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**Kommunikation im Energiemarkt –
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Kontextbezogene Modelle und Einbindungsmodelle für den
europäischen Markt
(IEC 57/2310/CDV:2020);
Englische Fassung prEN IEC 62325-451-8:2020**

Framework for energy market communications –
Part 451-8: HVDC processes, contextual and assembly models for European style market
(IEC 57/2310/CDV:2020);
English version prEN IEC 62325-451-8:2020

Cadre pour les communications pour le marché de l'énergie –
Partie 451-8: Processus HVDC, modèles contextuels et modèles d'assemblage pour le
marché de style européen
(IEC 57/2310/CDV:2020);
Version anglaise prEN IEC 62325-451-8:2020

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FRAMEWORK FOR ENERGY MARKET COMMUNICATIONS –

Part 451-8: Exchange of information for HVDC Link scheduling business process, contextual and assembly models for European style market

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1 Scope

This part of IEC 62325 specifies a UML package for the HVDC Link scheduling business process and its associated document contextual models, assembly models and XML schemas for use within the European style electricity markets.

This part of IEC 62325 is based on the European style market contextual model (IEC 62325-351). The business process covered by this part of IEC 62325 is described in Clause 5.3.

The relevant aggregate core components (ACCs) defined in IEC 62325-351 have been contextualised into aggregated business information entities (ABIEs) to satisfy the requirements of the European style market HVDC Link scheduling business process.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC TS 61970-2, Energy management system application program interface (EMS-API) – Part 2: Glossary

IEC 62325-301, Framework for energy market communications – Part 301: Common information model (CIM) extensions for markets

IEC 62325-351:2016, Framework for energy market communications – Part 351: CIM European market model exchange profile

IEC 62325-450:2013, Framework for energy market communications – Part 450: Profile and context modelling rules

IEC 62325-451-1, Framework for energy market communications – Part 451-1: Acknowledgement business process and contextual model for CIM European market

IEC 62325-451-3, Framework for energy market communications – Part 451-3: Transmission capacity allocation business process (explicit or implicit auction) and contextual models for European market

IEC 62325-451-7, Framework for energy market communications – Part 451-7: Exchange of information for balancing processes, contextual and assembly models for European style market

IEC 62361-100, Power systems management and associated information exchange – Interoperability in the long term – Part 100: CIM profiles to XML schema mapping

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 61970-2, as well as the following apply.

NOTE General glossary definitions can be found in IEC 60050, *International Electrotechnical Vocabulary*.

3.1

aggregate business information entity

ABIE

re-use of an aggregate core component (ACC) in a specified business

3.2

aggregate core component

ACC

collection of related pieces of business information that together convey a distinct business meaning, independent of any specific business context

Note 1 to entry: Expressed in modelling terms, this is the representation of an object class, independent of any specific business context.

[SOURCE: ISO TS 15000-5:2005, Clause 9, modified (second sentence has been transformed into Note 1 to entry)]

3.3

application program interface

API

set of public functions provided by an executable application component for use by other executable application components

3.4

assembly model

assembly model is a model that prepares information in a business context for assembly into electronic documents for data interchange

3.5

based on

IsBasedOn

use of an artefact that has been restricted according to the requirements of a specific business context

[SOURCE: IEC 62325-450:2013, 3.4]

3.6

business context

formal description of a specific business circumstance as identified by the values of a set of context categories, allowing different business circumstances to be uniquely distinguished

[SOURCE: UN/Cefact, Unified Context Methodology Technical Specification]

3.7

European style market profile

ESMP

European style market profile, the object of the part of IEC 62325-351, describing the set of classes and associations used to generate all the parts IEC 62325-451-x

3.8

information model

representation of concepts, relationships, constraints, rules, and operations to specify data semantics for a chosen domain of discourse

Note 1 to entry: It can provide shareable, stable, and organized structure of information requirements for the domain context.

[SOURCE: IEC 62325-450:2013, 3.6]

3.9

market management system

MMS

computer system comprised of a software platform providing basic support services and a set of applications providing the functionality needed for the effective management of the electricity market

Note 1 to entry: These software systems in an electricity market may include support for capacity allocation, scheduling energy, ancillary or other services, real-time operations and settlements.

3.10

message business information entity

MBIE

aggregation of a set of ABIEs that respects a defined set of assembly rules

3.11

profile

basic outline of all the information that is required to satisfy a specific environment

[SOURCE: IEC 62325-450:2013, 3.7]

4 Document contextual model and message assembly model basic concepts

4.1 Overview

The part IEC 62325-450 defines a set of CIM profiles that follows a layered modelling framework as outlined in Figure 1 going from the common information model (CIM), to different regional contextual models and their

subsequent contextualized documents for information exchange; the final step being the message specifications for information interchange.

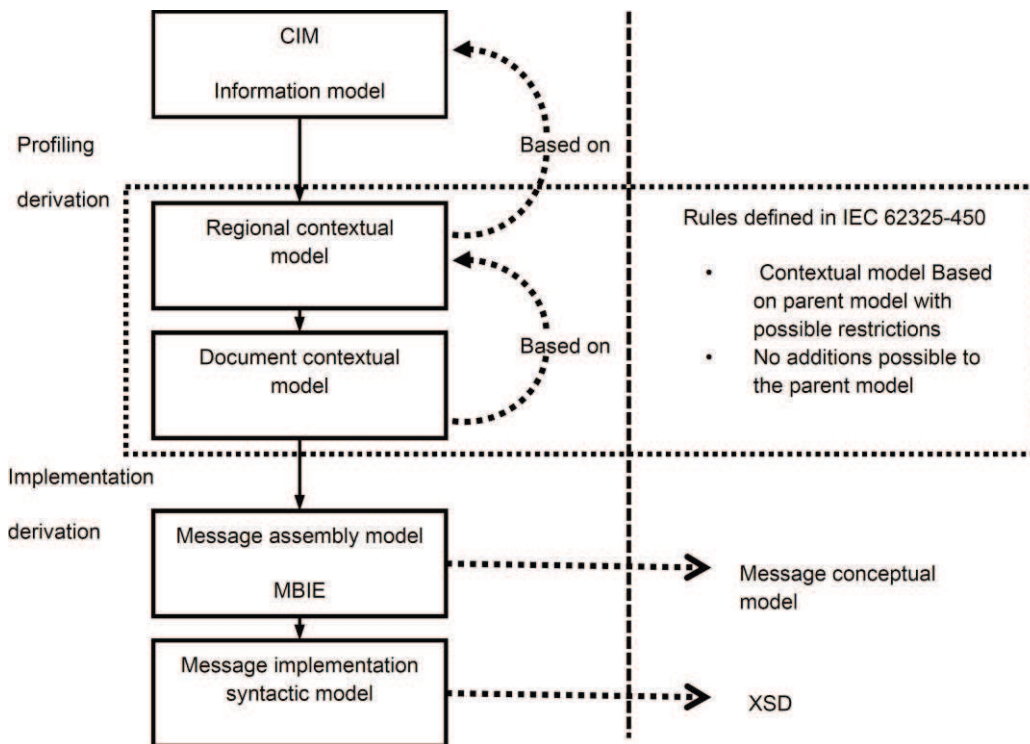


Figure 1 – IEC 62325-450 modelling framework

The regional contextual models are the basic components that are necessary to build electronic documents for information interchange. The European style market contextual model (IEC 62325-351) is, as an example, a regional contextual model based on IEC 62325-301. The components are also termed aggregate core components (ACCs).

A document contextual model is based upon a specific business requirements specification and is constructed from the contextualisation of the ACCs that can be found in the European style market contextual model. The contextualised ACCs at this stage are termed aggregate business information entities (ABIEs). These ABIEs are the constructs that are assembled together into a specific electronic document to satisfy the information requirements outlined in the business requirements specification. The transformation from an ACC to an ABIE shall respect the rules defined in IEC 62325-450.

Once a document contextual model that meets the business requirements has been built, a message assembly model can be automatically generated from it. The automatic generation respects the rules defined in IEC 62361-100.

XML schema then may be automatically generated from the message assembly model. If necessary, specific mapping can take place at this stage to transform the CIM class and attribute names into more market resilient names.

4.2 European style market package structure (ESMP)

The main package structure of the European style market profile is described in Figure 2.

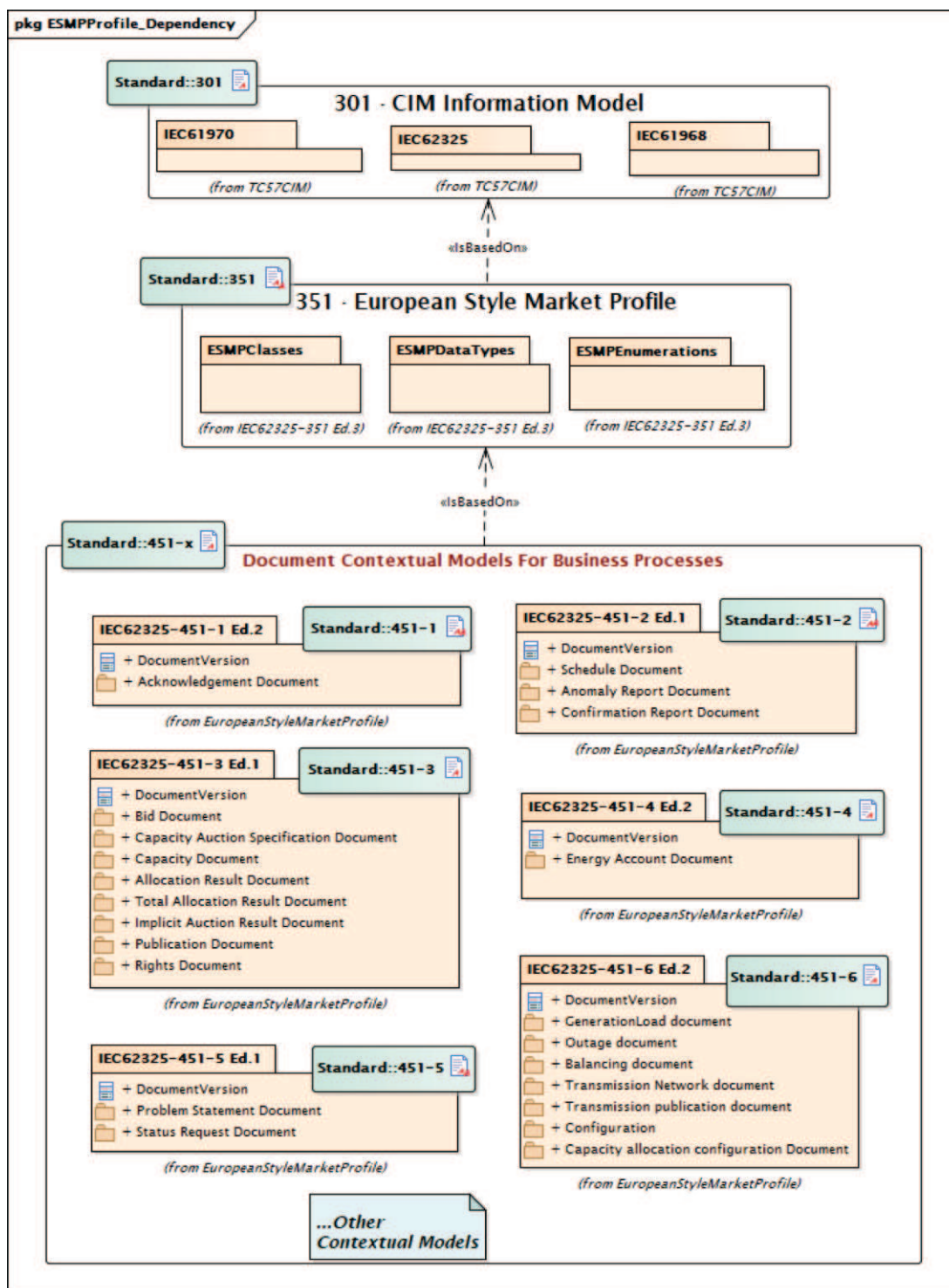


Figure 2 – Overview of European style market profile dependency

For each business process, a business process package is described in an IEC 62325-451-x standard. A business process package contains:

- the document contextual model (ABIE) and the automatically generated message assembly model (MBIE) for each electronic document required to enable the completion of the business process. Each document is a sub contextual model derived by restriction from the European style market profile;
- the XML schema of the business document that is automatically generated from the message assembly model.

The European style market profile (ESMP), as defined in the IEC 62325-351, provides the core components permitted for use in an IEC 62325-451-x standard. All ABIEs shall be “based on” the IEC 62325-351 core components:

- ESMPClasses: defining all the semi-contextual classes of the European style market profile derived by restriction from the CIM information model;
- ESMPDataTypes: defining all the core Datatypes used within the ESMP classes.

All the core components that are used in every electronic document structure have been harmonized and centralized in the European style market profile. These core components are consequently the basic building blocks from which all electronic document ABIEs are derived.

4.3 From the European style market profile to the document contextual model

The document contextual model for a given business process is constructed by an information analyst who identifies all the information requirements necessary to satisfy the business process.

Once the information requirements have been identified, the information analyst identifies the related ACCs that are available in the European style market profile and contextualises them to meet the information requirements. This contextualisation step creates a set of aggregate business Information entities (ABIEs).

In a final step the information analyst assembles together into a specific document contextual model package the ABIEs to form a document model satisfying the business requirements.

4.4 From the document contextual model to the message assembly model

Once the document contextual model has been finalised, the message assembly model may be automatically generated.

All document contextual models share the same core components and core datatypes. These are defined in the European style market profile (IEC 62325-351) and are contextualised and refined in all document contextual models (IEC 62325-451-x series) respecting the rules as described in IEC 62325-450.

4.5 From the assembly model to the XML schema

The final modelling step applies a standardized set of criteria in order to generate a uniform XML schema from the assembly model. This transformation process respects the rules defined in IEC 62361-100.

5 The HVDC Link scheduling business process

5.1 General

The HVDC Link Scheduling Process is carried out when 2 or more TSOs exchange information about their cross-border HVDC Links, (that may be overhead lines or cables) on a day ahead or an intra-day basis.

In many cases, active power schedules related to HVDC Links are drafted during the operational planning phase and may be influenced by several operational planning processes but also by the various purposes of the link.

HVDC Link schedules may be derived from market results or as a solution to an optimization problem focusing on several physical targets.

Market-based scheduling of HVDC can be applied to calculate set points for HVDC links that connect two different bidding zones (which are not necessarily in two different countries) or scheduling areas.

In the operational planning process, TSOs must calculate and coordinate their HVDC schedules. The HVDC schedules are determined according to certain criteria and aim at optimizing a given objective function (such as maximizing active power transmission of the HVDC or minimizing overall (AC + DC) losses or voltage angle difference).

The process encompasses 3 successive steps that are data dependent:

- the identification of HVDC constraints
- the definition of HVDC configuration

- the building of the HVDC schedule (this last step also incorporates information about the HVDC offered capacity, from the Capacity Allocation Process)

5.2 Roles

5.2.1 The Scheduling Area Responsible role

Each TSO involved in the HVDC Link scheduling process acts as a Scheduling Area Responsible.

As far as the European Market Style profile is concerned, a Scheduling Area Responsible is a party responsible for the coordination of nominated volumes within a scheduling area

5.2.2 Sub-roles

For the HVDC Link scheduling process, two sub-roles can be distinguished:

- Participating Scheduling Area Responsible: the scheduling area responsible who delegates the matching process to another Scheduling Area Responsible
- Matching Scheduling Area Responsible: the scheduling area responsible who is responsible for the matching of all data on a HVDC Link (or on a border) and has the eventual possibility of applying agreed rules to resolve mismatches.

5.3 HVDC Link scheduling business process

Figure 3 provides the overview of the business process. This incorporates the information that TSOs, acting as scheduling area responsables, shall exchange about their HVDC Links. #

The use cases that outline the HVDC Link Scheduling process make use of the same generic electronic document structure to provide the information to the market information aggregator. The electronic document structure itself is detailed later in this document.

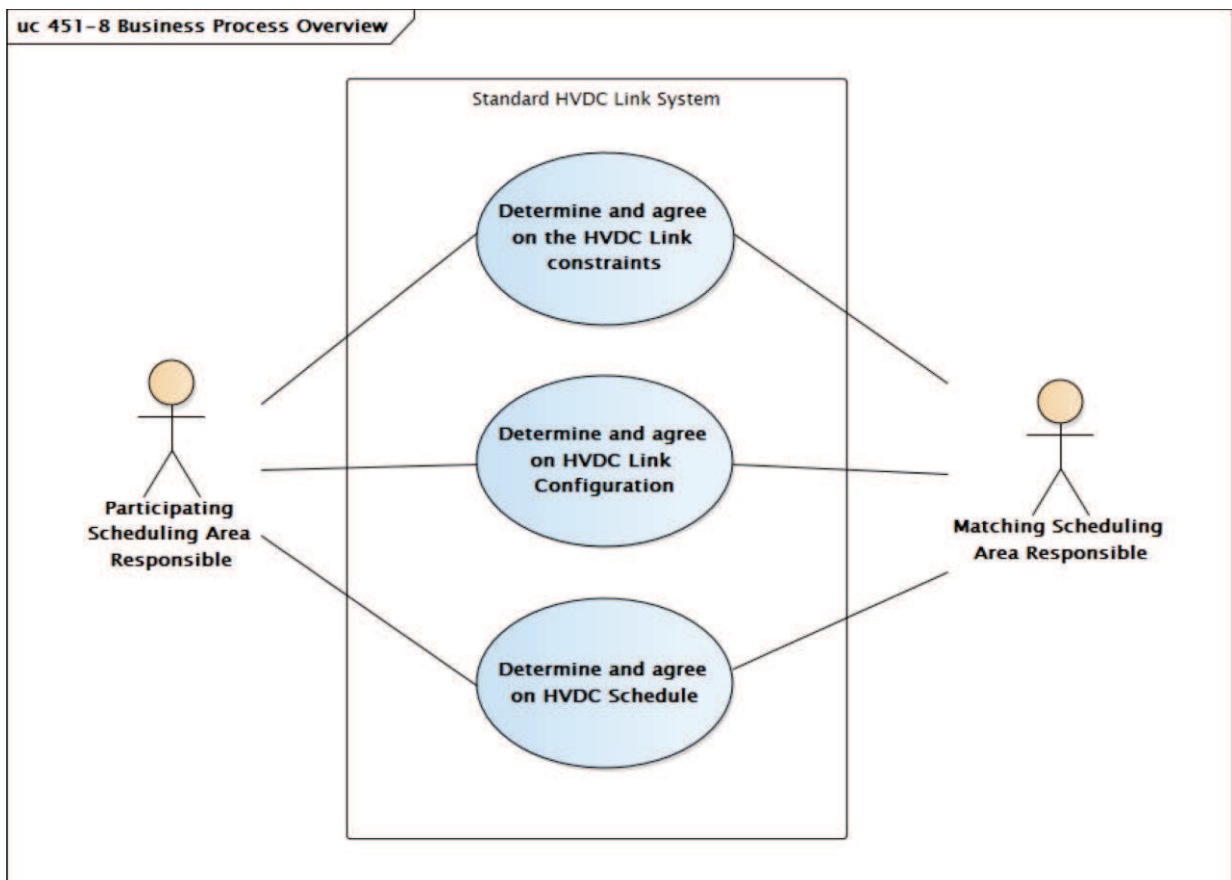


Figure 3 – HVDCLink Scheduling Process Overview

5.4 Use Cases

5.4.1 General Overview

The Figure 3 outlines the three different basic processes that are carried out within the HVDC Link Scheduling process.

In each basic process, the Scheduling Area Responsible determine their own data, then the Matching Responsible has the task to match, validate and share the matching data.

5.4.2 HVDC Link constraints

During this step, each Scheduling Area Responsible determines the limits upon the active power transmission for the HVDC Link: physical constraints on the surrounding grid, technical constraints on the HVDC cable, planned maintenance, etc.

Then the matching Scheduling Area Responsible performs the matching function on the constraints data, and generates a common set of constraints, based on the most restrictive values. The Scheduling Area Responsible agree on the matched HVDC Link constraints.

5.4.3 HVDC Link configuration

During this step, each Scheduling Area Responsible computes the configuration values of the HVDC Link: it consists, for a given set of exchange ranges, of a set of optimized HVDC parameters to be used for HVDC Scheduling.

The configuration depends on the HVDC operating mode (AC emulation, setpoint scheduling, or proportional external signal). It takes into account the HVDC Link constraints that have been previously defined. It may also take into account the NTC that has been matched (from standard process IEC 62325-451-3).

Then the matching Scheduling Area Responsible performs the matching function on the HVDC configuration data, and the Scheduling Area Responsible agree on the matched HVDC Link configuration.

5.4.4 HVDC Link schedule

During this step, each Scheduling Area Responsible determines the schedule of the HVDC Link: it contains the operational information required to operate the HVDC Link for a given time period. It shall take into account the HVDC Configuration data and the cross-border nominations (from standard process IEC 62325-451-2) that have been previously defined.

Then the matching Scheduling Area Responsible verifies and matches the schedule with its own HVDC schedule values. The values must be identical. If there is a mismatch, the participating Scheduling Area Responsible shall send a new intermediate HVDC schedule until the matching is successful. Once the HVDC schedules are matched, the matching Scheduling Area Responsible sends the final schedule to all participating Scheduling Area Responsible for final acceptance.

5.5 Sequence Diagram

The sequence diagram in Figure 4 outlines the generic exchange of data that occurs during the standard HVDC Link scheduling process.

This diagram presents the information flows that are exchanged between the two roles that intervene in the standard HVDC Link scheduling process. The determination of the data by each Scheduling Area Responsible, then the transmission of its intermediate data by the Participating Scheduling Area Responsible, then the matching of the two sets of data by the Matching Scheduling Area Responsible and the notification of the matched data to the Participating Scheduling Area Responsible.

The information flows identified in the sequence diagram are used to transmit all the information necessary in order to ensure the exchange of HVDC Link data for the scheduling process: constraints data, configuration data and schedules.

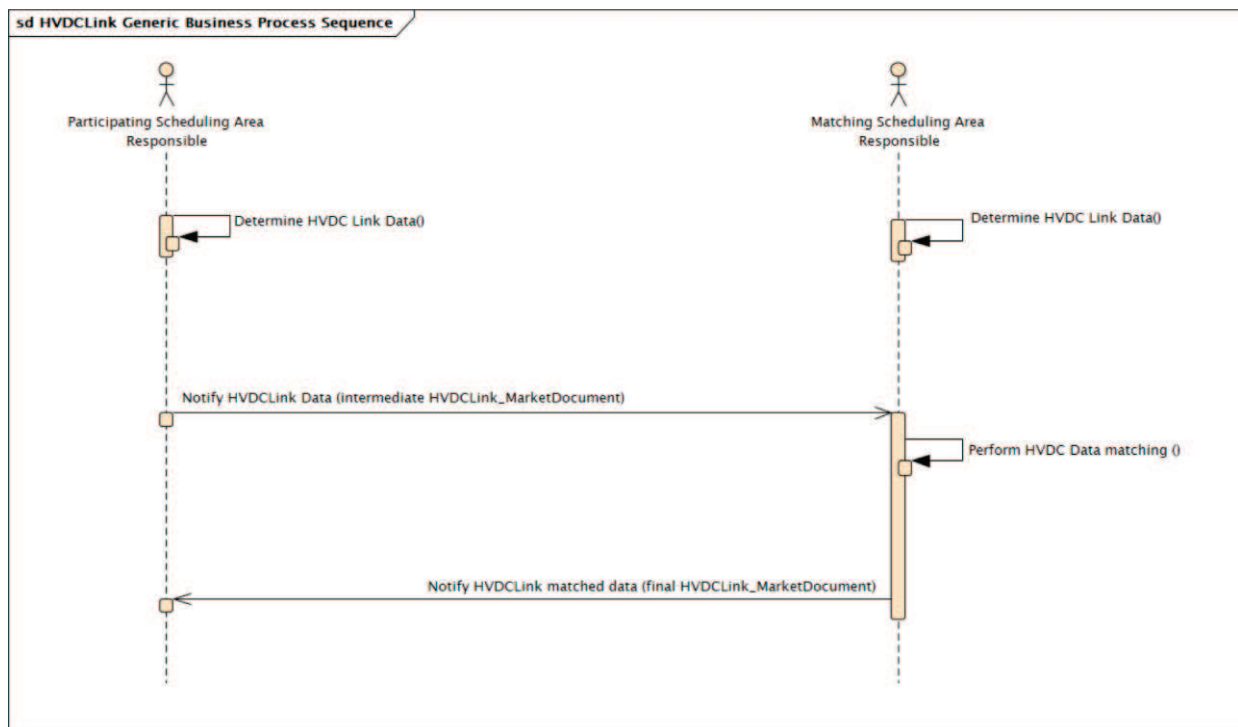


Figure 4 – Sequence diagram of the information flows

5.6 Electronic documents used

5.6.1 HVDC Link Document

The HVDCLink_MarketDocument is a standard document defined hereafter.

It shall be used to exchange the following information for a HVDC link:

- operational power range through the HVDC link constraints document type
- power control mode through the HVDC operating mode document type
- power setpoint through the HVDC configuration document type
- operational table through the HVDC schedule document type.

Note: During the Balancing Process, it may be used for the HVDC cross-border : each connecting TSO submits to the MOL Responsible the constraints and the schedules relative to these HVDC lines.

5.6.2 Capacity Document

The Capacity_MarketDocument is a standard document that is defined in IEC 62325-451-3.

In the Balancing Process, it is used to enable the exchange of information about the cross-border capacities:

- either the available cross-border capacity (ATC), submitted by each Connecting TSO to the Merit Order List, to feed the Activation Optimization function
- or the remaining cross-border capacity, calculated as a result of the activation optimization function, and which is sent by the Merit order list Responsible to the connecting TSOs at the end of the clearing phase.

5.7 Generic business rules for documents

5.7.1 General

All the business rules described in IEC 62325-351 are also valid for this part of IEC 62325. Additional rules are provided hereafter.

When a document is received, it shall be checked at the application level to ensure that there are no faults in it that could prevent its normal processing. After this check, an acknowledgement document, as defined in

IEC 62325-451-1, shall be generated either accepting in its entirety the document in question or rejecting it with the reasons for the rejection.

5.7.2 Document instance implementation

The XML documents described in this part of IEC 62325 are to be used for the upload of information to a transparency platform managed by the information market aggregator; they may also be used for the download of information to market participants in order to enable automatic processing of the information within their systems.

Consequently, attributes that describe basic configuration information (such as name, voltage level, etc.) have been included in the XML documents as optional attributes that may be used only in the case where information is provided to an information receiver. This information shall not be used in the case where information is uploaded to the market information aggregator.

The implementation of a data exchange shall be based upon dependency tables that are constructed as outlined in Table 1. In the case of the European market such tables are used to describe the different conditions in which all the optional attributes (i.e. the attributes that have a multiplicity of [0..1]) within a document structure are used.

The table below contains optional attributes as well as mandatory coded attributes in the left hand column. The top row provides the context where the contexts in which the use of the model is intended (e.g. exchange of information about HVDC constraints, exchange of information about HVDC configuration, HVDC Link scheduling).

Within each context row the possible values for the mandatory coded attributes are provided and an indication if the optional attributes are to be used (used, not used, used for upload only, etc.).

Table 1 – Dependency table outline for the HVDC Link scheduling process

Information model attribute	Usage context 1	Usage context 2	Usage context 3	Usage context n
type (Document)	Type code value 1	Type code value 2	Type code value 3	Type code value n
process.processType	Type code value	Type code value	Type code value	Type code value
businessType (TimeSeries)	Type code value	Type code value	Type code value	Type code value
Attribute value 1	Usage indication	Usage indication	Usage indication	Usage indication
Attribute value n	Usage indication	Usage indication	Usage indication	Usage indication

Such tables are to be provided in dedicated implementation guides for each relevant information to be delivered.

5.8 Rules governing the HVDCLink_MarketDocument

5.8.1 Retransmission of historical information

Information for a given delivery period in time may, depending of the nature of the information, be sent via several distinct transmissions (e.g. a document for each hour of the day or for each delivery period). For example, a separate electronic document could be sent every hour containing a quantity for the hour in question. Such documents will each have a distinct identification and version. The version could change in this case to correct the quantities for each delivery period.

It may be necessary to retransmit the complete set of historical information at the end of the period. This is carried out through the creation of a new document covering the complete period (e.g. all the hours in the day) that includes all the quantities that have been previously sent with any corrections that are necessary.

Every document version has a creation date and time that could be effectively used as the document timestamp since a new version of a document cancels and replaces the previous version of the document.

5.8.2 Rules governing the TimeSeries class

If the information contained in a previously transmitted time series is to be cancelled then a new version of the original document shall be sent with the time series in question cancelled, and all the Periods below the time series shall be removed.

The number of periods within a time series as characterized by the resolution must completely cover the period's time interval.

6 Contextual and assembly models

6.1 HVDCLink document contextual model

6.1.1 Overview of the model

Figure 5 shows the model.

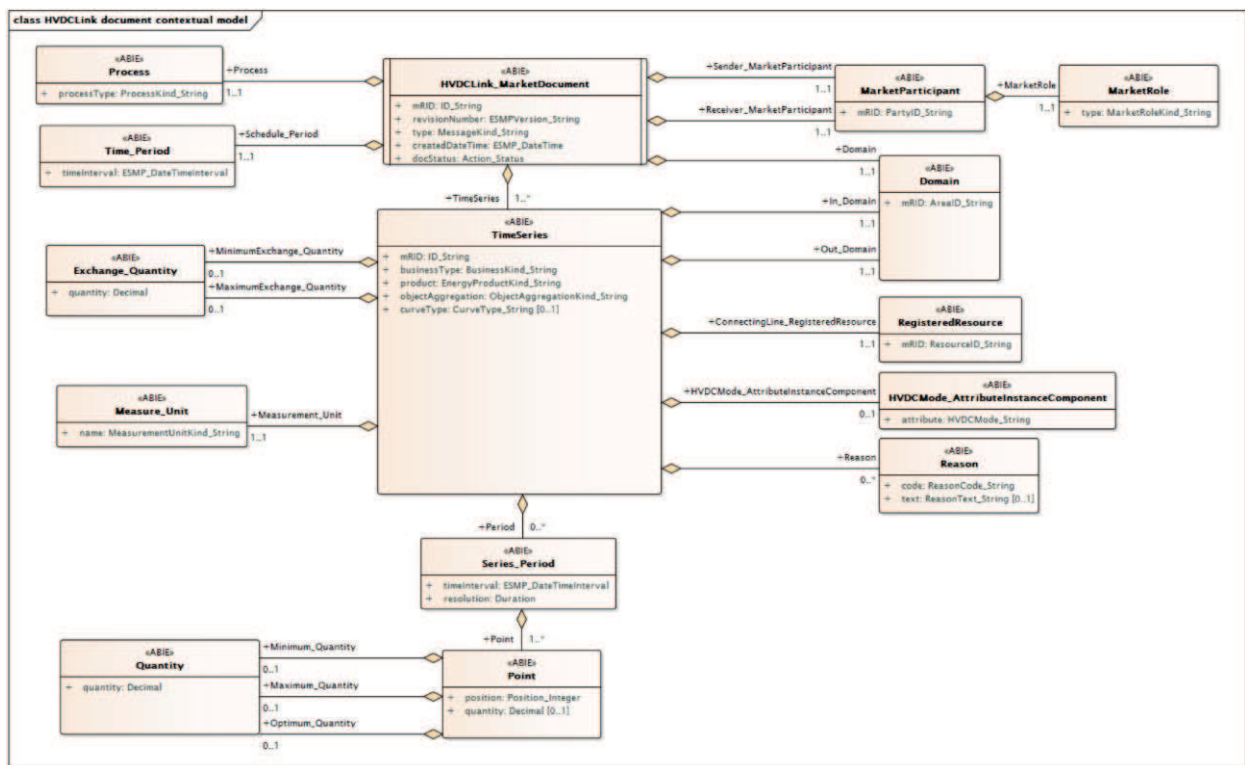


Figure 5 - HVDCLink document contextual model

6.1.2 IsBasedOn relationships from the European style market profile

Table 2 shows the traceability dependency of the classes used in this package towards the upper level.

Table 2 - IsBasedOn dependency

Name	Complete IsBasedOn Path
Domain	TC57CIM::IEC62325::MarketManagement::Domain
Exchange_Quantity	TC57CIM::IEC62325::MarketManagement::Quantity
HVDCLink_MarketDocument	TC57CIM::IEC62325::MarketManagement::MarketDocument
HVDCMode_AttributeInstanceComponent	TC57CIM::IEC62325::MarketManagement::AttributeInstanceComponent
MarketParticipant	TC57CIM::IEC62325::MarketCommon::MarketParticipant
MarketRole	TC57CIM::IEC62325::MarketCommon::MarketRole