EUROPEAN TELECOMMUNICATION STANDARD

ETS 300 211

December 1992

Source: ETSI TC-NA

Reference: DE/NA-053020

ICS: 33.040

Key words: Network, MAN, principles

Network Aspects (NA); Metropolitan Area Network (MAN) Principles and architecture

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Contents

Foreword

This European Telecommunication Standard (ETS) has been prepared by the Network Aspects (NA) Technical Committee of the European Telecommunications Standards Institute (ETSI).

This ETS describes the basic principles of the European Metropolitan Area Network (MAN) concept and is elaborated, taking into account the following:

- the emerging demand for multi-megabit communication services, especially for business users;

- the availability of new network technology based on distributed access over a shared broadband medium;

- the strategic need that the development and introduction of MAN products in Europe be driven by adequate ETSI standards;

- the requirement that MAN standardisation takes into account ongoing standardisation work on Broadband Integrated Services Digital Network (B-ISDN) and generate the necessary output so as to influence B-ISDN development.

MANs will promote B-ISDN by enabling network operators to timely offer a subset of B-ISDN services; in this way, user demand and provision of MANs should provide a graceful evolution towards B-ISDN by facilitating the access to this network.

The description of interworking aspects between the MAN and the transit network will be provided in the relevant ETSI documents.

General aspects of MAN management are defined in this ETS. More detailed information will be provided in the relevant ETSI documents.

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1 Scope

This European Telecommunication Standard (ETS) describes the basic principles and network architecture for an European Metropolitan Area Network (MAN).

This ETS defines and describes the MAN reference configuration and the functional blocks between the Customer Network (CN) and the MAN Switching System (MSS), which is described in Annex A (informative).

In addition, this ETS defines the protocol reference model for MANs, and is the basis for the development of companion ETSs related to MAN protocols (ETS 300 212 to ETS 300 216, [19] to [23], inclusive).

General aspects of MAN management are also defined in this ETS.

The MAN definition takes into account the final goal of providing an easy integration with Broadband Integrated Services Digital Network (B-ISDN).

The protocol chosen as the basis for this ETS is the IEEE Standard 802.6 [1].

The specification of performance figures is outside the scope of this ETS.

2 Normative references

This ETS incorporates, by dated or 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 ETS only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

[1] IEEE Standard 802.6 (1990): "Distributed Queue Dual Bus (DQDB) Subnetwork of a metropolitan area network (MAN)".

[2] CCITT Recommendation I.431 (1988): "Primary rate user-network interface - Layer 1 specification".

[3] CCITT Recommendation M.30 (1989): "Principles for a telecommunications management network".

[4] CCITT Recommendation X.200 (1988): "Reference model of open systems interconnection for CCITT applications".

[5] CCITT Recommendation I.113 (1991): "Vocabulary of terms for broadband aspects of ISDN".

[6] CCITT Recommendation I.121 (1991): "Broadband aspects of ISDN".

[7] CCITT Recommendation I.150 (1991): "B-ISDN asynchronous transfer mode functional characteristics".

[8] CCITT Recommendation I.211 (1991): "B-ISDN service aspects".

[9] CCITT Recommendation I.311 (1991): "B-ISDN general network aspects".

[10] CCITT Recommendation I.321 (1991): "B-ISDN protocol reference model and its application".

[11] CCITT Recommendation I.327 (1991): "B-ISDN functional architecture".

[12] CCITT Recommendation I.361 (1991): "B-ISDN ATM layer specification".

[13] CCITT Recommendation I.362 (1991): "B-ISDN ATM adaptation layer (AAL) functional description".

[14] CCITT Recommendation I.363 (1991): "B-ISDN ATM adaptation layer (AAL) specification".

[15] CCITT Recommendation I.413 (1991): "B-ISDN user network interface".

[16] CCITT Recommendation I.432 (1991): "B-ISDN user network interface Physical layer specification".

[17] CCITT Recommendation I.610 (1991): "OAM principles of the B-ISDN access".

[18] ISO/IEC 10038: "Information technology - Telecommunications and information exchange between systems - Local area network - Media access control (MAC) bridges".

[19] ETS 300 212 (1992): "Network Aspects (NA); Metropolitan Area Network (MAN) Media access control layer and physical layer specification".

[20] ETS 300 213 (1992): "Network Aspects (NA); Metropolitan Area Network (MAN) Physical layer convergence procedure for 2,048 Mbit/s".

[21] ETS 300 214 (1992): "Network Aspects (NA); Metropolitan Area Network (MAN) Physical layer convergence procedure for 34,368 Mbit/s".

[22] ETS 300 215 (1992): "Network Aspects (NA); Metropolitan Area Network (MAN) Physical layer convergence procedure for 139,264 Mbit/s".

[23] ETS 300 216 (1992): "Network Aspects (NA); Metropolitan Area Network (MAN) Physical layer convergence procedure for 155,520 Mbit/s".

[24] ETS 300 217, Parts 1 to 4 (1992): "Network Aspects (NA); Connectionless Broadband Data Service (CBDS)".

[25] ISO/IEC 8802-3 (1990): "Information processing systems - Local area networks - Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications".

[26] ISO/IEC 8802-5 (1992): "Information processing systems - Local and metropolitan area networks - Part 5: Token ring access method and physical layer specifications".

[27] IEEE Standard 802.3b (1988): "Broadband Medium Attachment Unit and Broadband Medium Specifications, Type 10 BROAD36".

[28] IEEE Standard 802.3i (1990) (supplement to 802.3, (1990) edition): "System Considerations for Multi-Segment 10MB/S Baseband Networks (Section 13) and Medium Attachment Unit and Baseband Medium specification, Type 10 Base-T (Section 14)".

[29] IEEE Standard 802.1 (1990): "Local Area Network and Metropolitan Area Network - Overview and architecture".

[30] CCITT Recommendation E.164 (1991): "Numbering plan for the ISDN era".

[31] CCITT X.700 Recommendation Series (1988) on System management.

[32] CCITT Recommendation I.411 (1988): "ISDN user-network interfaces - Reference configurations".

[33] CCITT Recommendation I.320 (1988): "ISDN protocol reference model".

[34] ISO 9314 (1989): "Information processing systems - Fiber Distributed Data Interface (FDDI)".

[35] prETS 300 273: "Network Aspects (NA); Metropolitan Area Network (MAN) Medium Access Control (MAC) layer management".

[36] prETS 300 275: "Network Aspects (NA); Metropolitan Area Network (MAN) Interconnection of MANs".

[37] prETS 300 276: "Network Aspects (NA); Metropolitan Area Network (MAN) Physical layer convergence procedure for 622,080 Mbit/s CCITT Recommendations G.707, G.708 and G.709 SHD based systems".

[38] prETS 300 268: "Network Aspects (NA); Metropolitan Area Network (MAN) Protocol Implementation Conformance Statement (PICS)".

[39] ISO/IEC TR 9575 (1990): "Information technology - Telecommunications and information exchange between systems - OSI Routing Framework".

[40] CCITT Recommendation G.773 (1990): "Protocol suites for Q-interfaces for management of transmission systems".

3 Definitions and abbreviations

This Clause consists primarily of those terms and definitions that are considered essential to the understanding and application of the principles of MANs.

3.1 Definitions

For the purposes of this ETS, the following definitions apply.

3.1.1 Interfaces

101 **Inter MAN Systems Interface (IMSI) :** IMSI is a generic term that correspond to a family of interfaces. These interfaces apply between two MSSs or between the MSS and the Transit Network. As far as the direct interconnection between MSSs is concern, corresponding interfaces are described in ETS 300 275 [36], the specification of the interconnection via Asynchronous Transfer Mode (ATM) links will be provided in another ETSI document.

102 **User MAN Interface (UMI):** interface between the CN and the Access Facility 1 (AF1).

103 **User Specific Interface (USI):** interface based on a user specific protocol.

3.1.2 Network elements

201 **Shared medium:** transmission facility whose capacity is shared among several users.

202 **Access Node (AN):** the network element located in the Customer EQuipment (CEQ) which performs the interfacing of various customer related protocols with the Distributed Queue Dual Bus (DQDB) protocol.

203 **Terminal Equipment (TE):** user terminals. The term "terminal" is used in a broad sense with different levels of complexity and functionality.

204 **Customer Network (CN):** the CN is defined between the T_M and S_M reference points.

205 **Customer EQuipment (CEQ):** the concatenation of equipment on the user side of the T_M reference point. In the case of multiple access, the CEQ includes all the equipment on the user side of all those accesses comprising the multiple access.

206 **Access Facility (AF):** the network segment that connects the CN to the MAN Switching System (MSS). The functionality of the AF may vary.

207 **Access Facility 1 (AF1):** an AF which only consists of a DQDB link between the CEQ and the MSS.

208 **Access Facility 2 (AF2):** an AF which consists of a gathering network.

209 **Gathering network:** a network which consists of several interconnected public MAN nodes.

210 **Metropolitan Area Network (MAN):** digital network based on a shared access broadband medium. A MAN covers an urban or metropolitan area (typically in the range of 50 km in diameter). A MAN is composed of one MSS and one or more AFs connected to the MSS. Remote MANs can be interconnected in order to cover a larger area by means of public Transit Network (TN) facilities. A MAN is a means to provide the support of narrowband and broadband services integrated in the same network.

211 **MAN Switching System (MSS):** a collection of functions that provides high-speed switching in the public network. It can be implemented through distributed or centralised switching.

212 **MAN Node (MN):** a network element, located in the public domain, performing the interfacing between the CEQ and the IEEE Standard 802.6 [1] DQDB protocol.

213 **Transit Network (TN) :** a network which provides transmission, switching and management functions to allow MSS interconnection. It can be implemented through point-to-point links, digital cross-connect, B-ISDN transit node, etc.

3.1.3 Functions

301 **DQDB Access Functions (DAF):** protocol functions required to receive and transmit information over the shared medium between different nodes. Functions for the management of the DQDB subnetwork are also contained in DAF.

302 **DQDB Access Termination (DAT):** functions within the MSS which consist of the DAF and Service Specific Function (SSF) functional blocks.

303 **Service Specific Functions (SSF):** those functions required for the provision of the connectionless, connection-oriented isochronous and connection-oriented non-isochronous services.

304 **User Access Functions (UAF):** the functionality to access a user specific network or a directly attached terminal.

3.1.4 Services

401 **Connectionless service:** a service, supporting the transfer of variable length data units that can tolerate variable delay but require error detection functions and without the establishment of an end to end connection. This service is described in ETS 300 217 [24] and is comparable to the "packet-oriented" Medium Access Control (MAC) service of ISO/IEC 8802 [25], Local Area Networks (LANs).

402 **Connection-oriented isochronous service:** a service which is oriented to the transport of isochronous data (e.g. conventional digitised voice); "isochronous" means that the time characteristic of an event or signal is recurring at known, periodic time intervals (as defined in IEEE Standard 802.6 [1]). The precise definition of this service is outside the scope of this ETS and is for further study.

403 **Connection-oriented non-isochronous service:** a service supporting the transfer, over a virtual channel, of information flows segmented into fixed-length cells having no specified inter-arrival time. The precise definition of this service is outside the scope of this document and is for further study.

3.2 Alphabetical list of terms

206 Access Facility (AF)

207 Access Facility 1 (AF1)

208 Access Facility 2 (AF2)

202 Access Node (AN)

402 Connection-oriented isochronous service

403 Connection-oriented non-isochronous service

401 Connectionless service

205 Customer EQuipment (CEQ)

204 Customer Network (CN)

301 DQDB Access Functions (DAF)

302 DQDB Access Termination (DAT)

209 Gathering network

101 Inter MAN systems Interface (IMSI)

210 Metropolitan Area Network (MAN)

212 MAN Node (MN)

211 MAN Switching System (MSS)

303 Service Specific Functions (SSF)

201 Shared medium

304 User Access Functions (UAF)

102 User MAN Interface (UMI)

103 User Specific Interface (USI)

203 Terminal Equipment (TE)

213 Transit Network (TN)

3.3 Abbreviations

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

ACF Access Control Field

AF Access Facility

AN Access Node

ATM Asynchronous Transfer Mode

AUI Attachment Unit Interface

B-ISDN	Broadband Integrated Services Digital Network
BT	BiT sublayer
C&S	Control & Switching functions
CEQ	Customer EQuipment
CN	Customer Network
CNMS	Customer Network Management Services
CSMA/CD	Carrier Sense Multiple Access with Collision Detection
DAF	DQDB Access Functions
DAT	DQDB Access Termination
DDI	Direct Dialling In
DLSAP	Data Link Service Access Point
DM	Derived MAC sublayer
DM-PDU	Derived MAC Protocol Data Unit
DQDB	Distributed Queue Dual Bus
DTE	Data Terminal Equipment
DXC	Digital Cross-Connect
E-LAN	Extended LAN
EOB	End Of Bus
FDDI	Fibre Distributed Data Interface
HL	Higher Layers
HOB	Head Of Bus
IM	Initial MAC sublayer
IM-PDU	Initial MAC-Protocol Data Unit
IMSI	Inter MAN Systems Interface
ISPBX	Integrated Services Private Branch eXchange
LAN	Local Area Network
LCRF	Local Connection Related Function
LLC	Logical Link Control
LT	Line Termination
M-LT	MAN-Line Termination
M-NT	MAN-Network Termination

MAC	Media Access Control
MAN	Metropolitan Area Network
MAU	Medium Attachment Unit
MDI	Medium Dependent Interface
MIC	Medium Interface Connector
MID	Message IDentifier
MMF	MSS Management Function
MN	MAN Node
MS	Management Services
MSAP	MAC Service Access Point
MSS	MAN Switching System
NMF	Node Management Function
NT	Network Termination
OSI	Open Systems Intercommunication
OUI	Organisationally Unique Identifier
PA	Pre-Arbitrated
PID	Protocol IDentifier
PHY	PHYsical layer
PLS	PhysicaL Signalling
PMA	Physical Medium Attachment
PRM	Protocol Reference Model
QA	Queued Arbitrated
QOS	Quality Of Service
SLT	SLoT sublayer
SLT-PDU	SLot Protocol Data Unit
SM	SegMent sublayer
SM-PDU	SegMent Protocol Data Unit
SNAP	Sub-Network Access Protocol
SSF	Service Specific Functions
SV	SerVice sublayer
TAT	Transit Access Termination

TC	Transmission Convergence sublayer
TCRF	Transit Connection Related Function
TCU	Trunk Coupling Unit
TE	Terminal Equipment
TL	Transit Link
TM	TransMission sublayer
TMN	Telecommunication Management Network
TN	Transit Network
UAF	User Access Functions
UMI	User MAN Interface
USI	User Specific Interface

4 Basic principles

A MAN is defined as a digital network that:

- is oriented to public domain network applications;
- is based on a shared access broadband medium;
- covers an urban or metropolitan area (typically in the range of 50 km in diameter);
- can be interconnected with other remote MANs in order to cover a larger area by means of public transit network facilities, whose specification is outside the scope of this ETS;

and is a means to provide integrated support of narrowband and broadband services (data, voice, video) as supported by bearer services e.g.:

- connectionless service;

  a service, supporting the transfer of variable length data units that can tolerate variable delay but require error detection functions and without the establishment of an end-to-end connection. This service is described in ETS 300 217 [24] and is comparable to the "packet oriented" MAC service of ISO/IEC 8802 [25], Local Area Networks (LANs);

- connection-oriented isochronous service;

  a service which is oriented to the transport of isochronous data; "isochronous" means that the time characteristic of an event or signal is recurring at known, periodic time intervals (as defined in IEEE Standard 802.6 [1]). The precise definition and description of this service and the way to support it are outside the scope of this ETS and are for further study;

- connection-oriented non-isochronous service;

  a service, supporting the transfer, over a virtual channel, of information flows segmented into fixed-length cells that have no specified inter-arrival time. The precise definition and description of this service and the way to support it in a MAN are outside the scope of this ETS and are for further study.

A MAN is oriented to public domain network applications, and is devoted to a multi-user environment. The same basic technologies and architectures can be used in a private environment, as CNs that are identified with the term "Extended LANs" (E-LANs), but the differences in operational and management attributes are substantial.

The field of application of MANs is primarily directed towards large business users.

MAN solutions are intended, in a first phase, mainly for carrying data services, in particular for the interconnection of LANs with resulting service characteristics comparable with those available within a single LAN, mainly in terms of throughput and delay.

As far as the isochronous services are concerned, the provision of primary rate access (CCITT Recommendation I.431 [2]), suitable e.g. for the interconnection of Integrated Services Private Branch eXchanges (ISPBXs), is considered to be of primary interest.

MANs are digital networks based on a shared access broadband medium: a broadband transmission medium (e.g. optical fibre) is shared by network nodes under the control of a distributed multiple access protocol.

MANs play the role of public access/gathering networks to provide multi-megabit communication services to heterogeneous users, in particular to business customers.

With reference to the B-ISDN, the MAN concept is based on "distributed Local Connection Related Functions (LCRF)": customers have access to the network using a shared medium.

The specificity of MANs may require, in some cases, the adoption of concepts and terminology other than those up to now defined by B-ISDN. Additional concepts, terminology, reference configurations, functional groups and reference points are required for MANs.

The IEEE Standard 802.6 [1] DQDB is the distributed multiple access protocol identified as the basis for ETSI MANs, at least for connectionless services. This multiple access protocol is specified in ETS 300 212 [19].

However, where only two DQDB nodes are connected to a dual bus (simple point-to-point configuration) a subset of the full IEEE Standard 802.6 [1] protocol may be implemented.

Simplifications applying in the special case are indicated in ETS 300 268 [38].

Enhancements to the IEEE Standard 802.6 [1] DQDB access method for the support of services with guaranteed constant bit rate and specified transfer delay is defined in ETS 300 276 [37].

The MAN concept includes not only the transmission infrastructure and the access protocol but also the necessary additional functions such as principles for network management and other operational issues, as required in a multi-user environment.

MAN architecture is described in functional terms, and it is recognised that MANs may be implemented in a variety of configurations according to specific situations.

5 Functional architecture

5.1 General architecture

A MAN is composed of one MSS and one or more AFs connected to the MSS. The general architecture for MANs is depicted in figure 1. The CNs are connected to AFs that terminate on MSSs. Several MSSs are interconnected, through the TN, through Inter MAN Systems Interfaces (IMSIs).

At least two options are envisaged for the AFs, as shown in figure 2:

- the first, (AF1), is based on a distributed multiple access protocol with shared medium; the CEQ is connected to this link through the UMI;

- the second one, (AF2), is based on a set of MNs, forming a gathering network; they communicate through a distributed multiple access protocol.

The MSS is a multi-megabit switching system. It may be implemented through distributed or centralised switching technology. The MSS shall provide the following functions:

- provision of AF termination;

- routing of the subscriber communication to the destination AF;

- routing of communication towards other MSSs.

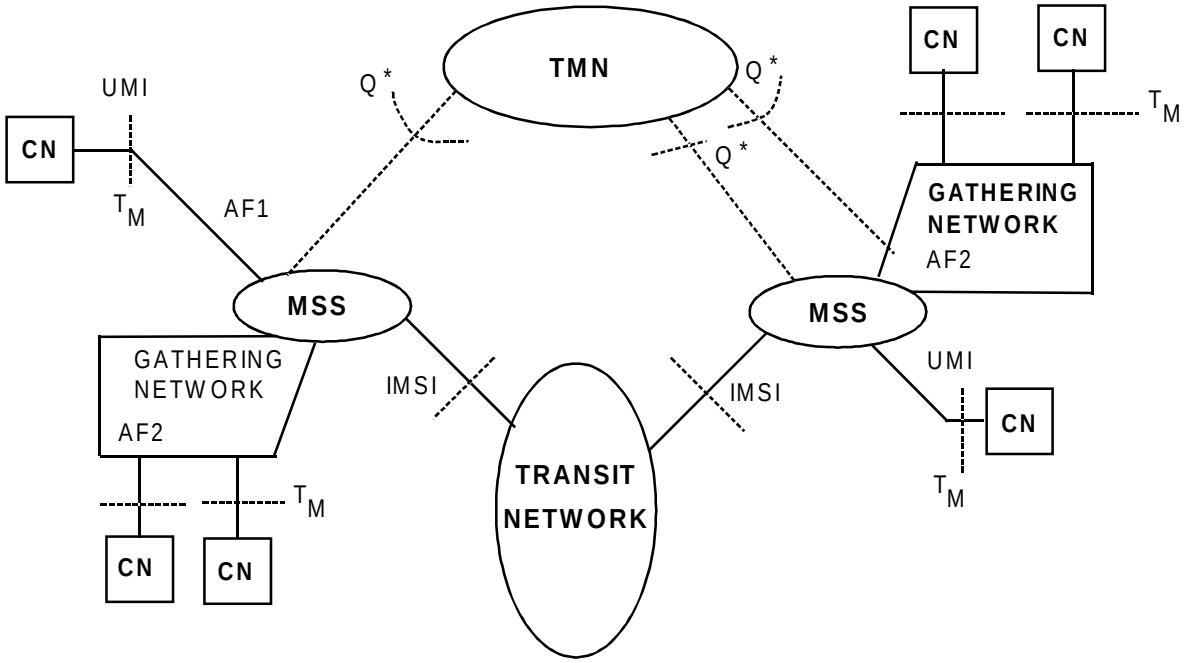
The IMSI links remote MSSs either directly or through the transit network; in this way, larger (e.g. nationwide) networks can be formed. Several options are envisaged for the IMSI, also depending on the time frame, e.g. dedicated links on wide area network carriers, Digital Cross-Connects (DXCs), B-ISDN, etc.

For MAN management, a set of management interfaces Q*, carrying management information to the Telecommunications Management Network (TMN) system, is identified.

The MSS and AFs exchange management information with the TMN management system through Q* interfaces.

General MAN management principles are based on the TMN model of CCITT Recommendation M.30 [3] and are described in Clause 8 of this ETS.

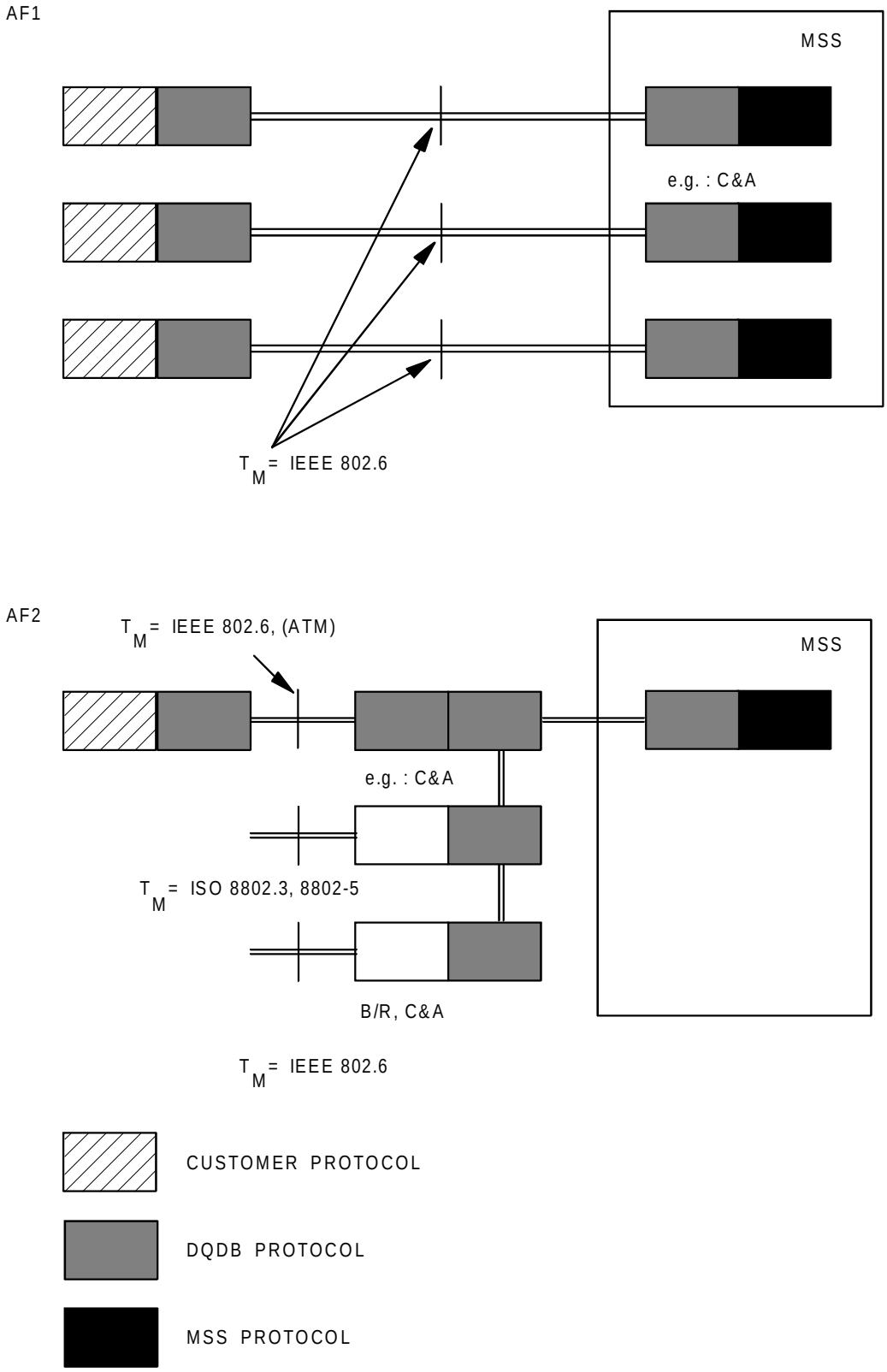
More detailed information will be provided in the relevant ETSI documents (e.g. ETS 300 273 [35]).



AF : Access Facility.
CN : Customer Network.
IMSI : Inter MAN systems Interface.
MSS : MAN Switching System.
Q* : Management Interfaces.
TMN : Telecommunications Management Network.
UMI : User MAN Interface.
TM : T reference point for MANs.

NOTE: For the interfaces of AF2 see subclause 5.3.2.1.

Figure 1: General architectural model for MANs



AF : Access Facility.
B/R : Bridging/Routing.
C&A : Charging & Access control.
MSS : MAN Switching System.

Figure 2: Simplified illustration of the access facilities

5.2 Reference configuration and functions

Figure 3 shows the reference configuration for MANs considered general enough to be applicable for all specific cases of MANs.

Reference points, functional groups and associated functions are described hereafter.

5.2.1 Reference points

The following reference points are identified:

- **T_M:**

  T_M, the T reference point for MAN, represents the boundary between the public network and the CN. It is at the conjunction of the MAN-Network Termination 2 (M-NT2) and the AF.

  In the MAN architecture several interfaces are foreseen at this reference point.

- **Y_M:**

  Y_M, the Y reference point for MAN, is set between the AF and the LCRF functional groups. At this reference point a DQDB-based access interface is implemented.

- **Z_M:**

  Z_M, the Z reference point for MAN, is set between the LCRF and the Transit Link (TL). The interface to be implemented at this reference point is an IMSI type interface.

- **S_M:**

  S_M, the S reference point for MAN, represents the boundary between the TE and the M-NT2.

5.2.2 List of functional groups

In the MAN reference configuration the following functional groups are identified:

- **Terminal Equipment (TE):**

  this functional group, according to CCITT Recommendation I.411 [32], includes functions broadly belonging to layer 1 and higher layers of the reference model of CCITT Recommendation X.200 [4].

Examples of TE functions are:

- user/user and user/machine dialogue and protocol;
- interface termination;
- protocol handling for signalling;
- connection handling to other equipment;
- management functions.

- **MAN-Network Termination 2 (M-NT2):**

  this functional group, according to CCITT Recommendation I.411 [32], includes functions broadly equivalent to layer 1 and higher layers of the reference model of CCITT Recommendation X.200 [4].

  M-NT2 is null in the case of coincidence between S_M and T_M.

Examples of M-NT2 functions are:

- adaptation of functions for different media and topologies;
- functions of distributed M-NT2;
- slot delineation;
- concentration;
- buffering;
- multiplexing and demultiplexing;
- resource allocation;
- management functions;
- signalling protocol handling.

M-NT2 implementations may be concentrated or distributed. In a specific access arrangement the M-NT2 may consist of only physical connections. When present, implementations of the M-NT2 shall be locally powered.

Similar to the CCITT B-ISDN Recommendations[1)], the CN is defined between the T_M and S_M reference points. The CEQ consists of the TE and an optional CN. The CEQ includes the user end-systems (e.g. ISO LANs, Fibre Distributed Data Interface (FDDI) LANs, data, voice or video equipment, IEEE Standard 802.6 [1] DQDB private networks, etc.).

- **Access Facility (AF):**

  the AF connects the CEQ to the LCRF. It is based on a IEEE Standard 802.6 [1] DQDB distributed multiple access protocol on a shared broadband medium. Different cases can be identified, namely:

  AF1: AF is a simple IEEE Standard 802.6 [1] DQDB link between the CEQ and the LCRF;

  AF2: AF includes a set of nodes communicating with each other and with the LCRF through the IEEE Standard 802.6 [1] DQDB protocol.

- **Local Connection Related Function (LCRF):**

  the LCRF corresponds to the MSS of figure 1 and includes the following functions: AF termination, switching, connection to the transit network and maintenance. The implementation of the MSS is not subject to standardisation but it is of interest to describe some examples of possible implementations. In particular, the MSS can be implemented as a centralised switching node, or as a set of nodes communicating with each other (see Annex A).

In the TN the following functional groups are identified:

- **Transit Link (TL):**

  the TL includes the transmission functions required to interconnect the LCRF and the Transit Connection Related Functions (TCRFs).

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1) CCITT Recommendations I.113, I.121, I.150, I.211, I.311, I.321, I.327, I.361, I.362, I.363, I.413, I.432 and I.610: normative references [5] to [17].

- **Transit Connected Related Function (TCRF):**

  the TCRF covers the functions of the TN of figure 1. It is in charge of the interconnection of different LCRFs. It includes switching and maintenance functions. TCRF can be implemented through point-to-point links, DXC, B-ISDN transit nodes, etc.;

  the configuration of the TN shown in figure 3 is one of the different possibilities described in CCITT Recommendation I.327 [11].

5.2.3 List of functions

The following functions are found in the identified functional groups. The functions which are relevant to the MSS only, are described in Annex A.

- **User Access Functions (UAF):**

  UAF contain the functions of accessing a user specific network or a directly attached terminal. In the case of the connectionless service the UAF performs the functionality of the physical and MAC layer of the user network protocol, for example, the ISO/IEC 8802-3 [25], 8802-5 [26] or ISO 9314 [34] Fiber Distributed Data Interface (FDDI) protocol.

- **Service Specific Functions (SSF):**

  the SSF contain all functions required for the provision of the services supported by MANs.

  In the case of the connectionless service the SSF may perform one or more of the following functions:

  - address validation (see ETS 300 217 [24]);
  - address screening (see ETS 300 217 [24]);
  - access class enforcement (see ETS 300 217 [24]);
  - charging support (see ETS 300 217 [24]);
  - multiplexing and demultiplexing;
  - encapsulation (see subclause 6.3);
  - bridging (see ISO/IEC 10038 [18]);
  - routing (see ISO/IEC TR 9575 [39]).

  In essence, those functions that are related with network integrity issues are denoted by SSF1 and include: address validation, address screening, access class enforcement, multiplexing and demultiplexing, filtering and forwarding. In addition, other functions like charging support may be included.

  Those functions that are related with relaying issues are denoted by SSF2 and include: encapsulation, bridging and routing. Other functions may be included.

- **DQDB Access Functions (DAF):**

  The DAF contain the functions required to receive and transmit information over a shared medium. In the case of the IEEE Standard 802.6 [1] DQDB protocol, the block performs the functionality of the PHYsical layer (PHY) and DQDB layer as described in subclause 6.2, as well as the functions for management of the DQDB subnetwork.

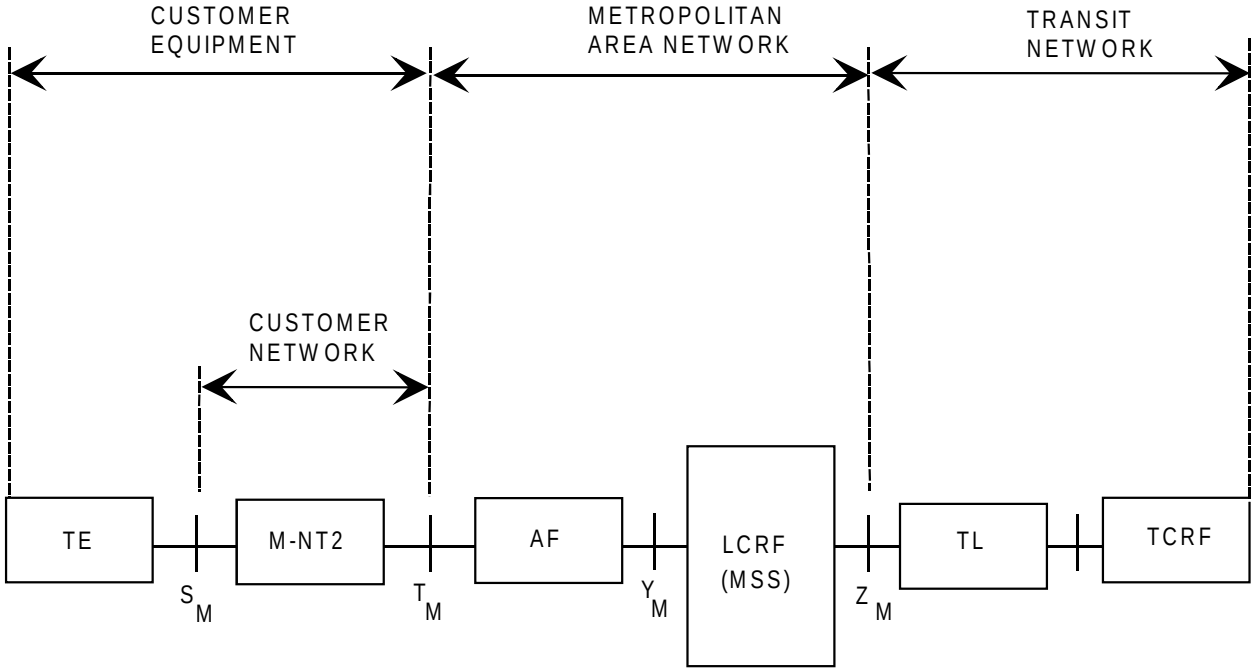
- **M-NT1 and MAN-Line Termination (M-LT):**

  these terminate the transmission line between the public network and the subscriber: they are required to provide functions broadly equivalent to the physical layer of the ISO Open Systems Interconnection (OSI) reference model including:

  - line transmission termination;
  - transmission interface handling;
  - management functions.

  In addition, the M-NT1 is the physical termination of the public network.

  Whether or not the functionalities of the M-NT1 and M-LT are identical to the ones specified in CCITT Recommendation I.411 [32] is for further study.



AF : Access Facility.
LCRF : Local Connection Related Functions.
MSS : MAN Switching System.
M-NT2 : MAN Network Termination 2.
TCRF : Transit Connection Related Function.
TE : Terminal Equipment.
TL : Transit Link.

Figure 3: MAN reference configuration

5.3 Access Facilities (AFs)

The AF connects the CEQ to the MSS. The AF is delimited by two reference points, T_M and Y_M, as depicted in figure 3.

The functionality of the AF may vary from case to case and at least two cases have been identified.

The DQDB protocol mentioned hereafter is described in IEEE Standard 802.6 [1] and is specified in ETS 300 212 [19]:

- AF1 is based on the IEEE Standard 802.6 [1] DQDB protocol, which is a distributed, multiple access protocol. The interface at the T_M reference point is referred to as the UMI, and the CEQ may consist of one or more nodes connected to the dual bus. The AF1 contains the M-NT1 and the MAN-Line Termination (M-LT). The M-NT1 clearly demarcates the boundary between the public network and the CN. This case is further described in subclause 5.3.1;

- AF2 is based on a set of nodes interconnected together forming a gathering network. The nodes are interconnected using the same IEEE Standard 802.6 [1] DQDB based protocol used in AF1 above. Each node can serve one or more CEQs. The nodes of the AF2 are under the control and supervision of the network operator. This case is further described in subclause 5.3.2.

The IEEE Standard 802.6 [1] DQDB protocol can be applied to two different subnetwork topologies:

- the open bus topology;

- the looped bus topology.

The applicability of these two topologies to AF configurations is described in Annex A.

5.3.1 Access facility 1 (AF1)

Figure 4 shows the functional configuration of AF1. The model is not intended to require or exclude any specific implementation, but to provide a guide for the specification of AF functions and their distribution and allocation.

The functions identified in figure 4 are described in subclause 5.2.3.

The CEQ is connected to the public MSS via an access link. The interface between the CEQ and the AF is referred to as the UMI and is located at the T_M reference point.

An M-NT1 located within AF1 demarcates the area of responsibility between the network operator and the customer.

The CEQ communicates with the MSS via a protocol based on the IEEE Standard 802.6 [1], DQDB protocol.

The CEQ may include more than one AN communicating by means of the IEEE Standard 802.6 [1] DQDB protocol.

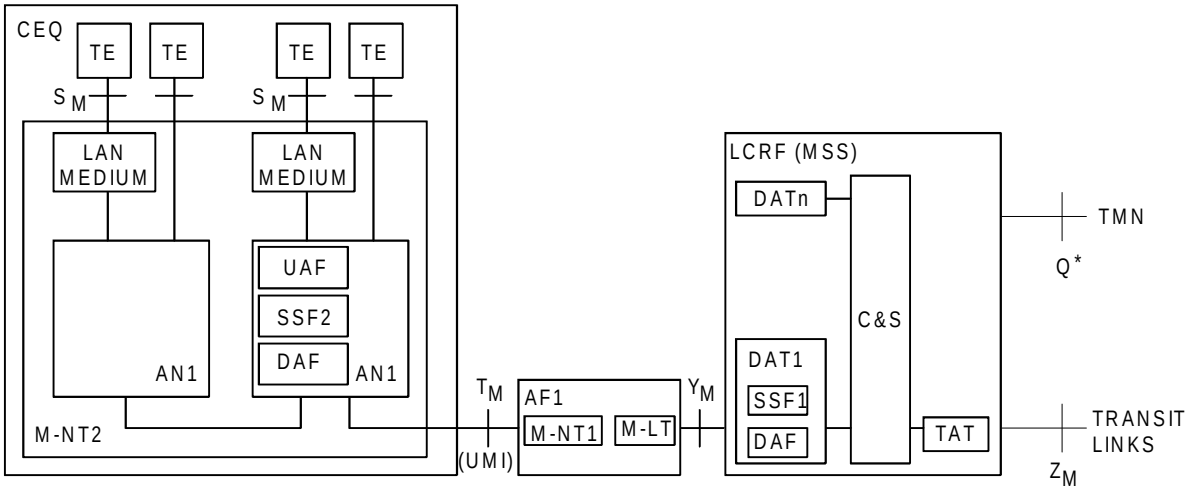
The AN performs the interfacing in the CEQ between various customer related protocols and the IEEE Standard 802.6 [1] DQDB protocol.

A single AN may be shared by several LANs, terminals, workstations or host computers.

A functional description of the MSS is provided in Annex A.

The MSS has to reflect a subset of AN functionalities.

In particular, the SSF1 functions should be implemented in the MSS to safeguard the network integrity.



AF : Access Facility.
AN : Access Node.
C&S : Charging & Access control.
CEQ : Customer Equipment.
DAF : DQDB Access Functions.
DAT : DQDB Access Termination.
LAN : Local Area Network.
LCRF : Local Connection Related Functions.
LT : Line Termination.
M-LT : MAN-Line Termination.
M-NT : MAN-Network Termination.
MSS : MAN Switching System.
NT : Network Termination.
SSF1 : Service Specific Functions (e.g. charging and screening).
SSF2 : Service Specific Functions (e.g. relaying and routing).
TAT : Transit Access Termination.
TE : Terminal Equipment.
UAF : User Access Functions.
UMI : User MAN Interface.

Figure 4: Functional configuration of AF1

5.3.2 Access Facility 2 (AF2)

The main goal of this architecture is supplying services to many customers by means of a shared medium access.

This topology exploits very well the MAN characteristics as each customer shares the access medium with other customers.

The MN, located in the public network domain, performs the interfacing between the CEQ and the IEEE Standard 802.6 [1] DQDB protocol.

The MSS and the MNs share a broadband medium and perform distributed switching as they are interconnected by means of the IEEE Standard 802.6 [1] DQDB protocol.

Moreover a single MN can serve more than one CEQ and can provide different services.

This solution is targeted primarily towards users which do not require the full capacity of the broadband medium.

The functions relevant to MSS are described in Annex A.

The main functions identified are depicted in figure 5.

Two functional configurations have been derived from figure 5, depending on the implementation of the bridging/routing functions in the MN and the M-NT2:

- AF2a, where such bridging and/or routing functions are implemented in the MN, leading to a location of the USI at the T_M reference point (see figures 6 and 8);

- AF2b, where these bridging and/or routing functions are implemented in M-NT2 leading to a location of the USI at the S_M reference point (see figures 7 and 8).

The functions identified in figures 6, 7 and 8 are described in subclause 5.2.3.

The SSF1 depicted in the MSS is not necessarily the same as the one in the MN.

IEEE Standard 802.6 [1] is the first protocol at T_M reference point for AF2b (see figure 7). In this case the protocol at T_M reference point is functionally equivalent to the UMI defined in AF1. It should be outlined that other protocols could be further developed at the T_M reference point for AF2b.

In particular, in case of ATM CEQ attachment, the protocol at the T_M reference point should comply with the relevant CCITT Recommendations[2)].

5.3.2.1 User Specific Interfaces (USIs)

It is essential that the USIs offer existing, widely used interfaces in order to facilitate the connection of existing customer networks (e.g. LANs) to the MAN.

Since in the first phase MANs are intended for the interconnection of LANs, primary candidates for the USI are the interfaces for LANs that have been developed by IEEE project 802 and have been accepted by ISO/IEC/JTC1 as ISO/IEC 8802-3 [25] and 8802-5 [26].

The cases of ISO/IEC 8802-3 [25] and ISO/IEC 8802-5 [26] are addressed in subclauses 5.3.2.1.1 and 5.3.2.1.2.

NOTE: Network providers are not forced to offer those and only those interfaces that are described in the following, because the interfaces that are actually used may vary among different countries.

5.3.2.1.1 USI based on ISO/IEC 8802-3 (CSMA/CD)

To ensure compatibility of all Carrier Sense Multiple Access with Collision Detection (CSMA/CD) LANs, several plug-level compatibility interfaces are specified.

Attachment Unit Interface (AUI)

In ISO/IEC 8802-3 [25] the AUI is specified to allow Data Terminal Equipment (DTE) or repeaters to connect to a specific Medium Attachment Unit (MAU).

The AUI is defined as compatibility interface, which means that all physical implementations of ISO/IEC 8802-3 [25] shall be compatible at this interface, although it is not necessarily exposed in all implementations.

The only exception is 1 BASE 5 "Star LAN", which is not widely used and is likely to be replaced by 10 BASE-T in the near future. Therefore, the provision of AUI as USI allows the connection of all commonly used CSMA/CD implementations.

The AUI is located between the PhysicaL Signalling (PLS) sublayer entity, residing in a DTE or a repeater, and the physically separated Physical Medium Attachment (PMA) sublayer entity, contained in the MAU (see figure 9).

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2) CCITT Recommendations I.113, I.121, I.150, I.211, I.311, I.321, I.327, I.361, I.362, I.363, I.413, I.432 and I.610: normative references [5] to [17].

The AUI has a plug-compatible connector at the PLS sublayer connection point and the MAU connection point. An interconnecting cable between the two connectors is also specified.

The physical realisation of the AUI USI in AF2a is depicted in figure 10.

If the AUI is provided at the USI, it shall be implemented according to ISO/IEC 8802-3 [25], Clause 7.

In this context the DTE is equivalent to the TE.

Medium Dependent Interface (MDI)

In addition to the AUI, a medium dependent compatibility interface is specified for each type of physical implementation.

The MDI defines the mechanical and electrical characteristics that are required for the connection to the medium (see figure 9).

If an MDI is used as USI, it shall be implemented according to the relevant specifications in ISO/IEC 8802-3 [25], IEEE Standard 802.3 [27] and IEEE Standard 802.3i [28] respectively:

- 10 BASE 5: ISO/IEC 8802-3 [25], sublause 8.5;

- 10 BASE 2: ISO/IEC 8802-3 [25], sublause 10.4;

- Fibre Optic Inter Repeater Link: ISO/IEC 8802-3 [25], subclause 9.9;

- 10 BROAD 36: IEEE Standard 802.3b [27], section 11.3;

- 10 BASE-T: IEEE Standard 802.3i [28], section 14.5.

5.3.2.1.2 USI based on ISO/IEC 8802-5 (Token Ring)

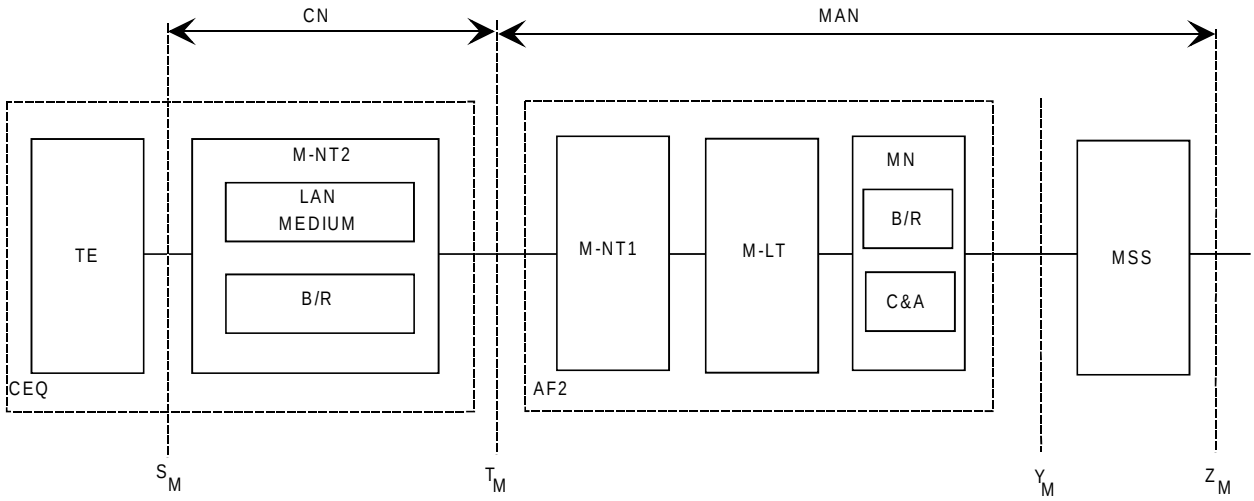
Medium Interface Connector (MIC)

The ISO/IEC 8802-5 [26] LAN medium is called a trunk cable medium (ISO/IEC 8802-5 [26], Clause 7). The function of the trunk cable medium is to transport data signals between successive stations of a baseband ring LAN. This communications medium consists of a set of Trunk Coupling Units (TCUs) interconnected sequentially by trunk cable links. Each TCU is connected to a TCU/MIC cable to which a station may be connected. The MN for AF2a will look like a LAN station on the ring, so it shall be connected with its own TCU. The MIC constitutes a safe line of demarcation providing that the physical implementation allows the TCU/MIC cable to be removed.

The relationship between these implementations and the MAN architecture model is shown in figure 11.

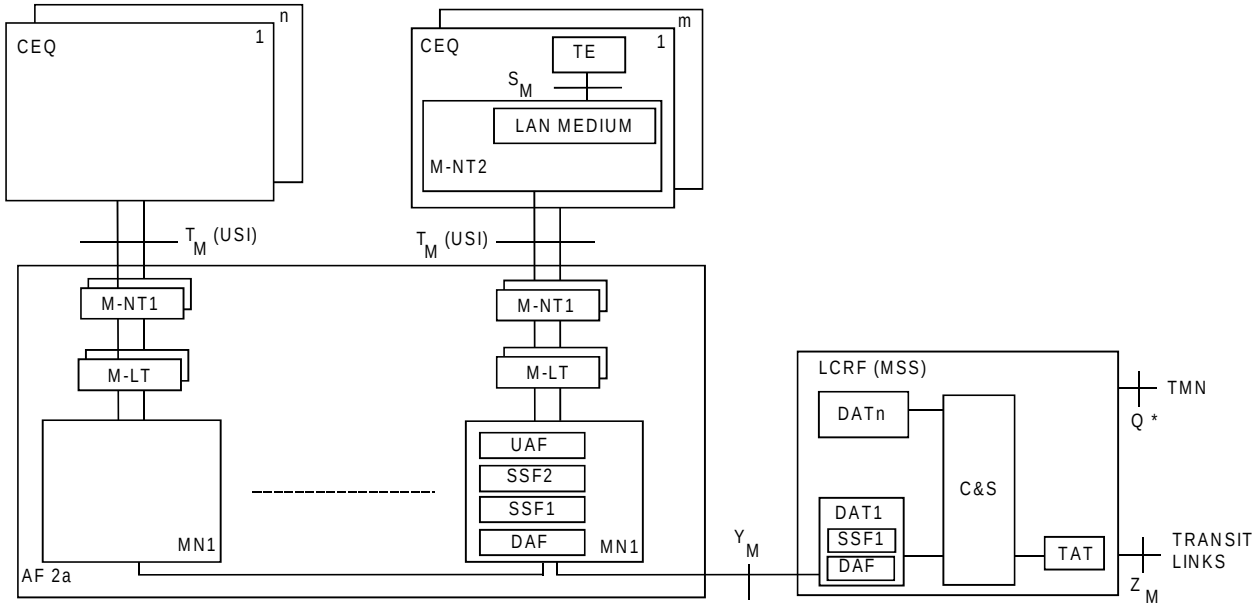
The connection of the MN to the trunk cable medium shall be via a shielded twisted pair cable.

NOTE: The need for repeater regenerative functions (M-NT1) depends on the location of the MN and also on the legal ability for the network operator to place network equipment such as the MN at customer premises.



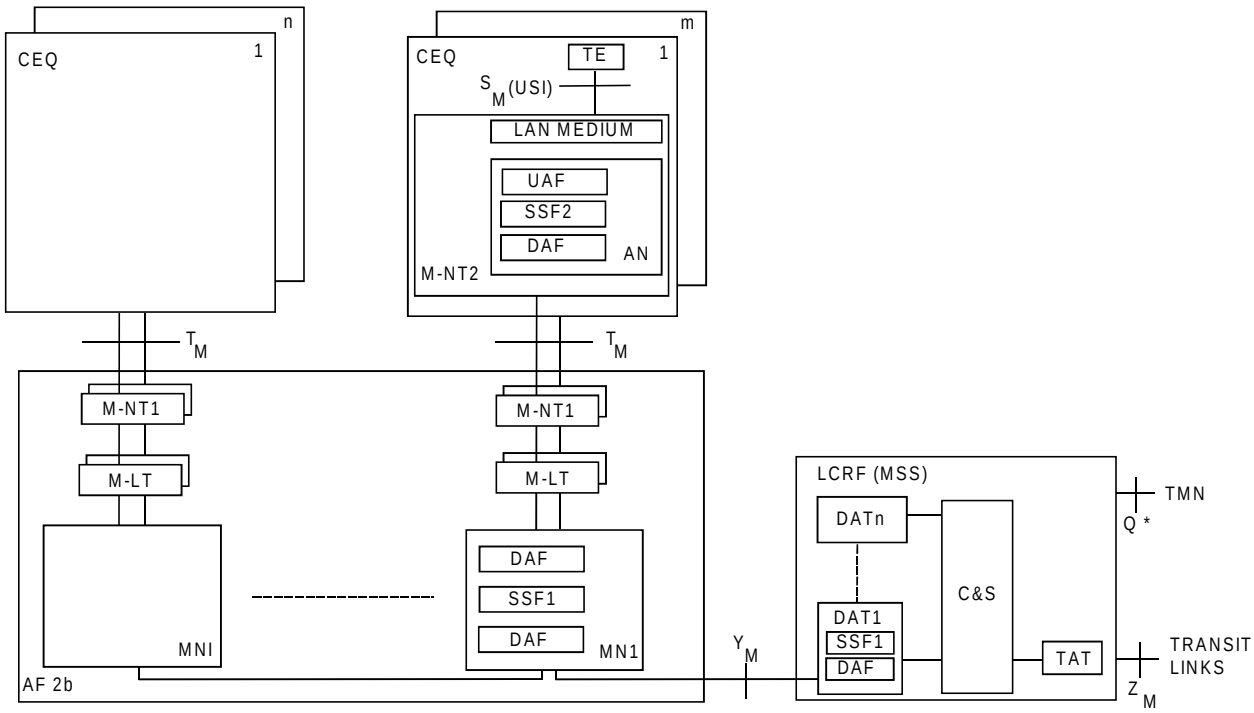
AF : Access Facility.
B/R : Bridging/Routing.
C&A : Charging & Access control.
CEQ : Customer Equipment.
CN : Customer Network.
LAN : Local Area Network.
LT : Line Termination.
M-LT : MAN-Line Termination.
M-NT : MAN-Network Termination.
MAN : Metropolitan Area Network.
MN : MAN Node.
MSS : MAN Switching System.
NT : Network Termination.
TE : Terminal Equipment.

Figure 5: General functional configuration



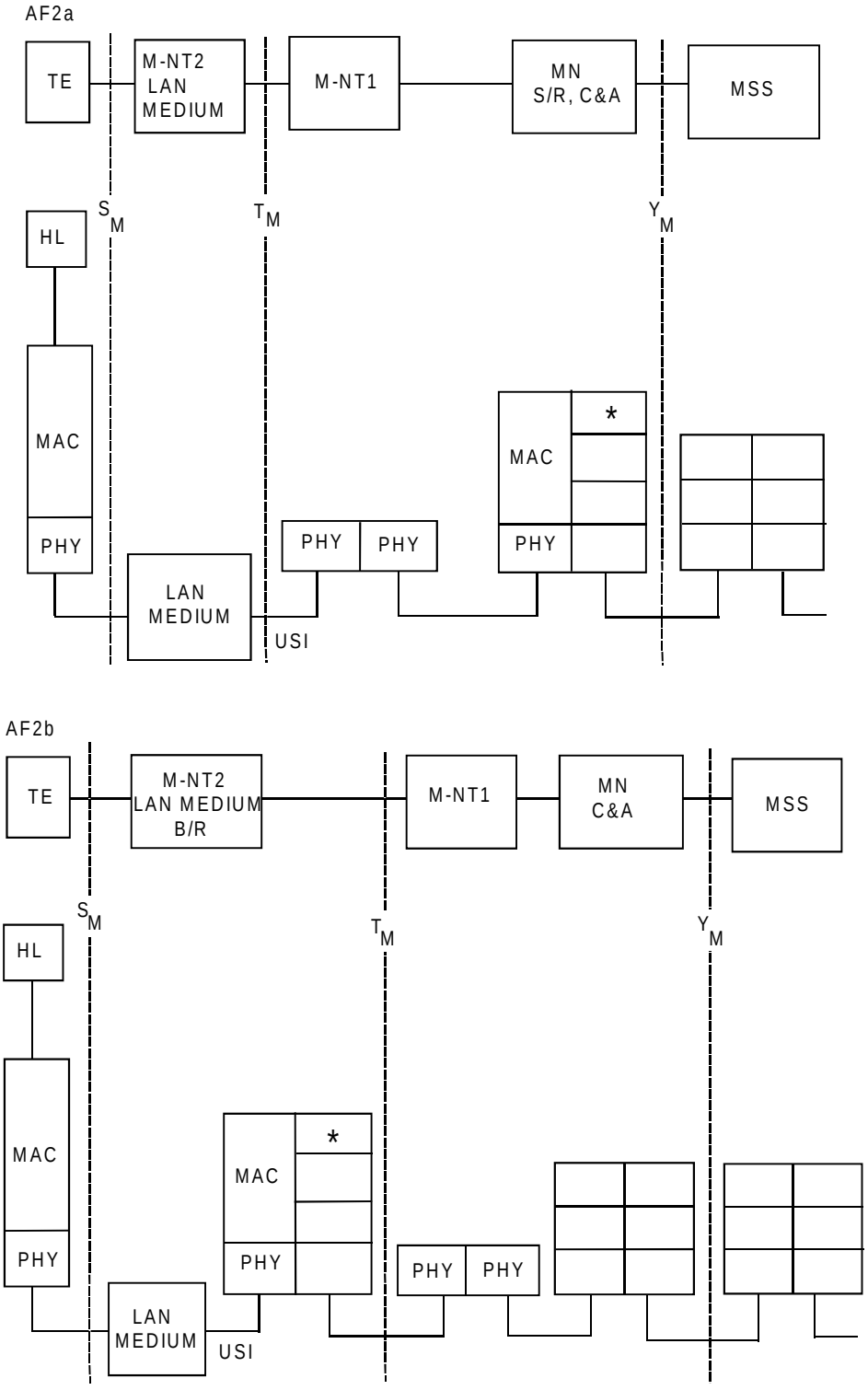
AF : Access Facility.
C&S : Charging & Access control.
CEQ : Customer Equipment.
DAF : DQDB Access Functions.
DAT : DQDB Access Termination.
LAN : Local Area Network.
LCRF : Local Connection Related Functions.
M-LT : MAN-Line Termination.
MN : MAN Node.
MSS : MAN Switching System.
M-NT : MAN-Network Termination.
SSF1 : Service Specific Functions (e.g. charging and screening).
SSF2 : Service Specific Functions (e.g. relaying and routing).
TAT : Transit Access Termination.
TE : Terminal Equipment.
TMN : Telecommunications Management Network.
UAF : User Access Functions.
USI : User Specific Interface.

Figure 6: Functional configuration of AF2a



AF : Access Facility.
AN : Access Node.
C&S : Charging & Access control.
CEQ : Customer Equipment.
DAF : DQDB Access Functions.
DAT : DQDB Access Termination.
LAN : Local Area Network.
LCRF : Local Connection Related Functions.
M-LT : MAN-Line Termination.
MN : MAN Node.
MSS : MAN Switching System.
M-NT : MAN-Network Termination.
SSF1 : Service Specific Functions (e.g. charging and screening).
SSF2 : Service Specific Functions (e.g. relaying and routing).
TAT : Transit Access Termination.
TE : Terminal Equipment.
TMN : Telecommunications Management Network.
UAF : User Access Functions.
USI : User Specific Interface.

Figure 7: Functional configuration of AF2b



* Encapsulation of the MAC-PDU

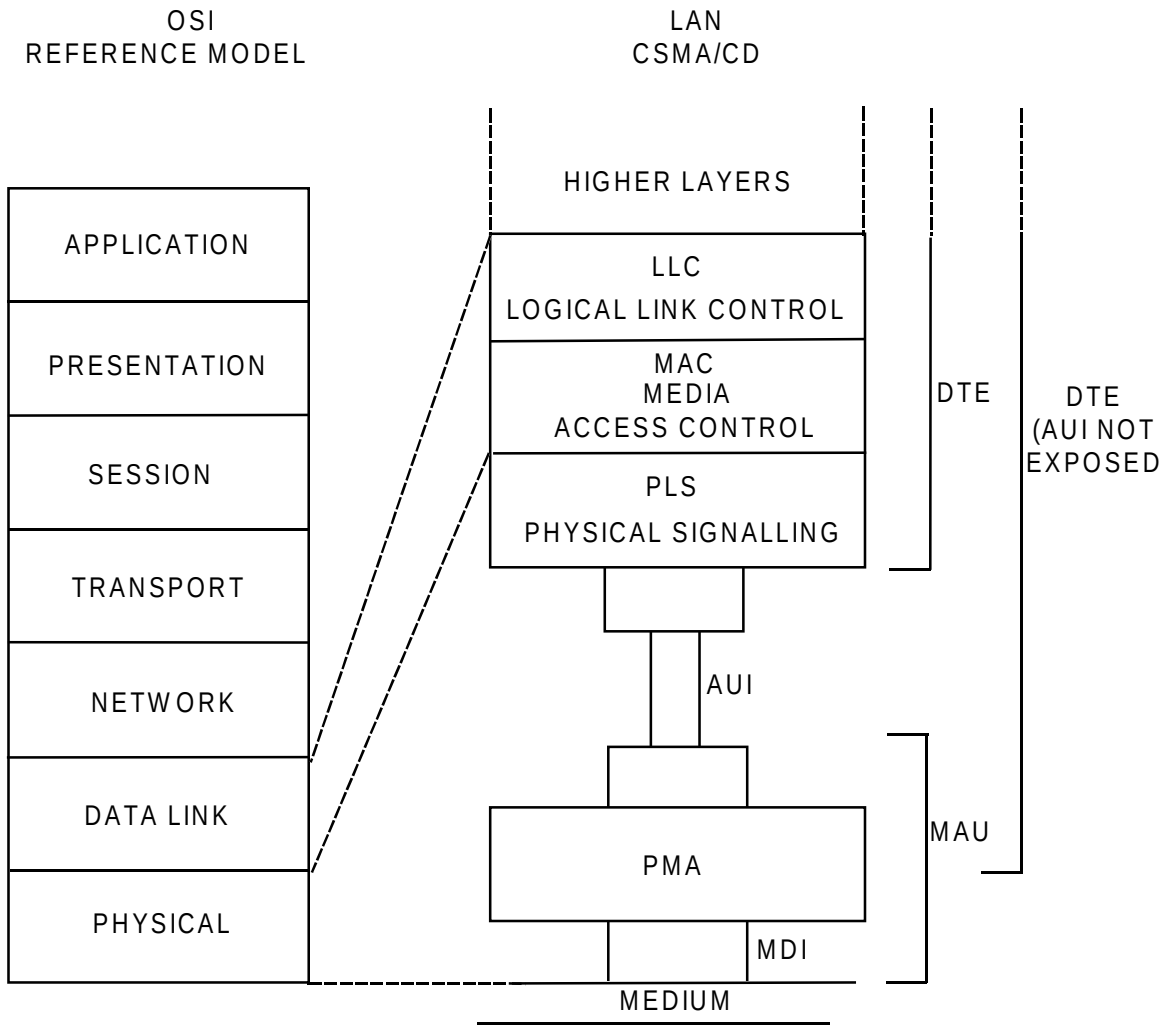
Elements of protocols

B/R : Bridging/Routing.
C&A : Charging & Access control.
HL : Higher Layers.
MAC : Media Access Control.
PHY : PHYsical layer.

Elements of configuration

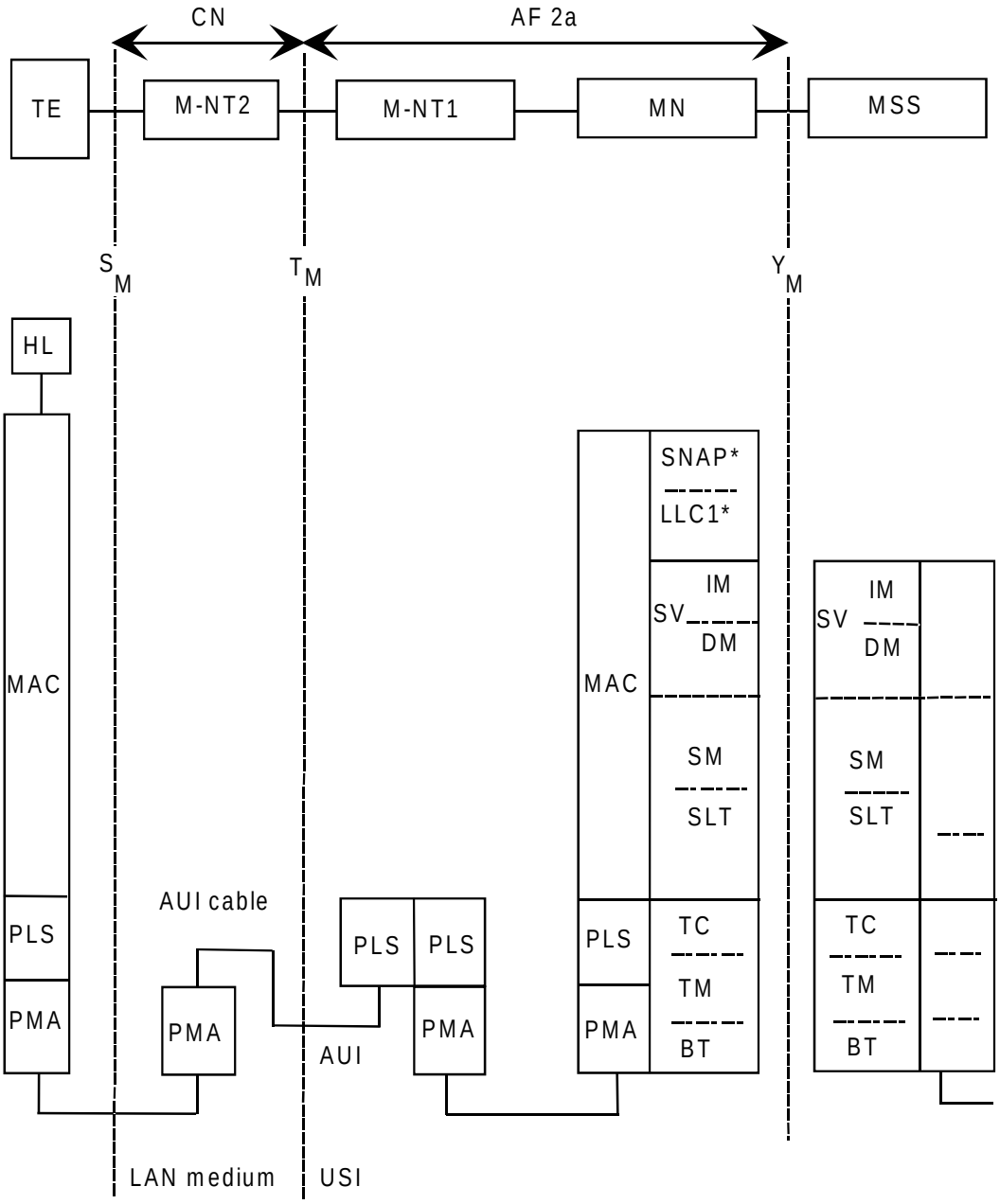
AF : Access Facility.
LAN : Local Area Network.
MN : MAN Node.
MSS : MAN Switching System.
NT : Network Termination.
TE : Terminal Equipment.
USI : User Specific Interface.

Figure 8: M-NT2 physical realisation



LAN	: Local Area Network.	OSI	: Open Systems Interconnection.
AUI	: Attachment Unit Interface.	MAC	: Media Access Control.
CSMA/CD	: Carrier Sense Multiple Access with Collision Detection.	MAU	: Medium Attachment Unit.
		MDI	: Medium Dependent Interface.
DTE	: Data Terminal Equipment.	PLS	: PhysicaL Signalling.
LLC	: Logical Link Control.	PMA	: Physical Medium Attachment.

Figure 9: CSMA/CD physical layer partitioning according to ISO/IEC 8802-3 [25]



* Protocols used for encapsulation.

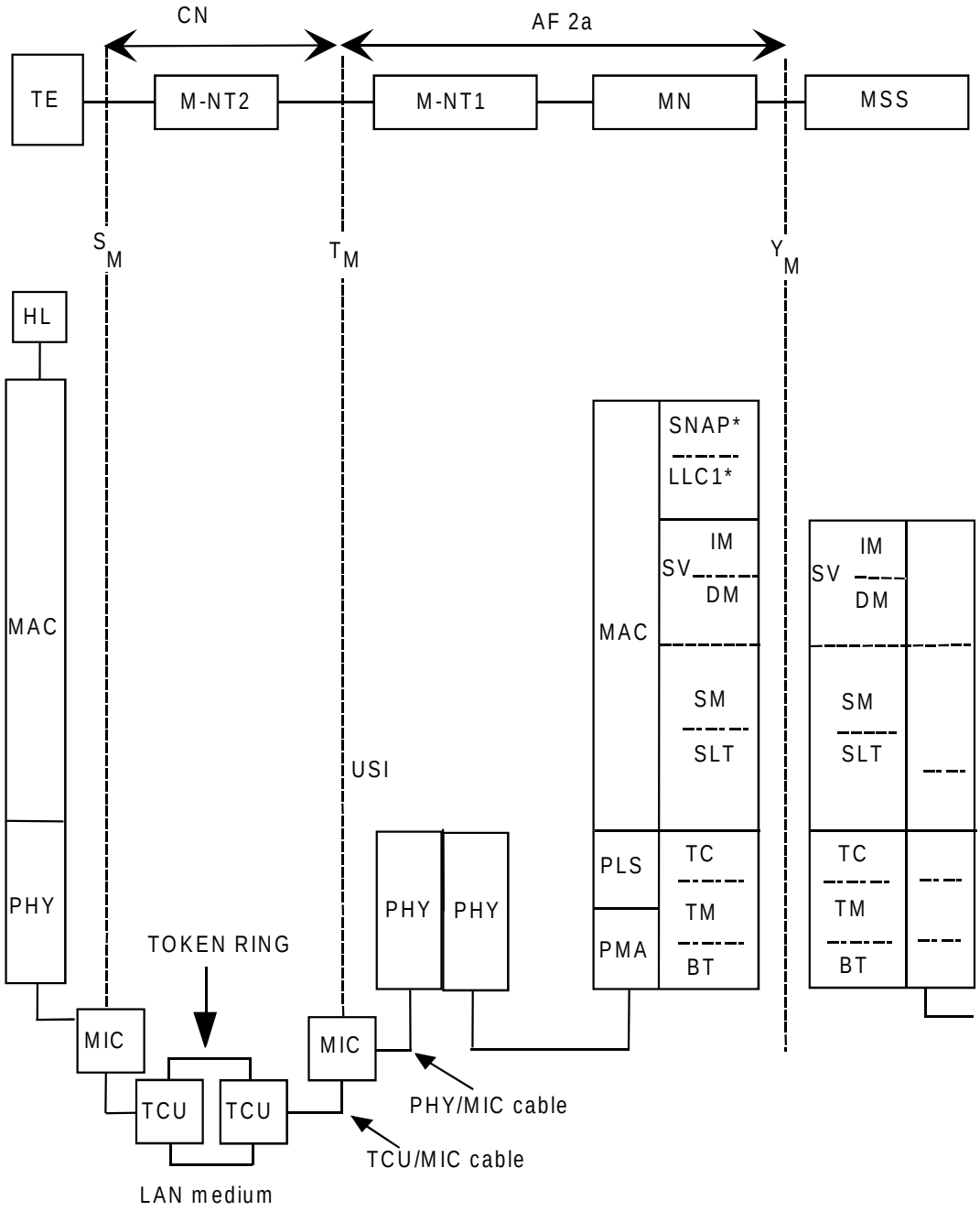
Elements of protocols

BT : BiT sublayer.
DM : Derived MAC sublayer.
HL : Higher Layers.
IM : Initial MAC sublayer.
LLC : Logical Link Control.
MAC : Media Access Control.
PLS : PhysicaL Signalling.
PMA : Physical Medium Attachment.
SLT : SLoT sublayer.
SM : SegMent sublayer.
SNAP : Sub-Network Access Protocol layer.
SV : SerVice sublayer.
TC : Transmission Convergence sublayer.
TM : TransMission sublayer.

Elements of configuration

AF : Access Facility.
AUI : Attachment Unit Interface.
CN : Customer Network.
LAN : Local Area Network.
MN : MAN Node.
MSS : MAN Switching System.
NT : Network Termination.
TE : Terminal Equipment.
USI : User Specific Interface.

Figure 10: ISO/IEC 8802-3 [25] attachment for MAN service AF2a



* Protocols used for encapsulation.

Elements of protocols

BT : BiT sublayer.
DM : Derived MAC sublayer.
HL : Higher Layers.
IM : Initial MAC sublayer.
LLC : Logical Link Control.
MAC : Media Access Control.
PHY : PHYsical layer.
SLT : SLoT sublayer.
SM : SegMent sublayer.
SNAP : Sub-Network Access Protocol layer.
SV : SerVice sublayer.
TC : Transmission Convergence sublayer.
TM : TransMission sublayer.

Elements of configuration

AF : Access Facility.
CN : Customer Network.
MIC : Medium Interface Connector.
MN : MAN Node.
MSS : MAN Switching System.
NT : Network Termination.
TCU : Trunk Coupling Unit.
TE : Terminal Equipment.
USI : User Specific Interface.

Figure 11: ISO/IEC 8802-5 [26] attachment for MAN service AF2a

6 Protocol reference model for MANs

This Clause outlines a Protocol Reference Model (PRM) for MANs. Its applicability to different MAN architectures is shown. The routing and relaying functions are not explicitly shown in the figures of this Clause. The PRM is structured in such a way that an evolution towards ATM-based networks is facilitated.

6.1 Generic reference model

As the primary objective of the MANs is to provide a connectionless data service comparable with the ISO/IEC 10039 MAC service, the following generic protocol model can be set up to provide this service (see figure 12):

- the PHYsical layer (PHY) provides functions for the transfer of a stream of bits over a physical medium;

- the MAC layer provides functions for accessing the medium and functions for the transfer of information blocks throughout the network.

The PHY corresponds in essence to the OSI physical layer, while the MAC layer performs a subset of the functionality of the OSI data link layer.

6.2 Protocol reference model

In order to facilitate an early introduction of the MAC service defined in Clause 5, the PRM represents the connectionless mode of the IEEE Standard 802.6 [1] DQDB protocol. Seven sublayers can be identified based on the functionality of the DQDB protocol.

These seven sublayers are identified in figure 13 together with the original DQDB layering.

The responsibilities of the seven sublayers are defined below:

SerVice sublayer (SV): provides MAC service to the upper protocol layers. This sublayer can be subdivided into:

- Initial MAC sublayer (IM) which contains appropriate addressing information for routing and relaying of Initial MAC-Protocol Data Units (IM-PDUs) which are of variable length. Other service specific functionalities contained in this layer are address recognition, Quality Of Service (QOS) selection, detection of errored IM-PDUs, buffer size information and explicit indication of the higher layer protocol;

- Derived MAC sublayer (DM) is responsible for segmentation and reassembly process of an IM-PDU into fixed-size segmentation units (44 octets), which constitute the payload of the Derived MAC Protocol Data Unit (DM-PDU). Preservation of the IM-PDU is provided by a DM-PDU segment type and payload length indication. Bit error detection capability is provided by a Cyclic Redundancy Check (CRC), which is calculated across the entire DM-PDU. The message identifier field is used to provide the logical linking between segmentation units derived from the same IM-PDU. Due to the introduction of a sequence number, the detection of lost and misinserted DM-PDUs is also performed at the DM sublayer.

SegMent sublayer (SM): identifies the appropriate convergence function (i.e. service) associated with the SegMent Protocol Data Unit (SM-PDU) payload. In addition, the "DQDB segment header" (SM-PDU header) is attached to/stripped from the SM-PDU payload. The 52-octet DQDB segment (SM-PDU) should not be confused with a segmentation unit of 44 octets (DM-PDU payload). The header generation process includes the coding of the virtual channel identifier, the segment priority and payload type fields. The associated header check sequence is calculated across the complete SM-PDU header.

SLoT sublayer (SLT): the characteristics of this sublayer are independent of the underlying transmission system. In the end nodes the Access Control Field (ACF) is added to/stripped from the DQDB segment (SM-PDU). The SLT sublayer provides the Queued Arbitrated (QA) and Pre-Arbitrated (PA) mechanisms and the associated medium access functions (contention resolution) and Head Of Bus / End Of Bus (HOB/EOB) functionality (idle slot insertion/removal). Optionally, slots which have reached their destination can be erased.

Transmission Convergence sublayer (TC): contains functions for slot mapping onto the payload structure of the appropriate transmission system. It is capable of recovering the slot boundaries within the flow of slots (slot delineation).

TransMission sublayer (TM): contains functions for establishing the physical link over which the SLT-PDUs are conveyed between the communicating entities. Generation and recovery of the transmission frame is included.

BiT sublayer (BT): contains all functions for bit level transmission over the physical media and supervising the quality of bit transmission. It includes bit alignment, clock recovery, line coding and electro-optical conversion.

The existence of a TC and a TM sublayer is motivated by the desire to reduce the complexity of the M-NT1 which normally only needs to terminate the TM sublayer. For special purposes, whenever required, the M-NT1 may even encompass the TC sublayer functionality.

For clarification, the name conventions for the DQDB data units are depicted in figure 14.

6.3 Extension of the MAN PRM to accommodate encapsulation of MAC-PDUs containing 48 bit addresses

In general, encapsulation is employed to carry information between two 48 bit addressed LANs over a 60 bit addressed MAN. The two communicating 48 bit LANs do not have to use the same MAC layer protocols. An encapsulation method, based on the SNAP specified in IEEE Standard 802.1 [29], is used. This method is depicted in figure 15.

A 48 bit address MAC-PDU is encapsulated by adding the SNAP header. The SNAP header consists of two fields: a 3-octet Organisationally Unique Identifier (OUI); and a two-octet Protocol IDentifier (PID) to identify the encapsulated MAC-PDU.

The usage of SNAP for encapsulation is indicated by use of the IEEE Standard 802.1 [29] OUI which corresponds to 00 80 C2 (hexadecimal format). The binary coding is defined in IEEE Standard 802.1 [29].

The PID values are fixed as follows (with frame check sequence assumed):

- ISO/IEC 8802-3 [25]: 00 01 (hexadecimal format);
- ISO/IEC 8802-5 [26]: 00 03 (hexadecimal format);
- ISO 9314 [34]: 00 04 (hexadecimal format);
- IEEE Standard 802.6 [1]: 00 05 (hexadecimal format).

The SNAP PDU is then encapsulated by a LLC1 header. The value of the Data Link Service Access Point (DLSAP) shall be : 01010101. This field indicates that the LLC1 SDU contains a SNAP PDU.

Using this mechanism, a receiving bridging function can identify both the presence of the SNAP protocol and the identity of the encapsulated 48 bit address MAC PDU. Any further action shall depend on the functionality of the receiving bridge/router.

In the context of the MAN PRM, the SNAP and the LLC protocol are on top of the IM.

6.4 Application of the PRM for Access Facility 1

The architecture of AF1 is depicted at the top of figure 16.

The application of the extended PRM onto that architecture can be found at the bottom of figure 16.

In figure 16, a LAN is attached to an AN, acting as a MAC bridge, whose one side terminates the specific LAN protocol up to the MAC layer. The received LAN frame is encapsulated using the SNAP and LLC1 protocols. It is then submitted to the IM which is the highest element of protocol pertinent to the MSS.

Routing and relaying of the IM-PDU is performed in the MSS, based on the addressing information found in the IM-PDU header. There is no need to re-assemble the IM-PDU to perform the routing function. The shown model does not preclude the possibility to have more than one AN at the user side of the UMI.

M-LT is not shown in figure 16 for reasons of simplicity.

6.5 Application of the PRM for Access Facility 2

The two generic options contained in AF2 are described in subclauses 6.5.1 and 6.5.2.

6.5.1 Application of the PRM for Access Facility 2a

The reference configuration of the AF2a is depicted at the top of figure 17.

M-LT is not shown in figure 17 for simplicity reasons.

The application of a layered architecture onto that reference configuration results in an architecture reference model appearing at the bottom of the same figure.

In the upper part of figure 17, a M-NT2 made of a LAN medium is shown attached to a MN which acts as a MAN bridge whose one side terminates the specific LAN protocol up to the MAC layer. The received LAN frame is encapsulated using the SNAP and LLC1 protocols. It is then submitted to the IM which is the highest element of protocol pertinent to the MSS.

Routing and relaying of the IM-PDU is performed in the MSS, based on the addressing information found in the IM-PDU header. There is no need to re-assemble the IM-PDU to perform the routing function. Several MNs can share the DQDB medium present at the Y_M reference point.

NOTE: The need for repeater regenerative functions (M-NT1) depends on the location of the MN and also on the legal ability for the network operator to place network equipment such as the MN at customer premises.

6.5.2 Application of the PRM for Access Facility 2b

The reference configuration of the AF2b is depicted at the top of figure 18. Mapping of a layered architecture onto that reference configuration results in the following architecture reference model appearing at the bottom of the same figure.

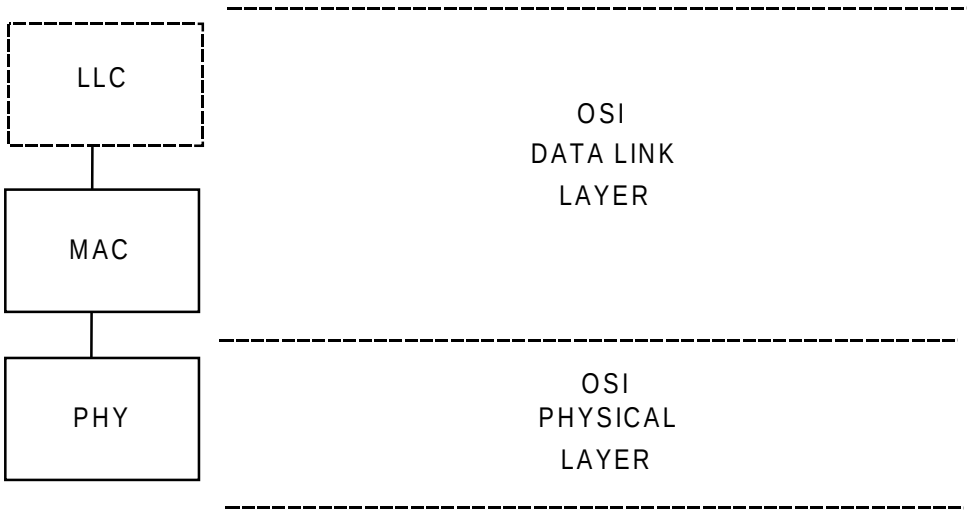
In the upper part of figure 18, a M-NT2 made of a LAN and a MAN bridge is attached to a MN through the DQDB protocol. The MAN bridge at the customer premises terminates on one side the specific LAN protocol up to the MAC layer and interfaces on the other side the MN through the DQDB medium at the T_M reference point.

M-LT is not shown in figure 18 for simplicity reasons.

Within the MAN bridge, the received LAN frame is encapsulated using the SNAP and LLC1 protocols. It is then submitted to the IM which is the highest element of protocol pertinent to both MN and MSS.

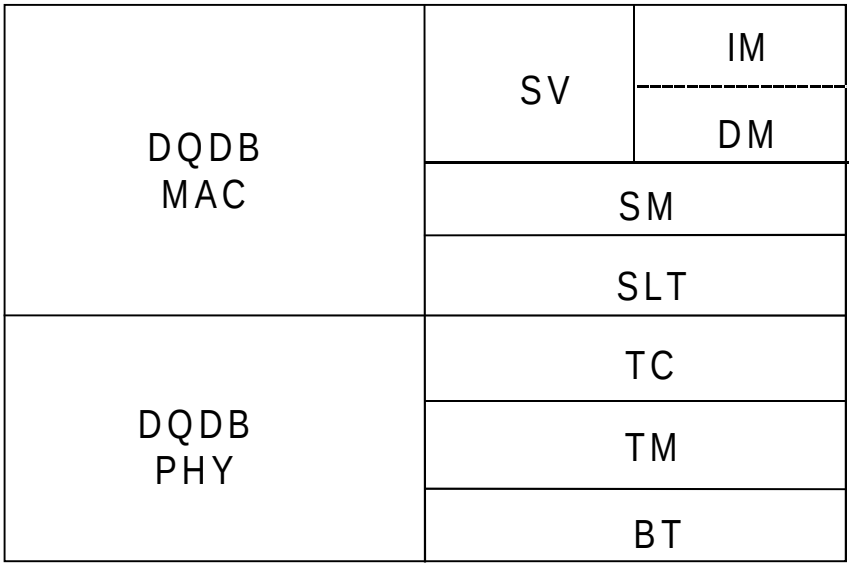
Routing and relaying of the IM-PDU is performed in the MSS, based on the addressing information found in the IM-PDU header. There is no need to re-assemble the IM-PDU to perform the routing function.

Several MNs can share the DQDB medium present at the Y_M reference point. At the customer premises, several M-NT2s, all belonging to the same subscriber, can share the DQDB medium present at the T_M reference point.



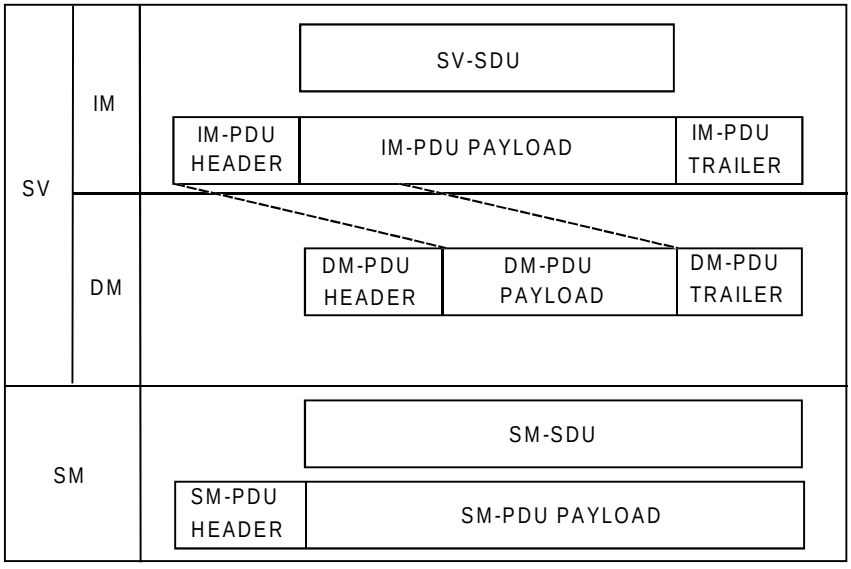
OSI : Open Systems Interconnection.
LLC : Logical Link Control.
MAC : Media Access Control.
PHY : PHYsical layer.

Figure 12: Generic protocol model for MAC service



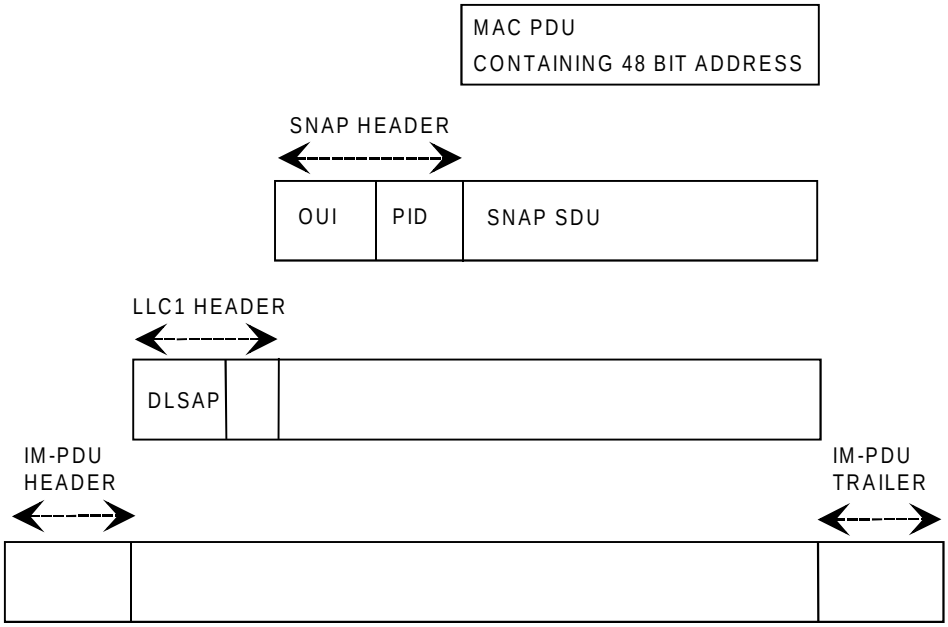
DQDB : Distributed Queue Dual Bus.
BT : Bit Sublayer.
DM : Derived MAC sublayer.
IM : Initial MAC sublayer.
MAC : Media Access Control.
PHY : Physical Layer.
SLT : Slot Sublayer.
SM : Segment Sublayer.
SV : Service Sublayer.
TC : Transmission Convergence sublayer.
TM : TransMission sublayer.

Figure 13: Functional sublayering of the DQDB protocol reference model



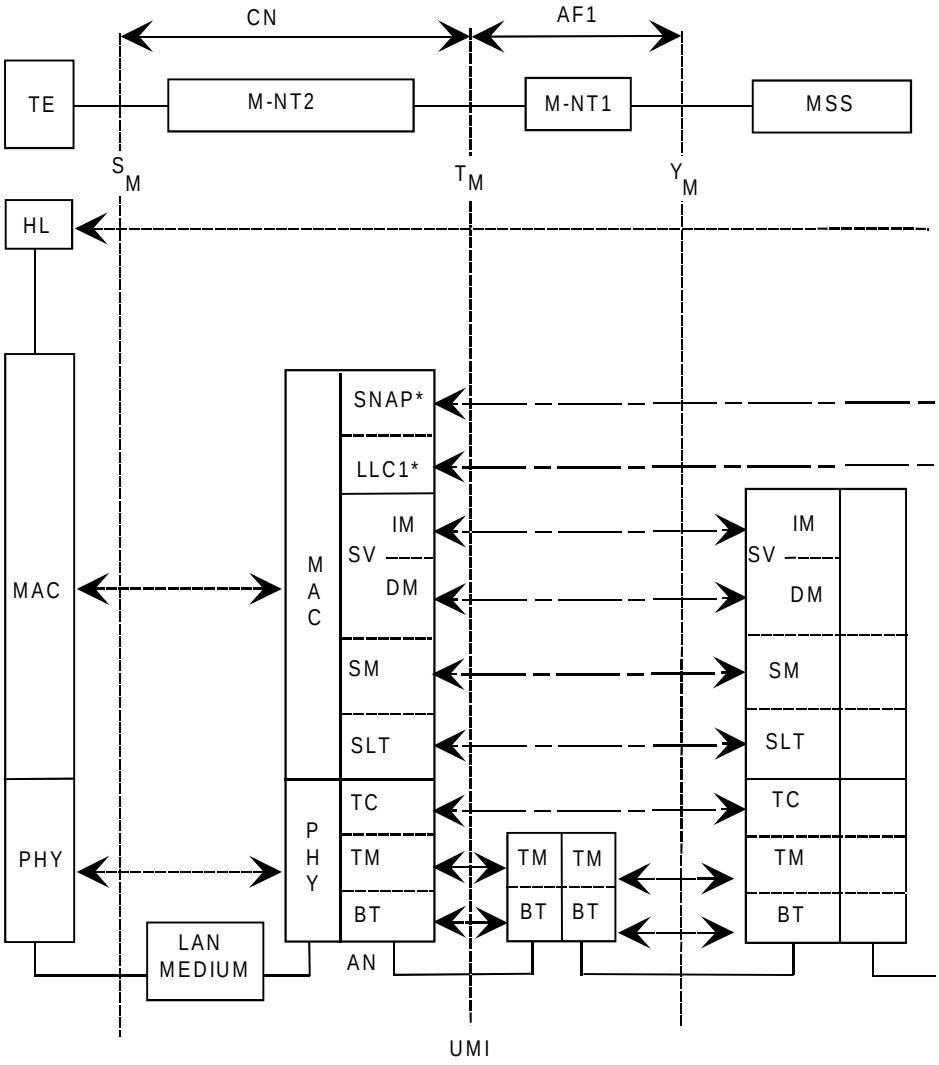
DM : Derived MAC sublayer.
IM : Initial MAC sublayer.
PDU : Protocol Data Unit.
SDU : Service Data Unit.
SM : SegMent sublayer.
SV : SerVice sublayer.

Figure 14: Name conventions for DQDB data units



PID : Protocol Identifier of the encapsulated MAC PDU.
DLSAP : Data Link Service Access Point.
IM : Initial MAC sublayer.
LLC : Logical Link Control.
MAC : Media Access Control.
OUI : Organisationally Unique Identifier.
PDU : Protocol Data Unit.
SDU : Service Data Unit.
SNAP : Sub-Network Access Protocol.

Figure 15: Encapsulation of MAC PDUs with 48 bit address



* Protocols used for encapsulation of the MAC-PDU.

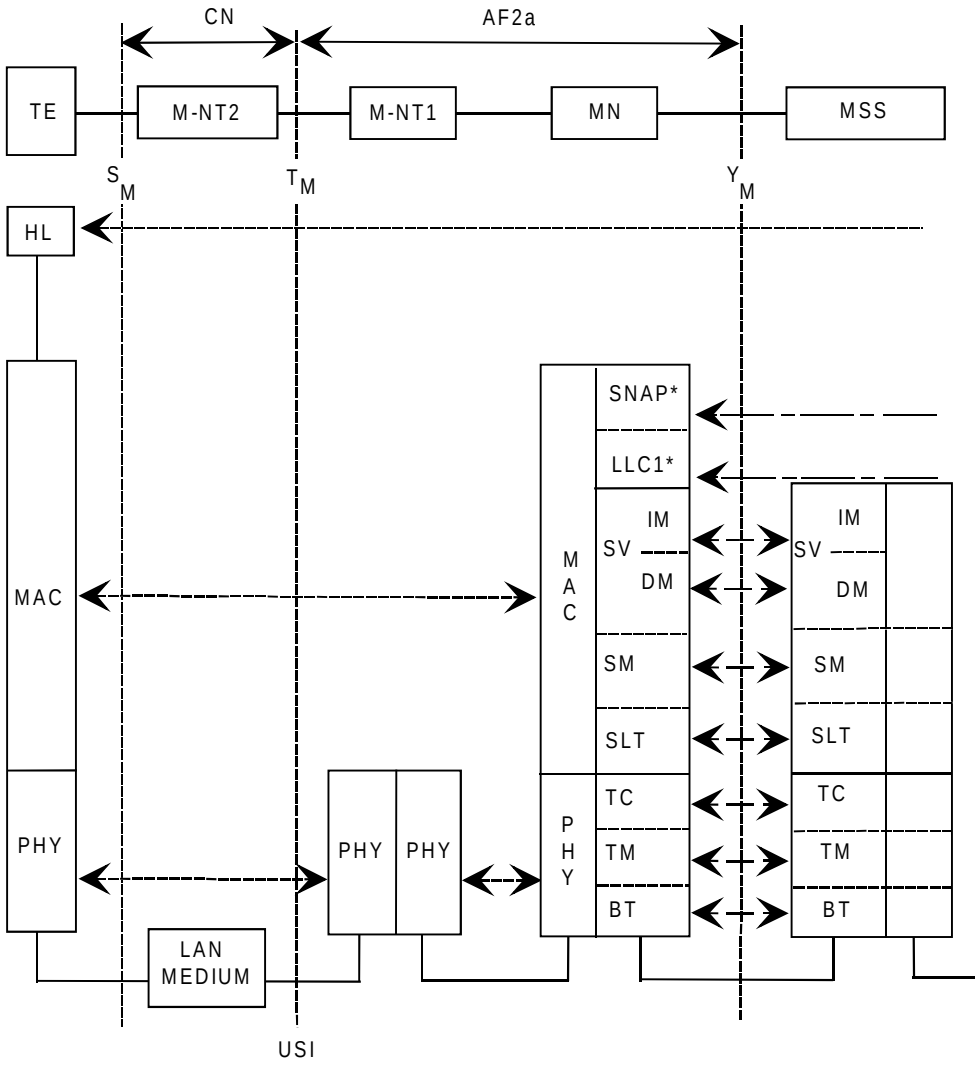
Elements of protocols

BT : BiT sublayer.
DM : Derived MAC sublayer.
HL : Higher Layers.
IM : Initial MAC sublayer.
LLC1 : Logical Link Control type 1 layer.
MAC : Media Access Control.
PHY : PHYsical layer.
SLT : SLoT sublayer.
SM : SegMent sublayer.
SNAP : Sub-Network Access Protocol layer.
SV : SerVice sublayer.
TC : Transmission Convergence sublayer.
TM : TransMission sublayer.

Elements of configuration

AF : Access Facility.
AN : Access Node.
CN : Customer Network.
LAN : Local Area Network.
MSS : MAN Switching System.
M-NT : MAN-Network Termination.
TE : Terminal Equipment.
UMI : User MAN Interface.

Figure 16: Protocol reference model for AF1



* Protocols used for encapsulation of the MAC-PDU.

Elements of protocols

BT : BiT sublayer.
DM : Derived MAC sublayer.
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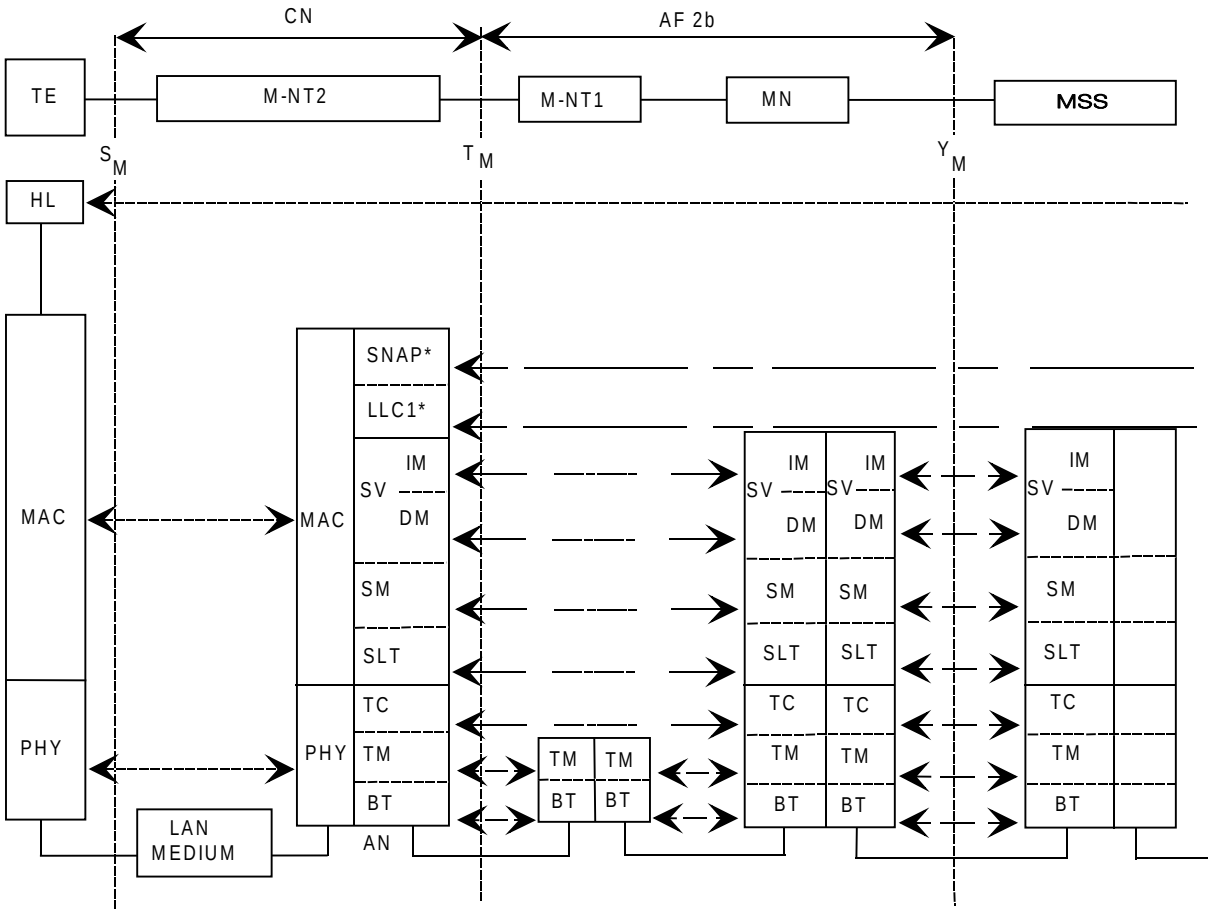
SM : SegMent sublayer.
SNAP : Sub-Network Access Protocol layer.
SV : SerVice sublayer.
TC : Transmission Convergence sublayer.
TM : TransMission sublayer.

Elements of configuration

AF : Access Facility.
CN : Customer Network.
LAN : Local Area Network.
MN : MAN Node.
MSS : MAN Switching System.
M-NT : MAN Network Termination.
TE : Terminal Equipment.
USI : User Specific Interface.

Figure 17: Protocol reference model for AF2a



* Protocols used for encapsulation of the MAC-PDU.

Elements of protocols

BT : BiT sublayer.
DM : Derived MAC sublayer.
HL : Higher Layers.
IM : Initial MAC sublayer.
LLC1 : Logical Link Control type 1 layer.
MAC : Media Access Control.
PHY : PHYsical layer.
SLT : SLoT sublayer.
SM : SegMent sublayer.
SNAP : Sub-Network Access Protocol layer.
SV : SerVice sublayer.
TC : Transmission Convergence sublayer.
TM : TransMission sublayer.

Elements of configuration

AF : Access Facility.
AN : Access Node.
CN : Customer Network.
LAN : Local Area Network.
MN : MAN Node.
MSS : MAN Switching System.
M-NT : MAN-Network Termination.
TE : Terminal Equipment.

Figure 18: Protocol reference model for AF2b

7 Addressing principles

7.1 Individual addresses

As far as the connectionless service is concerned the MAC Service Access Point (MSAP) described in IEEE Standard 802.6 [1] is associated with the MAN address.

In a public environment, in order to carry CCITT Recommendation E.164 [30] addresses, 60 bit publicly administered MSAP addresses are being used.

Several CCITT Recommendation E.164 [30] modelled numbers may be allocated to a single interface at the T_M reference point in AF1 and AF2b and to each MN in AF2a. These numbers can either be distinct or a range of sequential CCITT Recommendation E.164 [30] numbers similar to a Direct Dialling In (DDI) range.

Further identification of nodes beyond the T_M reference point or the MN may be achieved using other addressing mechanisms (e.g. MAC addresses in encapsulated LAN frames or higher layer addresses).

For LAN interconnection the mapping between LAN addresses and CCITT Recommendation E.164 [30] addresses is a function performed by SSF2 (see subclause 5.3). This mapping can be managed by the customer or by the public network.

Typically in AF1 and AF2b at least one CCITT Recommendation E.164 [30] number is associated with each AN. In AF2a at least one CCITT Recommendation E.164 [30] number could be associated with each CEQ.

7.2 Group addresses

Group addressing is a mechanism which allows for the transmission of the same data unit to several intended recipients. A group address is an address used to represent the set of individual addresses that identify the destinations of a group addressed data unit.

The presence of a group address is indicated by the address type field (see IEEE Standard 802.6 [1]) being set to "group 60 bit publicly administered".

The group address is defined in ETS 300 217-1 [24].

The source address used in a group addressed data unit need not be one of the individual addresses in the set represented by the group address.

8 MAN management

8.1 MAN management framework

The architecture and the general criteria to be adopted for the definition of MAN management are developed in the ETSs concerning MAN management. These are based on the general model described in CCITT Recommendation M.30 [3] (TMN). The adopted management interfaces are based on those defined by CCITT (e.g. CCITT Recommendation G.773 [40]). Additions to cater for MAN specific needs are considered (e.g. interfaces based on the DQDB layer protocol stack). MAN management interfaces are described in the relevant ETSI documents (e.g. ETS 300 273 [35]). The information model employed is based on CCITT X.700 series of Recommendations [31], and the MAN management specific aspects (e.g. DQDB Layer managed objects) is described in other ETSI documents.

MAN management offers:

- services to the network operator (to be known here as Management Services (MS));

- services to the users (to be known here as Customer Network Management Services (CNMS)).

MAN specific layer management aspects are aligned to those specified in IEEE Standard 802.6 [1], and are the subject of ETS 300 273 [35].

8.2 Generic MAN management functional architecture

The need for management functions within MANs has been identified. These functions are grouped in the following two sets of functional blocks:

- functional blocks required to offer management services (e.g. MSS Management Functions (MMFs), Node Management Functions (NMFs), etc.);

- functional blocks required to offer CNMS (e.g. customer network management manager and agent).

The MAN management architectural aspects are to be the subject of other ETSI documents.

Annex A (informative): MAN Switching System (MSS)

The MSS functional group corresponds to the LCRF as shown in figure A.1 and is a high-speed switching system that provides the following functions:

- termination of AFs;
- interconnection between terminated AFs;
- interconnection between AFs and other MSSs through TLs;
- management functions.

The MSS is defined in a technology and implementation independent way, so as to ensure that no constraints are placed on operators in terms of equipment and evolution.

A possible functional breakdown is produced in this Annex.

The MSS comprises four main functional blocks: MSS Management Functions (MMFs), Control & Switching functions (C&S), DAT and TAT as shown in figure A.1.

Initially the MSS will support connectionless services only: DAT suitability to support connection-oriented isochronous and connection-oriented non-isochronous services is for further study.

A.1 MSS management functions

The description of MMFs are outside the scope of this ETS.

A.2 Control & switching functions

This functional block can be based on centralised or distributed techniques as shown in figure A.2.

A.3 DQDB access termination

The DAT is shown in figure A.2 and can include the following functional blocks: DQDB access functions for each dual bus access network and SSF to connect to the C&S.

- **DQDB Access Functions (DAF)**

  The DAF may include the following functions: slot generation, master timing, Message IDentifier (MID) management, PA slot marking, state monitoring, configuration management and slot management, relay capability for management/control messages, support management information gathering (statistics, monitoring, etc.).

- **Service Specific Functions (SSF)**

  The SSF provide interworking between the DAF and C&S, and is described in subclause 5.2.3.

A.4 Transit access termination

The TAT terminates the TL at the Z_M reference point and ensures interworking with other MSSs.

The corresponding interface at the Z_M reference point is of IMSI type.

A.5 DQDB access termination configurations

Different DAT configurations are possible, as shown in figure A.3, in order to support the following AF configurations:

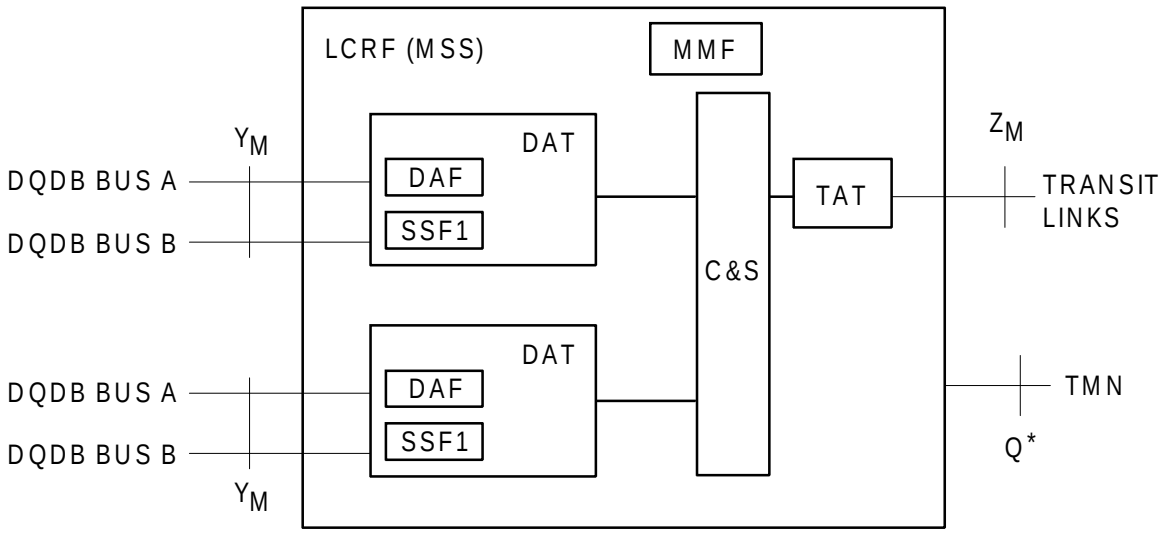
a) open bus topology.

In this case the HOB functions of one bus and EOB functions of the other bus are located in the MSS. HOB and EOB functions can be activated in other nodes in case of bus failure enabling AF reconfiguration and the provision of MAN services to the nodes that are still connected to the MSS. Internal traffic can still be exchanged between the other nodes.

b) looped bus topology.

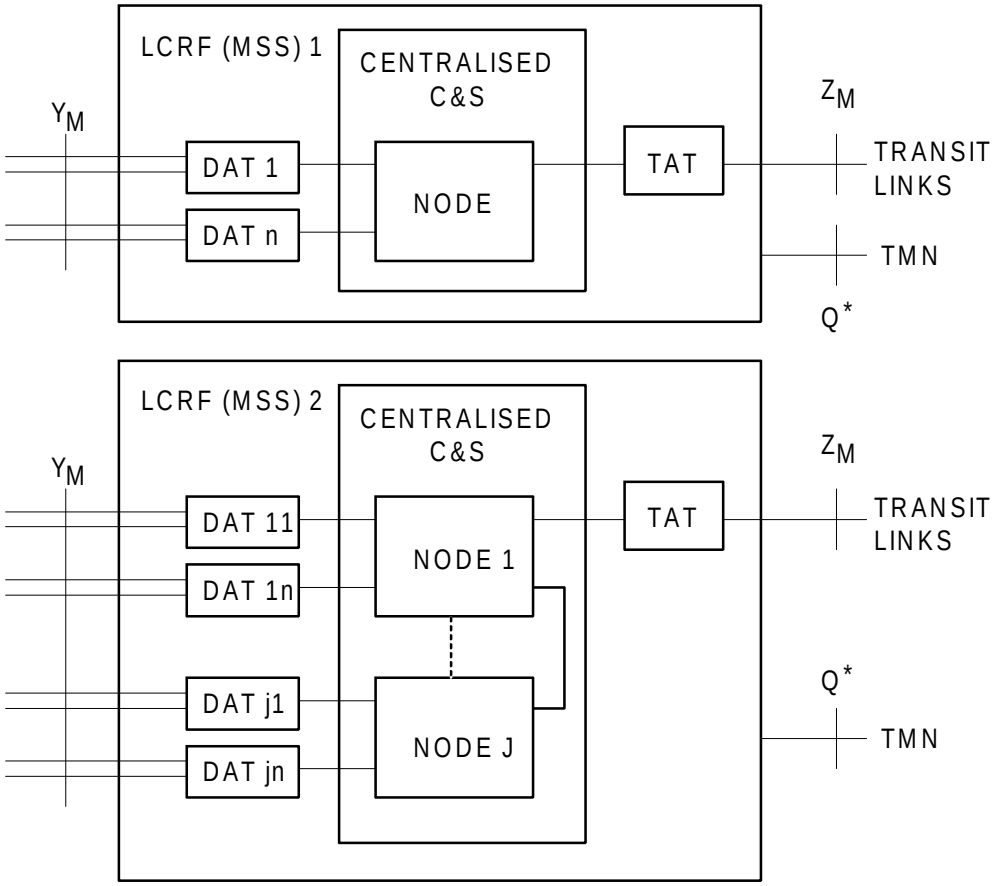
In this case the HOB and EOB functions of both busses are located at the MSS. HOB and EOB functions are also present in the other DQDB nodes but are not active: they are activated in case of bus failure enabling in this way automatic AF reconfiguration, and the provision of MAN services without degradation.

The operational aspects associated with the application of the two DAT configurations to AF1 and AF2 are for further study.



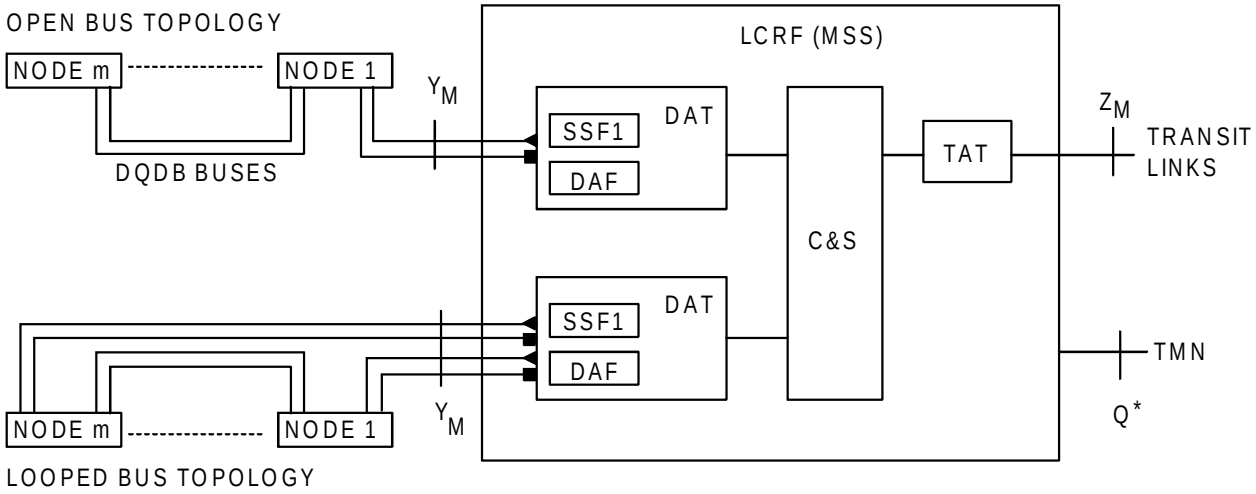
DQDB : Distributed Queue Dual Bus.
C&S : Control & Switching functions.
DAF : DQDB Access Functions.
DAT : DQDB Access Termination.
LCRF : Local Connection Related Functions.
TMN : Telecommunications Management Network.
MMF : MSS Management Functions.
MSS : MAN Switching System.
SSF : Service Specific Functions.
TAT : Transit Access Termination.

Figure A.1: MSS functional configuration



TMN : Telecommunications Management Network.
C&S : Control & Switching functions.
DAT : DQDB Access Termination.
LCRF : Local Connection Related Functions.
MSS : MAN Switching System.
TAT : Transit Access Termination.

Figure A.2: Possible MSS implementations



■ : Head Of Bus (HOB).
◀ : End Of Bus (EOB).

C&S	:	Control & Switching functions.	MSS	:	MAN Switching system.
DQDB	:	Distributed Queue Dual Bus.	SSF1	:	Service Specific Functions.
DAF	:	DQDB Access Functions.	TAT	:	Transit Access Termination.
DAT	:	DQDB Access Termination.	TMN	:	Telecommunications Management Network.
LCRF	:	Local Connection Related Functions.			

Figure A.3: Open and looped bus topologies

Annex B (informative): Bibliography

[B1] ISO/IEC 10039 (1989): "Information Technology - Open Systems Interconnection - Local Area Networks - Medium Access Control (MAC) Service Definition".

History

Document history	
December 1992	First Edition
February 1996	Converted into Adobe Acrobat Portable Document Format (PDF)