INTERNATIONAL STANDARD

ISO/IEC 9314-8

First edition
1998-08

Information technology –
Fibre Distributed Data Interface (FDDI) –

Part 8:
Media Access Control-2 (MAC-2)

Reference number
ISO/IEC 9314-8:1998(E)

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CODE PRIX
PRICE CODE X

Pour prix, voir catalogue en vigueur
For price, see current catalogue

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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 9314-8 was prepared by Joint Technical Committee ISO/IEC JTC 1 *Information technology*, Subcommittee SC 25*, Interconnection of information technology equipment.*

ISO/IEC 9314 consists of the following parts, under the general title *Information technology – Fibre Distributed Data Interface (FDDI):*

– *Part 1: Token Ring Physical Layer Protocol (PHY) (1989)*

– *Part 2: Token Ring Media Access Control (MAC) (1989)*

– *Part 3: Physical Layer Medium Dependent (PMD) (1990)*

– *Part 4: Single Mode Fibre Physical Layer Medium Dependent (SMF-PMD)* [1)]

– *Part 5: Hybrid Ring Control (HRC) (1995)*

– *Part 6: Station Management (SMT)*

– *Part 7: Physical Layer Protocol (PHY-2)*

– *Part 8: Media Access Control-2 (MAC-2)*

– *Part 9: Low-Cost Fibre – Physical Medium Dependent (LCF-PMD) (under consideration)*

– *Part 10: Token Ring Twisted Pair Physical layer Medium Dependent (TP-PMD) (under consideration)*

– *Part 13: Conformance Test Protocol Implementation Conformance Statement Proforma (CT-PICS)*

– *Part 20: Physical Medium Dependent Conformance Testing (PMD-ATS) (under consideration)*

– *Part 21: Physical Layer Protocol Conformance Testing (PHY-ATS) (under consideration)*

– *Part 25: Abstract test suite for FDDI – Station Management Conformance Testing (SMT-ATS)*

– *Part 26: Media Access Control Conformance Testing (MAC-ATS) (under consideration)*

1) To be published

INTRODUCTION

The Fibre Distributed Data Interface (FDDI), ISO/IEC 9314, is intended for use in a high-performance general purpose multi-node network and is designed for efficient operation with a peak data rate of 100 Mbit/s. It uses a Token Ring architecture with optical fibre as the transmission medium. FDDI provides for hundreds of nodes operating over an extent of tens of kilometres.

The Media Access Control (MAC) specifies the lower sublayer of the Data Link Layer for the FDDI. As such, it presents the specifications and services provided for conforming FDDI attachment devices. MAC specifies the access to the medium, including addressing, data checking, and data framing. MAC also specifies the receiver and transmitter state machines.

When the set of basic FDDI standards, ISO/IEC 9314, is completed it will include the following standards:

a) A Physical Layer Protocol (PHY), which specifies the upper sublayer of the Physical Layer of ISO/IEC 9314.

b) A Physical Layer Media Dependent (PMD), which specifies the lower sublayer of the Physical Layer of ISO/IEC 9314.

c) A Station Management (SMT), which specifies the local portion of the system management application process of ISO/IEC 9314.

A number of extensions to ISO/IEC 9314 are completed or in process. One extension, ISO/IEC 9314-5, for Hybrid Ring Control (HRC), commonly known as FDDI-II, extends the capability of FDDI to handle isochronous data streams at a multiplicity of data rates. Another extension, ISO/IEC 9314-4, provides for a single-mode optical fibre version of PMD (SMF-PMD) and will permit optical links of up to 60 km.

Other work, addressing alternate PMDs, is aimed at providing low-cost attachments for use in concentrator-to-workstation environments. This work includes a Low-Cost Fibre PMD (LCF-PMD) and a (copper) Twisted Pair PMD (TP-PMD).

This part of ISO/IEC 9314 for MAC-2 is an enhancement to the original FDDI standard on MAC (ISO 9314-2). It is referred to as MAC-2 when it is necessary to distinguish it from the original MAC. Changes include those identified in footnotes to ISO 9314-2 as areas that the standards committee intended to change as well as changes that were required for extensions to FDDI, such as FDDI-II and MAC level bridging. MAC-2 also includes editorial corrections and clarifications.

INFORMATION TECHNOLOGY — FIBRE DISTRIBUTED DATA INTERFACE (FDDI) —

Part 8: Media Access Control-2 (MAC-2)

1 Scope

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

FDDI (ISO/IEC 9314) provides a high-bandwidth (100 Mbit/s), general-purpose interconnection among information processing systems, subsystems and peripheral equipment, using fibre optics or other transmission media. FDDI can be configured to support a sustained data transfer rate of at least 80 Mbit/s (10 Mbyte/s). FDDI provides connectivity for many nodes distributed over distances of many kilometres in extent. Certain default parameter values for FDDI (e.g. timer settings) are calculated on the basis of up to 1 000 transmission links or up to 200 km total fibre path length (typically corresponding to 500 nodes and 100 km of dual fibre cable, respectively); however, the FDDI protocols can support much larger networks by increasing these parameter values.

As shown in figure 1, ISO/IEC 9314 consists of

a) A Physical Layer (PL), which is divided into two sublayers:

   1) A Physical Medium Dependent (PMD), which provides the digital baseband point-to-point communication between nodes in the FDDI network. The PMD provides all services necessary to transport a suitably coded digital bit stream from node to node. The PMD defines and characterizes the fibre-optic drivers and receivers, medium-dependent code requirements, cables, connectors, power budgets, optical bypass provisions, and physical-hardware-related characteristics. It specifies the point of interconnectability for conforming FDDI attachments. The initial PMD standard, ISO/IEC 9314-3, defines attachment to multi-mode fibre. Additional PMD sublayer standards are being developed for attachment to single-mode fibre and SONET.

   2) A Physical Layer Protocol (PHY), which provides connection between the PMD and the Data Link Layer. PHY establishes clock synchronization with the upstream code-bit data stream and decodes this incoming code-bit stream into an equivalent symbol stream for use by the higher layers. PHY provides encoding and decoding between data and control indicator symbols and code bits, medium conditioning and initializing, the synchronization of incoming and outgoing code-bit clocks, and the delineation of octet boundaries as required for the transmission of information to or from higher layers. Information to be transmitted on the medium is encoded by the PHY using a group transmission code.

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

   1) An optional Hybrid Ring Control (HRC), which provides multiplexing of packet and circuit switched data on the shared FDDI medium. HRC comprises two internal components, a Hybrid Multiplexer (H-MUX) and an isochronous MAC (I-MAC). H-MUX maintains a synchronous 125 µs cycle structure and multiplexes the packet and circuit switched data streams, and I-MAC provides access to circuit switched channels.

2) 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 packet data, including frame generation, repetition, and removal. The definition of MAC is contained in this part of ISO/IEC 9314.

3) An optional Logical Link Control (LLC), which provides a common protocol for any required packet data adaptation services between MAC and the Network Layer. LLC is not specified by FDDI.

4) An optional Circuit Switching Multiplexer (CS-MUX), which provides a common protocol for any required circuit data adaptation services between I-MAC and the Network Layer. CS-MUX is not specified by FDDI.

c) A Station Management (SMT), which provides the control necessary at the node level to manage the processes under way in the various FDDI layers such that a node may work cooperatively on a ring. SMT provides services such as control of configuration management, fault isolation and recovery, and scheduling policies.

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

ISO/IEC 9314 specifies the interfaces, functions, and operations necessary to ensure interoperability between conforming FDDI implementations. This part of ISO/IEC 9314 provides a functional description. Conforming implementations may employ any design technique that does not violate interoperability. Implementations that conform to this part of ISO/IEC 9314 shall also be interoperable with implementations that conform to ISO 9314-2 if the additional capability of hybrid mode operation (as defined in this document) is not being used. Implementers are encouraged to consult ISO 9314-2 in addition to this part of ISO/IEC 9314.

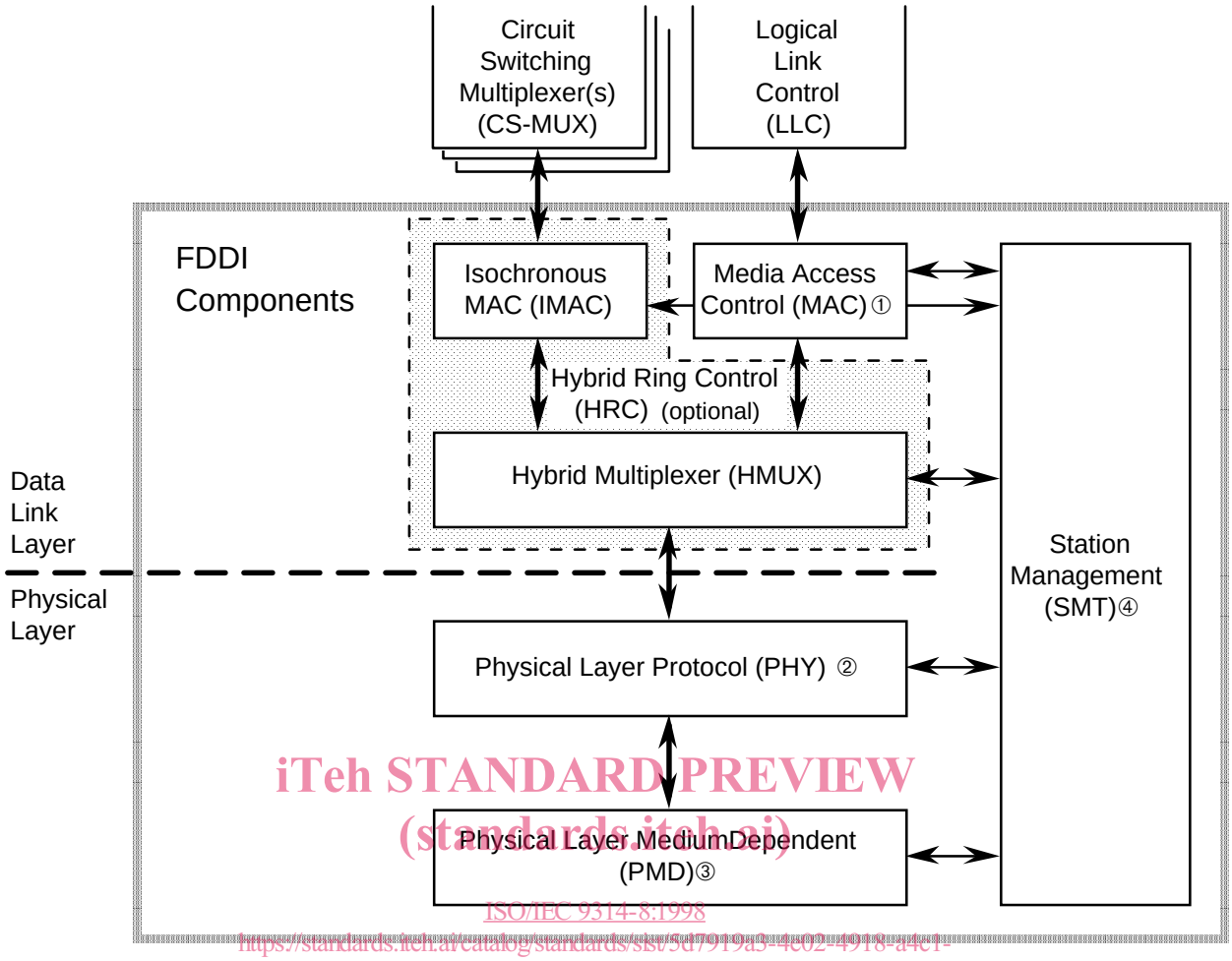

Figure 1 – FDDI structure

2 Normative references

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

ISO/IEC 8802-2: 1994, *Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 2: Logical link control*

ISO/IEC 8802-5: 1992, *Information technology - Telecommunications and information exchange between systems - Local and metropolitan area networks - Specific requirements - Part 5: Token ring access method and physical layer specifications*

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

ISO 9314-2: 1989, *Information processing systems - Fibre Distributed Data Interface (FDDI) - Part 2: Token Ring Media Access Control (MAC)*

ISO/IEC 9314-3: 1990, *Information processing systems – Fibre Distributed Data Interface (FDDI) – Part 3: Physical Layer Medium Dependent (PMD)*

ISO/IEC 9314-4, *Information technology – Fibre Distributed Data Interface (FDDI) – Part 4: Single Mode Fibre Physical Layer Medium Dependent (SMF-PMD)* [1)]

ISO/IEC 9314-5:1995, *Information technology - Fibre Distributed Data Interface (FDDI) - Part 5: Hybrid Ring Control (HRC)*

ISO/IEC 9314-6: *Information technology - Fibre Distributed Data Interface (FDDI) - Part 6: Station Management (SMT)*

ISO/IEC 9314-7: *Information technology - Fibre Distributed Data Interface (FDDI) - Part 7: Physical Layer Protocol (PHY-2)*

ISO/IEC 10038: 1993, *Information technology - Telecommunications and information exchange between systems - Local area networks - Media access control (MAC) bridges*

3 Definitions

For the purposes of this part of ISO/IEC 9314, the following definitions apply. In some cases these definitions may duplicate those contained in other parts of ISO/IEC 9314. Such definitions are included for completeness and to improve readability. In certain cases, definitions herein may slightly update those contained in the earlier published parts of ISO/IEC 9314 to improve their clarity.

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

3.2 Basic mode: The mode of ring operation where MAC PDUs (frames and tokens) are directly transmitted by PHY.

3.3 bypass: The ability of a node to optically isolate itself from the FDDI network while maintaining the continuity of the cable plant.

3.4 capture: The act of removing a token from the ring for the purpose of Frame transmission.

3.5 claim token: A process whereby one or more MACs bid for the right to initialize the ring.

3.6 counter-rotating: An arrangement whereby two signal paths in opposite directions exist in a ring topology.

3.7 cycle: A Protocol Data Unit transmitted between cooperating HRC entities on a ring, consisting of a fixed number of octets in each 125 µs interval.

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1) To be published.

3.8 entity: An active service or management element within an Open System Interconnection (OSI) layer, or sublayer.

3.9 fibre optics: A technology whereby signals are transmitted over an optical waveguide medium through the use of light-generating transmitters and light-detecting receivers.

3.10 frame: A Protocol Data Unit transmitted between cooperating MAC entities on a logical ring, consisting of a variable number of octets and control symbols.

3.11 Hybrid mode: The mode of ring operation where HRC PDUs (cycles) are transmitted by PHY.

3.12 Hybrid Ring Control (HRC): The Data Link Layer entity responsible for multiplexing of packet and circuit switched data, and providing access to circuit switched channels, in an FDDI logical ring.

3.13 immediate: A class of data transmission service whereby requests for service from SMT when the ring is non-operational are performed immediately without capture of a token.

3.14 logical ring: The set of FDDI Data Link Layer entities (HRC or MAC) serially connected to form a single ring. The FDDI network topology can form two counter-rotating logical rings; however, some subsets of this topology only form a single logical ring.

3.15 Media Access Control (MAC): The Data Link Layer entity responsible for scheduling and routing packet data transmissions in an FDDI logical ring.

3.16 my long address (MLA): The 48-bit Individual Address of this MAC.

3.17 my short address (MSA): The 16-bit Individual Address of this MAC.

3.18 network (FDDI network): A collection of FDDI nodes interconnected to form a trunk, or a tree, or a trunk with multiple trees. This topology is sometimes called a dual ring of trees.

3.19 node: A collection of Physical Layer (e.g. PMD and PHY) and optional Data Link Layer (e.g. MAC and HRC) entities within an FDDI network, capable of repeating information and optionally of transmitting and receiving information, and managed by one SMT entity.

3.20 non-restricted token: A token denoting the normal mode of asynchronous bandwidth allocation, wherein the available bandwidth is shared among requesters.

3.21 null address: An address of all zeros, or an address that is either not implemented or implemented but not enabled.

3.22 octet: A data unit composed of eight ordered binary bits. An octet is represented in FDDI as a pair of data symbols.

3.23 Physical Layer Medium Dependent (PMD): The Physical Layer entity responsible for delivering a code bit stream produced by a PHY entity to the physically adjacent PHY entity, attached via fibre optics, in an FDDI network.

3.24 Physical Layer Protocol (PHY): The Physical Layer entity responsible for delivering a symbol stream produced by an upstream DLL entity (MAC or HRC) to the logically adjacent downstream DLL entity in an FDDI network.

3.25 primitive: An element of the services provided by one entity to another.

3.26 Protocol Data Unit (PDU): The unit of information 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.

3.27 receive: The action of a node that consists of accepting an information stream (e.g. frame, token, cycle or control sequence) from the medium. The node receiving the information stream may examine it and selectively copy it as appropriate.

3.28 repeat: The action of a node that consists of receiving an information stream from an upstream node and reproducing it on the medium to a downstream node. The node repeating the information stream may examine it and selectively copy or modify it as appropriate.

3.29 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.

3.30 ring: A closed loop consisting of one 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.

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

3.32 services: A set of functions provided by one OSI layer or sublayer entity, for use by a higher layer or sublayer entity or by management entities. Data services are provided to a higher layer or sublayer entity; management services are provided to a management entity.

3.33 source routing: A method of routing frames through a bridged network in which the source station specifies within each frame the route it will traverse.

3.34 station: An addressable logical and physical node in an FDDI network, capable of transmitting, repeating and receiving information. An FDDI station has one or more PHY and PMD entities, zero or more HRC entities, one or more MAC entities, and one SMT entity.

3.35 Station Management (SMT): The supervisory entity within an FDDI node that monitors and controls the other FDDI entities in the node.

3.36 symbol: The smallest signalling element used by the Data Link Layer (DLL). The symbol set consists of 16 data symbols and 9 control symbols.

3.37 synchronous: A class of data transmission service whereby each requester is preallocated a maximum bandwidth and guaranteed a maximum access time.

3.38 token: An explicit indication of the right to transmit on a shared medium. On a token ring, the token circulates sequentially through the stations in the ring. At any time, it may be held by zero or one station. MAC uses two classes of tokens: restricted and non-restricted.

3.39 transmit: The action of a node that consists of generating an information stream (*e.g.* frame, token, cycle or control sequence) and placing it on the medium.

3.40 transparent bridging: A method of routing frames through a bridged network in which intermediate bridge stations determine the route that each frame will traverse without explicit involvement of the end stations.

4 Conventions and abbreviations

4.1 Conventions

The terms SMT, MAC, HRC, PHY and PMD, when used without modifiers, refer specifically to the local FDDI entities within a node. The term LLC unless otherwise qualified refers to any local user of MAC data services, other than SMT, including those conforming to ISO 8802-2.

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

The use of a period (*e.g.* MA_UNITDATA.request) is equivalent to the use of a low line except that a period is used as an aid to distinguish modifier words appended to an antecedent expression.

Subscripts or other object selectors are denoted by square brackets in text (*e.g.* aggregate object[subscript]).

Optional capabilities are distinguished from required capabilities by the use of dashed lines in drawings or curved braces in text (*e.g.* required capability { | optional capability }).

Subordinate clauses in state machine footnotes are denoted by indentation (*e.g.* matching THEN and ELSE clauses are indented one level beneath their IF clause).

Comments in state machine footnotes are denoted by double brackets (*e.g.* condition « comment »).

4.1.1 Addressing

MSA = the 16-bit Individual Address of this MAC, if implemented and enabled by SMT; otherwise MSA = Null.

MLA = the 48-bit Individual Address of this MAC, if enabled by SMT; otherwise MLA = Null.

Short_Addresses is the set of 16-bit MAC addresses including MSA if enabled, the 16-bit Broadcast Address (all ones), and any other 16-bit Group Addresses recognized by this MAC.

Long_Addresses is the set of 48-bit MAC addresses including MLA if enabled, the 48-bit Broadcast Address (all ones), and any other 48-bit Group Addresses recognized by this MAC.

When claiming the token, if the MAC transmits with 16-bit addressing, then MLA = Null; conversely, if the MAC transmits with 48-bit addressing, then MSA = Null.

A Null Address consists of all zeros in MAC PDUs. The representation of Null and/or disabled addresses within a station is not specified; however, by convention such addresses are represented as all zeros in this document.

Transparent_Bridge_Addresses is the set of 48-bit MAC addresses to be forwarded by transparent bridges.

4.1.2 Timing values and timers

All timing values, when encoded in binary form, are expressed as the unsigned twos complement 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