TECHNICAL SPECIFICATION **IEC TS 60870-6-602**

First edition
2001-04

Telecontrol equipment and systems –

Part 6-602: Telecontrol protocols compatible with ISO standards and ITU-T recommendations – TASE transport profiles

Matériels et systèmes de téléconduite –

Partie 6-602:
Protocoles de téléconduite compatibles avec les normes ISO et les recommandations de l'UIT-T – Profils TASE de transport

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TELECONTROL EQUIPMENT AND SYSTEMS –

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FOREWORD

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IEC 60870-6-602, which is a technical specification, has been prepared by IEC technical committee 57: Power system control and associated communications.

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

Enquiry draft	Report on voting
57/466/CDV	57/502/RVC

Full information on the voting for the approval of this technical specification 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 3.

The committee has decided that the contents of this publication will remain unchanged until 2004. At this date, the publication will be

- transformed into an International Standard;
- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

TELECONTROL EQUIPMENT AND SYSTEMS –

Part 6-602: Telecontrol protocols compatible with ISO standards and ITU-T recommendations – TASE transport profiles

1 Scope

This part of IEC 60870, which is a technical specification, describes the transport profiles for the IEC 60870-6 series over WAN with reference to international standardized profiles (ISPs) used by distributed SCADA/EMS applications in control centres, power plants and substations. The transport profiles use virtually any standard or *de facto* standard (including TCP/IP) connection-mode and connectionless-mode network services over any type of transmission media.

These profiles are part of the telecontrol communication architecture (TCA).

2 Normative references

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

2.1 General Standards

ISO/IEC 8072:1996, *Information technology – Open systems interconnection – Transport service definition*

ISO/IEC 8073:1997, *Information technology – Open Systems Interconnection – Protocol for providing the connection-mode transport service*

ISO/IEC 8348:1996, *Information technology – Open Systems Interconnection – Network Service Definition*

ISO/IEC 8473 (all parts), *Information technology – Protocol for providing the connectionless-mode network service*

ISO/IEC 8878:1992, *Information technology – Telecommunications and information exchange between systems – Use of X.25 to provide the OSI Connection-mode Network Service*

ISO/IEC TR 8802 (all parts), *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements*

ISO/IEC 9574:1992, *Information technology – Provision of the OSI connection-mode network service by packet mode terminal equipment to an integrated services digital network*

ISO/IEC TR 9577:1999, *Information technology – Protocol identification in the network layer*

ITU-T Recommendation X.121:2000, *International numbering plan for public data networks*

2.2 International standardized profiles

This subclause lists all current ISPs which may be implemented in telecontrol systems. For SCADA/EMS the TASE profiles IEC 60870-6-701 (TASE.1) and IEC 60870-6-702 (TASE.2) apply.

IEC 60870-6-501:1995, *Telecontrol equipment and systems – Part 6: Telecontrol protocols compatible with ISO standards and ITU-T recommendations – Section 501: TASE.1 Service definitions*

IEC 60870-6-502:1995, *Telecontrol equipment and systems – Part 6: Telecontrol protocols compatible with ISO standards and ITU-T recommendations – Section 502: TASE.1 Protocol definitions*

IEC 60870-6-503:1997, *Telecontrol equipment and systems – Part 6: Telecontrol protocols compatible with ISO standards and ITU-T recommendations – Section 503: TASE.2 Services and protocol*

IEC 60870-6-601:1994, *Telecontrol equipment and systems – Part 6: Telecontrol protocols compatible with ISO standards and ITU-T recommendations – Section 601: Functional profile for providing the connection-oriented transport service in an end system connected via permanent access to a packet switched data network*

IEC 60870-6-701:1998, *Telecontrol equipment and systems – Part 6-701: Telecontrol protocols compatible with ISO standards and ITU-T recommendations – Functional profile for providing the TASE.1 application service in end systems*

IEC 60870-6-702:1998, *Telecontrol equipment and systems – Part 6-702: Telecontrol protocols compatible with ISO standards and ITU-T recommendations – Functional profile for providing the TASE.2 application service in end systems*

IEC 60870-6-802:1997, *Telecontrol equipment and systems – Part 6: Telecontrol protocols compatible with ISO standards and ITU-T recommendations – Section 802: TASE.2 Object models*

2.2.1 Transport profiles

2.2.1.1 TA-profiles: CO transport over CL network services (CLNP)

ISO/IEC ISP 10608-1:1992, *Information technology – International Standardized Profile TAnnnn – Connection-mode Transport Service over Connectionless-mode Network Service – Part 1: General overview and subnetwork-independent requirements*

ISO/IEC ISP 10608-2:1992, *Information technology – International Standardized Profile TAnnnn – Connection-mode Transport Service over Connectionless-mode Network Service – Part 2: TA51 profile including subnetwork-dependent requirements for CSMA/CD Local Area Networks*

ISO/IEC ISP 10608-4:1994, *Information technology – International Standardized Profile TAnnnn – Connection-mode Transport Service over Connectionless-mode* Network Service – *Part 4: Definition of profile TA53, operation over a Token Ring LAN subnetwork*

ISO/IEC ISP 10608-5:1992, *Information technology – International Standardized Profile TAnnnn – Connection-mode Transport Service over Connectionless-mode Network Service – Part 5: TA1111/TA1121 profiles including subnetwork-dependent requirements for X.25 packet-switched data networks using virtual calls*

ISO/IEC ISP 10608-6:1995, *Information technology – International Standardized Profile TAnnnn – Connection-mode Transport Service over Connectionless-mode Network Service – Part 6: Definition of profile TA54, operation over an FDDI LAN subnetwork*

ISO/IEC ISP 10608-12:1996, *Information technology – International Standardized Profile TAnnnn – Connection-mode Transport Service over Connectionless-mode Network Service – Part 12: MAC sublayer and physical layer dependent requirements for a CSMA/CD LAN subnetwork*

ISO/IEC ISP 10608-13:1994, *Information technology – International Standardized Profile TAnnnn – Connection-mode Transport Service over Connectionless-mode Network Service – Part 13: MAC sublayer and physical layer dependent requirements for a token ring LAN subnetwork*

ISO/IEC ISP 10608-14:1995, *Information technology – International Standardized Profile TAnnnn – Connection-mode Transport Service over Connectionless-mode Network Service – Part 14: MAC, PHY and PMD sublayer dependent and Station management requirements over an FDDI LAN subnetwork*

2.2.1.2 TB/C/D/E-profiles: CO transport over CO network services (ITU X.25)

ISO/IEC ISP 10609-1:1992, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 1: Subnetwork-type independent requirements for Group TB*

ISO/IEC ISP 10609-5:1992, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 5: Definition of profiles TB1111/TB1121 [virtual call]*

ISO/IEC ISP 10609-9:1992, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 9: Subnetwork-type dependent requirements for Network Layer, Data Link Layer and Physical Layer concerning permanent access to a packet switched data network using virtual calls*

ISO/IEC ISP 10609-10:1994, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 10: LAN subnetwork-dependent, media independent requirements*

ISO/IEC ISP 10609-11:1994, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 11: CSMA/CD subnetwork-dependent media-dependent requirements*

ISO/IEC ISP 10609-12:1994, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 12: Definition of profile TC51, provision of the OSI connection-mode Transport Service using the OSI connection-mode Network Service in an End System attached to a CSMA/CD LAN*

ISO/IEC ISP 10609-14:1994, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 14: Definition of profile TC53, provision of the OSI connection-mode Transport Service using the OSI connection-mode Network Service in an End System attached to a token ring LAN*

ISO/IEC ISP 10609-15:1996, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 15: Definition of profile TC54, provision of the OSI connection-mode Transport Service using the OSI connection-mode Network Service in an End System attached to an FDDI LAN*

ISO/IEC ISP 10609-20:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 20: Overview of the generalized multi-part ISP structure for TC and TD group profiles for OSI usage of ISDN*

ISO/IEC ISP 10609-21:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 21: Subnetwork-type dependent requirements for network layer and data link layer for ISDN B-channel X.25 DTE to DTE operation*

ISO/IEC ISP 10609-22:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 22: Subnetwork type dependent requirements for network layer and data link layer for ISDN B-channel X.25 DTE to DCE operation*

ISO/IEC ISP 10609-23:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 23: Subnetwork-type dependent requirements for network layer and data link layer for data transfer concerning a packet switched mode integrated services digital network using virtual calls: B-channel access case*

ISO/IEC ISP 10609-24:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 24: Subnetwork-type dependent requirements for network layer and data link layer for data transfer concerning a packet switched mode integrated services digital network using virtual calls: D-channel access case*

ISO/IEC ISP 10609-25:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 25: Subnetwork-type dependent requirements for Q.931 circuit-switched operation*

ISO/IEC ISP 10609-26:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 26: Subnetwork-type dependent requirements for network layer for a call control procedures concerning the outgoing call of a packet switched mode Integrated services digital network in case b using virtual calls*

ISO/IEC ISP 10609-27:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 27: Subnetwork-type dependent requirements for network layer for a call control procedures concerning the incoming call of a packet switched mode Integrated services digital network in case b using virtual calls*

ISO/IEC ISP 10609-28:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 28: Subnetwork-type dependent requirements for data link layer for end systems attached to an ISDN subnetwork*

ISO/IEC ISP 10609-30:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 30: Definition of profile TC1131*

ISO/IEC ISP 10609-31:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 31: Definition of profile TC1231*

ISO/IEC ISP 10609-32:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 32: Definition of profile TC4111*

ISO/IEC ISP 10609-33:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 33: Definition of profile TC4211*

ISO/IEC ISP 10609-34:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 34: Definition of profile TC43111*

ISO/IEC ISP 10609-35:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 35: Definition of profile TC43112*

ISO/IEC ISP 10609-36:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 36: Definition of profile TC43211*

ISO/IEC ISP 10609-37:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 37: Definition of profile TC43212*

ISO/IEC ISP 10609-38:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 38: Definition of profile TC4331*

ISO/IEC ISP 10609-40:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 40: Definition of profile TD1131*

ISO/IEC ISP 10609-41:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 41: Definition of profile TD1231*

ISO/IEC ISP 10609-42:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 42: Definition of profile TD4111*

ISO/IEC ISP 10609-43:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 43: Definition of profile TD4211*

ISO/IEC ISP 10609-44:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 44: Definition of profile TD43111*

ISO/IEC ISP 10609-45:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 45: Definition of profile TD43112*

ISO/IEC ISP 10609-46:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 46: Definition of profile TD43211*

ISO/IEC ISP 10609-47:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 47: Definition of profile TD43212*

ISO/IEC ISP 10609-48:1995, *Information technology – International Standardized Profiles TB, TC, TD and TE – Connection-mode Transport Service over connection-mode Network Service – Part 48: Definition of profile TD4331*

3 Abbreviations

ATM: Asynchronous transfer mode
CL: Connectionless-mode
CLNS: Connectionless-mode network service
CLNP: Connectionless-mode network protocol
CO: Connection-mode
CONS: Connection-mode network service
COTS: Connection-mode transport service
CSMA/CD: Carrier sense, multiple access/collision detection
DCE: Data communication equipment
DTE: Data terminal equipment
ES: End system
FDDI: Fibre distributed data interface
ISDN: Integrated services digital network
IS: Intermediate system
ISP: International standardized profile
LAN: Local area network
NDPU: Network data protocol unit
PICS: Protocol implementation conformance statement
R-Profile: Relay profile
T-Profile: Transport profile (providing connection-mode transport service)
TASE: Telecontrol application service element
TCA: Telecontrol communication architecture

4 TASE telecontrol communication architecture

In this chapter, the TASE telecontrol communication architecture is described briefly to show that the transport profiles are part of the overall architecture.

4.1 Architectural model

The TASE communication architecture is based on international standards of the IEC 60870-6 series and is illustrated in the tables below to give an overview.

The architecture specification within TCA shown in the table below provides wide area subnetwork alternatives and a variety of network services. The combination of these protocols allows the architecture to provide a peer-to-peer communications infrastructure for distributed computing throughout a utility and between control centres of utilities.

Table 1 – Architecture specification within TCA

Layer	CO TASE.1 architecture IEC 60870-6	CO TASE.2 architecture IEC 60870-6
Application	IEC 60870-6-501/502 TASE.1 ISO 9072-1/2 ROSE ISO 8650 ACSE …	IEC 60870-6-503/802 TASE.2 ISO 9506 MMS ISO 8650 ACSE …
Presentation	ISO 8823/8825 BER	
Session	ISO 8327	
Transport	ISO 8072/8073 class 4, 2, 0 or RFC 1006/TCP (with IP)	
Network	ISO 8348 Add.1/8473 CLNP or ITU-T X.25 PLP ISO 8208 or Frame Relay or RFC 791 IP	
Data Link	ISO 8802.2 LLC1 or ISO 7776 LAPB or LLC2/ISDN	
	ISO 8802.X MAC or ISO 9314 FDDI MAC	
Physical	media, X.21, X.21bis, …	

4.2 Subnetwork access

Within OSI, end systems have access to subnetworks consisting of a single subnetwork (LAN) or multiple subnetworks. In the case of different subnetworks, interworking of end systems means end-to-end operation across a single subnetwork, or across multiple subnetworks linked by means of network (or lower) layer relays.

For TCA three types of WAN subnetwork access of end systems (ES) are identified:

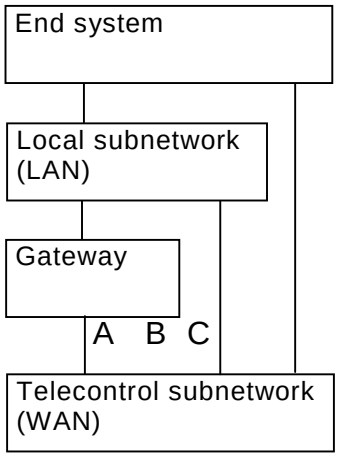

Figure 1 – WAN subnetwork access of end systems

4.2.1 Access type A

This type is used for end systems with 3-layer architecture which can communicate over one subnetwork (LAN), but because of a missing network layer it needs a gateway to access the WAN subnetwork (router network). An example of this is simple substation field devices on a substation bus which communicate with the control center over a substation host with routing capability.

4.2.2 Access type B

This type is used for end systems with 7-layer architecture which can communicate over multiple subnetworks using the network layer. Examples of this are TASE end systems in control centres, substations, power plants and 7-layer field devices in substations which communicate over the stations bus directly with the control center.

4.2.3 Access type C

This type is used for end systems with 7-layer architecture which can communicate over multiple subnetworks and interconnect directly to the WAN subnetwork. Examples are RTUs and single TASE end systems connected directly to the WAN router.

4.2.4 Multiprotocol access

Note that with today's multiprotocol routers, it is possible for an end system for all three access types to interconnect with a WAN subnetwork of *any* type (ISO 8473 CLNP, ITU-T X.25/ISO 8208, frame relay, IP, ISDN, ...) with only *one* network access protocol, the router working as a relay. This solution allows to move the burden of relaying from the end system to the router.

5 Transport profiles

5.1 Introduction

The TASE architecture specifies the use of existing protocols with particular sets of parameters and options called "profiles" and which apply to a reference point where the reference end system is interconnected to one subnetwork or multiple subnetwork. In the most simple case, this can be a leased line.

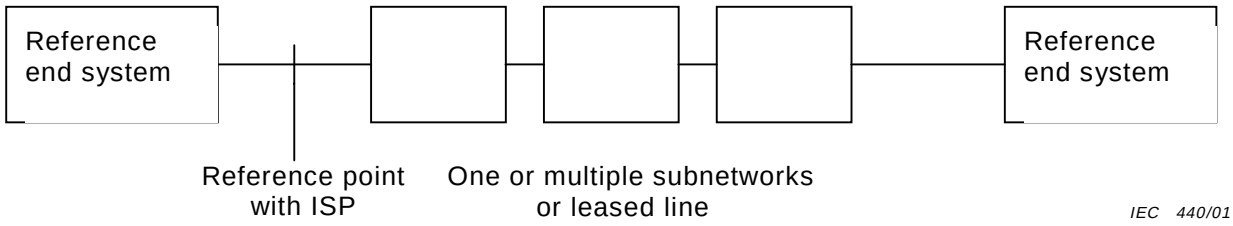

Figure 2 – Scenario description of a reference point

The architecture is described in terms of three kinds of these profiles: F-profiles (application formats), A-profiles spanning the upper three layers (application, presentation and session); T-profiles, the middle two layers (transport and network); and L-profiles, the lower two layers (data Link and physical).

Profiles of protocol stacks follow the structure defined in

ISO/IEC/TR 10000-1,

ISO/IEC/TR 10000-2 and

ISO/IEC/TR 10000-3.

In order to decouple representation of information or objects from communication protocols, and application-related protocol from subnetwork types, OSI and OSI-related profiles are divided into the following classes:

T-transport profiles providing connection-mode transport service;

U-transport profiles providing connectionless-mode transport services;

R-relay profiles;

A-application profiles requiring connection-mode transport services;

B-application profiles requiring connectionless-mode transport profiles;

F-interchange format and representation profiles.

Transport profiles of class T and U specify how the two modes of OSI transport service are provided over the two modes of OSI network service, and over specific subnetwork types, such as individual types of LANs, PSDNs, etc. In this way, they isolate the A/B-profiles from the network technology.

R-profiles specify relay functions needed to enable systems using different T- or U-profiles to interwork. Relays between T- and U-profiles are not provided.

Profiles are identified by GXYabcd where G is the profile group (T, U, R, A, B, F), XY are letters indicating the subdivision of a group, and numbers abcd indicate a further subdivision.

The transport profiles are specified in multi-part ISPs. One part, series TX, specifies the subnetwork-type independent requirements for group profiles, another the subnetwork-type dependent profile abcd, and finally one part subnetwork-type dependent requirements for OSI layer 1 to 3 including the physical interface.

International Standardized Profiles are published as ISO/IEC ISPs. The document ISO/IEC JTC 1/SGF N 100 accompanies the TR ISO/IEC TR 10000 series and serves as a dictionary of ISPs and profiles.

Within the concept of taxonomy of profiles, T- or U-sets build groups that are compatible in the sense that a system implementing one profile from the group and another system implementing a profile from the same group can be expected to interwork, according to OSI, to some minimal level which is determined by the mandatory features of the profiles in the group.

In this specification over WAN, only CO A- and T-profiles are used. The network services can be CO or CL. This simplifies the architecture and number of combinations considerably. Note that the current standardization of the IEC utility substation bus may also include CL B- and U-profiles in cases in which the station bus is directly interconnected to the control center over a router network.

The transport profiles of the TCA use OSI TP4 over a variety of connection-mode network services (ISO 8348/ISO 8206 (ITU X.25 PLP), frame relay) and connectionless-mode network services (ISO 8348/ISO 8473) and protocols and OSI TP0 over TCP/IP with RFC 1006. Note that the functionality of the last solution despite TP0 is equivalent to TP4.

Although the use of transport classes TP2 and TP0 are not excluded, TP4 should be preferred for data integrity reasons. HDLC and LAPB in layer 2 have well-known integrity deficits and with the use of TP4 the overall integrity conforms with integrity class I2 (see IEC 60870-1-4 and IEC 60870-5-1) for bit error rates higher than 10^{-6}.

For L-profiles there are no restrictions including ATM over adaptation layers. For LAN, ISO 8802-2 LLC1 should be used.

Throughout this specification, a uniform tabular presentation of profiles will be used as follows:

Table 2 – Tabular presentation of profiles

T-profile	Profile group 1	Profile group n
Transport layer	Standard	Standard
Network layer	Standard	Standard
Data link layer	Standard	Standard
Physical layer	Standard	Standard

R-profile	Profile group 1	Profile group n
Relay	Standard	Standard

5.2 T-profiles

Within the OSI taxonomy of transport profiles, group TA and TB profiles are used. For both TA and TB within the TCA, the transport classes 4, 2, and 0 have to be implemented. This provides full interworking between TA and TB profile groups. The identifier for the profile in the lower layers is of the form YXabcd where abcd is the structured numerical identifier indicating the subnetwork type supported in this profile.

The T-profiles use different types of subnetwork. Subnetwork types of interest for telecontrol are (numbers indicate subdivision indications abcd):

1 Packed switched data network (PSDN)
11 Permanent access to a PSDN
12 PSTN leased line
13 Digital data circuit/CSDN leased line
14 Switched access to a PSDN
15 PSTN case
16 CSDN case
17 ISDN B-channel case

2	Digital data circuit
3	Leased service
4	Dial-up service
2	Analogue telephone circuit
3	Leased service
4	Dial-up service
2	Integrated services digital network (ISDN)
4111	Semi-permanent service B-channel X.25 DTE to DTE operation
4211	Circuit-mode service B-channel X.25 DTE to DTE operation
41	Packet-mode service
42	D-channel access
43	B-channel semi-permanent access
2	Local area networks
3	CSMA/CD
4	Token bus
5	Token ring
6	FDDI.

Fourth number, if any, indicates 1 for virtual call (VC) and 2 for permanent access (PVC).

5.2.1 Connection-mode T-profiles with CLNS

TA profiles are used with connection-mode transport services (CO-TS) over connection-less network services (CL-NS) requiring the use of the class 4 transport protocol as defined in ISO 8072.

Note that a system implementing group TA and claiming conformance to ISO 8073 also has to implement the mandatory transport classes for operation over CO-NS (see below) as required by ISO 8073. That means for both TA and TB in the TCA the transport classes 4, 2, and 0 have to be implemented.

5.2.1.1 TP4/CLNP

The TP4/CLNP profile consists of the following:

Table 3 – TP4/CLNP profile

T-profile	TA1111/TA1121 X.25 PLP	TA51 CSMA/CD	TA53 token ring	TA54 FDDI
Transport layer	ISO/IEC 8073 TP4			
Network layer	ISO/IEC 8473 CLNP			
Data link layer	ISO 7776 LAPB	ISO/IEC 8802-2 LLC type 1		
Data link layer MAC	–	ISO 8802-3	ISO 8802-5	ISO 9314
Physical layer	X.21, X.21bis	ISO 8802-3	ISO 8802-5	ISO 9314

This is the profile used in OSI environments for connectionless network services. This profile represents the most efficient T-profile both in terms of processing/memory and bandwidth and is most appropriate where such constraints are tight and there is a strong requirement for reliability.

The following ISPs are used:

ISO/IEC ISP 10608-1, ISO/IEC ISP 10608-2, ISO/IEC ISP 10608-4, ISO/IEC ISP 10608-5, ISO/IEC ISP 10608-6, ISO/IEC ISP 10608-12, ISO/IEC ISP 10608-13 and ISO/IEC ISP 10608-14.

5.2.1.2 RFC 1006

The RFC 1006 profile consists of the following:

Table 4 – RFC 1006 profile

T-profile	TA1111/TA1121* X.25 PLP	TA51* CSMA/CD	TA53* token ring	TA54* FDDI
Transport layer	RFC 1006 (ISO/IEC 8073 TP0 equivalent) TCP (RFC 793)			
Network layer	IP (RFC 791) version 5			
Data link layer	ISO 7776 LAPB	ISO/IEC 8802-2 LLC type 1		
Data link layer MAC	–	ISO 8802-3	ISO 8802-5	ISO 9314
Physical layer	X.21, X.21bis	ISO 8802-3	ISO 8802-5	ISO 9314
* An OSI T-profile with TCP/IP using the RFC 1006 convergence layer.				

This profile is utilized in environments operating an OSI upper layer over TCP/IP. RFC 1006 provides the conversion from the stream semantics of TCP to the record semantics of TP4. This profile will generate more header overhead than the TP4/CLNP profile and will also require more memory and/or processing.

RFC 1006 specifies the use of TCP port 102 (decimal). This is considered the default port within the scope of this specification. Other port assignments are allowed but must be declared in an implementation's PICS. Additional information may be found within RFC 1006.

The OSI regional workshops (NIST OIW, EWOS, and AOW) have recommended that RFC 1006 be the preferred mechanism for utilizing OSI A-profiles over TCP/IP T-profiles. However, the RFC 1006 does not mandate the use of the TCP-KEEPALIVE function.

In order to allow maximum reliability to be achieved, implementations shall be able to configure the use of the TCP-KEEPALIVE function and the interval at which the function shall be used. Implementations that have no access to the use of the TCP-KEEPALIVE shall convey this via the PICS (protocol implementation conformance statement).

RFC 1070

The RFC 1070 profile consists of the following:

Table 5 – RFC 1070 profile

T-profile	TA51* CSMA/CD	TA53* token ring	TA54* FDDI
Transport layer	ISO/IEC 8073 TP4 RFC 1070 UDP (RFC 768)/IP (RFC 791) version 5		
Network layer	ISO/IEC 8473 CLNP		
Data link layer	ISO/IEC 8802-2 LLC type 1		
Data link layer MAC	ISO 8802-3	ISO 8802-5	ISO 9314
Physical layer	ISO 8802-3	ISO 8802-5	ISO 9314
* OSI TA-profiles with UDP/IP using the RFC 1070 convergence layer.			

This profile is used in environments that need to operate an OSI A- and T-profile over an IP network. This might occur in a mixed environment that was partially full OSI (in the subnets where there were tight performance constraints) and partially IP (in the subnets where there were no such constraints). In a pure OSI or IP subnetwork this alternative is not recommended. In a homogeneous IP environment the RFC 1006 profile should be preferred.

RFC 1070 specifies the use of UDP port 147 (decimal). This is considered the default port within the scope of this specification. Other port assignments are allowed but must be declared.

5.2.2 Connection-mode T-profiles with CONS

TB profiles are used with connection-mode transport services (CO-TS) over connection-less network services (CL-NS) requiring the use of the classes 4, 2 and 0 transport protocol as defined in ISO 8072.

5.2.2.1 TP4/ ITU-T X.25 PLP

The TP4/ ITU X.25 PLP profile consists of the following:

Table 6 – TP4/ ITU X.25 PLP profile

T-profile	TB1111/TB1121* X.25 PLP
Transport layer	ISO/IEC 8073
Network layer	ISO/IEC 8208
Data link layer	ISO 7776 LAPB
Data link layer MAC	–
Physical layer	X.21, X.21bis
* See TASE TB-profile IEC 60870-6-601.	

This is the profile used in OSI environments for connection oriented network services. This profile defines the permanent access of an end system to an X.25 packet switching network but no LAN interface.

The following ISPs are used:

ISO/IEC ISP 10609-1, ISO/IEC ISP 10609-5,

ISO/IEC ISP 10609-9, ISO/IEC ISP 10609-10, ISO/IEC ISP 10609-11 and ISO/IEC ISP 10609-12.

TB51 is used if the LAN has WAN access.

ISO/IEC ISP 10609-14.

TB53 is used if the LAN has WAN access.

ISO/IEC ISP 10609-15.

TB54 is used if the LAN has WAN access.

ISO/IEC ISP 10609-20, ISO/IEC ISP 10609-21, ISO/IEC ISP 10609-22, ISO/IEC ISP 10609-23, ISO/IEC ISP 10609-24, ISO/IEC ISP 10609-25, ISO/IEC ISP 10609-26, ISO/IEC ISP 10609-27 and ISO/IEC ISP 10609-28. ISO/IEC ISP 10609-30 to ISO/IEC ISP 10609-48 inclusive.

In all cases TBabcd is used.

With TASE.2 the profile IEC 60870-6-601 is based on ISO/IEC ISP 10609-5, with profile TB1111/TB1121 for analog and digital access to an ITU-T X.25 packet switching network respectively and on ISO/IEC ISP 10609-9 for the network layer, data link layer (LAPB) and the physical layer (ITU-T X.21 or ITU-T X.21bis). For LAN access see the ISP above.

5.2.2.2 TP4/ frame relay

Frame relay standardized by ANSI and ITU-T is used over digital transmission networks with low bit error rate. The TP4/frame relay profile consists of the following:

Table 7 – TP4/frame relay profile

T-profile	TB1111/TB1121* frame relay	TB51* CSMA/CD	TB53* token ring	TB54* FDDI
Transport layer	ISO/IEC 8073 TP4 ITU I.122, I.3XX, Q.921, Q.931			
Network layer				
Data link layer	ITU Q.922 LAPD	ISO/IEC 8802-2 LLC type 1		
Data link layer MAC	–	ISO 8802-3	ISO 8802-5	ISO 9314
Physical layer	X.21, X.21bis	ISO 8802-3	ISO 8802-5	ISO 9314
* OSI-like TB-profiles with frame relay				

This is the profile used in OSI environments for connection oriented network services.

5.2.3 Routing protocol profiles

The routing protocols use a distributed adaptive approach to route NPDUs through the subnets. Routing becomes more efficient with subnetting of network addresses.

5.2.3.1 IS-IS routing

IS-IS routing takes place in one routing domain (intradomain routing) or between routing domains (interdomain routing). In general, the use of IS-IS (ISO 10589) for intradomain routing and IDRP (ISO 10747) for interdomain routing is recommended for both CLNP and IP. In pure IP networks, OSPF (RFC 1247) for interdomain routing and BGP4 for interdomain routing may be used as an alternative.

Note that both ES-ES and OSPF support service dependent routing (priority information is routed over specified links) using the service type field of CLNP and IP which may be of interest for telecontrol.

Both IS-IS and OSPF support automatic and quick adoption to changed topologies, two-level hierarchical networks and scale well.

5.2.3.2 ES-IS routing

ES-IS routing takes place in one subnet (LAN). With TCP/IP, RIP-II or a simple default gateway is recommended. With CLNP, the ES-IS routing protocol ISO 9542 is used for CLNS. ISO 10030 is used in conjunction with ISO 8878 (ITU-T X.25 PLP) CONS.

5.2.4 Summary of T-profile protocols

5.2.4.1 Network layer

Name: **Connectionless network service (CLNS)**

Description: The connectionless network service performs network routing and relaying on a packet by packet basis without establishing a network connection.

References: The network layer service is the CLNS as defined by the network service definition [ISO-10]. The CLNS shall be used in end systems and intermediate systems within a utility for interworking between systems connected via a variety of local and wide area subnetworks. The protocol to provide the CLNS is ISO 8473 [ISO-11].

ISO 8473 shall be implemented over HDLC LAPB [ISO-2] point-to-point links, logical link control type 1 [ISO-3] local area networks, or X.25 1984 [ISO-12] subnetworks. In the case where 1984 X.25 equipment and services are not available, X.25 1980 [ITU-T-5] subnetwork may be used. Implementations shall follow the guidelines given in ISO 8473 for the subnetwork dependent convergence functions.

Implementation of 8473 over an ISDN subnetwork shall be provided in conjunction with the X.25 packet layer protocol (PLP) [ISO-12] as specified in the relevant sections of ISO 9574 [ISO-13]. More specifically, the PLP shall act as the Subnetwork Access Protocol (SNAcP) of the network service, and coordination between the ISDN channel control and the network service must be as defined in ISO 9574.

Implementations shall conform to the specific implementation guidelines and agreements specified for the CLNS in 3.5 of the NIST OIW Stable Implementation Agreements [NIST-1].

Because there is more than one possible network protocol, and because these network protocols can be used in different capacities in providing the network service, it is necessary to provide a mechanism for protocol identification. Network layer protocol identification shall be performed as specified in ISO TR 9577 [ISO-14].

Implementations shall conform to the specific implementation guidelines and agreements specified for protocol identification in 3.9 of the NIST OIW Stable Implementation Agreements [NIST-1].

Notations: None

Name: **Ipv4**

Description: This protocol defined in RFC 791 provides the connectionless network protocol functionality for TCP/IP networks. IP is a precursor of CLNP and is characterized by a smaller address space.

Name: **Routing data exchange**

Description: The routing data exchange protocol performs the exchange of information necessary to support the network protocol routing function.

References: Exchange of routing data between end systems (ES) and intermediate systems (IS) on local area networks and point-to-point links shall be performed as defined by the ES to IS routing protocol [ISO-15].

Implementations shall conform to the specific implementation guidelines and agreements specified for ES to IS routing in 3.8.1 of the NIST OIW Stable Implementation Agreements [NIST-1].

Notations: In addition to the ES to IS protocol, the use of IS to IS routing protocol is recommended. This is the most widely used routing protocol in the Internet today and it is much easier to configure and maintain than any of the alternatives.

Name: **Connection-oriented network service (CONS)**

Description: The connection-oriented network service performs network routing and relaying on a connection-by-connection basis.

References: In addition to the primary network service – CLNS, the connection-oriented network service (CONS) as defined by the network service definition [ISO-16], may optionally be supported. The CONS is provided only for use in end systems directly connected to X.25 or ISDN networks, and only for interworking with non-utility systems which do not support the CLNS.

The protocol to provide the CONS shall be the X.25-1984 packet layer protocol (PLP) [ISO-12]. The mapping between the X.25 PLP services and the services defined by ISO 8348 CONS shall be as specified in ISO 8878 [ISO-17].

In the case where 1984 X.25 equipment and services are not available, the X.25 1980 standard [ITU-T-5] may be used to support the CONS across a 1980 X.25 subnetwork. For X.25 1980 the network address structure is defined by ITU-T X.121. Therefore, in such an implementation, the guidelines regarding network layer addressing do not apply.

Implementation of the CONS over an ISDN subnetwork shall be provided in conjunction with the X.25 packet layer protocol (PLP) [ISO-12] in the manner specified by ISO 9574 [ISO-13] to achieve coordination between the ISDN channel control and the CONS.

Implementations shall conform to the specific implementation guidelines and agreements specified for the CONS in 3.6, but excluding 3.6.1.3 concerning LANs, of the NIST OIW Stable Implementation Agreements [NIST-1].

Because there is more than one possible network protocol, and because these network protocols can be used in different capacities in providing the network service, it is necessary to provide a mechanism for protocol identification. Network layer protocol identification shall be performed as specified in ISO TR 9577 [ISO-14].

Implementations shall conform to the specific implementation guidelines and agreements specified for protocol identification in 3.9 of the NIST OIW Stable Implementation Agreements [NIST-1].

Notations: Currently, the 1988 version of the ISO PLP has not achieved International Standard status and there are no implementer agreements for it.

5.2.4.2 Transport layer

Name: **Transport protocol**

Description: The transport protocol provides end-to-end reliable data transfer.

References: The protocol to provide the transport service shall be ISO 8073 [ISO-19]. Class 4 operation of the protocol shall be used with respect to the specifications in both ISO 8073 and ISO 8073 – addendum 2 [ISO-20].

Implementations shall conform to the specific implementation guidelines and agreements specified for transport protocol classes 4 and 0 in 4.5.1 and 4.5.2 respectively of the NIST OIW Stable Implementation Agreements [NIST-1].

Notations: The support of class 0 is necessary for conformance to the application layer standard MHS (message handling system).

5.3 L-profiles

L-profiles consist of the data-Link and physical layers. These two layers are heavily media-dependent and therefore it is not unusual to find that a given data link protocol is strongly associated with a given physical medium, often uniquely identified. The issues that would drive a utility to choose a medium are for the most part beyond the scope of this specification. Most of the media would meet various criteria for bandwidth, delay, error rate, etc. of a subnetwork where a utility might deploy it for a given set of applications. Beyond these basic criteria, criteria such as range of applicability, cost, maintainability, etc. become much more dominant. Unless otherwise specified, any standard data link and physical layer technologies can be used with this architecture as long as they are capable of transferring network layer PDUs transparently.

For LAN, the support of ISO 8802-X with LLC1 is mandatory for SCADA/EMS environments.

5.3.1 Use of LLC1

The LLC service primitives are aligned with those defined in ISO 8802-2. In general, the primitives that shall be used are:

L_DATA.request/indication

L-profiles make use of the following LLC class 1 functions:

send data with no immediate acknowledgement. This class of service shall be used for the contention avoidance. It should be noted that this service does not guarantee delivery of link level packets, but is required for use for communication multicasting.

The parameters, required by ISO 8802, for L_DATA are:

a) local address – this address parameter contains the local media access control (MAC) address. It also contains the link service access point (LSAP) for the initiating node. The following hex LSAP addresses are used:

   OxFE OSI network layer,

   OxFF broadcast;

b) remote address – this address parameter contains the destination media access control (MAC) address. It also contains the link service access point (LSAP) for the destination node;

c) LSDU (link service data unit) – this parameter specifies the link service data unit to be transferred by the link layer entity;

d) quality – the quality parameter specifies the service class desired for the data unit transfer.

6 Relays

Relays provide the ES with the means to communicate over subnets of different types. In clause 2, the current relay ISPs are listed. The following table shows the different relays.

6.1 Relaying connectionless network services CLNP

Table 8 – Relaying connectionless network services

Relay type for CLNS	From subsystem	To subsystem
RA51.51	CSMA/CD	CSMA/CD
RA51.54	CSMA/CD	FDDI
RA51.1111	CSMA/CD	PSDN with virtual call over leased line
RA51.1121	CSMA/CD	PSDN with digital circuit CSDN over leased line
RA53.53	Token ring	Token ring
RA53.54	Token ring	FDDI
RA54.54	FDDI	FDDI
RA53.1111	Token ring	PSDN with virtual call over leased line
RA53.1121	Token ring	PSDN with digital circuit CSDN over leased line
RA54.1111	FDDI	PSDN with virtual call over leased line
RA54.1121	FDDI	PSDN with digital circuit CSDN over leased line

6.2 Relaying connection-mode network services ITU-T X.25

Table 9 – Connection-mode network services ITU-T X.25

Relay type for CONS	From subsystem	To subsystem
RB51.1111	CSMA/CD	PSDN with virtual call over leased line
RB51.1121	CSMA/CD	PSDN with digital circuit CSDN over leased line
RC51.1111	CSMA/CD	PSDN with virtual call over leased line
RC51.1121	CSMA/CD	PSDN with digital circuit CSDN over leased line
RD51.51	CSMA/CD	CSMA/CD
RD51.54	CSMA/CD	FDDI
RD54.54	FDDI	FDDI
RD51.53	CSMA/CD	Token ring
RD53.53	Token ring	Token ring
RA53.54	Token ring	FDDI

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ISO/IEC ISP 10612-4:1995, *Information technology – International Standardized Profile RD – Relaying the MAC service using transparent bridging – Part 4: Profile RD51.51 (CSMA/CD LAN – CSMA/CD LAN)*

ISO/IEC ISP 10612-5:1995, *Information technology – International Standardized Profile RD – Relaying the MAC service using transparent bridging – Part 5: Profile RD51.54 (CSMA/CD LAN – FDDI LAN)*

ISO/IEC ISP 10612-6:1995, *Information technology – International Standardized Profile RD – Relaying the MAC service using transparent bridging – Part 6: Profile RD54.54 (FDDI LAN – FDDI LAN)*

ISO/IEC ISP 10612-7:1995, *Information technology – International Standardized Profile RD – Relaying the MAC service using transparent bridging – Part 7: Profile RD51.53 (CSMA/CD LAN – Token Ring LAN)*

ISO/IEC ISP 10612-8:1995, *Information technology – International Standardized Profile RD – Relaying the MAC service using transparent bridging – Part 8: Profile RD53.53 (Token Ring LAN – Token Ring LAN)*

ISO/IEC ISP 10612-9:1995, *Information technology – International Standardized Profile RD – Relaying the MAC service using transparent bridging – Part 9: Profile RD53.54 (Token Ring LAN – FDDI LAN)*

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Standards Survey

The IEC would like to offer you the best quality standards possible. To make sure that we continue to meet your needs, your feedback is essential. Would you please take a minute to answer the questions overleaf and fax them to us at +41 22 919 03 00 or mail them to the address below. Thank you!

Customer Service Centre (CSC)

International Electrotechnical Commission
3, rue de Varembé
1211 Genève 20
Switzerland

or

Fax to: **IEC**/CSC at +41 22 919 03 00

Thank you for your contribution to the standards-making process.

Nicht frankieren
Ne pas affranchir

Non affrancare
No stamp required

A Prioritaire

RÉPONSE PAYÉE

SUISSE

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Q1 Please report on **ONE STANDARD** and **ONE STANDARD ONLY**. Enter the exact number of the standard: *(e.g. 60601-1-1)*

.....

Q2 Please tell us in what capacity(ies) you bought the standard *(tick all that apply).* I am the/a:

purchasing agent ❑
librarian ❑
researcher ❑
design engineer ❑
safety engineer ❑
testing engineer ❑
marketing specialist ❑
other.....

Q3 I work for/in/as a: *(tick all that apply)*

manufacturing ❑
consultant ❑
government ❑
test/certification facility ❑
public utility ❑
education ❑
military ❑
other.....

Q4 This standard will be used for: *(tick all that apply)*

general reference ❑
product research ❑
product design/development ❑
specifications ❑
tenders ❑
quality assessment ❑
certification ❑
technical documentation ❑
thesis ❑
manufacturing ❑
other.....

Q5 This standard meets my needs: *(tick one)*

not at all ❑
nearly ❑
fairly well ❑
exactly ❑

Q6 If you ticked NOT AT ALL in Question 5 the reason is: *(tick all that apply)*

standard is out of date ❑
standard is incomplete ❑
standard is too academic ❑
standard is too superficial ❑
title is misleading ❑
I made the wrong choice ❑
other .....

Q7 Please assess the standard in the following categories, using the numbers:
(1) unacceptable,
(2) below average,
(3) average,
(4) above average,
(5) exceptional,
(6) not applicable

timeliness.....
quality of writing.....
technical contents.....
logic of arrangement of contents .....
tables, charts, graphs, figures.....
other .....

Q8 I read/use the: *(tick one)*

French text only ❑
English text only ❑
both English and French texts ❑

Q9 Please share any comment on any aspect of the IEC that you would like us to know:

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