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Ersatz für
DIN EN IEC 61970-456:2020-02
Siehe Anwendungsbeginn

**Schnittstelle für Anwendungsprogramme für Netzführungssysteme
(EMS-API) –****Teil 456: Gelöste Zustandsprofile des Stromversorgungssystems
(IEC 61970-456:2021);****Englische Fassung EN IEC 61970-456:2022**

Energy management system application program interface (EMS-API) –

Part 456: Solved power system state profiles

(IEC 61970-456:2021);

English version EN IEC 61970-456:2022

Interface de programmation d'application pour système de gestion d'énergie (EMS-API) –

Partie 456: Profils d'état de réseaux électriques résolus

(IEC 61970-456:2021);

Version anglaise EN IEC 61970-456:2022

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Anwendungsbeginn

Anwendungsbeginn für die von CENELEC am 2022-01-19 angenommene Europäische Norm als DIN-Norm ist 2024-03-01.

Für DIN EN IEC 61970-456:2020-02 besteht eine Übergangsfrist bis 2025-01-19.

Nationales Vorwort

Vorausgegangener Norm-Entwurf: E DIN EN IEC 61970-456:2022-08.

Für dieses Dokument ist das nationale Arbeitsgremium DKE/K 952 „Netzleittechnik“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE (www.dke.de) zuständig.

Aktuelle Informationen zu diesem Dokument können über die Internetseiten von DKE (www.dke.de) und DIN (www.din.de) durch eine Suche nach der Dokumentennummer aufgerufen werden.

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Der Zusammenhang der zitierten Dokumente mit den entsprechenden deutschen Dokumenten ergibt sich, soweit ein Zusammenhang besteht, grundsätzlich über die Nummer der entsprechenden IEC-Publikation. Beispiel: IEC 60068 ist als EN 60068 als Europäische Norm durch CENELEC übernommen und als DIN EN 60068 ins Deutsche Normenwerk aufgenommen.

Das Präsidium des DIN hat mit Präsidialbeschluss 1/2004 festgelegt, dass DIN-Normen, deren Inhalt sich auf internationale Arbeitsergebnisse der Informationsverarbeitung gründet, unter bestimmten Bedingungen allein in englischer Sprache veröffentlicht werden dürfen. Diese Bedingungen sind für die vorliegende Norm erfüllt.

Da sich die Benutzer der vorliegenden Norm der englischen Sprache als Fachsprache bedienen, wird die Englische Fassung der EN IEC 61970-456 veröffentlicht. Zu deren Einleitung und Abschnitt 1, der den Anwendungsbereich festlegt, und Abschnitt 3, der die Begriffe festlegt, wurde eine Übersetzung angefertigt und als informativer Nationaler Anhang NA der vorliegenden Norm hinzugefügt. Für die meisten der verwendeten Begriffe existieren keine gebräuchlichen deutschen Benennungen, da sich die deutschen Anwender in der Regel ebenfalls der englischen Benennungen bedienen. Diese Norm steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen.

Das Original-Dokument enthält Bilder in Farbe, die in der Papierversion in einer Graustufen-Darstellung wiedergegeben werden. Elektronische Versionen dieses Dokuments enthalten die Bilder in der originalen Farbdarstellung.

Änderungen

Gegenüber DIN EN IEC 61970-456:2020-02 wurden folgende Änderungen vorgenommen:

- a) zur Unterstützung von CIM17 (IEC 61970-301:2020+AMD1) und Anpassung an IEC 61970-452:ED4 aktualisiert;
- b) die Klassen PowerElectronicsConnection, PowerElectronicsUnit und PowerElectronicsWindUnit wurden zum Steady State Hypothesis-Profil (SSH) hinzugefügt, um den Änderungen der 4. Ausgabe von IEC 61970-452, Kern-Betriebsmittelprofil, zu entsprechen;
- c) relevante Begriffe, die in diesem Dokument verwendet werden, hinzugefügt;
- d) Anwendung von Equipment.inService und Equipment.normallyInService verdeutlicht.

Frühere Ausgaben

DIN EN 61970-456: 2014-04
DIN EN 61970-456/A1: 2019-03
DIN EN IEC 61970-456: 2020-02

Nationaler Anhang NA (informativ)

Auszugsweise Übersetzung

Reihenfolge und Inhalt der folgenden Abschnitte sind identisch mit denen in den jeweiligen Abschnitten der Englischen Fassung.

EINLEITUNG

Dieses Dokument ist eines von mehreren Teilen der Normenreihe IEC 61970, das Datensätze des allgemeinen Informationsmodells (CIM, en: Common Information Model) definiert, die zwischen Anwendungsprogrammen in Netzführungssystemen (EMS, en: Energy Management System) ausgetauscht werden.

Die Reihe IEC 61970-300 legt das allgemeine Informationsmodell (CIM) fest. Das CIM ist ein abstraktes Modell, das die Objekte in einem Energieversorgungsunternehmen darstellt, die in der Regel für die Betriebsaspekte einer Versorgungseinrichtung erforderlich sind.

Dieses Dokument gehört zur Reihe IEC 61970-400 mit Normen zu Komponenten-Schnittstellen, welche die semantische Struktur von Daten, die zwischen Komponenten (oder Anwendungen) ausgetauscht werden, und/oder von Daten, die von Komponenten öffentlich verfügbar gemacht werden. Dieses Dokument beschreibt die Nutzdaten, die übertragen werden, wenn Anwendungen über ein Messaging System kommunizieren. Die Norm umfasst jedoch nicht das Austauschverfahren und ist daher auf eine Reihe von Austauschumsetzungen anwendbar. Die Beispiele in diesem Dokument basieren auf dem Format der ausgetauschten Daten nach der Norm für das Austauschformat des CIM-XML-Modells, IEC 61970-552.

Dieses Dokument legt drei Profile fest:

- Das Steady State Hypothesis-Profil (SSH), das Eingangsvariablen für Lastflussanwendungen beschreibt, z. B. Spannungswerte, Schaltstatus usw.
- Das Topologieprofil, das ein Bus/Zweigleitungsmodell beschreibt. Ein topologisches Modell kann von einem Netzwerkmodellproduzent aus einem Knoten/Schalter-Modell mit SSH als Eingaben durch Nutzung der Topologieverarbeitung oder mittels eines Werkzeugs, mit dem ein Anwender interaktiv ein topologisches Modell schafft, erstellt werden. Daher wird ein topologisches Modell als Ausgabe definiert.
- Das Zustandsvariablenprofil (SV), das die Lösung eines Energieversorgungssystemsfalls, wie er etwa von Lastfluss- oder Zustandsschätzungsanwendungen erstellt wird, beschreibt.

Dieses Dokument beschreibt die Eingaben und Lösungen (Ausgaben) mit Verweisung auf ein Energieversorgungssystemmodell, das IEC 61970-452 in dieser Reihe aus miteinander verbundenen Normen entspricht. Die Unterteilung von Information in Profile ermöglicht auch die Unterteilung von Daten in Dokumenten für die entsprechenden Profile. So erzeugen die in diesem Dokument definierten Profile im Vergleich zu traditionellen Bus/Zweigleitungs- oder Knoten/Schalter-Formaten, die das Netzwerk, die anfänglichen Bedingungen und das Ergebnis umfassen, kleine Datendokumente.

1 Anwendungsbereich

Dieser Teil von IEC 61970 gehört zur Reihe IEC 61970-450 bis IEC 61970-499, die insgesamt auf einer abstrakten Ebene den Inhalt und die Austauschmechanismen für Daten definieren, die zwischen Energieversorgungssystemanalyseanwendungen, Netzleitstellen und/oder Teilen einer Netzleitstelle übertragen werden.

Ziel dieses Dokumentes ist eine strenge Definition einer Teilmenge von Klassen, Klassenattributen und Rollen aus dem CIM, welche für die Beschreibung des Ergebnisses der Zustandsschätzung, der Lastfluss- und anderer ähnlicher Anwendungen erforderlich sind, die eine Steady-State-Lösung eines Energieversorgungsnetzwerkes unter einer Reihe von Anwendungsfällen erzeugen, die informativ in dieses Dokument aufgenommen wurden.

Dieses Dokument richtet sich an zwei bestimmte Zielgruppen, Datenproduzenten und Datenempfänger, und kann daher aus diesen zwei Blickwinkeln gelesen werden. Aus Sicht der von dem Datenproduzenten verwendeten Software für den Modellexport beschreibt das Dokument wie ein Produzent eine Instanz eines Netzfalls beschreiben kann, um sie für ein anderes Programm zur Verfügung zu stellen. Aus Sicht des Konsumenten definiert das Dokument, was diese Importsoftware interpretieren können muss, um Lastflussszenarien zu konsumieren.

Es gibt viele verschiedene Anwendungsfälle, bei denen die Anwendung dieses Dokuments erwartet wird, und sie unterscheiden sich darin, wie das Dokument in jedem Fall angewendet wird. Es wird erwartet, dass Implementierer beachten, welche Anwendungsfälle sie abdecken wollen, um den Umfang der verschiedenen Optionen, die sie abdecken müssen, zu ermitteln. Beispielsweise werden die in diesem Dokument definierten Profile in einigen Fällen für den Austausch von Ausgangszuständen und nicht von gelösten Zuständen verwendet. Wenn dies also ein wichtiger Anwendungsfall ist, bedeutet dies, dass eine Verbraucheranwendung in der Lage sein muss, sowohl einen ungelösten Zustand als auch einen Zustand, der einige Lösungskriterien erfüllt hat, zu verarbeiten.

3 Begriffe

Für die Anwendung dieses Dokuments gelten die folgenden Begriffe.

ISO und IEC stellen terminologische Datenbanken für die Verwendung in der Normung unter den folgenden Adressen bereit:

- IEC Electropedia: verfügbar unter <http://www.electropedia.org/>
- ISO Online Browsing Platform: verfügbar unter <http://www.iso.org/obp>

3.1

eingebundenes Modell

Modell eines Model Authority Set mit gelösten internen Verweisungen

3.2

Grenzsatz

Satz, der alle Grenzpunkte enthält, die für ein Zusammenführungsmodell benötigt werden

3.3

CIM XML-Dokument/-Verteilung

Instanzdatei, die nach IEC 61970-552 mit einer Seriennummer versehen wurde

3.4

Verteilung

spezifische Darstellung eines Datensatzes

Anmerkung 1 zum Begriff: Ein Datensatz kann mit mehreren Seriennummern verfügbar sein, die sich auf verschiedene Weisen voneinander unterscheiden, einschließlich natürlicher Sprache, Medientyp oder Format, schematische Organisation, zeitliche und räumliche Auflösung. Der Detailgrad in der Verteilung wird durch ein oder mehrere Profile, denen der Datensatz entspricht, definiert.

3.5

externe gelöste Verweisungen

Zustand, in dem in den Modellen der Model Authority Sets keine hängenden Verweisungen vorliegen

3.6

gelöste Kopfverweisungen

Zustand, in dem die im Modellkopf definierten Verweisungen gelöst sind

3.7

interne gelöste Verweisungen

Zustand, in dem im Modell eines Model Authority Set keine hängenden Verweisungen vorliegen

3.8

zusammengeführtes Modell

Modell, das eine Einheit aus verschiedenen eingebundenen Modellen mit gelösten externen und Kopfverweisungen darstellt

3.9

Profil

Datenmodell zur Beschreibung der Instanzdatei für den Austausch von CIM-Daten

Anmerkung 1 zum Begriff: Ein Profil ist eine Teilmenge von Klassen, Beziehungen und Attributen, die benötigt wird, um einen speziellen Schnittstellentyp zu definieren und auf einem CIM-Datenmodell beruht. Profile können strengere Regeln für Original-Klassen und -Beziehungen festlegen. Ein Profil wird üblicherweise in ein Schema (XSD, RDF, OWL usw.) konvertiert, das zur Erstellung, zum Lesen und zur Validierung von Instanzdateien für den Datenaustausch verwendet werden kann.

Anmerkung 2 zum Begriff: Dieser Begriff darf verwendet werden, um entweder das semantische Modell für die Nutzdaten einer Instanz oder das Syntax-Schema der Nutzdaten einer Instanz zu definieren. Ein Profil darf in XSD-, RDF- und/oder OWL-Dateien beschrieben werden. Die Konformität von Instanzdaten mit einem Profil kann durch Datenaustausch zwischen Anwendungen geprüft werden. Ein Profil ist notwendig, um das kanonische Modell „verwenden“ zu können.

3.10

gelöstes Modell

Modell, das Instanzen von Zustandsvariablen (SV) enthält

3.11

Bus/Zweigleitungsmodell

vereinfachte Darstellung, die das Ergebnis der Topologieverarbeitung eines Knoten/Schaltermodells ist

Anmerkung 1 zum Begriff: Es umfasst keine vollständige Schalter- und Sammelschienenkonfiguration, allerdings sind aufbewahrte Schalter gestattet. Diese Darstellung wird von Lastfluss- oder Zustandsschätzungsalgorithmen verwendet.

3.12

Knoten/Schaltermodell

detaillierte Darstellung, die eine vollständige Schalter- und Sammelschienenkonfiguration umfasst

3.13

Energieversorgungssystemfall

Modell, das eine Steady-State-Energieversorgungssystemsituation, einschließlich Gerätestatus, Zielsetzung und Energieaustausch, beschreibt

Anmerkung 1 zum Begriff: Es kann sich um einen Zustandsschätzerfall oder ein Lastflussszenario handeln.

3.14

Basisfall

Energieversorgungssystemfall, der die Basis für andere Studien, wie etwa Kurzschluss, dynamische Netzstabilität oder Kontingenzzanalyse, bildet

EUROPEAN STANDARD

EN IEC 61970-456

NORME EUROPÉENNE

EUROPÄISCHE NORM

Februar 2022

ICS 33.200

Supersedes EN IEC 61970-456:2018 and all of its
amendments and corrigenda (if any)

English version

**Energy management system application program interface
(EMS-API) – Part 456: Solved power system state profiles
(IEC 61970-456:2021)**

Interface de programmation d'application pour
système de gestion d'énergie (EMS-API) – Partie 456:
Profils d'état de réseaux électriques résolus
(IEC 61970-456:2021)

Schnittstelle für Anwendungsprogramme für
Netzführungssysteme (EMS-API) – Teil 456: Gelöste
Zustandsprofile des Stromversorgungssystems
(IEC 61970-456:2021)

This European Standard was approved by CENELEC on 2022-01-19. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye and the United Kingdom.



European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brüssel

European foreword

The text of document 57/2406/FDIS, future edition 3 of IEC 61970-456, prepared by IEC/TC 57 "Power systems management and associated information exchange" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61970-456:2022.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop): 2022-10-19
- latest date by which the national standards conflicting with the document have to be withdrawn (dow): 2025-01-19

This document supersedes EN IEC 61970-456:2018 and all of its amendments and corrigenda (if any).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a Standardization Request given to CENELEC by the European Commission and the European Free Trade Association.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice

The text of the International Standard IEC 61970-456:2021 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 61970-1	NOTE	Harmonized as EN 61970-1
IEC/TS 61970-2	NOTE	Harmonized as CLC/TS 61970-2
IEC 61970-453	NOTE	Harmonized as EN 61970-453
IEC 61970-501	NOTE	Harmonized as EN 61970-501
IEC 61970-552	NOTE	Harmonized as EN 61970-552
IEC 61970-600-1	NOTE	Harmonized as EN IEC 61970-600-1
IEC 61970-600-2	NOTE	Harmonized as EN IEC 61970-600-2

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61970-301	2020	Energy management system application program interface (EMS-API) - Part 301: Common information model (CIM) base	EN IEC 61970-301	2020
A1 ¹	–		A1 ²	–
IEC 61970-452	2021	Energy management system application program interface (EMS-API) - Part 452: CIM static transmission network model profiles	EN IEC 61970-452	2021

¹ Under preparation. Stage at the time of publication: IEC/RPVC 61970-301/AMD1:2021.

² Under preparation. Stage at the time of publication: EN IEC 61970-301:2020/FprA1:2021.

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INTRODUCTION

This document is one of several parts of the IEC 61970 series that defines common information model (CIM) datasets exchanged between application programs in energy management systems (EMS).

The IEC 61970-300 series specifies the common information model (CIM). The CIM is an abstract model that represents the objects in an electric utility enterprise typically needed to model the operational aspects of a utility.

This document is one of the IEC 61970-400 series of component interface standards that specify the semantic structure of data exchanged between components (or applications) and/or made publicly available data by a component. This document describes the payload that would be carried if applications are communicating via a messaging system, but the standard does not include the method of exchange, and therefore is applicable to a variety of exchange implementations. The examples in this document are based on the exchanged data formatted specified in IEC 61970-552 CIM XML model exchange standard.

This document specifies three profiles:

- The Steady State Hypothesis (SSH) profile that describes power flow application input variables such as voltage set points, switch statuses etc.
- The topology profile (TP) that describes a bus-branch model. A topology model may be created by a network model builder from a node-breaker model with SSH as inputs using topology processing or by a tool where a user interactively builds a topology model. Therefore, a topology model is defined as an output.
- State variables profile (SV) that describes the solution of a power system case such as is produced by power flow or state estimation applications.

This document describes the inputs and solutions (outputs) with reference to a power system model that conforms to IEC 61970-452 in this series of related standards. The separation of information into profiles also enables separation of data into documents corresponding to the profiles. In this way the profiles defined in this document generate small data documents compared with traditional bus-branch or node-breaker formats that include the network, the initial conditions and the result.

ENERGY MANAGEMENT SYSTEM APPLICATION PROGRAM INTERFACE (EMS-API) – Part 456: Solved power system state profiles

1 Scope

This part of IEC 61970 belongs to the IEC 61970-450 to IEC 61970-499 series that, taken as a whole, defines at an abstract level the content and exchange mechanisms used for data transmitted between power system analyses applications, control centres and/or control centre components.

The purpose of this document is to rigorously define the subset of classes, class attributes, and roles from the CIM necessary to describe the result of state estimation, power flow and other similar applications that produce a steady-state solution of a power network, under a set of use cases which are included informatively in this document.

This document is intended for two distinct audiences, data producers and data recipients, and can be read from those two perspectives. From the standpoint of model export software used by a data producer, the document defines how a producer may describe an instance of a network case in order to make it available to some other program. From the standpoint of a consumer, the document defines what that importing software must be able to interpret in order to consume power flow cases.

There are many different use cases for which use of this document is expected and they differ in the way that the document will be applied in each case. Implementers are expected to consider what use cases they wish to cover in order to know the extent of different options they must cover. As an example, the profiles defined in this document will be used in some cases to exchange starting conditions rather than solved conditions, so if this is an important use case, it means that a consumer application needs to be able to handle an unsolved state as well as one which has met some solution criteria.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61970-301:2020, *Energy management system application program interface (EMS-API) – Part 301: Common information model (CIM) base*
IEC 61970-301:2020/AMD1:—³

IEC 61970-452:2021, *Energy management system application program interface (EMS-API) – Part 452: CIM static transmission network model profiles*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

³ Under preparation. Stage at the time of publication: IEC/RPVC 61970-301/AMD1:2021

3.1

assembled model

model of a Model Authority Set with internal references resolved

3.2

boundary set

set containing all boundary points necessary for a merge model

3.3

CIM XML document/distribution

instance file which is serialised according to IEC 61970-552

3.4

distribution

specific representation of a dataset

Note 1 to entry: A dataset might be available in multiple serializations that may differ in various ways, including natural language, media-type or format, schematic organization, temporal and spatial resolution. The level of detail in the distribution is defined by one or more profiles to which the dataset conforms.

3.5

external references resolved

state in which no dangling references are present across the models of Model Authority Sets

3.6

header references resolved

state in which the references defined in model header are resolved

3.7

internal references resolved

state in which no dangling references are present within the model of a Model Authority Set

3.8

merged model

model that is a union of different assembled models with external and header references resolved

3.9

profile

data model to describe instance file for exchange of CIM data

Note 1 to entry: A profile is a subset of classes, associations and attributes needed to accomplish a specific type of interface and based upon a CIM data model. Profiles may impose stricter rules on original classes and associations. A profile is usually converted to schema (XSD, RDF, OWL, etc.) that can be used to create, read and validate instance files for data exchange.

Note 2 to entry: This term may be used to define either the semantic model for an instance data payload or the syntactic schema for an instance data payload. A profile may be expressed in XSD, RDF, and/or OWL files. An instance data conforming to a profile can be tested in exchanges between applications. A profile is necessary in order to "use" the canonical model.

3.10

solved model

model containing instance of State Variables (SV)

3.11

bus-branch model

simplified representation, which is a result from a topology processing of a node-breaker model

Note 1 to entry: It does not include a complete breaker and busbar configuration however retained breakers are allowed. This representation is used by power flow or state estimation algorithms.

3.12

node-breaker model

detailed representation that includes a complete breaker and busbar configuration.

3.13

power system case

model which is describing a steady state power system situation including equipment status, control targets and energy interchange

Note 1 to entry: It can be a state estimator case or a power flow case.

3.14

base case

power system case that forms the basis for other studies like short circuit, dynamic stability or contingency analysis

4 Profile specification

4.1 General

4.1.1 General

The profiles defined in this document have the following version information.

4.1.2 Steady state hypothesis profile

- Title: Steady State Hypothesis Vocabulary
- Keyword: SSH
- Description: This vocabulary is describing the steady state hypothesis profile from IEC 61970-456.
- Version IRI: <http://iec.ch/TC57/ns/CIM/SteadyStateHypothesis/2.0>
- Version info: 2.0.0
- Prior version: <http://iec.ch/TC57/2013/61970-456/SteadyStateHypothesis/1>
- Conforms to: urn:iso:std:iec:61970-456:ed-3|urn:iso:std:iec:61970-301:ed-7:amd1|file://iec61970cim17v40_iec61968cim13v13a_iec62325cim03v17a.eap|urn:iso:std:iec:61970-401:draft:ed-1|urn:iso:std:iec:61970-501:draft:ed-2
- Identifier: urn:uuid:527c4385-0429-4987-9b1c-495be6e3ef63

4.1.3 Topology profile

- Title: Topology Vocabulary
- Keyword: TP
- Description: This vocabulary is describing the topology profile from IEC 61970-456.
- Version IRI: <http://iec.ch/TC57/ns/CIM/Topology/5.0>
- Version info: 5.0.0
- Prior version: <http://iec.ch/TC57/2013/61970-456/Topology/4>
- Conforms to: urn:iso:std:iec:61970-456:ed-3|urn:iso:std:iec:61970-301:ed-7:amd1|file://iec61970cim17v40_iec61968cim13v13a_iec62325cim03v17a.eap|urn:iso:std:iec:61970-401:draft:ed-1|urn:iso:std:iec:61970-501:draft:ed-2
- Identifier: urn:uuid:e36dcb99-2368-4eac-88ac-0be58a44af63

4.1.4 State variables profile

- Title: State Variables Vocabulary
- Keyword: SV
- Description: This vocabulary is describing the state variables profile from IEC 61970-456.
- Version IRI: <http://iec.ch/TC57/ns/CIM/StateVariables/5.0>
- Version info: 5.0.0
- Prior version: <http://iec.ch/TC57/2013/61970-456/StateVariables/4>
- Conforms to: urn:iso:std:iec:61970-456:ed-3|urn:iso:std:iec:61970-301:ed-7:amd1|file://iec61970cim17v40_iec61968cim13v13a_iec62325cim03v17a.eap|urn:iso:std:iec:61970-401:draft:ed-1|urn:iso:std:iec:61970-501:draft:ed-2
- Identifier: urn:uuid:f9744f43-258c-49cd-8d8d-449ab427a490

4.2 Requirements and constraints

This subclause defines requirements and constraints that shall be fulfilled by applications that conform to this document. The naming of the rules shall not be used for machine processing. The rule names are just a string. The naming convention of the constraints is as follows.

“{rule.Type}:{rule.Standard}:{rule.Profile}:{rule.Property}:{rule.Name}”

where

- rule.Type: C – for constraint; R – for requirement
- rule.Standard: the number of the standard e.g. 456 for IEC 61970-456, 452 for IEC 61970-452.
- rule.Profile: the abbreviation of the profile, e.g. TP for Topology profile. If set to “ALL” the constraint is applicable to all IEC 61970-456 profiles.
- rule.Property: for UML classes, the name of the class, for attributes and associations, the name of the class and attribute or association end, e.g. EnergyConsumer, IdentifiedObject.name, etc. If set to “NA” the property is not applicable to a specific UML element.
- rule.Name: the name of the rule. It is unique for the same property.

Example: C:456:TP:IdentifiedObject.name:stringLength

This subclause includes rules and constraints that are defined in IEC 61970-452, tagged "452". They are included to make the validation self-contained. The rule and constraints that are tagged "456" are mastered in this document.

- R:452:ALL:NA:exchange
Optional and required attributes and associations must be imported and exported if they are in the model file prior to import.
- R:452:ALL:NA:exchange1
If an optional attribute does not exist in the imported file, it does not have to be exported in case exactly the same data set is exported, i.e. the tool is not obliged to automatically provide this attribute. If the export is resulting from an action by the user performed after the import, e.g. data processing or model update the export can contain optional attributes.
- R:452:ALL:NA:exchange2
In most of the profiles the selection of optional and required attributes is made so as to ensure a minimum set of required attributes without which the exchange does not fulfil its basic purpose. Business processes governing different exchanges can require mandatory exchange of certain optional attributes or associations. Optional and required attributes and associations shall therefore be supported by applications which claim conformance with certain functionalities of IEC 61970-452. This provides flexibility for the business processes to adapt to different business requirements and base the exchanges on IEC 61970-452 compliant applications.

- R:452:ALL:NA:exchange3

An exporter may, at his or her discretion, produce a serialization containing additional class data described by the CIM Schema but not required by this document provided these data adhere to the conventions established in Clause 5.

- R:452:ALL:NA:exchange4

From the standpoint of the model import used by a data recipient, the document describes a subset of the CIM that importing software shall be able to interpret in order to import exported models. Data providers are free to exceed the minimum requirements described herein as long as their resulting data files are compliant with the CIM Schema and the conventions established in Clause 5. The document, therefore, describes additional classes and class data that, although not required, exporters will, in all likelihood, choose to include in their data files. The additional classes and data are labelled as required (cardinality 1..1) or as optional (cardinality 0..1) to distinguish them from their required counterparts. Please note, however, that data importers could potentially receive data containing instances of any and all classes described by the CIM Schema.

- R:452:ALL:NA:cardinality

The cardinality defined in the CIM model shall be followed, unless a more restrictive cardinality is explicitly defined in this document. For instance, the cardinality on the association between VoltageLevel and BaseVoltage indicates that a VoltageLevel shall be associated with one and only one BaseVoltage, but a BaseVoltage can be associated with zero to many VoltageLevels.

- R:452:ALL:NA:associations

Associations between classes referenced in this document and classes not referenced here are not required regardless of cardinality.

- R:452:ALL:IdentifiedObject.name:rule

The attribute "name" inherited by many classes from the abstract class IdentifiedObject is not required to be unique. It must be a human readable identifier without additional embedded information that would need to be parsed. The attribute is used for purposes such as User Interface and data exchange debugging. The MRID defined in the data exchange format is the only unique and persistent identifier used for this data exchange. The attribute IdentifiedObject.name is, however, always required for CoreEquipment profile and Short Circuit profile.

- R:452:ALL:IdentifiedObject.description:rule

The attribute "description" inherited by many classes from the abstract class IdentifiedObject must contain human readable text without additional embedded information that would need to be parsed.

- R:452:ALL:NA:uniqueIdentifier

All IdentifiedObject-s shall have a persistent and globally unique identifier (Master Resource Identifier – mRID).

- R:452:ALL:NA:unitMultiplier

For exchange of attributes defined using CIM Data Types (ActivePower, Susceptance, etc.) a unit multiplier of 1 is used if the UnitMultiplier specified in this document is "none".

- R:456:SV:SvPowerFlow:instance

As a minimum there shall be an instance of SvPowerFlow associated with the Terminal for all the following classes and their specialisation (subclass) that is part of an energized TopologicalIsland: RotatingMachine, EnergyConsumer, EquivalentInjection, ShuntCompensator, StaticVarCompensator, ExternalNetworkInjection, PowerElectronicsConnection and EnergySource. Additional instances of SvPowerFlow may optionally be available for other in service (SvStatus.inService=true) and energised equipment (equipment connected to a TopologicalNode part of the TopologicalIsland).

- C:456:SSH:ACDCCConverter:targets
The target values and related attributes for ACDCCConverter and its subclasses are optional in SSH. However, depending on the control mode of the converter some of the attributes shall be considered as required. The description of the control modes in the enumerations CsPpccControlKind, VsPpccControlKind and VsQpccControlKind provide information on necessary attributes which are then considered required attributes for each control mode in SSH.
- C:456:SSH:EnergyConsumer.p:ValueRange
EnergyConsumer.p shall be zero or positive value. Energy production shall be modelled as an energy producer class (e.g. GeneratingUnit) or an Equivalent classes.
- C:456:SSH:EnergyConsumer.q:ValueRange
EnergyConsumer.q shall be zero or positive value. Energy production shall be modelled as an energy producer class (e.g. GeneratingUnit) or an Equivalent classes.
- C:456:SSH:EnergySource:EnergySourcePQ
The attributes voltageAngle and voltageMagnitude shall not be used when the EnergySource is representing a constant active and reactive power injection (PQ injection), i.e. they shall only be used when the EnergySource is modelling a voltage source.
- C:456:SSH:EquivalentInjection.p:limits
The negated value (necessary due to sign convention) of EquivalentInjection.p shall be less than or equal to EquivalentInjection.maxP and shall be greater than or equal to EquivalentInjection.minP.
- C:456:SSH:EquivalentInjection.q:limits
The negated value (necessary due to sign convention) of EquivalentInjection.q shall be less than or equal to EquivalentInjection.maxQ and shall be greater than or equal to EquivalentInjection.minQ.
- C:456:SSH:EquivalentInjection:regulation
If EquivalentInjection.regulationCapability in EQ is true, then EquivalentInjection.regulationStatus and EquivalentInjection.regulationTarget are required in SSH. If EquivalentInjection.regulationCapability in EQ is false, then EquivalentInjection.regulationStatus and EquivalentInjection.regulationTarget are not exchanged in SSH.
- C:456:SSH:ExternalNetworkInjection.p:limits
The negated value (necessary due to sign convention) of ExternalNetworkInjection.p shall be less than or equal to ExternalNetworkInjection.maxP and shall be greater than or equal to ExternalNetworkInjection.minP.
- C:456:SSH:ExternalNetworkInjection.q:limits
The negated value (necessary due to sign convention) of ExternalNetworkInjection.q shall be less than or equal to ExternalNetworkInjection.maxQ and shall be greater than or equal to ExternalNetworkInjection.minQ.
- C:456:SSH:GeneratingUnit.normalPF:values
GeneratingUnit.normalPF is normally zero for generators which are non-energized (do not participate in the load flow). It can have a number in case of activating the GeneratingUnit is a remedial action. As .normalPF values are not normalized across different MAS, the application that imports a model shall have a power flow calculation logic setup to be able to normalize normalPF values for the purpose of the distributed slack and preserve the original values of GeneratingUnit.normalPF in case of export.
- C:456:SSH:NA:angleReference
Angle reference: In cases where it is required to exchange a solved model and compare power flow results (assuming identical/comparable calculation methods and initial conditions) it is required that the angle reference slack is placed within the exported model. The slack generator is the SynchronousMachine connected to the TopologicalNode referenced by TopologicallyIsland.AngleRefTopologicalNode and which has the highest SynchronousMachine.referencePriority in the exported MAS's SSH.

- C:456:SSH:NA:distributedActivePowerSlack
Active power slack by multiple generators per ControlArea: all GeneratingUnit(s) have non-zero normalPF, but there must be one GeneratingUnit per ControlArea that have maximum (the highest) participation factor (GeneratingUnit.normalPF) so that this GeneratingUnit is used as a single active power slack in case the tooling does not support active power slack by multiple generators per ControlArea.
- C:456:SSH:NA:notSolvedModel
In case of exchange of non-solved model (i.e. SV profile is not exchanged) the tools shall assign the angle reference node using the information from SSH (the highest SynchronousMachine.referencePriority or GeneratingUnit.normalPF in the exported MAS's SSH).
- C:456:SSH:NA:singleActivePowerSlack
Active power slack by a single generator per ControlArea: one generator has GeneratingUnit.normalPF set to a highest value (non-zero) and all other generating units have a zero GeneratingUnit.normalPF.
- C:456:SSH:RegulatingControl.targetValue:value
RegulatingControl.targetValue shall be positive value in cases where the RegulatingControl.mode is set to voltage in EQ profile.
- C:456:SSH:RotatingMachine.p:limits
The negated value (necessary due to sign convention) of RotatingMachine.p shall be less than or equal to GeneratingUnit.maxOperatingP and shall be greater than or equal to GeneratingUnit.minOperatingP of the associated GeneratingUnit. This applies regardless if the Equipment in service or not.
- C:456:SSH:RotatingMachine.q:limits
In case there is no ReactiveCapabilityCurve associated with the SynchronousMachine, the negated value (necessary due to sign convention) of RotatingMachine.q shall be less than or equal to SynchronousMachine.maxQ and shall be greater than or equal to SynchronousMachine.minQ. This applies regardless if the Equipment in service or not.
- C:456:SSH:RotatingMachine.pCapabilityCurve
In cases where a ReactiveCapabilityCurve is associated, the RotatingMachine.p shall be less than or equal to the maximum active power value defined by the curve and it shall be greater than or equal to the minimum active power value defined by the curve. NOTE: The machine operating mode (e.g. motor, generator etc) shall be taken into consideration.
- C:456:SSH:RotatingMachine.qCapabilityCurve
In cases where a ReactiveCapabilityCurve is associated, the RotatingMachine.q shall be less than or equal to the maximum reactive power value defined by the curve and it shall be greater than or equal to the minimum reactive power value defined by the curve. NOTE: The machine operating mode (e.g. motor, generator etc) shall be taken into consideration.
- C:456:SSH:ShuntCompensator.sections:value
In cases where RegulatingControl.discrete is true and RegulatingControl.enabled is true, ShuntCompensator.sections shall be integer.
- C:456:SSH:SynchronousMachine.operatingMode:matchType
The SynchronousMachine.operatingMode shall be consistent with the SynchronousMachine.type.
 - SynchronousMachine.operatingMode = "motor" shall be provided for SynchronousMachine.type in ["motor", "generatorOrMotor", "motorOrCondenser", "generatorOrCondenserOrMotor"],
 - SynchronousMachine.operatingMode = "condenser" shall be provided for SynchronousMachine.type in ["condenser", "generatorOrCondenser", "motorOrCondenser", "generatorOrCondenserOrMotor"], and
 - SynchronousMachine.operatingMode = "generator" shall be provided for SynchronousMachine.type in ["generator", "generatorOrMotor", "generatorOrCondenser", "generatorOrCondenserOrMotor"].
- C:456:SSH:TapChanger.step:value
In cases where RegulatingControl.discrete is true and RegulatingControl.enabled is true, TapChanger.step shall be integer.

- C:456:SV:IdentifiedObject.name:stringLength
The string IdentifiedObject.name has a maximum of 128 characters.
- C:456:SV:SvPowerFlow.p:synchronousMachine
The SvPowerFlow.p that is given by the steady state power flow solution for a SynchronousMachine shall normally be within the capability of the machine defined in the ReactiveCapabilityCurve or GeneratingUnit.maxOperatingP and GeneratingUnit.minOperatingP when ReactiveCapabilityCurve is not present. Active power can be outside the capability as part of start-up or shutdown of the generator. CIM cannot represent different operation mode so this constraint will only give a warning. Note that different data exchange processes can assign more restrictive severity depending on the business needs and power flow algorithm applied by the business process.
- C:456:SV:SvPowerFlow.q:synchronousMachine
The SvPowerFlow.q that is given by the steady state power flow solution for a SynchronousMachine shall normally be within the capability of the machine defined in the ReactiveCapabilityCurve or SynchronousMachine.maxQ, SynchronousMachine.minQ when ReactiveCapabilityCurve is not present. Reactive power can be outside the capability if powerflow excludes reactive restriction. CIM cannot represent this so this contains will also give a warning. Note that different data exchange processes can assign more restrictive severity depending on the business needs and power flow algorithm applied by the business process.
- C:456:SV:SvShuntCompensatorSections.sections:value
In cases where RegulatingControl.discrete is true and RegulatingControl.enabled is true, SvShuntCompensatorSections.sections shall be integer.
- C:456:SV:SvSwitch:instance
SvSwitch shall be exchanged for all switching devices. It is expected that in most cases the SvSwitch.open in SV instance data will be identical with Switch.open in SSH instance data. However, in cases where a regulating control is modifying the connection state of the controlled device a difference between SvSwitch.open and Switch.open can occur.
- C:456:SV:SvTapStep.position:value
In cases where RegulatingControl.discrete is true and RegulatingControl.enabled is true, SvTapStep.position shall be integer.
- C:456:SV:SvVoltage.v:absoluteLimit
SvVoltage.v shall be greater than 0,4 pu in cases where associated voltage limits are not defining different limit range.
- C:456:SV:SvVoltage.v:limits
The SvVoltage.v shall be less than or equal to VoltageLimit.value associated with OperationalLimitType.limitType=highVoltage and greater than or equal to VoltageLimit.value associated with OperationalLimitType.limitType=lowVoltage.
- C:456:SV:TopologicalIsland:instance
At least one TopologicalIsland instance shall be present per SV instance.
The TopologicalIsland-s for a merged model which are defined in the state variables instance file for the merged model are created with the solving on the power flow of the merged model, i.e. there are no TopologicalIsland-s defined per MAS in a merged model. In case a solved merged model is exchanged for a single MAS the state variables instance file shall include at least one instance of TopologicalIsland.
- C:456:TP:IdentifiedObject.description:stringLength
The string IdentifiedObject.description is maximum 256 characters.
- C:456:TP:IdentifiedObject.name:instance
Name is required for all classes in the profile except ACDCTerminal.
- C:456:TP:IdentifiedObject.name:stringLength
The string IdentifiedObject.name has a maximum of 128 characters.

- C:456:TP:Terminal:switch
The Terminal-s of the two sides of a retained Switch (Switch.retained=true) or any of its subclasses shall not be connected to the same TopologicalNode.
- C:456:TP:TopologicalNode:containment
The association TopologicalNode.ConnectivityNodeContainer is required however CGMES does not specify to which type of EquipmentContainer the association shall point to. Therefore the association TopologicalNode.ConnectivityNodeContainer shall point to any type of EquipmentContainer given by the connecting equipment (that is linked to the associated Terminal). Machine based validation is not performed. It is required that import and export shall not make any changes to this association.

5 Overview

5.1 General

This document describes an interface standard in which XML payloads are used to transfer initial conditions and results created during typical steady-state network analysis processes (e.g. state estimation or power flow solutions). Major requirements/objectives driving the design of this document include:

- Power flow solution algorithms and outputs are virtually the same whether run in operations or planning contexts. State estimator output shares a common core with power flow. A single standard is desired to minimize software development and enable use cases that cross between environments.
- While some users of this standard might only be interested in the output state, the more general situation is that users continue to perform follow-on analyses (e.g. security analysis, voltage stability) and require both the input on which the solution was based and the output result.
- Real life analytical processes often involve a series of solutions in which most of the input data remains the same from one solution to the next, and the standard must support these processes in a way that does not repeat data unnecessarily.
- Power flow solutions tend to drift if the result from a power flow run is used as input to a subsequent power flow run. By preserving the initial conditions between power flow runs the solutions do not drift.

This document is flexible and designed to satisfy a wide range of analytical scenarios in the planning and operating business environments. It enables parties that collaborate in some business process to create additional business agreements that describe any restrictions and customizations of the document that are deemed necessary for the business process. In most cases, these additional agreements are local agreements hence they are not included in IEC standards.

5.2 Modelling authorities

In order to meet the requirements, this document depends on modularizing the potentially voluminous overall input and output data into subsets that would each be realized as smaller, XML payloads. An instance of one of these subsets is referred to herein as a 'dataset'.

Two types of partitioning into datasets are utilized. In the first, the data is modularized according to what kind of data is produced (which generally corresponds with what kind of application produces the data). CIM 'profiles' (subsets of the complete CIM) define the classes and attributes that make up each kind of modularization. The second type of partitioning is by network parts, which divides data into sets of instances according to which utility or entity in an interconnection is responsible for the data. The party responsible for data is called the Model Authority of the data and the network parts are defined as belonging to a Model Authority Set (MAS). This partitioning occurs at the instance level and produces multiple datasets governed by a profile and network part. Datasets from different MAS combine to form the complete set of data for that profile, Figure 1 illustrates this.

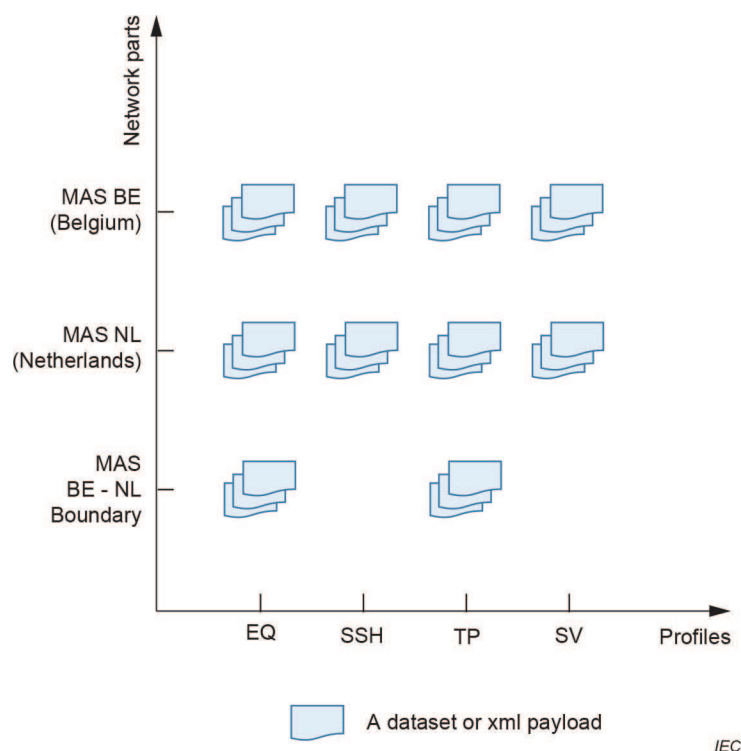


Figure 1 – Relations between MAS, profile and dataset

Different IEC 61970 profiles are listed along the horizontal axis:

- EQ for equipment are defined in IEC 61970-452.
- SSH for power flow initial data, TP for topology data and SV for state variables data are defined in this document.

A few examples of Model Authority Sets are listed along the vertical axis:

- MAS BE represents a regional Model Authority Set for Belgium that is a network part defined by a Model Authority BE, e.g. the Belgian TSO.
- MAS NL represents a regional Model Authority Set for Netherlands that is a network part defined by another Model Authority NL, e.g. the Netherlands TSO.
- MAS BE-NL Boundary represent a Model Authority Set that is a network part for the boundary between MAS BE and MAS NL. The boundary network part is typically agreed mutually between Model Authority BE and NL.

The document symbol in Figure 1 describes a dataset packaged as a payload.

The Model Authority Sets along the vertical axis in Figure 1 define parts of a network. Datasets belong to a Model Authority Set and this is indicated in Figure 1 by the horizontally aligned datasets at each MAS.

The profiles along the horizontal axis in Figure 1 describe a subset of the CIM canonical data used for a particular purpose. A dataset Figure 1 contains data for a specific profile and this is indicated in Figure 1 by the vertically aligned datasets at each profile.

At each crossing point between a Model Authority Set and profile there is a stack of datasets meaning that for this particular Model Authority Set and profile there may be many datasets e.g. representing different points in time or different study cases. The ways datasets can be created and combined is dependent on the use case. Specifications that better support use cases on how to combine datasets an explicit CIM model for Model Authority Sets is being developed and will be released in the future.

5.3 Profile relationships

Figure 2 illustrates some of the profiles that are defined by the IEC 61970-450 to IEC 61970-499 series and depicts the relationships between them.

Network models used in operations include detailed descriptions of measurements and their location in the network and switching devices, such models are called node-breaker models. Network models used in planning may not have this level of detail and typically exclude measurements and switching devices. Instead of computing the power flow buses (TopologicalNode-s) from switching device statuses the power flow buses are maintained manually in legacy bus-branch tools.

Node-breaker and bus-branch model representations can be combined in an assembled or a merged model and this is ensured by building of models using ConnectivityNode-s.

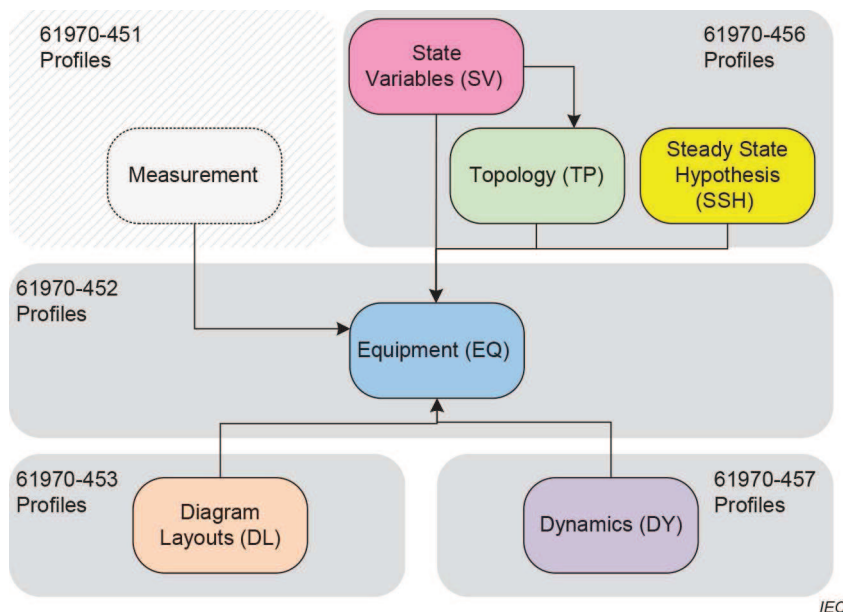


Figure 2 – Profile relationships

These modules satisfy the needs of network analysis business processes used in operations, in planning studies, as well as for transfers between operations and planning. The IEC 61970-451 profiles that support transfer of SCADA measurements to EMS applications do not yet exist and is planned work.

IEC 61970-452 defines specific profiles (or subsets) of the CIM for exchange of static power system data between utilities, security coordinators and other entities participating in an interconnected power system, such that all parties have access to the modelling of their neighbour's systems that is necessary to run state estimation or power flow applications. Currently three profiles, the Equipment Core profile, the Operation profile and the Short Circuit profile, have been defined.

Energy Management Systems and various network modelling and simulation tools employ a variety of schematic and quasi-geographic presentations in their user interfaces. These are sometimes generated automatically, but more often are hand-drawn and require considerable labour to create and maintain. Most of this labour goes into the arrangement, or 'layout' of the power system elements within the overall diagram. The IEC 61970-453 specifies guidelines for the exchange of diagram layout information for schematic data.

IEC 61970-457 specifies a profile to support the analysis of the steady state stability (small-signal stability) and/or transient stability of a power system or parts of it. The information is described with reference to a power system model that conforms to IEC 61970-452 and IEC 61970-456. Thus, equipment and other related power flow model data are not repeated in the information exchanged with this document. The schema(s) for expressing the dynamic model information are derived from IEC 61970-302.

In Figure 2, an arrow between profiles indicates that there are relationships defined between data in the two datasets. The directionality indicates that the data in the “from” dataset depends on classes in the “to” dataset. For data this means that “from” class data refers to or depends on “to” class data. Example: a dataset of an equipment model may have many Topology, State Variable and Steady State Hypothesis datasets that refer to it.

5.4 Connectivity model

Figure 3 illustrates an example of the equipment model in which the equipment connectivity is described by the ConnectivityNode and Terminal classes. The Terminal class is central in that and it supports Equipment, Topology, State Variables, Steady State Hypothesis and Diagram Layout profiles. Within the Equipment profile the Terminal is associated ConnectivityNode-s with ConductingEquipment and provides the multi Terminal equipment (e.g. Switch-es, ACLineSegment-s, etc.) with well-defined equipment “sides”.

The Equipment and Steady State Hypothesis profiles are the basis for network model building and power flow calculation. The Topology profile describes power flow busses that are an output of a topology processing of the equipment model, i.e. the TopologicalNode-s that are used as input by a power flow calculation. The State Variables profile describes the result of a power flow application.

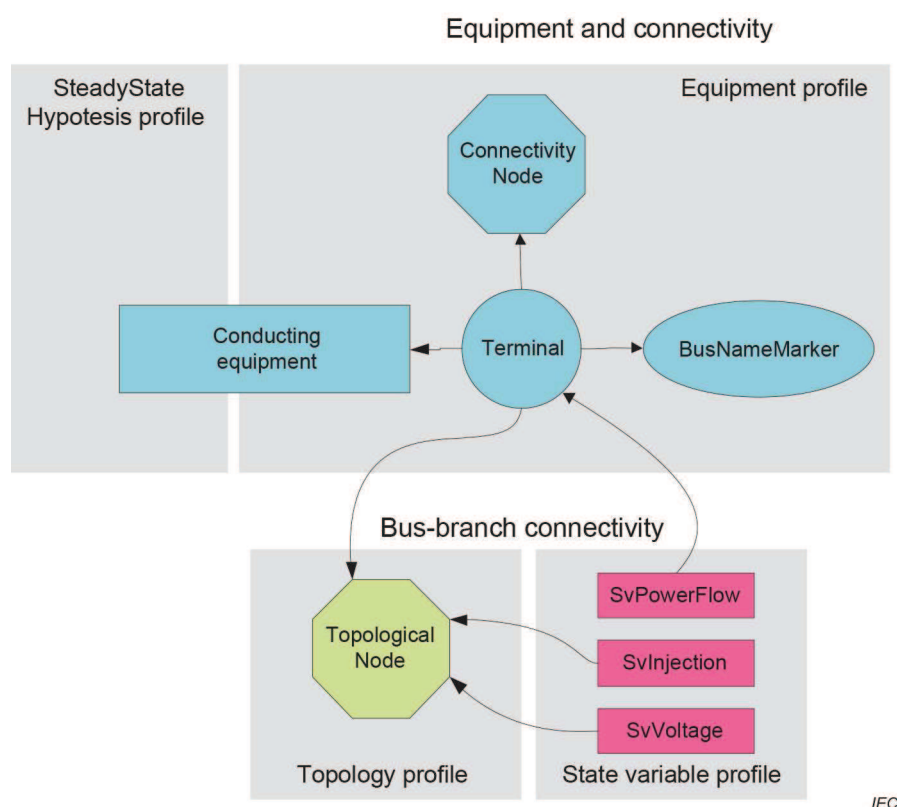


Figure 3 – Connectivity and solution model

The arrows in Figure 3 describe references between the CIM objects. TopologicalNode-s are computed from switching devices connecting ConnectivityNode-s.

A model uses ConnectivityNode-s to describe how ConductingEquipment-s are connected. In topology processing all ConductingEquipment-s connected with each other through closed Switch-es are identified and the Terminal-s of ConductingEquipment-s are assigned to a TopologicalNode.

BusNameMarker-s are used to avoid an arbitrary naming of TopologicalNode-s resulting from topology processing, as described in 7.1.1. It is possible to preserve the TopologicalNode names by creating BusNameMarker-s for one or more such sets of Switch.open and usage of the BusNameMarker names to name the TopologicalNode-s generated by topology processing.

This usage of BusNameMarker-s preserves TopologicalNode names but not the mRID (the rdf:ID/rdf:about in IEC 61970-552). Hence, TopologicalNode mRID-s will vary between different topology processing runs.

An equipment model using ConnectivityNode-s may not necessarily have any switches. A simplified equipment model can initially be created without switches. As the connectivity is described using ConnectivityNode-s it is possible to have a hybrid modelling representation where a detailed node-breaker model having switches is combined with a simplified bus-branch style model without switches. This is useful when operational models are to be combined with planning models to verify that the planned extensions work with existing operational models.

6 Use cases

6.1 Overview

This clause describes how the standard should be applied in business problems and gives examples of some scenarios.

Network applications use a bus-branch model in the basic power flow calculation where the branches are non-zero impedance elements. Real power systems have measurements and switching devices that are not described in bus-branch models but in node-breaker models. So, to run network calculations on a node-breaker model, a bus-branch model is created, where all zero impedance elements have been removed. In many study situations, it is impractical to deal with all the details in a node-breaker model, hence studies often use a bus-branch model for building study cases. The Steady State Hypothesis profile describes the data, e.g. switch statuses, needed to transform a node-barker model into a bus-branch model.

A large interconnected power network is typically divided into regions with a system operator that is responsible for operating the power network within a region. With increased and stronger interconnections between the regions the mutual dependency between the regions increases. A consequence is that a power flow set up for a particular region must also include a substantial part of the neighbouring regions including both EQ and SSH data. Figure 4 shows an example from Europe.

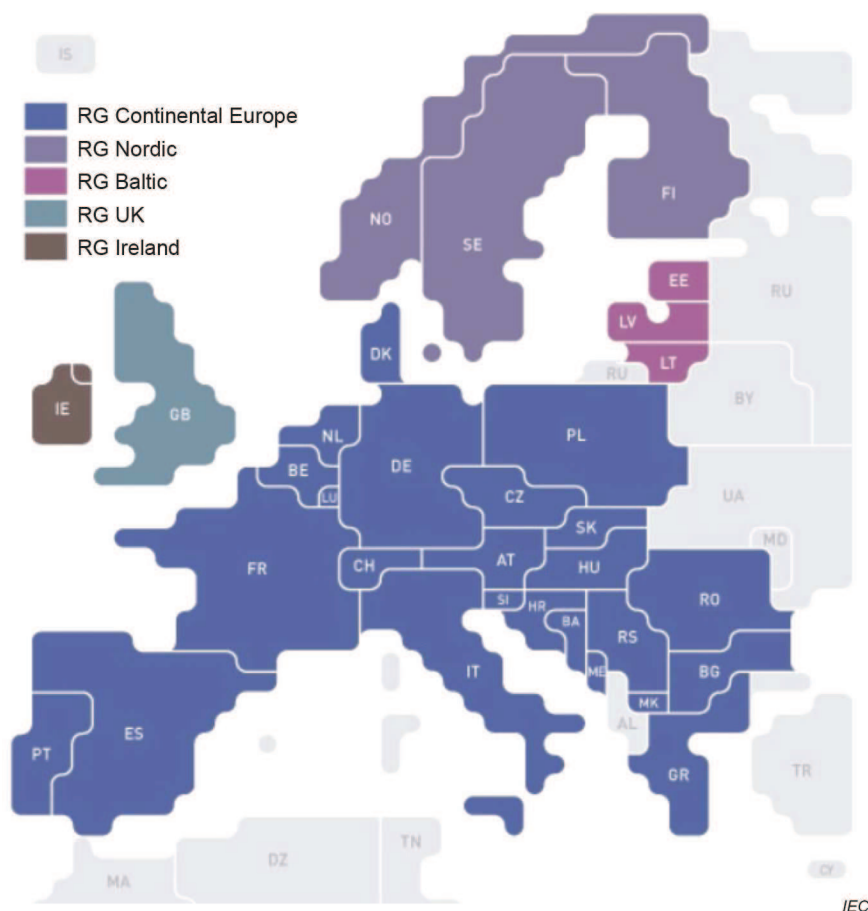


Figure 4 – The European power system with regions

The Case building process includes many sources of SSH data, as shown in Figure 5.

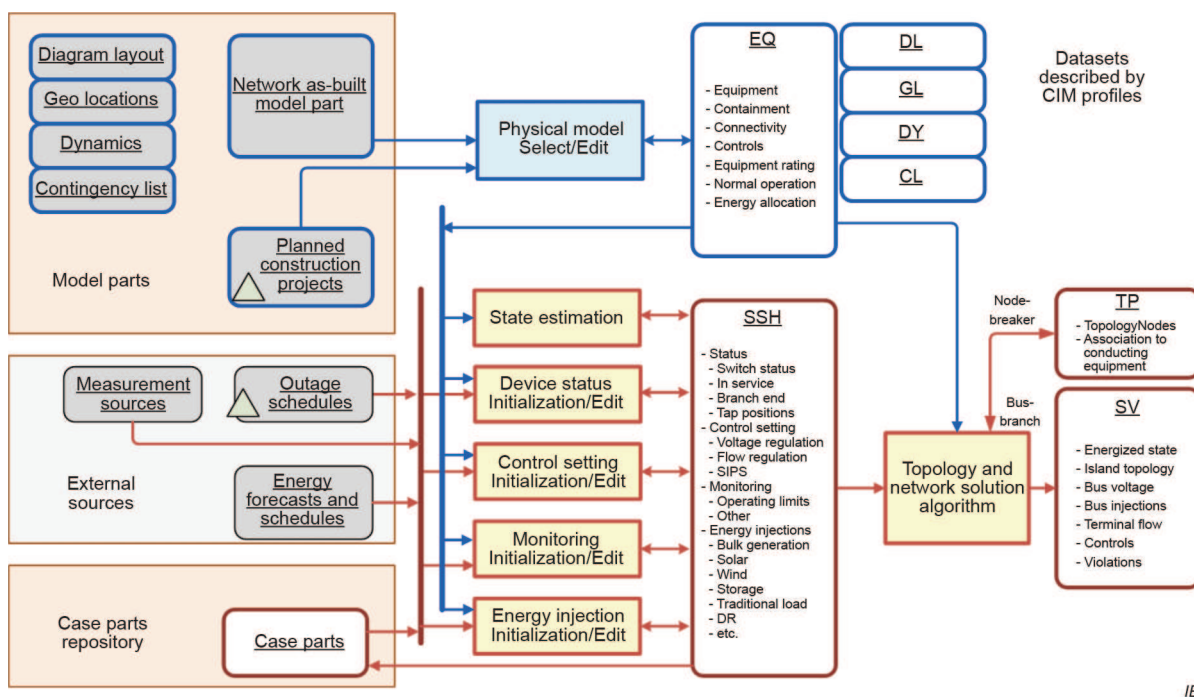


Figure 5 – Information exchange in power flow and sharing of results

Figure 5 describes how input to power flow calculation has many different possible sources. State Estimation and measurements create SSH data as input to power flow calculations. Case building includes selecting and combining data from different sources to form a complete input to a power flow study. The Steady State Hypothesis (SSH), Topology (TP) and State Variables (SV) are in scope of this specification. Other interfaces indicated in Figure 5 are outside the scope of this specification.

6.2 EMS network analysis integration

An architecture for transfer of data from a SCADA/EMS to other applications is shown in Figure 6.

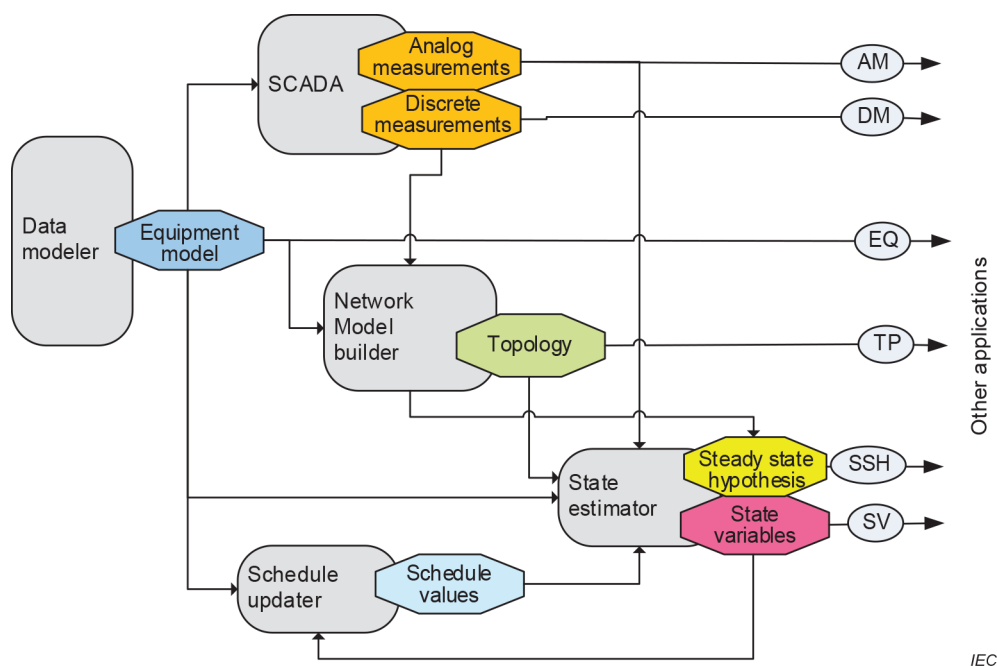


Figure 6 – EMS datasets to an external client

The following interfaces are shown in Figure 6:

- EQ: Equipment model data as described in IEC 61970-452;
- DM: network discrete measurements dataset;
- AM: network analog measurements dataset;
- TP: Topology dataset from network model builder;
- SV: State Variables dataset from state estimator;
- SSH: Steady State Hypothesis from the network model builder and state estimator is an output that can be used as input to power flow calculations as shown in Figure 7.

6.3 Power flow based network analysis

Architecture for power flow based applications on node-breaker models is presented in Figure 7.

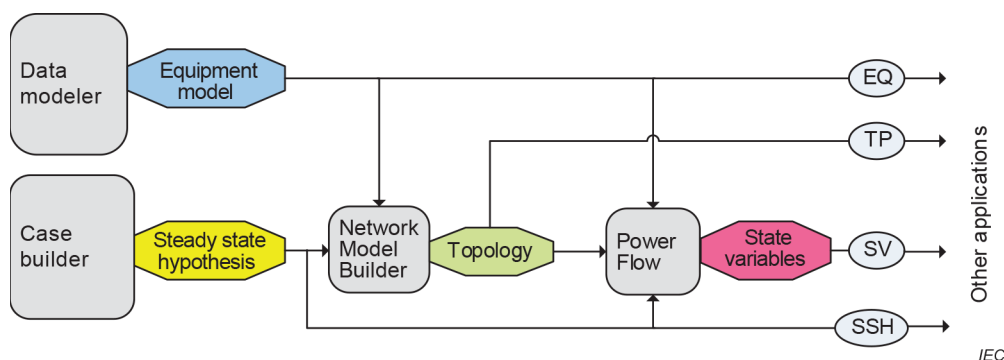


Figure 7 – Node-breaker power flow integration architecture

SSH and EQ data are the result of the Case builder activity. The Case builder activity produces all inputs needed for the Power Flow in addition to the Equipment model. SSH data may also be provided by the State Estimator as in Figure 6.

Architecture for power flow based applications on bus-branch models is presented in Figure 8.

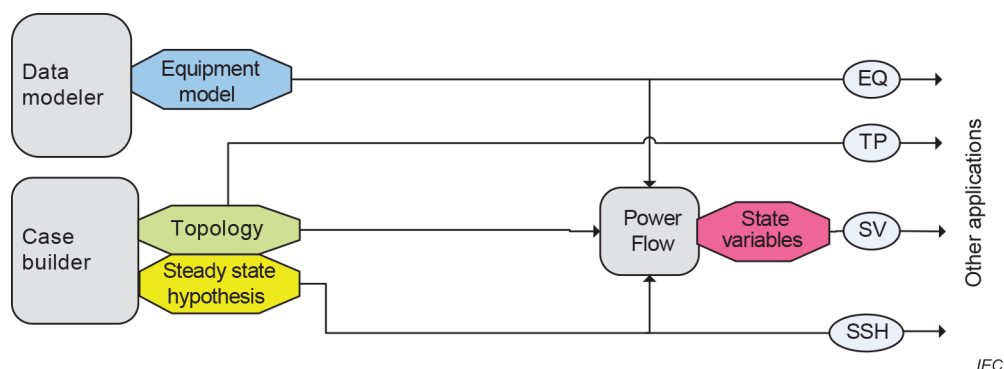


Figure 8 – Bus-branch power flow integration architecture

SSH, TP and EQ data are the result of the Case builder activity. The Case builder activity produces all inputs needed for the Power Flow in addition to the Equipment model.

Figure 7 and Figure 8 describe the case when all inputs to the power flow are known.

6.4 Model partitioning and boundary modelling

6.4.1 General

This subclause describes a method of partitioning a large power network. It is not necessary the recommended method of doing it, but it should be one of the methods that applications shall support. The text in 6.4 is planned to be moved to other documents which will distinguish between best practices and specific use cases.

For a large power network with many interconnected regions this may mean that data for many of the regions is collected and assembled to form the study case. In many study situations, a large number of power flow calculations are run, e.g. congestion forecast, and the case set up is automated without requirement for human intervention. This implies that the regional network models are described such that they can be assembled automatically. This is done with a method where the boundaries between the regions are described by separate boundary model authority sets that are used as an interface between the regions.