



European Network of  
Transmission System Operators  
for Electricity

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# INTEROPERABILITY TEST “CIM FOR SYSTEM DEVELOPMENT AND OPERATIONS” 2013

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FINAL REPORT

## FOREWORD

ENTSO-E conducted, along with European and American vendors and Transmission System Operators (TSOs), a common information model (CIM) interoperability test (IOP) — ENTSO-E IOP “CIM for System Development and Operations” 2013. The test was organised and directed by ENTSO-E from 8 to 12 July 2013 at ENTSO-E’s premises, in Brussels.

The future ENTSO-E CIM-based data exchange format, ENTSO-E Common Grid Model Exchange Standard (CGMES), which is based on the International Electrotechnical Commission (IEC) CIM standards 61970 (parts 301, 302, 452, 453, 456, 457, 552), was tested in this IOP on a large number of products. The test is a part of the development process of the ENTSO-E Common Grid Model Exchange Standard.

Key goals were to test and validate the latest IEC draft CIM standards on which the new version of the ENTSO-E CGMES is based. The correct implementation of the 1st edition of the ENTSO-E CIM Profile (CIM14), which is currently used for some of the ENTSO-E data exchanges, was also tested by some of the vendors. Additional rules which are to be applied to the 1st edition of the ENTSO-E CIM Profile were agreed. These additional rules are mandatory and modify some of the specifications of the 1st edition of the ENTSO-E CIM Profile.

The following companies participated with their tools in the testing: BCP Busarello + Cott + Partner AG, CESI, DIgSILENT, DMS Group and EKC, GE Energy, Nexant, Open Grid Systems, PSE Innowacje, RTE, SISCO, Siemens, Tractebel, Ventyx/ABB.

A set of test procedures was defined which provided step-by-step instructions to be followed to successfully complete each test. A set of official test models was prepared by Open Grid Systems, DIgSILENT, BCP Busarello + Cott + Partner AG, Ventyx/ABB, RTE, and GE Energy for use by all test participants.

Two CIM XML validation tools (CIMSpy and CIMdesk) 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 profiles, part of the ENTSO-E CGMES, were created using the following tool: CimConteXtor.

The results achieved during the test are in line with the expectations of the participants. The test results are summarised 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 and the test procedures are included in the report appendices.

The report is agreed by the IOP participants and it is a basis for further discussions in the ENTSO-E Committees as well as in the IEC TC57/WG13. The implementation schedule for the CGMES is subject to an ENTSO-E decision later this year.

## 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” 2013 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, Jesus Mendiola and Dario Frazzetta for directing the IOP, for assistance in witnessing the IOP, for preparation of test procedures, ENTSO-E CGMES documentation, and the final report.
- All participating TSOs as test witnesses for CGMES or involved in testing of Profile 1.
- Open Grid Systems – Alan McMorran for supporting preparation of the official test files (ENTSO-E 16, IEEE30 and IEEE118).
- DIgSILENT – Christoph Schmid and Richard Lincoln for supporting preparation of official test files (ENTSO-E 16 including dynamics and model for testing IEC 60909).
- BCP Busarello + Cott + Partner AG – Giatgen Cott for supporting preparation of the official test files in the part covering IEC 60909, dynamics and HVDC.
- Ventyx/ABB – Lars-Ola Osterlund for preparation of the Ventyx/ABB node-breaker test model.
- RTE – Youssef Akel for preparation of a test model used for testing of Profile 1.
- GE Energy – Feng Chen for preparation of the GE node-breaker test model.
- PowerInfo – Jun Zhu for preparation of CIMSpy and CIMdesk validation tools used to validate the model files for his assistance in preparation of the CGMES.
- Jean-Luc Sanson (ITG) and Andre Maizener (Zamiren) for maintaining CimConteXtor, which was used to generate the profiles of the CGMES.
- All participating vendors, for the hard work in a very short time to develop the necessary software for the testing of the CGMES and for providing inputs to the issues discussed during the preparatory work as well as during the IOP.

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

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# 1 INTRODUCTION

## 1.1 BACKGROUND INFORMATION

In 2009 the ENTSO-E member TSOs underlined their commitment to apply the CIM-based data exchange format to 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. Applying CIM improves TSO cooperation and has a direct impact on the outputs — the Third Energy Package of the EU mandates ENTSO-E to produce. For the first time the CIM-based exchange format was 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 benefits from the CIM-based data exchanges. 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 of 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 CIM-based data exchange format.

On 11 December 2009, ENTSO-E decided to organise 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). The purpose of these tests is to verify CGMES and the IEC CIM standards and recommend improvements to be considered for the next versions of the standards. The tests are also designed to allow TSOs and vendors to verify the correctness of the CIM standard to ensure 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, in order 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 the CIM-based data exchange format and its implementation will directly contribute to the task of developing network codes required by the Third Energy Package by the European Union. The interaction is obvious when taking into account the fact that data exchange processes and formats used in these processes will be part of several network codes.

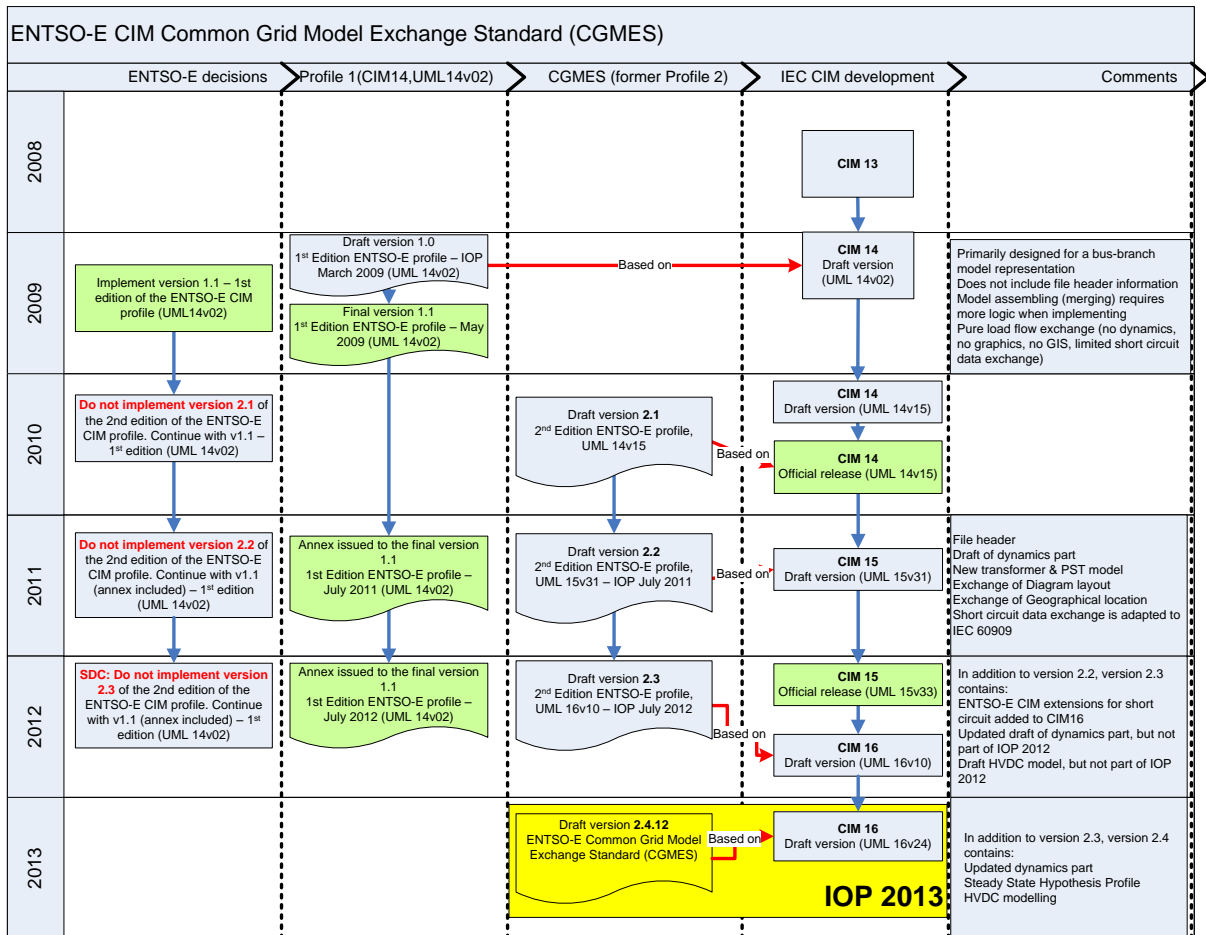
Additional information on CIM activities in ENTSO-E is available [here](#).

This document reports the results of the ENTSO-E Interoperability Test “CIM for System Development and Operations” 2013.

The chart below illustrates the versions of ENTSO-E Profile 1, the CGMES and the IOPs performed since 2009. In order to have a short reference in this document:

– Profile 1 refers to the 1st edition of the profile published in May 2009 (UML14v02), which includes all annexes agreed since 2009 [1]. The version is available [here](#).

– CGMES (Common Grid Model Exchange Standard) is the last version (v. 2.4) of the previously known as Profile 2 set of profiles — currently based on UML16v24 [2]. The version is available [here](#).



## 1.2 OBJECTIVES

The IEC is publishing international standards based on the CIM as a generalised 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 of the ENTSO-E CGMES 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 an official data exchange format once endorsed by the ENTSO-E committees responsible for the data exchanges.

The specific objectives of the ENTSO-E IOP 2013 were to:

1. Validate the resolution of all issues recorded in IOP 2012 and the latest draft of the CIM 16.



2. Validate the ENTSO-E CGMES 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 corrected before the release of the final document.
3. Verify the new concept of exchange of the Steady State Hypothesis profile.
4. Verify the new CIM package on dynamics.
5. Verify the HVDC model implemented in CIM.
6. Test tools using ENTSO-E Profile 1 (CIM14, UML14v02).

## 2 SUMMARY OF TEST RESULTS

Test procedures defined for the ENTSO-E Interoperability test described 33 tests that cover main functionalities to be applied in the ENTSO-E data exchanges using CGMES and eight additional tests related to the tests performed for Profile 1 (UML14v02). 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 for both Profile 1 and CGMES. In addition, some of the tools that were used to test the standard do not support some of the functionalities.

In order to check the new draft version of the CGMES in an efficient way, vendors focussed on different parts (different functionalities or profiles). No scores were applied for testing of the CGMES as all tests are considered part of the CGMES development process, where the standard is tested rather than the vendors' tools.

The following table summarises the tests performed using Profile 1.

Table 1. Summary tests – Profile 1

Tool	Test A	Test B	Test C	Test D	Test E	Test F	Test G	Test H	Test 1	Test 3	Test 9
Convergence	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗
EPC<->CIM converter	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓
SPIRA	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗
WinCreso	✓	✓	✓	✓	✓	✗	✓	✓	✗	✗	✗

The tests performed using the CGMES are summarised in tables 2 and 4 below.

Table 2. Summary tests (Test 1 to Test 10) – CGMES

Tool	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9	Test 10
Neplan	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CRESO	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓
SPIRA	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PowerFactory	✓	✓	✓	✓	✓	✗	✗	✓	✓	✗

<b>TNA</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>PSS/ODMS</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>Scope, Grid 360</b>	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
<b>EUROSTAG</b>	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗
<b>CIMPhony</b>	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓
<b>Network Manager DE400</b>	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗
<b>UIB Adapter PI-AF</b>	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗
<b>Enterprise Gateway</b>	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓

Table 3. Summary tests (Test 11 to Test 17) – CGMES

<b>Tool</b>	<b>Test 11</b>	<b>Test 12</b>	<b>Test 13</b>	<b>Test 14</b>	<b>Test 15</b>	<b>Test 16</b>	<b>Test 17</b>
<b>Neplan</b>	✗	✗	✗	✗	✓	✓	✓
<b>Sicre</b>	✗	✗	✗	✗	✓	✓	✓
<b>PowerFactory</b>	✗	✗	✗	✗	✓	✓	✓
<b>TNA</b>	✓	✓	✓	✗	✗	✗	✗
<b>PSS/ODMS</b>	✓	✓	✗	✗	✓	✓	✓
<b>EUROSTAG</b>	✗	✗	✗	✗	✓	✗	✗
<b>CIMPhony</b>	✓	✓	✓	✓	✓	✗	✗
<b>Enterprise Gateway</b>	✓	✗	✓	✗	✗	✗	✗

Table 4. Summary tests (Test 27 to Test 33) – CGMES

<b>Tool</b>	<b>Test 27</b>	<b>Test 28</b>	<b>Test 29</b>	<b>Test 30</b>	<b>Test 31</b>	<b>Test 32</b>	<b>Test 33</b>
<b>Neplan</b>	✗	✗	✓	✗	✗	✓	✗
<b>PowerFactory</b>	✓	✗	✗	✓	✗	✓	✓
<b>TNA</b>	✗	✗	✗	✓	✓	✓	✗
<b>PSS/ODMS</b>	✓	✗	✗	✗	✓	✓	✗
<b>CIMPhony</b>	✓	✓	✗	✓	✓	✓	✓
<b>UIB Adapter PI-AF</b>	✗	✗	✗	✓	✗	✗	✗
<b>Enterprise Gateway</b>	✓	✗	✗	✓	✓	✓	✓

The above tables are based on the record forms completed during the IOP. Therefore, it is recommended that individual test record forms (Appendix C) for each product/tool be checked in order to see the results in detail.

The above tables should not be used to draw conclusions on the vendors' performance as all tests are related to validation of the IEC standards and the CGMES. Some vendors selected to focus on particular parts of the standard in order to minimise resources and increase efficiency. The above

tables do not indicate the ability of vendors to support one or other profile features once the CGMES is approved for official data exchanges.

Tests from 18 to 26 have not been performed as the CGMES is not ready to support explicit modelling of user-defined 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. The IOP files are available on the CIM user group website ([www.cimug.org](http://www.cimug.org)).

### 3 CONCLUSIONS AND RECOMMENDATIONS

Various vendors that provide tools for a “system operational” environment as well as for a “system planning” environment attended ENTSO-E IOP and validated the 4th draft version (version 2.4) of the ENTSO-E CGMES.

The CGMES has a wide scope, is based on the latest IEC draft standards, and fully covers all classes and definitions described in IEC 61970-452 (CPSM profile), 61970-456, 61970-453, 61970-301, 61970-302, 61970-552, and 61970-457. The profile was created in a UML environment, which facilitates the maintenance process.

The main conclusions of the ENTSO-E Interoperability test “CIM for System Development and Operations” 2013 can be summarised as follows:

- The IOP successfully tested the most important features of the ENTSO-E CGMES Profiles. Test procedures and test models were validated for future use.
- The outcome of the test and the final post-IOP version of the CGMES are a solid basis for further ENTSO-E discussions towards the approval of this version of the CGMES.
- Important issues to be addressed to IEC/WG13 as well as CGMES-related issues were identified and discussed during the IOP. ENTSO-E IOP participants agreed on proposals to IEC/WG13 that are listed in this report. Issues listed in this report are not blocking the approval of the CGMES. Most of the issues will have been resolved by the time of publication of this report; others were implemented as ENTSO-E extensions.
- ENTSO-E IOP participants confirmed that the issues identified in IOP 2012 are well covered in the new version of the CGMES. These issues are listed in Appendix D and include a new way to exchange input parameters for the load flow (the so-called steady state hypothesis – SSH), HVDC modelling, and dynamics profile. In addition, the discussion during the preparation of the IOP 2013 identified a large number of issues that were resolved, with the CGMES updated accordingly.

The following recommendations were agreed:

- ENTSO-E should organise a process to prepare test models (the so-called ‘golden’ test models) for different functionalities and equipment in the CGMES profiles. These test models

will be used for validation of the production releases of the tools which support CGMES. The conformance of the tools with CGMES can only be confirmed after the approval of the CGMES. This measure is to ensure that TSOs will be able to obtain tools which are well tested against CGMES.

- Continuous maintenance of the ENTSO-E profile is necessary in order to facilitate IOP preparation work.
- IEC CIM standards should ensure backwards compatibility.
- A process for dynamics package implementation should be defined with the approval of the CGMES. Vendors agreed to participate in an implementation process which allows detail testing of standard models included in the dynamics exchange, but this process needs to be defined and agreed with all parties involved.

## **4 REFERENCES**

- [1] ENTSO-E CIM Profile, ENTSO-E CIM Model Exchange, 1st edition version 10 May 2009 and the annex published after the ENTSO-E IOP 2013.
- [2] ENTSO-E Common Grid Model Exchange Standard (CGMES), version 2.4, Sep 2013.

## **5 APPENDIX A: INFORMATION ON TOOLS TESTED/USED IN THE IOP**

Appendix A is included as a separate file.

## **6 APPENDIX B: TEST PROCEDURES**

Appendix B is included as a separate file.

## **7 APPENDIX C: TEST RECORD FORMS**

Appendix C is included as a separate file.

## 8 APPENDIX D: SUMMARY OF ISSUES FROM IOP 2013

All participants had discussions on CIM-related topics during the IOP. Issues related to the CIM UML and the CGMES were identified and mostly resolved. More than 60 people participated in the discussion (either present in the ENTSO-E premises or joining remotely via webinar). The outcome of these discussions and the agreements are summarised in this Appendix as issues to be addressed to IEC, CGMES' profiles issues, and recommendations.

### 8.1 ISSUES ADDRESSED TO IEC

ENTSO-E IOP identified the following issues that need to be further discussed within the IEC WG13 and agreed among IEC members. If the changes are not applied to the IEC UML, the resolutions of these issues will be further applied to the CGMES profiles as ENTSO-E extensions.

#### 8.1.1 ISSUE IEC 2013-1: MORE SPECIFIC OPERATIONALLIMITTYPES

ENTSO-E needs to describe the following specific limit types used in Europe and described by policy 3 of the Operational Handbook. Currently, the types are exchanged as a name which makes the validation more difficult.

- Permanent Admissible Transmission Loading (PATL).
- Temporary Admissible Transmission Loading (TATL).
- Tripping Current (TC).
- Etc.
- **ENTSO-E IOP proposal:** It is suggested that a new ENTSO-E enumeration be added to OperationalLimitType in the IEC UML.
- **WG13 decision (17 July 2013):** WG13 agreed that this should be implemented as the ENTSO-E extension.
- **Status** – Implemented

#### 8.1.2 ISSUE IEC 2013-2: MEANING OF OPERATIONALLIMITTYPES.DIRECTION

There is a need to clarify:

- how the limit value sign is related to high and low
- whether large negative limit value is high or low
- **Status** – WG13 postponed this issue. It is not considered critical for the approval of the CGMES.

#### 8.1.3 ISSUE IEC 2013-3: DCREACTOR ATTRIBUTES

There is a need for the following additional attributes on the class DCReactor:

- Resistance
- Capacitance or Inductance
- **ENTSO-E IOP proposal:** Split DCReactor to DCShunt and DCSeriesDevice. Add the following attributes:

- resistance
- inductance
- capacitance
- ratedU
- **WG 13 decision (17 July 2013):** WG 13 agreed on the change.
- DCRreactor changed to DCShunt. The following attributes were added: capacitance, ratedUdc, resistance.
- DCSeriesDevice added with the same attributes.
- **Status** – Implemented

#### 8.1.4 ISSUE IEC 2013-4: REMOVE "DCSIDE" IN CLASS NAMES

- **ENTSO-E IOP proposal:** CsConverterDCSide should be renamed as CsConverter. VsConverterDCSide should be renamed as VsConverter. The reason is that ConverterACSide was removed and there is no more need to have DCside.
- **WG13 decision (17 July 2013):** WG agreed to remove "DCside" from the names.
- **Status** – Implemented

#### 8.1.5 ISSUE IEC 2013-5: CARDINALITY PSR-CONTROL

- **ENTSO-E IOP proposal:** Change the cardinality from 1..\* to 0..\*.
- **WG13 decision:** WG 13 agreed to make the change in the UML.
- **Status** – Implemented

#### 8.1.6 ISSUE IEC 2013-6: STATICVARCOMPENSATOR ATTRIBUTES

- **ENTSO-E IOP proposal:** If the following attributes are not needed, they should be removed
  - voltageSetPoint
  - sVCControlMode
 There is a need to check whether it is necessary to add a participation factor in case of multiple SVC.
- **WG13 decision (14 Aug 2013):** It was agreed that SVCControlMode.off be removed and that SVC be kept as RegulatingCondEq. This will then allow for two ways to describe SVC control:
  - 1) use sVCControlMode and voltageSetPoint
  - 2) use RegulatingControl
 It is up to the receiving party to interpret and make use of any data received. In cases where multiple pieces of equipment, including an SVC, control the same point, they may share the same RegulatingControl. It needs to be further investigated how this functions in practice and if it is a real-use case.
- **Status** – Implemented

#### 8.1.7 ISSUE IEC 2013-7: SVINJECTION DOCUMENTATION

- **ENTSO-E IOP proposal:** The following text needs to be removed from the UML: "This includes exchange of partial models with boundary flows and state estimator solutions with residual mismatch."
- **WG13 decision (17 July 2013):** WG 13 agreed to delete the text.
- **Status** – Implemented

### 8.1.8 ISSUE IEC 2013-8: TRANSFORMER MODEL ISSUE 1

Some vendors expressed their concern that the new transformer model is difficult to handle. It is also understood that changes in the model will impact on a lot of implementations.

The model should contain data from transformer test reports.

- **Status** – This is an issue to be considered by WG13 for CIM17 or CIM18. WG13 agrees in general on the need that the model should contain data from transformer test reports. No change is expected now. The approval of the CGMES is not impacted upon by this issue.

### 8.1.9 ISSUE IEC 2013-9: TRANSFORMER MODEL ISSUE 2

There is a need to have a clear specification on transformer modelling including phase shift transformers. ENTSO-E agreed to provide the material. WG13 agreed to process this and issue a technical document to which various standards could refer.

- **Status** – This issue requires follow-up/check actions when the CGMES is approved.

### 8.1.10 ISSUE IEC 2013-10: JUNCTION

- **ENTSO-E IOP proposal:** IEC is requested to add Junction class in the 61970-452. The class is added to ENTSO-E CGMES.
- **Status** – The issue will be followed with WG13 when preparing the 61970-452. The approval of the CGMES is not impacted upon by this issue.

### 8.1.11 ISSUE IEC 2013-11: BOUNDARYPOINT

- **ENTSO-E IOP proposal:** IEC is requested to add BoundaryPoint class in the UML and in the 61970-452. The class should inherit from Connector. It is primarily used for the Geographical Location profile purpose and to identify boundary nodes in the boundary instance files.
- **WG13 decision (17 July 2013):** WG13 agreed to use Junction for this use case. A Junction in the boundary means it is an X-node.

In addition to using the Junction, it is proposed to:

- Add BoundaryPoint as an ENTSO-E extension which inherits from IdentifiedObject
- Add to BoundaryPoint all attributes we need; in this case we will not need BoundaryPoint Boolean as this information is given by the class
- Add three associations:
  - BoundaryPoint (cardinality 1) – ConnectivityNode (cardinality 0..1)
  - BoundaryPoint (cardinality 1) – TopologicalNode (cardinality 0..1)
  - BoundaryPoint (cardinality 1) – Junction (cardinality 0..1)

Cardinality 1 from the BoundaryPoint side would be to ensure that if we have ConnectivityNode, TopologicalNode and/or Junction, they will all have a reference to the BoundaryPoint.

- **Status** – Partly implemented. A separate document to summarise the discussion on this issue is created. The issue will either be implemented before the approval of the CGMES or it will be resolved in a minor version of the CGMES boundary profiles.

### 8.1.12 ISSUE IEC 2013-12: FILE HEADER

- **ENTSO-E IOP proposal:** To include the following statements in the 61970-552. ENTSO-E included these in the CGMES based on the IOP agreement:
  - A new ID is generated for new instance files only when instance data has changed its context. An export done on the imported instance data without any changes should have the same model ID reference in the header.
  - Dependent IDs are referring to IDs of the dependent instance files at the time of the export.
  - If all dependencies are resolved, there should not be unresolved references within the data.
  - The dependency reference in the header shall be used as guidance and shall not restrict the possibility to import profiles that are exported based on a previous version of a depending profile instance file. The standard is not preventing the tools from exchanging files where the file reference does not match. Unresolved or missing references should be reported to the user. In general, users are free to combine files on an ad-hoc basis, and tooling should identify and optionally resolve all unresolved references.
  - A model ID shall be the same if a re-export of a model contains the same objects and attributes.
    - If the information exchanged with the instance file is the same, the re-export is considered the same.
    - Rearrangements of classes and attributes in the instance file are allowed.
- **Status** – The issue will be followed with WG13 when preparing the 61970-552. The approval of the CGMES is not impacted upon by this issue.

### 8.1.13 ISSUE IEC 2013-13: MINOR AND MAJOR PROFILE VERSION

61970-552 defines the syntax of the profile URI. There is a possibility to define a major and minor version. It is necessary to standardise the meaning of a major and minor version.

- **ENTSO-E IOP proposal:** Based on the IOP agreement, ENTSO-E is specifying the following rules for a major and minor version:
  - A minor profile version in the profile URI is changed:
    - In case of supporting new functionality, new classes, attributes and associations are added to a profile. It is a compatible change.
  - A major profile version in the profile URI is changed:
    - In case the applied change is “breaking” implementations, i.e. something is deleted.
  - A minor profile revision will only include a non-breaking addition to the profile. Updates belonging to a minor revision update should not break the IOP for a major profile exchange. This means that a tool that supports 2.4 (two major revisions, and four minor revisions) should be able to import a file that is generated based on 2.5, where all the additional classes, attributes and associations are ignored.
- **Status** – The issue will be followed with WG13 when preparing the 61970-552. The approval of the CGMES is not impacted upon by this issue.

### 8.1.14 ISSUE IEC 2013-14: DIAGRAM TYPE

- **ENTSO-E IOP proposal:** There is a need to have an extension — optional association of Diagram with IdentifiedObject. In addition, it is necessary to have an extension of Diagram —



formatType optional attribute (string). This attribute has the following valid strings for the CGMES: node-breaker, bus-branch, geoschematic.

- **WG 13 decision (17 July 2013):** WG13 agreed to add a new DiagramType class. The use case justifying a link Diagram-IdentifiedObject needs further exploration.
- **Status** – Implemented (the new class DiagramStyle). The second part of the issue is related to the issue ENTSO-E 2013-12. The approval of the CGMES is not impacted upon by this issue.

### 8.1.15 ISSUE IEC 2013-15: CHANGING CLASSES WITH PERSISTENT MRID

- **ENTSO-E IOP proposal:** The following four options were discussed in the IOP:
  - Option 1: Change of class needs new mRID. If there is a need to support both types (GeneratingUnit and ThermalGeneratingUnit), the system should maintain two mRIDs.
  - Option 2: Allow for specialisation – GeneratingUnit -> ThermalGeneratingUnit
  - Option 3: Cast in the hierarchy – GeneratingUnit -> ThermalGeneratingUnit or ThermalGeneratingUnit -> GeneratingUnit
  - Option 4: Allow full change

ENTSO-E CGMES defines option 1 being applied.

- **Status** – The issue will be followed with WG13 for the update of the IEC standards or guidelines. The approval of the CGMES is not impacted upon by this issue.

### 8.1.16 ISSUE IEC 2013-16: SERIESCOMPENSATOR

- **ENTSO-E IOP proposal:** Metal Oxide Varistor associated with a Series Compensator containing the following attributes:
  - varistorRatedCurrent (current required for MOV to short down)
  - Enabled/Disabled

WG13 should propose a name and description of the two attributes for SeriesCompensator.

- **WG13 decision (17 July 2013):** The following attributes were added to the SeriesCompensator in CIM: varistorPresent, varistorRatedCurrent and varistorVoltageThreshold.
- **Status** – Implemented

### 8.1.17 ISSUE IEC 2013-17: POWER SYSTEM PROJECT SUPPORT

- **ENTSO-E IOP proposal:** Proposal to separate UML that describes metadata (project, header, MAS). Currently, this is included in the combined UML. The power system project support should be part of 61970-552. An agreement is expected at the beginning of 2014.
- **WG13 decision (17 July 2013):** WG13 agreed to move this UML to a separate EA file. The new file is named "iec61970-552\_Ed2.eap".
- **Status** – The issue will be followed with WG13 in Sep–Dec 2013 to finalise the discussions for the next versions of the CGMES. The approval of the CGMES is not impacted upon by this issue.

### 8.1.18 ISSUE IEC 2013-18: REGULATINGCONTROL

The following controllers should be supported in the CIM data exchanges:

- 1) Station Controller: Multiple Machines controlling the voltage at a node or the Q infeed of a terminal. A percentage per machine defines the reactive power distribution. Step-up transformers should be supported as additional controls.
- 2) Tap controller for transformers: Multiple Transformers controlled by one device; determines the tap position for all transformers.
- 3) Secondary controller or Power-Frequency controller: Controlling active power exchanges. A percentage per machine defines the active power distribution.

**ENTSO-E IOP proposal:** IOP 2013 assessed what is supported in the current version of the ENTSO-E CGMES, reaching a conclusion that only case 3) needs further development. It is recommended that WG13 perform some analysis and suggest an extension of the UML which is backwards compatible.

- **Status** – The issue will be followed with WG13 for further versions of the CGMES and IEC standards. The approval of the CGMES is not impacted upon by this issue.

### 8.1.19 ISSUE IEC 2013-19: HVDC IN SV PROFILE

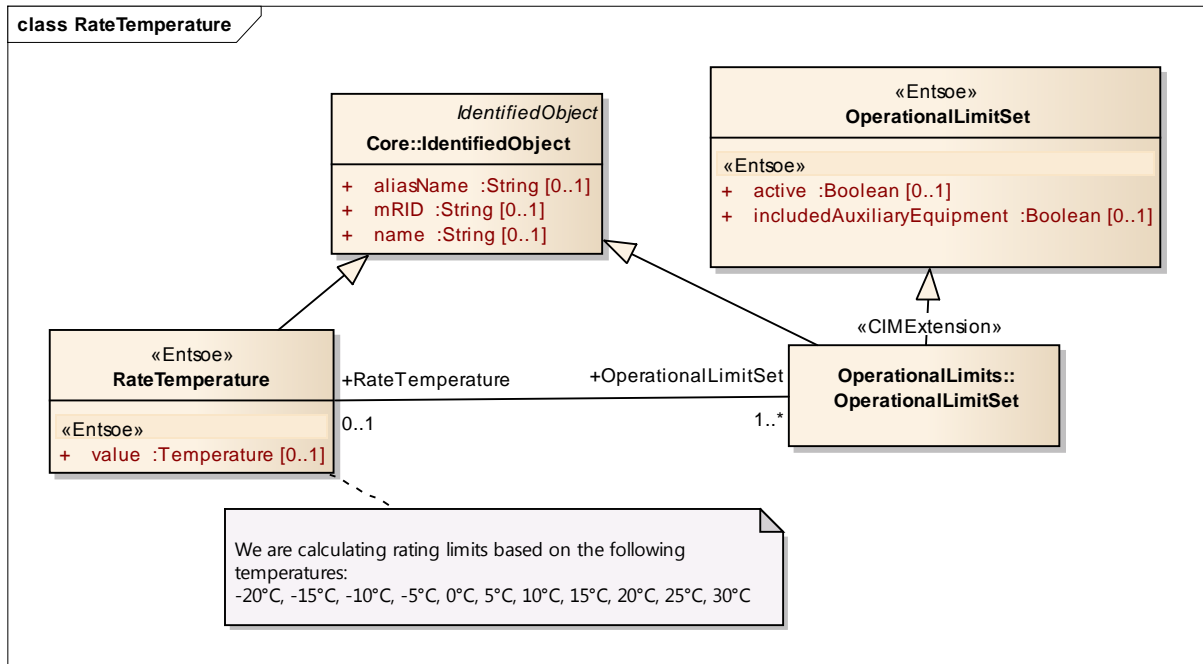
In the StateVariable Profile: the DCConductionEquipment does not have SvStatus.inService. There is a question of whether this is not relevant for DCConductionEquipment, or how it is considered the in/out of service to be on the container DCConverterUnit.

Modification to the SV profile might be necessary when the issue is resolved.

- **Status** – The issue will be followed with WG13 for further versions of the CGMES and IEC standards. The approval of the CGMES is not impacted upon by this issue.

### 8.1.20 ISSUE IEC 2013-20: TEMPERATURE DEPENDENT LIMITS

For planning into the future (or in cases where temperature data is missing), we need to be able to use fixed pre-calculated operational limits that are calculated based on predefined temperature. These temperatures will be defined in the new table, RateTemperature:



RateTemperature

Name	Type	Notes
Value	Temperature	The value/temperature for the rate temperature

OperationalLimitSet

Name	Type	Notes
active	Boolean	Flag indicating if this is the current active OperationalLimitSet
includedAuxiliary Equipment	Boolean	Flag indicating that limits given by end-point equipment like auxiliary equipment are included in the limit set for this equipment

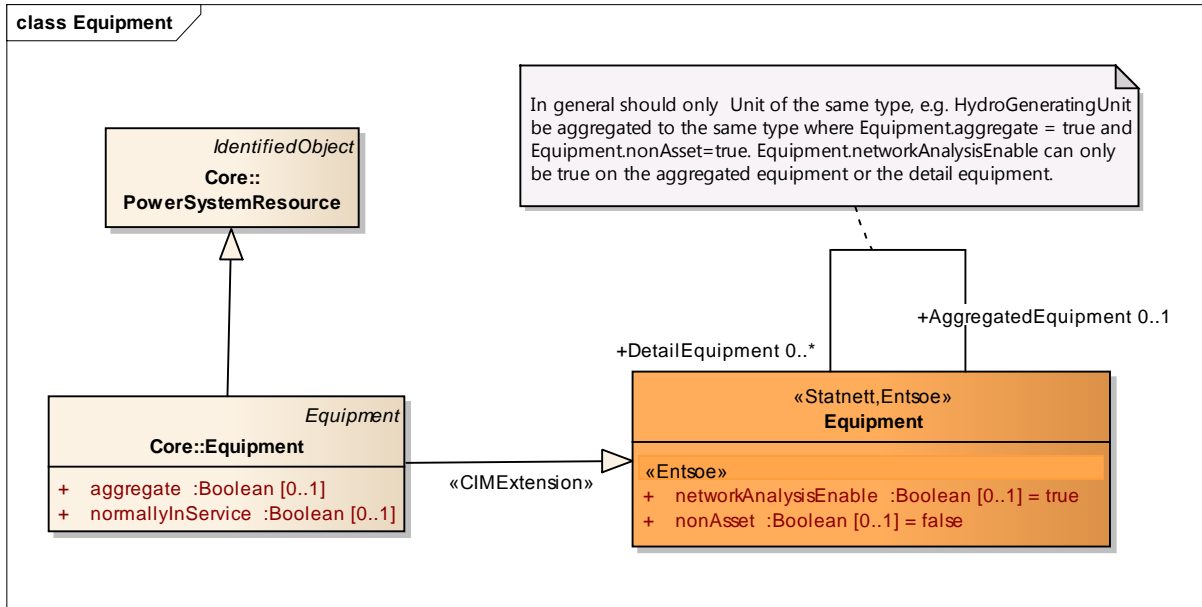
- **Status** – The issue will be followed with WG13 for further versions of the CGMES and IEC standards. The approval of the CGMES is not impacted upon by this issue.

8.1.21 ISSUE IEC 2013-21: AGGREGATED EQUIPMENT

In some TSOs, planning and operation models have different detailing on the equipment. In principle, are all the generators in operation "real" generators (not an aggregation of underlying production)? However, that is not always the case. Particularly with small embedded generators, Distributed Energy Resource (DER) is very difficult to get a model without using equivalent aggregates. In some cases, the dynamic and short-circuit data are only available on the aggregated units.

It is suggested to add an association from Equipment to Equipment with the following note: "Only Unit of the same type, e.g. HydroGeneratingUnit, can be aggregated to the same type where

Equipment.aggregate = true and Equipment.nonAsset = true. Equipment.networkAnalysisEnable can only be true on the aggregated equipment or the detail equipment."



The new association will go from Equipment.DetailEquipment to Equipment.AggregatedEquipment.

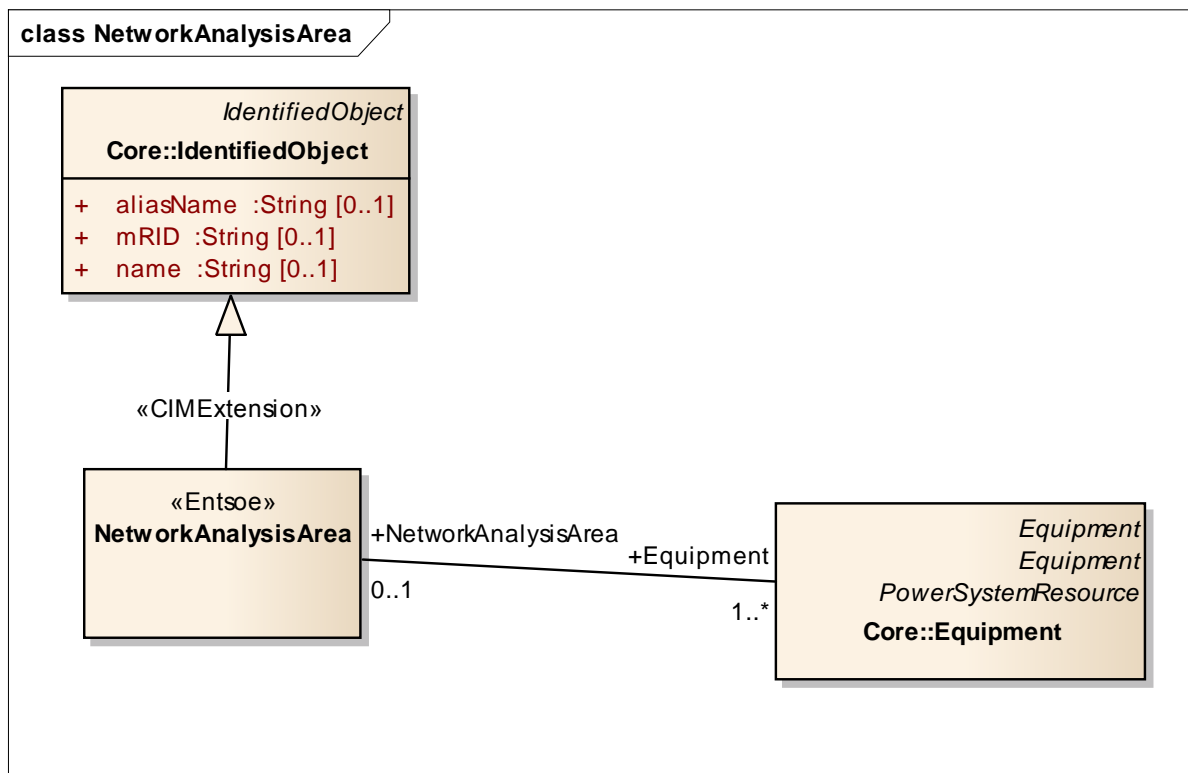
WG13 discussed this issue and agreed that the issue is part of a bigger discussion. It is not critical for the ENTSO-E CGMES IOP and CIM16. It could be added as an extension later on.

- **Status** – The issue will be followed with WG13 for further versions of the CGMES and IEC standards. The approval of the CGMES is not impacted upon by this issue.

### 8.1.22 ISSUE IEC 2013-22: NETWORK ANALYSIS AREA – ABILITY TO GROUP EQUIPMENT IN DIFFERENT WAYS

For some purposes it is useful to group various equipment in zones or specific areas.

System Development Planning and protection have an area grouping that is linked to an area or responsibility rather than to geographical areas.



- **Status** – The issue will be followed with WG13 for further versions of the CGMES and IEC standards. The approval of the CGMES is not impacted upon by this issue.

### 8.1.23 ISSUE IEC 2013-23: WINDGENERATINGUNIT

This issue relates to attributes mentioned in issue ENTSO-E 2013-14. These attributes could be added to CIM if agreed by WG13.

- **WG13 decision (17 July 2013):** The UML already support this by RegulatingControl having both a control mode and target value for a constant power factor. No change is required.
- **Status** – Implemented

### 8.1.24 ISSUE IEC 2013-24: FUTURE EXTENSIONS/WORK TO BE PLANNED

The following items should be considered for future CIM extensions:

- Auxiliary Equipment (there is an open issue with cleaning up the attributes, and should be added to 452)
- Protection Equipment (the following equipment should be added: VoltageRelay, FrequencyRelay and ImpedanceRelay)
- Branch/EquipmentTree (collection of Branches for node breaker) and Power Transfer Corridor (PTC)
- System Integrity Protection Scheme (SIPS) (alternative names RAS/SPS)
- Outage modelling
- Schedules modelling
- Fault/event list – measurement profile

- **Status** – The issue will be followed with WG13 for further versions of the CGMES and IEC standards. The approval of the CGMES is not impacted upon by this issue.

### 8.1.25 ISSUE IEC 2013-25: CARDINALITY REGULATINGCONTROL- TERMINAL

The RegulatingControl end is 0..\* and the Terminal end is 0..1. The description of RegulatingControl says:

"In case multiple equipment, possibly of different types, control the same terminal, there must be only one RegulatingControl at that terminal." This disagrees with the cardinality.

As RegulatingControl currently does not support multiple control strategies, it is suggested to change the cardinality at the RegulatingControl end to 0..1. As RegulatingControl not being connected to a Terminal does not make sense, it is suggested to change the Terminal end cardinality to 1.

- **Status** – The issue should be discussed in WG13, and UML updated. The change is already made in the CGMES.

## 8.2 PROFILE 1 (BASED ON UML14V02) ISSUES

In 2011 and 2012, ENTSO-E issued an annex to Profile 1. In 2013, additional issues were identified and discussed among TSOs and vendors. During the IOP an agreement on the following items was reached, with the annex to Profile 1 being extended and published on the ENTSO-E website:

- RegulatingControl
  - RegulatingControl.targetRange should be centrally oriented in the view of RegulatingControl.targetValue.
  - RegulatingControl.targetRange is not provided for a fixed type (RegulatingControlmodeKind.fixed).
- New definitions for PhaseTapChanger xStepMax and xStepMin. The name of these attributes should remain the same:
  - xStepMax – The maximum reactance (xMax) appears at the low and high tap positions.
  - xStepMin – The minimum reactance (xMin) appears at the mid tap position.
- Clarifications on PST are added in the document
  - Agreement to update the mapping in the profile so that missing information is added
  - RatioTapChanger
    - stepVoltageIncrement in %
  - PhaseTapChanger
    - Asymmetrical
      - voltageStepIncrementOutOfPhase in kV
      - windingConnectionAngle in AngleDegrees
    - Symmetrical
      - With constant impedance or voltage
        - stepPhaseShiftIncrement in AngleDegrees
      - Optionally, for information:
        - voltageStepIncrementOutOfPhase in kV
      - Otherwise
        - stepVoltageIncrement in %

## 8.3 CGMES (BASED ON UML16V22) ISSUES

Some profile-related issues were identified during the IOP. These issues were applied to CGMES v2.4.9. The issues listed in this section have been resolved during the IOP. The decisions were taken among all IOP participants. All issues which are resolved **are corrected** in the updated version of CGMES v2.4.12 [2], issued on 31 August 2013. There are no critical issues preventing approval of the CGMES.

### 8.3.1 ISSUE ENTSO-E 2013-1: MORE SPECIFIC OPERATIONALLIMITTYPES

Related to issue IEC 2013-1:

- **Applied changes to the EQ profile in CGMES:**
  - OperationalLimitType.limitType attribute added as ENTSO-E extension as well as related enumeration
  - Updated link in the note: "For further details on the use case and definitions, see ENTSO-E Operation Handbook (Policy 3): <https://www.entsoe.eu/publications/system-operations-reports/operation-handbook/>"
  - Delete the following notes associated with OperationalLimitType:
    - "The name of OperationalLimitType (inherited from IdentifiedObject) must have one of the following values: LowVoltage, HighVoltage, PATL, TATL, Alarm, TrippingCurrent, WarningTrippingCurrent."
- **Status** – Implemented

### 8.3.2 ISSUE ENTSO-E 2013-2: MEANING OF OPERATIONALLIMITTYPES.DIRECTION

Related to issue IEC 2013-2:

- **Status** – The issue is put on hold while waiting for the resolution of issue IEC 2013-2. The issue is not critical for the CGMES approval.

### 8.3.3 ISSUE ENTSO-E 2013-3: DCREACTOR ATTRIBUTES

Related to issue IEC 2013-3:

- **Applied changes to the EQ profile in CGMES:**
  - DCREactor changed to DCShunt and attributes added
  - DCSeriesDevice added with the same attributes as DCShunt
- **Status** – Implemented

### 8.3.4 ISSUE ENTSO-E 4: REMOVE "DCSIDE" IN CLASS NAMES

Related to issue IEC 2013-4:

- **Applied changes to the EQ, SSH and SV profile in CGMES:**
  - CsConverterDCSide renamed as CsConverter in EQ profile
  - VsConverterDCSide renamed as VsConverter in EQ profile
  - CsConverterDCSide renamed as CsConverter in SSH profile

- VsConverterDCSide renamed as VsConverter in SSH profile
- CsConverterDCSide renamed as CsConverter in SV profile
- VsConverterDCSide renamed as VsConverter in SV profile
- **Status** – Implemented

### 8.3.5 ISSUE ENTSO-E 2013-5: CARDINALITY PSR-CONTROL

Related to issue IEC 2013-5:

- **Applied changes to the EQ profile in CGMES:**
  - Change the cardinality from 1..\* to 0..\*
  - Inverse the direction of the association so that it points to PSR
- **Status** – Implemented

### 8.3.6 ISSUE ENTSO-E 2013-6: STATICVARCOMPENSATOR ATTRIBUTES

Related to issue IEC 2013-6:

- **Applied changes to the EQ profile in CGMES:**
  - SVCControlMode.off is deleted
  - The following note is added to the StaticVarCompensator:
    - “Two ways to describe SVC control are possible:
      - 1) Use sVCControlMode and voltageSetPoint
      - 2) Use RegulatingControl
The first is a model of the real device behaviour, while the latter is a simplified control in power flow programs. The following rules are recommended:
      - If the receiving system only supports the simplified control model (2), it may convert the detailed model (1) to the simplified (2).
      - If both controls are specified, it is up to the receiving system to choose which one to use.
It is up to the receiving party to interpret and make use of any data received.”
- **Status** – Implemented

### 8.3.7 ISSUE ENTSO-E 2013-7: SVINJECTION DOCUMENTATION

Related to issue IEC 2013-7:

- **Applied changes to the SV profile in CGMES:**
  - The resolution of issue IEC 2013-7 implemented
- **Applied changes to the CGMES document:**
  - The following note was added to the CGMES document: “EquivalentInjection classes are used to represent the power flow exchanges through Boundary Points. These classes are included in the TSO MAS and refer to the Boundary Points in the Boundary set. SvInjection class is not used for this purpose. In case the use cases require exchanging of multiple SSH, TP or SV instance files which are dependent on an EQ instance file, this EQ shall always include an instance of EquivalentInjection per Boundary Point. Therefore, in a multi-TSO exchange a Boundary Point will always have two EquivalentInjections per Boundary Point contained in different TSO MAS. Rdf:IDs of those EquivalentInjections are kept persistent.”
- **Status** – Implemented



### 8.3.8 ISSUE ENTSO-E 2013-8: STEADY STATE HYPOTHESIS

The issue aimed to clarify open points related to the Steady State Hypothesis profile and agree on changes to be documented in the CGMES document.

In the SSH discussion on how to describe bus-branch models, a proposal was made in which:

- Input topology is described by `cim:ConnectivityNodes`
- The result after topology processing is described by `cim:TopologicalNodes`

Consequences

- The TP profile will be merged into SV, with TP disappearing. 61970-552 allows an exchange of multiple profiles in one instance file. Therefore, this is supported.
- “Busses” will be described by `cim:ConnectivityNodes` in the EQ file.
- A power flow that starts from an unsolved case will start from `cim:ConnectivityNodes` in EQ and `Terminal.connected` or `Switch.open` in SSH.
- A power flow that starts from a solved case will start from `cim:TopologicalNodes` in SV and ignore `Terminal.connected` or `Switch.open` in SSH.

Perhaps there should not be a distinction drawn between solved and unsolved starting points. Any case can be started from EQ, and then topology processing and solution could be run. If the use case scenario is just to verify or continue studying the solution, the topology expressed in SV can be used. But if the use case is to take a solution based on operations-detail EQ connectivity and create a planning type case from it, the recommended practice would then be to initialise a connectivity model (in an EQ) from the solved topology by creating one `ConnectivityNode` for each `TopologyNode`. In other words, create an EQ with which planning software is able to deal. This enables the planning case to be exchanged in the normal way as EQ+SSH+SV. (Another way to look at this is that topology processing is an operation that can be performed on EQ to yield a new EQ.)

- CIM cannot concurrently describe both bus-branch and node-breaker versions of the same network (probably not an issue).

This is correct at the moment. Any alternative expression of a network requires a new instance of an EQ. It should be kept in mind, though, that there are lots of circumstances where different expressions of the network are needed — not just the node-breaker to bus-branch views. Equivalentents are a good example. An equivalent is an operation performed on one EQ to yield another. CIM currently cannot express both in one instance.

➤ **Applied changes to the SSH and TP profiles:**

- `Terminal.connected` is deleted from the TP profile; `ACDCTerminal` is added to the SSH profile as an abstract class with the attribute `connected`; and `Terminal` is added to SSH and inherits from `ACDCTerminal`. The note on `Terminal` — “For an open retained breaker, both Terminals are not connected” — moved to SSH.
- `Switch.open` is moved from TP to SSH. `ConductingEquipment` is deleted from the TP profile. `GroundDisconnector`, `Disconnector`, `ProtectedSwitch`, `LoadBreakSwitch`, and `Breaker` are added to SSH.
- `SolarGeneratingUnit`, `WindGeneratingUnit`, `HydroGeneratingUnit`, `NuclearGeneratingUnit`, and `ThermalGeneratingUnit` are added to the SSH profile.

➤ **Applied changes to the CGMES document:**

- The following text was added in the document: “A steady state hypothesis instance file is always exchanged in full. All objects in a steady state hypothesis instance file should have persistent mRIDs and rdf:IDs.”

- The following text was inserted in the document:

*“The CGMES supports node-breaker and bus-branch model exchange. Moving forward the procedures of the model exchanges using the CGMES, it is expected that equipment and steady state hypothesis data (EQ and SSH instance files) will be the input source data for all processes. This type of model should be the fully detailed model with all disconnectors/breakers, etc. Any configuration changes are made by changing switch statuses. The CGMES defines equipment and steady state hypothesis profiles as input, and all result in whether topology or state variable profile data must refer to the equipment and steady state hypothesis objects. Therefore, in case both equipment and steady state hypothesis instance files are available, there is no need to exchange topology or state variable instance files in order to obtain a load flow.*

*The following specific differences apply to bus-branch and node-breaker model exchange:*

- *Bus-branch model exchange:*
    - *TopologicalNodes must be persistent;*
    - *If a contingency list should be exchanged, it should refer to ConductingEquipment (TopologicalNode, branches, etc.). This causes a constraint on interoperability between planning and operation processes.*
  - *Node-breaker model exchange:*
    - *The TopologicalNodes represent the output from a topology processing on the detailed input source operational data. These can be optionally exchanged to be used by tools that have an interest in the computed buses.*
    - *A topology instance file is not exchanged using a difference file.*
    - *rdfIDs of the TopologicalNodes are not persistent.*
    - *If a contingency list should be exchanged, it should refer to ConductingEquipment (ConnectivityNode, which is not artificial, Busbar, etc.).”*
- **Status** – Implemented. Nevertheless, the discussion on this issue may continue; as a result, an implementation guide should be issued when the ENTSO-E CGMES is approved.

### 8.3.9 ISSUE ENTSO-E 2013-9: JUNCTION

Related to issues IEC 2013-10 and IEC 2013-11:

- **Applied changes to the EQ profile in CGMES:**
  - Junction added to the profile
- **Applied changes to the boundary EQ profile in CGMES:**
  - Connector and ConductingEquipment added to the profile as abstract classes
  - Junction added to the profile
  - ConnectivityNode.boundaryPoint added as ENTSO-E extension
- **Applied changes to the boundary TP profile in CGMES:**
  - TopologicalNode.boundaryPoint added as ENTSO-E extension

- **Status** – Partly implemented. A separate document to summarise the discussion on this issue is created. The issue will either be implemented before the approval of the CGMES or it will be resolved in a minor version of the CGMES boundary profiles.

### 8.3.10 ISSUE ENTSO-E 2013-10: PROFILING

IOP participants agreed to use three RDFS files for EquipmentCore, EquipmentShortCircuit and EquipmentOperation profiles.

Machine-readable validation rules will be implemented using OCL in the Enterprise Architect.

- **Status** – The work on this requirement is on-going and should be finalised after the approval of the CGMES. It is an important part of the CGMES implementation process.

### 8.3.11 ISSUE ENTSO-E 2013-11: OPTIONAL ATTRIBUTES HVDC MODEL

There is a need to define some basic rules for the HVDC: where the transformer is located; which attributes are optional (identify the minimum set of required attributes); OCL and Notes could be used.

- **Status** – The issue needs implementation before the approval of the CGMES or in a following version as the changes will apply changes to the EQ, TP, SSH and SV profiles in CGMES and will only specify a minimal set of mandatory attributes.

### 8.3.12 ISSUE ENTSO-E 2013-12: DIAGRAM TYPE

Related to issues IEC 2013-14:

- **Applied changes to the DL profile in CGMES:**
  - DiagramStyle class added
  - Association of DiagramStyle with Diagram added
  - The following note to the DiagramStyle was added: “The inherited IdentifiedObject.name shall have one of the following names: node-breaker, bus-branch, or geoschematic.”
- **Status** – Partly implemented as there is a need to discuss whether an extension (optional association of Diagram with IdentifiedObject) should be added as an ENTSO-E extension if the IEC issue is not finalised by the time of the CGMES approval.

### 8.3.13 ISSUE ENTSO-E 2013-13: DYNAMICS PROFILE AND UML

- **Applied changes to the DY profile in CGMES:**
  - SynchronousMachineTimeConstantReactance modelType and rotorType are changed to required.
  - Attributes of LoadStatic are changed to optional. No default behaviour should be applied to LoadStatic.
  - Reverse the association SynchronousMachineDynamics – TurbineGovernorDynamics; make 0..1 to 0..\*.

During the implementation (when there will be testing of model by model) the profile should specify assumptions for input signals in case some of the models are missing, e.g. if no voltage compensator model is provided, it must be defined as the terminal voltage. In addition, some rules related to the

reactances of the synchronous machines should be agreed. (The d-axis subtransient reactance ( $X''_d$ ) is equal to stator leakage reactance ( $X_l$ ), whereas it should be greater. In a more general way, it should be useful to include in the CIM model some constructive constraints on the parameters, like  $X_d > X'_d$ ,  $X'_d \geq X''_d$ ,  $X''_d > X_l$ ). TSOs and vendors should still reach an agreement on this.

An issue related to a common base system for the exchange — Dynamic model of synchronous machines (efdBaseRatio, efdBaseType) — was discussed. It was agreed that no change is needed in the UML or in the profile. Vendors agreed that they need to be aware that there are four possibilities for base systems for the exciter and support these possibilities.

- **Status** – This issue should be followed during the implementation process of the CGMES after the approval of the CGMES.

### 8.3.14 ISSUE ENTSO-E 2013-14: WINDGENERATINGUNIT

The following attributes could be added to the EQ profile as extensions. Further discussion is expected of this in WG13:

- Wind Generating Unit Power Factor
- Wind Generating Unit Var Output Capability Enumeration with the following options:
  - Use Var Limits
  - Var Limits Calculated from Power Factor using Watt output
  - Vars Calculated from Power Factor
  - Vars Calculated from Power Factor where Vars are negative of Watts

See issue IEC 2013-23 for the WG13 decision.

- **Status** – Implemented

### 8.3.15 ISSUE ENTSO-E 2013-15: DIAGRAM PROFILE

- **Applied changes to the DL profile in CGMES:**
  - Note added to DiagramObject: “The DiagramObject should link to SynchronousMachine and not GeneratingUnit.”
  - Note added to the CGMES document: “A full Diagram (non-difference instance file) represents a new drawing of the diagram. Data may change from one system drawing to another, e.g. two diagrams with the same mRID of the classes in the instance files do not need to be identical. The purpose of the Diagram layout profile is to support the understanding of the equipment data. If a diagram generated by one system is updated by another, the file does not need to be identical, with the exception of the edited changes. However, the updated and exported diagram instance file needs to include all the same relevant information and must include the same layout rendering in the new destination system (old source) as the original, with the exception of the changes. The expected behaviour is that a diagram may have a new layout with the same Diagram mRID as well as DiagramObject mRID. Persistence of Diagram and DiagramObject mRIDs is required if difference updates are supported.”
- **Status** – Implemented

### 8.3.16 ISSUE ENTSO-E 2013-16: HVDC PACKAGE

- **Applied changes to the EQ profile in CGMES:**

- Note on the VoltageLevel update: "DCConductingEquipment and DCConverterUnit are not allowed in VoltageLevels, which is intended for AC equipment only. DCConductingEquipment is allowed in DCEquipmentContainers only. The ACDCConverter is ConductingEquipment. Other AC equipment in a converter unit comprises the power transformer and converter reactor. All three shall be located in a DCConverterUnit and not a VoltageLevel."
- ConverterACSide – deleted
- ConverterDCSide renamed as ACDCConverter
- ACDCConverter inherits from ConductingEquipment
- ACDCConverter.nomUdc added to the EQ profile
- DCBaseTerminal added as abstract
- ACDCConverterDCTerminal added
- Polarity attribute moved from DCTerminal to ACDCConverterDCTerminal
- Association ACDCConverterDCTerminal to ACDCConverter added
- DCTerminal inherits from DCBaseTerminal
- Association DCNode to DCTerminal is now from DCNode to DCBaseTerminal
- **Applied changes to the TP profile in CGMES:**
  - Association DCNode to DCTerminal is now from DCNode to DCBaseTerminal
  - Association DCTopologicalNode to DCTerminal is not to DCBaseTerminal
  - Reverse the association DC Node-DCTopologicalNode
- **Applied changes to the SSH profile in CGMES:**
  - ConverterDCSide renamed as ACDCConverter
  - DCConductingEquipment class deleted as ACDCConverter now inherits from ConductingEquipment
  - P and q added to the ACDCConverter
- **Applied changes to the SV profile in CGMES:**
  - ConverterDCSide renamed as ACDCConverter
  - DCConductingEquipment class deleted as ACDCConverter now inherits from ConductingEquipment
- **Status** – Implemented

### 8.3.17 ISSUE ENTSO-E 2013-17: SV PROFILE

- **Applied changes to the SV profile in CGMES:**
  - TopologicalNode is changed to abstract
  - The note on TopologicalNode is deleted: *“In the SV profile, TopologicalNode.TopologicalIsland is defined. But there is no need to include this in the instance file. The SV profile does not require putting instances of TopologicalNode into the SV File, so the TopologicalNode.TopologicalIsland need not be an optional association in the SV profile. The "required" [1..1] multiplicity on an attribute or association (as for TopologicalNode.TopologicalIsland) is suggesting that if an instance of the containing class is included in the message, the attribute or association must then be present. It says nothing about whether or not the instance of TopologicalNode is required in the file.”*
  - The following note on SvInjection is deleted: *“SvInjection represents the flow through the TieLine at X-Node (boundary files). Parameters of SvInjection classes are set to zero when the State Variables file covers multiple MAS and if a tie-line is connected. It is not necessary that the SvInjection be set to zero at the time of the import. Additional functions should be made available for users to cover all necessary use cases when dealing with TSO MAS and Boundary MAS.”*
  - DCTopologicalNode changed to abstract

- Reverse the association DCTopologicalNode DCTopologicalIsland
- **Status** – Implemented

### 8.3.18 ISSUE ENTSO-E 2013-18: CONNECTIVITYNODE

According to the ENTSO-E profile, validation tools require a ConnectivityNode to be in a VoltageLevel, but Lines are not allowed to have VoltageLevels. The issue agrees with WG13, and the change will also be applied in 61970-452.

- **Applied changes to the ConnectivityNode in EQ and Boundary EQ profiles in CGMES:**

The following note is added to the ConnectivityNode in EQ and Boundary EQ profiles:

*"If the model is a TSO EQ, the ConnectivityNodes should be grouped under VoltageLevel;*

*If the model is a Boundary EQ, the ConnectivityNodes should be grouped under Line;*

*If the model is an assembled one, the ConnectivityNodes can be grouped under either VoltageLevel or Line.*

*With this approach the Line is also in the Boundary set. Instances of ACLineSegment can be in the Boundary set instance of Line or in another instance of Line. Consequently, there can be instances of Line that contain only ConnectivityNodes, but no ACLineSegments."*

- **Status** – Implemented

### 8.3.19 ISSUE ENTSO-E 2013-19: NAMESPACE URI

The namespace URIs for Extension and Geographical Location were not formatted properly. These URIs are changed to:

- ENTSO-E extension: <http://entsoe.eu/CIM/SchemaExtension/3/1#>
- Geographical Location: <http://entsoe.eu/CIM/GeographicalLocation/2/1>

- **Status** – Implemented

### 8.3.20 ISSUE ENTSO-E 2013-20: NOTES IN THE EQ PROFILE

The EQ profile in the CGMES has a set of notes that are inherited from the IEC CPSM profile. These notes are listed below, together with related requirements from "61970-452 Annex A: Common power system model (CPSM) minimum data requirements (informative)". Because the annex is informative and the requirements are not related to ENTSO-E exchanges or might be misleading as CIM has evolved since 2002, the following notes are deleted from the EQ profile.

- ConnectivityNode:
  - Requirements:
    - [R3.2] Control Area Location

- [R3.3] Base/nominal kV
  - [R3.5] High/Low Normal limits (kV)
  - Deleted notes in the EQ profile:
    - [R3.5] is satisfied by navigation to VoltageLevel
    - [R3.3] is satisfied by navigation to BaseVoltage
    - [R3.2] is satisfied by navigation to SubControlArea
- StationSupply:
  - Requirements:
    - [R8.2] Location (Electrical Junction and Substation)
  - Deleted notes in the EQ profile:
    - [R8.2] is satisfied by navigation to ConnectivityNode and Substation
- ACLineSegment:
  - Requirements:
    - [R4.5] "From" End location (Electrical Junction and Substation)
    - [R4.7] "To" End location (Electrical Junction and Substation)
  - Deleted notes in the EQ profile:
    - [R4.5] and [R4.7] are satisfied by navigation to ConnectivityNode and Substation
- Breaker:
  - Requirements:
    - [R6.2] "From" End location (Electrical Junction and Substation)
    - [R6.3] "To" End location (Electrical Junction and Substation)
    - [R6.4] Type (Breaker, Disconnect Switch, Switch, Fuse)
  - Deleted notes in the EQ profile:
    - [R6.4] is satisfied by the class name
    - [R6.2] and [R6.3] are satisfied by navigation to ConnectivityNode and Substation

- ConformLoad:
  - Requirements:
    - [R8.2] Location (Electrical Junction and Substation)
  - Deleted notes in the EQ profile:
    - [R8.2] is satisfied by navigation to ConnectivityNode and Substation
- Disconnecter:
  - Requirements:
    - [R6.2] "From" End location (Electrical Junction and Substation)
    - [R6.3] "To" End location (Electrical Junction and Substation)
    - [R6.4] Type (Breaker, Disconnect Switch, Switch, Fuse)
  - Deleted notes in the EQ profile:
    - [R6.2] and [R6.3] are satisfied by navigation to ConnectivityNode and Substation
    - [R6.4] is satisfied by the class name
- EnergyConsumer:
  - Requirements:
    - [R8.2] Location (Electrical Junction and Substation)
  - Deleted notes in the EQ profile:
    - [R8.2] is satisfied by navigation to ConnectivityNode and Substation
- LoadBreakerSwitch:
  - Requirements:
    - [R6.2] "From" End location (Electrical Junction and Substation)
    - [R6.3] "To" End location (Electrical Junction and Substation)
    - [R6.4] Type (Breaker, Disconnect Switch, Switch, Fuse)
  - Deleted notes in the EQ profile:
    - [R6.2] and [R6.3] are satisfied by navigation to ConnectivityNode and Substation



- [R6.4] is satisfied by the class name
- NonConformLoad:
  - Requirements:
    - [R8.2] Location (Electrical Junction and Substation)
  - Deleted notes in the EQ profile:
    - [R8.2] is satisfied by navigation to ConnectivityNode and Substation
- PowerTransformerEnd:
  - Requirements:
    - [R5.4] "From" End location (Electrical Junction and Substation)
    - [R5.6] "To" End location (Electrical Junction and Substation)
    - [R5.10] "Tap side" Electrical Junction Identifier
  - Deleted notes in the EQ profile:
    - [R5.4], [R5.6], and [R5.10] are satisfied by navigation to ConnectivityNode and Substation
- SeriesCompensator:
  - Requirements:
    - [R9.3] Location (Electrical Junction and Substation)
  - Deleted notes in the EQ profile:
    - [R9.3] is satisfied by navigation to ConnectivityNode and Substation
- StaticVarCompensator:
  - Requirements:
    - [R9.3] Location (Electrical Junction and Substation)
  - Deleted notes in the EQ profile:
    - [R9.3] is satisfied by navigation to ConnectivityNode and Substation
- Switch:
  - Requirements:
    - [R6.2] "From" End location (Electrical Junction and Substation)

- [R6.3] “To” End location (Electrical Junction and Substation)
  - [R6.4] Type (Breaker, Disconnect Switch, Switch, Fuse)
- Deleted notes in the EQ profile:
  - [R6.2] and [R6.3] are satisfied by navigation to ConnectivityNode and Substation
  - [R6.4] is satisfied by the class name
- SynchronousMachine:
  - Requirements:
    - [R7.2] Location (Electrical Junction and Substation)
    - [R9.3] Location (Electrical Junction and Substation)
  - Deleted notes in the EQ profile:
    - [R7.2] and [R9.3] are satisfied by navigation to ConnectivityNode and Substation
- ShuntCompensator:
  - Requirements:
    - [R9.3] Location (Electrical Junction and Substation)
  - Deleted notes in the EQ profile:
    - [R9.3] is satisfied by navigation to ConnectivityNode and Substation

➤ **Status** – Implemented

### 8.3.21 ISSUE ENTSO-E 2013-21: NOTES ON EQUIPMENT

**Old text:** “Attribute aggregate: for ENTSO-E, the TSOs will use this flag for equivalent equipment. This Boolean flag indicates that this equipment (element) of the power system model is obtained by a network reduction procedure. If the flag is set to “true”, the equipment is treated as an equivalent. This flag provides an alternative way of representing an aggregated (equivalent) element by allowing usage of all available attributes for a given class instead of usage of dedicated classes for equivalent equipment that has a limited number of attributes.

*Do not use this attribute for PowerTransformerEnd, BusBarSection, EquivalentBranch, EquivalentShunt and EquivalentInjection.”*

**New text:** “Equipment.aggregate provides an alternative way of representing an aggregated (equivalent) element by allowing usage of all available attributes for a given class **only if** usage of dedicated classes for equivalent equipment is not possible due to a limited number of attributes on

these classes. In this case and if the flag is set to "true", the equipment is treated as an equivalent obtained by a network reduction procedure.

The attribute is not used for the following classes: *PowerTransformerEnd*, *BusBarSection*, *EquivalentBranch*, *EquivalentShunt* and *EquivalentInjection*."

- **Status** – Implemented

### 8.3.22 ISSUE ENTSO-E 2013-22: CARDINALITY REGULATINGCONTROL- TERMINAL

This issue is related to the issue IEC 2013-25.

The cardinality at the RegulatingControl end is changed from 0..\* to 0..1 in the EQ profile.

- **Status** – Implemented

### 8.3.23 ISSUE ENTSO-E 2013-22: CHANGES DUE TO RESOLUTIONS OF THE IEC ISSUES

- **Changes in the EQ profile:**
  - The following attributes are added to the SeriesCompensator: *varistorPresent*, *varistorRatedCurrent* and *varistorVoltageThreshold*.
- **Changes in the SSH profile:**
  - *ACDCCConverter p* and *q* are added to the SSH profile.
- **Status** – Implemented

## 9 APPENDIX E: SUMMARY OF ISSUES FROM IOP 2012

ENTSO-E IOP 2012 identified the following issues that had to be further discussed within IEC WG13 and agreed among IEC members and IOP participants. Many of the issues required consultation with TSOs, which was performed before IOP 2013 in order to allow changes in the profiles before the IOP. This Appendix only informs on the resolution of these issues.

### 9.1 ISSUES ADDRESSED TO IEC

#### 9.1.1 ISSUE IEC 1: CURVE CLASS – MISSING ATTRIBUTES

A curve class does not have the following attributes: *y3Unit*, *y2Multiplier*, *y1Multiplier*, *y3Multiplier*, and *xMultiplier*. These attributes are missing in IEC 61970-452.

- **ENTSO-E IOP proposal:** Add these attributes to IEC 61970-452.
- **WG13 resolution** (8 Aug 2012, issues call): The consensus of the group is to stick with the current approach of specifying the values for the unit and multiplier attributes in the profile and not including those attributes in the exchange. Therefore, no changes are introduced.

## 9.1.2 ISSUE IEC 2: SYNCHRONOUSMACHINE CLASS – OUTDATED

### ATTRIBUTES

SynchronousMachine.r and SynchronousMachine.x are present in the UML and in the profiles, but these attributes are not needed anymore. The reason is that additional attributes were added to complete the model of SynchronousMachine in respect to short-circuit and dynamics data exchanges.

- **ENTSO-E IOP proposal:** Remove SynchronousMachine.r and SynchronousMachine.x in the UML and correct necessary standards (i.e. IEC 61970-452). In case removing these attributes from UML is not possible due to various reasons, the attributes should not be used in future profiles.
- **WG13 resolution** (22 Aug 2012, 5 Sep 2012, issues call): UML updated — the description of SynchronousMachine.r is updated with the text from SynchronousMachine.equivalentResistance, which was removed. SynchronousMachine.x was also removed.

## 9.1.3 ISSUE IEC 3: EXTERNALNETWORKINJECTION.GOVERNORSCD

There is an issue with the attribute governorSCD of the class ExternalNetworkInjection. Initially, the attribute ExternalNetworkInjection.GovernorSCD was copied from GeneratingUnit together with the unit (%). As an ExternalNetworkInjection does not contain generator data, the base value for the % is not given. The data type and description need to be updated to reflect the meaning of the attribute. Changes should be done in UML and in IEC 61970-452.

- **ENTSO-E IOP proposal:** Change data type from PerCent to MW/Hz. The new description of the attribute should be: "Power Frequency Bias. This is the change in power injection divided by the change in frequency and negated. A positive value of the power frequency bias provides additional power injection upon a drop in frequency."
- **WG13 resolution** (22 Aug 2012, issues call): Agreed to change ExternalNetworkInjection.governorSCD description and data type, as proposed.

## 9.1.4 ISSUE IEC 4: SYNCHRONOUSMACHINE.SATDIRECTTRANSX

The attribute SynchronousMachine.satDirectTransX was added to UML for short-circuit data exchanges, but this attribute is not required for short-circuit data exchanges according to IEC 60909. The description of the attribute should indicate this. Changes should be done in UML and in IEC 61970-452.

- **ENTSO-E IOP proposal:** The new description of the attribute should be: "Saturated Direct-axis transient reactance. The attribute is primarily used for short circuit calculations according to ANSI."
- **WG13 resolution** (1 Aug 2012, issues call): Agreed to change the description, as suggested.

## 9.1.5 ISSUE IEC 5: EXTERNALNETWORKINJECTION.MAXP

- **ENTSO-E IOP proposal:** The description of the attribute should be: "Maximum active power of the injection".
- **WG13 resolution** (1 Aug 2012, issues call): Agreed to change the description, as suggested.

### 9.1.6 ISSUE IEC 6: EXTERNALNETWORKINJECTION.MINP

- **ENTSO-E IOP proposal:** The description of the attribute should be: "Minimum active power of the injection".
- **WG13 resolution** (1 Aug 2012, issues call): Agreed to change the description, as suggested.

### 9.1.7 ISSUE IEC 7: SYNCHRONOUSMACHINE.SHORTCIRCUITROTORTYPE

- **ENTSO-E IOP proposal:** The description of the attribute should be: "Type of rotor, used by short circuit applications, only for single fed short circuit according to IEC 60909".
- **WG13 resolution** (22 Aug 2012, issues call): Agreed to change the description of SynchronousMachine.shortCircuitRotorType to "Type of rotor, used by short circuit applications, only for single fed short circuit according to IEC 60909".

### 9.1.8 ISSUE IEC 8: TRANSFORMER MODEL

Some vendors expressed their concern that the new transformer model is difficult to handle. It is also understood that changes in the model will impact on a lot of implementations. Vendors pointed out that it is difficult to restrict each transformer being modelled always from high voltage to low voltage. Some projects see a value to know that TransformerEnd.endNumber specifies what the highest voltage side is. There is a need to consider transmission-distribution transformers in case the two windings are the same voltage.

- **ENTSO-E IOP proposal:** The description of TransformerEnd.endNumber specifies that "Highest voltage winding should be 1". The recommendation is to delete this sentence as it is considered to be redundant information.
- **WG13 resolution** (8 Aug 2012 issues call; WG13 meeting 11 Oct 2012, issues call 31 Oct 2012; USA meeting Feb 2013): The consensus of the group is to leave the description of TransformerEnd.endNumber unchanged. WG13 also checked with WG14 about how they were using endNumber after that decision was made, but that didn't change WG13's original decision.

### 9.1.9 ISSUE IEC 9: NAME, NAME TYPE ISSUE

During the IOP preparatory phase a lot of concerns regarding the use of Name, NameType and NameTypeAuthority classes were expressed. IEC Standards do not define the use of this construction clear enough. It was pointed out that Name-NameType construction is intended as an alternative to a Naming (identifier) service to handle a system that is not compliant with the use of rdf:ID as an object identifier. In the process of ENTSO-E profile preparation it was agreed that Name, NameType, and NameTypeAuthority will not be used in the frozen version of the profile. It could stay in the profile in order to serve some of the use cases and be compatible with 61970-452. All names were added as ENTSO-E extensions to the IdentifiedObject and these will be the main ones to be used in the frozen version of the profile.

- **ENTSO-E IOP proposal:** Remove Name, NameType, and NameTypeAuthority from the 61970-452 or clearly specify the use and recommend how profiles compatible with 61970-452 should deal with name extensions (extensions to the IdentifiedObject).
- **WG13 and WG14 resolution:**
  - Name and NameType will be removed from 61970-452

- The exchange of alternate names shall be moved into a separate profile

### 9.1.10 ISSUE IEC 10: CLARIFICATION REGARDING RDF:ID AND MRID

During the IOP preparatory phase an issue on rdf:ID and mRID was identified. IEC WG13 took some actions and discussed the issue but was not able to reach an agreement before the IOP. Some TSOs and vendors are using rdf:ID as their internal identifier, which is not necessarily the GUID or UUID type. The argument for not using UUID is that the exchanging party would need to store the rdf:ID in its database as it needs to be persistent. This will require additional effort to maintain rdf:ID-specific IDs in all databases of TSOs or vendors.

- **ENTSO-E IOP proposal:** Try to reach a consensus and clarify this issue in the CIM standards before the release of standards related to CIM16.
- **WG13 and WG14 resolution:**
  - Agreed to update 61970-552 according to country comments. The standard was updated.
  - The CIMXML object ID is a UUID having the serialisation format:
    - Initial underscore “\_” that is not part of the UUID but added to keep validity in RDF. Having an ID starting with a number is invalid in RDF.
    - 8-character hex number
    - a dash “-”
    - 4-character hex number
    - a dash “-”
    - 4-character hex number
    - a dash “-”
    - 4-character hex number
    - a dash “-”
    - 12-character hex number
    - where letters are lower case,  
e.g. \_26cc8d71-3b7e-4cf8-8c93-8d9d557a4846
    - The container part of an ID is specified by an XML base `xml:base="urn:uuid"`

### 9.1.11 ISSUE IEC 11: SHUNTCOMPENSATOR

There is a challenge to model the variable shunt reactor regulated through a tap changer, e.g. 400 kV, 120–200 MVar, regulated in 25 steps, Non-linear MVAR-change per step. CIM does not allow a 1:1 model of this component. This problem exists in both EMS and planning model environments. It is also difficult to model regulating control correctly when splitting the shunt into several units.

- **ENTSO-E IOP proposal:** It is recommended that WG13 implement a lookup table with impedance per step. WG13 to consult with ENTSO-E on the right model to be implemented in CIM.
- **WG 13 resolution:**
  - The UML for CIM16v17 was updated based on the agreement of WG13. This approach should now resolve the ENTSO-E issue on the shunt compensator.

### 9.1.12 ISSUE IEC 12: ROUNDING ISSUE – DIFFERENCE FILES

During the IOP an issue related to rounding of numbers was identified. There is no way to specify that 0.000123967 is the same value as 0.0001239669509. With 61970-552, the values need to match exactly in order to allow modification of a value, deletion of an instance or execution of a difference file (reverses are actually pre-conditions).

- **ENTSO-E IOP proposal:** It is recommended that some degree of flexibility be specified in 61970-552 in order to make it possible to apply the standard in a correct way and avoid confusion.
- **WG13 resolution** (8 Aug 2012, issues call):
  - There are two aspects to this issue: 1) comparing floating point values between the sending and receiving systems, and 2) comparing floating point attributes that are pre-conditions in a difference file when applying an incremental change.
  - Both aspects require use of a threshold or deadband.
  - The first aspect only applies to IOP testing, so any deadband should be specified in test procedures rather than in IEC standards.
  - The second aspect applies to any software that uses the pre-conditions from a difference model. Any implementation of a comparison of floating point values has to include a threshold, with that threshold depending on aspects of the implementation, so this really is an implementation issue, not a standards issue.
  - Agreed to add text to the pre-conditions section of 61970-552 explaining that use of a deadband for comparison of floating point values is implementation-specific.
  - WG13 agreed to update 552 according to country comments.

### 9.1.13 ISSUE IEC 13: USE OF BAY CLASS

Some IOP test models used Bay class in a way it has never been used before. This caused some confusion in the IOP and was also considered a gap in the CIM Standards.

- **ENTSO-E IOP proposal:** It is recommended that the use of Bay class in the SCADA/EMS type of models be clarified before the release of CIM16-related standards.
- **WG13 resolution** (8 Aug 2012, issues call): Agreed that use of the Bay class in 61970-452 needs to be kept. Propose ENTSO-E test cases to include use of Bay because this needs to be handled by the vendors.

### 9.1.14 ISSUE IEC 14: CONNECTIVITYNODE IN LINE

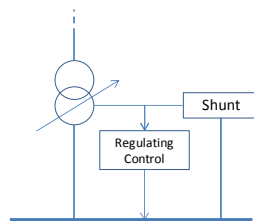
According to the ENTSO-E profile, validation tools require a ConnectivityNode to be in a VoltageLevel, but Lines are not allowed to have VoltageLevels. The current validation logic is the following: If the model is a TSO EQ, the ConnectivityNodes should be grouped under VoltageLevel; if the model is a Boundary EQ, the ConnectivityNodes should be grouped under Line; and if the model is a merged one, the ConnectivityNodes can be grouped under either VoltageLevel or Line.

- **ENTSO-E IOP proposal:** WG13 to clarify the containership and see if the validation rules are applied correctly. Necessary explanations in 61970-452 should be given.
- **WG13 resolution** (15 Aug 2012, issues call):
  - Agreed that the validation (as stated in the ENTSO-E issue) is correct. In other words, “if the model is a TSO EQ, the ConnectivityNodes should be grouped under VoltageLevel; if the model is a Boundary EQ, the ConnectivityNodes should be

- grouped under Line; and if the model is a merged one, the ConnectivityNodes can be grouped under either VoltageLevel or Line.”
- With this approach the Line is also in the Boundary set. Instances of ACLineSegment can be in the Boundary set instance of Line or in another instance of Line. Consequently, there can be instances of Line that contain only ConnectivityNodes, but no ACLineSegments.
- 452 needs to be updated to allow ConnectivityNode in Line.
- Need to add examples of Boundary sets in 452. Examples should include both the cases where the boundary is within a Line and where the boundary is within a Substation.

### 9.1.15 ISSUE IEC 15: DIFFERENT DEVICES ON THE SAME REGULATING CONTROL

During the IOP the issue on what type the regulating control (RegulatingControl or TapChangerControl) should have if devices of different types use the same regulating control was identified. A small diagram is provided below.



- **ENTSO-E IOP proposal:** WG13 to clarify the issue. Necessary explanations in 61970-452 should be given.
- **WG13 resolution** (15 Aug 2012, issues call):
  - In the case where a TapChanger and another type of RegulatingCondEquip are regulating the same Terminal, both can be associated with the same instance of TapChangerControl.
  - It is still allowed to have separate instances of RegulatingControl for each piece of equipment also regulating a particular Terminal.
  - This needs to be included in the next update of 301.
  - The description of the RegulatingControl has been updated.

### 9.1.16 ISSUE IEC 16: GENERATINGUNIT, FUEL TYPES ISSUE

In the preparation phase of the IOP, WG13 and ENTSO-E discussed various possibilities to extend the model in order to cover different generating units and fuel types. Some of the items were finalised, but others, like solar, marine and the connection of a wind model (dynamics and wires packages), are still open.

- **ENTSO-E IOP proposal:** WG13 to finalise the discussion before the release of CIM16.
- **WG13 resolution:**
  - SolarGeneratingUnit added. Agreed to keep WindGeneratingUnit as a way to represent a single turbine or an aggregation. The description of WindGeneratingUnit was changed accordingly. New class EnergySchedulingType under InfEnergySource with association to EnergySource was added. This class can be used by ENTSO-E to model photovoltaic and marine sources until a normative approach is complete.



- The solution of this is not final, but may work temporarily. A final solution was postponed for CIM17.

### 9.1.17 ISSUE IEC 17: ISSUES FROM IOP2011

These issues were moved to the section "Pending changes to IEC standards". The issues were discussed by IEC WG13 and agreed. Necessary changes were done in the UML for CIM 16.

### 9.1.18 ISSUE IEC 18: ISSUES AGREED BEFORE IOP

The following issues were discussed by IEC WG13 and agreed to be implemented in the next draft of the UML 16v11. The issues are listed here as follow-up action is necessary to release UML16v11.

- The association between OperationalLimit and Terminal should be deleted, as the association between OperationalLimitSet and ACDCTerminal was added. The same role names are used.
- The inheritance of IdentifiedObject on Terminal should be deleted, as TerminalACDC was added.
- Need to give a name for the other side of the associations between DCBiPole and DCPole.
- There are typos of the description on RegulatingControl.mode and in the description of RegulatingControl.targetValue.
- **WG13 resolution:** UML16v11 was released, with the above-mentioned changes being implemented in this version.

### 9.1.19 ISSUE IEC 19: POTENTIAL CHANGES ON ROTATINGMACHINE

Depending on the final agreement on ENTSO-E issue 3 "MISSING ATTRIBUTES NEEDED FOR DYNAMICS PROFILE", listed attributes could be moved to the Dynamics package under class RotatingMachineDynamics. Otherwise, changes in the IEC 61970-452 may be necessary.

- **WG13 resolution:**
  - Agreed to add class RotatingMachineDynamics as a subtype of DynamicsFunctionBlock and move the dynamics attributes from RotatingMachine to RotatingMachineDynamics. SynchronousMachineDynamics and AsynchronousMachineDynamics will both inherit from RotatingMachineDynamics.
  - Attributes of RotatingMachineDynamics:
    - .inertia
    - .damping
    - .saturationFactor
    - .saturationFactor120
    - .statorLeakageReactance
    - .statorResistance
  - Attributes of RotatingMachine:
    - .ratedS
    - .ratedPowerFactor
    - .ratedU
  - Changes done in CIM16v18

## 9.2 ADDITIONAL ISSUES AND/OR PRIORITIES FOR DISCUSSION

This is a summary of some additional issues addressed to WG13 and based on ENTSO-E priorities.

## 9.2.1 ENTSO-E BOUNDARY AND BASEVOLTAGE

- ENTSO-E addressed an issue that has been circulated via email about how to handle boundary ACLineSegments at two different BaseVoltages connecting at the same node.
- Email discussions had explained that there is no real problem for power flow to have ACLineSegments connecting two different BaseVoltages, but that a check for voltage level differences of no more than say 10% is a reasonable way to handle this.
- The 10% mentioned is not something that is mentioned in any WG13 document or the CIM UML.
- The use of a percentage for checking the differences is really an implementation or business agreement issue. This is similar to having agreed a minimum value for impedances in a data exchange.
- Discussed adding text to 61970-301 and 452 to explain that ACLineSegments with different BaseVoltages are an expected and allowed situation.
- Agreed to add text to 301, explaining that the situation is expected and allowed.
  - “The BaseVoltage at the two ends of ACLineSegments in a Line shall have the same BaseVoltage.nominalVoltage. However, boundary lines may have slightly different BaseVoltage.nominalVoltages, and variation is allowed. Larger voltage difference in general requires use of an equivalent branch.”
- Agreed to add text to 452, explaining that agreements on validation rules will be needed between the parties involved in a data exchange.
- WG13 – 5 June: there are changes on the ACLineSegment that fix this issue. The profile will define what the allowed difference is.

## 9.2.2 EXCHANGE OF OPERATIONAL STATE PROFILE

Exchange of operational state profile. The issue was discussed in the preparatory phase of the IOP 2012, but agreement has not been reached ahead of the IOP in order to perform testing. The approach on exchanges of operational state profiles is very important for TSOs' use cases, especially for such frequent exchanges as the Day-Ahead Congestion Forecast process. The way in which operational states are exchanged should utilise current partitioning of the data in order to exchange the data in an efficient way. IOP participants expressed their concern that adding more profiles would lead to more confusion and will be difficult to interoperate. The preference to have an extension (related to target values and controls) in the State Variables profile was given. On the other hand, putting a lot of attributes in one profile leads to a lot of optional attributes, which may also complicate matters. The following related issues should also be resolved:

- State Variables profile mixes input and output data for the load flow;
- There is no way to export a model which is not solved;
- Breaker status is in the Topology profile and currently there is a problem to exchange breaker status.

The issue was discussed during the WG13 meeting in October 2012. The summary of the discussion is:

- Categorisation of data depending on the source of the data. 452 includes two categories of data: 1) physical characteristics, and 2) EMS-related data for operating practices.
- Some use cases are:

- Output of State Estimator used as input to Power Flow
- Power Flow on scheduled input
- Input to Planning Power Flow
- The current issue is to define a profile for the Operating State (or Operating Hypothesis).
- There is a need to create the list of all attributes that are part of the Operating State before deciding how to model these inputs. The current list is:
  - Terminal.connected
  - RegulatingControl.targetValue
  - RegulatingControl.targetRange
  - RegulatingControl.mode
  - OperatingLimit.value
  - Generation active and reactive power
  - Load active and reactive power
  - TapChanger tap
  - ShuntCompensator sections (nonlinear as well)
  - Switch status
  - Relevant DC attributes?
- Options are:
  - Add attributes to existing classes
  - Create new classes (similar to State Variable) specifically for input
  - Add attributes for input to existing State Variable classes, plus add a few new classes.
- Is there a need for an incremental change to be exchanged on the Operating State? The answer to this question is *Yes*.

This issue was covered by the agreement to add the Steady State Hypothesis profile to the CGMES and to 61970-456.

### 9.2.3 SEPARATION OF THE EQ PROFILE

In the ENTSO-E profile, stereotypes are used to differentiate attributes which are only used for “Operation” or “ShortCircuit”. This approach appears to be useful but relies on assumptions that, e.g. the cardinalities are valid for a particular exchange. One of the solutions of this problem is to separate the EQ profile on the basis of existing information on the stereotypes which was agreed and tested. This option should not impact on a vendor’s implementation.

In case this direction is taken in the exchange, the current EQ profile will be separated as follows:

- EQ: which includes all classes/attributes which are not marked with any stereotype. This is then exchanged as an instance file used for exchanges that do not require the exchange of attributes which are pure Operation and/or ShortCircuit.
- EQ-Operation: which includes only classes/attributes that are currently marked as “Operation”. Therefore, two instance files — “EQ” and “EQ-Operation” — should be included in the exchange in case a detailed SCADA/EMS exchange switch model is to be exchanged.
- EQ-ShortCircuit: which includes only classes/attributes that are currently marked as “ShortCircuit”. Therefore, three instance files — “EQ”, “EQ-Operation” and “EQ-ShortCircuit” — should be included in the exchange in case a detailed SCADA/EMS exchange switch model that includes short-circuit information is to be exchanged. Two instance files — “EQ” and “EQ-ShortCircuit” — should be included in the exchange in case a bus-branch short-circuit model is exchanged.

Another option was discussed on the IOP call on 28 Jan 2013: This issue could also be resolved by keeping all information in one instance file, but the header information was agreed upon so that the instance file could be validated according to the use.

The current way is that the stereotypes define Short circuit/Operation, with the cardinality of the attributes only being valid if the exchange includes short circuit or operation.

IOP participants agreed that the best approach to handle this issue is to have three RDFS generated from the complete EQ profile. Necessary explanations were added to the CGMES profile.

#### 9.2.4 HVDC

This issue was discussed in the WG13 meeting in October 2012, with actions being taken. The current agreement could be summarised as follows:

- The CSC HVDC model should be finalised and tested in an ENTSO-E IOP. The initial agreement was that the VSC portion of HVDC can wait until CIM 17.
- Current Source HVDC modelling should be completed by the Feb. 2013 meeting of WG13.

The CGMES used for the ENTSO-E IOP in July 2013 covers both VSC and CSC HVDC.

#### 9.2.5 DYNAMICS

The dynamics package was updated for the IOP 2013. Therefore, if the CGMES is approved the preparation for the testing of individual models from the standard library could be triggered.

#### 9.2.6 EXCHANGE OF PROJECT INFORMATION TOGETHER WITH THE MODELS

The exchange of project information would be a valuable addition of the model exchange. There are a lot of processes that would benefit this one. The ENTSO-E Ten-Year Network Development Plan (TYNDP) is one of them. CIM would support such functionality by applying difference file exchange, which may need to be restricted in order not to complicate the exchange. Project information exchange should be valid for full files as well. Further discussion between ENTSO-E and WG13 is necessary to agree on the scope and use cases.

It should be assessed whether a basic approach (which should be extendable) could be defined and tested in the IOP 2013.

An approach was developed and discussed in the IOP 2013, but could not be tested. It was agreed that it will be finalised at the beginning of 2014.

#### 9.2.7 ENTSO-E SHOULD REVISE THE NAMING CONVENTION

There are some restrictions on IdentifiedObject.name/description for classes like TopologicalNode, VoltageLevel, etc. IOP participants pointed out that vendors should be able to support whatever is agreed by the users and that these restrictions do not make much sense when taking into account how data is treated nowadays. Therefore, this issue requires further ENTSO-E discussion in order to reach an agreement between TSOs. The change could be applied at the moment the 2nd profile is approved.

It should be assessed whether the agreement could be reached before the IOP and tested.

The ENTSO-E naming convention was updated in the CGMES. Two consultations were arranged: for vendors and for TSOs.

### 9.3 PENDING CHANGES TO IEC STANDARDS

This section summarises necessary and agreed WG13 changes in the IEC standards. These changes should be implemented when the drafts of the different standards are ready.

#### 9.3.1 IEC 61970-301

- Related to Issue IEC 2: Need to make sure that the explanation of which new attributes replace r and x is included in the updates section of part 301 for CIM 16.
- In part 301, a new section will be added explaining the use of grounding switches and PetersenCoils.
- PhaseTapChangerNonLinear.xMedian was replaced with xMin. It should be reflected in the text on 61970-301.
- Update related to the resolution of issue IEC-15 (from this report).
- Agreed to add FaultIndication as a measurementType for Discrete to the table in 61970-301.

#### 9.3.2 IEC 61970-452

- It was agreed that Terminal.phases is added to 61970-452 optionally. If it is not specified, the Terminal will be understood to be three phases (ABC or ABCN), except for terminals of grounding classes (specialisations of EarthFaultCompensator, GroundDisconnector, and Ground) which will be assumed to be N.
- Agreed to add the grounding classes (PetersenCoil, GroundImpedance, GroundDisconnector and Ground) to 452.
- Add SolarGeneratingUnit to 452.
- Switch.retained was agreed to be required in 61970-452. The change should be applied. It was suggested to add SvSwitch to represent input or output status values. Further discussion is needed.
- The association TransformerEnd.BaseVoltage should be added in IEC 61970-452. The change should be applied.
- TapChanger: It was agreed to make highStep, lowStep, neutralStep, and normalStep required in the 61970-452.
- It was agreed that the association ControlArea.EnergyArea should be optional in the 61970-452.
- The association EquivalentEquipment to EquivalentNetwork should be optional in IEC 61970-452.
- It was agreed to add BusNameMarker to 61970-452. The change should be applied.
- ENTSO-E extensions (mainly on short circuit) that were accepted by WG13 and added to the UML for CIM 16 should be added to relevant standards as well. The ENTSO-E profile could be used as a reference.
- Update according to resolution of issue IEC-14 (from this report).
- Add mRID for all classes in the next edition of 452 and will add text explaining that the mRID will be exchanged as rdf:ID.
- The new model for a shunt compensator should be included in 61970-452 — see also issue IEC-11.
- Remove Name and NameType from 61970-452.

- Add HydroPump to 452 and state that it shall be part of Substation.
- Update the profile and have direction HydroPump -> RotatingMachine.
- 452 needs to be updated to allow ConnectivityNode in Line – see issue IEC 14.
- Issue IEC 15 – different devices on the same regulating control.
- Measurement.unitSymbol – Hz will be added.

### 9.3.3 IEC 61970-453

- It was agreed that the documentation of the DiagramObject.rotation specify that zero degrees is pointing to the top of the diagram and rotation is always clockwise. The change was applied in UML. IEC 61970-453 should be reflected.

### 9.3.4 IEC 61970-456

- SvShortCircuit class was removed from UML. It should be removed from 61970-456 as well.

### 9.3.5 IEC 61970-552

- Update 552 with the resolution of issue IEC-12 (from this report).
- Update 552 to explain how to point to the many ends of an association from the one end.
- Make the changes agreed in the country comments. A statement will also be added that mRID will be added to 61970-452 and all 45x profiles, but it will continue to be exchanged as rdf:ID.

### 9.3.6 IEC 62361-101

- Text will be added to 62361-101 to specify the use of UUID for mRID. 101 will define a textual form of UUID that will be referenced by other documents.

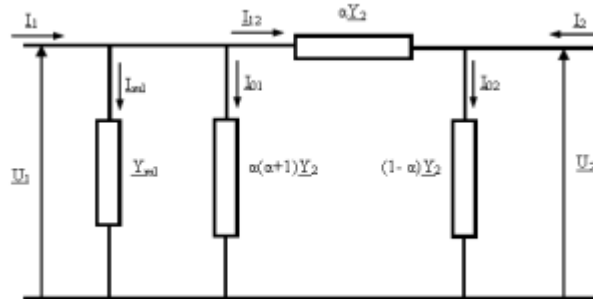
## 9.4 PROFILE 1 (BASED ON UML14v02) ISSUES

In 2011, ENTSO-E issued an annex to Profile 1. In 2012, additional issues were identified and discussed among TSOs and vendors. During the IOP an agreement on the following items was reached, with the annex to Profile 1 being extended and published on the ENTSO-E website:

- Slack bus is a given node of GeneratingUnit with NormalPF which is mandatory (at least one GeneratingUnit.NormalPF equals 1). Additional information is provided optionally by TopologicalIsland.AngleRef\_TopologicalNode. More than one slack node (i.e. distributed slack nodes) is allowed.
- Terminal.SequenceNumber is mandatory for any ConductingEquipment that has more than one Terminal (e.g. ACLineSegment, Switch, TransformerWinding, etc.).
- TapChanger.NeutralU: For a precise definition the 'RatedU at neutral settings' should be a value (e.g. 400kV). The source is the test report.
- TapChanger.lowStep and TapChanger.highStep can be negative and tools issued to handle this issue. TapChanger.highStep should be bigger than TapChanger.lowStep. TapChanger.highStep cannot be equal to TapChanger.lowStep.
- For the symmetrical phase shifting transformers having constant impedance or voltage, the phase shift cannot be given by using VoltageStepIncrementOutOfPhase and should thus be set

to 0. The PhaseTapChanger.stepPhaseShiftIncrement should be used and given in AngleDegrees.

- $\square(\square+1)Y2$  in the following diagram should be  $\square(\square-1)Y2$ .



- TopologicalNode.ControlArea is optional.

## 9.5 PROFILE 2 (BASED ON UML16V10) ISSUES

Some profile-related issues were identified during the IOP. These issues were applied to the 2nd edition of the ENTSO-E CIM Profile (IOP version issued on 3 July 2012). The issues listed in this section have been resolved during the IOP. The decisions were taken among all IOP participants. In the updated version of the 2nd edition of the ENTSO-E CIM Profile [2], issued on 26 August 2012, all issues described in this section **are corrected**.

### 9.5.1 ISSUE ENTSO-E 1: VSCCAPABILITYCURVE CLASS INHERITED

#### ATTRIBUTES

The following attributes of the VSCCapabilityCurve class (y3Unit, y2Multiplier, y1Multiplier, y3Multiplier, xMultiplier) should be removed from VSCCapabilityCurve and inherit from the Curve class. This profile issue is related to issue IEC 1, but the changes in the profile are already made.

- **Applied change to the profile:** The attributes y3Unit, y2Multiplier, y1Multiplier, y3Multiplier, and xMultiplier were removed from the Equipment profile. These attributes were added to the Curve class as optional attributes.

### 9.5.2 ISSUE ENTSO-E 2: SYNCHRONOUSMACHINE R AND X

- **Applied change to the profile:** SynchronousMachine.r and SynchronousMachine.x were removed from the Equipment profile. The issue is related to issue IEC 2.

### 9.5.3 ISSUE ENTSO-E 3: MISSING ATTRIBUTES NEEDED FOR DYNAMICS

#### PROFILE

The RotatingMachine class does not have the following attributes: damping, inertia, saturationFactor, saturationFactor120, statorLeakageReactance, and statorResistance

- **Applied change to the profile:** The above attributes were added as required attributes and with stereotype "Dynamics" to the RotatingMachine class in the Equipment profile.
- Further changes may be applied if it is decided that a RotatingMachineDynamics class will be created in the Dynamics package.

#### 9.5.4 ISSUE ENTSO-E 4: SHORTCIRCUIT CLASSES AND ATTRIBUTES

Classes and attributes related to short-circuit data exchange were clarified during the IOP. Applied changes to the equipment profile are as follows:

- The stereotype of the ExternalNetworkInjection class is removed as this class can be used in a regular load flow exchange.
- The following attributes of ExternalNetworkInjection do not have stereotype ShortCircuit: governorSCD, maxP, maxQ, minP, minQ, and referencePriority.
- The cardinality of the following attributes of ExternalNetworkInjection was changed to required as these attributes are required only for load flow exchange: governorSCD, maxP, maxQ, minP, minQ, and referencePriority.
- The following attributes of ExternalNetworkInjection have stereotype ShortCircuit, with the cardinality being changed to required: minZ0ToZ1Ratio, minR1ToX1Ratio, minR0ToX0Ratio, maxZ0ToZ1Ratio, maxR1ToX1Ratio, maxR0ToX0Ratio, maxInitialSymShCCurrent, and minInitialSymShCCurrent.
- The cardinality of the following attributes of ACLineSegment was changed to required: b0ch, g0ch, shortCircuitEndTemperature, r0, and x0.
- The cardinality of the following attributes of AsynchronousMachine was changed to required: converterFedDrive, efficiency, iaIrRatio, polePairNumber, ratedMechanicalPower, and reversible.
- The cardinality of the following attributes of EquivalentBranch was changed to required: negativeR12, negativeR21, zeroR21, zeroR12, positiveR12, positiveR21, positiveX12, negativeX21, negativeX12, zeroX12, zeroX21, and positiveX21.
- The cardinality of the following attributes of EquivalentInjection was changed to required: r, r0, r2, x, x0, and x2.
- The cardinality of PowerTransformer.isPartOfGeneratorUnit was changed to required.
- The cardinality of the following attributes of PowerTransformerEnd was changed to required: b0, g0, r0, x0, and phaseAngleClock.
- The cardinality of the following attributes of SeriesCompensator was changed to required: r0 and x0.
- The cardinality of the following attributes of ShuntCompensator was changed to required: b0PerSection and g0PerSection.
- The cardinality of the following attributes of SynchronousMachine was changed to required: earthing, equivalentResistance, r0, r2, x0, x2, and satDirectSubtransX.
- The following note was added to SynchronousMachine: "If SynchronousMachine.earthing is true, then SynchronousMachine.earthingStarPointR and SynchronousMachine.earthingStarPointX are required."
- The cardinality of the TransformerEnd.grounded was changed to required.
- The following note was added to TransformerEnd: "If TransformerEnd.grounded is true, then TransformerEnd.rground and TransformerEnd.xground are required."
- The profile document specifies that "in case classes/attributes have stereotype 'ShortCircuit', then their cardinality shall be valid for ShortCircuit data exchange".



### 9.5.5 ISSUE ENTSO-E 5: DIAGRAM LAYOUT: VISIBILITYLAYER

- **Applied change to the profile:** The class VisibilityLayer inherits from IdentifiedObject, i.e. uses the name attribute from IdentifiedObject.

### 9.5.6 ISSUE ENTSO-E 6: DIAGRAM LAYOUT: DIAGRAMOBJECTSTYLE

- **Applied change to the profile:** The class DiagramObjectStyle inherits from IdentifiedObject, i.e. uses the name attribute from IdentifiedObject.