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European Network of Transmission System Operators for Electricity

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NETWORK CODE PROFILES FOR REGIONAL COORDINATION PROCESSES RELEASE 2.3

STANDARD-VETTING INTEROPERABILITY TEST REPORT

ICTC approved | 16 October 2024

From: Common Information Model (CIM) Working Group

ENTSO-E Mission Statement

Who we are

ENTSO-E, the European Network of Transmission System Operators for Electricity, is the association for the cooperation of the European transmission system operators (TSOs). The 40 member TSOs, representing 36 countries, are responsible for the secure and coordinated operation of Europe's electricity system, the largest interconnected electrical grid in the world. In addition to its core, historical role in technical cooperation, ENTSO-E is also the common voice of TSOs.

ENTSO-E brings together the unique expertise of TSOs for the benefit of European citizens by keeping the lights on, enabling the energy transition, and promoting the completion and optimal functioning of the internal electricity market, including via the fulfilment of the mandates given to ENTSO-E based on EU legislation.

Our mission

ENTSO-E and its members, as the European TSO community, fulfil a common mission: Ensuring the security of the inter-connected power system in all time frames at pan-European level and the optimal functioning and development of the European interconnected electricity markets, while enabling the integration of electricity generated from renewable energy sources and of emerging technologies.

Our vision

ENTSO-E plays a central role in enabling Europe to become the first climate-neutral continent by 2050 by creating a system that is secure, sustainable and affordable, and that integrates the expected amount of renewable energy, thereby offering an essential contribution to the European Green Deal. This endeavour requires sector integration and close cooperation among all actors.

Europe is moving towards a sustainable, digitalised, integrated and electrified energy system with a combination of centralised and distributed resources. ENTSO-E acts to ensure that this energy system keeps consumers at its centre and is operated and developed with climate objectives and social welfare in mind.

ENTSO-E is committed to use its unique expertise and system-wide view – supported by a responsibility to maintain the system's security – to deliver a comprehensive roadmap of how a climate-neutral Europe looks.

Our values

ENTSO-E acts in solidarity as a community of TSOs united by a shared responsibility.

As the professional association of independent and neutral regulated entities acting under a clear legal mandate, ENTSO-E serves the interests of society by optimising social welfare in its dimensions of safety, economy, environment, and performance.

ENTSO-E is committed to working with the highest technical rigour as well as developing sustainable and innovative responses to prepare for the future and overcoming the challenges of keeping the power system secure in a climate-neutral Europe. In all its activities, ENTSO-E acts with transparency and in a trustworthy dialogue with legislative and regulatory decision makers and stakeholders.

Our contributions

ENTSO-E supports the cooperation among its members at European and regional levels. Over the past decades, TSOs have undertaken initiatives to increase their cooperation in network planning, operation and market integration, thereby successfully contributing to meeting EU climate and energy targets.

To carry out its legally mandated tasks, ENTSO-E's key responsibilities include the following:

› Development and implementation of standards, network codes, platforms and tools to ensure secure system and market operation as well as integration of renewable energy;

› Assessment of the adequacy of the system in different timeframes;

› Coordination of the planning and development of infrastructures at the European level (Ten-Year Network Development Plans, TYNDPs);

› Coordination of research, development and innovation activities of TSOs;

› Development of platforms to enable the transparent sharing of data with market participants.

ENTSO-E supports its members in the implementation and monitoring of the agreed common rules.

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Acknowledgement to contributors

ENTSO-E would like to thank the many people who worked hard to make the Standard Vetting Interoperability Test 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:

- *Eduardo Relaño Algaba (ENTSO-E) for the IOP organisation and preparation of the IOP report.*
- *Chavdar Ivanov (ENTSO-E, gridDigIt) for directing the IOP, for the preparation of the IOP report, and developing some of the test data.*
- *Attila Barta and Nenad Mijatović (IPS Intelligent Process Solutions GmbH) for demonstrating CGMES v3 and Network Code v2.3 support by IPS-NMM.*
- *Bodgan Lutovac and Boris Brdjanin (EKC Ltd.) for demonstrating CGMES v3 and Network Code v2.3 support by name of tool?*
- *Sindre Hunn (Siemens) for demonstrating CGMES v3 and Network Code v2.3 support by PSS®ODMS.*
- *Enric Micolau and Konstantinos Kouzelis (PSI Neplan) for demonstrating CGMES v3 support by Neplan.*
- *Lino Prka, Stephan Lupp and Harish Krishnappa (DNV) for validating the data with CIMbion.*
- *Max Jonax Werner (Associmates GmbH) for validating the data with ValiMate.*
- *Emil Hegyi and Florian Scheit (DIgSILENT GmbH) for demonstrating CGMES v3 and Network Code v2.3 support by PowerFactory.*
- *Pavel Kočica, Roman Vykuka and Lukáš Radek (Unicorn Systems a.s.) for demonstrating CGMES v2 and Network Code v2.2 support by CorNet project tool .*
- *René Kuchenbuch (int:net) for supporting the IOP from the EU-founded research project int:net.*
- *Jakub Szczegłow (PSE S.A.), Svein Olsen (Statnett), Lars Truelsen (Energinet), Stephan Stroobants (Elia Group), Michaela Gec Dumbović (Swissgrid) and Christophe Ocker (50Hertz) and Miguel Escribano Rodenas (Redeia) for supporting the CGMES and Network Code profiles development internally within TSOs.*
- *Santiago Peñate Vera (Redia, Gridcal) for demonstrating CGMES v3 support using the open-source tool Gridcal.*
- *Martynas Karobcikas (Baltic RCC OÜ) for demonstrating CGMES v3 and the Network Code v2.3 support by the RCC Baltic tool.*
- *Hernani Justo da Silva Junior (TSCNET) for demonstrating the Network Code v2.2 support by the CorNet project tool.*

- *Todd Allen Viegut (AspenTech) for demonstrating CGMES v3 and Network Code v2.3 support by CIMStudio*
- *Mate Zsebehazi (gridDigIt) for contributing to the preparation and validation of test models.*

The following companies, organisations, research institutions participated in the test:


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1. Introduction

The implementation of the Coordinated Security Analysis (CSA) business process is an ongoing effort in 2024. ENTSO-E covers the data exchange necessary for this process offering a set of profiles called Network Codes profiles (NC Profiles). These profiles were built by using the same baseline of Common Information Model (CIM) used for the development of the CGMES v3.0 (Common Grid Model Exchange Standard) IEC 61970-600-1:2021 and IEC 61970-600-2:2021. The CSA process defined considerable number of requirements that cannot be covered by the existing CIM. Therefore ENTSO-E defined a set of CIM extensions to the information model which are then used in the NC profiles.

The ICT Committee and the System Operation Committee approved the last version—at the moment of writing is v2.3—of extensions and NC profiles in May 2024. Earlier this year ENTSO-E decided to launch the yearly Standard Vetting Interoperability Tests (SV-IOP). This report summarises the outcome of the SV-IOP help in July 2024 and organised by ENTSO-E.

In that regard, the document highlights the conclusions and recommendations deriving from the discussions between the ENTSO-E CIM experts, TSOs, RCCs and software vendor members.

ENTSO-E worked on solving the issues detected during the test and as a result, has prepared the release 2.3.1 of the Network Code profiles alongside an update of the impacted documentation.

ENTSO-E will be working on gathering new inputs and use cases among TSOs to prepare the next releases of the NC profiles.

In the same line, ENTSO-E would like to thank all the parties involved for their contribution in the to the current report and hopes to continue cooperating to deliver a high quality, robust data exchange standards accelerating the power energy system digitalisation.

We hope to see you in again the 2025 SV-IOP.

2. Business driver and rationale

2.1. The ROSC project

ROSC (Regional Operational Security Coordination) is a congestion management process designed individually for each Capacity Calculation Region (CCR) in Europe, aimed at optimising Remedial Action (RA) based on a Security Analysis . The process is defined by the methodology based on SO-GL Article 76 developed per CCR. Overall guidelines for the design of the regional methodologies are given by the CSAm (Methodology for coordinating operational security analysis) based on SO GL Art. 75. One core component of ROSC is the CROSA (Coordinated Regional Operational Security Analysis). CROSA begins with data provision and identifying congestions on Cross-Border Relevant Network Elements (XNEs) inside the CCR in N and N-x state. Once congestions are identified, costly and non-costly Remedial Actions (RAs) to solve the congestions are determined with the help of an optimization. Following, these recommended RAs are coordinated between the TSOs of the CCR. .

Although CGM (Common Grid Model) provides the basis for power flow calculations and security analyses, the CROSA considers with the selection of XNEs of a specific CCR only a subset of all network elements represented in the common model. Specifically for the Core CCR, initially, topological RAs are selected manually, but these will eventually be optimised automatically in the target solution. NC profiles, which define SPS (Special Protection Schemes) and SIPS (System Integrity Protection Schemes), can also be used as RAs.

For software vendors, there is potential to develop platforms that support this optimisation process. Some TSOs are interested in vendor support for contingency analysis. As more generation is allocated at the distribution level, tools to support this process will become increasingly important.

From the TSO perspective, they are nowadays focussed on understanding the data exchange standard and applying it correctly within their IT system. That is, the focus is primarily on creating mock-up data to test their IT system and provide feedback on the profiles.

2.2. Why to organise a SV-IOP?

Organising a standard vetting Interoperability Test (SV-IOP) is crucial as it serves as a key milestone for testing the feasibility and robustness of a standard or a specification. The SV-IOP allows various stakeholders such as TSOs, RCCs, ENTSO-E, vendors, and other industry participants to collaboratively validate the standard and specifications in real-world scenarios using prototype implementations. By simulating specific scenarios as well as by providing a discussion platform, the SV-IOP can uncover potential issues, ensuring that the standard or the specification that is tested is technically sound and applicable for implementation across different systems and platforms.

Furthermore, the SV-IOP facilitates the identification of interoperability challenges early in the implementation process, reducing the risk of costly adjustments later. It also fosters communication and understanding among participants, enabling them to align on expectations and clarify ambiguities in the standard. Ultimately, this collective vetting process strengthens the standard's

reliability and enhances industry-wide adoption, paving the way for more seamless and effective operations in the future.

3. Summary of discussions

The following sections summarise some of the main tests and issue discussions that were held during the SV-IOP. Details on specific issues and their potential follow up are provided in the **Error! Reference source not found.**.

3.1. Profiles conversion tool to enable transition between specification versions

In order to realise and maintain a recurrent transition process, there is a need to support multiple versions of data exchange standards or specifications. SV-IOP participants discussed how to facilitate this.

After checking the cross compatibility of models written in CGMES version 2.4 and 3.0 and NC profiles in version 2.2 and 2.3, the SV-IOP participants stressed the limitations of backwards and forwards compatibility. Reader should refer to the test described in section 4.1.

Before continuing describing the discussion held during the SV-IOP, ENTSO-E would like to exemplify in Figure 1 what is understood as *development period* in between of ENTSO-E specification versions—a more simplified process in comparison to the one followed by international standardisation bodies like IEC.

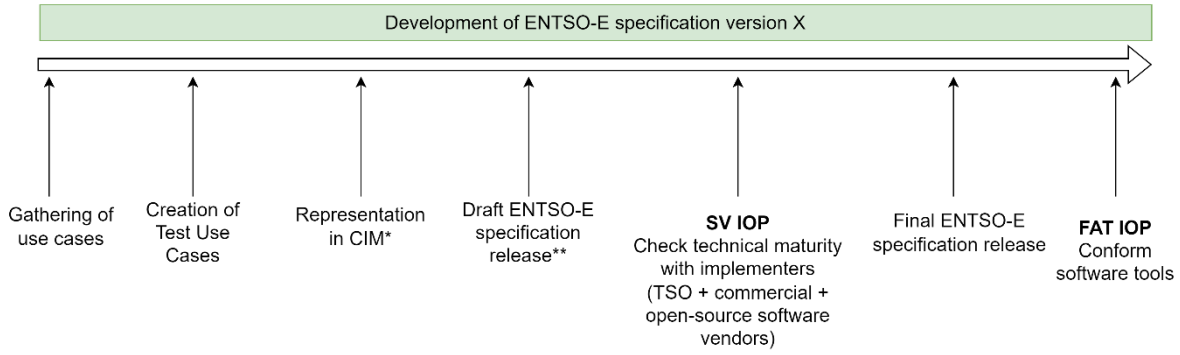


Figure 1: High-level development process of a ENTSO-E specification

In a *continuous improvement* process as the one described in Figure 2, one can easily admit that different organisations will adopt different versions of a given specification at their own pace. It is precisely in the overlapping moment between the adoption of a version and development of the subsequent, that the transition process occurs.

Readers should note ENTSO-E currently works on the development of a change and transition management strategy.

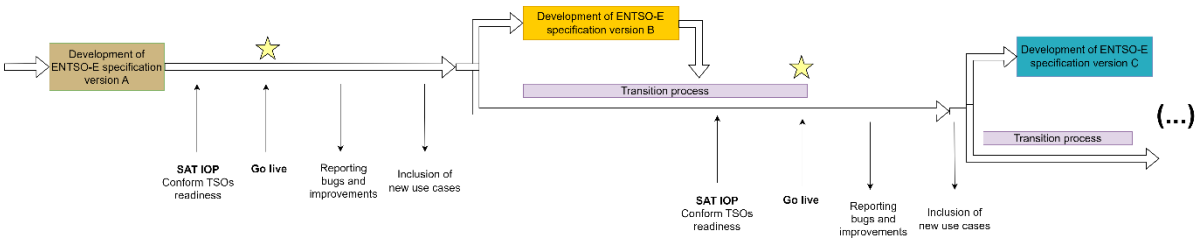


Figure 2: Continuous improvement process

At a certain point in time, SV-IOP participants agree that three different types of versions would coexist during a transition period:

- Future or next or *development* version.
- Current version.
- Previous or previous or *legacy* version.

It is important enabling the integration of different versions within the data exchange process because, as mentioned before, the population of implementers will adopt versions at a different pace. This leads to the separation of the population in three groups: late majority, early majority and innovators.

The Figure 3 exemplifies this situation under the hypothesis that one version of a specification is released per year.

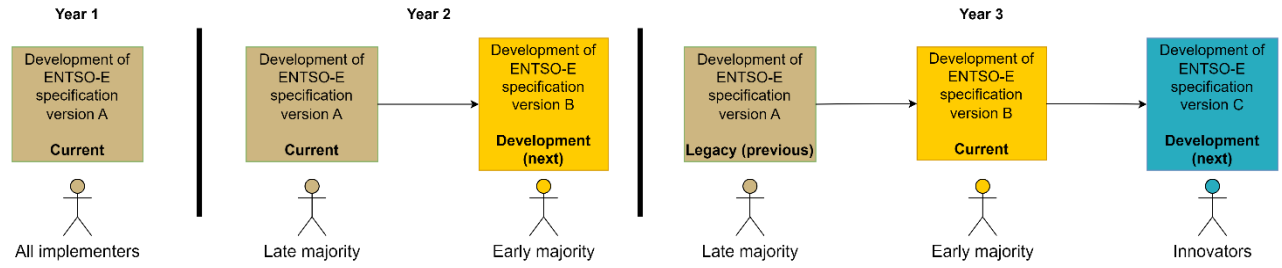


Figure 3: Population of implementers with three coexisting specification versions

Whereas TSOs need tools' multi-version support because of the implementing distribution, software vendors have difficulties to support various versions of a specification simultaneously.

This is why, SV-IOP participants agree on the benefit of creating a tool able to do the conversion between subsequent versions of the NC profiles to support TSOs and RCCs continuous improvement process.

All the functionalities of such tool and its scope should be properly described before ENTSO-E assesses to dedicate resources on it. However, a key, basic functionality of such tool would be:

1. Consuming NC profiles written in any of the three coexisting versions.

2. Allowing to downgrade from legacy to current version.

3. Allowing to downgrade from development to current version

The rest of the conversions are out of the scope for such central tool and should be enabled by local tools. Nevertheless, some conversions will imply an information loss.

The figure Figure 4 depicts such basic functionality of the conversion tool.

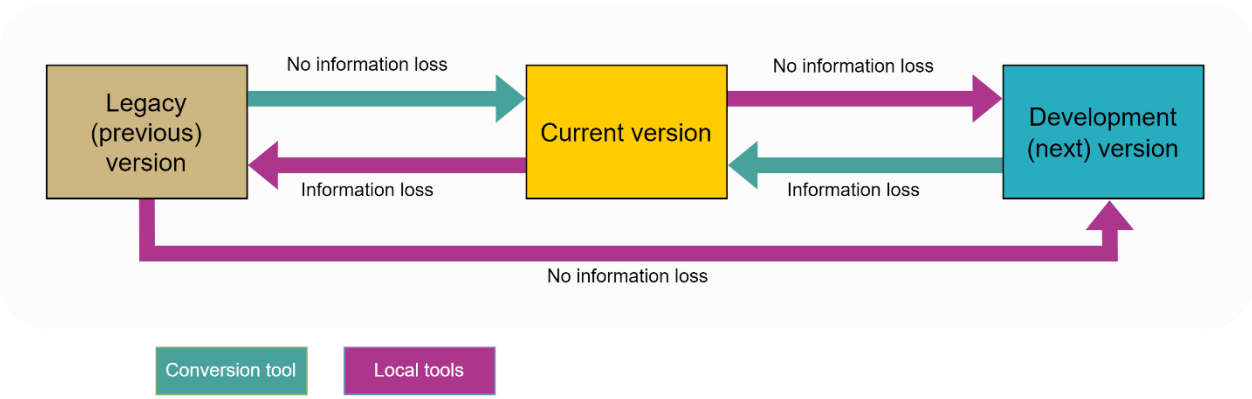


Figure 4: Conversion tool basic functionality

Continuing experts' brainstorming, there were voices outlining that such conversion tool should be a central tool, common to all TSOs. Subsequently, one could imagine the responsibilities several parties could have:

- Platform where the central tool is hosted:
    - It accepts the development, current and legacy versions of the NC profiles.
    - It allows conversion from legacy to current and from development to current version.
- TSOs
    - They provide data in one of the coexisting versions.
- Software vendors
    - They consume the version they support which is at least one of the three coexisting versions.

Software vendors defend that the creation of a central conversion tool would benefit the implementers' community for the following reasons:

– It would support understanding the latest, under development version of the standard.

– It would ensure continuity of the data exchange. However, this will be done assuming an information loss when downgrading to the legacy version.

3.2.Creation of a conformity assessment scheme

ENTSO-E gathers some feedback that software vendors made on how to check that their tools are properly adjust to TSOs expectations as described in the *Regional Coordination Processes Data Exchange Specification.*

In order to target the right testing of the applications, the conformity assessment scheme will distinguish between the types of applications that are tested.

One of the software vendors' feedback is that, for instance, an application that is designed to support analytic functions using the profiles as input will only need to conform to the analytic functions which will also test the ability to import and export the information. Therefore, such application will not be required to test separate import/export test use cases.

As a conclusion, SV-IOP participants acknowledged that the creation of a so-called *RCP* conformity assessment scheme—mirroring what was done for the CGMES standard—might be for the adoption of the Network Code profiles among the software vendor and TSO community.

3.3.Modelling of time series

Modelling of time series is important for multiple use cases such as

4. The exchange of situational data (steady state hypothesis) for multiple timestamps. Such exchange can be used for exchanging data for e.g. operational planning process for day ahead timeframe or week ahead or

5. The use case in which schedules produced by a simulation done on a market model needs to be applied to grid model. This is a task in long term planning where year-round grid model simulations could be performed.

In release 2.3 of Network Code profiles, ENTSO-E published Steady State Hypothesis Profiles. IOP participants examined the setup of the profile and provided feedback. No concrete tests were performed using this profile, but here is a consensus that such profile is necessary and the general approach was conformed.

3.4.Handling of namespaces

Vendors are having trouble understanding which namespace to use for their software. In both CGMES and NC profiles, the namespaces differ, and vendors currently tend to introduce the namespaces manually. Vendors are looking for solutions to make this process fast and automatic and to use the namespaces as they are intended.

During the development of CIM v17, IEC changed the namespace to CIM100. The practice was that CIM namespace changes with every version of CIM. Now this practice is being changed. Staring from CIM18 the CIM namespace will be stable. ENTSO-E is an early adopter of this change and aligned CIM namespace with the stable one. However as multiple versions are used e.g., CGMES v2.4, CGMES v3.0, various versions of NC profiles, multiple namespaces will need to be supported.

One proposal is to allow namespaces such as http://iec.ch/TC57/CIM100# (CIM17 namespace) and https://cim.ucaiug.io/ns (agreed stable CIM namespace) to be used interchangeably with the same meaning. The idea is that the system should understand both namespaces without distinction. However, this raises concerns about how it will affect the instance files that will ultimately be consumed. Some vendors fear that supporting both namespaces could break the current system.

A possible solution to avoid system disruptions could be to follow the approach used by the *geosparql* group. The general idea should be to leverage existing ontologies wherever possible, drawing inspiration from other standardization bodies and merging proposals.

As a result, the participants reached the following agreement:

- Develop a solution to support the three available namespaces, e.g.:
    - https://cim.ucaiug.io/ns
    - http://iec.ch/TC57/2013/CIM-schema-cim16#
    - http://iec.ch/TC57/CIM100#
- Create RDF based machine readable artifact that would describe relationship between the supported namespaces. This approach will also be used to support the understanding of the differences between classes and their properties included in different namespaces. If such approach turns out not to be feasible, the profiling effort can produce separate RDFS files to support the namespaces individually.

3.5.Use of Remedial Action Scheme

IOP participants raised questions on how exchange Remedial Action Scheme and how to validate it. Remedial action schemes are representing system integrity protection schemes which normally have triggering part, gate logic with different input pins, etc. This refers to the structural data part of the equipment exchange. In addition, there is part related to the regulation and set points.

It is realised that it is not possible to fully validate the configuration of a remedial action scheme just looking at one part of the dataset (e.g. RA dataset). The boundary information also needs to be considered together with the rest of the related information.

The following comments and guidance were provided on how to identify the dependencies. However, this is considered as action item to further explain in the relevant documentation.

- The boundary is there only to make sure that what there is on the two MAS(s) is the same information.
- Remedial action scheme logic cannot be tested until a full merge is performed.
- The related contingency cannot be validated of a single MAS as well without the contingency from the "other side" is taken into account.
- It should be possible to validate against the simple SHACL constraints – cardinalities, associations.
- If two TSOs have a shared remedial action, such remedial action shall be included in the boundary set (common data).
- If two TSOs are sharing logic, again, this shall be included in the boundary set (common data).
- Why to duplicate terminal that are already in the boundary set?
    - The validation of the IGM should be possible to be done without the boundary.
    - However, the CGM validation should be done with the boundary.

3.6.Suitable test model

It is essential to have a suitable test model where the community can apply the use cases and functionalities described not only on the RCP DES 2.3 but in upcoming releases. ENTSO-E is willing to lead the development and improvement of such test model, but they would need the collaboration of software vendors.

Unicorn proposes a model that is used for optimisation within the CorNet project. The rest of software vendors were able to import it, export it and perform some basic contingency analysis, contingency recalculation, and the analysis of remedial actions.

Additionally, the model *TC2* also includes relevant data for testing remedial action optimisation.

The SV-IOP participants recommend:

- Taking the model Unicorn and ENTSO-E shared as the basis of a test model where the use cased embarked in the RCP DES 2.3 can be tested.
    a. Such model should be called *RamoGrid*—standing for Remedial Action Model Optimisation Grid—and openly available.
- Collaborating to improve the quality of the RamoGrid model so it serves as reference for the whole community.
- In general, all models that will be part of the conformity assessment scheme are provided under open licence and are available to the community.

3.7.Models' quality and SHACL rules

Data quality at the source is a common process for many IT services. In the case of data exchange within TSOs, software vendors claim spending a considerable amount of time improving TSOs'

modelling errors. However, there is no clear-cut solution for this problem and any lack of quality in the source grid models is bound to produce errors down the stream.

When carefully looking at the problem one of the factors behind such problem would be the lack of a quality process allowing TSOs to improve their grid model data.

More concretely, SV-IOP participants point at some key problems:

- Topology and connectivity check. Many of the processed models fail this basic, simple test and it is undoubtedly a point TSOs should be careful when modelling.
- Merging data based on other data exchange formats such UCTE-DEF. Software vendors warn about the importance of keeping consistent data models that does not mix data exchanges formats.
- Workarounds out of the standard. The use or alternative, inventive solutions might collide when merging models from multiple users.
- Misinterpretation of standards. Users not fully understanding how the different profiles work will have difficulties implementing the same solution as other users.

Consequently, the SV-IOP participants emit the following recommendations:

- To report issues to cim@entsoe.eu. This is the only way ENTSO-E can take users' use cases and implement them in the next version of a certain specification or standard. Thus, many workarounds can be included in the standards.
- Blocking the export functionality until the exported data reaches a certain quality. Software vendors follow this best practice and avoid that users propagate errors down the processing stream.
- Asking your modelling questions. With regards to CGM Build Process, TSO modellers are highly recommended to use the ENTSO-E CGM OPDE task team modelling group and the CGM BP IOP to ask their modelling questions.
- To continue organising SV IOP events. This kind of events where the community performs tests and to verify specifications together has proven to be very useful and facilitates the knowledge sharing, standards development and their implementation.

3.8.SHACL libraries

The libraries that Associmates and DNV use do not behave identically. The W3C, the organisation behind the SHACL, tested the libraries. However, the tests are not up to date.

Currently, ENTSO-E is testing the validation tools through test use cases. However, if the community wants to test the instance data, ENTSO-E would need a lot of resources. This is the reason why the community should focus on building positive and negative test cases.

Deeper investigations were performed in the SV-IOP and it was possible to resolve one of the issues by using special SHACL syntax including the use of alternative paths. However, there are other areas where issues will be opened for some of the open libraries to verify their behaviour.

4. Summary of tests

4.1. Cross version compatibility of CGMES and Network Code profiles

Within ENTSO-E, the Network Code profiles were initially designed to fulfil the business requirements of the CSA process. This gave birth to the CSA Data Exchange Specification and the version 2.2 of the Network Code profiles.

To reflect the widening the scope to consider the CCC, STA and OPC business processes, ENTSO-E decided to change the name of the package to *Regional Coordination Processes (RCP)*. In this framework, the Network Code profiles version 2.3[1] were released.

While TSOs and RCCs implement the Network Code profiles, they do not all do it at the same pace. There will always be a transition period between versions as well as early adopters and late adopters.

In a similar way, two versions of the CGMES standard coexist nowadays: CGMES 2.4 and CGMES 3.0. While ENTSO-E transition between CGMES vendors it is important to consider the behaviour of software tools. On their side, software vendors provide a different level of support for each version.

ENTSO-E is interested in testing what results and problems software tools face when dealing with models written in different versions of CGMES and with an importing NC Profiles for which they have not been designed for.

4.1.1. Test description

The objective of the test is to show the level of backwards and forwards compatibility among CGMES and NC Profiles versions and to understand what aspects needs improvement to achieve a satisficing level.

This test does not make part of the described TUCs (refer to chapter 8.4) and thus, readers can find bellow a description:

1. Import 1:
   a. To import the IGM *ESO* from *Unicorn v2* TC (in CGMES v2.4)
   b. To import IGM *Transelectrica* from *Unicorn v2* TC (in CGMES 3.0).
2. Operation 1:
   a. To perform merge of the two IGMs. This will result in a CGM (from now on *Unicorn's CGM*).
   b. To perform a power flow calculation.
3. Export 1:

[1] *To avoid confusion, the ENTSO-E decided to continue the numbering of the Network Code profiles to the whole RCP package. Readers might want to refer to the RCP DES 2.3—the current release at the moment of writing—for more context.*

a.To export Unicorn's CGM and power flow results in CGMES 3.0.

4. Validation:
   a.To validate the Export.
5. Import 2:
   a.To import Unicorn's CGM in CGMES 3.0 (result from import 1)
   b.To import Unicorn's NCP (in version 2.2).
6. Operation 2:
   a.To perform a contingency analysis.
7. Export 2:
   a.To export contingency analysis results using NCP version 2.3.

4.1.2.Test results

- DIgSILENT
  i. Import 1 successful.
     1. We keep the IDs of the major assets.
  ii. Operation 1 and Export 1 successful.
     1. When comparing with DIgSILENT's internal data model, it throws the same power flow result.
     2. Some IDs might have changed during the export.
  iii. Validation:
     1. Validation is only performed at RDFS level.
     2. Some errors arise. Some classes and attributes are missing.
     3. The results of the validation are exported to a spreadsheet and transmitted to Unicorn.
- SIEMENS
  i. Import 2 successful.
  ii. Operation 2:
     1. We can run a contingency analysis.
     2. Additionally, we can run power flow calculation (just to double check).

iii. Export 2:

1. Some errors that need deeper analysis appear.

4.1.3.Conclusions

ENTSO-E along with the SV-IOP participants could check that working with more than two version of the CGMES and NC profiles does not work *out of the shelf,* but it is technically feasible. To link this conclusion, please refer to the section 3.1 of this report.

Other practical conclusions arising from the test are:

- All vendors support both CGMES v2.4 and v3.0
  a. Not all vendors have the same level of support but they can consume 2.4 and export 3.0 up until some extend.
- Some vendors prototyped parts of NC profiles v2.2 and most of the vendors prototyped NC profiles v2.3.
  a. Data storage is more supported than data processing and analysis.
- Thus, it is technically possible to combine profiles in multiple version (NC 2.2 and NC 2.3) conversion tools as there is no blocking point on the vendor side and the profiles design.
- Some vendors prefer to support of one versions at the same time.

4.2.SIPS implementation in the RA profile

Energinet led this discussion as they were working on use cases and their realisation using the NC profiles.

For that purpose, Energinet showed this simplyfied grid overview containing 3 MASs and 1 SIPS (note it has been changed to a pseudo grid after the SV IOP for clarification reasons):

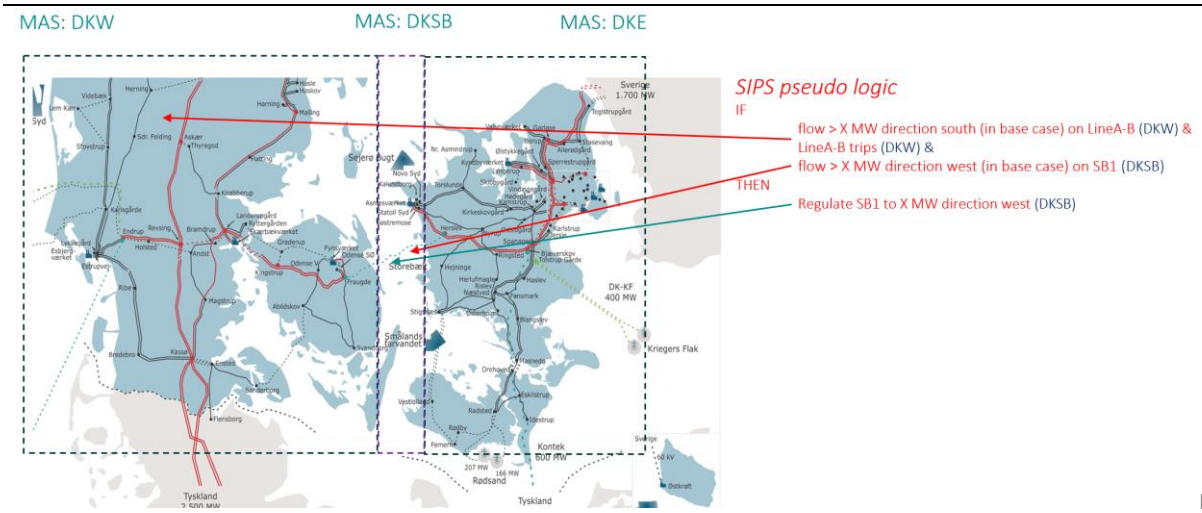
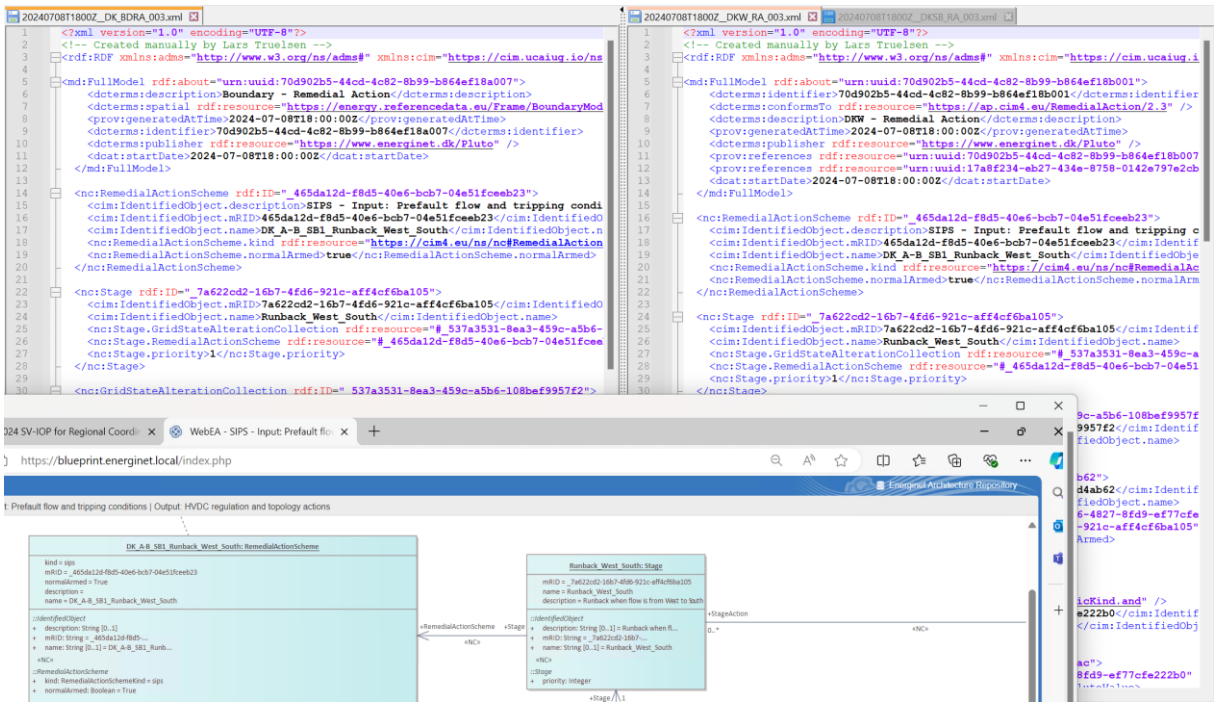


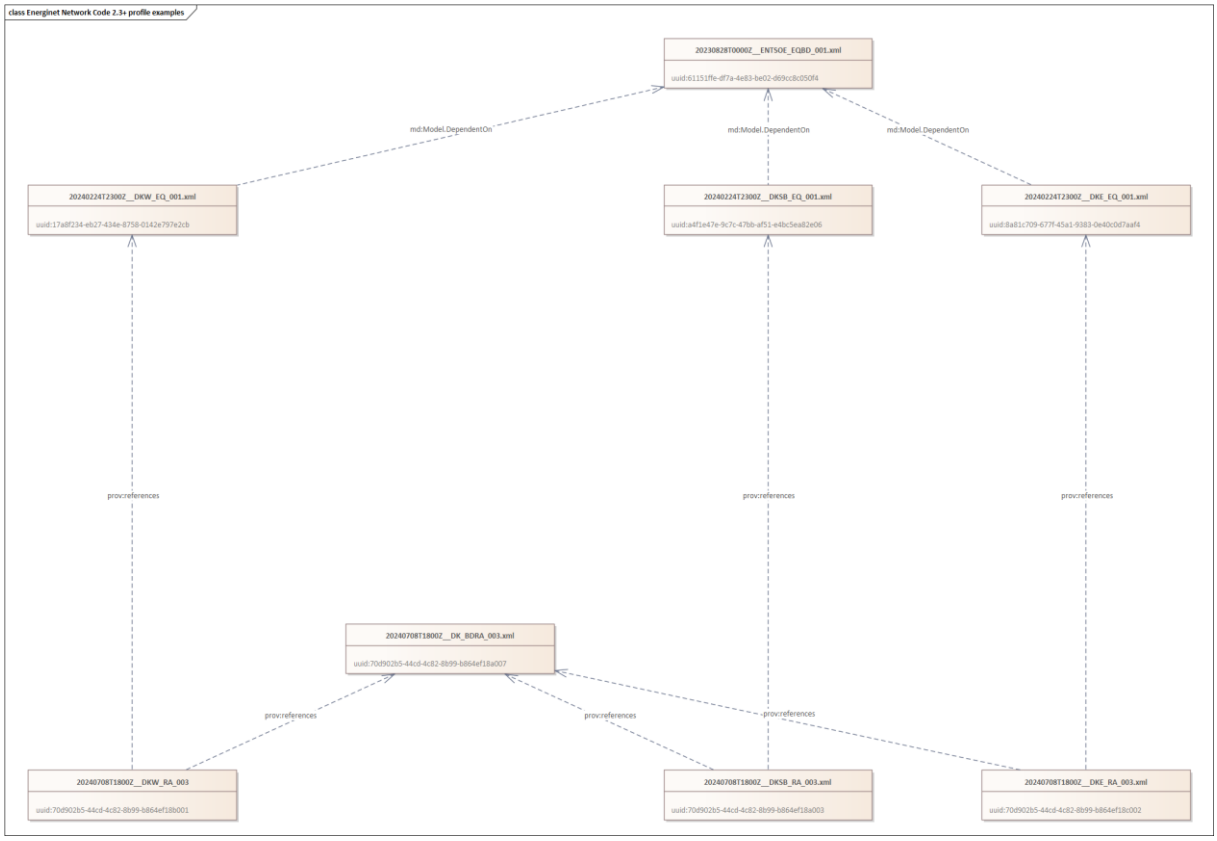
Figure 5: Energinet's example of the use of SIPS

4.2.1.Use case

Lars Truelsen (Energinet) showed the diagram below and 3 RA datasets to which the use case refers to. The 3 RA datasets were prepared according to the agreement regarding a so-called common RA boundary dataset, in which the structural parts of the SIPS referenced by entities in the 2 RA datasets, referencing objects in different MASs, are modelled. The common entities in the example below are: RemedialActionScheme, Stage, GridStateAlterationCollection.



In the diagram below, the 3 RA datasets, and their references to EQ dataset, as well as the inter RA references, are shown. The diagram also shows an RA dataset referencing the DKE MAS.



– Energinet wants to apply two types of GridStateAlterations:

  - **ACDCConverterAction** which they will use to change the setpoint on a HVDC converter to x MW (it will always stay like this, as the value is not subject to operational optimisation, it is a static configuration)

```
<nc:ACDCConverterAction rdf:ID="_598fdf34-094a-489c-bf38-76833aabc156">
  <nc:ACDCConverterAction.ACDCConverter rdf:resource="#_9e364770-1b8d-4543-89bb-22efbaffdfe2"/>
  <nc:GridStateAlteration.GridStateAlterationCollection rdf:resource="#_537a3531-8ea3-459c-a5b6-108bef9957f2"/>
  <nc:GridStateAlteration.normalEnabled>true</nc:GridStateAlteration.normalEnabled>
  <nc:GridStateAlteration.PropertyReference rdf:resource="http://energy.referencedata.eu/PropertyReference/ACDCConverter.targetPpcc"/>
  <cim:IdentifiedObject.mRID>598fdf34-094a-489c-bf38-76833aabc156</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>RegHvdcAbsolute_HVDC1_P1</cim:IdentifiedObject.name>
</nc:ACDCConverterAction>

<nc:StaticPropertyRange rdf:ID="_451f4fdd-21ec-42c9-9386-2c42d729f007">
  <cim:IdentifiedObject.mRID>451f4fdd-21ec-42c9-9386-2c42d729f007</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>RegHvdcAbsolute_HVDC1_P1</cim:IdentifiedObject.name>
  <nc:RangeConstraint.direction rdf:resource="https://cim4.eu/ns/nc#RelativeDirectionKind.none"/>
  <nc:RangeConstraint.normalValue>25</nc:RangeConstraint.normalValue>
  <nc:RangeConstraint.GridStateAlteration rdf:resource="#_598fdf34-094a-489c-bf38-76833aabc156"/>
  <nc:StaticPropertyRange.PropertyReference rdf:resource="https://energy.referencedata.eu/PropertyReference/ACDCConverter.targetPpcc"/>
  <nc:RangeConstraint.valueKind rdf:resource="https://cim4.eu/ns/nc#ValueOffsetKind.absolute"/>
</nc:StaticPropertyRange>
```

- Note: They use the set point action, which is not used for optimisation.

- **TopologyAction** which they will use to disconnect and connect Breakers

```
<nc:TopologyAction rdf:ID="_598fdf34-094a-489c-bf38-76833aabg156">
  <nc:TopologyAction.Switch rdf:resource="#_340ac043-b40d-4cc3-ba5b-fa973e7ad047"/>
  <nc:GridStateAlteration.GridStateAlterationCollection rdf:resource="#_537a3531-8ea3-459c-a5b6-108bef9957f2"/>
  <nc:GridStateAlteration.normalEnabled>true</nc:GridStateAlteration.normalEnabled>
  <nc:GridStateAlteration.PropertyReference rdf:resource="http://energy.referencedata.eu/PropertyReference/Switch.open"/>
  <cim:IdentifiedObject.mRID>598fdf34-094a-489c-bf38-76833aabg156</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>TopologyChange_Connect_340ac043-b40d-4cc3-ba5b-fa973e7ad047</cim:IdentifiedObject.name>
</nc:TopologyAction>

<nc:StaticPropertyRange rdf:ID="_451f4fdd-21ec-42c9-9386-2c42d729g007">
  <cim:IdentifiedObject.mRID>451f4fdd-21ec-42c9-9386-2c42d729g007</cim:IdentifiedObject.mRID>
  <cim:IdentifiedObject.name>TopologyChange_Connect_340ac043-b40d-4cc3-ba5b-fa973e7ad047</cim:IdentifiedObject.name>
  <nc:RangeConstraint.direction rdf:resource="https://cim4.eu/ns/nc#RelativeDirectionKind.none"/>
  <nc:RangeConstraint.normalValue>0</nc:RangeConstraint.normalValue>
  <nc:RangeConstraint.GridStateAlteration rdf:resource="#_598fdf34-094a-489c-bf38-76833aabg156"/>
  <nc:StaticPropertyRange.PropertyReference rdf:resource="https://energy.referencedata.eu/PropertyReference/Switch.open"/>
  <nc:RangeConstraint.valueKind rdf:resource="https://cim4.eu/ns/nc#ValueOffsetKind.absolute"/>
</nc:StaticPropertyRange>
```

To solve the same problem, DIgSILENT interpreted it as a scheduled constant value: “this equipment goes to the setpoint”. That way, they do not need to provide a range constraint.

PSE requested clarification on the setpoints and if they can be changes in the AS dataset. In general the AS if for availability. The best is to use other mechanisms sich as SIS and SSI datasets.

4.2.2.Performed tests

Using the Energinet RA (SIPS) Test Configuration (TC), some software vendors tried the Test Use Cases (TUC) described below (refer to Annex C for information about the TC and TUC).

- TUC 3: Import of NC Profiles Related to Structural Data
  a. DIgSILENT
     i. They obtained an invalida data type.
  b. SIEMENS
     i. They got two availability schedules with different parameter (this is wrong).
     ii. However, they also imported an event schedule with different time (one of them is active and one is unactive) which is correct.
- TUC 15: Support of SPS/SIPS Modelling
  a. DIgSILENT
     i. It did not worked.

4.2.3.Discussion and agreement

A question on the value that the parameter *direction* should take. Currently, ENTSO-E only allows “up” and “down” but this does not allow to have a fixed value.

By using the value *none,* the parameter *direction* would indicate that the value is fixed—nor *up*, nor *down*.

The RAO would not be able to interpret it correctly although it does not seem to be a problem for Energinet given that the condition we discuss—to reach a value of 250—should not be optimised. It is to be kept in mind that what we enable for optimisation of SIPS is the arming (on or off).

The underlying problem is that using a range for a fixed point is not a clean solution.

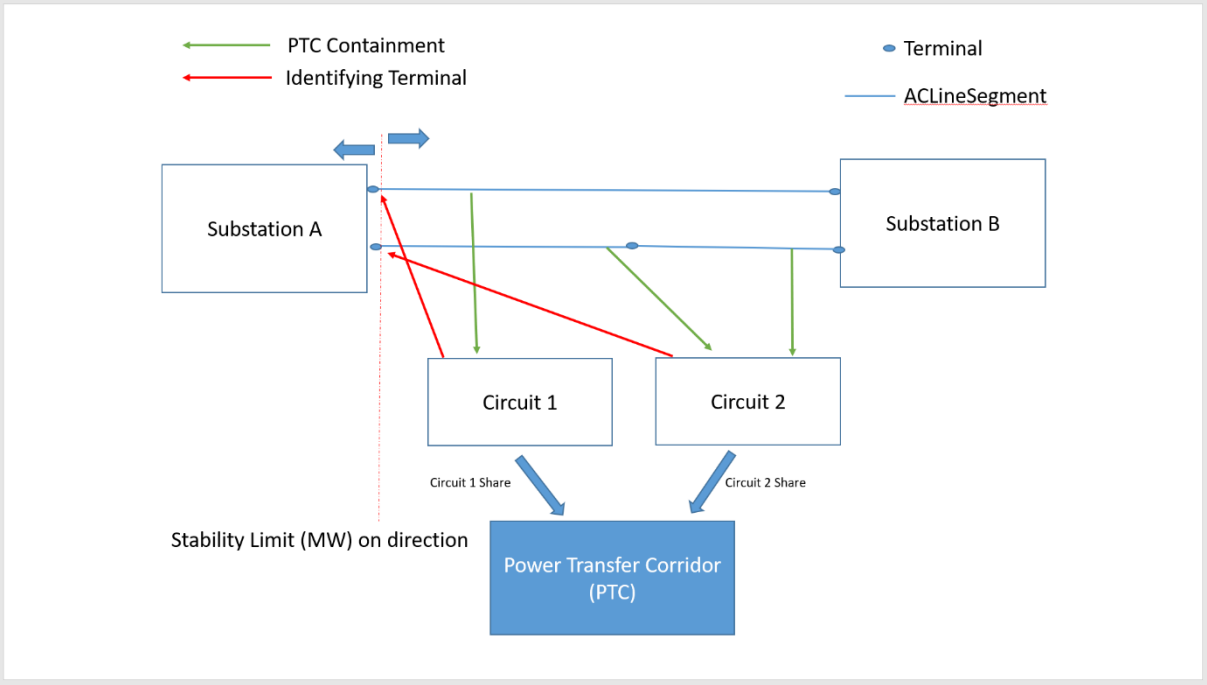
The participants agree:

- To accept the use case and provided data by Energinet.
- As a short-term solution, to use of *none* in the parameter *direction* indicates that the value is fixed.
- As a short-term solution, not to include a certain RA in the RAS profile unless it is subject to optimisation.
- As a long-term solution, to include a *normal* value in the GridStateAlteration class so you do not have to declare the range at all in the long-term.

4.2.4.Resulting example

Energinet and ENTSO-E agreed on the following posibilitites to be introduced in the next RCP release 2.3.1:

– **ER profile**: The successful to model a Power Transfer Corridor (PTC) based on Terminals, as well a successful to set a success value for possitiveFlowIn for each of the Terminals.

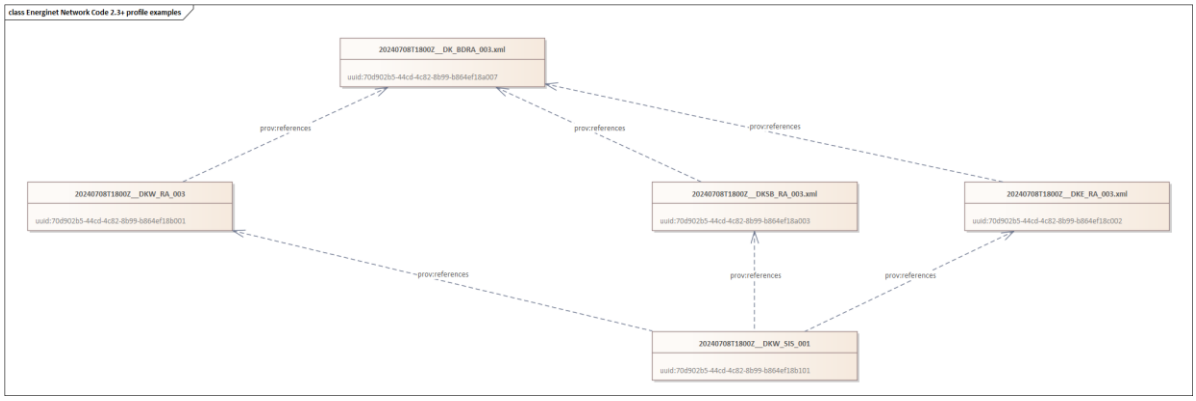


– **SIS profile**: The successful to set a StageTrigger inService like it is possible for a RemedialActionScheme. Furthermore, it has been agreed to include previous in the TimeSeriesInterpolationKind.

```
<nc:RemedialActionSchemeTimePoint rdf:ID="_bbe9a802-7e0a-4650-acb4-da646ca97784">
    <cim:IdentifiedObject.mRID>bbe9a802-7e0a-4650-acb4-da646ca97784</cim:IdentifiedObject.mRID>
    <nc:RemedialActionSchemeTimePoint.RemedialActionSchemeSchedule rdf:resource="#_4d4f62ed-bde1-430b-b521-fa7d7efc3349" />
    <nc:RemedialActionSchemeTimePoint.atTime>2024-07-15T15:00:00Z</nc:RemedialActionSchemeTimePoint.atTime>
    <nc:RemedialActionSchemeTimePoint.inService>true</nc:RemedialActionSchemeTimePoint.inService>
</nc:RemedialActionSchemeTimePoint>


<nc:RemedialActionSchemeSchedule rdf:ID="_4d4f62ed-bde1-430b-b521-fa7d7efc3349">
    <cim:IdentifiedObject.mRID>4d4f62ed-bde1-430b-b521-fa7d7efc3349</cim:IdentifiedObject.mRID>
    <nc:RemedialActionSchemeSchedule.RemedialActionScheme rdf:resource="#_465da12d-f8d5-40e6-bcb7-04e51fceeb23" />
    <nc:BaseTimeSeries.interpolationKind rdf:resource="https://cim4.eu/ns/nc#TimeSeriesInterpolationKind.previous" />
    <!-- 2024.07.16: "previous" not allowed at the moment, but it will be in the future -->
</nc:RemedialActionSchemeSchedule>
```

The SIS dataset can be use in relation to the RA datasets like in this example:



4.3.Application of remedial actions in the Swiss power system

Refer to Annex C for more information on the content of Swissgrid TC.

4.3.1.Performed tests

Using the Swissgrid v4 Test Configuration (TC), some software vendors tried the Test Use Cases (TUC) described below (refer to Annex C for information about the TC and TUC).

- TUC 3: Import of NC Profiles Related to Structural Data
    a. Unicorn
        i. Import not ok due to version of profile.
        ii. CorNet current tool only works with NCP 2.2 and it is not compatible with 2.3.
    b. DIgSILENT
        i. EQ profile can be converted without issues
        ii. We cannot convert NC profiles because of missing references (the TC must be changed and improved)
    c. SIEMENS
        i. They got two availability schedules with different parameter (this is wrong).
        ii. However, they also imported an event schedule with different time (one of them is active and one is unactive) which is correct.
- TUC 5: Import of NC Profiles Related to Scheduled and Solution Data
    a. Unicorn

i. Import not ok due to version of profile.

ii. CorNet current tool only works with NCP 2.2 and it is not compatible with 2.3.

b. DIgSILENT

i. N/A as the import does not work.

c. SIEMENS

i. There are many missing references.

ii. We are able to import it but not able to export (the only available profile showing up is the Equipment Boundary)

iii. We will update the logs of the import so Swissgrid knows what to improve.

d. PSI Neplan

i. Similar problem as above as Swissgrid only provides EQ and EQ BD profiles.

4.4.A small two node model

DIgSILENT prepared a small grid model along with the necessary information to perform a contingency analysis.

4.4.1.Performed tests

Using the *DIgSILENT small TC v2* Test Configuration (TC), some software vendors tried the Test Use Cases (TUC) described below (refer to Annex C for information about the TC and TUC).

- TUC 3: Import of NC Profiles Related to Structural Data

a. DIgSILENT

i. The import works for: AE, CO, RA, RAS and SAR.

b. SIEMENS

i. The import works for: AE, CO, RA, RAS and SAR.

c. AspenTech

i. The import works for: AE, CO, RA, RAS and SAR.

d. Baltic RCC

i. Import CGMES profiles, CO and AE.

- TUC 4: Export of NC Profiles Related to Structural Data
    a. DIgSILENT
        i. Export works (we find the same model as in the beginning).
        ii. We find issues with namespaces (In Siemens Export).
        iii. Nothing preventing the power flow convergence (In Siemens Export).
        iv. The import from Siemens export was identical.
    b. SIEMENS
        i. Export is ok although the namespaces are not handled correctly yet.
        ii. Minor issues found because it is a small model.
    c. AspenTech
        i. We were able to export AE, CO and RA profiles to confirm structural data.
    d. Baltic RCC
        i. We were able to export only the SAR profile.
- TUC 11: Perform Contingency Analysis
    a. DIgSILENT
        i. CO analysis works on all the three cases with the same results and triggering the same SIPS.
    b. SIEMENS
        i. We can perfom the analysis and export the results.
    c. Baltic RCC
        i. Successful analysis.
- TUC 15: Support of SPS/SIPS Modelling
    a. DIgSILENT
        i. It works correctly.

4.4.2.Conclusion

In summary, such small test configurations are very useful to debug on low level especially when tools are at prototyping stage. This emphasises the need to have a pool of test configurations that will support various types of tests.

4.5.DIgSILENT CGMES v3 model

DIgSILENT prepared a bigger with grid in the CGMES v3.0 standard model along with the necessary information to perform a contingency analysis.

4.5.1.Performed tests

Using the *DIgSILENT CGMES v3* Test Configuration (TC), some software vendors tried the Test Use Cases (TUC) described below (refer to Annex C for information about the TC and TUC).

- TUC 3: Import of NC Profiles Related to Structural Data
    a. DIgSILENT
        i. Import shows some problems.
        ii. We are able to do contingency analysis and to run contengencies.
        iii. Validation in PowerFactory shows some errors.
        iv. There are no “exceptional” contingencies as for the calculation, it does not matter.
    b. SIEMENS
        i. The import OK.
        ii. Contingency and Equipment imported correctly.
        iii. There are no major things lacking in the model.
    c. PSI Neplan
        i. We performed topology validation and then some issues appear (to be checked whether it is in the model or in the tool prototype).
- TUC 4: Export of NC Profiles Related to Structural Data
    a. DIgSILENT
        i. CIMbion shows errors (only SHACL validation) on tab changers, synchronous machine reactive errors.
    b. SIEMENS

i. Export successful from software side.

ii. Headers are not handled correctly yet.

iii. CIMbion picked some datatypes issues.

iv. CIMbion shows missing information for the CO profile (mRIDs).

4.5.2.Conclusion

For doing the contingency analysis there is no need to know the kind of the contingency. However, to be in line with the Network Code, there is a need to provide the exceptional contingencies (this is meant for justification).

There should be multiple contingencies in “out-of-range” and “exceptional” contingencies (which is how is it should be modelled in RCP r2.3). This is currently missing from the model and can be improved in the next version.

ENTSO-E needs to have a new version for the SHACL constraints (new regeneration) to support both namespaces. The new SHACL constraints will use the approach of alternative path in similar way as it was used in other parts of the SHACL constraints. This will be done in the release 2.3.1 of the NC profiles.

4.6.Testing model from CorNet

Unicorn provided a testing model from CorNet using the version 2.2 of the Network Code profiles along with the necessary information to perform a contingency analysis.

4.6.1.Performed tests

Using the *Unicorn v2* Test Configuration (TC), some software vendors tried the Test Use Cases (TUC) described below (refer to Annex C for information about the TC and TUC).

- TUC 5: Import of NC Profiles Related to Scheduled and Solution Data

  a. DIgSILENT

     i. When converting to CGMES v3.0, there are issues with the namings.

  b. SIEMENS

     i. Imported the Unicorn model exported by DIgSILENT in CGMES 3.0 (“UNICORN CGMES 3.0 DIgSILENT_CGM”) and got some issues.

     ii. We can also see some RA. What we ambition is that you should be able to apply a RA to a build case.

iii. There are some errors because of misinterpreting the functionality or because there is some information missing.

iv. Most probably, we have not imported all the parameters correctly.

v. We got 13 assessed elements.

vi. There is not rangeConstraints (maybe we are missing)

vii. We were not able to import the SIS but we will take a look at the log.

viii. We will investigate whether is a modelling issue (or), we were not able to run the RA in the build case

c. Unicorn

i. Successful import of the model.

ii. Successful import of the NC profiles.

- TUC 13: Perform Security Analysis Before and After RAO

a. Unicorn

i. Successful calculation of Security Analysis and exporting the SAR profile.

4.7.Baltics model

Baltic RCC created a grid model representing a part of the Baltic region using the version 2.3 of the Network Code profiles along with the necessary information to perform a contingency analysis.

4.7.1.Performed tests

- TUC 3: Import of NC Profiles Related to Structural Data

a. PSI Neplan

i. Import is successful for all the profiles.

5. Conclusions and Recommendations

The SV-IOP participants concluded that:

- The organisation of the SV-IOP is a necessary milestone for checking the feasibility of the agreed data exchange profiles in general. IOP participants concluded that such efforts should be well prepared, and participation ensured from all parties (vendors, TSOs, RCCs) in the data exchange in order to achieve the objectives.

- The transition between different versions is a key process to be put in place and give both a confidence that new versions will be improved and make sure that the process is well governed. The current data exchange for CSA relies on the UCTE-DEF format model exchange and does not meet the requirements of the Network Codes and methodologies. While there is a growing readiness among TSOs to switch to CGMES, the actual transition has been slow. Although some TSOs have made progress with CGMES profiles (e.g., v2.4 and testing v3.0), the majority of exchanges are still rooted in older versions. The need for clear deadlines and commitments from TSOs is critical to accelerate this transition and will give the right signals to vendors on both CGMES and NC profiles implementations.

- Vendors face several challenges, including unclear prioritisation of profile implementations, insufficient communication, and a lack of detailed guidance from TSOs. The absence of concrete use cases and functionalities makes it difficult for vendors to tailor their solutions. Moreover, there is a disconnect between current profiles and long-term planning needs, which hinders effective development and testing. Additionally, the collaboration and involvement from TSOs in the process is somewhat limited due to resources issues which has further contributes to these challenges. A set of recommendations are suggested to minimise risks and improve the situation.

The following recommendations are considered relevant to further improve the development and implementation processes concerning data exchange standards and specifications. It is recommended that they are considered together with the general recommendation to integrate the SV-IOP issues resolutions in the upcoming versions of the specifications and to promote efforts to integrate relevant CIM extensions into the IEC standards:

- **Accelerate the Transition to CGMES**: Business processes should commit to clear deadlines for transitioning to CGMES exchange and actively communicate their readiness to switch. Enhanced coordination and commitment among TSOs and RCCs will incentivise timely data delivery and improve the overall quality of exchanges. Well established transition principles and specific processes per business process implementation are key for the success.

- **Creation of an *RCP Conformity Assessment Scheme*.** In order to verify that tools conform to the specification and meet TSOs expectations, ENTSO-E could complement the current work

in the RCP DES and release a conformity assessment scheme including test use cases and test configurations (test models)—mirroring what was done for the CGMES standard.

- **Improve Vendor Communication and Collaboration**: ENTSO-E should enhance its direct communication with vendors by providing more detailed and specific guidance on the implementation of NC profiles and CGMES. Creating a collaborative environment, such as a git-based platform for knowledge sharing, and involving vendors more actively in discussions and testing processes, will lead to more aligned and effective tool development.

- **Develop and Share Concrete Use Cases**: TSOs need to provide concrete examples of how they intend to use the NC profiles and CGMES versions. This will help vendors prioritise their development efforts and better understand the real needs of their clients. Additionally, separating CGMES 3.0 topics from NC topics during discussions and focusing on specific use cases will enable deeper exploration and better alignment with industry standards.

- **Enhance Training and Standardisation Efforts**: ENTSO-E should work with conformity assessment bodies to offer more comprehensive training to both vendors and TSOs. This effort should include clear explanations of how CGMES and NC profiles interrelate and how they can be effectively used in long-term planning.

- **Tooling supporting transition**. Common tooling for validating and converting data should be developed to streamline the transition process and ensure consistency across the board. This should include capabilities to upgrade and downgrade between coexisting versions of a specification or standard.

- **Increase TSO and RCC Participation**: Encourage greater participation from TSOs and RCCs in the SV-IOPs. This will facilitate better understanding and communication of the requirements and challenges, ultimately leading to improved data quality and more effective use of CGMES.

6. Annex A: Information on Applications/Tools used in the IOP (alphabetical order)

6.1. Cimbion

6.1.1. Vendor presentation

Driven by our purpose of safeguarding life, property and the environment, DNV enables organisations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener.

6.1.2. DNV CIM services

- Basic and Advanced CIM training
- CIM/CGMES 3.0 conformance testing
- End-to-end CIM implementation support for Transmission and Distribution System Operators

6.1.3. Tool description

A Veracity service for CIM/CGMES 3.0 self-assessment and Conformance Testing, accredited by ENTSO-E, leveraging on DNV's expertise in the IEC CIM standards.

CIMbion for Conformance Testing

Conformance Testing is a crucial step to demonstrate that applications from different vendors are compliant to the standard and can interoperate by exchanging grid operations data in CGMES 3.0 format. The purpose is to create value to all stakeholders:

- Transmission & Distribution System Operators will be able to purchase well tested and compliant applications

- Vendors can leverage the conformity test to improve the quality of their CGMES 3.0 implementations

CIMbion for automated testing

CIMbion is also available to application developers and network operators for in-house testing.

- For IT and OT vendors
  - Enables integration in CI/CD pipelines via RESTful API
  - Helps in preparation for CIM Conformance Testing
- For utilities and network operators
  - Validate interoperability of new systems during SAT and business process testing

6.1.4.Contacts

– Harish Krishnappa, CIMbion Service Lead: Harish.Krishnappa@dnv.com

– Lino Prka, CIMbion Product Owner: Lino.Prka@dnv.com

For more information and to start your free trial, visit the link: https://store.veracity.com/cimbion

6.2.CimPal

6.2.1.Relevant information for SV IOP

– Used version: 2024.0.

– Import: RDFS and SHACL for CGMES v2.4, CGMES v3.0, NC Profiles v2.2 and v2.3.

– Export: RDFS and SHACL for all profiles.

– Conversion: conversion between CGMES v2.4 and CGMES v3.0 used in some of the tests

6.2.2.Vendor presentation

gridDigIt has been established in the beginning of 2020 with the objective to provide state of the art digital, innovative and interoperable tools and solutions. It provides consultancy services mainly in the following areas:

– power system analysis and modelling,

– networks models and data management,

– IEC CIM, CGMES, conformity of IEC CIM related standards,

– interoperability aspects of grid models exchange,

– research, development and innovation activities as well as

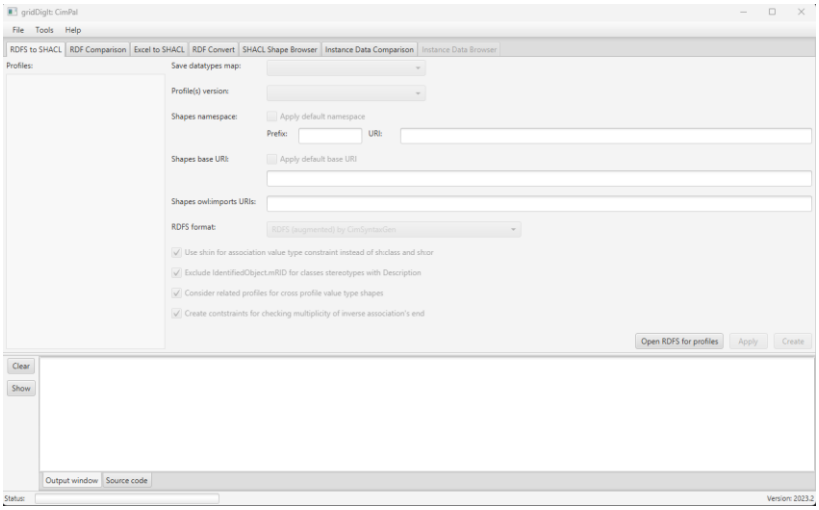
– training activities on various topics.

6.2.3.Tool description

Introducing CimPal: Empowering CIM Implementation and Simplifying Workflows!

CimPal, the innovative family of open-source Java applications, is here to revolutionise your CIM experience. Developed by gridDigIt and licensed under the EUPL-1.2-or-later, CimPal is your ultimate companion for effortless CIM implementation.

Powered by industry-leading technologies such as Apache Jena (Apache License v2.0), TopBraid SHACL API (Apache License v2.0), and JAVAFX (GPLv2+CE license), CimPal offers a comprehensive suite of tools designed to streamline your workflow and enhance productivity.



CimPal app features include:

– Seamless Conversion: Effortlessly convert from RDFS to SHACL, unlocking new possibilities for your CIM implementation.

– Simplified Constraints: Export SHACL constraints from an excel template, making it easier than ever to stay compliant and error-free.

– Intelligent Comparison: Perform RDFS comparisons with ease, swiftly identifying changes between different versions of CIM profiles.

– Documentation: Export RDFS descriptions and cardinalities in Excel, helping you to prepare clear and comprehensive documentation.

– Generate datatypes mapping effortlessly, eliminating the complexity associated with CIM data management.

– Generate inheritance structures from RDFS, gaining valuable insights into the organisation of your CIM profiles.

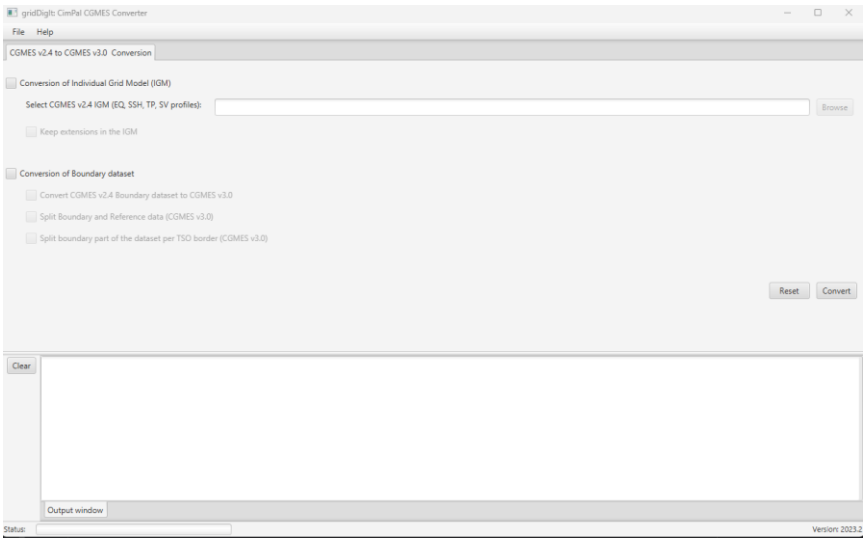
– Seamless RDF Conversion: Experience hassle-free conversion between different RDF serialisations like RDFXML, TURTLE, and JSON-LD (Note: advanced JSON-LD support is under development).

CimPal CGMES Converter, simplify your workflows and unlock new opportunities with these powerful features:

– Conversion: Seamlessly convert CGMES v2.4 to CGMES v3.0, effortlessly adapting to the latest standards.

– Profile Support: Equipment (EQ), Steady State Hypothesis (SSH), Topology (TP), and State Variables (SV).

– Conversion of boundary set



Continuous Improvement: gridDigIt is actively working on expanding the converter's functionalities, so stay tuned for future updates. While the first version of CimPal CGMES Converter focuses on core features, we are committed to constant improvement and addressing user needs.

Links:

- gridDigIt: https://griddigit.eu/
- CimPal GitHub repository: https://github.com/griddigit/CimPal
- CimPal CGMES Converter GitHub repository: https://github.com/griddigit/CimPal-CGMES-Converter

6.3.CIM Studio

6.3.1.Vendor presentation

AspenTech is a global leader in asset optimization software, serving the process industries. It provides software solutions for designing, operating, and maintaining industrial facilities to enhance profitability, safety, and sustainability. Some of the key areas where AspenTech software is used include:

- Engineering**:** Process design, simulation, and optimization
- Manufacturing**:** Plant operations, control, and optimization
- Supply chain: Inventory management, logistics, and planning
- Asset performance management: Predictive maintenance, asset reliability, and risk assessment
- Energy: Intelligent energy management, enhanced operational efficiency, and sustainability

Further, AspenTech's **Digital Grid Management (DGM)** solution, of which **CIM Studio** is a part of, is a comprehensive software suite designed to manage and optimize electrical power grids. AT's **DGM** solution covers various aspects of grid operations, including:

– Generation Management (AGC): Forecasting, optimization, scheduling, and real-time operation of power generation assets.

– Transmission Management (EMS): Comprehesive suite of software tools designed for power system analysis and optimization. Include real-time montoring, security analysis, situational awareness and support for offline engineering studies.

– Distribution Management (ADMS): Advanced applications, outage management, and distributed energy resource management for distribution grids.

– Distributed Energy Resource Management (DERMS): Modeling, monitoring, forecasting, scheduling, and controlling renewables and distributed energy resources.

6.3.2.Tool description

CIM Studio enables users to graphically build network models and to import and export electrical network models in the CIM. **CIM Studio** also provides the capability to modify CIM XML files and deploy the network model within **monarch**.

RTOs and ISOs require the ability to exchange electrical network models with transmission owners (TOs) and other market participants to support overall system security and the bulk energy market. These models enable RTOs and ISOs to understand the configuration and status of an electrical network. The Common Information Model (CIM) standard enables application software to exchange this model data in a common format.

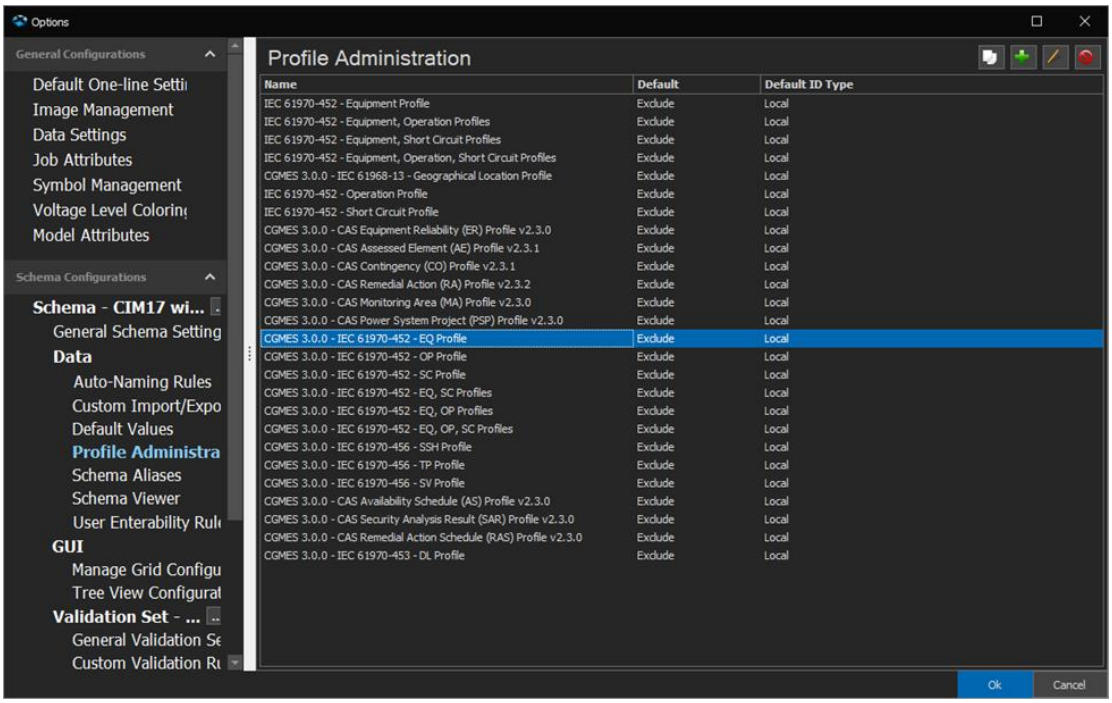
As a standalone graphical CIM editor, **CIM Studio** serves as a platform for transmission customers to view and edit power system network data in the CIM. This data can then be used by both real-time and study tools to interact with the data and perform advanced analysis. Apart from standalone deployment, **CIM Studio** additionally interfaces natively with **DGM's Maintenance Center** to provide workflow and manage deployment of the network model within **monarch**, where advanced analysis and specific offline engineering studies can be peformed.

Larger transmission operators who routinely send or receive model updates to or from their higher-level transmission operators can also use a standalone CIM "sandbox" to edit, maintain, and manipulate power system network model data in the CIM.

Core features include:

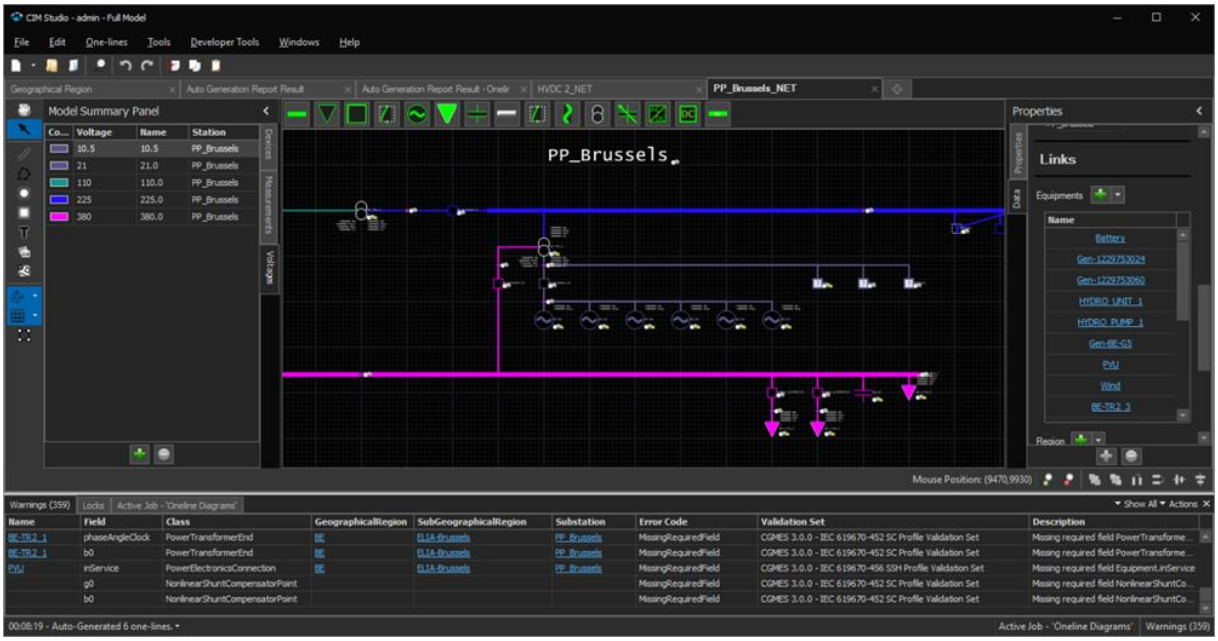
- OOTB support for CIM versions: CIM10, CIM15 (IEC 61970-301 Ed 5), CIM16 (IEC 61970-301 Ed 6), and CIM17 (IEC 61970-301 Ed 7.1)
- Import and export of IEC 61970-552 CIM/XML compliant files
    - Full CIM RDF XML files
    - Incremental CIM files
    - Profile-based imports and exports

- Profile Administration capabilities for both standard and custom profile definitions. Capabilities include:
    - Support for import of RDFS-based profiles in a variety of RDFS formats including IEC 61970-501 RDFS compliant augmented, RDFS2020 (i.e. RDFS variant for CGMES 2.4.15 and CGMES 3.0.0), etc.
    - Import of custom profiles using **CIMTool** and **CimConteXtor/CimSyntaxGen** supported



- Enables editing (add/delete/modify) of the network model data in CIM with support for:
    - Deep copy/paste functionality
    - Display data in a hierarchical (tree) view
    - Editing of CIM-based data in tabular view, properties view and graphical (one-line) view formats
- Tracking of network model changes in IEC 61970-552 compliant CIM incremental format
- Generates valid unique identifiers for CIM objects
- with new editions of the
- Support for defining custom extensions to any CIM schema
- Data Validation
    - Creation of categories of validation sets based on imported RDFS-based profiles in a variety of RDFS formats (see previously supported RDFS format types).
    - Import of custom profiles validation sets using **CIMTool** and **CimConteXtor/CimSyntaxGen** supported

- Cardinality
  - Data domains (e.g. no character data in an integer field)
  - Required associations
  - Configurable validation rules
  - Warning log
- Multiple user environment
  - Job control
  - Model merge
  - Conflict resolution
  - Version control
  - Full audit log
- Full interactive graphical one-line editor
- Auto one-line generation
- Overview diagrams to show station-to-station connectivity across geography



6.3.3.Contact

Website: https://www.aspentech.com/en

Contact: info@aspentech.com

Participants IOP: Todd Viegut

6.4.CorNet project tool

6.4.1.Vendor presentation

Unicorn Systems is a renowned European company providing the most complex information systems and solutions in the area of information technology. In the energy and utilities domain, we are focusing on the implementation of extensive information systems for market management and for the related field of energy trade both at the national and international levels. Our solutions ensure the reliable operation of integrated European energy networks on their way to the permanently sustainable energy industry.

6.4.2.Tool description

CorNet is a cooperation programme between the RCCs Coreso and TSCNET, focusing now on Coordinated Security Analysis (CSA) and Common Grid Model (CGM) services. The CorNet solution will further continue to be developed for other services and regions. Unicorn is one of the vendors of CorNet, responsible for building an IT platform, input and output data processing, etc.

Functionalities related to CGMES import/export and NC profiles in CorNet are based on Unicorn's Griffin platform that contains open business components and technical modules to support TSO/RCC needs in grid modelling, analysis and simulation on an enterprise, industrialised scale.

The following features of CorNet are relevant for CGMES and NC profiles:

- Import of CGME IGMs and CGM (CGMES 2.4.15 version currently supported).
- Merging of IGMs into CGM, including scaling and CGM validation.
- Export of CGM.
- Import of NC profiles (NC profiles version 2.2 currently supported).
- Export of imported profiles.
- ROSC process including security analysis, remedial action optimisation and remedial action coordination.

6.4.3.Contacts

Pavel Kočica (pavel.kocica@unicorn.com).

6.5.DIgSILENT – PowerFactory

6.5.1.Relevant information for SV IOP

– Used version: PowerFactory 2024 SP4 (and not published NC profile prototype extension)

– Import: Prototype for converting AE, CA, RA, SAR

– Export: Prototype for converting AE, CA, RA, SAR

6.5.2.Vendor presentation – DIgSILENT

DIgSILENT GmbH is an independent software and consulting company providing highly specialised services in the field of electrical power systems for transmission, distribution, generation, industrial plants and renewable energy. DIgSILENT's innovative product portfolio comprises ***PowerFactory***, ***StationWare*** and ***Monitoring Systems***.

6.5.3.Tool description – PowerFactory

PowerFactory is a leading power system analysis software application for use in analysing generation, transmission, distribution and industrial systems. It covers the full range of functionality from standard features to highly sophisticated and advanced applications including windpower, distributed generation, real-time simulation and performance monitoring for system testing and supervision.

Data exchange and conversion in PowerFactory

PowerFactory comes with various data conversion and interfacing options for bi-directional data exchange:

- DGS interface: Bi-directional, flexible DIgSILENT data exchange format (ASCII, XML, CSV, ODBC) supporting GIS and SCADA interfacing
- Data import converter:
    - PSS/E, PSS/U, PSS/ADEPT HUB (Siemens/PTI)
    - Sincal (Siemens)
    - UCTE (ENTSO-E)
    - CIM data exchange tools[1] (ENTSO-E Profiles 2009, CGMES 2.4.15 certified and CGMES 3.0), including CIM model editor and validator
    - Neplan
    - Integral 7 (FGH)
    - Reticmaster (Inspired Interfaces)
    - ANAREDE and ANAFAS

- Data export converter:
  - CIM (ENTSO-E Profiles: 2009, CGMES 2.4.15 certified and CGMES 3.0)
  - UCTE (ENTSO-E)
  - PSS/E (Siemens/PTI)
  - Integral 7 (FGH)
  - ANAREDE and ANAFAS

In addition, many other data formats and data from other tools can be converted based on existing customised solutions.

CGMES Tools in PowerFactory

The CGMES toolset in PowerFactory provides tools for importing and exporting CGMES datasets (archives and models) into CIM-data repository, tools for converting CGMES data to PowerFactory-network models and vice versa, a tool for validating and a facility for viewing and editing (manual and scripted) of CIM data stored in the repository. The CGMES dataset can be extended by additional classes, attributes and associations as well as, by user-defined profiles within PowerFactory.

The CGMES-tools within PowerFactory contain the following functions:

- **CIM Data Import**: Import of CGMES XML files and ZIP archive files containing XML files into CIM Archives in PowerFactory.
- **CIM Data Export**: Export of CIM data within PowerFactory to ZIP archives and XML files.
- **CIM to Grid Conversion**: Conversion of CIM into PowerFactory - Grid models.
- **Grid to CIM Conversion**: Conversion of PowerFactory-Grid models into CIM
- **CIM Data Validation**: Validation of CIM Archives and CIM Models in PowerFactory for compliance with the CGMES standard. import, export, display and editing of CGMES extensions.

PowerFactory version 15.2 (SP 15.2.8 ff) and version 2016 (SP1 ff) achieved Gold status in every available category in a 2016 conformity assessment test for CGMES 2.4.15. The conformity assessment for CGMES 3.0 is in progress.

NC Profile Prototype

The conversion for NC profiles is an extension to the CGMES toolset. The extension provides the Import, Export and Validation functionality to CIM-data conforming to the NC profiles version 2.3. All profiles from the NC profiles suite can be imported, exported, viewed, edited, and validated in PowerFactory. The conversion to the native PowerFactory format is under development and currently available for the AE, CA, RA, SAR profiles as a prototype. The prototype is compiled into two dll-files, compatible with all PowerFactory 2024 Service Packs and later versions. The NC profile prototype can be shared with PowerFactory users upon request.

1.1.2 Contacts

Website: https://www.digsilent.de/en/

Contact: mail@digsilent.de

Participants IOP: Florian Scheit, Emil Hegyi.

6.6.Transmission Network Analyzer (TNA)

6.6.1. Vendor presentation

Electricity Coordinating Center Ltd. Belgrade was established in 1993, first as the regional coordination & security and nowdays as consulting and software company supporting stakeholders in the field of electricity.

EKC provides a full range of strategic business and technical consultancy and engineering services in the field of power generation, transmission, distribution, electricity markets and software development as well as education and professional training, with client spanning over four continents.

6.6.2.Tool description

Transmission Network Analyzer (TNA) is a software tool developed within EKC for steady state analysis of power systems, covering the main operational procedures performed within TSOs and RCCs. The software tool is currently used within numerous European TSOs for operational planning procedures, two RSCs – TSCNET Munich as main EMF tool, and SCC Belgrade as main tool for all operational procedures, as well as ACER in Ljubljana.

- TNA supports UCTE, CIM and RAW network models building, validation, merging and conversion.
- Calculation of AC and DC load flow with tabular and graphical representations of results.
- Coordinated Security Analyses – N-1, N-X, Remedial Actions application.
- Coordinated Capacity Calculation – NTC, Flow Based, Compliance with 70% CEP rule (MACZT).
- Creation of IGMs and CGMs for Daily Congestion Forecast procedures, following latest QoCDC v3 requirements – YearAhead, WeekAhead, D2CF, DACF, IDCF, Snapshot
- Linearized network sensitivity analyses – PTDF, OTDF, PSDF, DCDF calculation
- Power Flow Colouring and Decomposition – for Loop, Internal, Market flow identification within RDCS procedure
- Statistical Analyses
- Fault Calculation
- Diagram and Geographical layout network representation

The tool is being used in both long and short-term related processes, spanning from Bidding Zone Review Studies, TYNDPs, as well as operational planning, IGM and CGM creation and security monitoring and capacity calculation procedures.

6.6.3. Expected CIM functionalities

TNA uses CGMES 2.4.15. format as internal model, converting all other network formats into CGMES structure. All abovementioned network functionalities are supported equally for CGMES, UCT and RAWv33 data formats. Currently, Quality of Datasets and Calculations v3 is supported, with v4 being in development.

TNA Software tool supports different formats of auxiliary files currently fulfilling the roles of NC network formats such as Critical Network Elements and Contingency (CNEC) lists, Generation/Load Shift Key (GSK) list, Contingency list, Remedial Actions and Additional Constraints (CRAC) file, Reference Program, Vulcanus, PEVF files.

Currently CGMES v3, QoCDC v4 and NC profiles are in different phases of development.

6.6.4. Contacts

Bogdan Lutovac: bogdan.lutovac@ekc-ltd.com

Dusica Markovic: dusica.markovic@ekc-ltd.com

EKC office: office@ekc-ltd.com

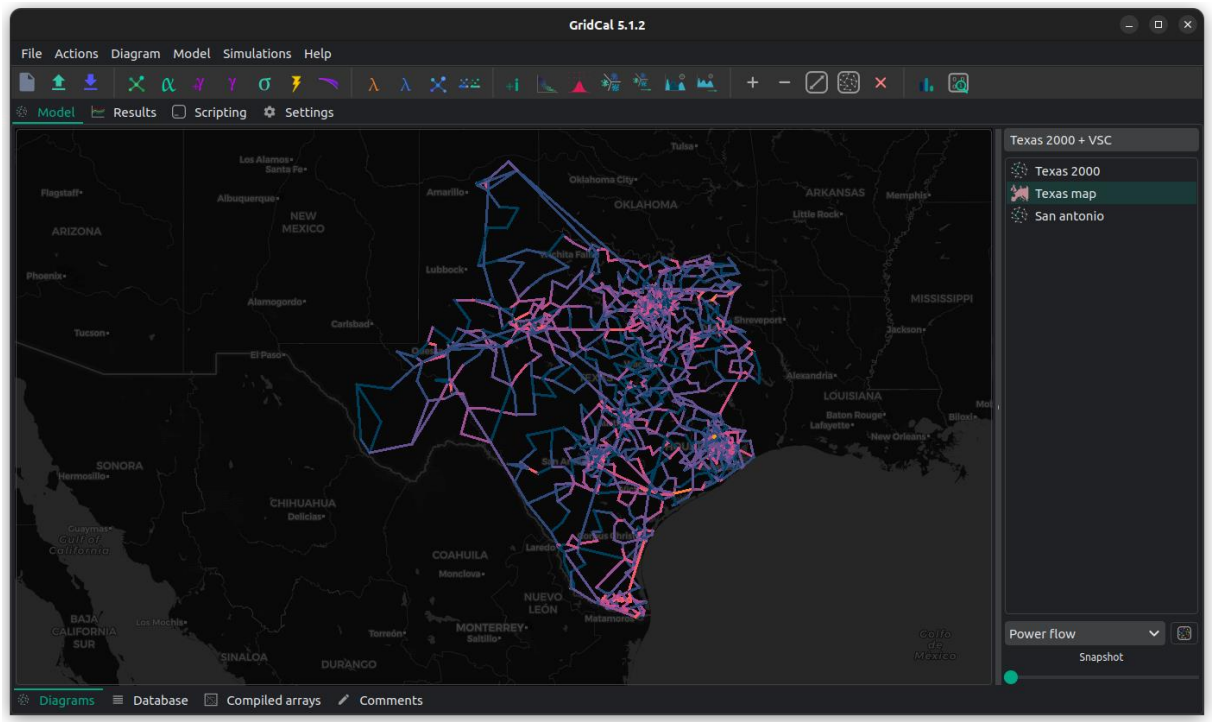
6.7.GridCal

6.7.1.Vendor presentation

As open-source project, there is no single vendor associated to the software.

6.7.2.Tool description

GridCal is a top tier power systems planning and simulation software that happens to be **open-source**. As such it has most static analysis studies, plus linear and non-linear optimisation functions, **merging the capabilities of market study software plus electrotechnical simulation software**. It has been validated by industry and academy for the last 10 years.



The current published version as of September 2024 is 5.1.26.

Further information about installation and features available at: https://github.com/SanPen/GridCal

Features:

- 50+ device types to model electricity and fluid grids.
- AC/DC multi-grid power flow with most controls available in the literature.
- AC/DC multi-grid Nonlinear optimal power flow.

- AC/DC multi-grid linear optimal power flow with automatic model repairing.
- AC contingency analysis (linear with PTDFs and Nonlinear with full power flows)
- AC linear net transfer capacity calculation.
- AC+HVDC optimal net transfer capacity calculation.
- AC/DC Stochastic power flow.
- AC Short circuit.
- AC Continuation power flow.
- Sigma analysis (one-shot stability analysis)
- Investments analysis.
- Bus-branch schematic diagrams.
- Substation-line map diagrams.
- Time series and snapshot for most simulations.
- Model bug report and repair.
- Import many file formats (PSSe .raw/rawx, epc, dgs, matpower, pypsa, json, cim, cgmes)
- Export in many file formats (gridcal .xlsx/.gridcal/.json/.sqlite, cgmes, psse .raw/.rawx)

*DC means actual DC components not linear power flow.

6.7.3.Expected CIM functionalities

As of September 2024, it can read and write CGMES 2.4.15 and 3.0 for power flow exchange. Upon reading, models are validated and converted to the tool internal model, trying to achieve the model correctness as much as possible through electrotechnical validation and buggy-data fixing.

- CGMES 2.4.15: Read and write.
- CGMES 3.0: Read and write.
- CGMES model inspection and validation with specific user interface.
- Model merging.
- Visualisation of schematics and maps.
- Proper 6+ decimal correctness in power flow model round trips (in beta stage)
- CGMES <-> RAW model roundtrip (in beta stage)
- Ability to support custom scripting and plugins for handling especific edge cases in CGMES model genertion and parsing.

The design is future proof since any new CGMES (or other format) can be inserted as a branch connected to the central GridCal model. By means of that, the user obtains conversions *from* and *to* all the other supported formats.

6.7.4.Contacts

Project maintainer: Santiago Peñate-Vera: santiago@gridcal.org / santiago.penate@redeia.com

6.8.IPS

6.8.1.Relevant information for SV IOP

– Used version: ??.

– Import: ??.

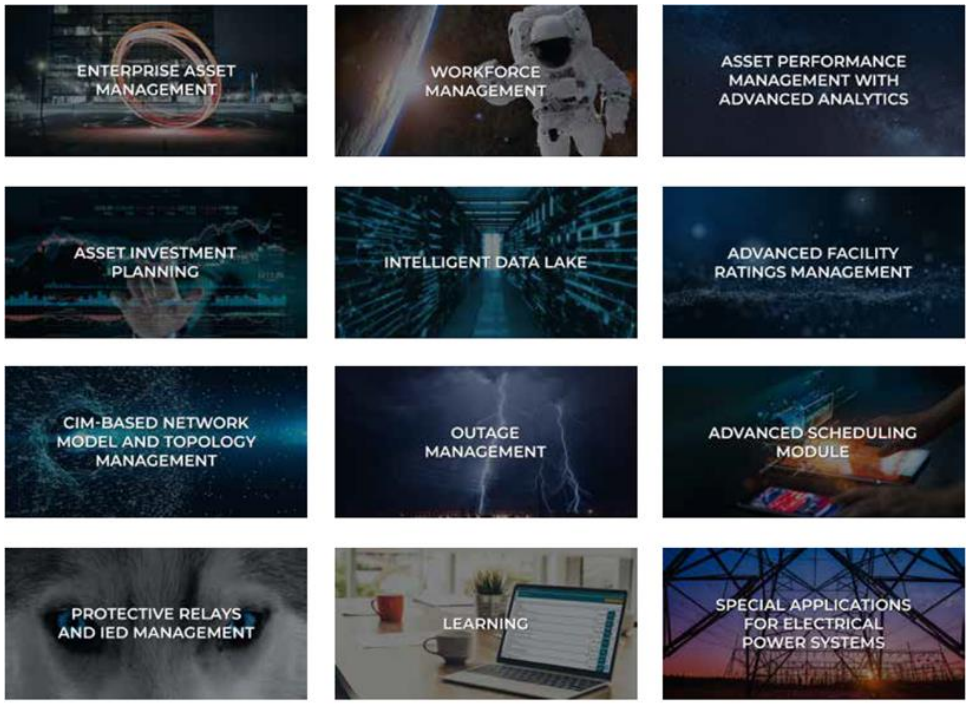
– Export: functionality under development.

– More: ??

6.8.2.Vendor presentation

IPS Intelligent Process Solutions GmbH is a German company, established in 2004, and leading provider of EAM, NMM, OMS, APM, AIP, AFRM, relay protection management and mobile workforce management software solutions for the global energy supply industry. IPS provides advanced, specialised, and valuable integrated solutions and support to client organisations around the world to transform data into real intelligence for critical business and technical decisions.

IPS offers comprehensive off-the-shelf solutions, with a focus on the utilities. IPS®SYSTEMS are characterised by their modular structure. Customers can add individual module groups according to functional requirements and implement the system step-by-step - starting with the basics and gradually implementing the full functionality.



6.8.3.Tool description

IPS has consistently proven itself as a leading provider of leader in providing innovative solutions for the power systems industry. With IPS®NMM Network Model Management, they continue to push the boundaries of network model management, empowering organisations to optimise their power system operations and drive sustainable success in the dynamic energy landscape.

IPS®NMM gives users unparalleled control over the creation, modification, administration, verification, and storage of CIM-based network models. Acting as a centralised hub, this cutting-edge software empowers organisations with a comprehensive repository and management system dedicated to the development and upkeep of power system network models.

Designed in accordance with the rigorous standards set forth by the CIM User Group, the IPS®NMM tool effortlessly fulfils all specified requirements. These requirements include key objectives, essential product features, proposed evaluation methods, typical NMM use cases, and a detailed list of specific requirements. At the heart of IPS®NMM lies a state-of-the-art CIM-based data repository carefully built on a database-agnostic system.

In addition to its CIM-CGMES compliance, IPS goes above and beyond by offering seamless integration capabilities with various other critical systems. IPS®NMM stands out as a versatile solution that can interface with multiple systems, including ERP, SCADA, OMS, and more, using IPS Identity Provider and IPS WebAPI supported CIM-based and/or non-CIM-based integration methods.

IPS®NMM serves as a unifying force, bridging the gap between network models and critical systems, and enabling organisations to harness the full potential of their power system data. With IPS®NMM, organisations can effortlessly connect their power system network models to these diverse systems,

enabling synchronised operations across multiple platforms. This interoperability facilitates efficient data exchange, streamlines workflows, and enhances the overall effectiveness of power system management.

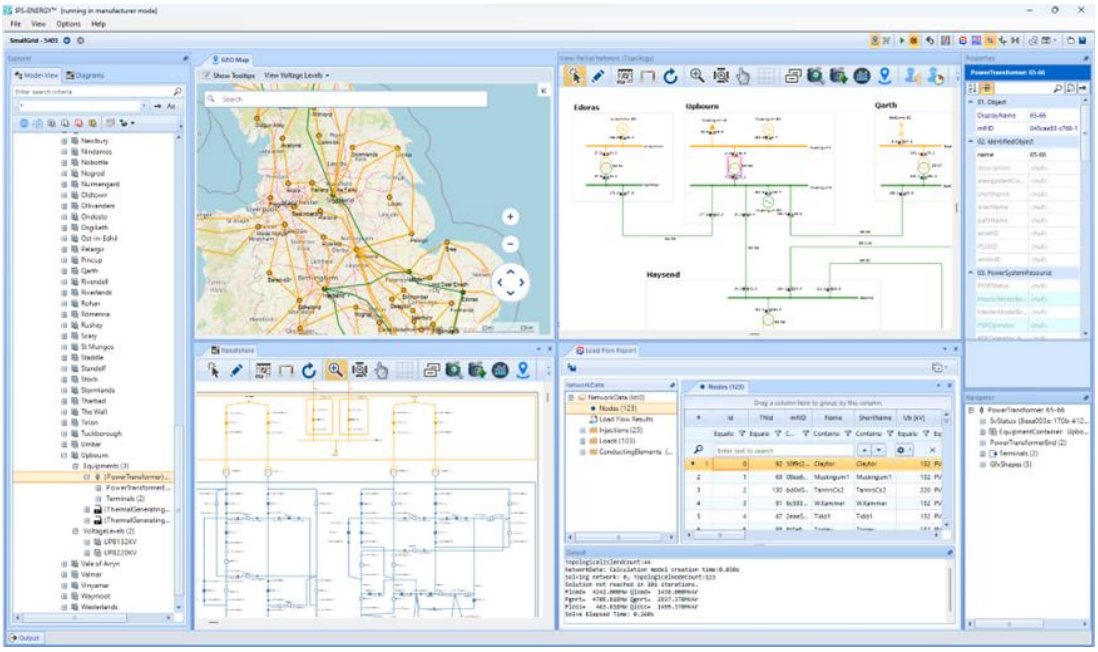
6.8.4.Expected CIM functionalities

The overall experience, vendor interaction, contract negotiation, contract flexibility, understanding of organisational needs, responsiveness to product questions and issues, responsive service and technical support, user group, and peer community are IPS's commitment to maintain into the future.

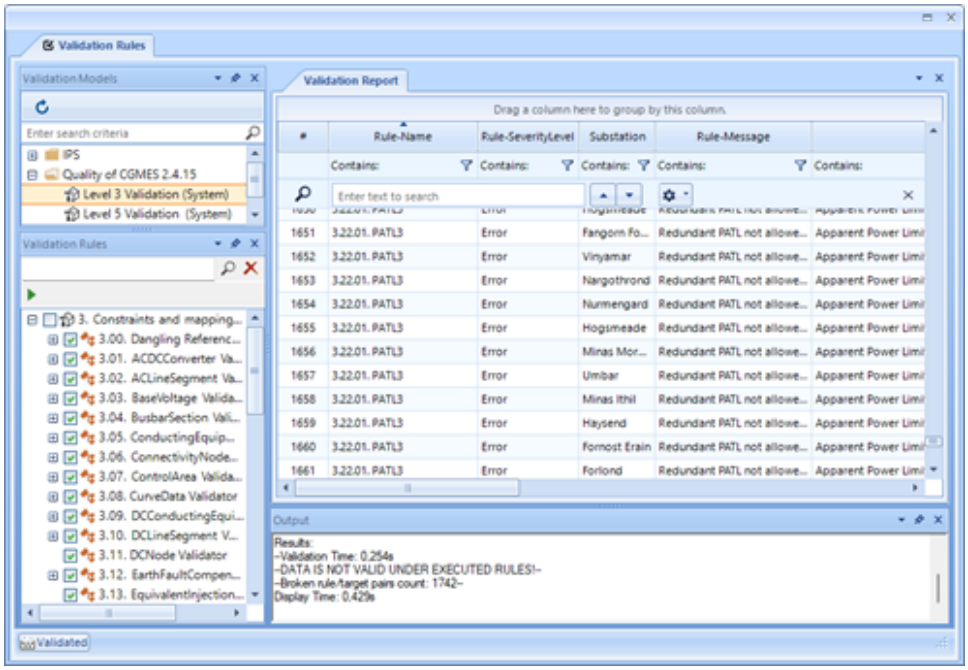
- IPS®NMM is fully built on CIM models (IEC 61970 and IEC61968) and supports customer specific extensions. It supports all CGMES profiles for CGMES 2.4.14. In a testing phase it supports all

the CGMES 3.0 profiles. The IPS system is compliant with the North American (NERC) standards. Additionally, the IPS®NMM also supports customer specific profiles.

– The CIM model could be visualised through hierarchical trees, GEO map, list views, diagrams, property grids and reports.

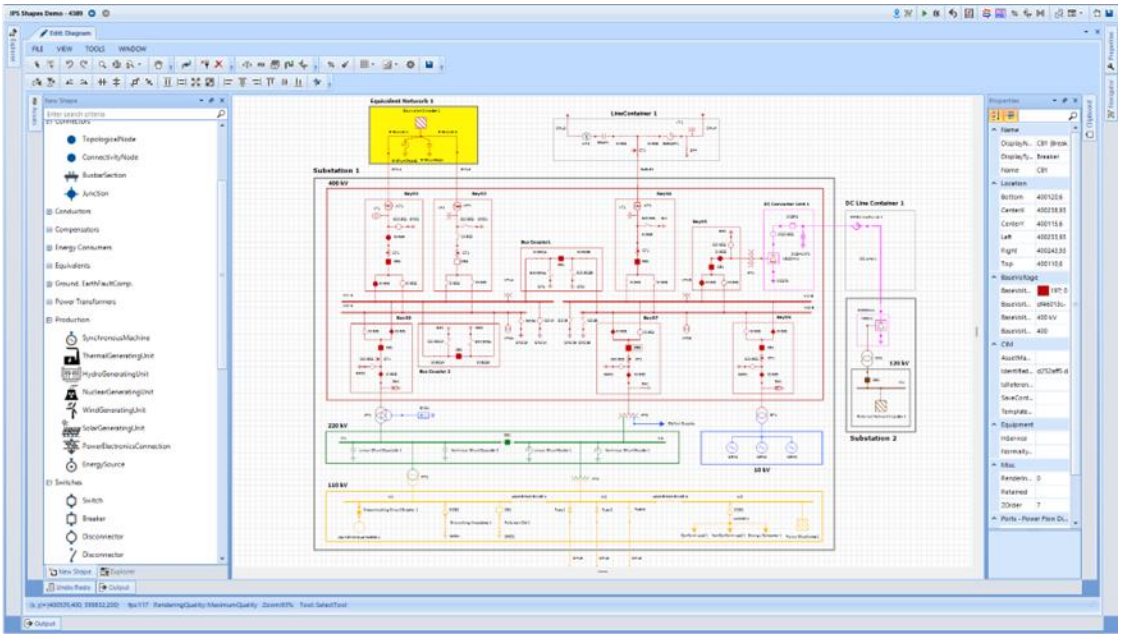


– IPS®NMM is updated continuously to comply with the ENTSO-E Quality of CQMES Datasets and Calculations (QoCDC) guide.

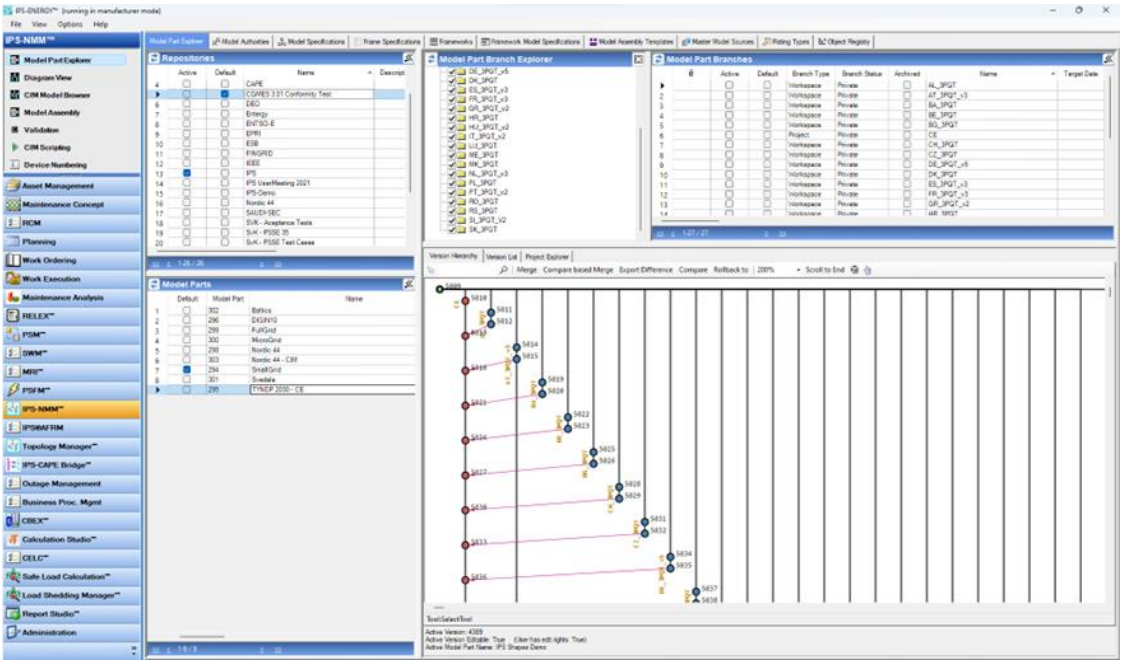


– Intuitive and powerful CIM node-breaker and bus-branch modelling are available via IPS Diagram Editor It supports creation of single line diagrams and topological diagrams. Based on diagram editing the CIM model is automatically updated. IPS®NMM supports customisable

single line auto-layout diagrams. Easy diagram update, based on CIM model is very useful feature.

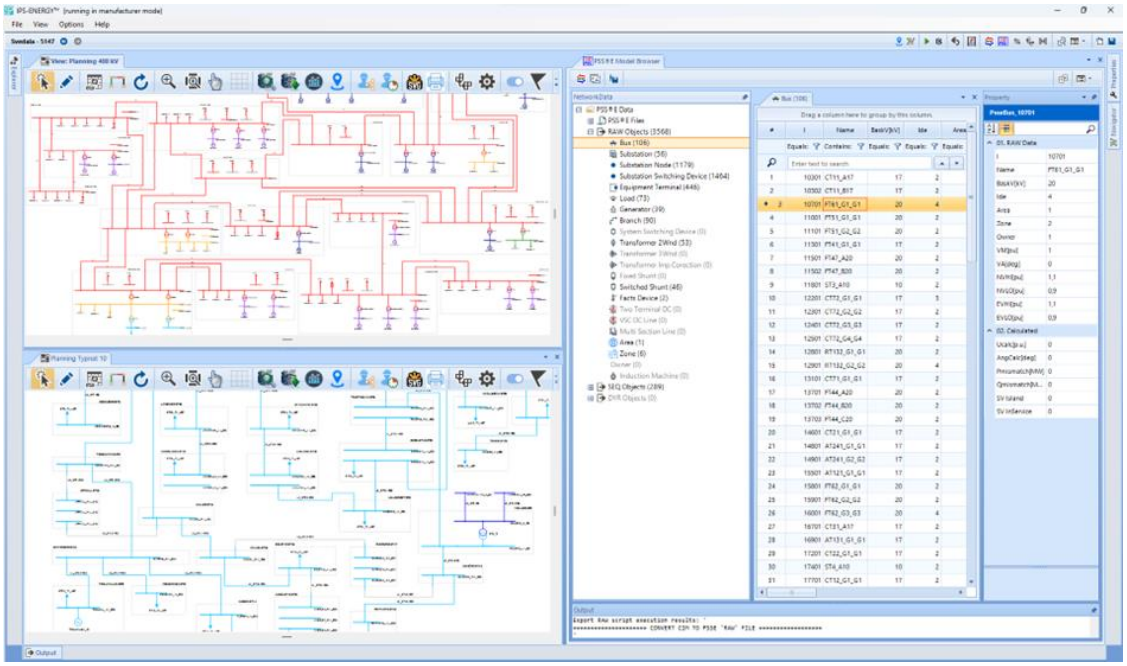


– Capability to easily merge large multi area (MAS) systems (tested with 26 TSO models simultaneously) together with the automatic generation of CGM models makes the IPS®NMM attractive option for ENTSO-E member TSOs.

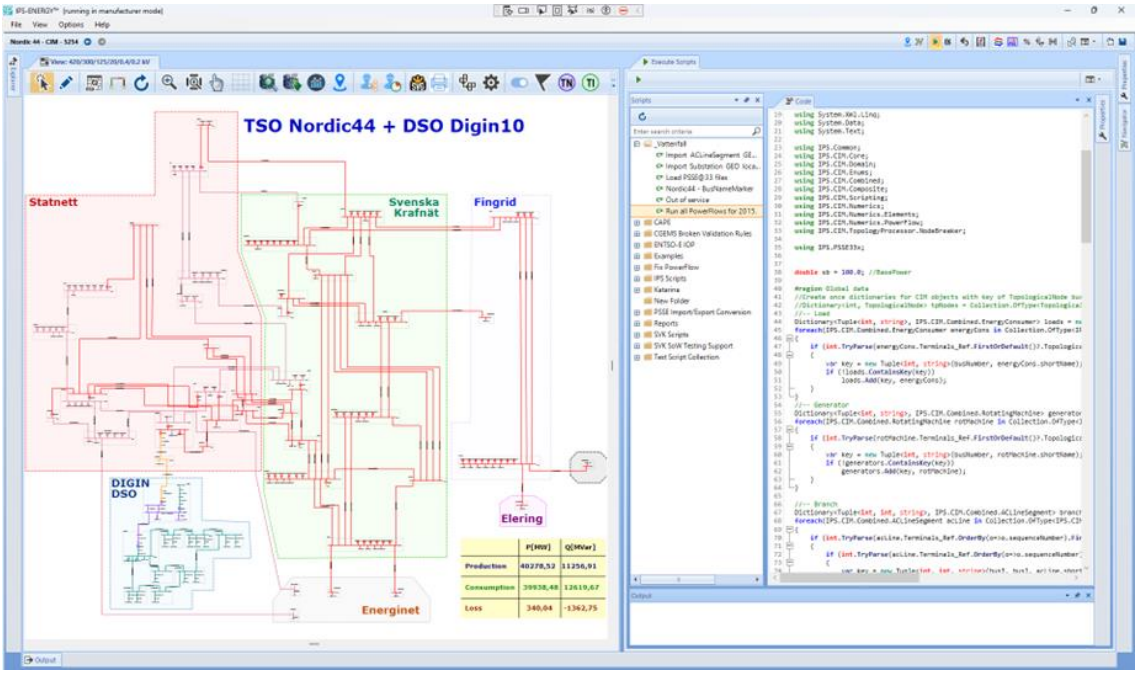


– The system fully supports the conversion of PSS®E (version 33 and 35) RAW, SEQ and DYR models from<->to CIM. The conversion from/to PSS®E v35 supports both node-breaker and

bus-branch model conversion. The customers with PSS®E installation could seamlessly integrate IPS®NMM with PSS®E via python interface.



– IPS®NMM has a script engine for massive manipulation with CIM models. C# and Python programming languages are supported.



6.9.Neplan

6.9.1.Relevant information for SV IOP

– Used version: PSI Neplan v. 1.9.5.2

– Import: CGMES v2.4 and CGMES v3.0

– Export: CGMES v2.4.15 to and CGMES v3.0

– More: Conversion between CGMES v2.4.15 to CGMES 3.0

6.9.2.Vendor presentation

PSI Neplan AG was founded in 1988 and develops high quality software for electrical, gas, water and district heating networks as well as specialised services related to these fields.

The company's head office is located in Küsnacht near Zurich, Switzerland and is privately owned and fully independent. As owner and developer of the first-class analysis tool NEPLAN® the company became one of the leading companies in the power system engineering software market.

PSI NEPLAN® is a high-end power system analysis tool for applications in transmission, distribution, generation, industrial, renewable energy systems, Smart Grid application and is used in more than 110 countries.

PSI Neplan AG is staffed of engineers with PhD and professor degrees for developing “Swiss Made” software and providing specialised consulting services and research activities, especially in the fields of renewable energy and storage.

PSI Neplan AG is member of the international NEPLAN® Consulting group, which has successfully carried out more than 1000 power system studies and consultancy work with NEPLAN®.

Our mission

The mission of PSI Neplan AG is to deliver first class Software Solutions and Services to the electrical, gas, water and district heating industry worldwide with its more than 25 years of expertise. Our professional team is dedicated first and foremost to the development of highest quality software to meet the needs and demands of our customers.

Our vision

Our Vision is to meet the challenge of achieving sustainable development in all our business areas so as to shape a better life quality for today’s and future generations.

6.9.3.Tool description

NEPLAN Electricity is a software tool to analyse, plan, optimise and simulate electrical networks. The strength of the software is the extremely user-friendly graphical interface with the extensive libraries for the network elements, protection devices and control circuits, which allows the user to perform study cases very efficiently. The software has a modular concept, is based on international standards, such as IEC, ANSI, IEEE, etc. and is customisable for the European and US market. It is used in transmission, distribution, generation / industrial networks amongst others for network and investment planning, power quality, multi-period optimisation, protection setting and assessment, dynamic simulation (RMS/EMT). The stationary and dynamic models for 1-2-3 phase (with neutral and earth wire) AC and DC networks have a high accuracy and performance. Very big network (above 500’000 bus bars) could be easily handled by new IT-techniques and algorithm.

NEPLAN has a client-server architecture and is able to run in a multi-user environment with a common SQL-database. This facilitates team working, both within the same business entity as well as with sharing projects between different departments or companies.

The software is available in different technologies, such as single user desktop or multi-user intranet or cloud application (see box “technologies” below).

NEPLAN is an open system and allows the full access to network data, solution algorithm and internal functions through:

- Scripting
- Event definition
- Web services
- OEM Integration to 3rd party environment

6.9.4.Expected CIM functionalities

- Full support of all CGMES profiles (Gold conformity level) for CGMES 2.5.14.
- Continuous update of ENTSO-E Quality of CQMES Datasets and Calculations (QoCDC) guide.
- User friendly CIM CGMES modelling, no need to be fully familiar with the CGMES standard, most of the things are done automatically by Neplan
- Capability to easily merge large multi area (MAS) systems (tested with 26 TSO models simultaneously) and automatic generation of CGM models.
- Development of CGMES 3.0 interchange, providing backwards compatibility to CGMES 2.5.14.
- Export of full model and incremental model for main CGMES 3.0 profiles.

6.10.ODMS

6.10.1.Relevant information for SV IOP

- Used version: 14.0.0.3.
- Import: Contingency, RemedialAction, RemedialActionSchedule, SystemAnalysisResults profiles.
- Export: functionality under development.
- More: the tool is able to run contingency analysis, remedial actions, etc.

6.10.2.Vendor presentation

SIEMENS

Siemens Grid Software enables grid operators as well as industry and infrastructure companies to accelerate and secure the energy transition in a sustainable and profitable way.

Designed to accelerate the energy transition of grids by adding mission-critical capabilities, Siemens Grid Software helps grid operators decode and shape the future of their power landscape. Our products are part of the Siemens Xcelerator for Grids portfolio, supporting the digital transformation of power utilities.

Siemens Grid Software are delivering solutions for Network planning, Operation and Control, Optimisation and Maintenance, Meter Data management and Consulting in a variety of genres.

6.10.3.Tool description

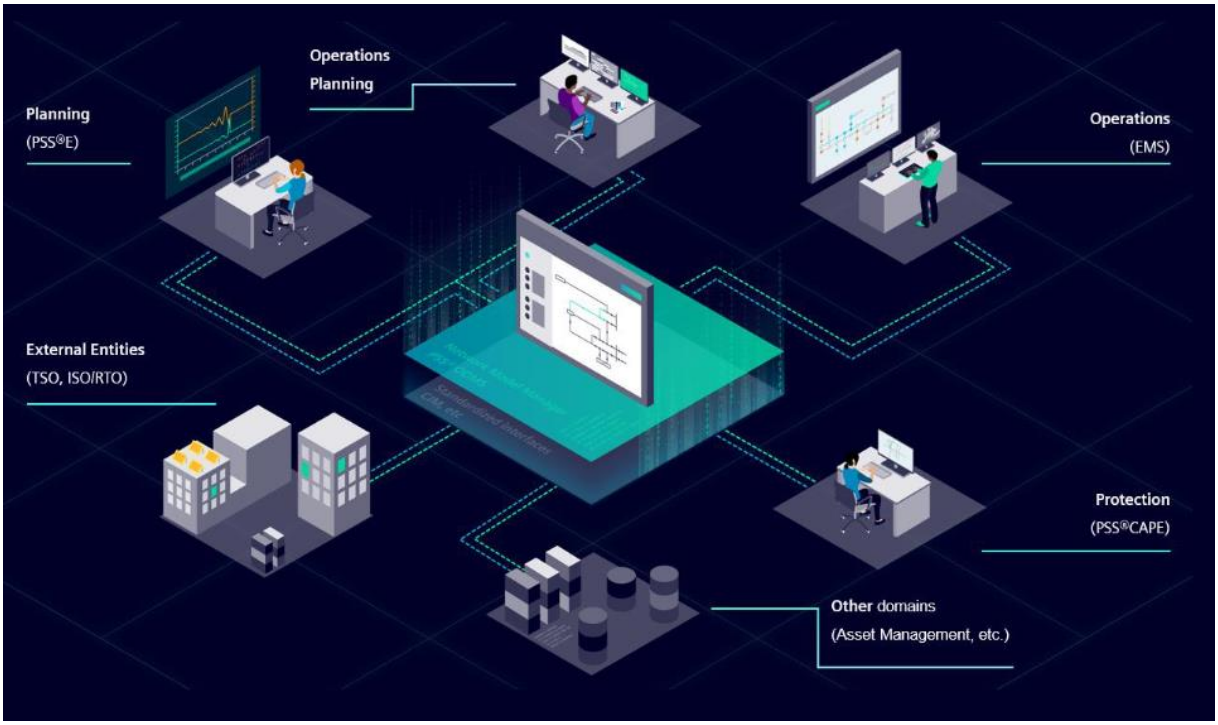
PSS®ODMS is a CIM-based transmission network modelling and analysis software and the core component of Siemens Network Model Management Solution.

Transmission operations studies and analyses are only as good as the data or models on which they are based. With the PSS®ODMS multipurpose solution, you can easily create, manage, validate, and exchange network models for use in long-term planning studies, near-term operational planning, and real-time system operation. PSS®ODMS is a CIM native application where data is stored according to the latest CGMES standard and acts as a proven bridge between multiple utility domains.

With its flexibility, lightweight deployment, ease of use, CIM (IEC 61970) compatibility, open architecture, public APIs, and seamless integration with planning tools like PSS®E, PSS®ODMS can benefit power companies of various sises and functions, including TSOs, ISOs, RTOs, balancing authorities, reliability coordinators, and integrated utilities.

PSS®ODMS will help you achieve greater efficiency in your model exchange workflows / business processes with a higher degree of accuracy in your power system studies, models, and simulations. Increase power system reliability/security while avoiding regulatory violations/fines. PSS®ODMS provide turnkey compliance with key regulatory requirements around model accuracy, audit trails, network analysis, and model exchange, and network model / data formats and have been a trusted tool for a variety of utilities for decades. For years, PSS®ODMS have been the preferred CIM tool for many European TSOs for generating their individual Grid Model (IGM) as part of Common Grid Model Alignment (CGMA) process.

Product Page and Brochure



PSS®ODMS is the hub that makes handling CIM data across your organisation easy.

6.10.4.CIM attestation and pipeline

- Compliance with North American (NERC) and European (ENTSO-E CGMES) data modelling and exchange standards
- ENTSO-E CGMES Gold Certification in all relevant categories for CGMES 2.4.15
- Regularly update PSS®ODMS to comply with ENTSO-E Quality of CQMES Datasets and Calculations guide (QoCDC).

Pipeline:

- ENTSO-E attestation for CGMES 3.0 compliance in all relevant categories.
- CGMES 2.4.15 <-> 3.0 upgrade and downgrade, ensuring backward compatibility.
- NC support for relevant classes and functions.

6.10.5.Contacts

Website:

https://www.siemens.com/global/en/products/energy/grid-software/planning/pss-software/pss-odms.html

Participants IOP: Sindre Hunn, sindre.hunn@siemens.com

6.11.ValiMate

6.11.1.Relevant information for SV IOP

– Used version: 1.2.5 + local development version for running unit tests with models.

6.11.2.Vendor presentation

Associmates is the digital partner for Europe‘s critical infrastructures. Founded in 2019, we are merging the capabilities of two well-respected consulting companies into one reliable and strong full-service digital partner for our European customers. We get up to change the world for the good of society. This is why we focus our efforts on critical infrastructures to maximize our positive impact. We believe in trust, quality, flexibility, and a better tomorrow.

Associmates provides digital advisory, architecture, management, testing, operational and software development services for Europe’s critical infrastructures with a strong focus on Europe‘s electricity transmission system operation.

Our software development and operations expertise expands across the whole range of CGMES related applications such as ECCo SP (ECP/EDX) and OPDM, providing development and operations services, supporting European TSOs with running ECCo SP and OPDM Client in the most efficient and effective way in on-premise or cloud data centers, on VMs or Kubernetes.

6.11.3.Tool description

ValiMate is the industry leading SHACL-based validation engine for CGMES 2.4.15, CGMES 3.0 and related CIM Standards. It is built on the power of SHACL – the Shapes Constraint Language – and can be used for any RDF based dataset validation.

Out of the box, ValiMate deals with specificities of CIM for network model exchange (IEC 61970 standards) including CGMES – IEC 61970-600-1 and IEC 61970-600-2).

ValiMate can be used and integrated via its command line interface or REST API. In addition, we offer a free GUI version with limited features.

– ValiMate can be used for validation of individual datasets, individual grid models (IGM) or common grid models (CGM).

– ValiMate generates validation reports in CSV and XLS formats, with the ability to customize the report format based on requirements.

– ValiMate can be easily executed on Windows, Linux, and Mac platforms.

– ValiMate offers a REST API based on Swagger/OpenAPI in the full version.

– ValiMate also offers a Docker version.

– Comprehensive product documentation and 24/7 support are available to ensure a seamless experience with ValiMate.

6.11.4.Expected CIM functionalities

Validation of any CGMES 2 and 3 models and Network Code Profiles.

6.11.5.Contact

Max Jonas Werner, max.werner@associmates.eu

7. Annex B: Summary of Issues

This annex summarises issues that have been discussed in the IOP. These issues should be presented to IEC, UCAIug and ENTSO-E in order to apply the proposed resolutions in the next release if related specifications or standards.

7.1.Wrong inheritance to IdentifiedObject

7.1.1.Description

In the ER profile, the AreaDispatchableUnit class does not inherit from IdentifiedObject. There are some issues with inheritances regarding identifiedObject to NC classes. The RDFS/UML Diagram showed no inheritances, but the attributes were used in the instance file.

7.1.2.Conclusion

In several clases, inheritance from IdentifiedObject makes sense to use it in order to have a human redeable name, but it also depends on the use case of the profiles. The issue with AreaDispatchableUnit is recognised as a profile issue that will be fixed.

7.2.Validation issues and References of ContingencyElement.Contingency type from ContingencyEquipment

7.2.1.Description

Based on the analyses of the validation report done for the DIgSILENT example it is detected that the validation did not consider references of ContingencyElement.Contingency type from ContingencyEquipment instances and thus reported multiple false negatives for OutOfRangeContingency and OrdinaryContingency instances. This is an issue in either the SHACL file, or in the validation tool.

The rest of the issues are reported for missing parameters on the model headers. These parameters are of informative nature, and the omission does not lead to any data issue. Adding these missing attributes with any random input should solve the problem.

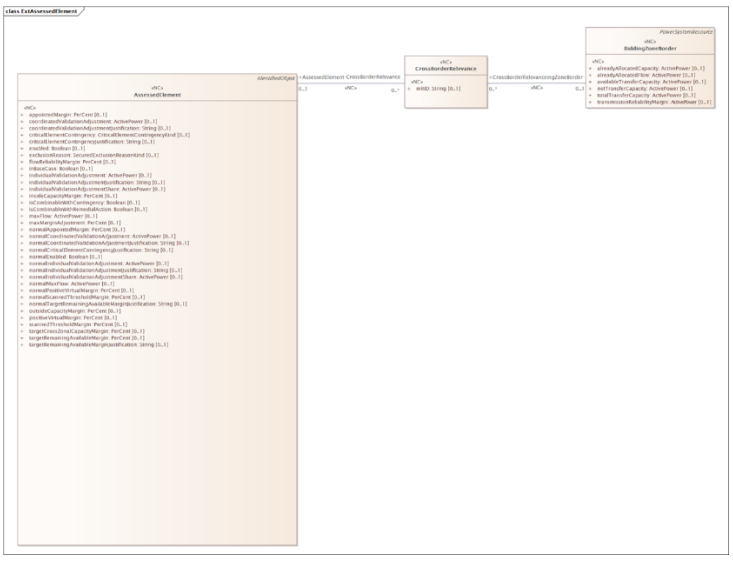
7.2.2.Conclusion

It was agreed that the problem is in the SHACL. The support for multiple namespaces will be improved by using alternative paths. Next version of the SHACL based constraints will have the issues fixed.

7.3.isCrossBorderRelevant update of snippet

7.3.1.Description

RCP DES must be updated with updated snippet.



7.3.2.Conclusion

The issue was discussed and recognised as a misalignment. Changes were done before the before the publication of the RCP DES 2.3.

7.4.Multiple profile / ConformTo reference

7.4.1.Description

In 20231022_EU-PowerSystem-CommonData_CD.xml

Currently:

<dcterms:conformsTo rdf:resource="http://entsoe.eu/ns/CIM/ObjectRegistry-EU/Constraints"/>
<dcterms:conformsTo rdf:resource="http://entsoe.eu/ns/CIM/ObjectRegistry-EU/2.1"/>
<dcterms:conformsTo rdf:resource="http://entsoe.eu/ns/CIM/EquipmentReliability-EU/2.2"/>
<dcterms:conformsTo rdf:resource="http://entsoe.eu/ns/CIM/DocumentHeader-EU/2.3"/>
<dcterms:conformsTo rdf:resource="http://entsoe.eu/ns/CIM/EquipmentReliability-EU/Constraints"/>

Fixed namespace:
<dcterms:conformsTo rdf:resource="https://ap-con.cim4.eu/ObjectRegistry/2.1"/>

<dcterms:conformsTo rdf:resource="https://ap.cim4.eu/ObjectRegistry/2.1"/>

<dcterms:conformsTo rdf:resource="https://ap.cim4.eu/EquipmentReliability/2.3"/>

<dcterms:conformsTo rdf:resource="https://ap.cim4.eu/DocumentHeader/2.3"/>

<dcterms:conformsTo rdf:resource="https://ap-con.cim4.eu/EquipmentReliability/2.3"/>

Alternative 1

20231022_EU-PowerSystem-CommonData_CD.xml:
<dcterms:conformsTo rdf:resource="https://ap.cim4.eu/ObjectRegistry/2.1"/>
<dcterms:conformsTo rdf:resource="https://ap.cim4.eu/EquipmentReliability/2.3"/>
<dcterms:conformsTo rdf:resource="https://ap.cim4.eu/DocumentHeader/2.3"/>

EquipmentReliability-AP_v2-3-0.ttl:
er:Ontology rdf:type owl:Ontology;
owl:versionIRI <https://ap.cim4.eu/EquipmentReliability/2.3>;
owl:versionInfo "2.3.0"@en;

owl.import https://ap-con.cim4.eu/EquipmentReliability-Simple/2.3.

7.4.2.Conclusion

The direction from the 3WC standard allows to refer to multiple profiles and multiple constraints. The implementations shall consider this as some exchanges require an exchange of multiple profiles in one instance file. In order to promote linked data principles and machine-readable concepts, ENTSO-E will provide description of the profiles utilising W3C DX-PROF. This would enable that only one conformsTo attribute to be exchanged in the header if it is meant that the dataset conforms to that profile. The profile description will describe what artifacts related to the profile. ENTSO-E will update metadata specification.

7.5.Update of Energy Reference Data

7.5.1.Description

There are some inconsistencies in the Energy Reference Data GitHub after the publication of the RCP release 2.3. ENTSO-E must update them. Among other, the energy type to the reference data in PowerShiftKey linkage needs to be corrected.

7.5.2.Conclusion

The issue was discussed, and tasks are planned to update the reference data.

7.6.How to specify the remedial actions?

7.6.1.Description

There are difficulties to understand what is mandatory to exchange. Also, there is a difficulty to map to the data source. It is not clear what TSOs', RCCs' and vendors' software need to support?

7.6.2.Conclusion

The discussion on this issue clarified that the primary objective of RCP DES document is to provide the necessary guidance. However, due to the complex setup of the business processes and the interactions between them the development of the RCP DES is an iterative process. Contributions from all parties is expected. The SV-IOP highlighted some elements that will be targeted when working on next versions. On another hand, the TSOs and RCCs will need to have the understanding of the different methodologies and make sure that the design of setting up contingency, assessed elements, remedial actions fits best the operational conditions they would like to apply for the power system under their responsibility. The mapping of the data is difficult topic as there are different systems used in different TSOs and the data is coming form different sources. Sharing best

practices, improving profile specifications, organising training, improving RCP DES are just some of the activities that will be performed to facilitate the implementation of NC Profiles.

7.7.Language in the header

7.7.1.Description

Why is it relevant to use the language in the header instead of just using free text?

7.7.2.Conclusion

The main reason is to adapt to the Semantic Web concepts and approach, to the way smarter systems work. It is expected that at least the English version of the information is exchanged. It is allowed to export in different languages. It was agreed to remove the language tag from the header attributes. However, it is expected that this will not block if a sender is defining an additional description e.g. in Spanish and in this case the language tag will need to be defined.

7.8.SHACL rules still check datatype

7.8.1.Description

This issue is similar to CGMES conformity assessment scheme where datatypes are still checked in the SHACL rules. It is expected that the datatypes are not checked as they are not part of the exchange. There are no open libraries to natively enhance the data based on the profile definitions.

7.8.2.Conclusion

The datatypes are essential part of the profile definition, but in the CIMXML serialisation that is used in the exchange, the datatypes are not exchanged. There are multiple ways to resolve this problem: 1) change the serialisation. This is what CIM community and ENTSO-E is working on. Adopting JSON-LD will solve the issue 2) provide open library to perform the parsing and mapping of datatypes; 3) have each vendor that validates datatype develop their own solution.

7.9.Swissgrid model EquivalentInjections contained by Lines not belonging to boundary MASRequester: Swissgrid + DNV

7.9.1.Description

The Swissgrid v2 model has EquivalentInjection obhjects contained by Lines that look much like boundary Lines but do not belong to a boundary MAS.

7.9.2.Conclusion

The issue was recognised as test configuration problem that will be fixed when next version is provided.

7.10.SHACL rule to identify validation was not carried out

7.10.1.Description

To specify the rules that identifies the fact that the validation was not carried out and give a reason instead of showing zero errors.

7.10.2.Conclusion

The issue was discussed and the SV-IOP participants will use conformsTo information in the header to have this understanding. Metadata specifications will be updated to state that if the reference to the profile is given it is understood that the dataset conforms to all related constraints and profile specifications.

7.11.Duplication of boundary points

7.11.1.Description

CGMES v2.4 and v3.0 does not allow duplication of boundary information. At the same time ENTSO-E published a document in May 2023 that specifies duplication of the boundary information. When should this be implemented?

7.11.2.Conclusion

The document published by ENTSO-E fixes gaps in CGMES v3.0. This specification should be included in the next version of the standard, but until then it can be used in the implementation projects if there is an agreement to do so to avoid any other workarounds.

7.12.Definition for isCombinableWithContingency and isCombiablewithRemedialAction

7.12.1.Description

Is there a definition for isCombinableWithContingency and isCombiablewithRemedialAction? What is the expected behaviour when this attribute is not defined? Possibility to turn it mandatory?

7.12.2.Conclusion

The discussion on this issue clarified that the explanations are provided in the last version of the RCP DES v2.3. The usage of these classes depends on the design of contingencies and remedial actions that the TSOs would like to implement. These classes provide flexibility to designate particular remedial actions that are applicable (make sense) for a particular contingency.

7.13.Multiple GeographiclRegions are present

7.13.1.Description

Validation reports multiple GeographicalRegion objects. What is the explanation of this problem?

7.13.2.Conclusion

This depends how data is validated. CGMES defined that there should be one GeographicalRegion per ModellingAuthoritySet. The SHACL constraint validates this, but the constraint does not have information if there are multiple MAS presented for validation. In case the validation is performed not only on the EQ dataset, but the complete IGM including boundary, SHACL validation will result in a violation of the constraint, which is normal. Therefore, it is important to select the right set of constraints depending on the validation scope.

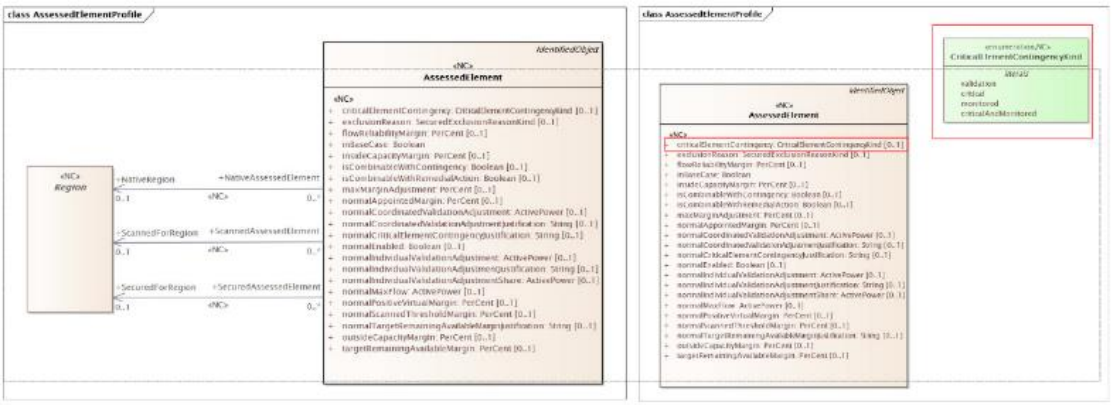
7.14.isCritical attribute | Critical element for contingency kind

7.14.1.Description

Inconsistency between CSA isSecuredFor and CCC criticalElementForContingency. What is the substitute for isCritical attribute?

7.14.2.Conclusion

The attribute isCritical was substituted by criticalElementContingency the as shown in the figure below.

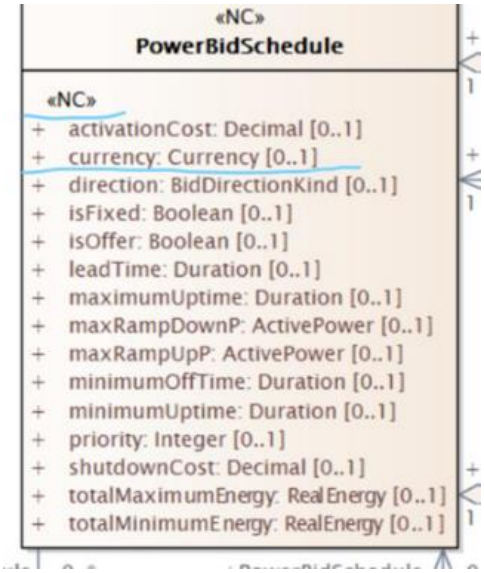


7.15.NC profiles currency enumeration

7.15.1.Description

There are questions regarding currency enumeration (specifically how it is designed in SIS profile) and the corresponding SHACL rules for the attributes datatype. How the following can be explained:

In State instruction schedule profile there is a PowerBidSchedule class with the "currency" attribute (it is specified under <nc> namespace).



However, in the SHACL rules currency enum has the following description (picture below, ttl snippet, datatype description).

```
sis:PowerBidSchedule.currency-datatype
        rdf:type          sh:PropertyShape;
        sh:description    "This constraint validates the datatype of the property (attribute).";
        sh:group          sis:DatatypesGroup;
        sh:in             ( cim:Currency.DKK cim:Currency.CLP cim:Currency.KZT cim:Currency.MZN cim:Currency.CHF cim:Curre
        sh:message        "The datatype is not IRI (Internationalized Resource Identifier) or it is enumerated value not p
        sh:name           "PowerBidSchedule.currency-datatype";
        sh:nodeKind       sh:IRI;
        sh:order          18;
        sh:path           nc:PowerBidSchedule.currency;
        sh:severity       sh:Violation .
```

Meaning xml serialisation would look something like this (for graph to pass the rules,):

- We have a mix of *nc* and *cim* namespaces.

```
<nc:PowerBidSchedule.currency rdf:resource="http://iec.ch/TC57/CIM100#Currency.EUR"/>
```

It is unsure whether this is a bug or how to address this, but it seems as a problem.

7.15.2.Conclusion

It is clarified that this is normal setup and the provided screenshot is correct. The attributes needs to be in the nc namespace and the enumeration needs to be in the cim namespace.

7.16.Make ExceptionalContingency.kind optional

7.16.1.Description

The need for ExceptionalContingency.kind is questioned. There is reference to regulation from CSAm Article 7. However, it is not necessarily clear if this is mandatory.

The question is if ExceptionalContingency.kind could be made optional, or secondary adding an additional enumerator other/unknown/undefined so that it is possible to use ExceptionalCongingency without the need to specify the kind.

7.16.2.Conclusion

The legal background is at Regulation - 2017/1485 - EN - EUR-Lex (europa.eu): articles 39, 54 and 59. There was a need to have extra classes to identify the types of the contingencies. It is agreed to consider if the kind can be made optional and then, the business can constraint it (in a quality document). It was also agreed that the specialisation will be left as it is (i.e., it will not be changed to enumeration).

7.17.CSA and CGMES profile RDFSs

7.17.1.Description

RDFS files for CSA 2.3 together with CGMES 3.0 were processed. It turns out, there are duplicate elements, one of them should have Stereotype "Description" or need other kind of redesigning:

Element	Profiles
cim:ConnectivityNode	EQ, EquipmentReliability
cim:CurveData	EQ, EquipmentReliability
cim:DCNode	EQ, EquipmentReliability
cim:NuclearGeneratingUnit	EQ, EquipmentReliability
cim:OperationalLimitType	EQ, EquipmentReliability
cim:ReactiveCapabilityCurve	EQ, EquipmentReliability
cim:Season	EQ, StateInstructionSchedule
cim:VsCapabilityCurve	EQ, EquipmentReliability
nc:EventSchedule	AvailabilitySchedule, RemedialActionSchedule
nc:EventTimePoint	AvailabilitySchedule, RemedialActionSchedule

nc:FrequencyControlFuntion	EquipmentReliability, SteadyStateInstruction
nc:GenericValueTimePoint	RemedialActionSchedule, StateInstructionSchedule
nc:GridStateIntensitySchedule	RemedialActionSchedule, StateInstructionSchedule
nc:PinTerminal	EquipmentReliability, RemedialAction
nc:PowerSchedule	PowerSchedule, RemedialActionSchedule
nc:PowerTimePoint	PowerSchedule, RemedialActionSchedule
nc:SolarRadiationDependencyCurve	EquipmentReliability, RemedialAction

7.17.2.Conclusion

Reported errors were analysed and the RDFS fixed when it was necessary.

7.18.Should normal attributes be mandatory?

7.18.1.Description

It is difficult to know what means when the normal attributes are not provided. In that case, some rules shall be developed and it brings difficulty to understand what they mean.

7.18.2.Conclusion

The discussion confirmed that it is not good to make attributes required as in most cases the systems will not have normal kind of value and it will be misleading for the receiving system and the business process. RCP DES was updated to have clearer explanation on how normal values, schedules and hourly values (MTU) are used.

7.19.Linking remedial action schemes to multiple EQ models

7.19.1.Description

It is not clear how to correctly configure an RA profile that contains complex trigger-conditions spreading across many MAS. A remedial action has a trigger-condition that observes two network elements, each in a different EQ model. How to link this single remedial action to both EQ profiles?

Apparently, the RCP specification does not fully support this constellation, since the RA can be linked to one EQ profile only. Would it make sense to enable ‘1..n’ multiplicity for the RA->ER association?

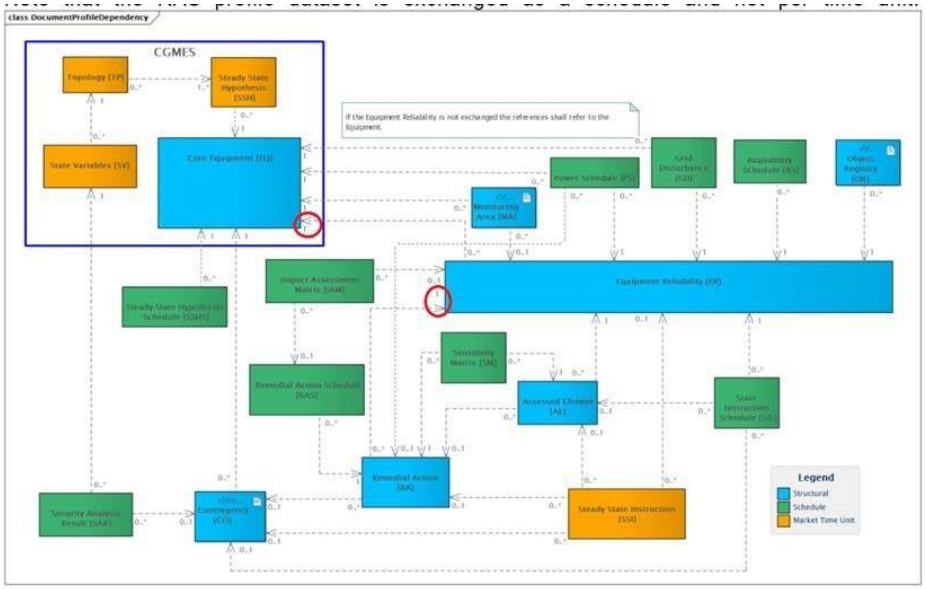


Figure 43 – Dataset dependencies

7.19.2.Conclusion

There are two MAS(s) (MAS|east, MAS|west), then there will be two RA(s). The HVDC being another MAS. The RA|1 will have a trigger (TR|1) and RA|2 will describe the action (AC|1). The vise versa situation is also possible. Both RA datasets refer to the same Boundary set. It is concluded that what is to be included in the boundary needs to be further investigated. The general recommendation is that shared Ras will need to be in teh common data (boundary data) that is agreed bilaterially.

8. Annex C: Test Procedures

8.1. Test rules

On-site rules

On-site test starts on 8 July 2024 at 13:00h and finishes on 11 July 2024 at 12:00h. On 9 July and 10 July test participants should be present in the ENTSO-E premises between 9:00h and 17:30h.

The following ground rules to be followed during the ENTSO-E Interoperability test:

- Vendors must submit the product release (version ID) for the software they are going to use.
- Test witnesses need to familiarize themselves with the test configurations and be able to witness the correct implementation of the profiles. The test witnesses move between test participants in order to cover all vendors and ensure that each test witness witnesses each vendor. The test participants (vendors) execute all tests which they would like to cover and complete the internal validation. Validation is performed by DNV and Associmates. The test witness ensures that all steps are executed and all issues are noted.
- The test participant (vendor) downloads the model files to be imported from the file storage location and the model files produced by the test participant are then uploaded to the agreed file server for use by other participants. DNV and Associmates are responsible for the CIM/XML file validation and for ensuring that the results are loaded onto the file server. However, the test witness should assist the test participant with these tasks as much as possible. At a minimum, the test witness should ensure the files are included on the file server. The test director ensures the contents of the file server are backed-up to a memory stick each day and makes the contents available to all test attendees upon request prior to the end of the IOP.
- Unstructured tests may be performed if there is time and the test participant wishes to complete these tests. Any unstructured test must be documented on the test record form by the test witness for inclusion into the IOP report. Each step of the procedure followed must be fully documented.
- The test participants may select what test cases and test procedure they wish to execute depending on the functionalities of their tools. The IOP report presents the results for all files used and all procedures executed.

Test scoring rules

The tests are not scored as the main objective is to confirm the correctness of the RCP DES and NC Profiles.

8.1.1.Validation tools

During the SV-IOP the ENTSO-E CGMES is supported by DNV and Associates to perform the validation of the exchanged test configurations.

8.1.2.File naming during the IOP

Due to the usage of file headers, vendors should not count on file names to identify information about file types. This information has to be obtained using file header.

8.1.3.File transfer

ENTSO-E SV-IOP will use a dedicated Microsoft SharePoint cloud storage (link). Only public, anonymised data will be exchanged.

8.2.Test configurations

Participants shared the following test configurations (TC)—that is, test models—to be used during the SV IOP. No all of them were finally used.

6. Baltic RCC
7. DIgSILENT
    a) CGMES v3
    b) CSA
    c) Small TC v2
8. Swissgrid test data v4
9. ENTSO-E TC1
    a) Boundary Duplicate
    b) Boundary Regular
    c) Boundary split BP and Common Data
    d) NC profiles
10. ENTSO-E TC 2
    a) Boundary Duplicate
    b) Boundary Regular
    c) Boundary Split BP and Common Data
    d) Boundary Split per Border
11. Unicorn test data v2
12. Energinet RA (SIPS)
13. ENTSO-E samples
    a) ObjectRegistry
    b) CommonData
    c) Boundary set

A graphical representation of the content of every test configuration and their variants can be found bellow in Figure 6.

Test configurations' content	CGMES									Boundary		Network Code extension									
	EQ	DL	SV	TP	GL	DY	SSH	EQ_BD	TP_BD (CGMES 2.4)	Boundary data	Common data	AE	CO	ER	IAM	RA	SIS	SSI	RAS	SAR	OR	AS
TC1 BoudaryDuplicate	x	x	x	x	x	x	x	x														
TC1 BoundaryRegular	x	x	x	x	x	x	x	x														
TC1 BoundarySplitBPandCommonData	x	x	x	x	x	x	x			x	x											
TC1 NC_Profiles												x	x									
TC2 CGM-BoundaryDuplicate	x		x	x			x															
TC2 CGM-BoundaryRegular	x		x	x			x															
TC2 CGM-BoundarySplitBPandCommonData	x			x			x			x	x											
TC2 BoundarySplitPerBorder	x						x				x											
Swissgrid v4	x							x				x	x	x	x	x	x	x				
DIgSILENT CGMES v3	x	x	x	x	x		x															
DIgSILENT CSA												x	x			x			x	x		
DIgSILENT small TC	x	x	x	x	x	x	x					x	x			x			x	x		
Unicorn v2	x		x	x			x	x	x			x	x			x	x	x				
Object Registry Sample											x										x	x
Baltic RCC test data v1	x	x	x	x	x		x	x				x	x			x			x	x		
Energinet RA (SIPS) models														x		x	x					x

Figure 6: Content of the different test configurations

8.3.Application functions

The following application functions are based on the applications functions defined in Section 10.1 and further adapted based on the SV-IOP discussed held in April 2024. The Application functions will be further discussed in the SV-IOP in the week of 8 Jul and adapted as necessary. The test use cases included in the test procedures are linked to the application functions defined in the table below. The objectives are that these application functions define the basis for the conformity assessment scheme related to the NC profiles.

Name	Description	Prerequisite	Required profiles
Selective export of individual profile	The Application supports NC profiles' datasets that are either exported individually or together as a package.	Handling of reference data and common data	Applied for all NC profiles supported by the Application
Selective import of individual profile	The Application supports NC profiles' datasets that are either imported individually or together as a package.	Handling of reference data and common data	Applied for all NC profiles supported by the Application

Support of difference model import	The Application supports import of difference model.	Selective import of individual profile	
Support of difference model export	The Application supports export of difference model.	Selective export of individual profile	
Structural data viewing	The Application offers structural data viewing.	Selective import of individual profile The Application shall support: - interactions of NC profiles and CGMES profiles defining the underlying power system model.	Equipment Reliability (ER), Monitoring Area (MA), Contingency (CO), Remedial Action (RA), Assessed Element (AE), ObjectRegistry (OR)
Structural data editing	The Application offers structural data editing.	Selective import of individual profile The Application shall support: - interactions of NC profiles and CGMES profiles defining the underlying power system model.	Equipment Reliability (ER), Monitoring Area (MA), Contingency (CO), Remedial Action (RA), Assessed Element (AE), ObjectRegistry (OR)
Scheduled data viewing	The Application offers scheduled data viewing.	Selective import of individual profile	State Instruction Schedule (SIS), Steady State Instruction (SSI)

	The Application shall support profiles related to the scheduled and per time unit data exchange.	The Application shall support: - interactions of NC profiles and CGMES profiles defining the underlying power system model.	
Scheduled data editing	The Application offers scheduled data editing. The Application shall support profiles related to the scheduled and per time unit data exchange.	Selective import of individual profile The Application shall support: - interactions of NC profiles and CGMES profiles defining the underlying power system model.	State Instruction Schedule (SIS), Steady State Instruction (SSI)
Handling of reference data and common data	The Application supports import and viewing of the reference and common data.		
Coordination Confirmation	The Application the interactions between parties sending data and parties receiving data.	The Application shall support: - interactions of NC profiles and CGMES profiles defining the underlying power system model.	Remedial Action Schedule (RAS), Security Analysis Results (SAR)

		- Selective export of individual profile (SAR, RAS) - Selective import of individual profile (RAS)	
Security analysis	The Application supports security analysis using power system model and information on contingencies and assessed elements. The Application can export the result of the security analysis.	The Application shall support: - interactions of NC profiles and CGMES profiles defining the underlying power system model. - Structural data - Scheduled data - Selective export of individual profile	Security Analysis Results (SAR)
Remedial action optimization	The Application supports optimization of the remedial actions and can export the result.	The Application shall support: - interactions of NC profiles and CGMES profiles defining the underlying power system model. - Selective export of individual profile	Remedial Action Schedule (RAS), Impact assessment Matrix (IAM)

8.4.Test Use Cases (TUC)

8.4.1.TUC 1: Import of IGM

Name	Import of IGM		
TUC Purpose	Verify that an application can import one or multiple IGMs supporting as minimum Equipment and Steady State Hypothesis profiles.		
Business Purpose	TSOs as part of CGM build process need to deliver an IGM and shall import IGMs for the purpose of updating surrounding grids. Perform modifications of own IGM and export own IGM. Ensure consistency with NC profiles data. The Merging function (application) as part of the CGM build process shall import IGMs and export a CGM.		
Preconditions/ Requirements			
Linked CGMES and NC Profiles	CGMES profiles (EQ, SSH)		
Test configurations	To be further defined.		
Comment			
No	**Description**	**Assessment Criteria**	**Test Step Outcome**
1	The application imports the test configuration.	Pass: the instance data is imported with no errors reported by the internal validation.	N/A
2	The Supplier provides proof of the correct import of the instance data. This includes comparison of instance data and a screenshot which shall be referenced in the documentation.	Pass: information is available and confirms the correct import. The data shall match with the documentation for the test configuration. Random instances are verified by the Review Team.	Screenshot

8.4.2.TUC 2: Export of IGM

Name	Export of IGM		
TUC Purpose	Verify that an application can export one or multiple IGMs supporting as minimum Equipment and Steady State Hypothesis profiles.		
Business Purpose	TSOs as part of CGM build process need to deliver an IGM and shall import IGMs for the purpose of updating surrounding grids. Perform modifications of own IGM and export own IGM. Ensure consistency with NC profiles data. The Merging function (application) as part of the CGM build process shall import IGMs.		
Preconditions/ Requirements			
Linked CGMES and NC Profiles	CGMES profiles (EQ, SSH)		
Test configurations	To be further defined.		
Comment			
No	**Description**	**Assessment Criteria**	**Test Step Outcome**
1	The application exports the test configuration and the export is submitted for assessment.	Pass: the instance data is exported with no errors reported by the internal export validation. Visual inspection of the file headers is done by the Review Team, the files pass validation without any issues.	EQ instance file SSH instance file
2	The Supplier modifies SSH value of one element (XYZ 1) and makes a	Pass: the instance data is exported with no errors reported by the internal export validation. Visual	EQ instance file for hour 1

	variant of the model for hour 1. The Supplier modifies SSH value of another element (XYZ 2) and makes a variant of the model for hour 2. The SSH shall contain both changes for elements XYZ 1 and XYZ 2. The Supplier adds a SynchronousMachine to the model and makes a variant of the model for hour 3. All 3 variants are exported. EQ for hour 2 is not exported as it is not modified.	inspection of the file headers is done by the Review Team, the files pass validation without any issues.	SSH instance file for hour 1 SSH instance file for hour 2 EQ instance file for hour 3 SSH instance file for hour 3

8.4.3.TUC 3: Import of NC Profiles Related to Structural Data

Name	Import of NC Profiles Related to Structural Data
TUC Purpose	Verify that an application can import NC profiles.
Business purpose	Import of the profiles is necessary for both TSOs and RCCs that are performing as part of the CSA business process. TSOs have to provide additional information on top of the IGMs. This information relates to list of contingencies, assessed elements, remedial actions, etc. When doing this TSOs need to import information from their neighbors as well as results from RCCs that will provide the TSOs with the results from the remedial action optimization.

Preconditions/ Requirements	Import of relevant IGM information
Linked CGMES and NC Profiles	ER, AE, CO, RA, MA, OR, PSP
Test configurations	To be further defined.
Comment	Use case for imported data: • Vendor could be a converter. • Next level would How do we validate that tools validate the import? • Who is the consumer of the results? What is the information that this client is seeking? What do vendors need to demonstrate? What is importing? • Until now, the meaning is getting a CIM model and translating it to tools' internal model but it does not mean that there is a preprocessing behind to do something with such data.

No	Description	Assessment Criteria	Test Step Outcome
1	The application imports the test configuration.	Pass: the instance data is imported with no errors reported by the internal validation.	N/A

8.4.4.TUC 4: Export of NC profiles Related to Structural Data

Name	Export of NC Profiles Related to Structural Data
TUC Purpose	Verify that an application can export NC profiles.
Business Purpose	Export of the profiles is necessary for both TSOs and RCCs that are performing as part of the CSA business process. TSOs have to provide additional information on top of the IGMs. This information relates to lists of contingencies, assessed

	elements, remedial actions, etc. RCCs need to export security analysis results and schedules for the remedial actions.		
Preconditions/ Requirements	Import of relevant IGM information		
Linked CGMES and NC Profiles	ER, AE, CO, RA,MA, OR, PSP		
Test configurations	To be further defined.		
Comment			
No	**Description**	**Assessment Criteria**	**Test Step Outcome**
1	The application exports the test configuration and the export is submitted for assessment.	Pass: the instance data is exported with no errors reported by the internal export validation. Visual inspection of the file headers is done by the Review Team, the files pass validation without any issues.	Datasets of related profiles

8.4.5.TUC 5: Import of NC Profiles Related to Scheduled and Solution Data

Name	Import of NC Profiles Related to Scheduled and Solution Data
TUC Purpose	Verify that an application can import NC profiles.
Business purpose	Import of the profiles is necessary for both TSOs and RCCs that are performing as part of the CSA business process. TSOs have to provide additional information on top of the IGMs. This information relates to list of contingencies, assessed elements, remedial actions, etc. When doing this TSOs need to import information from their neighbors as well as results from RCCs that will provide the TSOs with the results from the remedial action optimization.

Preconditions/ Requirements	Import of relevant IGM information		
Linked CGMES and NC Profiles	RAS, SAR, SSI, SIS, SHS, IAM, AS, PS, SM		
Test configurations	To be further defined.		
Comment			
No	**Description**	**Assessment Criteria**	**Test Step Outcome**
1	The application imports the test configuration.	Pass: the instance data is imported with no errors reported by the internal validation.	N/A

8.4.6.TUC 6: Export of NC profiles Related to Scheduled and Solution Data

Name	Export of NC Profiles Related to Scheduled and Solution Data
TUC Purpose	Verify that an application can export NC profiles.
Business Purpose	Export of the profiles is necessary for both TSOs and RCCs that are performing as part of the CSA business process. TSOs have to provide additional information on top of the IGMs. This information relates to lists of contingencies, assessed elements, remedial actions, etc. RCCs need to export security analysis results and schedules for the remedial actions.
Preconditions/ Requirements	Import of relevant IGM information
Linked CGMES and NC Profiles	RAS, SAR, SSI, SIS, SHS, IAM, AS, PS, SM
Test configurations	To be further defined.
Comment	

No	Description	Assessment Criteria	Test Step Outcome
1	The application exports the test configuration and the export is submitted for assessment.	Pass: the instance data is exported with no errors reported by the internal export validation. Visual inspection of the file headers is done by the Review Team, the files pass validation without any issues.	Datasets of related profiles

8.4.7.TUC 7: Import of Difference Model

Name	Import of Difference Model		
TUC Purpose	Verify that an application can import difference model of a dataset that conforms to NC profiles. Verify that the application can apply the changes on previously imported dataset both complete or other difference models.		
Business purpose	Import of difference model is useful to update a dataset that is supplying structural data.		
Preconditions/ Requirements	Import of relevant IGM information; Import of complete datasets		
Linked CGMES and NC Profiles	AE, CO, RA, ER,		
Test configurations	To be further defined.		
Comment			
No	**Description**	**Assessment Criteria**	**Test Step Outcome**
1	The application imports the test configuration.	Pass: the instance data is imported with no errors reported by the internal validation. The Review Team verifies that the data	N/A

		is updated by the difference model.	

8.4.8.TUC 8: Export of Difference Model

Name	Export of Difference Model		
TUC Purpose	Verify that an application can export difference model of dataset that conforms to NC profiles.		
Business Purpose	Export of difference model is useful to update a dataset that is supplying structural data.		
Preconditions/ Requirements	Import of relevant IGM information; Import of complete datasets		
Linked CGMES and NC Profiles	AE, CO, RA, ER,		
Test configurations	To be further defined.		
Comment			
No	**Description**	**Assessment Criteria**	**Test Step Outcome**
1	A change is applied to the imported data.	Pass: The change is documented and the Review Team confirms that the change is applied.	screenshot
2	The application exports the test configuration and the export is submitted for assessment.	Pass: the instance data is exported with no errors reported by the internal export validation. Visual inspection of the file headers is done by the Review Team, the files pass validation without any issues.	Datasets of related profiles

8.4.9.TUC 9: Data Viewing

Name	Data Viewing		
TUC Purpose	Verify that an application provides data viewing features.		
Business Purpose	Users need to inspect imported data or be aware which data should be exported.		
Preconditions/ Requirements	Import of relevant IGM information; Import of relevant NC profile datasets		
Linked CGMES and NC Profiles	AE, CO, RA, ER, OR		
Test configurations			
Comment			
No	**Description**	**Assessment Criteria**	**Test Step Outcome**
1	The application imports the test configuration.	Pass: the Review Team assesses if all imported data can be viewed.	N/A

8.4.10.TUC 10: Data Editing

Name	Data Editing
TUC Purpose	Verify that an application provides data editing features.
Business Purpose	Users need to edit imported data or prepare/modify data that should be exported.

	To create a contingency list. To be able to see whether the data inside tools' internal model is persistent. You		
Preconditions/ Requirements	Import of relevant IGM information; Import of relevant NC profile datasets		
Linked CGMES and NC Profiles	All except SAR and SM.		
Test configurations	To be further defined.		
Comment			
No	**Description**	**Assessment Criteria**	**Test Step Outcome**
1	The application imports the test configuration.	Pass: the Review Team assesses if all imported data can be edited.	N/A

8.4.11.TUC 11: Perform Contingency Analysis

Name	Perform Contingency Analysis
TUC Purpose	Verify that an Application can perform contingency analysis using imported information (IGMs or CGM and related NC profiles).
Business Purpose	CSA business process required to perform contingency analysis at multiple stages of the process, before and after remedial actions optimization.
Preconditions/ Requirements	Import a set of IGMs or a CGM (EQ, SSH) and related AE, CO datasets [TP and SV are optional datasets]
Linked CGMES and NC Profiles	EQ, SSH, [TP, SV], AE, CO
Test Configurations	DIgSILENT example can be used for this test

Comment			
No	**Description**	**Assessment Criteria**	**Test Step Outcome**
1	The application performs contingency analysis using imported datasets.	Pass: the Review Team assesses the ability of the application to perform the analysis.	N/A

8.4.12.TUC 12: Export Contingency Analysis Results

Name	Export Contingency Analysis Results		
TUC Purpose	Verify that an Application can export contingency analysis result.		
Business Purpose	CSA business process required to perform contingency analysis and export results at multiple stages of the process, before and after remedial actions optimization.		
Preconditions/ Requirements	Import a set of IGMs or a CGM and related AE, CO datasets [TP and SV are optional datasets]; Perform Contingency Analysis		
Linked CGMES and NC Profiles	EQ, SSH, [TP, SV], AE, CO, SAR		
Test Configurations	DIgSILENT (SAR profile that does not include the SPS/SIPS execution) and Unicorn's (which includes both grid in CGMES 2.4.15, NC profiles as input for SA and SAR profile as a result of SA.) examples can be used for this test		
Comment			
No	**Description**	**Assessment Criteria**	**Test Step Outcome**
1	Export results (a report of the violated contingencies) and compare with the supplied reference SAR profile.	Pass: the SAR dataset is exported with no errors reported by the internal export validation. Visual inspection of the file headers is done by the	SAR dataset

		Review Team, the files pass validation without any issues. The SAR dataset should be equal (with reasonable tolerance) to the reference SAR provided with the test case.	

8.4.13.TUC 13: Perform Security Analysis Before and After RAO

Name	Perform Security Analysis Before and After RAO		
TUC Purpose	Verify that an Application can perform security analysis involving contingency analysis and considering a set of remedial actions both initial and optimized sets.		
Business Purpose	Remedial action optimization function (application) needs to perform security analyses during different stages of the business process. Security analysis results need to be compared and assessed in terms of adequacy.		
Preconditions/ Requirements	Import a set of IGMs or a CGM and related AE, CO, RA, RAS datasets [TP and SV are optional datasets]		
Linked CGMES and NC Profiles	EQ, SSH, [TP, SV], AE, CO, RA, RAS, SAR		
Test configurations	06_TestConfigurations / Unicorn / v2		
Comment	**Limitation: So far, data only for testing SA before RAO provided**		
No	**Description**	**Assessment Criteria**	**Test Step Outcome**
1	The application performs contingency analysis using imported datasets. Preventive remedial actions are applied to the model prior the contingency analysis.	Pass: the Review Team assesses the ability of the application to perform the analysis.	N/A

2	Export results - before RAO (a report of the violated contingencies)	Pass: the SAR dataset is exported with no errors reported by the internal export validation. Visual inspection of the file headers is done by the Review Team, the files pass validation without any issues.	SAR dataset – before RAO
3	The application performs contingency analysis using imported datasets. Preventive remedial actions are applied to the model prior the contingency analysis. Optimized curative remedial actions are applied as well.	Pass: the Review Team assesses the ability of the application to perform the analysis.	N/A
4	Export results – after RAO (a report of the violated contingencies)	Pass: the SAR dataset is exported with no errors reported by the internal export validation. Visual inspection of the file headers is done by the Review Team, the files pass validation without any issues.	SAR dataset – after RAO
5	Compare SAR datasets before and after remedial action optimisation	Pass: the Review Team assesses the ability of the application to perform the analysis.	N/A
6	Update CGM by applying the remedial actions and export a solved CGM (updated SSH, TP and SV)	Pass: the CGM dataset is exported with no errors reported by the internal export validation. Visual inspection of the file headers is done by the Review Team, the files pass	Updated SSHs, TP and SV

		validation without any issues.	

8.4.14.TUC 14: Use IGMs Based on Different CGMES and NC Profiles Versions

Name	Use IGMs Based on Different CGMES and NC Profiles Versions		
TUC Purpose	Verify that an Application can import IGMs that are based on different CGMES versions (e.g. v2.4 and v3.0) and apply additional information provided by NC Profiles datasets.		
Business Purpose	CSA business process aims at using single version of CGMES and NC profiles when performing the process. However transition process will need to be supported for the period until all entities part of the process move to the next version.		
Preconditions/ Requirements			
Linked CGMES and NC Profiles	EQ, SSH, [TP, SV], AE, CO, SAR		
Test Configurations	To be further defined.		
Comment			
No	**Description**	**Assessment Criteria**	**Test Step Outcome**
1	The application imports an IGM based on CGMES version 2.4 and also imports additional information based on NC profiles v2.2.	Pass: the datasets are imported with no errors reported by the internal validation.	N/A
2	The application imports an IGM based on CGMES version 3.0 and also imports additional	Pass: the datasets are imported with no errors reported by the internal validation.	N/A

	information based on NC profiles v2.3.		
3	The application merges the model and performs a power flow calculation. Then the application performs contingency analysis.	Pass: the Review Team assesses the ability of the application to perform the analysis using information provided in different versions.	N/A
4	Export results (a report of the violated contingencies)	Pass: the SAR dataset is exported with no errors reported by the internal export validation. Visual inspection of the file headers is done by the Review Team, the files pass validation without any issues.	SAR dataset

8.4.15.TUC 15: Support of SPS/SIPS Modelling

Name	Support of SPS/SIPS Modelling
TUC Purpose	Verify that an Application can support modelling of SPS/SIPS data and reproduce its operation correctly.
Business Purpose	CSA business process aims at using single version of CGMES and NC profiles when performing the process. However transition process will need to be supported for the period until all entities part of the process move to the next version.
Preconditions/ Requirements	Import EQ, SSH, CO, AE, RA, RAS profiles Import SIPS/SPS from the NC profiles (RA); Perform Power Flow calculation; Perform Contingency analysis
Linked CGMES and NC Profiles	EQ, SSH, CO, AE, RA, RAS, SAR The applicability of TP and SV should be further studied.

Test Configurations	DIgSILENT example can be used for this test		
Comment			
No	**Description**	**Assessment Criteria**	**Test Step Outcome**
1	The application imports test configuration.	Pass: The Review Team inspects that data/parameters imported by the application are consistent with NC profiles and SIPS documentation: - Trigger conditions: Used elements (names) Value types Values Thresholds (min/max) etc. - SIPS/SPS Actions: Used elements (names) Action type Action value/result etc.	N/A
2	Execute contingencies one by one and evaluate if SIPS/SPS (currative remedial actions) are applied.	Pass: the Review Team assesses the ability of the application to perform the analysis. The behavior of the SIPS/SPS in the application is validated.	N/A
3	Export security analysis results with applied curative remedial action and compare with the	Pass: the SAR dataset is exported with no errors reported by the internal export validation. Visual	SAR dataset

	supplied reference SAR profile.	inspection of the file headers is done by the Review Team, the files pass validation without any issues. The SAR dataset should be equal (with reasonable tolerance) to the reference SAR provided with the test case.	

8.4.16.TUC 16: Remedial Action Optimization

Name	Remedial Action Optimization		
TUC Purpose	Verify that an Application can perform optimization of remedial actions and export the result.		
Business Purpose	CSA business process requires that remedial action optimization is performed in multiple coordination runs part of the process. The optimization is performed based on the available remedial actions provided by TSOs.		
Preconditions/ Requirements	Import a CGM; Import of NC profiles (ER, AE, CO, RA); Perform Power Flow calculation; Perform Contingency analysis; Export of optimization results (RAS).		
Linked CGMES and NC Profiles	EQ, SSH, [TP, SV], RA, RAS, AE, CO, ER		
Test Configurations	To be further defined.		
Comment			
No	**Description**	**Assessment Criteria**	**Test Step Outcome**
1	The application performs remedial action optimisation using imported datasets.	Pass: the Review Team assesses the ability of the application to perform the	N/A

		remedial action optimisation.	
2	Export results of the optimization	Pass: the RAS dataset is exported with no errors reported by the internal export validation. Visual inspection of the file headers is done by the Review Team, the files pass validation without any issues.	RAS dataset

8.4.17.TUC 17: Support of Simplified Structures Equality Test

Name	Support of Simplified Structures Equality Test
TUC Purpose	Verify that an application is capable to convert imported information.
Business Purpose	Business processes require models of high quality that represent the best forecast of real time snapshots. In the case of power flow calculation, it is necessary to check power flow numerical compatibility of CGMES based models before and after conversions performed by the applications.
Preconditions/ Requirements	Import ofEQ, TP, SSH, SV “Simplified structures” refer to link: https://entsoe.sharepoint.com/:b:/r/sites/2024SV-IOPforRegionalCoordinationProcesses/Shared Documents/General/02_Topic/UC Simplified structures equality test before and after conversions/CGMES_power_flow_mapping_requirements_for_ENTSOe.pdf?csf=1&web=1&e=rgHmPx
Linked CGMES and NC Profiles	EQ, SSH, [TP, SV]

<table>
<tr>
<td>Test Configurations</td>
<td>
Any grid must fulfill this test. To start, well known IEEE grids like IEEE14 and IEEE118 can be used.

IEEE models are provided as baseline models

(IEEE14, IEEE30, IEEE118) Since there are CGMES export and import steps in the test, the initial model format should be in any format supported by the tool, including but not limited to CGMES.

More specifically:
<table>
<tr><th>File</th><th>Meaning</th></tr>
<tr><td>BD_IEEE_grids.zip</td><td>Boundary set used</td></tr>
<tr><td>IEEE 14 bus.zip</td><td>IEEE 14 CGMES conversion</td></tr>
<tr><td>IEEE 14 bus.raw</td><td>IEEE 14 PSSe format</td></tr>
<tr><td>IEEE 14 bus.sav.xlsx</td><td>IEEE 14 comparison</td></tr>
<tr><td>IEEE 30 bus_33.zip</td><td>IEEE 30 CGMES conversion</td></tr>
<tr><td>IEEE 30 bus.raw</td><td>IEEE 30 PSSe format</td></tr>
<tr><td>IEEE 30 bus.sav.xlsx</td><td>IEEE 30 comparison</td></tr>
<tr><td>IEEE 118 Bus v2.zip</td><td>IEEE 118 CGMES conversion</td></tr>
<tr><td>IEEE 118 Bus v2.raw</td><td>IEEE 118 PSSe format</td></tr>
<tr><td>IEEE 118 Bus.sav.xlsx</td><td>IEEE 118 comparison</td></tr>
</table>
</td>
</tr>
<tr>
<td>Comment</td>
<td>
Redeia thinks that similar tests should be developed for new profiles.

Nothing is strictly required to perform this test. However, as advised, it is very convenient to have the simplified structures proposed by REE (see Rethinking CGMES – report for ENTSO-E (link)) to unequivocally understand what each CGMES device should do in a power flow simulation. This is useful because the proposed simplified structures are well understood by the power systems community and the power flow numerical inputs are straight forward to obtain from these.

Redeia performs the roundtrip psse->cgmes->psse using CIM Converter and achieving approximately 10^-5 or 10^-6 tolerance.
</td>
</tr>
</table>

No	Description	Assessment Criteria	Test Step Outcome
1	The application constructs Ybus matrices: - Load any model (Model A) - Compute Ybus (Ybus A) - Export the model in CGMES (model B) - Import the just saved Model B - Compute Ybus (Ybus B)	Pass: Ybus A and Ybus B matrices must be equal with at least 6 decimals precision. To compare Ybus a CSC sparse representation could be used. Alternatively, a dense representation is possible if the number of TologicalNodes is not too large.	N/A
2	The application performs power flow calculation: - Load any model (Model A) - Compute Power flow (Power flow A) - Export the model in CGMES (model B) - Import the just saved Model B. - Compute the power flow (Power flow B)	Pass: The voltages from “Power flow calculation A” and “Power flow calculation B” must be equal with at least 6 decimals precision.	SV dataset
3	Tests steps 1 and 2 can be repeated combining any pair of software tools to	Pass: As per test step 1 and 2.	N/A

	assess their mutual compatibility.		

8.4.18.TUC: Structural data setup

Name	Structural data setup		
Purpose	Demonstrate how the availability and unavailability can be resolved. How to combine data structure with daily updates. Possibility to add metadata.		
Preconditions/ Requirements			
Linked CGMES and NC Profiles	To be further defined.		
Test data	To be further defined.		
Comment			
No	**Description**	**Assessment Criteria**	**Test Step Outcome**

9. Glossary

Acronym	Full form
3WC	World Wide Web Consortium
ENTSO-E	Electrical Network of Transmission System Operators for Electricity
CCC	coordinated capacity calculation
CGM BP	common grid model building process
CIM	common information model.
DES	data exchange specification
FAT	Factory acceptance test
OPC	outage planning coordination
NC	network code
NCP	network code profiles
RA	remedial action
RAO	remedial action optimiser
RAS	remedial action schedule
RCC	regional coordination centre
RCP	regional coordination processes
ROSC	regional operational security coordination
SAT	Site acceptance test
SIPS	system integrity protection scheme
SHACL	shape constraint language
STA	short-term adequacy
SV-IOP	standard-vetting interoperability
TSO	transmission system operator
TYNDP	ten years network development plan
UCTE-DEF	union for the coordination of transmission of electricity data exchange format

Table 1: Glossary