Date d'approbation : 06/07/2020

-

Date d'applicabilité :

Date de fin de validité :

-

NT	RD	CNER-DCCL-SYS	15	00254

Indice : 5

Rte Substation Protection Automation and Control Systems IEC 61850 Model

348 Pages 0 annexes

Documents annulés : NT-RD-CNER-DCCL-SYS-15-00254 ind4

Documents de référence : [Doc. de réf.]

Référence fonctionnelle : [Réf. fonctionnelle]

Résumé : This document describes the IEC 61850 based Modelling of the communication interface of Rte's Substation Protection Automation and Control Systems. Creative Commons BY licence is applicable for the terms and conditions for using this document.

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Rte Substation Protection Automation and Control Systems
IEC 61850 Model

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HISTORIQUE

Ind.	Date	Projet ou Pour approbation	Rédacteurs	Modifications
1	14/11/17	For approval	P. Lhuillier B. Ilas V. Leitloff	Comments after pre-distribution of version 0.4 taken into account
2	06/04/18	For approval	P. Lhuillier B. Ilas V. Leitloff	
3	02/05/19	For approval	V. Leitloff Y. Leloup G. Duverbecq	Translation in English. Cf Track of changes between version 2 and version 3
4	06/12/19	For approval	V. Leitloff Y. Leloup G. Duverbecq J.E. Lemaire F. Fousseret	Substitution of Static and Dynamic descriptions by import based on configuration tool. Cf. Track of changes between version 3 and version 4
5	03/07/20	For approval	V. Leitloff Y. Leloup G. Duverbecq J.E. Lemaire F. Fousseret	Cf. Track of changes between version 4 and version 5

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List of changes between versions of the document

Changes	LD concerned
Document creation	
Changes between Versions 1 and 2	
Replacement of GAPC by TVTR in order to use DO FuFail	LDPX
Replacement of LN PDSE by LN PTOC to model detection of High Impedance Faults (HIF) and associated settings.	LDDEF, LDPW
Review of all LN GAPC to comply with DO authorised by the standard in this LN.	All LD with a GAPC in version 1 of the document
Modification of LDATB with introduction of Rte-created LN LTED	LDATB, LDRS, LDCMDDJ, LDAMU
Conversion of LDMODEXP into LDTAAS. Transfer of modelling of operating sub-station/bay into the LDPO. (see §4.4.2, see §8.12)	LDMODEXP, LDTAAS, LDPO, LDGW
Modelling of the busbars differential protection function	LDPDB
Modelling of the Local SCADA and Station-to-remote-SCADA Gateway	LDPO, LDGW
Added specifications for controllable object	
Modelling of the interface and monitoring function related to ACN (Process interface cubicle implemented in the yard))	LDIFTACN, LDSUACN
Possibility to individually inhibit thresholds of the LDPSL function.	LDPSL
Creation of the Dynamic Line Rating related overload protection	LDPSL_DLR
Review and update of the modelling of TAC (tele-protection schema) and remote trip functions	LDTAC, LDTDEC
ADD: direct circuit-breaker tripping by the ASLD function (without using ADD function at bay level).	LDADD, LDASLD
Transducer: add measurement of currents and harmonics. Possibility of using the objects published by LDCAP as input for certain functions instead of the SVs. The following functions subscribe to the PhV and/or A published by LDCAP: LDPSL, LDPSL_DLR, LDADA, LDPW, LDPAP	LDCAP LDPSL, LDPSL_DLR, LDADA, LDPW, LDPAP
Review of LDs of the ARS group (autorecloser related functions). Addition of REBTAM feature (tri-phase liveline-livebus reclosure after unsuccessful single phase reclosure) to LDREC	LDRS, LDREC, LDRTS, LRSE, LDAMU
Creation of Aloc as DO published by RXMU from LDDIFFL	LDDIFFL
Creation of LD dedicated to IED monitoring	LDSUIED
LTRK instantiation for each LD for IED monitoring (§4.4.8.1)	n.a.

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Changes	LD concerned
Addition of the LD relative to disturbance recording	LDEPF, LDEPS
Addition of modelling of the Transfer function enabling coupler circuit breaker to substitute line feeder circuit breaker.	LDRTANSFERT_F LDRTANSFERT_C
Update of the LDAUXDEB (TEMPO2DELTAT) function	LDAUXDEB
Changes between Versions 2 and 3	
Addition of parameters to function LDs	All LD
The Appendices corresponding to Input / Output references have been deleted.	n.a.
Introduction of LDMODEXPS for the management of PACS operation modes for the substation and LDMODEXPF for level	Creation of LDMODEXPS, LDMODEXPF Suppression of LDTAAS
Implementation of function associated to offshore wind farms	LDITFOSS
Review of LDSUDJ. Separation part "BCU" and acquisition (new LDITFSUDJ)	LDITFSUDJ, LDSUDJ
Creation of overload management function on substation level	LDAGSA
Creation LD for grouping of signals	LDGRP
Creation of busbar monitoring function	LDMQUB
Snap Disconnector Coordination Function	LDASRB
Recloser initialisation function in case of trip transfer to busbar coupler (INITARS)	Included in LDTRANFERT_C
D-Type Substation Transformer Automaton function (ATD)	LDATD
Monitoring of communication channels and physical I/O added to LDSUIED	LDSUIED
Creation of LD for PACS Monitoring function	LDSUCCN
Substitution of SGCB by a setpoint for recloser functions for the indication of the reclosing mode (cf. also §11.8)	LDRS, LDREC, LDAMU, LDRTS
Creation of Rte specific LN for recloser parameters	CREC
Publication of DO indicating the possibility of a live-live or live-dead recloser operation	LDCMDDJ
Update of LDBALIS	LDBALIS
Creation of Rte specific LN describing physical I/O interfaces	LDPI, LDPO, LPAI, LPLD, LMBI, LMSI
Creation of Rte specific LN for settings	LSET
Renaming LDPDEF into LDPCDH	LDPCDH
Changes between Versions 3 and 4	
Additional feature of LDPO (parameters - automatic disconnection time)	LDPO

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Changes	LD concerned
Addition of automatic disconnection time in IED %onitoring function	LDSUIED
Merger of LDSxy and LDBALIS. LDBALISxy deleted.	LDSxy, LDBALISxy
Deletion of "_" from LD names	LDTRANFER_F, LDTRANSFERTC, LDPSL_DLR
Modification of LTED introducing the reference number of an electrical node. Publication by LDTM and LDPHAS	LTED, LDATB, LDTM, LDPHAS
Creation of LDTOPO (Topological Busbar Management Function	LDTOPO
LDCAP is divided into three functionally different Logical Devices: LDCAP (measurements for Control Center), LDMEAS (power quality and harmonic measurement), LDPHAS (phasor acquisition)	LDCAP, LDPHAS, LDMEAS
Since CmdBlk is not inherited by LLN0 (Tissue 0694), this DO is deleted from LDRSE/LLN0 and the blocking is taken into charge by a dedicated HMI function	LDRSE
Data class of RecCycMod in proprieatray LN CREC is changed to cdc ENC	LDRS, LDREC, LDRTS, LRSE, LDAMU
LTRK instantiated only once in LDSUIED (§4.4.8.1)	LDSUIED
Creation of LD representing the test system	LDTEST
Integration of teletrip confirmation feature (CLODe) in LDTDEC	LDTDEC
Recloser cycle time delay for Live Bus Dead Line mod and for Live Line Dead Bus mod added to LSET. This allow to delete RREC2 and RREC3 (simplification and clarification).	LDRTS
Filtered disconnector and circuit breaker positions are used for interlock logic	LDCMDJ LDCMDSxy
Cable shield overcurrent protection: replacement of PTOC by PIOC (no time delayed operation required).	LDPMC
Substitution of Static and Dynamic descriptions by output from Model Master file based on configuration tool.	all LD
Interface for Migration from legacy PACS to IEC 61850 based PACS	LDITFMIG
Model of signal "recloser operation unsuccessful", of command "forced CB closing"	LDCMDDJ
Model of time delay setting for "external cb operation failure"	LDCMDDJ, LDCMSSxy
Update of tap change command and.	LDARU
Addition of indication of change of tap position under way	LDCHPRTR
Transmission of indication of cb closing in case of trip transfer	LDTRANSFERTF LDTRANSFERTC

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Changes	LD concerned
Changes between Versions 4 and 5	
Addition of WeiMod parameter, addition extended zone, change of FCS signals for zone start.	LDPX
Simplifcation of LDSUTCT: only applicable for CVT on feeders. Busbar CVT will be covered by another LD.	LDSUTCT
Subsription to LDTM/UnnppTVTR.FuFail in order to process blown fuse in published as INVALID. Publication of ElNodRef subscribed from LDTOPO.	LDPHAS
GAPC0.Ind1 deleted. Equivalent information is given by RREC1.Beh CALH0 added to indicate the Blocking signal for live line / dead busbar cycles of other feeders (Veroulliage réenclencehement barre) instead of RREC.OpCls	LDREC
Addition of Rte specific setting SetPhsOrig, SetNb	LSET
Addition of Settings and review of settings	LDARU LDSONKLAX LDTGSEC LDTGINFRA LDMODEXPS LDLOCDEF LDDFIL
Subscription of LDTOPO/ElNodRef by LDPHAS and LDCMDDJ. Other DO subscription from LDTOPO also added to LDCMDDJ	LDCMDDJ LDTOPO
DO ClcIntvPer, ClcIntvTyp, ClcMod, ClcRfPer, ClcRfTyp moved from LLN0 to another LN of the LD (not longer available in LLN0 in ed 2)	LDPHAS LDCAP LDMEAS
Creation of a LD representing the exchange terminal of signals and orders between TSO and generators	LDITFGEN
Addition of outputs ISAF2 and ISAF3 to LDTGSEC to facilitate telealarm operation of the PACS. Addition of the possibility to activate / desactive action time timers (CALH2.Mod) and corresponding timer settings. Indication of active intervention timer by GAPC0.Ind2. Activation of intervention timer by GAPC0.Ind1 instead CALH2.GrAlm	LDTGSEC
Indication of active intervention timer by GAPC3.Ind4.	LDITFTG
Grouped acoustic alarms represented by LDGRP subscribed by LDSONKLAX and LDTGSEC. Addition of selective sound inhibition on bay or substation level.	LDTGSEC LDSONKLAX
Addition of a DO DORef in LTED to designate an instanciated LN.DO. Publication of this DO by LDATB and subscription by LDCMDDJ. One *LTED to be instanciated for each feeder to which the associated LDCMDDJ subscribes.	LTED LDATB LDCMDDJ
Addition of LPCP and LCCH to LDGW. Modification of use of the corresponding DO. This allows to be in line with IEC 61850-90-4.	LDGW

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Changes	LD concerned
Addition of signals sent to DSO in case of TSO in backup alarm mode, for DSO transformer faillures and for intrusion alarm from TSO to DSO. Modification of LN designation by use of bayname as prefix. Improvement of DO labels in the static description.	LDITFRPTRPD
Addition of link between LDTRANSFERTC and LDSUDJ in dynamic description	LDTRANSFERTC LDSUDJ
Rename DO in LMBI, LMSI, LPLD, LPDI, LDPO, LPAI	
Extension of LDSUIED for virtualised infrastructure and auxiliary supply and memory. Addition of LN LPCP	LDSUIED
Addition of a time delay setting for Switch On FaulT Logic in overcurrent protection (LSET0.DlTmms)	LDMAXIL
Additon of a time delay setting (FXOT0.OpDlTmms). Possibility to activate / desactivate by LLN0.Mod. Addition of DO "Op" in LN "PTRC".	LDCOMPADA
Addition of LSET0.OnOff to LDATB in order to indicate the interpretation of busbar sections coonected to DSO transformer during reclosing. Subscription of quality of phasors form LDPHAS (substituting the quality DA of SV streams).	LDATB
Addition of the possibility of a time limited recording of faults in case of manual activation or slowly evoloving signals. Addition of a LREC for triggering of recording without re-trigger condition for manual or automaton initiated recordings. Common DO and parameters for recording function shifted to LRDE3.	LDEPF
Grouping of PTOV21 and PTOV22 to new PTOV2. The different actions are determined by instanciation of signals by configuration. Addition of thresholds settings and a setting indicating which phase is to be used.	LDMAXUL
Removing of DO ClcSrc. Subscription to FuFail information from LDTM.	LDCAP LDMEAS LDPHAS
LN Rte "LPLD" is renamed "LPLE" because "LPLD" is used in IEC61850-90-4 for another use case. Renaming of DOs in LPLE. Instanciation of one single LPLE covering all LED. Instanciation of one single LTRK per IED (compliance to orientations indicated by TC57 WG10). Multiple instances of LPCP, representing each one physical port.	LDSUIED
General requirements for switching of SV or GOOSE streams	§4.4.16, LDSUIED
Addition of setting parameters of Line and Cable Differential protection. In this context, addition of NamAccRtg and PhyConnITF to LSET	LDDIFL LSET
LDTM/LTED is deleted. Addition of explication. Addition of multiple instances of XSWI representing maintenance current circuit short circuit switches.	LDTM
Possibility to activate / disactivate interlock (AIVO) function by adding CILO0.Mod	LDCMDDJ LDCMDSxy

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Changes	LD concerned
Redondant time settings removed from FXOT0 et FXUT0. These parameters are covered by LSET0.	LDAMU
Creation of GAPC0.Ind5 for interfacing the information "Local Mode set or staff present" CALH1.GrInd and CALH2.GrInd used both for acquisition and restitution of presence of staff information. Creation of CALH9 and CALH10 for acquisition of telecommunication equipement status. Addition of GAPC3.Ind3 to enable activation / desactivation of intervention time function. Delation of GAPC4.SPCSO* since the corresponding orders for substation lightning are implemented in LDTGINFRA.	LDITFTG
Use of Str for subscription of start of fault recording by LDEPF. To this end, Str is added in PTRC of all protection functions.	LDDIFL, LDPRS, LDMAXIL, LDPMC, LDPSLDLR, LDMAXITR, LDPDTR, LDPDSQTR, LDPSPTR, LDPDCLTR, LDPCHD, LDMAXUL, LDPDB, LDPW
Removal of unnecassary setting LSET0.StrVal1 representing the residual power threshold.	LDPCDH
Creation of LDBALIS for the interface of IED identification indicators for maintenance	LDBALIS
Update of inputs and outputs regarding bell and horn. Addition of pulsated outputs for TPG and bells. Deletion of redundant outputs (instanciated if necessary in interface LD)	LDSONKLAX
Addition of synchronisation information to published phasors. Addition of a private LN with DO representing this information based on synchronisation information of the SV stream (cf. §11.10). Deletion of Power information published by LDPHAS – covered by LDCAP.	LDPHAS LSYN
Definition of a functional variant of Line Differential Protection related to the transmission of individual phase currents or sum of phase currents	LDDIFL
Addition of Telecontrol signal names (FCS column of static description).	LDTAC, LDAGSA, LDCOMPADAxy, Protection LD
Addition of DO required for withdrawable circuit breaker	LDDJ LDITFSUDJ
The block order for other feeders if a life-line / live-busbar recloser cycle is launched (verrouillage renvoi bar) is moved to LDCMDDJ from LDRS and LDREC. This simplifies the publication and subscription of this signal	LDCMDDJ LDRS LDREC
Creation of multiple command LD (LDCMDMULT)	LDCMDMULT
Instanciation of grouped signls in LDGRP: one instanciation of one GAPC per grouped signal instead of several ind* within one GAPC	LDGRP
MMS Access from IHM or GW to reset or set Fault Arc counter is added	LDITFSGIS LDSUDJ

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Changes	LD concerned
MMS Access from IHM or GW to activate / deactivate heating and ventilation	LDITFACN
Use of Add Clause "Time-limit-over"	§4.4.8.2
Configuration for the duration of output contact for cb open/ close command moved to LSET.OpDlTmms*	LDDJ
Addition of Fault Detection Function for Underground Lines	LDDFU
Additon of ISAFx representing ventilation faillure in the room occupied by battery/rectifier	LDITFUA

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1. Introduction

This document specifies the modelling based on IEC 61850 applicable to functions implemented in IEDs and equipment of Rte's new R#SPACE PACS.

This document is structured as follows:

- chapters 1, 2 and 3 include this introduction, a table of acronyms used in this document and the documentary references,
- chapter 4 describes the methods and principles chosen by RTE and applied throughout this document,
- le chapter 5 covers the modelling of protection functions,
- chapter 6 covers the modelling of substation automation functions,
- chapter 7 covers the modelling of high-voltage equipment and their interfaces,
- chapter 8 deals with the modelling of functions related to substation and network operation,
- chapter 0 deals with the modelling of functions related to monitoring,
- chapter 10 describes the modelling of functions related to substation and infrastructure management,

Two appendixes are added:

- Appendix 1 (§11): LN pertaining to the Rte Namespace. This appendix covers LN and DO for functions or features which are not avialbale in the current version of IEC 61850.
- Appendix 2 (§12): The dynamic description of some functions cannot be reproduced on a A4 page. Those schemes have been grouped in Appendix 2. The size of some schemes has increased due to the export of some schemes since they are expeorted from the Model Master file based on configuration tool.

Modifications in the text between indice 4 and indice 5 are indicated by a lateral line. All modifications are reflected in the track log before this section.

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2. Acronyms

Remarks:

a) Acronyms from IEC standards are not included in the list below
b) Acronyms from the Rte specific configuration file (FCS) are not described. On the other hand, a comment is given indicating their meaning.

Acronym	Definition
IEC	International Electrotechnical Commission
AFFB	Absence fusion fusible barre [Absence of fuse faillure]
ATB	Aiguillage tension barre [busbar voltage indicator]
AUB	Absence tension barre [Dead bus indication]
AUL	Absence tension ligne [Dead line indication]
MQUI	Voltage or Current Circuit Anomaly
ARS	Automate de reprise de service [Recloser Function and Service Restoration]
LDADS	Automate déclenchement secours [backup trip automaton]
AIVO	Automate inter-verrouillage organe HT [inter-lock automaton]
ASLD	Automate secours local disjoncteur [Breaker Failure Topological Trip Management Automaton]
BIED	Breaker (or switch) IED
CCTP	Cahier des Clauses techniques Particulières [Technical Specifications]
CDE	Consignateur d'état [Event Recorder]
CBO	Contrôle Barre [busbar bay]
CRITENC	Critère d'enclenchement [Closing of breaker indication for Switch-On-Fault-Trip logic (SOFT)]
DF	Défaut [Faillure of a function or equipment]
DT	Déclenchement [Tripping]
DJ	Disjoncteur [Circuit-breaker]
FCS	Fichier Client Site [Rte specific configuration file]
I	Intensité [Current]
MQUB	Manque tension barres [Absence of voltage on busbars]
MES/MHS	Mise en service / Mise hors service [Activation / Deactivation]
PACS	Protection, Automation and Control System
PO	Poste opérateur [(local/station) HMI]
PSEM	Poste sous enveloppe métallique [Gas Insulated Substation - GIS]
PUB	Présence tension barre [Live Bus indication]
PUL	Présence tension ligne [Live Line indication]
P	Puissance active [Real power]
Q	Puissance active [Reactive power]

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Acronym	Definition
REB	Rebouclage barre [live line - live bus recloser condition]
RISA	Référentiel des informations de monitoring et actions. [Monitoring and Signal information Reference].
RVB	Renvoi barre [Live line - dead bus recloser condition]
RVB+L	Renvoi barre ou ligne [live line- dead bus or dead line - live bus recloser condition]
RVL	Renvoi barre [dead line - live bus recloser condition]
SCL	Substation Configuration Language
SCU	Switchgear Control Unit
TAC	Téléaction [Equipment for teleprotection scheme]
TCPL	Télé-coupleur [Synchrocheck recloser function]
TS	Télésignalisation [Signal]
U	Tension [Voltage]

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3. References

[1] IEC 61850-5, Communication networks and systems in substations – Part 5Ed2 : Communication requirements for functions and device models (disponible en anglais uniquement).

[2] IEC 61850-7-2, Communication networks and systems for power utility automation – Part 7-2Ed2 : Basic information and communication structure – Abstract communication service interface (ACSI) (disponible en anglais uniquement).

[3] IEC 61850-7-3, Réseaux et systèmes de communication pour l'automatisation des systèmes électriques – Partie 7-3Ed2 : Structure de communication de base – Classes de données communes.

[4] IEC 61850-7-4, Communication networks and systems for power utility automation – Part 7-4Ed2 : Basic communication structure – Compatible logical node classes and data object classes (disponible en anglais uniquement).

[5] IEC 61850-8-1, Communication networks and systems for power utility automation – Part 8-1Ed2 : Specific Communication Service Mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3 (disponible en anglais uniquement).

[6] IEC 61850-9-2, Communication networks and systems in substations – Part 9-2 : Specific Communication Service Mapping (SCSM) – Sampled values over ISO/IEC 8802-3 (disponible en anglais uniquement).

[7] IEC 61850-90-2, Communication networks and systems for power utility automation – Part 90-2: Using IEC 61850 for communication between substations and control.

[8] ELECTRE UNIFIE - T3 - SPECIFICATIONS FONCTIONNELLES D'EXPLOITATION ET INGENIERIE. NA-ING-CNER-DCCL-SYS-12-00089 ind3.

[9] IEC 61850-6 Ed.2: Communication networks and systems for power utility automation – Parft 6: Configuration description language for communication in electrical substations related to IEDs.

[10] IEC 61869-9, Instrument transformers - Part 9 : Digital interface for instrument transformers.

[11] CIGRE TB 760 - WG B5.53 : Test Strategy for Protection, Automation and Control (PAC) functions in a full digital substation based on IEC 61850 applications, March 2019.

[12] D/R/CIT/CNER/01-P6-074 Indice 2) – Pièce n°4 Spécification fonctionnelle de l'option PAP-ligne des protections de distance.

[13] ELECTRE UNIFIE - T4 - SPECIFICATIONS DE PROTECTIONS ET AUTOMATISMES - 1ERE PARTIE NA-ING-CNER-DCCL-SYS-12-00090 ind3.

[14] NT-CC-CNER-SETP-PAE-07-00093 Ind 4 - Spécifications fonctionnelles des protections de distance numériques et fonctions associées.

[15] NT-MAINCC-CNER-DCCL-PPC-11-00152 Spécification fonctionnelle et de fourniture des protections différentielles de liaisons numériques.

[16] ELECTRE UNIFIE - T5 - SPECIFICATIONS DE PROTECTIONS ET AUTOMATISMES - 2IEME PARTIE NA-ING-CNER-DCCL-SYS-12-00091 ind3.

[17] R-CC-CNER-SETP-PAE-06-00091, Spécification fonctionnelle de la protection de la tranche primaire des transformateurs.

[18] D652/84-99 Spécification de fourniture de protection différentielle de courant pour liaison courte.

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[19] NT-DI-CNER-DCCL-PPC-15-00105 Ind 2 - Spécifications des protections différentielles de barres numériques de type "centralisée".

[20] NT-DI-CNER-DCCL-PPC-15-00174 Ind 1 - Spécifications des protections différentielles de barres numériques de type "décentralisée".

[21] IEC 61850-90-3, Communication networks and systems for power utility automation –Part 10-3 : Using IEC 61850 for Condition Monitoring Diagnosis and Analysis.

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4. Principles and general comments

The functions modelled in this document are based on the functions specified for and implemented in IEDs and equipment of Rte's new R#SPACE and on the functional specifications of protection functions (Cf. § 3).

4.1 Modelling method

The principles applied in the modelling method are:

- Do not consider implementation constraints. This means to define the model of the functions without taking into account whether they are implemented in a standalone IED integrated with other function in a multifunctional IED or equipment. Functions are in general not distributed over several IEDs.
- Each function modelled is associated to a LD (Logical Device) (consequence of principle 1)
- The choice of associating the concept of a Logical Device to that of a Function must be adapted to avoid subsequently producing an SCL file, non-compliant with the model of the standard (IEC 61850-6). Indeed, the standard and in particular the SCL, separates the bay part from the IED part. Rte's choice implies describing each LD [function] in each bay concerned. However, the LD is part of an IED and must be described in the appropriate part.
- Strictly follow IEC 61850 edition 2 standards (cf. [1], [2], [3], [4], [5], [6]) and their published amendments (edition 2.1).
- This documents is mainly limited to the Functional Constraints ST of the Data Objects and punctually refers to MX and SP. All other Functional Constraints are out of scope of this document.

The following chapters are associated with each function:

1. **Description of the function** - description in the function in the PACS specifications
2. **LN used** - gives a list of the Logical Nodes used for modelling the function as well as the extract from the standard (cf. [1]) which describes this LN. If no appropriate LN exists in the standard, LN and DO can be created following the prescriptions of the standard (cf. § 4.4.12).
3. **Specificities** – gives indications on the chosen principles whether in regard to the standard, operational particularities, electrical characteristics, processing, etc.
4. **Static description** - lists all the LNs, DOs and possibly the DAs used in a table. If applicable, each DO is mapped with the corresponding entry in the Rte specific configuration file (FCS).
5. **Dynamic description** - associates all LNs needed to model the function in a diagram, and shows their interaction with other functions.

It should be noted that LD internal exchanges are given as an indication.

4.2 Comments and general remarks

- Certain functions, associated in the PACS specification to a specific function, have been transferred to other LDs in order to achieve more consistent IEC 61850 modelling. This is the case for the verification of presence of line or busbar voltage for the recloser functions (function ARS-CT), which is better integrated into LDCMDDJ.

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- The current Rte configuration reference (RISA) associates an alarm (audible or other) with certain signals and independently, a level of emergency. This information comes from the configuration and is not covered by the present modelling.
- Communication to higher levels of supervision (power system control or maintenance), for the operation of the electrical grid or for its Maintenance, is not treated in depth in the present modelling.
  This communication covers remote power system control and monitoring data (disturbance recording, equipment monitoring, etc.) or legacy data (serial no., etc.).
  These aspects are dealt with in an IEC document [7].

4.3 Comments and remarks for modelling aspects concerning the substation level

4.3.1 Referencing of high voltage elements

Certain functions at the substation level provide information intended for different control systems of the substation. This is the case, for example, for the VT to be used as busbar voltage reference for recloser functions. The simplest way to designate a VT would be to give a number to each topological element. The disadvantage of this approach is that it does not allow to have a generic definition and must be reiterated for each substation. Using a generic means of identification of substation elements is a more effective and general approach. This identification must include:

- The voltage level. Several voltage levels are likely to exist in a substation and can be necessary for certain functions. E.g. Local State Estimator or verification of the consistency of analogue measurements can require elements to be identified at several voltage levels. Some electrical grid operators assign a figure to each voltage level. E.g. in the case of Rte "7" for "400kV", "6" for 225kV, etc…
- The topological element concerned (busbar, feeder, etc...)
- A unique number identifies the topological element. A numbering system can be different for each type of topological element
- A unique reference (if applicable) for identifying the sub-assembly of the topological element (e.g. busbar section number)

This approach can also be used for identifying instrument transformers which involves adding the following information:

- The reference of the phase which is traditionally given by multiples of 30°. For a given voltage level, these references can be associated with phases a, b, c of the standard IEC 61850. Several applications requiring knowing exactly which phase is the reference (cf. §4.3.2).
- The type of instrument transformer (current or voltage);
- The accuracy class of the winding of a current transformer;
- The reference of the real system when there is a redundant acquisition chain.

This information is compiled in a new LD called LTED with: "L" because this new LN is part of a system group like LLN0; "TED" for "Topological Element Designation" (cf. §11.1).

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4.3.2 Associations of primary HV phases

The following associations are defined between the phases in the IEC 61850 model and the primary HV phases of the substation:

Poles/Phases of HV equipment	Referencing in the specifications including information per phase	Instance number of functions modelled with an LN per phase	Instance prefix of functions modelled with an LN per phase as per the standard 61869-9
0, 11	phsA	1	I *nn p* TCTR *n* or U *nn p* TVTR *n*
4, 3	phsB	2	
8, 7	phsC	3	
/	neutral or cable shield-to-ground	4 (MU / SAMU only)	

4.3.3 Communication with the power system control

Power system control
Exchanges between the LDPO and the other LDs

In the modelling, the information published by the LDs representing the functions and intended for the telecontrol (LDGW) and substation level HMI (LDPO), is identified by a little circle next to the link which represents the transmission (cf. Figure 1).

All messages intended for the LDPO are of the **report** type (cf. [5]), independently of the type of exchange indicated in the dynamic modelling of functions.

Local HMI / SCADA application

Local SCADA / HMI uses services (ACSI) to command certain DOs of the target LNs. These commands are according to the mechanisms specified by the "CONTROL class" (cf. [2] § 20). In the dynamic representation, these commands are represented by green arrows carrying the name of the target [DO] of the LN.

Local HMI

In this document, the HMI is considered as an IEC 61850 client.

It includes the supervision function to highlight a change of a position of a disconnector or circuit breaker without previous command from the operator (CHANGETAT function).

4.3.4 Grouping of signals

Several signals have to be grouped into a general signal for the HMI and/or the telecontrol gateway. This grouping is performed by substation level automatons using specific grouping LD (LDGRP, cf. §8.22). These groupings include:

- The signalling of recloser configuration failure ARS.DEFAUT.CONFIG (ANO.CONS), elaborated from the functions RS, AMU and RTS,
- The signalling of recloser function failure DEFAUT.ARS (DEF.ARS), elaborated from the ARS group.

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4.3.5 Substation level functions

Monitoring of functions and equipment related to a functional bay is processed at the substation level based on equipment specific LD (e.g. LDSUIED) and LD specific health indications. This includes:

- Power supply
- IED fault
- Communication fault
- Stand-alone power supply monitoring of remote equipment
- Monitoring of the current/voltage circuits (cf. MQUI grouping of the PACS specification). With regard to the MQUI grouping:

Failures of SAMU or MU acquiring currents for protection functions (J, H and G circuit) or voltages for protection functions (V, W voltage circuits), contribute to the elaboration of the MQUI signal.

A SAMU/MU operational fault is a failure of the acquisition circuit for the electrical quantities used by the protection systems. Consequently, the DO health of the LLN0 of the LDTMs participates in the elaboration of MQUI signalling.

The MQUI grouping can receive information from several LDPXs of its bay and in case of the differential protection of the cable, from the remote SAMU/MU. These multiple entries are represented by * in the dynamic description.

4.3.6 IED supervision

In the Rte signal reference list (RISA), the failure of a function is often associated with an IED failure or the loss of its power supply. In an IEC 61850 system, IED failures are detected by LDSUIED (IED self-test) or by the communication failure (e.g. absence of published GOOSE).

Since the modelling is independent of the PACS architecture, an IED failure cannot be associated to a function in a generic way. For this reason, the decision was taken not to link signals associated with IED failures (DO LDSUIED/LPHD.Health) to functions failures in the modelling. Signals indicating the failure of a function are generated at the substation level or at the bay level.

The following proprietary IED, based on IEC 61850-7-5 draft document and IEC 61850-80-5 draft document, have been added in order to represent the monitoring of IED inputs and outputs:

- LPDI System Physical Digital Input (§11.2)
- LPDO System Physical Digital Output (§11.3)
- LPAI System Physical Analog Output (§11.4)
- LPLE System Physical LED representation (§11.5)
- LMBI System Physical Modbus Interface (§11.6)
- LMSI System Physical Modbus Slave Interface (§11.7)

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4.3.7 Parameters and adjustments

The DOs associated with a parameter or a setting, can be indicated in certain static models, depending on the representation describing publishing conventions (cf. 4.4.1). This is especially the case for settings using the SGCB mechanism. When possible, the DOs of IEC 61850 are to be used for configuration and setting of functions.

Settings and parameters have been added to the static models, but it should be noted that the present modelling does not completely cover all DOs concerned by settings.

A Rte specific LN for parameters not included in the LN defined in the standard has been created (cf. §11.9).

The setting DO identified in this document are variables which may be changed by the operator or the configuration process. This characteristic is not defined in this document.

4.3.8 Other comments

- The indicator for absence of busbar voltage for recloser uses the signalling of "Absence of fuse failure" for the VT representing the busbar voltage (AFFB). The DO TVTR.FuFail of each voltage transformer must be taken into account depending on the topology of the substation (double busbar, coupling, section).
- It has to be verified whether if it is necessary to topologically manage life line - dead busbar recloser (RVB) locking signals (for substations with several sections). This option is not implemented in the current PACS specifications.

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4.4 Principles

4.4.1 Publishing conventions

General

Any Object created by Rte, not defined in the IEC 61850 standard, is indicated in **green.** Objects defined in IEC 61850 drafts, but not yet standardised, are indicated in **violet.** They are described in §11.

This concerns:

- LN
- DO

Static representation

- A blue background corresponds to static setting or parameter of a function (e.g. type *G data object)
- A salmon coloured background corresponds to the SGCB service

Dynamic representation

A dynamic representation is associated with each LD. It shows

- the links between the function represented by the LD described in the chapter and other LDs,
- links between LNs forming part of the described function.

It should be noted that:

1. The type of link (GOOSE, Report, etc.) is given as an indication. One or several links can be created for each published DO at the instantiation of the LD.
2. If not indicated otherwise, the source and target functions are LDs of the same functional bay. The dynamic description mentions explicitely if DO's are published for or subscribed from LD associated to another functional bay.
3. An arrow terminating at the envelope of an LD signifies that this subscribed DO is needed for the function but cannot be linked directly to a particular LN in a meaningful way.
4. Potentially, all informations can be subscribed by the HMI, the gateway (GTW) or fault recorder (LDEPF). The information subscribed in an instantiated configuration is determined by the SCD. They are not systematically shown or indicated in the dynamic representation.

The different means of transmission of information whether by wire or by message are graphically shown in different forms (cf. Figure 1), listing the meaning associated with each type of link. This applies to all dynamic schmes given below.

The HMI and GTW subscribe to virtually all information. This link is thus indicated in the diagrams in order to keep them readable.

The distinction between GOOSE and Report indicates the preferred mode of transmission, taking also into account identified constraints for establishing client/server links. It may be implemented differently in order to take into account other constraints.

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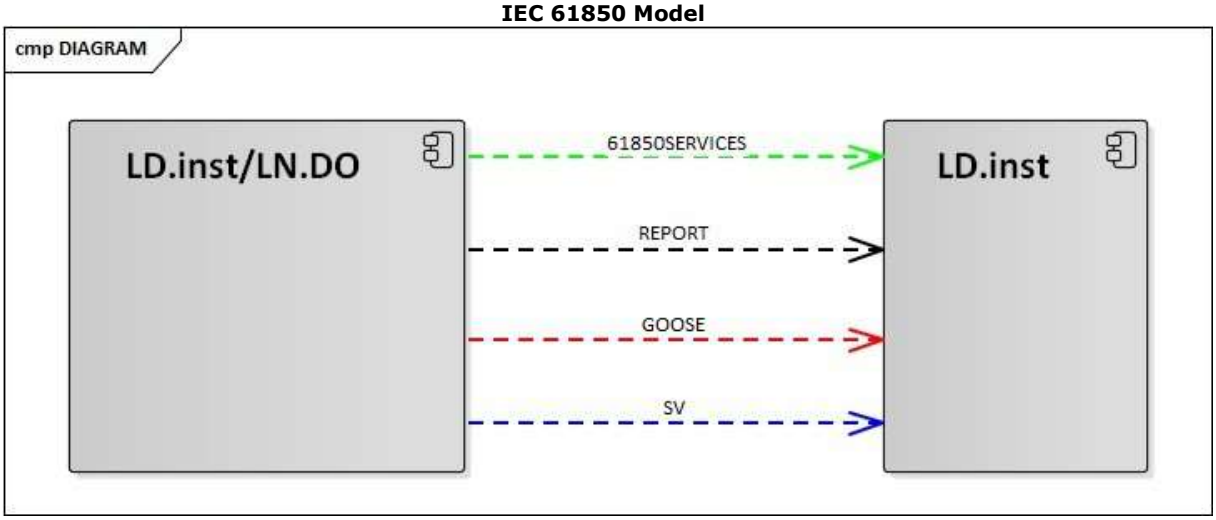

Figure 1: Dynamic description legend

4.4.2 Operating mode

The operation of a substation at Rte is defined according to **four distinct modes** which can be activated independently via the HMI (overall bay view or site view). These different modes are:

- **Remote Control Mode (TCD)** (the PACS control is provided by the Network Control Center)
- **Local Mode** (the PACS control is executed from the local HMI by an operator in the substation)
- **Remote Alarm Mode (TA)** (following the failure of the main transmission channel, , temporary basic monitoring of the substation installations is provided by another transmission channel)
- **Backup Alarm Mode (AS)** (similar to "Remote Alarm Mode" but for which the information is sent to another operator (normally DSO) with which the operation of certain structures of the site in question is shared)

TCD and local substation/bay modes are managed from LDMOEXPS, which also covers AS and TA modes (§8.14) and LDMODEXPF (cf. §8.15).

Site and/or bay operating modes determine what information must be transmitted

- In the case of remote signalling and remote measuring (TS,TM) to Network Control Center and/or to local equipment
- In the case of remote control and remote setpoint value setting (TV, TVC) to automatons or the process interface

4.4.3 Multifunction IEDs

In order to maintain freedom of action for the management of the operation and use of the different functions (protection, automatic control, etc.), one LD for each function is created. Consequently, an IED can cover several LDs, i.e. several LLN0s and therefore requires the distinct management of the associated control blocks (GOOSE, Log, SGCB, etc.).

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4.4.4 Monitoring of subscriptions to GOOSE and SV messages

The LDSUIED monitors the proper reception of GOOSE and SV messages. It contains LN LGOSs and LSVSs and is implemented in each IED (cf. §9.8).

4.4.5 Tripping order of protection functions

Choice of modelling of tripping orders

The question arises when it is necessary to have a single PTRC for sending the tripping order to the XCBR or if several PTRC can send this order to a single XCBR. The signalling of starting or tripping of protection functions must be relayed to the SCADA. To do this, Rte has decided to use an LN PTRC per protection function (i.e. one per LDP*) which regroups the DO Op of all concerned LNs (Pxxx).

As a consequence, in this modelling, LN PTRC is not associated to the LD representing the circuit breaker interface (LDDJ instantiated in SCU / BIED).

The tripping order of a circuit-breaker by a protection function is published using the DO PTRC.Tr to the subscribing LN LDDJ/XCBR.

As shown in Figure 2 below, there is no PTRC in the LDDJ, i.e. no unique PTRC associated with an LN XCBR in the circuit-breaker LD.

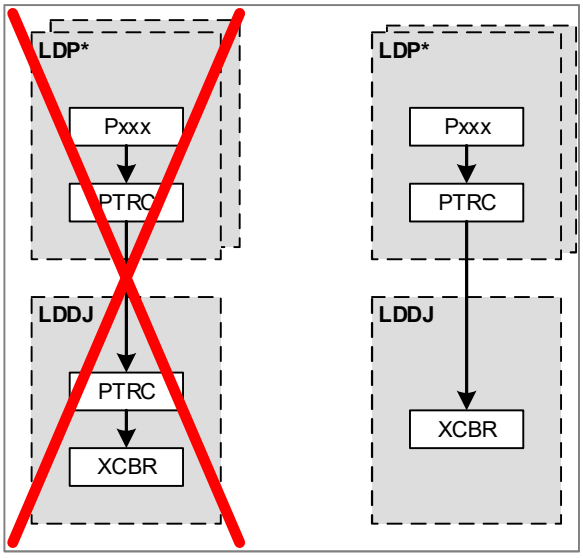

Figure 2: SCU (LDDJ) and PTRC

Downstream / Upstream fault direction indications to the SCADA are published by the PTRC depending on received DO Str of class ACD (DA dirGeneral) from protection oriented LN inside the LD.

Definitions of DOs published by the LNs. The following are distinguished:

- The detection of a fault characterised by the starting of the protection system (start = Str)
- The trip decision (operate = Op)
- The trip order (trip = Tr)

Normal and backup trip channel

The notion of sending trip orders via the normal or backup channel makes no sense in the context of IEC 61850 (process bus). Consequently, it has been decided not to take this into account in the

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modelling. On the other hand, the LDADD (CB Failure Protection) models the publication of a backup trip order.

4.4.6 Protection scheme signal transmission

Permissive and Blocking Schemes

Figure 3 gives the principles for the transmission of tele-protection scheme signals between two substations.

1st case: use of a dedicated tele-protection IED per transmission channel - the signals are published by the PSCH.Tx* of the LDP* of the issuing substation and transmitted to LDTAC. The local dedicated tele-protection IED transmits the order to the dedicated tele-protection IED of the remote substation which publishes it via its DO PSCH.Tx*. The LDP* of the remote substation, subscribed to this DO, uses it in the framework of the protection logic.

2nd case: direct communication link - the orders are published by the PSCH.Tx* of the LDP* of the issuing substation and transmitted via a direct IEC 61850 transmission link to the remote substation. The LDP* of the remote substation, subscribed to this DO, uses it in the framework of the protection logic.

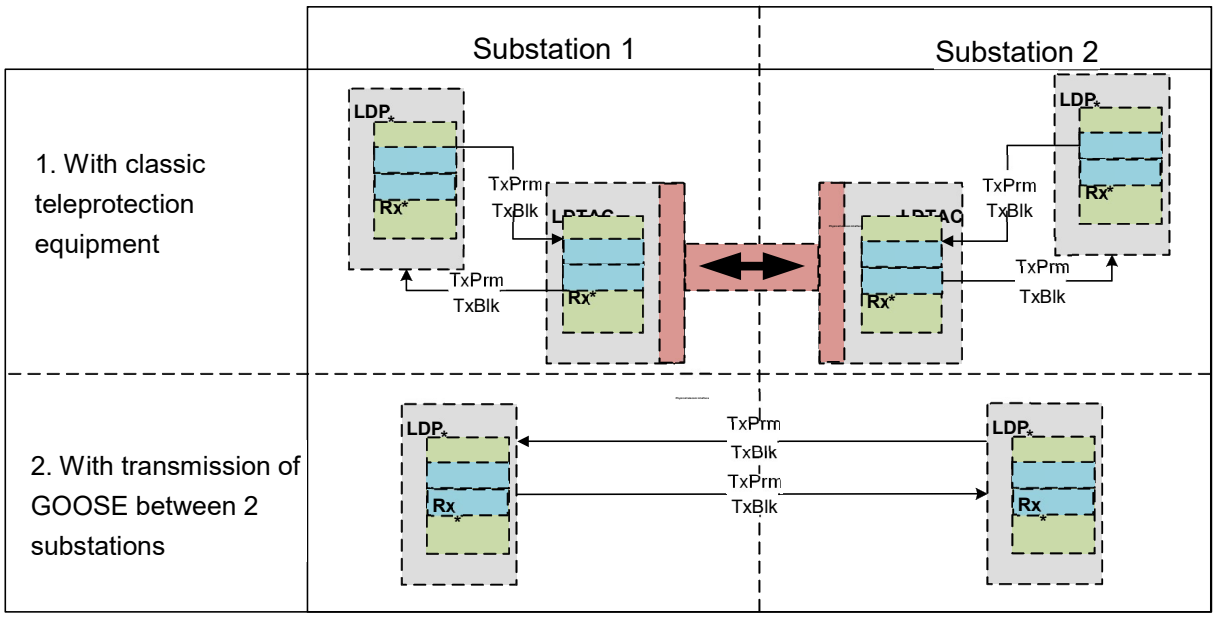

Figure 3: Tele-protection scheme signals modelling diagrams

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Remote tripping

Figure 4 shows the transmission of the tele-trip order between two substations.

1st case: Use of a dedicated tele-protection IED: - After receipt of a Remote Trip order issued by appropriate local function (Protection, Breaker failure, etc.), the signals are published by the PSCH.Tx* of the LDTDEC of the local bay. Once it is received by the local LDTAC, the trip signal is sent to the remote substation. The LDTAC of the remote substation then publishes PSCH.TxTr subscribed by a LDTDEC of a bay of the remote substation. It is the latter which sends the trip order to the circuit-breaker via the PTRC.Tr

2nd case: Direct communication link - Tele-trip signals are published by the PSCH.Tx* of the LDTDEC of the local substation, after reception of a trip order issued by appropriate functions (e.g. Protection, breaker failure, etc.) addressed to the remote LDTDEC. Once it is received by the LDTDEC of the issuing substation, the trip order for the circuit-breaker is transmitted via the PTRC.Tr

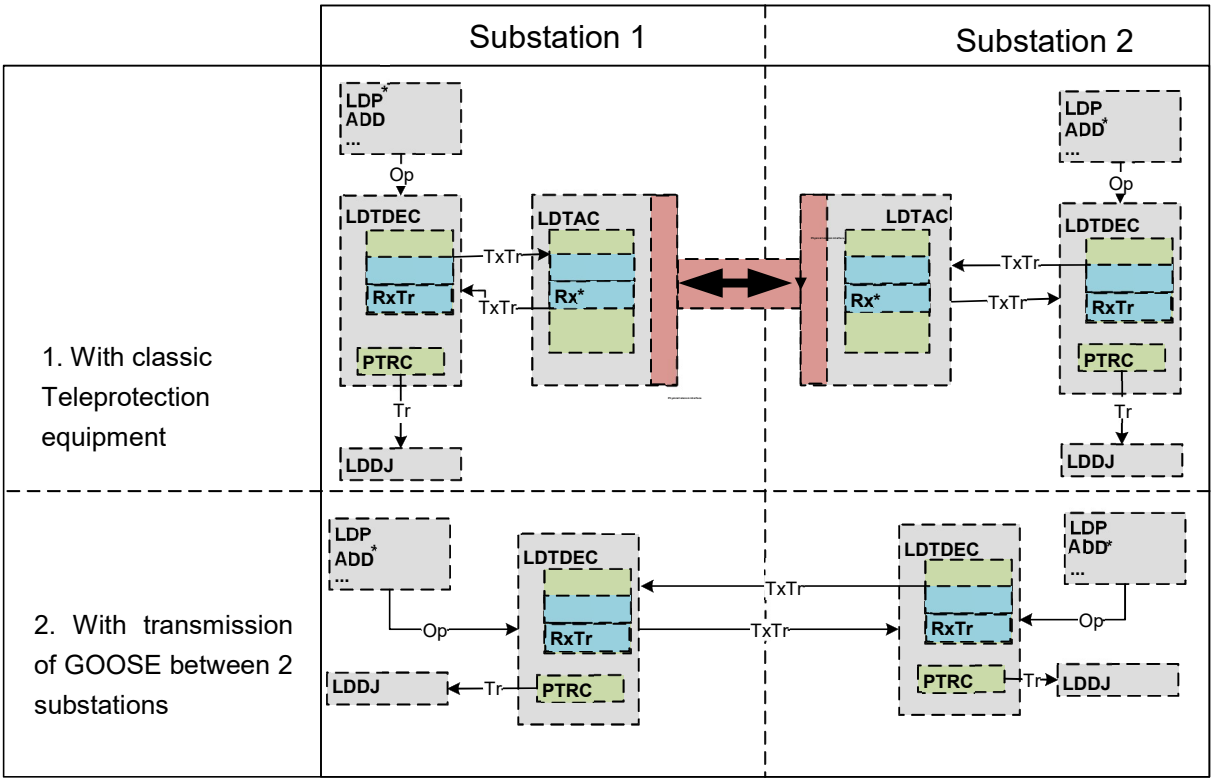

Figure 4: Tele-trip signals modelling diagrams

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4.4.7 Use of LPHD and LLN0

The activation / deactivation of functions, from the local SCADA or by remote control, is done by the command of DO Mod of LLN0 of each LD.

DO Mod and Beh are used in all the LDs for the testing. They are used to position or indicate the operational status of the LD.

The LN LPHD represents a physical equipment item (IED) while LLN0 represents an LD (cf. IEC 61850-7-4Ed2 § 5.3). Thus, for each function, an LLN0 and not the LPHD is used to publish information about its operational state.

Independent of the functions, the use of a watchdog to signal a failure of physical equipment is not modelled. If needed, the failure of an IED is indicated by the station supervision function (signal DF.CCN.x) (cf. §4.3.4, cf. LDSUCCN §9.9).

4.4.8 Processing of commands

4.4.8.1 Use of Service tracking

Client services to an MMS server need to be monitored, in particular:

- The services associated to the HV apparatus controls and automaton controls
- The services associated to SGCB
- The services associated to a set point
- The services associated to the communication Control Block

One LN LTRK is instantiated in the LDSUIED to allow the execution of these services to be monitored.

4.4.8.2 Treatment of controls for HV equipment

Any opening or closing command is managed with MMS at LDCMDDJ and LDCMDSxy level, and supervised by the CTS service (cf. [2] – Control service tracking). The following table indicates all command failure handled by RTE and their associations between the IEC 61850 standard and the R#SPACE PACS specification.

PACS specification (see [8]**) Reason for the refusal**	**Correspondence IEC 61850 (cf.** [2] **- § 20.5.2.9)**	
	Value (Add Cause)	**Explanation**
Commande interdite par le mode d'exploitation [Command forbidden by the operating mode]	Blocked-by-switching-hierarchy	Not successful since one of the downstream **Loc** switches like in **CSWI** has the value TRUE
Non-utilisé [Not used]	Select-failed	Cancelled due to an unsuccessful selection (**select service**)
Non-utilisé [Not used]	Invalid-position	Control action is aborted due to invalid switch position (**Pos** in **XCBR** or XSWI)
Objet en concordance [Object in target position]	Position-reached	Switch is already in the intended position (**Pos** in **XCBR** or **XSWI**)

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PACS specification (see [8]) Reason for the refusal	Correspondence IEC 61850 (cf. [2] - § 20.5.2.9)	
	Value (Add Cause)	**Explanation**
Non-utilisé [Not used]	Parameter-change-in-execution	Control action is blocked due to running **parameter change**.
Non-utilisé [Not used]	Step-limit	Control action is blocked, because tap changer has reached the limit (EndPosR or EndPosL in YLTC).
Non-utilisé [Not used]	Blocked-by-Mode	Control action is blocked, because the LN (**CSWI** or **XCBR**/**XSWI**) is in a mode (**Mod**) which doesn't allow any switching.
Défaut extérieur [External fault]	Blocked-by-process	Control action is blocked due to some external event at process level that prevents a successful operation, for example blocking indication (**EEHealth** in XCBR or XSWI).
Refus AIVO [Refused by interlock control automaton]*	Blocked-by-interlocking	Control action is blocked due to interlocking of switching devices (in **CILO** attribute EnaOpn.stVal="FALSE" or EnaCls.stVal="FALSE").
• Refus ARS Contrôle Tension [Refused by recloser voltage check] • Manœuvre refusée par TCPL. [Recloser cycle unsuccessfu]	Blocked-by-synchrocheck	Control action with synchrocheck is aborted due to exceed of **time limit** and missing synchronism condition.
Commande en cours [Command in progress]	Command-already-in-execution	Control, select or cancel service is rejected, because **control action** is already running.
Système en mode non nominal [System in non-nominal mode]	Blocked-by-health	Control action is blocked due to some internal event that prevents a successful operation (**Health**).
Commande en cours [Other manoeuver in progress]	1-of-n-control	Control action is blocked, because another **control action** in a domain (for example substation) is already **running** (in any **XCBR** or **XSWI** of that domain, the **DPC.stSeld**="**TRUE**").
Non-utilisé [Not used]	Abortion-by-cancel	Control action is aborted due to **cancel service**.
Commande terminée sur absence de retour de position dans le temps imparti (operTimeout) [Command terminated without expected position feeback within operTimeout]	Time-limit-over	Control action is terminated due to exceed of some **time limit**.
Non-utilisé [Not used]	Abortion-by-trip	Control action is aborted due to a trip (**PTRC** with **ACT.general="TRUE**").
Non-utilisé [Not used]	Object-not-selected	Control action is rejected, because control object was not selected
Non-utilisé [Not used]	Object-already-selected	Select action is not executed, because the addressed object is already selected.

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PACS specification (see [8]) Reason for the refusal	**Correspondence IEC 61850 (cf. [2] - § 20.5.2.9)**	
	Value (Add Cause)	**Explanation**
Utilisateur non habilité [User not certified]	No-access-authority	Control action is blocked due to lack of access authority
Non-utilisé [Not used]	Ended-with-overshoot	Control action executed but the end position has overshoot
Non-utilisé [Not used]	Abortion-due-to-deviation	Control action is aborted due to deviation between the command value and the measured value.
Non-utilisé [Not used]	Abortion-by-communication-loss	Control action is aborted due to the loss of connection with the client that issued the control.
Non-utilisé [Not used]	Unknown	Command not successful due to Unknown causes
Objet aliéné [Object blocked by operator]	Blocked-by-command	Control action is blocked due to the data attribute CmdBlk.stVal is TRUE.
Pas de motif de refus à remonter [No reason indicated for the refusal]	None	Control action successfully executed
Commande incohérente [command not consistent]	Inconsistent-parameters	The parameters between successive control services are not consistent, for example the ctlNum of Select and Operate service are different.
Commande interdite par le mode d'exploitation [Command forbidden by the operating mode]	Locked-by-other-client	Another client has already reserved the object.

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4.4.9 Specifications for the controllable DOs

Any unlisted attribute is acceptable as it can be handeled by the configuration tool.

Minimal classification of the DPC specification (cf. [3])

cdcId = DPC, UML class name = DPC			
Attribute name	**Attribute type**	**(Value/Value range) Description**	**Comments**
DataAttribute for status			
origin	Originator	See 'SPC.origin'.	Uses to monitor the origin of commands, notably if they come from a PLC.
stVal	CODED ENUM (DpStatusKind)	Status value of the controllable data object.	
q	Quality	Quality of the value in 'stVal'.	
t	Timestamp	Timestamp of the last event of 'stVal' or the last change of value in 'q'.	
stSeld	BOOLEAN	See 'SPC.stSeld'.	Use for SBO type commands.
DataAttribute for control mirror			
opRcvd	BOOLEAN	inherited from: ControlTestingCDC	
opOk	BOOLEAN	inherited from: ControlTestingCDC	
tOpOk	Timestamp	inherited from: ControlTestingCDC	
DataAttribute for substitution and blocked			
subEna	BOOLEAN	inherited from: SubstitutionCDC	The substitution serves in particular to re-establish the consistency between the reality in the field and the information transmitted. It can also serve for the purposes of maintenance.
subVal	CODED ENUM (DpStatusKind)	Value used to substitute 'stVal'.	
subQ	Quality	inherited from: SubstitutionCDC	
subID	VisString64	inherited from: SubstitutionCDC	
blkEna	BOOLEAN	inherited from: SubstitutionCDC	Used for managing certain DO Mod quantities.
DataAttribute for configuration, description and extension			
pulseConfig	PulseConfig	See 'SPC.pulseConfig'. The value 'persistent' for 'pulseConfig.cmdQual' is not allowed.	Used for configuration of the SCUs.
ctlModel	ENUMERATED (CtlModelKind)	See 'SPC.ctlModel'.	
sboTimeout	INT32U	See 'SPC.sboTimeout'.	Used for the waiting of the operator's order after selection.
operTimeout	INT32U	See 'SPC.operTimeout'.	Used for the waiting for the maneouvring of the primary equipment.
d	VisString255	inherited from: BasePrimitiveCDC	Used for the description of the instanciated object.

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Minimal classification of the SPC specification (cf. [3])

It is considered that the SBO control mode is not relevant for this type of specification.

cdcId = SPC, UML class name = SPC			
Attribute name	**Attribute type**	**(Value/Value range) Description**	**Comments**
DataAttribute for status			
origin	Originator	Information related to the originator of the last accepted operation on the controllable data object. It mirrors the appropriate contents of the control service. Substitution will not affect the value of 'origin'.	Uses to monitor the origin of commands, notably if they come from a PLC.
stVal	BOOLEAN	Status value of the controllable data object.	
q	Quality	Quality of the value in 'stVal'.	
t	Timestamp	Timestamp of the last event of 'stVal' or the last change of value in 'q'.	
DataAttribute for control mirror			
opRcvd	BOOLEAN	inherited from: ControlTestingCDC	
opOk	BOOLEAN	inherited from: ControlTestingCDC	
tOpOk	Timestamp	inherited from: ControlTestingCDC	
DataAttribute for substitution and blocked			
subEna	BOOLEAN	inherited from: SubstitutionCDC	The substitution serves in particular to re-establish the consistency between the reality in the field and the information transmitted. It can also serve for the purposes of maintenance.
subVal	BOOLEAN	Value used to substitute 'stVal'.	
subQ	Quality	inherited from: SubstitutionCDC	
subID	VisString64	inherited from: SubstitutionCDC	
blkEna	BOOLEAN	inherited from: SubstitutionCDC	
DataAttribute for configuration, description and extension			
pulseConfig	PulseConfig	Used to configure the output pulse generated with the command, if applicable.	Used for configuration of the SCUs.
ctlModel	ENUMERATED (CtlModelKind)	Control model of IEC 61850-7-2 that reflects the behaviour of the data. NOTE If the controllable equipment has no status information associated (or if that information is not required), then 'stVal' of the controllable data object does not exist. In that case, the value range for this attribute is restricted to 'direct-with-normal-security' and 'sbo-with-normal-security'.	
d	VisString255	inherited from: BasePrimitiveCDC	Used for the description of the instanciated object.

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Minimal classification of the ENC specification (cf. [3])

In this modelling, the DO Mod is the only one to be of this type. It is considered that the DO can neither be substituted nor blocked.

cdcId = ENC, UML class name = ENC			
Attribute name	**Attribute type**	**(Value/Value range) Description**	**Comments**
DataAttribute for status			
origin	Originator	See 'SPC.origin'.	Uses to monitor the origin of commands, notably if they come from a PLC.
stVal	ENUMERATED (EnumDA)	Status value of the controllable data object.	
q	Quality	Quality of the value in 'stVal'.	
t	Timestamp	Timestamp of the last event of 'stVal' or the last change of value in 'q'.	
DataAttribute for control mirror			
opRcvd	BOOLEAN	inherited from: ControlTestingCDC	
opOk	BOOLEAN	inherited from: ControlTestingCDC	
tOpOk	Timestamp	inherited from: ControlTestingCDC	
DataAttribute for substitution and blocked			
DataAttribute for configuration, description and extension			
ctlModel	ENUMERATED (CtlModelKind)	See 'SPC.ctlModel'.	
d	VisString255	inherited from: BasePrimitiveCDC	Used for the description of the instanciated object.

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Minimal classification of the BSC specification (cf. [3])

This type of specification is used in particular to control the taps of power transformers. Unlike the ISC specification, the BSC is used for increase/decrease commands of a tap.

cdcId = BSC, UML class name = BSC			
Attribute name	**Attribute type**	**TrgOp (Value/Value range) Description**	**Comments**
DataAttribute for status			
origin	Originator	See 'SPC.origin'.	Uses to monitor the origin of commands, notably if they come from a PLC.
valWTr	ValWithTrans	Status value of the controllable data object.	
q	Quality	Quality of the value in 'valWTr'.	
t	Timestamp	Timestamp of the last event of 'valWTr' or the last change of value in 'q'.	
DataAttribute for control mirror			
opRcvd	BOOLEAN	inherited from: ControlTestingCDC	
opOk	BOOLEAN	inherited from: ControlTestingCDC	
tOpOk	Timestamp	inherited from: ControlTestingCDC	
DataAttribute for substitution and blocked			
subEna	BOOLEAN	inherited from: SubstitutionCDC	The substitution serves in particular to re-establish the consistency between the reality in the field and the information transmitted. It can also serve for the purposes of maintenance.
subVal	ValWithTrans	Value used to substitute 'valWTr'.	
subQ	Quality	inherited from: SubstitutionCDC	
subID	VisString64	inherited from: SubstitutionCDC	
blkEna	BOOLEAN	inherited from: SubstitutionCDC	
DataAttribute for configuration, description and extension			
persistent	BOOLEAN	Configures the control output. If 'persistent'=false, the 'Operate' service results in the change of exactly one step higher or lower, as defined with 'ctlVal' (i.e., 'ctlVal'=higher'|'lower'). If 'persistent=true', the 'Operate' service initiates the persistent activation of the output (and 'ctlModel' shall be set to 'direct-with-normal-security'). The output will be deactivated by an 'OperateWithValue' service with 'ctlVal'='stop', or by a local timeout. A client may repeat sending the 'Operate' service in order to retrigger the output.	Used to indicate that the DA valWTr corresponds to an increase/decrease order
ctlModel	ENUMERATED (CtlModelKind)	See 'SPC.ctlModel'.	
sboTimeout	INT32U	See 'SPC.sboTimeout'.	
sboClass	ENUMERATED (SboClassKind)	See 'SPC.sboClass'.	
minVal	INT8	Minimum setting for 'valWTr.posVal' below which 'ctlVal'='lower' will have no effect.	Used to indicate the value of number of the lowest tap
maxVal	INT8	Maximum setting for 'valWTr.posVal' above which 'ctlVal'='higher' will have no effect.	Used to indicate the value of number of the highest tap
operTimeout	INT32U	See 'SPC.operTimeout'.	
d	VisString255	inherited from: BasePrimitiveCDC	

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Minimal classification of the ISC specification (cf. [3])

This type of specification is used in particular to control the taps of power transformers. Unlike the BSC specification, the ISC is used to give the number of the tap directly.

cdcId = ISC, UML class name = ISC			
Attribute name	**Attribute type**	**(Value/Value range) Description**	**Comments**
DataAttribute for status			
origin	Originator	See 'SPC.origin'.	Uses to monitor the origin of commands, notably if they come from a PLC.
valWTr	ValWithTrans	Status value of the controllable data object.	
q	Quality	Quality of the value in 'valWTr'.	
t	Timestamp	Timestamp of the last event of 'valWTr' or the last change of value in 'q'.	
DataAttribute for control mirror			
opRcvd	BOOLEAN	inherited from: ControlTestingCDC	
opOk	BOOLEAN	inherited from: ControlTestingCDC	
tOpOk	Timestamp	inherited from: ControlTestingCDC	
DataAttribute for substitution and blocked			
subEna	BOOLEAN	inherited from: SubstitutionCDC	The substitution serves in particular to re-establish the consistency between the reality in the field and the information transmitted. It can also serve for the purposes of maintenance.
subVal	ValWithTrans	Value used to substitute 'valWTr'.	
subQ	Quality	inherited from: SubstitutionCDC	
subID	VisString64	inherited from: SubstitutionCDC	
blkEna	BOOLEAN	inherited from: SubstitutionCDC	
DataAttribute for configuration, description and extension			
ctlModel	ENUMERATED (CtlModelKind)	See 'SPC.ctlModel'.	
sboTimeout	INT32U	See 'SPC.sboTimeout'.	
sboClass	ENUMERATED (SboClassKind)	See 'SPC.sboClass'.	
minVal	INT8	Minimum setting for 'ctlVal'.	Used to indicate the value of number of the lowest tap
maxVal	INT8	Maximum setting for 'ctlVal'.	Used to indicate the value of number of the highest tap
operTimeout	INT32U	See 'SPC.operTimeout'.	
d	VisString255	inherited from: BasePrimitiveCDC	

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4.4.10 Modelling of process interface

- It should be noted that advanced supervision of field equipment could need information acquired by the process interface. This information is not completely modelled in the current version of the document (e.g. CO2 leak from LDSEICO2). The list of the DO will be proposed in IEC TC57 WG10 so that they are incorporated into the future release of the document IEC 61850-90-3.
- In order to not impose the implementation of functions developed in equipment close to the process, their interface with the latter is provided by dedicated LDs.
- The standard describes a family of LNs of type T (transformer sensor) dedicated to the interface with field sensors (pressure, temperature, level, etc.). These data are used amongst others by LNs of type "S" supervision.
- In this document, the interface and the publication of measurements other than voltages and currents are not represented by LNs of type "T", but by LNs of type "S".
- It is assumed that the LDs interfacing the process can directly transmit signals to the SCADA.
- It is considered that the function interfacing the transformer cooling group (AEROTEMP) is a function close to the process, which receives wired inputs/outputs from cooling groups.

4.4.11 Naming

In this document, the naming convention related to LDs, LNs and DOs and applies the rules specified in the standard (cf. IEC 61850-7-2 Ed2 § 22 [2] and IEC 61850-6 [9]). As a reminder, the rules are the following:

- LD ≤ 64 characters
- LN = LN.Prefix [optinal] + LN.class (4 characters) + LN.Inst (integer) with a total lenth of ≤16 characters
- DO = ≤12 characters

LN.Inst corresponds to an identifier. It is numerical and optional. E.g. in the case of distance protection, 1 instance per zone is considered, i.e. PDIS1, PDIS2, PDIS3. If there is only one istance of a LN in a LD, LN.Inst is 0.

- The naming of the LN representing Instrument Transformers will be consistent with the standard IEC 61869-9 [10].

4.4.12 Creation of LN and DO

New types of LNs and DOs are created if:

- The LN is specific to Rte (e.g. not any LNs of part 7-4 is suitable)
- The LN responds to a particular functionality, not in line with the use intended by Rte

If none of the DOs of applicable LN of the standard correspond to the information to model, preference is given to the creation of a specific LN and associated DOs (indicated **in green** cf. §4.4.1). LN and DO present in IEC 61850 drafts, but not yet published as is, are indicated **in violet**.

The creation of a specific DO and its addition into a standardised LN is not used in this modelling.

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In addition, the WG10 has accepted the principle of using already existing LNs or DOs, even if the definition proposed by the regulatory instructions is too restrictive and the extension of use is not consistent with the primary function of the LN or the DO concerned. Examples:

- The use of LN XCBR for circuit-breakers of auxiliary supply while the standard restricts it to HV circuit-breakers.

4.4.13 LD implementation

The modelled LD for each function is a superset of all variants of this function. This means that the LD has to be implemented as described in every case.

If the instantiated function is a variant that needs not all LN, those are instantiated and set to Beh=off.

An instantiated function may be a variant that needs not all DO. Only the DO needed for communication with other function, HMI or SCADA are instantiated in the data sets.

4.4.14 Test mode and associated behaviours

The test methods to implement are described in the Brochure CIGRE B5.53 (cf. [11]).

4.4.15 Asset identification data

The DPL CDC of the DO PhyNams and EENames is used to indicate the information which allows equipment to be identified (field equipment, protective relays, etc.). The following table lists the DAs which may have to be implemented. In the framework of the modelling described in the present document, it also lists the DA to implement depending on the type of equipment concerned.

DA (data attribute name)	Meaning	Implementation	
		PhyNam	PhyNam
		IED	TCTR - TVTR
vendor	Vendor name	✓	✓
hwRev	Equipment version	✓	✓
swRev	Software version	✓	✓
serNum	Serial number	✓	✓
model	Model	✓	✓
location	Geographical location (substation name)	✓	✓
name	Name (of the equipment)	✓	✓
owner	Owner		
latitude	Latitude		
longitude	Longitude		
Altitude	Altitude		
d	Description		✓

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4.4.16 Change of subscribed GOOSE ou SV streams

If a protection or automation function is supposed to change the subscription of SV or GOOSE streams in runtime, including the streams published by test devices, the different possible subscribed streams are identified in the configuration in the DO InRef (including TstRef) of the protection function which are associated to attribute ExtRef in the SCL file. Several ExtRef are possible for each InRef. This mecnism is based on later binding in the configuration process of the IED hosting the function.

The DA of DO InRef which are concerned by this are: setSourceRef, setSourceCB, setTstRef and setTstCB.

The BAP are only applicable to the selected SV and GOOSE streams.

Case	Description	Configuration	Comment
1	Fixed SV or GOOSE stream and fixed test stream	setSourceRef : ValKind = RO with appropriate value designing the source setSourceCB : ValKind = RO with appropriate value designing the source setTstRef : ValKind = RO without value setTstCB : ValKind = RO without value	Use of ExtRef1, TestRef not supported
2	SV or GOOSE stream which can be changed by command	setSourceRef : ValKind = Set setSourceCB : ValKind = Set setTstRef : ValKind = Set setTstCB : ValKind = Set	Extern write command is possible on InRef in order to select the SV or GOOSE stream to be used TstRef activated by tstEna. setTstCB can be written
3	SV or GOOSE stream which changes automatically based on given criterea	setSourceRef : ValKind = RO setSourceCB : ValKind = RO setTstRef : ValKind = Set setTstCB : ValKind = Set	ExtRef1 designates main source. ExtRef2 designates back-up source. Criterea to switch have to be defined for each function. ExtRef3…n not will be used except TstRef.

The time delay to switch to the back-up source in case #3 is modelled on IED level by LDSUIED/LSET0.DlTmms2 (cf. §9.8).

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5. Protection functions

5.1 Passive Load Feeder Protection (LDPAP)

5.1.1 Description of the Function

The passive load feeder protection (PAP) function participates in the elimination of insulation faults on feeders permanently or temporarily connected to busbar which feature only load and no or insignificant generation. Often, this feeder is a tie connected to the line between two active substations. The PAP function can also be implemented at the load end of a two-ended line. In this case, the PAP function is implemented on the passive (or weakly powered) side of the feeder (cf. [12]).

5.1.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
LSET	Rte Extended Setting LN
PTOC	This LN shall also be used to model the directional time overcurrent (PDOC/IEEE device function number 67, IEEE C37.2:1996). The Definite Time overcurrent (also PTOC/IEEE device function number 51, from IEEE C37.2:1996) shall be modelled by use of PTOC and selecting the related curve.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.
PTUV	A function that operates when its input voltage is less than a predetermined value.

5.1.3 Specificities

- The requirements for the Power Supply Restoration function ARS (cf. [13], T4-ARS-GE-11 and T4-ARS-GE-03) specify the reset of auto-recloser functions (RS, REC, etc.) in case of tripping by the circuit breaker pole discrepancy protection or if the circuit-breaker is open. This requirement is also described in the functional specification of the PAP function (cf. [12]) which makes it redundant with those cited previously.
- The LDPAP uses pole discrepancy signals and the position of the circuit-breaker published by LDDJ for a single phase initialisation of the auto-recloser, or to extend a single-phase recloser cycle to a three-phase recloser cycle of a circuit-breaker.
- The quality (q) attribute of DOs, published by the LDTAC is used to indicate Télé-protection equipment failure indication (Abs.def.TAC) (cf. §8.7.3).
- PAP function uses residual current. This residual current is calculated by the application associated to the LD from phase currents Ia, Ib, Ic carried by AmpSv DO's subscribed from LDTM, and used by the LN PTOC.
- The diagram of the Télé-protection information transmission between two substations is explained in paragraph 4.4.6.

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- The selection of the faulted phase by the PAP is modelled by an LN PTUV. The fact that this phase selection is based on comparison between two voltages, one being a sum, is not represented in the modelling. This feature belongs to the application level associated with LDPAP. The DO Op. ph* is used to indicate the faulted phase.
- The time delay setting after phase selection is fixed in PAP function specification [12] to a value of 500 ms. For this reason, this time delay is not included in the modelled settings of this function.

5.1.4 Static Description

Passive Load Feeder Protection (LDPAP)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS	DF.PAP*	
	Mod	ENC		
	NamPlt	LPL		
LSET0	OnOff1	SPG	C0	Activation / deactivation of the teletrip mode
	NamPlt	LPL		
	OnOff2	SPG	C1	Management of nominal / degraded operation mode If ON: Nominal mode Tdec If OFF: degraded mode, Tdec delayed
	OnOff3	SPG	C2	Blocking of PAP function in case of upstream fault detected by distance protection
	OnOff4	SPG	P2	Use of current threshold for single phase fault
	OnOff5	SPG	P3	Trip Blocking in case of multi-phase fault
PTOC1	Beh	ENS		
	Op	ACT	DT.PAP*.IR	Tripping by residual I criterion Presence of residual current
	OpDlTmms	ING	Tt	Time delay for three-phase tripping
	StrVal	ASG.setMag	Ir_seuil	Residual current threshold setting
PTOC2	OpDlTmms	ING	Tm	Time delay for single-phase tripping
PTRC0	Beh	ENS		
	Op	ACT		Tri-phase protection Initiation of ARS (auto reclose)
	Str	ACD	PAP*.MISE ROUTE	
	Tr	ACT	DT.PAP*	Trip order (PhA,PhB,PhC)
	TrMod	ENG	P1	Trip mode for single phase mode
PTUV0	Beh	ENS		
	MinOpTmms	ING		Time delay for voltage memorisation

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Passive Load Feeder Protection (LDPAP)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Str	ACD		Start
	Op	ACT	DT.PAP*.PHASE*	Tripping by phase criterion Phase selector has determined the faulted phase
	StrVal	ASG.setMag	Urseuil (k)	Residual Voltage detection threshold

5.1.5 Dynamic description

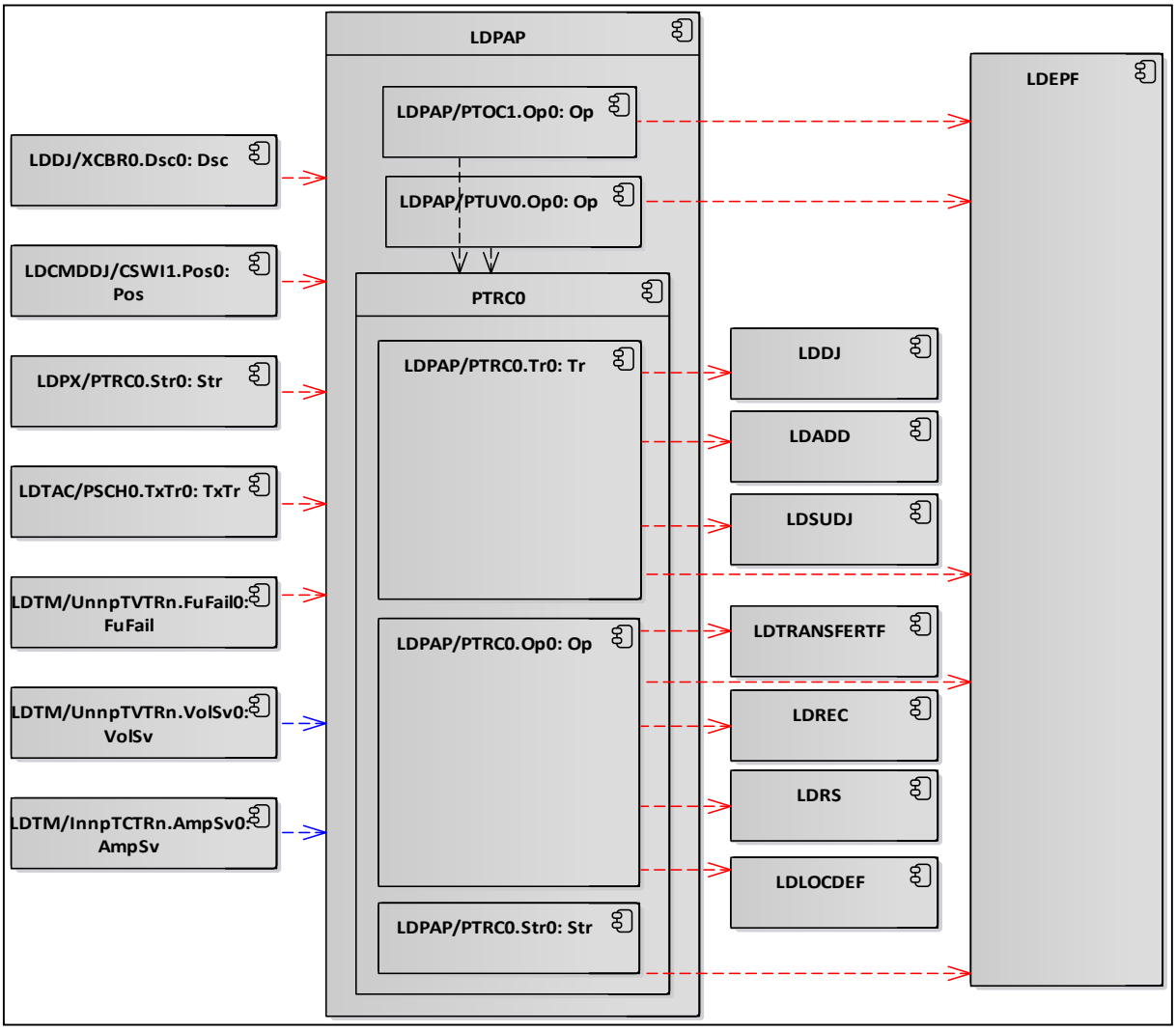

Figure 5: LDPAP dynamic description

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5.2 Zero Sequence Wattmetric Protection LD (LDPW)

5.2.1 Description of the Function

The Zero Sequence Wattmetric Protection (PW) function detects High Impedance phase-to-ground faults which may not be detected by a distance protection function (Cf. [14]).

5.2.2 LNs used

LN	Description
FXOT	Logical node FXOT shall be used to set a high-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, contro or alarm function is based on other physical measurements than primary electrical data.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
LSET	Rte Extended Setting LN
PSCH	This LN shall be used to model the logic scheme for line protection function co-ordination. The protection scheme allows the exchange of the "operate" outputs of different protection functions and conditions for line protection schemes. It includes data objects for teleprotection if applicable. In this case, all appropriate data objects shall be subscribed.
PSDE	This LN is used for directional earthfault handling in compensated and isolated networks. The use of "operate" is optional and depends both on protection philosophy and on instrument transformer capabilities. For compensated networks, this function is often called wattmetric directional earthfault. The very high accuracy needed for fault current measurement in compensated networks may require phase angle compensation. This shall be realised by the related LN TCTR.
PTOC	This LN shall also be used to model the directional time overcurrent (PDOC/IEEE device function number 67, IEEE C37.2:1996). The Definite Time overcurrent (also PTOC/IEEE device function number 51, from IEEE C37.2:1996) shall be modelled by use of PTOC and selecting the related curve.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

5.2.3 Specificities

- The residual voltage Vr and residual current Ir are calculated in the application associated to the LDPW. They are not subscribed from any other function.
- The LN PSDE is used despite the fact that 7-4 indicated that its use is limited to compensated or isolated neutral networks (principle accepted by IEC TC57 WG10).
- The "single-phase reclosing cycle in process" indication of the auto–recloser is modelled by the DO AutoRecSt coming from LDREC/RREC1.

5.2.4 Static Description

Zero Sequence Wattmetric Protection (LDPW)				
LN	**DO**	**CDC**	**FCS name**	**Comments**

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Zero Sequence Wattmetric Protection (LDPW)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS	DF.PW	Health of the function
	Mod	ENC		
LSET0	StrVal1	ASG.setMag		Zero sequence power threshold
	NamPlt	LPL		
	StrVal2	ASG.setMag	Sref	Zero sequence power reference (Sref)
PSCH0	Beh	ENS		
	TxTr	ACT		Publication of tripping signal to the LDTDEC (tele-protection)
	Op	ACT		
PSDE0	Ang	ASG.setMag	φ0	Angle of Zero sequence power compensation (φ0)
	OpDlTmms	ING	k	Dependant time factor (k) (s)
	StrDlTmms	ING	TA	Time delay before the PW function starts (TA)
PTOC0	Beh	ENS		
	Op	ACT		LN required for the setting and the configuration of the protection.
	OpDlTmms	ING	TB	Base time delay for PW function (TB)
	Str	ACD		Start of the disturbance recording
	StrVal	ASG.setMag		Zero sequence current threshold
PTRC0	Beh	ENS		
	Op	ACT	DT.PW	- Tripping signalling - CB Faillure protection (ADD) tri-phase initiation (current criterion) - tri-phase/slow protection initiation of ARS (auto reclose)
	Tr	ACT		Trip order to XCBR
	Str	ACD.general		

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5.2.5 Dynamic description

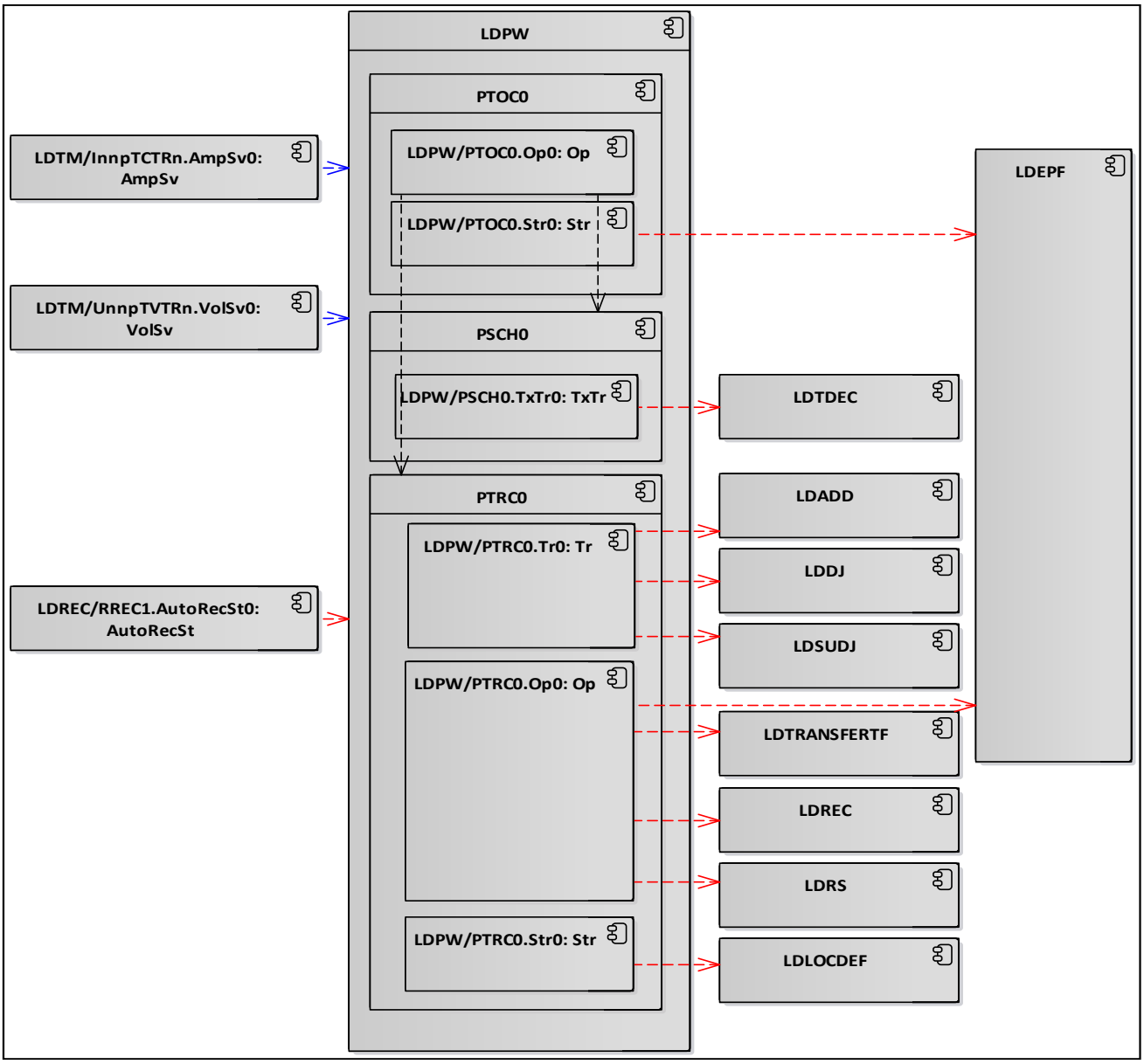

Figure 6: Dynamic description LDPW

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5.3 Distance Protection (LDPX)

5.3.1 Description of the Function

The distance protection (PX) function LDPX selectively detects isolation faults of all types on the protected line and causes the associated circuit breaker to trip. (Cf. [14]). LDPX includes a blown fuse detection feature and an echo function.

5.3.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PDIS	The phase start value and ground start value are minimum thresholds to release the impedance measurements depending on the distance function characteristic given by the algorithm and defined by the settings. The settings replace the data object curve as used for the characteristic on some other protection LNs. One instance of PDIS per zone shall be used.
PSCH	This LN shall be used to model the logic scheme for line protection function co-ordination. The protection scheme allows the exchange of the "operate" outputs of different protection functions and conditions for line protection schemes. It includes data objects for teleprotection if applicable. In this case, all appropriate data objects shall be subscribed.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.
RPSB	The power swing is characterised by slow periodic changing of measured impedance. Such a moderate impedance change is tolerated, but may result in tripping of the distance protection function. If the generator is out of step (pole slipping), transient changes of impedance (one per slip) are measured. After a small number of slips (MaxNumSlp) in a dedicated time window (EvTmms), the generator shall be tripped to avoid mechanical damage (out of step tripping). The actual number of slips shall be reset either by the trip or by the end of evaluation time.
TVTR	The voltage is delivered as sampled values. The sampled values are transmitted as engineering values, that is as "true" (corrected) primary voltage values. Therefore, the transformer ratio and the correction factors are of no interest for the transmitted samples but for maintenance purposes of an external conventional (magnetic) transducer only. In addition, status information is provided and some other settings are accepted from the LN TVTR.

5.3.3 Specificities

- Each zone of the distance protection is associated to one LN PDIS. As many LN PDIS as necessary are instantiated.
- The use of TVTR is necessary for modelling the sub-function of the distance protection which detects fuse failure. This LN does not directly represent the voltage transformer.
- As many LN PDIS as functional zones are instantiated.
- The synthesis of the Operate of PDIS is produced by the PSCH which takes signalling from the dedicated tele-protection IED (RxBlk, RxPrm) into account.
- Subscribing or not to signals RxBlk ou RxPrm from the teleprotection function depends on the variant of the PX function.

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- Publishing or not of signals TxBlk, TxPrmfor the teleprotection function depends on the variant of the PX function.
- The diagram of the telecommunications connection between two substations is explained in §4.4.6.

Zone extension

- If main 2 is a line differential protection, a zone extension can be implemented in case of failure of the line differential protection. This is modelled by an additional LN PDIS, the activation of which depends on LDDIFL/LLN0.health. In case of several LDDIFFL instances, the activation is only performed if all LDDIFL are not operating.
  The activation of the extended zone is indicated by the corresponding DO LDPX/LDISx.Beh.

Weak Infeed Function

- The DO PSCH0.EchoWei is used to signal the immediate re-transmission of a received authorisation order. This is a feature of the echo sub-function.
- PSCH0.WeiTmms is used to model the time delay setting of the DEF function. If required, this same time delay can also be used for permissive overreach or blocking mode.
- The setting PSCH0.WeiMod (ENG) is used to describe the weak infeed operation mode of the distance protection function:

Not active: PSCH0.WeiMod = Off (1)
Signal is echoed but no trip by LDPX: PSCH0.WeiMod = Echo (3)
Signal is echoed and trip by LDPX: PSCH0.WeiMod = Echo and Operate (4).

- It is recommended to always used the same LN PDIS for the extended zone to facilitate configuration (e.g. PDIS9)

Power Swing

- The settings for the power swing blocking function are modelled in LN RPSB. If no time delay for the power swing is needed, SwgTmms is set to its minimal value.
- The variant of the distance protection (e.g. use of permissive overreach, blocking, etc.) is indicated by instantiation of the associated teleprotection parameters (TxPrm, RxPrm1, TxBlk, RxBlk1).

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5.3.4 Static Description

Distance Protection (LDPX)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS	DF.PX	
	Mod	ENC		
	NamPlt	LPL		
PDISx	Beh	ENS		
	K0Fact	ASG.setMag		K0
	K0FactAng	ASG.setMag		Angle of K0
	LinAng	ASG.setMag		Line angle
	Op	ACT		Tripping decision following a fault detection in zone x on one phase (phs* = phsA, phsB, phsC). Only generated in case of an effective trip.
	OpDlTmms	ING.setVal		Time delay for zone x
	RisGndRch	ASG.setMag		R (P-N) (Ω phase HV)
	RisPhRch	ASG.setMag		R (P-P) (Ω phase HV)
	Str	ACD	PX*.ZONE 1 PX*.ZONE 2 PX*.STADE 3	Detection of a fault and transmission to PTRC for directional information.
	X1	ASG.setMag		Positive sequence reactance for zone x (Ω phase HV)
PSCH0	Beh	ENS		
	CrdTmms	ING		Timeout for reception of teleprotection signal
	DurTmms	ING		Prolongation of emission of teleprotection signal
	EchoWei	SPS		Information signalling that there has been an echo of the autorisation order received via the dedicated tele-protection function.
	Op	ACT		Tripping decision to PTRC
	TxBlk	ACT	EMI.VERROUIL.*Vv	Signal transmitted indication to the SCADA
	TxPrm	ACT	EMI.ACCELERA.*Vv EMI.AUTORIS.*Vv	Signal transmitted indication to the SCADA
	TxTr	ACT		
	WeiTmms	ING.setVal		Temporisation émission
	WeiMod	ENG		Mode of weak infeed function
PTRC0	Beh	ENS		

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Distance Protection (LDPX)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Op	ACT.general	DT.PX*	Tripping decision of 3 phases. Signalling of PX tripping transmitted to LDPDEF
	Op	ACT.phsA	DT.PX*.PHASE*	Tripping decision on one phase. (phs*=phsA, phsB or phsC)
	Op	ACT.phsB	DT.PX*.PHASE*	Tripping decision on one phase. (phs*=phsA, phsB or phsC)
	Op	ACT.phsC	DT.PX*.PHASE*	Tripping decision on one phase. (phs*=phsA, phsB or phsC)
	Op	ACT.neut	PX*.TERRE	Tripping decision on ground fault.
	Str	ACD.dirGeneral	PX*.AMONT PX*.AVAL	Backward or forward fault detection
	Str	ACD.general	PX*.MISE ROUTE	Start of PDIS elements after detection of a fault (or of all DO Str of LN PDIS*)
	Tr	ACT.general		Trip order to XCBR single phase Tripping (PTRC.Tr.phs*) three-phase Tripping (PTRC.Tr.general)
	Tr	ACT.phsA		Trip order to XCBR single phase Tripping (PTRC.Tr.phs*) three-phase Tripping (PTRC.Tr.general)
	Tr	ACT.phsB		Trip order to XCBR single phase Tripping (PTRC.Tr.phs*) three-phase Tripping (PTRC.Tr.general)
	Tr	ACT.phsC		Trip order to XCBR single phase Tripping (PTRC.Tr.phs*) three-phase Tripping (PTRC.Tr.general)
	TrMod	ENG		Type of tripping mode of the function
RPSBx	SwgReact	ASG.setMag		Power swing delta X
	SwgRis	ASG.setMag		Power swing delta R
	SwgTmms	ING.setVal		Power swing time
UnnpTVTR0	Beh	ENS		
	HzRtg	ASG.setMag		
	VRtg	ASG.setMag		
	FuFail	SPS		Contributes to the elaboration of the MQ.UI signalling by the MQUI function (analog circuit anomaly).

5.3.5 Dynamic description

Dynamic description is available in appendix 12.2.

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5.4 Line Differential Protection (LDDIFL)

5.4.1 Description of the Function

The task of line differential protection (cf. [15]) is to detect all insulation faults affecting the protected line, remaining insensitive to insulation faults on other part of the grid, on the basis of current measurements performed at the ends of the protected line.

5.4.2 LNs used

LN	Description
ITPC	The LN ITPC comprises all information for communication channel setting and supervision. ITPC is not intended to generate direct process data objects. Thus, it does not contain the input and output data objects to be transmitted and it has no "operate" data objects object.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
LSET	Rte Extended Setting LN
PDIF	This LN shall be used for all kinds of current differential protection. Proper current samples for the dedicated application shall be subscribed.
PSCH	This LN shall be used to model the logic scheme for line protection function co-ordination. The protection scheme allows the exchange of the "operate" outputs of different protection functions and conditions for line protection schemes. It includes data objects for teleprotection if applicable. In this case, all appropriate data objects shall be subscribed.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.
RMXU	This LN shall be used to provide locally calculated process values (phasors calculated out of samples or the samples itself) representing the local current values which are sent to the remote end and which are used for the local differential protection function (PDIF). Therefore, the LN RMXU together with LN PDIF models the core functionality of the differential protection function number 87 according to the IEEE designation (C37.2). In addition, the LNs RMXU on both sides of the line represents also the function to synchronize the samples. Therefore, also the samples sent from the local TCTR to the local PDIF are routed through the function represented by RMXU. The local RMXU is therefore the source of synchronized samples or phasors from the local current sensor, which sends its information to the local PDIF and to all required remote PDIF nodes.

5.4.3 Specificities

- In the specification of the PDIFL function (cf. [15]), several logic inputs are specified, not directly contributing to line differential protection. This concerns:
  - The open circuit-breaker used for the re-closing function (treated in the ARS functional group).
  - SF6 pressure for monitoring the SF6 pressure at remote cable heads (covered in chapter 9.3).
  - Stand-alone power supply monitoring of remote equipment (cf. § 4.3.6). The corresponding DOs are not covered by the LDDIFL.

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- The PDIFL is used for the protection of a complete line and/or for identifying a fault on the underground part of a mixed overhead / underground line. In the latter case, if no PDIFL is installed for the complete line, the PDIFL function can inhibit the re-closing cycle of the local remote recloser automatons (ARS). An inhibition order is transmitted via a dedicated communication link to the remote line end. A corresponding DO is not provided for in IEC 61850 ed2. In the present modelling, this transmission of recloser inhibition order is therefore modelled using TxTr DO of the PSCH. The recloser function at the other end of the line interprets the TxTr as a recloser inhibition order.
- The diagram of the connection between two substations is explained in §4.4.6.
- In the case of LDDIFL only having the "three-phase tripping" function, the DO Op.phs* and Tr.Op.phs* are also used and active (all phases). There is therefore no difference on the model, between a three-phase LDDIFL and a single-phase LDDIFL. This difference only concerns the application level.
- The LN RXMU allows currents to be transmitted to remote equipment either in the form of SV or in the form of phasors. The modelling takes into account these two possibilities. The type to use is choosen at the instantiation of the function taking into account the capacities of the IED.
- The fact that often a proprietary communication link between Line Differential Protection IED at the different line ends is used is symbolised by the blue area in the dynamic description.
- The parameters of the LDDIFL correspond to a "classic" differential current protection trip characteristic in the differential current - restraint current plain composed of two segments.
- In case of LDDIFL used in a configuration with more than two line ends, additional PSCH, RMXU and ITPC LN have to be instantiated for each additional line end. They are labled PSCHx, RMXUx and ITPCxy. For ITPC, x indicates the line end and y the telecommunication channel for this line end.
- Regarding settings, an envelope of settings is modelled. It is understood that not all of these settings are used by all manufacturers of line differential protections. In this context, the ratio of current transformers is not required as setting as all SV subscribed by the line differential protection are given in primary values.
- The number of line ends is indicated by LSET.SetNb1. This indicates the functional variant to be used and its value range depends on the application.
- Some applications need informationabot the accuracy of the current transformers to which the subscribed SV stream corresponds. This information is contained in LDTM and is copied at the instanciation of LDDIFL to LDDIFL/LSET0.NamAccRtg.
- It can be envisaged to exchange time synchronisation information via the communication links between line differential protection IED situated at different line ends. If this function is implemented, LDDIFL/LSET0.OnOff2 is used to select if the local PTP time synchronisation is to be used or if the time stamp of the SV has to be modified using the time synchronisation information obtained from the other line end.
- It is possible to transmit either one single current (ALoc - sum of the three phase currents) or each of the three phase currents (AmpLocPhs*) to the remote end. This corresponds to a functional variant of the line differential protection. This variant is identified by instantiating either RMUX1x for the first case or RMUX2x for the second case.

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5.4.4 Static description

Line Differential Protection (LDDIFL)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
ITPCxy	Beh	ENS		
	LosSig	SPS	DF.TRANSMISS.L	Transmission signal loss Instantiated for multi terminal lines for each additional line end. X indicates the line end and y the telecommunication channel for this line end.
	TxBndWid	ASG.setMag		Transmission channel bandwidth (Tx) Correspond to bit rate used for transmission channel.
LLN0	Beh	ENS	DIFL*.HS DIFLTEST	Protection deactivated
	Health	ENS	DF.DIFL* DF.PROTECTION L	The use of LLN0 and not LPHD as LLN0 represents the function and LPHD the physical equipment which can host several functions. Depending on the use of PDIFL, the Health of LLN0 can be used for issuing orders for changing to degraded mode.
	Mod	ENC		
	NamPlt	LPL		
LSET1	Beh	ENS		
	NamPlt	LPL		
	OnOff1	SPG		Enabling of capacitive current compensation
	OnOff2	SPG		True : synchronisation IED by PTP False : IED publishes PTP clock derived from communication link 11
	StrVal1	ASG.setMag	k1	Inclination of first restraint segment
	StrVal2	ASG.setMag	k2	Inclination of second restraint segment
	StrVal3	ASG.setMag		Differential threshold current for fast differential algorithm (in addition to PDIF0).
	SetNb1	ING.setVal		Number of line end
	SetNb2	ING.setVal		Designation of equipment (one number for each line end)
	DlTmms1	ING.setVal		Transmission time difference between emission and reception channel
	DlTmms2	ING.setVal		Time delay for publication of an alarm in case of loss or degradation of a telecommunication link

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Line Differential Protection (LDDIFL)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	DlTmms3	ING.setVal		Time delay before increase of differential threshold in case of loss or degradation of a telecommunication link
	SetNb3	ING.setVal		Threshold for bit error detection
	NamAccRtg	VSD		Indication of the accuracy class of the Current Transformer corresponding to the SV stream subscribed by LDDIFL
	PhyConnITFxy	ENG.setVal		Type of communication interface for channel xy (corresponding to ITPCxy)
	StrVal5	ASG.setMag	Irest12 (IS2)	Restraint current value between segment 1 et 2
LSET2	Beh	ENS		
	NamPlt	LPL		
	DlTmmsxy	ING.setVal		Calculated maximum propagation time delay for propagation channel xy
PDIF0	Beh	ENS		
	LinCapac	ASG.setMag	Bs (susceptance)	Line capacitance (for load currents)
	LoSet	ASG.setMag	Idiffmin (IS1)	Current threshold for minimal differential current
	Op	ACT		Tripping decision following a fault detection on one or several phase(s) (phs* = phsA, phsB, phsC). Only generated in case of an effective trip.
	Str	ACD		Start of the disturbance recording
PSCHx	Beh	ENS		
	TxTr	ACT		Instantiated for multi terminal lines for each additional line end
	Op	ACT		
PTRC0	Beh	ENS		
	Op	ACT.general	DT.DIFL* And / Or EMI.DESARM.ARS.*Vv E.TPLP*	Depending on the case of the use of DIFL: Signalling tripping decision on the 3 phases And / or Recloser disabling (R-GOOSE)
	Op	ACT.phsA	DT.DIFL*.*	Tripping decision on one phase (phsA).
	Op	ACT.phsB	DT.DIFL*.*	Tripping decision on one phase (phsB).
	Op	ACT.phsC	DT.DIFL*.*	Tripping decision on one phase (phsC).
	Str	ACD.general		

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Line Differential Protection (LDDIFL)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Tr	ACT.general		Trip order to XCBR (the SCU is subscriber of GOOSE PTRC.Tr) Tripping three-phase (PTRC.Tr.general)
	Tr	ACT.phsA		Trip order to XCBR (the SCU is subscriber of GOOSE PTRC.Tr) Tripping single phase (PTRC.Tr.phsA)
	Tr	ACT.phsB		Trip order to XCBR (the SCU is subscriber of GOOSE PTRC.Tr) Tripping single phase (PTRC.Tr.phsB)
	Tr	ACT.phsC		Trip order to XCBR (the SCU is subscriber of GOOSE PTRC.Tr) Tripping single phase (PTRC.Tr.phsC)
	TrMod	ENG		Tripping mode : 1 ph for 225kV and 400kV 3 ph for 63kV and 90kV and cables
RMXU1x	ALoc	WYE		Phasor transmitted to remote equipment. According to Ed2.1 ether Aloc or AmpLocPhsx is instantiated.
	Beh	ENS		
RMXU2x	AmpLocPhsA	SAV		SV transmitted to remote equipment. According to Ed2.1 ether Aloc or AmpLocPhsx is instantiated.
	AmpLocPhsB	SAV		SV transmitted to remote equipment. According to Ed2.1 ether Aloc or AmpLocPhsx is instantiated.
	AmpLocPhsC	SAV		SV transmitted to remote equipment. According to Ed2.1 ether Aloc or AmpLocPhsx is instantiated.
	Beh	ENS		

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5.4.5 Dynamic description

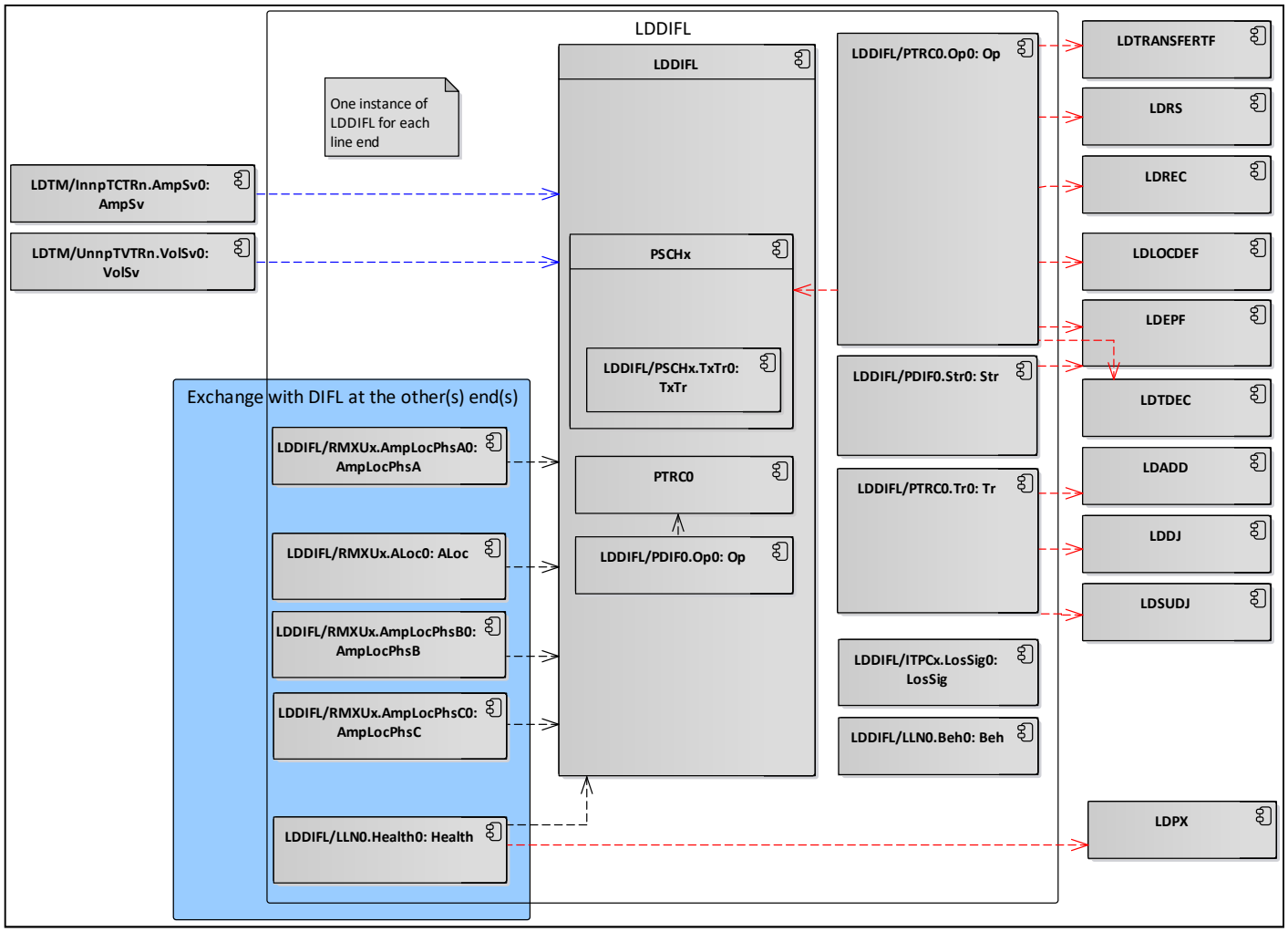

Figure 7: Dynamic description LDDIFL

5.5 Power Swing Protection (LDPRS)

5.5.1 Description of the Function

The Power Swing Detection function (LDPRS) detects a power-swing condition on its feeder. If the power swing conditions meets its preset criteria, the LDPRS trips the circuit breaker of the feeder.

This protection function is implemented on selected line between electrically homogenous parts of the network. Its aim is to isolate parts of the network which are not affected by the system disturbance and thus to limit the consequences of the latter.

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5.5.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.
RPSB	The power swing is characterised by slow periodic changing of measured impedance. Such a moderate impedance change is tolerated, but may result in tripping of the distance protection function. If the generator is out of step (pole slipping), transient changes of impedance (one per slip) are measured. After a small number of slips (MaxNumSlp) in a dedicated time window (EvTmms), the generator shall be tripped to avoid mechanical damage (out of step tripping). The actual number of slips shall be reset either by the trip or by the end of evaluation time.

5.5.3 Specificities

- The LDPRS function used the LN RPSB to model the power swing (out-of-step) detection by counting voltage maxima of the envelope of the line-to-ground voltage.

5.5.4 Static description

Power Swing Protection (LDPRS)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS	DF.PRS	
	Mod	ENC		
	NamPlt	LPL		
PTRC0	Beh	ENS		
	Op	ACT		
	Str	ACD.general		
	Tr	ACT.general		Trip order to XCBR
RPSB0	Beh	ENS		
	Op	ACT.general	DT.PRS	Signalling and tripping decision on the 3 phases and initialisation of disturbance modelling
	Str	ACD.general		

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5.5.5 Dynamic description

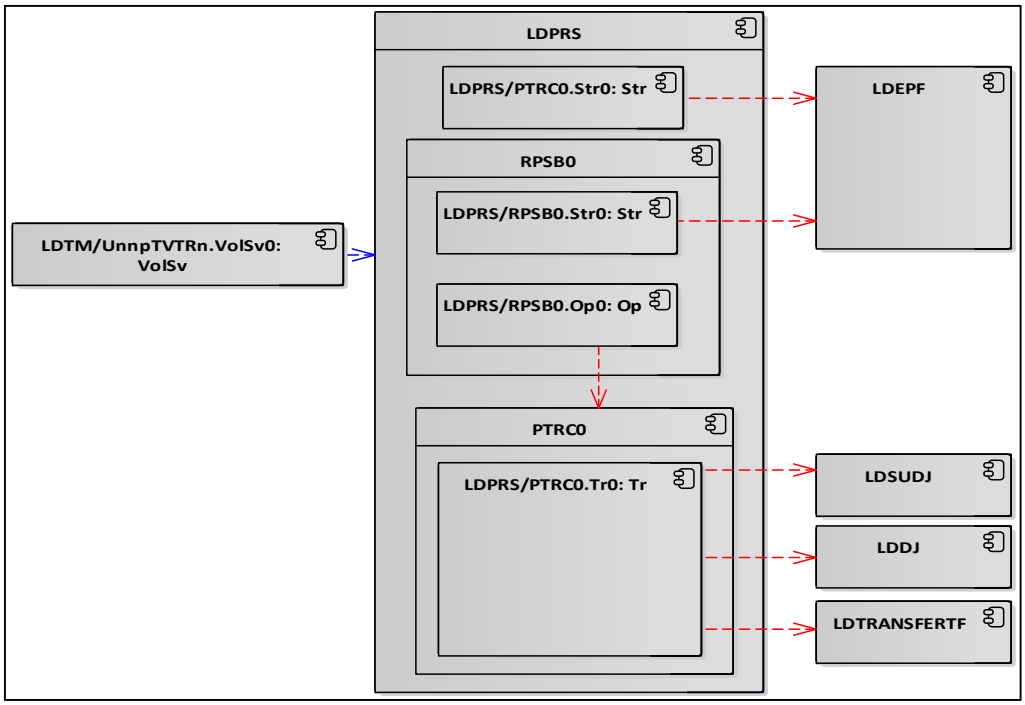

Figure 8: LDPRS dynamic description

5.6 Line Overcurrent Protection (LDMAXIL)

5.6.1 Description of the Function

The over current (cf. [13]) protection function is used to eliminate faults between phases (polyphase) and between a phase and ground (single-phase) on an overhead or underground line on which power transits in a single direction. In particular, this is the case of a feeder connected to a passive load (e.g.HVB/HVA transformer).

5.6.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTOC	This LN shall also be used to model the directional time overcurrent (PDOC/IEEE device function number 67, IEEE C37.2:1996). The Definite Time overcurrent (also PTOC/IEEE device function number 51, from IEEE C37.2:1996) shall be modelled by use of PTOC and selecting the related curve.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.
LSET	Rte Extended Setting LN

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5.6.3 Specificities

- The MAXIL function subscribes or not to signals RxBlk or RxPrm from the tele-protection function depending on its variant and configuration.
- The three modules of the MAXIL function associated with several thresholds (S1P, S1T, S2P), are associated to their own respective PTOC LN which are subscribing to the same SV stream. Each PTOC LN publishes his own Op and Str DO.
- The three modules of the MAXIL function publish the following DO subscribed by the SCADA:

  PTOC1 (S1P) => Phase Overcurrent Trip
  PTOC2 (S1T) => Residual Overcurrent trip
  PTOC3 (S2P) => Backup Overcurrent Trip

- Only three-phase tripping is used.
- The diagram of the connection between two substations is explained in §4.4.6.
- The objects intended for setting are characterised by the "setting group" functional constraint. If the modification of settings is intended to be more frequent, as for a Dynamic Line Rating (DLR) type function, the "setting group" functional constraint shall not be used. The present modelling only concerns static setting groups of the function.

5.6.4 Static description

Line Overcurrent Protection (LDMAXIL)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS	DF.MAXI*	
	Mod	ENC		
	NamPlt	LPL		
PTOC1	Beh	ENS		
	Op	ACT.general	DT.MAXI*	Circuit-breaker trip decision sent to the PTRC
	OpDlTmms	ING.setVal		Time delay T1P
	Str	ACD		Starting over current protection and disturbance recording
	StrVal	ASG.setMag		Current threshold S1P
PTOC2	Beh	ENS		
	Op	ACT.general	DT.MAXIT*	Circuit-breaker trip decision sent to the PTRC
	OpDlTmms	ING.setVal		Time delay T1T
	Str	ACD		Mise en route Max-I et init EP
	StrVal	ASG.setMag		Current threshold S1T
PTOC3	Beh	ENS		
	Mod	ENC	MES-STADE2	Activation/deactivation of 2nd stage

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Line Overcurrent Protection (LDMAXIL)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Op	ACT.general	DT.MAXIS*	Circuit-breaker trip decision sent to the PTRC
	OpDlTmms	ING.setVal		Time delay T2P
	Str	ACD		Starting over current protection and disturbance recording
	StrVal	ASG.setMag		Current threshold S2P
PTRC0	Beh	ENS		
	Op	ACT.general		Tripping decision signalling on 3 phases to SCADA and Auto-recloser, fault recoding and breaker failure initialisation
	Str	ACD.general		
	Tr	ACT.general		Trip order to XCBR
LSET0	NamPlt	LPL		
	DlTmms1	ING	T-ENCDEF	Time delay setting for switch on fault logic

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5.6.5 Dynamic description

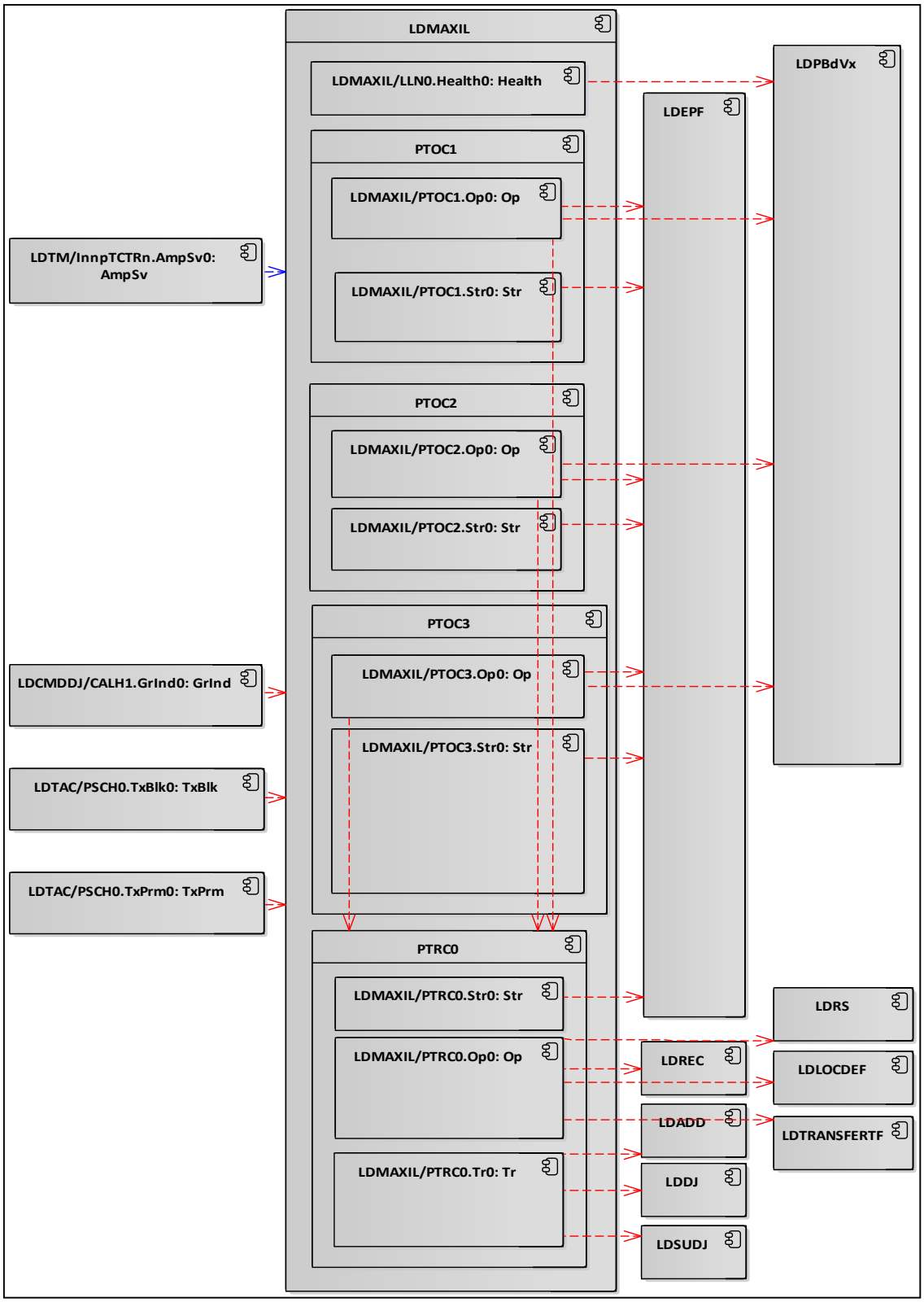

Figure 9: Dynamic description LDMAXIL

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5.7 Cable Shield-to-Ground Protection (LDPMC)

5.7.1 Description of the Function

The cable shield-to-ground protection function (LDPMC) is a maximum current protection connected to a current transformer installed on the unique ground connection of the cable shield. This constraint limits its application to short cables the shield of which is grounded at one single point. Usually, the cable shield-to-ground connection of all 3 phases of a cable are covered by one dedicated current transformer.

LDPMC detects currents circulating in the cable shields of the connection considered. Consequently, it only allows ground faults to be detected on the cable and is not able to detect the faulty phase and faults external to the cable itself.

It can be used for the protection of the following structures:

- Underground connections
- Overhead-underground connections

5.7.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PSCH	This LN shall be used to model the logic scheme for line protection function co-ordination. The protection scheme allows the exchange of the "operate" outputs of different protection functions and conditions for line protection schemes. It includes data objects for teleprotection if applicable. In this case, all appropriate data objects shall be subscribed.
PIOC	A function that operates with no intentional time delay when the current exceeds a preset value. The suffix TD should be used (e.g.,50TD) to describe a definite time overcurrent function. Use 50BF for a current monitored breaker failure function.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

5.7.3 Specificities

- When there are twinned cables or several sections of cable to protect, the LDPMC is instantiated as many times as needed. (e.g. secondary connections of auto-transformers or transformers). Each LDPMC monitors the current of a grounded shield of a three-phase cable.
- The trip of LDPMC is associated to the inhibition of the autorecloser cycles. A recloser inhibition order transmitted by the tele-protection function is not provided by IEC 61850 ed2. Consequently, the transmission of this order is modelled using DO PSCH.TxTr In this case, the bay at the other end of the line interprets the DO TxTr as a recloser cycle inhibition order (configuration).
- In the case of a bay (SP) providing backup for generator tripping, the tripping coming from the PTRC (Tr) will not be configured. In this case, TxTR is only, used to signal a fault.
- The diagram of the connection between two substations is explained in §4.4.6.

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- LDPMC does not include a time delayed operation. For this reason, PIOC and not PTOC is used.

5.7.4 Static description

(LDPMC)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS	DF.PMC	
	Mod	ENC		
	NamPlt	LPL		
PSCH0	Beh	ENS		
	TxTr	ACT	EMI.DESARM.ARS.*Vv	To Tele-protection trip(TD3, TD4 or TAC3) or Auto recloser inhibition order (R-GOOSE)
	Op	ACT		
PIOC0	Beh	ENS		
	Op	ACT.general		Circuit-breaker tripdecision sent to the PTRC
	StrVal	ASG.setMag	S-IC1	Current threshold
PTRC0	Beh	ENS		
	Str	ACD.general		
	Op	ACT.general	DT.MCAB or DF.CABL.T	Tripping indication to SCADA, Auto recloser inhibition order and Breaker failure initialisation and capacitor monitoring function (CONT-COND)
	Tr	ACT.general		Trip order to XCBR

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5.7.5 Dynamic description

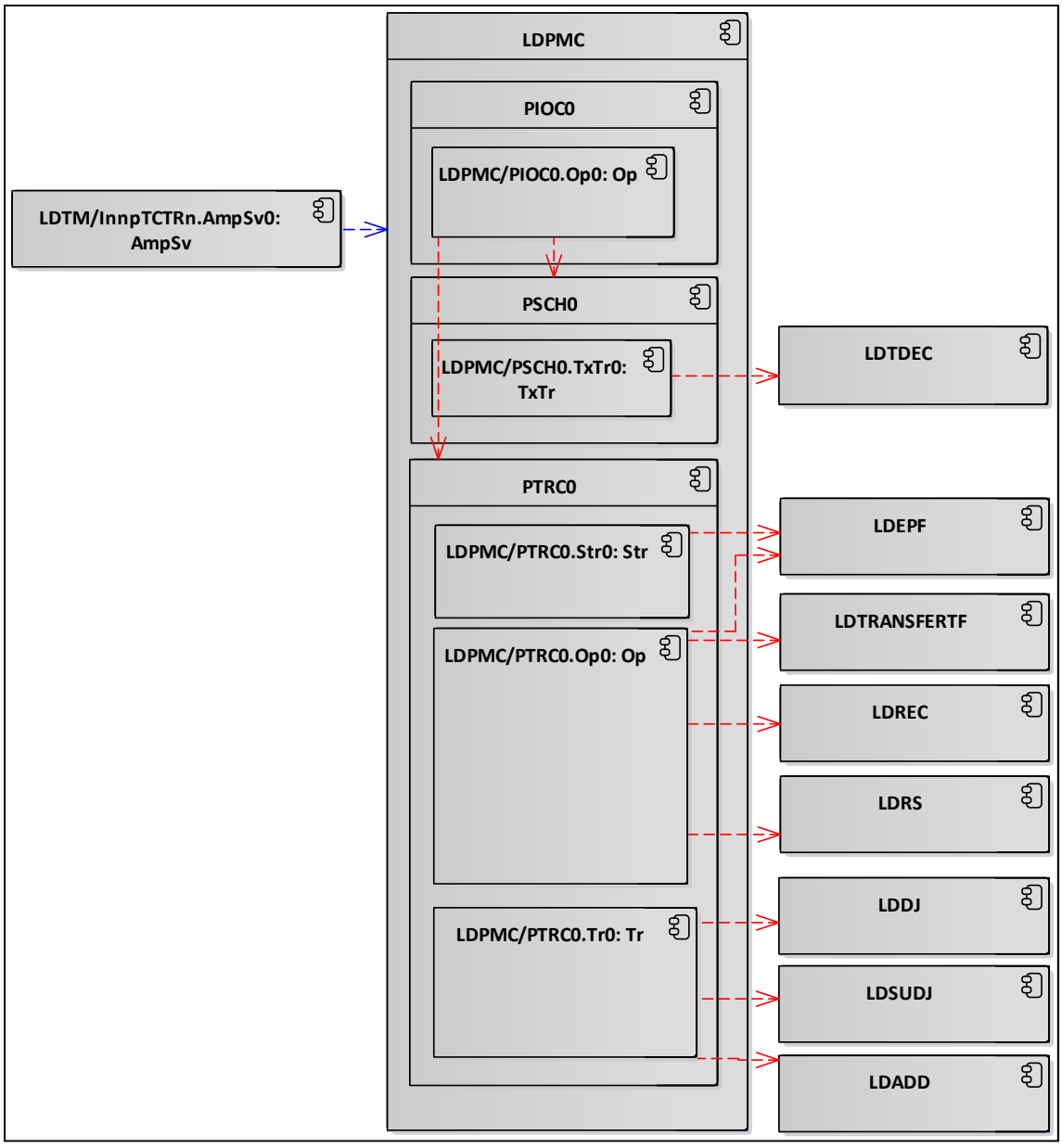

Figure 10: Dynamic description LDPMC

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5.8 Line Overload Protection LD (LDPSL)

5.8.1 Description of the Function

The purpose of the line overload protection function (LDPSL) is to elaborate an alarm after a delay (Ta) when an overload appears and then to order the tripping of the line if the overload not disappeared another time delay (Td).

5.8.1.1 Timeline

The operation time diagram is described in the figure below:

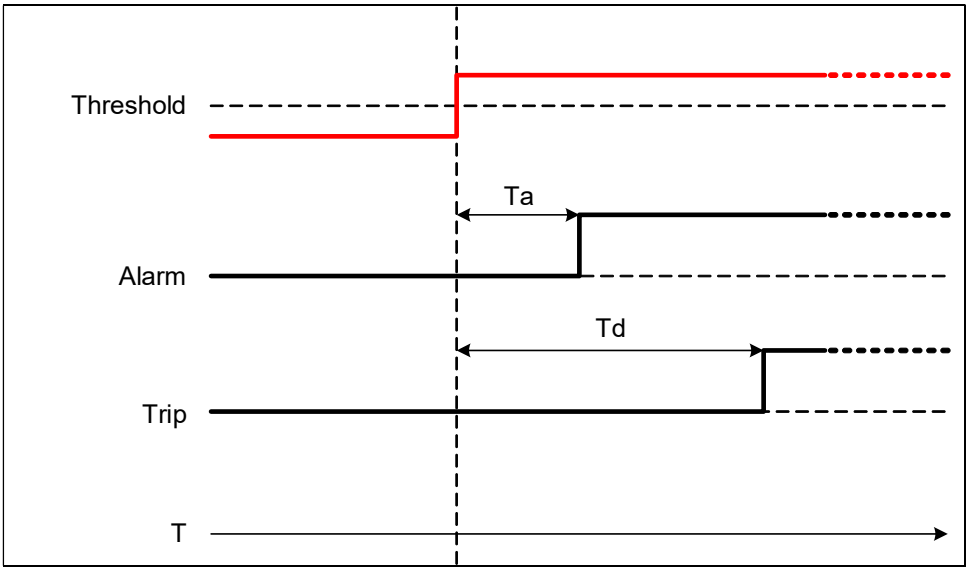

Figure 11: PSL operating timeline

- Ta is the alarm time delay
- Td is the trip time delay.

5.8.1.2 Seasonal regimes

The maximal load current of a line depends, among other factors, on the ambient temperature. Since the average maximal temperature varies with the seasons, a different threshold can be associated to each season for a given line.

The change from one regime to another involves the signalling of the stopping of the active regime and the activation of the new regime. E.g. the change from INTERSAI2 to HIVER1 leads to:

1. Stop publication of signal INTERSAI2
2. Start of publication of signal HIVER1 and maintaining it

It is possible to independently inhibit from 1 to 3 thresholds.

5.8.2 LNs used

LN	Description
FXOT	Logical node FXOT shall be used to set a high-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, contro or alarm function is based on other physical measurements than primary electrical data.

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LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTOC	This LN shall also be used to model the directional time overcurrent (PDOC/IEEE device function number 67, IEEE C37.2:1996). The Definite Time overcurrent (also PTOC/IEEE device function number 51, from IEEE C37.2:1996) shall be modelled by use of PTOC and selecting the related curve.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

5.8.3 Specificities

- The specification PSL/PSC (cf. [13]) specifies the use of a current criterion for the "overload protection" functionality. Therefore, the LN PTOC and FXOT are used with current inputs instead of LN PDOP which uses a power-based criterion.
- One PTOC/FXOT pair is used per threshold. This function uses three thresholds, i.e. three pairs. The thresholds are normally associated with an admissible overload time (e.g. 20 minutes, 10 minutes, etc.) The thresholds are set according to the corresponding regime (summer, winter, etc.) and using SGCB.
- LDPSL is instantiated for each bay, the seasonal regime being particular to each feeder.
- The LN PTOC of the standard only manages the time delay leading to a trip (Td) published by the DO PTRC.Op. The Str of PTOC indicates the detection of a fault (starting) and cannot be used for the alarm output as it cannot be associated with a time delay. Consequently, the time delay leading to an alarm (Ta) is modelled by the LN FXOT which uses the same input data as the PTOC.
- The use of DO Op from different PTOCs for signalling of tripping by the overload protection (DT.SURCHARGE) involves making a logical grouping. The use of the Op from PTRC for this indication is simpler
- The objects intended for setting are characterised by the "setting group" functional constraint. If the modification of the settings was more frequent, as foreseen for a DLR function, the SP (set point) functional constraint must be used (cf. §5.9). The present modelling only concerns static setting groups of the function.
- The individual inhibition of each threshold is possible by the commands on FXOT*.Mod and PTOC*.Mod.

5.8.4 Static description

Line Overload Protection (LDPSL)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
FXOT*	Beh	ENS		
	Mod	ENC		Command to inhibit threshold* (when set to off)

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Line Overload Protection (LDPSL)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Op	ACT.general	AL.SUR.*	Decision to issue an alarm following the detection of overload and the expiration of the alarm threshold (* = 1, 5, 10, 20 or 60 depending on the threshold and configuration)
	OpDlTmms	ING.setVal		Alarm delay Ta* The value is managed by the SGCB and but does not vary with the regimes
	StrVal	ASG.setMag		IS* current threshold (same value as for PTOC) The value is managed by the SGCB and varies with the regimes
LLN0	Beh	ENS	PSL/PSC	Signal "Function activated/deactivated"
	Health	ENS	DF.PSL/DF.PSC	
	Mod	ENC	PSL/PSC	Command to activate / deactivate the function(ES/HS)
	NamPlt	LPL		
	The SGCB mechanism is used to manage the 6 regimes of the PSL (Signals: SUR.ETE, SUR.ETE2, SUR.SAI1, SUR.SAI2, SUR.HIV1, SUR.HIV2 ; TC : ETE.TC, ETE2.TC, SAI1.TC, SAI2.TC, HIV1.TC, HIV2.TC)			
PTOC*	Beh	ENS		
	Mod	ENC		Command to inhibt threshold* (when set to off)
	Op	ACT.general		Circuit-breaker trip order sent to the PTRC
	OpDlTmms	ING		Alarm ltime delay Td* The value is managed by the SGCB and but does not vary with the regimes.
	Str	ACD.general		Overload detection (* = 1, 2 or 3 depending on the threshold)
	StrVal	ASG.setMag		Current threshold IS* The value is managed by the SGCB and varies with the regimes
PTRC0	Beh	ENS		
	Op	ACT.general	DT.SURCHARGE	Tripping decision of 3 phases
	Tr	ACT.general		Trip order to XCBR

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5.8.5 Dynamic description

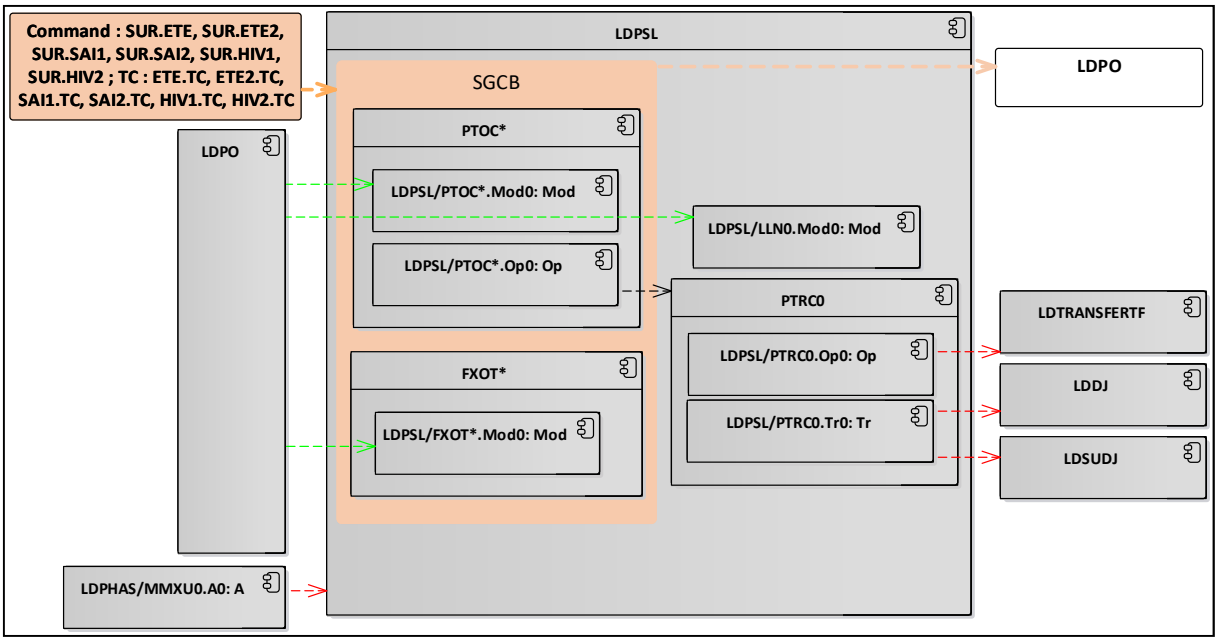

Figure 12: Dynamic description LDPSL

5.9 Dynamic Line Overload Protection LD (LDPSLDLR)

5.9.1 Description of the Function

The task of the dynamic overload protection function LDPSLDLR is to elaborate an alarm after a time delay when the overload appears and then to order the tripping of the line if the overload persists.

Unlike the LDPSL (cf. §5.8), the dynamic overload protection may frequently receive updates of the threshold, for example from a Wide Area Automation or a zonal automaton. The management of thresholds with the SGCB mechanism is then not applicable. Le LDPSLDLR does not use seasonal regimes.

Timeline

The timeline of the operation is the same which is described in Figure 11 (cf. §5.8).

5.9.2 LNs used

LN	Description
FXOT	Logical node FXOT shall be used to set a high-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, contro or alarm function is based on other physical measurements than primary electrical data.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTOC	This LN shall also be used to model the directional time overcurrent (PDOC/IEEE device function number 67, IEEE C37.2:1996). The Definite Time overcurrent (also PTOC/IEEE device function number 51, from IEEE C37.2:1996) shall be modelled by use of PTOC and selecting the related curve.

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LN	Description
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

5.9.3 Specificities

- The LN PTOC of the standard only manages the time delay leading to a trip (Td) published by PTRC.Op. PTOC.Str indicates the detection of a fault (starting) and cannot be used for the alarm output as it cannot be associated with a time delay. Consequently, the time delay leading to an alarm (Ta) is published by the LN FXOT which subscribes to the same input data as the PTOC.
- For the LDPSLDLR, there is only a single instantiation of LN FXOT and PTOC.
- The objects intended for the setting of LDPSLDLR are characterised by the SP (Setting - outside Setting group) functional constraint as the modification of the settings can occur frequently (several times per second).
- It is considered that, for the FCS, the alarms and the tripping correspond to a "One minute" overload threshold (the most constraint).

5.9.4 Static description

Dynamic Line Overload Protection (LDPSLDLR)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
FXOT0	Beh	ENS		
	Op	ACT.general	AL.SUR.1	Decision to issue an alarm following the detection of overload and the expiration of the alarm threshold.
	OpDlTmms	ING.setVal		Alarm time delay Ta.
	StrVal	ASG.setMag		IS current threshold (same value as for PTOC)
LLN0	Beh	ENS		Signal "Function activated/deactivated"
	Health	ENS		
	Mod	ENC		Command to activate / deactivate the function(ES/HS)
	NamPlt	LPL		
PTOC0	Beh	ENS		
	Op	ACT.general		Circuit-breaker trip order sent to the PTRC
	OpDlTmms	ING.setVal		Alarm time delay Td
	Str	ACD.general		Overload detection
	StrVal	ASG.setMag		Current threshold IS
PTRC0	Beh	ENS		
	Op	ACT.general	DT.SURCHARGE	Tripping indication of 3 phases to SCADA
	Str	ACD.general		
	Tr	ACT.general		Trip order to XCBR

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5.9.5 Dynamic description

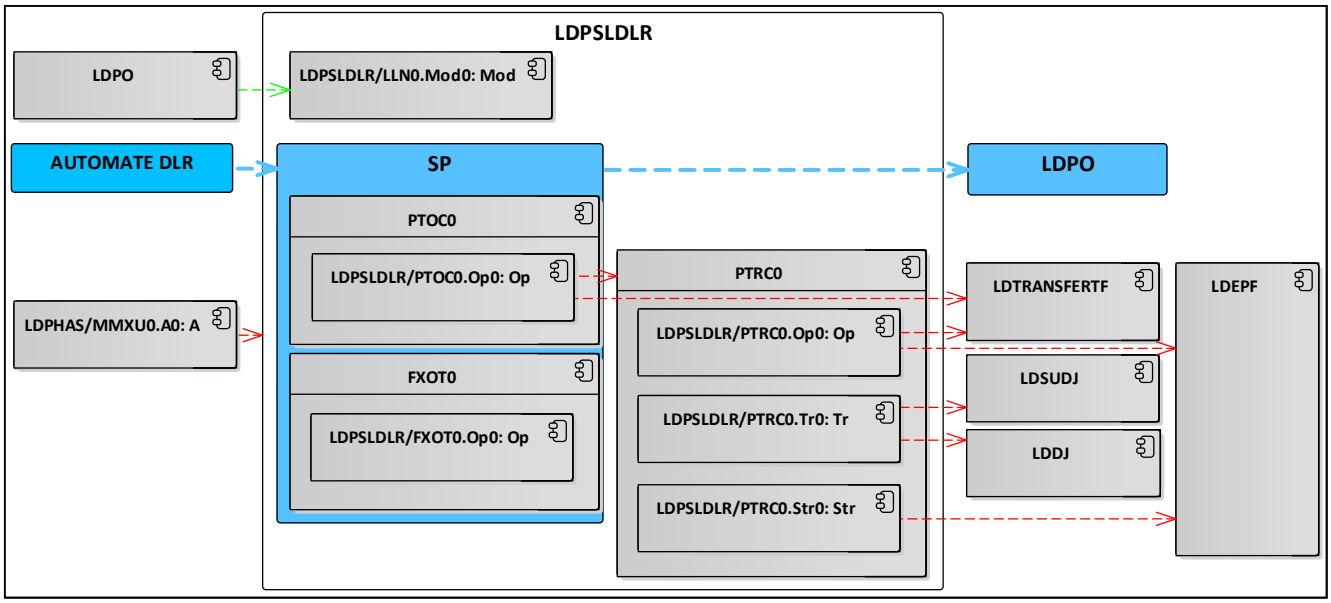

Figure 13: Dynamic description LDPSDLDLR

5.10 Circuit Breaker Pole Mismatch Protection (LDDISCP)

5.10.1 Description of the Function

The Circuit Breaker Pole Mismatch Protection (LDDISCP) is considered as a protection in this document and consequently, issues a trip (PTRC.Tr) to LDDJ. Its task is to trip in three-phase upon detection of mismatch of the poles of the protected circuit breaker, i.e. if the poles do not attain a consistent position in a given time delay.

It should be noted that the signalling of the mismatch of the position of the three poles of a circuit-breaker is treated by the LDDJ (cf. § 7.2).

5.10.2 LNs used

LN	Description
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
LSET	Rte Extended Setting LN
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

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5.10.3 Specificities

- The time delay T-DISCP (cf. [16]) is managed at the application level. It represented by PSCH0.OpDlTmms

5.10.4 Static description

Circuit Breaker Pole Mismatch Protection (LDDISCP)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
GAPC0	Beh	ENS		
	Op	ACT.general		Circuit-breaker trip order sent to the PTRC
LLN0	Beh	ENS		
	Health	ENS		Poles mis-match function state
	Mod	ENC		
	NamPlt	LPL		
LSET0	NamPlt	LPL		
	OpDlTmms	ING	T-DISCP	Time delay before pole discrepancy tripping
PTRC0	Beh	ENS		
	Op	ACT.general	DISC.POL	Tripping decision of 3 phases
	Tr	ACT.general		Trip order to XCBR

5.10.5 Dynamic description

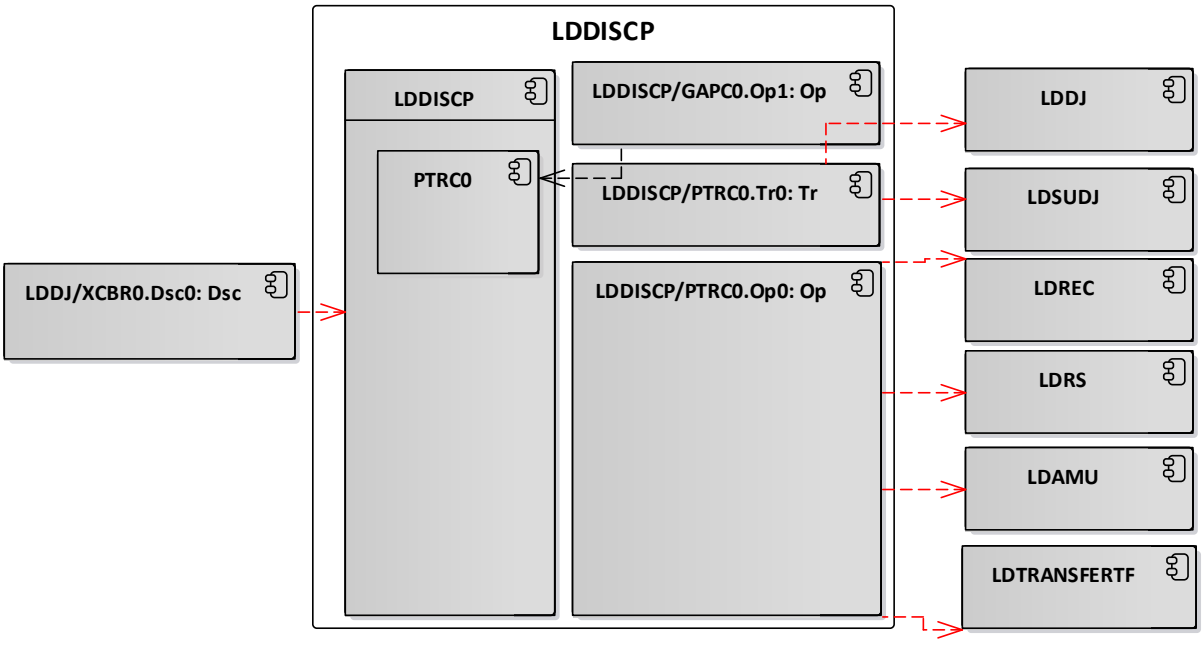

Figure 14: Dynamic description LDDISCP

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5.11 Transformer Tertiary Circuit Protection (LDPDTTR)

5.11.1 Description of the Function

This function is associated to autotransformers and transformers and protects their tertiary circuit. The tertiary circuit is the usually 20kV winding of transformers intended for powering auxiliary transformers of the substation. It also can be used to supply FACTS.

5.11.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PIOC	A function that operates with no intentional time delay when the current exceeds a preset value. The suffix TD should be used (e.g.,50TD) to describe a definite time overcurrent function. Use 50BF for a current monitored breaker failure function.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

5.11.3 Specificities

- If the TRANSFERT mode is activated, the LDADD associated with coupling is initialised upon receipt of the tripping decision from LDPDTTR (cf. LDTRANSFERTC §8.20).

5.11.4 Static description

Transformer Tertiary Circuit Protection (LDPDTTR)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		PDT function state
	Mod	ENC		
	NamPlt	LPL		
PIOC0	Op	ACT.general		"PDT tripping" signalling
PTRC0	Op	ACT.general	DT.ITERT	Signal of 3 phase trip decision
	Str	ACD.general		Start PDT
	Tr	ACT.general		Trip order to XCBR

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5.11.5 Dynamic description

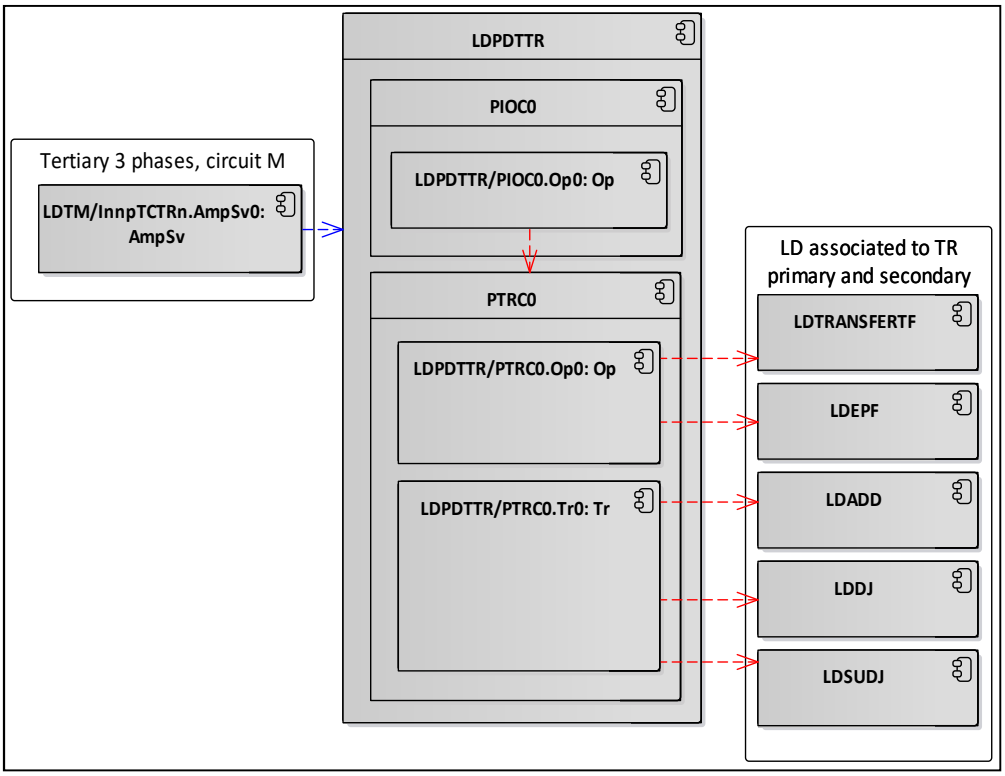

Figure 15: dynamic description LDPDTTR

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5.12 Transformer Overload Protection (LDPSTTR)

5.12.1 Description of the Function

The task of this function is to elaborate alarms when an overload (overcurrent) appears and to order the trip of the transformer when the overload condition persists for a determined time (cf. [13]).

5.12.2 LNs used

LN	Description
FXOT	Logical node FXOT shall be used to set a high-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, contro or alarm function is based on other physical measurements than primary electrical data.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTOC	This LN shall also be used to model the directional time overcurrent (PDOC/IEEE device function number 67, IEEE C37.2:1996). The Definite Time overcurrent (also PTOC/IEEE device function number 51, from IEEE C37.2:1996) shall be modelled by use of PTOC and selecting the related curve.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.
YPTR	This LN represents a power transformer and the associated equipment with all its associated data and parameters (if there are any) as well as its behavior concerning communication in the substation automation system.

5.12.3 Specificities

- The memorised temperature θM (cf. requirement PST-06 [13]) is treated at the application level and is not modelled in this document.
- The requirement PST10 requires the publication of a continuous measurement of the transformer temperature. This measurement is modelled by a specific LN in the LDITFSUTR (cf. §7.19). This measurement is therefore not issued by the LDPSTTR.

5.12.4 Static description

Transformer Overload Protection (LDPSTTR)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
FXOT1	Op	ACT.general		I>IN Signal "instantaneous crossing of threshold IN".
	StrVal	ASG.setMag	S-IN-1 S-IN-2 S-IN-3 S-IN-4 S-IN-5	Threshold value for I>IN
FXOT2	Op	ACT.general	SUR.I>IN	I>IN (T-AL-N) Signalling "I>IN"

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Transformer Overload Protection (LDPSTTR)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	OpDlTmms	ING		Time delay T-AL-N
	StrVal	ASG.setMag		Threshold value for I>IN
FXOT3	Op	ACT.general		I>IP Signal "instantaneous crossing of threshold IP".
	StrVal	ASG.setMag	S-IP-1 S-IP-2 S-IP-3 S-IP-4 S-IP-5	Threshold value for I>IP
FXOT4	Op	ACT.general	SUR.I>IP AL.SUR20	I>IP (T-AL-P) Signalling "I>IP" Signalling "Overload alarm 20 min"
	OpDlTmms	ING		Time delay T-AL-P
	StrVal	ASG.setMag		Threshold value for I>IP
FXOT5	Op	ACT.general		I>IM blocking order for Tap Changer Signal "instantaneous crossing of threshold S-IM"
	StrVal	ASG.setMag	S-IM-1 S-IM-2 S-IM-3 S-IM-4 S-IM-5	Threshold value for I>IM
FXOT6	Op	ACT.general	SUR.I>IM AL.SUR5	I>IM (T-AL-M) Signalling "I>IM" Signalling "Overload alarm 5 min"
	OpDlTmms	ING		Time delay T-AL-M
	StrVal	ASG.setMag		Threshold value for I>IM
FXOT7	Op	ACT.general	AL.T.SUP	θ > θS Oil temperature above threshold S-Θs
	StrVal	ASG.setMag		Threshold value for S-Θs
FXOT8	Op	ACT.general	AL.T.LIM	θ > θL Oil temperature above threshold S-θL
	StrVal	ASG.setMag		Threshold value for S-ΘL
FXOT9	Op	ACT.general		I>IS Signal "instantaneous crossing of threshold S-IS"

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Transformer Overload Protection (LDPSTTR)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	StrVal	ASG.setMag	S-IS-1 S-IS-2 S-IS-3 S-IS-4 S-IS-5	Threshold value for I>IS
FXOT10	Op	ACT.general	SUR.I>IS AL.SUR5	I>IS (T-AL-S) Signalling "I>IS" Signalling "Overload alarm 5 min"
	OpDlTmms	ING		Time delay T-AL-S
	StrVal	ASG.setMag		Threshold value for I>IS
FXOT11	Op	ACT.general		I>I-AERO1
	StrVal	ASG.setMag		Threshold value for I>I-AERO1
FXOT12	Op	ACT.general		I>I-AERO2
	StrVal	ASG.setMag		Threshold value for I>I-AERO2
LLN0	Beh	ENS		
	Health	ENS	DF.PST	PST function state
	Mod	ENC		
	NamPlt	LPL		
	The SGCB mechanism is used to manage the 5 regimes of the LDPSTTR (Signal: SUR.ETE, SUR.ETE2, SUR.SAI1, SUR.SAI2, SUR.HIV1, SUR.HIV2 ; Comand : ETE.TC, SAI1.TC, SAI2.TC, HIV1.TC, HIV2.TC)			
PTOC1	Op	ACT.general		I>IP (T-DEC-P)
	OpDlTmms	ING		Time delay T-DEC-P
	StrVal	ASG.setMag		Threshold value for I>IP tripping
PTOC2	Op	ACT.general		I>IM (T-DEC-M)
	OpDlTmms	ING		Time delay T-DEC-M
	StrVal	ASG.setMag		Threshold value for I>IM tripping
PTOC3	Op	ACT.general		I>IS (T-DEC-S)
	OpDlTmms	ING		Time delay T-DEC-S
	StrVal	ASG.setMag		Threshold value for I>IS tripping
PTRC0	Op	ACT.general	DT.SUR	Signal of 3 phases tripping decision
	Tr	ACT.general		Trip order to XCBR
YPTR0	Beh	ENS		
	OvlTm	MV		Estimated time for overloaded operation

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5.12.5 Dynamic description

Dynamic description is available in appendix 12.3

5.13 Power Transformer Thermal Protection (LDPTHTR) [PTP]

5.13.1 Description of the Function

The Main Protection of the Power Transformer (PTP) is described in the specification and is broken down as follows:

LDPTHTR	**Function which treats the temperature and the cooling system**
LDPMAXITR	Overcurrent Protections
LDPBCHTR	Buchholz protection
LDPDSQTR	HV zero sequence current protection

The transformer protection function ensures the elimination of internal faults of transformers or associated equipment, i.e.

- Auxiliary power supply transformers
- The neutral point transformer (for the Yd transformer coupling)
- The neutral point-to-ground reactance
- The tap changer

It also ensures the backup protection for faults on the secondary side of the power transformer, using over current protections.

Some functions or outputs only concern the bays associated to the primary or the secondary of the power transformer.

5.13.2 LNs used

LN	Description
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.
SFIR	This logical node represents fire supervision

5.13.3 Specificities

- The GAPC indicates power transformer tripping caused by stop of cooling pump.

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- The power transformer thermal protection is linked to the secondary side (winding) of a Power transformer (cf [17].). For this reason, the LDPTHTR subscribes to the LDCMDDJ of the circuit breaker connect to the secondary terminals of the transformer in order to obtain the information if this side is energised (LDCMDDJ/FXUT1.Op)
- The management of temperature alarms of the PTP (Main protection of the power transformer) is integrated in the LDAEROTEMP (cooling group interface), which is more consistent.
- Concerning the LDPTHTR, if the PIT (fire protection) function is not implemented, the DO FireAlm of the LN SFIR is used to block the pit pump or the air extraction.

5.13.4 Static description

Thermal protection of the transformer bay (LDPTHTR)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
GAPC0	Op	ACT		Trip because of pump stop
LLN0	Beh	ENS		
	Health	ENS		Contributes to DF.PTP signaling
	Mod	ENC		
	NamPlt	LPL		
PTRC0	Op	ACT.general	DT.POMP DT.PO.SE DT.PO.SH	Tripping decision on 3 phases to SCADA
	Tr	ACT.general		Trip order to XCBR for both sides of transformer
SFIR0	FireAlm	SPS		Incorporated into 90-3

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5.13.5 Dynamic description

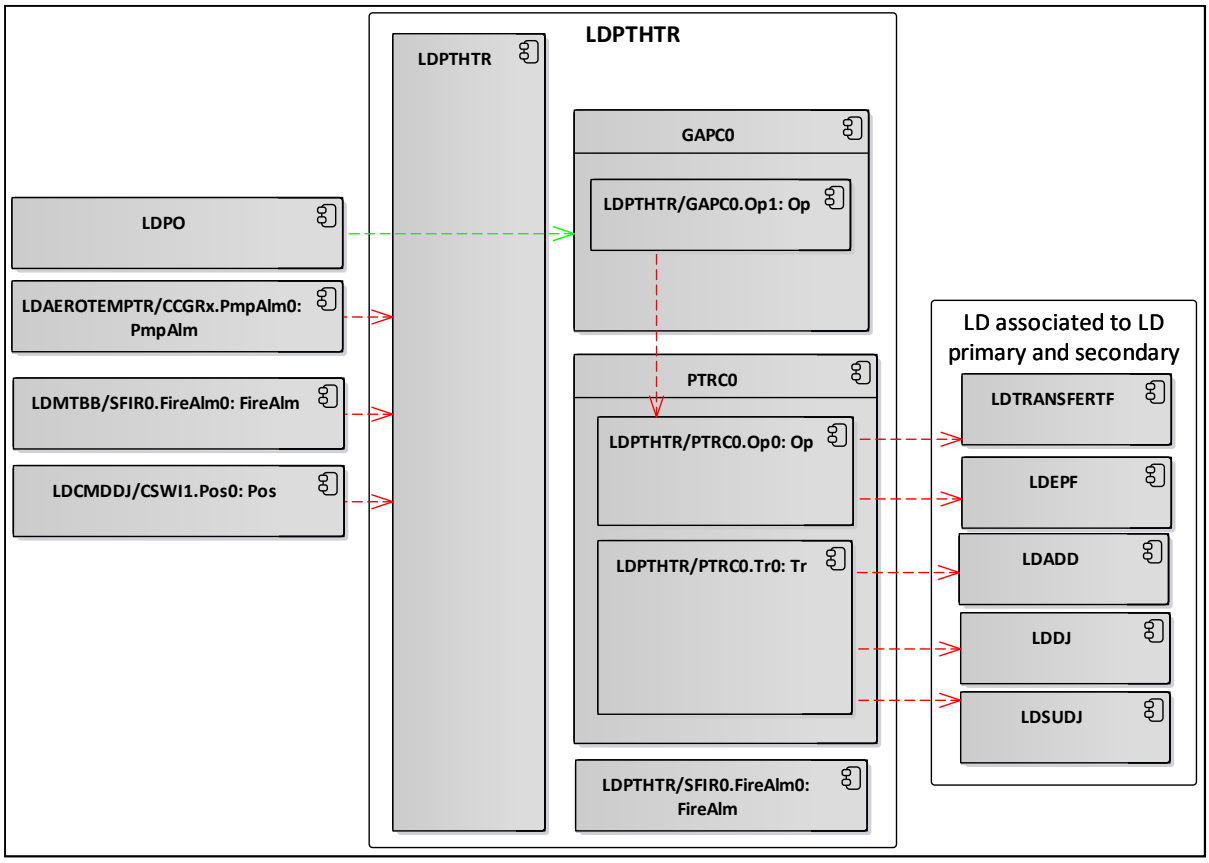

Figure 16: Dynamic description LDPTHTR

5.14 Power Transformer Overcurrent Protection (LDPMAXITR) [PTP]

5.14.1 Description of the Function

The Main Protection of the Power Transformer (PTP) is described in the specification and is broken down as follows:

LDPTHTR	Function which treats the temperature and the cooling system
LDPMAXITR	**Overcurrent Protections**
LDPBCHTR	Buchholz protection
LDPDSQTR	HV zero sequence current protection

The transformer protection function ensures the elimination of internal faults of transformers or associated equipment, i.e.

- Auxiliary power supply transformers
- The neutral point transformer (for the Yd transformer coupling)
- The neutral point-to-ground reactance
- The tap changer

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It also ensures the backup protection for faults on the secondary side of the power transformer, using over current protections.

Some functions or outputs only concern the bays associated to the primary or the secondary of the power transformer.

5.14.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTOC	This LN shall also be used to model the directional time overcurrent (PDOC/IEEE device function number 67, IEEE C37.2:1996). The Definite Time overcurrent (also PTOC/IEEE device function number 51, from IEEE C37.2:1996) shall be modelled by use of PTOC and selecting the related curve.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

5.14.3 Specificities

- The Main Power Transformer Protection (PTP) specification (cf. [17] § 6.1.4) provides several options for the treatment of the position of the HV circuit-breaker and the transfer trip behaviour. Their effect is a modification of the signal naming at SCADA. This treatment in the modelling will be performed in the LDPO. This implies that it is not necessary to subscribe the LD to the position of the HV circuit-breaker nor to the transfer indication.
- Some of the DO Op of the PTOC LNs are used to elaborate the blocking information (See specification cf. [17]).
- The VEFOSSE-VEAIR function associated with the transformer pit is incorporated into the Main Power Transformer Protection (PTP) (LDPTHTR and LDPMAXITR) if the system doesn't have a specific PIT (fire protection) function. Concerning the LDPMAXITR, the DO PTOCx.Op of the PTOC1/2/3 are used to block the pit pump or the air extraction.

5.14.4 Static description

Power Transformer Overcurrent Protection (LDPMAXITR)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Contributes to DF.PTP signalling
	Mod	ENC		
	NamPlt	LPL		
PTOC1	Op	ACT.general	DT.MAXI	Trip indication MAX I HV side and pit pump and air extraction blocking
PTOC2	Op	ACT.general	DT.CU.TR or DT.CU.AT or DT.CU.RE	Trip indication for main transformer (TP) tank ground fault

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Power Transformer Overcurrent Protection (LDPMAXITR)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
PTOC3	Op	ACT.general	DT.CUTPN or DT.CUBPN	Trip indication for ground fault of neutral point transformer (TPN) and neutral-to-ground reactance (BPN) tank
PTOC4	Op	ACT.general	DT.IRTSA	Trip indication neutral -to-ground overcurrent protection of auxiliary supply transformer (TSA)
PTOC5	Op	ACT.general	DT.IR.HT or DT.IN	Trip indication HV neutral -to-ground overcurrent protection of HV
PTRC0	Op	ACT.general	E.TPTP*	Indication of 3 phase Trip to SCADA And remote trip indication if implemented
	Str	ACD.general		
	Tr	ACT.general		trip order to XCBR to both circuit breakers of the transformer

5.14.5 Dynamic description

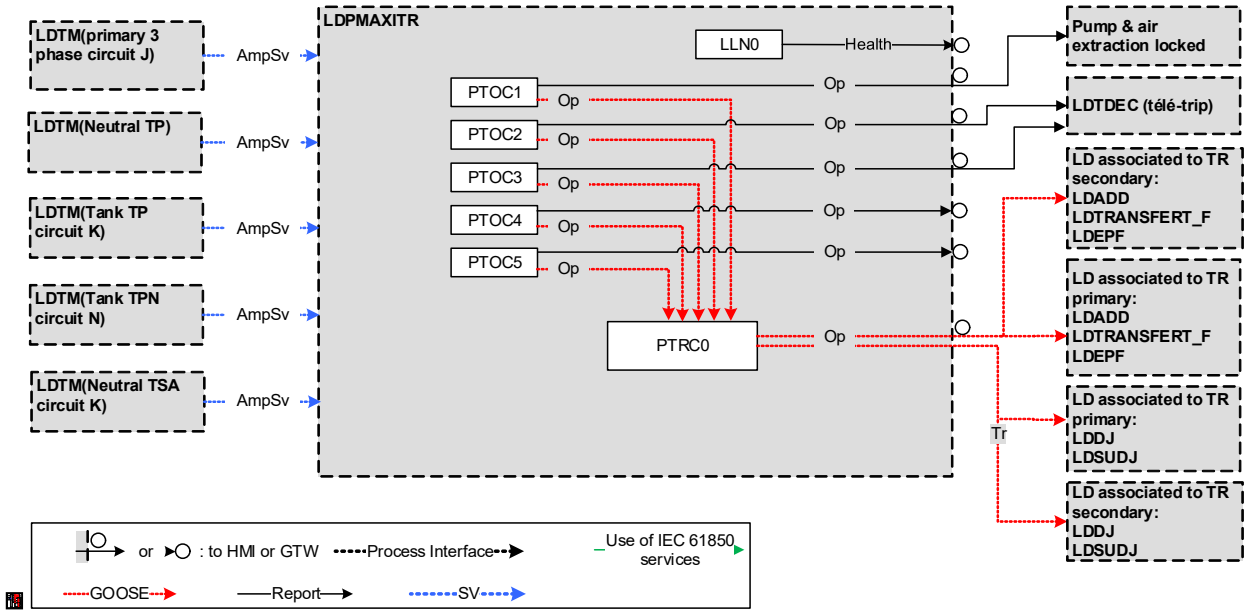

Figure 17: Dynamic description LDPMAXITR

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5.15 Transformer Bay Buchholz Protection (LDPBCHTR) [PTP]

5.15.1 Description of the Function

The Main Protection of the Power Transformer (PTP) is described in the specification and is broken down as follows:

LDPTHTR	Function which treats the temperature and the cooling system
LDPMAXITR	Overcurrent Protections
LDPBCHTR	**Buchholz protection**
LDPDSQTR	HV zero sequence current protection

The transformer protection function ensures the elimination of internal faults of transformers or associated equipment, i.e.

- Auxiliary power supply transformers
- The neutral point transformer (for the Yd transformer coupling)
- The neutral point-to-ground reactance
- The tap changer

It also ensures the backup protection for faults on the secondary side of the power transformer, using over current protections.

Some functions or outputs only concern the bays associated to the primary or the secondary of the power transformer.

5.15.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

5.15.3 Specificities

- The use of normal and backup trip circuit does not make sense in an IEC 61850 (process bus) context. Consequently, it has been decided to use only one single DO for the trip order (PTRC.Tr), which can be subscribed by several physical trip outputs.
- The DO GasInsTr of the LDMTBB is used to send the trip order to PRTC as suggested in the standard.
- Buchholz Alarms are published by the LDMTBB (cf. §7.5) which presents the interface for reactance type equipment. LDPBCHTR only regroups the trip order processed by the Main Power Transformer Protection (PTP cf. [17]).
- If the blocking information, associated to the Buchholz protections (cf. [17] - § 6.2.1.1), is configured in service, then the DO SIML.GasInsTr (of LDMTBB) is used for this function.
- The signals associated with the Buchholz relay are generated by the instances of LDMTBB (cf. § 7.5).

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5.15.4 Static description

Transformer Bay Buchholz Protection (LDPBCHTR)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Contributes to DF.PTP signalling
	Mod	ENC		
	NamPlt	LPL		
PTRC0	Op	ACT	E.TPTP*	Signal of 3 phase Trip decision to SCADA
	Tr	ACT		trip order to XCBR to both side of transformer And remote trip indication if implemented

5.15.5 Dynamic description

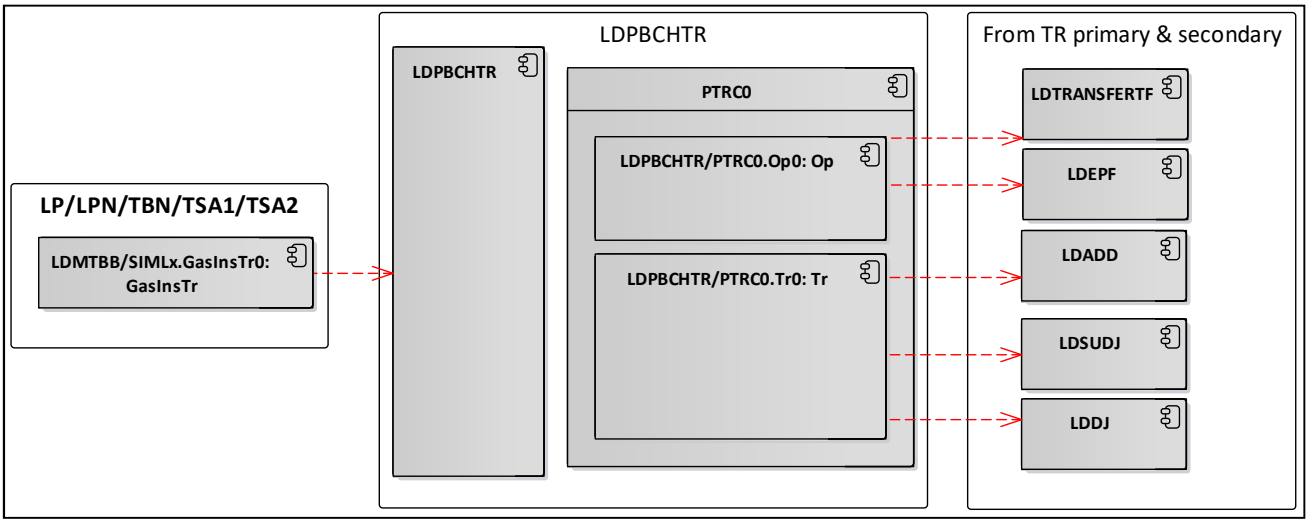

Figure 18: Dynamic description LDPBCHTR

5.16 Transformer Zero Sequence Current Protection (LDPDSQTR) [PTP]

5.16.1 Description of the Function

The Main Protection of the Power Transformer is described in the specification and is broken down as follows:

LDPTHTR Function which treats the temperature and the cooling system
LDPMAXITR Overcurrent Protections
LDPBCHTR Buchholz protection
LDPDSQTR **HV zero sequence current protection**

The transformer protection function ensures the elimination of internal faults of transformers or associated equipment, i.e.

- Auxiliary power supply transformers

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- The neutral point transformer (for the Yd transformer coupling)
- The neutral point-to-ground reactance
- The tap changer

It also ensures the backup protection for faults on the secondary side of the power transformer, using over current protections.

Some functions or outputs only concern the bays associated to the primary or the secondary of the power transformer.

5.16.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTOC	This LN shall also be used to model the directional time overcurrent (PDOC/IEEE device function number 67, IEEE C37.2:1996). The Definite Time overcurrent (also PTOC/IEEE device function number 51, from IEEE C37.2:1996) shall be modelled by use of PTOC and selecting the related curve.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

5.16.3 Specificities

- The use of normal and backup trip circuit does not make sense in an IEC 61850 (process bus) context. Consequently, it has been decided to use only one single DO for the trip order (PTRC.Tr), which can be subscribed by several physical trip outputs.
- The LDPDSQTR can be activated and deactivated (LLN0.Mod/Beh)
- The activation or deactivation of trip is performed by configuration (LDDJ subscribe or not to PTRC.Tr).
- IEC 61850-7-5 defines LN PPBR (reverse phase protection) to be used for this type of protection. According to IEC 61850-7-4, this is modelled by a PTOC. This needs clarification by WG57. LN PTOC is used in this document.

5.16.4 Static description

Transformer Zero Sequence Current Protection (LDPDSQTR)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		Signal "Function activated/deactivated"
	Health	ENS		Contributes to DF.PTP signaling
	Mod	ENC		Command to activate / deactivate the function (ES/HS)
	NamPlt	LPL		
PTOC0	Op	ACT.general	AL.NHT or AL.IN	HV IN imbalance
PTRC0	Beh	ENS		
	Op	ACT		Tripping decision on 3 phases to SCADA
	Str	ACD.general		

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Transformer Zero Sequence Current Protection (LDPDSQTR)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Tr	ACT		trip order to XCBR

5.16.5 Dynamic description

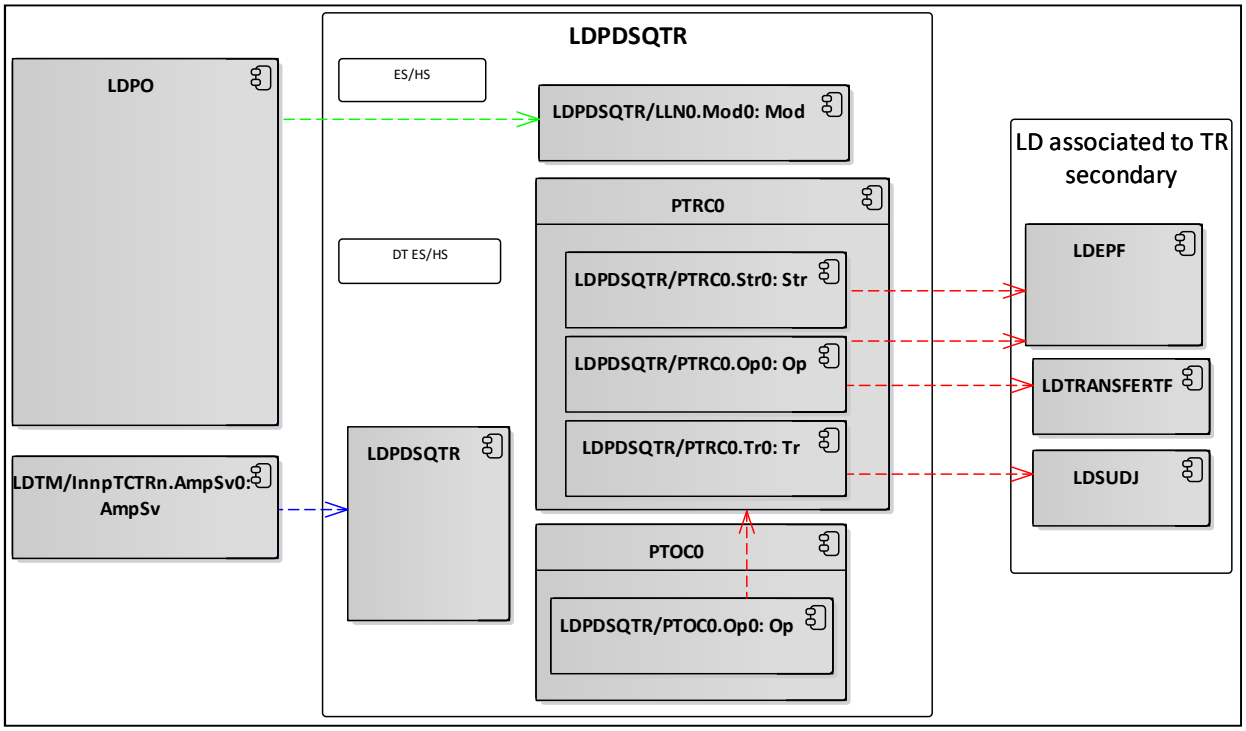

Figure 19: Dynamic description LDPDSQTR

5.17 Transformer Differential Protection (LDPDIFFTR)

5.17.1 Description of the Function

This function protects the power transformers against insulation faults. It is based on a differential comparison of currents from the primary, secondary and tertiary windings.

5.17.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PDIF	This LN shall be used for all kinds of current differential protection. Proper current samples for the dedicated application shall be subscribed.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

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5.17.3 Specificities

n.a.

5.17.4 Static description

Transformer Differential Protection (LDPDIFFTR)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS	DF.DIF.TRANSFO*	Transformer differential protection state
	Mod	ENC		
	NamPlt	LPL		
PDIF1	Op	ACT.general	DT.DIF.TRANSFO*	Indication of trip by PDIFT function
PDIF2	Op	ACT.general	DIF.TRANSF*.REFP	Indication of trip by Primary winding REF function
PDIF3	Op	ACT.general	DIF.TRANSF*.REFS	Indication of trip by Secondary winding REF function
PDIF4	Op	ACT.general	DIF.TRANSF*.REFT	Indication of trip by Tertiary winding REF function
PTRC0	Op	ACT.general		Indication of 3 phase Trip decision
	Str	ACD.general		
	Tr	ACT.general		trip order to XCBR to both sides of transformer

5.17.5 Dynamic description

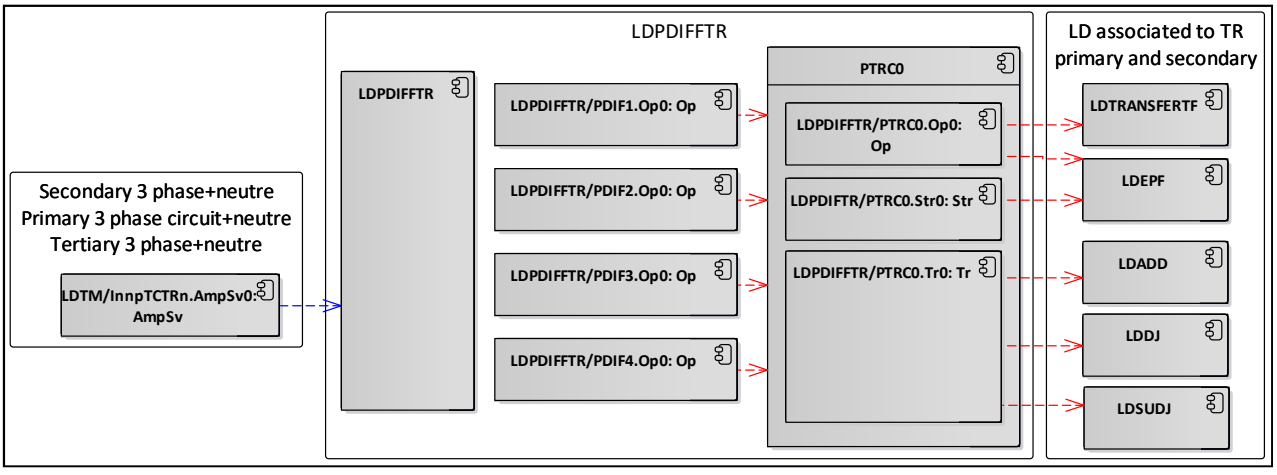

Figure 20: Dynamic description LDPDIFFTR

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5.18 Transformer Primary Backup Protection (LDPSPTR)

5.18.1 Description of the Function

The transformer primary backup protection (PSPT) ensures the backup elimination of a short-circuit affecting the primary connections of the transformer with the busbars (225 kV/HV transformer or 400/225 kV autotransformer).

PSPT is a minimum impedance protection installed on the HV connection of the transformer, which fulfils the following functions:

- The backup elimination of short circuit current contribution from the secondary side of the transformer to a busbar fault at the primary side.
- The backup elimination of a fault between the primary circuit-breaker and the transformer.
- The backup elimination of a fault in the transformer or on the secondary connection in case of failure of the protection systems associated to the primary transformer bay.
- The backup elimination of the primary current contribution to a busbar fault on the secondary of the power transformer.

5.18.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PDIS	The phase start value and ground start value are minimum thresholds to release the impedance measurements depending on the distance function characteristic given by the algorithm and defined by the settings. The settings replace the data object curve as used for the characteristic on some other protection LNs. One instance of PDIS per zone shall be used.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.
TVTR	The voltage is delivered as sampled values. The sampled values are transmitted as engineering values, that is as "true" (corrected) primary voltage values. Therefore, the transformer ratio and the correction factors are of no interest for the transmitted samples but for maintenance purposes of an external conventional (magnetic) transducer only. In addition, status information is provided and some other settings are accepted from the LN TVTR.

5.18.3 Specificities

- In the model, several instances of LN PDIS are used to model the different tripping zones provided in the PSPTR (forward / backward, 6 impedance loops).
- It is considered that the starting threshold current criteria), concerns the application and is therefore not represented in the modelling.
- The VERTHTPX function is incorporated into the PSPT. The activation/deactivation of the VERTHTPX function is set by configuration via the subscription of LN.
- The use of LN TVTR is necessary for modelling the sub-function which detects fuse failure in the subscribed voltage signals. This LN does not directly represent the voltage transformer.

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5.18.4 Static description

Transformer Primary Backup Protection (LDPSPTR)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS	DF.PSPT	PSPT function state
	Mod	ENC		
	NamPlt	LPL		
PDISx	Beh	ENS		
	Op	ACT		Tripping decision to PTRC
	Str	ACD.general	PSPT.MR	PSPT starting
PTRC0	Beh	ENS		
	Op	ACT.general	DT.PSPT	Tripping decision on 3 phases to SCADA
	Str	ACD.general		
	Tr	ACT.general		trip order to XCBR
UnnpTVTR0	Beh	ENS		
	VRtg	ASG.setMag		
	HzRtg	ASG.setMag		
	FuFail	SPS		Contributes to the elaboration of the MQ.UI signalling by the MQUI function.

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5.18.5 Dynamic description

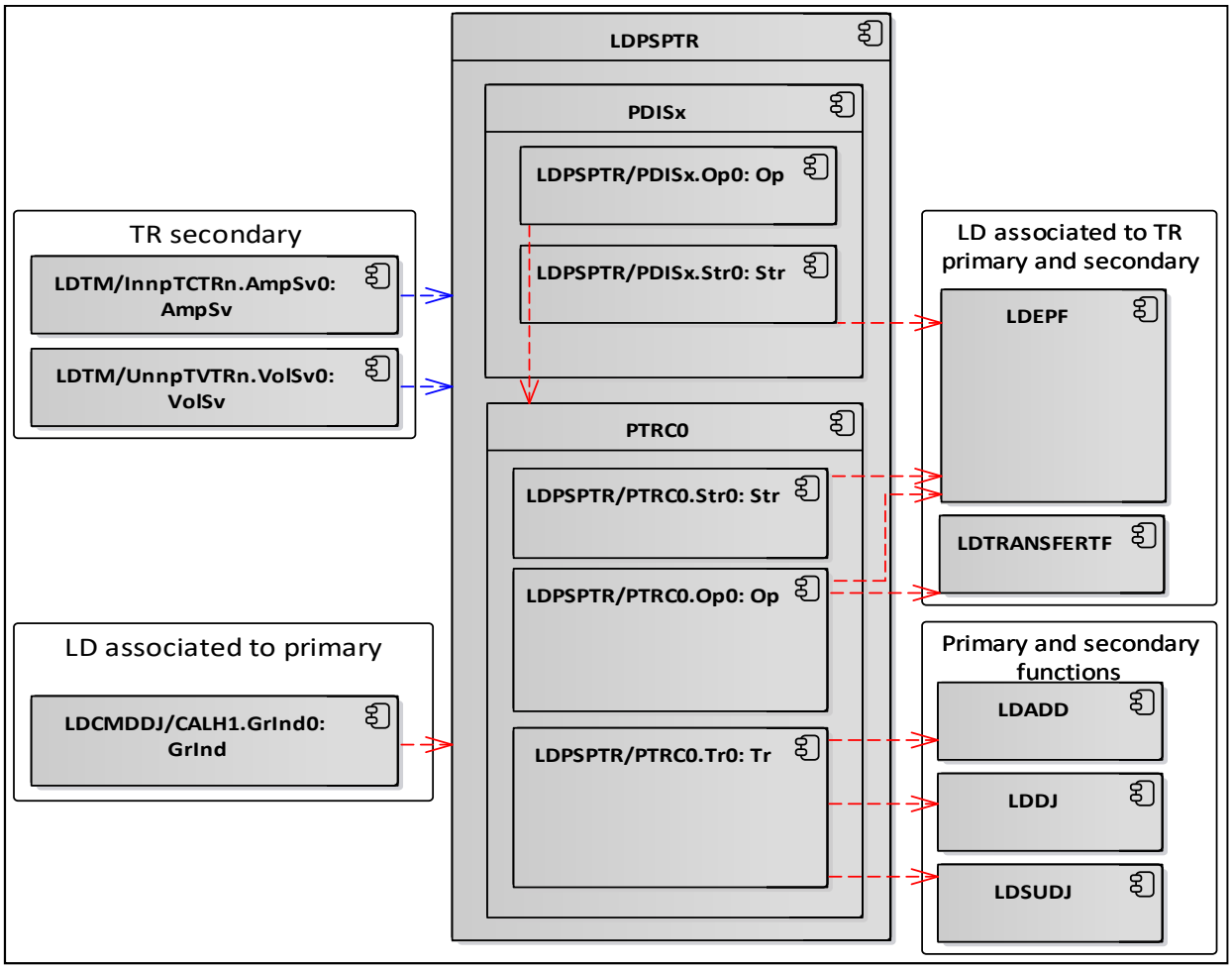

Figure 21: Dynamic description LDPSPTR

5.19 Transformer Secondary Feeder Differential Protection (LDPDLCTR)

5.19.1 Description of the Function

The transformer secondary feeder differential protection (PDLC) function is intended to protect the following structures:

- Connections from the HV busbar to the secondary terminals of power transformers (usually for 63 kV or 90 kV voltage level).
- The underground section of hybrid overhead-underground feeders of VHV/HV substations

5.19.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.

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LN	Description
PDIF	This LN shall be used for all kinds of current differential protection. Proper current samples for the dedicated application shall be subscribed.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

5.19.3 Specificities

- While the specification (cf. [18]) requires a time delay for the PDLC function, we use the LN PDIF which does not have one. It is considered that the time delay relates to the applications level.

5.19.4 Static description

Transformer Secondary Feeder Differential Protection (LDPDLCTR)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS	DF.PDLC	PDLC function state
	Mod	ENC		
	NamPlt	LPL		
PDIF0	Beh	ENS		
	Op	ACT		
PTRC0	Beh	ENS		
	Op	ACT	DT.PDLC	Indication of 3 phases Trip decision
	Tr	ACT		trip order to XCBR
	Str	ACD.general		

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5.19.5 Dynamic description

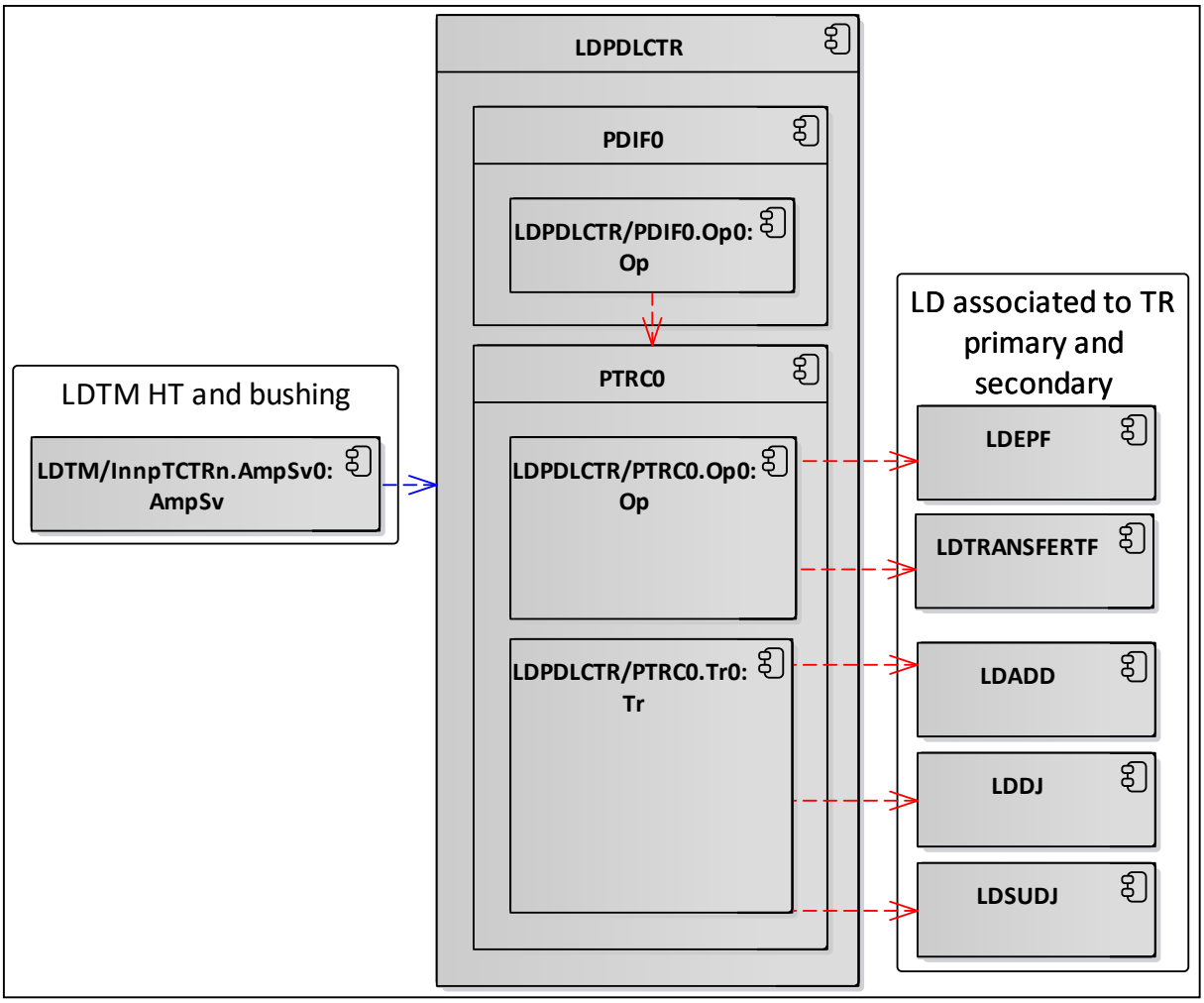

Figure 22: Dynamic description LDPDLCTR

5.20 Directional Earth Fault Protection (LDPCDH)

5.20.1 Description of the Function

The task of the PCDH function is the detection of phase-ground faults whose resistance is too high to be detected by the distance protection functions (Cf. [14]).

5.20.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PSCH	This LN shall be used to model the logic scheme for line protection function co-ordination. The protection scheme allows the exchange of the "operate" outputs of different protection functions and conditions for line protection schemes. It includes data objects for teleprotection if applicable. In this case, all appropriate data objects shall be subscribed.

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LN	Description
PSDE	This LN is used for directional earthfault handling in compensated and isolated networks. The use of "operate" is optional and depends both on protection philosophy and on instrument transformer capabilities. For compensated networks, this function is often called wattmetric directional earthfault. The very high accuracy needed for fault current measurement in compensated networks may require phase angle compensation. This shall be realised by the related LN TCTR.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.
LSET	Rte Extended Setting LN

5.20.3 Specificities

- LN PSDE represents the settings required for this function and is, for this reason used to model the PCDH (Directional Earth Fault) function (and not PTOC).

5.20.4 Static Description

Directional Earth Protection (LDPCDH)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		State of the DEF function
	Mod	ENC		
	NamPlt	LPL		
PSCH0	Beh	ENS		
	TxBlk	ACT		
	TxPrm	ACT	EMI.AUTORISA	Signal transmitted to tele-protection
	Op	ACT		
PSDE0	Beh	ENS		
	GndOp	ASG.setMag		Residual current threshold (Ir_seuil)
	GndStr	ASG.setMag		Residual voltage threshold (Ur_seuil)
	Op	ACT		Fault detection
	OpDlTmms	ING		Base operate time delay (T_dec)
	Str	ACD	PCDH*.MISE ROUTE	Start of the disturbance recording
	StrDlTmms	ING		Tempo émission TAC après Mise en route
PTRC0	Beh	ENS		
	Op	ACT	DT.PCDH*	Indication of 3 phases tripping by PCDH function
	Tr	ACT		Single or three-phase trip order

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Directional Earth Protection (LDPCDH)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Str	ACD.general		
LSET0	Beh	ENS		
	NamPlt	LPL		
	DlTmms1	ING		Blocking time of the forward signal after current reversal (T_inv-dir)
	OnOff1	SPG		Trip blocking in case of distance protection start

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5.20.5 Dynamic description

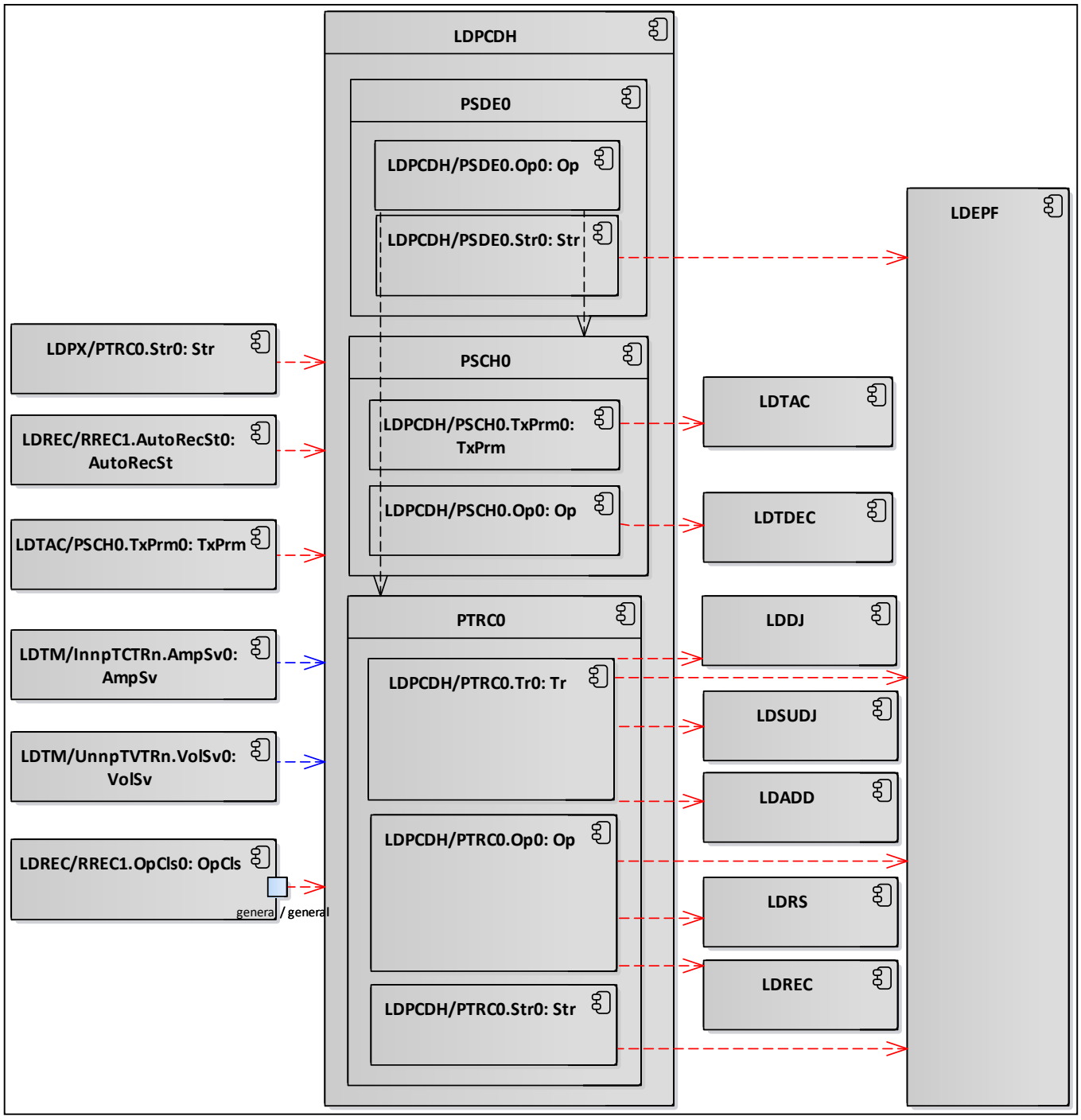

Figure 23: Dynamic description LDPCDH

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5.21 Line Over-Voltage Protection (LDMAXUL)

5.21.1 Description of the Function

The steady state overvoltage protection function is intended to be used on underground structures of the 400 kV and 225 kV RTE transport grid.

5.21.2 LNs used

LN	Description
FXOT	Logical node FXOT shall be used to set a high-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, contro or alarm function is based on other physical measurements than primary electrical data.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PSCH	This LN shall be used to model the logic scheme for line protection function co-ordination. The protection scheme allows the exchange of the "operate" outputs of different protection functions and conditions for line protection schemes. It includes data objects for teleprotection if applicable. In this case, all appropriate data objects shall be subscribed.
PTOV	For some applications such as transformer starpoint or delta supervision, "operate" may not be used.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.
LSET	Rte Extended Setting LN

5.21.3 Specificities

- The overvoltage protection can be set to measure phase-to-ground voltages or phase-to-phase voltages. The voltage to be considered is indicated in the parameter LSET.SetPhsOrig

5.21.4 Static description

Overvoltage Protection (LDMAXUL)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
FXOT1	Beh	ENS		
	Mod	ENC		
	Op	ACT	ALARME.MAX.U ALARME.MAX.U1 ALARME.MAX.U2	Overvoltage Alarm threshold 1
	StrVal	ASG.setMag		Overvoltage threshold 1
	OpDlTmms	ING.setVal		Time delay for overvoltage alarm threshold 1
FXOT2	Beh	ENS		
	Mod	ENC		
	Op	ACT		Overvoltage Alarm threshold 2
	StrVal	ASG.setMag		Overvoltage threshold 2

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Overvoltage Protection (LDMAXUL)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	OpDlTmms	ING.setVal		Time delay for overvoltage alarm threshold 2
FXOT3	Beh	ENS		
	Mod	ENC		
	Op	ACT		Overvoltage Alarm threshold 3
	StrVal	ASG.setMag		Overvoltage threshold 3
	OpDlTmms	ING.setVal		Time delay for overvoltage alarm threshold 3
FXOT4	Beh	ENS		
	Mod	ENC		
	Op	ACT		Overvoltage Alarm threshold 4 (optional)
	StrVal	ASG.setMag		Overvoltage threshold 4
	OpDlTmms	ING.setVal		Time delay for overvoltage alarm threshold 4
LLN0	Beh	ENS		
	Health	ENS		
	Mod	ENC		
	NamPlt	LPL		
PSCH0	Beh	ENS		
	Op	ACT		
	TxTr	ACT		Emission of remote trip order on overvoltage threshold 2
PTOV2	Beh	ENS		
	Op	ACT		Signal of trip on overvoltage threshold 2 or signaling of emission of remote trip on overvoltage threshold 2
	Str	ACD		
PTRC0	Beh	ENS		
	Op	ACT	DT.MAXU.SEUIL*	Signal of Trip order on overvoltage threshold 2
	Str	ACD.general		
	Tr	ACT		Trip order to LDDJ and LDSUDJ
LSET0	NamPlt	LPL		
	SetPhsOrig	ENG		Voltages to be use for overvoltage protection

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5.21.5 Dynamic description

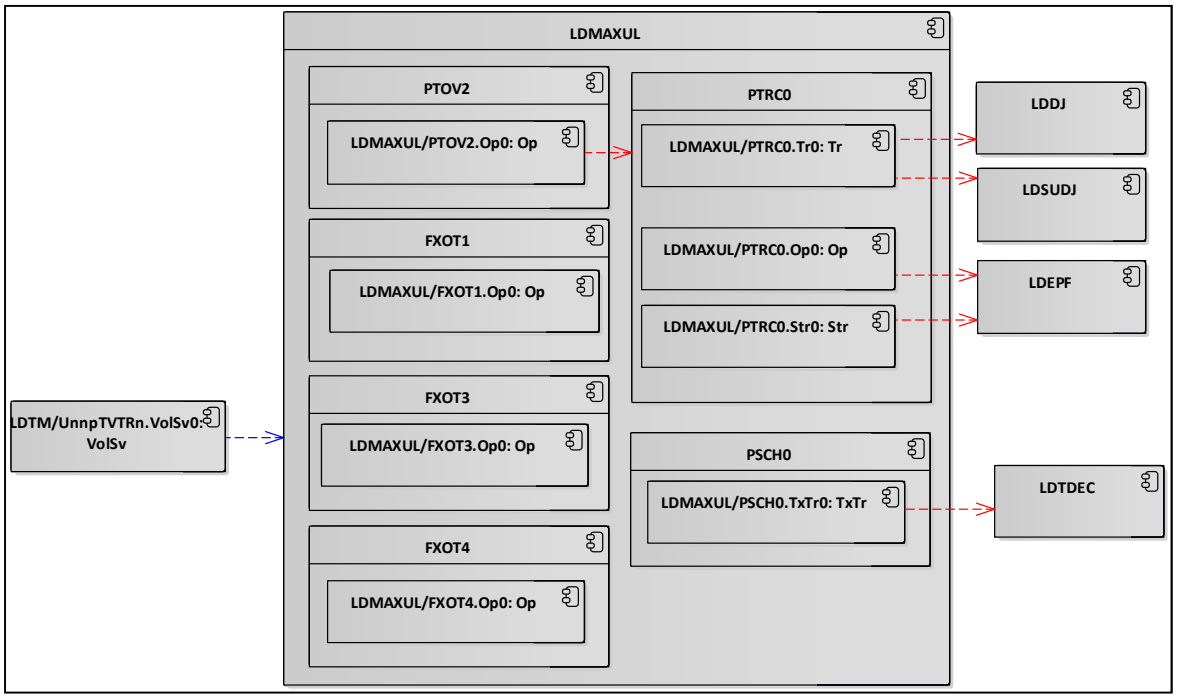

Figure 24: Dynamic description LDMAXUL

5.22 Auxiliary Busbar Protection (LDAUXDEB)

5.22.1 Description of the Function

The auxiliary busbar protection (TEMPO2DELTAT) is used when no dedicated decoupling protection is associated to the circuit breaker installed as busbar coupler. It integrates the function ECH-COUPL.

The overall function includes:

- Trip of the busbar coupler circuit-breaker (separation of the busbars), performed after the time delays (T1, T2, MR) of the main protection.
- Trip of the transformer secondary feeder (elimination of the contribution to the fault of the transformer), after a selective time delay 2 DELTA_T which is added to the time delays T1, T2, MR.

5.22.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

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5.22.3 Specificities

N/A

5.22.4 Static description

Auxiliary Busbar Protection (LDAUXDEB)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		
	Mod	ENC		
	NamPlt	LPL		
PTRC1	Beh	ENS		
	Op	ACT	DT.PX.SECONDAIRE DT.DEBOUCLAGE TR	Associated with the circuit-breaker of the secondary feeder of the transformer
	Tr	ACT		Tripping to LDDJ and LDSUDJ
PTRC2	Beh	ENS		
	Op	ACT		Associated with the circuit-breaker of the secondary feeder of the transformer
	Tr	ACT		Tripping to LDDJ and LDSUDJ
PTRC3	Beh	ENS		
	Op	ACT	DT.DEBOUCL.BARRE DT.DEB_s DT.DEB_s'	Associated with the circuit - breaker of the HV coupling
	Tr	ACT		Tripping to LDDJ and LDSUDJ of the HV coupling

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5.22.5 Dynamic description

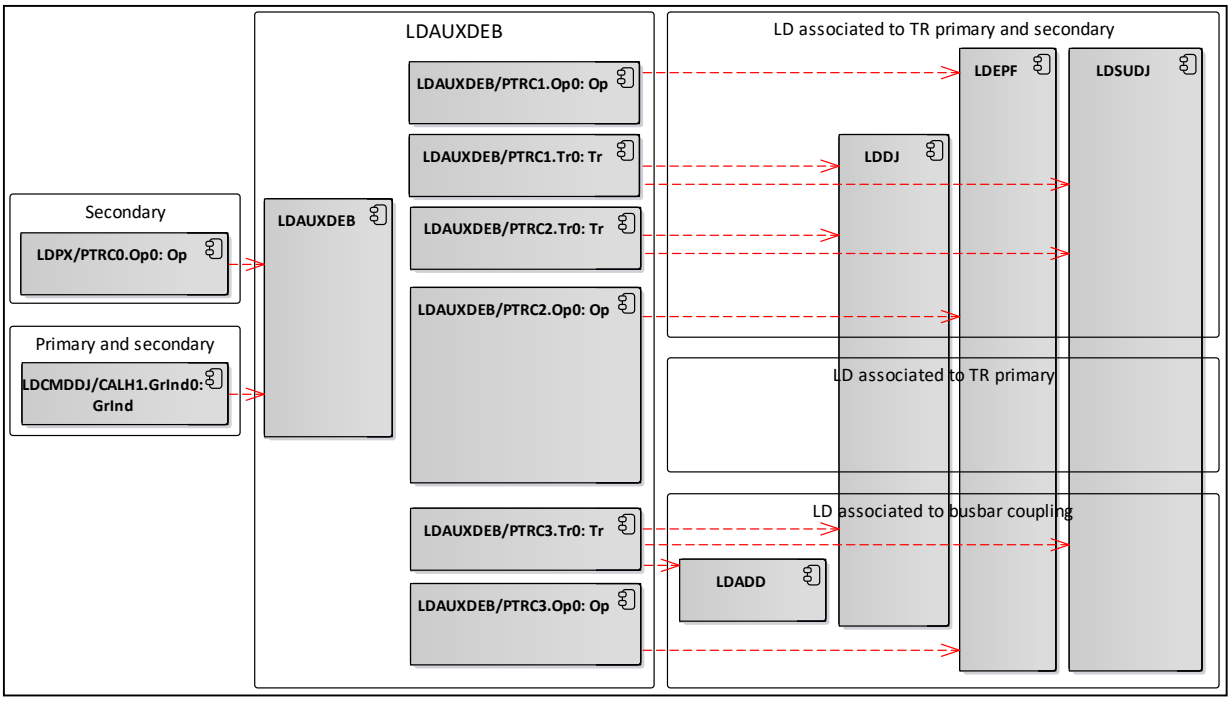

Figure 25: Dynamic description LDAUXDEB

5.23 Power Transformer Fire Protection (LDPIT)

5.23.1 Description of the Function

The power transformer fire protection (PIT) is a basic digital logic function which is used to isolate the high voltage structure in case of fire.

5.23.2 Specificities

- The transformer pit shutdown function (VEFOSSE-VEAIR), associated to the power transformer pit, is incorporated into the Main Power Transformer Protection (PTP, cf. §5.14).
- It is considered that the fire extinction system failure (DF.INC) signal is composed on the one hand of the binary input acquired at the process level (represented by LDMTBB/SIFR.EEHealth) and on the other by the DO Health of the IED hosting the PIT function. This grouping is performed at the station level.
- It is considered that the blocking of the fire protection corresponds to a binary input acquired by the LDMTBB, to which the fire detector is associated. The signal used in SCADA is that which is published by the latter.
- The FCT.INC signal is indicated as operation 1st and 2nd source in the output table of the PIT function (cf. [16]). The PACS specification does not specify whether there is one or two fire sensors. In the present modelling, it is considered that the function only uses one fire detection sensor.

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5.23.3 LNs used

LN	Description
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

5.23.4 Static description

Power Transformer Fire Protection (LDPIT)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
GAPC0	Ind1	SPS	FUIT.CO2	
	Ind2	SPS	ANO.FOSS	Power transformer Pit abnormal condition Activation of pit pump and aero
	Ind3	SPS	VER.INC	Pit pump blocking and air extraction blocking
LLN0	Beh	ENS		
	Health	ENS	DF.INC	PIT function state
	Mod	ENC		
	NamPlt	LPL		
PTRC1	Op	ACT	FCT.INC	Associated with the circuit-breaker of the secondary feeder of the transformer.
	Tr	ACT		Tripping to LDDJ and LDSUDJ
PTRC2	Op	ACT	FCT.INC	Associated with a circuit-breaker of the transformer primary feeder
	Tr	ACT		Tripping to LDDJ and LDSUDJ

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5.23.5 Dynamic description

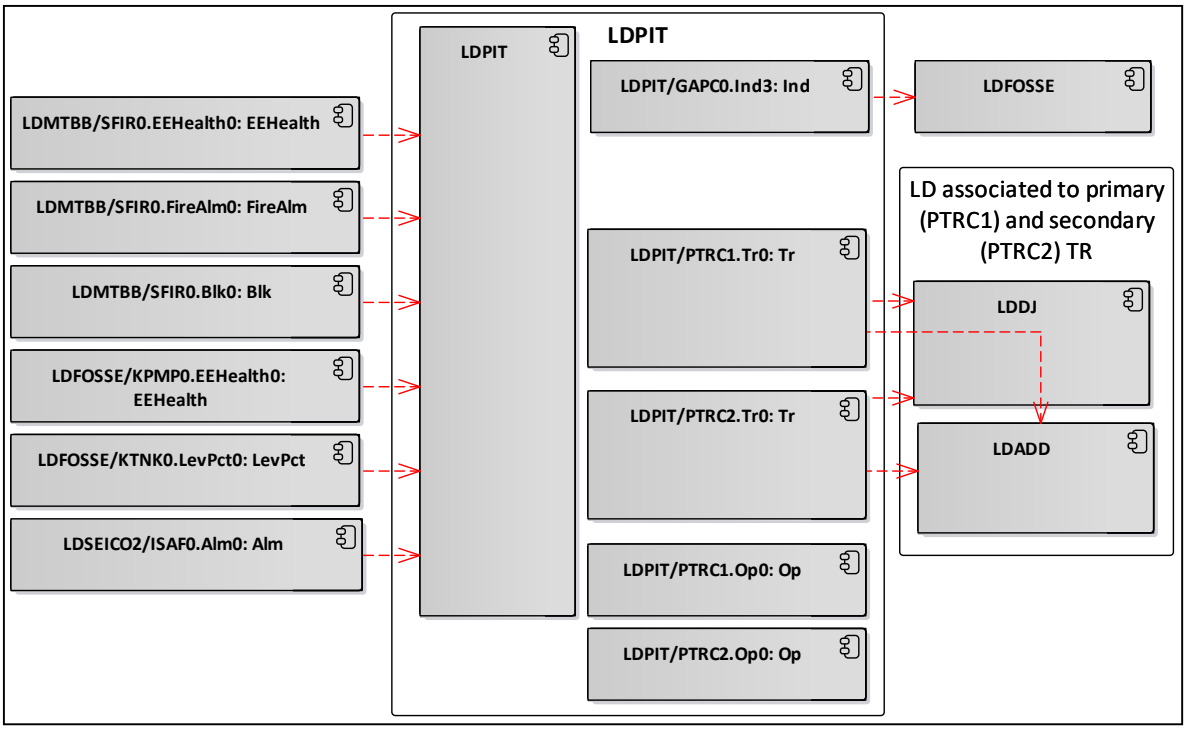

Figure 26: Dynamic description LDPIT

5.24 HV GIS Busbar Protection (LDPBdVx)

5.24.1 Description of the Function

The HV GIS busbar protection (PBdVx) is a function for the protection of the gas-insulated busbar of a small HV substation featuring only one busbar (cf. [13]). The function is based on the directional information of line feeder distance protections.

5.24.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.
PTUV	A function that operates when its input voltage is less than a predetermined value.

5.24.3 Specificities

- Given the constraints on tripping time, the LDPBdVx used the SVs as input data and not the phasors.
- There are as many instances of PbdVx as feeders. Each is subscribed to signalling of the start of the LDPXs of all bays

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- The deactivation of the complete function is done from the SCADA by deactivating all instances.
- Given the main criterion used in the PbdVx function, i.e. a voltage minimum criterion, the LN PTUV is used to model this function.
- The function can publish a trip order of the circuit-breakers associated with the power transformers owned by a client. It can be configured whether this trip order is published simultaneously to that of the circuit-breakers of the line feeders or with a tile delay. This configuration parameter is taken into account with the DO PTRC2.Mod.
- The ANO.PBdVx signal is indicated by the quality DA (INVALID) of DO PTRC1.Op. Consequently, the translation table between DA qualities of the PbdVx function is established.

5.24.4 Static description

HV GIS Busbar Protection (LDPBdVx)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		Signal "Function activated/deactivated"
	Health	ENS	DF.PBdVX	State of PBdVx function
	Mod	ENC.stVal		Command to activate / deactivate the function(ES/HS)
	NamPlt	LPL		
PTRC1	Beh	ENS		
	Op	ACT.general	FCT.PBdV	Signalling of the tripping decision and initialisation of the function, [ARS] (autorecloser) and EP (disturbance recorder).
	Op	ACT.q	PBdVx.AN	Signalling of anomaly of the function PBdVx following an anomaly of one or several PXs
	Tr	ACT		Tripping of the circuit-breakers of the line feeders.
PTRC2	Beh	ENS		
	Op	ACT		Signalling of the tripping decision of the Power Transformer circuit-breakers.
	Tr	ACT		Tripping of the circuit-breakers of the power transformers feeders.
PTUV0	Beh	ENS		
	Op	ACT		Use to represent the protection function at the applications level.

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5.24.5 Dynamic description

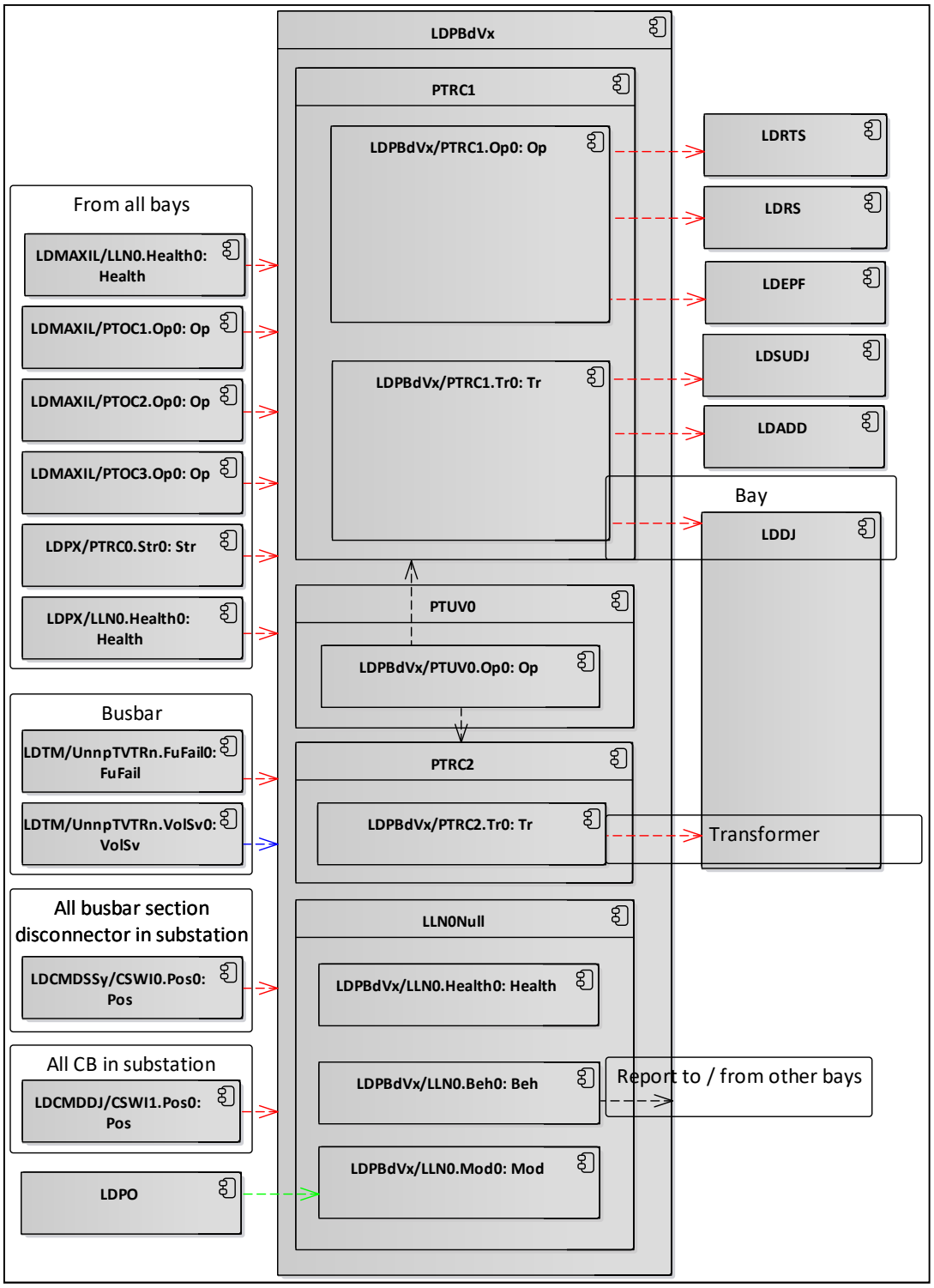

Figure 27: Dynamic description LDPBdVx

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5.25 Busbar Differential Protection (LDPDB)

5.25.1 Description of the Function

The PDB is a function for the protection of the busbar by safely, rapidly and selectively eliminating busbar faults. The detection is done at the level of each electrical node and the protection system sends three-phase trip orders to circuit-breakers of bays connected to faulty node. The protection system does not issue a trip order in case of fault external to the busbar.

LDPDB incorporates the GIDBS function (PDB Interface Management).

5.25.2 LNs used

LN	Description
FXOT	Logical node FXOT shall be used to set a high-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, contro or alarm function is based on other physical measurements than primary electrical data.
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
LSET	Rte Extended Setting LN
PDIF	This LN shall be used for all kinds of current differential protection. Proper current samples for the dedicated application shall be subscribed.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

5.25.3 Specificities

- The specifications of the digital differential busbar protection systems (cf. [19] and [20]) also provide the PDB function strictly speaking, the ADD and PDLP functions. These functions are not taken into account in the LDPDB modelling. If need be, LDADD and LDPDLP are to be used.
- Each PDIF instance corresponds to a busbar section x (or zone) of protection, which also corresponds to an electrical node.
- The LN PDIF0 includes the settings for the check zone of the function, which covers the complete busbar.
- For each bay equipped with a circuit-breaker (feeder, coupler, etc.) a dedicated PTRC instance is modelled in the LDPDB.
- For specific cases, the possibility of emission of remote trip using DO LDPDB/PSCH.TxTr is provided.
- The signal "DT.BARRE" which indicates the tripping by differential protection of the busbar, is a grouping of all the PTRCx.Ops. This grouping is performed at the substation level.

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- Possible communication problems between the PDB equipment are taken into account via the DO LLN0.Health.
- It is considered that the PDB blocking and activation/deactivation commands are common for all LD PDIFx.
- It is considered that the information "disconnector alarm" indicated by the LED on the front face of the equipment (cf. [19] and [20]) indicates an inconsistent disconnector position. While the information is available to the SCADA, the alarm is modelled in the LDPDB because of its impact at the operations level of the function. It is modelled by the DO LDPDB/GAPC.Alm1.
- The detection of a permanent differential current below a tripping threshold produces an "Anomaly I section x" alarm. This alarm is modelled by an LN FXOT instantiated for each section covered by the LDPDB.
- The information ANO.I for an electrical node may be latched and thus not disappear if the cause for the anomaly is cleared. This can be set as parameter. In this case, the information can be reset from SCADA.
- In the modelling, the LDPDB subscribes to the position of short-circuit switch the analogue current input. This information is not used in the current PACS specifications [20] and [19], but is added to allow this evolution in the future.
- The threshold for the differential current is given in percent by the protection studies. This corresponds to the values of LoSet and HiSet of LN PDIF. For the setting in an IEC 61850 based function, it is necessary to define the reference current. This current is defined by the DO FXOT0.StrVal. It corresponds to the highest nominal primary current of the TCs associated to the LDPDB. The conversion performed by the configuration tool.

5.25.4 Static description

Busbar Differential Protection (LDPDB)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
FXOT0	Beh	ENS		
	StrCrv	CSG	Istart kcheck	Threshold for check zone differential current (% Inom) Slope of check zone limit
FXOT10	Beh	ENS		
	StrCrv	CSG	k1 k2	Slope of start zone (set to 0 for Rte) Slope of differential zone
	StrCrv	CSG.pointZ	Istart	LN for settings of Bus Bar differential protection Threshold for zone differential current
FXOT11	Beh	ENS		
	StrVal	ASG.setMag		Rated Current (required as reference for LoSet).
FXOTx	Beh	ENS		
	Mod	ENC		Activation/Deactivation command of section x (same command as PDIFx.Mod)

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Busbar Differential Protection (LDPDB)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Op	ACT	ANO.I	Monitoring of differential current for each section (x = section number) [Signalling "Current anomaly b.t. s. section]
	OpDlTmms	ING		Time delay for ANO.I signal
	StrVal	ASG.setMag		Current Threshold for ANO.I signal
GAPCx	Alm1	SPS	AL.SECT	Disconnector alarm (position of disconnector unknown).
	Alm2	SPS	INTERCNX.SOMMET	Interconnection alarm (situation of double busbar-to-feeder connection).
	Beh	ENS		
LLN0	Beh	ENS	DIFBTEST DIFB*.HS	Global Activation/Deactivation signalling
	Health	ENS	DF.DIFB	
	Mod	ENC		Global Activated/Deactivated command
	NamPlt	LPL		
LSET0	OnOff1	SPG		Parameter to indicate whether TS ANO.I falls back or is latched and needs to be reset by the operator
	NamPlt	LPL		
	OpDlTmms1	ING		Time delay for signal "disconnector alarm" associated to (GAPC.Alm1)
	OpDlTmms2	ING		Time delay for alarm "Busbar connected" associated to INTERCNX.SOMMET (GAPC.Alm2)
PDIF0	Beh	ENS		
	Op	ACT	DT.DIFF.BARRES	Tripping on differential criterion for the whole function
PDIFx	Beh	ENS	bts.HS	Activated/Deactivated signalling of peak x b =1,2,3 (busbar), t=a, b, c (section with cb), s= 1,2,3,4 (section with disconnector)
	LoSet	ASG.setMag	Istart	Low operate value (percentage of the nominal current)
	Mod	ENC		Activation/Deactivation command of protection on peak x
	Op	ACT	DT.DIF.BARRE*	Tripping on differential criterion for section x (x = section number; one PDIF instance per section). Tripping decision following a fault detection for the section x.
PTRCx	Beh	ENS		
	Op	ACT		
	Str	ACD.general		

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Busbar Differential Protection (LDPDB)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Tr	ACT		Trip order to LDDJ of bay x (one PTRC instance per feeder and coupling / section with CB). Trip order to LDITFRPTRPD in case of transformer connected to busbar
	Str	ACD.general		

5.25.5 Dynamic description

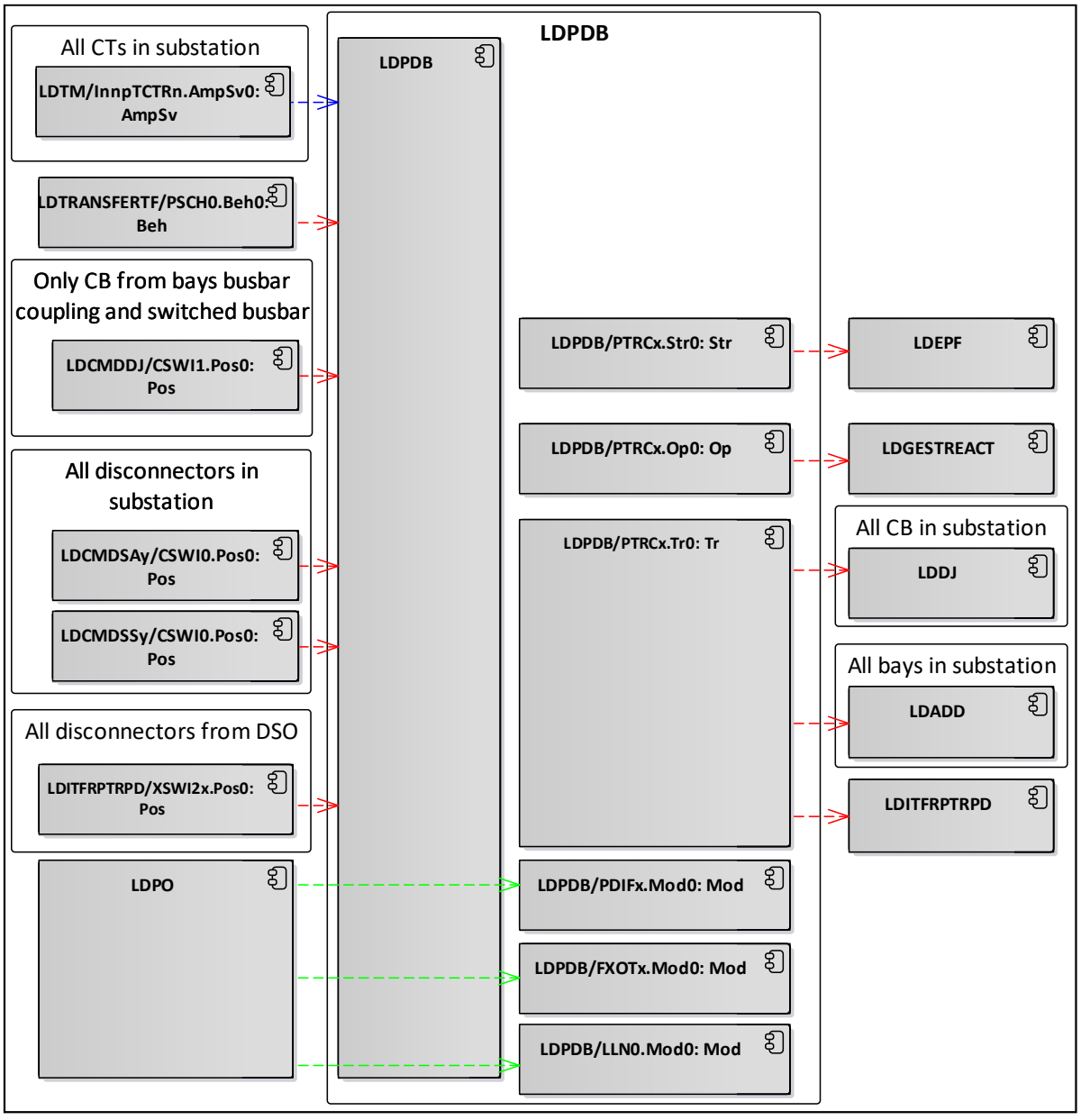

Figure 28: Dynamic description LDPDB

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5.26 Fault Detection Function for Underground line (LDDFU)

5.26.1 Description of the Function

The task of the Fault Detection Function for Underground lines is to detect all insulation faults affecting the protected line or cable section, on the basis of current measurements performed at the ends of the section.

5.26.2 LNs used

LN	Description
ITPC	The LN ITPC comprises all information for communication channel setting and supervision. ITPC is not intended to generate direct process data objects. Thus, it does not contain the input and output data objects to be transmitted and it has no "operate" data objects object.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PDIF	This LN shall be used for all kinds of current differential protection. Proper current samples for the dedicated application shall be subscribed.
PTOC	This LN shall also be used to model the directional time overcurrent (PDOC/IEEE device function number 67, IEEE C37.2:1996). The Definite Time overcurrent (also PTOC/IEEE device function number 51, from IEEE C37.2:1996) shall be modelled by use of PTOC and selecting the related curve.
PSCH	This LN shall be used to model the logic scheme for line protection function co-ordination. The protection scheme allows the exchange of the "operate" outputs of different protection functions and conditions for line protection schemes. It includes data objects for teleprotection if applicable. In this case, all appropriate data objects shall be subscribed.

5.26.3 Specificities

- One instance of LDDFU is instantiated for each monitored line or cable section.
- A LN ITPC is instatiated for each (optical) channel connection the fault detection system to optical current sensors.
- There are two variants of LDDFU function.

  The variant based on the current differential detection comparing currents at both ends of the monitored section is represented by a LN PDIF.

  The variant based on the overcurrent detection of cable shield-to-ground currents of the monitored section is represented by a LN PTOC.

- If the fault detection system is also used to trip on faults, LDDIFL (§5.4) or LDPMC (§5.7) has to be used.

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5.26.4 Static description

Fault Detection Function for Underground line (LDDFU)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS	DF.DET.DEF.LAS*	The use of LLN0 and not LPHD as LLN0 represents the function and LPHD the physical equipment which can host several functions
	Mod	ENC		
	NamPlt	LPL		
ITPC0	Beh	ENS		
	LosSig	SPS		Indicates degradation or loss of optical channel
PDIF0	Beh	ENS		
	LinCapac	ASG.setMag		Line capacitance (for load currents)
	LoSet	ASG.setMag		Current threshold for minimal differential current
	Op	ACT		Fault detection for the variant based on differential current evaluation
	Str	ACD		Start of the disturbance recording
PTOC0	Beh	ENS		
	Op	ACT		Fault detection for the variant based on overcurrent detection
	Str	ACD		
	StrVal	ASG.setMag		
PSCH0	Beh	ENS		
	TxTr	ACT		Instaciated for transmission of recloser disabling order to the other line end
	Op	ACT	DETEC.DEF.CABLE*	
LSET0	Beh	ENS		
	StrVal1	ASG.setMag	k1	Inclination of first restraint segment
	StrVal2	ASG.setMag	k2	Inclination of second restraint segment

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5.26.5 Dynamic description

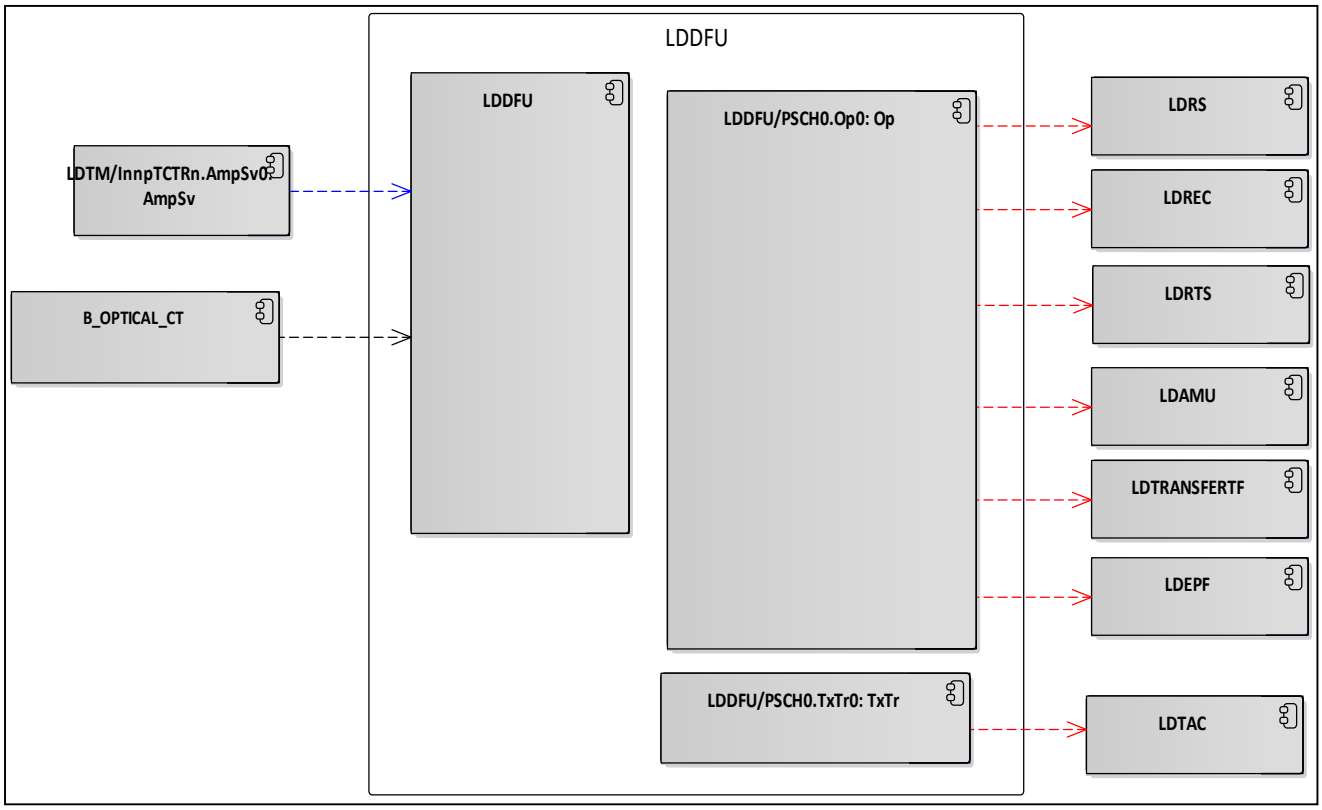

Figure 29: Dynamic description LDDFU

6. Substation Automation Functions

6.1 HV Switchgear Interlocking Function (LDAIVO)

Confer:

- § 8.1 – Circuit Breaker Command (LDCMDDJ)
- § 8.2 – Disconnector Command (LDCMDSxy)

6.2 Overload Management Function (LDADA)

6.2.1 Description of the Function

The overload management function (ADA) is used in the case of transit constraints on the HV grid. This automaton elaborates alarms or trips if the load current exceeds a configured threshold.

6.2.2 Operation particularities

6.2.2.1 Timeline

The operation timeline is described in the figure below:

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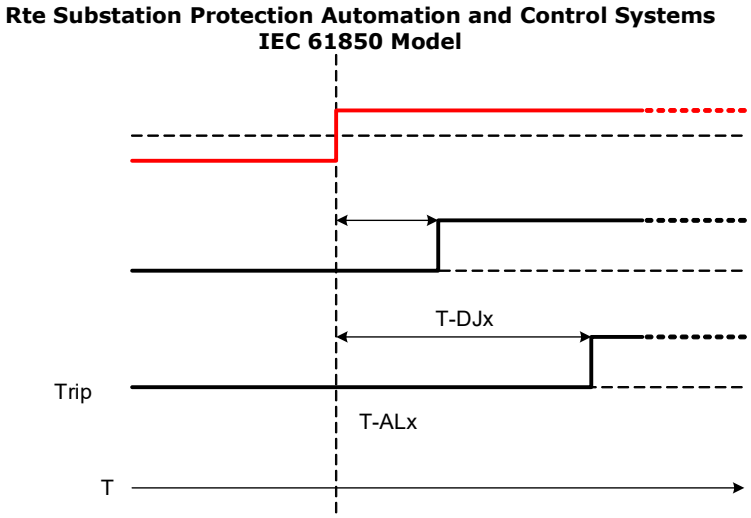

Figure 30: ADA Operation Timeline

- T-Alx is the alarm time delay
- T-CJx is the tripping time delay of the circuit-breaker

6.2.2.2 Seasonal regimes

Each seasonal regime is associated with a set of load current thresholds, which are organised in setting groups in this modelisation. The change from one setting group to another involves to signal the deactivation of the actual setting group and the activation of the new one. E.g., the change from INTERSAI2 to HIVER1 leads to:

1. To stop publishing the signal "INTERSAI2 active)
2. To start publishing the signal "HIVER1 active" and to maintaining it.

It is possibile to inhibit several thresholds by configuration.

6.2.3 LNs used

LN	Description
FXOT	Logical node FXOT shall be used to set a high-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, contro or alarm function is based on other physical measurements than primary electrical data.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTOC	This LN shall also be used to model the directional time overcurrent (PDOC/IEEE device function number 67, IEEE C37.2:1996). The Definite Time overcurrent (also PTOC/IEEE device function number 51, from IEEE C37.2:1996) shall be modelled by use of PTOC and selecting the related curve.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

6.2.4 Specificities

- The specification of the overload management function (ADA) (cf. [13]) requires the use of a current criterion. Therefore, the LN PTOC and FXOT are used with current inputs instead of LN PDOP which is based on power.

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- One PTOC/FXOT pair is used per threshold. This function uses three thresholds, i.e. three pairs. The thresholds are normally associated with an admissible overload period (e.g. 20 minutes, 10 minutes, etc.).
- The setting group for each seasonal regime is particular to each bay, which means one LDADA is instanciated in each bay where the function is needed.
- The LN PTOC of the standard only manages the time delay leading to a trip (T-DJx) published by PTRC.Op of the LD. PTOC.Str indicates the detection of a fault (starting) and cannot be used for the alarm output as it cannot be associated with a time delay. Consequently, the time delay leading to an alarm (T-Alx) is modelled by the LN FXOT which uses the same input data as the PTOC.
- The function COMP-ADA (complement to ADA function) (cf. §6.16) is a substation level function which is modelled separately
- The ADA function generates a signal indicating the direction of the load flow (forward / backward). This signal must be associated with the trip order and sent to the SCADA and to the LDCOMPADA. This association not being provided by the PTRC, it was decided that the subscribing functions concerned would generate this information from the DO Op and Str of the PTRC.
- The ADA function also generates a signal indicating the direction of the load flow (forward / backward) associated to the alarm threshold and used by LDCOMPADA. This association is being provided by the LDADA. the application associated to LDCOMPADA generates this information directly from the subsribed DO FXOT.Op and PTOC.Str.
- The activation/deactivation of the ADA function is perforfmed using LLN0.Mod. The feedback signal is LLN0.Beh.

6.2.5 Static description

Overload Management Function (LDADA)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
FXOT*	Beh	ENS		
	Op	ACT.general	ALARME.DEP.SEUIL*	Timer alarm when threshold reached(* = 1, 2 or 3 depending on the threshold)
	OpDlTmms	ING.setVal		Alarm time delay T-Alx The value is managed by the SGCB and varies with the regimes.
	StrVal	ASG.setMag		IS* current threshold (same value as for PTOC) The value is managed by the SGCB and varies with the regimes.
LLN0	Beh	ENS	AUT.DEB	Signal "Function activated/deactivated"
	Health	ENS	DF.AUTD	ADA Function state
	Mod	ENC	AUT.DEB	Command to activate / deactivate the function(ES/HS)
	NamPlt	LPL		

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Overload Management Function (LDADA)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	The SGCB mechanism is used to manage the 5 setting groups (commands: AUT.DEB Regime x) of ADA (signals: REG.INT1 AUTD.TC, REG.ETE AUTD.TC, REG.INT AUTD.TC, REG.INT2 AUTD.TC, REG.HIV1 AUTD.TC, REG.HIV AUTD.TC, REG.HIV2 AUTD.TC)			
PTOC*	Beh	ENS		
	Op	ACT.general		Trip order of circuit-breaker sent to PTRC (* = 1, 2 or 3 depending on the threshold)
	OpDlTmms	ING.setVal		Alarm time delay T-DJx The value is managed by the SGCB and varies with the regimes.
	Str	ACD.dirGeneral		Directional information elaborated during passage over a threshold
	StrVal	ASG.setMag		Current threshold IS* The value is managed by the SGCB and varies with the regimes.
PTRC0	Beh	ENS		
	Op	ACT.general	FONCT.AUT.DEB	Tripping decision of 3 phases
	Str	ACD	AUT.AVAL AUT.AMONT	Information on the direction of the fault
	Tr	ACT		Trip order to XCBR

6.2.6 Dynamic description

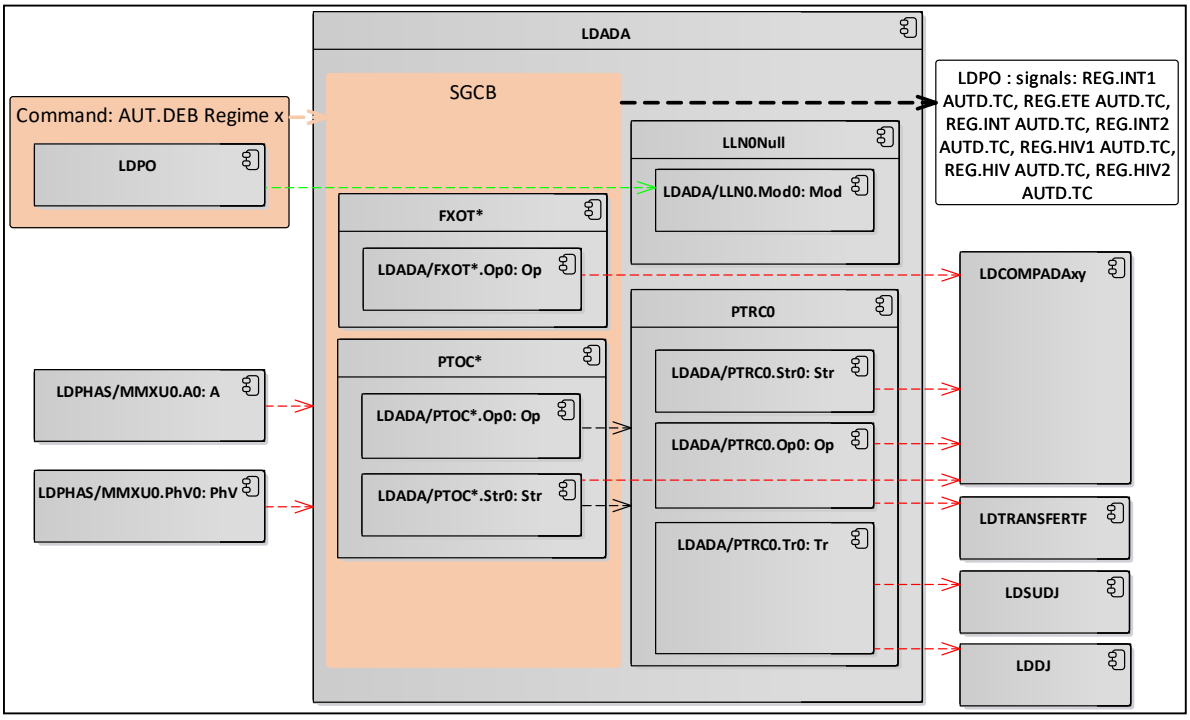

Figure 31: Dynamic description LDADA

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6.3 Auto-Recloser and Service Restoration function (LDRS) [ARS]

The ARS function described in the PACS specification concerns several sub functions, including recloser, service restoration, automatons managing a prolonged loss of voltage and safety functions related to life work on power lines. This ARS function is broken down as follows:

LDRS	**Reclosing and Service Restoration function (RT: Three-phase re-closing)**
LDREC	**Single-phase reclosing and Rapid three-phase reclosing**
LDAMU	**Automaton for the management of a prolonged loss of voltage [AMU: Automate de Manque de Tension] including the Voltage Loss Trip function [DMU: Déclenchement à Manque de Tension] and Service Restoration after Voltage Loss [RMU: Reprise de service après Manque de Tension]**
LDRTS	**Backup feeder energisation function [RTS: Renvoi de Tension en Secours]**
LDRSE	**Safety function related to life work on power line [RSE: Régime spécial d'exploitation]**

The function verifying the circuit breaker reclosing conditions based on busbar and line Voltage (CT) is incorporated into LDCMDDJ.

The signal "DF.ARS" (ARS failure) becomes a grouping of different LLN0.Health of all the LDs of the ARS sub functions.

The signal "AR.ENCLT / AR.ENCLT.ORDONNE" (Closing order from the ARS function) becomes a grouping of different OpCls of all the LDs of the ARS group except LD LDAMU and LDRSE.

6.3.1 Description of the Function

The Recloser and Service Restoration function corresponds to the requirements of the PACS specification (cf. ARS-RT-xx – long three-phase recloser cycle function). The elaboration of the signals PUL, PUB, AUL, AUB and Voltage Monitoring for a circuit-breaker re-closing request, is performed by the LDCMDDJ.

6.3.2 LNs used

LN	Description
CREC	Private LN
CSYN	This LN class shall be used to control the synchronizing conditions i.e. voltage, frequency and phase.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
RREC	The number of trigger modes (CycTrMod i) and reclose times (RecTmmsi) is equal to the maximum allowed number of reclose cycles (MaxCyc). The trigger for the activation of RREC can be the start signal of PTRC, or the report "breaker open" of the circuit breaker, or any other signals and combination of signals. If different types of protections are involved in the autoreclosing process, all relevant data objects have to be published and subscribed by the allocated protection LNs. A principal diagram of RREC is given in Annex G.

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6.3.3 Specificities

- The activation/deactivation of the function Recloser and Service Restoration function (LDRS) uses the Mod/Beh of LLN0 and at the same time determines the activation/deactivation of CSYN1 (RT). The activation of the functions of the second recloser cycle [IC (CSYN2), RT 2nd Setpoint (CSYN3)] uses the Mod/Behs of the LN CSYNs concerned.
- The setting of the different reclosing criteria to be used is based on the set point service. Three LN CSYN are implemented: CSYN1 associated with regular long three phase recloser cycle (RT), CSYN2 associated with a second recloser cycle with alternate reclosing criteria (IC) and CSYN3 associated to a second recloser cycle with different reclosing criteria (2nd RT) (cf. following tables).
- The reclosing criteria are:
- RVL: live busbar / dead line condition (RenVoi Ligne)
- RVB: live line / dead busbar condition (RenVoi Barre)
- REB : live line / live busbar condition (REBouclage)
- One control of ENUM type is used each of the RT and IC recloser cycles. The correspondence between the control value and the setting is indicated in the table in §11.8. This control is modelled by DO RecCycMod using the proprietary LN CREC (cf. §11.8). One instance of CREC is used for each type of recloser cycle.
- CSYN3 (2nd recloser cycle) has always the same recloser criteria and needs not to be set.
- The selection for the reclosing in life / dead conditions are represented by the DO LivDeaMod (cf. table in §11.8)
- The signal ANO.CONS (ARS parameter anomaly) is only based on the DO Beh=off of LN CSYN1 (RT). Consistency between the different setpoints is assured by the control mechanism which cannot, a priori, lead to an anomaly.
- The energisation of a dead busbar must be realised from at most one feeder at a time. A live line / dead busbar cycle has thus to be blocked for the other feeders if a cycle is launched in one feeder this blocking signal subscribed by the ARS functions of other bays, is published by LDCMDDJ/CALH2.Grind.
- DO CALH.Grind2 contributes to the elaboration of the signal "impossible to reclose" AR.IMPO (ID003293) cf. (ARS-GE-11 [13]).
- The verification of voltage conditions (CT) for ordinary circuit-breaker closing orders is implemented into LDCMDDJ.
- The functionality uses blocking time delays B1 and B2 to elaborate a definitive trip order when several initiations/triggers signals are received during this time delay (cf. requirements ARS-GE-06/07). These time delays relate to the applications level and are not represented in the modelling proposed in this document.
- The signal ARS.DEFAUT.CONFIG (ANO.CONS) is a grouped signal using inputs from the functions RS, AMU and RTS. It is considered that the IEC 61850 baed setting CREC.RecCycMod guarantees that there is always a valid setting. The only inconsistency is potentially if the first recloser cycle is disabled (CSYN1.Mod = off) and the function itself is active. For this reason, CSYN1 contributes to the grouping ANO.CONS as indicated in the sattric description below.
- The signal DEFAUT.ARS (DEF.ARS) is a grouped signal using inputs from all functions of the ARS group.

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- LDRS subscribes to LDRSE.Beh. If LDRSE is activated, LDRS takes into account, at applications level, the requirement ARS-RSE-02 [13] concerning the inhibition of any circuit breaker close order for functions of the ARS group if LDRSE is activated.
- LDRS subscribes to the LDCMDDJ of the same functional bay for the DO providing an information whether live-dead or live-live reclosing is possible (absence / presence of line and busbar voltage, threshold of voltage, phase and frequency).
- The re-closing cycle (cf. ARS-GE-03) is interrupted and disabled after reception of the information of trip by LDPMC (cable shield to ground), by the PDIFC (cable differential protection) or by an order received from a tele-protection function (LDTAC). This signalling is indicated in the dynamic description (cf. 6.3.5).
- DO RREC.AutoRecSt is used to elaborate the information "impossible to reclose" (AR.Impossible). This signal corresponds to values 9, 10 or 11 of AutoRecSt (see Appendix A, IEC 61850-7-4).

6.3.4 Static Description

Recloser and Service Restoration Function (LDRS)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
CREC1	RecCycMod	ENC	AR.REB, AR.RVB, AR.RVL, AR.RVB+L	Control of recloser mode of RT cycle
CREC2	RecCycMod	ENC	AR.ICREB, AR.ICRVB, AR.ICRVL	Control of recloser mode of IC cycle
CSYN1	Beh	ENS	ARS.DEFAUT.CONFIG	Cannot be switched of individually. Contributes to the signalling of inconsistency in settings (). (cf. CCTP T4 ARS-RT-31)
	DlSynTmms	ING	T-ATTRT	Minimal time during the conditions shall be present before reclosing
	Rel	SPS		Indication of the possibility of closing of the circuit-breaker elaborated by RT
	TotTmms	ING	T-ICRT	Time delay for second recloser cycle
CSYN2	Beh	ENS	AR.IC	IC - Activation/Deactivation of a second recloser cycle with alternate reclosing criterea
	Mod	ENC	AR.IC	IC - Activation/Deactivation of a second recloser cycle with alternate reclosing criterea
	Rel	SPS		Indication of the possibility of closing of the circuit-breaker elaborated by IC
CSYN3	Beh	ENS	AR.D.REN	RT 2C- Activation/Reactivation of 2nd second recloser cycle with different reclosing criterea
	Mod	ENC	AR.D.REN	RT 2C- Activation/Reactivation of 2nd second recloser cycle with different reclosing criterea
	Rel	SPS		Indication of the possibility of closing of the circuit-breaker elaborated by RT2C
LLN0	Beh	ENS	AR.TRIPH ES/HS	RT - Three-phase Re-closing Activation/Deactivation

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Recloser and Service Restoration Function (LDRS)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Health	ENS	DF.ARS	LDRS Function state Contributes to the ARS fault group)
	Mod	ENC	AR.TRIPH ES/HS	RT - Three-phase Re-closing Activation/Deactivation
	NamPlt	LPL		
RREC0	AutoRecSt	ENS	TRI.EC AR.impossible	RT - three-phase recloser cycle in progress – internal signa to the functions of ARS group and to LDCMDDJ – can be added to logs for the purposes of analysis of incidents.
	Beh	ENS		
	MaxTmms	ING	T-DESRT	Maximum time during autoreclosing is permitted
	OpCls	ACT	AR.ENCLT	Closing order to LDCMDDJ (Contributes to the AR.ENCLT signal of the ARS group). Used also to start fault recorder.
	Rec3Tmms1	ING	T-RT	Reclose time for 3-phase faults

6.3.5 Dynamic description

Dynamic description is available in appendix 12.5

6.4 Single-Phase reclosing and Rapid three-phase reclosing function (LDREC) [ARS]

The ARS function described in the PACS specification concerns several sub functions, including recloser, service restoration, automatons managing a prolonged loss of voltage and safety functions related to life work on power lines. This ARS function is broken down as follows:

LDRS Recloser and Service Restoration function (RT: Three-phase re-closing)

LDREC **Single-phase reclosing [RM: Réenclenchement Monophasé] and rapid three-phase reclosing [RTR: Réenclenchement Tripohasé Rapide]**

LDAMU Automaton for the management of a prolonged loss of voltage (AMU) comprising the Voltage Loss Trip function [DMU: Déclenchement à Manque de Tension] and Service Restoration after Voltage Loss [RMU: Reprise de Service après Manque de Tension]

LDRTS Backup feeder energisation function [Renvoi de Tension en Secours]

LDRSE Safety function related to life work on power line [Régime spécial d'exploitation]

The function verifying the circuit breaker reclosing conditions based on busbar and line Voltage (CT) is incorporated into LDCMDDJ.

The signal "DF.ARS" (ARS failure) becomes a grouping of different LLN0.Health of all the LDs of the ARS sub functions.

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The signal "AR.ENCLT / AR.ENCLT.ORDONNE" (Closing order from the ARS function) becomes a grouping of different OpCls of all the LDs of the ARS group except LD LDAMU and LDRSE.

6.4.1 Description of the Function

This function corresponds to single phase reclosing (RM) and to fast three phase reclosing (RTR) of the ARS functional group described in the PACS functional specification.

Mode: single phase cycle

Following a single phase trip, RM attempts a re-closing of the pole concerned.

If this re-closing fails, then there is a three-phase trip.

Mode: Fast three-phase re-closing

Following a three phase trip, RTR attempts a three-phase re-closing.

If this re-closing fails, there is either a second attempt or the three-phase trip is considered to be permanent.

Mode: Three-phase cycle after single-phase cycle

Following a single phase trip, RM attempts a re-closing of the pole concerned of the circuit-breaker.

If this re-closing fails, then there is a three-phase trip. If the "Three-phase cycle after single-phase" mode is activated, this three-phase trip leads to a three-phase re-closing attempt.

REBTAM function

The REBTAM function allows a Three-phase cycle to be performed after an unsuccessful Single-phase cycle when the TAM function is deactivated.

- RM = single-phase re-closing function depending on the requirements of the PACS specification (cf. [13] – ARS-RM).
- RtriApresMono = three-phase cycle after unsuccessful single-phase cycle. It is a sub-function of the single-phase re-closing function described above (cf. requirements [13] – ARS-REBTAM).
- RTR = rapid three-phase re-closing cycle according to the requirements of the PACS specification (cf. [13] – ARS-RTR).

6.4.2 LNs used

LN	Description
CREC	Private LN
CSYN	This LN class shall be used to control the synchronizing conditions i.e. voltage, frequency and phase.
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.

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LN	Description
RREC	The number of trigger modes (CycTrMod i) and reclose times (RecTmmsi) is equal to the maximum allowed number of reclose cycles (MaxCyc). The trigger for the activation of RREC can be the start signal of PTRC, or the report "breaker open" of the circuit breaker, or any other signals and combination of signals. If different types of protections are involved in the autoreclosing process, all relevant data objects have to be published and subscribed by the allocated protection LNs. A principal diagram of RREC is given in Annex G.

6.4.3 Specificities

- The DO CycTrMods present in the LN RREC instances designate the re-closing modes of each function RM, RTR, Cycle RtriAprèsMono (on the basis of [4]). The value CycTrMod=3 is associated with a specific type of trip (1=three-phase trip, 2= single-phase and three-phase trip).
- LN RREC1 is used for the single-phase cycle only and LN RREC3 is used for the "single-phase" cycle and for the function TAM (three-phase cycle if the single-phase cycle was unsuccessful).
  The following table describes the relation between of RREC1.Beh and RREC3.Beh and the status RM and TAM function (activated/deactivated).

Regarding single phase reclosing, the GAPC1 provides the grouping of the activated/deactivated information, DT.AR and AR.MONO signalling to the SCADA and other functions of the ARS functional group.
On the other hand, GAPC1 does not group the OpCls signals of each RREC. These DO are directly subscribed by LDCMDDJ.

Command		Beh RREC1	Beh RREC3	signal "RM" active	signal "RTAM" active
RM Single phase reclosing	RTAM 3 phase reclosing cycle after unsuccessful single phase reclosing				
On	On	Off	ON	= Beh RECC1 OR Beh RECC3	= Beh RECC3
On	Off	On	Off		
Off	On				
Off	Off	Off	Off		

- If applicable, the complete LD is meant to be put into test mode (LLN0.Mod). This means that the applicative level associated to LN GPAC does not need to take account of possible test modes of these 2 LN (RM- RREC1, RtriAprèsMono - RREC3).
- The functionality uses the blocking time delays B1 and B2 (cf. requirements ARS-GE-06/07). B2 is used to issue a definitive tripping signal when there are several triggers during this time delay. These time delays relate to the applications level and are not represented in the modelling proposed in this document.
- The signalling "failure of recloser functions" (DEFAUT.ARS, DEF.ARS), common to the ARS group, becomes a grouped signal.

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- LDREC subscribes to LDRSE.Beh. If LDRSE is activated, LDREC takes into account the requirement ARS-RSE-02 [13] at the applications level. This requirements concerns the inhibition of any circuit breaker close command for functions of the ARS group if LDRSE is activated. Any single-phase recloser init is in this case converted in a 3-phase trip order with inhibition of the recloser cycle.
- AR.TRI.R signal indicates the activation/deactivation of the RTR function (fast three-phase re-closing). This sub function is only used for voltage levels of 63 and 90kV.
- The energisation of a dead busbar must be realised from at most one feeder at a time. A live line / dead busbar cycle has thus to be blocked for the other feeders if a cycle is launched in one feeder this blocking signal subscribed by the ARS functions of other bays, is published. For the REBTAM function, the DO RREC4.OpCls associated is used for this purpose.
- The configuration of the different recloser criteria for the REBTAM function are covered by a control of ENUM type associated with the CSYN1. The correspondence between the control value and the setting is indicated in the table in §11.8. This control is modelled by DO RecCycMod using the proprietary LN CREC (cf. §11.8). One instance of CREC is used for each type of recloser cycle.
- DO RREC*.AutoRecSt is used for the signal "AR.Impossible". This signal corresponds to values 9, 10 or 11 of AutoRecSt (see Appendix A, IEC 61850-7-4).
- The LN GAPC is used to:
  - indicate the three-phase trip order of the RM function (ARS-RM-16),
  - provide RM activated/deactivated signalling,
  - put in common, the three-phase init of the single-phase inits when the RM function is deactivated (cf. requirements ARS-RM-13)
- According to IEC 61850-7-4, all DO CycTrMod* with *>1 are only accessible if MaxCyc >1. For this reason, this parameter is added to LN RREC3 and set to 2 cycles, causing the instantiation of CycTrMod1 and CycTrMod2.
- LDREC subscribes to the LDCMDDJ of the same functional bay for the DO providing an information whether live-dead or live-live reclosing is possible (absence / presence of line and busbar voltage, threshold of voltage, phase and frequency).
- The energisation of a dead busbar must be realised from at most one feeder at a time. A live line / dead busbar cycle has thus to be blocked for the other feeders if a cycle is launched in one feeder this blocking signal subscribed by the ARS functions of other bays, is published by LDCMDDJ/CALH2.Grind.

6.4.4 Static Description

Single Phase and Fast Re-closing (LDREC)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
CREC0	RecCycMod	ENC	AR.RVB, AR.REB	Control of recloser mode of REBTAM cycle
CSYN0	Beh	ENS		Contributes to the signal of inconsistency in the setting
	Rel	SPS		Indication of the possibility of closing of the circuit-breaker elaborated by REBTAM
GAPC0	Beh	ENS		

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Single Phase and Fast Re-closing (LDREC)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Op	ACT	DT.AR	Three-phase trip order after unsuccessful Single-phase recloser cycle and three phase recloser init I-ARS-T-R (when the RM function is deactivated (cf. requirements ARS-RM-13) to LDRS
LLN0	Beh	ENS		
	Health	ENS	DF.ARS.	Function state (Contributes to the ARS fault group)
	Mod	ENC		
	NamPlt	LPL		
RREC1	AutoRecSt	ENS	AR.Impossible	RM - signal "Single-phase cycle in progress" to LDRTS, LDREC and LDCMDDJ
	Beh	ENS	AR.MONO	RM - Signal "Single phase recloser function activated/deactivated" (set of activated/deactivated information of single-phase cycles
	CycTrMod1	ENG		CycTrMod= 3 for the RM function
	MaxTmms	ING	T-DESRM	Maximum time during auto- reclosing is permitted with RM function
	Mod	ENC		RM - Single-phase re-closing - Activation/Deactivation order of the single-phase cycle
	OpCls	ACT.general	AR.ENCLT	Closing order to LDCMDDJ (Contributes to the AR.ENCLT signalling of the ARS group). Used also to start fault recorder.
	OpCls	ACT.phsA	AR.ENCLT	Closing order to LDCMDDJ (Contributes to the AR.ENCLT signalling of the ARS group).
	OpCls	ACT.phsB	AR.ENCLT	Closing order to LDCMDDJ (Contributes to the AR.ENCLT signalling of the ARS group).
	OpCls	ACT.phsC	AR.ENCLT	Closing order to LDCMDDJ (Contributes to the AR.ENCLT signalling of the ARS group).
	Rec1Tmms1	ING	T-RM	Cycle duration of single-phase re-closing
RREC2	AutoRecSt	ENS	AR.Impossible	RTR - Rapid three-phase re-closing - Three-phase cycle in progress - signalling to LDRTS and LDCMDDJ - put on busbars at end of incident analysis development.
	Beh	ENS	AR.TRI.R	RTR - Rapid three-phase re-closing - Activated/deactivated signal of Three-phase cycle
	CycTrMod1	ENG		CycTrMod= 1 for the RTR function
	MaxTmms	ING	T-RTR	Cycle duration of rapid three-phase re-closing
	Mod	ENC	AR.TRI.R	RTR - Rapid three-phase re-closing - Order for Activation/Deactivation hree-phase cycle command
	OpCls	ACT.general	AR.ENCLT	Closing order to LDCMDDJ (Contributes to AR.ENCLT signalling). Used also to start fault recorder.
	Rec3Tmms1	ING	T-REVRTR	
RREC3	AutoRecSt	ENS	AR.Impossible	Signal "Three-phase cycle in progress" to LDCMDDJ and LDRTS.

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Single Phase and Fast Re-closing (LDREC)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Beh	ENS	AR.TAM	Three-phase cycle after RM - Activated/deactivated signalling
	CycTrMod1	ENG		CycTrMod= 3 for the Single-phase cycle function
	CycTrMod2	ENG		CycTrMod= 1 for the Three-phase cycle function
	MaxCyc	ING		Maximum number of reclose cycles (MaxCyc = 2 for TAM)
	Mod	ENC	AR.TAM	TAM - Three-phase cycle after RM Activation/Deactivation Three-phase cycle command after unsuccessful single-phase
	OpCls	ACT.general	AR.ENCLT	Closing order to LDCMDDJ (Contributes to the AR.ENCLT signalling of the ARS group). Used also to start fault recorder.
	OpCls	ACT.phsA	AR.ENCLT	Closing order to LDCMDDJ (Contributes to the AR.ENCLT signalling of the ARS group).
	OpCls	ACT.phsB	AR.ENCLT	Closing order to LDCMDDJ (Contributes to the AR.ENCLT signalling of the ARS group).
	OpCls	ACT.phsC	AR.ENCLT	Closing order to LDCMDDJ (Contributes to the AR.ENCLT signalling of the ARS group).
RREC4	AutoRecSt	ENS	AR.Impossible	Signalling "Three-phase cycle in progress" to LDCMD and LDRTS.
	Beh	ENS	TAMRBRVB	Three-phase cycle after RM - Signal "Activated/deactivated"
	CycTrMod1	ENG		CycTrMod= 1 for the Three-phase cycle function
	MaxTmms	ING	T-DESREBTAM	Maximum time during auto- reclosing is permitted with REBTAM function
	Mod	ENC	TAMRBRVB	REBTAM - Three-phase cycle after RM Order for Activation/Deactivation Three-phase cycle after unsuccessful single-phase
	OpCls	ACT.general	AR.ENCLT F.TAMREB	Closing order to LDCMDDJ (Contributes to AR.ENCLT signalling of the ARS group). Used also to start fault recorder.
	Rec3Tmms1	ING	T-REBTAM	Cycle duration of REBTAM

6.4.1 Dynamic description

Dynamic description is available in appendix 12.6

6.5 Function for the Management of Prolonged Loss of Voltage (LDAMU) [ARS]

The ARS function described in the PACS specification concerns several sub functions, including recloser, service restoration, automatons managing a prolonged loss of voltage and safety functions related to life work on power lines. This ARS function is broken down as follows:

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LDRS Recloser and Service Restoration function (RT: Three-phase re-closing)

LDREC Single-phase reclosing [RM: Réenclenchement Monophasé] and rapid three-phase reclosing [RTR: Réenclenchement Tripohasé Rapide]

LDAMU **Automaton for the management of a prolonged loss of voltage (AMU) comprising the Voltage Loss Trip function [DMU: Déclenchement à Manque de Tension] and Service Restoration after Voltage Loss [RMU: Reprise de Service après Manque de Tension]**

LDRTS Backup feeder energisation function [Renvoi de Tension en Secours]

LDRSE Safety function related to life work on power line [Régime spécial d'exploitation]

The function verifying the circuit breaker reclosing conditions based on busbar and line Voltage (CT) is incorporated into LDCMDDJ.

The signal "DF.ARS" (ARS failure) becomes a grouping of different LLN0.Health of all the LDs of the ARS sub functions.

The signal "AR.ENCLT / AR.ENCLT.ORDONNE" (Closing order from the ARS function) becomes a grouping of different OpCls of all the LDs of the ARS group except LD LDAMU and LDRSE.

6.5.1 Description of the Function

The functions DMU (Trip on voltage loss) and RMU (Circuit breaker reclosing after voltage restoration) are used for network topologies with several substations without power generation connected in series by power lines.

Generally these substation strings can be supplied from both ends, but are operated as open loop. Under these conditions, in case of fault, the remote protection systems can assure the tripping only from the side with source. The "Trip on Voltage Loss Function" (DMU) opens the circuit breaker of the passive line end in case of line and busbar voltage loss. This facilitates the service restoration sequence.

6.5.2 LNs used

LN	Description
CREC	Private LN
CSYN	This LN class shall be used to control the synchronizing conditions i.e. voltage, frequency and phase.
FXOT	Logical node FXOT shall be used to set a high-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, contro or alarm function is based on other physical measurements than primary electrical data.
FXUT	Logical node FXUT shall be used to set a low-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXUT can typically be used whenever a protection, control or alarm function is based on other physical measurements than primary electric data.
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.

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LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
LSET	Rte Extended Setting LN
RREC	The number of trigger modes (CycTrMod i) and reclose times (RecTmmsi) is equal to the maximum allowed number of reclose cycles (MaxCyc). The trigger for the activation of RREC can be the start signal of PTRC, or the report "breaker open" of the circuit breaker, or any other signals and combination of signals. If different types of protections are involved in the autoreclosing process, all relevant data objects have to be published and subscribed by the allocated protection LNs. A principal diagram of RREC is given in Annex G.

6.5.3 Specificities

- DMU requires the unfiltered position of the circuit-breaker (LDDJ/XCBR.pos).
- The activation/deactivation of the sub-function operates as a modification of DO Mod of the LN concerned. The return signal is associated with the DO Beh of this LN.
- The configuration of the different recloser criteria for the RMU function are covered by a control of ENUM type associated with the CSYN0. The correspondence between the control value and the setting is indicated in the table in §11.8. This control is modelled by DO RecCycMod using the proprietary LN CREC (cf. §11.8).
- The signalling "failure of recloser functions" (DEFAUT.ARS), common to the ARS group, becomes a grouped signal.
- LDAMU subscribes to LDRSE.Beh. If LDRSE is activated, LDAMU takes into account the requirement ARS-RSE-02 [13] at the applications level. This requirements concerns the inhibition of any circuit breaker close command for functions of the ARS group if LDRSE is activated. This includes the deactivation of the RMU function.
- The functionality uses blocking time delays B1 and B2 to elaborate a definitive trip order when several initiations/triggers signals are received during this time delay (cf. requirements ARS-GE-06/07). These time delays relate to the applications level and are not represented in the modelling proposed in this document.
- When the RMU function is implemented in a 225kV bay of an autotransformer, it also sends a closing signal to LD LDGESTREACT.
- DO RREC.AutoRecSt is used for the information "AR.Impossible". This signal corresponds to values 9, 10 or 11 of AutoRecSt (see Appendix A, IEC 61850-7-4).
- LDAMU subscribes to the LDCMDDJ of the same functional bay for the DO providing an information whether live-dead or live-live reclosing is possible (absence / presence of line and busbar voltage, threshold of voltage, phase and frequency).

6.5.4 Static Description

Function for the Management of Prolonged Loss of Voltage (LDAMU)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
CREC0	Beh	ENS		
	RecCycMod	ENC	RMU.REB, RMU.RVB, RMU.RVL	Control of recloser mode of RMU cycle

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Function for the Management of Prolonged Loss of Voltage (LDAMU)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
CSYN0	Beh	ENS	RMU ES/HS	RMU activated/deactivated
	Health	ENS	ANO.CONS	Contributes to the signal indicating inconsistency in the signalling of reclosing critera (ARS.DEFAUT.CONFIG). (cf. ARS-RMU-01)
	Mod	ENC	RMU ES/HS	RMU activated/deactivated
	Rel	SPS		Indication of closing by RMU intended for RREC
FXOT0	Beh	ENS		
	StrVal	ASG.setMag		
	Op	ACT		
FXUT0	Beh	ENS		
	Op	ACT		Time delay for tripping by voltage loss
	StrVal	ASG.setMag		
GAPC1	Beh	ENS		
	Ind1	SPS	*VEIL.MU (LL=*AMU EN VEILLE.T)	AMU pronlonged loss of voltage monitoring activated on the bay
	Op	ACT	DT.AMU	DMU – Trip order by DMU to circuit-breaker and signalling
	SPCSO1	SPC		Associated with Ind1 allows to deactivate the function monitoring the voltage return for service restoration.
GAPC2	Beh	ENS		
	Mod	ENC.stVal	DECP-DMU	Activation/deactivation of the primary 400/225kV autotransformer tripping by DMU
	Op	ACT	DT.AMU	
LLN0	Beh	ENS	AMU ES/HS	Signal indicating Activation/Deactivation (DMU-RMU).
	Health	ENS	DF.ARS	Faillure of AMU fault (Contributes to the fault of the ARS functional group)
	Mod	ENC	AMU ES/HS	Signal indicating Activation/Deactivation (DMU-RMU).
	NamPlt	LPL		
LSET0	OpDlTmms1	ING	T-ARMDMU	Activating time delay
	NamPlt	LPL		
	OpDlTmms2	ING	T-DECDMU	Time delay for tripping by voltage loss
RREC0	AutoRecSt	ENS	AR.Impossible	AR.Impossible corresponds to values 9, 10 or 11 of AutoRecSt (see Appendix A, IEC 61850-7-4)
	Beh	ENS		

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Function for the Management of Prolonged Loss of Voltage (LDAMU)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	MaxTmms	ING	T-VRMU	Period during the reclosing after voltage restoration is enabled
	OpCls	ACT	AR.ENCLT	Order of closing of the circuit-breaker elaborated by RMU. Used also to start fault recorder.
RREC1	AutoRecSt	ENS		
	OpCls	ACT		
	Rec3Tmms1	ING	T-RMURVL	Reclose time for Live Bus Dead Line mod by RMU function
RREC2	AutoRecSt	ENS		
	OpCls	ACT		
	Rec3Tmms1	ING	T-RMURVB	Reclose time for Live Bus Dead Line mod by RMU function
RREC3	AutoRecSt	ENS		
	OpCls	ACT		
	Rec3Tmms1	ING	T-RMUREB	Reclose time for Live Bus Dead Line mod by RMU function

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6.5.5 Dynamic description

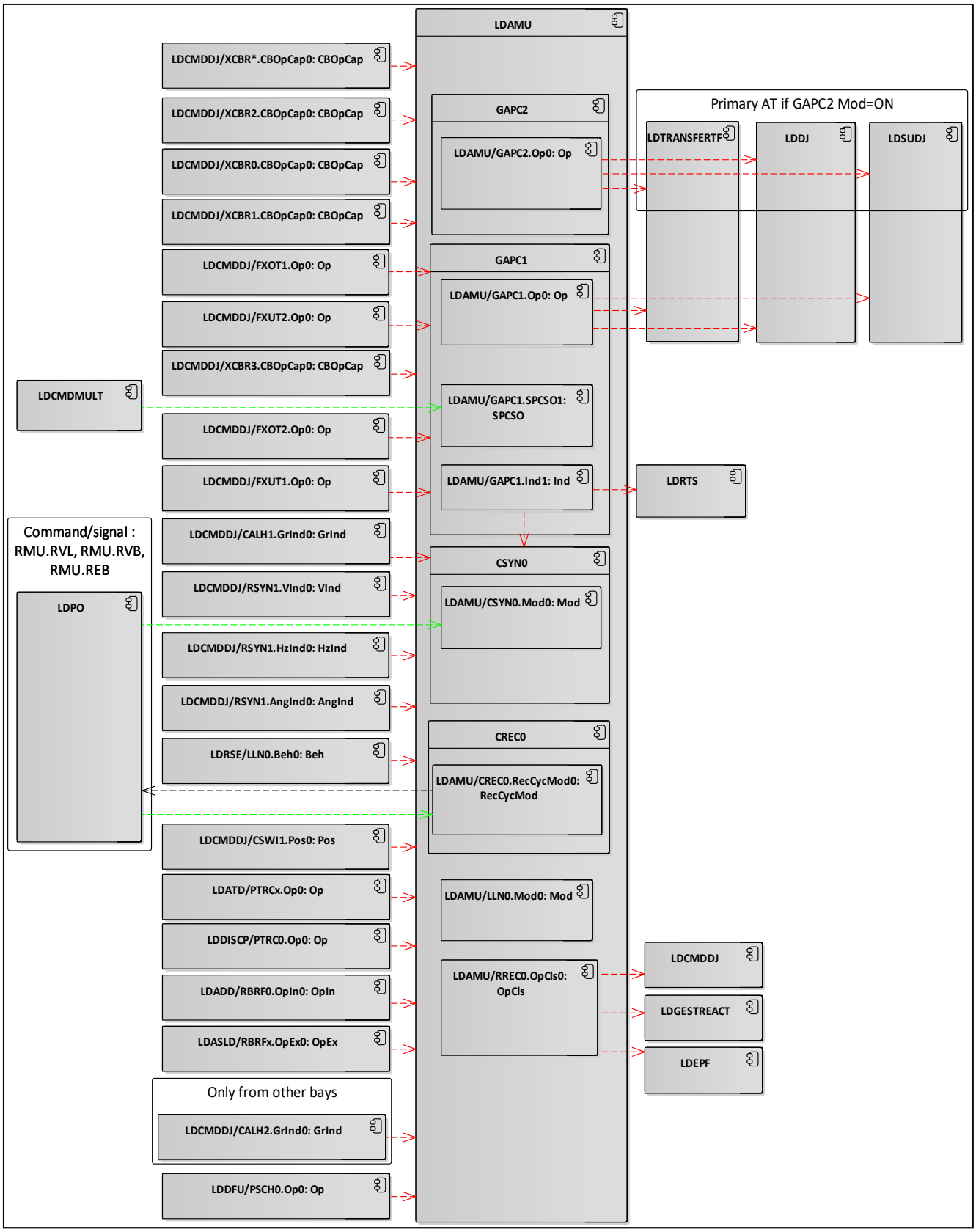

Figure 32: Dynamic description LDAMU

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6.6 Backup Feeder Energisation Function (LDRTS) [ARS]

The ARS function described in the PACS specification concerns several sub functions, including recloser, service restoration, automatons managing a prolonged loss of voltage and safety functions related to life work on power lines. This ARS function is broken down as follows:

LDRS Recloser and Service Restoration function (RT: Three-phase re-closing)

LDREC Single-phase reclosing [RM: Réenclenchement Monophasé] and rapid three-phase reclosing [RTR: Réenclenchement Tripohasé Rapide]

LDAMU Automaton for the management of a prolonged loss of voltage (AMU) comprising the Voltage Loss Trip function [DMU: Déclenchement à Manque de Tension] and Service Restoration after Voltage Loss [RMU: Reprise de Service après Manque de Tension]

LDRTS **Backup feeder energisation function [Renvoi de Tension en Secours]**

LDRSE Safety function related to life work on power line [Régime spécial d'exploitation]

The function verifying the circuit breaker reclosing conditions based on busbar and line Voltage (CT) is incorporated into LDCMDDJ.

The signal "DF.ARS" (ARS failure) becomes a grouping of different LLN0.Health of all the LDs of the ARS sub functions.

The signal "AR.ENCLT / AR.ENCLT.ORDONNE" (Closing order from the ARS function) becomes a grouping of different OpCls of all the LDs of the ARS group except LD LDAMU and LDRSE.

6.6.1 Description of the Function

The Backup Feeder Energisation function (RTS - Renvoi Tension Secours) is used for strings of substation including substations operated in open loop. Its purpose is to command the closing of the circuit-breaker in order to restore voltage onto a feeder or a busbar when the voltage on the nominal supply feeder has disappeared.

6.6.2 LNs used

LN	Description
CREC	Private LN
CSYN	This LN class shall be used to control the synchronizing conditions i.e. voltage, frequency and phase.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
LSET	Rte Extended Setting LN
RREC	The number of trigger modes (CycTrMod i) and reclose times (RecTmmsi) is equal to the maximum allowed number of reclose cycles (MaxCyc). The trigger for the activation of RREC can be the start signal of PTRC, or the report "breaker open" of the circuit breaker, or any other signals and combination of signals. If different types of protections are involved in the autoreclosing process, all relevant data objects have to be published and subscribed by the allocated protection LNs. A principal diagram of RREC is given in Annex G.

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6.6.3 Specificities

- The configuration of the different recloser criteria for the RTS function is covered by a control of ENUM type associated with the CSYN0. The correspondence between the control value and the setting is indicated in the table in §11.8. This control is modelled by DO RecCycMod using the proprietary LN CREC (cf. §11.8). The following criteria are used for RTS: RVB, RVL, RVB+RVL
- The signal "failure of recloser functions" (DEFAUT.ARS, DEF.ARS), common to the ARS group, becomes a grouped signal.
- LDRTS subscribes to LDRSE.Beh. If LDRSE is activated, LDRTS takes into account the requirement ARS-RSE-02 [13] at the application level.
- The functionality uses blocking time delays B1 and B2 to elaborate a definitive trip order when several initiations/triggers signals are received during this time delay (cf. requirements ARS-GE-06/07). These time delays relate to the application level and are represented in LDCMDDJ (cf. §8.1).
- The requirement of the PACS specification [13] T4 ARS-RTS-01 anticipates the signalling of setpoint inconsistency (ARS.DEFAUT.CONFIG). With the use of the setpoint mechanism, this inconsistency cannot occur. Consequently no DO is associated with this signalling in LDRTSLDRTS subscribes to the LDCMDDJ of the same functional bay for the DO providing an information whether live-dead is possible (absence / presence of line and busbar voltage, threshold of voltage, phase and frequency).

6.6.4 Static Description

Backup Feeder Energisation Function (LDRTS)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
CREC0	RecCycMod	ENC	RTS.RVB RTS.RVL	Control of recloser mode of RTS cycle
CSYN0	Beh	ENS		
	Rel	SPS	FCT.RTS	Order of closing of the circuit-breaker elaborated by RTS
LLN0	Beh	ENS	RTS ES/HS	Activation /Deactivation of RTS function And associated signal
	Health	ENS	DF.ARS	Failure of RTS function (Contributes to the fault of the ARS functional group)
	Mod	ENC	RTS ES/HS	Activation /Deactivation of RTS function And associated signal
	NamPlt	LPL		
LSET0	OpDlTmms1	ING	T-ARMRTS	Activation time delay for backup feedrer energisation sequence (RTS)
	NamPlt	LPL		
	DlTmms1	ING	T-RTSRVL	Recloser cycle time delay for Live Bus Dead Line mod by RTS function
	DlTmms2	ING	T-RTSRVB	Recloser cycle time delay for Live Line Dead Bus mod by RTS function

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Backup Feeder Energisation Function (LDRTS)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
RREC0	AutoRecSt	ENS	AR.Impossible	AR.Impossible corresponds to values 9, 10 or 11 of AutoRecSt (see Appendix A, IEC 61850-7-4).
	Beh	ENS		
	MaxTmms	ING	T-DESRTS	Time delay to automatic disarm the RTS function
	OpCls	ACT	AR.ENCLT	Closing order to LDCMDDJ. Used for RTS operation and for the elaboration of AR.ENCLT signal. Used also to start fault recorder.

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6.6.5 Dynamic description

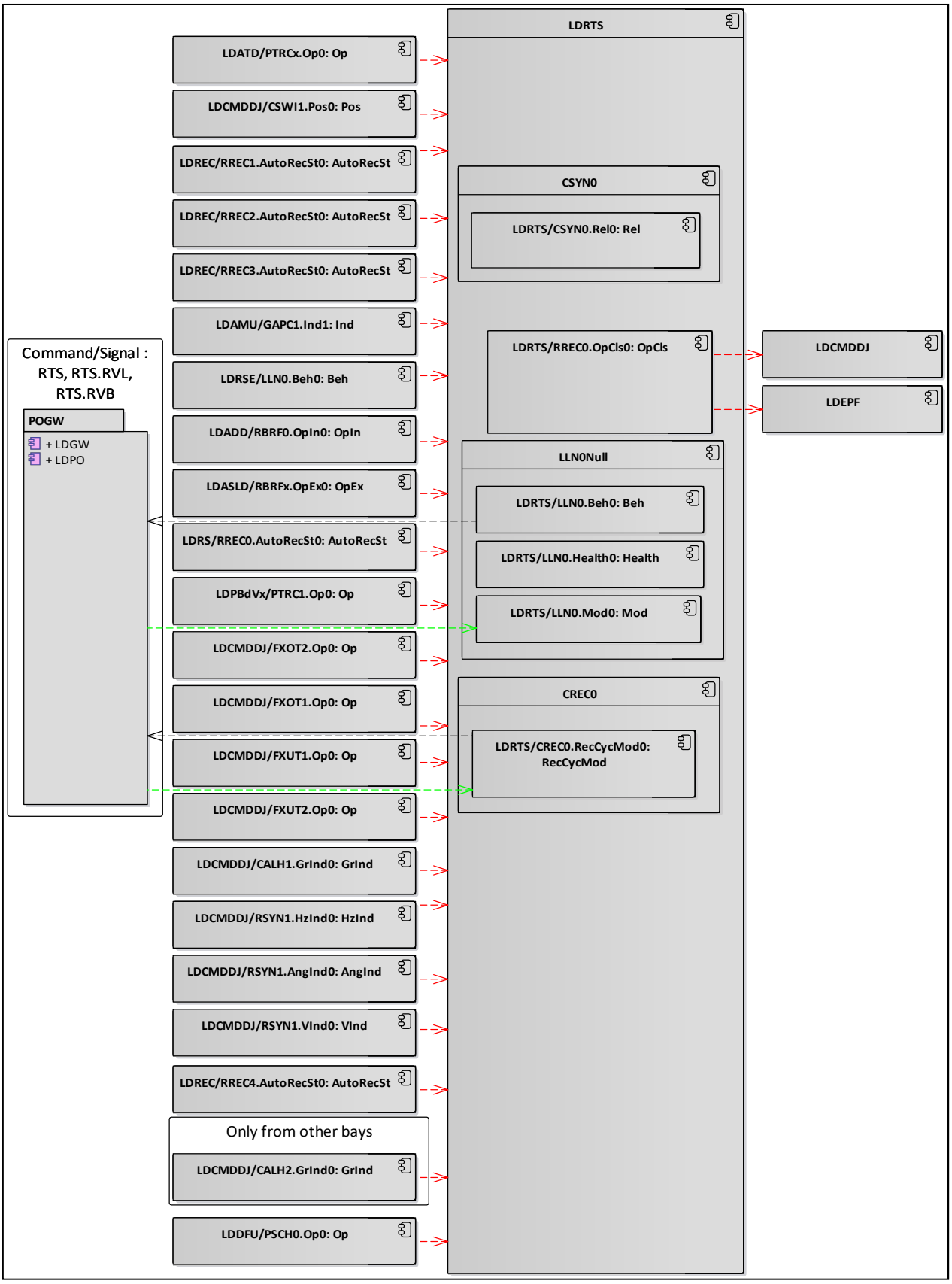

Figure 33: Dynamic description LDRTS

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6.7 Safety Function related to Life Work on Power Line (LDRSE) [ARS]

The ARS function described in the PACS specification concerns several sub functions, including recloser, service restoration, automatons managing a prolonged loss of voltage and safety functions related to life work on power lines. This ARS function is broken down as follows:

LDRS Recloser and Service Restoration function (RT: Three-phase re-closing)

LDREC Single-phase reclosing [RM: Réenclenchement Monophasé] and rapid three-phase reclosing [RTR: Réenclenchement Tripohasé Rapide]

LDAMU Automaton for the management of a prolonged loss of voltage (AMU) comprising the Voltage Loss Trip function [DMU: Déclenchement à Manque de Tension] and Service Restoration after Voltage Loss [RMU: Reprise de Service après Manque de Tension]

LDRTS Backup feeder energisation function [Renvoi de Tension en Secours]

LDRSE **Safety function related to life work on power line [Régime spécial d'exploitation]**

The function verifying the circuit breaker reclosing conditions based on busbar and line Voltage (CT) is incorporated into LDCMDDJ.

The signal "DF.ARS" (ARS failure) becomes a grouping of different LLN0.Health of all the LDs of the ARS sub functions.

The signal "AR.ENCLT / AR.ENCLT.ORDONNE" (Closing order from the ARS function) becomes a grouping of different OpCls of all the LDs of the ARS group except LD LDAMU and LDRSE.

6.7.1 Description of the Function

The Safety Function related to Life Work on Power Line (RSE - Régime Spécial d'Exploitation) is intended to support works under voltage (line or substation).

The RSE function

- inhibits any automatic closing of the ARS,
- causes single phase trips to be converted to three phase trip without recloser cycle (cf. LDREC)
- Opens the circuit-breaker in case of voltage loss after a configurable time delay.

6.7.2 LNs used

LN	Description
FXUT	Logical node FXUT shall be used to set a low-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXUT can typically be used whenever a protection, control or alarm function is based on other physical measurements than primary electric data.

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LN	Description
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.

6.7.3 Specificities

- LDRSE subscribes to the information regarding absence of line voltage individually for each phase (AULa, AULb, AULc) published by LDCMDDJ.The signalling "failure of recloser functions" (DEFAUT.ARS, DEF.ARS), common to the ARS group, becomes a grouped signal.
- LDRSE.Beh is subscribed by all LD of the group of recloser functions (ARS). If LDRSE is activated, these functions take into account the requirement ARS-RSE-02 [13] at the applications level.
- The local inhibition of the RSE function (alienation) is managed by the HMI. No block command to the LD itself is implemented, as this feature can only be used when the concerned bay is in local mode (DO LDMODEXPF/IHMI0.LocSta = TRUE, cf. §8.15) [8].

6.7.4 Static Description

Safety Function related to Life Work on Power Line (LDRSE)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
FXUT0	Beh	ENS		
	StrVal	ASG.setMag		
	OpDlTmms	ING	T-DRSE	Time delay before tripping
GAPC0	Beh	ENS		
	Op	ACT	DT.RSE	Order to open the Circuit-breaker
LLN0	Beh	ENS	RSE ES/HS	Activation / deactivation of RSE function And associated Signal Used to inhibit other functions of ARS functional group
	Health	ENS	DF.ARS	Failure of RSE function (Contributes to DF.ARS signal of ARS functional group)
	Mod	ENC	RSE ES/HS	Activation / deactivation of RSE function And associated Signal Used to inhibit other functions of ARS functional group
	NamPlt	LPL		

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6.7.5 Dynamic description

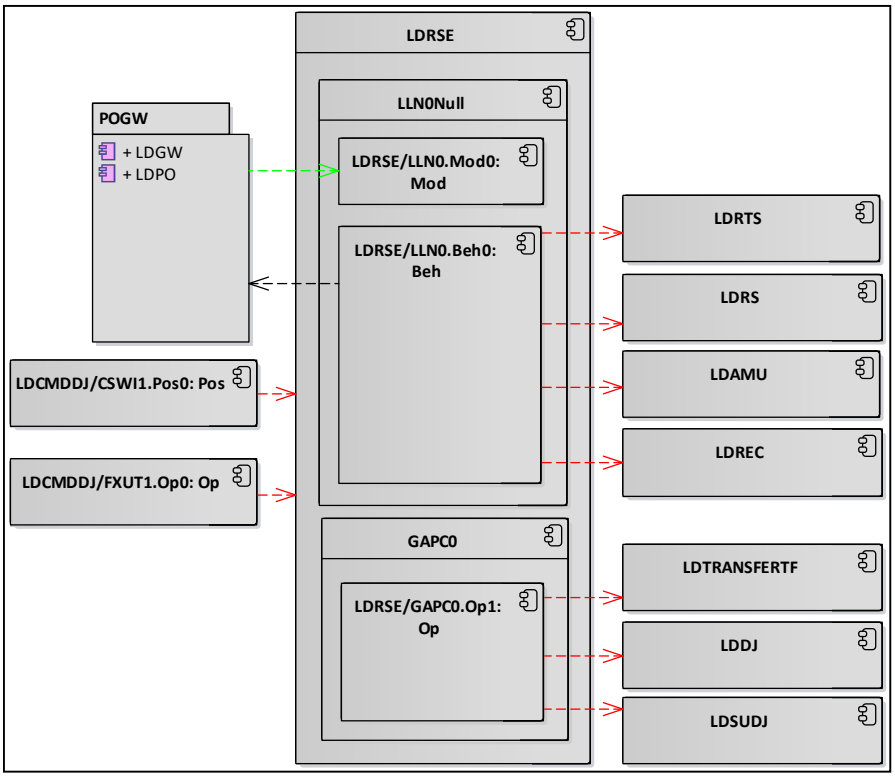

Figure 34: Dynamic description LDRSE

6.8 Circuit Breaker Failure Protection (LDADD)

6.8.1 Description of the Function

ADD is a function of the bay which has the following tasks:

- If a second trip contact is implemented, to duplicate the trip order of the circuit breaker to this contact
- To detect the possible absence of opening of one or several poles of the tripped circuit-breaker after a trip order
- If the failure is noted, to publish a trip order to neighbouring circuit-breakers.
- If a failure of the circuit breaker to open is noted, to issue a backup trip order in the case of certain GIS

6.8.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

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LN	Description
RBRF	This LN is used in case of circuit breaker failure which implies that the fault is not eliminated and leads to sending a trip order to neighbouring circuit breakers. This indicates the use of topology information.

6.8.3 Specificities

- Circuit breaker failure function (ADD) of bays receiving a trip order from a neighbour bay in case of circuit breaker failure does not publish the DOs corresponding to the signal DF.BARRE (cf. ADD-15). This signal is published for each bay concerned by LDASLD which also directly publishes the trip order to the circuit-breaker. This trip order is not subscribed and re-published by LDADD. The corresponding signal is generated on the basis of DO RBRF.OpEx for all the bays concerned by the trip order due to the circuit breaker failure (cf. § 6.15).
- The signal «circuit breaker failure function deactivated" (ADD HS) corresponds to DO RBRF.Beh. The LDADD cannot be completely deactivated, in all cases it provides all the recopying of trip orders to the duplicated binary outputs.
- In case of transfer of the trip order from a feeder to the busbar coupler, the ADD of the busbar coupler bay is initialised by LDTRANSFERTC (cf. §8.20, TD mode).
- The parameter "Durée d'émission Défaillance ADD" is deleted because it corresponds to the transmission time used for wired interbay breaker failure protection.
- The mode of initialisation of the circuit breaker function (current criteria or interlock criteria) is indicated by configuration for each subscribed input using InRef.
- The retrip function of ADD is represented by PTRC0.Tr. This LN cannot be put out of service because the retrip function is always operational.

6.8.4 Static Description

Circuit Breaker Failure Protection (LDADD)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS	DF.ADD	Failure of LDADD
	Mod	ENC.stVal	MES-ADD	Cf. ADD-1 requirement, no command of activation/deactivation
	NamPlt	LPL		
PTRC0	Beh	ENS		
	Tr	ACT.general		Trip order to XCBR
RBRF0	Beh	ENS	ADD.HS	Signal "Circuit breaker failure function" activated/deactivated. The other functions of LDADD cannot be deactivated
	DetValA	ASG.setMag	S-I-ADD	Threshold of fault current detection for circuit breaker failure function (ADD)
	FailMod	ENG		Fixed to 4 (other) in order to take into account that the CB failure initialisation can be current or interlock criteria
	FailTmms	ING		Delay time (BF Time delay for busbar trip)

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Circuit Breaker Failure Protection (LDADD)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Mod	ENC		
	OpEx	ACT		Contributes to busbar fault signalling elaborated in the ASLD for called upon bays
	OpIn	ACT	DFAIL.DJ	Trip order and elaboration of circuit-breaker failure signal and the recloser blocking order to the functional ARS group

6.8.5 Dynamic description

Dynamic description is available in appendix 12.4

6.9 Backup Trip Automaton (LDADS)

6.9.1 Description of the Function

The backup tripping automaton (ADS) represents the function performed by the backup trip circuit (CDC, previously RUD).

6.9.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.
RBRF	This LN is used in case of circuit breaker failure which implies that the fault is not eliminated and leads to sending a trip order to neighbouring circuit breakers. This indicates the use of topology information.

6.9.3 Specificities

- The subscription of backup trip order coming from a remote power plant is modelled by the use of a DO PSCH.RxTr.
- The use of the second tripping coil of a circuit-breaker is not represented in the IEC 61850 modelling. If need be, the contacts associated with a second coil are subscribed to the same DO Tr.

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6.9.4 Static Description

Backup Trip Automation (LDADS)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		Signal "ADS activated/deactivated"
	Health	ENS	ANO.COND	Backup trip automaton anomaly
	Mod	ENC		Activation/deactivation order
	NamPlt	LPL		
PTRC0	Beh	ENS		
	Op	ACT		
	Tr	ACT.general		Trip order to XCBR
RBRF0	Beh	ENS		
	OpIn	ACT	DT.V.SEC	Tripping decision and elaboration of circuit-breaker failure signalling and the deactivation order to the recloser (ARS functional group)

6.9.5 Dynamic description

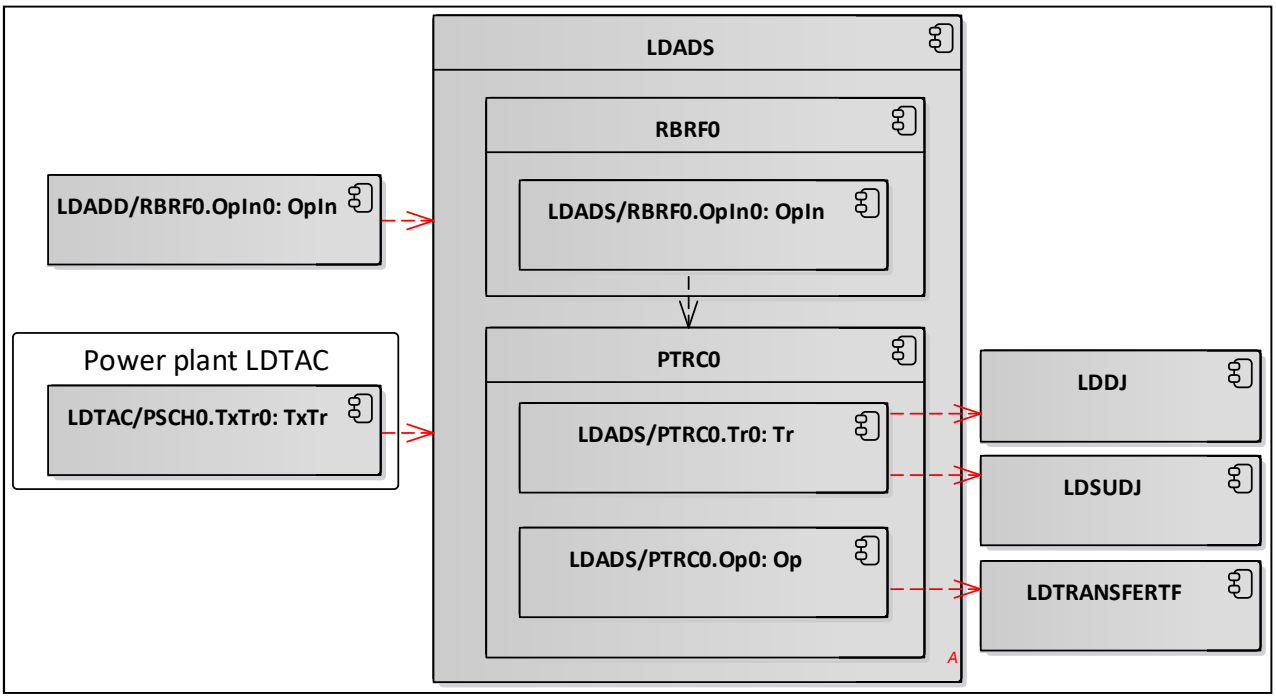

Figure 35: Dynamic description LDADS

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6.10 Transformer Voltage Regulation Automaton (LDARU)

6.10.1 Description of the Function

The role of the Transformer Voltage Regulation Automaton (ARU) is to regulate the transformer voltage by publishing raising or lowering tap change orders to the tap changer, situated on the secondary of the transformer and associated to one transformer.

6.10.2 LNs used

LN	Description
ATCC	Automatics to maintain the voltage of a busbar within a specific range using tap changers. This node operates the tap changer automatically according to given setpoints or by direct operator commands (manual mode).
FXOT	Logical node FXOT shall be used to set a high-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, contro or alarm function is based on other physical measurements than primary electrical data.
FXUT	Logical node FXUT shall be used to set a low-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXUT can typically be used whenever a protection, control or alarm function is based on other physical measurements than primary electric data.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
LSET	Rte Extended Setting LN
TVTR	The voltage is delivered as sampled values. The sampled values are transmitted as engineering values, that is as "true" (corrected) primary voltage values. Therefore, the transformer ratio and the correction factors are of no interest for the transmitted samples but for maintenance purposes of an external conventional (magnetic) transducer only. In addition, status information is provided and some other settings are accepted from the LN TVTR.

6.10.3 Specificities

- It is considered that the signal "failure of tap changer" (DF.REGUL) is generated by external signalling coming from primary equipment or by the failure of equipment hosting the LDCHPRTR (cf. § 7.6).
- In current versions of the Transformer Voltage Regulation Automatons (ARU) automatons, the orders are "raising" and "lowering" of the taps. In the modelling, the possibility that the order directly indicates the target tap number is added.
- In the case blocking of the tap changer, signal NON.BLOC indicates that the tap changer is not on the default tap. This is not elaborated by LDARU and can be created by a combination of of DO LTCBlk and TapPos.
- In the case of the blocking of the tap changer, the information "successful tap changer blocking" indicates that the load regulator is on the predetermined default tap. This signal is not elaborated by LDARU, but can be created by a combination of DO LTCBlk and TapPos.

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- In the case of tap changer blocking, the ARU function remains activated. In this situation, it is possible to pass orders manually. Only the automatic regulation is deactivated. Consequently, the signal "tap changer blocked" (BLOC.REG) is associated with DO ATTC1.Auto.
- It is considered that the display of the balance between Vregul and Vck is done at the level of IHM and not by the LDARU.
- In the framework of modelling, it is considered that the elaboration of the configuration fault, such as described in the requirement ARU-11, is not relevant.
- The use of TVTR is necessary for modelling the sub-function which detects fuse blowing. This LN does not directly represent the voltage transformer.
- ATTC1.TapChg is used for the order for increase or decrease of the tap position. DO TapOpL and TapOpR show inconsistencies between IEC 61850-7-3 and IEC 61850-7-4 and are not used.
- LDCHPRTR/GAPC0.Ind1 is used to indicate that the tap position is changing.
- Most settings specific to LDARU are instanciated in LSET.

6.10.4 Static description

Transformer Voltage Regulation Automation (LDARU)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
ATCC1	Auto	SPC	BLOC.REG REG.AUTO	Order and Signal "Automatic regulation activated/deactivated "
	EndPosL	SPS	REG.BAS	Signal "Low end position of tap changer"
	EndPosR	SPS	REG.HAUT	Signal "High end position of tap changer"
	LTCBlk	SPC	NON.BLOC.REGL.T	Indicates that the default tap has not been reached in case of tape changer blocking. Therefore, when LTCBlk is true (NON.BLOC.REGL.T false) then the tap changer has been blocked (ATCC1.auto = FALSE)
	LTCBlkAHi	SPS	IN.REGUL	
	LTCBlkVHi	SPS	U.ANORMA	
	LTCBlkVLo	SPS	U.ANORMA	
	TapChg	BSC	AUGMENTE DIMINUE	"Decrease" and "Increase" order
	TapOpErr	SPS	DF.REGTR	Signal "Tap Changer anomaly"
	TapOpStop	SPS		Change tap position stop
	TapPos	ISC	NUMPRISE	Direct order of the position to attain and return
	VolSpt	APC		
ATCC2	VolSpt	APC		
	TapPos	ISC		Direct order of the position to attain and return

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Transformer Voltage Regulation Automation (LDARU)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	LTCBlkVLo	SPS		"Regulation deactivated - Voltage absence" signalling
ATCC1	TapBlkR	ING	BLOC-REG	Together with TapBlkL used to block tap changer
	TapBlkL	ING	BLOC-REG	Together with TapBlkR used to block tap changer
FXOT0	Op	ACT.general		High voltage
FXUT0	StrVal	ASG.setMag		
	Op	ACT.general		Low Voltage
LLN0	Beh	ENS	REG.AUTO	Signal "ARU activated/deactivated"
	Health	ENS	DF.ARU	Health status of the function
	Mod	ENC	REG.AUTO	Activation/deactivation command
	NamPlt	LPL		
LSET0	SetPhsOrig	ENG	TYP-REGU	Indication of single phase or combined phase voltage
	NamPlt	LPL		
	StrVal1	ASG.setMag	S-PRESU	Voltage setting threshold
	StrVal2	ASG.setMag	K2	VC+VDC2 setting
	StrVal3	ASG.setMag	K3	VC+VDC3 setting
	StrVal4	ASG.setMag	K4	VC+VDC4 setting
	StrVal5	ASG.setMag	VC	VC setting
	StrVal6	ASG.setMag	ALPHA	
	StrVal7	ASG.setMag	BETA	
	DlTmms1	ING	T-ABSU	
	DlTmms2	ING	T-PRESU	
	OnOff1	SPG	TYP-COMP	Compoundage active/inactive
	OnOff2	SPG	TYP-COMP	Type1 or Type2
	StrVal8	ASG.setMag	A1	Type1 compounding coefficient for active power
	StrVal9	ASG.setMag	B1	Type1 compounding coefficient for reactive power
	StrVal10	ASG.setMag	A2	Type2 compounding coefficient for active power
	StrVal11	ASG.setMag	B2	Type2 compounding coefficient for reactive power
	DlTmms3	ING	T-BLOCREG	
	DlTmms4	ING	T-APP1	

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Transformer Voltage Regulation Automation (LDARU)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	DlTmms5	ING	T-APP2	
	SetNb1	ING	PP/N	Default position of the load tap changer
	DlTmms6	ING	T-SURV	Time delay before emitting alarm signal
	SetNb2	ING	PMIN	Low position of the load tap changer
	SetNb3	ING	PMAX	High position of the load tap changer
	OnOff3	SPG	POS-REGL	Load tap changer position to default tap position in case of voltage loss
	OnOff4	SPG	REGL-APP	Automatic activation of regulation when voltage returns after voltage loss
UnnpTVTR0	VRtg	ASG.setMag		Rated Voltage
	HzRtg	ASG.setMag		Rated Frequency
	FuFail	SPS		Regulation deactivated - VT circuit V fuse blown

6.10.5 Dynamic description

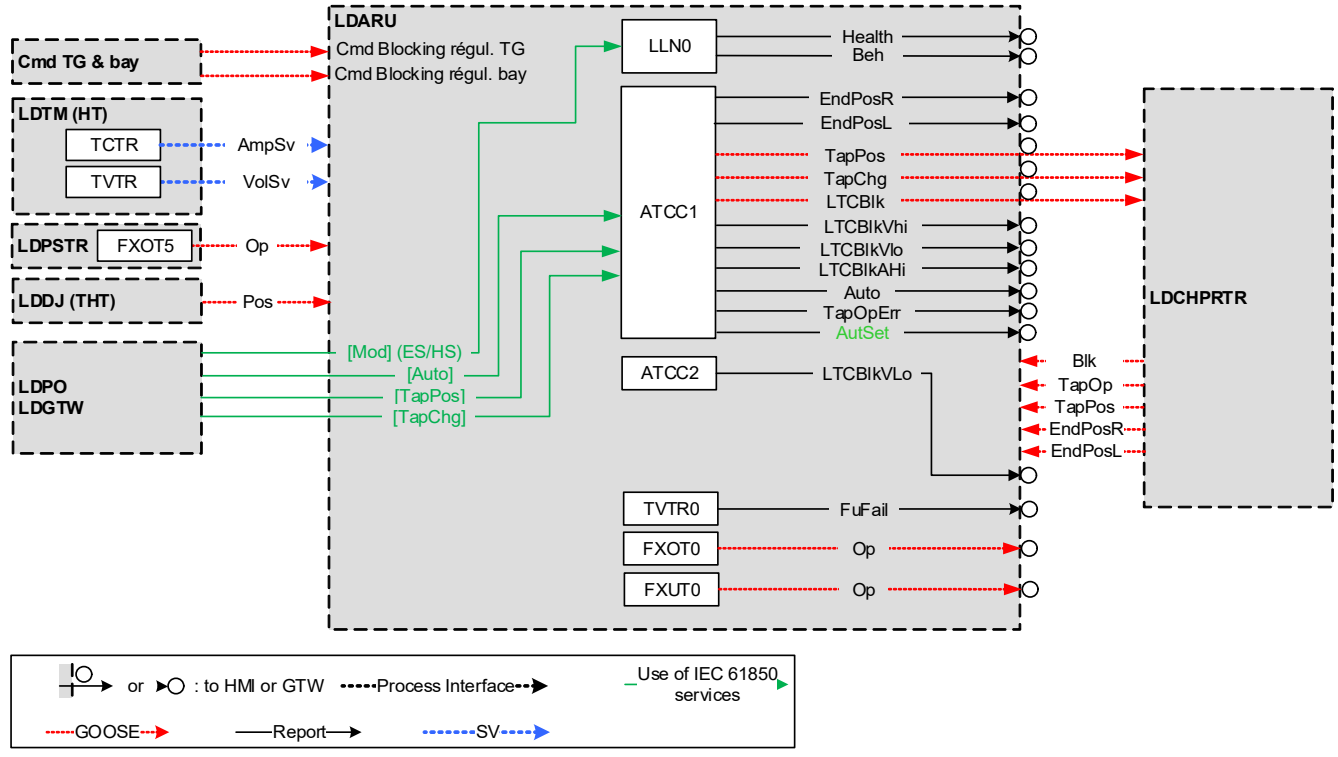

Figure 36: Dynamic description LDARU

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6.11 VERTHTPX (cf. LDPSPTR)

The VERTHTPX function is incorporated into the PSPT, backup protection of the transformer primary [Confer § 5.18 – Transformer Primary Backup Protection (LDPSPTR)].

6.12 VEFOSSE-VEAIR (cf. LDPTHTR & LPDMAXITR)

The VEFOSSE-VEAIR function, for the management of the distant transformer pit, is incorporated into the Main Power Transformer Protection (PTP) (LDPTHTR § 5.13 and LDPMAXITR § 5.14).

6.13 Reactance Management Function (LDGESTREACT)

6.13.1 Description of the Function

This function performs the management of the reactance associated with autotransformers. This includes topological management depending on the autotransformers in service. It corresponds to the functions ELECTRE Grand poste DEC225REACT, ENREACT and CONTREACT.

6.13.2 LNs used

LN	Description
CSWI	This LN class shall be used to control all switching conditions above process level. CSWI shall subscribe the data object POWCap ("point-on-wave switching capability") from XCBR if applicable. If a switching command (for example Select-before-Operate) arrives and "point-on-wave switching capability" is supported by the breaker, the command shall be passed to CPOW. OpOpn and OpCls shall be used if no Control Service is available between CSWI and XCBR (see GSE in IEC 61850-7-2).
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.

6.13.3 Specificities

- The information "reactance present" used by the function DEC225REACT and published by the function CONTREACT is not identified as output data of LDGESTREAC. It becomes internal information which remains at the application level.
- The LN CSWI is used to model the opening and closing orders of LDGESTREAC as no reactive management LN has suitable DOs.
- The CONTREACT function uses the position of disconnectors for connection to different tertiary circuits and for isolation of the reactance. These disconnectors are designated as SA1, SA2 and SI in spite of the fact that they are not used to connect to busbars. Nevertheless, the modelling of disconnectors is used to represent their positions.

6.13.4 Static Description

Reactance Management Function (LDGESTREACT)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
CSWI0	Beh	ENS		

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Reactance Management Function (LDGESTREACT)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Pos	DPC		
	OpCls	ACT		
	OpOpn	ACT		
LLN0	Beh	ENS		
	Health	ENS		Health of the function
	Mod	ENC		
	NamPlt	LPL		

6.13.12 Dynamic description

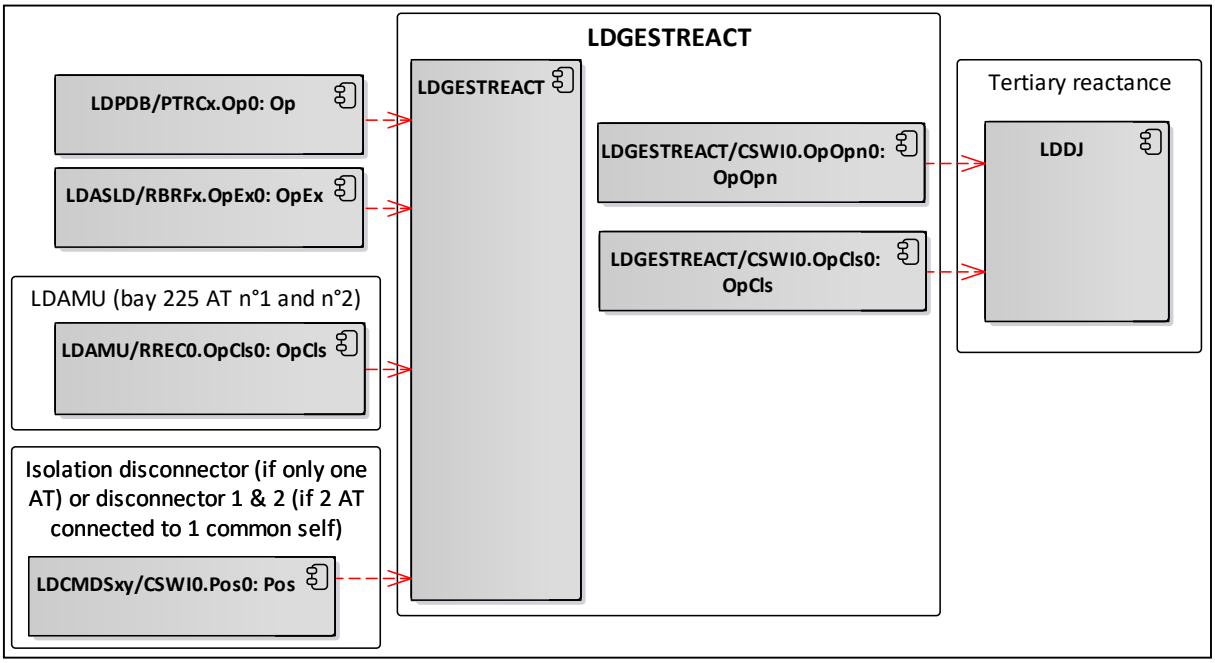

Figure 37: Dynamic description LDGESTREACT

6.14 Busbar Voltage reference Indication for Feeder Functions (LDATB)

6.14.1 Description of the Function

The Busbar Voltage Indication for Feeder Functions (Aiguillage Tension Barres - ATB) function is charged with monitoring the voltages supplied by the busbar VT and the line feeder VT. It publishes for each feeder the reference of the VT to use to obtain the busbar voltage corresponding to the section on which the feeder is connected. This function covers all of the R#SPACE ATB automatons of the (ATB-d, ATB-2BO-d, etc).

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6.14.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
LTED	Specific LN dedicated to the designation of the topological element.
LSET	Rte Extended Setting LN

6.14.3 Specificities

The LDATB indicates the VT to use as busbar voltage reference, in particular for reclosers, of the different busbar sections. As there is no DO in the standard to represent this information, the coding applied is that described in the paragraph (cf. § 4.3.1) concerning general principles of the modelling.

For a given feeder, the functions of the recloser LD (functional group ARS) use the DOs published by the ATB to identify the electrical nodes corresponding to their section. In particular, this it concerns the LDCMDDJ (for line and busbar voltage monitoring, cf. § 8.1) and the LDRS and LDAMU.

- The elementary electrical nodes correspond to a section of a busbar. One LTED corresponds to each elementary busbar section characterised by its busbar reference (b), main section (t) and susbsection (s).
- The ATB function subscribes to the quality attribute of the PhV published by the LDPHAS susceptible to provide the image of the busbar voltage to the different LDCMDDJ. Only valid phasor streams are considered by the application.
- The DO VTRefSt of type ENS, published by each LTEDbts, indicates for each busbar main section t, section s and busbar b (cf. §11.1):

  the designated VT is to be used,
  If the feeder is connected to a busbar section belonging to an electrical node which does not have an operating VT and whose voltage is estimated to be zero (electrically isolated on the basis of topological criteria),
  If the feeder is connected to a section belonging to an electrical node which does not have an operating VT and whose voltage is unknown,
  If the feeder is connected to a section belonging to an electrical node for which no VT output is valid.

- Alternatively, LTEDbts can publish DO DORef, which is an Object Reference to a LdName/LN.DO publishing a SV stream. It has the value of the corresponding Object Reference as given in the SCL.
- Alternatively, a *LTED instanciated for each feeder can publish DO DORef to be used as busbar voltage for the corresponding feeder.
- Boolean Settings LSET0.OnOff bts indicate if a busbar section is considered to be denergised even if a DSO transformer is connected to it. This is true if no distributed generation is connected to the transformer on MV side. bts indicates the busbar number and the section (main / sub).

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6.14.4 Static Description

Busbar Voltage reference Indication for Feeder Functions (LDATB)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		
	Mod	ENC		
	NamPlt	LPL		
LTEDbts	AcqChainRef	INS		Acquisition chain number
	Beh	ENS		
	NamPlt	LPL		
	CTAppli	ENS		Winding Reference – CT
	ElNodeNum	INS		Total number of Electrical Nodes
	FeederTyp	ENS		Topological Element Reference - Feeder (line, Power Transformer, Coil, Capacity, FACTS)
	ITType	ENS		Type of Instrument Transformer
	PhNum	ENS		Phase (ph0, ph3, ph4, ph7, ph8, ph11, neutral)
	BusbarNum	ENS		Busbar Number
	SectNum	INS		Topological Element Subset Reference - Busbar Section Number (1..n)
	SubSectNum	INS		Topological Element Subset Reference - Busbar Subsection number (1..m)
	TopoObj	ENS		Topological element
	TopoObjNum	INS		Topological Element Reference (1..n)
	VolLevel	ENS		Voltage level
	VTRefSt	ENS		Status of reference of VT concerned
	WgNum	INS		Winding Reference - VT (1,.n)
	ElNodeRef	INS		Reference of Electrical Node
	ElNodeVTRef	INS		Designate the voltage Information to be used as reference for the electrical node
	DORef	VSS		Object reference to a LdName/LN.DO publishing a SV stream
BayNameLTED0	AcqChainRef	INS		Acquisition chain number
	Beh	ENS		
	NamPlt	LPL		
	CTAppli	ENS		Winding Reference – CT

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Busbar Voltage reference Indication for Feeder Functions (LDATB)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	ElNodeNum	INS		Total number of Electrical Nodes
	FeederTyp	ENS		Topological Element Reference - Feeder (line, Power Transformer, Coil, Capacity, FACTS)
	ITType	ENS		Type of Instrument Transformer
	PhNum	ENS		Phase (ph0, ph3, ph4, ph7, ph8, ph11, neutral)
	BusbarNum	ENS		Busbar Number
	SectNum	INS		Topological Element Subset Reference - Busbar Section Number (1..n)
	SubSectNum	INS		Topological Element Subset Reference - Busbar Subsection number (1..m)
	TopoObj	ENS		Topological element
	TopoObjNum	INS		Topological Element Reference (1..n)
	VolLevel	ENS		Voltage level
	VTRefSt	ENS		Status of reference of VT concerned
	WgNum	INS		Winding Reference - VT (1,.n)
	ElNodeRef	INS		Reference of Electrical Node
	ElNodeVTRef	INS		Designate the voltage Information to be used as reference for the electrical node
	DORef	VSS		Object reference to a LdName/LN.DO publishing a SV stream
LSET0	NamPlt	LPL		
	OnOffbts	SPG.setVal	AUT-RVB-Sbts	Indicates if the busbar section bts is considered to be denergised even if a DSO transformer is connected

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6.14.5 Dynamic description

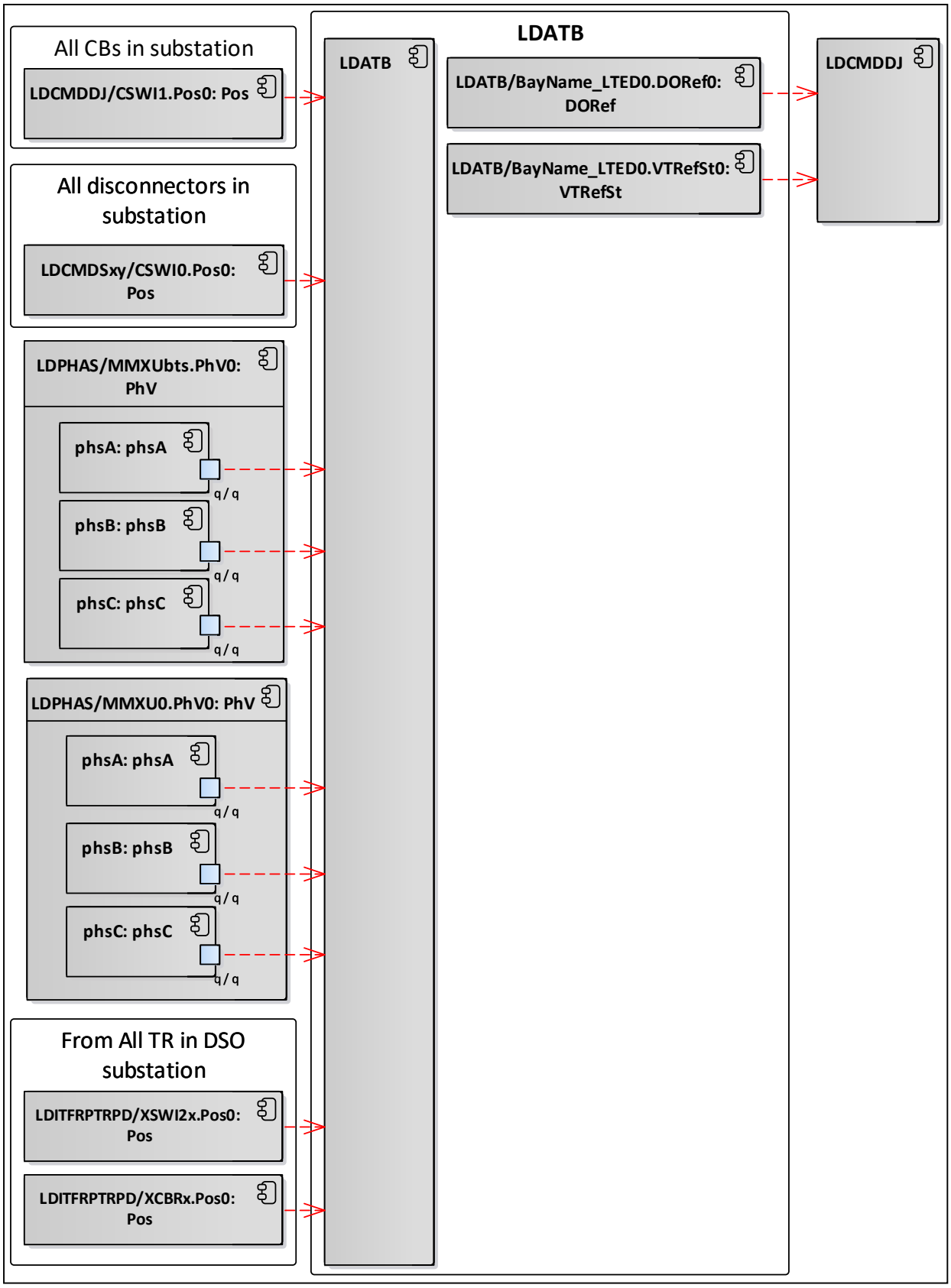

Figure 38: Dynamic description LDATB

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6.15 Circuit Breaker Failure Topology Management LD (LDASLD)

6.15.1 Description of the Function

The Circuit Breaker Failure Topology Management Function (Automate Secours Local Disjoncteur - ASLD) is a function at the substation level associated with the circuit breaker failure protection (ADD) at the bay level. Two approaches can be envisaged for this function:

1. **Centralised Approach**: ASLD subscribes to circuit-breaker failure indication from LDADDs and publishes them for other bays depending on the topology of the substation. This creates a common mode but, on the other hand, it presents the advantage of avoiding the complexity of a generalised mutual subscription of all LDADD.
2. **Decentralised Approach:** The ASLD function indicates for each bay which trip orders of subscribed LDADD from neighbour bays to process depending on the busbar topology. This means that all LDADDs subscribe to all other LDADDs. This approach is potentially more robust but implies problems of configuration as well a questions of feasibility (maximum number of GOOSE subscription).

The first approach is preferred and used for the modelling.

6.15.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.
RBRF	This LN is used in case of circuit breaker failure which implies that the fault is not eliminated and leads to sending a trip order to neighbouring circuit breakers. This indicates the use of topology information.

6.15.3 Specificities

- In the LDASLD function, an instance of LN RBRF is associated with each feeder.
- According to the PACS T4 specification (cf. [13]), the ASLD function takes into account whether or not the bay is under maintenance (ICT open). This particularity is covered in the modelling by the test or test/blocked mode.
- The Circuit Breaker Failure Topology Management Function (ASLD) subscribes to trip orders following the failure of a circuit breaker of a feeder. The function publishes in this case trip orders to the circuit breaker (LDDJ) of all feeders connected to the same electrical node.
- The ADD function (cf. § 6.8) of bays does not publish the DOs corresponding to the signal DF.BARRE indicating a trip order received via ASLD for a circuit breaker failure of a neighbour bay. The corresponding signal is generated on the basis of DO RBRF.OpEx for all the target bays concerned.

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- The ASLD function directly publishes the circuit-breaker trip orders via the LN PTRC. One LN RBFx and one LN PTRCx are associated to the feeder x. The trip orders do not transit via the circuit breaker failure function (LDADD) of the target bays. This increases tripping reliability and speed.

6.15.4 Static Description

Circuit Breaker Failure Topology Management (LDASLD)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS	MES-SLD	Activation/deactivation of ASLD function
	Health	ENS		
	Mod	ENC.stVal	MES-SLD	Activation/deactivation of ASLD function
	NamPlt	LPL		
PTRCx	Beh	ENS		
	Tr	ACT		The trip order for the circuit-breaker of feeder x
RBRFx	Beh	ENS		
	OpEx	ACT	DF.BARRE	There is 1 LN for each bay x representing feeder x. This signal is issued on behalf of the target bay

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6.15.5 Dynamic description

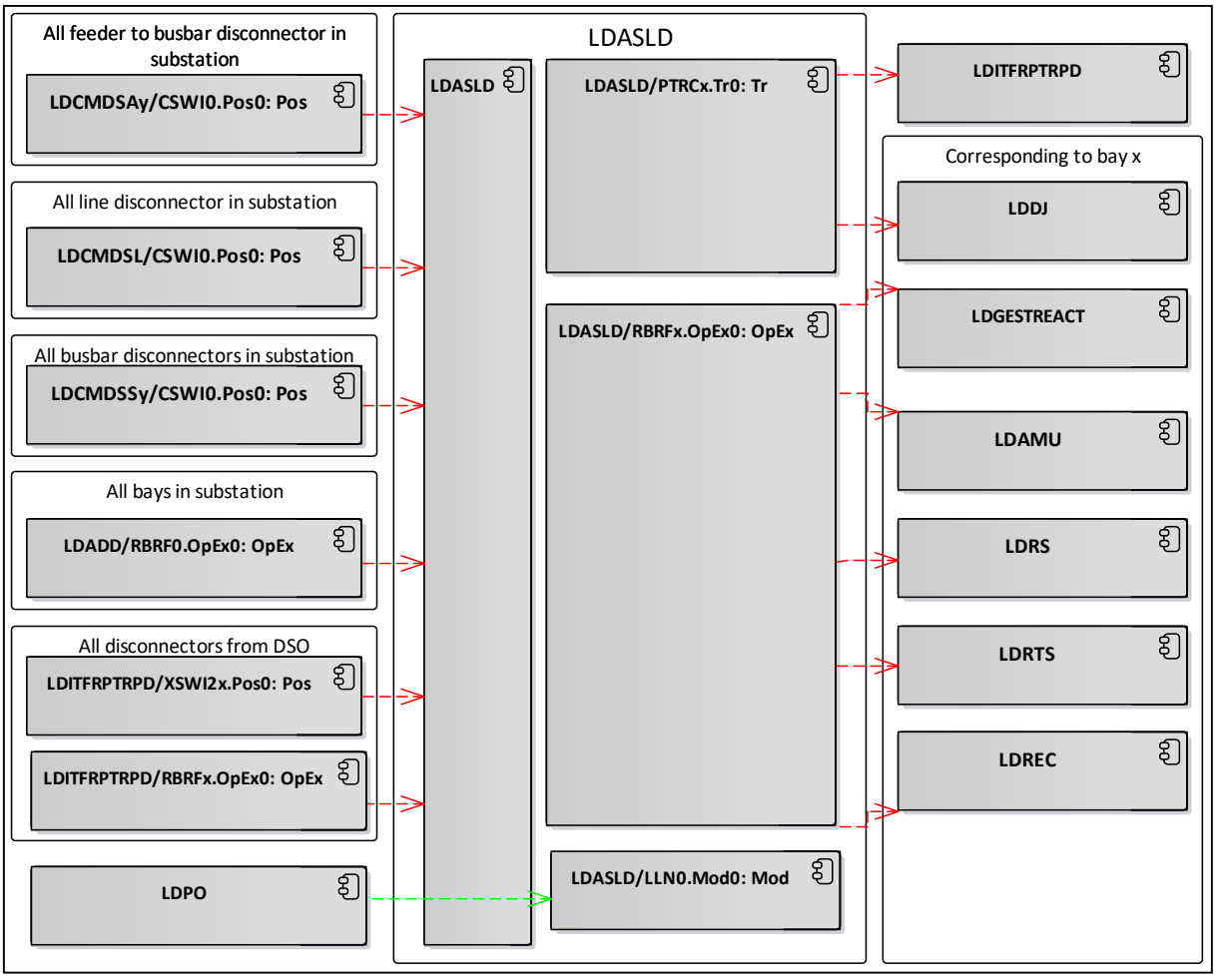

Figure 39: Dynamic description LDASLD

6.16 Substation Level Overload Management Function (LDCOMPADAxy)

6.16.1 Description of the Function

The Substation Level Overload Management Function (COMPADA) is a function complementing the overload management function at bay level (ADA, cf. §6.2) LDCOMPADA can acquire information about the exceeding of 3 ADA thresholds which leads to three possible timed-out actions to choose from amongst the following:

- Trip of another bay ("Trip")
- Close order for the circuit breaker of another bay ("Closing")
- Sending of information to the interface terminal connecting to distribution network operators sharing the substation("Information")

The configuration of this automaton determines the type of action and the associated time delay.

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6.16.2 LNs used

LN	Description
CSWI	This LN class shall be used to control all switching conditions above process level. CSWI shall subscribe the data object POWCap ("point-on-wave switching capability") from XCBR if applicable. If a switching command (for example Select-before-Operate) arrives and "point-on-wave switching capability" is supported by the breaker, the command shall be passed to CPOW. OpOpn and OpCls shall be used if no Control Service is available between CSWI and XCBR (see GSE in IEC 61850-7-2).
FXOT	Logical node FXOT shall be used to set a high-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, contro or alarm function is based on other physical measurements than primary electrical data.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

6.16.3 Specificities

- The function COMPADA requires 9 distinct time delays.
- For each time delay, the function can generate:
  - A trip order to another bay (Tr),
  - A trip order to close the circuit breaker to another bay (OpCls)
  - Information to DSO substation and/or to an LDTAC (Op).
- Depending on the configuration, LDCOMPADA can generate the corresponding signals:
  - FONC.AUT*, associated with the system level automaton bay
  - AUT.EXT, associated with the target bay in case of tripping or the closing of the circuit-breaker
- Each action and the associated DOs are modelled by an independent LDCOMPADA.
- The function in its entirety, such as defined in the PACS specification, is provided by 9 instances of LDCOMPADA. This group is identified by a substation number xy where x corresponds to threshold and y to a time delay setting.
- As LDCOMPADA is a substation level function, it uses as generic input the operating mode of the subscribed bays (Local / Remote). This information is modelled by the signal LDMODEXPF/LLN0.LocSta for each feeder.
- As the COMPADA function is a substation level function, it can be activated or deactivated. In addition, the function being modelled by several LDCOMPADAs, their activation or deactivation can be common. It is considered that the signal which indicates the status of the COMPADA function is generated by a grouping of DO LDCOMPADA*/LLN0.Beh.
- If necessary, each instance of LDCOMPADAxy can be activated / dactivated by LDCOMPADA*/LLN0.Mod.

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6.16.4 Static Description

Substation Level Overload Management Function (LDCOMPADAxy)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
6.16.12 CSWI0	Beh	ENS		
	Pos	DPC		
	OpCls	ACT	EM.TENCL.*Vv	Close order for the circuit-breaker of the target bay
6.16.13 FXOT0	Beh	ENS		
	StrVal	ASG.setMag		
	Op	ACT	FCT.AUT* AUT.EXT	* represents the reference of the instanciation of LDCOMPADA Signal associated with the functional bay Signal associated with the target bay This signal is also sent to DSO
	OpDlTmms	ING	T-xy	Time delay for COMPADA action (T-xy)
6.16.14 LLN0	Beh	ENS		
	Mod	ENC.stVal	ACT-SEUILxy	Activation/deactivation of LDCOMPADAxy
	Health	ENS	AUTOMATE* ANOM	* represents the number of the automaton
	NamPlt	LPL		
6.16.15 PTRC0	Beh	ENS		
	Op	ACT.general		Indication of 3 phase Trip decision
	Tr	ACT		Trip order for the circuit-breaker of the target bay

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6.16.16 Dynamic description

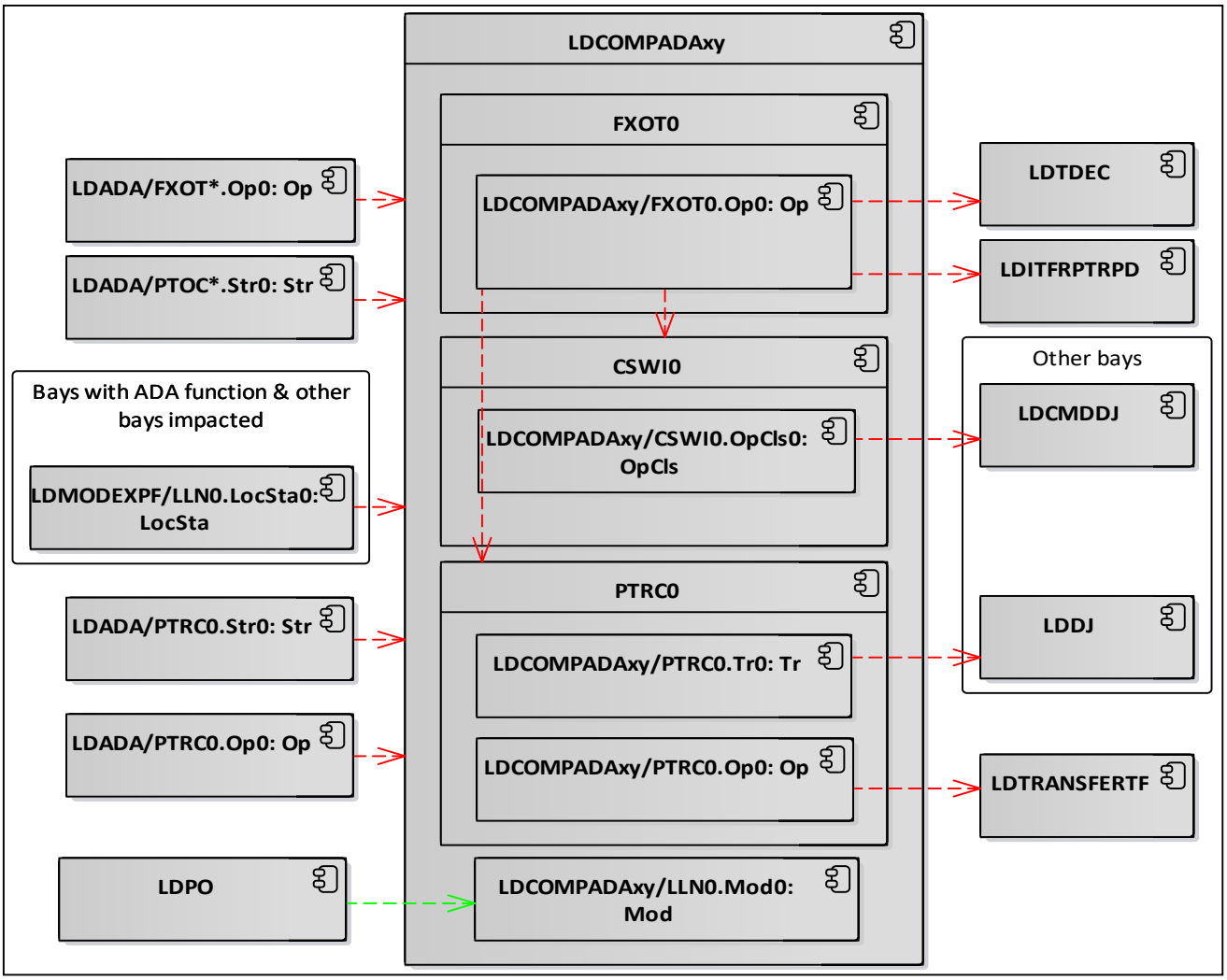

Figure 40: Dynamic description LDCOMPADA

6.17 Auto-Recloser Initialisation Management (INITARS)

The mission of the INIT-ARS function is to allow or not the initialisation of the ARS function by the distance protections. This function is included in LDTRANSFERTC (§8.20).

6.18 Switch Disconnector Coordination Function (LDASRB)

6.18.1 Description of the function

The Switch Disconnector Coordination function (Automate de sectionneur à rupture brusque -ASRB) is implemented in substations with « d » topology and having at least one HV/MV transformer connected to the busbar via a disconnector being able to interrupt transformer load current (switch disconnector). In this case, there is no circuit breaker associated to the transformer.

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This automaton is used to eliminate fault downstream of the snap action disconnector which needs to trip the transformer. The mission of the function is to transmit the tripping order received form the transformer protections to each circuit-breaker connected to the same electrical node as the snap action disconnector concerned by the fault. After de-energisation of the concerned electrical node, the switch disconnector is opened, disconnecting the faulted transformer from the rest of the busbar.

The LDASRB function also takes in charge the reenergising sequence after disconnection of the faulted transformer.

6.18.2 LNs used

LN	Description
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.
RREC	The number of trigger modes (CycTrMod i) and reclose times (RecTmmsi) is equal to the maximum allowed number of reclose cycles (MaxCyc). The trigger for the activation of RREC can be the start signal of PTRC, or the report "breaker open" of the circuit breaker, or any other signals and combination of signals. If different types of protections are involved in the autoreclosing process, all relevant data objects have to be published and subscribed by the allocated protection LNs. A principal diagram of RREC is given in Annex G.

6.18.3 Specificities

- Substations with « d » topology and having 2 or 3 sections can host Snap Disconnector Coordination function (LDASRB).
- The activation/deactivation of the function managing the opening of the snap action disconnector (ASRB.TR*) is independent for each transformer (3 transformers maximum). The DO SPCSO1 to SPCSO3 in LN GAPC0 represent these controls. If this function is deactivated for a transformer, the tripping order received from this transformer (LDITFRPTRPD.PTRCx.Op) will be ignored by the ASRB function.
- PTRCx.Tr are used for trip order to the different feeders. PTRC.Op may be used to inhibit the recloser (ARS Group)
- The renergisation function ASRB.AR can be activated and deactivated by setting RREC0.Mod. This function is automatically deactivated if all the function managing the opening of the snap action disconnector (ASRB.TR*) are deactivated.
- The maximum time duration before automatic deactivation of the recloser function is modelled by the RREC0.MaxTmms. This time duration is common to each LN RREC of the LDASRB.

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- It is possible to enable or disable the automatic closing control of the circuit-breaker for each feeder independently by using the DO Mod in each LN RREC. There is one RREC per feeder and 4 feeders maximum.
- The signal "FONCT.AUT.EXT" indicating the successful operation of the automaton is modelled with RRECx.OpCls.
- There is a specific signal ESS.ASRB indicating the test mode of the LDASRB. This signal is associated to the LLN0.Beh.
- The authorisation of reclosing of the ASRB is indicated by CSYN.Rel provided by the interface LD LDITFRPDRPT. This means that the disconnectors associated to the transformer have reached their new position
- The failure of reclosing (DF.ASRB) is modelled by RRECx.AutoRecSt = 10 (unsuccessful).

6.18.4 Static description

Switch Disconnector Coordination Function (LDASRB)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
GAPC0	Beh	ENS		
	SPCSOx	SPC		
	SPCSO1	SPC	ASRB.TR1	Activation/deactivation of the function managing the opening of the snap action disconnector for the transformer y (with 1 ≤ y ≤ 3)
	SPCSO2	SPC	ASRB.TR2	Activation/deactivation of the function managing the opening of the snap action disconnector for the transformer y (with 1 ≤ y ≤ 3)
	SPCSO3	SPC	ASRB.TR3	Activation/deactivation of the function managing the opening of the snap action disconnector for the transformer y (with 1 ≤ y ≤ 3)
LLN0	Beh	ENS	ESS.ASRB	ESS.ASRB = True if LLN0.Mod = test
	Health	ENS		Health status of the function
	Mod	ENC		Activation/deactivation of the function
	NamPlt	LPL		
PTRCx	Beh	ENS		
	Op	ACT		Tripping decision signal for the feeder x
	Tr	ACT		Tripping order to XCBR of the feeder x (with 1 ≤ x ≤ 4)
RREC0	Beh	ENS	ASRB.AR	
	AutoRecSt	ENS		
	OpCls	ACT		
	MaxTmms	ING	T-DesRS	Maximum time duration before automatic deactivation of recloser function

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Switch Disconnector Coordination Function (LDASRB)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Mod	ENC		Activation/deactivation of the recloser function
RRECx	AutoRecSt	ENS	DF.ASRB	Failure of reclosing by ASRB function indicated by AutoRecSt = 10 (unsuccessful)
	Beh	ENS	MES-AR-Lx	Enable/disable the automatic closing control of the circuit-breaker for the feeder x (with 1 ≤ x ≤ 4)
	Mod	ENC	MES-AR-Lx	Enable/disable the automatic closing control of the circuit-breaker for the feeder x (with 1 ≤ x ≤ 4)
	OpCls	ACT	FONCT.AUT.EXT	Closing order to LDCMDDJ. Contributes to FONCT.AUT.EXT signal

6.18.5 Dynamic description

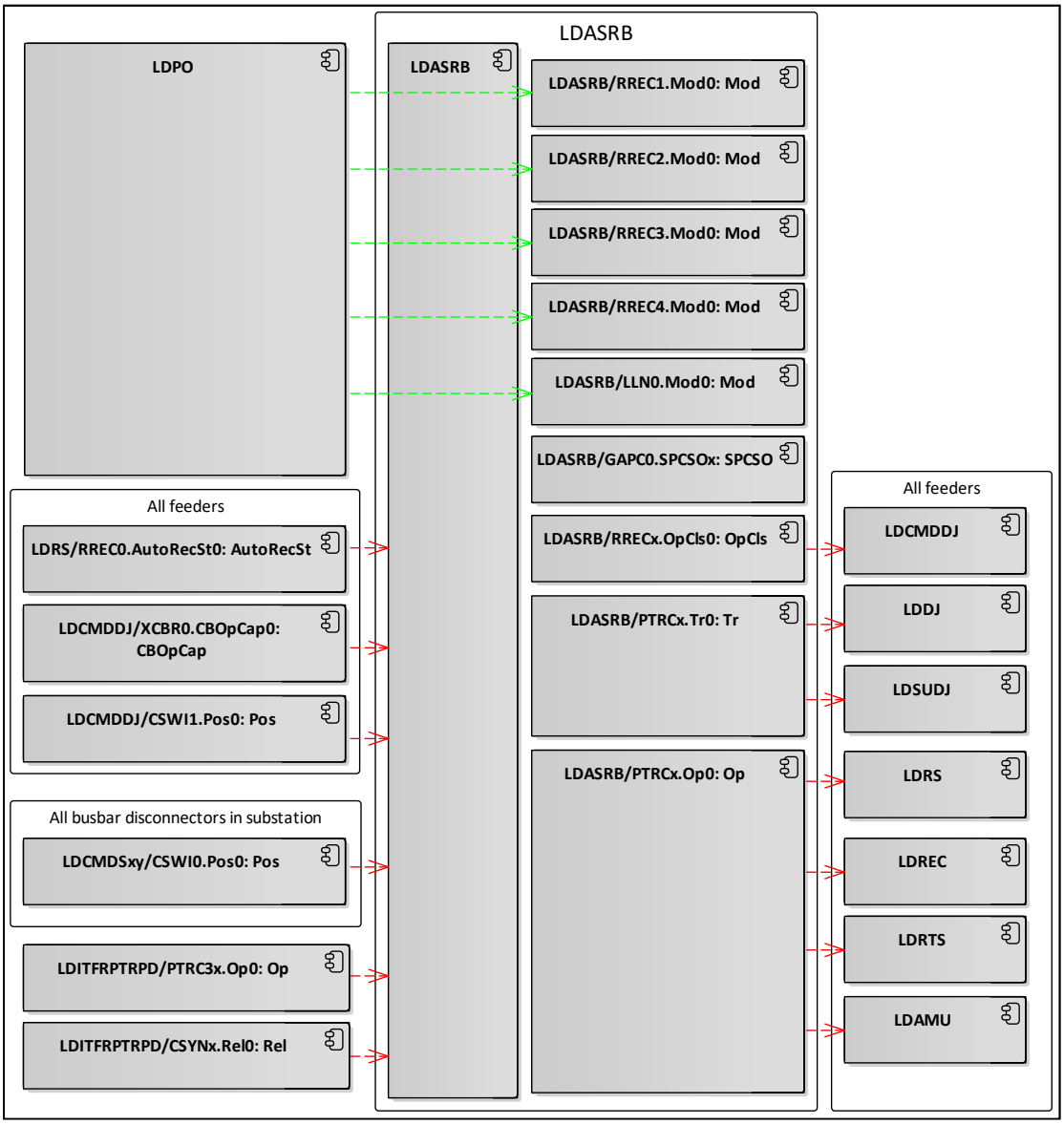

Figure 41: Dynamic description LDASRB

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6.19 D-Type Substation Transformers Automation (LDATD)

6.19.1 Description of the function

D type substation are substations with two busbars connected each to one single feeder. The busbars are operated as loaded antenna and there is no busbar coupler. The AT-D automaton is used in « D » type substation with at least one snap action disconnector linked to a HV/MV transformer. The two main functions of the AT-D are (cf. [13]):

- In case of absence of voltage on a HV feeder, the transformer automatons are initialised to switch the transformer from out aged busbar to the energised busbar.
- In case of HV/MV transformer failure and after the tripping of the circuit-breaker of the concerned HV feeder, the AT-D function sends a closing command to the feeder to re-energise all not faulted HV/MV transformers.

6.19.2 LNs used

LN	Description
FXUT	Logical node FXUT shall be used to set a low-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXUT can typically be used whenever a protection, control or alarm function is based on other physical measurements than primary electric data.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PSCH	This LN shall be used to model the logic scheme for line protection function co-ordination. The protection scheme allows the exchange of the "operate" outputs of different protection functions and conditions for line protection schemes. It includes data objects for teleprotection if applicable. In this case, all appropriate data objects shall be subscribed.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.
RREC	The number of trigger modes (CycTrMod i) and reclose times (RecTmmsi) is equal to the maximum allowed number of reclose cycles (MaxCyc). The trigger for the activation of RREC can be the start signal of PTRC, or the report "breaker open" of the circuit breaker, or any other signals and combination of signals. If different types of protections are involved in the autoreclosing process, all relevant data objects have to be published and subscribed by the allocated protection LNs. A principal diagram of RREC is given in Annex G.

6.19.3 Specificities

- For each HV/MV transformer, one LDATD is instantiated.
- There are 2 variants of substation hosting the AT-D function: the local variant where exchanges between TSO and DSO are realised in the substation, and the distant variant, where exchanges between TSO and DSO are realised by using telesignaling devices.
- The activation/deactivation of the AT-D is modelled by using LLN0.Mod.

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- The functional specification indicates that a deactivation then activation command of the AT-D can reset the anomaly signal "ANO-ATD" (ATD-01).
- On reception of a trip order sent by transformer protections (LDITFRPTRPD.PTRCx.Op or LDTAC.PSCHx.RxTr), the AT-D function sends a trip order to the feeder connected to the same electrical node as the faulted HV/MV transformer.
- If the reenergising function is activated (DO "RREC0.Beh = on), the T-ATD-CYCLE (RREC0.MaxTmms) timer is started and the signal of automaton start "ATD.CYCL", modelled by RREC0.AutoRecSt = 7 (wait to complete).
- PTRCx.OpA can be used as disabling order sent to the recloser function (ARS group) of the concerned feeder.
- After the tripping of the circuit-breaker of the feeder and the opening of the disconnector of the faulted HV/MV transformer, a closing order for the circuit breaker x (ENC_Lx) is received. This corresponds to

LDITFRPTRPD.CSYNx.Rel signal in local variant and
To LDTAC.PSCHy.RxPrm in distant variant.

This closing order is only executed if the DO RREC0.Beh is "ON".

- In the local typology, when an absence of voltage is detected on the feeder with the LDCMDDJ.FXUT.Op, the signal MU-Lx_RPT (DO LDATD.FXUTx.Op with x representing the number of the feeder) is sent only if the LDATD.FXUTx.Beh associated to this feeder is "ON".
- The presence or absence of voltage on the busbars is indicated by a LDMQUB. This information can be subscribed by LDITFRPTRPD.
- The authorisation of reclosing of the LDATD is indicated by CSYN.Rel provided by the interface LD LDITFRPDRPT. This means that the disconnectors associated to the transformer have reached their new position.
- The failure of reclosing (ANO-ATD) is modelled by RRECx.AutoRecSt = 10 (unsucessful).

6.19.4 Static description

D-Type Substation Transformers Automation (LDATD)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
FXUTx	Beh	ENS	ATD-MU_Lj	Activation or Deactivation of re-energising sequence for the feeder j
	Mod	ENC	ATD-MU_Lj	Activation or Deactivation of re-energising sequence for the feeder j
	StrVal	ASG.setMag		
	Op	ACT		Signal of absence line voltage from feeder "j" to DSO
LLN0	Beh	ENS	MES-ATD	Activation/deactivation of the function
	Health	ENS	ANO-ATD	Health status of the function
	Mod	ENC	MES-ATD	Activation/deactivation of the function
	NamPlt	LPL		
PSCHx	Beh	ENS		

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D-Type Substation Transformers Automation (LDATD)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	TxTr	ACT		Trip order to distant feeder x (in case of distant variant)
	Op	ACT		
PTRCx	Beh	ENS		
	Mod	ENC	LIG-j	Activation/deactivation of tripping for feeder x circuit breaker
	Op	ACT	CONF-ATD	Signal of trip decision for feeder x circuit breaker
	Tr	ACT		Trip order to XCBR of the feeder x
RREC0	OpCls	ACT		
	AutoRecSt	ENS	RAT.CYCL	Closing cycle of LDATD in progress AutoRecSt = 7 (wait to complete)
	Beh	ENS	ATD-TR_J	Activation or Deactivation of re-energising sequence for the transformer to feeder j
	MaxTmms	ING	T-ATD-CYCLE	Maximum time duration before automatic deactivation of AT-D function
	Mod	ENC	ATD-TR_J	Activation or Deactivation of re-energising sequence for the transformer to feeder j
RRECx	AutoRecSt	ENS	ANO-ATD	Failure of reclosing by ATD function indicated by AutoRecSt = 10 (unsuccessful)
	Beh	ENS		
	OpCls	ACT		Closing order to LDCMDDJ associated to the circuit breaker of feeder x.

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6.19.5 Dynamic description

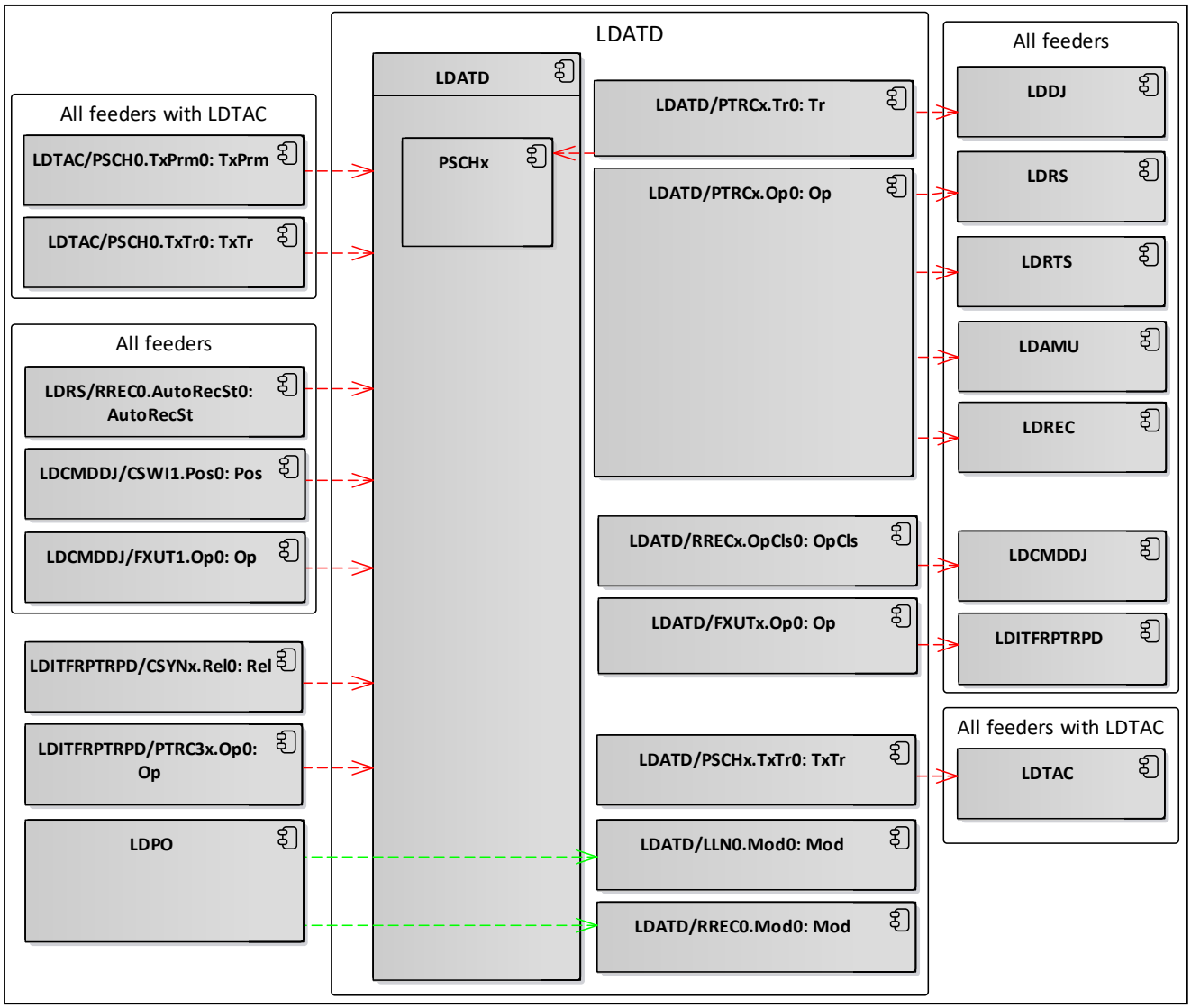

Figure 42: Dynamic description LDATD

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6.20 Substation level Overload Management Function (LDAGSA)

6.20.1 Description of the Function

The substation level overload management function (Automate de Gestion des Surcharges Ampèremetriques - AGSA) is used in the case of transit constraints on the HV grid. It combines the lien overload function (LDPSL) and the COMPADA function. This automaton elaborates alarms or trips if the load current exceeds a configured threshold for local or remote feeders.

6.20.2 Operation particularities

6.20.2.1 Timeline

The operation timeline is described in the figure below:

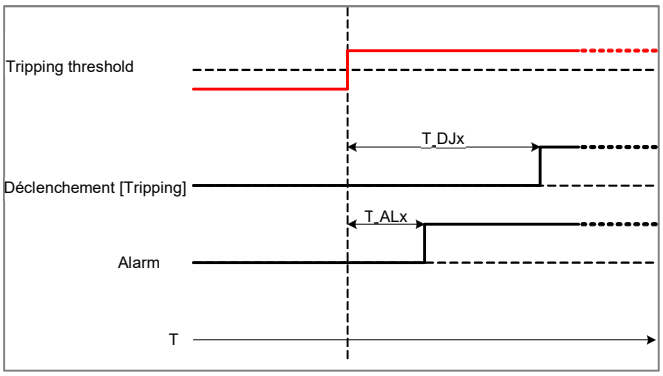

Figure 43: ADA Operation Timeline

- T_ALx is the alarm time delay
- T_DJx is the tripping time delay of the circuit-breaker

6.20.2.2 Seasonal regimes

LDAGSA has 6 seasonal regimes (HIVER2, HIVER1, INTERSAIS1, INTERSAIS2, ETE1, ETE2, corresponding to winter 1, 2, interseason 1, 2 summer 1, 2). Each seasonal regime is associated with a set of load current thresholds, which are organised in setting groups in this modelling. The change from one setting group to another involves signalling the deactivation of the actual setting group and the activation of the new one. E.g., the change from INTERSAI2 to HIVER1 leads to:

1. Stop publishing the signal "INTERSAI2 active)
2. Start publishing the signal "HIVER1 active" and maintaining it

It is possible to use only a subset of thresholds by configuration.

6.20.3 LNs used

LN	Description
CSWI	This LN class shall be used to control all switching conditions above process level. CSWI shall subscribe the data object POWCap ("point-on-wave switching capability") from XCBR if applicable. If a switching command (for example Select-before-Operate) arrives and "point-on-wave switching capability" is supported by the breaker, the command shall be passed to CPOW. OpOpn and OpCls shall be used if no Control Service is available between CSWI and XCBR (see GSE in IEC 61850-7-2).

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LN	Description
FXOT	Logical node FXOT shall be used to set a high-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, contro or alarm function is based on other physical measurements than primary electrical data.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PSCH	This LN shall be used to model the logic scheme for line protection function co-ordination. The protection scheme allows the exchange of the "operate" outputs of different protection functions and conditions for line protection schemes. It includes data objects for teleprotection if applicable. In this case, all appropriate data objects shall be subscribed.
PTOC	This LN shall also be used to model the directional time overcurrent (PDOC/IEEE device function number 67, IEEE C37.2:1996). The Definite Time overcurrent (also PTOC/IEEE device function number 51, from IEEE C37.2:1996) shall be modelled by use of PTOC and selecting the related curve.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

6.20.4 Specificities

- The specification of the overload management function requires the use of a current criterion. Therefore, the LN PTOC and FXOT are used with current inputs instead of LN PDOP which is based on power.
- One LDAGSA is associated to one bay, from which it subscribes the current phasors. If required, several LDAGSA are instantiated if the currents of several bays are to be used.
- One PTOC/FXOT pair is used per threshold. **This function uses three thresholds, i.e. three pairs**. The thresholds are normally associated with an admissible overload period (e.g. 20 minutes, 10 minutes, etc.).
- The LN PTOC of the standard only manages the time delay leading to a trip (T-DJx) published by PTRC.Op of the LD. PTOC.Str indicates the detection of a fault (starting) and cannot be used for the alarm output as it cannot be associated with a time delay. Consequently, the time delay leading to an alarm (T-Alx) is modelled by the LN FXOT which uses the same input data as the PTOC.
- Each of the LN PTOC can be associated to one or more of the following actions:

Trip in case of upstream load current higher than threshold (associated to LN PTRC*BI and LN PSCH*BI)

Trip in case of upstream load current higher than threshold (associated to LN PTRC *US and LN PSCH*US)

Trip in case of downstream load current higher than threshold (associated to LN PTRC *DS and LN PSCH*DS)

- Depending on the configuration, LN PTRC*y and LN PSCH*y are instantiated during the configuration.
- The LDAGSA/PTOC.Str is used to indicate the direction of the load flow (downstream / upstream).

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- The activation/deactivation of the LDAGSA function is performed using LLN0.Mod. The feedback signal is LLN0.Beh.

6.20.5 Static description

Substation level Overload Management Function (LDAGSA)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
CSWI*1	Beh	ENS		
	Pos	DPC		
	OpCls	ACT	FONCT.AUT.DEB EM.TENCL.*Vv	Close order in case of load current without directional criterion
CSWI*2	Beh	ENS		
	Pos	DPC		
	OpCls	ACT	FONCT.AUT.DEB EM.TENCL.*Vv	Close order in case of load upstream load current
CSWI*3	Beh	ENS		
	Pos	DPC		
	OpCls	ACT	FONCT.AUT.DEB EM.TENCL.*Vv	Close order in case of load downstream load current
FXOT*	Beh	ENS		
	Op	ACT.general	ALARME.DEP.SEUIL*	Timer alarm when threshold 1 reached
	OpDlTmms	ING.setVal		Alarm time delay T-Alx The value is managed by the SGCB and varies with the regimes.
	StrVal	ASG.setMag		IS* current threshold (same value as for PTOC) The value is managed by the SGCB and varies with the regimes.
LLN0	Beh	ENS	AUT.DEB	Signal "Function activated/deactivated"
	Health	ENS	DF.AUTD	AGSA Function state
	Mod	ENC.stVal	AUT.DEB	Command to activate / deactivate the function(ES/HS)
	NamPlt	LPL		
	The SGCB mechanism is used to manage the 6 setting groups (commands: AUT.DEB Regime x) of ADA (signals: REG.INT1 AUTD.TC, REG.ETE1 AUTD.TC, REG.ETE2 AUTD.TC, REG.ETE AUTD.TC, REG.INT AUTD.TC, REG.INT2 AUTD.TC, REG.HIV1 AUTD.TC, REG.HIV AUTD.TC, REG.HIV2 AUTD.TC)			
PSCH*1	Beh	ENS		
	Op	ACT.general	FONCT.AUT.DEB	Tripping decision of 3 phases

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Substation level Overload Management Function (LDAGSA)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	TxTr	ACT.general		Remote Trip order in case of load current without directional criterion
PSCH*2	Beh	ENS		
	Op	ACT.general	FONCT.AUT.DEB AUT.AMONT	Tripping decision of 3 phases
	TxTr	ACT.general		Remote Trip order to in case of upstream load current
PSCH*3	Beh	ENS		
	Op	ACT.general	FONCT.AUT.DEB AUT.AVAL	Tripping decision of 3 phases
	TxTr	ACT.general		Remote Trip order to in case of downstream
PTOC*	Beh	ENS		
	Op	ACT.general		Trip order of circuit-breaker sent to PTRC (* = 1, 2 or 3 depending on the threshold)
	OpDlTmms	ING.setVal		Alarm time delay T-DJx The value is managed by the SGCB and varies with the regimes.
	Str	ACD.dirGeneral		Directional information elaborated during passage over a threshold
	StrVal	ASG.setMag		Current threshold IS* The value is managed by the SGCB and varies with the regimes.
PTRC*1	Beh	ENS		
	Op	ACT.general	FONCT.AUT.DEB	Tripping decision of 3 phases
	Tr	ACT.general		Trip order in case of load current without directional criterion
PTRC*2	Beh	ENS		
	Op	ACT.general	FONCT.AUT.DEB AUT.AMONT	Tripping decision of 3 phases
	Tr	ACT.general		Trip order to in case of upstream load current
PTRC*3	Beh	ENS		
	Op	ACT.general	FONCT.AUT.DEB AUT.AVAL	Tripping decision of 3 phases
	Tr	ACT.general		Trip order to in case of downstream

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6.20.6 Dynamic description

Dynamic description is available in appendix 12.1

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7. Process interface

7.1 Fuse Blow Detection [FUSTT]

Confer § 7.4 – Instrument Transformers (LDTM).

7.2 Circuit Breaker Interface (LDDJ)

7.2.1 Description of the Function

This function represents the process interface of a high voltage circuit-breaker. The monitoring interface is covered by a dedicated LD (cf. Circuit Breaker Monitoring (LDSUDJ) 9.4).

7.2.2 LNs used

LN	Description
CSWI	This LN class shall be used to control all switching conditions above process level. CSWI shall subscribe the data object POWCap ("point-on-wave switching capability") from XCBR if applicable. If a switching command (for example Select-before-Operate) arrives and "point-on-wave switching capability" is supported by the breaker, the command shall be passed to CPOW. OpOpn and OpCls shall be used if no Control Service is available between CSWI and XCBR (see GSE in IEC 61850-7-2).
GGIO	This node shall be used only to model in a generic way process devices that are not predefined by the groups S, T, X, Y, or Z. If needed, all data objects listed in Clause 6 can be used single or multiple for a dedicated application of LN GGIO. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
XCBR	This LN is used for modelling switches with short circuit breaking capability. Additional LNs, for example SIMS, etc. may be required to complete the logical modelling for the breaker being represented. The closing and opening commands shall be subscribed from CSWI or CPOW if applicable. If no "time activated control" service is available between CSWI or CPOW and XCBR, the opening and closing commands shall be performed with a GSE-message (see IEC 61850-7-2).
XSWI	This LN is used for modelling switches without short circuit breaking capability, for example disconnectors, air break switches, earthing switches, etc. Additional LNs, SIMS, etc. may be required to complete the logical model for the switch being represented. The closing and opening commands shall be subscribed from CSWI. If no "time activated control" service is available between CSWI or CPOW and XSWI, the opening and closing commands shall be performed with a GSE-message (see IEC 61850-7-2).
LSET	Rte Extended Setting LN

7.2.3 Specificities

- The Circuit Breaker Interface LD (LDDJ) of each circuit-breaker is associated with a LDCMDDJ assuring its control and a LDSUDJ assuring the interface with the monitoring sensors of the same circuit-breaker. This triplet is represented in the dynamic modelling (cf. § 0).

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- One LN XCBR per phase and a "regrouping" LN XCBR (cf. [1]) are used in the modelling.
- Signal "DF.IN.COM.DJ": The DO LDDJ/LLN0.health (ENS specification) can be used, but this requires the use of one of the three variables of this ENUM DO for a simple binary signal. This may constitute a problem for acquisition and transmission, but is compatible with the standard - option retained by RTE
- The LDDJ publishes the position such as acquired at the process interface in real-time, including pole position mis-matches which appear during manoeuvres. The "filtered" position, which indicates the pole discrepancy only after a time delay, is published by the LDCMDDJ (cf. § 8.1).
- The Circuit-breaker function LDDJ which hosts the LN XCBR (normally implemented in the SCU) is subscribed to the DO Tr of the different protection functions. It is also subscribed to DO OpOpn and OpCls of LN LDCMDDJ/CSWI and, if applicable, to other functions controlling the circuit-breaker without passing by the LDCMDDJ
- The information regarding terminal block references correspond to the binary terminal I/O of the SCU. However these terminal blocks do not appear in the IEC 61850 model of the circuit-breaker
- The XCBR.BlkCls signal is used to elaborate the "Closing locked" signal in order to prevent the closing if the circuit-breaker is not able to ensure subsequent tripping.
- The T-ENC and T-DEC parameters, which define the impulsion duration for opening and closing the circuit-breaker are modelled by using the pulseConfig.onDur and pulseConfig.offDur DA.
- The circuit breaker can be configured to either trip or block in case of low pressure. This is achieved by LDDJ either subscribing DO LDITFSUDJ/SIMG0.InsBlk or LDITFSUDJ SIMG0.InsTr at the instantiation (cf. §7.14).
- CSWI0 is used to represent backup operation orders for the circuit breaker from local HMI, in case of emergency operation while regular operation via LDCMDDJ is not operational.
- The variant of withdrawable circuit breaker ("disjoncteur débrocchable") is covered by LN XSWI0. XSWI.Pos indicates whether the withdrawable circuit breaker is connected or deconnected. This indication is equivalent to the associated disconnecor information and is for this reason subscribed by LDCMDSxy.

7.2.4 Static description

Circuit Breaker Interface (LDDJ)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
CSWI0	Beh	ENS		
	Pos	DPC		
	OpCls	ACT		Close order send to physical output
	OpOpn	ACT		Open order send to physical output
GGIO0	Beh	ENS		
	Ind1	SPS		Indication of Manual Closing Order of the circuit breaker by switchyard push button
LLN0	Beh	ENS		

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Circuit Breaker Interface (LDDJ)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Health	ENS		Health status of LDDJ
	Mod	ENC		
	NamPlt	LPL		
XCBR0	Beh	ENS		
	BlkCls	SPC		Signal CB is blocked in opened state and unable to close
	BlkOpn	SPC		Signal CB is blocked in closed state and unable to open
	Dsc	SPS		CB pole Mis-match Direct or calculated acquisition for a separately controlled circuit-breaker from the XCBR*.pos of the unit poles. Subscribed by the ARS functional group and LDDISCP.
	EEHealth	ENS	DF.IN.COM.DJ	
	Pos	DPC	T-ENC	Directly acquired for a circuit-breaker with 3 phases control. Calculated for a separately controlled circuit-breaker poles from the XCBR*.pos of the unit poles. Relayed up to CSWI for the power system control. Represents the un-filtered states.
XCBR*	Beh	ENS		
	BlkCls	SPC		Signal CB is blocked in opened state and unable to close
	BlkOpn	SPC		Signal CB is blocked in closed state and unable to open
	Pos	DPC		XCBR / phase. Used for circuit-breakers separately controlled per pole. Used by XBCR to elaborate the pos value. Represents the un-filtered states
XSWI0	Beh	ENS		
	Pos	DPC		Indication that withdrawable circuit breaker is connected or disconnected
LSET0	Beh	ENS		
	OpDlTmms1	ING	T-ENC	Time duration for binary output contact for cb closing command
	OpDlTmms2	ING	T-DEC	Time duration for binary output contact for cb opening command

7.2.5 Dynamic description

Dynamic description is available in appendix 12.7

7.3 Disconnector Interface (LDSxy)

The meaning of "xy" is described in the following table:

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x	
A	Feeder to busbar
L	Line
T	Ground
S	Busbar section
I	Isolating
AT	Case self connected to 2 autotransformers
B	Busbar to ground disconnector

y	
1	Line-to-busbar disconnector for Busbar 1
2	SA Line-to-busbar disconnector for Busbar 2
3	SA Line-to-busbar disconnector for Busbar 3
-	For SL or ST (if we have only 1 SL or 1 ST per feeder)
1012	SS1.12 Busbar 1 – Disconnector between busbar sections 1 and 2 In instance name, "." Is replaced by "0"
1023	SS1.23 Busbar 1 – Disconnector between busbar sections 2 and 3 In instance name, "." Is replaced by "0"
11/12 **21/22** **.....**	For SA connected to busbar section (tronconnement). Letters A, B or C are replaced by number 1,2 or 3 (ex : 2B=22, 1A=11)

7.3.1 Description of the Function

The Disconnector Interface LD (LDSxy) represents the interface of all the high voltage disconnectors of a bay with electrical or manual control, including grounding disconnectors.

If the disconnector can be remotely blocked for HV maintenance work according Regulations, this function is integrated into the LDSxy representing disconnectors connecting the lien to the busbar, disconnectors, i.e. LDSAy instances.

The visual identification function is also processed by this LD's application. The command is sent from the operators.

LDSxy integrates a feature ("BALISAGE") to enable the operator to physically identify the HV equipment to be manoeuvred by an optical indicator installed on it in order to secure the manoeuvres. This function is particulary useful when an equipment cannot be controlled from the HMI. It can be implemented for any HV equipement to facilitate maintenance. The components controlled in this way are generally disconnectors (SL, SA, SMALT and ST).

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7.3.2 LNs used

LN	Description
CSWI	This LN class shall be used to control all switching conditions above process level. CSWI shall subscribe the data object POWCap ("point-on-wave switching capability") from XCBR if applicable. If a switching command (for example Select-before-Operate) arrives and "point-on-wave switching capability" is supported by the breaker, the command shall be passed to CPOW. OpOpn and OpCls shall be used if no Control Service is available between CSWI and XCBR (see GSE in IEC 61850-7-2).
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
XSWI	This LN is used for modelling switches without short circuit breaking capability, for example disconnectors, air break switches, earthing switches, etc. Additional LNs, SIMS, etc. may be required to complete the logical model for the switch being represented. The closing and opening commands shall be subscribed from CSWI. If no "time activated control" service is available between CSWI or CPOW and XSWI, the opening and closing commands shall be performed with a GSE-message (see IEC 61850-7-2).

7.3.3 Specificities

- The LDSxy publishes the position as acquired by the process interface in real time (LDSxy/XSW1.Pos), including any pole mismatches that appear during manoeuvres. The "filtered" pole position, which indicates the pole mismatch only after a time delay, is published by the LDCMDSxy (cf. § 8.2).
- The orders to operate the disconnector are processed by LDSxy.CSWI1
- The remote blocking for maintenance is represented by LN XSWI2 and CSWI2. This associated device can only be operated remotely from the Gateway.
- For each disconnector, a LDSxy and an associated LDITFSUSxy are instaciated. LDSxy represents its operation interface and LDITFSUSxy (cf. §7.15) represents its monitoring interface.
- Equipment optical indicators can be commanded by digital output using LDSxy/CSWI3.pos, but has no state return. The state of the indficator is changed by a command received from LDPO. DA Pos is used because there is only one physical output contact.

7.3.4 Static description

Busbar-to-Busbar Remote Blocking (LDSxy)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
CSWI1	Beh	ENS		
	OpCls	ACT		Order close send to physical output for disconnector
	OpOpn	ACT		Order open send to physical output for disconnector
	Pos	DPC		
CSWI2	Beh	ENS		

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Busbar-to-Busbar Remote Blocking (LDSxy)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	OpCls	ACT		Order close send to physical output for disconnector remotely blocked
	OpOpn	ACT		Order open send to physical output for disconnector remotely blocked
	Pos	DPC		
CSWI3	Beh	ENS		
	Pos	DPC	BAL.xx	Activation/Deactivation of contact associated to equipment visual indicators (mark-up)
LLN0	Beh	ENS		
	Health	ENS		Health status LDSxy
	Mod	ENC		
	NamPlt	LPL		
XSWI1	Beh	ENS		
	Loc	SPS		Local Control behaviour
	OpCnt	INS		Counter of operation (used for monitoring).
	SwTyp	ENS		Switch Type
	Pos	DPC		Disconnector position.
	BlkOpn	SPC		Block opening
	BlkCls	SPC		Block closing
XSWI2	Beh	ENS		
	Loc	SPS		Local Control behaviour
	OpCnt	INS		Counter of operation (used for monitoring).
	SwTyp	ENS		Switch Type
	Pos	DPC	CO.Sx	Indication "Disconnector remotely blocked for HV maintenance" [télé condamnation]
	BlkOpn	SPC		Block opening
	BlkCls	SPC		Block closing

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7.3.5 Dynamic description

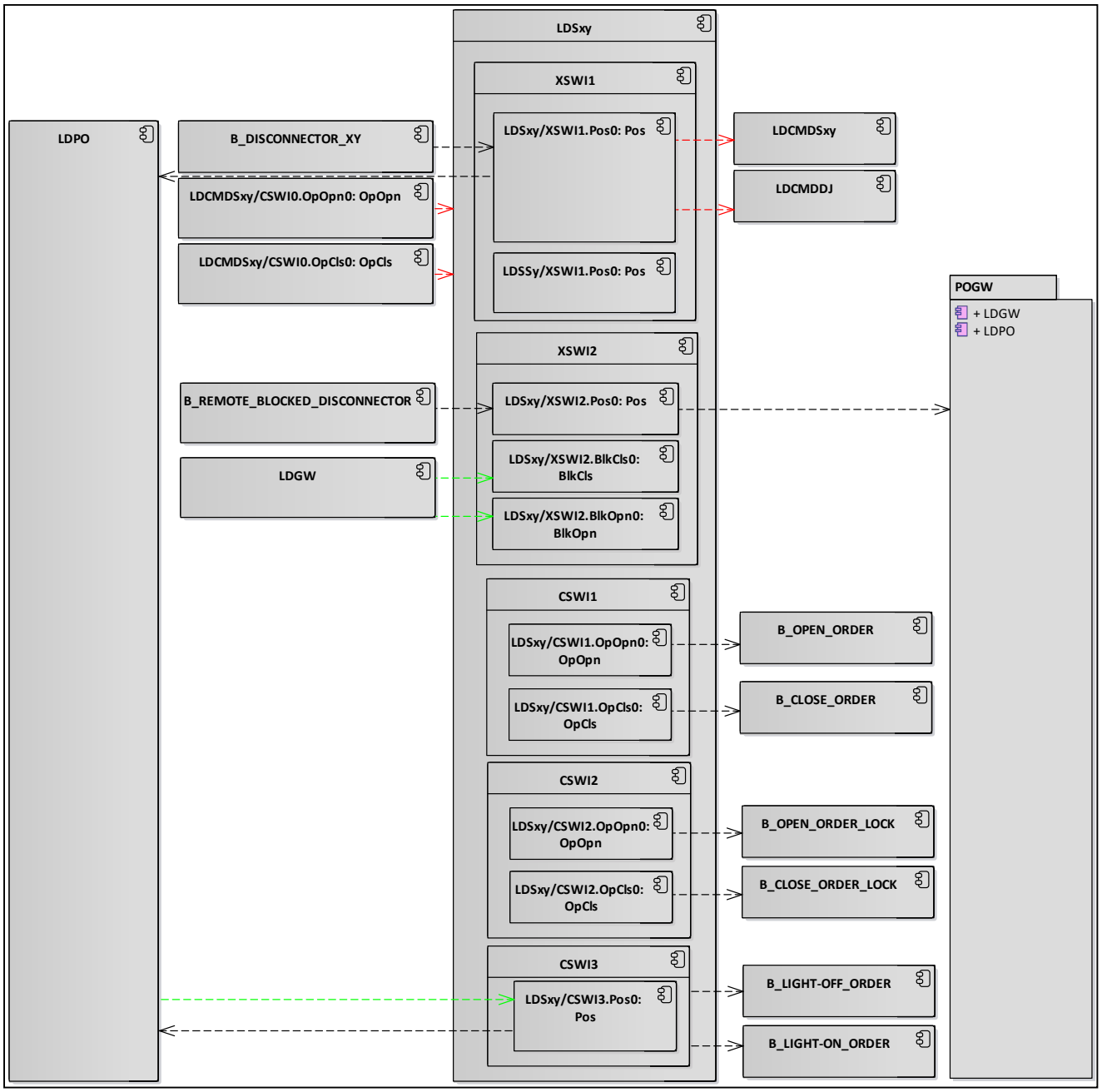

Figure 44: Dynamic Description LDSxy

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7.4 Instrument Transformers (LDTM)

7.4.1 Description of the Function

The process interface with the Instrument Transformers (LDTM) publishes the Sampled Values representing the primary currents and voltages, as well as information linked to the operation of the instrument transformers and their protections (fuses) and analogue input circuit switches and disconnectors. LDTM is used for SAMU connected to conventional Instrument Transformers and for MU linked to NCIT.

LDTM includes the lockout function to remotely islote the secondary of instrument transformers for line work (Télécondamnation TLCONDAM).

Note that from the point of view of IEC 61850, a SAMU interface is an MU.

7.4.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
XSWI	This LN is used for modelling switches without short circuit breaking capability, for example disconnectors, air break switches, earthing switches, etc. Additional LNs, SIMS, etc. may be required to complete the logical model for the switch being represented. The closing and opening commands shall be subscribed from CSWI. If no "time activated control" service is available between CSWI or CPOW and XSWI, the opening and closing commands shall be performed with a GSE-message (see IEC 61850-7-2).
TCTR	The current is delivered as sampled values. The sampled values are transmitted as engineering values, i.e. as "true" (corrected) primary current values. Therefore, the transformer ratio and the correction factors are of no interest for the transmitted samples, but for maintenance purposes of an external conventional (magnetic) transducer only. In addition, status information is provided and some other settings are accepted from the LN TCTR.
TVTR	The voltage is delivered as sampled values. The sampled values are transmitted as engineering values, that is as "true" (corrected) primary voltage values. Therefore, the transformer ratio and the correction factors are of no interest for the transmitted samples but for maintenance purposes of an external conventional (magnetic) transducer only. In addition, status information is provided and some other settings are accepted from the LN TVTR.

7.4.3 Specificities

- A LDTM is considered to be associated to a single outgoing feeder (4I, 4U – cf. [10]). There is one LDTM for each 3 phase current circuit (protection or measurement class - circuits designates as I, J, H, etc.). Each phase is associated to a specific LN TVTR/TCTR. Other bays, eg. Busbar management bay or transformer feeder may require SAMU with other configuration of analogue input.

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- As regards the zero-sequence values, the modelling covers their publication if these are acquired via the process interface. If they are not measured directly, they can be calculated by the subscribing functions if necessary. They are not calculated by the LDTM. However, fourth voltage/current analogue input of the SAMU could be used to acquire another value measured, such as the cable shield to ground currents.
- A MU operation fault represents a failure of the analogue acquisition chain used by the protections. Consequently, the DA q of the DO VolSv and AmpSv are contribute to the signal "failure in the analogue acquisition chain for protection functions" (MQUI -LDMQUI) for a feeder bay and the signal "open fuse of busbar VT" (FUSI.TT) (cf. 6.14.3) for a Voltage Transformer installed on a busbar.
- As regards current circuits reserved for measuring and metering functions (circuit I), the same LDTM is used as for the current circuits reserved for the protections (circuit J and H).
- In the case of current circuits G, associated to a cable-shield-to-ground current transformer subscribed by LDPMC, the same LDTM model is used. In this case, LDTM/LLN0.health, participates in the elaboration of the mentioned MQUI signal.
- The signal charged to indicate an open fuse (FUSTT) in a voltage transformer associated to a bay, is a grouping using TVTR.FuFail.
- The signal FUSI.TT associated to a busbar VT is elaborated on the basis of the grouping of DA TVTR.FuFail.StVal and TVTR.VolSv.q
- It was decided to model signals related to the position of the short-circuiting switches of the current circuits and signals indicating open or blown fuses in LDTM as this LD represents the process interface with the "Instrument Transformer". The short-circuiting switch is modelled by the LN XSWIx (cf. 4.4.12). There is one instance ofr each short-circuit switch (usually for a three phase circuit).
- The indication of open or blown fuses is modelled by DO TVTR.FuFail, as grouped signal for all 3 phases.
- The DO EEName (cf. §4.4.15) indicates the characteristics of the external equipment.
- Some functions do not need to subscribe to SV but can use phasors and RMS values. The LDCAP (cf. § 8.4) models the publication of these DO.
- The association of phases a, b and of the DO published in the primary phases is described in § 4.3.2.
- The LN tlcoXSWI0 is used to indicate that the instrument transformers are remotely blocked for HV maintenance (TLCONDAMN).
- For LN TCTR and TVTR parameters and LN naming is compliant to IEC 61869-9: 2016. The DO NamAccRtg which is mentioned in IEC 61869-9 and is meant to indicate the precision class of the instrument transformer is not present in IEC 61850-7-4.
- The reference of the Electrical Node to whitch the LDTM is associated, is calculated dynamically by LDTOPO (cf. §8.23). LDTM does not publish this information itself, a function requiring the reference of the Electrical Node of a SV streams needs to subscribe directly to the appropriate instance of LTED in LDTOPO.

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7.4.4 Static description

(LDTM)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Health of the LDTM
	Mod	ENC		
	NamPlt	LPL		
InnpTCTRn	AmpSv	SAV	Current circuit	1 TCTR per phase + neutral Instances 1, 2, 3, 4 are linked to phsA, phsB, phsC and neutral, respectively.
	Beh	ENS		
	NamPlt	LPL		
	ARtg	ASG.setMag		Rated current
	EEName	DPL		Characteristics of the measurement CT.
	HzRtg	ASG.setMag		Rated frequency of external current transformer
	NamAccRtg	VSD		Accuracy class rating according to 61869-9
	NamARtg	VSD		Rated primary currents according to 61869-9
	NamClipRtg	VSD		Ratio of the clipping limit of the instantaneous currents according to 61869-9
	Rat	ASG.setMag		Winding ratio of external current transformer
UnnpTVTRn	Beh	ENS		
	NamPlt	LPL		
	EEName	DPL		
	FuFail	SPS	FUS.V; FUS.W; FUSI.TT	Use to indicate a blown fuse of an outgoing feeder VT or a busbar VT.
	HzRtg	ASG.setMag		Rated frequency of external voltage transformer
	VRtg	ASG.setMag		
	NamAccRtg	VSD		Accuracy class rating according to 61869-9
	NamClipRtg	VSD		Ratio of the clipping limit of the instantaneous voltage according to 61869-9
	NamVRtg	VSD		Rated primary voltage according to 61869-9
	Rat	ASG.setMag		Winding ratio of external voltage transformer
	VolSv	SAV		1 TVTR per phase + neutral. Instances 1, 2, 3, 4 are linked to phsA, phsB, phsC and neutral, respectively.
XSWIx	Beh	ENS		
	Loc	SPS		Local Control behaviour

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(LDTM)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	OpCnt	INS		Counter of operation (used for monitoring).
	SwTyp	ENS		Switch Type
	Pos	DPC		Models the position of the current circuit short-circuiting switch of current circuit x
	BlkOpn	SPC		Block opening - not used
	BlkCls	SPC		Block closing - not used
tIcoXSWI0	Beh	ENS		
	Loc	SPS		Local Control behaviour
	OpCnt	INS		Counter of operation (used for monitoring).
	SwTyp	ENS		Switch Type
	Pos	DPC	TT.OCO	Models the position of the current circuit short-circuiting switch.
	BlkOpn	SPC		Block opening
	BlkCls	SPC		Block closing

7.4.5 Dynamic description

Dynamic description is available in appendix 12.10.

7.5 Power Transformers and Reactors interface (LDMTBB)

7.5.1 Description of the Function

This function represents the interface with oil-insulated HV equipment with windings such as reactors, transformers, and auto-transformers.

7.5.2 LNs used

LN	Description
CCGR	This LN class shall be used to control the cooling equipment. One instance per cooling group shall be used.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
SFIR	This logical node represents fire supervision
SIML	The insulation medium is a liquid such as oil, like that used for example for some transformers and tap changers. For other measuring objects related to the same IED, a new instance of SIML may be used. If the new measuring point(s) is/are related to a new IED a new instance of SIML shall be used.
SPTR	This LN is used for supervision of power transformer. It is used to asses the condition of the power transformer.

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7.5.3 Specificities

- The interface and the publication of measurements other than primary voltages and currents are not represented by "T"-type LN, but by "S"-type LN.
- The Buchholz relay signals acquired by the process interface for Power Transformers and Reactances (LDMTBB) are also used for the function monitoring the auxilary power supply circuits and equipment (SURVUA).
- For the use of LN SIML, see Chapter 5 (cf. § 4.4.9).

7.5.4 Static description

Power Transformers and Reactors interface (LDMTBB)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
CCGRx	OilTmpIn	MV		Oil temperature at the inlet of the refrigeration unit x
	OilTmpSet	ASG.setMag		Setting for oil temperature
	OilMotA	MV		Oil circulation motor drive current
	OilTmpOut	MV		Oil temperature at the outlet of refrigeration unit x
LLN0	Beh	ENS		
	Health	ENS		Health of the function
	Mod	ENC		
	NamPlt	LPL		
SFIR0	Blk	SPS		Blocking orders associated to a fire detection
	EEHealth	ENS		Fire detector fault
	NamPlt	LPL		
	FireAlm	SPS		Integrated in 90-3
SIMLx	C2H2ppm	MV		
	C2H4ppm	MV		
	C2H6ppm	MV		
	CH4ppm	MV		
	CmbuGas	MV		
	CO2ppm	MV		
	COppm	MV		
	FltGas	MV		

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Power Transformers and Reactors interface (LDMTBB)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	GasInsAlm	SPS	AL.BU.TR , AL.BU.AT, AL.BU, DF.CERT (reactance), AL.BUTPN, AL.BUBPN, AL.BUT*, AL.BU.SE, AL.BU.SH, AL.BU.REG, AL.BUCH.TSA, AL.BUCH.TSA1, AL.BUCH.TSA2, AL.BUCH.TSA3, AL.BUCH.TSA4	Buchholz alarm
	GasInsTr	SPS	DT.BUTRS, DT.BUATS, DT.BUS, DT.BUTPN, DT.BUBPN, DT.BUT*, DT.BUCHHOLZ TSA, DT.BUCHHOLZ TSA1, DT.BUCHHOLZ TSA2, DT.BUCHHOLZ TSA3, DT.BUCHHOLZ TSA4	Buchholz trip
	H2O	MV		
	H2ppm	MV		
	InsLevMax	SPS		Maximum oil level contact
	InsLevMin	SPS		Minimum oil level contact
	Lev	MV		
	MstAlm	SPS		
	N2ppm	MV		
	O2ppm	MV		
	Tmp	MV	TEMP.HUI	Temperature measurement in the upper part of the tank.
	TmpAlm	SPS		Associated to the contact from the thermostat situated in the upper part of the tank.
SPTR0	BotTmp	MV		
	Beh	ENS		
	NamPlt	LPL		
	CoreTmp	MV		

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Power Transformers and Reactors interface (LDMTBB)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	HPTmpClc	MV		

7.5.5 Dynamic description

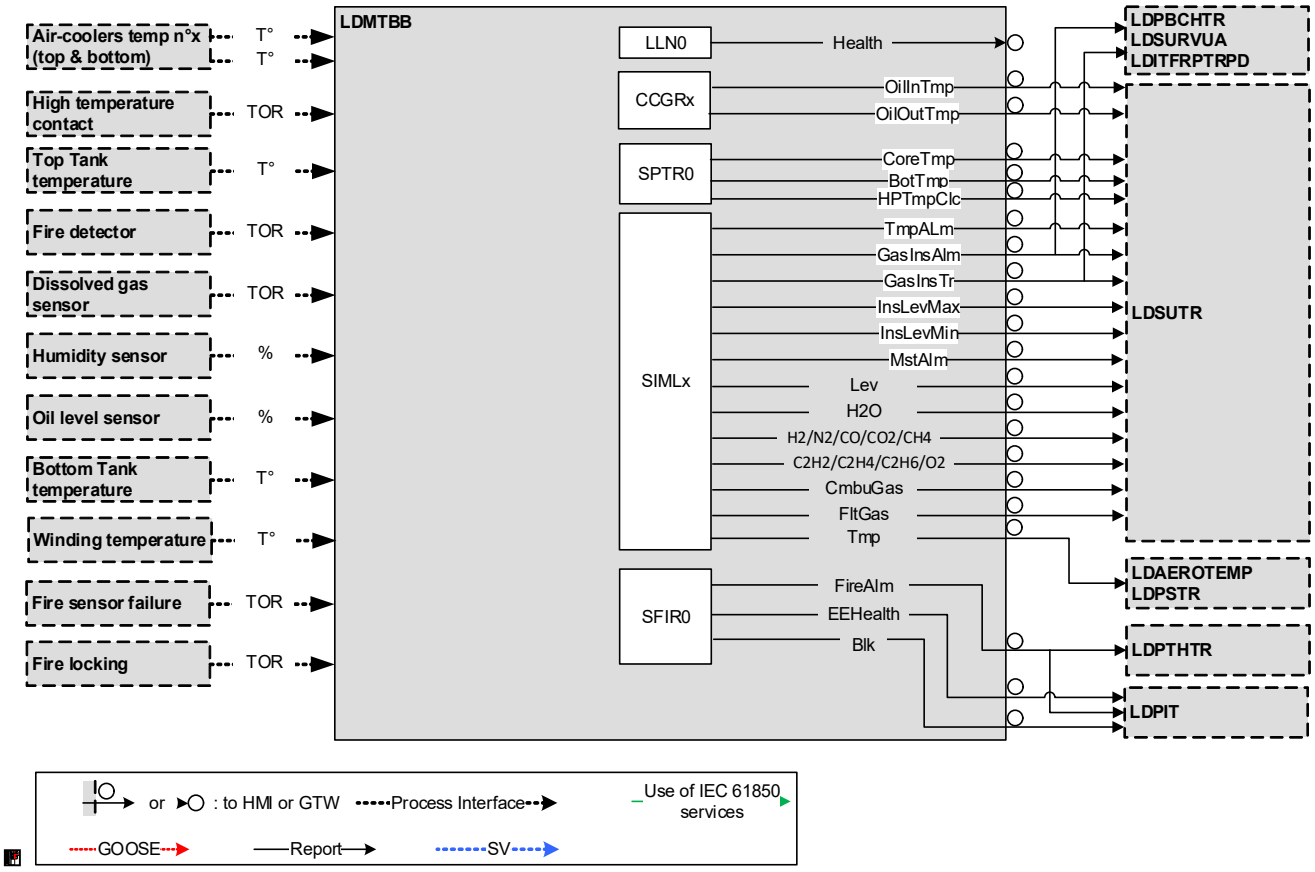

Figure 45: Dynamic Description LDMTBB

7.6 Transformer Tap Changer (LDCHPRTR)

7.6.1 Description of the Function

This function represents the interface with the power transformer tap changer.

7.6.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.

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LN	Description
SIML	The insulation medium is a liquid such as oil, like that used for example for some transformers and tap changers. For other measuring objects related to the same IED, a new instance of SIML may be used. If the new measuring point(s) is/are related to a new IED a new instance of SIML shall be used.
SLTC	This LN is used for supervision of tap changer. It is used to assess the condition of the tap changer.
YLTC	Device allocated to YPRT allowing changing taps of the winding for voltage regulation.

7.6.3 Specificities

- The DF.REGUL is considered to be generated by an external interfaced signal from the tap changer or by a failure of the IED where LDCHPRTR is implemented.
- In the current specification of the transformer voltage regulation function (ARU) automatons, the orders are "increase" and "decrease". In the modelling, the possibility is added that the order directly indicates the target tap number of the tap changer.
- LDCHPRTR/GAPC0.Ind1 is used to indicate that the tap position is changing.

7.6.4 Static description

Transformer Tap Changer (LDCHPRTR)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS	DF.REGUL	Health status of the LDCHPRTR function
	Mod	ENC		
	NamPlt	LPL		
GAPC0	Ind1	SPS	P.PRISE	Indication that tap position is changing
SIML0	InsLevMax	SPS		Oil - Maximum level indication
	InsLevMin	SPS		Oil - Minimum level indication
	Lev	MV		
	Tmp	MV		Tap changer temperature
SLTC0	Beh	ENS		
	NamPlt	LPL		
	Blk	SPS		
YLTC0	EEHealth	ENS		
	Beh	ENS		
	EndPosL	SPS		
	EndPosR	SPS		
	TapPos	ISC		

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7.6.5 Dynamic description

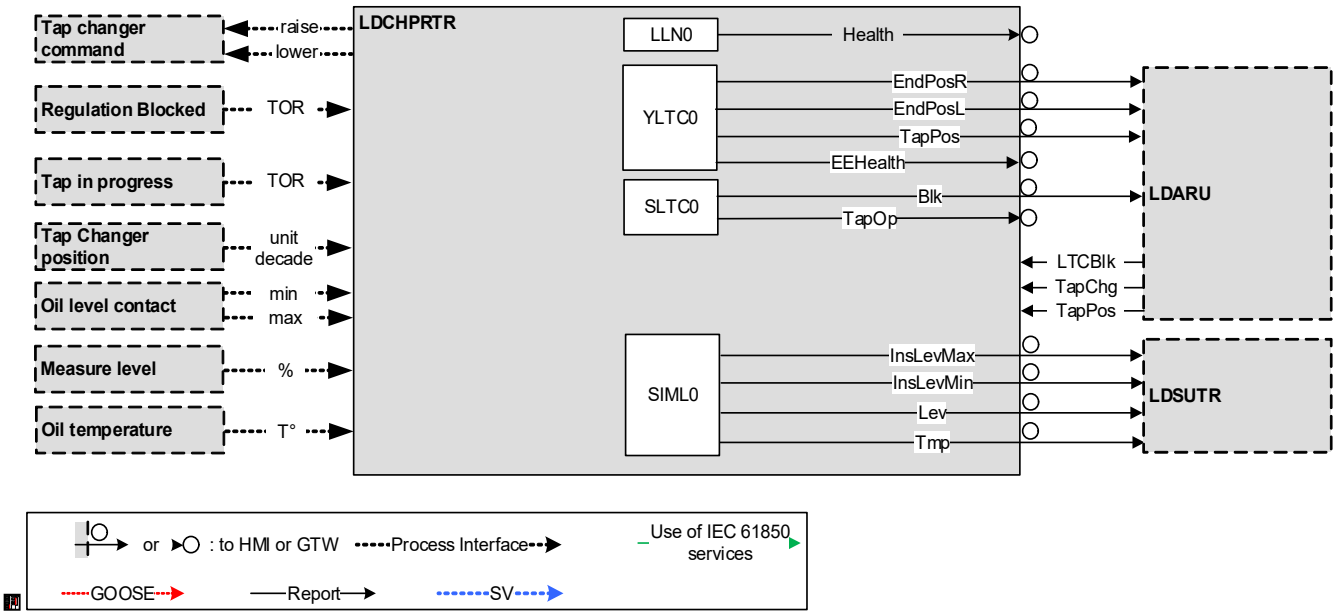

Figure 46: LDCHPRTR dynamic description

7.7 Transformer Pit (LDFOSSE)

7.7.1 Description of the Function

This function represents the interface with the sensors and control of the power transformer pit.

7.7.2 LNs used

LN	Description
KPMP	Logical node KPMP shall be used to represent a pump. It can be seen as an extended nameplate that allows the temporary setting of data object.
KTNK	Logical node KTNK shall be used to represent the physical device of a tank, such as a hydraulic oil tank. The tank can be pressurised or not. If used to represent a tank for pressurised gas, only the pressure MV will be used. If used for an oil sump, only the level MV will be used. For a simple level sensor, the SLVL logical node can be used instead.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.

7.7.3 Specificities

N/A

7.7.4 Static description

Transformer Pit (LDFOSSE)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
KPMP0	Beh	ENS		
	OpCtl	SPC		Control of pump

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Transformer Pit (LDFOSSE)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	EEHealth	ENS		Pit pump anomaly
KTNK0	Beh	ENS		
	LevPct	MV		Liquid level in water/oil separation tank
LLN0	Beh	ENS		
	Health	ENS	DF.REGUL	Health status of the function
	Mod	ENC		
	NamPlt	LPL		

7.7.5 Dynamic description

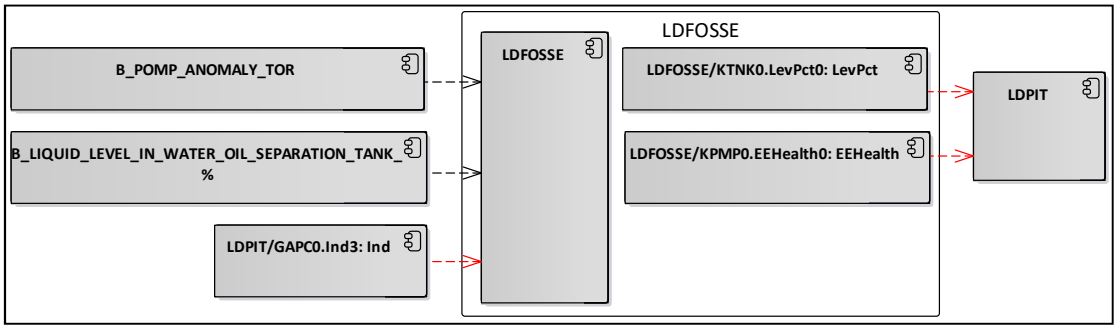

Figure 47: Dynamic description LDFOSSE

7.8 CO2 Fire Extinguishing System (LDSEICO2)

7.8.1 Description of the Function

This function represents the interface with the fire extinguishing system used, where necessary, for oil-insulated power transformers, reactors, and auto-transformers.

7.8.2 LNs used

LN	Description
ISAF	Logical node ISAF shall be used to represent an alarm push-button or any other device that is used to provide an alarm in case of danger to persons or property.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.

7.8.3 Specificities

N/A

7.8.4 Static description

CO2 Fire Extinguishing System (LDSEICO2)				
LN	**DO**	**CDC**	**FCS name**	**Comments**

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CO2 Fire Extinguishing System (LDSEICO2)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
ISAF0	Alm	SPS	FUITE.CO2	CO2 leakage
LLN0	Beh	ENS		
	Health	ENS		
	Mod	ENC		
	NamPlt	LPL		

7.8.5 Dynamic description

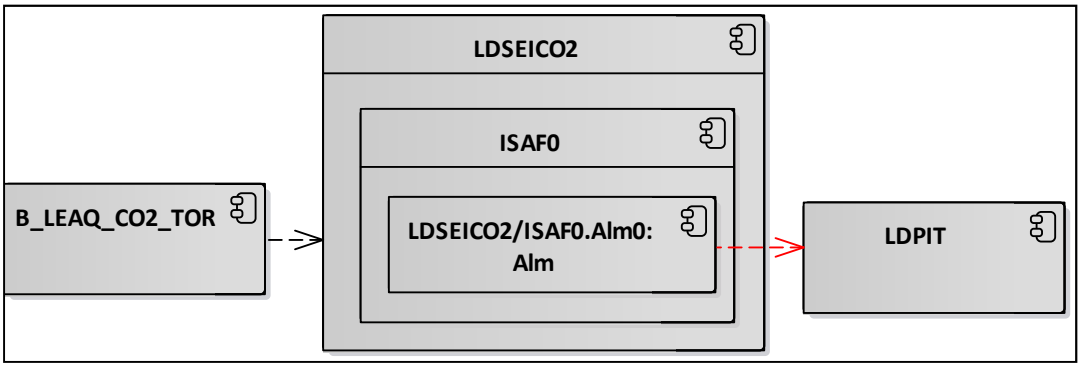

Figure 48: Dynamic description LDSEICO2

7.9 Substation Management Bay Interface (LDITFTG)

7.9.1 Description of the Function

This LD represents the interface for the Substation Management Bay (TG) with the various push-buttons, switches and other binary interfaced signals. This function includes ALTECH.

7.9.2 LNs used

LN	Description
CALH	CALH allows the creation of group warnings, group indications and group alarms. The individual alarms, which are used to calculate the group indications/alarms/warnings, are subscribed from elsewhere. The calculation is a local issue, usually performed by a logic scheme.
FXOT	Logical node FXOT shall be used to set a high-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, contro or alarm function is based on other physical measurements than primary electrical data.
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.
ISAF	Logical node ISAF shall be used to represent an alarm push-button or any other device that is used to provide an alarm in case of danger to persons or property.

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LN	Description
KFAN	Logical node KFAN shall be used to represent a fan. It can be seen as an extended nameplate that allows the temporary setting of data object.
KPMP	Logical node KPMP shall be used to represent a pump. It can be seen as an extended nameplate that allows the temporary setting of data object.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
SFIR	This logical node represents fire supervision

7.9.3 Specificities

- The LDITFTG is used, among other things, to interface push-buttons. The corresponding orders can also be sent from the HMI. The order from the HMI is directly modelled in the concerned target LDs, who also subscribe to the DO of LDITFTG representing the push buttons.
- In the case of binary inputs located at different places resulting in the impossibility to connect them to the same interfacing IED, an instance of the LDITFTG must be created for each IED. For this reason, the LN in the LDITFTG contains several instances of the same LN, each associated to a given type of functional interface.
- For push-buttons, the LDITFTG acquires the unfiltered status from the binary contact. Any processing (flip flop, raising or falling edge detection, etc.) will be carried out at application level by the subscribed functions to LDITFTG.
- The DO indicating the presence of staff (TSO or DSO) is represented by CALH1 and CALH2, respectively. The DO is updated by physically interfaced buttons at substation entry and its value is reflected by physical outputs used for indication lamps.
- The indication "Presence of staff or Local Substation or Feeder mode" is represented by GAPC0.Ind5. This information is subscribed from a LDGRP instanciated for this grouping of information.
- The commands from HMI for substation ligntning are performed on DO LDTGINGRA which publishes and receives GOOSE to the corresponding DO in LDITFTG.
- There are two outputs for danger alarm: ISAF2.Alm used for telealarme and actrivated only if Telealarm operation mode is selected and ISAF3.Alm to interface signal models.

7.9.4 Static description

Substation Management Bay Interface (LDITFTG)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
CALH1	Beh	ENS		
	GrInd	SPS		Physical Input/Output : Presence of staff(1) (TSO)
CALH2	Beh	ENS		
	GrInd	SPS		Physical Input/Output : Presence of staff(2) (DSO)
CALH3	Beh	ENS		
	GrAlm	SPS		Physical output : Horn (auxiliary voltage S)

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Substation Management Bay Interface (LDITFTG)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	GrWrn	SPS		Physical output : Bell (auxiliary voltage S)
CALH4	Beh	ENS		
	GrAlm	SPS		Physical output : Horn (auxiliary voltage TC)
	GrWrn	SPS		Physical output : Bell (auxiliary voltage TC)
CALH5	Beh	ENS		
	GrAlm	SPS		Physical output : Horn (auxiliary voltage S additional)
	GrWrn	SPS		Physical output : Bell (auxiliary voltage S additional)
CALH6	Beh	ENS		
	GrAlm	SPS		Physical output : Horn (auxiliary voltage TC additional)
	GrWrn	SPS		Physical output : Bell (auxiliary voltage TC additional)
CALH7	Beh	ENS		
	GrAlm	SPS		Physical output : Intrusion horn
CALH8	Beh	ENS		
	GrAlm	SPS		Physical output to TA interface for signal : Substation failure or DSO substation failure in backup alarm mode
CALH9	Beh	ENS		
	GrWrn	SPS	TCM.NURG	Telecommunication equipment warning
	GrAlm	SPS	TCM.URG	Telecommunication equipment alarm
CALH10	Beh	ENS		
	GrAlm	SPS	DF.CBI	Phone router equipment failure
FXOT0	Beh	ENS		
	StrVal	ASG.setMag		
	Op	ACT	POSTE INONDE	Substation flooded
GAPC1	Beh	ENS		
	Ind1	SPS		Call - door
	Ind2	SPS		Call – telephone TSO
	Ind3	SPS	PORT.OUV.INST	Door open (instantaneous)
	Ind4	SPS	PORT.OUV.INST	
	Ind5	SPS		Indication "Presence of staff or local substation or feeder mode set"
GAPC2	Beh	ENS		
	Ind1	SPS		Temporary Inhibition of Horn

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Substation Management Bay Interface (LDITFTG)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
GAPC3	Beh	ENS		
	Ind1	SPS		Output : Duration of maintenance operation exceeds time limit
	Ind2	SPS		Input : Restart intervention timer button
	Ind3	SPS		Input : Actiavtion/deactivation intervention time function
	Ind4	SPS		Output : Signal "Maintenance intervention timer is counting and active"
GAPC4	Beh	ENS		
	Ind1	SPS		Button- lighting of surrounding area
	Ind2	SPS		Button actioned- lighting of substation (or substation 1)
	Ind3	SPS		Button actioned -lighting of substation 2
	Ind4	SPS		Button actioned - lighting of substation 3
	Ind5	SPS		Substation lighting
	Ind6	SPS		Physical output to send order to switch on light in substation
	Ind7	SPS		Physical output to send order to switch on light in voltage level 1
	Ind8	SPS		Physical output to send order to switch on light in voltage level 2
	Ind9	SPS		Physical output to send order to switch on light in voltage level 3
	Ind10	SPS		Button actioned - lighting substation area (from CPPT)
GAPC5	Beh	ENS		
	Ind1	SPS		Failure of water extraction system
	Ind2	SPS		Technical Alarm - SCADA
	Ind3	SPS		Technical Alarm Air Conditioning
	Ind4	SPS		Technical Alarm smoke extraction
	Ind5	SPS		Technical Alarm (spare input)
GAPC6	Ind1	SPS		Physical output to TA interface for signal : remote alarm mode
ISAF1	Alm	SPS		Button danger alarm
	Beh	ENS		
ISAF2	Alm	SPS		Physical output to TA interface for signal : Danger Alarm
KFAN0	Beh	ENS		
	EEHealth	ENS		Technical Alarm - ventilation

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Substation Management Bay Interface (LDITFTG)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
KPMP0	Beh	ENS		
	OpCtl	SPC		Control of pump
	EEHealth	ENS		Technical Alarm - pump
LLN0	Beh	ENS		
	Health	ENS		Health of the LDITFTG
	Mod	ENC		
	NamPlt	LPL		
SFIR0	Beh	ENS	INC.HS	Fire protection out of service
	NamPlt	LPL		
	EEHealth	ENS		Technical Alarm fire
	FireAlm	SPS	"ALARME INCENDIE" or "ALARME INCENDI"	Fire Alarm on TSO permisses
KFAN0	OpCtl	SPC		Control of fan

7.9.5 Dynamic description

Dynamic description is available in appendix 12.8

7.10 Auxiliary Supply Unit Interface (LDITFUA)

7.10.1 Description of the Function

This LD represents the interface for the substation management bay (TG) with the monitoring function of the units providing the auxiliary supply voltages for the PACS.

7.10.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTOC	This LN shall also be used to model the directional time overcurrent (PDOC/IEEE device function number 67, IEEE C37.2:1996). The Definite Time overcurrent (also PTOC/IEEE device function number 51, from IEEE C37.2:1996) shall be modelled by use of PTOC and selecting the related curve.
SBAT	This logical node represents battery supervision
SIML	The insulation medium is a liquid such as oil, like that used for example for some transformers and tap changers. For other measuring objects related to the same IED, a new instance of SIML may be used. If the new measuring point(s) is/are related to a new IED a new instance of SIML shall be used.

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LN	Description
CSWI	This LN class shall be used to control all switching conditions above process level. CSWI shall subscribe the data object POWCap ("point-on-wave switching capability") from XCBR if applicable. If a switching command (for example Select-before-Operate) arrives and "point-on-wave switching capability" is supported by the breaker, the command shall be passed to CPOW. OpOpn and OpCls shall be used if no Control Service is available between CSWI and XCBR (see GSE in IEC 61850-7-2).
XCBR	This LN is used for modelling switches with short circuit breaking capability. Additional LNs, for example SIMS, etc. may be required to complete the logical modelling for the breaker being represented. The closing and opening commands shall be subscribed from CSWI or CPOW if applicable. If no "time activated control" service is available between CSWI or CPOW and XCBR, the opening and closing commands shall be performed with a GSE-message (see IEC 61850-7-2).
XSWI	This LN is used for modelling switches without short circuit breaking capability, for example disconnectors, air break switches, earthing switches, etc. Additional LNs, SIMS, etc. may be required to complete the logical model for the switch being represented. The closing and opening commands shall be subscribed from CSWI. If no "time activated control" service is available between CSWI or CPOW and XSWI, the opening and closing commands shall be performed with a GSE-message (see IEC 61850-7-2).
ZAXN	Auxiliary networks belong to the power supply system of substations and other power systems installations.
ZBAT	Provides data about battery status and for control of the charging/de-charging cycles.
ZBTC	General purpose Battery Charger (mostly to be used in conjunction with ZBAT) as the charger associated to a battery modelled with ZBAT
ZCON	Frequency conversion including AC/DC conversion.
ZGEN	ZGEN has to be used for all generators not modelled elsewhere in IEC 61850.
ISAF	Logical node ISAF shall be used to represent an alarm push-button or any other device that is used to provide an alarm in case of danger to persons or property.

7.10.3 Specificities

- The LDITFUA is used for the verification of the auxiliary supply voltage feeders of the PACS and publishes signals indicating a failure of these auxiliary voltages failure. As the auxiliary supply voltages used depend on the architecture of the PACS and the number of bays that it contains, it is used to model the signals indicating a failure of the "auxiliary voltage failure" by a DO xZAXNy.VPrs, where "x" represents the functional bay to which the auxiliary voltage is associated and "y", the auxiliary supply voltage in question.
- LDITFUA can be instanciated for a functional bay representing the Mini Circuit Breakers (MCB) associated to each IED, for a auxiliary supply stack representing the position of the MCB of the different auxiliary feedeers, or for a functional bay representing auxiliary supply services. In some of these cases, the prefix "BayName" is not necessary.
- Some signals are acquired by the Substation Management Bay (TG) in the migration phase via a dedicated migration interface. As the migration of the PACS in a substation can take considerable time (several months), LDITFUA is also used to model this migration interface.

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- The LN XCBR is used to model the auxiliary power supply feeder circuit breakers of the DC and AC busbars. If applicable, this LN is also used to model the remote control of these circuit breakers (cf. 4.4.12). A indixation that one of these circuit breakers has tripped is given by PTOC.op
- LDITFUA is also used for monitoring of auxiliary voltages in cubicles. In this case, only the LN required for this function are instantiated.
- LN xCSWIy represent position and command of IED auxiliary supply MCB breakers.

7.10.4 Static description

Auxiliary Supply Unit Interface (LDITFUA)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Health of the LDITFUA function
	Mod	ENC		
	NamPlt	LPL		
BayNamePTOCy	Op	ACT.general	DT.ALT.RESEA.UA, DT.ALT.RESEA.UA1, DT.ALT.RESEA.UA2, DT.ALT.SECOU.UA2, DT.ALT.RESEA.UA3, DT.ALT.SECOU.UA3, DT.ALT.RESEA.UA4, DT.ALT.SECOU.UA4, DT.DJ.ALT.N.PRIO, DT.DJ.ALT.PRIO,	Indixation of a trip of the cb of an auxiliary power supply feeder, "x" signifies the functional bay and "y" designates the concerned auxiliary voltage supply circuit. Also used to detect the breaker trip of an auxiliary power supply feeder.
SBATx	BatEF	SPS	TERRE BAT P, TERRE BAT.127, TERRE BAT1, TERRE BAT2	Battery-earth circuit faults. One LN, x is instantiated for each battery
	NamPlt	LPL		
	Beh	ENS		
SIMLx	Beh	ENS		
	GasInsAlm	SPS	AL.BUCH.TSA.UA AL.BUCH.TSA.UA1 AL.BUCH.TSA.UA2 AL.BUCH.TSA.UA3 AL.BUCH.TSA.UA4 AL.BUCH.TSA.UA5	Buchholz alarm from auxiliary voltage transformer
BayNameXCBRy	Beh	ENS		

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Auxiliary Supply Unit Interface (LDITFUA)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Pos	DPC	OUV.DJ.BAT.P, OUV.DJ.BAT.S, DJ.127OUVERT, OUV.DJ.BAT1, OUV.DJ.BAT2,	Position of the circuit breaker of DC and AC auxiliary feeders. "x" signifies the functional bay and "y" designates the concerned auxiliary voltage supply circuit.
BayNameCSWIy	OpOpn	ACT		Used for the open command of MCB
	OpCls	ACT		Used for the close command of MCB
	Pos	DPC		Position of the circuit breaker (MCB) of DC power supply IED. "x" signifies the functional bay and "y" designates the concerned auxiliary voltage supply circuit.
XSWI0	Beh	ENS		
	Loc	SPS		Local Control behaviour
	OpCnt	INS		Counter of operation (used for monitoring).
	SwTyp	ENS		Switch Type
	Pos	DPC	ICT.OUVERT	Bay lockout tag out disconnector
	BlkOpn	SPC		Block opening
	BlkCls	SPC		Block closing
BayNameZAXNy	Beh	ENS		
	NamPlt	LPL		
	EEHealth	ENS		Use for signals indicating a power supply failure signal

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Auxiliary Supply Unit Interface (LDITFUA)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	VPrs	SPS	Manque +-S.SA, Manque +-P2, Manque +-T, Manque +/-S, Manque +-SR MQ.ALT.RESEA.UA, MQ.ALT.RESEA.UA1, MQ.ALT.SECOU.UA, MQ.ALT.SECOU.UA1, MQ.U.TSA.NP.UA, MQ.U.TSA.NP.UA1, MQ.U.TSA.NP.UA1, MQ.ALT.SECOU.UA2, MQ.ALT.RESEA.UA2, MQ.U.TSA.NP.UA2, MQ.ALT.RESEA.UA3, MQ.ALT.SECOU.UA3, MQ.U.TSA.NP.UA3, MQ.ALT.RESEA.UA4, MQ.ALT.SECOU.UA4, MQ.U.TSA.NP.UA4,	Auxiliary supply voltage failure signal, where x signifies the functional bay (cf. rules described in § 4.4.11) and y, the auxiliary voltage in question.
ZBATx	Beh	ENS		
	EEHealth	ENS	U=BATP ANORMAL, U=BATS ANORMAL, ANO.U.BAT.127V, U=BAT1 ANORMAL, U=BAT2 ANORMAL, DF.UA.FH	Battery voltage anomalies, where x signifies the battery
ZBTCx	Beh	ENS		
	NamPlt	LPL	DF.CHARGEUR.PRIN, DF.CHARGEUR.SEC, DF.CHARGEUR1, DF.CHARGEUR2,	
	EEHealth	ENS	DF.CHARGEUR.PRIN, DF.CHARGEUR.SEC, DF.CHARGEUR1, DF.CHARGEUR2,	Battery charger anomalies, where x signifies the battery
ZCONx	Beh	ENS		
	EEHealth	ENS	DF.CONV.48CE.TCM 127/48V, DF.REDRES.127	Converter or rectifier faults, where x signifies the converter or rectifier
ZGENx	Beh	ENS		

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Auxiliary Supply Unit Interface (LDITFUA)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	DExt	SPC		Diesel Operation
	EEHealth	ENS	DF.DIESEL.UA, DF.DIESEL.UA1, DF.DIESEL.UA2, DF.DIESEL.UA3	Status of the diesel units, where x signifies the group number
	GnCtl	DPC		Diesel Operation
	GnSt	ENS	FONCT.DIESEL.UA, FONCT.DIESEL.UA1, FONCT.DIESEL.UA2, FONCT.DIESEL.UA3	
	OpNoLod	SPS		
	RotDir	ENS		
	OpUnExt	SPS		
	OpOvExt	SPS		
ISAFx	Beh	ENS		
	Alm	SPS		Battery/rectifier security alarm associated to ventilation failure in battery room. One DO can be instanciated for each battery/rectifier in the substation.

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7.10.5 Dynamic description

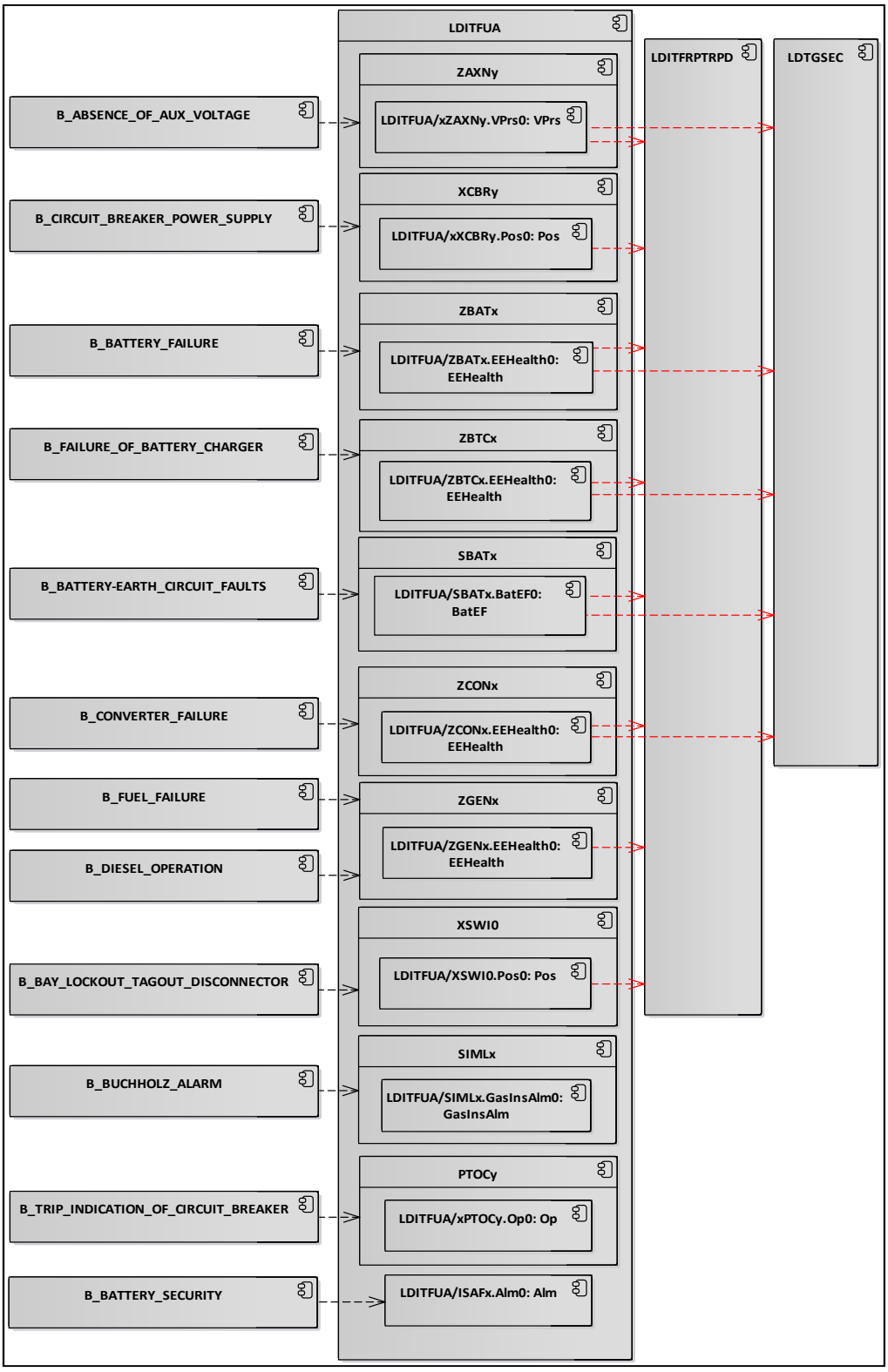

Figure 49: Dynamic description LDITFUA

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7.11 Switchyard Control Cabinet Interface (LDITFACN)

7.11.1 Description of the Function

This LD represents the interface with the Switchyard Control Cabinet (Armoire de Contrôle Numérique - ACN) monitoring function. The monitoring function of the Switchyard Control Cabinet is modelled in LDSUACN (§9.7).

7.11.2 LNs used

LN	Description
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.
KFAN	Logical node KFAN shall be used to represent a fan. It can be seen as an extended nameplate that allows the temporary setting of data object.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
MMET	Logical node MMET shall comprise the data objects that represent meteorological information. The data objects as shown in the following table focus on meteorological station information. MMET may in reality represent a collection of meteorological information from many sources, that is, from sensors located at different places.
PTTR	PTTR shall be used for all thermal overload functions. Depending on the algorithm, the LN describes either a temperature or a current (thermal model). Temperature data objects are also provided by other LNs. Examples are the hot spot temperature in LN YPTR or the isolation gas temperature in LN SIMG.
STMP	Logical node STMP shall be used to represent various devices that supervise the temperatures of major plant objects. It provides alarm and trip/shutdown functions. If more than one sensor (LN TTMP) is connected, the LN STMP shall be instantiated for each sensor.
XCBR	This LN is used for modelling switches with short circuit breaking capability. Additional LNs, for example SIMS, etc. may be required to complete the logical modelling for the breaker being represented. The closing and opening commands shall be subscribed from CSWI or CPOW if applicable. If no "time activated control" service is available between CSWI or CPOW and XCBR, the opening and closing commands shall be performed with a GSE-message (see IEC 61850-7-2).
XSWI	This LN is used for modelling switches without short circuit breaking capability, for example disconnectors, air break switches, earthing switches, etc. Additional LNs, SIMS, etc. may be required to complete the logical model for the switch being represented. The closing and opening commands shall be subscribed from CSWI. If no "time activated control" service is available between CSWI or CPOW and XSWI, the opening and closing commands shall be performed with a GSE-message (see IEC 61850-7-2).
ISAF	Logical node ISAF shall be used to represent an alarm push-button or any other device that is used to provide an alarm in case of danger to persons or property.
ZAXN	Auxiliary networks belong to the power supply system of substations and other power systems installations.

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7.11.3 Specificities

- The LN MMET is used to measure the environmental conditions inside the ACN cabinet but not outside.
- The LDITFACN can also subscribe to the measurements of the environmental conditions of a neighbouring ACN.
- ACN cabinets can contain redundant interface IEDs (A/B). This is reflected in the model. System A is associated to LN *1 and system B to LN*2.

7.11.4 Static description

Switchyard Control Cabinet Interface (LDITFACN)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
Bal_GAPC0	SPCSO1	SPC		Position indication ACN side A
	SPCSO2	SPC		Position indication ACN side B
Porte_GAPC0	Ind1	SPS		ACN A door position Open/Closed
	Ind2	SPS		ACN B door position Open/Closed
	Ind3	SPS		ACN door lock contact. Locked/unlocked status (open=unlocked)
Chauf_KFAN0	OpCtl	SPC		ACN heating on/off
Vent_KFAN0	OpCtl	SPC		ACN ventilation on/off
LLN0	Beh	ENS		
	Health	ENS		Health of the LDITFACN function
	Mod	ENC		
	NamPlt	LPL		
MMET0	DewPt	MV		Calculation of the temperature of the dew point
	EnvHum	MV		Measurement of the percentage of humidity (%).
	Beh	ENS		
	EnvPres	MV		Measurement of atmospheric pressure
	EnvTmp	MV		Measurement of the ACN internal temperature
PTTR1	Op	ACT		Signalling of the thermal trip of the Auxilary supply Circuit Breaker system A of the ACN
PTTR2	Op	ACT		Signalling of the thermal trip of the Auxilary supply Circuit Breaker system B of the ACN
Chauf_STMP0	Alm	SPS		ACN Low Temperature Alarm (heating system malfunction).
	Beh	ENS		
	AlmSet	ASG.setMag		Low temperature alarm threshold.

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Switchyard Control Cabinet Interface (LDITFACN)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
Vent_STMP0	Alm	SPS		ACN High Temperature Alarm (cooling system malfunction).
	Beh	ENS		
	AlmSet	ASG.setMag		High temperature alarm threshold.
XCBR1	Pos	DPC		Cabinet auxiliary power supply Circuit Breaker system A MCB position.
XCBR2	Pos	DPC		Cabinet auxiliary power supply Circuit Breaker system B MCB position.
XSWI1	Loc	SPS		Local Control behaviour
	OpCnt	INS		Counter of operation (used for monitoring).
	SwTyp	ENS		Switch Type
	Pos	DPC		Auxiliary power supply switch connected to source A.
	BlkOpn	SPC		Block opening
	BlkCls	SPC		Block closing
XSWI2	Loc	SPS		Local Control behaviour
	OpCnt	INS		Counter of operation (used for monitoring).
	SwTyp	ENS		Switch Type
	Pos	DPC		Auxiliary power supply switch position connected to source B.
	BlkOpn	SPC		Block opening
	BlkCls	SPC		Block closing
ISAF0	Alm	SPS		
	Beh	ENS		
ZAXN1	Vol	MV		Measurement of the ACN power supply voltage of source A.
	VolMin	ASG.setMag		Source A voltage threshold.
	NamPlt	LPL		
	VPrs	SPS		Voltage of source A greater than minimal level.
ZAXN2	Vol	MV		Measurement of the ACN power supply voltage of source B.
	VolMin	ASG.setMag		Source B voltage threshold.
	NamPlt	LPL		
	VPrs	SPS		Voltage of source B greater than minimal level.

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7.11.5 Dynamic description

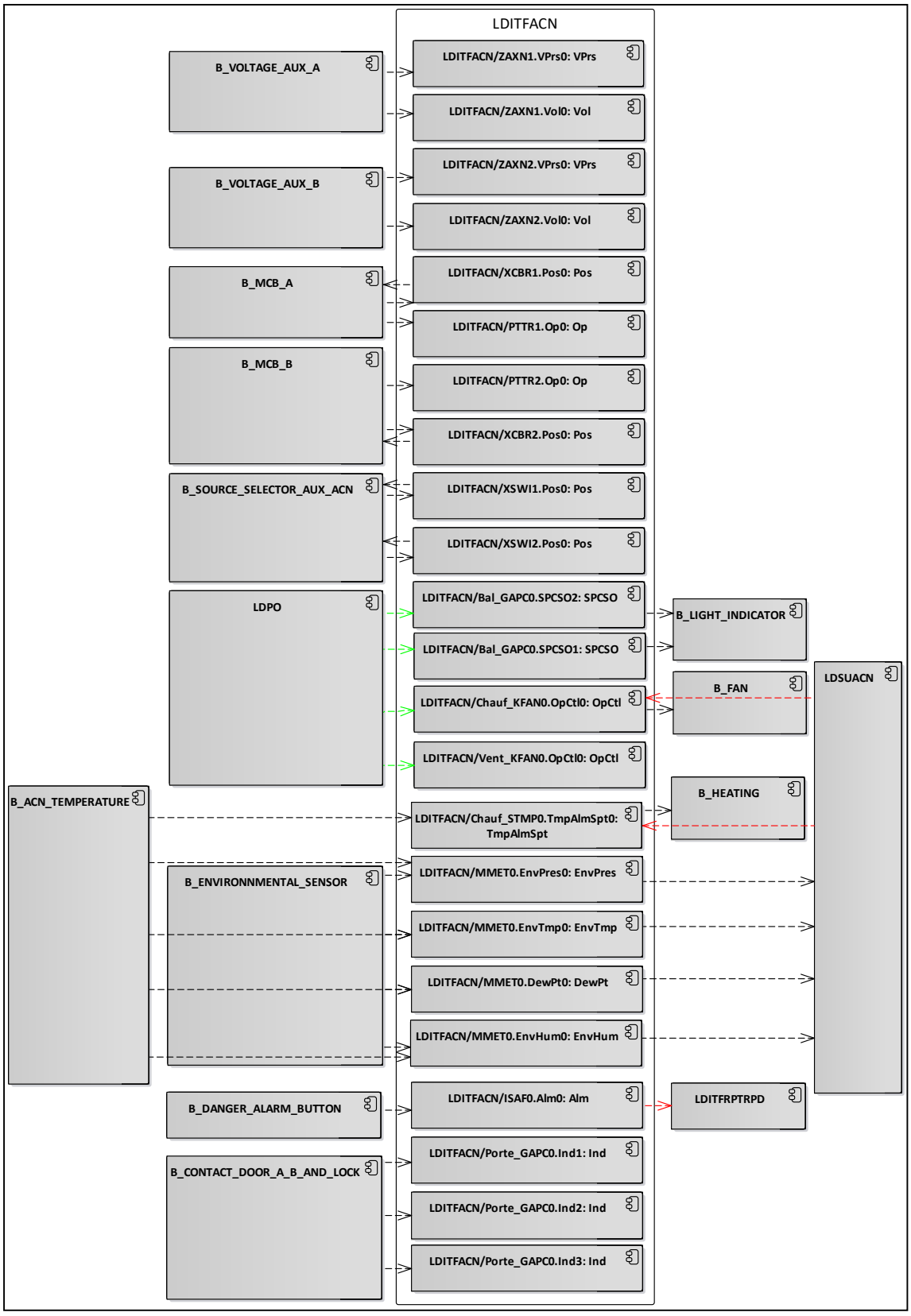

Figure 50: LDITFACN dynamic description

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7.12 GIS Monitoring Bay Interface (LDITFSGIS)

7.12.1 Description of the Function

This LD represents the interface for GIS monitoring.

7.12.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
SARC	LN for controlling the volumes of gas from GIS (gas insulated switch), for the switching arcs and arcs resulting from faults.
SIMG	Insulation medium is gas, for example SF6 in gas isolated devices. For other measuring objects related to the same IED, a new instance of SIMG may be used. If the new measuring point(s) is/are related to a new IED, in this new IED a new instance of SIMG shall be used.
THUM	Logical Node THUM shall be used to represent a measurement of humidity in the media that is monitored. The result is given in percent of maximum possible humidity.

7.12.3 Specificities

- The LDIFSGIS is used for monitoring the physical parameters of the GIS compartments. One LDIFSGIS is instantiated for each bay.
- An LN triplet SARC, SIMG, THUM is instantiated for each compartment of the bay, represented by the letter signifying each compartment (indicated as a prefix to the LN by x). In the case of individual compartments for each phase, the phase is indicated by y (0 - 11) (cf. rules for phase association §4.3.2).
- The grouping of the alarms related to GIS is not covered by this LD.
- The fault arc counter can be reset to zero or to another value by MMS access to the DO FACntRS.

7.12.4 Static description

GIS Monitoring Bay Interface (LDITFSGIS)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Health of the function
	Mod	ENC		
	NamPlt	LPL		
BayNameSARCy	FADet	SPS		Internal arc detection
	FACntRs	INC		Fault arc counter
	SwArcDet	SPS		Switch arc detected
BayNameSIMGy	Den	MV		Insulation Gas Density
	EEHealth	ENS	DF.INT	Sensor failure of compartment xy

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GIS Monitoring Bay Interface (LDITFSGIS)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	NamPlt	LPL		
	InsAlm	SPS	COMP.SF6	
	PresAlm	SPS		
	InsTr	SPS	ISOLER	Low pressure
	Pres	MV		Pressure
	Tmp	MV		Temperature
BayNameTHUMy	Beh	ENS		
	HumSv	SAV		Humidity

7.12.5 Dynamic description

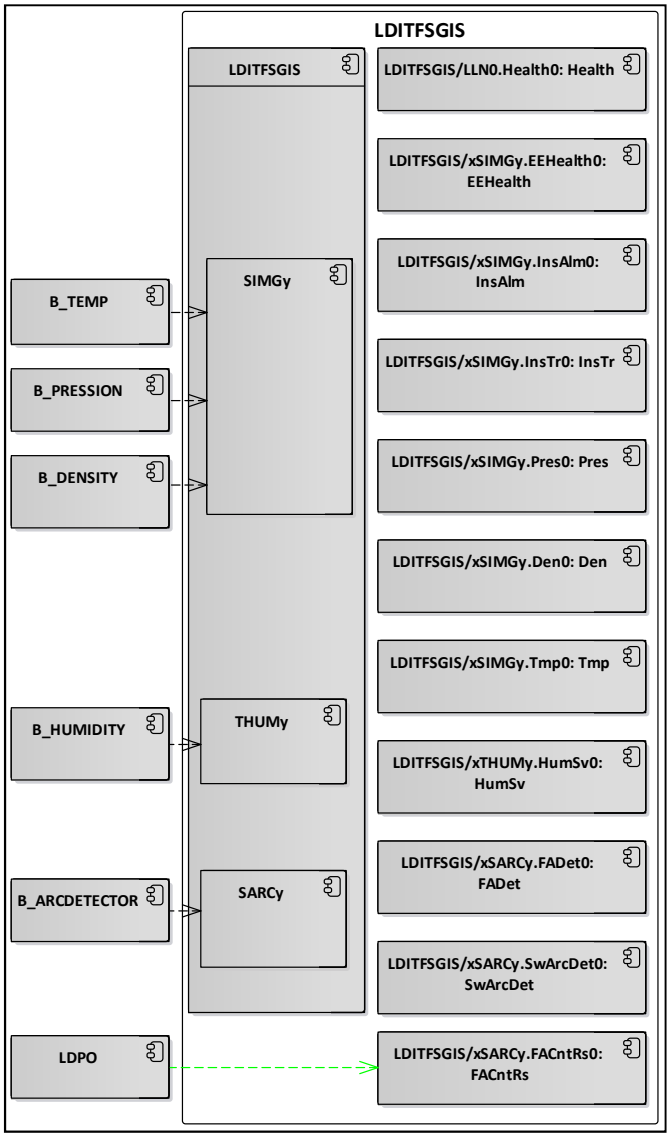

Figure 51: Dynamic description LDITFSGIS

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7.13 Offshore Substation cubicle interface (LDITFOSS)

7.13.1 Description of the Function

This LD represents the interface with Rte equipment monitoring installed on offshore platforms (wind generation connections).

7.13.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
MMET	Logical node MMET shall comprise the data objects that represent meteorological information. The data objects as shown in the following table focus on meteorological station information. MMET may in reality represent a collection of meteorological information from many sources, that is, from sensors located at different places.
STMP	Logical node STMP shall be used to represent various devices that supervise the temperatures of major plant objects. It provides alarm and trip/shutdown functions. If more than one sensor (LN TTMP) is connected, the LN STMP shall be instantiated for each sensor.

7.13.3 Specificities

- The LN MMET is instantiated several times to measure environmental conditions :

Inside cubicle OSS.
Temperatures in fibre optic boxes
Temperatures provided by temperature probes at several locations on the cable. This last measure is grouped in the LDITFOSS insofar as its perpetuation is not acquired.

- If the measurement interfaces are inside multiple IEDs, an instance of LDITFOSS is instantiated in each IED with only the LN / OD used.

7.13.4 Static description

Offshore Substation cubicle interface (LDITFOSS)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Health of the LDITFOSS function
	Mod	ENC		
	NamPlt	LPL		
MMET0	EnvHum	MV		Measurement of the percentage of humidity (%).
	EnvPres	MV		Measurement of atmospheric pressure
	EnvTmp	MV		Temperature measurement inside cubicle
STMP1	Tmp	MV		Temperature FO DTS 1
STMP2	Tmp	MV		Temperature FO DTS 2 (redundant measure)

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Offshore Substation cubicle interface (LDITFOSS)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
STMP3	Tmp	MV		Cable temperature - J-pipe deep 1
STMP4	Tmp	MV		Cable temperature - J-pipe deep 2
STMP5	Tmp	MV		Cable temperature - J-pipe deep 3

7.13.5 Dynamic description

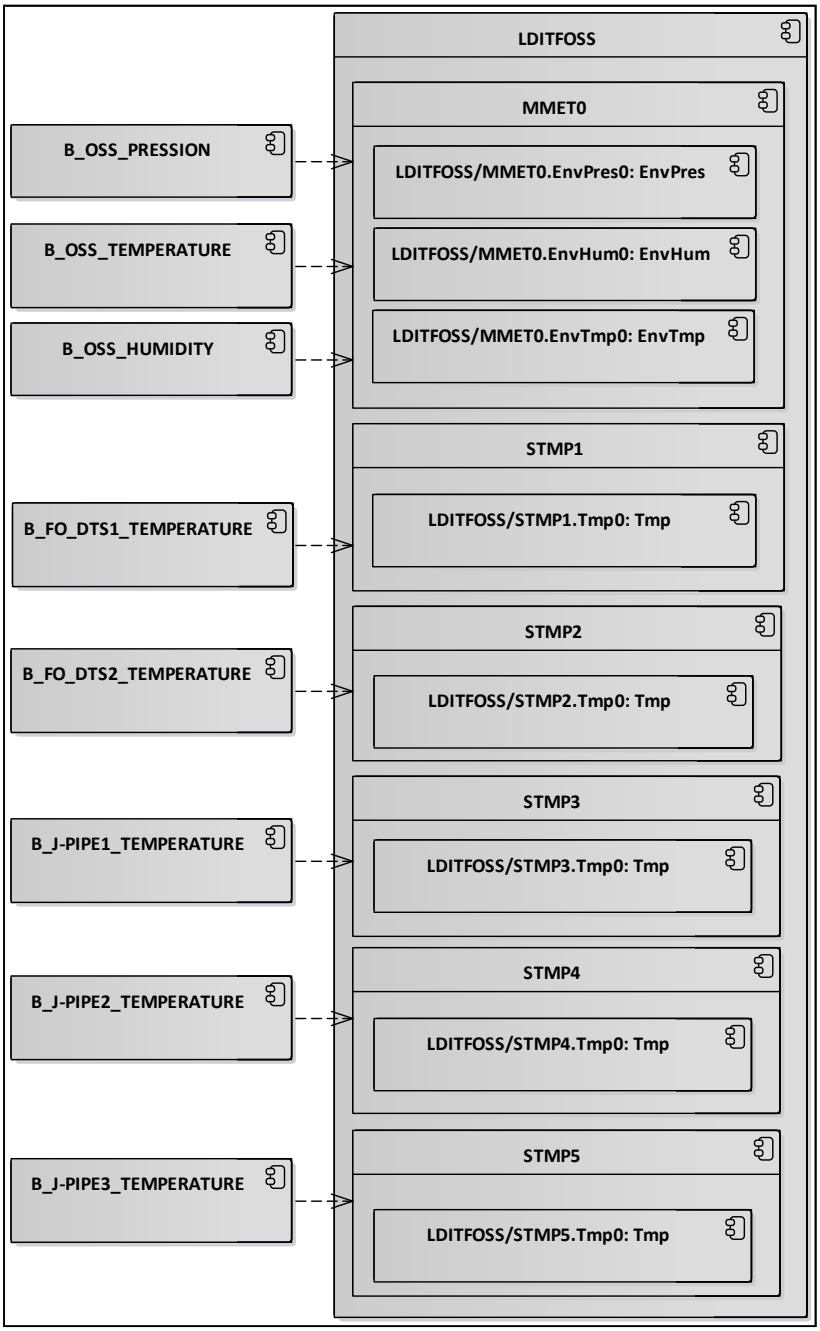

Figure 52 : Dynamic description LDITFOSS

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7.14 Monitoring Circuit-Breaker interface (LDITFSUDJ)

7.14.1 Description of the Function

This function is used to interface all the required sensors to monitor a high voltage circuit-breaker (SF6 or oil CB).

7.14.2 LNs used

LN	Description
KPMP	Logical node KPMP shall be used to represent a pump. It can be seen as an extended nameplate that allows the temporary setting of data object.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
SCBR	This LN is used for supervision of circuit breakers. Operating a breaker and especially tripping a short circuit causes always some abrasion (or erosion) of the breaker contacts. The supervision is per phase since each phase has its own contact.
SIMG	Insulation medium is gas, for example SF6 in gas isolated devices. For other measuring objects related to the same IED, a new instance of SIMG may be used. If the new measuring point(s) is/are related to a new IED, in this new IED a new instance of SIMG shall be used.
SIML	The insulation medium is a liquid such as oil, like that used for example for some transformers and tap changers. For other measuring objects related to the same IED, a new instance of SIML may be used. If the new measuring point(s) is/are related to a new IED a new instance of SIML shall be used.
SOPM	This LN is used for supervision of operating mechanism for switches. It is used to assess the condition of the operating mechanism and can be used to indicate a possible malfunction in the future. Today, different technologies for operating mechanisms are available. Typically operating mechanisms for circuit breakers contain an energy storage to provide the required switching energy within a short time. Examples for today s storage medias are springs or compressed gas. To operate the switch, the energy is transferred by means of a mechanical or hydraulical linkage. A charger motor is used to compensate energy losses due to leakages or to recharge the storage after a switch operation. The proposed attributes cover the status of the relevant components both of the hydraulic system and the spring system. Depending on the used technology, some of the attributes are not applicable. This LN can also be used for simple operating mechanisms that are directly driven by a motor.
GGIO	This node shall be used only to model in a generic way process devices that are not predefined by the groups S, T, X, Y, or Z. If needed, all data objects listed in Clause 6 can be used single or multiple for a dedicated application of LN GGIO. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.

7.14.3 Specificities

- Each LDITFSUDJ of a circuit-breaker is associated to a LDDJ assuring the physical interface with the circuit-breaker, to a LDCMDDJ assuring the control of the circuit-breaker and to a LDSUDJ assuring the monitoring. This combination of LD is represented in the dynamic modelling (§9.4.5).
- In the dynamic modelling, a LN SIMG or SIML are represented. The LN to be instantiated depends on the technology of the circuit-breaker and its isolation medium (SF6 or oil).

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- DO SIMG*.InsAlm is also used to indicate a sealing failure in the arc chamber of vacuum circuit-breakers.
- The circuit breaker can be configured to either trip or block in case of low pressure. This is achieved by LDDJ either subscribing DO SIMG0.InsBlk or SIMG0.InsTr at the instantiation (cf. §7.2).

7.14.4 Static description

Monitoring Circuit-Breaker interface (LDITFSUDJ)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
KPMP*	Beh	ENS		
	OpCtl	SPC		Control of pump
	EEHealth	ENS		Pump failure
LLN0	Beh	ENS		
	Health	ENS		Health of the function
	Mod	ENC		
	NamPlt	LPL		
SCBR*	Beh	ENS		
	NamPlt	LPL		
	ColOpn	SPS		Open command of trip coil
	RctTmOpn	MV		Acoustic monitoring of the operating time (* correspond to circuit breaker pole)
SIMG0	Beh	ENS		
	InsAlm	SPS	COMP.DJ.SF6	1st stage of SF6 low pressure for the whole circuit-breaker
	InsBlk	SPS	ISOL.DJ ISOL.DJ.T	2nd stage of SF6 low pressure for the whole circuit-breaker
	InsTr	SPS		Tripping order in case of SF6 low pressure
	PresAlm	SPS		Overpressure alarm
SIMG*	Beh	ENS		
	InsAlm	SPS	COMP.DJ.SF6*.*	1st stage of SF6 low pressure per phase
	Pres	MV		Monitor the SF6 pressure continuously in the pole (* correspond to circuit-breaker pole : if 1 cabinet/pole of the CB *=1,2 or 3, if 1 cabinet for the whole CB *=0)
	PresAlm	SPS		Overpressure alarm
SIMG4	Beh	ENS		
	InsAlm	SPS		For withdrawable circuit breakers, indicates that the SF6 monitoring pressure probe is disconnected
SIML*	Beh	ENS		

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Monitoring Circuit-Breaker interface (LDITFSUDJ)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	InsAlm	SPS		Oil low level alarm (* correspond to circuit breaker pole : if 1 cabinet/pole of the CB *=1,2,or 3, if 1 cabinet for the whole CB *=0)
	Lev	MV		Monitoring of the oil level in the oil circuit-breaker
SOPM*	Beh	ENS		
	MotStrNum	INS		Counter of motor starting
	Tmp	MV		Temperature inside drive cubicle (* correspond to circuit-breaker pole : if 1 cabinet/pole of the CB *=1,2 or 3, if 1 cabinet for the whole CB *=0)
GGIO0	Beh	ENS		
	Ind1	SPS		Failure of gas drying equipment (défaut assécheur)

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7.14.5 Dynamic description

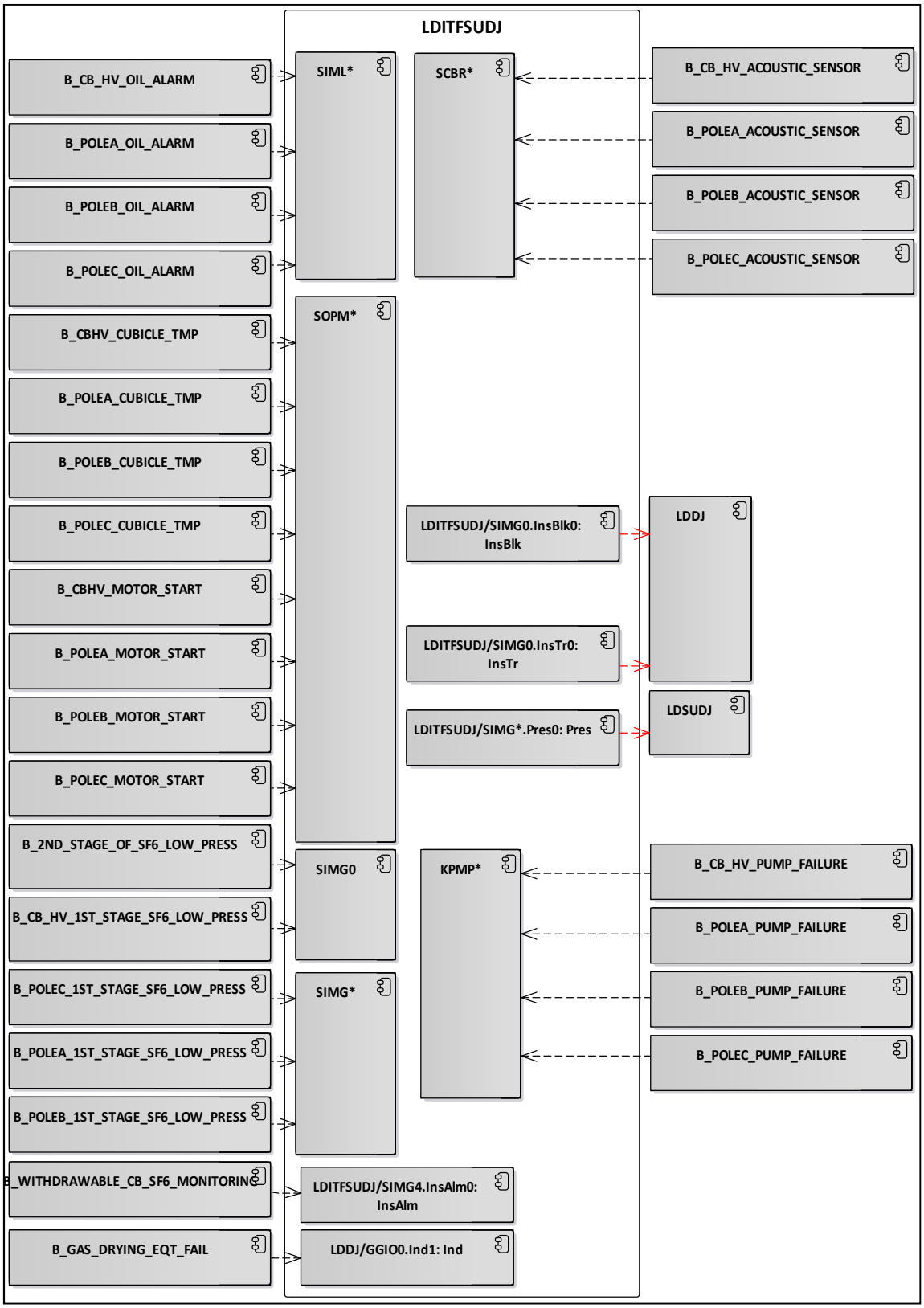

Figure 53 : Dynamic description LDITFSUDJ

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7.15 Monitoring disconnector interface (LDITFSUSxy)

7.15.1 Description of the Function

This function is used to interface all the required sensors to monitor a high voltage disconnector.

7.15.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
SOPM	This LN is used for supervision of operating mechanism for switches. It is used to assess the condition of the operating mechanism and can be used to indicate a possible malfunction in the future. Today, different technologies for operating mechanisms are available. Typically operating mechanisms for circuit breakers contain an energy storage to provide the required switching energy within a short time. Examples for today s storage medias are springs or compressed gas. To operate the switch, the energy is transferred by means of a mechanical or hydraulical linkage. A charger motor is used to compensate energy losses due to leakages or to recharge the storage after a switch operation. The proposed attributes cover the status of the relevant components both of the hydraulic system and the spring system. Depending on the used technology, some of the attributes are not applicable. This LN can also be used for simple operating mechanisms that are directly driven by a motor.

7.15.3 Specificities

- Each LDITFSUSxy of a disconnector is associated to a LDSxy assuring the physical interface with the disconnector and to a LDSUSxy assuring the monitoring.

7.15.4 Static description

Monitoring disconnector interface (LDITFSUSxy)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Health of the function
	Mod	ENC		
	NamPlt	LPL		
SOPM0	MotStrNum	INS		Counter of motor starting
	Tmp	MV		Temperature inside drive cubicle

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7.15.5 Dynamic description

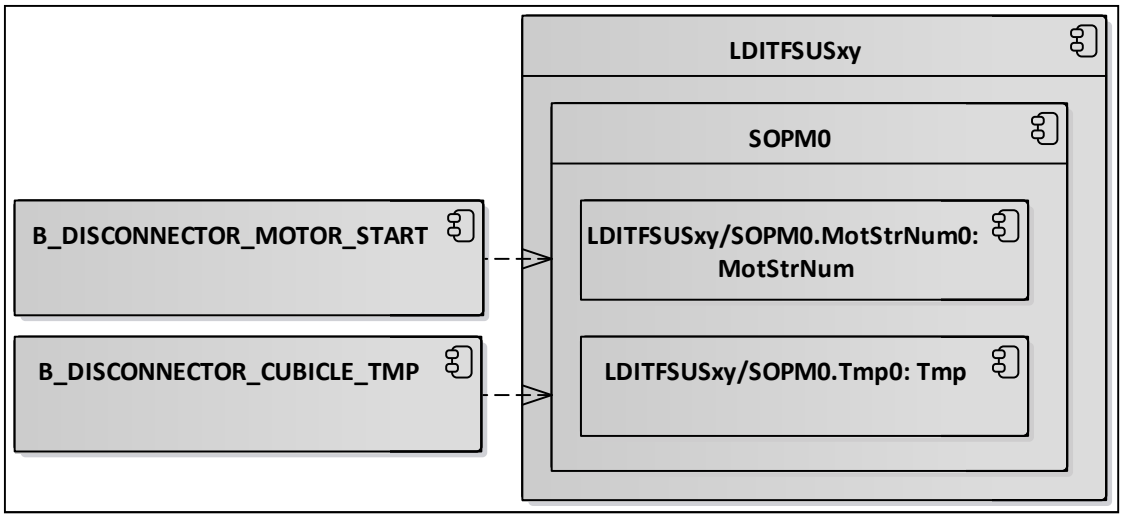

Figure 54 : Dynamic description LDITFSUSxy

7.16 Exchange Interface TSO/DSO (LDITFRPTRPD)

7.16.1 Description of the Function

This function is used for data exchange between TSO and DSO, independently of the bay hosting the function. This LD should be instantiated in each IED hosting a physical interface between TSO and DSO (ex: General bay, busbar bay, etc…)

These data are exchanged with several functions in the PACS (for example MQ.UB, ECH-MT, ECH-PROD …)

7.16.2 LNs used

LN	Description
CALH	CALH allows the creation of group warnings, group indications and group alarms. The individual alarms, which are used to calculate the group indications/alarms/warnings, are subscribed from elsewhere. The calculation is a local issue, usually performed by a logic scheme.
CSYN	This LN class shall be used to control the synchronizing conditions i.e. voltage, frequency and phase.
FXOT	Logical node FXOT shall be used to set a high-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, contro or alarm function is based on other physical measurements than primary electrical data.
FXUT	Logical node FXUT shall be used to set a low-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXUT can typically be used whenever a protection, control or alarm function is based on other physical measurements than primary electric data.

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LN	Description
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.
ISAF	Logical node ISAF shall be used to represent an alarm push-button or any other device that is used to provide an alarm in case of danger to persons or property.
KPMP	Logical node KPMP shall be used to represent a pump. It can be seen as an extended nameplate that allows the temporary setting of data object.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.
RBRF	This LN is used in case of circuit breaker failure which implies that the fault is not eliminated and leads to sending a trip order to neighbouring circuit breakers. This indicates the use of topology information.
SBAT	This logical node represents battery supervision
SFIR	This logical node represents fire supervision
XCBR	This LN is used for modelling switches with short circuit breaking capability. Additional LNs, for example SIMS, etc. may be required to complete the logical modelling for the breaker being represented. The closing and opening commands shall be subscribed from CSWI or CPOW if applicable. If no "time activated control" service is available between CSWI or CPOW and XCBR, the opening and closing commands shall be performed with a GSE-message (see IEC 61850-7-2).
XSWI	This LN is used for modelling switches without short circuit breaking capability, for example disconnectors, air break switches, earthing switches, etc. Additional LNs, SIMS, etc. may be required to complete the logical model for the switch being represented. The closing and opening commands shall be subscribed from CSWI. If no "time activated control" service is available between CSWI or CPOW and XSWI, the opening and closing commands shall be performed with a GSE-message (see IEC 61850-7-2).
ZAXN	Auxiliary networks belong to the power supply system of substations and other power systems installations.
ZBAT	Provides data about battery status and for control of the charging/de-charging cycles.
ZCON	Frequency conversion including AC/DC conversion.
SIML	The insulation medium is a liquid such as oil, like that used for example for some transformers and tap changers. For other measuring objects related to the same IED, a new instance of SIML may be used. If the new measuring point(s) is/are related to a new IED a new instance of SIML shall be used.

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7.16.3 Specificities

- In function « MQ.UB », with some substation topologies, absence busbar voltage information is sent to DSO from LDMQUB.
- LDITFRPTRPD receives from LDASLD function the CB failure information to be transmitted to circuit breaker associated to the DSO transformer, taking into accont with substation topology. LDASLD subscribes to the positions of HV circuit breaker and disconnectors and to circuit breaker failure indication from DSO.
- Busbar disconnector positions must to be sent to DSO. In case of substation with 2 busbars it's necessary to send positions of disconnector from primary transformer HV (or VHV)/MT (because Rte manage this disconnectors).
- In AT-D function, this LD receive trip and recloser authorisation information from transformer DSO (as for the ACDC function). TSO send dead line voltage and circuit breaker open position.
- GAPC1 represents both inputs and outputs to DSO. GAPC1.ind1-3 represents inputs from DSO to TSO, GAPC1.ind4-12 represents outputs from DSO to TSO.
- When possible, bayname prefix is used to designate transformer feeders or other feeders. When this is not possible because of multiple instances of a DO within an LN, x is used to refer to the bay. The mapping of x and bayname has to be covered by the configuration tool.
- baynameXSWI2.pos: this DO represents the disconnector position of DSO transformer feeder "bayname". Only one LN is instanciated because, under French regulation, transformer bay disconnectors are owned by the TSO if there is more than one busbar.

7.16.4 Static description

Interface exchange TSO/DSO (LDITFRPTRPD)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
CALH1	Beh	ENS		
	GrInd	SPS		
	GrAlm	SPS		Anomaly CVT from DSO to TSO
CALH2	Beh	ENS		
	GrAlm	SPS		DSO substation failure (in backup alarm mode)
	GrInd	SPS		Signal from custumer or DSO substation to indicated presence.
CALH3	Beh	ENS		
	GrAlm	SPS		Horn (auxiliary voltage S) from DSO to TSO
	GrWrn	SPS		Bell (auxiliary voltage S) from DSO to TSO
CALH4	Beh	ENS		
	GrAlm	SPS		Horn (auxiliary voltage TC) from DSO to TSO

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Interface exchange TSO/DSO (LDITFRPTRPD)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	GrWrn	SPS		Bell (auxiliary voltage TC) from DSO to TSO
CALH5	Beh	ENS		
	GrAlm	SPS		Group "Urgence 1" send to DSO
CALH6	Beh	ENS		
	GrAlm	SPS		Group "Urgence 2" send to DSO
CALH7	Beh	ENS		
	GrInd	SPS		CVT failure from TSO to DSO
CALH8	Beh	ENS		
	GrInd	SPS		Physical output "Présence TSO" to custumer substation
CALH9	Beh	ENS		
	GrInd	SPS		Physical output "Présence DSO" to DSO
CALH10	Beh	ENS		
	GrWrn	SPS		Anomaly from auxiliary power from TSO to DSO
CALH11	Beh	ENS		
	GrAlm	SPS		Substation failure in backup alarm mode sent to DSO
CALH12	Beh	ENS		
	GrAlm	SPS		Intrusion alarm sent from TSO to DSO
BayNameCSYN0	Beh	ENS		
	Rel	SPS		Signal from DSO to TSO to authorized reclosing of CB associated to the feeder "BayName"
FXOT1	Beh	ENS		
	StrVal	ASG.setMag		
	Op	ACT		Signal "Open door time filtered" send to DSO
FXOT2	Beh	ENS		
	StrVal	ASG.setMag		
	Op	ACT		Signal "TSO substation flooded" send to DSO
FXOT1x	Beh	ENS		
	StrVal	ASG.setMag		
	Op	ACT		Signal of information from COMPADA automaton to DSO to indicate threshold exceeded Value of "x"=1 to 9

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Interface exchange TSO/DSO (LDITFRPTRPD)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
FXUT1x	Beh	ENS		
	StrVal	ASG.setMag		
	Op	ACT		Absence of busbar voltage from LDMQUB Value of "x"=1 to 6
FXUT2x	Beh	ENS		
	StrVal	ASG.setMag		
	Op	ACT		Absence of feeder voltage from LDATD Value of "x"=1 to 2
GAPC1	Beh	ENS		
	DPCSOx	DPC	AMU.EXT	Signal indicating Activation/Deactivation Value of AMU (transformer n°x)
	Ind1	SPS		Open door from DSO to TSO
	Ind2	SPS		Door call from DSO to TSO
	Ind3	SPS		Remote control light from DSO to TSO
	Ind4	SPS		Physical output "TSO substation light"=ON
	Ind5	SPS		Physical output "Call door" TSO to DSO
	Ind6	SPS		Physical output "instantaneous open door" TSO to DSO
	Ind7	SPS		Physical output "technical alarm" TSO to DSO
	Ind8	SPS		Physical input DSO in backup alarm mode
	Ind9	SPS		Signal from DSO : substation in local mode or presence in substation
	Ind10	SPS		Grouping of the following signals TSO to DSO : CB open or busbar disconnector open or absence of auxiliary supply voltage for breaker and disconnectors position
	Ind11	SPS		TSO in backup alarm mode sent to DSO
ISAF1	Alm	SPS		Danger alarm from DSO or custumer substation
	Beh	ENS		
ISAF2	Alm	SPS		Danger Alarm from TSO to DSO
	Beh	ENS		
KPMP0	Beh	ENS		
	OpCtl	SPC		Control of pump
	EEHealth	ENS		Physical output "pump failure" to custumer substation

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Interface exchange TSO/DSO (LDITFRPTRPD)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Health of the function
	Mod	ENC		
	NamPlt	LPL		
PTRC40	Beh	ENS		
	Op	ACT		Trip CB "Priority DSO"
PTRC41	Beh	ENS		
	Op	ACT		Trip CB "Auxiliary feeder used for PACS supply"
PTRC42	Beh	ENS		
	Op	ACT		Trip CB "Auxiliary feeder used second level DSO supply"
PTRC50	Beh	ENS		
	Op	ACT	DT.PVH.E	Trip by PVH
BayNamePTRC1	Beh	ENS		
	Op	ACT	DF.CAB.E	Signal trip by cable shield to ground protection from DSO
BayNamePTRC2	Beh	ENS		
	Op	ACT	DT.AMU.E	Signal trip of voltage loss from DSO
BayNamePTRC3	Beh	ENS		
	Op	ACT		Signal trip from DSO CB transformer (case of ATD automaton) or trip from customer substation (case of ACDC automaton)
BayNamePTRC4	Beh	ENS		
	Op	ACT		
	Tr	ACT		Signal CB failure from LDASLD or differential busbar protection (LDPDB) to DSO bay "BayName"
BayNameRBRF0	Beh	ENS		
	OpEx	ACT	DFA.DJ.E	Signal CB failure from DSO
SBAT1	BatEF	SPS		Battery 127V earth fault
	NamPlt	LPL		
	Beh	ENS		
SBAT2	BatEF	SPS		Battery 48V earth fault
	NamPlt	LPL		

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Interface exchange TSO/DSO (LDITFRPTRPD)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Beh	ENS		
SFIR1	Beh	ENS		
	NamPlt	LPL		
	FireAlm	SPS		Fire alarm from DSO
SFIR2	Beh	ENS		
	NamPlt	LPL		
	FireAlm	SPS		Physicial output "Fire alarm" from TSO to DSO
XCBR20	Beh	ENS		
	BlkCls	SPC		
	BlkOpn	SPC		
	OpCnt	INS		
	Pos	DPC		Auxiliary supply CB "Battery 127V" open to DSO
XCBR21	Beh	ENS		
	BlkCls	SPC		
	BlkOpn	SPC		
	OpCnt	INS		
	Pos	DPC		Auxiliary supply CB "Battery 48V" open to DSO
XCBR22	Beh	ENS		
	BlkCls	SPC		
	BlkOpn	SPC		
	OpCnt	INS		
	Pos	DPC		Auxiliary supply CB "Battery 48V TCM" open to DSO
XCBR30	Beh	ENS		
	BlkCls	SPC		
	BlkOpn	SPC		
	Dsc	SPS		
	OpCnt	INS		
	Pos	DPC		Signal "TSO HV Feeder CB closed" to DSO
BayNameXCBR1	Beh	ENS		
	BlkCls	SPC		
	BlkOpn	SPC		

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Interface exchange TSO/DSO (LDITFRPTRPD)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Dsc	SPS		
	OpCnt	INS		
	Pos	DPC		Signal "TSO CB open for feeder BayName" to DSO (in case of ATD automaton is used)
BayNameXCBR2	Beh	ENS		
	Pos	DPC		Position of the CB feeder of transformer feeder "BayName" from DSO to TSO
XSWI1x	Beh	ENS		
	Loc	SPS		Local Control behaviour
	OpCnt	INS		Counter of operation (used for monitoring).
	SwTyp	ENS		Switch Type
	Pos	DPC		Position of TSO bar section disconnector to DSO
	BlkOpn	SPC		
	BlkCls	SPC		
BayNameXSWI2	Beh	ENS		
	Loc	SPS		Local Control behaviour
	OpCnt	INS		Counter of operation (used for monitoring).
	SwTyp	ENS		Switch Type
	Pos	DPC		Position of transformer bay disconnector "BayName" send from DSO to TSO (case of only one busbar)
	BlkOpn	SPC		
	BlkCls	SPC		
BayNameXSWI3	Beh	ENS		
	Loc	SPS		Local Control behaviour
	OpCnt	INS		Counter of operation (used for monitoring).
	SwTyp	ENS		Switch Type
	Pos	DPC		Signal "Position ofdisconnector for auxiliary supply voltage of hardwired interface associated to DSO transformer BayName closed" from DSO to TSO
	BlkOpn	SPC		
	BlkCls	SPC		
ZAXN1	Beh	ENS		
	NamPlt	LPL		

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Interface exchange TSO/DSO (LDITFRPTRPD)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	VPrs	SPS		Physical output "absence SR auxiliary voltage" to DSO
ZAXN2	Beh	ENS		
	NamPlt	LPL		
	VPrs	SPS		"DSO Main auxiliary voltage failure" to TSO
ZAXN3	Beh	ENS		
	NamPlt	LPL		
	VPrs	SPS		"Absence auxiliary AC voltage (source 1)" to DSO
ZAXN4	Beh	ENS		
	NamPlt	LPL		
	VPrs	SPS		"Absence auxiliary AC voltage (source 2)" to DSO
ZAXN5	Beh	ENS		
	NamPlt	LPL		
	VPrs	SPS		"Absence auxiliary AC voltage instantaneous" to DSO
ZAXN6	Beh	ENS		
	NamPlt	LPL		
	VPrs	SPS		Delayed signal "Absence auxiliary AC voltage" to DSO
ZBAT1	Beh	ENS		
	EEHealth	ENS		Battery voltage anomaly (127V dc) to DSO
ZBAT2	Beh	ENS		
	EEHealth	ENS		Battery voltage anomaly (48V dc) to DSO
ZBAT3	Beh	ENS		
	EEHealth	ENS		Battery voltage anomaly (48V dc TCM) to DSO
ZCON1	Beh	ENS		
	EEHealth	ENS		Converter failure (battery 127V) to DSO
ZCON2	Beh	ENS		
	EEHealth	ENS		Converter failure (battery 48V) to DSO
ZCON3	Beh	ENS		
	EEHealth	ENS		Converter failure (battery 48V TCM) to DSO
SIML0	Beh	ENS		
	GasInsAlm	SPS		Buchholz protection alarm indication from DSO to TSO

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Interface exchange TSO/DSO (LDITFRPTRPD)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	GasInsTr	SPS		Buchholz protection trip indication from DSO to TSO
ZAXN7	Beh	ENS		
	VPrs	SPS		DSO Auxiliary Transformer (TSA) voltage supply failure from DSO to TSO

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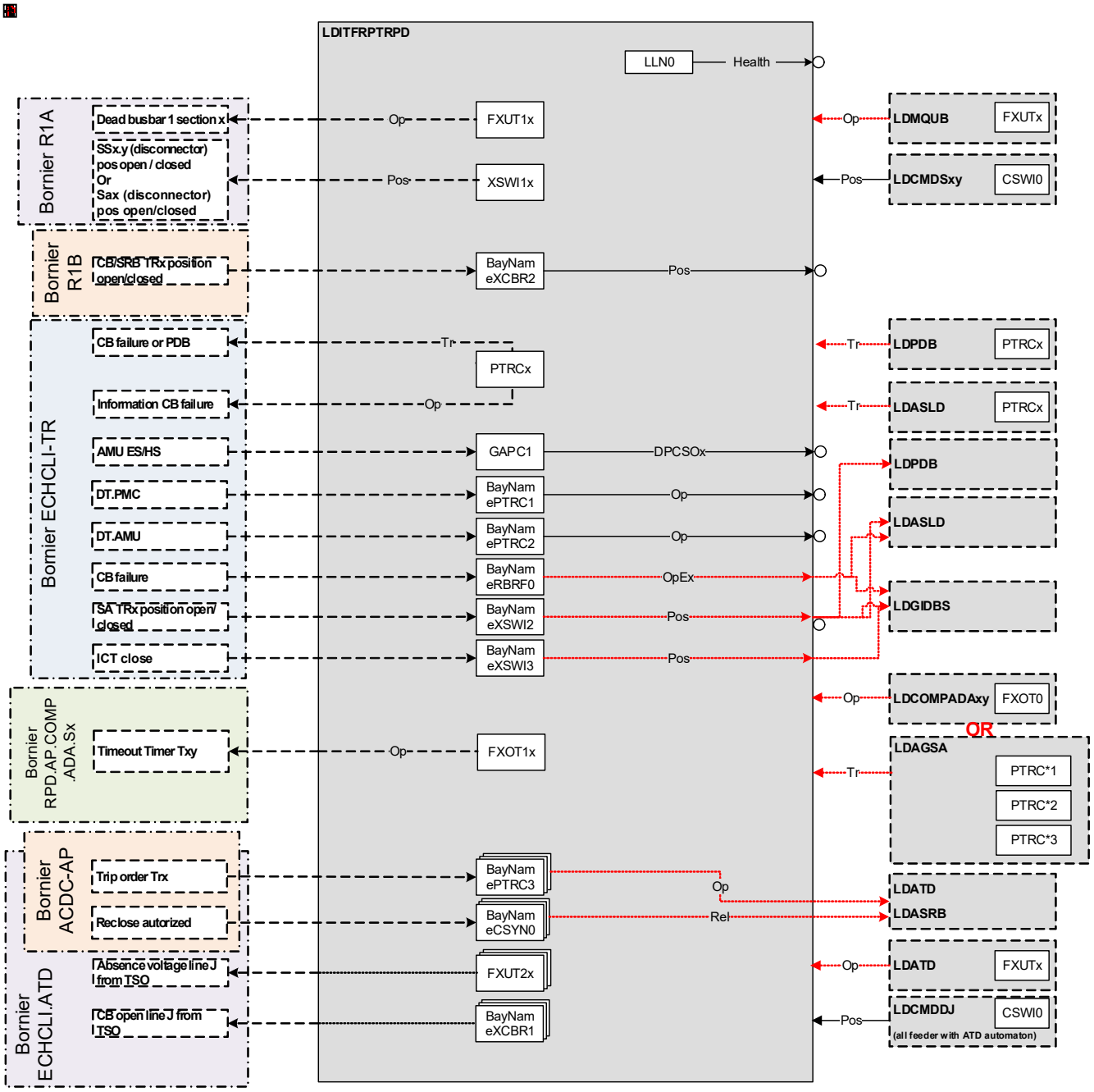
7.16.5 Dynamic description



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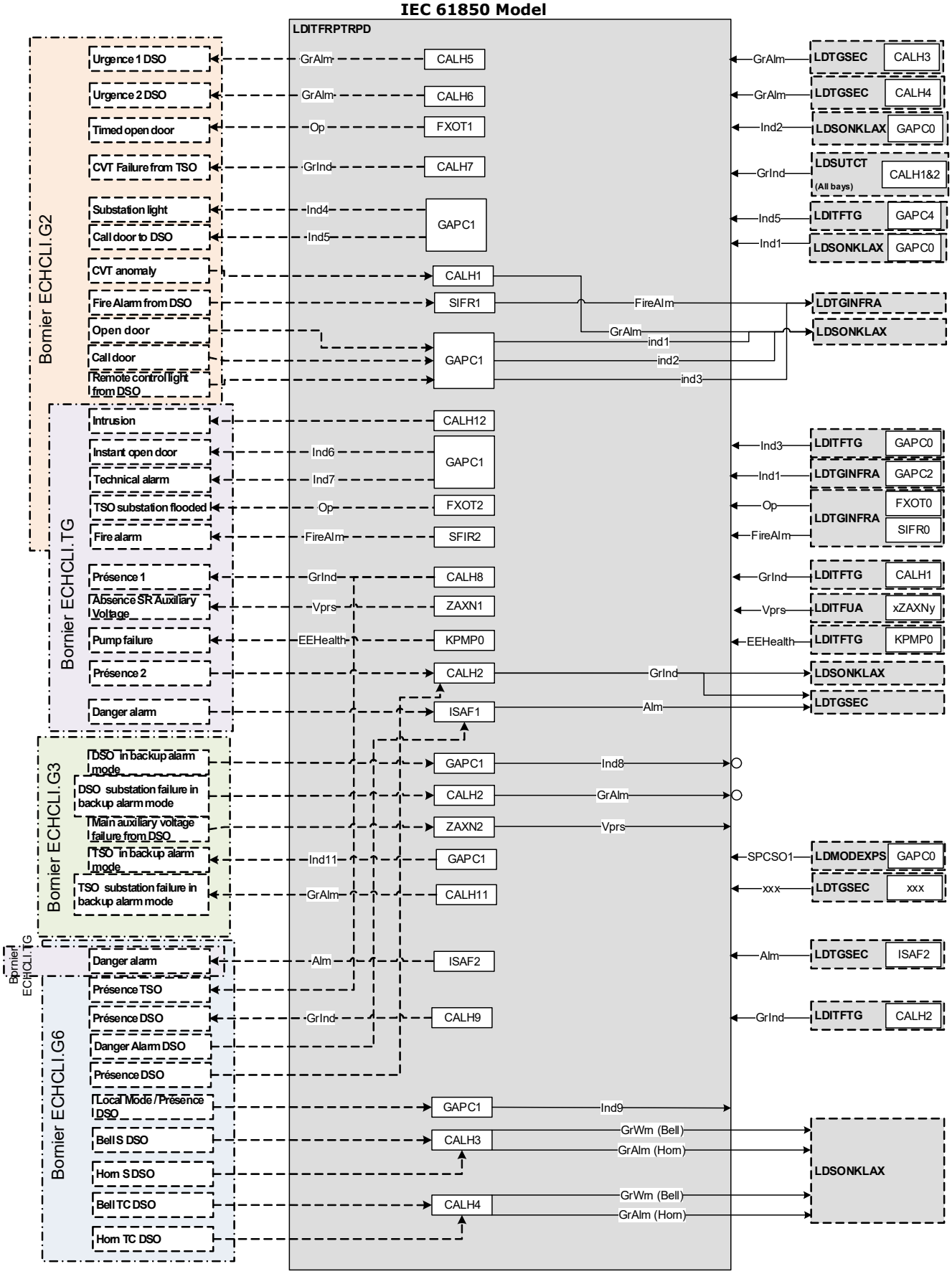

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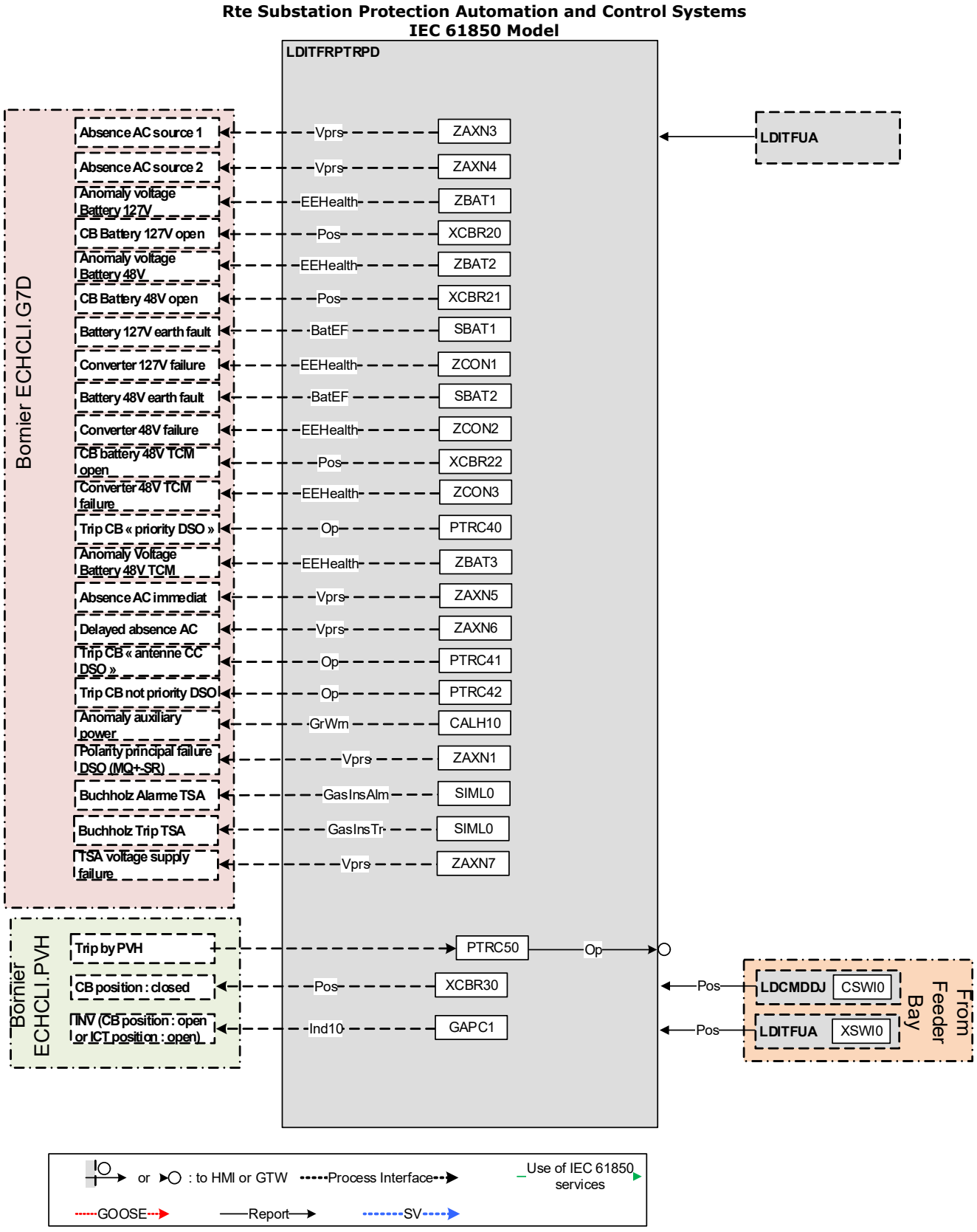

Figure 55 : Dynamic description LDITFRPTRPD

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7.17 Remote Isolation of Instrument Transformer secondary connections (TLCONDAM)

This function is used to remotely isolate the secondary of Instrument Transformer in cased of HV work on the line or feeder at the other line end (TLCONDAM). The function is taken into account in LDTM (§7.4).

7.18 Migration interface (LDITFMIG)

7.18.1 Description of the Function

This function is used to interface signals with the legacy PACS during the migration phase.

7.18.2 LNs used

LN	Description
ATCC	Automatics to maintain the voltage of a busbar within a specific range using tap changers. This node operates the tap changer automatically according to given setpoints or by direct operator commands (manual mode).
CALH	CALH allows the creation of group warnings, group indications and group alarms. The individual alarms, which are used to calculate the group indications/alarms/warnings, are subscribed from elsewhere. The calculation is a local issue, usually performed by a logic scheme.
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.
IHMI	This LN represents the operator interface on two levels: 1. Front panel of the operator interface at the unit used for configuration and local control, 2. Local operator interface (HMI) used as a work station for the substation operator. The role of the different IHM is not set for most of the functions and it is defined during the engineering phase.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PSCH	This LN shall be used to model the logic scheme for line protection function co-ordination. The protection scheme allows the exchange of the "operate" outputs of different protection functions and conditions for line protection schemes. It includes data objects for teleprotection if applicable. In this case, all appropriate data objects shall be subscribed.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.
XCBR	This LN is used for modelling switches with short circuit breaking capability. Additional LNs, for example SIMS, etc. may be required to complete the logical modelling for the breaker being represented. The closing and opening commands shall be subscribed from CSWI or CPOW if applicable. If no "time activated control" service is available between CSWI or CPOW and XCBR, the opening and closing commands shall be performed with a GSE-message (see IEC 61850-7-2).

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7.18.3 Specificities

- Two types of signals need to be considered:

Signals acquired from the legacy PACS and subscribed by functions of the IEC 61850 based PACS. These are modelled by instanciation of appropriate functional LDs and published by corresponding LN/DO. They are not covered by LDITFMIG, but listed in the table below:

Signal description from legacy PACS	Model	Functions of PACS subscribing
CB faillure	LDADD/RBRF0.OpEx	LDASLD
Trip of feeder in transfer mode	LDTRANSFERF/PSCH0.TXTR	LDTRANSFERTC
Information of cb closing operation (CRITENC)	LDCMDDJ/CALH0.GrInd	Protection functions of coupler bay
Position of circuit breaker of a transformer bay in transfer mode	LDCMDDJ/XCBR0.Pos	Protection of transformer
Signal confirming the blocked state of transformer tap changer	LDARU/ATCC1.Auto	Grouping signal of tap changer block signal (instance of LDGRP)
Signal indicating that the tap is not at the default tap after reception of block signal	LDARU/ATCC1.LTCBlk	Grouping signal for tap changer position (instance of LDGRP)
Indication that the Prolonged Loss of Voltage Monitoring is activated on a feeder	LDAMU/GAPC1.Ind1	Grouping signal for Prolonged Loss of Voltage monitoring active (instance of LDGRP)
Indication that a feeder is in local mode	LDMODEXPF/LLN0.LocSta	Grouping signal for "bay in local operation mode" (instance of LDGRP)
Alarm "SF6 low pressure" [COMP.SF6]	LDGRP/ORGAPC.Ind*	Grouping signal for "SF6 low pressure" (instance of LDGRP)
Alarm with different alarm levels	LDGRP/ORGAPC.Ind*	Grouping signal for "alam level x" (instance of LDGRP) (x= 1, 2, 3
Indication of teleprotection failure (DEF TAC)	LDGRP/ORGAPC.Ind*	Grouping signal for "TAC faillure" (instance of LDGRP)
Indication of equipment failure (DEF EQUIP)	LDGRP/ORGAPC.Ind*	Grouping signal for "equipment faillure" (instance of LDGRP)

- Signals coming from new PACS which need to be interfaced with the legacy PACS. These signals are covered by LDITFMIG.
- If required, one istance of LDITFMIG is to be instanciated for each voltage level.
- The indication "Substation in local or remote mode" is accociated to LDMODEXPF/LLN0.LocSta. It would not be semantically correct to use LDITFMIG/LLN0.LocSta to indicate the operation mode of the substation. For this reason, LDITFMIG/IHMI0.LocSta

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7.18.4 Static description

Migration Interface (LDITFMIGx)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Health of the LDITFMIG function
	Mod	ENC		
	NamPlt	LPL		
ATCC0	Auto	SPC		Allow for blocking the tap changer from IEC61850 PACS to legacy PACS
	TapPos	ISC		
	VolSpt	APC		
	Beh	ENS		
CALH0	Beh	ENS		
	GrInd	SPS		Blocking signalling for live line / dead busbar cycles of other feeders from IEC61850 PACS to legacy PACS
GAPC0	Beh	ENS		
	SPCSO1	SPC		Deactivation of prolonged loss of voltage monitoring (LDAMU) from IEC61850 PACS to legacy PACS feeder
IHMI0	Beh	ENS		
	Loc	SPS		
	LocSta	SPC		Indication "Substation in local or remote mode" from IEC61850 PACS to legacy PACS
PSCH0	Beh	ENS		
	TxTr	ACT		Grouped protection trip signal from IEC61850 PACS feeders in "Transfer" mode to busbar Coupler CB of legacy PACS
PTRC0	Beh	ENS		
	Tr	ACT		CB failure trip from IEC61850 PACS to legacy PACS
XCBR0	Beh	ENS		
	Pos	DPC		Position of CB of busbar Coupler from IEC61850 PACS to transformer protections of legacy PACS

7.19 Power Transformer Monitoring Interface (LDITFSUTR)

This function represents the interface unit for the sensors used for the monitoring of the power transformers, such as temperature, supply current for pumps and fans and dissolved gaz analysers.

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7.20 TSO - Generator Interface (LDITFGEN)

7.20.1 Description of the Function

This function is used for exchange between TSO and power generator via wired terminals. This includes exhanges with hydropower plants (GEH).

The information is used for the function ACDC.

7.20.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
GGIO	This node shall be used only to model in a generic way process devices that are not predefined by the groups S, T, X, Y, or Z. If needed, all data objects listed in Clause 6 can be used single or multiple for a dedicated application of LN GGIO. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

7.20.3 Specificities

- The interface receives a trip order autorisation from hydraulic production or another type of generator. This information is published by PTRCx.Op In case of hydraulic generation, this information is used by the automaton (ACDC).
- The interface may also receive a recloser authorization or recloser order. If applicable, this information is published by GGIOx.Ind1 and can be subscribed by the HMI or by ACDC automaton.
- For each generator feeder, a LN PTRC and/or GGIO can be instantiated.

7.20.4 Static description

TSO - Generation Interface (LDITFGEN)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS	ACDC	
	Health	ENS	ANO.ACDC	Health status of the function , contributes to ANO.ACDC signal
	Mod	ENC	ACDC	
	NamPlt	LPL		
GGIOx	Ind1	SPS		Recloser authorisation or recloser order
PTRCx	Op	ACT		Trip order from generation interface (1 instance for each incoming feeder)

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7.20.5 Dynamic description

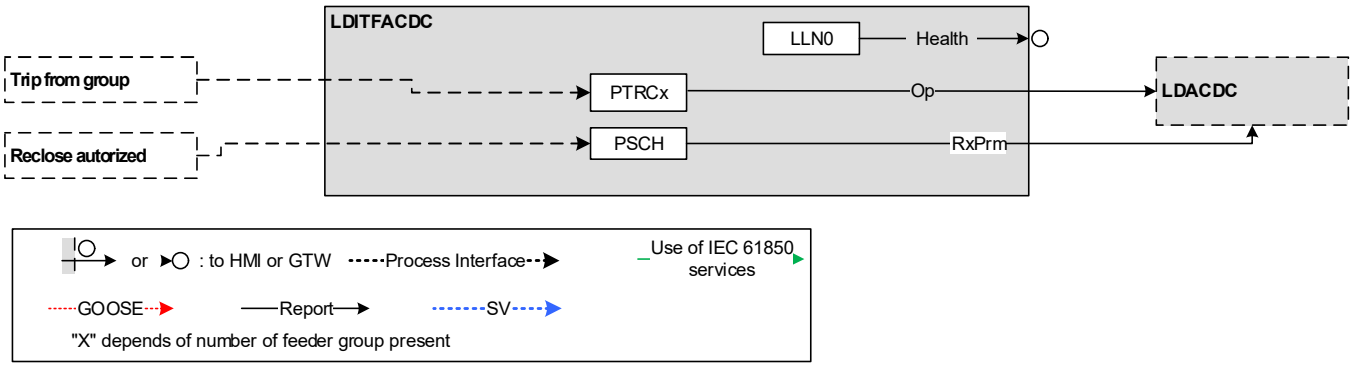

Figure 56 : Dynamic description LDITFGEN

7.21 IED Identification Interface Function (LDBALIS)

7.21.1 Description of the Function

This function is used to drive binary outputs for a lamp or LED associated to an IED. This allow to identify the IED for maintenance operation.

7.21.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.

7.21.3 Specificities

- For each IED covered by the Identification Interface function, one SPCSO in GAPC0 is instantiated.
- This interface is intended to be used with n indicator (LED or similar) installed close to the IED in order to help to identify it for maintenance action. This indicator is complementary to the LED which can be activated on the IED front panel (cf. LDSUIED §9.8).

7.21.4 Static Description

(LDBALIS)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		

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(LDBALIS)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Health	ENS		Health of the function
	NamPlt	LPL		
	Mod	ENC		
GAPC0	SPCSOx	SPC		Command for activation of the identification indicator for IED x

7.21.5 Dynamic Description

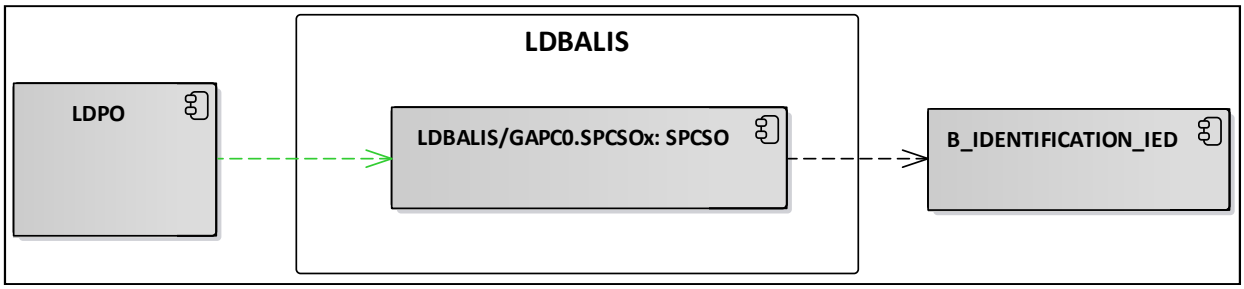

Figure 57 : Dynamic description LDBALIS

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8. Functions related to PACS operation

8.1 Circuit Breaker Command (LDCMDDJ)

8.1.1 Description of the Function

This LD contains the control function for circuit breaker of the bay.

The LDCMDDJ contains:

- The interlocking function (AIVO) concerning the circuit breaker. Its purpose is to verify manoeuvres from the local HMI on disconnector and circuit breakers.
- The CRITENC function, which signals any closing order of the circuit breaker (OR logic) regardless of its origin (control, protection, manual). In particular, this signal is subscribed by the recloser function (functional group ARS and, inhibiting reclosing during T_ENC time delay. It is used for SOFT functions (Switch On FaulT detection).
- The control (cf. ARS-CT-xx) for circuit breaker closure requests by an automaton (ARS in particular) or a command. This includes the publication of voltage status of line and busbar (live / dead).
- The evaluation of the status of the circuit-breaker recovery cycles (ARS-GE-05, -06, -07)
- The synchrocheck function (TCPL).

The motivations for refusal of a command are described in the chapter on processing of commands (cf. § 4.4.8).

8.1.2 LNs used

LN	Description
CALH	CALH allows the creation of group warnings, group indications and group alarms. The individual alarms, which are used to calculate the group indications/alarms/warnings, are subscribed from elsewhere. The calculation is a local issue, usually performed by a logic scheme.
CILO	This LN shall be used to "enable" a switching operation if the interlocking conditions are fulfilled. One instance per switching device is needed. At least all related switchgear positions have to be subscribed. The interlocking algorithm is a local issue.
CSWI	This LN class shall be used to control all switching conditions above process level. CSWI shall subscribe the data object POWCap ("point-on-wave switching capability") from XCBR if applicable. If a switching command (for example Select-before-Operate) arrives and "point-on-wave switching capability" is supported by the breaker, the command shall be passed to CPOW. OpOpn and OpCls shall be used if no Control Service is available between CSWI and XCBR (see GSE in IEC 61850-7-2).
FXOT	Logical node FXOT shall be used to set a high-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, contro or alarm function is based on other physical measurements than primary electrical data.
FXUT	Logical node FXUT shall be used to set a low-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXUT can typically be used whenever a protection, control or alarm function is based on other physical measurements than primary electric data.

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LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
LSET	Rte Extended Setting LN
RREC	The number of trigger modes (CycTrMod i) and reclose times (RecTmmsi) is equal to the maximum allowed number of reclose cycles (MaxCyc). The trigger for the activation of RREC can be the start signal of PTRC, or the report "breaker open" of the circuit breaker, or any other signals and combination of signals. If different types of protections are involved in the autoreclosing process, all relevant data objects have to be published and subscribed by the allocated protection LNs. A principal diagram of RREC is given in Annex G.
RSYN	The voltage phasor difference from both sides of an open breaker is calculated and compared with predefined switching conditions (synchrocheck). Included is the case that one side is dead (example: energising a dead line).
XCBR	This LN is used for modelling switches with short circuit breaking capability. Additional LNs, for example SIMS, etc. may be required to complete the logical modelling for the breaker being represented. The closing and opening commands shall be subscribed from CSWI or CPOW if applicable. If no "time activated control" service is available between CSWI or CPOW and XCBR, the opening and closing commands shall be performed with a GSE-message (see IEC 61850-7-2).

8.1.3 Specificities

Modelling:

- Each LDCMDDJ of a circuit breaker is associated to a LDDJ providing the interface with the primary equipment and to a LDSUDJ, providing the interface with the monitoring sensors of this same circuit breaker. This triplet is represented in the dynamic description (cf. § 8.1.5).
- Override closing command (Enclenchement forcé). This signal is processed by the functional group ARS.
- The (normal or override) open/close commands from the HMI are modelled by access to CSWI.Pos. The distinction between normal command and command with override is based on the service check condition cf. [2] § 20.5.2.7).
- The LDCMDDJ receives from the LDATB (at the substation) the information indicating which VT is to be used to represent the busbar voltage. The corresponding voltage values (amplitude and phase MMXU.PhV) are provided by LDPHAS both for VT installed on feeders and busbars. Some implementations my use the corresponding SV stream.
- The manoeuver authority (local or remote - disjoncteur local ou TCD) is represented by the DO LDMODEXPF/LLN0.LocSta (cf. §4.4.2). The LDCMDDJ checks whether a command received can be executed depending on its origin.
- The LDDJ (cf. § 7.2) publishes the position as acquired at the process interface in real time, including any pole mismatches appearing during manoeuvres. The "filtered" circuit breaker position, masking temporary manoeuver mismatches, is published by the LDCMDDJ.
- The recloser functions (ARS functional group) use the "Blocking close" signal to avoid to close the circuit-breaker when it is not able to open after that. The DO XCBR0.CBOpCap (CBOpCap ≤ 2) is used to elaborate the "Blocking close" signal.

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- The recloser functions (ARS functional group) use signal to indicate that a recloser cycle cannot be terminated successfully by a recloser command (AR.IMPOS). The DO RSYN1.ClcExp is used to indicate this event.
- The LDCMDDJ elaborates the "circuit-breaker phase x recovery" signal.
- The functional specification identifies the possibility to force the closing of the circuit breaker (Enclenchement force). In order to do this, a reduced set of verifications between line and busbar voltage is realised. This function is associated to LN CSWI2. On application level, OpCls of CSWI is used.

8.1.3.1 Voltage Control (CT -ARS)

- The LDCMDDJ published the following DO subscribed by LD of the recloser functions (ARS group):

Information used for live-live reclosing (Vind - Voltage difference indicator, AngInd - Angle difference indicator, HzInd - Frequency difference indicator, DifAngClc, Calculated difference of phase angle)

Information used for live-dead reclosing (Presence of line voltage - PUL, presence of busbar voltage -PUB, absence of line voltage -AUL, absence of busbar voltage -AUB).

- Settings describing the duration of the close command issued by GTW or PO are not required since these controls arfe realised by MMS (settings T-PASCOM and T-ENC-TCPL).
- The reference busbar voltage to be used is published by LDATB and designates the VT reference or, alternatively, the LD publishing the SV or PhV stream to be used.

8.1.3.2 Interlocking (AIVO)

- CSWI subscribes to CILO0 in order to continuously provide information on the interlock status for verification of received commands. The CSWI.OpCls is used as per the diagram below.
- The value of CILO0.EnaCls and CILO0.EnaOpn is TRUE or FALSE. A FALSE value corresponds to a refusal by interlock.
- The information AIVO.INV indicating an intermediate position of a circuit breaker or disconnector used for the interlock function, is modelled by a specific LDGRP (cf. §8.22) subscribing to the positions of these HV equipment.
- The activation or deactivation of the interlocking function is operated using CILO0.Mod. Since this operation is common for all circuit breaksers and disconnectos of a feeder, it is performed by an instance of LDCMDMULT.

8.1.3.3 Indication of circuit breaker closing

- The indication of circuit breaker closing (CRITENC) is produced on the basis of circuit breaker closing orders, whatever the origin (control centre, automaton function, and manual).

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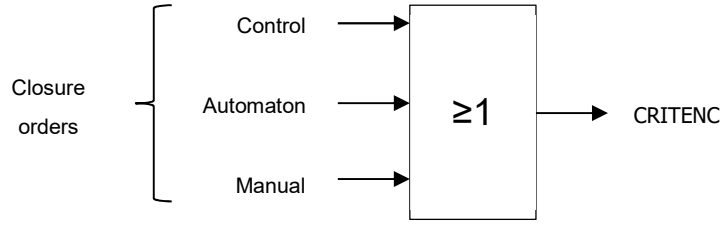

- Manual closing there in no pushbutton on the bay cubicle. All manual on-site orders for closing of the circuit breaker come from the IHM). The closing order from the pushbutton in the circuit breaker cabinet does not contribute to the elaboration of CRITENC.
- LN CALH1 is used to model the CRITENC information representing the grouping of closing commands from control, automations or operators (cf. diagram above).
- In order to avoid a simultanous live line – live busbar energising by several feeders, a block signal is published (CALH2.GrInd) (Verrouillage Renvoi Barres) if a circuit breakers has received a close order in those conditions.

8.1.3.4 Synchrocheck (TCPL)

- The LDCMDDJ integrates the synchrocheck function.
- If instantiated, RSYN2.SynPrh is used to activate / deactivate the synchrocheck function
- The signal "manoeuvre refused by synchrocheck" (TCPL.REF) corresponds to the "Blocked-by-synchrocheck" information (cf. 4.4.8 – Processing secondary component commands).The synchrocheck function (TCPL) is used when requested by an operator in order to close the circuit breaker when this manoeuvre cannot be carried out by the ARS. The synchrocheck never participates in other recloser operation, which is taken in charge by ARS functional group. The synchrocheck makes it possible to close the circuit breaker if there is a significative difference in the frequency of the voltage of line and busbar. There is also a threshold for this frequency difference for the synchrocheck beyond which any circuit breaker closing is refused.

8.1.4 Static description

Circuit Breaker Command (LDCMDDJ)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
CALH1	Beh	ENS		
	GrInd	SPS		CRITENC : Indication of a closing order executed by the circuit breaker. CALH1 contains OR
CALH2	Beh	ENS		
	GrInd	SPS		Blocking signal for live line / dead busbar cycles of other feeders (verrouillage réenclenchement barre)
CALH3	Beh	ENS		
	GrInd	SPS	TCPL.ENC	Indication of the closure ordered by synchrocheck
CILO0	Beh	ENS		

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Circuit Breaker Command (LDCMDDJ)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Mod	ENC.stVal		Used to enable/disable AIVO (interlock) function
	EnaCls	SPS	AIVO.REF	Closing Manoeuvre refused by interlock (AIVO) if EnaCls == FALSE (cf. specificity)
	EnaOpn	SPS	AIVO.REF	Opening Manoeuvre refused by interlock (AIVO) if EnaOpn == FALSE (cf. specificity)
	Health	ENS	DEF.AIVO	Failure of interlock function (AIVO)
CSWI1	Beh	ENS		
	ClcNxtTmms	ING		External CB operation failure time delay
	DscDlTmms	ING		Delay setting for discrepancy information
	CmdBlk	SPC		Used for inhibition of command on the DO Pos (alienation)
	Loc	SPS		
	LocSta	SPC		Indication of manoeuver authority of the circuit breaker (remote or on local (cf. §4.4.2)
	OpCls	ACT		Close order for LDDJ/XCBR
	OpOpn	ACT		Open order for LDDJ/XCBR
	Pos	DPC	DJ OUV DJ FER DJ O?F	Circuit breaker commands and signals for position of circuit breaker poles for Phases A,B,C Represents the filtered states
CSWI2	Beh	ENS		
	Pos	DPC	ENC.FOR	Used to force the closing of the CB
FXOT1	Beh	ENS		
	StrVal	ASG.setMag		
	Op	ACT		Indicates presence of line voltage (PUL)
FXOT2	Beh	ENS		
	StrVal	ASG.setMag		
	Op	ACT		Indicates presence of busbar voltage (PUB)
FXUT1	Beh	ENS		
	StrVal	ASG.setMag		
	Op	ACT		Indicates absence of line voltage (AUL and AULa, b, c)
FXUT2	Beh	ENS		
	StrVal	ASG.setMag		
	Op	ACT		Indicates absence of busbar voltage (AUB)
LLN0	Beh	ENS		
	Health	ENS		Health status of the LDCMDDJ function

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Circuit Breaker Command (LDCMDDJ)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Mod	ENC		
	NamPlt	LPL		
LSET0	DlTmms1	ING	T-ENCDJ	Maximum time during a closing command must be send by the operator before the TCPL function automatically turns off.
	NamPlt	LPL		
	DlTmms2	ING	T-REPDJ	TCPL- Typical response time of the circuit breaker to a closing command
	DlTmms3	ING	T-VALID	Minimum time during the voltage conditions should be valid
	SetPhNum	ENG	CTL	Reference phase for recloser (phase of the busbar instrument transformer)
	StrVal1	ASG.setMag	CT-UBL	Threshold of max busbar voltage for LivBus/DeaLin reclosing mode (RVL)
RREC1	AutoRecSt	ENS		
	OpCls	ACT		
	MaxTmms	ING		Maximum time duration before considering the closing command sent by the ARS function has failed
	RclTmms	ING	T-RECUP	Recovery time for circuit breaker (T-RECUP)
	RdyTmms	ING	T-B1	Blocking time 1 for ARS function (TB1)
RREC2	AutoRecSt	ENS		
	OpCls	ACT		
	RdyTmms	ING	T-B2	Blocking time 2 for ARS function (TB2)
RSYN1	AngInd	SPS		Angle difference indicator
	Beh	ENS		Voltage check function (ARS-CT)
	ClcExp	SPS	AR.IMPOS	Used to indicate the impossibility to realize the closing of the CB
	DeaBusVal	ASG.setMag	CT-AUB	Threshold of dead busbar voltage (AUB)
	DeaLinVal	ASG.setMag	CT-AUL	Threshold of dead line voltage (AUL)
	DifAng	ASG.setMag	CT-DPHILB	Threshold of angle difference - CT
	DifAngClc	MV	PHI	Calculated difference of phase angle
	DifHz	ASG.setMag	CT-DFLB	Threshold of frequency difference - CT
	DifV	ASG.setMag	CT-DULB	Threshold of modules difference - CT
	HzInd	SPS		Frequency difference indicator
	LivBusVal	ASG.setMag	CT-PUB	Threshold of live busbar voltage (PUB)
	LivLinVal	ASG.setMag	CT-PUL	Threshold of live line voltage (PUL)

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Circuit Breaker Command (LDCMDDJ)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Rel	SPS		Line-busbar verification for closure order. Used to elaborate the "ARS-CT Refusal" information
	VInd	SPS		Voltage difference indicator
RSYN2	Mod	ENC		
	AngInd	SPS		Angle difference indicator
	Beh	ENS		Synchocheck function (TCPL)
	ClcExp	SPS	TCPL.REF	Indicate the refusal to close the CB after synchrocheck timeout
	DifHz	ASG.setMag	S-Dfmax	Threshold of frequency difference - TCPL (asynchronism threshold)
	DifV	ASG.setMag	S-Dvmax	Threshold of modules difference - TCPL
	Health	ENS	DF.TCPL	Synchrocheck function failure
	HzInd	SPS	DF>DFMAX	Frequency difference is greater than the threshold configured for the synchrocheck function (TCPL)
	LivBusVal	ASG.setMag	TCPL-PUB	TCPL - Threshold of live busbar voltage (PUB)
	LivLinVal	ASG.setMag	TCPL-PUL	TCPL - Threshold of live line voltage (PUL)
	Rel	SPS		Validation of the closure conditions by synchrocheck function (TCPL)
	SynPrg	SPC	TCPL ES/HS	Activate / Deactivate synchrocheck function (TCPL)
	TotTmms	ING	T-TCPL	Maximum time during the synchrocheck is looking for closing conditions
	VInd	SPS	DV>SEUIL	Voltage difference is greater than the threshold configured for the synchrocheck function (TCPL)
XCBR0	Beh	ENS		
	Loc	SPS		Local Control Behavior
	CBOpCap	ENS		If ≤ 2, Blocking close signal used by ARS function. Generate the circuit breaker recovery signal to ARS function.
XCBR*	Beh	ENS		
	Loc	SPS		Local Control Behavior
	CBOpCap	ENS		If ≤ 2, Blocking close signal used by ARS function. Generate the circuit breaker recovery signal to ARS function.

8.1.5 Dynamic description

Dynamic description is available in appendix 12.9.

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8.2 Disconnector Command (LDCMDSxy)

The meaning of "xy" is described in the following table:

x	
A	Switching
L	Line
T	Ground
S	Busbar section
I	Equipment Isolation

y	
1	Disconnector Busbar 1 (SA1)
2	Disconnector Busbar 2 (SA2)
3	Disconnector Busbar 3 (SA3)
-	For earthing disconnectors (ST) or line side disconnectors (SL)

8.2.1 Description of the Function

This LD contains the control function of one disconnector of the substation. This disconnector may belong to a feeder or to a busbars.

For line bays, the LD integrates its part of the interlock function (AIVO), which is an operation assistance tool. Its purpose is to verify manoeuvres from the local HMI on disconnectors and circuit breakers.

The motivations for refusal of a command are described in the chapter on processing of commands (cf. § 4.4.8).

8.2.2 LNs used

LN	Description
CILO	This LN shall be used to "enable" a switching operation if the interlocking conditions are fulfilled. One instance per switching device is needed. At least all related switchgear positions have to be subscribed. The interlocking algorithm is a local issue.
CSWI	This LN class shall be used to control all switching conditions above process level. CSWI shall subscribe the data object POWCap ("point-on-wave switching capability") from XCBR if applicable. If a switching command (for example Select-before-Operate) arrives and "point-on-wave switching capability" is supported by the breaker, the command shall be passed to CPOW. OpOpn and OpCls shall be used if no Control Service is available between CSWI and XCBR (see GSE in IEC 61850-7-2).
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.

8.2.3 Specificities

Each disconnector is associated with its command LD (LDCMDSxy) and its interface LD (LDSxy). LDSxy/LDCMDSxy pairs are indicated in the dynamic description. A LD for the monitoring of the same disconnector can also be instantiated (LDITFSUSxy).

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- The manoeuver authority (local or remote - disjoncteur local ou TCD) is indicated by the DO LDMODEXPF/IHMI0.LocSta (cf. §8.15). The LDCMDSxy checks whether a command received can be executed depending on its origin.
- The LDSxy (cf. §7.2) publishes the position as acquired at the process interface in real time, including any pole mismatches that may appear during manoeuvres. The "filtered" disconnector position, masking temporary mismatches due to manoeuvres, is published by the LDCMDSxy.

Interlock (AIVO)

- The positions of the other disconnectors and the circuit breaker associated with the bay are necessary for the interlock function (AIVO).
- CSWI is subscribed to CILO in order to continuously provide the interlock status for authorisation of commands.
- The value of CILO0.EnaCls and CILO0.EnaOpn is TRUE or FALSE. A FALSE value corresponds to a refusal by interlock.
- The information AIVO.INV indicating an intermediate position of a circuit breaker or disconnector used for the interlock function, is modelled by a specific LDGRP (cf. §8.22) subscribing to the positions of these HV equipment.
- The activation or deactivation of the interlocking function is operated using CILO0.Mod. Since this operation is common for all circuit breaksers and disconnectos of a feeder, it is performed by an instance of LDCMDMULT.

VERSA-2AT

- This function is similar to the interlock function (AIVO) and implemented in the LDCMDSxy of the disconnectors of the reactances connected to the tertiary of the Autotransformer.

8.2.4 Static description

Disconnector Command (LDCMDSxy)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
CILO0	Beh	ENS		
	Mod	ENC.stVal		Used to enable/disable AIVO (interlock) function
	EnaCls	SPS	AIVO.INV	Interlock AIVO refusal invalid component (cf.§8.2.3)
	EnaOpn	SPS	AIVO.REF	Interlock (AIVO) refusal if EnaOpn == FALSE (cf.§8.2.3)
	Health	ENS	DEF.AIVO	
CSWI0	Beh	ENS		
	ClcNxtTmms	ING		External switchgear operation failure time delay
	DscDlTmms	ING		Discrepency delay setting
	Health	ENS		Interlock function (AIVO) failure

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Disconnector Command (LDCMDSxy)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Loc	SPS		
	LocSta	SPC		Indication of manoeuver authority of the disconnector (remote or local) (cf. §4.4.2)
	OpCls	ACT		GOOSE with close order published for LDSxy/XSWI
	OpOpn	ACT		GOOSE with open order published for LDSxy/XSWI
	Pos	DPC	SA.*, ST* OUV/FER/O?F ST**.POS, SL.POS	Commands Published position represents the filtered state of disconnector position
LLN0	Beh	ENS		
	Health	ENS		Health status of the function
	Mod	ENC		
	NamPlt	LPL		

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8.2.5 Dynamic description

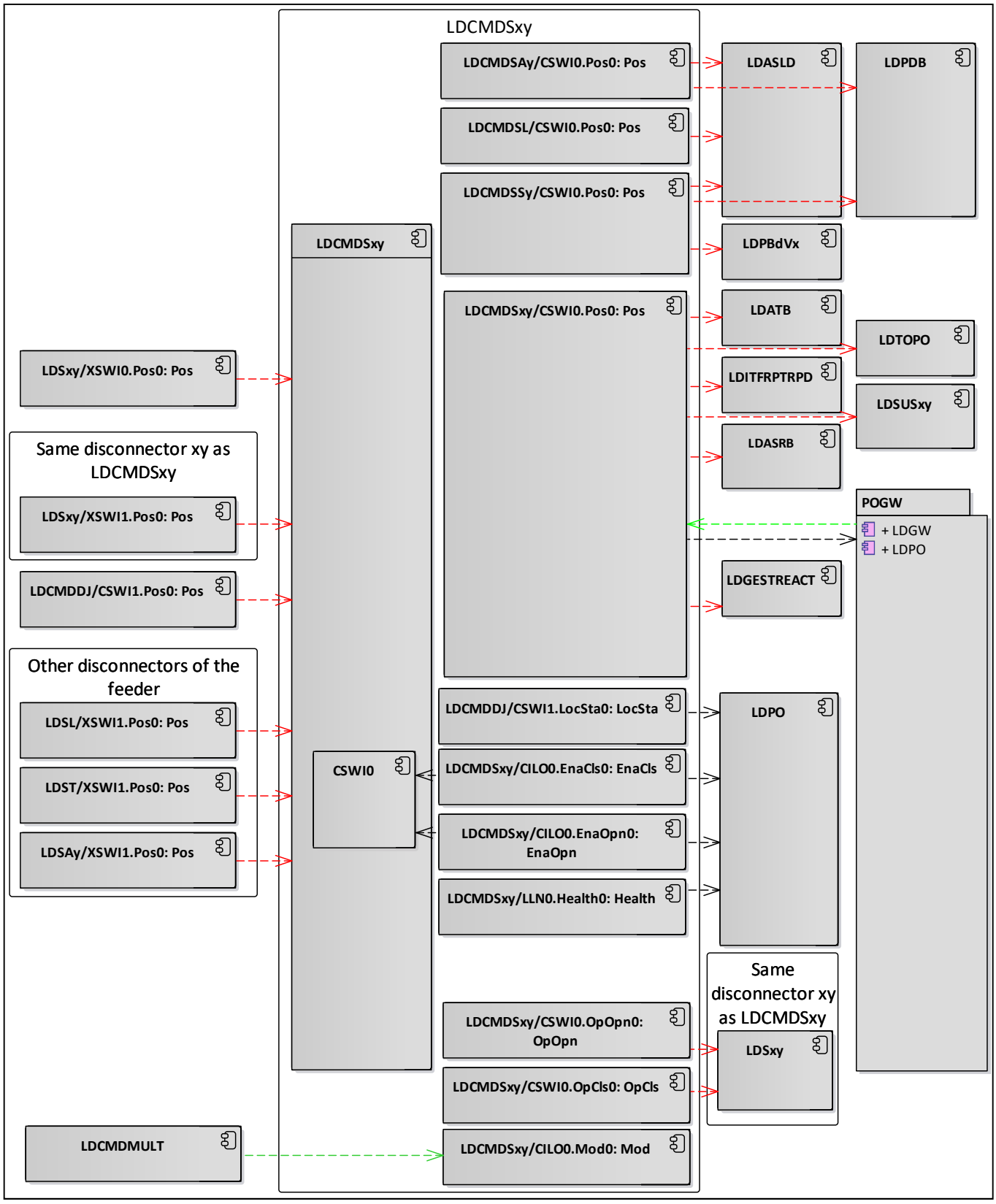

Figure 58: Dynamic description LDCMDSxy

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8.3 Fault Location (LDLOCDEF)

8.3.1 Description of the Function

The Fault Location function (LDLOCDEF) provides information on the presumed location of an isolation defect affecting the high-voltage structures of the transmission system. In addition, this function can also identify other characteristics of the fault, such as the type of fault (mono, bi earth, etc.), for example.

8.3.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
LSET	Rte Extended Setting LN
PDIS	The phase start value and ground start value are minimum thresholds to release the impedance measurements depending on the distance function characteristic given by the algorithm and defined by the settings. The settings replace the data object curve as used for the characteristic on some other protection LNs. One instance of PDIS per zone shall be used.
RFLO	For a description of this LN, see IEC 61850-5. In case of a fault, the fault location is calculated in ohm.

8.3.3 Specificities

- It is considered that fault distance, impedance and type information is transmitted to control centre.
- The inputs of the function modelled are the SV from the LDTM.
- In practice, the function most often uses the disturbance recording (LDEP function), which corresponds to the recording of SV.
- The start of the fault location algorithm are DO subscribed by LDLOCDEF, typically PTRC.Op from protection functions.
- In some cases, fault distance calculation is not possible, for example if the error range is too great. In this case, the location and impedance DO are published with q.validity=invalid.
- The fault location function requires line parameters. For the time being, it is considered that it is implemented in the same IED as LDPX and uses the line parameter settings of LN PDIS. An additional parameter regarding the line length is added.

8.3.4 Static description

Fault Location (LDLOCDEF)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Health of the LOCDEF function
	Mod	ENC		
	NamPlt	LPL		
LSET0	Beh	ENS		
	NamPlt	LPL		

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Fault Location (LDLOCDEF)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	StrVal1	ASG.setMag	LONG-LIGNE	Line length in km
PDIS0	Beh	ENS		
	K0Fact	ASG.setMag		K0
	K0FactAng	ASG.setMag		Angle of K0
	LinAng	ASG.setMag		Line angle
	X1	ASG.setMag	Z-LIGNE	Primary positive sequence reactance of the line in ohms
RFLO0	Beh	ENS		
	FltDiskm	MV	LD	Distance in km
	FltLoop	ENS		Fault type
	FltZ	CMV		Fault impedance in ohm

8.3.5 Dynamic description

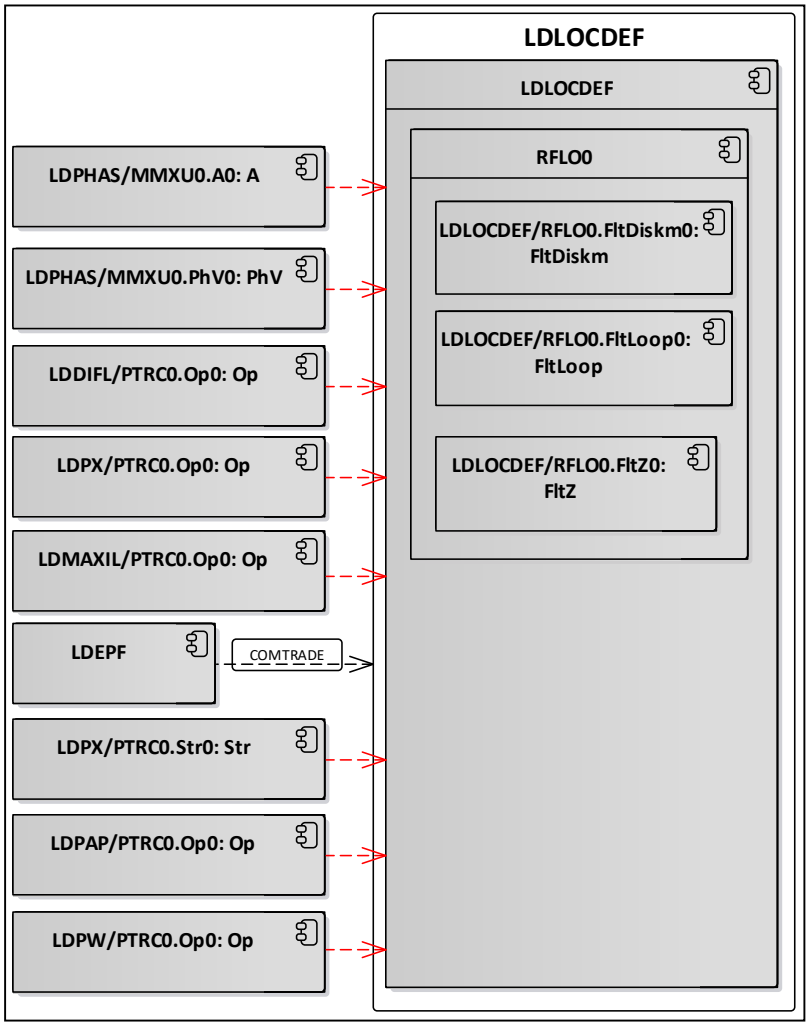

Figure 59: Dynamic description LDLOCDEF

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8.4 Measurement Transducer (LDCAP)

8.4.1 Description of the Function

The measurements published by this function are used for functions allocated in the Network Control Center and are used for two main purposes: control of the network and statistical studies.

The LDCAP measures phasor values (U and I), calculates electro-technical values (P, Q, U module), and transmits them to the remote control function (TCD) in the form of numerical telemeasurements (TMN).

The associated functions LDMEAS (cf. §8.5) and LDPHAS (cf. §8.6) provide local power quality measurements and phasor calculations for local automation functions.

8.4.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
MMXU	This LN shall be used for calculation of currents, voltages, powers and impedances in a three-phase system. The main use is for operative applications.
MSQI	To acquire values from CTs and VTs and to calculate the sequences and imbalances in a three/multi-phase power system.

8.4.3 Specificities

- For the LDCAP associated to the Instrument Transformers of the busbar bay, LN MMXU[b][s] represents the measurement of voltage of busbar #b section #s. Within the LDCAP, as much instance of MMXU[b][s] is created as necessary.
- For the LDCAP of a line bay, only the MMXU0 is used to measure the active and reactive power of the outgoing feeder.
- The amplitude and the phase of the phasors (WYE) are given by instcVal.mag and instcVal.ang, respectively.
- Configuration DO MMXU/PFSign (Power Factor Interpretation) is fixed to 2. It correspond to the IEC standard interpretation (cf. IEC 61850-7-4 ed2).
- For the unit and unit multiplier of the MVs published by LDCAP, a 32 bits floating format is chosen. DOI/DAI from the configuration file will respect this choice.
- The length of the acquisition window and the frequency of data updating are given in the DOs from LLN0. It is necessary to instantiate a LDCAP for each acquisition window.
- The settings for the acquisition window are in MMXU0 applicable to all DO published by LDCAP (ClcIntvPer, ClcIntvTyp, ClcMod, ClcRfPer, ClcRfTyp). As a consequence, LN MMXU0 needs to be always instantied for these settings.
  Remark: In edition 2, LLN0 is no longer available for hosting these setting DO.

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8.4.4 Static description

Measurements transducer (LDCAP)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Health of the CAP function
	Mod	ENC		
	NamPlt	LPL		
MMXU0	ClcIntvPer	ING		Duration of the acquisition window
	ClcIntvTyp	ENG		Base for calculating the acquisition window
	ClcMod	ENG		Default: SLIDING
	ClcRfPer	ING		Period of updating values
	ClcRfTyp	ENG		
	A	WYE		Used to provide current phasor values for the functions concerned and the HMI
	Beh	ENS		
	Hz	MV		Frequency
	PFSign	ENG		Power Factor Interpretation: fixed to 2 in IEC standard (cf. IEC 61850-7-4 ed2)
	PhV	WYE		Used to provide voltage phase to neutral phasor values for the functions concerned and the HMI
	PPV	DEL		Used to provide voltage phase to phase phasor values for the functions concerned and the HMI
	TotPF	MV		Power factor
	TotVA	MV		Apparent power
	TotVAr	MV	P.REACTIVE	Reactive power
	TotW	MV	P.ACTIVE	Real power
MMXUbts	Hz	MV		Frequency (busbar)
	PPV	DEL		Busbar voltage phasors. Only concern the busbar management bay (CBO) (LDRS, LDRSE, LDCMD and LDSUTCT).
MSQI0	SeqA	SEQ		Positive, negative and zero sequence current
	Beh	ENS		
	SeqV	SEQ		Positive, negative and zero sequence voltage

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8.4.5 Dynamic description

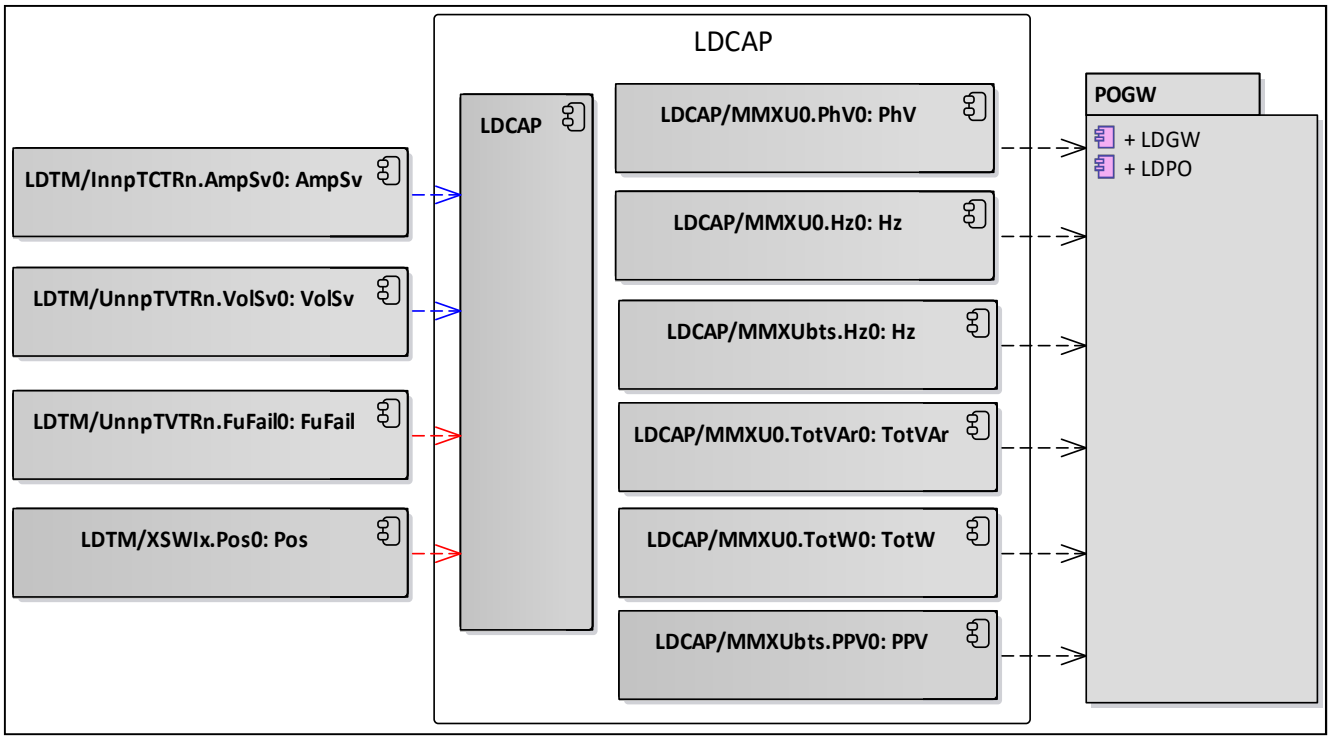

Figure 60: Dynamic description LDCAP

8.5 Measurements Transducer (LDMEAS)

8.5.1 Description of the Function

The measurements published by this function are used to provide local power quality measurements. This includes statistical studies, harmonics and voltage dips. One LDMEAS for each feeder can be instanciated.

The associated functions LDCAP (cf. §8.48.5) and LDPHAS (cf. §8.6) provide measurements for the network control center and phasor calculations for local automation functions.

8.5.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
MHAI	This LN shall be used for calculation of harmonics or interharmonics in a three-phase system. Instances either for harmonics (including subharmonics and multiples) or interharmonics are possible depending on the value of the basic settings, i.e.: - frequency f ("Hz"); - evaluation window DeltaT ("EvTmms"). The frequency may either be given (HzSet) or calculated (Hz). Both harmonics and interharmonics carry power and produce distortions. There are different methods to calculate disturbances. For more information and definitions, see IEC 61000-4-7 (2002), IEEE 519-1992, and IEEE 1459-2000.
LTED	Specific LN dedicated to the designation of the topological element.

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8.5.3 Specificities

- The harmonic number published in the DO HWYE must be indicated in the functional specifications.
- For the unit and unit multiplier of the MVs published by LDMEAS, a 32 bits floating format is chosen. DOI/DAI from the configuration file will respect this choice.
- The length of the acquisition window and the frequency of data updating are given in the DOs from LLN0. It is necessary to instantiate a LDMEAS for each acquisition window.
- LN MHAI define an application window. This window should be consistent with the window defined in the parameters of LLN0.
- The settings for the acquisition window are in MHAI0 applicable to all DO published by LDMEAS (ClcIntvPer, ClcIntvTyp, ClcMod, ClcRfPer, ClcRfTyp).
  Remark: In edition 2, LLN0 is no longer available for hosting these setting DO.

8.5.4 Static description

Power quality (LDMEAS)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Health of the MEAS function
	Mod	ENC		
	NamPlt	LPL		
MHAI0	Beh	ENS		
	ClcIntvPer	ING		Duration of the acquisition window
	ClcIntvTyp	ENG		Base for calculating the acquisition window
	ClcMod	ENG		Default: SLIDING
	ClcRfPer	ING		Period of updating values
	ClcRfTyp	ENG		
	EvTmms	ING		Duration of the calculating window: should be consistent with values contained in LLN0
	HA	HWYE		"Current" harmonic measurement
	HA	HWYE.numHar		Number of "Current" harmonics (max harmonic)
	HPhV	HWYE		Phase to phase "Voltage" harmonic measurement
	HPhV	HWYE.numHar		Number of "Voltage" harmonics (max harmonic)
	HPPV	HDEL		Phase to phase "Voltage" harmonic measurement
	HzSet	ASG.setMag		Base frequency fixed to 50Hz
	NumCyc	ING		Number of base cycle: should be consistent with values contained in LLN0
	ThdA	WYE		Current total harmonic distortion

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Power quality (LDMEAS)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	ThdPPV	DEL		Phase to phase voltage total harmonic distortion
LTED0	NamPlt	LPL		
	ElNodeRef	INS		Electrical Node reference

8.5.5 Dynamic description

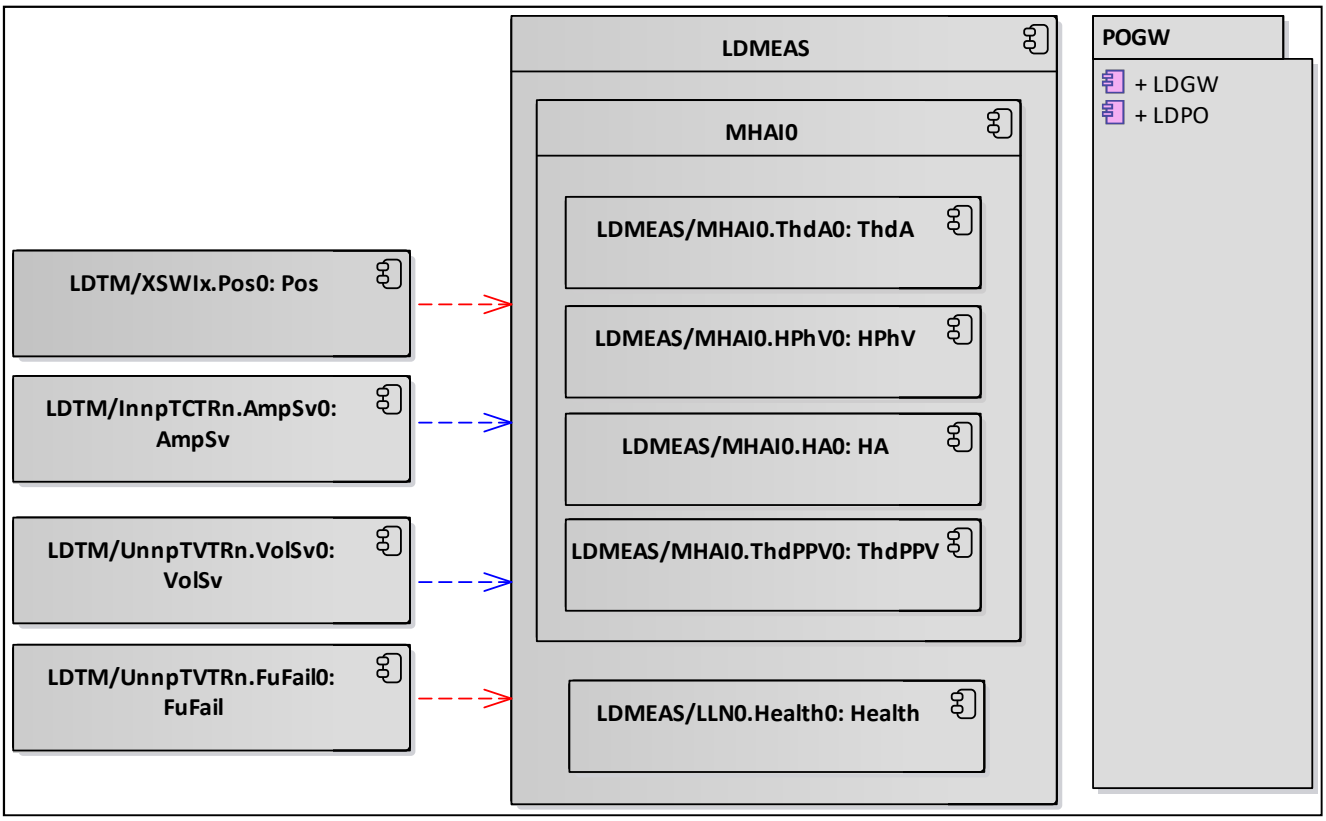

Figure 61: Dynamic description LDMEAS

8.6 Measurements Transducer (LDPHAS)

8.6.1 Description of the Function

The measurements published by this function are used to provide phasor calculations for local automation functions, including the recloser. One or several LDPHAS for each feeder can be instantiated. Several LDPHAS need to be instantiated if phasors of different characteristics are to be published (e.g. different acquisition windows)

The associated functions LDCAP (cf. §8.48.5) and LDMEAS (cf. §8.5) provide measurements for the network control center and local power quality measurements.

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8.6.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
MMXU	This LN shall be used for calculation of currents, voltages, powers and impedances in a three-phase system. The main use is for operative applications.
MSQI	To acquire values from CTs and VTs and to calculate the sequences and imbalances in a three/multi-phase power system.
LTED	Specific LN dedicated to the designation of the topological element.
LSYN	Phasor Synchronisation Information
LSET	Rte Extended Setting LN

8.6.3 Specificities

- For the LDPHAS associated to the Instrument Transformers of the busbar bay, LN MMXU[b][s] represents the measurement of voltage of busbar #b section #s. Within the LDPHAS, as many instances of MMXU[b][s] are created as necessary. The corresponding information for LTEDbts is subscribed from the corresponding LDTOPO/LTEDbts.ElNodRef.
- For the LDPHAS of a line bay, only the MMXU0 is used. The corresponding information for LTED0 is subscribed from LDTOPO/BayNameLTED0.ElNodRef.
- The amplitude and the phase of the phasors (WYE) are given by instcVal.mag and instcVal.ang, respectively.
- For the unit and unit multiplier of the MVs published by LDPHAS, a 32 bits floating format is chosen. DOI/DAI from the configuration file will respect this choice.
- The length of the acquisition window and the frequency of data updating are given in the DOs from LLN0. It is necessary to instantiate a LDPHAS for each acquisition window.
- The DO LTED0.ElNodeRef can be instantiated in order to indicate the Electrical Node Reference the measured values are associated to. This information is obtained from LDTOPO and published. In case of Busbar voltages, the corresponding LTEDbts are insantiated.
- In order to obtain this indication, LDPHAS subscribes to the relevant DO of LDTOPO.
- LDPHAS subscribes to LDTM/UnnppTVTR.FuFail and published the resulting voltage phasor as invalid in case of blown fuse.
- The settings for the acquisition window are in MMXU0 applicable to all DO published by LDPHAS (ClcIntvPer, ClcIntvTyp, ClcMod, ClcRfPer, ClcRfTyp). As a consequence, LN MMXU0 needs to be always instantied for these settings.
  Remark: In edition 2, LLN0 is no longer available for hosting these setting DO.
- IEC 61850-Ed2.1 does not provide synchronisation information for the phasors. This synchronisation information is conveyed by LSYN (cf. §11.10) and is valid for all phasors (WYE) published by LPHAS.
- Calculated Power (represented by DO TotPF, TotVA, TotVAr and TotW) is not covered by LDPHAS. If necessary, a LDCAP has to be instantiated for those values).
- Thersholds are instanciated in LSET for the detection of transient voltage and current.

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8.6.4 Static description

Measurements RMS (LDPHAS)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Health of the PHAS function
	Mod	ENC		
	NamPlt	LPL		
MMXU0	ClcIntvPer	ING		Duration of the acquisition window
	ClcIntvTyp	ENG		Base for calculating the acquisition window
	ClcMod	ENG		Default: SLIDING
	ClcRfPer	ING		Period of updating values
	ClcRfTyp	ENG		
	A	WYE		Used to provide current phasor values for the functions concerned and the HMI
	Beh	ENS		
	Hz	MV		Frequency
	PFSign	ENG		Power Factor Interpretation: fixed to 2 in IEC standard (cf. IEC 61850-7-4 ed2)
	PhV	WYE		Used to provide voltage phase to neutral phasor values for the functions concerned and the HMI
	PPV	DEL		Used to provide voltage phase to phase phasor values for the functions concerned and the HMI
MMXUbts	Hz	MV		Frequency (busbar)
	PFSign	ENG		Power Factor Interpretation: fixed to 2 in IEC standard (cf. IEC 61850-7-4 ed2)
	PhV	WYE		Busbar voltage phasors. Only concerns the busbar management bay (CBO) (LDRS, LDRSE, LDCMD and LDSUTCT).
MSQI0	SeqA	SEQ		Positive, negative and zero sequence current
	SeqV	SEQ		Positive, negative and zero sequence voltage
LTED0	ElNodeVTRef	INS		Indicates if this voltage is to be used as voltage reference for an Electrical Node
	NamPlt	LPL		
	ElNodeRef	INS		Electrical Node reference
LTEDbts	NamPlt	LPL		
	ElNodeRef	INS		Electrical Node reference
LSYN0	WYESync	ENS		Indication of synchronisation status of phasors published by LDPHAS

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Measurements RMS (LDPHAS)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	WYESyncSrcId	INS		Indication of grandmaster clock used to synchronise the SV stream from which the phasors published by LDPHAS are calculated
	Beh	ENS		
LSET0	Beh	ENS		
	NamPlt	LPL		
	StrVal1	ASG		Transient detection - DC threshold for voltage phasors expressed in primary voltage
	StrVal2	ASG		Transient detection - H2 threshold for voltage phasors expressed in primary voltage
	StrVal3	ASG		Transient detection - H3 threshold for voltage phasors expressed in primary voltage
	StrVal4	ASG		Transient detection - DC threshold for current phasors expressed in primary amps
	StrVal5	ASG		Transient detection - H2 threshold for current phasors expressed in primary amps
	StrVal6	ASG		Transient detection - H3 threshold for current phasors expressed in primary amps

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8.6.5 Dynamic description

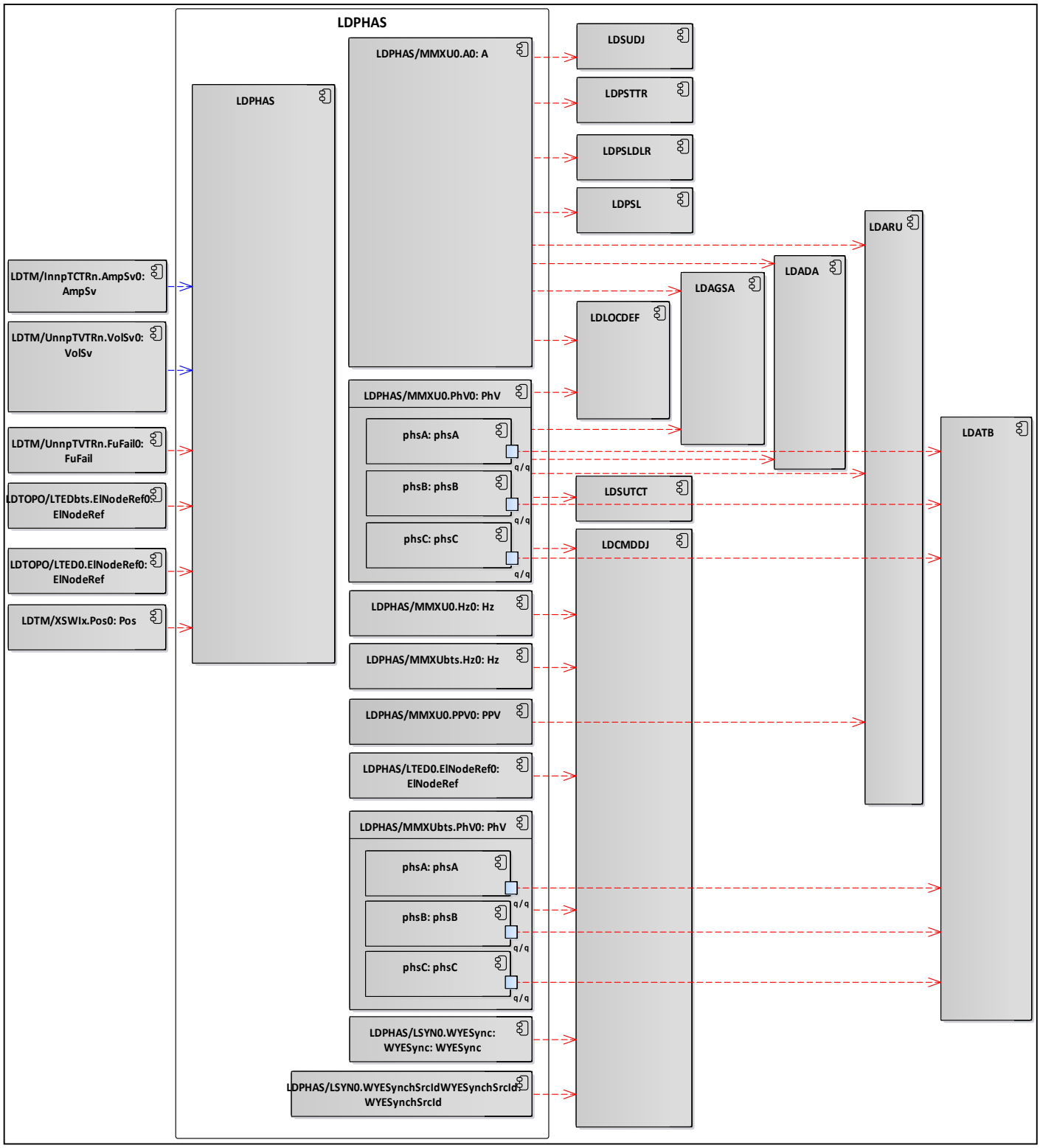

Figure 62: Dynamic description LDPHAS

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8.7 Teleprotection (LDTAC)

8.7.1 Description of the Function

The LDTAC models the teleprotection interface. The function covers the GESTP functions (cf. [16]) (formerly GESDTAC and parts of LOGTD).

8.7.2 LNs used

LN	Description
ITPC	The LN ITPC comprises all information for communication channel setting and supervision. ITPC is not intended to generate direct process data objects. Thus, it does not contain the input and output data objects to be transmitted and it has no "operate" data objects object.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PSCH	This LN shall be used to model the logic scheme for line protection function co-ordination. The protection scheme allows the exchange of the "operate" outputs of different protection functions and conditions for line protection schemes. It includes data objects for teleprotection if applicable. In this case, all appropriate data objects shall be subscribed.

8.7.3 Specificities

- Within the dedicated tele-protection IED equipment (TAC), an LDTAC is instanced as many times as necessary to represent each order associated with this equipment. An instantiation of the LDTAC therefore corresponds to TxPrm, TxBlk or TxTr (cf. Figure 63).
- The block diagram of the connection between 2 substations is explained in the chapter dedicated to general principles (cf.4.3.6).
- The signalling of the loss of a communication channel or the failure of the TAC equipment is generated on the basis of the quality DA published by the LDTAC.
- Signals DF.ACC, DF.VER, DF.DSAR and DF.TELEP are generated on SCADA/HMI level on the basis of publications by the DO ITPC.LosSig and dedicated tele-protection IED configuration.
- The "TD in test mode" information corresponds to the DO LDTAC/LLN0.Beh.
- According to [4], the DO EEHealth is to be used to signal the status of the TCM channel. This DO contributes to the different signal DF.TD**. These signals are also used to signal the failure of the dedicated tele-protection IED (LLN0.health or LPHD.health). The TS.DF*** are grouped at SCADA/HMI level.
- The possibility of remote closing of circuit breakers is not covered by the DO Rx/Tx of LN PSCH. The DO TxPrm / RxPrm are used for this feature.

8.7.4 Static description

Teleprotection (LDTAC)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
ITPC0	Beh	ENS		

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Teleprotection (LDTAC)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	EEHealth	ENS	DF.TD1V1 DF.TD1V2 DF.TD2V1 DF.TD2V2 DF.AC1.V1 DF.VE1.V1 DF.DSAR1 DF.AC1.V2 DF.VE1.V2 DF.DSAR2	Contributes to the Indication of the failure of telecommunication IEC 61850-7-4
	LosSig	SPS		Loss of signal.
LLN0	Beh	ENS	TD.HS*	
	Health	ENS	DF.TD1V1 DF.TD1V2 DF.TD2V1 DF.TD2V2 DF.AC1.V1 DF.VE1.V1 DF.DSAR1 DF.AC1.V2 DF.VE1.V2 DF.DSAR2 DF.TENCL	Health status of the function to the power system control Contributes to the dedicated tele-protection IED failure indication.
	Mod	ENC	TD.HS*	
	NamPlt	LPL		
PSCH0	Beh	ENS		
	RxBlk1	ACT		Reception of blocking order by dedicated tele-protection IED.
	RxPrm1	ACT		Reception of acceleration/authorisation order by dedicated tele-protection IED.
	RxTr1	ACT		Reception of remote trip order, or recloser disabling, by dedicated tele-protection IED.
	TxBlk	ACT	REC.VERROUIL.*Vv	Transmission to local user functions of the blockage order via the TCM link by dedicated tele-protection IED.
	TxPrm	ACT	REC.ACCELERA.*Vv REC.AUTORIS.*Vv REC.TENCL.*Vv	Transmission to local user functions of the acceleration/authorisation order via the TCM link by dedicated tele-protection IED.
	TxTr	ACT	REC.DESARM.ARS.v	Transmission to local user functions of the remote trip order or recloser disarming via the TCM link by dedicated tele-protection IED.
	Op	ACT		

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8.7.5 Dynamic description

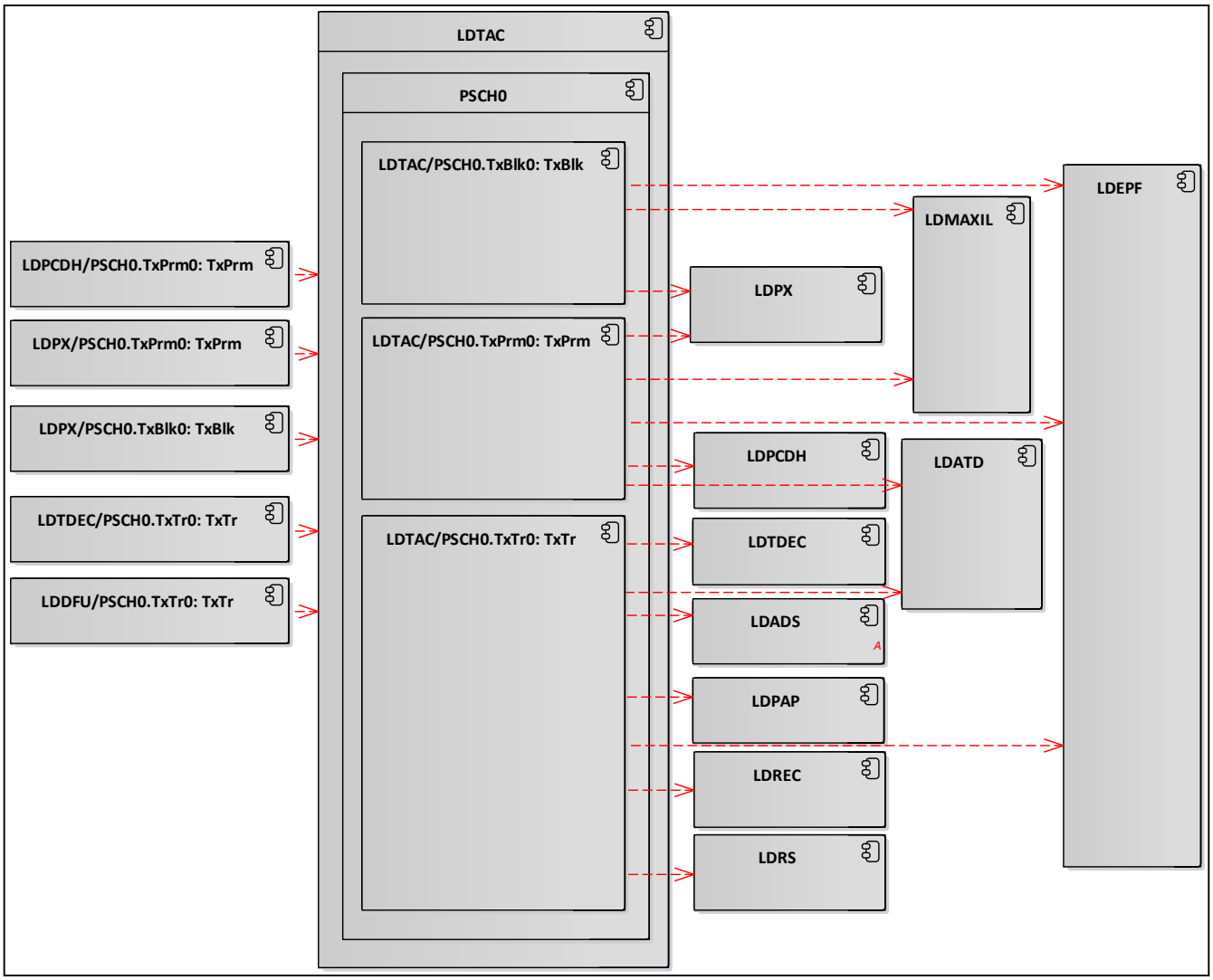

Figure 63: Dynamic description LDTAC

8.8 Remote tripping function (LDTDEC)

8.8.1 Description of the Function

The LDTDEC models the remote tripping logic of the LOGTD function. It also includes verification critera which can be used for teletrip (CLODe function).

8.8.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.

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LN	Description
PSCH	This LN shall be used to model the logic scheme for line protection function co-ordination. The protection scheme allows the exchange of the "operate" outputs of different protection functions and conditions for line protection schemes. It includes data objects for teleprotection if applicable. In this case, all appropriate data objects shall be subscribed.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.
FXOT	Logical node FXOT shall be used to set a high-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, contro or alarm function is based on other physical measurements than primary electrical data.

8.8.3 Specificities

- The block diagram of the connection between 2 substations is explained in the principle part (cf.4.4.6).
- The signalling to the subscribed functions of the loss of a channel of communication or the failure of the dedicated tele-protection IED equipment, is generated on the basis of the quality DA published by the LDTAC.
- The different remote tripping channels are managed by LDTAC instances and are not modelled by the LDTDEC.
- The DF.TELEDECL.1V* signals are generated by the corresponding LN ITPC of the LDTAC.
- The DF.FONC.TELEDEC and DF.TELEPROTEC signals are generated at HMI/SCADA level from DF.TELEDECL.1V* signals.
- The DO PTRC.Op is used for the initialisation of the ADD and/or for the inhibition of the recloser.
- The duration of TxTr signal is represented by the DO setting DurTmms. According to this DO definition in the LN, this setting could be applied to TxPrm signal.
- The "Local tripping" setting is managed by the DO Mod of the PTRC.
- Inhibation of the recloser, initialisation of the ADD and the managing of local automaton inputs (COMPADA or other) could be activated or not. It is a choice in the configuration and it will be implemented by subscribtion or not of these functions to PTRC.Op
- The function CLODe is integrated in LDTDEC. This function consists in

  Enable / Diable teletrip. This is achieved by setting PTRC0.Mod
  Condition teletrip by a residual voltage. This is achieved by FXOT.Mod and having LDTDEC subscribing residual voltage published by LDPHAS.

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8.8.4 Static description

(LDTDEC)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS	DF.TDPR* DF.TDPC* DFTPAPy* DF.TSUR DF.TCPT DF.TPLP DF.TDCL DF.T1DJ DF.TPTP DF.TEOL DF.TVCL DF.TINF	Health status of the function
	Mod	ENC	TD.HS.PR	
	NamPlt	LPL		
PSCH0	Beh	ENS		
	DurTmms	ING.setVal	T-MAINT_TXTR	Duration to maintain the tripping signal
	Op	ACT		
	RxTr1	ACT	REC.DESARM.ARS.*Vv REC.TELEDECL.*Vv R.TDDJy* R.TDPC** R.TDPR.* R.TPAPy* R.TSUR* R.TCPT* R.TPLP* R.TDCL* R.T1DJ* R.TPTP* R.TEOL* R.TVCL* R.TINF*	Signal of trip order Reception (R-GOOSE case).

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(LDTDEC)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	TxTr	ACT	EMI.DESARM.ARS.*Vv EMI.TELEDECL.*Vv E.TDDJy* E.TDPC** E.TDPR.* E.TPAPy* E.TSUR* E.TCPT* E.TDCL* E.T1DJ* E.TEOL* E.TVCL* E.TINF*	Remote tripping information emission order to LDTAC (proxy case). Signal of trip order Emission (R-GOOSE case).
PTRC0	Beh	ENS		Local tripping (LDDJ) enabled/disabled
	Mod	ENC.stVal	CHOIX-Dec	Local tripping (LDDJ) enabled/disabled
	Op	ACT		Trip order to local cb following reception of remote trip order. Inhibition of recloser.
	Tr	ACT		Signal of trip order following reception of remote trip order. Init of cb faillure protection (ADD) in certain cases.
FXOT0	Beh	ENS		Local tripping by residual voltage enabled/disabled
	Mod	ENC.stVal	CHOIX-Crit-Loc	Local tripping by residual voltage enabled/disabled
	OpDlTmms	ING.setVal	T-Vr-Clode	Time delay of presence of residual voltage
	StrVal	ASG.setMag	S-Vr-Clode	Residual voltage threshold (Vr_seuil)

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8.8.5 Dynamic description

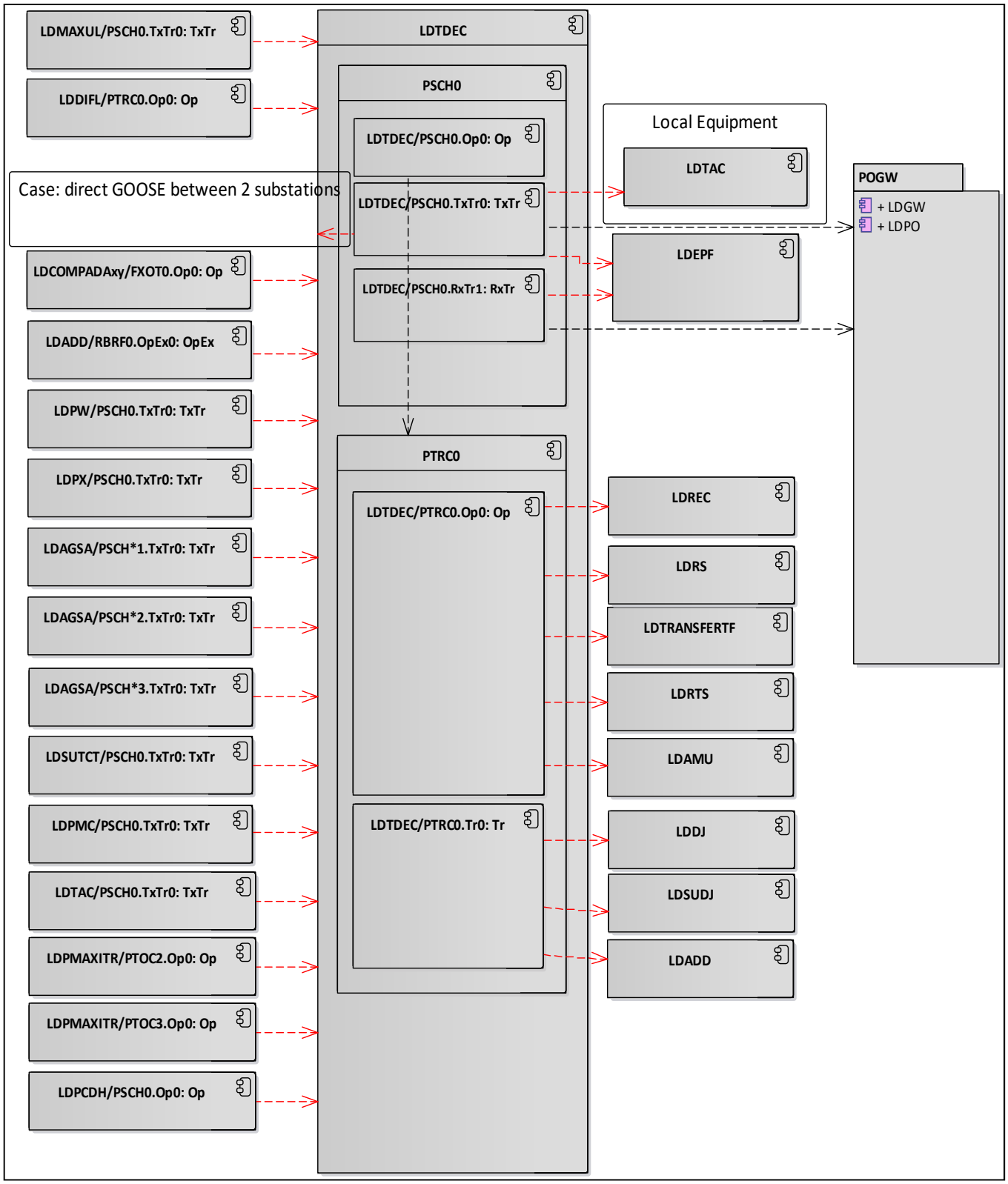

Figure 64: Dynamic description LDTDEC

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8.9 Busbar-to-Busbar Remote Blocking (cf. LDSxy)

Function used to avoid operation of a disconnector in the framework of work on an electrical installation, according to safety regulations.

Confer §8.9.

8.10 Synchrocheck (cf. LDCMDDJ)

Confer § 8.1 - Circuit Breaker Command (LDCMDDJ).

8.11 VERSA-2AT

Confer §4.3.4

8.12 HMI (LDPO)

8.12.1 Description of the Function

The LDPO represents the HMI of the PACS. It subscribes to most DO and is used by the local operator for commands.

8.12.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
LSET	Rte Extended Setting LN

8.12.3 Specificities

- N/A

8.12.4 Static description

HMI (LDPO)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Health status of the function to the power system control
	Mod	ENC		
	NamPlt	LPL		
LSET0	NamPlt	LPL		
	OpDlTmms	ING		HMI deconnection delay

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8.13 Gateway (LDGW)

8.13.1 Description of the Function

The LDGW, models the interface with the Network Control Center.

8.13.2 LNs used

LN	Description
ITCI	Telecontrol interface to be used for remote control from higher control level. Basically, the TCI will communicate the same data as the station level HMI or a subset of these data. The role of the different interfaces is not fixed for most of the functions and defined in the engineering phase.
LCCH	This LN is introduced in this part to model common issues for physical communication channels. It is instantiated for each physical channel or each pair of link level redundant physical channels.
LPCP	This logical node is used to model communication ports
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.

8.13.3 Specificities

- The Gateway interfaces the remote control (cf. § 4.3.4).
- Commands relating to the substation and bay operating modes are represented in the chapter on LDPO (cf. §8.12) and are not covered in the dynamic representation (cf. § 0).
- Orders from higher levels of control are transmitted via the Gateway. In order to simplify the representation, these commands are only indicated in the dynamic descriptions of the concerned LD and not in the dynamic description of LDGW.
- The gateway IED is designed to communicate with up to 4 distant centers and with 4 independant telecommunication links. Each center is represented by a LN ITCI instance. The name of each center is represented by the corresponding DO ITCI.EEName
- The telecommunication link to a center is represented by a LCCH based on LCCHext from IEC 61850-90-4. This includes two independent telecom links if applicable.
- For a given center, the instanciation number of LCCH is the same as the instanciation number of the ITCI.
- LPCP represents the monitoring of the physical telecommunication links to the centers. For each physical link, a LN LPCP is instanciated.
- LCCH.PortRef and LCCH.RedPortRef indicate the concerning LPCP reference.
- The monitoring of the IEC 61850 communication ports is performed by LDSUIED (cf. §9.8).If these links are supported by several IEDs, a LDGTW with the corresponding ITCI should be instanciated in each IED.

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8.13.4 Static description

Gateway (LDGW)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LPCP1	NamPlt	LPL		
	AutoNgt	SPS		Indicates if the channel is auto-negociated
	Mau	INS		Indicates the speed of the interface
	AutoNgtCfg	SPG		Setting for auto-negociation
	MauCfg	ING		Setting for manual speed configuration
	PortNum	ING		Number of the interface
	PortNam	VSG		Name of the interface
	MauCfgCap	ING		Indicates the possible configuration communication speeds
	PhyHealth	ENS		State of the physical interface #1
LPCP2	NamPlt	LPL		
	AutoNgt	SPS		Indicates if the channel is auto-negociated
	Mau	INS		Indicates the speed of the interface
	AutoNgtCfg	SPG		Setting for auto-negociation
	MauCfg	ING		Setting for manual speed configuration
	PortNum	ING		Number of the interface
	PortNam	VSG		Name of the interface
	MauCfgCap	ING		Indicates the possible configuration communication speeds
	PhyHealth	ENS		State of the physical interface #2
LPCP3	NamPlt	LPL		
	AutoNgt	SPS		Indicates if the channel is auto-negociated
	Mau	INS		Indicates the speed of the interface
	AutoNgtCfg	SPG		Setting for auto-negociation
	MauCfg	ING		Setting for manual speed configuration
	PortNum	ING		Number of the interface
	PortNam	VSG		Name of the interface
	MauCfgCap	ING		Indicates the possible configuration communication speeds
	PhyHealth	ENS		State of the physical interface #3
LPCP4	NamPlt	LPL		
	AutoNgt	SPS		Indicates if the channel is auto-negociated
	Mau	INS		Indicates the speed of the interface

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Gateway (LDGW)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	AutoNgtCfg	SPG		Setting for auto-negociation
	MauCfg	ING		Setting for manual speed configuration
	PortNum	ING		Number of the interface
	PortNam	VSG		Name of the interface
	MauCfgCap	ING		Indicates the possible configuration communication speeds
	PhyHealth	ENS		State of the physical interface #4
LPCP5	NamPlt	LPL		
	AutoNgt	SPS		Indicates if the channel is auto-negociated
	Mau	INS		Indicates the speed of the interface
	AutoNgtCfg	SPG		Setting for auto-negociation
	MauCfg	ING		Setting for manual speed configuration
	PortNum	ING		Number of the interface
	PortNam	VSG		Name of the interface
	MauCfgCap	ING		Indicates the possible configuration communication speeds
	PhyHealth	ENS		State of the physical interface #5
LPCP6	NamPlt	LPL		
	AutoNgt	SPS		Indicates if the channel is auto-negociated
	Mau	INS		Indicates the speed of the interface
	AutoNgtCfg	SPG		Setting for auto-negociation
	MauCfg	ING		Setting for manual speed configuration
	PortNum	ING		Number of the interface
	PortNam	VSG		Name of the interface
	MauCfgCap	ING		Indicates the possible configuration communication speeds
	PhyHealth	ENS		State of the physical interface #6
LPCP7	NamPlt	LPL		
	AutoNgt	SPS		Indicates if the channel is auto-negociated
	Mau	INS		Indicates the speed of the interface
	AutoNgtCfg	SPG		Setting for auto-negociation
	MauCfg	ING		Setting for manual speed configuration
	PortNum	ING		Number of the interface
	PortNam	VSG		Name of the interface

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Gateway (LDGW)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	MauCfgCap	ING		Indicates the possible configuration communication speeds
	PhyHealth	ENS		State of the physical interface #7
LPCP8	NamPlt	LPL		
	AutoNgt	SPS		Indicates if the channel is auto-negociated
	Mau	INS		Indicates the speed of the interface
	AutoNgtCfg	SPG		Setting for auto-negociation
	MauCfg	ING		Setting for manual speed configuration
	PortNum	ING		Number of the interface
	PortNam	VSG		Name of the interface
	MauCfgCap	ING		Indicates the possible configuration communication speeds
	PhyHealth	ENS		State of the physical interface #1
LCCH1	ChLiv	SPS		State of the telecommunication link A to remote center #1
	RedChLiv	SPS		State of the telecommunication link B to remote center #1
	PortRef	ORG		Link with physical port indicated by LPCP for telecommunication link A. LCCHExt from IEC61850-90-4 is used.
	RedPortRef	ORG		Link with physical port indicated by LPCP for telecommunication link B. LCCHExt from IEC61850-90-4 is used.
LCCH2	ChLiv	SPS		State of the telecommunication link A to remote center #2
	RedChLiv	SPS		State of the telecommunication link B to remote center #2
	PortRef	ORG		Link with physical port indicated by LPCP for telecommunication link A. LCCHExt from IEC61850-90-4 is used.
	RedPortRef	ORG		Link with physical port indicated by LPCP for telecommunication link B. LCCHExt from IEC61850-90-4 is used.
LCCH3	ChLiv	SPS		State of the telecommunication link A to remote center #3
	RedChLiv	SPS		State of the telecommunication link B to remote center #3
	PortRef	ORG		Link with physical port indicated by LPCP for telecommunication link A. LCCHExt from IEC61850-90-4 is used.
	RedPortRef	ORG		Link with physical port indicated by LPCP for telecommunication link B. LCCHExt from IEC61850-90-4 is used.
LCCH4	ChLiv	SPS		State of the telecommunication link A to remote center #4
	RedChLiv	SPS		State of the telecommunication link B to remote center #4
	PortRef	ORG		Link with physical port indicated by LPCP for telecommunication link A. LCCHExt from IEC61850-90-4 is used.
	RedPortRef	ORG		Link with physical port indicated by LPCP for telecommunication link B. LCCHExt from IEC61850-90-4 is used.

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Gateway (LDGW)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
ITCI1	EEName	DPL.name		Name of the center #1
ITCI2	EEName	DPL.name		Name of the center #2
ITCI3	EEName	DPL.name		Name of the center #3
ITCI4	EEName	DPL.name		Name of the center #4
LLN0	LocSta	SPC		Indication "Site in local/remote". This signal is the feedback of the command sent from the LDPO. This allows the supervision of the gateway
	Beh	ENS		
	Health	ENS		Health status of the function
	Mod	ENC		
	NamPlt	LPL		Indicates the software version of the gateway

8.13.5 Dynamic description

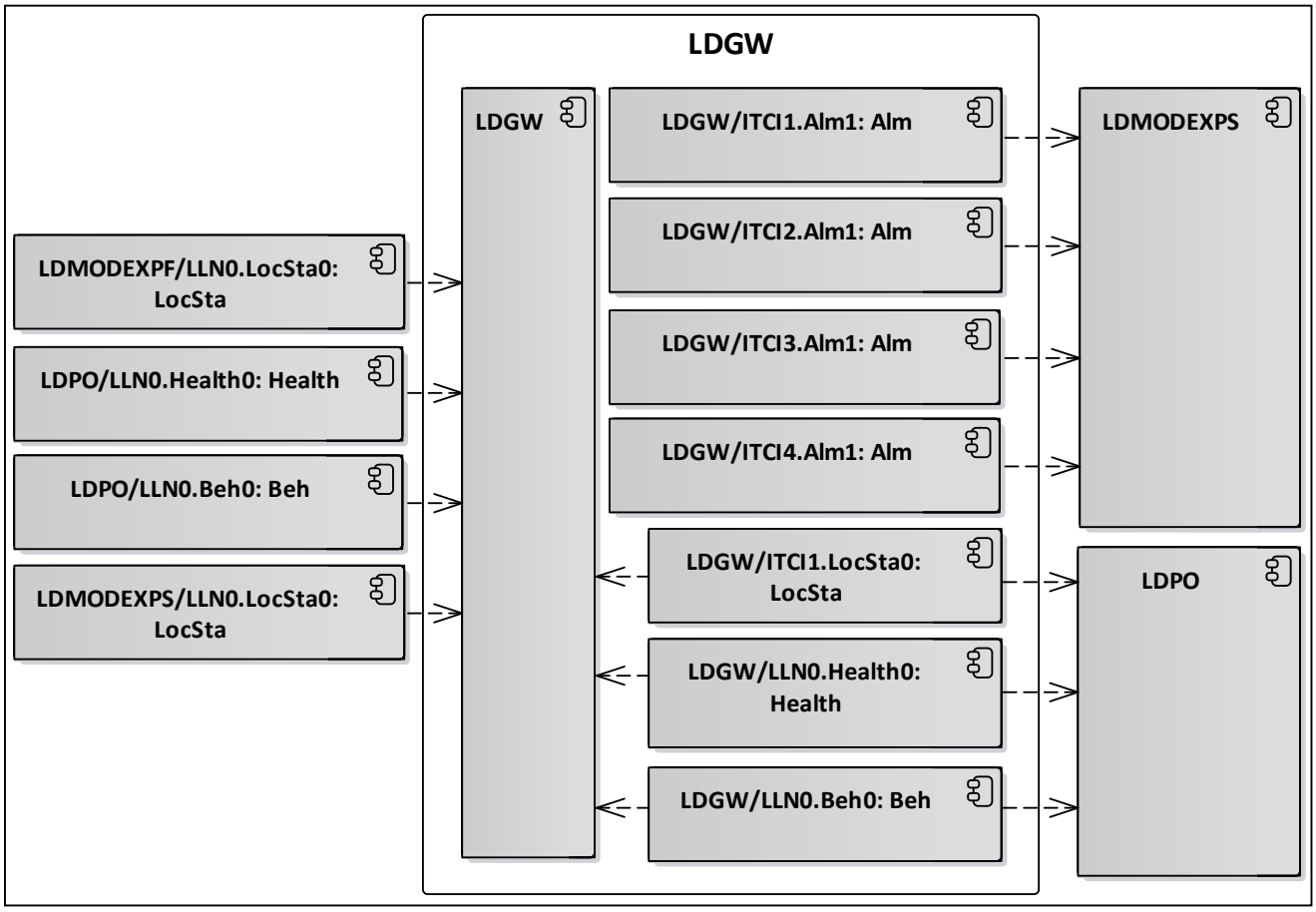

Figure 65: Dynamic description LDGW

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8.14 Substation level Operating Mode (LDMODEXPS)

8.14.1 Description of the Function

See §4.4.2,

The LDMODEXPS manages the operation mode of the substation for a given voltage level. The following table shows the principle of use of "LocSta" for management of different operating modes. For each functional bay, a LDMODEXPF indicationg its operating mode is instaciated (cf. §8.15).

Operating mode		**MODEXPS/ LLN0.LocSta**	**MODEXPF associated to the functional bay X**	
Sub-station	**Functional Bay X**		**IHMI0.LocSta indicating local/remote control authority for commands on DO**	**LLN0.LocSta indicating bay in local/remote**
Local	Local	True	True	Local
Remote	Local	False	True	Local
Local	Remote	True	True	Remote
Remote	Remote	False	False	Remote

- The term "remote", means "remote control", indicating control from the Control Centre (LDGW). "Local" means control from the local HMI.
- All commandable objects of a bay

only accept commands from LDGW if IHMI0.LocSta = False of its associated LDMODEXPF.
only accept commands from the local HMI if IHMI0.LocSta = True of its associated LDMODEXPF.

8.14.2 LNs used

LN	Description
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.
LSET	Rte Extended Setting LN
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.

8.14.3 Specificities

- The substation operation mode is represented by LDMODEXPS, and the bay operation mode by using the LDMODEXPF (one instance per bay representing an outgoing feeder).
- The MODEXP function (cf. [8]) describes the criteria for handling signalisations, measures and for acceptance of commands according to the substation operation mode and the bay operation mode. These requirements are covered by the application level and are not present in this document, which only describes the LDMODEXPF interface.

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- The signal "DSO substation in backup alarm mode" (ERDF en alarme secours - MODEXP-47/2) requirement, is directly published by LDRGWRPD, cf. §**Erreur ! Source du renvoi introuvable.**) and is not modelled in LDMODEXPS.
- The signal "one or more bay in local operation mode" is generated by LDMODEXPS (GAPC/Ind1).
- The transmission of data by the Telecontrol Gateway (LDGW §0) takes into account the value of LDMODEXPF/LLN0.LocSta.
- The signal "Substation in remote alarm mode" (Poste en Téléalarme) is interfaced in LDITFTG.
- LDMODEXPS subsribes to LDTGINFRA/GAPC3.DPCS01. This command wil generate a change of the substation operation mode to "TCD" if the latter is in AS or TA

8.14.4 Static description

Substation level Operating Mode (LDMODEXPS)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
GAPC0	Beh	ENS		
	Ind1	SPS	TR.LOC	One or more bay in local mode
	SPCSO1	SPC	RPTALSEC	Substation in backup alarm mode (AS)
	SPCSO2	SPC	POST.TA	Substation in remote alarm mode (TA)
LSET0	Beh	ENS		
	NamPlt	LPL		
	DlTmms1	ING	T-BASCULAUTO	Time delay for automatic switchover to telealarm device in case of telecontrol failure
	OnOff1	SPG	MES-TCD-TA	Automatic switchover to telealarm device enabled
	OnOff2	SPG	PROPTER	True : permisses owned by TSO False : permisses owned by other operator
	OnOff3	SPG	PROPTER	True : other operator is DSO False : other operator is third party
LLN0	Beh	ENS		
	Health	ENS		Health of the function
	LocSta	SPC	POST.LOC POST.TCD	Command/signal for "Substation in local/remote mode"
	Mod	ENC		
	NamPlt	LPL		

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8.14.5 Dynamic description

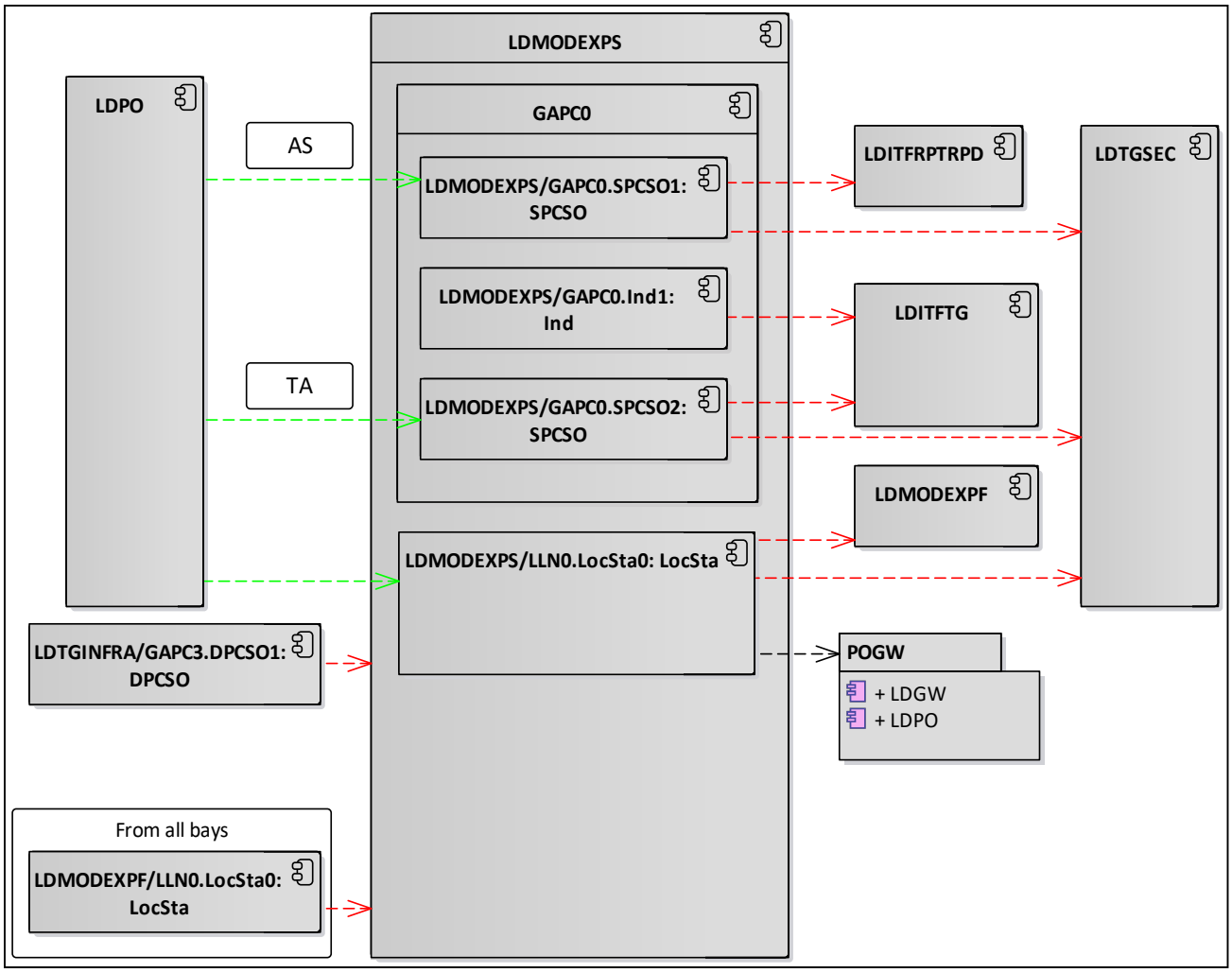

Figure 66: Dynamic description LDMODEXPS

8.15 Bay level Operating Mode (LDMODEXPF)

8.15.1 Description of the Function

See §4.4.2, §8.12

8.15.2 LNs used

LN	Description
IHMI	This LN represents the operator interface on two levels: 1. Front panel of the operator interface at the unit used for configuration and local control, 2. Local operator interface (HMI) used as a work station for the substation operator. The role of the different IHM is not set for most of the functions and it is defined during the engineering phase.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.

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8.15.3 Specificities

- The substation operation mode is represented by LDMODEXPS, and the bay operation mode by using the LDMODEXPF (one instance per bay representing an outgoing feeder).
- The MODEXP function (cf. [8]) describes the criteria for handling signalisations, measures and for acceptance of commands according to the substation operation mode and the bay operation mode. These requirements are covered by the application level and are not present in this document, which only describes the LDMODEXPF interface.
- The signal "bay in maintenance" (TR.MAINT) is not directly generated by LDMODEXPF.
- The signal "Remote trip in test mode" is generated by LDTAC/LLN0.Beh and is not described in LDMODEXPF.
- The signal "bay in local/remote operation mode" is modelled by the DO LDMODEXPF/LLN0.LocSta. It is applicable to all controllable objects of the functional bay associated to a feeder (eg. automaton, LDCMDDJ and LDCMDSxy). The application associated to these LD verifies for these objects check if a control is allowed.
- LDMODEXPF/**IHMI0**.LocSta results from the bay operation mode set by PO in LDMODEXPF/**LLN0**.LocSta and the substation operation mode indicated by subscribed LDMODEXPS/IHMI.LocSta
- The transmission of data by the Telecontrol Gateway (LDGW §0) takes into account the value of LDMODEXPF/IHMI0.LocSta.
- Some commands can be configured as independent of the substation operation mode. For these commands, the command authority only depands on the value of the bay operation mode modelled by LDMODEXPF/LLN0.LocSta.

8.15.4 Static description

Bay level Operating Mode (LDMODEXPF)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
IHMI0	Beh	ENS		
	Loc	SPS		
	LocSta	SPC		"LocSta to be used by LD of the functional bay and GW resulting from Site mode and bay mode
LLN0	InRef*	ORG		
	Beh	ENS		
	Health	ENS		Health of the function
	LocSta	SPC	TR.LOCAL	Command/signal "bay in local/remote mode
	Mod	ENC		
	NamPlt	LPL		

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8.15.5 Dynamic description

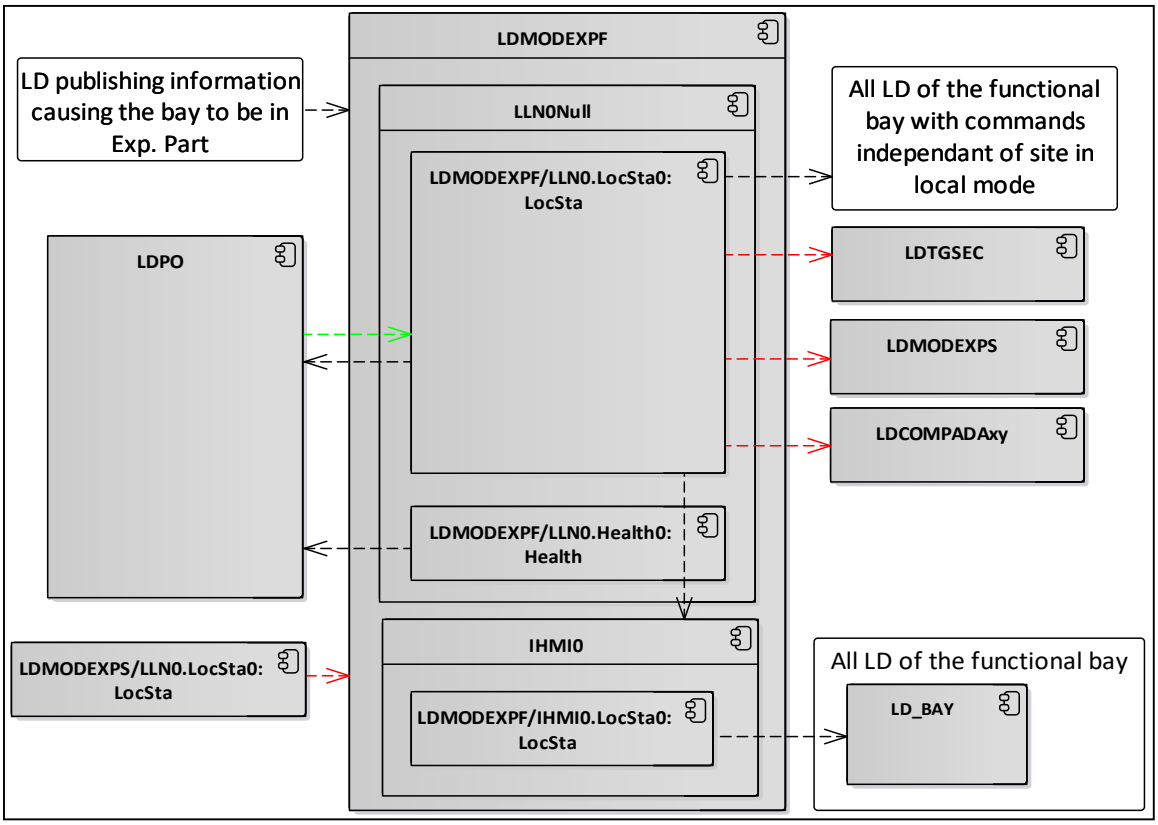

Figure 67: Dynamic description LDMODEXPF

8.16 Substation in Backup Alarm (Alarme Secours)

Cf. §8.14 (LDMODEXPS)

8.17 Bay Level Disturbance Recording (LDEPF)

8.17.1 Description of the Function

The LD EPF represents the disturbance recording function of the functional bay associated to a feeder.

8.17.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
LSET	Rte Extended Setting LN
RADR	In addition to the channel number, all attributes needed for the COMTRADE file (IEEE C37.111:1999) are provided either by data objects from the TVTR or TCTR or by attributes of the measured value (samples subscribed from TVTR or TCTR) itself or by data objects from pseudo channels (calculated values, derived values of power quality devices). The "circuit component" and "phase identification" is provided by the instance identification of the LN RADR. Channels "1" to "n" are created by "1" to "n" instances.

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LN	Description
RBDR	In addition to the channel number, all attributes needed for the COMTRADE file (IEEE C37.111:1999) are provided by attributes of the binary input (subscribed from another LN). The "circuit component" and "phase identification" is provided by the instance identification of the LN RBDR. Channels "1" to "n" are created by "1" to "n" instances.
RDRE	For consistent modelling, the disturbance recorder function described as a requirement in IEC 61850-5 is decomposed into one LN class for analogue channels (RADR) and another LN class for binary channels (RBDR). The output refers to the "IEEE Standard Format for transient data exchange (COMTRADE) for power systems" (see IEEE C37.111:1999). Disturbance recorders are logical devices built up with one instance of LN RADR or LN RBDR per channel. Since the content of logical devices (LD) are not standardised, other LNs may be inside the LD "disturbance recorder" if applicable. All enabled channels are included in the recording, independently of the trigger mode (TrgMod).

8.17.3 Specificities

- The bay level disturbance recording function (LDEPF) subscribes to the LDTM for the recording of analog values. Furthermore, according to the configuration of the function, it can subscribe, in the functional bay, to all DO of the bay.
- In order to enable starting of all disturbance recorders of a voltage level, the LDEPF publishes and subscribes to the station level disturbance recorder function (LDEPS).
- For each LDEPF function, it is possible individually to

  Turn the function on/off (LLN0.Mod).
  Inhibit the emission of init to the LDEPS function (RDRE2.Mod).
  Inhibit reception of init received from the LDEPS function.

- The DO RDRE3.TrgMod is used to inhibit the reception of init from the LDEPS function. Depending on its value, the trip is:

  1. (Internal): Init by functions of the associated bay.
  2. (External): Init by LDEPS
  3. (Both) Init by both (bay functions and LDEPS)

- Common DO and parameters for the recording function are supported by LDRE3.
- To set the label of the different channels in the disturbance file, a LN RADR is instanciated for each analog channel and a LN RBDR for each binary channel. The label is given in the UNICODE STRING 255 dU associated to the DO ChNum1.
- The file name of the record generated by LDEPF contains the bay name derived from the SCL file.

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- Two types of initialisation signals for fault recording exist. One is used for a continous recording (case of protections), represented by LN RDRE1. The second, represented by LN RDRE2, is a recording of limited time, e.g. used for manual init of recording or for a signal with slow evolution (e.g. overload protection or zero sequence voltage anomaly (ANO.TCT). The duration of the recording of this latter case is indicated by LSET.DlTmms2.
  It is necessary to use two different LN for these two type of recordings since the ReTrgMod is different for both ("true" for RDRE1 giving the possibility of re-triggering and "false" for RDRE2 indicating a unique recording without taking into account a possible re-trigger condition.
- The dynamic description (cf. §8.17.5) only shows signals of LDEPF subscribed and published to LDEPS and HMI. All other init and recorded signals are not shown in the dynamic description in order to simplify its presentation.
- It may be useful to trigger disturbance record also for faults on another voltage level. LDEPF can thus subsribe to several LDEPS/RDREx.RcdStr each corresponding to a different voltage level.

8.17.4 Static description

Bay Level Disturbance Recording (LDEPF)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		LDEPF on/off signal
	Health	ENS	DF.EP	Health of the LDEPF function
	Mod	ENC		Activation/deactivation command
	NamPlt	LPL		
LSET0	DlTmms1	ING.setVal	T-EP	Maximal time for recording
	NamPlt	LPL		
	DlTmms2	ING.setVal		Duration of disturbance recording in case of manual initialisation or slowly evolving signals
RADRx	ChNum1	ING.dU		Label of the analog channel X
RBDRx	Beh	ENS		
	ChNum1	ING.dU		Label of the binary channel Y
RDRE1	Beh	ENS		
	FltNum	INS		Fault number
	PreTmms	ING.setVal	T-PREDEF	Pre-trigger time
	PstTmms	ING.setVal	T-POSTDEF	Post-trigger time
	ReTrgMod	SPG		Set to true : continuous recording
RDRE2	Beh	ENS		
	FltNum	INS		Fault number

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Bay Level Disturbance Recording (LDEPF)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	PreTmms	ING.setVal		Pre-trigger time
	PstTmms	ING.setVal		Post-trigger time
	ReTrgMod	SPG		Set to false : one shot recording
RDRE3	RcdMade	SPS		Disturbance recording end signal.
	RcdStr	SPS		Disturbance recording start signal.
	RcdTrg	SPC		Used for the manual triggering of a recording from the HMI.
	FltNum	INS		Fault number
	TrgMod	ENG		1 (internal): Init by function of the functional bay. 2 (external): Init by EDEPS 3 (both) Init by the both (bay functions and LDEPS)
	Beh	ENS		Status of recording init to LDEPS.
	Mod	ENC.stVal	EMREP	On/off command of trigger of substation level trigger of disturbance recordering to LDEPS (trigger of disturbance recorders of other bays.
RADRx	LevMod	ENG		Signal triggers or not fault recording
	Beh	ENS		
	SrcRef	ORG		Source reference of the channel among LDEPF input signals
RBDRx	LevMod	ENG		Signal triggers or not fault recording
	SrcRef	ORG		Source reference of the channel among LDEPF input signals

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8.17.5 Dynamic description

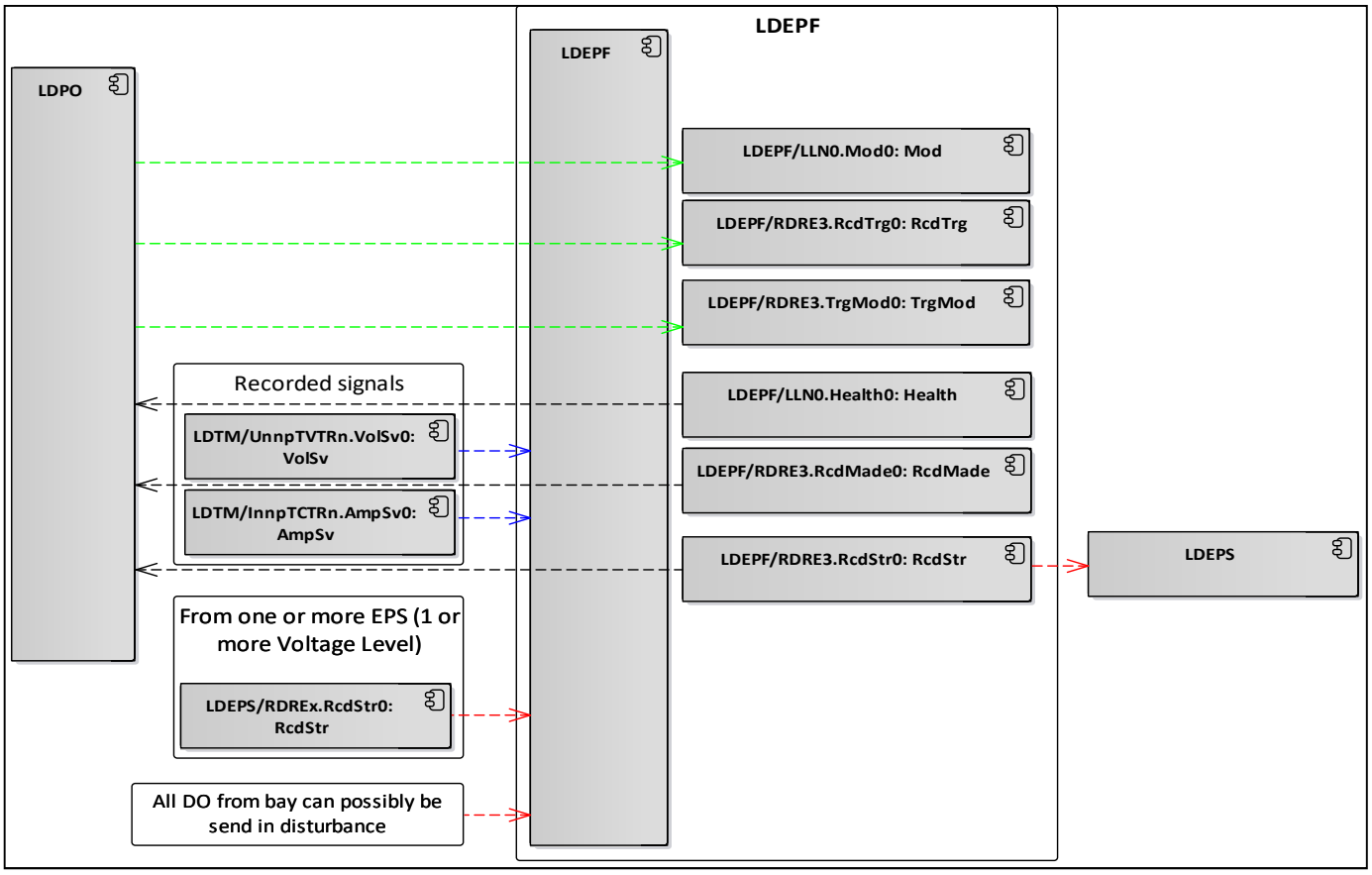

Figure 68: Dynamic description LDEPF

8.18 Substation level Disturbance Recording LD- Site (LDEPS)

8.18.1 Description of the Function

The LDEPS represents the disturbance recording function at the site.

8.18.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
RDRE	For consistent modelling, the disturbance recorder function described as a requirement in IEC 61850-5 is decomposed into one LN class for analogue channels (RADR) and another LN class for binary channels (RBDR). The output refers to the "IEEE Standard Format for transient data exchange (COMTRADE) for power systems" (see IEEE C37.111:1999). Disturbance recorders are logical devices built up with one instance of LN RADR or LN RBDR per channel. Since the content of logical devices (LD) are not standardised, other LNs may be inside the LD "disturbance recorder" if applicable. All enabled channels are included in the recording, independently of the trigger mode (TrgMod).

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8.18.3 Specificities

- A LN RDRE instance is instanciated for each voltage level
- DO RDREx.RcdStr

The function can be activated or deactivated

8.18.4 Static description

Substation level Disturbance Recording LD- Site (LDEPS)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		Status of recording init to LDEPS.
	Health	ENS	DF.EP	Health of the LDEPS function
	Mod	ENC		Activation/deactivation command
	NamPlt	LPL		
RDREx	Beh	ENS		
	RcdMade	SPS		A LN RDRE is instanciated for each voltage level
	RcdStr	SPS		Disturbance recording start signal to bay level disturbance recorders of voltage level x(LDEPF)
	RcdTrg	SPC		Used for the manual triggering of a recording from the HMI of a recording of all recorders of voltage level x

8.18.5 Dynamic description

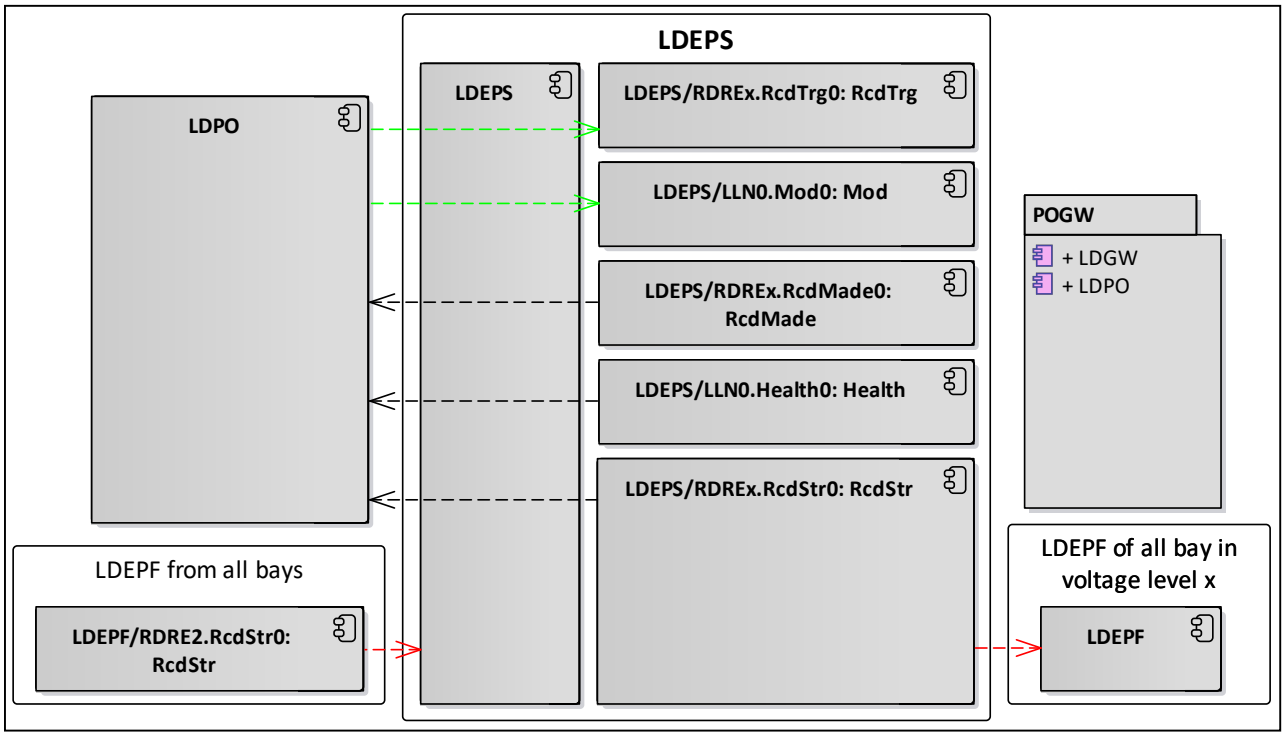

Figure 69 Dynamic description LDEPS

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8.19 Bay level Trip Transfer (LDTRANSFERTF)

8.19.1 Description of the Function

The LD LDTRANSFERTF represents the Trip Transfer function of the functional bay associated with a feeder. This function is used in case of circuit breaker outage of the feeder.

The trip orders are either transferred to the busbar coupler circuit breaker (Transfert mode) or generated by the protection of the busbar coupler (full line backup mode). In both cases, this requires to adapt a particular topology, leaving only the transferred feeder on one busbar.

8.19.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
CALH	CALH allows the creation of group warnings, group indications and group alarms. The individual alarms, which are used to calculate the group indications/alarms/warnings, are subscribed from elsewhere. The calculation is a local issue, usually performed by a logic scheme.
PSCH	This LN shall be used to model the logic scheme for line protection function co-ordination. The protection scheme allows the exchange of the "operate" outputs of different protection functions and conditions for line protection schemes. It includes data objects for teleprotection if applicable. In this case, all appropriate data objects shall be subscribed.

8.19.3 Specificities

FULL LINE BACKUP MODE

In FULL LINE BACKUP MODE (Secours Ligne), the protections and automatons of the busbar coupler bay substitute those of the bay associated to the feeder bay.

- For feeder bay, this mode implies deactivation of its LDDJ and LDADD of the functional bay (switch to "off").
- For the busbar coupler bay, this mode corresponds to the **TRANSFER TC** setting. In this case, the protections and automatons of the busbar coupler bay must be configured and set depending on the characteristics of the feeder.

TRANSFER

In "TRANSFER" mode, the protections and automatons of the feeder bay trip the circuit breaker of the busbar coupler bay.

- For the feeder, the "TRANSFER" mode implies
  - The publication of DO PSCH.TxTr subscribed by LDTRANSFERTC of the busbar coupler bay. This DO also initialises the LDADD of the busbar coupler.
  - To set LDDJ.Mod of the feeder to on/blocked.
  - LD TRANSFERTF subscribes to all the PTRC.Op of functions that trip the circuit breaker of the feeder bay.

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- LD TRANSFERTC subscribes to LDCMDDJ/CALH0.GrInd0 indicating closing of the circuit breaker (CRITENC). This information is published by LDTRANSFERTC/CALH0.GrInd0 and subscribed by LDTRANSFERTF which in turn publishes this DO for the relevant protection functions in the feeder functional bay.
- LD TRANSFERTF does not subscribe to the LDDJ of the backed-up feeder. This allows to maintain the transfer function operational in the event of SCU unavailability.

- For busbar coupler bay, this mode corresponds to the TRANSFER TD. In this case, the protection functions of the busbar coupler bay are to be switched to "off" mode.

In both cases, the HMI has to ensure overall consistency (only one feeder bay on transfer by voltage level, consistency of the modes of transfer selected).

8.19.4 Static description

(LDTRANSFERTF)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		Bay level Trip Transfer function On/Off signal.
	Health	ENS		Health of the function
	Mod	ENC		Bay level Trip Transfer function On/Off command.
	NamPlt	LPL		
CALH0	GrInd	SPS		
PSCH0	Beh	ENS		
	TxTr	ACT		
	Op	ACT		

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8.19.5 Dynamic description

Figure 70: Dynamic description LDTRANSFERTF

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8.20 Busbar Coupler Trip Transfer (LDTRANSFERTC)

8.20.1 Description of the Function

The LD LDTRANSFERTC represents the Transfer function for the busbar coupler bay.

This function also includes the INIT ARS function.

8.20.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
CALH	CALH allows the creation of group warnings, group indications and group alarms. The individual alarms, which are used to calculate the group indications/alarms/warnings, are subscribed from elsewhere. The calculation is a local issue, usually performed by a logic scheme.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

8.20.3 Specificities

FULL LINE BACKUP MODE

In FULL LINE BACKUP MODE (Secours Ligne), the protections and automatons of the busbar coupler bay substitute those of the bay associated to the feeder bay.

- For feeder bay, this mode implies deactivation of its LDDJ and LDADD of the functional bay (switch to "off").
- For the busbar coupler bay, this mode corresponds to the **TRANSFER TC** setting. In this case, the protections and automatons of the busbar coupler bay must be configured and set depending on the characteristics of the feeder.

TRANSFER

In "TRANSFER" mode, the protections and automatons of the feeder bay trip the circuit breaker of the busbar coupler bay.

- For feeder bay, the "TRANSFER" mode implies
  - The publication of a DO PSCH.TxTr subscribed by LDTRANSFERTC of the busbar coupler bay. This DO also initialises the LDADD of the busbar coupler.
  - To set LDDJ.Mod of the feeder to on/blocked.
- For busbar coupler bay, this mode corresponds to "TRANSFER TD". In this case :
- The protection functions of the busbar coupler bay are to be switched to "off" mode.
- LD TRANSFERTC initialise LDADD in busbar coupler bay.
- If the recloser function of the busbar coupler bay has to be used, each LD TRANSFERTC/PTRC*.Op also initialises the recloser function (ARS Group).
- The DO LDPX.PTRC0.Op.phs* is used to indicate there was a trip issued by the busbar coupling distance protection A while in TRANSFERT mode.
- Recloser functions are not initialised in this case.

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- LD TRANSFERTC subscribes to LDCMDDJ/CALH0.GrInd0 indicating closing of the circuit breaker (CRITENC). This information is published by LDTRANSFERTC/CALH0.GrInd0 and subscribed by LDTRANSFERTF which in turn publishes this DO for the relevant protection functions in the feeder functional bay.

In both cases, the HMI has to ensure overall consistency (only one feeder bay on transfer by voltage level, consistency of the modes of transfer selected).

8.20.4 Static description

Busbar Coupler Trip Transfer (LDTRANSFERTC)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		Signal "Busbar Coupler Trip Transfer function On/Off ".
	Health	ENS		Health of the function
	Mod	ENC	TRANSFERT	Busbar Coupler Trip Transfer function On/Off command.
	NamPlt	LPL		
CALH0	Beh	ENS		
	GrInd	SPS		
PTRC1	Beh	ENS		
	Op	ACT		
	Tr	ACT		
PTRC2	Beh	ENS		
	Op	ACT.general		
	Op	ACT.phsA	DT.PXA.TF.PH*	
	Op	ACT.phsB	DT.PXA.TF.PH*	
	Op	ACT.phsC	DT.PXA.TF.PH*	
	Tr	ACT		

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8.20.5 Dynamic description

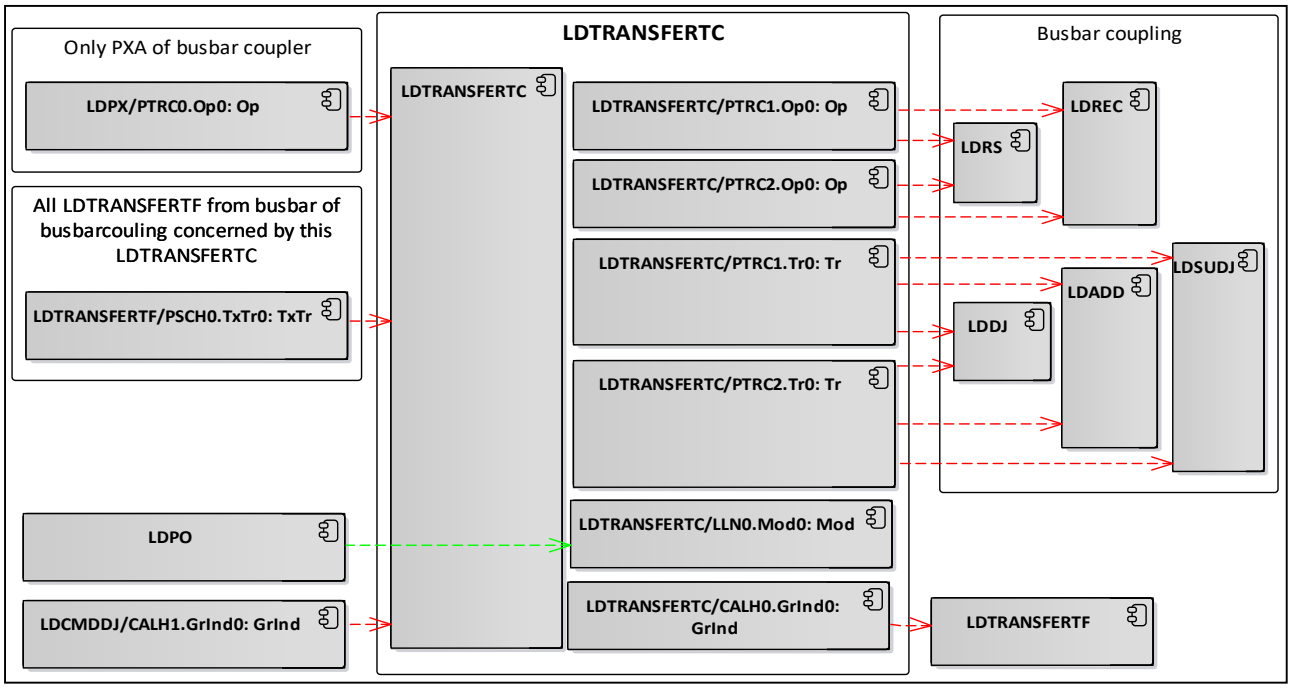

Figure 71: Dynamic description LDTRANSFERTC

8.21 Monitoring of busbar voltage (LDMQUB)

8.21.1 Description of the function

The LD MQUB represents the monitoring function of the busbar voltage of each busbar/section/segment for each voltage level.

8.21.2 LNs used

LN	Description
FXOT	Logical node FXOT shall be used to set a high-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, contro or alarm function is based on other physical measurements than primary electrical data.
FXUT	Logical node FXUT shall be used to set a low-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXUT can typically be used whenever a protection, control or alarm function is based on other physical measurements than primary electric data.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.

8.21.3 Specificities

- The absence of busbar voltage (Manque Tension Barres - MQUB) of a busbar element is identified if the corresponding voltage drops below a threshold (default 0.5*Vn) during at least Tub.

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- The presence of busbar voltage of a busbar element is identified if the corresponding voltage raises above a threshold (default 0.8*Vn). There is no time delay associated.
- The corresponding hysteresis is implemented on application level and not covered by the modelling.
- There is one couple of instances of LN FXUTx/FXOTx per busbar/section/segment dedicated for the monitoring of absence of busbar voltage.

8.21.4 Static description

Monitoring of busbar voltage (LDMQUB)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
FXOTx	Beh	ENS		
	Op	ACT		Indication of voltage presence on the busbar
	StrVal	ASG.setMag		Thershold for voltage presence (default 0.8*Vn)
FXUTx	Beh	ENS		
	Op	ACT	MQ.U.BARRE *	Indication of voltage absence of on the busbar
	OpDlTmms	ING		Time delay Tub (by default 3s) before signalling the absence of voltage
	StrVal	ASG.setMag		Threshold for absence of voltage (default 0.5*Vn)
LLN0	Beh	ENS		
	Health	ENS		Health of the function
	Mod	ENC		
	NamPlt	LPL		

8.21.5 Description dynamique

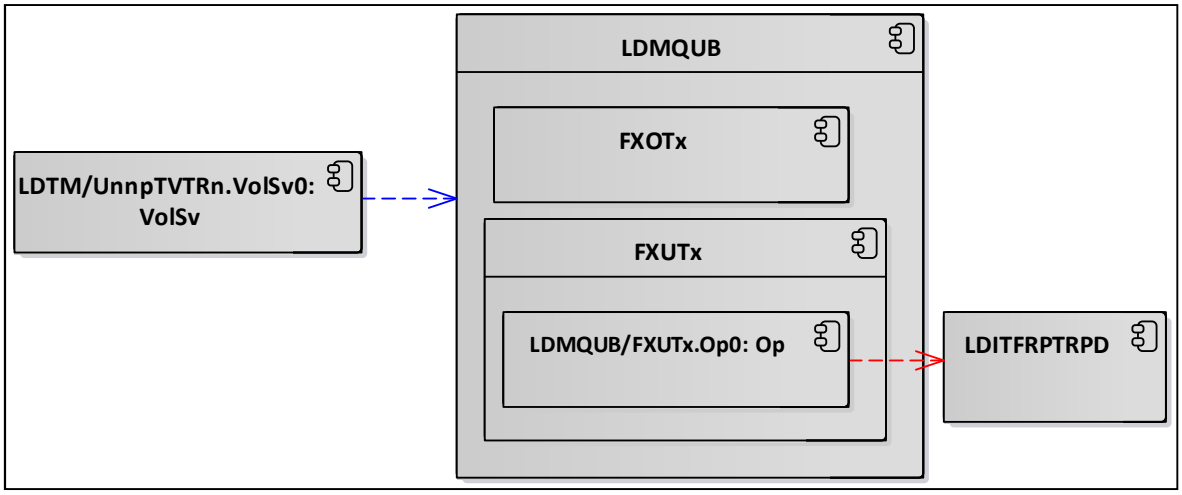

Figure 72: Dynamic description LDMQUB

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8.22 Grouping of Signals (LDGRP)

8.22.1 Description of the function

This LD is used to model grouping of signals, in general used for creating signals for the Event Recorder, PO or GateWay.

8.22.2 LNs used

LN	Description
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.

8.22.3 Specificities

- For each grouping, one LN GAPC is instanciated. Several types k of GAPC are identified in order to cover different variants of grouping (AND, OR, grouping of DO of ENUM type.
- kGAPC* may subscribe to DO which are not Boolean. In this case, the expected treatment to obtain Boolean output has to be specified on application or configuration level.
- LDGRP can subscribe to any DO. For this reason, it is not possible to display the corresponding dynamic description.
- This approach also enables the use of structured text describing the function in the GAPC Logical Node description inside the SCL file.
- If the grouped signals are to be grouped processing the operation mode of the bay (cf. LDMODEXPF § 8.15) or of the substation (LDMODEXPS § 8.14), the LDGRPP subscribes to this information and the logical equation of the grouping has to take this into account.

8.22.4 Static description

Grouping of Signals (LDGRPx)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
kGAPC*	Beh	ENS		
	Ind1	SPS	Grouped Name	Outpout of Grouping function of k type
LLN0	Beh	ENS		
	Health	ENS		Health of the function
	Mod	ENC		
	NamPlt	LPL		

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8.23 Busbar Topological Management Function (LDTOPO)

8.23.1 Description of the Function

This function is used to manage the topology of the busbar of a given voltage level. It indicates for each element the reference of the electrical node it is physically connected to.

8.23.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
LTED	Specific LN dedicated to the designation of the topological element.

8.23.3 Specificities

- One LN LTED is instanciated for each feeder connected to the busbar and for each busbar segment. The instance of LTED instanciated for the feeders is associated to the segment of the feeder the VT are connected to.
- LTEDx.ElNodeREef indicates the reference number of the Electrical Node as voltage reference for an Electrical Node.
- LDTOPO subscribes to the positons of all disconnectors and circuit breakers associated to the busbar.

8.23.4 Static description

Busbar Topological Management Function (LDTOPO)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Health of the function
BayNameLTED0	NamPlt	LPL		
	ElNodeRef	INS		Indicates the Electrical Node the element is connected to
LTEDbts	NamPlt	LPL		
	ElNodeRef	INS		Indicates the Electrical Node the element is connected to

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8.23.5 Dynamic description

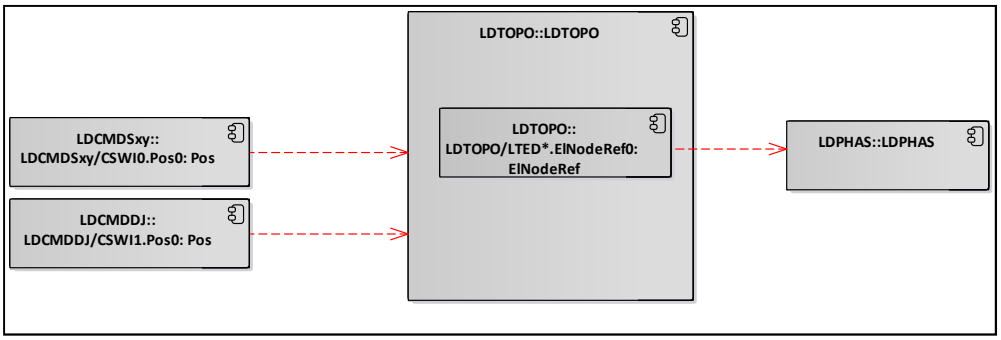

Figure 73: Dynamic description LDTPOPO

8.24 Test System (LDTEST)

8.24.1 Description of the Function

This function is used to perform test for the PACS functions.

8.24.2 Specificities

- The test system can be potentially subscribe to all DO of the PACS. This is not represented in the dynamic description.
- The Logical Nodes included in the LDTEST are designed for testing of PACS level functions, but my not be sufficient for testing all HMI level functions. For this, the test system would need to publish the complete data model used for the substation.
- Several LN of can be instantiated in the test system.
- All DO used in this document

8.25 Multiple Command Management Function (LDCMDMULT)

8.25.1 Description of the Function

This function is used to manage multiple commands. Multiple commands are simple commands receieved from remote control or local HMI which need to be dispatched to several clients. The LDCMDMULT performs this dispatch function.

8.25.2 LN Used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.

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8.25.3 Specificities

- One LDCMDMULT is instatiated for each multiple command. The prefix or suffix of the LDCMDMULT should reflect the nature of the command. E.g. LDCMDMULTDESARMU for the multiple command disabling
- GAPC0.SPCSO0 is used by the client to send the command. This command is processed by LDCMDMULT and published in form of GOOSE based on the GACPC0.Ind subscribed by the concerned second level functions.
- The acknowledgement from the second level functions is published by a DO depending on the nature of the command. These DO are subscribed by LDCMDMULTand processed in order to establish the acknowledgement towards the client the command has originated from.
- Different variants for the acknowledgement are possible:

1. Automatic Positive Acknowledgement regardeless of the GOOSE receieved from the second level functions. This variant is represented by an istanciation of GAPC1.
2. Acknowledgement based on GOOSE received from at least one second level function. This variant is represented by an istanciation of GAPC2.
3. Acknowledgement based on GOOSE received from at all one second level function. This variant is represented by an istanciation of GAPC3.

This is implemented on the application level and not reflected by the IEC 61850 model.

8.25.4 Static description

Multiple Command Management Function (LDCMDMULTx)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Health of the function
	Mod	ENC		
	NamPlt	LPL		
GAPC1	Beh	ENS		
	SPCSO1	SPC		Automatic Positive Acknowledgement regardeless of the goose received from the second level functions
	Ind1	SPS		
GAPC2	Beh	ENS		
	SPCSO1	SPC		Acknowledgement based on goose received from at least one second level function
	Ind1	SPS		
GAPC3	Beh	ENS		
	SPCSO1	SPC		Acknowledgement based on goose received from at all one second level function

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Multiple Command Management Function (LDCMDMULTx)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Ind1	SPS		

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9. Monitoring functions

9.1 Voltage or Current Circuit Faillure Monitor function (MQUI)

Confer § 4.3.4

9.2 Capactive Voltage Transformer Monitoring LD (LDSUTCT)

9.2.1 Description of the Function

The purpose of this function is to detect an anomaly of a Capacitve Voltage Transformer of a feeder.

9.2.2 LNs used

LN	Description
CALH	CALH allows the creation of group warnings, group indications and group alarms. The individual alarms, which are used to calculate the group indications/alarms/warnings, are subscribed from elsewhere. The calculation is a local issue, usually performed by a logic scheme.
FXOT	Logical node FXOT shall be used to set a high-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, contro or alarm function is based on other physical measurements than primary electrical data.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
PSCH	This LN shall be used to model the logic scheme for line protection function co-ordination. The protection scheme allows the exchange of the "operate" outputs of different protection functions and conditions for line protection schemes. It includes data objects for teleprotection if applicable. In this case, all appropriate data objects shall be subscribed.
PTRC	This LN shall be used to connect the "operate" outputs of one or more protection functions to a common "trip" to be transmitted to XCBR. In addition, or alternatively, any combinat "operate" outputs of the protection functions may be combined to a new "operate" of PTRC.

9.2.3 Specificities

- The LN CALH generates the signal indicating an abnormal situation of the CVT (ANO.TCT). FXOT1 (Vres), carries the T-ANOTCT time-delay setting.
- The residual voltage used by FXOT1 to produce the signal "Presence of Residual Voltage" and its derivative used by FXOT2/3/4, are calculated by the application using the voltages supplied by LDCAP (LDCAP.MMXU0.PhV).
- Specification (cf. [2]) asks for an indication of the presence of voltage in the feeder associated to the SUTCT function. In the modelling, this indication is supplied by the FXOT1 of the LDCMDDJ (and not by LDSUTCT).
- The reverse voltage used by FXOT5 to elaborate the « Presence of reverse voltage » signal is computed from the different voltages provided by the LDCAP function (LDCAP.MMXU0.PhV). The specification (cf. [2]) plans to indicate the presence of line voltage as an output from the SUTCT function. In the modelling this information is provided by LN FXOT1 from LDCMDDJ function which integrates voltage control.

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- The signal ANO.TCTU (FXOT3.Op) is not used in every case. In the case where this signal is not needed in configuration, the FXOT3.Mod will not be instanciated.
- The signal TS ANO.TCTU (FXOT4.Op) might be associated to a fast drift of the CVT. In the case where this signal is not needed in configuration, the FXOT4.Mod will not be instanciated.
- CVT monitoring of busbar CVT will be associated to a specific function (LDSUTCTBB)

9.2.4 Static description

CVT Monitoring LD (LDSUTCT)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
CALH1	Beh	ENS		
	GrInd	SPS	ANO.TCT	OR grouping of FXOT1.Op and FXOT5.Op
CALH2	Beh	ENS		
	GrInd	SPS	ANO.TCTbts	
FXOT1	Beh	ENS		
	Op	ACT		Indication "Presence of Residual Voltage" (for maintenance).
	OpDlTmms	ING	T-ANO.TCT	Time delay of the signal "presence of residual voltage (Vres)"
	StrVal	ASG.setMag	S-VRESID	Signal "presence of residual voltage (Vres)" threshold
FXOT2	Beh	ENS		
	Op	ACT		Threshold based on the derivative of the residual voltage,
	OpDlTmms	ING	T-DERIVE-LENTE-TCT	Time delay of the signal "derivated of residual voltage (Vres)"
	StrVal	ASG.setMag		Signal "derivated of residual voltage (Vres)" threshold
FXOT3	Beh	ENS		
	Op	ACT	ANO.TCTU	Uses the derivative of the residual voltage, which is an elaborated measurement (condition for use of FXOT). Associated with T-DERIVE-RAPIDE-TCT.
	StrVal	ASG.setMag		Signal "presence of fast residual voltage (Vres)" threshold
FXOT4	Beh	ENS		
	Op	ACT		Uses the derivative of the residual voltage, which is an elaborated measurement (condition for using FXOT) to supply the decision to trip.
	OpDlTmms	ING	T-DERIVE-RAPIDE-TCT	Time delay of the signal "derivated of fast residual voltage (Vres)"
	StrVal	ASG.setMag		Signal "derivated of fast residual voltage (Vres)" threshold
FXOT5	Beh	ENS		Signal "Negative sequence voltage CVT monitoring function On/Off ".

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CVT Monitoring LD (LDSUTCT)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Mod	ENC.stVal	MES-SVINV	Negative sequence voltage CVT monitoring function On/Off command.
	Op	ACT		Threshold overflow for CVT voltage
	StrVal	ASG.setMag	S-VINVER	Signal "presence of residual voltage (Vres)" threshold
LLN0	Beh	ENS		
	Health	ENS		Health of the SUTCT function
	Mod	ENC.stVal	MES-SUTCT	
	NamPlt	LPL		
PSCH0	Beh	ENS		
	TxTr	ACT		Remote trip order
	Op	ACT		
PTRC0	Beh	ENS		
	Op	ACT		New functionality not covered by document T5. Tripping decision of 3 phases. Should be associated with an FCS signal.
	Tr	ACT		Trip order to XCBR

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9.2.5 Dynamic description

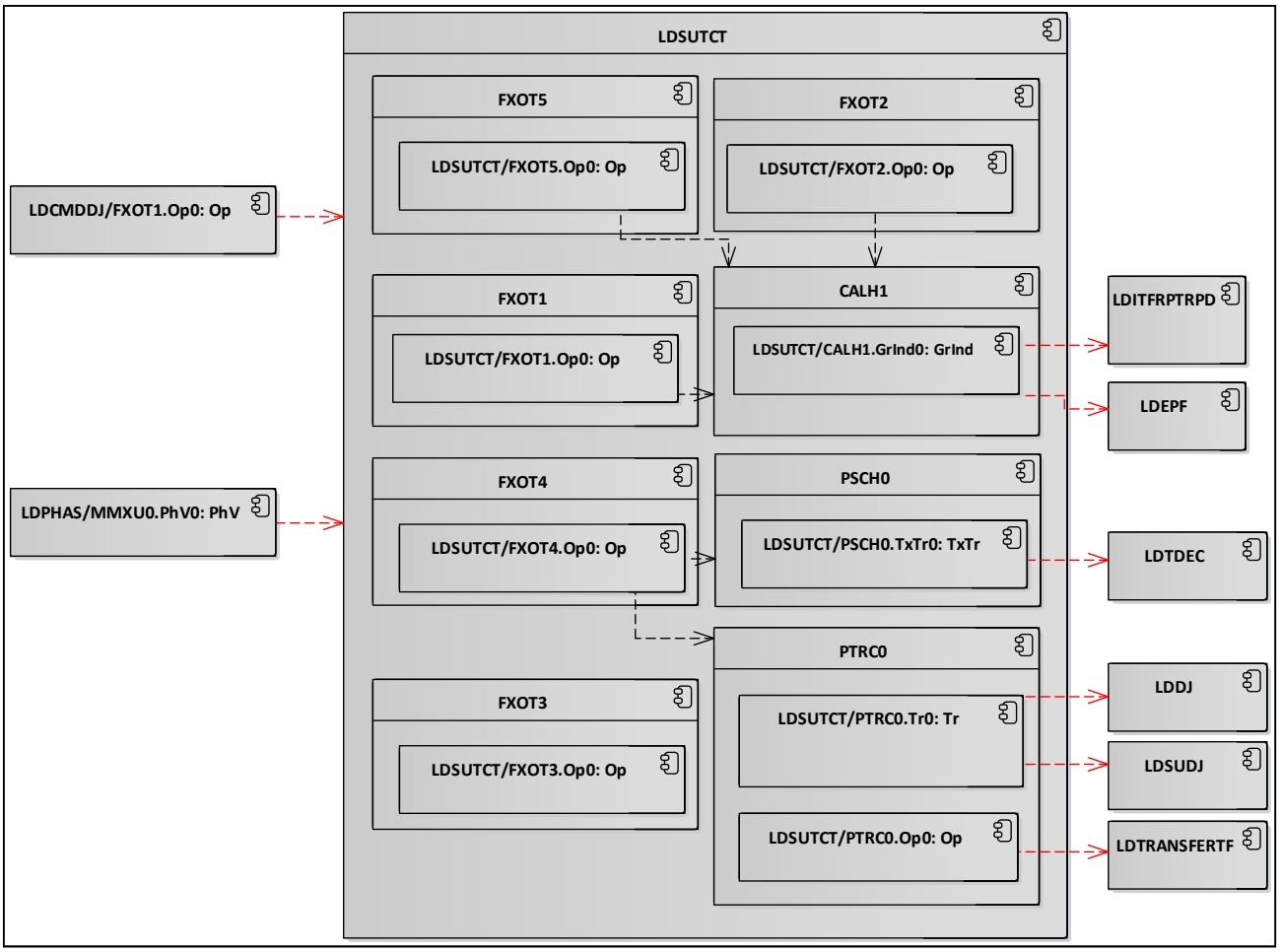

Figure 74: Dynamic description LDSUTCT

9.3 SF6 Cable connector monitoring LD (LDSUTDCSF6)

9.3.1 Description of the Function

N/A

9.3.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
SIMG	Insulation medium is gas, for example SF6 in gas isolated devices. For other measuring objects related to the same IED, a new instance of SIMG may be used. If the new measuring point(s) is/are related to a new IED, in this new IED a new instance of SIMG shall be used.

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9.3.3 Specificities

- For cable connectors located at a transition point between an overhead and an underground section of a mixed line, SF6 pressure signals can be acquired and transmitted by the cable differential protection that is installed at the transition point.

9.3.4 Static description

SF6 Cable head monitoring LD (LDSUTDCSF6)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Health of the function
	Mod	ENC		
	NamPlt	LPL		
SIMG11	PresAlm	SPS		Overpressure alarm
	InsAlm	SPS	COMP.TCAB.**.xy COMP.TRAV.SF6**	SF6 alarm per phase at cable end located in substation.
SIMG12	PresAlm	SPS		Overpressure alarm
	InsAlm	SPS	COMP.TCAB.**.xy COMP.TRAV.SF6**	SF6 alarm per phase at cable end located in substation.
SIMG13	PresAlm	SPS		Overpressure alarm
	InsAlm	SPS	COMP.TCAB.**.xy COMP.TRAV.SF6**	SF6 alarm per phase at cable end located in substation.
SIMG14	PresAlm	SPS		Overpressure alarm
	InsBlk	SPS	ISOL.CABL.POSTE ISOL.CABL.LIG	Stage 2 alarm of the 3 phases grouped for cable ends located at the substation.
SIMG21	PresAlm	SPS		Overpressure alarm
	InsAlm	SPS	COMP.TCAB.**.xy COMP.TRAV.SF6**	Alarm SF6 per phase at cable end located at transition point
SIMG22	PresAlm	SPS		Overpressure alarm
	InsAlm	SPS	COMP.TCAB.**.xy COMP.TRAV.SF6**	Alarm SF6 per phase at cable end located at transition point
SIMG23	PresAlm	SPS		Overpressure alarm
	InsAlm	SPS	COMP.TCAB.**.xy COMP.TRAV.SF6**	Alarm SF6 per phase at cable end located at transition point
SIMG24	PresAlm	SPS		Overpressure alarm

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SF6 Cable head monitoring LD (LDSUTDCSF6)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	InsBlk	SPS	ISOL.CABL.POSTE ISOL.CABL.LIG	Stage 2 alarm of the 3 phases grouped for cable ends located at transition point.

9.3.5 Dynamic description

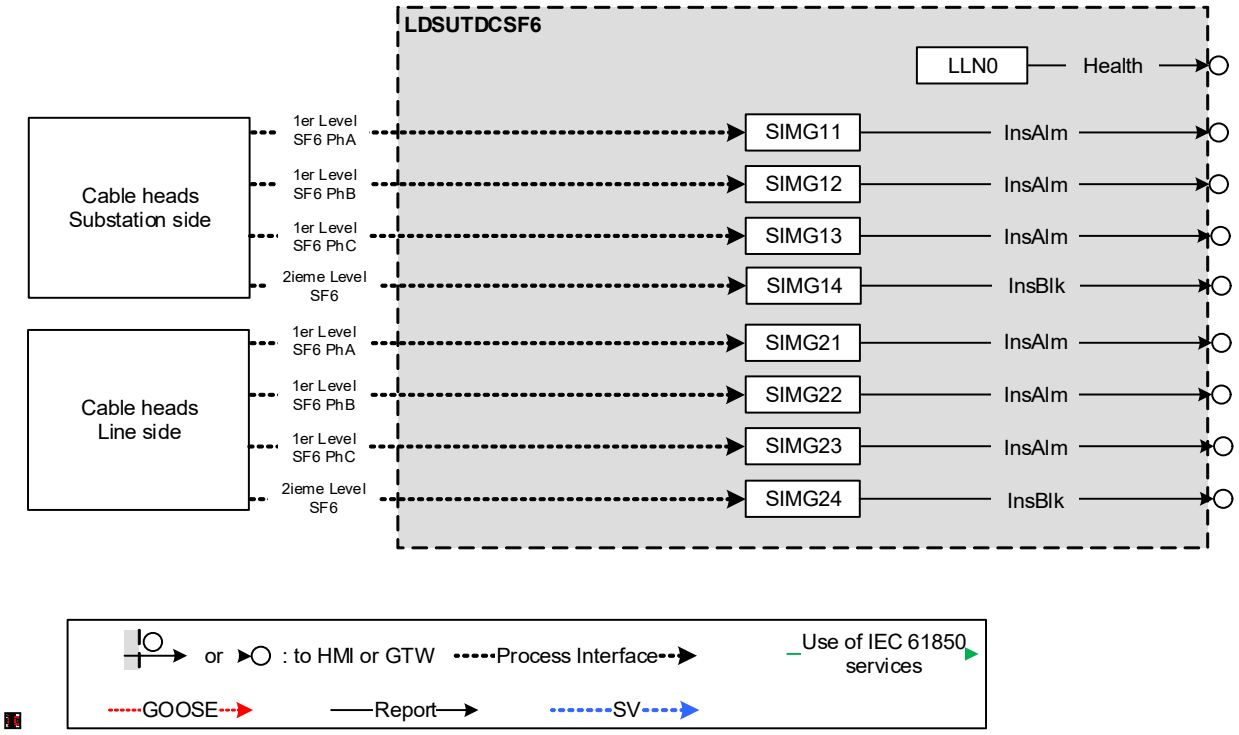

Figure 75: Dynamic description LDSUTDCSF6

9.4 Circuit Breaker Monitoring (LDSUDJ)

9.4.1 Description of the Function

This function is used for monitoring of a high voltage circuit breaker. The data are defined in the document dedicated to HV equipement monitoring and measurement of ambient conditions.

9.4.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
SARC	LN for controlling the volumes of gas from GIS (gas insulated switch), for the switching arcs and arcs resulting from faults.
SCBR	This LN is used for supervision of circuit breakers. Operating a breaker and especially tripping a short circuit causes always some abrasion (or erosion) of the breaker contacts. The supervision is per phase since each phase has its own contact.

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LN	Description
SIMG	Insulation medium is gas, for example SF6 in gas isolated devices. For other measuring objects related to the same IED, a new instance of SIMG may be used. If the new measuring point(s) is/are related to a new IED, in this new IED a new instance of SIMG shall be used.
XCBR	This LN is used for modelling switches with short circuit breaking capability. Additional LNs, for example SIMS, etc. may be required to complete the logical modelling for the breaker being represented. The closing and opening commands shall be subscribed from CSWI or CPOW if applicable. If no "time activated control" service is available between CSWI or CPOW and XCBR, the opening and closing commands shall be performed with a GSE-message (see IEC 61850-7-2).

9.4.3 Specificities

- Each LDSUDJ of a circuit breaker is associated with a LDDJ and LDITFSUDJ providing the interface with the primary equipment and to a LDCMDDJ, providing control of this same circuit breaker. This triplet is represented in the dynamic modelling (cf. §9.4.5).
- LN SCBR1* is used to calculate the amperes cut by the circuit breaker. To do this, it uses the analog values sampled by the SAMU combined with the position indication of each pole.
- The measurement of the operating time by acoustic sensor is integrated in the LDITFSUDJ.
- The DO SIMG0.InsAlm represents the alarm when an alarm threshold of the change rate of the measured SF6 pressure is exceeded. This rate is calculated by the application associated with the LDSUDJ.
- The LN XCBR is used for counting circuit breaker operation.
- Information related to withdrawable circuit breakers are covered by LDCMDDJ
- The fault arc counter can be reset to zero or to another value by MMS access to the DO FACntRS.

9.4.4 Static description

Circuit Breaker Monitoring (LDSUDJ)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Health status of circuit breaker monitoring function
	Mod	ENC		
	NamPlt	LPL		
SARC*	Beh	ENS		
	FADet	SPS		Switch Arc detected (* corresponds to the pole of the circuit breaker. * = 0 if a common cabinet, * = 1, 2 or 3 if instantiated per phase).
	FACntRs	INC		Fault arc counter
SCBR*	AccmTmh	BCR		Operating time of the trip and reclosing coils (cf.).
	Beh	ENS		
	NamPlt	LPL		

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Circuit Breaker Monitoring (LDSUDJ)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	ColOpn	SPS		Open command of trip coil
	IntSumSqA	BCR		Sum of A² cut. The 90-3 proposes a SumSqA in the LN destined for surveillance of the power TR. As the latter is APC type, it cannot be used here.
	RctTmOpn	MV		Measurement of the operating time based on SV
	SwA	MV		Measurement of amperes cut at each manoeuvre/ of the cricuit breaker.
SIMG0	Beh	ENS		
	PresAlm	SPS		Overpressure alarm
	InsAlm	SPS		Alarm when exceeding an alarm threshold of the measured SF6 pressure.
XCBR0	Beh	ENS		
	OpCnt	INS		Counter of operation (used for monitoring).

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9.4.5 Dynamic description

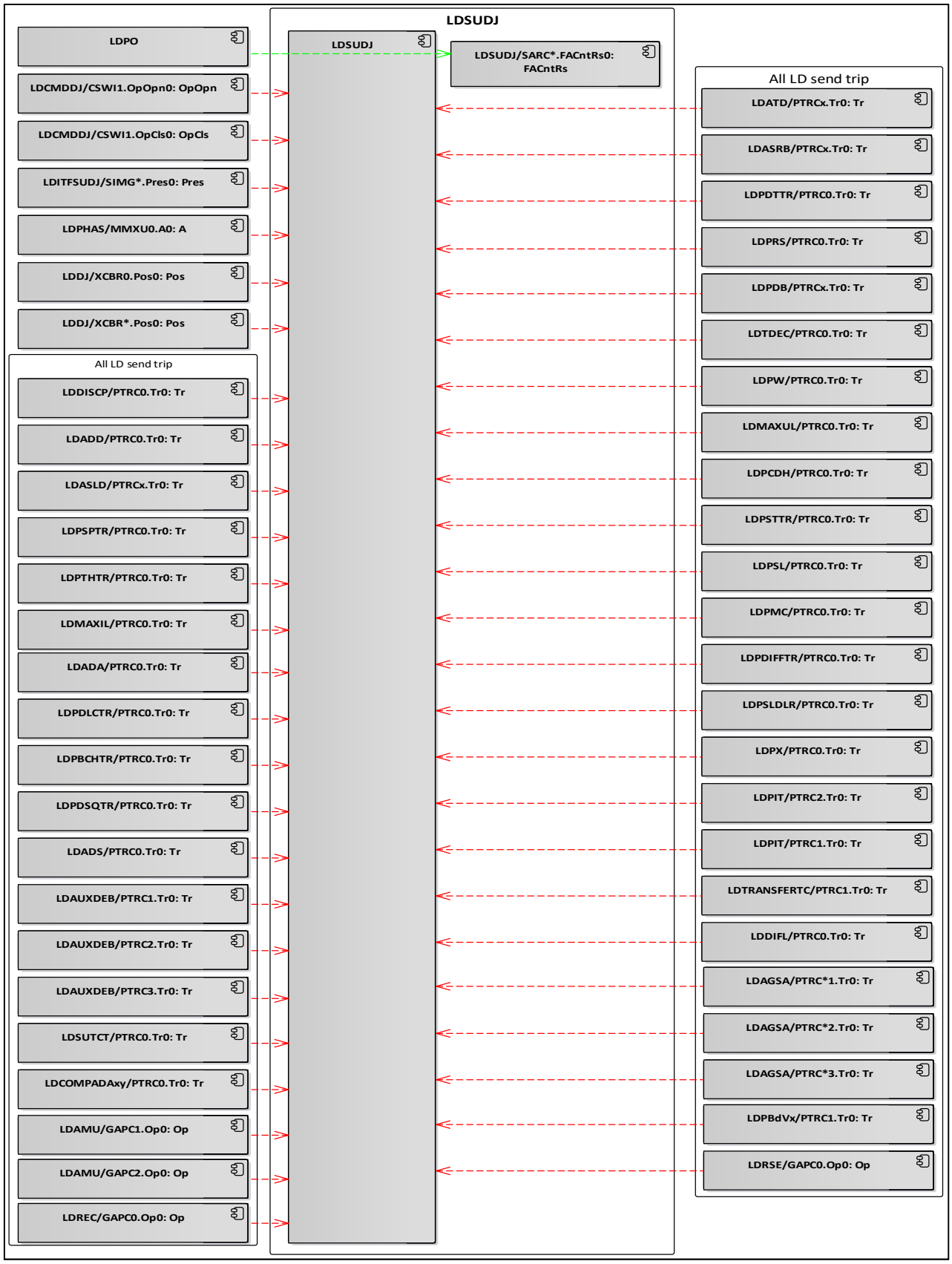

Figure 76: Dynamic description LDSUDJ

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9.5 Disconnector Monitoring Sxy (LDSUSxy)

9.5.1 Description of the Function

This function is used for monitoring of a high voltage disconnector. The data are defined in the document dedicated to HV equipement monitoring and measurement of ambient conditions (cf: I12).

9.5.2 LNs used

LN	Description
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
XSWI	This LN is used for modelling switches without short circuit breaking capability, for example disconnectors, air break switches, earthing switches, etc. Additional LNs, SIMS, etc. may be required to complete the logical model for the switch being represented. The closing and opening commands shall be subscribed from CSWI. If no "time activated control" service is available between CSWI or CPOW and XSWI, the opening and closing commands shall be performed with a GSE-message (see IEC 61850-7-2).

9.5.3 Specificities

- Each LDSUSxy of a disconnector is associated with a LDSxy.
- The LN XSWI is used for counting disconnector operation. The manoeuver counter counts the O/C cycles and not individual O or C manoeuvers.

9.5.4 Static description

Disconnector Monitoring Sxy (LDSUSxy)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Health of the function
	Mod	ENC		
	NamPlt	LPL		
XSWI0	Beh	ENS		Local Control behaviour
	Loc	SPS		Local Control behaviour
	OpCnt	INS		Counter of operation (used for monitoring).
	SwTyp	ENS		Switch Type
	Pos	DPC		Switch position
	BlkOpn	SPC		Block opening
	BlkCls	SPC		Block closing

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9.5.5 Dynamic description

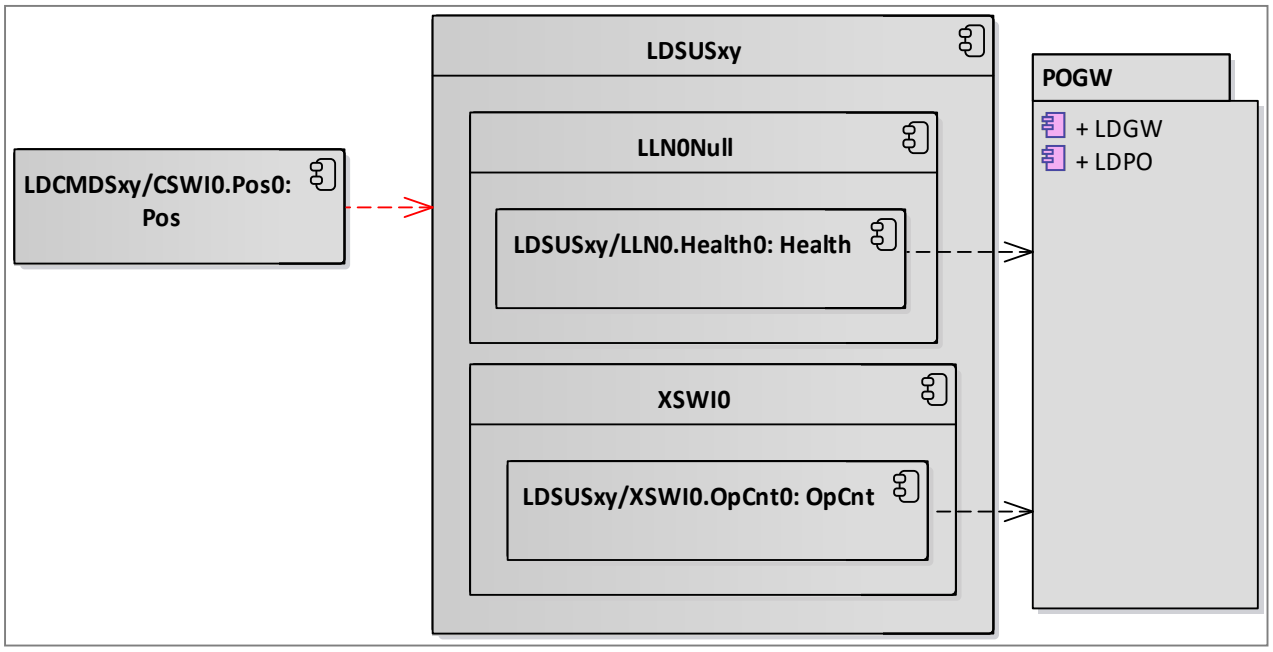

Figure 77: Dynamic description LDSUSxy

9.6 Transformer Cooling System Management LD (LDAEROTEMPTR)

9.6.1 Description of the Function

This function is used to start up the first group of air coolers and all oil circulation pumps for the following equipments:

- Autotransformers 400/225 kV
- VHV / HV transformers
- Primary reactance

It also manages the temperature alarm emitted by the thermal measurement sensors if the temperatuere exceeds the threshold defined and set by the manufacturer of the equipment to be protected.

9.6.2 LNs used

LN	Description
CCGR	This LN class shall be used to control the cooling equipment. One instance per cooling group shall be used.
KFAN	Logical node KFAN shall be used to represent a fan. It can be seen as an extended nameplate that allows the temporary setting of data object.
KPMP	Logical node KPMP shall be used to represent a pump. It can be seen as an extended nameplate that allows the temporary setting of data object.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.

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LN	Description
PTTR	PTTR shall be used for all thermal overload functions. Depending on the algorithm, the LN describes either a temperature or a current (thermal model). Temperature data objects are also provided by other LNs. Examples are the hot spot temperature in LN YPTR or the isolation gas temperature in LN SIMG.

9.6.3 Specificities

- An air cooling group contains one or more pumps and one or more ventilators. Each pump is linked to an LN KPMP, and each ventilator to an LN KFAN. These LN are linked to an LN CCGR, depending on the transformer configuration.
- The diagram does not show the link between the LN outgoing feeds and the wired controls for the ventilators and pumps. These binary outputs are managed by the applications.
- The temperature alarm is created by an LN PTTR associated with the temperature measurement at the top of the tank, and a binary input from a thermostat situated in the same place. The alarm is considered to be generated by the application.
- The management of temperature alarms of the Main Power Transformer Protection (PTP) is grouped together with the AEROTEMP LD by concern for consistency.
- It is considered that the function AEROTEMP is a function close to the process, which receives wired inputs/outputs from cooling units.

9.6.4 Static description

Transformer Cooling System Management (LDAEROTEMPTR)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
CCGRx	CECtl	SPC		Group x operation signal
	Beh	ENS		
	PmpAlm	SPS	ARR.POMP	Pump shut-down
KFANxy	OpCtl	SPC		Control of ventilo xy (group x, ventilo y)
KPMPxy	Beh	ENS		
	OpCtl	SPC		Control of pump xy (group x, pump y)
LLN0	Beh	ENS		
	Health	ENS		AEROTEMP function fault
	Mod	ENC		
	NamPlt	LPL		
PTTR1	AlmThm	SPS	AL.T.TPN or AL.T.BPN	TPN temperature alarm
	Beh	ENS		
PTTR2	Beh	ENS		
	AlmThm	SPS	AL.THERM	TP thermostat alarm

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9.6.5 Dynamic description

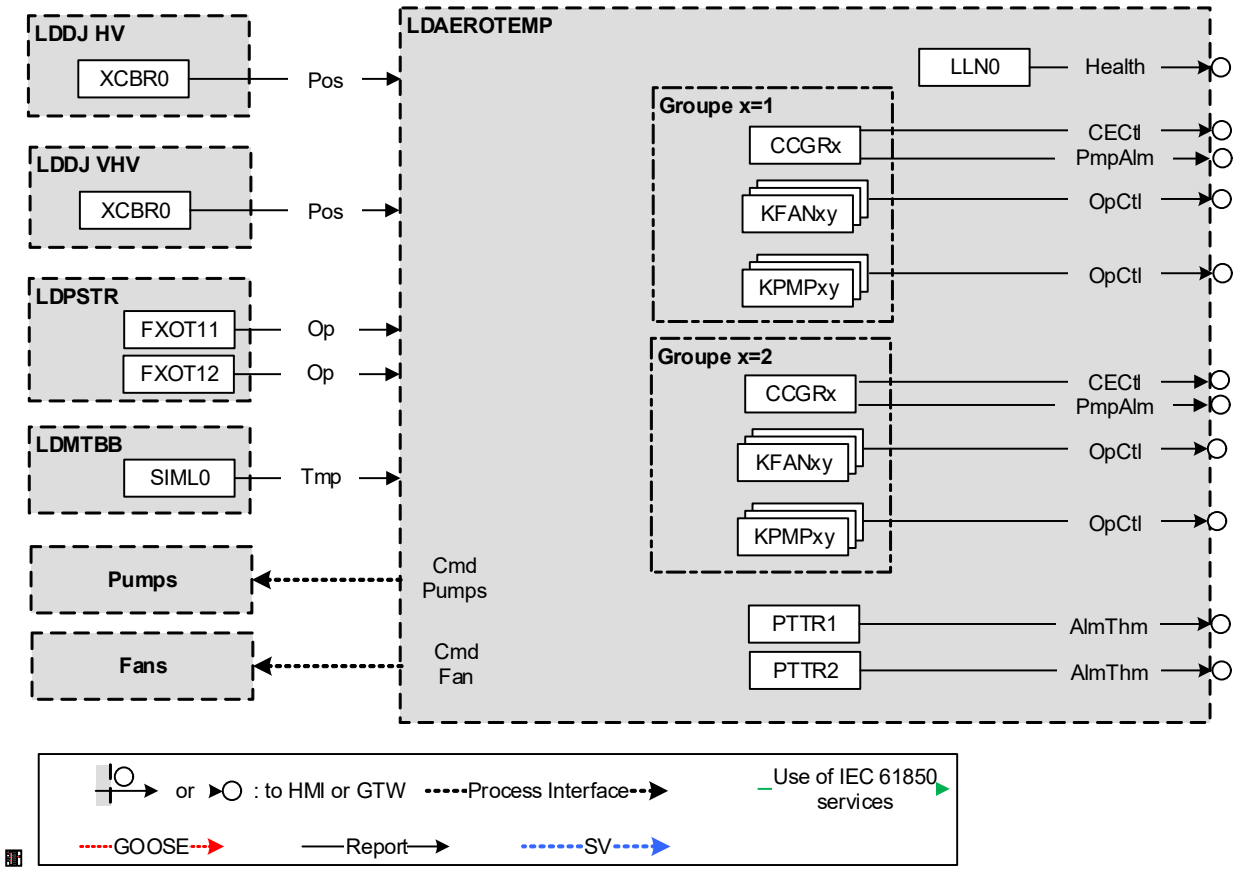

Figure 78: LDAEROTEMP dynamic description

9.7 Monitoring of field interface cubicle LD (LDSUACN)

9.7.1 Description of the Function

This LD represents the interface for the monitoring function of a Field Interface Cubicle (Armoire de Contrôle Numérique - ACN).

9.7.2 LNs used

LN	Description
FXOT	Logical node FXOT shall be used to set a high-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, contro or alarm function is based on other physical measurements than primary electrical data.
FXUT	Logical node FXUT shall be used to set a low-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXUT can typically be used whenever a protection, control or alarm function is based on other physical measurements than primary electric data.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.

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9.7.3 Specificities

- The start-up/shut-down logic for the ventilation and the heating is considered to be an application linked to the LDSUACN. The commands are sent by the LDSUACN to the LDITFACN by the communication services of Standard IEC 61850 (cf. [2]).

9.7.4 Static description

Monitoring of field interface cubicle LD (LDSUACN)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
Chauf_FXOT0	Op	ACT		Signal denoting exceedance of the temperature threshold associated with heating shutdown
	OpDlTmms	ING		Time delay for heating shutdown
	StrVal	ASG.setMag		Temperature threshold for heating shutdown
Vent_FXOT0	Op	ACT		Signal denoting exceedance of the temperature threshold associated with ventilation start-up
	OpDlTmms	ING		Time delay for ventilation start-up
	StrVal	ASG.setMag		Temperature threshold for ventilation start-up
Chauf_FXUT0	Op	ACT		Signal denoting exceedance of the temperature threshold associated with heating start-up
	OpDlTmms	ING		Time delay for heating start-up
	StrVal	ASG.setMag		Temperature threshold for heating start-up
Vent_FXUT0	Op	ACT		Signal denoting exceedance of the temperature threshold associated with ventilation shutdown
	OpDlTmms	ING		Time delay for ventilation shutdown
	StrVal	ASG.setMag		Temperature threshold for ventilation shutdown
LLN0	Beh	ENS		
	Health	ENS		Health of the LDSUACN function
	Mod	ENC		
	NamPlt	LPL		

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9.7.5 Dynamic description

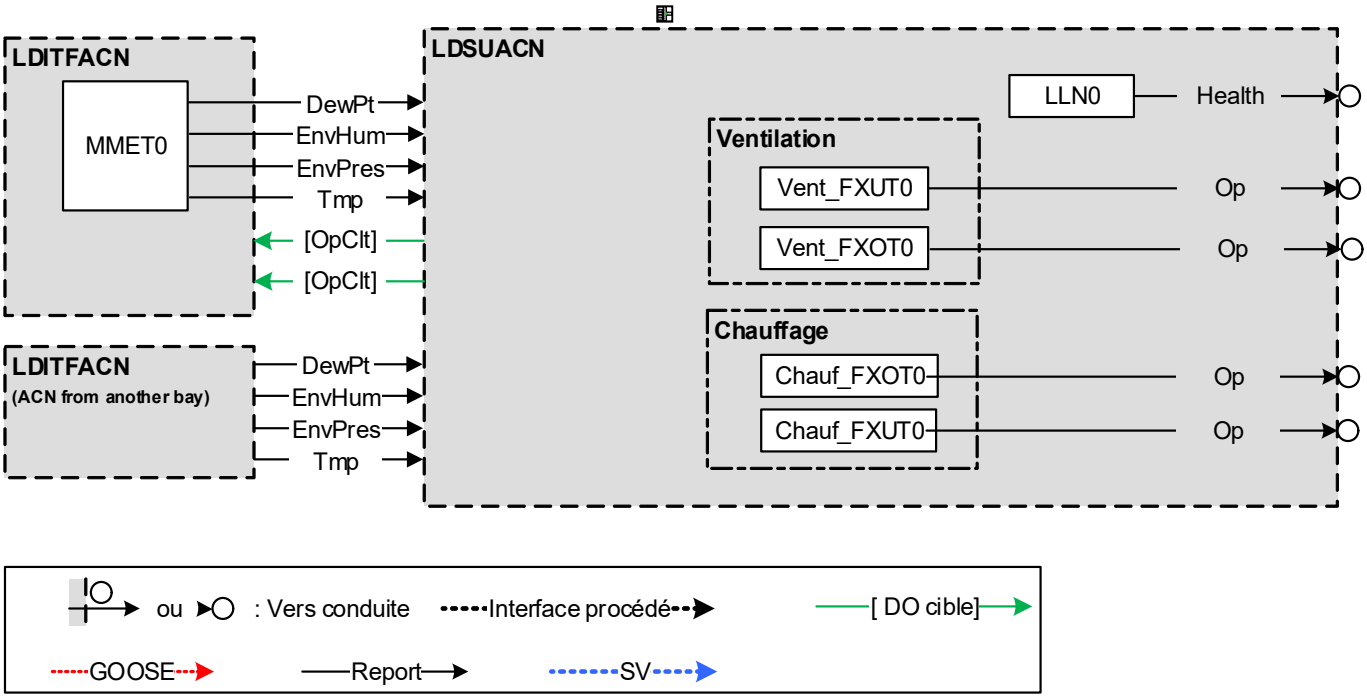

Figure 79: Dynamic description LDSUACN

9.8 IED Monitoring Function (LDSUIED)

9.8.1 Description of the Function

This LD represents the interface for monitoring of each IED. An instance of this LD is to be implemented in each IED. It also include markup of IED.

9.8.2 LNs used

LN	Description
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.
LCCH	This LN is introduced in this part to model common issues for physical communication channels. It is instantiated for each physical channel or each pair of link level redundant physical channels.
LGOS	The LN LGOS shall be used monitoring of GOOSE messages. There shall be one instance of LGOS per GOOSE subscription for a given GOOSE source. It allows for instance to diagnose the subscription state of a GOOSE message.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
LMBI	Proprietary Logical Node representing a ModBus interface
LMSI	Proprietary Logical Node representing a ModBus Slave interface

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LN	Description
LPHD	This LN is introduced in this part to model common issues for physical devices.
LPLE	Proprietary Logical Node representing a group of LED of the IED front panel
LSVS	The LN LSVS shall be used for diagnose and monitoring supervision of sampled value messages. There shall be one instance of LSVS per SV subscription for a given server. It allows for instance to diagnose the subscription of a SV message (status of subscription).
LTMS	The LN LTMS shall be used for the configuration and supervision of the time synchronization function in an IED.
LPDI	Proprietary Logical Node representing a group of Digital (Binary) Inputs
LPDO	Proprietary Logical Node representing a group of Digital (Binary) Outputs
LPAI	Proprietary Logical Node representing a group of Analogue Inputs
LTRK	This logical node allows tracking of service parameters for a server within IED. When used, service parameters will stay visible after the execution of service.
LPCP	This logical node is used to model communication ports
LSET	Rte Extended Setting LN

9.8.3 Specificities

- An instance of LGOS is to be implemented for each GOOSE subscribed by IED.
- An instance of LSVS is to be implemented for each SV subscribed by IED.
- A frontpannel LED on the IED itself to identify the IED for maintenance can be activated via DO GAPC.SPCSO1.
- LPHD.PwrSupAlm should be used to report a problem with the IED power board. In the case where the IED has a redundant power supply, the DO reports a problem on one or both of the cards.
- The LDSUIED/LLNO.PhyNam contains the NamePlate of IED which contains, among other things, information on the firmware and hardware version of the IED.
- The closing time of a contact is configured by pulseConfig.onDur
- The proprietary logical nodes representing the interfaces are used for the monitoring of these I/O and to map the physical terminal to the corresponding DO (LPDI, LPDO, LPLE, LPAI, LMBI and LMSI). They are based on the available draft of IEC 61850-7-5.
- One LN LMBI is instantiated for each ModBus port and one LN LMSI for each slave. Each LNBS is associated to a LMBI.
- For each type of IED, the necessary number of these proprietary logical nodes are instantiated.
- For the monitoring of each physical communication channel, a LN LCCH is instantiated. This includes ModBus communication ports.
- The number of LGOS depends on the number of Goose subscribed. This information is not available for the moment. We think that in step 1 of R#Space project, an approximation of 30 subscribed is possible.
- The number of LSVS depends on the number of subscribed SV streams. For the moment, there should not be more than 10 SV subscribed.
- A priori, there will be one common LCCH for both PRP ports and one LCCH for admin port (if IED have dedicated port for admin network).
- The number of instantiations of LPDI and LDPO depends of number of DI/DO board in IED.

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- The number of instantiations of LPAI corresponds to the number of analog inputs of the IED.
- One LN LPLE covering the LED of the IED is instanciated.
- The number of instantiations of LMBI corresponds to the number of MobBus ports of the IED.
- LTRK covering the IED is instantiated in LDSUIED (cf §4.4.8.1).
- Regarding virtual IEDs, the same LDSUIED is used. Only DO which are applicable to the virtualised IED are instanciated. It includes the supervision of the services for for the dockers and kvm.
- For the supervision of the virtualised infrastructure, a separate virtual IED for each physical machine is created. The LDSUIED of this IED covers the supervision of the virtual infrastructure including

  Supervision of physical ports of each structure (LPCP). One instance for each physical port.
  Supervision of network (LCCH)
  Supervision of CPU boards of each structure
  Supervision of auxiliary supply
  Supervision of memory and hard disc space

- GAPC0.Ind1 is used as watchdog. This information will be toggled with a time period defined in LSET.DITmms1.

9.8.4 Static description

IED Monitoring Function (LDSUIED)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
GAPC0	Beh	ENS		
	SPCSO1	SPC		Visual identification of the IED by front panel LED
	SPCSO1	SPC.pulseConfig		Closing time for a generic pulse contact
	SPCSO1	SPC.pulseConfig		Closing time for a generic pulse contact
	SPCSO1	SPC.pulseConfig		Closing time for a generic pulse contact
	SPCSO1	SPC.pulseConfig		Closing time for a generic pulse contact
LPDI0	ChatterNum*	ING	N	Number of toggling for a generic input
	ChatterTms*	ING	T	Time monitoring for toggling input
GAPC0	Ind1	SPS		Watchdog
LSET0	Beh	ENS		
	NamPlt	LPL		
	DlTmms1	ING		Period of watchdog for toggling (default time 5s)
	DlTmms2	ING		Time delay to switch to the backup source SV or GOOSE

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IED Monitoring Function (LDSUIED)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LCCHx	ApNam	VSG		Access point name
	ChLiv	SPS		Physical Channel status
	ChLivTms	ING		Time out for channel live
	InOv	SPS		Input communication buffer overflow
	OutOv	SPS		Output communication buffer overflow
	Beh	ENS		
	RedChLiv	SPS		Physical Channel status of redundant channel
LGOSx	Beh	ENS		
	ConfRevNum	INS		
	GoCBRef	ORG		
	LastStNum	INS		
	NdsCom	SPS		
	SimSt	SPS		
	St	SPS		Health of the GOOSE subscription.
LLN0	Beh	ENS		
	Health	ENS		Health of the LDSUIED function.
	Mod	ENC		
	NamPlt	LPL		
LMBIx	BrdNum	ING		Number of the board
	NamPlt	LPL		
	BrdPos	VSG		Physical position of the board
	MBusPortNam	VSG		Name of the Modbus Port
	MBusKind	ENG		Kind of Modbus (2 or 4 wires)
	PhyHealth	ENS		Physical Health of the Modbus Port
	PhyNam	DPL		Name Plate with information of ModBus Interface Board
	ScanPoDlTmms	ING		Delay for Modbus refresh cycle
	Beh	ENS		
	SerBaud	ENG		Baud Rate of Serial Modbus (1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200)
	SerDataBit	ENG		Number of bits for a word (7 bits or 8 bits)
	SerParBit	ENG		NumberType of parity bit for a Modbus telegram (even, odd, none)

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IED Monitoring Function (LDSUIED)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	SerPort	ING		Modbus Serial Port Unique Reference
	SerStopBit	ENG		Number of stop bits for a Modbus telegram (1 or 2)
LMSIxy	AnIn*	MV		Analogue Input acquired via Modbus Interface
	NamPlt	LPL		
	CmdDO*	SPC		Command of Digital Output sent via Modbus interface
	Ind*	SPS		Digital Input acquired via Modbus Interface
	MBusFunct*	ENG		ModBusModbus function to be used (1 to 24)
	MBusNumWd	ING		Number of bits of a Modbus word depending on the Modbus function
	MBusStrAddr	ING		Start address for R/W
	Beh	ENS		
	PhyHealth	ENS		Physical Health of the Slave
	PhyNam	DPL		Name Plate with information of Modbus Interface Slave
	SerPort	ING		Modbus Serial Port Unique Reference
	SlaveAddr	ING		Destination address (1 to 247)
LPHD0	NamAuxVRtg	VSD		a semicolon separated list or hyphenated range of rated auxiliary power supply voltages (Uar) in volts, with indication of ac or dc where applicable, e.g. "80-300 dc;100-250 ac"
	NamHoldRtg	VSD		the rated holdover time in seconds, e.g. "10"
	NamHzRtg	VSD		a semicolon separated list of the nominal frequencies (fR) supported, in
	NamMaxDlRtg	VSD		the maximum processing delay time in microseconds, e.g. "1500"
	NamVariant	VSD		a semicolon separated list of the variant codes supported, the codes being as defined in 6.903.2, e.g. "F4800S1I4U4;F14400S6I4U4;F4800S2I0-24U0-24"
	NumPwrUp	INS		
	PhyHealth	ENS	DF.CALCT.NONURG	
	PhyNam	DPL		
	PwrDn	SPS		

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IED Monitoring Function (LDSUIED)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	PwrSupAlm	SPS		External power supply alarm
	PwrUp	SPS		
	RsStat	SPC		
	Sim	SPC		
	WacTrg	INS		
	Proxy	SPS		Indicates if this LN is a proxy
	WrmStr	INS		
LPLE0	BrdNum	ING		Number of the board
	BrdPos	VSG		Physical position of the board
	CmdLED*	SPC		Command for each LED
	FrontPNam*	VSG		Front panel or display name of the LED
	Beh	ENS		
	FrontPRef*	VSG		Reference of the LED on the Front Panel or Display
	DisplayLab*	VSG		Label of the LED to display
	LatMod*	ENG		Latching behaviour (latched/non-latched)
	LedBlkMod*	ENG		LED Blink Mode for each LED
	LedOffCol*	ENG		Off-state color assignment on physical input for each LED
	LedOnCol*	ENG		On-state colour assignment on physical input
	NumLED	ING		Number of physical LED of the board or panel
	OutMod*	ENG		Active high / active low
	PhyHealth	ENS		Physical Health of the Board
	PhyNam	DPL		Name Plate with information of LED Board
	RdbSt*	SPS		Read back of LED status for each LED
LSVSx	ConfRevNum	INS		
	NdsCom	SPS		
	SimSt	SPS		
	Beh	ENS		
	St	SPS		Health of the SV subscription.
	SvCBRef	ORG		
LTMS0	Beh	ENS		

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IED Monitoring Function (LDSUIED)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	TmAcc	INS		
	TmChSt1	SPS		
	TmSrcTyp	ENS		
	TmSrc	VSS		
	TmSrcSet1	VSG		
	TmSyn	ENS		
LPDIx	NumInput	ING		Numbre of physical input of the board or group
	NamPlt	LPL		
	BrdNum	ING		Number of the board
	ConnNam*	VSG		Connector name of the input
	ConnRef*	VSG		Reference of the input on the connector
	WetVolt*	SPS		Presence of the wetting voltage
	BrdPos	VSG		Physical position of the board (slot name…=
	PhyNam	DPL		Name Plate with information Digital Input Board
	PhyHealth	ENS		Physical Health of the board
	Ind*	SPS		One instance for each digital input
	VinRtg*	ASG.setMag		Rated Input Voltage
	VinOnLvl*	ASG.setMag		Pick-up Voltage
	VinOffLvl*	ASG.setMag		Drop-off voltage
	DebTmms*	ING		Debounce time in ms
	ChatterTms*	ING		Chatter monitoring period in s
	ChatterNum*	ING		Number of contact chatters used as chatter criterion
	InMod*	ENG		Active high / active low
LPDOx	NumOut	ING		Number of physical output of the board
	NamPlt	LPL		
	BrdNum	ING		Number of the board
	BrdPos	VSG		Physical position of the board
	ConnNam*	VSG		Connector name of the output
	ConnRef*	VSG		Reference of the output on the connector
	PhyNam	DPL		Name Plate with information Digital Output Board

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IED Monitoring Function (LDSUIED)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	PhyHealth	ENS		Physical Health of the Board
	RdbSt*	SPS		Read back of output status associated to eachoutput
	CmdDO*	SPC		Command of Digital Output. One instance for each output contact
	LatMod*	ENG		Latching behaviour (latched/non-latched)
	OutMod*	ENG		Active high / active low
LPAIx	NumInput	ING		Number of physical inputs of the board
	BrdNum	ING		Number of the board
	NamPlt	LPL		
	BrdPos	VSG		Physical position of the board (slot name…)
	ConnNam*	VSG		Connector name of the input
	ConnRef*	VSG		Reference of the input on the connector
	Beh	ENS		
	PhyNam	DPL		Name Plate with information Analog Input Board
	PhyHealth	ENS		Physical Health of the Board
	AnIn*	MV		Analogue Input. One instance for each analog input
	ARtgLow*	ASG.setMag		Rated Input Current Low (Ex: -10mA, 0, 4mA…)
	ARtgHigh*	ASG.setMag		Rated Input Current High (Ex: 10mA, 20mA)
	RfHz*	ING		Refresh frequency, how often the data is acquired.
LTRK0	Beh	ENS		
	SpcTrk	CTS		Control service tracking for controllable single point status data.
	DpcTrk	CTS		Control service tracking for controllable double point status data.
	IncTrk	CTS		Control service tracking for controllable integer point status data.
	EncTrk1	CTS		Control service tracking for controllable enumerated BehaviourModeKind point status data.
	EncTrk2	CTS		Control service tracking for controllable enumerated RecCycModKind point status data.
	EncTrk3	CTS		Control service tracking for controllable enumerated StageControlKind point status data.

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IED Monitoring Function (LDSUIED)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	EncTrk4	CTS		Control service tracking for controllable enumerated SynchOperationModeKind point status data.
	ApcFTrk	CTS		Control service tracking for controllable analogue setpoint data with float command.
	BscTrk	CTS		Control service tracking for binary controlled step position data.
	IscTrk	CTS		Control service tracking for binary controlled analogue data.
	GenTrk	CST		Common service tracking for all services for which no specific tracking data exists.
	UrcbTrk	UTS		Access service tracking for unbuffered report control blocks.
	BrcbTrk	BTS		Access service tracking for buffered report control blocks.
	GocbTrk	GTS		Access service tracking for GOOSE control blocks.
	MsvcbTrk	MTS		Access service tracking for multicast sampled values control blocks.
	SgcbTrk	STS		Access service tracking for setting group control blocks.
LPCPx	NamPlt	LPL		
	Beh	ENS		
	PhyNam	DPL		Physical Device Name plate. DO coming from 90-4
	PortNam	VSG		DO coming from 90-4. Label of the terminal on the device
	PortNum	ING		DO coming from 90-4. Number of the terminal on the device
	PortMac	VSG		DO coming from 90-4. MAC address of the port, as dash-separated hex number
	AutoNgtCfg	SPG		DO coming from 90-4. If true, the port is set to auto-negotiation
	MauCfg	ING		DO coming from 90-4. Currently supported value from 'MauCfgCap' ; valid only if 'AutoNegCfg' = false
	MauCfgCap	ING		DO coming from 90-4. Supported medium access unit (MAU) setting n. The value corresponds to the MAU type list bit position in RFC 4836. For example, value 16 corresponds to 100BASE-TX full duplex mode.

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IED Monitoring Function (LDSUIED)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	AdminCfg	SPG		DO coming from 90-4. If true, the port is administratively up, otherwise it is down
	PhyHealth	ENS		Physical device health

9.8.5 Dynamic description

The LDSUIED does not need to be represented by a diagram. All DO published are destined for the LDPO.

9.9 PACS Monitoring Function (LDSUCCN)

9.9.1 Description of the Function

This LD represents the monitoring function of the PACS (CCN).

9.9.2 LNs used

LN	Description
CALH	CALH allows the creation of group warnings, group indications and group alarms. The individual alarms, which are used to calculate the group indications/alarms/warnings, are subscribed from elsewhere. The calculation is a local issue, usually performed by a logic scheme.
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.

9.9.3 Specificities

- CALH0 published the information urgent / non urgent PACS failure (CALH.GrAlm - DF.CCN.URG / CALHx.GrWrn - DF.CCN NON URG). The application level associated to this DO has to manage the proper elaboration of the signal, depending on the architecture of the PACS and on the definition of "urgent PACS failure".
- The CALHx.GrInd corresponds to the grouping of the equipment failure or function failure of the functional bays (DF.EQUIP.TRANCHE).
- The CALH0.GrInd corresponds to the grouping of all CALHx.GrInd of each functional bays.
- One LN CALHx is instantiated for each functional bay x by in order to elaborate the signal "Urgent Failure" (CALHx.GrAlm - DF.CALC.URG) and "Non Urgent Failure (CALHx.GrWrn - DF.CALC NON URG).
- CALHx.GrAlm indicates that the equipment of the associated functional bay are unable to perform vital protection or control function. The application level associated to this DO has to manage the proper elaboration of the signal, depending on the architecture of the bay and on the definition of "urgent failure". It may involve failure signals of several IED (SCU, SAMU and BCU) taking into account existing redundancies.
- CALHx.GrWrn correspond to a OR grouping of subscribed LDSUIED/LPHD.PhyHealth (cf. §9.8).

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9.9.4 Static description

PACS Monitoring Function (LDSUCCN)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
CALH0	GrAlm	SPS	DF.CCN URG	
	GrInd	SPS	DF.EQUIP.BT	
	GrWrn	SPS	DF.CCN.NON URG	
CALHx	GrAlm	SPS	DF.CALCT.URG	One instance of CALHx for each functional bay
	GrInd	SPS	DF.EQUIP.TRANCHE	
	GrWrn	SPS	DF.CALCT.NON URG	
LLN0	Beh	ENS		
	Health	ENS		Health of the function
	Mod	ENC		
	NamPlt	LPL		

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9.9.5 Dynamic description

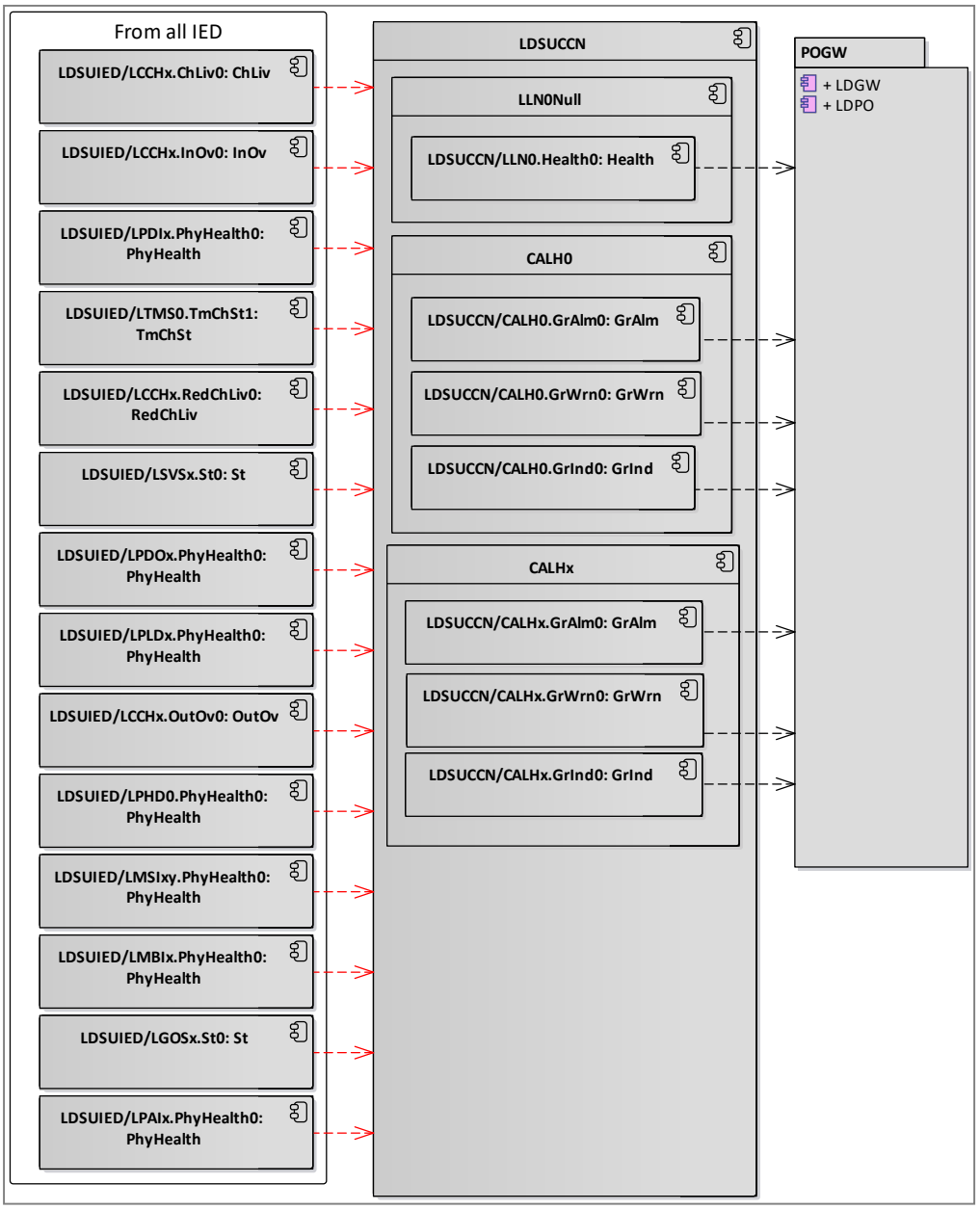

Figure 80: Dynamic description LDSUCCN

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10. General Substation Services System

10.1 General Substation Services System (LDTGINFRA) [Infrastructure]

10.1.1 Description of the Function

This LD includes the following functions:

- Lighting (cf. [8])
- Technical alarms (ALTECH) (cf. [8])

10.1.2 .LNs used

LN	Description
FXOT	Logical node FXOT shall be used to set a high-level threshold value to be used in control sequences. If a second level is necessary, a second instance can be modelled. FXOT can typically be used whenever a protection, contro or alarm function is based on other physical measurements than primary electrical data.
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.
LSET	Rte Extended Setting LN
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.
SFIR	This logical node represents fire supervision

10.1.3 Specificities

- The DSO fire alarm is transmitted directly from the RPTRPD interface.
- GAPC2 sends the signal "TECHNICAL ALARM" on the basis of the various technical alarms of the LDITFTG.
- GAPC3 is used to model a dummy command sent from the control center to verify the functional command chain. The command also causes the Substation Operation mode to be restored to normal telecontrol (TCD) if ther latter was in backup mode.

10.1.4 Static description

General Substation Automation System (LDTGINFRA)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
FXOT0	Beh	ENS		
	StrVal	ASG.setMag		
	Op	ACT		Signal substation flooded send to DSO (or other customer)
GAPC1	Beh	ENS		

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General Substation Automation System (LDTGINFRA)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	SPCSO1	SPC	ECLAI.BP	Control lighting surrounding area
	SPCSO2	SPC		Control lighting substation (or substation 1)
	SPCSO3	SPC		Control lighting substation 2
	SPCSO4	SPC		Control lighting substation 3
GAPC2	Beh	ENS		
	Ind1	SPS	ALARME TECHNIQUE	Technical alarm
GAPC3	DPCSO1	DPC	TC.FICTIVE	Dummy command from control center to test functional command chain
LSET0	Beh	ENS		
	NamPlt	LPL		
	OnOff1	SPG	SURV-ALTECH	Grouped technical alarm to be transmitted to DSO
	OnOff2	SPG	SURV-INCENDI	Grouped fire alarm to be transmitted to DSO
LLN0	Beh	ENS		
	Health	ENS		Health of the function
	Mod	ENC		
	NamPlt	LPL		
SFIR0	Beh	ENS		
	NamPlt	LPL		
	FireAlm	SPS		Signal global Fire alarm in substation

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10.1.5 Dynamic description

Figure 81: Dynamic description LDTGINFRA

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10.2 Bell and Horn Management function (LDSONKLAX)

10.2.1 Description of the Function

The function LDSONKLAX includes function related to bells and horns used by several alarm and substation housekeeping functions. It includes "REPORT" (Temporary inhibition of warning horns), "APPELPORTETEL" (Management of phone calls and substation door HMI) and "PORTE OUVERTE" (Management of substation entry door).

"LDSONKLAX" manages the emissions to acoustic warnings (bells and warning horns) and, thus is a function contributing to staff safety.

"REPORT" function allows to temporarily inhibit the warning horns after their activation as a result of alarm. This temporary inhibition can be activated by pressing a "Report" (Defer) push-button.

The purpose of the "APPELPORTETEL" (CallDoorTelephone) function is to transfer calls at the door and by phone if operators are present in the substation.

The purpose of the "PORTE OUVERTE" (Door Open) function is to ensure that the substation access door is not left open.

10.2.2 LNs used

LN	Description
CALH	CALH allows the creation of group warnings, group indications and group alarms. The individual alarms, which are used to calculate the group indications/alarms/warnings, are subscribed from elsewhere. The calculation is a local issue, usually performed by a logic scheme.
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.
LSET	Rte Extended Setting LN
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.

10.2.3 Specificities

- The SONKLAX (cf. [8]) function is interfaced with bells and horns using different auxiliary voltages. LDSONKLAX does not provide a separate DO for each auxiliary voltage. If necessary, this DO will be used for two different binary outputs supplying the bell and two different binary outputs supplying the horn.
- In the case of DSO bells and horn alarms, the auxiliary voltage used to interface this signal is not taken into account either. It is assumed that a single DO is supplied for bell (CALH.GrWrn) and a single one for the horn (CALH.GrAlm).
- The SONKLAX function is subscribed to the CALH, including presence 1 (TSO) and 2 (DSO). "Presence 1 or 2" information is generated in the application associated with the function.

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- DSO presence (presence2) is published by the LDITFTG (wired incoming feed from the presence cabinet) and by the LDITFRPTRPD (indication via gateway RPTRPD). In the application associated with the LDSONKLAX, DSO presence is produced using these two (2) feeds.
- LDSONKLAX publishes the DO GAPC.ind3, which corresponds to stopping of the sound from the Operator Station.
- The LDITFTG is used, among other things, to interface commands coming from push-buttons. The same commands can also be sent from the Operator Station. For sound shut-down, sound inhibition, horn deferral and ringing deferral, the command from the Operator Station is modelled in the LDSONKLAX.
- Management of the return of door calls (APPELPORTETEL) and the door open indication (PORTE OUVERTE) depending on the ownership of the site is managed by the application and not modelled in this document.
- Signal PORT.OUV.INST is published directly by LDITFTG (GAPC1.Ind3).
- The LDSONKLAX function subscribes to grouped alarms corresponding to alarms triggering the bell or the horn. There are different groupings of these alarm which may be organised on different levels. The highest level is the grouped alarm for a given voltage level. All grouped alarms are represented by an instance of LDGRP. LDSONKLAX subscribes thus to one or more instances of LDGRP representing the grouped alarms.
- The acoustic alarms can be inhibited for the complete substation. This control is represented by GAPC0.SPCSO4. In addition to this, the acoustic alarm can be inhitied selectively for a complete voltage level or for for each functional bay. The corresponding controls are represented by multiple instances of GAPCx.SPCSO1.
- GAPC0.SPCSO6 is used to generate a pulsated output to the bell. This allows to differentiate the origin. In the case of Rte, only incoming phone calls generate a pulsated output of the bell.
- GAPC0.Ind1 and GAPC0.Ind3 represent a door or phone call, respectively. This information can be subscribed by the HMI.

10.2.4 Static description

Bell and Horn Management function (LDSONKLAX)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
CALH1	Beh	ENS		
	GrAlm	SPS		Used for Output to physical contact: Horn
	GrWrn	SPS		Used for Output to physical contact: Bell
CALH2	Beh	ENS		
	GrAlm	SPS		Used for Output to physical contact: Additional Horn
	GrWrn	SPS		Used for Output to physical contact: Additional Bell
CALH3	Beh	ENS		
	GrAlm	SPS		Used for Output to physical contact: Accoustic alarm "Intrusion"
GAPC0	Beh	ENS		

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Bell and Horn Management function (LDSONKLAX)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	Ind1	SPS		Reception of call from interphone located at substation gate
	Ind2	SPS	PORTE OUVERTE	Timeout indication "gate open" associated to T-PORTEOUV2
	Ind3	SPS		Output indicating a reception of a phone call
	SPCSO1	SPC		Control of time limited inhibition of bell
	SPCSO2	SPC		Control of time limited inhibition of horn
	SPCSO3	SPC	ARRET SONNERIE	Control of "Stop bell/horns"
	SPCSO4	SPC		Control of "Inhibition of bell/horns" for substation level
	SPCSO5	SPC		Control of "Opening substation gate"
	SPCSO6	SPC		Output to bell with pulsated signal
	SPCSO7	SPC		Activation of horn without time delay (T-KLAX-AL)
	SPCSO8	SPC		Pulsated output "Door call"
	SPCSO9	SPC		Pulsated output "Phone call"
GAPCx	Beh	ENS		
	SPCSO1	SPC		Selective control of "Inhibition of bell/horns" for voltage level and bay level
LSET0	Beh	ENS		
	NamPlt	LPL		
	DlTmms1	ING	T_REPORT	Inhibition delay for accoustic alarms
	DlTmms2	ING	T-KLAX-AL	Time delay for horn after accoustic alarm by bell
	DlTmms3	ING	FINSONRPT	Time delay for time out of TSO accoustic alarm
	DlTmms4	ING	FINSONRPD	Time delay for time out of DSO accoustic alarm
	DlTmms5	ING	T-PORTEOUV1	Time delay for issuing an accoustic alarm after opening of substation gate
	DlTmms6	ING	T-PORTEOUV2	Time delay for issuing signal "gate open" after opening of substation gate
	OnOff1	SPG	S-SUP	Configuration of additionnal output contacts for bell and horn
	OnOff2	SPG	URBAIN	Substation situated in urban area
	OnOff3	SPG	PORTOUV	True : substation gate managed by TSO False : substation gate managed by DSO Shared parameter with LDMODEXPS/LSET0.OnOff2
	OnOff4	SPG	PROPTER	True : permisses owned by TSO False : permisses owned by other operator

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Bell and Horn Management function (LDSONKLAX)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
	OnOff5	SPG	PROPTER	True : other operator is DSO False : other operator is third party Shared parameter with LDMODEXPS/LSET0.OnOff3
LLN0	Beh	ENS		
	Health	ENS		Health of the function
	Mod	ENC		
	NamPlt	LPL		

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10.2.5 Dynamic description

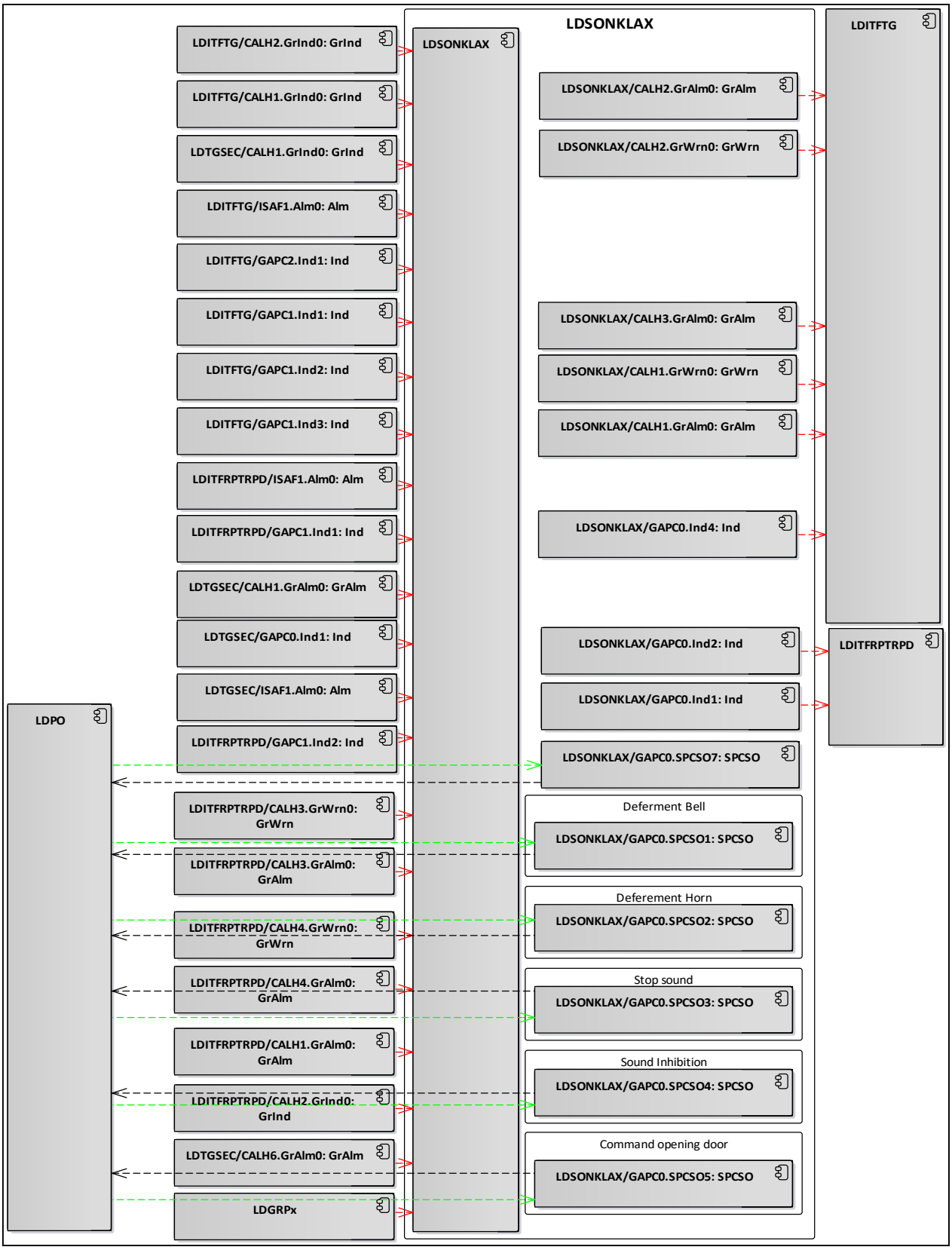

Figure 82: Dynamic description LDSONKLAX

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10.3 Substation fault function (cf. LDTGSEC)

The general substation management bay is responsible for

- The elaboration the "substation fault" information (DF.POSTE), representative of a property or safety problem (cf. § 10.5),
- Processing this information according to the active substation operating (cf. § 8.14).

This function is covered by LDTGSEC (§10.5)

10.4 Danger function (Cf. LD TGSEC)

The Danger function manages all information related to staff safety. This function is covered by LDTGSEC (§10.5)

10.5 Safety functions TG (LDTGSEC)

10.5.1 Description of the Function

The LDTGSEC covers part of the general substation management bay (TG) functions related to staff safety (cf. [8]).

The implementation of these functions must guarantee high availability. This has no impact on IEC 61850 modelling, but creating one unique LD makes it easier to take this requirement into account.

This function includes the substation fault (DEFPOST) and danger alarm function (DANGER).

10.5.2 LNs used

LN	Description
CALH	CALH allows the creation of group warnings, group indications and group alarms. The individual alarms, which are used to calculate the group indications/alarms/warnings, are subscribed from elsewhere. The calculation is a local issue, usually performed by a logic scheme.
GAPC	This node shall be used only to model in a generic way the processing/automation of functions that are not predefined by one of the groups A, C, M, P, or R. If needed, all data objects listed in Clause 6 of this standard can be used single or multiple for a dedicated application of LN GAPC. Data objects with proper semantic meaning should be preferred. The extension rules according to IEC 61850-7-1, Clause 14 shall be followed.
ISAF	Logical node ISAF shall be used to represent an alarm push-button or any other device that is used to provide an alarm in case of danger to persons or property.
LSET	Rte Extended Setting LN
LLN0	This LN shall be used to address common issues for logical devices. For example, LLN0 contains common information for the LD like health, mode and beh and NamPlt.

10.5.3 Specificities

- The "substation fault" information is modelled by DO CALH1.GrAlm. It is published regardless of the site's operating mode (cf. §8.14). On this basis, the signal "DF.POSTE TA" in local HMI and telecontrol is only gebnerated if the substation is in remote alarm mode. The application only transmits "Transport Substation fault in AS" information to the RPTRPD interface if the substation is on backup alarm mode (AS).

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- The DSO substation fault (DSO substation fault in AS) and the associated auxiliary voltage fault are published by the LDITFRPTRPD to which the LDPO is directly subscribed. This information does not pass through the LDTGSEC.
- The management of LED associated with certain substation fault information is not covered by the IEC 61850 model.
- DSO presence (also called presence #2) is published by the LDITFTG (wired input feed from a panel installed at the substation entry) and by the LDITFRPTRPD (gateway between DSO and TSO). In the application associated with the LDTGSEC, the signal "presence DSO" is generated using these two DO.
- The LDITFTG is used, among other things, to interface commands coming from push-buttons. For some features (duration of the intervention, general alarm, danger alarm and emergency shut-down), the LDTGSEC application also takes into account the corresponding command from the local HMI.
- For the "Danger" function, the signal "DANGER" is created on the basis of the wired interface associated with the push-button. This interfacing is modelled in LDITFTG. The associated DO is published by the LDITFTG. Depending on the operator presence, DANGER signal is to be transmitted to different interfaces (TCD, PO, TA, and ITFRPTRPD). The application associated with these different interfaces verfies whether the signal needs to be transmitted or not.
- The "Danger" alarm is also published by the LDITFTG and made available to the functions subscribed in parallel with those of LDTGSEC.
- The signal of absence of AC auxiliary voltage is modelled in LDITFUA (cf. §7.10).
- LN ISAF1 is used for indication a danger alarm in the substation, the origin of which may be TSO or DSO. In the latter case, the information is subscribed from LDITFRPTRPD. LN ISAF2 is used to publish this information to the other operator present in the substation via LDITFRPDRPD. This is used to avoid a closed loop situation for this information between the two operators.
- LN ISAF3 is added to represent the information "DANGER TA". This allows to create a separate terminal for the telelarm device which can be activated depending on the operation mode of the substation (cf. §8.14).
- The intervention duration timer is activated or deactivated by control of CALH2.Mod. The corresponding indication is represented by GAPC0.Ind1 in order to avoid publication of an invalid DO if CALH2 is "off". GAPC0.Ind2 indicates if the corresponding timer is active.
- Timers for the management of action time of T-S-INTERV and T-AL-INTERV.
- The LDTGSEC function subscribes to grouped alarms corresponding to alarms triggering the bell or the horn. There are different groupings of these alarm which may be organised on different levels. The highest level is the grouped alarm for a given voltage level. All grouped alarms are represented by an instance of LDGRP. LDTGSEC subscribes thus to one or more instances of LDGRP representing the grouped alarms.

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10.5.4 Static description

Substation fault function (LDTGSEC)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
CALH1	Beh	ENS		
	GrAlm	SPS	DF.POSTE1 DF.POSTE	Substation fault related to safety
	GrInd	SPS		Grouping of presence 1 and 2
CALH2	Beh	ENS		
	Mod	ENC		Activation/deactivation of duration of maintenance action
CALH3	Beh	ENS		
	GrAlm	SPS		Emergency or technical alarm to DSO
CALH4	Beh	ENS		
	GrAlm	SPS		Technical warning sent to DSO
CALH5	Beh	ENS		
	GrAlm	SPS	DF.POSTE TA	Substation failure or DSO substation failure in backup alarm mode
CALH6	Beh	ENS		
	GrAlm	SPS	DF.RPD	Substation fault related to safety in distribution substation
GAPC0	Beh	ENS		
	Ind1	SPS		Time Out reached for the set duration of maintenance action
	Ind2	SPS		Timer for maintenance action is activated and counting
	SPCSO1	SPC		Re-initialisation of duration of maintenance action
	SPCSO2	SPC		Activation/deactivation of Danger Alarm from HMI
ISAF1	Alm	SPS	DANGER	Danger Signal
	Beh	ENS		
ISAF2	Alm	SPS		Danger signal to DSO
	Beh	ENS		
ISAF3	Alm	SPS	ALARME DANGER TA	Danger signal when the substation is in backup alarm
	Beh	ENS		
LSET0	Beh	ENS		
	NamPlt	LPL		
	DlTmms1	ING	T-S-INTERV	Timer for maintenance operation associated to security function in case of time out
	DlTmms2	ING	T-AL-INTERV	Timer for maintenance operation associated to security alarm in case of time out

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Substation fault function (LDTGSEC)				
LN	**DO**	**CDC**	**FCS name**	**Comments**
LLN0	Beh	ENS		
	Health	ENS		Health of the function
	Mod	ENC		
	NamPlt	LPL		

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10.5.5 Dynamic description

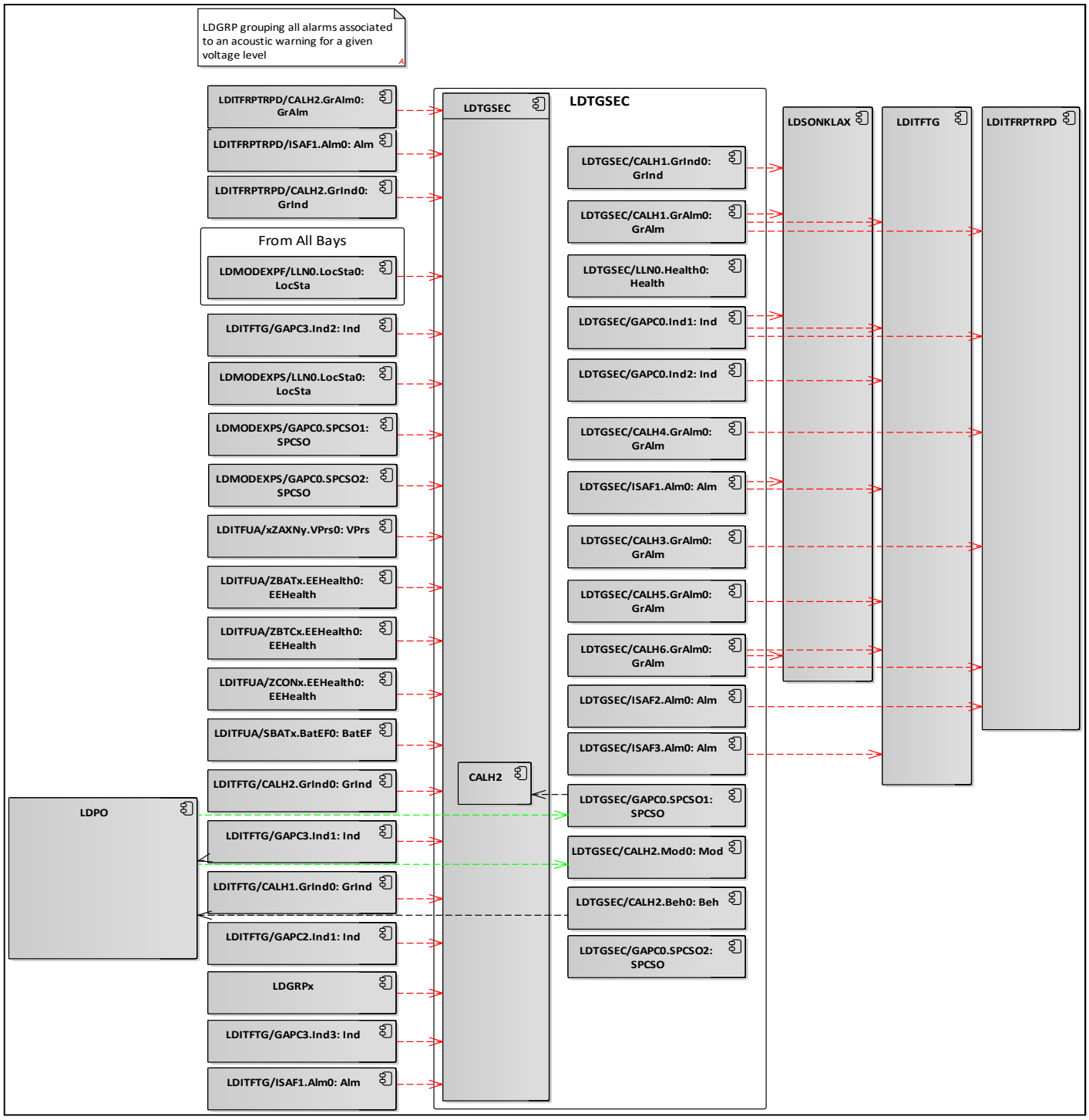

Figure 83: Dynamic description LDTGSEC

10.6 "REPORT" (Deferral) function (cf. LDSONKLAX)

The purpose of this function is to temporarily inhibit the horns sounding as a result of alarms that can be deferred by pressing a "Report" (Defer) push-button on a TPG (Security Room Panel). It is covered in this modelling by the Ringing and Horns LDSONKLAX (cf. § 10.2).

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10.7 Auxiliary Units monitoring

10.7.1 Description of the Function

The purpose of this function of the General Bay is to monitor the polarities of the bays and substation auxiliary services. To do this, the function transmits the information from control monitoring, to other functions and the DSO.

10.7.2 Specificities

- Most of the signals described by the SURVUA function (cf. [8]) are emitted by LDITFUA and LDMTBB.
- The groupings URGENCE1 and URGENCE2 DSO, depending on SURVSA-16/17 requirements, are produced by LDTGSEC which is subscribed to the signal concerned.
- The groupings DEFAUT SA URGENCE1 and DEFAUT SA URGENCE2, depending on SURVSA-22/23 requirements, are produced at control level.
- The signal MQ.ALTERNATIF of the SURVUA function corresponds to an incoming feed time-out "alternative trip of the Auxiliary Unit network" acquired by the LDITFUA. This signal is published by the LDTGSEC.
- The power supply of the IED is monitored at substation level (cf. § 4.3.6).

10.8 Door and Telephone Call [APPELPORTETEL function]

The purpose of this function is to authorise calls at the door and by phone in the event of presence in the substation. It is included in LDSONKLAX (cf. § 10.2).

10.9 Door Open Monitoring [PORTEOUVERTE function]

The purpose of this function is to ensure that the substation access door is not left open. It is included in LDSONKLAX (cf. § 10.2).

10.10 Lighting Function [ECLAIRAGE function]

The purpose of this function is to generate the site's external lighting. It is included in LDTGINFRA (cf. §10.1).

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11. Appendix 1: LN pertaining to Rte NameSpace

The following colour code is used (cf. §4.4.12).

LN / DO defined by Rte are indicated in green.

LN / DO defined in an IEC 61850 draft but no published as IS.

11.1 LTED - Topologic

The following table lists the elements mentioned above:

LTED				
DO name	**CDC**	**T**	**Explanation**	**M-O-C nds/ds**
Descriptions				
NamPlt	LPL		inherited from: DomainLN	O / na
Status information				
Beh	ENS (BehaviourModeKind)		inherited from: DomainLN	M / na
Health	ENS (HealthKind)		inherited from: DomainLN	O / na
VolLevelDes	ENS		Voltage Level (1..9)	O
VolLevel	ENS		Voltage Level (<45kV, 45kV, 63kV, 90kV, 150kV, 225kV, 400kV, 750kV, DC)	O
TopoObj	ENS		Topological Element Type (busbar, feeder, coupling, "omnibus", power transformer)	O
TopoObjNum	INS		Topological Element Reference (1..n)	O
FeederTyp	ENS		Topological Element Reference - Feeder (line, Power Transformer, Coil, Capacity, FACTS)	O
BusbarNum	ENS		Busbar Number	O
SectNum	INS		Topological Element Subset Reference - Busbar Main Section (1..n) [Troncon]	O
SubSectNum	INS		Topological Element Subset Reference - Busbar Subsection (1..m) [Section]	O
ITType	ENS		Instrument Transformer Type (Voltage, Current)	O
PhNum	ENS		Phase (ph0, ph3, ph4, ph7, ph8, ph11, neutral) cf. §4.3.2	O
CTAppli	ENS		Winding Reference – CT (cf. tableau CTAppli)	O
WgNum	INS		Winding Reference - VT (1,.n)	O
AcqChainRef	INS		Acquisition Chain Reference (1..n)	O

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LTED				
DO name	**CDC**	**T**	**Explanation**	**M-O-C nds/ds**
VTRefSt	ENS		Status of reference of VT concerned	O
ElNodeRef	INS		Reference Number of the Electrical Node	O
ElNodeVTRef	INS		Designates the Voltage Information to be used as reference for the electrical node	O
ElNodeNum	INS		Total number of Electrical Nodes	O
DORef	VSS		Object Reference to a LdName/LN.DO publishing a SV stream	O

The DO VTRefSt of type ENS, published by each LTEDbts, indicates for each busbar section and subsection s and busbar b:

- the designated VT is to be used,
- If the feeder is connected to a busbar section belonging to an electrical node which does not have an operating VT and whose voltage is estimated to be zero (electrically isolated on the basis of topological criteria),
- If the feeder is connected to a section belonging to an electrical node which does not have an operating VT and whose voltage is unknown,
- If the feeder is connected to a section belonging to an electrical node for which no VT output is valid.

The table below gives the different values of "ENUMERATED" defined for DO VTRefSt:

Value	Meaning
1	The designated VT is to be used
2	The voltage is estimated to be zero
3	The voltage is unknown because no TT is connected to the electrical node
4	The voltage is unknown because no VT output is valid
Note: The values of other DOs published by LTEDxy, in the case where DO VTRefSt adopts the values 2, 3 or 4 is to describe in the specification of the subscribing application.	

ElNodeRef indicates the reference number of the electrical node of the busbar to which the LN is associated, calculated on the base of its actual topology (disconnector and circuit breaker position).

ElNodeNum indicates the total number of electrical nodes into which a busbar is splitted on the base of its actual topology (disconnector and circuit breaker position).

ElNodeVTRef is used by the LD publishing voltage information (SV or PhV). Only one LD can adopt the number of the Electrical Node. This LD published the busbar voltage reference for corresponding electrical node, indicating if this voltage is to be used as voltage reference for an Electrical Node. If not, its value is set to zero.

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DORef is an Object Reference to a LdName/LN.DO publishing a SV stream. It has the value of the corresponding Object Reference as given in the SCL.

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11.2 LPDI – System Physical Digital Input

LPDI - System Physical Digital Input				
DO Name	**CDC**	**T**	**Explanation**	**M-O-C nds/ds**
Descriptions				
NamPlt	LPL		Inherited from: Domain LN	O/O
PhyNam	DPL		Name Plate with information Digital Input Board	M/M
Status Information				
Beh	ENS		Inherited from: Domain LN	M/M
Health	ENS		Inherited from: Domain LN	O/O
PhyHealth	ENS		Physical Health of the Board	O/O
Individual Status Information				
Ind	SPS			Mmulti/Mmulti
WetVolt	SPS		Presence of the wetting voltage	Omulti/Omulti
Controls				
Mod	ENC			O/O
Settings				
NumInput	ING		Number of physical inputs of the board or group.	O/O
BrdNum	ING		Number of the board	O/O
BrdPos	VSG		Physical position of the board	O/O
ConnName	VSG		Connector name of the input	Omulti/Omulti
ConnRef	VSG		Reference of the input on the connector	Omulti/Omulti
VinRtg	ASG		Rated Input Voltage	Omulti/Omulti
VinTyp	ENG		Type of Voltage	Omulti/Omulti
VinOnLvl	ASG		Pick-up Voltage	Omulti/Omulti
VinOffLvl	ASG		Drop-off voltage	Omulti/Omulti
DebTmms	ING		Debounce time in ms	Omulti/Omulti
ChatterTms	ING		Chatter monitoring period in s	Omulti/Omulti
ChatterNb	ING		Number of chatters used as chatter criterion	Omulti/Omulti
InMod	ENG		Active high / active low	Omulti/Omulti
LedOnCol	ENG		On state colour assignment on physical input (red, orange, yellow, green, blue, white, off)	Omulti/Omulti
LedOffCol	ENG		Off state colour assignment on physical input (red, orange, yellow, green, blue, white, off)	Omulti/Omulti

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11.3 LPDO - System Physical Digital Output

LPDO - System Physical Digital Output				
DO Name	**CDC**	**T**	**Explanation**	**M-O-C nds/ds**
Descriptions				
NamPlt	LPL		Inherited from: Domain LN	O/O
PhyNam	DPL		Name Plate with information Digital Output Board	M/M
Status Information				
Beh	ENS		Inherited from: Domain LN	M/M
Health	ENS		Inherited from: Domain LN	O/O
PhyHealth	ENS		Physical Health of the Board	O/O
Individual Status Information				
RdbSt	SPS		Read back of output status	Omulti/Omulti
Controls				
CmdDO	SPC		Command of Digital Output	Omulti/Omulti
Mod	ENC			O/O
Settings				
NumOut	ING		Number of the physical output of the board	Omulti/Omulti
BrdNum	ING		Number of the board	O/O
BrdPos	VSG		Physical position of the board	O/O
ConnName	VSG		Connector name of the output	Omulti/Omulti
ConnRef	VSG		Reference of the output on the connector	Omulti/Omulti
LatMod	ENG		Latching behavior (latched/non-latched)	Omulti/Omulti
OutMod	ENG		Active high / active low	Omulti/Omulti
LedClsCol	ENG		Close state colour assignment (red, orange, yellow, green, blue, white, off)	Omulti/Omulti
LedOpnCol	ENG		Open state colour assignment (red, orange, yellow, green, blue, white, off)	Omulti/Omulti

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11.4 LPAI – System Physical Analogue Input

LPAI - System Physical Analogue Input				
DO Name	**CDC**	**T**	**Explanation**	**M-O-C nds/ds**
Descriptions				
NamPlt	LPL		Inherited from: Domain LN	O/O
PhyNam	DPL		Name Plate with information Analogue Input Board	M/M
Status Information				
Beh	ENS		Inherited from: Domain LN	M/M
Health	ENS		Inherited from: Domain LN	O/O
PhyHealth	ENS		Physical Health of the Board	O/O
Individual Status Information				
AnIn	MV		Analogue Input	Omulti/Omulti
Controls				
Mod	ENC			O/O
Settings				
NumInput	ING		Number of the physical input of the board	Omulti/Omulti
BrdNum	ING		Number of the board	O/O
BrdPos	VSG		Physical position of the board (slot name…)	O/O
ConnName	VSG		Connector name of the input	Omulti/Omulti
ConnRef	VSG		Reference of the input on the connector	Omulti/Omulti
ARtgLow	ASG		Rated Input Current Low (Ex: -10mA, 0, 4mA…)	Omulti/Omulti
ARtgHigh	ASG		Rated Input Current High (Ex: 10mA, 20mA)	Omulti/Omulti
RfHz	ING		Refresh frequency, how often the data is acquired.	Omulti/Omulti

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11.5 LPLE - System Physical LED representation

LPLE - System Physical LED representation				
DO Name	**CDC**	**T**	**Explanation**	**M-O-C nds/ds**
Descriptions				
NamPlt	LPL		Inherited from: Domain LN	O/O
PhyNam	DPL		Name Plate with information of LED Board	M/M
Status Information				
Beh	ENS		Inherited from: Domain LN	M/M
Health	ENS		Inherited from: Domain LN	O/O
PhyHealth	ENS		Physical Health of the Board	O/O
Individual Status Information				
RdbSt	SPS		Read back of LED status	Omulti/Omulti
Controls				
CmdLED	SPC		Command of LED	Omulti/Omulti
Mod	ENC			O/O
Settings				
NumLED	ING		Number of the physical LED of the board or panel	Omulti/Omulti
BrdNum	ING		Number of the board	O/O
BrdPos	VSG		Physical position of the board	O/O
FrontPName	VSG		Front panel or display name of the LED	Omulti/Omulti
FrontPRef	VSG		Reference of the LED on the Front Panel or Display	Omulti/Omulti
DisplayLab	VSG		Label of the LED to display	Omulti/Omulti
LatMod	ENG		Latching behaviour (latched/non-latched)	Omulti/Omulti
OutMod	ENG		Active high / active low	Omulti/Omulti
LedOnCol	ENG		On-state colour assignment (red, orange, yellow, green, blue, white, off)	Omulti/Omulti
LedOffCol	ENG		Off-state colour assignment (red, orange, yellow, green, blue, white, off)	Omulti/Omulti
LedBlkMod	ENG		LED Blink Mode (fix, slow blinking, fast blinking)	Omulti/Omulti

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11.6 LMBI – System Physical Modbus Interface

Regarding the LMBI representing the Modbus interface, one LN has to be instantiated for each port.

LMBI - System Physical Modbus Interface				
DO Name	**CDC**	**T**	**Explanation**	**M-O-C nds/ds**
Descriptions				
NamPlt	LPL		Inherited from: Domain LN	O/O
PhyNam	DPL		Name Plate with information of Modbus Interface Board	M/M
Status Information				
Beh	ENS		Inherited from: Domain LN	M/M
Health	ENS		Inherited from: Domain LN	O/O
PhyHealth	ENS		Physical Health of the Board	O/O
Controls				
Mod	ENC			O/O
Settings				
MBusPortNam	VSG		Name of the Modbus Port	O/O
MBusKind	ENG		Kind of Modbus (2 or 4 wires)	O/O
BrdNum	ING		Number of the board	O/O
BrdPos	VSG		Physical position of the board	O/O
SerPort	ING		Modbus Serial Port Unique Reference	M/M
SerBaud	ENG		Baud Rate of Serial Modbus (1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200)	M/M
SerDataBit	ENG		Number of bits for a word (7 bits or 8 bits)	M/M
SerStopBit	ENG		Number of stop bits for a Modbus telegram (1 or 2)	M/M
SerParBit	ENG		Type of parity bit for a Modbus telegram (even, odd, none)	M/M
ScanPoDlTmms	ING		Delay for Modbus refresh cycle	M/M

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11.7 LMSI – System Physical Modbus Slave Interface

Regarding the LMSI representing the Modbus interface for a slave. One LN has to be instanciated for each slave.

LMSI - SYSTEM PHYSICAL MODBUS SLAVE INTERFACE				
DO Name	**CDC**	**T**	**Explanation**	**M-O-C nds/ds**
Descriptions				
NamPlt	LPL		Inherited from: Domain LN	O/O
PhyNam	DPL		Name Plate with information of Modbus Interface Slave	M/M
Status Information				
Beh	ENS		Inherited from: Domain LN	M/M
Health	ENS		Inherited from: Domain LN	O/O
PhyHealth	ENS		Physical Health of the Slave	O/O
Individual Status Information				
AnIn	MV		Analogue Input acquired via Modbus Interface	Omulti/Omulti
Ind	SPS		Digital Input acquired via Modbus Interface	Omulti/Omulti
Controls				
CmdDO	SPC		Command of Digital Output sent via Modbus interface	Omulti/Omulti
Mod	ENC			O/O
Settings				
SerPort	ING		Modbus Serial Port Unique Reference	M/M
SlaveAddr	ING		Destination address (1 to 247)	M/M
MBusFunct	ENG		Modbus function to be used (1 to 24)	Mmulti/Mmulti
MBusNumWd	ING		Number of bits of a Modbus word depending on the Modbus function	Omulti/Omulti
MBusStrAddr	ING		Start address for R/W	M/M

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11.8 CREC Recloser Control

CREC - Recloser Control			
DO Name	**CDC**	**T**	**Explanation**
Descriptions			
NamPlt	LPL	O	Inherited from: Domain LN
Status Information			
Beh	ENS		Inherited from: Domain LN
Health	ENS		Inherited from: Domain LN
Controls			
RecCycMod	ENC		Recloser Cycle Mode

The values of DO RecCycMod are indicated in the table below:

RecCycMod	1	2	3	4	5	6	7
Recloser Criteria	REB	RVB	RVL	RVB+L	REB+RVB	REB+RVL	all

- REB: lve-live (Rebouclage)
- RVB: live line dead bus (renvoi Barres)
- RVL: live bus dead line (renvoi Ligne)

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11.9 LSET Extended Specific Parameters

This LN contains parameters required for Rte functions and not covered by settings in LN included in the IEC 61850 standard.

LSET - Rte Extended Setting				
DO Name	**CDC**	**T**	**Explanation**	**M-O-C nds/ds**
Descriptions				
NamPlt	LPL		Inherited from: Domain LN	O/O
Status Information				
Beh	ENS		Inherited from: Domain LN	M/M
Health	ENS		Inherited from: Domain LN	O/O
Settings				
OpDlTmms	ING		Instance of Operate Delay Time	Omulti/Omulti
DlTmms	ING		Instance of DelayTime	Omulti/Omulti
StrVal	ASG		Instance of threshold	Omulti/Omulti
OnOff	SPG		Instance of Boolean parameter	Omulti/Omulti
SetNb	ING		Instance of integer parameter	Omulti/Omulti
SetPhNum	ENG		Phase (ph0, ph3, ph4, ph7, ph8, ph11, neutral), cf. §4.3.2	O/O
SetPhsOrig	ENG		Indication of single phase or combined phase voltage (a, b, c, ab, bc, ca, a_b_c, ab_bc_ca)	O/O
NamAccRtg	VSD		Accuracy class rating according to 61869-9	O/O
PhyConnITF	ENG		Indication of the type of a communication interface (e.g. for line differential protection). Possible values: FO_850_multimode, FO_1310_monomode, FO_1550_monomode, X21V11	Omulti/Omulti

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11.10 LSYN Phasor Synchronisation Information

Since CDC WYE does not allow to convey the synchronisation information of phasors, in particular to which clock the phasor uses as synchronisation reference, LSYN is created to enable the publication of this information.

LSYN – Phasor Synchronisation information				
DO Name	**CDC**	**T**	**Explanation**	**M-O-C nds/ds**
Descriptions				
NamPlt	LPL		Inherited from: Domain LN	O/O
Status Information				
Beh	ENS		Inherited from: Domain LN	M/M
Health	ENS		Inherited from: Domain LN	O/O
PhyHealth	ENS		Physical Health of the Slave	O/O
Individual Status Information				
WYESync	ENS		Not synchronised (0) | Local synchronisation (1) | Global (2) Note: Synchronisation status similar to SmpSync	M
WYESyncSrcId	INS		Corresponds to SynchSrcId or gmIdentity of the clock synchronising the SV stream used to generate the phasor	M

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12. Appendix 2: Dynamic descriptions

This section contains dynamic description for which the representation is too big to be included in the corresponding paragraphs.

12.1 LDAGSA: Overload Automation dynamic description (cf. §6.20)

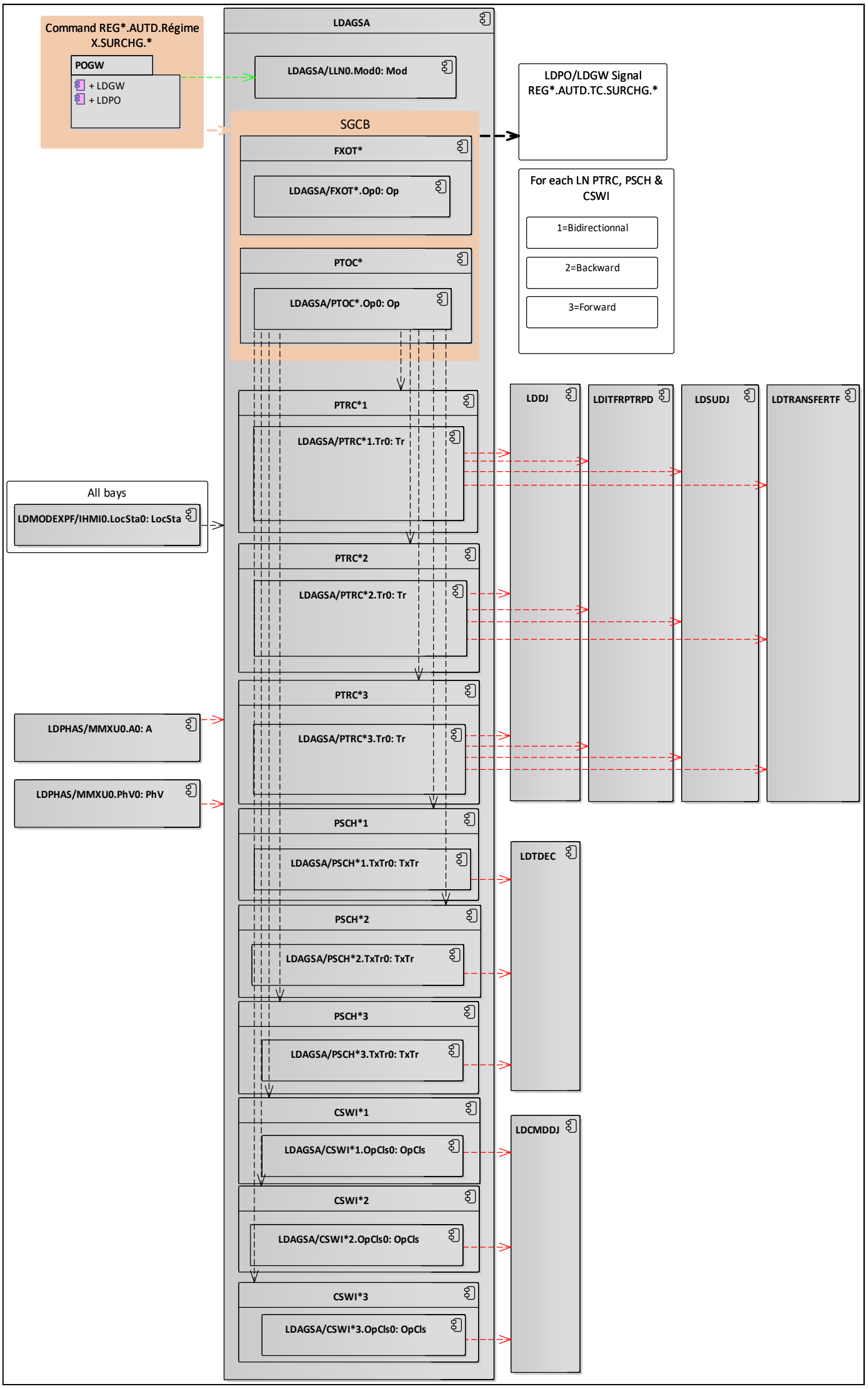

Figure 84 : Dynamic description LDAGSA

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12.2 LDPX : Distance Protection function - dynamic description (cf. §5.3)

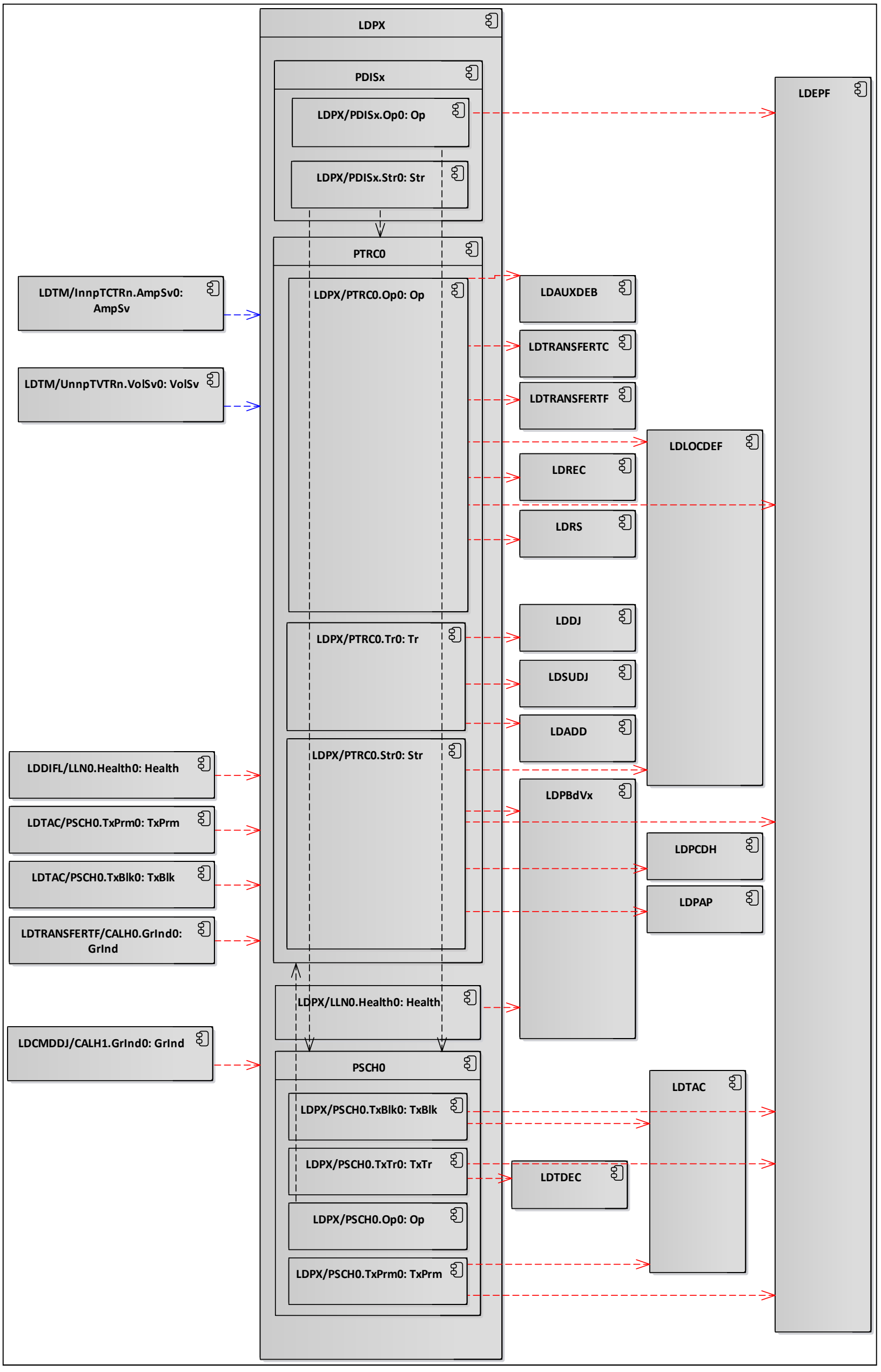

Figure 85 : Dynamic description LDPX

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12.3 LDPSTTR : Transformer Overload Protection - dynamic description (cf. §5.12)

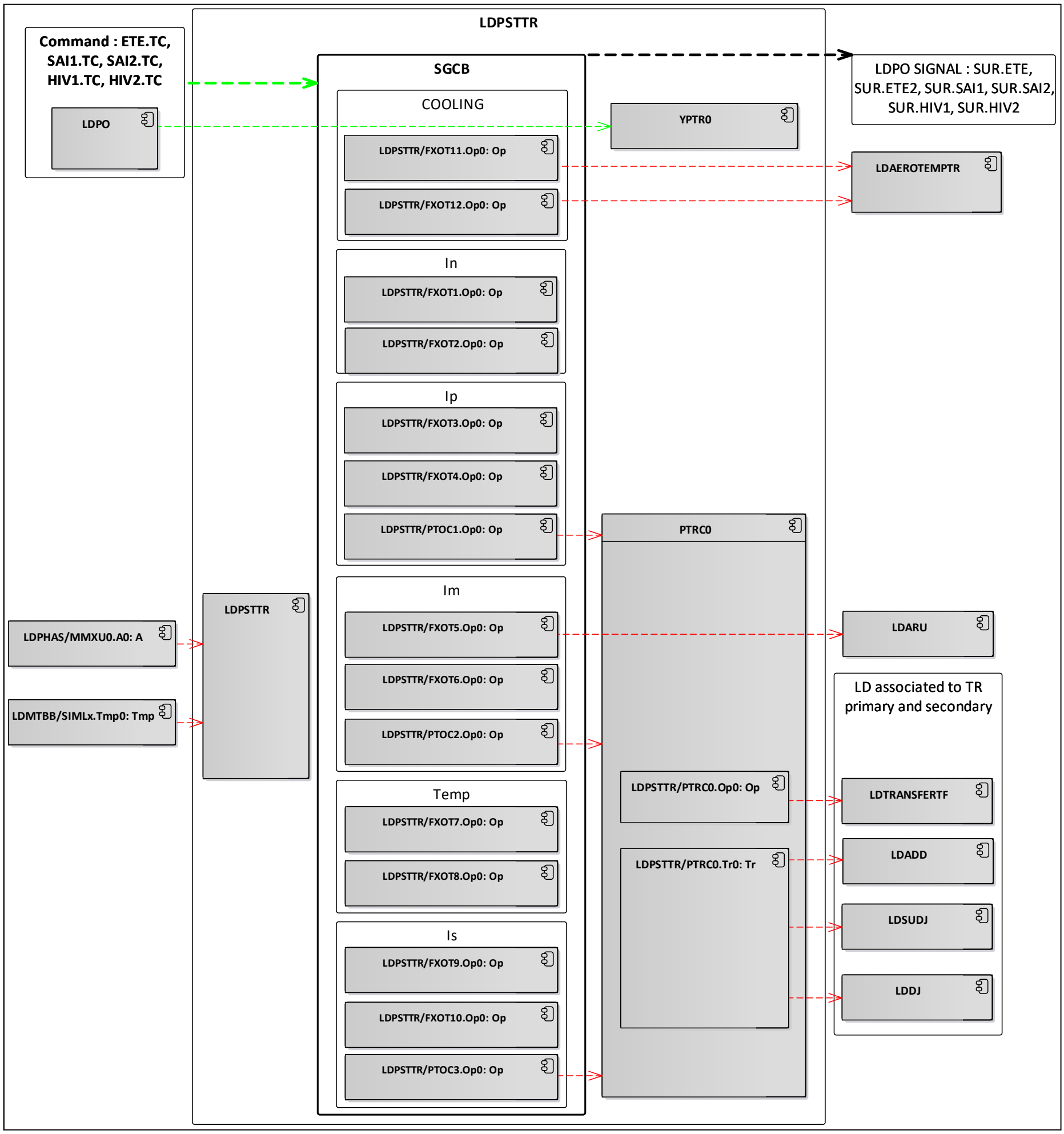

Figure 86 : Dynamic description LDPSTTR

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12.4 LDADD : Braker Failure Protectrion - dynamic description (cf. §6.8)

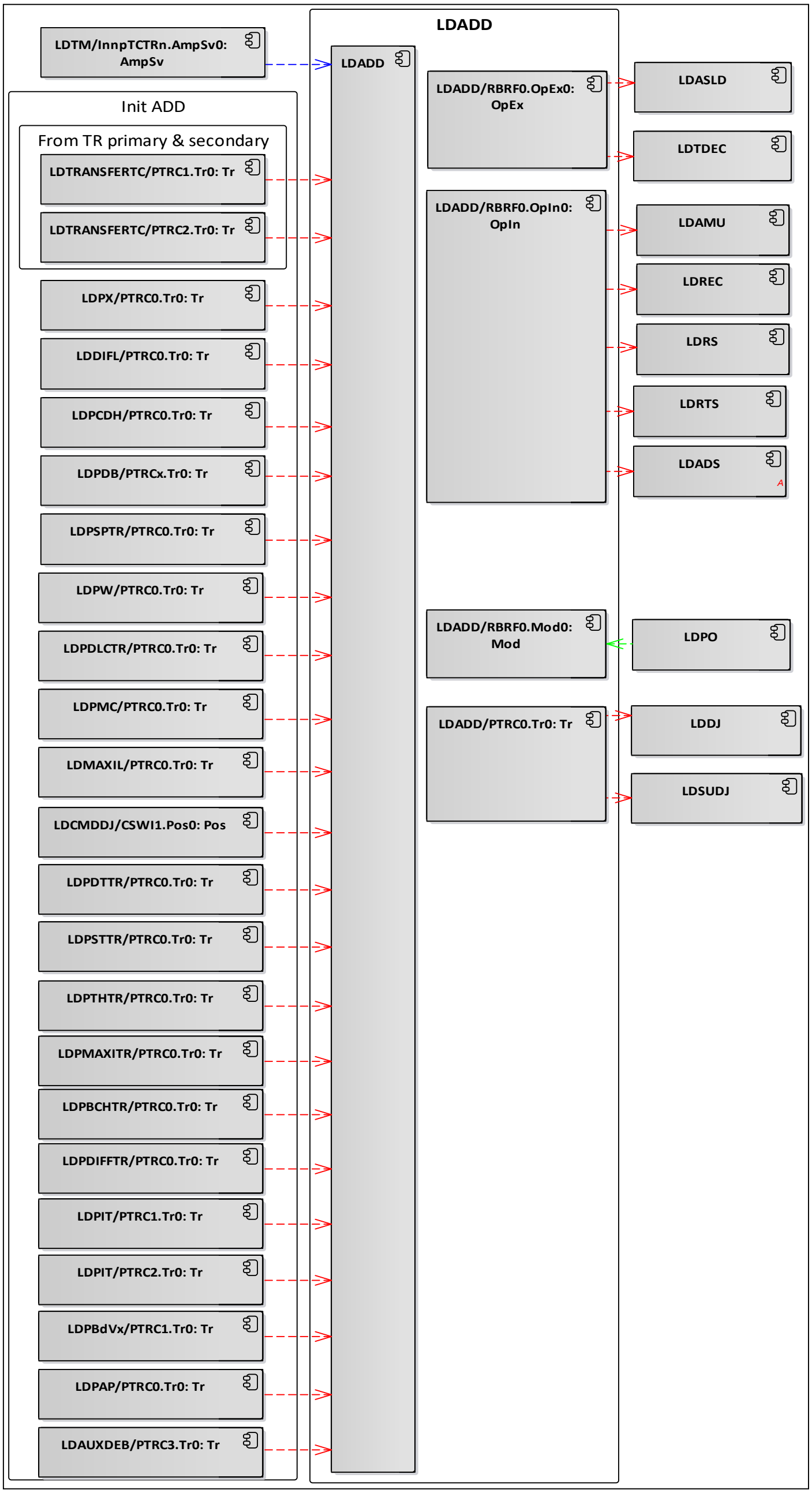

Figure 87 : Dynamic description LDADD

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12.5 LDRS : Auto-Recloser and Service Restoration function - dynamic description (cf. §6.3)

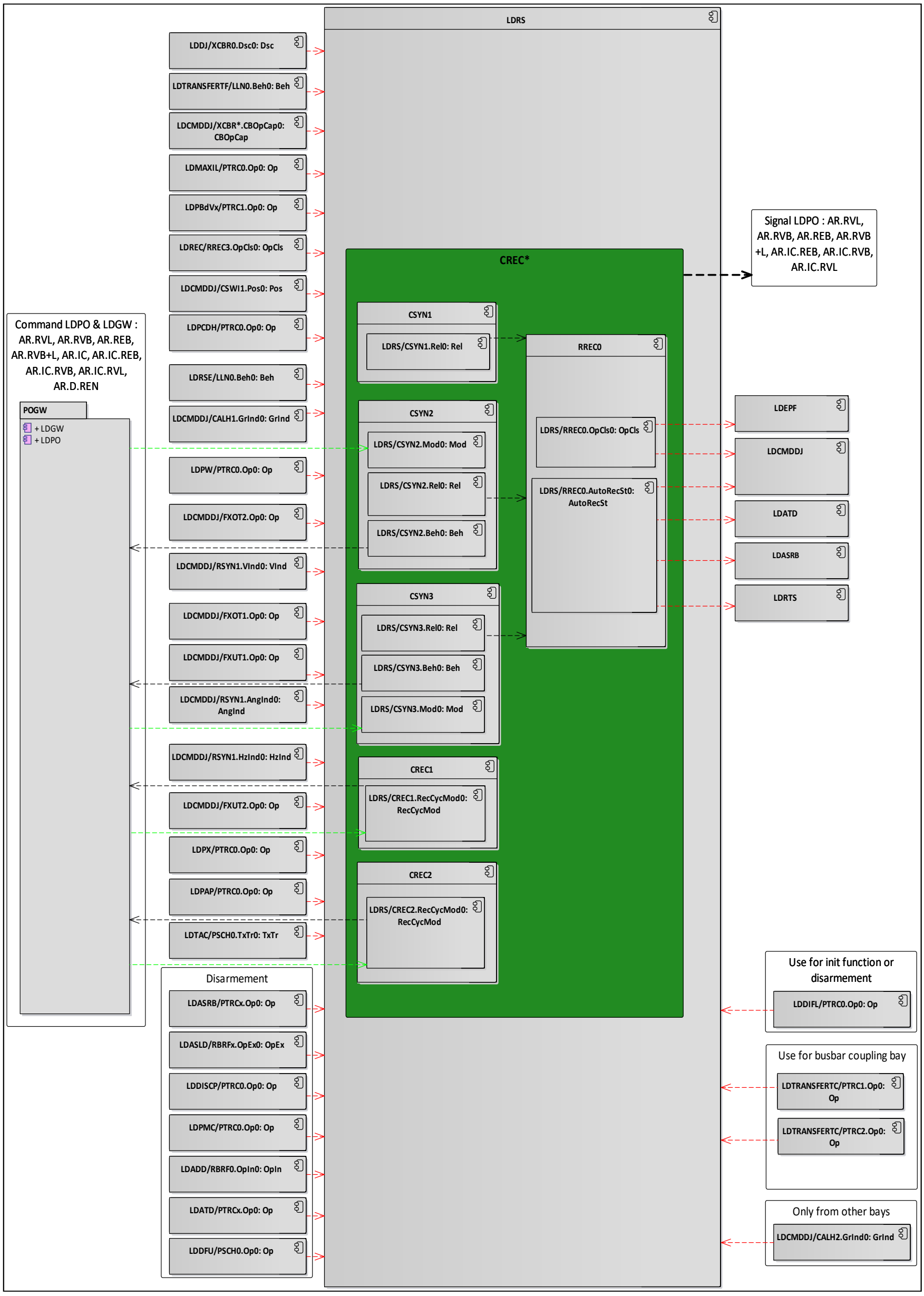

Figure 88 : Dynamic description LDRS

Unless otherwise indicated, the LDs indicated in the input in Figure 88 are those of the same functional bay.

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12.6 LDREC : Single-Phase reclosing and RTR function -dynamic description (cf. §6.4)

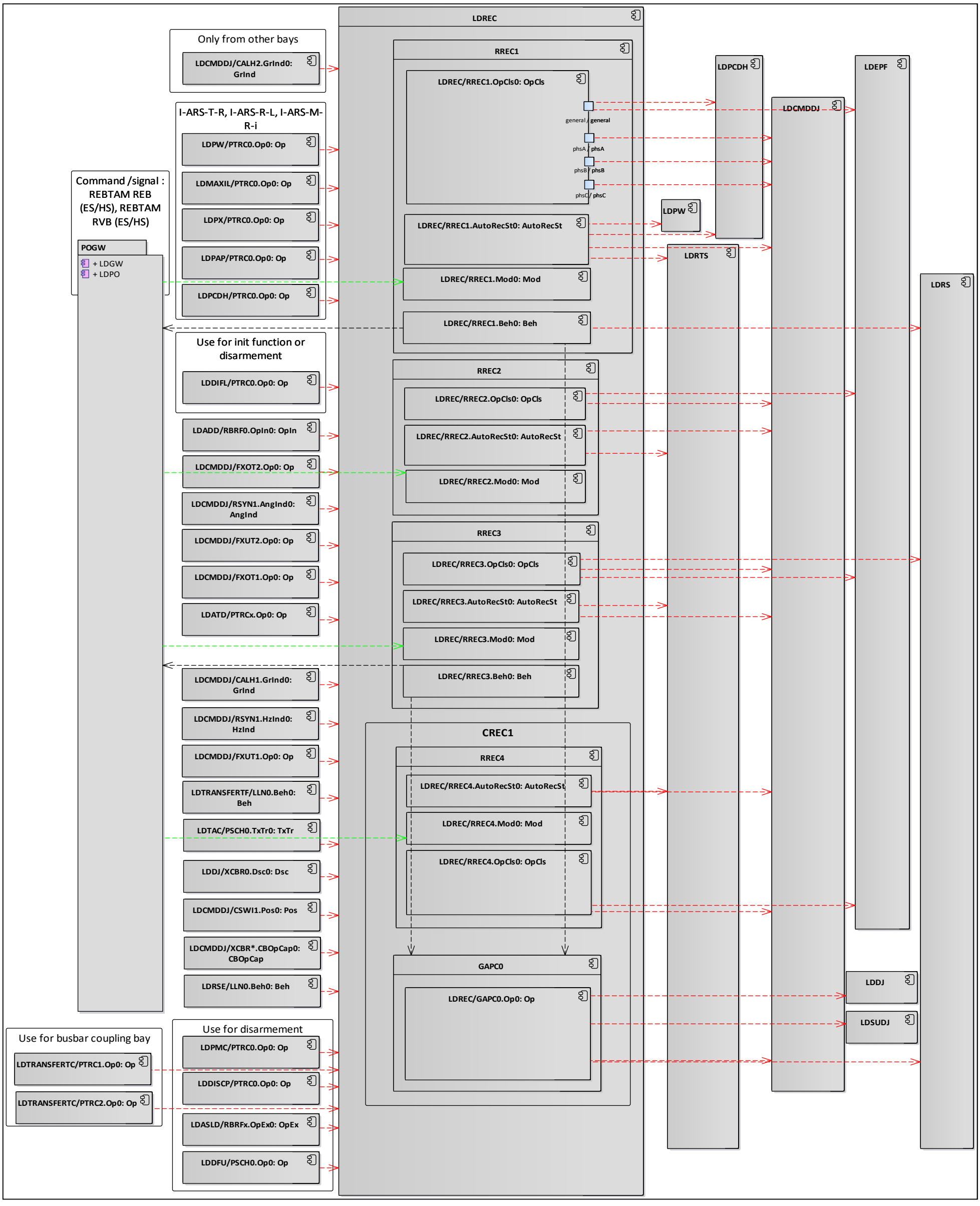

Figure 89 : Dynamic description LDREC

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12.7 LDDJ: Circuit Breaker Interface - dynamic description (cf. §7.2)

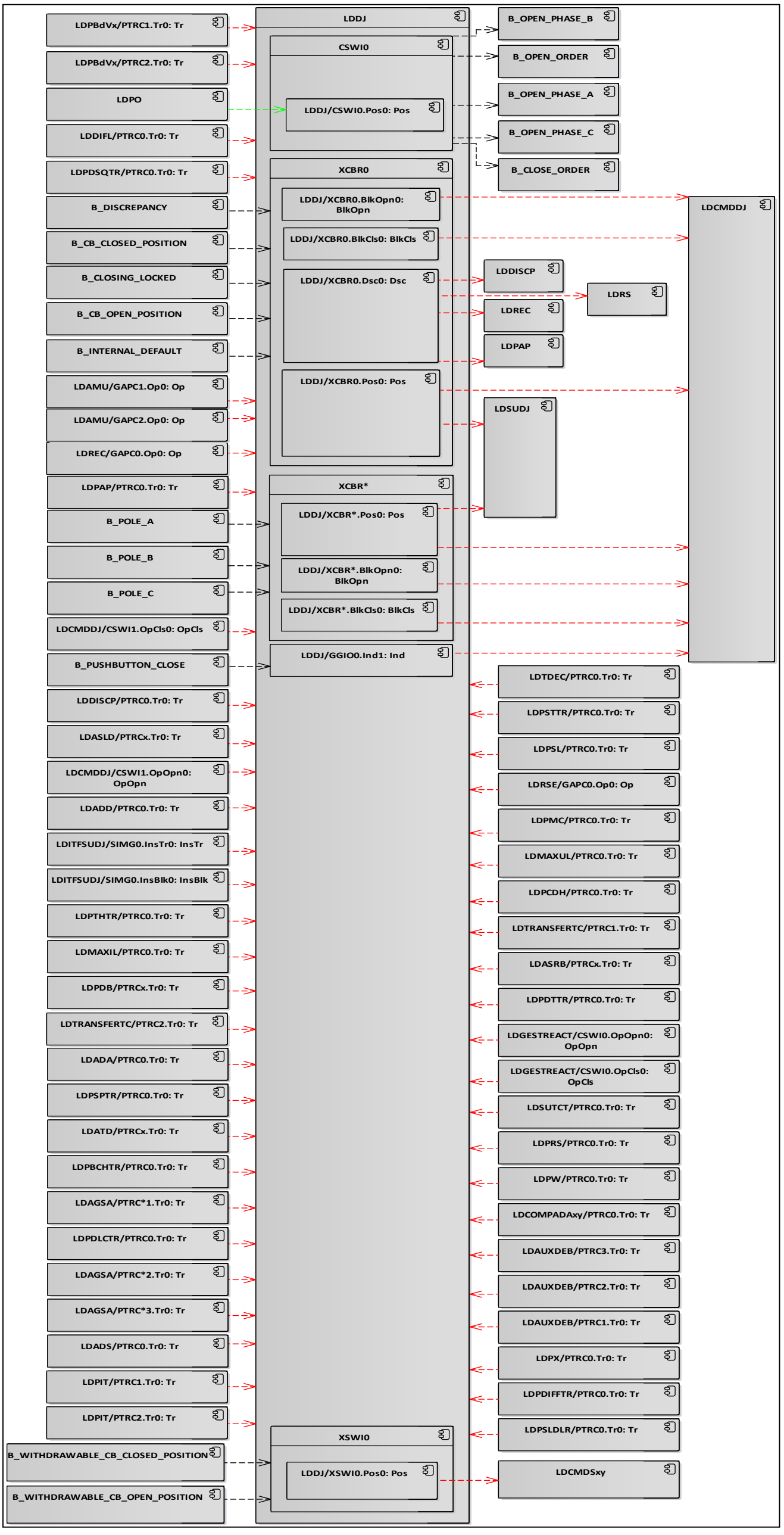

Figure 90 : Dynamic description LDDJ

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12.8 LDITFTG: Substation Management Bay Interface - dynamic description (cf. §7.9)

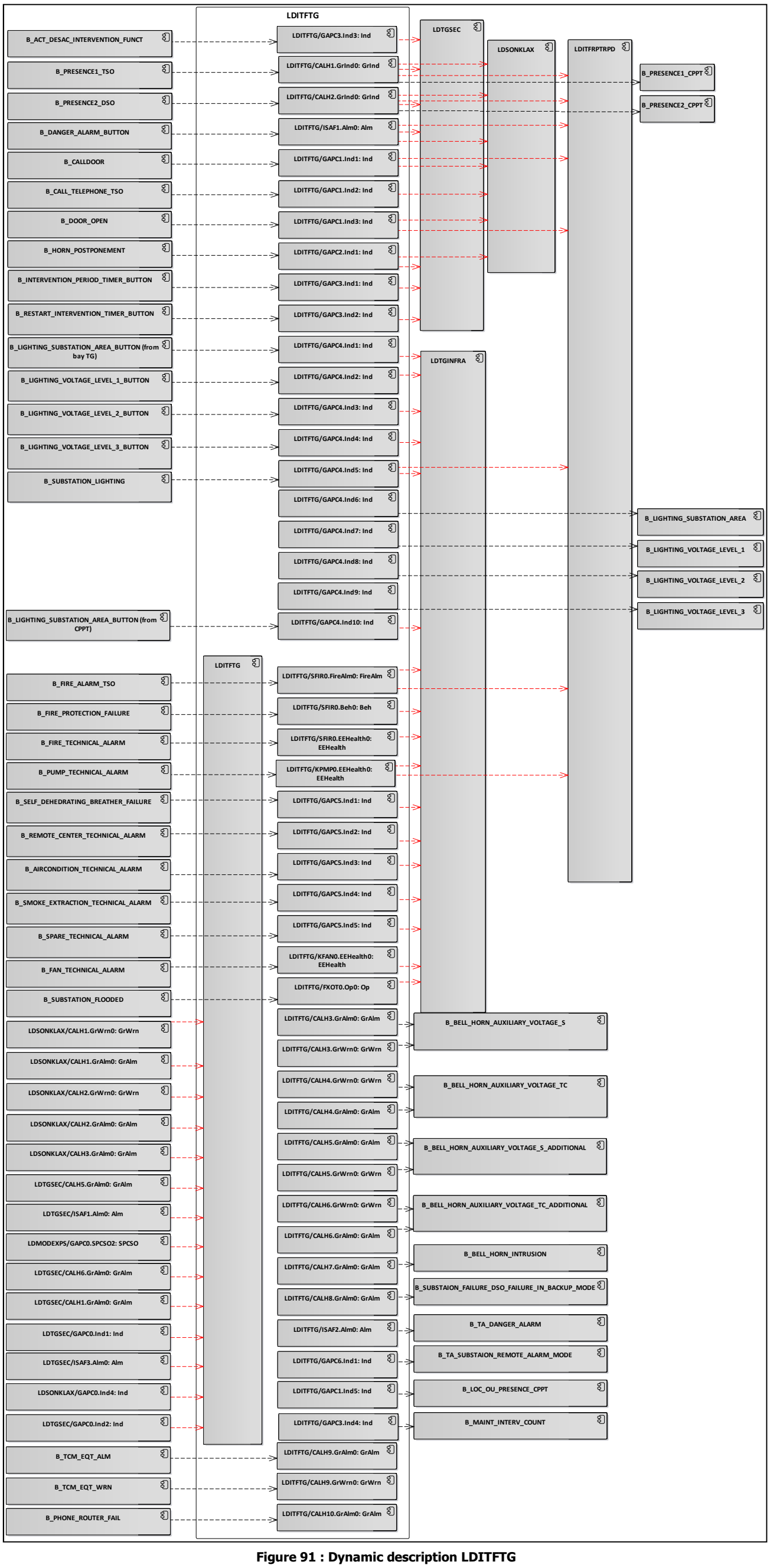

Figure 91 : Dynamic description LDITFTG

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12.9 LDCMDDJ: Circuit Breaker Command - dynamic description (cf. §8.1)

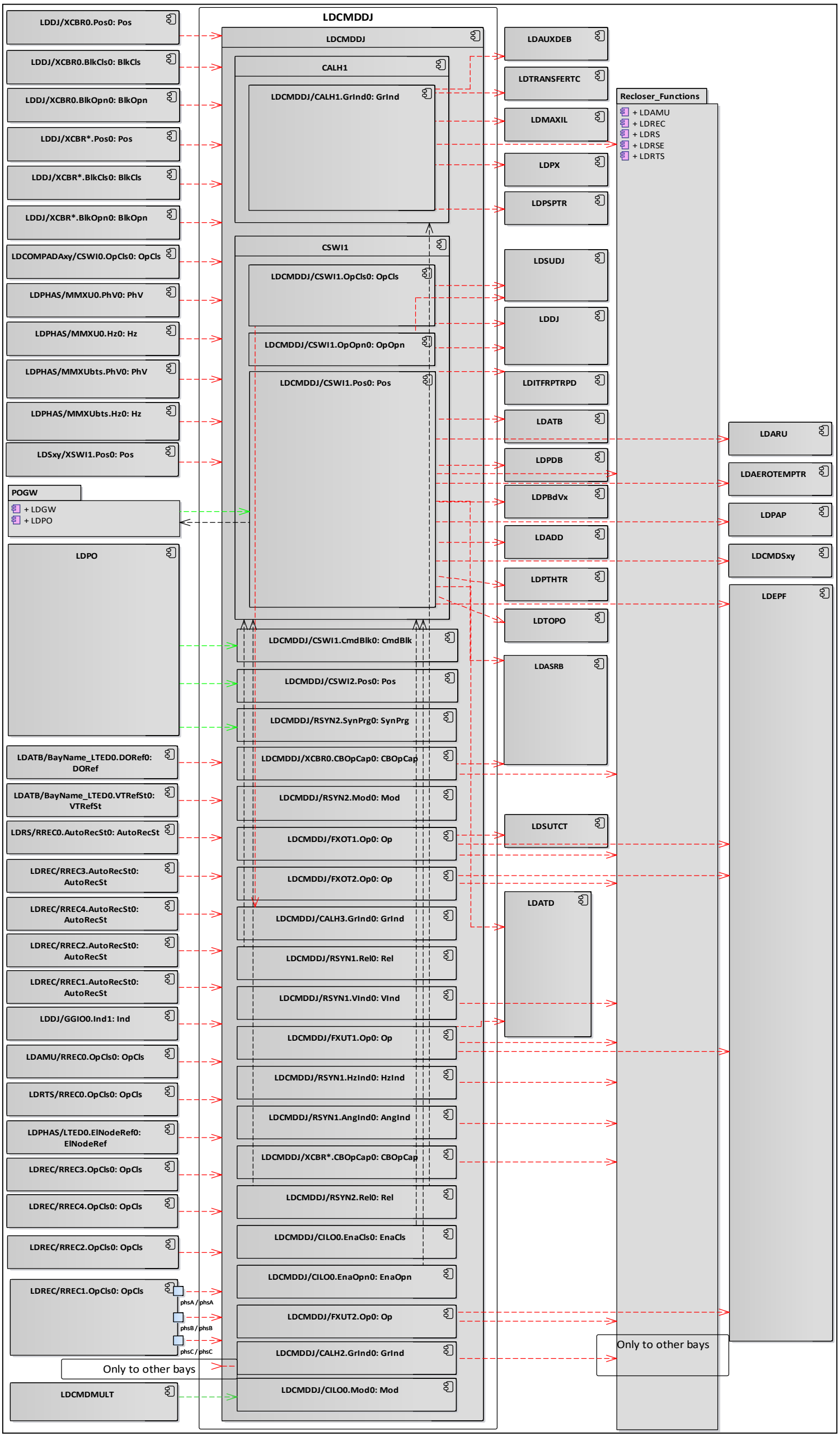

Figure 92: Dynamic description LDCMDDJ

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12.10 LDTM: Instrument transformer - dynamic description (cf. §7.4)

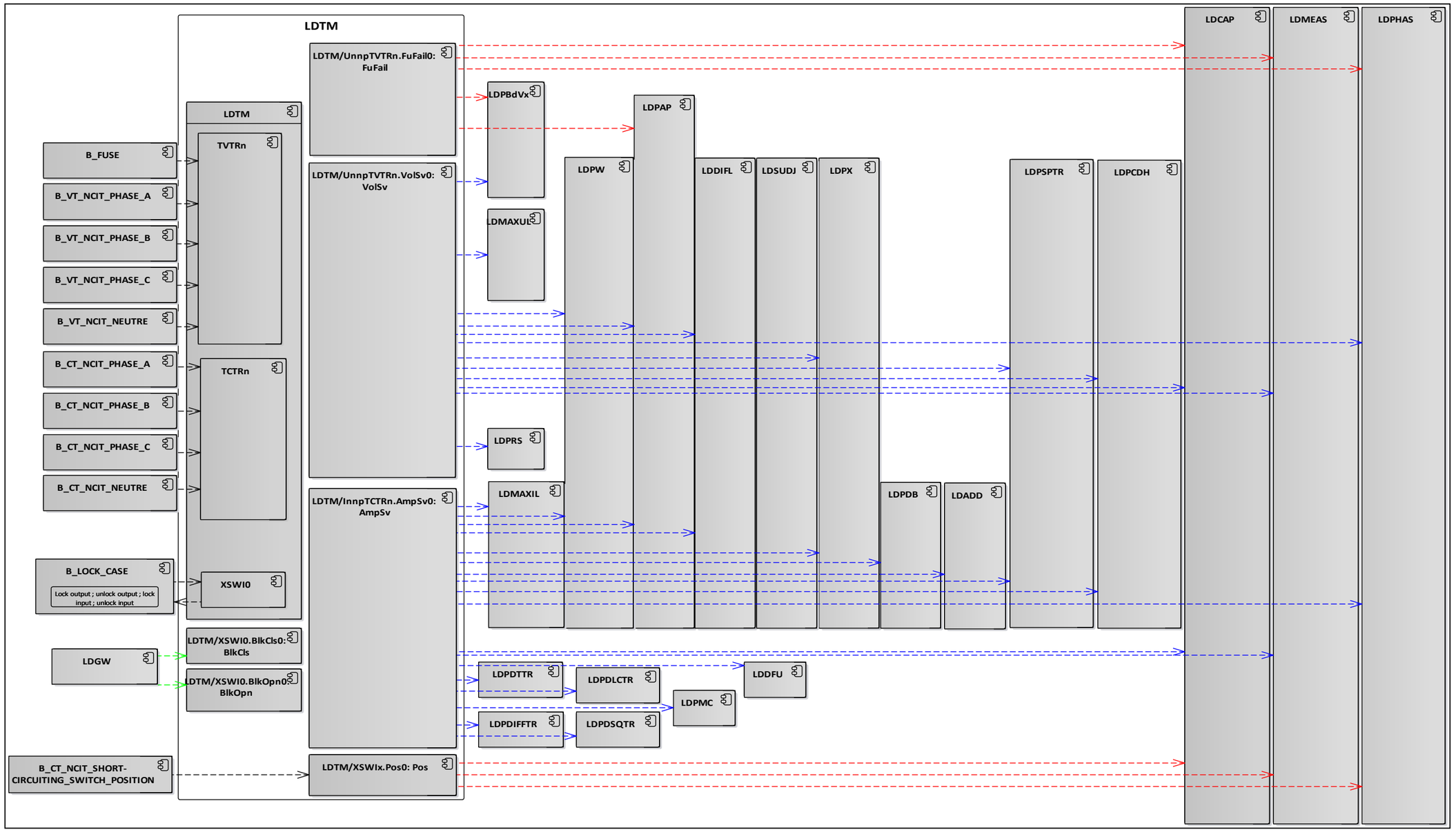

Figure 93: LDTM dynamic description

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