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TECHNICAL REPORT

colour inside

Power systems management and associated information exchange – Part 1: Reference architecture

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POWER SYSTEMS MANAGEMENT AND ASSOCIATED INFORMATION EXCHANGE –

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IEC 62357-1, which is a technical report, has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

This new edition cancels and replaces the first edition published in 2012 and constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) The new edition provides updates and defines layered Reference Architecture to help direct longer term goals and activities, specifically to ensure compatibility of all new standards developed in the IEC by benefitting from lessons learned during development of the current standards and their application to actual utility projects as well as through application of other internationally recognized architecture standards.

b) This edition reflects the progress recently achieved with the international Smart Grids (SG) initiatives and the CIGRE D2.24 large system architecture vision. It also leverages the work done by NIST-SGIP, CEN-CELELEC-ETSI SGCG M490, IEC SG3 Smart Grids Roadmap, and IEC SyC Smart Energy working groups.

The edition also reflects the most recent editions of the IEC standards relating to power systems management and associated information exchange, including the IEC 61850 series and the IEC 61968, IEC 61970 and IEC 62325 Common Information Model (CIM) standards.

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

Enquiry draft	Report on voting
57/1688/DTR	57/1745/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.

In this technical report, the following print types are used:

– *obligations: in italic underlined type.*

A list of all parts in the IEC 62357 series, published under the general title *Power systems management and associated information exchange*, can be found on the IEC website.

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

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- withdrawn,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

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

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POWER SYSTEMS MANAGEMENT AND ASSOCIATED INFORMATION EXCHANGE –

Part 1: Reference architecture

1 Scope

Electricity grids from generation to consumers, including transmission and distribution, as well as energy markets are facing many new challenges while integrating an increasing variety of digital computing and communication technologies, electrical architectures, associated processes and services. The new challenges lead very often to support an increasing level of interaction between involved actors, components and systems.

Thus, it is key for the IEC to propose a clear and comprehensive map of all standards which are contributing to support these interactions, in an open and interoperable way.

The purpose of this document is to provide such a map (as available in 2016), but also to bring the vision of the path which will be followed by the concerned IEC technical committees and working groups in the coming years, to improve the global efficiency, market relevancy and coverage of this series of standards.

2 Normative references

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

IEC 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 61850 (all parts), *Communication networks and systems for power utility automation*

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

IEC 61970 (all parts), *Energy Management System Application Program Interface (EMS-API)*

IEC 62325 (all parts), *Framework for energy market communications*

IEC 62351 (all parts), *Power systems management and associated information exchange – Data and communications security*

IEC TR 62357-200, *Power systems management and associated information exchange – Part 200: Guidelines for migration from Internet Protocol version 4 (IPv4) to Internet Protocol version 6 (IPv6)*

IEC 62361 (all parts), *Power systems management and associated information exchange – Interoperability in the long term*

IEC 62746 (all parts), *Systems interface between customer energy management system and the power management system*

3 Terms, definitions and abbreviated terms

3.1 Terms

3.1.1 Architecture

The purpose of architecture is to define or improve systems. The architectural process encompasses understanding the scope of interest, understanding stakeholder requirements, and arriving at a design to satisfy those requirements.

The two word-senses in which architecture is used are:

- A set of models with the purpose of representing a system of interest.
- The activity and/or practice of creating the set of models representing a system.

Model Driven Architecture advocates the application of modelling to the architectural process and formalizes the resulting artefacts such that the realization or improvement of the system may be more actionable, less expensive and less risky.

3.1.2 Reference Architecture

A Reference Architecture describes the structure of a system with its element types and their structures, as well as their interaction types, among each other and with their environment. Describing this, a Reference Architecture defines restrictions for an instantiation (concrete architecture). Through abstraction from individual details, a Reference Architecture is universally valid within a specific domain. Further architectures with the same functional requirements can be constructed based on the Reference Architecture. Along with Reference Architectures comes a recommendation, based on experiences from existing developments as well as from a wide acceptance and recognition by its users or per definition. [ISO/IEC 42010]

3.1.3 System

A system is a collection of parts and relationships among these parts that may be organized to accomplish some purpose.

In Model Driven Architecture, the term ‘system’ can refer to an information processing system but it is also applied more generally. Thus a system may include anything: a system of hardware, software, and people, an enterprise, a federation of enterprises, a business process, some combination of parts of different systems, a federation of systems – each under separate control, a program in a computer, a system of programs, a single computer, a system of computers, a computer or system of computers embedded in some machine, etc.

One of the key strengths of modelling, and one that distinguishes it from implementation technologies like software source code, is that it is an excellent way to represent, understand and specify systems.

In Smart Grids Architecture Model (SGAM) a system is a boundary which include all layers of SGAM

3.1.4 Functional Architecture / Concept

- A “function” represents a logical entity which performs a dedicated function. Being a logical entity, a function can be physically implemented in various ways (in devices or applications).
- A “function group” is a logical aggregation of one or more functions.

- An “interaction” of two or more functions is indicated by a connecting line between these functions. Interaction is realized by information exchange via the interfaces of functions and communication means.
- A “functional architecture” identifies the functional elements of a system and relates them to each other.

3.1.5 Service

This is the contract to perform a certain task, with certain deliverables (output) and other agreements on what is included (external view)

3.1.6 Function

This is when the service is carried out (internal view)

3.1.7 Application

This is the implementation of a service providing a certain functionality

3.1.8 Model

A model in the context of Model Driven Architecture (MDA) is information selectively representing some aspect of a system based on a specific set of concerns. The model is related to the system by an explicit or implicit mapping. A model should include the set of information about a system that is within scope, the integrity rules that apply to that system and the meaning of terms used.

A model may represent the business, domain, software, hardware, environment, and other domain-specific aspects of a system.

3.1.9 Modelling language

To be useful, any model needs to be expressed in a way that communicates information about a system among involved stakeholders that can be correctly interpreted by the stakeholders and supporting technologies. This requires that the model be expressed in a language understood by these stakeholders and their supporting technologies. Well-known modelling languages include Unified Modelling Language (UML), Structured Query Language (SQL), Business Process Model and Notation (BPMN, E/R, Ontology Web Language (OWL), EXtensible Mark-up Language (XML) Schema.

3.1.10 Elements

Elements are systems and a system may contain subsystems applications and devices. An element can also be a function or group of functions. An element can also be a service or group of services.

3.1.11 Profile

Generally a profile defines a subset of an entity (e.g. standard, specification or a suite of standards/specifications). Profiles enable interoperability and therefore can be used to reduce the complexity of a given integration task by:

- selecting or restricting standards to the essentially required content, e.g. removing options that are not used in the context of the profile
- setting specific values to defined parameters (frequency bands, metrics, etc.)

A standard profile for communications standards may contain a selection of communication capabilities applicable for specific deployment architecture. Furthermore a profile may define instances (e.g. specific device types) and procedures (e.g. programmable logics, message sequences) in order to support interoperability. It may also provide a set of engineering guidelines to ease the deployment of new technologies.

3.2 Abbreviated terms

AMM	Advanced Metering Manager
BPMN	Business Process Model and Notation
CEN/CENELEC	European Committee for Electrotechnical Standardization
CIGRE	Conseil International des Grands Réseaux Electriques
CIM	Common Information Model
COSEM	Companion Specification for Energy Metering
DER	Distributed Energy Resources
DR	Demand Response
DSO	Distribution System Operator
ebIX	European forum for energy Business Information eXchange
EFET	European Federation of Energy Traders
ENTSO-E	European Network of Transmission System Operators for Electricity
ETSI	European Telecommunications Standards Institute
EU	European Union
EV	Electric Vehicle
FERC	Federal Energy Regulatory Commission
GIS	Geographic Information System
ISO	International Standardization Organization
ITU	International Telecommunications Union
MDA	Model Driven Architecture
NERC	North American Electric Reliability Corporation
NIST	National Institute of Standards and Technology
OWL	Ontology Web Language
RA	Reference Architecture
RDF	Resource Description Framework
SCADA	Supervisory Control And Data Acquisition
SDO	Standards Development Organization
SG	Smart Grid
SGAC	Smart Grids Architecture Committee
SGAM	Smart Grids Architecture Model
SGIP	Smart Grids Interoperability Panel
SGTCC	Smart Grids Testing & Certification Committee
SNMP	Simple Network Management Protocol
SQL	Structured Query Language
TC	Technical Committees
TOGAF	The Open Group Architecture Framework
TSO	Transmission System Operator
UML	Unified Modelling Language
XML	Extensible Markup Language
XSD XML	Schema Definition

4 Drivers and objectives for Reference Architecture

The Reference Architecture drivers are:

- Need to manage the increase of intermittent and distributed energy resources

The objective is to anticipate the new usage of electricity and support the new business models attached to these new usages.

Electricity paradigms are changing due to the introduction of intermittent distributed resources, as well as a higher and higher presence of active users, modifying their behaviour to make the most of electricity.

It is the role of the IEC to enable the emergence of these new ways of using electricity.

It shall enable meaningful data to flow freely across the system as the energy flows in various directions and ensure any information is available anywhere it is needed.

The Reference Architecture shall consider and represent the specifics of intermittent and distributed energy resources. It shall support meaningful information exchanges and communication within the power system and to external parties to facilitate their integration.

- Need for sustainable and efficient energy

The objective is to make the best of available energy and preserve natural resources

The contribution of the Reference Architecture is to facilitate and consider specific requirements for interactions between or within involved players, renewable energy producers, markets, utilities and consumers to reach such a goal.

The Reference Architecture must provide a means to leverage energy efficiency potentials.

- Need for safe, secure, and reliable energy to have a resilient power system

The objective is to support the needed functions to provide the expected quality to consumers such as voltage and frequency regulation and outage reduction

The objective is to provide a resilient power management system complying with the reliability objective of the utility

Cyber security supports the reliable operation of power systems coping with technical, physical, and organizational security requirements related to specific use cases. The derivation of security requirements is typically based on a threat and risk analysis. Further security requirements may also stem from regulation. The security counter measures need to be appropriate to address the security requirements.

The Reference Architecture provides a framework for identifying risk and providing security counter measures.

- Need for economic efficiency

The objective is to support flexibility while maximising the use of existing foundations

Architecture flexibility refers to its ability to adapt to dynamic changes mostly through incremental changes.

This may lead the architecture to add/remove/update services/functions/components at different level of depths.