
LOCAL AND METROPOLITAN AREA NETWORKS

802.1B



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IEEE Standards for Local and Metropolitan Area Networks: LAN/MAN Management

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Abstract: Services and protocol elements that permit the exchange of management information between stations attached to IEEE 802 local and metropolitan area networks are defined. The standard includes the specification of managed objects that permit the operation of the protocol elements to be remotely managed.

Keywords: local area networks, management; metropolitan area networks, management

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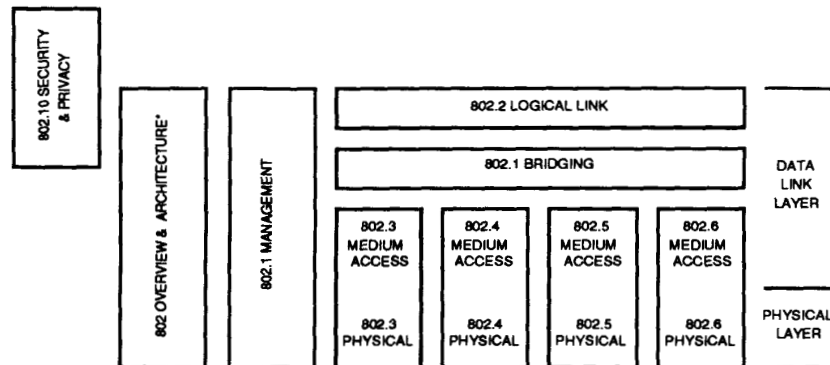
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Introduction

(This introduction is not a part of IEEE Std 802.1B-1992, IEEE Standards for Local and Metropolitan Area Networks: LAN/MAN Management.)

This standard is part of a family of standards for local and metropolitan area networks. The relationship between the standard and other members of the family is shown below. (The numbers in the figure refer to IEEE standard numbers.)



* Formerly IEEE Std 802.1A.

This family of standards deals with the physical and data link layers as defined by the ISO Open Systems Interconnection Basic Reference Model (ISO 7498 : 1984). The access standards define several types of medium access technologies and associated physical media, each appropriate for particular applications or system objectives. Other types are under investigation.

The standards defining these technologies are as follows:

- IEEE Std 802¹: Overview and Architecture. This standard provides an overview to the family of IEEE 802 Standards. This document forms part of the 802.1 scope of work.
- IEEE Std 802.1D: MAC Bridging. Specifies an architecture and protocol for the interconnection of IEEE 802 LANs below the MAC service boundary.
- IEEE Std 802.1E: System Load Protocol. Specifies a set of services and protocol for those aspects of management concerned with the loading of systems on IEEE 802 LANs.
- ISO 8802-2 [ANSI/IEEE Std 802.2]: Logical Link Control
- ISO/IEC 8802-3 [ANSI/IEEE Std 802.3]: CSMA/CD Access Method and Physical Layer Specifications
- ISO/IEC 8802-4 [ANSI/IEEE Std 802.4]: Token Bus Access Method and Physical Layer Specifications

¹The 802 Architecture and Overview Specification, originally known as IEEE Std 802.1A, has been renumbered as IEEE Std 802. This has been done to accommodate recognition of the base standard in a family of standards. References to IEEE Std 802.1A should be considered as references to IEEE Std 802.

- ISO/IEC 8802-5 [ANSI/IEEE Std 802.5]: Token Ring Access Method and Physical Layer Specifications
- IEEE Std 802.6: Metropolitan Area Network Access Method and Physical Layer Specifications
- IEEE Std 802.10: Interoperable Local Area Network (LAN) Security (SILS), Secure Data Exchange

In addition to the family of standards, the following is a recommended practice for a common technology:

- IEEE Std 802.7: IEEE Recommended Practice for Broadband Local Area Networks

Conformance Test Methodology

An additional standards series, identified by the number 1802, has been established to identify the conformance test methodology documents for the 802 family of standards. This makes the correspondence between the various 802 standards and their applicable conformance test requirements readily apparent. Thus the conformance test documents for 802.3 are numbered 1802.3, the conformance test documents for 802.5 will be 1802.5, and so on.

802.1B-1992

This document defines services and protocol elements that permit the exchange of management information between stations attached to IEEE 802 local and metropolitan area networks. The standard includes the specification of managed objects that permit the operation of the protocol elements to be remotely managed.

The reader of this standard is urged to become familiar with the complete family of standards.

This standard contains state-of-the-art material. The area covered by this standard is undergoing rapid evolution; revisions are anticipated to this standard within the next two years to clarify existing material and to incorporate new related material.

Information on the current revision state of this standard may be obtained from

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IEEE Standards for Local and Metropolitan Area Networks: LAN/MAN Management

1. Scope

This standard defines an Open Systems Interconnection (OSI) management-compatible architecture, and service and protocol elements for use in a LAN/MAN environment for the purpose of performing remote management of LAN-based or MAN-based devices. The protocol described is a connectionless-mode management protocol that makes use of Logical Link Control (LLC) Type 1 procedures as a means of conveying management information between stations in a LAN/MAN environment, thus providing for interworking of IEEE 802 standard devices for management purposes. The management information is conveyed using the protocol data unit (PDU) formats defined in ISO/IEC 9596-1 : 1991.¹ To this end, this standard

- a) Describes the services required for the transfer of management information between management processes in LAN/MAN stations.
- b) Defines the protocol and PDUs for conducting management information exchanges that support the provision of those services. This protocol is defined as an (N)-layer management protocol specific to the management of layers 1 and 2 in a LAN/MAN environment.
- c) Defines a convergence protocol and PDUs used for the exchange of management protocol data units.
- d) Describes the underlying services required for transfer of management PDUs between peer-management entities by means of the convergence protocol.
- e) Defines an access control mechanism and an event report forwarding mechanism that operate in conjunction with the management protocol.
- f) Defines managed object classes that relate to the operation of the management protocol and the convergence protocol.

NOTES

1—This standard provides only a set of management tools. The management operations that are specified by this standard are only meaningful in conjunction with the managed object definitions contained in the appropriate layer standards.

2—This standard defines an (N)-layer management protocol for the management of stations attached to IEEE 802 LAN or MAN subnetworks, in accordance with the terminology contained in the OSI Management Framework, ISO/IEC 7498-4 : 1989 and the OSI Systems Management Overview, ISO/IEC 10040 : 1992. The service and protocol described in this standard are based upon the OSI Common Management Information Service and Protocol standards (ISO/IEC 9595 : 1991 and ISO/IEC 9596-1 : 1991), and are therefore designed to be used in conjunction with managed objects defined in accordance with the Guidelines for the definition of managed objects (ISO/IEC 10165-4 : 1992). As such, this standard is intended to be complementary to the functionality of the OSI Management standards being developed in ISO/IEC JTC1 SC21/WG4.

¹Information on references can be found in clause 2.

2. References

The following standards contain provisions which, through references in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below.

CCITT Recommendation X.219 (1988), Remote Operations: Model, Notation and Service Definition, *Blue Book*, Vol. VIII.4.²

IEEE Std 802-1990, IEEE Standards for Local and Metropolitan Area Networks: Overview and Architecture (ANSI).³

IEEE Std 802.1D-1990, IEEE Standards for Local and Metropolitan Area Networks: Media Access Control (MAC) Bridges (ANSI).

IEEE Std 802.1E-1990, IEEE Standards for Local and Metropolitan Area Networks: System Load Protocol (ANSI).

P802.1F, Draft Standard for Local and Metropolitan Area Networks: Common Definitions and Procedures for 802 Management Information. D12/August 15, 1992.⁴

P802.1k, Draft Standard for Local and Metropolitan Area Networks: Supplement to LAN/MAN Management: Discovery and Dynamic Control of Event Forwarding. D6/August 5, 1992.

IEEE Std 802.10-1992, IEEE Standards for Local and Metropolitan Area Networks: Standard for Interoperable LAN Security (SILS), Part B: Secure Data Exchange.⁵

ISO 7498 : 1984, Information processing systems—Open Systems Interconnection—Basic Reference Model.⁶

ISO 8802-2 : 1989 (ANSI/IEEE Std 802.2-1989), Information processing systems—Local area networks—Part 2: Logical link control.

ISO/IEC 7498-4 : 1989, Information processing systems—Open Systems Interconnection—Basic Reference Model—Part 4: Management framework.

ISO/IEC 8824 : 1990, Information technology—Open Systems Interconnection—Specification of Abstract Syntax Notation One (ASN.1).

ISO/IEC 8825 : 1990, Information technology—Open Systems Interconnection—Specification of Basic Encoding Rules for Abstract Syntax Notation One (ASN.1).

²CCITT publications are available from the CCITT General Secretariat, International Telecommunications Union, Sales Section, Place des Nations, CH-1211, Genève 20, Switzerland/Suisse.

³IEEE publications are available from the IEEE Service Center, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

⁴P802.1F and P802.1k were not approved by the IEEE Standards Board at the time this went to press. They are available from the IEEE Service Center.

⁵As this standard goes to press, IEEE Std 802.10-1992 is not yet published. It is, however, available in manuscript form from the IEEE Service Center. Anticipated publication date is December 1992.

⁶ISO and ISO/IEC publications are available from the ISO Central Secretariat, 1 rue de Varembe, Case Postale 56, CH-1211, Genève 20, Switzerland/Suisse. In the US, they are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

ISO/IEC 9595 : 1991, Information technology—Open Systems Interconnection—Common management information service definition.

ISO/IEC 9596-1 : 1991, Information technology—Open Systems Interconnection—Common management information protocol—Part 1: Specification.

ISO/IEC 9596-2...⁷, Information technology—Open Systems Interconnection—Common management information protocol—Part 2: Protocol implementation conformance statement (PICS) proforma.

ISO/IEC 10040 : 1992, Information technology—Open Systems Interconnection—Systems management overview.

ISO/IEC 10164-1 : 1992, Information technology—Open Systems Interconnection—Systems management—Part 1: Object Management Function.

ISO/IEC 10164-2 : 1992, Information technology—Open Systems Interconnection—Systems management—Part 2: State Management Function.

ISO/IEC 10164-3 : 1992, Information technology—Open Systems Interconnection—Systems management—Part 3: Attributes for Representing Relationships.

ISO/IEC 10164-4 : 1992, Information technology—Open Systems Interconnection—Systems management—Part 4: Alarm Reporting Function.

ISO/IEC 10164-5 : 1992, Information technology—Open Systems Interconnection—Systems management—Part 5: Event Report Management Function.

ISO/IEC 10164-6 : 1992, Information technology—Open Systems Interconnection—Systems management—Part 6: Log Control Function.

ISO/IEC 10164-7 : 1992, Information technology—Open Systems Interconnection—Systems management—Part 7: Security Alarm Reporting Function.

ISO/IEC 10165-1 : 1992, Information technology—Open Systems Interconnection—Management information services—Structure of management information—Part 1: Management Information Model.

ISO/IEC 10165-2 : 1992, Information technology—Open Systems Interconnection—Management information services—Structure of management information—Part 2: Definition of management information.

ISO/IEC 10165-4 : 1992, Information technology—Open Systems Interconnection—Management information services—Structure of management information—Part 4: Guidelines for the definition of managed objects.

ISO/IEC TR 10178 : 1992, Information technology—Telecommunications and information exchange between systems—The structure and coding of Logical Link Control addresses in Local Area Networks.

ISO/TR 8509 : 1987, Information processing systems—Open Systems Interconnection—Service conventions.

⁷Presently at state of draft International standard.

3. Definitions

3.1 Definitions related to local and metropolitan area networks

Many of the specialized terms and abbreviations used in this standard are defined in IEEE Std 802-1990.

3.2 Logical Link Control definitions

This standard makes use of the following terms defined in ISO 8802-2 : 1989:

- a) LLC address
- b) LSAP address

3.3 Basic Reference Model definitions

This standard makes use of the following terms defined in ISO 7498 : 1984:

- a) open system
- b) systems management

3.4 Management Framework definitions

This standard makes use of the following terms defined in ISO/IEC 7498-4 : 1989:

- a) managed object
- b) management information base

3.5 Systems Management Overview definitions

This standard makes use of the following terms defined in ISO/IEC 10040 : 1992:

- a) agent
- b) (N)-layer management protocol
- c) managed object class
- d) management information
- e) manager
- f) notification
- g) notification type
- h) (systems management) operation
- i) systems managed object
- j) systems management protocol

3.6 Structure of Management Information (SMI) Information Model definitions

This standard makes use of the following terms defined in ISO/IEC 10165-1 : 1992:

- a) behaviour
- b) containment
- c) managed object boundary
- d) name binding

- e) package
- f) subordinate object
- g) superior object

3.7 Common Management Information Service (CMIS) definitions

This standard makes use of the following terms defined in ISO/IEC 9595 : 1991:

- a) attribute
- b) Common Management Information Services

3.8 Abstract Syntax Notation One (ASN.1) definitions

This standard makes use of the following terms defined in ISO/IEC 8824 : 1990:

- a) object identifier
- b) type

3.9 Guidelines for the Definition of Managed Objects (GDMO) definitions

This standard makes use of the following terms defined in ISO/IEC 10165-4 : 1992:

- a) managed object class definition
- b) template

3.10 Terms defined in this standard

The following terms are used throughout this document in a specialized manner:

3.10.1 affiliate: A remote convergence protocol entity (CPE) whose CPE address is known to the local CPE.

3.10.2 affiliation: A state that exists if both remote and local CPEs know each other's CPE addresses.

3.10.3 asynchronous: Protocol operation in which more than one exchange between a given pair of entities can be handled simultaneously.

3.10.4 convergence protocol: A protocol that provides the convergence service.

3.10.5 convergence service: A service that provides enhancements to an underlying service in order to provide for the specific requirements of the convergence service user.

3.10.6 CPE address: The LSAP address at which the CPE may be reached.

3.10.7 CPE instance identifier: The tuple of CPE address and CPE instance number that uniquely identifies a CPE instance within the LAN/MAN environment, within the limits of uniqueness of the CPE address and instance values used.

3.10.8 CPE instance number: A number, allocated to the CPE at instantiation time, that distinguishes a CPE instance from all other CPE instances, past and present, associated with a particular CPE address.

3.10.9 LAN/MAN Management: The management functionality specific to the management of IEEE 802 Local or Metropolitan Area subnetworks.

3.10.10 resource: That part of a LAN/MAN environment for which a managed object provides the management view. The management view of a resource may be limited to a subset of the functionality of the resource; some aspects of the resource may therefore be inaccessible for management purposes.

3.10.11 synchronous: Protocol operation in which only one exchange between a given pair of entities can be handled at any moment in time. The current exchange must complete before the next can be initiated.

3.11 Acronyms and Abbreviations

The following acronyms and abbreviations are used in this standard:

ACSE	Association Control Service Element
ACF	Access Control Function
APDU	Application PDU
ASN.1	Abstract Syntax Notation One
BER	Basic Encoding Rules
CMIP	Common Management Information Protocol
CMIS	Common Management Information Service
Conf	Confirm
CP	Convergence Protocol
CPE	Convergence Protocol Entity
CPDU	Convergence Protocol Data Unit
DLSDU	Data Link Service Data Unit
DSAP	Destination SAP
GDMO	Guidelines for the Definition of Managed Objects
ID	Identifier
Ind	Indication
LAN	Local Area Network
LCI	Local CPE Instance
LRG	Local Request Group
LRI	Local Request Instance
LLC	Logical Link Control
LSAP	Link SAP
MIB	Management Information Base
LMMP	LAN/MAN Management Protocol
LMMPE	LAN/MAN Management Protocol Entity
LMM_PDU	LAN/MAN Management Protocol Data Unit
LMMS	LAN/MAN Management Service
LMMU	LAN/MAN Management User
MAC	Media Access Control
MAN	Metropolitan Area Network
OSI	Open Systems Interconnection
PICS	Protocol Implementation Conformance Statement
PDU	Protocol Data Unit
PE	Protocol Entity
QOS	Quality of Service
RCI	Remote CPE Instance
RRG	Remote Request Group
RRI	Remote Request Instance
Req	Request

RO-APDU	Remote Operations APDU
ROSE	Remote Operations Service Element
Rsp	Response
SAP	Service Access Point
SDU	Service Data Unit
SMI	Structure of Management Information
SNAP	Subnetwork Access Protocol
SSAP	Source SAP
TR	Technical Report

4. LAN/MAN Management and Systems Management

OSI systems management functions are defined as those functions that support management applications, and that allow such applications to manipulate resources in the OSI environment. The management functional areas that give rise to these functions are described in the OSI Management Framework (ISO/IEC 7498-4 : 1989) and Systems Management Overview (ISO/IEC 10040 : 1992). The current set of functions defined by ISO/IEC are to be found in the Systems Management Function standards (ISO/IEC 10164, Parts 1–7).

The OSI Management Framework (ISO/IEC 7498-4 : 1989) defines Systems Management as an Application layer activity, related to the management of the use of OSI resources and their status across all seven layers of the OSI architecture. As a consequence, Systems Management requires the use of Application layer protocols supported by a full seven-layer protocol stack. The OSI Systems Management functions therefore require the support of CMIS, CMIP, and ROSE [ISO/IEC 9595 : 1991, ISO/IEC 9596-1 : 1991, and CCITT Recommendation X.219 (1988)], which in turn require the support of a full connection-oriented OSI stack.

Typical systems management activities include

- a) Management of the activation and deactivation of OSI resources
- b) Software loading
- c) Reporting status, status changes, and statistics
- d) Error detection, diagnosis, and recovery

The requirements for Systems Management protocol support can, however, be in conflict with the general requirements for management of the communications environment in that

- Management of the communication capability of a station is often required when part of the communication capability is unavailable, inoperable, or approaching inoperability. This may require the management protocol to be carried directly by simple, lower-layer services. Examples of such requirements are initialization and loading of a station's system software during "boot-strapping" of the system.
- Many of the devices that make up a communications network are constrained by memory or other resource limitations in ways that prohibit support of a full seven-layer connection-oriented OSI protocol stack for management purposes (e.g., modems, link layer bridges, repeaters, and hubs), and more economical methods of operation are a practical necessity.

The OSI Management Framework (ISO/IEC 7498-4 : 1989) allows for the provision of management functionality by means of (N)-layer management protocols in circumstances where the services of all seven layers are not available and where management is performed entirely within the context of specific layers. The IEEE 802.1 LAN/MAN Management protocol is therefore defined as an (N)-layer management protocol specific to the management of layers 1 and 2 in a LAN/MAN environment. It provides a means for resource-constrained, simple, or broken systems to be managed in a manner that is better suited to the capabilities of such systems while allowing them to interoperate in the OSI environment. This is achieved by defining the

LAN/MAN Management protocol in such a way that it requires only the services of the lower two layers, specifically the simple connectionless services available at the link layer in LAN/MAN technologies, to support the exchange of management information between stations.

The use of the LAN/MAN Management protocol does not preclude the use of OSI systems management protocols; in particular, the concepts of managed objects and management information used in this standard are based on those described in the OSI Structure of Management Information standards (ISO/IEC 10165, Parts 1, 2, and 4), and the protocol defined in this standard makes use of the protocol data units defined in CMIP (ISO/IEC 9596-1 : 1991) to carry management information between systems. The management information exchanged between stations may therefore be defined in a manner that makes it available both to the LAN/MAN Management protocol and to CMIP (ISO/IEC 9596-1 : 1991); hence this information may also be used to support Systems Management. The manner in which this specification is accomplished is described in P802.1F.

NOTES

1—It is recommended that, where practicable, management is performed through the use of OSI Systems Management, which operates over a full seven-layer protocol stack.

2—The management services and supporting protocols described in this standard were developed with the specific aim of providing remote management for layers 1 and 2 of the OSI reference model as they apply to a LAN/MAN environment. The use of these mechanisms in other contexts is outside the scope of this standard, but such use is in no way precluded.

5. Architecture

This clause contains a description of the major components of the LAN/MAN Management architecture and defines the terms used in relation to the architecture.

Within a LAN/MAN station, there are components that are concerned with the normal communication activities of the station, and components that are concerned with its management activities. The description in this clause relates only to

- a) The management aspects of a LAN/MAN station and
- b) The communication services and protocols that are required for management purposes.

NOTE—The description of the architecture makes use of the OSI concepts of a *service definition*, which defines, in an abstract manner, the mechanisms that permit the exchange of information between peer entities in the OSI environment; and of a *peer protocol*, which is used, in a defined way, to provide a given service. It should be borne in mind that service definitions do not describe exposed interfaces, and are therefore not the subject of conformance requirements.

5.1 Management communication

Figure 5-1 is an adaptation of figure A.2 in Annex A of the OSI Management Framework, ISO/IEC 7498-4 : 1989, showing how the concept of the (N)-layer management protocol is utilized in this standard in order to define an (N)-layer management protocol for use in the management of layers 1 and 2 in a LAN/MAN environment. The LAN/MAN Management Protocol defined by this standard corresponds to the (N)-layer management protocol shown in the figure; it in turn makes use of the services provided by the normal communication protocols available at layers 1 and 2 in a LAN/MAN environment.

Figure 5-2 depicts the service and protocol elements that are involved in management communication between LAN/MAN stations by means of the LAN/MAN Management protocol. There are three major elements involved in LAN/MAN Management communication: the *LAN/MAN Management Service (LMMS)*, the *LAN/MAN Management Protocol Entity (LMMPE)*, and the *Convergence Protocol Entity (CPE)*.

The LMMS defines the service that is available to the management process known as the *LAN/MAN Management User (LMMU)* for the purposes of exchanging management information with another LMMU. The

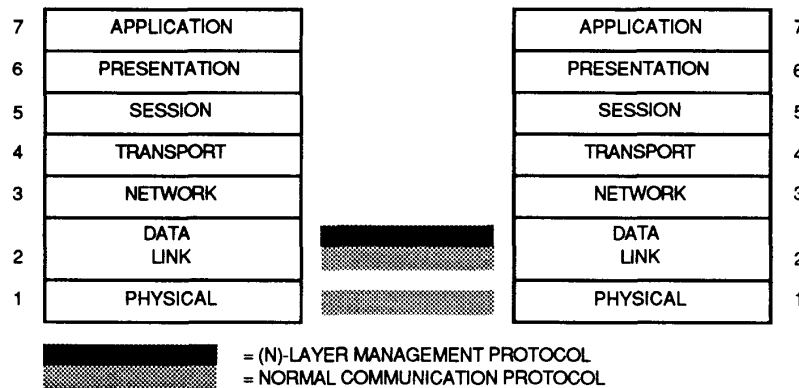


Figure 5-1—(N)-layer management protocol exchange at the Data Link layer

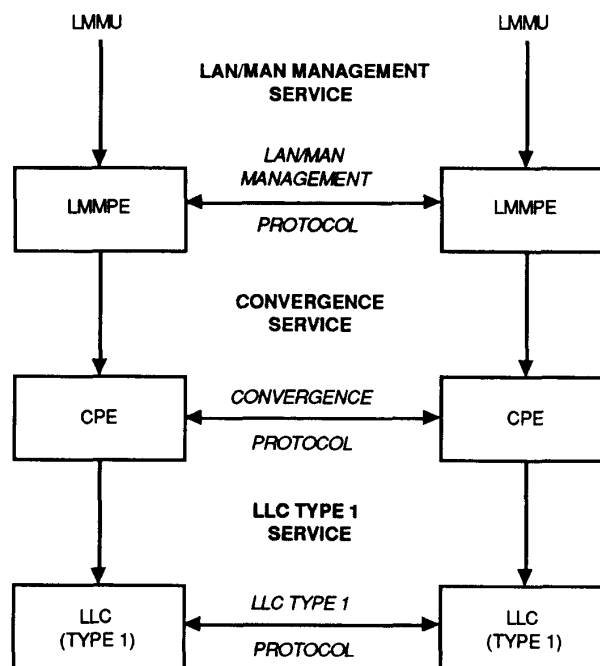


Figure 5-2—LAN/MAN Management communication architecture

LMMS makes use of service primitives defined in the Common Management Information Service (CMIS) (ISO/IEC 9595 : 1991), in the manner defined in clause 6.

The LMMPE is the protocol entity that is responsible for providing the LMMS, by means of LAN/MAN Management protocol exchanges. The LMMS makes use of procedures and protocol data units defined in the Common Management Information Protocol (CMIP) (ISO/IEC 9596-1 : 1991), in the manner defined in clause 7.

The CPE is a protocol entity that is responsible for providing convergence functions that enable the LMMS to be provided in a LAN/MAN environment. These functions are concerned with the provision of reliability and the maintenance of logical associations between LMMUs. The convergence service and protocol that supports these functions is described in clause 7.

The CPE assumes the availability of the Data Link service as an underlying service for the exchange of LAN/MAN Management protocol data units (LMM_PDUs). Only the LLC Type 1 (unacknowledged connectionless) procedures are used to support the operation of the convergence protocol.

5.2 Management Information and management operations

The component of a station that exists within a given OSI layer is known as a layer subsystem. Within a layer subsystem, resources such as protocol machines provide the normal communication functions of the layer. The definition of the functions of these entities is not within the scope of this standard.

For management purposes, it may be necessary to provide a means of monitoring and controlling aspects of the operation of layer subsystems and their components. This is achieved by the provision of management functionality that is concerned with providing the *management view* of the layer subsystem. They provide *management information* about the layer subsystem, effect control over it in defined ways, and indicate the occurrence of certain events within it. This functionality is defined in terms of one or more *managed objects* that provide the management view of the resources of the layer subsystem.

NOTE—The OSI Management Framework (ISO 7498 : 1984) describes the concept of the *Management Information Base (MIB)*, which is a conceptual repository of management information that corresponds to the set of managed objects instantiated in a system and the information associated with them; however, the MIB is not explicitly defined as part of the 802.1 architecture, as the concept does not add value to the concepts of managed objects and management information. The concepts described here are directly compatible with the OSI concept of the MIB and the managed objects that it contains; in particular, the use of CMIP (ISO/IEC 9596-1 : 1991) PDUs as the basis for the LMMP permits managed objects defined in accordance with the GDMO (ISO/IEC 10165-4 : 1992) templates to be compatible with both the LMMP and the CMIP.

Layer subsystems are also responsible for participating in other distributed functions (e.g., dynamic routing at the network layer). In order to achieve this, specific protocols may exist for communication of management information related to those functions. This aspect of management is not within the scope of this standard.

The functionality of a managed object is made available via the *managed object boundary*, as expressed in the OSI Management Information Model (ISO/IEC 10165-1 : 1992). The Management Information Model defines the set of generic operation and notification types that a managed object may support; a given managed object may support a subset of these types.

NOTE—The terms *managed object* and *managed object boundary* replace the terms *layer management entity (LME)* and *layer management interface (LMI)* that were used in early drafts of this standard, as follows:

- a) An LME corresponds to the set of managed objects that provide the management view of a layer subsystem;
- b) An LMI corresponds to the functionality available at the managed object boundaries of the set of managed objects represented by an LME.

The use of the terms LME and LMI is deprecated.

The functionality of a managed object may be utilized for management purposes by a managing process. Where the managing process is local to the managed object, the mechanisms used to effect this interaction are outside the scope of this standard. Where the managing process is remote from the managed object with which it is required to interact, the managing process may make use of the LMMS in order to communicate with a peer-managing process in the remote station. This communication is described in terms of the roles that each managing process plays in a particular exchange of management information—either the role of a *Manager* or the role of an *Agent*. The Manager and Agent managing processes involved in such exchanges are users of the LMMS and are therefore known as *LAN/MAN Management users (LMMUs)*. The terms