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First edition
2005-08

Electricity metering – Payment systems – Part 21: Framework for standardization



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Electricity metering – Payment systems – Part 21: Framework for standardization

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICITY METERING – PAYMENT SYSTEMS –

Part 21: Framework for standardization

FOREWORD

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Technical reports do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful by the maintenance team.

IEC 62055-21, which is a technical report, has been prepared by Technical Committee 13: Equipment of electrical energy measurement and load control.

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

Enquiry draft	Report on voting
13/1318A/DTR	13/1325A/RVC

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

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

IEC 62055 consists of the following parts, under the general title *Electricity metering – Payment systems*:

Part 21: Framework for Standardization

Part 31: Particular requirements – Static payment meters for active energy (classes 1 and 2)

Part 41: Standard Transfer Specification – Application layer protocol for one-way token carrier systems

Part 51: Standard Transfer Specification – Physical layer protocol for one-way numeric and magnetic card token carriers

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

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- withdrawn,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

INTRODUCTION

There is widespread activity in the application and development of payment metering systems in IEC member countries. Whilst there are many similarities in equipment functionality and operation of electricity payment metering systems in these countries, there is divergence in the particular payment technology used as well as in the use of particular token carrier technologies. An example of this is the large number of solutions using disposable magnetic cards.

A need has been identified to describe the various systems and their elements in a coherent manner and to provide a framework for standardization of payment metering systems, their elements and interfaces.

This technical report thus seeks to meet the following objectives:

- a) to present a systematic methodology to follow for use by suppliers to produce requirements specifications for system procurement;
- b) to present a systematic methodology to follow for use by equipment manufacturers to produce specifications for systems and products;
- c) to present a standard way in specifying system requirements or functionality in order that such specifications may be easily compared and evaluated by manufacturers and users;
- d) to ensure that such specifications are produced in an “open” format to allow the interoperability of sub-system components.

It has to be noted that it is not the intention of this technical report that there should be only one standard for payment metering systems or sub-systems, but that it should provide guidelines for defining several such standards according to the specific needs of the industry as and when these are identified.

The standardization work of TC13 WG15 should follow the guidelines given in this technical report in order to present such standards in a coherent and systematic way that meets the above objectives.

The IEC 62055 series covers payment systems, encompassing the customer information systems, point of sales systems, token carriers, payment meters and the respective interfaces that exist between these entities.

ELECTRICITY METERING – PAYMENT SYSTEMS –

Part 21: Framework for standardization

1 Scope

This technical report sets out a framework for the integration of standards into a system specification for electricity payment metering systems. It addresses the payment metering system application process, generic processes, generic functions, data elements, system entities and interfaces that exist in present payment metering systems. The approach taken in the framework is sufficiently generic to payment metering systems so that it should be equally applicable to future systems.

NOTE 1 This technical report excludes the application of coin-operated meters in payment systems.

NOTE 2 This technical report specifically covers electricity metering payment systems. However, it is recognised that payment metering is an established requirement in other utility services and the general framework for standardization in this technical report can be applied to such other utility services.

NOTE 3 Contract functions are confined to single bi-lateral supply agreements between a supplier and a customer and specifically exclude related third party agreements such as may be found in the deregulated markets.

NOTE 4 Future aspects are considered in Clause 9.

2 References

IEC 60050-300: *International Electrotechnical Vocabulary (IEV) – 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 62051:1999, *Electricity metering – Glossary of terms*

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

IEC/PAS 62055-41:2003, *Electricity Metering – Payment metering systems – Part 41: Standard Transfer Specification*

- NRS 009-6-6: *Interface Standards – Standard Transfer Specification / Credit dispensing unit – Electricity dispenser – Categories of tokens and transaction data fields*
- NRS 009-6-7: *Interface Standards – Standard Transfer Specification / Credit dispensing unit – Electricity dispenser – Token encoding and data encryption and decryption*
- NRS 009-6-8: *Interface Standards – Standard Transfer Specification / Disposable magnetic token technology – Token encoding format and physical token definition*
- NRS 009-6-9: *Interface Standards – Standard Transfer Specification / Numeric token technology – Token encoding format and physical token definition*
- NRS 009-7: *Standard transfer specification / The management of cryptographic keys*

¹ To be published.

IEC 62055-41, *Electricity Metering – Payment metering systems – Part 41: Standard Transfer Specification – Application layer for one-way token carrier systems*¹

IEC 62055-51, *Electricity Metering – Payment metering systems – Part 51: Standard Transfer Specification – Physical layer for one-way numeric and magnetic card token carrier systems*¹

IEC 62056-21:2001, *Electricity metering – Data exchange for meter reading, tariff and load control – Part 21: Direct local data exchange*

IEC 62056-46:2002, *Electricity metering – Data exchange for meter reading, tariff and load control – Part 46: Data link layer using HDLC protocol*

IEC 62056-47, *Electricity metering – Data exchange for meter reading, tariff and load control – Part 47: COSEM transport layers for IPv4 networks*²

IEC 62056-53:2002, *Electricity metering – Data exchange for meter reading, tariff and load control – Part 53: COSEM application layer*

IEC 62056-61:2002, *Electricity metering – Data exchange for meter reading, tariff and load control – Part 61: Object identification system (OBIS)*

3 Terms and definitions

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

Where there is a difference between the definitions in this technical report and those contained in other referenced IEC standards, then those defined in this technical report shall take precedence.

3.1 Definitions

3.1.1 token

subset of data elements, containing information that is present in the APDU of the application layer of the POS_to-Token_Carrier_Interface, and which is also transferred to the meter by means of a token carrier, and which is finally presented to the meter application process

The converse is also true in the case of a token being sent from the meter to the POS.

3.1.2 token carrier

medium that is used in the physical layer of the POS_to-Token_Carrier_Interface, onto which the token is modulated or encoded, and which serves to carry the token from the point where it is generated to the remote meter, where it is received

3.1.3 location

geographical area, clearly distinguishable from another adjacent area, on which the payment meter is installed

Examples of such locations are: consumer's premises, building, street or pavement.

3.1.4**local**

term defined in relation to the physical location of the payment meter installation

Any device that is on the same location as the payment meter is considered to be local.

3.1.5**remote**

term defined in relation to the physical location of the payment meter installation

Any device that is not on the same location as the payment meter is considered to be remote.

3.1.6**supplier**

legal entity that enters into a contractual supply agreement with a customer to effect delivery of electrical energy or other utilities

NOTE Other definitions of “supplier” may be relevant in deregulated markets.

3.1.7**transaction record**

group of data elements describing the necessary attributes of a financial transaction

This would normally include items like transaction amount, purchase item identifier, kWh value, payment type, receipt number, customer reference number, operator number, shift batch number, sales batch number, banking batch number, etc.

3.1.8**shift batch**

group of transaction records created during a single working shift of a particular POS operator

3.1.9**shift batch summary**

summary of transactions in a shift batch, summarized by transaction type and optionally by service type and by the supplier

NOTE It is common practice for an agent to perform the receipting function for several supply companies, thus requiring transaction records to be separated per supplier. A single supplier such as a municipality that supplies water and electricity also requires transaction records to be separated per service type.

3.1.10**sales batch**

group of shift batches

3.1.11**sales batch summary**

summary of transactions in a sales batch, summarized by shift batch and by transaction type and optionally by service type and by the supplier

3.1.12**banking batch**

group of sales batches

3.1.13**banking batch summary**

summary of transactions in a banking batch, summarized by sales batch, by shift batch and by transaction type and optionally by service type and by the supplier.

It includes bankable amounts totalled by payment type (and optionally by service type and by the supplier) in preparation for bank depositing and settlement with each supplier.

**Documents**

Document Sharing Hub

3.1.14

process

logically linked sequence of tasks that enables the system to achieve particular objectives

For definition of various processes, see Clause 10.

3.1.15

function

encapsulation of a defined capability or functionality of the system

For definition of various functions, see Clause 11.

3.2 Abbreviated terms

3DES	Triple DES (see also DES); Data Encryption Standard applied 3 times
AES	Advanced Encryption Standard
AMR	Automatic Meter Reading
APDU	Application Protocol Data Unit
ASN	Abstract Syntax Notation
BS	British Standard
CDROM	Compact disc read-only memory
CDU	Credit Dispensing Unit (see also POS)
CIS	Customer_Information_System
CRC	Cyclic_Redundancy_Code
CRT	Cathode-ray tube
C/S	Client / Server
DES	Data Encryption Standard
DIN	Deutsches Institut für Normung; a Germany-based standards organization
DLMS	Device Language Message Specification
ED	Electricity Dispenser or Energy Dispenser; used in Annex A interchangeably with “meter”
GMT	Greenwich Mean Time
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
HO	high-order portion of a number
HTML	Hyper Text Mark-up Language; a standard format for web documents
ID	Identifier or identification
IEC	International Electrotechnical Commission
IEC/PAS	IEC – Publicly Available Specification
ISO	International Standards Organization
kWh	kilo-watt hour
LAN	Local Area Network
LCD	Liquid-crystal display
LED	Light emitting diode
LO	low-order portion of a number

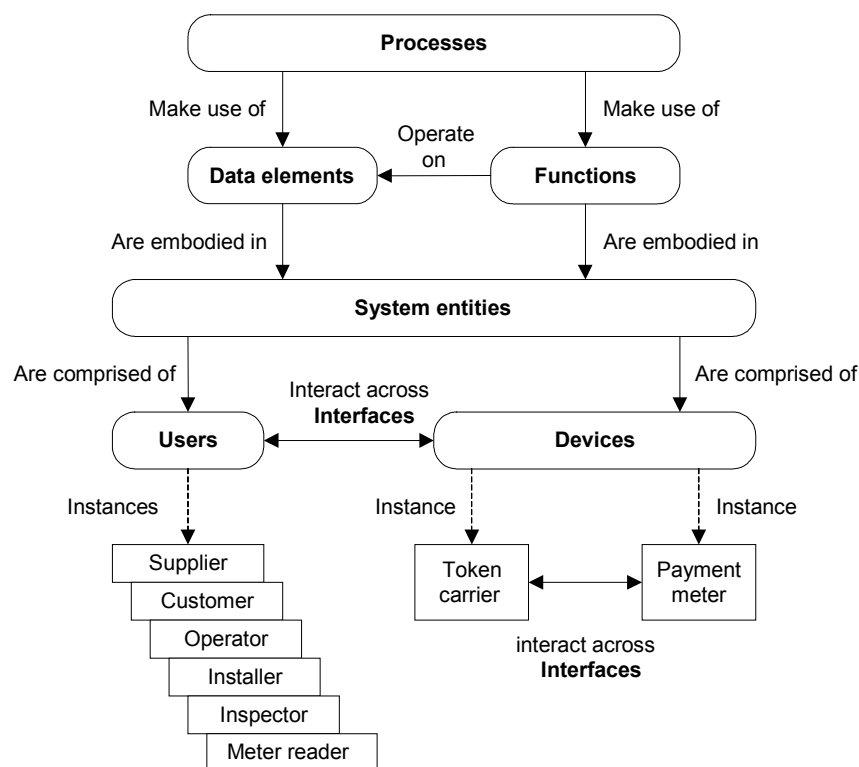
NRS	National Rationalized user Specification; a South African industry standard
OSI	Open System Interconnection; a reference model for communication protocols
PAN	Primary_Account_Number
PLC	Power Line Carrier
POD	Point_Of_Delivery
POS	Point_Of_Sale (see also CDU)
PSTN	Public Switched Telephone Network
RAM	Random Access Memory
RAS	Remote Access Server
RSA	A public key cryptography standard; Authors: Rivest, Shamir and Adelman
STS	Standard Transfer Specification
STT	Standard Token Translator; converts an STS format token into a specified proprietary format token
TC13	IEC Technical Committee 13
TCP/IP	Transmission Control Protocol / Internet Protocol
TID	Token_Identifier
TV	Television
WAN	Wide Area Network
WG15	Working Group 15 of IEC TC13
X.25	A standard for packet switching networks; layers 1, 2 and 3 in OSI model
XML	Extensible Mark-up Language; a standard format for data exchange

3.3 Notation and terminology

Throughout this technical report the following rules are observed regarding the naming of terms:

- entity names, data element names, function names and process names are treated as generic object classes and are given names in terms of nouns, which are capitalized and joined with an underscore to signify a single entity. Examples are: Supply_Group_Code as a data element name, Encryption_Algorithm as a function name and Installation_Connection as a process name;
- direct (specific) reference to a named class of object uses the capitalized form, while general (non-specific) reference uses the small caps form without underscore joining. A direct reference example is: "The Supply_Group_Code is linked to a group of meters", while an indirect reference example is: "A supply group code links to a vending key";
- other terms use the generally accepted abbreviated forms like PSTN for Public Switched Telephone Network.

4 General concepts



NOTE With outsourced services or deregulated market environments, there may be additional user instances such as vending agents and retail network services providers.

Figure 1 – General concepts of a Payment Metering System

A Payment Metering System is a collective infrastructure that supports the contractual relationship between a supplier of goods or services and a customer. It includes processes, functions, data elements, system entities (devices and users) and interfaces.

A Process is a logically linked sequence of tasks and activities that enable the system to achieve particular objectives in terms of the purpose for which it is designed. A process calls on the services of functions, which in turn operate on data elements. A process may also interact with other processes, (e.g. being invoked or terminated by another process) or it may invoke several functions to achieve a particular result. Because a particular function may be used by more than one process, there may be many more processes in a system than there are functions. See also Clause 10 for more on generic processes.

A Function is the encapsulation of a defined capability or functionality of the system, abstracted from the application domain, that gives the system entities the ability to act, react and interact. The internal working of a function is itself a process, but this is invisible from an external perspective, which sees only a start and end state. A process may thus also be encapsulated into a single function. A function is always embodied in one or more of the system entities and may even require several entities in order to realize a particular function. It is a well-defined task with a start and end state that, when invoked, will cause the task to be executed until completion. The end result of a function may be anything from a simple data manipulation, through calculating the answer of a complex mathematical problem, to the displaying of the contents of a particular register. It is important to note that a given function may not necessarily be implemented in the same physical part or system entity of a particular system as compared to that of another system even if the functions are identical. See also Clause 11 for more on generic functions.

Data Elements embody information about the properties or status of the system. They are the most basic part of the system and should not be decomposed below this definition. Data elements may vary from being the contents of a software register to being a visible marking on a label of a meter panel indicating a meter serial number. Data elements are created, recorded, transformed and moved around within the system by means of processes and functions. See also Clause 12 for more on data elements.

System Entities are discrete devices and users of the system that are deployed and configured within a system architecture in such a way as to enable the system to perform its objectives. Devices are typically computers, modems, networks, printers, token carriers, meters, software programs, etc. Each of these entities embodies functions and data elements that participate in processes. Similarly users are typically customers, POS operators, installation and maintenance personnel, etc. See also Clause 13 for more on system entities.

Interfaces will exist between those system entities that need to exchange data elements. These interfaces will have data elements passing over them in support of the functions and processes. Interfaces are selected at appropriate places within a defined architecture to suit a clear objective of the system design. See also Clause 13 for more on interfaces.

5 The generic entity model

A generic entity model for electricity payment metering systems is shown in Figure 2. Although it provides a limited perspective, it does serve to convey certain essential concepts.

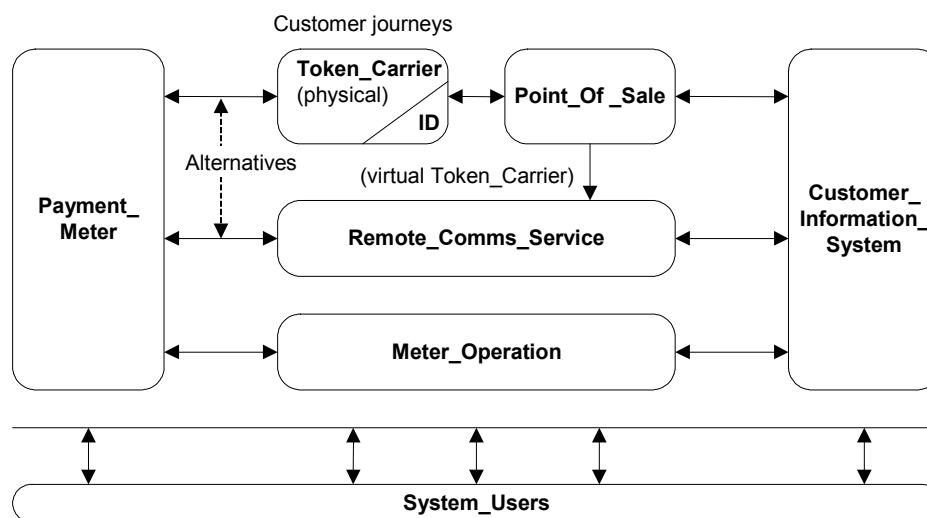


Figure 2 – Generic entity model for electricity payment metering systems

The essential entities of a payment metering system are:

- the Payment_Meter;
- the Token_Carrier or Remote_Communication_Services providing the means to communicate with the Payment_Meter;
- the Meter_Operation providing the means to install a payment meter and to configure its variable parameters;
- the Point_Of_Sale where a customer interfaces with the supplier to conduct transactions;
- the Customer_Information_System;
- the System_Interfaces where the various entities interact;
- the System_Users (operators, installers, inspectors, customers, meter readers, etc.).

NOTE 1 Independent retail network service providers and other service providers may also exist, especially in deregulated markets.

NOTE 2 System entities and interfaces are further discussed in Clause 13, except Customer_Information_Systems, Meter_Operation and Remote_Communication_Services because these are application specific and general guidelines cannot be given.

6 Generic functions and application process reference model for the Payment_Metering_System

6.1 Reference model

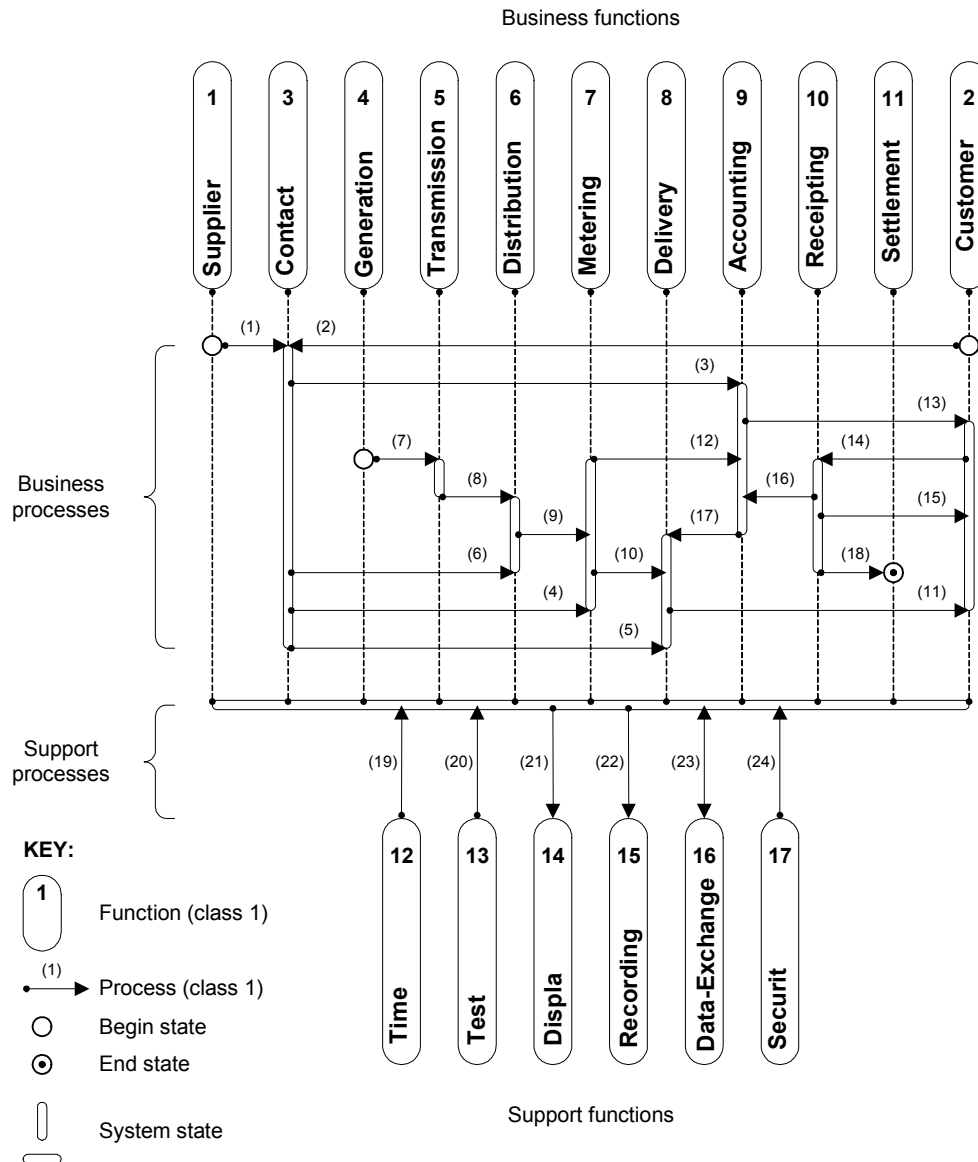


Figure 3 – Generic function model and application process for payment metering systems

6.1.1 Legend of symbols used in the reference model

A **function box** is an object-oriented representation (see 11.18) of a generic functional aspect of a payment metering system. For example: the Contract function represents all those aspects of the system that participate in providing the system with the capability to capture and enforce the business rules in accordance with the terms and conditions of the supply and purchase agreement between the Supplier and the Customer.

An **arrow** represents a process, which is an interactive relationship between two function objects. For example: process (6) manifests as the relationship between the Contract function and the Distribution function and is named Connection_Authorization.

The **dot** on the arrow represents the causal starting point of the process and the **head** represents the conclusive end point of the process. For example: process (3) is started by the Contract function and results in the establishment of a customer account within the Accounting function, which is the conclusive end of process (3).

A **system state box** represents a particular condition that a function enters into when a given event in the system causes it to do so. Such a condition is then a pre-requisite before other related events may be initiated. For example: process (1) and (2) are both required to instantiate a state in the Contract function, from which processes (3), (4), (5) and (6) may be started.

A **begin state circle** simply represents a starting point for a process that does not require a prior condition in order for it to start. For example: processes (1) and (2) may start at any time under the volition of the Supplier or the Customer.

An **end state circle** represents a condition of a function that does not cause any further events in the system and is the logical conclusion of a process. For example: process (18) ends at the Settlement function when the receipted payments from customers are handed to the supplier and there are hence no further actions to be taken from that point.

Between the business functions and the support functions there is a **common system state** (horizontal bar) that joins all the functions (1 to 17), and which serves to signify that the support functions have a relationship with each of the business functions by means of the support processes. However, each of the support functions in turn also has a relationship with the other support functions by means of the support processes. For example: the Time function serves the Accounting function with time information for controlling its time-based tariff schedules and also serves the Recording function with date and time information for tagging the data records where applicable.

6.1.2 Composition of the reference model

The multitude of functions in a payment metering system can be grouped and then abstracted into generic functions as depicted in Figure 3. This abstract function model is thus a generic representation of the functions in a payment metering system, from which all instances of specific systems are derived. Each generic function is allocated a class number (1 to 17), according to which all sub-functions are further classified, each sub-function thus inheriting its class from its generic parent function. Functions of class 1 to 11 are the business functions, while class 12 to 17 are support functions. A business function is one that implements application-specific business-related logic, while a support function is one that enhances the functionality of the business functions and also that of other support functions. It can thus be seen that one business function has a very specific interactive relationship with another business function, while a support function has a more general relationship with other functions and may interact with any other business function or with any other support function.

6.2 Business functions

The business functions are those that participate directly in the business rules of the application and enable the system to do what it is designed for. Thus they facilitate the delivery of goods and services in terms of the conditions of the supply and purchase agreement between the Supplier and the Customer.

With reference to Figure 3, the generic payment metering system application process employs the following generic business functions.

Table 1 – Generic business functions

Reference to items in Figure 3	Function
(1)	Supplier
(2)	Customer
(3)	Contract
(4)	Generation
(5)	Transmission
(6)	Distribution
(7)	Metering
(8)	Delivery
(9)	Accounting
(10)	Receipting
(11)	Settlement

See Clause 11 for a definition of each of these business functions.

6.3 Support functions

The support functions are those that enhance the functionality of the system and provide the basic foundation for the realization of the business functions of the system. Thus they do not participate directly in the business application.

With reference to Figure 3, the generic payment metering system application process employs the following generic support functions.

Table 2 – Generic support functions

Reference to items in Figure 3	Function
(12)	Time
(13)	Test
(14)	Display
(15)	Recording
(16)	Data_Exchange
(17)	Security

See Clause 11 for a definition of each of these support functions.

6.4 Business processes

The business processes are those activities that participate directly in the application of the particular business rules of the system. Thus they are primarily interactions between the business functions (see 6.2).

With reference to Figure 3, the generic payment metering system application process employs the following generic business processes.

Table 3 – Generic business processes

Reference to items in Figure 3	Process
(1)	Supply_Agreement
(2)	Purchase_Agreement
(3)	Account_Configuration
(4)	Metering_Configuration
(5)	Delivery_Configuration
(6)	Connection_Authorization
(7)	Transmission_Delivery
(8)	Distribution_Delivery
(9)	Installation_Connection
(10)	Point_Of_Delivery_Connection
(11)	Customer_Delivery
(12)	Meter_Reading
(13)	Customer_Billing
(14)	Payment_Receipting
(15)	Receipt_Issuing
(16)	Credit_Transfer
(17)	Delivery_Regulation
(18)	Supplier_Settlement

See Clause 10 for a definition of each of these business processes.

6.5 Support processes

The support processes are those activities that do not participate directly in the application of the business rules of the system, but provide supporting services to the business functions and processes. Thus they are interactions between the business functions (see 6.2) as well as between support functions (see 6.3).

With reference to Figure 3, the generic payment metering system application process employs the following generic support processes.

Table 4 – Generic support processes

Reference to items in Figure 3	Process
(19)	Time_Provision
(20)	System_Testing
(21)	Information_Display
(22)	Information_Recording
(23)	Data_Exchange
(24)	Security_Enforcement

See Clause 10 for a definition of each of these support processes.

6.6 Payment_Metering_Application process

The Payment_Metering_Application process is the combination of the business and support processes as the resultant interactions between the business and support functions, which thus describes the dynamic behaviour of the system as a whole.

The Supply_Agreement process(1) and the Purchase_Agreement process (2) capture the terms and conditions of supply and the terms and conditions of purchase in the customer Contract function. The participating parties are the Supplier and Customer or their legal representatives.

The Contract function enforces the terms and conditions by means of the Account_Configuration process (3) that instantiates the customer's account within the Accounting function. In turn, the Metering_Configuration process (4) ensures that the appropriate configuration of Metering equipment is installed and similarly the Delivery_Configuration process (5) ensures that the appropriate Delivery equipment is installed and configured at the customer's premises. Once the customer's installation is completed, the Connection_Authorization process (6) instructs the Distribution function to connect the customer's meter installation to the distribution network, which takes place by means of the Installation_Connection process (9).

The Generation function represents the source of the electrical energy supply and the Transmission_Delivery process (7) transfers the electrical energy from the generator to the transmission grid. The Transmission function makes the electrical energy available at the grid exit points, where the Distribution_Delivery process (8) similarly transfers it to the distribution network. The Distribution function makes the electrical energy available at the customer's premises for connection to the customer's meter installation.

NOTE The Supplier function has a commercial relationship with the Customer function and may also have other contractual agreements with the Generation function, Transmission function or Distribution function, but these contracts fall outside the scope of this model and technical report.

Once the customer's meter installation is connected to the distribution network the Point_Of_Delivery_Connection process (10) supplies metered electrical energy to the Delivery function from where the Customer_Delivery process (11) delivers it to the customer's load circuit.

The Meter_Reading process (12) obtains measurements of the delivered quantities of electrical energy from the Metering function and transfers it to the Accounting function for calculation and transacting of appropriate charges to the customer's account.

In a post-payment system the Customer_Billing process (13) will issue a request for payment (or credit) to the customer in the form of a bill or invoice. Whereas in a pre-payment system the Delivery_Regulation process (17) ensures that the quantity of electrical energy that is delivered to the customer is in accordance with the available credit balance in his account. It will typically cause the delivery of electrical energy to be interrupted when the available credit expires and allow it to be restored when the available credit is replenished.

The customer makes a payment by means of the Payment_Receipting process (14) and the Receipt_Issuing process (15) provides the customer with a proof of payment, usually in the form of a transaction receipt. The Credit_Transfer process (16) transfers payment credit to the customer's account in accordance with the payment amount. In a post-payment system this may be in the form of a journal entry into a bookkeeping system, while in a pre-payment system it is typically in the form of a credit token for transfer to the payment meter by means of a token carrier.

At some point in time the Supplier_Settlement process (18) will transfer the receipted payments to the supplier, which is typically in the form of bank deposits into the supplier's bank account.

The Time_Provision process (19) makes date and time information available to the other system functions where those functions control time-based schedules.

The System_Testing process (20) checks and validates the correct working of other system functions.

The Information_Display process (21) facilitates viewing of recorded information by users of the system.

The Information_Recording process (22) facilitates capturing and storing of information and events within the payment metering system.

The Data_Exchange process (23) moves data elements between functions deployed in system entities over interfaces using defined protocols.

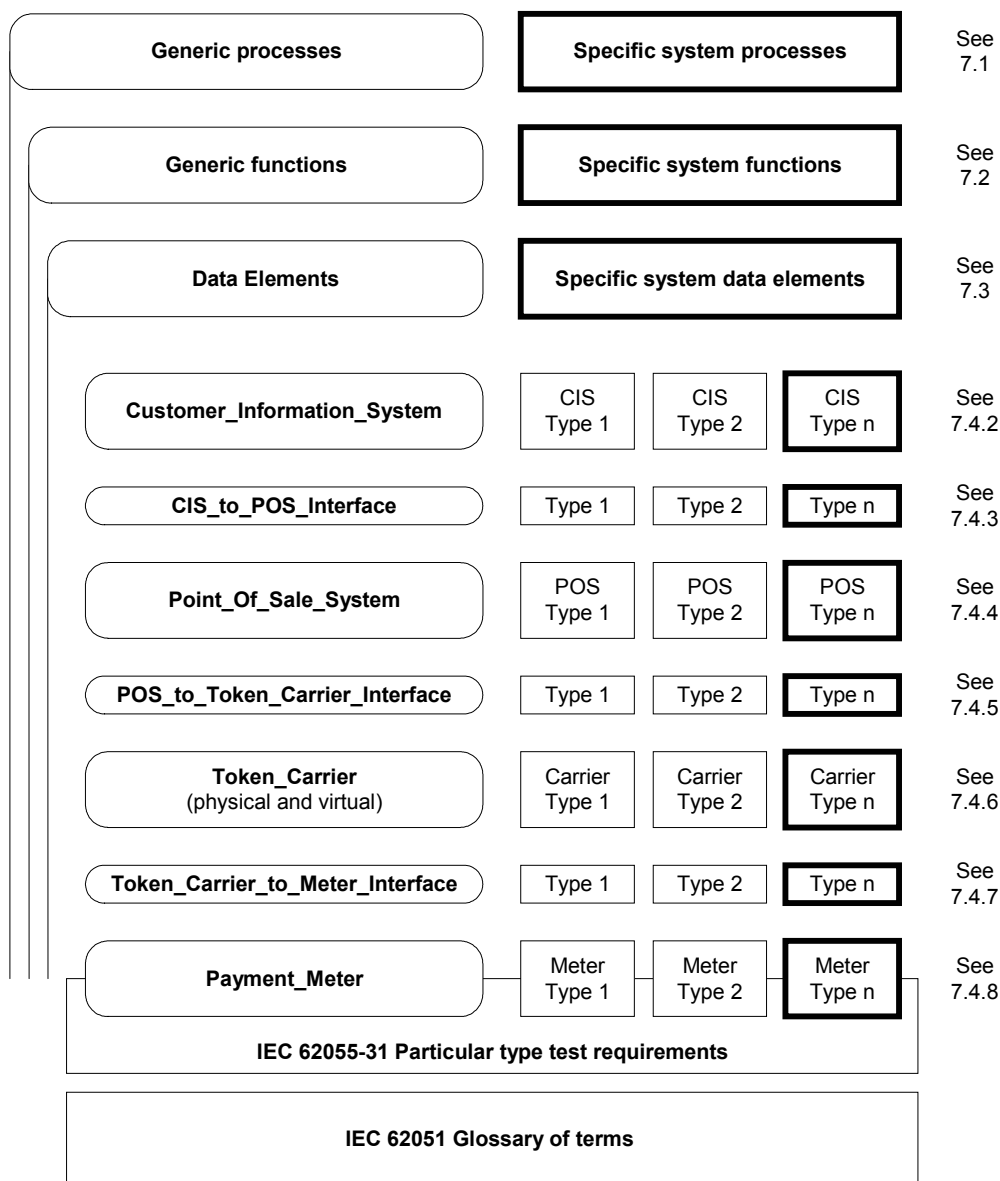
The Security_Enforcement process (24) enforces the security policies onto other relevant system functions and thus assures the integrity of the payment metering system.

Each generic process is allocated a class number (1 to 24), according to which all sub-processes are defined, each sub-process thus inheriting its class from its generic parent process.

Every instance of a process in a particular payment metering system will thus be classified according to one of the generic process classes.

It must be noted that because a function is an encapsulated process, the distinction between a function and a process is not always clear and it depends solely on how the definition is formulated. In principle, a function definition is a statement of a capability and a process definition is a statement of a sequence of tasks or events.

7 Framework for standardization



NOTE An interface from the CIS to the Token_Carriers may also exist and the CIS may also have an alternative communication service to the Payment_Meters.

Figure 4 – Framework for standardization in electricity payment metering systems

In the setting up of standards for any particular payment metering system, it is necessary to consider the physical entities, interfaces, data elements, functions and processes.

Figure 4 proposes a framework for standardization in electricity payment metering systems. The rounded boxes indicate generic elements and the squared boxes indicate specific instances. The dark outlined boxes illustrate a comprehensive payment metering system specification. Sub-system instances are also possible. For example: a POS, token carrier and meter with their respective interfaces can also be specified as a particular instance of a sub-system implementation.

It should also be noted that processes, functions and data elements are defined at the systems level as well as at each entity and interface, thus the framework dictates that any specification for an entity or interface should include reference to the functions and data elements. Conversely, a specification for a particular instance of a process should include reference to the functions and data elements that participate in the process. Similarly, a specification for a function should include reference to the data elements that it operates on.

The development of payment metering system standards should broadly follow the following process:

- when existing industry standards are proposed to the IEC for incorporation into the IEC 62055 set of standards, it would be necessary to formulate the proposed industry standards in terms of the framework for standardization and definitions given in this technical report. This would then be an instance of a particular industry standard for interfaces, data elements, functions, processes and entities like meters, token carriers and POS or CIS implementations. In this way, it gives opportunity for multiple systems to be standardized, while ensuring open standard specifications to the industry.

7.1 Generic processes

See Clause 10 for a more complete definition of generic processes that are found in payment metering systems and those activities that are required to operate a payment metering system. Any specific system or sub-system implementation would employ only some or all of these processes as particular instances of the generic processes. The standardization process of new work item proposals should involve transforming such proposals into the formats as defined in this framework as specific processes of such a specific system or sub-system. The classification scheme given in this framework should be used as the parent class for any sub-process definition.

7.2 Generic functions

See Clause 11 for a more complete definition of the generic functions that are found in payment metering systems. Any specific system or sub-system implementation would employ some or all of these functions as particular instances of the generic functions. The standardization process of new work item proposals should involve transforming such proposals into the formats as defined in this framework as specific functions of such a specific system or sub-system. The classification scheme given in this framework should be used as the parent class for any sub-function definition. This is particularly relevant to the IEC 62055-31 type test requirements for payment meters.

7.3 Data elements

See Clause 12 for a more complete definition of the data elements that are found in payment metering systems. Any specific system or sub-system implementation would employ only some or all of these data elements as particular instances of the generic data elements. The standardization process of new work item proposals should involve transforming such proposals into the formats as defined in this framework as specific data elements of such a specific system or sub-system.

7.4 System entities and interfaces

7.4.1 General

See Clause 13 for a more complete description and definition of system entities and interfaces.

7.4.2 CIS: Customer_Information_System

See 13.1 for a more complete description and definition of the customer information systems. Customer information systems should be defined in terms of data elements, functions, processes and interfaces within the context of the system as defined in this framework.

7.4.3 CIS_to_POS_Interface

See 13.2 for a more complete description and definition of this interface.

Interfaces should be defined in terms of data elements, functions and processes within the context of the system as defined in this framework.

It should be structured as an application layer and a physical layer in terms of the OSI reference model with optionally one or more intermediate layers. Functions and data formats are defined in each of the layers.

7.4.4 POS: Point_Of_Sale

See 13.3 for a more complete description and definition of point of sale infrastructure.

A point of sale should be defined in terms of data elements, functions, processes and interfaces within the context of the system as defined in this framework.

7.4.5 POS_to_Token_Carrier_Interface

See 13.4 for a more complete description and definition of this interface.

Interfaces should be defined in terms of data elements, functions and processes within the context of the system as defined in this framework.

It should be structured as an application layer and a physical layer in terms of the OSI reference model with optionally one or more intermediate layers. Functions and data formats are defined in each of the layers.

7.4.6 Token_Carrier

See 13.5 for a more complete description and definition of token carriers.

A token carrier should be defined as the medium in the physical layer of the POS_to_Token_Carrier_Interface and the Token_Carrier_to_Meter_Interface within the context of the system as defined in this framework.

NOTE In some two-way virtual token carrier based systems, there may be also a CIS_to_Token_Carrier_Interface for the remote communication services involved.

7.4.7 Token_Carrier_to_Meter_Interface

See 13.6 for a more complete description and definition of this interface.

Interfaces should be defined in terms of data elements, functions and processes within the context of the system as defined in this framework.

It should be structured as an application layer and a physical layer in terms of the OSI reference model with optionally one or more intermediate layers. Functions and data formats are defined in each of the layers.

7.4.8 Payment_Meter

See 13.7 for a more complete description and definition of payment meters.

Payment meters should be defined in terms of data elements, functions, processes and interfaces within the context of the system as defined in this framework.

8 Example specification for a payment metering system

See Annex A for an example of a requirement specification for a payment metering system based on an existing system using one-way token carriers and transferring energy credit units.

In this example, the functions, processes and data elements are kept together in order to retain the context with the devices or entities at the point where these are specified. The example is an outline of requirements only and serves to illustrate the principles of using the framework for standardization as defined in this technical report.

Clauses A.3, A.4 and A.5 merely give the essence of the CIS, POS and interface functions with some essential data elements.

Clauses A.6, A.7 and A.8 give a fairly comprehensive example for the interface between the point of sale, the token carrier and the meter. The example given is based on a current implementation for one-way token carriers using the IEC/PAS 62055-41 protocol.

Clause A.9 gives a fairly comprehensive example of a single-part payment meter installation. Because of the fragmented nature of the relevant reference specifications, these have not been reproduced, but are merely referenced from within the text.

9 Future aspects

Items relating to the standardization of payment metering systems that might need to be addressed in the future are:

- a) as each industry specification is proposed to the IEC for standardization, further work will be required from the WG15 to transform these into the format specified by this technical report;
- b) the adequacy of this technical report will be tested once the first transformation work is attempted. Some details may have to be altered or added once the first attempt is made and it will be further tested when many variants of payment metering systems are worked on. This is likely to be the case with two-way virtual token carrier based systems, for example;
- c) there may be a need to align payment metering system specifications with that of relevant parts of the DLMS-COSEM-OBIS specification as defined in the IEC 62056 series;
- d) the emerging needs of the deregulated electricity supply industry may require a revised approach to this model of the payment metering system. Issues pertaining to the arbitration and settlements of bills between the Generation Companies, Transmission Companies, Distribution Companies, Meter Operators, Suppliers/Retailers and Customers may have to be addressed, for example.

10 Generic processes

See also Clause 4 for a discussion on general concepts and Clause 6 on the generic payment metering system application process.

A process definition describes the flow of data elements or of a sequence of events, each being defined and distinguishable within the system. As a particular instance of a process progresses along its life cycle, it changes (transitions) from one state to the next state, each state having clearly defined entry and exit criteria. A process will have one or more start and end states with one or more specified intermediate states. Each state entry or exit or transition is triggered by defined conditions and will employ the services of functions or will invoke other processes to operate on or to move data elements within the system. These functions may be embodied in several different, but mutually associated devices that are deployed within the system. A process may thus employ the services of several functions, several other processes, involve several different system users and devices and operate on several data elements during the life cycle of a particular process instance. A process may be defined in terms of a state diagram, a flow diagram or by means of a pseudo code such as ASN. Certain processes may be automated, which will execute without the intervention of a system user, while manual processes require the participation of a user.

Processes are classified according to the generic model shown in Figure 3 and Clause 6. It should be noted that although each process class indicates the singular in the generic sense, actual system implementations typically have several instances of processes that belong to the same class.

With reference to Clause 6 and Figure 3, the generic process classes are defined as follows.

Table 5 – Definition of generic process classes

Class	Process	Subclause
1	Supply_Agreement	10.1
2	Purchase_Agreement	10.2
3	Account_Configuration	10.3
4	Metering_Configuration	10.4
5	Delivery_Configuration	10.5
6	Connection_Authorization	10.6
7	Transmission_Delivery	10.7
8	Distribution_Delivery	10.8
9	Installation_Connection	10.9
10	Point_Of_Delivery_Connection	10.10
11	Customer_Delivery	10.11
12	Meter_Reading	10.12
13	Customer_Billing	10.13
14	Payment_Receipting	10.14
15	Receipt_Issuing	10.15
16	Credit_Transfer	10.16
17	Delivery_Regulation	10.17
18	Supplier_Settlement	10.18
19	Time_Provision	10.19
20	System_Testing	10.20
21	Information_Display	10.21
22	Information_Recording	10.22
23	Data_Exchange	10.23
24	Security_Enforcement	10.24

10.1 Class 1: Supply_Agreement process

The legal processes associated with agreeing and establishing the Supplier's terms and conditions of supply and capturing these in the Contract.

10.2 Class 2: Purchase_Agreement process

The legal processes associated with agreeing and establishing the Customer's terms and conditions of purchase and capturing these in the Contract.

10.3 Class 3: Account_Configuration process

The processes associated with establishing the customer's account within the accounting infrastructure and setting up the rules for the Accounting function in accordance with the Contract.

10.4 Class 4: Metering_Configuration process

The processes associated with installing the customer's metering equipment and the setting up of the metrological properties and rules for the Metering function in accordance with the Contract.

10.5 Class 5: Delivery_Configuration process

The processes associated with installing the customer's delivery equipment and the setting up of the rules for the Delivery function in accordance with the Contract.

10.6 Class 6: Connection_Authorization process

The processes associated with notifying and authorising the distribution network service provider to connect the customer's meter installation to the distribution network.

10.7 Class 7: Transmission_Delivery process

The processes associated with transferring the generated electrical energy from the generator into the transmission grid.

10.8 Class 8: Distribution_Delivery process

The processes associated with transferring the transmitted electrical energy from the transmission grid into the distribution network.

10.9 Class 9: Installation_Connection process

The processes associated with making available electrical energy from the distribution network to the customer's meter installation.

10.10 Class 10: Point_Of_Delivery_Connection process

The processes associated with supplying metered quantities of electrical energy to the customer's delivery mechanism.

Examples of these would include meter installation, meter removals, meter commissioning, meter de-commissioning, and relevant inspection processes.

NOTE 1 The Point_Of_Delivery (POD) is the point where the transfer of ownership of the electrical energy takes place and is where the customer's load circuit connects to the delivery equipment.

NOTE 2 In some deregulated markets, the Point_Of_Delivery may also be known as the Identification_Connection_Point (ICP).

10.11 Class 11: Customer process_Delivery

The processes associated with transferring delivered electrical energy to the customer's load circuit.

Examples are: interruption and restoration of the supply to the customer's load. These may be automatic or manual and may be controlled locally or remotely.

10.12 Class 12: Meter_Reading process

The processes associated with obtaining measurements of the quantities of delivered electrical energy for the purpose of charging the customer's account.

In a system where the Accounting function is not located in the payment meter installation (i.e. remotely) this process may take place manually by meter readers or automatically by AMR. Where the Accounting function is located in the payment meter installation this process may take place automatically by direct connection between the Metering and the Accounting functions.

10.13 Class 13: Customer_Billing process

The processes associated with calculating the balance of charges due against payments made and issuing a request for payment (or credit) to the customer.

In a system where the Accounting function is not located in the payment meter installation this normally involves a printed bill that is sent to the Customer. Where the Accounting function is located in the payment meter installation a bill is normally not produced, but the supply to the customer's load circuit is interrupted instead. However in some cases a periodic statement may also be sent to the Customer.

10.14 Class 14: Payment_Receipting process

The processes associated with receiving payments from the Customer.

Implementation examples are: account payments and pre-paid token purchases, postal payments, operator assisted POS terminals, or automatic token vending machines.

10.15 Class 15: Receipt_Issuing process

The processes associated with providing the Customer with proof of payments received.

10.16 Class 16: Credit_Transfer process

The processes associated with transferring credit to the customer's account in accordance with payments made or other forms of credit grants.

For example: credit transferred by means of a pre-paid credit token to the payment meter accounting register, or by means of a journal entry into the debtor's ledger account in the case where the Accounting function is not located in the payment meter.

10.17 Class 17: Delivery_Regulation process

The processes associated with regulating the delivered quantity of electrical energy to the customer in accordance with available credit balance of his account.

In a system where the delivery function has a supply interruption facility this process is typically achieved by means of providing the available credit balance or issuing an instruction to the delivery function. Where the Delivery function does not have a supply interruption facility this process may be inactive.

10.18 Class 18: Supplier_Settlement process

The processes associated with transferring the receipted customer payments to the Supplier.

Examples are: cashing up and closing banking batch records, banking batch summary reports, drop-safe depositing, or handing to an agent, or depositing of funds at the bank, or direct electronic fund transfers from a vending agent to the supplier's bank account.

10.19 Class 19: Time_Provision process

The processes associated with providing date and time information to other functions for the control of time-based schedules. These include the generation, distribution and synchronization of timing signals and generally the management of timing functions in the system.

10.20 Class 20: System_Testing process

The processes associated with testing for the correct working of the system functions and processes.

10.21 Class 21: Information_Display process

The processes associated with displaying or viewing information within the system.

Examples are: reports for management purposes, notifications to customers or system operators and requests from customers.

10.22 Class 22: Information_Recording process

The processes associated with the recording of information and events within the system, including the generation, capturing and storage of the data elements.

10.23 Class 23: Data_Exchange process

The processes associated with the movement of data elements between entities within the system.

Examples are: uploading of transaction records from the POS to the CIS, transfer of credit from the POS to the meter by means of a token on a token carrier, downloading of customer records from the CIS to the POS, archiving and backup/restore.

10.24 Class 24: Security_Enforcement process

The processes associated with assuring the integrity of the system.

11 Generic Functions

See also clause 4 for a discussion on general concepts and clause 6 on generic functions employed by the generic payment metering system application process.

A function is in essence an encapsulated process with defined start and end states, input arguments, transformation function or logical operation and an end result. Functions may be simple or complex and will usually operate on data elements to move them within the system or transform them into different formats or to make logical decisions based on the results of such transformations or computations, which in turn direct the flow of processes. Functions are embodied in one or more devices or entities that may be distributed within a particular

system architecture and they may in turn call on the services of other functions during their execution or they may even invoke other processes. Functions may be implemented in software, electronic firmware or hardware and mechanical hardware. For example the function of the load switch is to interrupt or restore the supply to the customer's load circuit and the implementation may be a combination of firmware, electronic circuitry and mechanical parts to perform the switching function.

It should be noted that although these function classes indicate the singular for each class in the generic sense, actual implementations typically have several variant instances of functions that belong to the same generic class.

With reference to Clause 6 and Figure 3, the generic function classes are defined as follows.

Table 6 – Definition of generic function classes

Class	Function	Subclause
1	Supplier	11.1
2	Customer	11.2
3	Contract	11.3
4	Generation	11.4
5	Transmission	11.5
6	Distribution	11.6
7	Metering	11.7
8	Delivery	11.8
9	Accounting	11.9
10	Receipting	11.10
11	Settlement	11.11
12	Time	11.12
13	Test	11.13
14	Display	11.14
15	Recording	11.15
16	Data_Exchange	11.16
17	Security	11.17

11.1 Class 1: Supplier function

Capability of legally assuming responsibility for the supply and delivery of electrical energy to the Customer.

- Legal entity that enters into a contractual supply agreement with the Customer;
- Effects delivery of electrical energy to the Customer.

NOTE The supplier may optionally also have agreements with a generator company, a transmission company, a distribution company or a meter operator company. In the deregulated markets, the supplier may also be known as the retailer.

11.2 Class 2: Customer function

Capability of legally assuming responsibility for the payment of supplied and delivered electrical energy.

- Legal entity that enters into a contractual purchase agreement with the Supplier.
- Receives delivered electrical energy from the Supplier or his agent.

- Receives bills or statements (optional) from the Supplier or his agent.
- Makes payments for billed amounts due or for purchasing of pre-paid tokens.
- Receives receipts for payments made.

11.3 Class 3: Contract function

Capability of legal prosecution of the terms and conditions agreed between the Supplier and the Customer.

- Records the terms of the agreement entered into between the Supplier and the Customer.
- Legally defines and enforces the business rules and the control policies for the system.
- Serves as terms of reference for possible future law enforcement processes.
- Defines the operational attributes of the Accounting function.
- Defines the operational attributes of the Metering function.
- Defines the operational attributes of the Delivery function.
- Authorizes the Distribution function to connect the customer's installation to the distribution network.

NOTE In some cases the actual documents are maintained outside of the payment metering system, in which case only an agreement reference number is recorded for use inside the system.

11.4 Class 4: Generation function

Capability of generating electrical energy.

- Converts raw materials into electrical energy.
- Transfers the generated electrical energy into the transmission grid.
- Optionally has a contractual agreement with a transmission company and/or trades in the wholesale market.

NOTE 1 This technical report does not cover the Generation function in any detail, but some material is presented here for the sake of completeness and for possible future reference.

NOTE 2 In the context of the deregulated market, several generators may pool electrical energy into the grid at various time intervals. An independent entity collects measurements and arbitrates over the settlement of the accounts between several independent legal entities operating along the chain of supply from generation down to the point of delivery at the customer installation.

NOTE 3 There are instances of Generation functions that are integrated into payment metering systems. For example: certain payment metering systems currently employ an integrated solar energy generator, storage battery and pre-payment meter. In this case the generation, transmission, distribution, metering and delivery functions are all integrated into a single unit.

NOTE 4 The Generation function also contributes to other detrimental electro-magnetic disturbances that may be present at the metering and delivery points. For example: voltage regulation, load regulation, frequency regulation, harmonics, voltage dips and interruptions.

11.5 Class 5: Transmission function

Capability of transmitting electrical energy from the generator to the distribution network.

- Receives the generated electrical energy from the generator.
- Transmits the generated electrical energy from the generator to the distribution network;
- Transfers the transmitted electrical energy into the distribution network.
- Optionally has a contractual agreement with one or more generators.
- Optionally has a contractual agreement with one or more distributors.

NOTE 1 This technical report does not cover the Transmission function in any detail, but some material is presented here for completeness and for possible future reference.

NOTE 2 The transmission medium is generally referred to as the grid and transmission is typically done at high voltages to reduce energy losses over long distances.

NOTE 3 The grid also contributes to electro-magnetic disturbance that may be present at the metering and delivery points of the supply chain caused by events like high voltage switching, voltage and current surges induced by lightning and reflected load impedance changes. It is thus important to take cognisance of these characteristics when designing protection, withstand and performance specifications for equipment lower down in the supply chain, in particular metering and delivery equipment at the customer installation.

11.6 Class 6: Distribution function

Capability of distributing electrical energy from the transmission grid to the customer's installation.

- Receives the transmitted electrical energy from the transmission grid.
- Typically transforms it to appropriate voltage levels.
- Distributes it to the customer installation in a safe and efficient way.
- Receives authorisation to connect (or disconnect) the customer installation to the distribution network.
- Connects (or disconnects) the customer installation to the distribution network.
- Optionally creates the customer installation and installs the metering and delivery equipment.
- Optionally has a contractual agreement with the transmission company.

NOTE 1 The act of performing the connection (or disconnection) is a legal process and is distinctly different from the process of interruption or restoration of the supply to the customer's load in accordance with available credit in the Accounting function. See also Delivery function for more detail on the latter.

NOTE 2 The actual connection (or disconnection) is typically done outside the customer's premises in a junction box on the ground (for underground distribution networks) or on the top of a pole (for overhead distribution networks). The connection methods are subject to the relevant legal requirements and codes of practice that ensures the safety and technical performance of the installation.

NOTE 3 There may also be undesirable electro-magnetic disturbances that originate on the distribution network due to various design and operational factors. For example: voltage/load regulation, high neutral/earth impedance, lightning induced current and voltage surges, fault current protection and safety devices, electrical noise generated by certain customers' load equipment, harmonic distortion, voltage dips, brownouts and supply interruptions, etc. These are quality of supply factors that should be taken into consideration when specifying the requirements for the withstand capability and the performance of metering and delivery equipment.

11.7 Class 7: Metering function

Capability of measuring the quantity and optionally the quality of electrical energy delivered to the Customer.

- Receives and measures the electrical energy from the distribution network connected to the customer installation in accordance with relevant codes of practice for safety protection and equipment performance.
- Receives a metering configuration profile from the Contract function that determines the operational attributes of the Metering function.
- Makes the measurement information available for use by other functions.
- Transfers the metered electrical energy to the Delivery function.

An example of attributes for a metering configuration profile is:

- service type (electricity, water, gas, etc.);
- measurement types (frequency, voltage, current, phase angle, power factor, phase-unbalance, apparent power, active power, reactive power, apparent energy, active energy, reactive energy, etc);
- measurement accuracy class;
- measurement registers.

NOTE 1 Various methods of collecting meter readings are employed. For example: meter readers that visit the meter, remote automatic meter reading via communications infrastructure (telephone, radio networks, internet, etc) or direct wired connection to the Accounting function (integrated within the payment meter).

NOTE 2 In most currently used pre-payment meters, the Metering function and the Accounting function are integrated in a single unit, in which case the meter readings are fed directly (firmware or electronic) to the accounting registers.

NOTE 3 The Metering function implementations vary from being a separate device (such as a traditional Ferraris disk meter) to being fully integrated together with other functions (e.g. present style single-part pre-payment meter).

NOTE 4 Various metrological methods are employed. For example: electromechanical or static.

NOTE 5 In certain deregulated markets, the Supplier may outsource the Metering function to a 3rd party (typically termed the meter operator), in which case the 3rd party may own the metering equipment.

NOTE 6 In present payment metering systems, the quality of supply measurements may not be implemented as a billable attribute, but this may be a requirement for future systems.

NOTE 7 The metering equipment needs to have suitable protection against the electro-magnetic disturbances originating in the Generation, Transmission and Distribution functions.

11.8 Class 8: Delivery function

Capability of delivering metered electrical energy to the customer's load circuit and to regulate the quantity and/or availability in accordance with regulating control instructions from the Accounting function and any constraining rules.

- Regulates the amount of electrical energy delivered to the customer's load circuit in accordance with the available credit in the Accounting function.
- Receives a delivery configuration profile from the Contract function.
- Receives metered electrical energy from the Metering function.
- Provides a load interface for connection to the customer's load circuit.
- Delivers the electrical energy to the customer's load circuit.
- Optionally monitors the attribute values of other functions and may interrupt the supply in response to detected changes in accordance with the delivery configuration profile attributes.

An example of attributes for a delivery configuration profile is:

- service type (electricity, water, gas, etc.);
- constraining rules placed on interruption and restoration of the supply to the customer's load circuit; (Examples are: non-interrupt times, non-supply times, life-line supply on expiry of credit, power limiting if below certain average consumption level);
- detection control parameters (Examples are: overvoltage, undervoltage, voltage dips, voltage interruptions, power limits, voltage reverse polarity, reverse energy, phase unbalance, expiry of available credit, replenishment of available credit);
- control parameters for automatic interruption of supply to the load;
- control parameters for automatic restoration of supply to the load;
- control parameters for manual restoration of supply to the load;
- control parameters for safety protection (overcurrent limit, earth-leakage limit).

NOTE 1 This function is not to be confused with the connection of the customer installation to the distribution network, which is a different process (see 10.6, Connection_Authorization process class 6). See also Distribution function.

NOTE 2 Delivery equipment is typically part of the customer installation and the load interface terminal set is legally and technically the Point_Of_Delivery.

NOTE 3 Some payment meters have Delivery functions that offer safety protection features like overcurrent, earth-leakage and mains isolation. These functions are the subject of other relevant specifications.

NOTE 4 The load interface terminals may follow various standards like DIN, BS or other national standards.

NOTE 5 In some implementations, the payment meter may have an integrated power socket outlet, in which case there is no additional distribution board or house wiring installed at the premises.