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Information technology — Open Systems Interconnection — Local area networks — Medium Access Control (MAC) service definition

Technologies de l'information — Interconnexion de systèmes ouverts — Réseaux locaux — Définition du service de contrôle d'accès au milieu (MAC)

Reference number
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Contents

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 10039 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*.

Annex A of this International Standard is for information only.

Introduction

This International Standard is one of a set of International Standards produced to facilitate the interconnection of information processing systems. It is related to other standards in the set as defined by ISO 7498. The reference model described by ISO 7498 subdivides the area of standardization for Open Systems Interconnection (OSI) into a series of layers and allows for each layer to be further divided into sublayers.

This International Standard defines the service provided by the Medium Access Control Sublayer to the Logical Link Control Sublayer at the boundary between the Medium Access Control and Logical Link Control Sublayers. The Medium Access Control and Logical Link Control Sublayers are sublayers of the Data Link Layer of the OSI Basic Reference Model as illustrated in figure 1. The Medium Access Control Sublayer is not described in ISO 7498 but is of value in the specification of ISO/IEC 8802 Local Area Networks.

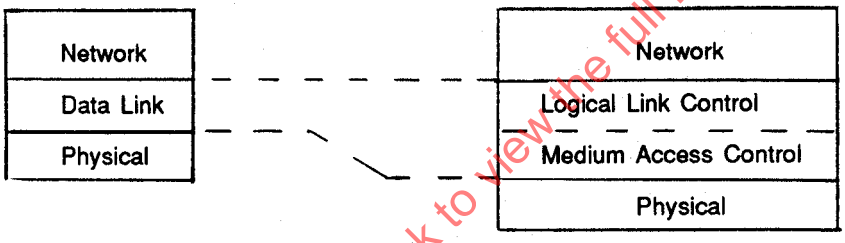

Figure 1 - Relationship of the Medium Access Control and Logical Link Control Sublayer to the OSI Data Link Layer

The International Standard provides a definition of the MAC Service made available to the MAC Service user by the action of a Medium Access Control Protocol over the underlying service. The relationship is illustrated in figure 2.

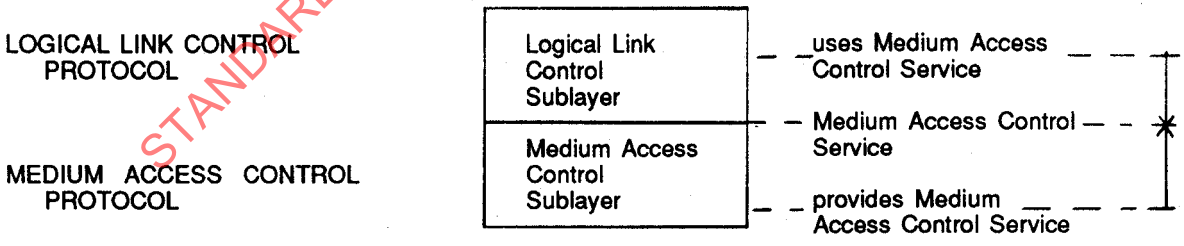

Figure 2 - Relationship of this International Standard to other standards

Throughout the set of International standards, the term "service" refer to the abstract capability provided by one layer of the OSI Basic Reference Model to the layer immediately above. Thus, the MAC Service defined in this document is a conceptual architectural service, independent of administrative divisions.

Information technology — Open Systems Interconnection — Local area networks — Medium Access Control (MAC) service definition

1 Scope

This International Standard defines the Medium Access Control Service found in local area network architecture in abstract terms of

a) the primitive actions and events of the service;

b) the parameters associated with each primitive action and event, and the form they take;

c) the interrelationship between, and the valid sequences of, these actions and events.

The principal objectives of this International Standard are

a) to specify the characteristics of a conceptual Medium Access Control Service;

b) guide the development of Medium Access Control Protocols.

c) guide the development of OSI protocols which make use of the MAC Service.

This International Standard does not specify individual implementation or products, nor does it constrain the implementation of Medium Access Control entities and interfaces within an information processing system.

There is no conformance of equipment to this International Standard. Instead, conformance is achieved through implementation of conforming Medium Access Control Protocols that fulfil the Medium Access Control Service defined in this International Standard.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 7498 : 1984, *Information processing systems - Open Systems Interconnection - Basic Reference Model.*

ISO 7498/Add.1 : 1987, *Information processing systems - Open Systems Interconnection - Basic Reference Model - Addendum 1: Connectionless-mode transmission.*

ISO 7498-3 : 1989, *Information processing systems - Open Systems Interconnection - Basic Reference Model - Part 3: Naming and addressing.*

ISO/TR 8509 : 1987, *Information processing systems - Open Systems Interconnection - Service Conventions.*

3 Definitions

3.1 Basic reference model definitions

Although the MAC Service is not identified or defined in the OSI Basic Reference Model, this International Standard is based on the concepts developed in the Basic Reference Model and makes use of the following terms defined in ISO 7498, as they might apply to the Medium Access Control Sublayer:

a) Entity

b) Sublayer

c) Service

d) Service-access-point

e) Service-access-point-address

f) Service-data-unit

g) Subnetwork address

3.2 Service conventions definitions

Although the MAC Service is not identified or defined in the OSI Basic Reference Model, this International Standard makes use of the following terms defined in ISO/TR 8509, as they might apply to the Medium Access Control Sublayer:

a) Service user

b) Service provider

c) Primitive

d) Request

e) Indication

3.3 MAC Service definitions

This International Standard makes use of the following definition:

a) Group-address (synonyms: group-MSAP-address, group Medium Access Control Service-access-point address): a value, otherwise valid as a Medium Access Control Service-access-point address, identifying a set of Medium Access Control Service-access-points, the set of end systems on which the identified Service-access-points are located being any subset of all stations on a particular local area network.

Note - By contrast, the general definition of an (N)-address restricts the identified Service-access-point to a single open system.

4 Abbreviations

LAN	Local Area Network
MAC	Medium Access Control
MSAP	Medium Access Control Service-access-point
MSDU	Medium Access Control Service-data-unit
OSI	Open Systems Interconnection
QoS	Quality of Service
OUI	Organizationally Unique Identifier

5 Conventions

5.1 General considerations

This International Standard uses the descriptive conventions given in ISO/TR 8509.

The service model, service primitives, and time-sequence diagrams used are entirely abstract descriptions; they do not represent a specification for implementation.

5.2 Parameters

Service primitives, used to represent service user/service provider interactions (ISO/TR 8509), convey parameters which indicate information available in the user/provider interaction, and have a global significance.

The parameters which apply to each group of MAC Service primitives are set out in table 1. Each "X" in the table indicates that the primitive labelling the column in which it falls shall carry the parameter labelling the row in which it falls.

Some entries are further qualified by items in parentheses. These are

a) A parameter specific constraint:

(=) indicates that the value supplied in an indication primitive is always identical to that supplied in a previous request primitive issued at the peer service-access-point.

b) Indication that some note applies to the entry:

(see note x) indicates that the referenced note contains additional information pertaining to the parameter and its use.

In any particular interface, not all parameters need be explicitly stated. Some may be implicitly associated with the MSAP at which the primitive is issued, for example, an MA-UNITDATA.request need not include the source address parameter which may be associated with the MSAP at which the primitive is issued.

6 Overview of the MAC Service

The MAC Service provides for the transparent transfer of data between MAC Service users. It makes invisible to these MAC Service users the way in which supporting communications resources are utilised to achieve this transfer.

In particular, the MAC Service provides for the following:

a) Independence of the underlying MAC Sublayer and Physical layer - the MAC Service relieves MAC Service users from all concerns, with the exception of QoS considerations, regarding which MAC technology is available.

b) Transparency of transferred information - the MAC Service provides for the transparent transfer of MAC Service user-data. It does not restrict the content, format or coding of the information, nor does it ever need to interpret its structure or meaning. It may however restrict the maximum number of octets of MAC Service user-data that can be supplied in a user/provider interaction.

c) Priority selection - the MAC Service makes available to MAC Service users a means to request the transfer of data at a specified priority.

d) Addressing - the MAC Service allows the MAC Service user to identify itself and to specify the MSAP to which data is to be transferred.

7 Types of MAC Service

Currently there is one type of MAC Service defined; the connectionless-mode MAC Service.

8 Features of the MAC Service

The MAC Service provides the following features to the MAC Service user:

a) A means by which MSDUs of limited length are delimited and transparently transmitted from one source MSAP to a destination MSAP in a single MAC Service access, without establishing or later releasing a connection.

b) Associated with each instance of connectionless-mode transmission certain measures of QoS, which may be requested by the sending MAC Service user when the connectionless-mode transmission is initiated and may be modified by the MAC Service provider depending on the MAC technology.

9 Model of the MAC Service

Although the MAC Service is not identified or defined in the OSI Basic Reference Model, this International Standard uses the abstract model for a layer service defined in ISO/TR 8509 :1987, clause 4 as it might apply to the MAC Sublayer. The model defines the interactions between the MAC Service users and the MAC Service provider which take place at the two MSAPs. Information is passed between the MAC Service user and the MAC Service provider by service primitives, which may convey parameters.

9.1 Model of a MAC connectionless-mode transmission

A defining characteristic of MAC connectionless-mode service - as provided between any two MSAPs - can be modelled in the abstract as an association between the two MSAPs. This association is permanent.

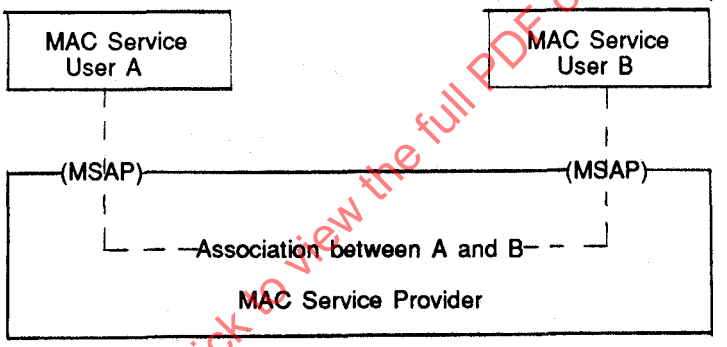

Figure 3 - Model for a MAC Service connectionless-mode Transmission

Only one type of object, the unitdata object, can be handed over to the MAC Service provider via a MSAP. In figure 3, MAC Service user A represents the MAC Service user that passes objects to the MAC Service provider. MAC Service user B represents the MAC Service user that accepts objects from the MAC Service provider.

9.2 Service provided by the connectionless-mode MAC Service

In general, the MAC Service provider may perform any or all of the following actions

a) discard objects;

b) change the order of the objects.

The MAC Service exhibits a negligible rate of

a) object duplication;

b) reordering of objects for a given priority.

The operations that are performed by the MAC Service provider for a particular MAC association do not depend on the behaviour of the MAC Service users. Awareness of the characteristics of the MAC Service provided, e.g. the rate at which objects may be discarded, duplicated or miss-ordered is part of the MAC Service users' a priori knowledge of the environment.

10 Quality of connectionless-mode service

The term "Quality of Service" (QoS) refers to certain characteristics of a connectionless-mode transmission as observed between the MSAPs. QoS describes aspects of a connectionless-mode transmission which are solely attributable to the MAC Service provider; it can only be properly determined in the absence of MAC Service user behaviour (which is beyond the control of the MAC Service provider) that specifically constrains or impedes the performance of the MAC Service.

Whether the view of the QoS during each instance of the use of connectionless-mode transmission is the same to each MAC Service user associated with the service depends on the nature of their association and the type of information concerning the nature of the service made available to the MAC Service user(s) by the MAC Service provider prior to the invocation of the service.

10.1 Determination of QoS for connectionless-mode service

A basic characteristic of a connectionless-mode service is that, unlike a connection-mode service, no dynamic association similar to that during a connection establishment is set up between the parties involved. Thus, characteristics of the service to be provided during the transfer are not negotiated on a peer-to-peer basis.

Associated with each MAC connectionless-mode transmission, certain measures of QoS are requested by the sending MAC Service user when the primitive action is initiated. The requested measures (or parameter values and options), are based on a priori knowledge by the MAC Service user of the service(s) made available to it by the MAC Service provider. Knowledge of the characteristics and type of service provided (i.e., the parameters, formats, and options that affect the transfer of data) is made available to a MAC Service user through some layer management interaction prior to (any) invocation of the MAC connectionless-mode service. Thus, the MAC Service user not only has knowledge of the parties with which it may communicate, it also has explicit knowledge of the characteristics of the service it can expect to be provided with for each invocation of the service.

10.2 Definition of connectionless-mode QoS parameters

QoS parameters can be classified as

a) parameters that express MAC Service performance, for example

- Transit Delay;
- Residual Error Rate (corruption, duplication);
- Probability of Lost Information.

b) parameters that express other MAC Service characteristics, for example

- Priority.

Some QoS parameters are defined in terms of the issuance of MAC Service primitives. Reference to a MAC Service primitive refers to the complete execution of that MAC Service primitive at the appropriate MSAP.

10.2.1 Transit delay

Transit delay is the elapsed time between MA-UNITDATA.request primitives and the corresponding MA-UNITDATA.indication primitives. Elapsed time values are calculated only on MSDUs that are transferred successfully.

Successful transfer of a MSDU is defined to occur when the MSDU is transferred from the sending MAC Service user to the intended receiving MAC Service user without error.

For connectionless-mode transfer, transit delay is specified independently for each MAC connectionless-mode transmission.

10.2.2 Residual error rate

Residual error rate is the ratio of the number of MSDUs received containing undetected errors to the number of MSDUs transferred across the MAC Service boundary during a measurement period. The relationship among these quantities is defined, for a particular MAC Service user pair, as shown in figure 4:

10.2.3 Probability of lost information

Probability of Lost Information is the ratio of the number of lost MSDUs to the number of MSDUs transferred across the MAC Service boundary during a measurement period. The relationship among these quantities is defined, for a particular MAC Service user pair, as shown in figure 4.

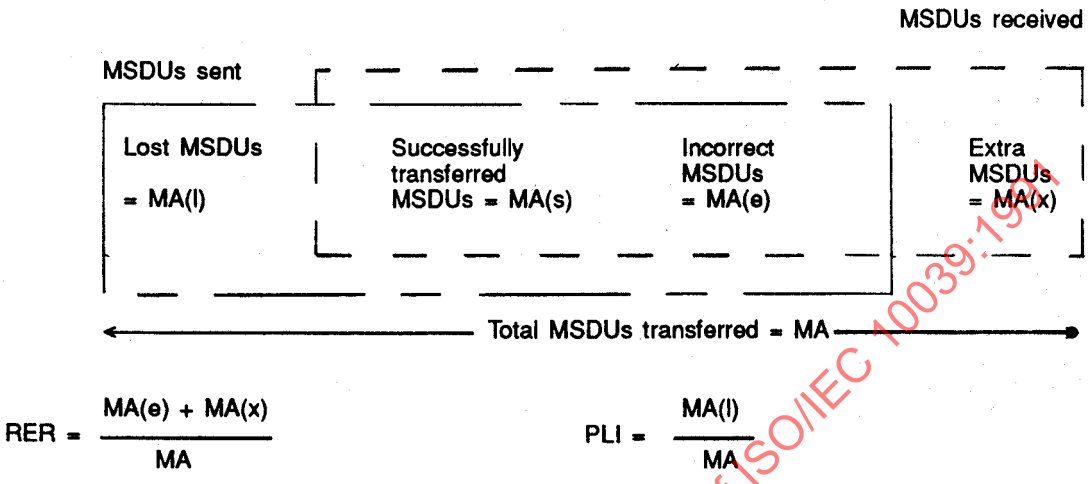

Figure 4 - Components of Residual Error Rate (RER) and Probability of Lost Information (PLI)

10.2.4 Priority

The Specification of priority is concerned with the relationship between connectionless data transfer invocations.

This parameter specifies the relative importance of unitdata objects with respect to gaining use of shared resources.

This parameter only has meaning in the context of some management entity or structure able to judge relative importance. The number of priority levels is limited.

11 Sequence of primitives at one MSAP

The possible overall allowed sequences of primitives at a MSAP are defined in the state transition diagram in figure 5.

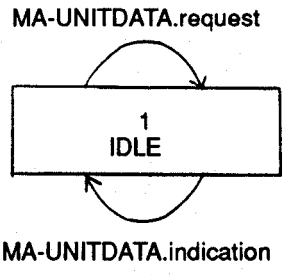

Figure 5 - State transition diagram for sequences of connectionless-mode primitive at one MSAP

12 Data transfer

12.1 Function

MAC connectionless-mode transmission service primitives can be used to transmit an independent, self contained MSDU from one MSAP to another MSAP in a single service access. It is self contained in that all of the information required to deliver the MSDU is presented to the MAC Service provider in a single service access; thus no initial establishment or subsequent release of a connection is required, provided that the MAC Service users exist and are known to the MAC Service provider.

A MSDU transmitted using MAC connectionless-mode transmission is not considered by the MAC Service provider to be related in any way to any previously transmitted MSDU. Although the MAC Service maintains the integrity of individual MSDUs, it does not necessarily deliver them to the receiving MAC Service user in the order in which they are presented by the sending MAC Service user.

No means are provided by which the receiving MAC Service user may control the rate at which the sending MAC Service user may send MSDUs (peer-to-peer flow control). The MAC Service provider will not maintain any state information relative to any aspect of the flow control of information between any specific combination of MSAPs.

12.2 Types of primitives and parameters

Table 1 indicates the types of primitives and parameters needed for the connectionless-mode data transmission service.

Table 1. MAC connectionless-mode data transfer primitives and parameters

Parameter \ Primitive	MA-UNITDATA. request	MA-UNITDATA. indication
Destination address	X	X (=)
Source address	X	X (=)
MSDU	X	X (=)
Priority	X	X (see NOTE)

Note - The relationship between the priority parameter in the indication primitive to that in the request primitive is dependent on the protocol(s) used to provide and support the MAC Service.

12.2.1 Addresses

The addresses referred to in table 1 are MAC addresses. The source address specifies an individual MSAP. The destination address specifies either an individual or group MSAP.

12.2.1.1 Address length

The length of the MAC address field in a MAC frame is either 16 bits, or 48 bits. However, at any given time, the source and destination address lengths are the same for all stations on a particular local area network. The length of the address field is determined by management facilities or on a priori knowledge basis.

12.2.1.2 Individual/Group addresses

An Individual address identifies a single MSAP and may be used as both a source and destination MAC address. For 16-bit and 48-bit address fields, the broadcast address is defined to be all address bits set to one, denoting the set of all MSAPs. The individual address of an MSAP is also the subnetwork address of the LAN station on which the MAC entity and MAC Service user are located.

A group address shall be used only as a destination MAC address. A group address is either

- A Multicast Group Address, which indicates a group of MSAPs; or
- A Broadcast Address, which indicates all MSAPs on a particular local area network.

For both 48-bit and 16-bit addresses, the left most bit of the binary representation of a MAC address is designated the I/G (Individual/Group) bit. If the I/G bit is 0 the address is an Individual address, if the I/G is set to 1 the address is a Group address.

12.2.1.3 Universally/Locally administered addresses

A Universally administered address is one where part of the address is allocated by a registration authority to an organization and is unique to that organization. The remainder of the address is allocated by the receiving organization.

A Local administered address is one where there is no registration authority allocating unique values for part of the address space.

In ISO/IEC 8802 LANs the registration authority for the Universal addresses is the American National Standards Institute Accredited Standards Committee, IEEE 802 Standards Board. For 48-bit MAC addresses, the next bit following the I/G bit of the binary representation of a MAC address is designated the U/L (Universal/Local) address bit. If the U/L bit is 0 the address is a Universally administered address, if the U/L bit is set to 1 the address is a Locally administered address. In the case of 16-bit MAC addresses the concept of Universally administered addresses is not applicable and all addresses are Locally administered.

12.2.1.4 Binary and hexadecimal representation of MAC addresses

Figure 6 illustrates an example of a 48-bit LAN MAC address in binary and hexadecimal representation.

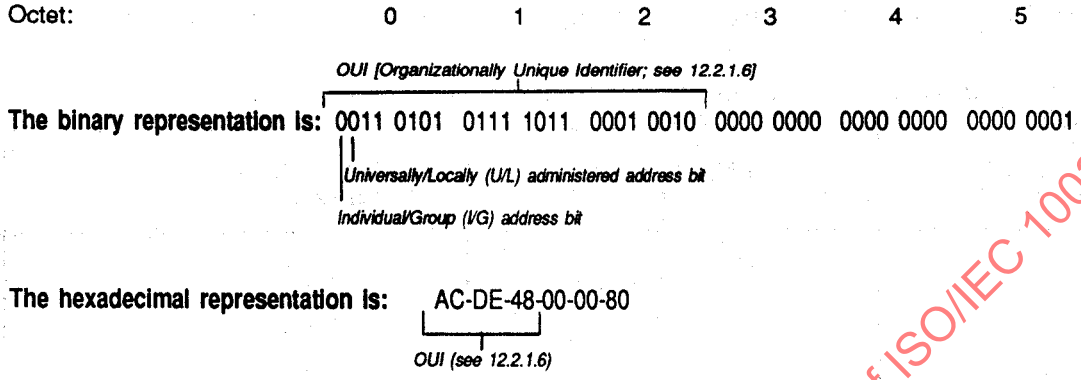

Figure 6 - Binary and hexadecimal representation of LAN MAC addresses

The 48-bit LAN MAC address (universal or local) is represented as a string of six octets. The octets are displayed from left to right, in the order that they are transmitted and received by peer MAC Sublayer entities. Each octet of the address is displayed as two hexadecimal digits. The left-most bit of the binary representation of a MAC address distinguishes individual from group addresses. The Universally or Locally (U/L) administered address bit is the next bit following the Individual/Group address bit. The U/L bit indicates whether the MAC address has been universally or locally assigned. For the previous example, the first octet transmitted is AC and the last octet transmitted is 80.

12.2.1.5 Own MAC addressed frames

If the local MSAP is designated by the destination address parameter of an MA-UNITDATA.request primitive, the indication primitive is also invoked by the MAC entity to the MAC Service user. For example, all frames transmitted to the broadcast address also invoke MA-UNITDATA.indication primitives at all MSAPs in the local area network including the station that generated the request. This full duplex characteristic of the MAC Service may be due to unique functionality within the MAC Sublayer or the full duplex characteristics of the lower layers.

12.2.1.6 Organizationally Unique Identifier

Organizationally Unique Identifiers allow a general means of assuring unique identifiers for a number of purposes. Currently, the IEEE assigns Organizationally Unique Identifiers to be used for generating individual LAN MAC addresses, group addresses, and protocol identifiers.

The Organizationally Unique Identifier (OUI) is the left-most 24 bits of the binary representation of a MAC address; an example is shown in figure 6. The U/L bit of the organizationally unique identifier being set to 0 indicates that the assignment is universal. Organizationally unique identifiers with the U/L bit set to 1 are locally assigned and have no relationship to the IEEE-assigned values. In the 48-bit LAN MAC address the OUI is contained in octets 0,1, and 2.

12.2.2 MSDU

This parameter allows the transmission of the MAC Service user-data between MAC Service users, without modification by the MAC Service provider. The MAC Service user may transmit any integral number of octets greater than zero, up to a limit determined by the MAC Service provider. The value of this limit is made available to the MAC Service user by the use of management facilities or a priori knowledge.

12.2.3 Priority

If the MAC Service user does not explicitly state a value for the priority parameter, or requests a value not supported by the provider, the MAC Service provider shall use default values.

The value of the priority parameter on the two primitives are related so that

a) on the request primitive, any defined value is allowed; and

b) on the indication primitive, the priority indicated is the value requested or as modified by the MAC Service provider.

12.3 Sequence of primitives

The sequence of primitives in a successful MAC Sublayer connectionless-mode transmission is defined in the time sequence diagram in figure 7.

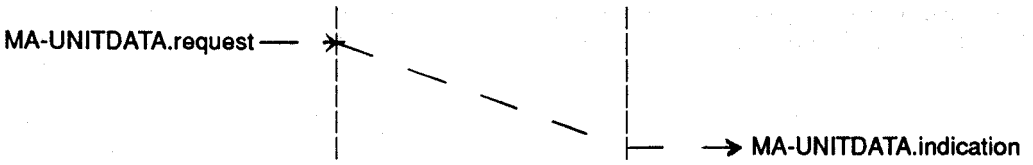

Figure 7 - Sequence of primitives

ANNEX A
(INFORMATIVE)

Mapping of the MAC Service to/from ISO/IEC 8802-3, ISO/IEC 8802-4, ISO/IEC 8802-5 and ISO/IEC 8802-7 MAC Protocols

Introduction

This annex specifies the mapping between elements of the MAC Service and elements of ISO/IEC 8802-3, ISO/IEC 8802-4, ISO/IEC 8802-5 and ISO/IEC 8802-7 MAC Sublayer protocols in clauses A.3, A.4, A.5 and A.6 respectively.

A.1 Scope

The MAC Service is defined in terms of primitive actions and events with associated parameters. For a protocol to support this service, there must be a mapping between the abstract primitives and parameters of the MAC Service and the elements of the protocol. This annex provides the mapping between elements of the MAC Service and the elements of the ISO/IEC 8802-3, ISO/IEC 8802-4, ISO/IEC 8802-5 and ISO/IEC 8802-7 MAC Protocols.

A.2 Informative references

ISO/IEC 8802-2 : 1989, *Information processing systems - Local area networks - Part 2: Logical link control.*

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.*

ISO/IEC 8802-4 : 1990, *Information processing systems - Local area networks - Part 4: Token-passing bus access method and physical layer specifications.*

ISO/IEC 8802-5 : -[1)], *Information processing systems - Local area networks - Part 5: Token ring access method and physical layer specifications.*

ISO/IEC 8802-7 : -[1)], *Information processing systems - Local area networks - Part 7: Slotted ring access method and physical layer specifications.*

A.3 General operation of MAC protocols to support the MAC Service

As stated above, in order to support the MAC Service there must be a mapping between the abstract primitives and parameters of the MAC Service and the elements of the protocol. Request primitives are translated into MAC frames; received MAC frames, where appropriate, are translated into indication primitives.

1) To be published.

A.4 Mapping the MAC Service to/from the ISO/IEC 8802-3 MAC Protocol

This section specifies the mapping of the MAC Service to/from the ISO/IEC 8802-3 MAC Protocol.

A.4.1 Primitive/parameter and MAC frame field relationships

Figure A.1 shows the mapping of the MA-UNITDATA.request primitive and parameters to the ISO/IEC 8802-3 MAC frame fields, and the mapping of the ISO/IEC 8802-3 MAC frame fields to the MA-UNITDATA.indication primitive.

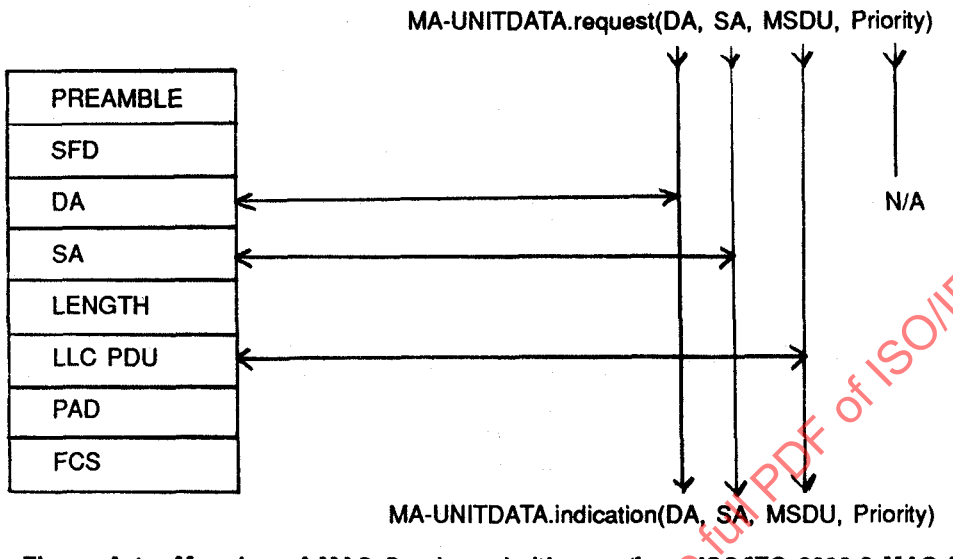

Figure A.1 - Mapping of MAC Service primitives to/from ISO/IEC 8802-3 MAC frames

The MAC frame structure is defined in ISO/IEC 8802-3.

The ISO/IEC 8802-3 MAC Protocol provides a single priority service regardless of the priority requested.

The ISO/IEC 8802-3 MAC Protocol does not provide the capability of transferring the requested priority to the remote MAC Service user.