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**Integration von Anwendungen in Anlagen der Elektrizitätsversorgung –
Systemschnittstellen für Netzführung –
Teil 9: Zählerfernauslesung und -steuerung (IEC 61968-9:2009);
Englische Fassung EN 61968-9:2009**

Application integration at electric utilities –
System interfaces for distribution management –
Part 9: Interface for meter reading and control (IEC 61968-9:2009);
English version EN 61968-9:2009

Intégration d'applications pour les services électriques –
Système d'interfaces pour la gestion de la distribution –
Partie 9: Interface pour les lectures de mesure et la conduite (CEI 61968-9:2009);
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Beginn der Gültigkeit

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Nationales Vorwort

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

Die enthaltene IEC-Publikation wurde vom TC 57 „Power systems management and associated information exchange“ erarbeitet.

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**Application integration at electric utilities –
System interfaces for distribution management –
Part 9: Interface for meter reading and control
(IEC 61968-9:2009)**

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CENELEC

European Committee for Electrotechnical Standardization
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Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of document 57/1009/FDIS, future edition 1 of IEC 61968-9, prepared by IEC TC 57, Power systems management and associated information exchange, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61968-9 on 2009-10-01.

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| – latest date by which the EN has to be implemented
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Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61968-9:2009 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

The purpose of this document is to define a standard for the integration of metering systems (MS), which would include traditional (one or two-way) automated meter reading (AMR) systems, with other systems and business functions within the scope of IEC 61968. The scope of this standard is the exchange of information between a metering system and other systems within the utility enterprise. The specific details of communication protocols those systems employ are outside the scope of this standard. Instead, this standard will recognize and model the general capabilities that can be potentially provided by advanced and/or legacy meter infrastructures, including two-way communication capabilities such as load control, dynamic pricing, outage detection, distributed energy resource (DER) control signals and on-request read. In this way, this standard will not be impacted by the specification, development and/or deployment of next generation meter infrastructures, either through the use of standards or proprietary means.

The IEC 61968 series of standards is intended to facilitate inter-application integration as opposed to intra-application integration. 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. Therefore, these interface standards are relevant to loosely coupled applications with more heterogeneity in languages, operating systems, protocols and management tools. This series of standards is intended to support applications that need to exchange data every few seconds, minutes, or hours rather than waiting for a nightly batch run. This series of standards, which are intended to be implemented with middleware services that exchange messages among applications, will complement, not replace utility data warehouses, database gateways, and operational stores.

As used in IEC 61968, a distribution 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. Standard interfaces are defined for each class of applications identified in the interface reference model (IRM), which is described in IEC 61968-1: System interfaces for distribution management – Part 1: Interface architecture and general requirements.

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This part of IEC 61968 contains the clauses listed below.

Document overview for IEC 61968-9

Clause/Annex	Title	Purpose
1	Scope	The scope and purpose of the document are described
2	Normative references	Documents that contain provisions which, through reference in this text, constitute provisions of this International Standard
3	Terms, definitions and abbreviations	Provides terms, definitions and abbreviations
4	Reference and information models	Description of general approach to metering system, reference model, use cases, interface reference model, meter reading and control functions and components, message type terms and static information model
5	Meter reading and control message types	Message types related to the exchange of information for documents related to meter reading and control
Annex A	Description of message type verbs	Description of the verbs that are used for the message types
Annex B	Recommended message structure	CIM extensions to support the recommended message structure for meter reading and control
Annex C	Recommended procedure for the generation of a ReadingType	Recommended technique for constructing, and offers sample enumerations for the ReadingType textual name and mRID
Annex D	Recommended Quality code enumerations	Recommends technique for constructing, and offers sample enumerations for reading quality codes
Annex E	Recommended EndDeviceEvent category enumerations	Recommends EndDeviceEvent alarm codes
Annex F	Recommended EndDeviceControl code enumerations	Describes recommended technique for leveraging EndDeviceEvent codes to create EndDeviceControl codes
Annex G	Recommended procedure for maintaining relationships between objects	To describe the use of the master resource identifier (mRID)
Annex H	XML schemas for message payloads	To provide xsd information for use by developers to create IEC 61968-9 messages
Annex I	Mappings to ebIX	To provide mappings between IEC 61968-9 meter readings and ebIX.
Annex J	Request parameters	Describes the qualification of GET requests using request parameters

APPLICATION INTEGRATION AT ELECTRIC UTILITIES – SYSTEM INTERFACES FOR DISTRIBUTION MANAGEMENT –

Part 9: Interfaces for meter reading and control

1 Scope

This document is Part 9 of the IEC 61968 standard and specifies the information content of a set of message types that can be used to support many of the business functions related to meter reading and control. Typical uses of the message types include meter reading, meter control, meter events, customer data synchronization and customer switching. Although intended primarily for electrical distribution networks, IEC 61968-9 can be used for other metering applications, including non-electrical metered quantities necessary to support gas and water networks.

The purpose of this document is to define a standard for the integration of metering systems (MS), which includes traditional manual systems, and (one or two-way) automated meter reading (AMR) systems, with other systems and business functions within the scope of IEC 61968. The scope of this International Standard is the exchange of information between a metering system and other systems within the utility enterprise. The specific details of communication protocols those systems employ are outside the scope of this standard. Instead, this standard will recognize and model the general capabilities that can be potentially provided by advanced and/or legacy meter infrastructures, including two-way communication capabilities such as load control, dynamic pricing, outage detection, distributed energy resource (DER) control signals and on-request read. In this way, this standard will not be impacted by the specification, development and/or deployment of next generation meter infrastructures either through the use of standards or proprietary means.

The capabilities and information provided by a meter reading system are important for a variety of purposes, including (but not limited to) interval data, time-based demand data, time-based energy data (usage and production), outage management, service interruption, service restoration, quality of service monitoring, distribution network analysis, distribution planning, demand reduction, customer billing and work management. This standard also extends the CIM (Common Information Model) to support the exchange of meter data.

2 Normative references

The following referenced documents are indispensable for the application 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 60050-300, *International Electrotechnical Vocabulary – Electrical and electronic measurements and measuring instruments – Part 311: General terms relating to measurements – Part 312: General terms relating to electrical measurements – Part 313: Types of electrical measuring instruments – Part 314: Specific terms according to the type of instrument*

IEC 61968-1, *Application integration at electric utilities – System interfaces for distribution management – Part 1: Interface architecture and general requirements*

IEC 61968-2, *Application integration at electric utilities – System interfaces for distribution management – Part 2: Glossary*

IEC 61968-3, *Application integration at electric utilities – System interfaces for distribution management – Part 3: Interface for network operations*

IEC 61970-301, *Energy management system application program interface (EMS-API) – Part 301: Common information model (CIM) base*

IEC 62051-1, *Electricity metering – Data exchange for meter reading, tariff and load control – Glossary of terms – Part 1: Terms related to data exchange with metering equipment using DLMS/COSEM*

IEC 62055-31, *Electricity metering – Payment systems – Part 31: Particular requirements –Static payment meters for active energy (classes 1 and 2)*

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

ISO 4217, *Codes for the representation of currencies and funds*

ISO 8601:2004, *Data elements and interchange formats – Information interchange – Representation of dates and times*

ANSI C12.19, *Utility Industry End Device Data Tables*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-300, IEC 61968-2, IEC 62051-1, IEC 62055-31 and the following apply.

Where there is a difference between the definitions in this document and those contained in other referenced IEC documents, then those defined in IEC 61968-2 shall take precedence over the others listed, and those defined in IEC 61968-9 shall take precedence over those defined in IEC 61968-2.

3.1.1

customer program

classification scheme for the sale of energy to consumers according to a particular tariff

The program may specify the purpose, conditions on the time of use, the service voltage(s), the volumes consumed, and/or other terms as a condition of the sale.

NOTE Utilities may promote particular programs to their industrial, commercial, agricultural, and residential customers in an effort to encourage a particular behaviour, or to make them aware of their options.

3.1.2

end device

equipment located at the end of the communication system, usually on the customer premises, which may perform functions such as metrology, connect/disconnect, load control, demand response, or other functions, and may have power relay and/or communications capability

This is represented within the CIM using the EndDeviceAsset class.

3.1.3

load control device

type of end device which can receive signals causing it to shed load for the purposes of maintaining network reliability and/or commercial agreements

3.1.4

meter

type of end device which performs metrology and supports the tariffing of the distribution and/or transmission network

This is represented using the CIM MeterAsset class, which is a subclass of EndDeviceAsset.

NOTE A meter could be defined as a 61850 device with logical nodes.

3.1.5

meter changeout

process of replacing an existing meter with a new meter

NOTE The installer will customarily follow a work order which specifies a given location, and usually requires that he or she capture readings from the old and new meters, and record the time and day in which the work was performed.

3.1.6

payment meter

electricity meter with additional functionality that can be operated and controlled to allow the flow of energy according to agreed payment modes

3.1.7

prepayment mode

payment mode in which automatic interruption occurs when available credit is exhausted

3.2 Abbreviations

AM	asset management
AMR	automated meter reading
AMI	advanced metering infrastructure
CIM	common information model
CIS	customer information system
COSEM	companion specification for energy metering
DLMS UA	device language message specification user association
DMS	distribution management system
IDR	interval data recorder
IEC	International Electrotechnical Commission
LC	load control
LMS	load management system
MAM	meter asset management
MDM	meter data management
MM	meter maintenance
MR	meter reading
MS	metering system
NO	network operations
OMS	outage management system
POS	point of sale
RF	radio frequency
VEE	validating, editing, and estimating
WM	work management

4 Reference and information models

4.1 General approach to metering systems

The spinning disk in an electromechanical meter generally serves as a pulse initiator to the meter recorder module. In a similar fashion, solid-state meters may also employ a metrology unit that generates pulses which represent a fraction of a kWh, and if more sophisticated, the solid-state meter may have a meter recorder which is able to accumulate many different kinds of information and store it for presentation to the meter communications module using a message and table-driven protocol such as ANSI C12.19 or IEC 62056.

The most common metered data element is kWh, but many electricity meters can also capture kW, kVAr, kVArh, and other similar billing quantities. Some meters can also capture pure engineering quantities such as voltage, current, power factor, etc.

Some AMR systems attempt to add value to low-end meters by adding functionality that the meter may lack. For low-end meters (e.g., energy only), it is common for an AMR meter module to add the capability to perform demand metering, interval data recording (IDR), maintain an energization count, or even provide estimates of certain engineering quantities such as voltage.

Commercial and industrial meters often employ current transformers and voltage transformers to meter the actual service. Primary voltages and currents are scaled down using potential transformers (PTs) and current transformers (CTs) so that the meter does not have to be constructed to withstand the high voltages and currents actually delivered to the load. Secondary voltage or current values are those that are often measured directly by the meter. Secondary values are small percentage of the primary values that may actually delivered to or connected to the load. If secondary voltages and currents are measured by the meter, these can be converted back to primary values using the PT and CT ratios, which are just the ratio of primary to secondary values.

The metering system will convey meter data and other value-added data through the metering system network to the destination. Depending on the system, the journey may involve multiple steps through public or private networks, licensed or unlicensed RF spectrums, standardized or proprietary systems, in a one-way or two-way fashion.

Some general operations or services can be defined for a metering system. These general operations will translate to specific actions in the context of a given metering solution.

General operations can be scheduled or called on-demand. Each operation returns an answer with a status. A message encapsulates a general operation.

Examples of meter general operations (reading) are:

- reading phone calls;
- reading load curve;
- reading encryption keys;
- reading equipment configuration;
- reading contract parameters;
- reading functional maintenance data;
- reading technical maintenance data;
- metrological reading;
- reading status parameters;
- reading quality;
- reading date-time;

- meter reading;
- reading historical data;
- reading programming data.

Examples of meter general operations (writing) are:

- writing client parameters;
- writing season parameters;
- writing date-time changing seasons;
- writing encryption keys;
- writing first time in-service;
- writing calling parameters;
- writing public holiday schedule;
- writing self-read parameters;
- writing status parameters;
- writing programming parameters (pricing);
- writing defect parameters;
- writing minimal defect threshold period;
- writing nominal voltage level.

Readers of IEC 61968-9 interested in standards concerning meter reading should refer to IEC 62056, DLMS UA (device language message specification user association) and the COSEM model: Companion specification for energy metering. COSEM specifies 3 steps:

- a) the meter model and data identification;
- b) the mapping of the model into protocol data units;
- c) the transportation of the bits.

4.2 Reference model

4.2.1 General

The following diagrams serve as reference models and provide examples of the logical components and data flows related to this International Standard. Subclause 4.5.2 provides references to terms that are defined by the CIM.

The “meter” is treated as an “end device”. The end device may contain a metrology capability, it may contain a communications capability, it may be a load control unit, and it may contain a mixture of many different types of functionality. Figure 1 attempts to describe the concept of essentially a shopping-list of functionality which may be available in the (logical or physical) end device.

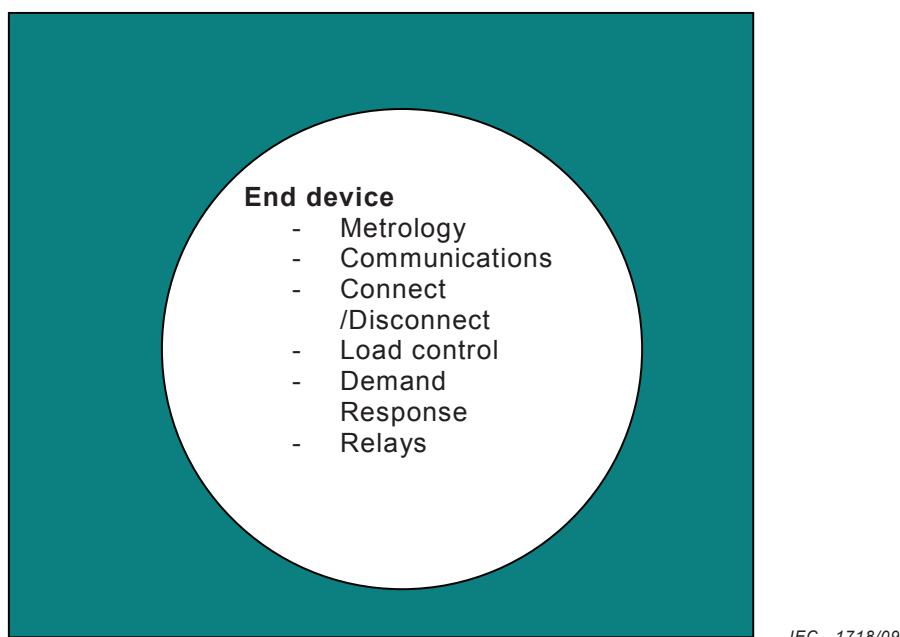


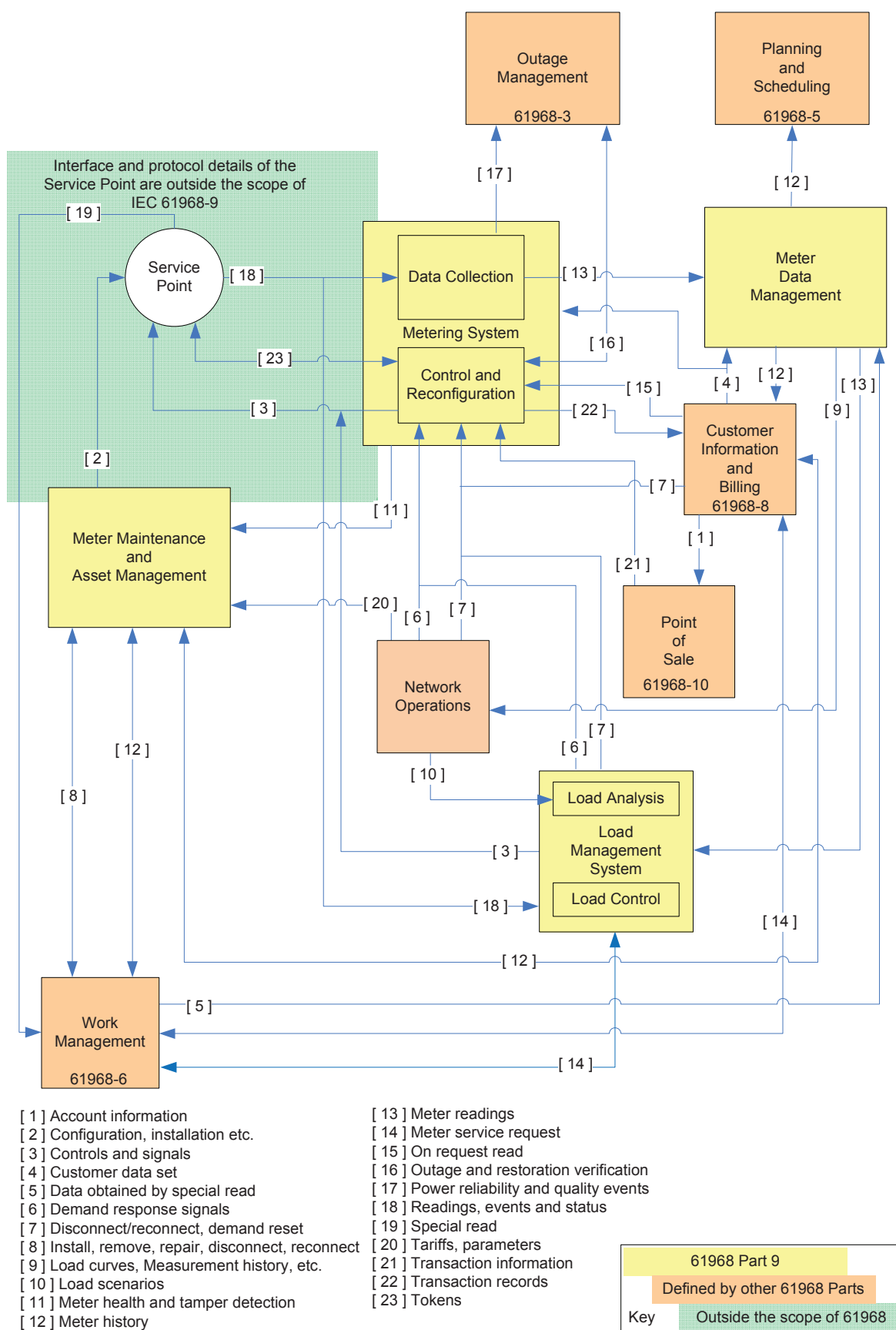
Figure 1 – Example of an end device with functions

The end device itself, while presenting a myriad of functionality, is not the subject of this standard. There are many interactions which ultimately affect the end device but occur as a result of a communication between systems at a much higher level in the control architecture. The interaction between systems is within the scope of this standard, and Figure 2 attempts to describe the exact systems involved, and provide an overview to the stakeholder landscape.

From the perspective of this standard, an end device:

- has a unique identity;
- is managed as a physical asset;
- may issue events;
- may receive control requests;
- may collect and report measured values;
- may participate in utility business processes.

The following diagrams of Figures 2 and 3 describe the flows between the components in the reference model. Two diagrams are used in order to reduce the complexity that would be experienced by a single diagram. The numbers in brackets provide linkages to the flow definitions.



IEC 1719/09

Figure 2 – IEC 61968-9 reference model

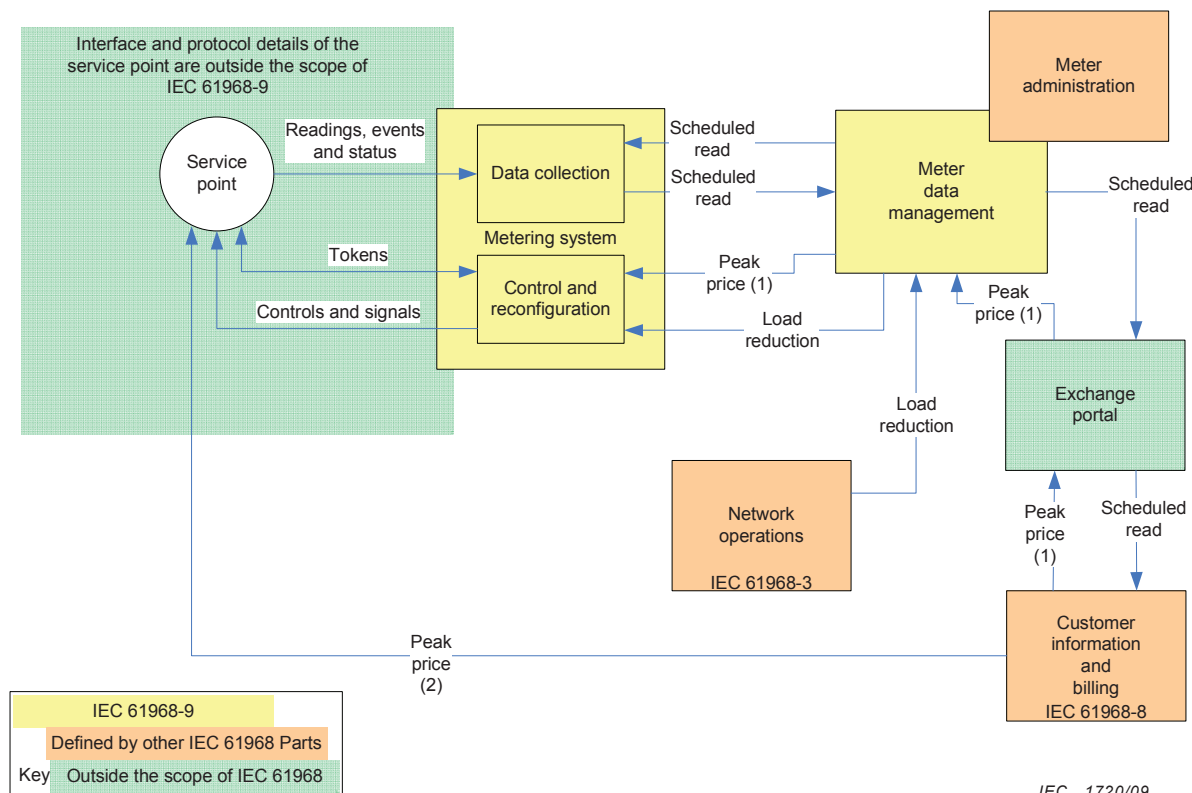


Figure 3 – IEC 61968-9 reference model with customer information and billing system

The reference architecture reflects five main logical components (potentially realized as systems or subsystems) related to metering:

- metering system, potentially including data collection and control and reconfiguration functionality;
- meter data management;
- meter maintenance;
- load management, potentially including load control and load analysis functionality;
- meter asset management;
- meter administration functions, which may be a part of meter data management.

The metering system and meter maintenance system components may be bound to a specific meter and associated communication technology or they may support multiple meters (and more generically end devices) types and associated communication technology. The meter data management system component may support and consolidate meter data from more than one metering system. The metering system may also support consolidation of various measurement and data collection implementations, providing a consistent interface to the meter data management system component.

4.2.2 Metering system (MS) – Data collection

The tasks of the data collection sub-component within the metering system may include:

- readings and status collection, obtained through either manual or automated means, on a scheduled or on-request basis;
- transmission of meter readings and status to a meter data management system;

- transmission of power reliability and quality event data to outage management, network operations, and capacity planning systems;
- transmission of communication network health information to those responsible for maintaining the communications network.

It is important to note that metering systems are significantly diverse with respect to technologies used, protocols used, capabilities and frequency of data collection. The details of the internals of meters, communication transports and protocols are outside the scope of this International Standard.

A handheld device used by a human meter reader could be regarded as a metering system. In a typical meter reading by human, a reader inputs meter data into a handheld device in a field. The handheld device is not connected to a communication network in a field. At the end of day work, the handheld device is connected to a communication network at reader's home (not in an office), and meter data is uploaded to a meter data management system. In this case, this communication network should be part of a metering system. Data collection is described in IEC 61968-1 as "MR-RMR."

4.2.3 Metering system (MS) – Control and reconfiguration

The tasks of the control and reconfiguration subcomponent within the metering system are:

- a) primary interface in executing meter control commands;
- b) communicating payment system information;
- c) act as a communication gateway for load control devices;
- d) service connect/disconnect;
- e) configuration of tariff units of measure and calendar;
- f) configuration of power quality measurement;
- g) configuration of meter event recording;
- h) relay of load control signals;
- i) configuration of meter identity and security credentials;
- j) fraud detection.

This subcomponent is identified separately within the metering system in order to recognize the existence of metering systems that do not have the ability to send messages to meters. IEC 61968-1 describes this subcomponent as "MR-MOP-Meter Configuration."

4.2.4 Load control

The metering system infrastructure may often be used as a communication gateway to load control units (IEC 61968-1 describes this as "MR-LDC"). Load control units are end devices with load control (LC) capability. These are wired to control individual, target devices. End devices with LC functionality can take on different forms. Quite often a dedicated LC unit can be located at (or near) the device to be controlled. Another approach is to use meters that have relays which are configured to serve as LC devices. Still another approach is to interface with a customer energy management system (which would be another type of end device).

4.2.5 Load management system (LMS)

A load management system is used to manage and control load by the utility in order to promote system reliability. A load management system may perform load forecasting, contingency analysis, and other simulations prior to issuing a load control command. This function largely falls under the domain of IEC 61968-5 (operational planning and optimization).

4.2.6 Outage management system (OMS)

An outage management system (OMS) is used by distribution operators to detect and track outages, and to assist in the process of verification and/or restoration. An OMS typically combines (or has ties to) functionality such as network operations fault management, operational planning and optimization, network operation simulation, maintenance and construction, maintenance and inspection, and work scheduling and dispatching.

The metering system can be an important source of information for identifying the existence and extent of outages, and can be used to verify the restoration of outages. The MS might have the ability to publish outage and restoration data to the OMS as it finds it. This type of information typically joins customer call-ins in the OMS to allow it to better predict the location of the outage. However, due to the time-sensitive nature of outage detection, there is also the potential need for a request/reply interface with the MS, where the OMS can ask for specific equipment on the distribution network to be tested by the MS, and an energization status returned for analysis. The request/reply interface can be used by the OMS to supply critical data needed to make an outage prediction, or by a dispatcher who would like to verify that power has been restored to all of the metered endpoints downstream of a particular switch prior to sending the lineman to the next location.

4.2.7 Meter asset management (MAM) system

Utilities will employ some form of asset management software in an effort to maintain detailed records regarding their physical assets. Asset management is treated categorically in IEC 61968-4. However, metering has such special requirements, that it is common for a utility to use specialized meter asset management software. The software inventories the asset – providing a record of its physical attributes as well as its location. For sake of discussion, IEC 61968-9 will talk about a MAM system which is closely coupled to the MS and MDM, though some implementations will successfully generalize the asset management application sufficiently so that it can live within a more generic AM system.

4.2.8 Meter data management (MDM) system

From a historical perspective, it was common for a utility to have more than one automated meter reading system. Alternatively, a utility might outsource meter reading services to one or more third-party service providers who operate an AMR system and/or read the meters manually. The meter data management (MDM) system is used to provide a common repository, and point of management and access of meter data that is collected from disparate metering systems. In addition to data aggregation, quite often the MDM will also make an effort to scrutinize the data collected from the various metering systems, and provide a validating, editing, and estimating (VEE) capability. (IEC 61968-1 includes these functions under “MR-RMR-Meter data aggregation,” and “MR-MOP-Meter data management.”)

4.2.9 Customer information system (CIS)

A CIS will typically encompass functionality related to customer care and billing. This is a subject which is external to the IEC 61968 standard (refer to customer account management (EXT-ACT)). The billing function is driven by readings, typically demand or time-of-use, obtained from the meter. The CIS is also often involved with processes related to billing inquiries, meter disconnect and meter reconnect, rate program changes.

4.2.10 Network operations (NO)

Network operations (IEC 61968-3) may occasionally need to issue load control and pricing signals to meters. This can be done for both economic and emergency reasons.

4.2.11 Meter maintenance (MM)

Meter maintenance is responsible for functionality related to the configuration and installation of meters. This type of functionality generally falls under meter asset management, or asset

management in general. Performing meter maintenance may require exchanges with work management.

4.2.12 Planning

The planning function is described in operational planning and optimization, network operation simulation (OP-SIM).

4.2.13 Work management (WM)

A work management system is responsible for work that is performed by field resources. This subject is covered in maintenance and construction maintenance and inspection (MC-MAI).

With respect to metering, WM includes the installation, maintenance and replacement of meters. This may also involve the process of special reads.

4.2.14 Point of sale (POS)

A point of sale (POS) system is used for the management of payment meters, where a customer either purchases a token or makes a payment for service.

4.2.15 Meter

The meter records the data used for tariffing public networks, and data used for network balancing mechanisms.

Readings captured by the metering system are collected by a system such as the MDM before being presented for billing purposes. Billing entities may correct the data, or, in some regions, the energy supplier may perform validating, editing, and estimating (VEE) according to rules established by the appropriate supervising regulatory agency. In any case, those corrections are made available to the user who requests them.

Where this International Standard refers to a 'meter', it should be realized that a 'meter' is an end device that has metrology capability, it may or may not have communications capability, it may or may not have connect/disconnect capability, or a host of other capabilities. Given that a meter will have metrology capability, it will in all likelihood meter kWh, but possibly also demand, reactive energy and demand, time of use quantities, interval data, engineering quantities and more.

4.2.16 Load control devices

Load control devices are used to control loads at a ServiceDeliveryPoint. The metering system may often have a communication network which can be used for transmitting load control signals to various CommunicationsAsset(s) in order to control the load presented by the EndDeviceAsset(s). Alternatively, the communication network could be used to communicate demand response (price) signals to the CommunicationsAsset(s) in order to affect the load presented by the EndDeviceAsset(s).

4.3 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 61968-3 to IEC 61968-9. It does not necessarily mean that compliant software is delivered neither as separate modules nor as a single system.

IEC 61968-1 describes infrastructure services common to all abstract components while IEC 61968-3 to IEC 61968-9 define the details of the information exchanged for specific types of abstract component.

IEC 61968 series defines the following.

- a) An inter-application infrastructure is compliant if it supplies services defined in IEC 61968-1 to support at least two applications with interfaces compliant to clauses of IEC 61968-3 to IEC 61968-9.
- b) An application interface is compliant if it supports the interface standards defined in IEC 61968-3 to IEC 61968-9 for the relevant abstract components defined in the interface reference model.
- c) An application is only required to support interface standards of the applicable components listed under abstract components. An application is not required to support interfaces required by other abstract components of the same business sub-function or within the same business function. While this standard primarily defines information exchanged among components in different business functions, it will occasionally also define information exchanged among components within a single business function when a strong market need for this capability has been realised.

4.4 Meter reading and control functions and components

It should be noted that the message types defined in this document: 'IEC 61968-9: Interfaces for meter reading and control', may be sent or received by any type of component within a distribution management system (DMS) system.

Table 1 shows these functions and typical abstract components that are expected to be producers of information for these message types. Typical consumers of the information include, but are not restricted to, the other components as listed in IEC 61968-1.

Table 1 – Business functions and abstract components

Business functions	Business sub-functions	Abstract components
Meter reading and control (MR)	Metering system (MS)	Data collection
		End point controls
		End point reconfiguration
		Disconnect/reconnect
		Demand reset
		On request read
		Point of sale
		Outage detection and restoration verification
		Power reliability and quality events
		Metering system events
	Meter maintenance and asset management	End point install, configure, remove, repair, disconnect, reconnect
		End point asset history
		End point reconfiguration
		Special read
		Meter service request
		Tariffs
	Meter data management (MDM)	Meter data repository
		Usage history
		Validation, estimation and editing
		Customer billing data
	Load management (LM)	Load analysis
		Load control
		Demand response
		Performance measurements
		Risk management

4.5 Static information model

4.5.1 General

The information model relevant to meter reading and control consists of classes that provide a template for the attributes for each message.

The classes are defined in detail in IEC 61970-301.

4.5.2 Classes for meter reading and control

Table 2 lists classes used within message types. Usually, all the attributes of these classes are contained within a message type. The descriptions provided describe usage within this part.

Classes described as type "Asset" are defined in the 61968/Assets package of the CIM.

Classes described as type "Customer" are defined in the 61968/Customers package of the CIM.

Classes described as type "Metering" are defined in the 61968/Metering package of the CIM.

Classes described as type "Prepayment" are described in the 61968/PaymentMetering package of the CIM.

Classes described as type "Profile" are contextual profiles defined for IEC 61968-9 that describe message definitions defined using CIM objects.

Table 2 – Classes for meter reading and control

Noun	Type	Description
AuxiliaryAccount	Prepayment	Variable and dynamic part of AuxiliaryAgreement, generally representing the current state of the account related to the outstanding balance defined in AuxiliaryAgreement.
AuxiliaryAgreement	Prepayment	An ad-hoc auxiliary account agreement associated with a customer agreement, not part of the customer's account, but typically subject to formal agreement between customer and supplier (utility). Typically this is used to collect revenue owing by the customer for other services or arrears accrued with the utility for other services. It is typically linked to a prepaid token purchase transaction, thus forcing the customer to make a payment towards settlement of the auxiliary account balance whenever he needs to purchase a prepaid token for electricity. The present status of AuxiliaryAgreement can be defined in the context of the utility's business rules, for example: enabled, disabled, pending, over recovered, under recovered, written off, etc.
AuxiliaryAgreementConfig	Profile	Message profile for AuxiliaryAgreements.
Card	Prepayment	Documentation of the tender when it is a type of card (credit, debit, etc).
Cashier	Prepayment	The operator of the point of sale for the duration of CashierShift. Cashier is under the exclusive management control of Vendor.
CashierShift	Prepayment	The operating shift for a cashier, during which he may transact against the CashierShift, subject to VendorShift being open.
Charge	Prepayment	A charge element associated with other entities such as tariff structures, auxiliary agreements or other charge elements. The total charge amount applicable to this instance of charge is the sum of fixedPortion plus percentagePortion.
Cheque	Prepayment	The actual tender when it is a type of cheque. Cheque reference number (as printed on the cheque) is specified in 'name.'
ComFunction	Metering	Communication function of communication equipment or a device such as a meter.
ComMediaAsset	Assets	Communication media such as fibre optic cable, power-line, telephone, etc.
ConsumptionTariffInterval	Prepayment	One of a sequence of intervals defined in terms of consumption quantity of a service such as electricity, water, gas, etc. It is typically used in association with TariffProfile to define the steps or blocks in a step tariff structure, where startValue simultaneously defines the entry value of this step and the closing value of the previous step. Where consumption is $\geq$ startValue, it falls within this interval and where consumption is $<$ startValue, it falls within the previous interval.
Customer	Customers	Organisation receiving services from ServiceSupplier.
CustomerAccount	Customers	Assignment of a group of products and services purchased by the customer through a CustomerAgreement, used as a mechanism for customer billing and payment. It contains common information from the various types of CustomerAgreements to create billings (invoices) for a customer and receive payment.
CustomerAccountConfig	Profile	Message profile for CustomerAccounts.

Noun	Type	Description
CustomerAgreement	Customers	Agreement between the customer and the ServiceSupplier to pay for service at a specific ServiceLocation. It records certain billing information about the type of service provided at the ServiceLocation and is used during charge creation to determine the type of service.
CustomerAgreementConfig	Profile	Message profile for CustomerAgreements.
CustomerMeterDataSet	Profile	The CustomerMeterDataSet includes one or more CustomerAccounts for one or more ServiceLocations for one or more ServiceDeliveryPoints. TheCustomerMeterDataSet may include one or more EndDeviceGroups.
DemandResponseProgram	Metering	Demand response program.
DeviceFunction	Metering	Function performed by a device such as a meter, communication equipment, controllers, etc.
ElectricmeteringFunction	Metering	Functionality performed by an electric meter.
EndDeviceAsset	Metering	The EndDeviceAsset is equipment that performs the role of an end device. It may contain functionality such as metrology, communications, load control, connect/disconnect, or other capabilities. It is known as "the meter", "a smart meter", an "advanced meter", "air conditioner", "refrigerator", "pool pump", etc. that a CommModule and/or MeterAsset may monitor and/or control. The asset may be owned by a consumer, a service provider, utility or other party.
EndDeviceAssets	Profile	Message used to convey descriptions of one or more EndDeviceAssets.
EndDeviceControl	Metering	Used to issue commands to EndDeviceAssets such as meters. May be addressed by EndDeviceAsset or by EndDeviceGroup. EndDeviceControls may have control types and parameters.
EndDeviceControls	Profile	Message used to convey one or more EndDeviceControls
EndDeviceEvent	Metering	Used to report events detected by end devices such as meters. Each EndDeviceEvent has an event type and a timestamp.
EndDeviceEvents	Profile	Message used to convey one or more EndDeviceEvents.
EndDeviceFirmware	Profile	Profile for EndDeviceAsset firmware configuration messages.
EndDeviceGroup	Metering	An EndDeviceGroup is used for grouping end devices for a variety of purposes including, but not limited to, load control and other types of demand response. An EndDeviceGroup may belong to another EndDeviceGroup, and an end device may belong to zero or more EndDeviceGroups. In some cases, the group ID is maintained within the end device, but in other cases it can be managed by a metering system.
IntervalBlock	Metering	Time sequence of readings of the same ReadingType. Contained IntervalReadings may need conversion through the application of an offset and a scalar defined in associated pending.
IntervalReading	Metering	Data captured at regular intervals of time. Interval data could be captured as incremental data, absolute data, or relative data. The source for the data is usually a tariff quantity or an engineering quantity. Data is typically captured in time-tagged, uniform, fixed-length intervals of 5 min, 10 min, 15 min, 30 min, or 60 min. NOTE Interval data is sometimes also called "interval data readings" (IDR).
MerchantAccount	Prepayment	The operating account controlled by MerchantAgreement, against which vendor may vend tokens or receipt payments. Transactions via VendorShift debit the account and bank deposits via BankStatement credit the account.
MerchantAgreement	Prepayment	A formal controlling contractual agreement between supplier and merchant, in terms of which merchant is authorised to vend tokens and receipt payments on behalf of supplier. Merchant is accountable to supplier for revenue collected at PointOfSale.

Noun	Type	Description
MeterAsset	Metering	The MeterAsset class is used to describe meters. A MeterAsset is a type of EndDevice typically used to measure and potentially monitor a customer load. The EndDeviceAsset class definition should be used as the basis for MeterAsset class.
MeterAssetConfig	Profile	Message profile for MeterAssets configuration messages.
MeterAssetReading	Profile	Profile for manually obtaining MeterReadings for MeterAssets.
MeterReading	Metering	A set of values obtained from the meter. Each MeterReading may have multiple ReadingTypes, and each ReadingType may contain multiple values.
MeterReadings	Profile	Profile for conveying MeterReadings.
MeterReadSchedule	Profile	A MeterReadSchedule message is used to schedule meter readings.
MeterServiceRequests	Profile	A meter service request is a type of work that can be used for a variety of meter service related activities. These activities would include meter installation, meter change out, customer disconnect/reconnect, , etc.
MeterServiceWork	Metering	Work involving meters.
MeterSystemEvents	Profile	Profile for meter system event messages.
Pending	Metering	When present, a scalar conversion that is associated with IntervalBlock and which needs to be applied to every contained IntervalReading value. This conversion results in a new associated ReadingType, reflecting the true dimensions of interval reading values after the conversion.
PointOfSale	Prepayment	Logical point where transactions take place with operational interaction between cashier and the payment system; in certain cases PointOfSale interacts directly with the end customer, in which case cashier might not be a real person: for example a self-service kiosk or over the internet.
ReadingQuality	Metering	Quality of a specific reading value or interval reading value. Note that more than one quality may be applicable to a given reading. Typically not used unless problems or unusual conditions occur (i.e., quality for each reading is assumed to be 'Good' unless stated otherwise in associated ReadingQuality).
ReadingType	Metering	Type of data conveyed by a specific reading.
Receipt	Prepayment	Record of total receipted payment from customer.
ReceiptRecord	Profile	Profile for receipt messages.
ReceiptSummary	Prepayment	Record of detail of receipts pertaining to one shift of operation (one record per 'tenderKind').
Register	Metering	Display for quantity that is metered on an end device such as a meter.
SDPLocation	Metering	Location of an individual service delivery point. For residential or most businesses, it is typically the location of a meter on the customer's premises. For transmission, it is the point(s) of interconnection on the transmission provider's transmission system where capacity and/or energy transmitted by the transmission provider is made available to the receiving party. The point(s) of delivery is specified in the service agreement.
SDPLocationConfig	Profile	Profile for SDPLocation configuration messages.
ServiceCategory	Customers	Category of service provided to the customer.
ServiceCategoryConfig	Profile	Profile for ServiceCategory configuration messages.
ServiceDeliveryPoint	Metering	Logical point on the network where the ownership of the service changes hands. It is one of potentially many service points within a ServiceLocation, delivering service in accordance with a CustomerAgreement. Used at the place where a meter may be installed.
ServiceDeliveryPointConfig	Profile	Profile for ServiceDeliveryPoint configuration messages.
ServiceLocationConfig	Profile	Profile for ServiceLocation configuration messages.

Noun	Type	Description
ServiceSupplier	Prepayment	Organisation that provides services to customers.
Shift	Prepayment	Generally referring to a period of operation or work performed. Whether shift is open/closed can be derived from attributes 'activityInterval.start' and 'activityInterval.end'. The grand total for receipts (i.e., cumulative total of all actual receipted amounts during this shift; bankable + non-bankable; excludes rounding error totals) can be derived from Receipt attributes: =sum(Receipt.receiptAmount) ; includes bankable and non-bankable receipts.
SupplierConfig	Profile	Profile for supplier configuration messages.
Tariff	Prepayment	Document, approved by the responsible regulatory agency, listing the terms and conditions, including a schedule of prices, under which utility services will be provided. It has a unique number within the state or province. For rate schedules it is frequently allocated by the affiliated public utilities commission.
TariffConfig	Profile	Profile for tariff configuration messages.
TariffProfile	Prepayment	A schedule of charges; structure associated with tariff that allows the definition of complex tariff structures such as step and time of use when used in conjunction with TimeTariffInterval and Charge. Inherited 'status.value' is defined in the context of the utility's business rules, for example: active, inactive, etc.
Tender	Prepayment	Tender is what is "offered" by the customer towards making a payment and is often more than the required payment (hence the need for 'change'). The payment is thus that part of the Tender that goes towards settlement of a particular transaction. Tender is modelled as an aggregation of cheque and card. Both these tender types can exist in a single tender bid thus 'accountHolderName' must exist separately in each of cheque and card as each could have a different account holder name.
TimeTariffInterval	Prepayment	One of a sequence of time intervals defined in terms of real time. It is typically used in association with TariffProfile to define the intervals in a time of use tariff structure, where startDateTime simultaneously determines the starting point of this interval and the ending point of the previous interval.
Transaction	Prepayment	The record of details of payment for service or token sale.
TransactionRecord	Profile	Profile for Transactions messages.
TransactionSummary	Prepayment	The record of detail of payment transactions pertaining to one shift of operation (one record per 'transactionKind').
Transactor	Prepayment	The entity that ultimately executes the transaction and who is in control of the process; typically this is embodied in secure software running on a server that may employ secure hardware encryption devices for secure transaction processing.
Vendor	Prepayment	The entity that owns PointOfSale and contracts with Cashier to receipt payments and vend tokens using the payment system. Vendor has a private contract with and is managed by merchant who is a type of organisation. Vendor is accountable to Merchant for revenue collected, who is in turn accountable to supplier.
VendorShift	Prepayment	The operating shift for a vendor during which he may transact against the merchant's account. It aggregates transactions and receipts during the shift and periodically debits a merchant account. The totals in VendorShift should always = sum of totals aggregated in all cashier shifts that were open under the particular vendor shift.
NOTE The class definitions provided here are for convenience purposes only. The normative definitions are provided by the CIM.		

4.5.3 Classes related to meter reading and control

Table 3 lists those classes that are associated with meter reading and control classes but only the name of an instance is given within messages defined in this standard. The detailed attributes of these classes are used in message types defined in other parts of IEC 61968.

Table 3 – Classes related to meter reading and control

Related class	Reference	Description
Circuit	Collection Package	Static collection of conducting equipment originating at a main distribution center and supplying one or more secondary distribution centers, one or more branch-circuit distribution centers, or any combination of these two types of equipment. It is the source to the next normally open point.
LoadDataSet	IEC 61968-7	Customer, supply point, or area load data. May include meter records for customers (where regulations allow).
Organisation	IEC 61968-4	This class is used to identify companies or divisions within companies. Organisations might have roles as utilities, contractors, suppliers, manufacturers, etc.
PowerSystemResource	IEC 61970-301	An entity that describes the logical view of a component part of the utility business. PowerSystemResources are further classified as EquipmentContainers e.g. Substations, ConductingEquipment, ProtectionEquipment etc. Instances of type PowerSystemResource may be related to instances of type asset.
PowerTransformer	IEC 61970-301	An electrical device consisting of two or more coupled windings, with or without a magnetic core, for introducing mutual coupling between electric circuits. Transformers can be used to control voltage and phase shift (MW flow).
ServiceLocation	Core2/Location Package	A Customer ServiceLocation has one or more ServiceDeliveryPoint(s). Meters are related to a ServiceDeliveryPoint. The location may be a point or a polygon depending on the specific circumstances. For distribution, the ServiceLocation is typically the location of the utility customer's premise. Because a customer's premise may have one or more meters, the ServiceDeliveryPoint is used to define the actual conducting equipment that the EndDeviceAsset attaches to at the utility customer's ServiceLocation. For Transmission, it is the point(s) of interconnection on the transmission provider's transmission system where capacity and/or energy transmitted by the transmission provider is made available to the receiving party.
NOTE The class definitions provided here are for convenience purposes only. The normative definitions are provided by the CIM.		

5 Meter reading and control message types

5.1 General

The purpose of this clause is to describe the message types related to IEC 61968-9. It is important to note that some of these message types may also be used by other parts of IEC 61968. The general approach to the realization of message structures and XML schemas for IEC 61968 messages is described in 61968-1.

Although they may be represented in sequence diagrams for context and completeness, this document does not describe message formats that are defined by other parts of IEC 61968. The key message payload structures defined by this part of IEC 61968 include the following:

- CustomerMeterDataSet;
- MeterAsset;

- MeterAssetReading;
- EndDeviceControls;
- EndDeviceEvents;
- MeterReadings;
- MeterReadSchedule;
- MeterServiceRequest;
- MeterSystemEvents;
- EndDeviceFirmware.

The normative XML schemas for messages defined by this document are provided in Annex H, providing more detailed, annotated descriptions of the message structures. Message structures are also diagrammed within this clause. The notation convention shows required elements with a solid outline, and option elements with dashed outlines.

It is also important to note that the use cases and sequence diagrams provided in this clause are informative in nature, and are intended to provide examples of usage for the normative messages definitions. There is no intent by this standard to standardize specific business processes.

5.2 End device event messages

5.2.1 General

End device events are viewed as a potential data stream which is not necessarily synchronized to the collection of meter reading for billing purposes. However, it may still be relevant to the billing process. A meter health alarm might be so severe that all readings from the meter have to be considered invalid. The data consumer (e.g. the MDM system) becomes responsible to subscribe to all of the available relevant data, and merge the findings appropriately.

5.2.2 Applications

5.2.2.1 Outage detection

When an outage is not due to a SCADA trip, electric utilities typically depend on the calls from the customers to identify the location of the fault. However, the use of a MS can provide another means to identify the location of trouble. It is often possible for a MS to determine that it has lost contact with a meter, in which case this can be reported for potential use by an outage management system. It is important to note that loss of communications with a meter may not be sufficient to identify the existence of an outage, as it is common for some MS infrastructures to occasionally lose contact with meters for brief periods of time.

Some MS systems may be prone to false alarms as a result of the particular technology used to communicate with the meters. Many vendors are working to improve their technology and the accuracy of the data. The MDM, much like the role it sometimes plays in cleaning up metered data for billing applications, in many instances, can also play a role in cleaning up outage data supplied by the MS before it is relayed to the OMS. Such a decision, to route outage data through the MDM, depends on the capability of the MS to supply accurate data, the ability of the MDM to clean up data without introducing excessive delays, and the ability of the OMS to tolerate false alarms and delays. To support outage analysis and filtering of bad data, the MS may supply audit-trail data and quality of measurement data for the outage event, much like it supplies audit-trail data for billing reads. Figure 4 describes a deployment in which the MDM is employed to broker outage information.

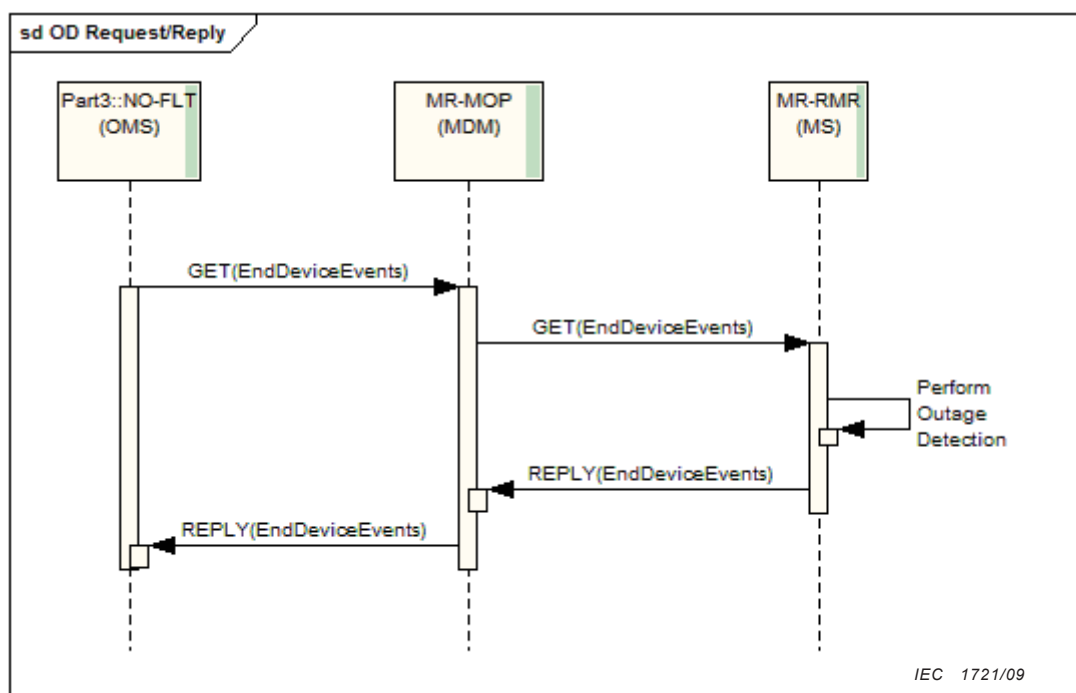


Figure 4 – Outage detection, request/reply message exchange, example 1

Outage management systems analyze the circuit in terms of network topology. The EndDeviceEvent.category can indicate an outage event as detected by an end device for consideration in the analysis, as well as other information such as trouble tickets.

The use of a MDM to broker outage data is at the discretion of the utility. In some deployments, the outage detection request from the OMS may be issued directly to the MS as in the example of Figure 5.

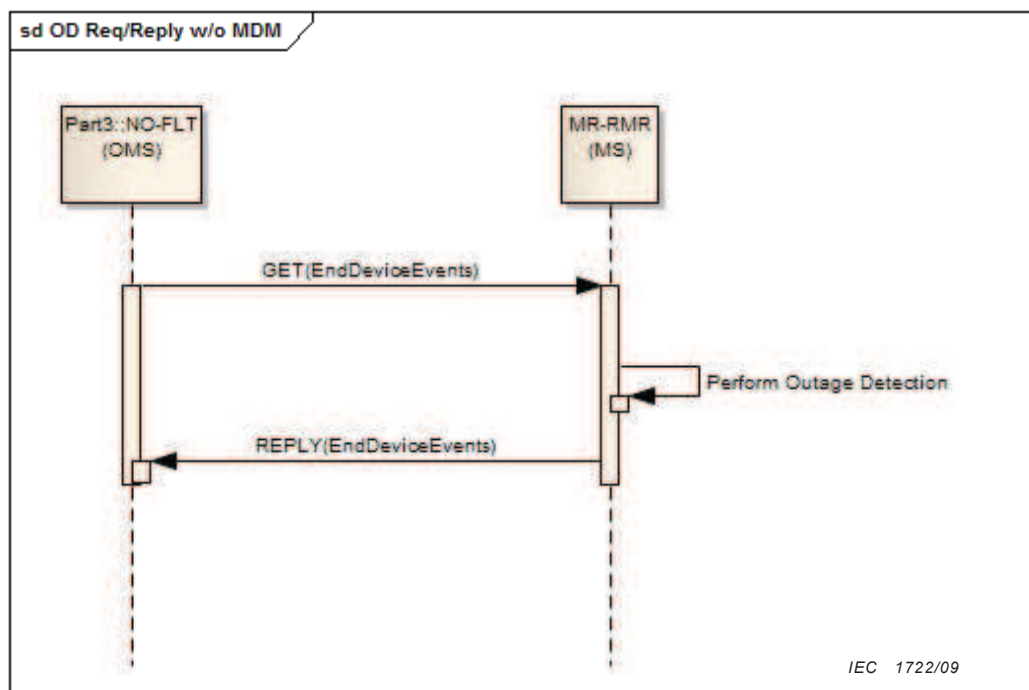


Figure 5 – Outage detection, request/reply message exchange, example 2

A reply (synchronous or asynchronous) from the MS will likely be in the form of zero or more EndDeviceEvents. The mRID will identify the end devices (e.g. meters) affected by the outage or restoration. Some data consumers that interact with the MS might only know how to deal with meter ID's. Depending on the deployment, it may be required to limit the scope of exchanged mRID's to that of meters ID's and not to that of power system resources in general. EndDeviceEvent.status can indicate "live" or "dead". EndDeviceEvent.category can be used to indicate that the status applies to a meter or power transformer. The reason for the event can be described (e.g. EndDeviceEvent.reason = "consecutiveFailCounter") and quantified (e.g. EndDeviceEvent.severity = "3").

While the request/reply exchange is useful whenever the OMS needs supplementary information, some MS are able to self-detect outages. A pub/sub exchange is ideal in these situations. Figure 6 shows such an exchange at a deployment where the MDM serves as an information broker. Figure 7 shows a deployment with information going directly from the MS to the OMS.

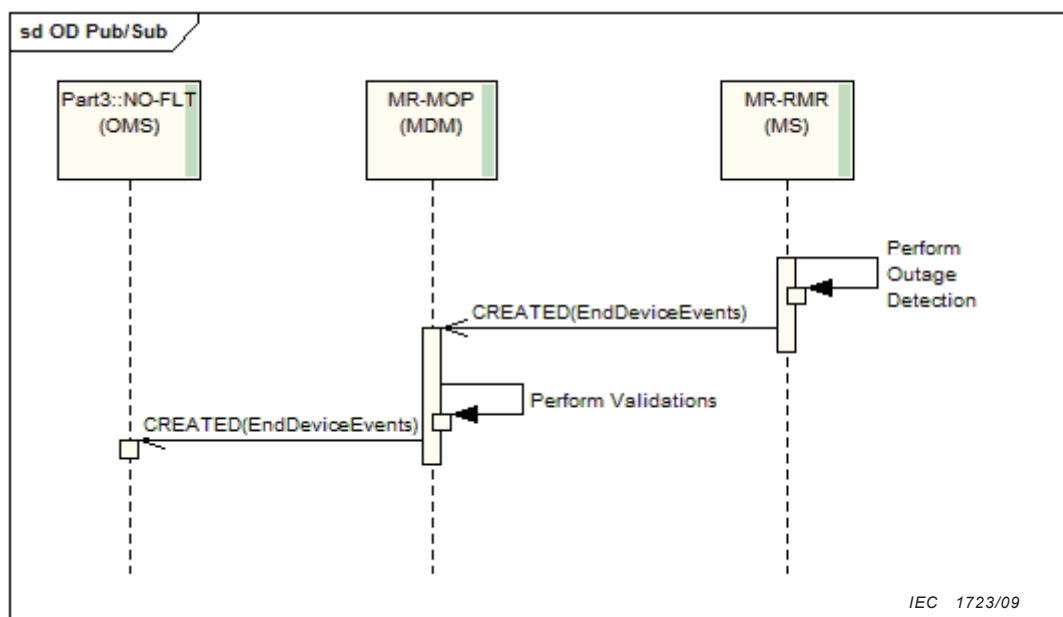


Figure 6 – Outage detection, publish/subscribe exchange, example 1

Not shown is the "SUBSCRIBE" that occurs typically only once upon system installation, and publication of events occurs repeatedly for the duration of the subscription.

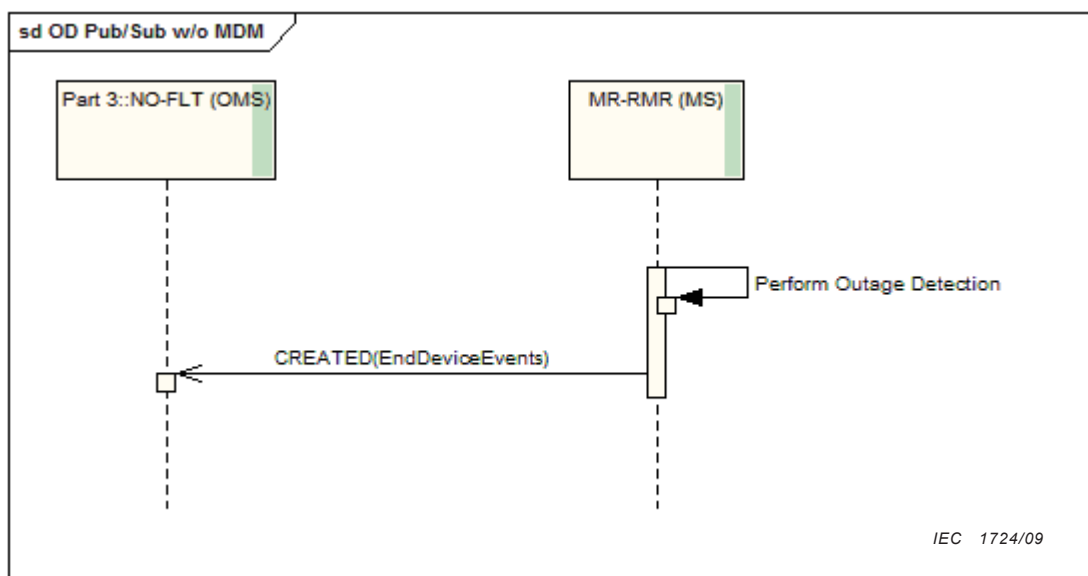


Figure 7 – Outage detection, publish/subscribe exchange, example 2

Some deployments may wish to limit the number of interfaces supported. The MeterReadings message structure also provides the means to convey EndDeviceEvents.

5.2.2.2 Meter health events

Some types of meters can sometimes generate meter health events, which can be used to identify issues with meter hardware, configuration or connection that should be resolved. The alarms include such things as diagnostic alarms, tamper alarms, or other unusual conditions. The severity of the alarm might range from a simple notification to “fatal”. Often times, resolution of meter health events require a site visit, so typically they result in the creation of a MeterServiceRequest. These events are communicated using EndDeviceEvent messages.

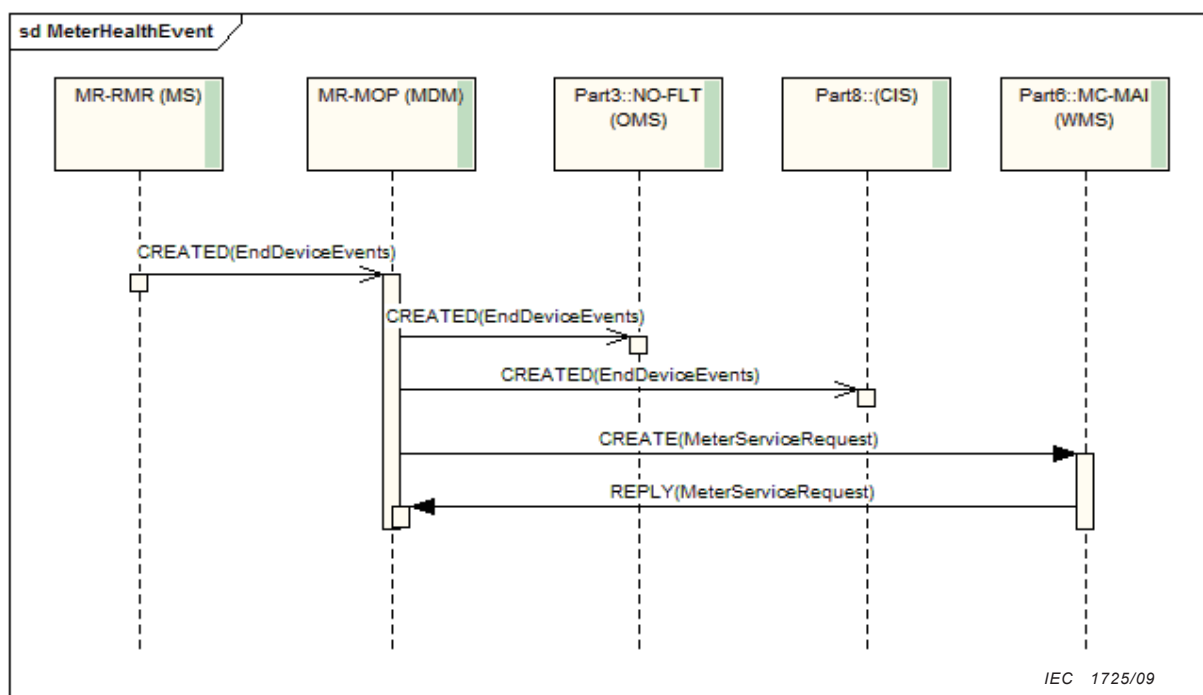


Figure 8 – Meter health event exchange, example 1

In some deployments, the MDM will be present to broker meter health data for other stakeholders as described in the scenario of Figure 8. Other installations however might not have a MDM or use it in this way. It is possible for the MS to publish data directly to the stakeholders that are equipped to receive it. Such an exchange is depicted in Figure 9.

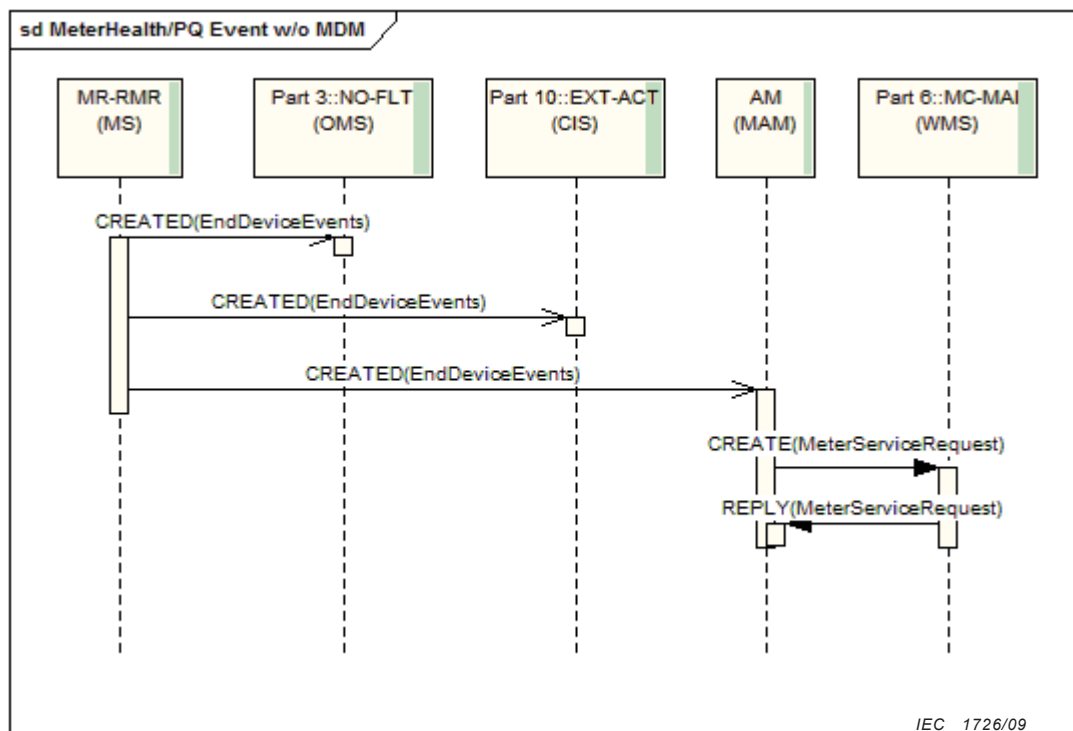


Figure 9 – Meter health event exchange, example 2

5.2.2.3 Power quality event

Meters may collect information related to power quality, including but not limited to, momentary outage events, sustained outage events, low or high voltage events, and high distortion events. This information could be used for outage analysis, maintenance scheduling or capacity planning. Power quality events are a subtype of EndDeviceEvent.

Power quality events may be brokered (i.e. publications managed) by a MDM (as described in Figure 10), or sent directly to the various stakeholders (as described in Figure 11).

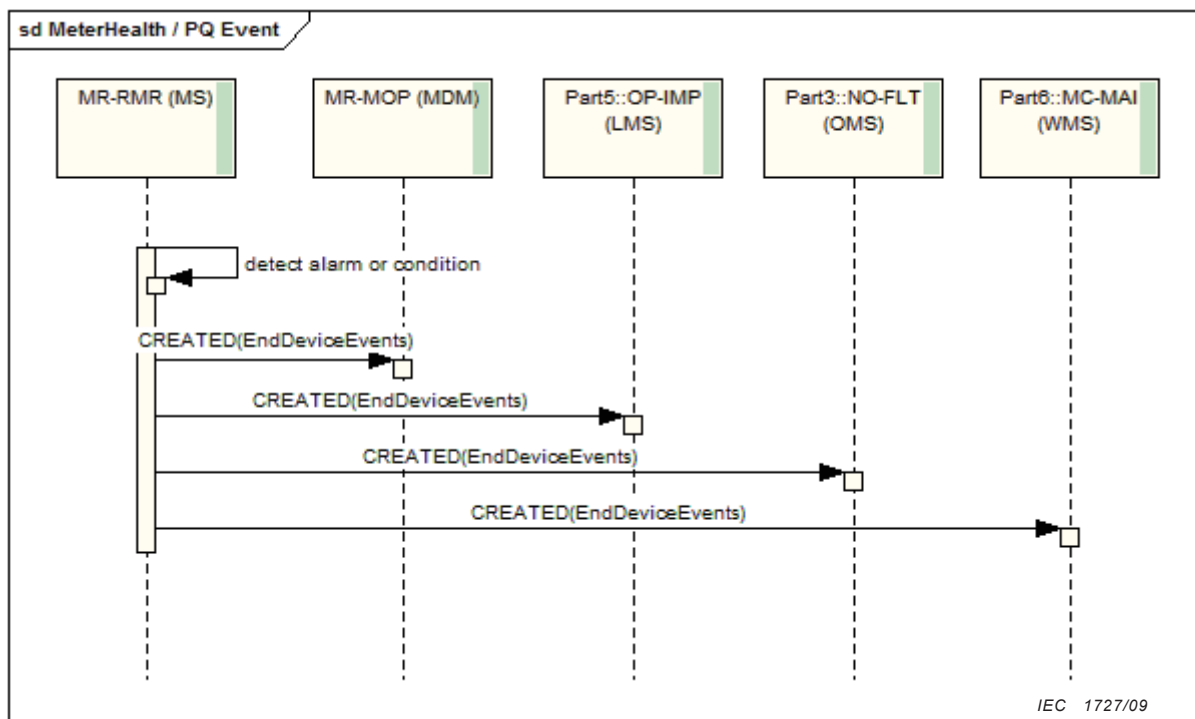


Figure 10 – Power quality event exchange, example 1

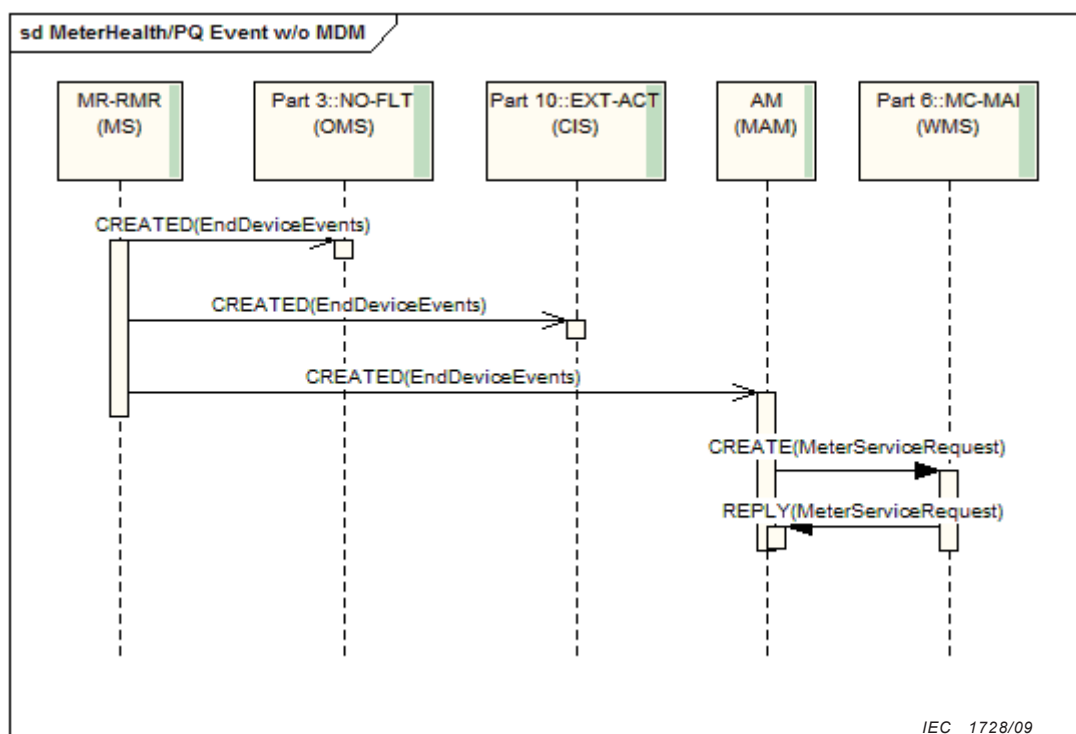


Figure 11 – Power quality event exchange, example 2

5.2.3 Message format

Meter event messages are implemented using EndDeviceEvent structures in order to support a wider variety of event sources than just meters. The EndDeviceEvent.category is an enumeration which indicates the type of event, such as outage detection, meter health, or power quality. The timestamp and mRID of the end device are also required. The message format is described in Figure 12.

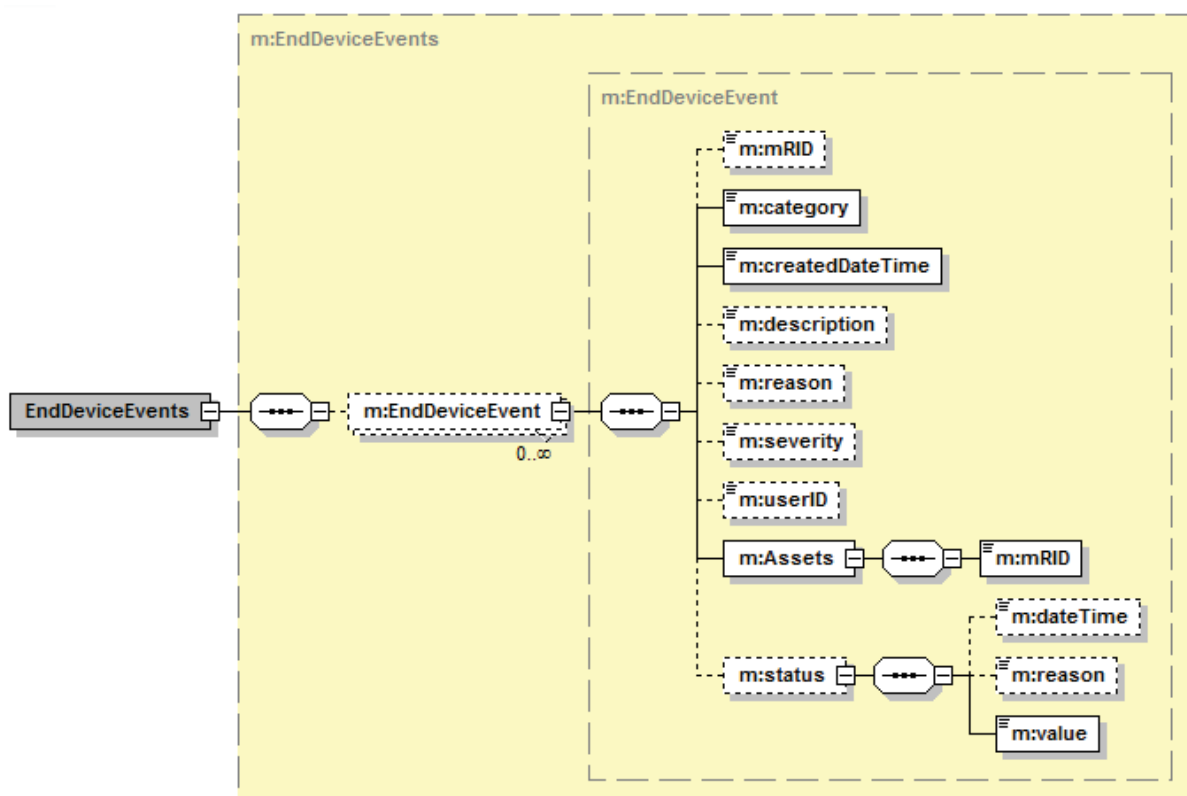


Figure 12 – End device event message format

As noted by Figure 12, only the mRID, timestamp and category elements are required. The category element will allow different event types (e.g. meter health, outage detection, etc.) to be differentiated. Different event types would allow for an EndDeviceEvent message to convey events related (but not limited) to:

- sustained outage detection;
- momentary outage detection;
- low voltage threshold detection;
- high voltage threshold detection;
- distortion;
- meter health;
- tamper detection;
- revenue event.

The detailed XML schema is provided in Clause H.4.

5.3 Synchronization between systems

5.3.1 General

In most cases, data may freely flow from the data producer to all of the data consumers (in parallel). In some cases however, systems add value to the data when they handle it. In this case, subscriptions must be established to route the data in sequence between systems.

5.3.2 Applications

5.3.2.1 Meter asset management

Most assets are assigned an ID by their system of record. (Alternatively, they may be assigned an mRID by an ID broker.) The mRID serves as a permanent key. When a data producer publishes information regarding changes to an asset, it can be understood that the mRID has not changed, but other information in the publication has. Information on the use of the SUBSCRIBE, CREATED, UPDATED, and DELETED verbs may be found in Annex A.

Subscriptions are typically established one time initially between systems (see Figure 13), using mechanisms provided by the messaging infrastructure as opposed to application-level messages. Publications flow as long as the subscription is maintained (see example in Figure 14).

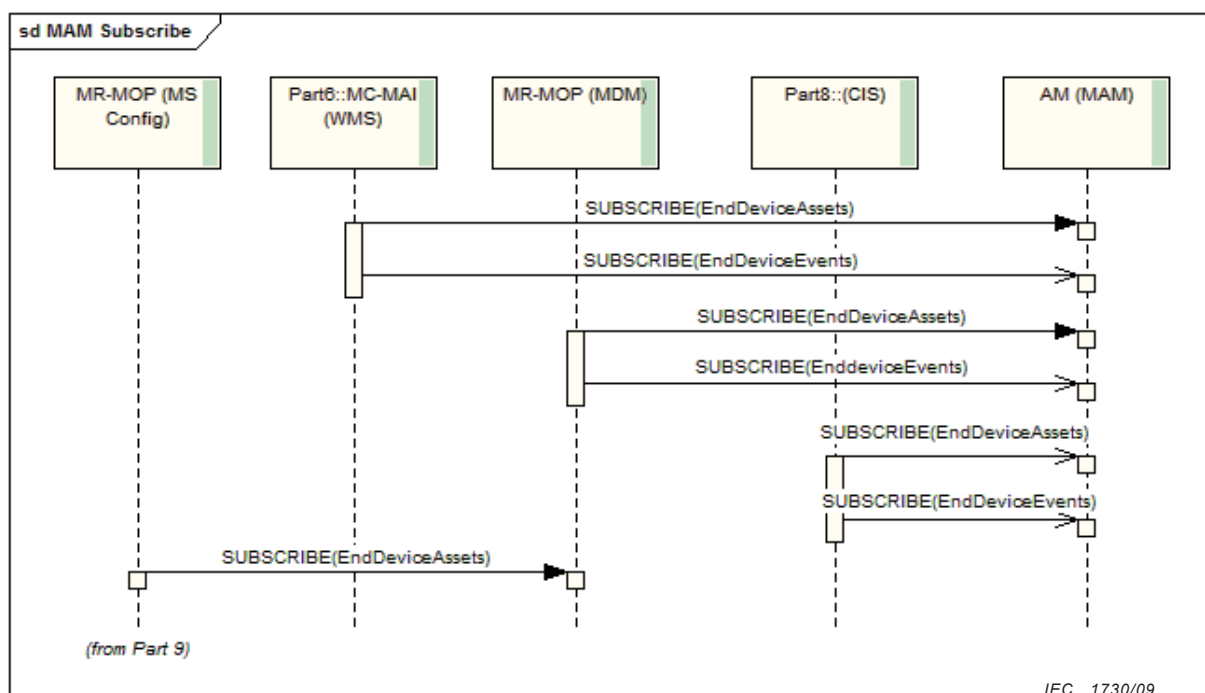


Figure 13 – Example of meter asset management subscriptions

5.3.2.2 End device acceptance into inventory

When an end device is purchased (a meter, a load control unit, whole-house connect/disconnect, etc.), the news of the purchase might propagate to the other systems. In this case, the event may be reported using either the CREATED (where the asset is new) or UPDATED (where the asset has been updated) verb. The EndDeviceAsset message is structured so that it can be used to present a bundle of DeviceFunctionality which describes the capability of the device identified by the Asset name. The EndDeviceAsset message can also be used to describe the relationship between components. For example, it can describe the relationship between a meter communication module, and the meter that hosts it.

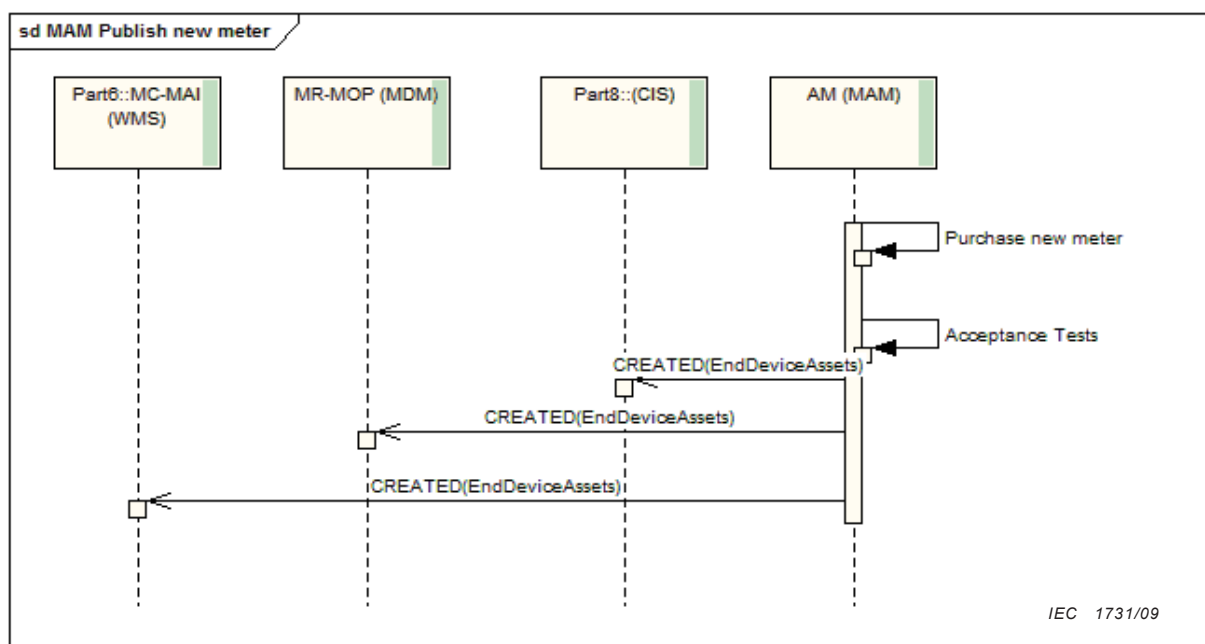


Figure 14 – Example of meter asset management publications

This information is conveyed by creating a meter asset (a subclass of EndDeviceAsset) and ActivityRecord for the new hardware. Test results from the meter vendor as well as any acceptance testing form the start of the ActivityRecord for the EndDeviceAsset.

5.3.2.3 End device retested

When a meter has been changed out (see the section on meter installation and removal), it is typically tested in the meter shop and recalibrated. The test results are added to the ActivityRecord. News of the recalibration, and the results can be sent from the WMS to the MAM as described in Figure 15.

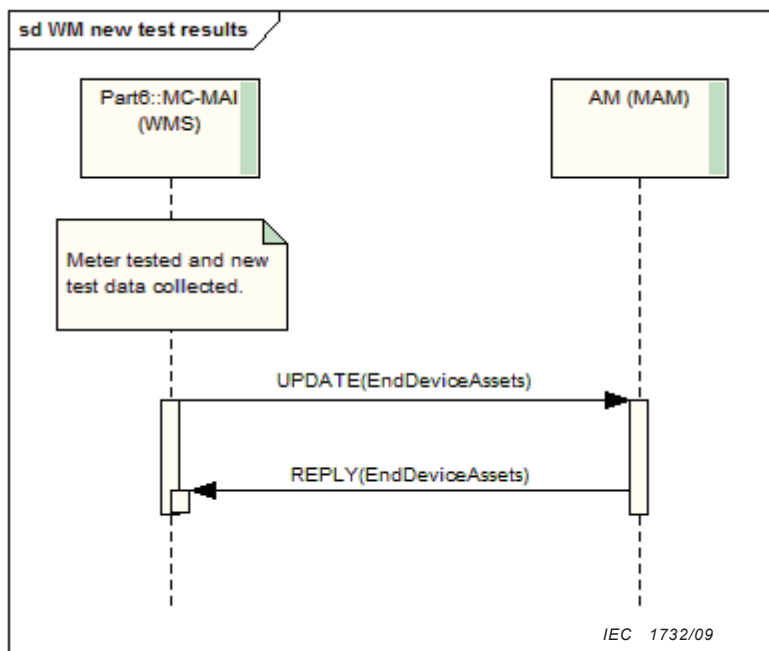


Figure 15 – Example of WM to MAM exchange – test results

5.3.2.4 End device removed from service

When an end device has reached the end of its useful life, it will be destroyed and the inventory adjusted to show that it is no longer an asset of the utility. This might happen when a meter (perhaps after failing a test) is deemed un-repairable, or when a load control unit is unresponsive and considered lost.

A utility might also sell a quantity of used meters in an effort to standardize around a particular brand or model. This too will remove the product from active inventory. Adjustments to inventory can be communicated using a method similar to that described in Figure 16.

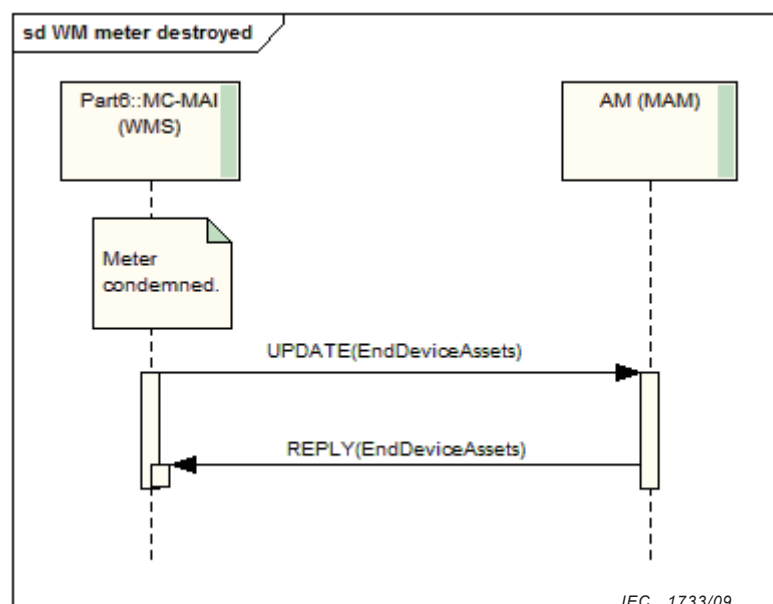


Figure 16 – Example of WM to MAM exchange – asset status update

5.3.2.5 Customer data synchronization

When changes are made to Customers, CustomerAccounts, CustomerAgreements, MeterAssets (EndDeviceAssets), ServiceDeliveryPoints or ServiceLocations, these changes will need to be published for consumption by systems such as OMS and MS. Often the Customer Billing system will be the master repository for this information.

Initially, a newly installed system may wish to immediately subscribe to changes in the data of interest (as shown by example of Figure 17.) The system however will require the history of the data as well, and may utilize “GET” and “REPLY” verbs to fill particular gaps, as shown by the example of Figure 18. Some MS may obtain customer data prepared for it by the MDM, while other MS may receive customer data directly from the CIS.

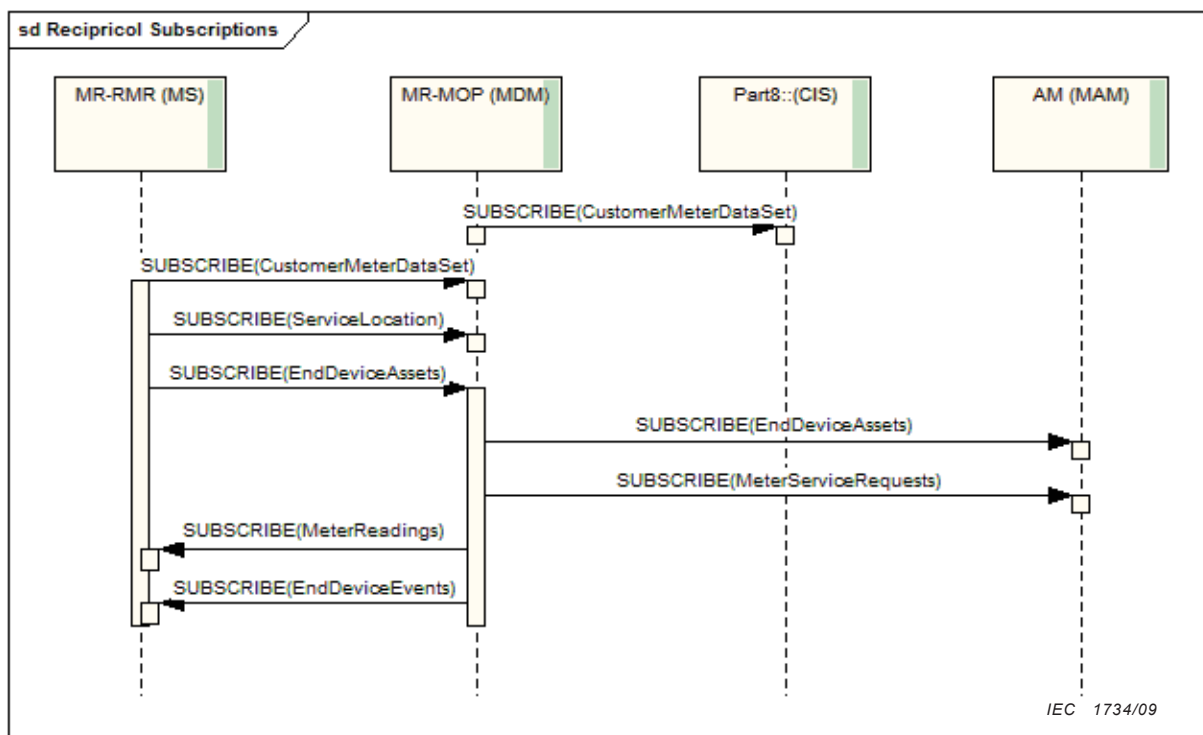


Figure 17 – Example of reciprocal subscriptions (with MDM present)

Metering systems are typically configured to read meters by group or category. Some metering systems may define particular groups or categories of meters directly in the MS. Other MS may subscribe to a meter group or category definition from a MDM. Either case of meter group definition may result in the creation of associated measurements in the MS.

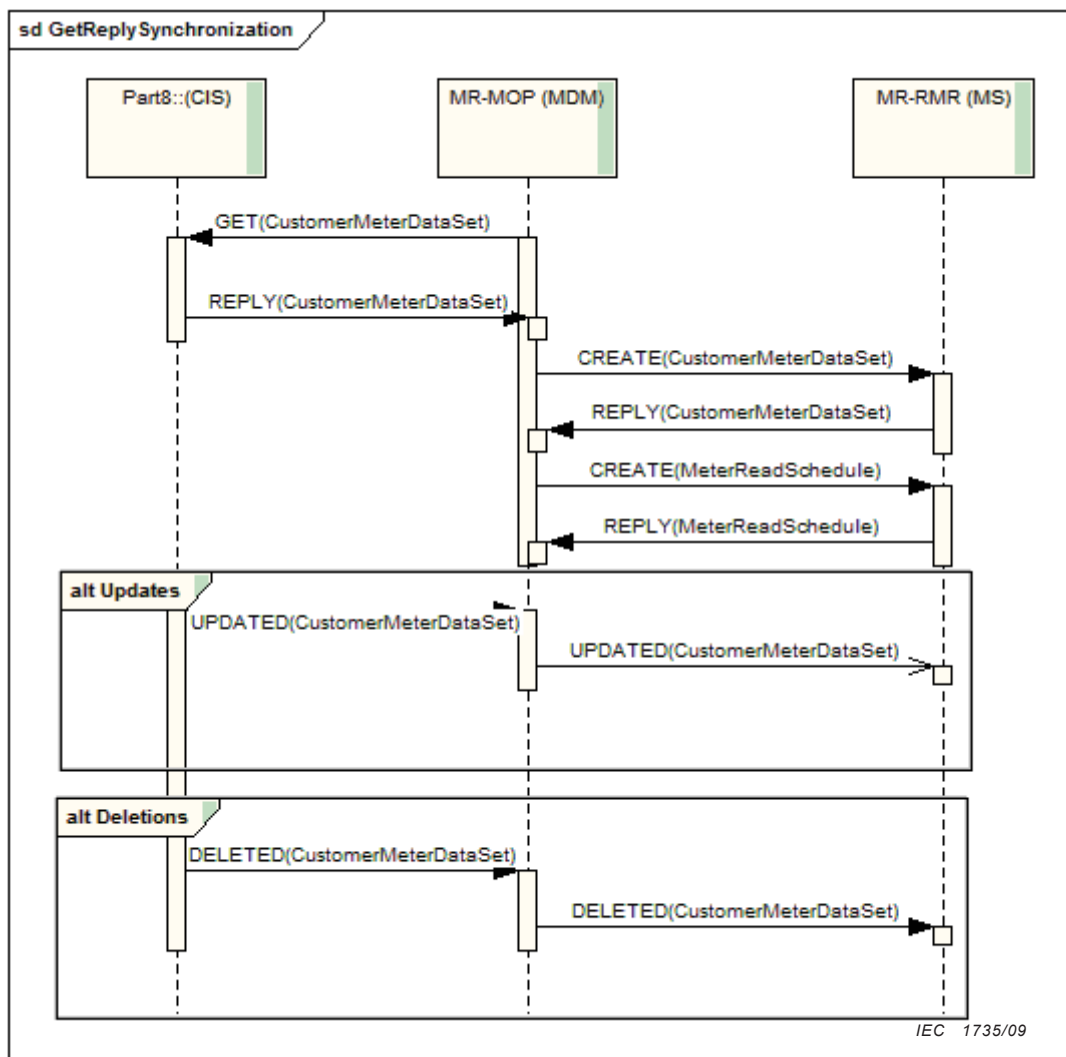
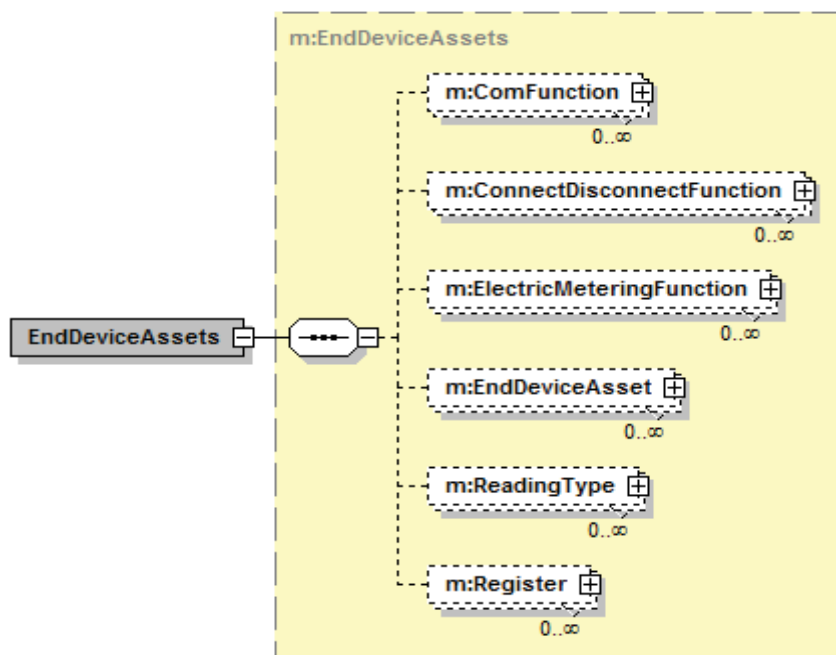


Figure 18 – Example of synchronization exchanges

5.3.3 Message format

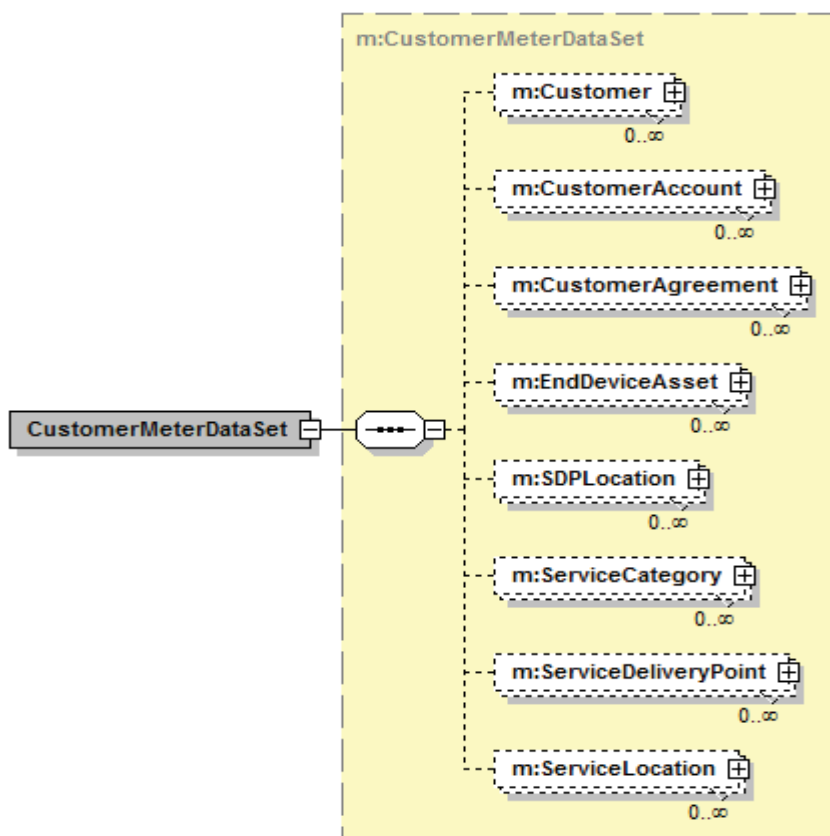
Messages are implemented using EndDeviceAssets and CustomerMeterDataSet messages. The message format for EndDeviceAssets is described in Figure 19 and the message format for CustomerMeterDataSet is described in Figure 20.



IEC 1736/09

Figure 19 – End device asset message format

The detailed XML schema for an EndDeviceAssets message is described in Clause H.10.



IEC 1737/09

Figure 20 – Customer meter data set message format

The detailed XML schema for a CustomerMeterDataSet is described in Clause H.2.

5.4 Meter reading messages

5.4.1 General

Whenever a “measurement” is required from an end device, a MeterReading exchange is quite likely the appropriate tool for the job. The end device may have metrology capability, and if so, is most likely called a “meter.” But there are other potential applications for MeterReading. If a data consumer wishes to measure the position of the switch on a connect/disconnect switch, this can be done as a MeterReading exchange. If a data consumer wishes to measure the “energization” status of the end device, this can be done with a MeterReading exchange or alternatively, with an EndDeviceEvent exchange as described in 5.2.

5.4.2 Applications

5.4.2.1 Periodic meter reads

It is necessary to periodically gather meter readings from a MS for billing through the customer billing system. The request for meter reading should specify a meter or group of meters, a type of reading to collect, and a frequency and duration of interest. The scheduled frequency may consist of regular or irregular periods.

The MeterReadSchedule request may be initiated to the MS from any of the following.

- The CIS (in an effort to collect billing determinants).
- A planning and scheduling application (in an effort to acquire engineering data about the distribution network).
- An OMS (to establish a stream of status information).
- A meter data management system (in an effort to broker data for any or all of the above applications).
- The MS itself may also self-initiate a MeterReadSchedule.

An example for one such exchange (this one using a MDM) is shown in Figure 21.

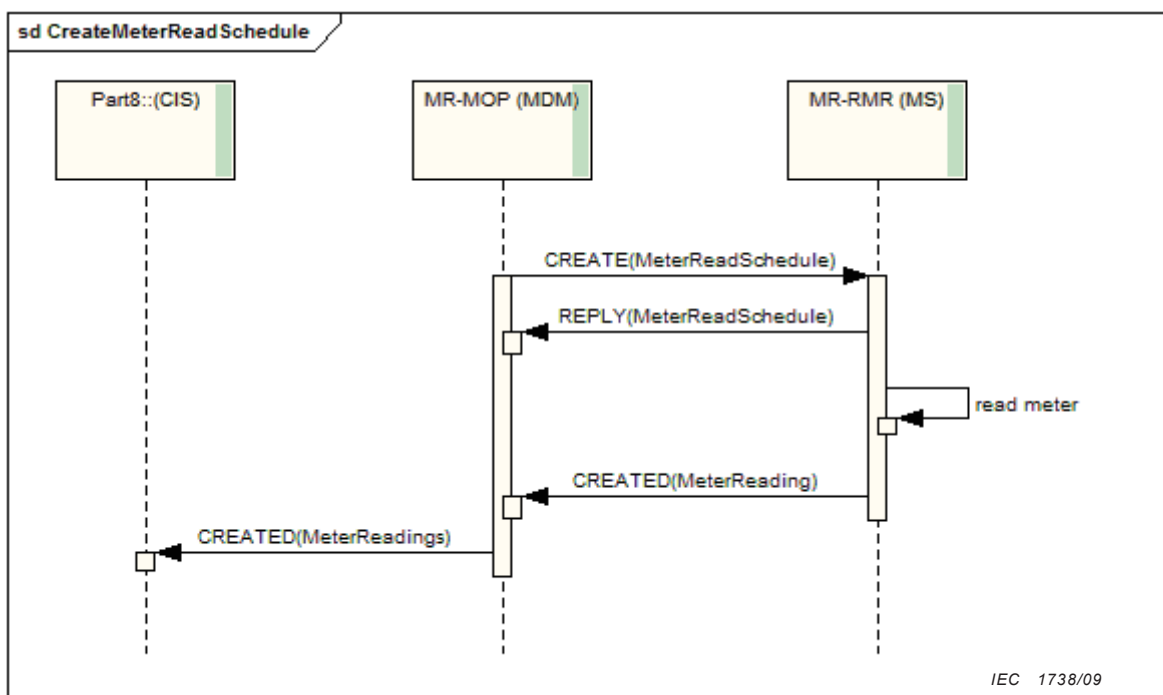


Figure 21 – Example use of meter read schedule to create subscription

Figure 22 shows the structure used for the payload of a MeterReadSchedule request message:

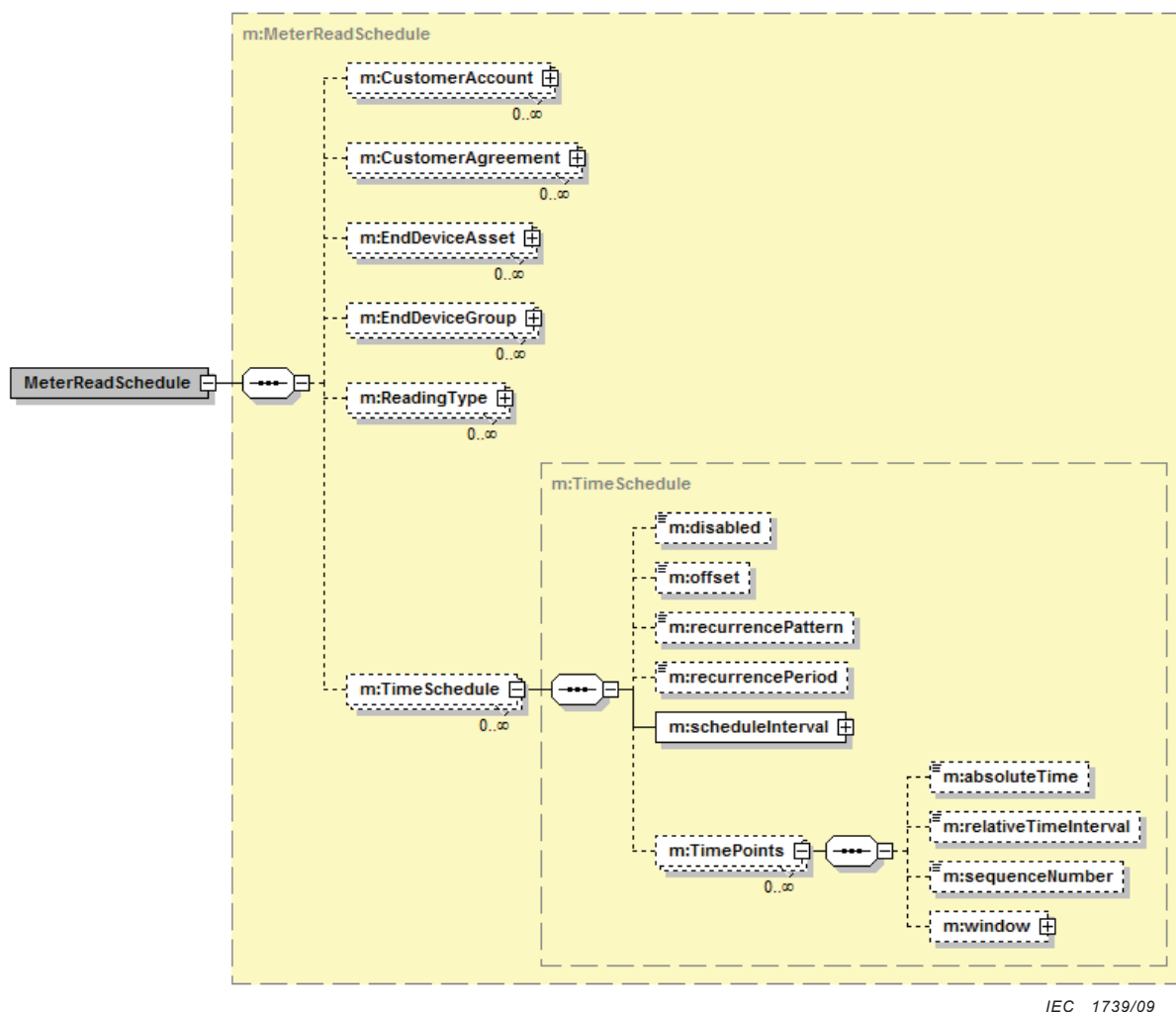


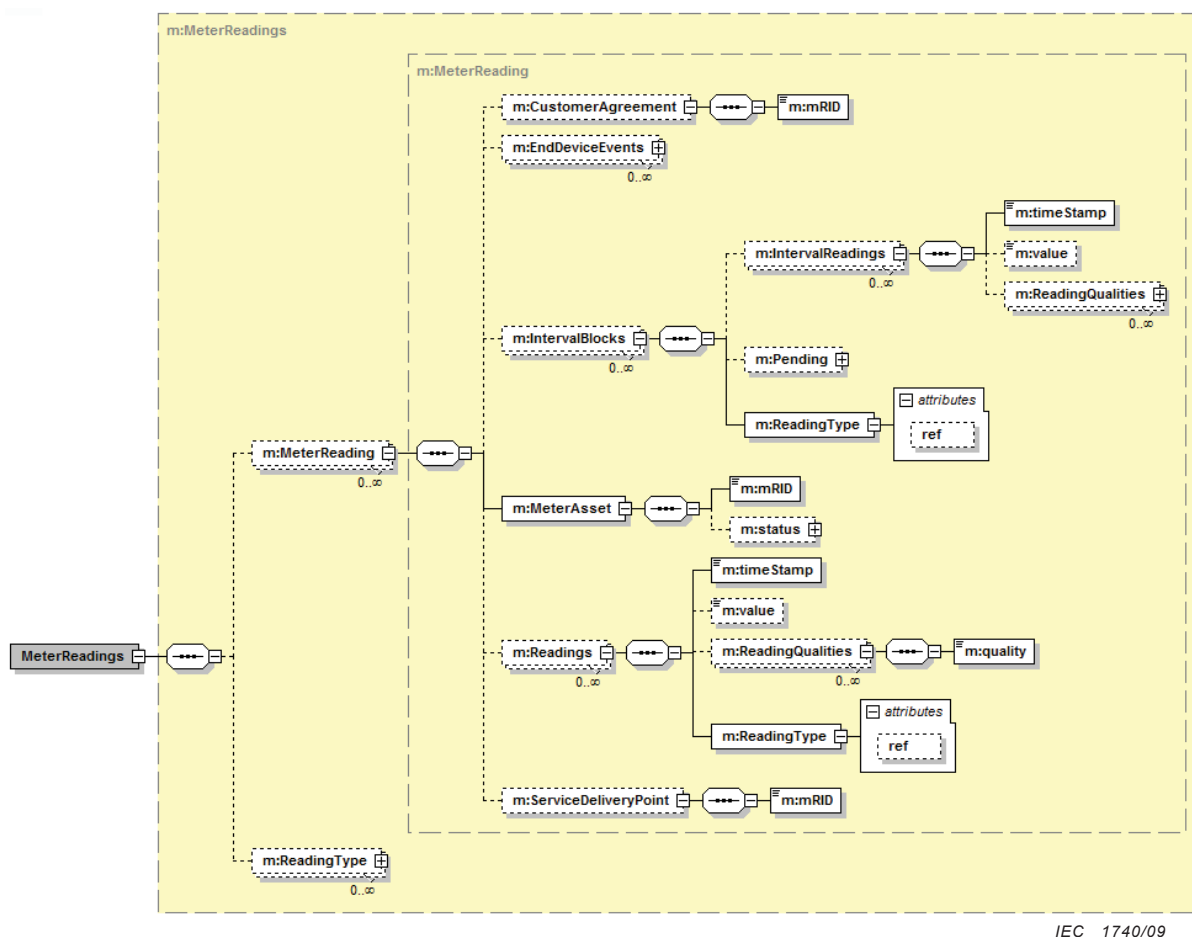
Figure 22 – Meter read schedule message format

Some metering systems may have the ability to decouple MeterReading collection from MeterReading reporting. For metering systems without this capability, readings are reported immediately upon collection. In the MeterReadSchedule request, MeterReadings may be requested using a variety of parameters, including:

- specific meter, using the EndDeviceAsset mRID;
- specific meter, using a serialNumber as known to the Metering System;
- EndDeviceGroups, where a EndDeviceGroup identifies a groupAddress used within the Metering System;
- by TimeSchedule;
- set of desired ReadingTypes.

The detailed MeterReadSchedule XML schema is provided in Clause H.6. Details related to the qualification of request messages are described in Annex J.

Figure 23 shows the message format used to present meter readings from one or more end devices.



IEC 1740/09

Figure 23 – Meter readings message format

The MeterReadings message structure allows for:

- readings from one or more meters;
- reading values each have an associated reading type, timestamp and value;
- many quality values can be associated with each reading value;
- readings can be supplied in the form of interval blocks, where readings of a common reading type are grouped together;
- event histories can be returned with meter readings.

Key to the reporting of a value from a meter is the reading type. The ReadingType class in the CIM is defined to allow capture of the following information as related to the description of a reading type:

- mRID (to uniquely identify a reading type);
- channel number;
- default quality;
- default value data type;
- dynamic configuration;
- default forward chronology;
- interval length (in seconds);
- measurement type category;
- unit of measure;

- register digits.

The details of this and other classes specific to metering are described in the metering package of the CIM. A more thorough discussion of reading types is provided in Annex C.

Readings are not limited to metering devices. Any EndDevice may potentially produce a measurement. The asset producing the reading is identified by the meterAsset class. It is expected that all assets have a unique mRID so that meters can be distinguished from remote connect/disconnect switches, and from other devices.

Interval data has unique timestamp requirements. The extended capabilities of ISO 8601 provide the means to specify both a formal interval length (as an ISO 8601 “period” of time), as well as a fixed reference point.

The following XML provides an XML example payload of a MeterReadings message.

```
<?xml version="1.0" encoding="UTF-8"?>
<m:MeterReadings xsi:schemaLocation="http://iec.ch/TC57/2009/MeterReadings# MeterReadings.xsd"
xmlns:m="http://iec.ch/TC57/2007/MeterReadings#" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
  <m:MeterReading>
    <m:CustomerAgreement>
      <m:mRID>35437383</m:mRID>
    </m:CustomerAgreement>
    <m:EndDeviceEvents>
      <m:mRID>47474</m:mRID>
      <m:category>6.6.1.47.1</m:category>
      <m:createdDateTime>2009-12-17T09:37:53.0Z</m:createdDateTime>
    </m:EndDeviceEvents>
    <m:IntervalBlocks>
      <m:IntervalReadings>
        <m:timeStamp>2009-12-17T09:30:47.0Z</m:timeStamp>
        <m:value>25.44</m:value>
      </m:IntervalReadings>
      <m:IntervalReadings>
        <m:timeStamp>2009-12-17T09:45:47.0Z</m:timeStamp>
        <m:value>37.57</m:value>
      </m:IntervalReadings>
      <m:IntervalReadings>
        <m:timeStamp>2009-12-17T10:00:47.0Z</m:timeStamp>
        <m:value>23.41</m:value>
      </m:IntervalReadings>
      <m:ReadingType ref="2.6.7.1.0.12.0.0.0.3.72"/>
    </m:IntervalBlocks>
    <m:MeterAsset>
      <m:mRID>6468822</m:mRID>
      <m:status>
        <m:value>OK</m:value>
      </m:status>
    </m:MeterAsset>
    <m:Readings>
      <m:timeStamp>2009-12-17T09:30:47.0Z</m:timeStamp>
      <m:value>3.14159E0</m:value>
      <m:ReadingType ref="0.0.1.0.2.13.2.0.0.0.111"/>
    </m:Readings>
    <m:Readings>
      <m:timeStamp>2009-12-17T09:30:47.0Z</m:timeStamp>
      <m:value>83837733</m:value>
      <m:ReadingQualities>
        <m:quality>2.5.256</m:quality>
      </m:ReadingQualities>
      <m:ReadingType ref="0.0.1.20.0.12.0.0.0.3.72"/>
    </m:Readings>
    <m:ServiceDeliveryPoint>
      <m:mRID>847647647</m:mRID>
    </m:ServiceDeliveryPoint>
  </m:MeterReading>
</m:ReadingType>
  <m:mRID>2.6.7.1.0.12.0.0.0.3.72</m:mRID>
  <m:aliasName>15-minute Incremental IntervalData Forward Energy (kWh)</m:aliasName>
  <m:unit>kWh</m:unit>
</m:ReadingType>
<m:ReadingType>
  <m:mRID>0.0.1.0.2.13.2.0.0.0.111</m:mRID>
```

```

        <m:aliasName>BulkQuantity LoadInterrupt n0 (Count)</m:aliasName>
        <m:unit>count</m:unit>
    </m:ReadingType>
    <m:ReadingType>
        <m:mRID>0.0.1.20.0.12.0.0.0.3.72</m:mRID>
        <m:aliasName>BulkQuantity Total Energy (kWh)</m:aliasName>
        <m:unit>kWh</m:unit>
    </m:ReadingType>
</m:MeterReadings>

```

5.4.2.2 Manual meter reading

Meter readings can be obtained manually by a meter reader. Data collected may be maintained by the meter data manager. Meters may collect a number of different measurement types. Some types of meters may measure more than one phase, or may collect values for non-electrical measurements, such as water or gas.

A meter reader may input data shown on the panel of meter into a handheld device, which could be regarded as a metering system. Data input occurs several hundred times per day. A meter reader may present an account of the read to the customer. Note that this account is not an invoice. Billing would be generated normally by the CIS even in the manual reading case. Figure 24 shows such an exchange.

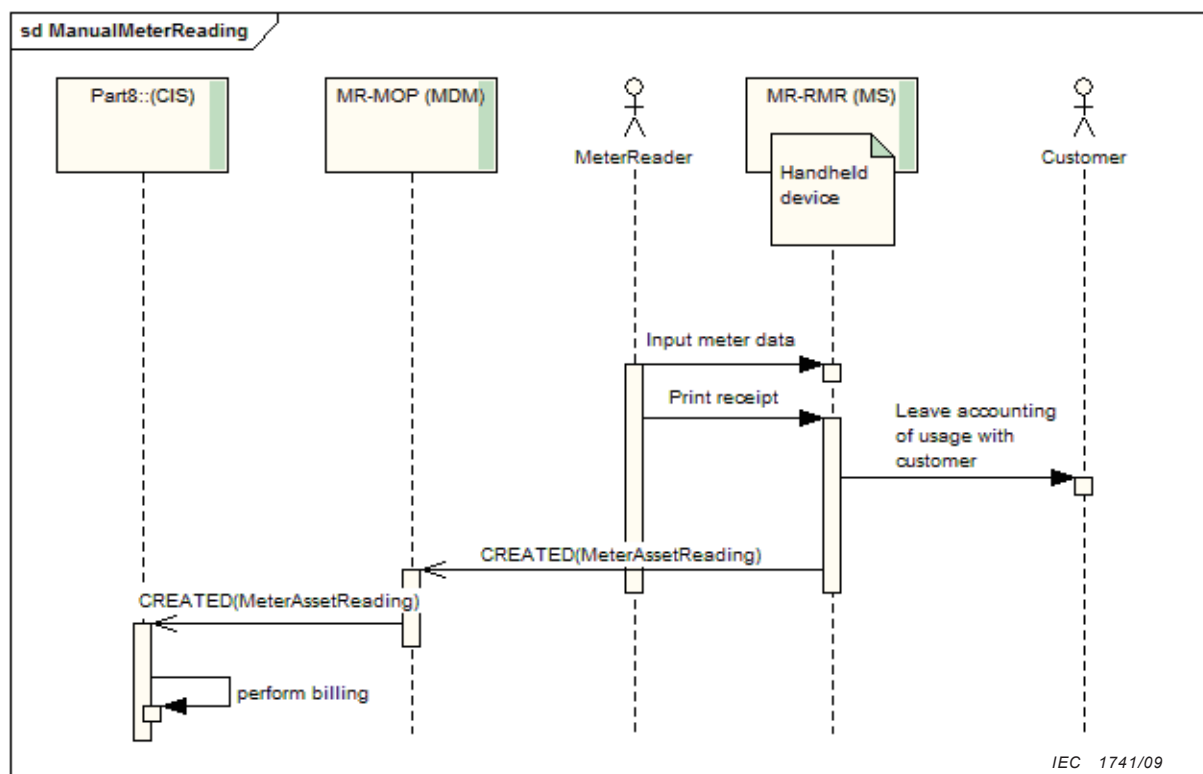


Figure 24 – Example manual meter reading exchange

At the end of the working day, all data stored in the handheld device is sent to the MDM via a communication network. The MDM publishes a message to the CIS informing of the creation of MeterAssetReading.

Schedules for walking a manual meter reading route are decided well in advance of performing the work.

5.4.2.3 On-request meter read

Meter read requests are issued to a MS in order to obtain meter readings on a per request basis. The MS will send a request to the desired meters. These can be used for billing inquiries, outage extent verification, and verification of restoration.

Many utilities have a policy of routing all revenue readings through the MDM so that all data will receive the same level of validation. However, not all MDM systems are able to offer validation services for outage data. For those that do, the utility must weigh the value of MDM validation over the time delay it introduces, as well as the ability of the particular OMS solution to reject incongruent data. For this reason, the example diagram shows revenue readings routed through the MDM, but outage data routed around it.

It is important to note that not all metering systems support 'on request' readings. For those that do, the implementation can also vary significantly.

On-request reads may be initiated to the MS from any of the following.

- The CIS (in an effort to collect billing determinants).
- A planning and scheduling application (in an effort to acquire engineering data about the distribution network).
- An OMS (in order to verify if a customer is affected by an outage or has been restored).
- A meter data management system (in an effort to broker data for any or all of the above applications).
- The MS itself may also directly initiate a meter read.

An example for one such exchange (this one using a MDM) is shown in Figure 25.

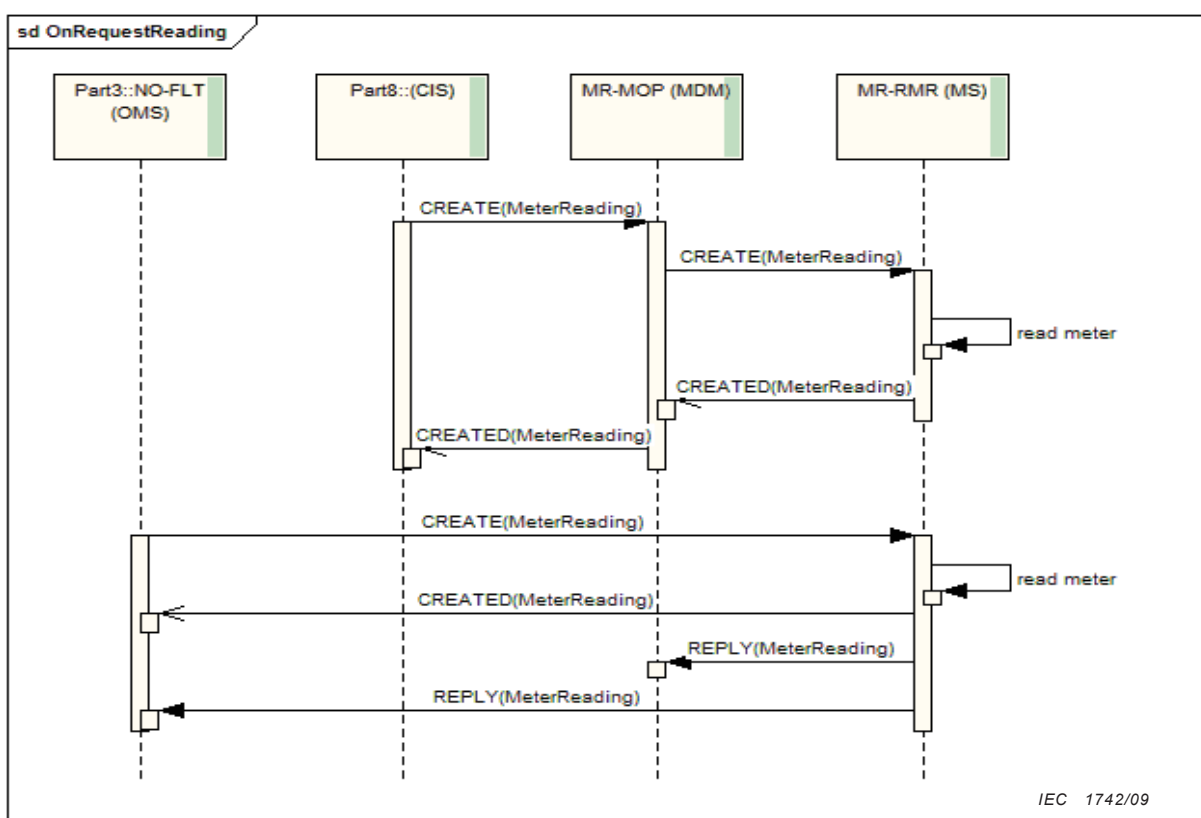


Figure 25 – Example on-request meter read exchange

5.4.2.4 Historical meter data access

A distribution network planner may use historical meter reading values as load information for capacity planning purposes (see the request/reply example in Figure 26). This would permit usage to be aggregated to determine loads for a transformer or feeder.

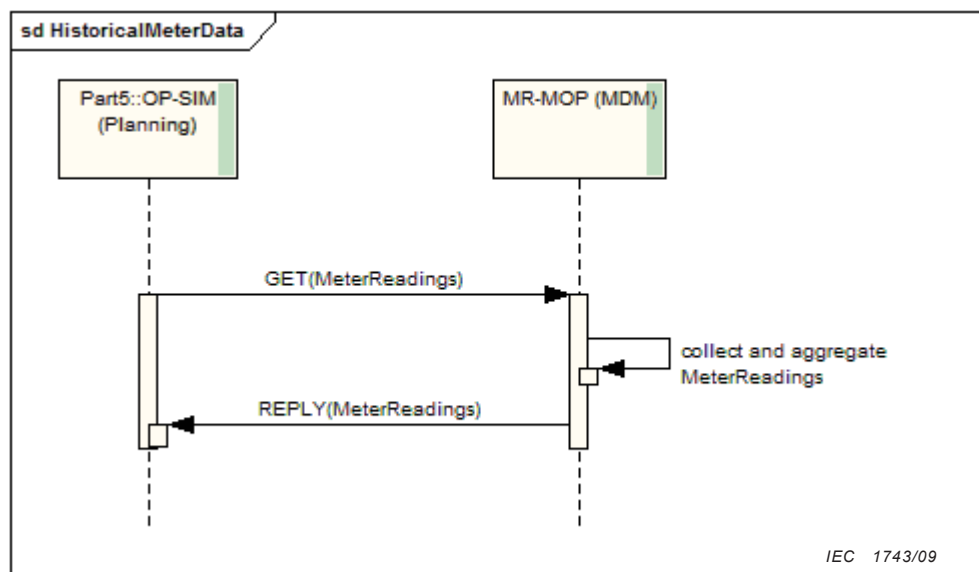


Figure 26 – HistoricalMeterData exchange

It is important to note the use of request parameters to qualify requests for meter data, filtering the results to obtain data for specific meters within specific timeframes.

5.4.2.5 Billing inquiry

A customer or an internal source may identify a customer billing issue. A meter read request in combination with historical meter reads may be used to resolve the billing issue. (The top of Figure 27 shows an inquiry being satisfied by data which recently arrived, while later on in the day an inquiry is made which requires a fresh reading from the meter.)

In some cases, the desired data may be accessible from the MDM. In other cases, it may be necessary to issue a read request remotely through the MS, or manually through a meter service request.

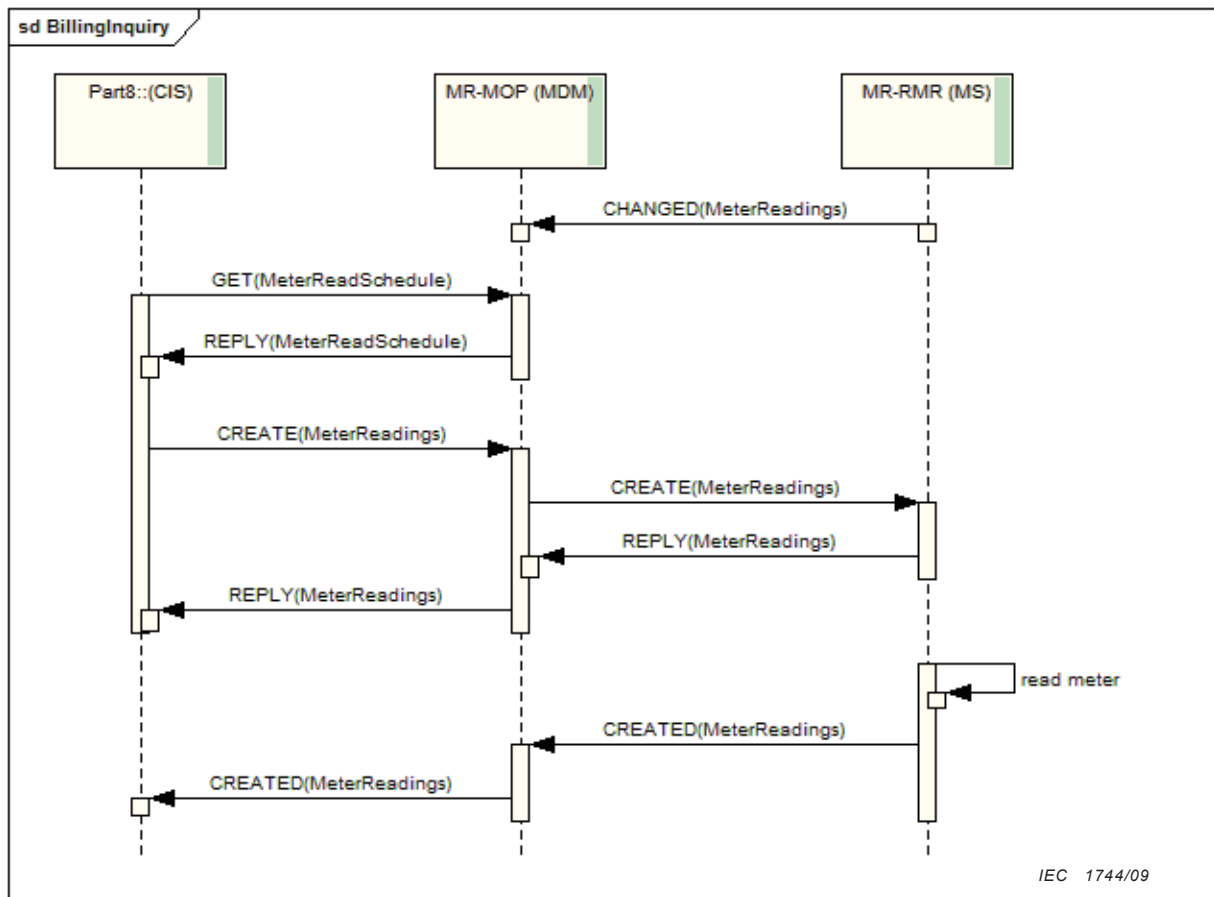


Figure 27 – Example billing inquiry message exchange

5.4.3 Message format

The message format used to convey a meter asset reading is described in Figure 28.

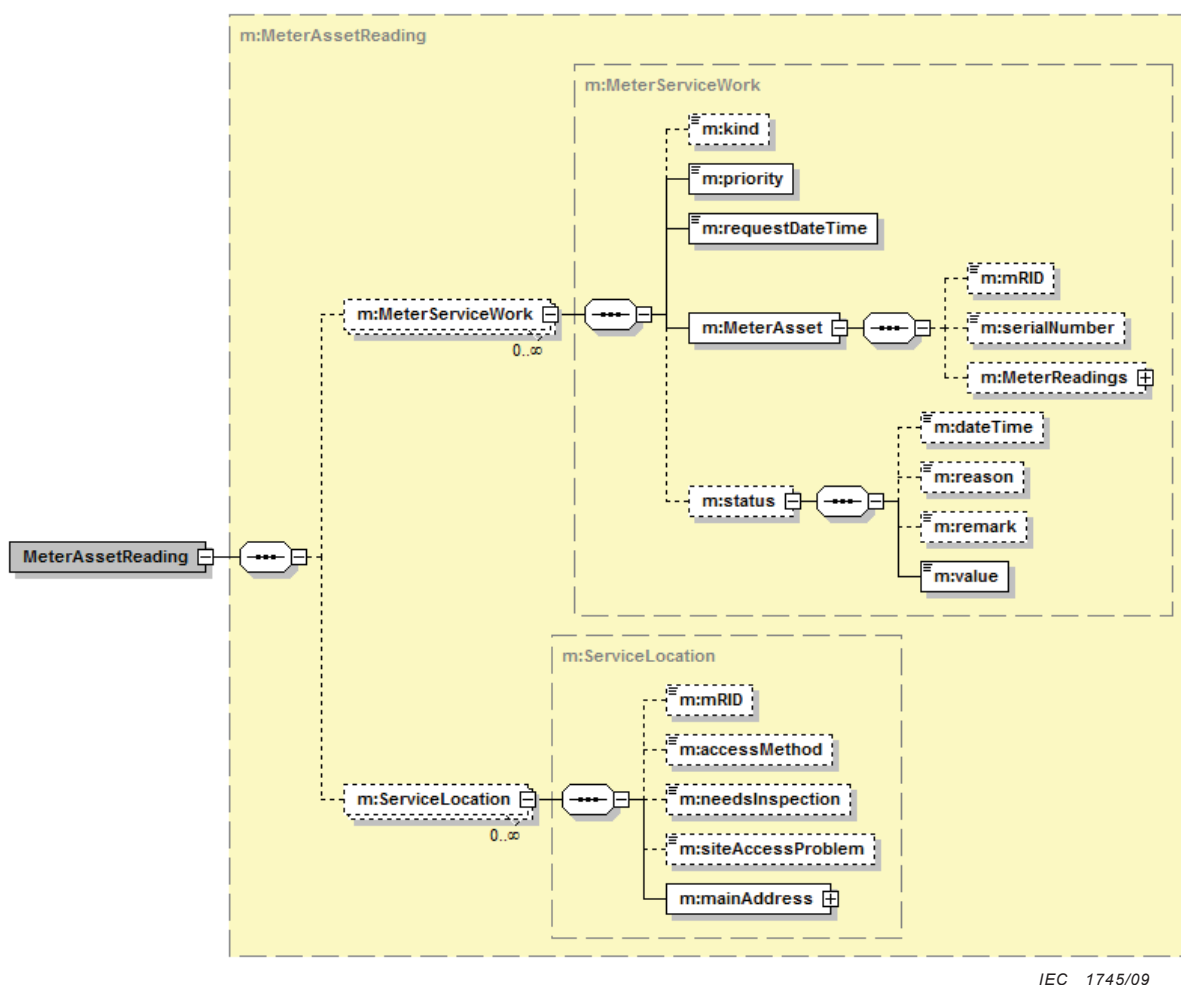


Figure 28 – Meter asset reading message format

A meter asset reading message may contain many MeterServiceWork items. Each MeterServiceWork item identifies a MeterAsset and Customer. There may be many Readings and EndDeviceEvents obtained from the MeterAsset. The detailed XML schema for a meter asset reading is described in Clause H.3.

5.5 End device control messages

5.5.1 General

There are many types of end device control messages. These are used to send instructions to one or more end devices.

5.5.2 Applications

5.5.2.1 Load control

Load control (a.k.a. direct load control) requests can often be made to a MS for the purpose of load curtailment. This request would typically be initiated from network operations. Not all MS will have load control capabilities.

It should also be noted that this is different from a disconnect, where a disconnect results in the complete loss of power to a single customer.

A load control will typically result in the shedding of specifically configured loads (e.g. air conditioning, pumps, etc.)