User Access Definition Group

MAP27

Mobile Access Protocol
for MPT 1327 equipment

Version 1.5

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Document History

Date	Version number	Comments
September 1992	1.0	The first approved edition
June 1993	1.1	In all sections have some text changes for clarity. Section 1: A note on conformance test added. Section 2: Definitions for C2, N2, C3 and N3. T3 is renamed to be 'activity' time control. Some abbreviations added and changed to follow MPT 1327. Section 4: FCS bit mapping into octets is clarified. 4.3.2.1 Version number is defined to be 1 for this release. 4.4 Discarding of faulty packets is mentioned. 4.4.1 Initialisation phase is clarified and contains at minimum one reception of LR and LA packet and a transmission of a LA packet for receive credit information. S(k) is set to '0' at initialisation phase. 4.4.1 T0 is started each time LR is sent. Starting and stopping of time controls is clarified. 4.4.1.2. Before entering 'ready' state the internal variables are initialised. 4.4.1.3. Before entering 'ready' state a LA packet is sent. 4.4.2.5 Use of retransmission counter (C2) and activity is defined. 4.4.2.6 Link failure detection is performed by the sending entity (LA packet number). 4.4.2.6 and 4.4.2.7 More detailed reasons are defined for link reset. 4.5 Time controls cover 'all' transmission rates. Activity (formally Credit) report timer (T3) usage is corrected to prevent unintentional link resets. - Timer T3 is started when entering 'ready' state, - Timer T3 is not stopped when receiving a LT packet. 4.5.1 A proposal for a longer T0. 4.5.6. N3 is a count. Section 5: Editorial corrections. Terminology (bytes, characters, octets) is changed to follow the MPT1327 format. Short and extended data messages are replaced by 'single segment and multiple segment transactions'. 5.2.1.3 Both DUMMYP and DUMMYI are defined as dummy values.

Date	Version number	Comments
June 1993	1.1	5.2.1.3. Address presentation is modified. ADESC field defines only local addressing format and PFIX and IDENT fields define the corresponding radio path format. ADESC '0011' clarified so that Extended address contains only the exchange number and the extension number in binary format is in the IDENT field. Address presentations ADESC '0100' defined so that Extended address contains the exchange number and the extension number in binary format. ADESC '0111' may be used in any man machine based addressing as MPT 1343. A new section '5.2.1.4 MPT 1327 Addressing' is added. 'IPFIXI' is not used in MAP27; interprefix calls use same format as common prefix calls. 5.2.1.5 Acknowledgement coding is presented. 5.2.1.6 User data presentation **is modified**. The new definition maps user data in a continuos manner into octets so that the transmitted and the received octet presentations are same (assuming '0' padding) although NLB numbers may differ. 5.2.2 PFIX and IDENT presentations are clarified. 5.2.2.4.2 Emergency calls may not be included. 5.2.2.4.3 SETUP PROGRESS ACKE is added. 5.2.2.4.5 AHY or AHY and GTC generated this message. Emergency call is never an include call. 5.2.2.4.6 RECEIVE PROGRESS ACKQ is replacing AHYQ. 5.2.2.6.2 Cause 'Message coding not possible, message rejected' added. 5.2.2.7.1 DIVERSION REQUEST Blocked party address may use extended addressing as an option. 'directed' replaced by 'diverted'. 5.2.2.7.2 DUMMY values are used also in a cancellation by a recipient. The ADDRESS field explanation is as in PFIX (first part only) 5.2.2.7.3 PFIX and IDENT is 'Diversion target address as in the corresponding Diversion Request or Cancel. ADDRESS field is never used in this message (ACKT is never received). 5.2.2.8.2 RADIO PERSONALITY SUPPORTED FACILITIESb is corrected. 5.2.2.8.10 DIALLED STRING Reference to addressing is added. 5.4 Figures numbering is corrected. A1: Calculation is clarified and an example is added. A2: SDL description is revised according to the section 4. A graphical SDL presentation is included. A3: Minor corrections. A6.4: BCD and Telex codings to ASCII are added. A6.5: Addressing examples are included. A7: Protocol constants are included.

August 1993	1.2	Some editorial errors in document history are corrected. Section 2. Typo is corrected. 5.1. A new section 'Network information' is added as 5.2.2.8.6. All sections starting from the previous 5.2.2.8.6 are advanced by one. 5.2.1.3 address presentations clarified. ADESC field defines address format **after** that field. (ADESC formats '0100' to '0110' are used in ACKT derived messages). 5.2.1.4 clarifications in Table 5-2. 5.2.1.7 allocation of future additions of new octets at the end of messages is stated. 5.2.2.2. and 5.2.2.3. both in SST and MST the PC character set code page is defined to be '437'. 5.2.2.4.6. Receive Progress cause field value '00001010' is removed. The 'System busy' related air interface signalling is under further study. 5.2.2.7.3. editorial correction 5.2.2.8.1. A new radio interrogation 'Network information' is added. 5.2.2.8.2. The 'MANUFACTURER'S CODE', 'MODEL' and 'SERIAL' are stated to be according to MPT 1343 section 7. 5.2.2.8.5. Operating condition message: a new field: 'MCDT' added with coding according to MPT 1343 11.5.5.4.5(c). 5.2.2.8.6. A new message 'Network information' is inserted with fields 'RADIO CHANNEL' and 'SYScode'. 5.3.6.2. A new section with references to 'Network information' is added. 5.3.7. Error situations are expanded to contain received reset indication. A2: Typos corrected. A2.3: In the state 'ready' INPUT activity_timeout(T3) IF activity_count_Zero THEN ... EXIT reset_wait (not link_wait). A.4: References to sections 5.2.2.8.12 and 5.2.2.8.13 updated. A.6: Notes for table 6-5 are clarified. A.6.5.7.3. An example of binary presentation of PABX extension numbers is added. A.6.6. PC character mapping into SST and MST is defined. A.7: Section numbers added. New message 'Network information' added.

February 1994	1.3	Only editorial changes in document are corrected. Section 2. Definitions for DCE, C2, T4 added. SYN: 15h to 16h corrected Change to Protocol version number 4.3 ... in the range 00h and 1Fh ... corrected. 4.3.2.1. added: The data field length chosen must be large enough for the longest network layer message used. 4.3.2.2 last sentence moved from 4.3.2.3 4.4.1.3 b) initialise internal variables and set S(k) to N(k), clear data buffers, and 4.4.2.6 c) the entity fails to receive an LA or an LT packet during the link failure detection time T4. The link failure detection time is a period greater then N3*T3. 5.2.1.2 If the second semi-octet is not used, then a NULL value shall be inserted. 5.2.2.5.1. and 5.2.2.5.2. added: Usage and user data format of this message is application specific. 2 USER DATA changed to 2**..** USER DATA Appendix 7, MAP27 Implementation form is now only one document, it includes the Additional Network Layer Information

November 1994	1.4	Some editorial changes in document are corrected. Appendix 7, MAP27 Implementation form corrected 2.3. T4: Link failure delay time. "acknowledge" changed to "acknowledgment" at certain places 4.4.1.2. " e) start time control T4, and " added 4.4.2.1. The entity may set the AR bit to '1', if it requires immediate acknowledgement. It is recommended that the AR bit is set to 1 when S(k)=1. 4.4.2.4. When an LA packet is received, the timer T4 is restarted and the value of N(R) ... The credit variable S(k) is set equal to the value of N(k) minus the number of outstanding LT packets. S(k) := N(k)-(V(s)-N(r)) 4.4.2.6. Link failure detection c) moved to 4.5.8. 4.5.7. "The maximum length parameter N1" and 4.5.8. "Link Failure Delay Time T4" added by moving from other places of the document. 5.2.2.4.6. Note1: modified Figure 5-2 "canc mess" changed to "inform last" A2.1. one sentence added A2.2.x. heading numbering added, Text changes A.2.2.8. "CV Current Version" added

May 1995	1.4	Some editorial changes in document are corrected. 2.3 C2 and C3 deleted 4.x.x procedure replaced by phase 4.4.1 new sentences clarifying parameter negotiations 4.4.1.1 point d) removed 4.4.1.2 comparison changed to negotiations 4.4.1.3 start time control T4 inserted 4.4.2.4, 4.4.2.5 C2 replaced by C1 4.4.2.6 new paragraph c) 4.5 Timers and constants sorted, T4 new A2 SDL representation Timer T4 included, C2 replaced by C1 A6 Number of ASCII characters corrected new Appendix A8

January 1998	1.5	**Section 5** 5.2.2.7.3 An additional cause has been added to the Division ACK Message to take a count of situation where DTE cancels a diversion by means of a disconnect message. 5.2.2.8.2 Radio Personality Supported Facilities. A table extended to include MPT 1327 short data message format (STF=0) 5.2.2.8.7 Radio Management. A coding field has been added to allow the DTE to specify the coding method acceptable for SST and MST messages. 5.2.2.8.8 Radio Settings. A coding field has been added to indicate the current coding set in the Radio Unit. 5.2.2.8.9 Protocol Info. Two additional reason codes have been added to indicate Radio Busy and Radio Ready. 5.3.1.2 Protocol Presentation. The No Service state has been removed Diversion wait state added. 5.3.4.3 Correction made to receive progress when Radio Unit call time is about to end. 5.3.5 Section revised to show the new State in response to each Diversion Cancel. 5.4 DTE Network Layer Matrix. The table has been revised to reflect the changes in 5.3.1.2 **Appendix A2** The activity counter and the associated function Set Activity Counter have been superseded by Link Failure Detection Timer (T4). All reference to Activity Counter has been removed from the appendix. A2.2.10 Tasks. Receive credit changed to K from K1. Packet outside window procedure moved to A2.2.11 IFs. Record Send Credit Procedure amended. A2.2.11 IFs Packet outside window procedure inserted. A2.3 SDL Representation minor typographical changes.

	Appendix 7 A7.5.16 Amended to take account of the changes in 5.2.2.7.3. **Appendix A9**. A new appendix has been added depicting MSC scenarios

TABLE OF CONTENTS

1. A user access protocol for MPT 1327

1.1. Scope

This standard specifies an interface between a mobile radio and a data terminal equipment. This interface gives access to and defines network layer procedures for call set-up and data transfer as specified in MPT 1327 and MPT 1343 or derivations thereof. A conformance test definition is outside the scope of this standard.

1.2. General

The MPT 1327 and MPT 1343 standards define rules for communication between radio units and trunking system controllers operating in land mobile radio systems. Recognising the growing user need for data communications the UK DTI Band 3 Drafting Group specified data services and procedures for use in trunked radio systems.

The standard includes procedures for sending:

- Status messages on a control channel. The status message is a number between 0 and 31.
- Short data on a control channel. Up to 176 or 184 bits of free format data or 25 ASCII characters.
- Extended data on a control channel. Up to 704 bits of free format data or 100 ASCII characters.
- Standard data on a dedicated data channel. Packet switched data with a defined bit rate of 1200 bit/s but an option for customised higher bit rates.

MPT 1343 refers to Short Data messages as Single Segment Transactions (SST). Extended data messages are only prescribed in MPT 1343 and are now referred to as Multiple Segment Transactions (MST).

In addition to those predefined data services a user may set up non-prescribed (modem) data connections.

The procedures and connections specified in this standard are sufficient for several types of data communication. Specific user needs include:

- Acknowledged messaging
- Letter type messaging/mailbox
- File transfer
- Interactive terminal
- Modem calls
- Automated speech call control.

For these types of communications a data and/or control interface is required on the radio unit. Through this interface the user may connect a data or control terminal to the unit. Such a device may be a laptop personal computer. By means of suitable application software on the PC the user can enter and transfer data in a 'user friendly' manner, It is in the interest of users, mobile and data terminal suppliers and application developers that this interface is a 'de facto' standard and widely accepted. This will create a non-fragmented market and therefore stimulate the use of data applications.

1.3. Protocol stack

This standard is based on the International Organisation for Standardisation (ISO) seven-layer reference model for Open Systems Interconnection (OSI). In this standard the following layers are defined:

layer 1: physical interface
layer 2: data link protocol
layer 3: network protocol.

Application layers 4 to 7 are not defined.

The physical interface describes the physical connection and the transmission format between a data terminal equipment (DTE) and a radio unit in a point-to-point configuration. Each data terminal has its own connection to the radio unit. Standard data uses a sub-address called PORT, which may be allocated to a physical or a logical connection.

The data link protocol describes the local connection information exchange using a packet oriented procedure.

The network protocol describes the end-to-end information exchange over the network. The data terminal or application may be logically connected directly or via a gateway to another DTE. The network protocol also defines local services and functions to control the radio unit.

A general network model and the protocol stack is shown in figures 1-1 and 1-2. In these figures the following abbreviations are used:

APP: Application of Higher layers
UA3: User Access Network Layer defined in this standard
UA2: User Access Data Link Layer defined in this standard
UA1: User Access Physical Layer defined in this standard
RA3: Radio Access Layer 3 defined in MPT1327
RA2: Radio Access Layer 2 defined in MPT1327
RA1: Radio Access Layer 1 defined by frequency allocation
GA3: Gateway Access Layer 3, ie. X25 or ISDN
GA2: Gateway Access Layer 2, ie. X25 or ISDN
GA1: Gateway Access Layer 1

The general protocol stack for communication between two DTEs over the radio path is shown in figure 1-1. The communication between two DTEs over a gateway which is connected to the network infrastructure is shown in figure 1-2.

The scope of this standard excludes the Gateway Access in the figure 1-2. MAP27 is also capable to support at least layers GA2 and GA3 of the Gateway Access in many situations.

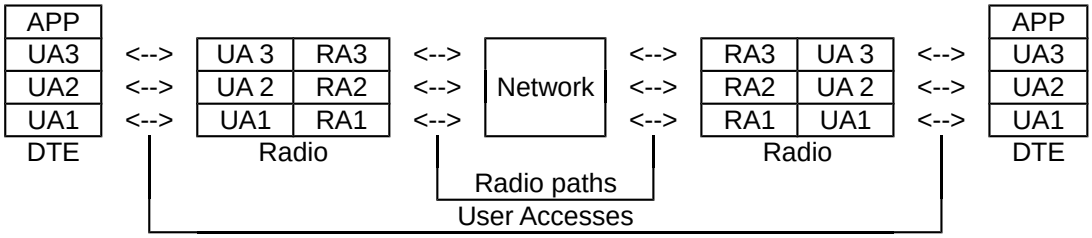


Fig 1-1. DTE-DTE communication over radio paths

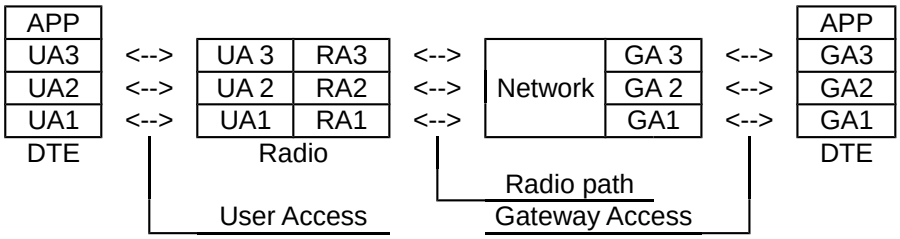


Fig 1-2. DTE-DTE communication via a gateway

1.4. References

The following references are used in the definition of MAP27 standard. In general references are not mentioned in the text.

[1] MPT 1327 A Signalling Standard for Trunked Private Land Mobile Radio Systems, © Crown Copyright 1988, First published January 1988, Reprinted and revised October 1990, Reprinted and revised November 1991 by the Radiocommunications Agency, Waterloo Bridge House, London.

[2] MPT 1343 Performance Specification System Interface Specification for radio units to be used with commercial trunked networks operating in Band III sub-bands 1 and 2, © Crown Copyright 1988, First Published 1988, Revised and reprinted September 1991 by the Radiocommunications Agency, Waterloo Bridge House, London.

[3] CCITT Recommendation T.50, © ITU.

[4] CCITT Recommendation V.24, © ITU.

[5] CCITT Recommendation V.28, © ITU.

[6] CCITT Recommendation V.42, © ITU.

[7] CCITT Recommendation Z.100, 1982, 1988, © ITU.

2. Definitions, abbreviations and symbols

2.1. Definitions

Character:	Eight bits (an octet) of data combined with Start and Stop bits.
Control message:	A message intended for layer control.
Data message:	A message intended for the transmission of higher layer data (user data).
DLE stuffing:	A method to ensure transparent data transmission and reliable packet start and end indication.
Header:	The layer control part of a message.
Message:	A generic name of control and data messages.
Modem call:	A data call using an external or internal modem and data transfer protocol, which are not defined in MPT 1327. The equivalent expression in the MPT 1327 standard is the 'non-prescribed data call'.
Packet body:	The section of the data link control and higher layer information between start and stop sequences.
Start bit:	The bit which signifies the beginning of an asynchronous character.
Stop bit:	The bit which signifies the end of an asynchronous character.
Start flag:	A unique data link packet start sequence used for receiver synchronisation.
Stop flag:	A unique data link packet end sequence used for receiver synchronisation.

2.2. Abbreviations

7-bit ASCII:	International Alphabet No. 5
8-bit ASCII:	Personal computer (PC) character set
ADESC:	Address descriptor
BCD:	Binary coded decimal
CRC:	Cyclic redundancy check
DCE:	Data communication equipment
DLE:	Data link escape (10h)
DTE:	Data terminal equipment
DUMMYI:	Dummy ident, all bits '0'
DUMMYP:	Dummy prefix, all bits '0'
ETX:	End of text (03h)
FCS:	Frame check sequence
H_byte:	Most significant Byte of a 16-bit value
IA2:	International Telegraph Alphabet No. 2
IA5:	International Alphabet No. 5
L_byte:	Least significant Byte of a 16-bit value
LSB:	Least significant bit
MSB:	Most significant bit
MST:	Multiple segment transaction (Extended data message)

NLB:	Number of last bits
NULL:	Null BCD character (0Fh)
NUL:	Null (00h)
RU:	Radio unit
RX:	Receiver
SST:	Single segment transaction (Short data message)
STX:	Start of text (02h)
SYN:	Synchronous idle (16h)
TX:	Transmitter

2.3. Symbols

C1:	The retransmission counter.
h:	Hexadecimal notation, e.g. 2Ah is equal to 42 decimal.
AR:	Parameter for immediate acknowledgement request.
k:	The maximum number of unacknowledged sequentially numbered user data packets at a specific time.
N1:	The maximum information length of an LT packet.
N2:	The maximum number of retransmissions of a packet.
N3:	The number of activity timeouts before link failure is detected.
T0:	The retry waiting time in the establishment phase after whose expiry a retransmission of a packet is initiated.
T1:	The retry waiting time in the data transfer phase after whose expiry a retransmission of a packet is initiated.
T2:	The waiting time after whose expiry transmission of an acknowledgement is initiated.
T3:	The inactivity time after whose expiry transmission of an acknowledgement to report the receive state is initiated.
T4:	Link failure detection time.
VERSION	Protocol version number.

2.4. Radio path definitions

This section is an incomplete and shortened extract from MPT 1327.

ACK:	A general positive acknowledgement message which terminates the transaction.
ACKB:	A call-back acknowledgement message which terminates the transaction.
ACKI:	An intermediate response message.
ACKQ:	A call request queued message.
ACKT:	A call diversion message which terminates the transaction.
ACKV:	A message which terminates a call or transaction attempt for operational reasons.
ACKX:	A message which terminates a call or transaction attempt for functional reasons.
AHY:	A radio availability check message.
AHYC:	A short data message invitation.
AHYQ:	A status message to a radio unit.
AHYX:	A message sent to a called radio unit to cancel an incoming traffic call addressed to the unit.
CLEAR:	A call disconnection message.
Codeword:	A radio path message containing 48 bits of data and/or control information, 15 bits for error detection and error correction and one bit parity.
Extended addressing:	Means of sending a call request where the PFIX of called party is different to that of the calling party.
GTC:	Go to the Traffic Channel message for a voice or modem call connection.
HEAD + data:	A short data message sent by the radio unit in response to AHYC and by the system without prompting.
IDENT:	The least significant 13 bits of a radio protocol address.
MAINT:	A call maintenance message.
PFIX:	The most significant 7 bits of a radio protocol address.
RQC:	A short data request message.
RQE:	An emergency voice or modem call set-up request message.
RQQ:	A status message.
RQS:	A voice or modem call set-up request message.
RQX:	A request to cancel a previous call request or abort a transaction e.g. a status transaction.
SAMIS:	A message used to send, for example, extended addressing information or telephone dialling data.
Tmessage:	Standard data user message on the radio path interface. May be of any length. May be used also to indicate any user message.

3. Physical interface

The physical interface describes physical connections between a data terminal equipment (DTE) and a radio unit. This definition covers a point-to-point type connection using a sub-set of V.24, V.28 and RS-232 recommendations. In addition to the electrical level it defines physical connection, pin numbers and the lowest layer transmission format.

3.1. Electrical characteristics

The electrical characteristics follow the CCITT Rec. V.28 for unbalanced signalling. Some electrical values are copied here for convenience. Source output voltage for any load resistance between 3 kilo-ohms and 7 kilo-ohms shall be between +5 volts and +15 volts for binary value '0' and ON condition (Space) and between -5 volts and -15 volts for binary value '1' and OFF condition (Mark). The open circuit source voltage shall not exceed 25 volts in magnitude.

The receive shall detect binary value '0' (Space) when voltage at the interface point is higher than +3 volts and binary value '1' (Mark) when voltage is lower than -3 volts.

3.2. Physical connection

The radio unit represents a data communications equipment (DCE) which is fitted with a device specific connector. If submin D connector is used, then the radio unit shall have either 25 or 9-pin connector (receptacle) with at least the minimum subset of V.24 signals.

The following table shows the signals and pin numbers used in this definition. Other pins specified by V.24 may be used for appropriate purposes. Designers should follow V.24 recommendations when these are adequate for the purpose. The use of the other signals shall not prevent interoperation with an equipment using only signals defined in the table 3.1. Signals or voltage levels should be within the limits set by CCITT rec. V.28 to ensure that no damage is caused to any DTE to which the unit is connected.

Signal	Assignment		Direction
	9-pin	25-pin	DTE DCE
Protective ground	Screen	1 and screen	<--->
Receive Data	2	3	<---
Transmit Data	3	2	--->
Signal Ground	5	7	<--->

Table 3-1: V.24 interface signals and pin numbers

3.3. Asynchronous transmission

To enable fully transparent data transmission an 8-bit character format is used. The characters are transmitted asynchronously with 1 start bit and 1 stop bit. No bit is used for parity checking. The 8-bit code is identified by b_8, b_7, b_6, b_5, b_4, b_3, b_2 and b_1, where b_8 is the most-significant bit (MSB) and b_1 is the least-significant bit (LSB). The bit combinations represent integers in the range 0 to 255 where b_8 has a binary weight of 128 and b_1 has a binary weight of 1.

The character format in the asynchronous operation is shown in figure 3-1.

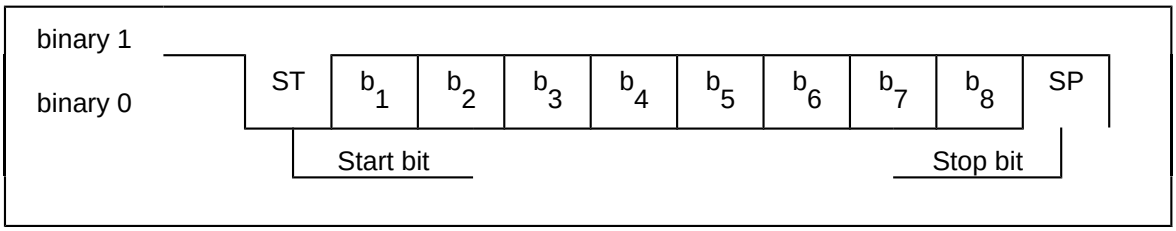


Figure 3-1: Asynchronous character transmission

The least-significant bit b_1 of the character is transmitted first.

3.4. Transmission speed

The transmission speed is 9600 bit/s. Other transmission speeds may be used for manufacture specific implementations. A preferred value is 1200 bit/s. The selection method of the transmission speed is outside the scope of the standard.

4. Data link layer

4.1. Introduction

This section describes the data link layer definition for communication between MPT 1327 type radios and data terminal equipment. The data link protocol is defined for data exchange between a data terminal equipment (DTE) and a radio unit (RU). The link protocol is full-duplex in the sense that data exchange is allowed simultaneously in both directions, irrespective of whether the radio link is simplex or duplex.

4.2. Requirements to the physical layer

The data link layer requires that the physical layer carries 8 bit characters (octet) transparently, see section 3 'Physical interface'. Loose timing requirements for the physical layer are set by the system parameters of the data link layer.

4.3. Data link protocol elements

The terminology is based on the CCITT T.50 recommendation (International Alphabet No. 5 - IA5). The data link layer uses a subset of control characters in the range 00h and 1Fh as defined in T.50. Only those control characters defined in the following sections have any affect to the function of the link layer. The data part (higher layer section) of a link layer message is fully transparent and may contain any 8-bit characters.

4.3.1. Packet format

The general packet format of the start-stop, octet oriented mode is shown in figure 4-1. The packet shall begin with a start sequence, using IA5 control characters SYN-DLE-STX. The start sequence is followed by a header field with a constant information length of 4 octets before DLE stuffing, see 4.3.1.1. The header field may be followed by a variable length data field. The packet shall end with a stop flag, using IA5 control characters DLE-ETX. The stop flag is followed by a two octet frame check sequence (FCS).

	8	7	6	5	4	3	2	1		
1	0	0	0	1	0	1	1	0	SYN	Start flag character 1
2	0	0	0	1	0	0	0	0	DLE	Start flag character 2
3	0	0	0	0	0	0	1	0	STX	Start flag character 3
4..7	Header 4 octets									Header field of the packet body
8..	Data n octets									Data field of the packet body
N-3	0	0	0	1	0	0	0	0	DLE	Stop flag character 1
N-2	0	0	0	0	0	0	1	1	ETX	Stop flag character 2
N-1 N	FCS 2 octets									16 bit cyclic redundancy check sum

Figure 4-1: General data link layer packet format

The data field, when present, contains transparent data. To transmit transparent user data a method called DLE stuffing is required. This method is described in subclause 4.3.1.1. The packet body (header and data) and DLE ETX stop flag are included in the FCS calculation. The start sequence and all DLE control characters used to maintain data transparency are excluded from the FCS calculation.

4.3.1.1. Transparency

The transmitting entity shall examine the packet body (header and data fields) and insert a DLE control character immediately following any occurrence of a DLE character. The DLE used in the start and stop flags shall not be doubled.

The receiving entity shall examine the packet body and discard the second DLE of a two-octet DLE-DLE sequence.

4.3.1.2. Error check

A cyclic redundancy check (CRC) is used for header and data protection. It is defined by the generator polynomial: $G(x) = x^{16} + x^{15} + x^2 + 1$.

The frame check sequence (FCS) comprises 16 bits and shall be used for error detection.

The check bits shall be the ones complement of the modulo 2 sum of:

a) the remainder of

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

divided modulo 2 by the generator polynomial G(x) where k is the number of bits to protect;

and

b) the remainder of the division modulo 2 by the generator polynomial G(x) of the product of

x^{16} by the content of information to protect, excluding the FCS field.

As a typical implementation at the transmitter, the initial content of the register of the device computing the remainder of the division is preset to all ones and is then modified by division by the generator polynomial G(x) of the information be protected; the ones complement of the resulting remainder is transmitted as the 16 check bits.

At the receiver, the initial content of the register of the device computing the remainder is preset to all ones. The final remainder after multiplication by x^{16} and then division by the generator polynomial G(x) of the incoming protected bits including the FCS, will be

$x^{15} \cdots x^0 = 1000\ 0000\ 0000\ 1101$

in the absence of transmission errors.

The FCS bits are mapped on FCS octets so that the x^{15} bit is the b_1 bit of the first octet and the x^7 bit is the b_1 bit of the second octet.

A simple and fast 8-bit oriented algorithm for FCS calculation, suitable for implementation in both a microprocessor controlled radio unit and in a standard PC, is given in Appendix A1.

4.3.2. Elements of procedure

The data link peer-to-peer protocol functions are defined by the header field. The header field may be followed by a variable length data field which contains transparent user data.

The header has a constant length of 4 octets and contains information for the remote data link layer but may be used as input to other layers. This information will not be transmitted over the radio path. The general header elements are as follows:

- Type indication
- Type dependent parameters

The type indication has a length of one octet and shall be the first octet of the header. The type indication identifies the header field and encoding for the remainder of the header field. Not used parameter fields are filled with 00h (IA5 character NUL). The following header types are specified:

- Link request (LR)
- Link transfer (LT)
- Link acknowledgement (LA)

4.3.2.1. Link request (LR) format

The link request (LR) format is used to establish (or re-establish) a connection between two entities with an active physical connection. LR packets have no data field. The header field structure is shown in figure 4-2.

1	LR	Link Request	Value 01h
2	N1	Maximum length	Range 0-255
3	k	Window size	Standard 1, other values optional
4	VERSION	Protocol version number	Standard 0-127, system specific 128-255

Figure 4-2: Link request header field

For definition of maximum length parameter N1 see 4.5.6.

The window size k defines the maximum number of outstanding LT packets, with a maximum data field length, that may be sent at a given time without waiting for an acknowledgement. The default value of k is 1. Other values up to 255 are optional.

The protocol version number shall have a value between 0 and 127. System specific versions are possible. These versions should have values between 128 and 255. The version number of this release is 1.

4.3.2.2. Link acknowledgement (LA) format

The link acknowledgement (LA) format is used both to confirm the link establishment and to acknowledge LT packets. One LA packet may acknowledge multiple LT packets. LA packets have no data field. The header structure is shown in figure 4-3.

1	LA	Link Acknowledgement	Value 02h
2	N(R)	Rx sequence number	binary, modulo 256
3	N(k)	Rx credit number	binary. modulo 256
4	Reserved	Reserved	NUL

Figure 4-3: Link acknowledge header field

The receive sequence number N(R) is the number of the next expected LT packet.

The receive credit number N(k) is the number of LT packets that can be sent before the sender must wait for an acknowledgement.

The ready or busy status of the receiver is controlled by the receive credit number N(k). This LA packet credit parameter contains the number of LT packets the receiver is able to accept at the moment of LA transmission. A credit value of zero stops the transmission of a new LT by the sender.

4.3.2.3. Link transfer (LT) packet

The link transfer (LT) packet is used to transfer higher layer data in sequentially numbered data fields. The data field contains transparent user data up to the field length defined by N1 negotiated during the establishment phase. The header structure is shown in figure 4-4.

1	LT	Link Transfer	Value 04h
2	N(S)	Tx sequence number	binary, modulo 256
3	AR	Acknowledgement request	0/1
4	Reserved	Reserved	NUL

Figure 4-4: Link transfer header field

The send sequence number N(S) is the number of the data field. This number is incremented in a modulus manner with each transmitted LT packet.

The acknowledgement request parameter AR shall have a value 0 or 1 with the following definition:

0 no special acknowledgement requested

1 this LT packet has to be acknowledged immediately

4.3.2.4. Variables and sequence numbers

All LA and LT packets are sequentially numbered and in each entity there are corresponding state variables which may have any value in the range 0 to m-1, where m is the modulus of the sequence numbers. The modulus is 256 and all arithmetic operations on state variables and sequence numbers defined are affected by the modulo 256 operation.

LT packets contain a send sequence number N(S). If an in-sequence LT packet is designated for transmission, N(S) is set equal to a send state variable V(S).

LA packets contain a receive sequence number N(R), the expected N(S) of the next received LT packet. The value of N(R) indicates that all LT packets correctly received are acknowledged up to and including N(R)-1. If an LA packet is designated for transmission, N(R) is set equal to a receive state variable V(R).

The send state variable V(S) denotes the sequence number of the next in-sequence LT packet to be transmitted. The value of V(S) shall be incremented by 1 with each successive LT packet transmission, but cannot exceed N(R) of the last received LA packet by more than the maximum number of outstanding LT packets, the window size k.

The receive state variable V(R) denotes the sequence number of the next in-sequence LT packet expected to be received. V(R) shall be incremented by 1 with each correctly received LT packet whose N(S) equals V(R).

The receive credit state variable R(k) denotes the number of LT packets the receiver is able to receive. The number of received LT packets not acknowledged plus R(k) cannot be greater than the window size k. R(k) is updated so often as required and represents the receiver's ability to accept LT packets.

LA packets contain a receive credit number N(k). If an LA packet is designated for transmission, N(k) is set equal to the receive credit state variable R(k). This N(k) indicates that the entity is able to receive LT packets numbered up to and including N(k)+N(R)-1.

The send state credit variable S(k) denotes the number of LT packets the sender is able to transmit without additional credit from the receiver. The number of LT packets not acknowledged cannot be greater than the last received N(k) which is in range from zero to the window size k. The value of S(k) shall be decremented by 1 each time a new LT packet is transmitted.

Upon initialisation phase the state variables are set as follows:

V(S) set to 1

V(R) set to 1

R(k) set to k

S(k) set to 0

4.4. Data link protocol description

The following two main states are defined with the data transfer protocol:

'Data link establishment' or 'reset_wait' and 'link_wait'
'Data transfer ready' or 'ready'

The data link establishment procedure begins after power-on or reset. After link establishment the entity is in the data transfer phase and is able to send or receive LT packets.

At any time after initial power-on a receiver must be capable of decoding and interpreting the header field of an incoming message and checksum. It may discard the data field if it is not ready to receive data.

The receiver shall discard a received packet if it is faulty e.g. checksum does not match.

This protocol in a SDL format is in Appendix A2.

4.4.1. Link establishment phase procedure

The entities at either end of a physical connection may initiate the link establishment procedure at any time and both entities may do so simultaneously.

The originating entity (the initiator) begins the procedure of the link establishment phase. The receiving entity shall be ready to respond to protocol messages and shall perform parameter negotiation with its internal parameters.

The receiving entity examines the parameters of the LR packet it receives, compares them to its internal parameters and determines the parameter values which will be suitable for both ends. Suitable parameter values shall be the lower of two compared values and shall be set as the parameter which will characterise the connection.

If the entity is in a data transfer phase and it receives an LR packet it shall enter the link establishment phase . It shall also enter the link establishment phase when switched on or reset.

During link establishment phase all data transfer is prohibited and all data buffers within the data link layer are cleared.

4.4.1.1. Sending LR packets

The Link establishment procedure shall be started by sending an LR packet with the highest internal parameter values of the originating entity.

An entity shall transmit an LR packet, enter or stay in the link establishment phase and start or restart time control T0 and stop time controls T1, T2, T3 and T4, if any of the following conditions occur:

a) power-on is completed, or
b) an entity detects a link failure with a need for re-establishment, or
c) the higher layer signals a reset request, or
d) the entity receives an LT packet in the link establishment phase, or
e) receives an LR packet in the data transfer phase, or
f) time control T0 expires.

4.4.1.2. Receiving LR packets

If the entity is in the link establishment state and receives an LR packet it shall perform parameter negotiation if the parameters are acceptable and the entity has sent in this link establishment phase at least once an LR packet with suitable parameters, it shall:

a) stop time control T0, and

b) initialise internal variables and clear data buffers, and

c) transmit an LA packet, and

d) start time control T3, and

e) start time control T4, and

f) signal data transfer ready to higher layer, and

g) enter the data transfer phase .

If the entity is in the link establishment phase and receives an LR packet with non-acceptable parameters or the entity has not sent an LR packet in this link establishment phase, it shall:

a) transmit an LR packet with suitable parameters, and

b) start time control T0.

4.4.1.3. Receiving LA packet

If an entity receives an LA packet in link establishment phase and has been sent at least once an LR packet in the current link establishment phase it shall:

a) stop time control T0, and

b) initialise internal variables and set S(k) to N(k), clear data buffers, and

c) send an LA packet, and

d) start time control T3, and

e) start time control T4, and

f) signal data transfer ready to the higher layer, and

g) enter the data transfer phase.

If an entity receives an LA packet in link establishment phase and has not been sent an LR packet in this link establishment phase it shall:

a) send an LR packet, and

b) start time control T0.

4.4.2. Data transfer phase procedure

After completion of the data link establishment the entities are in the data transfer phase and are able to exchange data using LT and LA packets. LT packets have a data field which shall contain no more user data than defined by N1, see 4.3.2.1.

4.4.2.1. Sending LT packets

When an entity has user data to transmit and the remote entity is ready to receive, it will transmit an LT packet with N(S) equal to its send state variable V(S). The value of V(S) shall be incremented and the value of S(k) shall be decremented by 1 (modulo 256).

Time control T1 shall be restarted and the retransmission counter C1 is reset when a new LT packet transmission is completed.

If S(k) = 0, the entity is not allowed to send LT packets until S(k) is updated to a non-zero value by receipt of an LA packet.

The entity may set the AR bit to '1', if it requires immediate acknowledgement.

It is recommended that the AR bit is set to 1 when S(k)=1.

4.4.2.2. Receiving LT packets

If an entity is ready to receive and it receives a valid LT packet whose N(S) equals its receive state variable V(R), the entity shall accept the data and increment its V(R) by 1 (modulo 256) and shall restart timer T2 and timer T4.

The receiving entity shall discard the data field of an LT packet if:

a) N(S) is not equal to the current V(R), or

b) the receive credit R(k) equals zero and the entity is not ready to receive user data.

4.4.2.3. Sending LA packets

An entity sends an LA packet with N(R) equal to its receive state variable V(R) and with N(k) equal to its receive credit variable R(k) to acknowledge one or more valid LT packets which have been received, or to report a condition which require retransmission of one or more LT packets, or to inform the remote entity about the ability to accept additional LT packets.

An LA packet shall be sent, timer T2 shall be stopped and timer T3 restarted, if one of the following conditions occur:

a) An out-of-sequence LT packet is received which N(S) is not equal to V(R).

b) An LT packet is received without credit (R(k) equals zero before update).

c) Timer T2 has expired.

d) R(k) is updated from zero to a higher value.

e) An LT packet is received with AR set to one (immediate acknowledge request).

f) If the timer T3 expires.

An LA packet may be sent each time the entity receives an LT packet or when R(k) is updated to a higher value than last used N(k) or when R(k) is decreased to zero.

4.4.2.4. Receiving LA packets

When an LA packet is received, the timer T4 is restarted and the value of N(R) shall be considered as acknowledgement for all outstanding LT packets with N(S) up to and including the received N(R)-1.

If N(R) equals V(S) (acknowledging all outstanding LT packets) the retransmission counter C1 is reset and the time control T1 is stopped, otherwise T1 is restarted.

The credit variable S(k) is set equal to the value of N(k) minus the number of outstanding LT packets.

S(k) := N(k)-(V(s)-N(r))

4.4.2.5. Retransmission of LT packets

Retransmission of outstanding LT packets shall be initiated and retransmission counter C1 shall be incremented if one of the following conditions occur:

a) A received LA packet has N(R) equal to the last received N(R).

b) Timer T1 expires

Retransmission starts with the first in-sequence not acknowledged LT packet. Time control T1 is started or restarted after transmission of each LT packet.

If an acknowledgement is received for specific LT packets during the re-transmission of packets due to the above conditions then the acknowledged packets are not re-transmitted.

4.4.2.6. Link failure detection

A failure of the connection is assumed and the entity shall perform a data link reset (see 4.4.1 and 4.4.1.1) when any of the following occurs:

a) the retransmission counter C1 reaches the maximum number of retransmissions N2, or

b) the received acknowledgement packet sequence number N(R) is outside of the expected range (N(R) is less than the last received acknowledge packet number or N(R) is higher than the transmission state variable V(S) value), or

c) Timer T4 expires.

The data link reset shall be signalled to the higher layer.

4.4.2.7. Receiving LR packet

If an entity receives an LR packet during data transfer phase, it shall perform a data link reset (see 4.4.1 and 4.4.1.1). The data link reset shall be signalled to the higher layer.

4.5. Data link system parameters

4.5.1. Time control T0 - establishment phase retry timer

Time control T0 is the time the entity waits before retransmission is initiated in the link establishment phase.

The initial value of T0 is 100 ms. The value of T0 may be increased, due to a prolonged link establishment phase, up to 15 s.

4.5.2. Time control T1 - transfer phase retry timer

Time control T1 is the time the entity waits before retransmission in the data transfer phase is initiated. The period of time T1 depends on the transmission speed of the physical connection. In the data transfer state the period is determined by the following formula:

$$T1 > 2 * (L_{lt} + L_{la}) / R$$

where

L_{lt} is the length of a LT packet dependent on N1 in bits,

L_{la} is the length of a LA packet in bits,

R is used data rate in bits per second.

Typical values for T1 are shown in table 4-1:

R	N1 = 0	N1 = 10	N1 = 100	N1 = 255
600	1,3 s	6,7 s	54,7 s	137,3 s
1200	0,7 s	3,4 s	27,4 s	68,7 s
2400	0,4 s	1,7 s	13,7 s	34,4 s
4800	0,2 s	0,9 s	6,9 s	17,2 s
9600	0.1 s	0,5 s	3,5 s	8,6 s
19200	0.05 s	0,3 s	1,8 s	4,3 s

Table 4-1: Time T1 values

4.5.3. Time control T2 - acknowledge timer

The time control T2 is the time within which an acknowledgement must be sent. The maximum value of T2 is T1 minus twice the length of an LA packet. When an entity sends an LA packet each time after receiving an LT packet, then time control T2 actions may not be required.

4.5.4. Time control T3 - activity timer

The time control T3 is the time an entity waits before transmission of an LA packet is initiated to report the receiver credit.

T3 has a maximum value of 15 seconds.

4.5.5. Time control T4 - link failure detection timer

The link failure detection time T4 is the time an entity waits to receive an LA or an LT packet before a failure of the connection is assumed and a data link reset is initiated. The link failure delay time T4 is a period greater than N3*T3.

4.5.6. The maximum length parameter N1

The maximum length parameter N1 defines the maximum data field length that can be sent with the link transfer packet. This parameter may have values between 0 and 255. The maximum data field length n_{octet} in octets is calculated as follows:

$$n_{octet} = 16 * (N1 + 1)$$

With N1=0 the maximum number of data octets is 16, and with N1=255 the maximum data field length is 4096. The data field length chosen must be large enough for the longest network layer message used.

4.5.7. The maximum number of retransmissions N2

The value of N2 is the maximum number of attempts an entity makes to complete successful LT packet transmissions to the correspondent entity.

The value of N2 shall be 10.

4.5.8. The maximum number of activity timeouts N3

The value of N3 is the number of timeouts of the time control T3 before a link activity failure is detected. N3 and T3 are used to define the value of the link failure delay timer T4.

The value of N3 shall be at least 2.

5. Data terminal equipment network layer

5.1 General

This section describes the network layer of the data terminal equipment (DTE) for communication between MPT 1327 and MPT 1343 type radio units and data terminal equipment. Some examples of message sequence charts are presented in Appendix A3. Network layer message descriptions are in section 5.2. and network layer protocol description is in section 5.3.

The network layer message types used by the network layer protocol are shown in table 5-1. Numbers before the message names refer to section 5.2. for more detailed information. Network layer implementations of the radio unit may contain some special messages. A list of standardised optional messages is in the Annex A4. Message type numbers are presented both in hexadecimal and binary formats. Direction of the message flow is shown by an arrow: D->R message is sent by the DTE to the radio unit and R->D message is sent by the radio to the DTE and D<->R denotes a message used in both directions.

Some messages may have multiple message types depending on the carried detailed information e.g. positive or negative acknowledgement.

Some messages have the same type number although they have different names. This reflects the usage of the radio path messages, which utilise the same codewords for different purposes.

Network layer messages and protocol hide most MPT 1327 specific action from a user.

Status messaging

	8	7	6	5	4	3	2	1			
80h	1	0	0	0	0	0	0	0	D->R	5.2.2.1.1.	SEND STATUS
80h	1	0	0	0	0	0	0	0	R->D	5.2.2.1.2.	RECEIVE STATUS
C0h	1	1	0	0	0	0	0	0	R->D	5.2.2.1.3.	STATUS ACK (positive)
D0h	1	1	0	1	0	0	0	0	R->D	5.2.2.1.3.	STATUS ACK (queuing)
E0h	1	1	1	0	0	0	0	0	R->D	5.2.2.1.3.	STATUS ACK (negative)

Short data (SST) messaging

81h	1	0	0	0	0	0	0	1	D->R	5.2.2.2.1.	SEND SST
81h	1	0	0	0	0	0	0	1	R->D	5.2.2.2.2.	RECEIVE SST
C0h	1	1	0	0	0	0	0	0	R->D	5.2.2.2.3.	SST ACK (positive)
D0h	1	1	0	1	0	0	0	0	R->D	5.2.2.2.3.	SST ACK (queuing)
E0h	1	1	1	0	0	0	0	0	R->D	5.2.2.2.3.	SST ACK (negative)

Extended data (MST) messaging

82h	1	0	0	0	0	0	1	0	D->R	5.2.2.3.1.	SEND MST
82h	1	0	0	0	0	0	1	0	R->D	5.2.2.3.2.	RECEIVE MST
C0h	1	1	0	0	0	0	0	0	R->D	5.2.2.3.3.	MST ACK (positive)
D0h	1	1	0	1	0	0	0	0	R->D	5.2.2.3.3.	MST ACK (queuing)
E0h	1	1	1	0	0	0	0	0	R->D	5.2.2.3.3.	MST ACK (negative)

Voice and modem (non-prescribed data) call

A4h	1	0	1	0	0	1	0	0	D->R	5.2.2.4.1.	SETUP VOICE / SETUP MODEM
A5h	1	0	1	0	0	1	0	1	D->R	5.2.2.4.2.	SETUP EMERGENCY VOICE / SETUP EMERGENCY MODEM
C4h	1	1	0	0	0	1	0	0	R->D	5.2.2.4.3.	SETUP PROGRESS (positive)
D4h	1	1	0	1	0	1	0	0	R->D	5.2.2.4.3.	SETUP PROGRESS (queuing)
E4h	1	1	1	0	0	1	0	0	R->D	5.2.2.4.3.	SETUP PROGRESS (negative)
A4h	1	0	1	0	0	1	0	0	R->D	5.2.2.4.4.	INCOMING VOICE CALL / INCOMING MODEM CALL
A5h	1	0	1	0	0	1	0	1	R->D	5.2.2.4.5.	INCOMING EMERGENCY VOICE CALL / INCOMING EMERGENCY MODEM CALL
C5h	1	1	0	0	0	1	0	1	R->D	5.2.2.4.6.	RECEIVE PROGRESS (positive)
D5h	1	1	0	1	0	1	0	1	R->D	5.2.2.4.6.	RECEIVE PROGRESS (warning)
E5h	1	1	1	0	0	1	0	1	R->D	5.2.2.4.6.	RECEIVE PROGRESS (call not connected)

Modem call data transfer										
A3h	1	0	1	0	0	0	1	1	D->R	5.2.2.5.1. SEND MODEM DATA
A3h	1	0	1	0	0	0	1	1	R->D	5.2.2.5.2. RECEIVE MODEM DATA
Connection clearing										
86h	1	0	0	0	0	1	1	0	D->R	5.2.2.6.1. DISCONNECT (normal end)
A6h	1	0	1	0	0	1	1	0	D->R	5.2.2.6.1. DISCONNECT (cancel attempt)
86h	1	0	0	0	0	1	1	0	R->D	5.2.2.6.2. CLEARED (normal end)
A6h	1	0	1	0	0	1	1	0	R->D	5.2.2.6.2. CLEARED (abnormal end)
Diversion control										
87h	1	0	0	0	0	1	1	1	D->R	5.2.2.7.1. DIVERSION REQUEST
A7h	1	0	1	0	0	1	1	1	D->R	5.2.2.7.2. DIVERSION CANCEL
C7h	1	1	0	0	0	1	1	1	R->D	5.2.2.7.3. DIVERSION ACK (positive)
E7h	1	1	1	0	0	1	1	1	R->D	5.2.2.7.3. DIVERSION ACK (negative)
Radio controlling and miscellaneous messages										
B0h	1	0	1	1	0	0	0	0	D->R	5.2.2.8.1. RADIO INTERROGATION
B0h	1	0	1	1	0	0	0	0	R->D	5.2.2.8.2. RADIO PERSONALITY
B1h	1	0	1	1	0	0	0	1	R->D	5.2.2.8.3. NUMBERING INFORMATION
B2h	1	0	1	1	0	0	1	0	D->R	5.2.2.8.4. RADIO CONTROL
B2h	1	0	1	1	0	0	1	0	R->D	5.2.2.8.5. OPERATING CONDITION
B5h	1	0	1	1	0	1	0	1	R->D	5.2.2.8.6 NETWORK INFORMATION
B3h	1	0	1	1	0	0	1	1	D->R	5.2.2.8.7. RADIO MANAGEMENT
B3h	1	0	1	1	0	0	1	1	R->D	5.2.2.8.8. RADIO SETTINGS
B4h	1	0	1	1	0	1	0	0	R->D	5.2.2.8.9. PROTOCOL INFO
B4h	1	0	1	1	0	1	0	0	D->R	5.2.2.8.9. PROTOCOL INFO
B6h	1	0	1	1	0	1	1	0	D->R	5.2.2.8.10. VOLUME CONTROL
B7h	1	0	1	1	0	1	1	1	D->R	5.2.2.8.11. DIALLED STRING
01h	0	0	0	0	0	0	0	1	D->R	5.2.2.8.12. RADIO TEST (Informative)
01h	0	0	0	0	0	0	0	1	R->D	5.2.2.8.13. RADIO TEST RESULT (Informative)
Others										
00h	0	0	0	0	0	0	0	0		Reserved for protocol escape mechanism
	0	0	*	*	*	*	*	*		All type values not defined are spare (free for customisation)
	0	1	*	*	*	*	*	*		All type values not defined are reserved
	1	*	*	*	*	*	*	*		All type values not defined are reserved

Table 5-1: Network layer message types'

5.2. Network layer messages

5.2.1. Introduction

This section describes network layer messages for communication between MPT 1327 type radio units and data terminal equipment. Some MPT 1343 features are also supported. Each message definition may contain a short description of the message use, but the actual protocol is defined in section 5.3. 'Network layer protocol description'.

5.2.1.1. Message structures

Each network layer message contains at least two octets. Bit positions in an octet are numbered from 1 to 8 and bit position 8 contains the most significant bit.

All network messages start with a single octet 'message type' and continue with one or more octets of parameter and data fields. The most significant bit of the message type divides messages into two categories: '1' indicates standardised messages and '0' indicates proprietary messages.

5.2.1.2. Number and value presentations

In the messages detailed in this specification the numbers and variable values are presented in the following formats unless otherwise indicated:

- Binary coded digits follow MPT 1327 Appendix 5 definition using semi-octets (The first two lines indicate the position of the bits in an octet):

8 7 6 5 4 3 2 1 Bit pattern	Decimal value	8 7 6 5 4 3 2 1 Bit pattern	Decimal value or character
0 0 0 0	0	1 0 0 0	8
0 0 0 1	1	1 0 0 1	9
0 0 1 0	2	1 0 1 0	Reserved
0 0 1 1	3	1 0 1 1	*
0 1 0 0	4	1 1 0 0	#
0 1 0 1	5	1 1 0 1	Reserved
0 1 1 0	6	1 1 1 0	Reserved
0 1 1 1	7	1 1 1 1	NULL

  The first (odd) digit occupies bit positions 8 to 5 and the most significant bit is in the bit position 8. The most significant bit of the second (even) digit occupies bit position 4. If the second semi-octet is not used, then a NULL value shall be inserted.

- Binary numbers in the range 0 to 255 using octets. The least significant bit of a number occupies the bit position 1.
- Binary numbers in the range from 0 to 15 using semi-octets. The least significant bit of a number occupies either bit position 1 or bit position 5 as appropriate.

In all cases the most significant bit of a binary number is the first to be sent over the radio path (MPT 1327, Appendix 5).

5.2.1.3. Address presentations

The network layer conveys MPT 1327 addresses in the PFIX and IDENT or TRANS format depending on the message type. Extended addressing uses MPT 1327 and MMI definitions. The address format used in the additional ADDRESS field after the ADESC and LENGTH fields is defined by those fields, see Appendix A6 for examples.

ADESC				LENGTH				
8	7	6	5	4	3	2	1	Type of number
0	0	0	0	0	0	0	0	No additional addressing
0	0	0	1					SAMIS BCD
0	0	1	0					Spare for customisation (for further study)
0	0	1	1					MPT 1327 PABX exchange number. The first ADDRESS semi octet, bits from 5 to 8, contains the PABX exchange number (FLAG1 and FLAG2) in the range from 0 to 3. (The extension number is in the IDENT field in binary format).
0	1	0	0					MPT 1327 PABX exchange number. Address information contains PFIX (DUMMYP), IDENT (extension number in binary format) and semi octet, bits from 5 to 8, which contains the PABX exchange number in the range from 0 to 3.
0	1	0	1					MPT 1327 address (PFIX and IDENT)
0	1	1	0					MPT 1327 address (PFIX , IDENT) and SAMIS BCD
0	1	1	1					MMI dialled number to called party
1	*	*	*					Reserved
				*	*	*	*	Number of the network layer message octets used to carry extended

address information in a network layer message. Value is a semi-octet binary number.

Note1: LENGTH field '0000' indicates that no addressing information is included after this octet. In this case the ADESC field shall be '0000' and the ADDRESS field is not used.

MPT 1327 addresses shall be mapped into fields of addressing octets in the following manner:

- The address section PFIX (7 bits) uses one octet. The most significant bit is in the bit position 7 and the bit 8 set to '0' to indicate a PFIX and IDENT addressing.
- The address section IDENT (13 bits) uses two octets. The first 5, higher order bits of an IDENT are mapped onto the first octet with the most significant bit in the bit position 5, bits 6 to 8 are set to '0' and the remaining 8 bits use the second octet with the least significant bit in bit position 1. The MPT 1327 PABX binary format extension number follows the same format.
- The transaction number TRANS (10 bits) uses two octets. The first 2 higher order bits of a TRANS are mapped to the first octet with the most significant bit in the bit position 2, bits 3 to 8 are set to '0' and the remaining 8 bits uses the second octet with the least significant bit in bit position 1. The TRANS format is used with MPT 1327 standard data which is not covered by this version of MAP27.
- If a PFIX or IDENT number is not available, then a dummy value is used. The dummy value is indicated by setting all bits to '0'. These values are indicated as DUMMYP and DUMMYI respectively. The DUMMYP is also a valid PFIX and the DUMMYI is also indicating the presence of a DUMMYP.

In addition to PFIX and IDENT an extended address may contain up to 24 binary coded digits.

5.2.1.4 MPT 1327 addressing

The MPT 1327 addressing mechanism uses IDENT field as an address type indicator. This fact is reflected in some extent to the MAP27 interface definition. The general usage of the IDENT field is presented in the table 5-2. Those IDENT values which are marked as 'Not used in MAP27' indicate call types which are supported by specific network layer messages. Those IDENTs should not be used and if used by the DTE the radio unit should discard them and notify DTE. The IDENT values in the table 5-2 are decimal values.

If there is any discrepancy between this table and what is defined in the MPT 1327 standard, the latter should be used.

A radio unit and network specific addressing is supported by MMI dialled numbers. In that case the radio unit is responsible of the address coding and the dialling strings needed to access a certain service may be both radio unit and network dependent. The use of this method is discouraged.

IDENT	ADESC	Additional MAP27 address information	Usage	Message types
DUMMYI 0000	Other than 0111 or 0011		Dummy ident when an ident is not needed or not available	
DUMMYI 0000	0111	MMI dialled number	MMI specific call set-up	
Ident 1 - 8100	0000	-	Common-prefix and Interprefix calls	RQC, RQE, RQQ, RQS, RQX,
PSTNGI 8101	0001	PSTN number	Call to a general PSTN destination	RQC, RQE, RQS, RQT, RQX,
PABXI 8102	0001	PABX number	Call to a PABX number	RQC, RQE, RQS, RQT, RQX,
DNI 8103	-		Not used in MAP27	
8104-8120	-	Reserved	Not used in MAP27	
PSTNSIj 8121, j=1 8135. j=15	0000	-	Call to a prearranged PSTN number	RQC, RQE, RQS, RQT, RQX,
8136-8180	*	Network dependent	Network dependent	

8181-8184	-	Reserved	Not used in MAP27	
REGI 8185	-		Not used in MAP27	
INCI 8186	-		Not used in MAP27	
DIVERTI 8187	-		Not used In MAP27	RQT, RQX,
SDMI 8188	-		Not used In MAP27	
IPFIXI 8189	-		Not used In MAP27	RQC, RQE, RQQ, RQS, RQT, RQX,
TSCI 8190	-		Not used in MAP27	RQC, RQQ, RQX,
ALLI 8191	0000	-	System-wide call	RQC, RQE, RQS, RQX,
extension number	0011	Exchange number	Call to a PABX extension with PABX selection	RQC, RQE, RQS

Table 5-2: Usage of MPT 1327 Idents

5.2.1.5. Acknowledgements

The radio path protocol uses the same acknowledgement messages for many kinds of calls and data transmissions. For clarity reasons message names at the user access interface differ from those used on the radio path. The radio unit generates these messages based on local protocol machine.

All acknowledge messages contain a 'Called party address'. This address is set to dummy value (DUMMYP and DUMMYI) in the radio unit or is retrieved from the radio protocol storage unless it is available from the radio path protocol. The acknowledgement messages are grouped by the message type higher order semi-octet. The acknowledgement categories are positive or negative (transaction terminating) messages or queuing and waiting more signalling acknowledgements. This grouping reflects the main purposes of the radio path protocol acknowledgements and is coded according to table 5-3.

8	7	6	5	4	3	2	1	
1	1	0	0	*	*	*	*	Positive transaction terminating message
1	1	0	1	*	*	*	*	Queuing and waiting more signalling message
1	1	1	0	*	*	*	*	Negative transaction terminating message
1	1	1	1	*	*	*	*	Reserved

Table 5-3: Acknowledgement message type coding

5.2.1.6. User Data presentation

User data in the user access network layer is presented in octets. MPT 1343 defines four Tmessage formats for the transfer of data within Single Segment Transactions (SST) and Multiple Segment Transactions (MST). It reserves two other formats for future definition and makes two spare for customisation. Short and extended data messages define the user information presentation format according to MPT 1343. This standard (MAP27) supports five methods; the four which are supported by MPT 1343:

- Binary or free format
- BCD characters
- Telex (CCITT Alphabet No 2) Recommendation S1
- 7-bit ASCII (CCITT Alphabet No 5) Recommendations V3 and V4.

In addition, 8-bit ASCII or PC character set within the binary or free format configurations.

The user access network layer uses octets to carry all the prescribed formats. The free format (MPT 1327) and binary (MPT1343) user data messages (the bit strings which are longer than eight bits) are divided into octets starting from the most significant bit, which is placed in the bit position 8 of the first data octet. The length of the binary user data may not be a multiple of eight bits in which case the remaining bits are placed in the last data octet starting from the bit position 8 where the most significant bit of the remaining bit string is placed. The unused, least significant bits of the last data octet are set to '0'. The number of valid bits in the last octet is indicated by the 'Number of Last Bits' (NLB) field. The actual number of user data bits in the last octet is NLB+1. For example the value NLB = 7 means that the octet is fully occupied, and the value NLB = 0 means that only the bit in the position 8 is used.

The NLB information is available only locally and in general the NLB of the sending DTE and radio unit combination is different than the NLB of the receiving radio and DTE combination. At the sending radio unit the NLB is a real indication of the length of the user data, but at the receiving radio unit the NLB indicates the end data field of a radio path codeword.

The radio path protocol supports discrete lengths of the MPT 1327 and MPT 1343 SSTs and MSTs. Detailed information is in appendix A6. If the quantity of the data transmitted from the DTE to the radio unit is insufficient to fill exact number of codewords then the radio unit shall set unused bits to '0'. These unused bits will be transmitted to the receiving DTE as a part of the user data. As a result, while the NLB value provided by the transmitted DTE may have any value from 0 to 7, the remote DTE will receive an NLB value determined by the way in which the data was packed into the codewords.

In the character format presentations one octet carries one character. The 'Number of Last Bits' field has always value NLB = 7 and the actual length of separate characters is defined by the coding

format. Characters represent binary values and the least significant bit is placed in bit position 1 and all unused higher order bits are set to '0'.

The user data is mapped into the radio path codewords starting from the first octet so that in the binary case the eighth bit of the first octet is placed into the first bit position of the user data field of the data codeword in the radio path protocol. Similarly, for example in the case of Telex characters, the fifth bit of the first octet is placed into the first bit position of the data codeword. In all cases the most significant meaningful bit of the first character or binary user data is sent as the first of user data over the radio path.

5.2.1.7. Reserved fields or bits and future additions

Some network layer messages contain octets which are only partially used. The unused bits should be set to '0'. Protocol implementation should be designed so that future allocations of those bits are not prevented. Protocol implementations should be designed also so that they can accept new added octets at the end of messages although the earlier version of the protocol cannot recognise or understand new additions, see also appendix A5.

5.2.2. Network layer message descriptions

5.2.2.1. Status messaging

5.2.2.1.1. SEND STATUS

This message is sent by the DTE. This message blocks all further user data transmission until an acknowledgement is received from the radio path protocol.

	8	7	6	5	4	3	2	1	
1	1	0	0	0	0	0	0	0	Message type
2	0	PFIX1							Called party address PFIX1
3	0	0	0	IDENT1a					Called party address IDENT1
4	IDENT1b								Called party address IDENT1
5	ADESC				LENGTH				Address coding information. Length of the address field in octets.
6..	ADDRESS								Called party address information according to the ADESC field.
N	STATUS								Status number. Range 0...31.

5.2.2.1.2. RECEIVE STATUS

This message is sent by the called radio unit to the DTE.

	8	7	6	5	4	3	2	1	
1	1	0	0	0	0	0	0	0	Message type
2	0	PFIX2							Calling party address PFIX2
3	0	0	0	IDENT2a					Calling party address IDENT2
4	IDENT2b								Calling party address IDENT2
5	ADESC				LENGTH				Address coding information. Length of the address field in octets.
6..	ADDRESS								Calling party address information according to the ADESC field.
N	STATUS								Status number. Range 0...31.

5.2.2.1.3. STATUS ACK

This message is sent by the radio unit to the DTE and either acknowledges that the called party radio or line unit has received the previous STATUS number or indicates the reason for an unsuccessful attempt.

	8	7	6	5	4	3	2	1	
1	1	1	*	*	0	0	0	0	Message type
2	0	PFIX1							Called party address PFIX1 or DUMMYP
3	0	0	0	IDENT1a					Called party address IDENT1 or DUMMYI
4	IDENT1b								Called party address IDENT1 or DUMMYI
5	ADESC				LENGTH				Addressing coding information. Length of the address field in octets.
6..	ADDRESS								Diversion address information from ACKT message according to the ADESC field.
N	CAUSE								Reason for sending this message

CAUSE for Message type C0h:

8	7	6	5	4	3	2	1		
0	0	0	0	0	0	0	0	ACK	Successful transaction

CAUSE for Message type D0h:

0	0	0	0	0	0	1	0	ACKQ	System busy, wait for signalling
0	0	0	0	1	0	1	0	ACKQ	Called unit engaged, wait for signalling
0	0	1	0	0	1	1	0	ACKT	Called unit's calls are diverted and radio unit tries to send message to the diversion address

CAUSE for Message type E0h:

0	0	0	0	1	0	0	0	ACK	Transaction aborted
0	0	0	0	0	0	1	1	ACKX	Invalid call, message rejected
0	0	0	0	1	0	1	1	ACKX	System or called unit overload, message rejected
0	0	0	0	0	1	0	0	ACKV	Called radio out of reach or transaction abandoned
0	0	0	0	1	1	0	0	ACKV	Called unit engaged or does not wish to accept message
0	0	0	0	0	1	1	0	ACKT	Called unit's calls are diverted
0	0	0	1	0	1	1	0	ACKT	Called unit's calls are diverted to a group address
0	0	0	0	1	1	1	0	ACKT	Called unit's calls are diverted, but the diversion address is not available

Others	Reserved for further extensions

5.2.2.2. Short data (SST) messaging

5.2.2.2.1. SEND SST

The DTE sends this message to the radio unit. It conveys a single segment transaction (SST) message between DTE and radio unit.

	8	7	6	5	4	3	2	1	
1	1	0	0	0	0	0	0	1	Message type
2	0							PFIX1	Called party address PFIX1
3	0	0	0					IDENT1a	Called party address IDENT1
4								IDENT1b	Called party address IDENT1
5	ADESC							LENGTH	Addressing coding information. Length of the address field in octets.
6..	ADDRESS								Called party address information according to the ADESC field.
N	CODING							NLB	Data message coding information. Number of bits in the last octet.
N+1..	DATA MESSAGE								Data message.

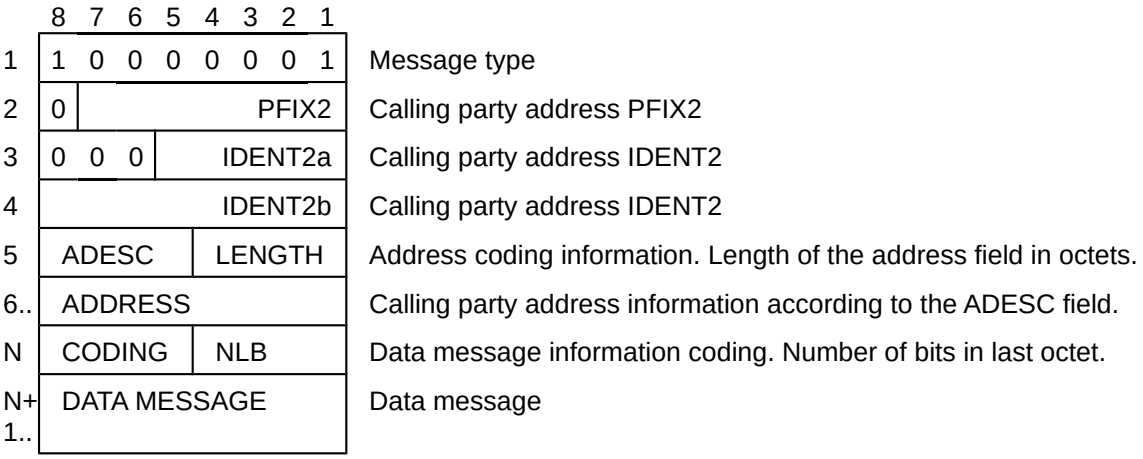
Data message coding information (CODING):

8	7	6	5	4	3	2	1	
0	0	0	0					MPT 1327: Free format data. Number of bits is in the range of 1...184.
0	0	0	1					MPT 1343: BCD radio path coding. Number of BCD numbers is in the range of 1...44. Numbers are presented as ASCII characters.
0	0	1	0					MPT 1343: CCITT Alphabet No 2 (Telex) radio path coding. Number of telex characters is in the range of 1...35. Characters are presented as ASCII characters.
1	0	0	0					MPT 1343: Binary. Number of bits is in the range of 1...176.
1	0	0	1					MPT 1343: BCD, see MPT 1327 Appendix 5. Number of BCD numbers is in the range of 1...44.
1	0	1	0					MPT 1343: CCITT Alphabet No 2 (Telex). Number of telex characters is in the range of 1...35.
1	0	1	1					MPT 1343: CCITT Alphabet No 5 (7 bit ASCII). Number of ASCII characters is in the range of 1...25.
1	1	0	0					MPT 1343: Reserved
1	1	0	1					MPT 1343: Reserved
1	1	1	0					MPT 1343: Spare
1	1	1	1					MPT 1343: eight bit characters according to PC character set. The character set number may be user dependent. Number of characters is in the range of 1...22. See appendix A6 for message format.
				*				Reserved, set to '0'
					*	*	*	Number of bits in the last byte. Range 1...8.
Others								Reserved

The presentation of the BCD and CCITT Alphabet No 2 (Telex) characters as ASCII characters is in appendix A6.

5.2.2.2.2. RECEIVE SST

The Radio unit sends this message to the DTE. It conveys a single transaction message between DTE and radio unit.



See SEND SST (5.2.2.2.1.) for details of the field descriptions.

5.2.2.2.3. SST ACK

This message is sent by the radio unit to indicate an acknowledgement to the previously sent SST. The acknowledgement contains information on the success of the transaction.

	8	7	6	5	4	3	2	1	
1	1	1	*	*	0	0	0	0	Message type
2	0	PFIX1							Called party address PFIX1 or DUMMYP
3	0	0	0	IDENT1a					Called party address IDENT1 or DUMMYI
4	IDENT1b								Called party address IDENT1 or DUMMYI
5	ADESC				LENGTH				Address coding information. Length of the address field in octets.
6..	ADDRESS								Diversion address information in ACKT messages according to the ADESC field.
N	CAUSE								Reason for sending this message

CAUSE for Message type C0h:

8	7	6	5	4	3	2	1		
0	0	0	0	0	0	0	0	ACK	Successful transaction

CAUSE for Message type D0h:

0	0	0	0	0	0	1	0	ACKQ	System busy, wait for signalling
0	0	0	0	1	0	1	0	ACKQ	Called unit engaged, wait for signalling
0	0	1	0	0	1	1	0	ACKT	Called unit's calls are diverted and radio unit tries to send message to the diversion address

CAUSE for Message type E0h:

0	0	0	0	1	0	0	0	ACK	Transaction aborted
0	0	0	0	0	0	1	1	ACKX	Invalid call, message rejected
0	0	0	0	1	0	1	1	ACKX	System or called unit overload, message rejected
0	0	0	0	0	1	0	0	ACKV	Called radio out of reach or transaction abandoned
0	0	0	0	1	1	0	0	ACKV	Called unit engaged or does not wish to accept message
0	0	0	0	0	1	1	0	ACKT	Called unit's calls are diverted
0	0	0	1	0	1	1	0	ACKT	Called unit's calls are diverted to a group address
0	0	0	0	1	1	1	0	ACKT	Called unit's calls are diverted, but the diversion address is not available

Others	Reserved for further extensions

5.2.2.3. Extended data (MST) messaging

5.2.2.3.1. SEND MST

The DTE sends this message to the radio unit. It conveys a multiple segment transaction message (MST) between DTE and radio unit.

After sending this message the radio unit waits for an radio path acknowledgement or a DISCONNECT (CANCEL CALL) message from the DTE before resuming further transmission of user data or call control.

	8	7	6	5	4	3	2	1	
1	1	0	0	0	0	0	1	0	Message type
2	0	PFIX1							Called party address PFIX1
3	0	0	0	IDENT1a					Called party address IDENT1
4	IDENT1b								Called party address IDENT1
5	ADESC				LENGTH				Address coding information. Length of the address field in octets.
6..	ADDRESS								Called party address information according to the ADESC field.
N	CODING				NLB				Data message coding information. Number of bits in last octet.
N+1..	DATA MESSAGE								Data message

Data message coding information (CODING):

8	7	6	5	4	3	2	1	
0	0	0	1					MPT 1343: BCD radio path coding. Number of BCD numbers is in the range of 1...176. Numbers are presented as ASCII characters.
0	0	1	0					MPT 1343: CCITT Alphabet No 2 (Telex) radio path coding. Number of telex characters is in the range of 1...140. Characters are presented as ASCII characters.
1	0	0	0					MPT 1343: Binary. Number of bits is in the range of 1...704.
1	0	0	1					MPT 1343: BCD, see MPT 1327 Appendix 5. Number of BCD numbers is in the range of 1...176.
1	0	1	0					MPT 1343: CCITT Alphabet No 2 (Telex). Number of telex characters is in the range of 1...140.
1	0	1	1					MPT 1343: CCITT Alphabet No 5 (7 bit ASCII). Number of ASCII characters is in the range of 1...100.
1	1	0	0					MPT 1343: Reserved
1	1	0	1					MPT 1343: Reserved
1	1	1	0					MPT 1343: Spare for customisation
1	1	1	1					MPT 1343: eight bit characters according to PC character set. The character set number may be network dependent. Number of characters is in the range of 1...88. See appendix A6 for message format.
*								Reserved
*	*	*						Number of bits in the last byte. Range 1...8.
Others								Reserved

The presentation of the BCD and CCITT Alphabet No 2 (Telex) characters as ASCII characters is in appendix A6.

5.2.2.3.2. RECEIVE MST

The Radio unit sends this message to the DTE. It conveys a multiple segment transaction (MST) message between radio unit and DTE.

	8	7	6	5	4	3	2	1	
1	1	0	0	0	0	0	1	0	Message type
2	0	PFIX2							Calling party address PFIX2
3	0	0	0	IDENT2a					Calling party address IDENT2
4	IDENT2b								Calling party address IDENT2
5	ADESC				LENGTH				Address coding information. Length of the address field in octets.
6..	ADDRESS								Calling party address information according to the ADESC field.
N	CODING				NLB				Data message coding information. Number of bits in last octet.
N+1..	DATA MESSAGE								Data message

See SEND MST (5.2.2.3.1.) for the details of the field descriptions.

5.2.2.3.3. MST ACK

This message is sent by the radio unit to indicate an acknowledgement to the previously sent multiple segment transaction. The acknowledgement contains information on the success of the transaction.

	8	7	6	5	4	3	2	1	
1	1	1	*	*	0	0	0	0	Message type
2	0	PFIX1							Called party address PFIX1 or DUMMYP
3	0	0	0	IDENT1a					Called party address IDENT1 or DUMMYI
4	IDENT1b								Called party address IDENT1 or DUMMYI
5	ADESC				LENGTH				Address coding information. Length of the address field in octets.
6	ADDRESS								Diversion address information from ACKT message according to the ADESC field.
N	CAUSE								Reason for sending this message

CAUSE for Message type C0h:

8	7	6	5	4	3	2	1		
0	0	0	0	0	0	0	0	ACK	Successful transaction

CAUSE for Message type D0h:

0	0	0	0	0	0	1	0	ACKQ	System busy, wait for signalling
0	0	0	0	1	0	1	0	ACKQ	Called unit engaged, wait for signalling
0	0	1	0	0	1	1	0	ACKT	Called unit's calls are diverted and radio unit tries to send message to the diversion address
0	0	1	0	0	0	1	0	Local	TSC does not support MST, the radio tries to use multiple SST

CAUSE for Message type E0h:

0	0	0	0	1	0	0	0	ACK	Transaction aborted
0	0	0	0	0	0	1	1	ACKX	Invalid call, message rejected
0	0	0	0	1	0	1	1	ACKX	System or called unit overload, message rejected
0	0	0	0	0	1	0	0	ACKV	Called radio out of reach or transaction abandoned
0	0	0	0	1	1	0	0	ACKV	Called unit engaged or does not wish to accept message
0	0	0	0	0	1	1	0	ACKT	Called unit's calls are diverted
0	0	0	1	0	1	1	0	ACKT	Called unit's calls are diverted to a group address
0	0	0	0	1	1	1	0	ACKT	Called unit's calls are diverted, but the diversion address is not available
0	0	0	0	1	1	0	1		TSC does not support MST, transaction aborted

Others	Reserved for further extensions

5.2.2.4. Voice and modem (non-prescribed data) call

5.2.2.4.1. SETUP VOICE / SETUP MODEM

This message is sent by the DTE to the radio unit and contains all the information needed to set-up a voice or modem call. The radio unit generates an RQS message.

	8	7	6	5	4	3	2	1	
1	1	0	1	0	0	1	0	0	Message type
2	0	PFIX1							Called party address PFIX1
3	0	0	0	IDENT1a					Called party address IDENT1
4	IDENT1b								Called party address IDENT1
5	ADESC				LENGTH				Address coding information. Length of the address field in octets.
6..	ADDRESS								Called party address information according to the ADESC field.
N	CALL DETAILS								Call details

CALL DETAILS:

8	7	6	5	4	3	2	1	
*								Reserved, set to '0'
	0							Non-include call
	1							Include call
		0						Individual or group call, called user(s) may reply
		1						Group call, called users are not allowed to reply
			0					Voice call
			1					Modem (Data) call
				0				High priority call
				1				Non-priority call
					0	0	0	Standard call
					*	*	1	Special customised service request
Others								Reserved

5.2.2.4.2. SETUP EMERGENCY VOICE / SETUP EMERGENCY MODEM

This message is sent by the DTE to the radio unit and contains all the information needed to set-up an emergency voice or modem call. The radio unit generates an RQE message.

	8	7	6	5	4	3	2	1	
1	1	0	1	0	0	1	0	1	Message type
2	0	PFIX1							Called party address PFIX1
3	0	0	0	IDENT1a					Called party address IDENT1
4	IDENT1b								Called party address IDENT1
5	ADESC				LENGTH				Address coding information. Length of the address field in octets.
6..	ADDRESS								Called party address information according to the ADESC field.
N	CALL DETAILS								Call details

CALL DETAILS:

8	7	6	5	4	3	2	1	
*								Reserved, set to '0'
	*							Reserved, set to '0'
		0						Individual or group call, called user(s) may reply
		1						Group call, called users are not allowed to reply
			0					Voice call
			1					Modem (Data) call
				*				Reserved, set to '0'
					0	0	0	Standard emergency call
					*	*	1	Special customised service request
Others								Reserved

5.2.2.4.3. SETUP PROGRESS

This message is sent by the radio unit to the calling DTE to indicate the progress, acceptance or rejection of a voice or modem call.

	8	7	6	5	4	3	2	1	
1	1	1	*	*	0	1	0	0	Message type
2	0	PFIX1							Called party address PFIX1
3	0	0	0	IDENT1a					Called party address IDENT1
4	IDENT1b								Called party address IDENT1
5	ADESC				LENGTH				Address coding information. Length of the address field in octets.
6	ADDRESS								Diversion address information from ACKT message according to the ADESC field.
N	CAUSE								Reason for sending this message

CAUSE for Message type C4h:

8	7	6	5	4	3	2	1		
0	0	0	0	0	0	0	0	GTC	Call connected
0	0	0	0	0	0	0	0	ACK	Include call connected

CAUSE for Message type D4h:

0	0	0	0	0	0	0	1	ACKI	Called unit alerting
0	0	0	0	0	0	1	0	ACKQ	System busy, wait for signalling
0	0	0	0	1	0	1	0	ACKQ	Called unit engaged, wait for signalling
0	0	0	0	0	1	0	1	ACKE	Emergency call is proceeding, wait for signalling
0	0	1	0	0	1	1	0	ACKT	Called unit's calls are diverted and radio unit tries to set-up call to the diversion address
0	0	1	1	0	1	1	0	ACKT	Called unit's calls are diverted to a group and radio unit tries to set-up call to the diversion address

CAUSE for Message type E4h:

0	0	0	0	1	0	0	0	ACK	Call set-up aborted
0	0	0	0	0	0	1	1	ACKX	Invalid call, call set-up rejected
0	0	0	0	1	0	1	1	ACKX	System or called unit overload, call set-up rejected
0	0	0	0	0	1	0	0	ACKV	Called radio out of reach or call set-up abandoned
0	0	0	0	1	1	0	0	ACKV	Called unit engaged or user does not wish to accept the call
0	0	0	0	0	1	1	0	ACKT	Called unit's calls are diverted
0	0	0	1	0	1	1	0	ACKT	Called unit's calls are diverted to a group address
0	0	0	0	1	1	1	0	ACKT	Called unit's calls are diverted, but the diversion address is not available
0	0	0	0	0	1	1	1	ACKB	Called unit has accepted the call for call-back

Others	Reserved for further extensions

5.2.2.4.4. INCOMING VOICE CALL / INCOMING MODEM CALL

This message is sent by the radio unit to the DTE to indicate an incoming voice or modem call. The radio unit generates this message from an AHY or a GTC message.

	8	7	6	5	4	3	2	1	
1	1	0	1	0	0	1	0	0	Message type
2	0	PFIX2							Calling party address PFIX2
3	0	0	0	IDENT2a					Calling party address IDENT2
4	IDENT2b								Calling party address IDENT2
5	ADESC				LENGTH				Address coding information. Length of the address field in octets.
6..	ADDRESS								Calling party address information according to the ADESC field.
N	CALL DETAILS								Call details
N+1..	Parameters								Parameter bits. Allowable range 0...44 bits in 5 and a half octets. (Valid only with customised services)

CALL DETAILS:

8	7	6	5	4	3	2	1	
*								Reserved, set to '0'
	0							Non-include call
	1							Include call
		0						Individual call
		1						Group call
			0					Voice call
			1					Data call
				0				Call has been connected (Hook signal is not needed) (GTC)
				1				Hook signal is required before connection is established (AHY)
					0	0	0	Standard call, no parameters field
					0	0	1	Reserved
					0	1	0	Reserved
					0	1	1	Reserved
					1	0	0	Reserved
					1	0	1	Customised service 1 indication
					1	1	0	Customised service 2 indication
					1	1	1	Customised service 3 indication
Others								Reserved

5.2.2.4.5. INCOMING EMERGENCY VOICE CALL / INCOMING EMERGENCY MODEM CALL

This message is sent by the radio unit to the DTE to indicate an incoming emergency voice or modem call. The radio unit generates this message from an AHY message or from an AHY and GTC messages.

	8	7	6	5	4	3	2	1	
1	1	0	1	0	0	1	0	1	Message type
2	0	PFIX2							Calling party address PFIX2
3	0	0	0	IDENT2a					Calling party address IDENT2
4	IDENT2b								Calling party address IDENT2
5	ADESC				LENGTH				Address coding information. Length of the address field in octets.
6..	ADDRESS								Calling party address information according to the ADESC field.
N	CALL DETAILS								Call details
N+1..	Parameters								Parameter bits. Allowable range 0...44 bits in 5 and a half octets. (Valid only on customised services)

CALL DETAILS:

8	7	6	5	4	3	2	1	
*								Reserved, set to '0'
	*							Reserved, set to '0'
		0						Individual call
		1						Group call
			0					Voice call
			1					Data call
				0				Call has been connected (Hook signal is not needed) (GTC)
				1				Hook signal is required before connection is established (AHY)
					0	0	0	Standard call, no parameters field
					0	0	1	Reserved
					0	1	0	Reserved
					0	1	1	Reserved
					1	0	0	Reserved
					1	0	1	Customised service 1 indication
					1	1	0	Customised service 2 indication
					1	1	1	Customised service 3 indication
Others								Reserved

5.2.2.4.6. RECEIVE PROGRESS

This message is sent by the radio unit to the called DTE to indicate the progress, acceptance or rejection of a voice or modem call.

	8	7	6	5	4	3	2	1	
1	1	1	*	*	0	1	0	1	Message type
2	0	PFIX2							Calling party address PFIX2
3	0	0	0	IDENT2a					Calling party address IDENT2
4	IDENT2b								Calling party address IDENT2
5	ADESC				LENGTH				Address coding information. Length of the address field in octets.
6	ADDRESS								Calling extended address information according to the ADESC field.
N	CAUSE								Reason for sending this message

CAUSE for Message type C5h:

8	7	6	5	4	3	2	1		
0	0	0	0	0	0	0	0	GTC	Call connected

CAUSE for Message type D5h:

0	0	0	0	0	0	0	1	MAINT	Transmission disabled
0	0	0	0	0	0	1	0	Note 1	System busy, wait for signalling
0	0	0	0	1	0	1	0	Local	Clear down timer warning (optional) Note 1

CAUSE for Message type E5h:

0	0	0	0	0	0	1	1	AHYX	Call set-up rejected
0	0	0	0	0	1	1	1	Local	Radio has accepted the call for call-back

Others	Reserved for further extensions

Note1: Exact messagetransmittedin the air interface protocol may be network dependent and may not be available in all networks.

5.2.2.5. Modem data transfer

5.2.2.5.1. SEND MODEM DATA

This message carries user data and is sent by the DTE to the radio unit or modem during a modem call. The message is optional. Usage and user data format of this message is implementation specific.

	8	7	6	5	4	3	2	1	
1	1	0	1	0	0	0	1	1	Message type
2..	USER DATA								Free format user data

5.2.2.5.2. RECEIVE MODEM DATA

This message carries user data and is sent by the radio unit or modem to the DTE during a modem call. The message is optional. Usage and user data format of this message is application specific.

	8	7	6	5	4	3	2	1	
1	1	0	1	0	0	0	1	1	Message type
2..	USER DATA								Free format user data

5.2.2.6. Connection clearing

5.2.2.6.1. DISCONNECT

This message is sent by the DTE to the radio unit to cancel a call request, to abort a transaction or to disconnect a modem or voice call. If the radio unit is waiting for further signalling on the control channel it sends a RQX message. If the radio unit has been sent to a traffic channel it sends a MAINT, OPER='011' (disconnect) message

	8	7	6	5	4	3	2	1	
1	1	0	*	0	0	1	1	0	Message type
2	0	PFIX1							Called or connected party address PFIX1
3	0	0	0	IDENT1a					Called or connected party address IDENT1
4	IDENT1b								Called or connected party address IDENT1
5	CAUSE								Cancellation or disconnection reason

CAUSE for Message type 86h:

	0	0	0	0	0	1	1	1	MAINT Disconnect voice or modem call, normal end

CAUSE for Message type A6h:

8	7	6	5	4	3	2	1		
0	0	0	0	1	0	0	0	RQX	Cancel any message transaction or normal call set-up attempt
0	0	0	0	1	0	0	1	RQX	Cancel include call set-up attempt
0	0	0	0	1	0	1	0	RQX	Abort diversion setting transaction
0	0	0	0	1	1	0	0	RQX	Cancel standard data call set-up attempt
Others									Reserved for further extensions

5.2.2.6.2. CLEARED

This message is sent by the radio unit to the DTE to indicate a cancelled transaction or a disconnected call.. Reasons for the message transaction and the phase of the call set-up disconnect are included in the STATUS ACK, SST/MST ACK, SETUP PROGRESS and RECEIVE PROGRESS messages.

	8	7	6	5	4	3	2	1	
1	1	0	*	0	0	1	1	0	Message type
2	0	PFIX1							Calling, called or connected party address PFIX1
3	0	0	0	IDENT1a					Calling, called or connected party address IDENT1
4	IDENT1b								Calling, called or connected party address IDENT1
5	CAUSE								Cancellation or disconnection reason

CAUSE for message type A6h:

8	7	6	5	4	3	2	1		
0	0	0	0	0	0	0	0	CLEAR MAINT Local	Not specified, all message transactions, call set-ups or calls are cancelled or disconnected
0	0	0	0	0	0	0	1	Local	Radio generated clear e.g. radio path protocol time-out or on-hook on the radio set
0	0	0	0	0	1	0	0	Local	Service not available (Radio unit not in radio contact)
0	0	0	0	0	1	0	1	Local	Transmission or message too long, call disconnected or message rejected
0	0	0	0	0	1	1	0	Local	Message coding not possible, message rejected
0	0	0	0	1	1	1	0	MAINT (110)	Voice or modem call disconnected, abnormal end

CAUSE for message type 86h:

0	0	0	0	1	0	1	1	CLEAR	Voice or modem call disconnected, normal end

Others	Reserved for further extensions

5.2.2.7. Diversion control

5.2.2.7.1. DIVERSION REQUEST

This message is sent by the DTE to the radio unit to request call diversions. The Radio unit generates an RQT message.

	8	7	6	5	4	3	2	1	
1	1	0	0	0	0	1	1	1	Message type
2	0							PFIX1	Address PFIX1 of the party to which calls are diverted
3	0	0	0					IDENT1a	Address IDENT1 of the party to which calls are diverted
4								IDENT1b	Address IDENT1 of the party to which calls are diverted
5	ADESC							LENGTH	Address coding information. Length of the address field in octets.
6..	ADDRESS								Address of the party to which calls are diverted. Address according to the first ADESC field.
N	DIVERSION INFO								Information of the diversion
N+1	0							PFIX1	Blocked party address PFIX1 in a third party diversion
N+2	0	0	0					IDENT1a	Blocked party address IDENT1 in a third party diversion
N+3								IDENT1b	Blocked party address IDENT1 in a third party diversion
N+4	ADESC							LENGTH	Address coding information. Length of the address field in octets.
N+5	ADDRESS								Blocked party address information according to the second ADESC field.

Note: Bytes starting from N+4 inclusive may not used in a MPT 1327 network and are optional.

DIVERSION INFO:

8	7	6	5	4	3	2	1	
*	*	*						Reserved, set to '0'
			0	0				Speech and data are diverted
			0	1				Speech calls are diverted
			1	0				Data calls are diverted
			1	1				Reserved
					*	*		Reserved, set to '0'
							0	Self initiated diversion request
							1	Third party diversion request
Others								Reserved

5.2.2.7.2. DIVERSION CANCEL

This message is sent by the DTE to the radio unit to cancel a call diversion. The Radio unit generates a RQT message.

	8	7	6	5	4	3	2	1	
1	1	0	1	0	0	1	1	1	Message type
2	0	PFIX1							Address PFIX1 of the party whose calls are no longer diverted or DUMMYP value for self cancellation or for general cancellation by recipient
3	0	0	0	IDENT1a					Address IDENT1a of the party whose calls are no longer diverted or DUMMYI value for self cancellation or for general cancellation by recipient
4	IDENT1b								Address IDENT1b of the party whose calls are no longer diverted or DUMMYI value for self cancellation or for general cancellation by recipient
5	ADESC				LENGTH				Address coding information. Length of the address field in octets.
6..	ADDRESS								Address of the party whose calls are no longer diverted according to the ADESC field.
N	DIVERSION INFO								Information of the diversion

DIVERSION INFO:

8	7	6	5	4	3	2	1	
*	*	*						Reserved, set to '0'
			0	0				Speech and data are no longer diverted
			0	1				Speech calls are no longer diverted
			1	0				Data calls are no longer diverted
			1	1				Reserved
					*			Reserved, set to '0'
						0	0	Self-initiated cancellation (ADESC='0000')
						0	1	Third party cancellation
						1	0	General cancellation by recipient (ADESC='0000')
Others								Reserved

5.2.2.7.3. DIVERSION ACK

This message is sent by the radio unit to the DTE to indicate the progress, acceptance or rejection of the message setting or cancellation a diversion.

	8	7	6	5	4	3	2	1	
1	1	1	*	0	0	1	1	1	Message type
2	0	PFIX1							Diversion target address PFIX1 value as in the corresponding DIVERSION REQUEST or CANCEL message
3	0	0	0	IDENT1a					Diversion target address IDENT1 value as in the corresponding DIVERSION REQUEST or CANCEL message
4	IDENT1b								Diversion target address IDENT1 value as in the corresponding DIVERSION REQUEST or CANCEL message
5	ADESC				LENGTH				Address coding information. Length of the address field in octets.
6	CAUSE								Reason for sending this message

CAUSE for message type C7h:

8	7	6	5	4	3	2	1		
0	0	0	0	0	0	0	0	ACK	Call diversion or diversion cancellation accepted

CAUSE for message type E7h:

0	0	0	0	1	0	0	0	ACK	Transaction aborted (response to RQX)
0	0	0	0	0	0	1	1	ACKX	Invalid diversion or TSC does not accept diversions, request rejected
0	0	0	0	1	0	1	1	ACKX	System overload, request rejected
0	0	0	0	0	1	0	0	ACKV	Transaction abandoned
Others									Reserved for further extensions

Note: In this message the ADESC and LENGTH fields are always '0000'.

5.2.2.8. Radio personality and control

5.2.2.8.1. RADIO INTERROGATION

This message from the DTE asks the radio unit for its personality and present operating conditions

	8	7	6	5	4	3	2	1	
1	1	0	1	1	0	0	0	0	Message type
2	REASON								Point of interrogation

REASON:

8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	0	Personality request
0	0	0	0	0	0	0	1	Numbering information
0	0	0	0	0	0	1	0	Status of radio settings
0	0	0	0	0	0	1	1	Operating condition
0	0	0	0	0	1	0	0	Network information from broadcast messages
1	*	*	*	*	*	*	*	Spare for customisation
Others								Reserved for future extensions

5.2.2.8.2. RADIO PERSONALITY

This message is sent by the radio unit to the DTE as the response to a radio personality interrogation.

	8 7 6 5 4 3 2 1	
1	1 0 1 1 0 0 0 0	Message type
2	0 PFIX1	Radio unit address PFIX1
3	0 0 0 IDENT1a	Radio unit address IDENT1
4	IDENT1b	Radio unit address IDENT1
5	MANUFACTURER'S CODE	Manufacturer's Code (8 bit binary number)
~~6~~	~~MODEL~~ ~~0 0~~ ~~SERIALa~~	~~Model number in the bit positions 8 to 5 and two most significant bits 18 and 17 of the Serial number in the bit positions 2 and 1~~
6	MODEL 0 0 SERIALa	Model number in the bit positions 8 to 5 and two most significant bits 18 and 17 of the Serial number in the bit positions 2 and 1
7	SERIALb	Serial number bits 16 to 9
8	SERIALc	Serial number bits 8 to 1
9	SUPPORTED FACILITIESa	List of supported facilities corresponding to the CONTROLSa bits on the RADIO MANAGEMENT message. Supported facility bits are set to '1'.
10	SUPPORTED FACILITIESb	List of supported facilities corresponding to the CONTROLSb bits on the RADIO MANAGEMENT message. Supported facility bits are set to '1'.
11	SUPPORTED FACILITIESc	Spare for customer specific supported facilities corresponding to the CONTROLSc bits on the RADIO MANAGEMENT message. Supported facility bits are set to '1'.
12	SUPPORTED CODINGS	Supported SST and MST coding types. Supported coding bits are set to '1'.

SUPPORTED FACILITIESa:

8	7	6	5	4	3	2	1	
0								Voice calls are not supported
1								Voice calls are supported
	0							Modem calls are not supported
	1							Modem calls are supported
		0						Status messages are not supported
		1						Status messages are supported
			0					SST messages are not supported
			1					SST messages are supported
				0				MST messages are not supported
				1				MST messages are supported
					0			Automatic call set-up to diversion address is not supported
					1			Automatic call set-up to diversion address is supported
						0		Call-back logging is not supported
						1		Call-back logging is supported
							*	~~Reserved for further extensions, set to '0'~~
							0	MPT 1327 Short Data Message format (STF=´0´) supported
							1	MPT 1327 Short Data Message format (STF=´0´) not supported

SUPPORTED FACILITIESb:

8	7	6	5	4	3	2	1	
*	*	*	*	*	*	*	*	Reserved for further extensions, set to '0'

SUPPORTED FACILITIESc:

8	7	6	5	4	3	2	1	
*	*	*	*	*	*	*	*	Space for customisation

SUPPORTED CODINGS:

8 7 6 5 4 3 2 1	
0	MPT 1343 BCD presentation as ASCII characters is not supported
1	MPT 1343: BCD radio path coding. Numbers and characters are presented as ASCII characters.
0	MPT 1343: CCITT Alphabet No 2 (Telex) presentation as ASCII characters is not supported
1	MPT 1343: CCITT Alphabet No 2 (Telex) radio path coding. Characters are presented as ASCII characters.
0	MPT 1343: Binary presentation is not supported
1	MPT 1343: Binary presentation.
0	MPT 1343: BCD presentation is not supported
1	MPT 1343: BCD, see MPT 1327 Appendix 5. Numbers are presented as BCD numbers.
0	MPT 1343: CCITT Alphabet No 2 (Telex).is not supported
1	MPT 1343: CCITT Alphabet No 2 (Telex). Characters are presented as Telex characters.
0	MPT 1343: CCITT Alphabet No 5 (7 bit ASCII) is not supported
1	MPT 1343: CCITT Alphabet No 5 (7 bit ASCII). Number of ASCII characters is in the range of 1...25.
0	MPT 1343: eight bit characters according to PC character set is not supported
1	MPT 1343: eight bit characters according to PC character set. The recommended character set number is 437.
*	Reserved

The coding of the BCD and Telex characters into ASCII characters and the eight bit PC character set coding into codewords are presented in Appendix A6.

MANUFACT CODE and SERIAL fields are presented as they are in the SAMIS radio path message according to MPT 1343 section 7. Note that check bits shall not be included into MAP27 message.

5.2.2.8.3. NUMBERING INFORMATION

This message is sent by the radio unit to the DTE either unsolicited or as the response to a radio numbering information interrogation.

	8	7	6	5	4	3	2	1	
1	1	0	1	1	0	0	0	1	Message type
2	0	PFIX1							Radio unit address PFIX1
3	0	0	0	IDENT1a					Radio unit address IDENT1
4	IDENT1b								Radio unit address IDENT1
5	L	INDIVIDUAL BASEa							Numbering scheme in bit position 8. Individual number base IDENT
6	INDIVIDUAL BASEb								Individual number base IDENT
7	HIGHEST IDENTa								Highest individual IDENT
8	HIGHEST IDENTb								Highest individual IDENT
9	L	GROUP BASEa							Numbering scheme in bit position 8. Group number base IDENT
10	GROUP BASEb								Group number base IDENT
11	HIGHEST GROUPa								Highest group IDENT
12	HIGHEST GROUPb								Highest group IDENT
13	GROUP PFIX1								Radio unit group address PFIX1
14	GROUP IDENT1a								Radio unit group address IDENT1
15	GROUP IDENT1b								Radio unit group address IDENT1
16	GROUP PFIX2								Radio unit group address PFIX2
17	GROUP IDENT2a								Radio unit group address IDENT2
18	GROUP IDENT2b								Radio unit group address IDENT2
N	GROUP PFIXn								Radio unit group address PFIXn
N+1	GROUP IDENT2na								Radio unit group address IDENTn
N+2	GROUP IDENT2nb								Radio unit group address IDENTn

L (numbering scheme):

L = '0': 2 digit fleet call numbers
L = '1': 3 digit fleet call numbers (MPT 1343 Section 6, Table 6.1 Item 6)

5.2.2.8.4. RADIO CONTROL

The DTE informs the radio unit of the user controlled actions needed in the radio path protocol.

	8	7	6	5	4	3	2	1	
1	1	0	1	1	0	0	1	0	Message type
2	CONTROLS								Set of pre-defined controls

CONTROLS:

8	7	6	5	4	3	2	1	
*	*	*	*	*	*			Reserved for further extensions, set to '0'
						0		On-hook indication i.e. user is no longer ready for a modem or speech call
						1		Off-hook indication i.e. user ready for a modem or speech call
							0	Transmit Off request
							1	Transmit On request

5.2.2.8.5. OPERATING CONDITION

The radio unit may send this message unsolicited or as a response to the operating condition and network information interrogation messages and radio control command message.

	8	7	6	5	4	3	2	1	
1	1	0	1	1	0	0	1	0	Message type
2	CONDITIONS								Operating conditions
3	FIELD STRENGTH								Received field strength
4	MCDT								Maximum call duration time

CONDITIONS:

8	7	6	5	4	3	2	1	
0	*	*	*	*				Reserved
					0			Radio unit is not in radio contact
					1			Radio unit is in radio contact
						0		Radio unit in On-Hook state (idle or disconnected)
						1		Radio unit in Off-Hook state (active)
							0	Radio not transmitting i.e. transmission not allowed
							1	Radio transmitting
1	*	*	*	*	*	*	*	Spare for customisation

FIELD STRENGTH:

8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	0	Dummy value, field strength not available
0	0	0	0	0	0	0	1	Lowest field strength
1	1	1	1	1	1	1	1	Highest field strength
Others								In between field strength

MCDT:

8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	0	Reserved
0	0	0	0	0	0	0	1	Call duration time is the shown value in minutes + 4 minutes (5 min)
0	0	0	0	1	0	0	1	Call duration time is the shown value in minutes + 4 minutes (13 min)
0	0	0	0	1	0	1	0	Call duration time is the shown value in seconds (10 sec)
1	1	1	1	1	1	1	0	Call duration time is the shown value in seconds (254 sec)
1	1	1	1	1	1	1	1	Call duration timer infinite or not supported

The call duration time is controlled by a broadcast message specified in MPT 1343 section 11.5.5.4(c). If radio unit applies CLIM parameter for call duration then this parameter value is used in MCDT field.

5.2.2.8.6. NETWORK INFORMATION

The radio unit may send this message unsolicited or as a response to the network information interrogation message.

	8	7	6	5	4	3	2	1	
1	1	0	1	1	0	1	0	1	Message type
2	0	0	0	0	0	0	RCb		Radio channel number, the highest order bit in the bit position 2
3	RADIO CHANNELb								Radio channel number, the lowest order bit in the bit position 1
4	0	SYSa							System identity code, the highest order bit in the bit position 7
5	SYSb								System identity code, the lowest order bit in the bit position 1

5.2.2.8.7. RADIO MANAGEMENT

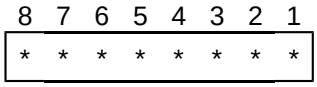
The DTE informs the radio unit of the user's operating requirements regarding the radio path protocol and thus controls the radio unit response to incoming calls. The control of call and message routings are left for further study.

	8	7	6	5	4	3	2	1	
1	1	0	1	1	0	0	1	1	Message type
2	CONTROLSa								Set (a) of pre-defined controls
3	CONTROLSb								Set (b) of pre-defined controls
~~4~~	~~CONTROLSc~~								~~Set (c) of spare control bits~~
4	CONTROLSc								Set (c) of pre-defined controls
5	CODINGS								SST and MST coding types (see 5.2.2.8.2)

CONTROLSa:

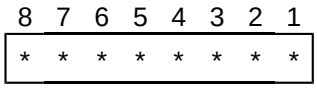
8	7	6	5	4	3	2	1	
~~0~~								~~User does not wish to or is not capable of receiving voice calls~~
0								User does not wish to or DTE is not capable of receiving voice calls
1								User wishes to receive voice calls
	~~0~~							~~User does not wish to or unit is not capable of receiving modem calls~~
	0							User does not wish to or DTE unit is not capable of receiving modem calls
	1							User wishes to receive modem calls
		~~0~~						~~User does not wish or unit is not capable to receive status messages~~
		0						User does not wish or DTE unit is not capable to receive status messages
		1						User wishes to receive status messages
			~~0~~					~~User does not wish or unit is not capable to receive SST messages~~
			0					User does not wish or DTE unit is not capable to receive SST messages
			1					User wishes to receive SST messages
				~~0~~				~~User does not wish or unit is not capable to receive MST messages~~
				0				User does not wish or DTE unit is not capable to receive MST messages
				1				User wishes to receive MST messages
					0			Radio shall not automatically set up calls to a diversion address
					1			Radio shall automatically set up calls to a diversion address
						0		Set call-back logging inactive
						1		Set call-back logging active
							*	Reserved for further extensions, set to '0'

CONTROLSb:



Reserved for further extensions, set to '0'

CONTROLSc:



Spare for customisation

5.2.2.8.8. RADIO SETTINGS

The radio unit may send this message as an acknowledgement to the radio management message or as the response to radio control message to indicate the activated settings of the radio unit.

	8 7 6 5 4 3 2 1	
1	1 0 1 1 0 0 1 1	Message type
2	RADIO SETTINGSa	Activated facilities corresponding the CONTROLSa bits of the RADIO MANAGEMENT message.
3	RADIO SETTINGSb	Activated facilities corresponding the CONTROLSb bits of the RADIO MANAGEMENT message.
4	RADIO SETTINGSc	Activated facilities corresponding the CONTROLSc bits of the RADIO MANAGEMENT message.
5	CODINGS	Activated SST and MST coding type (see 5.2.2.8.2).

RADIO SETTINGSa:

8 7 6 5 4 3 2 1	
0	Radio rejects incoming voice calls
1	Radio accepts incoming voice calls
0	Radio rejects incoming modem calls
1	Radio accepts incoming modem calls
0	Radio rejects incoming status messages
1	Radio accepts incoming status messages
0	Radio rejects incoming SST messages
1	Radio accepts incoming SST messages
0	Radio rejects incoming MST messages
1	Radio accepts incoming MST messages
0	Radio does not automatically set up calls to a diversion address
1	Radio does automatically set up calls to a diversion address
0	Call-back logging inactive
1	Call-back logging active
*	Reserved for further extensions, set to '0'

RADIO SETTINGSb:

8 7 6 5 4 3 2 1	
* * * * * * * *	Reserved for further extensions, set to '0'

RADIO SETTINGSc:

8 7 6 5 4 3 2 1	
* * * * * * * *	Spare for customisation

5.2.2.8.9. PROTOCOL INFO

The DTE or radio unit may send this message unsolicited or a response to indicate a protocol difficulty.

	8	7	6	5	4	3	2	1	
1	1	0	1	1	0	1	0	0	Message type
2	REASON								Reason to send this message

REASON:

8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	1	Unrecognised message
0	0	0	0	0	0	1	0	Facility or addressing not supported
0	0	0	0	0	0	1	1	Protocol state mismatch detected i.e. received message not compatible or allowed at the present state (optional)
0	0	0	0	0	1	0	0	Message coding not supported
~~1~~	~~*~~	~~*~~	~~*~~	~~*~~	~~*~~	~~*~~	~~*~~	~~Spare for customisation~~
0	0	0	0	0	1	0	1	Radio busy because of local operation
0	0	0	0	0	1	1	0	Radio ready for remote control
1	*	*	*	*	*	*	*	Spare for customisation
Others								Reserved

5.2.2.8.10. VOLUME CONTROL (Informative)

The DTE may send this message to the radio unit to adjust audio levels.

	8	7	6	5	4	3	2	1	
1	1	0	1	1	0	1	1	0	Message type
2	CONTROL POINT								Address of the volume control point
3	VOLUME SET								Volume set

CONTROL POINT:

8	7	6	5	4	3	2	1	
*	*	*	*	*				Reserved
					1			Modem audio path (audio level for a modem)
						1		Alert tones
							1	Normal speech audio path
Others								Reserved

VOLUME SET:

8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	1	Up
0	0	0	0	0	0	1	0	Down
*	*	*	*	0	0	1	1	Set to value in range 0...15, '0' is the lowest audio volume
0	0	0	0	0	1	0	0	Set to preset value e.g. value defined for emergency traffic (optional)
0	0	0	0	0	1	0	1	Reset to manual control (optional)
Others								Reserved

5.2.2.8.11. DIALLED STRING (Informative)

The DTE may send this message to the radio unit to initiate actions according to MPT 1343. Call set-ups are not supported by using this message, see section 5.2.1.4 for addressing dialled strings.

	8	7	6	5	4	3	2	1	
1	1	0	1	1	0	1	1	1	Message type
2..	DIALLED DIGITS								Characters used for dialling control actions.

5.2.2.8.12. RADIO TEST (Informative)

The DTE may send this message to the radio unit to initiate manufacturer specific radio testing.

	8	7	6	5	4	3	2	1	
1	0	0	0	0	0	0	0	1	Message type
2..	TEST CONTROL								Test controls, may contain one or more octets.

5.2.2.8.13. RADIO TEST RESULT (Informative)

The Radio unit may send this message to the DTE as a response to the manufacturer specific radio testing.

	8	7	6	5	4	3	2	1	
1	0	0	0	0	0	0	0	1	Message type
2..	TEST RESULT								Test results, may contain one or more octets.

5.3. NETWORK LAYER PROTOCOL DESCRIPTION

5.3.1. Introduction

This section defines the user network layer protocol for the data terminal equipment (DTE). The protocol rules are defined in MPT 1327 style though not necessarily in MPT 1327 terminology.

5.3.1.1. General remarks

The protocol description defines rules when the DTE network layer may send messages and how it should respond to received messages. Some usage examples of the rules are presented as message sequence diagrams in annex A3 'Network layer message sequence diagrams'.

In the text "DTE" is used in a broad sense and may contain, in addition to control functions, both speech and modem functions.

Communication between the application and the DTE network layer is not defined. Proposals in this document may be used at the discretion of the DTE designer.

Although the radio path protocol contains error recovery routines, which should prevent lock-up situations, some time-outs may be needed in the implementations. Actions for error situations, e.g. receiving an improper message, are mainly ignored.

A reset at any layer should force network layer into 'idle' state. The reset should be understood to cover only communication functions, equipment reset is not included.

5.3.1.2. Protocol presentation

This protocol presentation uses the following states:

'idle'
'outgoing call wait'
'outgoing include call wait'
'active'
'incoming call wait'
'status wait'
'segment transaction wait'
‘diversion wait’

These states are used to assist in the presentation of the protocol, but implementations of the protocol may use any number of states or any equivalent design mechanisms.

5.3.1.3. Messages

The network layer messages are described in section 5.2. 'Network layer messages'.

Acknowledge type messages contain two levels of information: an acknowledgement sub-set pointer in the message type and, in the cause field, the specific MPT 1327 or local acknowledgement in the sub-set to which the message type points. In most cases only message type information is used in the network layer and the reason field gives more detailed information of the acknowledgement to the higher layers.

In this protocol presentation the acknowledgement messages may have two parameters: the first for message type and the second for cause field. Both parameters are presented in hexadecimal format in the following sections. Where there is only one parameter it refers to the message type.

DTE network layer shall inform higher layers of all relevant received messages.

5.3.2. Status message transactions

5.3.2.1. DTE procedures to send a status message

The DTE network layer may send a status message when it is in the 'idle' state and the data link layer is ready. Only one status sending transaction may be active at any time.

After sending a SEND STATUS message the DTE network layer enters the 'status wait' state and may receive:

- STATUS ACK(C0h,00h) Successful transaction. DTE network layer shall enter into 'idle' state.
- STATUS ACK(D0h,02h) System busy, wait for signalling.
- STATUS ACK(D0h,0Ah) Called unit engaged, wait for signalling.
- STATUS ACK(D0h,26h) Called unit's calls are diverted and radio unit tries to send message to the diversion address.
- STATUS ACK(E0h,08h) Transaction aborted. DTE network layer shall enter into 'idle' state.
- STATUS ACK(E0h,03h) Invalid call, message rejected. DTE network layer shall enter into 'idle' state.
- STATUS ACK(E0h,0Bh) System or called unit overload, message rejected. DTE network layer shall enter into 'idle' state.
- STATUS ACK(E0h,04h) Called radio unit not in radio contact or message abandoned. DTE network layer shall enter into 'idle' state.
- STATUS ACK(E0h,0Ch) Called unit engaged or cannot accept message. DTE network layer shall enter into 'idle' state.
- STATUS ACK(E0h,06h) Called unit's calls are diverted. DTE network layer shall enter into 'idle' state.
- STATUS ACK(E0h,16h) Called unit's calls are diverted to a group address. DTE network layer shall enter into 'idle' state.
- STATUS ACK(E0h,0Eh) Called unit's calls are diverted, but the diversion address is not available. DTE network layer shall enter into 'idle' state.
- INCOMING VOICE CALL Radio unit has accepted an incoming call. DTE network layer shall accept incoming call, enter into 'active' or 'incoming call wait' state and terminate status sending attempt.
- CLEARED(A6h,00h) Transaction has been rejected, reason not specified. DTE network layer shall enter into 'idle' state.
- CLEARED(A6h,01h) Radio generated clear e.g. protocol time-out, transaction aborted. DTE network layer shall enter into 'idle' state.
- CLEARED(A6h,04h) Radio has lost radio contact. DTE network layer shall enter into 'idle' state.
- RECEIVE STATUS, RECEIVE SST, RECEIVE MST Radio unit has accepted a message. DTE network layer shall accept received message and stay in the 'status wait' state.
- PROTOCOL INFO(02h) Radio does not support status messaging. DTE network layer shall enter into 'idle' state and terminate status sending attempt.

While DTE network layer is in the 'status wait' state, it may send:

- DISCONNECT(A6h,08h) Abort status message. DTE network layer shall enter into 'idle' state.

5.3.2.2. DTE procedures to receive a status message

When in the 'idle' state the DTE may receive status messages. In some implementations the DTE network layer may also receive status messages in other states.

- RECEIVE STATUS Radio has received a status message. The DTE network layer shall accept the status message.

5.3.3. Single and Multiple Segment Transactions

MPT 1343 Single Segment Transactions (SST) and Multiple Segment Transactions (MST) are known colloquially as Short and Extended data messages respectively. In this document the formal terms are used throughout this text

5.3.3.1. DTE procedures to send SST or MST messages

The DTE network layer may send SST or MST messages when it is in the 'idle' state and the data link layer is ready. Only one SST or MST sending transaction may be active at any time. Both the SST and MST procedures are the same for DTE network layer and only the SST procedure is presented in full but with additional responses for MST messages.

After sending SEND SST message DTE network layer enters 'segment transaction wait' state and may receive:

- SST ACK(C0h,00h) Successful transaction. DTE network layer shall enter into 'idle' state.
- SST ACK(D0h,02h) System busy, wait for signalling.
- SST ACK(D0h,0Ah) Called unit engaged, wait for signalling.
- SST ACK(D0h,26h) Called unit's calls are diverted and radio unit tries to send message to the diversion address.
- MST ACK(D0h,22h) TSC does not support MST, Radio tries to use multiple SST.
- SST ACK(E0h,08h) Transaction aborted. DTE network layer shall enter into 'idle' state.
- SST ACK(E0h,03h) Invalid call, message rejected. DTE network layer shall enter into 'idle' state.
- SST ACK(E0h,0Bh) System or called unit overload, message rejected. DTE network layer shall enter into 'idle' state.
- SST ACK(E0h,04h) Called radio unit not in radio contact or message abandoned. DTE network layer shall enter into 'idle' state.
- SST ACK(E0h,0Ch) Called unit engaged or can not accept message. DTE network layer shall enter into 'idle' state.
- SST ACK(E0h,06h) Called unit's calls are diverted. DTE network layer shall enter into 'idle' state.
- SST ACK(E0h,16h) Called unit's calls are diverted to a group address. DTE network layer shall enter into 'idle' state.
- SST ACK(E0h,0Eh) Called unit's calls are diverted, but the diversion address is not available. DTE network layer shall enter into 'idle' state.
- MST ACK(E0h,0Dh) TSC does not support MST, transaction aborted. DTE network layer shall enter into 'idle' state.
- INCOMING VOICE CALL Radio unit has accepted an incoming call. DTE network layer shall accept incoming call, enter into proper 'active' or 'incoming call wait' state and terminate SST/MST sending attempt.
- CLEARED(A6h,00h) Transaction has been rejected, reason not specified. DTE network layer shall enter into 'idle' state.
- CLEARED(A6h,01h) Radio generated clear e.g. protocol time-out, transaction aborted. DTE network layer shall enter into 'idle' state.
- CLEARED(A6h,04h) Radio has lost radio contact. DTE network layer shall enter into 'idle' state.
- CLEARED(A6h,05h) Too long message (may be a result of Telex encoding), transaction aborted. DTE network layer shall enter into 'idle' state.
- CLEARED(A6h,06h) ASCII coded BCD or Telex message contains character which cannot be encoded using proposed coding method, transaction aborted. DTE network layer shall enter into 'idle' state.
- RECEIVE STATUS, RECEIVE SST, RECEIVE MST Radio unit has accepted a message. DTE network layer shall accept received message and stay in the 'status wait' state.

- PROTOCOL INFO(02h) Radio does not support corresponding data messaging. DTE network layer shall enter into 'idle' state and terminate data sending attempt.

While DTE network layer is in the 'segment transaction wait' state, it may send:

- DISCONNECT(A6h,08h) Abort SST message. DTE network layer shall enter into 'idle' state.

5.3.3.2. DTE procedures to receive a SST or MST message

The DTE network layer may receive SST and MST messages when in the 'idle' state. In some implementations the DTE network layer may also receive SST and MST messages when in other states.

- RECEIVE SST The radio unit has received a SST. The DTE network layer shall accept the SST message.

5.3.4. Voice and modem connections

Both voice and modem calls follow the same procedures and in this text word 'voice' is used to encompass both conditions.

5.3.4.1. DTE procedures for outgoing voice or modem call set-up

The DTE network layer call set-up starts from a higher layer call set-up request. The data link layer must be ready and the DTE network layer must be in an 'idle' state before the DTE network layer may sent a SETUP VOICE message. the DTE network layer enters into the 'outgoing call wait' state.

While the DTE network layer is in the 'outgoing call wait' state the valid responses from the radio unit are:

- SETUP PROGRESS(C4h,00h) Call connected. DTE network layer shall enter into 'active' state.
- SETUP PROGRESS(D4h,01h) Called unit alerting. (Higher layers may activate ringing indicator).
- SETUP PROGRESS(D4h,02h) System busy, wait for signalling.
- SETUP PROGRESS(D4h,0Ah) Called unit engaged, wait for signalling.
- SETUP PROGRESS(D4h,26h) Called unit's calls are diverted and radio unit tries connection to diversion address.
- SETUP PROGRESS(D4h,36h) Called unit's calls are diverted to a group address and radio unit tries connection to diversion address.
- SETUP PROGRESS(E4h,08h) Call set-up aborted. DTE network layer shall enter into 'idle' state. (Higher layers shall stop ringing indicator if activated).
- SETUP PROGRESS(E4h,03h) Invalid call, call set-up rejected. DTE network layer shall enter into 'idle' state.
- SETUP PROGRESS(E4h,0Bh) System or called unit overload, call set-up rejected. DTE network layer shall enter into 'idle' state.
- SETUP PROGRESS(E4h,04h) Called radio unit not in radio contact or call set-up abandoned. DTE network layer shall enter into 'idle' state.
- SETUP PROGRESS(E4h,0Ch) Called unit engaged or wish not to accept call. DTE network layer shall enter into 'idle' state.
- SETUP PROGRESS(E4h,06h) Called unit's calls are diverted. DTE network layer shall enter into 'idle' state.
- SETUP PROGRESS(E4h,16h) Called unit's calls are diverted to a group address. DTE network layer shall enter into 'idle' state.
- SETUP PROGRESS(E4h,0Eh) Called unit's calls are diverted, but the diversion address is not available. DTE network layer shall enter into 'idle' state.
- SETUP PROGRESS(E4h,07h) Called unit has accepted the call for call-back. DTE network layer shall enter into 'idle' state.

- CLEARED(A6h,0h) Call set-up attempt has been rejected. DTE network layer shall enter into 'idle' state.
- CLEARED(A6h,01h) Radio has rejected call set-up attempt. DTE network layer shall enter into 'idle' state.
- CLEARED(A6h,04h) Radio has lost radio contact. DTE network layer shall enter into 'idle' state.
- INCOMING VOICE CALL Radio unit has detected an incoming call. DTE network layer shall accept incoming call, enter into proper 'active' or 'incoming call wait' state for the new call and terminate original call set-up attempt.
- RECEIVE STATUS, RECEIVE SST, RECEIVE MST Radio unit has accepted a message. DTE network layer shall accept received message and stay in the 'outgoing call wait' state.
- PROTOCOL INFO(02h) Radio does not support voice or modem calls. DTE network layer shall abandon call set-up and enter into 'idle' state.
- DL-RESET.indication Data link layer has been initiated. DTE network layer shall abandon call set-up and enter into 'idle' state.

While DTE network layer is in the 'outgoing call wait' state, it may send:

- DISCONNECT(A6h,08h) Cancel call set-up attempt. DTE network layer shall enter into 'idle' state.
- DL-RESET.request service for Data link layer resetting. DTE network layer shall request datalink layer reset, abandon call set-up and enter into 'idle' state.

5.3.4.2. DTE procedures for incoming voice or modem call set-up

In the 'idle' state the DTE network layer may receive:

- INCOMING VOICE CALL Radio unit has detected an incoming call. DTE network layer shall enter into proper 'active' or 'incoming call wait' state.
- DL-RESET.indication Data link layer has been initiated.
- RECEIVE PROGRESS(E5h,07h) Radio unit has accepted the call for call-back. DTE network layer shall enter into 'idle' state.

In the 'incoming call wait' state the DTE network layer may receive:

- RECEIVE PROGRESS(C5h,00h) Radio unit has accepted incoming call. DTE network layer shall enter into 'active' state.
- RECEIVE PROGRESS(E5h,03h) Call set-up rejected. DTE network layer shall enter into 'idle' state.
- RECEIVE PROGRESS(E5h,07h) Radio unit has accepted the call for call-back. DTE network layer shall enter into 'idle' state.
- CLEARED(A6h,00h) Call set-up attempt has been rejected, reason not specified. DTE network layer shall enter into 'idle' state.
- CLEARED(A6h,01h) Radio has rejected call set-up attempt. DTE network layer shall enter into 'idle' state.
- CLEARED(A6h,04h) Radio has lost radio contact. DTE network layer shall enter into 'idle' state.
- RECEIVE STATUS, RECEIVE SST, RECEIVE MST Radio unit has accepted a message. DTE network layer shall accept received message and stay in the 'incoming call wait' state.
- DL-RESET.indication Data link layer has been initiated. The DTE network layer shall abandon the call set-up and enter into the 'idle' state.
- INCOMING VOICE CALL Radio unit has detected an incoming call and network layer shall enter into 'active' state.

  If this message refers to a different INCOMING VOICE CALL set-up, then DTE network layer shall terminate original call set-up attempt.

In the 'incoming call wait' state the DTE network layer may send:

- RADIO CONTROL(Bit2='0') Handset off-hook.
- RADIO CONTROL(Bit2='1') Handset on-hook. DTE network layer shall enter into 'idle' state.
- DL-RESET.request service for Data link layer resetting. DTE network layer shall request datalink layer reset, abandon call set-up and enter into 'idle' state.

5.3.4.3. DTE procedures during voice or modem call

While in the 'active' state the DTE network layer may receive:

- DISCONNECT(86h,0Bh) Voice or modem call disconnected, normal end. DTE network layer shall return to 'idle' state.
- RECEIVE PROGRESS(D5h,01h) Radio unit transmissions are disabled.
- RECEIVE PROGRESS(D5h,0Ah) Radio unit call time is about to end.
- CLEARED(A6h,00h) Call has been disconnected, reason not specified. DTE network layer shall enter into 'idle' state.
- CLEARED(86h,0Bh) Call has been disconnected, normal end. DTE network layer shall enter into 'idle' state.
- CLEARED(A6h,01h) Radio has disconnected call e.g. on-hook at the radio set. DTE network layer shall enter into 'idle' state.
- CLEARED(A6h,05h) Radio has detected a transmission the length of which exceeds the standard, call disconnected. DTE network layer shall enter into 'idle' state.
- CLEARED(A6h,04h) Radio has lost radio contact. DTE network layer shall enter into 'idle' state.
- CLEARED(A6h,0Eh) Call has been disconnected due to abnormal end. DTE network layer shall enter into 'idle' state.
- RECEIVE STATUS, RECEIVE SST, RECEIVE MST Radio unit has accepted a message. DTE network layer shall accept received message and stay in the 'active' state.
- DL-RESET.indication Data link layer has been initiated. DTE network layer shall abandon call and enter into 'idle' state.

While in the 'active' state the DTE network layer may send:

- DISCONNECT(86h,07h) Disconnect call, normal end. DTE network layer shall return to 'idle'.
- RADIO CONTROL(Bit2='0') Handset off-hook.
- RADIO CONTROL(Bit2='1') Handset on-hook. DTE network layer shall enter into 'idle' state.
- DL-RESET.request service for Data link layer resetting. DTE network layer shall request datalink layer reset, abandon call set-up and enter into 'idle' state.
- RADIO CONTROL(Bit1='1') Transmitter activation.
- RADIO CONTROL(Bit1='0') Transmitter de-activation.

5.3.4.4. DTE procedures for include call

While in the 'active' state the DTE network layer may send:

- SETUP VOICE Call set-up for an include call. DTE network layer shall enter into 'outgoing include call wait' state.

While in the 'outgoing include call wait' state the DTE network layer may, for include call, receive:

- SETUP PROGRESS(C4h,00h) Call connected. DTE network layer shall enter into 'active' state.
- SETUP PROGRESS(D4h,01h) Called unit alerting. (Higher layers may activate ringing indicator).
- SETUP PROGRESS(D4h,02h) System busy, wait for signalling.
- SETUP PROGRESS(D4h,0Ah) Called unit engaged, wait for signalling.
- SETUP PROGRESS(D4h,26h) Called unit's calls are diverted and radio unit tries connection to diversion address.

- SETUP PROGRESS(D4h,36h) Called unit's calls are diverted to a group address and radio unit tries connection to diversion address.
- SETUP PROGRESS(E4h,08h) Call set-up abandoned. DTE network layer shall return to 'active' state.
- SETUP PROGRESS(E4h,03h) Invalid call, call set-up rejected. DTE network layer shall return to 'active' state.
- SETUP PROGRESS(E4h,0Bh) System or called unit overload, call set-up rejected. DTE network layer shall return to 'active' state.
- SETUP PROGRESS(E4h,04h) Called radio unit not in radio contact or call set-up abandoned. DTE network layer shall return to 'active' state.
- SETUP PROGRESS(E4h,0Ch) Called unit engaged or wish not to accept call. DTE network layer shall return to 'active' state.
- SETUP PROGRESS(E4h,06h) Called unit's calls are diverted. DTE network layer shall return to 'active' state.
- SETUP PROGRESS(E4h,16h) Called unit's calls are diverted to a group address. DTE network layer shall return to 'active' state.
- SETUP PROGRESS(E4h,0Eh) Called unit's calls are diverted, but the diversion address is not available. DTE network layer shall return to 'active' state.
- SETUP PROGRESS(E4h,07h) Called unit has accepted the call for call-back. DTE network layer shall return to 'active' state.
- In addition DTE network layer may receive any relevant message to its original call.

While in the 'outgoing include call wait' state the DTE network layer may, for that call, send:

- DISCONNECT(A6h,09h) Cancel include call set-up attempt. DTE network layer shall enter into 'idle' state.

-3 In addition DTE network layer may send any relevant message to its original call.

5.3.5. DTE procedures for set-up and cancellation of call diversions

While in the 'idle' state the DTE network layer may send:

- DIVERSION REQUEST
- DIVERSION CANCEL

While DTE network layer is in the 'diversion wait' state it may receive for it's diversion message:

- DIVERSION ACK(C7h,00h) Call diversion or call diversion cancellation accepted. DTE network layer shall enter into 'idle' state.
- DIVERSION ACK(E7h,03h) Invalid diversion request. DTE network layer shall enter into 'idle' state.
- DIVERSION ACK(E7h,0Bh) System overload, request rejected. DTE network layer shall enter into 'idle' state.
- DIVERSION ACK(E7h,04h) Transaction abandoned. DTE network layer shall enter into 'idle' state.

While DTE network layer is in the 'diversion wait' state, it may send:

- DISCONNECT(A6h,0Ah) Abort diversion request. DTE network layer shall enter into 'idle' state.

5.3.6. DTE procedures for radio control

Radio controls are divided into main groups:

- Control of radio path protocol and functions
- Control of local radio functions

- Interrogation of network information and operating conditions.

The first is related to the previous protocol sections but the second and third are mainly unrelated and may be used at any time.

5.3.6.1. DTE radio path control

While in the 'idle' state the DTE network layer may send:

- RADIO CONTROL to indicate DTE Hook signal state. The sending of this message may not affect the function of the radio unit, which should already be in the 'On-Hook state'.
- RADIO MANAGEMENT to indicate the user wishes and capabilities for future radio responses used in the radio path protocol.

While in the 'idle' state the DTE network layer may receive:

- OPERATING CONDITION mainly to indicate changes in radio and the hook state of the radio unit. If the DTE also receives 'a radio transmitter on' indication the radio is controlled locally, independently of the DTE.
- RADIO SETTINGS to indicate the result of the activated settings of the radio.

While in the 'active' state the DTE network layer may send:

- RADIO CONTROL to request transmission start and end or to request call disconnection.

While in the 'active' state the DTE network layer may receive:

- OPERATING CONDITION indicating signal strength and squelch, radio unit transmission and hook signal states.

5.3.6.2. DTE local radio control

While in the 'idle' state the DTE network layer may send:

- RADIO INTERROGATION to request the radio unit personality and operating state.
- RADIO MANAGEMENT to indicate user's wishes and capabilities for future radio unit responses used in the radio path protocol.
- DIALLED STRING to control radio using MPT 1343 dialled characters. This message may not be used to set-up calls.
- RADIO TEST
- Any manufacturer specific message.

While in the 'idle' state the DTE network layer may receive:

- RADIO PERSONALITY indicating radio identities and supported facilities.
- NUMBERING INFORMATION as a response to RADIO INTERROGATION message.
- Any manufacturer specific message.

While in the 'idle', 'active', 'outgoing call wait', 'outgoing include call wait' or 'incoming call wait' state the DTE network layer may send:

- VOLUME CONTROL to set various audio levels.

While in any state DTE may receive:

- NUMBERING INFORMATION
- OPERATING CONDITIONS
- PROTOCOL INFO
- RADIO SETTINGS.

5.3.6.3. Interrogation of network and operating conditions

While in the 'idle' or 'active' state the DTE network layer may send:

- RADIO INTERROGATION to request the network information and operating state.

While in the 'idle' or 'active' state the DTE network layer may receive:

- NETWORK INFORMATION as a response to the RADIO INTERROGATION network information message
- OPERATING CONDITION .as a response to the RADIO INTERROGATION operating or network information message.

5.3.7. Error situations

While in any state the DTE may receive a message which:

- is valid but is not compatible with the current protocol state or
- is not recognisable or
- contains a request which is not supported by the DTE.

In such cases the DTE may send a PROTOCOL INFO message with an appropriate indication.

When errors occur frequently the DTE may try to cancel message sending or call set-up attempts, disconnect a call or request a data link layer reset.

The DTE may also receive a PROTOCOL INFO message with an appropriate indication. Depending on the current protocol state the DTE may try to re-send the previous message or try to cancel message sending or call set-up attempt, disconnect a call or request a data link layer reset.

When the DTE receives a data link layer reset indication which is not followed by an immediate DISCONNECT or CLEARED message it may need to continue previous actions instead of entering into 'idle' state (for further study).

5.4. DTE Network Layer Matrix

To give an overview of the states/events/actions possible at the network layer, the following matrices are generated. The top row shows the current state and the left hand column shows events. Per cell (state/event combination) an action is defined (lowercase), and a next state (uppercase), see also figure 5-1. The abbreviations for actions and states are explained below the matrices. The source of an event is enclosed by brackets ( ):

R Radio Unit
D Data Link Layer
N DTE Network Layer
A DTE Application Layer

General actions appearing in all matrices:

nothing	No action is executed, event is ignored.
appl error	The application issued a request which was not expected at that instant. Applications should be informed.
radio error	The radio unit sent a message which was not expected at that instant. The network layer should give appropriate information to the application.

To keep the matrices within a reasonable size, the STATUS, SST and MST WAIT states have been grouped to MESSAGE WAIT because all the actions are the same for each event.

An optional event is also presented: Response Timeout. It is generated by an internal network timer, which is (re)started every time a message is sent which requires an acknowledgement. The timer should not normally be necessary. It is used as a watch-dog to make sure the system does not wait forever.

In some states of the DTE the selected result of an apparently erroneous event is based on an obvious decision by the radio unit. Some error situations may be solved in an application specific way which differs from the one presented in this standard. These situations are marked by using italic characters in the table position, see figure 5-1. In any case the radio unit may respond with a PROTOCOL INFO message to show the protocol states mismatch. The DTE should then clear down the existing service or service attempt.

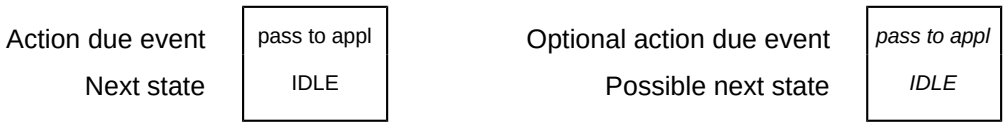


Figure 5-1: Content of state table cells

STATES events	IDLE	MESSAGE WAIT	DIVERT WAIT	INCALL WAIT	OUTCALL WAIT	INCLUDE WAIT	ACTIVE
Receive (R) Status/SST/ MST	pass to appl IDLE	pass to appl MESSAGE WAIT	pass to appl DIVERT WAIT	pass to appl INCALL WAIT	pass to appl OUTCALL WAIT	pass to appl *INCLUDE WAIT1)*	pass to appl ACTIVE
Send (A) Status/SST/ MST	send status MESSAGE WAIT	appl error MESSAGE WAIT	appl error DIVERT WAIT	appl error INCALL WAIT	appl error OUTCALL WAIT	appl error INCLUDE WAIT	appl error ACTIVE
Message (R) Interim. ACK	nothing IDLE	inform appl MESSAGE WAIT	*radio error* *IDLE 1)*	*radio error* *IDLE 1)*	*radio error* *IDLE 1)*	*radio error* *IDLE 1)*	*radio error* *IDLE 1)*
Message (R) Success ACK	nothing IDLE	inform last IDLE	*radio error* *IDLE 1)*	*radio error* *IDLE 1)*	*radio error* *IDLE 1)*	*radio error* *IDLE 1)*	*radio error* *IDLE 1)*
Message (R) Fail ACK	nothing IDLE	inform last IDLE	*radio error* *IDLE 1)*	*radio error* *IDLE 1)*	*radio error* *IDLE 1)*	*radio error* *IDLE 1)*	*radio error* *IDLE 1)*
Cancel (A) Message	nothing IDLE	inform last IDLE	appl error *DIVERT WAIT*	appl error *INCALL WAIT*	appl error *OUTCALL WAIT*	appl error *INCLUDE WAIT*	appl error *ACTIVE*
Message (R) Cancelled	nothing IDLE	inform last IDLE	*radio error* *IDLE 1)*	*radio error* *IDLE 1)*	*radio error* *IDLE 1)*	*radio error* *IDLE 1)*	*radio error* *IDLE 1)*

Figure 5-2: DTE Network layer Matrix, STATUS/SST/MST events

The Status/SST/MST actions are defined as follows:

pass to appl — Pass the received message (Status, SST, MST) to the application layers.

send status — Send the application status/SST/MST message to the radio unit. Start the response timer.

inform appl — Inform the application about the received progress status. Restart the response timer.

inform last — Inform the application about success or failure of the transmission. Stop the response timer.

Note 1: The DTE should not receive an acknowledgement to Status/SST/MST messages in these states and a "starting a recovery" process may be needed.

STATES events	IDLE	MESSAGE WAIT	DIVERT WAIT	INCALL WAIT	OUTCALL WAIT	INCLUDE WAIT	ACTIVE
Setup (A) Voice Modem	setup call OUTCALL WAIT	appl error MESSAGE WAIT	appl error DIVERT WAIT	appl error INCALL WAIT	appl error OUTCALL WAIT	appl error INCLUDE WAIT	include call INCLUDE WAIT
Setup (A) Emergency Call	setup call OUTCALL WAIT	appl error MESSAGE WAIT	appl error DIVERT WAIT	appl error INCALL WAIT	appl error OUTCALL WAIT	appl error INCLUDE WAIT	include call INCLUDE WAIT
Setup (R) Progress Int.	nothing IDLE	*radio error* *MESSAGE WAIT*	*radio error* *DIVERT WAIT*	*radio error* *INCALL WAIT*	inform appl OUTCALL WAIT	inform appl INCLUDE WAIT	*radio error* *ACTIVE*
Setup (R) Progress OK	nothing IDLE	*radio error* *MESSAGE WAIT*	*radio error* *DIVERT WAIT*	*radio error* *INCALL WAIT*	inform last ACTIVE	inform last ACTIVE	*radio error* *ACTIVE*
Setup (R) Progress Fail	inform appl IDLE	*radio error* *MESSAGE WAIT*	*radio error* *DIVERT WAIT*	*radio error* *INCALL WAIT*	inform last IDLE	inform last ACTIVE	*radio error* *ACTIVE*
Receive (R) Incoming Call	ring detect INCALL WAIT 1)	ring detect INCALL WAIT 1)	ring detect INCALL WAIT 1)	ring detect INCALL WAIT 1)	ring detect INCALL WAIT 1)	ring detect INCALL WAIT 1)	ring detect INCALL WAIT 1)
Receive (R) Emergency Call	ring detect INCALL WAIT 1)	ring detect INCALL WAIT 1)	ring detect INCALL WAIT 1)	ring detect INCALL WAIT 1)	ring detect INCALL WAIT 1)	ring detect INCALL WAIT 1)	ring detect INCALL WAIT 1)
Receive (R) Progress Intermediate	*inform appl* *IDLE*	*radio error* *MESSAGE WAIT*	*radio error* *DIVERT WAIT*	inform appl INCALL WAIT	*radio error* *OUTCALL WAIT*	*radio error* *INCLUDE WAIT*	inform appl *INCALL WAIT*
Receive (R) Progress OK	*inform appl* *IDLE*	*radio error* *MESSAGE WAIT*	*radio error* *DIVERT WAIT*	inform last ACTIVE	*radio error* *OUTCALL WAIT*	*radio error* *INCLUDE WAIT*	inform last ACTIVE
Receive (R) Progress Fail	*inform appl* *IDLE*	*radio error* *MESSAGE WAIT*	*radio error* *DIVERT WAIT*	inform last IDLE	*radio error* *OUTCALL WAIT*	*radio error* *INCLUDE WAIT*	radio error ACTIVE
Send (A) Disconnect	cancel all IDLE	cancel all IDLE	cancel all IDLE	cancel all IDLE	cancel all IDLE	disconnect IDLE	disconnect IDLE
Receive (R) Cleared	nothing IDLE	pass abort IDLE	pass abort IDLE	pass abort IDLE	pass abort IDLE	pass abort IDLE ACTIVE	pass disconn IDLE
Diversion (A) Request / Cancel	send div req DIVERT WAIT	appl error MESSAGE WAIT	appl error DIVERT WAIT	appl error INCALL WAIT	appl error OUTCALL WAIT	appl error INCLUDE WAIT	appl error ACTIVE
Diversion (R) ACK	radio error IDLE	radio error IDLE	inform last IDLE	radio error IDLE	radio error IDLE	radio error IDLE	radio error IDLE

Figure 5-3: DTE Network Layer Matrix, DIVERT/SPEECH/MODEM events

The DIVERT/SPEECH/MODEM actions are defined as follows:

send div req	Send diversion request or cancel message to the radio unit. Start response timer.
setup call	Send a setup voice/modem message to the radio unit. Start response timer.
include call	Send a setup voice/modem message to the radio unit. Start response timer.
inform appl	Inform the application layers about the intermediate call progress. Restart response timer.
inform last	Inform the application layers about success or failure of the call. Stop response timer.
ring detect	An incoming call is detected. Renew all previous subscriber values (if available), and inform the application.
cancel all	Send an unspecified DISCONNECT message to the radio unit. Stop response timer.
disconnect	Send a normal disconnect voice or modem call to the radio unit.
pass abort	Inform the application of an action abort. Stop the response timer.
pass disconn	Inform the application of the call disconnect status.

STATES events	IDLE	MESSAGE WAIT	DIVERT WAIT	INCALL WAIT	OUTCALL WAIT	INCLUDE WAIT	ACTIVE
Receive (A) Reset	init all IDLE	init all IDLE	init all IDLE	init all IDLE	init all IDLE	init all IDLE	init all IDLE
Radio (A) Interrogation	send interr IDLE	send interr MESSAGE WAIT	send interr DIVERT WAIT	send interr INCALL WAIT	send interr OUTCALL WAIT	send interr INCLUDE WAIT	send interr ACTIVE
Radio (A) Control On-hook signal	send on-hook IDLE	appl error *MESSAGE WAIT*	appl error *DIVERT WAIT*	release connection IDLE	release connection IDLE	release connection IDLE	release connection IDLE
Radio (A) Control Off-hook signal	send off-hook IDLE	appl error *MESSAGE WAIT*	appl error *DIVERT WAIT*	send off-hook INCALL WAIT	send off-hook OUTCALL WAIT	send off-hook INCLUDE WAIT	send off-hook ACTIVE
Radio (A) Control Transmit control	appl error IDLE	appl error *MESSAGE WAIT*	appl error *DIVERT WAIT*	appl error INCALL WAIT	appl error OUTCALL WAIT	appl error INCLUDE WAIT	send radio control ACTIVE
Radio (A) Management	send manag IDLE	*send manag* MESSAGE WAIT	*send manag* DIVERT WAIT	*send manag* *INCALL WAIT 1)*	*send manag* OUTCALL WAIT	*send manag* INCLUDE WAIT	*send manag* ACTIVE
Volume (A) Control	vol contr IDLE	vol contr MESSAGE WAIT	vol contr DIVERT WAIT	vol contr INCALL WAIT	vol contr OUTCALL WAIT	vol contr INCLUDE WAIT	vol contr ACTIVE
Dialed (A) String	send dial IDLE	*send dial* MESSAGE WAIT	*send dial* DIVERT WAIT	*send dial* INCALL WAIT	*send dial* OUTCALL WAIT	*send dial* INCLUDE WAIT	*send dial* ACTIVE
Protocol (N) Info 2)	send info IDLE	send info *MESSAGE WAIT*	send info *DIVERT WAIT*	send info *INCALL WAIT*	send info *OUTCALL WAIT*	send info *INCLUDE WAIT*	send info *ACTIVE*
Protocol (A) Info 2)	send info IDLE	send info *MESSAGE WAIT*	send info *DIVERT WAIT*	send info *INCALL WAIT*	send info *OUTCALL WAIT*	send info *INCLUDE WAIT*	send info *ACTIVE*
Response or connection(N) Time-out	*nothing* IDLE	cancel all IDLE	cancel all IDLE	cancel all IDLE	cancel all IDLE	cancel all IDLE	cancel all IDLE

Figure 5-4: DTE Network Layer Matrix, general and local events generated by the DTE

The actions are defined as follows:

cancel all	Send an unspecified DISCONNECT message to the radio unit. Stop response timer.
init all	Initialise all buffers and variables, reset Data Link layer and restart.
release conn	Send DISCONNECT message to the radio unit.
send dial	Send DIALLED STRING message to the radio unit.
send info	Send PROTOCOL INFO message to the radio unit.
send interr	Send RADIO INTERROGATION message to the radio unit.
send manag	Send RADIO MANAGEMENT message to the radio unit.
send off-hook	Send off-hook RADIO CONTROL message to the radio unit.
send on-hook	Send on-hook RADIO CONTROL message to the radio unit.
vol contr	Send VOLUME CONTROL message to the radio unit.

Note 1: A management action which invalidates present service is an application error which may result in the radio unit assuming the IDLE state.

Note 2: Sending a PROTOCOL INFO message with a 'state mismatch' reason may generate a previous message re-transmission or start a recovery or reset procedure. Sending a PROTOCOL INFO message which contains 'unrecognised message' or 'facility not supported' reasons does not affect the current state of the unit.

STATES events	IDLE	MESSAGE WAIT	DIVERT WAIT	INCALL WAIT	OUTCALL WAIT	INCLUDE WAIT	ACTIVE
Receive (D) Reset	reset all IDLE	reset all IDLE	reset all IDLE	reset all IDLE	reset all IDLE	reset all IDLE	reset all IDLE
Radio (R) Personality	info appl IDLE	*info appl* MESSAGE WAIT	*info appl* DIVERT WAIT	*info appl* INCALL WAIT	*info appl* OUTCALL WAIT	*info appl* INCLUDE WAIT	*info appl* ACTIVE
Numbering Info (R)	info appl IDLE	*info appl* MESSAGE WAIT	*info appl* DIVERT WAIT	*info appl* INCALL WAIT	*info appl* OUTCALL WAIT	*info appl* INCLUDE WAIT	*info appl* ACTIVE
Operating (R) Condition Radio contact lost	info appl IDLENO SERVICE	info appl MESSAGE WAITNO SERVICE	info appl DIVERT WAITNO SERVICE	info appl INCALL WAITNO SERVICE	info appl OUTCALL WAITNO SERVICE	info appl INCLUDE WAITNO SERVICE	info appl ACTIVENO SERVICE
Operating (R) Condition Radio contact regained	info appl IDLE	info appl MESSAGE WAITIDLE	info appl DIVERT WAITIDLE	info appl INCALL WAITIDLE	info appl OUTCALL WAITIDLE	info appl INCLUDE WAITIDLE	info appl ACTIVEIDLE
Operating (R) Condition Radio transmitting 1)	info error appl *ACTIVE*	info error appl *ACTIVE*	info error appl *ACTIVE*	info error appl *ACTIVE*	info error appl *ACTIVE*	info appl *INCLUDE WAIT*	info appl ACTIVE
Radio (R) Settings	info appl IDLE	info appl MESSAGE WAIT	info appl DIVERT WAIT	info appl INCALL WAIT 3)	info appl OUTCALL WAIT	info appl INCLUDE WAIT3)	info appl ACTIVE 3)
Protocol (R) Info Service not supported	*info appl* IDLE	info appl IDLE	info appl IDLE	info appl IDLE	info appl IDLE	info appl IDLE	*info appl* *ACTIVE*
Protocol (R) Info 2) States mismatch	*info appl* IDLE	info appl IDLE	info appl IDLE	info appl IDLE	info appl IDLE	info appl IDLE	*info appl* *ACTIVE / IDLE*

Figure 5-5: DTE Network Layer Matrix, general and local events generated by the radio unit

The actions are defined as follows:

reset all	Initialise all buffers and variables, inform application layers, and restart.
info appl	Pass the received radio unit info to the application layers.
info error appl	Pass the received transmission or no transmission info to the application layers and indicate unsuccessful response to the previous action.

Note 1: A 'radio transmitting' message is expected only when radio is in a speech or modem call.

Note 2: Receiving a PROTOCOL INFO with 'state mismatch' or 'unrecognised message' reasons may either generate previous message re-transmission(s) or start a recovery or reset procedure.

Note 3: A radio setting which invalidates present service is a protocol states mismatch (probably a radio unit error) and may need to start a recovery or reset procedure.

Appendix A1 An example of parallel FCS calculation

A1.1 Introduction

The following algorithm describes a CRC generator which calculates the FCS in an octet oriented parallel mode using the generator polynomial $G(x) = x^{16} + x^{15} + x^2 + 1$. This method may shorten the time for FCS calculation and is more useful with standard DTE (PC) than a bit oriented mode.

The octet oriented algorithm is defined by the programming language C and is intended to assist the system designer with a CRC generator implementation, but other than 8-bit oriented methods are possible.

The general method is, to calculate the FCS in an octet mode by using a look-up table. This look-up table may be produced after device initialisation or may be stored permanently.

A1.2 Look-up table production algorithm

To produce the look-up table the following two steps are required:

i Calculate the 16-bit remainder for each bit position in an octet (2^0, 2^1,..., 2^7) by division with G(x).

ii Produce the look-up table for any octet pattern (0...255) by modulo 2 sum of the 16-bit remainder of each bit position.

With asynchronous character transmission bit 1 of an octet is the first bit be transmitted. In the MAP27 standard the FCS is place into two octets as shown in figure A-1:

	b8	b1
Octet 1	2^8	2^{15}
Octet 2	2^0	2^7

Figure A1-1: FCS mapping convention

A 16-bit shift register used for division with G(x) is defined by shreg = $x^0 \ldots x^7\ x^8 \ldots x^{15}$. This shift register will be shifted to the right.

The generator polynomial G(x) (excluding the highest bit x^{16}) is mapped on a 16-bit constant CRC16 in the following manner:

CRC16 = $x^0 \ldots x^{15}$ = 1010 0000 0000 0001 = A001h.

The two octet division remainder is stored in the look-up table according to the FCS mapping convention. The octets are swapped and stored as octet 1 = $x^8 \ldots x^{15}$ and octet 2 = $x^0 \ldots x^7$.

The table entries corresponding to b8...b1=00h...FFh are represented in table A1-1.

$b_8...b_5$ \ $b_4...b_1$	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	0000	C1C0	81C1	4001	01C3	C003	8002	41C2	01C6	C006	8007	41C7	0005	C1C5	81C4	4004
1	01CC	C00C	800D	41CD	000F	C1CF	81CE	400E	000A	C1CA	81CB	400B	01C9	C009	8008	41C8
2	01D8	C018	8019	41D9	001B	C1DB	81DA	401A	001E	C1DE	81DF	401F	01DD	C01D	801C	41DC
3	0014	C1D4	81D5	4015	01D7	C017	8016	41D6	01D2	C012	8013	41D3	0011	C1D1	81D0	4010
4	01F0	C030	8031	41F1	0033	C1F3	81F2	4032	0036	C1F6	81F7	4037	01F5	C035	8034	41F4
5	003C	C1FC	81FD	403D	01FF	C03F	803E	41FE	01FA	C03A	803B	41FB	0039	C1F9	81F8	4038
6	0028	C1E8	81E9	4029	01EB	C02B	802A	41EA	01EE	C02E	802F	41EF	002D	C1ED	81EC	402C
7	01E4	C024	8025	41E5	0027	C1E7	81E6	4026	0022	C1E2	81E3	4023	01E1	C021	8020	41E0
8	01A0	C060	8061	41A1	0063	C1A3	81A2	4062	0066	C1A6	81A7	4067	01A5	C065	8064	41A4
9	006C	C1AC	81AD	406D	01AF	C06F	806E	41AE	01AA	C06A	806B	41AB	0069	C1A9	81A8	4068
A	0078	C1B8	81B9	4079	01BB	C07B	807A	41BA	01BE	C07E	807F	41BF	007D	C1BD	81BC	407C
B	01B4	C074	8075	41B5	0077	C1B7	81B6	4076	0072	C1B2	81B3	4073	01B1	C071	8070	41B0
C	0050	C190	8191	4051	0193	C053	8052	4192	0196	C056	8057	4197	0055	C195	8194	4054
D	019C	C05C	805D	419D	005F	C19F	819E	405E	005A	C19A	819B	405B	0199	C059	8058	4198
E	0188	C048	8049	4189	004B	C18B	818A	404A	004E	C18E	818F	404F	018D	C04D	804C	418C
F	0044	C184	8185	4045	0187	C047	8046	4186	0182	C042	8043	4183	0041	C181	8180	4040

Table A1-1: Look-up table mtab

An algorithm to produce look-up table is shown in the function create_table represented in figure A1-2.

The first loop (i=0 to 8) calculates the 16-bit remainder for each bit position (step j). The result of 80h (2^0 in the FCS mapping convention) is stored in the field btab[0]; the result on 01h (2^7 in the FCS mapping convention is stored in btab[7].

The second loop (i=0 to 256) calculates the final look-up table entries as modulo 2 sum of the corresponding btab entries (step ii). E.g. the table entry for the octet pattern 41h is calculated:

btab[1] btab[7] = C1C0h 01F0h = C030h .

```
 CRC16 0xA001;                                  /* CRC 16 constant */
unsigned int  mtab[256];                        /* modification table */
/*************************************************************
   Function: create_table                  produce the look-up table
   Input:    *mtab                       pointer to modification table
   Output:
   Note:     CRC16 is used
*************************************************************/
void create_table(unsigned int *mtab)
{
   unsigned int btab[8];                              /* table btab */
   unsigned int i,j;                               /* loop parameters */
   unsigned int q;                               /* calculation register */
   unsigned int shreg;                                /* shift-register */
   unsigned int carry,bit;                         /* bit parameters */
/*************************************************************
   Calculate the table btab:
*************************************************************/
   carry=1;                                     /* carry flag set to one */
   shreg=0;                                  /* shreg initialised with 0 */
   for(i=0; i<8; i++)
   {
       if(carry) shreg^=CRC16;
       btab[i]=(shreg<<8) | (shreg>>8);              /* swap bytes */
       carry=shreg & 1;
       shreg >>=1;
   }
/*************************************************************
   Calculate the modification table mtab:
*************************************************************/
   for (i=0; i<256; i++)
   {
       q=0;
       bit=0x80;
       for (j=0; j<8; j++)
       {
           if (bit & i) q^=btab[j];
           bit>>=1;
       }
       *mtab++=q;
   }
}
```

Figure A1-2: Function create_table

A1.3 FCS calculation algorithm

To calculate the FCS with a look-up table the following steps are required:

a) Initialise the FCS register (normally preset to all ones).

b) Produce an 8-bit table pointer by modulo 2 sum of the next data octet and the FCS high-order octet.(x^8 . . . x^{15}).

c) Fetch the modification value by the pointer.

d) Add (modulo 2) the modification value high-order octet and the FCS low-order octet (x^0. . . x^7). Repeat step b to d until the last data byte is checked.

e) Produce the FCS ones complement for transmission.

An algorithm for FCS calculation is shown in the function fcs_calc represented in figure A1-3.

```
/************************************************************
   Function:  fcs_calc          calculates the FCS sequence
   Input:     *mtab               pointer to modification table
              *buff                pointer to character buffer
              len                   length of character string
   Output:    fcs                     frame check sequence
   Note:      fcs is initialised with all ones
************************************************************/
unsigned int fcs_calc(unsigned int *mtab,
                              unsigned char *buff,unsigned int len)
{
   unsigned int fcs;                  /* frame check sequence */
   unsigned int q;                        /* calculation register */

   fcs=0xffff;  /* fcs initialised with all ones */
   while(len--)
   {
       q=*(mtab+(*buff++ ^ (fcs>>8)));
       fcs=((q&0xff00) ^ (fcs<<8)) | (q&0x00ff);
   }
   return (fcs^0xffff); /* return the fcs ones complement */
}
```

Figure A1-3: Function fcs_calc

A1.4 FCS Calculation example

The main steps of a FCS generation is shown in figure A1-4. The following example may help to understand this calculation method.

Example:

There is one data octet to be protected. The value of the data octet is 3Bh. The FCS register is initialised to FFFFh.

The modification pointer value according to the step b) in A1.3 is 3Bh FFh = C4h.

The modification value fetched by pointer C4h from the table A1-1 is 0193h which comprises mtab H and mtab L.

The modulo 2 sum of mtab H = 01h and the old FCS L = FFh gives a new FCS value FE93h in step d).

The ones complement of FCS is calculated by modulo 2 sum of the FCS value with FFFFh which gives a result of 016Ch.

The three octets to be transmitted, data + FCS, are 3Bh 01h 6Ch.

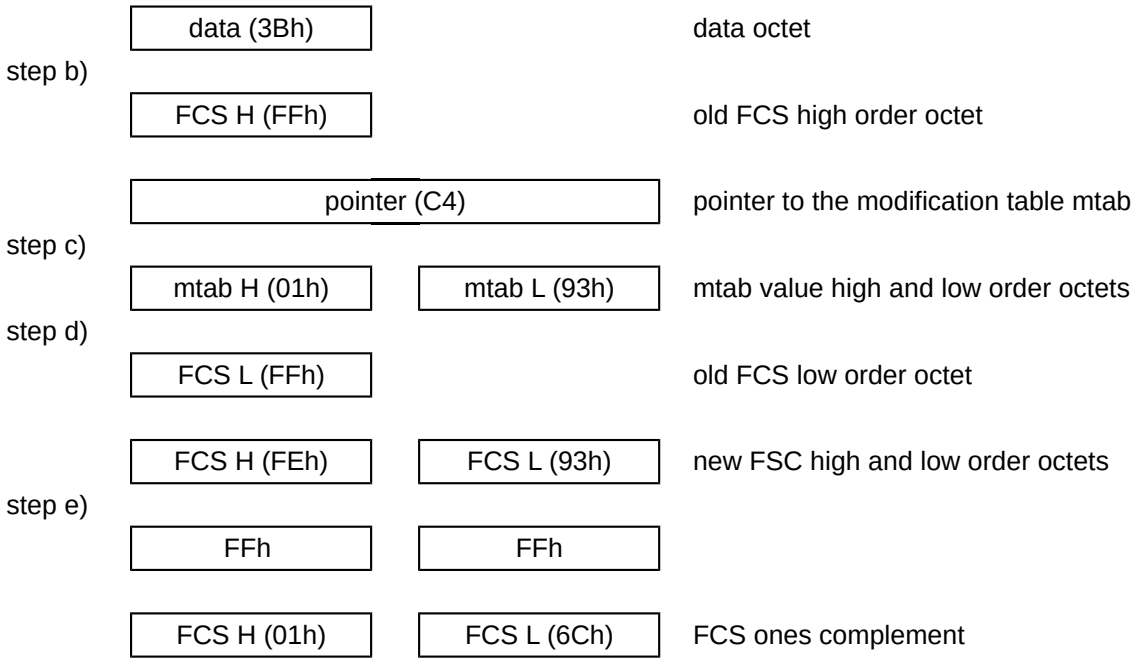


Figure A1-4: FCS generation

Appendix A2 SDL representation of MAP27 data link layer

A2.1. General

This Specification and Description Language (SDL) presentation [7] of the data link layer protocol is designed to help implementations. In it certain assumptions have been made and certain values have been assigned to variables. This does not mean that other values may not be used. Protocol states are for example only and a designer may choose to have a different number of states. If there is any discrepancy between the textual presentation and the SDL presentation, the text in the normative section 4 should have a higher priority. There is after this textual version a graphical presentation of this SDL. That SDL defines an optional procedure for an implementation of extended link establishment timeout.

A2.2. SDL definitions

/* This is the data_link process described in 'linear SDL' by subdivision into the following states:

reset_wait: This is the default state at power-up and this state is used for connection reset. The act of powering-on causes the data_link process to immediately activate the 'transition' initiated by the input 'power_on'. The data_link process remains in this state until it is satisfied that its opposite number has also started link establishment. On completion of the transition it changes state to 'link_wait'.

link_wait: The data_link process remains in this state until it is satisfied that it can communicate with its opposite number at the remote end of the RS-232 cable. Whenever it enters this state, the Link-establishment timer (T0) must be started. Whenever it leaves this state, the 'Network Layer' must be informed.

ready: The data_link process resides in this state as long as it believes it is in communication with its opposite number. If it loses communication, it must inform the Network Layer, attempt to re-establish the link, and return to the reset_wait and link_wait processes. Whenever it enters this state, the 'credit_report_timer' (T3) must be started. When in this state, data packets may be exchanged on the RS-232 link. When the data_link process exits this state, no timers except the link-establishment timer may be left running.

A2.2.1. Timers

The following timers exist and those timers may have a higher priority than the other messages:

T0 link_establishment_timer
T1 retry_timer
T2 acknowledgement_timer
T3 activity_timer
T4 link_failure_detection_timer

A2.2.2. Inputs from operating system

At power-up, the following message is input to this process:

power_on

A2.2.3. Inputs from timers

Expired timers input the following messages:

link_establishment_timeout(T0)
retry_timeout(T1)
acknowledgement_timeout(T2)
activity_timeout(T3)
link_failure_detection_timeout(T4)

A2.2.4. Inputs from RS-232 line

The following input messages may be received from the RS-232 port:

link_request(maximum_length, window_size, version)
link_acknowledge(rx_sequence_number, rx_credit_number)
link_transfer(tx_sequence_number, acknowledgement_request, network_layer_message)

A2.2.5. Inputs from network layer

The following input messages may be received from the network layer:

network_layer_reset

network_layer_packet(network_layer_message)

- note that in this case, the message passing mechanism must wrap the network-layer message in an envelope labelled 'network_layer_packet'.

credit_value(receive_credit)

- the network layer should send this message to the data-link layer whenever it removes a packet from its data_link layer input buffer.

A2.2.6. Outputs to RS-232 line

The following outputs may be sent along the RS-232 link:

link_request(maximum_length, window_size, version)

- This message is sent to the RS-232 port with its parameters set to the current values of maximum_length, window_size and version.

link_acknowledge(rx_sequence_number, rx_credit_number)

- When this output is initiated, the data-link layer first stores the value of 'receive_credit' in variable send_credit'. The link_acknowledge message is then sent to the RS-232 port with parameter 'rx_sequence_number' given the value of 'receive_state' and parameter 'rx_credit_number' given the value of 'receive_credit'.

link_transfer(tx_sequence_number,acknowledgement_request, network_layer_message)

- When this message is sent to the RS-232 port, its parameters are set to 'send_state' and 'LT_acknowledge_request' respectively, and its data area is filled with a network layer message from the queue of messages waiting to be transmitted. The correct message is identified by selecting the one whose stored_packet_number is equal to the value of the variable 'send_state'.

A2.2.7. Outputs to Network_layer

The following outputs may be sent to the network layer:

link_ready
link_failure
packet_accepted
packet_rejected
network_layer_packet(network_layer_message)

- note that in this case, the message passing mechanism must present the packet to the network layer as a variable message whose type depends upon the first octet of the packet's contents).

A2.2.8. Constants

The following constants are defined:

N2	Maximum number of re-transmissions
N3	Maximum number of inactivity timeouts
T0	Link establishment time
T1	Retry time
T2	Acknowledgement time
T3	Activity time
T4	link_failure_detection_time
tx_messages_buffer	A buffer >= maximum possible value (k * 16 * (N1+1)).
tx_message_pointer	A pointer to next message to be transmitted
unit_maximum_length	The maximum message length this unit can accommodate.
unit_maximum_window_size	The maximum window size this unit can accommodate.
unit_version	The highest MAP27 version number this unit knows.
CV	Current Version

A2.2.9. Variables

The following variables are defined for interfacing between the TASKs and IFs:

AR	LT_acknowledge_request
N1	maximum_length (number of octets is 16 * (N1+1))
C1	retransmission_count
k	window_size
N(k)	rx_credit_number
N(R)	rx_sequence_number
R(k)	receive_credit
S(k)	send_credit
SN(R)	stored_acknowledged_rx_sequence_number
SR(k)	stored_receive_credit
V(S)	send_state_variable
V(R)	receive_state_variable

A2.2.10. TASKs

The following TASKS are defined

adjust_link_parameters

- Sets values of variables maximum_length, window_size and current_version to the minima of unit_maximum_length, unit_maximum_window_size, and unit_version, and the values of the corresponding parameters received in the most recently received 'link_request' message.

decrement retransmission_counter(C1)

- Decrements the variable 'retransmission_count' (C1).

decrement_send_credit

- Decrements the variable 'send_credit' (S(k)).

delete_acknowledged_packets

- Removes acknowledged messages from the queue of network layer messages awaiting transmission by deleting all messages with 'stored_packet_number' less than the value of 'rx_sequence_number' (N(R)) in the last received link_acknowledgement message.

increment_send_state_variable

- Increments the variable 'send_state_variable' (V(S)).

initialise_variables

- Sets the following:

  send_state = 1
  receive_state = 1
  receive_credit = k~~1~~
  send_credit = 0
  stored_acknowledged_rx_sequence_number = 1
  clears data link layer message buffers
  clears RS-232 port buffers
  retransmission_count = N2

initialise_rs232_port

- This task sets the RS-232 port ready to operate at the pre-selected speed (9600 bps), with 8 bits, no parity, 1 start bit and 1 stop bit.

maximise_link_parameters

- Set values of variables 'maximum_length' (N1), 'window_size' (k) and 'current_version' (VERSION) to the maximum permissible for this unit, i.e., unit_maximum_length, unit_maximum_window_size, and unit_VERSION.

~~packet_outside_window~~

~~- Returns ´true´ if the tx_sequence_number of the last received ´link transfer´message is outside the range of values given by the expression [(rx_sequence_number-previous_credit_number) to (rx_sequence_number-1 + rx_credit_number)], these variables being the values of parameters in the last transmitted ´link_acknowledge´messages.~~

record_send_credit

- Store r~~x_credit_number of last received link_acknowledgment message as variable~~ the 'send_credit', S(k) as:~~.~~

  =N(k) - (V(s)-N(r))

  = rx_credit_number - (send_state_variable - rx_sequence_number).

rewind_packet_number

- Set 'send_state', V(S), to the value of the rx_sequence_number parameter (N(R)) of the last received link_acknowledgement message, and set tx_message_pointer to the corresponding message in the tx_messages_buffer, so that it will be the next message to be transmitted.

set_retransmission_counter

- Sets the variable 'retransmission_count' (C1) to its maximum value, N2.

store_acknowledged_rx_sequence_number

- Store latest received rx_sequence_number as stored_acknowledged_rx_sequence_number.

store_packet

- Stores most recently received packet from network layer, and marks it with a 'stored_packet_number' equal to the current value of the variable 'transmit_buffer_top' and increments the variable 'transmit_buffer_top'.

Store_receive_credit

- Stores the current 'receive_credit' (R(k)).as 'stored_receive_credit' SR(k).

update_receive_credit

- Calculates from the last received 'credit_value' message from network layer the new 'receive_credit' (R(k)).

A2.2.11. IFs:

The following tests are defined:

acknowledgement_outside_window

- Returns 'true' if the rx_sequence_number (N(R)) of the last received 'link_acknowledgement' message is outside the range of stored_acknowledged_rx_sequence_number SN(R) to send_state_variable V(S).

all_transmitted_packets_acknowledged

- Returns 'true' if the 'rx_sequence_number' (N(R)) parameter of the last received 'link_acknowledgement' message is one greater than the 'tx_sequence_number' parameter of the last transmitted 'link_transfer' message (equal to current V(S)).

immediate_reply_requested

- Returns 'true' if the 'acknowledgement_request' (AR) field of the most recently received link_transfer message is set to '1'.

packet_out_of_sequence

- Returns 'true' if the sequence_number (N(S)) of the last received link transfer message is not equal to the 'receive_state_variable' (V(R)).

packet_outside_window

- Returns ´true´ if the tx_sequence_number of the last received ´link transfer´message is outside the range of values given by the expression [(rx_sequence_number - stored receive_credit) to (rx_sequence_number-1 + rx_credit_number)], these variables being the values of parameters in the last transmitted ´link_acknowledge´messages.

receive_credit_available

- Returns 'true' if there is enough buffer space available in the network layer to pass the network_layer_message content of the last received 'link_transfer' message to the network layer.

received_parameters_acceptable

- Returns 'true' if the parameters in the last received 'link_request' message (maximum_length, window_size, version) are less than or equal to the maximum permissible values for this unit.

repeated_link_acknowledge

- Returns 'true' if the rx_sequence_number of the last received 'link_acknowledge' message is equal to the rx_sequence_number of the last but one received 'link_acknowledge' message, and is not equal to 'send_state'.

retransmission_count_zero

- Returns 'true' if the variable 'retransmission_count' (C1) is zero.

send_credit_available

- Returns 'true' if send_credit is greater than zero.

NOTE: Unless otherwise commented, INPUTs and OUTPUTs travel along the RS-232 link to the co-operating data_link process.*/

A2.3. SDL presentation

```
PROCESS data_link

   STATE reset_wait

      INPUT network_layer_reset                    /* -- from the network layer -- */ /* or */
      INPUT power_on                                        /* -- from operating system -- */
         TASK initialise_rs232_port
         TASK maximise_link_parameters
         TIMESTOP retry_timer(T1)
         TIMESTOP acknowledgement_timer(T2)
         TIMESTOP activity_timer(T3)
         TIMESTOP link_failure_detection_timer(T4)
         OUTPUT link_request
         TIMESTART link_establishment_timer(T0)
         EXIT reset_wait

      INPUT link_request
         TASK adjust_link_parameters
         OUTPUT link_request
         TIMESTART link_establishment_timer(T0)
         EXIT link_wait

      INPUT link_acknowledge
      INPUT link_transfer
      INPUT link_establishment_timeout(T0)
         OUTPUT link_request
         TIMESTART link_establishment_timer(T0)
         EXIT reset_wait

      INPUT network_layer_packet                   /* -- from network layer -- */
         OUTPUT packet_rejected                          /* to network_layer -- */
         EXIT reset_wait

   STATEND reset_wait

   /*********************/
```

```
STATE link_wait                    /* The link establishment timer must be running in this state */
    INPUT link_request
        TASK adjust_link_parameters
        IF received_parameters_acceptable THEN
            TASK initialise_variables
            TIMESTOP link_establishment_timer(T0)
            OUTPUT link_acknowledge
            OUTPUT link_ready                                   /* -- to network layer -- */
            TIMESTART activity_timer(T3)
            TIMESTART link_failure_detection_timer(T4)
            EXIT ready
        ELSE
            OUTPUT link_request
            TIMESTART link_establishment_timer(T0)
            EXIT link_wait
        FI

    INPUT link_acknowledge
        TASK initialise_variables
        TASK record_send_credit
        TIMESTOP link_establishment_timer(T0)
        OUTPUT link_acknowledge
        OUTPUT link_ready                                       /* -- to network layer -- */
        TIMESTART activity_timer(T3)
        TIMESTART link_failure_detection_timer(T4)
        EXIT ready

    INPUT link_establishment_timeout(T0)
    INPUT link_transfer
        OUTPUT link_request
        TIMESTART link_establishment_timer(T0)
        EXIT reset_wait

    INPUT network_layer_reset                                   /* -- from network layer -- */
        TASK initialise_rs232_port
        TASK maximise_link_parameters
        TIMESTOP retry_timer(T1)
        TIMESTOP acknowledgement_timer(T2)
        TIMESTOP activity_timer(T3)
        TIMESTOP link_failure_detection_timer(T4)
        OUTPUT link_request
        TIMESTART link_establishment_timer(T0)
        EXIT reset_wait

    INPUT network_layer_packet                                  /* -- from network layer -- */
        OUTPUT packet_rejected                  /* Optional message to network_layer -- */
        EXIT link_wait
```

```
    INPUT power_on          /* formally copied from ready state, must be discussed */
        TASK initialise_rs232_port
        TASK maximise_link_parameters
        OUTPUT link_failure                                          /* -- to network layer -- */
        TIMESTOP retry_timer(T1)
        TIMESTOP acknowledgement_timer(T2)
        TIMESTOP activity_timer(T3)
        TIMESTOP link_failure_detection_timer(T4)
        OUTPUT link_request
        TIMESTART link_establishment_timer(T0)
        EXIT reset_wait

STATEND link_wait

/*********************/


STATE ready

    INPUT network_layer_packet                                       /* -- from network layer -- */
        IF send_credit_available THEN
            OUTPUT packet_accepted                                   /* -- to network layer -- */
            TASK store_packet                                   /* in case we have to repeat it */
            TASK set_retransmission_counter(C1)
            OUTPUT link_transfer
            TASK increment_send_state_variable
            TASK decrement_send_credit_value
            TIMESTART retry_timer(T1)
                                /* don't reset activity_timer - other party may need a credit_report
                                       while we are sending a stream of link_transfer messages */
        ELSE
            OUTPUT packet_rejected
                                /* -- to network_layer, because no credit available to transmit it -- */
        FI
        EXIT ready

    INPUT retry_timeout(T1)
        TASK decrement_retransmission_counter(C1)
        IF   retransmission_count_zero THEN
            TASK maximise_link_parameters
            OUTPUT link_failure                                      /* -- to network layer -- */
            TIMESTOP retry_timer(T1)
            TIMESTOP acknowledgement_timer(T2)
            TIMESTOP activity_timer(T3)
            TIMESTOP link_failure_detection_timer(T4)
            OUTPUT link_request
            TIMESTART link_establishment_timer(T0)
            EXIT reset_wait
        ELSE
            TASK rewind_packet_number
            OUTPUT link_transfer
            TIMESTART retry_timer(T1)
            EXIT ready
        FI
```

```
INPUT link_acknowledge
    IF acknowledgement_inside_window THEN                    /* The link is still working!*/
        TIMESTART link_failure_detection_timer(T4)
        TIMESTART activity_timer(T3)
        TASK delete_acknowledged_packets
        TASK record_send_credit
        IF all_transmitted_packets_acknowledged THEN
            TIMESTOP retry_timer(T1)
            TASK set_retransmission_counter(C1)
            TASK store_acknowledged_rx_sequence_number
            EXIT ready
        ELSE
            IF repeated_link_acknowledge THEN
                                          /* this is a request to send some packets again */
                TASK decrement_retransmission_counter(C1)
                IF retransmission_count_zero   THEN
                    TASK maximise_link_parameters
                    OUTPUT link_failure                      /* -- to network layer -- */
                    TIMESTOP retry_timer(T1)
                    TIMESTOP acknowledgement_timer(T2)
                    TIMESTOP activity_timer(T3)
                    TIMESTOP link_failure_detection_timer(T4)
                    OUTPUT link_request
                    TIMESTART link_establishment_timer(T0)
                    EXIT reset_wait
                ELSE
                    TASK rewind_packet_number
                    OUTPUT link_transfer          /* starting at requested packet number*/
                    TIMESTART retry_timer(T1)
                    EXIT ready
                FI
            FI
        FI
    ELSE                                          /* acknowledgement is outside window */
        TASK maximise_link_parameters
        OUTPUT link_failure                                  /* -- to network layer -- */
        TIMESTOP retry_timer(T1)
        TIMESTOP acknowledgement_timer(T2)
        TIMESTOP activity_timer(T3)
        TIMESTOP link_failure_detection_timer(T4)
        OUTPUT link_request
        TIMESTART link_establishment_timer(T0)
        EXIT reset_wait
    FI
```

```
        INPUT link_request
            TASK adjust_link_parameters
            OUTPUT link_failure                                    /* -- to network layer -- */
            TIMESTOP retry_timer(T1)
            TIMESTOP acknowledgement_timer(T2)
            TIMESTOP activity_timer(T3)
            TIMESTOP link_failure_detection_timer(T4)
            OUTPUT link_request
            TIMESTART link_establishment_timer(T0)
            EXIT resetlink_wait

        INPUT power_on
            TASK initialise_rs232_port
            TASK maximise_link_parameters
            OUTPUT link_failure                                    /* -- to network layer -- */
            TIMESTOP retry_timer(T1)
            TIMESTOP acknowledgement_timer(T2)
            TIMESTOP activity_timer(T3)
            TIMESTOP link_failure_detection_timer(T4)
            OUTPUT link_request
            TIMESTART link_establishment_timer(T0)
            EXIT reset_wait

        INPUT network_layer_reset                                  /* -- from the network layer -- */
            TASK initialise_rs232_port
            TASK maximise_link_parameters
            TIMESTOP retry_timer(T1)
            TIMESTOP acknowledgement_timer(T2)
            TIMESTOP activity_timer(T3)
            TIMESTOP link_failure_detection_timer(T4)
            OUTPUT link_request
            TIMESTART link_establishment_timer(T0)
            EXIT reset_wait      /* Don't send 'link_failure' to network layer, as network layer initiated this
transition*/
```

```
INPUT link_transfer
   TIMESTART  link_failure_detection_timer(T4)
                                                              /* the link is working */
   IF packet_outside_window THEN                  /* Optional check; this is a data link error */
      TASK maximise_link_parameters
      OUTPUT link_failure                                     /* -- to network layer -- */
      TIMESTOP acknowledgement_timer          /* Optional, not used in 'link-wait' state */
      TIMESTOP retry_timer(T1)
      TIMESTOP acknowledgement_timer(T2)
      TIMESTOP activity_timer(T3)
      TIMESTOP link_failure_detection_timer(T4)
      OUTPUT link_request
      TIMESTART link_establishment_timer(T0)
      EXIT reset_wait                                         /* end of optional check */
   ELSE
      IF packet_out_of_sequence THEN                  /* Packet is inside window */
         TIMESTOP acknowledgement_timer(T2)
         OUTPUT link_acknowledge                  /* with expected paccket number */
         TIMESTART activity_timer(T3)
      ELSE
         IF receive_credit_available THEN
            OUTPUT network_layer_packet                       /* -- to network layer */
            TASK increment_receive_state
            TASK decrement_receive_credit    /* if network_layer is slow to update credit */
            IF immediate_reply_requested THEN
               TASK store_receive_credit
               TIMESTOP acknowledgement_timer(T2)
               OUTPUT link_acknowledge
               TIMESTART activity_timer(T3)
            ELSE
               TASK store_receive_credit
               TIMESTART acknowledgement_timer(T2)
            FI
         ELSE                                          /* no space to store the packet */
            TASK store_receive_credit
            TIMESTOP acknowledgement_timer(T2)
            OUTPUT link_acknowledge
            TIMESTART activity_timer(T3)
         FI
      FI
      EXIT ready
   FI

INPUT acknowledgement_timeout(T2)
   OUTPUT link_acknowledge
   TIMESTART activity_timer(T3)
   EXIT ready
```

```
        INPUT activity_timeout(T3)
                TIMESTOP acknowledgement_timer(T2)
                OUTPUT link_acknowledge
                TIMESTART activity_timer(T3)
                Exit ready

        INPUT link_failure_detection_timeout(T4)
                TASK maximise_link_parameters
                OUTPUT link_failure                              /* -- to network layer -- */
                TIMESTOP retry_timer(T1)
                TIMESTOP acknowledgement_timer(T2)
                TIMESTOP activity_timer(T3)
                TIMESTOP link_failure_detection_timer(T4)
                OUTPUT link_request
                TIMESTART link_establishment_timer(T0)
                EXIT reset_wait

        INPUT credit_value                                       /* -- from network layer -- */
            TASK update_receive_credit
            IF receive_credit_available THEN
                TIMESTOP acknowledgement_timer
                OUTPUT link_acknowledge
                TIMESTART activity_timer(T3)
            FI
            EXIT ready

    STATEND ready


    /*********************/


PROCEND data_link
```

Appendix A3. NETWORK LAYER SEQUENCE CHARTS

A3.1. Introduction

The network layer protocol is defined in section 5 which describes the use of the messages. The network layer messages are described in detail in the corresponding section. The time sequence diagrams of this appendix are intended to improve understanding of the protocol.

The sequence diagrams presented here cover the most common situations but with some simplification of radio path protocol. The radio path protocol may vary from network to network and no specific presentation is covered here.

This version contains Status, SST/MST transactions and voice and modem (non-prescribed data) calls. The standard data section may be covered in later versions.

A3.2. Examples of status messaging

In Figure 1 two examples are given of status message transactions between two radio units. In the first case radio units are using the same base station site (TSC) where the sending mobile receives the AHYQ message. The second example is similar but shows an interprefix status transaction and the sending mobile does not receive the AHYQ.

Figure 2 gives two examples of status messages sent from a line-connected device via the TSC. The signalling between the TSC and the data transfer equipment in the line connected base station is not defined in this figure and only descriptive names are used for the messages. In the second case DTE which is connected to the radio unit is not able to receive status messages and this state is signalled by a local message before the actual status transaction. To simplify the diagram the radio unit is shown as unable to store status messages for a later DTE interrogation.

Figure 3 shows more examples of unsuccessful transactions. The first case shows an overloaded TSC and the second case shows that the radio unit is out of radio contact.

A3.3. Examples of short and extended data messages

Short and extended data messages are known in MPT 1327 as the single segment (SST) and multiple segment (MST) transmissions. Figure 4 shows the basic MST or SST transaction. No radio path repetitions are shown in this figure unlike the example presented in MPT 1343 figure 14.1.

A3.4. Examples of voice and modem connections

In this context 'modem connections' means MPT 1327 non-prescribed data connections. Both voice and modem connections use the same messages for call establishment and disconnection and in the sequence diagrams only voice calls are shown. During a modem call the DTE may use 'Send Modem' and 'Receive Modem' messages if the equipment which is connected to the DTE supports that facility. Transmitter control is not shown in these sequence diagrams.

Figure 5 shows a typical, successful call in a system which supports off-air call set-up method. The DTE may still send Off-hook signal although this signal is not utilised by the radio unit.

Figure 6 shows a full off air call set-up signalling system. In this case an Off-hook signal is needed by the radio unit. In this example the called DTE initiates the call clear function. Any call may be cleared by either the calling or the called party or even by the TSC.

Figure 7 shows a call from a radio unit to a line connected device. This annex does not attempt to define any protocol between the TSC and a line connected DTE and only indicative signal names are used.

Figure 8 shows a call from a line connected DTE to a radio unit.

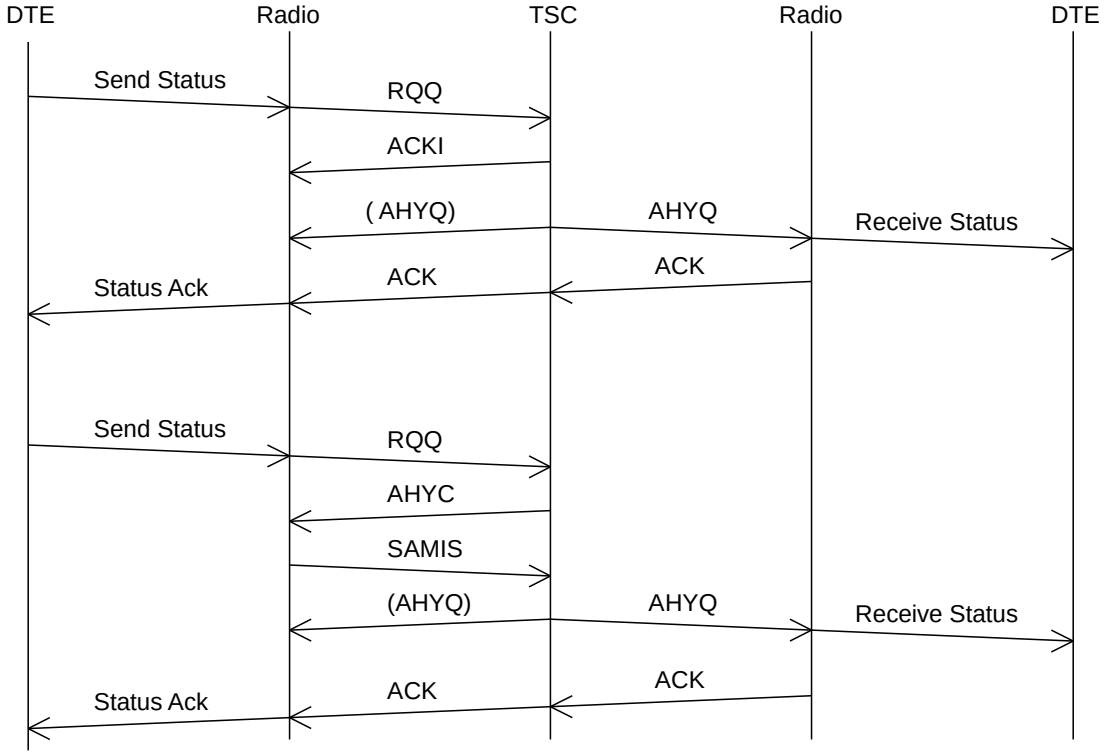


Fig. 1 Two examples of Status transactions between mobile stations

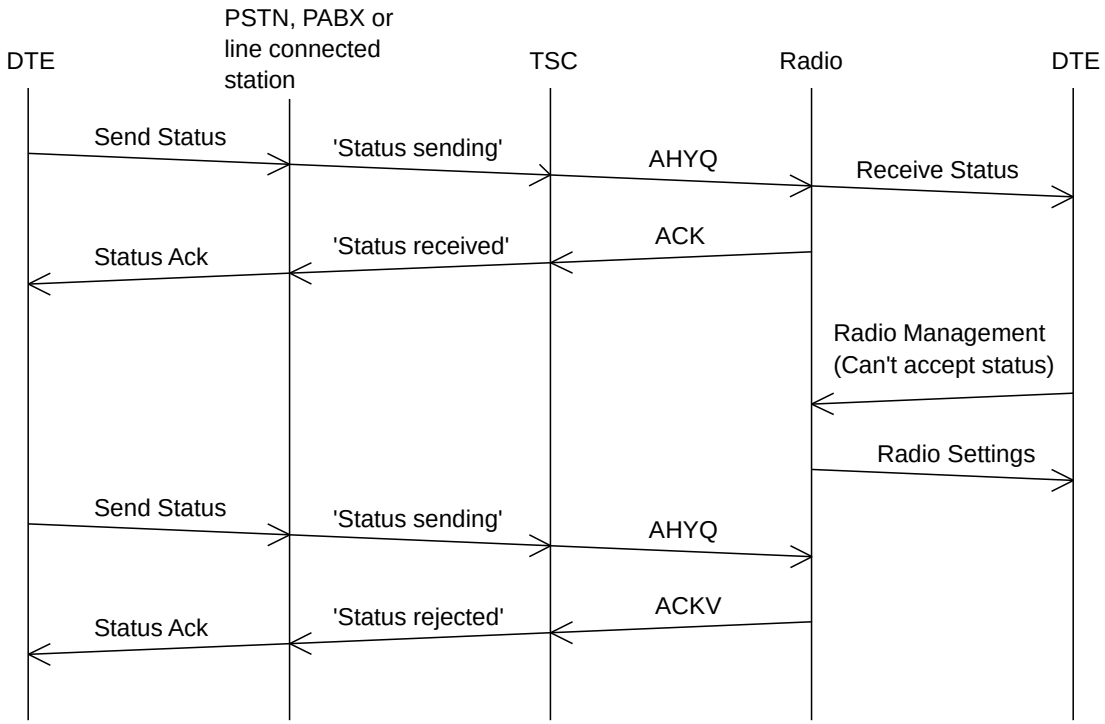


Fig. 2 Examples of a successful and an unsuccessful Status transactions from PSTN, PABX or line connected station to mobile station

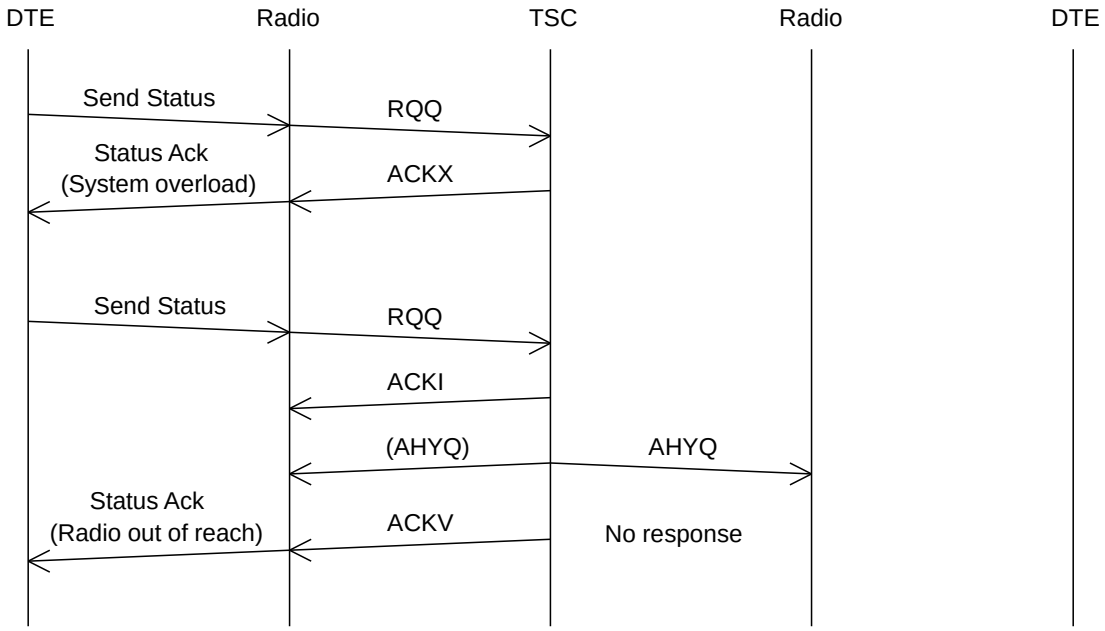


Fig. 3 Two examples of unsuccessfull status transactions between mobile stations

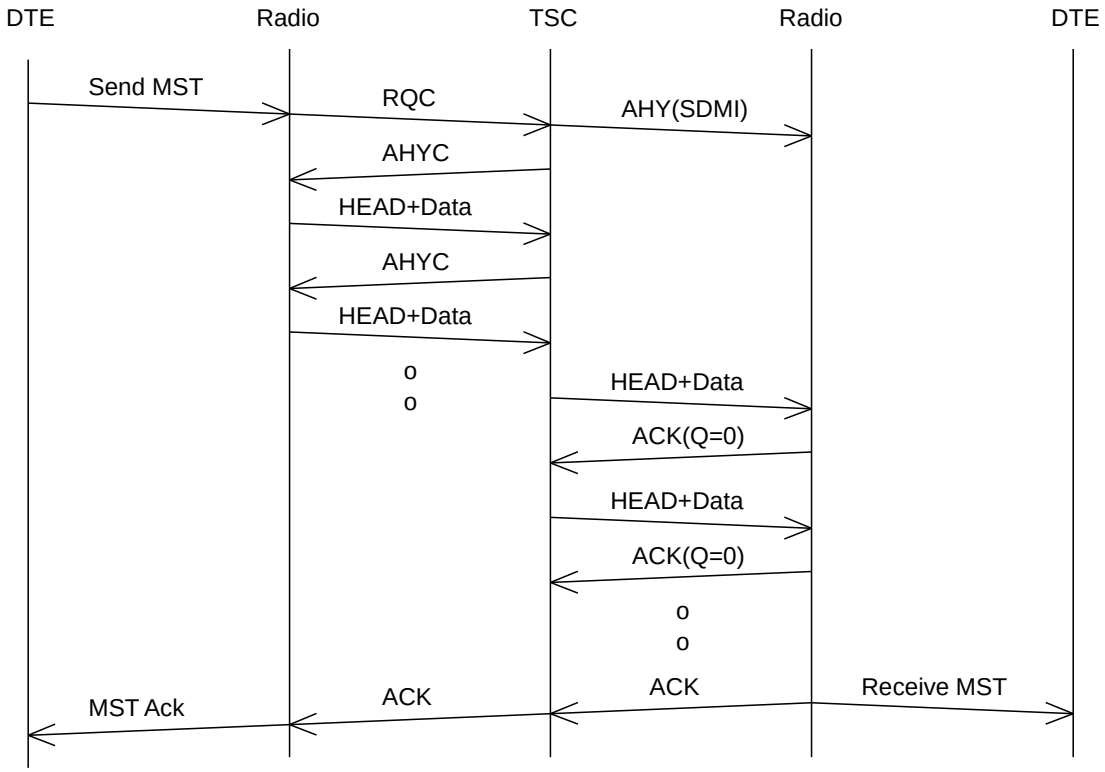


Fig. 4 An example of a MST or SST transactions between mobile stations

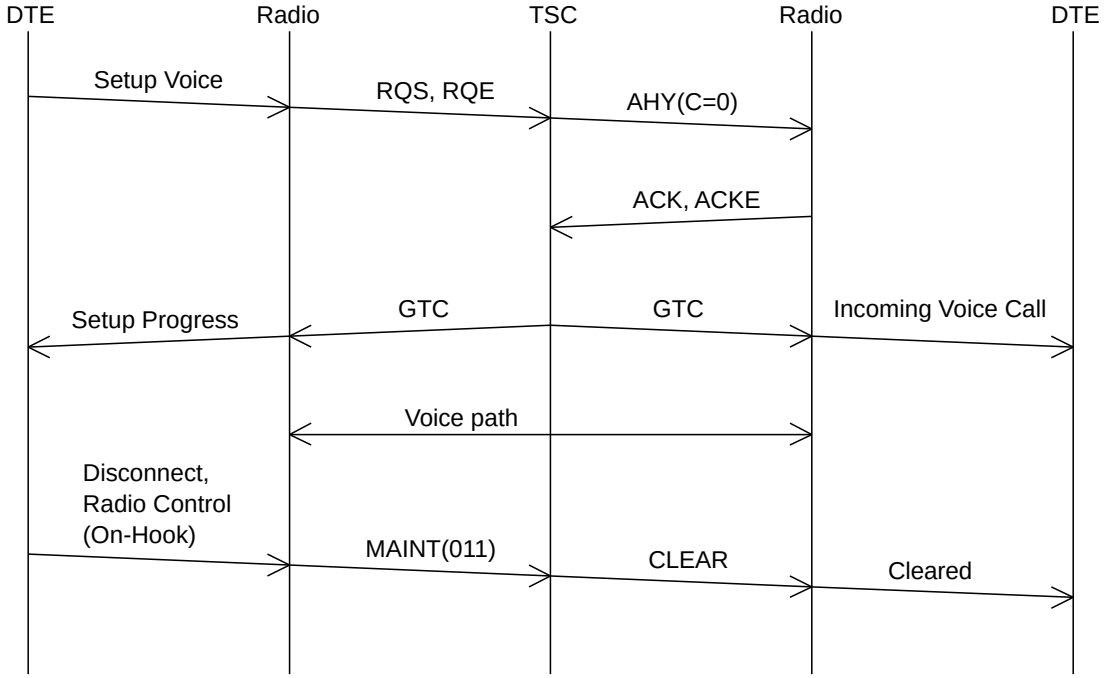


Fig. 5 An example of an off-air Modem or Voice call, disconnected by the calling party

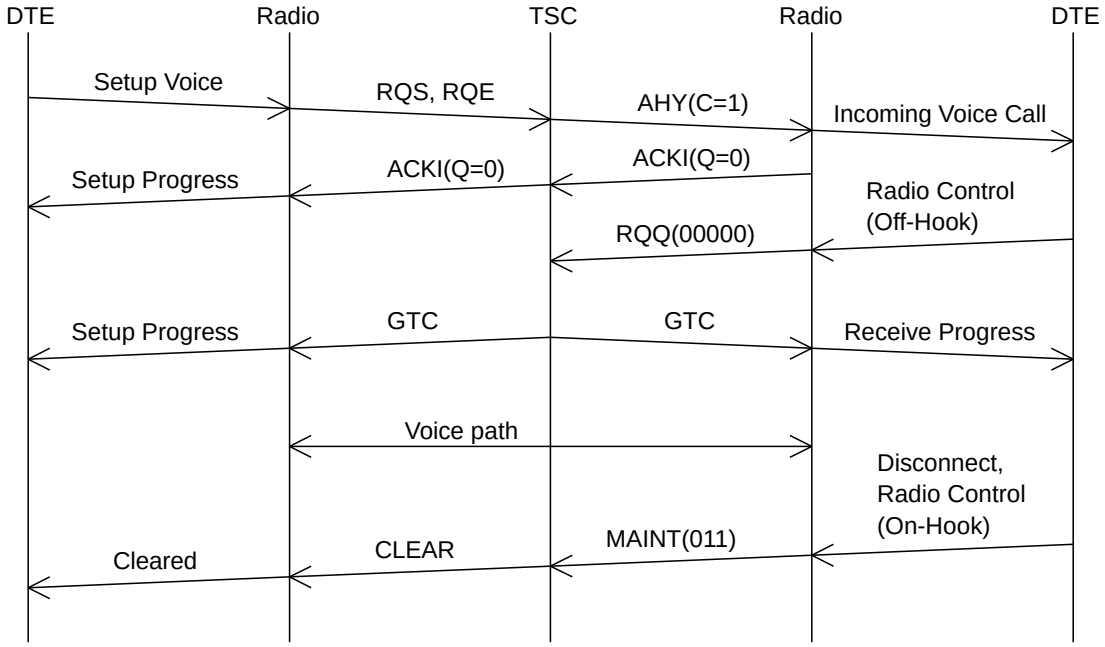


Fig. 6 An example of a full off-air Modem or Voice call, disconnected by the called party

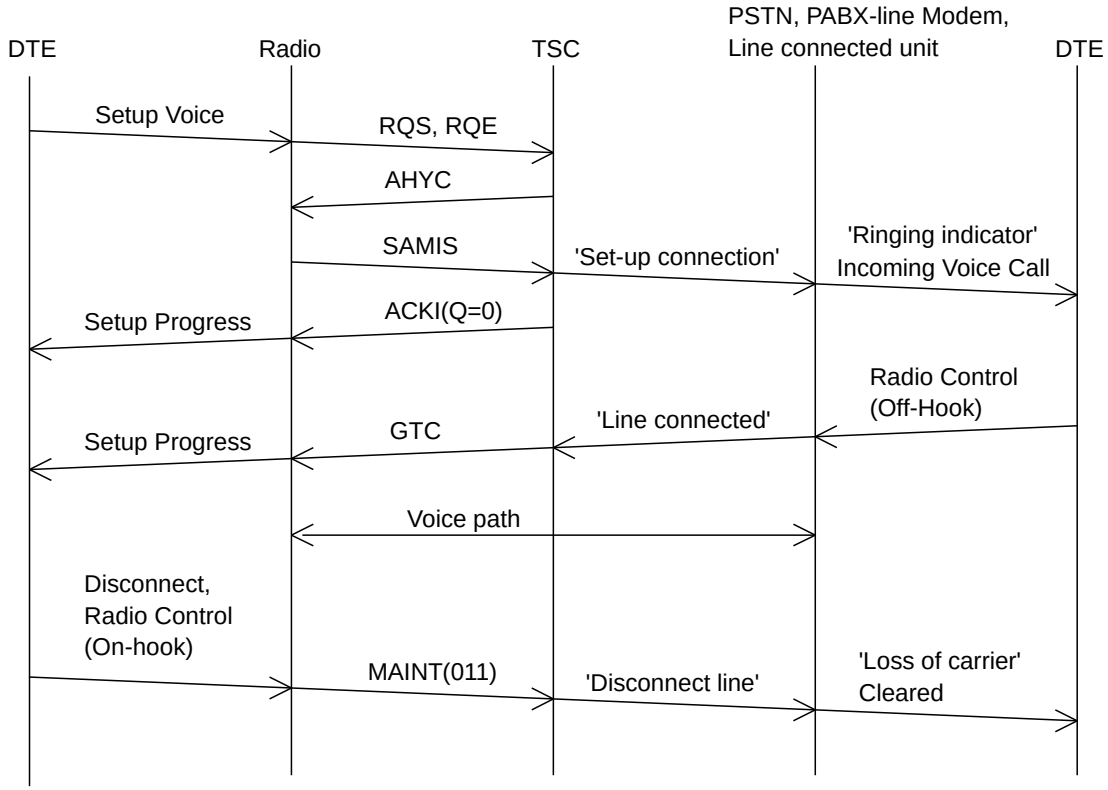


Fig. 7 An example of an off-air Modem or Voice call from a mobile station to a PSTN, PABX or line connected station

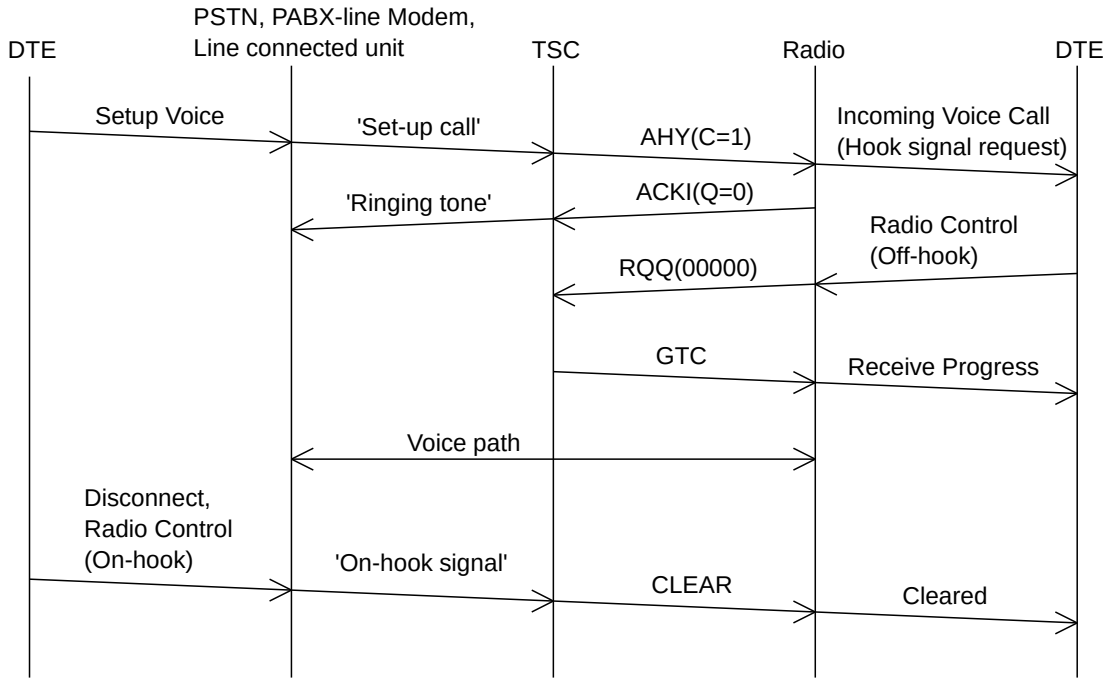


Fig. 8 An example of a full off-air Modem or Voice call from PSTN, PABX or line connected station to a mobile station

Appendix A4. OPTIONAL NETWORK LAYER MESSAGES (Informative)

A4.1. Introduction

This section contains information concerning a set of optional network layer messages. The use of these messages is a manufacturer specific option. The same functions could be implemented by other special messages or by separate control signals, but messages types presented here should be used as specified in this appendix.

A4.2. Message type selection

The user specific messages start with bit 8 of the message descriptor set to '0'. A common practice in most protocols is to reserve message type '00000000' to provide a hook to any other protocol. It is recommended that this practice should be adhered to and '00000000' should not be used as a message type number when defining proprietary messages. (See section 5.1)

A4.3. Optional network layer message descriptions

In this version sections 5.2.2.8.12 and 5.2.2.8.1.13 cover this issue.

APPENDIX A5. Network layer exception handling

A5.1. Scope

This section presents situations which may develop during interworking between a DTE and a radio unit and which are not fully covered by section 5.3. Proposals presented here are examples of how a designer may prevent or deal with these situations.

A5.2. DTE in the idle state

In the idle state the DTE may receive an OPERATING CONDITION message with 'radio transmitting' indication. In this case the radio is being controlled locally, independently of the DTE, and the DTE does not know anything about the call and may not control it by using messages which require the called party address.

Solutions
a) DTE does not interfere with the call at all.
b) The radio unit informs the DTE, by SETUP PROGRESS(Call connected) message, that it has set up a call before sending an OPERATING CONDITION(radio transmitter on) message.

APPENDIX A6. Network layer details (Informative)

A6.1. Introduction

This section presents conditions which may not be fully covered by section 5.3. Proposals presented here are examples of how a designer may prevent or deal with these situations.

A6.2. Short and extended data message length

MPT 1327 and MPT 1343 do not define an exact end for the user data in SSTs and MSTs but only how many codewords are used. Conversely the user access network layer does define a mechanism for such a purpose. However this information is not transferred over the radio path.

Solutions

a) Binary coded messages are always full multiples of fully used codewords. The application shall resolve the method of data presentation.

b) Character coded messages are padded to the next full length of radio path codewords by either NUL, NULL or Space characters depending on the coding type. Application specific characters may be used if the application does the necessary padding. As a result all received message lengths are always equivalent to fully used codewords.

c) User data messages are transmitted without length correction to the radio unit and the radio unit is allowed to pad the message using appropriate bits or characters.

The radio path protocol supports discrete lengths of MPT 1327 short data messages and MPT 1343 SSTs and MSTs as shown in tables A6-1 to A6-3. The message lengths result from the radio path data codewords which are either 46 bits in MPT 1327 format or 42/46/42/46 bits in MPT 1343 format.

Number of codewords	Binary bits	BCD characters	Telex characters	7-bit ASCII characters	8-bit PC characters
1	46	-	-	-	-
2	92	-	-	-	-
3	138	-	-	-	-
4	184	-	-	-	-

Table A6-1: Supported Lengths of MPT 1327 Short Data Messages

Number of codewords	Binary bits	BCD characters	Telex characters	7-bit ASCII characters	8-bit PC characters
1	42	10	8	5	5
2	88	22	17	12	11
3	130	32	25	18	16
4	176	44	35	25	22

Table A6-2: Supported Lengths of MPT 1343 SSTs

Number of codewords	Binary bits	BCD characters	Telex characters	7-bit ASCII characters	8-bit PC characters
1	-	-	-	-	-
2	-	-	-	-	-
3	-	-	-	-	-
4	-	-	-	-	-
5	218	54	43	30	27
6	264	66	52	37	33
7	306	76	60	43	38
8	352	88	70	50	44
9	394	98	78	55	49
10	440	110	87	62	55
11	482	120	95	68	60
12	528	132	105	75	66
13	570	142	113	80	71
14	616	154	122	87	77
15	658	164	130	93	82
16	704	176	140	100	88

Table A6-3: Supported Lengths of MPT 1343 MSTs

MPT 1343 also defines one spare bit in a SST message and four spare bits in a full length MST message when Telex or 7-bit ASCII format is used. This spare bit is in the first codeword of each set of four codewords. This bit is optionally sent as the eighth bit of the first octet in a set of four codewords. If this spare bit is not used it shall set to '0'.

A6.3. Modem user data

All modem user data is proprietary. Any implementation method is the concern of the supplier and its format, message length, compression method and error control characteristics are outside the scope of this standard.

A6.4. BCD and Telex character mapping into ASCII characters

A6.4.1. BCD character mapping

BCD characters as defined in section 5.2.1.2 (MPT 1327 Appendix 5) are mapped into octets using equivalent ASCII characters.

BCD Decimal value or character	BDC Bit pattern	ASCII character	ASCII character value
0	0000	0	30h
1	0001	1	31h
2	0010	2	32h
3	0011	3	33h
4	0100	4	34h
5	0101	5	35h
6	0110	6	36h
7	0111	7	37h
8	1000	8	38h
9	1001	9	39h
Reserved	1010	Reserved	-
*	1011	*	2Ah
#	1100	#	23h
Reserved	1101	Reserved	-
Reserved	1110	Reserved	-
NULL	1111	NUL	00h

Table A6-4: MPT 1327 BCD character coding

A6.4.2. Telex character mapping

Telex character coding is in table A6-5. The Telex characters use 5 bits which support only 32 combinations. To cover both 'LETTERS' and 'FIGURES' two special characters and a control mechanism is defined to change between Letters and Figures. Each time there is a change of current case value the corresponding control character is inserted into character stream.

This standard defines that the radio unit is responsible of the Telex encoding and decoding.

At the start of each SST or MST transmission the character case is set to a default value 'LETTERS' and is changed first time when Figures are needed. The need of case changes limits the maximum number of useful characters in a message. A transmitting DTE may calculate the number of needed case control characters and adjust accordingly maximum number of characters in a message. If the radio unit finds out that the number of character in an encoded message exceeds the capability of SST or MST, as appropriate, is shall inform the DTE by sending a CLEARED message with a cause indication 'Transmission or message too long, call disconnected or message rejected'.

Table A6-5 derfines Telex letters to be ASCII capital letters at the interface. An application also may choose to use lower case letters in displays or on keyboards.

In the Telex coding there are some non-allocated characters which are marked by Note 1. These characters are normally used to present 'special letters' like 'Å, Ä and Ö' or 'Ü, Ä and Ö'. The actual allocation of these characters varies from country to country.

	LETTERS Telex character case			FIGURES Telex character case		
Telex Bit pattern 54321	Telex character	ASCII character	ASCII character value	Telex character	ASCII character	ASCII character value
00011	A	A	41h	-	-	2Dh
11001	B	B	42h	?	?	3Fh
01110	C	C	43h	:	:	3Ah
01001	D	D	44h	WRU	Note 2	Note2
00001	E	E	45h	3	3	33h
01101	F	F	46h	Å Note 1	[	5Bh
11010	G	G	47h	Ä Note 1	\	5Ch
10100	H	H	48h	Ö Note 1	]	5Dh
00110	I	I	49h	8	8	38h
01011	J	J	4Ah	BELL	BEL	07h
01111	K	K	4Bh	(	(	28h
10010	L	L	4Ch	)	)	29h
11100	M	M	4Dh	.	.	2Eh
01100	N	N	4Eh	,	,	2Ch
11000	O	O	4Fh	9	9	39h
10110	P	P	50h	0	0	30h
10111	Q	Q	51h	1	1	31h
01010	R	R	52h	4	4	34h
00101	S	S	53h	'	'	27h
10000	T	T	54h	5	5	35h
00111	U	U	55h	7	7	37h
11110	V	V	56h	=	=	3Dh
10011	W	W	57h	2	2	32h
11101	X	X	58h	/	/	2Fh
10101	Y	Y	59h	6	6	36h
10001	Z	Z	5Ah	+	+	2Bh
	Case independent characters					
01000	CR	CR	0Dh			
00010	LF	LF	0Ah			
11111	LETTERS	SI	0Fh			
11011	FIGURES	SO	0Eh			
00100	SP	SP	20h			
00000	BLK	NUL	00h			

Telex Bit pattern has the most significant bit on the left hand side.

Table A6-5: Telex characters and equivalent ASCII characters

Note1: These characters may have a national meaning different to the shown examples.

Note 2: The Telex character 'Who are you' (WRU) may be used in an application dependent manner.

In this standard Telex control characters LETTERS and FIGURES are mapped onto 'Shift In' and 'Shift Out' ASCII characters although there is no need to use them in a communication between a DTE and a radio unit. If a DTE uses these characters in a message the radio unit shall not add unnecessary case control characters. The receiving radio unit decodes a Telex encoded message back to the original message and removes case control characters in the ASCII presentation format.

A6.5. Address presentation examples

This appendix gives some examples of addressing to help a designer to use MPT 1327 addresses in MAP27 in a proper manner. For the purpose of this interface a PFIX value DUMMYP equal to '0000000' is used althought it is a valid PFIX at the radio path. The address decoding should start from the IDENT field and discard PFIX value when IDENT is DUMMYI.

A6.5.1. Common prefix voice and modem calls; status, SST and MST messages.

A6.5.1.1. Outgoing

PFIX1	Called party address PFIX1
IDENT1	Called party address IDENT1
ADESC	0h
LENGTH	0h
ADDRESS	Not present

A6.5.1.2. Incoming

PFIX2	Calling party address PFIX2
IDENT2	Calling party address IDENT2
ADESC	0h
LENGTH	0h
ADDRESS	Not present

A6.5.1.3. Acknowledgements except ACKT

PFIX1	Called party address PFIX1
IDENT1	Called party address IDENT1
ADESC	0h
LENGTH	0h
ADDRESS	Not present

A6.5.2. Inter prefix voice and modem calls; status, SST and MST messages.

A6.5.2.1. Outgoing

PFIX1	Called party address PFIX1
IDENT1	Called party address IDENT1
ADESC	0h
LENGTH	0h
ADDRESS	Not present

A6.5.2.2. Incoming

PFIX1	Calling party address PFIX2 (except voice and modem group calls: DUMMYP)
IDENT1	Calling party address IDENT2 (except voice and modem group calls: DUMMYI)
ADESC	0h
LENGTH	0h
ADDRESS	Not present

A6.5.2.3. Acknowledgements except ACKT

PFIX1	DUMMYIP
IDENT1	DUMMYI
ADESC	0h
LENGTH	0h
ADDRESS	Not present

A6.5.3. PSTN voice and modem calls and status messages.

A6.5.3.1. Outgoing

PFIX1	DUMMYIP
IDENT1	PSTNGI
ADESC	1h
LENGTH	length of address field in octets
ADDRESS	packed BCD digits in dialled order, first digit corresponds the first digit in SAMIS message

A6.5.3.2. Incoming

PFIX2	Own number PFIX
IDENT2	PSTNGI
ADESC	0h (voice and modem calls) or 1h (PSTN status)
LENGTH	0h (voice and modem calls) or length of address field in octets (PSTN status)
ADDRESS	packed BCD digits in dialled order, first digit corresponds the first digit in SAMIS message (only in PSTN status)

A6.5.3.3. Acknowledgements except ACKT

PFIX1	Own number PFIX
IDENT1	PSTNGI
ADESC	0h
LENGTH	0h
ADDRESS	Not present

A6.5.4. PABX voice and modem calls and status messages (long PABX addressing).

A6.5.4.1. Outgoing

PFIX1	DUMMYIP
IDENT1	PABXI
ADESC	1h
LENGTH	length of address field in octets
ADDRESS	packed BCD digits in dialled order, first digit is the first digit in SAMIS message

A6.5.4.2. Incoming

PFIX2	Own number PFIX
IDENT2	PABXI
ADESC	0h (voice and modem calls) or 1h (PSTN status)
LENGTH	0h (voice and modem calls) or length of address field in octets (PSTN status)
ADDRESS	packed BCD digits in dialled order, first digit is the first digit in SAMIS message (only in PSTN status)

A6.5.4.3. Acknowledgements except ACKT

PFIX1	Own number PFIX
IDENT1	PABXI
ADESC	0h
LENGTH	0h
ADDRESS	Not present

A6.5.5. PABX voice and modem calls (short PABX addressing).

A6.5.5.1. Outgoing

PFIX1	DUMMYP
IDENT1	PABX extension number
ADESC	3h
LENGTH	1h
ADDRESS	first octet, bits 5...8 contain the Exchange number

A6.5.5.2. Incoming

PFIX2	Own number PFIX
IDENT2	PABXI
ADESC	0h
LENGTH	0h
ADDRESS	Not present

A6.5.5.3. Acknowledgements except ACKT

PFIX1	Own number PFIX
IDENT1	PABXI
ADESC	0h
LENGTH	0h
ADDRESS	Not present

A6.5.6. Call diversion set up and cancellation

A6.5.6.1 Self initiated diversion of voice and data calls

PFIX1	Diversion target address
IDENT1	Diversion target address
ADESC	Diversion target address
LENGTH	Address dependent
ADDRESS	Address dependent
DIVERSION INFO	'*******0'
PFIX1	Not present
IDENT1	Not present
ADESC	Not present
LENGTH	Not present
ADDRESS	Not present

A6.5.6.2 Third party initiated diversion of voice and data calls

PFIX1	Diversion target address
IDENT1	Diversion target address
ADESC	Diversion target address
LENGTH	Address dependent
ADDRESS	Address dependent
DIVERSION INFO	'*******1'
PFIX1	Diverted (blocked) party address
IDENT1	Diverted (blocked) party address
ADESC	Address dependent
LENGTH	Address dependent
ADDRESS	Diverted (blocked) party address

A6.5.6.3. Self or recipient initiated diversion cancel of voice and data calls

PFIX1	DUMMYP
IDENT1	DUMMYI
ADESC	DUMMYI
LENGTH	0h
ADDRESS	0h
DIVERSION INFO	'*******0'

A6.5.6.4. Third party initiated diversion cancel of voice and data calls

PFIX1	The address of the party who's calls are no longer diverted
IDENT1	The address of the party who's calls are no longer diverted
ADESC	Address dependent
LENGTH	Address dependent
ADDRESS	The address of the party who's calls are no longer diverted
DIVERSION INFO	'*******1'

A6.5.6.5. Diversion or diversion cancel acknowledgements (expect ACKT)

PFIX1	As in the corresponding diversion or diversion cancel message
IDENT1	As in the corresponding diversion or diversion cancel message
ADESC	0h
LENGTH	0h
ADDRESS	Not present

A6.5.7. Received ACKT (voice and modem calls, status and SST and MST messages)

A6.5.7.1. Calls diverted to radio or line unit (common or inter prefix)

PFIX1	DUMMYP
IDENT1	DUMMYI
ADESC	5h
LENGTH	3h
ADDRESS	first octet: diversion number PFIX second and third octet: diversion number IDENT

A.6.5.7.2. Calls diverted to PSTN or PABX number (voice and modem calls)

PFIX2	DUMMYP
IDENT2	DUMMYI
ADESC	6h
LENGTH	length of address field in octets
ADDRESS	first octet: diversion number PFIX (=own number PFIX) second and third octet: diversion number IDENT (=PSTNGI or PABXI) following octets: packed BCD digits in dialled order, first digit corresponds the first digit in a SAMIS message when a call is being initiated to the diversion number

A.6.5.7.3. Calls diverted to a PABX number presented in binary (voice and modem calls)

PFIX2	DUMMYP
IDENT2	DUMMYI
ADESC	4h
LENGTH	4h
ADDRESS	first octet: diversion number PFIX (=own number PFIX) second and third octet: diversion number IDENT (=Extension number in binary format) fourth octet: bit positions 5 and 6 contain Exchange number (FLAG2, FLAG1)

A6.6. PC character set mapping into SST and MST messages

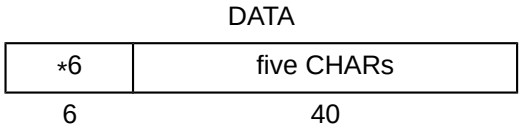
PC eight bit characters are mapped into the radio path codewords following MPT 1343 section 14.2 principles and using the spare GFI value '111' as defined in MPT 1343 section 14.2.2.2. The structure of the data field shall be as specified below.

Note: In the formats given below, "n*" represents the n most significant bits of an encoded character whose remaining bits form the start of the DATA field of the next codeword "*m" represents the m least significant bits of that character in the next DATA field.

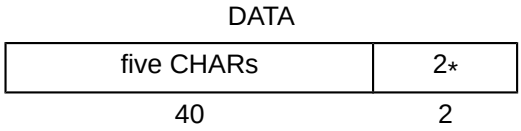
First codeword:

DATA	
five CHARs	2*

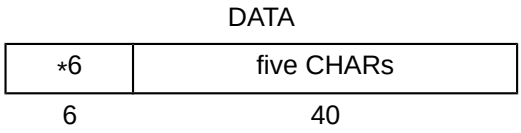
Second codeword:



Third codeword:



Fourth codeword:



CHAR binary value of a PC character set, code page '437'.

APPENDIX A7. MAP27 implementation form

This implementation form should be used when testing for compliance with MAP27.

This implementation form consists of three major parts:

a) general information about the product identification (A7.1), the physical interface (A7.2), and the data link layer parameters (A7.3), and

b) the network layer messages used in the product (A7.4), and

c) additional information about network layer messages used in the product (A7.5).

A7.1. Product identification

Product identification:	
Manufacturer:	
Date:	Protocol version number:

A7.2. Physical interface

Transmission speed (3.4):

9600 bit/s:	☐ Yes ☐ No	1200 bit/s:	☐ Yes ☐ No	Others:	

A7.3. Data link layer

Maximum length (4.3.2.1):	N1:		n_{octet}:		octets	
Maximum window size (4.3.2.1):	k:					
Acknowledgement request (4.3.2.3):	AR:	variable ☐	set to '0' ☐	set to '1' ☐		
Link establishment timer (4.4.1.1):	T0:		s			
Transfer phase retry timer (4.4.2.1):	T1:		s			
Acknowledgement timer (4.4.2.2):	T2:		s			
Activity timer (4.4.2.3):	T3:		s			
Retransmission count (4.4.2.6):	N2:					
Link failure detection time (4.4.2.6):	T4:		s			
Activity count (4.4.2.6):	N3:					

A7.4. Network layer messages

The "Note" columns of the network layer messages should be used to indicate whether the equipment complies or does not comply with the standard.

Note: S = supported, N = not supported at all, A = additional information, see A7.5

Code	D->R	Note	R->D	Note
00000000	Hook to other protocols		Hook to other protocols	
00000001	Radio Test		Radio Test Result	
00000010				
00000011				
00000100				
00000101				
00000110				
00000111				
00001000				
00001001				
00001010				
00001011				
00001100				
00001101				
00001110				
00001111				
00010000				
00010001				
00010010				
00010011				
00010100				
00010101				
00010110				
00010111				
00011000				
00011001				
00011010				
00011011				
00011100				
00011101				
00011110				
00011111				
00100000				
00100001				
00100010				
00100011				
00100100				
00100101				
00100110				
00100111				
00101000				
00101001				
00101010				
00101011				
00101100				
00101101				
00101110				
00101111				

A7.4. Network layer messages (cont.)

Code	D->R	Note	R->D	Note
00110000				
00110001				
00110010				
00110011				
00110100				
00110101				
00110110				
00110111				
00111000				
00111001				
00111010				
00111011				
00111100				
00111101				
00111110				
00111111				
01000000				
01000001				
01000010				
01000011				
01000100				
01000101				
01000110				
01000111				
01001000				
01001001				
01001010				
01001011				
01001100				
01001101				
01001110				
01001111				
01010000				
01010001				
01010010				
01010011				
01010100				
01010101				
01010110				
01010111				
01011000				
01011001				
01011010				
01011011				
01011100				
01011101				
01011110				
01011111				

A7.4. Network layer messages (cont.)

Code	D->R	Note	R->D	Note
01100000				
01100001				
01100010				
01100011				
01100100				
01100101				
01100110				
01100111				
01101000				
01101001				
01101010				
01101011				
01101100				
01101101				
01101110				
01101111				
01110000				
01110001				
01110010				
01110011				
01110100				
01110101				
01110110				
01110111				
01111000				
01111001				
01111010				
01111011				
01111100				
01111101				
01111110				
01111111				

A7.4. Network layer messages (cont.)

Code	D->R	Note	R->D	Note
10000000	Send Status		Receive Status	
10000001	Send SST		Recieve SST	
10000010	Send MST		Receive MST	
10000011				
10000100				
10000101				
10000110	Disconnect (normal end)		Cleared (normal end)	
10000111	Diversion Request			
10001000				
10001001				
10001010				
10001011				
10001100				
10001101				
10001110				
10001111				
10010000				
10010001				
10010010				
10010011				
10010100				
10010101				
10010110				
10010111				
10011000				
10011001				
10011010				
10011011				
10011100				
10011101				
10011110				
10011111				
10100000				
10100001				
10100010				
10100011	Send Modem Data		Receive Modem Data	
10100100	Setup Voice/Modem Call		Incoming Voice/Modem Call	
10100101	Setup Emergency Voice/Modem Call		Incoming Emerg. Voice/Modem Call	
10100110	Disconnect (cancel attempt)		Cleared (abnormal end)	
10100111	Diversion Cancel			
10101000				
10101001				
10101010				
10101011				
10101100				
10101101				
10101110				
10101111				

A7.4. Network layer messages (cont.)

Code	D->R	Note	R->D	Note
10110000	Radio Interrogation		Radio Personality	
10110001			Numbering Information	
10110010	Radio Control		Operating Condition	
10110011	Radio Management		Radio Settings	
10110100	Protocol Info		Protocol Info	
10110101			Network Information	
10110110	Volume Control			
10110111	Dialled String			
10111000				
10111001				
10111010				
10111011				
10111100				
10111101				
10111110				
10111111				
11000000			Status, SST and MST ACK (positive)	
11000001				
11000010				
11000011				
11000100			Setup Progress (positive)	
11000101			Receive Progress (positive)	
11000110				
11000111			Diversion ACK (positive)	
11001000				
11001001				
11001010				
11001011				
11001100				
11001101				
11001110				
11001111				
11010000			Status, SST and MST ACK (queuing)	
11010001				
11010010				
11010011				
11010100			Setup Progress (Queuing)	
11010101			Receive Progress (warning)	
11010110				
11010111				
11011000				
11011001				
11011010				
11011011				
11011100				
11011101				
11011110				
11011111				

A7.4. Network layer messages (cont.)

Code	D->R	Note	R->D	Note
11100000			Status, SST and MST ACK (negative)	
11100001				
11100010				
11100011				
11100100			Setup Progress (negative)	
11100101			Receive Progress (no connection)	
11100110				
11100111			Diversion ACK (negative)	
11101000				
11101001				
11101010				
11101011				
11101100				
11101101				
11101110				
11101111				
11110000				
11110001				
11110010				
11110011				
11110100				
11110101				
11110110				
11110111				
11111000				
11111001				
11111010				
11111011				
11111100				
11111101				
11111110				
11111111				

A7.5. Additional Network layer Information

The boxes in front of each row should be used to indicate whether the equipment complies or does not comply with the message and facility.

A7.5.1. STATUS ACK (5.2.2.1.3.)

CAUSE for Message type C0h:

	8	7	6	5	4	3	2	1		
	0	0	0	0	0	0	0	0	ACK	Successful transaction

CAUSE for Message type D0h:

	0	0	0	0	0	0	1	0	ACKQ	System busy, wait for signalling
	0	0	0	0	1	0	1	0	ACKQ	Called unit engaged, wait for signalling
	0	0	1	0	0	1	1	0	ACKT	Called unit's calls are diverted and radio unit tries to send message to the diversion address

CAUSE for Message type E0h:

	0	0	0	0	1	0	0	0	ACK	Transaction aborted
	0	0	0	0	0	0	1	1	ACKX	Invalid call, message rejected
	0	0	0	0	1	0	1	1	ACKX	System or called unit overload, message rejected
	0	0	0	0	0	1	0	0	ACKV	Called radio out of reach or transaction abandoned
	0	0	0	0	1	1	0	0	ACKV	Called unit engaged or does not wish to accept message
	0	0	0	0	0	1	1	0	ACKT	Called unit's calls are diverted
	0	0	0	1	0	1	1	0	ACKT	Called unit's calls are diverted to a group address
	0	0	0	0	1	1	1	0	ACKT	Called unit's calls are diverted, but the diversion address is not available

A7.5.2. SEND SST (5.2.2.2.1.), RECEIVE SST (5.2.2.2.2.)

Data message coding information (CODING):

	8	7	6	5	4	3	2	1	
	0	0	0	0					MPT 1327: Free format data.
	0	0	0	1					MPT 1343: BCD radio path coding. ASCII presentation at the interface.
	0	0	1	0					MPT 1343: CCITT Alphabet No 2 (Telex) radio path coding. ASCII presentation at the interface.
	1	0	0	0					MPT 1343: Binary.
	1	0	0	1					MPT 1343: BCD, see MPT 1327 Appendix 5.
	1	0	1	0					MPT 1343: CCITT Alphabet No 2 (Telex).
	1	0	1	1					MPT 1343: CCITT Alphabet No 5 (7 bit ASCII).
	1	1	1	0					MPT 1343: Spare
	1	1	1	1					MPT 1343: eight bit characters according to PC character set.

A7.5.3. SST ACK (5.2.2.2.3.)

CAUSE for Message type C0h:

8	7	6	5	4	3	2	1

	0	0	0	0	0	0	0	0	ACK	Successful transaction

CAUSE for Message type D0h:

	0	0	0	0	0	0	1	0	ACKQ	System busy, wait for signalling
	0	0	0	0	1	0	1	0	ACKQ	Called unit engaged, wait for signalling
	0	0	1	0	0	1	1	0	ACKT	Called unit's calls are diverted and radio unit tries to send message to the diversion address

CAUSE for Message type E0h:

	0	0	0	0	1	0	0	0	ACK	Transaction aborted
	0	0	0	0	0	0	1	1	ACKX	Invalid call, message rejected
	0	0	0	0	1	0	1	1	ACKX	System or called unit overload, message rejected
	0	0	0	0	0	1	0	0	ACKV	Called radio out of reach or transaction abandoned
	0	0	0	0	1	1	0	0	ACKV	Called unit engaged or does not wish to accept message
	0	0	0	0	0	1	1	0	ACKT	Called unit's calls are diverted
	0	0	0	1	0	1	1	0	ACKT	Called unit's calls are diverted to a group address
	0	0	0	0	1	1	1	0	ACKT	Called unit's calls are diverted, but the diversion address is not available

A7.5.4. SEND MST (5.2.2.3.1.), RECEIVE MST (5.2.2.3.2.)

Data message coding information (CODING):

	8	7	6	5	4	3	2	1	
	0	0	0	1					MPT 1343: BCD radio path coding. Numbers are presented as ASCII characters.
	0	0	1	0					MPT 1343: CCITT Alphabet No 2 (Telex) radio path coding. Characters are presented as ASCII characters.
	1	0	0	0					MPT 1343: Binary.
	1	0	0	1					MPT 1343: BCD, see MPT 1327 Appendix 5.
	1	0	1	0					MPT 1343: CCITT Alphabet No 2 (Telex).
	1	0	1	1					MPT 1343: CCITT Alphabet No 5 (7 bit ASCII).
	1	1	1	0					MPT 1343: Spare for customisation
	1	1	1	1					MPT 1343: eight bit characters according to PC character set.

A7.5.5. MST ACK (5.2.2.3.3.)

CAUSE for Message type C0h:

	8	7	6	5	4	3	2	1		
	0	0	0	0	0	0	0	0	ACK	Successful transaction

CAUSE for Message type D0h:

	0	0	0	0	0	0	1	0	ACKQ	System busy, wait for signalling
	0	0	0	0	1	0	1	0	ACKQ	Called unit engaged, wait for signalling
	0	0	1	0	0	1	1	0	ACKT	Called unit's calls are diverted and radio unit tries to send message to the diversion address
	0	0	1	0	0	0	1	0	Local	TSC does not support MST, the radio tries to use multiple SST

CAUSE for Message type E0h:

	0	0	0	0	1	0	0	0	ACK	Transaction aborted
	0	0	0	0	0	0	1	1	ACKX	Invalid call, message rejected
	0	0	0	0	1	0	1	1	ACKX	System or called unit overload, message rejected
	0	0	0	0	0	1	0	0	ACKV	Called radio out of reach or transaction abandoned
	0	0	0	0	1	1	0	0	ACKV	Called unit engaged or does not wish to accept message
	0	0	0	0	0	1	1	0	ACKT	Called unit's calls are diverted
	0	0	0	1	0	1	1	0	ACKT	Called unit's calls are diverted to a group address
	0	0	0	0	1	1	1	0	ACKT	Called unit's calls are diverted, but the diversion address is not available
	0	0	0	0	1	1	0	1		TSC does not support MST, transaction aborted

A7.5.6. SETUP VOICE / SETUP MODEM (5.2.2.4.1.)

CALL DETAILS:

8	7	6	5	4	3	2	1

	0	Non-include call
	1	Include call
	0	Individual or group call, called user(s) may reply
	1	Group call, called users are not allowed to reply
	0	Voice call
	1	Modem (Data) call
	0	High priority call
	1	Non-priority call
	0 0 0	Standard call
	* * 1	Special customised service request

A7.5.7. SETUP EMERGENCY VOICE / SETUP EMERGENCY MODEM (5.2.2.4.2.)

CALL DETAILS:

8 7 6 5 4 3 2 1	
0	Individual or group call, called user(s) may reply
1	Group call, called users are not allowed to reply
0	Voice call
1	Modem (Data) call
*	Reserved, set to '0'
0 0 0	Standard emergency call
* * 1	Special customised service request

A7.5.8. SETUP PROGRESS (5.2.2.4.3.)

CAUSE for Message type C4h:

8	7	6	5	4	3	2	1		
0	0	0	0	0	0	0	0	GTC	Call connected
0	0	0	0	0	0	0	0	ACK	Include call connected

CAUSE for Message type D4h:

0	0	0	0	0	0	0	1	ACKI	Called unit alerting
0	0	0	0	0	0	1	0	ACKQ	System busy, wait for signalling
0	0	0	0	1	0	1	0	ACKQ	Called unit engaged, wait for signalling
0	0	0	0	0	1	0	1	ACKE	Emergency call is proceeding, wait for signalling
0	0	1	0	0	1	1	0	ACKT	Called unit's calls are diverted and radio unit tries to set-up call to the diversion address
0	0	1	1	0	1	1	0	ACKT	Called unit's calls are diverted to a group and radio unit tries to set-up call to the diversion address

CAUSE for Message type E4h:

0	0	0	0	1	0	0	0	ACK	Call set-up aborted
0	0	0	0	0	0	1	1	ACKX	Invalid call, call set-up rejected
0	0	0	0	1	0	1	1	ACKX	System or called unit overload, call set-up rejected
0	0	0	0	0	1	0	0	ACKV	Called radio out of reach or call set-up abandoned
0	0	0	0	1	1	0	0	ACKV	Called unit engaged or user does not wish to accept the call
0	0	0	0	0	1	1	0	ACKT	Called unit's calls are diverted
0	0	0	1	0	1	1	0	ACKT	Called unit's calls are diverted to a group address
0	0	0	0	1	1	1	0	ACKT	Called unit's calls are diverted, but the diversion address is not available
0	0	0	0	0	1	1	1	ACKB	Called unit has accepted the call for call-back

A7.5.9. INCOMING VOICE CALL / INCOMING MODEM CALL (5.2.2.4.4.)

CALL DETAILS:

8	7	6	5	4	3	2	1	
	0							Non-include call
	1							Include call
		0						Individual call
		1						Group call
			0					Voice call
			1					Data call
				0				Call has been connected (Hook signal is not needed) (GTC)
				1				Hook signal is required before connection is established (AHY)
					0	0	0	Standard call, no parameters field
					1	0	1	Customised service 1 indication
					1	1	0	Customised service 2 indication
					1	1	1	Customised service 3 indication

A7.5.10. INCOMING EMERGENCY VOICE CALL / INCOMING EMERGENCY MODEM CALL (5.2.2.4.5.)

CALL DETAILS:

8	7	6	5	4	3	2	1	
		0						Individual call
		1						Group call
			0					Voice call
			1					Data call
				0				Call has been connected (Hook signal is not needed) (GTC)
				1				Hook signal is required before connection is established (AHY)
					0	0	0	Standard call, no parameters field
					1	0	1	Customised service 1 indication
					1	1	0	Customised service 2 indication
					1	1	1	Customised service 3 indication

A7.5.11. RECEIVE PROGRESS (5.2.2.4.6.)

CAUSE for Message type C5h:

8	7	6	5	4	3	2	1		
0	0	0	0	0	0	0	0	GTC	Call connected

CAUSE for Message type D5h:

8	7	6	5	4	3	2	1		
0	0	0	0	0	0	0	1	MAINT	Transmission disabled
0	0	0	0	0	0	1	0	Note 1	System busy, wait for signalling
0	0	0	0	1	0	1	0	Local	Clear down timer warning (optional)

CAUSE for Message type E5h:

8	7	6	5	4	3	2	1		
0	0	0	0	0	0	1	1	AHYX	Call set-up rejected
0	0	0	0	0	1	1	1	Local	Radio has accepted the call for call-back

A7.5.12. DISCONNECT (5.2.2.6.1.)

CAUSE for Message type 86h:

	8	7	6	5	4	3	2	1		
	0	0	0	0	0	1	1	1	MAINT	Disconnect voice or modem call, normal end

CAUSE for Message type A6h:

	0	0	0	0	1	0	0	0	RQX	Cancel any message transaction or normal call set-up attempt
	0	0	0	0	1	0	0	1	RQX	Cancel include call set-up attempt
	0	0	0	0	1	0	1	0	RQX	Abort diversion setting transaction
	0	0	0	0	1	1	0	0	RQX	Cancel standard data call set-up attempt

A7.5.13. CLEARED (5.2.2.6.2.)

CAUSE for message type A6h:

	8	7	6	5	4	3	2	1		
	0	0	0	0	0	0	0	0	CLEAR MAINT Local	Not specified, all message transactions, call set-ups or calls are cancelled or disconnected
	0	0	0	0	0	0	0	1	Local	Radio generated clear e.g. radio path protocol time-out or on-hook on the radio set
	0	0	0	0	0	1	0	0	Local	Service not available (Radio unit not in radio contact)
	0	0	0	0	0	1	0	1	Local	Transmission or message too long, call disconnected or message rejected
	0	0	0	0	0	1	1	0	Local	Message coding not possible, message rejected
	0	0	0	0	1	1	1	0	MAINT (110)	Voice or modem call disconnected, abnormal end

CAUSE for message type 86h:

	0	0	0	0	1	0	1	1	CLEAR	Voice or modem call disconnected, normal end

A7.5.14. DIVERSION REQUEST (5.2.2.7.1.)

DIVERSION INFO:

	8	7	6	5	4	3	2	1	
				0	0				Speech and data are diverted
				0	1				Speech calls are diverted
				1	0				Data calls are diverted
				1	1				Reserved
								0	Self initiated diversion request
								1	Third party diversion request

A7.5.15. DIVERSION CANCEL (5.2.2.7.2.)

DIVERSION INFO:

8	7	6	5	4	3	2	1	
			0	0				Speech and data are no longer diverted
			0	1				Speech calls are no longer diverted
			1	0				Data calls are no longer diverted
						0	0	Self-initiated cancellation (ADESC='0000')
						0	1	Third party cancellation
						1	0	General cancellation by recipient (ADESC='0000')

A7.5.16. DIVERSION ACK (5.2.2.7.3.)

CAUSE for message type C7h:

8	7	6	5	4	3	2	1		
0	0	0	0	0	0	0	0	ACK	Call diversion or diversion cancellation accepted

CAUSE for message type E7h:

0	0	0	0	1	0	0	0	ACK	Transaction aborted (response to RQX)
0	0	0	0	0	0	1	1	ACKX	Invalid diversion or TSC does not accept diversions, request rejected
0	0	0	0	1	0	1	1	ACKX	System overload, request rejected
0	0	0	0	0	1	0	0	ACKV	Transaction abandoned

A7.5.17. RADIO INTERROGATION (5.2.2.8.1.)

REASON:

8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	0	Personality request
0	0	0	0	0	0	0	1	Numbering information
0	0	0	0	0	0	1	0	Status of radio settings
0	0	0	0	0	0	1	1	Operating condition
0	0	0	0	0	1	0	0	Network information from broadcast messages
1	*	*	*	*	*	*	*	Spare for customisation

A7.5.18. RADIO PERSONALITY (5.2.2.8.2.)

SUPPORTED FACILITIESa:

8	7	6	5	4	3	2	1

0	Voice calls are not supported
1	Voice calls are supported
0	Modem calls are not supported
1	Modem calls are supported
0	Status messages are not supported
1	Status messages are supported
0	SST messages are not supported
1	SST messages are supported
0	MST messages are not supported
1	MST messages are supported
0	Automatic call set-up to diversion address is not supported
1	Automatic call set-up to diversion address is supported
0	Call-back logging is not supported
1	Call-back logging is supported

SUPPORTED FACILITIESb:

8 7 6 5 4 3 2 1	
* * * * * * * *	Reserved for further extensions, set to '0'

SUPPORTED FACILITIESc:

8 7 6 5 4 3 2 1	
* * * * * * * *	Space for customisation

SUPPORTED CODINGS:

8 7 6 5 4 3 2 1

	0	MPT 1343 BCD presentation as ASCII characters is not supported
	1	MPT 1343: BCD radio path coding. Numbers and characters are presented as ASCII characters.
	0	MPT 1343: CCITT Alphabet No 2 (Telex) presentation as ASCII characters is not supported
	1	MPT 1343: CCITT Alphabet No 2 (Telex) radio path coding. Characters are presented as ASCII characters.
	0	MPT 1343: Binary presentation is not supported
	1	MPT 1343: Binary presentation.
	0	MPT 1343: BCD presentation is not supported
	1	MPT 1343: BCD, see MPT 1327 Appendix 5. Numbers are presented as BCD numbers.
	0	MPT 1343: CCITT Alphabet No 2 (Telex).is not supported
	1	MPT 1343: CCITT Alphabet No 2 (Telex). Characters are presented as Telex characters.
	0	MPT 1343: CCITT Alphabet No 5 (7 bit ASCII) is not supported
	1	MPT 1343: CCITT Alphabet No 5 (7 bit ASCII).
	0	MPT 1343: eight bit characters according to PC character set is not supported
	1	MPT 1343: eight bit characters according to PC character set. The recommended character set number is 437.

A7.5.19. RADIO CONTROL (5.2.2.8.4.)

CONTROLS:

	8 7 6 5 4 3 2 1	
	0	On-hook indication i.e. user is no longer ready for a modem or speech call
	1	Off-hook indication i.e. user ready for a modem or speech call
	0	Transmit Off request
	1	Transmit On request

A7.5.20. OPERATING CONDITION (5.2.2.8.5.)

CONDITIONS:

8	7	6	5	4	3	2	1	
					0			Radio unit is not in radio contact
					1			Radio unit is in radio contact
						0		Radio unit in On-Hook state (idle or disconnected)
						1		Radio unit in Off-Hook state (active)
							0	Radio not transmitting i.e. transmission not allowed
							1	Radio transmitting
1	*	*	*	*	*	*	*	Spare for customisation

FIELD STRENGTH:

0	0	0	0	0	0	0	0	Dummy value, field strength not available
0	0	0	0	0	0	0	1	Lowest field strength
1	1	1	1	1	1	1	1	Highest field strength
Others								In between field strength

MCDT:

0	0	0	0	0	0	0	1	Call duration time is the shown value in minutes + 4 minutes (5 min)
0	0	0	0	1	0	0	1	Call duration time is the shown value in minutes + 4 minutes (13 min)
0	0	0	0	1	0	1	0	Call duration time is the shown value in seconds (10 sec)
1	1	1	1	1	1	1	0	Call duration time is the shown value in seconds (254 sec)
1	1	1	1	1	1	1	1	Call duration timer infinite or not supported

A7.5.21. RADIO MANAGEMENT (5.2.2.8.7.)

CONTROLSa:

8	7	6	5	4	3	2	1	
0								User does not wish to or is not capable of receiving voice calls
1								User wishes to receive voice calls
	0							User does not wish to or unit is not capable of receiving modem calls
	1							User wishes to receive modem calls
		0						User does not wish or unit is not capable to receive status messages
		1						User wishes to receive status messages
			0					User does not wish or unit is not capable to receive SST messages
			1					User wishes to receive SST messages
				0				User does not wish or unit is not capable to receive MST messages
				1				User wishes to receive MST messages
					0			Radio shall not automatically set up calls to a diversion address
					1			Radio shall automatically set up calls to a diversion address
						0		Set call-back logging inactive
						1		Set call-back logging active

CONTROLSb:

*	*	*	*	*	*	*	*	Reserved for further extensions, set to '0'

CONTROLSc:

*	*	*	*	*	*	*	*	Spare for customisation

A7.5.22. RADIO SETTINGS (5.2.2.8.8.)

RADIO SETTINGSa:

8	7	6	5	4	3	2	1	
0								Radio rejects incoming voice calls
1								Radio accepts incoming voice calls
	0							Radio rejects incoming modem calls
	1							Radio accepts incoming modem calls
		0						Radio rejects incoming status messages
		1						Radio accepts incoming status messages
			0					Radio rejects incoming SST messages
			1					Radio accepts incoming SST messages
				0				Radio rejects incoming MST messages
				1				Radio accepts incoming MST messages
					0			Radio does not automatically set up calls to a diversion address
					1			Radio does automatically set up calls to a diversion address
						0		Call-back logging inactive
						1		Call-back logging active

RADIO SETTINGSb:

*	*	*	*	*	*	*	*	Reserved for further extensions, set to '0'

RADIO SETTINGSc:

*	*	*	*	*	*	*	*	Spare for customisation

A7.5.23. PROTOCOL INFO (5.2.2.8.9.)

REASON:

8	7	6	5	4	3	2	1	
0	0	0	0	0	0	0	1	Unrecognised message
0	0	0	0	0	0	1	0	Facility or addressing not supported
0	0	0	0	0	0	1	1	Protocol state mismatch detected i.e. received message not compatible or allowed at the present state (optional)
0	0	0	0	0	1	0	0	Message coding not supported
1	*	*	*	*	*	*	*	Spare for customisation

A7.5.24. VOLUME CONTROL (Informative) (5.2.2.8.10.)

CONTROL POINT:

8	7	6	5	4	3	2	1	
					1			Modem audio path (audio level for a modem)
						1		Alert tones
							1	Normal speech audio path

VOLUME SET:

	0	0	0	0	0	0	0	1	Up
	0	0	0	0	0	0	1	0	Down
	*	*	*	*	0	0	1	1	Set to value in range 0...15, '0' is the lowest audio volume
	0	0	0	0	0	1	0	0	Set to preset value e.g. value defined for emergency traffic (optional)
	0	0	0	0	0	1	0	1	Reset to manual control (optional)

APPENDIX A8. Values of system parameters

ITEM NO.	ITEM	STORAGE TYPE	ITEM SIZE/ RANGE OF VALUES	NO. 0F ENTRIES	SOURCE OF DATA	M/OSO	COMMENTS	REFERENCE
1	Transmission speed	A	2 bits	1	NP	M	0 = 9600 bit/s 1 = 1200 bit/s 2 = customer defined	3.4
2	Maximum length N1	A	8 bit	1	NP	M		4.3.2.1
3	Maximum window size k	A	8 bit	1	NP	M		4.3.2.1
4	Acknowledgement request	A	2 bit	1	NP	M	0 = set to 0 1 = set to 1 2 = variable	4.3.2.3
5	Link establishment timer T0	A	8 bit	1	NP	M	100 ms resolution maximum 15 s	4.4.1.1
6	Transfer phase retry timer T1	A	8 bit	1	NP	M	100 ms resolution	4.4.2.1
7	Acknowledgement timer T2	A	8 bit	1	NP	M	100 ms resolution maximum 15 s	4.4.2.2
8	Activity timer T3	A	8 bit	1	NP	M	100 ms maximum 15 s	4.4.2.3
9	Link failure detection time T4	A	8 bit	1	NP	M	T4 > N3 * T3	4.4.2.6
10	Retransmission count N2	A	8 bit	1	NP	M	standard 10	4.4.2.6
11	Link activity count N3	A	8 bit	1	NP	M	standard 5 N3 >=2	4.4.2.6

APPENDIX A9. MSC-Scenarios

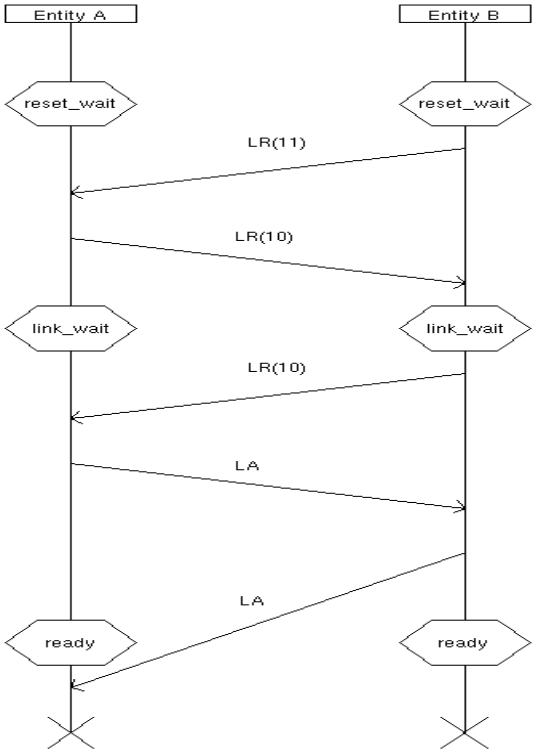


Figure A2.1. An example of a link establishment procedure with different N1 parameter values.

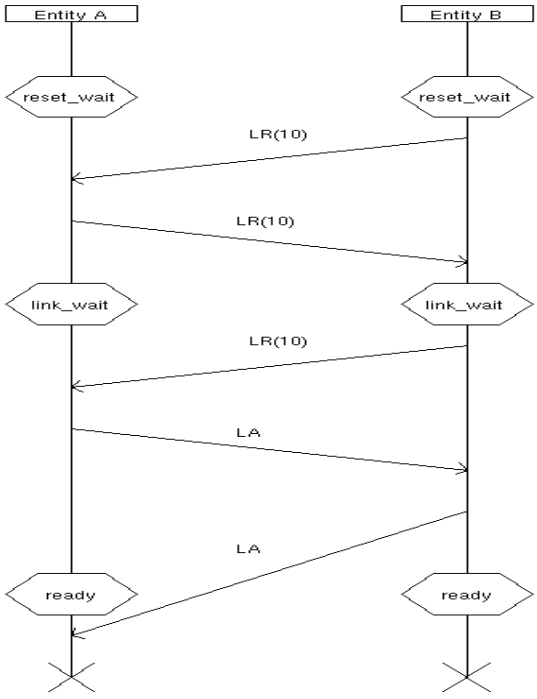


Figure A2.2. An example of a link establishment procedure with the same N1 parameter values.

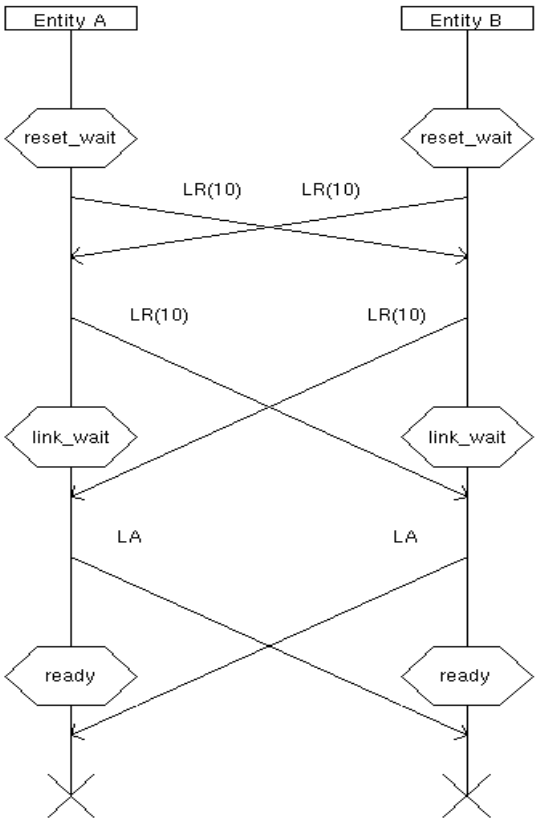


Figure A2.3. An example of a simultaneous link establishment procedure between two entities with the same N1 parameter values.

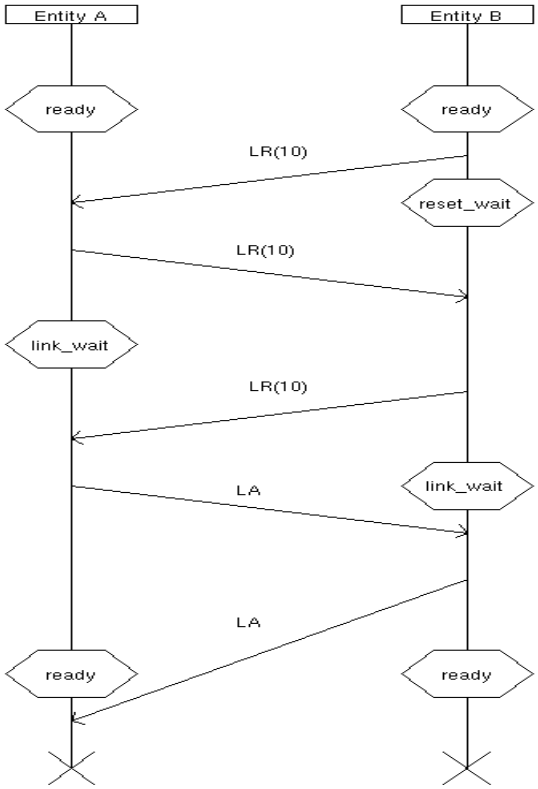


Figure A2.4. An example of a link failure.

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