ETSI TECHNICAL REPORT

ETR 135

August 1994

Source: ETSI TC-TM

Reference: DTR/TM-03004

ICS: 33.080

Key words: Layer 2, data, network

Transmission and Multiplexing (TM); Network aspects and applications for a 4 (and n x 4) kbit/s data link in a 2 048 kbit/s frame

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Foreword

This ETSI Technical Report (ETR) was produced by the Transmission and Multiplexing (TM) Technical Committee of the European Telecommunications Standards Institute (ETSI) in order to give guidance to Telecommunications Organizations and equipment manufacturers on the possible use of Sa bit(s) of ITU-T Recommendation G.704 [3] 2 048 kbit/s frame signals as a 4 (and n x 4) kbit/s data link.

This ETR should be used in conjunction with any specific ETS related to equipment having 2 048 kbit/s interface(s) according to ITU-T Recommendation G.704 [3] and ETS 300 167 [4].

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1 Scope

This ETSI Technical Report (ETR) describes network reference configurations and some possible applications for the use of a 4 (and n x 4) kbit/s data link in 2 048 kbit/s frame as an Embedded Operation Channel (EOC). Recommended protocols for this data link are described. The EOC is a client-network layer of the 2 048 kbit/s path (server layer). It is assumed that information carried on the EOC is only related to point-to-point application. Other network configurations or applications could be envisaged but these should be compatible with the relevant Clauses of this ETR.

2 References

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

[1] DE/TM-01013-1: "Transmission and Multiplexing (TM); Flexible multiplexer equipment Part 1: Flexible Multiplexer functional blocks".

[2] DE/TM-01013-2: "Transmission and Multiplexing (TM); Flexible multiplexer equipment Part 2: Management and control".

[3] ITU-T Recommendation G.704: "Synchronous frame structures used at primary and secondary hierarchical levels".

[4] ETS 300 167: "Transmission and Multiplexing (TM) ; Functional characteristics of 2 048 kbit/s interfaces".

[5] ITU-T Recommendation G.732: "Characteristics of primary PCM multiplex equipment operating at 2 048 kbit/s".

[6] ETS 300 010: "Transmission and Multiplexing (TM) ; Synchronous cross connect equipment, 64 and n x 64 kbit/s cross connection rate, 2 048 kbit/s access ports".

[7] ITU-T Recommendation M.3010: "Principles for a Telecommunications Management Network".

[8] ISO 8473: "Information processing systems - Data communications - Protocol for providing the connectionless-mode network service".

[9] ETS 300 233: "Transmission and Multiplexing (TM) ; Digital section for ISDN primary rate access".

[10] ITU-T Recommendation G.826: "Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate".

[11] ITU-T Recommendation M.2100: "Performance limits for bringing-into-service and maintenance of international digital paths, sections and transmission systems".

[12] ITU-T Recommendation M.2120: "Digital path, section and transmission system fault detection and localisation procedures".

3 Symbols and abbreviations

For the purposes of this ETR, the following symbols and abbreviations apply:

C/R	Command/Response
DCE	Data Circuit terminating Equipment
DPI	Dependent Point Identifier
DXC	Digital Cross Connect equipment
EA	Extension of Address
ECC	Embedded Control Channel
EOC	Embedded Operation Channel
E/R	Error Report flag
ET	Exchange Termination
FCS	Frame Check Sequence
FM	Flexible Multiplexer
HDLC	High level Data Link Control
ISDN	Integrated Services Digital Network
LAPD	Link Access Protocol on D channel
LT	Line Termination
m	a non-standard management interface between equipment and QA
M	M channel in ISDN primary rate access
MCF	Message Communication Function
MD	Mediation Device
MF	Mediation Function
MPI	Manager Point Identifier
MS	More Segment flag
NE	Network Element
NPDU	Network Protocol Data Unit
NT	Network Termination
NTU	Network Terminating Unit
OS	Operation System
PABX	Private Automatic Branch Exchange
PDU	Protocol Data Unit
PFM	Privately owned Flexible Multiplexer
PMT	Performance Monitoring and Test
PRA	Primary Rate Access
Q	Q-interface to the TMN
QA	Q Adapter
QAF	Q Adapter Function
Qx	a management interface between NE and MD or MF
R	Regenerator
RNR	Receive Not Ready
RR	Receive Ready
Sa	a spare bit from TS0 without frame alignment signal of a 2 048 kbit/s ITU-T Recommendation G.704 [3] frame
SAPI	Service Access Point Identifier
SDH	Synchronous Digital Hierarchy
SP	Segmentation Permitted flag
T	The T reference point of the PRA to ISDN
TEI	Terminal Equipment Identifier
TMN	Telecommunication Management Network
TS0	Time Slot 0
V3	V reference point at the network side of a PRA digital section
VPN	Virtual Private Network

4 Definitions

Network Element (NE): see ITU-T Recommendation M.3010 [7].

Flexible Multiplexer (FM): a FM provides services via a variety of tributary interfaces - both voice and data - carrying either switched or non-switched services. Specifications for such an equipment are described in DE/TM-1013 [1].

Private Flexible Multiplexer (PFM): a PFM is a Flexible Multiplexer located in the customer premises and which may be connected to the Public Network or to other(s) PFM by provision of digital leased line. It may belong to the customer or to the telecommunication organization providing a Virtual Private Network (VPN) service. In this ETR, this abbreviation may also be used when considering a Private Automatic Branch Exchange (PABX) or a Data Circuit terminating Equipment (DCE) providing an interface complying to ITU-T Recommendation G.704 [3] this interface being applied according to ITU-T Recommendation G.732 [5].

Embedded Operation Channel (**EOC):** an EOC is a physical channel of the managed network used for management communication purposes, specifically to exchange management information between equipment/Network Element (NE) functions and Operation System (OS)/mediation/QA functions. It is a point-to-point link which is carried in this application over a (several) Sa-bit(s) and it may be cross connected at layer 1 in intermediate equipment/NEs. Furthermore, in some applications described in this ETR, it should be possible to cross connect it, and/or to multiplex it, at a higher layer (e.g. at the layer 2).

5 Network reference configurations

Three network reference configurations where the 4 kbit/s data link is applicable have been identified and are described in figures 1 to 3.

Figures 1 to 3 provide reference configurations with ITU-T Recommendation M.3010 [7] terminology.

The first configuration (see figure 1) deals with 2 048 kbit/s signals formatted according to ITU-T Recommendation G.704 [3] that connect equipment located in customer premises (PABX, PFM) over the public network. The telecommunications organization supplies and maintains access to public network for the equipment and Telecommunication Management Network (TMN) functions are limited to the digital section. The equipment management system is not connected to the TMN.

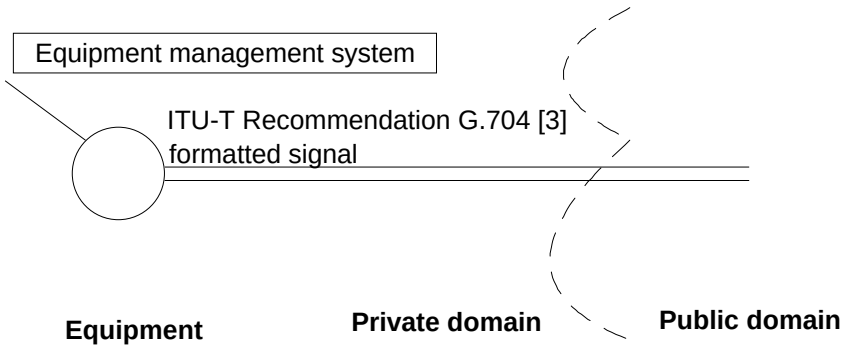


Figure 1: Network reference configuration

The second configuration (see figure 2) is modelling 2 048 kbit/s signals formatted according to ITU-T Recommendation G.704 [3] within the public domain. The telecommunications organization provides and maintains ITU-T Recommendation G.704 [3] transmission facilities, NE and digital services. The NE has access to the TMN via a Q interface.

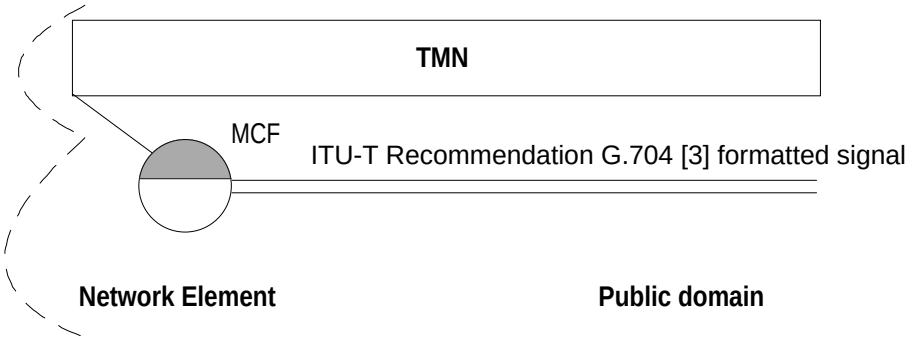
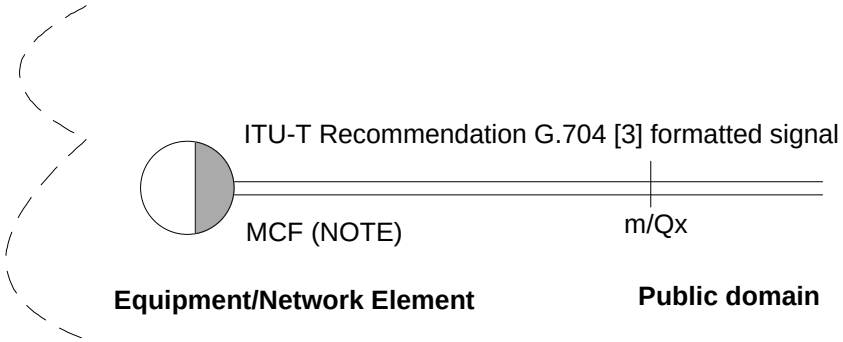


Figure 2: Network reference configuration

The third configuration (see figure 3) models 2 048 kbit/s signals formatted according to ITU-T Recommendation G.704 [3] within the public domain. The telecommunications organization provides and maintains ITU-T Recommendation G.704 [3] transmission facilities, equipment/NE and digital services. The equipment/NE has access to the TMN via the 4 kbit/s data link (m interface or Qx interface according to ITU-T Recommendation M.3010 [7].



NOTE: In case of a Qx interface.
m/Qx are provided by the 4 kbit/s data link.

Figure 3: Network reference configuration

6 Applications

This Clause gives some typical applications which may be considered for the use of the 4 (or n x 4) kbit/s data link into a 2 048 kbit/s frame in relation with network configurations given in Clause 6.

NOTE: Four applications are described hereafter and may correspond to situations faced by telecommunications organizations. Additional applications are not precluded.

6.1 M channel in Integrated Services Digital Network (ISDN) Primary Rate Access (PRA)

Figure 4 describes the related network architecture. It corresponds to the reference configuration given in figure 1a. The digital section for the ISDN PRA between the user-network interface and the local exchange is specified in ETS 300 233 [9]. Spare bits of the ITU-T Recommendation G.704 [3] frame are provisioned by this ETR:

- Sa-4 bit is reserved for the M channel;

- Sa-5 bit and Sa-6 bit are used at the V3 reference point for operation and maintenance of the PRA digital section.

ETS 300 233 [9] defines the M channel as a bi-directional 4 kbit/s data channel in the Sa-4 bit which is transparently transported by the PRA digital section. This channel is provided at the T and V3 reference points for the implementation of management features between the Exchange Termination (ET) and the Network Termination 2 (NT2). It is not precluded that the M channel contributes to a transfer mechanism from NT2 to NT2.

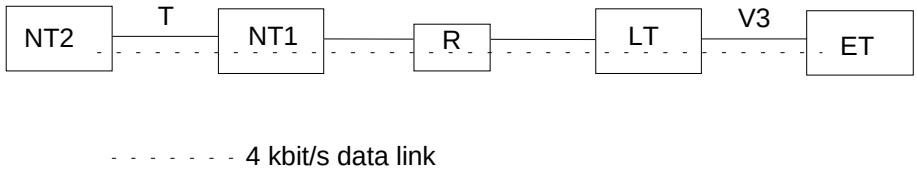
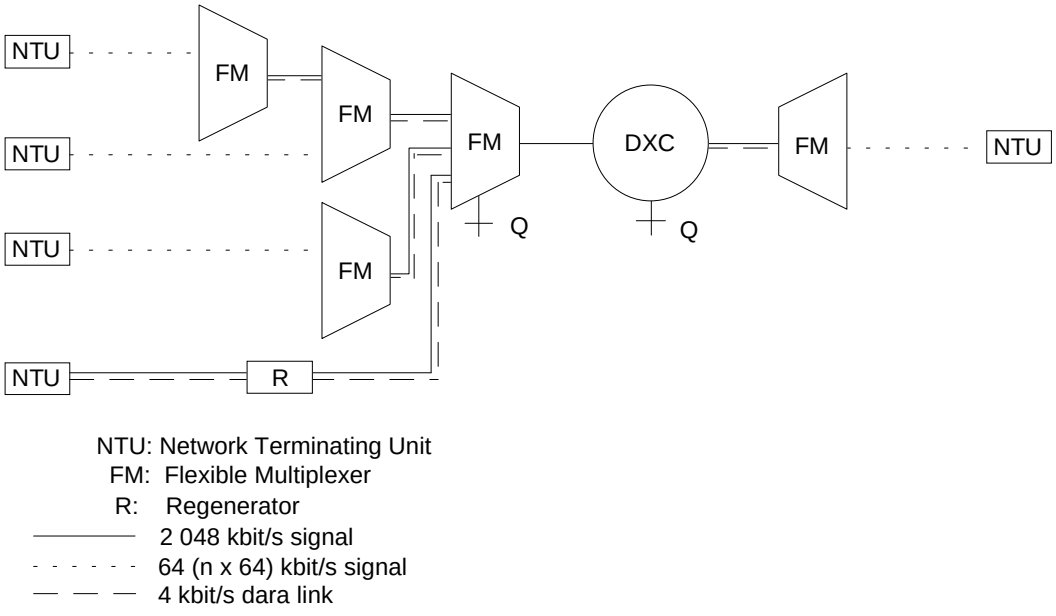


Figure 4: Management of the ISDN PRA

6.2 Digital leased line network

Figure 5 gives a possible architecture of a digital leased line network including equipment provided by the telecommunications organization (Digital Cross Connect Equipment (DXC), FM, Network Terminating Unit (NTU), Regenerator (R)). DXC are specified in ETS 300 010 [6]. NTU and R are not subject for the time being to any standardization. This network architecture contains 2 048 kbit/s signals corresponding to the reference configurations given in figure 1b and figure 1c.



NOTE: For TMN interconnection, it is necessary to implement Q Adapter (QA) or mediation functions when appropriate. These QA or mediation functions may be implemented in the FM or the DXC or another specific equipment.

Figure 5: Example of digital leased line network architecture

In this configuration, the management functions supported by the 4 kbit/s data link may be classified in four categories:

- configuration management: this includes particularly transmission of commands and responses related to the setting of circuit parameters, the selection of the circuit routeing and the selection of network terminating unit bit rate;

- event management: the generation of event notifications concerns NTU, line interface, FM and 2 048 kbit/s interface;

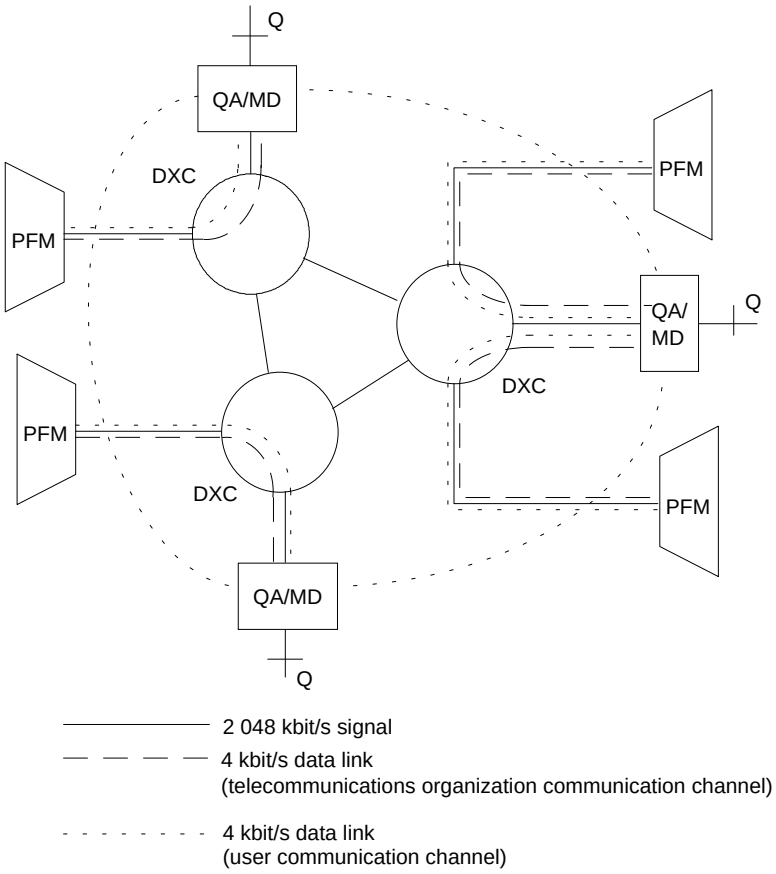
- performance management: a long term performance monitoring may be implemented in the FM and the results transmitted on request over the data link (m or Qx interface). The performance monitoring may be based on ITU-T Recommendations G.826 [10], M.2100 [11] and M.2120 [12]. In this situation and under normal conditions a FM should be requested to send on a one-day basis the results of its calculation. Alternatively, depending on the level of performance degradation (nominal analysis windows are 15 minutes and 24 hours) the nature of the reports could be modified becoming generated spontaneously and periodically;

- maintenance facilities: this includes specific messages for activation/deactivation of remote loop back or internal diagnostic functions.

6.3 Virtual private networking

Figure 6 gives a possible configuration of a private network built by provisioning of leased line through a cross connected leased line network.

The PFM (or PABX or DCE) belongs to the customer or to the telecommunications organization when applied to virtual private networking. In most cases, this equipment is not able to provide a TMN interface. In such a configuration, the 4 kbit/s data link may be used either for customer application or for telecommunications organization application.



NOTE: When PFM (or PABX or DCE) does not delivers a functional Q interface (e.g. does not contain a NE function), it is necessary to implement QA functional block for TMN access. This Q Adapter Function (QAF) may be contained in DXC or another specific equipment. When PFM (or PABX or DCE) delivers a functional Qx interface, it is necessary to implement MD functional block. This MF may be contained in DXC or another specific equipment. The means used for the transfer of user communication messages when collected by the QA/MD is out of the scope of this ETR.

Figure 6: Leased line and virtual private networking

The functions of the 4 kbit/s data link in the telecommunications organization communication channel relate to:

- maintenance of facilities used for transmission of 2 048 kbit/s signals;
- performance management of the digital path at 2 048 kbit/s (refer also to subclause 6.2);
- event management.

6.4 2 048 kbit/s digital leased line management

Figure 7 describes a configuration where a 2 048 kbit/s digital leased line is completed by Performance Monitoring and Test (PMT) devices able to perform non intrusive performance monitoring reporting to centralized performance monitoring and test controller. Under request PMT devices can enter in split mode providing loop back facilities for test purposes.

The 4 kbit/s data link in this context is used to carry performance reports and test control messages. While PMT resides in public domain in the representation given in figure 7, it may as well belongs to private domain. Reference configurations given in figure 1a and figure 1c apply respectively.

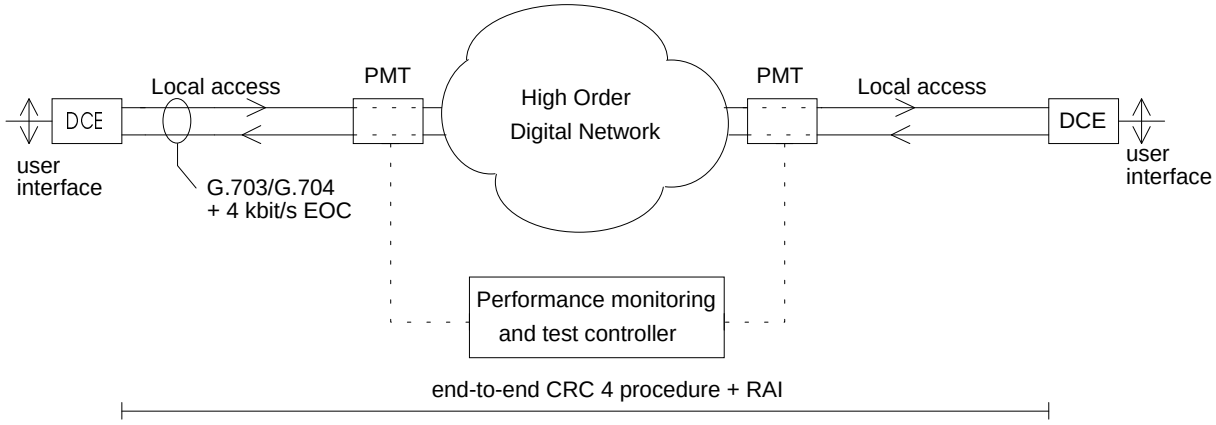


Figure 7: 2 048 kbit/s digital leased line service management

7 Simplified protocol stacks

One of the following protocols should be implemented in equipment when 4 kbit/s data link is used for management purposes. Layers 1, 2 and 3 are presented in detail in Annex A. An example for application layer for the m interface is given in Annex B.

7.1 Protocol stack for Qx interface

- Layer 1: Synchronous 4 kbit/s on Sa-bit 4 (optionally one other Sa-bit can be chosen instead);
- Layer 2: LAP4K;
- Layer 3: ISO 8473;
- Layer 4: not used;
- Layer 5: not used;
- Layer 6: not used;
- Layer 7: CMISE/ROSE, ASN.1 Basic Encoding Rules X.209.

7.2 Protocol stack for m interface

- Layer 1: Synchronous 4 kbit/s on Sa-bit 4 (optionally one other Sa-bit can be chosen instead);
- Layer 2: LAP4K;
- Layer 3: ISO 8473;
- Layer 4: not used;
- Layer 5: not used;
- Layer 6: not used;
- Layer 7: not to be standardized.

7.3 Layer 1 for n x 4 kbit/s data link

The use of other(s) Sa-bit (e.g. from Sa-5 to Sa-8) is suggested in order to provide additional transmission capacity for the EOC with a granularity of 4 kbit/s and not exceeding 20 kbit/s.

7.4 Provision of multiple EOC

It is not precluded to provide more than one data link by the use of different Sa-bit in a single 2 048 kbit/s ITU-T Recommendation G.704 [3] frame. This requirement should be detailed in the specification of related equipment and corresponding management functions.

7.5 Alternative layer 1 provision

Depending on the application or considering the functions available in a given network it could be required to use a complete time slot (TS) of the ITU-T Recommendation G.704 [3] frame instead of a Sa-bit of TS0. In this situation, the data link should have a bit rate of 64 kbit/s. This is out of the scope of this ETR but this situation could be considered either for application of the full protocol stack or for application of the simplified protocol.

Annex A: Simplified protocol for the 4 kbit/s data link, layers 1, 2 and 3 description

A.1 Principle

This Annex describes a minimum set of requirements applicable to the implementation of an EOC allowing management of equipment having 2 048 kbit/s signals based on ITU-T Recommendation G.704 [3] at the aggregate (or at the aggregate and tributary) side(s) in an economic way. The requirements do not intend to cover the application layer which is too dependant of real hardware or software implementation in the equipment as well as of telecommunication organization needs. But it should allow an easy interconnection of pieces of equipment provided by various vendors for the transfer of the related structured information.

For a clear understanding of the following requirements it should be noted that:

- the routeing functions and addressing in the network where the protocols apply, are performed by layer 2 by means of a frame relay type protocol;

- the segmentation functions, if needed, are performed by layer 3. The addressing function in layer 3 is only required for its sub-addressing capability and has no relation with the routeing process of messages in the network where the protocols apply.

A.2 Physical layer

Bit Sa-4 should be selected as a first candidate for the transport of a single 4 kbit/s data link. Alternatively, or if a second independent 4 kbit/s data link is needed, bit Sa-8 should be selected instead, or in addition.

It is not precluded to extend the available bit rate of a given data link by allocating additional Sa-n bits to this function up to a maximum of 20 kbit/s.

A.3 Link layer

The Link Access Protocol on D channel (LAPD) protocol is taken as a basis for the definition of this layer. This enables addressing function by the use of the TEI and SAPI fields.

A.3.1 Functional characteristics

The following functions of the LAPD protocol are maintained:

- data transfer service of High level Data Link Control (HDLC) type;

- permanent link monitoring.

Concerning the addressing function, TEI and SAPI variables will not characterize any more terminal entity and service access point. For the purpose of this application they are referred as DPI and MPI respectively.

The allocation of DPI and MPI fields is a management function.

NOTE: For point-to-point applications, the DPI and MPI fields may not be configurable and consequently may have fixed values.

A.3.1.1 Frame structure

LAPD envelope is maintained for the frame structure. This is given in figure A.1.

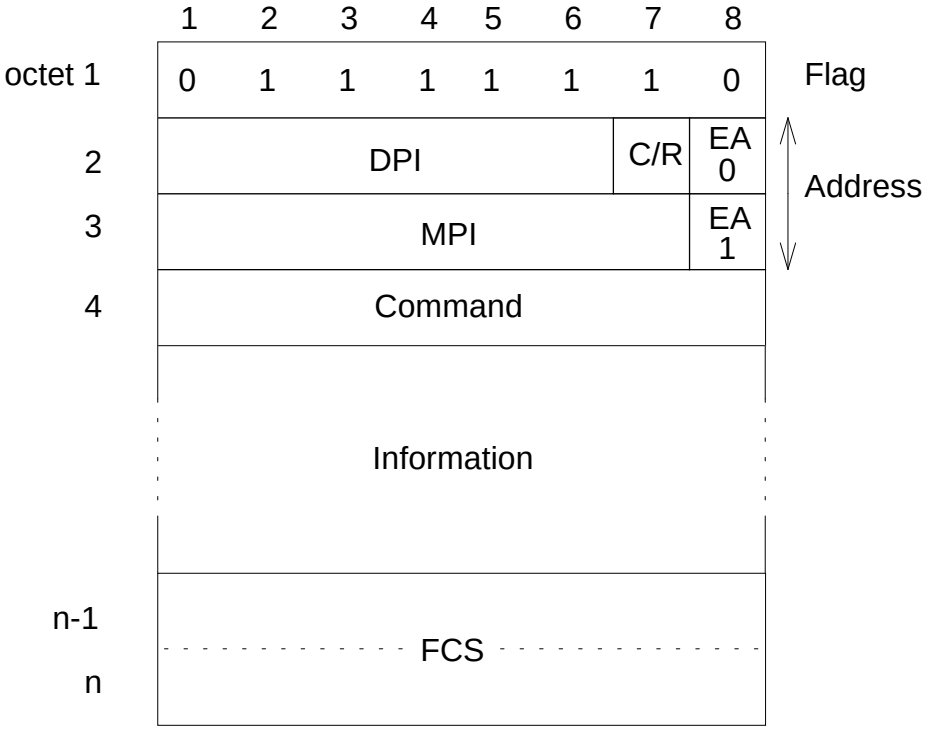
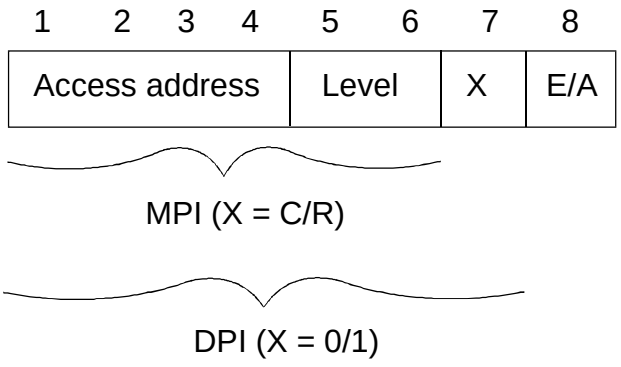


Figure A.1: Frame structure

Address field

Addressing functions are different from the standard LAPD. The communication relationship envisaged for the 4 kbit/s data link are limited, therefore, a simpler addressing scheme than the standard LAPD is used. Functional parts of a given equipment are sub-addressed at the layer 3 level.



Level: Indicates the level of cascading of a given node.
Access address: Access on which is connected a node.

Figure A.2: MPI and DPI fields

EA: Extension of Address field.

C/R: Command/Response.

Network	--> User	C/R = 1
User	--> Network	C/R = 0

MPI/DPI: Identifier of the transmitting or Receiving node depending on the transfer direction

Network	--> User	DPI = destination address, MPI = source address
User	--> Network	DPI = source address, MPI = destination address

Considering a same addressing capability for both DPI and MPI (6-bit coding), it is possible to consider structures containing up to 64 nodes. This figure seems convenient when considering existing networks. Figure A.2 summarizes the content of DPI and MPI in the addressing function. It is not precluded to leave the possibility to use the 7 bits of the DPI field for the node addressing function giving the possibility to connect to 128 nodes in a given configuration.

In order to enable and end to end message transfer function, when this function is part of the service provided by the telecommunication organization, the MPI code "000000" may be reserved to indicate the pass through mode to intermediate equipment for the corresponding frame.

Creation or deletion of a node (flexible multiplexer for example) is subject to the attribution or the suppression of its address at the management level. This implies address allocation depending on available addresses and information derived from a routeing table.

Command field

As in standard LAPD with the 3 formats: information; supervision; and unnumbered.

Error check

Based on the FCS field.

A.3.1.2 Flow control

Use of frame numbering and anticipation window. The frames transfer is controlled by the use of RR and RNR commands associated to counters and timers.

A.4 Network layer

The connectionless mode protocol ISO 8473 [8] is retained for the following use:

- sub-addressing capability for specific functional bloc or access;
- segmentation of long messages;
- allocation of priority level to the various types of messages (alarm, maintenance, etc.).

When the application does not require these functions, the inactive mode for the ISO 8473 [8] should be configured.

Network Protocol Data Units (NPDUs) are transferred from node to node in accordance to a mapping (routeing) table stored in any node. Routeing tables are to be modified when the access configuration to the node is modified.

A.4.1 Functional characteristics

NPDU format for the full protocol use is presented in figure A.4. When the protocol ISO 8473 [8] is in inactive mode, the NPDU format is that given in figure A.3.

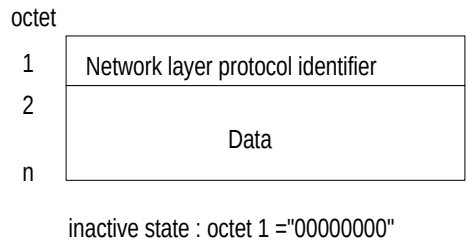


Figure A.3: NPDU format in inactive mode

A.4.1.1 Header field

The header is 7 octet long.

Octet 5 specifies:

Segmentation

- SP = 1 corresponds to message segmentation:

  MS = 1 --> the current Protocol Data Unit (PDU) is not last;

  MS = 0 --> the current PDU ends a message.

- SP = 0 when there is no segmentation:

  MS = 0 --> the segmentation field is not present.

E/R = 0 (no error report)

It is considered that the error check procedure at the link level is sufficient.

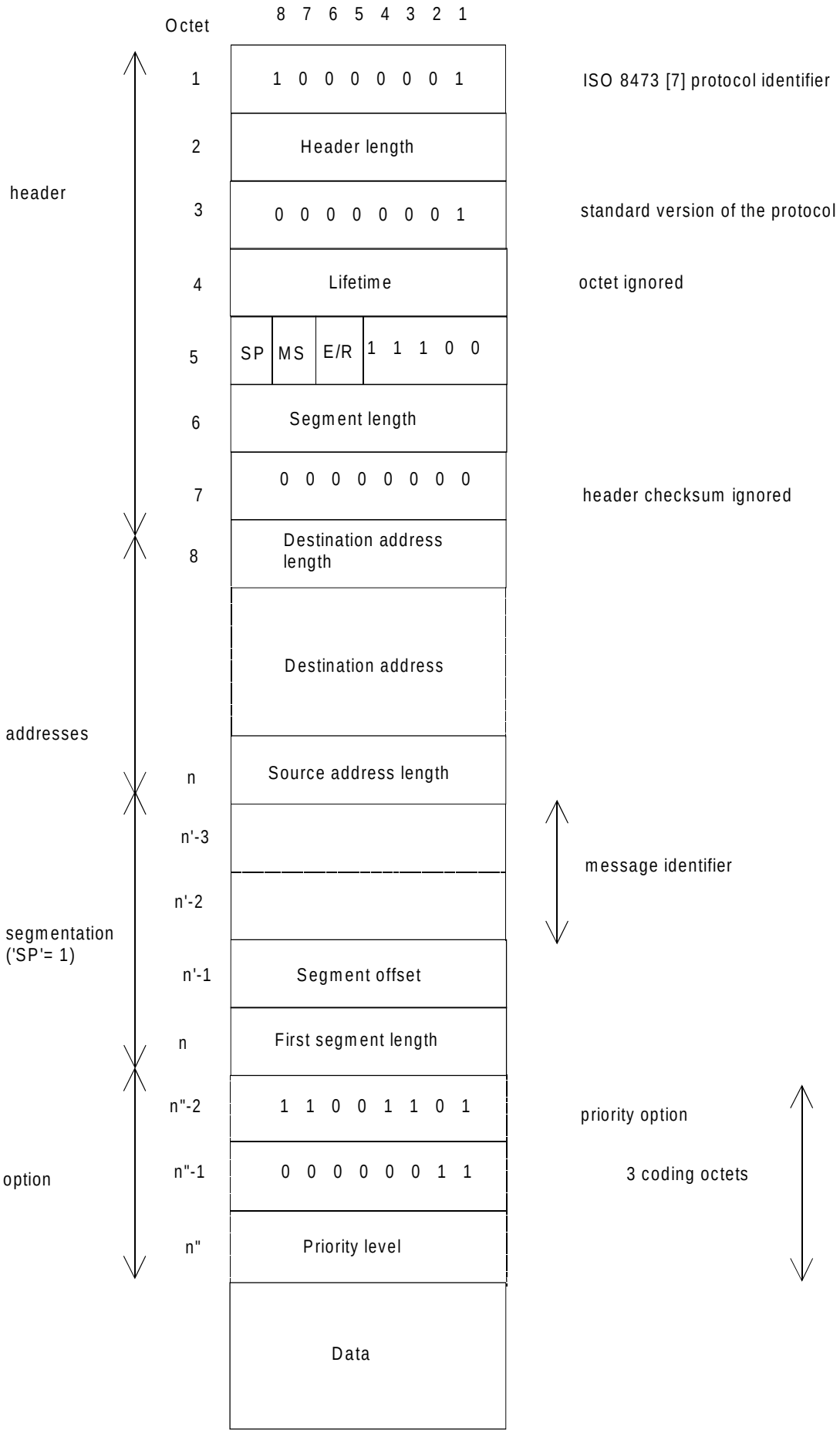


Figure A.4: ISO 8473 [8] protocol: NPDU format

Type = "11100"

Indicates that the PDU only transports data.

Segment length

Indicates the total octet number within the PDU.

Octet 7 = "00000000"

as E/R = "0".

A.4.1.2 Address field

Content of addresses may be specific to the application and not complying to that of ISO 8348 which defines the source and destination address formats in the transport network. the following requirements are suggested:

No use of source address, length = 0.

Destination address may be structure according to either physical or functional or logical implementation.

A.4.1.3 Segmentation field

Message identifier: characterizes the transported message.

Segment offset: by multiple of 8 octets, indicates the location of the data in the segment in the message.

A.4.1.4 Option field

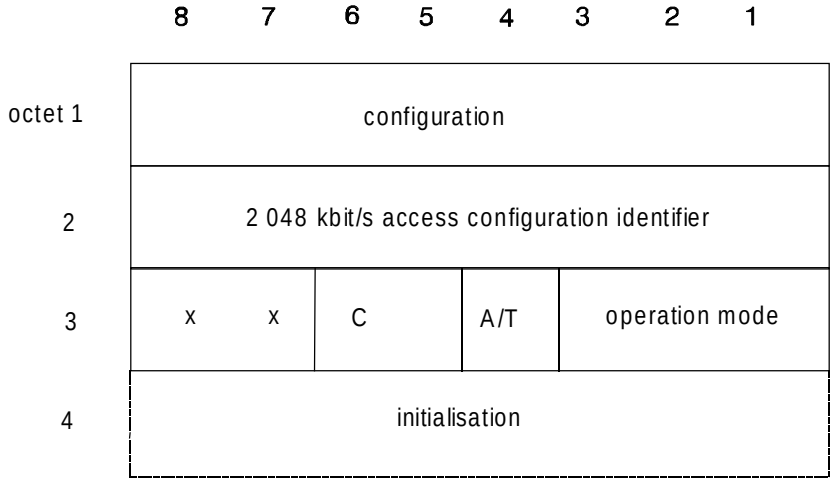
Specifies the level of priority of the transmitted message. Thus, alarm reports and maintenance message may be considered prior to any other kind.

A.4.1.5 Data field

The size is variable. Octet allocation may be considered at a later stage. Octets 1 and 2 could contain information on the category and type of the transported message. That could be used for a faster process at the destination point.

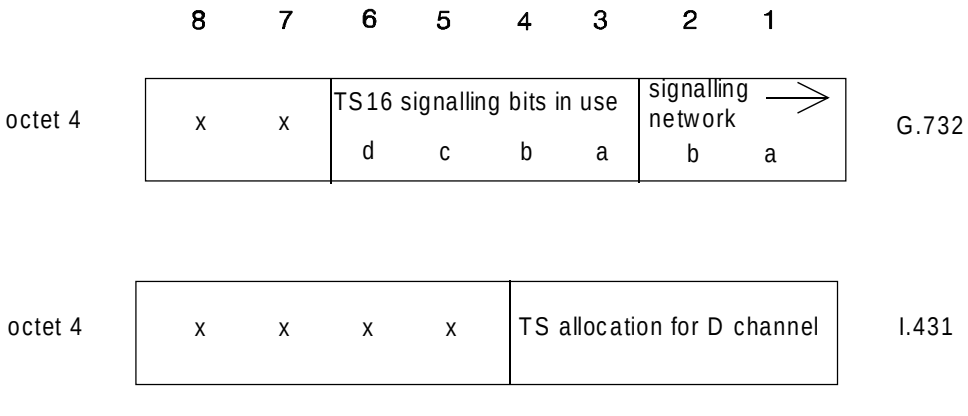
Annex B: Example of configuration messages for a 2 048 kbit/s access protocol stack for the m interface

This Annex presents examples of data field in the protocol used for the m interface. It presents neither a mandatory or a recommended aspect for a real implementation of the protocol.



operation mode
ITU-T Recommendation G.736
ITU-T Recommendation G.732 [5]
ITU-T Recommendation G.704 [3]
ITU-T Recommendation I.431
ONP
* .....

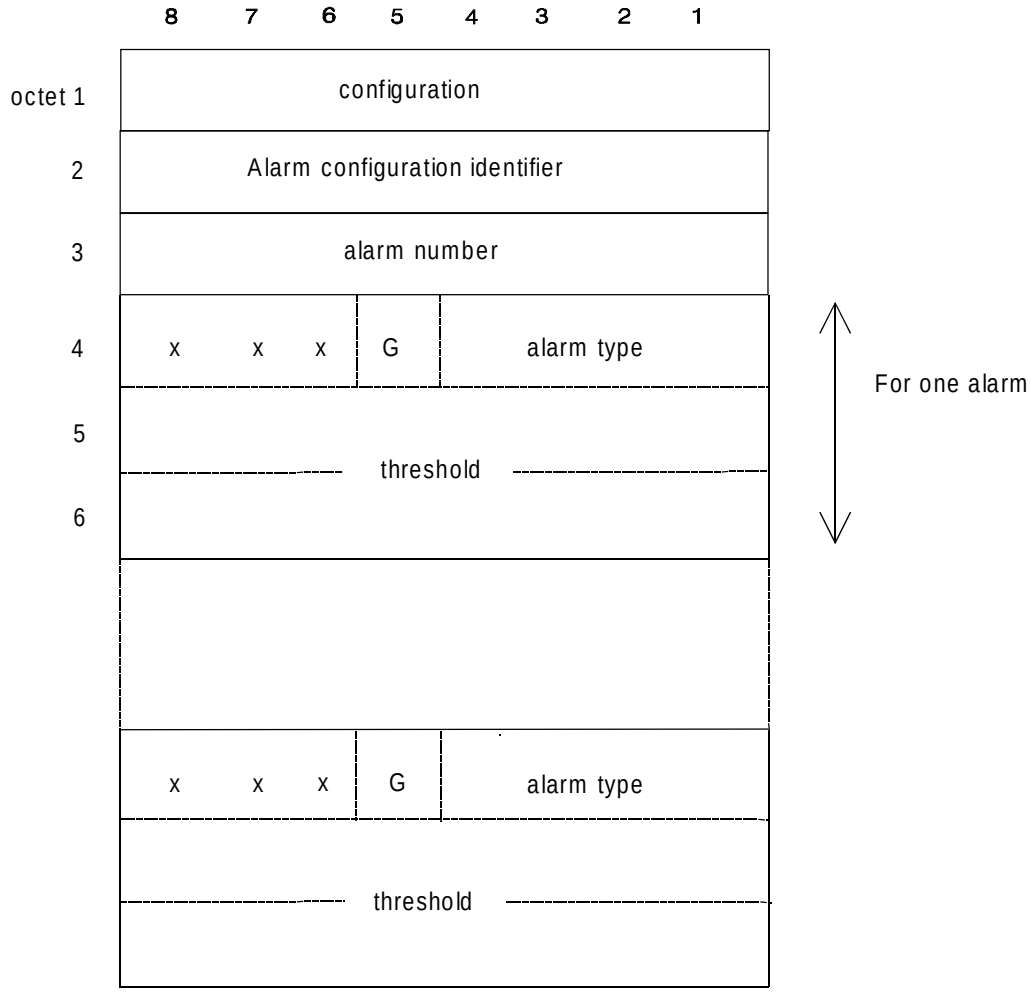
A/T: Aggregate/Tributary.
C: Use of 4 kbit/s data link.



Signalling → network: a and b bit in case of failure.

TS16 signalling bits in use: 0 = use, 1 = unused.

Figure B.1: 2 048 kbit/s access card configuration of operation mode



alarm type : an alarm to consider

"G'= 0 -> minor alarm
"G'= 1 -> major alarm

Threshold : threshold associated to a failure when an event counter or a timer is associated (set to 0 if not used)

* information field could contain up to 60 octets

Figure B.2: Alarm configuration

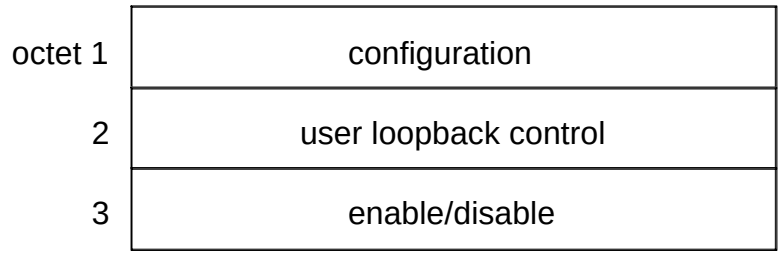


Figure B.3: Maintenance enabling

History

Document history	
August 1994	First Edition
March 1996	Converted into Adobe Acrobat Portable Document Format (PDF)