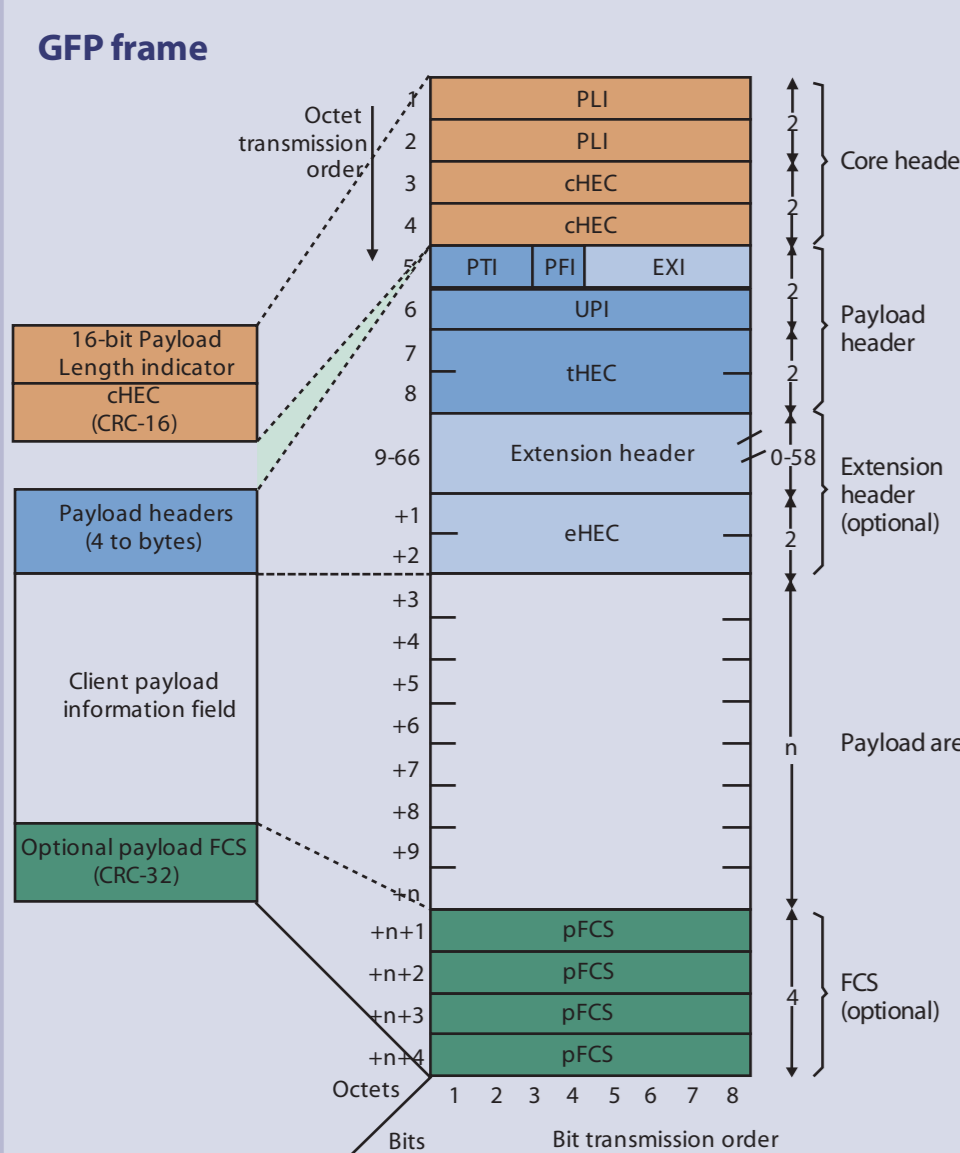
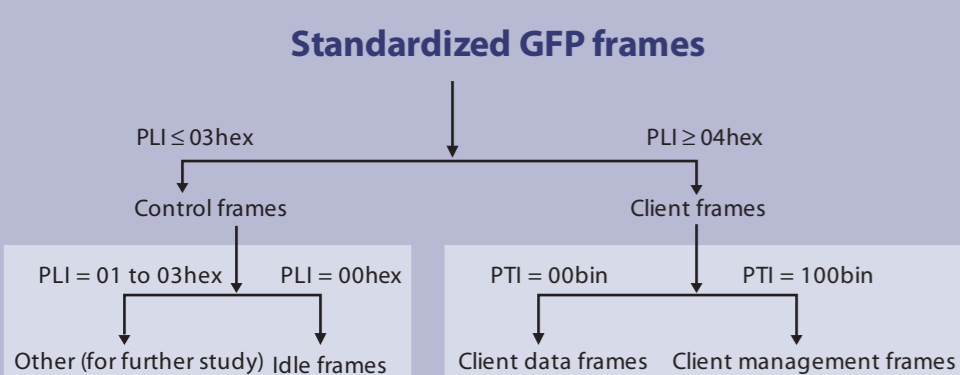


# Evolution of Next-Generation Networks

## Generic Framing Procedure (GFP)

GFP supports the rate adaptation between frame/packet-based traffic and synchronous traffic.



### PDU length indicator (PLI) field

The 2-octet PLI field: A binary number representing the number of octets in the GFP payload area. Minimum value of the PLI field in a GFP client frame is 4 octets.

### Core HEC (cHEC) field

The 2-octet core header error control field: CRC-16 error control code protecting the integrity of the contents of the core header by enabling both single-bit error correction and multi-bit error detection.

### Payload type identifier (PTI)

A 3-bit subfield identifying the type of GFP client frame. GFP client management frame user payload identifier table with PTI = 100, UPI value, and Usage.

### Payload FCS indicator (PFI)

A 1-bit subfield indicating the presence or absence of the payload FCS field. PFI = 0 FCS off, PFI = 1 FCS on.

### User payload identifier (UPI)

An 8-bit field identifying the type of payload conveyed in the GFP payload information field.

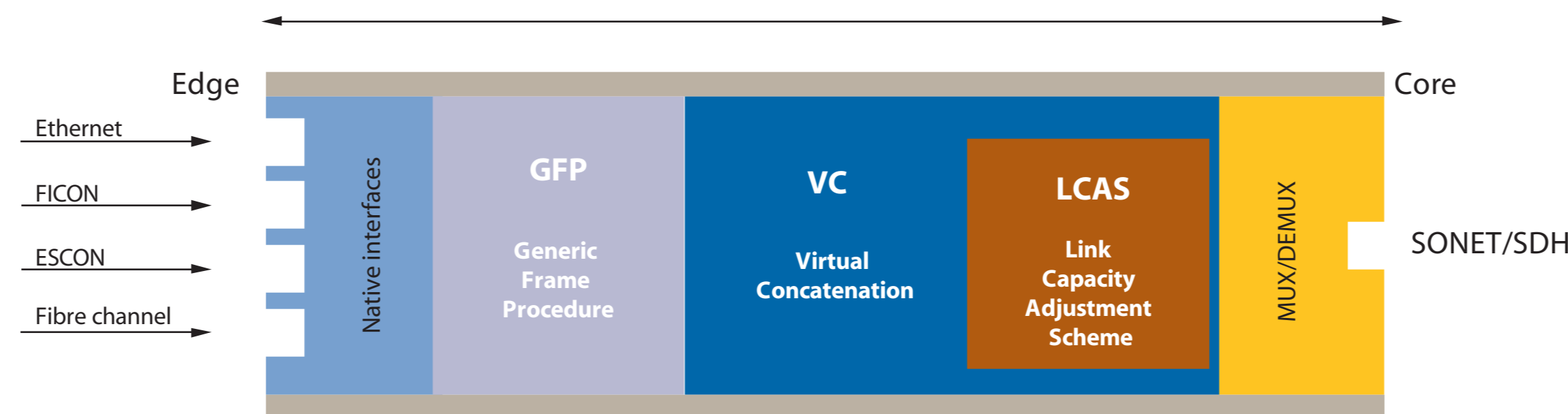
User payload identifier (binary)	Usage
0000 0000	Reserved and not available
0000 0001	Frame-mapped Ethernet
0000 0010	Frame-mapped PPP
0000 0011	Transparent Fibre Channel
0000 0100	Transparent FICON
0000 0101	Transparent ESCON
0000 0110	Transparent Gb Ethernet
0000 0111	Reserved for future
0000 1001	Frame-mapped multiple access Protocol over SDH (MAPOS)
0000 1010	Transparent DVB ASI
0000 1011	Frame-mapped IEEE 802.17
0000 1100	Resilient packet ring
0000 1101	Frame-mapped Fibre Channel FC BBW
0000 1110	Asynchronous transparent Fibre Channel
0000 1111	Frame-mapped MPLS (direct mapping)
1111 0000 through 1111 1110	Reserved for future standardization
1111 1111	Reserved for proprietary use*

### Type HEC (tHEC) field

The 2-octet type header error control field contains a CRC-16 error control code that protects the integrity of the contents of the type field.

## SONET/SDH meets data

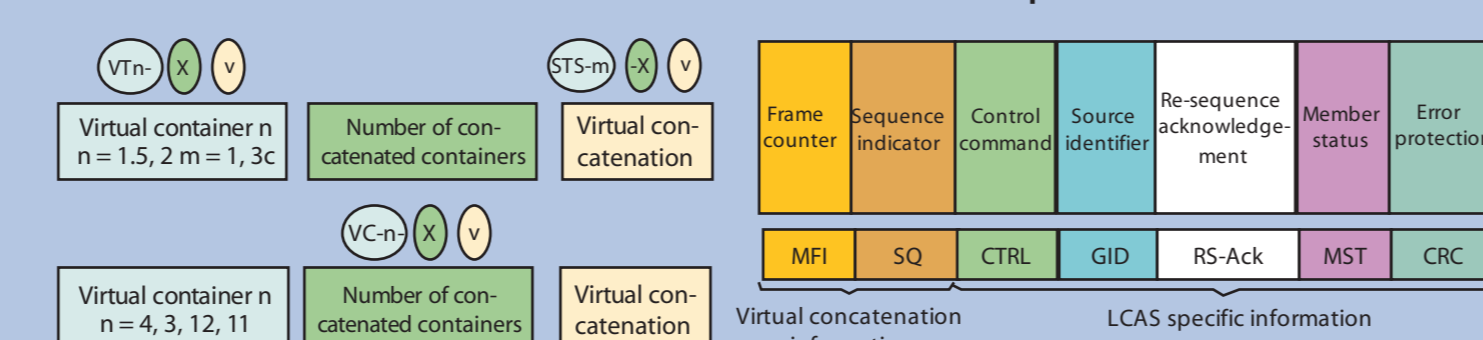
Adaptation



## Virtual Concatenation (VC) and Link Capacity Adjustment Scheme (LCAS)

VC supports the efficient use of transport capacity, LCAS enables the hitless bandwidth provisioning.

### Nomenclature for SONET and SDH virtual containers



VC	High-order VC-3/4, STS-1/3c	Low-order VC-11/12, VT-1.5/2
Frame counter (MFI): A combination of the 1 <sup>st</sup> multiframe and the 2 <sup>nd</sup> multiframe MFI = 0-4095	Frame counter (MFI): Multi-frame counter MFI = 0-31	Frame counter (MFI): Multi-frame counter MFI = 0-31
Sequence indicator (SQ): Number to identify each member in the VCG SQ = 0-255	Sequence indicator (SQ): Number to identify each member in the VCG SQ = 0-63	Sequence indicator (SQ): Number to identify each member in the VCG SQ = 0-63
Member status (MST): The status of all members (256) is transferred in 64 ms.	Member status (MST): The status of all members (64) is transferred in 128 ms.	Member status (MST): The status of all members (64) is transferred in 128 ms.

Parameters that are identical for high and low order VC: Ctrl: → table LCAS CTRL words; GID: Group identification bit, 1 bit identical for all members of the VCG in the multiframe. The content is given by a PRBS 2<sup>15</sup>-1; RS-Ack: Re-sequence acknowledge bit. Toggling value between 0 ↔ 1

### Sequence and multiframe indicator for the H4 coding

Bit	MFI1 (bit 1 to 4)	MFI2 (bit 5 to 8)	MFI1	MFI2
8 bit	0	0	0	0
4 bit	0	0	1	0
1 bit	0	1	0	0
8 bit	0	1	0	1
4 bit	0	1	1	0
1 bit	0	1	1	1
8 bit	1	0	0	0
4 bit	1	0	0	1
1 bit	1	0	1	0
8 bit	1	0	1	1
4 bit	1	1	0	0
1 bit	1	1	0	1
8 bit	1	1	1	0
4 bit	1	1	1	1
1 bit	1	1	1	1

### Sequence and multiframe indicator for the Z7/K4 [1] coding

Bit	Sequence indicator (SQ)	CTRL	GID	Member status	CRC-3
1	0	0	0	0	0
2	0	0	0	0	1
3	0	0	0	0	2
4	0	0	0	0	3
5	0	0	0	0	4
6	0	0	0	0	5
7	0	0	0	0	6
8	0	0	0	0	7

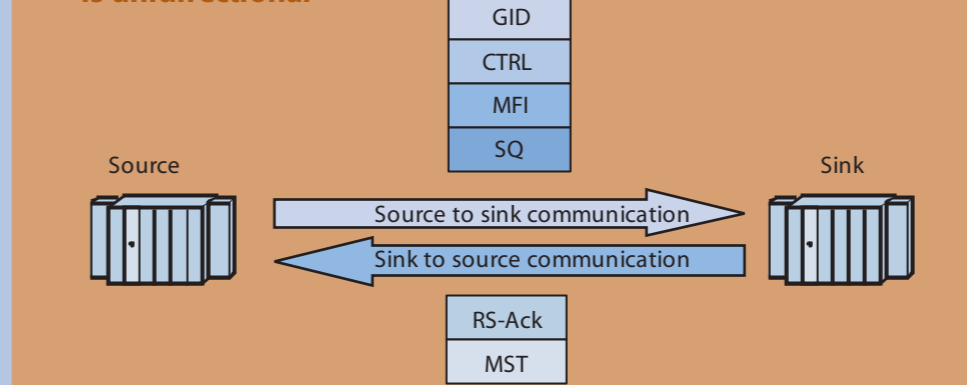
### Sequence and multiframe indicator for the Z7/K4 [2] coding

Bit	Sequence indicator (SQ)	CTRL	GID	Member status	CRC-3
1	0	0	0	0	0
2	0	0	0	0	1
3	0	0	0	0	2
4	0	0	0	0	3
5	0	0	0	0	4
6	0	0	0	0	5
7	0	0	0	0	6
8	0	0	0	0	7

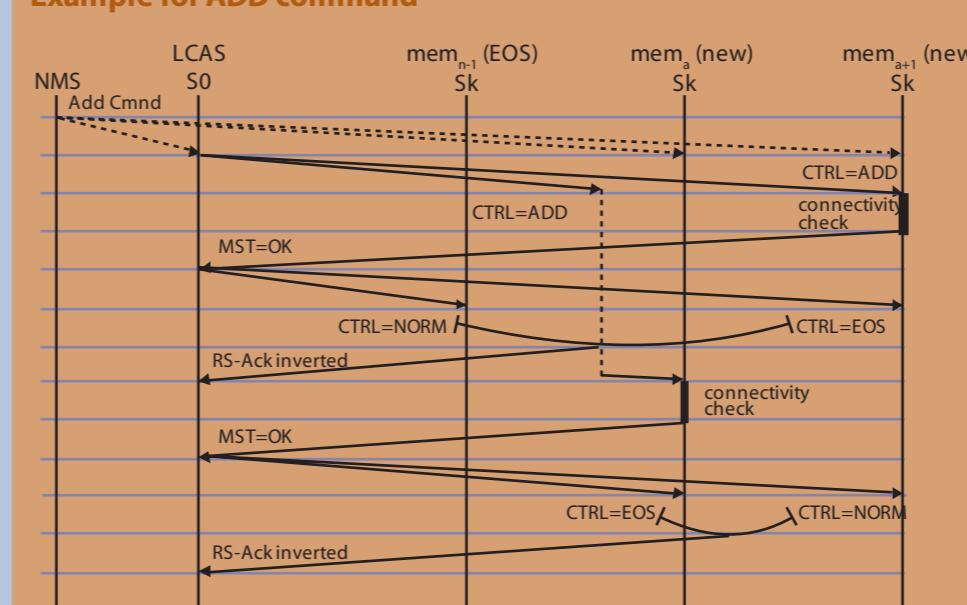
### LCAS CTRL words

Value	Command	Remarks
0000	FIXED	non-LCAS mode
0001	ADD	This member is about to be added to the group
0010	NORM	Normal transmission
0011	EOS	End of sequence indication and normal transmission
0101	IDLE	This member is not part of the group or about to be removed
1111	DNUN	Do Not Use: (the payload) the Sk side reported FAIL status

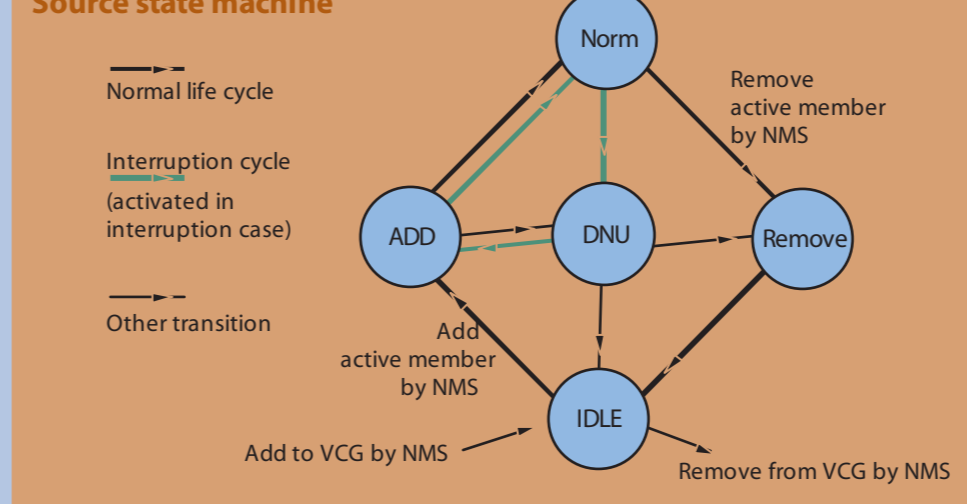
### LCAS communication is unidirectional



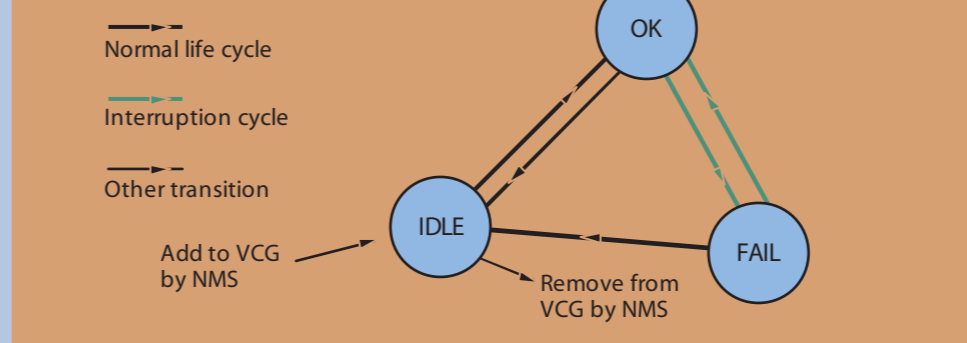
### Example for ADD command



### Source state machine



### Sink state machine



## Events and Abbreviations

Events NewSONET/SDH with NewGen Module 2.5G in accordance with ITU-T G.707 / G.783 / G.7041 / G.7042 / ANSI T.105 and IEEE 802.x / ISO-IEC 8802-3

Abbreviation	Definition	Generation and detection criteria	Abbreviation	Definition	Generation and detection criteria
<b>SONET/SDH</b>			<b>GFP Events</b>		
<b>STS PATH/TRIBUTARY UNIT</b>			<b>Core Header Single Error</b>	Core Header Single Error	Least significant cHEC bit is inverted.
OOM1	Out of Multiframe 1	OOM1 error detected in the MF1 multiframe.	<b>Core Header Multiple Error</b>	Core Header Multiple Error	Two least significant cHEC bits are inverted.
OOM2	Out of Multiframe 2	OOM2 error detected in the MF2 multiframe or first multiframe is in OOM1.	<b>Payload Type Header Single Error</b>	Payload Type Header Single Error	Least significant tHEC bit is inverted.
SQM	Sequence indicator Mismatch	Accepted sequence number does not match expected sequence number.	<b>Payload Type Header Multiple Error</b>	Payload Type Header Multiple Error	Two least significant tHEC bits are inverted.
LOA	Loss of Alignment	Alignment process cannot perform alignment of VCG members. Maximum differential delay exceeded.	<b>Optional CRC</b>	Optional CRC errors	Check sum errors (CRC) in GFP frame.
<b>Virtual Tributary PATH / LO - PATH</b>			<b>Loss of Frame Definition</b>	Loss of Frame Definition	Detect Type header state machine not in SYNC state. Generate/insert multi bit error in core header of GFP frame.
OOM1	Out of Multiframe 1	OOM1 error detected in MF1 multiframe.	<b>Client Signal Fail</b>	Client Signal Fail	Detect alarm frame with "loss of sign" or "loss of character" in Type field LPI Generate select "loss of sign" or "loss of character".
OOM2	Out of Multiframe 2	OOM2 error detected in MF2 multiframe or first multiframe is in OOM1.	<b>MAC Events</b>		
SQM	Sequence indicator Mismatch	Accepted sequence number does not match expected sequence number.	<b>In Range errors</b>		Only with IEEE 802.3. Payload length differs from value in length field.
LOA	Loss of Alignment	Alignment process cannot perform alignment of VCG members. Maximum differential delay exceeded.	<b>Run time frame</b>		Only with IEEE 802.3 and Esh. If frame is shorter than minimum frame length (64 byte).
<b>LCAS Events</b>			<b>Over-sized</b>		Certain number of VCG members have no transport capacity.
LOC	Loss of Transport Capacity	Member does not carry payload.	<b>LOTC (TX-RX)</b>	Loss of Total Transport Capacity	Checksum errors (CRC) in MAC frame.
LOPC (TX-RX)	Loss of Partial Transport Capacity	Certain number of VCG members have no transport capacity.	<b>MAC-FCS Jabber frame</b>		Checksum errors (CRC) in MAC frame.
LOTC (TX-RX)	Loss of Total Transport Capacity	No VCG member has transport capacity - all in LOC state (number 1 threshold).	<b>Lost frames</b>		Missing sequence number in JDSU test frame.
FOP_CRC	Failure of Protocol - excessive CRC errors	More than 3 consecutive CRC errors.	<b>Error frame</b>	Aggregate all frame errors	1. Run time frame 2. Frame too long 3. Alignment error frame
<b>MAC Events</b>			<b>LPAC</b>	Loss of Performance Assessment Capability	Checks all valid MAC criteria. No analyzable frames received for specific time interval or Higher Priority Alarm. Time interval is 10 sec.

## Native Services

Service	Naming	Line rate	Main applications
<b>Ethernet</b>			
This frame-based, connectionless transport protocol is mainly used in LANs and supports frames sizes between 48 and 1500 Bytes in length. Ethernet frames and types are standardized according to IEEE 802.x.	10BaseT	12.5 Mbps	LAN, VPN, NAS, data networks
	100BaseT	125 Mbps	
	1000BaseT	1.25 Gbps	
	10GE WAN	9.953 Gbps	WANs
	10GE LAN	10.313 Gbps	Metro networks
<b>Fibre Channel</b>			
Fibre Channel (FC) is a service that is mostly used in combination with SANs. Here it is of major importance that the channel connections are multi-protocol and allow fast, simple data communication.	FC eighth speed	132.813 Mbps	
	FC quarter speed	265.625 Mbps	
	FC half speed	531.250 Mbps	
	FC full speed	1.063 Gbps	SANs, Video, networks
	FC double speed	2.125 Gbps	
	FC quadruple speed	4.250 Gbps	
<b>ESCON / FICON</b>			
ESCON and FICON are data transport protocols developed for server-to-server and server-to-storage transport.	Enterprise Systems CONnection	200 Mbps	SANs, E-commerce
	Fiber CONnection	1 Gbps	

## Abbreviations

ADM	Add/Drop Multiplexer	GFP-F	Frame mapped GFP	MAC	Media Access Control	SAN	Storage Area Network
APS	Automatic Protection Switching	GFP-T	Transparent mapped GFP	MAPOS	Multiple Access Protocol over SONET/SDH	SDH	Synchronous Digital Hierarchy
cHEC	Core Header Error Control	GID	Group Identifier	MFI	Multi-Frame Indicator	SLA	Service Level Agreement
CID	Channel Identification	GMPLS	Generated Multi-Protocol Label Switching	MST	Member Status	SONET	Synchronous Optical Network
CRC	Cyclic Redundancy Check	HEC	Header Error Control	NAS	Network Attached Storage	SQ	Sequence Indicator
CSF	Client Signal Fail	HELC	High-Level Data Link Control	NE	Network Element	tHEC	Type Header Error Control
DVB	Digital Video Broadcasting	HO	High Order	NMS	Network Management System	UPI	User Payload Identifier
eHEC	Extension Header Error Control	LAN	Local Area Network	OTN	Optical Transport Network	VC	Virtual Concatenation
ESCON	Enterprise Systems Connection	LAPS	Link Access Protocol SDH	PDUI	Payload Data Unit	VCG	Virtual Concatenation Group
EXI	Extension Header Identifier	LCAS	Link Capacity Adjustment Scheme	PLI	PDU Length Identifier	VLAN	Virtual Local Area Network
FC	Fibre Channel	LO	Low Order	PFI	PDU Length Identifier	VPN	Virtual Private Network
FCS	Frame Check Sequence			PTI	Payload Type Identifier	WAN	Wide Area Network
FICON	Fibre Connection			RPR	Resilient Packet Ring		
GFP	Generic Frame Procedure			RS-Ack	Re-Sequence Acknowledge		

To learn more, visit [www.jdsu.com/ont](http://www.jdsu.com/ont)

