

IEEE Std 802.5t-2000

(Amendment to

ANSI/IEEE Std 802.5, 1998 Edition;

ANSI/IEEE Std 802.5r, 1998 Edition; and

ANSI/IEEE Std 802.5j, 1998 Edition)

**Information technology—
Telecommunications and information exchange
between systems—
Local and metropolitan area networks—
Specific requirements**

**Amendment to Part 5: Token Ring Access
Method and Physical Layer Specifications**

Sponsor

**LAN/MAN Standards Committee
of the
IEEE Computer Society**

Approved 13 January 2000

IEEE-SA Standards Board

Abstract: This supplement specifies the changes required to ANSI/IEEE Std 802.5, 1998 Edition, (Base standard) and ANSI/IEEE 802.5r, 1998 Edition, and ANSI/IEEE Std 802.5j, 1998 Edition, (Amendment 1 standard) to support 100 Mbit/s Dedicated Token Ring (DTR) operation. The Base standard, together with the Amendment 1 standard, specifies shared and dedicated (point-to-point) Token Ring operation at both 4 Mbit/s and 16 Mbit/s using either the TKP Access Protocol or the TXI Access Protocol. This supplement extends Token Ring operation to 100 Mbit/s for the DTR C-Port and Station using the TXI Access Protocol. Extensions to the medium access control (MAC) have been made to accommodate the requirements for high media rates (100 Mbit/s and above).

Keywords: data processing interconnection, dedicated token ring, full duplex operation, local area network (LAN), medium access control (MAC), 100 Mbit/s operation, token ring

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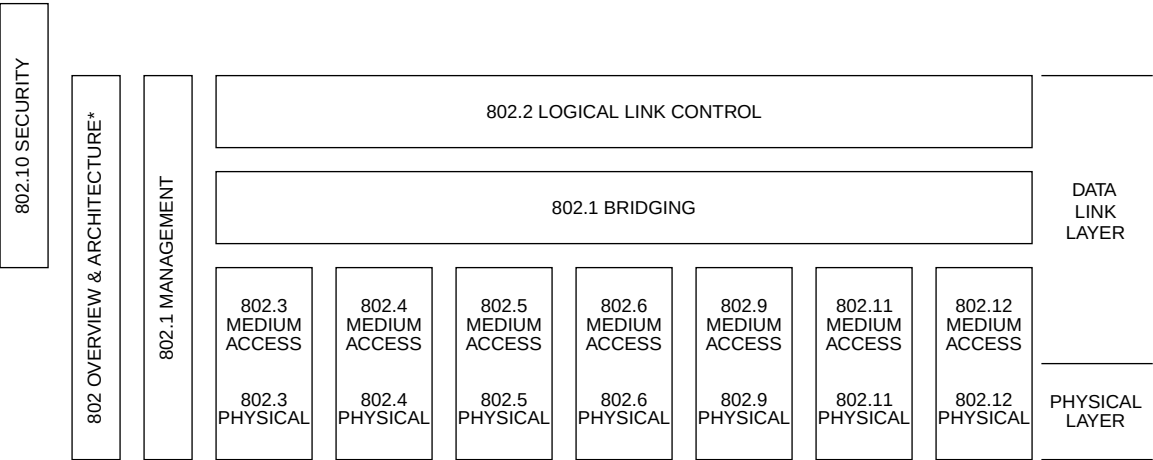
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Introduction

(This introduction is not part of IEEE Std 802.5t-2000, Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Amendment to Part 5: Token Ring Access Method and Physical Layer Specifications.)

This standard is part of a family of standards for local and metropolitan area networks. The relationship between this standard and other members of the family is shown below. (The numbers in the figure refer to IEEE standard numbers.)



* Formerly IEEE Std 802.1A.

This family of standards deals with the Physical and Data Link layers as defined by the International Organization for Standardization (ISO) Open Systems Interconnection (OSI) Basic Reference Model (ISO/IEC 7498-1:1994). The access standards define seven types of medium access technologies and associated physical media, each appropriate for particular applications or system objectives. Other types are under investigation.

The standards defining the access technologies are as follows:

- IEEE Std 802 *Overview and Architecture*. This standard provides an overview to the family of IEEE 802 Standards.
- ANSI/IEEE Std 802.1B and 802.1k [ISO/IEC 15802-2] *LAN/MAN Management*. Defines an OSI management-compatible architecture, and services and protocol elements for use in a LAN/MAN environment for performing remote management.
- ANSI/IEEE Std 802.1D [ISO/IEC 15802-3] *Media Access Control (MAC) Bridges*. Specifies an architecture and protocol for the interconnection of IEEE 802 LANs below the MAC service boundary.
- ANSI/IEEE Std 802.1E [ISO/IEC 15802-4] *System Load Protocol*. Specifies a set of services and protocol for those aspects of management concerned with the loading of systems on IEEE 802 LANs.
- IEEE Std 802.1F *Common Definitions and Procedures for IEEE 802 Management Information*
- ANSI/IEEE Std 802.1G [ISO/IEC 15802-5] *Remote Media Access Control Bridging*. Specifies extensions for the interconnection, using non-LAN communication technologies, of geographically separated IEEE 802 LANs below the level of the logical link control protocol.

- ANSI/IEEE Std 802.2 [ISO/IEC 8802-2] *Logical Link Control*
- ANSI/IEEE Std 802.3 [ISO/IEC 8802-3] *CSMA/CD Access Method and Physical Layer Specifications*
- ANSI/IEEE Std 802.4 [ISO/IEC 8802-4] *Token Passing Bus Access Method and Physical Layer Specifications*
- ANSI/IEEE Std 802.5 [ISO/IEC 8802-5] *Token Ring Access Method and Physical Layer Specifications*
- ANSI/IEEE Std 802.6 [ISO/IEC 8802-6] *Distributed Queue Dual Bus Access Method and Physical Layer Specifications*
- ANSI/IEEE Std 802.9 [ISO/IEC 8802-9] *Integrated Services (IS) LAN Interface at the Medium Access Control and Physical Layers*
- ANSI/IEEE Std 802.10 *Interoperable LAN/MAN Security*
- IEEE Std 802.11 [ISO/IEC DIS 8802-11] *Wireless LAN Medium Access Control and Physical Layer Specifications*
- ANSI/IEEE Std 802.12 [ISO/IEC DIS 8802-12] *Demand Priority Access Method, Physical Layer and Repeater Specifications*

In addition to the family of standards, the following is a recommended practice for a common Physical Layer technology:

- IEEE Std 802.7 *IEEE Recommended Practice for Broadband Local Area Networks*

The following additional working groups have authorized standards projects under development:

- IEEE 802.14 *Standard Protocol for Cable-TV Based Broadband Communication Network*
- IEEE 802.15 *Wireless Personal Area Networks Access Method and Physical Layer Specifications*
- IEEE 802.16 *Broadband Wireless Access Method and Physical Layer Specifications*

Participants

At the time this standard was balloted, the 802.5t working group had the following membership:

Robert D. Love, *Chair and Technical Editor*

Neil Jarvis, *Technical Editor-in-Chief*

Andrew Fierman, *Technical Editor*

Karl Reinke, *Technical Editor*

Kenneth T. Wilson, *Technical Editor*

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Syoun-Chin Peng

Bob Ross
Tam Ross
Steve Scandalis
Mike Siegel
Carson Stuart
Bo Thomsen
Christian Thrysoe
Scott Valcourt
Trevor Warwick
Dave Wilson
Ed Wong

The following members of the balloting committee voted on this standard:

Jack S. Andresen
Kit Athul
Thomas W. Bailey
J. Paul Benson, Jr.
Peter K. Campbell
James T. Carlo
David E. Carlson
Robert S. Crowder
Thomas J. Dineen
Daniel Dove
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Hans E. Weinrich
Donald W. Zipse

*Member Emeritus

Also included is the following nonvoting IEEE-SA Standards Board liaison:

Robert E. Hebner

Janet Rutigliano
IEEE Standards Project Editor

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Information technology— Telecommunications and information exchange between systems— Local and metropolitan area networks— Specific requirements

Amendment to Part 5: Token Ring Access Method and Physical Layer Specifications

1. Changes to Clause 1 of ANSI/IEEE Std 802.5, 1998 Edition, and ANSI/IEEE Std 802.5r, 1998 Edition, and ANSI/IEEE Std 802.5j, 1998 Edition

1.1 Scope

Add the following item to Scope:

- hh) Defines Dedicated Token Ring (DTR) operation at 100 Mbit/s.

1.2 Normative references

Add the following new references:

ANSI/IEEE Std 802.3:1998, Information technology—Telecommunications and information exchange between systems—Local and metropolitan area networks—Specific requirements—Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications.

ANSI X3.263-1995, Fibre Distributed Data Interface (FDDI) —Token Ring Twisted Pair Physical Layer Medium Dependent (TP-PMD).

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

1.3 Definitions

Add the following definitions:

high media rate (HMR): This term is used to indicate a data rate of 100 Mbit/s or greater.

media independent interface (MII): A set of signals with electrical, logical, and physical definitions that provide the complete interface between the medium access control (MAC) layer and Physical Layer (PHY) (via the RS).

Station: When capitalized, Station refers to DTR station or a C-Port in Station Emulation mode.

Replace these definitions in the base standard as follows:

1.3.43 physical media components (PMC): PMC is the sublayer of the PHY responsible for interfacing with the transmission medium. The functions of the PMC include receive, transmit, clock recovery, and ring access control. The PMCs for different medium rates and types are different.

1.3.44 physical signaling components (PSC): PSC is the sublayer of the PHY responsible for changing the signal elements received from the ring by the PMC into indicators and sending these indicators to the MAC. It is also responsible for conditioning the indicators received from the MAC for inclusion as signal elements by the PMC in the repeated data stream. At a particular medium rate, the PSC may be the same for different medium types.

1.5 Abbreviations and acronyms

Add the following acronyms:

FDDI	fibre distributed data interface
HMR	high media rate
MII	media independent interface
PMC	physical media components
PSC	physical signaling components

Replace 1.6 through 1.8 in ANSI/IEEE Std 802.5, 1998 Edition, and 1.6 through 1.9 in ANSI/IEEE Std 802.5r, 1998 Edition, and ANSI/IEEE Std 802.5j, 1998 Edition, with the following:

1.6 Conformance requirements

The conformance requirements for the Classic Token Ring entities (Clause 3 through Clause 8 in ANSI/IEEE Std 802.5, 1998 Edition) and the DTR entities (Clause 9 through Clause 13 in ANSI/IEEE Std 802.5r, 1998 Edition, and ANSI/IEEE Std 802.5j, 1998 Edition, and Clause 13 and Clause 14 in this document) are specified in Annex A.

The supplier of a protocol implementation that is claimed to conform to this supplement shall complete a copy of the Protocol Implementation Conformance Statement (PICS) proforma in Annex A and shall provide the information necessary to identify both the supplier and the implementation.

Common conformance requirements—Station and C-Port

A Classic Token Ring Station implementing the TKP Access Protocol, or a DTR Station and DTR C-Port implementing the TKP Access Protocol or TXI Access Protocol claiming conformance to this standard shall

- a) Implement the frame format, associated address formats and fields, and medium access control (MAC) frame vectors and subvectors specified as follows:
 - 1) Clause 3 for the Classic and DTR Station supporting the 4 Mbit/s or 16 Mbit/s media speeds;
 - 2) Clause 3 as amended by Clause 10 for the DTR C-Port or Station supporting the 4 Mbit/s or 16 Mbit/s media speeds;
 - 3) Clause 3 as amended by Clause 10 and Clause 14 for the DTR C-Port or Station supporting the High Media Rate (HMR) media speeds.
- b) Support 48-bit addressing and use either a universally administered individual address or a locally administered individual address, as specified in 3.2.4.
- c) Recognize the first bit of the source address as indication of the presence of the routing information field in the frame format defined in 3.2.5. Note that the ability to generate or respond to frames with source routing information is optional.
- d) Exhibit external behavior corresponding to the system timing parameters specified as follows:
 - 1) Clause 3 for the Classic station supporting the 4 Mbit/s or 16 Mbit/s media speeds, and using the TKP Access Protocol;
 - 2) Clause 3 as amended by Clause 10 for the DTR C-Port or Station supporting the 4 Mbit/s or 16 Mbit/s media speeds, and using the TKP or TXI Access Protocols;
 - 3) Clause 3 as amended by Clause 10 and Clause 14 for the DTR C-Port or Station supporting the HMR media speeds, and using the TXI Access Protocol.
- e) Exhibit external behavior corresponding to the Station Policy Flags and Variables specified as follows:
 - 1) Clause 3 for the Classic station supporting the 4 Mbit/s or 16 Mbit/s media speeds, and using the TKP Access Protocol;
 - 2) Clause 3 as amended by Clause 10 for the DTR C-Port or Station supporting the 4 Mbit/s or 16 Mbit/s media speeds, and using the TKP or TXI Access Protocols;
 - 3) Clause 3 as amended by Clause 10 and Clause 14 for the DTR C-Port or Station supporting the HMR media speeds, and using the TXI Access Protocol.
- f) Implement capabilities corresponding to the Error Counters specified as follows:
 - 1) Clause 3 for the Classic station supporting the 4 Mbit/s or 16 Mbit/s media speeds, and using the TKP Access Protocol;
 - 2) Clause 3 as amended by Clause 10 for the DTR C-Port or Station supporting the 4 Mbit/s or 16 Mbit/s media speeds, and using the TKP or TXI Access Protocols;
 - 3) Clause 3 as amended by Clause 10 and Clause 14 for the DTR C-Port or Station supporting the HMR media speeds and using the TXI Access Protocol.
- g) Perform the TKP and TXI Access Protocol functions as follows:
 - 1) Classic Token Ring for 4 Mbit/s or 16 Mbit/s using the TKP Access Protocol operation specified by the Station Operation Tables in ANSI/IEEE Std 802.5, 1998 Edition, Clause 4;
 - 2) DTR for 4 Mbit/s or 16 Mbit/s using the TKP Access Protocol operation specified by the Station and Port Operation Tables in ANSI/IEEE Std 802.5r, 1998 Edition, and ANSI/IEEE Std 802.5j, 1998 Edition, 9.3 through 9.6;
 - 3) DTR for 4 Mbit/s or 16 Mbit/s using the TXI Access Protocol operation specified by the Station and Port Operation Tables in ANSI/IEEE Std 802.5r, 1998 Edition, and ANSI/IEEE Std 802.5j, 1998 Edition, 9.2 and 9.3;
 - 4) DTR for the HMR using the TXI Access Protocol operation specified by the Station and Port Operation Tables in 9.2 and 9.3 in this document.

1.7 Fibre optic media conformance requirements

A 4 Mbit/s, 16 Mbit/s, and 100 Mbit/s media rate implementation, claiming conformance to this part of ANSI/IEEE Std 802.5, 1998 Edition, and operating in Station or Port mode, shall meet all appropriate parameters in Clause 13.

1.8 Local regulation

The supplier of a protocol implementation that is claimed to conform to this standard shall meet local safety and environmental regulations. Annex E provides some limited guidance in this area.

Replace the title of 2.2 with the following two titles to cover all types of Stations and C-Ports:

2.2 C-Port and Station functional organization and data flow

2.2.1 4 Mbit/s and 16 Mbit/s classic Station functional organization and data flow

The remainder of this clause remains unchanged.

Add a new title after 2.2.1 to cover the 100 Mbit/s DTR C-Port and Station:

2.2.2 100 Mbit/s C-Port and Station functional organization and data flow

Figure 2.2-1 and Figure 2.2-2 illustrate a C-Port's and Station's data flow, indicating which clauses of this standard address the various functions of a token ring C-Port or Station. Figure 2.2-1 is for a Station and C-Port connected using twisted-pair media. Figure 2.2-2 is for a Station and C-Port connected using fibre optic media.

- a) The PMC/PSC internal service interface (PM_UNITDATA.request; PM_UNITDATA.indication) defines the information exchange between the physical media components (PMC) specified in 9.7 and 9.8 and the physical signaling components (PSC) specified in 9.8. This service interface is defined in 9.8.
- b) The PSC/MAC internal service interface (PS_UNITDATA.indication, PS_UNITDATA.request) defines the information exchange between the PSC specified in 9.8 and the MAC sublayer specified in Clause 9 and Clause 14. Clause 14 defines frame formats and station facilities. Clause 9 also specifies the C-Port's Port Medium Access Control (PMAC) and Station's Station Medium Access Control (SMAC) protocol, which uses the formats and facilities defined in Clause 14 to receive and transmit information. This service interface is defined in 9.8.
- c) The PMAC/SMAC/PHY internal service interface (PM_STATUS.indication, PS_CONTROL.request, and PS_STATUS.indication) provides the control mechanism for the physical layer (PHY) functions by the MAC protocol, and the mechanism for indicating the status of the PHY functions to the MAC protocol. The PM_STATUS.indication service interface is defined in 9.7. The PS_CONTROL.request and PS_STATUS.indication service interfaces are defined in 9.8.
- d) The PMAC/SMAC/LLC service interface (MA_UNITDATA.indication, MA_UNITDATA.request) is specified in ISO/IEC 15802-1 and is used as specified in 9.1. It defines the information exchange between the PMAC/SMAC sublayer and the Logical Link Control (LLC) sublayer.
- e) The PMAC/SMAC/Bridge service interface (M_UNITDATA.indication, M_UNITDATA.request, M_UNITDATA.response) is specified in IEEE Std 802.1d and is used as specified in 9.1. It defines the information exchange between the MAC and the internal bridging sublayer.
- f) The PMAC/SMAC/MGT service interface (MGT_UNITDATA.indication, MGT_UNITDATA.request, MGT_CONTROL.request, MGT_STATUS.indication) defines the control mechanism of, the mechanism for indicating the status of, and the information exchange between the PMAC/SMAC protocol specified in Clause 9 and the system management entity (MGT). The managed objects are specified in Clause 11. The MGT_UNITDATA.indication and MGT_UNITDATA.request primitives are specified in Clause 9 and are used to convey MAC management frames between the MAC and the appropriate management function (e.g., RPS, CRS, REM).

The diagram illustrates the high-level block structure of the PMAC or SMAC Protocol. It is organized into several layers and components:

- Managed Objects (6 or 11):** The top layer, connected to the PMAC or SMAC Protocol via LLC, Management, and Bridge/Switch interfaces.
- PMAC or SMAC Protocol (9.2 and 9.3):** The main protocol layer, which includes:
 - MAC Facilities (10 & 14):** Contains Address Recognition, CRC Checking, and CRC Generation components.
 - Reconciliation Sub-layer:** Contains the PSC (9.8) block, which includes Symbol Decoder, Delimiter Generator & Detector, Link Status, and Symbol Encoder.
 - PMC (9.7 & 9.8):** Contains MLT-3 Decoder & De-scrambler, Clock Recovery, Receiver, Transmitter, Auto-Negotiation (optional), and Phantom Functions (optional).
- Station or C-Port:** The bottom layer, which has the same structure as the PMAC or SMAC Protocol.

Arrows indicate the flow of data and control signals between these components and layers.

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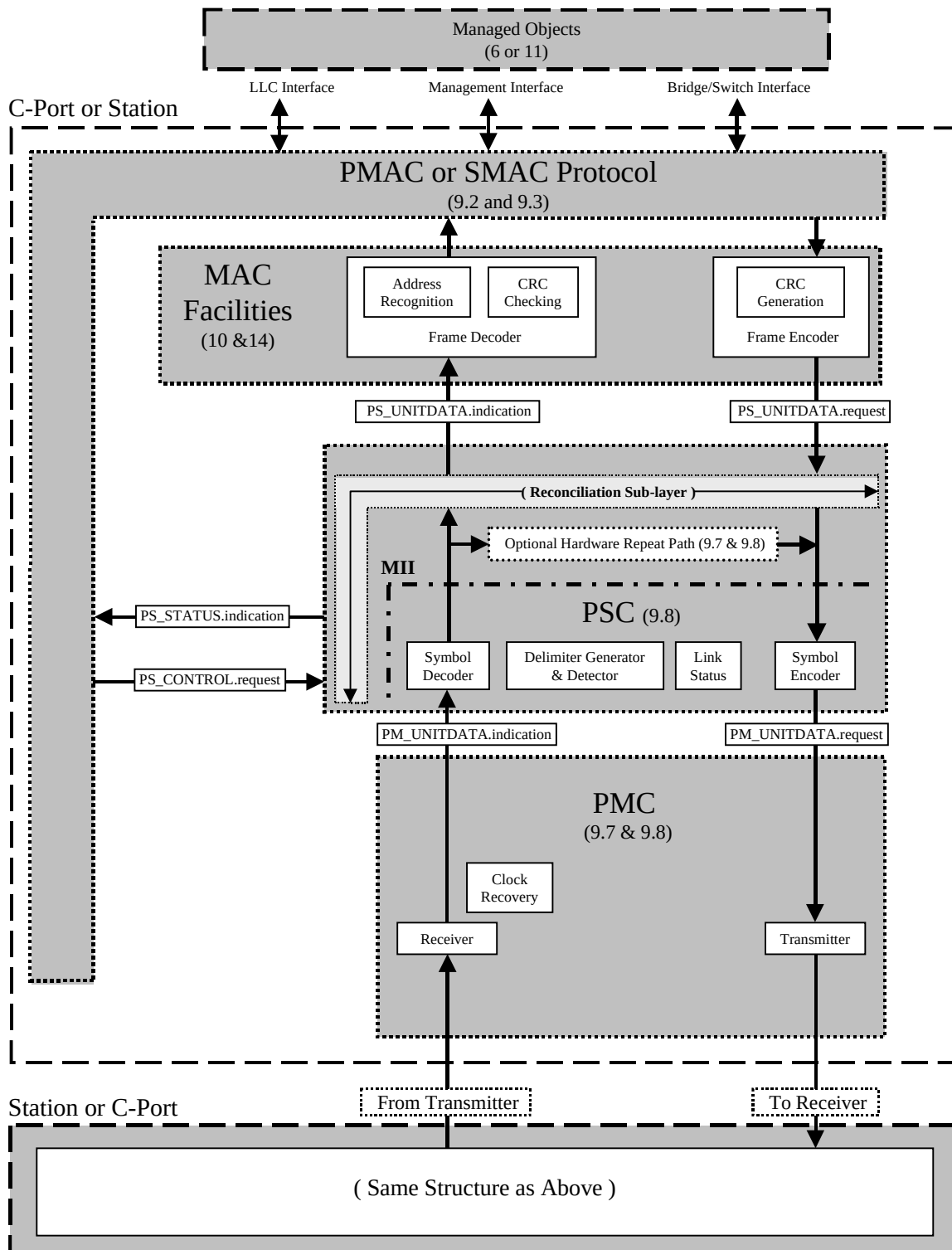


Figure 2.2-2—100 Mbit/s overview using Fibre Optic Media

Replace 9.0 with the following:

9. Dedicated Token Ring

This clause contains the specifications for the DTR Station and C-Port executing

- The TXI Access Protocol operating at 4 Mbit/s, 16 Mbit/s, or the HMR; and
- The TKP Access Protocol operating at 4 Mbit/s or 16 Mbit/s.

The TKP Access Protocol is not specified by this supplement for operation at the HMR.

This introduction illustrates and defines the DTR configurations supported, and concludes by describing the structure of Clause 9.

DTR configurations illustrated

Figure 9-1 illustrates the DTR configurations based on the following operational modes of the C-Port:

- Configuration 1: C-Port in Port Mode using the TXI Access Protocol;
- Configuration 2: C-Port in Station Emulation Mode using the TXI Access Protocol;
- Configuration 3: C-Port in Port Mode using the TKP Access Protocol;
- Configuration 4: C-Port in Station Emulation Mode using the TKP Access Protocol.

Each of these configurations is labeled as to the type of support (C-Port in Port Mode; C-Port in Station Emulation Mode, Station, or Concentrator), the access protocol being used, and the subclause(s) used to specify the configuration. Figure 9-1 abbreviates the TKP Access Protocol as TKP AP and the TXI Access Protocol as TXI AP.

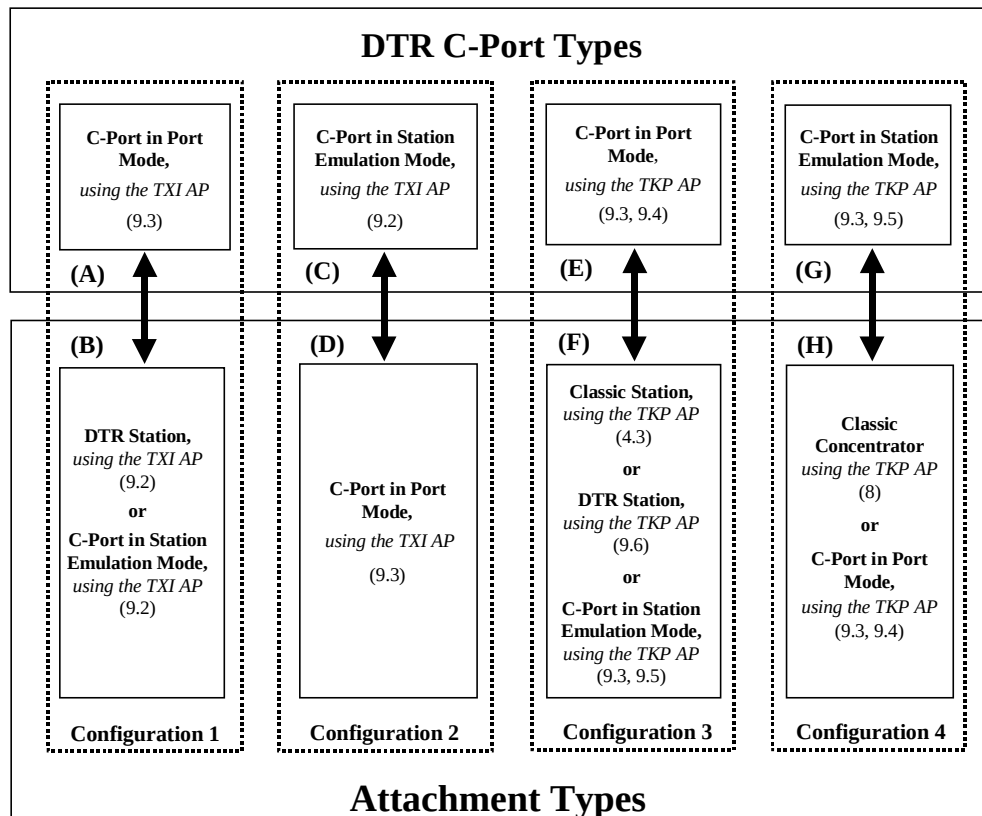


Figure 9-1—DTR configurations 1 through 4

DTR configurations

The following configurations are identified in Figure 9-1:

- Configuration 1 consists of a C-Port in Port Mode using the TXI Access Protocol (A) and an attached DTR Station (B) or C-Port in Station Emulation Mode (B).
- Configuration 2 consists of a C-Port in Station Emulation Mode using the TXI Access Protocol (C) and an attached C-Port in Port Mode (D).
- Configuration 3 consists of a C-Port in Port Mode using the TKP Access Protocol (E) and an attached Classic Station (F), DTR Station (F), or C-Port in the Station Emulation Mode (F).
- Configuration 4 consists of a C-Port in Station Emulation Mode using the TKP Access Protocol (G) and an attached Classic Concentrator (H) or C-Port in Port Mode (H).

Configuration functions

The Policy flags FSMRO (Station Media Rate Option) and FPMRO (C-Port Media Rate Option) are defined as follows:

- FSMRO=0 or FPMRO=0: 4 Mbit/s;
- FSMRO=1 or FPMRO=1: 16 Mbit/s;
- FSMRO<2 or FPMRO<2: 4 Mbit/s or 16 Mbit/s;
- FSMRO>1 or FPMRO>1: HMR;
- FSMRO=2 or FPMRO=2: 100 Mbit/s;
- FSMRO>2 or FPMRO>2: reserved and not defined by this supplement.

The functions used to support Configurations 1 and 2 are covered as follows:

- The DTR Station using the TXI Access Protocol when operating at 4 Mbit/s or 16 Mbit/s is defined in 9.1, 9.2, and 9.7.1, and when operating at the HMR is defined in 9.1, 9.2, 9.7.2, 9.8, and 13.9.
- The C-Port in Port Mode using the TXI Access Protocol when operating at 4 Mbit/s or 16 Mbit/s is defined in 9.1, 9.3, and 9.7.1, and when operating at the HMR is defined in 9.1, 9.3, 9.7.2, 9.8, and 13.9.
- The C-Port in Station Emulation Mode using the TXI Access Protocol when operating at 4 Mbit/s or 16 Mbit/s is defined in 9.1, 9.2, 9.3, and 9.7.1, and when operating at the HMR is defined in 9.1, 9.2, 9.3, 9.7.2, 9.8, and 13.9.

The functions used to support Configurations 3 and 4 are covered as follows:

- The DTR Station using the TKP Access Protocol, when operating at 4 Mbit/s or 16 Mbit/s, is defined in 9.1 and 9.6.
- The C-Port in Port Mode using the TKP Access Protocol, when operating at 4 Mbit/s or 16 Mbit/s, is defined in 9.1, 9.3, 9.4, and 9.7.1.
- The C-Port in Station Emulation Mode using the TKP Access Protocol, when operating at 4 Mbit/s or 16 Mbit/s, is defined in 9.1, 9.3, 9.5, and 9.7.1.
- The Classic Station, which uses only the TKP Access Protocol operating at 4 Mbit/s or 16 Mbit/s, is defined in Clause 4.
- The Classic Concentrator, which uses only the TKP Access Protocol operating at 4 Mbit/s or 16 Mbit/s, is defined in Clause 8.

Clause 9 structure

The remainder of Clause 9 is structured as follows:

- **Subclause 9.1** describes the common DTR Station and C-Port functions required to support the TXI Access Protocol when operating at 4 Mbit/s, 16 Mbit/s, or the HMR, and the TKP Access Protocol when operating at 4 Mbit/s or 16 Mbit/s.

The description of the Classic Station is found in Clause 4 and is not covered in Clause 9.

- **Subclause 9.2** specifies the DTR Station and the C-Port in Station Emulation Mode using the TXI Access Protocol when operating at 4 Mbit/s, 16 Mbit/s, or the HMR.

Annex L contains informative diagrams of the Low-Level Finite State Machines (FSMs) representing the SMAC contained in the Join, Transmit, and Monitor Station Operation Tables defined in 9.2.

- **Subclause 9.3** specifies the C-Port in Port Mode using the TXI Access Protocol when operating at 4 Mbit/s, 16 Mbit/s, or the HMR, and the TKP Access Protocol when operating at 4 Mbit/s or 16 Mbit/s. Subclause 9.3 defines the Join, Transmit, and Monitor functions for the TXI Access Protocol. Subclause 9.3 also defines the Join function for the TKP Access Protocol; the Transmit and Monitor functions for the TKP Access Protocol are defined in 9.4.

Annex M contains informative diagrams of the Low-Level FSMs representing the PMAC contained in the Join, Transmit, and Monitor Port Operation Tables defined in 9.3.

- **Subclause 9.4** specifies the C-Port in Port Mode using the TKP Access Protocol when operating at 4 Mbit/s or 16 Mbit/s. Subclause 9.4 defines the Transmit and Monitor functions; the Join function is defined in 9.3.

Annex N contains informative diagrams of the Low-Level FSMs representing the PMAC contained in the Transmit and Monitor Port Operation Tables defined in 9.4.

- **Subclause 9.5** specifies the C-Port in Station Emulation Mode using the TKP Access Protocol when operating at 4 Mbit/s or 16 Mbit/s.

Annex R contains informative diagrams of the Low-Level FSMs representing the PMAC contained in the Join, Transmit, and Monitor Port Operation Tables defined in 9.5.

- **Subclause 9.6** specifies the DTR Station using the TKP Access Protocol when operating at 4 Mbit/s or 16 Mbit/s.

Annex Q contains informative diagrams of the Low-Level FSMs representing the MAC contained in the Join, Transmit, and Monitor Station Operation Tables defined in 9.6.

- **Subclause 9.7** specifies the C-Port specific components and specifications used when supporting the TXI or TKP Access Protocols. The PHY requirements unique to the C-Port are defined by 9.7.1 for 4 Mbit/s or 16 Mbit/s, and 9.7.2 for the HMR.

The PHY requirements shared between Classic Concentrators and Classic Stations are defined in Clauses 5, 7, and 8.

- **Subclause 9.8** specifies the PHY functions used as defined in 9.2, 9.3, and 9.7.2 when operating at the HMR.

Replace 9.1 with the following:

9.1 DTR TXI and TKP Access Protocol support

This subclause provides an overview of the TKP and TXI Access Protocol for the DTR C-Port, DTR Station, and Classic Station supporting Configurations 1 through 4 illustrated in Figure 9-1. The Station Operation Tables and C-Port Join Operation Tables defined in 9.2 and 9.3, respectively, determine which configuration is being supported. This determination is based on policy flags, results of the Registration process, and phantom signaling detection by the C-Port.

This clause contains an overview of the DTR Station and DTR C-Port when using the TXI Access Protocol or the TKP Access Protocols as follows:

- a) The TXI definitions used by the C-Port and Station are described in 9.1.1.
- b) The TXI Access Protocol functions used by the Station's SMAC specified in 9.2, and the C-Port's PMAC specified in 9.3, are discussed as follows:
 - 1) Protocol checking is described in 9.1.2;
 - 2) Error handling is described in 9.1.3;
 - 3) Registration is described in 9.1.4;
 - 4) Registration query is described in 9.1.5;
 - 5) Lobe Media Test (LMT) is described in 9.1.6;
 - 6) Duplicate Address Check (DAC) is described in 9.1.7;
 - 7) Transmit is described in 9.1.8;
 - 8) Heart Beat is described in 9.1.9;
 - 9) Hard error recovery is described in 9.1.10;
 - 10) Soft error reporting is described in 9.1.11;

- 11) Configuration control is described in 9.1.12;
- 12) SMAC and PMAC service interfaces are described in 9.1.13;
- 13) Trade-up protocol is described in 9.1.14;
- 14) Remove Alert protocol is described in 9.1.15.

Each of the above is described by covering the function's purpose and then, if required, covering the unique C-Port and Station support of the function.

- c) The C-Port in Port Mode using the TKP Access Protocol in support of Configuration 3 is discussed in 9.1.16. The Port Operation Tables used to support this Configuration are specified in 9.4.
- d) The C-Port in Station Emulation Mode using the TKP Access Protocol in support of Configuration 4 is discussed in 9.1.17. The Port Operation Tables used to support this Configuration are specified in 9.5.
- e) The DTR Station using the TKP Access Protocol in support of Configuration 3 is discussed in 9.1.18. The Station Operation Tables used to support this configuration are specified in 9.6.

9.1.1 TXI definitions

This subclause contains definitions used by the C-Port and Station including FSM Notations and Interactions, PHY Signal Interpretation, frame Identification, Actions on frame Errors, and C-Port/Station Policy Variables.

9.1.1.1 FSM Notation

See 4.2.1 for the general rules controlling FSMs.

The C-Port Operation Tables and Station Operation Tables contain an abstract model of the DTR C-Port and Station Access Protocol machines. For all possible combinations of events and C-Port/Station states, the Operation Tables determine an unambiguous and consistent response by the C-Port or Station, including the next state, if necessary, and the primitives used at the various service interfaces.

The C-Port's Port Operation Tables in 9.3, 9.4, and 9.5, the Station Operation Tables in 9.2 and 9.6, and the FSMs defined in Annexes L, M, N, and R are evaluated as follows:

NOTE—The notation FxTI is used to mean FPTI or FSTI, FxTXC is used to mean FPTXC or FSTXC, TS=xTXN is used to mean TS=PTXN or TS=STXN, and TS=xTXD is used to mean TS=PTXD or TS=STXD.

- a) A snapshot of the value of all event terms is taken at an instant in time.
- b) All event statements are evaluated to TRUE or FALSE, depending on the truth of each element in the event statements.
- c) The actions for all TRUE events are performed.
- d) Actions are considered to occur simultaneously, except for Clock Source changes, Transmit Sequences (e.g., SFS, EFS, or FCS), and the transmission of fill.
- e) The transmission of frame data is performed as follows when the C-Port or Station is using the TXI Access Protocol and operating at 4 Mbit/s, 16 Mbit/s, or the HMR.

The starting point for the transmission of frames is the Transmit Normal state (TS=xTXN). In this state, the C-Port and Station transmit fill by setting FxTI=1 to invoke one of the following interface signals:

- PS_CONTROL.request(Transmit_mode=Fill) [C-Port and Station]; or
- PM_CONTROL.request(Transmit_mode=Fill) [C-Port only].

The following terms are defined:

Start-transmit-frame-data: The C-Port or Station detects the need to transmit a frame.

End-transmit-frame-data: The C-Port or Station detects the need to end frame data transmission.

1) TS=xTXN detects *Start-transmit-frame-data*

When one of the conditions for the *Start-transmit-frame-data* is detected, the C-Port's Transmit Port Operation Table 9.3-2, or the Station's Transmit Station Operation Table 9.2-2, transitions from the Transmit Normal state (TS=xTXN) to the Transmit Data state (TS=xTXD) as follows:

The Transmit Normal state (TS=xTXN) is exited and the following actions occur:

- i) The fill being transmitted by TS=xTXN is stopped as follows:
 - The Station stops transmitting fill by setting FSTI=0 to invoke the interface signal PS_CONTROL.request(Transmit_mode=No_fill).
 - The C-Port stops transmitting fill by setting FPTI=0 to invoke one of the following interface signals: PS_CONTROL.request(Transmit_mode=No_fill) or PM_CONTROL.request(Transmit_mode=No_fill).
- ii) The C-Port and Station use the PS_UNITDATA.request(Tx_indicator=Data_byte) signal for transmitting each octet. The transmission of the frame starts with the SFS [TX_SFS(P=x;R=0)].
- iii) When the last octet of the SFS is transmitted, the Transmit Data state (TS=xTXD) is entered and the transmission of the frame's data is started.
- iv) The Transmit Data state (TS=xTXD) causes each octet of the frame to be transmitted until one of the following *End-transmit-frame-data* conditions is detected:
 - The frame's end of data (EOD) occurs;
 - A Station Error or C-Port Error occurs.

2) TS=xTXD detects *End-transmit-frame-data*

When the *End-transmit-frame-data* condition is detected, the C-Port's Transmit Port Operation Table or the Station's Transmit Station Operation Table transitions from the Transmit Data state (TS=xTXD) to the Transmit Normal state (TS=xTXN) as follows:

The Transmit Data state (TS=xTXD) is exited and the following actions occur:

- i) The following actions occur if the *End-transmit-frame-data* is caused by the frame's EOD:
 - The transmission of a valid FCS (TX_FCS), followed by the transmission of the EFS [TX_EFS(I=E=0) for 4 Mbit/s and 16 Mbit/s, and TX_EFS(E=0) for the HMR].
 - When the last octet of the EFS is transmitted, the transmission of fill is started as follows:

The Station starts transmitting fill by setting FSTI=1 to invoke the interface signal PS_CONTROL.request(Transmit_mode=Fill).
 - The C-Port starts transmitting fill by setting FPTI=1 to invoke one of the following interface signals: PS_CONTROL.request(Transmit_mode=Fill) or PM_CONTROL.request(Transmit_mode=Fill).
 - The Transmit Normal state (TS=xTXN) is entered and the transmission of a frame has been completed.

- ii) One of the following actions occurs if the *End-transmit-frame-data* is caused by a Station Error or C-Port Error:

If $FxASO=0$, then the Abort Sequence is supported and the frame is aborted with an Abort Sequence (TX_AB) as follows:

- The transmission of the Abort Sequence is started.
- When the last octet of the Abort Sequence is transmitted, the transmission of fill is started as follows:

The Station starts transmitting fill by setting $FSTI=1$ to invoke the interface signal $PS_CONTROL.request(Transmit_mode=Fill)$.

The C-Port starts transmitting fill by setting $FPTI=1$ to invoke one of the following interface signals: $PS_CONTROL.request(Transmit_mode=Fill)$ or $PM_CONTROL.request(Transmit_mode=Fill)$.

- The Transmit Normal state ($TS=xTXN$) is entered and the transmission of a frame has been completed.

If $FxASO=1$, then the Abort Sequence is not supported, the frame is aborted with an invalid FCS, and the E-bit is set to 1 [TX_INV_FCS ; $TX_EFS(E=1)$] as follows:

- The transmission of an invalid FCS (frame shall not pass FCS receive checking) followed by the transmission of the EFS.
- When the last octet of the EFS is transmitted, the transmission of fill is started as follows:

The Station starts transmitting fill by setting $FSTI=1$ to invoke the interface signal $PS_CONTROL.request(Transmit_mode=Fill)$.

The C-Port starts transmitting fill by setting $FPTI=1$ to invoke one of the following interface signals: $PS_CONTROL.request(Transmit_mode=Fill)$ or $PM_CONTROL.request(Transmit_mode=Fill)$.

- The Transmit Normal state ($TS=xTXN$) is entered and the transmission of a frame has been completed.

- f) The C-Port repeat function, when using the TXI Access Protocol and operating at the 4 Mbit/s and 16 Mbit/s media rates, or operating at the HMRs and the C-Port's option flag $FPRPTO=1$ (indicating the hardware repeat path is supported), is performed as follows.

Notes and definitions:

Clock source change notes:

- At the 4 Mbit/s and 16 Mbit/s media rates, the C-Port shall delay at least 1.5 ms after a clock source change before proceeding (required by 5.7.1). This delay is required to allow the attached Station's receiver enough time to synchronize to the new clock source.
- At the HMRs, no clock source change shall occur because the C-Port always transmits using a signal that is derived from its internal crystal clock.

The following flag, defined in 9.3, is used to control the C-Port's repeat function when the C-Port's option flag $FPRPTO=1$:

- $FPRPT=1$: The C-Port's Transmit Normal state ($TS=PTXN$) detects the need to *start* the repeat function.
- $FPRPT=0$: The C-Port's Repeat state ($TS=PRPT$) detects the need to *stop* the repeat function.

The starting point for the C-Port repeat function is the Transmit Normal state (TS=xTXN). The C-Port transmits fill in this state by setting FPTI=1 to invoke one of the following interface signals:

- PS_CONTROL.request(Transmit_mode=Fill); or
- PM_CONTROL.request(Transmit_mode=Fill).

1) TS=PTXN detects FPRPT=1

The C-Port's Transmit Port Operation Table transitions from the Transmit Normal state (TS=PTXN) when the FPRPT=1 condition is detected to the Repeat state (TS=PRPT) and takes the following actions:

- i) The C-Port, when operating at 4 Mbit/s or 16 Mbit/s, changes its transmit clock source by setting FPTXC=0 (causing the transmit clock to be derived from the C-Port's received signal).
- ii) The C-Port stops transmitting fill by setting FPTI=0 to invoke one of the following interface signals: PS_CONTROL.request(Transmit_mode=No_fill) or PM_CONTROL.request(Transmit_mode=No_fill).
- iii) The C-Port, when operating at 4 Mbit/s or 16 Mbit/s, shall delay for at least 1.5 ms before proceeding.
- iv) The TS=PRPT state is entered and the following occurs: the data received at the C-Port's receiver is transmitted without change (with the exception of the E-bit, which, if present, may or may not be set).

2) TS=PRPT detects FPRPT=0

The C-Port's Transmit Port Operation Table transitions from the Repeat state (TS=PRPT) when the FPRPT=0 condition is detected to the Transmit Normal state (TS=PTXN) and the takes following actions:

- i) The C-Port, when operating at 4 Mbit/s or 16 Mbit/s, changes its transmit clock source by setting FPTXC=1 (causing the transmit clock to be derived from the C-Port's internal crystal clock).
- ii) The C-Port starts transmitting fill by setting FPTI=1 to invoke one of the following interface signals: PS_CONTROL.request(Transmit_mode=Fill) or PM_CONTROL.request(Transmit_mode=Fill).
- iii) The C-Port, when operating at 4 Mbit/s or 16 Mbit/s, shall delay for at least 1.5 ms before proceeding.
- iv) The Transmit Normal state (TS=PTXN) is entered and the repeat function has been completed.

g) Items e) and f) in 9.1.1.1 cover the operation of the C-Port's Transmit Port Operation Table 9.3-2 and Station's Transmit Station Operation Table 9.2-2.

However, a transmit clock source change (value of FxTXC changes) can also occur when operating at 4 Mbit/s or 16 Mbit/s via actions in the C-Port's Join and Monitor Port Operation Tables 9.3-1 and 9.3-3, and the Station's Join and Monitor Station Operation Tables 9.2-1 and 9.2-3. Since this change in the value of FxTXC is *not* under control of the C-Port or Station Transmit Operation Tables 9.3-2 or 9.2-2, enough time for the attached entity to synchronize to the new clock source shall occur *before* using the services of these two Transmit tables.

Therefore, the following general restriction is put upon *any* transition *outside* the C-Port's Transmit Port Operation Table and the Station's Transmit Station Operation Table that causes the value of FxTXC to change.

The C-Port or Station, when operating at 4 Mbit/s or 16 Mbit/s, shall delay at least 1.5 ms *before* attempting to transmit a frame via the transmit function specified by Port Operation Table 9.3-2 or Station Operation Table 9.2-2.

- h) Evaluation is repeated beginning with Step 1.

The C-Port and Station must have a way of ordering simultaneous external events, which would otherwise cause contradictory actions, such as simultaneous frame arrival and timer expiration. Except for the case of simultaneous events, the actions associated with the set of TRUE event statements in the FSM and C-Port and Station Operation Tables are never contradictory. The method that a C-Port and Station use to arbitrate simultaneous events is implementation dependent and not constrained by this standard. The C-Port and Station may act on simultaneous events in any order prior to considering subsequent events.

Actions do not affect the truth of event statements until the next snapshot.

Constants used in the tables are in hexadecimal notation, unless otherwise indicated.

9.1.1.2 Special optional notation used in Port and Station Operation Tables

When appropriate, some of the Port and Station Operation Table transitions have an Action/Output column that includes the notations: (optional), (optional-i), (optional-x), and (optional-unk). All of the optional actions are enclosed within brackets.

This standard provides the following guidance for this notation:

Notation	Meaning of notation
(Optional)	New implementations are allowed to include or exclude this option.
(Optional-i)	New implementations are encouraged to include this option.
(Optional-x)	New implementations are encouraged to exclude this option.
(Optional-unk)	Implementations supporting any transition containing the "FR_LTH=UNK" term shall implement this option.

9.1.1.3 PMAC and SMAC Protocol flags

C-Port and Station protocol flags use the notations FP (name of flag) and FS (name of flag), respectively. Protocol flags, which remember the occurrence of an event for a later action, are used internally by the Port Operation Tables and Station Operation Tables, and are not meant to imply any implementation requirements.

All C-Port and Station protocol flags are set to 0 by the "Set_initial_conditions" action.

In general, protocol flags are set to 1 when a condition occurs and set to 0 when the condition no longer exists or when the appropriate action is taken.

9.1.1.4 C-Port Interface Flags

The C-Port Interface Flags are used by the Join Port Operation Table as a method of communication between the Port Operation Tables in 9.2, 9.3, 9.4, and 9.5 as follows:

- Interface Flags are set to 0 by the C-Port action, "Set_initial_conditions."
- Interface Flags are set to 1 by the C-Port upon the detection of an appropriate condition.
- Interface Flags do not represent any implementation requirements.

C-Port Interface Flags use the notation FIP (name in the form of: Access Protocol, C-Port Operation, Condition Reported [optional]). This notation is illustrated in Figure 9.1-1.

C-Port Interface Flag Definition - Overview

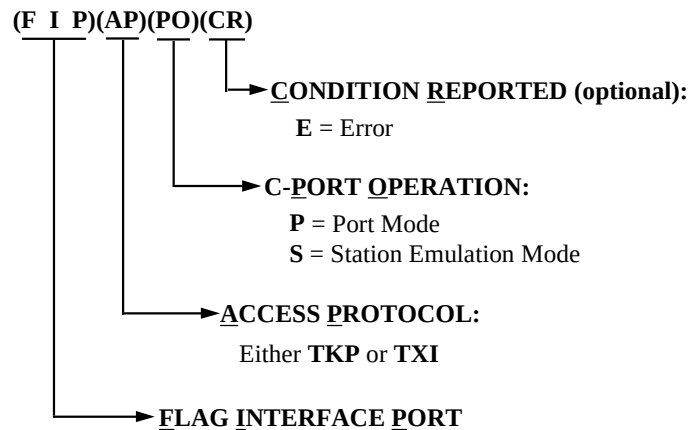


Figure 9.1-1—Interface Flag overview

The following Interface Flags are defined to support Configurations 2, 3, or 4.

9.1.1.4.1 Interface Flag support of the TXI Access Protocol

Flag, Interface C-Port TXI Station Emulation (FIPTXIS)

The flag FIPTXIS is set to 1 by the C-Port's Join FSM in 9.3, when it recognizes the need to enter the C-Port in Station Emulation Mode using the TXI Access Protocol. The Station Operation Tables in 9.2 use this flag to activate transitions necessary to support the C-Port functions (e.g., MRI handling).

The flag FIPTXIS is used to support the Configuration 2 entity (C).

9.1.1.4.2 Interface Flag Support of the TKP Access Protocol (4 Mbit/s and 16 Mbit/s)

Flag, Interface C-Port TKP Port Mode (FIPTKPP)

The flag FIPTKPP is set to 1 by the C-Port's Join FSM in 9.3, when it recognizes the need to enter the C-Port in Port Mode using the TKP Access Protocol. The Port Operation Tables in 9.4 use this flag to activate transitions necessary to support the C-Port in this mode.

The flag FIPTKPP is used to support the Configuration 3 entity (E) or Configuration 4 entity (H).

Flag, Interface C-Port TKP Port Mode Error (FIPTKPPE)

The flag FIPTKPPE is set to 1 by the C-Port's Monitor FSM in 9.4 to inform the Join Port Operation Table in 9.3 that the attached Station did not successfully complete its LMT during its Beacon Test state.

The flag FIPTKPPE is used to support the Configuration 3 entity (E) and Configuration 4 entity (H).

Flag, Interface C-Port TKP Station Emulation (FIPTKPS)

The flag FIPTKPS is set to 1 by the C-Port's Join FSM in 9.3, when it recognizes the need to enter the C-Port in Station Emulation Mode using the TKP Access Protocol. The Port Operation Tables in 9.5 use this flag to activate transitions necessary to support the C-Port in this mode.

The flag FIPTKPS is used to support the Configuration 3 entity (F) and Configuration 4 entity (G).

9.1.1.5 Join, Monitor, and Transmit FSM interaction

This subclause and its figure (Figure 9.1-2) explain the interaction of the DTR C-Port and Station TXI Access Protocol Join, Monitor, and Transmit FSMs. Functions performed by these C-Port and Station FSMs are defined in the TXI Access Protocol Specifications defined in 9.2.5 and 9.3.4, respectively. The Join Ring FSM is the parent to the Monitor FSM and the Transmit FSM. Figure 9.1-2 illustrates the interaction of the Join Ring (Master), Transmit (Slave), and Monitor (Slave) FSMs.

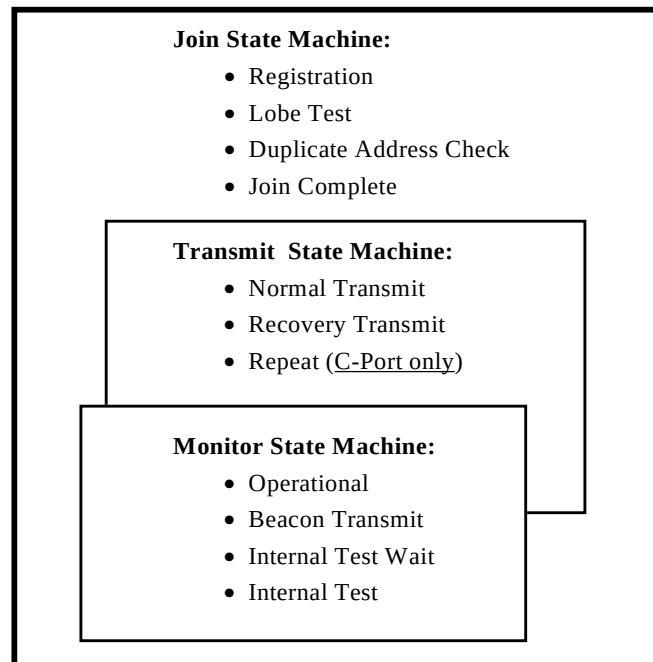


Figure 9.1-2—Join, Transmit, and Monitor FSM interaction

The starting state for the TKP Access Protocol and TXI Access Protocol is the Bypass state (JS=BP).

- The Bypass State is the initial state of the Join FSM. A C-Port or Station completing a power on reset sequence activates its Join FSM in this state. Entry into this state, when under FSM control, can occur due to local management action, network management action, or the detection of an uncorrectable error. Exit from the Bypass State is controlled by the local management actions: Connect.MAC, Connect.SMAC, or Connect.PMAC.
- The Transmit and Monitor states (TS=x, MS=x) *are not* specified while the Join Machine is in the Bypass state (JS=BP).

The following starting conditions (i.e., power on) for the C-Port and Station FSMs shall be established prior to leaving the Bypass State:

- a) Counters are set to zero (0).
- b) Event Flags are set to zero (0).
- c) Stored values are set to zero (0).
- d) C-Port and Station Policy Flags, and C-Port and Station Policy Variables, are set according to the C-Port and Station operational policies; and they are set *prior* to leaving the Bypass State (JS=BP).

Policy Flags and Policy Variables are examined, but are *never* changed by the Port Operation Tables or Station Operation Tables.

- e) Timers are not running (stopped, thus cannot expire).
- f) The FA(LMT) and FA(monitor) shall be set to 0.
- g) All transmit and receive queues shall be flushed.

9.1.1.6 PMAC and SMAC frame and token signals

The PMAC's C-Port Operation Tables and the SMAC's Station Operation Tables use four frame signals and one token signal. They are Frame (FR), Frame with Error (FR_WITH_ERR), Frame Header (FR_FC), Frame Access Control (FR_AC), and Token Access Control (TK_AC). These frame or token signals, which cause certain actions to be taken by the PMAC and SMAC, are defined separately for the 4 and 16 Mbit/s media rate, and for the HMR. The unique definitions of these signals for the TXI Access Protocol are defined below.

4 Mbit/s and 16 Mbit/s

The TK_AC signal is defined in 4.3.1; the FR, FR_WITH_ERR, and FR_AC signals are defined in 4.3.2; and the FR_FC is defined below.

Properties of a frame. (See Clause 3 and Clause 10 for definitions of frame and code symbols.)

- A** — Starts with valid SD (code symbol JK0JK0).
- E** — The frame format bits in the FC field are equal to 00 or 01.
- K** — The AC field has no code violations in the P-bits and T-bit, and optionally the M-bit and R-bits.
- L** — The T-bit is equal to 1, indicating a frame.
- M** — The FC field has no code violations.

Frame header (FR_FC). The FR_FC signal indicates a frame's SD, AC, and FC fields have been received that satisfy the following conditions:

A & K & L & M & E

High Media Rate

The FR, FR_WITH_ERR, FR_AC, and FR_FC signals for the HMR are defined below.

Properties of a frame. (See Clause 14 for the definition of a frame.)

- A** — Starts with valid SSD signal.
- B** — The AC field has no code violations.
- D** — Has no code violations in the FC field.
- E** — Is an integral number of octets in length.
- F** — Has FF bits in FC field equal to 00 or 01.
- G** — Has a valid FCS.
- H** — T bit is equal to 1, indicating a frame.
- J** — Is composed of only hexadecimal values (0 through F) between the SSD and ESD.
- K** — Has a minimum of 19 octets between SSD and ESD.
- L** — Ends with two valid hexadecimal values (0 through F), followed by a valid ESD signal.
- M** — Ends with at least one hexadecimal value (0 through F) in the two code-groups preceding a valid ESD signal.

Frame (FR). The FR signal indicates a valid frame has been received that satisfies one of the following conditions:

A & E & F & G & H & J & K & L (for MAC and LLC frames)

or **A & E & -F & H & J & L** (for undefined frame formats)

Frame with error (FR_WITH_ERR). The FR_WITH_ERR signal indicates a frame has been detected that **satisfies** one of the following conditions:

A & F & H & M & (-E or -G or -J or -K) (for MAC and LLC frames)

or **A & -F & H & M & (-E or -J)** (for undefined frame formats)

Frame access control (FR_AC). The FR_AC signal indicates a frame's SSD and AC fields have been received that satisfy the following conditions:

A & B & H

Frame header (FR_FC). The FR_FC signal indicates a frame's SSD, AC, and FC fields have been received that satisfy the following conditions:

A & B & D & F & H

9.1.1.7 Actions on a frame with error condition

When a frame is addressed to a C-Port or Station and has a frame with error (FR_WITH_ERR) condition (as specified in 4.3.2 for the 4 Mbit/s and 16 Mbit/s media rates and 9.1.1.6 for the HMR), the frame is not processed other than to count the error condition.

9.1.1.8 TXI Policy Flags and Variables

TXI Policy Flags and Variables are set *prior* to the Connect.SMAC or Connect.PMAC interface start-up signals and cannot be changed by the C-Port's Port Operation Tables or the DTR Station's Station Operation Tables. The Station and C-Port TXI Policy Flags and Variables are defined in 10.5 and 14.5.

9.1.1.9 Interpreting the FSMs

The high-level FSMs contained in 9.2 through 9.6, and the low-level FSMs contained in Annexes L, M, N, Q, and R, use the following set of rules.

These FSMs illustrate only the Port and Station Join, Transmit, and Monitor Operation Tables, even though *all* Port and Station Operation Tables defined are required for correct operation.

The Join, Transmit, and Monitor FSMs can operate simultaneously. Each FSM can have only *one* State active at a time.

Figure 9.1-3 illustrates states and transitions as follows:

- a) STATES as vertical lines, with the State name at the top of the line.
- b) TRANSITIONS as horizontal lines; always contain an arrowhead to show a connection to a STATE and may contain a state/transition number (e.g., J12).
- c) When state/transition numbers (e.g., J12) are present within a FSM:
 - 1) The first character represents the current FSM (J for Join, T for Transmit, and M for Monitor);

- 2) The second character is the State within the current FSM being exited;
- 3) The third character is the State within the current FSM being entered.

Occasionally, a transition between two states can be caused by a number of different conditions, each with different resulting actions. In these cases, the different paths are differentiated by the addition of a letter in the state transition label (e.g., J13A and J13B).

- d) Entry into a STATE occurs *only* when the transition ends at a STATE with an arrowhead.
- e) Some transitions are awkward to illustrate because of location within the FSM. TRANSITION J31 exits STATE J3 and enters STATE J1 [e.g., J31 labeled (A)].
- f) Some transitions cross a STATE without an arrowhead and indicate the STATE *is not* entered. TRANSITION J31 exits STATE J3 and enters STATE J1 [e.g., J31 labeled (B)].
- g) OPTIONAL conditions are enclosed in brackets (e.g., [Condition_6]).
- h) OPTIONAL actions are enclosed in brackets (e.g., [Action_6]).

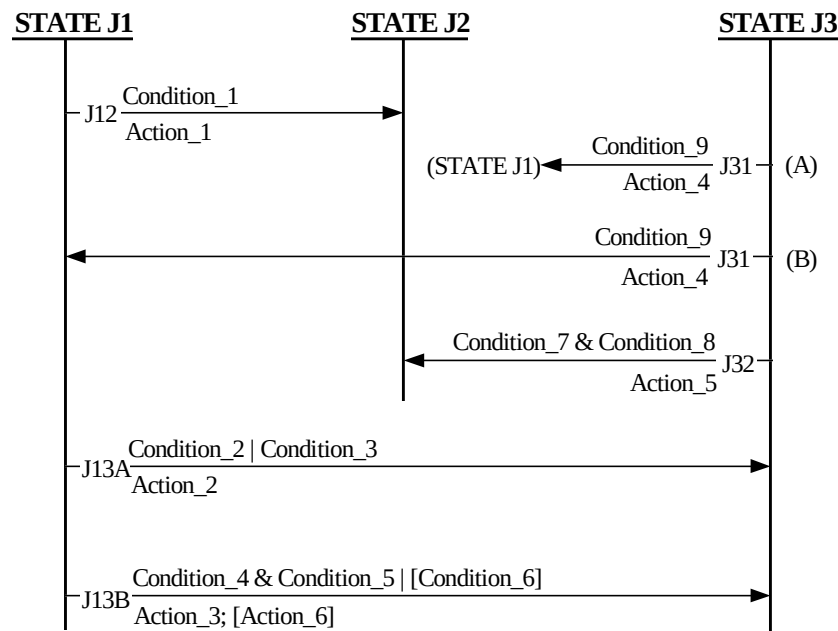


Figure 9.1-3—State/transitions (S/T) illustration

Figure 9.1-3 illustrates the following state transitions:

- STATE J1 to STATE J2 (transition J12) due to event of Condition_1, action of Action_1.
- STATE J1 to STATE J3 (transition J13A) due to event of Condition_2 OR Condition_3, action of Action_2.
- STATE J1 to STATE J3 (transition J13B) due to event of Condition_4 AND Condition_5, OR optional by Condition_6, action of Action_3, and optionally Action_6.
- STATE J3 to State J1: two different ways of illustrating the same transition.
 - STATE J3 to STATE J1 (transition J31) due to event of Condition_9, action of Action_4.
 - STATE J3 to STATE J1 (transition J31) due to event of Condition_9, action of Action_4.

In the Port and Station Operation Tables in Clause 9, the “Event/Event and conditions” column contains the current state. This state is not shown in the Low-Level FSMs in Annexes L, M, N, Q, or R because the vertical line illustrates the current state.

In the Port and Station Operation Tables in Clause 9, the “Actions/Outputs” column contains the state being entered. This state is not shown in the Low-Level FSMs in Annexes L, M, N, Q, or R because the state being entered is illustrated by the arrowhead connection to a vertical line.

Some of the Port and Station Operation Tables in Clause 9 contain transitions without a S/T entry. Although these transitions are not shown in the FSMs in Annexes L, M, N, Q, or R, they *are* required for correct FSM operation.

Some of the Port and Station Operation Tables in Clause 9 contain transitions that appear redundant because they seem to overlap. Close examination shows that uniqueness and redundant conditions do exist between the transitions. However, these are recognized at different points in time during the frame checking process. The following two examples extracted from Station Operation Table 9.2-1 appear redundant, but are not. The “Actions/Outputs” column explains under which conditions the event works, and following the table is an explanation of the differences in the frame checking processes.

S/T	REF	Event/Event and conditions	Actions/Outputs (with explanation)
JB0	3103	FR_MAC(SA<>MA & SA<>SUA & VC=00) & JS=SLT	JS=BP This action occurs for <i>any</i> MAC frame and <i>only</i> when (SA<>MA & SA<>SUA & VC=00).
JB0	3165	FR_SMP(SA<>MA) & JS=SLT NOTE—VC has an implicit value of 00 because of the definition of the SMP MAC frame.	JS=BP This action occurs <i>only</i> for a SMP MAC frame with (SA=SUA & VC=00), <i>and</i> 3103 does not operate.

Reference 3103 occurs during early frame checking *before* the type of MAC frame is recognized, while reference 3165 works *after* the SMP MAC frame has been recognized and is being checked for validity. For conditions that cause *both* transitions to work, reference 3103 operates.

9.1.2 TXI protocol checking

The Station and C-Port TXI Protocol Checking functions, when active, prevent TXI Access Protocol contamination. These functions are active when the Join FSM is in the following states: JS=SREG, JS=SLT, JS=SDAC, JS=SJC, JS=PLT, JS=PDAC, and JS=PJCI. A TXI Protocol Check causes the C-Port or Station to

- Return to the Bypass state (JS=BP); and
- Notify the appropriate Management entity of this event.

All frames are ignored during the Station’s HMR Trade-up State (JS=SHMRTU). The C-Port’s HMR Trade-up State (JS=PHMRTU) acts on REG_REQ frames only.

9.1.3 TXI error handling

The Station or C-Port using the TXI Access Protocol can experience error conditions that are classified as either Hard or Soft Errors, as follows:

- Hard Errors, which are defined in 9.1.10, are faults that prevent the Station from receiving the C-Port’s Heart Beat (PHB) MAC frames, or prevent the C-Port from receiving the Station’s Heart Beat (SHB) MAC frames.
- Soft Errors, which are defined in 10.6, are faults that cause data corruption, but do not prevent frames from being exchanged between the C-Port and the Station.

Error detection, reporting, and recovery procedures require Stations and C-Ports to identify and isolate fault conditions. In some cases, the Station and/or C-Port causing the fault condition is required to remove from the Network and report the error condition to the appropriate Management entities.

All error conditions are isolated to the fault domain described in 9.1.3.1. The Registration Process described in 9.1.4 establishes the operational domain of the TXI Access Protocol, including the individual addresses of the Station and C-Port. This operational domain is reported as the Fault Domain (as described in 9.1.3.2) either by the Beacon MAC frame for Hard Errors or by the Error Report MAC frame for Soft Errors as follows:

- Recovery from hard error conditions is managed by Hard Error Recovery, as described in 9.1.10.
- Reporting of soft error conditions is handled by the Station or C-Port, as described in 9.1.11.

9.1.3.1 TXI Fault Domain

The C-Port and Station *fault domain* establishes a boundary around an error condition and identifies the location of the fault for the appropriate corrective action. The Fault Domain for the TXI Access Protocol consists of the following, as illustrated in Figure 9.1-4:

- a) The C-Port (A);
- b) The Station (B); and
- c) The components (e.g., medium, connectors) between the C-Port and the Station.

In this fault domain, error reporting is accomplished by

- The Station (B) detecting an error condition and reporting this fault condition as being downstream of the C-Port (A); or
- The C-Port (A) detecting an error condition and reporting this fault condition as being downstream of the Station (B).

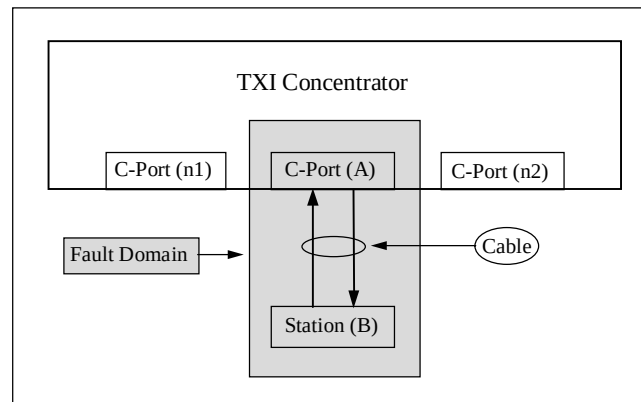


Figure 9.1-4—Fault domain illustration

9.1.3.2 TXI fault reporting

The TXI Access Protocol uses two reporting schemes, one for soft errors and one for hard errors. Subclauses 9.1.3.2.1 and 9.1.3.2.2 explain the handling of hard errors and soft errors using the fault domain illustrated by Figure 9.1-4.

9.1.3.2.1 Hard Errors

The TXI Access Protocol uses the Hard Error Recovery Process (see 9.1.10) in an attempt to recover from a Hard Error condition and restore normal operation. If recovery is not possible, the Beacon MAC frame identifies the Hard Error's fault domain for analysis by network management functions (Network Management and/or Station Management) as follows:

a) *Station Detected Hard Error*

The Hard Error's fault domain is identified and reported by Station (B) transmitting Beacon MAC frames when the Station detects a Hard Error (e.g., broken cable between C-Port [A] and Station [B]). This Beacon MAC frame

- 1) Contains the addresses of the detecting Station (B) and the connected C-Port (A); and
- 2) Allows the Station (B) to attempt to alert the C-Port (via the Beacon MAC frame) and its management that normal TXI Access Protocol is suspended until the hard error condition is terminated or removed. However, the nature of the Hard Error condition may make it impossible for the C-Port to receive the Station's Beacon MAC frame. When this occurs, C-Port management will not be aware the Station has detected an error condition.

b) *C-Port Detected Hard Error*

The Hard Error's fault domain is identified and reported by C-Port (A) transmitting Beacon MAC frames when the C-Port detects a Hard Error (e.g., broken cable between Station [B] and C-Port [A]). This Beacon MAC frame

- 1) Contains the addresses of the detecting C-Port (A) and the connected Station (B); and
- 2) Allows the C-Port (A) to attempt to alert the Station (via the Beacon MAC frame) and its management that normal TXI Access Protocol is suspended until the Hard Error condition is terminated or removed. However, the nature of the Hard Error condition may make it impossible for the Station to receive the C-Port's Beacon MAC frame. When this occurs, Station management will not be aware the C-Port has detected an error condition.

9.1.3.2.2 Soft Errors

The C-Port's and Station's TXI Access Protocol detects and reports Soft Errors as follows:

a) *Station Detected Soft Error*

The Soft Error's fault domain is identified and reported by Station (B) transmitting an Error Report MAC frame when the Station (B) detects a Soft Error (e.g., interference causing increased bit error rate (BER) between C-Port [A] and Station [B]). This Error Report MAC frame

- 1) Contains the addresses of the detecting Station (B) and the connected C-Port (A);
- 2) Contains the count of the errors detected (see 10.6); and
- 3) Is sent to the REM functional address for analysis by a Management application designed for the TXI Access Protocol.

b) *C-Port Detected Soft Error*

The Soft Error's fault domain is identified and reported by C-Port (A) indicating an Error Report Management Status when the C-Port (A) detects a Soft Error (e.g., interference causing increased BER between C-Port [A] and Station [B]). This Error Report Management Status

- 1) Contains the addresses of the detecting C-Port (A) and the connected Station (B);
- 2) Contains the count of the errors detected (see 10.6); and
- 3) Is sent via a Management Routing Interface (MRI) status indication for analysis by a Management application designed for the TXI Access Protocol.

9.1.4 TXI registration

The C-Port and the Station Join Machines use the Registration function to exchange the following information:

- Station saves the C-Port's source address (PMAC Address) in its Stored Upstream Address (SUA).
- C-Port saves the Station's source address (SMAC Address) in its SUA.
- C-Port saves the Station's Individual Address Count (IAC) in its Stored Individual Address Count (SIAC). The Station is required to support only the SMAC address, but may optionally support multiple individual addresses. The C-Port does not support multiple Individual Addresses.

- C-Port saves the Station's Phantom Drive (PD) subvector value in its Stored Phantom Drive (SPD) variable.

In addition, the C-Port and the Station Join Machines use Registration to determine whether the Station and C-Port are compatible (e.g., they are capable of using the same Access Protocols).

- a) If they are not compatible, the Registration function causes the following actions:
 - 1) The C-Port notifies the Station of the incompatibility via the Registration Response (REG_RSP) MAC frame with an AP_RSP subvector value of X'0000' and remains in its Registration State.
 - 2) The Station returns to the Bypass State and notifies the appropriate Management function.
- b) If they are compatible, the Registration function in the C-Port notifies the Station via the Registration Response (REG_RSP) MAC frame with an AP_RSP subvector with a value of X'0002' for the TXI Access Protocol, or a value of X'0004' for the HMR Trade-up Protocol.

9.1.4.1 Station support of registration

After a delay controlled by the timer TSIS, the registration function determines whether the C-Port can support the TXI Access Protocol by setting its request counter CSREQ to a value in the range of 4 through 12 (see 9.2.3.1 and 9.2.5), resetting the pacing timer TSREQ, and transmitting the Registration Request MAC frame defined in 10.3.5.1. The station proceeds with one of the following actions:

- a) If the Station receives a C-Port REG_RSP MAC frame and its AP_RSP subvector value is equal to X'0002', then the C-Port has accepted the Station's request and the Station, after delaying for a period controlled by TSLMTD, begins the TXI Access Protocol defined in 9.2 by entering the Station Lobe Test state (JS=SLT).
- b) If the Station has not received the C-Port's REG_RSP MAC frame prior to the expiration of TSREQ and CSREQ>0, then the Station retransmits the REG_REQ MAC frame, resets timer TSREQ, and decrements CSREQ.
- c) If the Station has not received the C-Port's REG_RSP MAC frame prior to the expiration of TSREQ and CSREQ=0, then the station takes one of the following actions, depending on the option flag FSOPO:
 - 1) When operating at the 4 Mbit/s or 16 Mbit/s media rate and if FSOPO=0, the Station attempts to join using the TKP Access Protocol by entering the Lobe Test state (JS=LT) defined in Clause 4 for the Classic Station and in 9.6 for the DTR Station.
 - 2) When operating at any media rate and if FSOPO=1, the Station does not allow selection of the TKP Access Protocol, enters the Bypass state (JS=BP), and reports this failure to Management.
- d) If the Station receives a C-Port REG_RSP MAC frame and its AP_RSP subvector value is X'0000' (indicating the C-Port has denied the Station's request), then the Station takes one of the following actions, depending on the option flag FSRDO:
 - 1) When operating at the 4 Mbit/s or 16 Mbit/s media rate and if FSRDO=0, the Station attempts to join using the TKP Access Protocol and enters the Lobe Test state (JS=LT) defined in Clause 4 for the Classic Station and in 9.6 for the DTR Station.
 - 2) When operating at any media rate and if FSRDO=1, the Station does not allow selection of the TKP Access Protocol, enters the Bypass state (JS=BP), and reports this failure to Management.
- e) If the Station operating at 4 Mbit/s or 16 Mbit/s receives a REG_RSP MAC frame with an AP_RSP subvector value of X'0004' (indicating the C-Port has honored the Station's request to trade up to the HMR), then the Station continues with the HMR Trade-up protocol described in 9.1.14.

- f) If the C-Port in Station Emulation Mode (FIPTXIS=1) operating at 4 Mbit/s or 16 Mbit/s with its Trade-up function active (FSHMRTUA=1), receives a REG_RSP MAC frame with an AP_RSP subvector value of X'0000' (indicating the C-Port has rejected the request to trade up to the HMR), then it restarts the Registration process to request operation at 4 Mbit/s or 16 Mbit/s.

9.1.4.2 C-Port support of registration

The C-Port supports the Registration function by entering the Registration State (JS=PREG) as follows:

4 Mbit/s and 16 Mbit/s

In the Registration state, a reliable repeat path is provided only if the C-Port is configured to support the TKP Access protocol [AND(PPV(AP_MASK),0001)=0001]. While in the Registration state, the C-Port waits for the Station's Registration Request (REG_REQ) MAC frame. Upon reception of the Station's Registration Request (REG_REQ) MAC frame, the C-Port examines the AP_REQ and PD subvector values and takes one of the following actions:

- If the value of the Station's AP_REQ when logically ANDed with the C-Port's PPV(AP_MASK) results in a value of X'0000' (indicating the AP_REQ value is not supported), or the value of the Station's PD when logically ANDed with the C-Port's PPV(PD) results in a value of X'0000' (indicating the PD value is not supported by the C-Port), then the C-Port denies the Station request by transmitting a Registration Response (REG_RSP) MAC frame with an AP_RSP subvector value of X'0000'. The C-Port remains in the Registration state (JS=PREG).
- If the value of the Station's AP_REQ when logically ANDed with the C-Port's PPV(AP_MASK) results in a value of X'0002', and the value of the Station's PD when logically ANDed with the C-Port's PPV(PD) results in a value of X'0001', then the C-Port accepts the Station request to use the TXI Access Protocol by transmitting a Registration Response (REG_RSP) MAC frame with an AP_RSP subvector value of X'0002', sets up the C-Port to support the Station's Lobe Test, and enters the C-Port Lobe Test state (JS=PLT).

NOTE—The Station's PD subvector shall have a value of X'0001' (indicating Phantom Drive is supported) when operating at the 4 Mbit/s and 16 Mbit/s media rates.

- If the value of the Station's AP_REQ when logically ANDed with the C-Port's PPV(AP_MASK) results in a value of X'0004', then the C-Port requests the Station to execute its Trade-up protocol by transmitting a Registration Response (REG_RSP) MAC frame with an AP_RSP subvector value of X'0004', and continues with the HMR Trade-up protocol described in 9.1.1.4.

High Media Rate

While in the Registration state, the C-Port waits for the Station's Registration Request (REG_REQ) MAC frame. Upon reception of the Station's Registration Request (REG_REQ) MAC frame, the C-Port examines the AP_REQ and PD subvector values and takes one of the following actions:

- If the value of the Station's AP_REQ when logically ANDed with the C-Port's PPV(AP_MASK) results in a value of X'0000' (indicating the AP_REQ value is not supported), or the value of the Station's PD when logically ANDed with the C-Port's PPV(PD) results in a value of X'0000' (indicating the PD value is not supported by the C-Port), then the C-Port denies the Station's request by transmitting a Registration Response (REG_RSP) MAC frame with an AP_RSP subvector value of X'0000'. The C-Port remains in the Registration state (JS=PREG).
- If the value of the Station's AP_REQ when logically ANDed with the C-Port's PPV(AP_MASK) results in a value of X'0002', and the value of the Station's PD when logically ANDed with the C-Port's PPV(PD) results in a value of X'0001' or X'0002', then the C-Port accepts the Station request to use the TXI Access Protocol by transmitting a Registration Response (REG_RSP) MAC

frame with an AP_RSP subvector value of X'0002', sets up the C-Port to support the Station's Lobe Test, and enters the C-Port Lobe Test state (JS=PLT).

NOTE—When operating at the HMR, the Station's PD subvector may have a value of X'0001' (indicating Phantom Drive is supported) or X'0002' (indicating Phantom Drive is not supported).

9.1.5 Registration Query Protocol

The purpose of the Registration Query Protocol is to allow two TXI-capable entities connected by a dedicated lobe, which have joined using the TKP Access protocol, to attempt to switch to the TXI Access Protocol. This situation could arise from a TXI-capable station attempting registration before the C-Port is ready to respond.

The Protocol is initiated by the C-Port completing Neighbor Notification and entering the Port Registration Query state (JS=PRQ). In this state, the C-Port will transmit up to five (5) Registration Query MAC frames to the attached station. If the Station is configured to respond to the Registration Query MAC frames, the Station drops Phantom, delays for the time specified by TSRW (allows the C-Port to detect phantom loss and change states), and re-enters the Registration State (JS=SREG) to begin the Registration Process. While in the Registration Query state (JS=PRQ), the C-Port responds to the loss of Phantom by entering its Registration state (JS=PREG).

If the Station does not drop phantom while the C-Port is in JS=PRQ and CPRQ decrements to zero, the C-Port ends Registration Query and completes the Join Process (JS=PJCP).

9.1.6 TXI Lobe Media Test

The Station, with support of the C-Port, uses the LMT function to determine if the media (lobe) and the associated hardware *between* the Station's SMAC and the C-Port are operating at an acceptable BER.

The type of LMT supported by the Station is determined by the option flag FSLMTO specified in 14.5.1.1.2 as follows.

- If FSLMTO is set to 0, the Station uses the 4 Mbit/s or 16 Mbit/s method of testing (TXI_TEST) defined in 9.1.6.1.
- If FSLMTO is set to 1, the Station uses the 4 Mbit/s, 16 Mbit/s, or HMR method of testing (FSRLMT=1) defined in 9.1.6.2.

9.1.6.1 LMT for FSLMTO=0

This LMT function is designed to be used at the 4 Mbit/s and 16 Mbit/s media rates, with the C-Port PHY repeat path (FPRPTO=1), as defined in 9.1.6.1.2. This PHY repeat path causes the C-Port to return the LMT frame transmitted by the Station.

The Station shall start the LMT with the TXI_TEST action. The operation of this test is defined in 9.1.6.1.1 and specified in 9.2.5.1 by Station Operation Table 9.2-1. The C-Port's support of this test is defined in 9.1.6.1.2 and specified in 9.3.4.1 by Port Operation Table 9.3-1.

9.1.6.1.1 Station support of the LMT

The Station shall be responsible for execution of the LMT function to determine if the lobe has an acceptable BER, as specified in Annex P. The Station's LMT normally uses the LMT MAC frame to test the lobe. The Station's LMT may use other frames for testing, but shall not use the Ring Recovery MAC frames (BN, CT, and RP) or the Neighbor Notification MAC frames (AMP and SMP). The Station transmits the frame and then checks this frame at its receiver for error conditions. The pass/fail criteria for BER calculations are specified in Annex P. If the Station detects success of the LMT function, it continues the Join process. If the

Station detects a failure of the LMT function, the Station assumes the lobe is bad, notifies the Station Management, and enters the Bypass state (JS=BP).

9.1.6.1.2 C-Port support of the LMT

The C-Port shall provide one of the two Repeat Paths defined in 9.7.1 to allow the Station to test the lobe, as stated in 9.1.6.1.1. Both of these repeat paths shall cause the C-Port to return the frames received from the Station unchanged, with the following exceptions:

- The Ending Delimiter's E-bit may or may not be set;
- The Frame Status A-bits may or may not be set; and
- The Frame Status C-bits may or may not be set.

9.1.6.2 LMT for FSLMTO=1

This LMT function tests the lobe by transmitting frames *without* Tokens and is designed to be used at any media rate (e.g., 4, 16, 100, etc.). Frames are returned by the C-Port to the Station as defined in 9.1.6.2.2.

The Station shall start the LMT by setting the flag Station Request LMT (FSRLMT) to 1. The operation of this test is defined in 9.1.6.2.1 and specified in 9.2.5.7 by Station Operation Table 9.2-7. The C-Port's support of this test is defined in 9.1.6.2.2 and specified in 9.3.4.1 by Port Operation Table 9.3-1.

During the LMT Testing stage defined in 9.1.6.2.1, the Station and C-Port activate their LMT functional addresses [FA(LMT)=1] as follows:

- When the Station detects the need to execute the LMT Testing Stage defined in 9.1.6.2.1;
- When the C-Port enters its C-Port Lobe Test state (JS=PLT) *and* it is using the PMAC lobe test repeat mechanism.

9.1.6.2.1 Station support of the LMT

The Station shall be responsible for execution of the LMT function to determine if the lobe has an acceptable BER, as specified in Annex P. The Station's LMT function shall not be sensitive to the form of the repeat mechanism provided by the C-Port and defined in 9.1.6.2.2.

This LMT function is divided into two stages: *Notification* and *Testing*. Annex X provides an analysis of the timing requirements for the Notification and Testing stages.

LMT Notification Stage

The Station enters the LMT Notification Stage when it detects conditions requiring the execution of the LMT function.

The Station in the LMT Notification Stage shall transmit the LMT Notification MAC frame, addressed to the *broadcast* address, to request the C-Port to prepare for the LMT Testing Stage. The Station uses an assured delivery process by periodic retransmission of this frame and proceeds as follows:

- If the Station does not receive a LMT Notification MAC frame before its timer TSLMTR expires, then the Station assumes the lobe is bad, notifies the Station Management, and enters the Bypass state (JS=BP).
- If the Station receives a LMT Notification MAC frame (indicating the C-Port has prepared for the Station's LMT), then it stops transmitting this frame and enters the LMT Testing Stage described next.

LMT Testing Stage

The Station in the LMT Testing Stage shall transmit the LMT MAC frame, addressed to the LMT functional address (see 10.2.3), to test the lobe as follows:

- a) The Station timer TSLMTC controls the total LMT time allotted for the Station's LMT. Therefore, the SMAC shall provide an *average* receive and transmit path time of *less than* 0.9 ms for *all* LMT MAC Frames to prevent the total LMT time from exceeding the time allowed by TSLMTC.
- b) The Station shall transmit "n7+1" (see 9.2.5) LMT MAC frames, each with a length of 112 octets, inclusive of the FCS. This standard does not specify the data values for the Wrap Data subvector.
- c) The Station shall fail its LMT if
 - 1) More than one frame out of the "n7+1" frames transmitted is either not received or is received with an error; or
 - 2) The total time for the LMT is exceeded (TSLMTC expires).

9.1.6.2.2 C-Port support of the LMT

The C-Port shall provide a repeat mechanism to allow the Station to test the lobe as stated in 9.1.6.2.1. The policy flag FPRPTO controls the type of repeat mechanism through the C-Port as follows:

- a) If FPRPTO=0, then the C-Port shall provide a PMAC LMT repeat mechanism as follows:
 - 1) Upon reception of a valid LMT Notification or LMT MAC frame, the PMAC shall either
 - i) Return the received frame; or
 - ii) Generate a replacement LMT Notification or LMT MAC frame.

The LMT Notification and LMT MAC frames shall be transmitted to the Station as follows:

The LMT Notification MAC frame shall contain the same information field as the one transmitted by the Station, but *may* or *may not* contain the same SA. This frame indicates the C-Port has

- Recognized the Station's request to start the LMT function; and
- Activated its PMAC repeat mechanism.

The LMT MAC frame shall be of the same length, but *may* or *may not* contain the same SA or information field as the one transmitted by the Station.

The total LMT time allotted for the Station's LMT is controlled by the Station timer TSLMTC. Therefore, the PMAC shall provide an *average* repeat time of *less than* 0.9 ms for *all* LMT MAC Frames to prevent the total LMT time from exceeding the time allowed by TSLMTC.

- 2) LMT Notification and LMT MAC frames detected with a FR_WITH_ERR condition shall be ignored by the C-port.
- b) If FPRPTO=1, then the C-Port shall provide the PHY repeat path defined in 9.7.2. This repeat path shall cause the C-Port to return the frames received from the Station unchanged with the following exceptions:
 - 1) The Ending Delimiter's E-bit may or may not be set;
 - 2) The Frame Status A-bits may or may not be set; and
 - 3) The Frame Status C-bits may or may not be set.

9.1.7 TXI Duplicate Address Check (DAC)

The DTR Station and C-Port use DAC to determine whether the Station has an individual address acceptable to the DTR Concentrator's Data Transfer Unit (DTU) defined in Annex K. It is intended that the scope of the DAC should be the set of MACs connected to the ports on a DTR Concentrator that together

comprise *one* logical ring (K.3.2.2). The DAC is completed when the C-Port's Insert Response (INS_RSP) MAC frame is sent as a result of the Station transmitting an Insert Request (INS_REQ) MAC frame.

9.1.7.1 Station support of DAC

The Station starts its DAC function by transmitting the Insert Request (INS_REQ) MAC frame and waits for the C-Port's INS_RSP MAC frame. The Station takes one of the following actions:

- a) If the Station receives an INS_RSP MAC frame with a response code of X'8020' (indicating the Station's address is detected as a duplicate address), then the Station does not remain attached to the DTR Concentrator, enters the Bypass State (JS=BP), and notifies the appropriate Management functions.
- b) If the Station receives an INS_RSP MAC frame with a response code of X'0000' (indicating the Station's address is not detected as a duplicate address), then the Station enters the Join Complete state (JS=SJC).

The Station's DAC function is terminated by the occurrence of the following events:

- If the Station's timer TSJC expires prior to the reception of the C-Port's INS_RSP MAC frame, the Station enters the Bypass State (JS=BP) and notifies the appropriate Management functions.
- If the Station's timer TSRHB expires while the Station is in the DAC state (JS=SDAC), the Station enters the Bypass State (JS=BP) and notifies the appropriate Management functions.

9.1.7.2 C-Port support of DAC

The C-Port starts the DAC function during Registration and completes DAC when it receives the Station's INS_REQ MAC frame and a response from the DTU interface [DTU_DAC.response(RC)] by transmitting the Insert Response (INS_RSP) MAC frame. The C-Port takes one of the following actions:

- a) The C-Port transmits an INS_RSP MAC frame with a response code of X'8020' if a duplicate address is detected, and terminates support of the Station by returning to the Bypass state (JS=BP).
- b) The C-Port transmits an INS_RSP MAC frame with a response code of X'0000' if a duplicate address is not detected, and completes Join by entering the Join Complete TXI state (JS=PJCI).

9.1.8 TXI Transmit Function

The C-Port and Station TXI Transmit Functions operate as shown in Figure 9.1-5. This figure illustrates the TXI Transmit Functions allowing frames to be transmitted by: first, requiring the conditions to be met and second, allowing the selection of Transmit Immediate frames (TXI_REQ) for transmission *prior* to the transmission of any queued frames (QUE_PDU).

The C-Port and Station may support multiple transmit queues. If multiple queues are supported, the operation of these queues is not standardized, other than requiring the condition and selection capabilities.

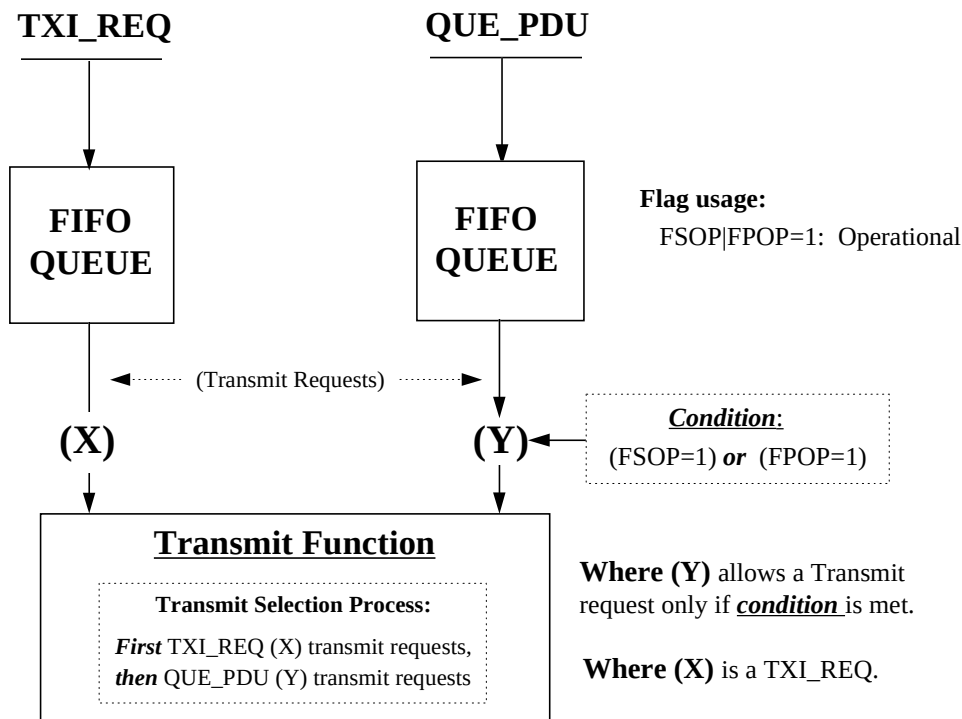


Figure 9.1-5 C-Port and Station Transmit Function

9.1.8.1 Station TXI Transmit Function

The Station's TXI Transmit function is supported by two states, Transmit Normal (TS=STXN) and Transmit Data (TS=STXD), as follows:

4 Mbit/s and 16 Mbit/s

Transmit Normal State (TS=STXN). This is the normal state for the Station's TXI Transmit Function. In this state, the Station is transmitting idles from either its crystal (FSTXC=1) or its recovered clock (FSTXC=0). The Join and Monitor Station Operation Tables control the setting of the Flag FSTXC.

If a transmit request is made, the Station honors the condition and selection scheme identified in 9.1.8 by providing the frame transmit sequence specified by 9.1.1.1, item 5, and entering the Transmit Data (TS=STXD) state.

Transmit Frame Data State (TS=STXD). This state is used by the Station or the C-Port in the Station Emulation Mode to transmit the frame's data. The data is transmitted until one of the following conditions is detected:

- The Station or the C-Port in the Station Emulation Mode has no more data to transmit (EOD reached). The Station or C-Port then releases the end-of-frame sequence (EFS) and returns to the Transmit Normal state (TS=STXN).
- The Station or the C-Port in the Station Emulation Mode detects a transmission error. The Station or C-Port then takes one of the actions defined under "Transmission Error" in 9.1.1.7.

High Media Rate

The Station's TXI Transmit Function always transmits idles (FSTI=1) and frame data (FSTI=0) using its crystal as the PHY's timing reference by setting the flag FSTXC=1 when the Join Station Operation Table exits the JS=BP state.

Transmit Normal State (TS=STXN). This is the normal state for the Station's TXI Transmit Function. In this state, the Station is transmitting idles.

If a transmit request is made, the Station honors the condition and selection scheme identified in 9.1.8 by providing the frame transmit sequence specified by 9.1.1.1, item 5, and entering the Transmit Data (TS=STXD) state.

Transmit Frame Data State (TS=STXD). This state is used by the Station or the C-Port in the Station Emulation Mode to transmit the frame's data. The data is transmitted until one of the following conditions is detected:

- The Station or the C-Port in the Station Emulation Mode has no more data to transmit (EOD reached). The Station or C-Port then releases the EFS and returns to the Transmit Normal state (TS=STXN).
- The Station or the C-Port in the Station Emulation Mode detects a transmission error. The Station or C-Port then takes one of the actions defined under "Transmission Error" in 9.1.1.7.

9.1.8.2 C-Port TXI Transmit Function

4 Mbit/s and 16 Mbit/s

The C-Port's TXI Transmit function is supported by three states: Transmit Normal (TS=PTXN), Transmit Frame Data (TS=PTXD), and Transmit Repeat (TS=PRPT).

Transmit Normal State (TS=PTXN). This is the normal state for the C-Port's TXI Transmit Function. During this state, the C-Port is transmitting idles (FPTI=1). The clock source is dependent on the state of the Join FSM as follows: prior to entering JS=PDAC, the clock source is recovered from the input signal (FPTXC=0); after entering JS=PDAC and in JS=PJCI, the clock source is its crystal (FPTXC=1).

When a transmit request is made (TXI_REQ or QUE_PDU) *and* a repeat request has not been made (FPRPT=0), the C-Port honors the condition and selection scheme identified in 9.1.8, turns off transmit idles (FPTI=0), transmits the appropriate starting frame sequence (see 9.1.1.1), and enters the Transmit Data state (TS=PTXD).

When a repeat request is made (FPRPT=1), the C-Port turns off crystal transmit (FPTXC=0) so its transmit signal is derived from the recovered clock, repeats received data (FPTI=0), and enters the Transmit Repeat state (TS=PRPT).

Transmit Frame Data State (TS=PTXD). This state is used by the C-Port to transmit frame data. The data is transmitted until one of the following conditions is detected:

- The C-Port detects it has no more data to be transmitted (EOD), releases the EFS, and returns to the Transmit Normal state (TS=PTXN).
- The C Port detects a transmission error and takes one of the actions defined under "Transmission Error" in 9.1.1.7.

Transmit Repeat (TS=PRPT). This state is used by the C-Port to provide a repeat path to support the Station's TXI LMT function defined in 9.1.6.

This repeat path, which is activated by the Transmit Normal state ($TS=PTXN$) detecting the flag $FPRPT=1$, is not required to examine data being repeated; however, the C-Port must receive any frame with a destination address equal to any of its addresses.

This repeat path is deactivated upon detection of the flag $FPRPT$ being set to 0. The C-Port starts transmitting idles ($FPTI=1$), changes its clock source to its crystal ($FPTXC=1$) if $FPOP=1$, and returns to the Transmit Normal state ($TS=PTXN$).

The characteristics of the repeat path used by the C-Port are found in 9.7.

High Media Rate

The C-Port's TXI Transmit Function always transmits idles ($FPTI=1$) and frame data ($FPTI=0$) using its crystal as the PHY's timing reference by setting Flag $FSTXC=1$ when the Join Port Operation Table exits the $JS=BP$ state. The C-Port's TXI Transmit function is supported by two states: Transmit Normal ($TS=PTXN$) and Transmit Frame Data ($TS=PTXD$).

Transmit Normal State ($TS=PTXN$). This is the normal state for the C-Port's TXI Transmit Function. During this state, the C-Port is transmitting idles ($FPTI=1$).

When a transmit request is made (TXI_REQ or QUE_PDU), the C-Port honors the condition and selection scheme identified in 9.1.8, turns off transmit idles ($FPTI=0$), transmits the appropriate starting frame sequence (see 9.1.1.1), and enters the Transmit Data state ($TS=PTXD$).

Transmit Frame Data State ($TS=PTXD$). This state is used by the C-Port to transmit frame data. The data is transmitted until one of the following conditions is detected:

- The C-Port detects it has no more data to be transmitted (EOD), releases the EFS, and returns to the Transmit Normal state ($TS=PTXN$).
- The C-Port detects a transmission error and takes one of the actions defined under "Transmission Error" in 0.

Transmit Repeat ($TS=PRPT$). This state is used by the C-Port to provide a repeat path when $FPRPT=1$ to support the Station's TXI LMT function defined in 9.1.6.

9.1.9 TXI Heart Beat

The TXI Heart Beat function is used to determine if the link between the C-Port and Station is operative as follows:

- a) If the C-Port or Station detect the *presence* of the Heart Beat MAC frame, then they reset their respective Heart Beat timers (TPRHB or TSRHB) and the TXI Heart Beat function continues.
- b) If the C-Port or Station detect the *absence* of the Heart Beat MAC frame by the expiration of their respective Heart Beat timers (TPRHB or TSRHB), then they take one of the following actions:
 - 1) If Join has been completed, they enter Hard Error Recovery (see 9.1.10);
 - 2) If Join has not been completed, they enter the Bypass state ($JS=BP$).

The TXI Heart Beat function is activated and deactivated by the Heart Beat Active flags, FPHBA and FSHBA, as follows:

- When the flags $FPHBA=0$ or $FSHBA=0$, the C-Port and Station TXI Heart Beat function is inactive.
- When the flags $FPHBA=1$ or $FSHBA=1$, the TXI Heart Beat function is active. The C-Port and the Station use their Queue Heart Beat timers (TPQBH or TSQHB) to pace the transmission of the C-Port Heart Beat MAC frames and Station Heart Beat MAC frames, respectively.

9.1.9.1 Station support of TXI Heart Beat

The Station's TXI Heart Beat function is activated by setting flag FSHBA to 1 when it detects the successful completion (TEST_OK) of its LMT and by entering its DAC state (JS=SDAC).

If the Station receives a C-Port Heart Beat MAC frame prior to the expiration of its Receive Heart Beat timer TSRHB, the Station resets TSRHB and the TXI Heart Beat function continues without interruption.

If the Station fails to receive a C-Port Heart Beat MAC frame before its Receive Heart Beat timer TSRHB expires (a TXI Heart Beat failure is detected), then the Station takes one of the following actions:

- a) If Join is complete (FSJC=1), the Station disables the TXI Heart Beat function by setting flag FSHBA to 0 and enters Hard Error Recovery (MS=STBN).
- b) If Join is not complete (FSJC=0), the Station enters its Bypass state (JS=BP) and notifies Management of the failure.

9.1.9.2 C-Port support of TXI Heart Beat

The C-Port's TXI Heart Beat function is activated by setting flag FPHBA to 1 when the C-Port detects the completion of the Station's LMT due to the reception of the Station's Insert Request (INS_REQ) MAC frame. This event causes the C-Port to enter its DAC state (JS=PDAC).

If the C-Port receives a Station Heart Beat MAC frame prior to the expiration of its Receive Heart Beat timer TPRHB, then the C-Port resets TPRHB and the TXI Heart Beat function continues without interruption.

If the C-Port fails to receive a Station Heart Beat MAC frame before its Receive Heart Beat timer TPRHB expires (a TXI Heart Beat failure is detected), then the C-Port takes one of the following actions:

- a) If Join is complete (FPJC=1), then the C-Port disables the TXI Heart Beat function by setting flag FPHBA to 0 and enters Hard Error Recovery (MS=PTBN).
- b) If Join is not complete (FPJC=0), then the C-Port enters its Bypass state (JS=BP) and notifies Management of the failure.

9.1.10 TXI Hard Error Recovery

Hard Error Recovery is a simple function used by the TXI Access Protocol to recover from a C-Port, Lobe, or Station failure that prevents communication between the Station and the C-Port. One of the major changes made to the Hard Error Recovery scheme for the TXI Access Protocol is to *always* require the C-Port and Station to execute the Station's LMT. This change eliminates the TKP Access Protocol's shortcoming of the Beacon Transmitter successfully completing Beacon Test, although the Lobe is operating at an unacceptable BER.

A Hard Error detected by the C-Port when Join has completed (FPJC=1) causes one of the following conditions to occur:

- The C-Port's TXI Heart Beat function fails, causing entry into the Beacon Transmit state (MS=PTBN).
- The C-Port receives a Beacon MAC frame while in its Operational State (MS=POPT), causing entry into the Port Internal Test state (MS=PIT).

A Hard Error detected by the Station when Join has completed (FSJC=1) causes one of the following conditions to occur:

- The Station's TXI Heart Beat function fails, causing entry into the Beacon Transmit state (MS=STBN).
- The Station receives a Beacon MAC frame while in its Operational State (MS=SOPT), causing entry into the Wire Fault Delay state (MS=SWFD).

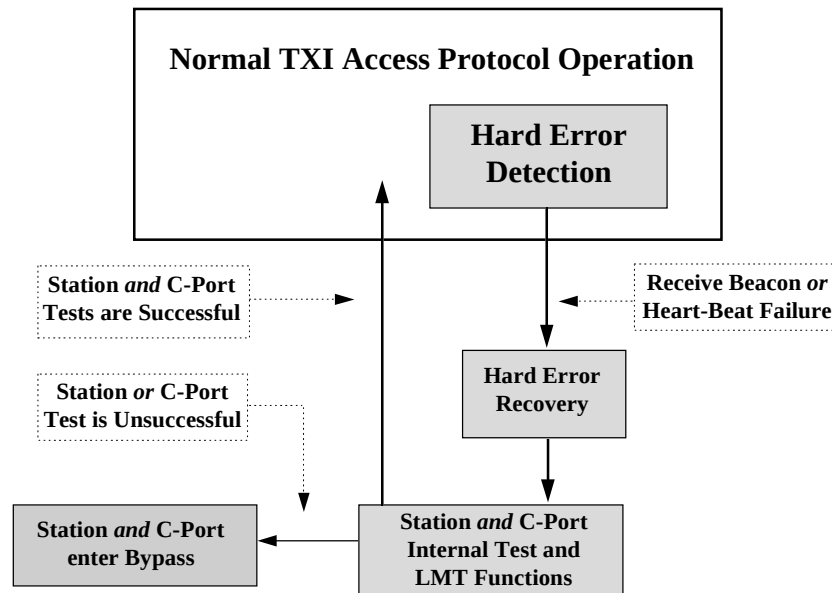


Figure 9.1-6—Hard Error Recovery

The TXI Hard Error Recovery scheme, illustrated in Figure 9.1-6, consists of the C-Port and Station Beacon Transmit states, the Station's Wire Fault Delay state, and the C-Port and Station Internal Test states. These states operate as follows:

9.1.10.1 Beacon Transmit State (MS=STBN or MS=PTBN)

A TXI Heart Beat function (see 9.1.9) failure causes the C-Port and Station to enter the Beacon Transmit state (MS=PTBN and MS=STBN, respectively) and transmit a Beacon MAC frame containing the reason for Beaconsing (Beacon Type) and the address of its upstream entity (UNA). Once the Beacon Transmit State has been entered, the C-Port and Station always execute their Internal Tests as follows:

- When the C-Port enters the Beacon Transmit State, it resets the timer TPIT. Expiration of TPIT causes the C-Port to enter its Internal Test State (MS=PIT).
- When the Station enters the Beacon Transmit State, it resets the timer TSIT. Expiration of the timer TSIT causes the Station enter its Internal Test State (MS=SIT).

Hard Error Recovery relies on the Beacon MAC frame and its Beacon Type subvector. A failure of the TXI Heart Beat causes the C-Port and/or Station to transmit *each* Beacon MAC frame with the value of the Beacon Type subvector set according to the value of the flag, Signal Loss (FPSL or FSSL). It is possible at 4 Mbit/s and 16 Mbit/s for the C-Port and Station loss-of-signal functions to have different flag Signal Loss (FPSL or FSSL) values. The loss-of-signal function is not supported by the HMR; thus, flags FPSL and FSSL are always equal to 0.

The following is an explanation of each Beacon Type used in Beacon Transmit:

Beacon Type 2 (4 Mbit/s and 16 Mbit/s only). The C-Port and/or Station *have* detected the presence of a long-term loss-of-signal because flags FPSL and/or FSSL are equal to 1. A Beacon Type 2 example includes a break in the medium, causing the Station and/or C-Port to be unable to detect the appropriate signal at their receivers.

Beacon Type 5 (4 Mbit/s and 16 Mbit/s only). The C-Port and/or Station *have* detected a Heart Beat failure, but *have not* detected the presence of a long-term loss-of-signal because flags FPSL and/or FSSL are equal to 0. Beacon Type 5 may be caused by bit streaming (i.e., the data received does not correspond to expected protocol). A Beacon Type 5 example includes the continuous transmission of fill by the C-Port and/or Station.

Beacon Type 5 (HMR only). The C-Port and/or Station *have* detected a Heart Beat failure. Beacon Type 5 may be caused by bit streaming (i.e., the data received does not correspond to expected protocol). A Beacon Type 5 example includes the continuous transmission of fill by the C-Port and/or Station.

9.1.10.2 Station Wire Fault Delay State (MS=SWFD)

The Station's Wire Fault Delay state is entered when the Station receives a Beacon MAC frame with SA=SUA, indicating it is upstream from the fault. This delay allows the Station enough time to detect a Wire Fault condition that may be the cause of C-Port's Beaconing before attempting to continue with Hard Error Recovery.

Upon entry into the Wire Fault Delay State, the Station causes its timers, TSIT and TSLMT, to be reset. When the timer TSIT expires and the Station has not detected a Wire Fault condition, the Station continues Hard Error Recovery by entry into its Internal Test State (MS=SIT). The timer TSLMT is used by the Station to start execution of its Lobe Test (JS=SLT).

9.1.10.3 Internal Test States (MS=SIT or MS=PIT)

The Station's Internal Test state (MS=SIT) is entered when the timer TSIT expires. The C-Port's Internal Test state (MS=PIT) is entered when the timer TPIT expires, or when the C-Port receives a Beacon MAC frame (SA=SUA) while in the Operational state (MS=POPT) or the Beacon Transmit state (MS=PTBN). Internal testing begins on entry into the MS=PIT or MS=SIT states.

The exact requirements of the C-Port and Station Internal Tests are not specified by this standard. However, it is recommended that the Station and C-Port entities test as much of their internal circuitry as possible, because the Station or C-Port has determined that a fault condition exists. This prevents the Hard Error Recovery function from providing incorrect fault information to Management entities.

The C-Port and Station Internal Test states operate as follows:

- a) If the C-Port or Station Internal Tests are unsuccessful, the failing entity removes itself from the TXI Lobe Connection and reports to its Management entity.

It is possible for the C-Port to remove from the TXI Lobe connection without the knowledge of the Station, or for the Station to remove from the TXI Lobe connection without the knowledge of the C-Port. In order to diagnose the cause of such a failure, an external agent must coordinate the error reports from the C-Port and Station. The definition of the external agent is outside the scope of this standard.

- b) If the C-Port and Station Internal Tests are successful, the Station and C-Port prepare their Join functions to execute the Station's LMT, as follows:

- 1) The Station waits for timer TSLMT to expire before causing the Station's Internal Test state to inform Join Machine to re-enter the Station's Lobe Test state (JS=SLT) by setting FSBNT to 1 (see 9.1.6.1).
- 2) When operating at any media rate and Phantom detection is supported, the C-Port waits for the loss of Phantom Drive (FPINSD=0) before enabling its Repeat Path (see 9.7.1) by setting FPRPT to 1, and informs its Join Machine to re-enter the C-Port's Lobe Test state (JS=PLT) by setting FPBNT to 1 (see 9.3.3.2).
- 3) When operating at the HMR and Phantom detection is not supported, the C-Port performs the following actions upon reception of a LMT Notification frame from the Station. It transmits a LMT Notification frame if its PMAC repeat path is being supported (FPRPTO=0). It informs its Join Machine to re-enter the C-Port's Lobe Test state (JS=PLT) by setting FPBNT to 1 (see 9.3.3.2).

9.1.11 TXI Soft Error Reporting

When a C-Port or Station detects a soft error condition (e.g., a FCS error), it increments the appropriate Error Counter (see 10.6). The expiration of TSER or TPER causes the value of the Error Counters to be reported using the Station's Error Report MAC frame or the C-Port's MRI. The Error Counters are reset after they have been reported. Persistent errors can be detected and isolated and, if required, the necessary action can be taken by Management.

9.1.12 TXI Configuration Control

As part of the function of maintaining the network configuration, the CRS can alter the configuration of the network by requesting DTR Stations or C-Ports to remove themselves from the network. The CRS can also query DTR Stations or C-Ports for various status information and can configure the DTR Station, and optionally the DTR C-Port, using the Change Parameters MAC frame.

9.1.13 DTR Service Interfaces

Subclauses 9.1.13.1 through 9.1.13.2 define the Service Interfaces supported by the Station's SMAC and the C-Port's PMAC.

9.1.13.1 TXI SMAC Service Interfaces

The LLC, Bridge, and Management interfaces are specified to provide the service required by other standards. These interfaces serve to specify operation and do not imply any particular implementation.

9.1.13.1.1 Service to LLC

Upon receipt of an MA_UNITDATA.request primitive from the local LLC entity, the SMAC shall compose a frame using the parameters supplied to create the FC, DA, SA, RI (if present), and INFO (user data) fields and calculate the FCS field. The RII bit shall be set to 1 if, and only if, routing information is present. The value of the YYY bits shall be either the value of the User_priority parameter (recommended) or optionally set to B'000'. The frame is then queued for transmission. If the Destination_address parameter matches the Station's individual address, one of the Station's group addresses, an active functional address, or one of the broadcast addresses, then an MA_UNITDATA.indication is made to the local LLC entity.

An MA_UNITDATA.indication is made to the local LLC entity when a valid LLC frame is received with a DA that matches any of the following:

- The Station's individual address;
- One of the Station's group addresses;

- An active functional address;
- One of the Station's broadcast addresses.

The value of the User_priority parameter shall be equal to the value of the YYY bits in the FC field.

9.1.13.1.2 Service to the Bridge

Upon receipt of an M_UNITDATA.request primitive from the local bridge entity, the SMAC shall compose a frame using the parameters supplied to create the FC, DA, SA, RI (if present), INFO (user data), and FCS fields. The RII bit shall be set to 1 if, and only if, the Routing Information Field is present. The Access_priority parameter is not used, and the User_priority parameter is encoded in the YYY bits of the FC field. If the FCS parameter is not specified, then the Station calculates the FCS value. The frame is then queued for transmission. If the Destination_address parameter matches the Station's individual address, one of the Station's group addresses, an active functional address, or one of the broadcast addresses, then an MA_UNITDATA.indication is made to the local LLC entity.

When a valid frame is received (independent of any address match), an M_UNITDATA.indication is made to the bridge entity. If the frame type is LLC, then the value for the User_priority parameter shall be the value of the YYY bits in the FC field; otherwise, the value for the User_priority parameter is unspecified.

9.1.13.1.3 Service to Management

Upon receipt of an MGT_UNITDATA.request primitive from the local management entity, the SMAC shall compose a MAC frame using the parameters supplied to create the FC, DA, SA, RI (if present), and INFO (vector) fields and calculate the FCS field. The RII bit shall be set to 1 if, and only if, the Routing Information Field is present. The frame is then queued for transmission.

If a valid MAC frame with a non-zero destination class is received with a DA that matches the Station's individual address, one of the group addresses, an active functional address, or one of the broadcast addresses, then an MGT_UNITDATA.indication is made to the local management entity.

9.1.13.2 PMAC Service Interfaces

The DTU and MRI interfaces are specified to provide the service required by the DTR Concentrator. These interfaces serve to specify operation and do not imply any particular implementation.

9.1.13.2.1 Service to the MRI

Upon receipt of an MRI_UNITDATA.request primitive from the MRI, the PMAC shall compose a MAC frame using the parameters supplied to create the FC, DA, SA, RI (if present), and INFO fields. The PMAC calculates the FCS field only if it is not present. The requested access priority (Pm) of the frame, defined only when the PMAC is operating the TKP Access Protocol, is specified as either 0, 3, or 7. The frame is then queued for transmission.

When a valid MAC frame is received (independent of any address match) where the destination class is neither 0 nor 3, then an MRI_UNITDATA.indication is made to the MRI.

9.1.13.2.2 Service to the DTU

Upon receipt of a DTU_UNITDATA.request primitive from the DTU, the PMAC shall compose a frame using the parameters supplied to create the FC, DA, SA, RI (if present), and INFO fields. The PMAC calculates the FCS field only if it is not present. The requested access priority (Pm) of the frame, defined only when the PMAC is operating the TKP Access Protocol, should be the greater of 4 or the User_priority, if the Frame_type parameter indicates user_data. The frame is then queued for transmission.

When a valid frame is received, independent of any address match, a DTU_UNITDATA.indication is made to the DTU. If the frame type is LLC, then the value for the User_priority parameter shall be the value of the YYY bits in the FC field; otherwise, the value of the User_priority parameter is unspecified.

During TXI Registration, when a valid Registration Request MAC frame is received, a DTU_DAC.request is made to the DTU. The Station_address parameter is the SA of the received frame. The Individual_address_count (IAC) parameter is the value of the IAC subvector from the received frame. Flag FPDTUREQ is set to 1, indicating there is an outstanding DTU_DAC.request that requires a response.

Upon receipt of a DTU_DAC.response primitive from the DTU, the PMAC shall store the result in SDAC_RC, and flag FPDTUREQ, which was set to 1 to indicate an outstanding DTU_DAC.request required a response, is set to 0. The SDAC_RC is used to compose an Insert Response MAC frame when the C-Port Join Port Operation Table is in the DAC state (JS=PDAC) in response to an Insert Request MAC frame.

9.1.14 HMR Trade-up Protocol

The HMR Trade-up protocol is used *only* by a Station that is registering to operate at 4 Mbit/s or 16 Mbit/s, but has been given permission to trade up to the HMR via the Policy flag FSHMRTUO (=1). During Registration, the Station indicates to the C-Port that it wants to use the TXI Access Protocol and that it is capable and, with permission, will support 100 Mbit/s (using the AP_REQ subvector value of X'0006').

If the C-Port *does not* support the HMR as requested by the Station, then the C-Port responds with a Registration Response MAC frame AP_RSP subvector value of X'0000' (registration failure) or X'0002' (registration complete). When the AP_RSP is X'0002', the C-Port and Station do not start the Trade-up function, but rather operate at the media speed originally requested by the Station. When the AP_RSP is X'0000', the Station will attempt another Registration Request, without indication that it can support 100 Mbit/s.

If the C-Port *does* support the HMR, then the C-Port responds with a Registration Response MAC frame AP_RSP subvector value of X'0004' (indicating the C-Port supports the HMR) and both the C-Port and Station start the Trade-up function.

9.1.14.1 Station support of the HMR Trade-up function

The Station, upon receipt of a Registration Response MAC frame with an AP_RSP subvector value of X'0004', starts the Trade-up function by entering the HMR Trade-up state (JS=SHMRTU), activating the HMR link speed, and resetting the timer TSHMRW.

If TSHMRW expires *before* the PS_STATUS.indication(Link_status=Asserted) signal occurs, then the HMR link failed to operate; the Station then enters the Bypass state (JS=BP) and provides management with an indication that the HMR request failed (an indication that the setting of the Policy flag FSHMRTUO needs to be changed by management).

If the PS_STATUS.indication(Link_status=Asserted) signal occurs *before* timer TSHMRW expires, then the C-Port and Station can operate at the HMR. The Station restarts the registration process at the HMR using the TXI Access Protocol.

9.1.14.2 C-Port support of the HMR Trade-up function

The C-Port, upon receipt of a Registration Request MAC frame with a AP_REQ subvector value of X'0006', determines whether it is able to support the HMR request.

If the C-Port *does not* support the HMR (FPHMRTUO=0), then the C-Port responds with a Registration Response MAC frame with an AP_RSP subvector value of X'0002', indicating that the C-Port and Station will continue to operate at the media speed originally requested by management.

If the C-Port *does* support the HMR (FPHMRTUO=1), then the C-Port responds with a Registration Response MAC frame with an AP_RSP subvector value of X'0004', indicating that the C-Port and Station will attempt operating at the HMR. The C-Port starts the Trade-up function by entering the HMR Trade-up state (JS=PHMRTU) and starting the assured delivery timer TPTUAD and the Trade-up timeout timer TPHMRW.

- If another Registration Request MAC frame is received by the C-Port from the Station *before* TPTUAD expires, then the C-Port transmits another Registration Request MAC frame.
- When TPTUAD expires, the C-Port activates the HMR link.
- If TPHMRW expires *before* the PS_STATUS.indication(Link_status=Asserted) signal occurs, then the HMR link failed to operate; the C-Port enters the Bypass state (JS=BP) and provides management with an indication that the HMR request failed (an indication that the setting of the Policy flag FPHMRTUO needs to be changed by management).
- If the PS_STATUS.indication(Link_status=Asserted) signal occurs *before* timer TPHMRW expires, then the C-Port and Station can operate at the HMR. The C-Port enters the Registration state and waits for the Station to request operation at the HMR using the TXI Access Protocol.

9.1.15 Remove Alert Protocol (TXI Access Protocol at the HMR only)

The Remove Alert function allows either the C-Port to inform the Station or the Station to inform the C-Port that an unexpected condition has been detected forcing its entry into the Bypass state. The intention of the Remove Alert function is to allow local management (either C-Port or Station) to understand that the entity on the other end of the link has stopped participating in the TXI Access Protocol and prevent false error conditions from being reported.

The following explains when the Remove Alert function is required, the actions taken when the Remove Alert function is executed, and the actions taken when the Remove Alert MAC frame is received.

- a) The following events shall execute the Remove Alert function:
 - 1) When the C-Port or Station have completed Join (FPJC=1 and FSJC=1 respectively) *and* are in their Lobe Test, DAC, or Join Complete states and
 - i) The Station detects a Disconnect.SMAC;
 - ii) The C-Port detects a Disconnect.PMAC; or
 - iii) The Station receives a Remove MAC frame.
 - 2) When the C-Port or Station have completed Join (FPJC=1 and FSJC=1 respectively) *and* are in the Join Complete state and
 - i) The C-Port detects the expiration of its timer TPPLD (failure to detect the expected Phantom loss or the reception of the LMT Notification MAC frame in the appropriate time);
 - ii) The C-Port detects the expiration of its timer TPPD (failure to detect the expected Phantom presence in the appropriate time); or
 - iii) The Station detects a Wire Fault condition.
 - 3) When the Station detects a LMT failure and the Station has completed Join (FSJC=1) *and* is in the Lobe Test state.
- b) The following actions shall occur when the Remove Alert function is executed:
 - 1) If the Station or C-Port is in the Join Complete state, the operational flag (FPOP or FSOP) is set to 0 to prevent transmission of upper layer frames.

- 2) In the Station, if phantom is asserted, then de-assert phantom.
- 3) The Remove Alert Transmit counter (CPRAT or CSRAT) is set to its initial value and the Remove Alert Pacing timer (TPRAP or TSRAP) is reset.
- 4) The Remove Alert MAC frame is transmitted.
- 5) The Remove Alert Wait state is entered (JS=PRAW or JS=SRAW) to disable all Join functions except the Remove Alert function. The following actions occur while in the Remove Alert Wait state:
 - i) Upon expiration of the Remove Alert Pacing timer and when the Remove Alert Transmit counter is *non-zero*, the Remove Alert counter is decremented, the Remove Alert Pacing timer is reset, and the Remove Alert MAC frame is transmitted. The C-Port or Station remain in their respective Remove Alert Wait states waiting for expiration of the Remove Alert Pacing timer.
 - ii) Upon expiration of the Remove Alert Pacing timer and when the Remove Alert Transmit counter is *zero*, the C-Port or Station enter their respective Bypass states.
- c) The Remove Alert MAC frame shall be recognized as follows:

The Remove Alert MAC frame causes entry into the Bypass state whenever the C-Port or Station have completed Join (FPJC=1 and FSJC=1 respectively) *and* are in their Lobe Test, DAC, or Join Complete states.

9.1.16 C-Port in Port Mode using the TKP Access Protocol (4 Mbit/s and 16 Mbit/s)

This subclause identifies the changes required in 4.3 to support the C-Port in Port Mode using the TKP Access Protocol [Configuration 3, entity (E)] to provide for the attachment of the following:

- The Classic Station [Configuration 3, entity (F)].
- The DTR Station using the TKP Access Protocol [Configuration 3, entity (F)].
- The C-Port in Station Emulation Mode using the TKP Access Protocol [Configuration 3, entity (F)].

These changes are specified in 9.4 and summarized as follows:

- a) In the TKP Access Protocol, the Station's Beacon Test state (MS=BNT) normally indicates the Station should perform Hard Error Recovery. The C-Port is not allowed to execute the Beacon Test function, but in its place provides a repeat path to allow the attached Station to perform its Beacon Test function.
- b) Soft Error conditions cause the C-Port to report these errors to the MRI.
- c) The detection of the interface signal PM_STATUS.indication(INSERT=DETECTED) is the equivalent of the ANSI/IEEE Std 802.5, 1998 Edition, Beacon Test "TEST_OK" condition. This signal allows the C-Port in Port Mode using the TKP Access Protocol to return to the state causing entry into the Beacon Test state (MS=BNT) [either the Repeat Beacon state (MS=RBN) or the Transmit Beacon state (MS=TBN)].
- d) The detection of the attached Station's failure to return to its Repeat Beacon state (MS=RBN) or the Transmit Beacon state (MS=TBN) indicating the Station has failed either its internal tests or LMT.

9.1.17 C-Port in Station Emulation Mode using the TKP Access Protocol (4 Mbit/s and 16 Mbit/s)

This subclause identifies the changes required in 4.3 to support the C-Port in Station Emulation Mode using the TKP Access Protocol [Configuration 4, entity (G)]. These changes allow the following attachments:

- The Classic Concentrator [Configuration 4, entity (H)].
- The C-Port in Port Mode using the TKP Access Protocol [Configuration 4, entity (H)].

These changes are specified in 9.5 and summarized as follows:

- The queuing transmission of frames with an unknown length (FR_LTH=UNK) is supported by adding a check which prevents the Transmit Data state (TS=DATA) from transmitting frames longer than allowed by PPV(MAX_TX).
- The handling of Soft Error conditions is augmented by causing the C-Port in DTR Station Emulation Mode to report these errors to the MRI.

9.1.18 DTR Station using the TKP Access Protocol (4 Mbit/s and 16 Mbit/s)

A DTR Station using the TKP Access Protocol [Configuration 3, entity (F)] is defined by reference to Clause 3 and Clause 4, and modified by 9.6. In summary, when the DTR Station elects to use the TKP Access Protocol, the DTR Station transitions are specified in 9.6. These transitions are identical to the Classic Station, except for the addition of the Registration Query Protocol. The Registration Query protocol allows the C-Port to invite the DTR Station to change to the TXI Access Protocol if supported.

Replace 9.2 with the following:

9.2 Station TXI Access Protocol specification

This subclause defines the TXI Access Protocol as follows:

- The DTR Station (FIPTXIS=0) in support of Configuration 1, entity (B).
- The DTR C-Port in the Station Emulation Mode (FIPTXIS=1) in support of Configuration 2, entity (C).

The decision as to which configuration is being supported is made as follows:

- The DTR Station's Join Station Operation Table (Table 9.2-1 in this subclause); or
- The DTR C-Port's Join Port Operation Table (Table 9.3-1 in 9.3).

For ease of reading, the DTR Station and the DTR C-Port in the Station Emulation Mode are referred to as the "Station" in the explanatory portion of this subclause.

Seven Station Operation Tables specify Station support of the TXI Access Protocol as follows:

- Station Join Station Operation Table 9.2-1;
- Station Transmit Station Operation Table 9.2-2;
- Station Monitor Station Operation Table 9.2-3;
- Station Error Handling Station Operation Table 9.2-4;
- Station Interface Signals Station Operation Table 9.2-5;
- Station Miscellaneous Frame Handling Station Operation Table 9.2-6;
- Station LMT when FSLMTO=1 Station Operation Table 9.2-7.

Low-Level FSMs representing the state changes in the Join, Transmit, and Monitor Station Operation Tables are presented in Annex L.

In case of a discrepancy between the Station Operation Tables, the FSM diagrams, or their supporting text, the Station Operation Tables shall take precedence.

9.2.1 FSM overviews

This subclause provides a functional overview of the Join, Transmit, and Monitor Station Operation Tables using three high-level FSM diagrams.

9.2.1.1 Station Join FSM overview

The Station Join FSM, shown in Figure 9.2-1, is used to join the Station in the TXI Access Protocol to the C-Port. Station Operation Table 9.2-1 specifies the Join FSM.

The Station Join FSM enters the Registration state (JA) from one of the following:

- The Bypass state (J0) as the result of this subclause detecting a Connect.SMAC to start the Station's TXI Access Protocol;
- The Bypass state (J0) as the result of 9.3 entering the C-Port in Station Emulation Mode using the TXI Access Protocol; or
- The Registration Wait state (J9) as the result of the 9.5 or 9.6 Station Operation Tables using the TKP Access Protocol responding to a Registration Query request from the C-Port.

The activation of the TXI Access Protocol is the result of the Registration Process and uses the Station Operation Tables specified in this subclause.

The TKP Access Protocol is activated as the result of the Registration Process as follows:

- For the DTR Station, via an exit to the 9.6 Station Operation Tables;
- For the C-Port in Station Emulation Mode, via an exit to the 9.5 Port Operation Tables.