



ISO/IEC 14165-243

Edition 1.0 2012-12

INTERNATIONAL STANDARD

**Information technology – Fibre channel –
Part 243: Fibre channel backbone-3 (FC-BB-3)**



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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE **XB**

ICS 35.200

ISBN 978-2-83220-542-6

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CONTENTS

FOREWORD	7
INTRODUCTION	8
1 Scope	9
2 Normative references	12
3 Terms, definitions and conventions	14
3.1 Terms and definitions	14
3.2 FC-BB-3_ATM definitions	17
3.3 FC-BB-3_SONET definitions	19
3.4 FC-BB-3_IP definitions	22
3.5 FC-BB-3_GFPT definitions	24
3.6 Editorial conventions	26
3.7 List of commonly used acronyms and abbreviations	27
3.7.1 General	27
3.7.2 FC-BB-3_ATM	28
3.7.3 FC-BB-3_SONET	28
3.7.4 FC-BB-3_IP	28
3.7.5 FC-BB-3_GFPT	28
3.8 Symbols	29
3.9 Keywords	29
4 FC-BB-3 structure and concepts	31
4.1 FC-BB-3 backbone mappings	31
4.2 FC-BB-3 reference models	31
4.3 FC-BB-3 models overview	33
4.3.1 FC-BB-3_ATM	33
4.3.2 FC-BB-3_SONET	34
4.3.3 FC-BB-3_IP	34
4.3.4 FC-BB-3_GFPT	34
4.4 FC-BB-3 requirements	35
4.4.1 Fibre Channel Class support	35
4.4.2 Payload transparency	35
4.4.3 Latency delay and timeout value	35
4.4.4 QoS and bandwidth	36
4.4.5 In-order delivery	36
4.4.6 Flow control	36
4.5 FC-BB-3 SW_ILS codes	36
5 FC-BB-3_ATM and FC-BB-3_SONET Messages and Formats	38
5.1 General	38
5.2 LLC/SNAP header format	38
5.3 BBW_Header format	38
5.4 BBW message payload format for SFC	39
5.5 BBW message payload format for SR	40
5.5.1 General	40
5.5.2 SR_Header formats	40
5.5.3 SR_BBW messages	41
5.5.4 Format field parameters	42
5.5.5 SR commands and responses	43
5.5.6 Exception condition reporting and recovery	47
6 SR and SFC Protocol Procedures	49
6.1 Applicability	49
6.2 SR protocol overview	49

6.3 Description of the SR procedure	50
6.3.1 SR mode of operation	50
6.3.2 SR procedure for addressing	50
6.3.3 SR procedure for the use of the P/F bit	50
6.3.4 SR procedure for data link set-up and disconnection	50
6.3.5 Procedures for information transfer using multi-selective reject	52
6.3.6 SR conditions for data link resetting or data link re-initialization	56
6.3.7 SR procedures for data link resetting	57
6.3.8 List of SR system parameters	58
6.4 Simple Flow Control (SFC)	59
7 FC-BB-3_ATM Structure and Concepts	60
7.1 Applicability	60
7.2 FC-BB-3_ATM overview	60
7.3 FC-BB-3_ATM B_Access functional model	61
7.3.1 Protocol layers	61
7.3.2 B_Port FC interface	61
7.3.3 ATM network interface	61
7.3.4 FC-BB-3_ATM protocol interface	62
7.3.5 B_Access Virtual ISL exchanges – Exchange B_Access Parameters (EBP) SW_ILS	67
7.3.6 B_Access initialization state machine	69
7.4 FC-BB-3_ATM network topologies	72
7.5 Mapping and message encapsulation using AAL5	73
7.5.1 Overview	73
7.5.2 Mapping BBW messages to AAL5	73
7.6 FC-BB-3_ATM service considerations	76
7.6.1 ATM service type	76
7.6.2 Latency delay and timeout value	77
7.6.3 Bandwidth sharing and allocation	77
7.6.4 Quality of Service (QoS)	77
7.6.5 Delivery Order	78
7.6.6 Loss and Flow Control	78
8 FC-BB-3_SONET Structure and Concepts	79
8.1 Applicability and related clauses	79
8.2 FC-BB-3_SONET overview	79
8.3 FC-BB-3_SONET functional model	80
8.3.1 Fibre Channel network interface	80
8.3.2 SONET network interface	81
8.3.3 Mapping and encapsulation	82
8.3.4 FC-BB-3_SONET forwarding	82
8.3.5 Call handling	82
8.3.6 Frame handling	82
8.4 Mapping and Message encapsulation using HDLC-like framing	82
8.4.1 Overview	82
8.4.2 Mapping of BBW messages to HDLC format	82
8.4.3 Mapping HDLC frames to SONET/SDH	84
8.5 FC-BB-3_SONET service considerations	87
8.5.1 Latency delay and timeout value	87
8.5.2 Delivery order	88
8.5.3 Loss and flow control	88
9 FC-BB-3_IP Structure and Concepts	89
9.1 Applicability	89
9.2 FC-BB-3_IP overview	89
9.3 VE_Port functional model	90
9.3.1 FC-BB-3_IP interface protocol layers	90
9.3.2 E_Port/F_Port FC interface	90

9.3.3 FC Switching Element (SE) with FC routing	90
9.3.4 FC-BB-3_IP protocol interface	90
9.3.5 IP network interface	96
9.4 B_Access functional model	96
9.4.1 FC-BB-3_IP interface protocol layers	96
9.4.2 B_Port FC interface	96
9.4.3 FC-BB-3_IP protocol interface	97
9.4.4 IP Network Interface	102
9.5 FC-BB-3_IP Network Topologies	102
9.6 Mapping and message encapsulation using TCP/IP	103
9.6.1 Encapsulated frame structures	103
9.6.2 TCP/IP encapsulation	106
9.7 FC-BB-3_IP Protocol Procedures	106
9.7.1 Overview	106
9.7.2 Procedures for platform management	106
9.7.3 Procedures for connection management	108
9.7.4 Procedures for error detection recovery	110
9.7.5 FC-BB-3_IP system parameters	111
9.8 FC-BB-3_IP service considerations	111
9.8.1 Latency delay	111
9.8.2 Throughput	111
9.8.3 Reliability	112
9.8.4 Quality of Service (QoS)	113
9.8.5 Delivery order	113
9.8.6 IP multicast and broadcast	114
9.8.7 Security and authentication	114
10 FC-BB-3_GFPT Structure and Concepts	115
10.1 Applicability	115
10.2 FC-BB-3_GFPT overview	115
10.3 FC-BB-3_GFPT functional model	116
10.3.1 FC-BB-3_GFPT initialization	116
10.3.2 FC-BB-3_GFPT initialization state machine	116
10.3.3 Login Exchange Monitors	120
10.3.4 Port initialization parameter observation and modification	123
10.3.5 Handling of BB_SCs, BB_SCr, and R_RDY Primitive Signals and BB_Credit initialization	123
10.3.6 FC-BB-3_GFPT flow control and WAN Primitive Signals	124
10.3.7 Overview	124
10.3.8 Adaptation of FC information for GFPT transport in FC-BB-3_GFPT	126
10.3.9 WAN Holdoff Timeout Value (WAN_HOLDOFF_TOV)	127
Annex A (normative) – Encoded SOF and EOF Ordered Sets	128
Annex B (informative) –ATM Traffic Management and Signaling	131
Annex C (informative) – SR Protocol Parameter Guidelines and State Diagram	141
Annex D (informative) – FC-BB-3_GFPT interoperability guidelines and GFPT-specific interoperability guidelines	144
BIBLIOGRAPHY	145

Figure 1 – Scope and components of FC-BB-3_ATM/SONET models	10
Figure 2 – Scope and components of FC-BB-3_IP model	10
Figure 3 – Scope and components of FC-BB-3_GFPT model	11
Figure 4 – FC-BB-3_ATM reference model	32
Figure 5 – FC-BB-3_SONET reference model	32
Figure 6 – FC-BB-3_IP reference model	33
Figure 7 – FC-BB-3_GFPT reference model	33
Figure 8 – SR flow control protocol between two BBWs	49
Figure 9 – FC-BB-3_ATM network configuration	60
Figure 10 – FC-BB-3_ATM protocol layers	63
Figure 11 – FC-BB-3_ATM B_Access functional model	66
Figure 12 – FCATM_LEP and FCATM_DE	67
Figure 13 – Scope of B_Access Virtual ISL	67
Figure 14 – B_Access initialization state machine	70
Figure 15 – FC-BB-3_ATM network topologies	72
Figure 16 – AAL5 Mapping of a BBW message with SFC	75
Figure 17 – AAL5 Mapping of a BBW message with SR	76
Figure 18 – Recommended ATM bandwidth allocation for multiple VCs	77
Figure 19 – FC-BB-3_SONET network configuration	79
Figure 20 – FC-BB-3_SONET functional block diagram	81
Figure 21 – SONET SPE HDLC mapping example	85
Figure 22 – Path signal label: C2	85
Figure 23 – Encapsulation of BBW message into HDLC frame using SFC	86
Figure 24 – Encapsulation of BBW message into HDLC frame using SR	87
Figure 25 – FC-BB-3_IP network configuration	89
Figure 26 – FC-BB-3_IP VE_Port functional model	91
Figure 27 – FC-BB-3_IP Protocol Layers	92
Figure 28 – Scope of VE_Port Virtual ISL	94
Figure 29 – Security layers	95
Figure 30 – FC-BB-3_IP B_Access functional model	98
Figure 31 – Scope of B_Access Virtual ISL	99
Figure 32 – B_Access initialization state machine	101
Figure 33 – FC-BB-3_IP network topologies	103
Figure 34 – TCP/IP encapsulation of an encapsulated FC frame	106
Figure 35 – FC-BB-3_GFPT protocol levels and layers	115
Figure 36 – FC-BB-3_GFPT initialization state machine	117
Figure 37 – Example port initialization process	124
Figure B.1 – Cell Transfer Delay distribution	133
Figure B.2 – SVC signaling at the UNI and Switched payload	140
Figure C.1 – SR protocol state diagram	142

Table 1 – FC-BB-3 Organization	9
Table 2 – ISO and American Conventions	27
Table 3 – Models and resident FC_Port types	31
Table 4 – FC-BB-3 SW_ILS codes	37
Table 5 – FC-BB-3 ELS codes	37
Table 6 – BBW message structure	38
Table 7 – LLC/SNAP header	38
Table 8 – BBW_Header	38
Table 9 – Flow control protocol type encodings	39
Table 10 – BBW message payload structure for SFC	39
Table 11 – BBW message payload structure for SR	40
Table 12 – SR_Header format	40
Table 13 – SS bits encoding	41
Table 14 – MMMMM bit encoding	41
Table 15 – SR_BBW messages	42
Table 16 – SR_I message format	44
Table 17 – SR_SREJ payload format example	45
Table 18 – SR_FRMR payload format	47
Table 19 – EBP request payload	68
Table 20 – EBP accept payload	69
Table 21 – EBP reject reason code explanation	69
Table 22 – Mapping of BBW messages to AAL5 CPCS	74
Table 23 – ATM VBR-NRT service specification	78
Table 24 – SONET/SDH data rates	81
Table 25 – Mapping of BBW messages to HDLC format	83
Table 26 – FC-BB-3_SONET protocol ptask	85
Table 27 – EBP request payload	99
Table 28 – EBP accept payload	100
Table 29 – EBP reject reason code explanation	100
Table 30 – TCP/IP Segment structure carrying encapsulated FC frame	104
Table 31 – Encapsulated FC frame structure	104
Table 32 – TCP/IP Segment structure carrying encapsulated FSF	105
Table 33 – Encapsulated FSF structure	105
Table 34 – ASF request payload	108
Table 35 – ASF accept response payload	108
Table 36 – FC-BB-3_GFPT initialization state machine keywords	116
Table 37 – Login Exchange Monitor (LEM) state machine	122
Table 38 – Values of FC-BB-3_GFPT ASFC_PAUSE and ASFC_RESUME Primitive Signals	125
Table 39 – Values of FC-BB-3_GFPT PING and PING_ACK Primitive Signals.	126
Table A.1 – Byte-encoded Frame delimiter format	128
Table A.3 – FC-BB-3 SOF Codes	129
Table A.2 – DS-Code Definition	129
Table A.4 – FC-BB-3 EOF Codes	130
Table B.1 – I.356 defined QoS parameters for different Traffic Classes	134
Table B.2 – Service Categories and its Traffic and QoS Attributes	136
Table B.3 – ATM service categories and guarantees	138

**INFORMATION TECHNOLOGY –
FIBRE CHANNEL –
Part 243: Fibre channel backbone-3 (FC-BB-3)**

FOREWORD

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This International Standard has been approved by vote of the member bodies and the voting results may be obtained from the address given on the second title page.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

INTRODUCTION

This International Standard specifies mechanisms that allow extension of Fibre Channel links and/or switched networks across Wide Area Networks. FC-BB-3 defines four distinct Fibre Channel backbone mappings: FC over ATM, FC over SONET, FC over TCP/IP, and FC over GFPT.

INFORMATION TECHNOLOGY – FIBRE CHANNEL – Part 243: Fibre channel backbone-3 (FC-BB-3)

1 Scope

This part of ISO/IEC 14165-243 consists of four distinct Fibre Channel mappings resulting in the following four models:

- FC-BB-3_ATM (FC over ATM backbone network)
- FC-BB-3_SONET (FC over SONET backbone network)
- FC-BB-3_IP (FC over TCP/IP backbone network)
- FC-BB-3_GFPT (FC over SONET/SDH/OTN/PDH backbone network using GFPT adaptation)

Figure 1, figure 2, and figure 3 illustrate the scope and the major components of the FC-BB-3 models and its relationship to the FCIP standard and the ATM Forum/ITU-T standards. Table 1 shows the organization of this standard. FC-BB-3_IP, FC-BB-3_ATM, FC-BB-3_SONET, and FC-BB-3_GFPT do not interoperate in any way and are independent models.

Table 1 – FC-BB-3 Organization

Model type	Applicable Clauses and Annexes
FC-BB-3_ATM, FC-BB-3_SONET, FC-BB-3_IP, FC-BB-3_GFPT	1-4
FC-BB-3_ATM, FC-BB-3_SONET	5, 6
FC-BB-3_ATM	7, Annexes A, B, C
FC-BB-3_SONET	8, Annexes A, C
FC-BB-3_IP	9, Annex A
FC-BB-3_GFPT	10

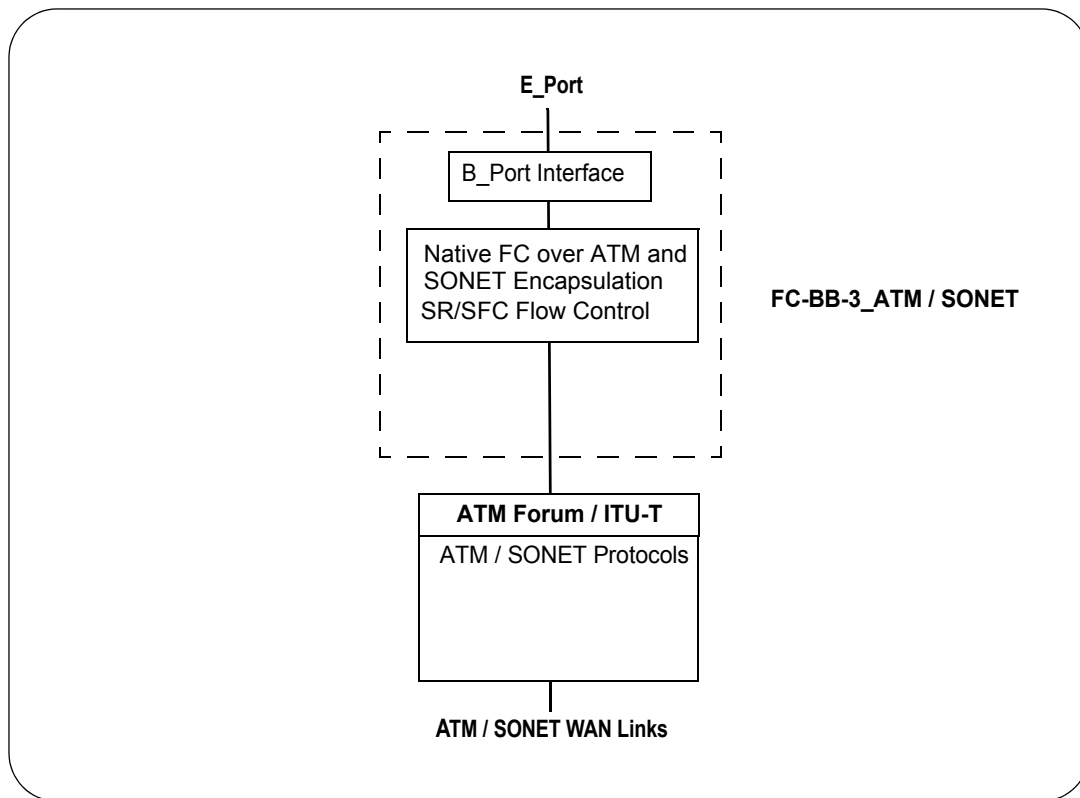


Figure 1 – Scope and components of FC-BB-3_ATM/SONET models

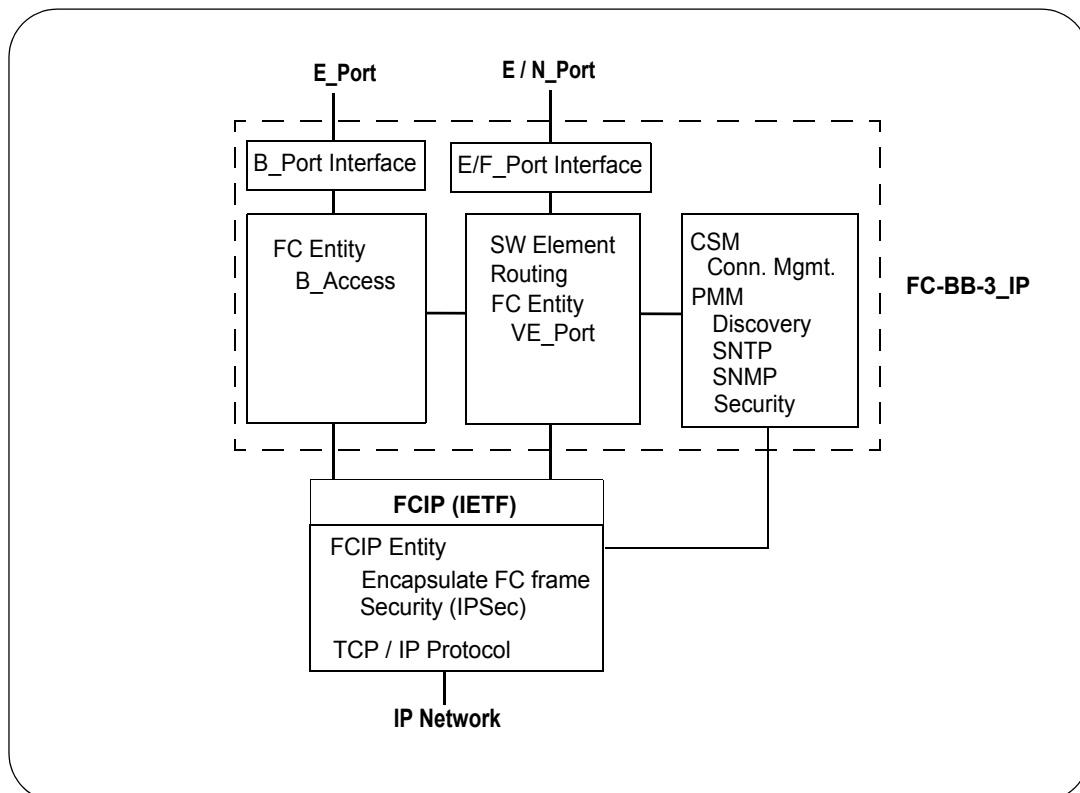


Figure 2 – Scope and components of FC-BB-3_IP model

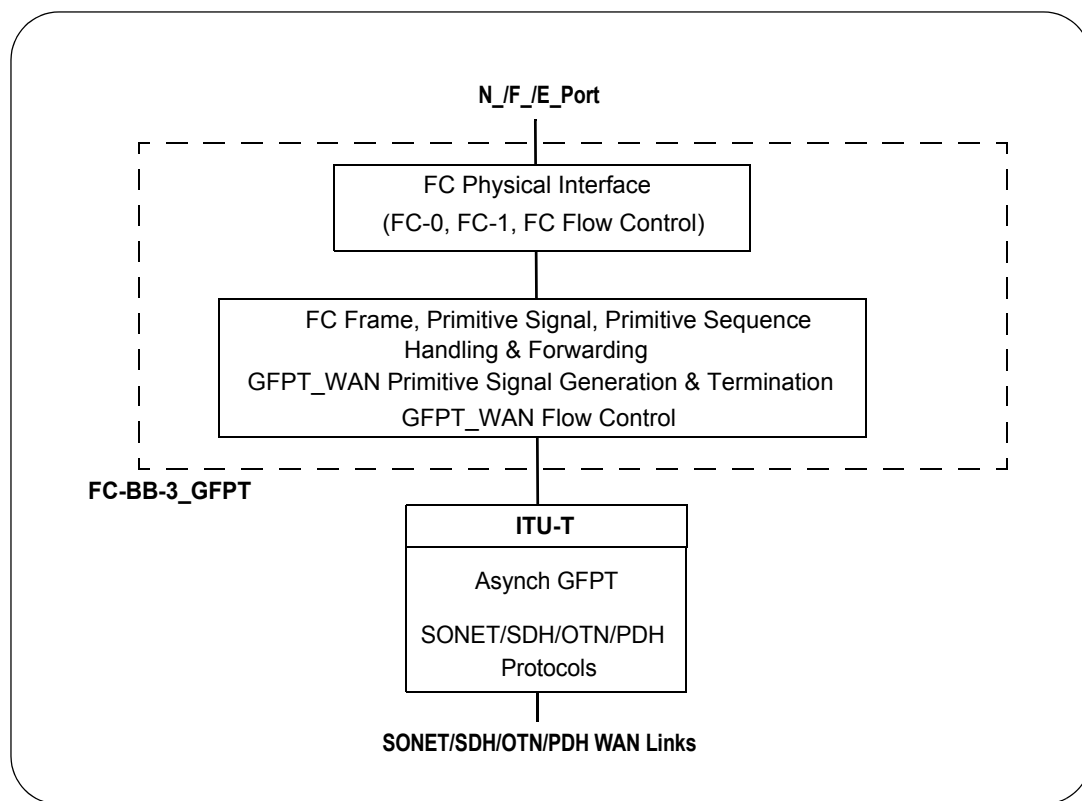


Figure 3 – Scope and components of FC-BB-3_GFPT model

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document, including any amendments, applies.

ISO/IEC 3309:1993, *Information technology - Telecommunications and information exchange between systems - High-level Data Link Control (HDLC) Procedures - Frame structure* (withdrawn)

ISO/IEC 13239:1997(E), *Information technology - Telecommunications and information exchange between systems - High-level data link control (HDLC) procedures*

INCITS 426-2007, *Information technology - Fibre Channel Security Protocols (FC-SP)*¹
(planned as ISO/IEC 14165-431)

ANSI T1.105-2001, *Synchronous Optical Network (SONET) - Basic Description Including Multiplex Structures, Rates, and Formats*

For electronic copies of references under development by INCITS T11, see www.t11.org

INCITS 418-2006, *Fibre Channel - Switch Fabric - 4 (FC-SW-4)*

INCITS 424-2007, *Fibre Channel - Framing and Signaling -2 (FC-FS-2)*

INCITS 433-2007, *Fibre Channel - Link Services (FC-LS)*

Copies of the following approved ITU-T standards may be obtained through the ITU-T Publications department at <http://www.itu.int>

ITU-T Rec. I.356 (2000), *B-ISDN ATM layer cell transfer performance*

ITU-T Rec. I.363.5 (1996), *B-ISDN ATM Adaptation Layer specification: Type 5 AAL*

ITU-T X.25-1997, *Interface between Data terminal Equipment (DTE) and Data Circuit-terminating Equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit, X.25-1997*

ITU-T Q.2931 (1995), *Broadband Integrated Services Digital Network (B-ISDN) Digital Subscriber Signaling System No. 2 (DSS2); User-Network Interface (UNI) Layer 3 Specification for Basic Call/Connection Control*

ITU-T Q.2971 (1995), *Broadband Integrated Services Digital Network (B-ISDN) Digital Subscriber Signaling System No. 2 (DSS2); User-Network Interface (UNI) Layer 3 Specification for Point-to-Multipoint Call/Connection Control*

ITU-T Rec. G.707/Y.1322, *Network/Node Interface for the Synchronous Digital Hierarchy (SDH)*, 2003

ITU-T Rec. G.709/Y.1331, *Interfaces for the Optical Transport Network (OTN)*, 2004

ITU-T Rec. G.7041/Y.1303, (2003), *Generic Framing Procedure (GFP)*

ITU-T Rec. G.7042/Y.1305 (2004), *Link capacity adjustment scheme (LCAS) for virtual concatenated signals*

ITU-T Rec. G.7043/Y.1343 (2004) *Virtual concatenation of PDH signals*

ITU-T Rec. G.783, (2000), *Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks*

ITU-T Rec. G.798, (2002), *Characteristics of optical transport network hierarchy equipment functional blocks*

ITU-T Rec. G.8040/Y.1340, (2003), *GFP Frame Mapping into Plesiochronous Digital Hierarchy (PDH)*

ITU-T Rec. G.806, *Characteristics of Transport Equipment - Description Methodology and Generic Functionality*

Copies of the following approved IETF standards may be obtained through the Internet Engineering Task Force (IETF) at www.ietf.org.

RFC 1619, *PPP over SONET/SDH*, May 1994

1. T11/Project 1570D/Rev. 1.6

RFC 1661, *The Point-to-Point Protocol (PPP)*, July 1994

RFC 1662, *PPP in HDLC-like Framing*, July 1994

RFC 2030, *Simple Network Time Protocol (SNTP) Version 4 for IPv4, IPv6 and OSI*, October 1996

RFC 3643, *Fibre Channel (FC) Frame Encapsulation*, December 2004

RFC 3821, *Fibre Channel Over TCP/IP (FCIP)*, July 2004

RFC 3822, *Finding Fibre Channel over TCP/IP (FCIP) Entities Using Service Location Protocol version 2 (SLPv2)*, July 2004

Copies of the following approved ATM Forum standards may be obtained through the MFA Forum at http://www.mfaforum.org/tech/atm_specs.shtml

ATM Forum (1996), *Traffic Management Specification 4.0*. AF-TM-0056.000

3 Terms, definitions and conventions

3.1 Terms and definitions

For the purposes of this document the following terms and definitions apply.

3.1.1

BBW

refers to either an FC-BB-3_ATM or an FC-BB-3_SONET device

3.1.2

B_Port

Bridge Port on a device that implements FC-BB-3_ATM, FC-BB-3_SONET or FC-BB-3_IP, and connects to an E_Port on an FC switch

3.1.3

B_Port_Name

name_Identifier (see 3.1.20) that identifies a B_Port (see 3.1.2) for identification purposes

Note 1 to entry: The format of the name is specified in FC-SW-4.

3.1.4

BSW

generic term for a backbone switch

Note 1 to entry: See FC-SW-4.

3.1.5

codeword

sequence of bits of a code corresponding to a symbol

3.1.6

E_Por

Fabric expansion port that attaches to another E_Port to create an Inter-Switch Link

Note 1 to entry: See FC-SW-4.

3.1.7

E_Port_Name

Name_Identifier (see 3.1.20) that identifies an E_Port (see 3.1.6)

3.1.8

Fabric_Name

Name_Identifier (see 3.1.20) associated with a Fabric

Note 1 to entry: See FC-SW-4.

3.1.9

F_Port

port by which non-loop N_Ports are attached to a Fabric

Note 1 to entry: This port does not include FL_Ports.

Note 2 to entry: See FC-SW-4 and FC-FS-2.

3.1.10

F_Port_Name

Name_Identifier (see 3.1.20) that identifies an F_Port (see 3.1.9)

3.1.11**Fabric Initialization**

process for configuring and building a Fabric

Note 1 to entry: See FC-SW-4.

3.1.12**FC-BB-3_ATM**

model defining equipment that interfaces with a Fibre Channel switched network on one side and an ATM network on the other side

3.1.13**FC-BB-3_GFPT**

equipment model defining gateway functionality for the interconnection of two non-Arbitrated Loop FC physical ports across a GFPT WAN infrastructure

EXAMPLE SONET, SDH, OTN, PDH

Note 1 to entry: Supports both arbitrary-rate WAN transport and distance extension of buffer-to-buffer flow control.

3.1.14**FC-BB-3_IP**

model defining equipment that interfaces with a Fibre Channel switched network on one side and an IP network on the other side

3.1.15**FC-BB-3_SONET**

model defining equipment that interfaces with a Fibre Channel switched network on one side and a SONET/SDH network on the other side

3.1.16**FC_Port**

port generating/terminating and/or forwarding FC frames, and generating/terminating FC Primitive Signals and Primitive Sequences

Note 1 to entry: FC_Ports include N_Ports, F_Ports, E_Ports, B_Ports, VE_Ports, and B_Access.

3.1.17**Fibre Channel Backbone link**

Transport Trail or equivalent network channel connection used for communications between two FC-BB-3 devices

Note 1 to entry: This encompasses FC-BBW_ATM, FC-BBW_SONET, FC-BB-3_IP, and GFPT_WAN links.

Note 2 to entry: Note that a Fibre Channel Backbone link may, in some cases, be comprised of more than one physical or logical connection.

3.1.18**Generic Framing Procedure****GFP**

procedure for adaptation of data (i.e., PDUs or 8B/10B encoded characters) to octet-synchronous (i.e., SONET, SDH, OTN) and bit-synchronous (i.e., PDH) Wide Area Network transport infrastructures, specified by ITU-T

Note 1 to entry: Wide Area Network transport infrastructures is specified by ITU-T.

Note 2 to entry: See ITU-T Rec. G.7041/Y.1303.

3.1.19

keep alive timeout value

K_A_TOV

timer that is used by the Link Keep Alive (LKA) ELS as a trigger for issuing LKA

Note 1 to entry: For LKA ELS see FC-LS.

3.1.20

Name_Identifier

64-bit identifier, with a 60-bit value preceded with a 4-bit Network_Address_Authority Identifier, used to identify entities in Fibre Channel (e.g., N_Port, node, F_Port, or Fabric) (see FC-FS-2)

3.1.21

Node_Name

Name_Identifier (see 3.1.20) associated with a node (see FC-FS-2)

3.1.22

N_Port

device port that generates/terminates FC-4 channel traffic

3.1.23

N_Port_Name

name_Identifier (see 3.1.20) that identifies an N_Port (see 3.1.22)

3.1.24

Ordered Set

See FC-FS-2.

3.1.25

outstanding poll condition

condition where the BBW has sent a command message with the P bit (see 5.5.4.7) set to one and has not yet received a response message with the F bit (see 5.5.4.7) set to one (see 6.3.5)

3.1.26

Simple Flow Control

SFC

flow control protocol that may be applied between two FC-BB-3_ATM or FC-BB-3_SONET devices across a ATM/SONET WAN

3.1.27

Selective Retransmission flow control

SR flow control

sliding window flow control protocol that may be applied between two FC-BB-3_ATM or FC-BB-3_SONET devices across a ATM/SONET WAN

Note 1 to entry: SR flow control provides for both flow control and error recovery.

3.1.28

Switch_Name

Name_Identifier (see 3.1.20) that identifies a Switch or a Bridge device

Note 1 to entry: The format of the name is specified in FC-FS-2. Each Switch and Bridge device shall provide a unique Switch_Name within the Fabric.

3.1.29

WAN interface

interface that connects to a Wide Area Network

Note 1 to entry: A WAN interface may be physical (e.g., ATM, SONET) or logical (e.g., GFPT_WAN).

3.2 FC-BB-3_ATM definitions

3.2.1

AAL

ATM Adaptation Layer

collection of standardized protocols that adapt user traffic to 48-octet payloads that may be placed in a cell-formatted stream

Note 1 to entry: The AAL is subdivided into the Convergence Sublayer (CS) and the Segmentation and Reassembly (SAR) sublayer. There are currently four types of AALs (i.e., AAL1, AAL2, AAL3/4, and AAL5) to support the various service categories.

3.2.2

AAL Service Categories

the ATM Forum has defined five Traffic Service Categories supported by the AALs: Constant Bit Rate (CBR), Variable Bit Rate-Real Time (VBR-RT), Variable Bit Rate-Non Real Time (VBR-NRT), Available Bit Rate (ABR), and Unspecified Bit Rate (UBR)

3.2.3

AAL Type 5

AAL5

protocol standard that is used in FC-BB-3_ATM

Note 1 to entry: AAL5 was originally intended for variable bit rate traffic not requiring source-destination timing relation.

Note 2 to entry: AAL5 is now also used with applications that have constant bit rate traffic where source-destination timing relation is important.

3.2.4

ATM

Asynchronous Transfer Mode

Note 1 to entry: Broadband-ISDN standards defined by ITU-T and the ATM Forum.

3.2.5

ATM QoS parameters

set of performance characteristics of the contracted ATM connection

Note 1 to entry: Six ATM QoS parameters are currently defined: Peak-to-peak Cell Delay Variation (CDV), Maximum Cell Transfer Delay (maxCTD), Cell Loss Ratio (CLR), Cell Error Ratio (CER), Severely Errored Cell Block Ratio (SECBR), and Cell Misinsertion Rate (CMR).

3.2.6

ATM Traffic Descriptor

traffic characteristics of an ATM connection

Note 1 to entry: A Connection Traffic Descriptor includes a Source Traffic Descriptor, CDV Tolerance (CDVT), and a Conformance definition. A Source Traffic Descriptor is described by the following parameters: Peak Cell Rate (PCR), Sustainable Cell Rate (SCR), Maximum Burst Size (MBS), and a Minimum Cell Rate (MCR).

3.2.7

Cell Loss Priority

CLP

one-bit field in the ATM cell header specifying whether the cell is more (i.e., CLP=1) or less (i.e., CLP=0) likely to be discarded by an ATM network experiencing congestion

3.2.8

Cell Loss Ratio

CLR

QoS parameter that gives the ratio of lost cells to the total number of transmitted cells

3.2.9

Connection Admission Control

CAC

actions taken by the ATM network to accept or reject a connection request based on its QoS and traffic parameter requirements and then route this connection across the network

3.2.10

Convergence Sublayer Protocol Data Unit

PDU used at the Convergence Sublayer (CS) for passing information between the higher layers and the Segmentation and Reassembly (SAR) sublayer that is located below the CS where the cell conversion takes place (see 3.2.1)

3.2.11

GCRA

method applied at the network side of the UNI (see 3.2.19) to test the conformance of an ATM cell to its traffic contract

3.2.12

Operations, Administration, And Maintenance

OAM

management framework defined by the ITU

Note 1 to entry: OAM cells are special purpose ATM cells exchanged between an ATM end-system and an ATM switch and between ATM switches. OAM cells are used for network fault and performance management and analysis.

3.2.13

Permanent Virtual Circuit

PVC

preconfigured logical connection between two ATM devices

3.2.14

Permanent Virtual Connection

PVC

ATM term for a Permanent Virtual Circuit (see 3.2.13) between ATM devices

Note 1 to entry: The terms may be used interchangeably.

3.2.15

Switched Virtual Call

generic term that refers to switched virtual circuits (see 3.2.16) and switched virtual connections (see 3.2.17)

3.2.16

Switched Virtual Circuit

logical ATM connection established via signaling

Note 1 to entry: End systems transmit a UNI 3.1/4.0 signaling request via the Q.2931 Signaling Protocol.

3.2.17

Switched Virtual Connection

SVC

ATM term for Switched Virtual Circuit (see 3.2.16)

3.2.18**Usage Parameter Control****UPC**

set of policing mechanisms implemented by the network at the UNI (see 3.2.19) to monitor and control traffic submitted by each end user

3.2.19**User-network Interface****UNI**

interface, defined as a set of protocols and traffic characteristics, between the customer premises equipment and the ATM networks

3.2.20**Virtual Channel**

one of several logical connections defined within one Virtual Path (see 3.2.23) between two ATM devices

3.2.21**Virtual Channel Connection****VCC**

concatenation of Virtual Channel Links

Note 1 to entry: Switching cells within an ATM switch for a given VCC is based on the VPI/VCI (see 3.2.25) value indicated on the cell header.

3.2.22**Virtual Circuit****VC**

connection that is set up across the network between a source and a destination where a fixed route is chosen for the entire session and bandwidth and ID dynamically allocated to the user

3.2.23**Virtual Path****VP**

logical connection between two ATM devices (e.g., CPEs, switches)

Note 1 to entry: A Virtual Path consists of a set of Virtual Channels (see 3.2.20).

3.2.24**Virtual Path Connection****VPC**

concatenation of Virtual Path Links (VPLs)

Note 1 to entry: Switching cells within an ATM switch for a given VPC is based on the VPI value indicated on the cell header.

3.2.25**Virtual Path Identifier/Virtual Channel Identifier****VPI/VCI**

combination of two numbers, namely the VPI and the VCI, used to identify a Virtual Connection (VC) and switch cells in an ATM network

3.3 FC-BB-3_SONET definitions**3.3.1****Administrative Unit****AU**

SDH-specific information structure, consisting of an STS SPE (see 3.3.14) and its associated set of STS pointer/pointer action bytes

3.3.2**Concatenated Synchronous Transport Signal Level N** **STS- N c**

STS- N Line layer signal in which the STS Envelope Capacities from the N STS-1s have been combined to carry an STS- N c Synchronous Payload Envelope (SPE) (see 3.3.14) that is transported not as several separate signals but as a single entity

Note 1 to entry: The equivalent SDH term for an STS-3c SPE is a VC-4.

3.3.3**container**

SDH term that is equivalent to the payload capacity of a Synchronous Payload Envelope (SPE) (see 3.3.14)

3.3.4**Operations, Administration, and Maintenance****OAM**

management framework defined by the ITU

Note 1 to entry: OAM cells are special purpose ATM cells exchanged between an ATM end-system and an ATM switch and between ATM switches.

Note 2 to entry: OAM cells are used for network fault and performance management and analysis.

3.3.5**Optical Carrier Level N** **OC- N**

optical signal that results from an optical conversion of an STS- N signal

Note 1 to entry: SDH does not make the distinction between a logical signal (e.g., STS-1 in SONET) and a physical signal (e.g., OC-1 in SONET). The equivalent SDH term for both logical and physical signals is Synchronous Transport Module Level M (STM- M), where $M = (N/3)$. There are equivalent STM- M signals only for values of $N = 3, 12, 48$, and 192 .

3.3.6**Optical Transport Network****OTN**

framework of ITU standards for optical signal multiplexing and transport

3.3.7**Path**

logical connection between the point at which a standard frame format for the signal at the given rate is assembled, and the point at which the standard frame format for the signal is disassembled

Note 1 to entry: The equivalent SDH term is also Path.

3.3.8**Payload Pointer**

pointer that indicates the location of the beginning of the Synchronous Payload Envelope (see 3.3.14)

Note 1 to entry: The equivalent SDH term is pointer.

3.3.9**Plesiochronous Digital Hierarchy****PDH**

bit-oriented telecommunications multiplexing and transport protocols (e.g., DS-3, E3)

3.3.10**SONET**

acronym for Synchronous Optical NETwork

Note 1 to entry: SONET is a term in general usage, that refers to the rates and formats specified in ANSI T1.105.

3.3.11

STS Path Terminating Equipment

STS PTE

network elements that multiplex/demultiplex the STS payload

Note 1 to entry: STS PTEs may originate, access, modify, or terminate the STS Path Overhead necessary to transport the STS payload, or may perform any combination of these actions.

3.3.12

super-rate signals

signal that has to be carried by a Concatenated Synchronous Transport Signal level Nc (STS-Nc)

Note 1 to entry: There is no equivalent SDH term.

3.3.13

Synchronous Digital Hierarchy

SDH

family of ITU-T standards whose technical contents closely resemble that found for the SONET family of ANSI standards

3.3.14

STS Synchronous Payload Envelope

STS SPE

125-microsecond frame structure composed of STS Path Overhead and bandwidth for payload

Note 1 to entry: The term generically refers to STS-1 SPEs and STS-Nc SPEs. The equivalent SDH term for STS-1 SPE is Virtual Container level 3 (VC-3). The equivalent SDH term for STS-3c SPE is Virtual Container level 4 (VC-4). The equivalent SDH term for STS-Nc SPE ($N > 3$) is Virtual Container level 4-Xc (VC-4-Xc), where $X = (N/3)$.

3.3.15

Synchronous Transport Module Level M

STM-M

transport signals for the Synchronous Digital Hierarchy (SDH) (see 3.3.13)

Note 1 to entry: Defined signals exist at rates of M times 155.52 Mbit/s, where $M = 1, 4, 16$, or 64 .

Note 2 to entry: These are equivalent to SONET OC-N signals, where $N = 3M$.

3.3.16

Synchronous Transport Signal Level N

STS-N

signal obtained by byte interleaving N STS-1 signals together

Note 1 to entry: The rate of the STS-N is N times 51.840 Mbit/s.

Note 2 to entry: SDH does not make the distinction between a logical signal (e.g. STS-N in SONET) and a physical signal (e.g. OC-N in SONET).

Note 3 to entry: The equivalent SDH term for both logical and physical signals is Synchronous Transport Module Level M (STM-M), where $M = (N/3)$. There are equivalent STM-M signals only for values of $N = 3, 12, 48$, and 192 .

3.3.17

Tributary Unit

TU

SDH term for SONET Virtual Tributary (see 3.3.19)

3.3.18

Virtual Container

VC

SDH term for either an STS or VT SPE

3.3.19

Virtual Tributary

VT

structure designed for transport and switching of sub-STs-1 payloads

Note 1 to entry: There are currently four sizes of VT. The equivalent SDH term is Tributary Unit (see 3.3.17).

3.4 FC-BB-3_IP definitions

3.4.1

B_Access

component of the FC Entity (see 3.4.8) that interfaces with the FCIP_LEP (see 3.4.20) component of the FCIP Entity (see 3.4.15) on one side and the B_Port on the other side

3.4.2

B_Access_Name

Name_Identifier (see 3.1.20) of B_Access portal

3.4.3

B_Access Virtual ISL

Virtual ISL (see 3.4.27) that connects two B_Access portals

3.4.4

control and service module

CSM

control component of the FC-BB-3_IP interface that mainly handles connection management

Note 1 to entry: CSM interfaces with the PMM (see 3.4.22).

3.4.5

encapsulated FC frame

SOF/EOF delimited FC frame prefixed with a 28-byte FC frame Encapsulation Header (see RFC 3643)

3.4.6

Encapsulated Frame Receiver Portal

TCP access point through which an encapsulated FC frame (see 3.4.5) is received from the IP network by an FCIP_DE (see 3.4.14)

3.4.7

Encapsulated Frame Transmitter Portal

TCP access point through which an encapsulated FC frame (see 3.4.5) is transmitted to the IP network by the FCIP_DE (see 3.4.14)

3.4.8

FC Entity

principal interface point to the FC switched network on one side and in combination with the FCIP Entity to the IP network on the other side.

Note 1 to entry: It is the data forwarding component of the FC-BB-3_IP interface consisting of VE_Port(s) (see 3.4.24) and/or B_Access (see 3.4.1) portals.

3.4.9

FC Entity Protocol Layer

protocol layer that lies between the Fibre Channel level FC-2 and the FCIP Entity Protocol Layer (see 3.4.16)

Note 1 to entry: Its primary function is to support one or more Virtual E_Ports (see 3.4.24) or B_Access (see 3.4.1) portals and to communicate with the FCIP Entity (see 3.4.8).

3.4.10

FC Receiver Portal

access point through which an FC frame and timestamp enters an FCIP_DE (see 3.4.14) from the VE_Port/ B_Access (see 3.4.24/3.4.1)

3.4.11

FC Transmitter Portal

access point through which an FC frame and timestamp leaves an FCIP_DE (see 3.4.14) to the VE_Port/ B_Access (see 3.4.24/3.4.1)

3.4.12

FC-BB-3_IP device

device defined by the FC-BB-3_IP model

3.4.13

FC-BB-3_IP interface

the point that has interfaces to the FC switched network on one side and the IP network on the other side

Note 1 to entry: FC-BB-3_IP interface consists of a Switching Element, FC/FCIP Entity pair(s), the CSM, and the PMM.

3.4.14

FCIP Data Engine

FCIP_DE

the data forwarding component of the FCIP Entity's (see 3.4.15) FCIP_LEP (see 3.4.20) that handles FC frame encapsulation, de-encapsulation, and transmission of encapsulated frames through a single TCP connection

3.4.15

FCIP Entity

data forwarding component of the FC-BB-3_IP interface consisting of the FCIP_LEP (see 3.4.20) and it is the principal interface point to the IP network on one side and in combination with the FC Entity (see 3.4.8) to the FC switched network on the other side

Note 1 to entry: Its primary function is formatting, encapsulating, and forwarding encapsulated FC frames (see 3.4.5) across the IP network interface.

3.4.16

FCIP Entity Protocol Layer

protocol layer that lies between the FC Entity (see 3.4.8) layer and the TCP layer

3.4.17

FCIP frame

FCIP term for an encapsulated FC frame (see 3.4.5)

3.4.18

FCIP Link

virtual link that connects an FCIP_LEP (see 3.4.20) in one FC-BB-3_IP device (see 3.4.12) with another

Note 1 to entry: It consists of one or more TCP connections.

3.4.19

FCIP Link Originator and Acceptor

the FC-BB-3_IP FCIP_LEP (see 3.4.20) that originates an FCIP Link is defined as the FCIP Link Originator

Note 1 to entry: The corresponding FCIP_LEP that accepts this link is defined as the FCIP Link Acceptor

3.4.20

FCIP Link Endpoint

FCIP_LEP

component of an FCIP Entity (see 3.4.15) that contains one or more FCIP_DEs (see 3.4.14)

3.4.21

FCIP Transit Time

FTT

total transit time of an encapsulated Fibre Channel frame in the IP network

3.4.22

Platform Management Module

PMM

management component of the FC-BB-3_IP interface that handles time synchronization, discovery, and security

Note 1 to entry: It interfaces with the CSM (see 3.4.4).

3.4.23

Request For Comment

RFC

documents put out by the IETF

3.4.24

Virtual E_Port

VE_Port

data forwarding component of the FC Entity (see 3.4.8) that emulates an E_Port (see 3.1.6)

Note 1 to entry: The term virtual indicates the use of a non Fibre Channel link connecting the VE_Ports. In the case of the FC-BB-3_IP model, a VE_Port interfaces with the FCIP_LEP component (see 3.4.20) of the FCIP Entity (see 3.4.15) on one side and a Fibre Channel Switching Element on the other side.

3.4.25

VE_Port Name

Name_Identifier (see 3.1.20) of the VE_Port (see 3.4.24)

3.4.26

VE_Port Virtual ISL

Virtual ISL (see 3.4.27) that connects two VE_Ports (see 3.4.24)

3.4.27

Virtual ISL

ISL that connects two VE_Ports (see 3.4.24) or two B_Access portals (see 3.4.1) across a non-FC link

3.5 FC-BB-3_GFPT definitions

3.5.1

ASFC_PAUSE

GFPT_WAN Primitive Signal used to pause flow on a GFPT_WAN link (see 10.3.4)

Note 1 to entry: ASFC_PAUSE is never transmitted to, or expected from, FC_Ports.

3.5.2

ASFC_RESUME

GFPT_WAN Primitive Signal used to resume flow on a GFPT_WAN link (see 10.3.4)

Note 1 to entry: ASFC_RESUME is never transmitted to, or expected from, FC_Ports.

3.5.3

ELP

Exchange Link Parameters SW_ILS (see FC-SW-4)

3.5.4**FLOGI**

Fabric Login ELS (see FC-LS)

3.5.5**F_BSY**

Fabric Busy (see FC-FS-2)

3.5.6**GFP Server**

Generic Framing Procedure (see 3.1.18) adaptation/de-adaptation engine

3.5.7**GFPT**

(Asynchronous) Transparent Generic Framing Procedure (see 3.1.18)

3.5.8**GFPT_WAN interface**

Transport network-side interface, on an FC-BB-3_GFPT device, corresponding to one GFPT_WAN facility (see 3.5.10), and to one Transport Trail (see 3.5.24)

Note 1 to entry: May or may not correspond to the full SONET/SDH/OTN/PDH access facility/bandwidth.

3.5.9**GFPT_WAN link**

Transport Trail (see 3.5.24) assigned to one GFPT_WAN facility (see 3.5.10)

3.5.10**GFPT_WAN facility**

Transport Trail (see 3.5.24), GFP Server (see 3.5.6), FC-BB-3_GFPT devices, and their respective GFPT_WAN interfaces (see 3.5.8), corresponding to one interconnected FC_Port pair

3.5.11**inbound**

sent from the FC-BB-3_GFPT device to the attached FC_Port

3.5.12**ISL**

Inter-Switch Link (see FC-SW-4)

3.5.13**LEM**

Login Exchange Monitor (see 10.3.3)

3.5.14**LS_ACC**

Link Service Accept frame (see FC-LS)

3.5.15**LS_RJT**

Link Service Reject frame (see FC-LS)

3.5.16**outbound**

sent from the attached FC_Port to the FC-BB-3_GFPT device

3.5.17**PING**

GFPT_WAN Primitive Signal used to initiate latency measurement on a GFPT_WAN link



Note 1 to entry: PING is never transmitted to, or expected from, FC_Ports.

3.5.18

PING_ACK

GFPT_WAN Primitive Signal used to reply to a PING and complete round-trip latency measurement on a GFPT_WAN link

Note 1 to entry: PING_ACK is never transmitted to, or expected from, FC_Ports.

3.5.19

PLOGI

Port Login (see FC-LS)

3.5.20

P_BSY

N_Port Busy (see FC-FS-2)

3.5.21

RPSC ELS

Report Port Speed Capabilities ELS (see FC-LS)

3.5.22

SW_ACC

SW Accept Reply frame (see FC-SW-4)

3.5.23

SW_RJT

SW Reject Reply frame (see FC-SW-4)

3.5.24

Transport Trail

contiguously or virtually-concatenated signal group (see T1.105-2001) comprised of one or more standardized SONET/SDH/OTN/PDH synchronous transport signals

3.5.25

WAN Primitive Signal

ASFC_PAUSE (see 3.5.1), ASFC_RESUME (see 3.5.2), PING (see 3.5.17), or PING_ACK (see 3.5.18) Primitive Signal

Note 1 to entry: These Primitive Signals are always generated and terminated by FC-BB-3_GFPT devices and transmitted only between FC-BB-3_GFPT devices.

Note 2 to entry: They are never transmitted to nor received from FC_Ports.

3.5.26

WAN_HOLD OFF_TOV

time-out value, specific to FC-BB-3_GFPT devices, which defines the period that elapses, following detection/indication of a GFPT_WAN link failure, before a GFPT_WAN Down condition is declared for the purposes of the state machine described in 10.3.2

Note 1 to entry: The criteria for such detection are WAN-specific and outside the scope of this standard.

3.6 Editorial conventions

In FC-BB-3, a number of conditions, mechanisms, sequences, parameters, events, states, or similar terms are printed with the first letter of each word in uppercase and the rest lowercase (e.g., Exchange, Sequence). Any lowercase uses of these words have the normal technical English meaning.

Lists sequenced by letters (e.g., a-red, b-blue, c-green) show no ordering relationship between the listed items.
Numbered lists (e.g., 1-red, 2-blue, 3-green) show an ordering relationship between the listed items.

The ISO convention of numbering is used (i.e., the thousands and higher multiples are separated by a space and a comma is used as the decimal point). A comparison of the American and ISO conventions are shown in table 2.

Table 2 – ISO and American Conventions

ISO	American
0,6	0.6
1 000	1,000
1 323 462,9	1,323,462.9

In case of any conflict between figure, table, and text, the text, then tables, and finally figures take precedence. Exceptions to this convention are indicated in the appropriate sections.

In all of the figures, tables, and text of this document, the most significant bit of a binary quantity is shown on the left side. Exceptions to this convention are indicated in the appropriate sections.

When the value of the bit or field is not relevant, x or xx appears in place of a specific value. If a field or a control bit in a frame is specified as not meaningful, the entity that receives the frame shall not check that field or control bit.

Numbers that are not immediately followed by lower-case b or h are decimal values.

Numbers immediately followed by lower-case b (xxb) are binary values.

Numbers or upper case letters immediately followed by lower-case h (xxh) are hexadecimal values.

3.7 List of commonly used acronyms and abbreviations

Abbreviations and acronyms applicable to this standard are listed. Definitions of several of these items are included in clause 3.

3.7.1 General

BB	Backbone
BB-2	Backbone -2
BBW	Backbone (ATM or SONET) WAN
BSW	Border Switch
EBP	Exchange B_Access Parameters
ELP	Exchange Link Parameters
EOF	End of Frame
ESC	Exchange Switch Capabilities
FCIP	Fibre Channel Over TCP/IP
FCS	Frame Check Sequence
FC-SP	Fibre Channel - Security Protocol
FC-SW-3	Fibre Channel - Switched Fabric - 3
ISL	Inter-switch Link
ITU-T	International Telecomm. Union - Telecommunication Standardization Section
K_A_TOV	Keep Alive Timeout value
LKA	Link Keep Alive
MTU	Maximum Transfer Unit
PDU	Protocol Data Unit
SFC	Simple Flow Control
SOF	Start of Frame
SR	Selective Retransmission
SW_ACC	Switch Fabric Internal Link Service Accept
SW_CS	Switch Fabric Common Services
SW_ILS	Switch Fabric Internal Link Services
SW_RJT	Switch Fabric Internal Link Service Reject
WAN	Wide Area Network

3.7.2 FC-BB-3_ATM

AAL5	ATM Adaptation Layer 5
ATM	Asynchronous Transfer Mode
BER	Bit Error Rate
CLR	Cell Loss Ratio (ATM)
CPCS	Common Part Convergence Sublayer
PVC	Permanent Virtual Circuit, Permanent Virtual Connection
QoS	Quality of Service
SAAL	Signaling ATM Adaptation Layer
SVC	Switched Virtual Circuit, Switched Virtual Connection
UBR	Unspecified Bit Rate (ATM)
UNI	User Network Interface (ATM)
VBR-NRT	Variable Bit Rate - Non Real Time (ATM)
VC	Virtual Circuit

3.7.3 FC-BB-3_SONET

HDLC	High-level Data Link Control
nm	Nanometer
OC-N	Optical Carrier Level N
ppm	Parts per Million
PPP	Point-to-Point Protocol
PTE	Path Terminating Equipment
RFC	Request for Comment
SDH	Synchronous Digital Hierarchy
SMT	Station Management (FDDI)
SONET	Synchronous Optical Network
SPE	Synchronous Payload Envelope
STM-M	Synchronous Transport Module level M
STS	Synchronous Transport Signal
STS-N	Synchronous Transport Module level N
STS-Nc	Synchronous Transport Module level Nc
TU	Tributary Unit
ULA	48-bit Universal LAN MAC Address
ULP	Upper Level Protocol
ULP_TOV	Upper_Level_Protocol_Timeout value
VC	Virtual Container
VP	Virtual Path
VT	Virtual Tributary

3.7.4 FC-BB-3_IP

B_Access	B_Access Portals
CSM	Control and Service Module
FCIP	FC over TCP/IP
FCIP_DE	FCIP Data Engine
FCIP_LEP	FCIP Link Endpoint
IETF	IETF Internet Engineering Task Force (www.ietf.org)
PMM	Platform Management Module
RFC	Request For Comment
VE_Port	Virtual E_Port

3.7.5 FC-BB-3_GFPT

ASFC	Alternate Simple Flow Control
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ELP	Exchange Link Parameters
F_BSY	Fabric Busy
FLOGI	Fabric Login
GFP	Generic Framing Procedure
GFPT	(Asynchronous) Transparent Generic Framing Procedure
GFPT_WAN	GFPT Wide Area Network
ISL	Inter-Switch Link
LEM	Login Exchange Monitor
LS_ACC	Link Service Accept Reply Frame
LS_RJT	Link Service Reject Reply Frame
P_BSY	N_Port Busy
PLOGI	Port Login
SW_ACC	SW Accept Reply Frame
SW_RJT	SW Reject Reply Frame

3.8 Symbols

Unless indicated otherwise, the following symbol has the listed meaning.

|| concatenation

3.9 Keywords

3.9.1

expected

keyword used to describe the behavior of the hardware or software in the design models assumed by this standard. Other hardware and software design models may also be implemented

3.9.2

ignored

keyword used to describe an unused bit, byte, word, field or code value. The content or value of an ignored bit, byte, word, field or code value shall not be examined by the receiving device and may be set to any value by the transmitting device

3.9.3

invalid

keyword used to describe an illegal or unsupported bit, byte, word, field or code value. Receipt of an invalid bit, byte, word, field or code value shall be reported as an error

3.9.4

mandatory

keyword indicating an item that is required to be implemented as defined in this standard

3.9.5

may

keyword that indicates flexibility of choice with no implied preference (equivalent to “may or may not”)

3.9.6

may not

keyword that indicates flexibility of choice with no implied preference (equivalent to “may or may not”)

3.9.7

optional

keyword that describes features that are not required to be implemented by this standard. However, if any optional feature defined by this standards is implemented, then it shall be implemented as defined in this standard

3.9.8

reserved

keyword referring to bits, bytes, words, fields and code values that are set aside for future standardization. A reserved bit, byte, word or field shall be set to zero, or in accordance with a future extension to this standard

Recipients are not required to check reserved bits, bytes, words or fields for zero values. Receipt of reserved code values in defined fields shall be reported as an error

3.9.9

shall

keyword indicating a mandatory requirement. Designers are required to implement all such mandatory requirements to ensure interoperability with other products that conform to this standard

3.9.10

should

keyword indicating flexibility of choice with a strongly preferred alternative; equivalent to the phrase “it is strongly recommended”

3.9.11

x or xx

the value of the bit or field is not relevant

4 FC-BB-3 structure and concepts

4.1 FC-BB-3 backbone mappings

FC-BB-3 models (i.e., FC-BB-3_ATM, FC-BB-3_SONET, FC-BB-3_IP, and FC-BB-3_GFPT), specified in this standard, define equipment capable of extending Fibre Channel switched networks and/or links over Wide Area Network infrastructures and over distance (i.e., over non-negligible link latencies). One important distinction among the models discussed in this standard is the emphasis placed on the backbone (i.e., WAN) type. The FC-BB-3_ATM and FC-BB-3_SONET models assume ATM and SONET transport network technologies. The FC-BB-3_IP models assume the use of TCP connections over IP networks. The FC-BB-3_GFPT model makes use of the Asynchronous Transparent Generic Framing Procedure (GFPT) (see ITU-T Rec. G.7041/Y.1303). GFPT may be used for adaptation to different transport facilities including SONET, SDH, OTN and PDH. Details regarding the mapping of GFPT-adapted traffic to such transport facilities are elaborated in various ITU-T standards (see clause 2).

A second important distinction among the mappings discussed in this standard relates to supported architectures (i.e., network and/or link topologies) and the place of the defined devices within them. FC-BB-3_ATM and FC-BB-3_SONET define a fabric bridge device that interconnects the E_Ports of external FC switches. The switch-facing interfaces resident on these bridges are called B_Ports. B_Ports have selected fabric functions (see FC-SW-4). B_Ports are fabric ports, and FC-BB-3_ATM and FC-BB-3_SONET devices are components of an FC fabric. FC-BB-3_IP also defines support for FC bridge devices with fabric-facing B_Ports. However, FC-BB-3_IP also supports functional integration within an FC Switch. Thus FC-BB-3_IP devices may also have E_Ports and F_Ports. FC-BB-3_GFPT defines a device that is not a component of a fabric, and supports no fabric functionality. Instead, it interconnects two Fibre Channel physical ports (i.e., attached FC_Ports), appearing architecturally as a wire to those ports.

NOTE 1 - Future extension of FC-BB-3_ATM and FC-BB-3_SONET models to include support for resident E_Ports and F_Ports is not precluded.

4.2 FC-BB-3 reference models

FC-BB-3 defines four reference models, corresponding to the FC-BB-3_ATM, FC-BB-3_SONET, FC-BB-3_IP, and FC-BB-3_GFPT models. These reference models are shown in figure 4, figure 5, figure 6, and figure 7, respectively. In figure 4 and figure 5 (i.e., FC-BB-3_ATM and FC-BB-3_SONET, respectively), frames destined for a remote FC network enter a B_Port and are forwarded on the backbone network to their destination. In figure 6 (i.e., FC-BB-3_IP), frames destined for a remote FC network enter a B_Port, an E_Port, or an F_Port, and are forwarded on the backbone network to their destination. In figure 7 (i.e., FC-BB-3_GFPT), FC physical signals (i.e., relevant 8B/10B codewords) enter an FC physical port on an FC-BB-3_GFPT device, and are forwarded on the backbone network to their destination.

The FC-BB-3_ATM and FC-BB-3_SONET models support the attachment of FC switches (i.e., E_Ports) via one or more B_Ports. The FC-BB-3_IP model supports the attachment of FC switches (i.e., E_Ports) via one or more B_Ports or E_Ports and the attachment of N_Ports via one or more F_Ports. The FC-BB-3_GFPT model supports the attachment of N_Ports, F_Ports, and E_Ports, and the following Fibre Channel port interconnections:

- a) N_Port to N_Port;
- b) N_Port to F_Port; and
- c) E_Port to E_Port.

Table 3 summarizes the resident FC_Port types for the four different FC-BB-3 models.

Table 3 – Models and resident FC_Port types

	Reference Model			
	FC-BB-3_ATM	FC-BB-3_SONET	FC-BB-3_IP	FC-BB-3_GFPT
Resident FC_Port Type(s)	B_Port	B_Port	B_Port, E_Port, F_Port	None (FC Physical Interface)

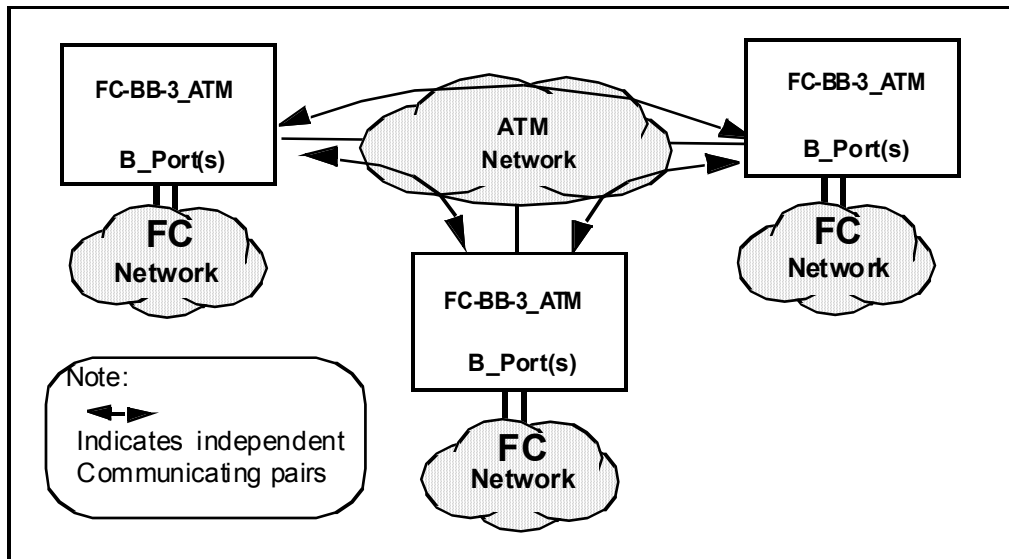


Figure 4 – FC-BB-3_ATM reference model

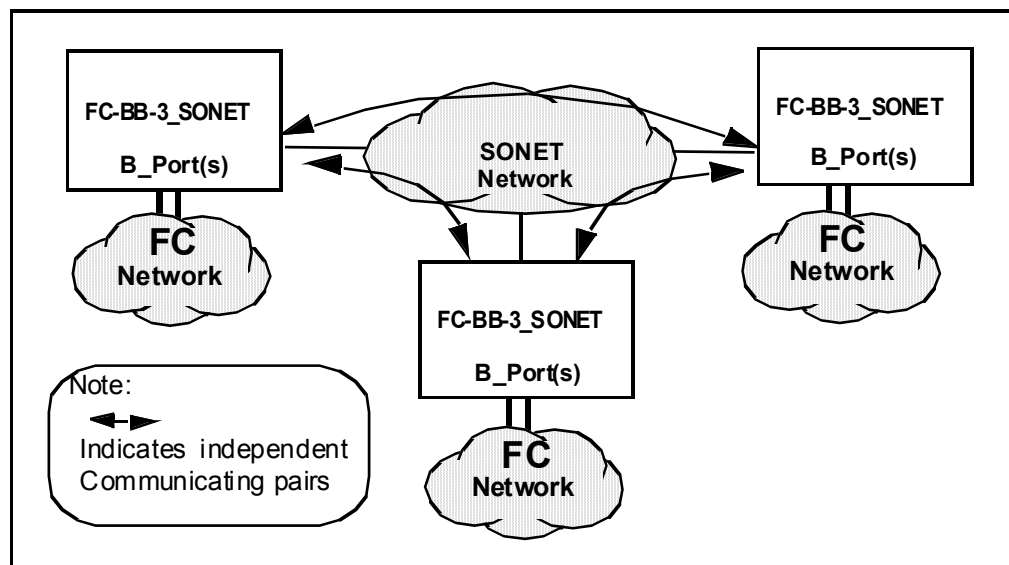


Figure 5 – FC-BB-3_SONET reference model

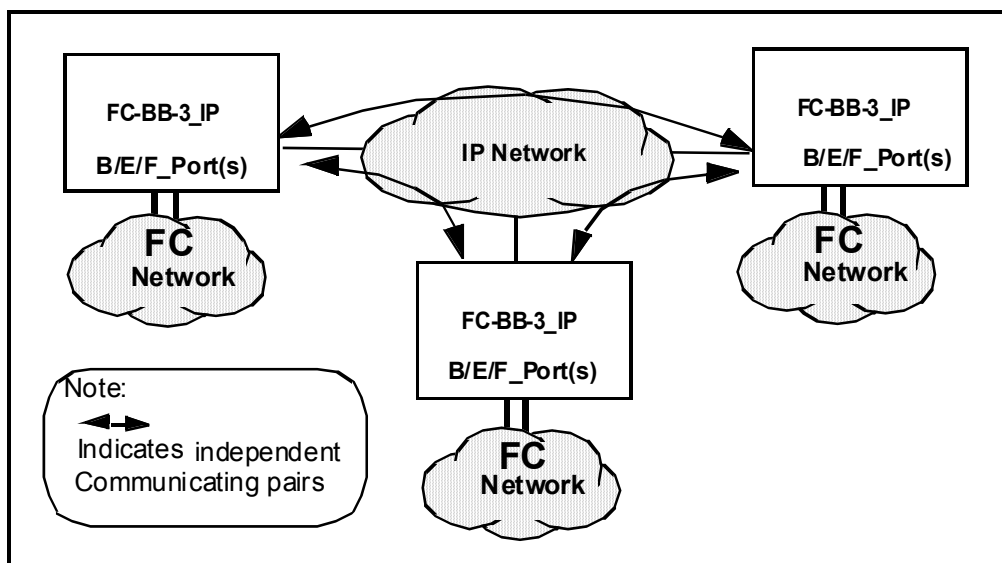


Figure 6 – FC-BB-3_IP reference model

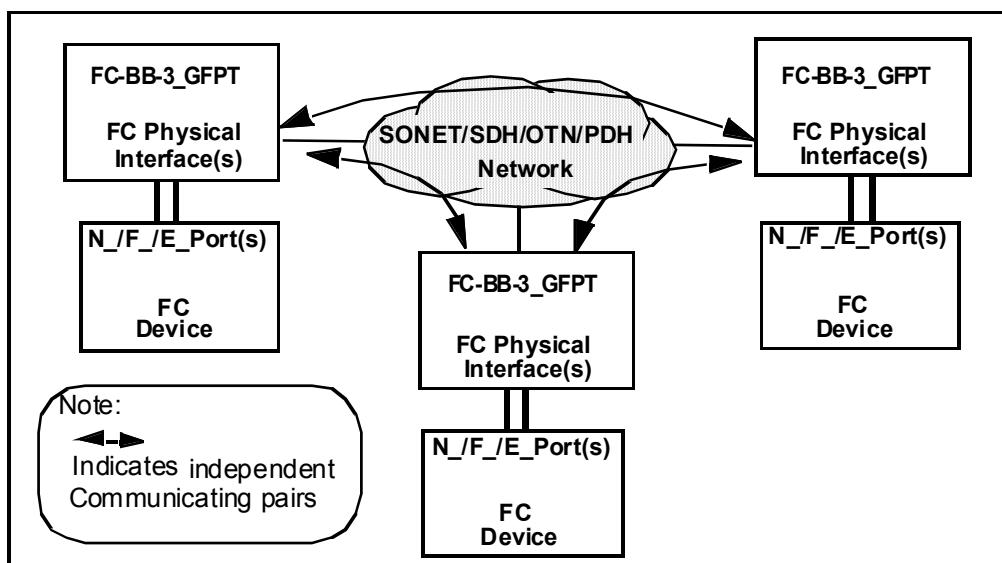


Figure 7 – FC-BB-3_GFPT reference model

4.3 FC-BB-3 models overview

4.3.1 FC-BB-3_ATM

The FC-BB-3_ATM model defines the means by which Fibre Channel networks interface with and connect across a wide-area ATM network. FC-BB-3_ATM defines the frame mapping, encapsulation, and any signaling required by the ATM protocols. FC-BB-3_ATM also defines the frame handling, call handling, addressing, flow control protocol, and error recovery required to support the Fibre Channel mapping over ATM. FC-BB-3_ATM makes use of the ATM Adaptation Layer 5 for payload transport.

FC-BB-3_ATM messages are formed by encapsulating byte-encoded Class 2, 3, 4, or F Fibre Channel frames into a suitable format for carriage over the WAN. Clause 5 describes the FC-BB-3_ATM message in detail.

SR and SFC are two flow control protocols that may be used over ATM networks. The SR protocol provides a reliable transport of frames between two FC-BB-3_ATM devices. Use of the SR protocol is optional. The SFC protocol is an efficient sliding window link-layer full-duplex protocol that supports data transport with flow control.

and error recovery functions. SR has been adopted from ITU's Link Access Protocol B (LAPB), that is derived from ISO/IEC's High-level Data Link Control (HDLC) (Balanced Classes). Use of LAPB in SR is limited to a subset of the synchronous modulo 32768 super sequence numbering service option. Clause 6 describes the SR protocol in detail. The SFC protocol (see 6.4) provides a mechanism to temporarily pause the transmission of frames from a remote FC-BB-3_ATM device. Use of the SFC protocol is optional.

4.3.2 FC-BB-3_SONET

The FC-BB-3_SONET model defines the means by which Fibre Channel networks interface with and connect across a wide-area SONET/SDH network. FC-BB-3_SONET defines the frame mapping, encapsulation, and any signaling required by the SONET protocols. FC-BB-3_SONET also defines the frame handling, call handling, addressing, flow control protocol, and error recovery required to support the Fibre Channel mapping over SONET/SDH. FC-BB-3_SONET makes use of either the High-level Data Link Control (HDLC) for payload transport (described in detail in this standard), or the relevant Frame Mapped Generic Framing Procedure (GF-PF) mapping described in ITU-T Rec. G.7041/Y.1303.

NOTE 2 - The FC over SONET/GFP mappings defined by FC-BB-3_SONET and FC-BB-3_GFPT, are fundamentally different from the native FC transport supported by the Synchronous, Full-Rate Transparent Mapped Generic Framing Procedure defined in ITU-T Rec. G.7041/Y.1303. The latter mapping constitutes a full-rate, fully transparent FC wire extension between two FC_Ports and is not discussed in this standard.

The SR and SFC flow control protocols may be used over SONET networks.

4.3.3 FC-BB-3_IP

The FC-BB-3_IP model defines the means by which Fibre Channel networks interface with and connect across an IP network. FC-BB-3_IP makes use of the FCIP standard (see RFC 3821) to define the mapping and control required by the TCP/IP protocol and the FC frame encapsulation standard (see RFC 3643) to define the encapsulation. FC-BB-3_IP also defines the connection management, addressing, time synchronization, discovery, security, switching, routing, and error recovery required to support Fibre Channel over TCP/IP. FC-BB-3_IP is agnostic about the underlying physical technology that exists beneath the IP layer. In this sense, the IP network could use ATM, SONET, Gigabit Ethernet, or any other link-level technology below it.

FC-BB-3_IP encapsulates byte-encoded Class 2, 3, 4, or F Fibre Channel frames into a suitable format (i.e., encapsulated FC frames) for carriage over the IP network. Subclause 9.6 describes encapsulated FC frames in detail. The TCP/IP protocol suite provides a reliable transport of frames over the IP network. TCP provides flow control and error recovery.

The FC-BB-3_IP protocol provides mechanisms to create VE_Port or B_Access connectivity as the case may be, over the IP network (see 9).

4.3.4 FC-BB-3_GFPT

The FC-BB-3_GFPT model defines the means by which FC physical links may be extended over any WAN transport infrastructure for which GFP mapping is defined. FC-BB-3_GFPT supports the interconnection of arbitrary, legal, non-Arbitrated Loop FC_Port combinations, imposing no requirements, and making no suppositions, regarding the topology, or even the presence of an FC fabric. FC-BB-3_GFPT supports efficient transport of FC data over transport facilities of arbitrary bandwidths and potentially large distances. FC-BB-3_GFPT supports Class 2, 3, and F traffic.

FC-BB-3_GFPT devices do not generate FC frames and do not directly participate in port initialization or other Exchanges. FC-BB-3_GFPT devices are exempt from any requirements regarding FC_Port authentication (see FC-SP), and they do not impede or interfere with any such processes that may occur between the attached and interconnected FC_Ports. FC-BB-3_GFPT devices have no FC identity or visibility, and administratively they may be kept strictly separated and distinct from FC fabrics and ports.

FC_Ports are interconnected pair-wise over SONET/SDH/OTN/PDH networks, via FC-BB-3_GFPT devices, in a point-to-point fashion. Although multiple FC_Ports may interface with a single FC-BB-3_GFPT device, each opposing FC_Port pair is connected via a dedicated Transport Trail (e.g., a contiguously or virtually-concatenated group). Since trail and access section configurations may differ, FC-BB-3_GFPT devices have both physical interfaces to the transport network, and individual FC-BB-3_GFPT devices may have more than one

such physical interface, as well as logical interfaces associated with individual circuits. Logical interfaces are referred to as GFPT_WAN interfaces. A GFPT_WAN interface corresponds to a specific Transport Trail, and always to a single attached FC_Port pair. Governance of the relationship of GFPT_WAN interfaces to physical SONET/SDH/OTN/PDH interfaces, and of any changes of such relationships (e.g., as may occur during network protection events), is specified in the appropriate ITU-T and ANSI-T1 standards (see clause 2), and is therefore outside the scope of this standard. Multiple GFPT_WAN links originating on one FC-BB-3_GFPT device may be terminated on different, and geographically disparate, FC-BB-3_GFPT devices. The routing and provisioning of network facilities underlying GFPT_WAN links is outside the scope of this standard.

The FC-BB-3_GFPT device interfaces to attached FC_Ports are FC physical interfaces operating at standard rates. The FC physical interfaces on FC-BB-3_GFPT devices may support link speed negotiation with the attached FC_Ports.

4.4 FC-BB-3 requirements

4.4.1 Fibre Channel Class support

Class F shall be supported between FC-BB-3 devices. Class 1 is not supported, and Class 2, 3 or 4 may be supported between FC-BB-3 devices.

4.4.2 Payload transparency

4.4.2.1 FC-BB-3_ATM, FC-BB-3_SONET, FC-BB-3_IP

Arriving Class 2, 3, 4, and F Fibre Channel frames from an FC network and destined to a remote FC network shall be encapsulated using the FC-BB-3_ATM/SONET/IP defined mechanisms and transmitted to the appropriate FC-BB-3_ATM/SONET/IP device.

Arriving encapsulated frames received from remote FC-BB-3_ATM/SONET/IP device shall be de-encapsulated and sent to an FC network.

Primitive Signals and Primitive Sequences shall not be transported between FC-BB-3_ATM/SONET/IP devices.

4.4.2.2 FC-BB-3_GFPT

FC frames inbound from one attached FC_Port shall be delivered to the remote FC_Port in native form (i.e., without further encapsulation) across the transport network according to the adaptation processes described in 10.3.8. Frames received from remote FC-BB-3_GFPT devices shall be forwarded to the attached FC_Port. Selected ELP, SW_ACC, FLOGI, PLOGI, and LS_ACC frames may be subject to inspection and/or minor modifications, in transiting one or the other FC-BB-3_GFPT device, as described in 10.3.4.

Primitive Signals transmitted by an attached FC_Port may be forwarded across the transport network for delivery to the remote FC_Port according to the rules described in 10.3.5. When they are forwarded, they are forwarded in native form (i.e., without further encapsulation) according to the adaptation processes described in 10.3.8.

Primitive Sequences transmitted by an attached FC_Port are forwarded across the transport network for delivery to the remote FC_Port according to the rules described in clause 10. Primitive Sequences are forwarded in native form (i.e., without further encapsulation) according to the adaptation (including rate adaptation) processes described in 10.3.8.

4.4.3 Latency delay and timeout value

FC-BB-3_IP shall ensure that the incoming encapsulated FC frames whose FCIP Transit Time (FTT) exceeds $1/2 E_D_TOV$ shall be discarded and not admitted into the FC network. Fibre Channel timeout values shall be administratively set to accommodate the FTT.

FC-BB-3_IP shall allow Class F encapsulated FC frames to be transmitted with a zero timestamp value.

FC-BB-3_GFPT requires that the inherent latency between two FC-BB-3_GFPT devices be bounded and included within one-half of the E_D_TOV and R_T_TOV values of the attached devices, and within the R_A_TOV values of the attached fabric(s), if any.

4.4.4 QoS and bandwidth

FC-BB-3_ATM shall use the VBR-NRT ATM service. VBR-NRT ATM service provides cell loss and bandwidth guarantees. It is recommended that FC-BB-3_ATM make use of a single Virtual Circuit (VC). Use of additional VCs to address special traffic QoS requirements is allowed but not recommended. FC-BB-3_ATM recommends allocating a minimum bandwidth for each FC-BB-3_ATM VC that is used in order to avoid starvation; however, the service discipline prioritization for the VCs is implementation-specific and beyond the scope of this standard.

FC-BB-3_SONET has no specific SONET service requirements.

FC-BB-3_IP recommends that some form of preferential QoS be used for the FCIP traffic in the IP network to minimize latency and packet drops although no particular form of QoS is recommended. See RFC 3821.

FC-BB-3_GFPT has no specific transport service requirements.

4.4.5 In-order delivery

FC-BB-3_ATM shall guarantee in-order delivery of frames within each ATM VC. No other ordering relationship among ATM VCs need be preserved.

FC-BB-3_SONET shall guarantee in-order delivery of frames within each SONET/SDH provisioned path. No other ordering relationship among SONET/PDH provisioned paths need be preserved.

FC-BB-3_IP shall guarantee in-order delivery of frames within the scope of any TCP connection.

FC-BB-3_GFPT shall provide in-order delivery within each provisioned Transport Trail for all transmitted data (i.e., frames, Primitive Signals and Primitive Sequences), as discussed and with the exceptions detailed in clause 10.

4.4.6 Flow control

FC-BB-3_ATM or FC-BB-3_SONET devices may use the Selective Retransmission (SR) protocol to provide for reliable delivery of frames over the WAN between two devices. In the case of FC-BB-3_ATM, if the SR protocol is used, then the flow control is separately applied to each ATM VC.

FC-BB-3_ATM or FC-BB-3_SONET devices may use the Simple Flow Control (SFC) protocol to temporarily pause the transmission of frames from a remote device. In the case of FC-BB-3_ATM, if the SFC protocol is used, then the flow control is separately applied to each ATM VC.

FC-BB-3_IP devices shall ensure that TCP flow control and error recovery acts in proper concert with the Fibre Channel BB_Credit flow control mechanism.

Flow control at E_Ports, F_Ports, VE_Ports, and B_Ports shall operate as defined in FC-SW-4.

The Alternate Simple Flow Control (ASFC) mechanism (see 10.3.4) shall be used between FC-BB-3_GFPT devices. Flow control on FC_Port-facing links is specified in clause 10.

Flow control at FC-BB-3_GFPT physical interfaces to attached FC devices shall operate as defined in FC-SW-4 or FC-FS-2, as appropriate.

4.5 FC-BB-3 SW_ILS codes

Table 4 shows the SW_ILS codes allocated for FC-BB-3 use.

Table 4 – FC-BB-3 SW_ILS codes

Encoded Value (hex)	Description	Abbr.	Reference
28 03 00 00	Authentication Special Frame Request	ASF	9.7.2.3.2
28 01 00 00	Exchange B_Access Parameter	EBP	7.3.5

Table 5 shows the ELS codes allocated for FC-BB-3 use.

Table 5 – FC-BB-3 ELS codes

Encoded Value (hex)	Description	Abbr.	Reference
80 00 00 00	Link Keep Alive Request	LKA	FC-LS

5 FC-BB-3_ATM and FC-BB-3_SONET Messages and Formats

5.1 General

In all text to follow, the term BBW applies to both FC-BB-3_ATM and FC-BB-3_SONET. The structure of a BBW message is given in table 6. It consists of 3 fields: LLC/SNAP Header, BBW_Header, and the BBW message payload. The structures of the fields are given in table 7, table 8, table 10, and table 11.

Table 6 – BBW message structure

	Field	Size (Bytes)
BBW message	LLC/SNAP Header	8
	BBW_Header	4
	BBW message payload	Max: 2148

5.2 LLC/SNAP header format

LLC/SNAP Header (8 bytes): The Logical Link Control (LLC)/Sub Network Access Protocol (SNAP) Header consists of a 3-byte LLC field and a 5-byte SNAP sub-field.

Table 7 – LLC/SNAP header

Field		Word	Byte	Encoded Value (hex)
LLC	DSAP	0	0	AA
	SSAP		1	AA
	CTRL		2	03
SNAP	OUI	0	3	00
		1	0	00
		1	1	00
	PID	1	2	88
		1	3	8D

LLC (3 bytes): The LLC field consists of three 1-byte sub-fields: Destination Service Access Point (DSAP), Source Service Access Point (SSAP), and Control (CTRL). The encoding for LLC given in table 7 indicates that an IEEE 802.2 SNAP follows.

SNAP (5 bytes): The SNAP field consists of two sub-fields: A 3-byte Organizationally Unique Identifier (OUI) sub-field and a 2-byte Protocol Identification (PID) sub-field. The encoding for OUI given in table 7 indicates the presence of an IEEE 802.2 Routed protocol in the payload. The encoding for PID given in table 7 indicates the payload protocol type is Fibre Channel.

5.3 BBW_Header format

The 4-byte BBW_Header (see table 8) consists of three fields: A 1-byte Flow Control Type field, a 2-byte PAUSE field and a 1-bit Address Bit field. The structure of the Flow Control Type field is given in table 9.

Table 8 – BBW_Header

Word	Byte	Field	Size (Bytes)	Remarks
2	0	Flow Control Type	1	
	1-2	PAUSE	2	Applicable only when SFC protocol is specified as the Flow Control Type.
	3	<bit 0>: Address Bit 1= Command; 0 = Response <bits 1-7>: Reserved	1	Applicable only when SFC protocol is specified as the Flow Control Type

Flow Control Type (1 byte): This field defines encodings for Simple Flow Control (SFC) and SR flow control.

Table 9 – Flow control protocol type encodings

Encodings (hex)	Flow Control Type
00	SFC
01	SR
Others	Reserved

PAUSE (2 bytes): The 2-byte PAUSE field is applicable only when the Flow Control Type is SFC. The PAUSE field defines the number of 512-bit time units to pause transmission. A value of zero indicates zero pause transmission time units. This field is also set to zero value when no flow control is desired with the Flow Control Type specified as SFC.

Address Bit (bit 0: Byte 3): This field is applicable only when the Flow Control Type is SR flow control. This bit identifies the SR message as either a command or a response. Messages containing commands shall set this bit to 1. Messages containing responses shall set this bit to 0. This field is used in conjunction with the Poll Bit of the SR protocol.

5.4 BBW message payload format for SFC

The general structure of the BBW message payload when SFC is specified as the Flow Control Type is given in table 10. It consists of the following fields: 4-byte SOF, 24-byte FC-Header, FC frame payload, 4-byte CRC, and 4-byte EOF. The SOF and EOF byte encodings are defined in annex A. The FC Header, FC frame payload, and the CRC are standard Fibre Channel frame fields that arrive at the B_Port or the E_Port interface.

NOTE 3 - The format also applies when the Flow Control Type is specified as SFC and the PAUSE field carries a zero value (i.e., when no flow control is desired).

Table 10 – BBW message payload structure for SFC

Field	Size (Bytes)
SOF	4
FC Header	24
FC frame payload (includes optional header)	Min: 0 Max: 2 112
CRC	4
EOF	4

5.5 BBW message payload format for SR

5.5.1 General

The general structure of the BBW message payload when SR is specified as the Flow Control Type is given in table 11. It consists of a 4-byte SR_Header and the SR_BBW message payload. SR_Header encodings specify the SR_BBW message type. SR_Header is described in 5.5.2.

Table 11 – BBW message payload structure for SR

Field	Field	Size (Bytes)
SR_BBW message	SR_Header	4
	SR_BBW message payload	Max: 2 148

The SR_BBW message payload format depends on the type of the SR_BBW message and is described in 5.5.5.1, 5.5.5.4, and 5.5.5.9.

5.5.2 SR_Header formats

5.5.2.1 Field formats

The SR_Header defines three types of field formats that are used to perform numbered information transfer (i.e., I-format), numbered supervisory functions (i.e., S-format), and unnumbered control functions (i.e., U-format) (see table 12). SR makes use of nine different types of messages:

- a) I-format (1): SR_I;
- b) S-format (3): SR_RR, SR_RNR, SR_REJ; and
- c) U-format (5): SR_SM, SR_DISC, SR_FRMR, SR_UA, SR_DM.

Bits 0 and 1 of the SR_Header provide the encodings for the three field formats. Bits 2 and 3 provide the encodings for the different S-format messages and are shown in table 13. Bits 2, 3, 5, 6, and 7 provide the encodings for the different U-format messages and are shown in table 14.

Table 12 – SR_Header format

For- mat	3 1	3 0	2 9	2 8	2 7	2 6	2 5	2 4	2 3	2 2	2 1	1 0	1 9	1 8	1 7	1 6	1 5	1 4	1 3	1 2	1 1	1 0	9	8	7	6	5	4	3	2	1	0
I	N(R)														P	N(S)																0
S	N(R)														P / F	Reserved										S	S	0	1			
U	Reserved															Reserved						M	M	M	P / F	M	M	1	1			
N(S): Transmitter send sequence number; N(R): Transmitter receive sequence number. SS: Supervisory function bits defined in table 13. MMMMM: Modifier function bits defined in table 14. P/F: Poll/Final bit; P Poll bit (1 = Poll).																																

Table 13 – SS bits encoding

SS Bits		Supervisory message
3	2	
0	0	SR_RR
0	1	Reserved
1	0	SR_RNR
1	1	SR_SREJ

Table 14 – MMMMM bit encoding

MMMMM Bits					Unnumbered message
7	6	5	3	2	
1	1	0	0	0	SR_SM
0	1	0	0	0	SR_DISC
1	0	0	0	1	SR_FRMR
0	1	1	0	0	SR_UA
0	0	0	1	1	SR_DM

5.5.2.2 Information transfer I-format

The I-format is used to perform an information transfer. The functions of the N(S), N(R), and P fields are independent (i.e., each SR_I message has a N(S), a N(R), that may or may not acknowledge additional SR_I messages received by the BBWs, and a P bit that may be set to a 0 or 1).

5.5.2.3 Supervisory S-format

The S-format is used to perform data link supervisory control functions such as acknowledge SR_I messages, request retransmission of SR_I messages, and to request a temporary suspension of transmission of SR_I messages. The functions of the N(R) and P/F fields are independent (i.e., each supervisory message has a N(R) that may or may not acknowledge additional SR_I messages received by the BBW, and a P/F bit that may be set to 0 or 1).

5.5.2.4 Unnumbered U-format

The U-format is used to provide additional data link control functions. This format contains no sequence numbers, but does include a P/F bit that may be set to a 0 or a 1.

5.5.3 SR_BBW messages

A description of the nine different SR_BBW messages appears in table 15. Only the SR_I, SR_SREJ, and SR_FRMR messages carry a payload, all other messages carry a null payload.

Table 15 – SR_BBW messages

Purpose	Message	Command/ Response ^a	Description
Information transfer	SR_I	Command	Carries encapsulated Class 2, 3, 4, or F frames as payload.
Control (Supervisory messages)	SR_RR	Command or Response	Indicates Ready to Receive SR_I messages (negates busy condition) and acknowledges previous SR_I messages; carries no payload.
	SR_RNR	Command or Response	Indicates Receiver Not Ready to accept more SR_I messages (busy condition) and acknowledges previous SR_I messages; carries no payload.
	SR_SREJ	Command or Response	Indicates Selective Retransmission of errored SR_I messages; carries a payload.
Control (Unnumbered messages)	SR_SM	Command	Mode setting command to set up link and resets all messages counters to 0; carries no payload.
	SR_UA	Response	Unnumbered response to the SR_SM command and indicates an acceptance and information transfer phase; carries no payload
	SR_DM	Response	Unnumbered response to the SR_SM command and indicates a disconnected phase; carries no payload
	SR_FRMR	Response	Unnumbered response to the SR_SM command and indicates message reject for the SR_SM message; carries a payload
	SR_DISC	Command	Command indicates the sender is suspending operation and enters the disconnected mode after receiving an SR_UA response; carries no payload
a) Command/Response indicated by the Address Bit in byte 3 of the BBW_Header.			

5.5.4 Format field parameters

5.5.4.1 General

The following subclauses describe the different format fields and other related aspects of the SR protocol.

5.5.4.2 Modulus of SR

Each SR_I message is sequentially numbered and may have the value 0 through modulus minus 1, where “modulus” is equal to 32 768 (i.e., the maximum value of the sequence numbers). The sequence numbers cycle through the entire range.

5.5.4.3 Send state variable V(S)

The send state variable V(S) denotes the sequence number of the next-in-sequence SR_I message to be transmitted. V(S) may take on the values 0 through modulus minus 1. The value of V(S) is incremented by 1 with each successive SR_I message transmission, but cannot exceed the N(R) of the last received SR_I or supervisory message by more than the maximum number of outstanding SR_I messages *k*. The value of *k* is defined in 6.3.8.4.

5.5.4.4 Send sequence number N(S)

Only SR_I messages contain N(S), the send sequence number of the transmitted SR_I message. At the time that an in-sequence SR_I message is designated for transmission, the value of N(S) is set to the value of the send state variable V(S).

5.5.4.5 Receive state variable V(R)

The receive state variable V(R) denotes the sequence number of the next-in-sequence SR_I message expected to be received. V(R) may take on the values 0 through modulus minus 1. The value of V(R) is incremented by 1 by the receipt of an error-free, in-sequence SR_I message whose send sequence number N(S) equals the receive state variable V(R).

5.5.4.6 Receive sequence number N(R)

All SR_I messages and supervisory messages, except SR_SREJ messages with the F bit set to 0, shall contain N(R), the expected send sequence number of the next received SR_I message. At the time that a message of the above types is designated for transmission, the value of N(R) is set to the current value of the receive state variable V(R). N(R) indicates that the BBW transmitting the N(R) has correctly received all SR_I messages numbered up to and including N(R)-1.

5.5.4.7 Functions of the Poll/Final bit (P/F)

All messages contain P/F, the Poll/Final bit. In command messages, the P/F bit is referred to as the P bit. In response messages it is referred to as the F bit.

The Poll bit set to 1 is used by the BBW to solicit (i.e., poll) a response from the remote BBW.

The Final bit set to 1 is used by the BBW to indicate the response message transmitted by the remote BBW, as a result of the soliciting (i.e., poll) command.

The use of the P/F bit is described in 6.3.3.

5.5.5 SR commands and responses

5.5.5.1 Information (SR_I) command

The function of the information (SR_I) command is to transfer a sequentially numbered message containing an information field across a data link.

The SR_I message command carries the mapped byte-encoded Class 2, 3, 4, or F frames. The following steps are involved in generating the SR_I message:

- a) constructing the SR_I message payload by prefixing the proper 32-bit SOF delimiter to the incoming FC-Header, FC frame payload, and the CRC; and appending the corresponding 32-bit EOF delimiter to the CRC; and

NOTE 4 - The original Fibre Channel frame CRC field remains and the sender does not have to send a valid CRC and the receiver does not have to validate the CRC.

- b) constructing the 4-byte SR_Header and prefixing it to the SR_I message payload.