BS EN IEC 62325-451-7:2021

BSI Standards Publication

Framework for energy market communications

Part 451-7: Balancing processes, contextual and assembly models for European style market

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National foreword

This British Standard is the UK implementation of EN IEC 62325-451-7:2021. It is identical to IEC 62325-451-7:2021.

The UK participation in its preparation was entrusted to Technical Committee PEL/57, Power systems management and associated information exchange.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Published by BSI Standards Limited 2021

ISBN 978 0 539 05114 8

ICS 33.200

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 May 2021.

Amendments/corrigenda issued since publication

Date	Text affected

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN IEC 62325-451-7

April 2021

ICS 33.200

English Version

Framework for energy market communications - Part 451-7: Balancing processes, contextual and assembly models for European style market (IEC 62325-451-7:2021)

Cadre pour les communications pour le marché de l'énergie - Partie 451-7: Processus d'équilibrage, modèles contextuels et modèles d'assemblage pour le marché de style européen (IEC 62325-451-7:2021)

Kommunikation im Energiemarkt - Teil 451-7: Ausgleichsprozesse, kontextuelle Modelle und Regeln zum Aufbau von Modellen für den Markt nach europäischem Stil (IEC 62325-451-7:2021)

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European foreword

The text of document 57/2332/FDIS, future edition 1 of IEC 62325-451-7, 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 62325-451-7:2021.

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) 2022-01-21
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2024-04-21

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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.

Publication	Year	Title	EN/HD	Year
IEC/TS 61970-2	-	Energy management system application program interface (EMS-API) - Part 2: Glossary	CLC/TS 61970-2	-
IEC 62325-351	2016	Framework for energy market communications - Part 351: CIM European market model exchange profile	EN 62325-351	2016
IEC 62325-450	2013	Framework for energy market communications - Part 450: Profile and context modelling rules	EN 62325-450	2013
IEC 62325-451-1	-	Framework for energy market communications - Part 451-1: Acknowledgement business process and contextual model for CIM European market	EN 62325-451-1	-
IEC 62325-451-2	-	Framework for energy market communications - Part 451-2: Scheduling business process and contextual model for CIM European market	EN 62325-451-2	-
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	EN 62325-451-3	-
IEC 62325-451-4	-	Framework for energy market communications - Part 451-4: Settlement and reconciliation business process, contextual and assembly models for European market	EN 62325-451-4	-
IEC 62325-451-5	-	Framework for energy market communications - Part 451-5: Problem statement and status request business processes, contextual and assembly models for European market	EN 62325-451-5	-

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Publication	Year	Title	EN/HD	Year
IEC 62361-100	-	Power systems management and associated information exchange - Interoperability in the long term - Part 100: CIM profiles to XML schema mapping	EN 62361-100	-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FRAMEWORK FOR ENERGY MARKET COMMUNICATIONS –

Part 451-7: Balancing processes, contextual and assembly models for European style market

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International Standard IEC 62325-451-7 has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

The text of this standard is based on the following documents:

FDIS	Report on voting
57/2332/FDIS	57/2345/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

This IEC standard includes Code Components i.e. components that are intended to be directly processed by a computer.

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The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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INTRODUCTION

This document is one part of the IEC 62325 series for deregulated energy market data exchanges based on the European style market profile. This part of IEC 62325 defines the document contextual models, the message assembly models as well as the XML schemas to be used for the Balancing process.

The principal objective of the IEC 62325 series is to produce standards which facilitate the integration of market application software developed independently by different vendors into a market management system, between market management systems and market participant systems. This is accomplished by defining message exchanges to allow these applications or systems access to public data and exchange information independent of how such information is represented internally.

The common information model (CIM), i.e. IEC 62325-301, IEC 61970-301 and IEC 61968-11, specifies the basis for the semantics for message exchange.

This European style market profile is based on different parts of the CIM IEC standards and specifies the content of the messages exchanged.

This document provides, for the European style market profile, the necessary information to be exchanged between Balancing Service Providers, Transmission System Operators and a Common Merit Order List about the Electricity Balancing market.

These market processes are based on the European regulations (No. 1227/2011 and No. 543/2013), on the European Balancing Guidelines on Electricity Balancing (No. 2017/2195), and on the concepts of third-party access and zonal markets. (see Annex ZZ)

This part of IEC 62325 was originally based upon the work of the European Network of Transmission System Operators (ENTSO-E) CIM Expert Group (formerly Working Group EDI).

The profile in this document is also designed to be used in markets in other countries, including Japan, that are designed based on the European style market.

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FRAMEWORK FOR ENERGY MARKET COMMUNICATIONS –

Part 451-7: Balancing processes, contextual and assembly models for European style market

1 Scope

This part of IEC 62325 specifies a UML package for the electricity balancing 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.

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 publication business process.

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

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 62325-451-2, *Framework for energy market communications - Part 451-2: Scheduling 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 62325-451-4, *Framework for energy market communications - Part 451-4: Settlement and reconciliation business process, contextual and assembly models for European market*

IEC 62325-451-5, *Framework for energy market communications - Part 451-5: Problem statement and status request business processes, contextual and assembly models for European market*

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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 and the following 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

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
activation price
price that is used to remunerate the bid energy volume (or bid capacity volume) that has been activated

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
balancing resource
reserve-providing unit or a reserve-providing group, able to provide balancing services

3.6
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]

3.7
bidding price
price that is offered for a balancing Reserve Bid

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Note 1 to entry: It is expressed in a unit of currency per unit of measure (capacity or energy).

3.8
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]

3.9
clearing price
price that is calculated by an activation optimisation function algorithm during a clearing phase, and based on marginal pricing

3.10
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

3.11
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]

3.12
power frequency control
secondary control of the active power of generating sets in response to variations in system frequency and to the variation in the grand total of active power exchanged with the interconnected systems.

[SOURCE: IEC 60050 603-04-06 (formerly 614-05-22)]

3.13
message business information entity
MBIE
aggregation of a set of ABIEs that respects a define set of assembly rules

3.14
profile
basic outline of all the information that is required to satisfy a specific environment

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

3.15
standard balancing energy bid
balancing offer based upon a standard product, which is a harmonised balancing product defined by all LFC Operators for the exchange of balancing services

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4 Document contextual model and message assembly model basic concepts

4.1 Overview

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.

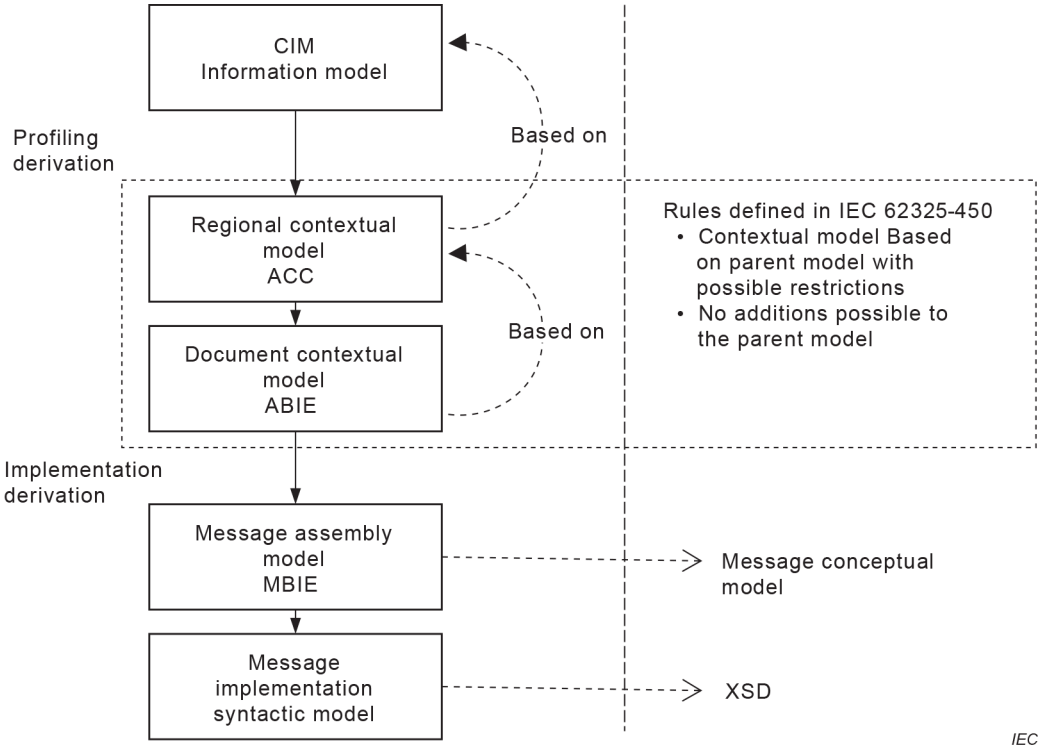

Figure 1 – IEC 62325-450 modelling framework

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.

An 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.

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4.2 European style market package structure (ESMP)

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

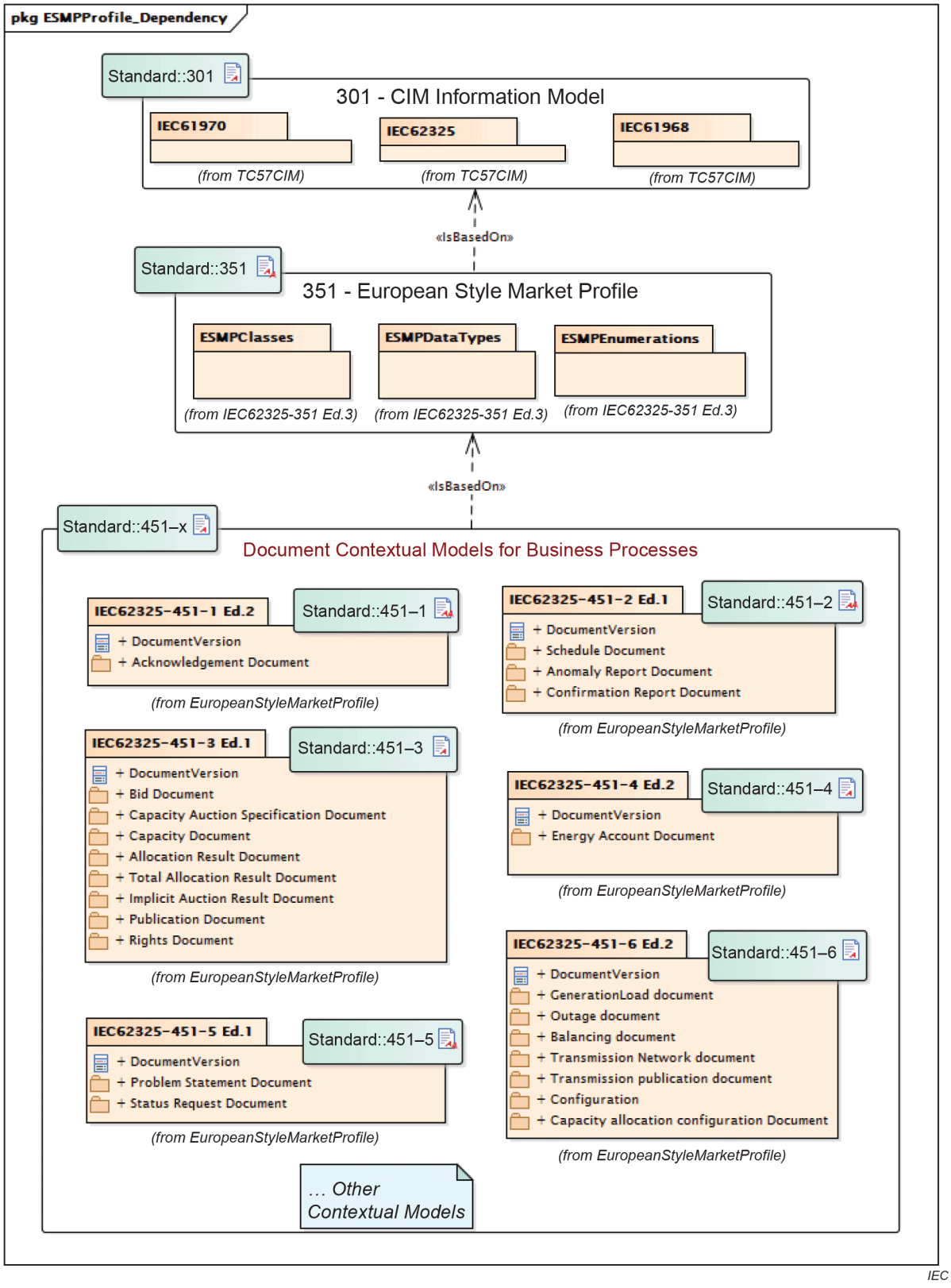

Figure 2 – Overview of European style market profile dependency

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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 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.

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5 The balancing business process

5.1 General

The intraday market provides the possibility for market participants to balance themselves as close as possible to real time. The imbalances remaining at the end of the intraday market can be balanced by the Load-Frequency Control Operator with the balancing market, in order to ensure network security and stability.

The balancing business process enables Transmission System Operators, acting as Load-Frequency System Operators (LFC Operators) to ensure in a continuous way, the maintenance of system frequency within a predefined stability range, and compliance with the amount of reserves needed with respect to the required quality.

In the European Style Market Profile, the integration of balancing energy markets would be facilitated with the establishment of common European platforms for operating the imbalance netting process and for enabling the exchange of balancing energy from frequency containment reserves (FCR), automatic and manual frequency restoration reserves (aFRR and mFRR) and replacement reserves (RR), as described in the European Guidelines on Electricity Balancing (see Annex ZZ).

The common platforms for the exchange of balancing energy from frequency containment reserves, frequency restoration reserves and replacement reserves shall apply a model with merit order lists in order to ensure cost-efficient activation of bids.

5.2 Roles

5.2.1 The Load-Frequency Control Operator role (LFC Operator)

The Load-Frequency Control Operator is responsible for the load frequency control for its LFC Area or LFC Block.

An LFC Area is a part of a synchronous area or an entire synchronous area, physically demarcated by points of measurement at interconnectors to other LFC Areas, operated by one or more TSOs fulfilling the obligations of load-frequency control.

An LFC Block is a part of a synchronous area or an entire synchronous area, physically demarcated by points of measurement at interconnectors to other LFC Blocks, consisting of one or more LFC Areas, operated by one or more TSOs fulfilling the obligations of load-frequency control.

As far as the European style market profile is concerned, the LFC Operator role is typically performed by a TSO participating in the Balancing Business Process.

- A Connecting LFC Operator is an LFC Operator that operates the LFC Area in which balancing service providers shall be compliant with the terms and conditions related to balancing
- A Requesting LFC Operator is an LFC Operator that requests the delivery of balancing energy.

5.2.2 The Merit Order List Responsible role (MOL Responsible)

According to the European Balancing Guidelines (see Annex ZZ), the MOL Responsible is a common European platform mandated by the LFC Operators for the management and the exchange of standard products for balancing energy. It shall apply to a multilateral System Operator – System Operator model and it is responsible for updating and sharing a common merit order list of balancing energy bids and of balancing needs.

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The Merit Order List Responsible is a party that is responsible for the management of the available tenders for all Requesting System Operators to establish the order of the reserve capacity that can be activated.

As far as the European style market profile is concerned, within the Balancing Process, the Merit Order List Responsible (MOL Responsible) may be defined as follows:

- Responsible for the management of the available Balancing Energy bids for all Requesting LFC Operators to establish the order of the reserve capacity that can be activated
- Responsible for the management of the Balancing needs of all Requesting LFC Operators,
- Responsible for the operation of an optimization algorithm, during the clearing phase, to determine which tenders meet the balancing needs, in compliance with the qualification criteria, and to assign tenders. This optimization algorithm is applied to optimise the activation of balancing energy bids.

The optimization algorithm launched during the clearing phase aims to optimize the social welfare and maximize inelastic need satisfaction. It can also aim to minimize cross-border flows, maximize traded volume, minimize cross-border prices difference.

5.2.3 The Balancing Service Provider role (BSP)

As far as the European style market profile is concerned, a Balancing Service Provider (BSP) may be defined as a Market participant with reserve-providing units or reserve-providing groups able to provide balancing services to LFC Operators. The reserve can be either generation or load.

Balancing services can be:

- Balancing Energy: energy provided by a BSP and used by an LFC Operator to perform balancing

  or

- Balancing Capacity: a volume of reserve capacity that a BSP has agreed to hold and in respect to which it has agreed to submit to the LFC Operator one or several bids for a corresponding volume of balancing energy.

5.2.4 The Coordination Center Operator role

The Coordination Center Operator is responsible for ensuring that, in a verification process, the sum of all imports and exports of all LFC areas, at any time, sums up to zero.

5.2.5 The Market Information Aggregator role

The Market Information Aggregator is a party that provides market related information that has been compiled from the figures supplied by different actors in the market. This information may also be published or distributed for general use.

The Market Information Aggregator may receive information from any market participant that is relevant for publication or distribution. As an example, the required information for the European electricity markets is described in the European regulation No 453/2013 (see Annex ZZ).

5.2.6 The Imbalance Settlement Responsible role

The Imbalance Settlement Responsible is a party that is responsible for settlement of the difference between the contracted quantities and the realised quantities of energy products for the Balance Responsible Parties in a Scheduling Area.

The Imbalance Settlement Responsible may delegate the invoicing responsibility to a more generic role such as Billing Agent.

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5.3 Overview of balancing business process

The balancing business process incorporates the information that shall be exchanged between the three main actors:

– LFC Operators (this role is typically performed by a TSO),
– Balancing Service Providers,
– a Merit Order List Responsible,

in the context of a common balancing platform, i.e. a common IT system allowing to integrate balancing process and to optimize the activation of balancing energy bids.

Besides, this process incorporates other information that shall be exchanged with a Market Information Aggregator and an Imbalance Settlement Responsible. This process may also include the transmission of information between the MOL Responsible and a Coordination Center Operator.

Figure 3 presents the balancing business process, which includes five distinct and consecutive phases: the pre-tendering phase, the tendering phase, the clearing phase, the activation phase and the post-clearing phase.

Those five phases occur before the delivery period of the balancing energy by the BSPs. During this delivery period, the LFC Operator executes the real-time management of the system, while respecting operational security constraints.

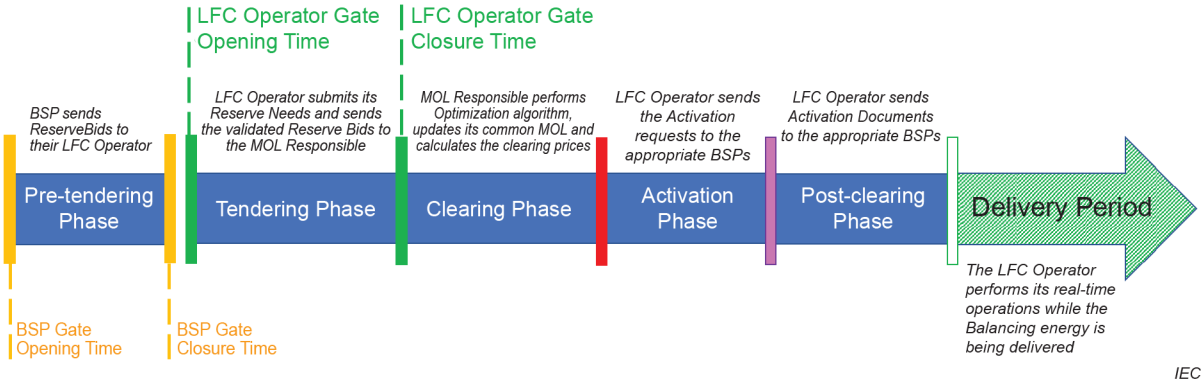

Figure 3 – Phases of the Balancing Process

The pre-tendering phase spans between the BSP Gate Opening Time and the BSP Gate Closure Time. During this phase, each LFC Operator shall collect and validate all the balancing energy offers that are submitted by Balancing Service Providers. The LFC Operator shall also calculate the balancing needs of its LFC Area.

At the LFC Operator Gate Opening Time, the tendering phase begins: during this Phase, the MOL Responsible has the task to assemble balancing information (balancing bids and balancing needs) and other network constraint information from all participating LFC Operators, in order to manage and to share its common merit order list. This phase ends at the LFC Operator Gate Closure Time.

The Clearing phase begins immediately after the LFC Operator Gate Closure Time. During this phase, the MOL Responsible has the responsibility to perform its optimization function, in order to ensure cost-efficient activations of offers, and to define its clearing results.

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At the end of the clearing phase, which corresponds to the beginning of the Activation phase, the MOL Responsible shall transmit the clearing results to all the participating LFC Operators. During this Activation phase, each LFC Operator is responsible for interpreting the MOL Responsible clearing results, and for transmitting the activation requests to the relevant Balancing Service Providers that are connected to its LFC Area or its LFC Block.

During the Post-clearing phase, the MOL Responsible has the responsibility to provide market transparency data to the Market Information Aggregator, as described in European Regulations No 1227/2011 and No 543/2013 (See Annex ZZ). It must also provide settlement data to the Imbalance Settlement Responsible.

The use cases that outline the balancing business process make use of several different generic electronic document structures to exchange the information between the different actors. The electronic document structures themselves are detailed later in this document.

5.4 Use Cases

5.4.1 General Overview

Figure 4 outlines the different basic processes that are carried out within the balancing business process.

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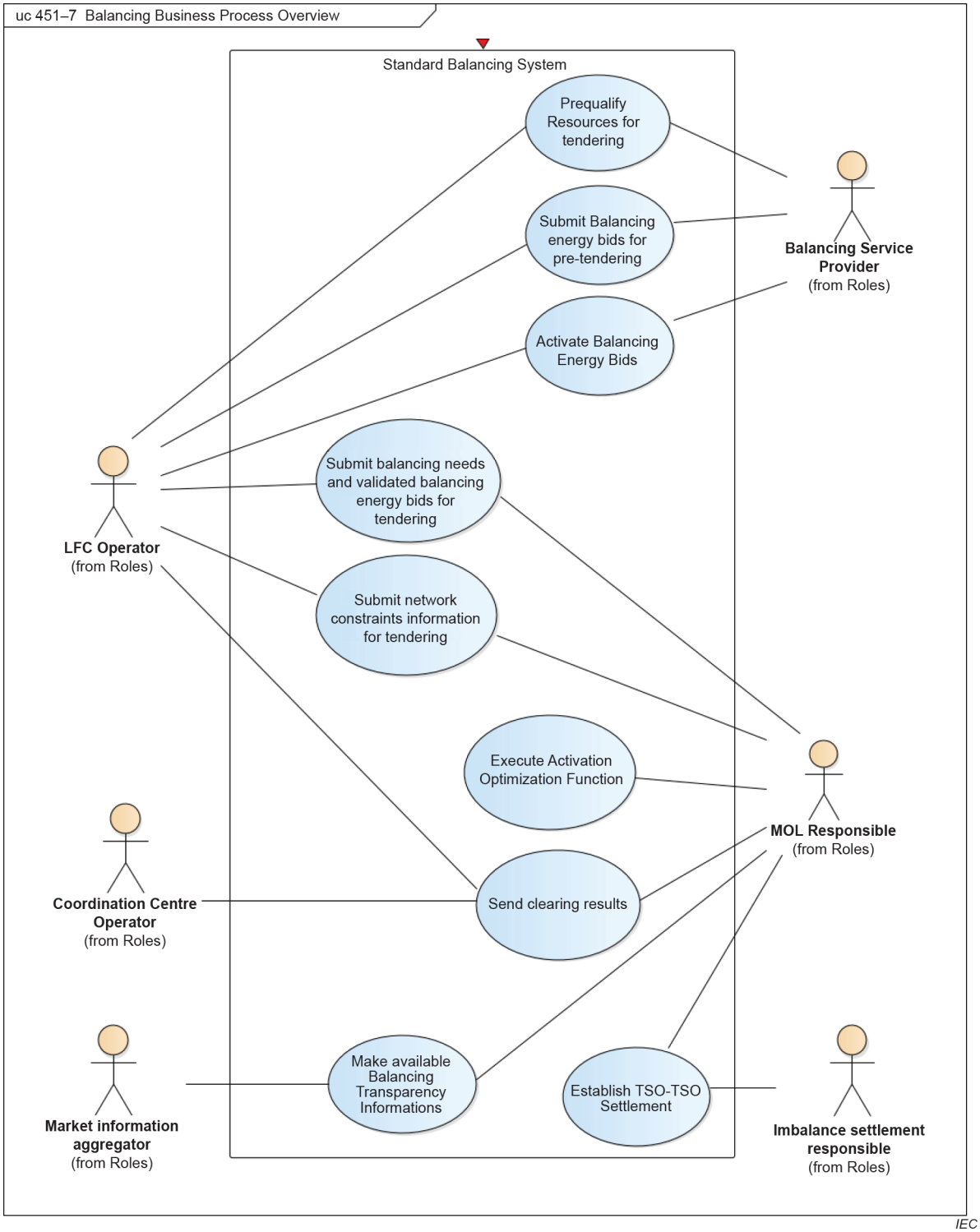

Figure 4 – Balancing Process Overview

5.4.2 Pre-qualification phase: Pre-qualify Balancing Resources

Before the Pre-tendering phase, each balancing service provider intending to participate to the balancing market and to provide balancing service should successfully pass a pre-qualification process of its balancing resources, which can be either production groups or demand-response facilities.

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This prequalification process is defined and monitored by each LFC Operator, depending on local market rules and on technical information, in close cooperation with Distribution System Operators when necessary.

The BSP shall request to its connecting LFC Operator the pre-qualification of its balancing resources for the balancing market, for one or several standard products (e.g. RR, aFRR, mFRR, FCR).

The LFC Operator may then carry out verification for each balancing resource to ensure that it meet the technical requirements that have been established for each balancing standard product.

The LFC Operator then informs the BSP of the prequalification results of its balancing resources.

Once its balancing resources have been qualified, the BSP may participate to the pre-tendering phase by submitting reserve bids based upon them.

5.4.3 Pre-tendering phase: Submit balancing energy bids for pre-tendering

During the pre-tendering phase (i.e. during the time interval between the BSP gate opening time and the BSP gate closure time), all BSPs willing to participate to the upcoming balancing period should transmit their standard balancing energy bids to their connecting LFC.

5.4.4 Tendering phase: Submit balancing needs and validated balancing energy bids

Each connecting LFC Operator shall validate that each balancing energy bid does not include erroneous data nor an unfeasible delivery volume. The BSP is informed about the result of this validation using the Acknowledgement Market Document, as defined in IEC 62325-451-1. The LFC Operator acknowledges the receipt by either accepting or rejecting the bid entirely.

The connecting LFC Operator shall not modify standard balancing energy bids but can withhold the balancing energy bids that cannot be available due to constraint network issues.

During the tendering phase, each participating LFC Operator shall submit the MOL Responsible all validated balancing energy bids that have been sent by the BSPs.

Each participating LFC Operator shall also establish the total balancing needs that it requires for the upcoming delivery period. The LFC Operator can perform comparisons and limitations between the total volume of bids submitted and the volume of balancing needs that shall be required.

The participating LFC Operator shall submit this information to the MOL Responsible during the tendering phase.

5.4.5 Tendering phase: Submit network constraints information necessary for tendering

During the tendering phase, each connecting LFC Operator shall also submit the MOL Responsible all necessary constraint information for the operation of its optimization function. The LFC Operators shall then provide:

- information about the capacity constraints on the cross-border lines: Available transfer capacity (ATC) for each border
- information about HVDC lines technical constraints: HVDC Schedules and HVDC constraints schedules, in case of HVDC cross-border links. (This information is optional, and may be used only in case of HVDC lines)

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5.4.6 Clearing phase: Execute optimization activation function

During the clearing phase, the MOL Responsible shall manage the available tenders and establish a merit order list of the bids that can be activated. The MOL Responsible executes an optimization activation algorithm to determine which tenders meet balancing needs and to assign the tenders to the needs. The MOL Responsible fixes the clearing prices, calculates the cross-border schedules and the remaining available transfer capacity.

5.4.7 Activation phase: Sending clearing results

At the end of the clearing phase, the MOL Responsible updates its merit order list, in order to maintain the final status of all the balancing energy bids that it includes.

The MOL Responsible shall then send to each LFC Operator the different outputs of its optimization algorithm:

- the balancing energy bids of its LFC area or LFC block, that are to be activated,
- the satisfied balancing needs,
- updated information on the cross-border capacities related to its LFC area: the ATC that remains unallocated at the end of the clearing process, the cross-border schedules that have to be included to the coming scheduling process and the net positions of each scheduling area of all participating LFC Operators.

The MOL Responsible may also make available all the cross-border net positions to the Coordination Centre Operator, which is responsible for ensuring that, in a verification process, the sum of all imports and exports of all LFC areas, at any time, sums up to zero.

5.4.8 Activation phase: Activate balancing energy bids

During the Activation Phase, each connecting LFC Operator activates the balancing energy under its responsibility and that have been selected by the MOL Responsible to satisfy the overall needs of all concerned LFC Operators. The LFC Operator transmits an activation order to activate its balancing resources to each relevant BSP.

In the context of the Balancing Business Process, “activation” means that the LFC Operator issues an order to the BSP Provider to activate the reserves that have been offered through a balancing energy bids, for the delivery of balancing energy (which is different from real-time control command orders that may be sent by SCADA or by automats).

The request for activation of a balancing energy bid by the MOL Responsible shall oblige the requesting LFC Operator and the connecting LFC Operator to accept the exchange of balancing energy. Each connecting LFC Operator shall ensure the activation of the balancing energy bids selected by the activation optimisation function of the MOL Responsible.

5.4.9 Post-clearing phase: Make available balancing transparency information

During the post-clearing phase, at the end of the delivery period, the MOL Responsible makes available all the information required for transparency purposes. As an example, it shall submit to a Market information Aggregator the clearing prices, the list of all available balancing energy bids, and the total volume of all energy bids that have been activated.

5.4.10 Post-clearing phase: Establish TSO-TSO Settlement

The MOL Responsible establishes TSO-TSO settlement calculations and provides invoices and financial data to the Imbalance Settlement Responsible that will carry out financial settlement between the different LFC Operators.

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5.5 Sequence Diagram

The sequence diagram in Figure 5 outlines the main five distinct phases that occur during the standard balancing process.

This diagram presents the information flows between the different actors that are involved in the European standard Balancing process.

The information flows identified in the sequence diagram are used to convey all the necessary information for balancing products.

Only the Reserve Bid document, the MeritOrderList document and the Activation document are in the scope of the present standard IEC 62325-451-7.

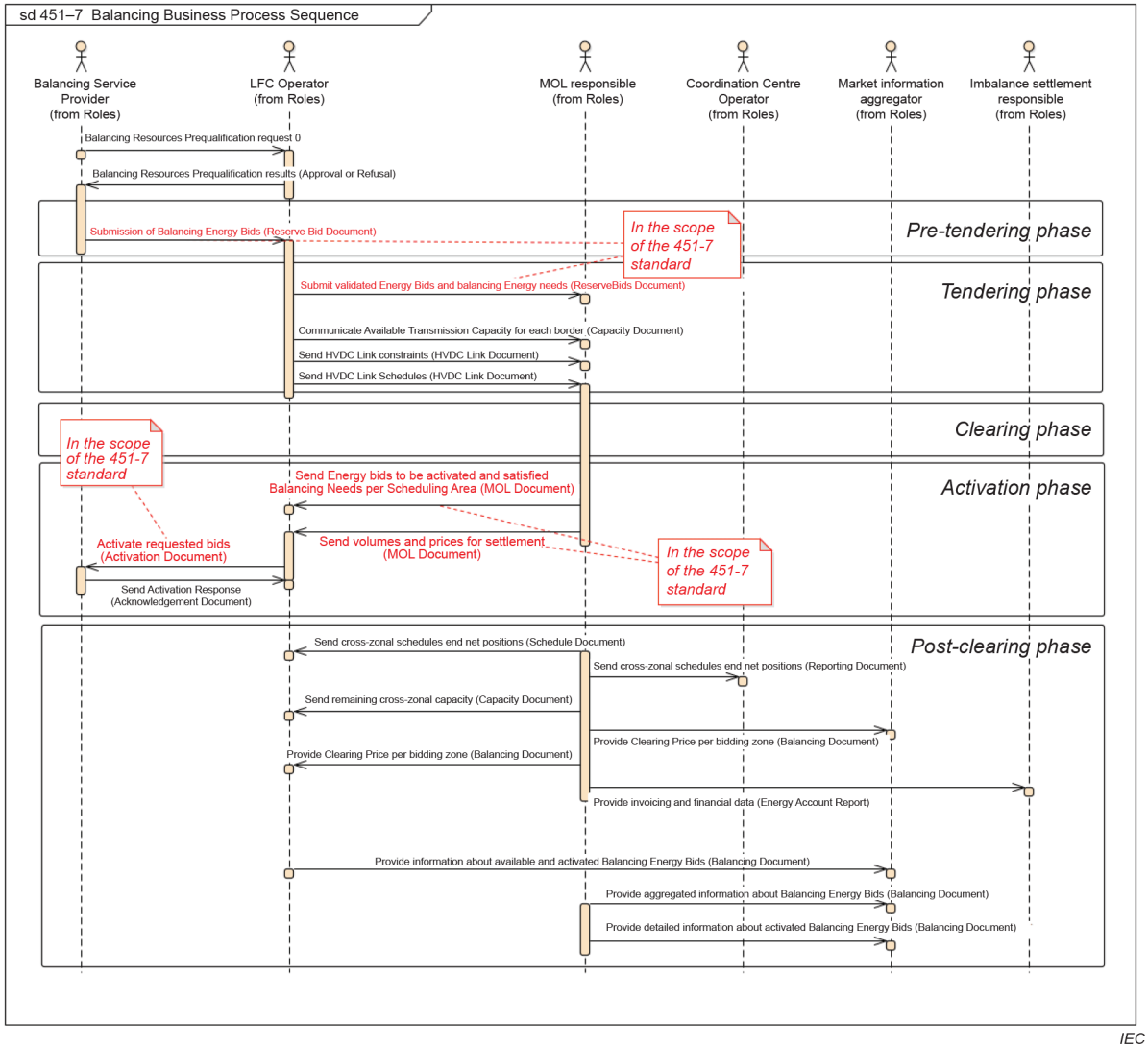

Figure 5 – Sequence diagram of the information flows

5.6 Electronic documents used

5.6.1 Reserve Bid Document

The ReserveBid_MarketDocument shall be used to define a set of balancing energy bids transmitted by each Balancing Service Provider. Each bid is represented by a TimeSeries: it describes the energy resource used, the amount of energy offered on each period, and the price of the bid.

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The ReserveBid_MarketDocument shall also be used by each Connecting LFC Operator to transmit the set of all validated balancing energy bids to the MOL Responsible. It shall also be used by each LFC Operator to submit to the MOL Responsible its balancing energy needs.

There may be several Reserve Bid Documents submitted by a Sender (BSP, LFC Operator) for the same period and subject party.

5.6.2 MeritOrder List Document

The MeritOrderList_MarketDocument shall be used to define the main attributes of a merit order list: either a merit order list of balancing energy bids, or a merit order list of balancing needs.

This document is used to enable the exchange of information about the merit order list managed by the MOL Responsible.

5.6.3 Activation Document

The Activation_MarketDocument is used to enable the exchange of information about the reserve Bids that are to be activated, the quantity of energy that shall be delivered, and the activation price. In particular, this document shall be used to transmit the information about the ReserveBid that shall be activated to the BSP.

5.6.4 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 Transfer Capacity (ATC), submitted by each Connecting LFC Operator to the Merit Order List Responsible, 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 LFC Operators at the end of the clearing phase.

5.6.5 HVDC Link Document

The ENTSO-E HVDCLink_MarketDocument is used to exchange detailed information about a HVDC Link. The ENTSO-E HVDCLink_MarketDocument is under standardization process and will be defined in IEC 62325-451-8. It is available in ENTSOE website (EDI library) until defined in IEC.

In the Balancing business process, it may be used only if some cross-border connectors are high voltage direct current lines (HVDC).

With this generic document, the connecting LFC Operator can submit to the MOL Responsible the corresponding schedules for those HVDC lines, and the constraints that have been identified.

5.6.6 Schedule Document

The ENTSO-E Schedule_MarketDocument is a standard document that is defined in IEC 62325-451-2.

With this generic document, the MOL Responsible can transmit to each Connecting LFC Operator its cross-zonal schedules (about the remaining ATC) or its net positions on the borders concerned by the Balancing process.

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5.6.7 Reporting Document

The Reporting_MarketDocument is currently used in the case of exchange of information with a Coordination Center Operator. In this process, it is used to transmit information relative to net positions to a Coordination Center Operator.

The information flow between the MOL Responsible and the Coordination Center Operator is out of context of the Balancing Process and won't be described hereafter.

5.6.8 Balancing Document

The Balancing_MarketDocument is a standard document that is defined in IEC 62325-451-6. This generic document is used in the case of the transmission to a transparency platform (i.e. Market Information aggregator) to provide different kinds of information related to the balancing market.

In this process, it is used to transmit information relative to accepted offers (detailed or aggregated view), balancing needs, clearing prices per Scheduling area.

5.6.9 Energy Account Report Document

The EnergyAccountReport_MarketDocument is a generic document that is defined in IEC 62325-451-4.

During the Post-clearing phase of the balancing process, it is used in the case of the transmission of invoicing and financial data to the Imbalance Settlement Responsible.

5.6.10 ProblemStatement Document

The ProblemStatement_MarketDocument is described in IEC 62325-451-5.

This document can be used to report troubles to deliver information between involved parties (LFC Operators, BSPs, MOL Responsible) during the Balancing Process.

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 the document in question entirely or rejecting it with justification.

5.7.2 Document instance implementation

The XML documents described in this part of IEC 62325 are to be used for exchanging the information between an LFC Operator, BSPs and a Merit Order List Responsible; they may also be used for downloading the information in order to enable automatic processing of the information within their systems.

The implementation of a data exchange shall be based upon dependency tables, constructed as outlined in Table 1.

In the case of the European style 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.

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Table 1 contains optionally coded attributes as well as mandatory attributes in the left-hand column. The top row provides various contexts in which the use of the model is intended (e.g. European style balancing process for a-FRR products, or European style balancing process for RR).

Within each context, 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 Energy Balancing process

Information model attribute	Usage context A	Usage context B	Usage context C	Usage context Z
Mandatory attribute 1	Type code value 1A	Type code value 1B	Type code value 1C	Type code value 1Z
Mandatory attribute 2	Type code value 2A	Type code value 2B	Type code value 2C	Type code value 2Z
Mandatory attribute n	Type code value nA	Type code value nB	Type code value nC	Type code value nZ
Optional Attribute 1	*Usage indication*	*Usage indication*	*Usage indication*	*Usage indication*
Optional Attribute 2	*Usage indication*	*Usage indication*	*Usage indication*	*Usage indication*
Optional Attribute n	*Usage indication*	*Usage indication*	*Usage indication*	*Usage indication*

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

5.7.3 Version of a document

Each XML document shall be used to convey information for a given time interval. Depending on the context, if the information contained in the document changes, then the transmission of a new document can be required (i.e, a new XML document with a new document name different from the previous one) or the transmission of a new version of the initial document can be required (i.e. an XML document with the same document name, but with a revision number that has been incremented).

5.7.4 Rules governing the Activation_MarketDocument

5.7.4.1 Transmission of Activation information

Only information concerning energy to be activated during a given activation time interval shall be identified in an Activation_MarketDocument. If the Activation Time Interval changes, then the transmission of a new document is required. If not, then the transmission of a new version can be used.

5.7.4.2 Absence of time series in a document

Under certain circumstances electronic document may contain no time series. In a submission scenario it may be used to meet a submission deadline although no information is available (e.g. no reserve bid has been activated).

5.7.4.3 Rules governing the TimeSeries class

Each time series enables to describe the activation of a specific reserve bid. It conveys the data related to the activation, such as the quantity of energy to be activated and the activation price.

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.

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

5.7.5 Rules governing the MeritOrderList_MarketDocument

5.7.5.1 Transmission of Merit Order List information

Each Merit Order List information shall be transmitted within a single document. Any changes necessary to the information transmitted should be adjusted through the use of a new version of the document in question.

The latest version of a document provides the current state of the information contained in the document.

5.7.5.2 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.

5.7.6 Rules governing the ReserveBid_MarketDocument

5.7.6.1 Retransmission of historical information

Information for a given delivery period in time (e.g. at each gate closure 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 at the end of the period the complete set of historical information. 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.

5.7.6.2 Absence of time series in a document

Under certain circumstances, an electronic document may contain no time series. In a submission scenario it may be used to meet a submission deadline although no information is available.

5.7.6.3 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.

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6 Contextual and assembly models

6.1 Activation contextual model

6.1.1 Overview of the model

Figure 6 shows the model.

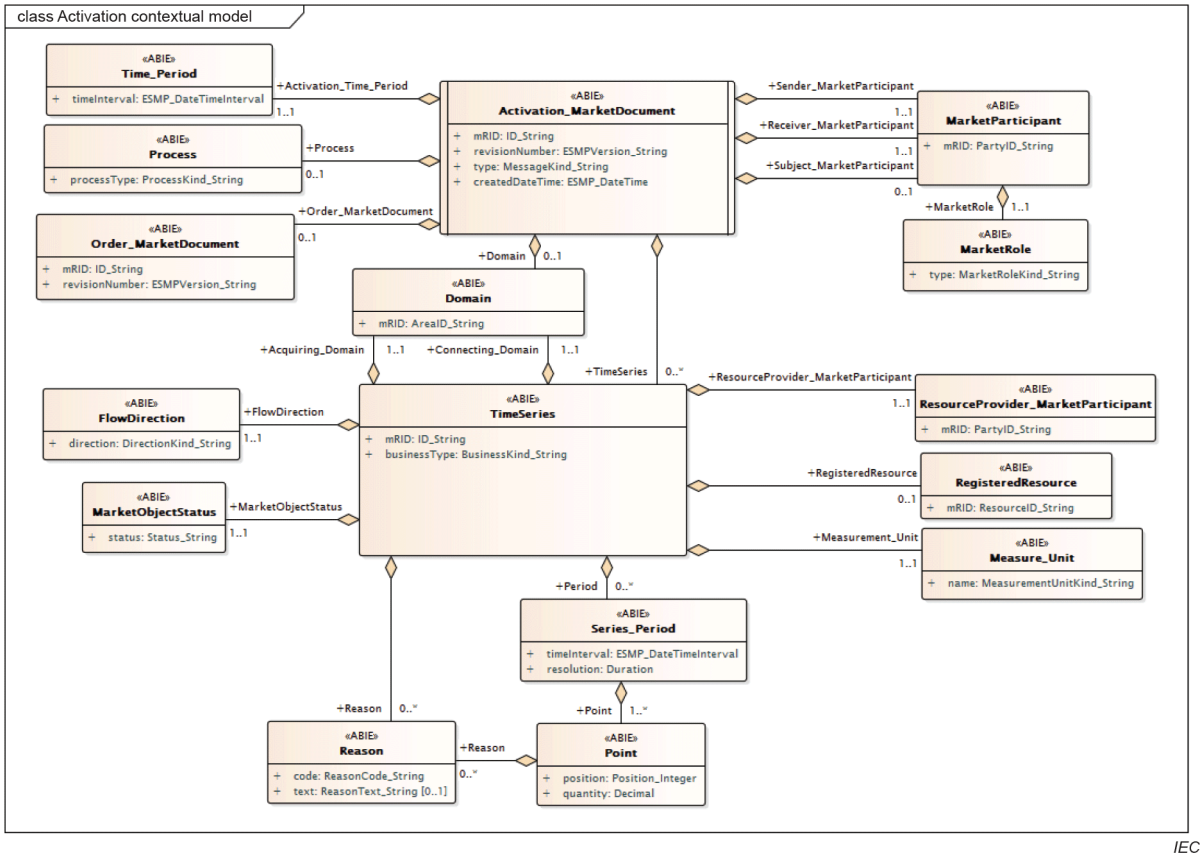

Figure 6 – Activation contextual model

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
Activation_MarketDocument	TC57CIM::IEC62325::MarketManagement::MarketDocument
Domain	TC57CIM::IEC62325::MarketManagement::Domain
FlowDirection	TC57CIM::IEC62325::MarketManagement::FlowDirection
MarketObjectStatus	TC57CIM::IEC62325::MarketManagement::MarketObjectStatus
MarketParticipant	TC57CIM::IEC62325::MarketCommon::MarketParticipant
MarketRole	TC57CIM::IEC62325::MarketCommon::MarketRole
Measure_Unit	TC57CIM::IEC62325::MarketManagement::Unit
Order_MarketDocument	TC57CIM::IEC62325::MarketManagement::MarketDocument

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Name	Complete IsBasedOn Path
Point	TC57CIM::IEC62325::MarketManagement::Point
Process	TC57CIM::IEC62325::MarketManagement::Process
Reason	TC57CIM::IEC62325::MarketManagement::Reason
RegisteredResource	TC57CIM::IEC62325::MarketCommon::RegisteredResource
ResourceProvider_MarketParticipant	TC57CIM::IEC62325::MarketCommon::MarketParticipant
Series_Period	TC57CIM::IEC62325::MarketManagement::Period
Time_Period	TC57CIM::IEC62325::MarketManagement::Period
TimeSeries	TC57CIM::IEC62325::MarketManagement::TimeSeries

6.1.3 Detailed Activation contextual model

6.1.3.1 Activation_MarketDocument root class

An electronic document containing the information necessary to satisfy the requirements of a given business process.

Table 3 shows all attributes of Activation_MarketDocument.

Table 3 – Attributes of Activation contextual model::Activation_MarketDocument

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID ID_String	The unique identification of the document being exchanged within a business process flow.
1	[1..1]	revisionNumber ESMPVersion_String	The identification of the version that distinguishes one evolution of a document from another.
2	[1..1]	type MessageKind_String	The coded type of a document. The document type describes the principal characteristic of the document.
6	[1..1]	createdDateTime ESMP_DateTime	The date and time of the creation of the document.

Table 4 shows all association ends of Activation_MarketDocument with other classes.

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Table 4 – Association ends of Activation contextual model:: Activation_MarketDocument with other classes

Order	mult.	Class name / Role	Description
3	[0..1]	Process Process	The process dealt with in the document. Association Based On: ESMPClasses::MarketDocument.[] ----- ESMPClasses::Process.Process[0..*]
4	[1..1]	MarketParticipant Sender_MarketParticipant	Document owner. Association Based On: ESMPClasses::MarketDocument.[] ----- ESMPClasses::MarketParticipant.MarketParticipant[0..*]
5	[1..1]	MarketParticipant Receiver_MarketParticipant	Document recipient. Association Based On: ESMPClasses::MarketDocument.[] ----- ESMPClasses::MarketParticipant.MarketParticipant[0..*]
7	[1..1]	Time_Period Activation_Time_Period	This information provides the start and end date and time of the activation time interval. Association Based On: ESMPClasses::MarketDocument.[] ----- ESMPClasses::Time_Period.Period[0..*]
8	[0..1]	Domain Domain	The identification of the domain that is covered in the document. Association Based On: ESMPClasses::MarketDocument.[] ----- ESMPClasses::Domain.Domain[0..1]
9	[0..1]	MarketParticipant Subject_MarketParticipant	Association Based On: ESMPClasses::MarketDocument.[] ----- ESMPClasses::MarketParticipant.MarketParticipant[0..*]
10	[0..1]	Order_MarketDocument Order_MarketDocument	Association Based On: ESMPClasses::MarketDocument.[] ----- ESMPClasses::MarketDocument.MarketDocument[0..*]
11	[0..*]	TimeSeries TimeSeries	The time series that is associated with an electronic document. Association Based On: ESMPClasses::MarketDocument.[] ----- ESMPClasses::TimeSeries.TimeSeries[0..*]

6.1.3.2 Domain

A domain covering a number of related objects, such as market balance area, grid area, borders etc.

Table 5 shows all attributes of Domain.

Table 5 – Attributes of Activation contextual model::Domain

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID AreaID_String	The unique identification of the domain.

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6.1.3.3 FlowDirection

The coded identification of the direction of energy flow.

Table 6 shows all attributes of FlowDirection.

Table 6 – Attributes of Activation contextual model::FlowDirection

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	direction DirectionKind_String	The coded identification of the direction of energy flow.

6.1.3.4 MarketObjectStatus

The condition or position of an object with regard to its standing.

Table 7 shows all attributes of MarketObjectStatus.

Table 7 – Attributes of Activation contextual model::MarketObjectStatus

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	status Status_String	The coded condition or position of an object with regard to its standing.

6.1.3.5 MarketParticipant

The identification of the party participating in energy market business processes.

Table 8 shows all attributes of MarketParticipant.

Table 8 – Attributes of Activation contextual model::MarketParticipant

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID PartyID_String	The identification of a party in the energy market.

Table 9 shows all association ends of MarketParticipant with other classes.

Table 9 – Association ends of Activation contextual model:: MarketParticipant with other classes

Order	mult.	Class name / Role	Description
1	[1..1]	MarketRole MarketRole	The role associated with a MarketParticipant. Association Based On: ESMPClasses::MarketParticipant.[] --- ESMPClasses::MarketRole.MarketRole[0..1]

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6.1.3.6 MarketRole

The identification of the intended behaviour of a market participant played within a given business process.

Table 10 shows all attributes of MarketRole.

Table 10 – Attributes of Activation contextual model::MarketRole

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	type MarketRoleKind_String	The identification of the role played by a market player.

6.1.3.7 Measure_Unit

A particular quantity, defined and adopted by convention, with which other quantities of the same kind are compared in order to express their magnitudes relative to that quantity.

Table 11 shows all attributes of Measure_Unit.

Table 11 – Attributes of Activation contextual model::Measure_Unit

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	name MeasurementUnitKind_String	The identification of the formal code for a measurement unit (UN/ECE Recommendation 20).

6.1.3.8 Order_MarketDocument

An electronic document containing the information necessary to satisfy the requirements of a given business process.

Table 12 shows all attributes of Order_MarketDocument.

Table 12 – Attributes of Activation contextual model::Order_MarketDocument

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID ID_String	The unique identification of the document being exchanged within a business process flow.
1	[1..1]	revisionNumber ESMPVersion_String	The identification of the version that distinguishes one evolution of a document from another.

6.1.3.9 Point

The identification of the values being addressed within a specific interval of time.

Table 13 shows all attributes of Point.

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Table 13 – Attributes of Activation contextual model::Point

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	position Position_Integer	A sequential value representing the relative position within a given time interval.
1	[1..1]	quantity Decimal	The principal quantity identified for a point.

Table 14 shows all association ends of Point with other classes.

Table 14 – Association ends of Activation contextual model::Point with other classes

Order	mult.	Class name / Role	Description
2	[0..*]	Reason Reason	At the Point level the reason code is used to identify the nature of a curtailment that has been imposed on the specified quantity. The Reason information associated with a Point providing motivation information. Association Based On: ESMPClasses::Point.[] --- ESMPClasses::Reason.Reason[0..*]

6.1.3.10 Process

A formal identification of the business process in which a flow of information is exchanged.

Table 15 shows all attributes of Process.

Table 15 – Attributes of Activation contextual model::Process

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	processType ProcessKind_String	The identification of the nature of process that the document addresses.

6.1.3.11 Reason

The motivation of an act.

Table 16 shows all attributes of Reason.

Table 16 – Attributes of Activation contextual model::Reason

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	code ReasonCode_String	The motivation of an act in coded form.
1	[0..1]	text ReasonText_String	The textual explanation corresponding to the reason code.

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6.1.3.12 RegisteredResource

A resource that is registered through the market participant registration system. Examples include generating unit, load, and non-physical generator or load.

Table 17 shows all attributes of RegisteredResource.

Table 17 – Attributes of Activation contextual model::RegisteredResource

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID ResourceID_String	The unique identification of a resource.

6.1.3.13 ResourceProvider_MarketParticipant

The identification of the party participating in energy market business processes.

Table 18 shows all attributes of ResourceProvider_MarketParticipant.

Table 18 – Attributes of Activation contextual model::ResourceProvider_MarketParticipant

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID PartyID_String	The identification of a party in the energy market.

6.1.3.14 Series_Period

The identification of the period of time corresponding to a given time interval and resolution.

Table 19 shows all attributes of Series_Period.

Table 19 – Attributes of Activation contextual model::Series_Period

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	timeInterval ESMP_DateTimeInterval	The start and end time of the period.
1	[1..1]	resolution Duration	The definition of the number of units of time that compose an individual step within a period.

Table 20 shows all association ends of Series_Period with other classes.

Table 20 – Association ends of Activation contextual model:: Series_Period with other classes

Order	mult.	Class name / Role	Description
2	[1..*]	Point Point	The Point information associated with a given Series_Period.within a TimeSeries. Association Based On: ESMPClasses::Series_Period.[] --- ESMPClasses::Point.Point[1..*]

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6.1.3.15 Time_Period

The identification of a time interval.

Table 21 shows all attributes of Time_Period.

Table 21 – Attributes of Activation contextual model::Time_Period

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	timeInterval ESMP_DateTimeInterval	The start and end date and time for a given interval.

6.1.3.16 TimeSeries

A set of time-ordered quantities being exchanged in relation to a product.

Table 22 shows all attributes of TimeSeries.

Table 22 – Attributes of Activation contextual model::TimeSeries

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID ID_String	A unique identification of the time series.
2	[1..1]	businessType BusinessKind_String	The identification of the nature of the time series.

Table 23 shows all association ends of TimeSeries with other classes.

Table 23 – Association ends of Activation contextual model:: TimeSeries with other classes

Order	mult.	Class name / Role	Description
1	[1..1]	ResourceProvider_MarketParticipant ResourceProvider_MarketParticipant	The identification of the party putting the product into the in area. Association Based On: ESMPClasses::TimeSeries.[] ----- ESMPClasses::MarketParticipant.MarketParticipant[0..*]
3	[1..1]	Domain Acquiring_Domain	The area where the product is being delivered. Association Based On: ESMPClasses::TimeSeries.[] ----- ESMPClasses::Domain.Domain[0..*]
4	[1..1]	Domain Connecting_Domain	The area where the product is being extracted. Association Based On: ESMPClasses::TimeSeries.[] ----- ESMPClasses::Domain.Domain[0..*]
5	[1..1]	Measure_Unit Measurement_Unit	The unit of measurement used for the quantities expressed within the time series. Association Based On: ESMPClasses::TimeSeries.[] ----- ESMPClasses::Measure_Unit.Measurement_Unit[0..*]

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Order	mult.	Class name / Role	Description
6	[1..1]	FlowDirection FlowDirection	Association Based On: ESMPClasses::TimeSeries.[] ----- ESMPClasses::FlowDirection.FlowDirection[0..1]
7	[1..1]	MarketObjectStatus MarketObjectStatus	Association Based On: ESMPClasses::TimeSeries.[] ----- ESMPClasses::MarketObjectStatus.MarketObjectStatus[0..1]
8	[0..1]	RegisteredResource RegisteredResource	The identification of a resource associated with a TimeSeries. Association Based On: ESMPClasses::RegisteredResource.RegisteredResource[0..*] ----- ESMPClasses::TimeSeries.[]
9	[0..*]	Series_Period Period	The time interval and resolution for a period associated with a TimeSeries. Association Based On: ESMPClasses::TimeSeries.[] ----- ESMPClasses::Series_Period.Period[0..*]
10	[0..*]	Reason Reason	Association Based On: ESMPClasses::TimeSeries.[] ----- ESMPClasses::Reason.Reason[0..*]

6.2 Activation assembly model

6.2.1 Overview of the model

Figure 7 shows the model.

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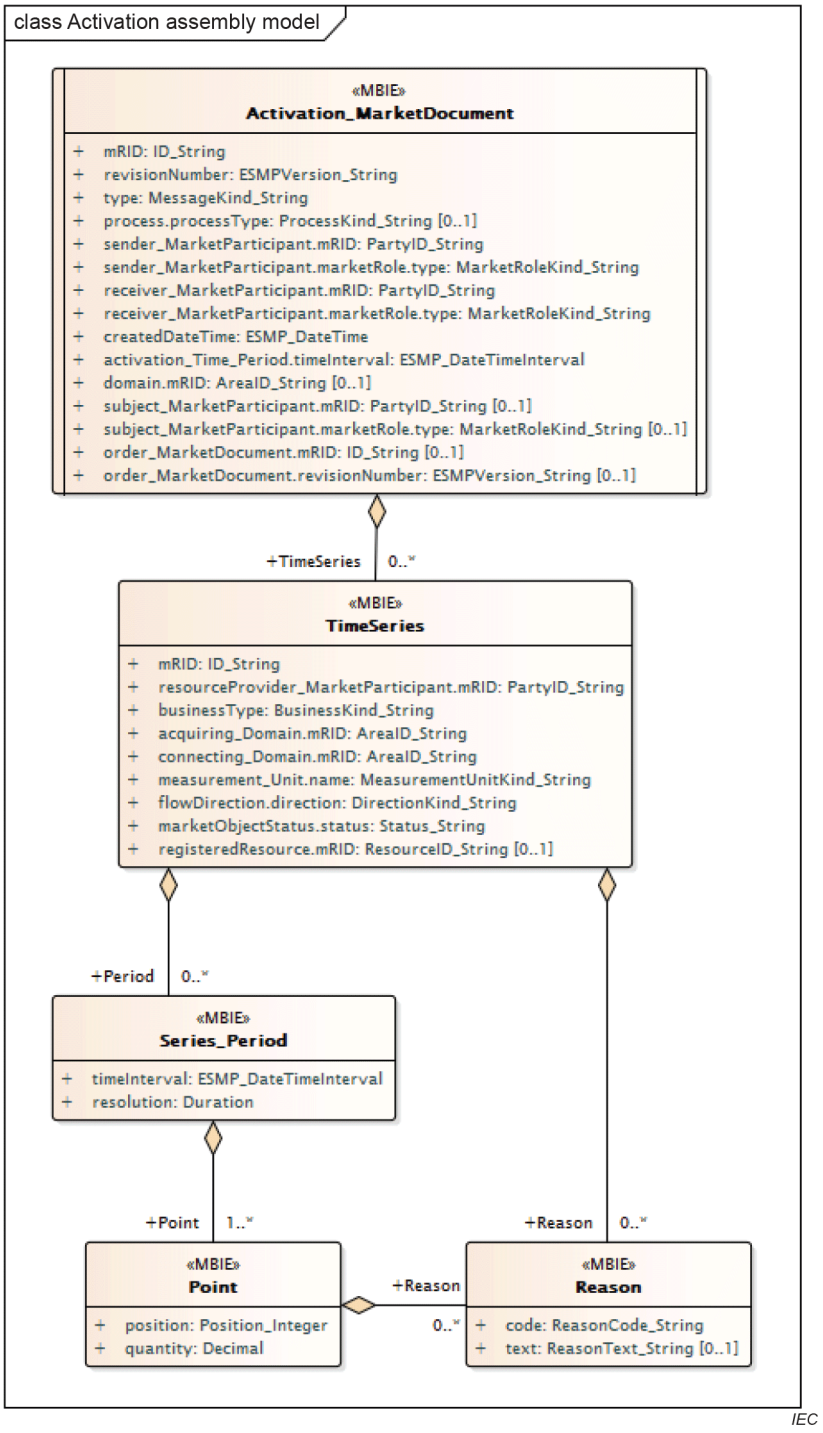

Figure 7 – Activation assembly model

6.2.2 IsBasedOn relationships from the European style market profile

Table 24 shows the traceability dependency of the classes used in this package towards the upper level.

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