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Information technology –
Fibre distributed data interface (FDDI) –

Part 6:
Station Management (SMT)

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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 9314-6 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.

Station Management (SMT) specifies the local portion of the system management application process for FDDI, including the control required for proper operation of a node in an FDDI ring. SMT provides services such as connection management, station insertion and removal, station initialization, configuration management, fault isolation and recovery, communications protocol for external authority, scheduling policies, and collection of statistics.

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 Physical Layer Protocol (PHY), which specifies the upper sublayer of the Physical Layer 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, will provide low-cost attachments for use in concentrator-to-workstation environments.

This part of ISO/IEC 9314 for SMT represents the final standard in the set of basic FDDI standards. SMT is a sophisticated document specifying many critical aspects of interoperability in a multi-vendor FDDI network and, as such, has proved to be by far the most difficult of the set of FDDI standards to complete. The successful completion of the work on SMT is the result of a high degree of cooperation between competing manufacturers of FDDI equipment.

INFORMATION TECHNOLOGY — FIBRE DISTRIBUTED DATA INTERFACE (FDDI) —

Part 6: Station Management (SMT)

1 Scope

This part of ISO/IEC 9314 specifies the Station Management (SMT) for the Fibre Distributed Data Interface (FDDI).

FDDI provides a high bandwidth (100 megabits per second) general purpose interconnection among computers and peripheral equipment using optical fibre as the transmission medium in a ring configuration. FDDI can be configured to support a sustained transfer rate of approximately 80 megabits (10 megabytes) per second. The use of dual attachment stations with dual MACs allows these rates to be doubled under the circumstance of a fault-free FDDI ring.

FDDI establishes the connection among many stations (nodes) distributed over distances of several kilometres in extent. Default values for FDDI were calculated on the basis of 1 000 physical connections and a total fibre path length of 200 km.

The 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 the purposes of this part of ISO/IEC 9314, references to the PL are made in terms of the Physical Layer protocol (PHY) and the Physical Layer Media Dependent (PMD) entities which are the upper and lower sublayers of PL, respectively.

b) A Data Link Layer (DLL) which controls the accessing of the medium and the generation and verification of frame check sequences to assure the proper delivery of valid data to the higher layers. DLL also concerns itself with the generation and recognition of device addresses and the peer-to-peer associations within the FDDI network. For the purposes of this part of ISO/IEC 9314, references to the DLL are made in terms of the Media Access Control (MAC) entity which is the lowest sublayer of DLL.

c) A Station Management (SMT) standard, this part of ISO/IEC 9314, which provides the control necessary at the station (node) level to manage the processes underway in the various FDDI layers such that a station may work cooperatively as a part of an FDDI network. SMT shall provide services such as connection management, station insertion and removal, station initialization, configuration management, fault isolation and recovery, communications protocol for external authority, scheduling policies, and collection of statistics.

The definition of SMT as contained herein includes the set of services that it provides for, and receives from, the other entities that are contained within a node. Within SMT resides both knowledge of the uniqueness of this node and the current network structure to the extent that this node's function is affected.

The set of International Standards for FDDI, ISO/IEC 9314, specifies the interfaces, functions and operations necessary to insure interoperability between conforming FDDI implementations. This part of ISO/IEC 9314 is a functional description. Conforming implementations may employ any design technique which does not violate interoperability.

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/IEC 7498-4(1989) *Information processing systems – Open Systems Interconnection – Basic Reference Model – Part 4: Management framework*

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 TR3 8802-1(1997) *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 1: Overview of Local Area Network Standards*

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

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

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

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. Other parts of ISO/IEC 9314, e.g. FDDI MAC, PHY and PMD, may however, contain additional definitions of interest.

3.1 attachment: The capability of a station or concentrator for connection into an FDDI network. Stations and concentrators are classified as dual attachment, single attachment or null attachment.

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

3.3 concentrator: An FDDI node that has additional Ports beyond those required for its own attachment to an FDDI network. These additional Ports (type M – see 5.2.4) are for attaching other FDDI nodes (including other concentrators) in a tree topology.

3.4 counter-rotating: An arrangement whereby two signal paths, one in each direction, exist in a ring topology.

3.5 Dual Attachment Concentrator (DAC): A concentrator that offers a dual attachment to the FDDI network and is capable of accommodating a dual (counter-rotating) ring.

3.6 Dual Attachment Station (DAS): A station that offers a dual attachment to the FDDI network and is capable of accommodating a dual (counter-rotating) ring.

3.7 dual ring (FDDI dual ring): A pair of counter-rotating logical rings.

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

3.9 fibre optic cable: A cable containing one or more optical fibres.

3.10 Local Path: A Local Path represents the segment(s) of ring(s) other than the primary ring and secondary ring that pass through the node.

3.11 logical ring: The set of MACs serially connected to form a single ring. A fault-free FDDI network provides two logical rings.

3.12 Media Interface Connector (MIC): A mated connector pair that provides an attachment between an FDDI node and a fibre optic cable plant. The MIC consists of two parts: a MIC plug and a MIC receptacle.

3.13 MIC plug: The male part of the MIC which terminates a fibre optical cable.

3.14 MIC receptacle: The female part of the MIC which is contained in an FDDI node.

3.15 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.

3.16 node: A generic term applying to an active element in an FDDI network (station or concentrator).

3.17 Null Attachment Concentrator (NAC): A concentrator that does not contain an A, B, or S Port.

3.18 Path: A Path represents the segment(s) of a logical ring that pass through a node.

3.19 Physical Connection: The full-duplex physical layer association between adjacent PHY entities (in adjacent nodes) in an FDDI network, i.e. a pair of Physical Links.

3.20 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 adjacent nodes) in an FDDI network.

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

3.22 Primary Path: A Primary Path represents, to the best of a node's knowledge, the segment(s) of the primary ring that pass through the node. Conditions may exist in parts of the network which may cause the Path to be in a different ring (e.g. Secondary Path instead of Primary Path).

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

3.24 receiver (optical): An opto-electronic circuit that converts an optical signal to an electrical logic signal.

3.25 repeater: A physical-layer relay in an FDDI network. A repeater is not further defined in this International Standard.

3.26 ring: A set of nodes wherein information is passed sequentially between nodes, each node in turn examining or copying the information, finally returning it to the originating node.

3.27 rooted node: A node that does not have any active A, B, or S Ports in tree mode.

3.28 Secondary Path: A Secondary Path represents, to the best of a node's knowledge, the segment(s) of the secondary ring that pass through the node. Conditions may exist in parts of the network which may cause the Path to be in a different ring (e.g. Primary Path instead of Secondary Path).

3.29 services: The services provided by one entity to another. Data services are provided to a higher layer entity; management services are provided to a management entity in the same or another layer.

3.30 Single Attachment Concentrator (SAC): A concentrator that offers a single attachment to the FDDI network.

3.31 Single Attachment Station (SAS): A station that offers a single attachment to the FDDI network.

3.32 station: An addressable node on an FDDI network capable of transmitting, repeating and receiving information. A station has exactly one SMT, at least one MAC, at least one PHY, and at least one PMD.

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

3.34 transmitter (optical): An opto-electronic circuit that converts an electrical logic signal to an optical signal.

3.35 trunk: A physical loop topology, either open or closed, employing two optical fibre signal paths, one in each direction (i.e. counter-rotating), forming a sequence of peer connections between FDDI nodes. When the trunk forms a closed loop it is sometimes called a trunk ring.

3.36 tree: A physical topology consisting of a hierarchy of master-slave connections between a concentrator and other FDDI nodes (including subordinate concentrators).

4 Conventions and abbreviations

4.1 Conventions

The terms SMT, MAC, LLC, PHY, and PMD when used without modifiers, refer specifically to the local entities.

The terms node, station, concentrator and repeater are used as follows in this part of ISO/IEC 9314. The term node is used as a generic term to denote any active element in an FDDI network. Station is used to denote a node that has at least one MAC. Concentrator is used to denote any node that has concentrator capability. The terms station and concentrator thus overlap in such a way that some nodes may be referred to by either term. In this case, the term actually used will be dependent upon the context of the usage. The term repeater is used only to denote a physical-layer relay in an FDDI network and is not further defined.

This Intentional Standard when referring to any of the PMD components assumes the multimode optical fibre PMD. This does not preclude the use of other PMD media types.

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

In 6.4, hyphens are used in place of low lines. This is done to maintain compatibility of the encoding of the names of attributes with the standard on ASN.1 (see ISO 8824) which does not allow the use of low lines. No difference in meaning is implied. Thus T-Max in 6.4 is exactly equivalent to T_Max as used in clause 10 of this International Standard and in ISO/IEC 9314-2.

The use of a period (e.g. SM_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.

The use of an asterisk (e.g. *:SM_PM_CONTROL.request) indicates that the primitive is to be sent to all of the entities of the type that receive the primitive. Thus, issuing *:SM_PM_CONTROL.request will send a SM_PM_CONTROL.request to all the PMD entities under control of this SMT.

In the presentation of diagrams, dashed lines are used to indicate optional entities, data paths, transitions and states. Dotted lines are used to indicate a functional unit that may be broken into other functional units.

Timers are given by a name of the form TXX, where XX are two capital letters. An example is the PCM timer, TPC.

This part of ISO/IEC 9314 on FDDI SMT contains four kinds of documentation as follows:

a) Narrative text, including text associated with state machines,

b) State machine diagrams, including associated footnotes,

c) Pseudo code,

d) Examples, which are specifically noted as such.

If any discrepancies exist between the above, the following precedence shall be used to resolve those discrepancies and determine conformance:

a) State machine diagrams,

b) Pseudo code,

c) Narrative text.

Examples are provided only for clarification and shall not be used for determining conformance.

4.1.1 State machines

SMT operation is defined using cooperating state machines. It is assumed that time elapses only in discrete states, with instantaneous transitions between the states.

State diagrams are expressed using vertical staffs to represent states and horizontal arrows to represent transitions.

Transitions are illustrated with the triggering condition located above the horizontal arrow and any actions on transition located below the transition arrow. Transition actions are performed while remaining in the previous state, before entry into the new state.

The state name appears above the vertical staff representing state and entry actions in the state, if any, appear directly below the state name. Entry actions in a state are executed on any transition entering a state, including those transitions exiting and entering that same state.

The following event-processing sequence is assumed:

a) Evaluate all transition conditions from the current state;

b) If a transition condition is satisfied, then

1) perform the associated transition actions in the current state,

2) enter the new state,

3) perform entry actions, if any, for the new state,

4) if a transition condition from this new state is satisfied, then repeat the transition sequence steps 1 to 4;

c) Perform any instate actions when their associated conditions are satisfied.

Logical symbols are represented in state machines and pseudo code using | to represent the 'or' operator and & to represent the 'and' operator.

Footnotes are used in state diagrams to give precise detail on transition conditions, transitions actions, entry actions, and instate actions

4.1.2 Default and initial values

Default values are defined for many of the attributes and parameters in this part of ISO/IEC 9314. These default values provide correct protocol operation and interoperability of equipment over a broad range of network configurations. Implementers may use alternate values than the defaults specified. The effects of using an alternate value are not directly described.

An initial value is the value assumed by the attribute or parameter as the result of an implementer defined causative action (e.g. power-on). When an initial value is specified in this part of ISO/IEC 9314, the station shall be capable of assuming that value.

4.2 Abbreviations

A	Port type A
ALS	Active Line State
ASN.1	Abstract Syntax Notation One
B	Port type B
BER	Basic Encoding Rules
CCE	Configuration Control Element
CEM	Configuration Element Manager
CF_State	Configuration state
CFM	Configuration Management
CMT	Connection Management
DA_Flag	Duplicate Address flag
DAC	Dual Attachment Concentrator
DAS	Dual Attachment Station
DM-DAS	Dual-MAC Dual Attachment Station
DNA	Downstream Neighbour Address
ECF	ECHO Frame
ECM	Entity Coordination Management
ESF	Extended Service Frame
GDMO	Guidelines for the Definition of Managed Objects
HLS	Halt Line State
ID	Identifier (field)
ILS	Idle Line State
LCT	Link Confidence Test
LEM	Link Error Monitor
LER	Link Error Rate
LS_Flag	Line State flag
LSU	Line State Unknown
M	Port type M
MIB	Management Information Base
MLS	Master Line State
MSB	Most Significant Bit
N	PC_Mode is None
NAC	Null Attachment Concentrator
NIF	Neighbour Information Frame
NLS	Noise Line State
NSA	Next Station Addressing
P	Mode is Peer
Path_Test	Path Test state variable
PC_Withhold	PCM Connection Withhold variable
PCM	Physical Connection Management
PDR	PHY Data Request
PDU	Protocol Data Unit
PMD	Physical Media Dependent
PMF	Parameter Management Frame
QLS	Quiet Line State

R_Val	PCM signalling Received Value array
RAF	Resource Allocation Frame
RDF	Request Denied Frame
RMT	Ring Management
S	Port type S
SAC	Single Attachment Concentrator
SAS	Single Attachment Station
SBA	Synchronous Bandwidth Allocation
SIF	Status Information Frame
SM-DAS	Single-MAC Dual Attachment Station
SRF	Status Report Frame
T	Mode is Tree
T_Val	PCM signalling Transmitted Value array
TEC	Timer, Entity Coordination
TID	Timer, Idle Detection
TNE	Timer, Noise Events
TNN	Timer, Neighbour Notification
TPC	Timer, Physical Connection
TRM	Timer, Ring Management
TSR	Timer, Status Reporting
TVD	Timer, Valid Downstream Neighbour
TVU	Timer, Valid Upstream Neighbour
UNA	Upstream Neighbour Address
UNDA_Flag	Upstream Neighbour Duplicate Address flag
WC_Flag	Withhold Connection flag

5 General description

An FDDI network consists of a set of nodes logically connected. Information is transmitted sequentially, as a stream of suitably encoded symbols, from one active node to the next. Each node generally regenerates and repeats each symbol and serves as the means for attaching one or more devices to the network for the purpose of communicating with other devices on the network. The method of actual physical attachment to an FDDI network may vary and is dependent on specific application requirements as described herein.

The basic building block of an FDDI network is the Physical Connection which consists of paired Physical Layer entities in two adjacent nodes on the FDDI network connected with a transmission medium. Connection to the physical medium, specified in PMD, is controlled by the station insertion and removal algorithms of Station Management (SMT) which are contained herein.

SMT specifies the local functions within an FDDI node necessary to manage the FDDI network. This clause describes the physical and logical topologies of an FDDI network and specifies examples of allowable node configurations used for specification of SMT protocols.

5.1 Definition of an FDDI node

A variety of internal node configurations are possible. However, a node shall have one, and only one, SMT entity. It may, however, have multiple instances of MACs, PHYs, and PMDs, with the actual number, within bounds, being implementer defined.

Several internal node configurations are defined within SMT with state machines provided to specify their operation. These fall into the general classifications of single attachment nodes and dual attachment nodes. FDDI trunk rings are normally composed of dual attachment nodes which have two Ports (each consisting of one PHY and one PMD) to accommodate the dual (counter-rotating) rings.