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Edition 1.0 2009-08

PUBLICLY AVAILABLE SPECIFICATION

PRE-STANDARD

Industrial communication networks – Fieldbus specifications –
Part 3-22: Data-link layer service definition – Type SNpTYPE elements

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**Industrial communication networks – Fieldbus specifications –
Part 3-22: Data-link layer service definition – Type SNpTYPE elements**

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Part 3-22: Data-link layer service definition – Type SNpTYPE elements

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Draft PAS	**Report on voting**
65C/530/PAS	65C/534/RVD

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The list of all the parts of the IEC 61158 series, under the general title *Industrial communication networks – Fieldbus specifications*, can be found on the IEC web site.

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INTRODUCTION

This PAS contains an additional profile – SNpTYPE – which may be integrated into a future new edition of the IEC 61158-3 series.

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 3-22: Data-link layer service definition – Type SNpTYPE elements

1 Scope

1.1 Overview

This part of IEC 61158-3 provides common elements for basic time-critical messaging communications between devices in an automation environment. The term “time-critical” is used to represent the presence of a time-window, within which one or more specified actions are required to be completed with some defined level of certainty. Failure to complete specified actions within the time window risks failure of the applications requesting the actions, with attendant risk to equipment, plant and possibly human life.

This part of IEC 61158-3 defines in an abstract way the externally visible service provided by the Type SNpTYPE fieldbus data-link layer in terms of:

a) the primitive actions and events of the service;

b) the parameters associated with each primitive action and event, and the form which they take; and

c) the interrelationship between these actions and events, and their valid sequences.

The purpose of this part of IEC 61158-3 is to define the services provided to:

- the Type SNpTYPE fieldbus application layer at the boundary between the application and data-link layers of the fieldbus reference model; and
- systems management at the boundary between the data-link layer and systems management of the fieldbus reference model.

1.2 Specifications

The principal objective of this part of IEC 61158-3 is to specify the characteristics of conceptual data-link layer services suitable for time-critical communications, and thus supplement the OSI Basic Reference Model in guiding the development of data-link protocols for time-critical communications. A secondary objective is to provide migration paths from previously-existing industrial communications protocols.

This specification may be used as the basis for formal DL-Programming-Interfaces. Nevertheless, it is not a formal programming interface, and any such interface will need to address implementation issues not covered by this specification, including:

a) the sizes and octet ordering of various multi-octet service parameters; and

b) the correlation of paired request and confirm, or indication and response, primitives.

1.3 Conformance

This part of IEC 61158-3 does not specify individual implementations or products, nor do they constrain the implementations of data-link entities within industrial automation systems.

There is no conformance of equipment to this data-link layer service definition standard. Instead, conformance is achieved through implementation of the corresponding data-link protocol that fulfils the Type SNpTYPE data-link layer services defined in this part of IEC 61158-3.

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2 Normative references

The following referenced documents are indispensable for the application 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.

ISO/IEC 7498-1, *Information technology – Open Systems Interconnection – Basic Reference Model — Basic Reference Model: The Basic Model*

ISO/IEC 7498-3, *Information technology – Open Systems Interconnection – Basic Reference Model — Basic Reference Model: Naming and addressing*

ISO/IEC 10731, *Information technology – Open Systems Interconnection – Basic Reference Model — Conventions for the definition of OSI services*

3 Terms, definitions, symbols, abbreviations and conventions

3.1 Reference model terms and definitions

This part of IEC 61158-3 is based in part on the concepts developed in ISO/IEC 7498-1 and ISO/IEC 7498-3, and makes use of the following terms defined therein:

3.1.1 DL-address [7498-3]

3.1.2 called-DL-address [7498-3]

3.1.3 calling-DL-address [7498-3]

3.1.4 DL-connection [7498-1]

3.1.5 DL-connection-end-point [7498-1]

3.1.6 DL-connection-end-point-identifier [7498-1]

3.1.7 DL-connection-mode transmission [7498-1]

3.1.8 DL-connectionless-mode transmission [7498-1]

3.1.9 correspondent (N)-entities [7498-1]
correspondent DL-entities (N=2)
correspondent Ph-entities (N=1)

3.1.10 decentralized multi-end-point-connection [7498-1]

3.1.11 DL-duplex-transmission [7498-1]

3.1.12 (N)-entity [7498-1]
DL-entity (N=2)
Ph-entity (N=1)

3.1.13 DL-facility [7498-1]

3.1.14 flow control [7498-1]

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3.1.15 (N)-layer [7498-1]
DL-layer (N=2)
Ph-layer (N=1)

3.1.16 layer-management [7498-1]

3.1.17 DL-local-view [7498-3]

3.1.18 multi-endpoint-connection [7498-1]

3.1.19 DL-name [7498-3]

3.1.20 naming-(addressing)-domain [7498-3]

3.1.21 peer-entities [7498-1]

3.1.22 primitive name [7498-3]

3.1.23 DL-protocol [7498-1]

3.1.24 DL-protocol-connection-identifier [7498-1]

3.1.25 DL-protocol-data-unit [7498-1]

3.1.26 DL-relay [7498-1]

3.1.27 reassembling [7498-1]

3.1.28 reset [7498-1]

3.1.29 responding-DL-address [7498-3]

3.1.30 routing [7498-1]

3.1.31 segmenting [7498-1]

3.1.32 (N)-service [7498-1]
DL-service (N=2)
Ph-service (N=1)

3.1.33 (N)-service-access-point [7498-1]
DL-service-access-point (N=2)
Ph-service-access-point (N=1)

3.1.34 DL-service-access-point-address [7498-3]

3.1.35 DL-service-connection-identifier [7498-1]

3.1.36 DL-service-data-unit [7498-1]

3.1.37 DL-simplex-transmission [7498-1]

3.1.38 DL-subsystem [7498-1]

3.1.39 systems-management [7498-1]

3.1.40 DL-user-data [7498-1]

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3.2 Service convention terms and definitions

This part of IEC 61158-3 also makes use of the following terms defined in ISO/IEC 10731 as they apply to the data-link layer:

3.2.1 acceptor

3.2.2 asymmetrical service

3.2.3 confirm (primitive);
requestor.deliver (primitive)

3.2.4 deliver (primitive)

3.2.5 DL-confirmed-facility

3.2.6 DL-facility

3.2.7 DL-local-view

3.2.8 DL-mandatory-facility

3.2.9 DL-non-confirmed-facility

3.2.10 DL-provider-initiated-facility

3.2.11 DL-provider-optional-facility

3.2.12 DL-service-primitive;
primitive

3.2.13 DL-service-provider

3.2.14 DL-service-user

3.2.15 DL-user-optional-facility

3.2.16 indication (primitive);
acceptor.deliver (primitive)

3.2.17 multi-peer

3.2.18 request (primitive);
requestor.submit (primitive)

3.2.19 requestor

3.2.20 response (primitive);
acceptor.submit (primitive)

3.2.21 submit (primitive)

3.2.22 symmetrical service

3.3 Data-link service terms and definitions

3.3.1
acyclic data
data which is transferred from time to time for dedicated purposes

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3.3.2
cell
synonym for a single DL-segment which uses RTFL communication model

3.3.3
communication cycle
fixed time period between which the root device issues empty frames for cyclic communication initiation in which data is transmitted utilizing CDC and MSC

3.3.4
cycle time
duration of a communication cycle

3.3.5
cyclic
events which repeat in a regular and repetitive manner

3.3.6
cyclic communication
periodic exchange of frames

3.3.7
cyclic data
data which is transferred in a regular and repetitive manner for dedicated purposes

3.3.8
cyclic data channel (CDC)
one or more frames, which are reserved for cyclic data

3.3.9
data
generic term used to refer to any information carried over a fieldbus

3.3.10
device
physical entity connected to the fieldbus

3.3.11
DL-segment
single DL-subnetwork in which any of the connected DLEs may communicate directly, without any intervening DL-relaying, whenever all of those DLEs that are participating in an instance of communication are simultaneously attentive to the DL-subnetwork during the period(s) of attempted communication

3.3.12
error
discrepancy between a computed, observed or measured value or condition and the specified or theoretically correct value or condition

3.3.13
extended link
DL-subnetwork, consisting of the maximal set of links interconnected by DL-relays, sharing a single DL-name (DL-address) space, in which any of the connected DL-entities may communicate, one with another, either directly or with the assistance of one or more of those intervening DL-relay entities

NOTE An extended link may be composed of just a single link.

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3.3.14
frame
denigrated synonym for DLPDU

3.3.15
gateway
device acting as a linking element between different protocols

3.3.16
interface
shared boundary between two functional units, defined by functional characteristics, signal characteristics, or other characteristics as appropriate

3.3.17
link
synonym for DL-segment

3.3.18
master clock
global time base for the PCS mechanism

3.3.19
message
ordered sequence of octets intended to convey data

3.3.20
message channel (MSC)
one or more frames, which are reserved for acyclic data

3.3.21
network
set of devices connected by some type of communication medium, including any intervening repeaters, bridges, routers and lower-layer gateways

3.3.22
open network
any Ethernet-based network with no further restrictions

3.3.23
ordinary device (OD)
slave in the communication system, which utilizes RTFL for cyclic and acyclic data interchange with other ODs in the same logical double line

3.3.24
precise clock synchronization (PCS)
mechanism to synchronize clocks of RTFL devices and maintain a global time base

3.3.25
process data
data designated to be transferred cyclically or acyclically for the purpose of processing

3.3.26
protocol
convention about the data formats, time sequences, and error correction in the data exchange of communication systems

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3.3.27
root device (RD)
master in the communication system, which organises, initiates and controls the RTFL cyclic and acyclic data interchange for one logical double line

3.3.28
real time frame line (RTFL)
communication model for communication with high real time requirements

3.3.29
real time frame network (RTFN)
communication model for communication with low real time requirements

3.3.30
switch
MAC bridge as defined in IEEE 802.1D

3.3.31
timing signal
time-based indication of the occurrence of an event, commonly as an interrupt signal, used for DL-user synchronization

3.3.32
topology
physical network architecture with respect to the connection between the stations of the communication system

3.4 Symbols and abbreviations

3.4.1 CDC	Cyclic data channel
3.4.2 CDCS	Cyclic data channel send
3.4.3 DA	Device address
3.4.4 DL-	Data-link layer (as a prefix)
3.4.5 DLL	DL-layer
3.4.6 DLS	DL-service
3.4.7 DMR	DL-DelayMeasurement read
3.4.8 DMS	DL-DelayMeasurement send
3.4.9 ID	Identification
3.4.10 IP	Internet protocol
3.4.11 IRQ	Interrupt request
3.4.12 MAC	Medium access control
3.4.13 MII	Media independent interface

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3.4.14 MIIR DL-Media independent interface read

3.4.15 MIIW DL-Media independent interface write

3.4.16 MSC Message channel

3.4.17 MSCDN Message channel data notification

3.4.18 MSCR Message channel read

3.4.19 MSCS Message channel send

3.4.20 MSCSB Message channel send broadcast

3.4.21 NV DL-Network verification

3.4.22 OD Ordinary device

3.4.23 OSI Open systems interconnection

3.4.24 PID Packet ID

3.4.25 PCS Precise clock synchronization

3.4.26 PCSC DL-PCS configuration

3.4.27 RD Root device

3.4.28 RDCD DL-Read configuration data

3.4.29 RTF Real time frame

3.4.30 RTFL Real time frame line

3.4.31 RTFLCFG DL-RTFL configuration

3.4.32 RTFLCTL DL-RTFL control

3.4.33 RTFN Real time frame network

3.4.34 RTFNCE DL-RTFN connection establishment

3.4.35 RTFNCR DL-RTFN connection release

3.4.36 RTFNSNR DL-RTFN Scan network read

3.4.37 SYNC Synchronization

3.4.38 SYNC_MC DL-Sync master configuration

3.4.39 SYNC_START DL-Sync start

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3.4.40 SYNC_STOP DL-Sync stop

3.4.41 TCP Transmission control protocol

3.4.42 UDP User datagram protocol

3.5 Common conventions

This part of IEC 61158-3 uses the descriptive conventions given in ISO/IEC 10731.

The service model, service primitives, and time-sequence diagrams used are entirely abstract descriptions; they do not represent a specification for implementation.

Service primitives, used to represent service user/service provider interactions (see ISO/IEC 10731), convey parameters that indicate information available in the user/provider interaction.

This part of IEC 61158-3 uses a tabular format to describe the component parameters of the DLS primitives. The parameters that apply to each group of DLS primitives are set out in tables throughout the remainder of this part of IEC 61158-3. Each table consists of up to six columns, containing the name of the service parameter, and a column each for those primitives and parameter-transfer directions used by the DLS:

- the request primitive's input parameters;
- the request primitive's output parameters;
- the indication primitive's output parameters;
- the response primitive's input parameters; and
- the confirm primitive's output parameters.

NOTE The request, indication, response and confirm primitives are also known as requestor.submit, acceptor.deliver, acceptor.submit, and requestor.deliver primitives, respectively (see ISO/IEC 10731).

One parameter (or part of it) is listed in each row of each table. Under the appropriate service primitive columns, a code is used to specify the type of usage of the parameter on the primitive and parameter direction specified in the column:

M parameter is mandatory for the primitive.

U parameter is a User option, and may or may not be provided depending on the dynamic usage of the DLS-user. When not provided, a default value for the parameter is assumed.

C parameter is conditional upon other parameters or upon the environment of the DLS-user.

(blank) parameter is never present.

Some entries are further qualified by items in brackets. These may be a parameter-specific constraint:

(=) indicates that the parameter is semantically equivalent to the parameter in the service primitive to its immediate left in the table.

In any particular interface, not all parameters need be explicitly stated. Some may be implicitly associated with the primitive.

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In the diagrams which illustrate these interfaces, dashed lines indicate cause-and-effect or time-sequence relationships, and wavy lines indicate that events are roughly contemporaneous.

4 Data-link layer services and concepts

4.1 Operating principle

Type SNpType of this series of international standards describes a real-time Ethernet technology which overcomes the requirements of modern automation technology. For the purpose of fast intra-machine communication Type SNpTYPE describes a communication model (RTFL) for fast real-time communication. Furthermore, networking of several parts of an automation system into an overall system is supported by the specification of a second communication model (RTFN). Type SNpTYPE is designed as a multi-master bus system. This makes networking of individual control systems to a distributed automated solution quite easy.

From an Ethernet point of view, a Type SNpTYPE network utilizes standard ISO/IEC 8802-3 Ethernet frames for both communication models.

4.2 Communication models

4.2.1 Overview

Type SNpTYPE technology essentially specifies two communication models. RTFL communication is intended for fast machine communication while RTFN provides for the networking of individual machines or cells.

For RTFL communication model, communication follows a line topology. RTFL communication is based on cyclic data transfer in an ISO/IEC 8802-3 Ethernet frame. This basic cyclic data transfer is provided by a special device, the root device (RD). Root devices act as communication master to cyclically initiate communication. The Ethernet frames originated by the root device are passed to the Type SNpTYPE ordinary devices (OD). Each ordinary device receives the frame, writes its data and passes the frame on. A RTFL network requires exactly one root device. The last ordinary device of a RTFL network sends the processed frame back. The frame is transferred back in reverse device order to the root device so that it is returned by the first ordinary device to the root device as response frame. In backward direction, the ordinary devices read their relevant data from the frame.

For RTFN communication model, communication is based on individual point to point connections between participating devices.

4.2.2 RTFL device reference model

Type SNpTYPE services are described using the principles, methodology and model of ISO/IEC 7498-1 (OSI). The OSI model provides a layered approach to communications standards, whereby the layers can be developed and modified independently. The Type SNpTYPE specification defines functionality from top to bottom of a full OSI model. Functions of the intermediate OSI layers, layers 3 to 6, are consolidated into either the Type SNpTYPE data-link layer or the DL-user. The device reference model for a Type SNpType RTFL device is shown in Figure 1.

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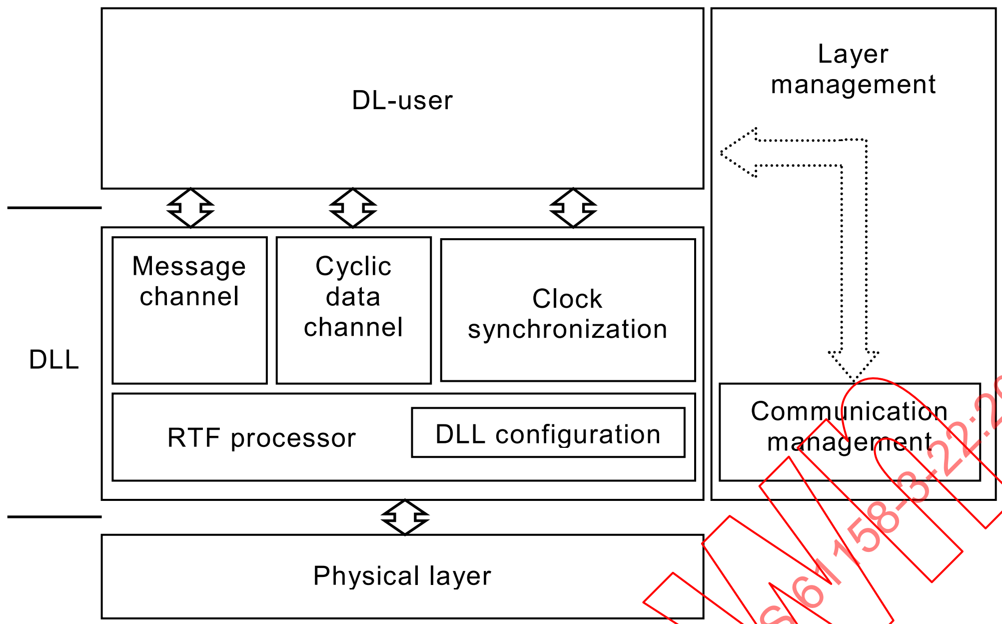

Figure 1 – RTFL device reference model

4.2.3 RTFN device reference model

Type SNpTYPE services are described using the principles, methodology and model of ISO/IEC 7498-1 (OSI). The OSI model provides a layered approach to communications standards, whereby the layers can be developed and modified independently. The Type SNpTYPE specification defines functionality from top to bottom of a full OSI model. Functions of the intermediate OSI layers, layers 3 to 6, are consolidated into either the Type SNpTYPE data-link layer or the DL-user. The device reference model for a Type SNpType RTFN device is shown in Figure 2.

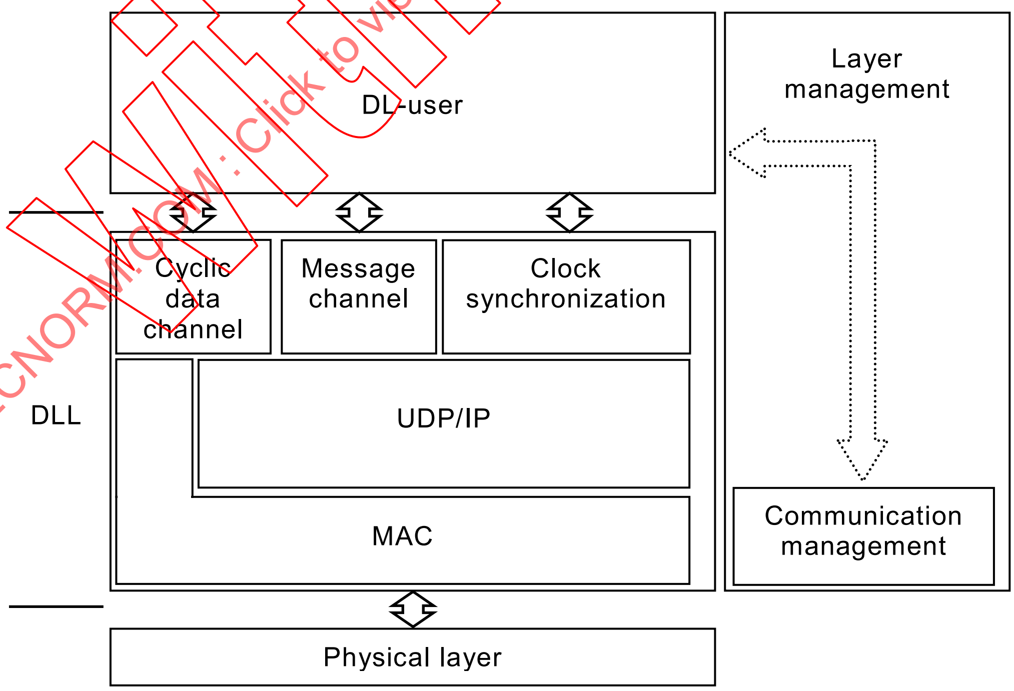

Figure 2 – RTFN device reference model

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4.3 Topology

4.3.1 RTFL topology

A Type SNpTYPE network utilizing the RTFL communication model uses a line topology. Data transfer is handled by frame transfer from one device to the next device along a line. The last ordinary device returns the frame back to the root device along all participating ordinary devices. The line corresponds to the logical addressed device sequence. A logical double line is represented by the arrangement of all ordinary devices and the root device and the frame processing in forward and backward direction.

A logical double line is able to allow different network topologies. In a switch operated tree structure each ordinary device has a predecessor and a successor device although they are not physically located in a sequence. This is shown in Figure 3.

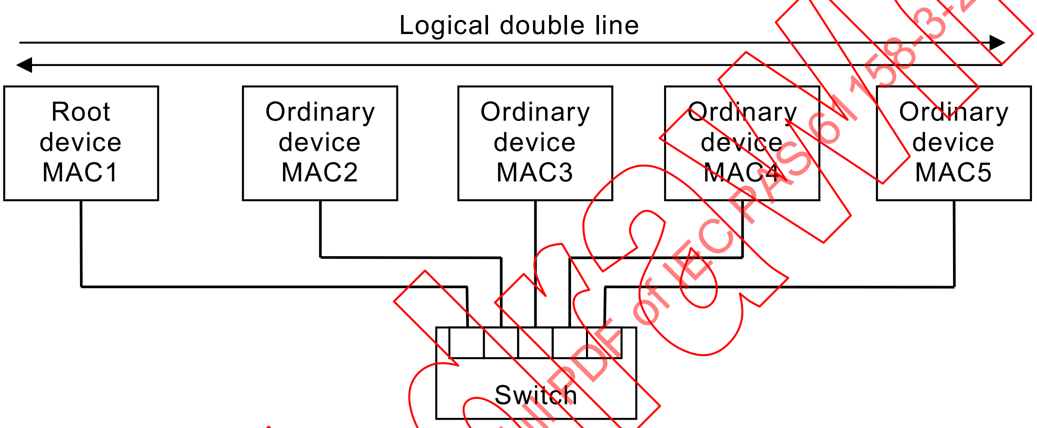

Figure 3 – Logical double line in a physical tree topology

The ordinary devices for the RTFL communication model should provide two Ethernet interfaces. This allows set-up of a physical line structure as shown in Figure 4. If the ordinary devices are arranged in a physical line frames shall be directly forwarded from one interface to the next interface and processed on-the-fly (cut-through).

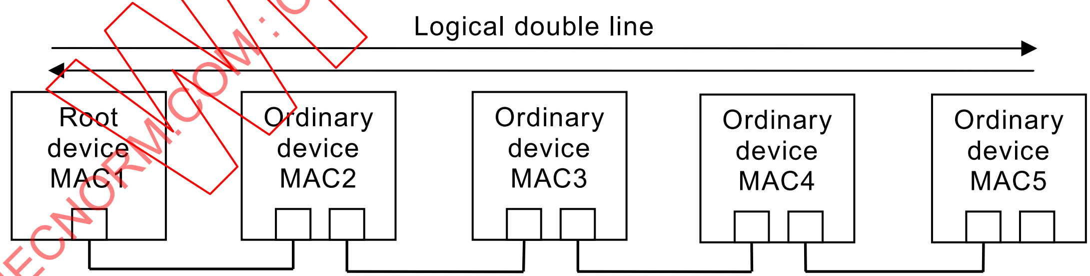

Figure 4 – Logical double line in a physical line topology

For a Type SNpTYPE network utilizing the RTFL communication model the frame pump concept is specified. This concept shall be applied by the root device within a RTFL network to cyclically initiate communication. Frame pumping depicts the generation of an RTF Ethernet frame into the RTFL network to be processed by all participating ordinary devices for communication purposes.

4.3.2 RTFN topology

A Type SNpTYPE network utilizing the RTFN communication model shall support all commonly used Ethernet topologies.

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4.4 Addressing

4.4.1 Overview

Different addressing modes are supported for Type SNpTYPE devices, as noted in Figure 5. A general differentiation exists for RTFL devices and RTFN devices.

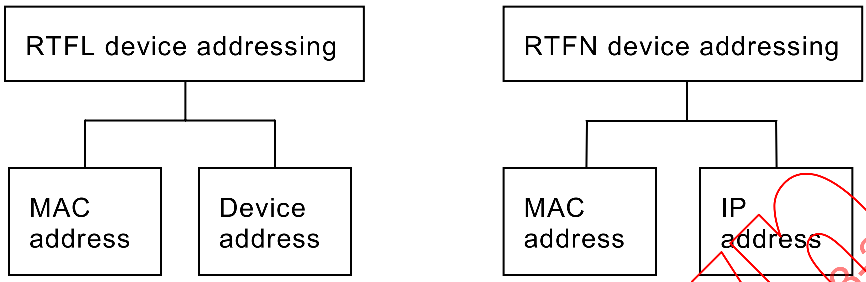

Figure 5 – Addressing modes

4.4.2 RTFL device addressing

MAC addresses shall be used to address each device via its MAC address within the logical double line.

Device addresses shall be used to address devices via a configured device address assigned by the root device during the start-up phase. Device addresses shall be used for addressing devices within DL-user communication relationships.

4.4.3 RTFN device addressing

IP addresses shall be used to address devices within a RTFN network for cyclic or acyclic communication based on UDP frames.

MAC addresses shall be used to address devices within a RTFN network for cyclic communication based on MAC frames.

4.5 Gateway

The gateway acts as linking element between RTFL and RTFN networks. In addition, it is a standard Ethernet gateway between Type SNpTYPE networks and the open network. A device incorporating a gateway can be an ordinary device or can also include the root device. Address translation between the different addressing modes for RTFL and RTFN shall be performed by the gateway.

4.6 Interaction models

4.6.1 Overview

Depending on the specified communication models RTFL and RTFN Type SNpTYPE networks utilize different interaction models for cyclic data exchange.

4.6.2 Producer-consumer

Communication model RTFL uses the producer-consumer interaction model. It involves a single producer and a group of zero or more consumer(s). The model is characterized by an unconfirmed service requested by the producer to distribute its cyclic data and a correlated service indication in all available consumers.

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4.6.3 Publisher-subscriber

Communication model RTFN utilizes the publisher-subscriber push interaction model for cyclic data exchange. Publisher-subscriber interactions involve a single publisher and a group of one or more subscribers. Two services are used, one confirmed and one unconfirmed. The confirmed service is used by the subscriber to request to join the publishing. The response to this request is returned to the subscriber. The unconfirmed service is used by the publisher to distribute its cyclic data to subscribers.

4.7 Synchronization concept

Clock synchronization within Type SNpTYPE networks is based on synchronization protocols. For DL-users, synchronization is achieved by using a set of DL-services.

Synchronization protocols enable all Type SNpTYPE devices to have the same system time. This system time is synchronized with a dedicated master clock. Based on this time, the concept of synchronized timing signals (IRQs) that can be generated independent of the communication cycle for DL-users is provided. Each timing signal is unambiguously identifiable within a Type SNpTYPE network and assigned to a dedicated synchronization master (SYNC master). The synchronization master shall maintain all required configuration information. DL-users which act as synchronization slaves (SYNC slave) shall request this information for configuration and activation purpose using a DL-service. The main properties of synchronized timing signals are:

- cycle time;
- time offset; and
- start time.

DL-users which act as synchronization master (SYNC master) shall use a local configuration service for the configuration.

Figure 6 illustrates the interactions between a SYNC slave and a SYNC master for configuration data exchange utilizing a time-sequence diagram.

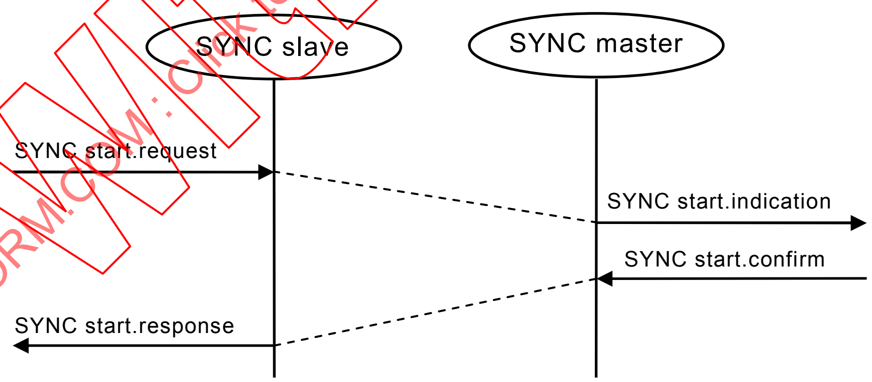

Figure 6 – Time sequence diagram for time SYNC_START service

Figure 7 illustrates the generation of synchronized timing signals (IRQs) for one SYNC slave and its corresponding SYNC master after successful slave configuration. Independent from the communication system synchronized timing signals (IRQs) are generated in both devices to the DL-user.

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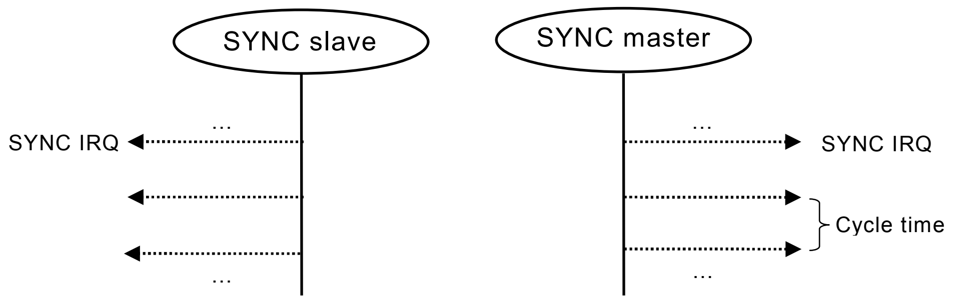

Figure 7 – Synchronized timing signals without offset

Figure 8 illustrates the generation of synchronized timing signals (IRQs) for one SYNC slave and its corresponding SYNC master after successful slave configuration. Independent from the communication system synchronized timing signals (IRQs) are generated in both devices to the DL-user. For the SYNC slave, a time offset relating to the SYNC master timing signal is configured.

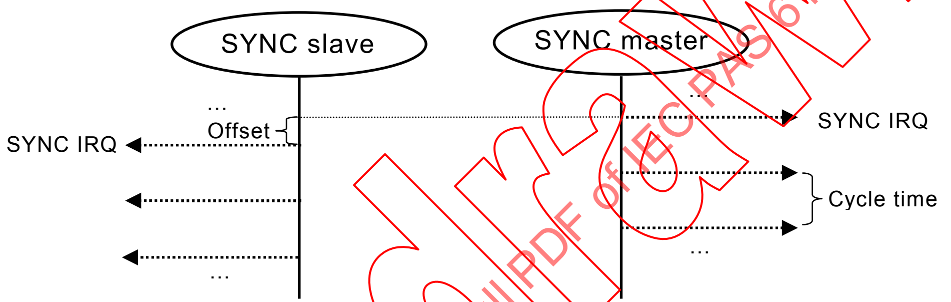

Figure 8 – Synchronized timing signals with offset

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5 Communication services

5.1 Overview

The data-link layer specifies Type SNpTYPE services for reading and writing data from devices in a Type SNpTYPE network (see Table 1). There are four different types of services:

- communication management services (confirmed and unconfirmed, non-cyclic);
- cyclic data channel (CDC) services (unconfirmed, cyclic);
- message channel (MSC) services (confirmed and unconfirmed, non-cyclic);
- time synchronization services (confirmed, non-cyclic).

Table 1 – Summary of DL-services and primitives

Service	Primitive
Acknowledged connection oriented data transfer: Network verification (NV)	DL-NV request DL-NV indication DL-NV response DL-NV confirmation
Acknowledged connection oriented data transfer: RTFN scan network read (RTFNSNR)	DL-RTFNSNR request DL-RTFNSNR indication DL-RTFNSNR response DL-RTFNSNR confirmation

Service	Primitive
Acknowledged connection oriented data transfer: RTFN connection establishment (RTFNCE)	DL-RTFNCE request DL-RTFNCE indication DL-RTFNCE response DL-RTNFCE confirmation
Unacknowledged connectionless data transfer: RTFN connection release (RTFNCR)	DL-RTFNCR request DL-RTFNCR indication
Unacknowledged connectionless data transfer: RTFL control (RTFLCTL)	DL-RTFLCTL request DL-RTFLCTL indication
Acknowledged connection oriented data transfer: RTFL configuration (RTFLCFG)	DL-RTFLCFG request DL-RTFLCFG indication DL-RTFLCFG response DL-RTFLCFG confirmation
Unacknowledged connectionless data transfer: CDC send (CDCS)	CDCS request CDCS indication
Acknowledged connection oriented data transfer: MSC send (MSCS)	MSCS request MSCS indication MSCS response MSCS confirmation
Unacknowledged connectionless data transfer: MSC send broadcast (MSCSB)	MSCSB request MSCSB indication
Unacknowledged connectionless data transfer: DelayMeasurement start (DMS)	DL-DMS request DL-DMS indication
Acknowledged connection oriented data transfer: DelayMeasurement read (DMR)	DL-DMR request DL-DMR indication DL-DMR response DL-DMR confirmation
Unacknowledged connectionless data transfer: PCS configuration	DL-PCSC request DL-PCSC indication
Acknowledged connection oriented data transfer: Sync start (SYNC_START)	DL-SYNC_START request DL-SYNC_START indication DL-SYNC_START response DL-SYNC-START confirmation

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5.2 Communication management services

5.2.1 Overview

With communication management services, Type SNpTYPE devices perform the initialization of a Type SNpTYPE network and connections.

5.2.2 Network verification

5.2.2.1 DL-Network verification service (NV)

With the NV service as specified in Table 2 a DL-user can verify the Type SNpTYPE RTFL network against a preset set of participating devices.

Table 2 – DL-Network verification service (NV)

Parameter name	Request input	Indication output	Response input	Confirmation output
Identification data list			M	M (=)
NOTE The method by which a confirm primitive is correlated with its corresponding preceding request primitive is a local matter. The method by which a response primitive is correlated with its corresponding preceding indication primitive is a local matter. See 1.2.				

Parameter description

Identification data list

This parameter shall contain the result of the RTFL network verification. It shall reflect the participating devices by a list consisting of one identification data set for each device.

5.2.2.2 DL-RTFN scan network read service (RTFNSNR)

The RTFNSNR service as specified in Table 3 allows to explore a RTFN network. All participating devices are identified by descriptive identification data.

Table 3 – DL-RTFN scan network read service (RTFNSNR)

Parameter name	Request input	Indication output	Response input	Confirmation output
Identification data list			M	M (=)
NOTE The method by which a confirm primitive is correlated with its corresponding preceding request primitive is a local matter. The method by which a response primitive is correlated with its corresponding preceding indication primitive is a local matter. See 1.2.				

Parameter description

Identification data list

This parameter shall contain the result of the RTFN topology exploration. It shall reflect the participating RTFN devices by a list consisting of one identification data set for each device.

5.2.3 Communication management

5.2.3.1 DL-RTFN connection establishment service (RTFNCE)

With the RTFNCE service as specified in Table 4 a device shall establish its CDC connections to other devices.

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Table 4 – DL-RTFN connection establishment DLL service (RTFNCE)

Parameter name	Request input	Indication output	Response input	Confirmation output
Command	M	M (=)		
PID	M	M (=)		
UseUDP	M	M (=)		
Error code			M	M (=)
IP address			M	M (=)
NOTE The method by which a confirm primitive is correlated with its corresponding preceding request primitive is a local matter. The method by which a response primitive is correlated with its corresponding preceding indication primitive is a local matter. See 1.2.				

Parameter description

Command

This parameter shall indicate the connection management function performed for the dedicated CDC connection.

PID

This parameter shall identify the requested process data.

UseUDP

This parameter indicates whether transmission of cyclic data shall use either UDP or MAC frames.

Error code

This parameter shall contain the error code for the performed connection management function.

IP address

This parameter depicts the IP Address of the data publisher.

5.2.3.2 DL-RTFN connection release service (RTFNCR)

With the RTFNCR service as specified in Table 5 a device shall terminates its CDC connections with other devices.

Table 5 – DL-RTFN connection release service (RTFNCR)

Parameter name	Request input	Indication output
Command	M	M (=)
PID	M	M (=)

Parameter description

Command

This parameter shall indicate the connection management function performed for the dedicated CDC connection.

PID

This parameter shall identify the process data.

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5.2.3.3 DL-RTFL control service (RTFLCTL)

The RTFLCTL service as specified in Table 6 is used by a root device to reset the communication system of participating devices.

Table 6 – DL-RTFL control service (RTFLCTL)

Parameter name	Request input	Indication output
Command	M	M (=)

Parameter description

Command

This parameter contains the reset command.

5.2.3.4 DL-RTFL configuration service (RTFLCFG)

The RTFLCFG service as specified in Table 7 is used by a root device to configure participating devices.

Table 7 – DL-RTFL configuration service (RTFLCFG)

Parameter name	Request input	Indication output	Response input	Confirmation output
Predecessor MAC	M	M (=)		
Successor MAC	M	M (=)		
Successor MAC altern.	M	M (=)		
Device Address	M	M (=)		
MSCShortMsgSize	M	M (=)		
Number of frames	M	M (=)		
Cycle time	M	M (=)		
RTF timeout	M	M (=)		
Master clock DA	M	M (=)		
IP configuration	C	C (=)		
Configuration summary			M	M (=)
NOTE The method by which a confirm primitive is correlated with its corresponding preceding request primitive is a local matter. The method by which a response primitive is correlated with its corresponding preceding indication primitive is a local matter. See 1.2.				

Parameter description

Predecessor MAC

This parameter indicates the MAC address of the preceding device within the logical double line.

Successor MAC

This parameter indicates the MAC address of the succeeding device within the logical double line.

Successor MAC alternative

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This parameter indicates an alternative MAC address of a succeeding device within the logical double line.

Device address

This parameter indicates the device address which shall be used.

MSCShortMsgSize

This parameter indicates the maximum message size in octets for an un-segmented message transfer using MSC.

Number of frames

This parameter indicates the number of RTF frames used for both possible communication channels.

Cycle time

This parameter indicates the cycle time of the communication cycle.

RTF timeout

This parameter indicates a maximum delay time for the RTFL communication cycle time from the expected communication cycle time.

Master clock DA

This parameter indicates the device address of the device which integrates the master clock.

IP configuration

This parameter indicates IP configuration data.

Configuration summary

This parameter contains a summary of the performed device configuration in terms of state information for the configured parameters.

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5.2.3.5 DL-Read configuration data service (RDCD)

The local RDCD service as specified in Table 8 is used by a DL-user to read the DL-configuration.

Table 8 – DL-Read configuration data service (RDCD)

Parameter name	Request input	Indication output	Response input	Confirmation output
Predecessor MAC			M	M (=)
Successor MAC			M	M (=)
Successor MAC altern.			M	M (=)
Device Address			M	M (=)
MSCShortMsgSize			M	M (=)
Number of frames			M	M (=)
Cycle time			M	M (=)
RTF timeout			M	M (=)
Master clock DA			M	M (=)
IP configuration			C	C (=)
NOTE The method by which a confirm primitive is correlated with its corresponding preceding request primitive is a local matter. The method by which a response primitive is correlated with its corresponding preceding indication primitive is a local matter. See 1.2.				

Parameter description

Predecessor MAC

This parameter indicates the MAC address of the preceding device within the logical double line.

Successor MAC

This parameter indicates the MAC address of the succeeding device within the logical double line.

Successor MAC alternative

This parameter indicates an alternative MAC address of a succeeding device within the logical double line.

Device address

This parameter indicates the device address which shall be used.

MSCShortMsgSize

This parameter indicates the maximum message size in octets for an un-segmented message transfer using MSC.

Number of frames

This parameter indicates the number of RTF frames used for both possible communication channels.

Cycle time

This parameter indicates the cycle time of the communication cycle.

RTF timeout

This parameter indicates a maximum delay time for the RTFL communication cycle time from the expected communication cycle time.

Master clock DA

This parameter indicates the device address of the device which integrates the master clock.

IP configuration

This parameter indicates IP configuration data.

5.3 CDC service

5.3.1 Overview

The cyclic data channel (CDC) is intended for cyclic real time data transfer. This mechanism shall be initiated by the DL-user.

5.3.2 CDC send service (CDCS)

With the CDCS service as specified in Table 9 a DL-user shall write the configured cyclic data for the next communication cycle.

Table 9 – CDC send service (CDCS)

Parameter name	**Request** input	**Indication** output
PID	M	M (=)
Data	M	M (=)

Parameter description

PID

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This parameter shall identify the process data to be sent.

Data

This parameter shall contain the cyclic data which has to be sent.

5.4 MSC services

5.4.1 Overview

The message channel is used for acyclic communication. Data is transferred as variable-length segmented messages. The MSC service is a confirmed service.

5.4.2 MSC send service (MSCS)

A DL-user shall use the MSCS service as specified in Table 10 to send data to a device selected by a device or IP address.

Table 10 – MSC send service (MSCS)

Parameter name	Request input	Indication output	Response input	Confirmation output
Data	M	M (=)		
Destination DA	C	C (=)		
IP address	C	C (=)		
Error code			M	M (=)
NOTE The method by which a confirm primitive is correlated with its corresponding preceding request primitive is a local matter. The method by which a response primitive is correlated with its corresponding preceding indication primitive is a local matter. See 1.2.				

Parameter description

Data

This parameter shall contain the data which is sent to the device.

Destination DA

This parameter shall contain the destination device address

IP Address

This parameter shall contain the IP address of the source or destination

Error code

This parameter shall contain the error code for the send request.

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5.4.3 MSC send broadcast service (MSCSB)

A DL-user shall use the MSCSB service as specified in Table 11 to send data to all participating devices.

Table 11 – MSC send broadcast service (MSCSB)

Parameter name	Request input	Indication output
Data	M	M (=)