European Network of
Transmission System Operators
for Electricity

ENTSO-E CONTINGENCY LIST, REMEDIAL ACTIONS AND ADDITIONAL CONSTRAINTS (CRAC)

IMPLEMENTATION GUIDE

2019-09-10
APPROVED DOCUMENT
VERSION 2.3

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The force of the following words is modified by the requirement level of the document in which they are used.

- SHALL: This word, or the terms “REQUIRED” or “MUST”, means that the definition is an absolute requirement of the specification.
- SHALL NOT: This phrase, or the phrase “MUST NOT”, means that the definition is an absolute prohibition of the specification.
- SHOULD: This word, or the adjective “RECOMMENDED”, means that there may exist valid reasons in particular circumstances to ignore a particular item, but the full implications shall be understood and carefully weighed before choosing a different course.
- SHOULD NOT: This phrase, or the phrase “NOT RECOMMENDED”, means that there may exist valid reasons in particular circumstances when the particular behaviour is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behaviour described with this label.
- MAY: This word, or the adjective “OPTIONAL”, means that an item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because the vendor feels that it enhances the product while another vendor may omit the same item. An implementation which does not include a particular option MUST be prepared to interoperate with another implementation which does include the option, though perhaps with reduced functionality. In the same vein an implementation which does include a particular option MUST be prepared to interoperate with another implementation which does not include the option (except, of course, for the feature the option provides.).

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Revision History

Version	Release	Date	Comments
1	0	2016-05-11	Approved by Market Committee
2	0	2017-01-10	Version to be submitted to Market Committee following EDI meeting of 11th and 12th of January 2017 DocStatus, Status attributes and Reason classes added to send CRAC anomaly report AdditionalConstraint_RegisteredResources class added to describe a phase shift angle
2	1	2017-10-24	Version to be submitted to Market Committee following EDI meeting of 24th and 25th of October 2017 - measurement_Unit.name and quantity.quantity attributes set to optional in the AdditionalConstraint_Series class - AggregateNodes added in the RemedialAction_RegisteredResource class - Related_MarketDocument association added at header level - Optimization_MarketObjectStatus attribute added at Series level
2	2	2018-06-19	Version approved by MC. - Addition of a MarketObjectStatus.status attribute in the AdditionalConstraint_RegisteredResource - Addition of a Monitored_Series - Addition of an association between the Party_MarketParticipant class and the sub_Series - In/out_Domain put to optional in the AdditionalConstraint_Series
2	3	2019-09-10	This version of the IG takes into account the changes apllied on v2.4 of CRAC document. Just for information v2.3 and v2.2 are the same, but v2.3 of the xsd fixes a small bug. - pSRType.psrType in RemedialAction_RegisteredResource is optional - Analog class linked to RenedialAction_RegisteredResource class and Contingency_RegisteredResource class - New 0..1 price.Amount attribute within RemedialAction_Series - New 0..1 Related currency_Unit.name and 0..1 price_Measure_Unit.name within TimeSeries - New 0..1 MarketObjectStatus attribute linked to Contingency_RegisteredResource - Consequently small changes on the dependency tables and contextual and assembly models. - mRID of Document, Series and Timeseries (ID_String type) was enlarged from 35 to 60 characters. Approved by MC.

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INTRODUCTION

This document is drafted based on IEC 62325 series. In particular, the IEC 62325-450 methodology was applied to develop the conceptual and assembly models.

This methodology is described in the following document: *ENTSO-E Common information model (CIM) European style market profile User guide*.

1 Scope

The objective of this implementation guide is to make it possible for software vendors to develop an IT application for TSO and RSC to exchange information relative to contingency list, remedial actions and additional constraints used for coordinated capacity calculation process.

The implementation guide is one of the building blocks for using UML (Unified Modelling Language) based techniques in defining processes and messages for interchange between actors in the electrical industry in Europe.

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

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

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

Critical network element implementation guide

Generation and load shift key implementation guide

3 Terms and definitions

3.1
contingency
The identified and possible or already occurred fault of an element, including not only the transmission system elements, but also significant grid users and distribution network elements if relevant for the transmission system operational security

3.2
network constraint
A situation in which there is a need to prepare and activate a remedial action in order to respect operational security limits.

3.3
flow
This is the computed physical flow (current or active power) in a network element, resulting from a load flow calculation on a power system ("N Situation", “N-1 Situation” ...), where one or several contingencies can be applied. The flow is expressed in A, MW, or % of the maximum flow allowed in the network element.

3.4
Transitory admissible transmission limit (TATL)
The temporary overloads of transmission system elements which are allowed for a limited period and which do not cause physical damage to the transmission system elements as long as the defined duration and thresholds are respected.

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3.5
Permanent admissible transmission limit (PATL)
The permanent loads of transmission system elements which are allowed for an unlimited period and which do not cause physical damage to the transmission system elements as long as the defined thresholds are respected.

3.6
monitored registered resource / monitored network element
This is the network element of the power system monitored during the network studies. The list of these elements is established by power system analysts, and is used to identify the critical network elements after the network studies. Some analog measurements associated with this elements provides the maximum flows allowed in a given network situation.

3.7
outage registered resource / outage network element
This is one of the network elements which are disconnected for the studied contingency.

3.8
remedial action series
This is a set of one or several network elements on which remedial actions are carried out to relieve the network constraint. Those actions are used to alleviate the constraints induced by the contingency. The remedial actions should be automatic, preventive or curative. The type of the remedial action includes generation, load and/or topology changes.

3.9
critical network element
A network element either within a bidding zone or between bidding zones taken into account in the capacity calculation process, limiting the amount of power that can be exchanged.

3.10
Special Protection System (SPS)
The set of coordinated and automatic measures designed to ensure fast reaction to Disturbances and to avoid the propagation of Disturbances in the Transmission System.

3.11
Individual Grid Model (IGM)
A data set describing power system characteristics (generation, load and grid topology) and related rules to change these characteristics during capacity calculation, prepared by the responsible TSOs, to be merged with other individual grid model components in order to create the common grid model.

3.12
Common Grid Model (CGM)
A Union-wide data set agreed between various TSOs describing the main characteristic of the power system (generation, loads and grid topology) and rules for changing these characteristics during the capacity calculation process.

3.13
Special Protection Scheme (SPS)
A remedial action consisting in an automatic device triggered after contingency.

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4 The coordinated capacity calculation process

4.1 Overall business context

The business process described in this document focuses on the exchange of contingency list, remedial actions and additional constraints used for the coordinated capacity calculation processes (Flow Based or NTC capacity calculation).

TSOs are responsible to send in two days-ahead (or in intra-day) their network data to the capacity coordinator. The network data consists of the following data:

- The network state, described in the D2CF and DACF files. These documents are defined by the common grid model European standard (CGMES) and are out of the scope of this document.
- The generation and load shift keys (GLSK) document iec62325-451-n-glsk provides the allowed shifts of generation and load on generators or loads. This document is described in the generation and load shift key implementation guide and is out of the scope of this document.
- The list of contingencies, each one identified by a mRID and including one or more contingencies. A contingency list is a list of network elements to be simulated as disconnected during the contingency analysis study. The contingencies are identified by their mRID (which is an EIC Code or a CGMES Code).
- The list of monitored elements,each one identified by a mRID and including one or more monitored resources. A monitored element list consists in the registered resources to be monitored during the load flow studies and if overloaded, become critical network elements. The monitored registered resources are identified by their mRID (which is an EIC Code or a CGMES Code).
- The list of remedial actions, each remedial action is identified by a mRID and it is composed of one or several actions on registered resource or bilateral exchanges. Each registered resource is identified by its mRID (which is an EIC Code or a CGMES Code).
- The additional constraints are provided by the TSO for limiting the bilateral exchanges or the flow in the network elements. The additional constraints can be bilateral exchanges values, bidding zone net position values, etc..

Using the CGM (steady state solution) and this additional data, the capacity coordinator determines the critical network elements by applying the contingencies and if necessary the remedial actions in a contingency analysis processor. The capacity coordinator uses the GLSK in order to vary the internal or bilateral exchanges. Once a network constraint occurs, i.e. the flow in one of the monitored registered resources is higher than the TATL or PATL, the capacity coordinator uses one of the given remedial actions to relieve this network constraint.

Figure 1 shows how the network data are used by the capacity coordinator in order to determine the coordinated capacity (or flow based domain) and the associated critical network elements.

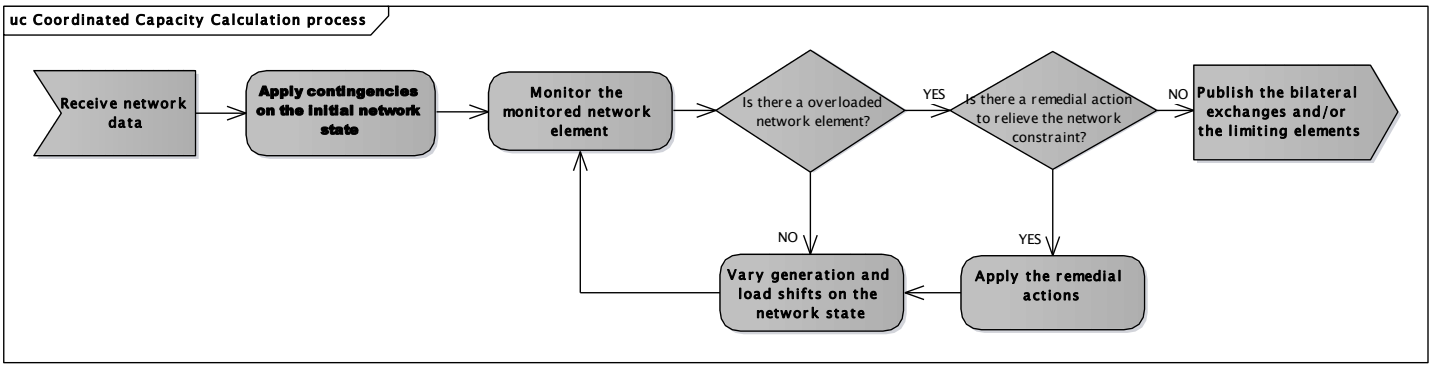

Figure 1 – Coordinated capacity calculation process

The process is finished when the capacity coordinator performed all the contingencies and found the maximum bilateral exchanges associated to the critical network elements on the

coordinated capacity region. These results are published to the TSOs, and to the market operator.

In a last step, after the capacity allocation, TSOs publish the critical network elements that limit the market domain to the market information aggregator using the iec62325-451-n-criticalnetworkelement document defined in the Critical Network Element Implementation Guide.

Figure 2 provides the use cases of the coordinated capacity calculation process between TSOs and its capacity coordinator.

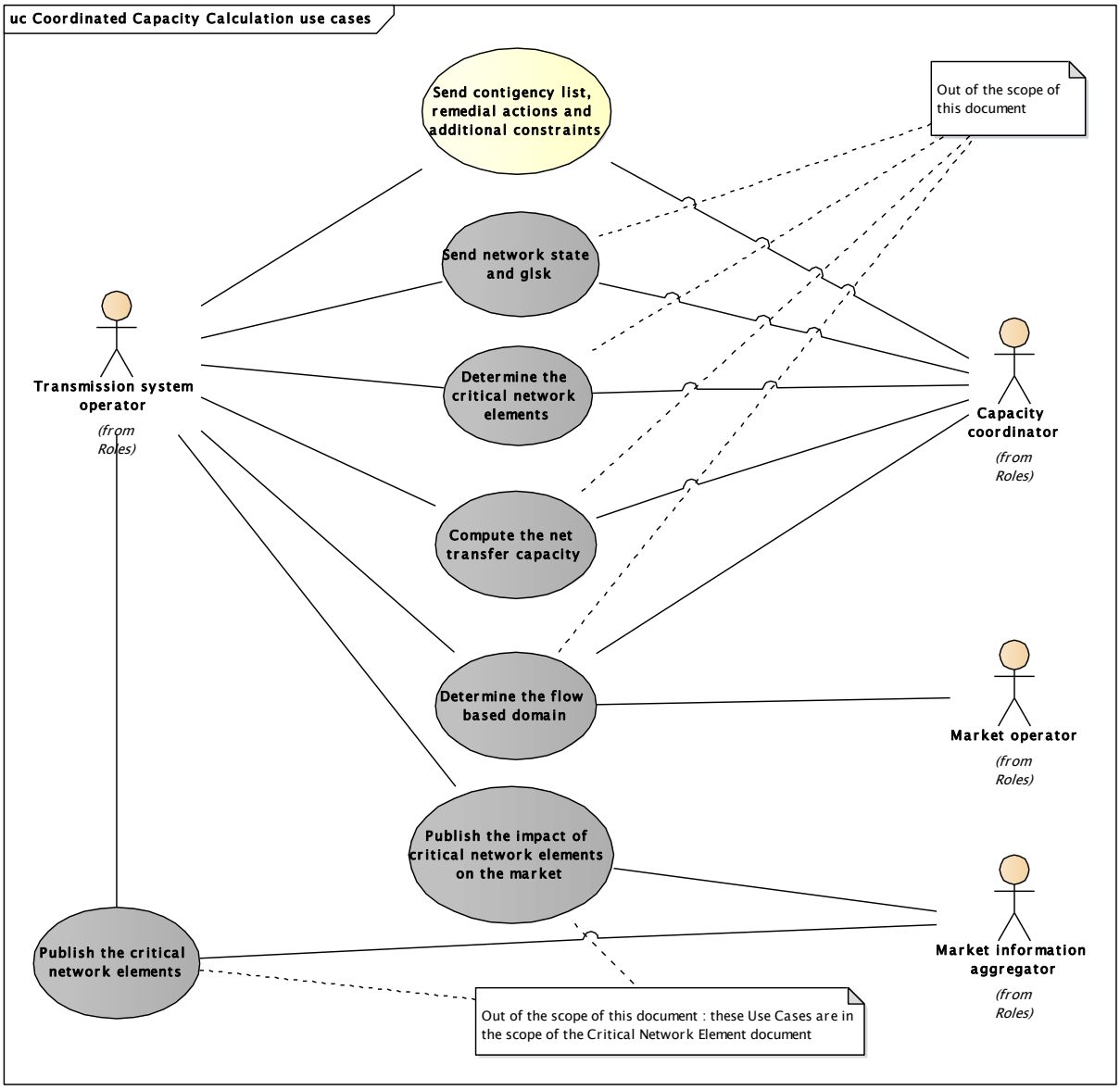

Figure 2 – Use cases of coordinated capacity calculation process

4.2 Contingency list, remedial actions and additional constraint exchange process

TSOs send their contingency lists, remedial actions and additional constraint through two documents.

- The configuration document: the purpose of this document is to provide all the characteristics of the network elements and remedial actions that will be used by the capacity coordinator for the load flow studies. This step enables to give a unique master identifier (mRID) for each elements and its characteristics.

The TSOs can update these configuration data as necessary, it can be once a year or every day, etc. depending on the update frequency of the TSOs network data.

- The network constraint document: this document provides the link between contingencies, monitored elements and remedial actions, using the master identifiers (mRID) defined in the previous document. This link defines the network constraint situation to be taken into account by the capacity coordinator during the load flow studies.

The document can also include the additional constraints imposed by the TSOs.

Depending on the regional calculation rules, the network constraint document can be more or less restrictive. A TSOs can decide to define a network constraint as a list of contingencies, associated with only one monitored network element, itself associated with one set of remedial actions. It can also define a network constraint as only a list of contingencies. A list of monitored network elements is also provided and a third list of remedial actions without any link between them. In this case, the capacity coordinator simulates the contingencies, monitoring all the provided network elements and choosing the best remedial actions to relieve the network constraints.

This document is sent every day for a two days-ahead process or several times a day for an intra-day process.

If necessary, the TSO can send only one document providing both configuration and the network constraints. In this case the configuration data are sent every day, even if there is no change in the network element characteristics.

The capacity coordinator receiving these two documents could send back CRAC anomaly reports using the same schema, i.e. the CRAC document. These CRAC anomaly reports provide all the discrepancies found in the network data sent by the TSO. For example, the capacity coordinator could precise if a registered resource provided in the CRAC does not exist in the IGM (Individual Grid Model).

The sequence diagram is provided in Figure 3.

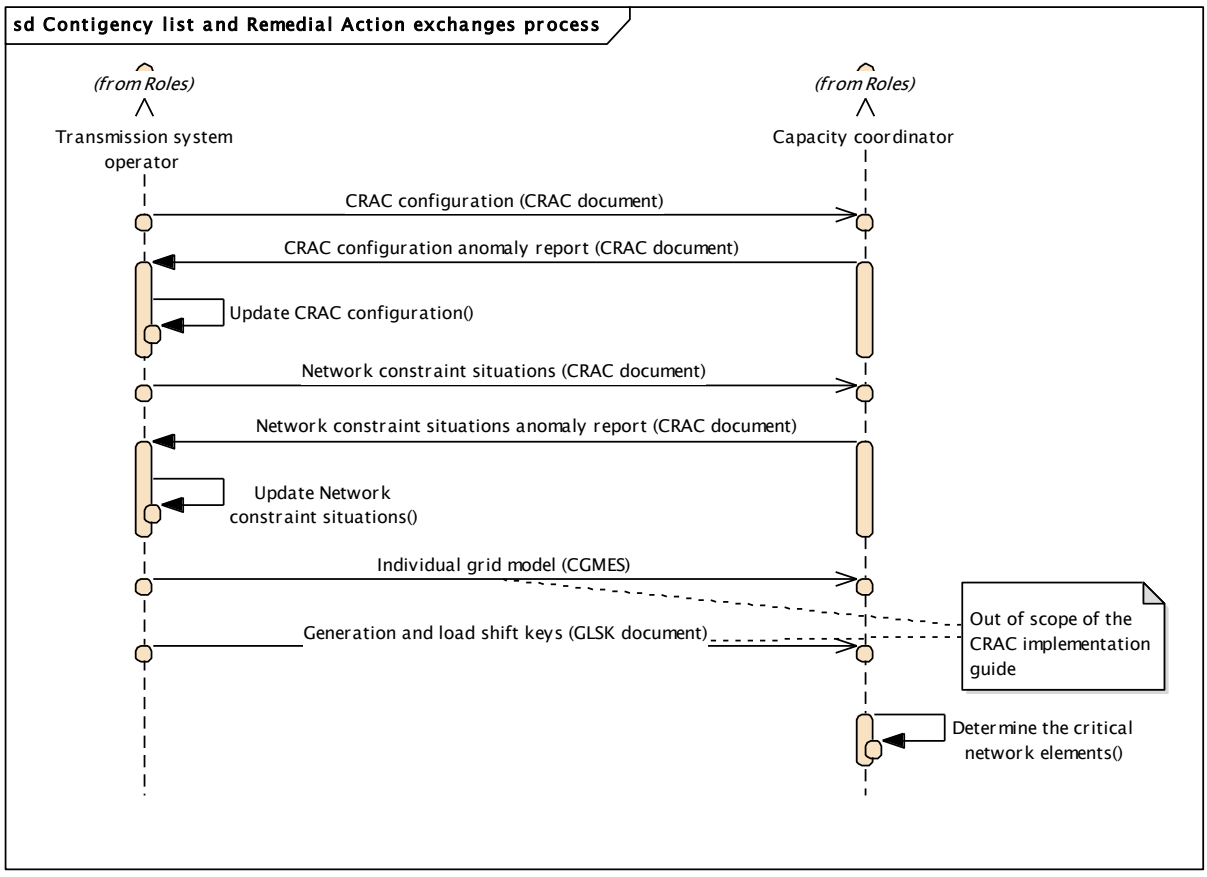

Figure 3 – Contingency list, remedial actions and additional constraint exchange

4.3 Business rules for the constraint network elements and remedial actions exchange process

4.3.1 General rules

The generic rules defined in IEC 62325-351 applied to the document described in this part. In particular, IEC 62325-351 describes the concept of curve type that is to be used to define the pattern of the constraint network elements for a day.

For each electronic data interchange defined in this document, an application acknowledgement is required as defined in IEC 62325-451-1.

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.

4.3.2 Rules governing the CRAC_MarketDocument for the configuration document

The following rules applied to the CRAC_MarketDocument:

- A CRAC_MarketDocument should contain for a specific position several TimeSeries.
  - The docStatus attribute identifies the status of the document given by the sender: it could be proposed, confirmed or rejected.
  - Additionally, the status attribute indicates if the document contains the individual network data of a TSO, or the common network data for the whole capacity calculation area.

Table 1 shows an example of implementation to handle the attribute docStatus between a TSO and a capacity coordinator.

Table 1 - docStatus dependency table

File	Proposed individual network constraint situation	CRAC anomaly report
Type	Network constraint document	Network constraint document
Sender	TSO	Capacity coordinator
Receiver	Capacity coordinator	TSO
docStatus	Proposed	Rejected
status	Individual network data	Individual network data

- The TimeSeries of the CRAC_MarketDocument provides the main related oriented border of the calculation in case of a NTC determination process.
  - In_Domain.mRID: the area of the related oriented border study where the energy flows into.
  - Out_Domain.mRID: the area of the related oriented border study where the energy comes from.
- The Series_Period identifies the period of application for the configuration data described in the Series
- The Series provides the list of network elements configuration data
  - The Series contains:
    - A mRID which identifies the configuration list.

– A BusinessType which identifies the kind of network elements list: contingency/monitored network element/remedial action.

– If the Series is a contingency list:

  - There are as many Contingency_Series as contingency to be simulated.
  - Each Contingency_Series is associated with one or several RegisteredResource elements, which describe the network elements in fault.
  - The in_Domain and out_Domain should be used to identify the location of the resource, particularly in case of an interconnection.

– If the Series is a list of monitored network elements:

  - There are as many Monitored_Series as a set of network elements to monitor during the network studies.
  - Each Monitored_Series is associated with one or several RegisteredResource elements, which describe the network elements to be monitored.
  - For orientation purpose, In_AggregateNode and Out_AggregateNode, using EIC code, should be used.
  - A list of measurements of interest for the Monitored_RegisteredResource should be provided. These measurementType should be used to provide the technical constraints of the Monitored_RegisteredResource like the PATL, the reference flow, etc.

– If the Series is a list of remedial actions:

  - The RemedialAction_Series provides the remedial actions used to relieve the network constraints in the studied cases.
  - The RemedialAction_Series contains unitary remedial actions that are applied simultaneously. For example a Busbar or a SPS (automation) are described with one RemedialAction_Series and as many registered resources as there are network elements to open and close in order to modify the network topology. If this remedial action is accompanied by a change of power on a generation unit, another RemedialAction_Series will describe this action.
  - The mRID identifies the RemedialAction_Series. This mRID is used in the network constraint document to provide the link between contingency/monitored network elements/remedial actions.

    If the RemedialAction_Series contains only one registered resource, the EIC code or the CGMES code of the resource should be used as the mRID.
  - The applicationMode_MarketObjectStatus shall be provided as automatic, preventive or curative.
  - The Shared_Domain shall be used to identify the areas (LFC Area, Bidding Zone, etc.) where the remedial action can be applied if a network constraint happens on these areas.
  - If the remedial action is a change of bilateral exchange capacity,
    - Out_Domain and In_Domain shall provide the direction of the exchange
    - Quantity shall provide the new value of the exchange capacity

    If not, Table 2 provides the rules governing the RegisteredResource Class :

Table 2 - Remedial Action Registered Resource dependency table

	TIELINE / LINE	CIRCUIT BREAKER	TURBINES (GENERATION)/ PUMPS (LOAD)/ CAPACITOR BANK, etc.	GENERATION	LOAD	PHASE SHIFT TRANSFORMER
mRID	CGMES ID of the resource					

MarketObjectStatus.status	OPEN / CLOSE	OPEN / CLOSE	STOP/START	ABSOLUTE/ RELATIVE	ABSOLUTE/ RELATIVE	ABSOLUTE/ RELATIVE
resourceCapacity.maximumCapacity	Not used	Not used	Not used	Maximum Shift or value of the generation (absolute or relative to initial state).	Maximum Shift or value of the load (absolute or relative to initial state).	Maximum tap number available (absolute or relative to initial state).
resourceCapacity.minimumCapacity	Not used	Not used	Not used	Minimum Shift or value of the generation (absolute or relative to initial state).	Minimum Shift or value of the load (absolute or relative to initial state).	Minimum tap number available (absolute or relative to initial state).
resourceCapacity.defaultCapacity	Not used	Not used	Not used	Shift or new value of the generation, (absolute or relative to initial state).	Shift or new value of the load, (absolute or relative to initial state).	Shift tap number (absolute or relative to initial state).

The attributes reason associated to the series and registered resources can be used in the CRAC anomaly reports in order to precise the discrepancies found in the network data sent by a TSO.

4.3.3 Rules governing the CRAC_MarketDocument for the network constraint document

The following rules apply to the CRAC_MarketDocument if the party sends a network constraint situations document:

- A CRAC_MarketDocument should contain for a specific position several TimeSeries.

The docStatus attribute is used to identify the status of the document given by the sender, it can be proposed, confirmed or rejected, and the Status attribute is used to indicate if the document contains the individual network data or the common network data for the whole capacity calculation area.

- The Related_MarketDocument class can be used to identify the documents related to a specific network constraint document within the capacity calculation process (for example, a related grid model or GLSK document).
- The TimeSeries of the CRAC_MarketDocument provides the main related oriented border of the calculation in case of a NTC determination process.
- In_Domain.mRID: the area of the related oriented border study where the energy flows into.
- Out_Domain.mRID: the area of the related oriented border study where the energy comes from.
- The Series_Period identifies the period of application of the Series
- The Series provides the network data to take into account for the load flow studies.
  - The Series contains:
    - A mRID which identifies the network constraint situation to be simulated or the network elements lists.
    - A BusinessType which identifies nature of the series.
      - If the Business Type is “Network constraint situation”, it means that the Series provides a contingency to be simulated with its associated remedial actions and monitored elements, and potential additional constraints.
      - If the Business Type is “Contingency”, it means that the Series provides only a list of contingencies to be simulated. The remedial actions and monitored elements are given in other Series.

  - If the Business Type is “Remedial action”, it means that the Series provides Remedial Actions that should be used with all the contingencies provided in other Series.
  - If the Business Type is “Monitored network elements”, it means that the Series provides “Monitored network elements” that shall be monitored with all the contingencies series provided in in other Series.
- An Optimization_MarketObjectStatus which allows to describe the status of the constraint situation for a Remedial Action Optimization process (branch which margin must be optimized, constraint for the optimization…).

- The AdditionalConstraint_Series should provide an additional constraint like an imposed bilateral exchange or a net position for a given area.
  - The business type identifies the nature of the additional constraint (TTC, NTC, Net Position, or Phase Shift Angle).
  - If the additional constraint is an exchange or a net position constraint, In_Domain and Out_Domain shall identify the direction of the exchange or the area concerned by a net position.
  - If the additional constraint is a phase shift angle, the AdditionalConstraint_Series is associated with AdditionalConstraint_RegisteredResource elements, which describe the elements between which a maximum phase shift angle must not be exceeded.

    Within the AdditionalConstraint_RegisteredResource, the direction of the phase shift angle is provided by the MarketObjectStatus.status attribute.
- The Contingency_Series shall be provided to describe the contingency.
  - There are as many Contingency_Series as contingencies to be simulated. The capacity coordinator shall simulate a contingency on all network elements at the same time.
  - Each Contingency_Series is associated with one or several Contingency_RegisteredResource elements, which describe the network elements in fault.
- The Monitored_Series provided in the Series, shall be monitored during the contingency simulation.
  - There are as many Monitored_Series as sets of elements to be monitored. The capacity coordinator shall monitor all the registered resources associated with a Monitored_Series at the same time.
  - For orientation purpose, In_AggregateNode and Out_AggregateNode, using EIC code, should be used in the Monitored_RegisteredResource.

    The measurementType in the class Analog shall be used to provide the TATL or PATL allowed in the Monitored_RegisteredResource.
- The RemedialAction_Series provides the remedial actions used to relieve the constraints in the studied cases.
  - The applicationMode_MarketObjectStatus shall be provided as automatic, preventive or curative.
  - The condition of use of the remedial action are given by the Monitored_RegisteredResource measurementType of the current Series. Consequently, if a remedial action shall be used for a given TATL and another remedial action shall be used for PATL, two Series shall be created with the same Contingency_Series and Monitored_RegisteredResource but with two different measurementTypes.

The class Reason associated to the Series and RegisteredResource could be used in the CRAC anomaly reports in order to precise the discrepancies found in the network data sent by a TSO.

Table 3 provides the dependency table for the configuration document and the network constraint situations document.

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Table 3 – CRAC document dependency table

Class	Attribute	Configuration document	Network constraint document
CRAC_MarketDocument	Type	A95 = Configuration document	B15 = Network constraint document
	process.processType	A43 = Flow Based domain constraint day-ahead A44 = Flow Based domain constraint intraday A15 = Capacity determination A40 = Intraday process A53 = Common Grid Model Process	
	sender_MarketParticipant.marketRole.type	A04 = TSO A44= Regional Security Coordinator	
	receiver_MarketParticipant.marketRole.type	A36 = Capacity Coordinator A44= Regional Security Coordinator	
	docStatus	A40: Proposed A37: Confirmed A34: Rejected	
	status	A41: Individual Network Data A42: Common Network Data	
	received_MarketDocument.mRID	mRID of the received document in case of a CRAC anomaly report	
	received_MarketDocument.version	version of the received document in case of a CRAC anomaly report	
	Related_MarketDocument.mRID	mRID of a related MarketDocument within a given process	
	Related_MarketDocument.RevisionNumber	RevisionNumber of a related MarketDocument within a given process	
	domain.mRID	used as EIC code of the Study Area	
Time Series	mRID	used to identify the TS	
	businessType	B54 = Network constraint situation that constraints the market B59 = Network Element B88 = Base Case Network Situation C14 = Network constraint situation that cannot limit the market C20 = Common Grid Model Equipment	
	CurveType	Used to identify the curve type method	
	In_Domain.mRID	In case of NTC Determination process, EIC code of the area where the energy flows into.	
	Out_Domain.mRID	In case of NTC Determination process, EIC code of the area where the energy comes from.	
	Currency-Unit.name	Currency of the expected costs for the remedial action	
	Price_Measurement_Unit.name	The unit of measure in which the price in the time series is expressed: MWH MWh	
Series_Period			
Point			
Series			
Series	mRID	used to identify the TimeSeries	used to identify the TimeSeries
	businessType	B54 = Network constraint situation that constraints the market B55 = Contingency B56 = Remedial Action B57 = Monitored Network Element B59 = Network Element (PTC) B88 = Base Case Network Situation C14 = Network constraint situation that cannot limit the market C15 = Flat participation for all generators or loads C16 = Proportional to installed capacity of generators C20 = Common Grid Model Equipment	

Class	Attribute	Configuration document	Network constraint document
	name	not used	not used
	Party_MarketParticipant.mRID	not used	not used
	Optimization_MarketObjectStatus.status	Used to identify the status of the Series for a Remedial Action optimization process	Used to identify the status of the Series for a Remedial Action optimization process
AdditionalConstraint_Series	mRID	Used to identify the additional constraint	Used to identify the additional constraint
	Business Type	A81 : TTC B09 : Net position A27 : NTC B87 : Phase Shift Angle	not used
	name	Used as the name of the Additional Constraint	not used
	Party_MarketParticipant.mRID	Used to identify the owner of the Additional Constraint	not used
	In_Domain.mRID	If the additional constraint is an exchange or a net position constraint: used to identify area where the energy flows into	not used
	Out_Domain.mRID	If the additional constraint is an exchange or a net position constraint: used to identify area where the energy comes from	not used
	Measurement_unit.name	The measurement unit of the additional constraint	not used
	Quantity.quantity	The value of the additional constraint	not used
RegisteredResource	mRID	used as the EIC or CGMES code of one of the registered resources between which there is a maximum phase shift angle	used as the EIC or CGMES code of one of the registered resources between which there is a maximum phase shift angle
	name	used as the name of one of the registered resources between which there is a maximum phase shift angle	not used
	In_Domain.mRID	used to identify InArea where the registered resource is located	not used
	Out_Domain.mRID	used to identify OutArea where the registered resource is located	not used
	marketObjectStatus.status	Used to provide the direction of the phase shift angle A46: Importing element A47: Exporting element	not used
Contingency_Series	mRID	Used to identify a given contingency	Used to identify a given contingency
	name	Used as the name of the contingency to be simulated	not used
	Party_MarketParticipant.mRID	Used to identify the owner of the contingency	not used
	Reason.code	Used to identify the contingency type B43 = Ordinary B44 = Exceptional B45 = Out of range	Used to identify the contingency type B43 = Ordinary B44 = Exceptional B45 = Out of range
	Reason.text	May be used	May be used
Contiinge ncy_Regis teredReso urce	mRID	used as EIC or CGMES code of the contingency	used as EIC or CGMES code of the contingency
	name	used as the name of the contingency	not used

Class	Attribute	Configuration document	Network constraint document
	In_Domain.mRID	used to identify InArea where the registered resource is located	not used
	Out_Domain.mRID	used to identify OutArea where the registered resource is located	not used
	marketObjectStatus.status	Use to identify the state of the contingency A03 = Deactivated A05 = Active A21 = Open A22 = Close A23 = Stop A24 = Start A25 = Relative A26 = Absolute	Use to identify the state of the contingency A03 = Deactivated A05 = Active A21 = Open A22 = Close A23 = Stop A24 = Start A25 = Relative A26 = Absolute
Analog (Linked to Contingecy_RegisteredResource Class)	measurementType	used to identify the contingency measurement type A01 = Flow A19 = Tap changer A20 = Regulator mode A21 = Regulator set-point	used to identify the contingency action measurement type A01 = Flow A19 = Tap changer A20 = Regulator mode A21 = Regulator set-point
	unitSymbol	used to identify the unit of the measurement "A", "MW", "%"…	used to identify the unit of the measurement "A", "MW", "%"…
	positiveFlowIn	Not used	Not used
	value	used to provide the measurement value	used to provide the measurement value
Monitored_Series	mRID	Used to identify a given set of monitored elements	Used to identify a given set of monitored elements
	name	Used as the name of the set of monitored elements	not used
	Party_MarketParticipant.mRID	used to identify the owner of the set of monitored elements	not used
Monitored_RegisteredResource	mRID	used as EIC or CGMES code of the Monitored element	used as EIC or CGMES code of the Monitored element
	name	used as the name of the Monitored element	not used
	In_Domain.mRID	used to identify InArea	not used
	Out_Domain.mRID	used to identify OutArea	not used
	In_AggregateNode	used to identify InAggregateNode for element orientation	not used
	Out_AggregateNode	used to identify OutAggregateNode for element orientation	not used
Analog (Linked to Monitored_RegisteredResource Class)	measurementType	used to identify the monitored measurement type A02 = PATL A07 = TATL	used to identify the monitored measurements type A02 = PATL A07 = TATL
	unitSymbol	used to identify the unit of the measurement "A", "MW", "%"…	used to identify the unit of the measurement "A", "MW", "%"…

Class	Attribute	Configuration document	Network constraint document
	positiveFlowIn	should be used to identify on which direction the element is monitored A01 = Direct A02 = Opposite Not used = Double	should be used to identify on which direction the element is monitored A01 = Direct A02 = Opposite Not used = Double
	value	used to provide the measurement value	used to provide the measurement value
RemedialAction_Series	mRID	Used to identify the set of remedial actions	Used to identify the set of remedial actions
	BusinessType	B58 ; Busbar B59 : Network Element A60 : SPS A27 : NTC A81 : TTC	not used
	name	used as the name of the element on which a remedial action is carried out	not used
	ApplicationMode_marketObjectStatus.status	Used to identify the status of the remedial action A18 = Preventive A19 = Curative A27 = Curative or preventive A20 = Automatic	
	Availability_MarketObjectStatus.status	If a remedial action optimizer is used, used to identify whether or not the remedial action must be used by the optimizer A38: Shall Be Used A39: Might Be Used	
	Party_MarketParticipant.mRID	used to identify the owner of the set of remedial actions	not used
	In_Domain.mRID	If Business Type = TTC or NTC, used to identify the area where the energy is going to	not used
	Out_Domain.mRID	If Business Type = TTC or NTC, used to identify the area where the energy comes from	not used
	Measurement.unit.name	If Business Type = TTC or NTC, the measurement unit of the quantity	not used
	Quantity.quantity	If Business Type = TTC or NTC, the value of the new bilateral exchange	not used
	Price.amount	Expected cost of executing the Remedial Action	Not used
RegisteredResource	mRID	used as EIC or CGMES code of the element on which a remedial action is carried out	not used
	name	used as the name of the element on which a remedial action is carried out	not used
	In_Domain.mRID	used to identify InArea	not used
	Out_Domain.mRID	used to identify OutArea	not used
	In_AggregateNode.mRID	If the element is an HVDC link, used to identify the InAggregateNode for element orientation	not used
	Out_AggregateNode.mRID	If the element is an HVDC link, used to identify the OutAggregateNode for element orientation	not used
	pSRType.psrType	used to identify the type of the remedial action	not used

Class	Attribute	Configuration document	Network constraint document
		A01 = Tieline, A02 = Line, A04 = Generation, A05 = Load, A06 = Phase Shift Transformer A07 = Circuit breaker (see dependency rules in Table 2)	
	marketObjectStatus_status	Used to identify the action of the remedial action : A21 = Open A22 = Close A23 = Stop A24 = Start or the variation type : A25 = Relative A26 = Absolute	not used
	resourceCapacity.maximumCapacity	If Action_marketObjectStatus_status = Relative or Absolute : Used to identify the maximum variation or the maximum target value of tap, generation or load	not used
	resourceCapacity.minimumCapacity	If Action_marketObjectStatus_status = Relative or Absolute : Used to identify the minimum variation or the minimum target value of tap, generation or load	not used
	resourceCapacity.defaultCapacity	If Action_marketObjectStatus_status = Relative or Absolute : Used to identify the variation or target value of tap, generation or load	not used
	resourceCapacity.unitSymbol	If Action_marketObjectStatus_status = Relative or Absolute : Used to identify the unit of the target values described	not used
Analog (Linked to RemedialAction_RegisteredResource Class)	measurementType	used to identify the remedial action measurement type: A19 = Tap Changer A20 = Regulator mode	used to identify the remedial action measurement type A19 = Tap Changer A20 = Regulator mode
	unitSymbol	used to identify the unit of the measurement "A", "MW", "%"…	used to identify the unit of the measurement "A", "MW", "%"…
	positiveFlowIn	Not used	Not used
	value	used to provide the measurement value	used to provide the measurement value
Shared_Domain	Shared_Domain.mRID	EIC code of the area which can use the remedial action	not used

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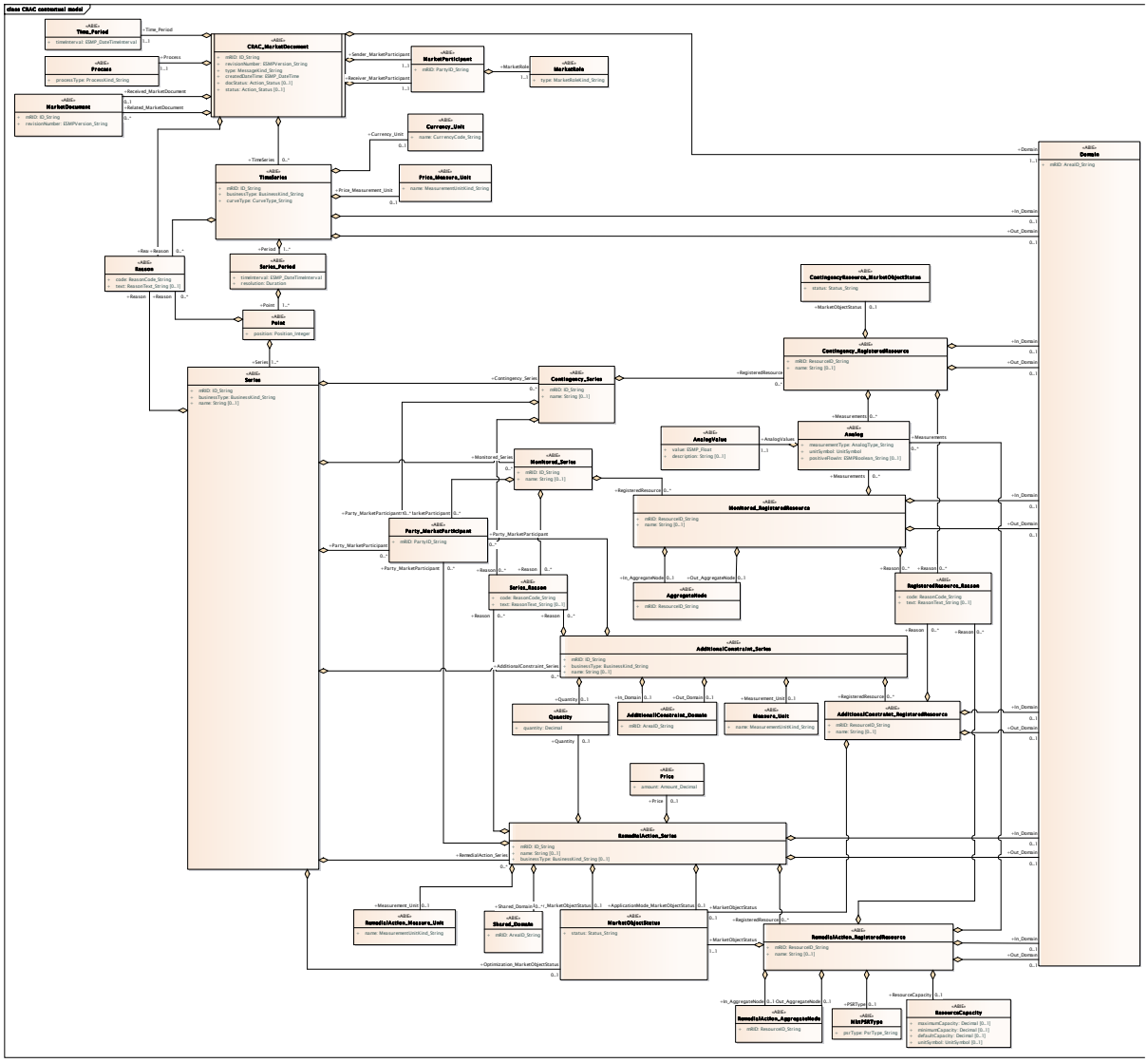
4.4 CRAC contextual model

4.4.1 Overview of the model

Figure 4 shows the model.



481

482 **Figure 4 - CRAC contextual model**

483 ### 4.4.2 IsBasedOn relationships from the European style market profile

484 Table 4 shows the traceability dependency of the classes used in this package towards the
485 upper level.

486 **Table 4 - IsBasedOn dependency**

Name	Complete IsBasedOn Path
AdditionalConstraint_RegisteredResource	TC57CIM::IEC62325::MarketCommon::RegisteredResource
AdditionalConstraint_Series	TC57CIM::IEC62325::MarketManagement::Series
AdditionallConstraint_Domain	TC57CIM::IEC62325::MarketManagement::Domain
AggregateNode	TC57CIM::IEC62325::MarketOperations::ReferenceData::AggregateNode
Analog	TC57CIM::IEC61970::Base::Meas::Analog
AnalogValue	TC57CIM::IEC61970::Base::Meas::AnalogValue
Contingency_RegisteredResource	TC57CIM::IEC62325::MarketCommon::RegisteredResource
Contingency_Series	TC57CIM::IEC62325::MarketManagement::Series
ContingencyResource_MarketObjectStatus	TC57CIM::IEC62325::MarketManagement::MarketObjectStatus
CRAC_MarketDocument	TC57CIM::IEC62325::MarketManagement::MarketDocument
Currency_Unit	TC57CIM::IEC62325::MarketManagement::Unit
Domain	TC57CIM::IEC62325::MarketManagement::Domain
MarketDocument	TC57CIM::IEC62325::MarketManagement::MarketDocument
MarketObjectStatus	TC57CIM::IEC62325::MarketManagement::MarketObjectStatus
MarketParticipant	TC57CIM::IEC62325::MarketCommon::MarketParticipant
MarketRole	TC57CIM::IEC62325::MarketCommon::MarketRole
Measure_Unit	TC57CIM::IEC62325::MarketManagement::Unit
MktPSRType	TC57CIM::IEC62325::MarketManagement::MktPSRType
Monitored_RegisteredResource	TC57CIM::IEC62325::MarketCommon::RegisteredResource
Monitored_Series	TC57CIM::IEC62325::MarketManagement::Series
Party_MarketParticipant	TC57CIM::IEC62325::MarketCommon::MarketParticipant
Point	TC57CIM::IEC62325::MarketManagement::Point
Price	TC57CIM::IEC62325::MarketManagement::Price
Price_Measure_Unit	TC57CIM::IEC62325::MarketManagement::Unit
Process	TC57CIM::IEC62325::MarketManagement::Process
Quantity	TC57CIM::IEC62325::MarketManagement::Quantity
Reason	TC57CIM::IEC62325::MarketManagement::Reason
RegisteredResource_Reason	TC57CIM::IEC62325::MarketManagement::Reason
RemedialAction_AggregateNode	TC57CIM::IEC62325::MarketOperations::ReferenceData::AggregateNode
RemedialAction_Measure_Unit	TC57CIM::IEC62325::MarketManagement::Unit
RemedialAction_RegisteredResource	TC57CIM::IEC62325::MarketCommon::RegisteredResource

Name	Complete IsBasedOn Path
RemedialAction_Series	TC57CIM::IEC62325::MarketManagement::Series
ResourceCapacity	TC57CIM::IEC62325::MarketCommon::ResourceCapacity
Series	TC57CIM::IEC62325::MarketManagement::Series
Series_Period	TC57CIM::IEC62325::MarketManagement::Period
Series_Reason	TC57CIM::IEC62325::MarketManagement::Reason
Shared_Domain	TC57CIM::IEC62325::MarketManagement::Domain
Time_Period	TC57CIM::IEC62325::MarketManagement::Period
TimeSeries	TC57CIM::IEC62325::MarketManagement::TimeSeries

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4.5 CRAC assembly model

4.5.1 Overview of the model

Figure 5 shows the model.

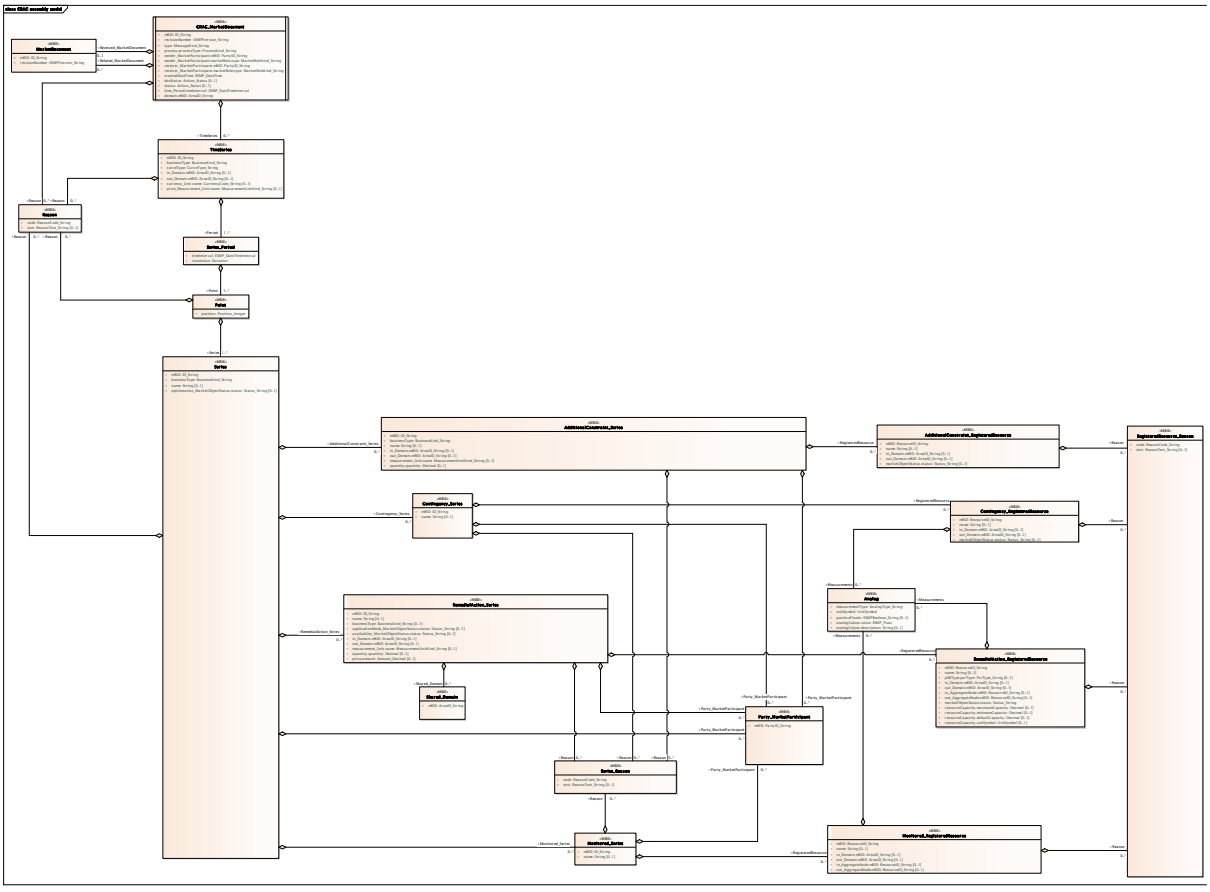

Figure 5 - CRAC assembly model

4.5.2 IsBasedOn relationships from the European style market profile

Table 5 shows the traceability dependency of the classes used in this package towards the upper level.

Table 5 - IsBasedOn dependency

Name	Complete IsBasedOn Path
AdditionalConstraint_RegisteredResource	TC57CIM::IEC62325::MarketCommon::RegisteredResource
AdditionalConstraint_Series	TC57CIM::IEC62325::MarketManagement::Series
Analog	TC57CIM::IEC61970::Base::Meas::Analog
Contingency_RegisteredResource	TC57CIM::IEC62325::MarketCommon::RegisteredResource
Contingency_Series	TC57CIM::IEC62325::MarketManagement::Series
CRAC_MarketDocument	TC57CIM::IEC62325::MarketManagement::MarketDocument
MarketDocument	TC57CIM::IEC62325::MarketManagement::MarketDocument
Monitored_RegisteredResource	TC57CIM::IEC62325::MarketCommon::RegisteredResource
Monitored_Series	TC57CIM::IEC62325::MarketManagement::Series
Party_MarketParticipant	TC57CIM::IEC62325::MarketCommon::MarketParticipant
Point	TC57CIM::IEC62325::MarketManagement::Point
Reason	TC57CIM::IEC62325::MarketManagement::Reason
RegisteredResource_Reason	TC57CIM::IEC62325::MarketManagement::Reason
RemedialAction_RegisteredResource	TC57CIM::IEC62325::MarketCommon::RegisteredResource
RemedialAction_Series	TC57CIM::IEC62325::MarketManagement::Series
Series	TC57CIM::IEC62325::MarketManagement::Series
Series_Period	TC57CIM::IEC62325::MarketManagement::Period
Series_Reason	TC57CIM::IEC62325::MarketManagement::Reason
Shared_Domain	TC57CIM::IEC62325::MarketManagement::Domain
TimeSeries	TC57CIM::IEC62325::MarketManagement::TimeSeries

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4.5.3 Detailed CRAC assembly model

4.5.3.1 CRAC_MarketDocument root class

This document provides the contigency lists, remedial actions and additional constraints to be used for the coordinated capacity network studies.

Table 6 shows all attributes of CRAC_MarketDocument.

Table 6 - Attributes of CRAC assembly model::CRAC_MarketDocument

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID ID_String	The unique identification of the document being exchanged within the coordinated capacity calculation process.
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.
3	[1..1]	process.processType ProcessKind_String	The identification of the nature of process that the document addresses. --- The process dealt with in the document.
4	[1..1]	sender_MarketParticipant.mRID PartyID_String	The identification of a party in the energy market. --- Document owner.
5	[1..1]	sender_MarketParticipant.marketRole.type MarketRoleKind_String	The identification of the role played by a market player. --- Document owner. --- The role associated with a MarketParticipant.
6	[1..1]	receiver_MarketParticipant.mRID PartyID_String	The identification of a party in the energy market. --- Document recipient.
7	[1..1]	receiver_MarketParticipant.marketRole.type MarketRoleKind_String	The identification of the role played by a market player. --- Document recipient. --- The role associated with a MarketParticipant.
8	[1..1]	createdDateTime ESMP_DateTime	The date and time of the creation of the document.
9	[0..1]	docStatus Action_Status	The identification of the condition or position of the document with regard to its standing.
10	[0..1]	status Action_Status	Status of subject matter (e.g., Agreement, Work) this document represents. For status of the document itself, use 'docStatus' attribute.
13	[1..1]	time_Period.timeInterval ESMP_DateTimeInterval	The start and end date and time for a given interval. --- This information provides the start and end date and time of the constraint network elements study time interval. All time intervals for the time series in the document shall be within the total time interval for the study. The receiver will discard any time intervals outside the time period.
14	[1..1]	domain.mRID AreaID_String	The unique identification of the domain. --- The identification of the domain that is covered in the constraint network element document. It is in general the coordinated capacity determination area that is the subject of the schedule plan.

Table 7 shows all association ends of CRAC_MarketDocument with other classes.

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Table 7 - Association ends of CRAC assembly model::CRAC_MarketDocument with other classes

Order	mult.	Class name / Role	Description
11	[0..1]	MarketDocument Received_MarketDocument	Association Based On: CRAC contextual model::MarketDocument.Received_MarketDocument[0..1] --- CRAC contextual model::CRAC_MarketDocument.[]
12	[0..*]	MarketDocument Related_MarketDocument	The identification of an electronic document that is related to an electronic document header. Association Based On: CRAC contextual model::CRAC_MarketDocument.[] --- CRAC contextual model::MarketDocument.Related_MarketDocument[0..*]
15	[0..*]	TimeSeries TimeSeries	The time series that is associated with an electronic document. Association Based On: CRAC contextual model::CRAC_MarketDocument.[] --- CRAC contextual model::TimeSeries.TimeSeries[0..*]
16	[0..*]	Reason Reason	The Reason associated with the electronic document header providing different motivations for the creation of the document. Association Based On: CRAC contextual model::Reason.Reason[0..*] --- CRAC contextual model::CRAC_MarketDocument.[]

4.5.3.2 AdditionalConstraint_RegisteredResource

This is a resource contributing to the relevant additional constraint.

Table 8 shows all attributes of AdditionalConstraint_RegisteredResource.

Table 8 - Attributes of CRAC assembly model::AdditionalConstraint_RegisteredResource

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID ResourceID_String	The unique identification of a resource.
1	[0..1]	name String	The name is any free human readable and possibly non unique text naming the object.
2	[0..1]	in_Domain.mRID AreaID_String	The unique identification of the domain. --- The identification of the domain linked by the registered resource.
3	[0..1]	out_Domain.mRID AreaID_String	The unique identification of the domain. --- The identification of the domain linked by the registered resource.
4	[0..1]	marketObjectStatus.status Status_String	The coded application mode. --- The status of the registered resource, e.g. connected, disconnedted, outage, ...

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

519 **Table 9 - Association ends of CRAC assembly**
520 **model::AdditionalConstraint_RegisteredResource with other classes**

Order	mult.	Class name / Role	Description
5	[0..*]	RegisteredResource_Reason Reason	The reason information associated with a RegisteredResource providing motivation information. Association Based On: CRAC contextual model::RegisteredResource_Reason.Reason[0..*] ----- CRAC contextual model::AdditionalConstraint_RegisteredResource.[]

521

522 #### 4.5.3.3 AdditionalConstraint_Series

523 An additional constraint to be taken into account in the load flow study

524 Table 10 shows all attributes of AdditionalConstraint_Series.

525 **Table 10 - Attributes of CRAC assembly model::AdditionalConstraint_Series**

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID ID_String	A unique identification of the additional constraint.
1	[1..1]	businessType BusinessKind_String	The nature of the additional constraint
2	[0..1]	name String	The name is any free human readable and possibly non unique text naming the object.
4	[0..1]	in_Domain.mRID AreaID_String	The unique identification of the domain. --- The Domain identifying where energy of the External Constraint is going to.
5	[0..1]	out_Domain.mRID AreaID_String	The unique identification of the domain. --- The Domain identifying where the energy of the External Constraint comes from.
6	[0..1]	measurement_Unit.name MeasurementUnitKind_String	The identification of the formal code for a measurement unit (UN/ECE Recommendation 20). --- The unit of measure of the External Constraint quantity
7	[0..1]	quantity.quantity Decimal	The quantity value of the additional constraint --- The value of the External Constraint

526

527 Table 11 shows all association ends of AdditionalConstraint_Series with other classes.

528 **Table 11 - Association ends of CRAC assembly model::AdditionalConstraint_Series**
529 **with other classes**

Order	mult.	Class name / Role	Description
3	[0..*]	Party_MarketParticipant Party_MarketParticipant	The identification of a market participant associated with a TimeSeries. Association Based On: CRAC contextual model::Party_MarketParticipant.Party_MarketParticipant[0..*] ----- CRAC contextual model::AdditionalConstraint_Series.[]

Order	mult.	Class name / Role	Description
8	[0..*]	AdditionalConstraint_RegisteredResource RegisteredResource	The identification of a resource associated with a TimeSeries. Association Based On: CRAC contextual model::AdditionalConstraint_RegisteredResource.RegisteredResource[0..*] --- CRAC contextual model::AdditionalConstraint_Series.[]
9	[0..*]	Series_Reason Reason	The reason information associated with a TimeSeries providing motivation information. Association Based On: CRAC contextual model::Series_Reason.Reason[0..*] --- CRAC contextual model::AdditionalConstraint_Series.[]

530

531 #### 4.5.3.4 Analog

532 Analog represents an analog Measurement.

533 Analog provides the analog measurements monitored for one specific
534 Monitored_RegisteredResource.

535 Table 12 shows all attributes of Analog.

536 **Table 12 - Attributes of CRAC assembly model::Analog**

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	measurementType AnalogType_String	Specifies the type of measurement. For example, it specifies if the measurement represents flow, maximum flow, reference flow, etc.
1	[1..1]	unitSymbol UnitSymbol	The unit of measure of the measured quantity.
2	[0..1]	positiveFlowIn ESMPBoolean_String	If true then this measurement is an active power, reactive power or current with the convention that a positive value measured at the Terminal means power is flowing into the related Monitored_RegisteredResource depending on the In_AggregateNode and the Out_AggregateNode.
3	[1..1]	analogValues.value ESMP_Float	The value to supervise. --- Measurement to which this value is connected.
4	[0..1]	analogValues.description String	The description of the measuremenType and its associated value. --- Measurement to which this value is connected.

537

538 #### 4.5.3.5 Contingency_RegisteredResource

539 This is one of the network elements which are in outage for the studied contingency defined in
540 the Series.

541 Table 13 shows all attributes of Contingency_RegisteredResource.

542 **Table 13 - Attributes of CRAC assembly model::Contingency_RegisteredResource**

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID ResourceID_String	The unique identification of the resource in outage.
1	[0..1]	name String	The name is any free human readable and possibly non unique text naming the object.

Order	mult.	Attribute name / Attribute type	Description
2	[0..1]	in_Domain.mRID AreaID_String	The unique identification of the domain. --- The area where an extremity of the resource is located. This is used to provide orientation information.
3	[0..1]	out_Domain.mRID AreaID_String	The unique identification of the domain. --- The area where an extremity of the resource is located. This is used to provide orientation information.
4	[0..1]	marketObjectStatus.status Status_String	The coded condition or position of an object with regard to its standing. --- The status of the registered resource, e.g. connected, disconnedted, outage, ...

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

Table 14 - Association ends of CRAC assembly model::Contingency_RegisteredResource with other classes

Order	mult.	Class name / Role	Description
5	[0..*]	Analog Measurements	The power system resource that contains the measurement. Association Based On: CRAC contextual model::Analog.Measurements[0..*] ----- CRAC contextual model::Contingency_RegisteredResource.[]
6	[0..*]	RegisteredResource_Reason Reason	The reason information associated with a RegisteredResource providing motivation information. Association Based On: CRAC contextual model::RegisteredResource_Reason.Reason[0..*] ----- CRAC contextual model::Contingency_RegisteredResource.[]

4.5.3.6 Contingency_Series

A contingency defined by a set of elements on which a modification is applied in order to simulate a defect.

Table 15 shows all attributes of Contingency_Series.

Table 15 - Attributes of CRAC assembly model::Contingency_Series

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID ID_String	A unique identification of the time series.
1	[0..1]	name String	The name is any free human readable and possibly non unique text naming the object.

Table 16 shows all association ends of Contingency_Series with other classes.

555 **Table 16 - Association ends of CRAC assembly model::Contingency_Series with other**
556 **classes**

Order	mult.	Class name / Role	Description
2	[0..*]	Party_MarketParticipant Party_MarketParticipant	The identification of a market participant associated with a TimeSeries. Association Based On: CRAC contextual model::Party_MarketParticipant.Party_MarketParticipant[0..*] ----- CRAC contextual model::Contingency_Series.[]
3	[0..*]	Contingency_RegisteredResource RegisteredResource	The identification of a resource associated with a TimeSeries. Association Based On: CRAC contextual model::Contingency_RegisteredResource.RegisteredResource[0..*] ----- CRAC contextual model::Contingency_Series.[]
4	[0..*]	Series_Reason Reason	The reason information associated with a TimeSeries providing motivation information. Association Based On: CRAC contextual model::Series_Reason.Reason[0..*] ----- CRAC contextual model::Contingency_Series.[]

557

558 #### 4.5.3.7 MarketDocument

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

561 Table 17 shows all attributes of MarketDocument.

562 **Table 17 - Attributes of CRAC assembly model::MarketDocument**

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

563

564 #### 4.5.3.8 Monitored_RegisteredResource

565 This is a network element to be monitored during the load flow study after applying the
566 contingencies described in the Series. analog measurements are monitored for this resource to
567 identify the network constraints.

568 Table 18 shows all attributes of Monitored_RegisteredResource.

569 **Table 18 - Attributes of CRAC assembly model::Monitored_RegisteredResource**

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID ResourceID_String	The unique identification of a resource.
1	[0..1]	name String	The name is any free human readable and possibly non unique text naming the object.

Order	mult.	Attribute name / Attribute type	Description
2	[0..1]	in_Domain.mRID AreaID_String	The unique identification of the domain. --- The area where the flow measurement enters for the monitored resource.
3	[0..1]	out_Domain.mRID AreaID_String	The unique identification of the domain. --- The control area connected to the monitored resource where the flow measurement comes out.
4	[0..1]	in_AggregateNode.mRID ResourceID_String	The unique identification of an AggregateNode. In the ESMP context, the "model authority" is defined as an authorized issuing office that provides an agreed identification coding scheme for market participant, domain, measurement point, resources (generator, lines, substations, etc.) identification. Master resource identifier issued by a model authority. The mRID is unique within an exchange context. Global uniqueness is easily achieved by using a UUID, as specified in RFC 4122, for the mRID. The use of UUID is strongly recommended. For CIMXML data files in RDF syntax conforming to IEC 61970-552 Edition 1, the mRID is mapped to rdf:ID or rdf:about attributes that identify CIM object elements. --- The identification of the aggregate node that is linked to the registered resource.
5	[0..1]	out_AggregateNode.mRID ResourceID_String	The unique identification of an AggregateNode. In the ESMP context, the "model authority" is defined as an authorized issuing office that provides an agreed identification coding scheme for market participant, domain, measurement point, resources (generator, lines, substations, etc.) identification. Master resource identifier issued by a model authority. The mRID is unique within an exchange context. Global uniqueness is easily achieved by using a UUID, as specified in RFC 4122, for the mRID. The use of UUID is strongly recommended. For CIMXML data files in RDF syntax conforming to IEC 61970-552 Edition 1, the mRID is mapped to rdf:ID or rdf:about attributes that identify CIM object elements. --- The identification of the aggregate node that is linked to the registered resource.

570

571 Table 19 shows all association ends of Monitored_RegisteredResource with other classes.

572 **Table 19 - Association ends of CRAC assembly model::Monitored_RegisteredResource**
573 **with other classes**

Order	mult.	Class name / Role	Description
6	[0..*]	Analog Measurements	The monitored measurements of the monitored network element. Association Based On: CRAC contextual model::Analog.Measurements[0..*] ----- CRAC contextual model::Monitored_RegisteredResource.[]
7	[0..*]	RegisteredResource_Reason Reason	The reason information associated with a RegisteredResource providing motivation information. Association Based On: CRAC contextual model::RegisteredResource_Reason.Reason[0..*] ----- CRAC contextual model::Monitored_RegisteredResource.[]

574

575 #### 4.5.3.9 Monitored_Series

576 A situation to be monitored defined by a set of elements on which a coupled monitoring must
577 be performed.

578 Table 20 shows all attributes of Monitored_Series.

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Table 20 - Attributes of CRAC assembly model::Monitored_Series

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID ID_String	A unique identification of the time series. In the ESMP context, the "model authority" is defined as a party (originator of the exchange) that provides a unique identification in the context of a business exchange such as time series identification, bid identification, ... Master resource identifier issued by a model authority. The mRID is globally unique within an exchange context. Global uniqueness is easily achieved by using a UUID for the mRID. It is strongly recommended to do this. For CIMXML data files in RDF syntax, the mRID is mapped to rdf:ID or rdf:about attributes that identify CIM object elements.
1	[0..1]	name String	The name is any free human readable and possibly non unique text naming the object.

Table 21 shows all association ends of Monitored_Series with other classes.

Table 21 - Association ends of CRAC assembly model::Monitored_Series with other classes

Order	mult.	Class name / Role	Description
2	[0..*]	Party_MarketParticipant Party_MarketParticipant	The identification of a market participant associated with a TimeSeries. Association Based On: CRAC contextual model::Party_MarketParticipant.Party_MarketParticipant[0..*] --- CRAC contextual model::Monitored_Series.[]
3	[0..*]	Monitored_RegisteredResource RegisteredResource	The identification of a resource associated with a TimeSeries. Association Based On: CRAC contextual model::Monitored_RegisteredResource.RegisteredResource[0..*] --- CRAC contextual model::Monitored_Series.[]
4	[0..*]	Series_Reason Reason	The reason information associated with a TimeSeries providing motivation information. Association Based On: CRAC contextual model::Monitored_Series.[] --- CRAC contextual model::Series_Reason.Reason[0..*]

4.5.3.10 Party_MarketParticipant

The identification of the limiting TSOs for the given contingency, obtained after the network studies. It can also identify the TSO that provides the Series.

Table 22 shows all attributes of Party_MarketParticipant.

Table 22 - Attributes of CRAC assembly model::Party_MarketParticipant

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID PartyID_String	The identification of the limiting TSO associated to the TimeSeries.

4.5.3.11 Point

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

593 Table 23 shows all attributes of Point.

594 **Table 23 - Attributes of CRAC assembly 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.

595

596 Table 24 shows all association ends of Point with other classes.

597 **Table 24 - Association ends of CRAC assembly model::Point with other classes**

Order	mult.	Class name / Role	Description
1	[1..*]	Series Series	TheTimeSeries provides additional information related to a Position within a given time interval. Association Based On: CRAC contextual model::Series.Series[1..*] ----- CRAC contextual model::Point.[]
2	[0..*]	Reason Reason	The Reason information associated with a Point providing motivation information. Association Based On: CRAC contextual model::Point.[] ----- CRAC contextual model::Reason.Reason[0..*]

598

599 #### 4.5.3.12 Reason

600 The coded motivation of an act.

601 Table 25 shows all attributes of Reason.

602 **Table 25 - Attributes of CRAC assembly 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.

603

604 #### 4.5.3.13 RegisteredResource_Reason

605 Comment related to a registered resource

606 Table 26 shows all attributes of RegisteredResource_Reason.

607 **Table 26 - Attributes of CRAC assembly model::RegisteredResource_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.

608

4.5.3.14 RemedialAction_RegisteredResource

This is one of the network element on which remedial action are carried out to improve the constraint situation. Those elements are used to remedy to constraints induced by the constraint situation.

Table 27 shows all attributes of RemedialAction_RegisteredResource.

Table 27 - Attributes of CRAC assembly model::RemedialAction_RegisteredResource

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID ResourceID_String	The unique identification of the remedial registered resource
1	[0..1]	name String	The name is any free human readable and possibly non unique text naming the object.
2	[0..1]	pSRType.psrType PsrType_String	The coded type of the registered resource. --- The coded type of the associated resource.
3	[0..1]	in_Domain.mRID AreaID_String	The unique identification of the domain. --- The area where an extremity of the resource is located. This is used to provide orientation information.
4	[0..1]	out_Domain.mRID AreaID_String	The unique identification of the domain. --- The area where an extremity of the resource is located. This is used to provide orientation information.
5	[0..1]	in_AggregateNode.mRID MeasurementPointID_String	The unique identification of an AggregateNode. In the ESMP context, the "model authority" is defined as an authorized issuing office that provides an agreed identification coding scheme for market participant, domain, measurement point, resources (generator, lines, substations, etc.) identification. Master resource identifier issued by a model authority. The mRID is unique within an exchange context. Global uniqueness is easily achieved by using a UUID, as specified in RFC 4122, for the mRID. The use of UUID is strongly recommended. For CIMXML data files in RDF syntax conforming to IEC 61970-552 Edition 1, the mRID is mapped to rdf:ID or rdf:about attributes that identify CIM object elements. --- The identification of the aggregate node that is linked to the registered resource.
6	[0..1]	out_AggregateNode.mRID MeasurementPointID_String	The unique identification of an AggregateNode. In the ESMP context, the "model authority" is defined as an authorized issuing office that provides an agreed identification coding scheme for market participant, domain, measurement point, resources (generator, lines, substations, etc.) identification. Master resource identifier issued by a model authority. The mRID is unique within an exchange context. Global uniqueness is easily achieved by using a UUID, as specified in RFC 4122, for the mRID. The use of UUID is strongly recommended. For CIMXML data files in RDF syntax conforming to IEC 61970-552 Edition 1, the mRID is mapped to rdf:ID or rdf:about attributes that identify CIM object elements. --- The identification of the aggregate node that is linked to the registered resource.
7	[1..1]	marketObjectStatus.status Status_String	The coded application mode. --- The action to be realized on a registered resource like open/close/stop or the nature of the capacity values like absolute/Relative in case the resource capacity element is used.
8	[0..1]	resourceCapacity.maximumCapacity Decimal	The maximum variation or target value of tap, generation or load
9	[0..1]	resourceCapacity.minimumCapacity Decimal	The minimum variation or target value of tap, generation or load

Order	mult.	Attribute name / Attribute type	Description
10	[0..1]	resourceCapacity.defaultCapacity Decimal	The variation or target value of tap, generation or load
11	[0..1]	resourceCapacity.unitSymbol UnitSymbol	Unit selection for the capacity values.

615

616 Table 28 shows all association ends of RemedialAction_RegisteredResource with other
617 classes.

618 **Table 28 - Association ends of CRAC assembly**
619 **model::RemedialAction_RegisteredResource with other classes**

Order	mult.	Class name / Role	Description
12	[0..*]	Analog Measurements	The power system resource that contains the measurement. Association Based On: CRAC contextual model::Analog.Measurements[0..*] ----- CRAC contextual model::RemedialAction_RegisteredResource.[]
13	[0..*]	RegisteredResource_Reason Reason	The reason information associated with a RegisteredResource providing motivation information. Association Based On: CRAC contextual model::RegisteredResource_Reason.Reason[0..*] ----- CRAC contextual model::RemedialAction_RegisteredResource.[]

620

621 #### 4.5.3.15 RemedialAction_Series

622 A set of remedial actions provided to relieve a network constraint after applying the
623 contingencies provided in the Series or free to use by the capacity calculator.

624 Table 29 shows all attributes of RemedialAction_Series.

625 **Table 29 - Attributes of CRAC assembly model::RemedialAction_Series**

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID ID_String	A unique identification of the set of remedial action.
1	[0..1]	name String	The free human readable name of the set of remedial actions.
2	[0..1]	businessType BusinessKind_String	The nature of the set of remedial actions.
3	[0..1]	applicationMode_MarketObjectStatus.status Status_String	The coded application mode. --- The condition of use of the remedial action. It can be preventive, curative or automatic.
4	[0..1]	availability_MarketObjectStatus.status Status_String	The coded application mode. --- The status of an object associated with a TimeSeries.
6	[0..1]	in_Domain.mRID AreaID_String	The unique identification of the domain. --- In case of Bilateral Exchange Remedial Action, the area where the energy is going to
7	[0..1]	out_Domain.mRID AreaID_String	The unique identification of the domain. --- In case of Bilateral Exchange Remedial Action, the area where the energy comes from

Order	mult.	Attribute name / Attribute type	Description
8	[0..1]	measurement_Unit.name MeasurementUnitKind_String	The identification of the formal code for a measurement unit (UN/ECE Recommendation 20). --- The unit of measure associated with the quantity if a Bilateral Exchange remedial action is described, or associated to the capacity values if the resource capacity element is used.
9	[0..1]	quantity.quantity Decimal	The quantity value of the additional constraint --- The value of a bilateral exchange used as remedial action
10	[0..1]	price.amount Amount_Decimal	A number of monetary units specified in a unit of currency. --- The price information associated to a TimeSeries.

Table 30 shows all association ends of RemedialAction_Series with other classes.

Table 30 - Association ends of CRAC assembly model::RemedialAction_Series with other classes

Order	mult.	Class name / Role	Description
5	[0..*]	Party_MarketParticipant Party_MarketParticipant	The identification of a market participant associated with a TimeSeries. Association Based On: CRAC contextual model::Party_MarketParticipant.Party_MarketParticipant[0..*] ----- CRAC contextual model::RemedialAction_Series.[]
11	[0..*]	RemedialAction_RegisteredResource RegisteredResource	The registered resources on which remedial actions are carried out Association Based On: CRAC contextual model::RemedialAction_RegisteredResource.RegisteredResource[0..*] ----- CRAC contextual model::RemedialAction_Series.[]
12	[0..*]	Shared_Domain Shared_Domain	The area of the monitored network elements where the remedial action series can be used in case of a network security constraint. Association Based On: CRAC contextual model::Shared_Domain.Shared_Domain[0..*] ----- CRAC contextual model::RemedialAction_Series.[]
13	[0..*]	Series_Reason Reason	The reason information associated with a TimeSeries providing motivation information. Association Based On: CRAC contextual model::Series_Reason.Reason[0..*] ----- CRAC contextual model::RemedialAction_Series.[]

4.5.3.16 Series

The set of contingency network elements, monitored network elements, remedial actions and additional constraints enabling to create a contingency.

Table 31 shows all attributes of Series.

Table 31 - Attributes of CRAC assembly model::Series

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID ID_String	A unique identification of a list of contingencies, a list of monitored registered resources or remedial actions.

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Order	mult.	Attribute name / Attribute type	Description
1	[1..1]	businessType BusinessKind_String	The identification of the nature of the Series.
2	[0..1]	name String	The free human readable name of the Series.
4	[0..1]	optimization_MarketObjectStatus.status Status_String	The coded application mode. --- The status of an object associated with a TimeSeries.

636

637 Table 32 shows all association ends of Series with other classes.

638 **Table 32 - Association ends of CRAC assembly model::Series with other classes**

Order	mult.	Class name / Role	Description
3	[0..*]	Party_MarketParticipant Party_MarketParticipant	The identification of the limiting TSOs for the given network constraint situation, obtained after the network studies. It can also identify the TSO that provides the constraint_series. Association Based On: CRAC contextual model::Series.[] ----- CRAC contextual model::Party_MarketParticipant.Party_MarketParticipant[0..*]
5	[0..*]	AdditionalConstraint_Series AdditionalConstraint_Series	An External Constraint to be taken (or taken) into account in the network studies associated to a Constraint Series Association Based On: CRAC contextual model::AdditionalConstraint_Series.AdditionalConstraint_Series[0..*] ----- CRAC contextual model::Series.[]
6	[0..*]	Contingency_Series Contingency_Series	Association Based On: CRAC contextual model::Contingency_Series.Contingency_Series[0..*] ----- CRAC contextual model::Series.[]
7	[0..*]	Monitored_Series Monitored_Series	Association Based On: CRAC contextual model::Monitored_Series.Monitored_Series[0..*] ----- CRAC contextual model::Series.[]
8	[0..*]	RemedialAction_Series RemedialAction_Series	A set of remedial actions provided for a given Constraint Situation or free to use by the capacity calculator if no outage and monitored elements are provided in the constraint series. Association Based On: CRAC contextual model::RemedialAction_Series.RemedialAction_Series[0..*] ----- CRAC contextual model::Series.[]
9	[0..*]	Reason Reason	The reason information associated with a Series providing motivation information. Association Based On: CRAC contextual model::Series.[] ----- CRAC contextual model::Reason.Reason[0..*]

639

640 #### 4.5.3.17 Series_Period

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

642 Table 33 shows all attributes of Series_Period.

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643 **Table 33 - Attributes of CRAC assembly 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.

644

645 Table 34 shows all association ends of Series_Period with other classes.

646 **Table 34 - Association ends of CRAC assembly 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: CRAC contextual model::Series_Period.[] --- CRAC contextual model::Point.Point[1..*]

647

648 #### 4.5.3.18 Series_Reason

649 Comment related to a Series

650 Table 35 shows all attributes of Series_Reason.

651 **Table 35 - Attributes of CRAC assembly model::Series_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.

652

653 #### 4.5.3.19 Shared_Domain

654 The areas allowed to use the remedial action.

655 Table 36 shows all attributes of Shared_Domain.

656 **Table 36 - Attributes of CRAC assembly model::Shared_Domain**

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

657

658 #### 4.5.3.20 TimeSeries

659 A set of time-ordered Series.

660 Table 37 shows all attributes of TimeSeries.

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661 **Table 37 - Attributes of CRAC assembly model::TimeSeries**

Order	mult.	Attribute name / Attribute type	Description
0	[1..1]	mRID ID_String	A unique identification of the time series.
1	[1..1]	businessType BusinessKind_String	The identification of the nature of the time series.
2	[1..1]	curveType CurveType_String	The identification of the coded representation of the type of curve being described.
3	[0..1]	in_Domain.mRID AreaID_String	The unique identification of the domain. --- In case of NTC determination process, this is the area of the related oriented border study in which the energy flows into.
4	[0..1]	out_Domain.mRID AreaID_String	The unique identification of the domain. --- In case of NTC determination process, this is the area of the related oriented border study in which the energy comes from.
5	[0..1]	currency_Unit.name CurrencyCode_String	The identification of the formal code for a currency (ISO 4217). --- The currency associated with a TimeSeries.
6	[0..1]	price_Measurement_Unit.name MeasurementUnitKind_String	The identification of the formal code for a measurement unit (UN/ECE Recommendation 20). --- The unit of measure associated with the quantities in a TimeSeries.

662

663 Table 38 shows all association ends of TimeSeries with other classes.

664 **Table 38 - Association ends of CRAC assembly model::TimeSeries with other classes**

Order	mult.	Class name / Role	Description
7	[1..*]	Series_Period Period	The time interval and resolution for a period associated with a TimeSeries. Association Based On: CRAC contextual model::TimeSeries.[] ----- CRAC contextual model::Series_Period.Period[1..*]
8	[0..*]	Reason Reason	The reason information associated with a TimeSeries providing motivation information. Association Based On: CRAC contextual model::TimeSeries.[] ----- CRAC contextual model::Reason.Reason[0..*]

665

666 ### 4.5.4 Datatypes

667 The list of datatypes used for the CRAC assembly model is as follows:

668 • Action_Status compound
669 • ESMP_DateTimeInterval compound
670 • Amount_Decimal datatype
671 • AnalogType_String datatype, codelist AnalogTypeList
672 • AreaID_String datatype, codelist CodingSchemeTypeList
673 • BusinessKind_String datatype, codelist BusinessTypeList
674 • CurrencyCode_String datatype, codelist CurrencyTypeList
675 • CurveType_String datatype, codelist CurveTypeList
676 • ESMP_DateTime datatype
677 • ESMP_Float datatype
678 • ESMPBoolean_String datatype, codelist IndicatorTypeList
679 • ESMPVersion_String datatype

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- ID_String datatype
- MarketRoleKind_String datatype, codelist RoleTypeList
- MeasurementPointID_String datatype, codelist CodingSchemeTypeList
- MeasurementUnitKind_String datatype, codelist UnitOfMeasureTypeList
- MessageKind_String datatype, codelist MessageTypeList
- PartyID_String datatype, codelist CodingSchemeTypeList
- Position_Integer datatype
- ProcessKind_String datatype, codelist ProcessTypeList
- PsrType_String datatype, codelist AssetTypeList
- ReasonCode_String datatype, codelist ReasonCodeTypeList
- ReasonText_String datatype
- ResourceID_String datatype, codelist CodingSchemeTypeList
- Status_String datatype, codelist StatusTypeList
- UnitSymbol datatype, codelist UnitSymbol
- YMDHM_DateTime datatype

4.6 CRAC schema definition

This version of the CRAC Implementation Guide refers to the schemas as defined in version 2.4 of the CRAC XSD.

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