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foreword

the national committee is K 952 "power system control" of the German Commission for Electrical, Electronic & Information Technologies of DIN and VDE (http://www.dke.de) responsible for this supplement. It contains the German translation of the International Technical Report IEC / TR 61850-1: 2003 standard.

In the event of an undated reference in the normative text (reference to a standard without specifying the date of issuance, with no reference to a section number, a table, an image, etc.), the reference refers to the latest valid edition of the referenced standard.

In the event a dated reference in the normative text, the reference always refers to the edition referred to the standard.

The relationship of the cited standards with the corresponding German standards arises, to the extent there is a relationship, basically on the number of the relevant IEC publication. Example: IEC 60068 is adopted as EN 60068 as a European Standard by CENELEC and incorporated into the German body of standards as DIN EN 60068th

Under the general title "communication networks and systems in substations" the standards of IEC 61850 include the following parts: Part

1 Introduction and Overview Part 2 Glossary Part 3 General requirements Part 4 system and project management

Chapter 5 Communication requirements for functions and device models

Part 6 language for the description of the configuration of the communication stations with intelligent electronic devices (IED)

Part 7-1 Basic communication structure for station- and feeder equipment - Principles and models

Part 7-2 Basic communication structure for station- and feeder equipment - Abstract Communication service interface (ACSI)

Part 7-3 Basic communication structure for station- and feeder equipment - Common data classes

Part 7-4 Basic communication structure for station- and feeder equipment - Compatible Logical node and data classes

Part 8-1 Specific Communication Service Mapping (SCSM) - pictures on MMS (ISO 9506-1 and ISO 9506-2) and ISO / IEC 8802-3

Part 9-1 Specific Communication Service Mapping (SCSM) - Sampled values over serial Simplex multiple point-to-point connection

Part 9-2 Specific Communication Service Mapping (SCSM) - Sampled values over ISO / IEC 8802-3

Part 10 conformity test

This document contains an introduction and overview of the standards of the DIN EN 61850. It describes the contents and basic approaches and of other documents that have been involved in the development of.

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1 Scope

This Technical Report applies to Substation Automation Systems (SAS). It defines the communication between intelligent electronic devices (IEDs) in the station and on related system requirements.

This part provides an introduction and an overview of the standards of IEC 61850. He refers to this, and includes text and images from them.

2 references

IEC 60870-5-103: 1997, *Telecontrol equipment and systems - Part 5: Telecontrol protocols - Section 103: Companion standard for the informative interface of protection equipment.*

IEC 61850-3, *Communication networks and systems in substations - Part 3: General requirements.*

IEC 61850-5, *Communication networks and systems in substations - Part 5: Communication requirements for functions and device models.*

IEC 61850-7-1, *Communication networks and systems in substations - Part 7-1: Basic communication structure for substation and feeder equipment - Principles and models.*

IEC 61850-7-2, *Communication networks and systems in substations - Part 7-2: Basic communication structure for substation and feeder equipment - Abstract communication service interface (ACSI).*

IEC 61850-7-3, *Communication networks and systems in substations - Part 7-3: Basic communication structure for substation and feeder equipment - Common data classes.*

IEC 61850-7-4, *Communication networks and systems in substations - Part 7-4: Basic communication structure for substation and feeder equipment - Compatible logical node classes and data classes.*

ISO 9001: 2001, *Quality management systems - Requirements.*

IEEE Std C37.2: 1996, *Electrical Power System Device Function Numbers and Contact Designations.*

IEEE 100: 1996, *IEEE Standard Dictionary of Electrical and Electronics Terms.*

IEEE-SA TR 1550: 1999, *Utility Communications Architecture (UCA) Version 2.0 - Part 4: UCA Generic Object Models for Substation and Feeder Equipment (GOMSFE).*

3 Definitions and Abbreviations

3.1 terms

For the application of the Technical Report, the following definitions apply.

3.1.1
Abstract Communication Service Interface ACSI

a virtual interface IEDs which provides abstract communication services that are independent of the actual protocol stack and the profiles used, for example, services for connecting, variable access, unacknowledged data transfer, device control and file transfer

3.1.2
Field (s: bay)
a station composed of tightly interconnected parts with a common functionality. Examples are the switches between an infeed or an outgoing line and the busbar,

the coupling with their associated circuit breakers and disconnectors and grounding switches or the transformer with its associated switches between the two busbars, which represent the two voltage levels. The field concept can be applied to 1½-breaker and ring busbar arrangements by the circuit breakers and associated equipment are combined into a virtual field. These fields represent a subset of the high-voltage system is that needs to be protected, such as a transformer or the end of a line, and the control of its switch is subject to some constraints such as joint mutual locking or precisely defined switching sequences. The identification of such parts is important for maintenance purposes (which parts can be switched off at the same time having a minimal impact on the rest of the station) or for extension plans (which must be added when a new line is appended). These parts are called "fields", can be operated by units with the general name "field control" and may have protection systems which are called "field protection". The concept of a field is not applied worldwide. The field level provides an additional control level below the inter-station level. can be operated by units with the general name "field control" and may have protection systems which are called "field protection". The concept of a field is not applied worldwide. The field level provides an additional control level below the inter-station level. can be operated by units with the general name "field control" and may have protection systems which are called "field protection". The concept of a field is not applied worldwide. The field level provides an additional control level below the inter-station level.

3.1.3
Data object (s: data object, DO)
Part of a logical node representing a specific information, such. B. condition or measurement. seen Objektorientiert a data object is an instance of a "data object class". Data objects are usually used as transaction objects, ie they are data structures.

3.1.4
Device (s: device)
a mechanism or a part of a device which serve a purpose or intended to perform a function,
z. As switches, relays, or terminal computer 100 IEEE

1996

3.1.5
Functions (s: functions)
Tasks that are performed by the station automation system, ie by application functions. In general, functions swap with other functions from data. Details depend on the functions considered. Functions are IEDs (physical devices) running. Functions can be divided into parts that are implemented on different physical devices, but with each other (distributed function) or with parts from other functions to communicate. This communicating sub-functions are called logical nodes.

In the context of this standard the division of functions and the extent of sub-functions is determined exclusively by the communication behavior. Therefore, all the considered features of logical nodes, which exchange data exist.

3.1.6
Intelligent electronic device (s Intelligent
Electronic Device, IED)
any device that is equipped with one or more processors, with the ability to receive data / commands from an external source and send to this (eg. B. electronic counter, digital relays, controllers)

3.1.7
Interchangeability (s: interchangeability)
Ability to replace a device from one manufacturer with a device from another manufacturer, without having to make changes to other elements of the system changes

3.1.8
Interoperability (s: interoperability)
the ability of two or more IEDs of the same or different manufacturers to exchange information and to use this specified the correct execution functions

3.1.9
logical node (s: Logical Node LN)
LN is the smallest part of a function that exchanges data. A LN is an object that is defined by its data and methods.

03/01/10
open protocol
Protocol, the "stack" is either standardized or available to the public

03/01/11
Physical device (s Physical Device, PD)
equivalent in the context of this series of standards with IED

3.1.12
PICOM
Description of an information transfer with accepted communication parameters between two logical nodes (piece of information for Communication). Included is also the information to be communicated and beyond request attributes, such as the transmission time. The actual structure and the actual format of the exchanged via the communication network data is not defined. The PICOM approach was adopted by the CIGRE Working Group 34.03.

3.1.13
Protocol (s: protocol)
Set of rules that determines the behavior of functional units for setting up and carrying out a communication

3.1.14
Self-documentation (s: self-description)
Device contains information about its configuration. may have to the presentation of this information to be accessible and standardized means of communication (in the context of this standard).

3.1.15
System (s: system)
within the scope of this standard is system refers to station automation system, unless otherwise indicated

3.1.16
Specific communication service mapping SCSM (s: Specific Communication Service Mapping)
standardized procedure for specific mapping of ACSI services and objects to a protocol "stack" or a communication profile.

To facilitate interoperability, a small number of standard mappings (SCSM) is sought. Special applications such as "ward" and "Process" may lead to more than one figure. For a protocol "stack" but should be defined only one SCSM and a single profile.

A SCSM should represent detail how abstract services in protocol-specific individual services or consequences of services are instantiated in order to meet the conditions specified in ACSI service. In addition, a SCSM should be the mapping of ACSI objects to objects in detail, which are supported by the application protocol.

SCSMs specified 8-x and 9-x of this standard in the parts.

3.2 Abbreviations

ACSI	abstract communication service interface (s: Abstract Communication Service Interface)
AIS	Outdoor switching device (s: Air insulated switchgear)
CB	Circuit breaker (s Circuit breaker)

CDC	Common Data Class (s: Common data class)
DO	Data object (s: data object)
EMC	electromagnetic compatibility, EMC (s: Electromagnetic Compatibility)
GOMSFE	general data model for the stations and their resources (s: Generic Object Models for Substation and Feeder Equipment)
IED	Intelligent electronic device (s Intelligent Electronic Device)
GIS	Gas-insulated switchgear (en: Gas insulated switchgear)
LN	logical node (s: Logical Node)
PD	Physical device (s: Physical Device)
PICOM	Information element for communication (s: Piece of information for communication)
SA	Substation Automation (s: Substation automation)
SAS	Substation Automation System (s: Substation automation system)
SCSM	Specific communication service mapping (s: Specific Communication Service Mapping)

4 goals

Substation Automation Systems (SAS) made possible by the rapid technological development of highly integrated circuits has led to today's sophisticated, fast and powerful microprocessors are available. This attracted a development of the resources of the secondary systems from electromechanical to digital devices by themselves. This in turn opened up the possibility of developing SAS, where multiple intelligent electronic devices (IED) perform the required functions (protection, on-site and remote control and monitoring, etc.). As a consequence, the need for efficient communication between the IED showed particularly a standardized protocol. So far, company-specific, developed by each manufacturer's protocols were used

Industry experience show both the need and the opportunity to develop standardized communication protocols to support interoperability of IED from different manufacturers. Interoperability in this case is the ability to work and Path on the same communication network or and share information and commands together. There is still a desire for the interchangeability of IED, that is, without making changes to the possibility of replacing a device from one manufacturer with a device from another manufacturer to the other elements in the system. Interchangeability is outside of the contemplation of this communication standard. Interoperability is a common goal of electricity utilities, manufacturers and standards.

The goal of the standardization of substation automation (SA) is to develop a communication standard that meets the functional and performance requirements, taking into account future technological developments. To achieve the full benefits, a consensus on the way needs to be found between IED manufacturers and users, as such devices can exchange information without restriction.

The communication standard must support the operational functions of a station. Therefore, the standard must take into account operational requirements, however, the purpose of the norm either in the standardization (or any limitation) the coordinated with the station operating functions nor their arrangement in the SAS. The application functions are shown and described in order to define their requirements for communications (eg. As data to be exchanged quantity and seasonal conditions). The standard for the communication protocol should be used as much as possible present standards and generally accepted method of communication.

The standard should ensure, inter alia, the following characteristics:

The complete communication profile is based on IEC / IEEE / ISO up / OSI standards, if available. The protocols used are open and support self-documenting devices. Adding new functionality is possible.

The standard is based on data objects that are tailored to the needs of utility companies.

The communication syntax and semantics based on the use of common data objects that are related to the high-voltage system.

The communication standard into account the station as a node of the power network, that is, the SAS as an element in the overall power control system.

5 history

Starting in 1994, an ad hoc working group "substation control and protection interface" of the IEC / Technical Committee drafted 57 proposals for the standardization of communication in substation automation systems. The following proposals were submitted to the National Committees and adopted by them:

Development of a standard on functional architecture, communication structure and general Conditions;

Developing a standard for communication within and between field and station level; Developing a standard for the communication within and between process and field levels; Developing a companion standard for the information interface of protection equipment.

The application-specific standard for the information interface of protective devices has been developed by the ad hoc working group and published as IEC 60870-5-103.

The communication interfaces within the substation automation system can be represented by the general structure according to figure 1.

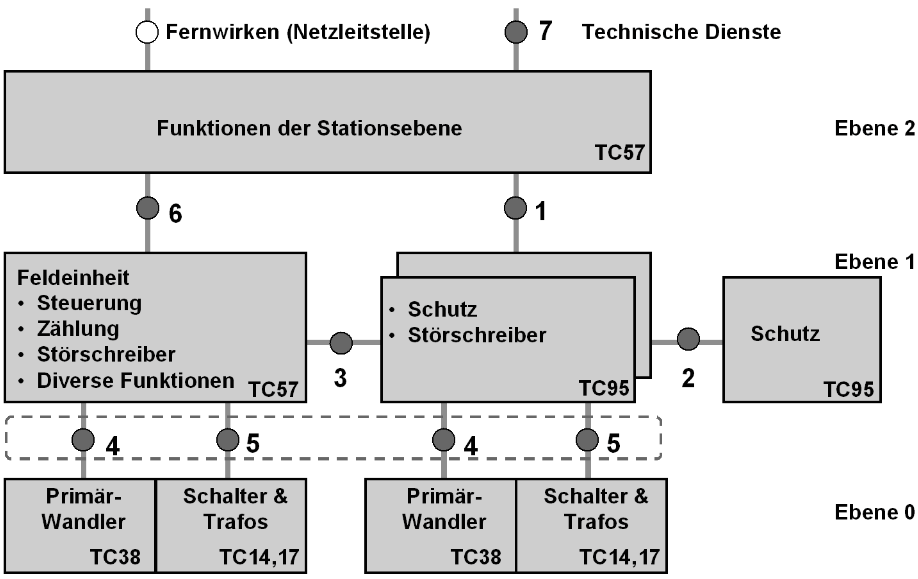


Figure 1 - Logical interfaces of SAS

NOTE The logical interface Nr. 2 (protection signal transmission) and the interface to the network control center (NCC) are outside the scope of the IEC 61850 standard.

The interfaces between the functional blocks do not provide physical interfaces of physical equipment, but rather are "logical interfaces", ie independent of real communication systems.

Figure 1 shows the Technical Committee of the IEC, who are responsible for device-related standards; working closely with these committees was deemed necessary. all the listed committees professionals to ensure they have delegated in the working groups on the development of IEC 61850 standard.

6 Procedure for the preparation of an applicable standard

6.1 General

The approach combines the advantages of three methods: separation of functions, data flow and modeling of the information.

This function decomposition is used to understand the relationship between components of a distributed function, and it is represented by logical node, describe the functions, sub-functions and functional interfaces.

The data flow is used to understand the communication interfaces that support the exchange of information between distributed functional components and must meet the functional performance requirements.

The modeling of the information is used to define the abstract syntax and semantics of the information exchanged, and (services) and their relationships represented by data object classes and types, attributes, abstract object methods with each other.

6.2 functions and logical nodes

The aim of the standard is to specify requirements and to provide a set of rules in order to achieve interoperability between IEDs of different manufacturers.

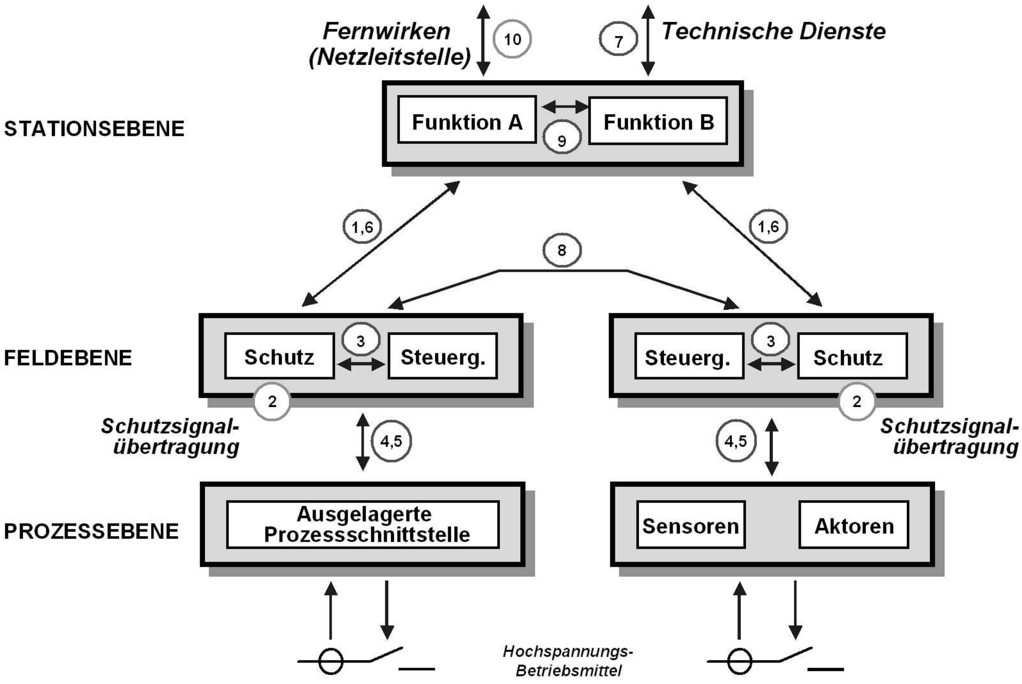
The assignment of functions to devices (IEDs) and control levels is not fixed. It is usually dependent on availability requirements, performance requirements, cost considerations, from the prior art, the philosophy of the operator, etc. Therefore, the standard is to support any allocation of functions.

In order to allow free assignment of functions to IEDs, interoperability to be achieved between the functions that are performed in the station, but in devices (physical devices) are arranged from different manufacturers. The functions can be divided into sub-functions which, although assigned to different IEDs, but communicate with each other (distributed function). Therefore, the communication behavior of such sub-functions must be called logical nodes, ensure the required interoperability of IEDs.

The functions (application functions) of SAS are control and monitoring, and the protection and monitoring of high-voltage devices and the network. Other functions (system functions) are based on the system itself, such. B. Monitoring of communication.

The functions can be divided into three levels: the station level, the field level and the process level.

It was recognized early on that the logical interfaces are not sufficient in accordance with Figure 1; logical interfaces between functions at the station level and between functions in different fields were missing. Therefore, a new structure has been designed which contains the additional logical interfaces. The diagram in Figure 2 is the basis for the standards of IEC 61850 standard.



NOTE The numbers of the interfaces used in other parts of the IEC 61850 as a reference and have no special meaning.

Figure 2 - interface model of a substation automation system

The importance of the interface is the following: Interface

1:	Protection data exchange between field and station level
Interface 2:	Protection data exchange between the field level and stepped protection (outside the scope of this standard)
Interface 3:	Data exchange within the field level
Interface 4:	Transmission of instantaneous values of current and voltage transformers (especially of samples) between field and process level
Interface 5:	Exchange of control and monitoring information between field and process level
Interface 6:	Exchange of control and monitoring information between station and field level
Interface 7:	Data exchange between the station (-sebene) and a remote engineer workstation
Interface 8:	Direct data exchange between fields, especially for fast functions such as locking
Interface 9:	Data exchange within the station level
Interface 10:	Information exchange between the devices of the station or station and a network control center (outside the scope of this standard)

The devices of a substation automation system may be physically arranged in different functional planes to be (stop, field and process). This refers to the physical interpretation of image. 2

NOTE The function distribution in a communication environment can be done using wide area networks (WAN), local area networks (LAN) and Prozessbustechnologien. The functions are independent of the communication technology used.

Devices the process level are typically remote input / output, intelligent sensors and actuators (see examples in Figure 2).

Devices at the field level are control, protection and monitoring units per box.

Devices of the station level the station computer with a database, the operator station, interfaces for remote communication, etc.

To achieve the standardization objectives mentioned above, all known functions were identified in a station automation system and (logical nodes) are divided into sub-functions. logical nodes can be arranged in different devices and in different levels. Figure 3 shows examples to explain the relationship between functions, logical nodes and physical nodes (devices).

A function is called "distributed function", if it is more logical nodes is carried out by two or arranged in different physical devices. Since all functions communicate somehow, the definition of a local or distributed function is not unique, but depends on the definition of functional steps that need to be executed until the function is executed.

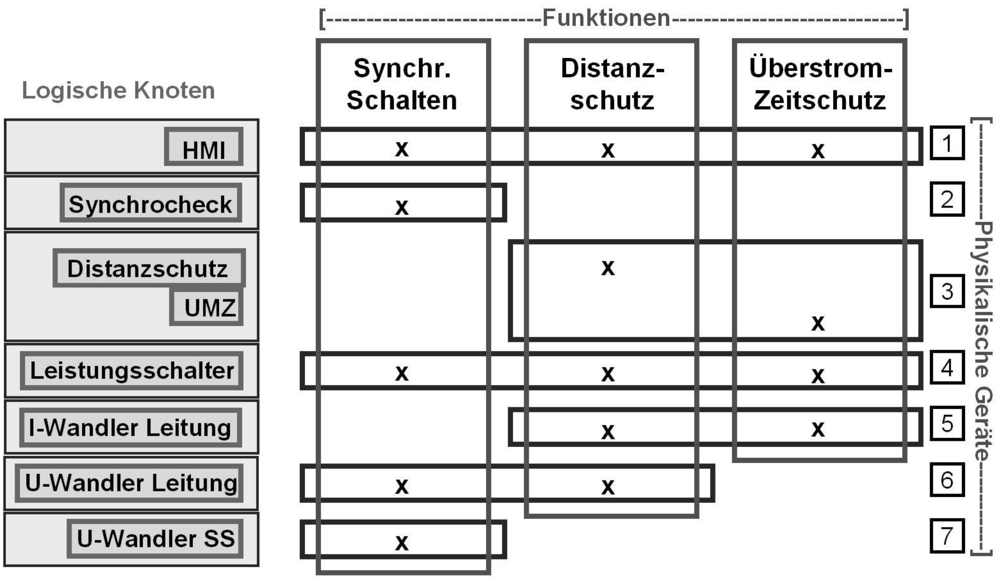


Figure 3 - relationship between functions, logical nodes and physical node (Examples)

Examples in Figure 3: Physical device 1: Station computer, 2: synchronizing, 3: Distance protection device with built-in over-current-time protection function, 4: panel controller, 5 and 6: current and voltage transformers, 7: busbar voltage transformers.

All known functions are described in IEC 61850-5 by:

The object of the function; Start criterion for the function; Result or effect of the function; Performance of the function; Functional decomposition;

Interaction with other functions.

NOTE It is not the intention of the standard IEC 61850 functions to standards.

All related logical nodes are described in IEC 61850-5 by:

Grouping according to their most common use area; brief verbal description of the functionality;

IEEE device function number, if applicable (only for protection and some protection related logical nodes, see IEEE C.37.2, 1996);

Relationship between functions and logical node in tables and in the functional description; exchanged PICOMs described in tables.

"Dynamic" requirements for transmission of explicit PICOMs including their attributes, such as the required data integrity were developed by working group 03 of the CIGRÉ Study Committee 34; the results were published in a report and used in this series of standards.

To simplify the procedure, the PICOMs however, were assigned to different types of messages depending on the requirements of the SAS (Table 1).

Table 1 - Message Types

Type	designation	Examples
1a	Fast News - Trip	trips
1b	Fast News - Other	Commands, simple messages
2	medium speed News	readings
3	Messages low speed	parameter
4	Raw data messages	Output data of transmitters and transducers
5	File transfer functions	large files
6a	Time synchronization messages a	Time synchronization; ward
6b	Time synchronization messages b	Time synchronization; Process bus
7	Commands with authentication	Commands from the station control

6.3 Station topologies

As noted above, functional requirements should be independent of the station size. It is thus necessary for the entire range of power requirements and for different station types and sizes of the resulting data flow (bus load) to be determined. Therefore representative types worldwide common stations were analyzed and the resulting data flow documented (see IEC 61850-5). Figure 4 shows typical medium and high voltage stations. All considered types of stations are described in Appendix A.

The name of the station types, such. B. D1-2, is used as follows: The letter D stands for distribution stations (en: "distribution substations"), the letter T stands for stations of the transport network (s: "transmission substations"). The first number indicates the station size (small, medium, large, the greater the number, the greater the station), the second number indicates variants.

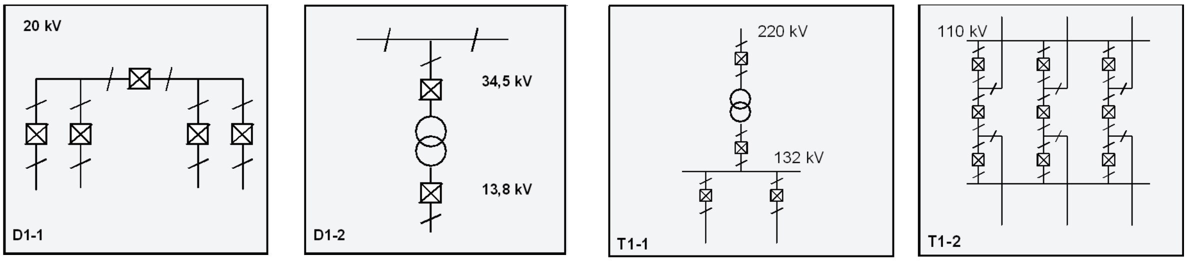


Figure 4 - types of medium and high voltage stations

6.4 Dynamic Scenarios

The data flow on logical interfaces was calculated for typical stations for normal and worst-case conditions. Table 2 shows an example of the type of station T1-1. The data flow contains only the information bits and no additional information that control the communication and monitoring.

Table 2 - Calculated flow of information to logical interfaces (Example)

No interface.	operating condition	Max. Busload [KBytes / s]	comment
Simple Network	normal	244	
Simple Network	Worst case	442	
1, 3, 6	"	123	ward
8th	"	24	ward
4, 5	"	295	Process bus over all fields
4, 5	"	65	Process bus in only one field

NOTE The worst case closes the operating states of "normal operation", "faulty", "emergency" and "state after an emergency" as well as the respective highest demands on a transmission time for all the signals (see IEC 61850-5, Section 12).

6.5 demands on a physical communication system

logical interfaces can be mapped to several different types of physical interfaces. A station bus typically includes logical interfaces 1, 3, 6 and 9, a process bus could include the logical interfaces 4 and 5. FIG. The logical interface 8 ("Inter-Bay Communications") can be either mapped to both or to one. This image typically has a significant impact on the requirements for the performance (throughput) (Figures 5 and 6).

The mapping of all logical interfaces to only one communication bus is possible if it meets the performance requirements.

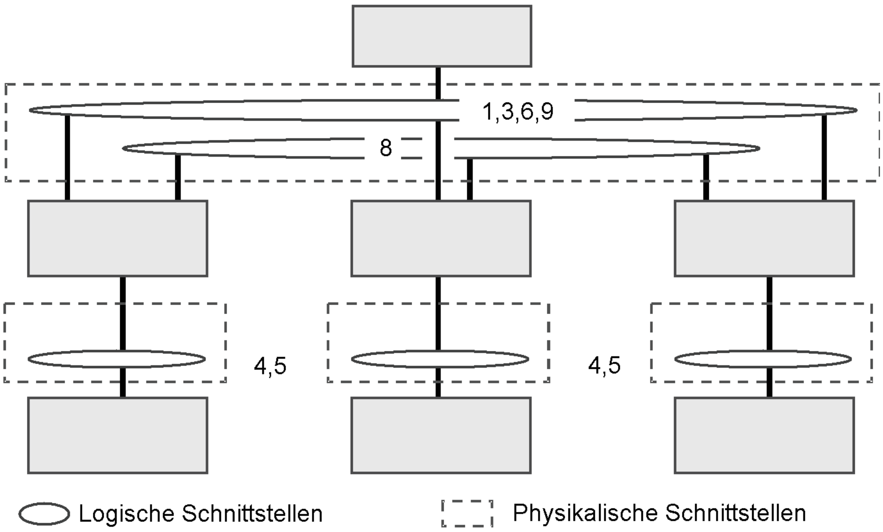


Figure 5 - mapping of logical to physical interfaces; Mapping of the logical Interface 8 to the station bus

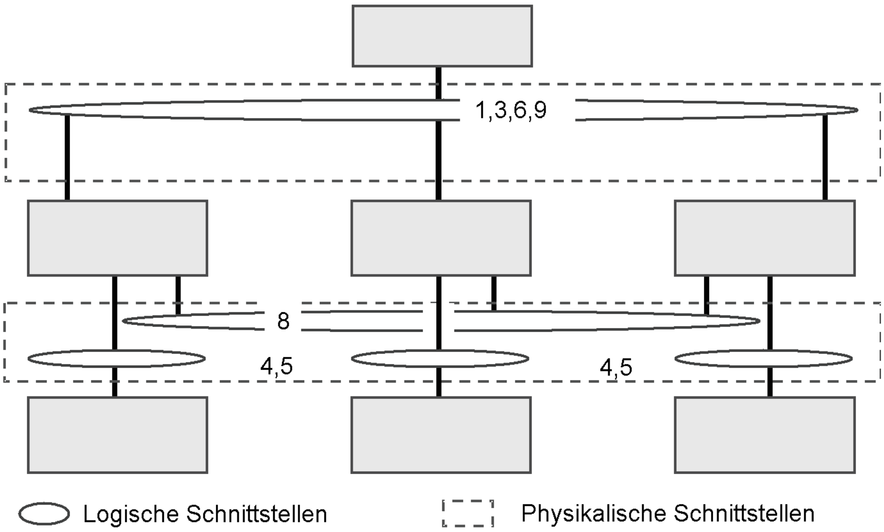


Figure 6 - mapping of logical to physical interfaces; Mapping of the logical Interface 8 to the process bus

7 How to meet the high rate of innovation in communications technology

7.1 Independence of communication and application

The standards of IEC 61850 defines a set of abstract services and objects, allowing to describe applications in a manner independent of any particular protocol. This abstraction allows both the manufacturers and to obtain application functionalities and when it is appropriate to optimize these energy utilities. The application of this standard model consists of a set up by the manufacturer / user application function that is formulated so that an associated group of ACSI services (Abstract Communication Service Interface) is invoked or may be reacting to them.

The standards of IEC 61850 describe the group of abstract services that must be used between the application and "application objects" and a compatible exchange of information between components of a substation automation system allowed. These abstract services / objects must allerdings be instantiated by the application of specific application protocols and communication profiles.

The concrete realization of the internal device interface to the ACSI services is a local matter and not covered by this standard.

As described in the context of an assumed "Specific Communication Service mapping" (SCSM) is subsequently the local ACSI on the matching group concretely Application Protocol / Communications services displayed. The condition or state changes of data objects are transferred as concrete data.

The standards of IEC 61850 provide a number of pictures that can be used for communication within the station; the selection of an appropriate application is based on functional and performance requirements.

NOTE Only then components are interoperable if they use the same SCSM.

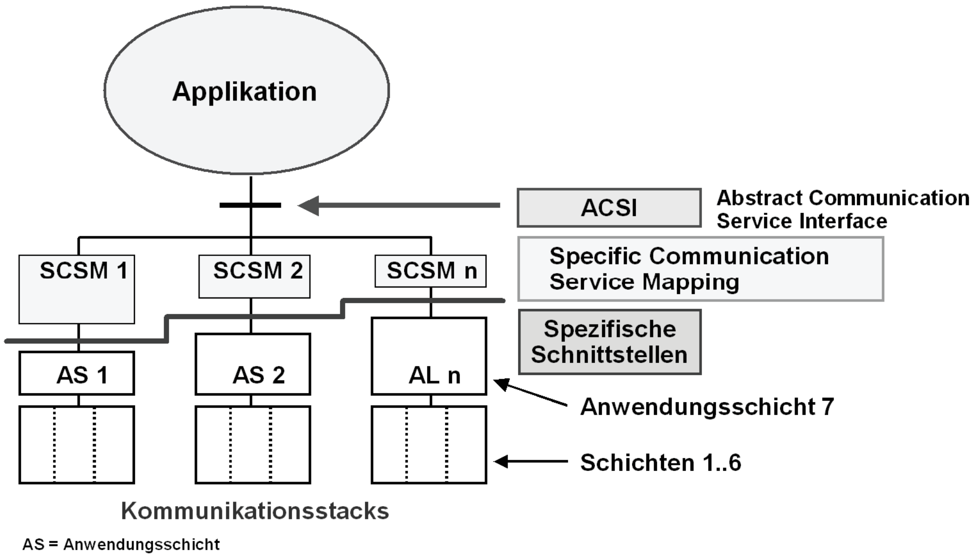


Figure 7 - Basic Reference Model

This diagram is shown in Figure 7 as "SCSM". The expense for the picture may be different, depending on the characteristics of the application layer.

7.2 Data Modeling and services

logical nodes can cooperate only when they interpret the received data and process can (syntax and semantics) and when the communication services used are matched. It is therefore necessary, logical node associated data objects and their logical addressing to standards.

Data and services of an application can be modeled in three levels (see Figure 8). The first level describes abstract models and communication services, which are used to exchange information between logical nodes. Levels 2 and 3 define the specific to the application object model. This includes a specification of data classes with attributes and their mapping to logical node.

Level 1: Abstract communication service interface (s: Abstract Communication Service Interface, ACSI)

The ACSI specifies the models and services that are used to access the elements of the application (substation automation) specific object model. communication services not only provide mechanisms for reading and writing of object values, but also for other operations such as control of resources of the primary equipment.

Level 2: Common Data Classes (s Common data classes)

The second level defined as "common data class" (CDCs). A common data class defines a structured information, which consists of one or more attributes. The data type of an attribute can be a base type (eg. B. INTEGER), as defined in IEC 61850-7-1. In Level 2 Other general data attribute types are defined. Data classes, as defined in level 3, are specializations of CDCs according to their specific use in the application context.

level 3: Compatible classes of nodes and logical data

This level defines a compatible object model which specifies classes of nodes and data logic. Since the identity and meaning (semantics) of the classes are defined by nodes and logical data, no additional specification is necessary. An example of a data class "switch position with quality and time tag".

Data classes this level are defined in IEC 60870-5-103 "objects" similar. logical nodes this level are similar to the "bricks" as they are defined in the document "Utility Communications Architecture (UCA)," version 2.0 (see reference in Appendix B, item 12).

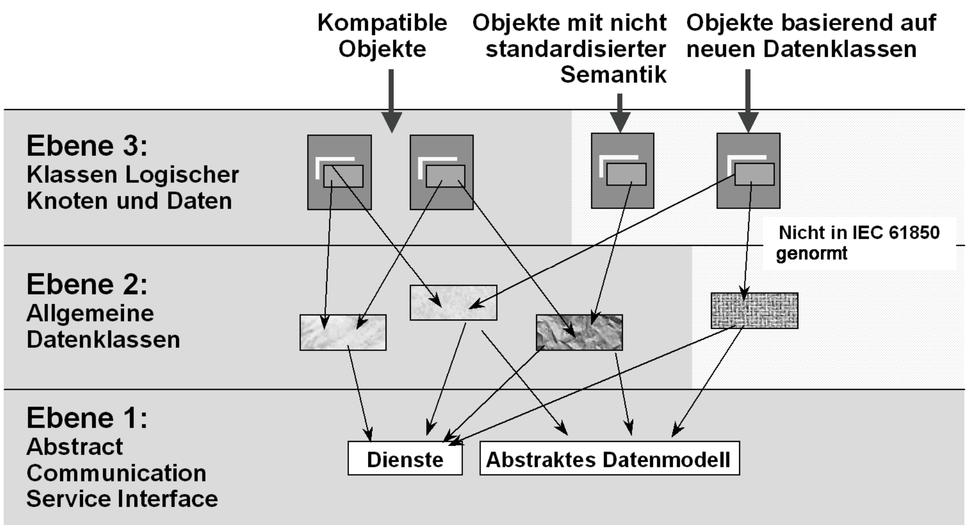


Figure 8 - Modeling according to IEC 61850

8 General System Aspects

8.1 motivation

If an electricity company is planning to build a SAS, while intended to combine IEDs from different manufacturers, it expects not only interoperability of features and equipment, but also a uniform handling of the system and harmonized general system properties.

This is the reason why the series of standards IEC 61850 not only dealt with communication, but also qualitative properties of engineering tools and measures for quality and configuration management.

8.2 engineering tools and parameters

Components of SAS include both configuration and operational parameters. Configuration parameters are typically entered offline and require after each change a restart of the application; Operating parameters can be entered online and changed without disturbing the operation of the system.

System parameters determine the cooperation of IEDs, including the internal structures and procedures of SAS in terms of its technical limits and available components. System parameters must be consistent; otherwise distributed functions do not work properly.

Process parameters describe the information that is exchanged between the process and the SAS.

Function parameters describe the qualitative and quantitative functionality features that are used by the customer. Usually the function parameters can be changed online.

All tools should be suitable at least for this exchange system and configuration parameters and detect violations consistency (and prevent). One way to achieve this is shown in Fig. 9 Syntax and semantics of the system parameters specified in IEC 61850-6 exchanges are.

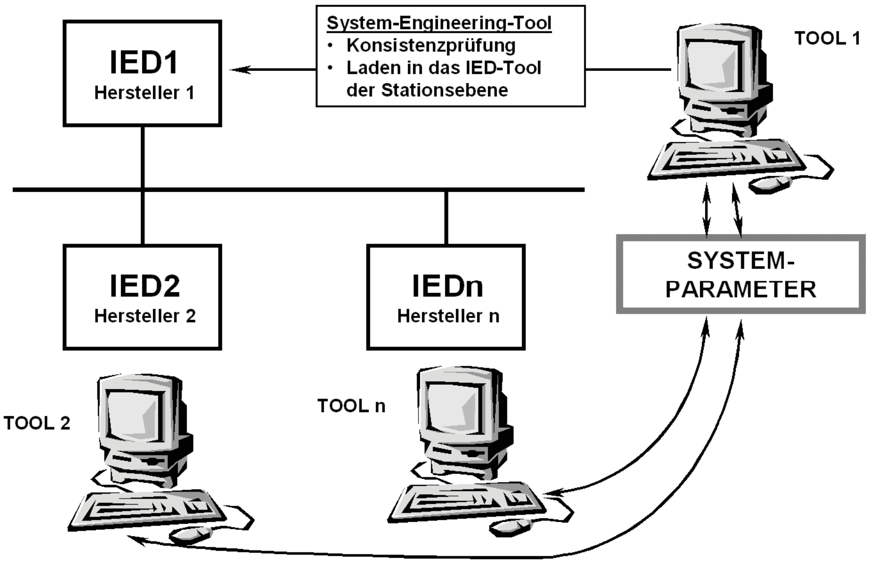


Figure 9 - exchange of system parameters

Engineering tools are tools that allow the application-specific functionality and integration of devices into the SAS is established and documented. They can be classified as follows:

Configuration tools;

Parameterization and configuration tools;

Documentation tools.

The standard IEC 61850 defines requirements for engineering tools, particularly for system configuration and parameterization.

8.3 configuration language for the substation automation system

Designing a system usually begins before the system is physically available. In addition, modern IEDs for many tasks are customizable. This does not mean that all possible tasks can be performed simultaneously, which is why more subsets of skills for the same

Device must be defined, which can then be instantiated at the same time as a subset and used.

Therefore, should, even though the devices can be self-describing, the device capabilities as well as the general device configuration for a project described taking into account the system parameters in a standardized manner, and configured.

to exchange compatible to those device descriptions and system parameters between tools from different manufacturers, defined IEC 61850-6, the station configuration description language (Substation Configuration Description Language, SCL). This language allows

61850-7-x to describe the capabilities of an IED in terms of the models from IEC 61850-5 and IEC for import into a system configuration tool;

to describe all data to define the system parameters of a single IED. This includes in particular the connection of IEDs and its functions to the switchgear at the level of single-pole scheme, and its place in the communication system.

The language is based on XML. For the above purpose, it includes the following segments:

Substation segment: describes the single-pole diagram of the slave station and its connection to the logical node as well as the placement of the logical nodes on IEDs. Thus the connection of IEDs is defined to the switchgear.

Communication Segment: describes the communication links between IEDs. IED segment: describes capabilities and configurations of one or more IEDs and the flow of data to and from the logical node to other IEDs.

LNType segment: defines which data objects are actually included in the instances of a logical node IEDs.

8.4 Quality and Life Cycle Management

The series of standards IEC 61850 treated quality assurance system lifecycles and defines responsibilities of utilities and manufacturers.

The responsibility of the manufacturer ranges from the development in accordance with EN ISO 9001, system testing, type testing and certification (including certification of conformity) to services and supplies for manufacturing setting.

Since the SAS and its components are subject to continuous development, the system, the components and engineering tools should be clearly identifiable by Version markings.

An example of obligations of producers for shipment to manufacturing setup is shown in Figure 10th

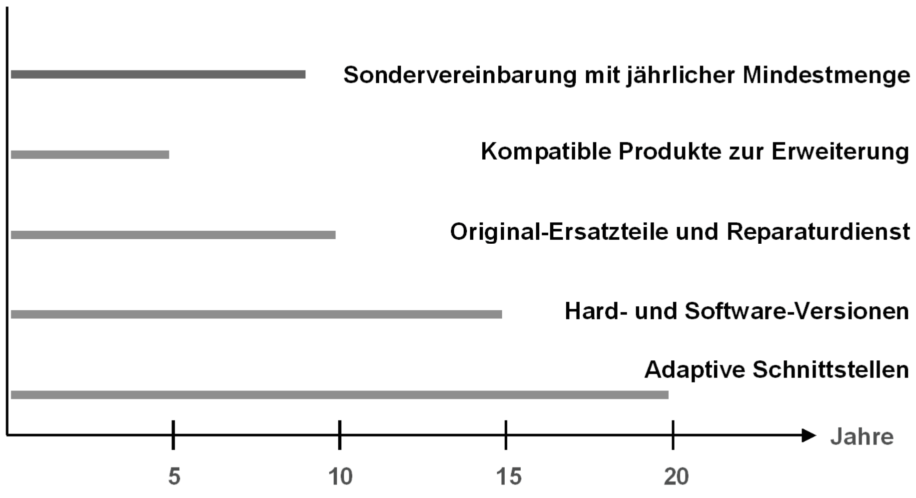


Figure 10 - periods for delivery obligations (Example)

8.5 General Requirements

General requirements for the communication network are defined in IEC 61850-3, with emphasis on the quality requirements. This part also includes guidelines for environmental conditions and auxiliary equipment, with recommendations for the implementation of specific requirements from other standards and specifications are given.

Quality requirements are defined in detail, such as reliability, availability, maintainability, IT security, data integrity, and others who applied to communication systems that are used for the control and monitoring of the process in the station.

Other "general" requirements are geographic requirements. Communications networks within stations should be able to bridge distances up to 2 km. Some components of SAS, for. As field controllers, there is no competent "Product Committee" at IEC. Therefore, environmental conditions must be standardized, by referring to other appropriate IEC standards.

What climatic, terms of mechanical and electrical influences to the media and interfaces that are used for the control and monitoring of processes within the station, reference is made to other IEC standards.

Communication devices may be exposed to various types of electromagnetic disturbances, which are transmitted via power supply lines or signal lines or radiate directly from the environment. Fault types or degrees depending on specific conditions under which the communication devices have to work.

Regarding EMC requirements will be referred to other IEC standards. However, additional requirements have been developed.

9 compliance testing

Declarations of Conformity and the determination of validity are important elements of the acceptance of systems and facilities. IEC 61850 specifies methods for conformance testing of devices of substation automation systems and also contains guidelines for the design of test environments and system testing, thereby promoting the interoperability of equipment and systems.

Safety and EMC compliance requirements are specified in IEC 61850-3.

10 structure and content of the standard series

Title and content of published or planned parts of the standard IEC 61850 are as follows:

IEC 61850-1 Introduction and Overview

Introduction and overview of IEC 61850 standard.

IEC 61850-2 Dictionary

Terms collection.

IEC 61850-3 General requirements

Quality requirements (reliability, maintainability, system availability, portability, security);

Environmental conditions;

Auxiliaries;

other standards and specifications.

IEC 61850-4 system and project management

Engineering needs (classification parameters, engineering tools, documentation); System life cycle (product versions, manufacturing setting to support manufacturing setting);

Quality assurance (responsibilities, testing equipment, type testing, system testing, FAT and SAT).

IEC 61850-5 Communication requirements for functions and device models

Basic requirements; Principle of logical

nodes;

logical communication links; PICOM concept;

logical nodes and associated PICOMs; Time

requirements; functions;

"Dynamic Scenarios" (Requirements for the flow of information at different operating conditions).

IEC 61850-6 language for the description of the configuration of the communication stations with intelligent electronic devices (IED)

Overview of the planned system engineering process;

Definition of the XML-based file format for the exchange of system and configuration parameters consisting of

- the single-pole diagram of the primary system,
- the description of the communication links,
- the capabilities of IEDs;

Allocation of the logical nodes that represent the functions to equipment and to the primary system.

IEC 61850-7-1 Basic communication structure for station- and feeder equipment - Principles and models

Introduction to IEC 61850-7-x; Communication

principles and models.

IEC 61850-7-2 Basic communication structure for station- and feeder equipment - Abstract communication service interface (ACSI)

Description of the ACSI;

Specification of the abstract communication services; Model of the

device database structure.

IEC 61850-7-3 Basic communication structure for station- and feeder equipment - Common data classes

Common data classes and associated attributes.

IEC 61850-7-4 Basic communication structure for station- and feeder equipment - Compatible logical node classes and data classes

Defining classes of nodes and logical data; Classes of logical nodes are formed from data classes.

IEC 61850-8 Specific Communication Service Mapping

Figure (s) of services that are commonly used for communication within the entire station.

IEC 61850-9 Specific Communication Service Mapping

Figure (s) of services that are used for the transmission of analog samples.

IEC 61850-10 conformance testing

Conformity assessment procedures;

Quality assurance and testing; required

documentation;

device-related compliance tests;

Certification of testing equipment, testing equipment and requirements for their validation.

Appendix A
(informative)

Station types and Kommunikationsbusstrukturen

A.1 Definitions typical configurations station

The performance requirements for a communications network in a station will depend on the size of the station and its importance in the high-voltage grid. The following sections stations are classified according to their size and function. The function of the high-voltage grid determines the class and the communication requirements.

To formulate performance requirements for communications, stations are typically divided into distribution grid and transportation network stations. A distribution station has to customary definitions mainly cable outlets in the voltage range of 30 kV and below. The one or two supplies may have the voltage of the transmission network. A station in the transmission system has according to the usual definition fields with the voltage of the transmission network (that is, 100 kV and more), though sometimes a small busbar portion with the distribution voltage is present. These voltage values do not represent exact boundaries; the voltages of the transport network and the distribution network can be defined differently by different RUs. Further classification is based on the number of controlled high-voltage elements in the station. An item in this sense, is. Example, a field, a transformer or a capacitor bank.

Stations without remote control and without SAS (Substation Automation System) are not considered in this document.

A.2 station types

A.2.1 D1 Small distribution station

A station with no more than five fields. A typical example is a switching station with 4 outlets and one busbar disconnectors. The station is equipped with a simple over-time protection, sums alerts, field-related on-site control and limited control options such. B. exclusively control the circuit breaker. The measurement will detect a single-phase current only per field. Substation automation is limited to the gateway to the network control center. Communication system interfaces used are 3 and 6, sometimes additionally 4 and 5. FIG.

In the automation system, a station level exists only limited; it consists primarily of the gateway to the Network Management Center.

For some distribution stations, the primary technology is designed as a closed, by the manufacturer prefabricated modules that contain the entire device technology including field control and protection. This allows a complete assembly and testing of the communication interfaces 3, 4 and 5 at the factory and with very little additional effort on site.

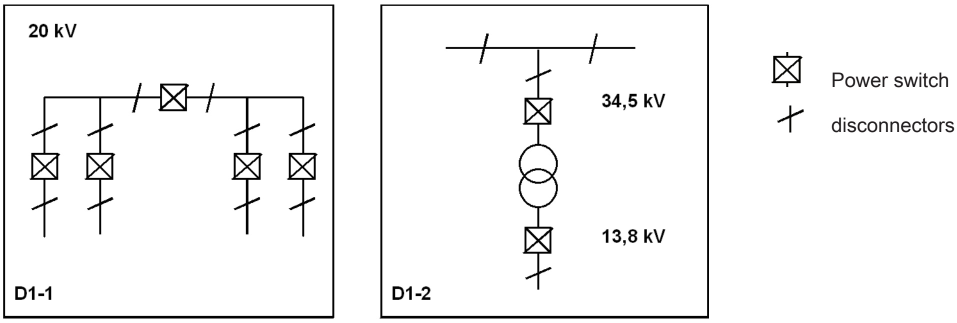


Figure A.1 - Examples of typical single-pole circuit diagrams for type D1

A.2.2 D2 Mean distribution station

The most common type of station has more than five but less than 20 fields. A typical example is a station with two power supplies, two transformers, two busbars under voltage side and a number of outlets, but at least to a bus bar on each voltage level. The station usually has overcurrent, directional earth fault and transformer differential protection. The busbar is protected by a backup overcurrent protection in the feeds, with blocking signals from the relays of the feeders. There are individual warning messages, the measurement usually includes the busbar voltage and single-phase power per feeder. The control of the field level includes all circuit breakers and other switches. The station level may includes a simple local control and a gateway to the network control center, and automatic control functions for voltage and neutral control. Communication between fields is used for directional protection blocks and distributed functions.

For stations of this size that a station-wide communications network is required.

The SAS-used communication interfaces are 1, 3, 4, 5, 6, 7 and 8. FIG.

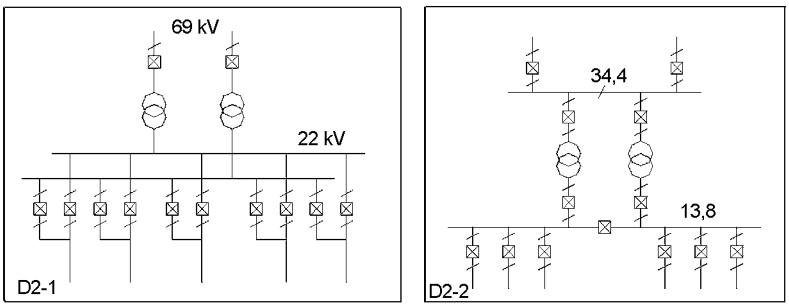


Figure A.2 - Examples of typical single-pole circuit diagrams for the type D2

A.2.3 D3 Large distribution station

A large distribution station usually has more than 20 fields, often considerably more. A typical example has at least two voltage levels, multiple busbars, transformers, etc. The protection concept could except the D2 features include a busbar protection. The station level includes a full local control one, the entire switchgear is controlled, and all individual warning messages are transmitted. The measurement includes the busbar voltage, three-phase feeder currents, active and reactive power, etc. The bus topology may change during the operating period. Special functions such. As automatic switching sequences are common.

The communication between the station and the network control center can consist of one main and one backup connection. Communication between fields is required, for example for the lock.

For the larger stations, the local communication network could be divided into segments connected by routers to limit the number tailed nodes per segment.

The SAS-used communication interfaces are 1, 3, 4, 5, 6, 7 and 8. FIG.

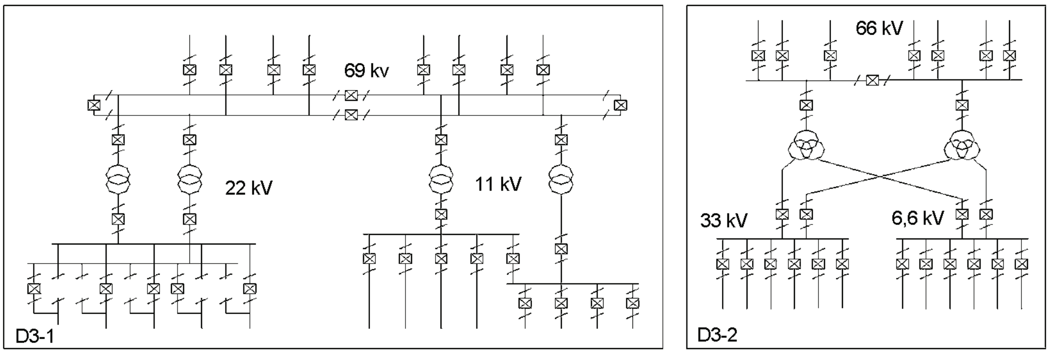


Figure A.3 - Examples of typical single-pole circuit diagrams for the type D3

A.2.4 T1 Small transmission network station

In contrast to distribution stations, the equipment technology for the transport layer often of independent (separate) units together that are by the manufacturers delivered directly to the station, which does not allow a complete assembly and testing at the factory before delivery.

A small transport network station usually has less than 10 fields and is in the energy network of less importance. Redundant protection is often not used. Feeder Protection may include remote tripping (interface 2), and busbar protection is a common practice. The station level is restricted to the gateway to the network control center and to a simple local control. Circuit breakers and sometimes other switches are controllable. The measurement includes the busbar voltage and single-phase currents per outgoing, active and reactive power. Some utility companies equip all branches of the transport plane with fault recording.

The communication interfaces 1-8 are used.

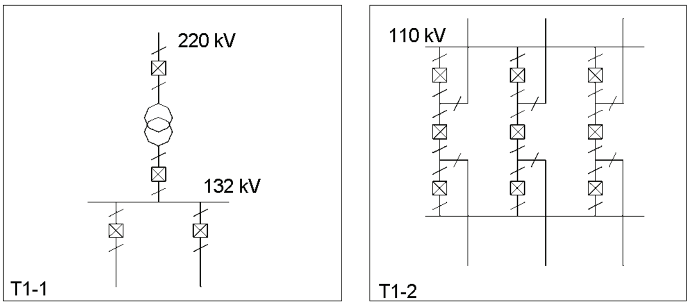


Figure A.4 - Examples of typical single-pole circuit diagrams for type T1

A.2.5 T2 Large transmission network station

A large transport network station has more than 10 fields of high importance in the energy network. She has several busbars and transformers. A high protection is used, including both reserve and redundant protection systems. Special automation functions such as network restoration or switching sequences are included. Fault recording and local processing of event and alerts are part of the system. The fully existing station level includes the local control, control of the entire substation and station-related locking. Communication between the fields is required.

There may be requirements for redundant communication links both within the station and between station and network control center. The communication network can be divided at the major stations in segments.

All communication interfaces are used.

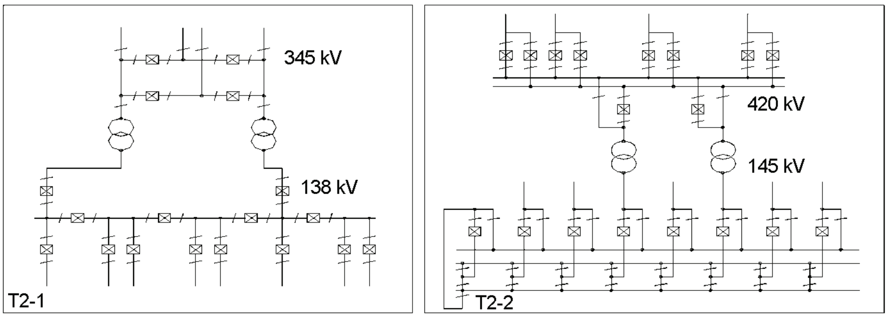


Figure A.5 - Example of a typical single-line plan for type T2

A.2.6 combinations

There can be combinations of two types of stations such. B. a transport network station (T1), which also contains outlets of the distribution plane (D2). In such cases, the combined requirements apply.

There are cases in which the communication network is divided. This can be due to different owners (network control centers) of the units, different voltage levels, land, etc. related.

A.3 Station types and interfaces used

Table A.1 summarizes the cross-relationships between communication interfaces and station types together. An X indicates that the corresponding interface is used, a (X) indicates that it is used by some utility companies, but not by all.

Table A.1 - station types and used interfaces

station	interfaces used						
Type	1	3	4	5	6	7	8th
D1		X			X		
D2	X	X	(X)	(X)	X	(X)	X
D3	X	X	(X)	(X)	X	X	X
T1	X	X	X	X	X	X	X
T2	X	X	X	X	X	X	X

Table A.2 gives an overview of the main distinctive elements of station types. An X indicates that the function is commonly used in the station type, a (X) that the function is sometimes applied in the station type, but usually not.

Under man-machine interface is "field level" for the operation of the switching field itself (at medium voltage stations) from the field or control cabinet (in the case of high voltage stations). Simple human machine interface is a simple alphanumeric screen for displaying warning messages and switching states, which is a simple operation allowed. A fully equipped local control usually includes one or two full graphic displays, special application functions as overview images and selections, storage of archive data for trend analysis and so on.

Under protective few typical examples are presented to show the function levels.

Table A.2 - station types and used functions

station type	D1	D2	D3	T1	T2
number fields	1-5	5-20	> 20	1-10	> 10
Human-machine interface field level					
	X	X	X	X	X
Station level, easy		X		X	
Station level, completely		(X)	X		X
Control functions					
Circuit breaker	X	X	X	X	X
Switch / line & earth		(X)	X	X	X
regulator		X	X	X	X
switching sequences			X	(X)	X
synchrocheck		(X)	(X)	X	X
Fault sum message Only					
	X	X		(X)	
full Störmeldungsverarbeitung		(X)	X	X	X
overcurrent					
protection	X	X	X	X	X
backup protection		X	X	X	X
Distance protection			(X)	X	X
redundant protection				(X)	X
Busbar protection		(X)	X	X	X
Single-phase current					
measurement and counting	X	X	X		
Busbar voltage		X	X		
Three-phase measurement		(X)	(X)	X	X
energy metering	(X)	(X)	X	(X)	X

A.4 Kommunikationsbusstrukturen

A.4.1 General

To further determine the communication requirements in a station, it can be divided into physical or functional units.

For this, the station D2-2 was chosen as an example, as shown in Figure A.2. This is one of the most common types of station that can be found in most electric utilities. Figure A.6 shows the same example as D2-2, but with current and voltage transformers.

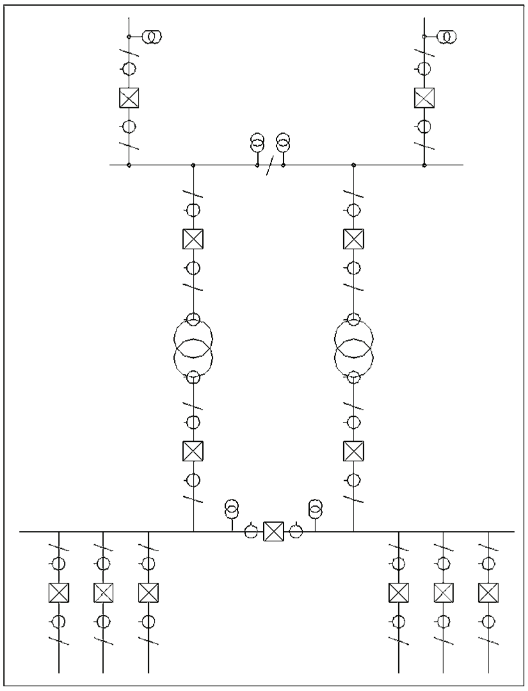


Figure A.6 - Possible arrangements of current and voltage transformers in station D2-2

The picture shows all possible arrangements of current transformers. Most utility companies do not use in a particular station usually all these positions.

A.4.2 Typical physical units (fields)

A station can be divided in different ways into components. One example is the allocation in units of fields, that is, the station is divided into units according to the arrangement of the high-voltage devices.

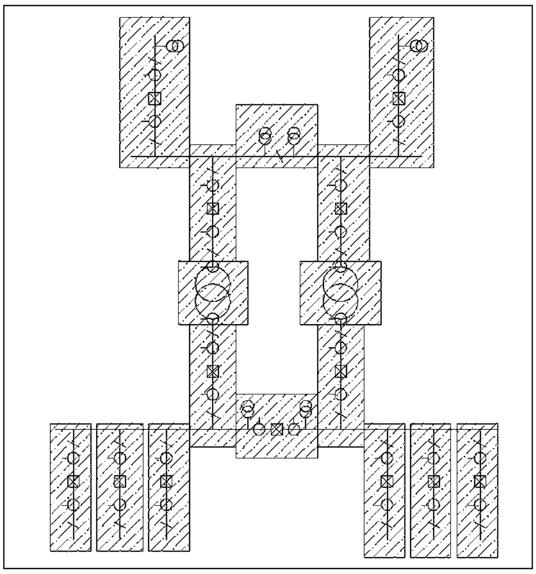


Figure A.7 - assignment of field units (example)

Each block shown in Figure A.7 consists of parts are delivered to the plant or to be assembled on site either assembled.

A.4.3 Typical protection zones

An alternative to the division into physical units to look at the data flow within the facilities. The station can then be divided into functional communication blocks within which the control and protection functions with the same data to work. As an example, Figure A.8 shows overlapping protection zones of relays.

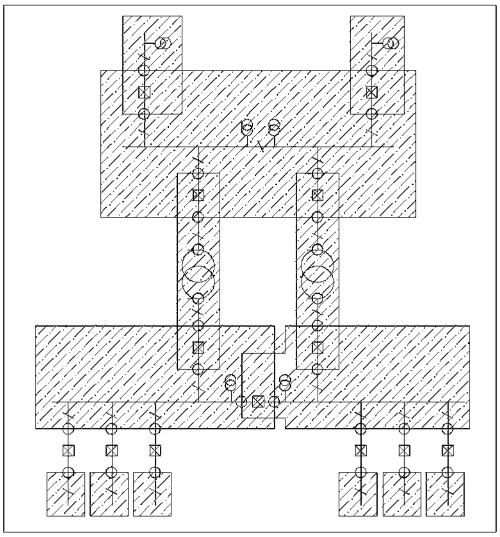


Figure A.8 - Typical protection zones

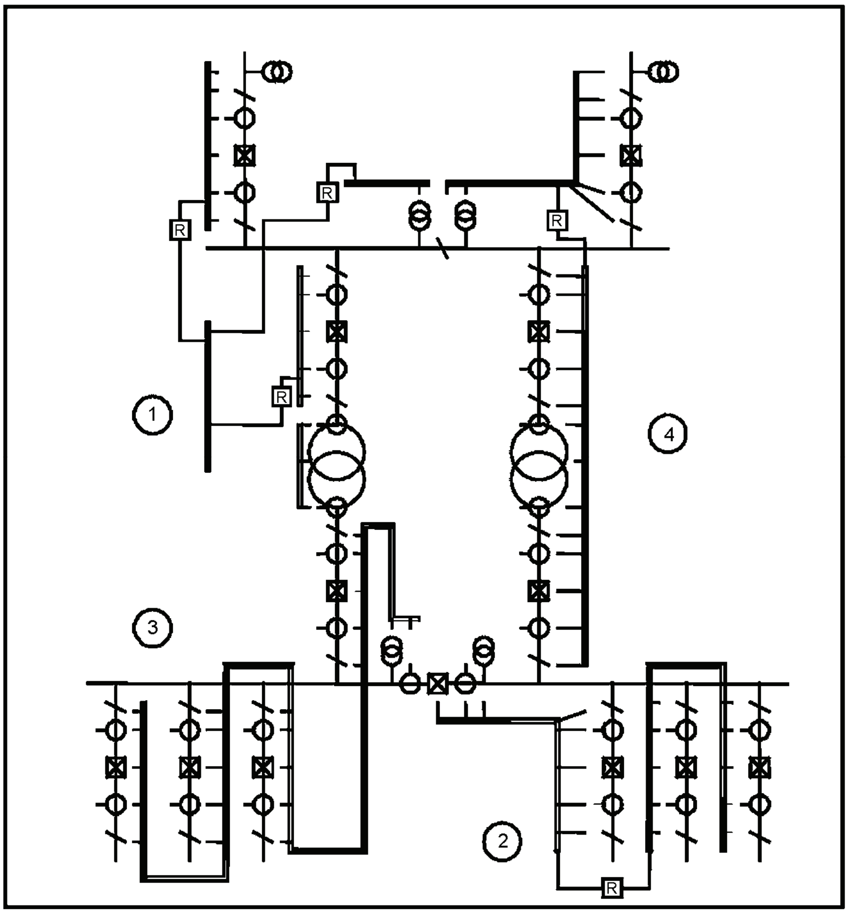
This again shows a possible arrangement of protective zones; Utility companies may prefer other alternatives, depending on the importance of the station and to the general business practice.

Each relay in the zone usually requires data from all current transformers at the borders (of the zone) and in some cases of voltage transformers within the zone. usually it transmits trigger signals to all the circuit breakers within the zone.

A.4.4 Communication structures of the process bus

The communication process level can be arranged in several different ways, depending on flow requirements, reliability requirements, or by practical considerations during installation.

Picture A.9 shows four possible solutions.



Legend

R: Route

Picture A.9 - solutions for the communications process level

Solution Figure 1 shows a communication bus, wherein each field (installation unit) has its own process bus segment. need for crowd control and protection equipment, the data from more than one segment, a station further communication will be installed, which is connected via router with any field-related segment to transmit the required data streams.

Solution 2 shows a similar structure, but each field segment covers more than just a field. Data streams that are required in more than one segment to be passed over router. The example shows data of the busbar voltage transformer, which are used by directional protection equipment relays in all fields.

Solution 3 shows a single station-wide communication bus are connected to all devices. This requires a high data rate on the bus, but eliminates the need for routers.

Solution 4 is a function-oriented bus structure. In this case, the bus segments to have proper protection zones. Although routers are required, the segments can be arranged so that the amount of data transmitted between segments is minimized.

A.4.5 Communication structures of the station bus

The structure of the communication bus of the station level can be based on one of the station types according to A.2.

Station Type D1 requires only a very simple communication bus to connect field devices with the remote control interface. There is no communication between the fields and no need for quick messages.

Station Type D2 requires a station-wide communications with the ability to support all message types.

Station Type D3 requires a segmented communication bus, connected by routers or bridges, to process the large amounts of data for the connected devices. Segmentation should be designed so that no quick messages must pass through routers.

Station type T1 requires the same type of a communication bus such as D2, but with the additional possibility to address two duplicate (redundant) devices.

Station type T2 may require duplicated (redundant) Kommunikationsbusstrukturen. In some cases, where the physical size of the station also requires a segmented communication, the bus must be divided into segments.

It must be emphasized that the above-defined types and their communication requirements are given as examples. The actual importance and therefore required reliability of a particular station does not only depend on their size and configuration.

A.4.6 Summary

The examples above show that the viewing station or field types does not provide sufficient information to calculate the load on the communication system, especially when a process bus is enclosed. Interconnection and Prozessbusstrukturen and power requirements can be entirely of the station structure, be derived the specific functions and their arrangement as well as the structure of the switchgear and the way how the devices are arranged.

The most cost-effective communication system for a given station may require more than one type of OSIProtokoll stacks. The current selection can then due to the station type, ie the size, complexity and the required reliability of the station, are taken as a result of the expected data rate to station and process bus.

Appendix B

(informative)

Documents that were included in the standard IEC 61850

SAS was for years the subject of broad interest, with activities of a number of organizations in several countries. The following list shows the known publications that have been considered in the work of IEC / TC 57 working groups. All have been reviewed and used as contributions to the deliberations of the working groups.

1) *VDEW recommendation "Digital Substation Automation", VDEW AK "Substation Automation"* 20 June 1994. VDEW issued the first draft of a document on integrated substation control systems in 1988; This document updates these recommendations based on the experience of five years. While the document contains many valuable and useful general standards and guidelines, it does not deal with the data communication standard between devices at the field level and the station level. Accordingly, no interoperability between devices from different manufacturers is provided. On August 20, 1995, however, the draft companion standard on protective Communication (Revision 3.1) was released.

2) IEC 57/214 / INF *Report of the Ad Hoc Working Group "Substation Control and Protection Interfaces"* February 1995.

   This report includes the work of the Ad Hoc Working Group from March 1994 to April 1995. The group was constituted in November 1993 and had 24 members from 12 countries. They met a total of four times, and the working result formed the basis for the insertion of the work groups 10, 11 and 12. FIG.

3) IEC 57/210 / NP *Communication standards for substations - Part 1: Functional architecture, communication structure and general requirements,* February 1995.

   This document defines the work area and objectives for the Working Group 10, based on the work product of the ad hoc working group.

4) IEC 57/211 / NP *Communication standards for substations - Part 2: Communication within and between unit and substation levels,* February 1995.

   This document defines the work area and objectives for the Working Group 11, based on the work product of the ad hoc working group.

5) IEC 57/212 / NP *Communication standards for substations - Part 3: Communication within and between process and unit levels,* February 1995.

   This document defines the work area and objectives for the Working Group 12, based on the work product of the ad hoc working group.

6) IEC 57/232 / RVN *Results of voting on New Work Proposal, Communication standards for substations - Part 1: Functional architecture, communication structure and general requirements,* August 1995.

   This document describes the outcome of the vote of the countries on the use of the three new working groups; 21 countries voted for, 11 countries expressed their willingness to participate, and three countries did not answer.

7) IEC 95/15 / NP IEC 1733-1 *Protection Communication Interfaces - Part 1: General.*

   This document provides general information about typical hierarchical systems and the typical array of devices communicating in an open system.

8th) IEC 95/15 / NP IEC 1733-2 *Protection Communication Interfaces - Part 2: Communication Standards in Electrical Installations, Overall Structure,* April 1995.

   This document presents the results of work of the Working Group 6 of the Technical Committee 95th This is the second part of a planned seven-part series of standards. The first two parts are used as reference documents. TC 95 / W G6 has decided to active members in TC 57 / WGs to delegate 10, 11 and 12 and to examine the results.

9) CIGRE WG 34.03, *Communication Requirements in terms of Data Flow Within substations, Draft Report,* November 15, 1995.

This report complements the work that has been discussed in the previous document, and developed a model (object) definition of elements within a station. These models can then be used to identify data flow requirements for different operating conditions.

The final report was as CIGRE - Technical Report No. Ref. 180 - *Communication requirements in terms of data flow within substations* published (CE / SC 34 03, 2001.112 pages).

10) EPRI RP3599, *Substation Integrated Protection, Control and Data Acquisition, Requirements Specification, Preliminary Report, Version 1.2,* February 1998.

This document defines a model and performance requirements for IEDs in stations. As part of the EPRI-sponsored activities that led to the publication of UCA version 2.0, a series of experiments was started to develop detailed object models general field devices, including the definition of their visible through the communication system algorithms and communication behavior. The project RP 3599 "Substation integrated protection, control, and data acquisition" was one of those experiments that led to the above-mentioned report.

11) IEEE-SA TR 1550, 1999: *Utility Communications Architecture (UCA) Version 2.0 - Part 3: UCA Common Application Services Models (CASM) and mapping to MMS,* November 1999. This document describes the mapping of the UCA Generic Object model to the application services and the mechanisms that represent the application services in the downstream UCAAnwendungsschicht (in this case MMS).

12) IEEE-SA TR 1550, 1999: *Utility Communications Architecture (UCA) Version 2.0 - Part 4: UCA Generic Object Models for Substation and Feeder Equipment (GOMSFE)* November 1999. This document provides a library of basic common objects and standardized modules that are used to model substation and feeder protection and control and monitoring functions.