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Maritime navigation and radiocommunication equipment and systems –
Digital interfaces – Part 410: Multiple talkers and multiple listeners –
Ship systems interconnection –
Transport profile requirements and basic transport profile
(IEC 61162-410:2001); German version EN 61162-410:2002, Text in English

Matériels et systèmes de navigation et de radiocommunications maritimes –
Interfaces numériques – Partie 410: Émetteurs multiples et récepteurs multiples –
Interconnexion des systèmes embarqués –
Exigences de la couche transport et couche transport de base
(CEI 61162-410:2001); Version allemande EN 61162-410:2002, texte en anglais

Die Europäische Norm EN 61162-410:2002 hat den Status einer Deutschen Norm.

Beginn der Gültigkeit

Die EN 61162-410 wurde am 2002-02-01 angenommen.

Nationales Vorwort

Für die vorliegende Norm ist das nationale Arbeitsgremium K 738 „Elektronische Navigationsinstrumente“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE zuständig.

Das Präsidium des DIN hat mit Präsidialbeschluss 1/78 festgelegt, dass Deutsche Normen, deren Inhalt sich auf internationale Arbeitsergebnisse der IEC gründet, unter bestimmten Bedingungen allein in englischer Sprache veröffentlicht werden dürfen. Die Bedingungen sind für diese Norm erfüllt. Sie steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen. Es kann davon ausgegangen werden, dass die Anwender über hinreichende englische Sprachkenntnisse verfügen. Für viele der verwendeten Benennungen existieren keine gebräuchlichen deutschen Benennungen, da sich die deutschen Anwender im Bereich der Seeschifffahrt in der Regel ebenfalls der englischen Benennungen bedienen.

Norm-Inhalt für die Teile 400, 401, 410 und 420 der Reihe DIN EN 61162-4 war veröffentlicht als E DIN IEC 80/175/CD:1998-10 und E DIN IEC 80/176/CD:1998-10.

Die enthaltene IEC-Publikation wurde vom TC 80 „Maritime navigation and radiocommunication equipment and systems“ erarbeitet.

Die Reihe DIN EN 61162 besteht aus 4 Teilen, wobei der Teil 4 in mehrere Einzelnormen unterteilt ist. Eine zusammenfassende Beschreibung der Normen dieser Reihe und eine Übersicht über deren unterschiedliche Anwendbarkeit ist in Anhang B der Norm DIN EN 61162-400 enthalten.

Das IEC-Komitee hat entschieden, dass der Inhalt dieser Publikation bis Juni 2005 unverändert bleiben soll. Zu diesem Zeitpunkt wird entsprechend der Entscheidung des Komitees die Publikation

- bestätigt,
- zurückgezogen,
- durch eine Folgeausgabe ersetzt oder
- geändert.

Fortsetzung Seite 2
und 63 Seiten EN

DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE
Normenstelle Schiffs- und Meerestechnik (NSMT) im DIN Deutsches Institut für Normung e.V.

Nationaler Anhang NA (informativ)

Zusammenhang mit Europäischen und Internationalen Normen

Für den Fall einer undatierten Verweisung im normativen Text (Verweisung auf eine Norm ohne Angabe des Ausgabedatums und ohne Hinweis auf eine Abschnittsnummer, eine Tabelle, ein Bild usw.) bezieht sich die Verweisung auf die jeweils neueste gültige Ausgabe der in Bezug genommenen Norm.

Für den Fall einer datierten Verweisung im normativen Text bezieht sich die Verweisung immer auf die in Bezug genommene Ausgabe der Norm.

Der Zusammenhang der zitierten Normen mit den entsprechenden Deutschen Normen ergibt sich, soweit ein Zusammenhang besteht, grundsätzlich über die Nummer der entsprechenden IEC-Publikation. Beispiel: IEC 60068 ist als EN 60068 als Europäische Norm durch CENELEC übernommen und als DIN EN 60068 ins Deutsche Normenwerk aufgenommen.

IEC hat 1997 die Benummerung der IEC-Publikationen geändert. Zu den bisher verwendeten Normnummern wird jeweils 60000 addiert. So ist zum Beispiel aus IEC 68 nun IEC 60068 geworden.

Navigations- und Funkkommunikationsgeräte und -systeme für die
Seeschifffahrt – Digitale Schnittstellen –
Teil 410: Mehrere Datensender und mehrere Datenempfänger –
Schiffssystemzusammenschaltung –
Anforderungen an Transportprofile und Basistransportprofil
(IEC 61162-410:2001)

Maritime navigation and radiocommunication
equipment and systems – Digital interfaces –
Part 410: Multiple talkers and multiple listeners –
Ship systems interconnection – Transport profile
requirements and basic transport profile
(IEC 61162-410:2001)

Matériels et systèmes de navigation et de
radiocommunications maritimes –
Interfaces numériques –
Partie 410: Emetteurs multiples et récepteurs
multiples – Interconnexion des systèmes
embarqués – Exigences de la couche transport
et couche transport de base
(CEI 61162-410:2001)

Diese Europäische Norm wurde von CENELEC am 2002-02-01 angenommen. Die CENELEC-Mitglieder sind gehalten, die CEN/CENELEC-Geschäftsordnung zu erfüllen, in der die Bedingungen festgelegt sind, unter denen dieser Europäischen Norm ohne jede Änderung der Status einer nationalen Norm zu geben ist.

Auf dem letzten Stand befindliche Listen dieser nationalen Normen mit ihren bibliographischen Angaben sind beim Zentralsekretariat oder bei jedem CENELEC-Mitglied auf Anfrage erhältlich.

Diese Europäische Norm besteht in drei offiziellen Fassungen (Deutsch, Englisch, Französisch). Eine Fassung in einer anderen Sprache, die von einem CENELEC-Mitglied in eigener Verantwortung durch Übersetzung in seine Landessprache gemacht und dem Zentralsekretariat mitgeteilt worden ist, hat den gleichen Status wie die offiziellen Fassungen.

CENELEC-Mitglieder sind die nationalen elektrotechnischen Komitees von Belgien, Dänemark, Deutschland, Finnland, Frankreich, Griechenland, Irland, Island, Italien, Luxemburg, Malta, Niederlande, Norwegen, Österreich, Portugal, Schweden, Schweiz, Spanien, der Tschechischen Republik und dem Vereinigten Königreich.

CENELEC

Europäisches Komitee für Elektrotechnische Normung
European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique

Zentralsekretariat: rue de Stassart 35, B-1050 Brüssel

Vorwort

Der Text des Schriftstücks 80/311/FDIS, zukünftige 1. Ausgabe von IEC 61162-410, ausgearbeitet von dem IEC TC 80 „Maritime navigation and radiocommunication equipment and systems“, wurde der IEC-CENELEC Parallelen Abstimmung unterworfen und von CENELEC am 2002-02-01 als EN 61162-410 angenommen.

Nachstehende Daten wurden festgelegt:

- spätestes Datum, zu dem die EN auf nationaler Ebene durch Veröffentlichung einer identischen nationalen Norm oder durch Anerkennung übernommen werden muss (dop): 2002-11-01
- spätestes Datum, zu dem nationale Normen, die der EN entgegenstehen, zurückgezogen werden müssen (dow): 2005-02-01

Anhänge, die als „normativ“ bezeichnet sind, gehören zum Norminhalt.

Anhänge, die als „informativ“ bezeichnet sind, enthalten nur Informationen.

In dieser Norm ist Anhang ZA normativ und die Anhänge A, B, C und D sind informativ.

Der Anhang ZA wurde von CENELEC hinzugefügt.

Anerkennungsnotiz

Der Text der Internationalen Norm IEC 61162-410:2001 wurde von CENELEC ohne irgendeine Abänderung als Europäische Norm angenommen.

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INTRODUCTION

International Standard IEC 61162 is a four-part standard which specifies four digital interfaces for applications in marine navigation, radiocommunication and system integration.

The four parts are:

- IEC 61162-1 Single talker and multiple listeners
- IEC 61162-2 Single talker and multiple listeners, high speed transmission
- IEC 61162-3 Multiple talkers and multiple listeners – Serial data instrument network
- IEC 61162-4 Multiple talkers and multiple listeners – Ship systems interconnection.

Part 4 of the standard is subdivided into a number of individual standards with part numbers in the 400 series.

This part of the standard contains the specification of the requirements to an IEC 61162-4 transport profile (T-profile) and also the specification of one implementation, based on redundant Ethernet and Internet protocol functionality. The T-profile is the protocol transport mechanisms that offer simple message or byte stream transport services to the higher protocol layers (defined in other parts of the standard). In addition, the T-profile also offers services for time distribution and physical network management.

The use of Internet and Ethernet protocols offer low cost and high efficiency data transport in any kind of system. However, for safety related applications, certain measures have to be taken to avoid that particulars of office-quality and off-the-shelf technology create safety risks. This part of the standard specifies mechanisms by which a certain degree of quality of service can be guaranteed from these networks, including the provision of redundancy.

Other T-profile documents will be prepared with specifications of the same T-profile requirements over other transport protocols. This will be issued in the same number series as this standard (IEC 61162-41x).

Relationship with the other parts of the IEC 61162 series of standards is defined in annex B to IEC 61162-400.

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – DIGITAL INTERFACES –

Part 410: Multiple talkers and multiple listeners – Ship systems interconnection – Transport profile requirements and basic transport profile

1 Scope and object

This part of IEC 61162-4 defines the general requirements of the T-profile and three implementations of the T-profile over the Internet V4 (IPV4) protocol suite. Part 400 of this standard defines the relationship between the different protocol levels (T-profile, A-profile and companion standards) and part 401 defines the A-profile, the immediate user of the protocol level defined in this part.

The different components of the IEC 61162-4 standard are defined in IEC 61162-400. The T-profile is the specification of the communication services and the communication protocols used by the LNA to implement the A-profile functionality. Basically, the T-profile consists of the following components:

- a) a transport layer interface (TLI) definition that specifies the services and the semantics that will be available to the application level of the LNA (and in some cases the MAU). This includes data transport as well as time and network management services. The TLI will be general to all T-profiles and is defined in this part 410 of the standard,
- b) A T-profile protocol definition that specifies how the services provided by the TLI and additional time distribution and physical network management services are implemented on the protocol level. This part 410 contains a number of alternative T-profile protocol specifications using the Internet V4 series of standards. Additional parts of this standard will address other T-profiles based on other protocol families.

Note that the time distribution and network management functionality may or may not include specific TLI services. For some systems this functionality may be interfaced to directly by the underlying operating system. Note also that time distribution and network management are not strictly speaking transport related protocol functionality. However, the implementation of these services is normally dependent on the transport protocols in use and is, thus, placed in the T-profile part of the standard.

The purpose of this standard is to define and describe the services that will be provided at the transport level interface in a way which is completely independent of the underlying network environment as well as defining one possible implementation of these services over the Internet V4 protocols. The separation of service and protocol definitions allows the specification of several different transport profiles, each one dedicated to a specific network environment, and to use the same transport service interface in all cases.

Clause 4 defines the transport level services and clause 5 describes the transport layer interface through which the services are offered. These clauses define the general, network independent services.

Clause 6 defines the transport profile architecture for redundant Ethernet and Internet protocols version 4 (IPV4). Clause 7 defines the architecture for a local area non-redundant Internet network. These clauses define two specific implementations of the T-profile services.

Clause 8 defines a simple MAU-LNA protocol for use over wide area network (WAN) TCP/IP links. This can be used to implement a WAN architecture for the overall system. The WAN architecture is not intended for integrated ship control systems, but can be used for remote test integration and remote maintenance and diagnostics. The WAN protocol can also be used to support MAUs that are located in other host computers than the LNA, but on one local network (conformance class 4).

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61162. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 61162 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.

IEC 61162-400, *Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 400: Multiple talkers and multiple listeners – Ship systems interconnection – Introduction and general principles*

ISO 8802-3, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

ISO/IEC 9595: *Information technology – Open Systems Interconnection – Common management information service*

ISO/IEC 9596-1: *Information technology – Open Systems Interconnection – Common management information protocol – Part 1: Specification*

RFC 768:1980, *User Datagram Protocol (UDP)*, Internet Activities Board recommended standard

RFC 793:1981, *Transmission Control Protocol (TCP)*, Internet Activities Board recommended standard

RFC 826:1982, *Address Resolution Protocol (ARP)*, Internet Activities Board elective standard

RFC 894:1984, *Internet Protocol on Ethernet Networks*, Internet Activities Board elective standard

RFC 1157:1990, *Simple Network Management Protocol (SNMP)*

RFC 1189:1990, *Common Management Information Services and Protocols for the Internet (CMOT and CMIP)*

RFC 1213:1991, *Management Information Base for Network Management of TCP/IP-based Internets: MIB-II*

RFC 1305:1992, *Network Time Protocol, Version 3 – Specification and Implementation*

RFC 2030:1996, *Simple Network Time Protocol (SNTP), Version 4 for IPv4, IPv6 and OSI*

RFC 2500:1999, *Internet Official Protocol Standards – Internet Activities Board standard*

NOTE RFC (request for comments) is a document, issued by the Internet engineering task force (IETF) the International standardization body for the Internet, that describes a part of the Internet protocol. Some RFCs are accepted as official Internet standards and listed in the "Internet Official Protocol Standards" itself an RFC.

3 Definitions

For the purpose of this part of IEC 61162, the definitions in IEC 61162-400 and the following definitions apply:

3.1

broadcast

see multicast

3.2

CL – connectionless

a connectionless communication means that sender and receiver do not have to know each other. There is no association established between sender(s) and receiver(s) before messages are sent (see also peer-to-peer and client-server)

3.3

client-server

a client-server communication link is established by the client after a server has allowed the connection attempt by the establishment of a listening connection point. The client is the active part while the server allows the connection (see also connectionless and peer-to-peer)

3.4

CMIP – common management information protocol

see ISO/IEC 9595 and ISO/IEC 9596-1

3.5

CMIS – common management information services

see ISO/IEC 9595 and ISO/IEC 9596-1

3.6

CMOT – CMIS/CMIP over TCP/IP

an Internet proposed standard protocol. Its status is elective (see RFC 1189)

3.7

CO – connection-oriented

the opposite of CL (connectionless). A data exchange where an association between sender and receiver exists

3.8

connection point

an entity that can represent a communication link end point (for established connections) or a connection attempt between two host computers in some state. It is also used for connectionless communication, but in this case it represents just the local host computer's port to the network

3.9

Ethernet

refers to a carrier sense multiple access collision detect (CSMA/CD) local area network protocol standard as defined in ISO/IEC 8802-3. The medium access control (MAC) frame format shall use the Internet protocol type (0800) in the length/protocol field (see RFC 894).

Any type of Ethernet can be used in systems compliant with this standard as long as they fulfil relevant technical requirements and the system integrator ensures compatibility between the integrated components. The most relevant technologies are:

- 10Base-5 – thick coaxial, shared media bus – can be used in environments that require noise immunity;
- 10Base-2 – thin (RG58) coaxial, shared media bus – can be used in environments with low noise immunity requirements;
- 10Base-T – shielded or unshielded twisted pair – used in conjunction with a repeating or switching hub;
- 10Base-F – fibre optic media, as above, but for very high noise immunity applications;
- 100Base-TX – shielded or unshielded twisted pair, as above. Note that this medium requires special precautions to extend network lengths beyond 200 m;
- 100Base-FX – fibre optic, as previous, but for very high noise immunity.

The recommended solution is the use of non-duplex switching hubs with 10 and/or 100 megabit links to the host computers.

The system integrator must make sure that the relevant physical characteristics of the selected network solution satisfies the requirements defined in ISO/IEC 8802-3 and other applicable standards

3.10

ICMP – Internet control message protocol

an integral part of the Internet protocols (see 3.12)

3.11

IGMP – Internet group management protocol

a protocol used between hosts and multicast routers on a single physical network to establish hosts' membership in particular multicast groups. Multicast routers use this information, in conjunction with a multicast routing protocol, to support IP multicast forwarding across the Internet. The IGMP standard is part of the Internet RFC system, but is currently not used in this standard

3.12

IP – Internet protocol.

refers to RFC 2500. All required parts as defined by that document shall be implemented in an Internet compliant protocol stack. It is also required that the system in question implements the ARP (see RFC 826) address resolution protocol. Optionally, other address resolution schemes can be used at the discretion of the system integrator.

RFC 2500 will give additional information as to which additional standards apply to conforming implementations of the Internet protocol.

RFC 1918 lists a set of reserved private address spaces that can be used for a ship-board control network that must not be connected to off-ship or other ship-board Internets. For the purpose of this standard, it is recommended that the following network addresses are used:

172.16.0.1 to 172.16.255.254 (network mask 255.255.0.0 – class B)

3.13

IPV4 – Internet protocol version 4

the version used in this issue of the standard (see previous subclause)

3.14

IPV6 – Internet protocol version 6

the proposed next generation Internet protocol. It is currently not sufficiently accepted to be viable as the basis of this standard, but future generations of this standard are expected to migrate to IPV6

3.15

LAN – local area network

a network within a delimited physical area. Typical for control system networks (see also WAN, MAN)

3.16**LNAC – LNA communication module interface**

a variant of TLI that is dedicated to MAU-LNA communication

3.17**loop-back interface**

refers to the loop-back function in the Internet protocol whereby an Internet message can be sent between two entities on the same network host. The complete class A network number 127 is assigned the “loop-back” function (see RFC1060). The address 127.0.0.1 will be used for the loop-back

3.18**MA – management agent**

an SNMP agent located in a network element (NE)

3.19**MAN – metropolitan area network**

a network between LAN and WAN. The area the network covers is more than local, but not worldwide

3.20**MIB – management information base**

basis for physical network management protocol

[RFC 1213]

3.21**MTU – maximum transmission unit**

the largest message that can be transmitted over a given T-profile without fragmentation. For Ethernet, the MTU is 1 500 octets

3.22**multicast**

a transport mechanism by which any number of computer hosts can be reached with one transmitted message. This transport mechanism is referred to as multicast or broadcast. The T-profile specification defines the actual physical mechanism that is used to implement this service

3.23**NE – network element**

term used within SNMP to identify a managed entity in a network. This is typically a host computer with its protocol entities, a router, a gateway or a switch

3.24**NMA – network management applications**

applications within a NMS

3.25**NMS – network management station**

a host computer, with software implementing one or more NMA, that is responsible for physical network monitoring (see MIB and SNMP)

3.26**NNN – network node number**

an identification of one node on a TP network. This is typically the Internet host number (excluding the network part of the address) for IPV4 networks. The NNN shall be unique and unambiguous for one node, even if this node is on a redundant network with two different network addresses. The NNN is a 32-bit unsigned integer

3.27

NTP – network time protocol

all references in this standard address the Internet time distribution and synchronization protocol described in RFC 1305

3.28

OSI – open systems interconnect

this term is defined in IEC 61162-400

3.29

peer-to-peer

a two-way communication link that can be established by both sides concurrently. The T-profile shall make sure that only one link is established and that the link has the same identification on both sides (see client-server and connectionless)

3.30

primary network

a redundant network has two independent transport paths between any two nodes (primary and secondary network). The primary network is the transport path defined as the one that is normally used when connections are established between the nodes, and that normally is to be used if non-redundant nodes are attached to the network. However, the T profile will be able to use the secondary network in the same manner as the primary (i.e. accept incoming connects that arrive on the secondary network alone). The T-profile may process request on the secondary network after requests on the primary

3.31

priority

assigns importance to messages or message streams transported through the communication network. Three levels are defined: urgent, normal and low.

It must (as a minimum) act as a rudimentary bandwidth allocation scheme where high priority (importance) data is serviced before lower priority data

3.32

QoS – quality of service

degree to which a certain protocol (typically T-profile) supplies certain services to the higher levels

[IEC 61162-400]

3.33

redundant IPV4

reference to a redundant Internet means a T-profile as defined in clause 6 of this standard. Where the standard redundant IPV4 network is used (LNADR_IPV4R), the following addresses are used:

172.16.0.1 to 172.16.255.254 (network mask 255.255.0.0 – “primary”).

172.17.0.1 to 172.17.255.254 (network mask 255.255.0.0 – “secondary”).

Other addresses can be used when the system integrator defines new T-profile networks for use in a specific implementation (LNADR_IPV4RE).

Both networks will be of the same class (class B for the standard network) and each network node will have the same node address on the primary and secondary networks.

For all IP networks the following port numbers will be used:

Table 1 – Internet IPV4 protocol port numbers

Port type	Protocol	Port
LNA-LNA listening port (normal)	TCP	23305
LNA-LNA listening port (urgent)	TCP	23306
LNA-MAU listening port (normal)	TCP	23303
LNA-MAU listening port (urgent)	TCP	23304
MAU-MAU stream listening ports	TCP	22307-
ABC0 (standard broadcast)	UDP	23307 (23308)
ABC1	UDP	23309 (23310)
ABC2	UDP	23311 (23312)
ABC3	UDP	23313 (23314)
ABC4	UDP	23315 (23316)
ABC5	UDP	23317 (23318)

NOTE 1 The port numbers are different from the ones used in MiTS. This is done to support the co-existence of MiTS and IEC 61162-4 networks.

NOTE 2 The stream ports will be selected by trying different port numbers in sequence, starting with the one specified.

Two port numbers are listed for each UDP broadcast port. The first number (odd number) is the mandatory listening (destination) port. The even number in parenthesis is the recommended sending port (source) port. Other sending port numbers can be used if desired in an implementation.

NOTE Some implementations of UDP can cause problems when the same port number is used for sending and receiving. A typical problem is that sent broadcast messages are not received by the sending computer itself.

Likewise, two port numbers are used for the message ports to support differentiation between normal and urgent messages. Implementations that do not support differentiation will use the normal port (valid for MAU-LNA link only).

The same ports will be used for all IP type networks and on both the primary and secondary side of a redundant network.

3.34

secondary network

represents the second transport path

See primary network (3.30)

3.35

SMI

structure and identification of management information is a model for description of the structure of needed information

3.36

SNMP – simple network management protocol

Internet protocol used for physical network management

[RFC 1157]

3.37

TCP/IP – transmission control protocol/Internet protocol

refers to the reliable and stream oriented protocol defined by RFC 793. A system implementing TCP/IP will also implement the Internet protocol as described above

3.38

TPN – TP network

definition of a physical network architecture with all relevant address and network parameters. IEC 61162-410 defines a number of different TP networks based on the IPV4 family of protocols

3.39

UDP – user datagram protocol

the unreliable message based protocol defined by RFC 768. A system implementing UDP shall also implement the Internet protocol as described above

3.40

WAN – wide area network

a network that, in principle, can span the entire world. A typical example is the Internet

4 Transport layer service specification

4.1 General

The transport layer will provide the upper layers (the MAUs and the A-profile) with functions for the following services:

- communication services;
- time services;
- network management services;
- graceful degradation facility.

Communication and graceful degradation services are provided by the transport layer while time and management services typically involve the transport layer and/or other entities (upper layers, resources depending on actual implementation).

4.2 T-profile network and host computer addressing

4.2.1 Introduction

This subclause defines requirements for the T-profile network and host computer addressing. The described addressing scheme shall ensure easy portability for higher level entities between different T-profiles.

4.2.2 Addressing scheme

Host computers that communicate via a specific T-profile use a two-level addressing scheme:

- each T-profile shall as a minimum, define one T-profile network (TP network) that specifies the physical architecture of the network. This network is logically a linear network without any further subdivisions or segmentation. Some T-profiles may define more than one TP network to subdivide the different functions supplied by the T-profile into separate modules.

NOTE A typical example is a redundant Internet profile that subdivides the TP network into one for MAUs (supporting only stream communication) and one for the LNA (supporting message-based communication).

- each host computer has a unique and singular network node number (NNN). This number when referenced to a specific TP network shall be sufficient to address the host computer by the T-profile implementation.

4.2.3 Unique and singular hosts on the network

The T-profile shall provide an addressing mechanism that makes each host computer on a T-profile network uniquely and singularly identifiable by a network node number (NNN). This applies for all types of T-profile networks, for those that are non-redundant as well as redundant. One NNN shall map to one and only one possible host computer.

NOTE For redundant networks the single NNN must normally be convertible to two physical network addresses, one for each of the active links.

4.2.4 Non-segmented logical network

The addressing scheme defined here creates a non-segmented logical network on which the host computers reside. However, a T-profile network may optionally provide physical segmentation between groups of host computers in the NNN address space. This standard does not specify how this can or should be done. This standard requires that all nodes on the T-profile network, independent of physical segmentation, shall be able to establish communication links between themselves and exchange data over these links.

NOTE A T-profile for the wide area Internet may need to handle broadcasts specially (e.g. by using a multicast protocol, for example IGMP) to enable general MAU name look-up over several networks.

4.2.5 Size of network

The NNN is an unsigned integer of at most 32 bits in length. Physical addressing schemes that require more bit-space must define attributes in the T-profile network description that supply the extra information so that a shorter NNN can be mapped to the correct address.

NOTE IPV6 uses a 128 bit long network address. To make host computers addressable by 32 bits, the remaining 96 bits must be determined from the T-profile network attributes. The same applies to redundant networks, for example for IPV4, where each host computer typically has two network addresses.

4.3 Communication services requirements

4.3.1 Introduction

This subclause defines the general attributes of the communication services that shall be made available through the T-profile.

4.3.2 Connectivity and data transfer internally and externally

The T-profile shall provide the following general services:

- the transfer of data between any nodes attached to the embedded system level network;
- allow connection to one or more other networks than the embedded system level network.

NOTE The concept of defining different logical T-profile networks allows several T-profiles to coexist on the same physical network. In this case, the *other* network may be another T-profile. More commonly, the other network is some form of administrative network accessed via a separate network interface card (NIC).

Different service classes are defined in this standard for data transfer on the embedded system network. Data transfer out of the embedded system network is not covered by this standard.

4.3.3 Service classes

4.3.3.1 Overview

This subclause defines the service classes that shall be supported. Table 2 summarizes the service classes and their main characteristics.

Table 2 – Service classes

Communication	Connection	Data	Priority	Relation	Instances
LNA-LNA data	CO	Msg	U and N	Peer-to-peer	One
LNA-LNA MC in	CL	Short msg	U and / N	Multicast listen	Six MC ports
LNA-LNA MC out	CL	Short msg	U and / N	Multicast send	Six MC ports
MAU-MAU stream N	CO	Stream	N	Client/server	Any
MAU-MAU stream L	CO	Stream	L	Client/server	Any
MAU-LNA data	CO	Msg	U and N	Client/server	One

NOTE The first column specifies the service class and by that, its normal area of use.

The second column specifies whether the communication uses a connection-oriented (CO) or connectionless service.

The third column specifies whether data is sent as messages (with message boundaries) or as streams.

The fourth column specifies the priority classes that shall be supported for this service class.

The fifth column specifies the relationship between host computers using the service.

The final column specifies the various instances that are supported for each communication class. For LNA-LNA and MAU-LNA links, it is just one: The one standard path to the one listening LNA. For multicast services, the A-profile requires six predefined addresses, one for name look up and five for anonymous broadcast. For MAU-MAU link the TP network should support a reasonable number of CP to allow possible multiple MAUs on one host computer to have multiple connections to other MAUs.

The communication service classes are:

- LNA-LNA data: this is a communication link providing reliable bi-directional data transfer between any two LNAs (communication initiated by any party – peer-to-peer);
- LNA-LNA MC: this is a broad- or multicast service that provides name look-up, watchdog and anonymous broadcast services between LNAs. This is also essentially a peer-to-peer communication class, although connectionless. The service is divided into a transmitting and a receiving component;
- MAU-MAU stream: this is a service providing bulk data transfer between MAUs. The communication is initiated by a client connecting to a waiting server. There are two stream classes, one for normal and one for low priority (priority is associated with the link rather than with the data transported). The service is bi-directional;
- MAU-LNA data: this is a service (defined in the A-profile) providing communication between a MAU and its LNA. This is also a client-server type communication. The service is bi-directional.

4.3.3.2 Implementation of multiple service classes

One implementation of a T-profile may provide one or more of the above service classes, dependent on the required use. The minimum requirements are listed in the table below.

Table 3 – T-profile service implementation

TP implementation for	Required service classes
LNA-LNA	LNA-LNA data, LNA-LNA MC
MAU-MAU	MAU-MAU stream N, MAU-MAU stream L
MAU-LNA	MAU-LNA data

NOTE Although all these services may be implemented by one T-profile, the implementation may offer the services to the users as a different TP network. Typically, the three groups of services will be offered as three distinct TP networks.

4.3.3.3 Message or stream type communication

The following communication services shall be provided to the upper layers:

- Msg: reliable message transfer. The transfer mode will be a unicast (point to point) transfer mode. Message length may be limited by T-profile implementation. In particular, urgent messages may be limited to the MTU of the T-profile;
- Stream: reliable stream transfer of a unicast (point to point) transfer mode. Data is transmitted between sender and receiver without regard to message boundaries;
- Short msg: unreliable short message transfer. The transfer mode will be a multicast (point to multipoint) or broadcast transfer mode. The message length is typically limited by the MTU of the T-profile (and, hence, is “short”).

4.3.3.4 Connection modes and flow control

A reliable transfer will be achieved through a connection-oriented (CO) mode protocol while an unreliable transfer will be achieved through a connectionless (CL) mode protocol.

A CO mode protocol provides for full duplex reliable (with guarantee of delivery to the destination), sequential and without duplication end to end data transfers by using sequence numbers, acknowledgements to indicate correct delivery of the data, and retransmissions in case of error (data loss, data damage).

A flow control mechanism shall be provided for CO services to avoid a receiver being congested by too many arriving messages.

A mechanism should be provided to detect that either side of an established connection has ceased to function (remote network node damage). This mechanism will in any case be augmented by a similar service in the A-profile so it will not be of critical importance.

A CL mode protocol provides for unreliable (without guarantee of delivery to the destination(s)) end to end message type data transfers. No notification is generated for either loss, duplication or out of sequence delivery of data. Damaged data need not be retransmitted, but shall in no case be delivered to the receiver (i.e. discard messages with bad checksums). The service is specified to be unidirectional (i.e. a listening service must be used together with a sending service).

Unreliable messages shall be short messages. It will be the responsibility of the upper layers to ensure that the length of the messages provided at the transport layer is within the permitted maximum value (medium MTU).

Reliable streams / long messages shall be segmented and reassembled at the transport layer when necessary. Short messages (typically of urgent priority) should, if possible, be transmitted in one physical layer message.

4.3.3.5 Priority

In order to support the time dependency of the transmitted data (time critical or not) and to allow the intermixing of data flows of different significance on the network, importance levels shall be defined as follows:

- urgent;
- normal;
- low.

The implementation of these priorities will be T-profile dependent. In particular, there may not be a well-defined relationship between priority levels for CL and CO services as the CL and CO mode transfers may use different protocols. A T-profile may also in some cases handle different priority classes as the same (e.g. not distinguish between urgent and normal multicast priorities) due to limitations in underlying protocol. The T-profile shall in any case provide a best effort implementation of priorities.

The system integrator must verify that the implemented priority mechanism is suitable for the use to which the T-profile is being put.

4.3.3.6 Logical communication paths and node relationships

A logical communication path results from the association between two (point to point communication) or more (point to multipoint communication) transport level end points.

Dependent of communication class, different principles apply for the establishment of logical paths:

- peer-to-peer: communication between two LNAs can be established by any part at any time. The T-profile implementation must make sure that concurrent connection establishments result in only one logical path;

NOTE To facilitate a similar handling of all types of communication links, also the peer-to-peer service will be established in the same way as a client/server connection.

- client-server: communication between LNA and MAU and between MAUs is established by one of the parties acting as client (doing the connection request) and the other acting as server (waiting for connection attempt). This always results in one unambiguous communication path;
- multicast: this communication is connectionless and does not use logical paths.

4.4 Time services

4.4.1 General

A common time reference shall be available in the system level network in order to timestamp all time dependent data transmitted by the nodes and to estimate the validity of the received data.

The time shall be generated and maintained at the network level at least at one dedicated time generator/server. The time distribution service shall allow the use of multiple (redundant) servers.

A time distribution service shall be provided to update and to synchronize the local clock available at each attached node to the global clock available at the time generator/server.

In addition, the time shall be maintained at each node in order to make available to their local user(s) a reference time even in case of failure of the dedicated common reference time generator/server(s).

The T-profile specification shall minimize synchronization jitters by, for example using urgent priorities for time-related messages. Other means can also be employed. The worst case jitters shall be specified.

4.4.2 Services

The time service shall maintain a synchronized time over the complete T-profile network. No particular services are provided to the applications. It is assumed that the time related services are made available through the operating system interface.