

INTERNATIONAL STANDARD

**Maritime navigation and radiocommunication equipment and systems – Digital
interfaces –
Part 450: Multiple talkers and multiple listeners – Ethernet interconnection**



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**Maritime navigation and radiocommunication equipment and systems – Digital
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Part 450: Multiple talkers and multiple listeners – Ethernet interconnection**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**MARITIME NAVIGATION AND RADIOCOMMUNICATION
EQUIPMENT AND SYSTEMS –
DIGITAL INTERFACES –****Part 450: Multiple talkers and multiple listeners –
Ethernet interconnection**

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International Standard IEC 61162-450 has been prepared by IEC technical committee 80: Maritime navigation and radiocommunication equipment and systems.

This second edition of IEC 61162-450 cancels and replaces the first edition published in 2011 and Amendment 1:2016. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) network traffic filtering based on IGMP snooping added;
- b) network traffic balancing added;
- c) new encapsulation of IEC 61162-3 PGNs added;

- d) new alternative for binary file transfer added: TCP/IP based on Annex H of IEC 62388:2007 on radars;
- e) general authentication tag "a:" added to support managing of cyber security risk.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
80/880/FDIS	80/885/RVD

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

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

A list of all parts in the IEC 61162 series, published under the general title *Maritime navigation and radiocommunication equipment and systems -Digital interfaces*, can be found on the IEC website.

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

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- withdrawn,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

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

MARITIME NAVIGATION AND RADIOCOMMUNICATION EQUIPMENT AND SYSTEMS – DIGITAL INTERFACES –

Part 450: Multiple talkers and multiple listeners – Ethernet interconnection

1 Scope

This part of IEC 61162 specifies interface requirements and methods of test for high speed communication between shipboard navigation and radiocommunication equipment as well as between such systems and other ship systems that need to communicate with navigation and radio-communication equipment. This document is based on the application of an appropriate suite of existing international standards to provide a framework for implementing data transfer between devices on a shipboard Ethernet network.

This document specifies an Ethernet based bus type network where any listener can receive messages from any sender with the following properties.

- This document includes provisions for multicast distribution of information formatted according to IEC 61162-1, for example position fixes and other measurements, as well as provisions for transmission of general data blocks (binary file), for example between radar and VDR, and also includes provisions for multicast distribution of information formatted according to IEC 61162-3, for example position fixes and other measurements.
- This document is limited to protocols for equipment (network nodes) connected to a single Ethernet network consisting only of OSI level one or two devices and cables (Network infrastructure).
- This document provides requirements only for equipment interfaces. By specifying protocols for transmission of IEC 61162-1 sentences, IEC 61162-3 PGN messages and general binary file data, these requirements will guarantee interoperability between equipment implementing this document as well as a certain level of safe behaviour of the equipment itself.
- This document permits equipment using other protocols than those specified in this document to share a network infrastructure, provided that it is supplied with interfaces which satisfy the requirements described for ONF.
- This document includes provisions for filtering of the network traffic in order to limit the amount of traffic to manageable level for each individual equipment.

This document does not contain any system requirements other than the ones that can be inferred from the sum of individual equipment requirements. An associated standard, IEC 61162-460, further addresses system requirements.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60825-2, *Safety of laser products – Part 2: Safety of optical fibre communication systems (OFCS)*

IEC 60945, *Maritime navigation and radiocommunication equipment and systems – General Requirements – Methods of testing and required test results*

IEC 61162-1:2016, *Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 1: Single talker and multiple listeners*

IEC 61162-3:2008, *Maritime navigation and radiocommunication equipment and systems – Digital interfaces – Part 3: Serial data instrument network*

IEEE Std 802.3-2015, *IEEE Standard for Ethernet*

ISOC RFC 768, *User Datagram Protocol, Standard STD0006*

ISOC RFC 791, *Internet Protocol (IP), Standard STD0005 (and updates)*

ISOC RFC 792, *Internet Control Message Protocol (ICMP), Standard STD0005 (and updates)*

RFC 793:1981, *Transmission Control Protocol (TCP)*

ISOC RFC 826, *An ethernet Address Resolution Protocol*

ISOC RFC 1112, *Host Extensions for IP Multicasting, Standard STD0005 (and updates), (include IGMP version 1)*

ISOC RFC 1918, *Address Allocation for Private Internets, Best Current Practice BCP0005*

ISOC RFC 2236, *Internet Group Management Protocol, Version 2*

ISOC RFC 2474, *Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers*

ISOC RFC 3376, *Internet Group Management Protocol, Version 3*

ISOC RFC 5000, *Internet Official Protocol Standards, Standard 0001*

ISOC RFC 5227, *IPv4 Address Conflict Detection*

ISOC RFC 5424, *The Syslog Protocol*

NMEA 0183:2008, *Standard for interfacing marine electronic devices, Version 4.00*

NOTE The standards of the Internet Society (ISOC) are available on the IETF websites <http://www.ietf.org>. Later updates can be tracked at <http://www.rfc-editor.org/rfcsearch.html>.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1

ASCII

printable 7 bit character encoded in one byte

3.2

binary file

data block without formatting known to this protocol, i.e., non IEC 61162-1 formatted data, that can be transmitted with the protocol defined in 7.3 or in 7.5

Note 1 to entry: The term "binary file" is used to differentiate the general data transfer protocol (which may or may not be in ordinary text format) from the transmission of sentences that is always in 7 bit ASCII format.

3.3

byte

group of 8 bits treated as one unit

Note 1 to entry: This corresponds to what is also sometimes called an octet.

3.4

command-response pair

CRP

messages exchanged between parties that synchronize state changes on both sides through the exchange

Note 1 to entry: CRP are defined in Annex A.

Note 2 to entry: Both the command and the reply message may also be used as a sensor broadcast message in some cases. Thus, the implementation of the semantics of the message exchange is somewhat different between different users of the exchange.

3.5

datagram

atomic UDP transmission unit on the Ethernet as defined in ISOC RFC 768 and as constrained elsewhere in this document

3.6

Ethernet

carrier sense, multiple access collision detect (CSMA/CD) local area network protocol standard as defined in IEEE Std 802.3 and later revisions and additions to IEEE 802

Note 1 to entry: The types of Ethernet media that can be used for implementation of this document are defined in Clause 5.

3.7

function block

specified functionality implemented by equipment

Note 1 to entry: Equipment normally implements multiple function blocks. Requirements to equipment are the sum of requirements to the function blocks it implements. Function blocks are defined in Clause 4.

3.8

Internet Group Management Protocol

IGMP

communications protocol used by hosts and adjacent routers on IPv4 networks to establish multicast group memberships

Note 1 to entry: The IGMP is an integral part of IP multicast.

3.9

IGMP snooping

process of listening to Internet Group Management Protocol (IGMP) network traffic

3.10

Internet assigned number authority

IANA

global coordination of the Domain Name Server (DNS) Root, IP addressing, and other Internet protocol resources, including UDP and TCP port numbers

Note 1 to entry: The currently assigned numbers are listed in <http://www.iana.org/assignments/port-numbers>.

3.11

Internet protocol

IP

signalling protocol used and defined in ISOC RFC 791 (and updates)

3.12

message

collection of one or more sentences that are grouped by mechanisms internal to the sentence, for instance by sequence numbers as in the TXT sentence

Note 1 to entry: A stand-alone sentence is a message.

3.13

message type

classification of IEC 61162-1 sentence formatters into SBM, MSM and CRP types

Note 1 to entry: SBM, MSM and CRP types are defined in Annex A.

Note 2 to entry: This document defines different requirements to the transmission of different message types.

3.14

multi-sentence message

MSM

logical group of messages and/or sentences where the full meaning of the group is dependent on the receiver reading the full group

Note 1 to entry: Multi-sentence messages that are grouped together with a TAG construct are also a sentence group.

Note 2 to entry: MSM are defined in Annex A.

3.15

network

physical Ethernet network with one Internet address space, consisting only of the network nodes, switches, cables and supporting equipment such as power supply units

3.16

network function block

NF

function block responsible for physical connectivity to the network and connectivity to the transport layer as described in 4.3

3.17

network infrastructure

part of the network that provides a transmission path between network nodes

Note 1 to entry: The network nodes are not part of the network infrastructure.

3.18

network node

physical device connected to the network and which have an Internet address

Note 1 to entry: It is also called an Internet host.

Note 2 to entry: A network node will normally correspond to equipment. "Equipment" is used in this document.

3.19

other network function block

ONF

function block that interfaces to the network, but which is not using the protocol definition in Clauses 5, 6 and 7

Note 1 to entry: For example, real time streaming of radar and CCTV image transfer, or VDR sound transfer.

Note 2 to entry: Requirements as defined in 4.7 ensure that an ONF can co-reside with SF network nodes and function blocks that make use of this document's protocol.

3.20

PGN to network gateway function block

PNGF

function block that enables transfer of sentences between the network and devices that are compliant with the IEC 61162-3 serial data instrument network interface

3.21

PGN message

parameter group number message

message consisting of an 8-bit or 16-bit number that identifies each parameter group

Note 1 to entry: The parameter group number (PGN) is analogous to the three-character sentence formatter in IEC 61162-1. By definition, parameter groups identified by 16-bit parameter group numbers are broadcast to all addresses on the network. Parameter groups identified by 8-bit parameter group numbers may be used to direct data for use by a specific address.

[SOURCE: IEC 61162-3:2008, 3.1.21, modified – The word "message" has been added to the term, and the definition has been rephrased.]

3.22

sensor broadcast message

SBM

message consisting of only one sentence

Note 1 to entry: SBMs are sent with a sufficiently high update rate to ensure that the receiver can maintain the correct status even in environments where some messages may be lost.

Note 2 to entry: SBMs are defined in Annex A.

3.23

sentence

standard information carrying unit as described in IEC 61162-1

3.24

sentence group

logical group of sentences (which may consist of only one) that need to be processed together to give full meaning to the information contained in the sentence(s)

Note 1 to entry: The grouping of sentences into sentence group is done by TAG block mechanisms.

Note 2 to entry: This document allows the explicit grouping of sentences by using coding in a datagram. This document does not enforce any relationship between datagram and sentence group. Thus a datagram may contain more than one sentence group, or a sentence group may be split over two or more datagrams.

3.25

serial to network gateway function block

SNGF

function block that enables transfer of sentences between the network and devices that are compliant with the IEC 61162-1 and IEC 61162-2 serial line interface

3.26

system function block

SF

function block, identified by a unique system function ID (SFI), that is the only function block that can send information in a datagram format as defined in Clause 7

3.27

system function ID

SFI

parameter string as defined in 4.4.2

3.28

transmission group

pair of a multicast address and a port number that are used by an SF to transmit sentences

Note 1 to entry: The transmission groups are defined in Table 4, and Annex A defines default transmission groups for the SF.

3.29

transport annotate and group

TAG

formatted block of data, defined in NMEA 0183, that adds parameters to IEC 61162-1 sentences

Note 1 to entry: Annex B gives an overview of the TAG blocks used in this document.

3.30

user datagram protocol

UDP

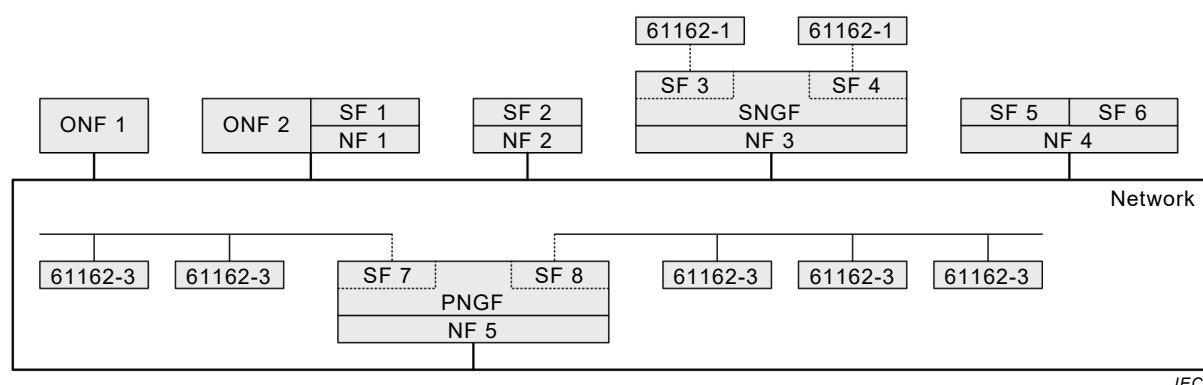
connection-less datagram protocol defined by ISOC RFC 768

Note 1 to entry: ISOC RFC 768 makes no provision for transport-layer acknowledgement of packets received.

4 General network and equipment requirements

4.1 Network topology example

Figure 1 shows a possible IEC 61162-450 network topology consisting of one IP local area network (LAN) and a number of different network nodes, each containing different function blocks. This diagram is informal and does not imply any requirements other than the ones defined in Clause 4.



Key

- SF system function block
- NF network function block
- SNGF serial to network gateway function block
- ONF other network function block
- PNGF PGN to network gateway function block

Figure 1 – Network topology example

Some examples of network nodes are (see Figure 1):

- a sensor, for example a GNSS receiver that is also a network node (SF2 and NF2);
- a device that sends or receives IEC 61162-450 compliant data (sentences and/or binary file) as well as other types of information onto the network, for example an ECDIS that can also load chart data from another device (SF1, ONF2 and NF1);
- two independent functions, such as a gyrocompass also approved as a rate of turn sensor that are implemented in one network node (SF5, SF6 and NF4);
- a system device function block represented by an IEC 61162-1 compliant equipment connected to a serial to network gateway function (SNGF); in this case, the SNGF will format outgoing sentences according to requirements in this document (SF3, SF4, SNGF and NF3);
- a system device function block presented by an IEC 61162-3 compliant equipment connected to network gateway function (PNGF); in this case, the PNGF will format outgoing sentences according to requirements of this document (SF7, SF8, PNGF and NF5);
- a device that does not send or receive IEC 61162-450 compliant data (sentences and/or binary file), but which satisfies minimum requirements for compatible use of the same network (ONF1).

4.2 Basic requirements

4.2.1 Requirements for equipment to be connected to the network

(see 8.2.1)

The requirements for equipment connected to the network are as follows.

- All equipment connected to the network, including network infrastructure equipment, shall satisfy the relevant physical and electrical requirements defined in 5.1.
- All equipment that implements one or more of SF and/or SNGF shall implement the NF. This equipment shall satisfy the requirements to the function blocks they implement as defined in 4.3 (NF), 4.4 (SF), 4.5 (SNGF) and 4.6 (PNGF).

- All other equipment that is not network infrastructure equipment and that shares the network infrastructure shall comply with requirements to an ONF as defined in 4.7.
- Network infrastructure equipment, i.e., switches, shall satisfy requirements in 4.2.2.
- All equipment connected to a network shall satisfy the requirements of IEC 60945.

NOTE This requirement only applies to devices on the network when the network is in normal operation. During commissioning or maintenance, when the system is not being used for safety-related navigation, other equipment can be temporarily connected to the network that does not comply with IEC 60945.

Any other equipment is not allowed to be connected to the network.

4.2.2 Additional requirements for network infrastructure equipment

(see 8.2.2)

To avoid potential problems with certain network infrastructure equipment, repeater hubs shall not be used to interconnect components of an IEC 61162-450 network.

NOTE 1 Repeater hubs are network infrastructure devices without internal storage that repeat incoming datagrams onto all outgoing connections.

NOTE 2 Switches are network infrastructure devices that based on forwarding tables can process, and forward datagrams between nodes on the same network, using intermediate storage in the switch before retransmission.

Switches used in an IEC 61162-450 network shall have means to filter network traffic using IGMP snooping. When the IGMP snooping is enabled and when a multicast datagram is received, the switch shall forward it only to the ports which have joined the same multicast group. The means which shall be provided to support multicast data filtering using IGMP snooping are the following:

- IGMP snooping shall be provided based on IGMPv1, IGMPv2 or IGMPv3; the selection of the IGMP version shall be based on highest version supported by all the connected nodes;
- multicast traffic filtering shall be provided based on IP multicast address;
- multicast data filtering shall not be enabled for the address range of 224.0.0.1 to 224.0.0.255 as recommended in RFC 4541.

In addition to or instead of multicast filtering techniques, such as IGMP snooping, it is also permitted to configure manually individual ports of the switches to block unnecessary traffic flow (for example to isolate simple sensors from ECDIS and radar).

See Annex D for IGMP snooping compatibility issues of nodes based on IEC 61162-450:2011.

Another possible method to filter and control network traffic is described in Annex E.

4.3 Network function (NF) requirements

4.3.1 General requirements

All equipment that implements a NF shall satisfy the requirements in Clauses 5 and 6.

4.3.2 Maximum data rate requirements

(see 8.3.1)

The manufacturer shall specify the maximum input rate under which the equipment can still perform all functions required by its performance standards.

Maximum input rate shall be specified as

- a) the maximum number of datagrams per second received, intended for and processed by the equipment,

- b) the maximum number of datagrams per second received by, but not intended for, the equipment, and
- c) the maximum number of datagrams per second received by, but not intended for, the equipment at 50 % of the maximum load for item a).

NOTE 1 "Received by" means datagrams that are received on all transmission groups that the equipment listens to.

NOTE 2 "Intended for" are datagrams that are processed by the equipment as part of its specified function.

The maximum data rates shall be the mean rate over a 10 s measurement period.

4.3.3 Error logging function

(see 8.3.2)

4.3.3.1 Internal logging

Means shall be provided in each NF to record errors that occur in the NF itself as well as SF and SNGF using it. Subclauses 4.5.2, 7.1.2, 7.2.5 and 7.3.9 give minimum requirements as to what shall be logged.

As a minimum, the manufacturer shall provide mechanisms by which error logs can be inspected by a human operator, for example by trained service engineer. It is allowed that the inspection is done through a simple network mechanism, such as a terminal emulator, as defined in this document or any other reasonable method.

The minimum requirements for the log are to count the number of each occurrence. The counter may reset itself by a manufacturer specified method.

4.3.3.2 External logging

A NF may be configured to support external logging, where non-trivial information is sent to a logging server. In this case, a "syslog" message as defined in ISOC RFC 5424 shall be used.

Syslog messages shall be formatted as ASCII text messages and sent as UDP packets on port 514 and the multicast address defined in Table 6. Error messages defined in this document shall be reported through a simplified message as described in Table 1, where italicised words are place-holders for data explained in the right hand column. Other characters shall be transmitted as shown, including spaces.

Table 1 – Syslog message format

Element	Description
<pri>	The combined priority and facility code (number from 0 to 199 inclusive) enclosed in pointed brackets. For the errors defined in this document, the value 131 shall be used (facility "local use 0" and priority "error condition").
Version	The version code. The code 1 (one) shall be used for messages from this document.
Space	One space character.
Timestamp	Timestamp, containing date and time and optional UTC offset, in a valid format, for example 1985-04-12T23:20:50-03:00. The example shows date, followed by upper case "T", then local time and finally offset from UTC (3 hours west – negative, east offsets shall be prefixed by a "+". UTC offset can be abbreviated to a single upper case "Z", without leading "-" or "+"). Alternatively, the timestamp field may be nil ("-"), a single dash character).
Space	One space character.
Hostname	The host name of the network node, represented as the IP address in dotted decimal notation. Alternatively, this field may be nil ("-"), a single dash character).
Space	A space character.
Appname	The application name. This shall be the string "450-" followed by the configured SFI code if the error originates in the SF or SNGF, "NF" if the error originates from the network function block or "ONF" if it originates in the ONF function block.
Space	A space character.
Procid	Normally, this field should be nil ("-") a dash character). Other values as defined in the syslog standard may be used.
Space	A space character.
Msgid	For errors defined in this document, this field shall be the error code as defined in Table 2.
Space	A space character.
Structured	This field can be nil ('-', a single dash character) or contain information as defined in ISOC RFC 5424.
Space	A space character.
Msg	A free format message in ASCII format.

A "syslog" packet shall not exceed 480 bytes and shall be sent as a single UDP datagram. The "syslog" packet for multiple occurrence of same message identity shall not be reported more often than once per minute. The "syslog" packet for any occurrence of message identity shall not be delayed more than 10 min.

This document does not specify requirements for equipment receiving syslog messages. This type of equipment would fall into the category of ONF. As Table 1 is a subset of the full ISOC RFC 5424 specification, implementers of such equipment shall refer to ISOC RFC 5424 and make sure that syslog messages from other ONF can be received and processed without problems.

To facilitate the use of the syslog protocol, the errors defined in this document have been assigned a message identity as defined in Table 2.

Table 2 – Syslog error message codes

Message identity	Description	Subclause
101	SNGF buffer overflow	4.5.2
102	Datagram header error	7.1.2
103	TAG or sentence format error	7.2.5
104	Binary file error	7.3.9
201	PNGF buffer overflow	4.6.2
202	PGN message errors	7.4.2 and 7.4.4
203	No available address for devices	7.4.3.2

Additional information can be given in the "Msg" field, if available.

4.3.4 Provisions for network traffic filtering – IGMP

NOTE The purpose of the IGMP for this document is to provide the possibility to perform network traffic filtering based on IGMP snooping.

The manufacturer shall specify the version of IGMP as defined in ISOC RFC 1112, RFC 2236 and RFC 3376 that the NF supports. At least version 1 as defined in ISOC RFC 1112 shall be implemented.

See Annex D for compatibility issues of nodes based on IEC 61162-450:2011.

4.4 System function block (SF) requirements

4.4.1 General requirements

(see 8.4.1 and 8.2.3)

Equipment that implements an SF shall satisfy the following requirements:

- requirements in 6.2 shall be satisfied for all equipment implementing SF;
- implements at least one of the datagram types defined in Clause 7, but does not have to implement all of them;
- implemented datagram types shall be specified in the manufacture's documentation (see 7.1.1);
- requirements in 7.2 shall be satisfied for all equipment implementing IEC 61162-1 sentence transmitting or receiving function blocks;
- requirements in 7.3 shall be satisfied for equipment that implements an SF that can transmit or receive binary file data;
- requirements in 7.4 shall be satisfied for all equipment implementing IEC 61162-3 PGN message transmitting or receiving function blocks.

4.4.2 Assignment of unique system function ID (SFI)

(see 8.4.2)

The format of the SFI parameter string shall be "ccxxxx"

where "cc" is two valid characters as defined in IEC 61162-1 and "xxxx" is four numeric characters.

An SF implementing the functionality of an equipment that has been given a talker mnemonic code in IEC 61162-1 shall use this talker mnemonic as the "cc" characters in the SFI. If the talker mnemonic is proprietary (i.e. consists of character "P" followed by a three character

manufacturer's mnemonic code), then two first characters are used as the "cc" characters in the SFI.

Other SF may have their SFI string format defined in other standards or the manufacturer may have to choose a code. In the latter case, the already defined talker mnemonic codes shall be avoided.

The numeric character string "xxxx" will be an instance number in the range "0001" to "9999". The numeric character string "9999" is reserved for an un-configured SF and shall not be used by any transmitting SF during normal operation. However, all receiving equipment shall accept the "9999" string.

During normal operation, the SFI parameter string shall be unique for all SF in an IEC 61162-450 network.

It is recommended that all SF on a ship, independent on whether they are residing on one common network or not, are given a ship unique SFI.

There may be multiple SF, each communication with their own SFI, assigned to a single IP address or MAC address.

Means shall be provided by the manufacturer to configure the SFI for each SF (see 7.2.3.4).

4.4.3 Implementing configurable transmission groups

(see 8.4.3)

As default, each SF shall be assigned a single transmission group/multicast address for all outgoing messages. The default for this transmission group is determined by the SFI as described in Annex A.

For each SF that the equipment implements, the manufacturer shall document the default transmission groups the SF listens to and what sentences it expects to receive on each group. The default transmission groups can be selected by the manufacturer from the list of groups in 6.2.2.

Means shall be provided to configure all transmission groups and the SFs which are assigned to them within the valid range of multicast addresses defined in 5.4. A system integrator may, for example, split an SF into different transmission groups to support optimal load balancing for a given system. Where non-default configurations of SF and transmission groups are utilised, the details should be documented by the system integrator.

4.5 Serial to network gateway function (SNGF) requirements

4.5.1 General requirements

(see 8.5.1)

The SNGF shall implement all relevant functionality defined in 4.4 for each SF it supports.

The SNGF may support one or more serial ports. Unless the SNGF implements multi-SF serial port, each serial port shall be implemented as a separate SF and assigned a separate SFI. If practical, the "cc" part of the SFI shall be based on the talker identifier in use by the serial port.

All sentences, including those with unidentified or illegal content, as well as proprietary sentences shall be transmitted from the SF associated with the serial port. Sentences with unidentified or illegal content shall be sent with a legal transport annotate and group (TAG) block as defined in 7.2.3, but with the raw received serial data following the TAG block.

As a destination, each serial port shall be associated with the corresponding SFI. Outgoing sentences shall be transmitted exactly as received in the datagram.

The SNGF may support one or more sources distinguished by different talker mnemonics at each serial port. Each source in a shared serial port shall be implemented as a separate SF and assigned a separate SFI. If practical, the "cc" part of the SFI shall be based on the talker mnemonic in use by each source in a shared serial port. As a destination, each source in a shared serial port shall be based on the SFI. Proprietary sentences include no talker identifier and based on setup parameters they shall use the same SFI as standardized sentences from the same source. The STN sentence is an additional qualifier for the following sentence. The STN sentence and the following sentence belong to the same SF and shall use the same SFI.

Proprietary sentences belong to the default SF of the associated serial port or to the SF determined by the preceding STN sentence.

The TAG block for source identification (s:) shall be based on the SFI. If available, routing from a 450-network to serial ports shall be based on the TAG block for destination identification (d:).

The default SFI of an SNGF used for administrative purposes, such as syslog, shall use the talker mnemonic "SI".

The SNGF may implement different types of filtering with regard to what serial line sentences are retransmitted as datagrams and what datagrams will result in a serial line sentence being sent. Any filtering methods shall be described in the manufacturer's documentation.

NOTE A typical filtering method would be to use the destination TAG "d" to determine what sentences in incoming datagrams are to be sent on the serial line.

4.5.2 Serial line output buffer management

(see 8.5.2)

An SNGF function block shall provide an independent buffer for each separate SF implemented for each serial port it can send sentences onto. The manufacturer shall specify the maximum buffer capacity for each port. The maximum capacity may be configurable at installation.

The buffer shall be implemented as a FIFO (first in, first out) buffer. In case of a full buffer, newly arrived sentences shall be discarded, unless these sentences are specified as prioritized (see below). Newly arrived sentences will be inserted into the buffer when buffer space is available. The method of treatment of sentences grouped by the TAG g (see 7.2.3.3) may be configurable or specified in the manufacturer's documentation.

The SNGF may implement a priority-based functionality for some sentences with specified sentence formatters. The prioritised formatters may be configurable or specified in the manufacturer's documentation.

Processing of prioritized sentences shall be as follows.

- Only one sentence with identical talker ID and sentence formatter shall exist in the buffer. Exception is a multi sentence message or a TAG block group of sentences: they shall only be replaced in their entirety.

NOTE When prioritizing AIS VDM and VDO sentences, the string beginning with the "!" character and ending with the 7th character of the encapsulation field is used for comparison to identify identical sentences. A match of this string from a newly arrived sentence with one in the buffer means the sentence contains the same ITU-R M.1371 message from the same MMSI as the sentence already in the buffer, and can then replace the older sentence at its position in the queue.

- If a single sentence, multi sentence message or a TAG block grouped sentences with identical talker ID and sentence formatter exists in the buffer, the new sentence or

sentences will replace the existing sentence or sentences at its position in the queue. This replacing shall not cause logging of an error nor sending anything to syslog.

When prioritizing TAG block grouped sentences, several fields within the TAG block need to be compared as well as the sentence comparisons. All of the compared components should match those of the current TAG block group in order to the replace TAG block group in the queue. The components to compare are: the TAG block source parameter code value, the "number of lines" portion of the TAG block group parameter code, and the sentences within the TAG block group.

- Otherwise, the new sentence shall follow the FIFO principle as described above.

If a sentence is discarded from the queue, this event shall be logged as an error internally in the equipment as defined in 4.3.3. The equipment shall have separate error counts for each serial port.

4.5.3 Datagram output requirements

(see 8.5.3)

The SNGF shall format outgoing datagrams as defined in 7.2.

The SNGF shall either transmit one IEC 61162-1 sentence or, if part of a multi sentence sequence, may transmit multiple IEC 61162-1 sentences per outgoing IEC 61162-450 datagram. The multi sentence sequence includes the case described in IEC 61162-1:2016, 7.3.9, and the cases for which IEC 61162-1 requires a sentence sent prior sending another sentence. The datagram shall include the correct SFI, source identification (s:) and, if required, destination identification (d:).

4.5.4 Multi SF serial port

(see 8.5.4)

The SNGF is allowed to implement more than one SFs for any single serial line. Received sentences on this serial line with a valid talker mnemonic will be transmitted from one of the associated SFs dependent on the talker mnemonics. Each SF shall be assigned a separate SFI and, as a destination, transmit outgoing sentences on the serial line according to the rules in 4.5.1.

Proprietary sentences received on the serial line include no talker identifier. It shall be determined by setup parameters from what SF they shall be transmitted.

Unidentified data from the serial line shall be sent from all SFs associated with the serial port. This sending of unidentified data shall not cause logging of an error nor sending anything to syslog.

4.5.5 Handling malformed data received on serial line

(see 8.5.5)

The SNGF is intended as a remote serial data converter with minimum data processing. For each of the cases below, the SNGF shall send a datagram with the malformed data as required by 4.5.1 and 4.5.4. If the formatted message exceeds the maximum datagram length, the data shall be truncated from the end. The following cases shall cause a message containing the malformed data to be sent:

- 1) if data has been received before a start character;
- 2) if data has been received after a valid start character and the maximum sentence and TAG block length has been exceeded;
- 3) if data has been received after a valid start character and end of line (CR,LF) has not been received after 1 s;

- 4) if a reserved character has been received and not having been appropriately escaped;
- 5) if random binary data is received on the serial line.

"Start character" is a valid start of sentence ("\$", "!") or TAG block start character.

4.6 PGN to network gateway function (PNGF) requirements

(see 8.12)

4.6.1 General requirements

(see 8.12)

The PNGF shall implement all relevant functionality for each SF it supports as defined in 4.4.

The default SFI of a PNGF used for administrative purposes, such as syslog, shall use the talker mnemonic "SI".

The PNGF may implement different types of filtering based on the PGN messages from and to IEC 61162-3 network. Any filtering methods shall be described in the manufacturer's documentation.

NOTE The accurate timing between PGN messages available in the IEC 61162-3 network is not supported when the same is converted into IEC 61162-450 network.

4.6.2 Output buffer management from IEC 61162-450 network to IEC 61162-3 network

(see 8.12)

A PNGF function block shall provide an independent buffer for each IEC 61162-3 network it can send into. The manufacturer shall specify the maximum buffer capacity for each port. The maximum capacity may be configurable at installation.

PNGF buffer management shall be based on the IEC 61162-3 priority included into each message. The manufacturer shall describe the method in documentation.

If the buffer is full and a PGN message is discarded, it shall be recorded as specified in 4.3.3.

4.6.3 Datagram output requirements

(see 8.12)

The PNGF shall format outgoing messages as defined in 7.4.1.

The PNGF shall transmit one IEC 61162-3 PGN message per outgoing IEC 61162-450 datagram to minimise delays.

4.6.4 PGN group number

(see 8.12)

A PGN group is defined as a logical group of devices that can share the information and message. A message from a device is broadcasted to all devices that belong to the same PGN group. A device may belong to more than one PGN groups. The maximum number of PGN groups is no more than four. The PGN group may be used for filtering of messages (see 4.6.1).

4.7 Other network function (ONF) requirements

(see 8.6)

The ONF represents a function that is allowed to share the same network infrastructure as the network function blocks (NF) on an IEC 61162-450 network.

The ONF shall conform to the requirements given in 4.2.1.

The ONF equipment shall not use any IP multicast address reserved by this document as defined in 5.4.

Documentation shall be provided describing the network protocols used by the ONF to send datagrams or byte streams, for instance UDP, TCP/IP or other.

Documentation shall be provided describing the impact of the ONF to the network.

5 Low level network requirements

5.1 Electrical and mechanical requirements

(see 8.7.1)

The cable and connectors used shall at least meet the specifications listed in Table 3 when used in protected environment as defined in IEC 60945.

The safety requirements and installation practices specified in IEEE Std 802.3™-2015, 14.7 and Clause 27, shall be followed. Also refer to IEEE Std 802.3-2015, informative Annex 67.

Fibre optic interfaces shall comply with the laser safety requirements for Class 1 devices specified in IEC 60825-2.

The physical layer requirement for IEC 61162-3 ports of the PNGF shall be compliant with IEC 61162-3:2008, Clause 4.

Table 3 – Interfaces, connectors and cables

IEEE 802.3 Interface	Max network segment link distance	Mechanical device interface connector type (protected environment)	Pin assignment	Cable category, minimum
100BASE-TXS IEEE Std 802.3-2015, 14.7 and Clauses 24 and 25	100 m	IEC 60603-7-3, 8-way shielded modular connector Refer to IEEE Std 802.3-2015, Clause 3, IEC 60603-7, Figures 1 through 5, and IEEE Std 802.3/25	^b	CAT5 STP Two shielded twisted pairs ANSI/TIA/EIA-568-A, ANSI/TIA/EIA-568-B or ISO/IEC 11801 (Class D).
(not specified)	^a	Terminal block	^b	CAT5 STP Two shielded twisted pairs
100BASE-SX IEEE Std 802.3-2015, Clauses 24 and 26	550 m	IEC 61754-20 LC type duplex optical connector ^d		Two multimode optical fibres Short wavelength 850 nm
1000BASE-T IEEE Std 802.3-2015, Clause 40	100 m	IEC 60603-7-7, 8-way shielded modular connector Refer to IEEE Std 802.3-2015, Clause 3, and IEC 60603-7, Figures 1 through 5. See IEEE Std 802.3/25	^c	CAT5 STP Four shielded twisted pairs ANSI/TIA/EIA-568-A, ANSI/TIA/EIA-568-B or ISO/IEC 11801 (Class D).
1000BASE-SX IEEE Std 802.3-2015, Clause 38	220 m (62/125 µm, low modal bw) 550 m (50/125 µm, high modal bw)	IEC 61754-20 LC type duplex optical connector ^d		Two multimode optical fibres Short wavelength 850 nm
For use in exposed environments, additional provisions are necessary. Consideration should be given to the M12-type specified in IEC 61076-2-101 for copper network cable. And similar rugged connector should be considered for external fibre optic connections.				
^a In this case, the maximum operating distance should be specified by the manufacturer. ^b The 8-way modular connector specified in IEC 60603-7 is the "8P8C" type that has commonly been used in desktop computer LAN connections and incorrectly but widely referred to as "RJ45". Wires are in the order 1, 2, 3, 6, 4, 5, 7, 8 on the modular jack; the same at each end of a cable. The color-order from wire 1 to 8 shall be green/white, green, orange/white, blue, blue/white, orange, brown/white, brown; the same at both ends of the cable. Refer to IEEE Std 802.3-2015, 25.4.3, and IEC 60603-7-3. ^c The 8-way modular connector specified in IEC 60603-7 is the "8P8C" type that has commonly been used in desktop computer LAN connections and incorrectly but widely referred to as "RJ45". Wires are in the order 1, 2, 3, 6, 4, 5, 7, 8 on the modular jack; the same at each end of a cable. The color-order from wire 1 to 8 shall be green/white, green, orange/white, blue, blue/white, orange, brown/white, brown; the same at both ends of the cable. Refer to IEEE Std 802.3-2015, 40.8.1 and IEC 60603-7-7. ^d See TIA/EIA-604-10-A:2002.				

5.2 Network protocol requirements

(see 8.7.2)

Equipment shall implement IPv4 as generally described in ISOC RFC 5000 with a minimum requirement of support for the following specific network protocols:

- ARP – Address Resolution Protocol as described in ISOC RFC 826 and as updated in ISOC RFC 5227;