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TECHNICAL COMMITTEE NO. 57

POWER SYSTEM CONTROL AND ASSOCIATED COMMUNICATION

A Companion standard of

telecontrol protocol IEC 60870-5

Draft: **Telecontrol equipment and systems**

Part 5: **Transmission protocols**

Section 104: **Network access for IEC 60870-5-101 using standard transport profiles**

Revision 8

This draft has been prepared by working group WG 03

CONTENTS

Introduction

IEC 60870-5-101 provides a communication profile for sending basic telecontrol messages between a central telecontrol station and telecontrol outstations, which uses permanent directly connected data circuits between the central station and individual outstations.

In some applications it may be required to send the same types of application messages between telecontrol stations using a data network containing relay stations which store and forward the messages and provide only a virtual circuit between the telecontrol stations. This type of network delays messages by varying amounts of time depending on the network traffic load.

In general the variable message delay times mean that it is not possible to use the link layer as defined in IEC 60870-5-101 between telecontrol stations. In some cases it may be possible to connect telecontrol stations having all three layers of the companion standard IEC 60870-5-101 to suitable data networks using Packet Assembler Disassembler (PAD) type stations to provide access for balanced communication.

In all other cases this companion standard which does not use the Link functions of IEC 60870-5-101 may be used to provide balanced access via a suitable transport profile.

Note: The requesting of data by continuous cyclic requests (polling) is not excluded. Such cyclic requests burden the network with the transmission of excess of information and should be avoided.

1 Scope and object

This section of IEC 60870-5 applies to telecontrol equipment and systems with coded bit serial data transmission for monitoring and controlling geographically widespread processes. It defines a telecontrol companion standard that enables interoperability among compatible telecontrol equipment. The defined telecontrol companion standard utilizes standards of the series of documents IEC 60870-5. The specifications of this standard present a combination of the application layer of IEC 60870-5-101 and the transport functions provided by a TCP/IP (Transmission Control Protocol/Internet Protocol). Within TCP/IP various network types can be utilized including X.25, FR (Frame Relay), ATM (Asynchronous Transfer Mode) and ISDN (Integrated Service Data Network). Using the same definitions alternative ASDUs as specified in other IEC 60870-5 companion standards may be combined with TCP/IP, but this is not described further in this standard.

Note:This standard uses TCP/IP Transport Profile as defined in other referenced standards, without alteration.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this section of IEC 60870-5. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this section of IEC 60870-5 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 50(371): 1984, International Electrotechnical Vocabulary (IEV)- Chapter 371: Telecontrol

IEC 60870-1-1: 1988, Telecontrol equipment and systems - Part 1: General considerations - Section One: General principles

IEC 60870-1-3: 1997 Ed. 2, Telecontrol equipment and systems - Part 1: General considerations - Section Three: Glossary

IEC 60870-1-4: 1994, Telecontrol equipment and systems - Part 1: General considerations - Section 4: Basic aspects of telecontrol data transmission and organization of standards of IEC 60870-5 and IEC 60870-6

IEC 60870-5-3: 1992, Telecontrol equipment and systems - Part 5:
Transmission protocols - Section 3: General structure of application data

IEC 60870-5-4: 1993, Telecontrol equipment and systems - Part 5:
Transmission protocols - Section 4: Definition and coding of application information elements

IEC 60870-5-5: 1995, Telecontrol equipment and systems - Part 5:
Transmission protocols - Section 5: Basic application functions

IEC 60870-5-101: 1995, Telecontrol equipment and systems - Part 5:
Transmission protocols - Section 101: Companion standard for basic telecontrol tasks

IEC 60870-5-102: 1996, Telecontrol equipment and systems - Part 5:
Transmission protocols - Section 102: Companion standard for the transmission of integrated totals in electric power systems

ISO 7498-1: 1994, Information technology - Open Systems Interconnection - Basic Reference Model: The Basic Model

ISO/IEC 8208: 1990, Information technology - Data communications - X.25 packet layer protocol for data terminal equipment

ITU - CCITT Geneva 1989, Data Communication Networks: Services and Facilities, Interfaces - Recommendations X.1-X.32
Blue Book, Volume VIII - Fascicle VIII.2

[RFC791] Internet Protocol
Request for Comments 791 (MILSTD 1777)
(September, 1981)

[RFC793] Transmission Control Protocol
Request for Comments 793 (MILSTD 1778)
(September, 1981)

[RFC1700] Assigned Numbers
Request for Comments 1700 (STD 2)
(October, 1994)

[RFC 2200] Internet Official Protocol Standard
Request for Comments 2200
(June, 1997)

Note: Further RFC documents (such as RFC 1122 and RFC 1123) are available on the Internet address http://www.ietf.org.

3 General architecture

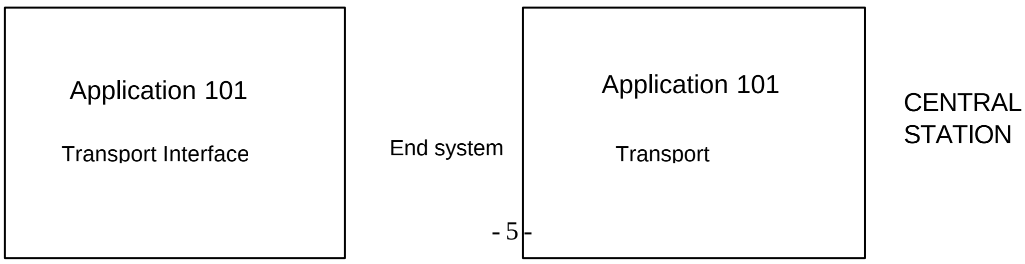
This document defines the use of an open TCP/IP-interface to a network, containing for example a LAN for telecontrol equipment, which transports IEC 60870-5-101 ASDUs. Routers which include the different

WAN-types (e.g. X25, Frame Relay, ISDN etc.) may be connected via a common TCP/IP-LAN-interface (see figure 1). The figure 1 shows a redundant configuration in the central station in addition to a non redundant system.

Motivations:

The use of separate routers offers advantages as follows.

- No need for network-specific software in end systems.
- No need for routing functionality in end systems.
- No need for network management in end systems.
- Facilitates obtaining end systems from telecontrol specialist manufacturers.
- Facilitates obtaining individual separate routers, to suit a variety of networks from manufacturers specialising in this (non-telecontrol specific) field.
- A change of network type requires only a change of router type, without affecting the end systems.
- Particularly suitable for converting existing end systems that conform to IEC 60870-5-101.
- Suitable for present and future implementations.



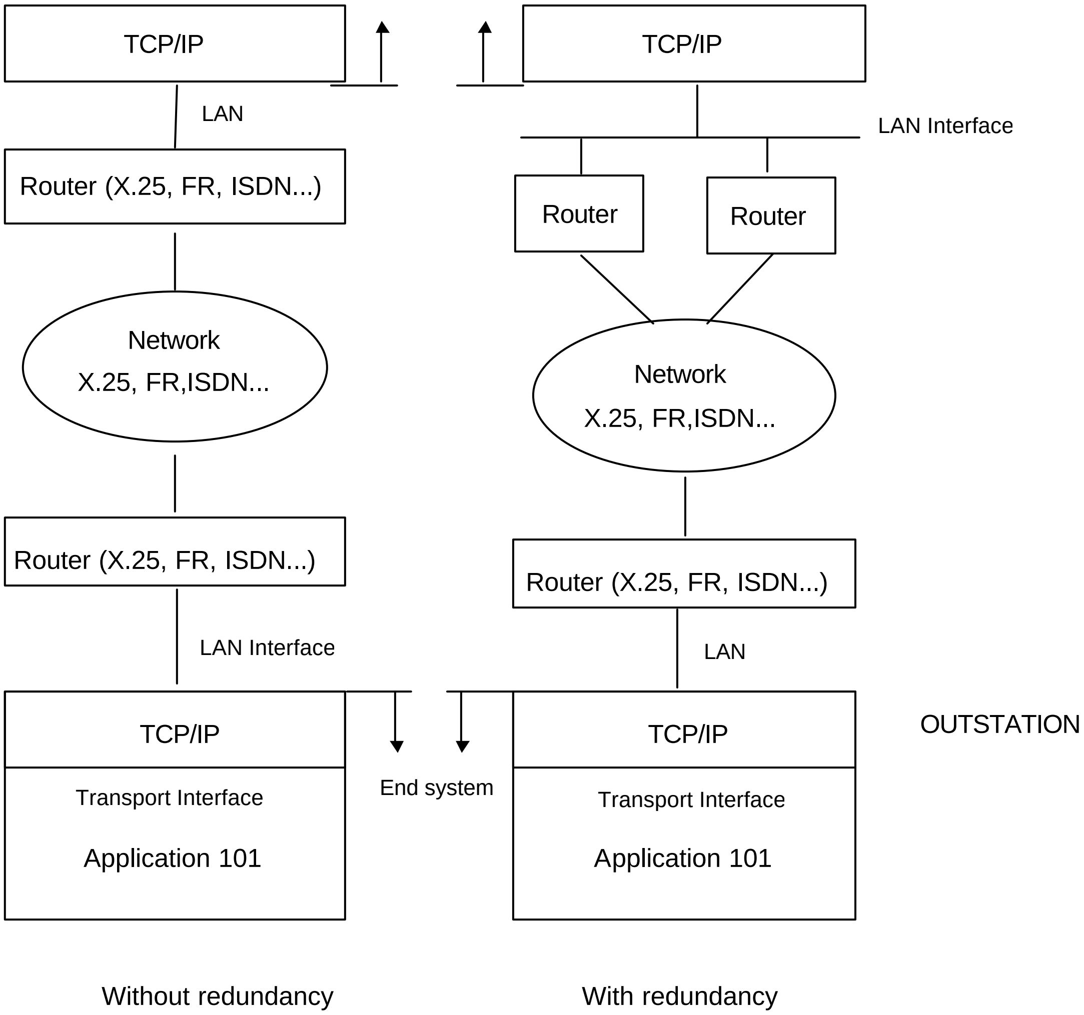


Figure 1 - General architecture (example)

4 Protocol structure

Figure 2 shows the protocol structure of the end system.

<table>
<tr><td>Selection of Application Functions
of
IEC 60870-5-5 according to IEC 60870-5-101</td><td>Initialization</td><td>User process</td></tr>
<tr><td colspan="2">Selection of Application Service Data Units
of
IEC 60870-5-101 and 104</td><td rowspan="2">Application (layer 7)</td></tr>
<tr><td colspan="2">APCI Application Protocol Control Information
Transport Interface (User to TCP interface)</td></tr>
<tr><td colspan="2" rowspan="4">Selection of
TCP/IP Protocol suite (RFC 2200)</td><td>Transport (layer 4)</td></tr>
<tr><td>Network (layer 3)</td></tr>
<tr><td>Link (layer 2)</td></tr>
<tr><td>Physical (layer 1)</td></tr>
</table>

Note: Layers 5 and 6 are not used

Figure 2 - Selected standard provisions of the defined telecontrol companion standard 104

The following figure shows the selection of the TCP/IP Protocol suite (RFC 2200) used in this standard. At the time of publication, the RFCs indicated were valid, but may be revised by equivalent, topical RFCs. The topical RFCs are available on the Internet address http://www.ietf.org.

The Ethernet 802.3 stack shown may be used by a telecontrol station end system or DTE to drive a separate router as shown in the example in figure 1. If a redundant configuration is not required, a point-to-point interface (e.g. X.21) to the separate router may be used instead of a LAN interface, thus retaining more of the original hardware when converting end systems.

Other compatible selections from RFC 2200 are also permitted.

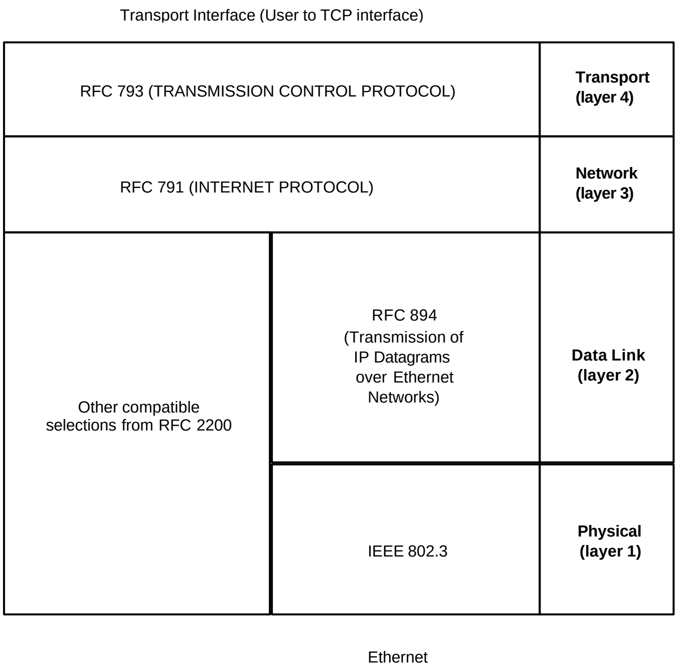


Figure 3 - Selected standard provisions of the TCP/IP Protocol suite RFC 2200

5 Definition of Application Protocol Control Information APCI

The transport interface (User to TCP interface) is a stream oriented interface which does not define any start or stop mechanism for the ASDUs of IEC 60870-5-101. For detecting the start and end of ASDUs a start character, the specification of the Length of the ASDU plus the Control field of the APCI are defined for each APDU (see figure 4). Either a complete APDU or for control purposes the APCI fields only may be transferred (see figure 5).

Note: The abbreviations used above are taken from IEC 60870-5-3 clause 5 as follows.

APCI Application Protocol Control Information

ASDU Application Service Data Unit

APDU Application Protocol Data Unit

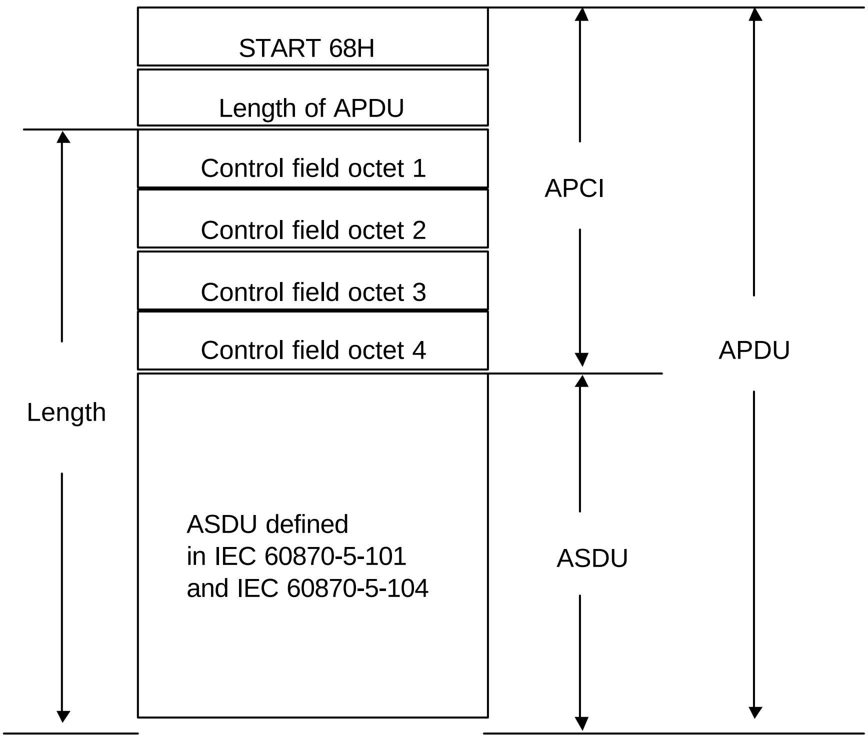


Figure 4 - Application Protocol Data Unit of the defined telecontrol companion standard 104

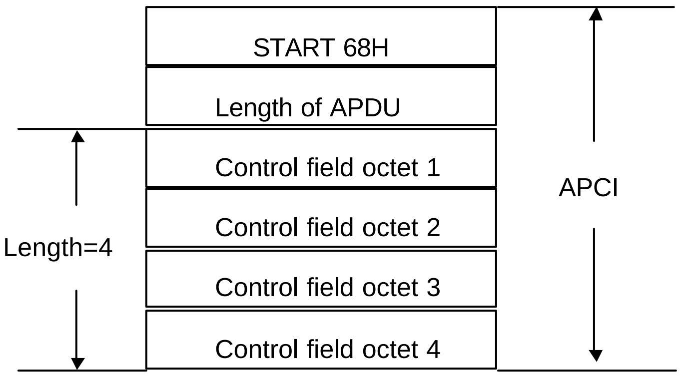


Figure 5 - Application Protocol Control Information of the defined telecontrol companion standard 104

START 68H defines the point of start within the data stream.

Length of APDU defines the length of the body of the APDU which consists of the four control field octets of the APCI plus the ASDU. The first counted octet is the first octet of the control field, the last counted octet is the last octet of the ASDU. The maximum length of the ASDU is limited to 249 because the maximum value of length of APDU is 253 ($APDU_{max}$=255 minus start and length octet) and the length of the control field is 4 octets.

The control field defines control information for the protection against loss and duplication of messages, start and stop of message transfers and the supervision of transport connections. The counter mechanism of the control field is defined according clauses 2.3.2.2.1 to 2.3.2.2.5 of the X.25 recommendations.

Figure 6, 7 and 8 show the definition of the control field.

Three types of control field formats are used to perform numbered information transfer (I format), numbered supervisory functions (S format) and unnumbered control functions (U format).

Control field octet 1 bit 1 = 0 defines the I format. I format APDUs always contain an ASDU. The control information of an I format is shown in figure 6.

Bit	8	7	6	5	4	3	2	1	
	Send Sequence Number N(S) LSB							0	octet 1
	MSB Send Sequence Number N(S)								octet 2
	Receive Sequence Number N(R) LSB							0	octet 3
	MSB Receive Sequence Number N(R)								octet 4

Figure 6 - Control field of type Information transfer format (I format)

Control field octet 1 bit 1 = 1 and bit 2 = 0 define the S format. S format APDUs consist of the APCI only. The control information of an S format is shown in figure 7.

Bit	8	7	6	5	4	3	2	1	
	0						0	1	octet 1
	0								octet 2
	Receive Sequence Number N(R) LSB							0	octet 3
	MSB Receive Sequence Number N(R)								octet 4

Figure 7 - Control field of type numbered Supervisory functions (S format)

Control field octet 1 bit 1 = 1 and bit 2 = 1 defines the U format. U format APDUs consist of the APCI only. The control information of an U format is shown in figure 8. Only one function TESTFR, STOPDT or STARTDT may be active at the same time.

Bit	8	7	6	5	4	3	2	1	
	TESTFR		STOPDT		STARTDT				
	con	act	con	act	con	act	1	1	octet 1
	0								octet 2
	0							0	octet 3
	0								octet 4

Figure 8 - Control field of type Unnumbered control functions (U format)

5.1 Protection against loss and duplication of messages

The use of the Send Sequence Number N(S) and the Receive Sequence Number N(R) is identical to the same method defined in X.25. Due to some simplifications the sequences are additionally defined in the figures 9 to 12.

Both Sequence Numbers are sequentially increased by one for each APDU and each direction. The transmitter increases the Send Sequence Number N(S) and the receiver increases the Receive Sequence Number N(R). The receiving station acknowledges each APDU or a number of APDUs when it returns the Receive Sequence Number up to the number whose APDUs are properly received. The sending station holds the APDU or APDUs in a buffer until it receives back its own Send Sequence Number as a Receive Sequence Number which is a valid acknowledge for all numbers <= the received number. Then it may delete the correctly transmitted APDUs from the buffer. In case of longer data transmission in one direction only, an S format has to be sent in the other direction to acknowledge the APDUs before buffer overflow or time out. This method should be used in both directions. After the establishment of a connection the send and receive sequence numbers are set to zero.

The following definitions are valid for the figures 9 to 16:

V(S) = Send state variable (see X.25)

V(R) = Receive state variable (see X.25)

Ack = Indicates that the DTE has received correctly all I format APDUs numbered up to and including this number.

I(a,b) = Information format APDU with a = send sequence number and b = receive sequence number.

S(b) = Supervisory format APDU with b = receive sequence number.

U = Unnumbered control function APDU.

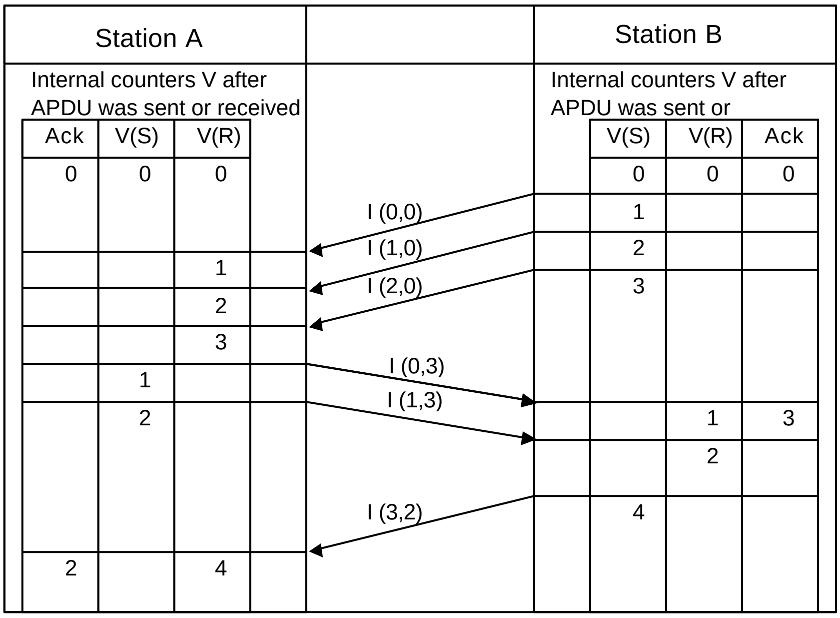


Figure 9 - Undisturbed sequences of numbered I format APDUs

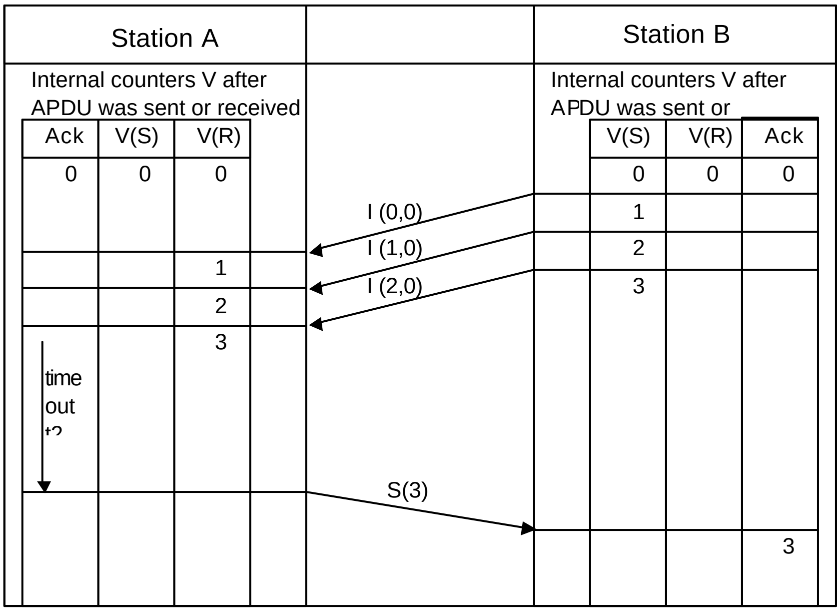


Figure 10 - Undisturbed sequences of numbered I format APDUs acknowledged by an S format APDU

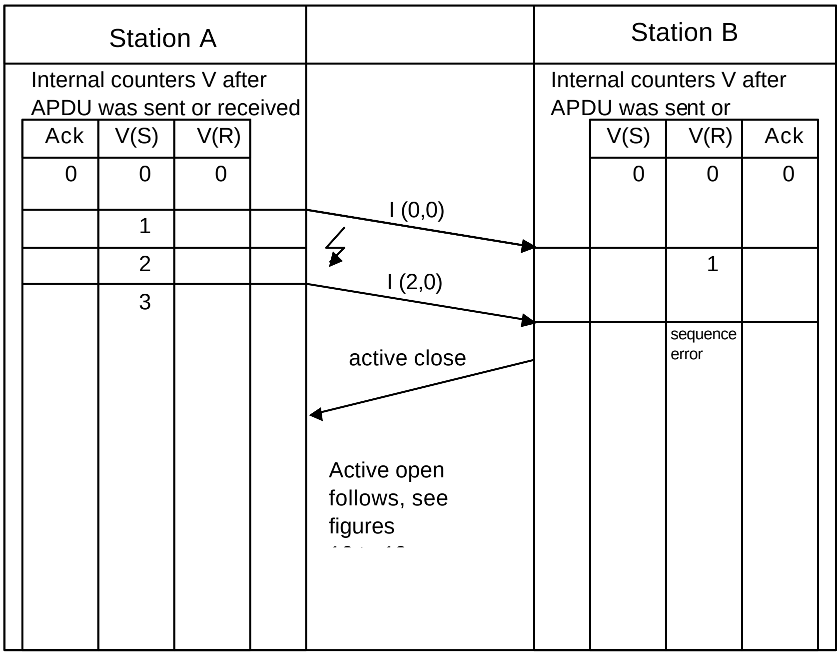


Figure 11 - Disturbed sequence of numbered I format APDUs

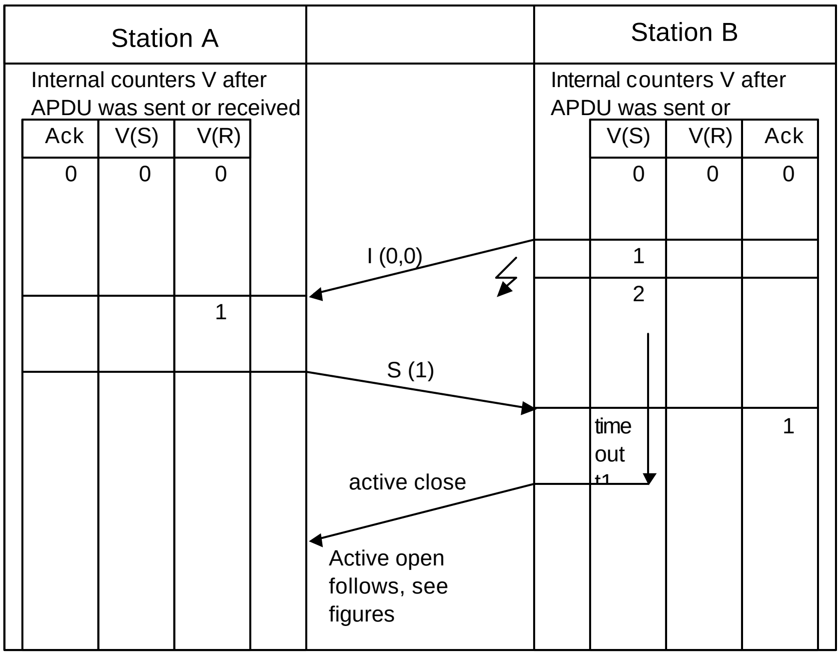


Figure 12 - Time out in case of a not acknowledged last I format APDU

5.2 Test procedures

Unused, but open connections may be periodically tested in both directions by sending test APDUs (TESTFR = act) which are confirmed by the receiving station sending TESTFR = con. Both stations may initiate the test procedure after a specified period of time in which no data transfers occur (time out).

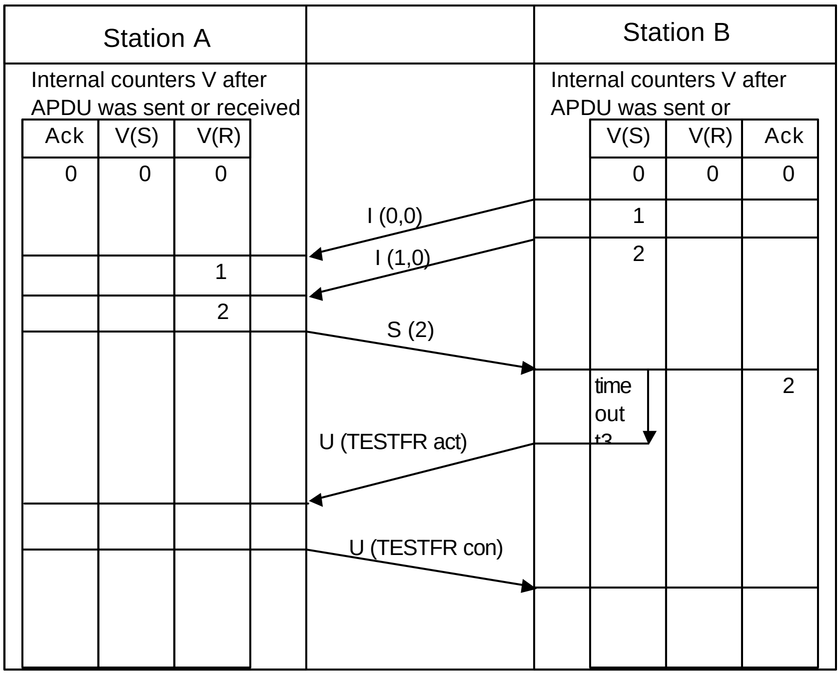


Figure 13 - Undisturbed Test procedure

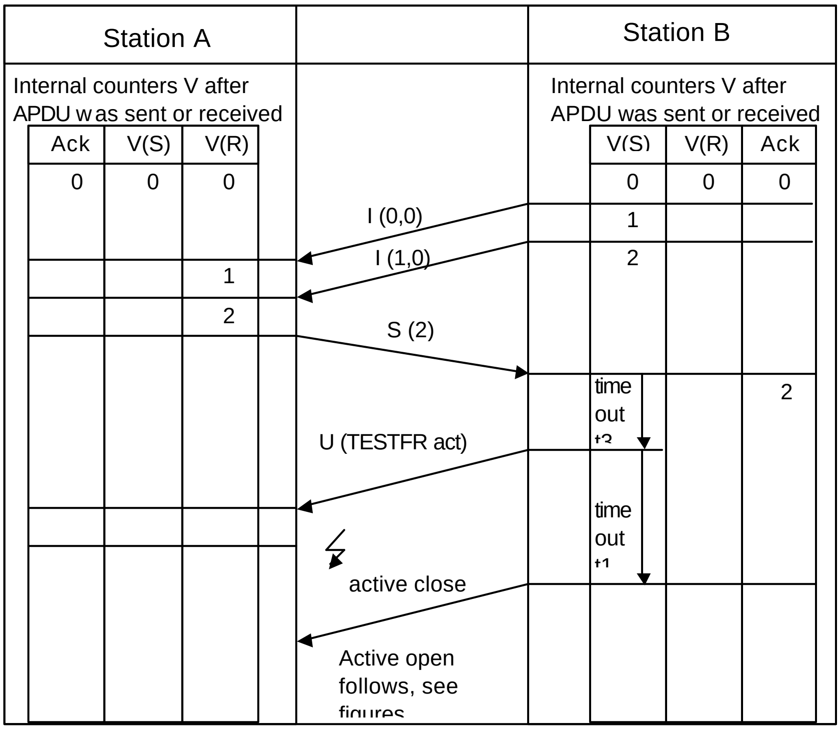


Figure 14 - Unconfirmed Test procedure

5.3 Transmission Control using Start/Stop

STARTDT (Start Data Transfer) and STOPDT (Stop Data Transfer) are used to control the data transfer by the controlling station (Station A), mainly when more than one connection to a controlled station (Station B) is open and therefore available, but only one is used for the data transfer. The defined functionality avoids loss of data in case of switchovers from one connection to another.

After the establishment of a connection STOPDT is default. In this state the controlled station does not send any data via this connection. The controlling station activates the data transfer on a connection by sending a STARTDT act via this connection which is returned as a STARTDT con. In case of a not confirmed STARTDT the connection is closed by the controlling station.

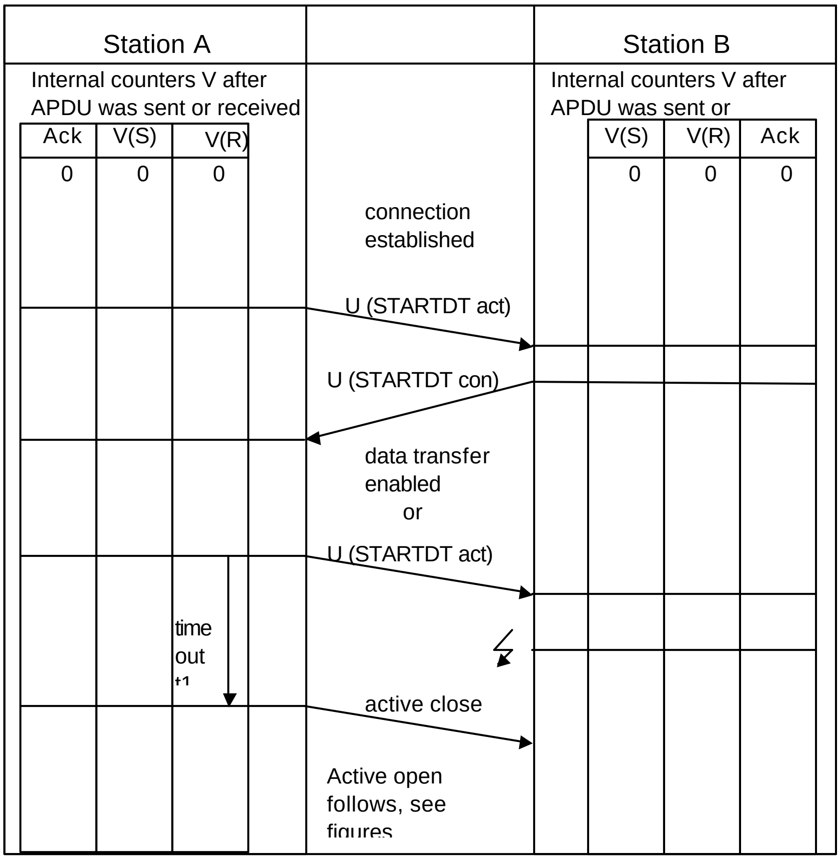


Figure 15 - Start data transfer procedure

In case of e.g. a switchover from an active connection to another one (e.g. by an operator) the controlling station transmits a STOPDT act first. The controlled station stops the data transfer via this connection and returns a STOPDT con. After receiving the STOPDT con the controlling station may close the connection.

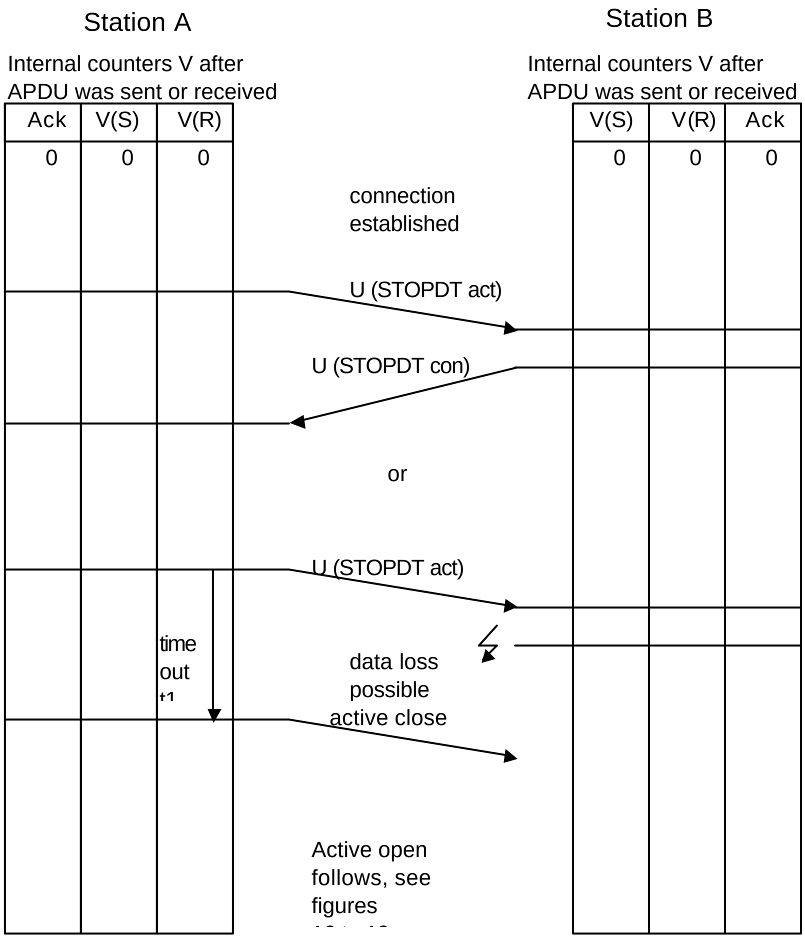


Figure 16 - Stop data transfer procedure

5.4 Portnumber

Every TCP address consists of an IP address and a portnumber. Every equipment connected to the TCP-LAN has its particular IP address while the same portnumber is defined for the complete system. For the use in this standard the portnumber

2404

is defined and has been confirmed by IANA.

5.5 Maximum number of outstanding I format APDUs k

The value of k shall indicate the maximum number of sequentially numbered I format APDUs that the DTE may have outstanding (i.e. unacknowledged) at a given time. The value of k shall never exceed n-1 for modulo n operation (see clause 2.4.8.6 of the X.25 recommendations).

- The transmitter stops the transmission at k unacknowledged I format APDUs.
- The receiver acknowledges latest after receiving w = I format APDUs *).
- The maximum number of k is n-1 for modulo n operation.

*) Acknowledging before k is reached avoids a transmission stop.

6 Selection of ASDUs defined in IEC 60870-5-101 and additional ASDUs

The following ASDUs defined in IEC 60870-5-101 and clause 8 of this standard are valid:

Table 1 - Process information in monitor direction

TYPE IDENTIFICATION := UI8[1..8]<0..44>

	<0>	:=	not defined	
	<1>	:=	single-point information	M_SP_NA_1
	<3>	:=	double-point information	M_DP_NA_1
	<5>	:=	step position information	M_ST_NA_1
	<7>	:=	bitstring of 32 bit	M_BO_NA_1
	<9>	:=	measured value, normalized value	M_ME_NA_1
	<11>	:=	measured value, scaled value	M_ME_NB_1
	<13>	:=	measured value, short floating point number	M_ME_NC_1
	<15>	:=	integrated totals	M_IT_NA_1
	<20>	:=	packed single-point information with status change detection	M_PS_NA_1
	<21>	:=	measured value, normalized value without quality descriptor	M_ME_ND_1
	<22..29>	:=	reserved for further compatible definitions	
*)	<30>	:=	single-point information with time tag CP56Time2a	M_SP_TB_1
*)	<31>	:=	double-point information with time tag CP56Time2a	M_DP_TB_1
*)	<32>	:=	step position information with time tag CP56Time2a	M_ST_TB_1
*)	<33>	:=	bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
*)	<34>	:=	measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
*)	<35>	:=	measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
*)	<36>	:=	measured value, short floating point number with time tag CP56Time2a	M_ME_TF_1
*)	<37>	:=	integrated totals with time tag CP56Time2a	M_IT_TB_1
*)	<38>	:=	event of protection equipment with time tag CP56Time2a	M_EP_TD_1
*)	<39>	:=	packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
*)	<40>	:=	packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1
	<41..44>	:=	reserved for further compatible definitions	

*) these types are defined in the addendum A1 to IEC 60870-5-101.

Table 2 - Process information in control direction

TYPE IDENTIFICATION := UI8[1..8]<45..69>

CON	<45>	:=	single command	C_SC_NA_1
CON	<46>	:=	double command	C_DC_NA_1
CON	<47>	:=	regulating step command	C_RC_NA_1
CON	<48>	:=	set point command, normalized value	C_SE_NA_1
CON	<49>	:=	set point command, scaled value	C_SE_NB_1
CON	<50>	:=	set point command, short floating point number	C_SE_NC_1
CON	<51>	:=	bitstring of 32 bit	C_BO_NA_1

<52..57> := reserved for further compatible definitions

ASDUs for process information in control direction with time tag:

CON	<58>	:=	single command with time tag CP56Time2a	C_SC_TA_1
CON	<59>	:=	double command with time tag CP56Time2a	C_DC_TA_1
CON	<60>	:=	regulating step command with time tag CP56Time2a	C_RC_TA_1
CON	<61>	:=	set point command, normalized value with time tag CP56Time2a	C_SE_TA_1
CON	<62>	:=	set point command, scaled value with time tag CP56Time2a	C_SE_TB_1
CON	<63>	:=	set point command, short floating point number with time tag CP56Time2a	C_SE_TC_1
CON	<64>	:=	bitstring of 32 bit with time tag CP56Time2a	C_BO_TA_1

<65..69> := reserved for further compatible definitions

Process information in control direction may be sent with or without a time tag, but must not be mixed when sending to a given station.

Note:
*- ASDUs marked (**CON)** in control direction are confirmed application services and may be mirrored in monitor direction with different causes of transmission. These mirrored ASDUs are used for positive/negative acknowledgements (verifications).*

Table 3 - System information in monitor direction

TYPE IDENTIFICATION := UI8[1..8]<70..99>

	<70>	:=	end of initialization	M_EI_NA_1

<71..99> := reserved for further compatible definitions

Table 4 - System information in control direction

TYPE IDENTIFICATION := UI8[1..8]<100..109>

CON	<100>	:=	interrogation command	C_IC_NA_1
CON	<101>	:=	counter interrogation command	C_CI_NA_1
	<102>	:=	read command	C_RD_NA_1
CON	<105>	:=	reset process command	C_RP_NA_1
CON	<107>	:=	test command with time tag CP56time2a	C_TS_TA_1

<108..109> := reserved for further compatible definitions

Table 5 - Parameter in control direction

TYPE IDENTIFICATION := UI8[1..8]<110..119>

CON	<110>	:=	parameter of measured value, normalized value	P_ME_NA_1
CON	<111>	:=	parameter of measured value, scaled value	P_ME_NB_1
CON	<112>	:=	parameter of measured value, short floating point number	P_ME_NC_1
CON	<113>	:=	parameter activation	P_AC_NA_1

<114..119> := reserved for further compatible definitions

Table 6 - File transfer

TYPE IDENTIFICATION := UI8[1..8]<120..127>

	<120>	:=	file ready	F_FR_NA_1
	<121>	:=	section ready	F_SR_NA_1
	<122>	:=	call directory, select file, call file, call section	F_SC_NA_1
	<123>	:=	last section, last segment	F_LS_NA_1
	<124>	:=	ack file, ack section	F_AF_NA_1
	<125>	:=	segment	F_SG_NA_1
	<126>	:=	directory	F_DR_TA_1

<127> := reserved for further compatible definitions

Note
- ASDUs marked (**CON)** in control direction are confirmed application services and may be mirrored in monitor direction with different causes of transmission. These mirrored ASDUs are used for positive/negative acknowledgements (verifications).

7 Mapping of selected Application Data Units and Functions to the TCP Services

In the following the functions which are selected from IEC 60870-5-5 for the use in this standard are specified. The application services defined in this standard are assigned to the suitable transport services defined in RFC 793. The ASDU labels specified are as defined in IEC 60870-5-5.
The controlling station is equivalent to the client (connector), the controlled station to the host (listener).

7.1 Station initialization (6.1.5 to 6.1.7 in 60870-5-5)

Release of connections may be performed by both, the controlling and the controlled station. Establishing of connections is performed by

- the controlling station in case of a controlled station as a partner
- a fixed selection (parameter) in case of two equivalent controlling stations or partners see figure 1.

Figure 17 shows that an established connection may be closed by the controlling station giving an active close call to its TCP, followed by the controlled station giving a passive close to its TCP. The figure then shows the establishment of a new connection by the controlling station giving an active open call to its TCP after the controlled station has previously given a passive open call to its TCP. Finally the figure shows the alternative active close of the connection by the controlled station.

Figure 18 shows that during the initialization of the controlling station, a connection is established with each controlled station in turn. Starting with station 1 the controlling station gives an active open call to its TCP which results in connection establishment if the TCP of station 1 has the listen status (status not shown in the figure). This is then repeated for the remaining controlled stations.

Figure 19 shows the controlling station repeatedly attempting to establish a connection with a controlled station. These attempts fail until the controlled station has performed a local initialization and given a passive open call to its TCP which has then acquired the listen status (status not shown in the figure).

Figure 20 shows the controlling station establishing a connection by giving an active open call to its TCP. The controlling station then sends Reset_Process to the connected controlled station, which confirms back the Reset_Process and gives an active close call to its TCP. The connection then closes after the controlling station has given a passive close call to its TCP. Then the controlling station tries to connect the controlled station by giving cyclic active opens to its TCP. When the controlled station is again available, after its remote initialization, it returns a CLT=SYN, ACK. This results in the establishment of a new connection if the controlling station acknowledges the CLT=SYN, ACK.

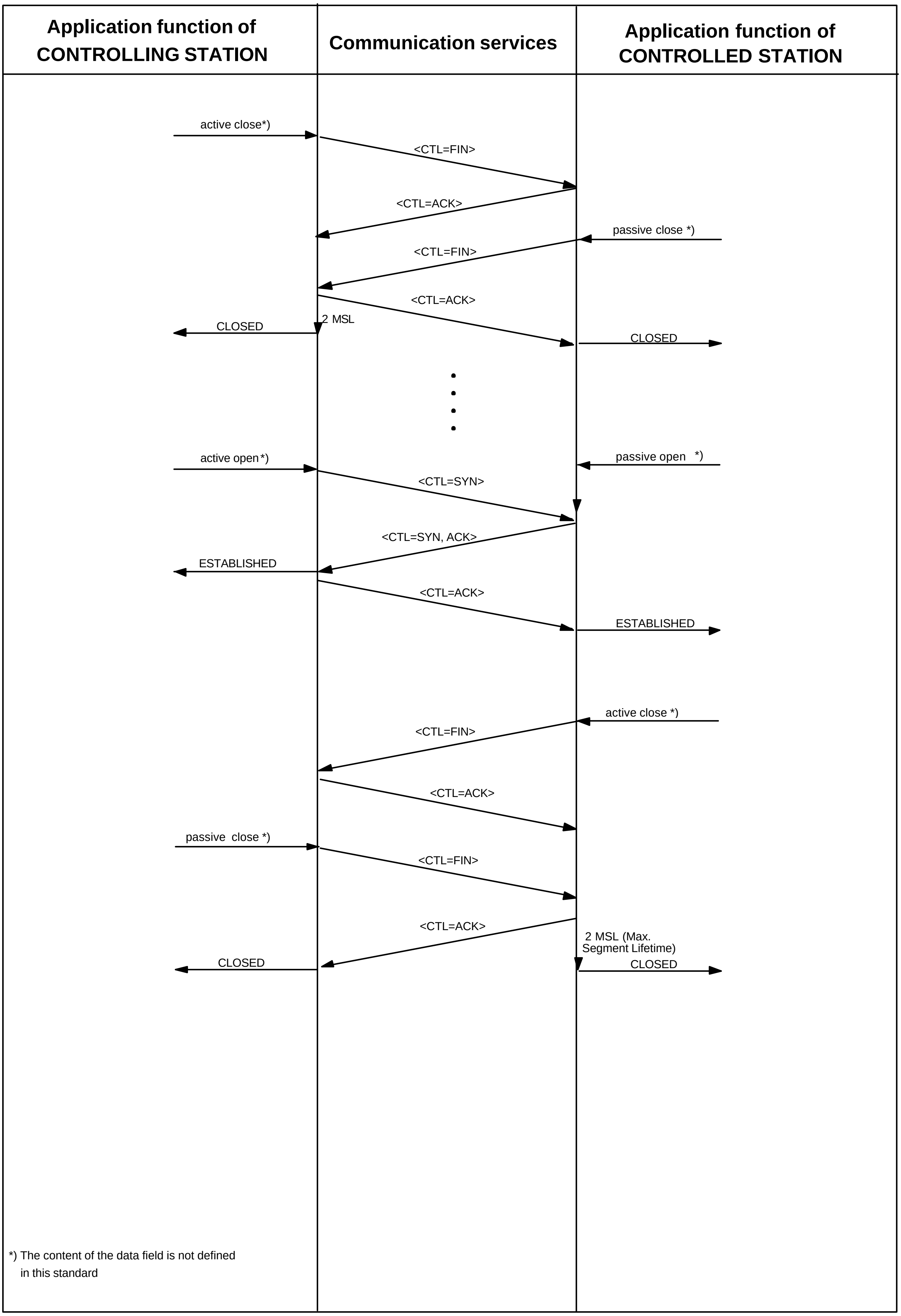


Figure 17: TCP Connection establishment and close

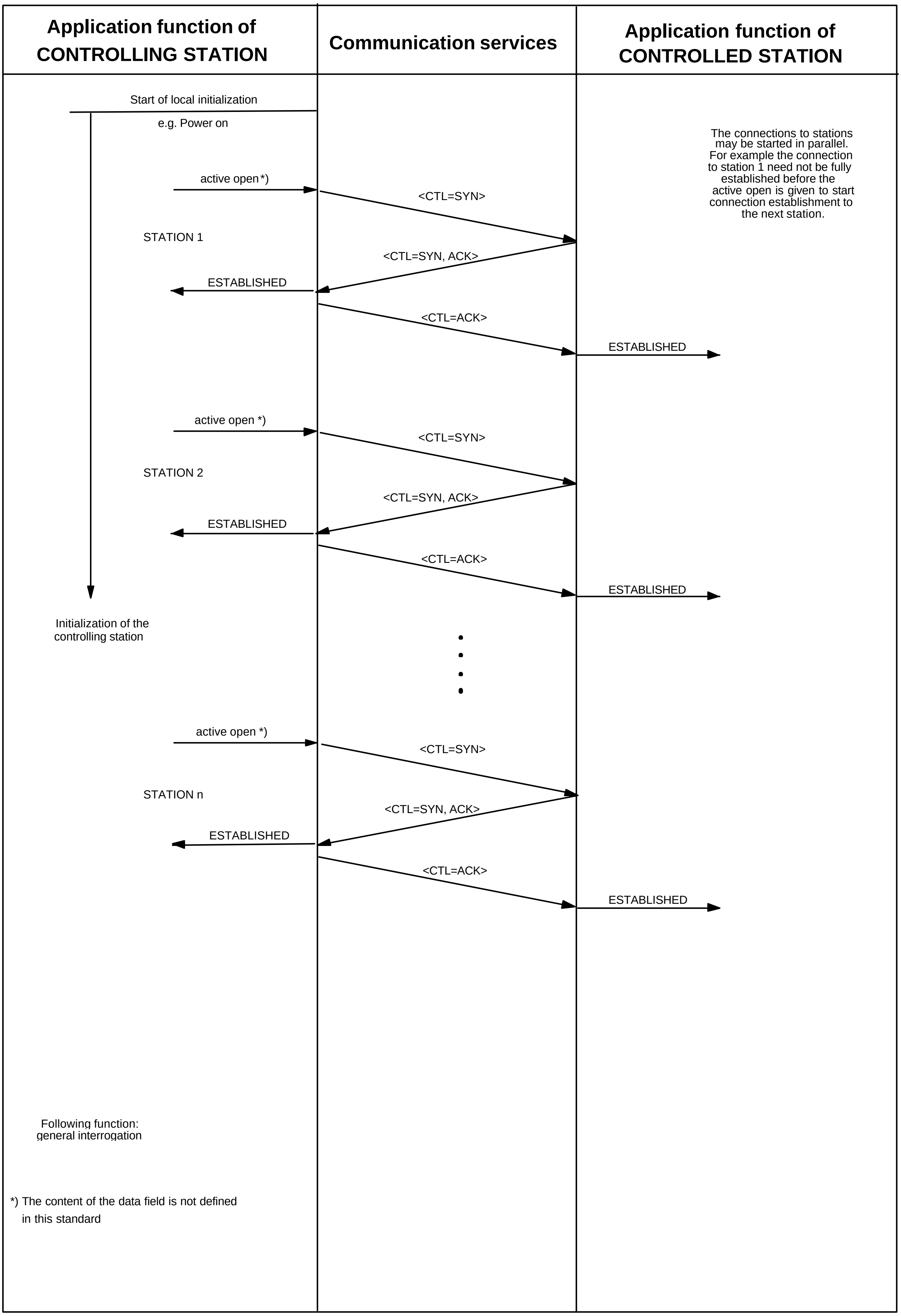


Figure 18: Initialization of the controlling station

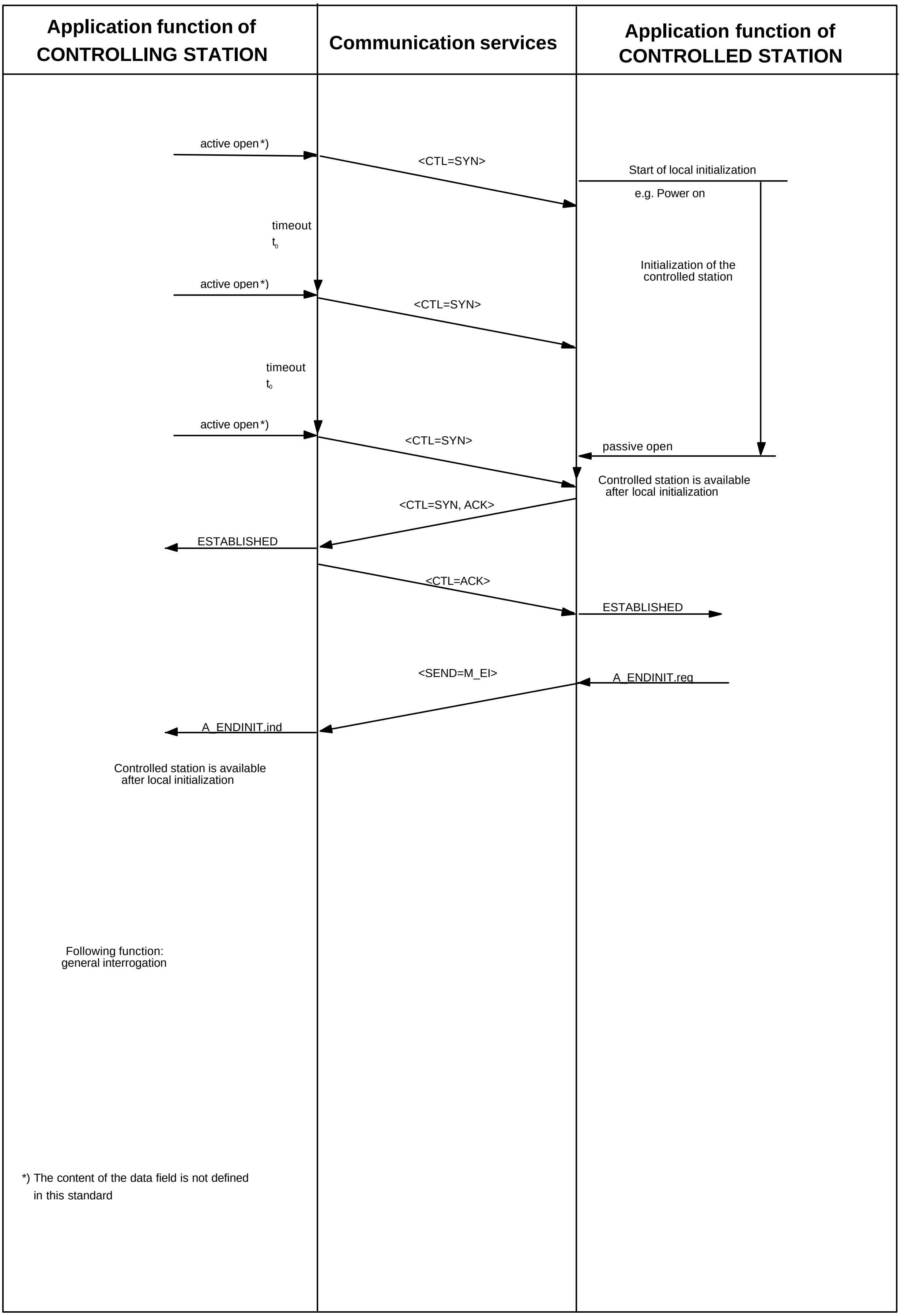


Figure 19: Local initialization of the controlled station

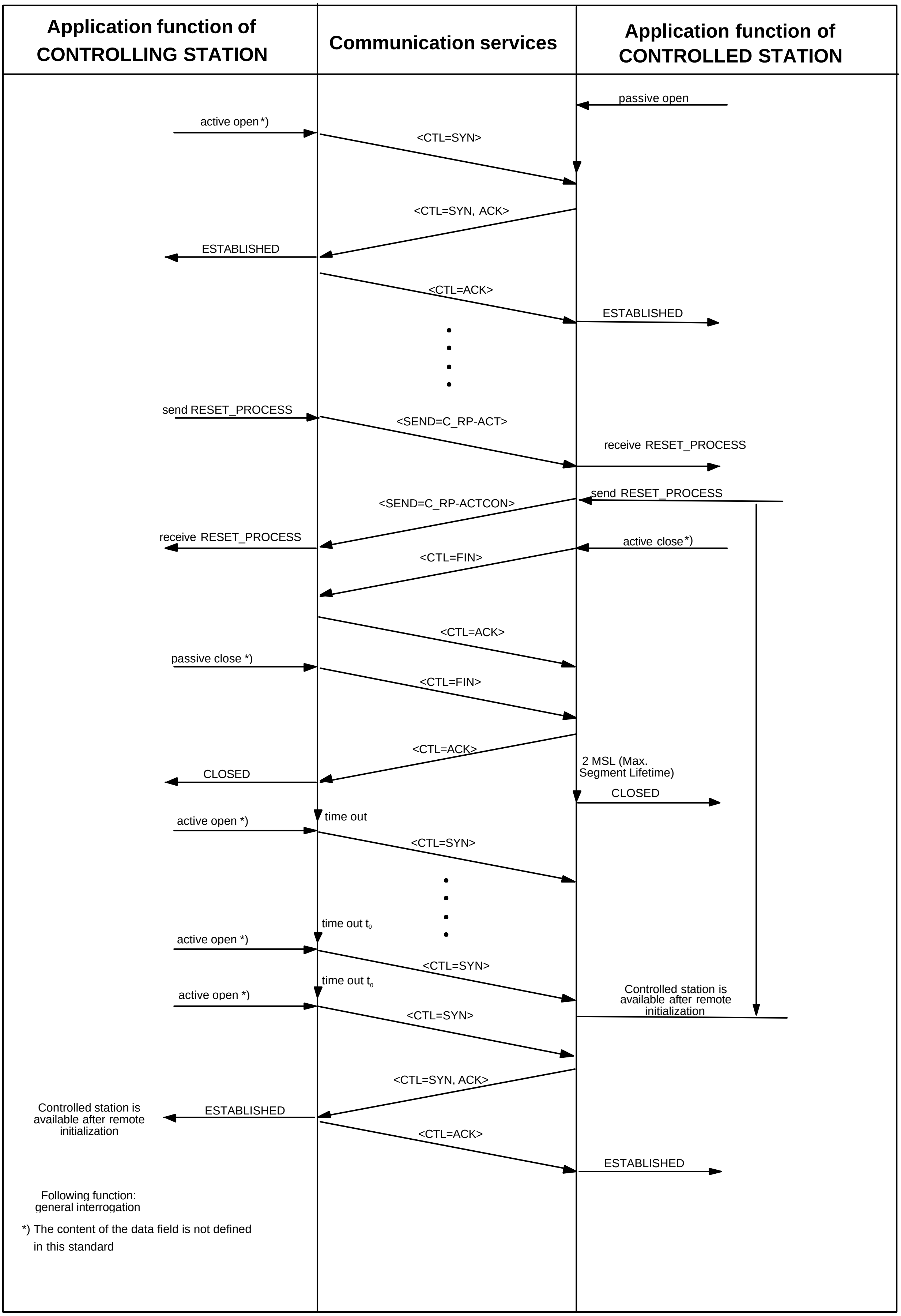


Figure 20: Remote initialization of the controlled station

7.2 Data acquisition by polling (6.2 in 60870-5-5)

Request of user data class 1 and 2 are link functions of 60870-5-2 and therefore not available in this standard. However, data may be read (requested) as shown in the bottom part of figure 10 of IEC 60870-5-5.

Application Service IEC 60870-5-5	TCP Service RFC 793	ASDU Label IEC 60870-5-5
A_RD_DATA.req	send	C_RD
A_RD_DATA.ind	receive	C_RD
A_M_DATA.req	send	M
A_M_DATA.ind	receive	M

7.3 Cyclic data transmission (6.3 in 60870-5-5)

Application Service IEC 60870-5-5	TCP Service RFC 793	ASDU Label IEC 60870-5-5
A_CYCLIC_DATA.req	send	M CYCLIC
A_CYCLIC_DATA.ind	receive	M CYCLIC

7.4 Acquisition of events (6.4 in 60870-5-5)

Application Service IEC 60870-5-5	TCP Service RFC 793	ASDU Label IEC 60870-5-5
A_EVENT.req	send	M SPONT
A_EVENT.ind	receive	M SPONT

7.5 General interrogation (6.6 in 60870-5-5)

Application Service IEC 60870-5-5	TCP Service RFC 793	ASDU Label IEC 60870-5-5
A_GENINCOM.req	send	C_IC ACT
A_GENINCOM.ind	receive	C_IC ACT
A_GENINACK.req	send	C_IC ACTCON
A_ GENINACK.ind	receive	C_IC ACTCON
A_INTINF.req	send	M
A_INTINF.ind	receive	M
A_ENDINT.req	send	C_IC ACTTERM
A_ENDINT.ind	receive	C_IC ACTTERM

7.6 Clock synchronization (6.7 in 60870-5-5)

Application Service IEC 60870-5-5	TCP Service RFC 793	ASDU Label IEC 60870-5-5
A_CLOCKSYN.req	send	C_CS ACT
A_CLOCKSYN.ind	receive	C_CS ACT
A_TIMEMESS.req	send	C_CS ACTCON
A_TIMEMESS.ind	receive	C_CS ACTCON

The clock synchronization procedure defined in IEC 60870-5-5 cannot be used in this standard because the link layer according to IEC 60870-5-2 which provides the exact time of sending the clock command is no longer available.

However, clock synchronization may be used in configurations where the *maximum network delay* is *less* than the required accuracy of the clock in the receiving station. E.g., if the network provider guarantees that the delay in the network will never be more than 400 ms (a typical X.25 WAN value) and the required accuracy in the controlled station is 1 second, the clock synchronization procedure is useful. Use of this procedure avoids the necessity of installing clock synchronization receivers or similar in potentially several hundreds or thousands of controlled stations.

The procedure is a copy of `section 6.7 in 870-5-5, with the „first bit“ and „time correction“ requirements and link layer options (SEND/No reply or SEND/CONFIRM) removed.

Clocks in controlled stations have to be synchronized with the clock in the controlling station to provide correct chronologic sets of time-tagged events or information objects that are transmitted to the controlling station or logged locally. The clocks are initially synchronized by the controlling station after system initialization and then re-synchronized periodically by agreement by transmitting C_CS ACT PDUs.

The C_CS ACT PDU contains the whole (date and time) current clock time with the required time resolution at the instant when the message is generated by the application layer. After the execution of the clock sync internally the controlled station generates a C_CS ACTCON PDU that contains the local time *before* it was synchronized. This message is transmitted after any buffered time-tagged PDUs, that may be waiting for transmission. Time-tagged events that occur *after* the internal clock synchronization are transmitted *after* the C_CS ACTCON PDU.

Controlled stations expect the reception of clock synchronization messages within agreed upon time intervals. When the synchronization command does not arrive within this time interval, the controlled station sets all time-tagged information objects with a mark that the time-tag may be inaccurate (invalid). This mark is also set after station initializiation (warm and cold boot) of controlled stations before reception of a valid C_CS ACT PDU. Time-tagged events that occur after the reception of valid C_CS ACT PDU are transmitted without the mark.

7.6.1 Description of sequential procedure

(refers to figure 15 of IEC 60870-5-5)

The application process in the controlling station sends the clock synchronization command as a CLOCKSYN.req primitive with the time as known in the application process and with the required accuracy to the communication services. The communication services transmit this request as a C_CS ACT PDU and delivers this request as a A_CLOCKSYN.ind primitive to the application process in the controlled station.

After the execution of the clock synchronization operation the application process of the controlled station produces the time message which is transmitted as a C_CS ACTCON PDU initiated by an A_TIMEMESS.req primitive. This request contains the time which is known in the application process in the controlled station *before* reception of the A_CLOCKSYN.ind. This PDU is issued to the application process of the controlling station as an A_TIMEMESS.ind primitive.

7.7 Command transmission (6.8 in 60870-5-5)

Application Service IEC 60870-5-5	TCP Service RFC 793	ASDU Label IEC 60870-5-5
A_SELECT.req	send	C_SC, C_DC, C_SE, C_RC, C_BO ACT
A_SELECT.ind	receive	C_SC, C_DC, C_SE, C_RC, C_BO ACT
A_SELECT.res	send	C_SC, C_DC, C_SE, C_RC, C_BO ACTCON
A_SELECT.con	receive	C_SC, C_DC, C_SE, C_RC, C_BO ACTCON
A_BREAK.req	send	C_SC, C_DC, C_SE, C_RC, C_BO DEACT
A_BREAK.ind	receive	C_SC, C_DC, C_SE, C_RC, C_BO DEACT
A_BREAK.res	send	C_SC, C_DC, C_SE, C_RC, C_BO DEACTCON
A_BREAK.con	receive	C_SC, C_DC, C_SE, C_RC, C_BO DEACTCON
A_EXCO.req	send	C_SC, C_DC, C_SE, C_RC, C_BO ACT
A_EXCO.ind	receive	C_SC, C_DC, C_SE, C_RC, C_BO ACT
A_EXCO.res	send	C_SC, C_DC, C_SE, C_RC, C_BO ACTCON
A_EXCO.con	receive	C_SC, C_DC, C_SE, C_RC, C_BO ACTCON
A_RETURN_INF.req	send	M_SP, M_DP, M_ST
A_RETURN_INF.ind	receive	M_SP, M_DP, M_ST
A_COTERM.req	send	C_SC, C_DC, C_SE, C_RC, C_BO ACTTERM
A_COTERM.ind	receive	C_SC, C_DC, C_SE, C_RC, C_BO ACTTERM

7.8 Transmission of integrated totals (6.9 in 60870-5-5)

Application Service IEC 60870-5-5	TCP Service RFC 793	ASDU Label IEC 60870-5-5
A_MEMCNT.req	send	C_CI ACT
A_MEMCNT.ind	receive	C_CI ACT

A_MEMCNT.res	send	C_CI ACTCON
A_MEMCNT.con	receive	C_CI ACTCON
A_MEMINCR.req	send	C_CI ACT
A_MEMINCR.ind	receive	C_CI ACT
A_MEMINCR.res	send	C_CI ACTCON
A_MEMINCR.con	receive	C_CI ACTCON
A_REQINTO.req	send	C_CI ACT
A_REQINTO.ind	receive	C_CI ACT
A_REQINTO.res	send	C_CI ACTCON
A_REQINTO.con	receive	C_CI ACTCON
A_INTO_INF.req	send	M_IT
A_INTO_INF.ind	receive	M_IT
A_IBREAK.req	send	C_CI DEACT
A_IBREAK.ind	receive	C_CI DEACT
A_IBREAK.res	send	C_CI DEACTCON
A_IBREAK.con	receive	C_CI DEACTCON
A_ITERM.req	send	C_CI ACTTERM
A_ITERM.ind	receive	C_CI ACTTERM

7.9 Parameter loading (6.10 in 60870-5-5)

Application Service IEC 60870-5-5	TCP Service RFC 793	ASDU Label IEC 60870-5-5
A_PARAM.req	send	P_ME ACT
A_PARAM.ind	receive	P_ME ACT

A_PARAM.res	send	P_ME ACTCON
A_PARAM.con	receive	P_ME ACTCON
A_PACTIV.req	send	P_AC ACT
A_PACTIV.ind	receive	P_AC ACT
A_PACTIV.res	send	P_AC ACTCON
A_PACTIV.con	receive	P_AC ACTCON
A_LCPACH.req	send	P_ME SPONT
A_LCPACH.ind	receive	P_ME SPONT

7.10 Test procedure (6.11 in 60870-5-5)

Application Service IEC 60870-5-5	TCP Service RFC 793	ASDU Label IEC 60870-5-5
A_TEST.req	send	C_TS ACT
A_TEST.ind	receive	C_TS ACT
A_TEST.res	send	C_TS ACTCON
A_TEST.con	receive	C_TS ACTCON

7.11 File transfer (6.12 in 60870-5-5) Control and monitor direction

Application Service IEC 60870-5-5	TCP Service RFC 793	ASDU Label IEC 60870-5-5
A_CALL_DIRECTORY.req	send	F_SC
A_CALL_DIRECTORY.ind	receive	F_SC

A_CALL_DIRECTORY.res	send	F_DR
A_CALL_DIRECTORY.con	receive	F_DR
A_SELECT_FILE.req	send	F_SC
A_SELECT_FILE.ind	receive	F_SC
A_FILE_READY.req	send	F_FR
A_FILE_READY.ind	receive	F_FR
A_CALL_FILE.req	send	F_SC
A_CALL_FILE.ind	receive	F_SC
A_SECTION1_READY.req	send	F_SR
A_SECTION1_READY.ind	receive	F_SR
A_CALL_SECTION1.req	send	F_SC
A_CALL_SECTION1.ind	receive	F_SC
A_SEGMENT1.req	send	F_SG
A_SEGMENT1.ind	receive	F_SG
A_SEGMENTn.req	send	F_SG
A_SEGMENTn.ind	receive	F_SG
A_LAST_SEGMENT.req	send	F_LS
A_LAST_SEGMENT.ind	receive	F_LS
A_ACK_SECTION1.req	send	F_AF
A_ACK_SECTION1.ind	receive	F_AF
A_SECTIONm_READY.req	send	F_SR
A_SECTIONm_READY.ind	receive	F_SR
Application Service IEC 60870-5-5	**Transport Service RFC 793**	**ASDU Label IEC 60870-5-5**
A_CALL_SECTIONm.req	send	F_SC
A_CALL_SECTIONm.ind	receive	F_SC
A_ACK_SECTIONm.req	send	F_AF
A_ACK_SECTIONm.ind	receive	F_AF

A_LAST_SECTION.req	send	F_LS
A_LAST_SECTION.ind	receive	F_LS
A_ACK_FILE.req	send	F_AF
A_ACK_FILE.ind	receive	F_AF
A_DIRECTORY.req	send	F_DR
A_DIRECTORY.ind	receive	F_DR

8 ASDUs for process information in control direction with time tag

This clause defines the additional ASDUs in control direction which are extended with the time tag CP56Time2a. This time includes date and clock time in milliseconds up to years and is defined in IEC 60870-5-101. The ASDUs with the time tag may be used alternatively to the ASDUs without time tag in case of using networks which might cause unpermitted delays of commands. A controlled station receiving a dangerously delayed command is then able to take appropriate actions.

The clause numbers shown in the figures refer to the clauses of IEC 60870-5-101.

8.1 TYPE IDENT 58: C_SC_TA_1
Single command with time tag CP56Time2a

Single information object (SQ = 0)

0 0 1 1 1 0 1 0	TYPE IDENTIFICATION	DATA UNIT IDENTIFIER Defined in 7.1
0 0 0 0 0 0 0 1	VARIABLE STRUCTURE QUALIFIER	
Defined in 7.2.3	CAUSE OF TRANSMISSION	
Defined in 7.2.4	COMMON ADDRESS OF ASDU	
Defined in 7.2.5	INFORMATION OBJECT ADDRESS	INFORMATION OBJECT
S/E | QU | 0 | SCS	SCO = Single command, defined in 7.2.6.15	
CP56Time2a Defined in 7.2.6.18	Seven octet binary time (Date and clock time in milliseconds up to years)	

Figure 21 - ASDU: C_SC_TA_1 Single command with time tag CP56Time2a

C_SC_TA_1 := CP{Data unit identifier,Information object address,SCO,CP56Time2a}

CAUSES OF TRANSMISSION used with

TYPE IDENT 58 := C_SC_TA_1

CAUSE OF TRANSMISSION

in control direction:
<6> := activation
<8> := deactivation

in monitor direction:
<7> := activation confirmation
<9> := deactivation confirmation
<10> := activation termination

8.2 TYPE IDENT 59: C_DC_TA_1
Double command with time tag CP56Time2a

Single information object (SQ = 0)

0 0 1 1 1 0 1 1	TYPE IDENTIFICATION	DATA UNIT IDENTIFIER Defined in 7.1
0 0 0 0 0 0 0 1	VARIABLE STRUCTURE QUALIFIER	
Defined in 7.2.3	CAUSE OF TRANSMISSION	
Defined in 7.2.4	COMMON ADDRESS OF ASDU	
Defined in 7.2.5	INFORMATION OBJECT ADDRESS	INFORMATION OBJECT
S/E | QU | DCS	DCO = Double command, defined in 7.2.6.16	
CP56Time2a Defined in 7.2.6.18	Seven octet binary time (Date and clock time in milliseconds up to years)	

Figure 22 - ASDU: C_DC_TA_1 Double command with time tag CP56Time2a

C_DC_NA_1 := CP{Data unit identifier,Information object address,DCO,CP56Time2a }

CAUSES OF TRANSMISSION used with

TYPE IDENT 59 := C_DC_TA_1

CAUSE OF TRANSMISSION

in control direction:
<6> := activation
<8> := deactivation

in monitor direction:
<7> := activation confirmation
<9> := deactivation confirmation
<10> := activation termination

8.3 TYPE IDENT 60: C_RC_TA_1
Regulating step command with time tag CP56Time2a

Single information object (SQ = 0)

0 0 1 1 1 1 0 0	TYPE IDENTIFICATION	DATA UNIT IDENTIFIER Defined in 7.1
0 0 0 0 0 0 0 1	VARIABLE STRUCTURE QUALIFIER	
Defined in 7.2.3	CAUSE OF TRANSMISSION	
Defined in 7.2.4	COMMON ADDRESS OF ASDU	
Defined in 7.2.5	INFORMATION OBJECT ADDRESS	INFORMATION OBJECT
S/E | QU | RCS	RCO = Regulating step command, defined in 7.2.6.17	
CP56Time2a Defined in 7.2.6.18	Seven octet binary time (Date and clock time in milliseconds up to years)	

Figure 23 - ASDU: C_RC_TA_1 Regulating step command with time tag CP56Time2a

C_RC_TA_1 := CP{Data unit identifier,Information object address,RCO,CP56Time2a}

CAUSES OF TRANSMISSION used with

TYPE IDENT 60 := C_RC_TA_1

CAUSE OF TRANSMISSION

in control direction:
<6> := activation
<8> := deactivation

in monitor direction:
<7> := activation confirmation
<9> := deactivation confirmation
<10> := activation termination

8.4 TYPE IDENT 61: C_SE_TA_1
Set-point command with time tag CP56Time2a, normalized value

Single information object (SQ = 0)

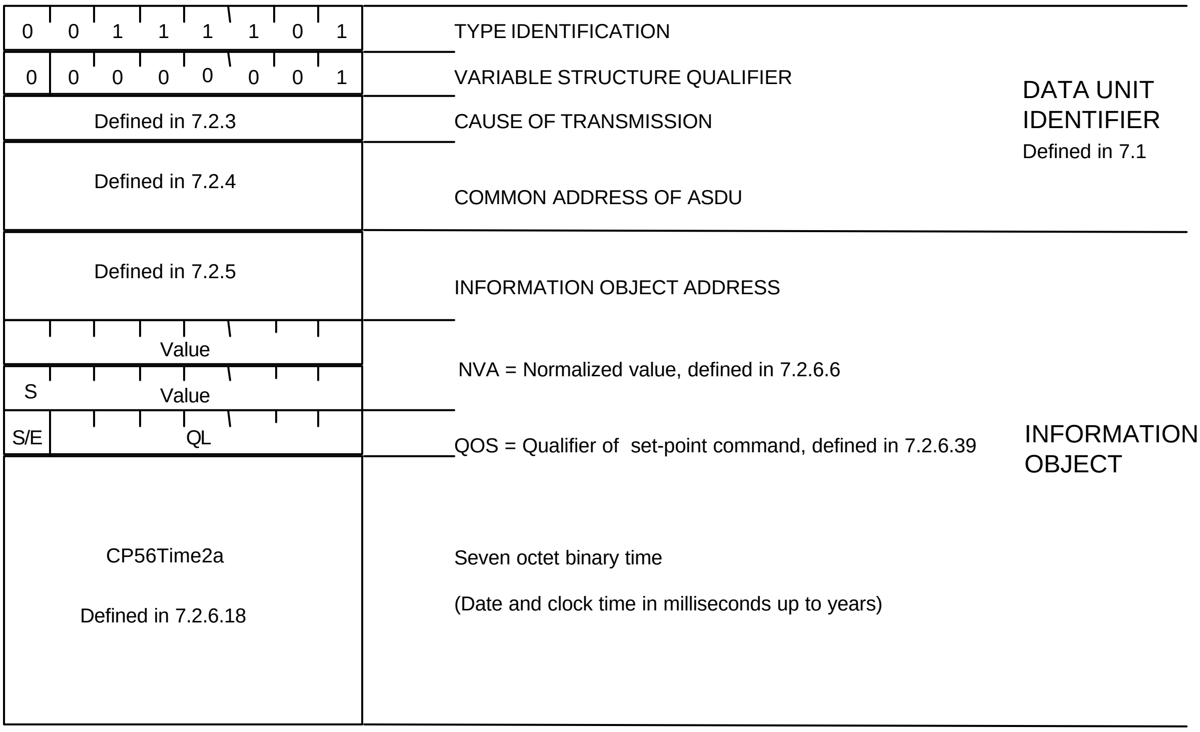


Figure 24 - ASDU: C_SE_TA_1 Set-point command with time tag CP56Time2a, normalized value

C_SE_TA_1 := CP{Data unit identifier,Information object address,NVA,QOS,CP56Time2a}

CAUSES OF TRANSMISSION used with
TYPE IDENT 61 := C_SE_TA_1

CAUSE OF TRANSMISSION

in control direction:
<6> := activation
<8> := deactivation

in monitor direction:
<7> := activation confirmation
<9> := deactivation confirmation
<10> := activation termination (opt)

8.5 TYPE IDENT 62: C_SE_TB_1
Set-point command with time tag CP56Time2a, scaled value

Single information object (SQ = 0)

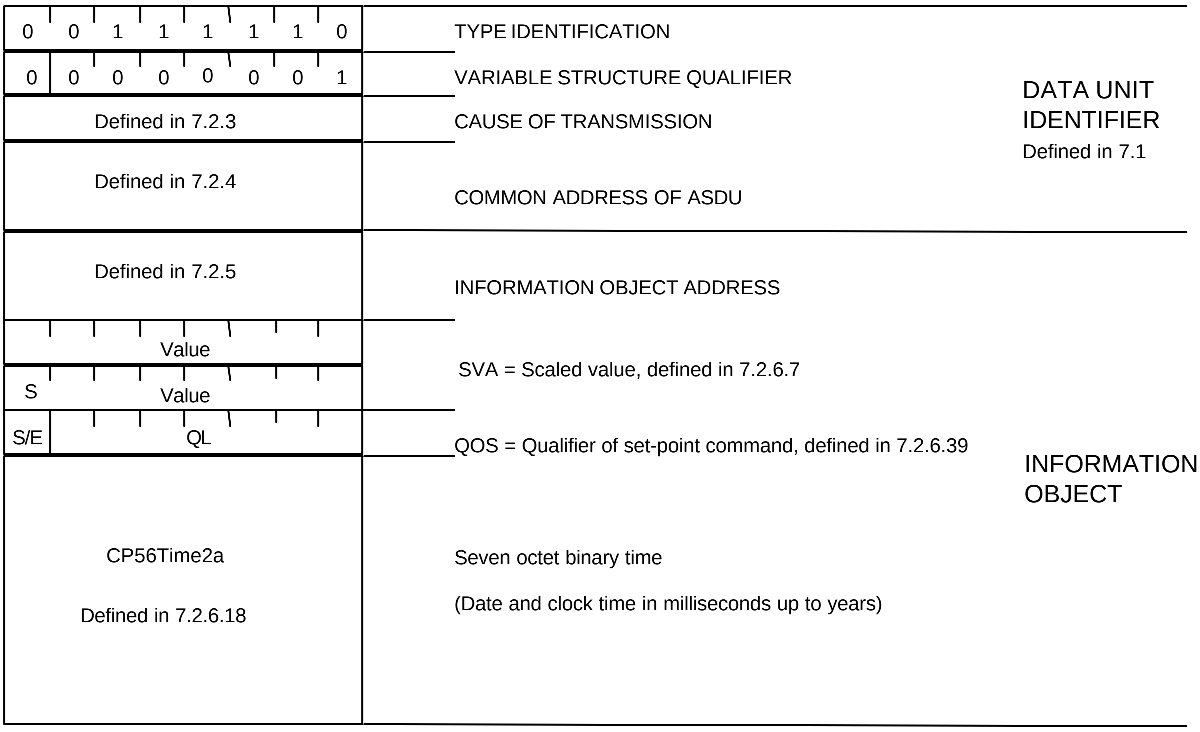


Figure 25 - ASDU: C_SE_TB_1 Set-point command with time tag CP56Time2a, scaled value

C_SE_TB_1 := CP{Data unit identifier,Information object address,SVA,QOS,CP56Time2a}

CAUSES OF TRANSMISSION used with
TYPE IDENT 62 := C_SE_TB_1

CAUSE OF TRANSMISSION

in control direction:

<6>	:=	activation
<8>	:=	deactivation

in monitor direction:

<7>	:=	activation confirmation
<9>	:=	deactivation confirmation
<10>	:=	activation termination (opt)

8.6 TYPE IDENT 63: C_SE_TC_1
Set-point command with time tag CP56Time2a, short floating point number

Single information object (SQ = 0)

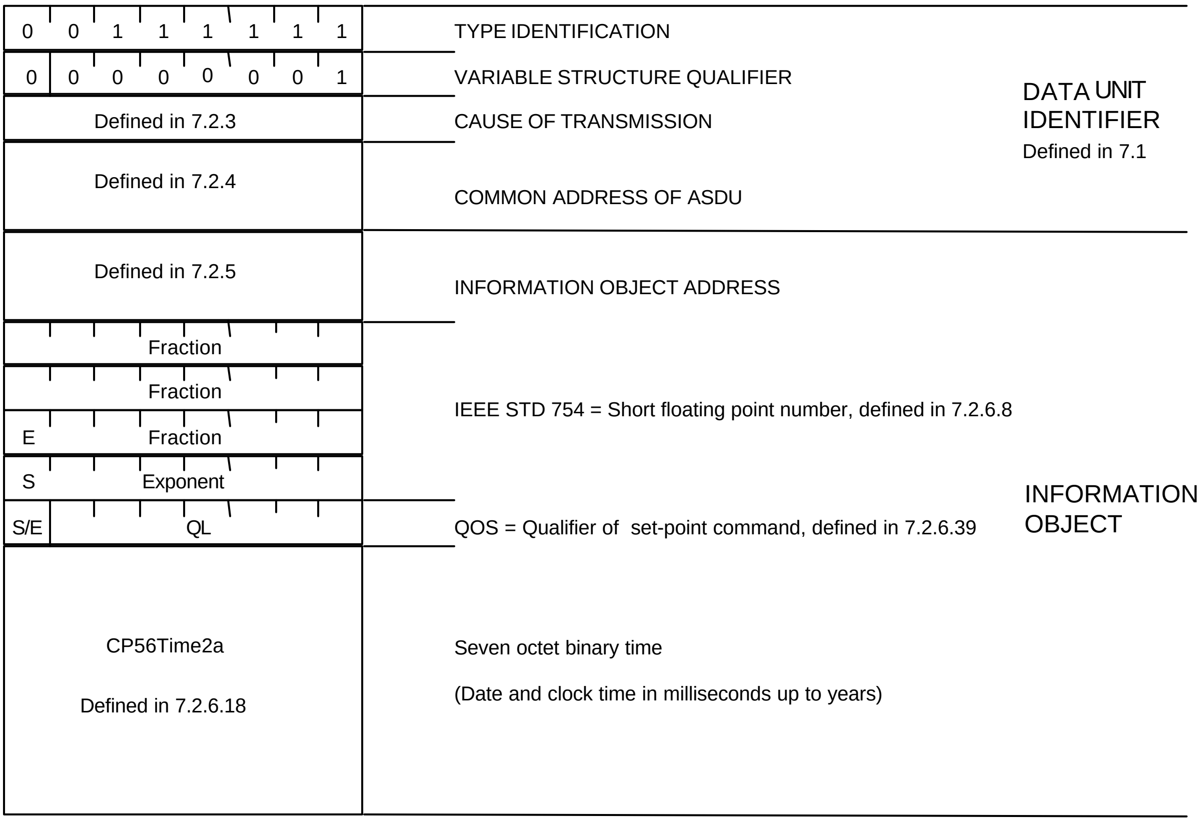


Figure 26 - ASDU: C_SE_TC_1 Set-point command with time tag CP56Time2a, short floating point number

C_SE_TC_1 := CP{Data unit identifier,Information object address,IEEE STD 754,QOS, CP56Time2a}

CAUSES OF TRANSMISSION used with

TYPE IDENT 63 := C_SE_TC_1

CAUSE OF TRANSMISSION

in control direction:
<6> := activation
<8> := deactivation

in monitor direction:
<7> := activation confirmation
<9> := deactivation confirmation
<10> := activation termination (opt)

8.7 TYPE IDENT 64: C_BO_TA_1
Bitstring of 32 bit with time tag CP56Time2a

Single information object (SQ = 0)

0 1 0 0 0 0 0 0	TYPE IDENTIFICATION	DATA UNIT IDENTIFIER Defined in 7.1
0 0 0 0 0 0 0 1	VARIABLE STRUCTURE QUALIFIER	
Defined in 7.2.3	CAUSE OF TRANSMISSION	
Defined in 7.2.4	COMMON ADDRESS OF ASDU	
Defined in 7.2.5	INFORMATION OBJECT ADDRESS	INFORMATION OBJECT
Bitstring	BSI = Binary state information, 32 bit, defined in 7.2.6.13	
Bitstring		
Bitstring		
Bitstring		
CP56Time2a Defined in 7.2.6.18	Seven octet binary time (Date and clock time in milliseconds up to years)	

Figure 27 - ASDU: C_BO_TA_1 Bitstring of 32 bit with time tag CP56Time2a

C_BO_TA_1 := CP{Data unit identifier,Information object address,BSI,CP56Time2a}

CAUSES OF TRANSMISSION used with

TYPE IDENT 64 := C_BO_TA_1

CAUSE OF TRANSMISSION
in control direction:
<6> := activation
<8> := deactivation

in monitor direction:
<7> := activation confirmation
<9> := deactivation confirmation
<10> := activation termination (opt)

8.8 TYPE IDENT 107: C_TS_TA_1
Test command with time tag CP56Time2a

Single information object (SQ = 0)

0 1 1 0 1 0 1 1	TYPE IDENTIFICATION	DATA UNIT IDENTIFIER Defined in 7.1
0 0 0 0 0 0 0 1	VARIABLE STRUCTURE QUALIFIER	
Defined in 7.2.3	CAUSE OF TRANSMISSION	
Defined in 7.2.4	COMMON ADDRESS OF ASDU	
Defined in 7.2.5	INFORMATION OBJECT ADDRESS	INFORMATION OBJECT
TSC	TSC = Test sequence counter, 16 bit	
CP56Time2a Defined in 7.2.6.18	Seven octet binary time (Date and clock time in milliseconds up to years)	

Figure 28 - ASDU: C_TS_TA_1 Test command with time tag CP56Time2a

C_TS_TA_1 := CP{Data unit identifier,Information object address,TSC,CP56Time2a}

TSC := UI16[1..16]<0..65535>
TSC is a binary counter which counts the number of the test commands. After a reset the counter restarts with an initial value of 0.

CAUSES OF TRANSMISSION used with

TYPE IDENT 107 := C_TS_TA_1

CAUSE OF TRANSMISSION
in control direction:
<6> := activation

in monitor direction:
<7> := activation confirmation

9 Interoperability

This companion standard presents sets of parameters and alternatives from which subsets have to be selected to implement particular telecontrol systems. Certain parameter values, such as the number of octets in the COMMON ADDRESS of ASDUs represent mutually exclusive alternatives. This means that only one value of the defined parameters is admitted per system. Other parameters, such as the listed set of different process information in command and in monitor direction allow the specification of the complete set or subsets, as appropriate for given applications.This clause summarizes the parameters of the previous clauses to facilitate a suitable selection for a specific application. If a system is composed of equipment stemming from different manufacturers it is necessary that all partners agree on the selected parameters.

The selected parameters should be crossed in the white boxes.

Note
- In addition, the full specification of a system may require individual selection of certain parameters for certain parts of the system, such as the individual selection of scaling factors for individually addressable measured values.

The interoperability list is defined as in IEC 60870-5-101 and extended with parameters used in this standard. Parameters which are not valid for this companion standard are marked with hatched boxes.

9.1 Network configuration

(network-specific parameter)

☐ Point-to-point
☐ Multiple point-to-point
☐ Multipoint-party line
☐ Multipoint-star

9.2 Physical layer

(network-specific parameter)

Transmission speed (control direction)

Unbalanced interchange circuit V.24/V.28 Standard	Unbalanced interchange circuit V.24/V.28 Recommended if >1 200 bit/s	Balanced interchange circuit X.24/X.27	
☐ 100 bit/s	☐ 2 400 bit/s	☐ 2 400 bit/s	☐ 56 000 bit/s
☐ 200 bit/s	☐ 4 800 bit/s	☐ 4 800 bit/s	☐ 64 000 bit/s
☐ 300 bit/s	☐ 9 600 bit/s	☐ 9 600 bit/s	
☐ 600 bit/s		☐ 19 200 bit/s	
☐ 1 200 bit/s		☐ 38 400 bit/s	

Transmission speed (monitor direction)

Unbalanced interchange circuit V.24/V.28 Standard	Unbalanced interchange circuit V.24/V.28 Recommended if >1 200 bit/s	Balanced interchange circuit X.24/X.27	
☐ 100 bit/s	☐ 2 400 bit/s	☐ 2 400 bit/s	☐ 56 000 bit/s
☐ 200 bit/s	☐ 4 800 bit/s	☐ 4 800 bit/s	☐ 64 000 bit/s
☐ 300 bit/s	☐ 9 600 bit/s	☐ 9 600 bit/s	
☐ 600 bit/s		☐ 19 200 bit/s	
☐ 1 200 bit/s		☐ 38 400 bit/s	

9.3 Link layer

(network-specific parameter)

Frame format FT 1.2, single character 1 and the fixed time out interval are used exclusively in this companion standard.

Link transmission procedure

☐ Balanced transmission
☐ Unbalanced transmission

Frame length

☐ Maximum length L (number of octets)

Address field of the link

☐ not present (balanced transmission only)
☐ One octet
☐ Two octets
☐ structured
☐ unstructured

9.4 Application layer

Transmission mode for application data

Mode 1 (Least significant octet first), as defined in clause 4.10 of IEC 60870-5-4, is used exclusively in this companion standard.

Common address of ASDU
(system-specific parameter)

☒ One octet ☐ Two octets

Information object address
(system-specific parameter)

☒ One octet ☐ structured
☒ Two octets ☐ unstructured
☐ Three octets

Cause of transmission
(system-specific parameter)

☒ One octet ☐ Two octets (with originator address)
Set to zero in case of no originator address

Length of APDU
(system-specific parameter)

The maximum length L of the APDU is 253 (default). The maximum length L may be reduced per system.

☐ Maximum length of APDU per system

Selection of standard ASDUs

Process information in monitor direction
(station-specific parameter)

☐	<1> :=	Single-point information	M_SP_NA_1
☒	<2> :=	Single-point information with time tag	M_SP_TA_1
☐	<3> :=	Double-point information	M_DP_NA_1
☒	<4> :=	Double-point information with time tag	M_DP_TA_1
☐	<5> :=	Step position information	M_ST_NA_1
☒	<6> :=	Step position information with time tag	M_ST_TA_1
☐	<7> :=	Bitstring of 32 bit	M_BO_NA_1
☒	<8> :=	Bitstring of 32 bit with time tag	M_BO_TA_1
☐	<9> :=	Measured value, normalized value	M_ME_NA_1
☒	<10> :=	Measured value, normalized value with time tag	M_ME_TA_1
☐	<11> :=	Measured value, scaled value	M_ME_NB_1
☒	<12> :=	Measured value, scaled value with time tag	M_ME_TB_1
☐	<13> :=	Measured value, short floating point value	M_ME_NC_1
☒	<14> :=	Measured value, short floating point value with time tag	M_ME_TC_1
☐	<15> :=	Integrated totals	M_IT_NA_1
☒	<16> :=	Integrated totals with time tag	M_IT_TA_1
☒	<17> :=	Event of protection equipment with time tag	M_EP_TA_1
☒	<18> :=	Packed start events of protection equipment with time tag	M_EP_TB_1
☒	<19> :=	Packed output circuit information of protection equipment with time tag	M_EP_TC_1
☐	<20> :=	Packed single-point information with status change detection	M_PS_NA_1
☐	<21> :=	Measured value, normalized value without quality descriptor	M_ME_ND_1
☐	<30> :=	Single-point information with time tag CP56Time2a	M_SP_TB_1
☐	<31> :=	Double-point information with time tag CP56Time2a	M_DP_TB_1
☐	<32> :=	Step position information with time tag CP56Time2a	M_ST_TB_1
☐	<33> :=	Bitstring of 32 bit with time tag CP56Time2a	M_BO_TB_1
☐	<34> :=	Measured value, normalized value with time tag CP56Time2a	M_ME_TD_1
☐	<35> :=	Measured value, scaled value with time tag CP56Time2a	M_ME_TE_1
☐	<36> :=	Measured value, short floating point value with time tag CP56Time2a	M_ME_TF_1
☐	<37> :=	Integrated totals with time tag CP56Time2a	M_IT_TB_1
☐	<38> :=	Event of protection equipment with time tag CP56Time2a	M_EP_TD_1
☐	<39> :=	Packed start events of protection equipment with time tag CP56Time2a	M_EP_TE_1
☐	<40> :=	Packed output circuit information of protection equipment with time tag CP56Time2a	M_EP_TF_1

Process information in control direction

(station-specific parameter)

☐	<45> :=	Single command	C_SC_NA_1
☐	<46> :=	Double command	C_DC_NA_1
☐	<47> :=	Regulating step command	C_RC_NA_1
☐	<48> :=	Set point command, normalized value	C_SE_NA_1
☐	<49> :=	Set point command, scaled value	C_SE_NB_1
☐	<50> :=	Set point command, short floating point value	C_SE_NC_1
☐	<51> :=	Bitstring of 32 bit	C_BO_NA_1
☐	<58> :=	Single command with time tag CP56Time2a	C_SC_TA_1
☐	<59> :=	Double command with time tag CP56Time2a	C_DC_TA_1
☐	<60> :=	Regulating step command with time tag CP56Time2a	C_RC_TA_1
☐	<61> :=	Set point command, normalized value with time tag CP56Time2a	C_SE_TA_1
☐	<62> :=	Set point command, scaled value with time tag CP56Time2a	C_SE_TB_1
☐	<63> :=	Set point command, short floating point value with time tag CP56Time2a	C_SE_TC_1
☐	<64> :=	Bitstring of 32 bit with time tag CP56Time2a	C_BO_TA_1

Either ASDUs of the set <45 - 51> or of the set <58 – 64> are used.

System information in monitor direction
(station-specific parameter)

☒	<70> :=	End of initialization	M_EI_NA_1

System information in control direction
(station-specific parameter)

☐	<100> :=	Interrogation command	C_IC_NA_1
☐	<101> :=	Counter interrogation command	C_CI_NA_1
☐	<102> :=	Read command	C_RD_NA_1
☐	<103> :=	Clock synchronization command (optional, see clause 7.6)	C_CS_NA_1
■	<104> :=	Test command	C_TS_NA_1
☐	<105> :=	Reset process command	C_RP_NA_1
■	<106> :=	Delay acquisition command	C_CD_NA_1
☐	<107> :=	Test command with time tag CP56time 2a	C_TS_TA_1

Parameter in control direction
(station-specific parameter)

☐ <110> := Parameter of measured value, normalized value		P_ME_NA_1
☐ <111> := Parameter of measured value, scaled value		P_ME_NB_1
☐ <112> := Parameter of measured value, short floating point value		P_ME_NC_1
☐ <113> := Parameter activation		P_AC_NA_1

File Transfer
(station-specific parameter)

☐ <120> := File ready		F_FR_NA_1
☐ <121> := Section ready		F_SR_NA_1
☐ <122> := Call directory, select file, call file, call section		F_SC_NA_1
☐ <123> := Last section, last segment		F_LS_NA_1
☐ <124> := Ack file, ack section		F_AF_NA_1
☐ <125> := Segment		F_SG_NA_1
☐ <126> := Directory		F_DR_TA_1

9.5 Basic application functions

Station initialization
(station-specific parameter)

☐ Remote initialization

General interrogation
(system- or station-specific parameter)

☐ global

☐ group 1	☐ group 7	☐ group 13
☐ group 2	☐ group 8	☐ group 14
☐ group 3	☐ group 9	☐ group 15
☐ group 4	☐ group 10	☐ group 16
☐ group 5	☐ group 11	
☐ group 6	☐ group 12	Addresses per group have to be defined

Clock synchronization
(station-specific parameter)

☐ Clock synchronization

optional, see clause 7.6.

Command transmission
(object-specific parameter)

☐ Direct command transmission
☐ Direct set point command transmission
☐ Select and execute command
☐ Select and execute set point command
☐ C_SE ACTTERM used

☐ no additional definition
☐ Short pulse duration (duration determined by a system parameter in the outstation)
☐ Long pulse duration (duration determined by a system parameter in the outstation)
☐ Persistent output

Transmission of integrated totals

(station- or object-specific parameter)

☐ Counter request
☐ Counter freeze without reset
☐ Counter freeze with reset
☐ Counter reset

☐ General request counter
☐ Request counter group 1
☐ Request counter group 2
☐ Request counter group 3
☐ Request counter group 4

Addresses per group have to be defined

Parameter loading
(object-specific parameter)

☐ Threshold value
☐ Smoothing factor
☐ Low limit for transmission of measured value
☐ High limit for transmission of measured value

Parameter activation
(object-specific parameter)

☐ Act/deact of persistent cyclic or periodic transmission of the addressed object

File transfer
(station-specific parameter)

☐ File transfer in monitor direction
☐ File transfer in control direction

Definition of time outs

Parameter	Default value	Remarks	Selected value
t_0	30 s	Time out of connection establishment	
t_1	15 s	Time out of send or test APDUs	
t_2	10 s	Time out for acknowledges in case of no data messages $t_2 < t_1$	
t_3	30 s	Time out for sending S-frames in case of a long idle state $t_3 > t_1$	

Maximum range of values for all time outs: 1 to 255 s, accuracy 1 s

Maximum number of outstanding I format APDUs k and latest acknowledge

Parameter	Default value	Remarks	Selected value
k	12 APDUs	Maximum difference receive sequence number to send state variable	
w	8 APDUs	Latest acknowledge after receiving w I format APDUs	

Maximum range of values k: 1 to 32767 (2^{15}-1) APDUs, accuracy 1 APDU
Maximum range of values w: 1 to 32767 APDUs, accuracy 1 APDU (Recommendation: w should not exceed 2/3 of k).

Portnumber

Parameter	Value	Remarks
Portnumber	2404	In all cases

RFC 2200 suite

RFC 2200 is an official Internet Standard which describes the state of standardization of protocols used in the Internet as determined by the Internet Architecture Board (IAB). It offers a broad spectrum of actual standards used in the Internet. The suitable selection of documents from RFC 2200 defined in this standard for given projects has to be chosen by the user of this standard.

☐ Ethernet 802.3

☐ Other selection from RFC 2200:

List of valid documents from RFC 2200

1. …………………………………………….. .
2. …………………………………………….. .
3. …………………………………………….. .
4. …………………………………………….. .
5. …………………………………………….. .
6. …………………………………………….. .
7. etc.