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Electricity metering - Data exchange for meter reading, tariff and load control - Part 51: Application layer protocols

Electricity metering - Data exchange for meter reading, tariff and load control - Part 51: Application layer protocols

Comptage d'électricité - Echange de données pour la lecture des compteurs, le contrôle des tarifs et de la charge - Partie 51: Protocoles de couche application

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Partie 51: Protocoles de couche application

Electricity metering – Data exchange for meter reading, tariff and load control –

Part 51: Application layer protocols

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICITY METERING – DATA EXCHANGE FOR METER READING, TARIFF AND LOAD CONTROL –

Part 51: Application layer protocols

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical report of one of the following types:

- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;
- type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;
- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard, for example “state of the art”.

Technical reports of types 1 and 2 are subject to review within three years of publication to decide whether they can be transformed into International Standards. Technical reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

IEC 62056-51, which is a technical report of type 2, has been prepared by IEC technical committee 13: Equipment for electrical energy measurement and load control.

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

Committee draft	Report on voting
13/1131/CDV	13/1167/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 document is issued in the type 2 technical report series of publications (according to G.3.2.2 of part 1 of the IEC/ISO Directives) as a "prospective standard for provisional application" in the field of data exchange for meter reading, tariff and load control, because there is an urgent requirement for guidance on how standards in this field should be used to meet an identified need.

This document is not to be regarded as an "International Standard". It is proposed for provisional application so that information and experience of its use in practice may be gathered. Comments on the content of this document should be sent to IEC Central Office.

A review of this type 2 technical report will be carried out not later than three years after its publication, with the options of either extension for a further three years or conversion to an International Standard or withdrawal.

Annexes A, B, C, D and E form an integral part of this technical report.

ELECTRICITY METERING – DATA EXCHANGE FOR METER READING, TARIFF AND LOAD CONTROL –

Part 51: Application layer protocols

1 General

1.1 Scope

This technical report describes an architectured application layer used for communication with metering equipments in general, whatever the associated physical medium and lower layer protocols in a collapsed three-layer model are.

This technical report specifies the protocols to be applied for the application layer except the DLMS (Distribution Line Message Specification) model, which is already covered by IEC 61334-4-41.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this technical report. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this technical report are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 61334-4-41:1996, *Distribution automation using distribution line carrier systems – Part 4: Data communication protocols – Section 41: Application protocols – Distribution line message specification (DLMS)*

ISO/IEC 8824:1990, *Information technology – Open Systems Interconnection – Specification of Abstract Syntax Notation One (ASN.1)*

2 General description

2.1 Basic vocabulary

All communications involve two sets of equipment represented by the terms Caller system and Called system. The Caller is the system that decides to initiate a communication with a remote system known as the Called party; these denominations remain valid throughout the duration of the communication.

A communication is broken down into a certain number of transactions. Each transaction is represented by a transmission from the Transmitter to the Receiver. During the sequence of transactions, the Caller and Called systems take turns to act as Transmitter and Receiver.

The terms Client and Server have the same meanings as in the DLMS model (see IEC 61334-4-41). The Server is the system that acts as a VDE (see IEC 61334-4-41) for the submission of all special service requests. The Client is the system that uses the Server for a specific purpose by means of one or more service requests.

The situation involving a Caller Client and a Called Server is undoubtedly the most frequent case, but a communication based on a Caller Server and a Called Client is also possible, in particular to report the occurrence of an urgent alarm.

2.2 Sub-layers and protocols

The Application layer model described in this technical report uses a breakdown into three sub-layers: Transport, Application and DLMS. Each of these sub-layers is the subject of a protocol whose name is given in the table 1.

Table 1 – Sub-layers and protocols

Sub-layers	Protocols
DLMS	DLMS+
Application	Application+
Transport	Transport+

The Transport and Application sub-layers set up a homogeneous package called LLAC (Logical Link Access Control).

The DLMS+ protocol of the DLMS sub-layer is described in IEC 61334-4-41.

2.3 Specification language

In this technical report, the protocol of each sub-layer is described by state transitions represented in the form of tables. The syntax used in making up these tables is defined by a specification language described in annex A.

In the event of a difference in interpretation between part of the text and a state transition table, the table is always taken as the reference.

3 Transport sub-layer

3.1 Transport+ protocol

The Transport+ protocol of the Transport sub-layer is designed to support the multiplexing of transport connections. It is strictly identical for the Caller and for the Called party (completely symmetrical behaviour).

3.2 General information

The Transport sub-layer is the first one to handle direct connections between the systems at the ends of the links. All the connections set up at this level and those at higher levels can be considered as end-to-end links. This end-to-end notion indicates that the transport entities offer services which are completely independent of the physical networks.

The most important properties of the Transport sub-layer are end-to-end transport (mentioned above), transparency (any binary configuration must be accepted by the transport protocol and delivered without modification, whatever its format or size) and selection of a quality of service. The notion of quality of service is mentioned here for information only, as the Transport+ protocol is oriented without connection.

The Transport sub-layer accepts the messages from the Application sub-layer. As the size of these messages is dictated by the application, the Transport sub-layer must segment them into packets (called TPDUs: transport protocol data units) and transmit them to the correspondent Transport sub-layer. Reciprocally, it must receive the packets from the correspondent Transport sub-layer and assemble them into coherent messages for the Application sub-layer.

The Transport+ protocol must be able to transmit data in parallel in both directions, Caller-Called and Called-Caller. Moreover, the multiplexing of transport connections on the same virtual circuit means that several application associations can coexist in a given communication.

Whatever their origin, the TPDUs are transmitted using the services of the Data Link layer. Of course, this sub-layer is not aware of the multiplexing implemented at the higher level.

3.3 Transport protocol classes

The ISO proposes different types of network services depending on the residual errors in the transmissions at the lower levels. Two sorts of error are identified: the reported errors (for example forced disconnection with error indication) and the unreported errors (undetected and uncorrected transmission errors). On this basis, there are three types of network, summarized in table 2.

Table 2 – Types of network services depending on residual errors

Type	Definition
A	Acceptable residual error rate (reported and unreported)
B	Acceptable rate of unreported errors Unacceptable rate of reported errors
C	Unacceptable rate of both types of errors

The Transport+ protocol is derived from ISO class 2 which supposes a type A network, and which is characterized by segmenting and assembly functions with multiplexing, but without resumption after error or flow control.

3.4 Transport services and service primitives

Table 3 services and service primitives are available to users of the Transport+ protocol.

Table 3 – Transport services and service primitives

Service	Primitive
T_DATA	T_DATA.req(STSAP, DTSAP, Pr, TSDU) T_DATA.ind(STSAP, DTSAP, TSDU)
T_ABORT	T_ABORT.req(Strong) T_ABORT.ind(ErrorNb)

The role assigned to each primitive is as follows:

- T_DATA.req(STSAP, DTSAP, Pr, TSDU) enables the Application sub-layer to request the Transport sub-layer to transfer with the priority Pr [1] a TSDU message from a source transport address STSAP to a destination transport address DTSAP or from a destination transport address DTSAP to a source transport address STSAP;
- T_DATA.ind(STSAP, DTSAP, TSDU) enables the Transport sub-layer to inform the Application sub-layer of the arrival of a TSDU message from a source transport address STSAP to a destination transport address DTSAP or from a destination transport address DTSAP to a source transport address STSAP;
- T_ABORT.req(Strong) enables the Application sub-layer to request the Transport sub-layer to terminate its activity with the priority Strong [2];
- T_ABORT.ind(ErrorNb) enables the Transport sub-layer to inform the Application sub-layer of the occurrence of a fatal error identified by the number ErrorNb.

3.5 Description of transport protocol data units (TPDUs)

The messages exchanged between transport entities are routed by segments in TPDUs, each of which contains a whole number of octets.

In the Transport+ protocol, there is only one type of TPDU defined by the following five fields:

- TPDUType (DT+) : 3 bits
- End : 1 bit
- STSAP : 2 bits
- DTSAP : 10 bits
- Packet : 0 octet to MaxPktSize octets

3 bits	1 bit	2 bits	10 bits	0 octet to MaxPktSize octets
DT+	End	STSAP	DTSAP	Packet

Figure 1 – Format of a TPDU

The DT+ field is always encoded "101"B.

When it is set to 1, the bit of the End field indicates that the corresponding data unit is the last one of a segmented message.

The STSAP field contains the source transport address and the DTSAP field contains the destination transport address. By convention, the value "0000000000"B is reserved for the DTSAP of the communication protocols management DLMS Server.

Finally, the Packet field contains the current data segment.

1) The priority level Pr differentiates the processing of emergency services such as InformationReport (level Pr=1) from that of the other DLMS services (level Pr=0).

2) The Strong parameter differentiates the processing of fatal errors (Strong=1) from that of the other physical disconnection requests (Strong=0) initialized by the Application sub-layer.

3.6 Transport parameters

In the absence of an explicit connection stage, the number of transport connections and the size of the buffers are not negotiated. The following rules are observed:

- a maximum of 4 096 transport connections each identified by a (STSAP, DTSAP) pair;
- a memory space requirement for all the transmission and reception buffers of all the active transport connections that does not exceed the capacity of the remote equipment.

The actual size of the overall memory space depends on each equipment but shall not be less than 512 octets. A DLMS management variable, BufferPoolSize, contains the corresponding value. This variable is accessible through the communication protocols management DLMS Server.

The value of the Packet field size, MaxPktSize, shall be adjusted to the frame capacity of the Data Link layer.

3.7 State transitions

The state machine of the Caller is strictly identical to that of the Called system. The two systems are in turn Transmitter and Receiver of TSDUs. At any time, there is only one occurrence of this controller in each set of equipment.

Table 4 – Transport+ state transitions

Initial state	Triggering condition	Set of actions	Final state
Stopped	$true()	init()	Idle
Idle	T_DATA.req(STSAP, DTSAP, Pr, TSDU) & bufferpool(TSDU)	SMsg=TSDU	M.Sgt
Idle	DL_DATA.ind(Pr, TPDU) & check_sgt(TPDU) & bufferpool(TPDU) & not(last_sgt(TPDU))	tsap(TPDU, STSAP, DTSAP) RMsg[STSAP, DTSAP, Pr]= concat(RMsg[STSAP, DTSAP, Pr], extract_pkt(TPDU))	Idle
Idle	DL_DATA.ind(Pr, TPDU) & check_sgt(TPDU) & bufferpool(TPDU) & last_sgt(TPDU)	tsap(TPDU, STSAP, DTSAP) T_DATA.ind(STSAP, DTSAP, concat(RMsg[STSAP, DTSAP, Pr], extract_pkt(TPDU))) RMsg[STSAP, DTSAP, Pr]=""	Idle
Idle	(T_DATA.req(_, _, _, TSDU) & not(bufferpool(TSDU))) | (DL_DATA.ind(_, TPDU) & check_sgt(TPDU) & not(bufferpool(TPDU)))	T_ABORT.ind(ET-2F) DL_ABORT.req(Strong=1)	Stopped
Idle	DL_DATA.ind(_, TPDU) & not(check_sgt(TPDU))	T_ABORT.ind(ET-1F) DL_ABORT.req(Strong=1)	Stopped
Idle	T_ABORT.req(Strong)	DL_ABORT.req(Strong)	Stopped
Idle	DL_ABORT.ind(ErrorNb)	T_ABORT.ind(ErrorNb)	Stopped
M.Sgt	size(SMsg)>MaxPktSize	End=0 DL_DATA.req(Pr, concat(DT+, End, STSAP, DTSAP, substr(1, MaxPktSize, SMsg))) SMsg=substr(MaxPktSize+1, SMsg)	M.Sgt
M.Sgt	size(SMsg)<=MaxPktSize	End=1 DL_DATA.req(Pr, concat(DT+, End, STSAP, DTSAP, SMsg)) SMsg=""	Idle

Table 5 – Meaning of the states listed in table 4

State	Meaning
Stopped	Startup state common to the Caller and the Called party
Idle	State waiting for a request from the Application sub-layer or an indication from the Data Link layer
M.Sgt (Must Segment)	State in which a message is being segmented on a transport connection

Table 6 – Definition of the procedures and functions classified in alphabetical order

Procedure or function	Definition
bufferpool(TPDU) or bufferpool(TSDU)	Check that the data unit TPDU or TSDU can be stored in the overall memory space defined by the management variable BufferPoolSize
check_sgt(TPDU)	Check that the type of the TPDU received is DT+
concat(MsgPart, Packet) or concat(DT+, End, STSAP, DTSAP, Packet)	Construction of a binary string by concatenation of several parameters
extract_pkt(TPDU)	Extraction of the Packet field from the received TPDU
init()	Initialization of DT+ at "101"B, of MaxPktSize and of each element of the array RMsg[] at "". The array RMsg[] has three dimensions: the first indicates the STSAP number, the second indicates the DTSAP number and the third indicates the priority (0 or 1)
last_sgt(TPDU)	Check that the received TPDU has an End field raised to 1
size(SMsg)	Calculation of the size of the SMsg message in octets
substr(Begin, Length, SMsg) or substr(Begin, SMsg)	Extraction of part of the SMsg message from the Begin octet over the length Length in octets. If the length is not specified, the extracted part corresponds to the end of the partial message
tsap(TPDU, STSAP, DTSAP)	Extraction of the STSAP and DTSAP fields from the received TPDU

3.8 List and processing of errors

The errors are listed with the following codes:

ET error in the Transport sub-layer

– separator

N number of the error

F fatal error