



BSI Standards Publication

Communication networks and systems for power utility automation

Part 90-6: Use of IEC 61850 for Distribution Automation Systems

National foreword

This Published Document is the UK implementation of IEC TR 61850-90-6:2018, incorporating corrigendum January 2020.

The start and finish of text introduced or altered by corrigendum is indicated in the text by tags. Text altered by IEC corrigendum January 2020 is indicated in the text by AC1 AC1.

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

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2020
Published by BSI Standards Limited 2020

ISBN 978 0 539 12865 9

ICS 33.200

Compliance with a British Standard cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 30 September 2018.

Amendments/corrigenda issued since publication

Date	Text affected
29 February 2020	Implementation of IEC corrigendum January 2020

TECHNICAL REPORT



Communication networks and systems for power utility automation – Part 90-6: Use of IEC 61850 for Distribution Automation Systems

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 33.200

ISBN 978-2-8322-6039-5

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	9
INTRODUCTION.....	11
1 Scope.....	13
1.1 General.....	13
1.2 Namespace name and version	13
1.3 Namespace Code components distribution	14
2 Normative references	15
3 Terms, definitions, abbreviated terms and definitions of fault types	16
3.1 Terms and definitions.....	17
3.2 Abbreviated terms.....	17
3.2.1 Proposed specifically for the data model part of the report.....	17
3.2.2 Existing abbreviations used in the original IEC 61850 data object names model	18
3.3 Definitions of fault types.....	30
4 Common actors	30
5 Requirements and use cases.....	39
5.1 General.....	39
5.2 Use case 1: Fault indication and report	40
5.2.1 General	40
5.2.2 Use case 1a: Generic use case – Not fault type specific	40
5.2.3 Use case 1b: Overcurrent non directional Fault Localization and Indication (F1C/NC).....	59
5.2.4 Use case 1c: Phase to earth faults, non directional fault detection (F2)	60
5.2.5 Use case 1d: Overcurrent and Phase to earth faults detection non directional (F3)	60
5.2.6 Use case 1e: Overcurrent, directional and non directional, fault detection (F4).....	61
5.2.7 Use case 1f: Overcurrent, non directional, phase to earth faults, directional and non directional fault detection (F5).....	61
5.2.8 Use case 1g: Overcurrent and phase to earth faults, directional and non directional fault detection (F6)	61
5.3 Use case 2: FLISR based on local control.....	61
5.3.1 General	61
5.3.2 Use case 2a: FLISR using sectionalizers detecting fault current	61
5.3.3 Use case 2b: FLISR using sectionalizers detecting feeder voltage (SDFV)	73
5.4 Use case 3: FLISR based on centralized control	90
5.4.1 General	90
5.4.2 Use case 3a: FLISR in a radial feeder based on centralized control	90
5.4.3 Use case 3b: FLISR in an open loop feeder based on centralized control	99
5.5 Use case 4: FLISR based on distributed control.....	105
5.5.1 General	105
5.5.2 Use case 4a: FLISR in an open loop network based on distributed control – Type A	106
5.5.3 Use case 4b: FLISR based on distributed control – Type B.....	130
5.6 Use case 5: Centralized Voltage and Var Control.....	147
5.6.1 Description of the use case	147



5.6.2	Diagrams of use case	149
5.6.3	Technical details.....	150
5.6.4	Step by step analysis of use case	151
5.6.5	Information exchanged	153
5.7	Use case 6: Anti-islanding protection based on communications	153
5.7.1	Description of the use case	153
5.7.2	Diagrams of use case	155
5.7.3	Technical details.....	158
5.7.4	Step by step analysis of use case	159
5.7.5	Information exchanged	162
5.8	Use Case 7: Automatic transfer switch	162
5.8.1	Description of the use case	162
5.8.2	Diagrams of use case	163
5.8.3	Technical details.....	165
5.8.4	Step by step analysis of use case	165
5.8.5	Information exchanged	167
5.9	Use Case 8: Monitor energy flows (Energy flow related Use cases)	167
5.9.1	Use case breakdown	167
5.9.2	Monitor Energy flows	169
5.9.3	Elaborate the direction of the energy flow	170
5.10	Use Case 9: Environment situation awareness.....	173
5.10.1	Description of the use case	173
5.11	Use case 10: Configuration of IEDs participating in distributed control.....	176
5.11.1	Description of the use case	176
6	Information models	191
6.1	Mapping of requirements on LNs	191
6.1.1	Mapping of the requirements of Fault Identification and report	191
6.1.2	Mapping of the requirements of FLISR based on local control – Type 2	193
6.1.3	Mapping of the requirements of FLISR based on centralized control – Type 3	196
6.1.4	Mapping of the requirements of FLISR based on distributed control – Type 4	197
6.1.5	Mapping of the requirements of VVC use case – Type 5	205
6.1.6	Mapping of the requirements of anti-islanding protection use case – Type 6	207
6.1.7	Mapping of the requirements of automatic transfer switch use case – Type 7	208
6.1.8	Mapping of the requirements of Monitor energy flows related Use case – Type 8	210
6.1.9	Mapping of Environment situation awareness use case – Type 9	211
6.2	Mapping summary of the set of UCs over the LNs (existing or new)	214
7	Logical node classes and data objects modelling	215
7.1	General.....	215
7.2	Logical node classes.....	215
7.2.1	General	215
7.2.2	Abstract LN of 90-6 namespace (Abstract90-6LNs)	215
7.2.3	LN of Group A (LNGroupA_90_6)	220
7.2.4	LN of Group D (LNGroupD_90_6)	231
7.2.5	LN of Group K (LNGroupK_90_6)	233
7.2.6	LN of Group M (LNGroupM_90_6)	237

7.2.7	LN from Group P (LNGroupP_90_6)	250
7.2.8	LN of Group R (LNGroupR_90_6)	252
7.2.9	LN of Group S (LNGroupS_90_6)	255
7.3	Data semantics	267
7.4	Enumerated data attribute types	274
7.4.1	General	274
7.4.2	Actual source (ActualSourceKind enumeration)	274
7.4.3	AffectedPhases90_6Kind enumeration	275
7.4.4	ATSAutoReturnModeKind enumeration	275
7.4.5	ATSSequenceResultKind enumeration	276
7.4.6	ATSSequenceStatusKind enumeration	276
7.4.7	FaultConfirmationModeKind enumeration	277
7.4.8	FaultPermanenceKind enumeration	277
7.4.9	FaultSourceTypeKind enumeration	278
7.4.10	GateStatusKind enumeration	278
7.4.11	IslandingStateKind enumeration	279
7.4.12	momentary close request in case of use of RFV automation (MomentaryCloseResultKind enumeration)	279
7.4.13	NormalSourceKind enumeration	279
7.4.14	RFVFuncTypeKind enumeration	279
7.4.15	Result of the latest restoration process (SequenceEndResultKind enumeration)	280
7.4.16	SequenceStatusKind enumeration	280
7.5	SCL enumerations (from DOEnums_90_6)	281
8	Communication and architectures	283
8.1	Types of communication architecture	283
8.1.1	General	283
8.1.2	Digital communication with remote monitoring	283
8.1.3	Digital communications with remote monitoring and control	284
8.1.4	Digital communication with distributed control	284
8.2	Architectures matching use cases	285
8.3	Cyber-security	286
9	Configuration	286
Annex A (informative)	Interpretation of logical node tables	296
A.1	General interpretation of logical node tables	296
A.2	Conditions for element presence	296
Annex B (informative)	Typical Grid topologies considered in this report	299
Annex C (informative)	NSD File Update	300
Bibliography		302
Figure 1 – Actors top level hierarchy		31
Figure 2 – System Actors SGAM positioning (function)		32
Figure 3 – System Actors SGAM positioning (not function related)		33
Figure 4 – Fault indication – Main use case		42
Figure 5 – Fault indication for FPI – T1		43
Figure 6 – Fault indication and report for FPI – T2		44
Figure 7 – Fault indication for FPI – T3,T4 (with communication to HV/MV SS) in the context of FLISR as described in 5.4		45

Figure 8 – Fault indication for FPI – T3,T4 (without communication to HV/MV SS) in the context of FLISR as described in 5.4.....	46
Figure 9 – Voltage Presence/Absence	60
Figure 10 – FLISR use case breakdown.....	64
Figure 11 – Fault location sequence diagram	65
Figure 12 – Fault isolation sequence diagram	66
Figure 13 – Service restoration sequence diagram.....	67
Figure 14 – A distribution grid configuration in a multi-source network based on open loops	74
Figure 15 – The basic behavior of distribution feeder in FLISR using sectionalizers detecting feeder voltage	76
Figure 16 – FLISR-SDFV use case break down	77
Figure 17 – FLISR-SDFV Fault Location and Identification sequence diagram	78
Figure 18 – FLISR-SDFV Fault Location and Identification sequence diagram	79
Figure 19 – FLISR-SDFV Fault Location and Identification sequence diagram	79
Figure 20 – FLISR-SDFV Fault Location and Identification sequence diagram	80
Figure 21 – Auxiliary use cases for FLISR using SDFV	80
Figure 22 – FLISR-SDFV Set X specific time sequence diagram	81
Figure 23 – FLISR-SDFV Set Y specific time sequence diagram	81
Figure 24 – FLISR-SDFV Release blocking of closing sequence diagram	81
Figure 25 – FLISR-SDFV Set functional type sequence diagram	82
Figure 26 – FLISR-SDFV Set connection direction sequence diagram	82
Figure 27 – FLISR-SDFV Supervisory sequence diagram	82
Figure 28 – Common actors in a distribution system with FLISR using SDFV	84
Figure 29 – Centralized FLISR in a radial feeder – Use cases.....	92
Figure 30 – Centralized FLISR for radial feeder – Fault location sequence diagram	93
Figure 31 – Centralized FLISR for radial feeder – Fault isolation sequence diagram	94
Figure 32 – Centralized FLISR for radial feeder – Service restoration sequence diagram	94
Figure 33 – Centralized FLISR for open loop – Use case breakdown	101
Figure 34 – Centralized FLISR for open loop – Service restoration sequence diagram	102
Figure 35 – A distributed DAS for an open loop overhead feeder	108
Figure 36 – Distributed FLISR in an open loop network – Upstream use cases breakdown	111
Figure 37 – Distributed FLISR in an open loop network – Operation use cases breakdown	112
Figure 38 – Distributed FLISR in an open loop network – Topology discovery sequence diagram	113
Figure 39 – Distributed FLISR in an open loop network – FLISR operation sequence diagram	115
Figure 40 – Logical selectivity – FLI along the MV feeder	132
Figure 41 – Logical selectivity – FLI inside the EU plant	133
Figure 42 – Logical selectivity – FLI along the MV feeder and anti-islanding	134
Figure 43 – Distributed FLISR 4b – Use case breakdown.....	135
Figure 44 – Distributed FLISR 4b – For further analysis	136
Figure 45 – Volt-Var Control – Use case breakdown	149

Figure 46 – Volt-Var Control – Sequence diagram	150
Figure 47 – Possible fault location on the feeder.....	154
Figure 48 – Anti-islanding protection – Use case breakdown.....	155
Figure 49 – Anti-islanding protection – Role diagram	156
Figure 50 – Anti-islanding protection – Sequence diagram.....	157
Figure 51 – Automatic transfer switch – Scenario flowchart.....	164
Figure 52 – Automatic transfer switch – Use cases breakdown	164
Figure 53 – Automatic transfer switch – Activity flowchart	166
Figure 54 – Monitor energy flows – use case breakdown	168
Figure 55 – Sequence diagram for the “Monitor energy flows” use case.....	169
Figure 56 – Environment situation awareness – Use cases breakdown	174
Figure 57 – Environment situation awareness – Sequence diagram	175
Figure 58 – The schematic diagram of remote configuration process	179
Figure 59 – Configuration of IEDs participating in distributed control – Use case diagram	180
Figure 60 – Configuration of IEDs participating in distributed control – Sequence diagram	181
Figure 61 – Possible arrangement of LNs to support fault passage indication	193
Figure 62 – Typical Arrangement of LNs to support FLISR using sectionalizers detecting fault current	194
Figure 63 – Typical Arrangement of LNs to support FLISR using SDFV	195
Figure 64 – Logical arrangement of LNs to support FLISR using SDFV.....	195
Figure 65 – Typical Arrangement of LNs to FLISR based on centralized control.....	197
Figure 66 – Typical arrangement of LNs to support distributed fault location (case 4a)	198
Figure 67 – Typical arrangement of LNs (between FeCtl) to support distributed fault location (case 4a)	199
Figure 68 – Typical arrangement of LNs to support distributed fault isolation (case 4a)	200
Figure 69 – Typical arrangement of LNs (between FeCtl) to support distributed fault isolation (case 4a)	200
Figure 70 – Possible arrangement to support distributed service restoration	201
Figure 71 – Break down of LNs and relationships to support distributed service restoration	202
Figure 72 – Possible LN arrangement of breakers related functions, contributing to distributed FLISR (case 4b)	204
Figure 73 – Possible LN arrangement of disconnectors related functions, contributing to distributed FLISR (case 4b)	205
Figure 74 – Possible LN arrangement for the mapping for tap changer control.....	206
Figure 75 – Possible LN arrangement for the mapping for capacitor bank control	206
Figure 76 – Breakdown of LNs and relationships to support unintentional islanding protection	208
Figure 77 – Possible arrangement of LNs to perform automatic transfer switch.....	210
Figure 78 – Possible arrangement of LNs to Monitor energy flows related Use cases	211
Figure 79 – Possible arrangement of LNs to support Environment situation awareness use cases	213
Figure 80 – Class diagram LogicalNodes_90_6::LogicalNodes_90_6	215
Figure 81 – Class diagram Abstract90-6LNs::LN AbstractLN 90_6	216

Figure 82 – Statechart diagram LNGroupA_90_6::AATS Generic state-machine	220
Figure 83 – Statechart diagram LNGroupA_90_6::AATS Normal-Back-up	221
Figure 84 – Class diagram LNGroupA_90_6::LN GroupA 90_6	222
Figure 85 – Class diagram LNGroupD_90_6::LN GroupD 90_6	232
Figure 86 – Class diagram LNGroupK_90_6::LN GroupK 90_6	234
Figure 87 – Class diagram LNGroupM_90_6::LN GroupM (1) 90_6	237
Figure 88 – Class diagram LNGroupM_90_6::LN GroupM (2) 90_6	238
Figure 89 – Class diagram LNGroupP_90_6::LN GroupP 90_6	250
Figure 90 – Class diagram LNGroupR_90_6::LN GroupR 90_6	252
Figure 91 – Class diagram LNGroupS_90_6::LN GroupS (1) 90_6	255
Figure 92 – Class diagram LNGroupS_90_6::LN GroupS (2) 90_6	256
Figure 93 – Class diagram DOEnums_90_6::DO Enumerations 90_6	274
Figure 94 – Centralised distribution automation architecture with monitoring	283
Figure 95 – Centralised distribution automation architecture with monitoring and control	284
Figure 96 – Distributed control architecture	284
Figure 97 – Mixed distribution automation architecture combining distributed and centralised monitoring and control	285
Figure 98 – Distributed feeder automation system for an open loop overhead feeder	287
Figure 99 – Configuration process for the information exchange between substation automation and grid automation systems	288
Figure B.1 – Typical grid topologies	299
Table 1 – Normative abbreviations for data object names	18
Table 2 – Normative abbreviations for data object names	18
Table 3 – Time based Fault types	30
Table 4 – List of common actors	34
Table 5 – Mapping of Fault Identification and report use case 1 requirements onto LNs	191
Table 6 – Mapping of FLISR using sectionalizers detecting fault current use case 2a requirements onto LNs	194
Table 7 – Mapping of FLISR using SDFV use case 2b requirements onto LNs	196
Table 8 – Mapping of Distributed FLISR (fault location) use case 4a onto LNs	197
Table 9 – Mapping of Distributed FLISR (fault isolation) use case 4a onto LNs	199
Table 10 – Mapping of Distributed FLISR (service restoration) use case 4a onto LNs	201
Table 11 – Mapping of Distributed FLISR use case 4b requirements onto LNs	203
Table 12 – Mapping of anti-islanding use case requirements onto LNs	207
Table 13 – Mapping of automatic transfer switch use case requirements onto LNs	209
Table 14 – Energy flow related use case requirement mapping over LNs	211
Table 15 – Mapping of Environment situation awareness use cases to existing or new LNs	212
Table 16 – Data objects of AutomatedSequenceLN	217
Table 17 – Data objects of AutomaticSwitchingLN	218
Table 18 – Data objects of ASWI	223
Table 19 – Data objects of AATS	225
Table 20 – Data objects of AFSI	227

Table 21 – Data objects of AFSL.....	228
Table 22 – Data objects of ASRC.....	230
Table 23 – Data objects of DISL	233
Table 24 – Data objects of KFIM.....	235
Table 25 – Data objects of KILL	236
Table 26 – Data objects of MENVExt	239
Table 27 – Data objects of MMETExt	241
Table 28 – Data objects of MMTNExt.....	243
Table 29 – Data objects of MMTRExt.....	245
Table 30 – Data objects of MMXNExt.....	247
Table 31 – Data objects of MMXUExt.....	248
Table 32 – Data objects of PTRCExt.....	250
Table 33 – Data objects of RRFV	253
Table 34 – Data objects of SCPI	257
Table 35 – Data objects of SFOD.....	258
Table 36 – Data objects of SFPI	259
Table 37 – Data objects of SFST	261
Table 38 – Data objects of SGPD	262
Table 39 – Data objects of SSMK	264
Table 40 – Data objects of SPSE	265
Table 41 – Data objects of SVPI	266
Table 42 – Attributes defined on classes of LogicalNodes_90_6 package	267
Table 43 – Literals of ActualSourceKind	275
Table 44 – Literals of AffectedPhases90_6Kind	275
Table 45 – Literals of ATSAutoReturnModeKind	276
Table 46 – Literals of ATSSequenceResultKind	276
Table 47 – Literals of ATSSequenceStatusKind	277
Table 48 – Literals of FaultConfirmationModeKind	277
Table 49 – Literals of FaultPermanenceKind.....	278
Table 50 – Literals of FaultSourceTypeKind.....	278
Table 51 – Literals of GateStatusKind.....	278
Table 52 – Literals of IslandingStateKind	279
Table 53 – Literals of MomentaryCloseResultKind	279
Table 54 – Literals of NormalSourceKind	279
Table 55 – Literals of RFVFuncTypeKind	280
Table 56 – Literals of SequenceEndResultKind.....	280
Table 57 – Literals of SequenceStatusKind.....	280
Table 58 – Distribution automation architecture matching the use cases.....	285
Table 59 – Mapping information models onto the protocol.....	286
Table A.1 – Interpretation of logical node tables	296
Table A.2 – Conditions for presence of elements within a context	296

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**COMMUNICATION NETWORKS AND SYSTEMS
FOR POWER UTILITY AUTOMATION –****Part 90-6: Use of IEC 61850 for Distribution Automation Systems**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC 61850-90-6, which is a technical report, has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
57/1929/DTR	57/2008/RVDTR

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

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

AC₁ This IEC standard includes Code Components i.e. components that are intended to be directly processed by a computer.

Such content is any text found between the markers <CODE BEGINS> and <CODE ENDS>, or otherwise is clearly labelled in this standard as a Code Component.

The purchase of this IEC standard carries a copyright license for the purchaser to sell software containing Code Components from this standard to end users either directly or via distributors, subject to IEC software licensing conditions, which can be found at: <http://www.iec.ch/CCv1>

Attribute	Content
Namespace IEC specific information	
Version of the UML model used for generating the document (informative)	WG17build1
Date of the UML model used for generating the document (informative)	2019-04-07
Autogeneration software name and version(informative)	jCleanCim 02v02-NS beta2 built 2

AC₁

As a reminder a Joint Ad Hoc Group (JAHWG 51) had been set up between IEC Technical Committee 38 and IEC TC 57 in order to capture the requirements elaborated by the experts of the Fault Passage Indicators domain, which resulted in the publication of IEC TR 62689-100 in October 2016.

As agreed in the term of reference of this JAHWG 51, IEC TC 57 merged the conclusions of the above work within this document.

In return, it was agreed that IEC 62689-3, dealing with *Current and Voltage sensors or detectors, to be used for fault passage indication purposes – Part 3: Communication*, should be based on the content of IEC TR 61850-90-6.

A list of all parts in the IEC 61850 series, published under the general title *Communication networks and systems for power utility automation*, can be found on the IEC website.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

IEC 61850 consists of the following parts, under the general title *Communication networks and systems for power utility automation* (all parts may have not been published yet).

- Part 1: Introduction and overview
- Part 2: Glossary
- Part 3: General requirements
- Part 4: System and project management
- Part 5: Communication requirements for functions and device models
- Part 6: Configuration description language for communication in electrical substations related to IEDs
- Part 7-1: Basic communication structure – Principles and models
- Part 7-2: Basic communication structure – Abstract communication service interface (ACSI)
- Part 7-3: Basic communication structure – Common data classes
- Part 7-4: Basic communication structure – Compatible logical node classes and data classes
- Part 7-410: Hydroelectric power plants – Communication for monitoring and control
- Part 7-420: Basic communication structure – Distributed energy resources logical nodes
- Part 8-1: Specific communication service mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3
- Part 80-1: Guideline to exchange information from a CDC based data model using IEC 60870-5-101/104
- Part 9-2: Specific communication service mapping (SCSM) – Sampled values over ISO/IEC 8802-3
- Part 90-1: Use of IEC 61850 for the communication between substations
- Part 90-2: Using IEC 61850 for the communication between substations and control centres¹
- Part 90-3: Using IEC 61850 for condition monitoring
- Part 90-4: Network Engineering Guidelines – Technical report
- Part 90-5: Using IEC 61850 to transmit synchrophasor information according to IEEE C37.118
- Part 90-7: Object models for power converters in distributed energy resources (DER) systems
- Part 90-8: Object model for E-mobility
- Part 10: Conformance testing

In addition to the above, the IEC 61850 basic communication structure for Wind Turbines has been published as IEC 61400-25, *Wind turbines – Communications for monitoring and control of wind power plants*.

IEC 61850-1 is an introduction and overview of the IEC 61850 series. It describes the philosophy, work approach and contents of the other parts.

Distribution Automation (DA) is a concept which emerged in the 1970s to promote the application of computer and communication technologies for the betterment of distribution system operating performance. It is in general used as an umbrella term to capture the deployment of automation technologies for protection, control, monitoring, and operation of distribution systems. These technologies enable electric utilities to monitor, control, and

¹ Under preparation. Stage at the time of publication: IEC/PWI 61850-90-2:2018.

operate distribution components in a real-time or non-real-time mode. The industry is also pushing towards smart and active distribution networks which support the high penetration of Distributed Energy Resources (DERs) and have better supply reliability and operation efficiency. As a result, DA concepts are also being extended in the form of Advanced Distribution Automation (ADA), which includes automation of DERs and demand response programs.

A widely-recognized instance of a DA project involves utilization of communication and information technology to enable real-time monitoring and control of switching devices including circuit breakers, line reclosers, automatic sectionalizers as well as capacitor banks and line regulators in MV networks. This control can be achieved in local, distributed, and central means. Local control is implemented inside a device based on local measurements. Distributed control involves peer-to-peer communication among relevant field devices. Central control is SCADA-like and is implemented in a substation or control room. This category of DA is also referred to as Feeder Automation (FA). Before the deployment of FA, the switching operations have to be done by the field crew, requiring physical patrolling of the feeder route to locate faults and manual verification of every switching action. Evidently, this practice prolongs the switching time and gives rise to extended outage times and system inefficiencies. With the application of data collection and real-time control through FA, these switching tasks are accomplished in an automated fashion giving rise to accelerated restoration times which are much less than those offered by the legacy systems.

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 90-6: Use of IEC 61850 for Distribution Automation Systems

1 Scope

1.1 General

The contents of Distribution Automation (DA) vary between different countries, regions, even between different utilities in the same country. DA may cover HV/MV substations, MV networks, LV networks, distributed energy resources, as well as demand sides. This part of IEC 61850, which is a technical report, provides basic aspects that need to be considered when using IEC 61850 for information exchange between systems and components to support Distribution Automation applications, within MV network automation, as presented in Annex B.

In particular, this document:

- defines use cases for typical DA applications that require information exchange between two or more components/systems
- provides modelling of components commonly used in DA applications
- proposes new logical nodes and the extensions to the existing logical nodes that can be used in typical DA applications.
- provides guidelines for the communication architecture and services to be used in DA applications
- provides configuration methods for IEDs to be used in DA systems.

Its content also results from the merge of the preparatory work exposed in IEC TR 62689-100 – *Current and voltage sensors or detectors, to be used for fault passage indication purposes – Part 100: Requirements and proposals for the IEC 61850 series data model extensions to support fault passage indicators applications.*



1.2 Namespace name and version

This new subclause is mandatory for any IEC 61850 namespace (as defined by IEC 61850-7-1:2011).

Table 60 shows all attributes of (Tr)IEC61850-90-6:2018B namespace.

Table 60 – Attributes of (Tr)IEC61850-90-6:2018B namespace

Attribute	Content
Namespace nameplate	
Namespace Identifier	(Tr)IEC61850-90-6
Version	2018
Revision	B
Full Namespace Name	(Tr)IEC61850-90-6:2018B
Namespace Type	transitional
Namespace dependencies	
extends	IEC 61850-7-4:2007B version :2007 revision :B
Namespace transitional status	
Future handling of namespace content	The name space (Tr)IEC61850-90-6:2018B is considered as "transitional" since the models are expected to be included in further editions IEC 61850-7-4xx. Potential extensions/modifications may happen if/when the models are moved to the International Standard status

1.3 Namespace Code Component distribution

The Code Components are in light and full version:

- The full version is named : *IEC_TR_61850-90-6.NSD.2018B.Full*. It contains definition of the whole data model defined in this standard with the documentation associated and access is restricted to purchaser of this part
- The light version is named : *IEC_TR_61850-90-6.NSD.2018B.Light*. It doesn't contain any documentations but contains the whole data model as per full version, and this light version is freely accessible on the IEC website for download at : <http://www.iec.ch/tc57/supportdocuments>, but the usage remains under the licensing conditions.

The Code Components for IEC 61850 data models are formatted in compliance with the NSD format defined by the standard IEC 61850-7-7. Each Code Component is a ZIP package containing :

- the electronic representation of the Code Component itself (possibly multiple files),
- the grammar files (XSD) enabling to check the consistency of the associated files against the defined version of NSD, but as well against the IEC 61850 flexibility rules in case of private extensions
- a file describing the content of the package (IECManifest.xml).

The IECManifest contains different sections giving information on:

- The copyright notice

- The identification of the code component
- The publication related to the code component
- The list of the electronic files which compose the code component
- An optional list of history files to track changes during the evolution process of the code component

The life cycle of a code component is not restricted to the life cycle of the related publication. The publication life cycle goes through two stages, Version (corresponding to an edition) and Revision (corresponding to an amendment). A third publication stage (Release) allows publication of Code Component in case of urgent fixes of InterOp Tissues, thus without need to publish an amendment. Consequently new release(s) of the Code Component may be released, which supersede(s) the previous release, and will be distributed through the IEC TC57 web site at: <http://www.iec.ch/tc57/supportdocuments>.

The latest version/release of the document will be found by selecting the file named *IEC_TR_61850-90-6.NSD.{VersionStateInfo}.Light* with the filed VersionStateInfo of the highest value. 

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC TS 61850-2, *Communication networks and systems in substations – Part 2: Glossary*

IEC 61850-5, *Communication networks and systems for power utility automation – Part 5: Communication requirements for functions and device models*

IEC 61850-6:2009, *Communication networks and systems for power utility automation – Part 6: Configuration description language for communication in electrical substations related to IEDs*

IEC 61850-6:2009/AMD1:2018

IEC 61850-7-2:2010, *Communication networks and systems for power utility automation – Part 7-2: Basic information and communication structure – Abstract communication service interface (ACSI)*

IEC 61850-7-2:2010/AMD1:2018²

IEC 61850-7-3:2010, *Communication networks and systems for power utility automation – Part 7-3: Basic communication structure – Common data classes*

IEC 61850-7-3:2010/AMD1:2018³

IEC 61850-7-4:2010, *Communication networks and systems for power utility automation – Part 7-4: Basic communication structure – Compatible logical node classes and data object classes*

IEC 61850-7-4:2010/AMD1:2018⁴

IEC 61850-8-1:2011, *Communication networks and systems for power utility automation – Part 8-1: Specific communication service mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3*

² Under preparation. Stage at the time of publication: IEC/AFDIS 61850-7-2/AMD1:2018.

³ Under preparation. Stage at the time of publication: IEC/AFDIS 61850-7-3/AMD1:2018.

⁴ Under preparation. Stage at the time of publication: IEC/AFDIS 61850-7-3/AMD1:2018.

IEC 61850-8-2⁵, *Communication networks and systems for power utility automation – Part 8-2: Specific Communication Service Mapping (SCSM) – Mapping to Extensible Messaging Presence Protocol (XMPP)*

IEC TS 61850-80-1, *Communication networks and systems for power utility automation – Part 80-1: Guideline to exchanging information from a CDC-based data model using IEC 60870-5-101 or IEC 60870-5-104*

IEC TR 61850-90-2, *Communication networks and systems for power utility automation – Part 90-2: Using IEC 61850 for communication between substations and control centres*

IEC 62689-1:2016, *Current and voltage sensors or detectors, to be used for fault passage indication purposes – Part 1: General principles and requirements*

IEC 62689-2, *Current and voltage sensors or detectors, to be used for fault passage indication purposes – Part 2: System aspects*

IEC 62559-2, *Use case methodology – Part 2: Definition of the templates for use cases, actor list and requirements list*

3 Terms, definitions, abbreviated terms and definitions of fault types

For the purposes of this document, the terms and definitions given in IEC 61850-2 and IEC 61850-7-2 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

⁵ Under preparation. Stage at the time of publication: IEC/CFDIS 61850-8-2:2017.

3.1 Terms and definitions

3.1.1

fault passage indicator

FPI

device able to detect faults providing indications about their localization (upstream or downstream from the FPI's location) and/or about the direction of fault current (usually referred as the direction of load current, i.e. from the HV/MV transformer towards end of MV feeders in a radial operated network)

[SOURCE: IEC 62689-1:2016, 3.1.1]

3.1.2

substation

substation of a power system

part of a power system, concentrated in a given place, including mainly the terminations of transmission or distribution lines, switchgear and housing and which may also include transformers

Note 1 to entry: This generally includes facilities necessary for system security and control (e.g. the protective devices).

Note 2 to entry: Applies equally to overhead and underground equipment.

[SOURCE: IEC 62689-1:2016, 3.1.3, modified (addition of Note 2 to entry)]

3.1.3

distribution substation unit

DSU

device (or a combination of devices and/or functions) able to perform, in addition to specific FPI's functionalities, additional features, not strictly related to fault detection (for instance remote communication/commands, Switch control or Breaker control, Network Automation, Distributed Energy Resources monitoring and control, etc.)

Note 1 to entry: Could also be named Distribution Automation Unit.

[SOURCE: IEC 62689-1:2016, 3.1.4]

3.2 Abbreviated terms

3.2.1 Proposed specifically for the data model part of the report

Table 1 shows normative terms that are combined to create data object names.

Table 1 – Normative abbreviations for data object names

Term	Description	Term	Description
Abc	Absence	Nph	Not phase related
Alwd	Allowed	Pm	Permanent
Ani	Animal	Q	Quadrant
Ats	Automatic transfer switch	Q1	Refer to the quadrant Q1 of the P/Q diagram
Cfm	Confirm	Q2	Refer to the quadrant Q2 of the P/Q diagram
Drn	Drone	Q3	Refer to the quadrant Q3 of the P/Q diagram
Evo	Evolution, Evolutive	Q4	Refer to the quadrant Q4 of the P/Q diagram
Fght	Fighting	Rsto	Restoration
Frz	Freezing	Rtn	Return
Hmn	Human	Seism	seism
Illum	Illumination	Sfx	Self-extinguishing
Imd	Immediate	Sht	Shutter
Inf	Information	Spm	Semi-permanent
Isld	island, islanding	Tfr	Transfer
Itm	Intermittent	Uxp	Unexpected
Mmnt	Momentary		
Nml	Normal		

3.2.2 Existing abbreviations used in the original IEC 61850 data object names model

Table 2 shows normative terms that are combined to create data object names.

Table 2 – Normative abbreviations for data object names

Term	Description	Term	Description
A	Current; phase A (L1)	Admin	Administrative
AC	AC, alternating current	Adp	Adapter, adaptation
AGC	Automatic generation control	Aff	Affected
ASG	Analogue setting CDC	Age	Ageing
AWatt	Wattmetric component of current	Ahr	Ampere hours
Abr	Abrasion	Air	Air
Abs	Absolute	Alg	Algorithm
Absb	Absorbing	Alm	Alarm
Acc	Accuracy; acceleration (deprecated: use Accl instead)	Als	Alarm set
Accl	Acceleration	Alt	Altitude
Accm	Accumulated	Altn	Alternate
Ack	Acknowledgement, acknowledge	Amnt	Amount
Acs	Access	Amp	Ampere, current DC or non-phase-related AC
Act	Action, activity, active, activate	An	Analogue
Actr	Actuator	Anc	Ancillary
Acu	Acoustic	Ane	Anemometer
Addr	Address	Ang	Angle
Adj	Adjustment	Ap	Access point
		Apc	Analogue point control

Term	Description
App	Apparent
Ar	Amperes reactive (reactive current)
Arc	Arc
Area	Area
Arr	Array
Asyn	Asynchronous
At	At
Auth	Authorisation
Auto	Automatic
Aux	Auxiliary
Av	Average
Avl	Availability
Ax	Axial
Azi	Azimuth
B	Bushing; phase B (L2)
BG	Before Gain
Bac	Binary-controlled analogue value
Bar	Barrier
Base	Base
Bat	Battery
Bck	Backup
Bec	Beacon
Beh	Behaviour
Ber	Bit error rate
Bias	Bias
Bl	Blade
Blb	Bulb
Blk	Block, blocked
Blow	Blowby
Bnd	Band, bandwidth
Boil	Boiler
Bot	Bottom
Brcb	Buffered report control block
Brg	Bearing
Brk	Brake
Bsc	Binary status control
Bst	Boost
Bt	Heartbeat
Bub	Bubbling
Bus	Bus
Byb	Bypass
C	Carbon; phase C (L3)
C2H2	Acetylene
C2H4	Ethylene

Term	Description
C2H6	Ethane
CB	Circuit breaker
CE	Cooling equipment (see also Cl)
CG	Core ground
CH4	Methane
CHP	Combined heat and power
CO	Carbon monoxide
CO2	Carbon dioxide
Cab	Cable
Cal	Calorie, caloric
Cam	Cam, e.g. rotating non-circular disk
Can	Cancel
Cap	Capability, capacity
Capac	Capacitance
Car	Carrier
Cbr	Calibration
Ccw	Counter clockwise
Ccy	Currency
Cds	Condensation
Ceil	Ceiling
Cel	Cell
Cf	Crest factor
Cff	Coefficient
Cfg	Configuration
Cg	Combusted Gas
Ch	Channel
Cha	Charger
Chg	Change
Chk	Check
Chr	Characteristic
Chs	Chassis
Circ	Circulating, circuit
Cl	Cooling, coolant, cooling system (see also CE)
Clc	Calculate, calculated
Clip	Clip
Clk	Clock
Cloud	Cloud
Clr	Clear
Clc	Close, closed
Cm	Centimetres
Cmbu	Combustible, combustion
Cmd	Command
Cmpl	Completed, completion, complete

Term	Description
Cmut	Commute, commutator
Cndct	Conductivity, Conducting
Cnt	Counter
Cntt	Contractual
Cnv	Converter
Col	Coil
Comm	Communication
Comp	Compensation
ConfRev	Configuration revision (confRev from IEC 61850-7-2)
Conn	Connected, connections
Cons	Constant (general)
Cor	Correction
Core	Core
Cost	Cost
Crank	Crank
Crd	Coordination
Crit	Critical
Crl	Correlation
Crp	Creeping, slow movement
Crv	Curve
Csmp	Consumption, consumed
Ctl	Control
Ctr	Center
Cum	Cumulative
Cur	Current
Cut	Cut, cut-out, cut-in
Cvr	Cover, cover level
Cw	Clockwise
Cwb	Crowbar
Cyc	Cycle
D	Derivate
DC	DC, direct current
DER	Distributed energy resource
DExt	De-excitation
DPCSO	Double point controllable status output
DQ0	Direct, quadrature, and zero axis quantities
DS	Device state
DT	Daylight saving time
Dam	Dam
Damp	Damping
Date	Date, date and time of action
Day	Day
Db	Deadband

Term	Description
Dcl	DC-link
Dct	Direct
De	De (prefix)
Dea	Dead
Dec	Decrease
Deg	Degrees
Dehum	De-humidifier
Del	Delta
Den	Density
Dep	Dependent
Desc	Description
Det	Detected
Detun	Detuning
Dev	Device
Dew	Dew
Dff	Diffuse
Dfl	Deflector (used in Pelton turbines)
Dft	Default
Dia	Diaphragm
Diag	Diagnostics
Dif	Differential, difference
Dig	Digital
Dip	Dip
Dir	Direction
Dis	Distance
Dist	Distribution
Dith	Dither
DI	Delay
Dlt	Delete
Dlv	Delivery
Dmd	Demand
Dn	Down, downstream
Dpc	Double point control
Dpt	Departure
Drag	Drag hand
Dropout	Dropout
Drp	Droop
Drt	Derate
Drtb	Draft tube
Drv	Drive
Dsa	Disable, disabled
Dsc	Discrepancy
Dsch	Discharge
Dscon	Disconnected

Term	Description
Dsp	Displacement
Dtc	Detection
Dur	Duration
Dust	Dust
Dv	Deviation
Dw	Delta Omega
Dyn	Dynamic
EE	External equipment
EF	Earth fault
EFN	Earth-fault neutraliser (Petersen coil)
EMA	E-mobility Account
ENG	Enumerated status setting CDC
ENS	Enumerated status CDC
EPC	Emergency Power Control
EV	Electrical Vehicle
EVSE	EV Supply Equipment
Echo	Echo
Ecp	Electrical connection point
Edt	Edit, edited
Efc	Efficiency
EI	Elevation
Ela	Elasticity
Em	Emission
Emg	Emergency
En	Energy
Ena	Enabled, enable, allow operation
Enc	Enumerated control
Encl	Enclosure
End	End
Eng	Engine
Ent	Entity, entities
Entr	Entry, entries
Env	Environment
Eq	Equalization, equal, equivalent
Err	Error
Est	Estimated
Ev	Evaluation
Evn	Even
Evt	Event
Ex	External
ExIm	Export/import
Exc	Exceeded
Excl	Exclusion
Exp	Expired

Term	Description
Exps	Expansion
Expt	Export
Ext	Excitation
F	Float
FA	Fault arc
FPM	Fuel processing module
Fa	"Fire all" sequence (to thyristors)
Fact	Factor
Fail	Failure
Fan	Fan
Fbc	Field breaker configuration
Fer	Frame error rate
Fil	Filter, filtration system
Fire	Fire
Fish	Fish
Fix	Fixed
Fld	Field
Flk	Flicker
Fll	Fall
Flm	Flame
Flood	Flood
Flsh	Flash, flashing
Flt	Fault
Flush	Flush
Flw	Flow, flowing
Fol	Follower, following
Forc	Forced
Fu	Fuse
Fuel	Fuel
Full	Full
Fun	Function
Fwd	Forward
Gain	Gain
Gas	Gas
Gbx	Gearbox
Gdv	Guide vane
Gen	General
Glob	Global
Gm	Grand master
Gn	Generator
Gnd	Ground
GoCBRef	GOOSE control block reference
Gocb	GOOSE control block

Term	Description
Gr	Group
Gra	Gradient
Grd	Guard
Gri	Grid
Gross	Gross
Gs	Grease
Gte	Gate
Gust	Gust
H	Harmonics (phase-related)
H2	Hydrogen
H2O	Water (chemical aspect: liquid, steam, etc.)
HP	Hot point
HPh	Harmonics phase
Ha	Harmonics (non-phase-related AC)
Har	Harmonic
Hb	Harmonic bin
Hd	Head
Health	Health
Heat	Heater, heating, heat (see also Ht)
Hello	Hello signal, Live signal, "I am alive" signal
Hi	High, highest
Hlf	Half
Hold	Hold
Hor	Horizontal
Horn	Horn
Ht	Heating, heating system (see also Heat)
Htex	Heat-exchanger
Hub	Hub
Hum	Humidity
Hy	Hydraulic, hydraulic system
Hyd	Hydrological, hydro, water
Hys	Hysteresis
Hz	Frequency
Hz1	Frequency at side 1
Hz2	Frequency at side 2
I	Integral, integration
ING	Integer status setting CDC
INS	Integer status CDC
ISCSO	Integer status controllable status output
Ia	Information available
Iafm	Information available force majeure
Iano	Information available non-operative
Ianofo	Information available non-operative forced outage

Term	Description
Ianopca	Information available non-operative planned corrective action
Ianos	Information available non-operative suspended
Ianosm	Information available non-operative scheduled maintenance
Iao	Information available operative
Iaog	Information available operative generating
Iaogfp	Information available operative generating with full performance
Iaogpp	Information available operative generating with partial performance
Iaong	Information available operative non-generating
Iaongel	Information available operative non-generating out of electrical specification
Iaongen	Information available operative non-generating out of environment specification
Iaongrs	Information available operative non-generating requested shutdown
Iaongts	Information available operative non-generating technical standby
Ice	Ice
Id	Identity, identifier
Ieee	IEEE definition
IeeeKH	Proportional gain HF (High Frequency). Defined in IEEE 421.5
IeeeKH1	Proportional gain HF positive. Defined in IEEE 421.5
IeeeKH1 1	Lead gain HF positive. Defined in IEEE 421.5
IeeeKH1 7	Lead gain HF negative. Defined in IEEE 421.5
IeeeKH2	Proportional gain HF negative. Defined in IEEE 421.5
IeeeKI	Proportional gain IF (Intermediate Frequency). Defined in IEEE 421.5
IeeeKI1	Proportional gain IF positive. Defined in IEEE 421.5
IeeeKI11	Lead gain IF positive. Defined in IEEE 421.5
IeeeKI17	Lead gain IF negative. Defined in IEEE 421.5
IeeeKI2	Proportional gain IF negative. Defined in IEEE 421.5
IeeeKL	Proportional gain LF (Low Frequency). Defined in IEEE 421.5
IeeeKL1	Proportional gain LF positive. Defined in IEEE 421.5
IeeeKL1 1	Lead gain LF positive. Defined in IEEE 421.5
IeeeKL1 7	Lead gain LF negative. Defined in IEEE 421.5
IeeeKL2	Proportional gain LF negative. Defined in IEEE 421.5

Term	Description
leeeKs1	Gain Ks1. Defined in IEEE 421.5
leeeKs2	Gain Ks2. Defined in IEEE 421.5
leeeKs3	Gain Ks3. Defined in IEEE 421.5
leeeM	Ramptrack lowpass degree M. Defined in IEEE 421.5
leeeN	Ramptrack overall degree N. Defined in IEEE 421.5
leeeT1	Time constant T1. Defined in IEEE 421.5
leeeT10	Time constant T10. Defined in IEEE 421.5
leeeT11	Time constant T11. Defined in IEEE 421.5
leeeT2	Time constant T2. Defined in IEEE 421.5
leeeT3	Time constant T3. Defined in IEEE 421.5
leeeT4	Time constant T4. Defined in IEEE 421.5
leeeT7	Time constant T7. Defined in IEEE 421.5
leeeT8	Time constant T8. Defined in IEEE 421.5
leeeT9	Time constant T9. Defined in IEEE 421.5
leeeTH1	Time constant TH1 (High frequency positive). Defined in IEEE 421.5
leeeTH10	Time constant TH10 (High frequency negative). Defined in IEEE 421.5
leeeTH11	Time constant TH11 (High frequency negative). Defined in IEEE 421.5
leeeTH12	Time constant TH12 (High frequency negative). Defined in IEEE 421.5
leeeTH2	Time constant TH2 (High frequency positive). Defined in IEEE 421.5
leeeTH3	Time constant TH3 (High frequency positive). Defined in IEEE 421.5
leeeTH4	Time constant TH4 (High frequency positive). Defined in IEEE 421.5
leeeTH5	Time constant TH5 (High frequency positive). Defined in IEEE 421.5
leeeTH6	Time constant TH6 (High frequency positive). Defined in IEEE 421.5
leeeTH7	Time constant TH7 (High frequency negative). Defined in IEEE 421.5
leeeTH8	Time constant TH8 (High frequency negative). Defined in IEEE 421.5
leeeTH9	Time constant TH9 (High frequency negative). Defined in IEEE 421.5
leeeTI1	Time constant TI1 (Intermediate frequency positive). Defined in IEEE 421.5
leeeTI10	Time constant TI10 (Intermediate frequency negative). Defined in IEEE 421.5
leeeTI11	Time constant TI11 (Intermediate frequency negative). Defined in IEEE 421.5
leeeTI12	Time constant TI12 (Intermediate frequency negative). Defined in IEEE 421.5
leeeTI2	Time constant TI2 (Intermediate frequency positive). Defined in IEEE 421.5
leeeTI3	Time constant TI3 (Intermediate frequency positive). Defined in IEEE 421.5

Term	Description
leeeTI4	Time constant TI4 (Intermediate frequency positive). Defined in IEEE 421.5
leeeTI5	Time constant TI5 (Intermediate frequency positive). Defined in IEEE 421.5
leeeTI6	Time constant TI6 (Intermediate frequency positive). Defined in IEEE 421.5
leeeTI7	Time constant TI7 (Intermediate frequency negative). Defined in IEEE 421.5
leeeTI8	Time constant TI8 (Intermediate frequency negative). Defined in IEEE 421.5
leeeTI9	Time constant TI9 (Intermediate frequency negative). Defined in IEEE 421.5
leeeTL1	Time constant TL1 (Low frequency positive). Defined in IEEE 421.5
leeeTL10	Time constant TL10 (Low frequency negative). Defined in IEEE 421.5
leeeTL11	Time constant TL11 (Low frequency negative). Defined in IEEE 421.5
leeeTL12	Time constant TL12 (Low frequency negative). Defined in IEEE 421.5
leeeTL2	Time constant TL2 (Low frequency positive). Defined in IEEE 421.5
leeeTL3	Time constant TL3 (Low frequency positive). Defined in IEEE 421.5
leeeTL4	Time constant TL4 (Low frequency positive). Defined in IEEE 421.5
leeeTL5	Time constant TL5 (Low frequency positive). Defined in IEEE 421.5
leeeTL6	Time constant TL6 (Low frequency positive). Defined in IEEE 421.5
leeeTL7	Time constant TL7 (Low frequency negative). Defined in IEEE 421.5
leeeTL8	Time constant TL8 (Low frequency negative). Defined in IEEE 421.5
leeeTL9	Time constant TL9 (Low frequency negative). Defined in IEEE 421.5
leeeTw1	Time constant wash out Tw1. Defined in IEEE 421.5
leeeTw2	Time constant wash out Tw2. Defined in IEEE 421.5
leeeTw3	Time constant wash out Tw3. Defined in IEEE 421.5
leeeTw4	Time constant wash out Tw4. Defined in IEEE 421.5
leeeVHM _{ax}	Maximum limit set-point HF. Defined in IEEE 421.5
leeeVHM _{in}	Minimum limit set-point HF. Defined in IEEE 421.5
leeeVIM _{ax}	Maximum limit set-point IF. Defined in IEEE 421.5
leeeVIM _{in}	Minimum limit set-point IF. Defined in IEEE 421.5
leeeVLM _{ax}	Maximum limit set-point LF. Defined in IEEE 421.5
leeeVLM _{in}	Minimum limit set-point LF. Defined in IEEE 421.5

Term	Description
IeeeVsi1 Max	Input High Limit 1. Defined in IEEE 421.5
IeeeVsi1 Min	Input Low Limit 1. Defined in IEEE 421.5
IeeeVsi2 Max	Input High Limit 2. Defined in IEEE 421.5
IeeeVsi2 Min	Input Low Limit 2. Defined in IEEE 421.5
IeeeVstMax	Output High Limit. Defined in IEEE 421.5
IeeeVstMin	Output Low Limit. Defined in IEEE 421.5
Imb	Imbalance
Imp	Impedance non-phase-related AC
Impact	Impact
Impt	Import
In	Input
Ina	Inactivity
Inc	Integer control
Incl	Inclination
Incr	Increment, increase
Ind	Indication
Indp	Independent
Iner	Inertia
Inh	Inhibit
Inl	Inline
Inlet	Inlet
Inn	Inner
Ins	Insulation
Insol	Insolation
Inst	Instantaneous
Int	Integer
Intm	Intermediate
Intrn	Internal
Intr	Interrupt, interruption
Intv	Interval
Inv	Inverter, inverted, inverse
Isc	Integer status control
Isld	Islanded
Iso	Isolation
Iu	Information unavailable
Ix	Index
Jmp	Jump
Jnt	Joint
K	Constant (regulation)
K0Fact	Zero-sequence (residual) compensation factor

Term	Description
KFact	K factor (harmonics)
Kck	Kicker
Key	Key, physical control device
L	Lower (action)
LDC	Line drop compensation
LDCR	Line drop compensation resistance
LDCX	Line drop compensation reactance
LDCZ	Line drop compensation impedance
LED	Light-emitting diode
LTC	Load tap changer
Last	Last
Ld	Lead
Ldp	Link discovery protocol
Leap	Leap (second)
Len	Length
Lev	Level
Lft	Lifting, lift
Lg	Lag
Life	Lifetime
Lim	Limit
Lin	Line
Liv	Live
Lkd	Locked
Lkg	Leakage
LI	Last long (interval)
Lo	Low (state or value)
Loc	Local
Locb	Log control block
Lod	Load, loading
Log	Log
Lok	(use Lkd instead) Locked
Loop	Loop
Los	Loss
Ls	Last short (interval)
Lst	List
Lub	Lubrication
Lum	Luminosity
M	Minutes
MV	Measured value CDC
Mac	Media access control, MAC-address
Made	Made
Mag	Magnetic, magnitude
Maint	Maintenance
Man	Manual

Term	Description
Mat	Material
Mau	Medium access unit
Max	Maximum
Mbr	Membrane
Md	Motor drive
Mdul	Module
Meas	Measurement
Mech	Mechanical
Media	Media
Mem	Memory
Min	Minimum
Mir	Mirror
Mlt	Multiple
Mns	Mains
Mod	Mode
Mot	Motor
Mrg	Margin
Mrk	Market
Mst	Moisture
Msv	Main signaling voltage
Msvcb	Multicast sampled values control block
Mth	Method
Mult	Multiplier
Mvm	Movement, moving
N2	Nitrogen
NOx	Nitrogen oxide
NQS	Average partial discharge current
Nam	Name
Name	Name (reserved for use in data objects EENam and LNName only)
Ndl	Needle (used in Pelton turbines)
NdsCom	Needs commissioning
Neut	Neutral
Ng	Negative
NgT	Negotiation
Nhd	Net head
Night	Night
No	No, not
Nom	Nominal, normalising
Num	Number
Nxt	Next
O2	Oxygen
O3	Ozon, trioxygen
Obl	Obligation

Term	Description
Oc	Open circuit
Odd	Odd
Of	Offline
Off	Off, device disengaged, not running
Ofs	Offset
Oil	Oil
On	On, device applied, running
Oo	Out of
Op	Operate, operating, operation
Operate	Operate order to any device
Opn	Open, opened
Ord	Order
Out	Output
Ov	Over, override, overflow
Ovl	Overload
Ox	Oxidant
P	Proportional
PF	Power factor
PH	Acidity, value of pH
PNV	Phase-to-neutral voltage
POW	Point on wave switching
PP	Phase to phase
PPV	Phase to phase voltage
PT1	Low-pass exponential time rate filter
Pa	Partial
Pair	Pair, paired
Pap	Paper
Par	Parallel
Pas	Passive
Path	Path
Pcb	Power quality classifier bin
Pct	Percent, percentage
Pdm	Power quality demodulation
Pe	Electric Power
Per	Periodic, period
Ph	Phase to reference
Phs	Phase
Phy	Physical
Pi	Instantaneous real power
Pin	Pin
Pipe	Pipe
Pk	Peak
Pl	Plant
Plg	Plug

Term	Description
Pls	Pulse
Plt	Plate; long-term flicker severity
Pmp	Pump
Po	Polar
Pol	Polarizing
Polytr	Polytropic
Port	Port
Pos	Position
Pot	Potentiometer
Prc	Price, pricing
Pre	Pre-
Prec	Precondition, initial status
Pres	Pressure
Prg	Progress, in progress
Prim	Primary
Prio	priority
Prm	Permissive
Pro	Protection
Proc	Process
Proxy	Proxy
Prs	Presence
Prt	Parts, part
Ps	Positive
Psk	Penstock
Pss	PSS, power system stabiliser function
Pst	Post, short-term flicker severity
Pt	Point
Pth	Pitch
Pwr	Power
Qty	Quantity
Qu	Queue
Qud	Quad
R	Raise, increase
Rad	Radiation
Ral	Rail
Ramp	Ramp
Rat	Ratio
Rb	Runner blade
Rcd	Record, recording
Rch	Reach
Rcl	Reclaim
Rct	Reaction
Rdy	Ready
Re	Retry

Term	Description
React	Reactance, reactive
Rec	Reclose
Rec1	Reclose after single phase fault
Rec13	Reclose after evolving fault
Rec3	Reclose after three phase fault
Recha	Recharge, recharging
Rect	Rectifier
Red	Redundant; (deprecated meaning) reduction
Ref	Reference
Reg	Regulation
Rel	Release
Req	Requested
Res	Residual
Reso	Resonance
Reuse	Reuse
Rf	Refreshment
Rin	Reinsertion
Ris	Resistance
RI	Relation, relative
Rm	Mutual resistance
Rmp	Ramping, ramp
Rms	Root mean square
Rn	Rain
Rnbk	Runback
Rng	Range
Rod	Rod
Root	Root
Rot	Rotation, rotor
Rpt	Repeat, repetition
Rs	Reset, resettable
Rsl	Result
Rst	Restraint, restriction
Rsv	Reserve
Rt	Ride-through
Rte	Rate
Rtg	Rating
Rub	Run-up/back
Run	Run
Rv	Reverse
Rvc	Rapid voltage change
Rvrt	Revert
Rwy	Runaway, e.g. in runaway speed
Rx	Receive, received
S10	Coefficient S1.0

Term	Description
S12	Coefficient S1.2
SM	Servo, servo-motor
SNL	Speed-no-load, connected but not generating
SOx	Sulphur oxide
SPCSO	Single point controllable status output
SPG	Single point setting CDC
SPS	Single point status CDC
SPI	Single pole/phase
ST	Standard time
Saf	Safety
Sag	Sag
Sar	Surge arrestor
Sat	Saturation
Sc	Short circuit
Scale	Scale
Schd	Schedule
Scnd	Secondary
Sco	Supply change over
Sec	Security
Sel	Select
Self	Self
Seq	Sequence
Ser	Series, serial
Set	Setting
Sgcb	Setting group control block
Sh	Shunt
Shar	Shared
Shft	Shaft
Shld	Shielded
Sig	Signal
Sign	Sign
Sim	Simulation, simulated
Sld	Solidity
SInt	Salinity, saline content
Slp	Sleep; slip
Smok	Smoke
Smp	Sampling
Snd	Sound pressure
Snpt	Snapshot
Snr	Signal to noise ratio
Snw	Snow
Soc	State of charge
Sof	Switch on to fault

Term	Description
Spc	Single point control
Spcf	Specific
Spd	Speed
Spec	Spectra
Spir	Spiral
Spt	Setpoint
Sq	Square
Src	Source
Srfc	Surface
St	Status, state
Sta	Station, function at plant level
Stab	Stabilizer
Stat	Statistics
Stc	Stack
Std	Standard
Stdby	Standby
Step	Step
Stk	Stroke
Stl	Still, not moving
Stnd	Stand, standing
Sto	Storage, e.g. activity of storing data
Stop	Stop
Storm	Storm
Stow	Stow
Str	Start
Strg	String
Stt	Stator
Stuck	Stuck, cannot move
Sub	Sub
Sum	Sum
Sup	Supply
Sv	Sampled value
SvCBRef	SV control block reference
Svc	Service
Sw	Switch, switched
Swg	Swing
Swl	Power quality event swell
Syn	Synchronisation, synchronous, synchronism, synchrocheck
Sys	System
TP	Three pole/phase
Ta	Armature time constant
Tag	Tag (maintenance work in progress)
Tap	Tap

Term	Description
Task	Task
Td	Transformer derating
Td0p	Td0'
Td0s	Td0''
Tdd	Total demand distortion
Tdf	Transformer derating factor
Tdp	Td'
Tds	Td''
Tech	Technology
Term	Termination
Test	Test
Tgt	Target
Thd	Total harmonic distortion
Thm	Thermal
Ti	Telephone influence
Tilt	Tilt
Tm	Time
Tm1	Time constant 1
Tm2	Time constant 2
Tm3	Time constant 3
Tmh	Time in h
Tmm	Time in min
Tmms	Time in ms
Tmp	Temperature (°C)
Tms	Time in s
Tnk	Tank
Tns	Tension (stress)
Top	Top (position)
Topo	Topology
Torq	Torque
Tot	Total
Tow	Tower
Tp	Test Point
Tpc	Teleprotection
Tpy	Temporarily
Tq0p	Tq0'
Tq0s	Tq0''
Tqp	Tq'
Tqs	Tq''
Tr	Trip (electrical protection function)
Trf	Transformer
Trg	Trigger
Trip	Trip (non-electrical function)
Trk	Track, tracking

Term	Description
Trp	Transient Performance Class
Trs	Transient
Trunk	Trunk
Ts	Total signed
Tu	Total unsigned
Tun	Tuning
Tur	Turbine
Tx	Transmit, transmitted
Typ	Type
UPS	Uninterruptible power supply
UTC	Coordinated Universal Time
Uhf	Ultra-high-frequency
Un	Un-; under
Unav	Unavailable
Unb	Unbalanced
Unld	Unload
Unt	Unit, production unit
Up	Up, upstream
Ups	Uninterruptible Power Supply
Urcb	Unbuffered report control block
Use	Use
Used	Used
Usvcb	Unicast sampled values control block
Util	Utility
V	Voltage
V1	Voltage at side 1
V2	Voltage at side 2
VA	Apparent power (volt amperes)
VAh	Apparent energy
VAR	Reactive power (volt amperes reactive)
VARh	Reactive energy
Va	Variation
Vac	Vacuum
Val	Value
Vbr	Vibration
Ver	Vertical
Viol	Violation
Vis	Visibility
Visc	Viscosity
Vlan	VLAN
Vld	Valid, validate, validated
Vlm	Volume
Vlv	Valve
Vol	Voltage DC or non-phase-related AC

Term	Description
VolAmpr	Non-phase-related AC reactive power
Vss	Steady state voltage
W	Active power
W200	Watts peak at 200 W/m ²
Wac	Watchdog
Wash	Washout
Watt	Active power non-phase-related AC
Wav	Wave, waveform
Wd	Wind
Week	Week
Wei	Weak end infeed
Wet	Wet
Wgt	Weight
Wh	Watt hours
Wid	Width
Win	Window
Wkup	Wake up
Wld	Welding
Wnd	Winding
Wrm	Warm
Wrn	Warning
Wrs	Warning set
Wtr	Water (physical aspect: river, cooling, etc.)
Wup	Windup

Term	Description
X	Reactance (imaginary part of impedance)
X0	Zero sequence reactance
X1	Positive sequence reactance
X2	Negative sequence reactance X2
Xd	Synchronous reactance Xd
Xdir	X-direction
Xdp	Transient synchronous reactance Xd'
Xds	Subtransient reactance Xd''
Xm	Mutual reactance
Xq	Synchronous reactance Xq
Xqp	Transient synchronous reactance Xq'
Xqs	Subtransient reactance Xq''
Xsec	Cross-section
Ydir	Y-direction
Yw	Yaw
Z	Impedance
Zer	Zero
Zero	(use 'Zer' instead) Zero
Zm	Mutual impedance
Zn	Zone
Zro	Zero sequence
km	Kilometre
ppm	Parts per million

3.3 Definitions of fault types

Table 3 describes the fault classification referred to in this document. It contains the categorization of faults according to their clearance together with the fault source types.

Table 3 – Time based Fault types

Fault type	Description	Notes
Intermittent	Short fault (<20ms) appearing every 100 to 200ms	Given durations are only here as example
Self extinguishing	Duration < protection response time (no tripping)	
Transient	Eliminated by the fast cycle of recloser (cycle 1)	
Semi-permanent	Eliminated by the slow cycles of recloser (cycle 2 or cycle 3)	
Permanent	Not eliminated by the recloser cycles	
Evolving	Same as permanent fault but the phases in Str Data Object at the end of the fault are not the same as the phases recorded at the beginning of the fault	
Unknown	Unknown type	Different from the above classification
NOTE These definitions are aligned with the conventional usage of "Transient" in textbooks relating to Network protection and Automation and with: [IEC 60050-614:2016, 614-02-09] transient fault an insulation fault which only temporarily affects a device's dielectric properties which are restored after a short time [IE C 60050-614:2016, 614-02-12] intermittent fault a transient fault which recurs repeatedly in the same place and due to the same cause [IEC 60050-614:2016, 614-02-08] permanent fault a fault which affects a device and prevents its restoration into service until action has been taken at the point of the fault [IEC 60050-614:2016, 614-02-10] self-extinguishing fault an insulation fault where the arc extinguishes without it being necessary to disconnect the device from the system for its essential dielectric properties to be restored		

4 Common actors

Table 4 contains the list of the actors commonly used in this document. If additional (and specific) actors are needed in the description of the use case, they will be described in the corresponding subclause dedicated to the given use case.

Figure 1 to Figure 3 help to better understand the global hierarchy of the proposed list of actors. The figures also help to discriminate between high level actors such as system, persons, devices and application type of actors.

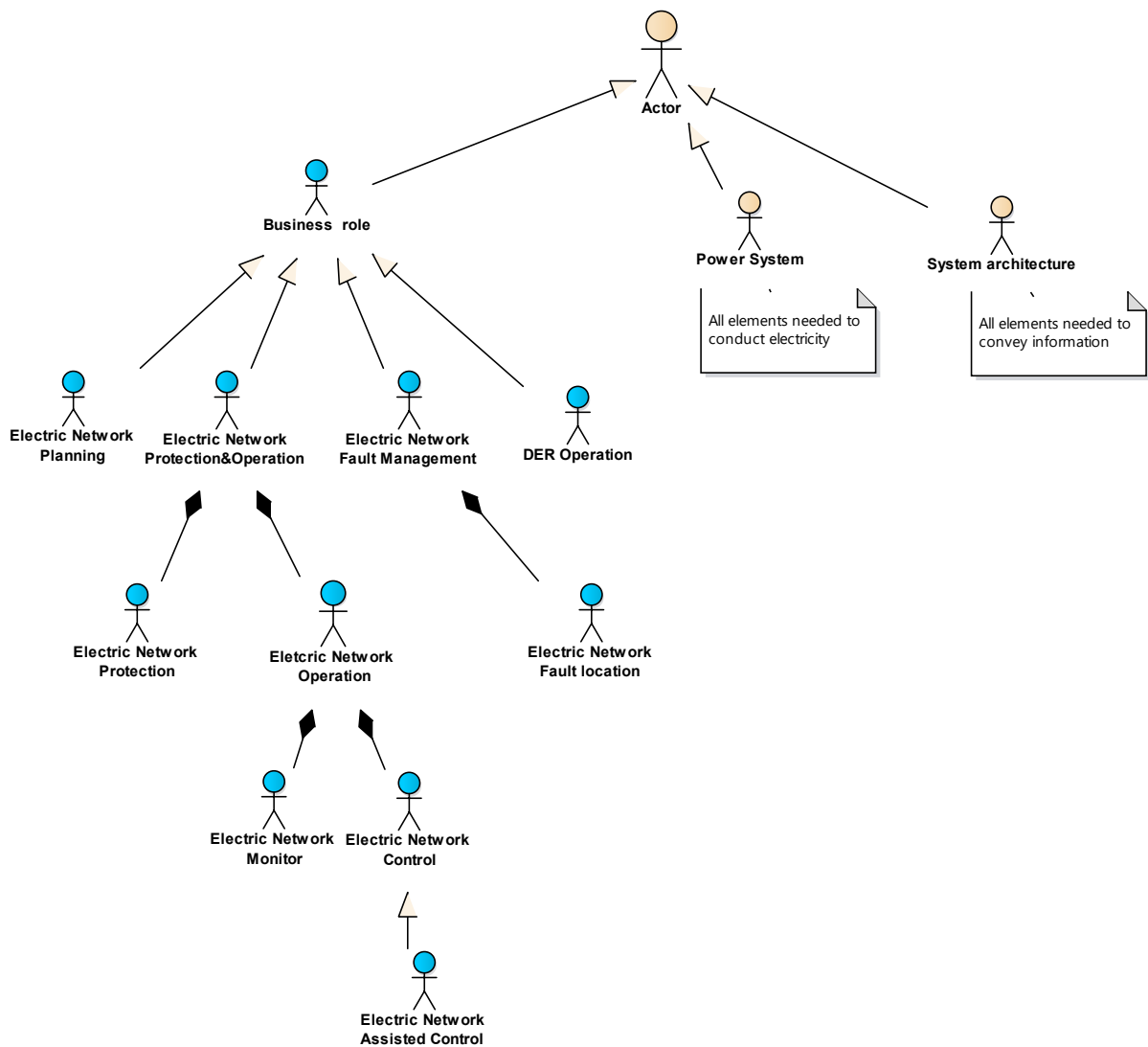


Figure 1 – Actors top level hierarchy

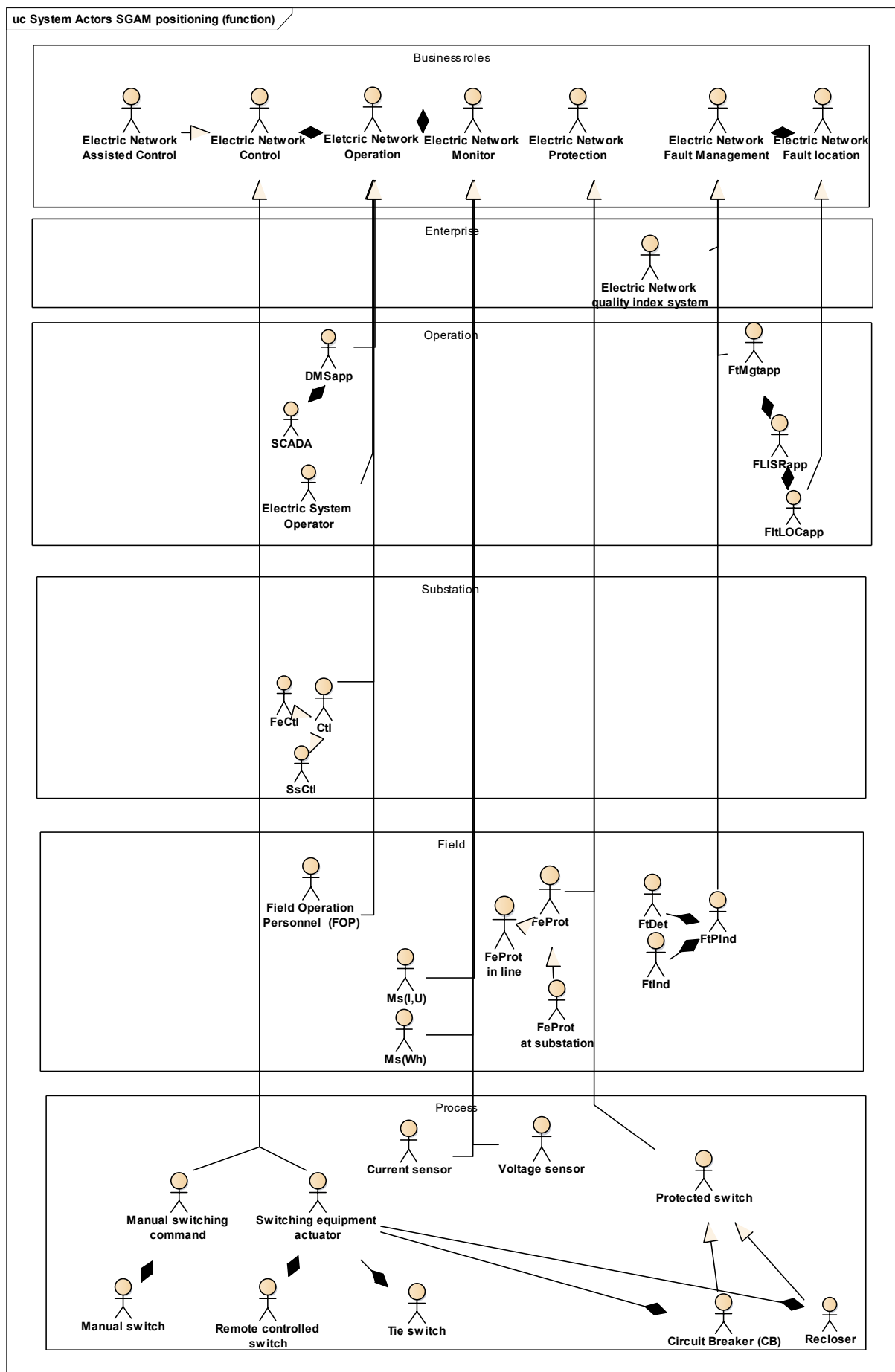


Figure 2 – System Actors SGAM positioning (function)

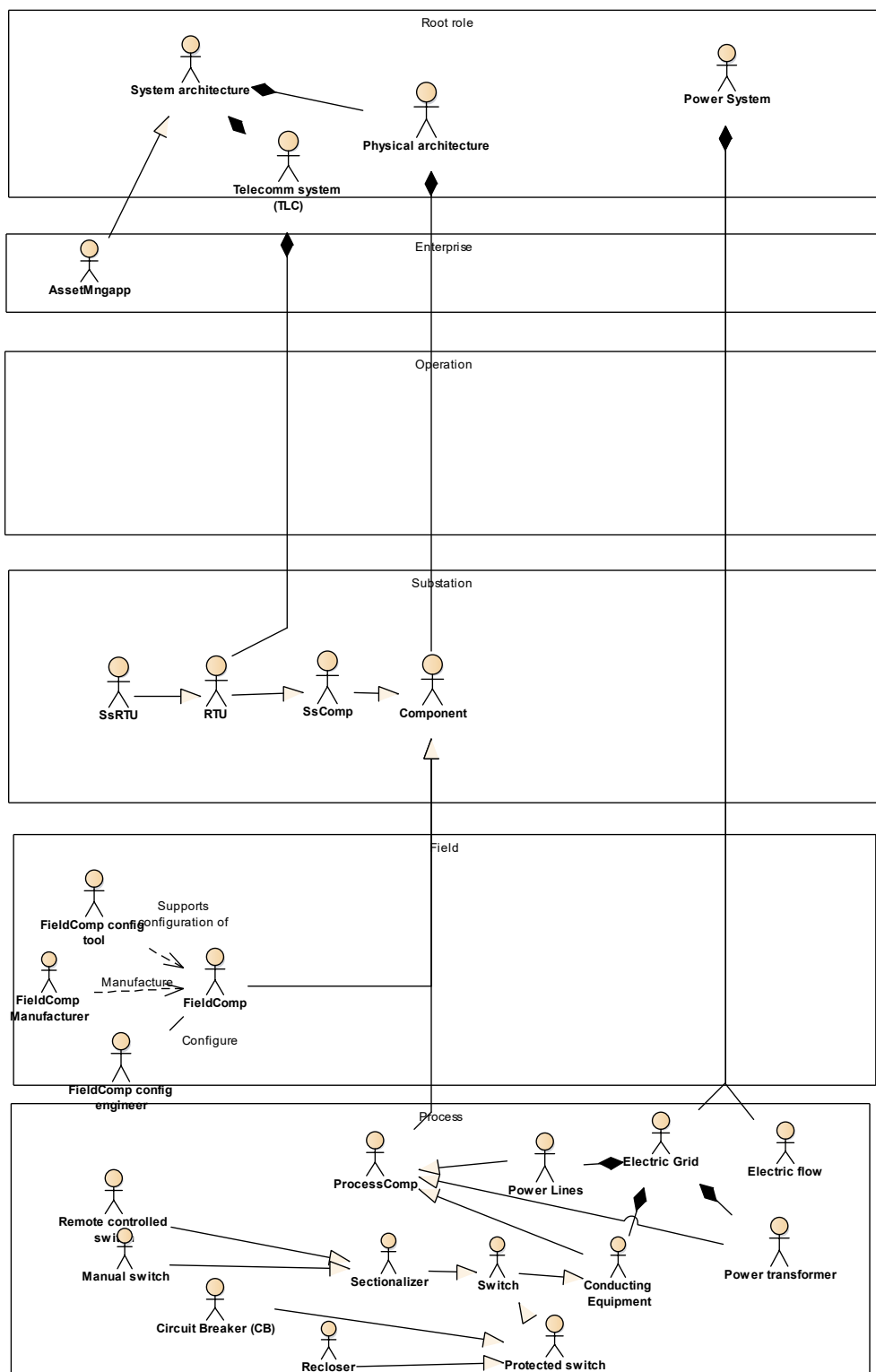


Figure 3 – System Actors SGAM positioning (not function related)

The “system architecture” tree designates the “boxes” and “wires” which are used to make the system running. These boxes host a set of functions described in Figure 2, and “wires” support “exchanges” between boxes.

In our case, we focus mostly of components located in the field. For a selected geographical area, a first class at substation level “Component” designates the upper parent class.

such component (hosting for example the longitude/latitude/altitude, etc.). Then they are sorted into three sub-families:

- SsComp -> the one located at “substation zone” such as RTU, Substation controller
- FieldComp -> the one located at “field zone” such as protection relay, power meters, etc.
- ProcessComp -> the one located at “process zone” such as switchgear, breakers, transformers, lines, etc.

Table 4 – List of common actors

Actors			
Actor name	Actor type	Actor description	Further information
Autorecloser (AR)	System field	Function which is located in the field along the feeder to protect the downstream assets by eliminating fault current and having communicating capability to indicate trip conditions to upper levels. This device includes the protection detection function and the recloser function. It also has the ability to be remotely controlled to re-energize the protected feeder.	Electric Network Protection&Operation [field-process]...autorecloser
Controller at distribution substation	System substation	Controller function installed at the substation level which communicates with both the field devices and the control center. FLISRapp may be implemented at the substation computer as an option.	Electric Network Assisted Control [substation]...controller ... substation ... distribution
DER Management System (DER MS)	System	The DER MS provides the DER-type-independent communication interface for the communication to the DMS. It forwards the information coming from the DER unit and executes the commands from the DMS.	DER Operation [operation-field]
DER Unit	System process	Distributed energy resources. A DER Unit consists of the physical equipment to generate, store and consume electrical power.	Power system [process]/DER [process]
DER Unit Controller (DERCTL)	System Field	Distributed energy resources. A DER Unit consists of the physical equipment to generate, store and consume electrical power.	DER Operation [field]
SysOp	People	Person who monitors network and identifies the need for and performs or contributes to perform remote operation such as required switching using the FLISRapp Application, or triggering VVC.	Electric Network Operation [Operation]...distribution grid
DMS application module (DMSapp)	System Operation	Refer to IRM. It represents the aggregation of Network Operation, Fault Management, and many others. DMS System feature hosted at control center level that monitors continuously the Grid network and based on a given network topology reflects the energy path and flows.	Electric Network Operation [operation]
Electric Grid	System process	Represent the set of equipment of a distribution feeder including lines, DER, loads, interconnections, switching equipment and voltage transformers.	Power system [process]... distribution ... feeder
Electric Network Fault management	System operation	Refer to IRM.	Electric Network Fault Management [operation]

Actors			
Actor name	Actor type	Actor description	Further information
Electric Network Planning (Planning)	System enterprise	Refer to IRM.	Electric Network Planning [enterprise]
Electric Network quality index system (QIS)	System enterprise	System which collects outage data for reporting to Utility Commissions.	Electric Network Fault Management [enterprise]...Network quality logger
Electric System operator (SysOp)	People	Person who monitors network and identifies the need for and performs or contributes to perform required switching using the FLISRApp Application.	Electric Network Operation [operation]
Electrical measurement(Ms(I,U))	System field	Function that elaborates electrical measurement such as I, U, P, Q, PF, ...	Electric Network Protection/Electric Network Operation [field-process]...Electrical measurement
Energy counting for operation (Ms(Wh))	System field	Function that elaborates energy counting (for operational purpose).	Electric Network Protection/Electric Network Operation [field-process]...Energy counting
Power Flow direction computation(Ms(power flow direction))	System field	Function that elaborates the direction of power flow: forward – from supply or backward – to supply (for operational purpose).	Electric Network Protection/Electric Network Operation [field-process]... Power Flow direction computation
Fault Indicator(FtInd)	System field	Function that identifies the presence of a fault on the Grid.	Electric Network Protection/Electric Network Operation [field-process]...Fault indication
Fault location application module (FtLOCapp)	System operation	Fault location module of a FLISRApp.	Electric Network Fault location [operation]...FLISR application module ... fault location
Fault passage indicator at feeder level (FtPInd)	System field	Function located along the feeder and capable of detecting and indicating a fault. It includes the needed sensors to perform the function.	Electric Network Fault location [field-process]...fault detector ... feeder
Fault signature detection (FtDet)	System field	Function that detects and reports on fault presence (including the update of concerned statistics).	Electric Network Protection/Electric Network Operation [field-process]...Fault signature detection
Electric Network Fault management application module (FtMgtapp)	System operation	Application module which manages or help managing network faults impact and resolution (usually part of an Outage Management application module).	Electric Network Fault Management [operation]...Fault Management application module
Feeder equipment controller (FeCtl)	System substation	Feeder equipment controller located along a feeder which helps to control either the feeder switching equipment and possibly a set of equipment connected to the feeder at this connection point (such as a MV/LV transformer, and a LV switchgear).	Electric Network Operation [substation-field]...feeder substation, feeder equipment

Actors			
Actor name	Actor type	Actor description	Further information
Substation controller (SsCtl)	System substation	Substation controller which helps to control any equipment located in a selected substation (such as a HV/MV transformer, HV incomers, MV feeders).	Electric Network Operation [substation-field]... substation, substation equipment
External environment	System	Groups many external elements such as weather conditions, flooding conditions, live presence status, geographical perimeter status (doors, etc.).	
Adjacent feeder equipment controller (Adjacent FeCtl)	System substation	Feeder equipment controller located adjacent to another specific feeder equipment controller, i.e., its attached switching equipment are sharing a same line segment.	Electric Network Operation [substation-field]...feeder substation, feeder equipment...adjacent to()
Feeder equipment controller downstream to fault (Downstream FeCtl)	System substation	Feeder equipment controller located along a feeder and specifically located downstream to a fault.	Electric Network Operation [substation-field]...feeder substation, feeder equipment...downstream to fault
Feeder equipment controller upstream to fault (Upstream FeCtl)	System substation	Feeder equipment controller located along a feeder and specifically located upstream to a fault.	Electric Network Operation [substation-field]...feeder substation, feeder equipment...upstream to fault
Feeder Protection equipment at feeder end substation (FeProt at end substation)	System field	A Feeder Protection equipment located at the other end of the feeder.	Power system [process]/Electric Network Protection [field-process]...Protection equipment .. Feeder protection equipment... at feeder end substation
Feeder In Line Protection equipment (FeProt in line)	System field	A Feeder Protection equipment located within the feeder.	Power system [process]/Electric Network Protection [field-process]...Protection equipment .. Feeder protection equipment... in line
Feeder Protection equipment at main substation (FeProt at main substation)	System field	A breaker-type equipment associated with a protection function, located at the main substation to protect an outgoing feeder. It may have communication capability to indicate trip conditions to upper levels. It may also have the ability to be remotely controlled (closed) to re-energize the feeder. It may as well have an autoreclosing function.	Power system [process]/Electric Network Protection /Electric Network Operation[field-process]...Protection equipment .. Feeder protection equipment... at main substation
Feeder Protection function at substation (FeProt at substation)	System field	A function located in the substation that trips a breaker to eliminate fault current in a feeder. It may also reclose the breaker when a preconfigured delay time is expired after the breaker is tripped.	Electric Network Protection /Electric Monitor & control[field]...Protection function ... Feeder Protection function

Actors			
Actor name	Actor type	Actor description	Further information
General Protection function at end-user side (GeneralProt-eu)	System field	A function located at the connecting point of the End User in charge of clearing faults inside its premise.	Electric Network Protection /Electric Monitor & control[field]...Protection function ... Feeder Protection function
Generator Interface protection function (GeneratorInterfaceProt-eu)	System field	A function(s) which are located inside the End User power plant in charge of tripping to disconnect the generators in case of faults in the Distribution Network.	Electric Network Protection /Electric Monitor & control[field]...Protection function ... Feeder Protection function
Generator Interface disconnection function (GeneratorInterfaceDisconnect-eu)	System field	A function(s) which are located inside the End User power plant in charge of disconnecting the generators when the GeneratorInterfaceProt -eu trips.	Electric Network Protection /Electric Monitor & control[field]...Protection function ... Feeder Protection function
Field level physical component (FieldComp)	System substation	IEC 61850 physical component of a selected system.	System Architecture.. Components [substation-process].. Physical component .. Field
Field level physical component configuration engineer (FieldComp config engineer)	People	Person who is in charge of using a Field level physical component configurator.	System Architecture.. Components [substation-process].. Physical component configurator .. Configuration engineer
Field level physical component configurator (FieldComp config tool)	System substation	Configurator of an IEC 61850 physical component of a selected system.	System Architecture.. Components [substation-process].. Physical component configurator .. Field
Field level physical component setting tool (FieldComp setting tool)	System substation	Tool used to enter field parameter settings for an IEC 61850 physical component of a selected system.	System Architecture.. Components [substation-process].. Physical component setting tool .. Field
Field level physical feeder sub-system configurator (FieldSyst config tool)	System operation	Configurator of a subsystem made of IEC 61850 physical components including potentially many substation/equipment of a selected feeder or a set of feeders.	System Architecture.. Feeder sub-system [operation-process]
Field Operation Personnel (FOP)	People	Person who is activated by people/systems in charge of monitoring network. He performs the required switching operation in filed using the outcome of an overall FLISRapp.	Electric Network Operation [substation-process]
FLISR application module (FLISRapp)	System operation	Application module that performs Fault Location, Isolation and Service Restoration at network operation level.	Electric Network Fault location [operation]...FLISR application module
New Field level physical component	System substation	New IEC 61850 physical component of a selected system.	System Architecture.. Components [substation-process].. Physical component .. Field ..new

Actors			
Actor name	Actor type	Actor description	Further information
ProcessComp	System process	Any physical component (asset, such as switch, breaker, transformer, lines, ...) located at "process zone level". It enables hosting the common properties such physical asset has, such as a physical nameplate, a volume, a location, an age, etc.,	System Architecture.. Components [substation-process].. Physical component .. Process
Power Transformer Tap	System process	Taps actuator on transformer windings that change the turns ratio of the transformer.	Power system [process] Electric Network Operation process]... Power transformer .. Tap
Remote terminal at Substation (Substation RTU)	System substation	Gateway function with the capability of receiving or sending data/control from or to an external source (for example, electronic multifunction meters, digital relays, controllers), ensuring the interface of a substation of field equipment to the remote world. This device may be either a function included in other devices and/or a specific device including also the so-called Remote Terminal Units.	Electric Network Operation [substation].. .gateway ... remote terminal
Sectionalizer	System process	Function located along the feeder – sectionalizers/sectionalizing autoreclosers, and switches.	Power system [process]/Electric Network Protection&Operation [process]...sectionalizer
Service Restoration Controller (SRC)	System operation	The function that controls the service restoration of downstream healthy sections of a fault. This function internally gets the support of the role "Operation Planning – switching action scheduling" to establish the switching sequence – this may have been predefined at configuration.	Electric Network Assisted Control [operation] ...
Shunt Capacitor Switching equipment	System process	Switches associated with shunt capacitors. They can operate automatically through remote communications from the control center, or manually by the field crew.	Power system [process]/Electric Network Operation [field-process]...switching equipment ... capacitor shunt
Switching equipment actuator	System process	Primary equipment switches which are located along the grid lines to enable the operator or the system to isolate the faulty section. They can be manually operated or remotely/locally operated through the FSCs. In this use case we will restrict our analysis to remotely controllable switches.	Power system /Electric Network Operation [process]...switching equipment ...actuator
Switching equipment as Tie switch	System process	A special normally open tie point device function, which is able to sense voltage presence on both sides of its current interrupting mechanism. It also includes the logic to close the interrupting mechanism either automatically upon loss of voltage on one side, or through communication control command. This function can be implemented with recloser, sectionalizer or switch.	Power system [process]...switching equipment (Tie)

Actors			
Actor name	Actor type	Actor description	Further information
Tie switch equipment actuator	System process	Actuator of a switching equipment operated as a Tie switch.	Power system /Electric Network Operation [process]...switching equipment (Tie) ...actuator
Voltage presence indicator (VPI)	System field	A device that indicates the presence of voltage over a certain limit on the measured point. It includes the needed sensors to perform the function.	Electric Network Fault location [field-process]...voltage detector
VVC application module (VVCapp)	System operation	Application that performs voltage and var control. It determines optimal settings for capacitors and voltage regulators, and either applies them directly to the devices or recommends them to the DSO for approval.	Electric Network Assisted control [operation]...VVC application module

5 Requirements and use cases

5.1 General

The objective of this clause is to go down to the general high level requirements of information exchanges of Distribution Automation Systems (DASs) as a starting point for proposing the new LNs, the extension of new LNs, new communication services, communication profiles and configuration methods.

The following use cases for basic DA functions that may require the definition of new LNs and the extension of existing LNs are described hereafter:

- **Fault Passage Indication:** This is the main purpose of proper devices indicated as Fault Passage Indicator (FPI) or Distribution Substation Unit (DSU), depending on their performances, which are, respectively, a device or a device/combination of devices and/or functions able to detect faults and provide indications about their localization.
- **FLISR (Fault Location, Isolation and Service Restoration):** This includes the FLISR using auto reclosers and auto-sectionalizers, the FLISR based on the centralized control of the master station and the FLISR based on the distributed control scheme in which field IEDs exchange fault and control information through a peer-to-peer communication network. These are the main typical implementation/architecture for supporting the FLISR. The reality may be a mix of all these three modes.
- **VVC (Voltage and Var Control):** The objective of VVC is to minimize the power losses in the network, improve the voltage profile, or both, using the settings of LTC substation transformers, bus/feeder voltage regulators and switching shunt capacitors. More advanced VVC applications may also use the active and reactive power injection by DER units as well as distribution FACTS devices such as D-STATCOM and D-SVC. Only the basic VVC scenario which involves the control of voltage regulators and switching shunt capacitors is considered in this document.
- **Anti-Islanding Protection Based on Communications:** If the feeder circuit breaker opens, an unintentional islanding may have been created. The involved DERs in the island have to be forced to stop energizing the feeder for workers' safety, system security and power quality reasons. Whilst the islanding detection methods using local measurements at intertie may have none-detection zone, the anti-islanding protection can be improved through detecting the tripping of substation breakers and transmitting this information down to the DERs.
- **Automatic Switch Transfer:** When a voltage loss occurs on the primary source, the system decides under specific conditions to transfer the load to the backup source.

- **Monitoring Energy Flow:** Active or reactive or net cumulated energy either per quadrant, or globally delivered or received at the point of measurement, based on the energy flows direction conventions.
- **Environment Situation Awareness:** Manages a set of specific sensors related to environment situations such as weather conditions, flooding conditions, live presence status, geographical perimeter status (doors, etc.) and elaborates from these raw measurements warnings and alarms based on pre-defined thresholds and other criteria.

A Distribution Automation System (DAS) can have up to tens of thousands of IEDs spreading over a wide area distribution network. From time to time, the new IEDs may be introduced, and the configuration of the existing IEDs may need to be modified. The current configuration method for substation automation systems may not be adequate to DASs, and a new configuration method may be needed. Therefore, a use case for introducing new IEDs and updating the configuration of existing IEDs will also be described in this clause.

5.2 Use case 1: Fault indication and report

5.2.1 General

Fault indication and report are fundamental functions for the fault management of distribution networks. The seven use cases in this clause will describe the general high level requirements of information exchanges between a Fault Passage Indicator, as defined in IEC 62689-1 and IEC 62689-2 and the rest of the Distribution Automation Systems (DASs).

These requirements are expressed under the form of use cases as recommended by IEC 62559-2. F1, F2 ... Fn refer to FPI function classes as defined in 62689-1.

In this document the meanings of the following terms are:

- **Fault Indication:** fault detection (no intra/extra-substation communication directly managed from FPI, only local indication to system operator, usually via the DMS application module);
- **Report:** following the fault identification, remote communication concerning the fault may be present and managed either by other devices, or directly from the DSU, client-server mode and/or peer-to-peer mode.

When a fault occurs on the network, the fault passage indicator needs to identify such fault. Once the fault is identified and possibly confirmed, the fault passage indicator needs to report to the external local or remote components information related to this fault. This is to allow fault clearing and possible supply restoration, as well as counting fault occurrence based on different criteria.

5.2.2 Use case 1a: Generic use case – Not fault type specific

5.2.2.1 Description of the use case

5.2.2.1.1 Name of use case

Use case identification		
ID	Domain(s)	Name of use case
	Distribution Automation	Fault identification and report

5.2.2.1.2 Version Management

Version management						
Version management changes / version	Date	Name author(s) or committee	Domain expert	Area of expertise / Domain / Role	Title	Approval status draft, for comments, for voting, final
First version in IEC template	24/08/15	JAHWG51				Draft

5.2.2.1.3 Scope and objectives of use case

Scope and objectives of use case	
Related business case	Distribution System Operation
Scope	The Distribution Automation (DA) system with the help (or not) of the Operator identifies and locates a fault in a feeder of a radially operated network.
Objective	Contribute to minimize the duration of the supply interruptions. Improve the continuity of service for users connected in MV or LV, by reducing the overall process of fault isolation thanks to automation, therefore reducing the number of customer minutes lost due to outages.

5.2.2.1.4 Narrative of use case – Short description

The fault detection process (and possible FLISR) is described considering both only local fault indication and different kinds of extra-substation communication, according to FPIs communication classes described in IEC 62689-1.

Different types of faults (short circuits, earth faults, etc.) are not considered explicitly, the fault is a generic one.

Possible automatic reclosing cycles are not considered in this generic use case

5.2.2.1.5 Narrative of use case – Complete description

The Fault Detection and indication functionalities are (optionally) preliminary set (e.g. by the Field Operation Personnel).

The monitoring of the power system is constantly performed also by the FPIs located on the radially operated power system under focus.

A fault on the power grid can be Permanent or Fugitive. The involved FPIs (located upstream to the fault) detect the fault signature and indicates to the Field Operation Personnel or/and to the FtMgtapp (fault management application), according to its communication class, the information that such fault signature was observed.

The Field Operator and the FtMgtapp have the information to perform further (out of the scope) fault isolation and service restoration actions.

The fault event may be reported to the Quality index system (refer to Clause 0) to contribute to the quality index calculation

5.2.2.1.6 General remarks

This use case describes the function of fault identification, location and report in a network which feeders are radially operated without any MV/MV autotransformer.

Currently the use case does not consider the presence of DER.

This use case assumes that the feeder has at least one FPI located upstream to the fault. The use case applies to feeders with sections of overhead line or underground cable or a mixture of both types

5.2.2.2 Diagrams of use case

For the sake of simplifying the diagram, the Quality index system (refer to Clause 4) is not represented on the sequence diagram shown in Figures 4 to 8. Basically any fault event received by the FtMgtapp should also be received by the Quality index system (refer to Clause 4).

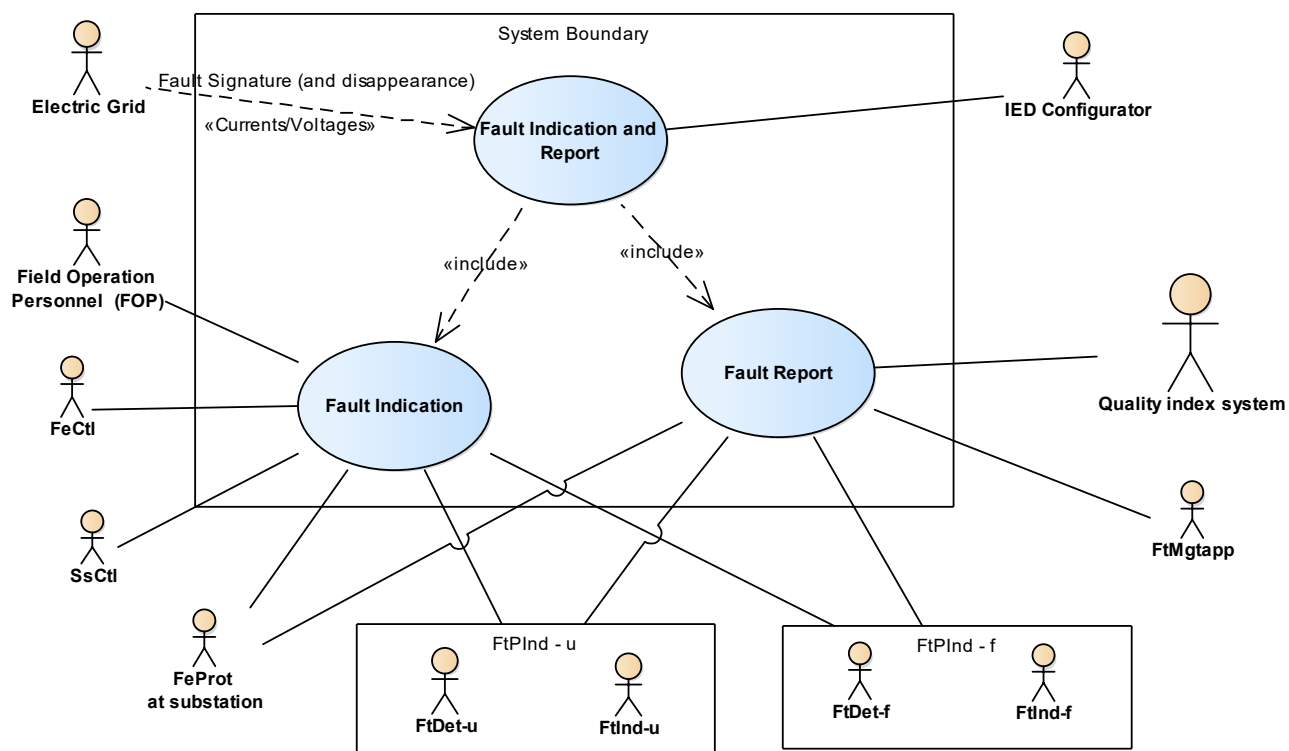


Figure 4 – Fault indication – Main use case

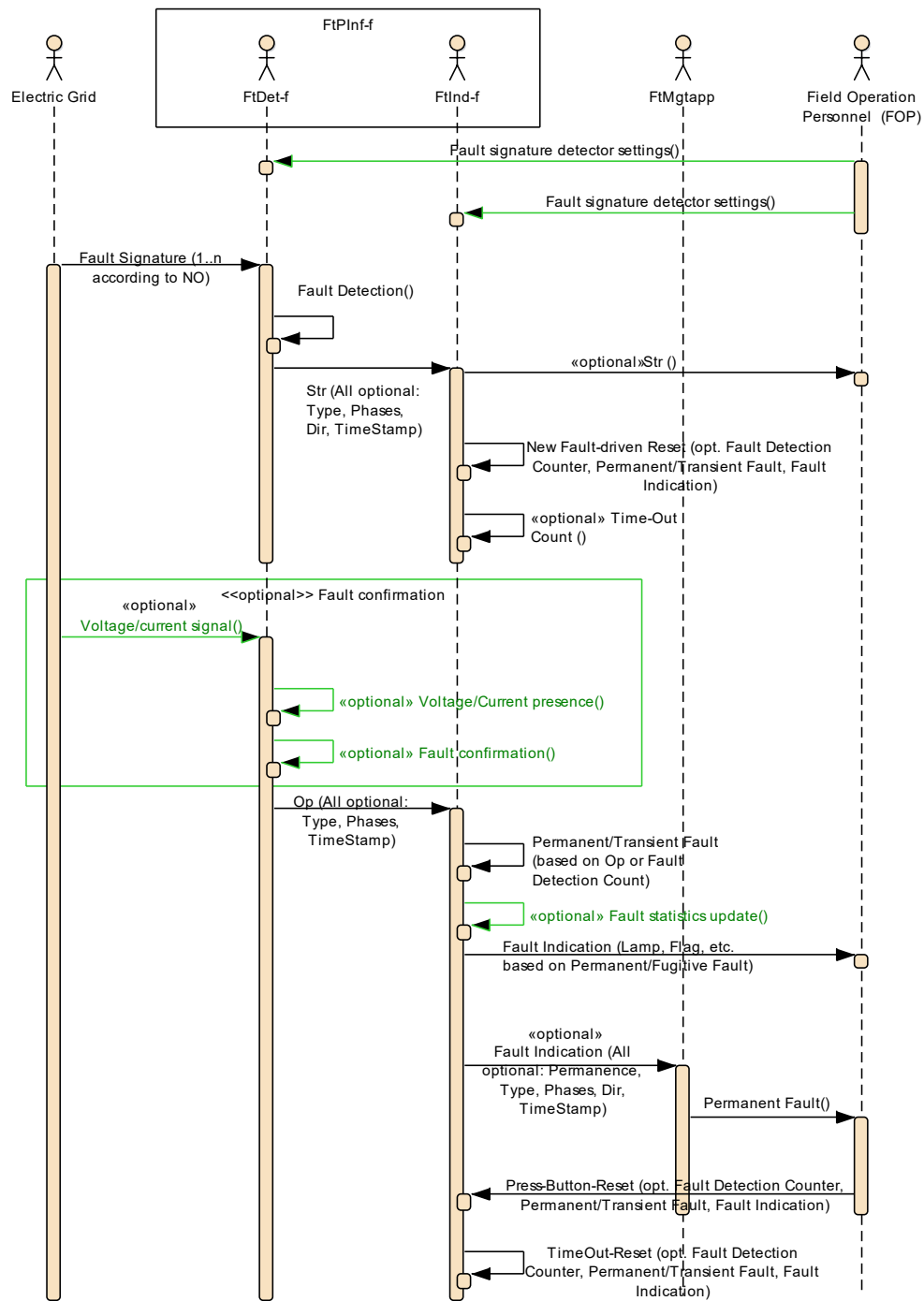


Figure 5 – Fault indication for FPI – T1

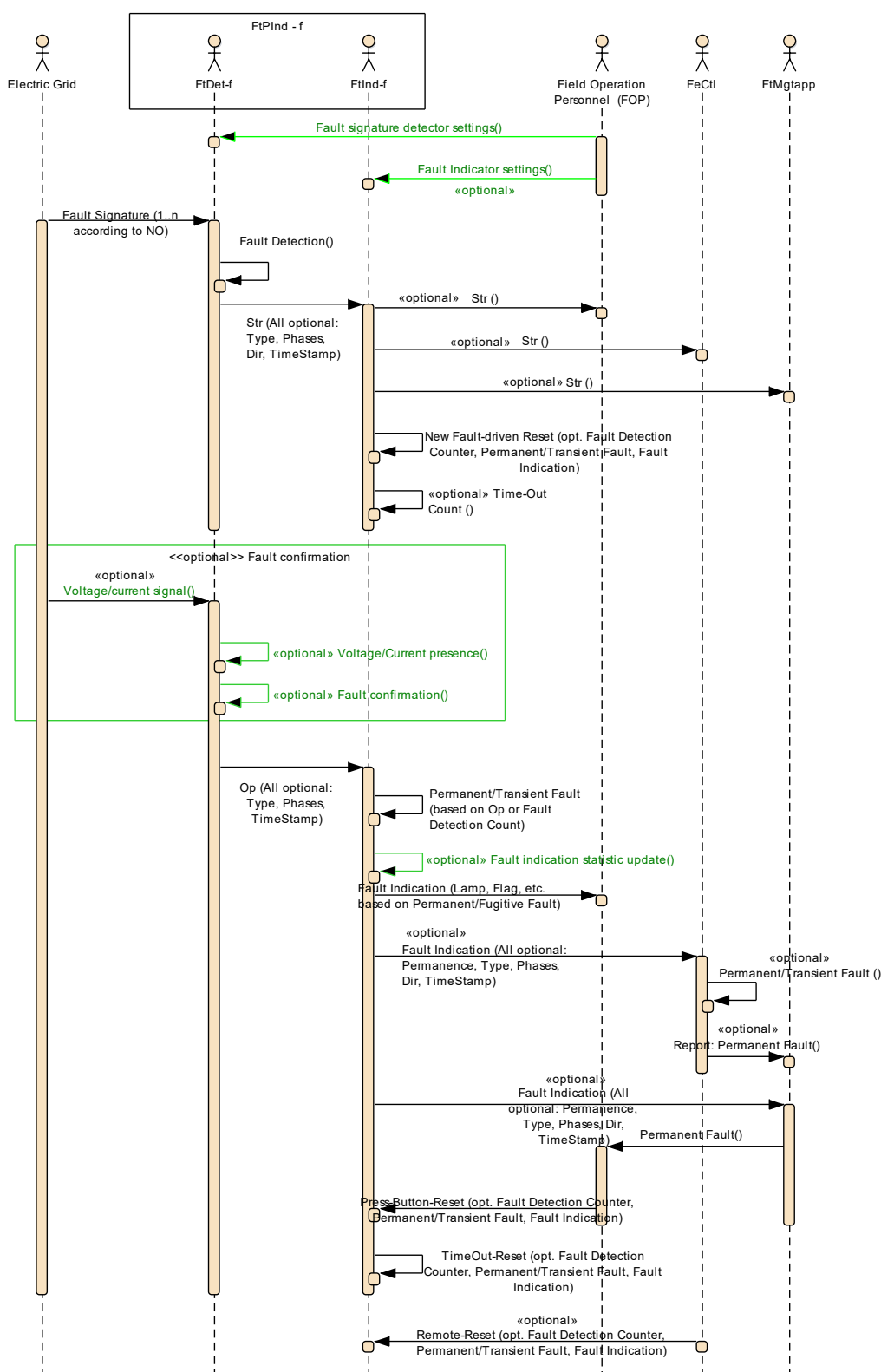


Figure 6 – Fault indication and report for FPI – T2

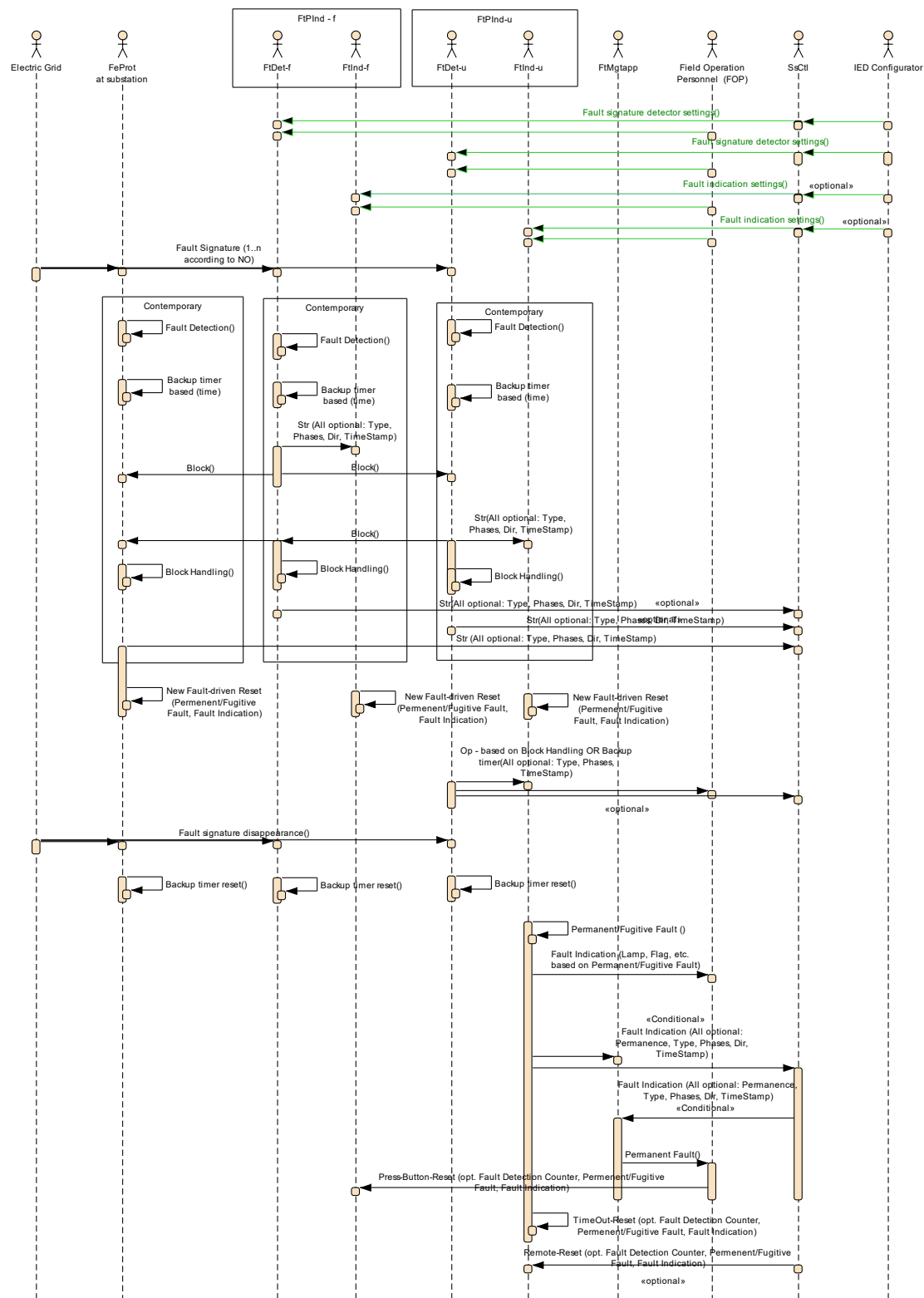


Figure 7 – Fault indication for FPI – T3,T4 (with communication to HV/MV SS) in the context of FLISR as described in 5.4

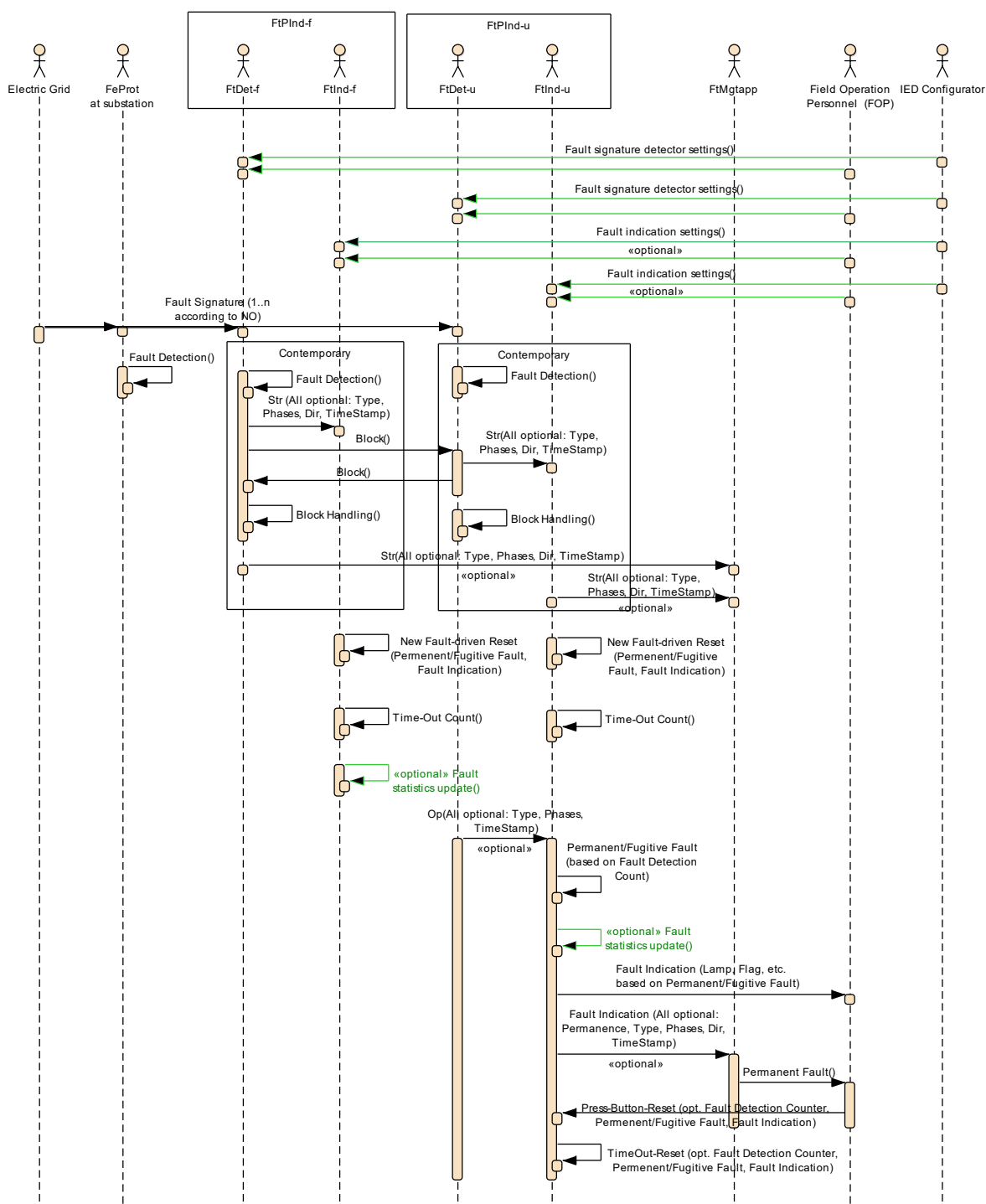


Figure 8 – Fault indication for FPI – T3,T4 (without communication to HV/MV SS) in the context of FLISR as described in 5.4

5.2.2.3 Technical details

5.2.2.3.1 Actors: People, systems, applications, databases, the power system, and other stakeholders

Actors			
Actor name see actor list	Actor type see actor list	Actor description see actor list	Further information specific to this use case
Electric Grid	System	Refer to Clause 4.	
FeProt at main substation	Device	Refer to Clause 4.	
FtPInd	Device	Refer to Clause 4.	
FtInd	Device	Refer to Clause 4.	
FtDet	Device	Refer to Clause 4.	
Field Operation Personnel (FOP)	Person	Refer to Clause 4.	
RTU	Device	Refer to Clause 4.	
DMSapp	(System) Application	Refer to Clause 4.	
Quality index system	(System) Application	Refer to Clause 4.	
FtMgtapp	(System) Application	Refer to Clause 4.	
Fault Location	(System) Application	Refer to Clause 4.	

5.2.2.3.2 Preconditions, assumptions, post condition, events

Use case conditions			
Actor/System/ Information/Contract	Triggering event	Pre-conditions	Assumption
DMSapp	Continuous		The Grid is continuously monitored The Grid topology is known and reflects the real topology The Grid energy path is known and reflects the real path (effective status of remote monitored and controllable switches).
Grid	Fault		The Grid is reacting in presence of the fault.
FtLOCapp	Fault Detection Autorecloser Operation		The application that performs Fault Indication and Reporting (Location), is activated by the fault detection. The application may operate autonomously using local signals or/and with the support of communication network (Client-server or peer-to-peer). If communication is used, enough energy storage shall be available.
FeProt at main substation	Fault Detection		The application that performs Fault Location for the Indication and Reporting is activated by the fault detection. The application may operate autonomously using local signals or/and with the support of communication network (Client-server or peer-to-peer). It is assumed that enough energy storage is available.
FtPInd	Overcurrent/earth faults/over-voltage, etc.		Backup power/battery shall be available for operation and communications.
Optionality of information exchange and/or processes/functions	N.A.		If no optionality is reported in the Sequence Diagrams and "Step by Step Analysis of Use Case", the information/function/process is assumed as mandatory.
Setting for Directional Detection	N.A.		These parameters are included in the Protection settings.

5.2.2.3.3 References / Issues

References						
No.	References type	Reference	Status	Impact on use case	Originator / Organization	Link

5.2.2.4 Step by step analysis of use case**5.2.2.4.1 General**

Scenario conditions					
No.	Scenario name	Primary actor	Triggering event	Pre-condition	Post-condition
5.1.1.4.1	Fault Indication for FtPInd – T1	FtPInd	Fault Signature handling		The distribution system stakeholders are aware of the fault and its characteristics (type, location, etc.)
5.1.1.4.2	Fault Indication for FtPInd – T2	FtPInd	Fault Signature handling		The distribution system stakeholders are aware of the fault and its characteristics (type, location, etc.)
5.1.1.4.3	Fault Indication for FtPInd – T3,T4 (with communication to HV/MV SS)	FtPInd, HV/MV SS protection	Fault Signature handling		The distribution system stakeholders are aware of the fault and its characteristics (type, location, etc.)
5.1.1.4.4	Fault Indication for FtPInd – T3,T4 (without communication to HV/MV SS)		Fault Signature handling		The distribution system stakeholders are aware of the fault and its characteristics (type, location, etc.)

5.2.2.4.2 Steps – Fault indication for FtPInd – T1

The details of the Str and Op information (directionality, general or per single phase and/or neuter) depends on the type of Fault Detection handling, according to 5.2.3, 5.2.4, 5.2.5, 5.2.6, 5.2.7 and 5.2.8.

