European Network of
Transmission System Operators
for Electricity

INTEROPERABILITY TEST “CIM FOR SYSTEM DEVELOPMENT AND OPERATIONS” 2010

14 AUGUST 2010

FINAL REPORT

FOREWORD

ENTSO-E conducted, along with European and American vendors and Transmission System Operators (TSOs), the largest common information model (CIM) interoperability tests (IOP) to date – ENTSO-E IOP "CIM for System Development and Operations" 2010. The test was organized and directed by ENTSO-E from 12 to 16 July 2010 at ENTSO-E's premises, in Brussels.

The future ENTSO-E CIM-based data exchange format (ENTSO-E CIM profile), which complies with the International Electrotechnical Commission (IEC) CIM standard, was tested on a large number of products owned by 15 vendors. BCP Busarello + Cott + Partner AG, Siemens Power Technologies International, CESI, Tractebel and RTE, ABB Power Technologies, Open Grid Systems, FGH, SISCO, ABB, Intercompro AG, ALSTOM grid, EDF R&D, DIgSILENT and GE Energy participated in the test that was observed by 15 test witnesses from TSOs including Statnett (Norway), Amprion (Germany), TenneT (Netherlands), Transelectrica (Romania), TERNA (Italy), EPCON (subsidiary of PSE-Operator, Poland), swissgrid (Switzerland), REN (Portugal) and ENTSO-E.

The test is considered as a part of the ENTSO-E CIM profile development process. In addition, a key goal was to test and validate the latest IEC CIM standard. The implementation schedule for the ENTSO-E CIM profile that has been tested is subject to ENTSO-E decision as it is defined by the ENTSO-E roadmap for implementation of future updates of the data exchange format as previously announced.

A set of test procedures were defined which provided step-by-step instructions to be followed to successfully complete each test. A set of official test cases were prepared by Siemens PTI, GE Energy, ABB, FGH and ENTSO-E for use by all test participants.

Two CIM XML validation tools (CIMTool and CIMSpy) were used to validate the correctness of the official test cases as well as each set of CIM XML files produced by the participants during the test.

The results achieved during the test are in line with the expectations of the participants. The test results are summarized and presented in detail in this report showing the specific tests successfully completed by each vendor and the test case files that were exchanged.

Issues recorded during the testing and proposed resolutions are included in this report, along with some guidelines on how to implement the CIM standards within the TSO/utility enterprise. Details on the products tested, the test procedures, test record forms and the test configuration used are included in the report appendices.

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ACKNOWLEDGEMENTS

ENTSO-E would like to thank the many people who worked hard to make the ENTSO-E Interoperability Test "CIM for System Development and Operations" 2010 a success. Not all people who contributed can be named here. However, ENTSO-E would like to give special recognition to the following utilities and vendors:

- ENTSO-E – Chavdar Ivanov for directing the IOP, for assistance in witnessing the IOP, for preparation of test procedures, ENTSO-E CIM Profile document, the official test files and the final report.
- SISCO – Margaret Goodrich for preparation of ENTSO-E CIM Profile.
- Siemens PTI – Chuck Dubose and Michael Ford for preparation of official test files.
- GE Energy – Feng Chen for preparation of official test files.
- ABB – Lars-Ola Osterlund for preparation of official test files.
- FGH – Dirk Cremer for preparation of official test files.
- DIgSILENT – Christoph Schmid for preparation of official test files using proprietary models in dynamics package
- Langdale Consultants – Arnold deVos for generation of CIMTool used to validate the model files and generate the RDF files used in the test.
- PowerInfo - Jun Zhu for generation of the CIMSpy validation tool used to validate the model files.
- EPRI – David Becker for providing open access to EPRI CIM projects' deliverables to ENTSO-E IOP participants.
- Svein Olsen, Statnett (TSO, Norway) - for his assistance in witnessing and recording the test results.
- Marcel Forlong, Amprion (TSO, Germany) - for his assistance in witnessing and recording the test results.
- Reinier van Offeren, TenneT (TSO, The Netherlands) - for his assistance in witnessing and recording the test results.
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- Rimantas Rutkauskas and Francisco Reis, ENTSO-E - for their assistance in witnessing and recording the test results.

- Mario Ferreira, REN (TSO, Portugal) - for his assistance in witnessing and recording the test results.

- All participating vendors, for the hard work in a very short time to develop the necessary software for testing and providing inputs to the issues discussed during the preparatory work as well as during the IOP.

In addition, ENTSO-E acknowledges IEC TC57/WG13 members, CIM user group and EPRI that provided assistance and supported ENTSO-E IOP in various ways.

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1 INTRODUCTION

1.1 BACKGROUND INFORMATION

In 2009 the 42 ENTSO-E member TSOs have been underlining their commitment to apply the CIM-based data exchange format in all data exchange processes. This format is based on the CIM standards of the International Electrotechnical Commission and was initially tested during the UCTE interoperability test in March 2009. Using CIM will improve TSO cooperation and will have a direct impact on the outputs, the Third Package mandates ENTSO-E to produce. For the first time the CIM-based exchange format is used in early 2010 for preparing network models as a basis for system development studies. One important example in this context is the Ten-Year Network Development Plan, which will benefit from the upcoming CIM-based data exchanges for network modelling. In addition to applying the CIM-based data exchange format for the exchange of system studies, the exchange of system operations data (performed on an hourly or daily basis) will be adjusted to the use the CIM-based data exchange format. The support from vendors is essential in this context since they are providing software tools required for the effective use of the new data exchange format.

On 11 December 2009 ENTSO-E decided to organize two Common Information Model (CIM) interoperability tests per year to support the development of the ENTSO-E CIM-based data exchange format and the CIM Standard issued by the International Electrotechnical Commission (IEC). Moreover, ENTSO-E agreed on a roadmap for the implementation of future updates of the CIM-based format for exchanges of system operations and system studies. The purpose of these tests is to demonstrate the interoperability of the ENTSO-E CIM-based data exchange format and the IEC CIM-based standard taking into account all changes proposed to be included in the updated CIM standard. The tests are also designed in order to allow vendors to verify the correctness of the implementation of the updated CIM standard and to support ENTSO-E processes towards achieving the objectives given to ENTSO-E by the EU Third Energy Package. More specifically, the Regulation 714/2009 on conditions for access to the network for cross-border exchanges in electricity states that ENTSO-E has to adopt common network operation tools to ensure the coordination of network operation, to elaborate network codes on data exchange and interoperability rules as well as transparency rules.

The adoption of the ENTSO-E CIM interoperability tests and the CIM/XML-based data exchange format is a direct contribution to the above mentioned tasks since it supports data exchanges and ensures the interoperability of the tools used in the ENTSO-E data exchange processes. The experience gained from the process of developing CIM-based data exchange format and its implementation will directly contribute to the task to develop network codes required by the Third Energy Package by European Union. The interaction is obvious taking into account the fact that data exchange processes and formats used in these processes will be part of several network codes.

ENTSO-E agreed to organize two CIM Interoperability tests per year:

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- The ENTSO-E IOP "CIM for System Development and Operations" that covers all needs of system development and operations such as operational to operational exchanges, operational to planning, short circuit data, planning, dynamics exchanges and the interface with distribution. Specific data collection and data processes can also be tested. The goal is to allow and facilitate any kind of study in TSOs' scope: static analyses, dynamic studies, short circuit assessments, etc.;
- The ENTSO-E IOP "CIM for Energy Market" that covers needs of market exchanges. It contributes to the further development of the IEM (European Internal Energy Market) by actively supporting market harmonization and integration and plays a crucial role for demonstrating the correctness of European market CIM profile.

This document reports the results of the ENTSO-E Interoperability Test „CIM for System Development and Operations" 2010.

1.2 OBJECTIVES

The IEC is publishing international standards based on the CIM as a generalized abstract information model and is progressing data interface specifications based on the CIM to exchange power system models. The ENTSO-E CIM IOP is an important step in validating these standards as well as the new draft ENTSO-E CIM Profile which specifies those parts of the CIM needed to support the ENTSO-E business processes.

ENTSO-E IOP is a stage in the development process of the next ENTSO-E CIM based data exchange format, which will become official data exchange format once endorsed by the ENTSO-E committees responsible for these data exchanges. The IOP helps to verify CIM profile definitions and debug vendors' tools in order to ensure smooth implementation process once ENTSO-E decision is taken.

The general objectives of the ENTSO-E interoperability tests and demonstrations were to:

1. Demonstrate interoperability between different products based on the ENTSO-E CIM Model Exchange Profile (here after referred to as the ENTSO-E CIM profile). This included applications from EMS and Planning as well as independently developed applications from third party suppliers.
2. Validate the ENTSO-E CIM Profile document. The goal was to ensure it is correct, complete and ready to be used in ENTSO-E data exchanges or identify issues to be further corrected and verified during the next ENTSO-E IOP.
3. Demonstrate the exchange of power system models using the CIM with an RDF Schema and XML representation of the model data.
4. Demonstrate that the test participants' applications work effectively with the ENTSO-E CIM XML files by comparing power flows run on both the original form of the models and the CIM form of the models.

5. Demonstrate that the application vendors can interoperate via the ENTSO-E CIM profile by showing that CIM cases produced by one vendor can be consumed by the others.

Specific objectives of the ENTSO-E IOP included validation of the:

- File header
- Model Authority Sets
- Merging concept: merging of models submitted by different model authority sets
- Exchange of data for dynamics calculations
- Exchange between SCADA/EMS and „planning“ tools
- Exchange of difference files
- Partial exchange of CIM profiles (equipment, topology, state variables and dynamics)

2 SUMMARY OF TEST RESULTS

Test procedures defined for the ENTSO-E Interoperability test described 31 tests that cover all necessary functionalities to be applied in the ENTSO-E data exchanges. Due to the large number of tests and tools that were tested during the IOP not all predefined tests could be performed by all vendors and using all official test models. In addition, some of the tools that were tested do not support some of the data exchanges such as data for dynamic calculations.

The following tables summarize all tests performed during the IOP. The meaning of the indicators is the following:

- P – Pass
- PP – Partial Pass – some of test witnesses applied this score in case the tool was not able to perform all steps described in the test procedures
- PE – Pass with errors
- The number shown in brackets indicates how many times this test was performed (with how many different files)

The indicators listed in the tables below are the same as test scores granted by test witnesses. Not all errors observed are related to vendors' products. In some cases, exchanged test models contain quite a lot of non-ENTSO-E conformed information, which has been lost after a few data exchanges. This normally results in different validation results.

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Therefore it is recommended that individual test record forms for each Product/Tool are checked in order to understand these issues correctly.

Tool	Test number							
	1	2	3	4	5	6	7	8
ABB MMS CIMExplorer	P	P						
Network manager SCADA/EMS								
E-terrasource	PP	P		PP	PP			
Cimphony	P (2)	P	P	P (2)	P		P	
CRESO	P	PE	P				P	
PowerFactory 14.1	P (2)	P (2)	P (3)	P	P (2)	P	P (2)	P
CIMClipse	P (2)							
INTEGRAL 7	P (7)	P (2)						
Enterprise Gateway	P	P	P	P	P	P (3)	P	
ISPEN	P	P (2)		P	P			
NEPLAN 5.4.4	P	P	P	P	P	PE	P	P
SICRE 6.31								
PSS®ODMS (PSS®E)	P	P	P	P	P	P	P	
SISCO UIB PI-AF	P (9)			P				
SPIRA	P (4)	P (2)	P	P	P	P	P (2)	P (2)
Collaborative Information Manager	P							
EUROSTAG 4.6								

Tool	Test number							
	9	10	11	12	13	14	15	16
ABB MMS CIMExplorer	PE	PE					P (2)	P (2)
Network manager SCADA/EMS								
E-terrasource	PP	PP	PP	PP				
Cimphony	P		P	P	P			
CRESO								
PowerFactory 14.1	P	P					P	P
CIMClipse								
INTEGRAL 7	P	P (4)						
Enterprise Gateway	P	P	P		P		P (2)	P (2)
ISPEN	P							
NEPLAN 5.4.4	P	P	P	P	P	P	P	
SICRE 6.31							P	
PSS®ODMS (PSS®E)	P	P	P	P	P		P	P
SISCO UIB PI-AF	P	P		P			P	
SPIRA	PP							
Collaborative Information Manager	P							
EUROSTAG 4.6								

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Tool	Test number							
	17	18	19	20	21	22	23	24
ABB MMS CIMExplorer								
Network manager SCADA/EMS								
E-terrasource								
Cimphony								
CRESO								
PowerFactory 14.1	P							P
CIMClipse								
INTEGRAL 7								
Enterprise Gateway								
ISPEN								
NEPLAN 5.4.4	P							
SICRE 6.31	PE							
PSS®ODMS (PSS®E)	P							
SISCO UIB PI-AF								P
SPIRA								
Collaborative Information Manager								
EUROSTAG 4.6								

Tool	Test number							
	25	26	27	28	29	30	31	Unstr.
ABB MMS CIMExplorer			PE					
Network manager SCADA/EMS			P					
E-terrasource			P					
Cimphony			P				P	
CRESO								
PowerFactory 14.1	P	P			PE(2)		P	
CIMClipse								
INTEGRAL 7								
Enterprise Gateway			P			P	P	
ISPEN								
NEPLAN 5.4.4								
SICRE 6.31								
PSS®ODMS (PSS®E)			P	P			P	
SISCO UIB PI-AF				P			P (3)	P (3)
SPIRA								
Collaborative Information Manager								
EUROSTAG 4.6								P (2)

SISCO UIB PI-AF successfully performed an unstructured test. This unstructured test covers valuable use case that was not described in the test procedures. The test procedure for this unstructured test was the following:

- Import of boundary model authority set from the official test model
- Import of BE and NL model authority sets exported by different tools

Tractebel/RTE with Eurostag successfully performed an unstructured test which was based on test No 9.

Tests 18, 19, 20, 21, 22 and 23 were not performed by any of vendors due to the lack of test models.

All single test record forms that show complete information on files exchanged during the IOP and tool summary forms are available in Appendix C which is provided in separate files (5 parts) due to the file size. The IOP files are available in the CIM user group web site (www.cimug.org).

3 SUMMARY OF IDENTIFIED ISSUES

3.1 ISSUES ADDRESSED TO IEC

ENTSO-E IOP identified the following issues that need to be be further discussed within IEC WG13 and agreed among IEC members:

CIM Issues	ENTSO-E IOP Proposal
Sign convention for SvPowerFlow and SvInjection classes: The issue will require a change of the official UML.	To apply Industry Standard, positive for Load; negative for Generation
TransformerWinding.ratedS: The attribute is optional in ENTSO-E and CPSM profiles.	This attribute has to be required.
OperationalLimitSet.Equipment	This attribute should be optional. OperationalLimitSet.Terminal is used.
„Planning"; „Operational" profiles	Split CPSM profile group into „planning" and „operational" profiles
OperationalLimit.type	UML needs to be corrected. Remove OperationalLimit.type or OperationalLimit.OperationalLimitType
File header – profile attribute description attribute	URI should be used instead of description. The change should be applied in 552
SvTapStep.position	It should be deleted. continuousPosition should be used. The same applies to SvShuntCompensatorSections
Substation in Boundary MAS	Necessary discussion in WG13 to find a solution that will serve „operational" and

	„planning" profiles. Decision points: - Substation in or not in the boundary - Is the NodeContainer needed in the boundary? - Is a BaseVoltage needed for boundary nodes? If yes, what the solution is.
Additional parameters for short-circuit calculation	IEC CIM Standard should comply with IEC 60909-2001. IEC test model has to be used to demonstrate interoperability when exchanging short-circuit data.
Target voltage values – in equipment or in state variables files	Necessary to update 456 and better describe the case. Proposal: If there is no solution to start with the target values are taken from equipment file. If state variable file is available target values are taken from SvVoltage. The same method should be applied for Normal step in TapChanger and continuosPosition in SvTapChanger.
Ordering of Limit values	To describe the meaning of different types of limits and how they relate each other.

3.2 PROFILE ISSUES

A few profile related issues were identified during the IOP. These issues apply on ENTSO-E CIM Profile, IOP version issued on 12 July 2010 [5].

The issues listed in the table below have been resolved during the IOP. The decision was taken among all IOP participants.

Profile Issues	ENTSO-E IOP decision
OperationalLimitSet.Equipment	This attribute should be optional. OperationalLimitSet.Terminal is used.
CurrentLimit: It is an abstract class; in rdfs generated from CIMTool	It should be a concrete class
VoltageLimit: It is an abstract class; in rdfs generated from CIMTool	It should be a concrete class
Association ConnectivityNode to Terminal	It should be removed including all associations to classes which are not used.
SvTapStep.position	It should be deleted. continuousPosition should be used. The same applies to SvShuntCompensatorSections
The name of the GeographicalRegion is not a 2 letters ISO name (may be EU should be allowed by the profile)	Naming convention should be corrected to allow country ISO and EU
SynchronousMachine comments in the profile description	The following comments should be deleted: - - „SynchronousMachine.GeneratingUnit is required for this profile - need to change UML

	to reflect this.“ - „For the 2010 ENTSOE IOP, this is required for Synchronous Machine.“ – the comment is related to the SynchronousMachine.GeneratingUnit - „Attributes qPercent, r, r0, r2, x, x0, x2, ratedS and referencePriority are not required.“
ControlArea.type	It should be optional
RatioTapChanger.tculControlMode	It should be optional
ACLineSegment.BaseVoltage	ACLineSegment.BaseVoltage should be checked in the CIMTool if it is a native attribute. The goal is to have one BaseVoltage.
TopologicalNode and ENTSO-E Naming convention – missing association from TopologicalNode to VoltageLevel	A comment should be added“ ToplogicalNode.ConnectivityNodeContainer must be a VoltageLevel“
The class „XXXCIMversion“	It should be removed as file header provides the same information
UML documentation issues	- On TransformerWinding and SeriesCompensators : the comment in ConductingEquipment (For the 2010 ENTSOE IOP, the BaseVoltage association for SeriesCompensator and TransformerWinding is required). It could be repeated for TransformerWinding and SeriesCompensato or adapted. - On the svInjection: adding some comment explaining it is related to tie-lines - On svPowerFlow: the comment related to loads and generators of the last profile (ENTSO-E v1.0) was helpful

4 REFERENCES

The ENTSO-E CIM based data exchange format references the following normative IEC standards and other documents:

[1] IEC 61970-452: CIM Model Exchange.

[2] IEC 61970-456: Steady-State Solution Interface.

[3] IEC 61970-552: CIM Model Exchange Format. This document describes how model information is formatted for exchange.

[4] Reference Manual for Exchanging Standard Power System Dynamic Models: Based on the IEC 61970 Common Information Model (CIM). EPRI, Palo Alto, CA: 2009. 1020200.

[5] ENTSO-E CIM Profile, ENTSO-E CIM Model Exchange, 2nd edition, IOP version, 12 July 2010.

5 CONCLUSIONS AND RECOMMENDATIONS

The conclusions of the ENTSO-E Interoperability test “CIM for System development and Operations” 2010 can be summarized as follows:

- Various vendors that provide tools for “system operational” environment as well as for “system planning” environment attended ENTSO-E IOP and demonstrated CIM compatibility using the ENTSO-E CIM Profile (second edition - draft) which is based on the last IEC CIM Standards.

- The IOP successfully tested the most important features of the second edition of the ENTSO-E CIM Profile such as: file header, model authority sets, merging process, deference files, exchange of short circuit and dynamic data.

- The outcome of the test and the ENTSO-E profile developed in preparation stage are a solid basis for further ENTSO-E discussion in accordance with the ENTSO-E roadmap for future implementation of the updates to the ENTSO-E CIM profile.

- Important issues to be addressed to IEC/WG13 as well as profile related issues were identified and discussed. ENTSO-E IOP participants agreed on proposals to IEC/WG13 that are listed in this report.

- Complete interoperability between all tools could not be seen due to the large scope of the test and the large number of tools that have different level of development and different features that they support.

- ENTSO-E and ENTSO-E IOP participants expect that the following items will be treated with high priority and included in the updated version of IEC CIM Standards (items sorted by priority):

    - Separation of “operational” and “planning” profiles so that profiles groups are created in a way that ensures improved functionalities of the CIM and providing full support of relevant use cases, i.e. exchange between “operational” and “planning” systems.

    - Improvement of the definition and examples of file header and boundary model authority sets files in order to better support various data exchanges.

    - Implementation of improved models for transformer and regulation devices and ensuring full compatibility with all kinds of phase shift transformers.

    - Update of the CIM standard in to cover exchange of short-circuit data. IEC CIM Standard should comply with IEC 60909-2001. IEC test model has to be used to demonstrate interoperability when exchanging short-circuit data.

- o Update of the CIM standard in order to cover exchange of dynamics data. The process started with EPRI project "CIM for Dynamics" and the approach was tested again during ENTSO-E IOP. All deliverables should be implemented in the IEC standard and harmonised to have consistent CIM modelling.

- o Collection of use cases and covering exchanges between transmission and distribution systems is necessary in order to create an adequate data exchange profiles between transmission and distribution. These profiles should be linked as much as possible with existing profiles to avoid overlap of data exchanges.

The following recommendations to the future IOPs or CIM development in general were expressed:

- Continuous maintenance of the ENTSO-E profile is necessary in order to facilitate IOP preparation work.

- The profile to be used in the IOP should be fixed one month before the on-site test. In order to achieve this goal substantial commitment by vendors and IEC/WG13 is expected during the process of updating of IEC standards and revising the definitions in the draft versions of the profiles.

- IEC CIM standards should have stable development roadmap as much as possible. Features that have been already implemented and used in real data exchanges should be kept unchanged in case no significant problem is observed. Necessary major changes should be properly documented and presented to wider auditory in order to receive wide acceptance ahead of issuing of the updated IEC CIM standards.

- IEC, CIM user group and ENTSO-E should work in close cooperation to define CIM/XML test files that cover as much use cases as possible. It is preferable that these test files are referenced in the IEC CIM standards.

- Exchange of test models created by vendors is necessary in order to simulate exchanges of real data as much as possible. Each tool has its special functionalities that are often used by users during the real data exchanges to model different parts on the power system. The usage of different modelling approaches that are in most cases tool dependent creates difficulties when applying CIM in real data exchange in case the conversion process related to these specific functionalities have not been properly tested during an IOP.

6 APPENDIX A: INFORMATION ON TOOLS TESTED IN THE IOP

6.1 ABB MMS CIMEXPLORER

6.1.1 VENDOR PRESENTATION

ABB is one of the largest grid management and electricity market management system vendors in the world. ABB has been a supplier of technology to the deregulated energy industry from the earliest days when the first mandatory bilateral markets and energy pools in the world were created. Within the last decade, ABB systems have been deployed to support the largest and most sophisticated power markets in some of the world's largest economic regions.

http://www.abb.com/industries/db0003db004333/c12573e7003305cbc1257023003e93e4.aspx

6.1.2 TOOL DESCRIPTION

CIMExplorer is one of the integral components of ABB's Market Management System (MMS). It is used for importing and exporting the Network Model and Power Flow solution in the form of CIM/XML files that is based on ENSTO-E profile document.

The applications included in MMS CIMExplorer are:

CIM2ORA

To load an integrated CIM/XML file or individual files (i.e., Equipment, Topology and State Variable) to the CIM database. The capability is provided to merge the individual files into a single file before loading into the CIM database. The application contains three major components:

- Parsing CIM/XML File
- Preparing CIM/XML Schema Flat Files
- Loading to CIM Oracle database

ORA2CIM

To export the information stored in the CIM database to an integrated single file or individual files (i.e., Equipment, Topology and State Variable). Guided by the CIM profile which specifies the target CIM/XML, the ORA2CIM application queries the CIM Oracle Database and retrieves the required information. The retrieved information is then stored in an RDF-compliant in-memory data structure. The stored CIM information will be persisted as a CIM/XML file conforming to CIM/RDF specification.

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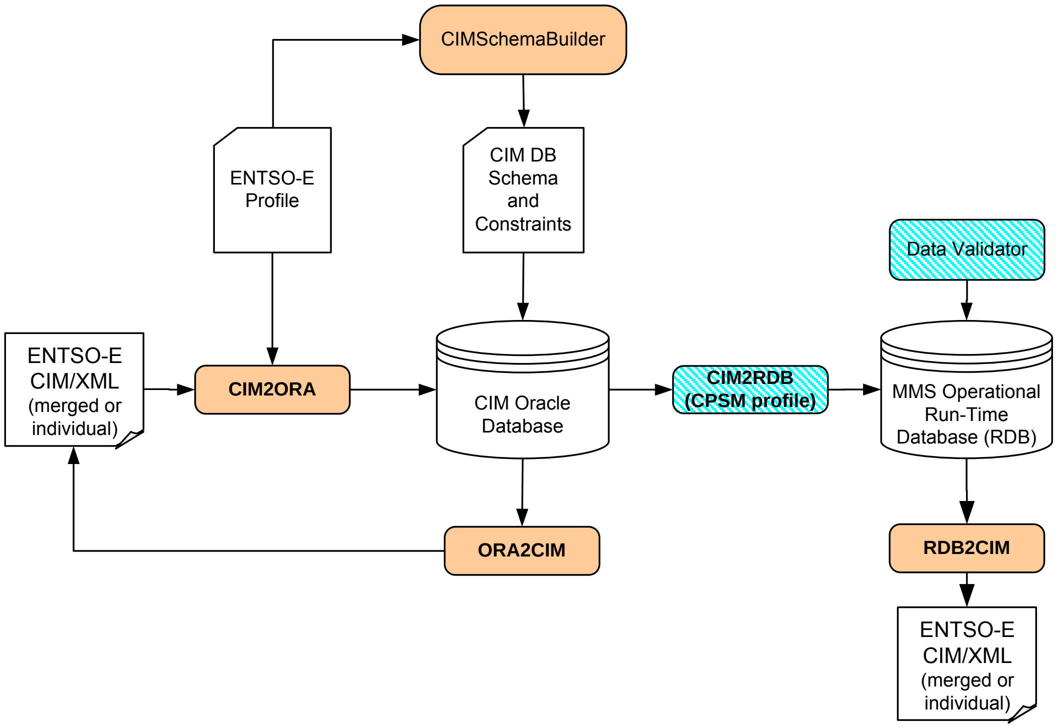
CIM2RDB

This application is available for CPSM profile only.

RDB2CIM

To export an operational model to a planning model based on the ENTSO-E profile. The exported model could be an integrated single file or in the form of individual files (i.e., Equipment, Topology and State Variable), all in the CIM/XML format.

The figure below provides an overview of CIM/XML Import and Export Processes.



OVERVIEW OF APPLICATIONS WITHIN MMS CIMEXPLORER

6.1.3 OTHER TOOLS LINKED TO THE ABB MMS CIMEXPLORER

No other tool is linked.

6.1.4 EXPECTED CIM FUNCTIONALITIES

ABB as a major vendor of Market Management Systems (MMS) develops tools based on CIM Standards for MMS interfaces with external systems. These interfaces provide transmission network models from EMS or Network Model Manager Systems. Other interfaces include those with Market Participants and Market Operators for various CIM Market Extension (CME) data.

6.2 ABB NETWORK MANAGER SCADA/EMS

6.2.1 VENDOR PRESENTATION

ABB is one of the largest grid management and electricity market management system vendors in the world. ABB has been a supplier of technology to the deregulated energy industry from the earliest days when the first mandatory bilateral markets and energy pools in the world were created. Within the last decade, ABB systems have been deployed to support the largest and most sophisticated power markets in some of the world's largest economic regions.

http://www.abb.com/industries/db0003db004333/c12573e7003305cbc125702600386176.aspx

6.2.2 TOOL DESCRIPTION

Secure and reliable grid operation

Network Manager SCADA/EMS/GMS is the right control center solution to manage your complex energy system processes and reduce your operating costs, while ensuring the required levels of cyber security. Network Manager SCADA/EMS/GMS is also an energy information system that provides reliable process information to all levels of decision makers in your organization.

Network Manager SCADA/EMS/GMS is an open and versatile system that conforms to all the relevant industry standards. It can be configured to meet the specific needs of each utility, allowing for simple integration with corporate information systems. It also provides a comprehensive set of tools for smooth system maintenance and expansion.

With ABB's solutions and support, our Utility Customers are able to increase profitability in both energy supply and business processes, improve network security and stability, minimize environmental impact and improve customer service.

Network Manager SCADA/EMS/GMS facilitates an efficient, secure and reliable grid operation, not only for managing today's power networks but also for tomorrow's Smart Grids, with rapidly expanding sources of renewable energy.

Real-time power system operation

The primary objectives in power system operation are security, quality, reliability and economy. To meet these objectives, Network Manager SCADA/EMS/GMS provides a comprehensive set of monitoring and control functions and an advanced set of power applications with state-of-the-art modeling techniques and solution algorithms. The ABB power applications have been deployed on numerous control centers around the world, some with over 12,000 buses and 1,000 generators.

The philosophy behind the Network Manager SCADA/EMS/GMS functionality is to provide both the tools and the incentives to increase efficiency and optimize the power system operation. To relieve the Operators from tedious and repetitive tasks, some functions like Load Shedding and Supervisory Control Sequences can be fully automated. This creates the time and incentives to use the advanced applications in the most effective manner.

Network Manager SCADA/EMS/GMS is designed to meet the high availability and performance requirements of real-time power system operations. Network Manager SCADA/EMS/GMS comprises a set of components that can be combined and implemented in a flexible way to meet the requirements of each individual utility. The system also includes real-time functions to assess the performance of the power system operation, for instance, transmission losses or the performance of Automatic Generation Control.

Network Manager creates a control center environment that encourages learning and continuous improvements in operational performance.

Transmission Management and Wide Area Monitoring

Managing the Transmission Grid involves planning, monitoring and controlling the available assets to achieve and maintain an optimal operating state. Network Manager SCADA/EMS provides a modern platform and advanced applications for the analysis and optimization of day-to-day transmission operations.

Network Manager SCADA/EMS also includes an integrated Wide Area Monitoring function (WAMS) that offers robust and scalable phasor data concentration and signal processing, a time series recording, and optional control of FACTS devices.

WAMS recordings for post fault analysis provide additional insights into the dynamic response of the power system. This provides new opportunities for benchmarking of transmission planning models, leading to improved planning and utilization of the transmission system. The major benefits of the Network Manager SCADA/EMS system for transmission operations include:

- Optimal utilization of the transmission network assets
- Enhanced network security and continuous monitoring of the system stability, with early warning of incipient operating conditions that could lead to widespread blackout
- Advanced visualization and situational awareness for operators, leading to enhanced grid operation
- Higher quality of supply

Generation Management

Managing Power Generation is all about optimizing the use of the available resources while meeting regulatory standards and contractual requirements. Network Manager SCADA/GMS performs real-time dispatch of the generation resources, including renewables, while minimizing production costs and keeping adequate levels of reserves. Optional modules are available for wholesale trading and minimization of financial risks in deregulated markets.

The major benefits of the Network Manager SCADA/GMS system for generation operations include:

- Optimal scheduling, dispatch and control of generation resources, subject to operational and environmental constraints
- Co-optimization of generation reserves
- Support for emission constraints
- Compliance with the latest reliability standards from NERC and UCTE (now ENTSO-E Regional Group Continental Europe)
- Accurate weather-adaptive load forecasting
- Support for multiple markets and control areas, in hierarchical configurations and across multiple time zones
- Interfaces with Market Operations

6.3 CIMCLIPSE OCL VALIDATOR

6.3.1 VENDOR PRESENTATION

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.

6.3.2 TOOL DESCRIPTION

CimClipse (http://wwwdi.supelec.fr/software/cimclipse) is an umbrella name for tools used within or based on Eclipse or its plugins, used for CIM related tasks and released as Open Source. Currently, it encompasses tools developed in the Computer Science Department of Supélec with funding from EDF R&D.

CimClipse OCL Validator is a tool that can validate CimXml files against rules written in OCL (Object Constraint Language). These rules can correspond to a profile or can be defined by a company to enforce some business rules.

6.3.3 OTHER TOOLS LINKED TO THE CIMCLIPSE OCL VALIDATOR

Other CIM tools are available on the CimClipse site that are either used inside CimClipse OCL Validator 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

6.3.4 Expected CIM functionalities

Currently, CimClipse does not process incremental files. It is expected to add this functionality.

Converters from or to CimXml files will be built using CIM models and model transformation tools.

6.4 CIMPHONY

6.4.1 Vendor presentation

Open Grid Systems

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.

6.4.2 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.

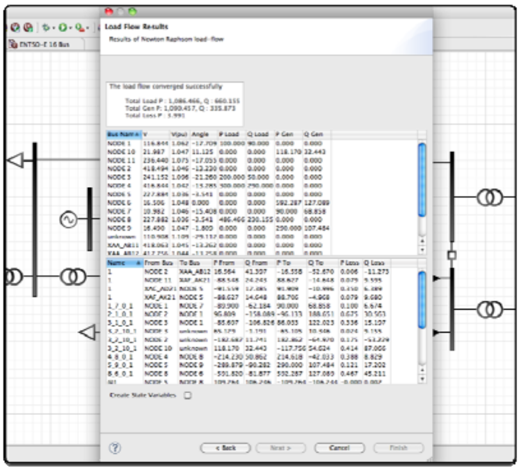
The core CIMPHONY modules provide model-independent services for:

- 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.

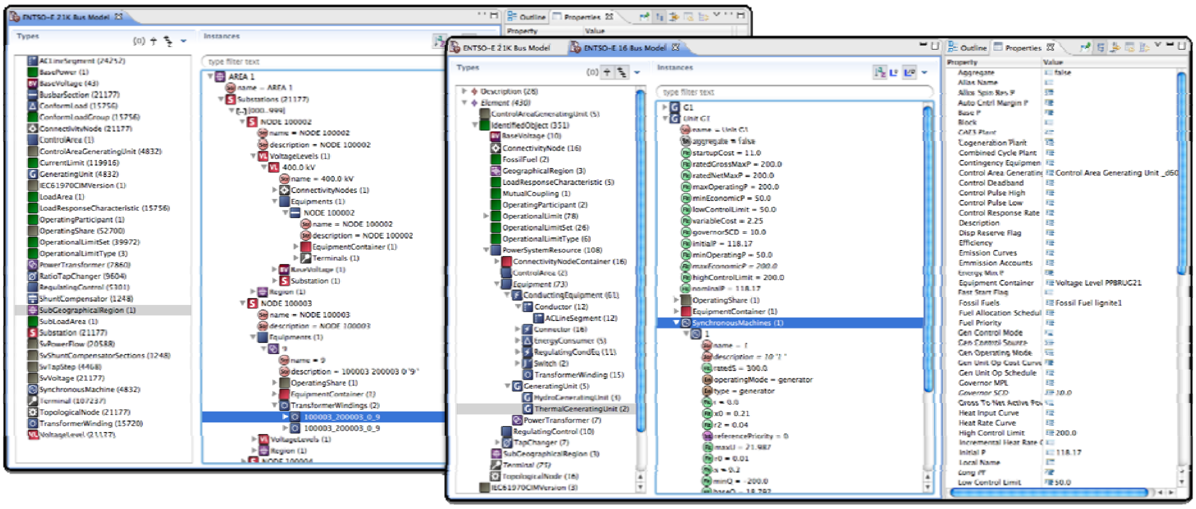
In addition to the model management service, CIMPHONY provides CIM and power-system specific functionality including the ability to execute load-flow simulations on balanced, three-phase models using the **Jacobi** load-flow engine, and supports the export of these results using the IEC 61970-456/ENTSO-E 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.



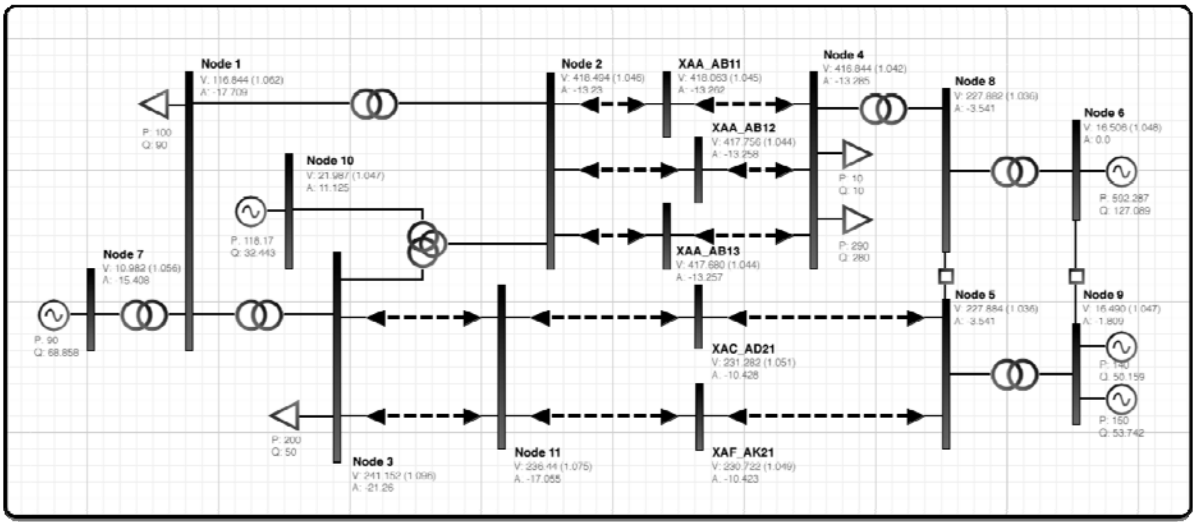
Load Flow Results

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

6.4.3 OTHER TOOLS LINKED TO CIMPHONY

The core CIMPHONY modules for RDF import/export, profile support, validation, transformation and difference model generation/merging can be utilised for building custom model-driven interfaces and applications and has been utilised to create stand-alone transformation and validation applications.

Jacobi is the load-flow engine used within CIMPHONY, part of a suite of services that can be integrated to provide:

- Newton-Raphson and Fast Decoupled load-flow engines
- Optimal Power Flow
- Contingency Analysis
- Steady State Estimator

These tools are being integrated with the graphical viewer to provide a rich UI for visualising simulation results.

An unbalanced distribution network simulator is currently under development, which will be integrated into CIMPHONY to support simulation of distribution models. This will enhance the existing model-management and geographical visualisation export support for the IEC 619768-13 Common Distribution Power System Model (CDPSM) profile.

6.4.4 EXPECTED CIM FUNCTIONALITIES

CIMPHONY currently supports the core functionality required for managing the exchange of CIM data including support for CIM v10-14 (plus v15 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

Open Grid Systems was one of six vendors that participated in the EPRI CPSM Interoperability test in Knoxville, Tennessee (June 2010) and 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.

6.5 CIMSPY EE/CIMDESK

6.5.1 VENDOR PRESENTATION

Power Info LLC (www.powerinfo.us) is an independent consulting firm specializing in providing the standard-based solutions to electric utilities in the power industry. Our area of expertise includes standard-based enterprise application integration, CIM-based model exchange and information management, and power grid visualization. As a small highly-motivated group, we strive to deliver the cutting-edge solutions to our clients and are committed to keeping at the leading edge of our areas of competence.

6.5.2 TOOL DESCRIPTION

CIMSpy Enterprise Edition (CIMSpy EE) is a CIM-based tool framework designed to address a wide range of common information engineering requirements in the power industry.

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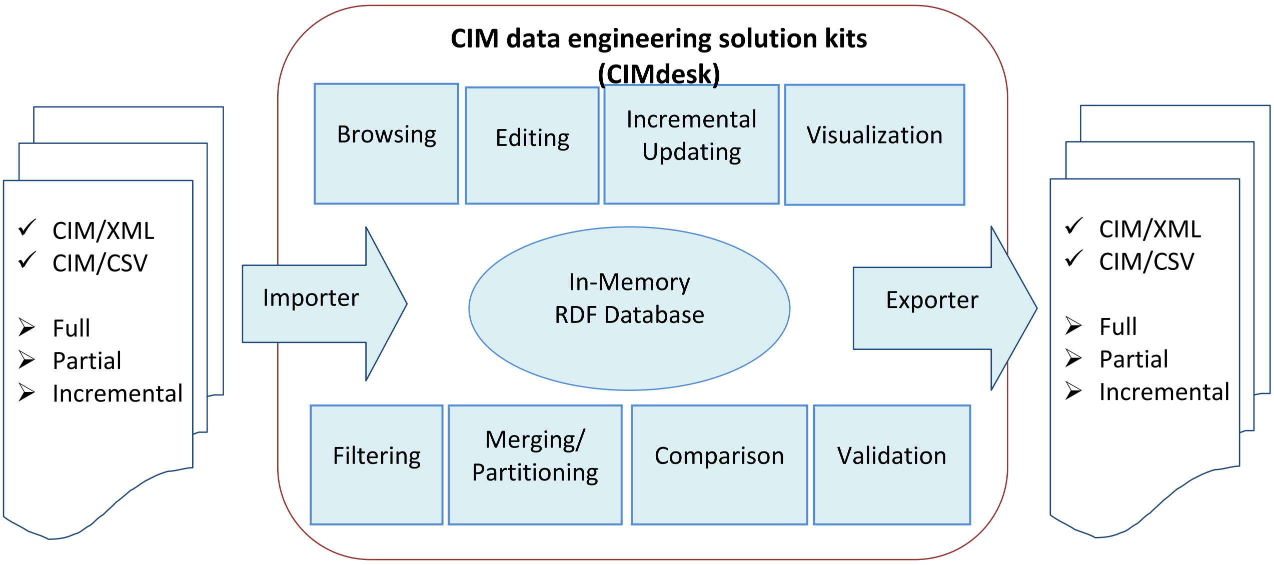
Architecturally, CIMSpy EE is a distributed Web-based enterprise application containing three tiers: a Web browser based user interface (UI), an application server, and a CIM-compliant data repository. Functionally it includes a set of infrastructure and application modules designed to significantly reduce the engineering effort required to exchange and manage information in a utility environment. Based on the open architecture and the infrastructure support of the CIMSpy EE framework, new solutions can be quickly built and deployed to address the changing business requirements in various CIM-based application areas, ranging from model exchange to power system modelling and grid visualization.

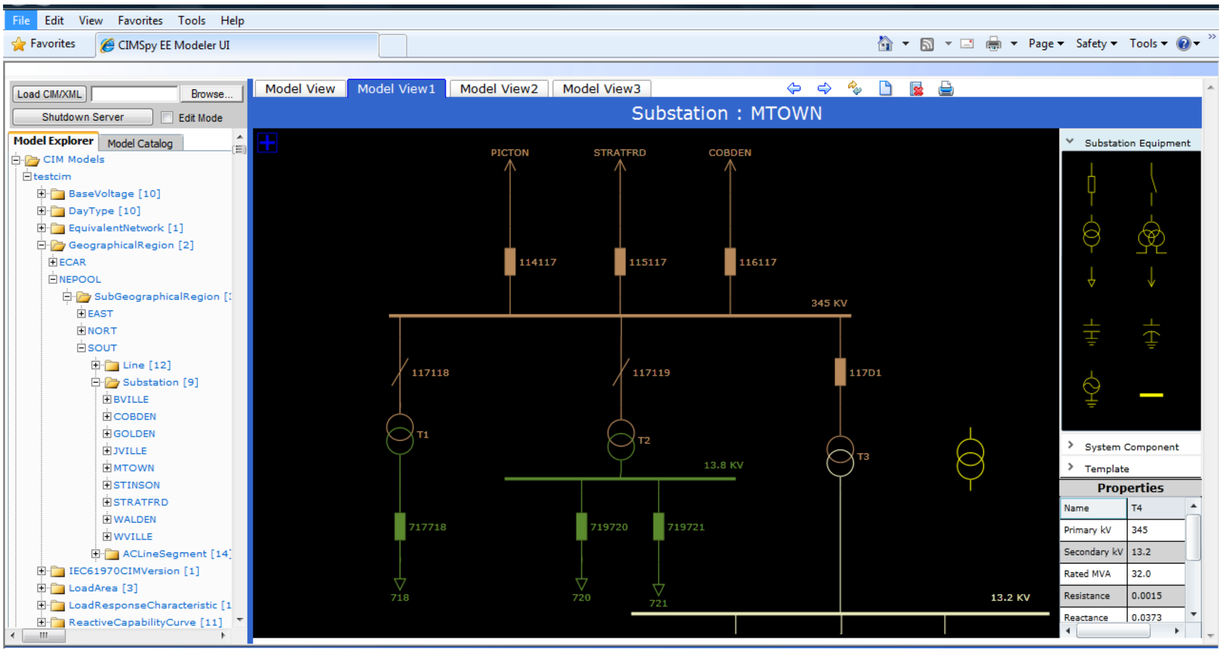
For example Power Info LLC has recently delivered the CIM data engineering solution kit (CIMdesk) to the European Network of Transmission System Operators for Electricity (ENTSO-E) and its Transmission System Operator (TSO) members. CIMdesk was built on the top of CIMSpy EE. It was customized to support the ENTSO-E/CICIM profile and model merging business processes specifically designed to support the model exchange among ENTSO-E and its TSO members.

More specifically, CIMdesk is designed to provide an integrated data engineering environment in support of CIM-based model exchange. Users can load reality-based exchanged CIM/XML files into the tool and perform various data engineering functionalities, including model browsing, visualization, validation, editing, merging, partitioning, and applying incremental update. The engineered models can be further exported into various formats such as XML or CSV, ready to be consumed by other CIM-compliant information infrastructures.



One of the key design goals of CIMSpy EE tool framework is supporting CIM-based single-entry modelling and centralized information management. Designed as a distributed enterprise application, CIMSpy EE provides an effective administrative environment and comprehensive facilities for managing the model evolution and tracking the status of each project. CIMSpy EE supports collaborative model building and maintenance, enabling users from different divisions or organizations to work collaboratively. It provides a role-sensitive model administration capability to support the collaborative modelling. Users are assigned a set of data access authorities specific to their tasks. By leveraging the CIMSpy EE collaborative modelling support, the grid coordinating organization simply defines the model boundary sets and then let its member utilities build and maintain the model within their service territories. This centralized single-entry modelling has fundamentally eliminated the necessity of the traditional model merging processes. In addition to the role-based modelling, CIMSpy EE also provides sophisticated but customizable work flow process to automate the model management. Users could draft the model changes, build a study case, run the validation, and finally submit the model changes. The model management facilities automatically enforce these business processes and trace the model evolution.

CIMSpy EE delivers rich user experience addressing a variety of common power system modelling requirements. Unlike many traditional modelling tools which mainly serve as data entry wizards or database editors, CIMSpy EE provides various mechanisms to visualize the underlying information model, enforce the modelling constraints, and facilitate model building and maintenance. At its core, CIMSpy EE provides a graphical editor for building and maintaining your power system models. The model visualization engine can auto-generate a graphic layout of system and substation one-line diagram based on the underlying network topology model. Users can adjust the auto-generated diagrams or create new portion of the models by dragging graphical symbols from the tool bar, dropping them to the diagram, and making the connection. All of these rich graphical modeling experiences are delivered through a thin Web-based user interface (UI).



6.5.3 OTHER TOOLS LINKED TO THE CIMSPY EE

In addition to CIMSpy EE/CIMdesk, Power Info LLC also provides a set of CIM-based data engineering components that can be embedded into other CIM compliant information infrastructure, including high-performance CIM/XML parsing, station diagram auto-generation, operational to planning model transformation, and model merging and equivalencing, etc.

6.5.4 EXPECTED CIM FUNCTIONALITIES

The following features and enhancements have been planned for the future versions of CIMSpy EE:

- Supporting CIM Schematic Layouts Standard (IEC 61970-453)
- Supporting IEC 61970-456 and interfacing with EMS/SCADA to enhance situational awareness in a grid control centre environment.
- Supporting visualization of bulk power system operating conditions over wide geographical regions

6.6 CIMTOOL

6.6.1 VENDOR PRESENTATION

CIMTool is developed by Langdale Consultants as an open source project with the support of a number of vendors and utilities in the CIM community.

Langdale Consultants is an independent consulting firm based in Sydney, Australia which provides support for CIM projects internationally. More generally, Langdale assists utilities to specify, select, deploy and integrate their information systems.

Langdale has been engaged in the CIM standards process for more than 10 years. See: http://www.langdale.com.au

6.6.2 Tool Description

CIMTool creates and edits profile definitions, which are subsets of the CIM that govern data exchanges. It also validates exchanged data against these profiles. See: http://cimtool.org

The ENTSO-E CIM profile was created with CIMTool, including the RDFS and OWL artefacts and the per-class documentation. CIMTool also provided a validation capability during the ENTSO-E interoperability tests.

CIMTool is designed to maintain a profile throughout its life. It can compare profile versions, reconcile profiles with CIM changes and find errors in a profile and offer corrections.

CIMTool can assist in the construction of CIM-based software. It generates implementation artefacts such as database schema definitions and programming language bindings. A template system makes it possible to customise these as required.

6.6.3 Other Tools Linked to CIMTool

CIMTool is built on the eclipse tools platform and forms part of the eclipse integrated development environment (see http://eclipse.org). It can be used in concert with the eclipse XML document and schema editors and the many other eclipse modelling and software development tools.

The CIMTool validation functions are available as a standalone command line tool called CIMCheck (see http://wiki.cimtool.org/CIMCheck.html). This allows validation to be automated via scripting.

The OWL artefacts produced by CIMTool, both profiles and the CIM as a whole, are OWL 2 compliant. They can be used in ontology editors including Top Braid and Protege (see http://www.topquadrant.com and http://protege.stanford.edu).

6.6.4 Expected CIM Functionalities

CIMTool is under ongoing development. Forthcoming features include:

- Datatype definition refinements using XML Schema facets such as an allowed range of values or a string pattern.
- More flexible profile definitions and the ability to share definitions between profiles.
- Multispeak-compatible XML schemas.

6.7 CRESO

6.7.1 CESI PRESENTATION

CESI (Centro Elettrotecnico Sperimentale Italiano), established in 1956 as a market leader in testing and certification of electromechanical equipment and electrical power systems studies, is today a global power consultant and provider of services and special equipment to the electric industry and public administration.

As a joint stock company, its main shareholders include in a balanced way the Italian ISO, the main Italian electric utilities (Terna, Enel, Edison, Edipower, E.ON, Tirreno Power, A2A, Sogin) and the main equipment manufacturers (ABB, Areva, Ansaldo, Prysmian). CESI employs 500 people (40% with university degrees) and operates in over 40 countries world-wide. Its range of activities covers the whole electricity sector - power generation, electricity transmission and distribution, end-use of electricity, environment and renewable energies, equipment testing and certification, standardisation – thus ensuring an integrated, comprehensive approach to the problems of the power sector. CESI includes also the ISMES division which works in the fields of environmental risk, design support and structural assessment on buildings and structures, with tests and studies on mechanical and industrial components.

CESI has been operating world-wide with a marketing network in about 40 countries offering services to:

- Electrical Utilities (production, transmission and distribution)
- Independent System Operators (ISO)
- Regulation Authorities
- Electromechanical and Electronic Manufacturers
- Industrial Users
- Public Administrations
- International Financial Institutions.

CESI activities cover, apart from erection, the whole cycle of a project i.e: feasibility, design, commissioning, operation and disposal. The offer concerns:

- techno-economic studies on networks, systems, plants and components
- consulting and specialised diagnostic and maintenance interventions
- plant and component life assessment / life extension studies

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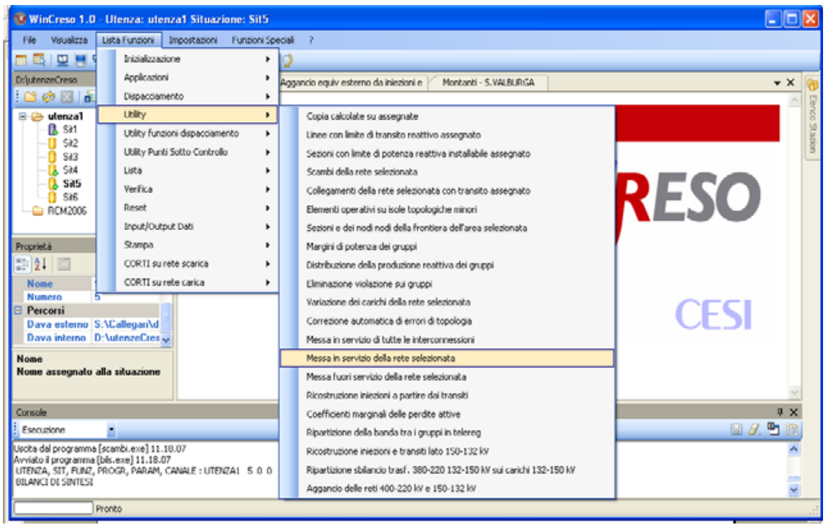
- management and training procedures and tools
- qualification tests, component, system and plant certification
- supply of testing laboratories, special components
- environmental studies and services: monitoring and assessments, design and realisations, structure engineering, technology developments.

6.7.2 TOOL DESCRIPTION

CRESO (Network Calculation for Security Operation and Optimization) is a Windows-platform integrated software system that permits the simulation and the analysis of a power network under steady-state conditions, as well as the optimization of the active and reactive power generation. Advanced functions for network studies are also available, such as, for instance, the calculation of the distance from the voltage failure point.

The following are the system main characteristics:

- user-friendly MMI (Man-Machine Interface), promptly understandable and making the operator-system interaction extremely easy;



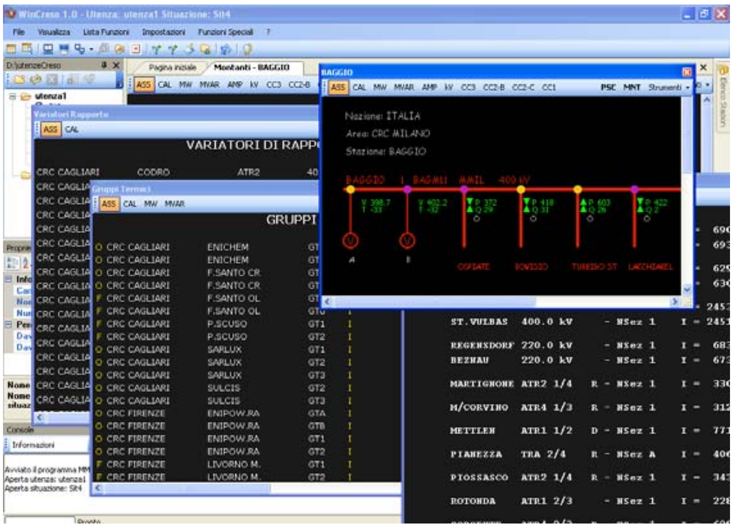
- extreme modularity of the software architecture, permitting the easy addition of new properties without abandoning a complete integration;
- a complete set of algorithms comprehensive of all the functions necessary for the simulation and the analysis of a power network under steady-state conditions, the security assessment, the optimization of the active and reactive power generation, the short circuit calculation and the harmonic distortion evaluation;
- absolute universality and completeness of the model system and of the algorithmic solutions adopted to implement the different functions; this permits the use of CRESO for the study of any type of network.

Even though it is a typical tool for off-line analysis within operation planning and post-mortem analysis, CRESO can be easily integrated with the Italian on-line control system, this aspect being underlined even more by the fact that CRESO provides also the Estimate of the state, which is a classical function of on-line control systems.

Another remarkable characteristic is the construction of all the data and processing results displays, starting from network data only, such construction being entirely automatic and transparent for the User.

The following are the main functions available with CRESO:

- Acquisition of analogue and topologic quantities; the latter can be provided either as switchgear position or under the more summarized form of electric node
- Estimate of the state and validation of remote signals and acquired remote measurements
- Load flow calculation (considering or not considering the Active/Reactive decoupling)
- Static Security analysis that establishes the steady-state conditions of the network, considering the speed primary regulation of units only, or else the frequency-power regulation. The two versions that consider or do not consider the active/reactive decoupling are available for this function as well
- Security Analysis of the entire network (N-1, with the tripping of transmission lines and power generators), underlining the contingencies that give rise to current and/or voltage violations, also taking into account the system automatic actions, such as primary and secondary power regulation or load-shedding actions



- Optimal dispatching of active power generation (OPF), based on an economic or safety objective function, considering the following constraints:
  - o the current passage limits on all the connections;
  - o N-1 security limits on a selected set of connections;
  - o the limits for the exchange of active power between countries and between different areas within the same country

- Optimal dispatching of the reactive power generation (ORPF), so as to minimize network active losses and to minimize the voltage distortion from and assigned profile, considering also the following:
    - the voltage limits for all the nodes;
    - the reactive power generation limits of the generators
- Security Analysis of Voltage Profiles and calculation of the distance from the failure point, with the indication of the maximum loadability of the system
- Calculation of active and reactive power balances at country level and/or regional level within the same network
- Short circuit calculations, such as calculation of single-phase or multi-phases short circuits, in every bus or along intermediate point of the transmission lines, evaluation of voltage drop, check of the protection system. Furthermore, there are also functions for the evaluation of the harmonic and flicker distortion.
- Numerous functions are available as a support for data validation, for network configuration analysis and for the display and interpretation of results.

6.7.3 THE POWER SYSTEM MODEL

The network model managed by CRESO is made up of the following components:

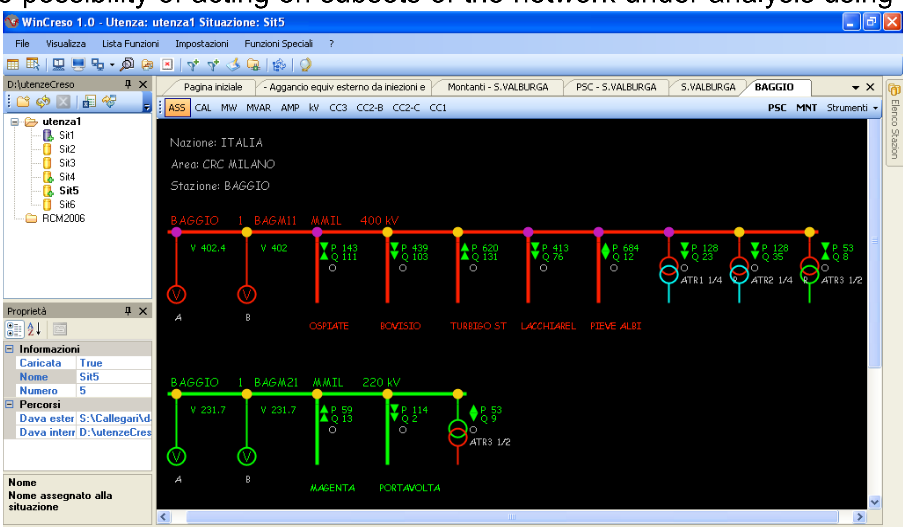
- countries;
- stations;
- sections;
- AC lines (for interconnection and loading);
- DC lines (for interconnection only);
- 2-winding transformers (for interconnection and loading);
- 3-winding transformers (for interconnection only);
- tap changers (ratio changers, phase transformers, diagonal and mixed changers);
- thermal units and plants;
- hydroelectric units and plants;
- wind farms;
- synchronous compensators;

- capacitors;
- reactors;
- Thyristor Controlled Series Capacitors (TCSCs);
- Static VAR Compensators (SVCs);
- AC/DC converters.

The main regulations are the following:

- the primary voltage regulation of thermal and hydroelectric units and of synchronous compensators, within their reactive producible condition limit (capability);
- the secondary voltage regulation (area regulation) with thermal and hydroelectric units and possibly with synchronous compensators, interlocked with the same regulator and aligned at the same level of reactive power generation, within their reactive producible condition limits (capability);
- the speed regulation of thermal and hydroelectric units;
- the f/P regulation;
- the regulation of converters;
- the regulation of the secondary voltage of transformers equipped with ratio changer;
- the regulation of the active power flow for the phase shifting transformers and for TCSCs;
- the voltage regulation of SVCs;
- the voltage and frequency dependency of the loads.

It is worth underlining the possibility of acting on subsets of the network under analysis using the network selection functions made available by CRESO.



The selection takes place at section level on three aggregations of items:

- geographical area;

- managerial responsibility;
- voltage level.

This permits, for instance, the carrying-out of a static security analysis in a selected country to assess whether or not it is in a position to autonomously remedy the active power deficit provoked by the loss of a generator set, avoiding the recourse to adjoining countries.

6.7.4 NAVIGATION WITHIN CRESO

The use of CRESO takes place through the navigation across the displays that represent the interface with the user and that can be divided into two large groups:

- layout displays;
- table displays.

The first type of displays provides the information by means of a graphical display characterized by a high degree of communicability; the displays that illustrate a section layout, for instance, belong to this type: they represent a section layout with its bus bar trunks, its connections to the feeders and the position of the switchgear, as well as the power and current values that flow through the different feeders and the voltage values of each trunk.

The second type of displays, instead, provides the information under the form of tables: such displays are characterized by a high density of information and are fundamental for an appropriate use of instruments.

The passage from one display to another takes place by means of sensitive hyper-links that allow a simple and immediate passage from one display to another.

The information level of individual displays is strengthened also by the use of the overlay technique, that permits the use of the same physical field to display different types of information (such as, for instance, to display first the active power flowing through a given feeder and then the reactive power).

6.7.5 OTHER TOOLS LINKED TO CRESO

CRESO, with the support of SICRE, is also the tool used to set up the scenarios for the simulations performed by the Dispatcher Training Simulator (DTS) and by the Dynamic Security Assessment (DSA). The links between these tools and CRESO is via internal proprietary format;

- DTS is used for training Control Room Operators as a replica of Control Room System with teaching sessions representing different real situations, from normal condition (e.g. morning load ramp) to extreme critical situation (e.g. blackout).
- DSA is an on-line security preventive assessment; taking the most recent steady state power flow calculation DSA performs the screening of several network contingencies.

6.7.6 EXPECTED CIM FUNCTIONALITIES

At the beginning of 2010 CESI starts to update CRESO in order to cover ENTSO-E needs and rules regarding the reliability of load-flow results. Up to now the software is under development in order to be compliant with the models used during the IOP tests.

In the future CRESO (used also in the Operation departments) would include also the operational profile of CIM.

6.8 DIGSILENT POWERFACTORY

6.8.1 VENDOR PRESENTATION

DIgSILENT GmbH
Company Profile

DIgSILENT GmbH is a consulting and software company providing engineering services in the field of electrical power systems for transmission, distribution, generation and industrial plants.

DIgSILENT GmbH was founded in 1985 and is a fully independent, privately owned company located in Gomaringen/Tübingen, Germany, where the new offices have been in operation since early 2002. DIgSILENT continued expansion by establishing offices in Australia, South Africa, Italy, Chile and Spain, thereby facilitating improved service following the world-wide increased use of its products and services. DIgSILENT has established a strong partner network in many countries such as Mexico, Malaysia, UK, Switzerland, Colombia, Brazil, Peru, Argentina, Iran, Venezuela and China. DIgSILENT services and software installations have been conducted in more than 110 countries.

DIgSILENT PowerFactory
DIgSILENT develops the leading integrated power system analysis software PowerFactory, which covers the full range of functionality from standard features to highly sophisticated and advanced applications including wind power, dispersed generation, real-time simulation and performance monitoring for system testing and supervision. For wind power applications, Power Factory has become the power industry's de-facto standard tool, due to PowerFactory models and algorithms providing unmet accuracy and performance.

DIgSILENT StationWare is a reliable central protection settings database and management system for the complete power system substation data based on latest .NET technology. StationWare stores and records all settings in a central database, allows modelling of relevant workflow sequences, provides quick access to relay manuals, interfaces with manufacturer specific relay settings software and integrates with PowerFactory software, allowing powerful and easy-to-use settings co-ordination studies.

DIgSILENT Consulting
DIgSILENT GmbH is staffed with experts of various disciplines relevant for performing consulting services, research activities, user training, educational programs and software developments. Highly specialized expertise is available in many fields of electrical engineering applicable to liberalized power markets and to the latest developments in power generation technologies such as wind power and dispersed generation. DIgSILENT has provided expert consulting services to several prominent wind-grid integration studies.

PowerFactory Monitor is a flexible performance recording and monitoring system that copes easily and efficiently with the special requirements for system test implementation, system performance supervision and the determination and supervision of connection characteristics. Numerous Monitoring Systems installed at various grid locations can be integrated to a Wide-Area-Measurement-System (WAMS). The PowerFactory Monitor fully integrates with the PowerFactory.

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6.8.2 TOOL DESCRIPTION

DIgSILENT
Power System Analysis Software

DIgSILENT has set standards and trends in power system modelling, analysis and simulation for more than 20 years. The proven advantages of PowerFactory software are its overall functional integration, its applicability to the modelling of generation, transmission-, distribution- and industrial networks and its comprehensive user interface. PowerFactory is the ideal tool for studying the grid integration of new generation-technologies.

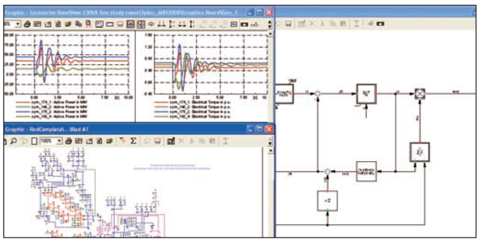
PowerFactory Applications

POWER TRANSMISSION

PowerFactory offers a complete suite of functions for studying large interconnected power systems integrating new technologies for power generation and transmission such as wind generation, virtual power plants, HVDC-VSC or FACTS. The fast and robust load flow algorithm can be applied to any AC or DC network topology. It uses highly accurate models including various types of MW and Mvar-controllers. PowerFactory's functions can be applied to improve the security, stability and economics of complex power transmission systems.

Typically required functions include:

- Load flow/Contingency analysis/OPF
- Nodal price and marginal cost indices
- Short circuit analysis (IEC 60909, ANSI C37, multiple fault analysis)
- Reliability assessment
- Integrated stability and transient (EMT) simulation
- Small signal stability analysis, also for very large networks
- Transmission system protection coordination and simulation
- Interfaces to SCADA/Energy Management Systems



POWER DISTRIBUTION

Different phasing technologies, such as single-wire earth return, two-phase, bi-phase or classical three-phase systems, have created a need for multi-phase distribution system modelling. PowerFactory provides the most comprehensive modelling features for studying all kinds of phasing technologies, meshed or radial topologies and railway supply systems connected to public distribution systems. In order to reduce network unbalance, improve quality of supply and optimize distribution networks, PowerFactory offers a large variety of functions, such as multi-phase load flow analysis, short circuit analysis (IEC 60909, ANSI C37 and multiple fault analysis), harmonic analysis, time-domain simulation and reliability assessment. Other standard features include the modelling of distributed generation and virtual power plants, voltage drop analysis, branch loading calculation, daily load curves and the consideration of LV load diversity. This is complemented by an easy-to-use protection coordination wizard.

Other important aspects are:

- Open tie optimisation
- Optimal capacitor placement
- Cable reinforcement strategies
- Quality of Supply Analysis
  - Geographic Information Systems (GIS)
  - Network Control Systems (SCADA)

INDUSTRIAL SYSTEMS

Industrial power systems supplying refineries, paper-mills, car factories or other plants with high power quality requirements benefit from high precision PowerFactory load flow algorithms, short circuit calculation features, 4-wire modelling, harmonics-analysis and filter design options.

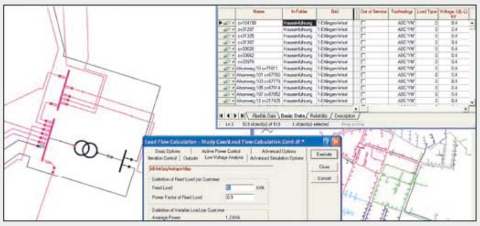
Other relevant functions include:

- Motor starting, voltage sag analysis and plant re-acceleration
- Protection coordination and settings verification
- Stability analysis and electromagnetic transients

DISTRIBUTED GENERATION

Generation at distribution levels defines entirely new challenges for distribution planning engineers due to reverse power flows, voltage drops and extreme variations in equipment loading. Various generation technologies are possible, such as synchronous and asynchronous cogeneration units, PV-cells, wind turbines, fuel cells and micro-turbines. Typical studies include steady-state and dynamic analyses, taking into consideration time-varying correlated or un-correlated energy sources.

PowerFactory is the ideal tool for analyzing the impact of distributed generation on the network. It combines classical distribution system analysis functions such as voltage drop calculation, unbalanced network, load and generation modelling, selectivity analysis, etc. with the power of a highly modern analysis tool featuring dynamic simulation functions and reliability analysis. Full support is available for developing and analysing the impact of virtual power plants and new control techniques on distribution networks.



WIND GENERATION

Complex studies for the integration of wind generation into distribution and transmission networks are becoming increasingly important. PowerFactory, the de-facto standard in wind generation modelling, combines extensive modelling capabilities with advanced solution algorithms, providing the analyst with tools to undertake the full range of studies required for grid connection and grid impact analysis. The modelling capabilities of PowerFactory allow the inclusion of complex control dynamics, new generator technologies, blade control and wind turbulence.

Detailed wind turbine models
- Doubly-fed induction generator models (DFIG)
- Converter driven synchronous machine models (CDSG)
- Squirrel-cage induction generator models
- Manufacturer-specific high precision model with built-in control code

Power electronic devices and grid harmonic analysis

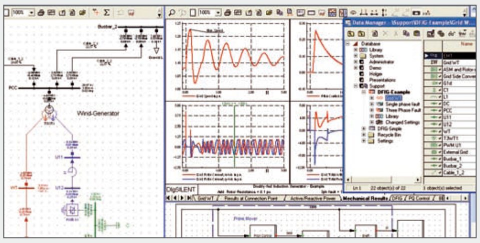
Generator protection and Crow Bar modelling

Blade control

Wind turbulence and gust models

Stability and EMT analysis

Integrated modelling of large wind parks



DIgSILENT

PowerFactory Features

Basic Functionality

Data Organization and Access
- Single-user[1] and Multi-user[2] database
- User accounting and user roles
- Parameter characteristics on any parameter
- User-friendly Data Manager
- Non-redundant data modelling
- Data versioning and data sharing
- Management of multi-user data editing
- Time stamped model variations
- Highly flexible Study Case management and Operation Scenario administration

Interfaces
- Standard data formats, e.g. UCTE
- Flexible DGS interface (ASCII,CSV,ODBC)
- OPC and RPC Client- / Server support

Scripting
- DPL-DIgSILENT Programming Language
- C++ Interface for DPL scripts
- Parameter variation studies

Network Diagrams
- Schematic and semi-geographical diagrams
- Overview single line diagrams
- Classical single line diagrams
- Design diagrams/Switch diagrams
- Integration of overview and substation diagrams

Results and Reporting
- Text and spreadsheet reports
- Reporting in network diagrams
- Around 30 diagrams for result visualisation
- Specific diagrams for protection, harmonics, stability and transients

Models
- Support of any kind of meshed / radial 1-, 2-, 3- and 4 wire AC and DC networks
- Synchronous and induction machines
- Network branches (cables, OHLs, transformers, etc.)
- Line routes and sections
- Shunt and filter elements
- FACTS and HVDC systems
- AC/DC voltage and current sources
- Virtual power plants
- Doubly-fed induction machine
- Wind generators, PV, fuel cell, micro- turbines
- VSC, thryristor converters
- Diodes, thyristors and transistors

Power Flow
- AC and DC load flow algorithms
- SVC, shunt and tap controllers
- Generator capability curves
- Station- and network control features
- Secondary and primary control
- Inertial response
- Accurate induction machine models
- Voltage dependent load models
- Sensitivity analysis

Contingency Analysis
- AC or DC load flow analysis
- Fast contingency screening
- Modelling of multiple time phases
- Fault case management
- Event-based post-fault actions
- Tracing of individual contingency cases

Fault Analysis
- IEC 60909, ANSI C37 and VDE 0102/0103
- Complete superposition method
- Multiple fault analysis

Integrated Functions
- Network reduction
- Voltage stability (PV curves, dV/dQ)
- OHL parameter calculation
- Cable loading (IEC 364)
- Cable parameter calculation
- Asynchronous machine identification
- Comprehensive DPL script library

Optimal Power Flow (OPF)
- AC optimization (interior point method)
- DC optimization (linear programming)
  - Contingency constraints (DC only)
- Various objective functions such as:
  - Minimization of losses
  - Fuel costs
- Various controls such as:
  - Generator P and Q
  - Transformer and shunt taps
- Flexible constraints such as:
  - Branch flows and voltage limits
  - Generator active / reactive power limits
  - Active/reactive power reserve
  - Boundary flows

Time Domain Simulation and Small Signal Analysis

Dynamic Modelling
- Graphical Editor for block diagram definition
- Library of IEEE standard models
- DSL - DIgSILENT Simulation Language
- High precision built-in macros & functions
- Multi-level dynamic modelling environment
- MatLab/Simulink and C++ Interfaces
- OPC interface for real-time applications

Stability Functions
- Multi-phase AC networks
- DC-networks
- Fast, adaptive step-size algorithm
- A-stable numerical integration algorithms
- High precision event handling
- Simulation of any kind of fault or event
- Support of all protection library relays
- Small signal analysis
- Selective Eigenvalue analysis

Electromagnetic Transients (EMT)
- Fast, adaptive step-size algorithm
- Constant and frequency-dependent distributed parameter cable/OHL models
- Non-linear elements and saturation characteristics
- Surge arrestor models
- Stochastic switching analysis
- Impulse voltage & current source for lightning surge analysis
- Discrete R-L-C elements
- FFT and user-defined models via DSL
- Ferro resonance, SSR and TRV
- COMTRADE-file support
- Combined RMS/EMT simulation

Protection Functions
- Comprehensive relay library with detailed static and dynamic relay models
- Transient / steady state response checks
- Synchronization with StationWare

Overcurrent-time protection
- Fuses and low-voltage circuit breakers
- Cable and transformer damage curves
- Coordination Wizard for settings calculation
- CT verification according to IEC 60044

Distance protection
- Comprehensive relay library
- Electromechanical, static & digital relays
- Any relay characteristic (MHO, polygonal)
- R-X diagrams
- Automatic time-distance diagrams

Harmonic Analysis
- Harmonic load flow
- Harmonic voltage and current indices
- Continuous frequency sweep
- Multi-phase or positive sequence model
- Harmonic current and voltage sources
- Unbalanced harmonic sources
- Non-characteristic harmonics
- Inter-harmonics
- Frequency-dependent R and X values
- Various filter models & filter sizing
- Ripple control analysis

Reliability
- Fast and accurate state enumeration
- Failure models:
  - Line, transformer, generator, busbar and circuit breaker failures
  - Common mode failures
  - Double earth faults
  - Protection/circuit breaker failures
- Maintenance schedules
- Network Analysis:
  - Connectivity analysis
  - Power flow analysis
- Failure effect analysis (FEA):
  - Automatic protection-based fault clearing
  - System restoration
  - Sectionalizing
  - Overload alleviation
  - Undervoltage load-shedding
- Tracing of individual cases
- Calculation of all common indices
- Components' contributions to reliability indices

Distribution Network Optimization
- Optimal capacitor placement
- Open tie optimization
- Cable reinforcement optimization

Low Voltage Network Analysis
- Line loads and load unbalances
- Consideration of simultaneity factors
- Voltage drop and cable loading analysis
- Feeder plots and feeder scaling

State Estimation
- P, Q, I and V-measurements
- Observability and bad data checking
- Pseudo measurements
- Consideration of load flow constraints
- Support of OPC

[1] Workstation Edition with local hardlock

[2] Server Edition incl. license server and driver for ORACLE and MS-SQL

6.8.3 OTHER TOOLS LINKED TO THE POWERFACTORY SOFTWARE

PowerFactory does not require any additional software such as an external database for handling CIM data import and export tasks. Typically required tools for handling of various grids, grid scenarios, timed grid expansion stages, data revisions and operational scenarios are integrated to the PowerFactory software data management system incl. 3-way compare and merge tools. In addition, working team is directly supported via multi-user database operation as well.

6.8.4 EXPECTED CIM FUNCTIONALITIES

DIgSILENT is supporting the development of internationally unified data definition and data exchange mechanisms and is therefore committed to integrate and continuously update a number of CIM standards.

DIgSILENT GmbH has contributed in the past to the CIM standard development and participated successfully in various CIM related IOPs.

The DIgSILENT PowerFactory software is currently supporting the following CIM profiles:

- UCTE profile published in May 2009
- Distribution profile: IEC 61968-13

Future versions of PowerFactory will provide data transfer based on:

- ENTSO-E profile 2010
- CIM for Dynamic Models

Further, ENTSO-E planning processes as well as operation processes such as DACF, D-2CF are already fully supported by PowerFactory.

DIgSILENT will continue contributing to the development of CIM related standards and future profiles.

6.9 ENTERPRISE GATEWAY

6.9.1 VENDOR PRESENTATION

GE is a diversified infrastructure, finance and media company taking on the world's toughest challenges. From aircraft engines and power generation to financial services, medical imaging, and television programming, GE operates in more than 100 countries and employs about 300,000 people worldwide.

GE has a strong set of global businesses in infrastructure, finance and media aligned to meet today's needs, including the demand for global infrastructure; growing and changing demographics that need access to healthcare, finance, and information and entertainment; and environmental technologies.

GE Energy's XA/21 is a field proven, scalable and feature-rich Supervisory Control and Data Acquisition (SCADA) / Energy Management System (EMS) solution that is specifically designed to meet the needs of today's electric utilities.

Since its debut as the first open Energy Management System (EMS) offering in early 1990, XA/21 has continued to revolutionize the industry. With an established track record of field performance—over five million hours of online operation— premier utilities the world over have entrusted XA/21 with the management of their critical transmission & generation assets. GE Energy's worldwide team of professionals and XA/21's modular software and open system architecture combine to enhance service performance and overall reliability, while facilitating continued compliance with ever-changing industry requirements.

For more detail, please visit http://www.ge.com

6.9.2 Tool Description

Enterprise Gateway (EG) is GE Energy's tool for CIM exchange in EMS area and supports Full Export and Import, Incremental Import and Export, Partial Import and Export, ICCP data exchange, model exchange (import and export), Equivalent Network Export and Import, Model Authority Set Import, Update and Export, Multiple profile processing. It was totally redesigned and upgraded to a powerful version 3.x. Here are some benefits of EG.

Performance: EG can finish full import or export for most moderate power system networks (around 1000 buses) in less than 1 minute.

Compliance: Passed the strict Interoperability Tests for both model exchange and power flow solution. EG supports CPSM 3.0 up to latest CIM/CPSM standards, as well as Planning profiles for ENTSO-E.

Self-Adaptive: EG is model-driven and adaptive to change in the CIM RDF or OWL Schema and XA/21 network model schemas. This minimizes maintenance/upgrade efforts.

Partner Organizer: EG organizes the partners (e.g. surrounding utilities who exchange CIM/XML model with the user) automatically and keep track of their transactions for model retrievals.

Multi-user: EG supports multiple users, who can work on model exchange in parallel.

Model Comparison/Merge: EG can compare different version of CIM or XA models and show the changes side-by-side to easy viewing. It also supports merging CIM or XA models.

EGTree: EG carries an EGTree tool to view and modify the CIM/XML model directly in a tree view format. Cascading delete is also supported. Another benefit of EGTree is to conveniently define the boundary for Partial model exchange. The tree hierarchy is user-configurable and compatible with all CPSM versions when the respective RDF schema is provided.

One-line auto-generation: An EG supporting tool can be used to generate the one-line diagram from the import of the CIM model with the option to show parameters of the power system devices.

6.9.3 OTHER TOOLS LINKED TO THE ENTERPRISE GATEWAY

XA/21 Transmission Security Management (TSM) is a network analysis application for electric utilities that monitors and controls their high voltage transmission networks. The application provides a powerful set of tools to perform network analysis, contingency analysis, network optimization (SCD, Voltage/VAR Scheduling, Remedial Action, Preventative Action), and fault-level analysis with transmission security management. Control center operators can quickly identify and analyze potential operating problems and formulate preventative strategies.

This network analysis package includes a comprehensive suite of applications:

Network Analysis - Provides system operators with a detailed representation of the overall power system.

State Estimator - Determines the operating state of the network model based on available real-time telemetry. Estimated values are provided for all input measurement types, bus phase angles, branch series, and shunt impedances.

Penalty Factor Calculator - Computes transmission loss penalty factors for all generating units in the power system model. Penalty factors are then used to adaptively update the appropriate segment of a matrix of penalty factor sets, know as the penalty factor grid.

Contingency Analysis - Assesses power system operating conditions from the simulation pre-defined lists of contingency cases.

Security Constrained Dispatch - Derives a recommended schedule of active power controls to optimize a user-specified objective, while simultaneously satisfying system-operating constraints.

Voltage/VAR Scheduling - Derives a recommended schedule of reactive power controls to optimize a user-specified objective, while simultaneously satisfying system operating constraints.

Remedial Action - Determines independent optimized corrective rescheduling plans for harmful contingency cases.

Preventative Action - Determines optimized preventative scheduling plans for a list of contingency cases.

Short Circuit Calculation - Calculates three-phase, phase-ground, phase-phase and phase-phase-ground fault currents.

Equipment Outage Scheduler - Provides the dispatcher with the capability to prepare and maintain outage plans for any generator, load, shunt, SVC, line, transformer, DC Lines, series reactive device, static VAR controller, or switching device in the transmission network.

Fault Level Analysis - Provides real-time and study capability tools to simulate three-phase, phase-ground, phase-phase and phase-phase-ground fault currents.

For other related XA/21 software, please check website
http://www.gepower.com/prod_serv/products/scada_software/en/xa21.htm

ENTSO-E AISBL • Avenue Cortenbergh 100 • 1000 Brussels • Belgium • Tel +32 2 741 09 50 • Fax +32 2 741 09 51 • info@entsoe.eu • www.entsoe.eu

6.9.4 EXPECTED CIM FUNCTIONALITIES

Enterprise Gateway supports both CPSM and ENTSO-E profiles and already has the full functionality related to CIM/XML exchange. It will be updated continuously to be compliant with later CIM standards updates for Operation and Planning.

6.10 E-TERRASOURCE -- A POWER SYSTEM MODELER

6.10.1 VENDOR PRESENTATION

Alstom Grid supplies automation systems for electric power transmission, distribution and market operations.

6.10.2 TOOL DESCRIPTION

e-terra*source* is a sophisticated, RDBMS-based tool for managing power system models, based on the CIM standards. It provides a full-featured user interface for navigating and editing models. It supports concurrent operation by multiple users. It captures changes in annotated and effective dated projects. It supports generation of past, present and future / hypothetical views of the model. It supports CIM model authority set concepts. It provides complete audit trails of activity. It manages multiple kinds of models.

For more information, send email to jay.britton@areva-td.com.

6.10.3 OTHER TOOLS LINKED TO THE E-TERRASOURCE

e-terra*source* is linked to **e-terra***platform* (Alstom's EMS product).

6.10.4 EXPECTED CIM FUNCTIONALITIES

e-terra*source* is especially targeted toward the cooperative development of models that must take place in large interconnected power grids such as that covered by ENTSO-E. It provides members or regional entities in such an interconnection a tool for managing their own model territory and for constructing analytical models from submitted models of other members. We expect that the current level of ENTSO-E CIM interchange of models is only the beginning. We expect that these procedures will need to be extended so that the models used for EMS operations are consolidated with the models used for day-ahead analysis and for longer-term planning. **e-terra***source* is the tool with the right complete set of features and a robust RDBMS-based design that will satisfy future as well as present requirements and unify modelling for all purposes.

6.11 EUROSTAG®

6.11.1 VENDOR PRESENTATION

Eurostag is co-developed by RTE and Tractebel Engineering.

6.11.2 TRACTEBEL ENGINEERING

Tractebel Engineering is part of GDF SUEZ Energy Services, one of the business lines of GDF SUEZ and the European leader in multitechnical services.

With about 3,700 employees around the world, Tractebel Engineering (GDF SUEZ) is one of Europe's major engineering companies, and offers state-of-the-art engineering and consulting solutions to power, nuclear, gas, industry and infrastructure customers in the public and private sector. Services include a full range of engineering assignments throughout the lifecycle of the customers' installations: architect engineer, owner's engineer and consulting engineer.

Power System Consulting (PSC), belonging to Tractebel Engineering (GDF SUEZ) is a group of 40 high profile electrical engineers and mathematicians acting worldwide as consultant in power system operation and development. PSC is a centre of excellence in power system analysis for the delivery of high added value services to public and industrial power systems.

6.11.3 RTE

RTE is the French TSO. (www.rte-france.com).

The missions of RTE are:

- Balancing electricity generation with consumption at all times
- Guaranteeing the secure operation of the power system (carrying electricity 24 hours a day, 7 days a week)
- Maintaining and developing the network to allow generators, distribution networks and consumers to be connected, as well as interconnection with neighbouring countries
- Guaranteeing non-discriminatory access to the transmission network, whilst ensuring that commercially sensitive information remains confidential
- Integrating transmission installations into the environment and ensuring the security of people and property

➔ all at the most economical cost possible

6.11.4 TOOL DESCRIPTION

Objective

Accurate simulation of the dynamics in all electric power systems.

Application

EUROSTAG® covers the full range of transient, mid and long-term stability, from electromechanical oscillations up to daily load evolution. By allowing understanding in depth all critical system mechanisms, EUROSTAG® helps solving

- conventional problems such as critical clearing times, power oscillations, tuning of generating units controllers, or load shedding policies
- as well as highly complex power system problems such as voltage collapse and black-out scenarios, set up of defence plans and restoration procedures, transfer capability, study of centralized voltage or frequency controls, or power electronics : FACTS and HVDC.

It also provides an entry point for new opportunities such as on-line dynamic calculations in EMS, system modelling in an integrated environment for analysis, and use of other compatible simulation applications. In every way, EUROSTAG®

A unique algorithm

EUROSTAG is based on a unique and robust algorithm using a continuous varying integration time step-size from 1ms to 100sec which will adapt automatically to the accuracy requirement. The step-size becomes short if a fast phenomenon (such as a loss of synchronism) is excited. It remains long and allows extended simulations (up to several hours) if only slow phenomena are excited.

Main advantages

- Continuous display of both fast and slow phenomena – EUROSTAG ® enables scenario simulations of a few seconds to several hours, making it ideal for studying conditions over time in which fast and slow phenomena interlock.
- Reliable simulation – EUROSTAG ® replicates and integrates all power system components, as well as the actions of operators, to produce authentic real-time dynamic simulation. Observation of any physical variation is possible at any moment, without any prior declaration.
- Flexible but secure power system modelling – EUROSTAG ® offers a vast library of power system models (including dispersed and renewable generation facilities) and processes. These can be used directly or modified - using an advanced modelling language that automatically generates the appropriate equations, removing all risk of human error. It allows representing in a specific way any type of process or controller, whatever the technology.
- Open software - EUROSTAG® reads data in international formats and can recover models and parameters used in older programs. Results can also be exported to other specialised programmes (Mathworks Matlab®, Microsoft® Office). EUROSTAG 4.5 is also CIM compliant.

- Faster and easier studies – EUROSTAG® offers a user-friendly graphical interface for rapid modelling, data edition, simulation, results interpretation and analysis. The advanced modelling language enables for instance the customization of standard existing models or the input of new models, directly on the screen without any programming.

6.11.5 OTHER TOOLS LINKED TO EUROSTAG

6.11.5.1 TRACTEBEL ENGINEERING

Tractebel Engineering developed the following tools linked to EUROSTAG®:

1. Three complementary modules that can be plugged on EUROSTAG®
    - Dynamic security assessment (SYSCAN);
    - Dynamic Response Optimization (STAG-O!);
    - Small signal stability (HERCULES).
2. ***PSA PLATFORM***, for both Advanced Dynamic and Static Power System Analysis, that includes EUROSTAG®

    Static
    - Load-Flow;
    - Contingency Analysis;
    - Short-circuit calculation (static).
    - Short circuit currents (SHOCC);
    - Optimum power flow (IPSO);
    - Network reduction (REI).

    Dynamic

    EUROSTAG® (cf. above)
    - Dynamic security assessment (SYSCAN);
    - Dynamic Response Optimization (STAG-O!);
    - Small signal stability (HERCULES).

3. ***FAST***, dynamic real time Dispatcher Training Simulator. FAST is compatible with EUROSTAG®.

The PSA Platform is a planning tool where the different integrated software solutions are using the same internal format. Supporting CIM with EUROSTAG® will facilitate to connect the whole PSA Platform to CIM.

On the other hand, our real time Dispatcher Training Simulator FAST uses an operational model and is thus concerned with the CIM CPSM.

6.11.5.2 RTE: ASSESS

ASSESS allows to generate new systematic or random situations modelling the uncertainties. It is possible to model uncertainties on any variable defining the studied network.

To do so, the user has access to a great variety of probability laws. In a typical ASSESS study, the user generates between 1000 and 30000 new situations. Then each situation can be analyzed with a full range of tools.

6.11.6 EXPECTED CIM FUNCTIONALITIES

The aim is to be able to import CIM data files in EUROSTAG®, run simulations on those cases and export the results in CIM format. EUROSTAG® being not a daily exchange tool, we are more interested by the full model exchange than by the split by MAS, incremental or partial exchanges.

The first step was to be compliant with CIM static data files. The version 4.5 of EUROSTAG® is already compliant with the CIM ENTSO-E Edition 1.0.

The next step is to take into account CIM dynamic data in the next versions of the software.

6.12 INTEGRAL 7 (FGH)

6.12.1 VENDOR PRESENTATION

FGH (Forschungsgemeinschaft für Elektrische Anlagen und Stromwirtschaft e. V.) is a non-profit research association of electricity supply industry and electrical industry with the aim of developing and providing competence and practice-oriented technical knowledge together with its members. The bundling of these tasks and the independent safeguarding of the member's interests attain increasing meaning in the liberalised market. Here, our members and partners from network operation, industry, service and science profit by the activities of FGH.

The co-operation with RWTH Aachen University as well as other research institutes guarantees the comprehensive coverage of the entire sphere of activity. As an interface FGH ensures a fast transfer of solutions from science into practice. FGH has a relevant share to the world-wide top-ranking of the security and quality of German transmission and distribution networks. With our services we help to protect this position in the liberalised market.

Current topics of our work include e.g.

- Reliability-oriented network planning according to deterministic or probabilistic criteria
- Implementation of the new outage and availability statistics
- Asset management and development of appropriate maintenance strategies
- Condition evaluation and estimation of the residual life duration of technical equipment
- Integration of decentralised power generation units into the network

- Evaluation of protection and control systems
- Certification of the power generation characteristics of wind energy converters

For more than 30 years software development has been a core competence of FGH. Together with our member companies, FGH has conceived and is continuously improving the network planning system INTEGRAL.

With the program INTERASS, FGH offers another leading software product for the collection and evaluation of disturbance data according to the statistic schemes of FNN and VEÖ.

Beside the standard products INTEGRAL and INTERASS, FGH develops individual software solutions that support special processes in utilities.

Internet: *http://www.fgh-ma.de*

6.12.2 TOOL DESCRIPTION

INTEGRAL is a powerful tool for the planning of electrical power systems. The roots of INTEGRAL go back for more than 30 years. Until 1974 the German TSOs did their own development of software for network analyses. In 1974 finally their efforts were centralized at FGH and a first program for power flow and short-circuit calculation was developed. In 1982 the first graphical output of networks was added and since 1986 the user is able to interact via a graphical user interface. Since 1990 additional calculation modules like state estimation and voltage-var optimization were added.

Main calculation modules in INTEGRAL are:

- Power flow calculation and outage simulation
- Short circuit calculation according to IEC 60909 (single fault and Takahashi's method)
  - 1-phase faults
  - 2-phase faults (with/without ground connection)
  - 3-phase faults
- Universal fault calculation: Definition of arbitrary fault combinations (with/without consideration of the current power flow situation)
- Extended Ward network reduction (separately for power flow and short circuit calculation)
- State estimation
- Calculation of line parameters for overhead lines
- Reliability analysis

- Voltage-var optimization
- Simulation of fault clearing
- Analysis of harmonics propagation
- Cost analysis

Customer specific program modules can be developed and integrated into the graphical user interface.

INTEGRAL uses a detailed data model with complete modelling of the switch gear. This is a prerequisite for reliability analyses, simulation of fault clearing and cost analyses. But it also enables automatic creation of network graphics from the data model. Figure 1 shows the graphical user interface of INTEGRAL with an open network graphic.

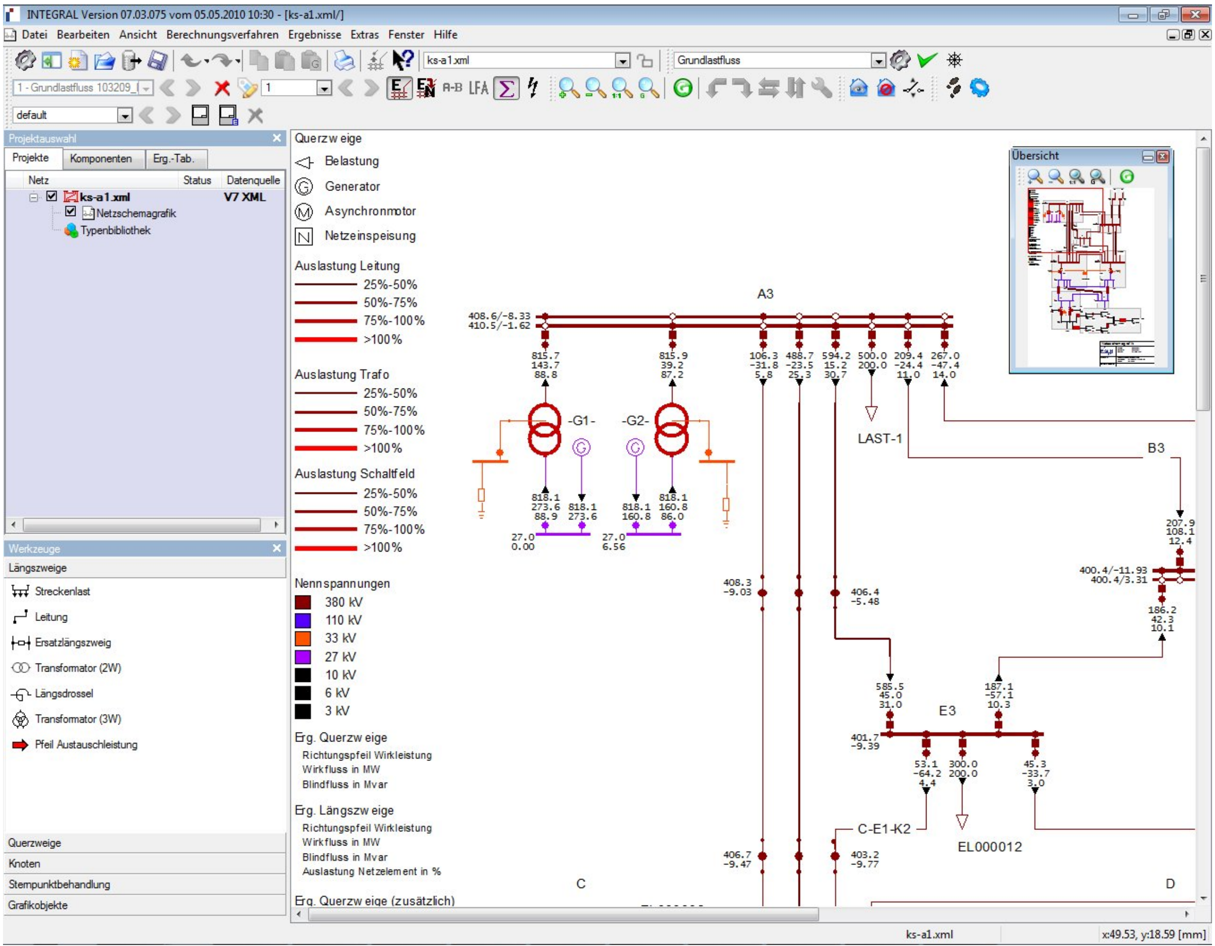


Fig. 1: GUI of INTEGRAL 7 with open network graphic

Additionally to the classic network graphic INTEGRAL provides a geographical presentation of the network, shown in figure 2. This geographic presentation gives a simplified overview of the network. Some calculation results can be visualized by background colors. This graphic is also an easy way to define a route model of the network.

Routes connect substations. They can bare poles and trenches. If overhead lines are assigned to poles, the line parameters of the overhead line can be calculated from the pole geometry (Fig. 3), including mutual couplings. Also poles can be used to easily define common-mode failures for reliability analyses.

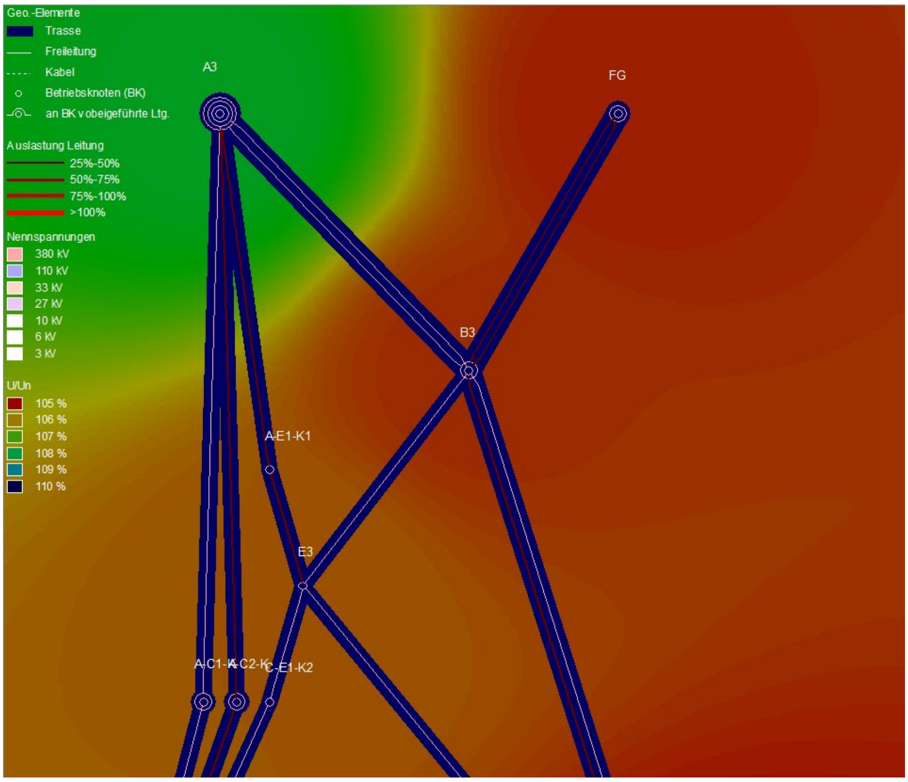


Fig. 2: Geographical presentation with visualisation of voltages as background colour

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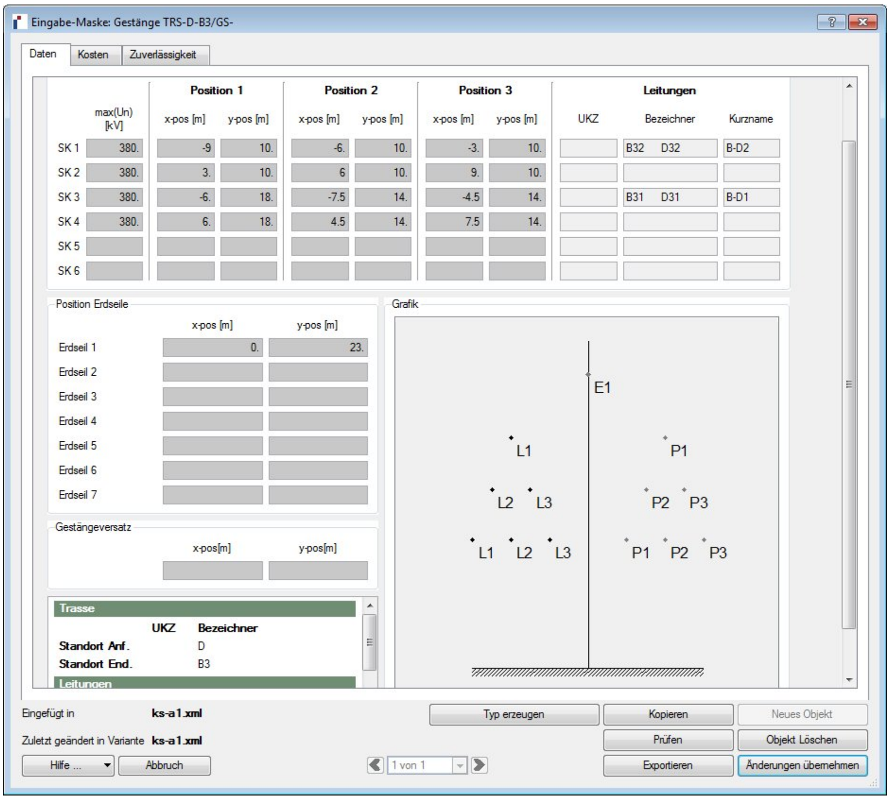

Fig. 3: Template for pole geometry

Periodical execution of always the same working steps is time consuming. Therefore in INTEGRAL a macro language is integrated to automate working procedures. The macro language is based on JavaScript. More than 3000 instructions allow access to the complete data model and calculation modules of INTEGRAL. Additionally it is possible to create own GUIs within the macros.

6.12.3 OTHER TOOLS LINKED TO INTEGRAL 7

None

6.12.4 EXPECTED CIM FUNCTIONALITIES

In the future the connection to a stability program is planned. After that also the CIM import/export routine can be extended to dynamics data.

6.13 ISPEN

6.13.1 VENDOR PRESENTATION

Intercompro has more than 30 years of experience in the field of Power Application Software. The focus is on simulation software used by the dispatchers in the control center of a TSO.

http://www.ispen.ch/

6.13.2 TOOL DESCRIPTION

ISPEN is the centerpiece of a product family specialized for online applications. The software can simulate networks of the magnitude 22'000 nodes and 30'000 lines. The basic import interfaces are designed for:

- UCTE-DEF

- CIM/XML

The import features allow the user to enter n MAS files of the kinds EQ, TP and SV in order to form the desired network. Thus, n EQ files serve as input to the EQ import converter and the corresponding n TP and SV files serve as input to the TP and SV import converters.

The export can be done in UCTE-DEF format or in the CIM/XML format with EQ, TP and SV files. The exported EQ file is the same file(s) as once was imported since the simulations carried out in ISPEN do not involve any creation of new network elements.

The CIM/XML import converters is a very fast high performance software that converters the large network (9'600 nodes) used at the UCTE 2009 interoperability test held in Paris in about 4.5 seconds when running on a standard lap-top.

6.13.3 OTHER TOOLS LINKED TO THE ISPEN

All the tools in the ISPEN family have a common proprietary data structure and each tool can use ISPEN to perform import/export as described in the previous section.

An outstanding tool is ISPEN/OCD that is used by several TSOs for the automated monitoring of the N-1 security. This is a standard application in which the online network of the TSO is embedded in the ENTSO-E network model of the European interconnected network in order to have a real external network that is needed to model the erratic flows of the deregulated energy market. The execution of a standard N-1 contingency list for a large power system with about 400 cases is done in about 13 seconds. This very fast performing software allows any TSO to detect any N-1 problem in time to carry out counter measures.

http://www.ispen.ch/

6.13.4 EXPECTED CIM FUNCTIONALITIES

One major development of the tool will be to import state estimation results from a SCADA/EMS system that will be used as base case for the ISPEN online applications.

A second development involves the import of short-circuit data in order to carry out a standard 3-phase symmetrical short-circuit calculation as security check in the dispatching of a TSO.

ISPEN
For Your Secure Power Network

Your Power Network

The security of supply is one of the main responsibilities of a transmission system operator, who has to fulfill the Multi Lateral Agreement of the UCTE. It is a challenging task to do that in a complex environment with interconnected networks, with independent traders and producers.

How Secure is Your Power Network?

To answer this question you need a security monitor, displaying relevant security indices. If these indices show, that your network is not secure, it is helpful for you to have more information about the overloaded elements and the causers of the overload condition.

ISPEN/OCD is our online contingency diagnosis tool giving you accurate information about the *n-1* security and *n-k* security (cascading risk) of supply in a few seconds.

Planning an Action

If you plan to switch off a branch or change the topology, the question is if the network will be secure after that action.

ISPEN/IPFA is an interactive power flow simulation tool enabling you to answer the question mentioned above.

Your SCADA/EMS System is Out Of Service

If your SCADA/EMS system is out of service, you have no information about your system and you do not have a chance to control it. You only have planning data available (e.g. for production, topology). If the planning data is accurate, why not use them instead of no data.

Based on selected ISPEN functions we develop your customized **ISPEN solution** building virtual power networks. You can use it for controlling the network or for monitoring the security.

Integrating Neighbor's Online Networks

In order to control your power network its near real time data are displayed on your SCADA system. And your neighbors also have a similar environment, but up to now, you can not integrate their data in a large online network.

The best base for control and security monitoring is an online network including the online data of your neighbors.

Having access to the estimated data of your neighbors, **ISPEN/MON** can merge them to a large online network und gives you a new dimension in network control and security monitoring.

Proper DACF Files

The Day Ahead Congestion Forecast files (DACF) in the UCTE format are widely used. For the user of the DACF files as well as for the producer of them it is important that the DACF files are proper.

ISPEN/UFA is an analyzer of files containing data in the UCTE format. It not only analyzes the syntax but also checks the plausibility of the values by calculating the power flow.

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Converting Files

It is often necessary to convert files from one format to another one. An example is our converter from the DVG format to the UCTE format.

ISPEN/CON is the solution for that task.

Ways to a secure power network

Optimizing the Power Flow

On customer request, it is possible to perform optimization (OPF) based on operational objectives.

For customer specific **ISPEN solutions** ISPEN functions will be used

Consulting

Applying simple best practices results within a more secure network. We are proud on our 30 years' experience in the field of estimation, power flow calculations and security monitoring. Rely on our Consulting services to meet your requirements.

EPS Software Engineering AG
Pestalozzistrasse 27
CH-9501 WIL (SG)
+41 (0)71 914 40 50
info@eps.ch
www.eps.ch

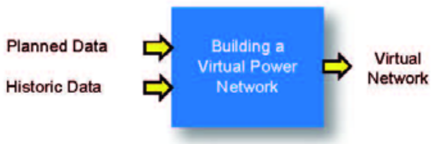
ISPEN solutions

Emergency Operation and Forecasting

In case of emergency operation as well as forecasting, no current online data is available. However, in such cases, we can build a virtual power network as input for controlling and monitoring of security state in the future using schedules.

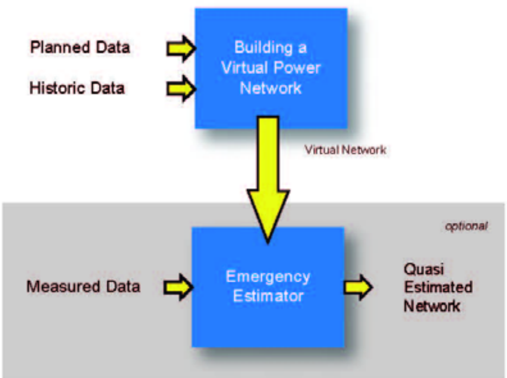
Building Virtual Power Networks

If your planned data for topology, exchange, production, as well as history data are available and this data reflects the real state of your network in sufficient accuracy, you can build a virtual network based on this data.



Emergency Operation

In case of emergency operation, a better result can be achieved if you also have access to some measured data.



Application of Virtual Power Networks

Virtual power networks can be applied in the same manner as online networks:

- As input to the SCADA/EMS system
- As input to the security monitoring system (ISPEN/OCD)
- As input to simulation tools like ISPEN/IPFA

Optimizing

Power flow optimization (OPF) is a method to improve the operational and economic objectives. We are experienced in implementing power flow analysis and optimization algorithms. Therefore, we are skilled to tailor optimization algorithms and objectives to the individual needs of the customers. Benefit from our expertise and our already developed algorithms.

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Pestalozzistrasse 27
CH-9501 WIL (SG)
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6.14 NEPLAN®

6.14.1 VENDOR PRESENTATION

BCP Busarello + Cott + Partner AG was founded 1988 in Zurich, Switzerland and is specialized in the field of power systems engineering. BCP is the developer and owner of the power system analysis tool NEPLAN and is one of the leading companies in the power system engineering software market. Small and large utilities, industrial organizations, engineering companies and universities in more than 90 countries around the world appreciate our high Swiss quality products.

BCP is member of the international NEPLAN®-Consulting group, which offers a wide range of power system studies and consultancy work, like network reliability analysis, defining new maintenance concepts, stability studies, consultancy on integration of wind energy and much more. Within this NEPLAN ®-Consulting group we have successfully carried out more than 1000 power system analysis and planning studies with NEPLAN®.

Product: NEPLAN
Company: BCP Busarello + Cott + Partner AG
Bahnhofstr. 40
CH-8703 Erlenbach (Switzerland)

Web: www.neplan.ch
E-Mail: giatgen.cott@neplan.ch

6.14.2 TOOL DESCRIPTION

NEPLAN® is a high end power system analysis tool for transmission, distribution and industrial networks. Further information about the NEPLAN Transmission package may be found at:
http://www.neplan.ch/pdf/english/packages/NEPLAN_TransmissionModules.pdf

According to our customers NEPLAN distinguishes oneself especially by these features:

1) It is very easy to use. The graphical user interface is very user-friendly and offers all features of a modern CAD system. Planning task may be done extremely **efficiently**.

2) It is a very complete analysis tool, with a huge range of different analysis modules. It offers for every electrical phenomenon in a power system network a calculation module. Main modules for transmission networks are:

   single line diagram editor, power flow, short circuit analysis, transient stability, EMT analysis, voltage stability, contingency analysis, protection coordination, OPF, NTC, C/C++ API to develop user defined applications and more.

3) The "NEPLAN® **Risk based planning**" tool is the benchmark tool for investigation of the power system network reliability (e.g. SAIFI, SAIDI).
   Further info at
   http://www.neplan.ch/html/e/e_brochures_default.htm

4) NEPLAN® is a very open system. The NEPLAN® algorithm and functionalities may be easily integrated into any existing environment like a GIS (geographical information systems) or SCADA/ DMS systems through a C/C++ API. NEPLAN® may be connected directly on a TCP/IP bus and used as calculation server or as a GUI client. This architecture allows

building user defined flexible applications like **DACF** implementations or sophisticated **SmartGrid** concepts.
Further info DACF:
http://www.neplan.ch/pdf/english/modules/NEPLAN_T05_DACF_engl.pdf
Further info C/C++ API:
http://www.neplan.ch/pdf/english/modules/NEPLAN_B11_NPL_engl.pdf
Further info SmartGrid:
http://www.neplan.ch/pdf/english/factsheets/e_neplan-SmartGrid-v2.pdf

5) The **NEPLAN® dynamic simulator**" offers unrivalled features for transient stability and electromagnetic transient analysis. It is fast and easy to use. It includes many predefined models. Researchers and developers like the powerful modelling capabilities for developing new models and control strategies (e.g. for renewable energy systems like wind power and solar energy plant).
Further info at:
http://www.neplan.ch/pdf/english/modules/NEPLAN_B08_Simulator_engl.pdf

6.14.3 OTHER TOOLS LINKED TO NEPLAN®

1) BCP develops also analysis tools for **Gas, Water and District Heating** Networks. All data may be accessed via MS-Excel or SQL database.

2) The **'NEPLAN®-Asset Management'** product includes two main modules:

- **Reliability Centered Maintenance** module

The radical changes taking place in the energy markets are putting huge pressure on the affected companies to cut costs. There is considerable potential for this in the field of maintenance, among others. By selecting suitable custom maintenance strategies, the cost of maintenance can be substantially reduced without putting the required functionality at risk. The 'Reliability Centered Maintenance' module includes a budgeting tool, which calculates the cost for the following maintenance strategies:

- Corrective
- Time-based
- Condition-based
- Reliability-centered

- **Asset Simulation** module:

It simulates the future behaviour of network components based on experience of the past. Among others, the module calculates the CAPEX and OPEX costs for each year of simulation. The asset simulation helps the asset manager, together with the future objective network and maintenance strategy, to optimize:

- Investment timing
- Network structures
- Network operation

- Power supply reliability and quality

The asset management product integrates smoothly into our NEPLAN power system analysis tool. The results from the NEPLAN risked based analysis may be used as input. The data are stored in a SQL database (like Oracle, SQL-Server, MS-Access, etc.) and is as such unique on the market.

More information about our asset management product maybe found at: http://www.neplan.ch/html/e/e_brochures_default.htm

6.14.4 EXPECTED CIM FUNCTIONALITIES

1) We will further improve the NEPLAN risk based simulation and the asset management modules, since we see that here is a big cost savings potential for many utilities.

2) The NEPLAN Programming Library (C/C++ API), which allows building customized NEPLAN procedures and products (e.g. SmartGrids), will be enhanced with additional functions.

3) The 'Phasor Dynamic Algorithm' of the 'NEPLAN® Dynamic Simulator' module will be improved. The 'Phasor Dynamic Algorithm' allows more accurate simulations than the traditional transient stability algorithms (RMS simulations) and is more computationally efficient than the traditional EMT simulations for phenomena's which are outside the fundamental frequency range. Additional models for renewable energy systems will be added.

6.15 PSS®ODMS

6.15.1 VENDOR PRESENTATION

Siemens Power Technologies International (Siemens PTI), the provider of network consulting, software solutions and T&D training within Siemens Energy, is a world leader in electrical power network analysis for generation, transmission and distribution systems, and industrial plants.

www.energy.siemens.com/hq/en/services/power-transmission-distribution/power-technologies-international/

6.15.2 TOOL DESCRIPTION

PSS®ODMS is a commercial software product built on a CIM-compliant relational database schema. It contains built-in CIM/XML import and export functions that support full, partial and incremental CIM/XML operations and planning model data. The product is also fully compatible with PSS®E with import and export functions that support the PSS®E RAW, SEQ and DYR file formats. PSS®ODMS offers an intuitive Windows user interface with extensive network modelling features including an integrated one-line diagram-based graphical model editor and a fully customizable and extensible hierarchical editor. PSS®ODMS is designed to support a unified transmission operations-planning model through past, present and future conditions. It offers integrated Advanced Network Applications functions (Power Flow, State Estimator, Short Circuit and Contingency Analysis) with advanced results visualization capabilities. The product has an open architecture with comprehensive API's and supports custom user extensions to the database schema. PSS®ODMS can be deployed as either a single-user application or a multi-user enterprise solution and is currently used in production at various electrical power organizations throughout the world.

www.energy.siemens.com/hq/en/services/power-transmission-distribution/power-technologies-international/software-solutions/pss-odms.htm

6.15.3 OTHER TOOLS LINKED TO THE PSS®ODMS

PSS®E is a commercial software product that has provided Planners with a fully integrated set of applications to study future transmission system modifications. PSS®E is an integrated, interactive program for simulating, analyzing, and optimizing power system performance. It provides the user with the most advanced and proven methods in many technical areas, including:

Power Flow

Optimal Power Flow

Balanced or Unbalanced Fault Analysis

Dynamic Simulation

Extended Term Dynamic Simulation

Open Access and Pricing

Transfer Limit Analysis

Network Reduction

www.energy.siemens.com/hq/en/services/power-transmission-distribution/power-technologies-international/software-solutions/pss-e.htm

6.15.4 EXPECTED CIM FUNCTIONALITIES

PSS®ODMS will be continually updated with the latest CIM version to support ENTOSE and CPSM in managing Planning and operations models. We see PSS®ODMS supporting a fully integrated tool set for managing a full ENTSOE model, exporting solved model authority sets, and merging model authority sets to produce a solved case.

6.16 SICRE

6.16.1 CESI PRESENTATION

CESI (Centro Elettrotecnico Sperimentale Italiano), established in 1956 as a market leader in testing and certification of electromechanical equipment and electrical power systems studies, is today a global power consultant and provider of services and special equipment to the electric industry and public administration.

As a joint stock company, its main shareholders include in a balanced way the Italian ISO, the main Italian electric utilities (Terna, Enel, Edison, Edipower, E.ON, Tirreno Power, A2A, Sogin) and the main equipment manufacturers (ABB, Areva, Ansaldo, Prysmian). CESI employs 500 people (40% with university degrees) and operates in over 40 countries world-wide. Its range of activities covers the whole electricity sector - power generation, electricity transmission and distribution, end-use of electricity, environment and renewable energies, equipment testing and certification, standardisation – thus ensuring an integrated, comprehensive approach to the problems of the power sector. CESI includes also the ISMES division which works in the fields of environmental risk, design support and structural assessment on buildings and structures, with tests and studies on mechanical and industrial components.

CESI has been operating world-wide with a marketing network in about 40 countries offering services to:

- Electrical Utilities (production, transmission and distribution)
- Independent System Operators (ISO)
- Regulation Authorities
- Electromechanical and Electronic Manufacturers
- Industrial Users
- Public Administrations
- International Financial Institutions.

CESI activities cover, apart from erection, the whole cycle of a project i.e: feasibility, design, commissioning, operation and disposal. The offer concerns:

- techno-economic studies on networks, systems, plants and components
- consulting and specialised diagnostic and maintenance interventions
- plant and component life assessment / life extension studies
- management and training procedures and tools

- qualification tests, component, system and plant certification
- supply of testing laboratories, special components
- environmental studies and services: monitoring and assessments, design and realisations, structure engineering, technology developments.

6.16.2 TOOL DESCRIPTION

The SICRE Power System Dynamic Simulator has been being developed since 1980s, earlier at the former ENEL research centre and then at the CESI network studies department.

6.16.3 MAIN FUNCTIONALITIES

SICRE consists of a set of functions devoted to simulation and analysis which are able to represent the dynamic behaviour of power systems, over different time scales, both in normal and emergency conditions. Simulation of short-term and long-term dynamics is possible, with an integration step suitable for ranging between electromechanical transients (power oscillations) to slow phenomena (voltage instabilities), and taking into account of all the components, modelled in high detail, involved in the system dynamics.

The package is complete from the viewpoint of the components that are modelled with a high degree of detail, efficient from the viewpoint of the algorithms and based on modern SW/HW technologies.

The main application fields of SICRE are analysis and control during both the operational planning and the day-by-day operation stages, in order to assess the overall dynamic performances of the system. For example:

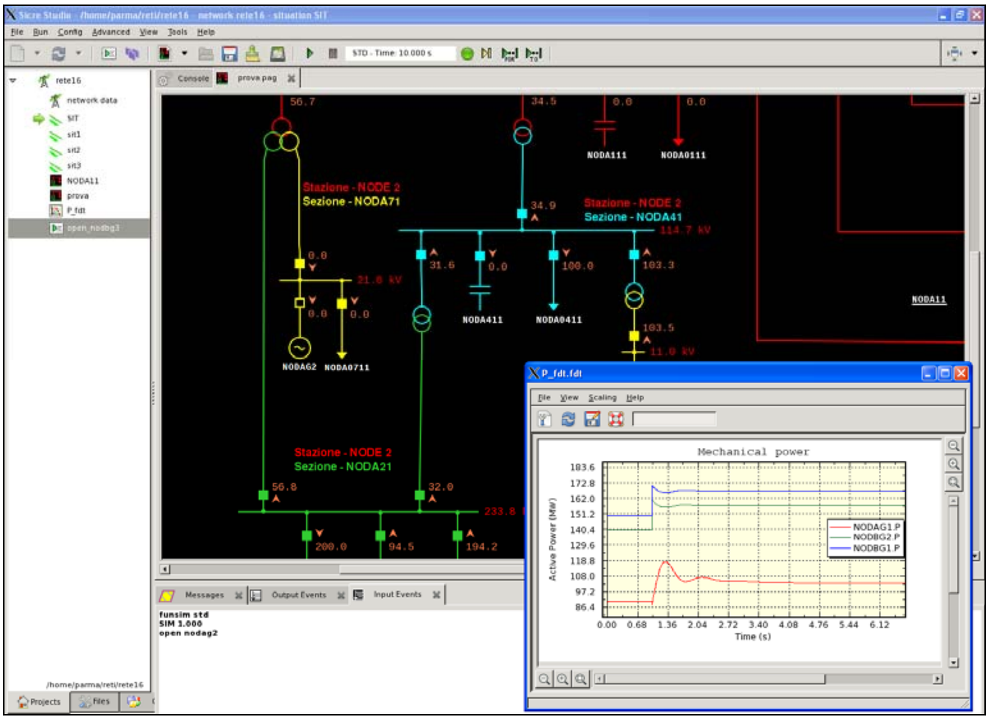
- design and test of control strategies and controllers tuning (with linear – eigenvalues analysis functions);
- large incident reconstruction, in order to completely understand events and dynamic phenomena and verify system components (protections, automatons, regulators, etc.);
- design and verification of new automatic defence actions, in order to avoid and prevent incidents or to limit and control their consequences;
- verification of restoration procedures, from internal black-start units or survived external networks;
- Analysis and control during the operational planning and day-by-day operation stages in order to assess the overall dynamic performances of the system.

Besides the wide variety of AGC, AVR, PSS, PST and Tap changer models in SICRE are available additional elements and controls:

- Primary and secondary voltage controllers;
- Ballast loads;
- HVDC models;
- Wind farms;

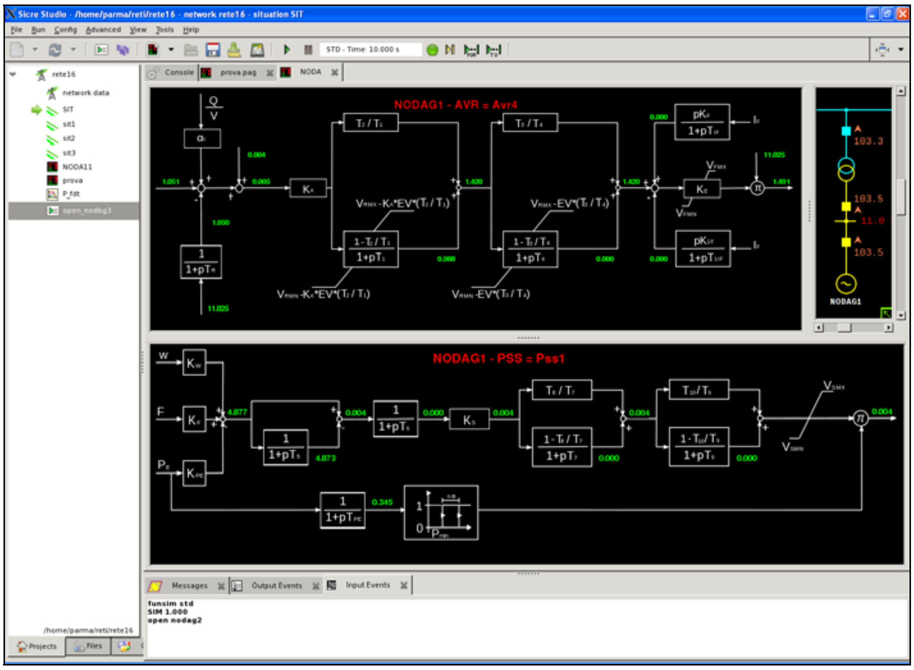
and defence plan logics and devices:

- Protection systems operating on power/frequency/voltage/current measurements;
- Fast valving;
- Load shedding;
- Line distance protections;
- Unit out of step protections;
- Remote trip of units, lines, loads;



VIEW OF SICRE HMI

The SICRE highly interactive and user friendly HMI allows the user to create and manipulate displays of the network plans and diagrams, as well as send commands to the core (engine) of the simulator. It is very easy to set up complete diagrams containing the trends and the transients of all the variables of interest. It is also possible to create text reports containing information about the network that is simulated. Trends and Cartesian diagrams can be displayed during the simulation and through the page editor is possible to create and modify displays containing network schemes.



Example of Block schemes view

The user interacts with the simulated system introducing perturbations (e.g. load modifications, variation of set points, three phase short circuit and unsymmetrical faults) or executing manoeuvres (such as breaker opening or closing) either through the HMI facilities or in a pre-established scenario. A specific HMI oriented to the analysis of power systems is available.
In recent years a complete rewrite of the HMI has been carried out: the result is a completely new HMI, based on open source graphics libraries, fully compliant with Windows platform but operable also to Linux platforms.

The accuracy of SICRE simulator results has been confirmed by comparing its simulation outputs with real trends measurements, restoration tests and outage reconstruction studies.

More details are available at CESI web site http://www.cesi.it/ in the section →supplies →services →software tools.

<u>Basic features related to CIM import/export</u>

The SICRE CIM dynamic data acquisition stage is developed in order to be integrated with the proprietary dynamic format and database.

6.16.4 OTHER TOOLS LINKED TO SICRE

SICRE, with the support of CRESO, is also the simulation engine of the Dispatcher Training Simulator (DTS) and of the Dynamic Security Assessment (DSA). The links between these tools and SICRE is via internal proprietary format;

- DTS is used for training Control Room Operators as a replica of Control Room System with teaching sessions representing different real situations, from normal condition (e.g. morning load ramp) to extreme critical situation (e.g. blackout).

- DSA is an on-line security preventive assessment; taking the most recent steady state power flow calculation DSA performs the screening of several network contingencies.

6.16.5 EXPECTED CIM FUNCTIONALITIES

At the beginning of 2010 CESI starts to update SICRE in order to cover ENTSO-E needs and rules regarding the reliability of load-flow results and dynamic transients. Up to now the software is under development in order to be compliant with the dynamics models used during the IOP tests.

For the July 2010 IOP SICRE takes part to the tests related to import of full dynamic model (standard models only) and comparison of dynamic simulation.

In the future SICRE functionalities will be extended to satisfy the CIM test procedures for the import/export interoperability of dynamic files containing user-defined model.

6.17 SPIRA

6.17.1 CESI PRESENTATION

CESI (Centro Elettrotecnico Sperimentale Italiano), established in 1956 as a market leader in testing and certification of electromechanical equipment and electrical power systems studies, is today a global power consultant and provider of services and special equipment to the electric industry and public administration.

As a joint stock company, its main shareholders include in a balanced way the Italian ISO, the main Italian electric utilities (Terna, Enel, Edison, Edipower, E.ON, Tirreno Power, A2A, Sogin) and the main equipment manufacturers (ABB, Areva, Ansaldo, Prysmian). CESI employs 500 people (40% with university degrees) and operates in over 40 countries world-wide. Its range of activities covers the whole electricity sector - power generation, electricity transmission and distribution, end-use of electricity, environment and renewable energies, equipment testing and certification, standardisation – thus ensuring an integrated, comprehensive approach to the problems of the power sector. CESI includes also the ISMES division which works in the fields of environmental risk, design support and structural assessment on buildings and structures, with tests and studies on mechanical and industrial components.

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- consulting and specialised diagnostic and maintenance interventions
- plant and component life assessment / life extension studies
- management and training procedures and tools
- qualification tests, component, system and plant certification
- supply of testing laboratories, special components
- environmental studies and services: monitoring and assessments, design and realisations, structure engineering, technology developments.

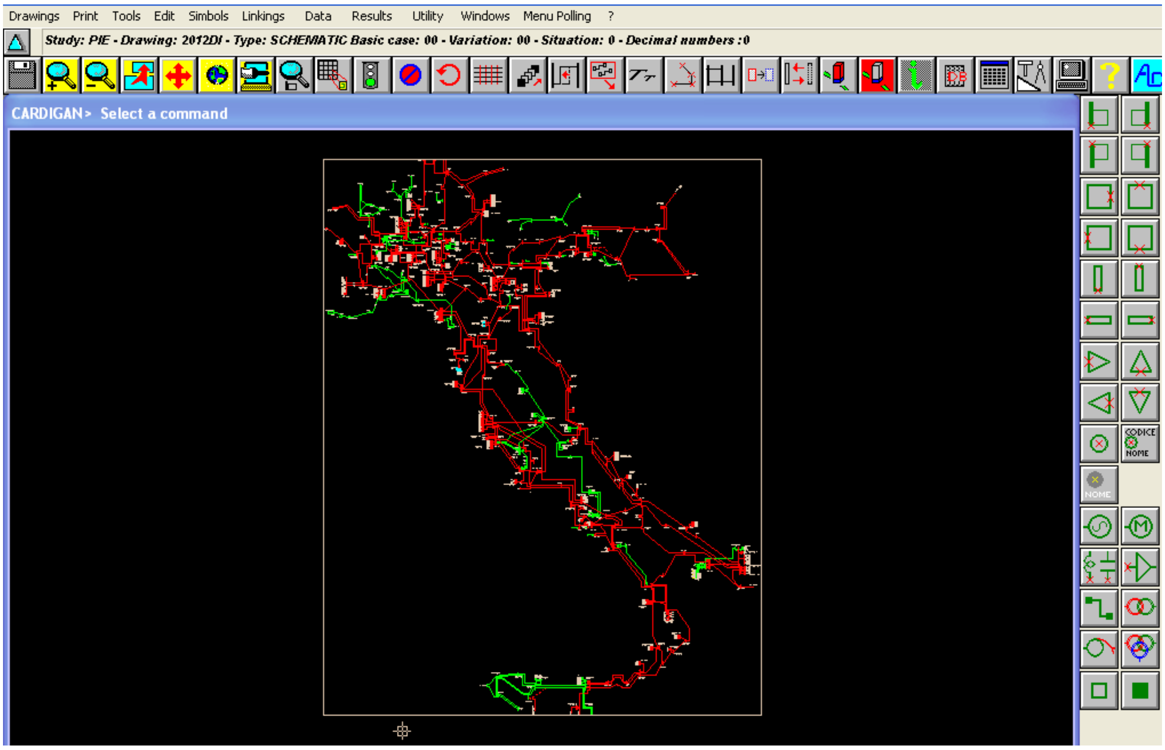
6.17.2 TOOL DESCRIPTION

SPIRA (Integrated system for the planning of HV transmission networks) is an advanced computing system (on Windows platforms) for the planning of HV transmission networks that:

- includes both optimisation and power analysis computing models developed by CESI and applied since many years in several electric system studies carried out both on Italian and foreign Country networks
- constitutes an interactive graphic system to manage digital programs utilised in the search of optimum strategies of short/long term expansion of HV networks
- allows one line schematic and-geographic diagrams of the network under consideration to be created by assuring formal coherence between the network

topology and alpha-numerica the electrical parameters relevant to its components and graphic functions.

- allows the creation, up-dating and queries of the data base with the electrical parameters of the network to be studied being managed, by means of specific menus and forms.



6.17.3 COMPUTATION PROGRAM

The various technical-economical facets are analyzed by means of specific computation programs that take parameters mostly affecting the investigated problem into due account.

- FLOWAC: for checking the a.c. load flow under normal operating conditions and with automatically-selected contingencies of network components (lines and transformers)
- CTINEW: for defining short circuit current levels at network nodes
- SIPARIO: For defining active and reactive optimisation (OPF) of the network with different objective functions
- GRARE: For adequacy analysis of transmission network with probabilistic and deterministic approach

The SPIRA system, moreover, allows specific network problems to be analyzed by means of specialistic computation programs such as:

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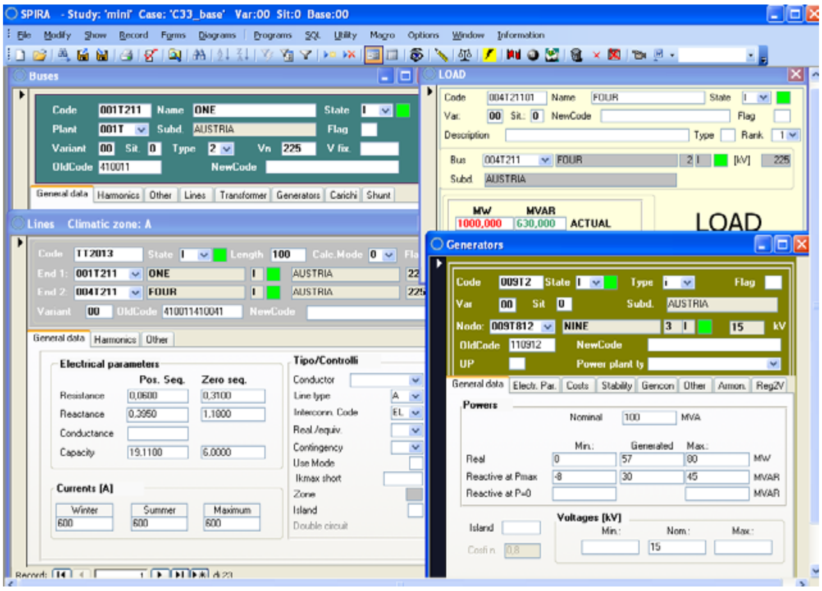
- EQSTAR for the evaluation of network equivalents, or parts thereof, to be used in a.c. load flows and network adequacy probabilistic analysis computations
- EQUI for the evaluation of network equivalents, or parts thereof, when calculating short circuit currents
- DIFOAR for the appraisal of "flicker" disturbance caused by open arc furnaces at the various network nodes
- CORARM for investigating harmonics propagation into network in the presence of disturbing loads

6.17.4 KEY FEATURES

The graphic man/machine interface (MMI) of the system enables :



- the network to be managed in a graphic mode
- external data bases to be activated
- computation programs to be activated
- active processes to be handled
- the data base to be queried and modified
- study results to be managed
- peripherals to be managed
- utility programs to be handled

CARDIGAN is the CAD interface enabling all graphic functions to be carried out that are needed for creating the network schemes

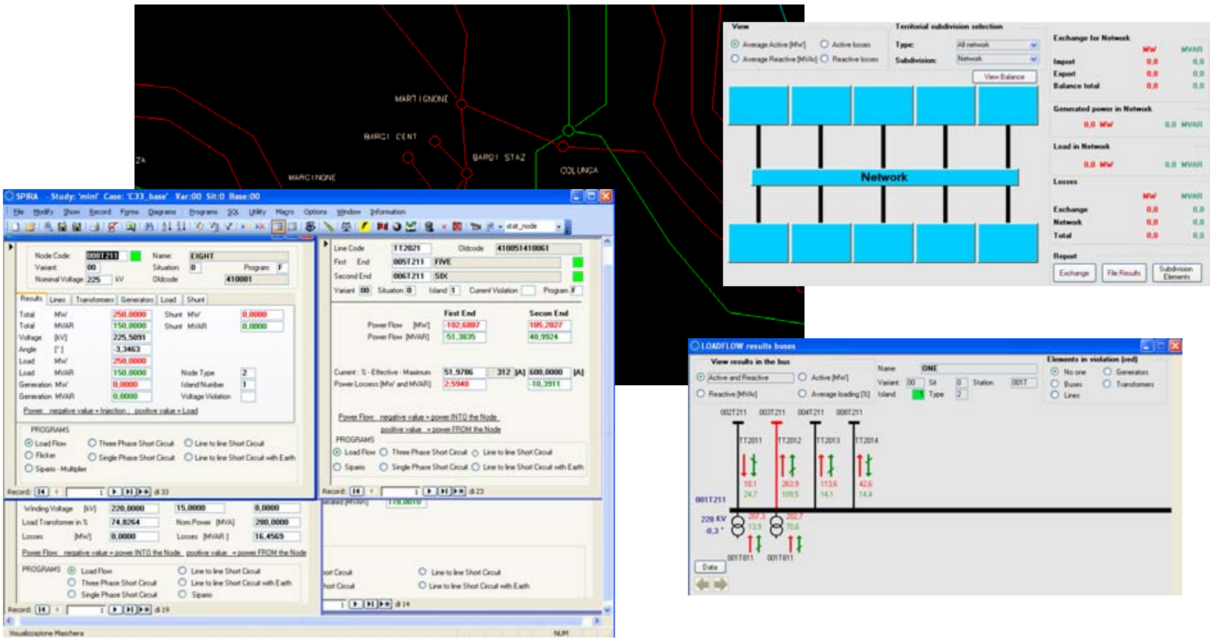
STUDY DB constitutes the data base of the network electric parameters that is shared by all applicative computation programs and holds the results of computations carried out by these applicative programs.

The access, gained through special menus and masks as well as by means of the graphic interface, enables variants to be introduced on the investigated network for a rapid check about possible network alternatives.

The STUDY DB data base, moreover, provides the user with a set of default parameters for such components as lines and transformers to be predominantly used in the planning stage when accurate parameters are still unavailable.

Thanks to the graphic interface, it is possible to create the network scheme layout.

Drawing set-up as well as modifications thereof are made easier by several graphic functions that can be activated by means of icons on the screen.



Besides, when drawing a network scheme layout, access can be gained to the data base for the automatic introduction of topologic-type alphameric information.

The results of studies that are more frequently carried out (load flow, short circuit current evaluations) can be displayed on the screen and on paper, but also on the network scheme in order to facilitate its analysis.

Graphic functions also enable the most interesting network sections to be selected for a graphic presentation of results that are to be included in study

6.17.5 MODULARITY AND OPEN-ENDED LAYOUT TO OTHER COMPUTATION SYSTEM

The SPIRA system features a modular structure enabling personalized versions to be made ready by embodying computation programs as needed to a customer's specific requirements.

An overall open-ended layout to other computation systems is made easier by special interface programs for data exchange in order to facilitate the preparation of data files in a SPIRA environment.

Communication interfaces to other computation systems also make it possible to perform other types of studies about electrical systems. As an example, it is possible, by means of the SICRE simulator, to analyze the short-term and long-term system dynamics by taking into account, with the help of detailed models, the behaviour of control and protection equipment operating on the system itself at local, regional or national levels.

6.17.6 OTHER TOOLS LINKED TO SPIRA

No other projects related to.

6.17.7 EXPECTED CIM FUNCTIONALITIES

CESI participated to the first IOP tests for UCTE held in Paris in 2009 with SPIRA, and since there this tool (usually used in planning departments) is continuously maintained and developed with the new release of the profiles. In the future SPIRA will follow the evolutions of the profile of CIM.

6.18 TIBCO INTELLIEDGE FOR CIM

6.18.1 VENDOR PRESENTATION

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®.

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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 to seize opportunities, mitigate risks, and avoid threats.

Together, these capabilities add up to real-time business and give organizations what TIBCO calls The Power of Now®:

TIBCO's Future: Business Optimization - Enabling PREDICTIVE BUSINESS®

TIBCO is working toward enabling a future in which organizations will have such a complete and current understanding of their operations and markets that you can identify and address threats and opportunities before they impact your operations, customers or 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 occurring throughout your enterprise and the markets you serve.
- The ability to seamlessly merge historical data with real-time information to aid in the identification and optimal resolution of situations that you've faced before.
- The ability to apply extremely sophisticated rules to automate that identification and resolution when human intervention shouldn't be required.

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- The ability to manage data coming from all of your disparate systems and information sources.

6.18.2 TOOL DESCRIPTION - INTELLIEDGE FOR CIM

For many organizations, the ultimate goal is to create an integrated enterprise – what TIBCO calls the real-time enterprise. SOA connects people, processes, and information by integrating systems and providing a platform to develop new functionality while getting the most out of existing investments. Master Data Management 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. Some organizations consider MDM to be a subset of the overall SOA strategy rather than a separate discipline, further reinforcing the role of MDM within an SOA. Regardless, SOA augmented with MDM provides IT organizations the tools to boost productivity and cut application development costs. More importantly, it gives them the ability to rapidly roll out new solutions that take advantage of accurate up-to-the-minute data about the company's products, customers, and vendors. It ensures that information is being properly managed and utilized throughout the organization to help the company achieve its business objectives.

Multi-Domain Platform

TIBCO provides a single platform to manage all types of master data (product, customer, vendor, asset, network equipment, network topologies, employee, etc.). In doing so, TIBCO provides a best-of-breed solution to address immediate requirements with the ability to gracefully scale the solution as needs evolve. Not only does a single platform provide a low total cost of ownership, but it allows customers to manage and view relationships across data domains such as different types of electrical network equipment and their topological connectivity within the network.

Process-Centric Approach

TIBCO takes a process-centric approach to managing master data by providing customizable processes to introduce, edit, and publish data – ensuring that clean data remains clean over time.

Service-Oriented Architecture

Through a loosely coupled architecture, pre-packaged web services, and 20+ years of experience in integration and distributed computing, TIBCO provides information alignment and consistency across systems so that business services and composite applications within an SOA have accurate, consistent, and timely information. The embedded distributed cache ensures that master data is served-up in a highly available manner via services to requesting application.

Real-Time and Event-Driven

TIBCO IntelliEDGE for CIM solution is built on a real-time event platform, allowing organizations to respond to business 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 Google-type 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

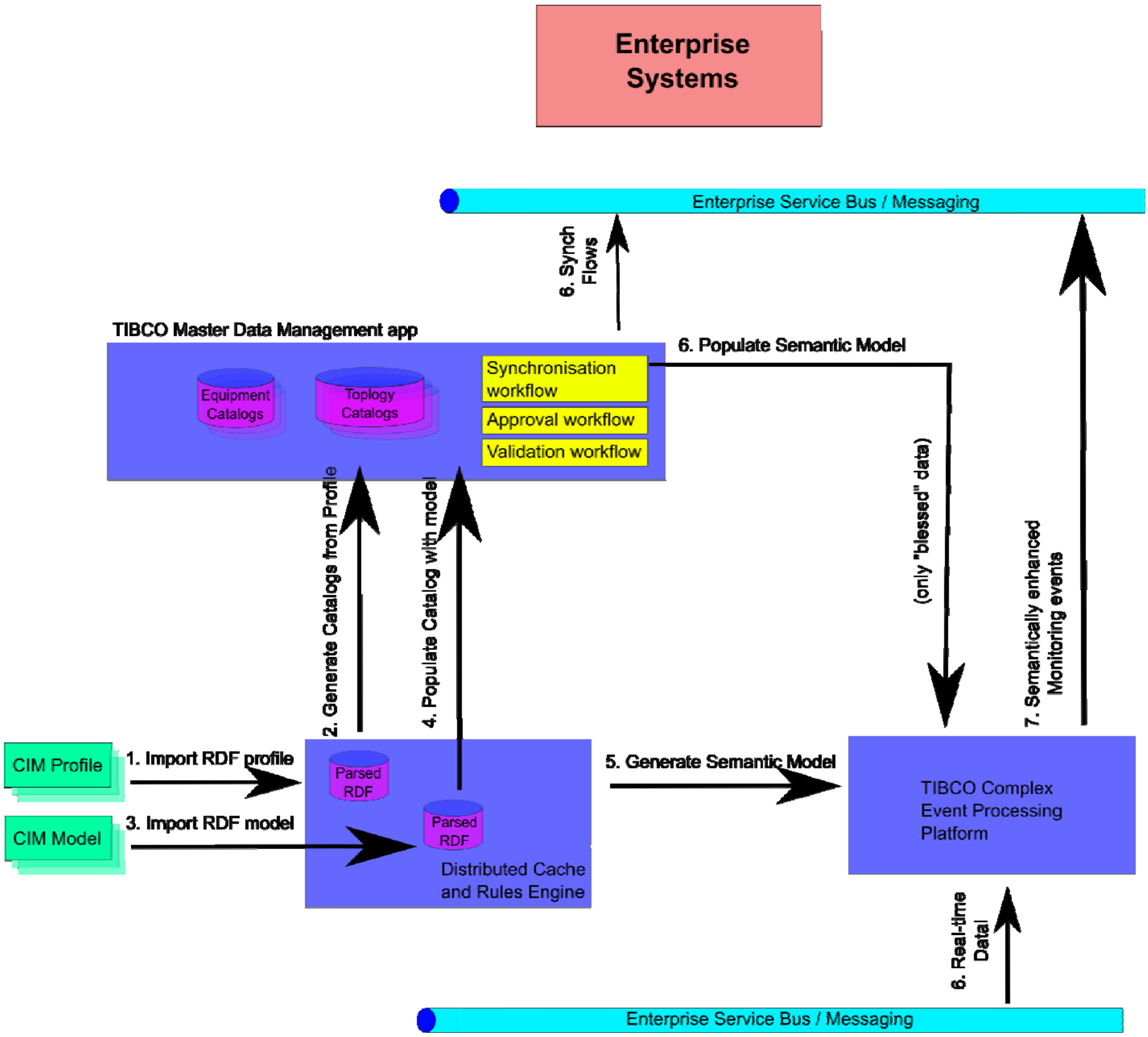
Robust Architecture

- 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

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.



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:

- Master catalogue creation 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, also validation rules and initialization rules are generated based on constraint definitions as captured in the CIM Profile definitions.

- Creation of relationships and hierarchies between equipment modules, representing electrical connectivity and topology as derived from the corresponding CIM Profile definitions.

- Creation of 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.

- Creation of 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.

6.18.3 OTHER TOOLS LINKED TO THE TIBCO INTELLIEDGE FOR CIM

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™** is one of the leading service creation, orchestration, and integration products on the market. It has been deployed by over 1,000 companies worldwide and is the foundation for several of the largest mission critical service-oriented business applications in production today. Built entirely 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. This is the core of TIBCO's SOA/ESB product suite.

- **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. 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).

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6.18.4 EXPECTED CIM FUNCTIONALITIES

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 on operations optimization, addressing the costs of time and money associated with sub-optimal business activities in pursuit of asset condition management and process execution efficiency associated with system operator's core business model. This business functionality will be delivered through the marketing leading capability of TIBCO's Complex Event Processing (CEP) Platform in conjunction with the wider TIBCO technology suite. The solution framework leverages the CIM data model as a Common Data Model to accelerate the creation of a real-time integrated and event-driven operations environment for utility system operators. As part of the development of the TIBCO IntelliEDGE for CIM, TIBCO expects to further leverage the CIM data model in order to:

- Implement both import- and export-functionalities, 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
- Further develop the solution based template to maintain the semantic data model based on CIM including entities and relations.
- Develop event based (synchronous and asynchronous) routing and filtering, implemented in TIBCO BusinessEvents based on a CIM derived common data model. It is the responsibility of the routing and filtering subcomponent to introspect incoming requests, queries or other events and route them to the appropriate endpoint, i.e. back end system or client application. The solution works closely with cached semantic model, meta data, subscription management and subcomponent for transformation and validation.
- 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.

6.19 UIB ADAPTER FOR USE WITH THE OSISOFT PI SYSTEM

6.19.1 VENDOR PRESENTATION

Systems Integration Specialists Company (SISCO, Inc). is a privately held company founded in 1983 and based in. SISCO was originally founded with a focus on applying modern computer technology to industrial automation. SISCO soon became involved in international communications standards and developed products to make the implementation of standards

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based systems feasible. Since then, SISCO has established itself as a world leader in providing cost-effective standards based communications and integration solutions.

Today, SISCO software is used in a wide variety of industries from electrical power transmission, distribution and generation systems to manufacturing and postal automation equipment. SISCO serves both end users and OEMs. SISCO's proven track record of working effectively with OEMs and integrators has been a key to the success of standards based solutions in the industries we serve. SISCO's ability to partner with OEMs in non-competitive ways has allowed us to become the world-wide leader in providing the software that glues together the many large multi-national power system data exchange networks that are being built today. Working with SISCO allows our OEM and integrator partners to deliver more capabilities to their customers at a lower total cost of ownership and with lower technical risk. End users working with SISCO are assured that they have chosen a reliable supplier that can be counted on to work effectively with their other suppliers to deliver a working solution.

Corporate Headquarters: 6605 19 1/2 Mile Road, Sterling Heights, MI 48314, USA
Main Telephone Number: +1-586-254-0020
Website: http://www.sisconet.com

6.19.2 TOOL DESCRIPTION

SISCO's Utility Integration Bus (UIB) adapter for use with 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 adapter receives modelling information, such as a network connectivity model typically maintained by a network modelling tool, EMS,DMS, or GIS system; and automatically configures the PI Analysis Framework (AF) 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 IEC'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 AF entries, and PI configuration needed. The UIB and PI System provide a unique cost saving solution for electric utility users that minimizes manual reconfiguration.

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 PI AF. Supports IEC CIM imports and procedures for:
  - Schema creation through the merging of CIM profile files.
  - Full model imports
  - Incremental Model Imports
  - Merging of Model Instance files through the use of Model Authorities and CIM Model File Headers

  - Built in validation of instance files versus schema/profiles.
- 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.
- Provides a Model Explorer interface that allows users to browse and edit the resulting models.

An additional capability, not tested at this IOP is that the product can auto-create PI tag names based upon the model definitions as well as integration with Enterprise Service Bus (ESB) technology for imports. This ESB capability also allows PI System information to be exposed to other applications, attached to the ESB, through the SISCO Utility Integration Bus layer.

For a complete data sheet, see: http://www.sisconet.com/downloads/MKTLit_UIB_PI.pdf

6.19.3 Handling. Other tools linked to the UIB Adapter for use with the OSIsoft PI System

The product is part of a family of products that integrate together through the SISCO Utility Integration Bus (UIB). The UIB provides application adapters, and programmatic interfaces, based upon the CIM Generic Interface Definition (GID) standard. Through the proper deployment/integration of the UIB products, real-time data can be exchanged within the context of the CIM model over ESB middlewares such as IBM, Tibco, WebMethods, etc.

For more detailed information, see the following link: http://www.sisconet.com/uib.htm

6.19.4 Expected CIM functionalities

The adapter is a core product component from which other products/systems can be created. Its flexibility allows for it to be used as a basis to:

- Emission of IEC 61968-9 CIM messages
- Condition Based Maintenance Applications
- Wide Area protection schemes
- Synchrophasor applications
- User developed applications

7 APPENDIX B: TEST PROCEDURES

7.1 TEST RULES

7.1.1 ON-SITE RULES

On-site test will start on 12 July 2010 and will last 5 days. Test participants should be present in the ENTSO-E premises between 8:30h and 17:30h.

The following ground rules will be followed during this test:

- Test witness and test witness substitute, if any, will need to familiarize themselves with the test models and be able to witness the validation of the model contents within the test participants tool and within the validation tools used in the test. The test witness may move between test participants if needed. The test participants (vendors) will actually execute all tests and complete the internal validation as well as execute the validation tools for the external file validation. The test witness will ensure all steps are executed and all issues are noted. The test witness will also score (Pass, Pass with error, Fail) each test.

- The test participant (vendor) will download the model files to be imported from the file storage location and the model files produced by the test participant will be uploaded to the agreed file server for use by other participants. The test participants will be responsible for the CIM/XML file validation and for ensuring that the files produced during the test are loaded onto the file server. However, the test witness should assist the test participant with these tasks as much as possible. At a minimum, the test witness should ensure the files are included on the file server. The test director will ensure the contents of the file server are backed-up to a memory stick each day and will make the contents available to all test attendees upon request prior to the end of the IOP.

- Vendors must submit the product release (version ID) for the software under test. If the software is not production grade, indicate when the production release will contain this software.

- Unstructured tests may be performed if there is time and the test participant wishes to complete these tests. Any unstructured test must be documented on the test record form by the test witness for inclusion into the IOP report. Each step of the procedure followed must be fully documented.

- The test files used in the ENTSO-E IOP must contain all required classes and attributes defined in the ENTSO-E profile.

- The test participants may select what test cases and test procedure they wish to execute. The IOP report will present the results for all files used and all procedures executed.

7.1.2 IOP AGENDA

- Monday, 12 July 2010
  - 8:30h - Welcome, Introductions and Practical information – Chavdar Ivanov
  - 9:00h
    - Vendors meet in test room and complete set up
    - Test witnesses meet with Chavdar Ivanov to review the procedures and forms (30)
  - 10:00h - Vendors perform dry run testing
  - 10:30h-17:00h - Interoperability testing
  - 17:00h-17:30h - Summary of the day review (test progress, discuss test status, schedule for the next day)
- Tuesday, 13 July 2010
  - 8:30h-17:00h - Interoperability testing
  - 17:00h-17:30h - Summary of the day review (test progress, discuss test status, schedule for the next day)
- Wednesday, 14 July 2010
  - 8:30h-17:00h - Interoperability testing
  - 17:00h-17:30h - Summary of the day review (test progress, discuss test status, schedule for the next day)
- Thursday, 15 July 2010
  - 8:30h-15:00h - Interoperability testing
  - 15:00h-15:30h - Summary of the day review (test progress, discuss test status, schedule for the next day)
  - 15:30h-17:30h – Discussion on identified issues agreements on profile changes, if necessary
  - ENTSO-E invites you for a dinner!
- Friday, 16 July 2010

- 8:30h-12:00h - Interoperability testing
- 12:00h-14:00h - Review the results with each vendor/test witness individually to ensure all reports and results are clear – Chavdar Ivanov
- 14:00h-16:00h – Discussion on identified issues agreements on profile changes, if necessary
- 16:00h – 17:30h – Agreements on Final IOP report: CIM issues to be listed, recommendations to IEC, issues to be further discussed within ENTSO-E, etc. Discussion on action plan after the IOP – to do list for the next IOP.

7.1.3 VALIDATION TOOLS

ENTSO-E profile is supported by the following tools: CIMTool, CIMSpy and CIMPhony. These tools can be used by test participant to validate exported xml files.

7.1.4 FILE NAMING DURING THE IOP

Due to the usage of file headers, vendors should not count on file names to identify information about file types (equipment, topology, state variables and dynamics). This information has to be obtained using file header.

In order to facilitate file organization during the test the following abbreviations are included in the file name to track import/export actions:

- **EQ**: Equipment file
- **TP**: Topology file
- **SV**: State variables file
- **DY**: Dynamics file
- **EQb**: Boundary file (equipment)
- **TPb**: Boundary file (topology)
- **NE**: BCP Busarello + Cott + Partner AG (NEPLAN)
- **OD** for PSS®ODMS, **S** for PSS®E: Siemens Power Technologies International (PSS®ODMS; PSS®E)
- **SP** for SPIRA, **CR** for CRESO, **SI** for SICRE: CESI (SPIRA; CRESO; SICRE)
- **EU**: Tractebel and RTE (EUROSTAG)
- **NM**: ABB Power Technologies (ABB Network Manager)
- **CP**: Open Grid Systems (Cimphony)

- **IN**: FGH (INTEGRAL7)
- **PI**: SISCO (UIB Adapter for PI-AF)
- **BM**: ABB (BMS CIM Explorer)
- **IS**: Intercompro AG (ISPEN)
- **PS**: EMS (Power System Analyzer, PSA)
- **TS** for e-terrasource, **TP** for e-terraplatform: AREVA T&D (e-terrasource; e-terraplatform)
- **GE** for GEDEON Database, **CS** for CIMclipse, **CC** for CIM-ENTSO-E Converters: EDF R&D (GEDEON Database; CIMclipse; CIM-ENTSO-E Converters)
- **PF**: DIgSILENT GmbH (PowerFactory 14.1)
- **AM**: TIBCO (TIBCO ActiveMatrix platform)
- **EG**: GE Energy (Enterprise Gateway)

An example of a file name for equipment file exported by DIgSILENT GmbH (PowerFactory 14.1) is: ENTSO-E_16_EQ_PF_12J14h.xml. 12J14h indicates that the file has been exported on 12 July 2010 at 14:00h.

7.1.5 FILE TRANSFER

ENTSO-E IOP will use local file server to support file exchange among vendors.

Connection address:

- \\172.16.12.4\Public
- Login: nas
- Password: nas

Access will be provided via:

- Wi-Fi (**<u>to be used in Room 1 and Room 2</u>**):
  - ENTSO-E_GUESTS
  - Password: 3nts03_guest
- LAN with 2 switches (24 ports each) is installed in Room 3. **<u>Participants in Room 3 should not use Wi-Fi</u>**

60 GB HDD is accessible via Wi-Fi and LAN. Internet access is also provided via the same Wi-Fi and LAN.

Memory sticks can be used to backup data. All files produced during the ENTSO-E IOP will be uploaded in the CIMug site (www.cimug.org) at the end of each test date.

7.1.6 TEST RECORD FORMS

ENTSO-E IOP will use two types of test record forms:

- Tool summary form – one record form per tool. In case the tool participates in many tests additional form can be filled in.
- Single test record form – this is the record form that should be used to record results from single tests.

7.1.6.1 TOOL SUMMARY FORM

- The form is completed by vendors
- The form is completed electronically in a single Word document and printed in two copies (one original for the vendor, one original for ENTSO-E) and signed by vendor, test witnesses and ENTSO-E. Scanned version of the form will be part of the final IOP report (Appendix)
- The form provides information on the vendor and on which tool is tested
- The form lists all test witnesses that witnessed that particular tool.
- „Test No“ is a reference number which refer to the „Single test record form“, e.g. 3_4 means test No3 (from the test procedure 1.2.3 is the test No3), 4th time of execution of this test.
- Summarizes the results from all tests that are performed
- Comments are included in „Comments“ section. Comments can be: CIM issues, references to documents that provide additional information on particular issues, etc. Comments section must include a list of other tools with which this tool demonstrates interoperability. Comments section must include a list of tests that have not been performed. All tests that are not performed should be grouped according to the reason why they have not been performed and short information on the reason must be provided (e.g. time constrain, limitation in tool’s functionalities this is not supported by the tool, require additional development time). The comments must also include short information on the vendor’s intention to cover this functionality in next releases.
- The form can be extended (additional lines created) in case of need to add additional comments or lines for tests that were performed

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- The vendor updates this table on daily basis and submits it to the test director from ENTSO-E for inclusion in the final IOP report.

7.1.6.2 SINGLE TEST RECORD FORM

- The form is completed by vendors
- The form is completed electronically in a single Word document and printed in two copies (one original for the vendor, one original for ENTSO-E) and signed by vendor, test witnesses. Scanned version of the form will be part of the final IOP report (Appendix)
- The form provides information on the vendor and on which tool is tested in that particular test.
- „Test No" is a reference number, e.g. 3_4 means test No3 (from the test procedure 1.2.3 is the test No3), 4th time of execution of this test.
- „Comments/Results/Issues" section can include: CIM issues, any information required by the test procedure, other information by test witness, etc.
- „Suplementary files" section includes: references to documents that provides additional information on particular issues, file name of screenshots, etc. Please specify the purpose of each file.
- The form can be extended (additional lines created) in case of need to add additional comments, etc
- The form (signed by vendor and test witness) is submitted to the test director (ENTSO-E) together with tool summary form for inclusion in the final IOP report.

7.2 TEST PROCEDURES DESCRIPTION

7.2.1 IMPORT OF FULL LOAD FLOW MODEL

7.2.1.1 OBJECTIVE

The aim of this test is to prove that full load flow model is properly imported in the tool.

7.2.1.2 DESCRIPTION

Full set of test model is used: equipment, topology and state variables files. A single MAS (a TSO model) model is imported together with boundary MAS or boundary MAS is imported before the "TSO model". The following procedure is applied:

- Vendor A imports all three files (equipment, topology and state variables). The import considers the rule for importing boundary MAS. Imported files can be official test files or exported files from other tests.

- Vendor A executes a load flow to demonstrate that the models can be solved.
- Test witnesses check instance data and load flow results;

7.2.1.3 TEST RECORD

The following information should be recorded in the test form:

- File names of the imported xml files;
- Which instance data (types of instance data) was checked;
- At least one screenshot that show imported instance data has to be referenced as a supplementary document.

7.2.2 EXPORT OF FULL LOAD FLOW MODEL

7.2.2.1 OBJECTIVE

The aim of this test is to prove that full load flow model is properly exported from the tool. Exported files are used to demonstrate interoperability among vendors.

7.2.2.2 DESCRIPTION

Full set of test model is used: equipment, topology and state variables files. A single MAS (a TSO model) model is used. The following procedure is applied:

- Vendor A uses imported files from the test 1.2.1;
- Vendor A exports all three files (equipment, topology and state variables) as a single model authority set (a TSO model). Export of boundary MAS is not required.
- Vendor A validates exported set of files using validation tools
- Test witnesses check instance data/validation report using validation tools;

7.2.2.3 TEST RECORD

The following information should be recorded in the test form:

- File names of the imported xml files;
- File names of the exported xml files;
- Which instance data (types of instance data) was checked;
- At least one screenshot that shows imported instance data has to be referenced as a supplementary document;
- One screenshot that shows validation report has to be referenced as a supplementary document.

7.2.3 Comparison of the load flow results between tools

7.2.3.1 Objective

The aim of this test is to demonstrate interoperability among vendors. Load flow results should match in an engineering tolerance (max 5%).

7.2.3.2 Description

Full set of test models are used: equipment, topology and state variables files. The models that will be compared have a single model authority set (TSO models). This test can be performed using both official test files and exported files from test 1.2.2. The following procedure is applied:

- Vendor A (Tool A) and vendor B (Tool B) can use already imported files from the test 1.2.1 or import new xml files;
- Vendor A (Tool A) and vendor B (Tool B) execute a load flow.
- Test witnesses compare load flow results between Tools;

7.2.3.3 Test record

The following information should be recorded in the test form:

- File names of the imported xml files;
- Which solution parameters were checked;
- At least one screenshot (from Tool A) that shows solution results has to be referenced as a supplementary document;
- At least one screenshot (from Tool B) that shows solution results has to be referenced as a supplementary document;

7.2.4 Apply topology changes and export topology and state variables files only

7.2.4.1 Objective

The aim of this test is to demonstrate the ability of the tool to export topology and state variables files only.

7.2.4.2 Description

Full set of test model (a single MAS - TSO model) model is used: equipment, topology and state variables files. This test is performed using both official test files and exported files from test 1.2.2. The following procedure is applied:

- Vendor A can use imported files from the test 1.2.1 or import already exported files from test 1.2.2;
- Vendor A applies topology changes suggested by test witness.
- Vendor A executes a load flow
- Vendor A exports topology and state variable files and validates them using CIM validation tools;

7.2.4.3 TEST RECORD

The following information should be recorded in the test form:

- File names of the imported xml files;
- File names of the exported xml files (topology and state variables);
- Which topology changes were applied;
- At least one screenshot that shows new solution results has to be referenced as a supplementary document;
- At least one screenshot that shows validation results has to be referenced as a supplementary document;

7.2.5 APPLY SOLUTION CHANGES (GENERATION, LOAD, VOLTAGE REFERENCES) AND EXPORT STATE VARIABLES FILE ONLY

7.2.5.1 OBJECTIVE

The aim of this test is to demonstrate the ability of the tool to export state variables file only.

7.2.5.2 DESCRIPTION

Full set of test model (a single MAS – TSO model) is used: equipment, topology and state variables files. This test is performed using both official test files and exported files from test 1.2.2. The following procedure is applied:

- Vendor A can use imported files from the test 1.2.1;
- Vendor A applies changes (generation, load, voltage references, etc.) suggested by test witness.
- Vendor A executes a load flow
- Vendor A exports a state variable file and validates it using CIM validation tools;

7.2.5.3 TEST RECORD

The following information should be recorded in the test form:

- File names of the imported xml files;
- File names of the exported xml file (state variables);
- Which state variables changes were applied;
- At least one screenshot that shows new solution results has to be referenced as a supplementary document;
- At least one screenshot that shows validation results has to be referenced as a supplementary document;

7.2.6 IMPORT OF TOPOLOGY AND STATE VARIABLES FILES ONLY AND COMPARISON OF THE LOAD FLOW RESULTS BETWEEN TOOLS

7.2.6.1 OBJECTIVE

The aim of this test is to demonstrate the ability of the tool to import topology and state variables files only (update of an imported project). The test also demonstrates interoperability between vendors. Load flow results should match in an engineering tolerance (max 5%).

7.2.6.2 DESCRIPTION

The model that have a single model authority set - TSO model is used. This test is performed using both official test files and exported files from test 1.2.2. The following procedure is applied:

- Vendor A and vendor B import an equipment file from the official test files or from exported files (test 1.2.2). Boundary MAS is imported in order to complete the TSO model.
- Vendor A and vendor B import topology and state variables files exported in test 1.2.4.
- Vendor A and vendor B executes a load flow;
- Test witnesses compare load flow results.

7.2.6.3 TEST RECORD

The following information should be recorded in the test form:

- File names of the imported xml file (equipment);

- File names of the imported xml files (boundary MAS);
- File names of the imported xml files (topology and state variables);
- At least one screenshot that shows solution results (Tool A) has to be referenced as a supplementary document;
- At least one screenshot that shows solution results (Tool B) has to be referenced as a supplementary document;

7.2.7 IMPORT OF A STATE VARIABLES FILE ONLY AND COMPARISON OF THE LOAD FLOW RESULTS BETWEEN TOOLS

7.2.7.1 OBJECTIVE

The aim of this test is to demonstrate the ability of the tool to import state variables file only. The test also demonstrates interoperability between vendors. Load flow results should match in an engineering tolerance (max 5%).

7.2.7.2 DESCRIPTION

The model that have a single model authority set - TSO model is used. This test is performed using both official test files and exported files from test 1.2.2. The following procedure is applied:

- Vendor A and vendor B import equipment and topology files from the official test files or from exported files (test 1.2.2). Boundary MAS is imported in order to complete the TSO model.
- Vendor A and vendor B import a state variables file exported in test 1.2.5.
- Vendor A and vendor B executes a load flow;
- Test witnesses compare load flow results.

7.2.7.3 TEST RECORD

The following information should be recorded in the test form:

- File names of the imported xml files (equipment and topology);
- File names of the imported xml files (Boundary MAS);
- File names of the imported xml file (state variables);
- At least one screenshot that shows solution results (Tool A) has to be referenced as a supplementary document;

- At least one screenshot that shows solution results (Tool B) has to be referenced as a supplementary document;

7.2.8 Comparison of the short-circuit results between tools

7.2.8.1 Objective

The aim of this test is to demonstrate the ability of the tool to import short circuit data. The test also demonstrates interoperability between vendors. Short-circuit results should match in an engineering tolerance.

7.2.8.2 Description

This test is performed using both official test files and exported files from test 1.2.2. The following procedure is applied:

- Vendor A and vendor B import all three files (equipment, topology and state variables) from the official test files or from exported files (test 1.2.2). Boundary MAS is imported in order to complete the TSO model.
- Vendor A and vendor B perform a short-circuit calculation (a three phase short-circuit and an unbalanced fault).
- Test witnesses compare short-circuit results.

7.2.8.3 Test record

The following information should be recorded in the test form:

- File names of the imported xml files (equipment, topology, state variables and boundary MAS);
- At least one screenshot that shows short-circuit results (Tool A) has to be referenced as a supplementary document;
- At least one screenshot that shows short-circuit results (Tool B) has to be referenced as a supplementary document;

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7.2.9 IMPORT OF FULL LOAD FLOW MODELS FROM DIFFERENT MODEL AUTHORITY SETS, MERGE OF THESE MODELS AND EXPORT OF FULL MERGED MODEL (EQUIPMENT FILES, TOPOLOGY FILES, A STATE VARIABLES FILE AND BOUNDARY FILES)

7.2.9.1 OBJECTIVE

The aim of this test is to prove that tools can import full load flow models from different model authority sets (MAS). This test simulates merging process and demonstrated the ability of the tool to update one of the MAS in the merged model.

7.2.9.2 DESCRIPTION

Models from different model authority sets are imported. This test is performed using both official test files (ENTSO-E 16 nodes – 2 areas) and exported files. The following procedure is applied:

- Vendor A imports boundary files (equipment and topology). Boundary MAS is imported first or together with other MAS (next two steps).
- Vendor A imports all required files (equipment, topology and state variables) for MAS A (Area 1);
- Vendor A imports all required files (equipment, topology and state variables) for MAS B (Area 2).
- Vendor A merges Area 1 and Area 2 and performs load flow solution (Solution 1)
- Vendor A exports merged model - 2 equipment files (one per each MAS), 2 topology files (one per each MAS), 2 boundary files (equipment and topology) and **1 state variables file**.
- Vendor A validates exported set of files using validation tools
- Vendor A imports files resulted from test 1.2.4 (topology and state variable files are combined with the right equipment file). Therefore the vendor updates one of the MAS (Area 1 or Area 2)
- Vendor A performs load flow solution (Solution 2)

7.2.9.3 TEST RECORD

The following information should be recorded in the test form:

- File names of the imported xml files - 2 equipment, 2 topology, 2 state variables and 2 boundary files (equipment and topology);

- File names of the imported xml files (1 equipment, 1 topology and 1 state variables) – updated MAS;
- File names of the exported xml files - 2 equipment, 2 topology, 1 state variables and 1 boundary files (equipment and topology);
- At least one screenshot that shows load flow results (Solution 1) of the merged model has to be referenced as a supplementary document;
- At least one screenshot that shows load flow results (Solution 2) of the merged model has to be referenced as a supplementary document;

7.2.10 IMPORT OF FULL MERGED MODEL (EQUIPMENT FILES, TOPOLOGY FILES, A STATE VARIABLES FILE AND BOUNDARY FILES). COMPARISON OF THE LOAD FLOW RESULTS OF FULL MERGED MODEL BETWEEN TOOLS

7.2.10.1 OBJECTIVE

The aim of this test is to prove that tools can import merged model which contains different MAS. This test can also be used to compare Solution 2 from test 1.2.9

7.2.10.2 DESCRIPTION

This test is performed using exported models from the test 1.2.9. The following procedure is applied:

- Vendor A imports all files exported in 1.2.9 - 2 equipment, 2 topology, 1 state variables and 2 boundary files (equipment and topology);
- Vendor A performs load flow solution
- Vendor A and Vendor B compare load flow results

7.2.10.3 TEST RECORD

The following information should be recorded in the test form:

- File names of the imported xml files - 2 equipment, 2 topology, 1 state variables and 2 boundary files (equipment and topology);
- At least one screenshot that shows load flow results from Tool A of the merged model has to be referenced as a supplementary document;
- At least one screenshot that shows load flow results from Tool B of the merged model has to be referenced as a supplementary document;

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7.2.11 APPLY EQUIPMENT CHANGES AND EXPORT EQUIPMENT DIFFERENCE FILE AND FULL TOPOLOGY AND STATE VARIABLES FILES

7.2.11.1 OBJECTIVE

The aim of this test is to demonstrate exchange of difference files.

7.2.11.2 DESCRIPTION

This test is performed using exported models from previous tests. The following procedure is applied:

- Vendor A applies changes suggested by the test witness. These changes should be in the equipment part of the model;
- Vendor A performs load flow solution and records the results
- Vendor A exports difference models for equipment and full topology and state variables files
- Vendor A validates exported files

7.2.11.3 TEST RECORD

The following information should be recorded in the test form:

- File names of the imported xml files (equipment, topology, state variables);
- List all changes that have been applied
- At least one screenshot that shows load flow results has to be referenced as a supplementary document;
- At least one screenshot that shows validation results has to be referenced as a supplementary document;

7.2.12 IMPORT OF DIFFERENCE FILES (EQUIPMENT) AND FULL TOPOLOGY AND STATE VARIABLES FILES. COMPARISON OF THE LOAD FLOW RESULTS BETWEEN TOOLS

7.2.12.1 OBJECTIVE

The aim of this test is to demonstrate interoperability when importing difference files.

7.2.12.2 DESCRIPTION

This test is performed using exported models from previous tests (1.2.11). The following procedure is applied:

- Vendor A and Vendor B apply importing procedure that takes into account that difference models of equipment need to be imported. Topology and state variable files are imported in full.
- Vendor A and Vendor B perform load flow solution and records the results
- Test witnesses compare load flow results.

7.2.12.3 TEST RECORD

The following information should be recorded in the test form:

- File names of the imported xml files (equipment, topology, state variables) including difference models;
- At least one screenshot that shows load flow results (from Tool A) has to be referenced as a supplementary document;
- At least one screenshot that shows load flow results (from Tool B) has to be referenced as a supplementary document;

7.2.13 APPLY EQUIPMENT CHANGES ON FULL MERGED MODEL AND EXPORT DIFFERENCE FILE (EQUIPMENT) AND FULL TOPOLOGY AND STATE VARIABLES FILES

This test is the same as test 1.2.11 with the only difference that changes are applied in equipment file from different MAS. The same procedure as 1.2.11 is followed.

7.2.14 IMPORT OF DIFFERENCE FILE (EQUIPMENT) AND FULL TOPOLOGY AND STATE VARIABLES FILES FOR FULL MERGED MODEL AND COMPARISON OF THE LOAD FLOW RESULTS BETWEEN TOOLS

This test is the same as test 1.2.12. Difference file (equipment) coming from different MAS is imported. The same procedure as 1.2.12 is followed.

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7.2.15 IMPORT OF FULL DYNAMIC MODEL THAT CONTAINS STANDARD MODELS ONLY

7.2.15.1 OBJECTIVE

The aim of this test is to prove that vendors can import data for dynamics studies.

7.2.15.2 DESCRIPTION

Five types of files are used in this test: equipment, topology, state variables, boundary and dynamics. Equipment, topology, state variables and boundary files can be official files or files exported during previous tests. The following procedure is applied:

- Vendor A applies importing procedure that takes into account different model authority sets.
- Test witness checks instance data
- Vendor A runs load flow and initializes the model.

7.2.15.3 TEST RECORD

The following information should be recorded in the test form:

- File names of the imported xml files (equipment, topology, state variables, boundary, dynamics);
- At least one screenshot that shows imported instance data has to be referenced as a supplementary document;
- At least one screenshot that shows load flow result and initialization conditions has to be referenced as a supplementary document;

7.2.16 EXPORT OF FULL DYNAMIC MODEL THAT CONTAINS STANDARD MODELS ONLY

7.2.16.1 OBJECTIVE

The aim of this test is to prove that vendors can export data for dynamics studies.

7.2.16.2 DESCRIPTION

The files imported in the test procedure 1.2.15 are used for this test. Equipment, topology, state variables and boundary files can be official files or files created during previous tests. The following procedure is applied:

- Vendor A exports all files taking into account different model authority sets.

- Vendor A validates exported files.
- Test witness checks instance data.

7.2.16.3 TEST RECORD

The following information should be recorded in the test form:

- File names of the imported xml files (equipment, topology, state variables, boundary, dynamics);
- File names of the exported xml files (equipment, topology, state variables, boundary, dynamics);
- At least one screenshot that shows imported instance data has to be referenced as a supplementary document;
- At least one screenshot that shows exported instance data has to be referenced as a supplementary document;
- At least one screenshot that shows validation report has to be referenced as a supplementary document;

7.2.17 COMPARISON OF THE DYNAMIC SIMULATION RESULTS BETWEEN TOOLS (FOR MODEL USING STANDARD MODELS)

7.2.17.1 OBJECTIVE

The aim of this test is to demonstrate the interoperability between vendors. Simulation results should match in an engineering tolerance.

7.2.17.2 DESCRIPTION

This test is performed using imported files in test 1.2.15. The following procedure is applied:

- Vendor A and vendor B import all files required for dynamics simulation (equipment, topology, state variables, boundary and dynamics);
- Vendor A and vendor B perform apply a fault (a three phase short-circuit and an unbalanced fault) or step response (Vref=±5% Vref). The simulation is run for at least 10 sec. The following signals are recorded during the simulations: Vref, Pgen (P flow), Qgen (Q flow), V.
- Test witnesses compare simulation results.

7.2.17.3 TEST RECORD

The following information should be recorded in the test form:

- File names of the imported xml files (equipment, topology, state variables, boundary, dynamics);
- At least one screenshot that shows simulation results (Tool A) has to be referenced as a supplementary document;
- At least one screenshot that shows simulation results (Tool B) has to be referenced as a supplementary document;

7.2.18 IMPORT OF A DYNAMIC FILE THAT CONTAINS USER-DEFINED MODEL WITH STANDARD CONNECTIONS

The test is identical with test 1.2.15. The focus is on importing a User-defined model that will replace one or more standard models components. The same procedure as 1.2.15 is followed.

7.2.19 EXPORT OF A DYNAMIC FILE THAT CONTAINS USER-DEFINED MODEL WITH STANDARD CONNECTIONS

The test is identical with test 1.2.16. The focus is on exporting a User-defined model that will replace one or more standard models components. The same procedure as 1.2.16 is followed.

7.2.20 COMPARISON OF THE DYNAMIC SIMULATION RESULTS BETWEEN TOOLS (FOR MODEL USING USER-DEFINED MODEL WITH STANDARD CONNECTIONS)

The test is identical with test 1.2.17. The same procedure as 1.2.17 is followed.

7.2.21 IMPORT OF A DYNAMIC FILE THAT CONTAINS USER-DEFINED MODEL WITHOUT STANDARD CONNECTIONS

The test is identical with test 1.2.15. The focus is on importing a User-defined model that will replace one or more standard models components and applying changes in standard connections. The same procedure as 1.2.15 is followed.

7.2.22 EXPORT OF A DYNAMIC FILE THAT CONTAINS USER-DEFINED MODEL WITHOUT STANDARD CONNECTIONS

The test is identical with test 1.2.16. The focus is on exporting a User-defined model that will replace one or more standard models components and applying changes in standard connections. The same procedure as 1.2.16 is followed.

7.2.23 COMPARISON OF THE DYNAMIC SIMULATION RESULTS BETWEEN TOOLS (FOR MODEL USING USER-DEFINED MODEL WITHOUT STANDARD CONNECTIONS)

The test is identical with test 1.2.17. The same procedure as 1.2.17 is followed.

7.2.24 IMPORT OF A DYNAMIC FILE THAT CONTAINS PROPRIETARY MODEL

The test is identical with test 1.2.15. The focus is on importing a proprietary model that will replace one or more standard models. The same procedure as 1.2.15 is followed.

7.2.25 EXPORT OF A DYNAMIC FILE THAT CONTAINS PROPRIETARY MODEL

The test is identical with test 1.2.16. The focus is on exporting a proprietary model that will replace one or more standard models. The same procedure as 1.2.16 is followed.

7.2.26 COMPARISON OF THE DYNAMIC SIMULATION RESULTS BETWEEN TOOLS (FOR MODEL USING A PROPRIETARY MODEL)

The test is identical with test 1.2.17. The same procedure as 1.2.17 is followed.

7.2.27 EXPORT OF A "PLANNING" MODEL USING AN "OPERATIONAL" MODEL (SCADA/EMS VENDORS ONLY)

7.2.27.1 OBJECTIVE

The aim of this test is to prove the ability of SCADA/EMS vendors to export a "planning" model using an "operational" model.

7.2.27.2 DESCRIPTION

This test is performed using xml files (operational – detailed model) used in CPSM Interoperability Test. The following procedure is applied:

- Vendor A imports all files required by CPSM Profile;
- Vendor A exports the same model but compliant with the ENTSO-E Profile.
- Vendor A validates exported files
- Test witness checks instance data and validation report.

7.2.27.3 TEST RECORD

The following information should be recorded in the test form:

- File names of the imported xml files;
- File names of the exported xml files;
- At least one screenshot that shows instance data of the imported model has to be referenced as a supplementary document;
- At least one screenshot that shows validation results has to be referenced as a supplementary document;

7.2.28 IMPORT OF A "PLANNING" MODEL RESULTED FROM AN "OPERATIONAL" MODEL ("PLANNING" VENDORS ONLY) AND COMPARISON OF THE LOAD FLOW RESULTS BETWEEN TOOLS

7.2.28.1 OBJECTIVE

The aim of this test is to prove the ability of "Planning" vendors to import a "planning" model that results from an "operational" model and compare load flow results between planning and SCADA/EMS tools and well as among planning tools.

7.2.28.2 DESCRIPTION

This test is performed using exported xml files in test 1.2.27. The following procedure is applied:

- Vendor A (Tool A) imports all files exported in 1.2.27;
- Vendor A (Tool A) runs load flow solution;
- Vendor B (Tool B) imports all files exported in 1.2.27;
- Vendor B (Tool B) runs load flow solution;
- Test witnesses check instance data and load flow results.

7.2.28.3 TEST RECORD

The following information should be recorded in the test form:

- File names of the imported xml files;
- At least one screenshot (from Tool A) that shows solution results has to be referenced as a supplementary document;

- At least one screenshot (from Tool B) that shows solution results has to be referenced as a supplementary document;

7.2.29 IMPORT OF AN "OPERATIONAL" MODEL BY "PLANNING" VENDORS AND COMPARISON OF THE LOAD FLOW RESULTS BETWEEN TOOLS

7.2.29.1 OBJECTIVE

The aim of this test is to prove the ability of "Planning" vendors to import an "operational" model and compare load flow results between planning and SCADA/EMS tools.

7.2.29.2 DESCRIPTION

This test is performed using xml files from CPSM Interoperability Test. The following procedure is applied:

- Vendor A (Tool A) imports all files necessary to produce planning case (bus-branch model);
- Vendor A (Tool A) runs load flow solution;
- Test witness checks instance data and load flow results.

7.2.29.3 TEST RECORD

The following information should be recorded in the test form:

- File names of the imported xml files;
- At least one screenshot (from Tool A – planning tool) that shows solution results has to be referenced as a supplementary document;
- At least one screenshot (from Tool B – SCADA/EMS tool) that shows solution results has to be referenced as a supplementary document;

7.2.30 MODEL AUTHORITY SETS EXCHANGE TEST

7.2.30.1 OBJECTIVE

The MAS exchange test demonstrates that a boundary and regional set (TSO set) may be imported into a base model, creating a single model that contains the original base and the new boundary and regional model segments. This test is partly included in the test 1.2.9. Here a special attention on MAS is paid.

7.2.30.2 DESCRIPTION

The following procedure is applied:

- Vendor A imports the base model.

- Vendor A imports the boundary and regional sets and links them into the base model. Using internal validation, verify that the new model is complete and accurate. The MAS model is identified from the CIM/XML document file header. In this step the imported MAS updates the existing MAS in the base model.

- Export the new full model and validate it using one or more of the CIM validation tools.

- Vendor B imports the file exported by Vendor A.

- Test witness validates that the new data from the boundary and regional sets are contained in the model.

7.2.30.3 TEST RECORD

The following information should be recorded in the test form:

- File names of the imported xml files;

- At least one screenshot (from Vendor A) that shows validation results has to be referenced as a supplementary document;

- At least one screenshot (from Vendor B) that shows validation results has to be referenced as a supplementary document;

7.2.31 FILE HEADER TEST

7.2.31.1 OBJECTIVE

The file header test demonstrates the ability of vendors to use the information included in the file header.

7.2.31.2 DESCRIPTION

The following procedure is applied:

- Test witness requests Vendor A to introduce a change in the file header information of the one or more of the xml files of the base model. The change needs to be done outside the tool of Vendor A.

- Vendor A imports the necessary xml files to form base model (e.g. equipment, topology, state variables and boundary). File header information of one or more xml files is changed.

- Test witness checks the import procedure applied by Vendor A. The tool needs to produce error message and advise the user on the appropriate action to be performed to correct the error.

7.2.31.3 TEST RECORD

The following information should be recorded in the test form:

- File names of the imported xml files;
- Description of introduced change in the file header;
- At least one screenshot that shows error message produced by Vendor A has to be referenced as a supplementary document;

7.3 TEST RECORD FORM TEMPLATES

7.3.1 TOOL SUMMARY FORM (PER TOOL)

Vendor:		**Tool:**	
Witnessed by			
Name	**Signature**	**Name**	**Signature**
1.		9.	
2.		10.	
3.		11.	
4.		12.	
5.		13.	
6.		14.	
7.		15.	
8.		16.	

Performed tests					
Test No	**Score**	**Test No**	**Score**	**Test No**	**Score**

Comments:

Date	**Vendor**		**ENTSO-E**	
	Name	**Signature**	**Name**	**Signature**

7.3.2 SINGLE TEST RECORD FORM

Test No:	Tool:	Score:

Test files	
Import	**Export**
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.

Comments/Results/Issues:

Supplementary files:

Date	Vendor		Test witness	
	Name	Signature	Name	Signature

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8 APPENDIX C: TEST RECORD FORMS

Appendix C is a collection of all test record forms (single test record forms and tool summary forms) produced during the ENTSO-E IOP. Due to the size of the file this appendix is available as separate documents (five parts):

- **Appendix C Part 1**: ENTSO-E_IOP_2010_Test_record_forms_Part_1.pdf
- **Appendix C Part 2**: ENTSO-E_IOP_2010_Test_record_forms_Part_2.pdf
- **Appendix C Part 3**: ENTSO-E_IOP_2010_Test_record_forms_Part_3.pdf
- **Appendix C Part 4**: ENTSO-E_IOP_2010_Test_record_forms_Part_4.pdf
- **Appendix C Part 5**: ENTSO-E_IOP_2010_Test_record_forms_Part_5.pdf

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9 APPENDIX D: TEST MODELS DESCRIPTION

9.1 ENTSO-E 16 NODES MODEL

Version: 4a - IOP version

Date: 25 July 2010

Versions history:

- version 1: 17 April 2010 – draft version based on the former ENTSO-E 10A model prepared for previous IOPs
- version 2: 6 July 2010 – draft version: updates: clean of typing bugs, charts for dynamics are deleted
- version 3; 7 July 2010 – draft version: short-circuit data added; added - GeneratingUnit.governorSCD GeneratingUnit.startupCost; GeneratingUnit.startupCost for all units
- version 4; 8 July 2010 – IOP version: Change in the table for generators

NODE 9	15.750	2	140
NODE 9	15.750	1	150

- version 4a; 25 July 2010 – IOP version: Remark on MutualCoupling data added

9.1.1 REQUIREMENTS TO THE XML VERSION OF THE MODEL

- **TYPES POWER PLANTS**
  - Node 6 – hydro
  - Node 10 – thermal, fuel type – lignite
  - Node 9 – 2 generators, hydro
  - Node 7 – thermal, fuel type - lignite
- Naming
  - IDENTIFIEDOBJECT.NAME
    - GeographicalRegion
      - Area 1 should be: BE
      - Area 2 should be: NL
      - Boundary (if GeographicalRegion is needed): EU
    - SubGeographicalRegion
      - for Area 1: ELIA
      - for Area 2: TENNET
      - Boundary (if SubGeographicalRegion is needed): ENTSO-E
    - Substation
      - Node 1, Node 2, Node 3, Node 7, Node 10 belong to substations in power plant: PP_Brussels
      - Node 11: Anvers

    - Node 4, Node 8, Node 5, Node 6, Node 9: PP_Amsterdam

- TopologicalNode
    - Node 1: 51
    - Node 2: B1
    - Node 3: C4
    - Node 4: B4
    - Node 5: K8
    - Node 6: BB
    - Node 7: F5
    - Node 8: Y7
    - Node 9:D5
    - Node 10: S4
    - Node 11:M7
    - XAA_AB12: XAA_AB12
    - XAA_AB11: XAA_AB11
    - XAA_AB13: XAA_AB13
    - XAC_AD21: XAC_AD21
    - XAF_AK21: XAF_AK21
- GeneratingUnit

- Node 7: G1
- Node 10: Unit G1
- Node 9 (gen 1): Unit 1
- Node 9 (gen 2): Unit 2
- Node 6: G1

- ACLineSegment
  - 2-12: 1
  - 12-4: A
  - 2-11: Line 1
  - 11-4: L1
  - 2-13: London
  - 13-4: WKRL-W
  - 16-14: H1
  - 14-4: 1
  - 16-15: 1
  - 15-5: 1
  - 3-16 (line 1): DFG-THY 1
  - 3-16 (line 2): DFG-THY 2
- ControlArea

    - FOR AREA 1: BELGIUM CONTROL BLOCK
    - FOR AREA 2: NL

- EnergyConsumer
    - Node 1: D1
    - Node 3: L1
    - Node 4 (load 1): Load 1
    - Node 4 (load 2): Load 2
    - Node 8: A
- POWERTRANSFORMER
    - 1-7: TG1
    - 1-2: T1
    - 3-10-2: 3WT1
    - 1-3: T2
    - 4-8: T3
    - 8-6: T4
    - 5-9: T5
- ShuntCompensator
    - Node 1: S1
    - Node 2: S2

    - Node 4: shunt 3
  - SWITCH / BREAKER / DISCONNECTOR
    - 5-8: B1
    - 6-9: BUSBARCOUPLER 1
  - VoltageLevel
    - Node 1: PPBRU110
    - Node 7: PPBRUG10
    - Node 10: PPBRUG21
    - Node 3: PPBRU220
    - Node 11: ANVER220
    - Node 2: PPBRU400
    - 11, 12, 13: XNODE400
    - 14, 15: XNODE220
    - Node 4: PPAMS400
    - Node 8, Node 5: PPAMS220
    - Node 9, Node 6: PPAMS15
- IdentifiedObject.description
  - SUBSTATION

  - NODE 1, NODE 2, NODE 3, NODE 7, NODE 10 BELONG TO SUBSTATIONS IN POWER PLANT - PP_BRUSSELS: NEW CONFIGURATION LONG TERM ONLY
  - NODE 11- ANVERS: MAINTENANCE IN 2011
  - NODE 4, NODE 8, NODE 5, NODE 6, NODE 9 - PP_AMSTERDAM: NEW POWER PLANT IN 2020
- TopologicalNode
  - Node 1: 51; BGENT_51
  - Node 2: B1; BGENT_11
  - Node 3: C4; BGENT_21
  - Node 4: B4; NAMST_11
  - Node 5: K8; NAMST_22
  - Node 6: BB; NAMST_71
  - Node 7: F5; BGENT_71
  - Node 8: Y7; NAMST_21
  - Node 9:D5; NAMST_72
  - Node 10: S4; BGENT_72
  - Node 11:M7; BBRUS_21
  - XAA_AB12: XAA_AB12
  - XAA_AB11: XAA_AB11
  - XAA_AB13: XAA_AB13

    - XAC_AD21: XAC_AD21
    - XAF_AK21: XAF_AK21
- GENERATINGUNIT
    - Node 7: new in 2015
    - Node 10:
    - Node 9 (gen 1):
    - Node 9 (gen 2): out of service in 2015 due to maintenance
    - Node 6: new in 2020
- ACLineSegment
    - 2-12: NEW IN 2020
    - 12-4: NEW IN 2020
    - 2-11:
    - 11-4:
    - 2-13:
    - 13-4:
    - 16-14:
    - 14-4:
    - 16-15:
    - 15-5:

    - 3-16 (LINE 1): TYNDP PROJECT BE-4; MAP REFERENCE 567
    - 3-16 (LINE 2): TYNDP PROJECT BE-5; MAP REFERENCE 568
- ENERGYCONSUMER
    - Node 1:
    - Node 3: EVN
    - Node 4 (load 1):
    - Node 4 (load 2): EON
    - Node 8:
- PowerTransformer
    - 1-7:
    - 1-2:
    - 3-10-2: TNYDP PROJECT BE-99; MAP REFERENCE 666
    - 1-3:
    - 4-8:
    - 8-6:
    - 5-9:
- SHUNTCOMPENSATOR
    - Node 1:
    - Node 2:

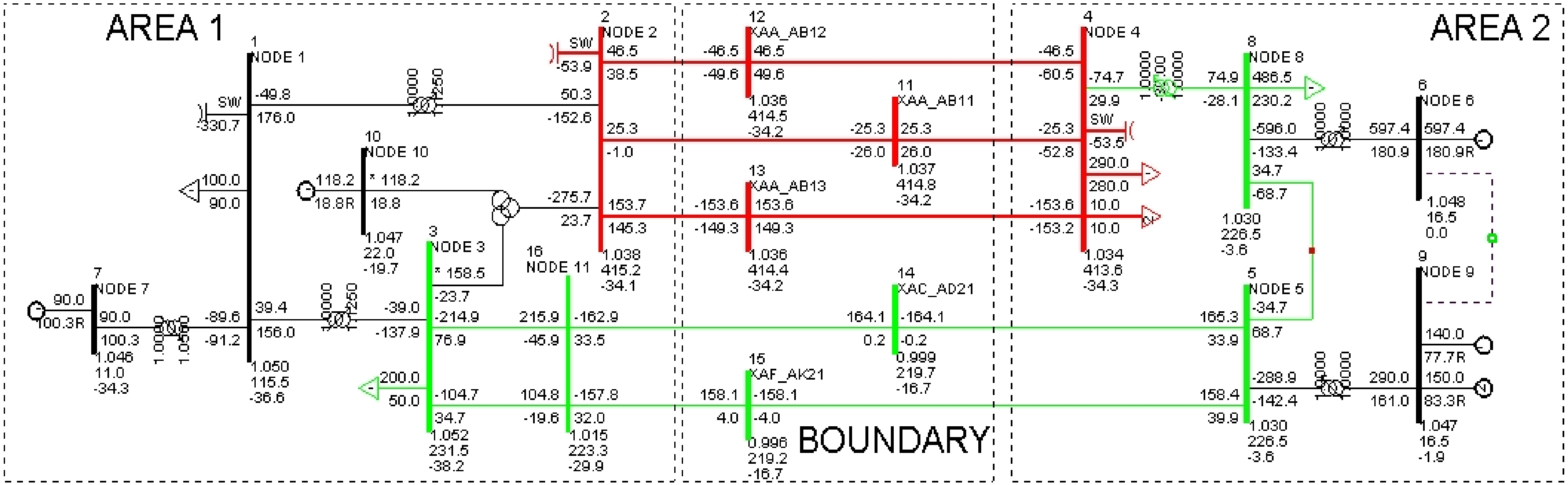
        - Node 4: 2020 only
    - Switch / Breaker / Disconnector
        - 5-8:
        - 6-9: NEW
- IdentifiedObject.aliasname
    - TOPOLOGICALNODE
        - XAA_AB12: 10T-AL-RS-000019
        - XAA_AB11: 10T-AT-CH-00001X
        - XAA_AB13: 10T-AT-CH-00002V
        - XAC_AD21: 10T-AT-CH-00102V
        - XAF_AK21 10T-AT-CH-00202V
    - ACLineSegment
        - 2-12: 10T-AT-DE-000061
        - 12-4: 10T-AT-DE-000061
        - 2-11: 10T-AT-DE-00008Y
        - 11-4: 10T-AT-DE-00008Y
        - 2-13: 10T-AT-DE-00009W
        - 13-4: 10T-AT-DE-00009W
        - 16-14: 10T-AT-DE-00010A

- 14-4: 10T-AT-DE-00010A
- 16-15: 10T-AT-DE-000118
- 15-5: 10T-AT-DE-000118
- 3-16 (LINE 1): 10T-AT-DE-000126
- 3-16 (LINE 2): 10T-AT-DE-000233

- MODEL AUTHORITY SETS – 3 MAS: BE, NL, BOUNDARY
- FILE HEADER
- THE MODEL SHOULD BE SPLIT TO 3 PARTS: AREA 1 WITH INJECTIONS AT THE MID OF TIE-LINES; AREA 2 WITH INJECTIONS AT THE MID OF TIE-LINES; BOUNDARY – ALL XNODES

9.1.2 LOAD FLOW

9.1.2.1 DIAGRAM



9.1.2.2 BASIC INFORMATION - INSTANCE DATA, SUMMARY

Nodes: 16

Lines: 12

Transformers: 7

Loads: 5

Shunts: 3

Generators: 5

Switches (busbar couplers): 2

Slack bus: Node 6

Area interchange:

Area Name	Area Swing Bus	Desired Interchange (MW)	Tolerance (MW)
AREA 1	Node 10	-100	10
AREA 2	Node 6	100	10

Lines:

From Bus Name	To Bus Name	Id	Line R (pu)	Line R (ohms)	Line X (ohms)	Line X (pu)	Charging (pu)	Charging (μF)	Length, km

NODE 2 400.00	XAA_AB11 400.00	1	0.000650	1.040000	12.000000	0.007500	0.251200	0.499746	30.000	
NODE 2 400.00	XAA_AB12 400.00	2	0.000270	0.432000	6.408000	0.004005	0.104000	0.206901	35.000	
NODE 2 400.00	XAA_AB13 400.00	3	0.000145	0.232000	2.024000	0.001265	0.041495	0.082552	40.000	
NODE 3 220.00	NODE 11 220.00	1	0.002203	1.066010	34.285350	0.070837	0.022325	0.146824	45.000	Aggregate flag set to true
NODE 3 220.00	NODE 11 220.00	2	0.001075	0.520300	71.000380	0.146695	0.010165	0.066852	100.00	
NODE 4 400.00	XAA_AB11 400.00	1	0.000650	1.040000	12.000000	0.007500	0.251200	0.499746	30.000	
NODE 4 400.00	XAA_AB12 400.00	2	0.000270	0.432000	6.408000	0.004005	0.104000	0.206901	35.000	
NODE 4 400.00	XAA_AB13 400.00	3	0.000145	0.232000	2.024000	0.001265	0.041495	0.082552	40.000	
NODE 5 220.00	XAC_AD21 220.00	1	0.004405	2.132020	68.570690	0.141675	0.044650	0.293647	22.000	
NODE 5 220.00	XAF_AK21 220.00	2	0.001075	0.520300	71.000380	0.146695	0.010165	0.066852	23.000	
XAC_AD21 220.00	NODE 11 220.00	1	0.004405	2.132020	68.570690	0.141675	0.044650	0.293647	22.000	
XAF_AK21 220.00	NODE 11 220.00	1	0.001075	0.520300	71.000380	0.146695	0.010165	0.066852	23.000	
NODE 5 220.00	NODE 8 220.00	1	0	0	0.0484	0.0001	0	0	0	zero impedance lines (busbar couplers)=Switches/breakers in
NODE 6 15.750	NODE 9 15.750	1	0	0	0.000248	0.0001	0	0	0	

										CIM

Loads:

Bus Name	Id	Pload (MW)	Qload (Mvar)	IPload (MW)	IQload (Mvar)	YPload (MW)	YQload (Mvar)
NODE 1 110.00	1	100	90	0	0	0	0
NODE 3 220.00	1	200	50	0	0	0	0
NODE 4 400.00	1	290	280	0	0	0	0
NODE 4 400.00	2	10	10	0	0	0	0
NODE 8 220.00	1	400	250	50	25	33	43

Generators:

Bus Name	Id	Pgen (MW)	Pmax (MW)	Pmin (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	Mbase (MVA)
NODE 6 15.750	1	597.4429	1000	300	180.9147	600	0	1111
NODE 7 10.500	1	90	200	50	100.2557	160	-100	300
NODE 9 15.750	2	140	250	130	77.7426	200	0	250
NODE 9 15.750	1	150	250	130	83.2957	200	0	250
NODE 10 21.000	1	118.1702	200	50	18.7919	200	-200	300

-> Generator at Node 7 regulates Node 1

Switched shunts:

Bus Name	Binit (Mvar)	Blk 1 Bstep (Mvar)	Blk 2 Bstep (Mvar)	Blk 3 Bstep (Mvar)	Blk 4 Bstep (Mvar)
NODE 1 110.00	300	100	100	100	100
NODE 2 400.00	50	50	0	0	0
NODE 4 400.00	50	50	0	0	0

Transformers:

From Bus Name	To Bus Name	Id	Tap Positions	Control Mode	Specified R (pu or watts)	Specified X (pu)	Rate A (MVA)	Rate B (MVA)	Rate C (MVA)	Magnetizing G (pu or watts)	Magnetizing B (pu)	Control Bus

NODE 1 110.00	NODE 2 400.00	1	25	Voltage	0.0017	0.07692	650	630	620	0	0	2
NODE 1 110.00	NODE 3 220.00	1	25	Voltage	0.0017	0.07692	650	630	620	0	0	3
NODE 1 110.00	NODE 7 10.500	1	33	None	0.00086	0.047992	250	250	250	0.00211	-0.01011	
NODE 4 400.00	NODE 8 220.00	1	25	MW	0.00087	0.01807	320	330	340	0.0009	-0.00712	
NODE 5 220.00	NODE 9 15.750	1	33	None	0.00014	0.01135	1260	1260	1260	0.00882	-0.06804	
NODE 8 220.00	NODE 6 15.750	1	33	None	0.00014	0.01135	1260	1260	1260	0.00882	-0.06804	
[redacted]												
		Id	Winding MVA Base	Wnd 1 Ratio (pu or kV)	Wnd 1 Nominal kV	Wnd 1 Angle (degrees)	Wnd 2 Ratio (pu or kV)	Wnd 2 Nominal kV	Rmax (pu kV or deg)	Rmin (pu kV or deg)	Vmax (pu, kV MW, or Mvar)	Vmin (pu, kV MW, or Mvar)
NODE 1 110.00	NODE 2 400.00	1	630	1.125	400	0	1	110	1.15	0.85	1.2	0.95
NODE 1 110.00	NODE 3 220.00	1	630	1.125	220	0	1	110	1.15	0.85	1.2	0.95
NODE 1 110.00	NODE 7 10.500	1	250	1.05	110	0	1	10.5	1.1	0.85	1.1	0.9
NODE 4 400.00	NODE 8 220.00	1	300	1	400	-30	1	220	90	-90	300	-300

NODE 5 220.00	NODE 9 15.750	1	1300	1	220	0	1	15.75	1.1	0.9	1.1	0.9
NODE 8 220.00	NODE 6 15.750	1	1300	1	220	0	1	15.75	1.1	0.9	1.1	0.9

From Bus Name	To Bus Name	Last Bus Name	W1-2 R (pu or watts)	W1-2 X (pu)	W2-3 R (pu or watts)	W2-3 X (pu)	W3-1 R (pu or watts)	W3-1 X (pu)	Magnetizing G (pu or watts)	Magnetizing B (pu)	Winding 1,2,3 MVA Base	Star Point Bus Voltage	Star Point Bus Angle
NODE 3 220.00	NODE 2 400.00	NODE 10 21.000	0.00125	0.08114	0.00359	0.46172	0.0037	0.89058	0	-0.00123	100	1.25401	-17.6

Solution method (load flow):

- Full Newton-Raphson
- Tap adjustment, switched shunts – locked
- Interchange control - enabled

9.1.3 SHORT-CIRCUIT DATA

Lines:

Node 3-Node11 – first circuit

<cim:ACLineSegment.gch>0.0001</cim:ACLineSegment.gch>

<cim:ACLineSegment.r0>1.16601</cim:ACLineSegment.r0>

<cim:ACLineSegment.x0>34.38535</cim:ACLineSegment.x0>

<cim:ACLineSegment.b0ch>0.0001</cim:ACLineSegment.b0ch>

<cim:ACLineSegment.g0ch>0.0002</cim:ACLineSegment.g0ch>

Node 3-Node11 – second circuit

<cim:ACLineSegment.gch>0.0001</cim:ACLineSegment.gch>

<cim:ACLineSegment.r0>0.6203</cim:ACLineSegment.r0>

<cim:ACLineSegment.x0>71.10038</cim:ACLineSegment.x0>

<cim:ACLineSegment.b0ch>0.0002</cim:ACLineSegment.b0ch>

<cim:ACLineSegment.g0ch>0.0001</cim:ACLineSegment.g0ch>

Node 2 – XAA_AB12

<cim:ACLineSegment.gch>0.0001</cim:ACLineSegment.gch>

<cim:ACLineSegment.r0>0.452</cim:ACLineSegment.r0>

<cim:ACLineSegment.x0>6.508</cim:ACLineSegment.x0>

<cim:ACLineSegment.b0ch>0.0002</cim:ACLineSegment.b0ch>

<cim:ACLineSegment.g0ch>0.0001</cim:ACLineSegment.g0ch>

Node 2 – XAA_AB13

<cim:ACLineSegment.gch>0.0001</cim:ACLineSegment.gch>

<cim:ACLineSegment.r0>0.332</cim:ACLineSegment.r0>

<cim:ACLineSegment.x0>2.124</cim:ACLineSegment.x0>

<cim:ACLineSegment.b0ch>0.0002</cim:ACLineSegment.b0ch>

<cim:ACLineSegment.g0ch>0.0001</cim:ACLineSegment.g0ch>

Node 11 – XAC_AD21

<cim:ACLineSegment.gch>0.0001</cim:ACLineSegment.gch>

<cim:ACLineSegment.r0>2.23202</cim:ACLineSegment.r0>

<cim:ACLineSegment.x0>68.6707</cim:ACLineSegment.x0>

<cim:ACLineSegment.b0ch>0.0002</cim:ACLineSegment.b0ch>

<cim:ACLineSegment.g0ch>0.0001</cim:ACLineSegment.g0ch>

Node 11 – XAF_AK21

<cim:ACLineSegment.gch>0.0001</cim:ACLineSegment.gch>

<cim:ACLineSegment.r0>0.5403</cim:ACLineSegment.r0>

<cim:ACLineSegment.x0>71.50038</cim:ACLineSegment.x0>

<cim:ACLineSegment.b0ch>0.0002</cim:ACLineSegment.b0ch>

<cim:ACLineSegment.g0ch>0.0001</cim:ACLineSegment.g0ch>

Node 2 – XAA_AB11

<cim:ACLineSegment.gch>0.0001</cim:ACLineSegment.gch>

<cim:ACLineSegment.r0>1.14</cim:ACLineSegment.r0>

<cim:ACLineSegment.x0>12.2</cim:ACLineSegment.x0>

<cim:ACLineSegment.b0ch>0.0002</cim:ACLineSegment.b0ch>

<cim:ACLineSegment.g0ch>0.0001</cim:ACLineSegment.g0ch>

XAA_AB12 – Node 4

<cim:ACLineSegment.gch>0.0001</cim:ACLineSegment.gch>

<cim:ACLineSegment.r0>0.532</cim:ACLineSegment.r0>

<cim:ACLineSegment.x0>6.508</cim:ACLineSegment.x0>

<cim:ACLineSegment.b0ch>0.0001</cim:ACLineSegment.b0ch>

<cim:ACLineSegment.g0ch>0.0002</cim:ACLineSegment.g0ch>

XAF_AK21 – Node 5

<cim:ACLineSegment.gch>0.0001</cim:ACLineSegment.gch>
<cim:ACLineSegment.r0>0.5303</cim:ACLineSegment.r0>
<cim:ACLineSegment.x0>71.10038</cim:ACLineSegment.x0>
<cim:ACLineSegment.b0ch>0.0001</cim:ACLineSegment.b0ch>
<cim:ACLineSegment.g0ch>0.0002</cim:ACLineSegment.g0ch>

XAC_AD21 – Node 5

<cim:ACLineSegment.gch>0.0001</cim:ACLineSegment.gch>
<cim:ACLineSegment.r0>2.23202</cim:ACLineSegment.r0>
<cim:ACLineSegment.x0>68.6707</cim:ACLineSegment.x0>
<cim:ACLineSegment.b0ch>0.0001</cim:ACLineSegment.b0ch>
<cim:ACLineSegment.g0ch>0.0002</cim:ACLineSegment.g0ch>

XAA_AB11 – Node 4

<cim:ACLineSegment.gch>0.0001</cim:ACLineSegment.gch>
<cim:ACLineSegment.r0>1.14</cim:ACLineSegment.r0>
<cim:ACLineSegment.x0>12.3</cim:ACLineSegment.x0>

<cim:ACLineSegment.b0ch>0.0001</cim:ACLineSegment.b0ch>

<cim:ACLineSegment.g0ch>0.0002</cim:ACLineSegment.g0ch>

XAA_AB13 – Node 4

<cim:ACLineSegment.gch>0.0001</cim:ACLineSegment.gch>

<cim:ACLineSegment.r0>0.332</cim:ACLineSegment.r0>

<cim:ACLineSegment.x0>2.124</cim:ACLineSegment.x0>

<cim:ACLineSegment.b0ch>0.0001</cim:ACLineSegment.b0ch>

<cim:ACLineSegment.g0ch>0.0002</cim:ACLineSegment.g0ch>

Generators:

Node 10

<cim:SynchronousMachine.r>0.0</cim:SynchronousMachine.r>

<cim:SynchronousMachine.x>0.2</cim:SynchronousMachine.x>

<cim:SynchronousMachine.r0>0.01</cim:SynchronousMachine.r0>

<cim:SynchronousMachine.r2>0.04</cim:SynchronousMachine.r2>

<cim:SynchronousMachine.x0>0.21</cim:SynchronousMachine.x0>

<cim:SynchronousMachine.x2>0.22</cim:SynchronousMachine.x2>

Node 7

<cim:SynchronousMachine.r>0.0</cim:SynchronousMachine.r>

<cim:SynchronousMachine.x>0.2</cim:SynchronousMachine.x>

<cim:SynchronousMachine.r0>0.02</cim:SynchronousMachine.r0>

<cim:SynchronousMachine.r2>0.03</cim:SynchronousMachine.r2>

<cim:SynchronousMachine.x0>0.22</cim:SynchronousMachine.x0>

<cim:SynchronousMachine.x2>0.23</cim:SynchronousMachine.x2>

Node 9 - Gen 1

<cim:SynchronousMachine.r>0.0</cim:SynchronousMachine.r>

<cim:SynchronousMachine.x>0.23</cim:SynchronousMachine.x>

<cim:SynchronousMachine.r0>0.01</cim:SynchronousMachine.r0>

<cim:SynchronousMachine.r2>0.04</cim:SynchronousMachine.r2>

<cim:SynchronousMachine.x0>0.25</cim:SynchronousMachine.x0>

<cim:SynchronousMachine.x2>0.26</cim:SynchronousMachine.x2>

Node 6

<cim:SynchronousMachine.r>0.0</cim:SynchronousMachine.r>

<cim:SynchronousMachine.x>0.318</cim:SynchronousMachine.x>

<cim:SynchronousMachine.r0>0.01</cim:SynchronousMachine.r0>

<cim:SynchronousMachine.r2>0.02</cim:SynchronousMachine.r2>

<cim:SynchronousMachine.x0>0.32</cim:SynchronousMachine.x0>

<cim:SynchronousMachine.x2>0.33</cim:SynchronousMachine.x2>

Node 9 - Gen 2

<cim:SynchronousMachine.r>0.0</cim:SynchronousMachine.r>

<cim:SynchronousMachine.x>0.23</cim:SynchronousMachine.x>

<cim:SynchronousMachine.r0>0.01</cim:SynchronousMachine.r0>

<cim:SynchronousMachine.r2>0.04</cim:SynchronousMachine.r2>

<cim:SynchronousMachine.x0>0.25</cim:SynchronousMachine.x0>

<cim:SynchronousMachine.x2>0.26</cim:SynchronousMachine.x2>

Mutual coupling – Node 3 – Node 11

<cim:MutualCoupling rdf:ID="_10000000000000000000000000000044">

<cim:IdentifiedObject.name>test</cim:IdentifiedObject.name>

<cim:IdentifiedObject.description>Node 3 to Node 11</cim:IdentifiedObject.description>

<cim:MutualCoupling.First_Terminal rdf:resource="#_1b8e9df66a5711dfa90800059a3c7800" />

<cim:MutualCoupling.Second_Terminal rdf:resource="#_1b8e9df76a5711dfa90800059a3c7800" />

<cim:MutualCoupling.r0>0.001</cim:MutualCoupling.r0>

<cim:MutualCoupling.x0>0.002</cim:MutualCoupling.x0>

<cim:MutualCoupling.g0ch>0.0005</cim:MutualCoupling.g0ch>

<cim:MutualCoupling.b0ch>0.0004</cim:MutualCoupling.b0ch>

<cim:MutualCoupling.distance11>0.11</cim:MutualCoupling.distance11>

<cim:MutualCoupling.distance12>0.12</cim:MutualCoupling.distance12>

<cim:MutualCoupling.distance21>0.21</cim:MutualCoupling.distance21>

<cim:MutualCoupling.distance22>0.22</cim:MutualCoupling.distance22>

</cim:MutualCoupling>

An issue with MutualCoupling was identified during the IOP. MutualCoupling.First_Terminal rdf:resource and MutualCoupling.Second_Terminal rdf:resource should point to different ACLineSegments. Test model has not been corrected. The correction is expected in the next releases.

Transformers:

All windings the same parameters

<cim:TransformerWinding.r0>0.3</cim:TransformerWinding.r0>

<cim:TransformerWinding.x0>9.5</cim:TransformerWinding.x0>

<cim:TransformerWinding.b0>0.002</cim:TransformerWinding.b0>

<cim:TransformerWinding.g0>0.001</cim:TransformerWinding.g0>

<cim:TransformerWinding.rground>0.01</cim:TransformerWinding.rground>

<cim:TransformerWinding.xground>0.02</cim:TransformerWinding.xground>

ShuntCompensator

Shunts in Node 2 and Node 4

<cim:ShuntCompensator.bPerSection>0.0003125</cim:ShuntCompensator.bPerSection>

<cim:ShuntCompensator.b0PerSection>0.003</cim:ShuntCompensator.b0PerSection>

<cim:ShuntCompensator.g0PerSection>0.001</cim:ShuntCompensator.g0PerSection>

Shunt in Node 1

<cim:ShuntCompensator.bPerSection>0.0082644</cim:ShuntCompensator.bPerSection>

<cim:ShuntCompensator.b0PerSection>0.004</cim:ShuntCompensator.b0PerSection>

<cim:ShuntCompensator.g0PerSection>0.001</cim:ShuntCompensator.g0PerSection>

9.1.4 DYNAMICS

9.1.4.1 MODELS, INSTANCE DATA

GENERATORS:

***CIM Model type: GenSync: synchronousGeneratorType: salientPole (GENSAL in PSS®E and PSLF, ElmSym in DigSILENT, M2 in EUROSTAG)**:*

Generator / Node	T'do	T"do	T"qo	Inertia H	Speed Damping	Xd	Xq	X'd	X"d = X"q	X1	S(1.0)	S(1.2)

					D							
1 / NODE 6 15.750	8.8	0.031	0.0354	9.9	1	2.35	2.24	0.452	0.318	0.193	0.025	0.29
1 / NODE 9 15.750	9.6	0.08	0.0837	4.4	1	1.98	0.8	0.37	0.23	0.23	0.025	0.29
2 / NODE 9 15.750	9.6	0.08	0.0837	4.4	1	1.98	0.8	0.37	0.23	0.23	0.025	0.29

***CIM Model type: GenSync: synchronousGeneratorType: roundRotor (GENROU in PSS®E and PSLF, ElmSym in DigSILENT, M2 in EUROSTAG)**:*

Generator / Node	T'do	T"do	T'qo	T"qo	Inertia H	Speed Damping D	Xd	Xq	X'd	X'q	X"d = X"q	Xl	S(1.0)	S(1.2)
1 / NODE 7 10.500	6.4	0.12	6.4	0.12	4.25	1	1.97	1.97	0.29	0.29	0.2	0.16	0.03	0.3
1 / NODE 10 21.000	6.4	0.12	6.4	0.12	4.25	1	1.97	1.97	0.29	0.29	0.2	0.16	0.03	0.3

TURBINE/GOVERNORS:

***CIM Model type: GovHydro2 (IEEEG3 in PSS®E and PSLF, gov_IEEEG3 in DigSILENT, HYD3IEEE in EUROSTAG)**:*

Generator / Node	TG, Gate Servomotor Time Constant	TP, Pilot Value Time Constant	UO Opening Gate Rate Limit	UC Closing Gate Rate Limit	PMAX Maximum Gate Position	PMIN Minimum Gate Position	sigma, Permanent Speed Droop Coefficient	delta, Transient Speed Droop Coefficient	TR	TW, Water Starting Time	a11	a13	a21	a23

1 / NODE 6 15.750	1	0.04	0.2	-0.2	1	-1	0.05	0.52	9.1 9	1.84	0.5	1	1.5	1

CIM Model type: GovSteam1 (IEEEG1 in PSLF, WSIEG1 (IEEEG1) in PSS®E, gov_WSIEG1 in DigSILENT, STMIEEE in EUROSTAG):

Generator / Node	K	T1	T2	T3	Uo	Uc	PMAX	PMIN	T4	K1	K2	T5	K3	K4	T6	K5	K6	T7	K7	K8
1 / NODE 7 10.500	25	5	1.5	0.3	1.05	- 1.05	1.05	0	0.15	0.25	0	2	0.6	0	0.1	0.15	0	0	0	0

CIM Model type: GovHydro1 (HYGOV in PSLF and PSS®E, gov_HYGOV in DigSILENT, ? in EUROSTAG):

Generator / Node	R, Permanent Droop	r, Temporary Droop	Tr Governor Time Constant	Tf Filter Time Constant	Tg Servo Time Constant	VELM, Gate Velocity Limit	GMAX, Maximum Gate Limit	GMIN, Minimum Gate Limit	TW Water Time Constant	At, Turbine Gain	Dturb, Turbine Damping	qNL, No Load Flow
1 / NODE 9 15.750	0.05	1.27	10.4	0.099	0.9	0.2	0.75	0	2.6	1.2	0.3	0.08
2 / NODE 9 15.750	0.05	1.27	10.4	0.099	0.9	0.2	0.75	0	2.6	1.2	0.3	0.08

CIM Model type: GovSteam0 (TGOV1 in PSLF and PSS®E, gov_TGOV1 in DigSILENT, ? in EUROSTAG):

Generator / Node	R	T1	V MAX	V MIN	T2	T3	Dt
1 / NODE 10 21.000	0.04	0.3	1	0	1.5	5	0.3

EXCITATION SYSTEMS:

CIM Model type: ExcST1A (ESST1A (EXST1) in PSS®E and PSLF, avr_ESST1A (avr_EXST1) in DigSILENT, ST1IEEE in EUROSTAG):

Generator / Node	TR	VI MAX	VI MIN	TC	TB	TC1	TB1	KA	TA	VA MAX	VA MIN	VR MAX	VR MIN	KC	KF	TF	KLR	ILR
1 / NODE 9 15.750	0.04	0.2	-0.2	1.5	10	0	0	190	0.1	8	-8	7.8	-6.7	0.08	0.02	0.8	0	0
2 / NODE 9 15.750	0.04	0.2	-0.2	1.5	10	0	0	220	0.1	8	-8	7.8	-6.7	0.08	0.02	0.8	0	0

CIM Model type: ExcAC4A (ESAC4A (EXAC4) in PSS®E and PSLF, avr_ESAC4A in DigSILENT, AC4IEEE in EUROSTAG):

Generator / Node	TR	VI MAX	VI MIN	TC	TB	KA	TA	VR MAX	VR MIN	KC
1 / NODE 7 10.500	0.01	0.1	-0.1	1.8	8.5	200	0.07	5	-4.65	0.05
1 / NODE 10 21.000	0.01	0.1	-0.1	1.8	8.5	250	0.07	5	-4.65	0.05

***CIM Model type: ExcAC1A (ESAC1A (EXAC1) in PSLF, ESAC1A (EXAC1, IEEX2A, IEET1A) in PSS®E, avr_ESAC1A (avr_IEET1A) in DigSILENT, AC1IEEE in EUROSTAG)**:*

Generator / Node	TR	TB	TC	KA	TA	VA MAX	VA MIN	TE	KF	TF	KC	KD	KE	E1	SE(E1)	E2	SE(E2)	VR MAX	VR MIN
1 / NODE 6 15.750	0.01	0.02	0	30	0.05	10	-10	0.4	0.03	1	0.2	0.4	1	3.14	0.03	4.18	0.1	10	0

<u>POWER SYSTEM STABILIZERS</u>:

***CIM Model type: PssIEEE2B (PSS2B (PSS2A) in PSLF and PSS®E, pss_PSS2A in DigSILENT, ? in EUROSTAG)**:*

Generator / Node	TW1 Washout Time constant - Signal 1	TW2 Washout Time Constant - Signal 1	T6 Lag Time Constant - Signal 1	TW3 Washout Time Constant - Signal 2	TW4 Washout Time Constant - Signal 2	T7 Lag Time Constant - Signal 2	KS2 Gain - Signal 2	KS3 Gain - Signal 2	KS4 Gain	T8 Ramp Tracking Filter Lead Time Constant	T9 Ramp Tracking Filter Lag Time Constant	M	N
1 / NODE 6 15.750	2	2	0	2	0	2	0.2	1	1	0	0.1	5	1
1 / NODE 7 10.500	2	2	0	2	0	2	0.31	1	1	0.2	0.1	5	1
1 / NODE 9 15.750	2	2	0	2	0	2	0.31	1	1	0.2	0.1	5	1
2 / NODE 9 15.750	2	2	0	2	0	2	0.31	1	1	0.2	0.1	5	1

1 / NODE 10 21.000	2	2	0	2	0	2	0.31	1	1	0	0.1	5	1

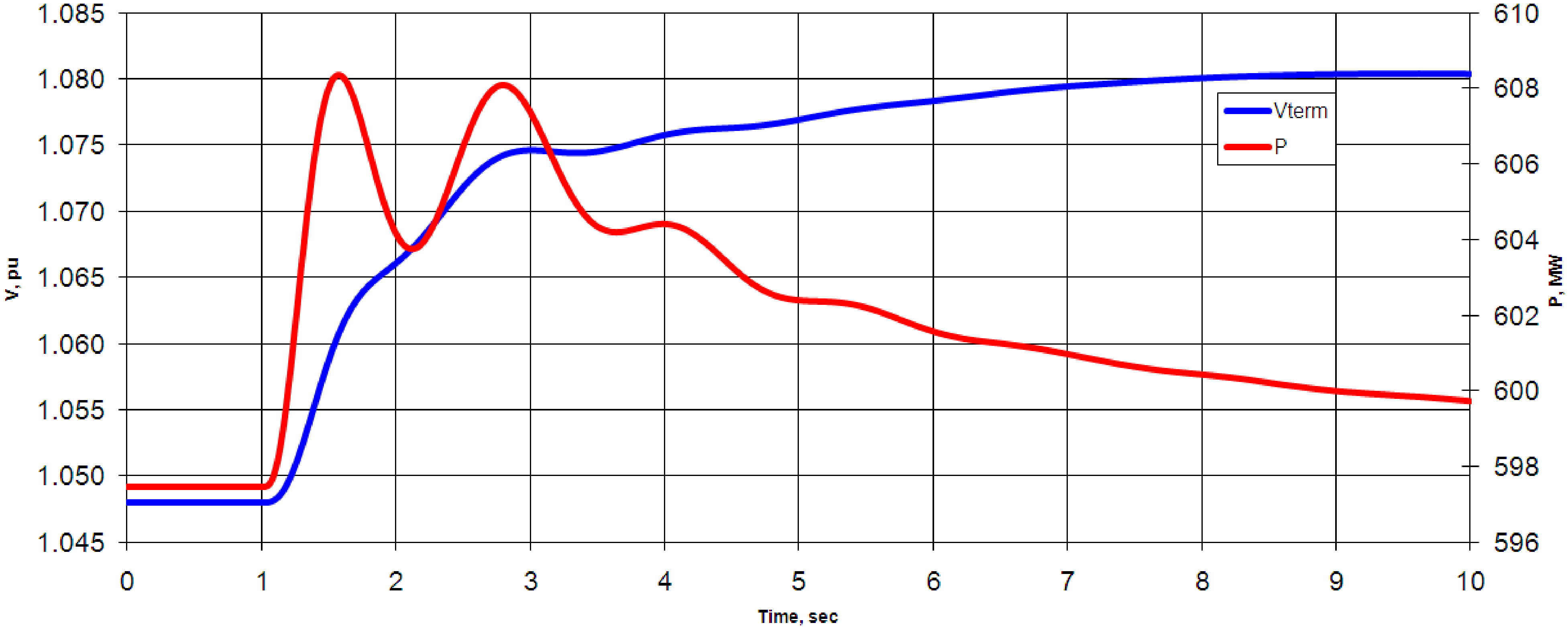
Generator / Node	KS1 Stabilizer Gain	T1 Lead Time Constant - Phase Comp. Block 1	T2 Lag Time Constant - Phase Comp. Block 1	T3 Lead Time Constant - Phase Comp. Block 2	T4 Lag Time Constant - Phase Comp. Block 2	T10 Lead Time Constant - Phase Comp. Block 3	T11 Lag Time Constant - Phase Comp. Block 3	a - Phase Comp. Block 4	Ta Lead Time Constant - Phase Comp. Block 4	Tb Lag Time Constant - Phase Comp. Block 4	VSTMAX Stabilizer Output Maximum	VSTMIN Stabilizer Output Minimum
1 / NODE 6 15.750	12	0.12	0.02	0.3	0.02	0	0	1	0	0	0.1	-0.1
1 / NODE 7 10.500	16	0.2	0.02	0.45	0.02	0	0	1	0	0	0.1	-0.1
1 / NODE 9 15.750	10	0.12	0.02	0.4	0.02	0	0	1	0	0	0.1	-0.1
2 / NODE 9 15.750	10	0.3	0.02	0.45	0.02	0	0	1	0	0	0.1	-0.1
1 / NODE 10 21.000	8	0.12	0.02	0.35	0.02	0	0	1	0	0	0.1	-0.1

9.1.4.2 REFERENCE RESULTS

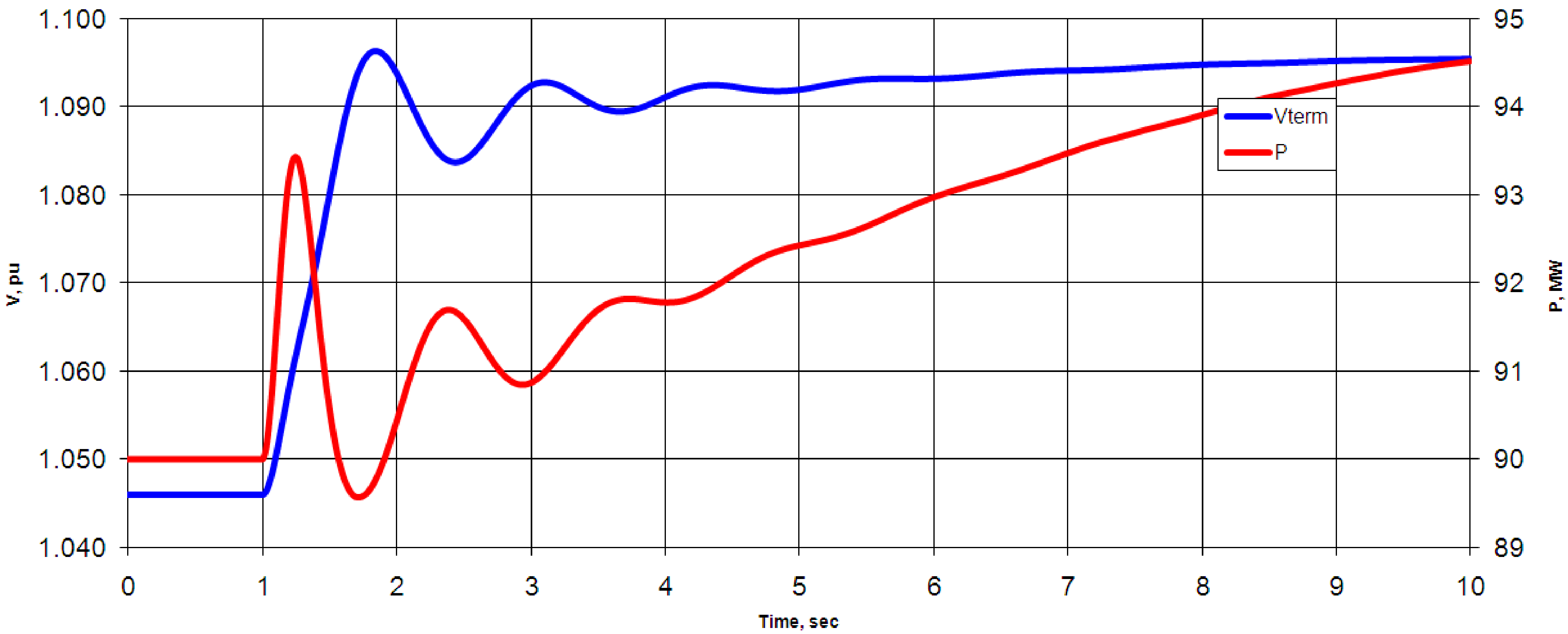
Simulation step (Delta) = 0.001 sec.

➢ Step responses

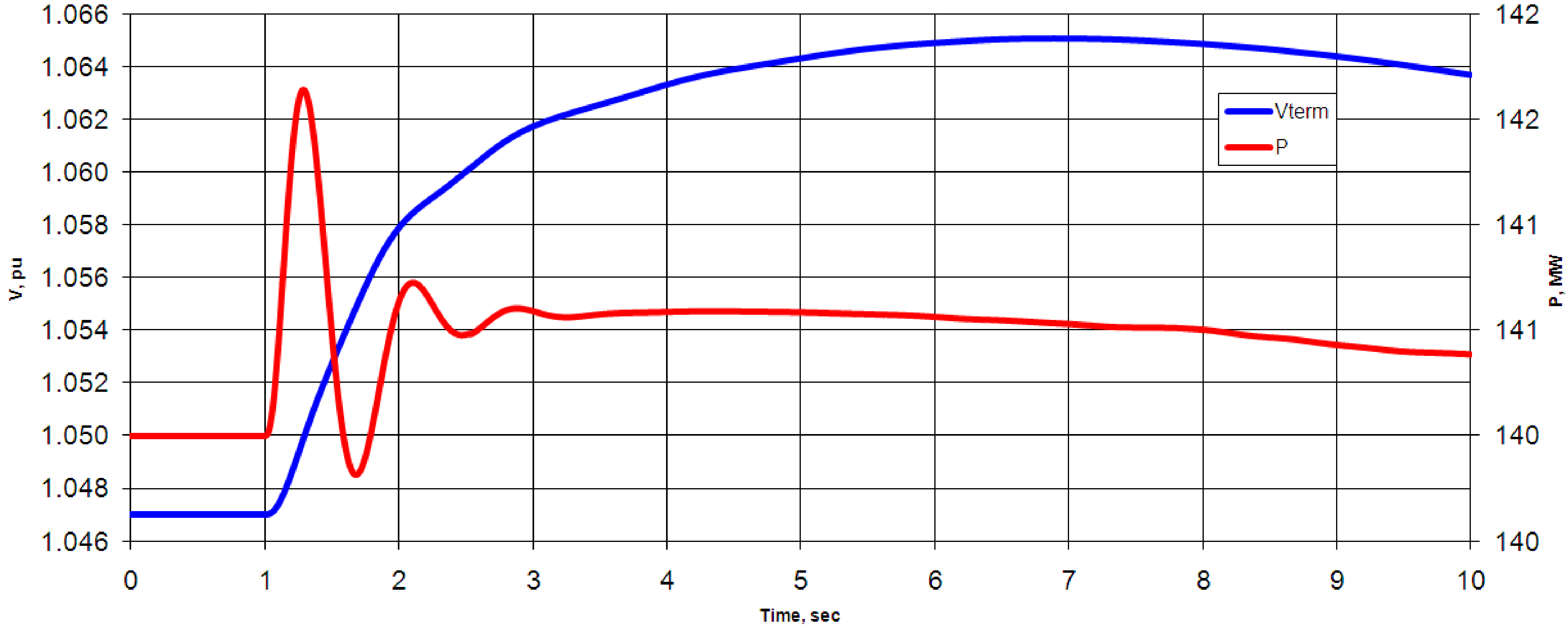
- Generator at Node 6: +5% Vref (increment of 0.05 pu)



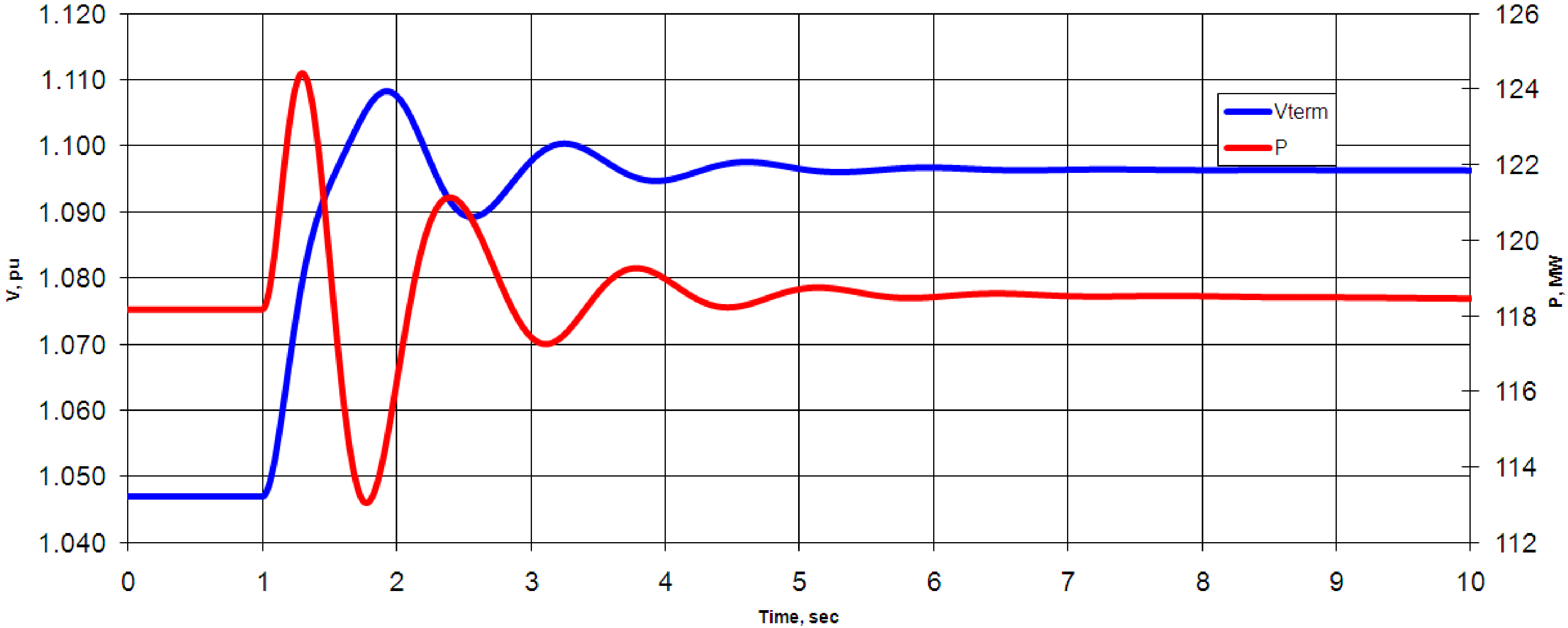
- Generator at Node 7: +5% Vref (increment of 0.05 pu)



- GENERATOR (ID 1) AT NODE 9: +5% VREF (INCREMENT OF 0.05 PU)



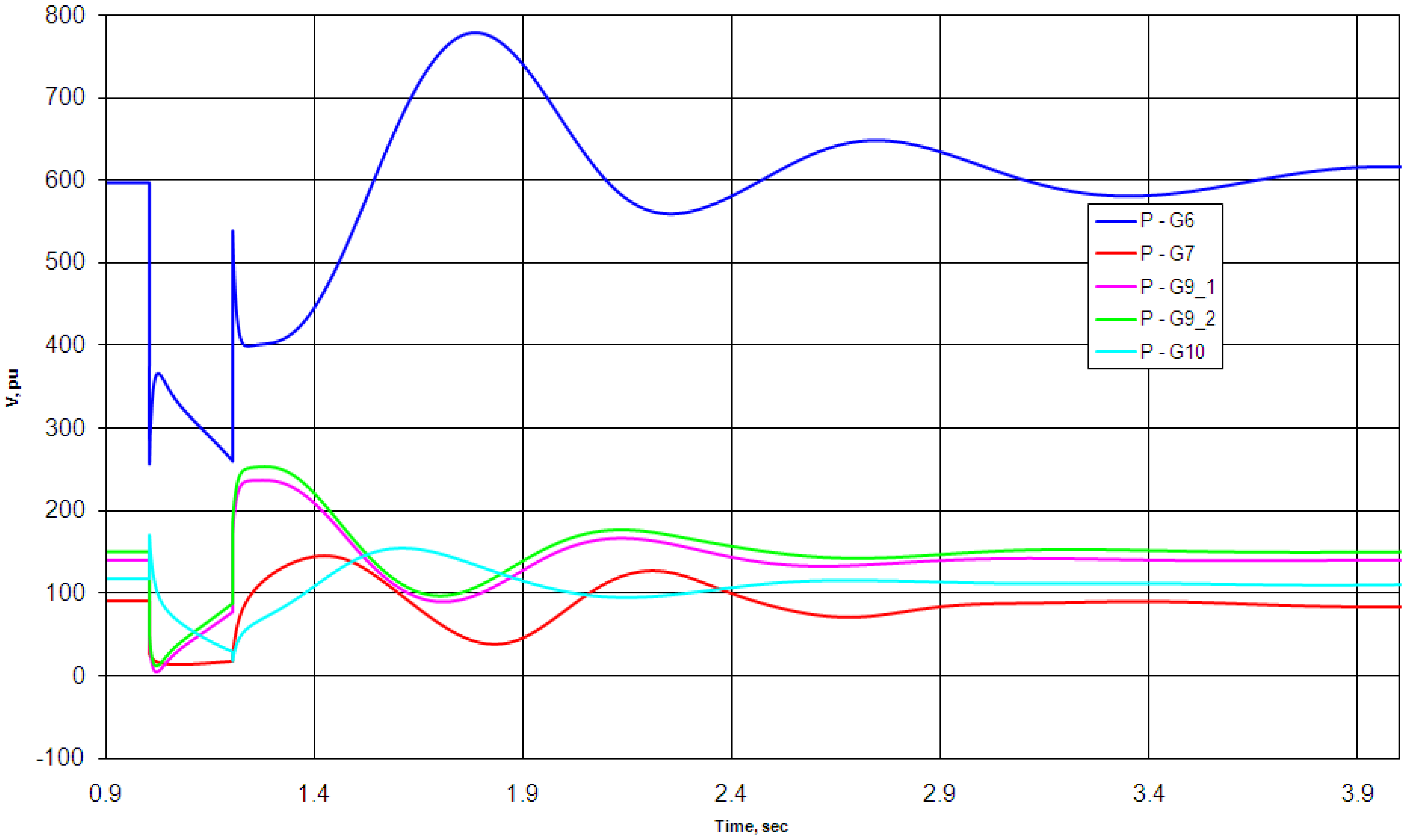
- Generator at Node 10: +5% Vref (increment of 0.05 pu)



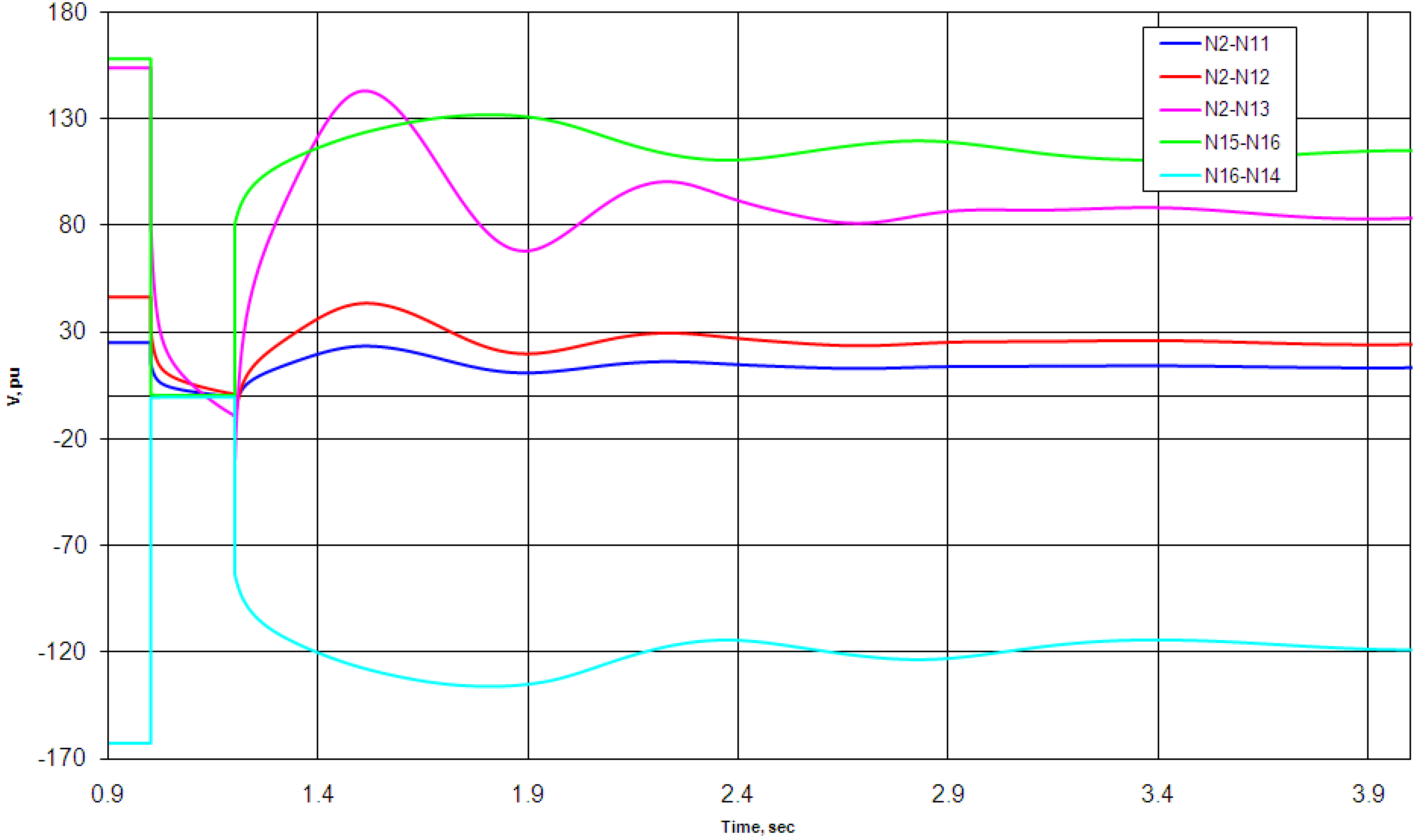
➢ THREE PHASE SHORT CIRCUIT

Simulation details:

- No disturbance until 1 sec.;
- Three phase short circuit on the line (Node 3 – Node 11, name: DFG-THY 1), time of SC=0.2 sec.;
- SC is cleared the line is disconnected;
- Simulation until 10th sec.


800
700
600
500
400
300
200
100
0
-100
V, pu
0.9
1.4
1.9
2.4
2.9
3.4
3.9
Time, sec
P - G6
P - G7
P - G9_1
P - G9_2
P - G10

ACTIVE POWER OF ALL GENERATORS



Active power: tie-lines

9.2 ENTSO-E 21000 NODES FICTITIOUS MODEL

Version: 1

Date: 17 April 2010

Versions history:

- version 1: 17 April 2010 – fictitious large dynamic model;

9.2.1 LOAD FLOW

9.2.1.1 BASIC INFORMATION - INSTANCE DATA, SUMMARY

Nodes: 21117

Lines: 24252

Transformers: 7860

Loads: 15756

Generators: 4832 (964 out of service)

Slack bus: Node 250042

Solution method (load flow):

- Full Newton-Raphson
- Tap adjustment, switched shunts – locked
- Interchange control - disabled

9.2.2 DYNAMICS

9.2.2.1 MODELS, INSTANCE DATA

<u>GENERATORS:</u>

CIM Model type: GenSync: synchronousGeneratorType: salientPole (GENSAL in PSS®E and PSLF, ElmSym in DigSILENT, M2 in EUROSTAG)*: 1396*

CIM Model type: GenSync: synchronousGeneratorType: roundRotor (GENROU in PSS®E and PSLF, ElmSym in DigSILENT, M2 in EUROSTAG)*: 1268*

CIM Model type: GenEquiv: *2168*

<u>TURBINE/GOVERNORS</u>:

CIM Model type: GovHydro2 (IEEEG3 in PSS®E and PSLF, gov_IEEEG3 in DigSILENT, HYD3IEEE in EUROSTAG)*: 896*

CIM Model type: GovSteam1 (IEEEG1 in PSLF, WSIEG1 (IEEEG1) in PSS®E, gov_WSIEG1 in DigSILENT, STMIEEE in EUROSTAG)*: 828*

CIM Model type: GovHydro1 (HYGOV in PSLF and PSS®E, gov_HYGOV in DigSILENT, ? in EUROSTAG)*: 440*

CIM Model type: GovSteam0 (TGOV1 in PSLF and PSS®E, gov_TGOV1 in DigSILENT, ? in EUROSTAG)*: 496*

<u>EXCITATION SYSTEMS</u>:

CIM Model type: ExcST1A (ESST1A (EXST1) in PSS®E and PSLF, avr_ESST1A (avr_EXST1) in DigSILENT, ST1IEEE in EUROSTAG)*: 132 (PSS®E – ESST1A) + 336 (PSS®E – EXST1)*

CIM Model type: ExcAC4A (ESAC4A (EXAC4) in PSS®E and PSLF, avr_ESAC4A in DigSILENT, AC4IEEE in EUROSTAG)*: 280 (PSS®E – ESAC4A) + 240 (PSS®E – EXAC4)*

CIM Model type: ExcAC1A (ESAC1A (EXAC1) in PSLF, ESAC1A (EXAC1, IEEX2A, IEET1A) in PSS®E, avr_ESAC1A (avr_IEET1A) in DigSILENT, AC1IEEE in EUROSTAG)*: 92 (PSS®E – ESAC1A) + 8 (PSS®E – EXAC1)*

CIM Model type: ExcDC1A (ESDC1A (EXDC1) in PSLF, ESDC1A (IEEEX1, IEEET1) in PSS®E, avr_ESDC1A (avr_IEEET1) in DigSILENT, DC1IEEE in EUROSTAG)*: 516 (PSS®E – IEEET1) + 212 (PSS®E – ESDC1A)*

CIM Model type: ExcSEXS (SEXS in PSLF, SEXS in PSS®E, avr_SEXS in DigSILENT, ? in EUROSTAG)*: 280 (PSS®E – SEXS)*

CIM Model type: ExcST3A (ESST3A (EXST3) in PSS®E and PSLF, avr_ESST3A in DigSILENT, ST3IEEE in EUROSTAG)*: 4 (PSS®E – EXST3)*

CIM Model type: ExcDC2A (ESDC2A (EXDC2A) in PSLF, ESDC2A (EXDC2) in PSS®E, ? in DigSILENT, DC2IEEE in EUROSTAG)*: 92 (PSS®E –ESDC2A)*

CIM Model type: ExcST2A (ESST2A (EXST2, EXST2A) in PSS®E and PSLF, avr_ESST2A in DigSILENT, ST2IEEE in EUROSTAG)*: 16 (PSS®E – ESST2A)*

CIM Model type: ExcST5B (ESST5B in PSLF, ST5B (URST5T) in PSS®E, ? in DigSILENT, ? in EUROSTAG)*: 236 (PSS®E – URST5T) + 148 (PSS®E – ST5B)*

POWER SYSTEM STABILIZERS:

CIM Model type: PssIEEE2B (PSS2B (PSS2A) in PSLF and PSS®E, pss_PSS2A in DigSILENT, ? in EUROSTAG)*: 364 (PSS®E – PSS2A)*

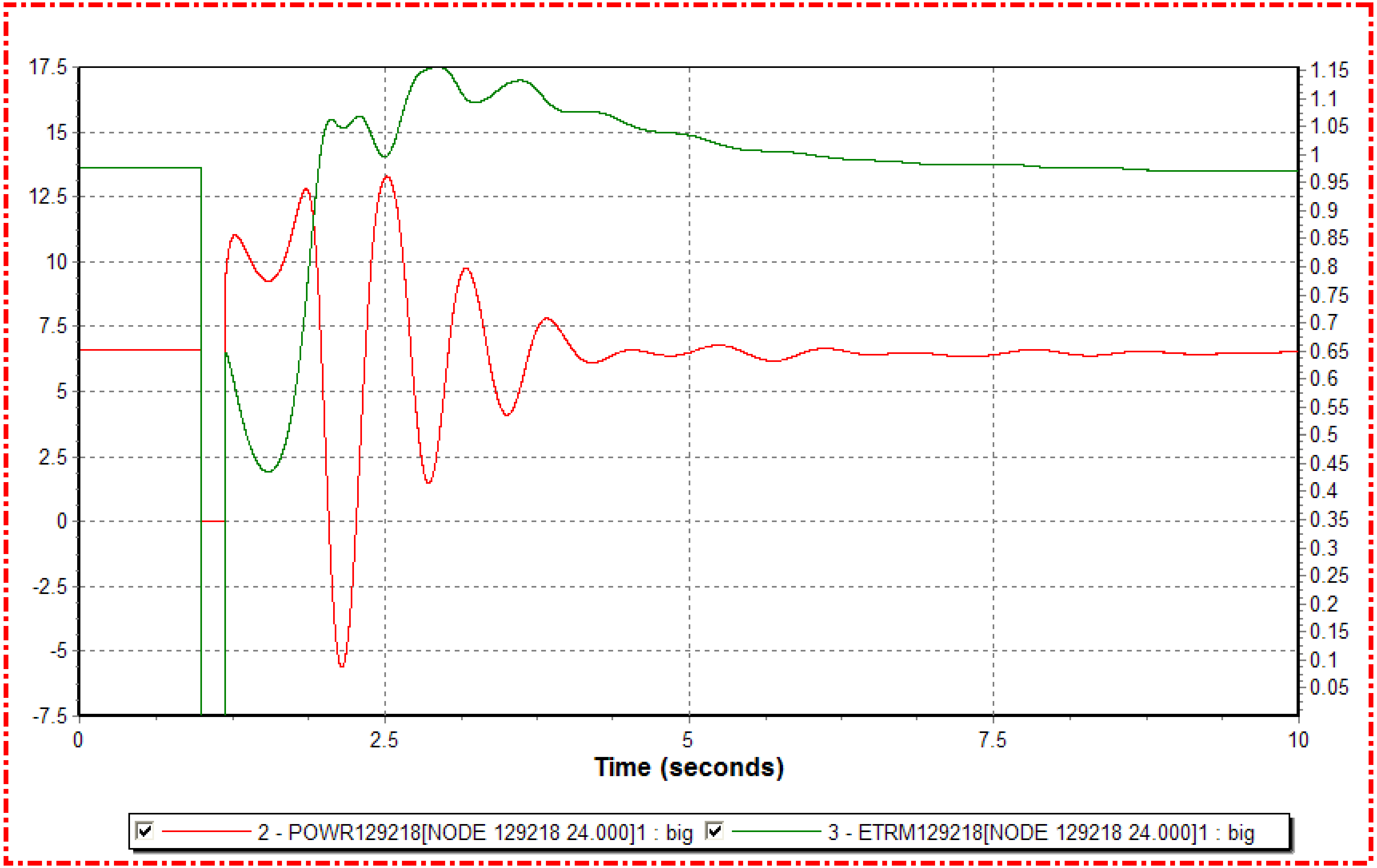
9.2.2.2 REFERENCE RESULTS

Simulation step (Delta) = 0.001 sec.

THREE PHASE SHORT CIRCUIT

Simulation details:

- No disturbance until 1 sec.;
- Three phase short circuit on Node 129218, time of SC=0.2 sec.;
- SC is cleared;
- Simulation until 20th sec.

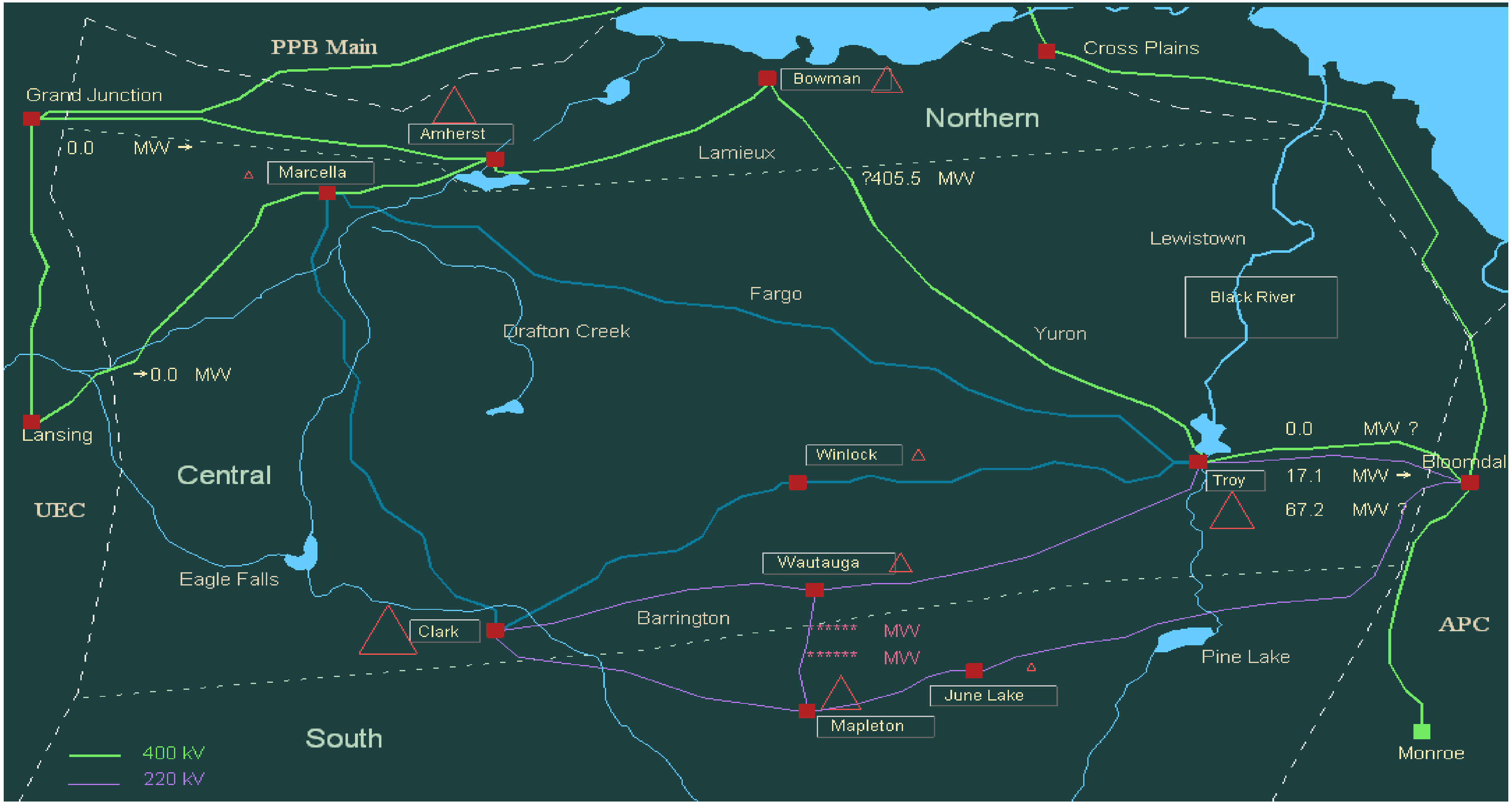


ACTIVE POWER AND TERMINAL VOLTAGE OF THE GENERATOR AT NODE 129218

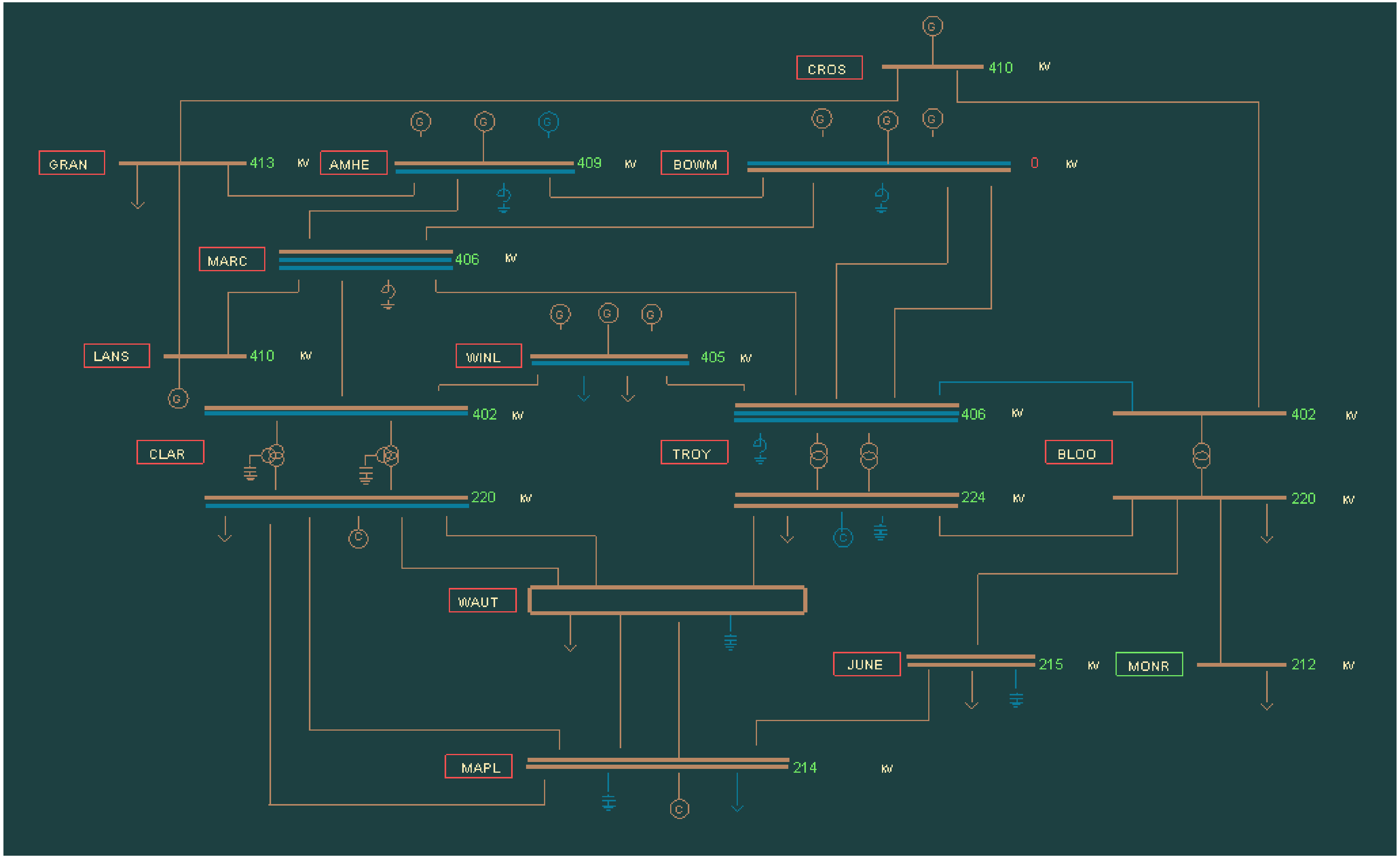
9.3 ABB 40 NODES MODEL

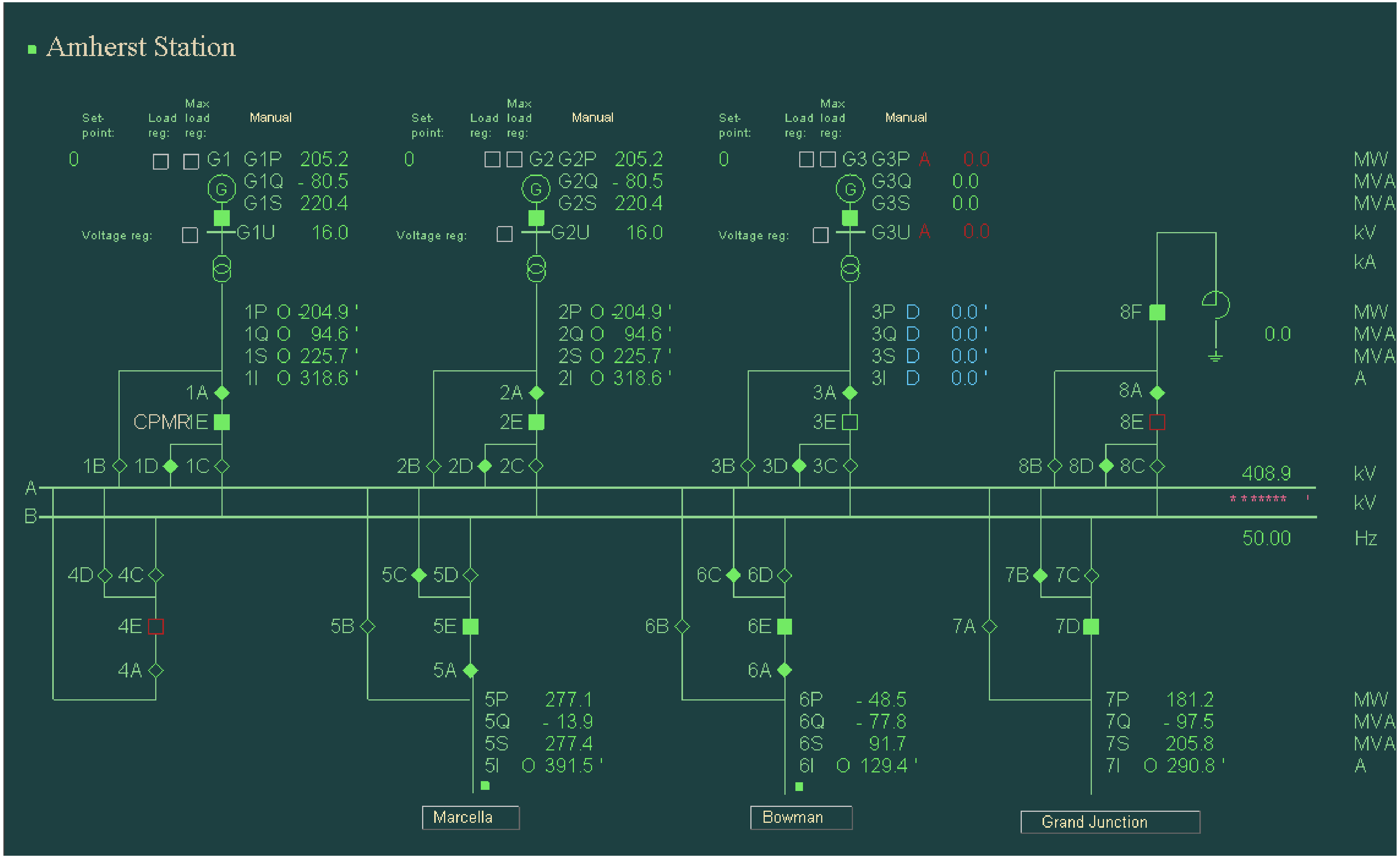
The ABB40bus network was developed for testing of SCADA/EMS/DMS/BMS software. It is often used in CIM/XML interoperability tests. Any party is free to use the ABB40bus network in CIM interoperability test in any other context as long as it is clearly stated that ABB is the origin of the network and ABB is notified of the usage

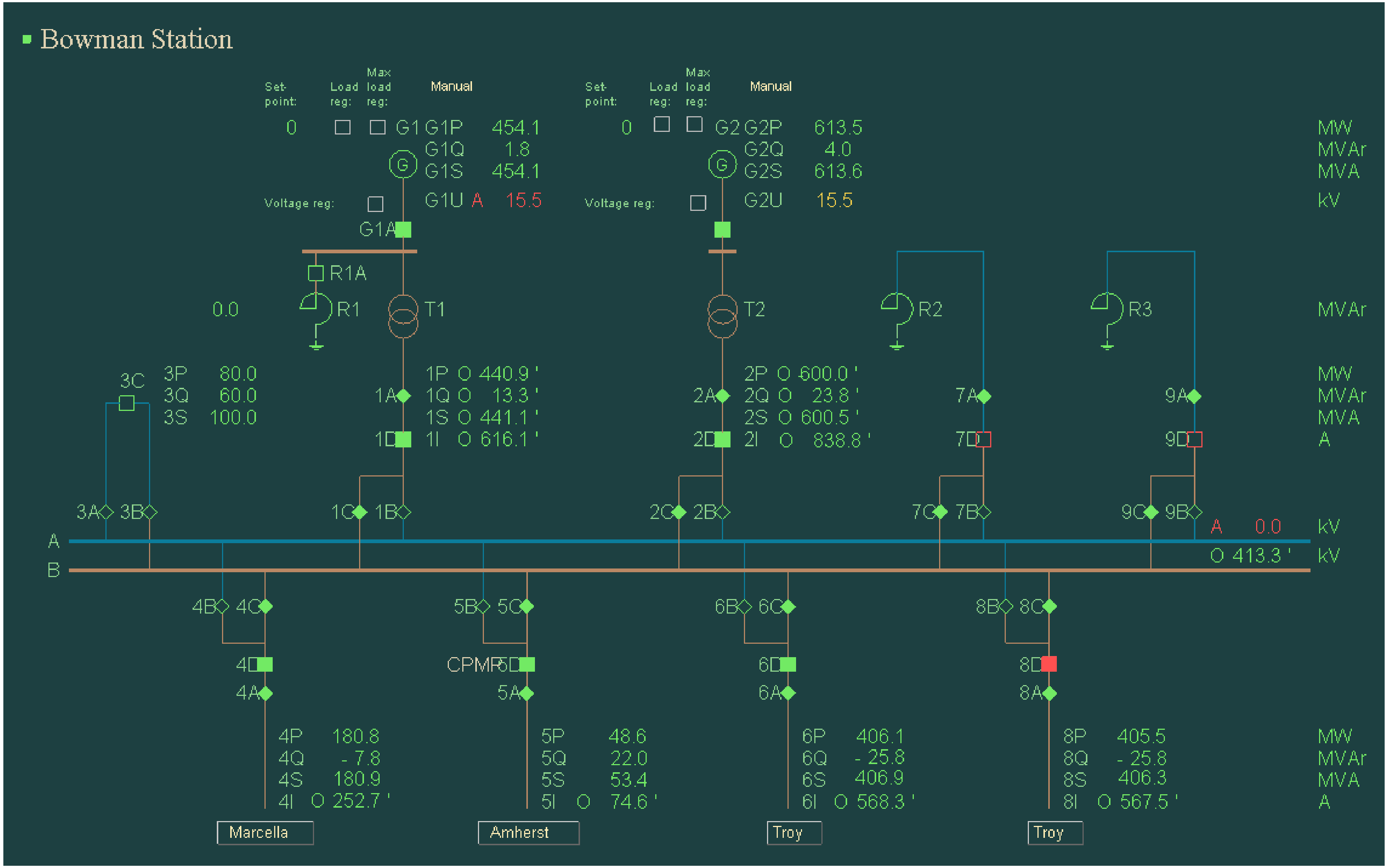
Geographical Overview

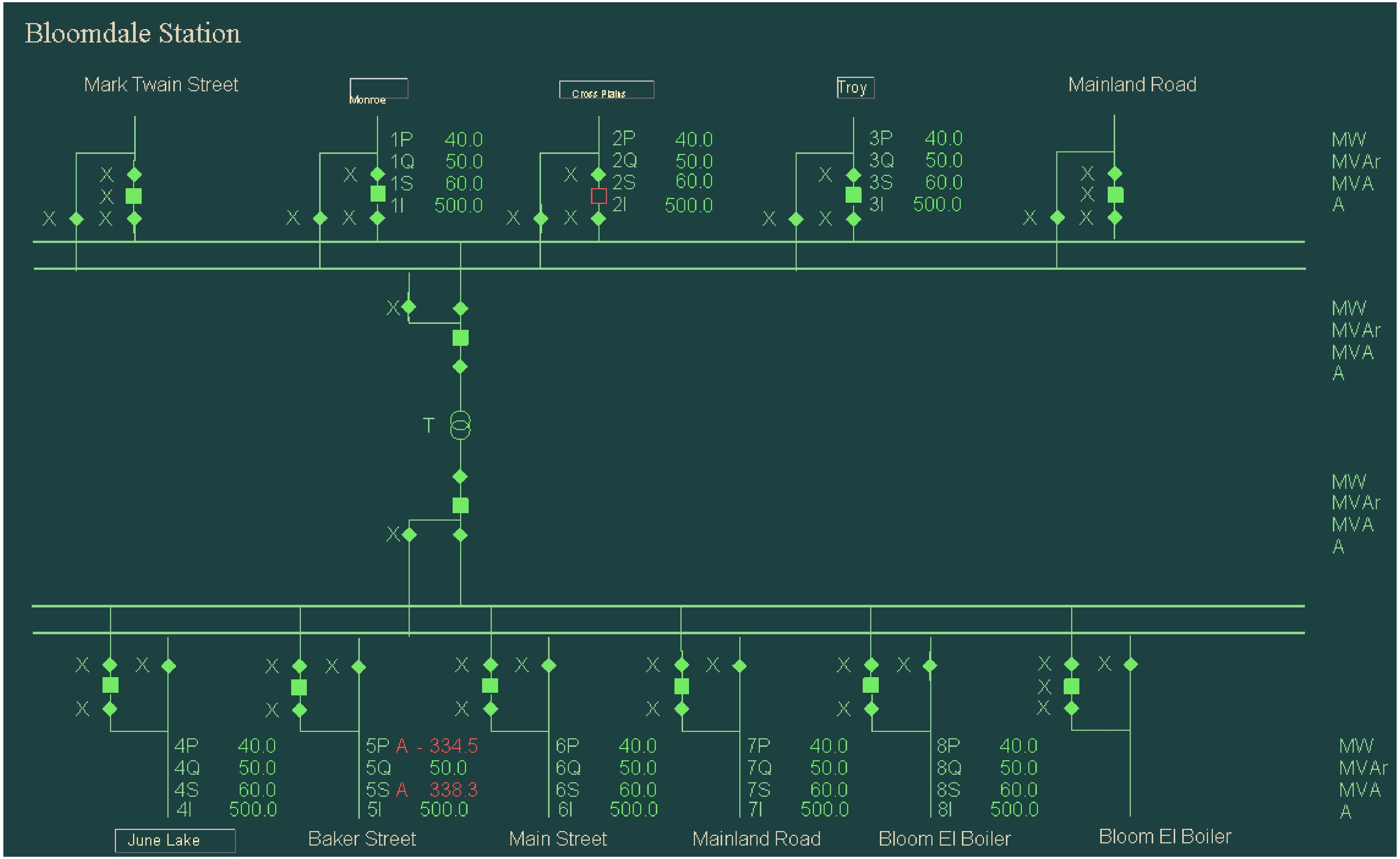


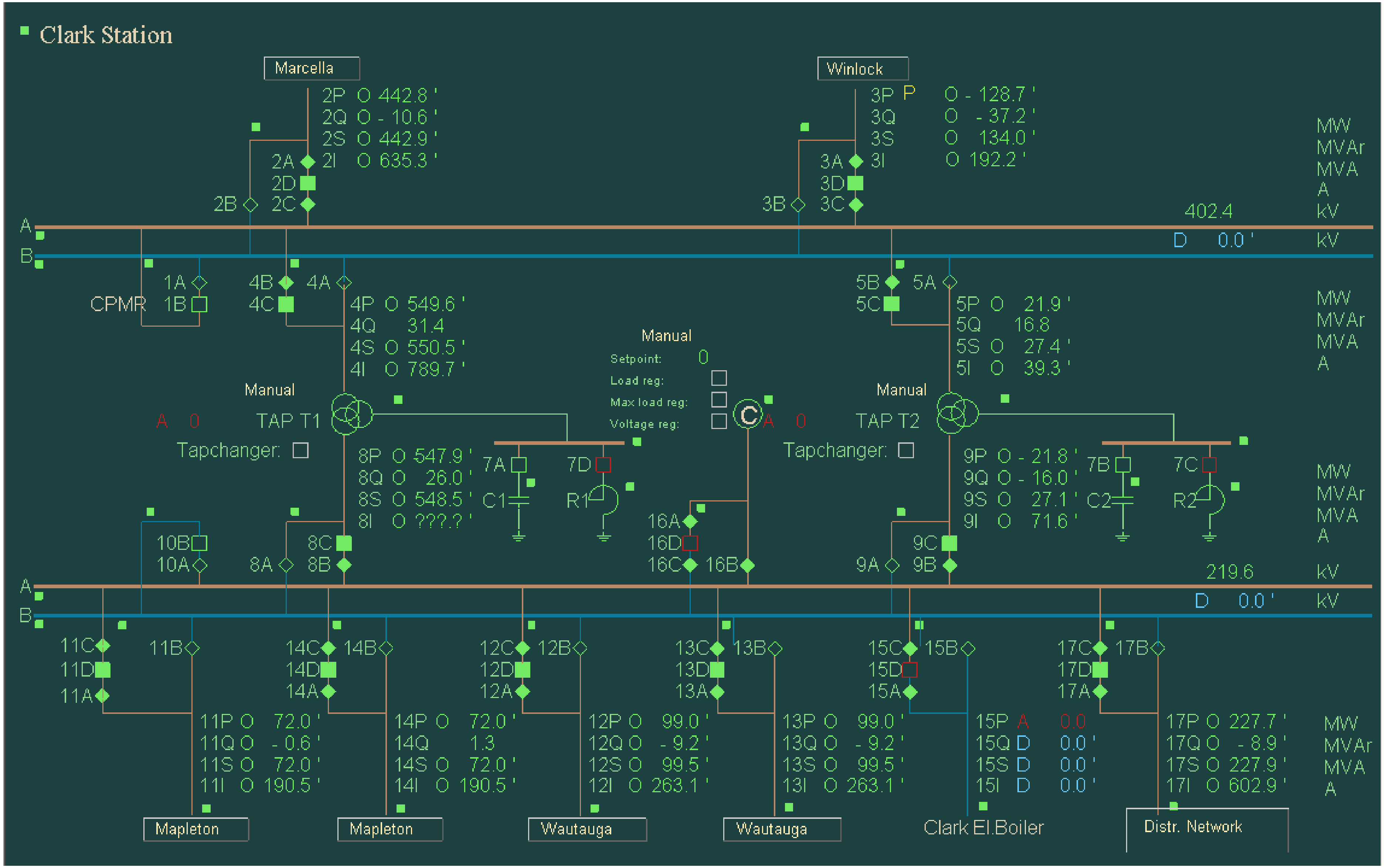
Network Overview

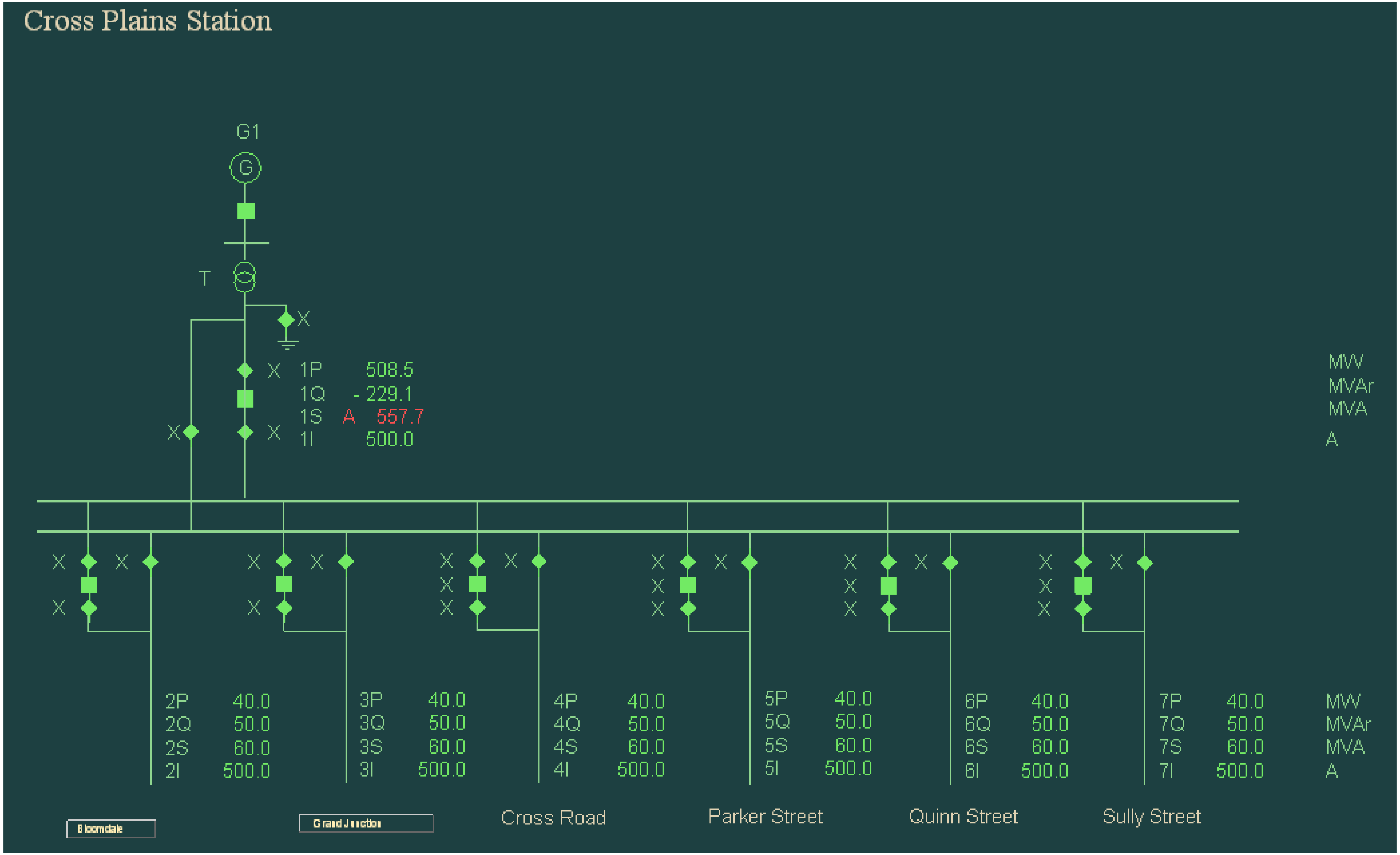


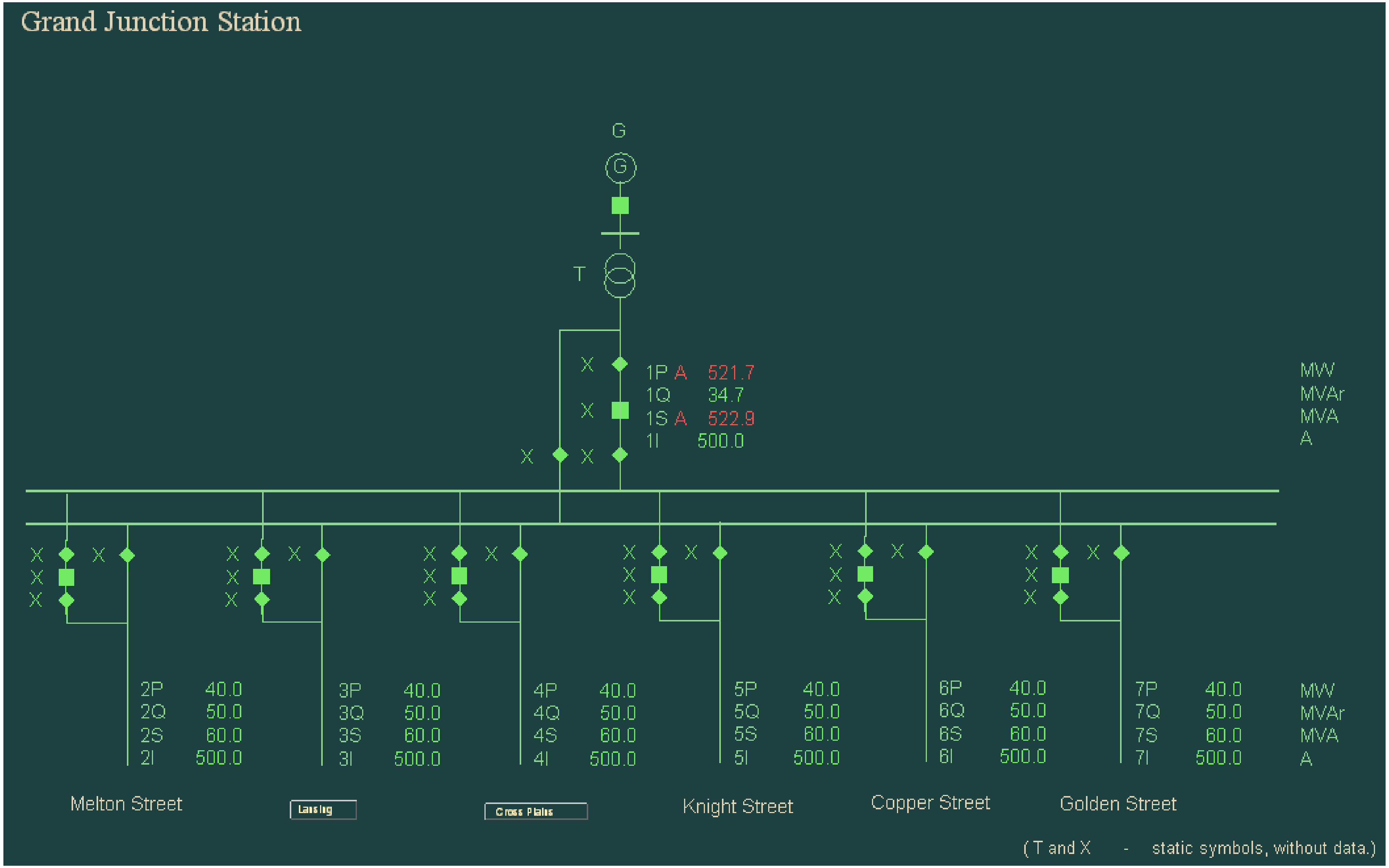

Amherst Station
Set point:
Load reg:
Max load reg:
Manual
G1 G1P 205.2
G1Q - 80.5
G1S 220.4
Voltage reg:
G1U 16.0
G2 G2P 205.2
G2Q - 80.5
G2S 220.4
G2U 16.0
G3 G3P A 0.0
G3Q 0.0
G3S 0.0
G3U A 0.0
1P O 204.9
1Q O 94.6
1S O 225.7
1I O 318.6
2P O 204.9
2Q O 94.6
2S O 225.7
2I O 318.6
3P D 0.0
3Q D 0.0
3S D 0.0
3I D 0.0
1A
CPMRIE
1B 1D 1C
2A
2E
2B 2D 2C
3A
3E
3B 3D 3C
8F
8A
8E
8B 8D 8C
0.0
408.9
50.00
A
B
4D 4C
4E
4A
5C 5D
5B
5E
5A
5P 277.1
5Q - 13.9
5S 277.4
5I O 391.5
6C 6D
6B
6E
6A
6P - 48.5
6Q - 77.8
6S 91.7
6I O 129.4
7B 7C
7A
7D
7P 181.2
7Q - 97.5
7S 205.8
7I O 290.8
Marcella
Bowman
Grand Junction
MW
MVA
MVA
kV
kA
MW
MVA
MVA
A
kV
kV
Hz
MW
MVA
MVA
A

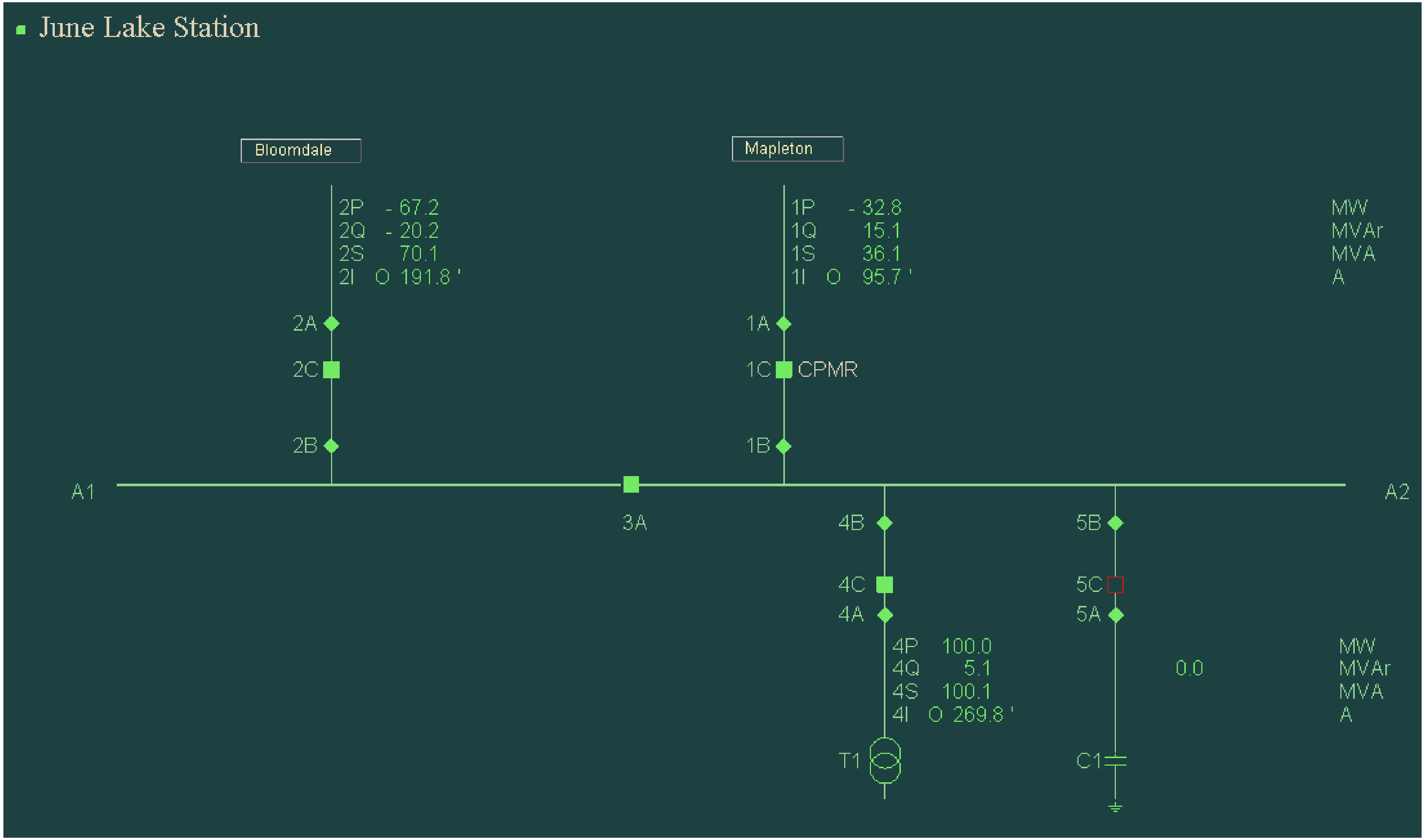

Bowman Station
Set-point:
Load reg:
Max load reg:
Manual
0
G1 G1P 454.1
G1Q 1.8
G1S 454.1
Voltage reg:
G1U A 15.5
G1A
0
G2 G2P 613.5
G2Q 4.0
G2S 613.6
G2U 15.5
MW
MVAr
MVA
kV
R1A
0.0
R1
T1
T2
R2
R3
MVAr
3C
3P 80.0
3Q 60.0
3S 100.0
1P O 440.9 '
1A
1Q O 13.3 '
1S O 441.1 '
1D
1I O 616.1 '
2P O 600.0 '
2A
2Q O 23.8 '
2S O 600.5 '
2D
2I O 838.8 '
7A
7D
9A
9D
MW
MVAr
MVA
A
3A 3B
1C 1B
2C 2B
7C 7B
9C 9B
A
B
A 0.0
O 413.3 '
kV
kV
4B 4C
5B 5C
6B 6C
8B 8C
4D
CPMR5D
6D
8D
4A
5A
6A
8A
4P 180.8
4Q - 7.8
4S 180.9
4I O 252.7 '
5P 48.6
5Q 22.0
5S 53.4
5I O 74.6 '
6P 406.1
6Q - 25.8
6S 406.9
6I O 568.3 '
8P 405.5
8Q - 25.8
8S 406.3
8I O 567.5 '
MW
MVAr
MVA
A
Marcella
Amherst
Troy
Troy

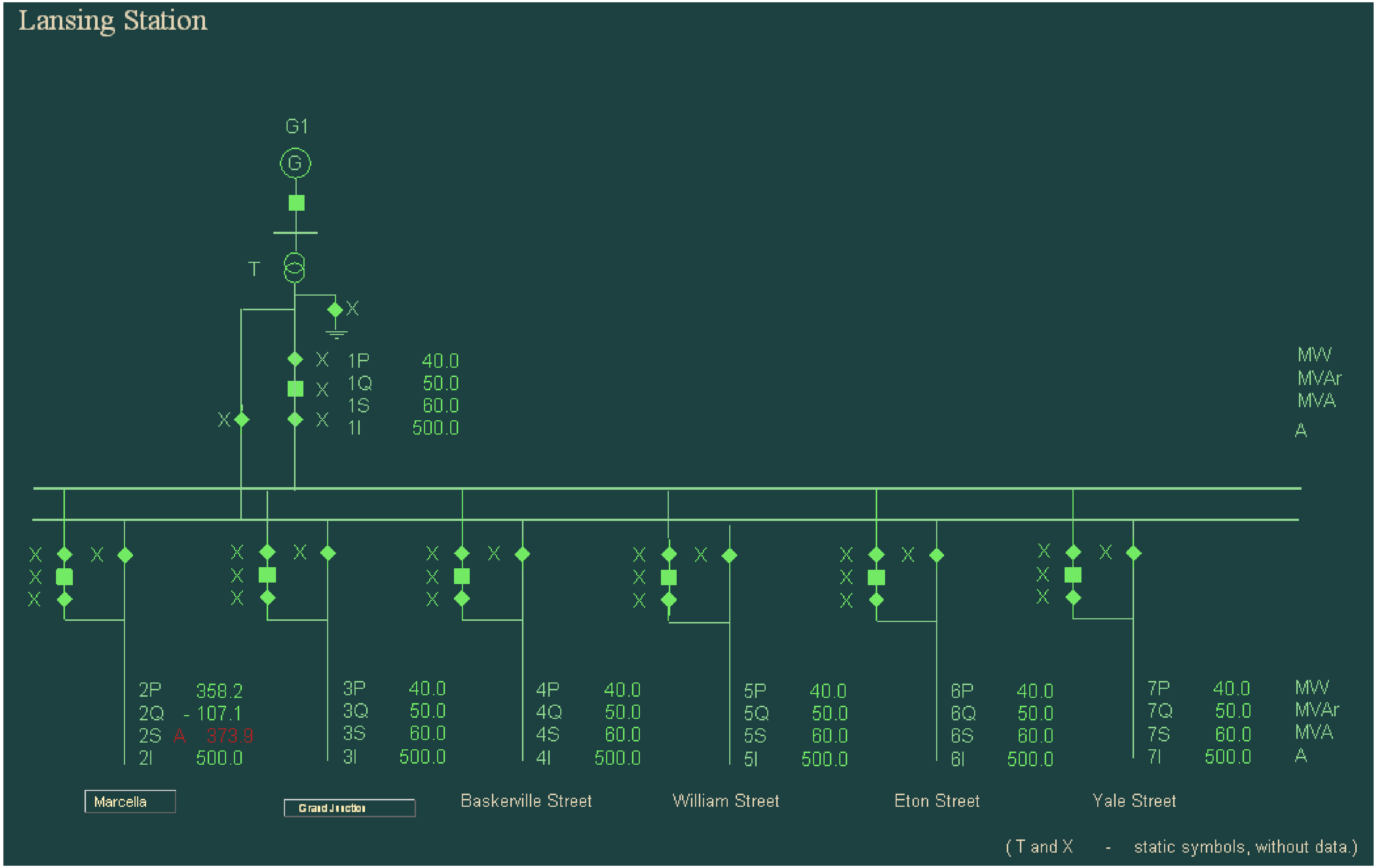

Bloomdale Station
Mark Twain Street
Monroe
Cross Plains
Troy
Mainland Road
1P 40.0
1Q 50.0
1S 60.0
1I 500.0
2P 40.0
2Q 50.0
2S 60.0
2I 500.0
3P 40.0
3Q 50.0
3S 60.0
3I 500.0
MW
MVAr
MVA
A
T
4P 40.0
4Q 50.0
4S 60.0
4I 500.0
5P A - 334.5
5Q 50.0
5S A 338.3
5I 500.0
6P 40.0
6Q 50.0
6S 60.0
6I 500.0
7P 40.0
7Q 50.0
7S 60.0
7I 500.0
8P 40.0
8Q 50.0
8S 60.0
8I 500.0
June Lake
Baker Street
Main Street
Mainland Road
Bloom El Boiler
Bloom El Boiler

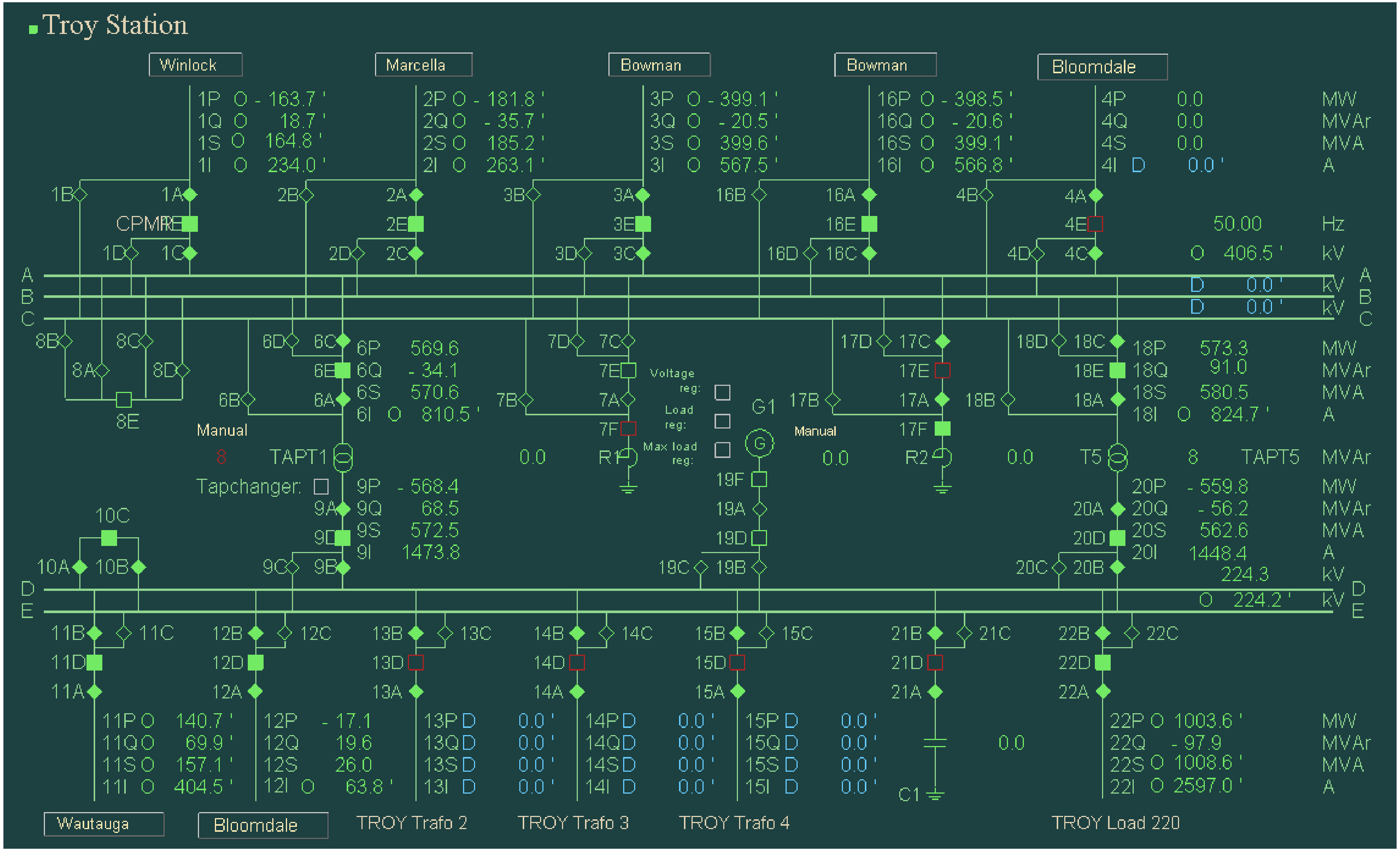

Clark Station
Marcella
2P O 442.8 '
2Q O - 10.6 '
2S O 442.9 '
2I O 635.3 '
2A
2D
2B
2C
Winlock
3P P O - 128.7 '
3Q O - 37.2 '
3S O 134.0 '
3I O 192.2 '
3A
3D
3B
3C
MW
MVAr
MVA
A
kV
402.4
D 0.0 '
kV
A
B
1A
1B
CPMR
4B
4C
4A
4P O 549.6 '
4Q 31.4
4S O 550.5 '
4I O 789.7 '
5B
5C
5A
5P O 21.9 '
5Q 16.8
5S O 27.4 '
5I O 39.3 '
Manual
Setpoint: 0
Load reg:
Max load reg:
Voltage reg:
C
A 0
Manual
TAP T1
A 0
Tapchanger:
Manual
TAP T2
Tapchanger:
8P O 547.9 '
8Q O 26.0 '
8S O 548.5 '
8I O ???.? '
7A
7D
C1
R1
16A
16D
16C
16B
9P O - 21.8 '
9Q O - 16.0 '
9S O 27.1 '
9I O 71.6 '
7B
7C
C2
R2
10B
10A
8A
8C
8B
9A
9C
9B
219.6
kV
D 0.0 '
kV
11C
11D
11A
11B
14C
14B
14D
14A
12C
12B
12D
12A
13C
13B
13D
13A
15C
15B
15D
15A
17C
17B
17D
17A
11P O 72.0 '
11Q O - 0.6 '
11S O 72.0 '
11I O 190.5 '
14P O 72.0 '
14Q 1.3
14S O 72.0 '
14I O 190.5 '
12P O 99.0 '
12Q O - 9.2 '
12S O 99.5 '
12I O 263.1 '
13P O 99.0 '
13Q O - 9.2 '
13S O 99.5 '
13I O 263.1 '
15P A 0.0
15Q D 0.0 '
15S D 0.0 '
15I D 0.0 '
17P O 227.7 '
17Q O - 8.9 '
17S O 227.9 '
17I O 602.9 '
MW
MVAr
MVA
A
Mapleton
Mapleton
Wautauga
Wautauga
Clark El.Boiler
Distr. Network

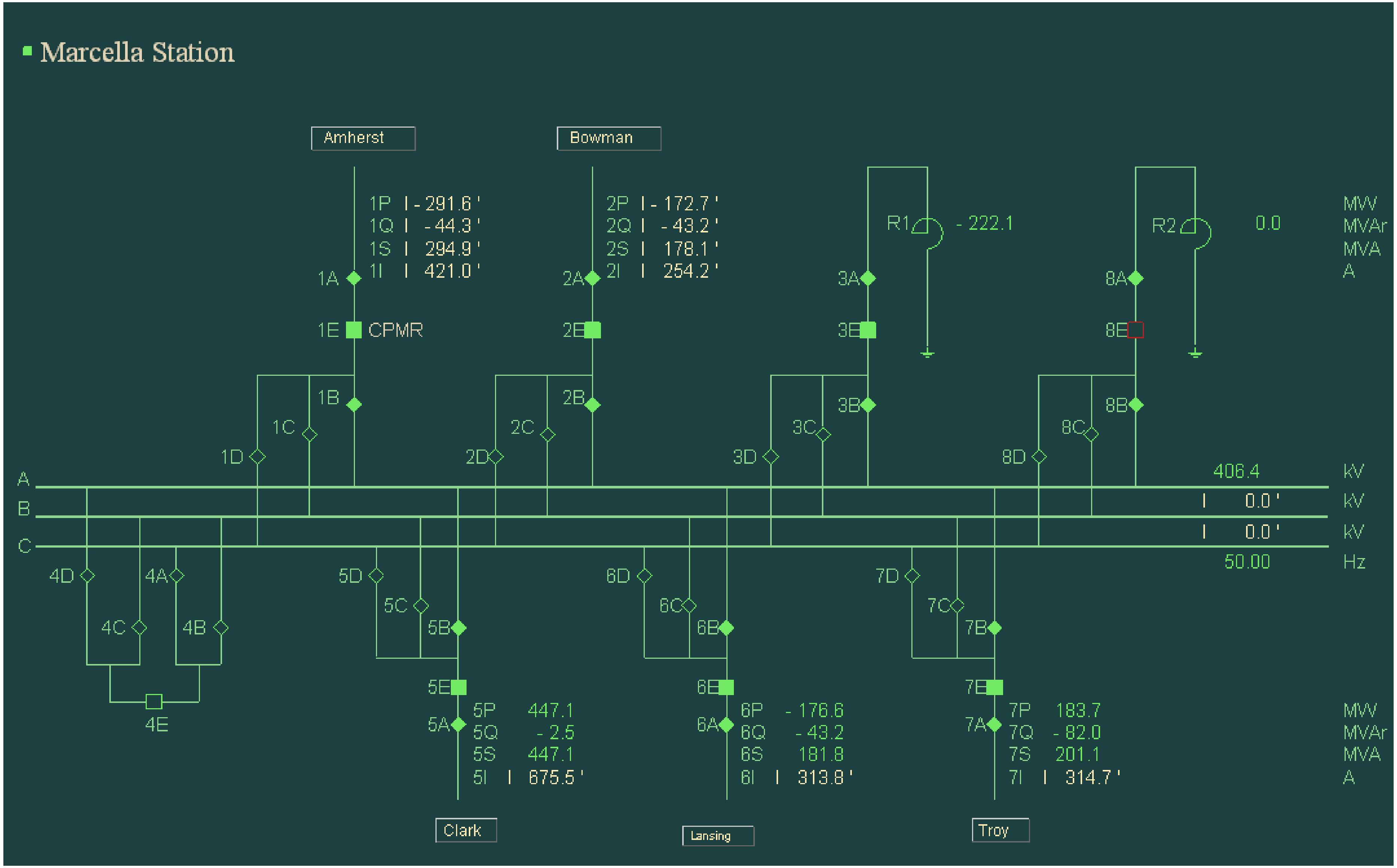

Cross Plains Station
G1
G
T
X
X
1P 508.5
1Q - 229.1
1S A 557.7
1I 500.0
X
X
MW
MVAr
MVA
A
2P 40.0
2Q 50.0
2S 60.0
2I 500.0
3P 40.0
3Q 50.0
3S 60.0
3I 500.0
4P 40.0
4Q 50.0
4S 60.0
4I 500.0
5P 40.0
5Q 50.0
5S 60.0
5I 500.0
6P 40.0
6Q 50.0
6S 60.0
6I 500.0
7P 40.0
7Q 50.0
7S 60.0
7I 500.0
MW
MVAr
MVA
A
Cross Road
Parker Street
Quinn Street
Sully Street

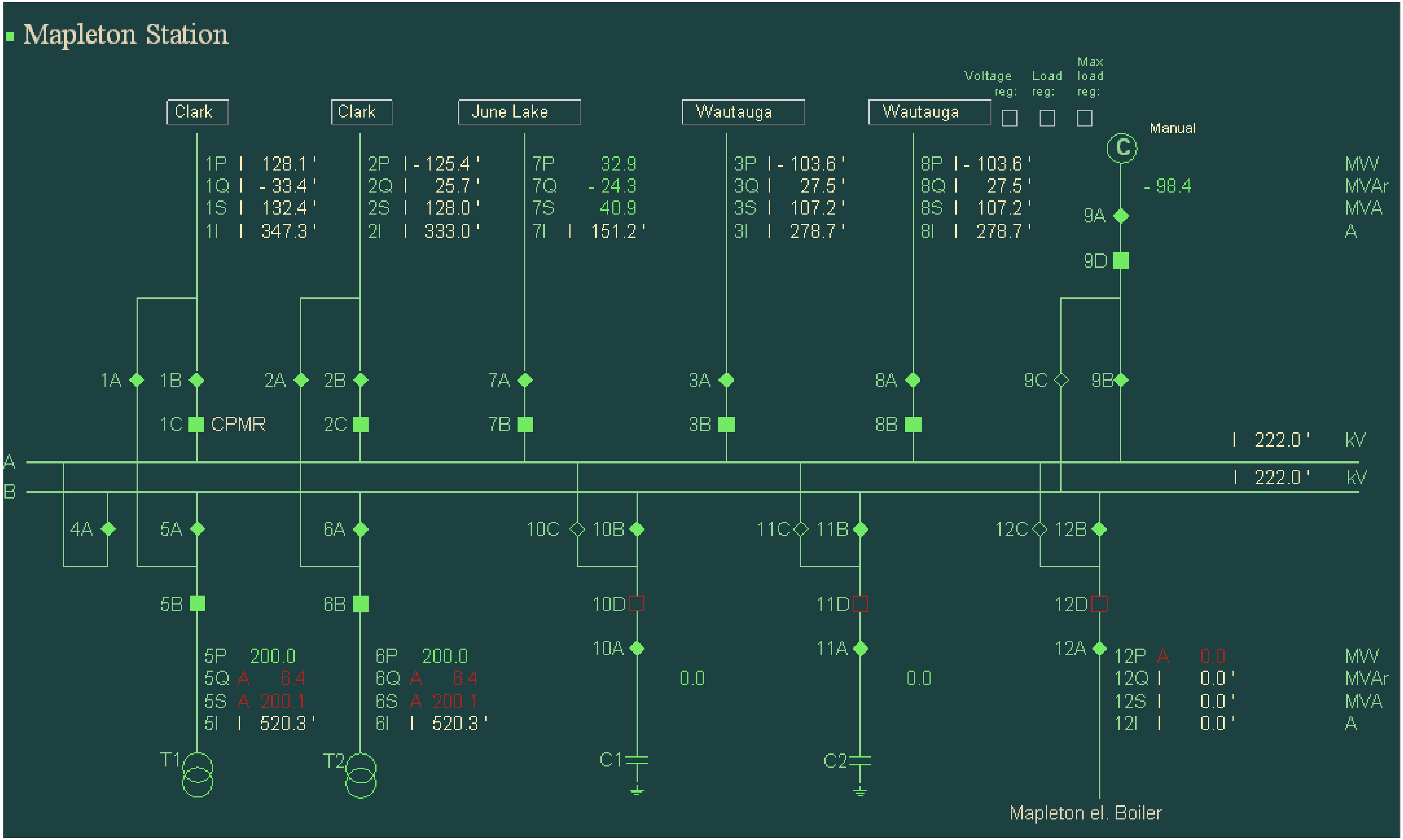

Grand Junction Station
G
T
X
1P A 521.7
1Q 34.7
1S A 522.9
1I 500.0
MW
MVAr
MVA
A
2P 40.0
2Q 50.0
2S 60.0
2I 500.0
3P 40.0
3Q 50.0
3S 60.0
3I 500.0
4P 40.0
4Q 50.0
4S 60.0
4I 500.0
5P 40.0
5Q 50.0
5S 60.0
5I 500.0
6P 40.0
6Q 50.0
6S 60.0
6I 500.0
7P 40.0
7Q 50.0
7S 60.0
7I 500.0
Melton Street
Lansing
Cross Plains
Knight Street
Copper Street
Golden Street
(T and X - static symbols, without data.)

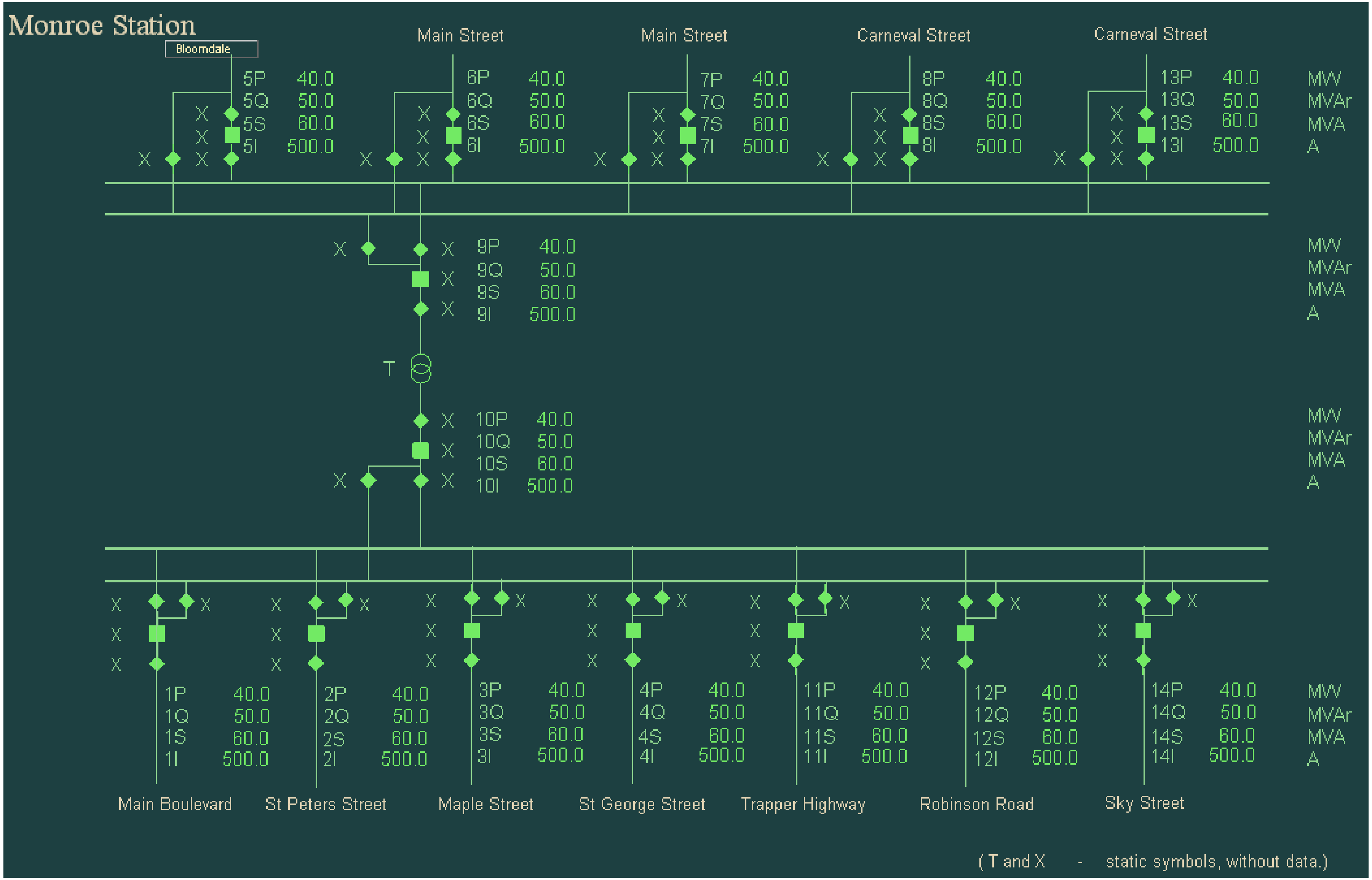

June Lake Station
Bloomdale
Mapleton
2P - 67.2
2Q - 20.2
2S 70.1
2I O 191.8 '
1P - 32.8
1Q 15.1
1S 36.1
1I O 95.7 '
MW
MVAr
MVA
A
2A
2C
2B
1A
1C CPMR
1B
A1
3A
A2
4B
5B
4C
5C
4A
5A
4P 100.0
4Q 5.1
4S 100.1
4I O 269.8 '
0.0
MW
MVAr
MVA
A
T1
C1

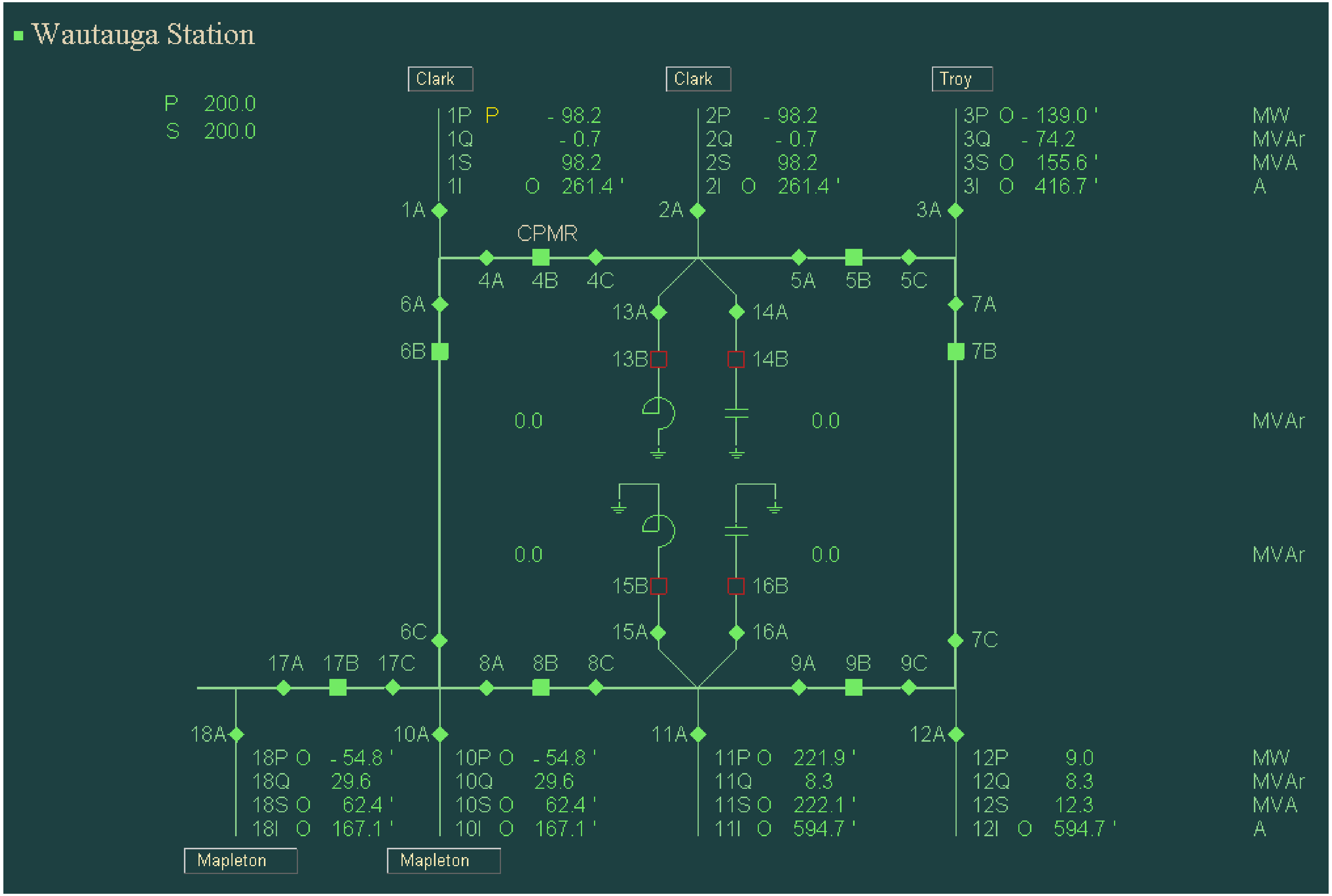

Lansing Station
G1
G
T
X
1P 40.0
1Q 50.0
1S 60.0
1I 500.0
MW
MVAr
MVA
A
2P 358.2
2Q - 107.1
2S A 373.9
2I 500.0
3P 40.0
3Q 50.0
3S 60.0
3I 500.0
4P 40.0
4Q 50.0
4S 60.0
4I 500.0
5P 40.0
5Q 50.0
5S 60.0
5I 500.0
6P 40.0
6Q 50.0
6S 60.0
6I 500.0
7P 40.0
7Q 50.0
7S 60.0
7I 500.0
MW
MVAr
MVA
A
Marcella
Baskerville Street
William Street
Eton Street
Yale Street
(T and X - static symbols, without data.)

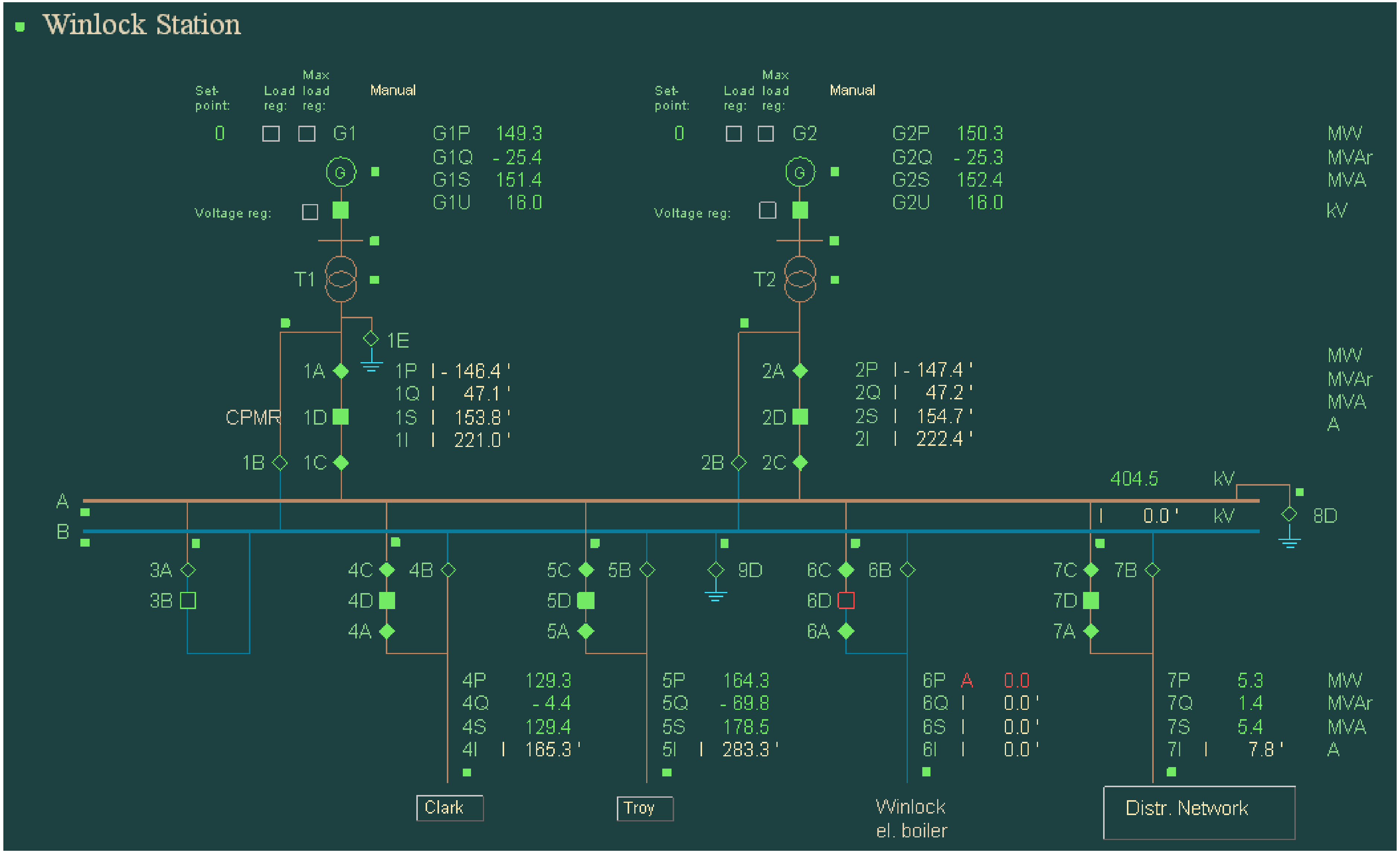

Troy Station
Winlock
Marcella
Bowman
Bowman
Bloomdale
1P O - 163.7 '
1Q O 18.7 '
1S O 164.8 '
1I O 234.0 '
2P O - 181.8 '
2Q O - 35.7 '
2S O 185.2 '
2I O 263.1 '
3P O - 399.1 '
3Q O - 20.5 '
3S O 399.6 '
3I O 567.5 '
16P O - 398.5 '
16Q O - 20.6 '
16S O 399.1 '
16I O 566.8 '
4P 0.0 MW
4Q 0.0 MVAr
4S 0.0 MVA
4I D 0.0 ' A
50.00 Hz
O 406.5 ' kV
D 0.0 ' kV
D 0.0 ' kV
A
B
C
18P 573.3 MW
18Q 91.0 MVAr
18S 580.5 MVA
18I O 824.7 ' A
6P 569.6
6Q - 34.1
6S 570.6
6I O 810.5 '
Voltage reg:
Load reg:
Max load reg:
G1
Manual
Manual
TAPT1
Tapchanger:
8
0.0
R1
0.0
R2
0.0
T5
8 TAPT5 MVAr
9P - 568.4
9Q 68.5
9S 572.5
9I 1473.8
20P - 559.8 MW
20Q - 56.2 MVAr
20S 562.6 MVA
20I 1448.4 A
224.3 kV
O 224.2 ' kV
D
E
11P O 140.7 '
11Q O 69.9 '
11S O 157.1 '
11I O 404.5 '
12P - 17.1
12Q 19.6
12S 26.0
12I O 63.8 '
13P D 0.0 '
13Q D 0.0 '
13S D 0.0 '
13I D 0.0 '
14P D 0.0 '
14Q D 0.0 '
14S D 0.0 '
14I D 0.0 '
15P D 0.0 '
15Q D 0.0 '
15S D 0.0 '
15I D 0.0 '
C1
0.0
22P O 1003.6 ' MW
22Q - 97.9 MVAr
22S O 1008.6 ' MVA
22I O 2597.0 ' A
Wautauga
Bloomdale
TROY Trafo 2
TROY Trafo 3
TROY Trafo 4
TROY Load 220


Marcella Station
Amherst
Bowman
1P | - 291.6 '
1Q | - 44.3 '
1S | 294.9 '
1I | 421.0 '
2P | - 172.7 '
2Q | - 43.2 '
2S | 178.1 '
2I | 254.2 '
R1
- 222.1
R2
0.0
MW
MVAr
MVA
A
1A
2A
3A
8A
1E
CPMR
2E
3E
8E
1B
2B
3B
8B
1C
2C
3C
8C
1D
2D
3D
8D
A
B
C
406.4
kV
| 0.0 '
kV
| 0.0 '
kV
50.00
Hz
4D
4A
4C
4B
4E
5D
5C
5B
5E
5A
6D
6C
6B
6E
6A
7D
7C
7B
7E
7A
5P 447.1
5Q - 2.5
5S 447.1
5I | 675.5 '
6P - 176.6
6Q - 43.2
6S 181.8
6I | 313.8 '
7P 183.7
7Q - 82.0
7S 201.1
7I | 314.7 '
MW
MVAr
MVA
A
Clark
Lansing
Troy


Mapleton Station
Voltage reg:
Load reg:
Max load reg:
Clark
Clark
June Lake
Wautauga
Wautauga
Manual
1P 128.1
1Q -33.4
1S 132.4
1I 347.3
2P -125.4
2Q 25.7
2S 128.0
2I 333.0
7P 32.9
7Q -24.3
7S 40.9
7I 151.2
3P -103.6
3Q 27.5
3S 107.2
3I 278.7
8P -103.6
8Q 27.5
8S 107.2
8I 278.7
-98.4
MW
MVAr
MVA
A
9A
9D
1A 1B 2A 2B 7A 3A 8A 9C 9B
1C CPMR 2C 7B 3B 8B
222.0 kV
222.0 kV
A
B
4A 5A 6A 10C 10B 11C 11B 12C 12B
5B 6B 10D 11D 12D
10A 11A 12A
5P 200.0
5Q A 6.4
5S A 200.1
5I 520.3
6P 200.0
6Q A 6.4
6S A 200.1
6I 520.3
0.0
0.0
12P A 0.0
12Q 0.0
12S 0.0
12I 0.0
MW
MVAr
MVA
A
T1
T2
C1
C2
Mapleton el. Boiler


Monroe Station
Bloomdale
Main Street
Main Street
Carneval Street
Carneval Street
5P 40.0
5Q 50.0
5S 60.0
5I 500.0
6P 40.0
6Q 50.0
6S 60.0
6I 500.0
7P 40.0
7Q 50.0
7S 60.0
7I 500.0
8P 40.0
8Q 50.0
8S 60.0
8I 500.0
13P 40.0
13Q 50.0
13S 60.0
13I 500.0
MW
MVAr
MVA
A
9P 40.0
9Q 50.0
9S 60.0
9I 500.0
MW
MVAr
MVA
A
T
10P 40.0
10Q 50.0
10S 60.0
10I 500.0
MW
MVAr
MVA
A
1P 40.0
1Q 50.0
1S 60.0
1I 500.0
2P 40.0
2Q 50.0
2S 60.0
2I 500.0
3P 40.0
3Q 50.0
3S 60.0
3I 500.0
4P 40.0
4Q 50.0
4S 60.0
4I 500.0
11P 40.0
11Q 50.0
11S 60.0
11I 500.0
12P 40.0
12Q 50.0
12S 60.0
12I 500.0
14P 40.0
14Q 50.0
14S 60.0
14I 500.0
MW
MVAr
MVA
A
Main Boulevard
St Peters Street
Maple Street
St George Street
Trapper Highway
Robinson Road
Sky Street
(T and X - static symbols, without data.)


Wautauga Station
P 200.0
S 200.0
Clark
Clark
Troy
1P P - 98.2
1Q - 0.7
1S 98.2
1I O 261.4 '
2P - 98.2
2Q - 0.7
2S 98.2
2I O 261.4 '
3P O - 139.0 '
3Q - 74.2
3S O 155.6 '
3I O 416.7 '
MW
MVAr
MVA
A
CPMR
0.0
0.0
0.0
0.0
MVAr
MVAr
18P O - 54.8 '
18Q 29.6
18S O 62.4 '
18I O 167.1 '
10P O - 54.8 '
10Q 29.6
10S O 62.4 '
10I O 167.1 '
11P O 221.9 '
11Q 8.3
11S O 222.1 '
11I O 594.7 '
12P 9.0
12Q 8.3
12S 12.3
12I O 594.7 '
MW
MVAr
MVA
A
Mapleton
Mapleton


Winlock Station
Set-point:
Load reg:
Max load reg:
Manual
0
G1
G1P 149.3
G1Q - 25.4
G1S 151.4
G1U 16.0
Voltage reg:
T1
1E
1A
1P | - 146.4 '
1Q | 47.1 '
1S | 153.8 '
1I | 221.0 '
CPMR
1D
1B
1C
Set-point:
Load reg:
Max load reg:
Manual
0
G2
G2P 150.3
G2Q - 25.3
G2S 152.4
G2U 16.0
Voltage reg:
T2
2A
2P | - 147.4 '
2Q | 47.2 '
2S | 154.7 '
2I | 222.4 '
2D
2B
2C
MW
MVAr
MVA
kV
MW
MVAr
MVA
A
404.5 kV
| 0.0 ' kV
8D
A
B
3A
3B
4C
4B
4D
4A
5C
5B
5D
5A
9D
6C
6B
6D
6A
7C
7B
7D
7A
4P 129.3
4Q - 4.4
4S 129.4
4I | 165.3 '
5P 164.3
5Q - 69.8
5S 178.5
5I | 283.3 '
6P A 0.0
6Q | 0.0 '
6S | 0.0 '
6I | 0.0 '
7P 5.3
7Q 1.4
7S 5.4
7I | 7.8 '
MW
MVAr
MVA
A
Clark
Troy
Winlock
el. boiler
Distr. Network

9.4 GE ENERGY 262 NODES MODEL

Models summary

ACLineSegment	234
ApparentPowerLimit	660
BaseVoltage	9
Breaker	998
BusbarSection	262
ConformLoad	152
ConformLoadGroup	4
ConformLoadSchedule	4
ConnectivityNode	1260
CurrentLimit	1404
CurveData	4
DayType	1
FullModel	1
GeneratingUnit	12
GeographicalRegion	4

IEC61970CIMVersion	1
LoadArea	4
MeasurementValueSource	1
OperationalLimitSet	950
PowerTransformer	109
RatioTapChanger	109
ReactiveCapabilityCurve	2
RegularTimePoint	12
RegulatingControl	59
Season	4
SeriesCompensator	1
ShuntCompensator	35
SubGeographicalRegion	4
SubLoadArea	4
Substation	4
SynchronousMachine	55
Terminal	3188

ThermalGeneratingUnit	43
TransformerWinding	218
VoltageLevel	262
VoltageLimit	1572

TopologicalNode	263
SvPowerFlow	930
SvShuntCompensatorSections	35
SvTapStep	109
SvVoltage	263
TopologicalIsland	4

Model load flow results

7.47 TSM BC Island Summary (1/1) - SCADA

Study Case I 07/15/10 04:40:48.618 EDT: STNA: DPF: demand execution

Note:

Status: CASE CONTAINS CONVERGED SOLUTION

	Convergence	Gross Generation		Load		Shunt/SVC		Island	Losses	
Isld#	Status	MW	MVAR	MW	MVAR	MW	MVAR	Charging	MW	MVAR
1	Convergent	2053	-923	1983	578	0	-521	2672	71	-2022
2	Convergent	5	25	5	100	0	75	0	0	0
3	Convergent	45	1	45	128	0	103	26	0	-24
4	Convergent	63	-4	63	10	0	16	0	0	3

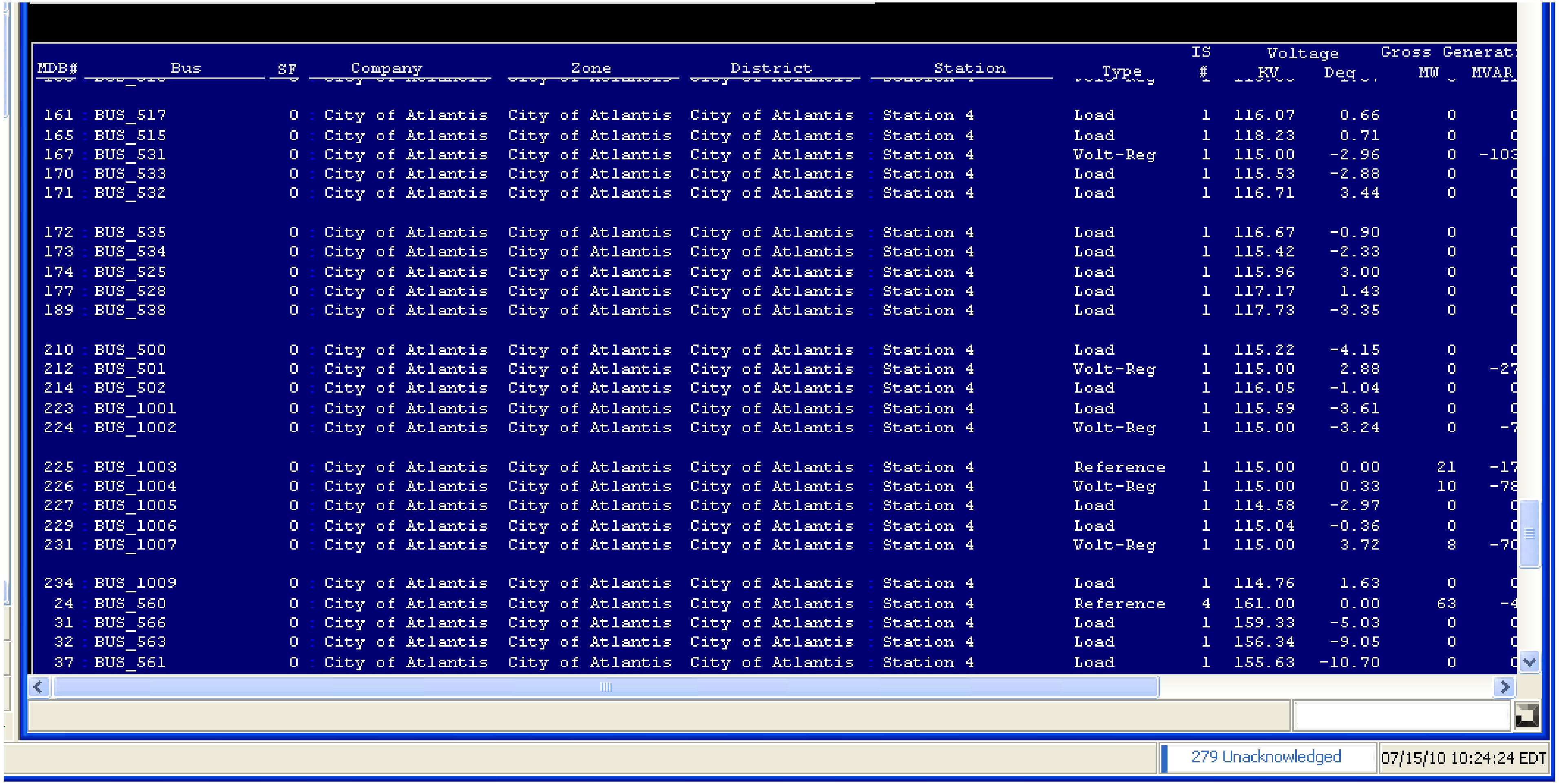
UPDATE PENALTY FACTORS

Generator MDB#	Name	Company	Station	Bus	SF	Control Type	Status	MW Optimzn	Gross MW	Gross MVAR	PF
7	GEN_148	Western Area	Station 3	BUS_457	0	VtRegulation	Online	Off	94.0	-16.9	1.040
6	GEN_149	Western Area	Station 3	BUS_458	0	VtRegulation	Online	Off	94.0	-16.9	1.040
12	GEN_188	Western Area	Station 3	BUS_844	0	VtRegulation	Online	Off	22.0	-8.8	1.010
13	GEN_189	Western Area	Station 3	BUS_845	0	VtRegulation	Online	Off	75.0	-28.4	1.008
18	GEN_151	Western Area	Station 3	BUS_460	0	VtRegulation	Online	Off	94.0	2.4	1.052
17	GEN_152	Western Area	Station 3	BUS_461	0	VtRegulation	Online	Off	93.0	2.3	1.052
16	GEN_150	Western Area	Station 3	BUS_459	0	VtRegulation	Online	Off	94.0	-16.9	1.040
11	GEN_146	Western Area	Station 3	BUS_434	0	VtRegulation	Online	Off	0.0	-3.2	0.979
45	GEN_179	Western Area	Station 3	BUS_614	0	VtRegulation	Online	Off	0.0	-2.7	0.988
55	GEN_180	Western Area	Station 3	BUS_615	0	VtRegulation	Online	Off	0.0	-2.7	0.988
24	GEN_320	Western Area	Station 3	BUS_9954	0	VtRegulation	Online	Off	-6.6	-1.4	0.992
44	GEN_319	Western Area	Station 3	BUS_9953	0	VtRegulation	Online	Off	-6.6	0.1	0.991
41	GEN_318	Western Area	Station 3	BUS_9952	0	VtRegulation	Online	Off	-6.9	-17.7	0.993
39	GEN_317	Western Area	Station 3	BUS_9951	0	VtRegulation	Online	Off	-19.1	-7.0	0.993
49	GEN_178	Western Area	Station 3	BUS_611	0	VtRegulation	Offline	Off	0.0	0.0	1.000
48	GEN_177	Western Area	Station 3	BUS_610	0	VtRegulation	Online	Off	225.0	-31.7	1.007
46	GEN_175	Western Area	Station 3	BUS_603	0	VtRegulation	Offline	Off	0.0	0.0	1.000
47	GEN_176	Western Area	Station 3	BUS_607	0	VtRegulation	Offline	Off	0.0	0.0	1.000
14	GEN_187	Western Area	Station 3	BUS_832	0	VtRegulation	Online	Off	0.0	-42.9	0.946
36	GEN_165	Western Area	Station 3	BUS_553	0	VtRegulation	Online	Off	0.0	-105.1	0.978
15	GEN_190	Rural Co-op	Station 2	BUS_855	0	VtRegulation	Online	Off	49.0	3.5	0.986
1	GEN_141	Rural Co-op	Station 2	BUS_410	0	VtRegulation	Online	Off	42.0	-13.8	1.035
4	GEN_143	Rural Co-op	Station 2	BUS_414	0	VtRegulation	Online	Off	45.0	-6.7	1.016
3	GEN_144	Rural Co-op	Station 2	BUS_415	0	VtRegulation	Online	Off	45.0	-6.7	1.016
5	GEN_142	Rural Co-op	Station 2	BUS_412	0	VtRegulation	Online	Off	0.0	-24.6	0.914

MDB#	Line Name	Company	ion	From Bus	SF	Status	From MW	From MVAR	From MVA	Charge	To Bus
172	9954_TO_9956	Western Area		BUS_9954	0	Online	-6.6	-1.4	6.8	0.00	BUS_9956
171	9953_TO_9956	Western Area		BUS_9953	0	Online	-6.6	0.1	6.6	0.00	BUS_9956
170	9952_TO_9955	Western Area		BUS_9952	0	Online	-6.9	-17.7	19.0	0.00	BUS_9955
169	9951_TO_9955	Western Area		BUS_9951	0	Online	-19.1	-7.0	20.3	0.00	BUS_9955
163	9958_TO_9960	Western Area		BUS_9958	0	Online	-19.3	-13.7	23.7	0.00	BUS_9960
161	9957_TO_9959	Western Area		BUS_9957	0	Online	-19.3	-13.7	23.7	0.00	BUS_9959
159	9956_TO_9960	Western Area		BUS_9956	0	Online	-13.2	-1.3	13.3	0.00	BUS_9960
173	9955_TO_9959	Western Area		BUS_9955	0	Online	-26.0	-24.7	35.9	0.00	BUS_9959
112	429_TO_433	Western Area		BUS_429	0	Online	-2.1	0.9	2.3	1.52	BUS_433
109	429_TO_439	Western Area		BUS_429	0	Online	0.7	-1.3	1.5	0.34	BUS_439
154	452_TO_453	Western Area		BUS_452	0	Online	-26.7	5.6	27.3	1.80	BUS_453
148	453_TO_613	Western Area		BUS_453	0	Online	-32.5	5.1	32.9	2.48	BUS_613
89	865_TO_867	Western Area		BUS_865	0	Online	-28.5	8.3	29.7	0.31	BUS_867
106	431_TO_447	Western Area		BUS_431	0	Online	-8.1	2.8	8.6	2.42	BUS_447
119	432_TO_445	Western Area		BUS_432	0	Online	-11.7	-6.8	13.6	2.94	BUS_445
118	432_TO_534	Western Area		BUS_432	0	Online	5.4	7.7	9.4	2.72	BUS_534
95	843_TO_867	Western Area		BUS_843	0	Online	28.6	-8.6	29.9	0.37	BUS_867
102	427_TO_860	Western Area		BUS_427	0	Online	3.7	-2.5	4.5	3.35	BUS_860
103	427_TO_807	Western Area		BUS_427	0	Online	-6.6	19.8	20.9	0.55	BUS_807
83	427_TO_806	Western Area		BUS_427	0	Online	-0.2	14.1	14.1	0.34	BUS_806
101	428_TO_431	Western Area		BUS_428	0	Online	5.0	0.9	5.1	4.09	BUS_431
99	428_TO_445	Western Area		BUS_428	0	Online	-13.9	-0.3	13.9	3.87	BUS_445
153	447_TO_452	Western Area		BUS_447	0	Online	-12.6	5.8	13.9	2.07	BUS_452
152	445_TO_454	Western Area		BUS_445	0	Online	19.9	-10.6	22.5	2.84	BUS_454
143	442_TO_449	Western Area		BUS_442	0	Online	4.4	-1.0	4.5	1.94	BUS_449
144	442_TO_613	Western Area		BUS_442	0	Online	39.0	0.1	39.0	4.58	BUS_613

279 Unacknowledged 07/15/10 10:07:26 EDT

MDB#	Transformer Name	Company	Station	From Bus	SF	Control Type	Status	From MW	From MVAR	From MVA
41	434-446	Western Area	Station 3	BUS_434	0	LTC Volt Ctl	Online	0.0	-1.6	1.6
48	434-440	Western Area	Station 3	BUS_434	0	LTC Volt Ctl	Online	-0.0	-1.6	1.6
32	436-446	Western Area	Station 3	BUS_436	0	LTC Volt Ctl	Online	-7.5	-0.4	7.5
33	436-440	Western Area	Station 3	BUS_436	0	LTC Volt Ctl	Online	-6.9	0.1	6.9
46	432-433	Western Area	Station 3	BUS_432	0	LTC Volt Ctl	Online	3.0	-2.0	3.6
57	843-844	Western Area	Station 3	BUS_843	0	LTC Volt Ctl	Online	-19.9	11.7	23.1
58	843-845	Western Area	Station 3	BUS_843	0	LTC Volt Ctl	Online	-69.7	38.2	79.5
45	442-460	Western Area	Station 3	BUS_442	0	LTC Volt Ctl	Online	-93.8	7.4	94.1
27	442-461	Western Area	Station 3	BUS_442	0	LTC Volt Ctl	Online	-92.8	7.2	93.1
38	438-439	Western Area	Station 3	BUS_438	0	LTC Volt Ctl	Online	1.7	1.0	1.9
89	613-614	Western Area	Station 3	BUS_613	0	LTC Volt Ctl	Online	0.0	2.8	2.8
91	613-615	Western Area	Station 3	BUS_613	0	LTC Volt Ctl	Online	0.0	2.8	2.8
105	554-555	Western Area	Station 3	BUS_554	0	LTC Volt Ctl	Online	11.6	2.7	11.9
39	435-446	Western Area	Station 3	BUS_435	0	LTC Volt Ctl	Online	7.4	2.0	7.7
42	435-440	Western Area	Station 3	BUS_435	0	LTC Volt Ctl	Online	7.0	1.6	7.1
56	842-843	Western Area	Station 3	BUS_842	0	LTC Volt Ctl	Online	-25.6	26.5	36.8
47	426-427	Western Area	Station 3	BUS_426	0	LTC Volt Ctl	Online	14.2	18.9	23.6
54	426-427	Western Area	Station 3	BUS_426	0	LTC Volt Ctl	Online	16.1	21.2	26.7
28	444-445	Western Area	Station 3	BUS_444	0	LTC Volt Ctl	Online	28.4	5.5	29.0
29	444-445	Western Area	Station 3	BUS_444	0	LTC Volt Ctl	Online	27.5	5.6	28.1
37	441-457	Western Area	Station 3	BUS_441	0	LTC Volt Ctl	Online	-93.5	24.9	96.8
43	441-458	Western Area	Station 3	BUS_441	0	LTC Volt Ctl	Online	-93.5	24.9	96.8
44	441-459	Western Area	Station 3	BUS_441	0	LTC Volt Ctl	Online	-93.5	24.9	96.8
36	441-442	Western Area	Station 3	BUS_441	0	LTC Volt Ctl	Online	-62.6	9.9	63.4
62	826-827	Western Area	Station 3	BUS_826	0	LTC Volt Ctl	Online	26.6	30.8	40.7
40	437-443	Western Area	Station 3	BUS_437	0	LTC Volt Ctl	Online	24.9	6.3	25.7
70	604-885	Western Area	Station 3	BUS_604	0	LTC Volt Ctl	Online	27.4	16.2	31.8



MDB#	Bus	SF	Company	Zone	District	Station	Type	IS #	Voltage KV	Voltage Deg	Gross Generat MW	Gross Generat MVAR
161	BUS_517	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Load	1	116.07	0.66	0	0
165	BUS_515	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Load	1	118.23	0.71	0	0
167	BUS_531	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Volt-Reg	1	115.00	-2.96	0	-103
170	BUS_533	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Load	1	115.53	-2.88	0	0
171	BUS_532	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Load	1	116.71	3.44	0	0
172	BUS_535	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Load	1	116.67	-0.90	0	0
173	BUS_534	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Load	1	115.42	-2.33	0	0
174	BUS_525	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Load	1	115.96	3.00	0	0
177	BUS_528	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Load	1	117.17	1.43	0	0
189	BUS_538	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Load	1	117.73	-3.35	0	0
210	BUS_500	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Load	1	115.22	-4.15	0	0
212	BUS_501	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Volt-Reg	1	115.00	2.88	0	-27
214	BUS_502	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Load	1	116.05	-1.04	0	0
223	BUS_1001	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Load	1	115.59	-3.61	0	0
224	BUS_1002	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Volt-Reg	1	115.00	-3.24	0	-7
225	BUS_1003	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Reference	1	115.00	0.00	21	-17
226	BUS_1004	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Volt-Reg	1	115.00	0.33	10	-78
227	BUS_1005	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Load	1	114.58	-2.97	0	0
229	BUS_1006	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Load	1	115.04	-0.36	0	0
231	BUS_1007	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Volt-Reg	1	115.00	3.72	8	-70
234	BUS_1009	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Load	1	114.76	1.63	0	0
24	BUS_560	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Reference	4	161.00	0.00	63	-4
31	BUS_566	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Load	1	159.33	-5.03	0	0
32	BUS_563	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Load	1	156.34	-9.05	0	0
37	BUS_561	0	City of Atlantis	City of Atlantis	City of Atlantis	Station 4	Load	1	155.63	-10.70	0	0

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9.5 FGH 34 NODES MODEL

The original FGH model consists of

- 34 nodes in 19 substations
- Branches:
  - 4 busties
  - 30 overhead lines
  - 1 equivalent branch
  - 3 two-winding transformers
  - 4 three-winding transformers
- Shunts:
  - 2 generators
  - 4 network infeeds
  - 12 loads
  - 1 induction machine

The picture below shows the network plan with power flow results for the following settings:

- Primary control enabled
- Transformer voltage control disabled
- Transformer active power control disabled

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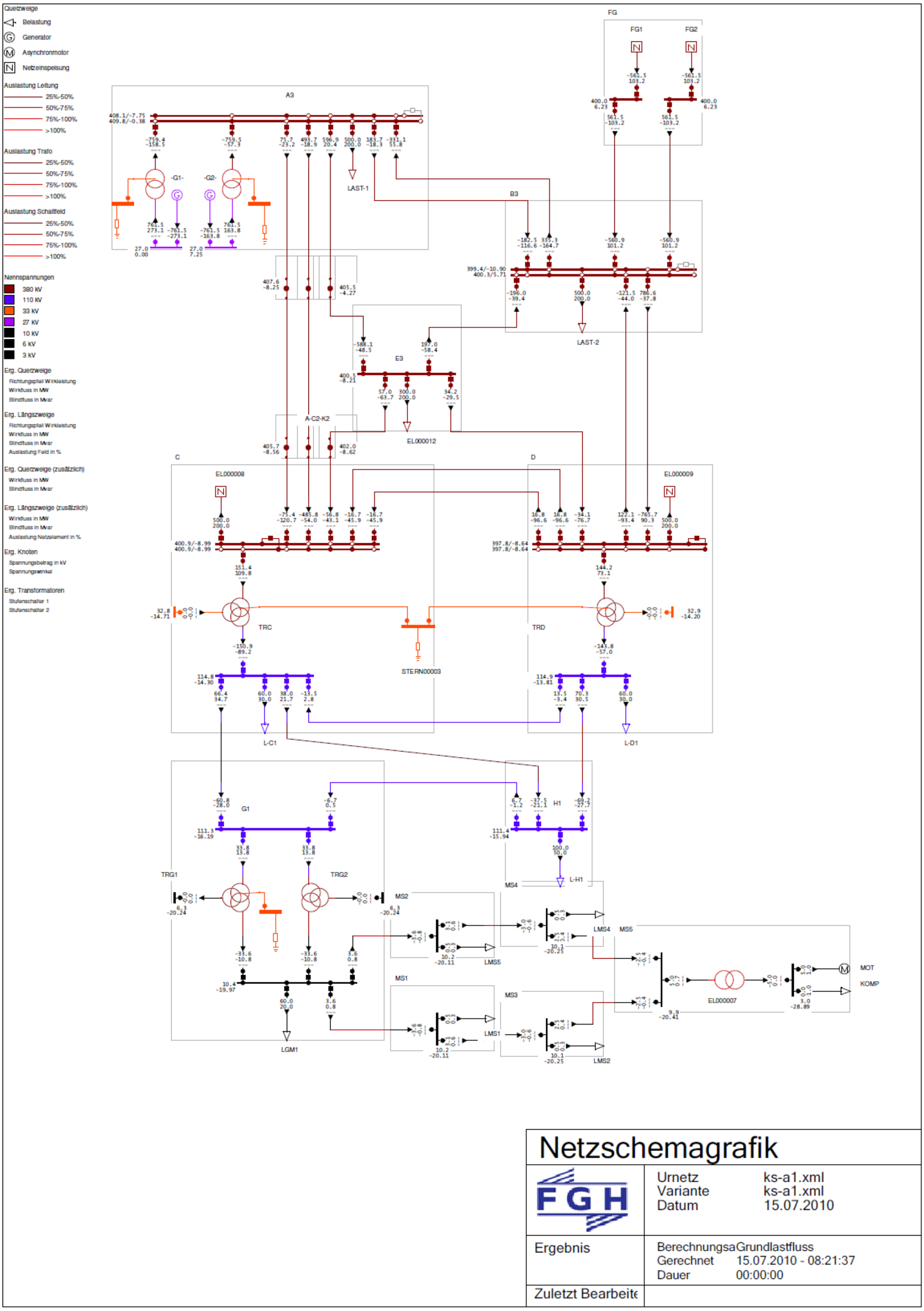
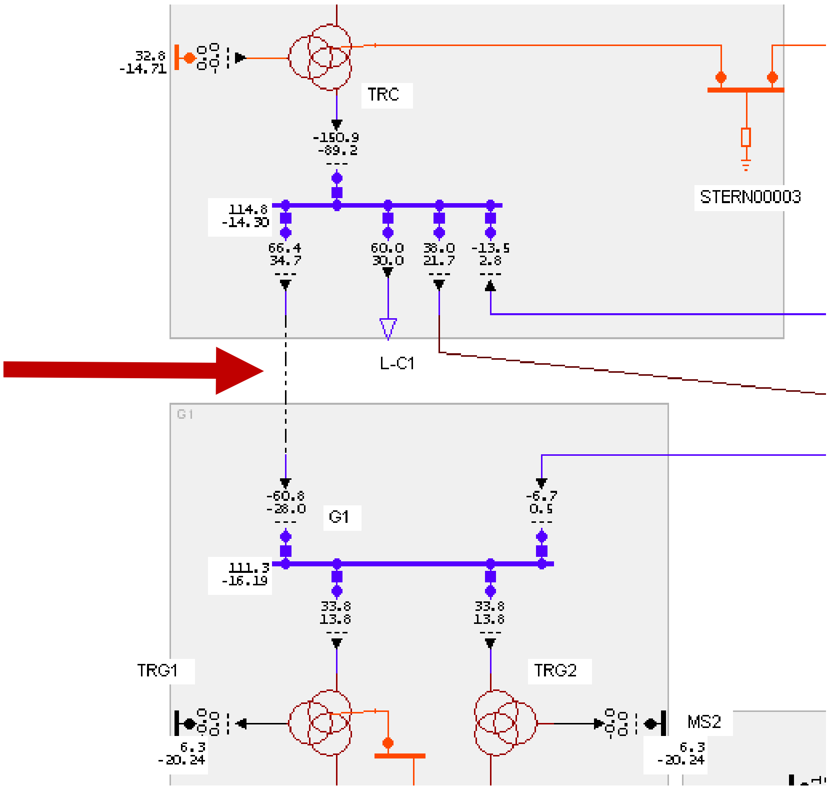

Querzweige
Belastung
Generator
Asynchronmotor
Netzeinspeisung
Auslastung Leitung
25%-50%
50%-75%
75%-100%
>100%
Auslastung Trafo
25%-50%
50%-75%
75%-100%
>100%
Auslastung Schaltfeld
25%-50%
50%-75%
75%-100%
>100%
Nennspannungen
380 kV
110 kV
33 kV
27 kV
10 kV
6 kV
3 kV
Erg. Querzweige
Richtungspfeil Wirkleistung
Wirkfluss in MW
Blindfluss in Mvar
Erg. Längszweige
Richtungspfeil Wirkleistung
Wirkfluss in MW
Blindfluss in Mvar
Auslastung Feld in %
Erg. Querzweige (zusätzlich)
Wirkfluss in MW
Blindfluss in Mvar
Erg. Längszweige (zusätzlich)
Wirkfluss in MW
Blindfluss in Mvar
Auslastung Netzelement in %
Erg. Knoten
Spannungsbetrag in kV
Spannungswinkel
Erg. Transformatoren
Stufenschalter 1
Stufenschalter 2
FG
FG1
FG2
A3
-G1-
-G2-
LAST-1
B3
LAST-2
E3
A-C2-K2
EL000012
C
D
EL000008
EL000009
TRC
TRD
STERN00003
L-C1
L-D1
G1
H1
L-H1
TRG1
TRG2
MS1
MS2
MS3
MS4
MS5
LMS1
LMS2
LMS4
LMS5
EL000007
MOT
KOMP
LGM1
Netzschemagrafik
FGH
Urnetz ks-a1.xml
Variante ks-a1.xml
Datum 15.07.2010
Ergebnis
BerechnungsaGrundlastfluss
Gerechnet 15.07.2010 - 08:21:37
Dauer 00:00:00
Zuletzt Bearbeite

Note on equivalent branches:

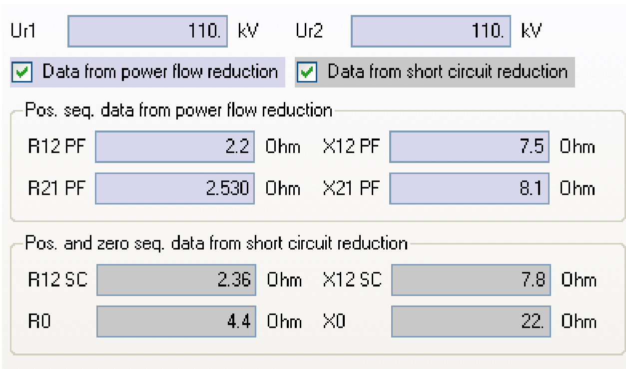
Equivalent branches shown in the Figure below as they are created by a Ward-reduction cannot be modeled correctly in ENTSO-E CIMXML format.



Equivalent branch

Equivalent branches may connect different voltage levels. If there were phase-shifting transformers in the network which was reduced, then the Ward network reduction for power flow calculation will produce asymmetrical equivalent branches ($R_{12} \neq R_{21}$, $X_{12} \neq X_{21}$). Since short circuit calculations according to IEC 60909 are performed with tap changers in neutral tap position, the short circuit impedances of the equivalent branches are always symmetrical.

The figure below shows the data of the equivalent branch pointed in the network diagram shown above.



Data of equivalent branch

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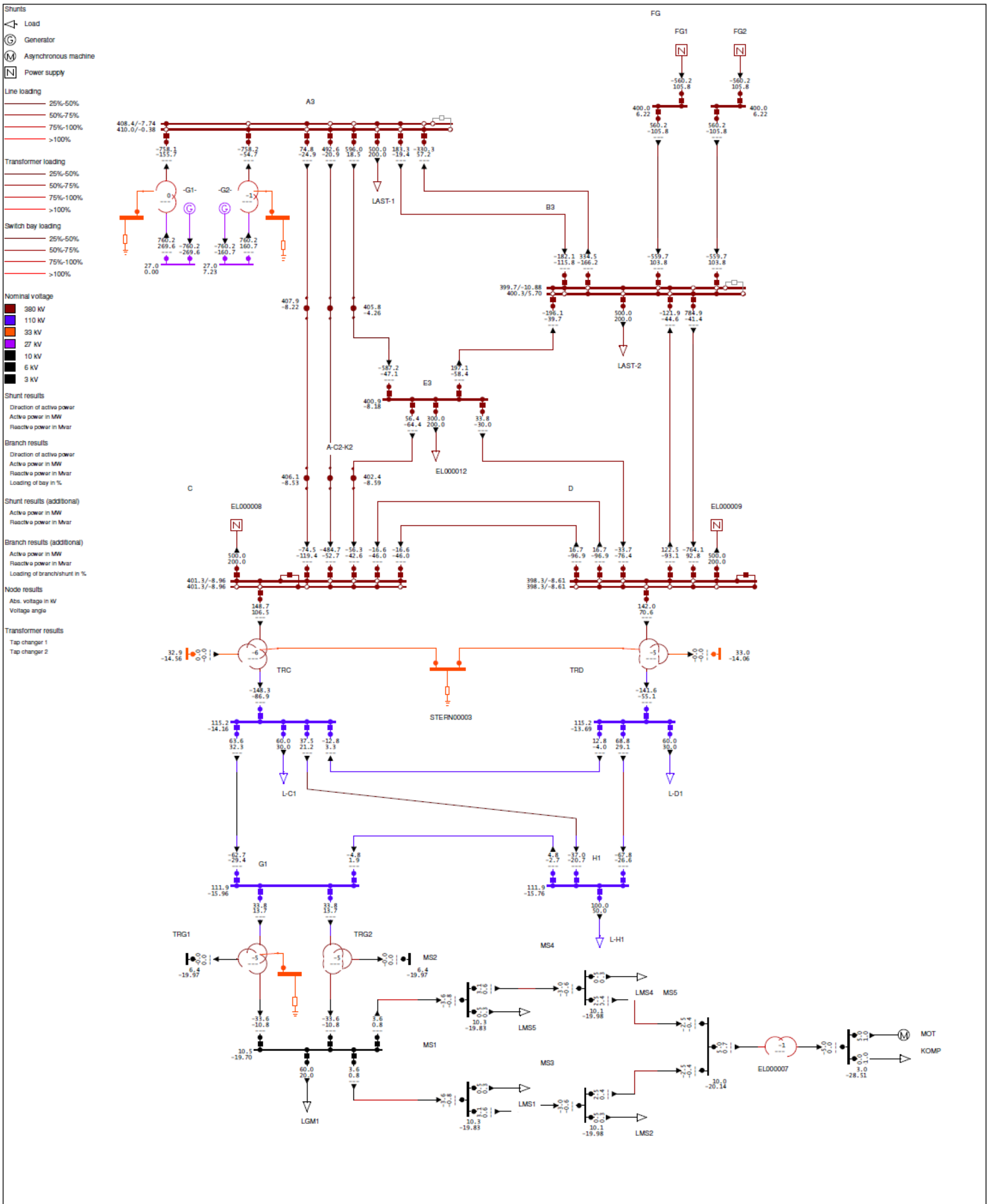
Since in ENTSO-E CIM Profile equivalent branches are not supported in the way that allows all attributes to be directly expressed, this branch is exported to the test network as ACLineSegment with R = 2.2 Ohm and X = 7.5 Ohm. With this modification the power flow results differ significantly.

Additional notes on other network equipment:

ENTSO-E CIM Profile does not distinguish between generators and network in-feeds. Therefore, in this test model the generators are exported with an aggregate flag of false and the network in-feeds with an aggregate flag of true. All Information needed for impedance correction according to IEC 60909 of generators get lost (the same also counts for transformers).

Induction machines are not supported by ENTSO-E CIM Profile. Therefore, the induction machine of the test model was exported as a load.

The picture below shows the network diagram with power flow results after the changes described above.



Netzschemagrafik		
FGH	Urnetz Variante Datum	ks-a1.xml ks-a1.xml 16.07.2010
Ergebnis	BerechnungsaPower flow calculatior Gerechnet Dauer	 16.07.2010 - 09:30:17 00:00:00
Zuletzt Bearbeite		