S A T 1.3.4
Author: Federico Milano, (c) 2002-2005
e-mail: fmilano@thunderbox.uwaterloo.ca
website: http://thunderbox.uwaterloo.ca/~fmilano

File: C:\Program Files\MATLAB71\work\SIMULATEUR\Simulateur_de_reseau\#Fichiers_de_traitements\SIMU_1\Reseau_PSAT_connexions

Date: 30-Mar-2011 16:35:27

NETWORK STATISTICS
Buses: 129
Lines: 127
Transformers: 4
Generators: 1
Loads: 44

SOLUTION STATISTICS
Number of Iterations: 4
Maximum P mismatch [MW] 0
Maximum Q mismatch [MVar] 0

POWER FLOW RESULTS

Bus V phase P gen Q gen P load Q load

	[kV]	[rad]	[MW]	[MVar]	[MW]	[MVar]
42095E0004	19.6481	-0.09711	0	0	0	0
42095E0008	19.6639	-0.09683	0	0	0	0
42095E0018	19.6198	-0.09722	0	0	0	0
…						
43184P0019	19.5554	-0.02731	0	0	0.116	0.03828
43184P0020	19.5646	-0.02736	0	0	0.014	0.00462
43184P0021	19.5852	-0.02715	0	0	0.022	0.00726

LINE FLOWS

From Bus	To Bus	Line	P Flow	Q Flow	P Loss	Q Loss
			[MW]	[MVar]	[MW]	[MVar]
F_VERB1000	F_VERC0017	1	3.2835	1.7086	0	0
F_VERB1000	F_VERC0033	2	4.443	2.2215	1e-005	1e-005
F_VERB1000	F_VERC0034	3	1.769	0.8845	0	0
…						
ND_BILAN	F_VERBHT00	130	24.6781	5.0366	2e-005	0.4249
ND_BILAN	P_SALBHT00	131	3.9152	1.3974	0	0.01765

LINE FLOWS

From Bus	To Bus	Line	P Flow	Q Flow	P Loss	Q Loss
			[MW]	[MVar]	[MW]	[MVar]
F_VERC0017	F_VERB1000	1	-3.2835	-1.7086	0	0
F_VERC0033	F_VERB1000	2	-4.443	-2.2215	1e-005	1e-005
…						
F_VERBHT00	ND_BILAN	130	-24.6781	-4.6117	2e-005	0.4249
P_SALBHT00	ND_BILAN	131	-3.9152	-1.3797	0	0.01765

GLOBAL SUMMARY REPORT
TOTAL GENERATION
REAL POWER [MW] 28.5933
REACTIVE POWER [MVar] 6.434
TOTAL LOAD
REAL POWER [MW] 28.4444
REACTIVE POWER [MVar] 13.5337

TOTAL SHUNT
REAL POWER [MW] 0
REACTIVE POWER (IND) [MVar] 0
REACTIVE POWER (CAP) [MVar] 9.3936

TOTAL LOSSES
REAL POWER [MW] 0.1489
REACTIVE POWER [MVar] 2.2939

GE Digital Energy Product Descriptions

The Electric Office GIS application and the Smallworld GIS Adapter were the source of the GIS network export models.

Electric Office

The Smallworld Electric Office™ suite for electric transmission and distribution is a comprehensive platform that provides geospatial support for the electric utility asset management lifecycle, from planning and design through replacement and refurbishing. Built on the proven network technology of GE Energy's Smallworld™ Product Suite, the Smallworld Electric Office™ suite contains the underlying data models, industry applications, and productivity tools required to support the essential utility operations.

More details can be found at:
http://www.gedigitalenergy.com/geospatial/catalog/smallworld_office.htm

GE Digital Energy – Smart Grid Solutions

1990 West NASA Blvd Melbourne, FL 32904
Phone: (321)435-5120
Fax: (321) 435-5650
www.GEDigitalEnergy.com

Company Overview

GE Digital Energy, based in Atlanta, Georgia, is one of the world's leading suppliers of power generation, energy delivery, and smart grid technologies for the energy industry including coal, natural gas, nuclear energy, and renewable resource generation such as water, wind, solar, and alternative fuels.

The Smart Grid Solutions business consists of Asset Management (design and planning services, field automation & workforce management including GIS, Mobile solutions, Field force solutions), Asset Control (Real time control systems for the management of transmission and distribution networks – DMS, OMS, EMS, Metering & Sensing Systems, Smart Substations) Intelligent Solutions (real time closed loop data analytics) and Solutions as a Service (Hosted solutions and consulting services). The Smart Grid Solutions group, with operations in Melbourne, Florida, USA, Cambridge UK, Hyderabad India, Montreal, Canada and Livingston, Scotland, is a leading global supplier of grid management solutions.

The Smart Grid business is focused on bringing together a unique and powerful collection of skills, products, and partnerships that enable the Smart Grid and help utilities not only improve their overall performance, but also realize tangible benefits in the areas of operational efficiency, energy efficiency, customer satisfaction and environmental impact.

Operations

Founded: 1892

Employees: 300,000+
Sales: $155+ Billion

Key Personnel

Larry Sollecito, Vice President, Smart Grid
Sisir Padhy, General Manager, Automation
Claudio Cargnelli, General Manager, Marketing
Melvyn Ten, Product Line Leader, EMS (Melvyn.Ten@ge.com)
David Daly, Product Line Leader, DMS and OMS (David.Daly@ge.com)

Customers

EMS/DMS/OMS: over 175 global utilities

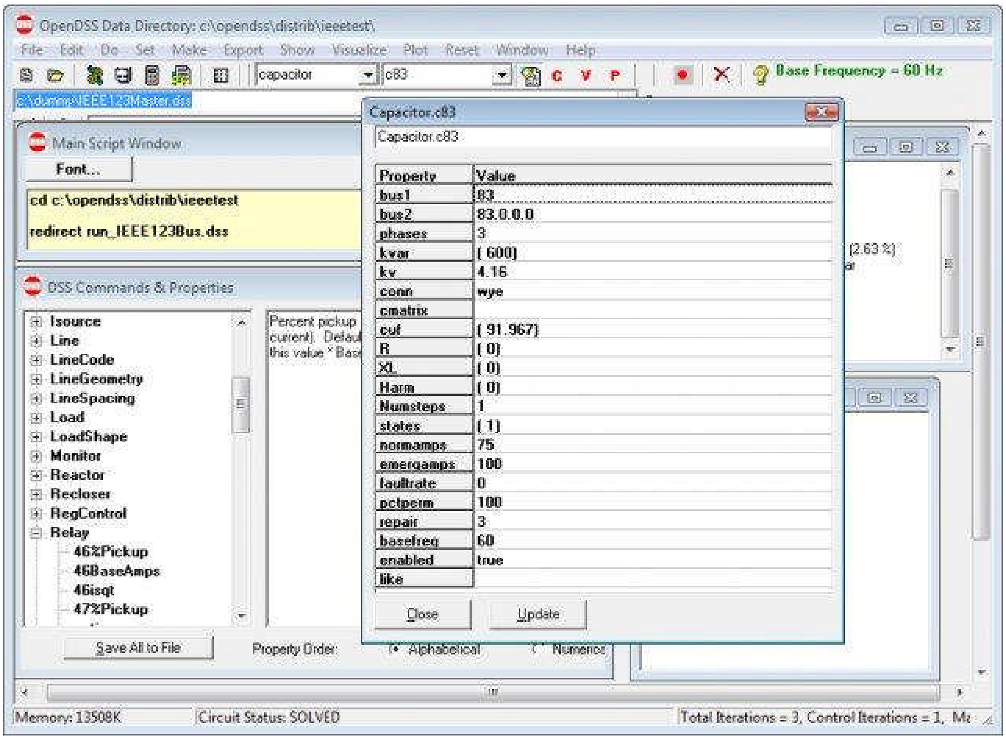
Open DSS

The OpenDSS is a simulator specifically designed to represent electric power distribution circuits. OpenDSS is designed to support most types of power distribution planning analysis associated with the interconnection of distributed generation (DG) to utility systems. It also supports many other types of frequency-domain circuit simulations commonly performed on utility electric power distribution systems. It represents unbalanced conditions, stochastic processes, and other aspects of electrical power distribution systems and equipment in far greater detail than many other tools, including commercial products. Through COM and scripting interfaces, other programs can drive OpenDSS in highly customized simulations, Monte Carlo analysis, etc. Users can define their own models through dynamic linking, scripting, or automation.

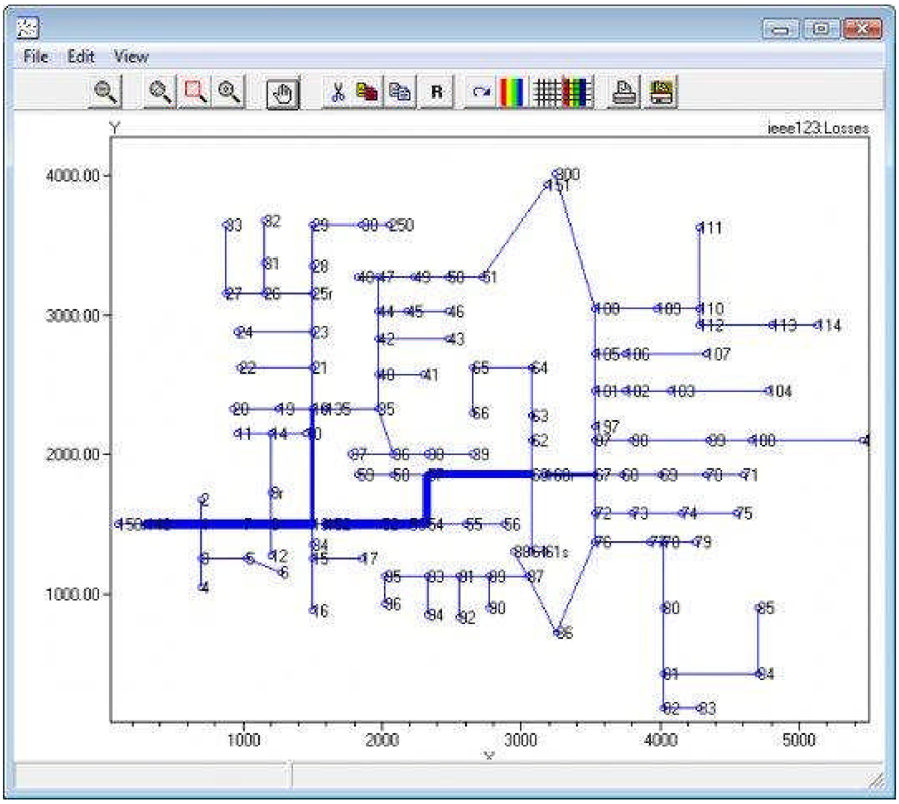
Electric Power Research Institute, Inc. (http://www.epri.com) uses OpenDSS in its research and services work and continues to enhance the software. Earlier proprietary versions were used in dozens of studies for electric utility clients, and in a Web-based wind power simulator at http://www.uwig.org/distwind. There are several goals in making OpenDSS an open-source project at this time:

- Enhance the modeling capabilities available to government laboratories, universities, and other researchers engaged in grid modernization work.
- Encourage interfaces between OpenDSS and complementary tools, such as communication system simulators or model compilers.
- Encourage the adoption of items 1 and 2 into commercial products used by electric utilities.
- Encourage collaborative efforts between industry, government, and university researchers in power distribution system analysis for grid modernization efforts.
- Provide a capable testing platform for data and object modeling efforts currently underway in the electric utility industry, at http://cimug.ucaiug.org and http://www.multispeak.org.

OpenDSS runs on 32-bit Windows, and the programming language is Delphi (http://www.embarcadero.com). The present version of OpenDSS is compiled with Delphi 2010. There is also a Free Pascal version of the program. Some of the supporting modules may require a C++ compiler to build from source. Linux and 64-bit Windows versions are under development. The OpenDSS software, documentation, source code, and examples may be downloaded from http://sourceforge.net/projects/electricdss/, A BSD-new type of open source license applies.



OpenDSS Graphical User Interface



Weighted plot of line losses for IEEE 123-bus test circuit.

Open Grid Systems

Open Grid Systems

CIMPHONY

Vendor presentation

Open Grid Systems Ltd. is a consultancy and software company based in Glasgow, UK providing services to the electrical power industry focussed on model-driven software engineering, open standards and cutting-edge technologies. Open Grid Systems provides expertise in the areas of data management, information modelling, data transformation, data-exchange technologies, visualisation and power system network analysis software. We utilise the power of open standards and model-driven architectures to provide modern, scalable solutions to the challenges faced by utilities in the smart-grid enabled world.

Tool description

CIMPHONY

CIMPHONY began as a research project in the University of Strathclyde and in its previous incarnation was utilised at a number of EPRI and UCA-sponsored interoperability tests for model validation. The new version is fully re-engineered, based on open-source software and utilises the OSGi modular system and an Eclipse-based UI to provide a multi-platform framework for data management and power system analysis tools.

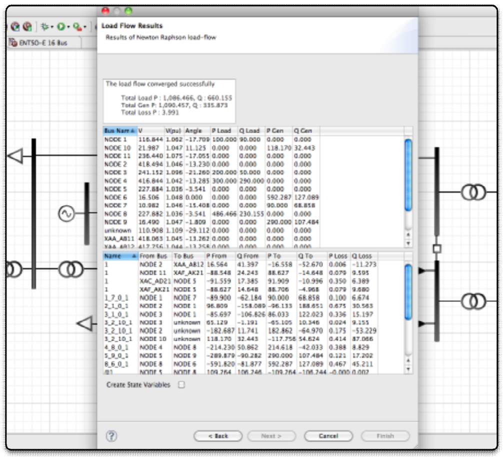
The core CIMPHONY modules provide model-independent services for:

- Data management and editing
- OCL-driven validation
- Model-driven transformation
- Distributed database persistence
- Graphical visualisation
- Geographical export using KML

The model-driven architecture allows support for new formats and data models to be added to CIMPHONY without requiring the core frameworks to be altered. Support is already in-place for a number of data models including established open standards such as CIM (multiple versions including ENTSO-E profiles), MultiSpeak and IEC61850; or proprietary formats such as PSS/E (v30-32) and extended standard models such as that used at ERCOT. Transformation and validation services using these models are defined using OMG standard languages allowing the rapid development of transformation mappings between data models.

Multiple resources can be combined in dynamic working sets, supporting the ENTSO-E model multiple profiles and authority set concepts. The workspace provides gives the user the ability to integrate, export, substitute, add and remove individual resources on an ad-hoc basis from their dynamic working set.

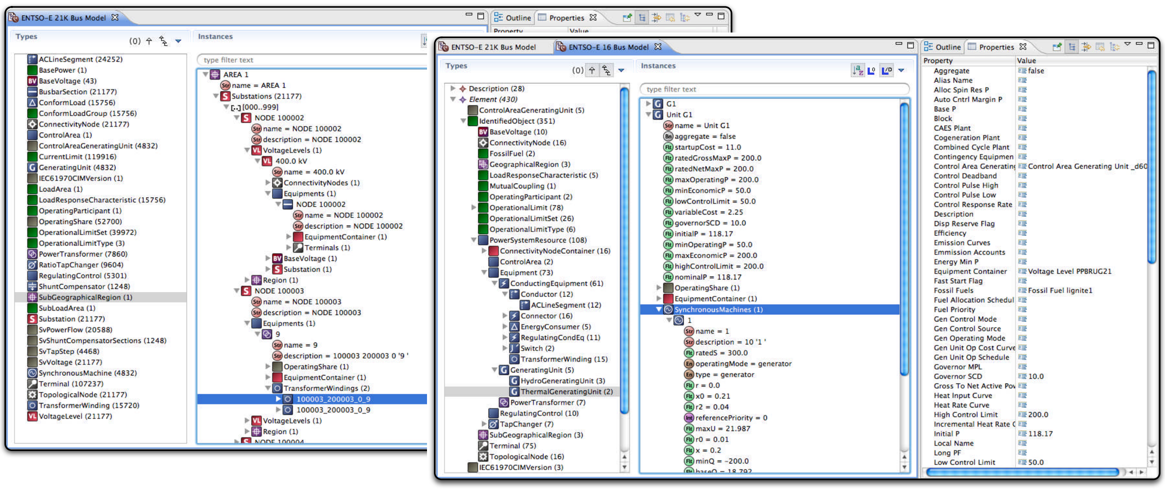
In addition to the model management service, CIMPHONY provides CIM and power-system specific functionality including the ability to execute load-flow simulations on balanced, three-phase models using an internal power-flow engine, and supports the export of these results using the IEC 61970-456/ENTSO-E CIM XML State Variable profiles. In addition a topology processor module allows operational models compliant with IEC 61970-452 to be imported and a topology file (as defined by IEC 61970-456) to be created and exported thus allowing an ENTSO-E compatible planning model to be generated from an operational CPSM model.



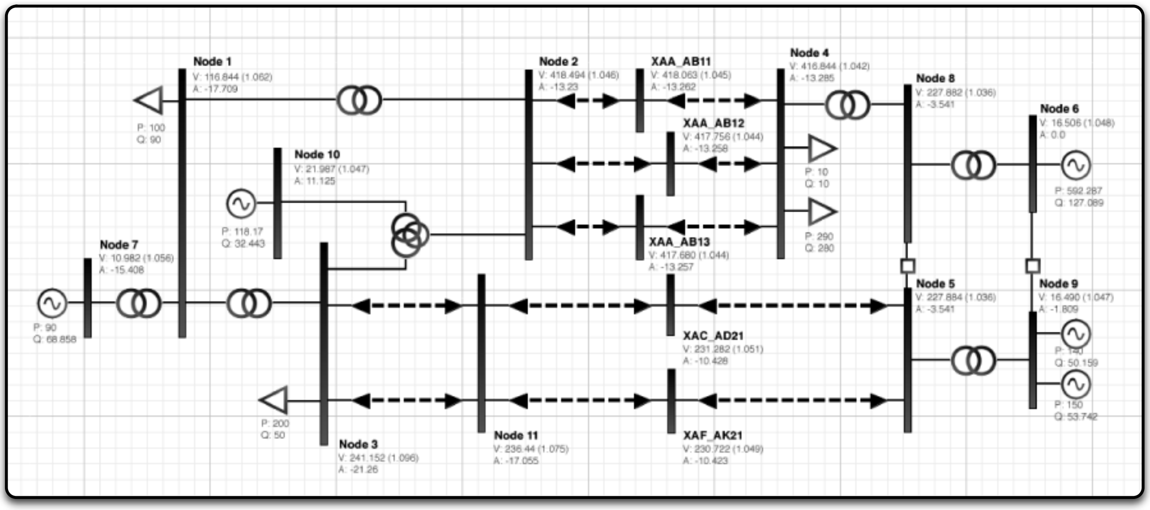
Load Flow Results

The CIMPHONY components can be deployed in a number of environments: an application library for integration with other Java applications; web-services; command-line application; web-based UI; distributed, cloud-computing environments; or as a native, rich-client UI utilising Eclipse frameworks.

The rich-client UI can be run on Windows, Linux or OS X. As well as providing a UI for the validation, transformation, import/export and difference model functions, it provides an *infinite-tree* model-driven browser and graphical editor with preliminary support for single-line diagram creation and editing in a common UI (with support for multiple data-models).



Browser Interface with different hierarchical views



Graphical Editor acting as a Single Line Diagram editor

CIM functionalities

CIMPHONY currently supports the core functionality required for managing the exchange of CIM data including support for CIM v10-15 (plus v16 draft) and associated modules:

- Full dataset RDF XML import/export
- Incremental dataset Difference Model RDF XML import/export/generation and merging
- Profiled importing and exporting and transparent inter-dataset dependencies
- ENTSO-E Profiles and model authority set support
- IEC 61970-452/456 CPSM Profile
- IEC 61968-13 CDPSM Profile
- IEC 61970-552 Header model support including dependency verification
- Preliminary support for draft IEC 61970-453 CIM Graphics Exchange standard

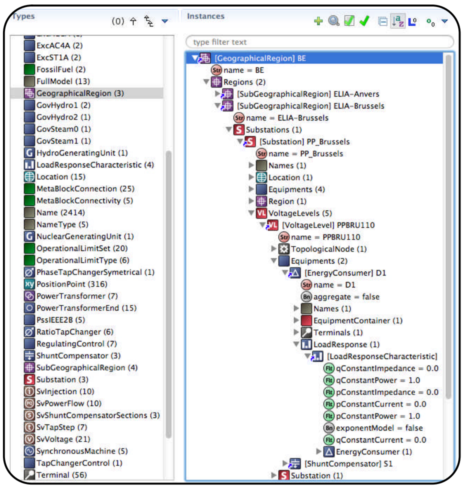
CIMPHONY will continue to support the latest versions of the CIM in addition to other IEC and industry standards. Open Grid Systems is committed to continuing involvement with future interoperability tests while supporting the international standards process through active participation at the working group level.

Open Grid Systems

Open Grid Systems Ltd. is a consultancy and software company based in Glasgc providing services to the electrical power industry focussed on model-driven so engineering, open standards and cutting-edge technologies.

Open Grid Systems provides expertise in the areas of data management, inforn modelling, data transformation, data-exchange technologies, visualisation and system network analysis software. We utilise the power of open standards and n driven architectures to provide modern, scalable solutions to the challenges fa utilities in the smart-grid enabled world.

Cimphony



Model-independent Cimphony Browser with *infinite tree* data navigation

Cimphony is a model-driven power system data management application supporting a number of power system data formats and provides a **modular**, multi-platform framework for **data management** and power system analysis tools.

The core **Cimphony** modules provide model-independent services for:

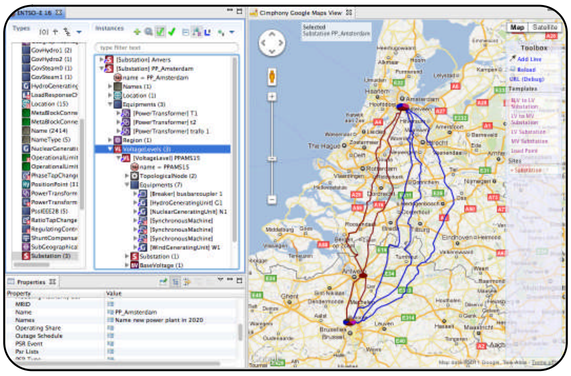
- Data Management
- Data Validation
- Model-Driven Transformation
- Graphical Editing
- Geographical Network Editing

The model-driven architecture allows support for new formats and data models to be added to **Cimphony** without requiring the core frameworks to be altered. Support is already in-place for a number of data models including established open standards such as **CIM 10-15**, **MultiSpeak**, IEEE Common Data Format and **IEC 61850 SCL**; proprietary formats such as **PSS®E (v30-32)** and extended standard models such as that used at ERCOT.

Data validation integrated with Cimphony Browser

Validation services using these models are defined using the OMG standard **OCL** language to deploy multiple validation **profiles** that can be executed against the loaded data.

Geographical Editor

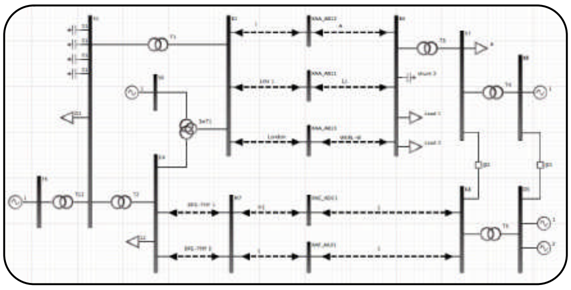


ENTSO-E 16 Bus network rendered in Geographical Editor

The Geographical Editor provides a rich **Google Maps** driven interface for building, editing and visualising geographical network data within Cimphony. The editor is **integrated** with the Cimphony Browser and Validation views, with real-time synchronisation between the interfaces.

The interface supports **multiple geographical coordinate systems**; uses a template-driven, plugin architecture to enable pre-defined network components to be used to quickly build networks; and supports **IEC 61968-13** (Common Distribution Power System Model)

Single Line Diagram Editor

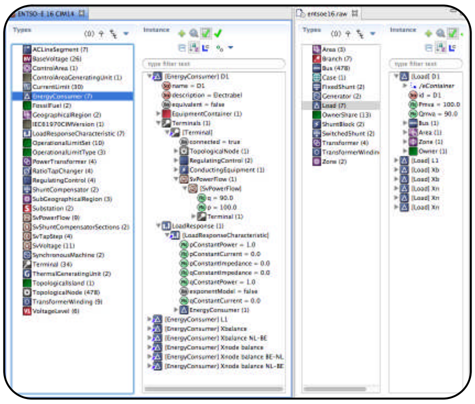


ENTSO-E 16 Bus network rendered in Single Line Diagram Editor

The Single Line Diagram Editor provides a model-driven graphical editor with support for the new **IEC 61970-453** (CIM Diagram Layout) standard. The editor can be used to build new networks; edit existing network diagrams or to visualise other diagrams exported in a standard format.

The editor integrates with the **Cimphony Browser** to allow **drag-and-drop** placement of components from its tree view.

Model Driven Transformation



Network as CIM & PSS®E in Cimphony Browser

Cimphony uses a model-driven approach to data management, validation and transformation. Data transformations are defined between models, allowing complex data translations to be **modularised** and defined **independently** of the source and target **serialisation formats** (such as the **IEC 61970-552** CIM RDF XML standard)

Cimphony includes support for a number of transformations between CIM, PSS®E, MultiSpeak and KML including inter-version transformations for CIM. New transformations are being added regularly along with support for new meta-models and serialisation formats.

Siemens Product Descriptions

Siemens participated with the products Spectrum Power IMM and Spectrum Power DNA.

Spectrum Power IMM
Smart data management in intelligent grids

Spectrum Power IMM – open and fully interoperable

Benefit from all the advantages of central, consistent data management

The Spectrum Power Information Model Manager (IMM) is a unique, proven and tested tool for data modeling, data maintenance, and data exchange of power-system-related models of any size utilized on a worldwide basis. It provides data for applications within energy management systems (EMS) and distribution management systems (DMS), for SCADA, for communication with telecontrol devices, and other company data. Spectrum Power IMM is a central repository to efficiently manage data compliant with CIM, IEC 61970. The component makes all grid data available for use – for current operation as well as for planned future modifications. Innovative functions like time-based modeling provide an exact overview of all previous changes and their documentation along with an outlook for planned future model versions based on the planned energization dates. Spectrum Power IMM ensures lasting data consistency within a hierarchical control center environment through automated electronic coordination capabilities.

Your benefits at a glance

- Considerable savings potential through central data management
- Openness and interoperability for the component's seamless integration into the application environment
- Modern, user-friendly architecture
- Service-oriented architecture (SOA interfaces) for easy integration into the company platform via enterprise service bus (ESB)
- Standardized model and information exchange using CIM-XML/RDF format
- Multilevel security system for the protection of all data
- Time-based models add the ability to reflect the evolutionary nature of work and allows getting the right data at any point in time from past to planned future horizons

Solutions for control centers and energy management

Answers for energy.

SIEMENS

Key features of Spectrum Power IMM

Spectrum Power IMM gives your utility a single, central location to input and maintain all of your power-system-related data within a future-proof open and standardized tool. Profile-based import and export of mass data or of incremental data changes via CIM-XML/RDF format are supported. Spectrum Power IMM thus helps protect investments and further expand them in a competitive manner.

Spectrum Power IMM is based on the Common Information Model (CIM) IEC 61970. Control systems that are based on CIM and its extensions according to IEC 61968 (DMS) and IEC 62325 (energy market) provide an optimal basis for IT integration. The CIM-conformant database allows easy incorporation of future information types – with all the advantages for the long-term reliability of the system:

- easy, standardized data exchange
- CIM data remains stable, and data model expansions are easy to implement
- possibility of easier, faster, and lower-risk upgrade or even migration of existing data
- low-cost interconnection of application packages from different manufacturer to a single system through plug and play via CIM application interface.

Spectrum Power IMM is based on the standard Microsoft® Windows™ PC platform and a commercial relational database (RDBMS) from Oracle®. This ensures intuitive operation without the need for user training as well as highly available, highly performant data management.

The component supports the three main engineering workflows:

- During graphical network display construction, the associated CIM domain data and grid topology is automatically created
- Powerful graphical templates and libraries allow mapping of well-designed graphical structures to existing, optionally imported CIM domain data and grid topology
- Spectrum Power IMM allows automatic generation of network displays based on existing CIM domain data and grid topology. This significantly saves the labor effort associated with manually building displays and ensures the consistency between the network model and the operational schematic displays

The right data model at any point of time – for any purpose

Spectrum Power IMM provides synchronized chronological model tracking from planned future to past horizons.

All data changes are recorded with the exact planned time of commissioning. The respective time of commissioning can be rescheduled in order to represent deferrals of the respective construction work within the grid in the data model. Entry of a random future date and time, as well as the data modifications to be observed, allows deriving a model of the system for that particular point in time for any purpose.

Data version management and automatic data model archiving facilities provides a history of model changes. This enables analyses and investigations in case of operational incidents with the model that was in operation at that point in time. This enables more accurate and correct conclusions of the analysis to be achieved.

Hierarchical data model management within control center groups

Data changes at one control center within a hierarchical control center group can affect more than just one's own system. Generally, planned data changes must be submitted, reviewed for regional and supraregional feasibility, approved or rejected, and then implemented at the operating level. As responsibilities and rights for the entire grid model are clearly defined within Spectrum Power IMM, these processes can be automated to a wide extent.

Within a hierarchical group of control centers, Spectrum Power IMM maximizes transparency and process reliability:

- clear-cut responsibilities and user rights
- faster availability of modified models within the entire control center group
- lower risk of inconsistent models and increased data integrity
- reduction of time-consuming and labor-intensive manual processes
- conflict detection in model mergers

Spectrum Power IMM is open and completely interoperable. Sponsored by EPRI, this has been validated in extensive regular interoperability tests with products from leading suppliers of control centers or components. With Spectrum Power IMM, Siemens has passed these tests from the outset.

Spectrum Power IMM is there to support grid operators in their efforts to control the grids in an intelligent, safe, and efficient manner – today and tomorrow.

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Spectrum Power DNA: future-proof solution for advanced distribution network operation

Spectrum Power DNA enables the cost-effective operation of distribution networks of any size

The Spectrum Power Distribution Network Applications (DNA) suite provides the tools required for the advanced operation of distribution networks as well as for the operational management of faults and planned outages in these networks. They increase the reliability and efficiency of control center operation and field activities, minimize downtime, and increase work safety.

The Spectrum Power DNA suite is integrated in the Spectrum Power Distribution Management System (DMS). Thanks to its service-oriented architecture (SOA), the DNA suite can also be integrated with other DMS/OMS systems using Enterprise Service Bus (ESB) middleware.

Information available from distribution automation and automated metering is used by the DNA suite, which is designed to meet current as well as evolving industry standards and to satisfy regulatory requirements. This makes the DNA suite an essential component of any smart distribution grid solution.

Benefits that speak for themselves

Improved monitoring and control of the distribution network with an accurate real-time state of the network.

Ability to assess network state in real time for instant identification of equipment overloads, voltage limit violations, losses, loops, parallels, and other abnormal operating conditions.

Ability to evaluate and optimally select network control actions under a wide variety of what-if conditions.

Improved real-time secure operation of the distribution network in open loop mode or in closed loop mode with a fully automated implementation via SCADA.

Improved fault location process, including the coordination with field crews, and accelerated restoration of service.

Improved field crew safety and reduced service interruptions.

Solutions for control centers and energy management

Answers for energy.

SIEMENS

The Spectrum Power DNA suite comprises two main functional areas: network analysis applications, and network optimization and planning applications.

Distribution network analysis applications

These applications are used to determine and assess the state of the distribution network and to automate fault location, fault isolation, and service restoration.

Distribution system state estimation

A mathematically robust tool for the estimation of the real-time state of the distribution network using all available measurement results and load data profiles. The application provides improved results over actual measurements and network state as determined from SCADA measurements only, and detection of certain measurement errors. The application will also monitor and alarm any real-time operational limit violation.

Distribution system power flow

An efficient and intelligent tool for the evaluation of alternatives and strategies for the real-time network situation, as well as for studying planned configurations under different load conditions in the distribution system. It calculates the state of the distribution network elements to detect potential equipment loading and voltage limit violations.

Fault location

This application quickly identifies the most probable location of electrical faults in the distribution network. It evaluates real-time data received from the feeder breaker, reclosers, fault relays, and indicators.

Fault isolation and service restoration

This application determines switching actions which enable the operator to efficiently isolate faulted areas of the network and restore service to customers on non-faulted feeder sections – even before repair work begins.

Distribution security analysis

This application determines the impact of faults as well as planned outages on the security of the distribution network. It simulates single, multiple, and cascading or conditional equipment outages including that of distributed generators.

Short-circuit calculation

This application calculates fault currents in the distribution network to determine potential operating conditions and network configurations that may exceed circuit breaker ratings. It can also be used to verify circuit breaker capacity and protection settings.

Distribution network optimization and planning applications

These applications are used to optimize system operation while avoiding potential system limit violations, to restore security in the presence of operational limit violations, and to plan optimal capacitor placement for a secure voltage profile.

Optimal voltage and reactive power control

This application provides recommendations for the control of transformer tap changers and switchable shunt reactive devices (typically capacitors) in order to keep distribution feeder equipment loading and voltages within defined limits. Optimization options include the minimization of power losses, demand or reactive power, and the maximization of revenue. The application can be used in either automatic closed-loop mode or user-interactive open-loop mode for global or local optimization.

Optimal feeder reconfiguration

This application determines switching plans and options for feeder reconfiguration accounting for equipment loading limits, voltage limits, and feeder losses. It can supply multiple prioritized plans to the operator and is particularly effective in Large Area Restoration.

Optimal capacitor placement

This application determines the optimal size and location of the capacitors in the distribution network to minimize power loss, undervoltage, and power factor constraints. It is mainly used for distribution network planning and design.

An overview of the key features:

- Availability of all applications in real-time and study mode
- Field-proven application suite used with many distribution networks of all sizes
- Improved distribution transformer load model
- Automated fault isolation and service restoration based on automated device controls
- Optimization of voltage profile, network losses, and network configuration
- Interactive and automated creation of switching plans to support work and restoration activities
- Easy integration with outage management and distribution SCADA systems
- Architecture and model-building tools that support enterprise integration with a geographic information system
- Support of temporary operational network changes such as jumpers, cuts, and grounds
- Support of multiple simultaneous studies

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SISCO Product Descriptions

UIB Adapter for the OSIsoft™ PI System

Description

SISCO's Utility Integration Bus (UIB) adapter for the PI System (PI) from OSIsoft combines the power of the OSIsoft world-leading platform for real-time performance management with the application integration and common information exchange model capabilities of SISCO's UIB. The UIB PI adapter receives modeling information, such as a network connectivity model typically maintained by a network modeling tool, EMS, DMS, or GIS system; and automatically configures the PI Module Database and Analysis Framework for those points that are being historized by the PI Server. The UIB Adapter organizes the PI tags within the context of models familiar to the user such as EPRI's Common Information Model (CIM), existing models from other applications like GIS or EMS, or a user-defined power system model. Changes made to the connectivity model are delivered via the UIB to the UIB PI adapter, which automatically creates the PI AF2/MDB entries, and PI configuration needed. The UIB and PI System provide a unique cost saving solution for electric utility users that minimizes manual reconfiguration and data handling.

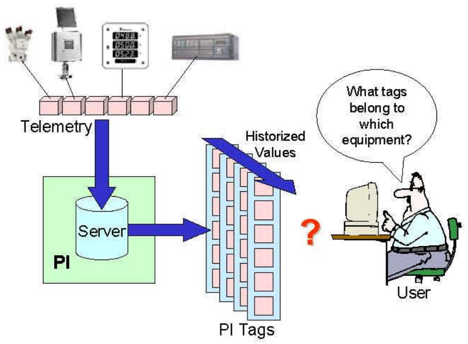
Features

- Works with customer defined models, models derived from applications, or industry standard models such as CIM, IEC61850, ISA, etc.
- Imports XML model definitions and network connectivity information into the PI MDB-AF2.
- Can auto-create PI tag names based upon the model definitions.
- Supports model synchronization between the PI and the power system models in other systems to enable historization of these external model changes within the PI environment.

Benefits

- View and search for PI tags within the context of familiar power system models.
- Facilitates the development of reusable analysis and display applications for PI ProcessBook™.
- Lowers configuration and maintenance costs by providing automatic configuration updates when changes are made to the system model.
- Provides a common integration framework that eliminates costly point-to-point data transformations and integration links.
- Leverages existing Enterprise Application Integration (EAI) and middleware products such as IBM WebSphere and others to provide maximum performance and flexibility for integration with other enterprise applications.
- Support for industry standard models and APIs reduces costs for integrating utility applications based on commercial EAI and middleware software.

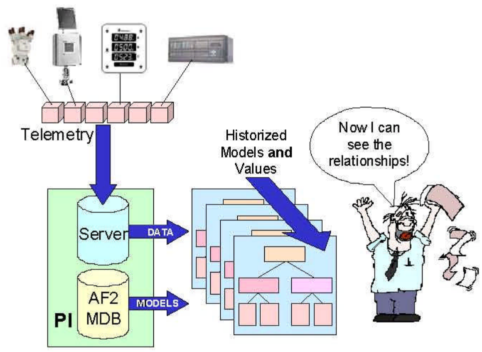
The need to Organize Tags



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

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

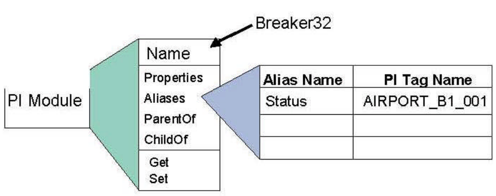
PI Analysis Framework



The PI Analysis Framework (AF) or Module Database (MDB) allows model and relationship definitions to be defined. The SISCO UIB PI Adapter enhances the capability of PI through algorithmic and model centric population and maintenance of the PI AF2 or MDB. The Adapter allows for model relationships based upon class hierarchy (e.g. a breaker is a type of switch) and instance relationships (e.g. a breaker contained within a given substation) to be visualized and maintained as part of the PI System.

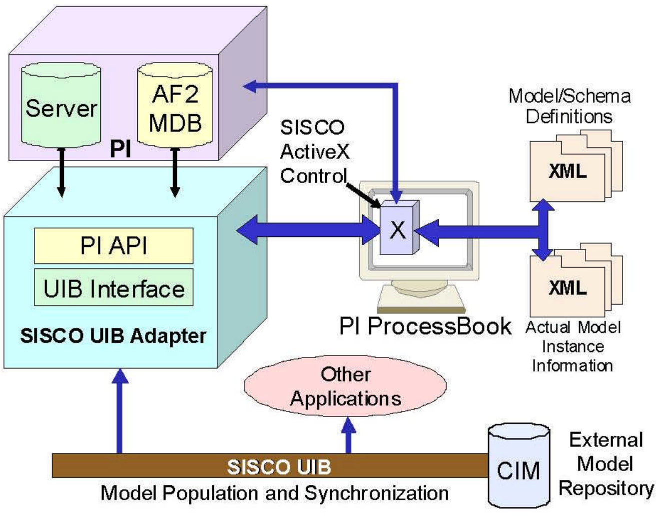
The benefit, to the user, is that programming based upon prior knowledge is minimized. Consistent algorithms for displaying information (e.g. Status) can be programmed in PI ProcessBook instead of relying on hard coded tag names. This will significantly decrease application life-cycle costs (e.g. development,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

Anatomy of a Model



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

How it Works



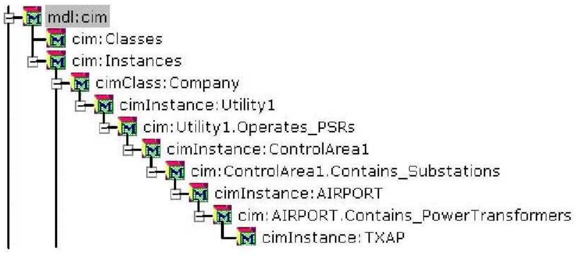
SISCO's UIB PI Server Adapter consists of: the adapter itself and a Process Book compatible ActiveX™ Control. The software allows for model creation and maintenance in the PI AF2 automatically enabling standardized or customer defined models to be used.

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

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

The Result

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



About SISCO

SISCO, Inc. is a private company founded in 1983. We have offices in Michigan, New Jersey and Alabama with engineering staff in other locations as well.

Over the years SISCO has established itself as a leader in several technologies. Today our capabilities are used in a wide variety of industries from automotive manufacturing to electrical and gas power transmission, distribution and generation systems. We work with both end users and OEMs serving those end users. SISCO's ability to partner with other OEMs and integrators allows us to deliver more capabilities at a lower cost resulting in better solutions for you. Today SISCO has demonstrated leadership and capabilities to provide solutions in the following areas:

Message bus based integration technology based upon advanced publish/subscribe and object oriented technology for enterprise integration of heterogeneous applications

Real-time communications and networking based upon open, public, and international standards such as:

- Inter-control Center Communications Protocol (ICCP) per IEC60870-6 TASE.2
- IEC 61850 Substation Automation and Centralized Remedial Action Systems

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Supelec

Supélec (http://www.supelec.fr) is a French engineering institute with a threefold mission: degree courses, research & development, continuing education. It is the reference in its field, electric energy and information sciences, with classes of 440 engineers graduating each year.

TOOL DESCRIPTION

CimClipse (http://wwwdi.supelec.fr/software/cimclipse) is a set of tools used within or based on Eclipse or its plugins, used for CIM related tasks and released as Open Source as an Eclipse plugin. Currently, it encompasses tools developed in the Computer Science Department of Supélec with funding from EDF R&D. CimClipse is designed as a demonstrator of the benefits of using Model Driven Engineering approach in the context of CIM tasks.
The tools currently available in the CimClipse plugin allow to:
- import and merge CIMXML files
- import and merge ZIP (as defined in ENTSO-E profile version 2) of CIMXML files (headers not checked)
- display and edit objects and their attributes
- export data as CIMXML files
- check data against constraints expressed in OCL (Object Constraint Language). These rules can correspond to a profile or can be defined by a company to enforce some business rules.
- apply incremental file to loaded data
- create incremental file by comparing existing data to a CIMXML file

OTHER TOOLS LINKED TO THE CIMCLIPSE OCL VALIDATOR

Other CIM tools are available on the CimClipse site that are either used inside CimClipse or used to build it:
- Some versions of CIM models compliant with the UML2 layer of Eclipse
- Same versions of CIM models compliant with the Ecore layer of Eclipse
- Some model transformation tools used to obtain previous models

EXPECTED CIM FUNCTIONALITIES

The full support of sub-profiles (profile defines by several parts corresponding to different data files) is expected for the next release.

CimClipse does not support the computation of load flow. A preliminary version for this task exists, but is not adapted to ENTSO-E profile.

TIBCO® IntelliEDGE for CIM

Equipment and network topology represent critical information assets for network operations in the utility industry. While many efforts are currently underway to implement distributed real-time infrastructure to support many smart grid initiatives, their success is largely dependent on ensuring that critical equipment assets information is aligned internally and across the value chain and delivered to people and systems alike in real time.
TIBCO® IntelliEDGE for CIM solution manages the network equipment master data assets and supports the necessary processes, policies and procedures to ensure that clean data stays clean.

Background

Headquartered in Palo Alto, California, TIBCO Software Inc. (NASDAQ:TIBX) provides enterprise software that helps companies achieve service-oriented architecture (SOA), business process management (BPM) and Business Optimization success. With over 4,000 customers and offices in 40 countries, TIBCO has given leading organizations around the world better awareness and agility–what TIBCO calls The Power of Now®.

Markets and technologies are changing more quickly than ever, so the ability to adapt is becoming a key competitive advantage for large organizations, requiring:

- **Real-Time Visibility:** The power to see what is happening right now across your operations and marketplace.
- **Real-Time Understanding:** The power to make sense of it all so you can understand developing situations.
- **Real-Time Action:** The power to adapt immediately in order to seize opportunities, mitigate risks, and avoid threats.

Enabling PREDICTIVE BUSINESS®

TIBCO has built its legacy on integration and Enterprise Service Bus (ESB) technology and continues to be a leader in developing solutions to support Service Oriented Architecture (SOA). In addition,TIBCO is working toward enabling a future in which organizations will have such a complete and current understanding of their operations and markets that they can identify and address threats and opportunities before they impact operations, customers or the bottom line. This future involves the theory of Complex Events Processing (CEP) and the Master Data Management (MDM) within the enterprise. TIBCO has delivered on this vision by evolving the following capabilities.

- The ability to discern meaningful patterns among countless discrete events which occur both inside and outside the enterprise.
- The ability to seamlessly merge historical data with real-time information to aid in the identification and optimal resolution of situations.
- The ability to apply extremely sophisticated rules to automate the identification and resolution of issues thereby avoiding human intervention.
- The ability to manage data coming from all of your disparate systems and information sources.

TIBCO® IntelliEDGE for CIM

Equipment and network topology represent critical information assets for network operations in the utility industry. While many efforts are currently underway to implement distributed real-time infrastructure to support many smart grid initiatives, their success is largely dependent on ensuring that critical equipment assets information is aligned internally and across the value chain and delivered to people and systems alike in real time.

TIBCO IntelliEDGE for CIM solution manages the network equipment master data assets and supports the necessary processes, policies and procedures to ensure that clean data stays clean.

The diagram in Figure 1 illustrates the component architecture for the TIBCO IntelliEDGE for CIM solution.

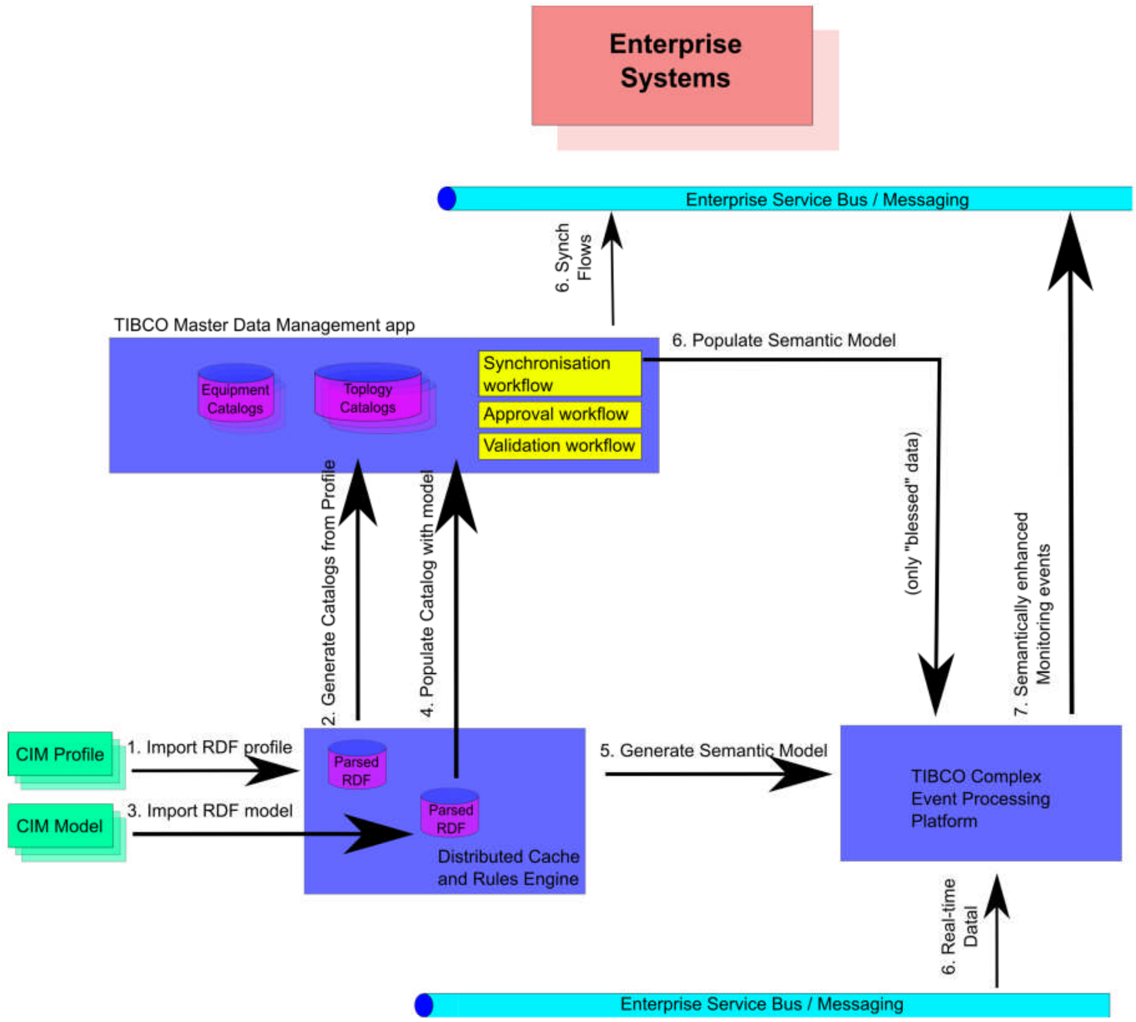

Figure 1: Import flows in TIBCO IntelliEDGE for CIM

In order to accelerate the implementation of a network equipment master data management solution, TIBCO IntelliEDGE for CIM provides the capabilities to quickly create and maintain:

- A master catalogue for all equipment types as defined within the CIM data model, generated from CIM Profile definitions. The creation of such catalogues can be aggregated from multiple CIM Profile definitions that describe different characteristics of the same equipment types.
- With the master catalogue creation, validation and initialization rules are generated based on constraint definitions as captured in the CIM Profile definitions.
- Relationships and hierarchies between equipment modules, representing electrical connectivity and topology as derived from the corresponding CIM Profile definitions.

- Batch import definitions for each of the equipment types, facilitating out of the box import of equipment model data into the TIBCO catalogues by reading the RDF representations of both Equipment and Topology data in CIM format.
- Relationship mappings for the batch import definitions, to facilitate the management of relationships between equipment elements when importing Equipment and Topology profiles in CIM RDF format.

Technology Platform

For many organizations, the ultimate goal is to create an integrated enterprise. Service Oriented Architectures (SOA) connect people, processes, and information by integrating systems and providing a platform to develop new functionality while getting the most out of existing investments.

TIBCO's Master Data Management (MDM) provides the information management component – ensuring that critical information assets and foundation for other solutions, is aligned internally and across the value chain and delivered to people and systems alike in real time.

The combination of SOA and MDM allows organizations to be connected in real time at nearly every level, from processing day-to-day activities to making strategic decisions. SOA augmented with MDM provides the ability to take advantage of accurate up-to-the-minute data about equipment and topology and ensures that information is being properly managed and utilized throughout the organization to help achieve business objectives.

TIBCO IntelliEDGE for CIM solution is built on a real-time event platform, allowing organizations to respond to events in real-time to take advantage opportunities or avert problems before they escalate, through real-time notifications and automated corrective action.

Key Features of TIBCO® IntelliEDGE for CIM

Information Management

- Master catalogue creation; aggregation from multiple data sources with survivorship; version control.
- Management of relationships and hierarchies including across data domains
- Matching and de-duplication through an advanced fuzzy match engine that uses human-similarity algorithms rather than rules to determine a match
- Images and unstructured information
- Metadata import and export from UI
- Structured and context-free search
- Role- and user-based access control

Business Collaboration

- User-configurable data quality and business rules
- Long-lived, stateful, cross-enterprise workflow
- Out-of-the-box workflow templates such as new equipment introduction
- Data stewardship and exception handling

Universal Data Connectivity

- Bus-based integration (including non-TIBCO)
- Mapping and transformation
- Web service API for real-time access to metadata, data, and application functionality

Business Intelligence and Analysis

- Process effectiveness visibility
- Detailed versioning, including version compare and roll back
- Full event history for data lineage tracking and auditing

Robust Architecture

- Real-time event-based architecture
- Zero client footprint
- JMX-based monitoring
- Multi-threaded parallelization and caching for high performance access, loading, and workflow
- Distributed enterprise deployment
- Support for industry standard databases, operating systems, application servers, and EAI and B2B platforms

TIBCO® IntelliEDGE for CIM Functionality

TIBCO IntelliEDGE for CIM provides a real-time event driven integration and management environment, which delivers new levels of timely visibility and intelligence with respect to operational exceptions and exception management for system operators in the utility industry. The solution framework facilitates real time intelligence for operations optimization and addresses the issue of sub-optimal asset condition management and process execution efficiency that is part of the system operator's core business model. The TIBCO IntelliEDGE for CIM solution framework leverages the CIM data model as a Common Data Model in order to:

- Implement both import and export functionality, as well as event-driven integration of equipment and topology data within the data life-cycle management workflows of TIBCO Collaborative Information Manager to automatically integrate with transactional systems based on a CIM derived common data model.

- Support a solution based template to maintain the semantic data model based on CIM including entities and relationships.

- Develop CIM based situational awareness applications built with TIBCO BusinessEvents which delivers new levels of timely visibility and intelligence with respect to operational exceptions and exception management for system operators in the utility industry.

Tools Linked to the TIBCO® IntelliEdge for CIM Solution

The TIBCO IntelliEDGE for CIM framework leverages the CIM data model as a Common Data Model to accelerate the creation of real-time integrated and event-driven operations environment for utility system operators. Within this framework the TIBCO solution works seamlessly together with TIBCO ActiveMatrix BusinessWorks™, TIBCO Collaborative Information Manager™ and TIBCO BusinessEvents™.

- **TIBCO ActiveMatrix BusinessWorks™ -** This is the core of TIBCO's SOA/ESB product suite and one of the leading service creation, orchestration, and integration products on the market. It has been deployed by many companies worldwide and is the foundation for several of the largest mission critical service-oriented business applications in production today. Built on open standards, ActiveMatrix BusinessWorks enables companies to expose existing systems as services, build new services, and orchestrate and assemble services into applications with little or no coding.

- **TIBCO Collaborative Information Manager™ -** This is the core of TIBCO's master data management solution that enables organizations to manage their enterprise master data assets and build and support the necessary processes, policies and procedures to ensure that clean data stays clean. It allows organizations to align master data across multiple business units, departments and partners and synchronize that information with downstream IT transactional systems. TIBCO Collaborative Information Manager takes a process-centric approach to managing master data by providing customizable processes to introduce, edit, and publish data.
- **TIBCO BusinessEvents™** helps companies identify and quantify the impact of events and notify people and systems about meaningful events so processes can be adapted on-the-fly and people can take action to capitalize on opportunities and remediate threats. TIBCO BusinessEvents uses a unique model-driven approach to collect, filter, and correlate events and deliver real-time operational insight and is TIBCO's solution for Complex Events Processing (CEP).

CIMTool by Langdale Consultants

CIMTool is an open source tool that supports the Common Information Model (CIM) standards used in the electric power industry. It is potentially useful for other semantic applications too. CIMTool can be downloaded in several forms from www.cimtool.org. A presentation given at the Austin CIM Users' Group meeting explains the motivation for CIMTool: CIMUGPresentation.pdf.

CIMTool lets you create and use profiles of a larger, global information model. The global model is generally the IEC Common Information Model with extensions. A profile is a small model used for specific application that conforms to the larger model.

CIMTool can:

- read and merge CIM and local UML models in XMI form
- browse models and check inconsistencies
- generate equivalent OWL ontologies
- create and edit profiles
- generate XML schemas, OWL and RDFS ontologies for profiles
- validate instances against profiles (including very large CIM/XML instances)

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APPENDIX: TEST APPROACH AND DESCRIPTIONS

Test Approach

As stated in the test objectives, there will be three types of model exchange 1) CDPSM full model data exchange tests using CIM XML-RDF files; 2) CDPSM Incremental model data exchange tests using CIM XML-RDF Incremental files; and, 3) CDPSM full GIS model data for exchange with a DMS system. Participants may perform one, two or all three of these exchange tests. Full and Incremental models will be sufficient to allow a Power Flow solution to be executed.

The CDPSM data exchange tests can be performed by participants with exchange adapters and some type of display (tabular or graphical) to show the completion of the import. However, the Solution tests will require the use of power flow applications to operate on the power system models to calculate power flow solutions. These solutions will be used to validate the correct transfer and transformation of model files between participants. The Solution tests may use the same model files as the other model and data exchange tests.

Full Distribution Model Exchange Test

Each participant in this test will be required to (1) generate and export a file that conforms to the standards for the model used and/or (2) import a file from another vendor's product and correctly interpret the model data contained. The model files used will be the EDF and GE model instance files prepared by the participants. These models contain at least one instance of the CIM classes, attributes and relationships defined in the CDPSM profiles. These models will be available before the formal testing begins to allow the participants to checkout and debug their software as well as to discover any discrepancies or errors in the files themselves.

Test Process

Figure 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 the sample model file into a standard CIM XML representation of that model. Separate XML tools are used to validate the format of the file and the conformance with XML and the RDF Syntax.

For import, the product converts the standard CIM XML representation to the product's proprietary internal representation. Product specific tools are used to validate that the import is successful.

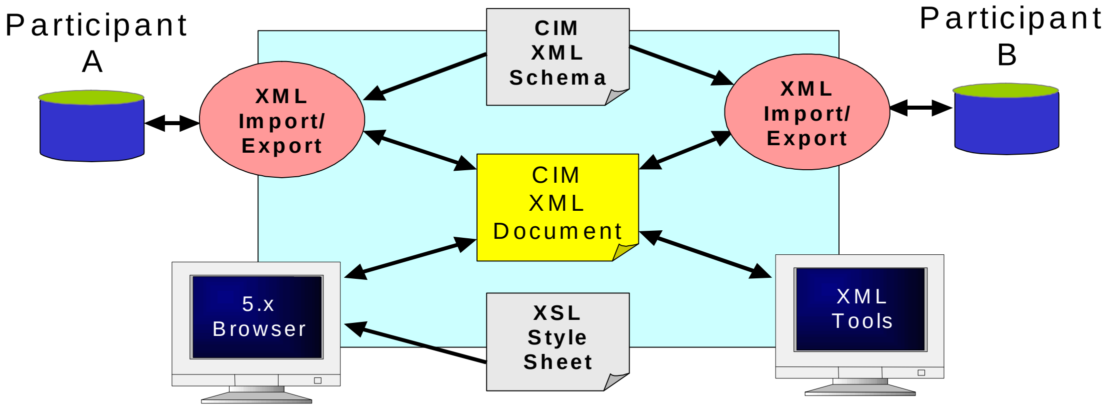

Figure 1: Export/Import Process Basics

The sample model file and files successfully exported by a participant's product will be loaded onto a storage device for use by other participants to test their import capability.

Testing will be accomplished in two parts. First, each participant's product will demonstrate correct import/export from/to the standard CIM XML/RDF format. This will show *compliance* with the standard. Second, each participant able to successfully export a file to the CIM XML/RDF format will make it available for the other participants to import. This tests *interoperability* of different vendor's products.

The basic steps involved are illustrated in Figure 2 below. Each participant (Participant A in Figure 2) will be required to import the CIM XML-formatted test files (CIM XML Doc 1) from the storage device and demonstrate successful conversion to their product's proprietary format (step 1). If the product has an internal validation capability to check for proper connectivity and other power system relationships, that will be used to validate the imported file. If the import is successful, the file is then converted back into the CIM XML format (step 2) to produce CIM XML Doc 2, which should be the same as the original.

For this test, the Test Witnesses will validate the files used on the participant computer or deliver the files produced in step 2 to the validation station (where step 3 will be executed) and the original will be compared to the file produced in step 2. In addition, the file produced in step 2 will be used as input to the Validation tools to validate that the CIM XML file meets the minimum requirements defined in the CDPSM profile group.

If the files produced in step 2 pass the validation and comparison tests (step 3), Participant A will have demonstrated compliance to the standard. The comparison test executed as part of step 3, verifies that no changes are introduced in the process of converting to the internal format and back to the CIM XML format.

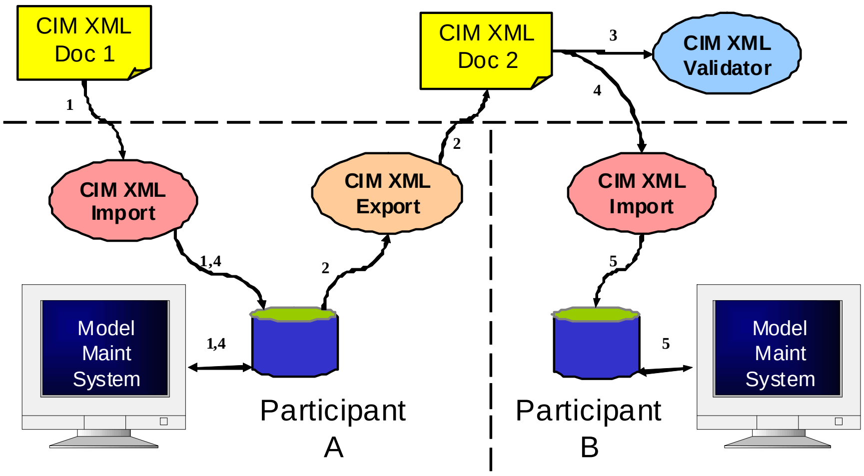

Figure 2: CIM XML Interoperability Test Process Steps

At this point the exported file will be loaded onto the storage device for another participant (Participant B in Figure 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 4). This final step demonstrates interoperability of different vendor's products through use of the CIM XML/RDF standard.

Steps 2 – 4 will be performed on unmodified test files.

Participants will be allowed to correct deficiencies or errors found during testing and, if time permits, retesting will be allowed.

Solution Test

The Solution test will verify the correct exchange and transformation of power system model files including generation and load through the execution of power flow applications. Verification will be accomplished by a comparison of solutions before and after transformation and model exchange, as illustrated in Figure 3.

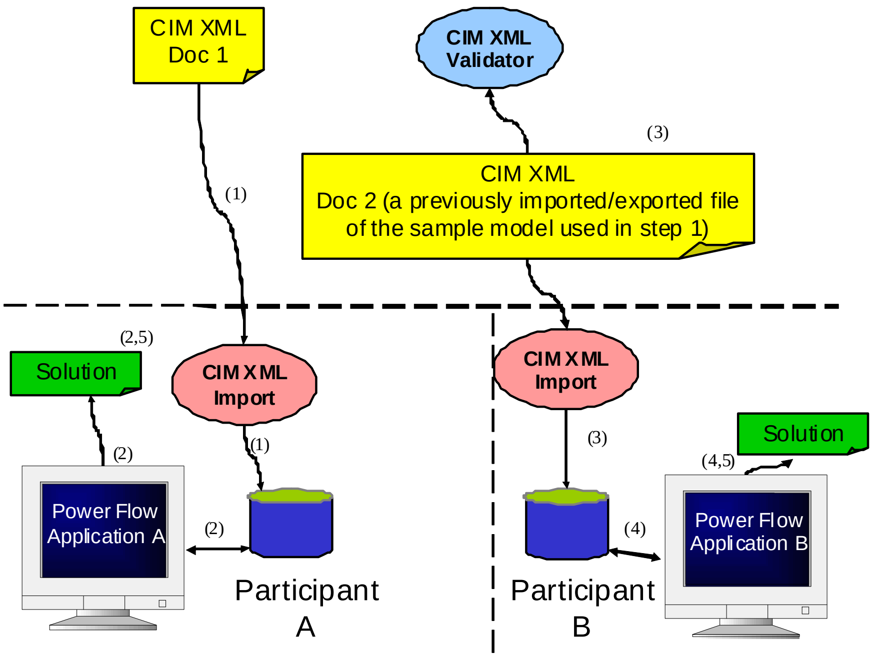

Figure 3: Solution Test Process

Test Process

The steps for this process are as follows:

(1) Participant A imports a sample power system model file (CIM XML doc 1) created by another participant from the storage device and converts it to a local representation. The imported model in the local representation is then validated using participant's tools.

(2) Participant A then runs a power flow and records the solution results for later comparison.

(3) Participant B imports CIM XML Doc 2 and converts to local representation. The imported model in local representation is then validated using participant's display tools.

(4) Participant B then runs a power flow and checks to verify correct operation.

(5) A comparison with Participant A's results from step (2) and Participant B's results from step (5) is completed. If the solutions match within a reasonable margin, the test is successful[2].

2 The solutions of multiple runs of a power flow after exporting and re-importing from another participant should result in consistent solutions, or with reasonable differences that may come from model translation to local representation.

Incremental Exchange Test

The incremental model update test will demonstrate the ability of products to accept small changes to existing model files, rather than sending a complete replacement model file.

This test will use either the GE or EDF instance files, depending on the incremental files that are used. The Test Participants may generate incremental files that will be used for this test. These files will be provided on a mass storage device by the Test Director. The format and syntax for these files are described in IEC 61970, Part 552-4: CIM XML Model Exchange Format.

Test Process

The most realistic testing is to have the incremental file produced by one participant imported by another. This tests the ability of the first participant to produce a correctly formed file with correct resource IDs, and tests the second participant's ability to interpret the file correctly and apply it to the internally stored base model file. In the event that the participant is not able to produce an incremental file, these tests may be executed using one or more of the pre-configured files that are loaded on the mass storage device.

Each system participating in the incremental model update test needs to follow these steps:

(1) import the full model file and validate, then

(2) import the incremental file(s) for the model used, apply the updates to the base model file, and demonstrate correct interpretation of the incremental file changes.

Due to the contents of the incremental file changes, there may be an import order that is required to be followed. The exact order will depend on the incremental instance files use but a possible order for multiple incremental instance files may be:

1. Perform all incremental additions first
2. Complete all incremental modifications
3. Implement all incremental deletes last

Examples of changes may include the following:

1. change the value of some attributes on existing classes
2. add a new instance of a class and enter attribute values for that class
3. delete a single leaf instance of a class
4. delete an entire equipment class instance

GIS Exchange Test

The GIS exchange model test will verify the ability of the GIS system to produce a connectivity model and the DMS system to import and correctly apply the model.

The test will use the GE connectivity model.

Test Process

The steps for this test are as follows:

(1) Participant A with a GIS system exports the profiles for the connectivity model and the files are validated with one of the model validation tools.

(2) Participant B with a DMS system imports the GIS profiles and validates that the model instance data is now stored in the internal representation.

(3) Participant B exports the model files and the files are validated with one of the model validation tools to ensure the CIM XML files are correctly exported.