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TECHNICAL REPORT

Communication networks and systems for power utility automation – Part 7-6: Guideline for definition of Basic Application Profiles (BAPs) using IEC 61850

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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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colour inside

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FOREWORD

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International Standard IEC 61850 has been prepared IEC technical committee 57: Power systems management and associated information exchange.

The text of this Technical Report is based on the following documents:

Draft TR	Report on voting
57/1986/DTR	57/2034/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.

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 document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document 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- withdrawn,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

The IEC 61850 series of standards offers a broad basis for communication networks and systems in power utility automation. Due to its broad coverage of power utility automation applications, it is up to the standard's user (utility, vendor, system integrator, etc.) to pick and choose specific options from the standard in order to meet the requirements of the intended objective. As a consequence, implementations of IEC 61850 represent specific subsets of the standard.

In the context of standards the term "profile" is commonly used to describe a subset of an entity (e.g. standard, model, rules).

Accordingly an IEC 61850 standard profile contains a selection of data models (mandatory elements), applicable communication services and relevant engineering conventions (based on the Substation Configuration Language SCL defined in IEC 61850-6) for an application function of a specific use case in the domain of power utility automation.

Depending on the scope and objective different profile types can be distinguished:

- User profile – defined subset that is valid for a specific user / organization (e.g. utility)
- Product / device profile – implemented subset in a specific vendor product /device
- Domain profile – defined subset for a specific domain and relevant use cases (e.g. monitoring of substation)
- Application / function profile – subset covering a specific application or function (e.g. substation interlocking)

These profile types target the reduction of complexity and facilitation of interoperability for their specific scope and during engineering and device / substation lifetime. In order to achieve both these goals, a properly defined profile and appropriate implementations (processes, tools, products) that support the profile are required.

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 7-6: Guideline for definition of Basic Application Profiles (BAPs) using IEC 61850

1 Scope

This part of IEC 61850, which is a technical report, is focused on building application / function profiles and specifies a methodology to define Basic Application Profiles (BAPs). These Basic Application Profiles provide a framework for interoperable interaction within or between typical substation automation functions. BAPs are intended to define a subset of features of IEC 61850 in order to facilitate interoperability in a modular way in practical applications.

It is the intention of this document to provide a common and generic way to describe the functional behaviour of a specific application function in the domain of power utility automation systems as a common denominator of various possible interpretations/implementations of using IEC 61850.

The guidelines in this document are based on the functional definitions of

- IEC 61850-5, Communication requirements for functions and device models, which gives a comprehensive overview of all application functions needed in a state-of-the-art substation automation implementation.
- IEC TR 61850-7-500, Basic information and communication structure – Use of logical nodes for modelling application functions and related concepts and guidelines for substations, which illustrates and explains application functions for the substation/protection domain of Logical Nodes in modelling simple and complex functions, to improve common understanding in modelling and data exchange, and finally to lead to interoperable implementations.
- IEC TR 61850-90-3, Using IEC 61850 for condition monitoring diagnosis and analysis, which gives use cases and data modelling for condition monitoring diagnosis and analysis functions for substation and power grid facilities.

This document does not describe the applications and respective implementation requirements; the focus is on their typical information exchange including data and communication services and engineering conventions.

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 61850-5:2013, *Communication networks and systems for power utility automation - Part 5: Communication requirements for functions and device models*

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

IEC TR 61850-90-3, *Communication networks and systems for power utility automation - Part 90-3: Using IEC 61850 for condition monitoring diagnosis and analysis*

IEC TR 62361-103:2018, *Power systems management and associated information exchange - Interoperability in the long term - Part 103: Standard profiling*

3 Terms and definitions

For the purposes of this document, the following terms and definitions 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

3.1
Basic Application Profile
BAP
user/user group agreed-upon selection and interpretation of relevant parts of the applicable standards and specifications, intended to be used as building blocks for interoperable user/project specifications

Note 1 to entry: BAPs must not have options; all selected criteria are required to facilitate interoperability. For implementation in projects, BAPs might be extended or refined to meet the user specific requirements.

[SOURCE: CEN-CENELEC-ETSI SG-CG Report on Interoperability CEN_9762_CLC_9624 – Clause 12.1, Terms and definitions]

3.2
Basic Application Interoperability Profile
BAIOP
interoperability test for BAPs defined by test sequences and test cases

[SOURCE: CEN-CENELEC-ETSI SG-CG Report on Interoperability CEN_9762_CLC_9624 – Clause 12.1, Terms and definitions]

3.3
compliance
accordance of the whole implementation with specified requirements or standards

Note 1 to entry: Some requirements in the specified standards may not be implemented.

[SOURCE: CEN-CENELEC-ETSI SG-CG Report on Interoperability CEN_9762_CLC_9624 – Clause 12.1, Terms and definitions]

3.4
conformance
accordance of the implementation of a product, process or service with all specified requirements or standards

Note 1 to entry: Additional features to those in the requirements / standards may be included.

Note 2 to entry: All features of the standard/specification are implemented and in accordance, but some additional features are not covered by the standard/specification.

[SOURCE: CEN-CENELEC-ETSI SG-CG Report on Interoperability CEN_9762_CLC_9624 – Clause 12.1, Terms and definitions]

3.5
conformance test
check of data flow on communication channels in accordance with the standard conditions concerning access organization, formats and bit sequences, time synchronization, timing, signal form & level and reaction to errors

Note 1 to entry: The conformance test can be carried out and certified to the standard or to specifically described parts of the standard. The conformance test should be carried out by an ISO 9001 certified organisation or system integrator.

Note 2 to entry: Beside the ISO 9001 certification also an accreditation by an appropriate entity is required for the testing organization or system integrator to perform a conformance test.

[SOURCE: IEC 61850-4:2011, 3.17, modified (addition of Note 2 to entry)]

3.6
interoperability
ability of two or more IEDs from the same vendor, or different vendors, to exchange and use information for correct execution of the specified functions

[SOURCE: IEC 61850-2:2003, 2.85]

3.7
interoperability testing
testing performed to verify that communicating entities within a system are interoperable, i.e. they are able to exchange information in a semantically and syntactic correct way

Note 1 to entry: During interoperability testing, entities are tested against peer entities known to be correct (profiles).

[SOURCE: CEN-CENELEC-ETSI SG-CG Report on Interoperability CEN_9762_CLC_9624 – Clause 12.1, Terms and definitions]

3.8
profile
agreed-upon subset of derived from a specification

Note 1 to entry: A common profile is required for achieving interoperability especially in those cases when a specification could have more than one interpretation and there are probably many optional features.

[SOURCE: IEC TR 62361-103:2018, 3.11]

3.9
SGAM
Smart Grid Architecture Model, the 3D-Model for Smart Grid mappings
High level conceptual model of the Smart Grid developed by the CENELEC M/490 Reference Architecture working group describing main actors of the Smart Grid and their main interactions.

[SOURCE: CEN-CENELEC-ETSI SG-CG Report on Interoperability CEN_9762_CLC_9624 – Clause 12.1, Terms and definitions]

4 Methodology for profiling

4.1 General

In general, profiling within a standard and between standards and specifications helps to both facilitate interoperability and meet expectations of different projects where these will be implemented.

Out of this broad basis of the definitions of the IEC 61850 standard series, specific subsets (selected by vendors) are implemented in products and systems.

IEC 61850 applications can also differ dependent on user type, region and philosophy. Stakeholders officially request guidelines and tools to facilitate interoperability in projects and therefore the challenge is to find a common concept/guideline to both facilitate interoperability and meet expectations of different projects.

Flexibility of standards which were created to meet the requirements of the industry of the global world, containing many options, contradicts with the goal of interoperability of functions. If a function can be implemented in more than one way in products, the risk that those products will be unable to perform the function in an interoperable way is high. To facilitate the goal of interoperability in addition to the mandatory elements the mandatory inclusion of selected optional elements offered by the standard may be defined. That limitation of options offered by a standard is done by defining commonly agreed subsets (profiles), which might be interpreted as disadvantageous inflexibility against specific user requirements.

To facilitate the goal of interoperability, a common understanding and interpretation of the related standard and the identical use of functional elements for required layers to fulfil application functions is necessary. This can be achieved by defining profiles. They could be best provided by User Groups in the domain of substation automation. A User Group consists of interested parties, e.g. utilities, vendors, certification bodies, test labs, system integrators and regulators, see Figure 1.

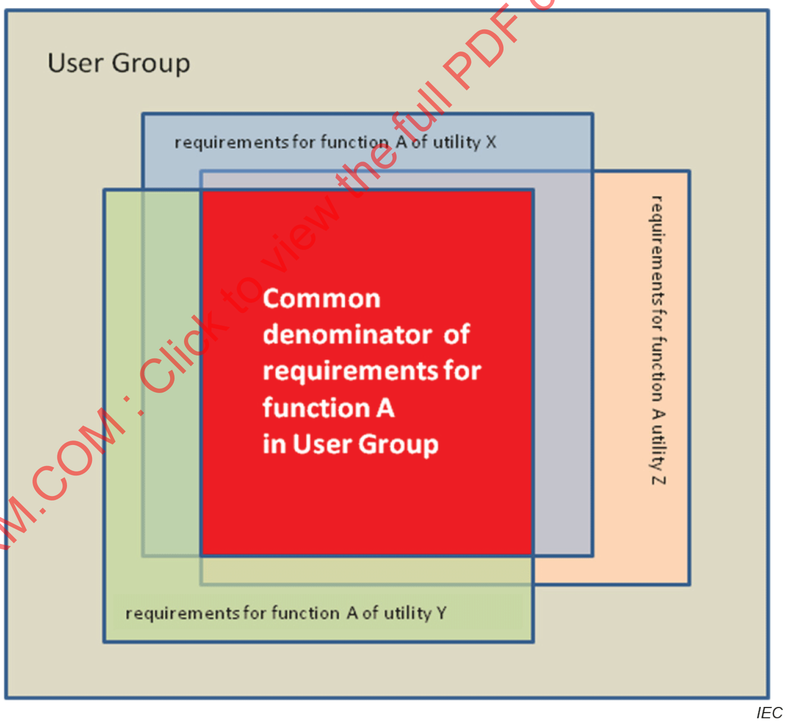


Figure 1 – Stakeholders collaborate in user groups to create a common IOP profile

IEC TR 62361-103:2018, 4.1, defines a common concept and framework for the process of profiling within the IEC.

4.2 IEC 61850 profiling concept

4.2.1 General

The primary goal of the IEC 61850 series is to facilitate interoperability in a modular way between subsystems and components in order to enable more or less complex system functions. Therefore the IEC 61850 series covers specifications for functional and non-functional requirements, information and communication aspects for devices and systems as well as device and system engineering. With that the IEC 61850 series offers a broad basis for communication networks and systems in power utility automation.

Due to its broad coverage of power utility automation functions and applications, it is up to the user of the standard (utility, vendor, system integrator etc.) to pick and choose specific options offered by the standard in order to meet the requirements according to their intended project objectives. As a consequence, implementations of IEC 61850 represent specific subsets of the standard instead of covering it as a whole.

IEC 61850 profiles express (interoperability) requirements of actors' roles in a specific business context to be fulfilled by devices and systems.

4.2.2 IEC 61850 profile definition

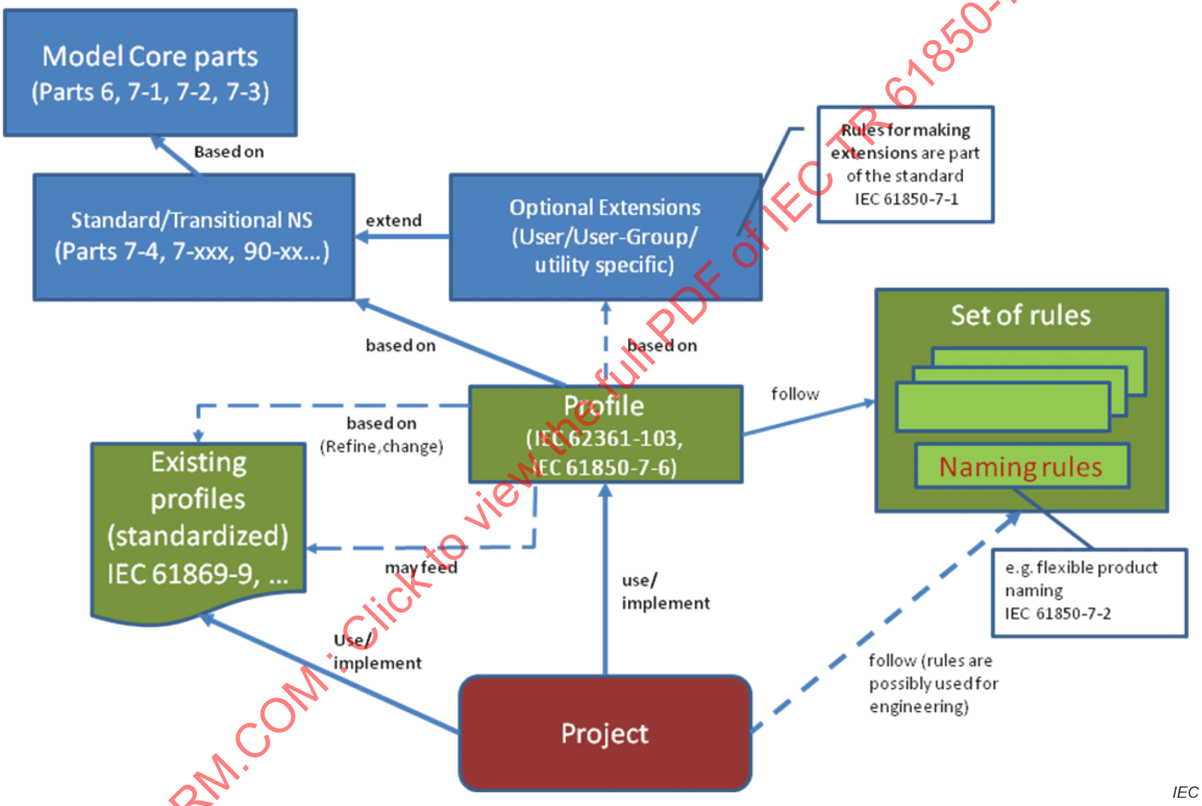


Figure 2 – Framework for profiling IEC 61850

Figure 2 shows the main relationship between the different elements constituting the profiling activity of IEC 61850.

An IEC 61850 standard profile may contain a selection of data models (with mandatory and optional elements) and communication services applicable for a specific role within a detailed use case. The data models and communication services are all based on the same core parts as described in Figure 2.

It is acknowledged that a profile cannot be less demanding than the standard itself, i.e. a field or item said to be mandatory (or forbidden) by the standard shall remain mandatory (or forbidden) in a profile. The standard represents a sort of minimum base line.

Furthermore a profile may define specific features (e.g. pay load, specific device types) and procedures (e.g. programmable logics, message sequences). Subclause 4.3 provides possible content of a profile.

Depending on the scope and objective different profile types can be distinguished:

- User profile –defined subset that is valid for a specific user / community of users (e.g. utility)
- Domain profile – defined subset for a specific domain and relevant use cases (e.g. asset management)
- Basic Application Profile (BAP) – standardized subset [5] defining an atomic application function (e.g. reverse blocking)
- Application profile – profile covering a specific application mostly based by aggregating BAPs (e.g. busbar protection)
- Device profile – profile covering a typical IED functionality (e.g. Merging Unit, IEC 61869-9)
- Product profile – implemented subset in a specific vendor product

All these profile types target reducing complexity and facilitate interoperability in a modular way for their specific scope. In order to achieve these goals, both a properly defined profile and appropriate implementations (processes, tools, products) that support the profile are required.

4.3 Basic Application Profiles (BAPs)

A Basic Application Profile (BAP) is based on system/subsystem specific basic application functions descriptions. The term “basic” means here that an elementary application function/subfunction is the chosen context for defining the profile. The level of what is perceived as elementary is application dependant, and may include for example many Logical Node (LN) instances of many LN classes, when using IEC 61850.

A BAP is a user/user group agreed-upon selection and interpretation of relevant parts of the applicable standards and specifications and is intended to be used as building blocks for interoperable user/project specifications.

The key ideas of BAPs are:

- BAPs are elements in a modular framework for specific application systems/subsystems
- Combinations of different BAPs can be used in real projects as building blocks
- Project specific refinement additional to the BAP might be necessary to meet specific requirements for implementation in projects. These additional requirements should be frequently fed back into the User Group and may lead to a new or revised BAP based on user experiences and group decisions.

BAPs shall represent a user agreed common denominator of a recommended implementation or a proven best practice implementation of an application function in the domain of substation automation, but is not aimed to cover all possible implementation options.

BAPs shall not have options; all selected criteria are therefore mandatory in the interest of interoperability. If variants of BAPs for an application function are needed, different BAPs for the same application function shall be defined to facilitate interoperability in a modular way.

5 Most of the profile types above may follow a standardization process, in order to collect the widest range of comments and guarantee their stability for a defined period.

IEDs might contain more options as requested by BAPs to achieve more flexibility to satisfy the needs of the global market, but it is considered to be useful if the BAP specific definitions can be selected easily (e.g. by some settable BAP identifier).

BAPs are built on the basis of international standards and also may have an influence in the further development of standards by possible feedback and implementation of lessons learned.

BAPs shall include (BAP template):

- Functional description
  - Verbal description of the function supported by figures to explain the required functional behaviour of the application function
- Description of the use case and the associated roles/actors
  - List of roles /actors
  - Sequence diagram showing the typical interactions between the associated roles/actors
- Logical architecture
  - Description of the application function by using LNs and description of the interaction between those LNs using attributes defined inside the LNs
- Allocation variants (conditional)
  - This clause shall be used if the allocation of sub-functions (LNs) into different physical devices can be done in different ways e.g. Allocation of subfunctions (LNs) in configuration with or without process bus
- Functional variants
  - To avoid multiple BAP definitions for the same application function caused by slightly different behaviour this clause can be used to define so called implementation variants for the same application function the use of attributes needed for these functional variants has to be shown in the description of the data model e.g. with or without monitoring of status signals
- Performance requirements
  - Functional related e.g. required behaviour in case of loss of communication
  - Service related e.g. timing constraints, required reaction time, etc.
  - It is recommended to use the performance classes defined in IEC 61850-5:2013, Clause 11.
- Description of data model per actor
  - Semantic model

    In case functional variants are used, this shall be shown in the semantic data model by using columns for each functional variant
  - Syntactic model
- Communication services
  - Description of the IEC 61850 services used to perform the required behaviour of the application function
- Device related requirements (conditional)
  - This clause shall be used if a device containing sub-functions of the BAP (LN's) requires special network or device configuration to achieve the required variant of the application function.
  - Configuration capabilities

    In case that a specific configuration of the device on the station network is needed to fulfil the achieved required variant of the application function is needed (e.g. works on process bus only)

– Communication capabilities

  In case specific configuration of communication services or network configuration is needed for the device to achieve the required variant of the application function

- Engineering Tool related requirements
- Naming rules
  – There might be requirements for constraining names in the profile which should be defined in this section.
  – Any restrictions in naming may cause risk of limited cohabitation with other profiles in one device.
- Capabilities for testing
  – A taskforce within the IEC is currently working IEC 61850-10-3 which defines standardized capabilities of application functions and rules needed for interoperability testing.

    e.g. the standardized use of the data attributes “Mod” and ”Beh” as well the standardized use of the quality attribute “test” which might also lead to a test BAP.

The objective of a BAP is to reduce complexity, clarify vague or ambiguous specifications and so it aims to facilitate interoperability in a modular way.

The profiling concept selected for IEC 61850 is a classical modular bottom-up approach to facilitate interoperability in a modular way between functions/subfunctions located in IEDs forming a substation automation environment. IEC 61850-5 shows how the domain of substation automation can be decomposed into functions/sub functions.

That concept, as presented in Figure 3, is recommended by the Interoperability Report worked out by the Smart Grid Coordination Group of CENELEC (CEN-CENELEC-ETSI SG-CG Report on Interoperability CEN_9762_CLC_9624).

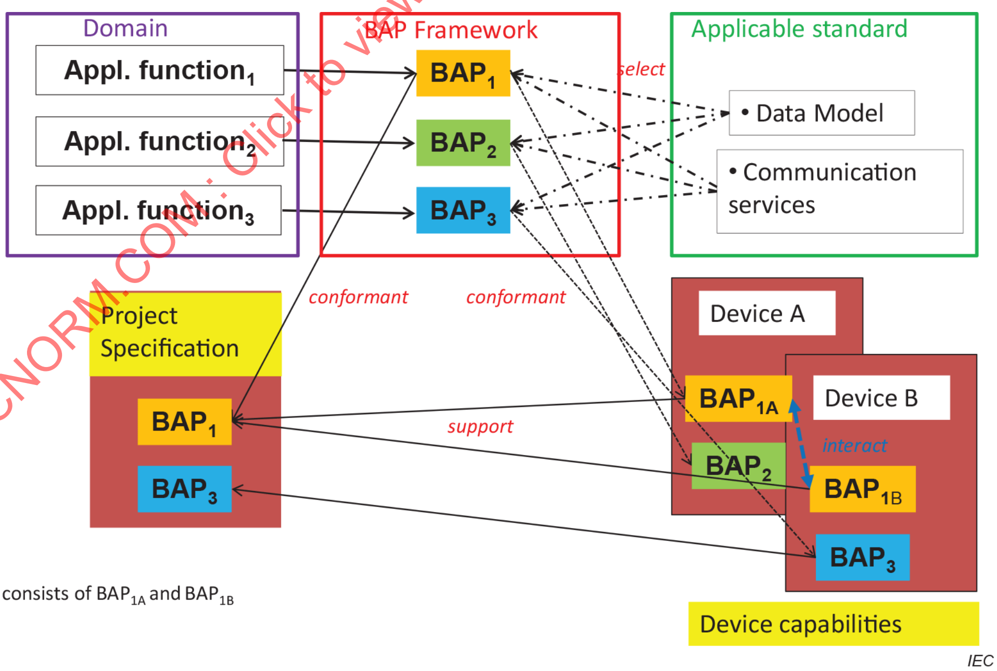


Figure 3 – Aggregating BAPs

4.4 Basic Application Interoperability Profiles (BAIOPs)

The conformance test defined in IEC 61850-10 is a prerequisite for functional testing which is needed to facilitate interoperability.

The conformance test simply verifies if the implementation of IEC 61850 (described in PICS, PIXIT, MICS, etc.) is conformant to the definitions of the standard.

IEC 61850-10 does not contain any requirement for testing of functional interoperability by a device or between devices.

No testing to facilitate interoperability on functional level is performed in a conformance test.

Functional testing needs different test sequences and test cases compared to a conformance test.

The test cases defined in a BAIOP shall focus on the use case of the BAP to verify the functional interaction of LNs based on the selected attributes of the data model and the selected services for communication.

BAPs are defined by User-Groups representing the asset owner or a collective of asset owners e.g. typically utilities with a common interest. BAIOPs are normally defined and performed by different stakeholders like test labs, certification bodies etc. which can add value by contributing their special experience and knowledge about testing to facilitate interoperability.

For interoperability testing a BAP shall be amended by

- relevant engineering related requirements (e.g. concept of functional naming)
- device configuration
- test configuration with communication infrastructure (topology)
- BAP related functional test sequence diagrams and test cases
- specific capability descriptions (e.g. PICS, PIXIT, MICS in the case of IEC 61850)
- engineering framework for data modelling (instances) and communication infrastructure (topology, communication service mapping)

IEC TR 62361-103:2018, 4.1, also defines a common concept and framework for the process of testing profiles within the IEC. The common concept and framework of testing is shown in Figure 4.

The tests defined in a BAIOP shall prove that the implementation of relevant parts of IEC 61850 in a device is both conformant to the corresponding BAP and facilitates interoperability in a modular way among devices from different vendors.

An organization which is qualified to perform interoperability testing (with a possible certification) for BAPs/BAIOPs still needs to be defined.

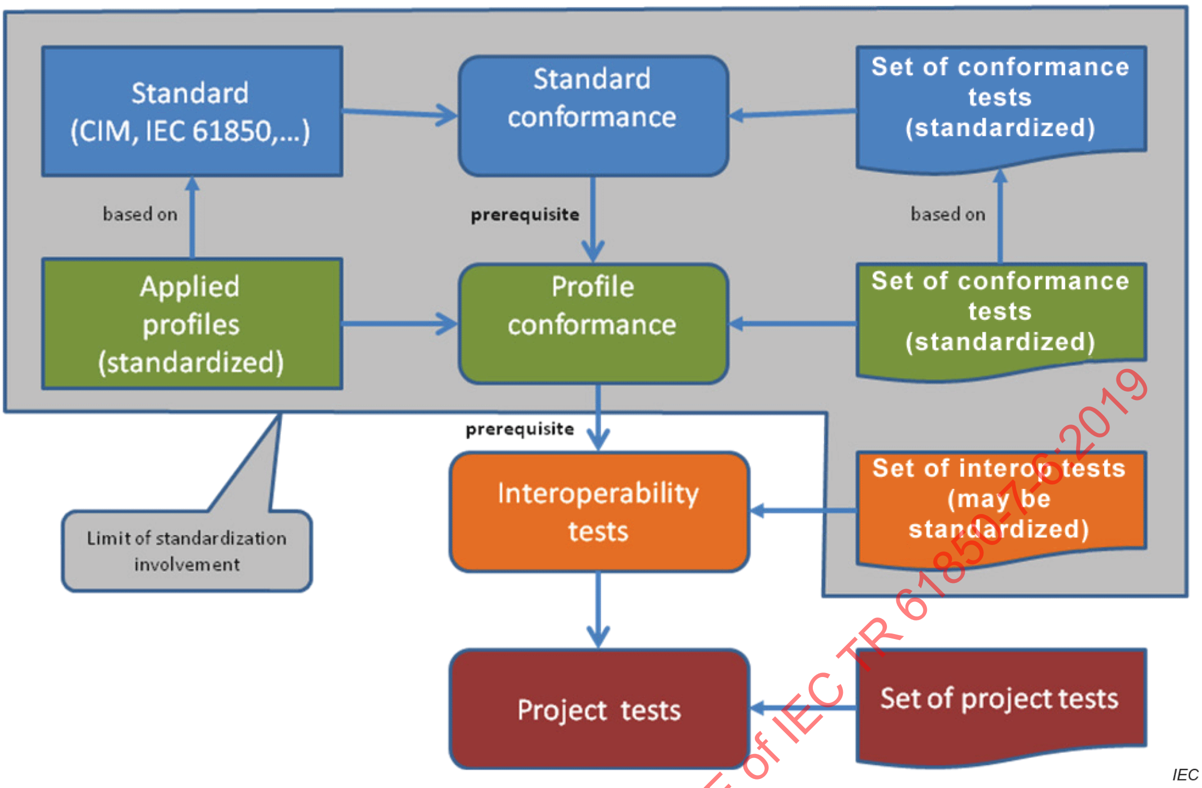


Figure 4 – Framework for testing a profile

The definition and common use of BAPs and BAIOPS should lead to a win-win situation for all stakeholders involved in the power utility automation domain in general, e.g.:

- The benefit for users (e.g. asset owners) and user groups is the chance to harmonize the various company specific application function variants to a common denominator / best practice implementation for each basic application function. This reduces the risk of interoperability problems caused by products/systems as these may be selected from standardized BAP frameworks and tested according to BAIOPs.
- The benefit for manufacturers which will use standardized BAPs in their products is the reduction of project specific or customer specific implementation variants of application functions and therefore reduce product complexity, development costs and parameterization efforts. BAIOPs can be used for internal tests before the product will be placed on the market.
- The benefit for certification bodies / test labs is the ability to perform interoperability tests based on BAIOPs and create out of the need for interoperability a new business case. The benefit for system integrators is that they can specifically select products conformant with BAPs and tested according to BAIOPs. This should reduce the efforts for integration of subsystems or devices.

4.5 Process from a use case to interoperability on SGAM function layer

Figure 5 illustrates the process from a use case to facilitate interoperability on SGAM function layer in a modular way by using BAPs and BAIOPs.

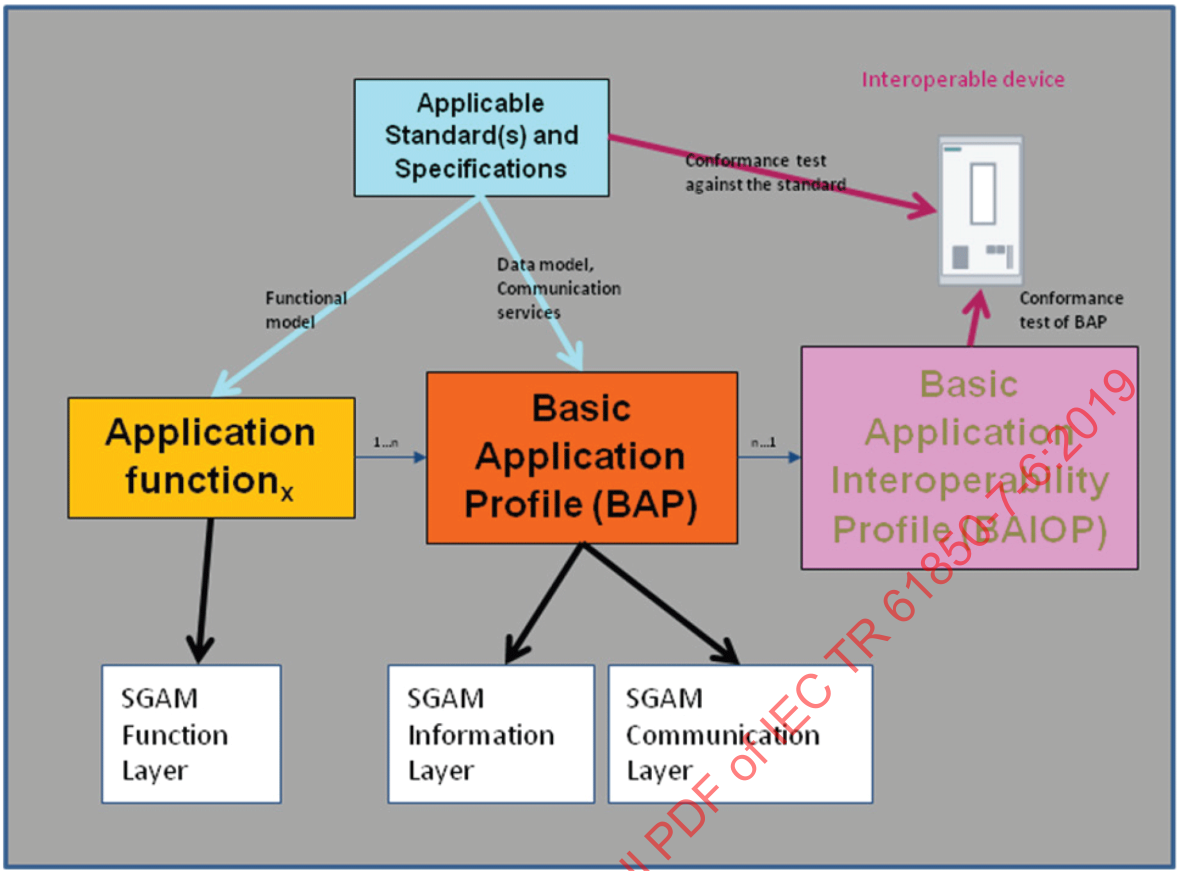
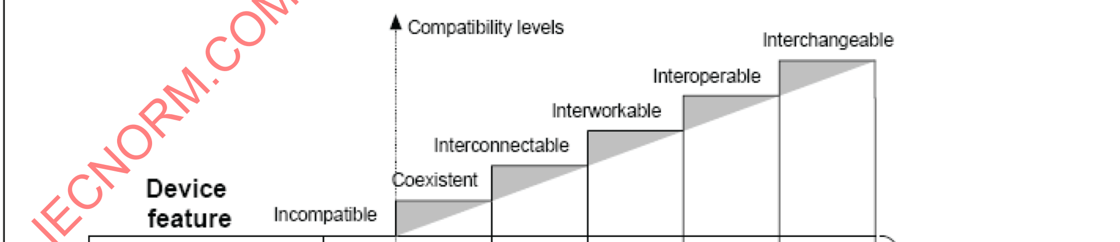


Figure 5 – Relation between BAP and SGAM interoperability

To achieve the required level of compatibility (from coexistent up to interchangeability), it may be useful to consider the device compatibility levels derived from TC65/920/DC which are shown in Figure 6. With an increased required level of compatibility towards IOP, the necessary device features that need to be covered by profiles are also increasing.



Device feature	Incompatible	Coexistent	Interconnectable	Interworkable	Interoperable	Interchangeable
Dynamic Behavior						X
Application Functionality					X	X
Parameter Semantics					X	X
Data Types				X	X	X
Data Access			X	X	X	X
Communication Interface			X	X	X	X
Communication Protocol		X	X	X	X	X

Device Profile Application part (Dynamic Behavior to Data Types)

Device profile Communication part (Data Types to Communication Protocol)

IEC

Figure 6 – Device features covered by profiles depending on compatibility levels according to IEC Technical Committee 65, Industrial-process measurement, control and automation

4.6 Managing profiles

It is important that a profiling management is in place in order to ensure that profiles are applied and understood in the same way by all affected stakeholders, and to avoid that diverging profiles for the same purpose will be developed and applied in parallel. This mainly includes:

- the responsibilities and roles of the different actors which are involved to create and manage profiles
- change management and versioning control of updated profiles
- communication of changes to affected stakeholders

It is recommended that user groups (e.g. UCA or ENTSO-E) take ownership of creating and managing profiles. This also means that lessons learned shall be fed back by users of the profiles to the corresponding user groups to enable them to improve their profiles according to predefined cycles. Therefore clear contact information shall be attached to profiles. The user group shall be also responsible for the change management and versioning control of updated profiles, and to communicate changes to the affected stakeholders and other user groups in an adequate way, e.g. by newsletters or information on user group websites.

4.7 Implementation of BAPs in real projects

BAPs and BAIOPs are elements in a modular framework for specific application systems/subsystems and can be used in combination as building blocks in real projects. The user involved in the project (e.g. a company or system integrator) is responsible for developing and maintaining project specific application profiles based on these building blocks, but specific refinement still might be necessary to meet the project requirements. Figure 7 illustrates this process.

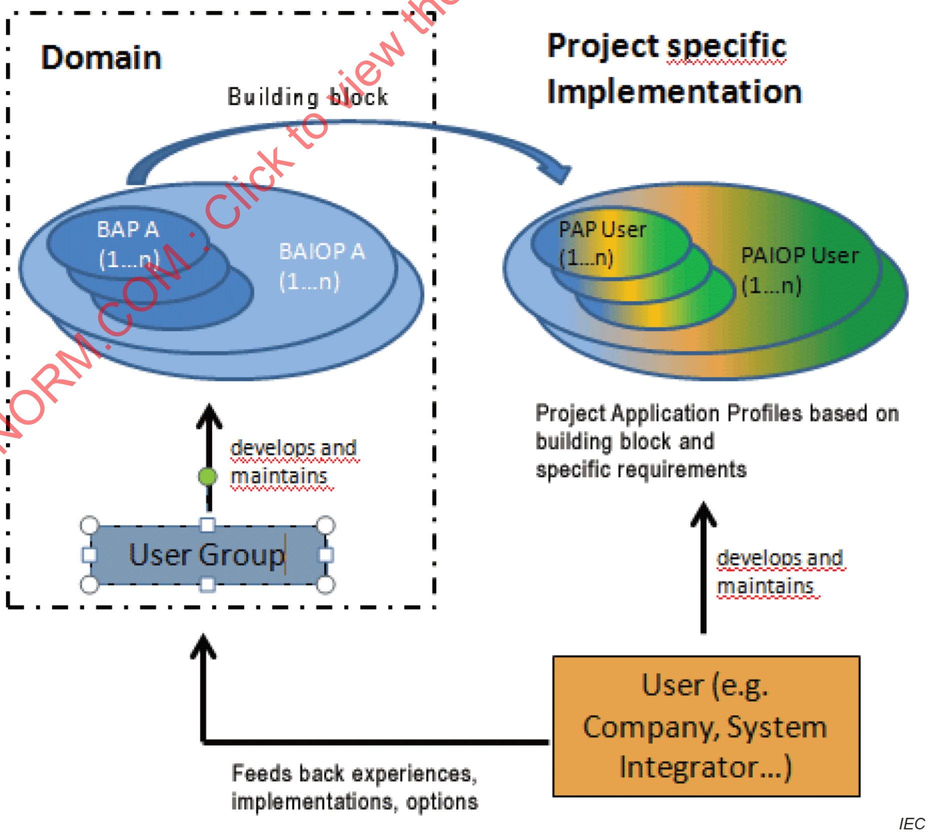


Figure 7 – BAPs and BAIOPs as building blocks for user/project specific implementation and testing

Annex A
(informative)

Example for BAP of distributed automation function “reverse blocking” using BAP template

A.1 Functional description

The reverse blocking function is applied in case of a unidirectional (radial) power flow from one typical infeed to many loads and implements some kind of a simple bus bar protection based on overcurrent protection. It is typically used in medium voltage systems, which classically have a radial power flow. The standard implementation to distinguish bus faults from load feeder faults using an overcurrent functions with a different time delay, so that a load trip can be performed before an infeed trip.

Typically, the infeed happens at higher voltage level (HV, transmission) and the radial load distribution at lower voltage level (MV, distribution). Therefore, the transformer between the two voltage levels is shown in Figure A.1 but plays no role in the scheme. The same is valid for voltage transformers, disconnectors and earthing switches being left out for simplicity.

In radial networks with single infeed, the function reverse blocking can be used to set up a simple busbar protection. The first overcurrent stage I>> of the definite time overcurrent device of the bus bar’s incoming feeder bay (here infeed bay) is set to a short tripping time of e.g. 0,1 seconds. Additionally, blocking of this stage is configured via a blocking signal. The second overcurrent stage I> of the definite time overcurrent device of the outflow feeder bays of the busbar (here e.g. outflow bay 1 … bay n) are set to a tripping time of e.g. 1 second. The pickup signal of the I> stage or the general pickup signal are configured to be sent as an output. All outputs of the outgoing protection devices are transmitted to the blocking input of the infeed protection.

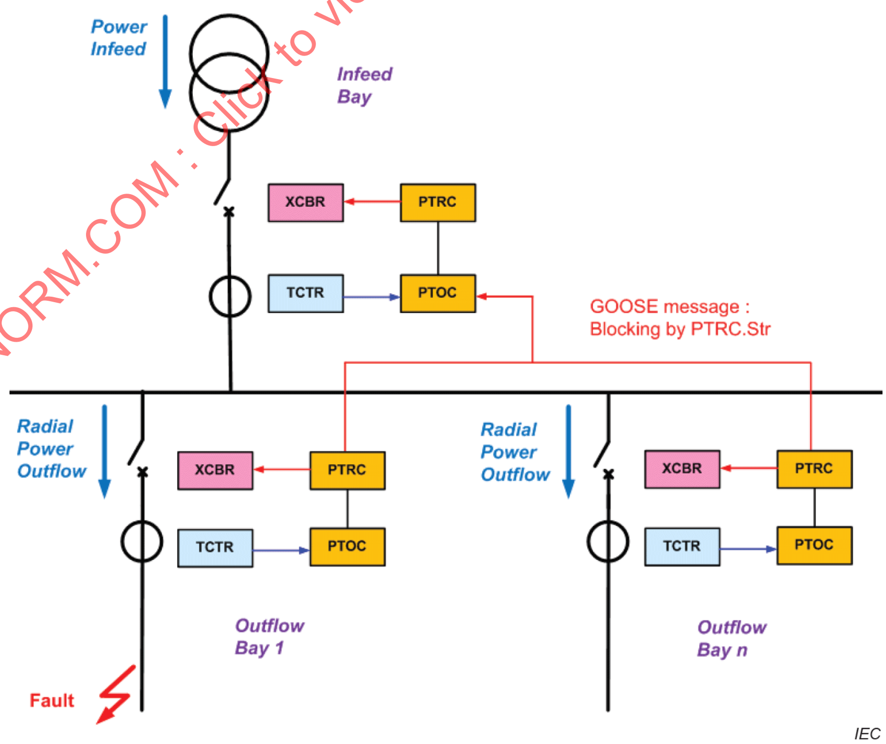


Figure A.1 – Behaviour in the event of faults on an outflow bay

When a fault occurs on an outflow bay, the pickup of the protection (PTOC) of the affected outflow bay will instantaneously generate a blocking signal to the protection (PTOC) of the infeed bay and its I>> stage will not trip instantaneously (condition < e.g. 100 ms). The outflow bay protection (PTOC)) generates a trip (PTRC) selectively for the faulted outflow bay and the busbar can remain operational, as shown in Figure A.2.

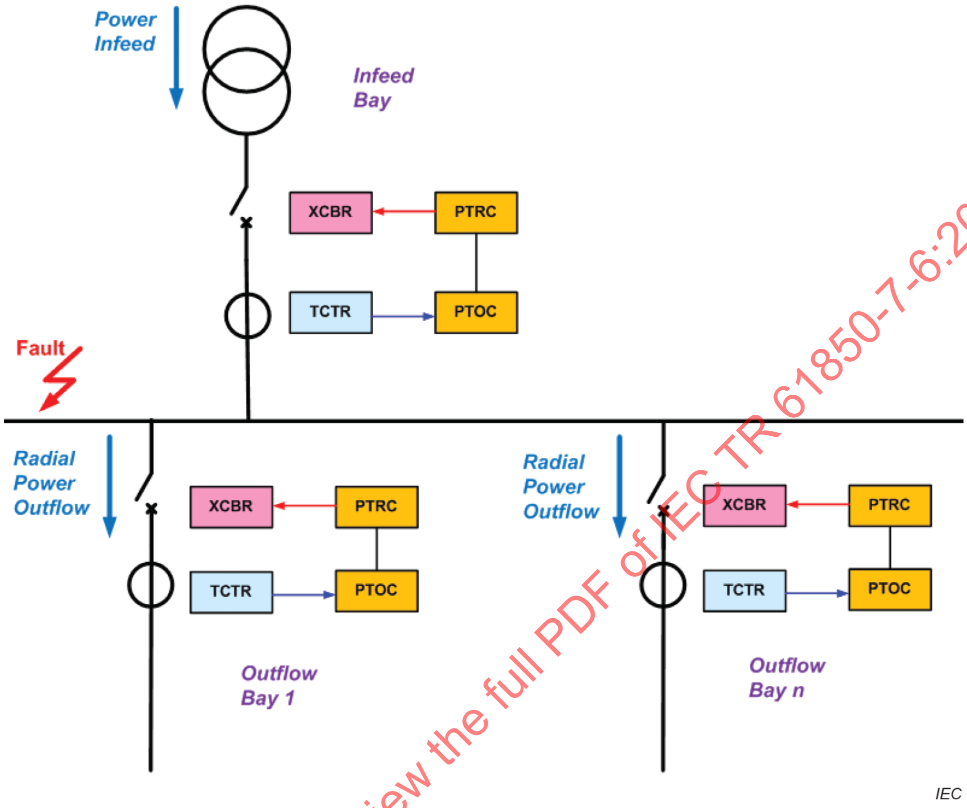


Figure A.2 – Behaviour in the event of busbar faults

When a fault occurs on the busbar, the I>> stage of the infeed bay protection (PTOC) will pick up but none of the outflow bay protection will generate the blocking signal since the affected protection devices of the outflow bays do not pick up. The infeed bay protection (PTOC) will thus switch off the infeed bay (PTRC) instantaneously after 0,1 sec.

A.2 Description of use case and associated roles/actors

A.2.1 List of roles / actors

Figure A.3 provides a list of roles / actors for the function reverse blocking.

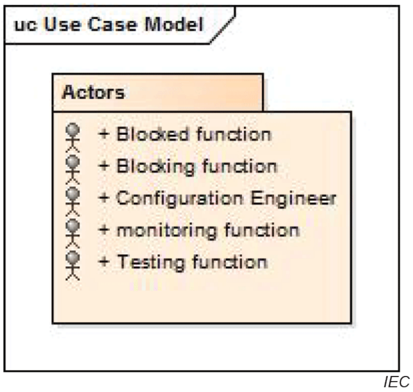


Figure A.3 – List of roles / actors reverse blocking

A.2.2 Use case

Figure A.4 demonstrates the reverse blocking use case.

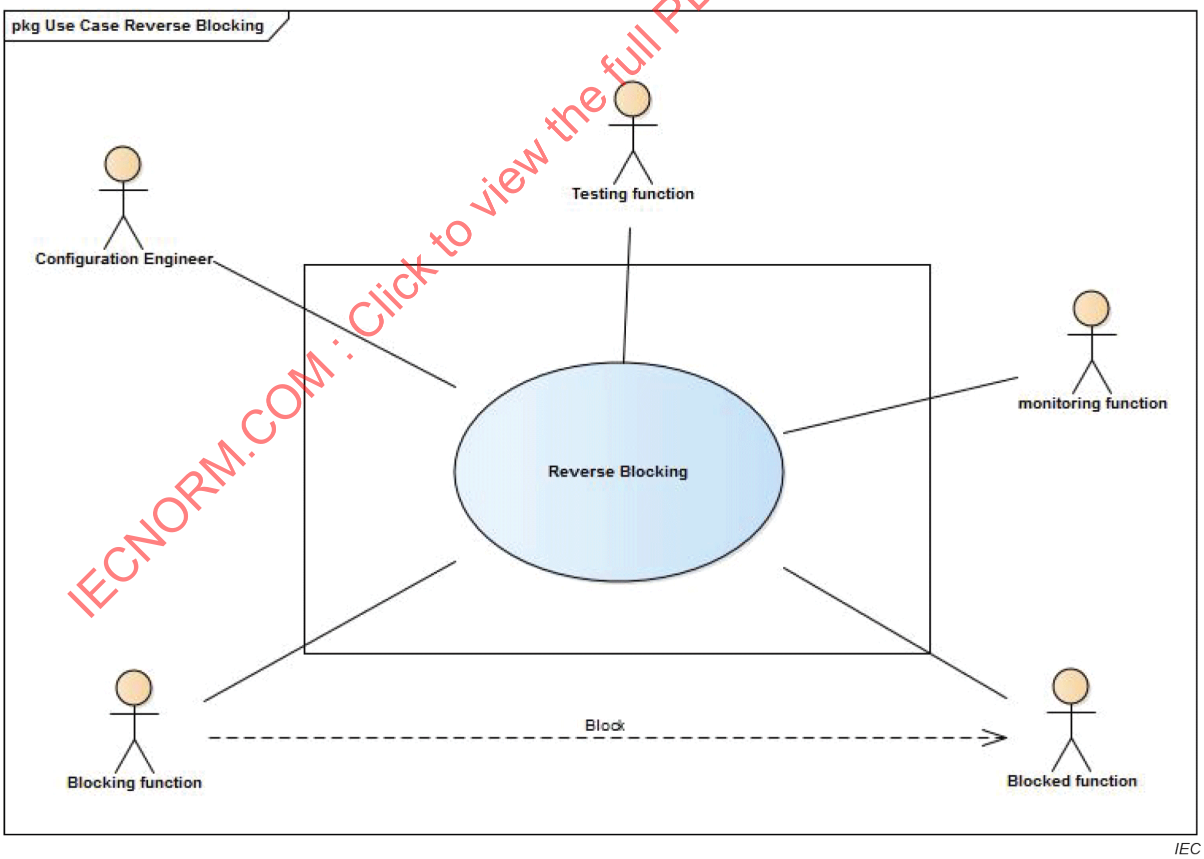


Figure A.4 – Use case reverse blocking

A.2.3 Sequence diagram of typical interactions

Figure A.5 shows the typical sequence diagram of the function reverse blocking.

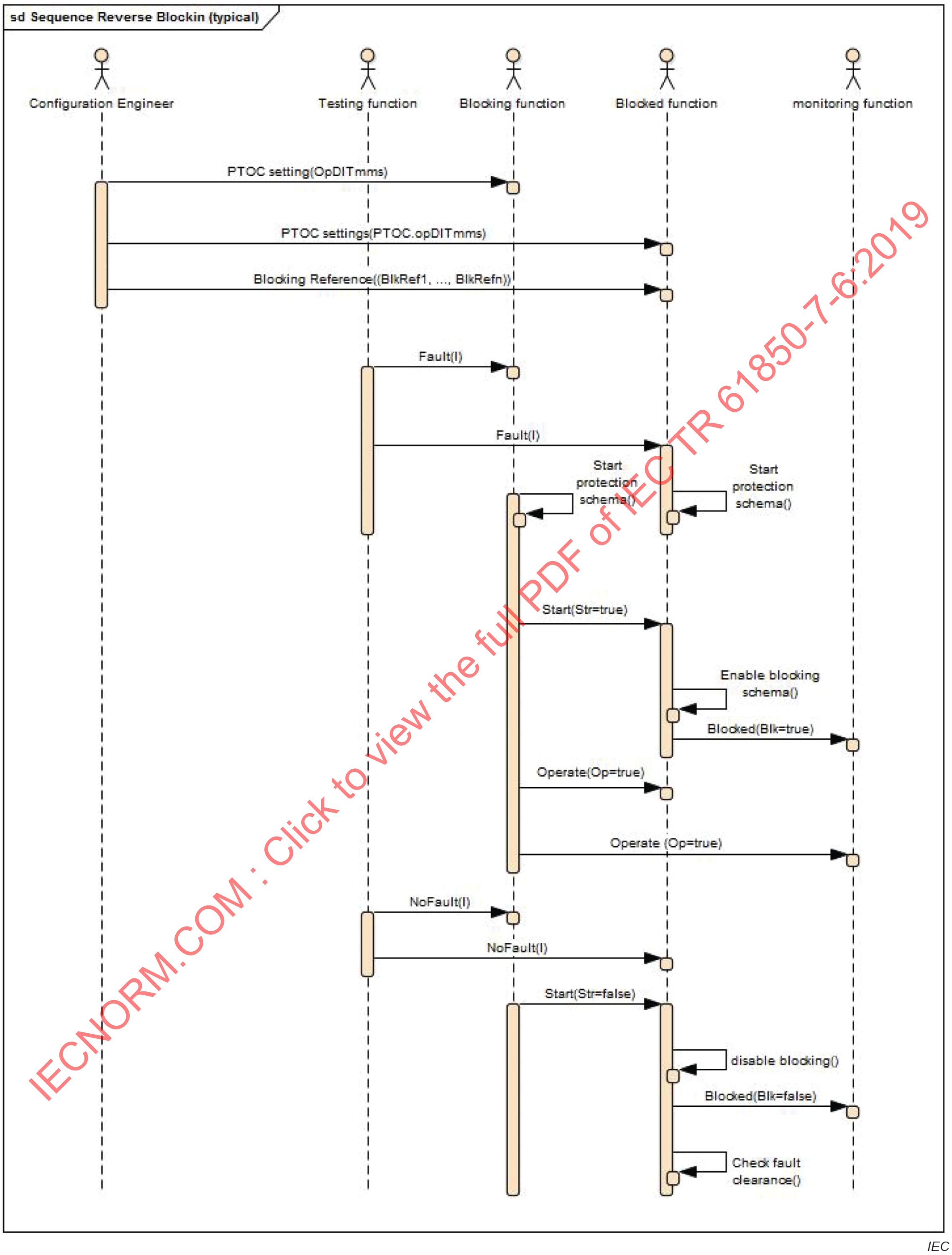


Figure A.5 – Sequence diagram reverse blocking

A.3 Logical architecture

Figure A.6 shows the logical architecture of the function reverse blocking.

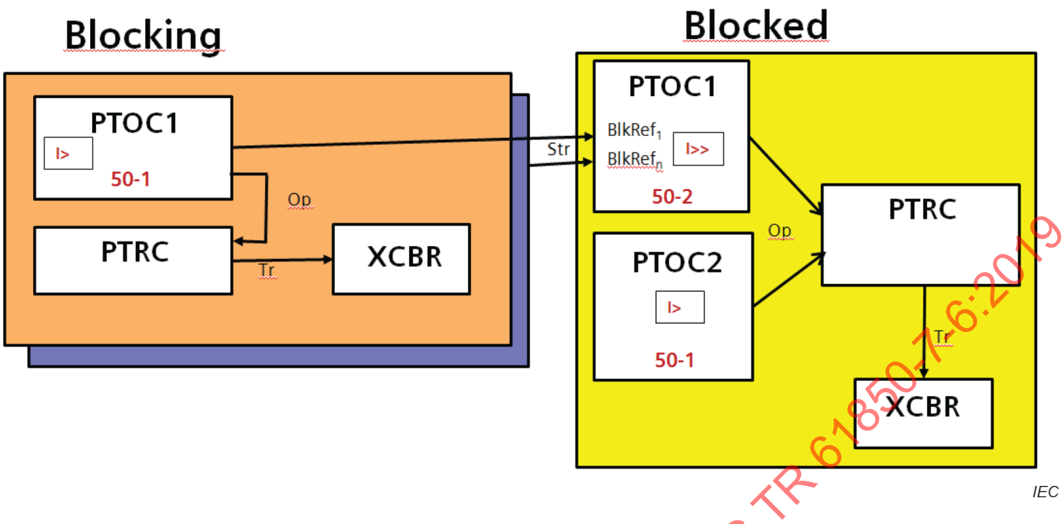


Figure A.6 – Logical architecture reverse blocking

NOTE The Dataflow configuration occurs mandatorily over the SCL LN->Inputs->ExtRef configuration. BlkRef1 BlkRefn are solely the DOI of LN PTOC that exposed the configured DataFlow for discovery purpose.

A.4 Allocation variants (conditional)

For the logical architecture it is not important if the circuit breaker (XCBR) is located in a separate IED.

A.5 Functional variants

A.5.1 Core functional variants

A.5.1.1 Variant FA:

Equipment is preconfigured or settings are outside of the scope of IEC 61850.

Communication between “Blocking” and “Blocked” is wired (out of scope of IEC 61850)

A.5.1.2 Variant FB:

Equipment can be configured through IEC 61850

Communication between “Blocking” and “Blocked” is based on IEC 61850 (typically Goose)

A.5.2 Noncore functional variants

A.5.2.1 Variant MA:

No monitoring

A.5.2.2 Variant MB:

Monitoring of “Operate” (Op) and “Block” (Str)

A.5.2.3 Variant TA:

Test is outside of required features

A.5.2.4 Variant TB:

Test is part of required features

A.6 Performance requirements

A.6.1 Functional related

For safety reasons any missing pickup signal reception from outflow bays (blocking) shall not lead to a "blocking" behaviour of the overcurrent protection (PTOC) of the Infeed bay (blocked). The loss of communication between outflow bays and infeed bay shall also not lead to a "blocking" behaviour of the overcurrent protection (PTOC) of the infeed bay.

For safety reasons any pickup signal reception from outflow bays with a quality "test" set shall not lead to a "blocking" behaviour of the overcurrent protection (PTOC) of the infeed bay unless the Infeed Bay itself is in test condition.

A.6.2 Service related

The transmission must be completed within less than the set command time OpDlTmms (tI>>) of the incoming feeder protection, which is 100 ms in the example. The time requirement applies here for the transmission path from generation of the pickup PTOC1 from feeder 1… n until the actual blocking has effect in PTOC1 from the infeed bay. The transmission must take place without delay; therefore a spontaneous transmission via GOOSE is an absolute precondition.

A.7 Description of data model per actor

A.7.1 General

Meaning of attributes:

"R" means that the considered object or object functionality is required, e.g. exposed through the server capabilities of the host, independently of the fact that IEC 61850-7-4 stated its presence condition as Mandatory or Optional or Conditional (M/O/C).

NOTE The attribute "R" has no relationship with the attributes "M" (mandatory) or "O" (optional) used in the definitions of logical nodes in IEC 61850-7-4. It simply indicates that the object is needed to fulfil the function/application defined in the profile.

"Rc" means that the considered object or object functionality is functionally required, e.g. managed/got through the client capabilities of the host.

A.7.2 PTOC for blocked function (infeed bay)

Table A.1 gives a selection of data attributes for PTOC of actor blocked.

Table A.1 – Selection of data attributes for PTOC of actor blocked

LN	Data	CDC	Attributes	Values and Report Text	Description	FA	FB	MA	MB	TA	TB
PTOC											
	Mod	ENC (BehaviourModeKind)	stVal = Test/Test-Blocked/Blocked		Value for testing with IEC 61850 – supported						R
	Str	ACD	general q t	True False	Pickup – for reporting of the non blocking state of the protection function. Quality (validity, test) Timestamp		R				
	Op	ACT	general q t	True False	Operate Quality (validity, test) Timestamp		R		R		
	Blk	SPS	stVal q t	True False	Blocked – for reporting of the blocking state of the protection function Quality (validity, test) Timestamp				R		
	OpDlTmms	ING	setVal	100 ms, 1 s	Operate delay time millisecond		R				
	BlkRef1	ORG	setSrcRef		Reference of the first blocking input reference (Reference of pickup of the first feeder)		R				
	BlkRef2	ORG	setSrcRef		Reference of the second blocking input reference (Reference of pickup of the second feeder)		R				
	BlkRefn	ORG	setSrcRef		Reference of the nth blocking input reference (Reference of pickup of the nth feeder)		R				

NOTE In the infeed bay the information connected to BlkRef1…n is "OR-ed" (as long as the quality "q" is marked as "valid") to generate the blocking state (visible via Blk) of the overcurrent protection function PTOC.

A.7.3 PTOC for blocking function 1 to n (outflow bay(s))

Table A.2 gives a selection of data attributes for PTOC of actor blocking.

Table A.2 – Selection of data attributes for PTOC of actor blocking

LN	Data	CDC	Attributes	Values and Report Text	Description	FA	FB	MA	MB	TA	TB
PTOC											
	Mod	ENC (Behaviour ModeKind)	stVal = Test/Test-Blocked/Blocked		Value for testing with IEC 61850 – supported						R
	Str	ACD	general q t	True False	Pickup – for blocking the infeed bay Quality (validity, test) Timestamp (for reporting only)		R				
	Op	ACT	general q t	True False	Operate Quality (validity, test) Timestamp (for reporting only)		R		R		
	OpDlTmms	ING	setVal	100ms	Operate delay time millisecond		R				

A.7.4 Monitoring

Table A.3 gives a selection of data attributes of PTOC for monitoring.

Table A.3 – Selection of data attributes of PTOC for monitoring

LN	Data	CDC	Attributes	Values and Report Text	Description	FA	FB	MA	MB	TA	TB
PTOC											
	Mod	ENC (Behaviour ModeKind)	stVal = Test/Test-Blocked/ Blocked		Value for testing with IEC 61850 – supported						Rc
	Str	ACD	general q t	True False	Pickup – for reporting of the non blocking state of the protection function. Quality (validity, test) Timestamp				Rc		Rc
	Op	ACT	general q t	True False	Operate Quality (validity, test) Timestamp				Rc		Rc

LN	Data	CDC	Attributes	Values and Report Text	Description	FA	FB	MA	MB	TA	TB
PTOC											
	Blk	SPS	stVal q t	True False	Blocked – for reporting of the blocking state of the protection function Quality (validity, test) Timestamp				Rc		Rc

NOTE RC means required as client capability.

A.8 Communication services

To achieve a fast and reliable blocking – even in burst situations – the blocking signals shall be sent via GOOSE services.

Every outflow bay sends the pickup signal (Str) to dynamically block the infeed bay overcurrent protection function (PTOC) by connecting to an instance of BlkRef .

Each outflow bay shall have a GOOSE control block with a data set referring to the pickup signals generated by the LN PTOC (Selection of data model in Table A.2).

In case monitoring for reverse blocking is used, the infeed bay device and all outflow bay devices shall have a report control block with a data set referring to the data attributes used for monitoring as shown in A.7.4.

A.9 Device related requirements (conditional) – Test behaviour

- Outflow bay 1 or n in test mode, infeed bay not in test mode

  Incoming blocking signals with quality "test" shall not lead to a blocked status of the infeed PTOC1.
- Outflow bay 1 or n in test mode and infeed bay in test mode

  Incoming blocking signals with quality "test" shall lead to a blocked status of the infeed PTOC1.
- Outflow bay 1 or n not in test mode, infeed bay in test mode

  Incoming blocking signals with quality "test" NOT set shall lead to a blocked status of the infeed PTOC1.

  NOTE This is not recommended, because, depending on the test conditions, the bus bar might not be protected.

A.10 Engineering tool related requirements

There are no particular descriptions for this item.

A.11 Naming rules

There are no particular descriptions for this item.

A.12 Capabilities for testing

Under consideration by the IEC Taskforce on Functional testing.

Annex B
(informative)

Example for BAP of "condition monitoring diagnosis functions of on-load tap changer" using BAP template

B.1 Functional description

Condition monitoring diagnosis (CMD) function of an on-load tap changer (LTC) consists of the following five sub-functions.

- Monitoring LTC operation properties
- Monitoring LTC operation counts
- Monitoring contact abrasion
- Monitoring LTC oil temperature and flow
- Monitoring operation of oil filter unit

An LTC is a device for changing the tap of a winding while the transformer is energized or on load. The features are as follows:

- Changing the tap while the transformer is on load.
- Required for long lifetime although some parts such as contacts are consumed due to many operations.
- Cooperation with the transformer in the case of power system fault or overload.

The structure of an LTC is shown in Figure B.1.

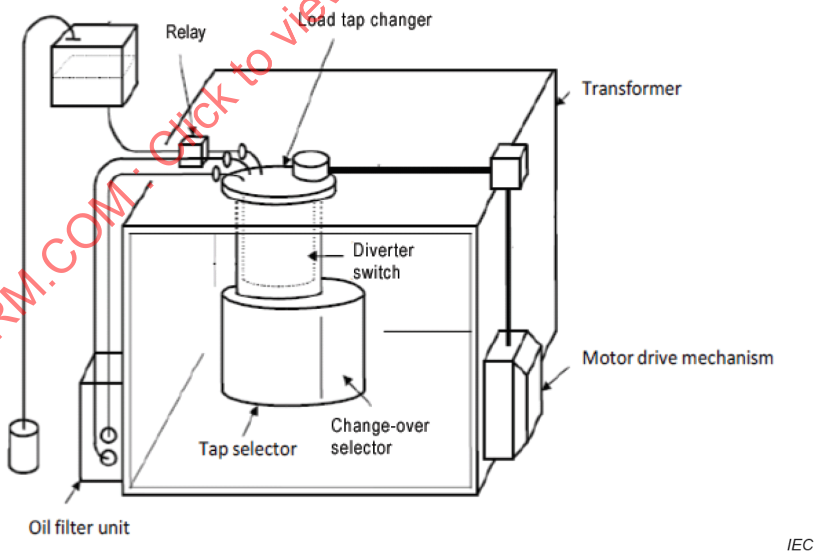


Figure B.1 – Structure of LTC

NOTE Detailed descriptions such as overview of LTC, CMD functions of LTC is stipulated in IEC TR 61850-90-3.

In this BAP, a system configuration for the LTC CMD is assumed as depicted in Figure B.2.

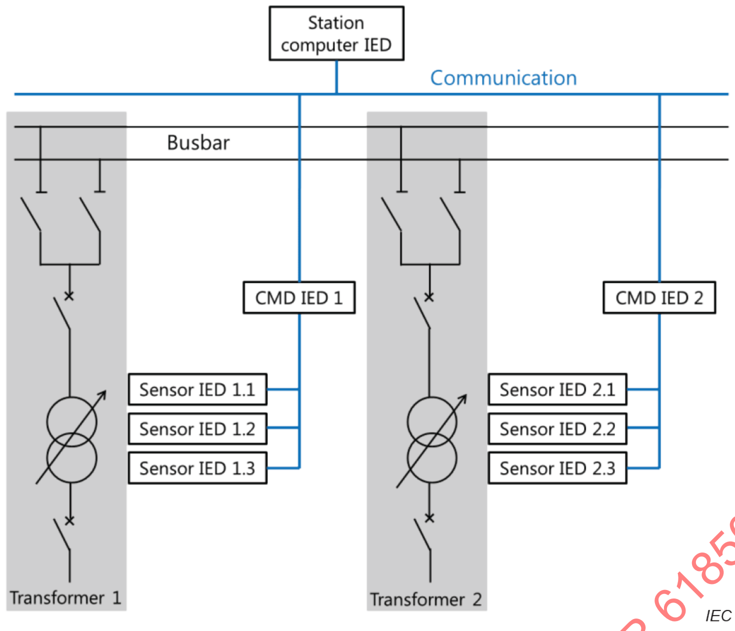


Figure B.2 – Overview of system configuration of LTC condition monitoring

The sensor IED measures various information from a target equipment, and sends signals to a CMD IED.

The CMD IED stores data according to time sequence and processes several data from sensors to new data such as percentage of contact abrasion. Also, the CMD IED judges whether data is within the normal range or not.

The station computer IED exchanges data with the CMD database or other computers via WAN.

The typical monitoring system configuration of the LTC CMD is shown in Figure B.3. This document covers communication between the functions implemented in the devices shown within a dashed line box.

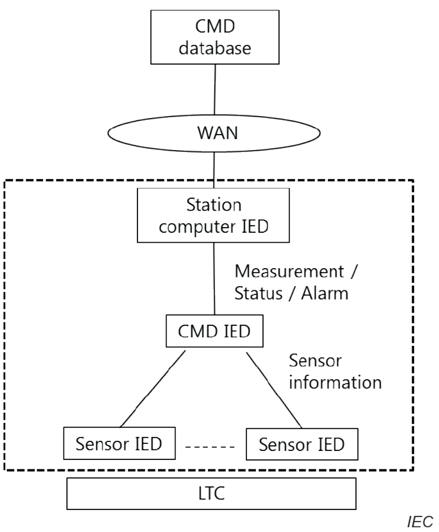


Figure B.3 – Typical system configuration of LTC condition monitoring system

B.2 Description of use case and associated roles/actors

B.2.1 List of roles / actors

Table B.1 provides a list of roles / actors for the function condition monitoring diagnosis functions of on-load tap changer

Table B.1 – List of actors

Name	Role description
Motor-driving current sensor	Measure the motor driving current.
Torque sensor	Measure the drive torque.
Tap position sensor	Indicate tap position of LTC.
LTC operation signal sensor	Detect start/end time of LTC operation.
Load current sensor	It measures load current.
LTC oil temperature sensor	It measures temperature of LTC oil.
Transformer oil temperature sensor	It measures temperature of transformer oil.
LTC oil flow relay	It detects LTC oil flow relay operation caused by gas produced by arc discharge.
OFU (Oil Filter Unit) operation signal sensor	It detects start/end time of OFU operation.
Equipment supervision	Supervise status of target equipment.
Maintenance planning support	Support planning maintenance work.
Configuration management	Manage specifications and histories of target equipment.

NOTE Detailed actors and the role of the LTC are stipulated in IEC TR 61850-90-3.

B.2.2 Use case

Five elementary use cases are shown in Figure B.4.

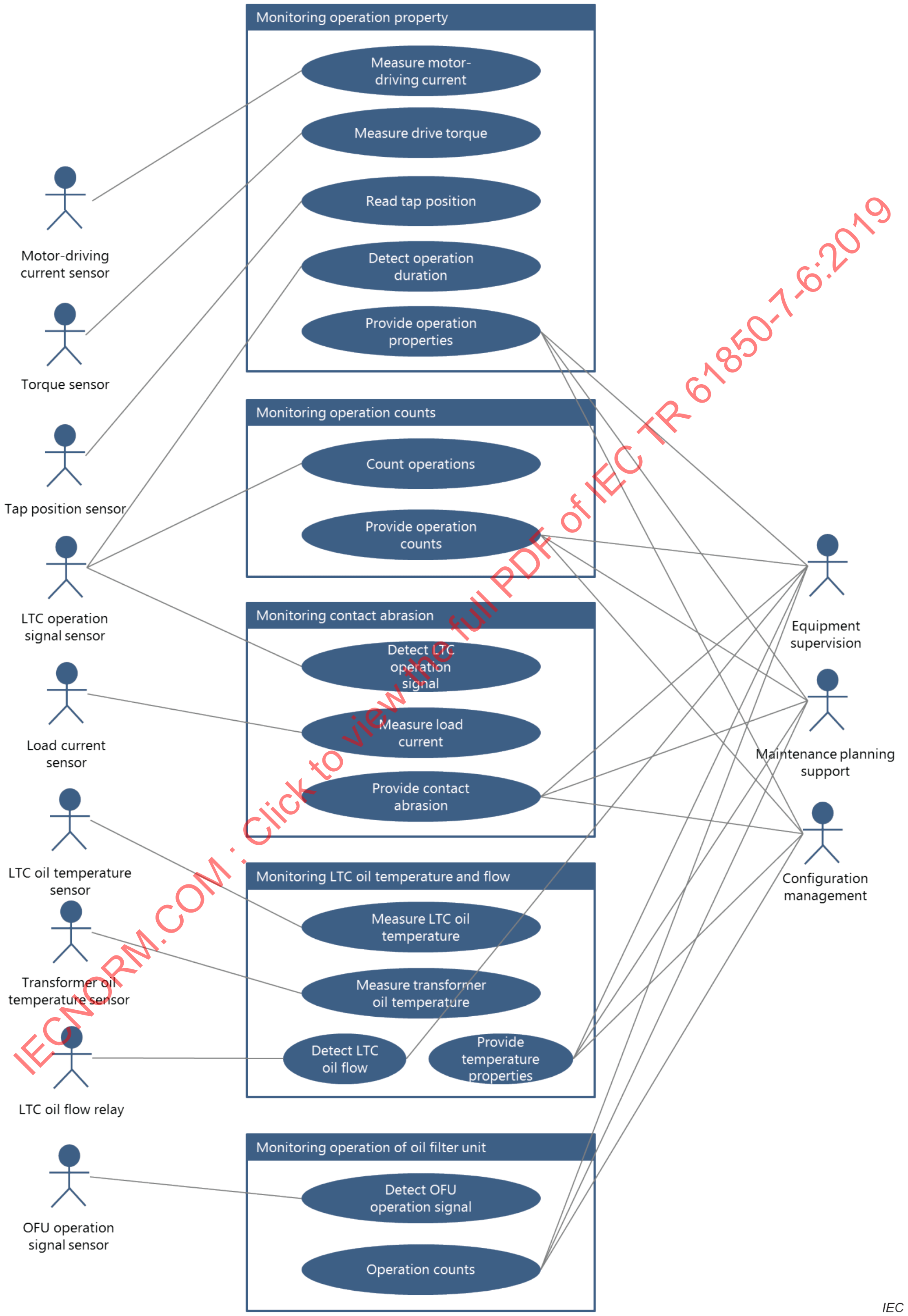


Figure B.4 – Use cases

NOTE Detailed use cases, basic flow and data model of LTC are stipulated in IEC TR 61850-90-3.

B.2.3 Sequence diagram of typical interactions

B.2.3.1 General

This subclause describes a sequence diagram with all signals exchanged between the associated roles/actors for each of the five elementary use cases. Applied logical nodes and data for each signal in a sequence diagram are shown in Clause B.7.

NOTE All the following sequence diagrams are based on use cases band basic flow stipulated in IEC TR 61850-90-3.

B.2.3.2 Monitoring operation property

Figure B.5 shows the typical sequence diagram for monitoring operation property.

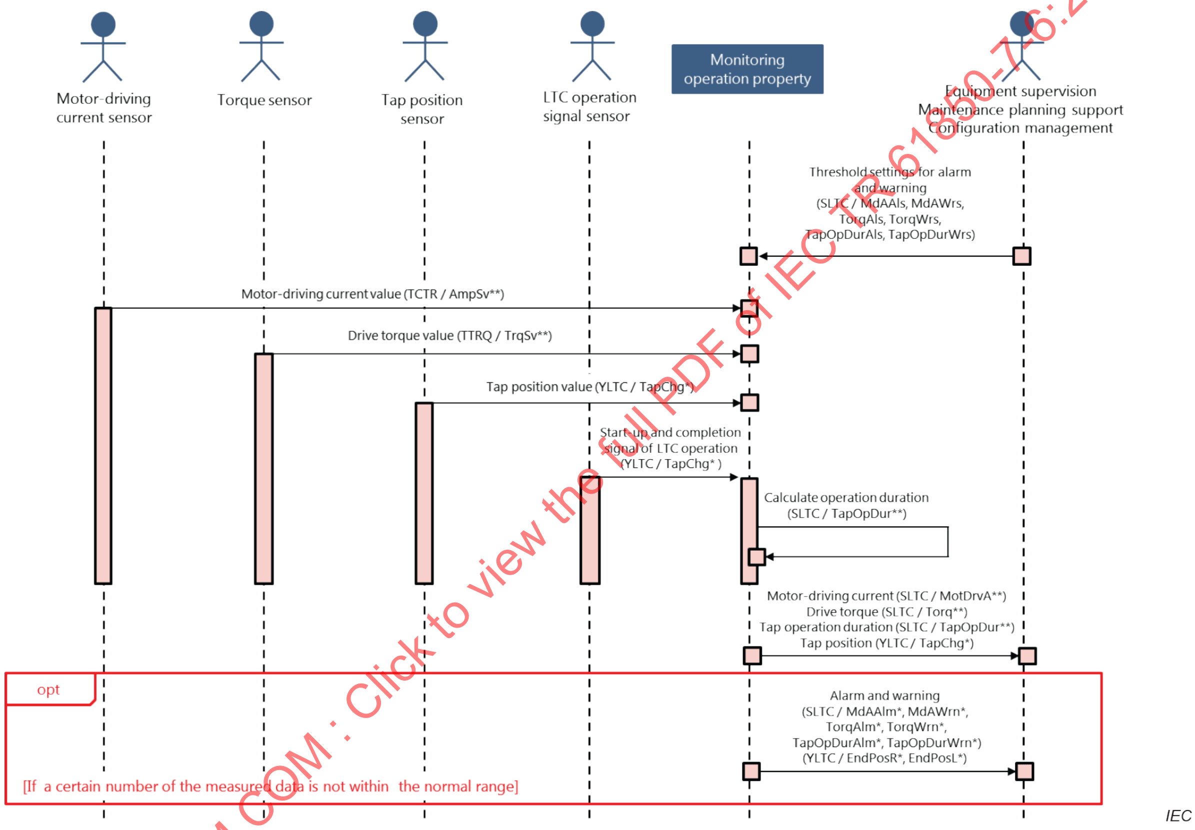


Figure B.5 – Sequence diagram for monitoring operation property

NOTE *shows event driven communication
** shows cyclic/periodic communication

B.2.3.3 Monitoring operation counts

Figure B.6 shows the typical sequence diagram for monitoring operation counts.

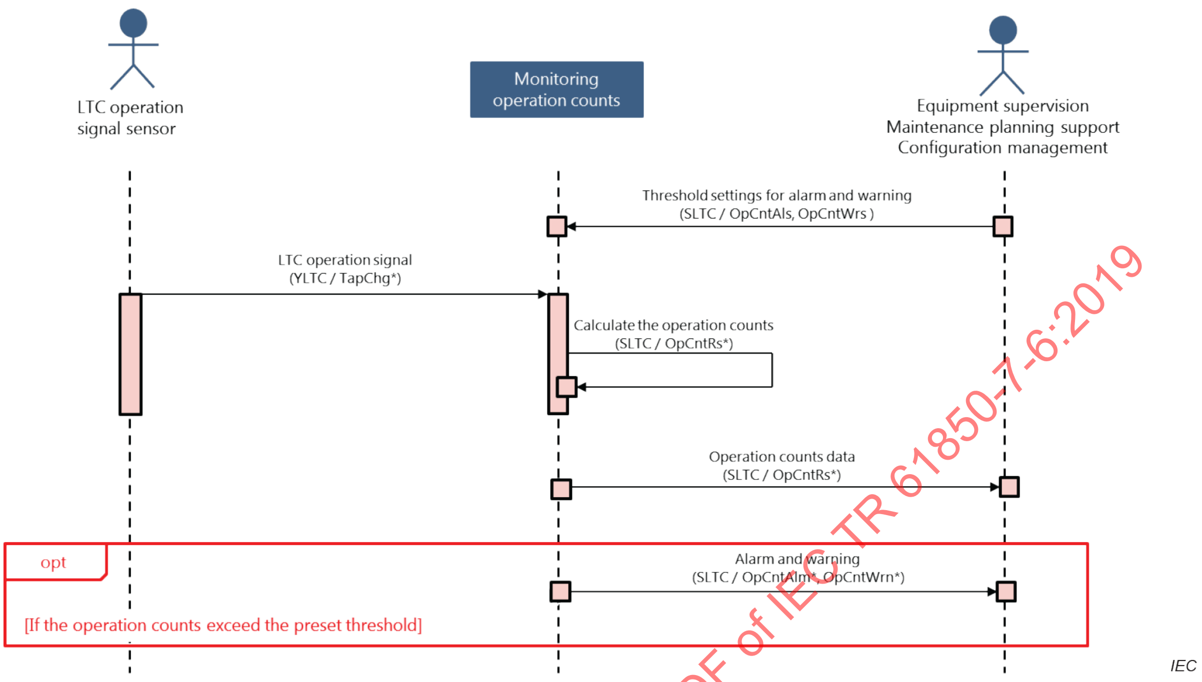


Figure B.6 – Sequence diagram for monitoring operation counts

B.2.3.4 Monitoring contact abrasion

Figure B.7 shows the typical sequence diagram for monitoring contact abrasion.

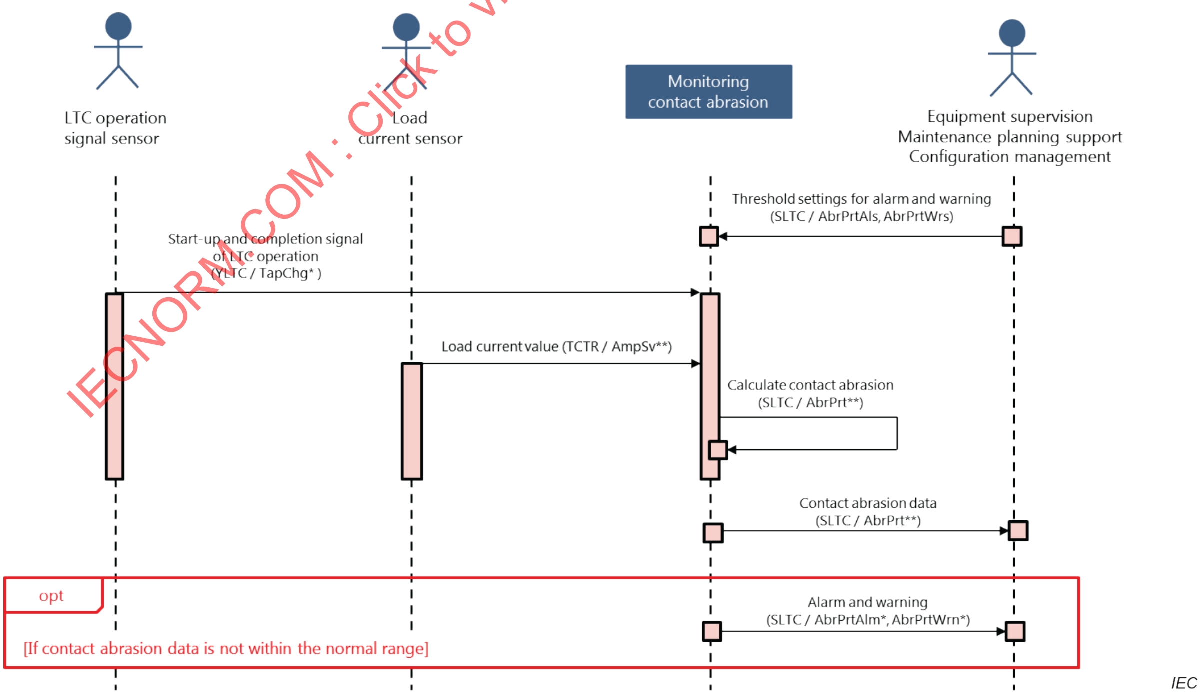


Figure B.7 – Sequence diagram for monitoring contact abrasion

B.2.3.5 Monitoring LTC oil temperature and flow

Figure B.8 shows the typical sequence diagram for monitoring oil temperature and flow.

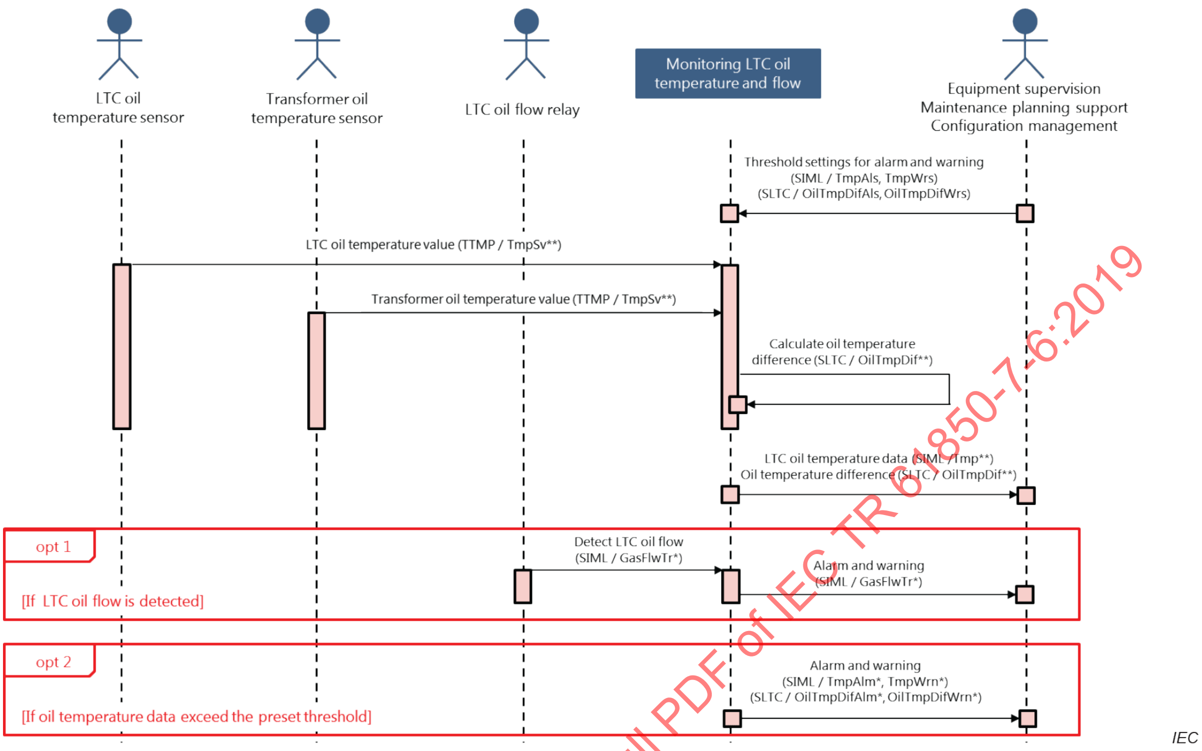


Figure B.8 – Sequence diagram for monitoring oil temperature and flow

B.2.3.6 Monitoring operation of oil filter unit

Figure B.9 shows the typical sequence diagram for monitoring operation of the oil filter unit.

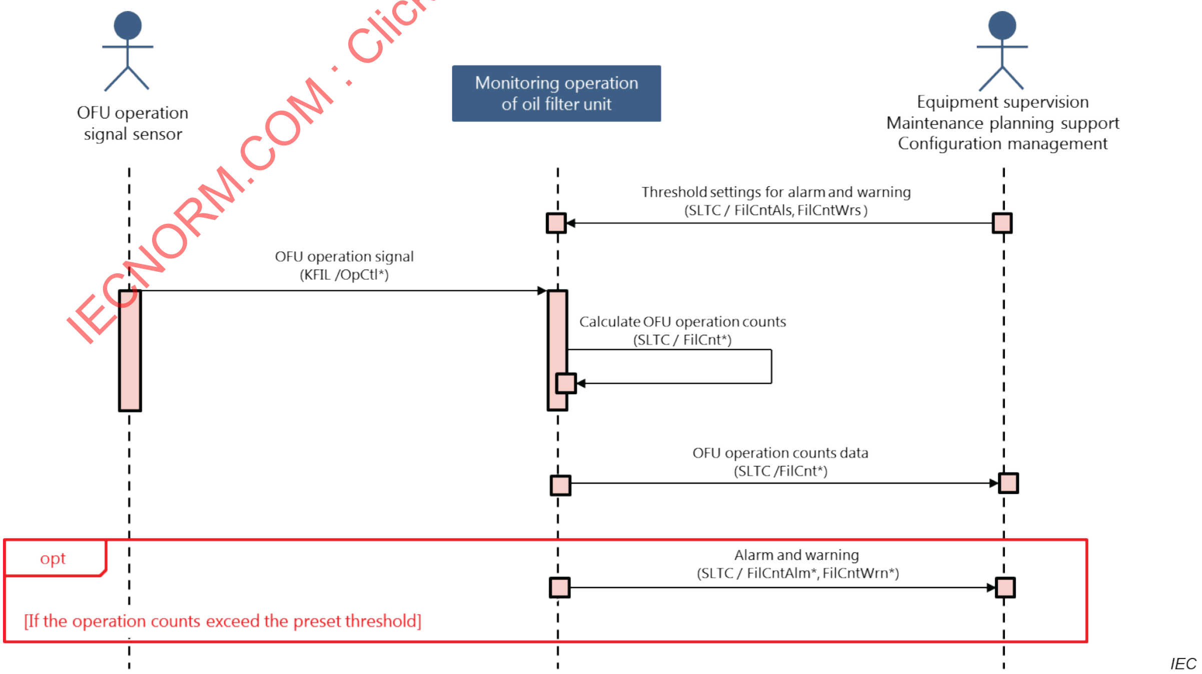


Figure B.9 – Sequence diagram for monitoring operation of oil filter unit

B.3 Logical Architecture

B.3.1 Overview

Figure B.10 provides the architecture of logical nodes. The solid arrow in the figure indicates real time data communication of LTC CMD functions and the dotted line arrow indicates non real time data communication.

The alternate long and short dashed line indicates data communication related to control of YLTC, which is out of scope of this Annex.

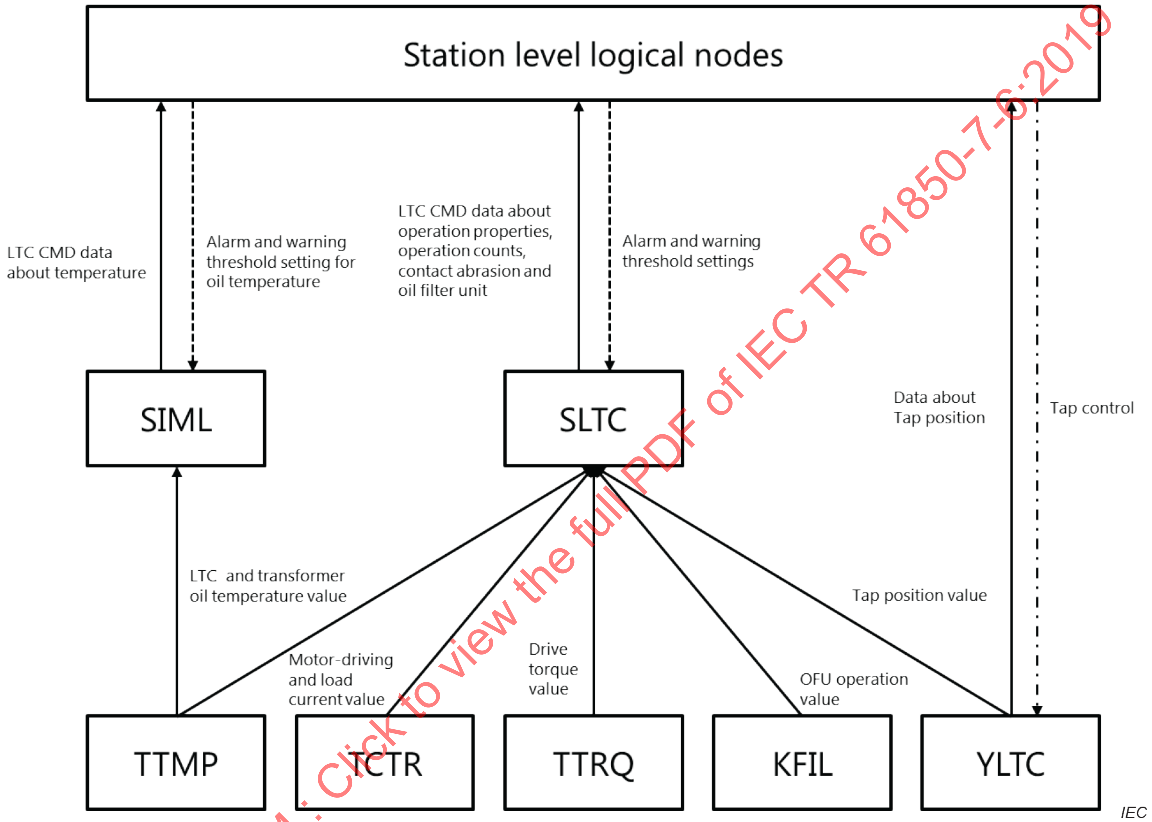


Figure B.10 – Logical architecture

Figures B.11 to B.15 describe logical node architectures with all signals exchanged between the associated logical nodes for each of the five elementary use cases.

B.3.2 Monitoring operation property

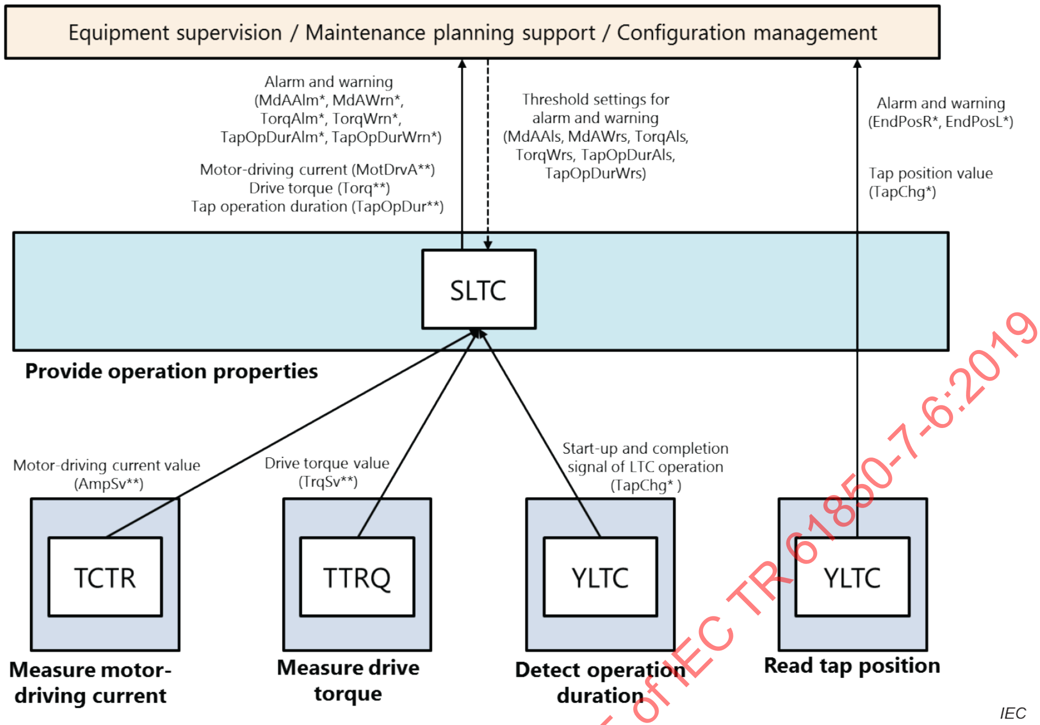


Figure B.11 – Logical architecture for monitoring operation property

NOTE * shows event driven communication
** shows cyclic/periodic communication

B.3.3 Monitoring operation counts

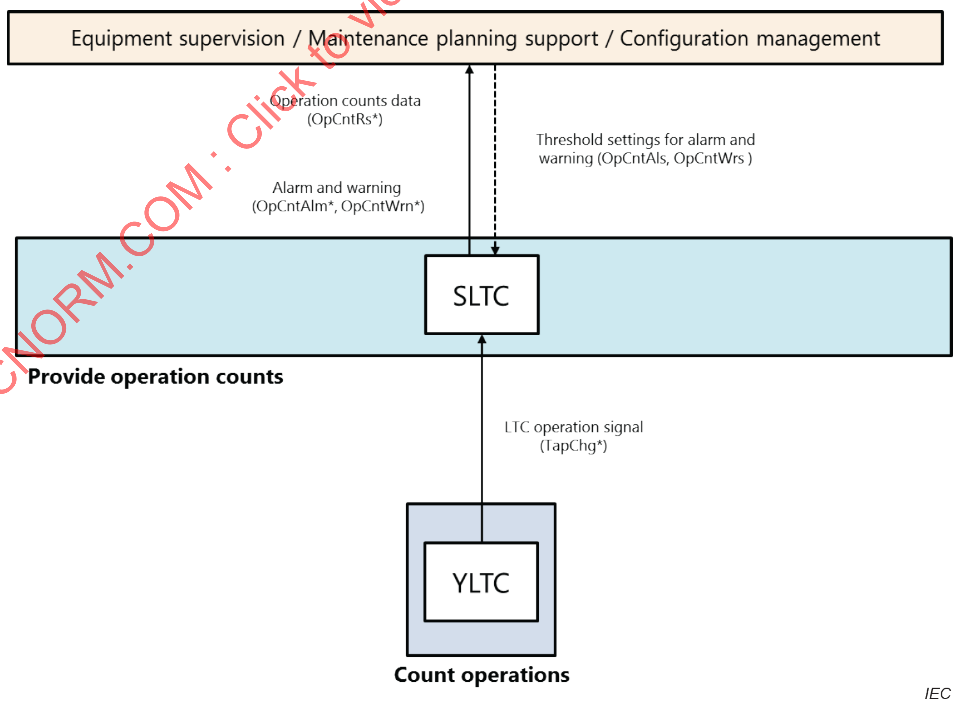


Figure B.12 – Logical architecture for monitoring operation counts

NOTE * shows event driven communication
** shows cyclic/periodic communication

B.3.4 Monitoring contact abrasion

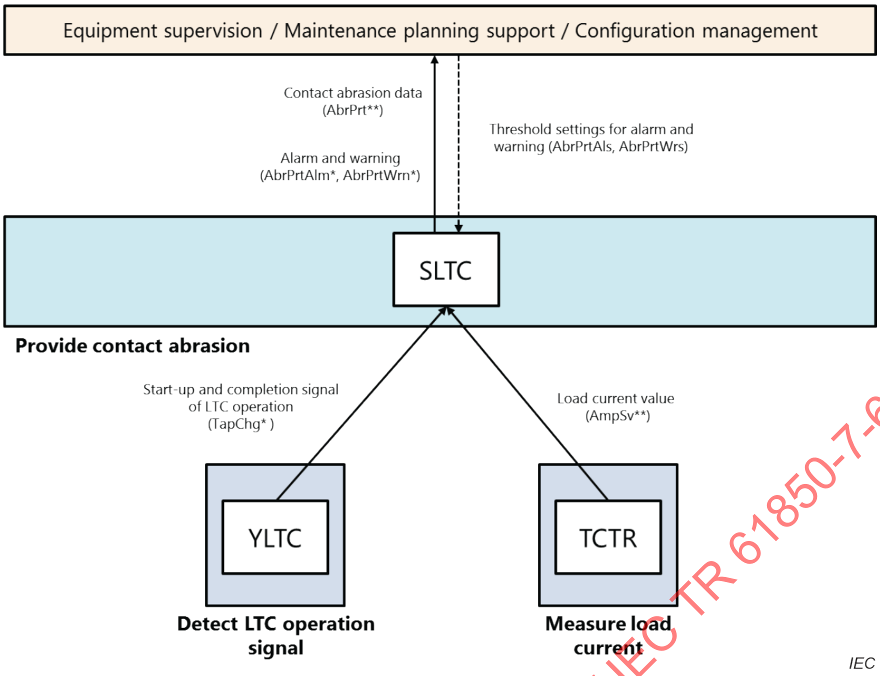


Figure B.13 – Logical architecture for monitoring contact abrasion

NOTE * shows event driven communication
** shows cyclic/periodic communication

B.3.5 Monitoring LTC oil temperature and flow

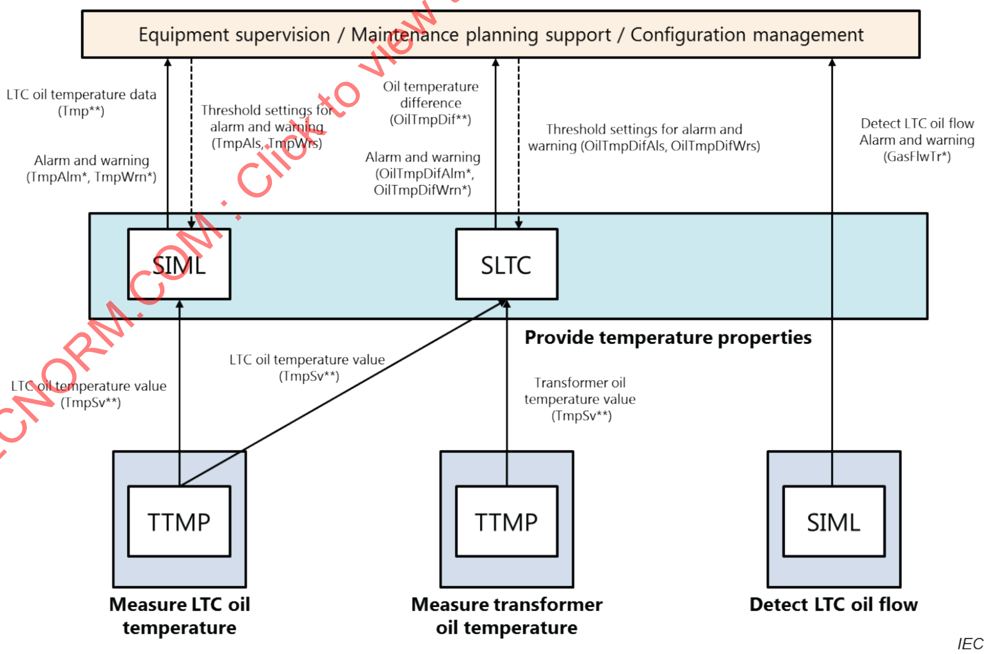


Figure B.14 – Logical architecture for monitoring LTC oil temperature and flow

NOTE * shows event driven communication
** shows cyclic/periodic communication

B.3.6 Monitoring operation of oil filter unit

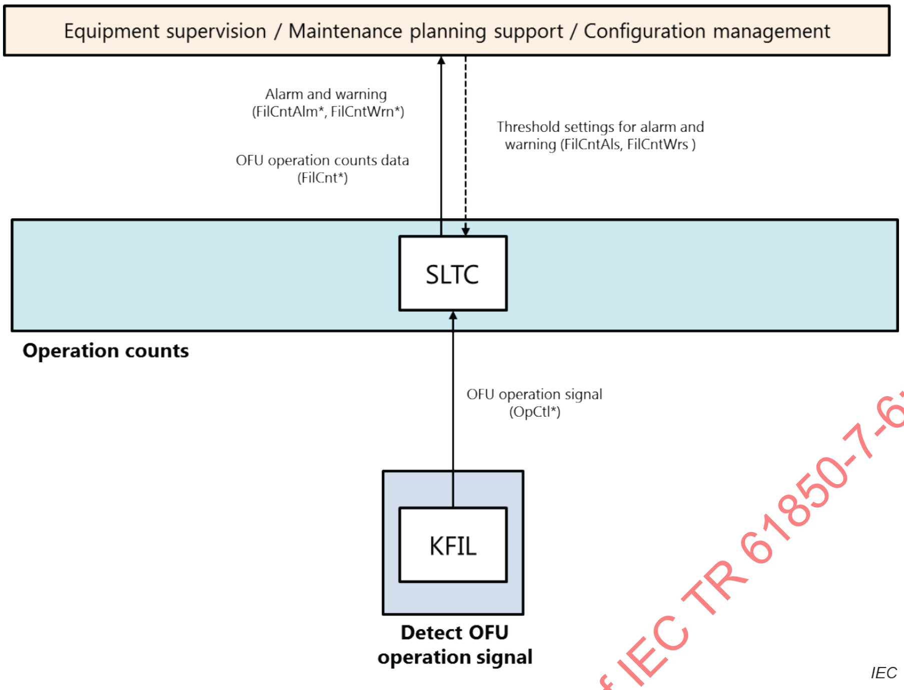


Figure B.15 – Logical architecture for monitoring operation of oil filter unit

NOTE * shows event driven communication
** shows cyclic/periodic communication

B.4 Allocation variants (conditional)

There are no particular descriptions for this item.

B.5 Functional variants

There are no particular descriptions for this item.

B.6 Performance requirements

B.6.1 Functional related

This is a monitoring function which does not require high speed performance, different from protective functions. Also, tap operation time of LTC is several tens of seconds. Therefore, approximately one to two seconds' response performance is generally required related to information on measurements, status and alarms.

B.6.2 Service related

With regard to communication performance, the following performance classes stipulated in IEC 61850-5 are applied:

- Measurements, status and alarms: Type 3, P5/TT2 or P6/TT1 Class
- Sampled Value: Type 4, P8/TT5 Class

B.7 Description of data model per actor

B.7.1 General

Meaning of attributes:

"R" means that the considered object or object functionality is required, e.g. exposed through the server capabilities of the host, independently from the fact that IEC 61850-7-4 stated its presence condition as Mandatory or Optional or Conditional (M/O/C).

NOTE The attribute “R” has no relationship with the attributes “M” (mandatory) or “O” (optional) used in the definitions of Logical nodes in IEC 61850-7-4. It simply indicates that the object is needed to fulfil the function/application defined in the profile.

“Rc” means that the considered object or object functionality is functionally required, e.g. managed/got through the client capabilities of the host.

B.7.2 SLTC

Table B.2 shows a selection of data attributes of SLTC.

Table B.2 – Selection of data attributes of SLTC

Data	CDC	Attributes	Values	Description	R/Rc
Status information					
AbrPrtAlm	SPS	stVal q t	True False	If true, the predefined level alarm limit AbrPrtAls for the abrasion of parts has been reached.	R
AbrPrtWrn	SPS	stVal q t	True False	If true, the predefined level warning limit AbrPrtWrs for the abrasion of parts has been reached.	R
FilCnt	INS	stVal q t	int32	Oil filtration counter	R
FilCntAlm	SPS	stVal q t	True False	If true, the predefined level alarm limit FilCntAls for the oil filtration counter has been reached.	R
FilCntWrn	SPS	stVal q t	True False	If true, the predefined level warning limit FilCntWrs for the oil filtration counter has been reached.	R
MdAAlm	SPS	stVal q t	True False	If true, the predefined level alarm limit MdAAls for the motor drive current has been reached.	R

Data	CDC	Attributes	Values	Description	R/Rc
Status information					
MdAWrn	SPS	stVal q t	True False	If true, the predefined level warning limit MdAWrs for the motor drive current has been reached.	R
OilTmpDifAlm	SPS	stVal q t	True False	If true, the predefined level alarm limit OilTmpDifAls for the oil temperature difference has been reached.	R
OilTmpDifWrn	SPS	stVal q t	True False	If true, the predefined level warning limit OilTmpDifWrs for the oil temperature difference has been reached.	R
OpCntAlm	SPS	stVal q t	True False	If true, the predefined level alarm limit OpCntAls for the LTC operations has been reached.	R
OpCntWrn	SPS	stVal q t	True False	If true, the predefined level warning limit OpCntWrs for the LTC operations has been reached.	R
TapOpDurAlm	SPS	stVal q t	True False	If true, the tap change operation duration has exceeded the threshold defined in TapOpDurAls	R
TapOpDurWrn	SPS	stVal q t	True False	If true, the tap change operation duration has exceeded the warning threshold defined in TapOpDurWrs	R
TorqAlm	SPS	stVal q t	True False	If true, the predefined level alarm limit TorqAls for the drive torque has been reached.	R
TorqWrn	SPS	stVal q t	True False	If true, the predefined level warning limit TorqWrs for the drive torque has been reached.	R
Measured and metered values					
MotDrvA	MV	mag q t	Analogue Value	Motor drive current	R

Data	CDC	Attributes	Values	Description	R/Rc
Status information					
Torq	MV	mag q t	Analogue Value	Drive torque	R
AbrPrt	MV	mag q t	Analogue Value	Abrasion (in %) of parts subject to wear	R
OilTmpDif	MV	mag q t	Analogue Value	Oil temperature difference between LTC oil and transformer oil (in °C)	R
TapOpDur	MV	mag q t	Analogue Value	Duration of the latest tap change operation (in s)	R
Controls					
OpCntRs	INC	stVal q t	int32	Resettable operation counter Note: It is classified as "Controls", but only status information data is used.	R
Settings					
AbrPrtAls	ASG	setMag	Analogue Value	Abrasion of parts (in %) threshold setting for alarm	R
AbrPrtWrs	ASG	setMag	Analogue Value	Abrasion of parts (in %) threshold setting for warning	R
FilCntAls	ING	setVal	int32	Oil filtration counts threshold setting for alarm	R
FilCntWrs	ING	setVal	int32	Oil filtration counts threshold setting for warning	R
MdAAls	ASG	setMag	Analogue Value	Motor drive currant alarm threshold setting	R
MdAWrs	ASG	setMag	Analogue Value	Motor drive current threshold setting for warning	R
OilTmpDifAls	ASG	setMag	Analogue Value	Oil temperature difference threshold setting for alarm (in °C)	R
OilTmpDifWrs	ASG	setMag	Analogue Value	Oil temperature difference threshold setting for warning (in °C)	R
OpCntAls	ING	setVal	int32	LTC operation counts threshold setting for alarm	R
OpCntWrs	ING	setVal	int32	LTC operation counts threshold setting for warning	R
TapOpDurAls	ASG	setMag	Analogue Value	Threshold for the tap change operation duration alarm	R
TapOpDurWrs	ASG	setMag	Analogue Value	Threshold for the tap change operation duration warning	R
TorqAls	ASG	setMag	Analogue Value	Drive torque threshold setting for alarm	R
TorqWrs	ASG	setMag	Analogue Value	Drive torque threshold setting for warning	R

B.7.3 YLTC

Table B.3 shows a selection of data attributes of YLTC.

Table B.3 – Selection of data attributes of YLTC

Data	CDC	Attributes	Values	Description	R/Rc
Status information					
TapChg	BSC	valWTr q t	ValWithTrans	Tap position NOTE Though both TapPos and TapChg appear in IEC TR 61850-90-3, this BAP example uses TapChg.	R
EndPosR	SPS	stVal q t	True False	If true, end position raise or highest allowed tap position reached	R
EndPosL	SPS	stVal q t	True False	If true, end position lower or lowest allowed tap position reached	R

B.7.4 TTRQ

Table B.4 shows a selection of data attributes of TTRQ.

Table B.4 – Selection of data attributes of TTRQ

Data	CDC	Attributes	Values	Description	R/Rc
Measured and metered values					
TorqSv	SAV	instMag q	Analogue Value	Torque	R

B.7.5 TCTR

Table B.5 shows a selection of data attributes of TCTR.

Table B.5 – Selection of data attributes of TCTR

Data	CDC	Attributes	Values	Description	R/Rc
Measured and metered values					
AmpSv	SAV	instMag q	Analogue Value	Current	R

B.7.6 SIML

Table B.6 shows a selection of data attributes of SIML.

Table B.6 – Selection of data attributes of SIML

Data	CDC	Attributes	Values	Description	R/Rc
Status information					
TmpAlm	SPS	stVal q t	True False	If true, the predefined level alarm limit TmpAls for the Insulation liquid temperature has been reached.	R
TmpWrn	SPS	stVal q t	True False	If true, the predefined level warning limit TmpWrs for the Insulation liquid temperature has been reached.	R
GasFlwTr	SPS	stVal q t	True False	Insulation liquid flow trip because of gas	R
Measured and metered values					
Tmp	MV	mag q t	Analogue Value	LTC oil temperature	R
Settings					
TmpAls	ASG	setMag	Analogue Value	Temperature alarm threshold setting (in °C)	R
TmpWrs	ASG	setMag	Analogue Value	Temperature warning threshold setting (in °C)	R

B.7.7 TTMP

Table B.7 shows a selection of data attributes of TTMP.

Table B.7 – Selection of data attributes of TTMP

Data	CDC	Attributes	Values	Description	R/Rc
Measured and metered values					
TmpSv	SAV	instMag q	Analogue Value	Temperature	R

B.7.8 KFIL

Table B.8 shows a selection of data attributes of KFIL.

Table B.8 – Selection of data attributes of KFIL

Data	CDC	Attributes	Values	Description	R/Rc
Controls					
OpCtl	SPC	stVal q t	on (True) off (False)	Operate filter NOTE It is classified as “Controls”, but only status information data is used.(ctlModel = status-only)	R

B.8 Communication services

Depending on the signal, the following communication services stipulated in IEC 61850-7-2 are applied:

- Alarm, Status: RCB
- Measurement value: RCB
- Setting value: SGCB
- Instantaneous value: SVCB

B.9 Device related requirements (conditional)

There are no particular descriptions for this item.

B.10 Engineering tool related requirements

There are no particular descriptions for this item.

B.11 Naming rules

There are no particular descriptions for this item

B.12 Capabilities for testing

Under consideration by the IEC Taskforce on Functional testing.

Annex C
(informative)

Example for BAP of protection function "line distance protection" using BAP template

C.1 Functional description

The line distance protection function is an impedance type protection function for feeders. Basically, the impedance calculated by the protection function based on the acquired voltage and current measurements is compared to a zone in the impedance diagram depending on the setting of the protection function. A fault is detected when the impedance enters the setting zone. The protection function the issues a tripping command for the breaker. This trip command can be delayed depending on the zone.

As this function has to evaluate impedances, it needs to acquire line voltage and current.

A distance protection usually has several identified "zones", corresponding to an area in the impedance diagram (e.g. 3 zone distance protection function).

Depending on the line topology and characteristic a distance protection function can be associated to a tele-protection scheme using permissive or blocking commands.

The line protection function also issues a start signal to the fault recorder in order to obtain COMTRADE files of the event for post mortem analyses.

C.2 Description of use case and associated roles/actors

C.2.1 List of roles / actors

- CT and VT
- Circuit breaker
- Tele-protection
- Remote/local SCADA
- Auto recloser
- Configuration engineer
- Distance protection function (of other feeders or of the other end of the line)
- Fault recorder

C.2.2 Use case

Figure C.1 shows the typical use case of function distance protection.

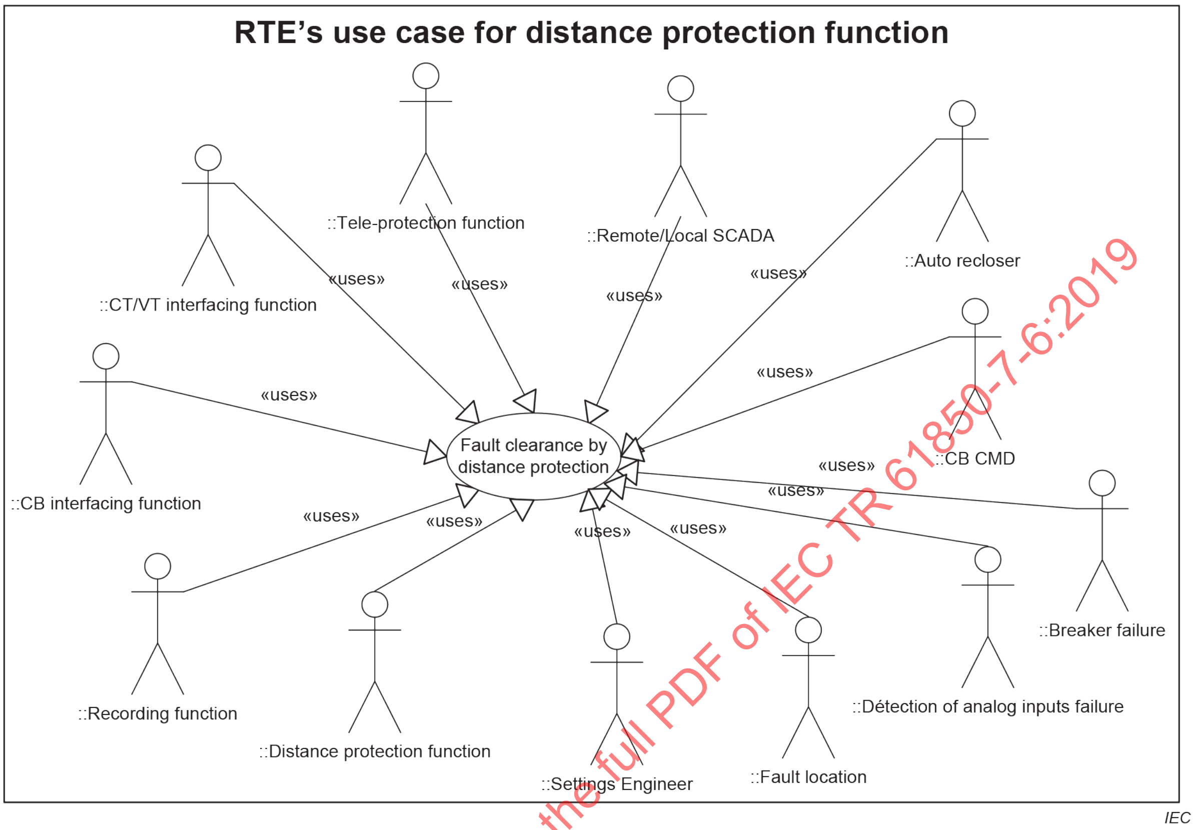


Figure C.1 – Use case distance protection

C.2.3 Sequence diagram of typical interactions

Figure C.2 shows the typical sequence diagram of function distance protection.

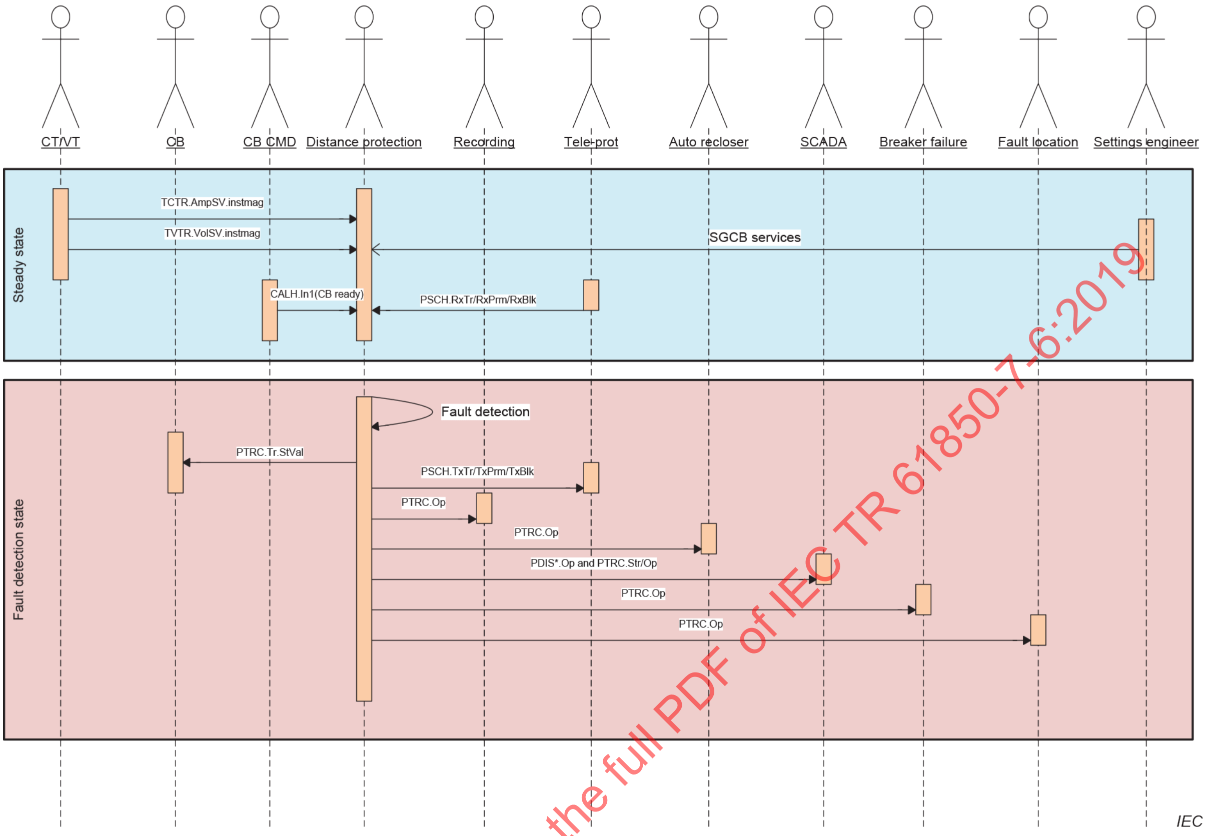


Figure C.2 – Sequence diagram distance protection

C.3 Logical architecture

Figure C.3 shows the distance protection logical architecture.

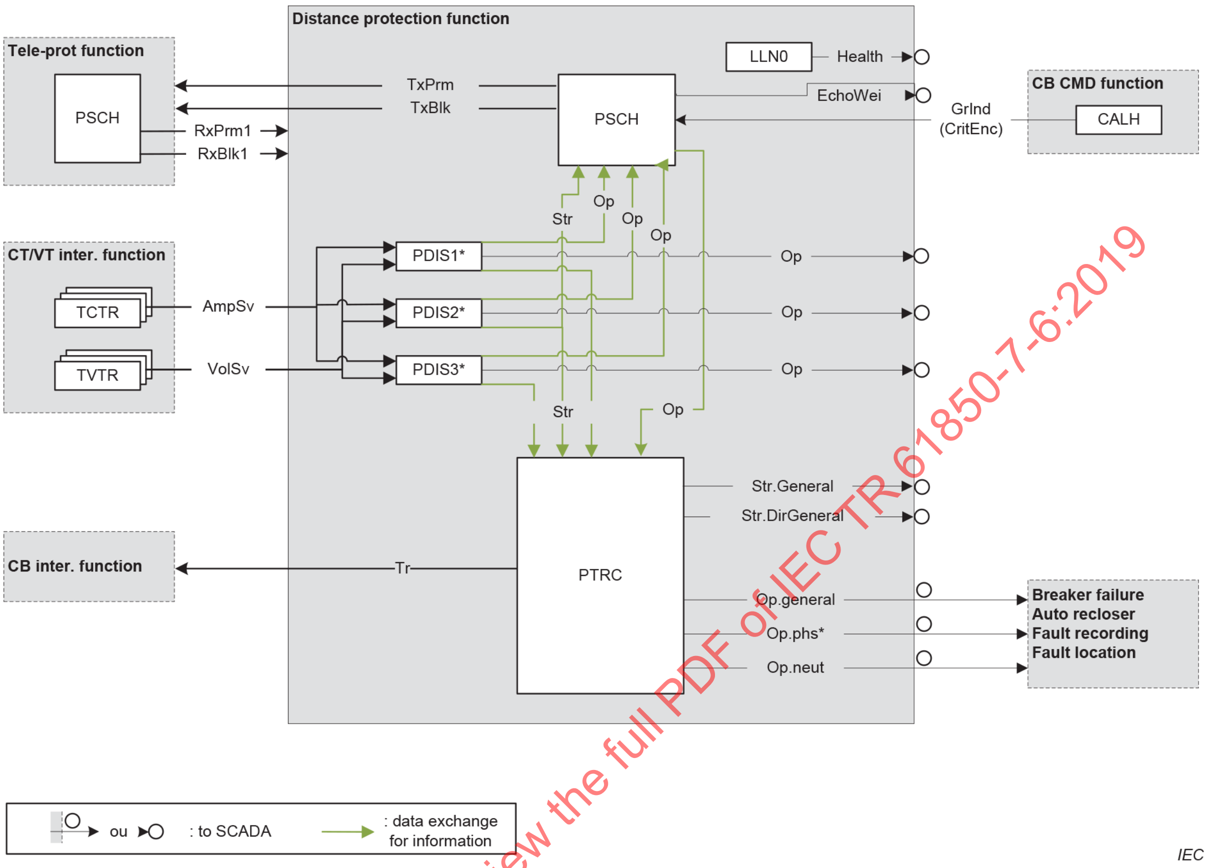


Figure C.3 – Logical architecture distance protection

C.4 Allocation variants (conditional)

The logical architecture is a proposed IEC 61850 based model of a logical device "Line Distance Protection", also showing interactions with other logical devices. If all LNs and associated application functions are implemented just in one single IED, the displayed dataflow between LNs, inside the line distance protection function is just shown for clarification of the interactions.

C.5 Functional variants

C.5.1 Core functional variants

C.5.1.1 Variant FA:

The IED that hosts the distance protection function is not able to handle process bus connectivity. The IED is able to communicate to a Local/remote SCADA or gateway device. CT/VT values and trip can be wired.

C.5.1.2 Variant FB:

Additional to the ability to communicate with a local/remote SCADA or gateway the IED that hosts the distance protection function is able to handle process bus (SV and trip GOOSE).

Equipment can be configured through IEC 61850 (e.g. zone associated tripping delay). The communication with CT/VT and circuit breaker uses the services of the process bus (SV and GOOSE).

C.5.2 Noncore functional variants (different features for testing)

C.5.2.1 Variant TPA:

No tele-protection scheme associated

C.5.2.2 Variant TPB:

Tele-protection scheme allowing blocking reception and emission

C.5.2.3 Variant TPC:

Tele-protection scheme allowing permissive reception and emission (underreach)

C.5.2.4 Variant TPD:

Tele-protection scheme allowing permissive reception and emission (overreach)

C.5.2.5 Variant TA:

Test is not based on IEC 61850 features

C.5.2.6 Variant TB:

Test is based on IEC 61850 features

C.5.2.7 Variant SA:

Settings are not based on IEC 61850 (preconfigured)

C.5.2.8 Variant SB:

Settings use IEC 61850 based services

C.6 Performance requirements)

C.6.1 Functional related

The distance protection algorithm of PDIS shall be qualified according the user-dependent specification for distance protection.

C.6.2 Service related

The communication network used (both station and process bus) shall be redundant and resilient (e.g. hardened against packet storm). The transmission of measured values shall be done via SV service. The transmission of the trip command shall be done via GOOSE service.

The performance requirements for transmission delay are:

Protection to process: ≤ 2 ms (GOOSE)

Process to protection: ≤ 2 ms (GOOSE)

Protection to automatic functions (e.g. Autorecloser): ≤ 2 ms (GOOSE)

Protection and automatic functions to local SCADA: ≤ 50 ms

To manage the settings of the zone parameters the SGCB service shall be used.

C.7 Description of data model per actor

Meaning of attributes:

"R": means that the considered object or object functionality is functionally required, i.e. exposed through the server capabilities of the host, independently from the fact that IEC 61850-7-4 stated its presence condition as Mandatory or Optional or Conditional (M/O/C).

NOTE The attribute "R" has no relationship with the attributes "M" (mandatory) or "O" (optional) used in the definitions of Logical nodes in IEC 61850-7-4. It simply indicates that the object is needed to fulfil the function/application defined in the profile.

"Rc": means that the considered object or object functionality is functionally required, i.e. managed or read through the client capabilities of the host.

This method is the original one, based on "what is required for the application in the described LN (and associated DO) of IEC 61850-7-4", as shown in Table C.1.

Table C.1 – Description of data model

Distance Protection				Variants								Description
LN	**DO**	**CDC**	**Attributes**	**TPA**	**TPB**	**TPC**	**TPD**	**TA**	**TB**	**SA**	**SB**	
LLN0	Health	ENS	stVal q t	R	R	R	R	R	R	R	R	Distance protection supervision state for maintenance
	Mod	ENC	origin ctlNum stVal q t ctlModel sboTimeout sboClass operTimeout	R	R	R	R	R		R	R	Used to control Test features
	Beh	ENS	stVal q t	R	R	R	R	R		R	R	Supervision of Test mode
PDIS1*	Op	ACT	general phsA phsB phsC neut q t	R	R	R	R	R	R	R	R	Operate (Zone 1)
	Str	ACD	general dirGeneral q t	R	R	R	R	R	R	R	R	Start (Zone 1)

Distance Protection				Variants								Description
LN	**DO**	**CDC**	**Attributes**	**TPA**	**TPB**	**TPC**	**TPD**	**TA**	**TB**	**SA**	**SB**	
PDIS2*	Op	ACT	general phsA phsB phsC neut q t	R	R	R	R	R	R	R	R	Operate (Zone 2)
	Str	ACD	general dirGeneral q t	R	R	R	R	R	R	R	R	Start (Zone 2)
PDIS3*	Op	ACT	general phsA phsB phsC neut q t	R	R	R	R	R	R	R	R	Operate (Zone 3)
	Str	ACD	general dirGeneral q t	R	R	R	R	R	R	R	R	Start (Zone 3)
PSCH	EchoWei	SPS	stVal q t	R				R	R	R	R	Supervision of teleprotection connection state
	TxPrm	ACT	general q t	R	R			R	R	R	R	Teleprotection permissive signal
	RxPrm1	ACT	general q t	R	R			R	R	R	R	Activation information
	TxBlk	ACT	general q t	R		R	R	R	R	R	R	Teleprotection blocking signal
	RxBlk1	ACT	general q t	R		R	R	R	R	R	R	Activation information
	Op	ACT	general q t	R				R	R	R	R	Operate to Trip logic (in case of Permission reception)

Distance Protection				Variants								Description
LN	DO	CDC	Attributes	TPA	TPB	TPC	TPD	TA	TB	SA	SB	
PTRC	Op	ACT	general phsA phsB phsC neut q t	R	R	R		R	R	R	R	Reflect effective tripping information sent to the process
	Str	ACD	general dirGeneral q t	R	R	R		R	R	R	R	Start
	Tr	ACT	general phsA phsB phsC neut q t	R	R	R		R	R	R	R	Trip

C.8 Communication services

C.8.1 General

Depending on the main variant an IED which host the distance protection function has to support the following communication services, as shown in Tables C.2 and C.3:

C.8.2 Variant FA:

Table C.2 – Services for variant FA

	Non-core functional variants							
Service	TPA	TPB	TPC	TPD	TA	TB	SA	SB
MMS Server	X	X	X	X	X	X	X	X
GOOSE publisher	X	X	X	X	X	X	X	X
GOOSE subscriber		X	X	X				
SV subscriber								
SBCB							X	X

C.8.3 Variant FB:

Table C.3 – Services for variant FB

	Non-core functional variants							
Service	**TPA**	**TPB**	**TPC**	**TPD**	**TA**	**TB**	**SA**	**SB**
MMS Server	X	X	X	X	X	X	X	X
GOOSE publisher	X	X	X	X	X	X	X	X
GOOSE subscriber		X	X	X				
SV subscriber	X	X	X	X	X	X	X	X
SBCB							X	X

The transmission of measured values via process bus shall be done via SV service. The transmission of the trip command shall be done via GOOSE service.

C.9 Device related requirements (conditional)

C.9.1 Degraded operation behaviour

For each function (represented by a LD), the expected behaviour in degraded conditions shall be defined. For functions subscribing and using data published by other functions or coming from process-connected IED, this concerns in particular that the behaviour in case of non-nominal status of the quality attribute of the subscribed IEC 61850 DO. This also holds for the source information and for time synchronisation information.

Since the quality attribute has a number of detailed quality items, it is possible to differentiate the expected behaviour for each of them.

The expected behaviour can be summarized in a number of possible categories:

- to fall back to a default input value configured by the user with good quality
- to continue to use the last known input value with good quality
- to use the received input value and force its quality to good
- to do a dynamic blocking of the function (Blk=True)

Also, in some cases one might want the function to emit an alarm or to change the Quality Attribute of the DO it publishes.

Concerning the distance protection use case, Table C.4 for degraded operation behaviours is proposed.