



European Network of  
Transmission System Operators  
for Electricity

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

## IMPLEMENTATION GUIDE

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DOCUMENT APPROVED  
VERSION 2.2

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36 prepared to interoperate with another implementation which does include the option,  
37 though perhaps with reduced functionality. In the same vein an implementation which  
38 does include a particular option **MUST** be prepared to interoperate with another  
39 implementation which does not include the option (except, of course, for the feature the  
40 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 11 <sup>th</sup> and 12 <sup>th</sup> 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 24 <sup>th</sup> and 25 <sup>th</sup> of October 2017 <ul style="list-style-type: none"> <li>- measurement_Unit.name and quantity.quantity attributes set to optional in the AdditionalConstraint_Series class</li> <li>- AggregateNodes added in the RemedialAction_RegisteredResource class</li> <li>- Related_MarketDocument association added at header level</li> <li>- Optimization_MarketObjectStatus attribute added at Series level</li> </ul>
2	2	2018-06-19	Version approved by MC. <ul style="list-style-type: none"> <li>- Addition of a MarketObjectStatus.status attribute in the AdditionalConstraint_RegisteredResource</li> <li>- Addition of a Monitored_Series</li> <li>- Addition of an association between the Party_MarketParticipant class and the sub_Series</li> <li>- In/out_Domain put to optional in the AdditionalConstraint_Series</li> </ul>

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## 131 INTRODUCTION

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

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

### 136 **1 Scope**

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

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

### 143 **2 Normative references**

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

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

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

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

154 *Critical network element implementation guide*

155 *Generation and load shift key implementation guide*

### 156 **3 Terms and definitions**

#### 157 **3.1** 158 **contingency**

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

#### 162 **3.2** 163 **network constraint**

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

#### 166 **3.3** 167 **flow**

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

#### 172 **3.4** 173 **Transitory admissible transmission limit (TATL)**

174 The temporary overloads of transmission system elements which are allowed for a limited  
175 period and which do not cause physical damage to the transmission system elements as long  
176 as the defined duration and thresholds are respected.

- 177 **3.5**  
178 **Permanent admissible transmission limit (PATL)**  
179 The permanent loads of transmission system elements which are allowed for an unlimited period  
180 and which do not cause physical damage to the transmission system elements as long as the  
181 defined thresholds are respected.
- 182 **3.6**  
183 **monitored registered resource / monitored network element**  
184 This is the network element of the power system monitored during the network studies. The list  
185 of these elements is established by power system analysts, and is used to identify the critical  
186 network elements after the network studies. Some analog measurements associated with this  
187 elements provides the maximum flows allowed in a given network situation.
- 188 **3.7**  
189 **outage registered resource / outage network element**  
190 This is one of the network elements which are disconnected for the studied contingency.
- 191 **3.8**  
192 **remedial action series**  
193 This is a set of one or several network elements on which remedial actions are carried out to  
194 relieve the network constraint. Those actions are used to alleviate the constraints induced by  
195 the contingency. The remedial actions should be automatic, preventive or curative. The type of  
196 the remedial action includes generation, load and/or topology changes.
- 197 **3.9**  
198 **critical network element**  
199 A network element either within a bidding zone or between bidding zones taken into account in  
200 the capacity calculation process, limiting the amount of power that can be exchanged.
- 201 **3.10**  
202 **Special Protection System (SPS)**  
203 The set of coordinated and automatic measures designed to ensure fast reaction to  
204 Disturbances and to avoid the propagation of Disturbances in the Transmission System.
- 205 **3.11**  
206 **Individual Grid Model (IGM)**  
207 A data set describing power system characteristics (generation, load and grid topology) and  
208 related rules to change these characteristics during capacity calculation, prepared by the  
209 responsible TSOs, to be merged with other individual grid model components in order to create  
210 the common grid model.
- 211 **3.12**  
212 **Common Grid Model (CGM)**  
213 A Union-wide data set agreed between various TSOs describing the main characteristic of the  
214 power system (generation, loads and grid topology) and rules for changing these characteristics  
215 during the capacity calculation process.
- 216 **3.13**  
217 **Special Protection Scheme (SPS)**  
218 A remedial action consisting in an automatic device triggered after contingency.

219 **4 The coordinated capacity calculation process**

220 **4.1 Overall business context**

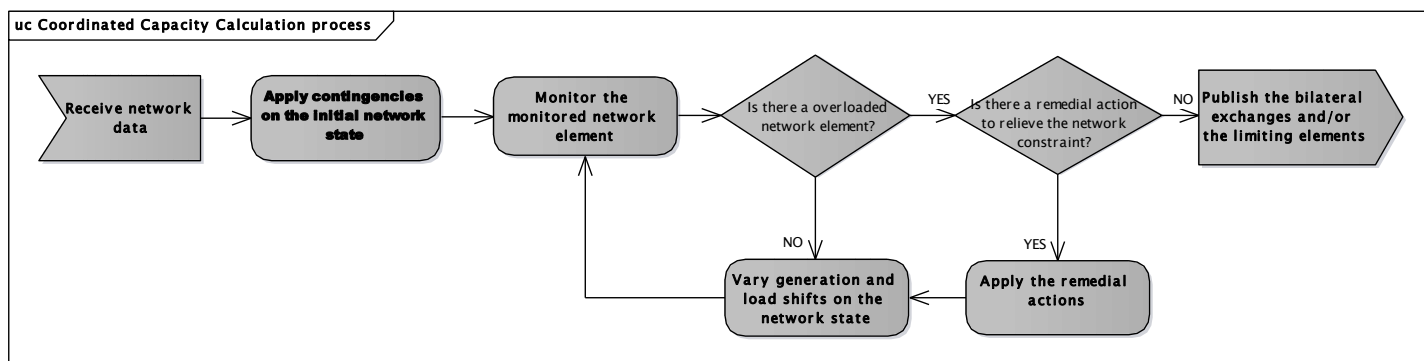
221 The business process described in this document focuses on the exchange of contingency list,  
222 remedial actions and additional constraints used for the coordinated capacity calculation  
223 processes (Flow Based or NTC capacity calculation).

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

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

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

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



256 **Figure 1 – Coordinated capacity calculation process**

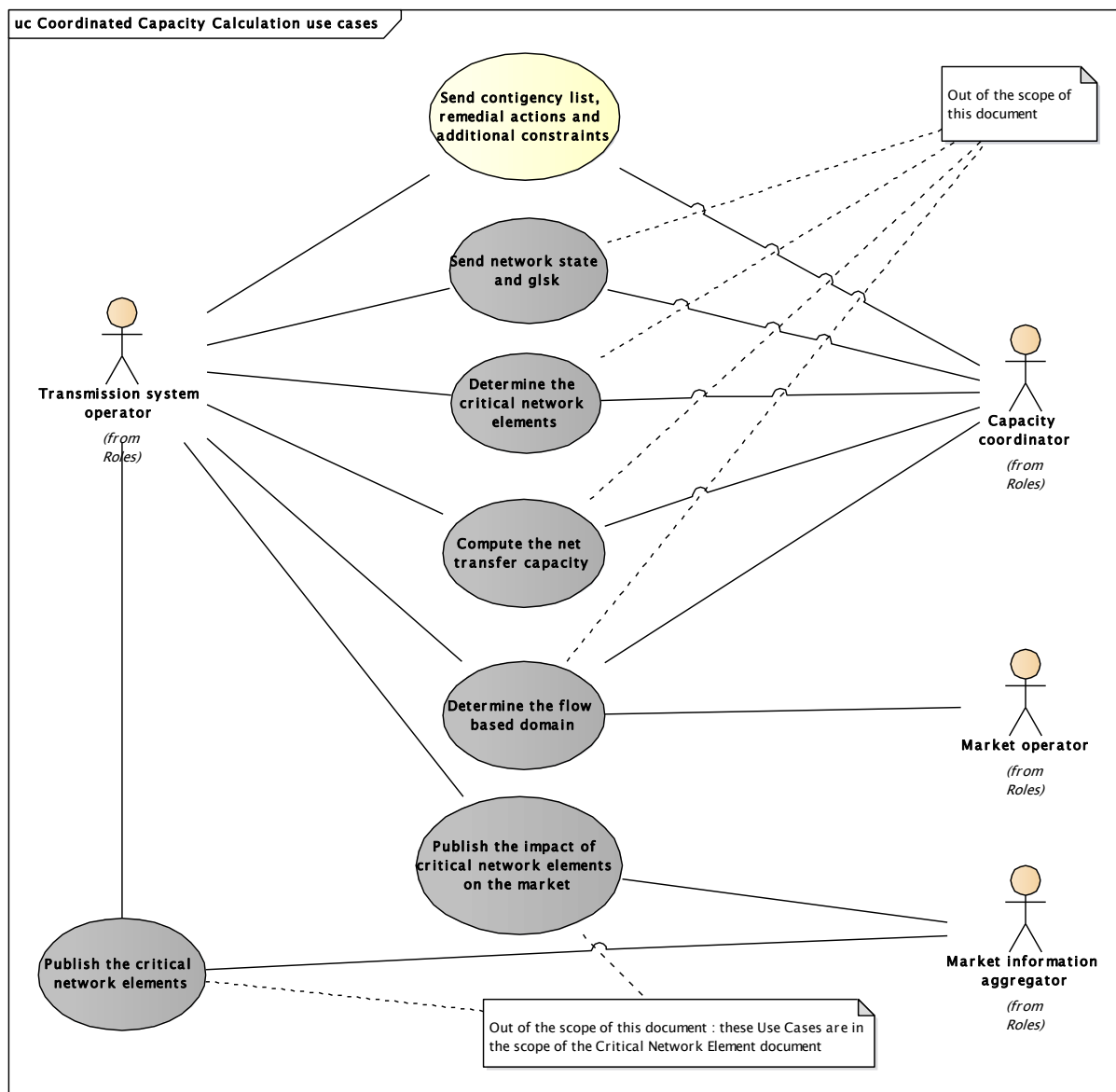
257 The process is finished when the capacity coordinator performed all the contingencies and  
258 found the maximum bilateral exchanges associated to the critical network elements on the



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

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

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



267

268

**Figure 2 – Use cases of coordinated capacity calculation process**

269 **4.2 Contingency list, remedial actions and additional constraint exchange process**

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

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

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

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

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

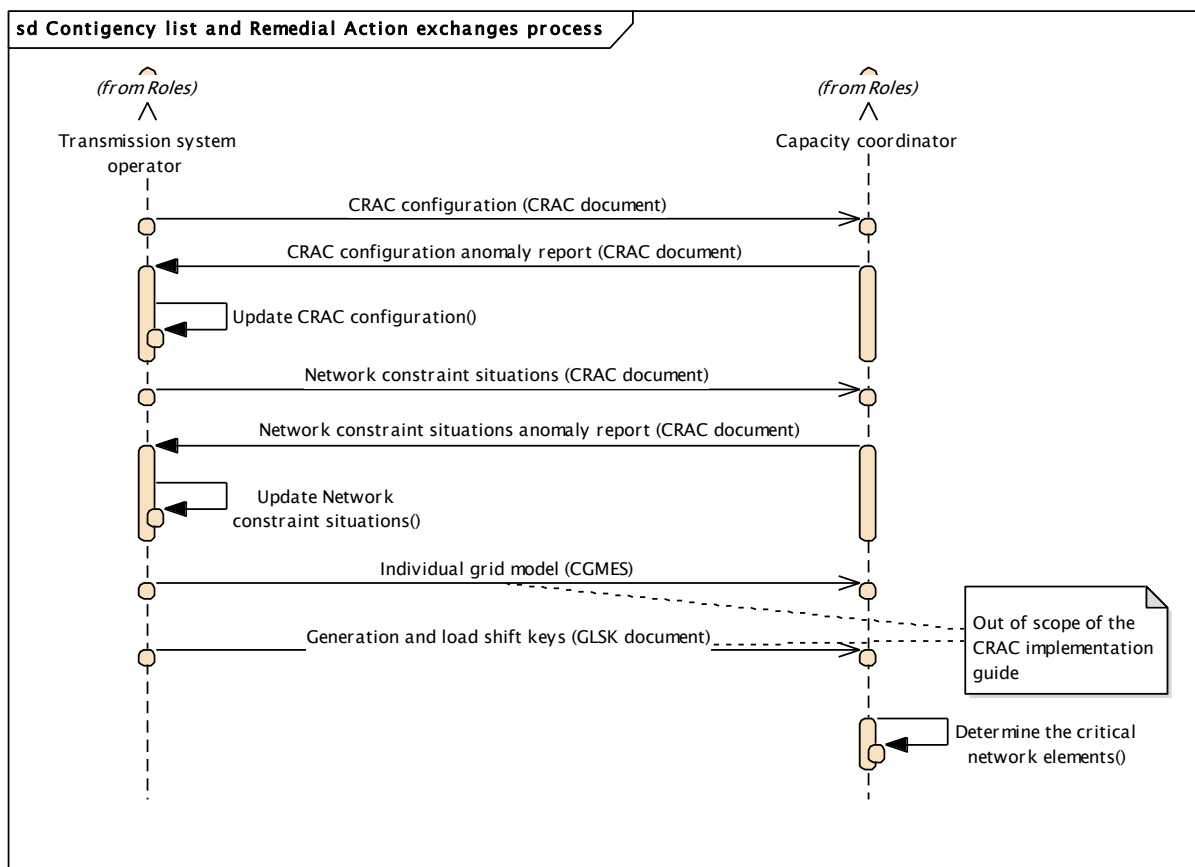
284 Depending on the regional calculation rules, the network constraint document can be more  
285 or less restrictive. A TSOs can decide to define a network constraint as a list of  
286 contingencies, associated with only one monitored network element, itself associated with  
287 one set of remedial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

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

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

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

302 The sequence diagram is provided in Figure 3.



303

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

305 **4.3 Business rules for the constraint network elements and remedial actions**  
306 **exchange process**

307 **4.3.1 General rules**

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

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

313 When a document is received, it shall be checked at the application level to ensure that there  
314 are no faults in it that could prevent its normal processing. After this check, an  
315 acknowledgement document, as defined in IEC 62325-451-1, shall be generated either  
316 accepting in its entirety the document in question or rejecting it.

317 **4.3.2 Rules governing the CRAC\_MarketDocument for the configuration document**

318 The following rules applied to the CRAC\_MarketDocument:

- 319 • A CRAC\_MarketDocument should contain for a specific position several TimeSeries.
- 320 – The docStatus attribute identifies the status of the document given by the sender: it  
321 could be proposed, confirmed or rejected.
- 322 – Additionally, the status attribute indicates if the document contains the individual  
323 network data of a TSO, or the common network data for the whole capacity calculation  
324 area.

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

327 **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

- 329
- 330 • The TimeSeries of the CRAC\_MarketDocument provides the main related oriented  
331 border of the calculation in case of a NTC determination process.
- 332 – In\_Domain.mRID: the area of the related oriented border study where the energy flows  
333 into.
- 334 – Out\_Domain.mRID: the area of the related oriented border study where the energy  
335 comes from.
- 336 • The Series\_Period identifies the period of application for the configuration data  
337 described in the Series
- 338 • The Series provides the list of network elements configuration data
- 339 • The Series contains:
  - 340 – A mRID which identifies the configuration list.

- 341 – A BusinessType which identifies the kind of network elements list:  
342 contingency/monitored network element/remedial action.
- 343 – If the Series is a contingency list:
- 344 • There are as many Contingency\_Series as contingency to be simulated.
- 345 • Each Contingency\_Series is associated with one or several  
346 RegisteredResource elements, which describe the network elements in fault.
- 347 • The in\_Domain and out\_Domain should be used to identify the location of the  
348 resource, particularly in case of an interconnection.
- 349 – If the Series is a list of monitored network elements:
- 350 • There are as many Monitored\_Series as a set of network elements to monitor  
351 during the network studies.
- 352 • Each Monitored\_Series is associated with one or several RegisteredResource  
353 elements, which describe the network elements to be monitored.
- 354 • For orientation purpose, In\_AggregateNode and Out\_AggregateNode, using  
355 EIC code, should be used.
- 356 • A list of measurements of interest for the Monitored\_RegisteredResource  
357 should be provided. These measurementType should be used to provide the  
358 technical constraints of the Monitored\_RegisteredResource like the PATL, the  
359 reference flow, etc.
- 360 – If the Series is a list of remedial actions:
- 361 • The RemedialAction\_Series provides the remedial actions used to relieve the  
362 network constraints in the studied cases.
- 363 • The RemedialAction\_Series contains unitary remedial actions that are applied  
364 simultaneously. For example a Busbar or a SPS (automation) are described  
365 with one RemedialAction\_Series and as many registered resources as there  
366 are network elements to open and close in order to modify the network  
367 topology. If this remedial action is accompanied by a change of power on a  
368 generation unit, another RemedialAction\_Series will describe this action.
- 369 • The mRID identifies the RemedialAction\_Series. This mRID is used in the  
370 network constraint document to provide the link between  
371 contingency/monitored network elements/remedial actions.
- 372 If the RemedialAction\_Series contains only one registered resource, the EIC  
373 code or the CGMES code of the resource should be used as the mRID.
- 374 • The applicationMode\_MarketObjectStatus shall be provided as automatic,  
375 preventive or curative.
- 376 • The Shared\_Domain shall be used to identify the areas (LFC Area, Bidding  
377 Zone, etc.) where the remedial action can be applied if a network constraint  
378 happens on these areas.
- 379 • If the remedial action is a change of bilateral exchange capacity,
- 380 • Out\_Domain and In\_Domain shall provide the direction of the  
381 exchange
- 382 • Quantity shall provide the new value of the exchange capacity
- 383 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	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).

385

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

389 **4.3.3 Rules governing the CRAC\_MarketDocument for the network constraint**  
390 **document**

391 The following rules apply to the CRAC\_MarketDocument if the party sends a network constraint  
392 situations document:

- 393 • A CRAC\_MarketDocument should contain for a specific position several TimeSeries.

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

- 398 • The Related\_MarketDocument class can be used to identify the documents related to a  
399 specific network constraint document within the capacity calculation process (for  
400 example, a related grid model or GLSK document).

- 401 • The TimeSeries of the CRAC\_MarketDocument provides the main related oriented  
402 border of the calculation in case of a NTC determination process.

- 403 • In\_Domain.mRID: the area of the related oriented border study where the energy flows  
404 into.

- 405 • Out\_Domain.mRID: the area of the related oriented border study where the energy  
406 comes from.

- 407 • The Series\_Period identifies the period of application of the Series

- 408 • The Series provides the network data to take into account for the load flow studies.

- 409 • The Series contains:

- 410 – A mRID which identifies the network constraint situation to be simulated or the  
411 network elements lists.

- 412 – A BusinessType which identifies nature of the series.

- 413 – If the Business Type is “Network constraint situation”, it means that the  
414 Series provides a contingency to be simulated with its associated  
415 remedial actions and monitored elements, and potential additional  
416 constraints.

- 417 – If the Business Type is “Contingency”, it means that the Series provides  
418 only a list of contingencies to be simulated. The remedial actions and  
419 monitored elements are given in other Series.

- 420 – If the Business Type is “Remedial action”, it means that the Series  
421 provides Remedial Actions that should be used with all the contingencies  
422 provided in other Series.
- 423 – If the Business Type is “Monitored network elements”, it means that the  
424 Series provides “Monitored network elements” that shall be monitored  
425 with all the contingencies series provided in in other Series.
- 426 – An Optimization\_MarketObjectStatus which allows to describe the status of the  
427 constraint situation for a Remedial Action Optimization process (branch which  
428 margin must be optimized, constraint for the optimization...).
- 429 • The AdditionalConstraint\_Series should provide an additional constraint like an  
430 imposed bilateral exchange or a net position for a given area.
- 431 – The business type identifies the nature of the additional constraint (TTC, NTC,  
432 Net Position, or Phase Shift Angle).
- 433 – If the additional constraint is an exchange or a net position constraint, In\_Domain  
434 and Out\_Domain shall identify the direction of the exchange or the area  
435 concerned by a net position.
- 436 – If the additional constraint is a phase shift angle, the AdditionalConstraint\_Series  
437 is associated with AdditionalConstraint\_RegisteredResource elements, which  
438 describe the elements between which a maximum phase shift angle must not be  
439 exceeded.
- 440 Within the AdditionalConstraint\_RegisteredResource, the direction of the phase  
441 shift angle is provided by the MarketObjectStatus.status attribute.
- 442 • The Contingency\_Series shall be provided to describe the contingency.
- 443 • There are as many Contingency\_Series as contingencies to be simulated. The  
444 capacity coordinator shall simulate a contingency on all network elements at the  
445 same time.
- 446 • Each Contingency\_Series is associated with one or several  
447 Contingency\_RegisteredResource elements, which describe the network  
448 elements in fault.
- 449 • The Monitored\_Series provided in the Series, shall be monitored during the  
450 contingency simulation.
- 451 – There are as many Monitored\_Series as sets of elements to be monitored. The  
452 capacity coordinator shall monitor all the registered resources associated with a  
453 Monitored\_Series at the same time.
- 454 • For orientation purpose, In\_AggregateNode and Out\_AggregateNode, using EIC  
455 code, should be used in the Monitored\_RegisteredResource.
- 456 The measurementType in the class Analog shall be used to provide the TATL or  
457 PATL allowed in the Monitored\_RegisteredResource.
- 458 • The RemedialAction\_Series provides the remedial actions used to relieve the  
459 constraints in the studied cases.
- 460 • The applicationMode\_MarketObjectStatus shall be provided as automatic,  
461 preventive or curative.
- 462 • The condition of use of the remedial action are given by the  
463 Monitored\_RegisteredResource measurementType of the current Series.  
464 Consequently, if a remedial action shall be used for a given TATL and another  
465 remedial action shall be used for PATL, two Series shall be created with the  
466 same Contingency\_Series and Monitored\_RegisteredResource but with two  
467 different measurementTypes.

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

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

472

**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	
	sender_MarketParticipant.marketRole.type	A04 = TSO	
	receiver_MarketParticipant.marketRole.type	A36 = Capacity 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	
	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.	
	businessType	B54 = Network constraint situation B59 = Network Element B88 = Base Case Network Situation	
	CurveType	Used to identify the curve type method	
Series_Period			
Point			
Series			
Series	mRID	used to identify the TimeSeries	used to identify the TimeSeries
	businessType	B54 = Network constraint situation B55 = Contingency B56 = Remedial Action B57 = Monitored Network Element	
	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

Class	Attribute	Configuration document	Network constraint document
	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
RegisteredResource	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
	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
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



Class	Attribute	Configuration document	Network constraint document
	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	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", "%"...
	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

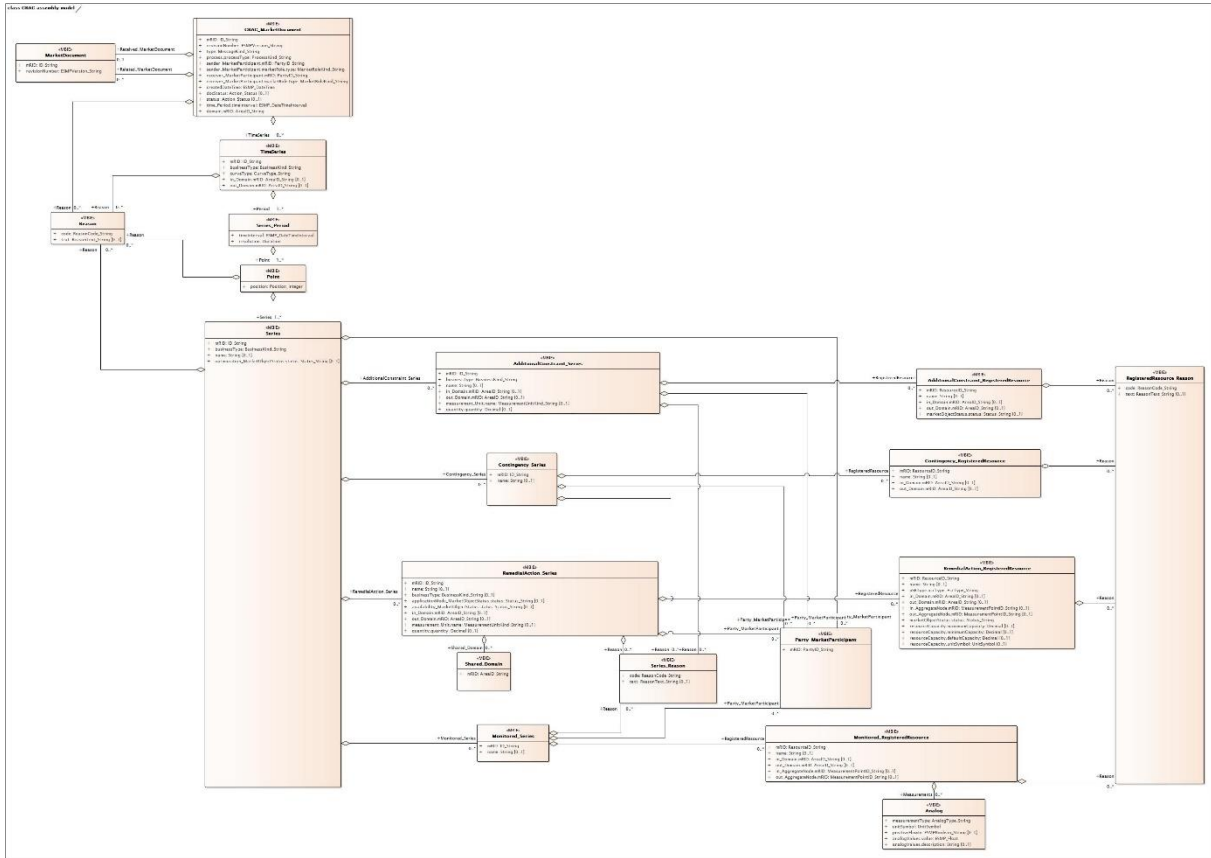
Class	Attribute	Configuration document	Network constraint document
RegisteredResource	mRID	used as EIC or CGMES code of the element on which a remedial action is carried out	not used
	name	used as the name of the element on which a remedial action is carried out	not used
	In_Domain.mRID	used to identify 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 A01 = Tieline, A02 = Line, A04 = Generation, A05 = Load, A06 = Phase Shift Transformer A07 = Circuit breaker  (see dependency rules in Table 2)	not used
	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	
Shared_Domain	Shared_Domain.mRID	EIC code of the area which can use the remedial action	not used

473



Name	Complete IsBasedOn Path
Contingency_RegisteredResource	TC57CIM::IEC62325::MarketCommon::RegisteredResource
Contingency_Series	TC57CIM::IEC62325::MarketManagement::Series
CRAC_MarketDocument	TC57CIM::IEC62325::MarketManagement::MarketDocument
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
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
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

- 484 **4.5 CRAC assembly model**
- 485 **4.5.1 Overview of the model**
- 486 Figure 5 shows the model.



487  
488 **Figure 5 - CRAC assembly model**

- 489 **4.5.2 IsBasedOn relationships from the European style market profile**
- 490 Table 5 shows the traceability dependency of the classes used in this package towards the
- 491 upper level.

492 **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

Name	Complete IsBasedOn Path
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

493

494 **4.5.3 Detailed CRAC assembly model**

495 **4.5.3.1 CRAC\_MarketDocument root class**

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

498 Table 6 shows all attributes of CRAC\_MarketDocument.

499 **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.

Order	mult.	Attribute name / Attribute type	Description
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.

500

501 Table 7 shows all association ends of CRAC\_MarketDocument with other classes.

502 **Table 7 - Association ends of CRAC assembly model::CRAC\_MarketDocument with**  
503 **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.[]

504

#### 505 4.5.3.2 AdditionalConstraint\_RegisteredResource

506 This is a resource contributing to the relevant additional constraint.

507 Table 8 shows all attributes of AdditionalConstraint\_RegisteredResource.

508 **Table 8 - Attributes of CRAC assembly**  
509 **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.

Order	mult.	Attribute name / Attribute type	Description
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, disconnected, outage, ...

510

511 Table 9 shows all association ends of AdditionalConstraint\_RegisteredResource with other  
512 classes.

513

**Table 9 - Association ends of CRAC assembly  
model::AdditionalConstraint\_RegisteredResource with other classes**

514

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.[]

515

#### 516 4.5.3.3 AdditionalConstraint\_Series

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

518 Table 10 shows all attributes of AdditionalConstraint\_Series.

**Table 10 - Attributes of CRAC assembly model::AdditionalConstraint\_Series**

519

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

520

521 Table 11 shows all association ends of AdditionalConstraint\_Series with other classes.



522 **Table 11 - Association ends of CRAC assembly model::AdditionalConstraint\_Series**  
523 **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.[]
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.[]

524

525 **4.5.3.4 Analog**

526 Analog represents an analog Measurement.

527 Analog provides the analog measurements monitored for one specific  
528 Monitored\_RegisteredResource.

529 Table 12 shows all attributes of Analog.

530 **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 measurementType and its associated value. --- Measurement to which this value is connected.

531

532 **4.5.3.5 Contingency\_RegisteredResource**

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

535 Table 13 shows all attributes of Contingency\_RegisteredResource.

536 **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.
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.

537

538 Table 14 shows all association ends of Contingency\_RegisteredResource with other classes.

539 **Table 14 - Association ends of CRAC assembly**  
540 **model::Contingency\_RegisteredResource with other classes**

Order	mult.	Class name / Role	Description
4	[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.[]

541

#### 542 4.5.3.6 Contingency\_Series

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

545 Table 15 shows all attributes of Contingency\_Series.

546 **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.

547

548 Table 16 shows all association ends of Contingency\_Series with other classes.

549 **Table 16 - Association ends of CRAC assembly model::Contingency\_Series with other**  
550 **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.[]

551

#### 552 4.5.3.7 MarketDocument

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

555 Table 17 shows all attributes of MarketDocument.

556 **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.

557

#### 558 4.5.3.8 Monitored\_RegisteredResource

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

562 Table 18 shows all attributes of Monitored\_RegisteredResource.

563 **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 MeasurementPointID_String	The unique identification of an AggregateNode. --- The node connected to the monitored resource from which the flow measurement enters.
5	[0..1]	out_AggregateNode.mRID MeasurementPointID_String	The unique identification of an AggregateNode. --- The node connected to the monitored resource from which the flow measurement comes out.

564

565 Table 19 shows all association ends of Monitored\_RegisteredResource with other classes.

566 **Table 19 - Association ends of CRAC assembly model::Monitored\_RegisteredResource**  
567 **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.[]

568

#### 569 4.5.3.9 Monitored\_Series

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

572 Table 20 shows all attributes of Monitored\_Series.

573 **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.

574

575 Table 21 shows all association ends of Monitored\_Series with other classes.

576  
577

**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..*]

578

#### 579 4.5.3.10 Party\_MarketParticipant

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

582 Table 22 shows all attributes of Party\_MarketParticipant.

583 **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.

584

#### 585 4.5.3.11 Point

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

587 Table 23 shows all attributes of Point.

588 **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.

589

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

591 **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..*]

592

593 **4.5.3.12 Reason**

594 The coded motivation of an act.

595 Table 25 shows all attributes of Reason.

596 **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.

597

598 **4.5.3.13 RegisteredResource\_Reason**

599 Comment related to a registered resource

600 Table 26 shows all attributes of RegisteredResource\_Reason.

601 **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.

602

603 **4.5.3.14 RemedialAction\_RegisteredResource**

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

607 Table 27 shows all attributes of RemedialAction\_RegisteredResource.

608 **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	[1..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
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.

609

610 Table 28 shows all association ends of RemedialAction\_RegisteredResource with other  
611 classes.

612 **Table 28 - Association ends of CRAC assembly**  
613 **model::RemedialAction\_RegisteredResource with other classes**

Order	mult.	Class name / Role	Description
12	[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.[]

614

615 **4.5.3.15 RemedialAction\_Series**

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

618 Table 29 shows all attributes of RemedialAction\_Series.

619 **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
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

620

621 Table 30 shows all association ends of RemedialAction\_Series with other classes.



622  
623

**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.[]
10	[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.[]
11	[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.[]
12	[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.[]

624

#### 625 4.5.3.16 Series

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

628 Table 31 shows all attributes of Series.

629

**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.
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.

630

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

632 **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..*]

633

634 **4.5.3.17 Series\_Period**

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

636 Table 33 shows all attributes of Series\_Period.

637 **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.

638

639 Table 34 shows all association ends of Series\_Period with other classes.

640 **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..*]

641

642 **4.5.3.18 Series\_Reason**

643 Comment related to a Series

644 Table 35 shows all attributes of Series\_Reason.

645 **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.

646

647 **4.5.3.19 Shared\_Domain**

648 The areas allowed to use the remedial action.

649 Table 36 shows all attributes of Shared\_Domain.

650 **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.

651

652 **4.5.3.20 TimeSeries**

653 A set of time-ordered Series.

654 Table 37 shows all attributes of TimeSeries.

655 **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.

Order	mult.	Attribute name / Attribute type	Description
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.

656

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

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

Order	mult.	Class name / Role	Description
5	[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..*]
6	[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..*]

659

#### 660 4.5.4 Datatypes

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

- 662 • Action\_Status compound
- 663 • ESMP\_DateTimeInterval compound
- 664 • AnalogType\_String datatype, codelist AnalogTypeList
- 665 • AreaID\_String datatype, codelist CodingSchemeTypeList
- 666 • BusinessKind\_String datatype, codelist BusinessTypeList
- 667 • CurveType\_String datatype, codelist CurveTypeList
- 668 • ESMP\_DateTime datatype
- 669 • ESMP\_Float datatype
- 670 • ESMPBoolean\_String datatype, codelist IndicatorTypeList
- 671 • ESMPVersion\_String datatype
- 672 • ID\_String datatype
- 673 • MarketRoleKind\_String datatype, codelist RoleTypeList
- 674 • MeasurementPointID\_String datatype, codelist CodingSchemeTypeList
- 675 • MeasurementUnitKind\_String datatype, codelist UnitOfMeasureTypeList
- 676 • MessageKind\_String datatype, codelist MessageTypeList
- 677 • PartyID\_String datatype, codelist CodingSchemeTypeList
- 678 • Position\_Integer datatype
- 679 • ProcessKind\_String datatype, codelist ProcessTypeList
- 680 • PsrType\_String datatype, codelist AssetTypeList
- 681 • ReasonCode\_String datatype, codelist ReasonCodeTypeList
- 682 • ReasonText\_String datatype
- 683 • ResourceID\_String datatype, codelist CodingSchemeTypeList
- 684 • Status\_String datatype, codelist StatusTypeList
- 685 • UnitSymbol datatype, codelist UnitSymbol
- 686 • YMDHM\_DateTime datatype

687

688

689 **4.6 CRAC schema definition**

690 This version of the CRAC Implementation Guide refers to the schemas as defined in version 2.2 of the  
691 CRAC XSD.