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Information processing systems — Fibre Distributed Data Interface (FDDI) —

Part 2 : Token Ring Media Access Control (MAC)

Systèmes de traitement de l'information — Interface de données distribuées sur fibre (FDDI) —

Partie 2 : Mécanisme d'accès au support de l'anneau à jeton (MAC)

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Contents

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 9314-2 was prepared by Technical Committee ISO/TC 97, *Information processing systems.*

ISO 9314 consists of the following parts, under the general title *Information processing systems — Fibre Distributed Data Interface (FDDI) —*

- *Part 1: Token Ring Physical Layer Protocol (PHY)*
- *Part 2: Token Ring Media Access Control (MAC)*
- *Part 3: Token Ring Physical Layer, Medium Dependent (PMD)*

Introduction

This part of ISO 9314 on the FDDI media access control is intended for use in a high-performance multistation network. This protocol is designed to be effective at 100 Mbit/s using a Token ring architecture and fibre optics as the transmission medium over distances of several kilometres in extent.

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Information processing systems - Fibre Distributed Data Interface (FDDI) -

Part 2:
Token Ring Media Access Control (MAC)

1 Scope

This part of ISO 9314 specifies the Media Access Control (MAC), the lower sublayer of the Data Link Layer (DLL), for Fibre Distributed Data Interface (FDDI).

FDDI provides a high-bandwidth (100 Mbit/s), general-purpose interconnection among computers and peripheral equipment using fibre optics as the transmission medium in a ring configuration. FDDI can be configured to support a sustained transfer rate of approximately 80 Mbit/s (10 Mbyte/s). It may not meet the response time requirements of all unbuffered high speed devices. FDDI establishes the connection among many stations distributed over distances of several kilometres in extent. Default values for the FDDI were calculated to accommodate rings of up to 1 000 physical links and a total fibre path length of 200 km (typically corresponding to 500 stations and 100 km of dual fibre cable).

FDDI consists of

(a) A Physical Layer (PL), which provides the medium, connectors, optical bypassing, and driver/receiver requirements. PL also defines encode/decode and clock requirements as required for framing the data for transmission on the medium or to the higher layers of the FDDI. For purposes of this part of 9314, references to the PL are made in terms of the Physical Layer entity designated PHY.

(b) A Data Link Layer (DLL), which is divided into two sublayers:

(1) A Media Access Control (MAC) which provides fair and deterministic access to the medium, address recognition, and generation and verification of frame check sequences. Its primary function is the delivery of frames, including frame insertion, repetition, and removal. The definition of MAC is contained in this part of ISO 9314.

(2) A Logical Link Control (LLC) which provides a common protocol to provide the required data assurance services between MAC and the Network Layer.

(c) A Station Management (SMT)[1] which provides the control necessary at the station level to manage the processes under way in the various FDDI layers such that a station may work co-operatively on a ring. SMT provides services such as control of station initialization, configuration management, fault isolation and recovery, and scheduling procedures.

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[1] SMT will form the subject of a future part of ISO 9314.

The MAC definition contained herein is designed to be as independent as possible from bo the physical medium and the speed of operation. Concepts employed in ISO 8802-5, dealir with Token Ring MAC operation have been modified to accommodate the higher FDDI speed while retaining a similar set of services and facilities.

ISO 9314 specifies the interfaces, functions, and operations necessary to ensure interoperabili between conforming FDDI implementations. This part of ISO 9314 provides a function description. Conforming implementations may employ any design technique that does n violate interoperability.

2 Normative references

The following standards contain provisions which, through reference in this text, constitut provisions of this part of ISO 9314. At the time of publication, the editions indicated wer valid. All standards are subject to revision, and parties to agreements based on this part (ISO 9314 are encouraged to investigate the possibility of applying the most recent editions (the standards listed below. Members of IEC and ISO maintain registers of currently val International Standards.

ISO 8802-2: ----[1], *Information processing systems - Local Area Networks - Part 2: Logic Link Control (LLC).*

ISO 8802-5: ----[1], *Information processing systems - Local Area Networks - Part 5: Tok Ring Access Method and Physical Layer specification.*

ISO 9314-1: 1989, *Information processing systems - Fibre Distributed Data Interface (FDDI) Part 1: Token Ring Physical Layer Protocol (PHY).*

ISO 9314-3: ----[1], *Information processing systems - Fibre Distributed Data Interface (FDDI) Part 3: Token Ring Physical Layer, Medium Dependent (PMD).*

3 Definitions

For the purposes of this part of ISO 9314, the following definitions apply:

3.1 asynchronous: A class of data transmission service whereby all requests for servic contend for a pool of dynamically allocated ring bandwidth and response time.

3.2 capture: The act of removing a Token from the ring for the purpose of Fram transmission.

3.3 claim token: A process whereby one or more stations bid for the right to initialize th ring.

3.4 entity: An active functional agent within an Open System Interconnection (OSI) layer sublayer, including both operational and management functions.

3.5 fibre optics: The technology whereby optical signals from light-generating transmitters a propagated through optical fibre waveguides to light-detecting receivers.

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[1] To be published.

3.6 frame: A PDU transmitted between co-operating MAC entities on a ring, consisting of a variable number of octets and control symbols.

3.7 Media Access Control (MAC): The Data Link Layer responsible for scheduling and routing data transmissions on a shared medium Local Area Network (e.g., an FDDI ring).

3.8 nonrestricted token: A Token denoting the normal mode of asynchronous bandwidth allocation, wherein the available bandwidth is time-sliced among all requesters.

3.9 octet: A data unit composed of eight ordered bits (a pair of data symbols).

3.10 Physical (PHY): The Physical Layer responsible for delivering a symbol stream produced by an upstream MAC Transmitter to the logically adjacent downstream MAC Receiver in an FDDI ring.

3.11 physical connection: The full-duplex physical layer association between adjacent physical layer entities (in concentrators, repeaters, or stations) in an FDDI ring.

3.12 primitive: An element of the service interface presented by an entity.

3.13 Protocol Data Unit (PDU): The unit of data transfer between communicating peer layer entities. It may contain control information, address information, data (e.g., an SDU from a higher layer entity), or any combination of the three. The FDDI MAC PDUs are Tokens and Frames.

3.14 receive: The action of a station in accepting a Token, Frame, or other symbol sequence from the incoming medium.

3.15 repeat: The action of a station in receiving a Token or Frame from the adjacent upstream station and simultaneously sending it to the adjacent downstream station. The FDDI MAC may repeat received PDUs (Tokens and Frames), but does not repeat the received symbol stream between PDUs. While repeating a Frame, MAC may copy the data contents and modify the control indicators as appropriate.

3.16 restricted token: A Token denoting a special mode of asynchronous bandwidth allocation, wherein the bandwidth available for the asynchronous class of service is dedicated to a single extended dialogue between specific requesters.

3.17 ring: Two or more stations connected by a physical medium wherein information is passed sequentially between active stations, each station in turn examining or copying and repeating the information, finally returning it to the originating station.

3.18 Service Data Unit (SDU): The unit of data transfer between a service user and a service provider.

3.19 services: A set of functions provided by one OSI layer sublayer entity, for use by a higher layer or sublayer entity or by management entities.

3.20 station: An addressable logical and physical attachment in a ring, capable of transmitting, receiving, and repeating information. An FDDI station has one or more PHY entities, one or more MAC entities, and one SMT entity.

3.21 Station Management (SMT): The supervisory entity within an FDDI station that monitors and controls the various FDDI entities including PMD, MAC, and PHY.

3.22 symbol: The smallest signalling element used by MAC, i.e., the PHY SDU. The symb set consists of 16 data symbols and 8 control symbols. Each symbol maps to a speci sequence of five code bits as transmitted by the Physical Layer.

3.23 synchronous: A class of data transmission service whereby each requester preallocated a maximum bandwidth and guaranteed a response time not to exceed a speci delay.

3.24 token: An explicit indication of the right to transmit on a shared medium. On a Tok Ring, the Token circulates sequentially through the stations in the ring. At any time, it may held by zero or one station. FDDI uses two classes of Tokens: restricted and nonrestricte

3.25 transmit: The action of a station in generating a Token, Frame, or other symb sequence and placing it on the outgoing medium.

4 Conventions and abbreviations

4.1 Conventions

The terms SMT, MAC, LLC, and PHY, when used without modifiers, refer specifically to t local entities. The term LLC unless otherwise qualified refers to any local user of MAC da services, other than SMT, including ISO 8802-2.

Low lines (e.g., requested_service_class) are used as a convenience to mark the name signals, functions, etc., that might otherwise be misinterpreted as independent individual words they were to appear in text.

The use of a period (e.g., MA_UNITDATA.request) is equivalent to the use of low lines exce that a period is used as an aid to distinguish modifier words appended to an antecede expression.

4.1.1 Addressing

my short address (MSA): 16-bit Individual Address of this station (0 = Null).

my long address (MLA): 48-bit Individual Address of this station (0 = Null). If a stati does not implement 48-bit addressing then MLA=0.

short addresses: Set of 16-bit station Addresses including MSA if not Null, the 16-l Broadcast Address (all ones), and any other 16-bit Group Addresses recognized by this stati

long addresses: Set of 48-bit Station Addresses including MLA if not Null, the 48-l Broadcast Address (all ones), and any other 48-bit Group Addresses recognized by tl station.

If a station does not implement 48-bit addressing, then MLA = 0.

When claiming the Token (i.e., the transmitter is in Claim Token state), if the station transm with 16-bit addressing, then MLA = 0; conversely, if the station transmits with 48-l addressing, then MSA = 0.

4.1.2 Timing values and timers:

All timing values are expressed as the unsigned twos complements of the target, or remaining, time in octets, i.e., the numerically greater magnitude represents the shortest time remaining. This definition is for reference purposes only and does not prescribe the implementation, except where these timing values appear in Protocol Data Units on the ring. These timing values are not all used simultaneously in the state machines; consequently, the implementation need not materialize them when they are not needed.

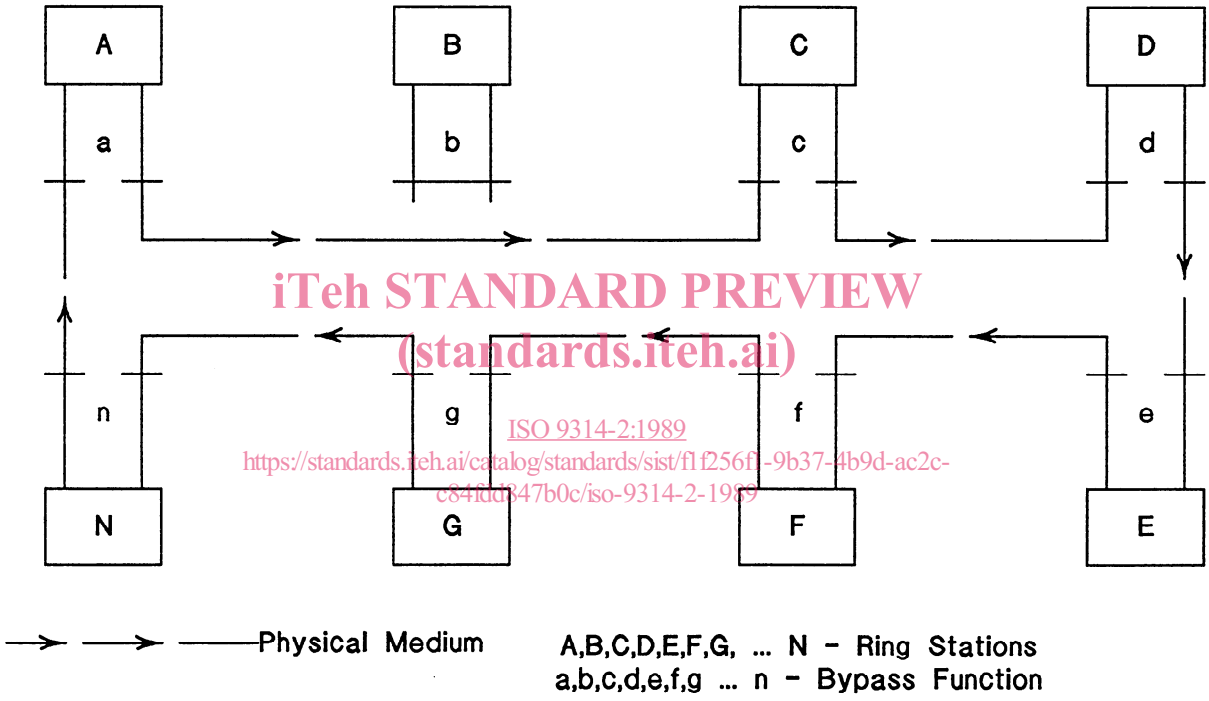
For the purpose of the description contained in this part of ISO 9314, all timers are assumed to be initialized with the unsigned twos complement of the target, or remaining, time in octets. Timers are further assumed to count upward if enabled, expiring when an overflow occurs. All timer comparisons are expressed on the basis of elapsed time. These conventions are only for the convenience of documenting this part of ISO 9314 and do not prescribe implementation.

4.2 Abbreviations

Error_Ct	Count of reportable frame errors
Frame_Ct	Count of all frames received
Late_Ct	Count of TRT expirations (Token Lateness)
Lost_Ct	Count of PDUs detected as lost
A_Flag	Indicates Destination Address match in last received frame
C_Flag	Indicates successful copying of last received frame
E_Flag	Indicates error detected in last received frame
H_Flag	Indicates Higher Source Address received
L_Flag	Indicates Lower Source Address received
M_Flag	Indicates My Source Address received
N_Flag	Indicates next station addressing
R_Flag	Indicates the Token_class of the last valid Token received was restricted
A_Max	Maximum signal acquisition time
D_Max	Maximum ring latency time
F_Max	Maximum frame time
I_Max	Maximum station physical insertion time
L_Max	Maximum Transmitter Frame set-up time
M_Max	Maximum number of MAC entities allowed on the ring
S_Min	Minimum safety timing allowance
T_Bid_Rc	Bidding TTRT received by this station in Claim Frames
T_Bid_Tx	Bidding TTRT transmitted in this station's Claim Frames
T_Init	Ring initialization time
T_Max	Maximum TTRT to be supported by this station
T_Min	Minimum TTRT to be supported by this station
T_Neg	Negotiated TTRT during Claim process (in receiver)
T_Opr	Operative TTRT for this station (in transmitter)
T_Pri	Set of n priority Token rotation time thresholds
T_Pri(n)	Element n of the set T_Pri
T_React	Worst Case time to react to a station insertion or removal
T_Req	Requested TTRT for this station's synchronous traffic
T_Resp	Worst case time to recover a Token
THT	Token-Holding Timer
TRT	Token-Rotation Timer
TTRT	Target Token Rotation Time
TVX	Valid-Transmission Timer

5 General description

A Token ring consists of a set of stations serially connected by a transmission medium form a closed loop (see figure 1). Information is transmitted sequentially, as a stream symbols, from one active station to the next. Each station generally regenerates and repe each symbol and serves as the means for attaching one or more devices to the ring for purpose of communicating with other devices on the ring. A given station (the one that access to the medium) transmits information on to the ring, where the information circula from one station to the next. The addressed destination station(s) copies the information a passes. Finally, the station that transmitted the information effectively removes it from ring.



All stations are active except B (b illustrated in bypass mode)

Figure 1 - Token ring configuration example

A station gains the right to transmit its information on to the medium when it detects a To passing on the medium. The Token is a control signal comprised of a unique symbol seque that circulates on the medium following each information transmission. Any station, u detection of a Token, may capture the Token by removing it from the ring. The station n then transmit one or more frames of information. At the completion of its informa transmission, the station issues a new Token, which provides other stations the opportunity gain access to the ring.

A Token-holding timer, or equivalent means, limits the length of time a station may (occupy) the medium before passing the Token.

Multiple levels of priority are available for independent and dynamic assignment depending upon the relative class of service required. The classes of service may be synchronous (typically used for applications such as real-time voice), asynchronous (typically used for interactive applications), or immediate (used for extraordinary applications such as ring recovery). The allocation of ring bandwidth occurs by mutual agreement among users of the ring.

Error detection and recovery mechanisms are provided to restore ring operation in the event that transmission errors or medium transients (e.g., those resulting from station insertion or removal) cause the access method to deviate from normal operation. Detection and recovery for these cases utilizes a recovery function that is distributed among the stations attached to the ring.

The media access method as specified herein is not intended to place constraints on the logical link control or higher level protocols employed to effect data transfer.

6 Services

This clause specifies the services provided by MAC and the services required by MAC. The intent is to allow higher-level protocol(s) (e.g., ISO 8802-2) to operate correctly with this MAC. How many of the services described in this clause are chosen for a given implementation is up to that implementer; however, a set of MAC services shall be supplied sufficient to satisfy the higher level protocol(s) being used. The services as defined herein do not imply any particular implementation, or any interface. Services described are

(a) MAC services provided to the local LLC entity, or other MAC users (indicated by MA__ prefix).

(b) Services required from the local PHY entity by MAC (indicated by PH__ prefix).

(c) MAC services provided to the local SMT entity (indicated by SM__MA__ prefix).

6.1 MAC-to-LLC services

This subclause specifies the services provided by the Medium Access Control (MAC) to allow the local LLC entity to exchange LLC service data units with peer LLC entities. These services are also used for implementer frames. The following primitives are defined:

MA__UNITDATA.request
MA__UNITDATA.indication
MA__UNITDATA__STATUS.indication
MA__TOKEN.request

The description of each primitive includes a description of the information that is passed between the LLC and MAC entities.

6.1.1 MA__UNITDATA.request

This primitive defines the transfer of one or more Service Data Units (SDUs) from a local LLC entity to a single peer LLC entity, or to multiple peer LLC entities in the case of group addresses.

6.1.1.1 Semantics of the primitive

MA__UNITDATA.request (
FC__value (1),
destination__address (1),
M__SDU (1),
requested__service__class (1),
stream (1),
FC__value (2),
destination__address (2),
M__SDU (2),
requested__service__class (2),
stream (2),
.
.
.
FC__value (n),
destination__address (n),
M__SDU (n),
requested__service__class (n),
stream (n),
Token__class
)

Each set of FC__value, destination__address, M__SDU, requested__service__class and strea parameters specifies one frame for transmission and is referred to as a subrequest.

The FC__value parameter supplies the Frame Control (FC) field to be transmitted as part the frame.

The destination__address parameter may specify either an individual or a group MAC addres It shall contain sufficient information to create the DA (Destination Address) field that included in the frame by MAC. Address length is determined by the L bit of the associate FC__value parameter (see 7.3.3).

Each M__SDU parameter specifies an LLC service data unit as received at the MAC interfac to be transmitted by MAC. There is sufficient information associated with the M__SDU f MAC to determine the length of the service data unit. Associated with each M__SDU is requested__service__class parameter.

Requested__service__class may be either Synchronous or Asynchronous. If asynchronous, th requested__Token__class and the priority level may optionally be specified.

Stream is a parameter that, if set, shall cause multiple M__SDUs to be transmitted as a resu of the MA__UNITDATA.request. Stream, when reset, indicates that this M__SDU is the last or associated with this MA__UNITDATA.request. The frames shall be transmitted in the ord presented by this primitive regardless of the associated requested__service__class. If TR (Token-Rotation Timer) has expired (Late__Ct not= 0) or if a frame is encountered that cann be transmitted because of its associated requested__service__class and the current value THT (Token-Holding Timer), then transmission is terminated and a Token is issued as define by the Token__class parameter. A MA__UNITDATA__STATUS.indication is subsequently returne to LLC. If the transmission__status is successful, MAC may initiate transmission of th remaining frames on the next permitted access opportunity or, alternatively, MAC may requi reissuance of a new MA__UNITDATA.request.

Token_class specifies the class of Token that MAC shall issue following transmission of the associated SDUs (i.e., at the end of the request), if no other request is pending that can be honoured. With requests for synchronous service the Token_class shall be the Token_class that was captured; with requests for asynchronous service it may be either restricted or nonrestricted. If no SDUs were specified by the MA_UNITDATA.request, then MAC shall immediately issue the requested class of Token.

6.1.1.2 When generated

This primitive is generated by the local LLC entity whenever data is to be transferred to a peer LLC entity or entities or a Token is to be generated. This may be in response to a request from higher layers of protocol or from data generated internally to LLC.

6.1.1.3 Effect of receipt

The receipt of this primitive shall cause MAC to append all MAC-specific fields, including DA, SA (Source Address), and any fields that are unique to the medium access method, and pass the properly formed frames to the lower layers of protocol for transfer to peer MAC entity or entities.

NOTE - This primitive is the normal means of requesting the transfer of data. The capture of a Token is implicit in this primitive and therefore it is not necessary to issue an MA_TOKEN.request primitive in conjunction with it.

6.1.2 MA_UNITDATA.Indication

This primitive defines the transfer of data from MAC to the local LLC entity.

6.1.2.1 Semantics of the primitive


```
MA_UNITDATA.indication          (
                                FC_value,
                                destination_address,
                                source_address,
                                M_SDU,
                                reception_status
                                )
```

The FC_value parameter specifies the value of the frame's FC (Frame Control) field. The destination_address parameter may be either an individual or a group address as specified by the DA field of the incoming frame. The source_address parameter is an individual address as specified by the SA field of the incoming frame. The M_SDU parameter shall specify the MAC service data unit as received by the local MAC entity.

The reception_status parameter indicates the success or failure of the incoming frame. It consists of the following elements:

(a) Frame validity: FR_GOOD, FR_BAD

If a FR_BAD is reported, the reason for the error shall also be reported. The reason shall be one of the following:

(1) **Invalid FCS:** Calculated FCS (Frame Check Sequence) does not match the received FCS