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Foreword

This document is the Publicly Available Specification (PAS) of the TETRAPOL land mobile radio system, which shall provide digital narrow band voice, messaging, and data services. Its main objective is to provide specifications dedicated to the more demanding PMR segment: the public safety. These specifications are also applicable to most PMR networks.

This PAS is a multipart document which consists of:

Part 1 General Network Design

Part 2 Radio Air interface

Part 3 Air Interface Protocol

Part 4 Gateway to X.400 MTA

Part 5 Dispatch Centre interface

Part 6 Line Connected Terminal interface

Part 7 Codec

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Part 18 Base station to Radioswitch interface

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1. Scope

This specification is a subpart of PAS 0001-3: TETRAPOL Air Interface protocol.

This subpart 3-1 specifies the TETRAPOL interface transport protocol and link procedures at reference points R3 and R4 (see PAS 0001-1 [1]).

The different Clauses cover:

- The data link layer (LLC) offered Services, Primitives and the Protocol Data Units;
- The Transport protocol offered Services, the TPDU structure, the procedures;
- The Datagram Transport layer.

2. Normative references

This PAS incorporates by dated and undated reference, provisions from other applications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revision of any of these publications apply to this PAS only when incorporated in it by amendment or revision. For undated references the latest edition of publication referred to applies.

[1] PAS 0001-1-1: "TETRAPOL Specifications; General Network Design; Reference Model".

[2] PAS 0001-1-2: "TETRAPOL Specifications; General Network Design; Voice and Data Services in Network and Direct Mode".

[3] PAS 0001-3-1: "TETRAPOL Specifications; Air Interface Protocol; Air Interface Application Protocol".

[4] PAS 0001-3-2: "TETRAPOL Specifications; Air Interface Protocol; Air Interface Application Messages".[5] ISO 3309: "High level data link control (HDLC) procedures; Frame structure".

[6] ISO 7809: "Information processing systems; Remote operations; High level data link control procedures; Procedure classes consolidation".

[7] PAS 0001-2-0: "TETRAPOL Specifications; Radio Air Interface ".

3. Definitions and abbreviations

3.1 Definitions

For the purposes of this PAS, the following definitions apply:

Logical Channel: Predefined subset of superframe blocks. Endpoint SwMI or ST applications use logical channels for exchanging TPDUs (defined in this document). If the exchange is bi-directional, both block subsets are identified by the same name in the superframe sent by SwMI and the superframe received by SwMI respectively.

Base network: Autonomous equipment assembly (RSW), digital links, radio cells, line connection interface units, ...) used throughout a given geographic area providing STs with system services.

ST address: Logical identifier which unambiguously identifies an ST within the system. The ST address is a string of numeric characters; the first characters identify the regional network to which the ST belongs.

Coverage: Predefined set of radio cells and line connection terminal units.

Group (of users) / alias **OG** (Operational Group): Group of STs sharing the same service at a given time.

Group number / alias **OG** number: Logical number which identifies an operational user group.

Multiframe: Set of superframe (length in time slot: (base period*50*(two to the power of index of the maximum period used in the project)),

duration value included between 0 and 3 h

maximal number of slots = 540000

Hyperframe: Set of multiframe

maximal value for a hyperframe: (maximal slot number of multiframe(540000)*maximal number of TLR (256))=138240000 time slots

3.2 Abbreviations

For the purposes of this PAS, the following abbreviations apply:

A/I	Air Interface
ASB	Associated Signalling Bits
BCH	System information Broadcast Channel
BN	Base Network
BS	Base Station
CC	Connection Confirm
CCH	Control CHannel
CGI	Collective Group Identifier
COI	Collective Object Identifier
CR	Connection Request
CRP	Connection Reference Point
CTCH	Collective Traffic CHannel
CUG	Closed User Group
DACH	Dynamic Access CHannel
DB	Data Base
DC	Disconnection Confirm
DCH	Data CHannel
DCN	Delivery Confirmation Notification
DCS	Dispatch Centre Server
DFN	Delivery Failure Notification
DM	Direct Mode
DM/NM	Direct Mode / Network Monitoring
DP	Dispatch Position
DPS	Dispatch Position Switch
DPSI	Dispatch Position Switch Interface
DR	Disconnection Request
DT	Data Transfer primitive TPDU
DU	Data Unit
ECCH	Extended Control CHannel
EDT	External Data Terminal
FBM	FallBack Mode
FDR	Fast Disconnection Request
FN	Flag Number (to differentiate mono, bi, multi-block frames)
HMSW	Home Main SWitch
HRSW	Home Radio SWitch
ISI	Inter System Interface
KMC	Key Management Centre
LCIU	Line Connection Interface Unit
LCT	Line Connected Terminal
LC	Logical Link Control
LLC	Logical Link Control
MAC	Medium Access Control

MM	Mobility Management
MOCH	Multisite Open CHannel
MRI	Mobile Random Identity
MS	Mobile Station
MSG APPLI	Messaging APPLIcation
NMC	Network Management Centre
OCI	Object Call Identifier
OG	Operational Group
OMC	Operation and Maintenance Centre
PABX	Private Automatic Branch eXchange
PAS	Publicly Available Specification
PCH	Paging CHannel
(P)DN	(Public) Data Network
PDU	Protocol Data Unit
PMR	Private Mobile Radiocommunications
PSTN	Public Switched Telecommunications Network
PTCH	Private Traffic CHannel used for private voice calls
PTT	Push-To-Talk
RACH	Random Access CHannel
RCH	Random access answer CHannel
Ri	Reference point index i
RP	RePeater
RSW	Radio SWitch
RT	Radio Terminal
RTI	Random Terminal Identifier
SADP	Stand Alone Dispatch Position
SCH	Signalling CHannel
SCH_TI	Signalling CHannel for Transmitter Interruption
SDCH	Signalling and Data CHannel
SDL	Specification and Description Language
SDP	Submit Delivery Protocol
SFN	Submit Failure Notification
SIM	Subscriber Identity Module
ST	System Terminal (RT or LCT)
SwMI	Switching and Management Infrastructure
TCH	Traffic CHannel
TCP/IP	Transmission Control Protocol/Internet Protocol
TDX	Telephone and Data eXchange
TMSG-Id	Temporary MeSsaGe Identifier
TP	TransPort layer
TPDU	Transport service Protocol Data Unit
TSAP	Transport Service Access Point
TSAP-ID	Transport Service Access Point IDentifier
TSDU	Transport Service Data Unit
TTI	Temporary Terminal Identity
UA	User Agent
UDT	User Data Terminal
VCH	Voice Channel
VRSW	Visited Radio SWitch
X.400 MTA	X.400 Message Transfer Agent

4. Frame format descriptions

4.1 Numbering scheme

The figure below illustrates the numbering scheme. The bits are grouped in octets. The content of each octet is described in horizontal sequence. Successive octets are described in vertical sequence, numbered from 1 to n.

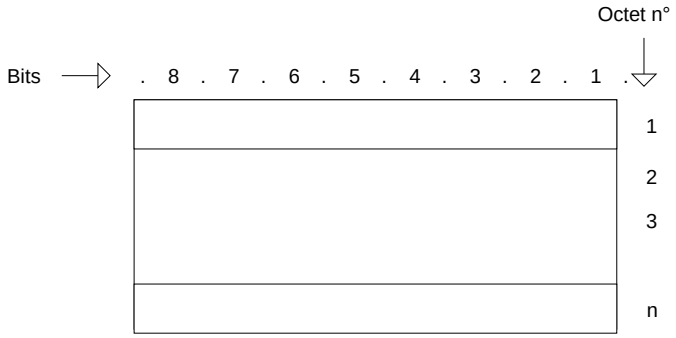


Figure 1: Numbering scheme

4.1.1 Order of bit transmission

Octets shall be transmitted in ascending order from 1 to n. Their content shall be transmitted in sequence, beginning with the least significant bit (bit 1 of octet 1 shall correspond to the first bit to transmit).

The protocol transmission direction adheres to the ISO HDLC standard. However, for ease of reading, the bit fields in this document are shown in the reverse order of the "conventional" HDLC model, with the least significant bits to the right of most significant bits.

4.1.2 Field override

When a field is conveyed in one octet, the least significant bit in the octet shall correspond to the least significant bit in the field.

When a field is coded in several octets, the significance of bits shall diminish as the number of octets increases.

Example:

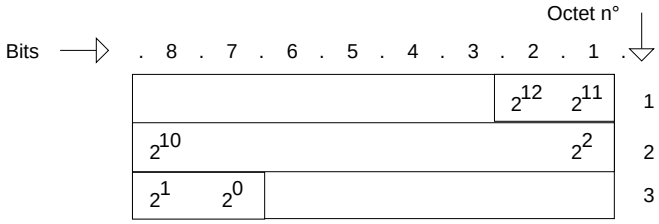


Figure 2: Field override

The formats described in this document are those exchanged by level 1 and the level above, and not those transmitted on the channel. Radio level 1 is described in PAS 001-2 [7].

5. Channel organisation

At a given time, the base station physical resources are allocated to either a Control CHannel (CCH), a Traffic CHannel (TCH).

A CCH may be either a Main Control CHannel (MCCH) or an Extended Control CHannel (ECCH).

In operational conditions, each base station should have at least one MCCH, M ECCHs (M can be 0) and N TCHs.

These channels should be strictly synchronous in a given direction. A control channel (CCH) supports signalling and/or data transmissions. A traffic channel (TCH) supports voice or data transfer transactions..

5.1 Logical channel multiplexing on control channel (CCH)

The control channel (CCH) shall carry five statically allocated time-division multiplexed logical channels and one dynamically allocated logical channel (DACH). (See Figure 1). The period of allocation shall be four seconds.

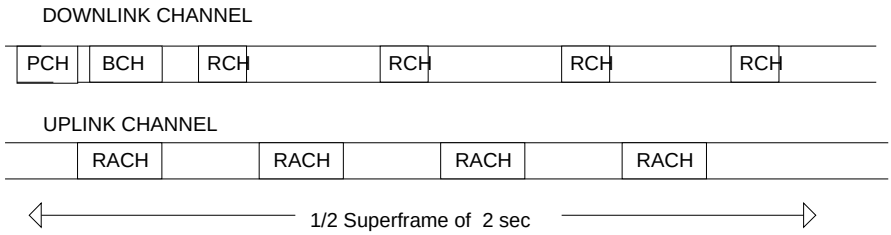


Figure 3: Logical Channel multiplexing on control channel

NOTE: The unfilled parts shall convey the SDCH (for the downlink channel) and the DACH/SDCH for the uplink channel.

5.1.1 Downlink channels

5.1.1.1 Broadcast CHannel (BCH)

The Broadcast Channel shall be used to broadcast static or semi-static information to all terminals.

5.1.1.2 Paging CHannel (PCH)

The Paging Channel can be used to transmit information inviting terminals either to listen to all the downlink logical channels of the control channel (CCH) or to immediately answer on the uplink dynamic access channel (DACH). The Paging Channel shall also be used to transmit information concerning activity of all the collective communications involved in the SwMI.

All the terminals on the control channel shall listen to PCH.

5.1.1.3 Random access answer CHannel (RCH)

This Channel shall be used to transmit the acknowledgements for blocks received on RACH. The SwMI shall transmit the acknowledgements in the same order that blocks are received on RACH.

5.1.1.4 Signalling and Data CHannel (SDCH)

The Signalling and Data Channel shall be used to realise transactions with the terminals.

5.1.2 Uplink Channels

5.1.2.1 Random Access Channel (RACH)

The terminal shall use the Random Access Channel to initiate an exchange with the Switching and Management Infrastructure (SwMI). Channel access procedure is determined by an algorithm, described later in this document [subclause 7.8]. The informations transmitted on RACH are described later in the document.

5.1.2.2 Signalling and Data Channel (SDCH)

The terminal uses the Signalling and Data Channel for data transactions with the base station. The terminal may only send a message on SDCH after obtaining permission from the Switching and Management Infrastructure (SwMI). The uplink and downlink SDCH form a bi-directional logical data channel.

The informations transmitted on SDCH are described later in the document.

5.1.2.3 Dynamic Access Channel (DACH)

The terminal can use this channel to spontaneously transmit information.

The Dynamic Access Channel is constructed with unused, uplink SDCH blocks.

The Switching and Management Infrastructure (SwMI) shall allocate unused SDCH blocks to DACH and shall supply the Terminals with the information they need to know their positions.

5.1.3 Multiplex definition

The position of logical channels in the control channel superframe is described in this section. The superframe shall contain 200 blocks of 20 ms each. Therefore, the superframe duration is 4 seconds. The blocks making up a logical channel are not always consecutive.

The beginning of the superframe is called "block 0". A superframe shall contain eight groups of three access blocks and two groups of PCH blocks.

Channel positions: 2 different configurations are avalaible, in this case the multiplex is indicated in the D_SYSTEM_INFO TSDU see PAS 0001-3-1: "TETRAPOL Specifications; Air Interface Protocol; Air Interface Application Protocol".

Downlink channel: (default TETRAPOL value)

- PCH: blocks 98, 99 and 198, 199;
- BCH: blocks 0 to 3 and 100 to 103;
- RCH: blocks 14 + (i * 25), i = 0 to 7;
- SDCH: other blocks.

Uplink channel:

- RACH: blocks 0 + (i * 25), 1 + (i * 25), 2 + (i * 25) for i = 0 to 7;
- DACH: blocks defined as usable by SwMI;
- SDCH: other blocks.

Downlink channel: type2

PCH: blocks 48, 49, 98, 99, 148, 149 and 198, 199;
All other logical channel identicals to default TETRAPOL value

5.2 Logical channel multiplexing on traffic channel (TCH)

A traffic channel may be assigned to a voice call or to data transmissions. It supports dynamic time-division multiplexed logical channels. The traffic channel superframe contains 200 blocks of 20 ms each. Therefore, the superframe duration is 4 seconds.

When assigned to a voice call a TCH contains the logical channels:

- VCH;
- SCH_TI;
- SCH.

When assigned to data transmissions a TCH contains the logical channels:

- DCH.

5.2.1 Downlink and uplink Channels

5.2.1.1 Voice Channel (VCH)

This Channel is used to transmit voice blocks or data blocks (circuit protocol management frames).

5.2.1.2 Data Channel (DCH)

This Channel is used to transmit data blocks and also high rate data blocks.

5.2.2 Downlink Channels

5.2.2.1 Signalling Channel (by stealing) (SCH)

This Channel is constructed in mode 1 or mode 2 depending on the immediate use determined by SwMI.

mode 1 = in respect of a frame stealing rate of VCH blocks (limited to 2 blocks per 100 blocks)
mode 2 = by systematically stealing all the VCH blocks.

5.2.2.2 SCH for Transmitter Interruption (SCH_TI)

This channel is used to force the end of terminal or all terminals transmissions. This channel is reserved when necessary by pre-empting "block 0" on the downlink channel.

6. Physical organisation on a radio channel

Downlink and uplink radio channels contains 20 ms blocks which represent an information quantum. Any one of the previously defined logical channels contains one or more 20 ms blocks per multiframe.

A 20 ms block may be formatted in four ways:

- voice block format;
- data block format (for PCH, DACH, BCH, SDCH, SCH, DCH, RCH);
- data block format for high rate (DCH only);
- Access block format (RACH and SDCH);
- Interruption block format.

6.1 Block formats

6.1.1 Voice block format

Each block shall contain:

- 120 information bits destined for the vocoder;
- 2 signalling bits named ASB (bits X and Y).

ASB bit X is used on TCH to indicate transparent blocks.
ASB bit Y is used on CCH to indicate DACH blocks on the uplink (see hereafter).

Table 1: Use of ASB bits

on TCH	downlink_voice	downlink_data	uplink_voice	uplink_data
ASB bit X	transparent	transparent	transparent	transparent
ASB bit Y	unused	unused	unused	unused

on CCH	downlink_data	uplink_data
ASB bit X	unused	unused
ASB bit Y	DACH_access	unused

6.1.2 Data block format

Each data block shall contain:

- 64 information bits, protected by a error-correcting code;
- 2 signalling bits named ASB;
- a flag number on 2 bits named FN which allows to differentiate single, bi or multi-block frames.

6.1.3 High rate Data block format (DCH only)

Each data block shall contain:

- 92 information bits;
- 2 signalling bits named ASB;
- a flag number on 2 bits named FN which allows to differentiate single, bi or multi-block frames.

6.1.4 Access block format

The access block shall contain 14 bits extracted from RTI or TTI address field ::

- The most significant bits represent Y field {Y2,Y1,Y0}
- The 11 other bits represents {X11,X10,...,X1 } : (X0 is not transmitted)

See "Generic TTI/RTI/CGI/COI address field format"

6.1.5 Interruption block format

The interruption block shall contain the terminal link level identifier.

6.2 Data frame definitions

Only PCH, DACH, BCH, SCH, RCH, DCH and SDCH channel frames are concerned.

Frames are grouped in three categories: mono, bi and multi-block frames. The FN allows the frame to be reassembled.

Bi-and multi-block frames shall be contained in "consecutive" blocks (in the logical channel meaning) of the logical channel on which they are carried. The logical channel multiplexing on a physical channel may break the physical continuity of a logical channel; this does not affect their "consecutive block" quality in a logical channel meaning.

6.2.1 Single block frame

Single-block frames carry 64 information bits (or 92 bits for high rate). The FN bits in these frames shall equal zero.

Table 2: Single block frame

FN = 0 0	DATA

6.2.2 Bi-block frame

Bi-block frames carry 128 information bits, divided into two blocks (or 184 bits for high rate). The first FN in these frames equals 1, and the second equals 3.

Table 3: Bi-block frame

FN = 0 1	DATA
FN = 1 1	DATA

6.2.3 Multi-block frame

A multi-block frame belonging to a same logical channel conveys n times 64 information bits (4 ### n ### 9) (or n times 92 bits for high rate). The last frame block shall be a closing block with FN = 01 carrying a vertical EXCLUSIVE OR of all the previous blocks, for correcting one errored data block (any one but only one) in those received. The last block does not, therefore, convey "useful" data.

These frames contain n consecutive blocks, as shown below:
The generic format shall be:

Table 4: Multi-block frame

FN = 01	DATA
FN = 10	DATA
FN = 11	DATA

.....

FN = 11	DATA
FN = 10	DATA
FN = 01	DATA

The FN fields delimit the multi-block frames. Each multi-block frame shall carry:

- two blocks with FN = 01 and FN = 10 respectively;
- N information blocks with FN = 11 for 0 ### N ### 5;
- two closing blocks with FN = 10 and FN = 01 respectively.

According to this format, three block frames cannot be used.

6.3 DACH organisation

This paragraph describes the way whereby SwMI designates DACH blocks on CCH.

6.3.1 DACH location

A DACH location is formed by N_DACH+1 physically consecutive blocks; the first block shall be a synchronisation block.

6.3.2 DACH frame

A DACH frame carried in a DACH location shall be a frame of at least one block and at the most N_DACH physically consecutive data blocks.

6.3.3 Associated block

To construct DACH, each downlink CCH block shall be associated with an uplink CCH block. If N is the downlink block number (modulo 200), the associated block number is N + shift_dach.

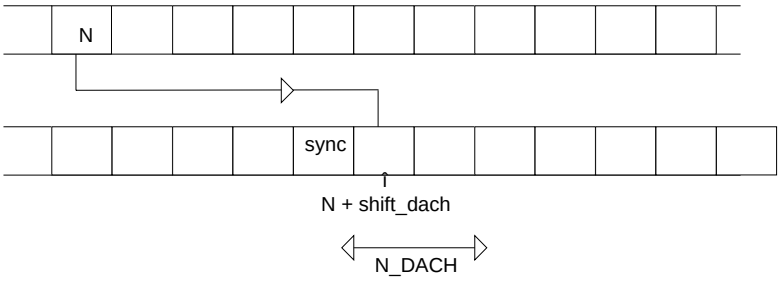


Figure 4: DACH organisation

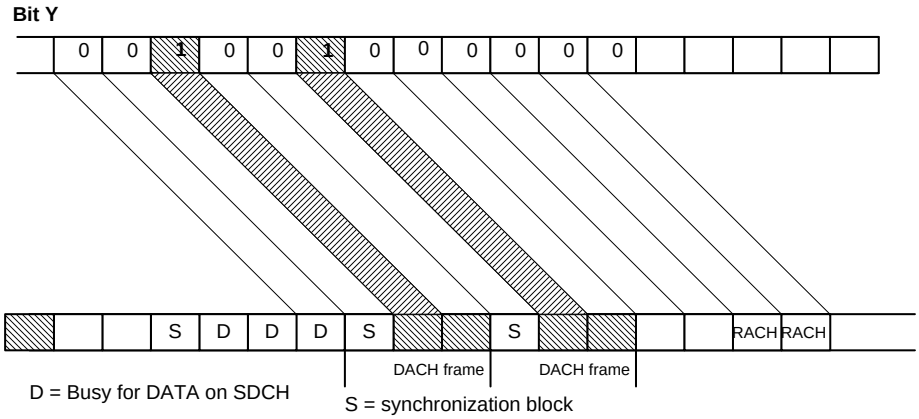
6.3.4 Associated signalling bit management (ASB)

Each downlink block on CCH shall contain 2 associated signalling bits (ASB).

SwMI shall manage ASB bit Y according to this rule:

bit Y = 1: the associated block is the first data block of the DACH frame;
i.e.: the first block of the N_DACH blocks frame.

bit Y = 0: otherwise.



7. Link procedures - link level

7.1 Introduction

To ensure reliable information transfer between the terminal and base station, the transmission function is based on high-level data link control (HDLC) procedures. Exchanges are bi-directional, in alternate duplex mode, in a centralised multi-point configuration.

The link level provides the functional and procedural means required to set up, maintain and release data link connections.

7.2 Capabilities and service provision

7.2.1 Capabilities

The essential link level capabilities are to:

- set up, maintain and release a data link between the primary (SwMI side) and secondary (ST side) stations;
- convey information frames in the following modes: numbered mode, unnumbered mode, dynamic access mode; polling mode; a dedicated access mode.
- recover transmission errors;
- manage the uplink channel with granting transmit rights to secondary stations;
- manage RACH/RCH;
- manage DACH;
- manage the group paging procedure.

7.2.2 Services provided by the data link layer

Information is transferred to and from the service provider. The chart below reviews data link service primitives.

7.2.2.1 List of primitives

Table 5: List of primitives

PRIMITIVES	PARAMETERS	BS	ST
DATA LINK CONNECTION REQUEST & DATA LINK CONNECTION INDICATION	Called party address Calling party address	X	 X
DATA LINK CONNECTION CONFIRM	Address returned in response	X	
DATA TRANSFER REQUEST	Data link service user data Priority	X X	X
DATA TRANSFER CONFIRM	ACK or NACK data acknowledgement	X	
DATA TRANSFER INDICATION	Data link service user data	X	X
DATA POLLING REQUEST	Data link service user data		X
DATA POLLING CONFIRM	ACK or NACK acknowledgement		X
DATA POLLING INDICATION	Data link service user data	X	
GROUP PAGING REQUEST	Data link service user data	X	
GROUP PAGING INDICATION	Data link service user data		X
GROUP PAGING RESPONSE			X
GROUP PAGING CONFIRM	ACK or NACK	X	
CHANGE DATA LINK PARAMETER REQUEST	Length of frames Terminal look-ahead window in transmit mode	X	X X
DATA LINK DISCONNECTION REQUEST	Address of party involved	X	*
DATA LINK DISCONNECTION INDICATION	Address of party involved Cause	X X	 X
DATA LINK DISCONNECTION CONFIRM			*
LINK ABORT	Address of party involved	X	
CLEAR FRAMES WAITING TO BE SENT	Address of party involved	X	
TRANSMIT REQUEST	Address of party involved	X	
DACH ACCESS REQUEST	Service user data	*	X
DACH ACCESS CONFIRM	DACH access ACK/NACK acknowledgement	*	X
DACH ACCESS INDICATION	Service user data	X	*

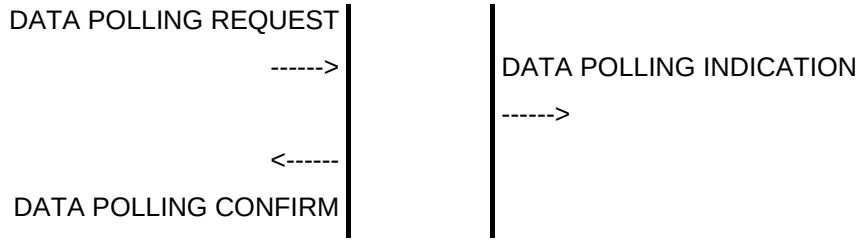
Key:

BS Base Station
ST System Terminal
X Mandatory parameters (not exhaustive)
* Unavailable service

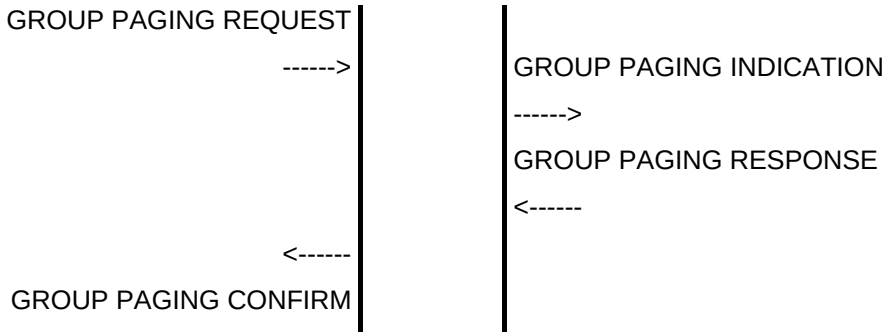
7.2.2.2 Primitive sequencing chart

This subclause defines data link service primitive sequences. The order in which primitives have to be sent is specified hereafter in the most common cases.

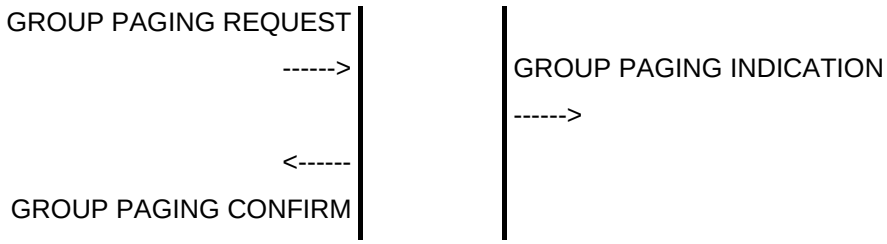
The use of a data link service primitive on one end of the data link connection, usually provokes a reaction on the other end. The relationship between the type of data link service primitive used at one end, and the data link service primitives used on the other are listed below (not exhaustively).



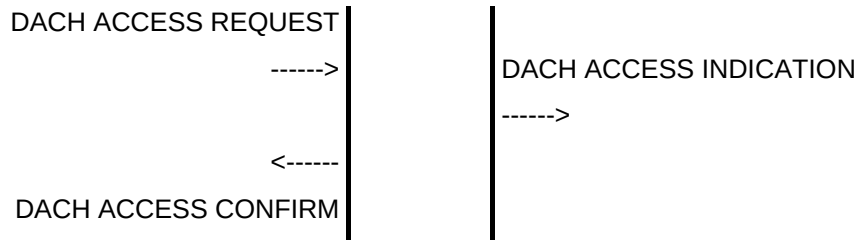
Data transfer on polling mode



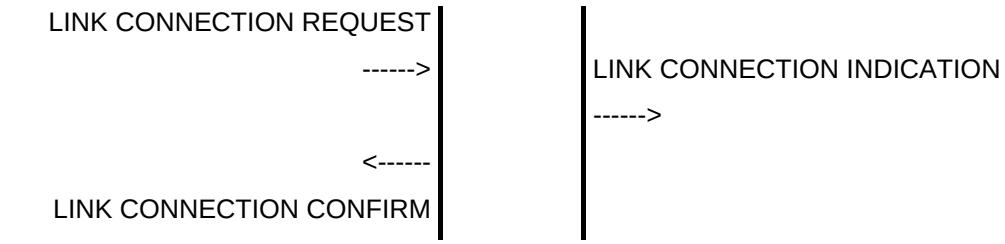
Group paging (successful case)



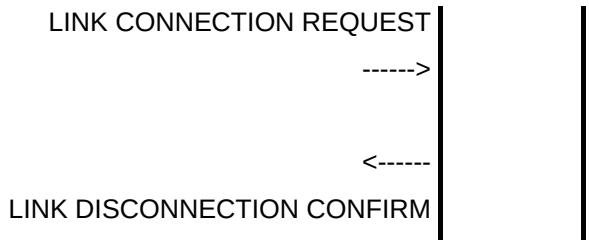
Group paging (unsuccessful case: no response)



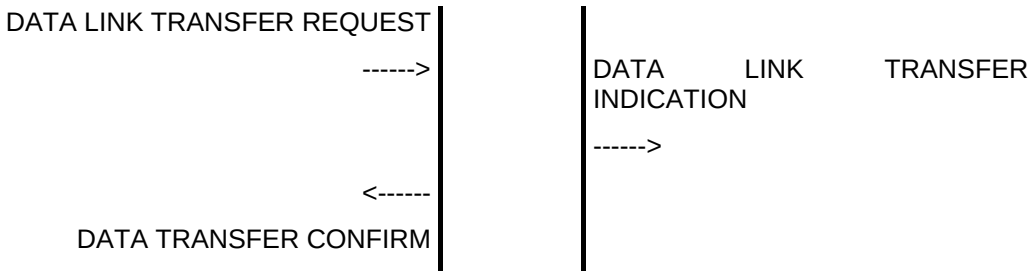
Data transfer on DACH



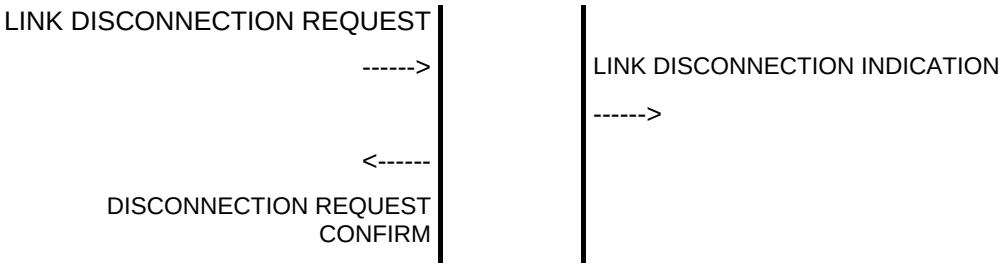
Successfully set up data link connection



Data link connection request refused



Data transfer



Release of a data link connection initiated by the base station

7.3 Definitions

7.3.1 Command frame

Any downlink frame, i.e., sent to the terminal by the base station, is called a command frame.

7.3.2 Response frame

Any uplink frame, i.e., sent to the base station by the terminal, is called a response frame.

7.3.3 Temporary Terminal Identifier (TTI)

The base station identifies each terminal by an identifier. The identifier is said to be temporary because it is allocated to a terminal for a limited length of time. PAS 0001-3-1 [3] describes TTI allocation principles.

7.3.4 Random Terminal Identifier (RTI)

The base station allocates a TTI in a signalling exchange initiated by the terminal. During the signalling exchange, the terminal uses a random terminal identifier (RTI).

7.3.5 Collective Group Identifier (CGI)

For some applications, all STs engaged in the application require a collective TTI. The Terminal alone allocates the identifier on the basis of information supplied by the application in question.

PAS 0001-3-1 [3] also describes the CGI.

7.3.6 Collective Object Identifier (COI)

For some application, all STs engaged in the application require a collective TTI. The Terminal alone allocates the identifier on the basis of information supplied by the Terminal User.

7.3.7 Look ahead window

A window is defined on the primary/secondary interface, and in each data transmission direction, as the ordered set of k consecutive transmitted information frame sequence numbers which may be sent across the interface without intermediate acknowledgements.

The smallest sequence number in the window is called the lower limit. After data link initialisation, the value of the lower limit of the window in each transmission direction equals zero.

7.4 Structure of frames exchanged by endpoints

7.4.1 SDCH, DCH, DACH, SCH and BCH

The data field in a single or multi-block radio frame constitutes the basic HDLC frame. The structure definition is based on the ISO 3309 standard [5], except for the opening, closing flags and FCS preceding the closing flag.

7.4.1.1 Basic frame structure

All the frames conveyed by the link level between the two endpoints are formatted as follows:

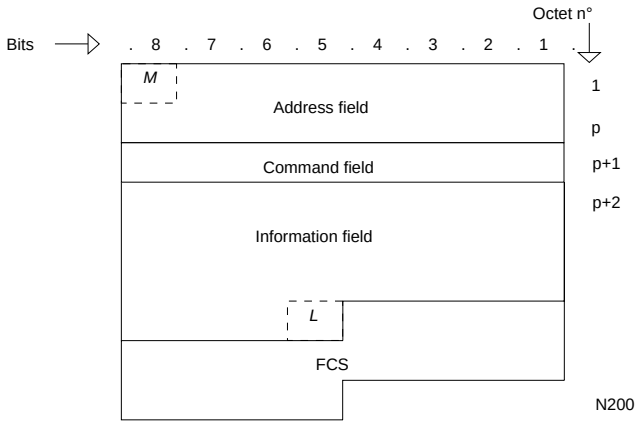


Figure 5: Basic frame structure

N200 is not necessarily an integer number of octets.

The FCS field is 2 octets long and is defined as the one's complement of the remainder R(x) obtained by dividing (modulo 2):

$(x^{16} * G(x)) + \{(x^{8*(N200-2)})(x^{15} + x^{14} + x^{13} + x^{12} + x^{11} + x^{10} + x^{9} + x^{8} + x^{7} + x^{6} + x^{5} + x^{4} + x^{3} + x^{2} + x + 1)\}$

by the polynomial generator $P(x) = x^{16} + x^{12} + x^{5} + 1$.

G(x) is defined as string of binary information where $x^{[8*(N200-2)]-1}$ and x^{0} correspond respectively to bit « M » and bit « L » in the figure.

Throughout the remaining Clause, the HDLC frames refer to this structure.

7.4.1.2 Frame boundaries

Frames are delimited by FN information according to their flag numbers (FN).

7.4.1.3 Unused bits in Information field

Some frames may not use the entire Information field. In this case, the value of unused bits shall be "0".

7.4.1.4 Address field

The address field in command frames shall identify the destination station. The address field in response frames shall identify the responding station.

The address field shall be constructed with:
- either an individual TTI;
- or the collective TTI: "all STs";
- or the "no ST" TTI;
- or a RTI;
- or a CGI;
- or a COI;

Table 6: Possible addresses versus logical channels

Logical channel Address	SDCH	BCH	DACH	SCH	PCH	DCH	
TTI	- individual - all STs - no ST	- all STs	- individual	- individual - all STs	individual - all STs - no ST	- individual - all STs	
RTI	X						
CGI	X		X	X	X	X	
COI					X		

The address "no ST" shall be used for stuffing frames on SDCH, RCH, PCH.

7.4.1.4.1 Generic TTI/RTI/CGI/COI address field format

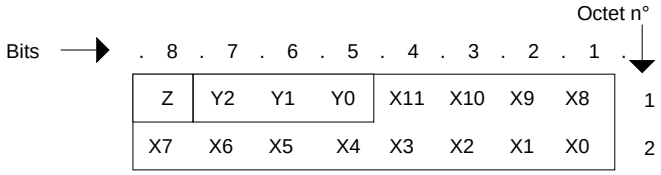


Figure 6: Generic address field format

Throughout the remaining Clause:

- Y references the ordered set {Y2,Y1,Y0}
- X references the ordered set {X11,X10,...,X1,X0}
- The set {Y,X} references the TTI/RTI/CGI/COI address

7.4.1.4.2 Address field format for SDCH, BCH, DACH, DCH

For RTI, 4 096 possible values, Z = 1 and Y = 0, the format shall be:

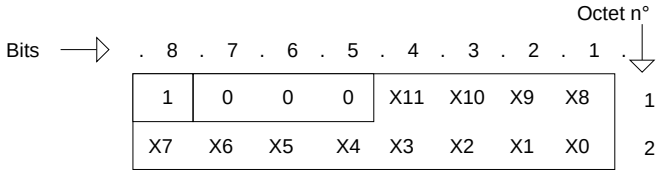


Figure 7: RTI address format (used on SDCH only)

For CGI, 4 096 possible values, Z = 0 and Y = 0, the format shall be:

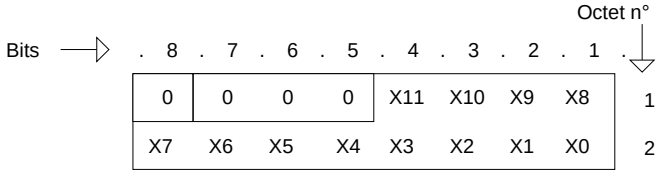


Figure 8: CGI address format

collective address "all STs": X shall be {1,1,1,...,1,1,1}

For TTI, 24 576possible values; Z= 0 and Y shall not be {0,0,0} nor (0,0,1), the format shall be:

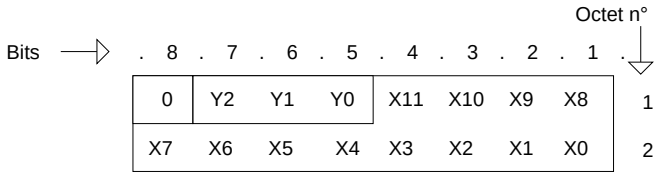


Figure 9: TTI address format

address "all STs": X shall be {1,1,1,...,1,1,1} and Y = {1,1,1}
address "no ST": X shall be {0,0,0,...,0,0,0} and Y = {1,1,1}
bit Z is reserved for future use and shall be set to 0

7.4.1.4.3 Address field format for SCH

For CGI, 4 096 possible values, Y = 0 the format shall be:

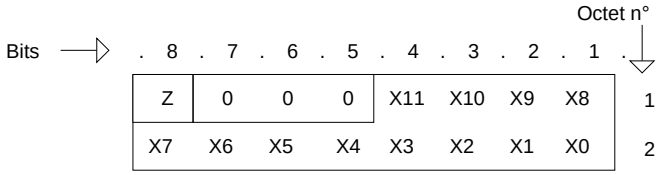


Figure 10: CGI address format

collective address "all STs": X shall be {1,1,1,...,1,1,1}

Role of bit Z:

Bit Z shall be set to 1 to indicate that the secondary station shall necessarily take this frame into account if it "knows" this collective group address.
When bit Z is set to 0, the secondary station makes the decision to take this frame into account or not.

For TTI, 24 576possible values; Z= 0 and Y shall not be {0,0,0} nor (0,0,1), the format shall be:

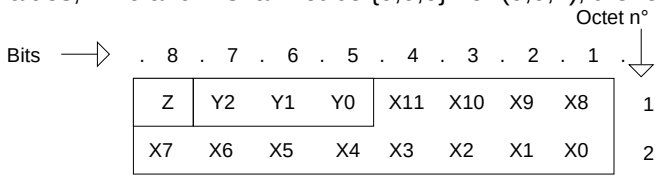


Figure 11: TTI address format

address "all STs": X shall be {1,1,1,...,1,1,1} and Y = {1,1,1}
address "no ST": X shall be {0,0,0,...,0,0,0} and Y = {1,1,1}

Role of bit Z:

Bit Z shall be set to 1 to indicate that the secondary station shall necessarily take this frame into account and answers to primary station following paging.
When bit Z is set to 0, the secondary station makes the decision to take this frame into account or not.

7.4.1.4.4 Address field format for PCH

For CGI, 4 096 possible values, Y = 0 the format shall be:

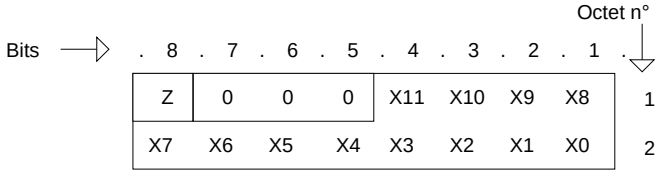


Figure 12: CGI address format

collective address "all STs": X shall be {1,1,1,...,1,1,1}

Role of bit Z:

Bit Z shall be set to 1 to indicate that the secondary station shall necessarily take this frame into account if it "knows" this collective group address.

When bit Z is set to 0, the secondary station makes the decision to take this frame into account or not.

For COI, 4 096 possible values, Y = (0,0,1) the format shall be:

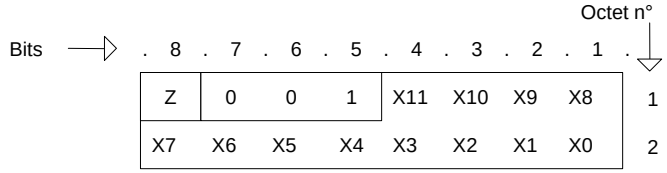


Figure 13: COI address format

collective address "all STs": X shall be {0,0,0,...,0,0,0}

Role of bit Z:

Bit Z shall be set to 1 to indicate that the secondary station shall necessarily take this frame into account if it "knows" this collective object address.
When bit Z is set to 0, the secondary station makes the decision to take this frame into account or not.

For TTI, 24 576possible values; Z= 0 and Y shall not be {0,0,0} nor (0,0,1), the format shall be:

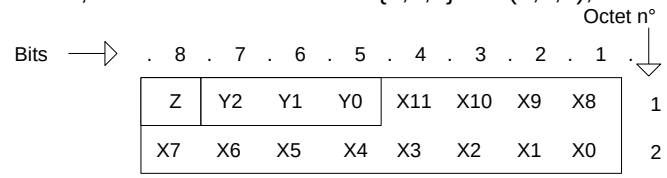


Figure 14: TTI address format

address "all STs": X shall be {1,1,1,...,1,1,1} and Y = {1,1,1}
address "no ST": X shall be {0,0,0,...,0,0,0} and Y = {1,1,1}

when paging ST; otherwise it shall be set to 0

7.4.1.5 Command field

The command field conveys the command or response types and contains the sequence numbers (if necessary). This field is used:

- either to send a command to the secondary station to perform an operation,
- or to send a response to a command from the secondary station to the primary station.

See subclause 7.5.4.

7.4.1.6 Information field

The information field (if any) follows the command field.

7.4.1.7 Invalid frames

All invalid frames shall be ignored and no action shall be taken when an invalid frame is received. Base station and terminal shall declare the frame as invalid when it contains an error detected by the frame control sequence. Furthermore, the terminal shall declare the frame as invalid when it contains an address unknown to the terminal.

7.4.1.8 Frame rejection condition

A frame rejection condition occurs when an errored frame satisfies one of the conditions listed in "Frame reject response (FRMR)".

7.4.1.9 Inter-frame time stuffing on SDCH

Only downlink channel shall be concerned with stuffing. This shall be achieved by transmitting single block HDLC frames. This shall be a UI type frame (see table 2) with a "no ST" TTI address field, and a bit P = 0 in the command field. The 5 next octets, including the FCS, shall be random octets according to the following rules. A sequence of 31 bits, used in circular fashion, with an offset of one bit to the right on each new frame, is defined by:

$x_O = x_1 = x_2 = x_3 = 0, x_4 = 1$

and

$x_n = (x_{n-3} + x_{n-5}) \bmod 2$

The last nine bits reuse the values of the first nine bits. A stuffing frame in its initial configuration is illustrated below. The 31 bit string shall be offset to the right in each new frame.

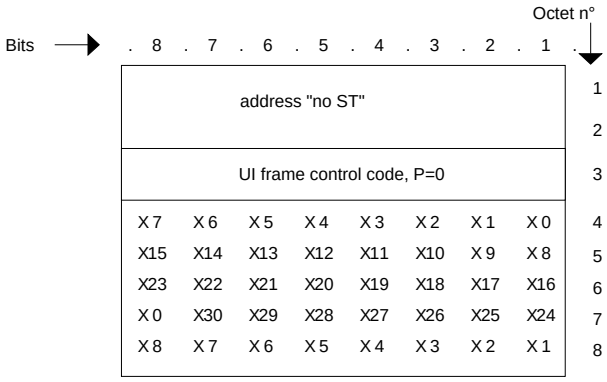
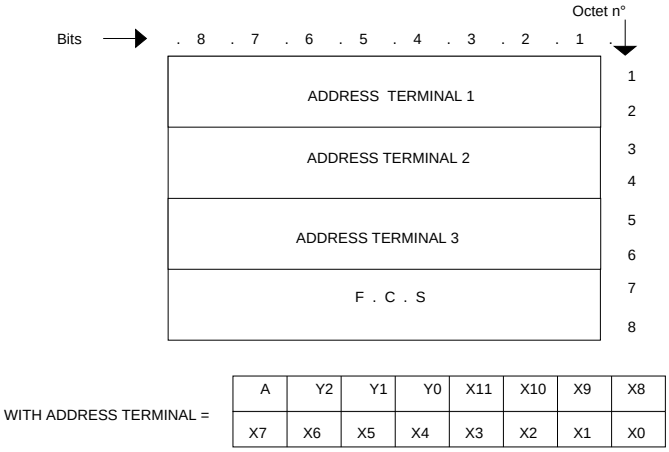


Figure 15: SDCH stuffing frame

7.4.2 RCH

The mono-block RCH frame shall contain three fields, each carrying a terminal address and acknowledgement information, with a FCS field protecting the block as a whole.

Where:



WITH ADDRESS TERMINAL =

A	Y2	Y1	Y0	X11	X10	X9	X8
X7	X6	X5	X4	X3	X2	X1	X0

Figure 16: RCH frame format

A = 0:

ACK acknowledgement for the terminal i. Field {Y,X} shall be Terminal i address TTI or RTI address.

A = 1:

NACK acknowledgement (negative acknowledgement). Bits of type X are not significant. Bits of type Y shall be:

{Y2=1,Y1=0,Y0=0} to indicate received noise
{Y2=1,Y1=0,Y0=1} to indicate collision

Unused address fields shall be the "no ST" TTI address.

The FCS is defined as the one's complement of the remainder R(x) obtained by dividing (modulo 2):
x^{16} G(x)+ x^{48} (x^{15} +x^{14} +x^{13} +x^{12} +x^{11} +x^{10} +x^{9} +x^{8} +x^{7} +x^{6} +x^{5} +x^{4} +x^{3} +x^{2} +x+1)
by the polynomial generator P(x) = x^{16} + x^{12} + x^{5} + 1.
G(x) is the 47 degree polynomial, where the coefficient of x^{47} is bit 8 in octet 1 and the coefficient of x^{0} is bit 1 in octet 6.

NOTE: The terminal address is defined in "TTI/RTI address" without the address extension bit (Bit 1 in octets 1 and 2).

7.4.3 PCH

The bi-block PCH frame shall contain:

- A 64 bits field in the first block containing an activation bitmap (see PAS 0001-3-1 [3] for use);
- 4 fields in the second block, each carrying a terminal address.

The PCH frame can convey zero, one, two, three or four TTI/CGI/COI type addresses. In the first four cases, the unused addresses shall be transmitted with the "no ST" TTI address. The first PCH address field shall always be used preferably, then the second, then the third, to carry useful addresses.

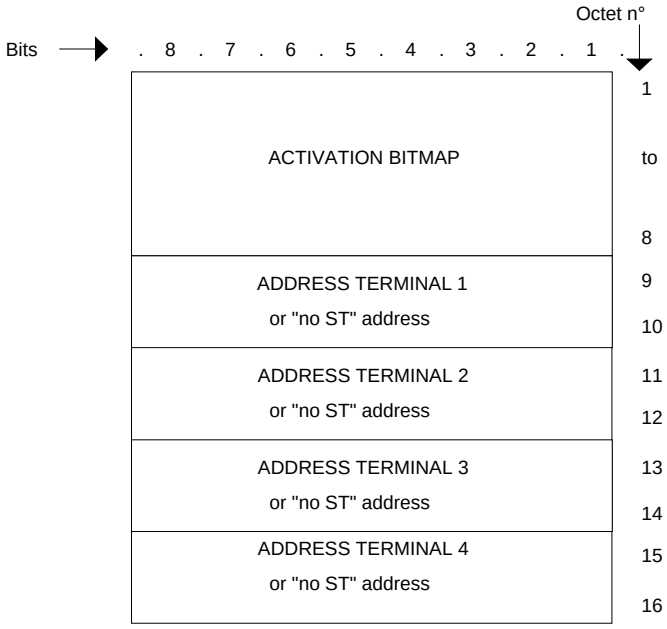


Figure 17: PCH frame format

7.5 Procedure element

7.5.1 Definitions

The link is unbalanced, bi-directional in duplex mode and multipoint. Two types of processing stations are therefore defined:

- the base station (SwMI side) is called the **"primary"** station. It issues commands and receives responses. It is responsible for recovery operations in case of link errors;
- the terminals are called **"secondary"** stations. They receive commands and issue responses.

7.5.2 Procedure class

The procedure class, conforming to ISO 7809 [6], is UNC 2,4,7 (unbalanced in normal response mode, with REJ, UI frames and extended addressing format) except on the DACH logical channel.

7.5.3 Operating modes

7.5.3.1 Operational mode

Primary and secondary stations operate in bi-directional duplex normal response mode (NRM).

The secondary station shall only transmit when the primary station grants the explicit right to send a response. The response is transmitted in one or more frames. The primary station knows the maximum number of response frames and allocates an exchange window accordingly. The last transmitted response frame shall be explicitly identified by the secondary station. After indicating the last frame, the secondary station shall stop transmitting until the primary station explicitly grants the right to send again.

7.5.3.2 Inactive mode

The mode used is the normal disconnected mode, where the secondary station link is disconnected. In this situation, the station is not allowed to send or to accept numbered information frames.

7.5.4 Command field format and parameters

7.5.4.1 Command field format

The command field contains a command or response and sequence numbers (if necessary). Four command field formats are used (see table 1):

- I format, numbered for sending information;
- S format, numbered for supervision functions;
- A format, numbered for data transfers and DACH channel supervision;
- U format, unnumbered for command functions and unnumbered information transfers.

Table 7: Command field formats

COMMAND FIELD	COMMAND FIELD BITS							
STRUCTURE	8	7	6	5	4	3	2	1
I Format	N (R)			P/E	N (S)			0
S Format	N (R)			P/E	S	S	0	1
A Format	N'(R) / N'(S)			R	1	1		
U Format	M	M	M	P/E	M	M	1	

-N(S): Send sequence number (where bit 2 is the least significant bit)
-N(R): Receive sequence number (where bit 6 is the least significant bit)
-S: Bits to specify the supervision frame.
-M: Bits to specify the unnumbered frame.
-P/E: Transmission grant bit given by the primary station (Proceed to send) or End bit transmitted in a secondary station response frame.
-R: Retry flag
-N'(R)/N'(S): Sequence number respectively for receiving or sending on the DACH channel (where bit 6 is the least significant bit)

7.5.4.1.1 I format for sending information

The I structure is used to send information. N(S), N(R) and P/E functions are independent

7.5.4.1.2 S Format for supervision

The S format is used to perform link control supervision functions, such as received I frame acknowledgements, temporary halt of I frame transmissions.

N(R) and P/E functions are independent, meaning that all supervision frames shall contain:

7.5.4.1.3 A format for DACH access

The A format is used by the secondary station to send data on the DACH channel and by the primary station to send corresponding acknowledgements.

7.5.4.1.4 Unnumbered U format

The U format is used to provide additional link control functions and to send unnumbered data frames. It does not include a sequence number, but it contains a P/E bit which may be 1 or 0.

7.5.4.2 Command field parameters

7.5.4.2.1 Numbering window (Nu)

The numbering window, Nu, shall equal eight. Each S or I frame shall contain one or two sequence numbers, which may have values from zero to Nu-1. The complete numbering cycle is used.

7.5.4.2.2 Frame and sequence number variables

Overview:

In HLDC operating terms, each station shall support independent send and receive state variables (V(S) and V(R)) for all the I frames it sends and receives from another station. Each secondary station shall therefore support a V(S) variable for the I frames it sends to the primary station and a V(R) variable for the I frames correctly received from the primary station. Likewise, the primary station shall support independent V(S) and V(R) variables for the I frames sent to and received from each secondary station on the data link.
Concerning the DACH link procedure, each secondary station shall support independently a send state variable V'(S) for all the I_DACH frames it sends to the primary station. Likewise, each primary station shall support independently a receive state variable V'(R) for the I_DACH frames received from a secondary station.

Send state variables V(S):

The send state variable shall designate the sequence number of the next I frame to be transmitted. The value of the send state variable shall be between 0 and Nu-1 (where Nu is the numbering window, or in other terms the modulo of frame sequence number congruence where the complete numbering cycle is used). The value of the send state variable shall be increased by one for every consecutive transmitted I frame, but shall not exceed N(R) of the last received frame above Nu-1.

Send sequence number N(S):

Only I frames contain an N(S), which is the send sequence number of the transmitted frame. Before sending an I frame in sequence, N(S) shall be set with the value of the send state variable.

Receive state variables V(R):

The receive state variable designates the sequence number of the next frame to be received in sequence. This value of the receive state variable shall be between 0 and Nu minus one (where Nu is the numbering window, or in other terms the modulo of frame sequence number congruence where the complete numbering cycle is used). The value of the receive state variable shall be increased by one for

every consecutive correctly received I frame with a send sequence number N(S) equal to the receive state variable V(R).

Receive sequence number N(R):

All I and S frames shall contain an N(R) which is the sequence number N(S) of the next expected I frame. Before sending an I or S frame, the value of N(R) shall be set to equal the current receive state variable V(R). N(R) indicates that the station sending the N(R) has correctly received all the I frames numbered up to N(R) -1.

Send state variables V'(S):

The send state variable V'(S) shall designate the sequence number of the next I_DACH frame to be sent in sequence by the secondary station. The value of the send state variable shall be between 0 and Nu minus one (where Nu is the numbering window, or in other terms the modulo of frame sequence number congruence where the complete numbering cycle is used).

Send sequence number N'(S):

I_DACH frames shall contain an N'(S), which is the send sequence number of the transmitted frame. Before sending an I_DACH frame, N'(S) shall be set with the value of the send state variable V'(S).

Receive state variables V'(R):

Not used.

Receive sequence number N'(R):

All the ACK_DACH frames shall contain an N'(R) which is the sequence number N'(S) of the last received I_DACH frame. Before sending an ACK_DACH frame, the value of N'(R) shall be set to equal the send sequence number N'(S).

Retry flag R:

The secondary station shall set the R bit to 1 in retried I_DACH frame. Otherwise, the R bit shall be set to 0 (first I_DACH frame or ACK_DACH frame).

RA:

The UI_P0 frame contains the RA field: which indicates to the primary stations if bit RA = 0 that there is an uplink message to be transmitted by the « Polling service transmission » or dedicated access service is pending.**RSP : response**

The URR frame contains the RSP field: which indicates to the secondary stations which frame is expected in response.

Table 8: expected response frame format

RSP	Expected response frame format
00	UI_P0 frame
01	Reserved
10	Reserved
11	Reserved

7.5.4.2.3 Proceed to send / End bit (P/E)

All the frames except A frames shall contain a Proceed to send / end P/E bit. In command frames, the P/E bit is called the P bit. In response frames, it is called the E bit.

The P/E bit shall be used to manage proceed to send information. A bit P = 1 shall be used to ask the secondary station for a response frame with bit E = 1. Only one frame with bit P = 1 shall be waiting for a response on a link.

The primary station shall receive a response frame with bit E = 1 from the secondary station before it can send another frame with bit P = 1.

The secondary station may only transmit I frames if it receives an I frame with the bit P to 1 or if it receives RR or REJ frames (S frames) with the bit P to 1.

The secondary station shall send a bit E = 1 in the last response frame to return sending rights to the primary station. After sending the last response frame, the secondary station stops transmitting until it receives another command frame with bit P = 1.

Bit P/E is used with UI frames (see "group paging") and URR (see "data polling procedure").

7.5.4.3 Commands and responses

Table 9: Commands and Responses

FORMAT	COMMANDS Downlink frames	RESPONSES Uplink frames	CODING (Bits) 8	7	6	5	4	3	2	1
Information transfer	I (information)		**N(R)**			**P/E**	**N(S)**			**0**
Supervision	RR (ready to receive)						**0**	**0**	**0**	**1**
	RNR (not ready to receive)						**0**	**1**		
	REJ (retransmit request)						**1**	**0**		
DACH access	ACK_DACH	I_DACH	**N'(S)** **N'(R)**			**R** **0**	**1**	**1**		
Unnumbered frames	UI (Unnumbered information		**0**	**0**	**0**	**P/E**	**0**	**0**	**1**	
			0	**0**	**1**					
	DISC		**0**	**1**	**0**	**P**				
		UA	**0**	**1**	**1**	**E**				
	SNRM		**1**	**0**	**0**	**P**				
	UI_CD (Circuit data)		**1**	**0**	**1**	**0**				
	UI_VCH (unnumbered information)		**1**	**1**	**0**					
			1	**1**	**1**					
		UI_P0	**0**	**0**	**0**	**RA**	**0**	**1**		
	U_RR		**RSP**		**1**	**P=1**				
		FRMR (Frame reject)	**1**	**0**	**0**	**E**				
							1	**0**		
		DM (Disconnected Mode)	**0**	**0**	**0**	**E**	**1**	**1**		

7.5.4.3.1 Information command and response (I)

The information frame (I) is used to transmit sequentially numbered frames on the data link. It contains an information field.

7.5.4.3.2 Ready to receive (RR)

The "ready to receive" supervision frame is used by primary and secondary stations to:

- indicate they are ready to receive one or more I frames;
- acknowledge previously received numbered I frames, up to and including [N(R)-l].

An RR frame can be used to indicate the end of a busy condition reported in a previously sent RNR frame by the same station. The primary station can also use the RR command with bit P = 1 to obtain the secondary station state.

It does not carry any information. It is a single block frame with all the information field bits set to 0.

7.5.4.3.3 Not ready to receive (RNR)

A station uses the RNR frame to indicate a busy condition, i.e.; the temporary inability to accept additional I frames. The RNR frame acknowledges reception of I frames with a sequence number less or equal to [N(R)-l]. It does not carry any information: it is a single block frame with all the information field bits set to 0.

If one or more I frames with an N(S) greater or equal to N(R) have been sent, they shall not be considered to be acknowledged. They may be accepted in the following exchanges.

A secondary station shall never activate RACH access mechanisms if it detects a busy state on the primary station.

7.5.4.3.4 Retransmit request (REJ)

Primary and secondary stations shall use the reject supervision frame (REJ), with bit P = 1 (primary station) or bit E = 1 (secondary station), to ask for the I frames numbered from N(R) to be retransmitted. It does not carry any information: it is a single block frame with all the information field bits set to 0. The REJ frame acknowledges reception of I frames with a sequence number less or equal to [N(R)-l].

The REJ exception condition is cancelled on receipt of an I frame with a sequence number N(S) equal to the N(R) number in the REJ frame.

7.5.4.3.5 Set normal response mode (SNRM)

The unnumbered SNRM frame is used to set the secondary station in normal response mode (NRM).

It does not carry any information: it is a single block frame with all the information field bits set to 0. The secondary station shall confirm SNRM command acceptance by sending a UA response, with a bit E = 1, as soon as it is able to reply.

If the command is accepted, the send and receive variables on the secondary station are reset to zero.

When this frame is received, any previously sent, unacknowledged I frames remain unacknowledged. The level above is responsible for all unacknowledged I frames.

7.5.4.3.6 Disconnection command (DISC)

The unnumbered DISC command is used to ask the secondary station to change out of NRM mode requested in the previous SRNM command. Furthermore it informs the secondary station that the primary station is closing down the data link. The secondary station then changes to logical disconnected mode. The DISC command does not carry any information: it is a single block frame with all the information field bits set to "0".

Before taking into account the command, the secondary station shall confirm DISC command acceptance by sending a UA response (or DM if it is already in disconnected mode).

When this command is used, the level above is responsible for all the unacknowledged I frames assigned to the data link.

7.5.4.3.7 Frame reject response (FRMR)

The secondary station shall use the unnumbered FRMR frame in operational mode to indicate a received frame error with a valid FCS field, which cannot be corrected by retransmitting an identical frame.

An FRMR frame is the result of at least one of the following conditions:

- reception of an undefined command control field;
- reception of an incorrect N(R);

- reception of a frame with an illegal information field (multi-block received instead of mono-block);
- reception of an I frame with an too long information field.

An incorrect N(R), sent by the primary station, is defined as a number, which with regard to the look-ahead window, designates a previously sent and acknowledged I frame, or an unsent I frame which is not the next I frame due to be sent.

The primary station that receives an FRMR response is charged with initiating the appropriate corrective action (sending SNRM, or DISC in a disconnection phase).

An information field is returned with the response giving the cause of frame rejection.

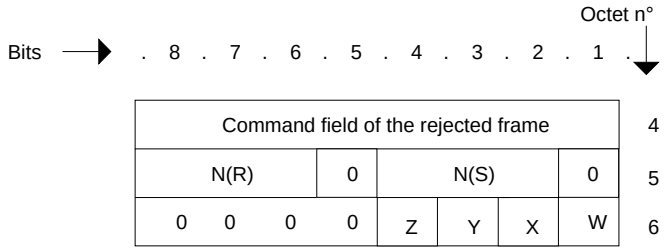


Figure 16: Information field structure

The field functions are:

N(S) and N(R) are the current values of the secondary station's send and receive state variables. The least significant bits of N(S) and N(R) are bits 2 and 6 respectively.

"1" in the W field indicates that the first octet contains the received command field.

"1" in the X field indicates (as in the W field) that the received command field, returned in the first octet, is considered incorrect because the frame contained an illegal information field for the command.

"1" in the Y field indicates that the received information field exceeds the maximum length that the secondary station can handle.

"1" in the Z field indicates that the received command field, returned in the first octet, contained an incorrect N(R).

7.5.4.3.8 Unnumbered acknowledgement response (UA)

The secondary station shall use an unnumbered UA response to confirm reception and acknowledge SNRM and DISC commands. The UA response does not carry any information: it is a single block frame with all the information field bits set to "0".

7.5.4.3.9 Disconnected mode response (DM)

The secondary station shall use the DM response to indicate a logical disconnection state during the disconnection phase. The DM response shall be returned in this state to inform the primary station that it shall send a set up command in normal mode. The DM response does not carry any information: it is a single block frame with all the information field bits set to "0".

A secondary station, in disconnection phase, shall check the received commands and shall react to an SNRM command by returning a UA response with bit E = 1. When the secondary station receives any other command frame (defined, undefined or not implemented) with bit P = 1, it shall send a DM response with a bit E = 1. It shall ignore the other frames received during the disconnection phase.

7.5.4.3.10 Unnumbered information frame (UI)

The UI command shall be used to send information to one or more secondary stations without affecting the receiver station's V(S) and V(R) variables. Since the UI frame does not contain a sequence number, the data link procedures do not check correct delivery on the destination end. The UI frame may therefore be lost if a data link event occurs while the command is being transmitted.

A UI command with bit P=1 may be used to send a "group paging" request to one or several secondary stations, each secondary station, depending on the user data content shall answer to this request; if no response is required, the secondary station shall send nothing.

The response is described in 7.6.5 .

7.5.4.3.11 Unnumbered Ready to receive frame (URR)

The URR command with bit P=1 may be used to send a polling request to one (and only one) secondary station ; the secondary station shall react to this polling request (when received) by returning a UI_P0 response with bit RA = 0 if an uplink message to be transmitted by the « Polling service transmission » is pending ; if no uplink message is pending, the secondary station shall send nothing.

7.5.4.3.12 Polled information frame (UI_P0)

The UI_P0 response shall be used by the secondary station to send information to the primary station without affecting the receiver station's V(S), V'(S) and V(R) variables. Since the UI_P0 frame does not contain a sequence number, the data link procedures do not check correct delivery on the destination end. The UI_P0 frame may therefore be lost if a data link event occurs while the command is being transmitted.

The UI_P0 frame is sent :

-in response to a U_RR frame (with RSP field set to the correct value).

7.5.4.3.13 Unnumbered Circuit Data information frame (UI_CD)

UI_CD command shall be used to transmit transparent data information on the VCH channel for end to end signalling purposes in voice sessions (from one secondary station to other secondary stations involved in the voice session through the primary stations) ; the data link procedures do not check correct delivery on the destination ends. The UI_CD frame may therefore be lost if a data link event occurs while the command is being transmitted.

7.5.4.3.14 Unnumbered VCH information frame (UI_VCH)

UI_VCH command shall be used to transmit duplex management information on the VCH channel between the primary station and one or more secondary stations without affecting the receiver station's V(S) and V(R) variables. Since the UI frame does not contain a sequence number, the data link procedures do not check correct delivery on the destination end. The UI_VCH frame may therefore be lost if a data link event occurs while the command is being transmitted.

7.5.4.3.15 Unnumbered DACH access frames (I_DACH / ACK_DACH)

I_DACH command shall be used by the secondary station to transmit information on the DACH channel to a primary station.

ACK_DACH response shall be used by the primary station to acknowledge the received I_DACH frame. The ACK_DACH response does not carry any information: it is a single block frame with all the information field bits set to "0".

7.5.5 Link level event signalling and cancellation

This paragraph describes the error recovery procedures which shall be used when an error is detected or an event occurs at link level. Events are situations provoked by transmission errors, primary/secondary station malfunctions, or operational situations.

7.5.5.1 Busy state

A busy state is caused by the inability of one end to continue to receive I frames because of internal constraints, for example, receive buffer memory limitations. In this case:

- the primary station shall not grant a secondary station the right to transmit;
- the busy secondary station shall send an RNR frame. The secondary station can transmit information frames waiting to be sent before or after the RNR frame transmission.

The end of the busy state for a secondary station shall be considered by the primary station when an RR, REJ or I frame is received on the primary station, or when the data link is reinitialised. Likewise, the primary station sends a proceed to send bit (P = 1) to grant a secondary station transmit right at the end of its busy state.

7.5.5.2 N(S) missequencing error

The information field in any received I frame with an N(S) number which does not match the V(R) state variable shall be ignored. The I frame responsible for the error shall not be acknowledged (the receive state variable shall not be increased by 1). All subsequently received I frames are also ignored until an I frame with a correct N(S) is received.

An endpoint that receives one or more valid I frames, containing sequence errors, or any other supervision frame (RR, RNR, REJ), shall accept the command information contained in the N(R) field and the P/E bit so as to execute link supervision functions.

7.5.5.2.1 Error recovery using REJ

The destination end uses the REJ retransmission request frame to mark the start of transmission error recovery when an N(S) sequence number error is detected.

An exception condition (REJ sent) is cancelled when the requested I frame is received. The endpoint receiving the REJ frame starts to retransmit the I frames in sequence beginning with the I frame identified by the N(R) received in the REJ frame.

7.5.5.2.2 Time-controlled error recovery

If the secondary station does not receive (or receives and ignores) a unique I frame or the last I frames in a sequence of I frames because of a transmission error, it cannot detect an N(S) sequence error and does not therefore send a REJ frame. At time-out, specified by the system, the primary station performs an appropriate error recovery action to restart transmissions. This time-out, T200, is described in the "List of system parameters". Transmissions are restarted, if necessary, N201 times. If an RR frame is used to grant sending rights to the secondary station, the primary station performs N204 times the N201 reiteration sequence at intervals of T200. The N204 sequences are themselves repeated at intervals of T206. This mechanism is used to overcome short radio channel reception problems.

7.6 Procedure description on SDCH or DCH

The procedures described in this paragraph only concern transactions on SDCH logical channel or transactions on DCH. Particular behaviours on DCH will be pointed out whenever it will be necessary.

7.6.1 Addressing procedure

The primary station shall send commands using the TTI or RTI of each secondary station. The secondary station shall send responses with the same TTI or RTI.

When a terminal finds a control channel, it initialises registration signalling using a random terminal address (RTI). After registration, a temporary terminal address (TTI) is assigned to the terminal. The TTI is used for all subsequent transactions between the primary and secondary stations. The TTI shall be used until the secondary station reinitialises another registration sequence.

The registration phase is described in PAS 0001-3-1 [3].

7.6.2 Uplink transmit rights

The primary station shall manage transmit rights. It shall grant the secondary station transmit rights by sending one or more frames with bit P = 1 in the last frame.

The secondary station, which is allowed to transmit, sends a response and returns control by sending an bit E = 1 in the last transmitted frame.

The secondary station's transmit rights are limited in time, either by a supervision frame (or one unnumbered frame), or to a number k of numbered frames matching the look-ahead window. The primary station knows the time limit and can therefore reassign uplink transmit rights.

The date when the secondary station responds to a command granting transmit rights is formally determined by:

- n: the number of the last command block granting transmit rights to the secondary station;
- offset: the number of offset blocks between sending and receiving.

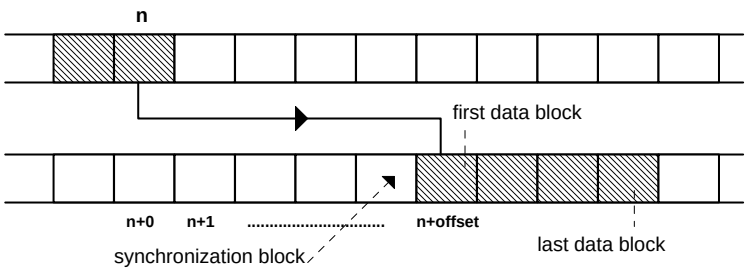


Figure 18: uplink transmit rights case 1

The starting date of the response window shall take the presence of blocks from RACH on the uplink into account. (no RACH on DCH)

Therefore, if neither blocks n+offset-l nor n+offset belongs to RACH, the response window shall start at block n+offset.

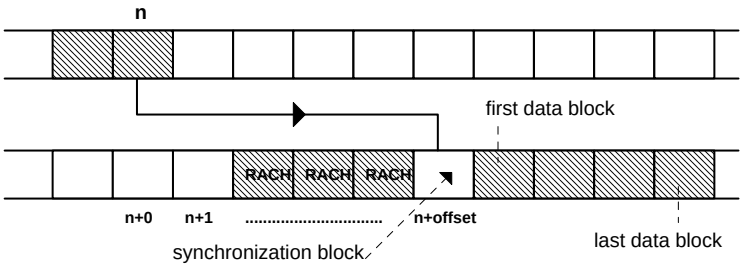


Figure 19: uplink transmit rights case 2

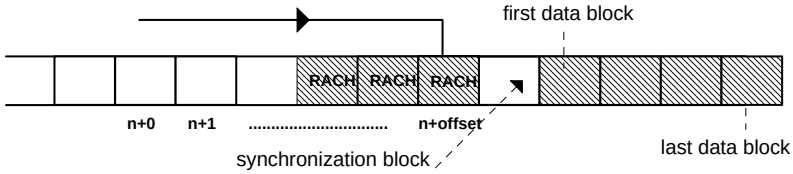


Figure 20: uplink transmit rights case 3

However, if blocks n+offset-l or n+offset belongs to RACH, the response window shall start at the second block following the group of RACH blocks (the first block after the RACH blocks shall be a synchronisation block).

If the message returning control is lost, the primary station shall recover control when T200 expires (see "List of system parameters"). T200 shall be started when a frame granting transmit rights is sent and stopped when control is returned. When T200 expires, control shall be returned to the primary station.

The offset is invariable; the primary station frame position (with P = 1) shall be determined according to previous rules (notably according to RACH blocks position).

7.6.3 Connect and disconnect procedures

Any transaction between the primary and a secondary station requires that a link has been previously set up. The link is connected and disconnected as requested by the layers above.

7.6.3.1 Link connection

Only the primary station can set up the data link. The secondary station may, however, prompt the primary station to set up a link by executing random access on RACH except on DCH.

The primary station shall set up the link by sending an SNRM command with bit P = 1, and setting a time-out T200. If the secondary station receives the command correctly, it shall send an UA response with bit E = 1 and shall reset its state variables to zero. If the primary station receives the response correctly, it shall consider the link set up, reset its state variables to zero and stop the T200 timer. If the UA response has not been correctly received when T200 elapses, the primary station shall retransmit the SNRM command and start T200 again.

After the primary station has sent SNRM N201 times, the secondary station shall be declared as "unreachable". The layers above are charged with managing the future attempts.

7.6.3.2 Information transfer phase

When the link is set up, the information transfer is possible. If the secondary station has requested connection and the primary station is not in busy state, the secondary station shall be granted the right to transmit in an RR command with bit P = 1. From then onwards, the primary and secondary stations can send and accept I frames and supervision frames in accordance with the procedures described in the "Information transfer procedure".

When the secondary station receives an SNRM command during the information transfer phase, the secondary station shall adhere to the initialisation procedures described in the "Information transfer procedure".

7.6.3.3 Link disconnection

During the information transfer phase, the primary station shall notify a link disconnection request by sending a DISC command and setting T200.

On receiving an UA or DM response to the previously sent DISC command, the primary station shall stop T200 and switch over the disconnection phase. If an UA or DM response has not been correctly received when T200 expires, the primary station shall retransmit a DISC command and reset T200. The primary station can send successive DISC commands only N201 times; the level above shall be informed in case of failure (after N201 attempts). The value of N201 is described in the "List of system parameters".

7.6.3.4 Disconnection phase

The primary station shall switch over the disconnection phase after receiving the UA or DM response to a DISC command. The secondary station shall switch over this phase after sending the UA response to the DISC command sent by the primary station.

Both ends may initiate link connection in this phase on SDCH but only the primary station on DCH.

If the secondary station receives any command frame other than SNRM (defined, undefined or not implemented) with bit P = 1, it shall send a DM response with bit E = 1 (except for UI frames). It shall ignore any other frames received during the disconnection phase (except UI frames).

7.6.4 Information transfer procedure

I frame sending procedures, in both directions during the information transfer phase, are described below.

7.6.4.1 I frame sending

When the primary/secondary station has an I frame to send (a new I frame or a retransmitted I frame), it shall send the I frame with N(S) at the current value of its send state variable V(S), and the N(R) at the current value of its receive state variable V(R). After sending the I frame, it shall increase its send state variable by one unit (modulo Nu).

For each transfer, the primary station shall send no more than k1 frames, with bit P = 1 in the last frame and shall set T200.

If the send state variable V(S) equals the last received value of N(R) increased by k (where k is the maximum number of look-ahead I frames, see "List of system parameters"; k1 for the primary station and k2 for the secondary station), the primary/secondary station shall not send any new I frame, but may retransmit an I frame.

In all cases, the number of I frames sent shall be less or equal to k (k1 for the primary station or k2 for the secondary station). For a secondary station, the last frame shall be with E bit to "1" and a time-out T205 shall be started when sending this last frame to limit the waiting time for acknowledgement.

For only SDCH, if in the secondary station, a new I frame is due to be sent after all previously sent frames have been acknowledged, two cases shall be considered:

- if the primary station has not stopped sending transmit rights, the secondary station shall start T212. When a RR frame with bit P = 1 is received by the secondary station, it shall transmit the I frame and cancel T212. If T212 expires, the secondary station shall process the RACH/RCH procedure.

- If the primary station has stopped sending transmit rights, the secondary station shall process the RACH/RCH procedure: it shall start T208 which limits the RACH/RCH procedure, and shall initiate random access on RACH. After receiving a positive acknowledgement on RCH, it shall cancel T208 and start T203. If it is granted the right to transmit, it shall cancel T203 and proceed to send the I frame according to the procedure above. If it does not receive the right to transmit, or if no positive acknowledgement to RACH is received, a procedure described later in the document shall be applied.

7.6.4.2 I frame reception

When the primary/secondary station is not in busy state and receives a valid I frame with a send sequence number N(S) equal to the receive state variable V(R), it shall accept the information field in the frame and increase its receive state variable V(R) by one, then continues as below.

7.6.4.2.1 Primary station

When the primary station is not in busy state and the E bit in the received I frame is "1" and when it has an I frame to send, it shall proceed as in "I frame sending" and shall acknowledge received I frames assigning the number N(R) in the command field of the next sent I frame the value of the receive state variable V(R). For only SDCH, if the primary station has no I frame to sent, it shall start T209. When T209 expires or for DCH (and no I frame needs to be sent), it shall send an RR frame with the value of N(R) equal to the receive state variable V(R).

T209 shall be cancelled if an I frame needs to be sent or if the transport layer asks for ST transmit rights.

When the primary station is in busy state and E bit in the last received I frame is "1", it shall send an RNR frame with bit P = 0 and the value of N(R) set to the receive state variable V(R).

7.6.4.2.2 Secondary station

When the secondary station is not in busy state, and the P bit in the last received I frame is "1", it shall start T201. If, on T201 expiry, it has an I frame to send, it shall proceed as described in "I frame sending" and shall acknowledge received I frames, assigning the number N(R) in the command information field of the next sent I frame the value of the receive state variable V(R). If, when T201 expires, the secondary station has no I frame to send, it shall send an RR frame with the value of N(R) equal to the receive state variable V(R).

When the secondary station is in busy state and the P bit in the last received I frame is "1", it shall send an RNR frame with bit E = 1 and N(R) equal to the value of the receive state variable V(R). In this case, the secondary station may receive an information frame from the primary station but the acknowledgement may be positive or negative according to its state.

7.6.4.3 Invalid frame reception

The primary/secondary stations shall ignore invalid frames.

7.6.4.4 Missequenced I frames

When a primary/secondary station receives a valid I frame with an incorrect send sequence number, i.e., value is not equal to the current value of the receive state variable V(R), it shall ignore the frame information field. However, it shall use the indications given by the number N(R) in the ignored I frame:

- If N(R) does not acknowledge at least all the frames sent by the primary/secondary station up to and including the frame containing a bit P/E = 1, the primary/secondary station shall retransmit I frames from N(S) = received N(R) onwards
- If N(R) acknowledges all transmitted frames:

    - If at least one I frame has to be sent, the procedure described in "I frame sending" shall be applied;
    - If no I frame has to be sent, the primary/secondary station shall send a REJ frame with N(R) equal to V(R) and with the P/E bit set to "1".

The primary/secondary station shall ignore the information fields in all the received I frames until the expected I frame is correctly received. When it receives the expected I frame, it shall acknowledge reception as described in "I frame reception".

7.6.4.5 Acknowledgement reception and checking

When one end receives a bit P/E = 1 in an I frame or supervision frame (RR, RNR, REJ), it shall consider that the number N(R) in the frame acknowledges reception of all the I frames it has sent with a number N(S) ≤ [N(R)-l]. This shall apply even when the end is in busy state. However, it shall not apply if the end is in frame rejection state.

If N(R) does not acknowledge reception of at least all the frames sent by the primary/secondary station up to and including the frame containing a bit P/E = 1, it applies the I frame retransmission procedure from N(S) = received N(R) onwards.

If the number of unacknowledged frames is less than the look-ahead window, it shall send unacknowledged frames and unsent frames but the total number shall not exceed the look-ahead window k.

7.6.4.6 REJ frame reception

When a primary/secondary station receives a REJ frame, it shall assign its send state variable V(S) the value of N(R) received in the REJ frame command field. It shall retransmit the I frame(s). If any I frames are waiting, it may also transmit previously unsent I frames but the total number shall not exceed the look-ahead window k.

7.6.4.7 RNR frame reception

7.6.4.7.1 Primary station

In downlink information transfers, and when the primary station receives an RNR frame with bit E = 1, it shall assign its send state variable V(S) the value of N(R) received in the RNR frame and shall start a time-out T202 (see "List of system parameters").

When T202 expires, the primary station shall retransmit the last I frame(s) according to the value of V(S) and the size k1 of the look-ahead window. If the number of consecutive received RNR frames reaches N202, the primary station shall disconnect the link according to the previously described procedure (see "Link disconnection").

7.6.4.7.2 Secondary station

In uplink information transfers, if the secondary station receives an RNR frame, it shall assign its send state variable V(S) the value of N(R) received in the RNR frame and shall set a time-out T204. In this case, the RACH access shall not be possible.

When T204 expires, the secondary station shall change to disconnected state. T204 shall be cancelled if any frame other than RNR is received with bit P = 1.

7.6.4.8 Primary station reception of RR

On CCH, the primary station shall stop sending transmit rights to a secondary station if it receives (RR, bit E = 1) N203 times in response to sending (RR, P = 1) N203 times and no I frame is waiting to be sent or acknowledged. The time interval between retransmissions shall be less than the secondary station's T203 time-out.

On DCH, the primary station shall stop sending transmit rights to a secondary station if it receives (RR, bit E = 1) N203 times in response to sending (RR, P = 1) N203 times and no I frame is waiting to be sent or acknowledged. In this case, the primary station shall start T207. At T207 expiry (and no I frame is waiting to be sent), the primary station shall send an RR frame (P = 1). T207 shall be cancelled when an I frame needs to be sent or when the transport layer asks for ST transmit rights. N203 shall be considered to be 0 when the primary station sends a frame inducing a channel switch over on the secondary station.

7.6.4.9 Secondary station reception of RR

When the secondary station receives an RR, bit P = 1 command, it shall issue an RR response with bit E = 1, if no frames are waiting to be sent or acknowledged.

7.6.4.10 Busy state

7.6.4.10.1 Primary station

A primary station in busy state shall not grant the secondary station(s) transmit rights.

If the busy state persists, the data link level shall not take any action. If the primary station is deadlocked, it shall disconnect the link according to the previously described procedure (see "Link disconnection").

7.6.4.10.2 Secondary station

When the secondary station goes into busy state, it shall send an RNR response with bit E = 1 as soon as it can. The secondary station can acknowledge the last I frames with the RNR response.

In this state, the secondary station shall send RNR whenever it is granted transmit rights (in busy state). When the busy state ends and the station receives transmit rights, its shall send an RR frame if there are no I frames waiting to be sent, else it shall send the I frames according to the procedure described in "I frame sending".

7.6.4.11 Waiting for acknowledgements

7.6.4.11.1 Primary station

When the primary station sends a bit P = 1 in a frame, it shall open a window of n blocks matching the T200 time-out value and shall set an internal variable X to zero. If no response is received at time-out, it shall increase the variable X by one unit. Else, it shall reset X to zero.

If the primary station does not receive a response, it shall retransmit the last sent frames. When the send counter X equals N201, the primary station shall stop the retransmissions and shall consider the secondary station to be unreachable. If the right to transmit is conveyed in an RR frame, the primary station shall perform N204 times the N201 retransmission sequence at intervals of T200. The N204 sequences are themselves repeated at intervals of T206. Therefore, after N204 * N201 retransmissions the primary station shall consider the secondary station as unreachable. This mechanism is used to overcome temporary radio channel reception problems.

Upper layers are requested to restore the link.

7.6.4.11.2 Secondary station

Whenever the secondary station returns control (bit E = 1), the waiting time for information acknowledgement shall be limited by T205. The timer shall be reset if the primary station starts to retransmit any or some of the frames. If the acknowledgement has not arrived when T205 expires, the secondary station shall alert the service user about link loss and changes to disconnected state.

Furthermore, for each frame sent with bit E = 1 on DCH, a waiting time for next transmit rights to be granted shall be limited by T211. This timer shall be reset on reception of a frame with bit P = 1. At T211 expiry, the secondary station shall alert the service user about link loss and changes to disconnected state.

7.6.4.12 Secondary station waiting for transmit rights on SDCH

The secondary station waits for transmit rights when it has at least one frame ready to be sent and has executed a random access. Each time is granted the right to transmit, the secondary station shall cancel T203, if necessary. If it has not been granted transmit rights when T203 expires, it shall alert the service user that the waiting frame cannot be transmitted and shall change to disconnected state.

7.6.4.13 Waiting for random access acknowledgement on SDCH

The random access procedure, which ends when the secondary station receives a positive RCH acknowledgement, is limited in time by T208. If the secondary station has not received a positive RCH when T208 expires, it shall alert the service user of unsuccessful random access and shall change to disconnected state.

7.6.5 Group paging procedure

On user service request, the primary station shall send only one UI frame with bit P = 1 and shall set T200 according to a mono-block frame for the response .

If no response is received at time-out, the primary station shall alert the service user that no response has been received.

When the secondary station receives an UI frame with bit P = 1, it shall start T201 and deliver the contents to the service user.

If n is the number of the last downlink block carrying the UI frame, T201 will be set to guaranty that the response from secondary station will occur on block n + offset -1.

If, on T201 expiry, the user service decides to respond, it shall send an access block containing the Secondary station identifier (TTI) or an RTI if the secondary station is not registered.

If, when T201 expires, the secondary station has no response, nothing has to be done.

The primary station shall try to receive the access block and delivered to the service user one of these information :

- An access block is received;
- A collision is detected (access burst);
- No received signal.

7.6.6 Polling Information transfer procedure

The secondary station Information sending procedure under primary station control on SDCH are described below.

For each transfer, the primary station shall send only one URR frame with bit P = 1 and shall set T200 according to a bi-block frame for the response.

The URR frame will indicate which format is expected for the response. The actual response format is UI_P0.

If no response is received at time-out, the primary station shall alert the service user that no response has been received.

When the secondary station receives an URR frame with bit P = 1, it shall start T201. If, on T201 expiry, it has service user data previously submitted via DATA POLLING REQUEST primitive, it shall send the UI_P0 frame with bit RA = 0 and confirm the transfer via the DATA POLLING CONFIRM primitive;

If, when T201 expires, the secondary station has no UI_P0 frame to respond, nothing has to be done.

On good receipt of the UI_P0 frame with bit RA=0, the primary station shall accept the information field and deliver it to the service user via DATA_POLLING_INDICATION primitive.

Invalid frames shall be ignored on primary/secondary stations.

Only one DATA POLLING REQUEST primitive may be processed at the same time, if the service user submit another data transfer via DATA POLLING REQUEST before the previous request has not been processed, the previous transfer is discarded and the transport layer advise the service user by a DATA POLLING CONFIRM (NAK) .

7.6.7 Link resetting condition

When the primary station receives an FRMR or DM response from the secondary station during an information transfer phase, it shall trigger the link resetting procedure.

Likewise, when the primary station detects the same types of errors as those reported in an FRMR frame, it shall trigger the link resetting procedure.

7.6.8 Link resetting procedure

The link resetting procedure is used to restart information sending in the previously set up direction. This procedure shall only be applied during the information transfer phase. Else, it shall notify the end of a busy state.

The primary station shall send an SNRM command to start the link resetting procedure. When it receives an UA response from the secondary station, it shall reset its send state V(S) and receive state V(R) variables to zero, stop T202, grant transmit rights to the terminal by sending RR, P = 1 and remain in the information transfer phase.

If the secondary station requests link resetting, it shall send an FRMR frame with bit E = 1, change to frame rejection state and wait to receive SNRM. It shall ignore all frames other than SNRM and DISC. Moreover, if the frame other than SNRM or DISC is received with bit P = 1, the secondary station shall retransmit the FRMR frame. When the secondary station receives the SNRM frame with bit P = 1, it shall reset its V(s) and V(R) variables to zero and send an UA frame. When the secondary station receives a DISC frame with bit P = 1, it shall send an UA frame and change to disconnected mode.

When the primary station receives an FRMR response, it shall send an SNRM command to start the resetting procedure.

7.7 DACH Link procedure description

The procedures described in this paragraph only concern transactions on DACH.

7.7.1 Preliminary remarks

The transport layer presents the requests to send data on DACH to the data link layer.

The data link layer can only execute one send data request on DACH at a time.

Any new send request on DACH presented before the primary station has acknowledged the previous request shall be considered to be a new request that cancels the previous one. It is the transport layer which may take the decision to send a new request. Its main use is to interrupt sending on DACH to transmit a higher priority request on DACH.

7.7.2 I_DACH frame sending by the secondary station

7.7.2.1 Step 1

The secondary station:

- shall set a variable N = N210;
- shall start T210 (If T210 expires, it informs the transport layer of transmission failure. The procedure ends);
- shall increase V'(S) by one.

7.7.2.2 Step 2

The secondary station shall set N'(S) to V'(S) in the I_DACH frame and shall set the R bit to 0 the first time or to 1 for retransmissions.

The secondary station shall draw a random value Y where 0 < Y ### MIN (2^N, N212).

Then the secondary station shall wait for the Yth DACH frame occurrence and spontaneously transmit the I_DACH frame and set D211. This frame contains the data supplied by the transport layer.

In case of retransmission, when waiting for the Yth DACH frame occurrence, the secondary station can receive the acknowledgement. In this case, it shall consider transmission to be successful, cancel T210 and submit success confirmation to the transport layer.

7.7.2.3 Step 3

The secondary station shall switch to permanent reception on SDCH.

If the secondary station receives:

- an ACK_DACH frame whose N'(R) equals to the N'(S) of the transmitted I_DACH frame, it shall submit success confirmation to the transport layer. The procedure ends;
- a stuffing frame (before D211 expires), the secondary station does not take any action;
- a stuffing frame (after D211 expires), it shall increase N by 1 and switch to step 2;
- another frame, the secondary station does not take any action.

7.7.3 I_DACH frame reception by the primary station

The primary station which receives a I_DACH frame on DACH shall transmit an ACK_DACH frame with N'(R) = N'(S) on the downlink SDCH.

The primary station shall send frame contents to the above layer.

7.8 RACH/RCH link procedure description

7.8.1 General principle

The RACH (uplink channel) is organised in 8 groups of 3 accesses per superframe. The secondary station shall use its access number to select its access among the 3 accesses of each group. This access number is defined with the 4 least significant bits modulo 3 of the link level terminal identifier ([X3,X2,X1,X0] bits of TTI or RTI); for example, if (X3,X2,X1,X0)=(1,0,1,1), the access number shall be 2.

The period of random access recurrence for a terminal is, therefore, 0.5s.

A RACH block shall always carry an access block which contain the 14 most significant bits of the link level terminal identifier (TTI or RTI); the SwMI shall find the missing bit (X0).

The downlink RCH rate shall be used to send the acknowledgement for every uplink access. A RCH frame is sent every 0.5 seconds, containing 3 acknowledgements for the three uplink access.

The principle used is a random access at a rate of 0.5 second; the acknowledgement indications, collision detection or unreceived access indications in the RCH are used to control retransmission.

7.8.2 Primary station operations

If the access block is not correctly received:

- the RCH shall contain one of the two following indications:

    - Collision detection: based on a criterion defined from the indications supplied by the base station modem (received power, synchro word detection,...);
    - Not received: no received signal.

If the access block is correctly received:

the primary station shall find the value of the X0 bit with the help of the access number (named AN later on); if X = (X3,X2,X1), X0 is then defined as (X+AN) modulo 3 excluding impossible cases giving X0=2; for these excluded cases, the primary station shall consider the RACH block is not correctly received.
Accordingly, this rule is detailed in this following chart:

Table 10: Chart

	AN = 0	**AN = 1**	**AN = 2**
X = (0,0,0)	X0 = 0	X0 = 1	Impossible
X = (0,0,1)	X0 = 1	Impossible	X0 = 0
X = (0,1,0)	Impossible	X0 = 0	X0 = 1
X = (0,1,1)	X0 = 0	X0 = 1	Impossible
X = (1,0,0)	X0 = 1	Impossible	X0 = 0
X = (1,0,1)	Impossible	X0 = 0	X0 = 1
X = (1,1,0)	X0 = 0	X0 = 1	Impossible
X = (1,1,1)	X0 = 1	Impossible	X0 = 0

In all the valid cases, the RCH shall contain an indication of positive acknowledgement and the 15 bits of the TTI/RTI identifier.

After sending the RCH block and:

- if there is a existing context corresponding to the received address in the primary station, the primary station shall grant the secondary station transmit rights by sending an RR frame with bit P = 1
- if there is no context corresponding to the received address in the primary station:
    - if the address is a TTI address, the primary station shall set up the link and afterwards shall grant the secondary station transmit rights by sending an RR frame with bit P = 1
    - if the address is a RTI address, the primary station shall inform the above layer.

7.8.3 Terminal retransmission algorithm

The algorithm used allows random access peaks to be absorbed.

A terminal sends an RACH frame at a given time. If a positive acknowledgement (ACK) is received, the access is successful. In case of acknowledgement for another terminal (NACK) of an unreceived RCH frame (EFF), or base station non reception (NR), the terminal shall retransmit an RACH frame in the next access. In case of collision with another terminal (COLL) it shall draw a random heads/tails:

- Tails: it shall retransmit in the next access;
- Heads: it shall switch to level 1 wait state.

In level wait states, it shall listen to RCH without sending RACH. Whenever a collision is detected, it shall switch down to the next level till level NMAX (8) in the stack. In case of NR, NACK or EFF, it shall switch up to the previous level till transmit state (level 0).

In case a collision is detected in NMAX level wait state, the terminal shall change to conventional slotted ALOHA mode, with a probability of retransmission (PR) or around 0.05. NMAX shall be dimensioned to avoid falling into slotted ALOHA mode in the vast majority of cases.

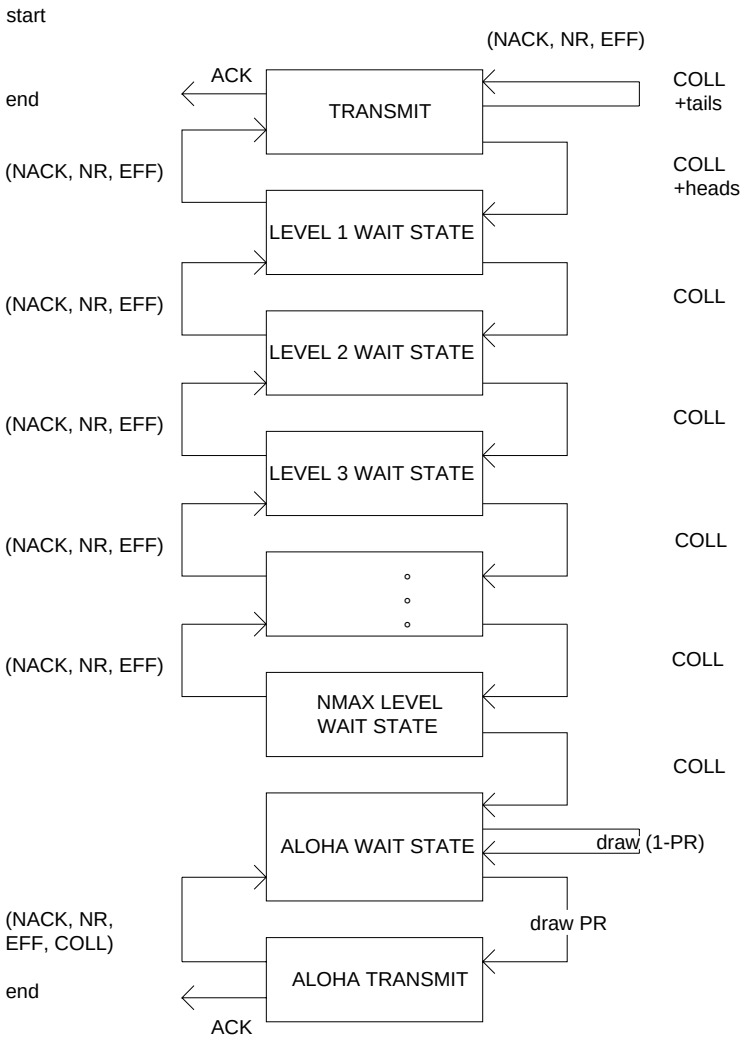


Figure 21: Terminal retransmission algorithm

7.9 List of system parameters

The system parameters are those mentioned in different paragraphs of the present document.

7.9.1 T200 timer

The primary station uses the T200 timer. It corresponds to the transmit right window granted to a secondary station. T200 is set whenever a frame with bit P = 1 is sent. Control is returned to the primary station when T200 expires. T200 is cancelled when a frame with a bit E = 1 is received.

The T200 timer run varies with the type of information expected from the secondary station.

The value of this timer is calculated according to the number of expected blocks and according to the offset between sending and receiving (see "Uplink transmit rights" in "Procedure description" of this document).

7.9.2 T201 timer

Only the secondary station uses T201; it is started at the receipt of a frame with bit P equal to 1. When T201 expires, the transmit window is opened. This timer has to be synchronised on the start of the window. The secondary station sends the frame at a fixed date known to the primary station. This timer shall correspond to the sending of the synchronisation block of the frame to send.

7.9.3 T202 timer

The primary station initialises this timer on receiving an RNR from the secondary station. The primary station uses it to ensure change from busy to normal transfer state. The value of T202 is implicitly communicated by the level above for each downlink data transfer session (typical value: 140 ms).

7.9.4 T203 timer

The secondary station manages this timer. T203 expiry means that the secondary station has not received transmit rights. Its value shall cover N201 times T200 (typical value: 12s).

7.9.5 T204 timer

The secondary station manages this timer. T204 expiry means the primary station is still in busy state. (typical value: 5s).

7.9.6 T205 timer

The secondary station manages this timer. T205 expiry means that the primary station has not acknowledged one or more information frames (typical value: 15s).

7.9.7 T206 timer

The primary station manages this timer. It is set after N201 RR frame repetitions with bit P = 1 with no response from the secondary station. When T206 expires, transmit rights are retransmitted to the secondary station. This sequence is repeated no more than N204 consecutive times (typical value: 5s).

7.9.8 T207 timer (used only for DCH)

The primary station manages this timer. T207 expiry means that the primary station shall grant transmit rights to the secondary station. (typical value 500 ms)

7.9.9 T208 timer

The secondary station manages this timer. T208 expiry means that no positive random access acknowledgement has been received. It therefore limits the RACH/RCH algorithm execution time (typical value: 10s).

7.9.10 T209 timer

The primary station manages this timer. It delays the transmission of an RR frame acknowledging the received I frames. It is set when an I frame with bit E = 1 is received, if the primary station has no I frames to send. It is cancelled if an I frame has to be sent to the secondary station, or when the transport layer asks the primary station to grant transmit rights to the secondary station. When T209 expires, the primary station sends an RR frame to acknowledge received frames (typical value: 500 ms).

7.9.11 T210 timer

The secondary station manages this timer. T210 expiry means that no positive acknowledgement has been received for DACH access. It therefore limits the DACH access algorithm execution time (typical value: 10s).

7.9.12 D211 timer

The secondary station manages this timer. It corresponds to the waiting delay for ACK_DACH frames. After this delay, the secondary station waits for either an ACK_DACH frame or a stuffing block. If the first received event corresponds to a stuffing block, the secondary station triggers the retry procedure. (see the complete procedure in this document) (typical value: 400 ms).

7.9.13 T211 timer (used only for DCH)

The secondary station manages this timer. T211 expiry means that transmit rights have not been granted for a long time. (typical value 30s)

7.9.14 T212 timer

The secondary station manages this timer. It corresponds to the waiting delay for a RR, P=1 frame. If this timer expires, the secondary station starts the RACH/RCH procedure to request the transmit rights (typical value 2s).

7.9.15 N200 parameter

N200 is the maximum number of octets in an I frame; it depends on the number of blocks in an I frame. It is defined as follows:

N200 = M1*M2
Where:
M1: number of data octets in a block;
M2: number of blocks in a frame, without the exclusive OR block (if any).

7.9.16 N201 parameter

N201 is the maximum number of transmissions and retransmissions for a frame after T200 expiry. It is fixed in the primary station (typical value: 3).

7.9.17 N202 parameter

N202 corresponds to the maximum number of consecutive RNR frames received by the primary station (typical value: 3).

7.9.18 N203 parameter

N203 is a parameter defined in the primary station. It is the maximum number of consecutive sequences: primary station frame transmission (RR, P = 1), secondary station transmission in response to a frame (RR, E = 1). It ends transmit right transmissions to the secondary station (typical value: 1).

7.9.19 N204 parameter

N204 is the maximum number of times the end of RR frame transmission can be repeated by the primary station. This sequence of N201 attempts (see definition of N201) is reiterated N204 times, at intervals of T206 (typical value: 3).

7.9.20 N210 parameter

N210 is the initial value used to define the window size for drawing a random value in DACH access (typical value: 0).

7.9.21 N212 parameter

N212 is the maximum window size for drawing a random value in DACH access (typical value: 8).

7.9.22 Maximum number k of look-ahead I frames

The maximum number k of sequentially numbered I frames that the primary or secondary station may have in the look-ahead window (unacknowledged frames) at any given time, is a system parameter. This number is fixed at k1 in the downlink direction, and k2 in the uplink direction (typical values: k1=3; k2=1 on SDCH, k1= 5 and k2 depends on QoS on DCH.

7.9.23 Maximum number of I frame blocks

The maximum number of I frame blocks is a system parameter negotiated by the primary station for each connection.

However, this number shall not exceed 8 (number of useful blocks, i.e., without counting the exclusive OR block) to optimise channel performances.

7.9.24 Offset between SDCH uplink and downlink channels

Offset (in number of blocks) between the last frame block sent by the primary station giving the secondary station transmit rights on SDCH, and the first data block in the secondary station response frame. If the last frame block sent by the primary station is numbered N, the first data block sent in response by the secondary station shall be numbered N+offset.

offset = 7.

7.9.25 SHIFT_DACH

Offset (in number of blocks) between the block sent by the primary station designating a DACH access, and the first DACH access block that the secondary station can access.

shift_dach = 5.

7.9.26 N_DACH

Number of data blocks for a DACH access.

N_DACH = 2.

8. Connection-oriented transport level

The present Clause defines the services and information transport protocol on the SwMI/ST interface. The transport entity offers several protocol procedure classes and different qualities of service. It is used for signalling and sending data between the SwMI and the ST.

The procedures mentioned in this Clause concern information units crossing the SwMI/ST interface via the link in an error-free way.

8.1 Definitions

The present Clause is based on the concepts established in the Open Systems Interconnection reference model and uses the following terms.

8.1.1 Transport service user

Abstract representation, within a same sub-system, of the full set of entities which uses the transport service.

8.1.2 Uplink transport

Initiated by the ST.

8.1.3 Downlink transport

Initiated by the SwMI.

8.1.4 Multiplexing/demultiplexing

Transport layer function which combines several transport connections on a single data link connection. Multiplexing is performed in the Transport to data Link direction and demultiplexing is performed in the opposite direction.

8.1.5 Flow control

Function which controls the flow of data between adjacent layers, namely the transport and data link layers.

8.1.6 Segmentation

Function which matches a service data unit and several protocol data units.

8.1.7 Reassembly

Function which matches several protocol data units and one service data unit. This function is the opposite of the segmentation function.

8.1.8 TSAP

Transport Service Access Point.

8.1.8.1 TSAP identity

Each TSAP is known by both ends and is identified by a fixed identifier called the TSAP id.

8.1.8.2 TSAP reference

Specifically identifies a transport level connection between the SwMI and an ST on ONE END. Therefore, for any given connection there is a TSAP reference on the SwMI end and another on the ST end. These two references are not necessarily equal except for fast type connections.

8.1.9 TPDU

Transport Protocol Data Unit. Each TPDU is conveyed in data link layer I frame information field.

8.1.10 TSDU

Transport Service Data Unit. A TSDU is sent in one or more TPDUs.

8.1.11 LSDU

Link Service Data Unit. An LSDU is a data link information frame.

8.1.12 Quality of service

The QoS corresponds to the duration an ST is allowed to transmit on the uplink SDCH on CCH or on the uplink DCH. It is allocated by the SwMI transport entity.

8.1.13 Preferred quality

Quality of service requested and required by the application entity using transport layer services.

8.1.14 Adopted quality

Quality of service indicated by SwMI in a TPDU CR or FCR for downlink transport, and a TPDU CC for uplink transport.

8.2 The transport protocol

The transport protocol offers the means to set up a transport connection with another transport service user for exchanging TSDUs, and also the possibility to request, negotiate or agree on a certain quality of service. This is specified in the quality of service parameter of the primitives used during the connection set-up phase. A quality of service is associated with every transport connection.

8.2.1 Services provided by the transport layer

The transport service primitives listed in the table below are used to transfer information to and from the transport service user.

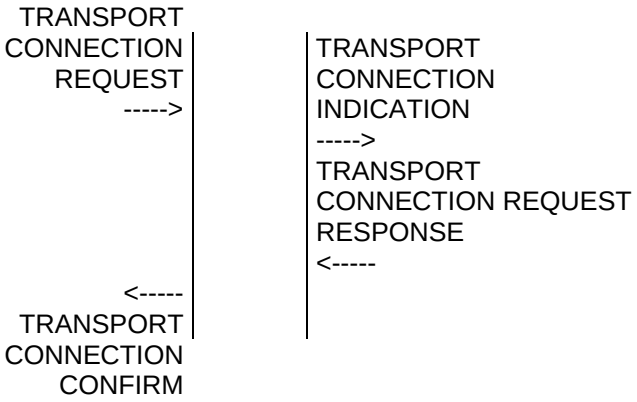
Table 11: List of primitives

PRIMITIVES	PARAMETERS
TRANSPORT CONNECTION REQUEST TRANSPORT CONNECTION INDICATION	Called user link address (note 1) Destination TSAP id Preferred/Negotiated quality of service Called user location (note 1) Type (Normal/Fast connection) User data
TRANSPORT CONNECTION REQUEST RESPONSE	Called user link address (note 1) TSAP reference Adopted quality of service (note 1) User data
TRANSPORT CONNECTION CONFIRM	Called user link address (note 1) TSAP reference Adopted quality of service User data
TRANSPORT DATA TRANSFER REQUEST TRANSPORT DATA TRANSFER INDICATION	Called user link address (note 1) TSAP reference User data Data type (Normal/Express)
TRANSPORT DATA TRANSFER CONFIRM	Called user link address (note 1) TSAP reference Transfer type (Normal/Express) Report (OK/NOK) (note 1)
TRANSPORT DISCONNECTION REQUEST	Called user link address (note 1) TSAP reference User data Type of disconnection (Normal/Fast) (note 1)
TRANSPORT DISCONNECTION CONFIRM	Called user link address (note 1) TSAP reference Report (OK/NOK) Type of disconnection (Normal/Fast) (note 1)
TRANSPORT DISCONNECTION INDICATION	Called user link address (note 1) TSAP reference User data Type of disconnection (Normal/Fast) (note 2) Cause
TRANSPORT CONNECTION ABORT (note 3)	Called user link address (note 1) TSAP reference (Single) / Multi TSAP With/Without link level disconnection
NOTE 1: Parameter not used by the ST NOTE 2: Parameter not used by the SwMI NOTE 3: Primitive accepted on SwMI side only if parameter n°3 is: "with link level disconnection"	

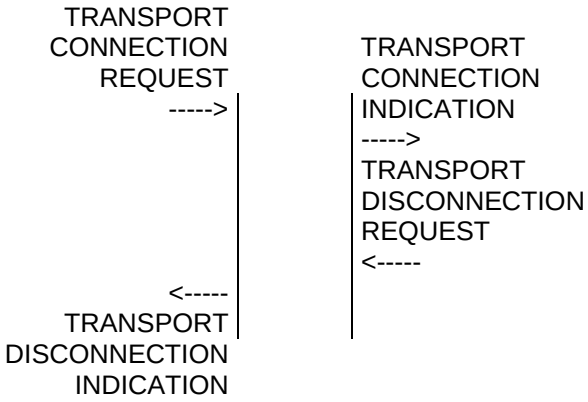
8.2.1.1 Primitives sequencing chart

This paragraph defines transport service primitives sequencing requirements. The order in which primitives have to be sent is specified hereafter in the most common cases.

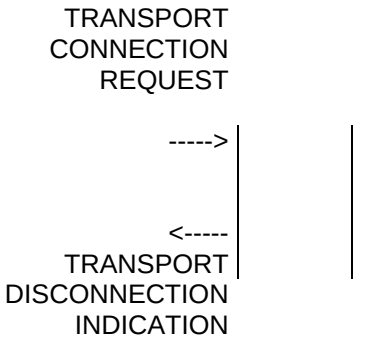
The use of a transport service primitive on one end of a transport connection, generally provokes a reaction on the other end. The relationships between the type of transport service primitive used on one end, and the service primitives used on the other end are listed below (not exhaustively).



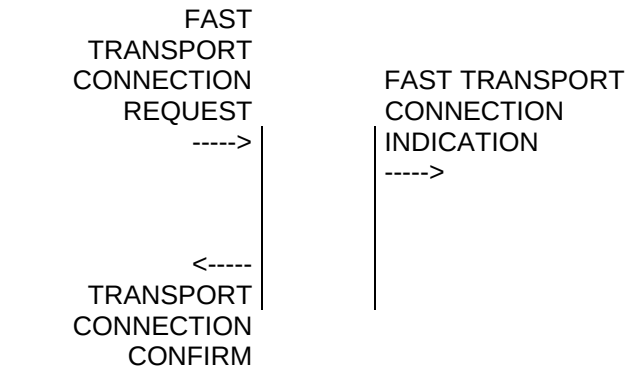
Successful set-up of normal transport connection



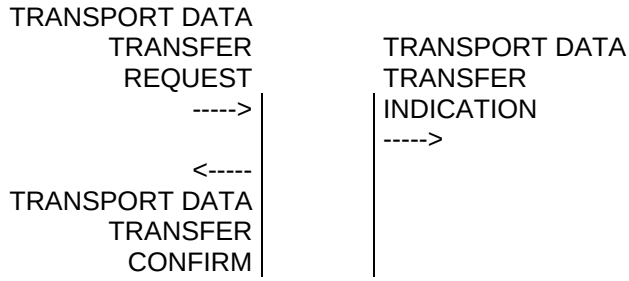
User rejection of normal transport connection request



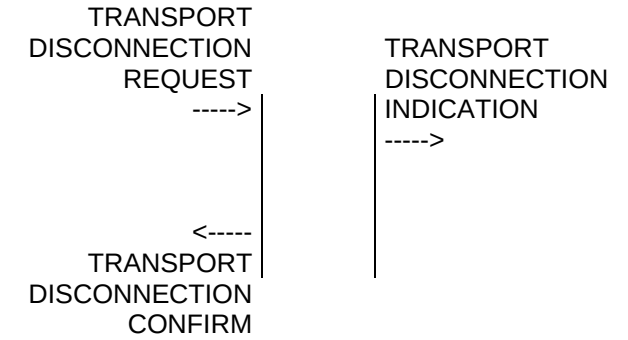
Normal connection rejection by transport service provider



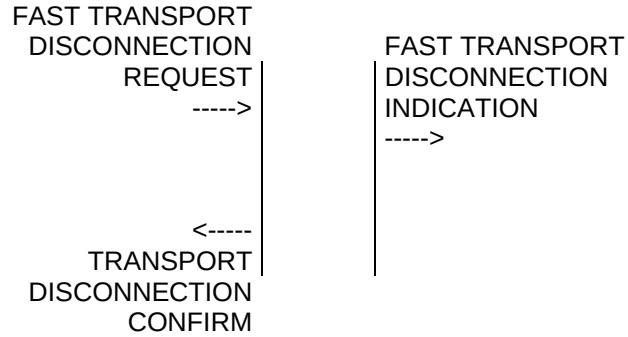
Set-up of fast transport connection requested by SwMI transport service user



Data transfer



Normal release of transport connection requested by transport service user



Fast release of transport connection requested by SwMI transport service user

Figure 22: Primitives sequencing chart

8.2.1.1.1 State transition diagram

This paragraph defines the state transition diagram of authorised transport service primitive sequences on one end of the transport connection.

In the following diagram:

- NOT CONNECTED state indicates the absence of a transport connection. It is the initial and final state of any primitive sequence;
- A transport connection release procedure may be initiated at any time during the transport connection set-up phase or data transfer phase;
- No procedure other than the transport connection release procedure may be initiated during the connection set-up phase;
- The actions undertaken following an unauthorised primitive sequence are determined locally.

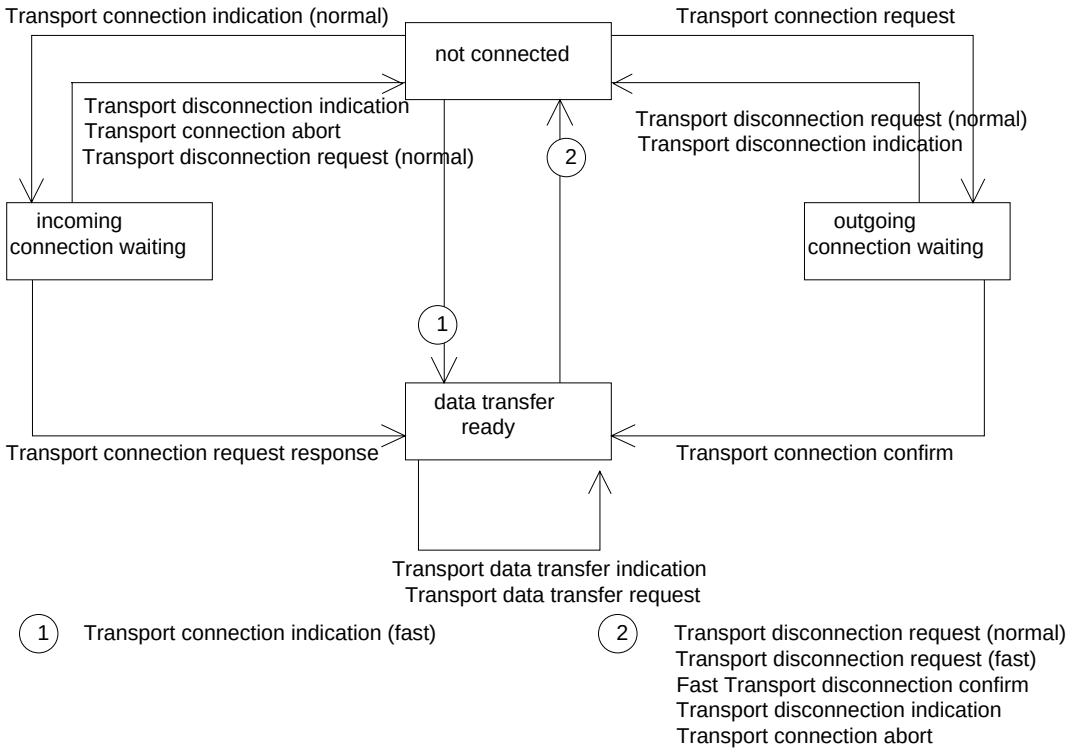


Figure 23: State transition diagram of possible primitive sequences

8.2.1.1.2 Transport service primitive sequences

The possible sequences of transport service primitives may be derived from the state diagram in the previous paragraph.

8.2.2 Expected data link layer services

Information is exchanged in both directions by the data link service provider and the transport service provider.

8.2.3 Transport layer capabilities

The transport layer capabilities are those required to fill the gap between the services provided by the data link layer, and the services offered to transport service users. Other functions are enabled to make data link connection set up phases transparent to users.

The capabilities are:

- Multiplexing and demultiplexing: function which combines several transport connections on one data link connection;
- Segmentation and reassembly: function which divides a TSDU into several TPDUs on the sender transport end, then reassembles them on the receiver transport entity again to reproduce their original format;
- Setting the optimum TPDU size for segmentation;
- Transferring TPDUs;
- Flow control: function which regulates the flow of TPDUs between the transport layer and the data link layer;
- Negotiating the transport service quality with transport service users;
- Allocation by SwMI of data link parameters for the terminal.

8.2.4 Quality of service

Transport Layer capabilities are grouped in a single class offering different qualities of service. The quality of service corresponds to the transmission duration allocated to a terminal on SDCH of CCH or on DCH, and therefore influences the length and the number of TPDU sent by the terminal.

The quality of service is assigned following a connection request sent by a transport service user. It may affect the mechanism whereby the SwMI allocates the window size of transmit rights to the terminal. The data link layer shall manage the allocation mechanism.

A quality of service, negotiated during the connection set-up phase, is associated with each transport connection. The transmission duration allocated to the terminal shall correspond to the highest quality of service of all the current transport connections for that terminal.

The SwMI shall allocate the quality of service during the connection set-up phase. The choice made by the SwMI transport entity depends on:

- the transport service user's demand expressed via the service primitives used during connection set-up;
- the qualities of service of any other already set up connections;
- the uplink load on SDCH or DCH.

Negotiation procedures are described later in the document.

8.2.5 Transport layer model

A transport entity communicates with transport service users via one or more TSAP by means of service primitives. The primitives are the cause or result of TPDU exchanges between peer entities associated by a transport connection. The data link layer services are used to exchange TPDUs. The model is shown below:

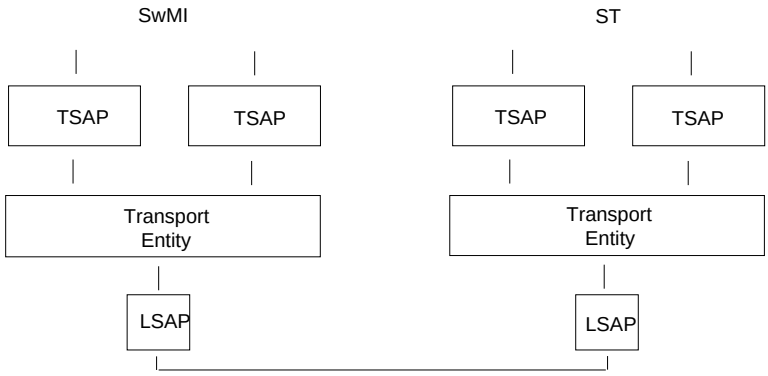


Figure 24: Transport layer model

NOTE: Examples of two TSAP are shown in this model.

8.3 TPDU structure and coding

8.3.1 TPDU structure

All TPDUs shall contain no more than N octets and each one is carried by a link layer I frame. The N parameter shall equal N400 in the uplink direction and shall depend on the quality of service. It shall equal N401 in the downlink direction. The figure below shows the TPDU structure. Each TPDU is divided into two parts, a TPDU header followed by a part whose structure varies according to the following parameters:

- TPDU type;
- presence or not of user data to be carried;
- segmentation or not.

There are three sub-fields in the part following the header, each of which may, or may not, be present:

- length of TPDU user data sub-field;
- user data sub-field;
- stuffing sub-field.

If a received TPDU contains user data, these data may be immediately transferred to the service user, or deferred if the reassembly function is active. A data TPDU shall contain an integer number of octets. The octets are numbered in sequence from one onwards and shall be sent in this order to the data link layer.

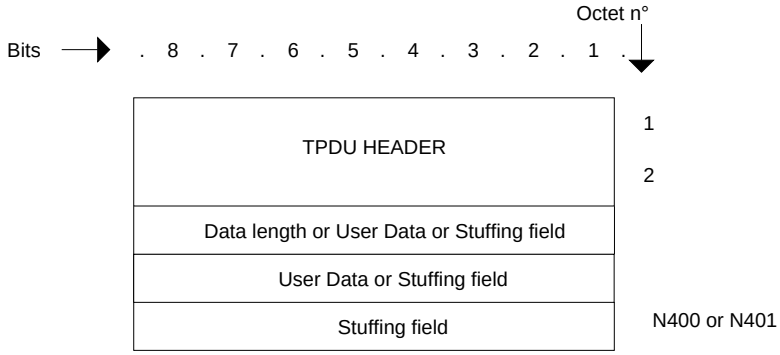


Figure 25: Generic TPDU format

N400 and N401 are described in the paragraph SYSTEM PARAMETERS.

8.3.1.1 TPDU header

Only the transport entity interprets the TPDU header .The header shall contain six separate fields. The header shall be structured as below:

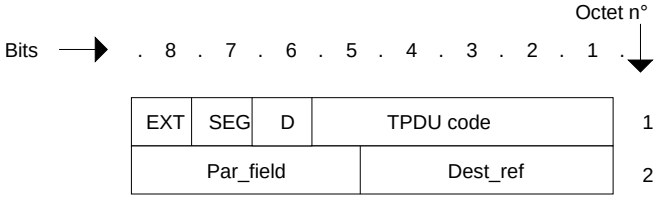


Figure 26: Generic TPDU header format

Each field is described below. The exceptions are specified in the descriptions of each TPDU type.

8.3.1.1.1 EXT field

This field is reserved for a future transport header extension. In the present state of specifications, the value of the EXT field is 0 (no header extension).

8.3.1.1.2 SEG field

This field delimits a user data TSDU. When a TSDU is sent in several consecutive TPDUs (see segmentation), the value of the SEG field shall be "1" provided the transferred TPDU does not delimit the TSDU. Therefore, all the TPDU shall be transferred with a SEG = 1 field, except the last TPDU which delimits the user data and whose SEG field = 0.

8.3.1.1.3 D field

Shall be analysed in conjunction with SEG and TPDU code fields. The D field indicates the presence or absence of user data. For all the TPDUs except DTE and DC, the D field indicates the presence (D = 1) or absence (D = 0) of transparent user data. In DTE TPDU, necessarily carrying user data, the D field is 1. Since DC TPDU cannot carry data, the D field is 0. In case of segmentation, when the field SEG = 1, the TPDU shall contain transparent user data, the transferred D field shall therefore be set to "1".

8.3.1.1.4 TPDU code field

This field contains the TPDU code.

Table 12: Valid TPDUs and the corresponding codes

Name	Code description	TPDU code
CR	Connection request	0 0 X X X
CC	Connection confirm	0 1 X X X
FCR	Fast connection request	1 0 X X X
DR	Disconnection request	1 1 0 0 0
FDR	Fast disconnection request	1 1 0 0 1
DC	Disconnection confirm	1 1 0 1 0
DT	Data	1 1 0 1 1
DTE	Data expedited	1 1 1 0 0

8.3.1.1.5 PAR_FIELD field

The PAR_FIELD field contains the different TPDU parameters. The content is described later on for each TPDU type.

8.3.1.1.6 DEST_REF field

The DEST_REF field contains, depending on the TPDU code, the TSAP identifier or the remote TSAP reference.

8.3.1.2 Data length or Data or stuffing field

If the TPDU does not carry user data (field D = 0), this field is part of the stuffing field. If it carries data and SEG = 1, this field is part of the data field. If it carries data and the SEG =0, it contains the length of the data field.

8.3.1.3 Data field

When the TPDU carries user data (D = 1) this field contains the data.

8.3.1.4 Stuffing field

This field fills to no more than N400 or N401, the space taken up by the previous fields to that the total number of bits transmitted is contained in an integer number of blocks. When it exists, all the bits it contains shall be set to "0".

8.3.2 Connection request TPDU (CR)

8.3.2.1 Object

The CR TPDU CR is used during the set-up phase of a normal connection with transport level acknowledgement.

8.3.2.2 Structure

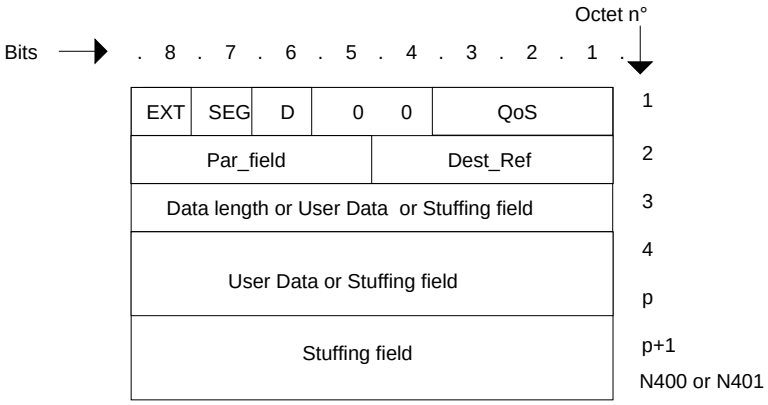


Figure 27: CR TPDU format

8.3.2.2.1 Par_field field

This field shall contain the TSAP reference of the sender transport entity. This reference shall be subsequently used as the destination reference for all the TPDUs sent over the connection to the sender CR TPDU transport entity.

The value of a TSAP reference associated with a normal type connection shall be from 0 to 7 inclusive.

8.3.2.2.2 Dest_Ref field

This field shall contain the TSAP identity of the transport service user. TSAP identities are known by both ends when the system is generated.

8.3.2.2.3 QoS field

The QoS field shall carry the preferred quality for uplink transport and the adopted quality for downlink transport.

8.3.2.2.4 Data length or User Data or Stuffing field

If the TPDU does not carry user data, i.e., D = 0; this field is part of the stuffing field;

If the TPDU carries all the user data sent with the connection request primitive, i.e. D = 1 and SEG = 0, this field shall contain the length of transported user data, i.e. p-3;

If the TPDU does not carry all the user data sent with the connection request primitive, i.e. D = 1 and SEG = 1, this field is part of the User Data field and shall contain the first data octet.

8.3.2.2.5 User data or Stuffing field

This field, when it exists, shall contain transparent user data.

8.3.2.2.6 Stuffing field

This field, when it exists, shall be sent with value "0".

8.3.3 Fast connection request (FCR)

8.3.3.1 Object

Only the SwMI shall use this TPDU during the fast connection set-up phase.

8.3.3.2 Structure

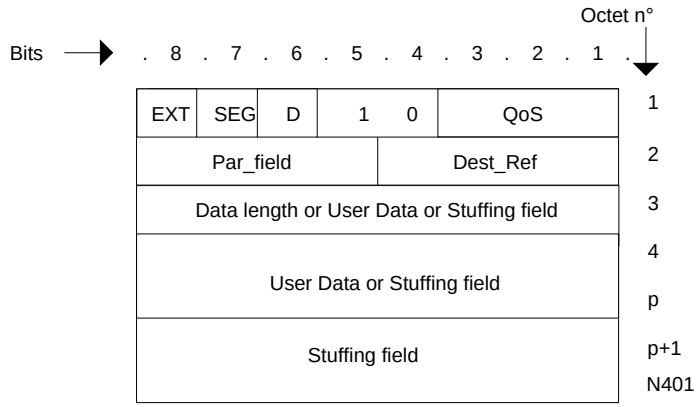


Figure 28: TPDU FCR format

8.3.3.2.1 Par_field field

This field shall contain the TSAP reference of the sender and recipient transport entity (they shall be identical). This reference shall be subsequently used by both ends for all TPDU concerning the connection.

The value of the TSAP reference associated with a fast connection shall be comprised between 8 and 14 inclusive.

8.3.3.2.2 Dest_Ref field

This field shall contain the TSAP identity of the service transport user. TSAP identities are known by both ends when the system is generated.

8.3.3.2.3 QoS field

The QoS field shall carry the adopted quality of service for downlink transport.

8.3.3.2.4 Data length or User Data or Stuffing field

If the TPDU does not carry user data, i.e. D = 0, this field is part of the stuffing field.

If the TPDU carries all the user data sent with the connection request primitive, i.e. D = 1 and SEG = 0, this field shall contain the length of transported user data, i.e. p-3.

If the TPDU does not carry all the user data sent with the connection request primitive, i.e. D = 1 and SEG = 1, this field is part of the User Data field and shall contain the first data octet.

8.3.3.2.5 User Data or Stuffing field

This field, when it exists, shall contain transparent user data.

8.3.3.2.6 Stuffing field

This field, when it exists, shall be sent with value "0".

8.3.4 Connection confirm TPDU (CC)

8.3.4.1 Object

The CC TPDU is used during the normal connection set-up phase with transport level acknowledgement. It acknowledges reception of a CR TPDU.

8.3.4.2 Structure

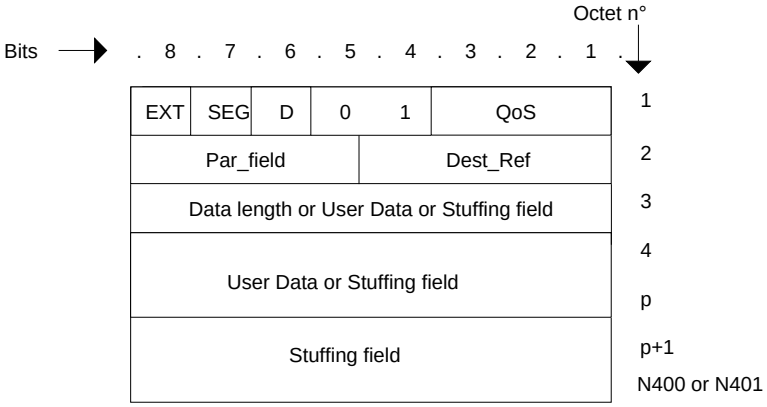


Figure 29: CC TPDU format

8.3.4.2.1 Par_field field

This field shall contain the TSAP reference of the sender transport entity. It shall be subsequently used as the destination reference for all the TPDUs sent on the connection to the CC TPDU sender transport entity.

The value of the TSAP reference shall be from zero to seven inclusive.

8.3.4.2.2 Dest_Ref field

This field shall contain the TSAP reference of the recipient transport entity. This reference shall be that indicated in the CR TPDU par_field.

8.3.4.2.3 QoS field

For uplink transport, the QoS field shall carry the quality adopted by SwMI. For downlink transport the QoS field is not significant and shall be transmitted with value zero.

8.3.4.2.4 Data length or User Data or Stuffing field

If the TPDU does not carry user data, i.e. D = 0, this field is part of the stuffing field.

If the TPDU carries all the user data sent with the transport connection request response primitive, i.e. D = 1 and SEG = 0, this field shall contain the length of transported user data, i.e. p-3.

If the TPDU does not carry all the user data sent with the transport connection request response primitive, i.e. D = 1 and SEG = 1, this field is part of the User Data field and shall contain the first data octet.

8.3.4.2.5 User Data or Stuffing field

This field, when it exists, shall contain transparent user data.

8.3.4.2.6 Stuffing field

This field, when it exists, shall be sent with value "0".

8.3.5 Disconnection request TPDU (DR)

8.3.5.1 Object

The DR TPDU shall be used in three cases:

- to notify connection refusal to the transport service user entity in response to the CR TPDU;
- to disconnect a connection after a service user request;
- to disconnect a connection requested by the transport entity when it detects an error.

8.3.5.2 Structure

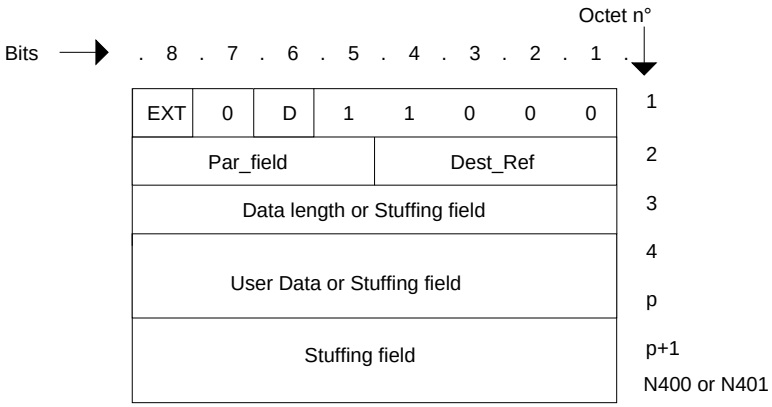


Figure 30: DR TPDU format

8.3.5.2.1 Par_field field

This field shall contain the TSAP reference of the sender entity or the reserved reference value of 15 if the transport entity initiates disconnection.

In this case (value 15) the length field shall contain the cause of disconnection.

8.3.5.2.2 Dest_Ref field

This field shall contain the TSAP reference of the recipient transport entity.

8.3.5.2.3 Data length or Stuffing field

It the TPDU carries user data, i.e. D = 1, this field shall contain the length of the user data field in the TPDU, i.e. p-3. Else, this field is part of the stuffing field.

8.3.5.2.4 User Data or Stuffing field

This field, when it exists, shall contain transparent user data. Field length shall not exceed (N400 or N401) - 3 octets.

8.3.5.2.5 Stuffing field

This field, when it exists, shall be sent with value "0".

8.3.6 Fast Disconnection Request TPDU (FDR)

8.3.6.1 Object

This TPDU shall be used to perform fast disconnection.

8.3.6.2 Structure

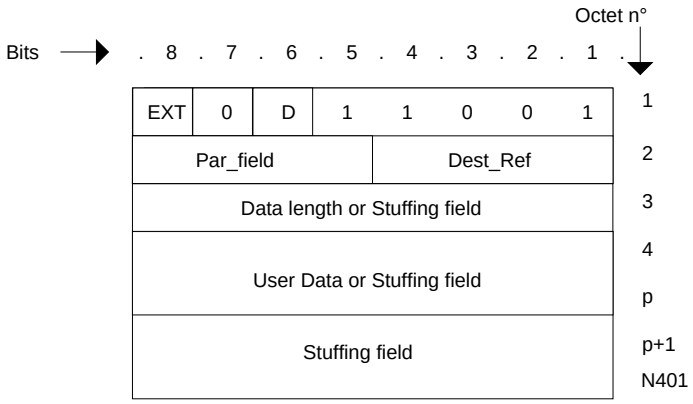


Figure 31: FDR TPDU format

8.3.6.2.1 Par_field field

This field shall contain the TSAP reference of the sender transport entity.

8.3.6.2.2 Dest_Ref field

This field shall contain the TSAP reference of the recipient transport entity.

8.3.6.2.3 Data length or Stuffing field

It the TPDU carries user data, i.e. D = 1, this field shall contain the length of the user data field in the TPDU, i.e. p-3. Else, this field is part of the stuffing field.

8.3.6.2.4 User Data or Stuffing field

This field, when it exists, shall contain transparent user data. Field length shall not exceed (N400 or N401) - 3 octets.

8.3.6.2.5 Stuffing field

This field, when it exists, shall be sent with value "0".

8.3.7 Disconnection confirm TPDU (DC)

8.3.7.1 Object

The DC TPDU acknowledges reception of a DR TPDU during the transport disconnection phase.

8.3.7.2 Structure

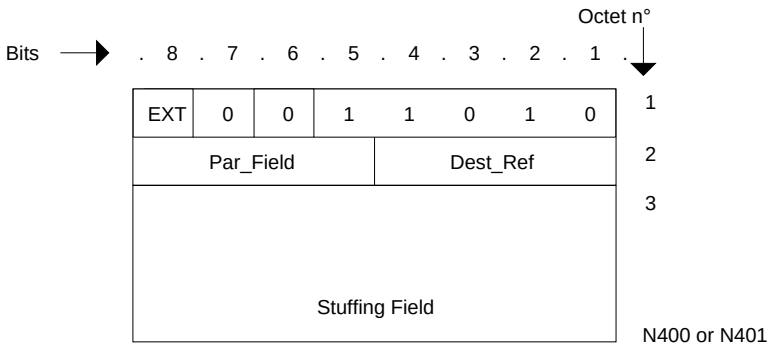


Figure 32: DC TPDU format

8.3.7.2.1 Par_field field

This field shall contain the TSAP reference of the sender transport entity.

8.3.7.2.2 Dest_Ref field

This field shall contain the TSAP reference of the recipient transport entity.

8.3.7.2.3 Stuffing field

All the bits in the field shall be sent with value "0".

8.3.8 Data TPDU (DT)

8.3.8.1 Object

This TPDU carries transparent user data. The DT TPDU can only be used after the transport connection is completely set up.

8.3.8.2 Structure

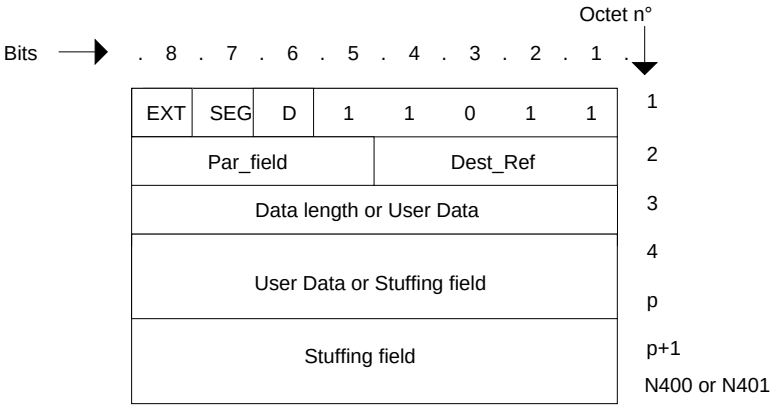


Figure 33: TPDU DT format

8.3.8.2.1 Par_field field

This field shall contain the TSAP reference of the sender transport entity.

8.3.8.2.2 Dest_Ref field

This field shall contain the TSAP reference of the recipient transport entity.

8.3.8.2.3 Data length or User Data

When the TPDU is sent with SEG =0, this field shall contain the length of user data in the DT TPDU, i.e. p-3. In all other cases, this field is part of the User Data field and shall contain the first octet in the field.

8.3.8.2.4 User data or Stuffing field

This field shall contain transparent user data.

8.3.8.2.5 Stuffing field

This field, when it exists, shall be sent with value "0".

8.3.9 Expedited data TPDU (DTE)

8.3.9.1 Object

This TPDU carries transparent user data. TPDU content is considered to have priority. In case of conflict with DT TPDU, the DTE shall be first sent to the data link. The DTE TPDU can only be used after the transport connection is completely set up.

8.3.9.2 Structure

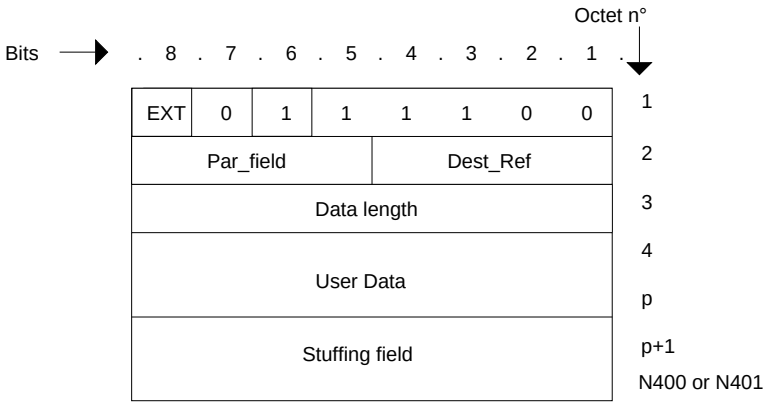


Figure 34: TPDU DTE format

8.3.9.2.1 Par_field field

This field shall contain the TSAP reference of the sender transport entity.

8.3.9.2.2 Dest_Ref field

This field shall contain the TSAP reference of the recipient transport entity.

8.3.9.2.3 Data length field

This field shall contain the length of user data in the DTE TPDU, i.e. p-3.

8.3.9.2.4 User Data field

This field shall contain transparent user data.

8.3.9.2.5 Stuffing field

This field, when it exists, shall be sent with value "0".

8.4 Procedure elements

The mode described in this paragraph and sub-paragraphs concern the connection-oriented mode where SwMI and STs may only exchange TPDUs after a data link level connection is set up.

8.4.1 Operating mode

Both SwMI and STs may request the set-up and release of a transport connection.

There are two connection and disconnection modes, namely normal connection with explicit TPDU exchanges and fast connection mode without acknowledgement from the transport level.

8.4.1.1 Normal mode

Both the terminal and base station may request normal connection.

8.4.1.2 Fast mode

Only the SwMI may initiate fast connection. Since no acknowledgement is required on transport level, this mode is useful when a large number of terminals have to be rapidly connected.

8.4.2 Quality of service

8.4.2.1 Object

The quality of service fixes the transmission speed assigned to a terminal for a connection according to the need expressed by the terminal or by SwMI. This speed is determined by the transmission window during which the terminal can transmit information to SwMI.

The quality of service therefore influences N400 parameter values (TPDU length) and N402 values (look-ahead window size in transmit mode, on the terminal data link level). The allocation procedure is described later in the document.

8.4.2.2 Parameter

This parameter is conveyed by downlink CR, FCR or CC TPDUs. The different existing Qualities of Service are:

Table 13: Available quality of service

QUALITY of SERVICE (QoS)	NB of I FRAME BLOCKS	SIZE OF LOOK-AHEAD WINDOW N402	MAXIMUM SPEED PER WINDOW N400 (octets)
0	2	1	11 / 18 (see note 2)
1	4	1	19 / 29
2	6	1	35 / 52
3	9	1	59 / 87
-	-	-	-
5	9	5	87
-	-	-	-
7	9	7	87
NOTE 1: Other Quality of service values are reserved for future use. NOTE 2: Second value for high rate.			

8.4.2.3 Default parameters

When the transport entity connects, the values of N400 and N402 used at data link level depend on any other set-up transport connections. These values shall be used during the new transport connection set-up phase, and shall remain unchanged until the quality of service demanded for a new connection changes.

The first transport connection is set up with a default quality of service of 0.

8.4.3 Segmentation and reassembly

8.4.3.1 Segmentation

8.4.3.1.1 Object

Segmentation concerns the TSDU sending procedures. This function shall be only activated when a normal type (not expedited) TSDU is transmitted with a length greater than X, where:

- X equals N400-3 on terminal side;
- X may depend on the downlink load on SwMI side.

The TSDU to be sent is sub-divided into elementary blocks of finite length to be transported in DT TPDU.

This function may be activated during and after the set-up of a transport connection.

8.4.3.1.2 Transport primitives used

The transport layer primitives used by the segmentation function are:

- TRANSPORT CONNECTION REQUEST carrying transparent user data;
- TRANSPORT CONNECTION REQUEST RESPONSE, carrying transparent user data;
- TRANSPORT DATA TRANSFER REQUEST, normal type data.

Only normal type data transfers may be segmented. The length of TSDU containing expedited data (not handled by the segmentation function), shall therefore:

- comply to the connection QoS, on terminal side;
- be less than the maximum length of an I frame information field minus the length of the TPDU header including the length field, on SwMI side.

8.4.3.1.3 Procedure

Terminal side

If Segmentation is activated when a Data Transfer or Connection request response primitive is used: The transport layer shall divide the data TSDU into N elementary blocks. The number N shall equal [INT(length(TSDU)/(N400-2))]+1. The size of the first N-1 blocks shall be N400-2 and the last shall contain the remainder. Depending on the connection state, the first block is carried by CC or DT TPDU. The following N-1 shall be carried in DT TPDUs. The first N-1 TPDUs shall be sent with SEG = 1 and with no length field. The last TPDU shall be sent with SEG = 0 and the length field shall contain the length of the data carried in the last TPDU.

If Segmentation is activated when the transport Connection Request primitive is used: The transport layer shall divide the data TSDU into N elementary blocks. The number N shall equal 1 + [INT((length(TSDU)-a)/(N400-2))] + 1 where a=9 on SDCH and a=16 for high rate. The first block shall be sent in the CR TPDU with no length field, with D = 1, SEG = 1 and a length of b octets where b=11 on SDCH and b=18 for high rate. This TPDU shall be sent with QoS 0, since the QoS it carries is a requested QoS which is not necessarily the adopted QoS. The N-2 following blocks shall be sent in DT TPDUs, of size N400, with no length field and SEG = 1. The last DT TPDU carrying the remainder, shall be sent with SEG = 0 and a length field specifying the length of the remaining data.

Base station side

Segmentation is dynamically performed according to the TSDU size, and shall adhere to the block generation requirement of blocks less or equal to the maximum conveyable length by an I frame information field.

8.4.3.2 Reassembly

8.4.3.2.1 Object

Reassembly is the reverse of segmentation. This function reconstructs the TSDU from the received TPDUs. It shall be activated when a DT, CR, FCR or CC TPDU is received with SEG = 1.

8.4.3.2.2 Procedure

The reassembly procedure consists of concatenating the user data fields in the received TPDUs with a field SEG = 1. If a DT TPDU is received with SEG = 0, the received TSDU shall be delimited using the length field. After delimiting the received TSDU, the transport layer shall forward it to the service user whose TSAP identity is indirectly identified by the Dest_Ref field contained in the received DT TPDUs.

SwMI side:

- if a DT TPDU is received with SEG = 1, a request shall be sent to the link layer to grant the ST transmit rights,
- if a CR TPDU is received with SEG = 1, no request shall be sent for granting ST transmit rights. Transmit rights shall be granted in the CC or DR TPDU.

8.4.3.2.3 Acknowledgement

The Transport level does not acknowledge received TSDUs. However, the sender entity shall check the link level acknowledgement to see whether the TSDU has been correctly routed.

When a DR TPDU is returned in response to CR or DT TPDU with SEG = 1, TSDU reassembling shall be stopped on one end and segmentation on the other.

8.4.4 Multiplexing and demultiplexing

8.4.4.1 Object

Multiplexing and demultiplexing procedures are used to allow several transport connections to be handled at the same time on one data link connection.

8.4.4.2 Procedure

8.4.4.2.1 Assigning references

A transport connection is identified by a local source TSAP reference and a destination TSAP reference. These references shall be used for all TPDU exchanges.

- Normal connection mode:

During the connection phase, the end requesting the connection shall assign a source TSAP reference to the connection and shall send it in the Par_field of the CR TPDU. Likewise, the recipient transport entity shall assign a destination reference and shall send it to the requesting entity in the Par_field of the CC TPDU.

ST and SwMI assign references locally. This number on each end shall be from zero to seven inclusive. No more than eight normal connections can be set up at the same time. The procedure for assigning references shall allow any problems caused by crossing disconnection and connection reference to be solved.

- Fast connection mode:

During the fast connection phase, the SwMI transport entity shall assign a source reference to the connection and shall send it in the Par_field of the FCR TPDU.

The terminal transport connection shall assign the SAME destination reference number to the connection.

The number assigned shall be from eight to fourteen inclusive. No more than seven fast connections can be set up at the same time.

8.4.4.2.2 TPDU and transport connection associations.

This procedure shall be used to translate a received LSDU into a TPDU and to associate each TPDU obtained with a transport connection. The transport entity uses the DATA TRANSFER INDICATION service primitive of the data link entity for this purpose.

To allocate the received TPDU to a connection, the following parameters shall be used:

- DESTINATION REFERENCE for all TPDUs;
- SOURCE REFERENCE for CR, FCR, CC TPDUs.

If the received TPDU is a CR or FCR, and if the DESTINATION REFERENCE (TSAP identity in field Dest_Ref) is known, and if the SOURCE REFERENCE (sender TSAP reference in field Par_field) parameter does not correspond to an open transport connection, the transport entity shall create a new connection.

If a CR, FCR, CC, DT, DTE or DR TPDU is received containing user data with an unknown DESTINATION REFERENCE parameter, a DR TPDU shall be sent with a DESTINATION REFERENCE field containing a copy of the errored TPDU SOURCE REFERENCE and a SOURCE REFERENCE field (field Par_field) containing the reserved value of 15. If the same error is detected in FDR, DC, DR TPDU with no data, the errored TPDU shall be ignored.

Finally, if a CR, FCR, or CC TPDU is received with an already used SOURCE REFERENCE or a TPDU other than CR, FCR and CC with an out of context SOURCE REFERENCE, the TPDU shall be ignored.

8.4.4.3 Restrictions

The multiplexing/demultiplexing function is active throughout the time the terminal remains on the same CCH or DCH. When the terminal changes physical channel, the existing connections have to be aborted by both SwMI and ST.

8.5 Procedures description

8.5.1 Overview

The transport layer provides users with two types of connections. Explicit connection oriented mode, with positive or negative acknowledgement from the recipient, and implicit connection mode where the terminal transport entity cannot refuse the connection. The second mode offers fast connection capabilities, namely in case of collective connections.

To provide a reliable information transfer service, the transport entity is supported by the data link entity services. The procedures described in this paragraph do not include restart procedures; these procedures are handled by the data link layer.

In the procedures described below, the case of uplink and downlink transport crossing is not described since it is allowed by the multiplexing function. The service user is charged with solving this situation.

Lastly, the transport layer uses a one ahead mechanism (TPDU), with regard to the data link during set-up and release phases. In all other cases, the look-ahead mechanism complies with data link look-ahead window requirements.

8.5.2 Transport layer states

8.5.2.1 SwMI

The transport entity has six states:

- an idle state called NOT CONNECTED. All transport connections are created in this state;
- two states called FAST and NORMAL SET-UP IN PROGRESS. These two states are activated for normal connections with acknowledgement and for fast connections;
- a CONNECTED state for TPDU transport;
- two states called NORMAL and FAST RELEASE IN PROGRESS. These states are used to end connections in progress for normal connections with confirmation and fast connections.

8.5.2.2 ST

The states of the ST transport entity are a sub-set of the SwMI states. The states, used in the same conditions as above, are NOT CONNECTED, NORMAL SET UP IN PROGRESS, CONNECTED, NORMAL RELEASE IN PROGRESS.

8.5.3 Connection set-up

8.5.3.1 Normal connection

8.5.3.1.1 Object

It shall be used to set up a connection with transport level acknowledgement.

8.5.3.1.2 Procedures

The transport connection is initiated by the transport layer service user. The user entity calls a TRANSPORT CONNECTION REQUEST primitive. The transport entity shall create a connection by assigning a reference number to the connection, then shall ask data link layer service to sent a CR TPDU. When the transport entity receives the CR TPDU acknowledgement from the link layer, it shall start a time-out T400. When the transport entity receives CC TPDU from the other end, it shall cancel T400 and use the TRANSPORT CONNECTION CONFIRM primitive to confirm the connection. The response may be sent with user data, so enabling TSDU exchanges. If T400 expires, the transport entity shall use the TRANSPORT DISCONNECTION INDICATION primitive to notify failure and shall cancel the current connection.

If a transport entity in NOT CONNECTED state receives a valid CR TPDU, it shall create a connection by assigning a TSAP reference number and shall notify the user identified in the Ref_dest field of the CR TPDU transport header using the TRANSPORT CONNECTION INDICATION primitive. Cases of transport entity or service user refusal are described hereafter. If the service user confirms the connection with the TRANSPORT CONNECTION REQUEST RESPONSE primitive, the transport entity shall send a CC TPDU via the data link. On positive acknowledgement from the data link layer, it shall change to CONNECTED state, and in case of a negative acknowledgement shall inform the user with the TRANSPORT DISCONNECTION INDICATION primitive.

8.5.3.2 Fast connection

8.5.3.2.1 Object

This type of connection shall be used, and exclusively initiated by a SwMI transport service user. It does not request an acknowledgement from the transport and obliges the transport service user on the terminal end to accept the connection.

8.5.3.2.2 Procedure

After receiving a fast TRANSPORT CONNECTION REQUEST, the SwMI entity shall ask the link layer to send an FCR TPDU. When the transport entity receives a positive acknowledgement from the link layer, it shall use the TRANSPORT CONNECTION CONFIRM primitive to inform the service user of connection set up.

When the terminal transport entity receives a FCR TPDU, it shall send the TRANSPORT CONNECTION INDICATION primitive to inform the recipient of connection set up. All DT TPDUs exchanges are possible from then onwards. It the recipient TSAP identity (field Dest_Ref) is not known, the transport entity shall send a DR TPDU with a SOURCE REFERENCE = 15 to indicate its refusal.

8.5.3.3 Quality of Service

The SwMI assigns a Quality of Service to the terminal during the connection set up phase.

8.5.3.3.1 Downlink transport

When the transport entity receives a connection request from the service user, it shall check the available QoS. If the requested QoS cannot be supplied, the transport entity shall use the TRANSPORT DISCONNECTION INDICATION primitive to indicate its refusal and the cause of refusal. Otherwise, the QoS is assigned the requested value and the connection procedure is activated. A CR or FCR TPDU, according to the type of connection, shall be sent to inform the terminal.

8.5.3.3.2 Uplink transport

The terminal transport entity shall indicate the QoS requested by the user in a CR TPDU. The SwMI transport entity shall extract the QoS. If the QoS requested by the terminal coincides with uplink load, the requested value shall be assigned. Otherwise, the SwMI shall assign the maximum available QoS. The terminal shall then be informed of the adopted quality of service in a CC TPDU.

If the requested QoS is greater than the adopted QoS, the service user shall decide whether to continue. For a given connection, the adopted QoS is never, whatever the case, greater than the requested QoS.

8.5.3.4 Change of QoS

When the multiplexing function is activated, the QoS may change for each new connection or disconnection.

- For each new connection, the N400 parameter used by the link level may increase if the QoS negotiated during the new connection set-up phase is greater than that of all the QoS of existing transport connections.
- For each new disconnection, the N400 parameter used by the link level may decrease if the QoS on the connection being disconnected is greater than that of all the existing transport connections.

8.5.3.4.1 Increased QoS

Uplink transport:

The terminal transport entity may only increase the QoS after receiving the CC TPDU sent by the SwMI. The SwMI transport entity shall increase the QoS immediately after sending the CC TPDU.

Downlink transport:

The terminal transport entity shall increase the QoS when it receives the CR or FCR TPDU sent by the SwMI. The SwMI transport entity shall increase the QoS immediately after sending the CR or FCR TPDU.

8.5.3.4.2 Decreased QoS

Change of QoS, requesting side:

After sending the DR or FDR TPDU, the transport entity waits for the acknowledgement from the link level. The QoS can only be decreased after the acknowledgement is received.

Change of QoS, requested side:

After receiving the DR or FDR TPDU, the requested entity shall decrease the QoS. If the requested side is the terminal, the frames whose length is greater than the new N400 value have to be purged at link level.

8.5.3.5 Normal connection refusal

8.5.3.5.1 By the transport entity

If on receiving the CR TPDU, the transport entity refuses the transport connection, it shall send a DR TPDU to indicate refusal. In this case, the TPDU SOURCE REFERENCE parameter shall be set to 15 and the TPDU DESTINATION REFERENCE shall be returned with the SOURCE REFERENCE value of the CR TPDU.

8.5.3.5.2 By the service user

During normal connection set-up, the requested user may refuse the connection. In this case, it shall invoke the TRANSPORT DISCONNECTION REQUEST primitive on receiving the TRANSPORT CONNECTION INDICATION primitive. The transport entity shall send a DR TPDU after setting the SOURCE REFERENCE field with TSAP reference assigned during the connection phase. The normal release procedure, described below, shall then be applied.

8.5.3.6 Normal release

8.5.3.6.1 Object

The transport entity or transport entity service user may release the connection. If the DR TPDU contains user data, this phase consists of DR and DC TPDU exchanges. Otherwise, the DR TPDU alone is needed to release the connection.

8.5.3.6.2 Procedure

If user data is sent with the disconnection request, the transport entity shall send a DR TPDU containing the user data, and shall wait for the acknowledgement. If the link layer positively acknowledges the DR TPDU, the transport entity shall start the time-out T401 and shall wait for a DC TPDU from the far end containing the acknowledgement. If the link layer sends a negative acknowledgement or T401 expires, the transport entity shall change to NOT CONNECTED state. Likewise, the DC TPDU reception ends the connection release. While waiting for the DC TPDU, the transport entity may receive a DR or FDR TPDU. It shall immediately release the connection involved, without sending a TPDU of any sort, even when the received DR TPDU contains data.

If no user data is sent with the disconnection request, then the release procedure ends as soon as the link layer positively acknowledges the DR TPDU.

If disconnection is requested during an outgoing connection set-up phase, the transport entity shall postpone sending the DR TPDU and shall wait for the CC TPDU in order to determine the TSAP reference of the remote transport entity.

If a DR TPDU is received during a connection set-up phase, or during an exchange of data TPDU, the transport entity shall send a TRANSPORT DISCONNECTION INDICATION primitive to inform the user and shall terminate the connection. If the DR TPDU contains user data, a DC TPDU shall be sent before releasing the connection.

In all cases, the TSAP reference assigned to the connection can be re-used on both ends when the connection is released.

8.5.3.7 Fast release

8.5.3.7.1 Object

This procedure releases a connection with a minimum of exchanges. This procedure can only be activated when the connection is in set-up state.

8.5.3.7.2 Procedure

This procedure is activated with a fast DISCONNECTION REQUEST primitive. The transport entity shall then send an FDR TPDU. When the transport entity receives an acknowledgement (positive or negative) from the link layer, or if a DR TPDU is received, the transport entity shall terminate the connection and inform the user. The originating transport entity shall ignore any DT TPDU received during this phase. In all cases, a report shall be sent to the user with a fast TRANSPORT DISCONNECTION CONFIRM primitive.

After receiving the FDR TPDU, the transport entity shall terminate the connection and inform the TSAP user with a fast TRANSPORT DISCONNECTION INDICATION primitive.

8.5.3.8 Transaction abort

8.5.3.8.1 By the service user

The transport entity allows the transport connection user to abort the connection as long as the connection is open.

8.5.3.8.2 Terminal side

If the abort is requested on the terminal side, the transport entity shall release the named connection locally and immediately decrease the QoS. If any TPDUs with the TSAP reference of the released connection as DESTINATION REFERENCE are subsequently received, a DR TPDU shall be sent with a SOURCE REFERENCE of 15 and the DESTINATION REFERENCE containing the SOURCE REFERENCE of the received TPDU.

8.5.3.8.3 SwMI side

All transport abort requests from the SwMI side, shall be accompanied by a link level disconnection.

8.5.3.8.4 By the data link layer

Whenever the transport entity receives a LINK LAYER DISCONNECTION INDICATION, and in whatever state, it shall cancel any timers that are running and release all the transport connections. Moreover, all the users of the connections involved shall be informed of the event with a TRANSPORT DISCONNECTION INDICATION primitive.

8.5.3.9 Data TPDU sending

A TRANSPORT DATA TRANSFER REQUEST provokes sending of one DTE TPDU or one or more DT TPDUs (see segmentation function).

8.5.3.10 Data TPDU reception

There are two cases:

- if the received TPDU is an unsegmented DTE or DT, the "user data" field is transferred to the service user via its TSAP;
- if the received TPDU is a segmented DT, then the reassembly function is activated. When the TSDU is delimited, it is sent to the destination service user via the TSAP.

In all cases, the TRANSPORT DATA TRANSFER INDICATION primitive shall be used to indicate TSDU reception.

8.5.3.11 Acknowledgement reception

This information is implicit. It is produced from the link level acknowledgement of the last DT TPDU sent. In this case, the transport entity shall inform the service user of TSDU acknowledgement by the far end.

8.6 List of system parameters

8.6.1 Length of a TPDU sent by the terminal (N400)

The N400 parameter, which depends on the Quality of Service, gives the maximum length of a TPDU sent by a terminal.

Table 14: Length of a TPDU sent by the terminal (N400) on SDCH

QoS	MAXIMUM NUMBER OF BLOCKS	Max Length of I FRAME (octet)	N400 (octet)	MAXIMUM QUANTITY OF USER DATA (octet)
0	2	16	11	8 / 9 (see note)
1	4	24	19	16 / 17 (see note)
2	6	40	35	32 / 33 (see note)
3	9	64	59	56 / 57 (see note)
NOTE: The second number concerns segmented TPDUs.				

Table 15: Length of a TPDU sent by the terminal (N400) for normal rate on DCH

QoS	MAXIMUM NUMBER OF BLOCKS	Max Length of I FRAME (octet)	N400 (octet)	MAXIMUM QUANTITY OF USER DATA (octet)
0	2	16	11	8 / 9 (see note)
1	4	24	19	16 / 17 (see note)
2	6	40	35	32 / 33 (see note)
3	9	64	59	56 / 57 (see note)
5	9	64	59	56 / 57 (see note)
NOTE: The second number concerns segmented TPDUs.				

Table 16: Length of a TPDU sent by the terminal (N400) for high rate on DCH

QoS	MAXIMUM NUMBER OF BLOCKS	Max Length of I FRAME (octet)	N400 (octet)	MAXIMUM QUANTITY OF USER DATA (octet)
0	2	23	18	15 / 16 (see note)
1	4	34.5	29	26 / 27 (see note)
2	6	57.5	52	49 / 50 (see note)
3	9	92	87	84 / 85 (see note)
5	9	92	87	84 / 85 (see note)
7	9	92	87	84 / 85 (see note)
NOTE: The second number concerns segmented TPDUs.				

Whatever the QoS, a TPDU not containing user data shall be single block.

8.6.2 Length of a TPDU sent by the SwMI (N401)

The N401 parameter, which depends on the TSDU size, gives the maximum length of a TPDU sent by the SwMI.

Table 17: Length of a TPDU sent by the SwMI (N401) on SDCH

MAXIMUM NUMBER OF BLOCKS	Max Length of I FRAME (octet)	N401 (octet)	MAXIMUM QUANTITY OF USER DATA (octet)
2	16	11	8 / 9 (see note)
4	24	19	16 / 17 (see note)
5	32	27	24 / 25 (see note)
6	40	35	32 / 33 (see note)
7	48	43	40 / 41 (see note)
8	56	51	48 / 49 (see note)
9	64	59	56 / 57 (see note)
NOTE: The second number concerns segmented TPDUs.			

Table 18: Length of a TPDU sent by the SwMI (N401) for normal rate on DCH

MAXIMUM NUMBER OF BLOCKS	Max Length of I FRAME (octet)	N401 (octet)	MAXIMUM QUANTITY OF USER DATA (octet)
2	16	11	8 / 9 (see note)
4	24	19	16 / 17 (see note)
5	32	27	24 / 25 (see note)
6	40	35	32 / 33 (see note)
7	48	43	40 / 41 (see note)
8	56	51	48 / 49 (see note)
9	64	59	56 / 57 (see note)
NOTE: The second number concerns segmented TPDUs.			

Table 19: Length of a TPDU sent by the SwMI (N401) for high rate on DCH

MAXIMUM NUMBER OF BLOCKS	Max Length of I FRAME (octet)	N401 (octet)	MAXIMUM QUANTITY OF USER DATA (octet)
1	11.5	6	3 / 4 (see note)
2	23	18	15 / 16 (see note)
4	34.5	29	26 / 27 (see note)
5	46	41	38 / 39 (see note)
6	57.5	52	49 / 50 (see note)
7	69	64	61 / 62 (see note)
8	80.5	75	72 / 73 (see note)
9	92	87	84 / 85 (see note)
NOTE: The second number concerns segmented TPDUs.			

A TPDU not containing user data shall be single block.

8.6.3 Maximum size of linklevel look ahead window (N402)

The N402 parameter gives the maximum size of the link level look-ahead window.

On the uplink way (from the terminal to the SwMI), the N402 parameter depends on the QoS.
On the downlink way (from the SwMI to the terminal), the N402 parameter depends on the radio channel (SDCH, DCH normal rate, DCH high rate).

Table 20: Maximum size of linklevel look ahead window (N402) on SDCH

QoS	N402 on uplink way	N402 on downlink way
0	1	3
1	1	
2	1	
3	1	

Table 21: Maximum size of linklevel look ahead window (N402) on DCH for normal rate

QoS	N402 on uplink way	N402 on downlink way
0	1	5
1	1	
2	1	
3	1	
5	5	

Table 22: Maximum size of linklevel look ahead window (N402) on DCH for high rate

QoS	N402 on uplink way	N402 on downlink way
0	1	7
1	1	
2	1	
3	1	
5	5	
7	7	

8.6.4 T400

T400 is a time-out when waiting CC TPDU reception during the transport set-up phase. (typical value 18s)

8.6.5 T401

T401 is a time-out when waiting DC TPDU reception during the transport connection release phase. (typical value 18s)

9. Datagram transport level

9.1 Introduction

The present Clause defines the transport service in datagram or connectionless mode, and the uni-directional information transport protocol from SwMI to terminal. This service is used to broadcast information on BCH, SDCH, DCH and SCH or to test the presence of a group of user terminals (group paging).

The procedures described in this Clause concern the information units which cross the SwMI/terminal interface correctly, via the data link.

9.2 Definitions

9.2.1 DU

Transport protocol data unit in datagram mode. Each DU is conveyed in the information field of a data link layer UI frame.

9.3 Datagram transport layer capabilities

The datagram transport service provides means of routing user data from the SwMI to the terminal(s) without acknowledgement (neither at transport level nor at link level) in the general case or from a terminal to SwMI in polling mode and also provides means to access transparently to logical channels at users.

According to the user data size N to transmit, this transport layer automatically offers a data transfer service in segmented mode or unsegmented mode

The datagram transport layer capabilities are:

- Segmentation and reassembly: function which divides a TSDU into several DUs on the sender transport end, then reassembles them on the receiver transport again to reproduce their original format (not available in polling mode);

- Management of several levels of DU repetition according to the security level requested by the service user (normal, secure, very secure);

- Management of optimum TPDU size in segmentation cases.

9.4 General description

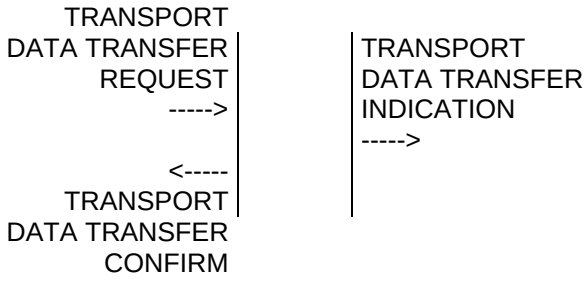
9.4.1 List of primitives

Table 23: List of primitives

PRIMITIVES	PARAMETERS
TRANSPORT DATA TRANSFER REQUEST	Called entity link address Destination TSAP id Called entity location (BCH/SDCH/SCH/DCH) User data Security level Priority Paging mode
TRANSPORT DATA TRANSFER CONFIRM	Called entity link address Destination TSAP id Called entity location (BCH/SDCH/SCH/DCH)
START INDICATION OF DATA TRANSFER	User data Transfer reference Priority

ERROR INDICATION IN DATA TRANSFER	Transfer reference Priority
STOP REQUEST OF DATA RECEIPT	
TRANSPORT DATA TRANSFER INDICATION	User data Transfer reference Priority

9.4.2 Primitive sequencing chart



Data transfer without segmentation

Data transfer with segmentation

Error in Data transfer with segmentation

Figure 35: Primitive sequencing chart

9.5 DU Structure

DU shall contain no more than N450 octets, each of which is carried in a link layer UI frame.

The DU structure is defined below. Each DU is divided into three parts, the DU header, user data and the stuffing field.

The transport entity interprets the DU header and performs the appropriate actions.

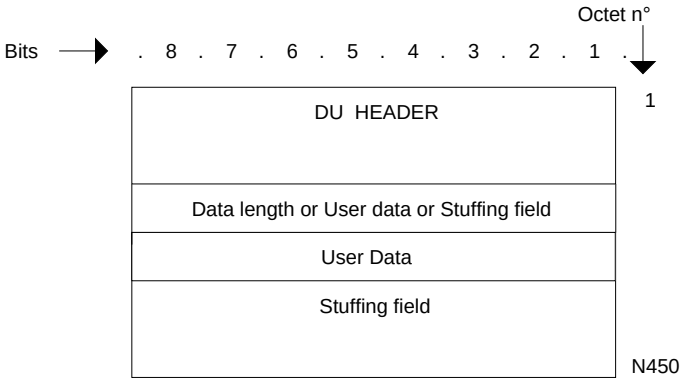


Figure 36: Generic DU format

The different formats depend on the segmentation.

9.5.1 DU structure (without segmentation)

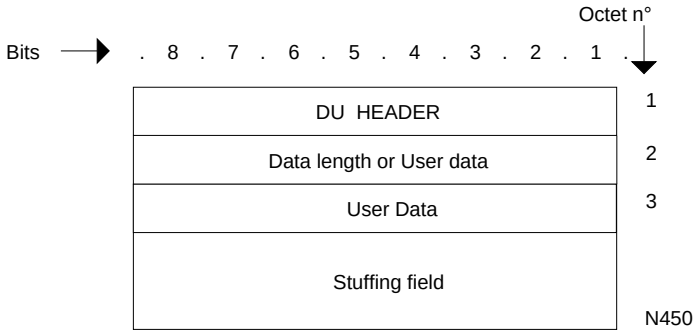


Figure 37: DU structure (without segmentation)

9.5.1.1 DU Header

The transport layer interprets the DU header. The header shall contain four separate fields. The header structure is shown below:

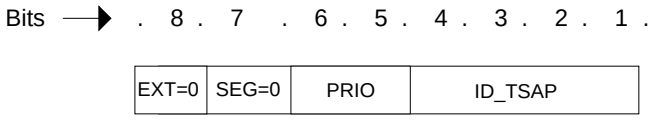


Figure 38: DU Header

9.5.1.1.1 EXT field

This field set to 0 indicates that the header is one octet long. This is sufficient to identify a DU without segmentation.

9.5.1.1.2 SEG field

This field is the same that the SEG field described in connected mode. For DU without segmentation, it shall be set to 0.

9.5.1.1.3 PRIO field

This field shall contain the relative DU priority. The service user request allows to assign the field content. For the moment, it shall be set to 0,0.

9.5.1.1.4 ID_TSAP field

This field shall contain the TSAP id of the called entity.

9.5.1.2 Data length or User data

This field shall contain the length of data in the user data field when N450 is greater than 6 for high rate or 3 otherwise. Otherwise it shall be part of the user data field.

9.5.1.3 User Data field

This field shall contain transparent user data.

9.5.1.4 Stuffing field

All the bits in this field, when it exists, shall be sent with value “0”.

9.5.2 DU structure (with segmentation)

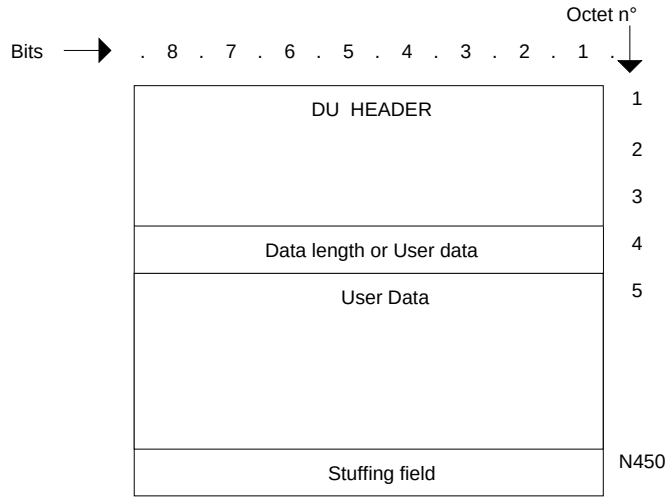


Figure 39: DU structure (with segmentation)

9.5.2.1 DU Header

The transport layer interprets the DU header. The header structure is shown below:

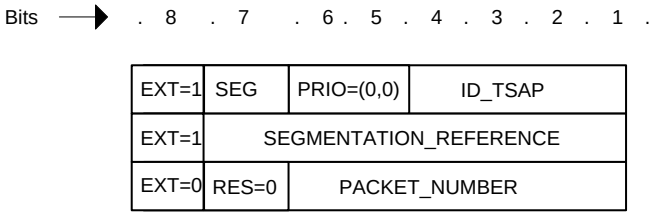


Figure 40: DU Header

9.5.2.1.1 EXT field

This field set to 1 indicates that the next octet is also part of header. The last octet shall contain EXT=0.

9.5.2.1.2 SEG field

This field is identical to the SEG field described in connected mode. It shall be set to 1 for each TPDU of the same segmented TSDU except for the last one (where it shall be set to 0).

9.5.2.1.3 PRIO field

This field shall contain the relative DU priority. The service user request allows to assign the field content. It shall be set to 0,0.

9.5.2.1.4 ID_TSAP field

This field shall contain the TSAP id of the called entity.

9.5.2.1.5 Segmentation_reference field

This reference is assigned by the transport layer for each segmented TSDU request to send. It shall be the same for each DU of the same TSDU.

9.5.2.1.6 RES field

This field is reserved for future use. For the moment, it shall be set to 0.

9.5.2.1.7 Packet_number field

This field conveys the DU sequence number of a segmented TSDU. The first DU of a segmented TSDU shall have its Packet_number field set to 0.

9.5.2.2 Data length or User data

This field shall contain the length of data in the user data field when SEG=0. Otherwise, it shall be part of the user data field.

9.5.2.3 User Data field

This field shall contain transparent user data.

9.5.2.4 Stuffing field

All the bits in this field, when it exists, shall be sent with value "0".

9.6 Procedure elements

9.6.1 Operating mode

In disconnected mode, the SwMI can send DUs to the terminal without any previous exchange. A link level connection is not necessary.

9.6.2 Segmentation / Reassembly

9.6.2.1 Segmentation

Segmentation concerns TSDU sending procedures only on SwMI side.

This function allows to divide a TSDU into N DUs where:

N = [INT(length(TSDU)/(N450max-3)] + 1

The N-1 first DUs convey each one N450max-3 user data octets; the last DU conveys the remainder.

The N-1 first DUs shall be with SEG=1 and without data length field; the last DU shall be with SEG=0 and with the data length field set to the data length in this last DU.

DUs shall be numbered from 0 to maximum N452.

9.6.2.2 Reassembly

This function allows to reassemble the received DUs on the receiver transport to reproduce the TSDU original format.

It shall be activated on reception of a DU with SEG=1. DUs of the same TSDU carry the same segmentation reference.

User data fields are reassembled according to the DU packet numbers (see Packet_number field). The last DU shall be identified with SEG=0.

9.6.3 Security level

Each service user shall specify the security level for each TSDU transmission. According to the specified level, each DU shall be sent one or more times:

- "Normal" level: each DU shall be sent once and once only;
- "Secure" level: each DU shall be sent twice;
- "Very secure" level: each DU shall be sent three times.

9.6.4 Interleaving factor (N453)

This factor concerns only transmissions with at least the secure level (secure and very secure). It allows to define in what order the transport layer shall transmit the packets to the data link layer.

N453 defines how many packets two similar packets shall be separated from (when possible). This function allows to protect transmission from temporary radio transmission problems.

For example: segmentation of a TSDU into 4 DUs with N453=3 and security level="secure":

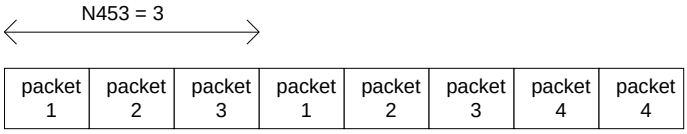


Figure 41: Example of Interleaving (4 DUs)

If TSDU is segmented into only 2 DUs, this shall be:

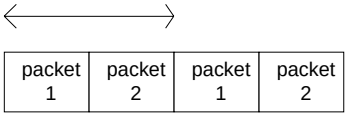


Figure 42: Example of Interleaving (2 DUs)

9.7 Procedures

9.7.1 Without segmentation

9.7.1.1 Sending

The service user shall send the transfer request with the DATA TRANSFER REQUEST primitive. The transport entity submits the resulting DU to the data link layer.

This DU shall be sent once and once only in this mode, whatever the security level requested.

9.7.1.2 Reception

When the transport entity receives a DU via the data link, it shall test the validity of the TSAP id contained in the DU header. If the transport entity does not recognise the TSAP id, it shall ignore the received DU. In all other cases, the transparent data and PRIO field contents shall be transferred to the service user with the DATA TRANSFER INDICATION primitive.

9.7.2 With segmentation

9.7.2.1 SwMI side

The service user shall send the transfer request with the DATA TRANSFER REQUEST primitive.

The transport layer shall:

- divide the TSDU into N DUs and shall create the segmentation_reference to carry it into each DU header;
- shall share out these DUs among several groups of maximum N453 DUs in an ordered arrangement;
- send each group to the data link layer one or more times according to the security level.

9.7.2.2 ST side

When the transport entity receives a DU via the data link, it shall test the validity of the TSAP id contained in the DU header. If the transport entity does not recognise the TSAP id, it shall ignore the received DU.

The transport layer shall create a new reassembly context when it receives a DU whose packet number is less than N453 and whose segmentation reference is a new one. Each context is identified by a segmentation reference. Several reassembly contexts can coexist at the same time.

The transport layer, for each reassembly context, shall inform the destination application (identified by the DU ID_TSAP field) when the first DU (numbered 0) is received. The transparent data, PRIO field and segmentation_reference field contents shall be transferred to the service user with the START INDICATION of DATA TRANSFER primitive.

For each reception of a DU corresponding to an opened context or a context opening in progress, the transport layer shall start or restart the T454 timer (associated with this context).

The transport layer shall close a context when all DUs are received (so T454 shall be cancelled); in this case, the transparent data of the reassembled TSDU, PRIO field and segmentation_reference field contents shall be transferred to the service user with the DATA TRANSFER INDICATION primitive.

For a given context, at each DU reception, if a DU of a previous group (of N453 DUs) is not received (after the possible repetitions according to the security level), the context shall be closed. In this case, the PRIO field and segmentation_reference field contents shall be transferred to the service user with the ERROR INDICATION IN DATA TRANSFER primitive.

When T454 expires, the transport layer shall close the context. In this case, the PRIO field and segmentation_reference field contents shall be transferred to the service user with the ERROR INDICATION IN DATA TRANSFER primitive.

9.8 System parameters

9.8.1 DU length (N450)

The length of the DU is determined by the length of data to be sent. The chart below shows the possible values of N450.

Table 24: DU length (N450)

NB of UI FRAME BLOCKS	LENGTH OF UI FRAME (octet)	MAX NUMBER OF USER DATA OCTETS			N450 (oct.)
		a	b	c	
1	8			2	3
2	16		7	9	11
4	24		15	17	19
5	32		23	25	27
6	40		31	33	35
7	48		39	41	43
8	56		47	49	51
9	64	56	55	57	59

Table 25: DU length (N450) for high rate

NB of UI FRAME BLOCKS	LENGTH OF UI FRAME (octet)	MAX NUMBER OF USER DATA OCTETS			N450 (oct.)
		a	b	c	
1	11,5			5	6
2	23		14	16	18
4	34,5		25	27	29
5	46		37	39	41
6	57,5		48	50	52
7	69		60	62	64
8	80,5		71	73	75
9	92	84	83	85	87

a DU with segmentation (except last packet)
b DU with segmentation (last packet)
c DU without segmentation

9.8.2 N452

This parameter defines the maximum number of DUs for a TSDU (typical value 64).

9.8.3 N453

This parameter defines the interleaving factor (typical value 3).

9.8.4 T454

This parameter defines the time-out value for DUs reception in the reassembly process (typical value 10s).

10. Short Access transport level

10.1 Introduction

The present Clause defines the uni-directional short information transfer protocol between the terminal and the SwMI.

Several services are described:

- The first consist in sending information on DACH;
- The second consist in transmitting information on SDCH on primary station invitation (polling transfer service).

The procedures described in this Clause concern the information units that cross the SwMI/interface correctly, via the data link.

10.2 Definitions

10.2.1 DU

Transport protocol data unit in "short access mode". Each DU (DT_SHORT) is carried in the information field of a data link layer I_DACH (transfer on DACH) or UI_P0 (polling transfer service).

The same terms as in the previous Clause are used.

10.3 General description

10.3.1 Services provided by the DACH access transport service

The transport layer offers a SHORT transfer service with data link level acknowledgement, and provides transparent means for users to access to DACH channel.

10.3.2 Services provided by polling transport service

This service provides means of routing user data from the secondary station to the primary station on SDCH, on primary station invitation without data level acknowledgement.

10.3.3 List of primitives

Table 26: List of primitives

PRIMITIVES	PARAMETERS
DACH ACCESS REQUEST (see note 1)	TSAP Id User data
DACH ACCESS CONFIRM (see note 1)	TSAP Id Report (Ack / Nack)
DACH ACCESS INDICATION (see note 2)	Called user link address TSAP Id User data
DATA POLLING REQUEST (see note 1)	TSAP Id User data
DATA POLLING CONFIRM (see note 1)	TSAP Id Report (Ack / Nack)
DATA POLLING INDICATION (see note 2)	Called user link address TSAP Id User data
NOTE 1: Primitive not implemented in SwMI. NOTE 2: Primitive not implemented in terminal.	

10.3.4 Primitive sequence chart

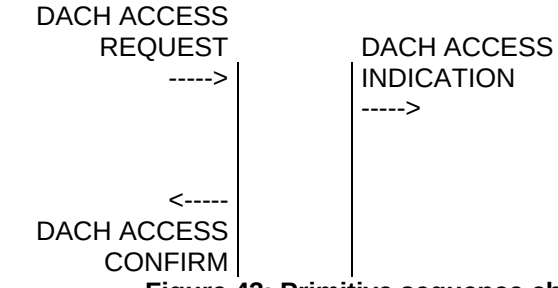


Figure 43: Primitive sequence chart

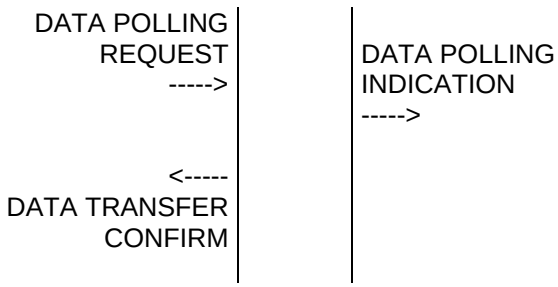


Figure 44: Successful polling (without segmentation)

10.4 DT_SHORT structure

DU shall contain no more than N460 octets, each of which is conveyed in a link layer I_DACH or UI_P0 frame .

DU structure is defined below. Each DU is divided into two parts, the DU header and user data.

The transport entity shall interpret the DU_SHORT header and perform the appropriate actions.

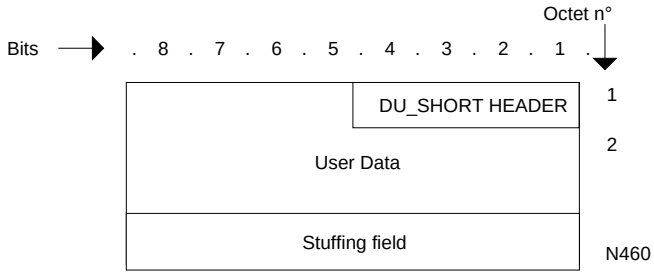


Figure 45: Generic DT_SHORT format

10.4.1 DU_SHORT header

The transport layer interprets the DU header. The header contains single field. The header structure is as follows:

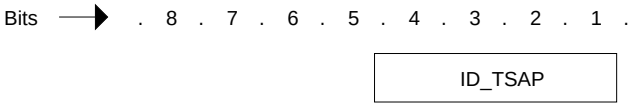


Figure 46: DU header

The field contains the TSAP identity of the called entity.

10.4.2 User Data field

This field contains transparent user data.

10.4.3 Stuffing field

All the bits in this field, when it exists, shall be sent with value “0”.

10.5 DACH information transfer Procedure description

10.5.1 Terminal side

The service user sends a DACH access request with the DACH ACCESS REQUEST primitive.

The transport entity shall immediately submit the resulting DU to the data link layer. This request shall interrupt any other access request being processed in the link layer.

The transport entity shall wait for DACH access confirmation from the link layer to return an access request execution indication to the user application in the DACH ACCESS CONFIRM primitive.

10.5.2 SwMI side

When the transport entity receives a DU_SHORT via the data link, it shall test the validity of the TSAP Id contained in the DU_SHORT header.

If the transport entity does not recognise the TSAP Id, it shall ignore the received DU.

In all other cases, the transparent data shall be transferred with the DACH ACCESS INDICATION primitive.

10.6 Polling information transfer Procedure description

10.6.1 Terminal side

The service user sends information with the DATA POLLING REQUEST primitive.

The transport entity shall immediately submit the resulting DU to the data link layer. This request shall interrupt any other polling request being processed in the link layer.

The transport entity shall wait for data polling confirmation from the link layer to return a request execution indication to the user application in the DATA POLLING CONFIRM primitive.

10.6.2 SwMI side

When the transport entity receives a DU_SHORT via the data link, it shall test the validity of the TSAP Id contained in the DU_SHORT header.

If the transport entity does not recognise the TSAP Id, it shall ignore the received DU.

In all other cases, the transparent data shall be transferred with the DATA POLLING INDICATION primitive.

10.7 System parameters

10.7.1 DU_SHORT Length (N460)

The length of the DU_SHORT is determined by the length of data to be sent. The table below shows the possible values of N460.

Table 23: DU_SHORT Length (N460)

NB of datalink FRAME BLOCKS	LENGTH OF datalink FRAME (octet)	MAXIMUM NUMBER OF USER DATA OCTETS	N460 (oct.)
1	8	2,5	3
2	16	10,5	11

11. History

Document history		
Date	**Status**	**Comment**
6 November 1995	First draft	Version 0.0.1
12 December 1995	References change	Version 0.0.2
23 February 1996	Formatting	Version 0.0.3
18 March 1996	Edition	Version 0.0.4
04 April 1996	Formatting	Version 0.0.5
10 April 1996	Update after review	Version 0.1.0
30 April 1996	Tetrapol Forum approval	Version 1.0.0
31 July 1996	Formatting	Version 1.0.1
02 December 1996	Update with DCH, Polling, UI-CD	Version 1.0.2
16 December 1996	Update after review	Version 1.1.0
16 March 1997	Update with group paging and data polling transfer service	Version 1.1.1
15 April 1997	Update after review	Version 1.2.0
25 June 1997	Tetrapol Forum Approval	Version 2.0.0
22 December 1997	Update after review	Version 2.0.1
30 January 1998	Editorial correction	Version 2.0.2
22 September 1999	Update after change requests	Version 2.0.3
12 June 2002	Update with Object Call paging	Version 2.0.
19 September 2002	Update after review	Version 2.0.5
20 november 2003	Update	Version 2.0.6