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Information technology – Fibre distributed data interface (FDDI) – Part 7: Physical Layer Protocol (PHY-2)

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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 9314-7 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 kilometers.

The Physical Layer Protocol (PHY) specifies the upper sublayer of the Physical Layer for the FDDI. As such, it presents the specifications and services provided for conforming FDDI attachment devices. PHY specifies the data encode and decode, framing, and clocking requirements. PHY also specifies the elasticity buffer, smoothing, and repeat filter functions.

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

a) A Media Access Control (MAC), which specifies the lower sublayer of the Data Link 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 60 km.

Other extensions, addressing alternate PMDs, provide low-cost attachments for use in concentrator-to-workstation environments.

This part of ISO/IEC 9314 for PHY-2 is an enhancement to the original FDDI standard on PHY (ISO 9314-1). It is referred to as PHY-2 when it is necessary to distinguish it from the original PHY. Changes include those identified in footnotes to ISO 9314-1 as areas that the standards committee intended to change as well as changes that were required for extensions to FDDI, such as FDDI-II. PHY-2 also includes editorial corrections and clarifications.

INFORMATION TECHNOLOGY —
FIBRE DISTRIBUTED DATA INTERFACE (FDDI) —

Part 7: Physical Layer Protocol (PHY-2)

1 Scope

This part of ISO/IEC 9314 specifies the Physical Layer Protocol (PHY), the upper sublayer of the Physical Layer, for Fibre Distributed Data Interface (FDDI).

FDDI 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 kilometers 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, FDDI consists of

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 defines attachment to multi-mode fibre. Alternative PMD sublayer standards are being developed for attachment to other transmission media and for mapping to Synchronous Optical Network (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. The definition of PHY is contained in this part of ISO/IEC 9314.

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,

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,

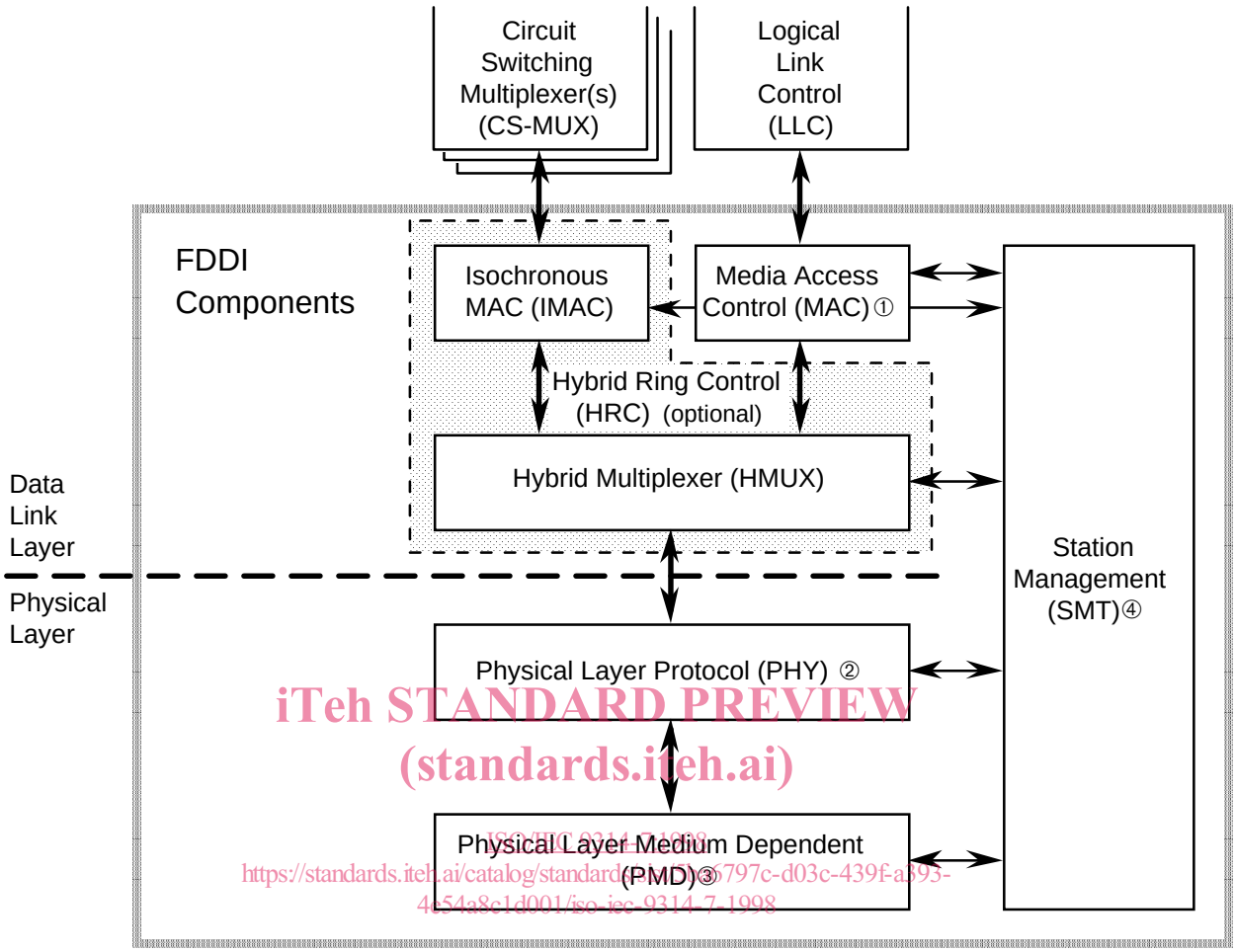
4) An optional Circuit Switching Multiplexer (CS-MUX), which provides a common protocol for any required circuit data adaptation services between I-MAC and the Network Layer. CS-MUX is not specified by FDDI.

c) A Station Management (SMT), which provides the coordination 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 definition of PHY as contained in this part of ISO/IEC 9314 is designed to be as independent as possible from the actual physical medium.

This part of ISO/IEC 9314 is an optional alternative to the original part of ISO/IEC 9314 on PHY (ISO 9314-1) for implementations without an (optional) HRC, and is required for implementations with an HRC. Implementations that conform to this part of ISO/IEC 9314 shall also be interoperable with implementations that conform to ISO 9314-1 if the additional capability of Hybrid mode operation (as defined in this part of ISO/IEC 9314) is not being used. Implementers are encouraged to read ISO 9314-1 in addition to this part of ISO/IEC 9314.

The set of FDDI standards specifies the interfaces, functions and operations necessary to ensure interoperability between conforming FDDI implementations. This part of ISO/IEC 9314 is a functional description. Conforming implementations may employ any design technique that is interoperable.



① MAC-2 with HRC; MAC or MAC-2 otherwise.

② PHY-2 with HRC; PHY or PHY-2 otherwise.

③ PMD, SMF-PMD, TP-PMD or LCF-PMD.

④ SMT-2 with HRC; SMT or SMT-2 otherwise.

Figure 1 – Structure of FDDI standards

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 indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

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 9314-8, *Information technology – Fibre Distributed Data Interface (FDDI) – Part 8: Media Access Control (MAC-2)*

ISO/IEC 9314-9:199X, *Fibre Distributed Data Interface (FDDI) – Part 9: Token ring low-cost fibre physical layer medium dependent (LCF-PMD)*

ISO/IEC 9314-10:199X, *Fibre Distributed Data Interface (FDDI) – Part 10: Token ring twisted pair physical layer medium dependent (TP-PMD)*

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

3.2 byte: A pair of symbols on an even-symbol boundary.

3.3 code bit: The smallest signalling element used by the Physical Layer for transmission on the medium.

3.4 code group: A Protocol Data Unit transmitted between cooperating PHY entities on a Physical Link, consisting of a specific sequence of five code bits representing a symbol.

3.5 concentrator: A node which provides connections for multiple subordinate nodes in an FDDI network. A concentrator has two or more Physical Layer attachments and may or may not have one or more Data Link Layer entities.

3.6 Connection Management (CMT): That portion of the Station Management (SMT) function that controls network insertion, removal, and connection of PHY and Data Link Layer entities (MAC or HRC) within a node.

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

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1) To be published.

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

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

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

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

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

3.13 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.

3.14 logical ring: The set of FDDI Data Link Layer entities (HRC and 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 can 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 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.

3.17 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.

3.18 non-return to zero (NRZ): A coding technique where one polarity level represents a logical "1" (one) and the opposite polarity level represents a logical "0" (zero).

3.19 non-return to zero, invert on ones (NRZI): A coding technique where a polarity transition represents a logical "1" (one) and the absence of a polarity transition denotes a logical "0" (zero).

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

3.21 Physical Connection: The full-duplex physical layer association between adjacent PHY entities (in concentrators, repeaters, or stations) in an FDDI ring, i.e. a pair of Physical Links.

3.22 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 or other media, in an FDDI network.

3.23 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.

3.24 Physical Link: The simplex path (via PMD and attached medium) from the transmit function of one PHY entity to the receive function of an adjacent PHY entity (in concentrators, repeaters, or stations) in an FDDI ring.

3.25 Port: A PHY entity and a PMD entity in a node, together creating a PHY/PMD pair, that may connect to the optical fibre or other media and provide one end of a physical connection with another node.

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

3.27 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 PHY PDUs are code groups.

3.28 quartet: A data unit composed of four ordered binary bits. A quartet is represented in FDDI as a single data symbol.

3.29 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.

3.30 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.

3.31 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.

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

3.33 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.

3.34 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. Each symbol corresponds to a specific code group to be transmitted by PHY.

3.37 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.

3.38 Unit Interval (UI): The transmission time for a fixed length signalling element (e.g. a code bit or a symbol).

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. When this edition is to be distinguished from the first edition (ISO 9314-1: 1989) it shall be referred to as PHY-2; the term PHY is used generically where either version may be applicable.

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

The use of a period (e.g. PH_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]).

An overbar ($^{-}$) after a decimal fraction denotes a continued fraction (e.g. $0{,}04^{-}$ = 0,044 444 …).

A vertical stroke (|) in a logical expression denotes a logical ‘OR’.

An ampersand (&) in a logical expression denotes a logical ‘AND’.

A tilde (~) in a logical expression denotes a logical ‘NOT’.

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 }).

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

4.2 Abbreviations

PMD	Physical Layer Medium Dependent (see ISO/IEC 9314-3, 9314-4, 9314-9 or 9314-10)
PHY	Physical Layer Protocol (see ISO/IEC 9314-7 or this standard)
HRC	Hybrid Ring Control (see ISO/IEC 9314-5)
MAC	Media Access Control (see ISO/IEC 9314-2 or 9314-8)
SMT	Station Management (see ISO/IEC 9314-6)
CMT	Connection Management
SONET	Synchronous Optical Network
DLL	Data Link Layer
ALS	Active Line State
CLS	Cycle Line State
HLS	Halt Line State
ILS	Idle Line State
MLS	Master Line State
NLS	Noise Line State
QLS	Quiet Line State
LSU	Line State Unknown
NRZ	Non Return to Zero
NRZI	Non Return to Zero, Invert on Ones
PI	Primary In
PO	Primary Out
SI	Secondary In
SO	Secondary Out
UI	Unit Interval
AT_max	Maximum PHY acquisition time
LS_Max	Maximum line state change interval
Limit_ct	Current Limit Smoother extension (in symbols)
Target_ct	Current Target Smoother extension (in symbols)
Out_ct	Number of output symbols
C_Flag	Indicates Hybrid mode operation
S_Flag	Indicates synchronization established in Hybrid mode
T_Flag	Indicates current frame cannot be stripped
D_Max	Maximum ring latency
Limit_max	Maximum Limit Smoother capacity (in symbols)
Limit_cntr	One half of maximum Limit Smoother capacity (in symbols)
Target_max	Maximum Target Smoother capacity (in symbols)
Target_cntr	One half of maximum Target Smoother capacity (in symbols)
Target_th	Current Target Smoother threshold (in symbols)
PA_max	Maximum Hybrid mode preamble length (in symbols) before loss of synchronization
MIC	Media Interface Connector
P_max	Maximum number of Ports in a logical ring
SD_max	Maximum effective starting delimiter delay contribution of this attachment
SD_min	Minimum starting delimiter delay through this attachment
ms	millisecond
µs	microsecond
ns	nanosecond