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**Integration von Anwendungen in Anlagen der Elektrizitätsversorgung –
Systemschnittstellen für Netzführung –
Teil 1: Schnittstellenarchitektur und allgemeine Anforderungen
(IEC 57/1110/CDV:2011);
Englische Fassung FprEN 61968-1:2011**

Application integration at electric utilities –
System interfaces for distribution management –
Part 1: Interface architecture and general requirements
(IEC 57/1110/CDV:2011);
English version FprEN 61968-1:2011

Intégration d'applications pour les services électriques –
Interfaces système pour la gestion de distribution –
Partie 1: Architecture des interfaces et recommandations générales
(CEI 57/1110/CDV:2011);
Version anglaise FprEN 61968-1:2011

Anwendungswarnvermerk

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Weil die beabsichtigte Norm von der vorliegenden Fassung abweichen kann, ist die Anwendung dieses Entwurfes besonders zu vereinbaren.

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Gesamtumfang 87 Seiten

DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE

Nationales Vorwort

Die Englische Fassung des europäischen Dokuments FprEN 61968-1:2011 „Integration von Anwendungen in Anlagen der Elektrizitätsversorgung – Systemschnittstellen für Netzführung – Teil 1: Schnittstellenarchitektur und allgemeine Anforderungen“ (Entwurf in der Umfrage) ist unverändert in diesen Norm-Entwurf übernommen worden.

Die Internationale Elektrotechnische Kommission (IEC) und das Europäische Komitee für Elektrotechnische Normung (CENELEC) haben vereinbart, dass ein auf IEC-Ebene erarbeiteter Entwurf für eine Internationale Norm zeitgleich (parallel) bei IEC und CENELEC zur Umfrage (CDV-Stadium) und Abstimmung als FDIS (en: Final Draft International Standard) bzw. Schluss-Entwurf für eine Europäische Norm gestellt wird, um eine Beschleunigung und Straffung der Normungsarbeit zu erreichen. Dem entsprechend ist das internationale Dokument Integration von Anwendungen in Anlagen der Elektrizitätsversorgung – Systemschnittstellen für Netzführung – Teil 1: Schnittstellenarchitektur und allgemeine Anforderungen IEC 57/1110/CDV:2011 „Application integration at electric utilities – System interfaces for distribution management – Part 1: Interface architecture and general requirements“ unverändert in den Entwurf FprEN 61968-1:2011 übernommen worden.

Das internationale Dokument wurde vom TC 57 „Power systems management and associated information exchange“ der Internationalen Elektrotechnischen Kommission (IEC) erarbeitet.

Bei der Abstimmung zu dem Europäischen Schluss-Entwurf bei CENELEC und dem Internationalen Schluss-Entwurf bei IEC [Final Draft International Standard (FDIS)] sind jeweils nur „JA/NEIN“-Entscheidungen möglich, wobei „NEIN“-Entscheidungen fundiert begründet werden müssen. Dokumente, die bei CENELEC als Europäische Norm angenommen und ratifiziert werden, sind unverändert als Deutsche Normen zu übernehmen.

Für diesen Norm-Entwurf ist das nationale Arbeitsgremium K 952 „Netzleittechnik“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE (www.dke.de) zuständig.

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Für den Fall einer datierten Verweisung im normativen Text bezieht sich die Verweisung immer auf die in Bezug genommene Ausgabe der Norm.

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Änderungen

Gegenüber DIN EN 61968-1:2004-09 wurden folgende Änderungen vorgenommen:

- a) Fachlich komplett überarbeitet;
- b) Klarstellungen und Berichtigungen;
- c) Modell für Informationsaustausch mit CIM-Profil ersetzt.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

Application integration at electric utilities – System interfaces for distribution management –

Part 1: Interface architecture and general requirements

FOREWORD

- 1) The IEC (International Electrotechnical Commission) is a world-wide 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.
- 2) The formal decisions or agreements of the 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 National Committees.
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- 6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights. International Standard IEC 61968-1 has been prepared by Working Group 14, of IEC technical committee 57: Power System Control And Associated Communications. IEC 61968 is a series of standards:

IEC 61968 Part	Title
1.	Interface Architecture And General Recommendations
2.	Glossary
3.	Interface Standard For Network Operation
4.	Interface Standard For Records And Asset Management
5.	Interface Standard For Operational Planning And Optimisation
6.	Interface Standard For Maintenance And Construction
7.	Interface Standard For Network Extension Planning
8.	Interface Standard For Customer Support

- | | |
|-----|--|
| 9. | Interface Standard For Meter Reading And Control |
| 11. | Common information model (CIM) extensions for distribution |
| 13. | CIM RDF Model Exchange Format for Distribution |

The text of this standard is based on the following documents:

FDIS	Report on voting
57/274/NP	57/294/RVN
57/525/CDV	
57/650/FDIS	

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This document is currently a maintenance cycle report (MCR) released November 2010.

CONTENTS

	Page
FOREWORD	1
Introduction	5
1 Scope	9
2 Normative references	9
3 Interface reference model	10
3.1 Domain	10
3.2 Business functions	10
3.3 Interface reference model	11
4 Integration infrastructure recommendations	51
4.1 Requirements analysis methodology	51
5 Interface profile	51
5.1 Components	52
5.2 Component adapters	53
5.3 Interface specification	53
5.4 Middleware adapter	53
5.5 Middleware services	54
5.6 Communication services	55
5.7 Platform environment	55
6 Information exchange model	56
6.1 General requirements	56
6.2 Message structures	57
6.2.1 General recommendation	57
6.2.2 Message header	57
6.2.3 Message type payload	58
6.2.4 Explanation of associations	60
6.2.5 Compliance	61
6.2.6 Extension	61
6.2.7 Request message	61
6.2.8 Response message	62
6.2.9 Event message	62
6.2.10 Fault message	63
6.2.11 Signature element	63
7 Component reporting and error handling	64
7.1 Error message handling	64
8 Security and authentication	65
9 Maintenance aspects	66
Annex A	67
Distribution Management Domain	67
Annex B	71
Use of IEC 61968 Series Of Standards	74

Annex C	82
Inter-Application Integration Performance Considerations	82
Annex D	83
Views Of Data In A Conventional Electric Utility	83

Tables

Table 1: Document Overview for IEC 61968 - Part 1	8
Table 2: The Interface Reference Model (IRM)	12
Table 3: Overview of Message Header	57
Table A.1: Examples of data exchange in a company environment	69
Table A.2: Data Categories	70
Table B.1: Use Case Template	75
Table B.2: Commonly Used Verbs	80
Table C.1: Typical Load Scenario	82

Figures

Figure 1: Distribution management with IEC 61968 compliant interface architecture	5
Figure 2: Example Utility Implementation Of IEC 61968	7
Figure 3: Typical Functions Mapped to Interface Reference Model	11
Figure 4: Overview of the Interface Profile and Corresponding Sub-Clause Numbers	52
Figure 5: Example of a message type payload	59
Figure 6: Example of how message elements are derived from the CIM	60
Figure 7: Navigating associations in CIM (UML notation)	60
Figure 8: Navigating associations in message type schemas	61
Figure A.1: Hierarchy of complexity in a system environment	67
Figure A.2: General utility structure	68
Figure B.1: Process 2A: Typical business sub-functions of DMS and external systems	72
Figure B.2: Process 2B: (Continuation) An Overview Of An Utility's Application Of The IEC 61968 Standard	73
Figure D.1: Database views depend on the time and user	84

Annexes

Annex A	67
Annex B	71
Annex C	82
Annex D	83

IEC 61968 System Interfaces for Distribution Management – Part 1: Interface Architecture and General Recommendations

Introduction

The IEC 61968 series is intended to facilitate *inter-application integration*, as opposed to *intra-application integration*, of the various distributed software application systems supporting the management of utility electrical distribution networks. Intra-application integration is aimed at programs in the same application system, usually communicating with each other using middleware that is embedded in their underlying runtime environment, and tends to be optimized for close, real-time, synchronous connections and interactive request/reply or conversation communication models. IEC 61968, by contrast, is intended to support the inter-application integration of a utility enterprise that needs to connect disparate applications that are already built or new (legacy or purchased applications), each supported by dissimilar runtime environments. Therefore, IEC 61968 is relevant to loosely coupled applications with more heterogeneity in languages, operating systems, protocols and management tools. IEC 61968 is intended to support applications that need to exchange data on an event driven basis. IEC 61968 is intended to be implemented with middleware services that broker messages among applications, complementing not replacing utility data warehouses, database gateways, and operational stores.

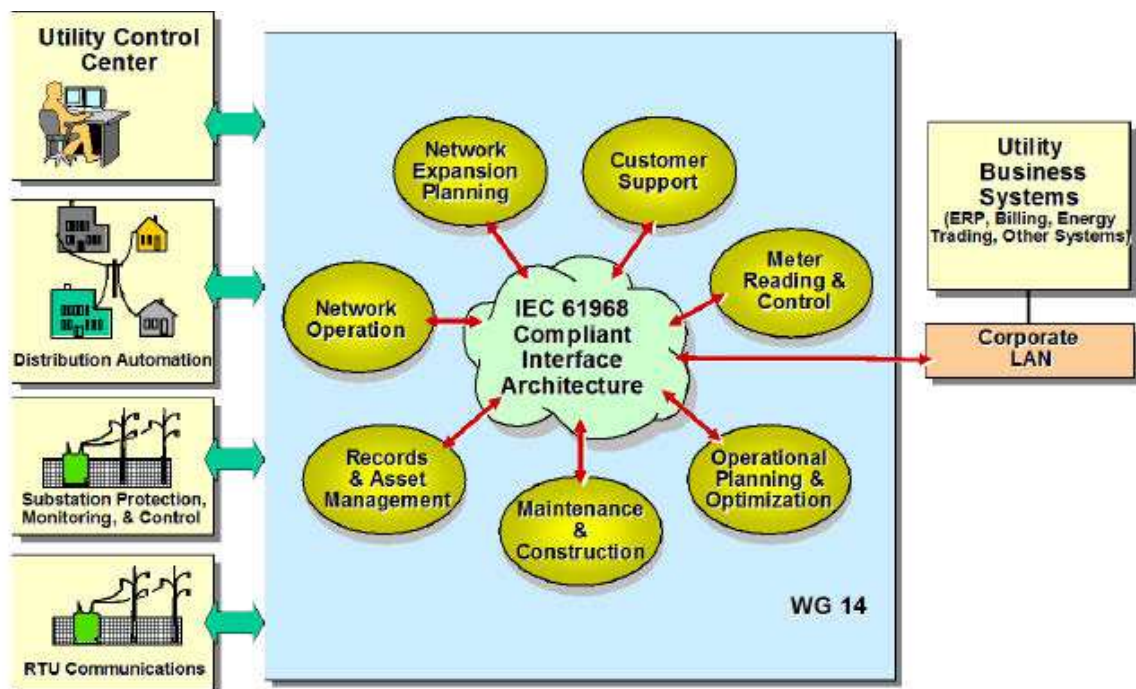


Figure 1: Distribution management with IEC 61968 compliant interface architecture

Figure 1 clarifies the scope of IEC 61968-1 graphically in terms of business functions and shows distribution management with IEC 61968 compliant interface architecture.

As used in IEC 61968, a Distributed Management System (DMS) consists of various distributed application components for the utility to manage electrical distribution networks. These capabilities include monitoring and control of equipment for power delivery, management processes to ensure system reliability, voltage management, demand-side management, outage management, work management, automated mapping and facilities management. The distributed management system could also be integrated with premise area network (PAN) through advanced metering infrastructure (AMI) network. Standard interfaces are to be defined for each class of applications identified in the Interface Reference Model (IRM).

IEC 61968 recommends that the semantics (domain model) of system interfaces of a compliant utility inter-application infrastructure be defined using Unified Modelling Language (UML).

The eXtensible Markup Language (XML) is a data format for structured document interchange particularly on the Internet. One of its primary uses is information exchange between different and potentially incompatible computer systems. XML is thus recommended to define *grammar/syntax* (profiles) of a compliant utility inter-application infrastructure.

Where applicable, Parts 3 to 9 and 13 of this standard will define the information recommended for '*message payloads*'. *Message Payloads* will be formatted using XML, with structures defined using XML Schema (parts 3-9) or RDF Schema (part 13) with the intent that these payloads can be loaded on to messages of various messaging transports, e.g. SOAP, JMS, RESTful HTTP, Web Services (WS), and etc. It is the intent of IEC 61968 to be leveraged by both Service-Oriented Architectures (SOA) and Enterprise Service Buses (ESB). In the future, it is possible that payload formats other than XML could be officially adopted by IEC 61968 for specific parts or information exchanges.

Communication between application components of the IRM requires compatibility on two levels:

- Message formats and protocols.
- Message contents must be mutually understood, including application-level issues of message layout and semantics.

Clause 5 defines abstract middleware services recommended to support communication between the applications defined in the IRM. These services are intended to be deployed, with little additional software required, by mapping them to commonly available services from various messaging technologies including web services (WS-*) and middleware such as Message Brokers, Message Oriented Middleware (MOM), Message-Queuing Middleware (MQM), and Enterprise Service Buses (ESB). Clause 5 is organized as follows:

- Sub-clause 5.1 identifies general recommendations of the applications identified in the IRM.
- Sub-clause 5.2 describes how standard information exchange services may either be invoked directly from an application (native mode) or that software may be used to map (adapt) an application to the information exchange services.
- Sub-clause 5.3 identifies standard services recommended for applications to exchange information with other applications.
- Sub-clause 5.4 describes how information exchange services may either be supported directly by middleware or that software may be required to map (adapt) the utility's middleware services to the standard information exchange services.
- Sub-clauses 5.5 to 5.7 describe environmental recommendations for information exchange.

An Example Using IEC 61968

An example of a typical utility's implementation of IEC 61968 is provided in Figure 2. In this example, the utility has used *interface adapters* as a means to integrate many of its legacy systems with other application systems that are IEC 61968 compliant. Note those legacy systems and IEC 61968 compliant systems both continue to use proprietary integration techniques among their internal applications; only information that needs to be exchanged among applications at the utility enterprise level is expected to use IEC 61968 interface services.

For purposes of this example, assume that the utility's Outage Management System (OMS) already has the capability to issue controls to and gather device states from the Distribution Automation System (DAS). As it is working acceptably for the utility, this interface does not need to be changed. However, because other applications need to be notified when distribution devices change state, the DAS publishes state changes through middleware services. Another benefit of publishing events is that they can be recorded by an event history application in a data store; this data can then be used in the generation of various types of reports. As much of the information exchanged among these systems is useful for management decision support, a data warehouse application has also been connected to the IEC 61968 middleware services so that it may receive published information.

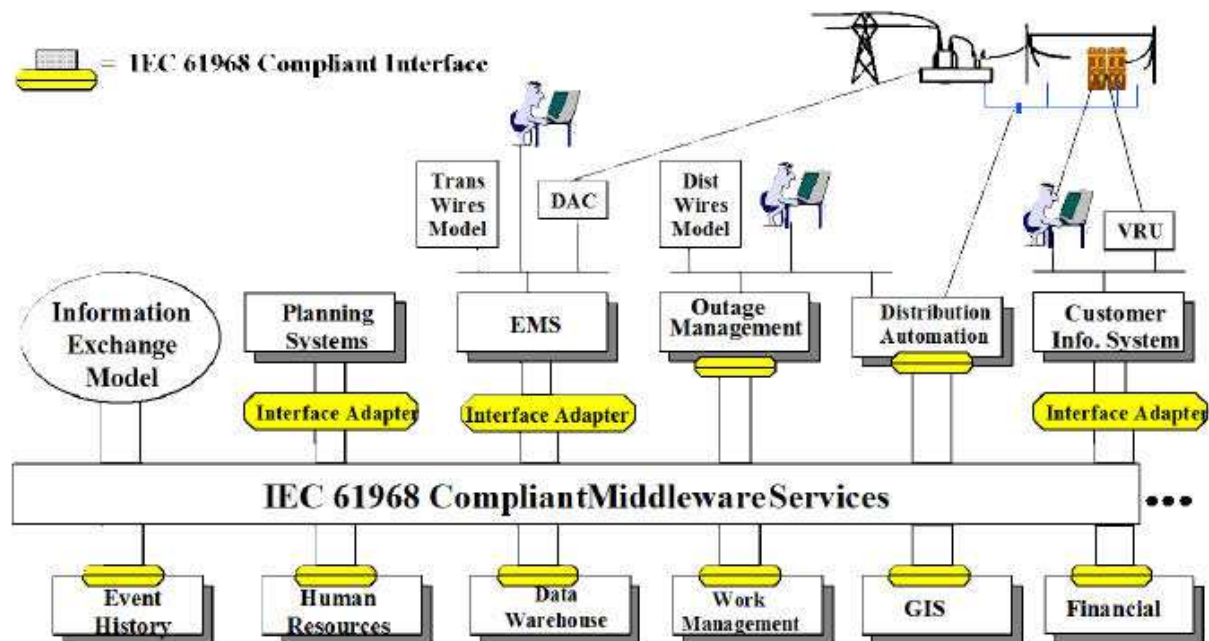


Figure 2: Example Utility Implementation Of IEC 61968

The organization of IEC 61968-1 is described in Table 1.

Table 1: Document Overview for IEC 61968 - Part 1

Clause	Title	Purpose
1.	Scope	Scope of IEC 61968, Part 1.
2.	Normative References	Documents that contain provisions which, through reference in this text, constitute provisions of this International Standard.
3.	Interface Reference Model	The domain relevant to IEC 61968 is described. For each relevant business function, a list of abstract components is provided, which is described by the functions performed by the component. IEC 61968 Parts 3-9 define interfaces for these abstract components.
4.	Integration Infrastructure Recommendations	The Interface Reference Model for utility inter-application integration is provided along with the rationale for its infrastructure.
5.	Interface Profile	Utility inter-application integration environmental requirements are described. Abstract message passing services are defined and must be available for applications to communicate information to other applications, including publish and subscribe services.
6.	Information Exchange Model	Requirements and recommendations are provided for information exchange between applications/functions listed in the IRM.
7.	Component Reporting And Error Handling	Recommendations for audit trails and error message handling authentication necessary to support utility inter-application integration are described.
8.	Security and Authentication	Recommendations for security and authentication necessary to support utility inter-application integration are described.
9.	Maintenance Aspects	General maintenance recommendations are specified.
Informative Annex A	Distribution Management Domain	An overview of business functions recommended for electric utility distribution management is described.
Informative Annex B	IEC 61968 Series Of Standards – Development Process	The methodology used to determine interface architecture recommendations for utility inter-application integration is described.
Informative Annex C	Inter-Application Integration Performance Considerations	Some typical performance recommendations necessary to support utility inter-application integration are described. These recommendations are of a general nature as specific implementation requirements will vary by utility.
Informative Annex D	Views of Data in a Conventional Electric Utility	This annex describes some of the underlying principles of defining the reference data dictionary of Part 11.

1 Scope

This standard, IEC 61968-1, is the first in a series that, taken as a whole, define interfaces for the major elements of an interface architecture for distribution management. This standard, referred to as Part 1, identifies and establishes *recommendations for standard interfaces* based on an Interface Reference Model (IRM). Subsequent parts of this standard are based on each interface identified in the IRM. This set of standards is limited to the definition of interfaces. They provide for interoperability among different computer systems, platforms, and languages. Methods and technologies used to implement functionality conforming to these interfaces are considered outside of the scope of these standards; only the interface profiles are specified in these standards.

As used in IEC 61968, distribution management consists of various distributed application components for the utility to manage electrical distribution networks. These capabilities include monitoring and control of equipment for power delivery, management processes to ensure system reliability, voltage management, demand-side management, outage management, work management, automated mapping and facilities management. The IRM is specified in Clause 3.

2 Normative references

The following normative documents contain provisions that, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 61968-11, *Application integration at electric utilities – System interfaces for distribution management - Part 11: Common Information Model (CIM) extensions for distribution*

IEC 62361-100, *Naming and Design Rules for CIM Profiles to XML Schema Mapping*

IEC 61970-301 *Energy Management System Application Program Interface (EMS API) – Common Information Model (CIM) Base*

IEC 61970-501 *Energy Management System Application Program Interfaces – Part 501 Common Information Model Resource Description Framework (CIM RDF) schema.*

3 Interface reference model

3.1 Domain

Within this document, the Distribution Management domain covers all aspects of management of utility electrical distribution networks. A distribution utility will have some or all of the responsibility for monitoring and control of equipment for power delivery, management processes to ensure system reliability, voltage management, demand-side management, outage management, work management, automated mapping and facilities management.

The Distribution Management domain may be organised as two inter-related types of business, Electricity Supply and Electricity Distribution. Electricity Supply is concerned with the purchase of electrical energy from bulk producers for sale to individual consumers. Electricity Distribution covers the management of the physical distribution network that connects the producers and consumers. In some countries, the responsibility of organisations may be legally restricted and certain sections of the standard will be inapplicable.

A utility domain includes the software systems, equipment, staff and consumers of a single utility organisation, which could be a company or a department. It is expected that within each utility domain, the systems, equipment, staff and consumers can be uniquely identified. When information is exchanged between two utility domains, then identifiers may need extending with the identity of the utility organisation in order to guarantee global uniqueness.

3.2 Business functions

Various departments within a utility co-operate to perform the operation and management of a power distribution network; this activity is termed Distribution Management. Other departments within the organisation may support the Distribution Management function without having direct responsibility for the distribution network. This segmentation by business function¹ is provided in the Interface Reference Model (IRM), which is described in detail in sub-clause 3.3.

The use of a business-related model should ensure independence from vendor-produced system solutions. It is an important test of the viability of this standard that the IRM be recognisable to utility staff as a description of their own distribution network operation and management.

Major utility business functions and sub-functions of the IRM are shown in Figure 3.

¹ The work of the CIREN Working Group on Distribution Automation, published in 1996, is fully acknowledged in the segmentation.

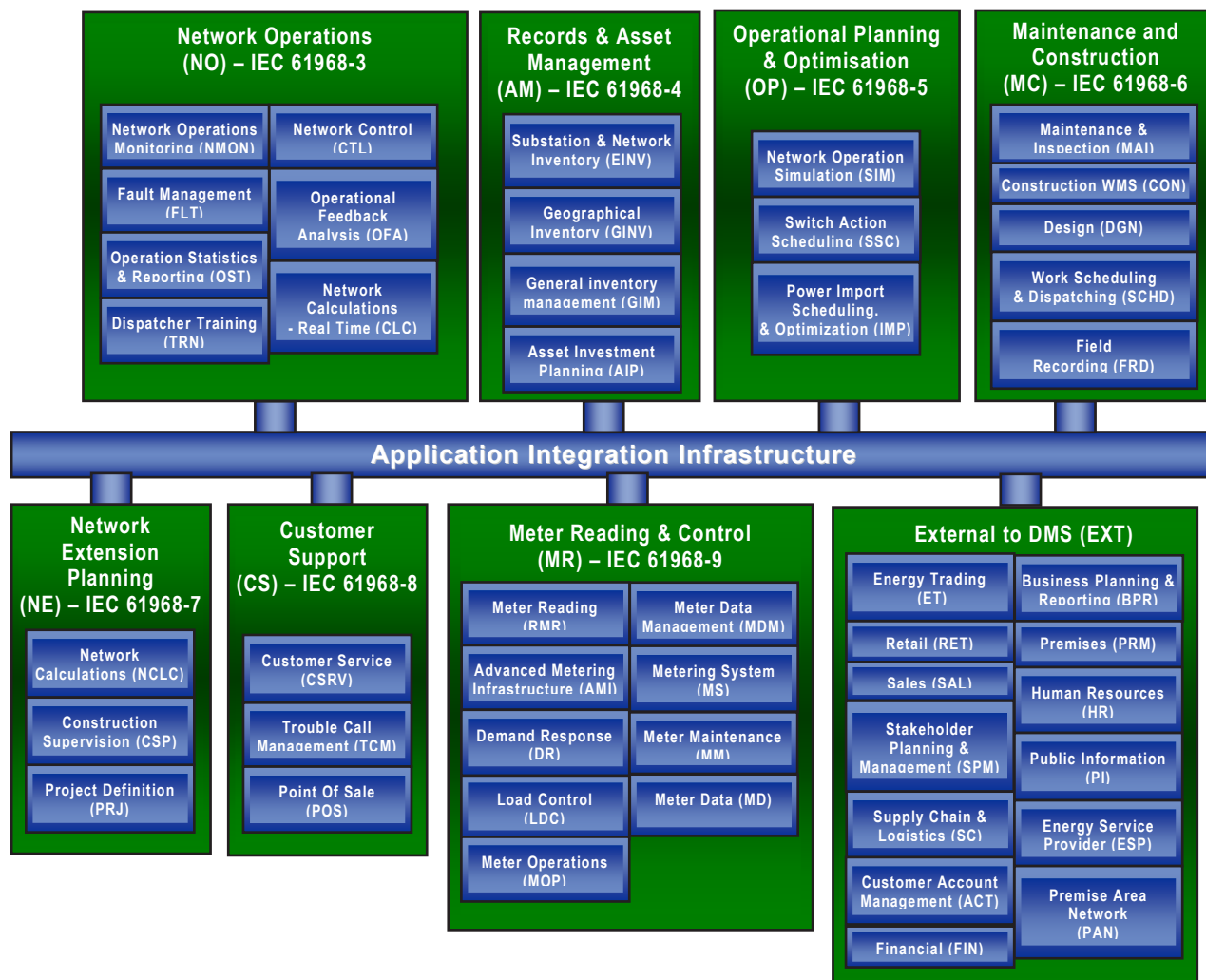


Figure 3: Typical Functions Mapped to Interface Reference Model

3.3 Interface reference model

It is not the intention of this standard to define the applications and systems that vendors should produce. It is expected that a concrete (physical) application will provide the functionality of one or more abstract (logical) components as listed in this standard. These abstract components are grouped by the business functions of the Interface Reference Model.

In this standard, the term abstract component is used to refer to that portion of a software system that supports one or more of the interfaces defined in IEC 61968 Parts 3 to 9 and 13. It does not necessarily mean that compliant software is delivered as separate modules.

In this sub-clause, the definitions of business functions defined in Sub clause 3.2 are further extended into:

- Sub-business Functions (second column).
- Abstract Components (third column).

NOTE: Some abstract components may be used by several different business functions. For example, a component like power flow can be used for network operation, short term operational planning and optimisation, and long term network extension planning. Much of the information exchanged for power flow purposes in each of these areas will therefore use many of the same Information Exchange Message Types (refer to Clause 6).

Applications from different vendors package the *functionality* of these abstract components in different ways. To use the IEC 61968 services, each application must support one or more of the *interfaces* for the abstract components.

Part 1 of this series of standard describes infrastructure services common to all abstract components whilst Parts 3-9 and 13 define the details of the information exchanged for specific types of abstract component.

IEC 61968 defines that:

1. An inter-application infrastructure is compliant if it supplies services defined in Part 1 to support at least two applications with interfaces compliant to sections of Parts 3 to 9 and 13.
2. An application interface is compliant if it supports the interface standards defined in Parts 3 to 9 and 13 for the relevant abstract components defined in the Interface Reference Model.
3. An application is only required to support interface standards of the applicable components listed in Column 3. It is not required to support interfaces required by other abstract components (Column 3) of the same business sub-function (Column 2) or within the same business function (Column 1). While this standard primarily defines information exchanged among components in different business functions, it may occasionally define information exchanged among components within a single business function when a strong market need for this capability has been realised.

Table 2: The Interface Reference Model (IRM)

Business Functions	Business Sub-Functions	Abstract Components	Description
<u>Network operation (NO)</u> [Refer to IEC 61968-3 and IEC 61968-13]	Network operation monitoring (NMON)		Provides the means for supervising main substation topology (breaker and switch state) and control equipment status. It also provides the utilities for handling network connectivity and loading conditions. It also makes it possible to locate customer telephone complaints and supervise the location of field crews.
		Substation state supervision	Provides the means for supervising main substation topology (breaker and switch state) and control equipment status. This function is supported by a mimic diagram of substations.
		Network state supervision	Provides the means for handling network connectivity and loading conditions. It also makes it possible to supervise the location of field crews.

Business Functions	Business Sub-Functions	Abstract Components	Description
			telephone complaints and supervise the location of field crews.
		Switching action supervision	Provides a view of all incoming work on the systems. Work details are recorded for each set of switching actions (examination of manual and remote controlled operations, work characteristics, and crews involved in the work).
		Switching pinning action supervision	Provides a view of all switching states other than the open or closed of the switch or device. For example, some utilities employ a pinning convention to denote: 1. switch held open (Red Pin) and associated with a clearance safety document, 2. closed fused switch involved in energized line work (Orange Pin) and associated with a Hot Line Work Permit safety document, 3. normally open switch (Green Pin), 4. abnormally open switch (Yellow Pin), 5. abnormally closed switch (Yellow with Green dot Pin), 6. fuse size deviation or information (Blue Pin), 7. Out of Order or defective equipment (Brown Pin), and 8. Transfer of Control (Pink Pin). A normally closed switch is not pinned.
		Process and network data management	Includes the exchange of dynamic data which is process dependent as well as the sharing of static data which is needed to perform different functions.
		Operation data management	Management of data acquired through operation (field crews, customers, scheduled and unscheduled outages).
		Regulation step supervision	Provides a view for reporting the regulator tap-position. Substation regulator and pole-mounted distribution line regulator installations will be reporting tap-position via the "Process and network data management" abstract component.
		Alarm supervision	Network monitoring system where thresholds are set to indicate system failure and response required.

Business Functions	Business Sub-Functions	Abstract Components	Description
		Operator event logs and	Operator logs capture field changes and scheduled work requiring downtimes. Events logs capture outage and other relevant information.
		Weather monitoring (lightning detection)	Allows to predict impacts on the electrical networks, especially where outages are likely to occur due to heavy storm activity. Temperature and wind speed are sometimes used to calculate dynamic load limits on electrical network assets.
	Network control (CTL)		Network control is achieved through decentralised control functions which need to be coordinated at an upper level of the control hierarchy Local automatic control functions can be performed using only local information and which do not need knowledge of network connectivity. These functions are supported locally by substation control equipment at substation level, Area network control functions coordinate the local functions. These functions are operator-dependent and are provided firstly by the remote control function and secondly through local control which is related to the orders given to field crews through mobile station terminals.
		User access control	All network monitoring applications have user access control.
		Automatic controls: • Protection (fault clearance) • Sectionalising • Local voltage/reactive power control	Protection (fault clearance), sectionalising and local voltage/ reactive power control devices which are self protecting. Some "smarter" devices are programmable and allow control of the threshold indicating how long the device is in fault before it trips, automatic re-closures may automatically close the circuit at a given time.

Business Functions	Business Sub-Functions	Abstract Components	Description
		Assisted control: • Remote switch control • Load shedding • Voltage reduction broadcast • Local control through field crews • Maintain voltage profiles	Remote switch control, load shedding, voltage reduction broadcast, maintaining voltage profiles and local control through field crews. Protection devices which are network programmable as well as manual network switches.
		Safety document management	Management of safety documents, which are used during the course of work on the electrical system for safety purposes. There are many types of safety documents that could be defined based upon organisational practices.
		Safety checking and interlocks	Following procedures to ensure safety of people and equipment when working with energized electrical networks.
		Major incident coordination	Coordination for major outage response.
	Fault Management (FLT)		Fault management functions which are intended to enhance the speed at which fault localisation and service restoration can be achieved. The fault management function supports the utilities required to identify disruptions in the system, to carry out restoration switching actions and to provide customers with notification of disruptions detected (in terms of duration and cause of breakdown). Fault management makes it possible: • to improve customer complaint

Business Functions	Business Sub-Functions	Abstract Components	Description
			response system, providing a prompt reply and a good interface between the Utility and the Customer (better image), - to provide field information to the dispatch operator, helping to restore supply during disruptions, - to compile all information about Quality of Service and make it available outside the Utility (Customers and official entities).
		Trouble call handling and coherency analysis for LV networks	A trouble ticket is a document which is generated when a customer calls to report electrical trouble. The trouble may either be an outage or non-outage problem, such as power quality.
		Protective relays analysis	Coordination of protective schemes is accomplished through analysis of protective relays. Protective relay is an electro-mechanical device used to initiate a protection scheme such as opening a breaker after a high current is detected.
		Fault location by analysis of fault detectors and/or trouble call localisation	Connectivity analysis is used to determine the location of the fault. Eventually a special tester is sent to the field to locate the fault.
		Supply restoration assessment	Estimated restoration time provided to customer before and during restoration activities.
		Customer incident information usage	Data including service address, customer number, customer name, premise number, meter number, and etc. Customer call centre usually receives these calls.
		Distribution circuit energization supervision	The energization state of the geographical distribution circuit is to be presented in as well as the connected equipment, e.g. switches, transformers, regulators, capacitors, substation, and etc. The energization state presentation will include predictive state information from

Business Functions	Business Sub-Functions	Abstract Components	Description
			an outage management system. A prediction outage state will frequently become a confirmed state, perhaps illustrated by the open state of a switch, when verified by field personnel. Switches, devices, equipment and circuits in the distribution network model can also have a predicted out-of-service state, which will be different from a service interruption state.
	Operation feedback analysis (OFA)		Information can be retrieved from substation and customer records and compared with records taken from real-time operation related to information on network incidents, connectivity and loading. This information analysis provides indicators for optimising periodic maintenance according to fault rates in the network. This requires identification of concurrent values at multiple locations and time tagging of events and values.
		Mal-operation analysis	The review of records for equipment to ascertain the cause of its incorrect operation.
		Network fault analysis	The review of fault records, sequence of events records, and other documentation produced upon a fault to determine the cause of the fault, its total impact, steps taken by the system to recover from the fault, and the possible avoidance of a future occurrence. This data includes pre-fault information as well as post fault information for a specified period.
		Quality index analysis	Quality analysis includes frequency of outages, outage duration, voltage level, voltage fluctuations (drops, peaks, rapid and slow changes) and other factors to measure the quality of power supplied.
		Device operation history	Data concerning the operation of electrical devices. It is often used in condition-based maintenance schemes.
		Post-disturbance review	The review of historical records to understand the sequence of events leading up to a disturbance to determine

Business Functions	Business Sub-Functions	Abstract Components	Description
			the root cause of the problem.
	Operation statistics and reporting (OST)		Operating statistics and reporting functions makes it possible to archive on-line data and to perform feedback analysis of system efficiency and reliability.
		Maintenance information	Planned and unplanned maintenance data including root cause and repair/replace details.
		Information for planning	Service history data used for operational planning
		Information for management control	Service history data used for management control.
	Network calculations – real-time (CLC)		Network calculations provide system operators with the ability to assess the reliability and security of the power system.
		Load estimation	The estimation of load values, calculated on a more granular basis than load forecasts, based on specified conditions, weather and other events.
		Energy trading analysis	Performing network calculations to assess energy trading options and scenarios.
		Load flow/voltage profile	Perform voltage assessment of the network by analyzing operating conditions and predicting and preventing voltage problems.
		Fault current analysis	The review of fault records, sequence of events records, and other documentation produced upon a fault to determine the cause of the fault, its total impact, steps taken by the system to recover from the fault, and the possible avoidance of a future occurrence. This data includes pre-fault information as well as post fault information for a specified period.

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		Adaptive relay settings	Protective relay setting that can be adjusted based on conditions such as weather and operational conditions.
	Dispatcher training (TRN)		Training facilities for dispatchers that simulate the actual system they will be using to perform the dispatch function. Various scenarios can be tested to prepare dispatchers for being able to handle atypical events.
		SCADA simulation	Simulating network faults to train dispatchers.
<u>Records and asset management (AM)</u> [Refer to IEC 61968-4]	Substation and network inventory (EINV)		The electrical substation and network assets that a utility owns, or for which has legal responsibility, and will maintain an accurate asset register developed around an asset hierarchy that supports advanced asset management functions.
		Equipment characteristics	Data concerning the nature and operational parameters of physical devices designed to perform particular functions. A characteristic can be viewed as a relationship between two or more variable quantities which describes the performance of a device under given condition.
		Connectivity model	A model of all networked electrical equipment. It is the physical definition of how equipment is connected together. In addition it models topology which is the logical definition of how equipment is electrically connected via closed switches. The topology definition is independent of the other electrical characteristics.
		Substation display	Schematic display of substations with references to relevant network data displays and geographic maps. Schematic display includes substation control equipment status and power equipment status.
		Telecontrol database	Telecommunication relationships for remote control and dynamic data acquisition, and other functions requiring

Business Functions	Business Sub-Functions	Abstract Components	Description
			electronic communications.
	Geographical inventory (GINV)		Management of geospatial data, typically by utilizing computer graphics technology to enter, store, and update graphic and non-graphic information. Geographic depictions and related non-graphic data elements for each entity are typically stored in some form of a data store. The graphic representations are referenced using a coordinate system that relates to locations on the surface of the earth. Information in the data store can be queried and displayed based upon either the graphic or non-graphic attributes of the entities.
		Network displays	Circuit diagrams of the physical distribution network
		Geographic maps	A map, which displays planimetric, electrical, physical asset and/or topographic features and which may be used as a base for a thematic layer. Features which may be included on a base map are roads, rivers, major structures (buildings), contours, etc. Feature presentation will, however, be map scale dependent. A geographic feature is a term applied to the natural or cultural objects shown on a map or chart.
	General inventory management (GIM)		The non-electrical assets (e.g., tools, concrete, poles, cross-arms, etc.) that a utility owns, or for which has legal responsibility, and will maintain an accurate asset register that supports advanced asset management functions.
		Non-electrical asset inventory	The inventory and condition of installed and non-installed assets other than those covered in EINV Substation and network inventory.
		Materials inventory	The inventory and condition of materials available for use at various locations in the utility.
		Vehicle inventory	The inventory and condition of all utility

Business Functions	Business Sub-Functions	Abstract Components	Description
			owned and leased vehicles.
	Asset investment planning (AIP)		Asset investment planning involves strategy definition and prioritisation, maintenance strategy planning, risk management, programme management and decision-making. It drives the condition, configuration, performance, operating costs, and flexibility of the asset base, with the aim of maximising value.
		Maintenance strategy	Maintenance strategy that balances risk, cost, and schedule while applying schedule-based maintenance, reliability-centered maintenance, condition-based maintenance as appropriate.
		Life-cycle planning	Planning the use of an asset throughout its life-span, from the time a decision is made to purchase it until the time it is properly discarded.
		Reliability centred analysis	Identifying reliability trends and corrective actions. For example, looking at all the faults for a given year (planned and outage) and performing root cause analysis and suggesting corrective actions.
		Engineering and design standards	The establishment of measurable conditions and performance of assets and how they are employed. Characteristics or attributes of a standard describe its required level of performance, which typically describe “how much”, “of what nature” and “how frequently”. Often engineering and design standards reference industry standards and manufacturing specifications.
		Performance measurements	Asset management decisions are based on lifecycle costs. Assets are measured so that full economic costs of activities are understood.
		Risk management	To monitor, understand, and manage the risks involved in business activities and to ensure that policies, processes, and practices are committed accordingly.

Business Functions	Business Sub-Functions	Abstract Components	Description
		Environmental management	Assets must be installed and maintained with an awareness of both environmental impacts on the assets (salt corrosion, ice, water, sand, etc.) as well as impacts on the environment by the asset. The later is subject to many forms of government regulation.
		Decision support	Data warehousing and business intelligence used to support asset investment planning decision.
		Thermal ratings of network equipment and lines	Changes in electrical asset performance limits based on temperature and wind speed.
		Maintain work triggers	Converting schedules into work plans such as preventive maintenance for an aging pole.
		Asset maintenance groups (lists)	A list of assets organized into a category, for example to add efficiency to certain types of maintenance and inspection work.
		Asset failure history	The history of failures related to all assets in the distribution network including burnout and accidents.
		Asset financial performance	Return On Investment (ROI) for assets. Understanding the value and costs of assets and the financial resources needed to appropriately sustain them (short and long term).
		Budget allocation	Allocation of budget for procurement, maintenance, and replacement
<u>Operational planning and optimisation (OP)</u>	Network operation simulation (SIM)		This set of functions allows facilities to define, prepare and optimise the sequence of operations required for carrying out maintenance work on the system (release/clearance orders) and operational planning.

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[Refer to IEC 61968-5 and IEC 61968-13]		Load forecast	A forecast of the expected load at a specific time and day-of-week for each feeder in the network. The load forecasting function predicts the hourly system load and maintains a real-time forecast and a study forecast. The real-time forecast is based on actual historical load and weather data and generates a load forecast for the current hour. The study forecast uses a completely independent set of historical and predicted data that the operator may use to set up and evaluate hypothetical situations up to seven days in the future.
		Power flows computation	The power flow function allows dispatchers to study control actions upon the power system. The power flow function operates in study or real-time. Dispatcher power flow allows the operator to determine the effects of control actions (breaker switching, tap changing, and interchange adjustments) on the system.
		Contingency analysis	A study of the effect of unexpected failure or outage of a system component. In distribution systems it generally involves the study of how to restore power to customers when the normal supply path is unavailable.
		Short circuit analysis	Analysis of short circuits in transmission and distribution networks. On-line short circuit calculation is required for the following types of faults: single line to ground; line to line; double line to ground; three lines to ground; single line open; double line open.
		Optimal power flow	The optimal power flow function allows dispatchers to optimise the control actions on power system based on the given criteria (flows of real or reactive power, switching of compensation devices, optimal settings for voltage control, etc.). In optimal power flow, the control actions are automatically predetermined within the limitations of the power system.
		Supply restoration	Analysis of switching options after a network fault to re-connect supply to as

Business Functions	Business Sub-Functions	Abstract Components	Description
		assessment	many customers as possible in the shortest time possible.
		Switching simulation	Simulating the switching operations to isolate a network section and subsequently reconnect it.
		Incident simulation	Recreating an incident on the network for analysis and also for training.
		Weather forecast analysis	Weather is monitored to predict impacts on the electrical networks, especially where outages are likely to occur due to heavy storm activity. Temperature and wind speed are sometimes used to calculate dynamic load limits on electrical network assets.
		Fire risk analysis	Analyzing the risk of fire in the network. For example, thermal rating of network equipment. There is a certain temperature when transformers may explode.
		Define operational limits	Defines operating limits for monitoring operations of the transmission and distribution facilities.
		Thermal ratings of network equipment and lines	Changes in electrical asset performance limits based on temperature and wind speed and current season. This is distinguished from AIP counterpart, which includes new construction and reconductoring.
	Switch action scheduling / operation work scheduling (SSC)		Switch action scheduling provides supports for handling all aspects relevant to switch order formulation, drawing up operating guidelines, dispatching repair crews and informing customers affected. It assists in collecting the related data and delivering it in the various forms required.
		Release/clearance remote switch command scheduling	A clearance is special authority given a person or persons working on de-energized cables, wires or equipment.
		Field crew loading analysis	Insuring that field crews have appropriate

Business Functions	Business Sub-Functions	Abstract Components	Description
		and work order scheduling	work and are allocated efficiently.
		Customer outage analysis and information	The troubleshooting process uses customers' telephone trouble calls, telemetry data and network topology during incidents to provide information on service conditions and suspected fault locations.
	Power import scheduling and optimisation (IMP)		Power import scheduling and optimisation aims to minimise the cost of imported power by keeping the average imported power close to the contracted value, making use of peak plants, load switching or load shedding.
		Non native generation planning	Received schedules from Distributed Energy Resources (DER) to be used during planning.
		Interchange transaction planning	Optimizing planned interchange.
<u>Maintenance and construction (MC)</u> [Refer to IEC 61968-6]	Maintenance and inspection (MAI)		Work involving inspection, cleaning, adjustment, or other service of equipment to enable it to perform better or to extend its service life. Examples of maintenance work are routine oil changes and painting. Examples of inspection work are pole inspections, vault inspections, and substation inspections.
		Maintenance program management	Planning the specific times when a set of maintenance activities should be performed taking into account a variety of constraining factors such as the impact of removing the equipment from service, availability and work load of maintenance crews, etc.
		Maintenance orders	Work can be scheduled to perform maintenance as a result of limits being exceeded for certain criteria regarding an assets' condition, found either through telemetry or inspection, or through routine scheduling.