TECHNICAL REPORT

IEC TR 62357

First edition
2003-07

Power system control and associated communications – Reference architecture for object models, services and protocols

Reference number
IEC/TR 62357:2003(E)

Publication numbering

As from 1 January 1997 all IEC publications are issued with a designation in the 60000 series. For example, IEC 34-1 is now referred to as IEC 60034-1.

Consolidated editions

The IEC is now publishing consolidated versions of its publications. For example, edition numbers 1.0, 1.1 and 1.2 refer, respectively, to the base publication, the base publication incorporating amendment 1 and the base publication incorporating amendments 1 and 2.

Further information on IEC publications

The technical content of IEC publications is kept under constant review by the IEC, thus ensuring that the content reflects current technology. Information relating to this publication, including its validity, is available in the IEC Catalogue of publications (see below) in addition to new editions, amendments and corrigenda. Information on the subjects under consideration and work in progress undertaken by the technical committee which has prepared this publication, as well as the list of publications issued, is also available from the following:

- **IEC Web Site (www.iec.ch)**

- **Catalogue of IEC publications**

  The on-line catalogue on the IEC web site (http://www.iec.ch/searchpub/cur_fut.htm) enables you to search by a variety of criteria including text searches, technical committees and date of publication. On-line information is also available on recently issued publications, withdrawn and replaced publications, as well as corrigenda.

- **IEC Just Published**

  This summary of recently issued publications (http://www.iec.ch/online_news/justpub/jp_entry.htm) is also available by email. Please contact the Customer Service Centre (see below) for further information.

- **Customer Service Centre**

  If you have any questions regarding this publication or need further assistance, please contact the Customer Service Centre:

  Email: custserv@iec.ch
  Tel: +41 22 919 02 11
  Fax: +41 22 919 03 00

TECHNICAL REPORT

IEC TR 62357

First edition
2003-07

Power system control and associated communications – Reference architecture for object models, services and protocols

International Electrotechnical Commission, 3, rue de Varembé, PO Box 131, CH-1211 Geneva 20, Switzerland
Telephone: +41 22 919 02 11 Telefax: +41 22 919 03 00 E-mail: inmail@iec.ch Web: www.iec.ch

Commission Electrotechnique Internationale
International Electrotechnical Commission
Международная Электротехническая Комиссия

PRICE CODE U

For price, see current catalogue

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

POWER SYSTEM CONTROL AND ASSOCIATED COMMUNICATIONS – Reference architecture for object models, services and protocols

FOREWORD

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

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

IEC 62357, 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
57/611A/DTR	57/627/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.

The committee has decided that the contents of this publication will remain unchanged until 2004[1]. At this date, the publication will be

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

[1] IEC Technical Committee 57 will revise this document immediately in order to accommodate comments received during the voting process with the goal of reflecting recent developments.

0 Introduction

IEC Technical Committee 57 develops standards for electric power system control and associated telecommunications in the areas of generation, transmission and distribution real-time operations and planning. The primary purpose of this Technical Report is to provide a reference architecture to show how the various standardisation activities within IEC Technical Committee 57 relate to each other and how they individually and collectively contribute to meeting the objectives of IEC Technical Committee 57. A second objective is to develop a strategy to combine and harmonize the work of these various activities to help facilitate a single, comprehensive plan for deployment of these standards in product development and system implementations.

The need for this framework is motivated by at least two major factors:

1. There are multiple independent standard initiatives that need to be coordinated and harmonized to minimize the need for data transformation to exchange data between systems using these various standards.
2. There is a need to have a comprehensive vision of how to deploy these standards for actual system implementation and integration efforts.

There are several different initiatives within IEC Technical Committee 57, each dealing with a selected part of the real-time operations and planning. Each has a specific objective and may have sufficient breadth of scope to provide the bulk of the relevant standards needed for product vendors to develop products based on those standards.

Trend toward integration of planning and control systems

In today's utility enterprise where information exchange between the various generation, transmission and distribution management systems and other IT systems is not only desirable but necessary in most cases, each system plays the role of either supplier or consumer of information, or more typically both. That means that both data semantics and syntax need to be preserved across system boundaries, where system boundaries in this context are interfaces where data is made publicly accessible to other systems or where requests for data residing in other systems are initiated. In other words, the *what* of the information exchange is actually much more important for system integration purposes than *how* the data is transported between systems.

Most previous efforts to define system architectures have dealt primarily with the *how* (i.e., definition of protocols for transporting the data), with a focus on utilizing as many existing ISO or TCP/IP standards to provide the various layers in the ISO OSI seven-layer reference model for protocol profiles.[2] However, the increasing use of object modeling techniques to define the data for information exchange within the different standards initiatives has appropriately shifted the focus away from the *how* to the *what*. This is the good news. The bad news is that each initiative has chosen its own modelling language/notation and more importantly generated its own object model definitions. This was not done intentionally, and in fact each initiative had perfectly good reasons for their choices, given the limited scope of their domain of application. But the consequence is that instead of one object model for each physical entity in the generation, transmission and distribution operations domain being standardized, at least two or more object models exist in most cases with different definitions for classes, attributes, data types, and relationships between classes. Furthermore, in most cases different modeling languages have also been used.

---

2 The original EPRI UCA project, for example, had the focus of settling on the use of MMS and a few standard profiles for transporting data rather than on the semantics of information transfer between systems.

POWER SYSTEM CONTROL AND ASSOCIATED COMMUNICATIONS – Reference architecture for object models, services and protocols

1 General

1.1 Scope and purpose of reference architecture

The first objective of a reference architecture is to describe all the existing object models, services, and protocols and how they relate to each other. A strategy can then be developed to show where common models are needed, and if possible, recommend how to achieve a common model. Where changes cannot be made due to maturity of standards, then recommendations for adapters to make the necessary transformations between models are made.

This report deals with the following standardisation initiatives and their relationships:

1. IEC Technical Committee 57, which is responsible for developing standards for power system control and associated telecommunications. Technical Committee 57 comprises a number of working groups of which the following are covered in this Technical Report:
   - IEC Technical Committee 57 Working group 3 – standards for reliable data acquisition and control on narrow-band serial data links or over TCP/IP networks between SCADA masters and substations.
   - IEC Technical Committee 57 Working group 7 – standards for the exchange of real-time operational data between control centers over Wide Area Networks (WANs).
   - IEC Technical Committee 57 Working group 9 – standards for data communications over distribution line carrier systems.
   - IEC Technical Committee 57 Working groups 10, 11 and 12 – standards for substations.
   - IEC Technical Committee 57 Working group 13 – standards to facilitate integration of applications within a control center, including the interactions with external operations in distribution as well as other external sources/sinks of information needed for real-time operations.
   - IEC Technical Committee 57 Working group 14 – standards for Distribution Management System interfaces for information exchange with other IT systems.
   - IEC Technical Committee 57 Working group 15 – standards for data and communication security.
   - IEC Technical Committee 57 Working group 16 – standards for deregulated energy market communications.
2. The Electric Power Research Institute (EPRI), which is responsible for the following projects that have contributed to the work of IEC Technical Committee 57:
   - CCAPI project, which is developing interfaces for information sharing between application programs in a control center with a scope that includes transmission, distribution, and generation (provides input to IEC Technical Committee 57 Working groups 13 and 14)
   - UCA2, which focuses primarily on communications to substation and substation devices in transmission and distribution substations (provides input to IEC Technical Committee 57 Working groups 10 to 12)
   - ICCP, also known as TASE.2, for inter-control center communications, but also applicable to substation communications in certain circumstances (provides input to IEC Technical Committee 57 Working group 7)

There are other standards-related activities that are relevant to IEC Technical Committee 57 and are the source of either existing or planned standards that can be adopted (perhaps with some tailoring to meet utility-specific needs). Figure 1 graphically depicts these activities and domain of application. Of particular interest are the following:

- Object Management Group (OMG), an industry consortium responsible for the CORBA standards for open distributed computing. IEC Technical Committee 57 Working group 13 is working closely with the OMG Utilities Domain Task Force (DTF) to develop standards for common data access and acquisition of SCADA data.
- Open Application Group (OAG), an industry consortium responsible for Enterprise Application Integration (EAI) solutions. IEC Technical Committee 57 Working group 14 is working closely with the OAG to develop standard XML messages for information exchange between distribution management systems and other IT systems.

While there are liaisons between individual IEC Technical Committee 57 working groups and these organizations, they are not the subject of this Technical Report and are therefore not discussed further. The interested reader is referred to working groups mentioned above and the websites of these organizations for more information.

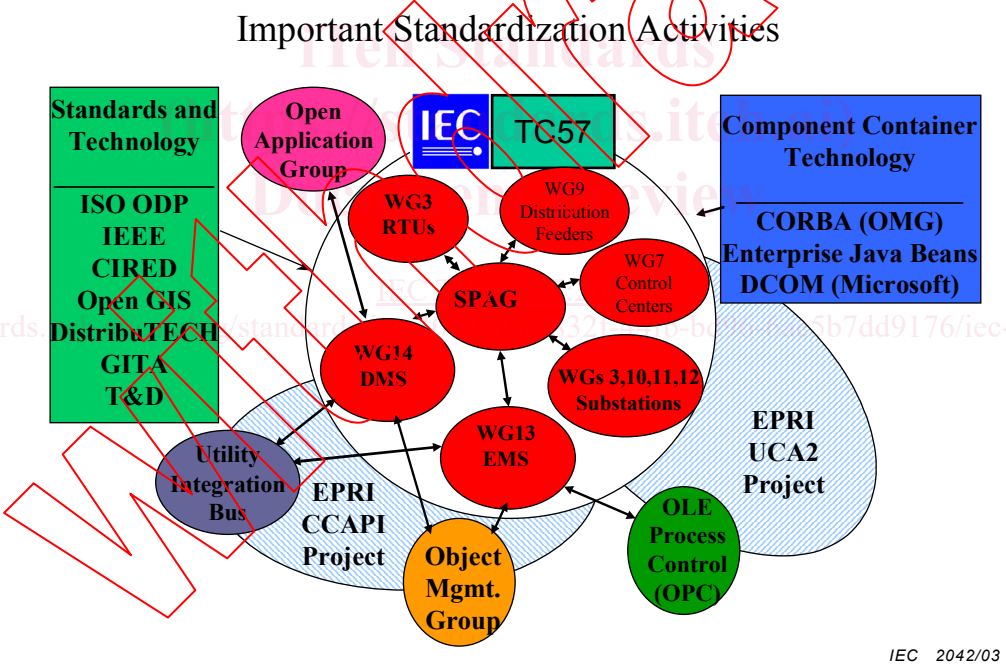

Figure 1 – Coordination among standards activities

Figure 2 shows the scope of activity encompassed by the IEC Technical Committee 57 working groups identified above. The standards shown in Figure 2 are described in the following Clause.

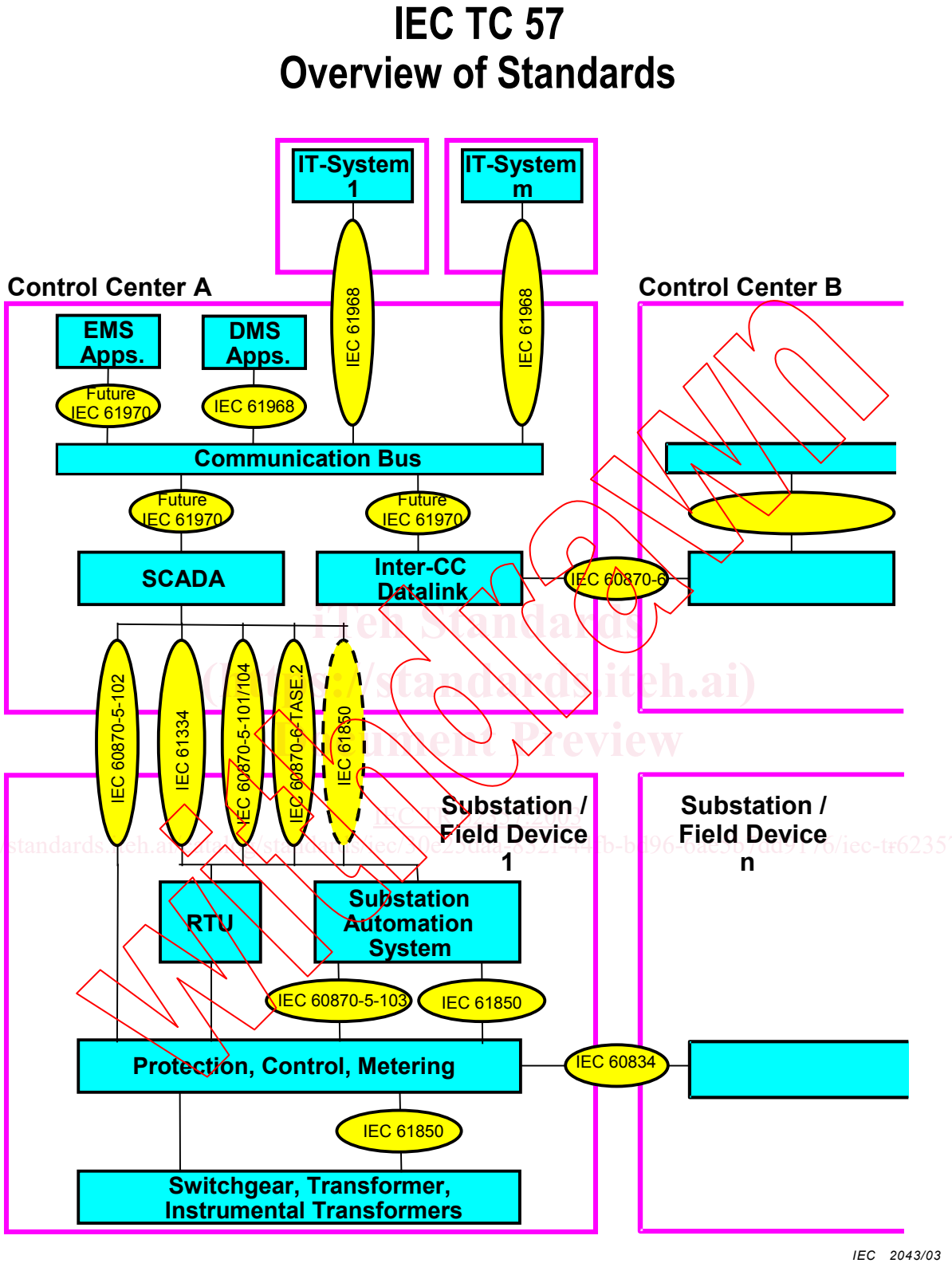

Figure 2 – Application of IEC Technical Committee 57 Standards to a power system

1.2 Reference documents

IEC 60870-5 (all parts), *Telecontrol equipment and systems - Part 5: Transmission protocols*

IEC 60870-6 (all parts), *Telecontrol equipment and systems - Part 6: Telecontrol protocols compatible with ISO standards and ITU-T recommendations*

IEC 61334 (all parts), *Distribution automation using distribution line carrier systems*

IEC 61850 (all parts), *Communication networks and systems in substations*

IEC 61968 (all parts), *Application integration at electric utilities – System interfaces for distribution management*

IEC 62056 (all parts), *Electricity metering - Data exchange for meter reading, tariff and load control*

ISO/IEC 8824-1, *Information technology - Abstract Syntax Notation One (ASN.1): Specification of basic notation*

ISO/IEC 8824-2, *Information technology - Abstract Syntax Notation One (ASN.1): Information object specification*

ISO/IEC 9506 (all parts), *Industrial automation systems - Manufacturing message specification*

2 IEC Technical Committee 57 Standards

As in most standards activities, the working documents from Technical Committee 57 that eventually become standards originate within the individual working groups of Technical Committee 57. These working groups were formed from the bottom up rather than from an initial vision embodied in an umbrella framework or reference architecture handed down by IEC Technical Committee 57. That is, within the broad charter of IEC Technical Committee 57, which is "power systems control and associated telecommunications", working groups were formed whenever a member country took the initiative to propose a new work item.

The first working groups focused on protocols and services for data links from control centers to substations and to other control centers (IEC Technical Committee 57 Working groups 3 and 7). This work primarily provided standards for exchanging SCADA data and controlling substation devices.

2.1 IEC 60870-5 Standards from IEC Technical Committee 57 Working group 3

IEC Technical Committee 57 Working group 3 initially focused on providing standards for reliable communications on narrow-band serial data links traditionally used for communications between a SCADA master in a control center and RTUs located in transmission substations in the field. The first IEC Technical Committee 57 Working group 3 standard IEC 60870-5-101 resulted in a three-layer protocol stack custom designed for high reliability and low bit rate on the wire. Later, the scope of IEC Technical Committee 57 Working group 3 was broadened to include telecontrol protocols mapped onto data networks, such as router-based WANs. This resulted in IEC 60870-5-104, which provides network access for IEC 60870-5-101 using standard transport profiles, primarily TCP/IP.