TECHNICAL REPORT

IEC TR 61850-1

First edition
2003-04

Communication networks and systems in substations –

Part 1: Introduction and overview

Réseaux et systèmes de communication dans les postes –

Partie 1:
Introduction et vue d'ensemble

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 1: Introduction and overview

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical specifications, technical reports or guides and they are accepted by the National Committees in that sense.
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6) Attention is drawn to the possibility that some of the elements of this technical report may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

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

IEC 61850-1, which is a technical report, has been prepared by IEC technical committee 57: Power system control and associated communications

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

Enquiry draft	Report on voting
57/524/CDV	57/561/RVC

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

IEC 61850 consists of the following parts, under the general title *Communication networks and systems in substations* [1].

Part 1: Introduction and overview

Part 2: Glossary [2]

Part 3: General requirements

Part 4: System and project management

Part 5: Communication requirements for functions and device models [3]

Part 6: Configuration description language for communication in electrical substations related to IEDs [2]

Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models

Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)

Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes

Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes

Part 8-1: Specific communication service mapping (SCSM) – Mappings to MMS (ISO/IEC 9506-1 and ISO/IEC 9506-2) and to ISO/IEC 8802-3 [2]

Part 9-1: Specific communication service mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link

Part 9-2: Specific communication service mapping (SCSM) – Sampled values over ISO/IEC 8802-3 [2]

Part 10: Conformance testing [2]

This part is an introduction and overview of the IEC 61850 standard series. It describes the philosophy, the work approach, the contents of the other parts, and documents of other bodies which have been reviewed.

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be

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

[1] For more details, see Clause 10.

[2] Under consideration.

[3] To be published.

COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

Part 1: Introduction and overview

1 Scope

This technical report is applicable to substation automation systems (SAS). It defines the communication between intelligent electronic devices (IEDs) in the substation and the related system requirements.

This part gives an introduction and overview of the IEC 61850 standard series. It refers to and includes text and Figures from other parts of the IEC 61850 standard series.

2 Reference documents

IEC 60870-5-103:1997, *Telecontrol equipment and systems – Part 5-103: Transmission protocols – 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 C37.2,1996 *IEEE Standard Electrical Power System Device Function Numbers and Contact Designations*

IEEE 100,1996, *IEEE Standard Dictionary of Electrical and Electronic 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 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this Technical Report, the following terms and definitions apply:

3.1.1
Abstract Communication Service Interface
ACSI
virtual interface to an IED providing abstract communication services, for example connection, variable access, unsolicited data transfer, device control and file transfer services, independent of the actual communication stack and profiles used

3.1.2
bay
a substation consists of closely connected subparts with some common functionality. Examples are the switchgear between an incoming or outgoing line and the busbar, the bus coupler with its circuit breaker and related isolators and earthing switches, the transformer with its related switchgear between the two busbars representing the two voltage levels. The bay concept may be applied to one and a half breaker and ring bus substation arrangements by grouping the primary circuit breakers and associated equipment into a virtual bay. These bays comprise a power system subset to be protected such as a transformer or a line end, and the control of its switchgear has some common restrictions such as mutual interlocking or well-defined operation sequences. The identification of such subparts is important for maintenance purposes (which parts may be switched off at the same time with a minimum impact on the rest of the substation) or for extension plans (what has to be added if a new line is to be linked in). These subparts are called bays and may be managed by devices with the generic name “bay controller” and have protection systems called “bay protection”.

The concept of a bay is not commonly used all over the world. The bay level represents an additional control level below the overall station level.

3.1.3
data object
part of a logical node object representing specific information, for example, status or measurement. From an object-oriented point of view, a data object is an instance of a data object class. Data objects are normally used as transaction objects; i.e., they are data structures.

3.1.4
device
mechanism or piece of equipment designed to serve a purpose or perform a function, for example, breaker, relay, or substation computer

[IEEE 100,1996]

3.1.5
functions
tasks, which are performed by the substation automation system, i.e. by application functions. Generally, functions exchange data with other functions. The details are dependent on the functions in consideration. Functions are performed by IEDs (physical devices). Functions may be split in parts residing in different IEDs but communicating with each other (distributed function) and with parts of other functions. These communicating function parts are called logical nodes.

In the context of this standard, the decomposition of functions or their granularity is ruled by the communication behaviour only. Therefore, all functions considered consist of logical nodes that exchange data.

3.1.6
Intelligent Electronic Device
IED
any device incorporating one or more processors with the capability of receiving or sending data/control from or to an external source (for example, electronic multifunction meters, digital relays, controllers)

3.1.7
interchangeability
ability to replace a device supplied by one manufacturer with a device supplied by another manufacturer, without making changes to the other elements in the system

3.1.8
interoperability
ability of two or more IEDs from the same vendor, or from different vendors, to exchange information and use that information for correct execution of specified functions

3.1.9
Logical Node
LN
smallest part of a function that exchanges data. A LN is an object defined by its data and methods.

3.1.10
open protocol
protocol whose stack is either standardised or publicly available

3.1.11
Physical Device
PD
equivalent to an IED as used in the context of this standard

3.1.12
PICOM
description of an information transfer on a given logical connection with given communication attributes between two logical nodes (Piece of Information for COMmunication). It also contains the information to be transmitted and, in addition, requirement attributes such as performance. It does not represent the actual structure and format for data that is exchanged over the communication network. The PICOM approach was adopted from CIGRE working group 34.03.

3.1.13
protocol
set of rules that determines the behaviour of functional units in achieving and performing communication

3.1.14
self-description
a device contains information on its configuration. The representation of this information has to be standardised and has to be accessible via communication (in the context of this standard series).

3.1.15
system
within the scope of this standard, system always refers to substation automation systems unless otherwise stated

3.1.16
Specific Communication Service Mapping
SCSM
standardised procedure which provides the concrete mapping of ACSI services and objects onto a particular protocol stack/communication profile.

To facilitate interoperability it is intended to have a minimum number of standardized mappings (SCSM). Special application subdomains such as “station bus” and “process bus” may result in more than one mapping. However, for a specific protocol stack selected only one single SCSM and one single profile should be specified.

A SCSM should detail the instantiation of abstract services into protocol specific single service or sequence of services which achieve the service as specified in ACSI. Additionally, a SCSM should detail the mapping of ACSI objects into object supported by the application protocol.

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

3.2 Abbreviated terms

ACSI	Abstract Communication Service Interface
AIS	Air Insulated Switchgear
CB	Circuit Breaker
CDC	Common Data Class
DO	Data Object
EMC	Electromagnetic Compatibility
GOMSFE	Generic Object Models for Substation and Feeder Equipment
IED	Intelligent Electronic Device
GIS	Gas Insulated Switchgear
LN	Logical Node
PD	Physical Device
PICOM	Piece of Information for COMmunication
SA	Substation Automation
SAS	Substation Automation System
SCSM	Specific Communication Service Mapping

4 Objectives

The possibility to build SAS rests on the strong technological development of large-scale integrated circuits, leading to the present availability of advanced, fast, and powerful microprocessors. The result was an evolution of substation secondary equipment, from electro-mechanical devices to digital devices. This in turn provided the possibility of implementing SAS using several intelligent electronic devices (IEDs) to perform the required functions (protection, local and remote monitoring and control, etc.). As a consequence, the need arose for efficient communication among the IEDs, especially for a standard protocol. Up to now, specific proprietary communication protocols developed by each manufacturer have been used, requiring complicated and costly protocol converters when using IEDs from different vendors.

The industry’s experiences have demonstrated the need and the opportunity for developing standard communication protocols, which would support interoperability of IEDs from different manufacturers. Interoperability in this case is the ability to operate on the same network or communication path sharing information and commands. There is also a desire to have IED interchangeability, i.e. the ability to replace a device supplied by one manufacturer with a device supplied by another manufacturer, without making changes to the other elements in the system. Interchangeability is beyond this communication standard. Interoperability is a

common goal for electric utilities, equipment vendors and standardisation bodies. In fact, in recent years several National and International institutions started activities to achieve this goal (see Annex B).

The objective of SA standardisation is to develop a communication standard that will meet functional and performance requirements, while supporting future technological developments. To be truly beneficial, a consensus must be found between IED manufacturers and users on the way such devices can freely exchange information.

The communication standard must support the operation functions of the substation. Therefore, the standard has to consider the operational requirements, but the purpose of the standard is neither to standardise (nor limit in any way) the functions involved in substation operation nor their allocation within the SAS. The application functions will be identified and described in order to define their communication requirements (for example, amount of data to be exchanged, exchange time constraints, etc.). The communication protocol standard, to the maximum possible extent, should make use of existing standards and commonly accepted communication principles.

The standard should ensure, among others, the following features:

- That the complete communication profile is based on existing IEC/IEEE/ISO/OSI communication standards, if available.
- That the protocols used will be open and will support self descriptive devices. It should be possible to add new a functionality.
- That the standard is based on data objects related to the needs of the electric power industry.
- That the communication syntax and semantics are based on the use of common data objects related to the power system.
- That the communication standard considers the implications of the substation being one node in the power grid, i.e. of the SAS being one element in the overall power control system.