Trend's Next Generation SDH

Pocket Guide

VictoriaCombo NG 2.5G

High-performance tool for testing Next Generation SDH/ SONET.

All the features needed to speed up the installation and maintenance of new data-aware SDH networks in a compact, user-friendly battery operated tester.

This new test module enables you to test Ethernet over metropolitan SDH/SONET networks that use Higher and Lower-Order Virtual Concatenation, LCAS and GFP.

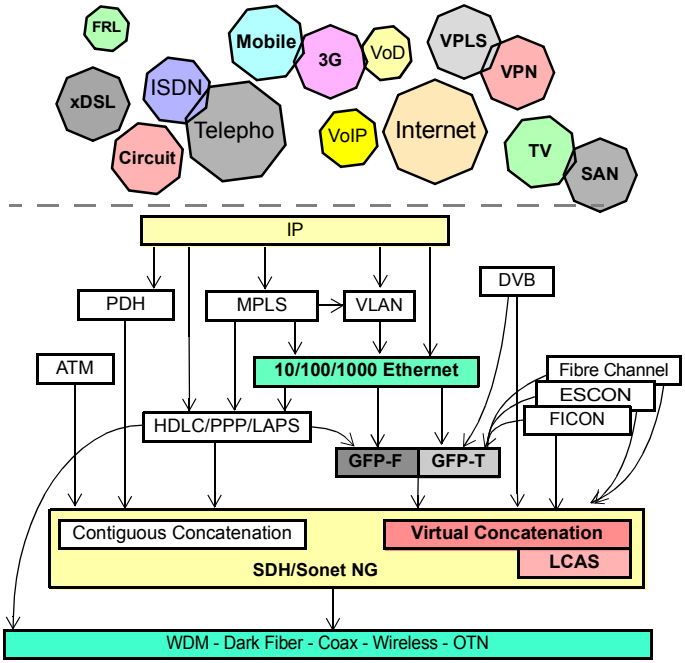


Figure 1 Versatile, flexible and efficient Next Generation SDH

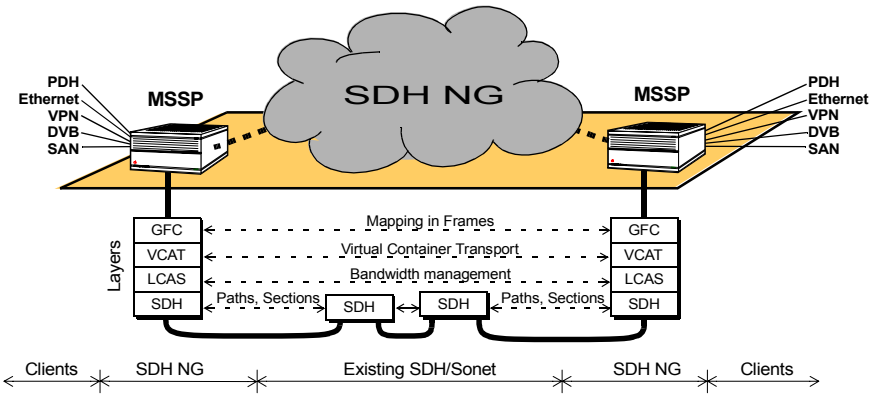


Figure 2 Next Generation SDH enables operators to provide more data transport services while increasing the efficiency of installed SDH/SONET base, by adding just the new MSSP edge nodes. Therefore, it will not be necessary to install an overlap network or migrating all the nodes or fiber optics. This reduces the cost per bit delivered, and will attract new customers while keeping legacy services.

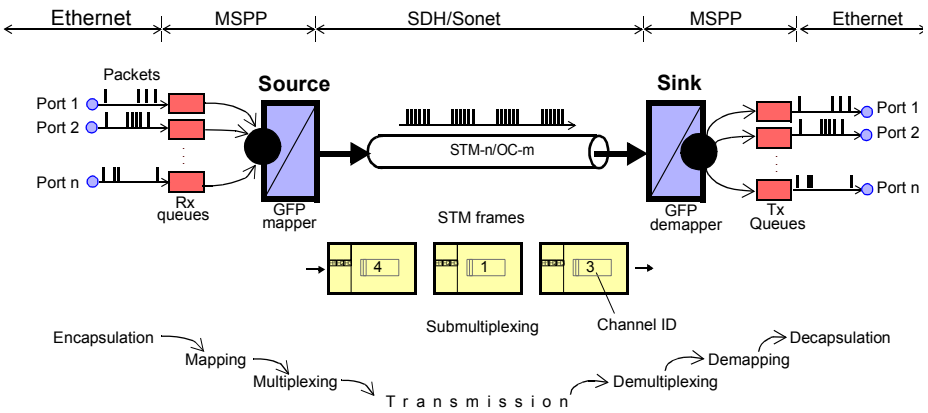
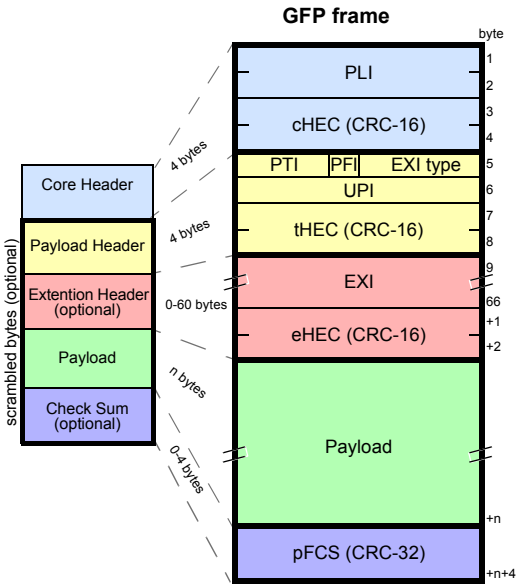
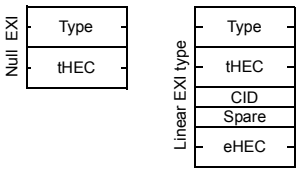


Figure 3 Data packet aggregation using GFP. Packets are in queues, waiting to be mapped onto a TDM channel. At the far end, packets are dropped again to a queue and delivered. GFP frame multiplexing and sub multiplexing. The figure shows the encapsulation mechanism and the transport of the GFP frames into VC containers embedded in the STM frames.



PLI: PDU Length Indicator
cHEC: Core HEC protection
PTI: Payload type Identifier
000: client data
100: client management
PFI: Payload FCS Indicator
1: presence of FCS
0: absence
EXI type: Extension Header Identifier
0000: Null
0001: Linear
0010: Ring
UPI: User Payload Identifier (PTI=0)
01x: Ethernet (GFP-F)
02x: PPP (GFP-F)
03x: Fiber Channel (GFP-T)
04x: FICON (GFP-T)
05x: ESCON (GFP-T)
06x: Gigabit Ethernet (GFP-T)
08x: MAPOS (GFP-F)
09x: DVB (GFP-T)
0Ax: RPR (GFP-F)
0Bx: Fiber Channel (GFP-F)
0Cx: Async Fiber Channel (GFP-T)
tHEC: Type HEC protection
EXI: Extension Header Identifier



tHEC: Type HEC protection
CID: Channel ID for submultiplexing
eHEC: Extension HEC protection
Payload: Space for the framed PDU
pFCS: Payload FCS

Figure 4 GFP frame formats and protocols

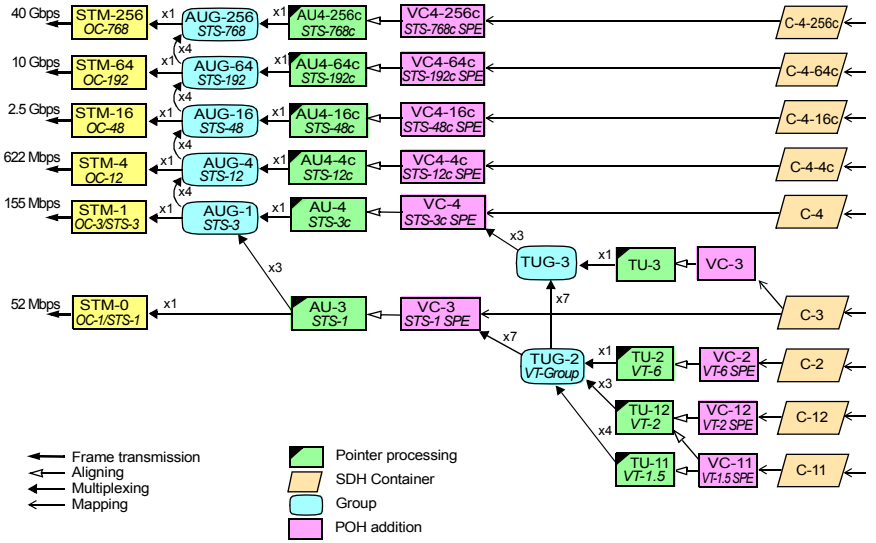


Figure 5 SDH and Sonet multiplexing map

Nine bytes Path Overhead (POH)

SDH	Sonet	
J1	J1	Path trace, message with CRC
B3	B3	BIP-8 parity control
C2	C2	Signal label (mapping)
G1	G1	Path status
F2	F2	Path user channel (voice or data)
H4	H4	Position and sequence indicator
F3	F3	Path user channel (voice or data)
K3	Z3	Automatic Protection Switching
N1	Z4	Tandem Connection Monitoring

C2:

00: unequipped	14: DQDB
01: reserved	15: FDDI
02: TUG	16: HDLC/PPP
03: locked TU	17: SDL
04: E3, T3	18: HDLS/LAPS
12: E4	1A: 10GEthernet
13: ATM	FE: Test Signal

K3:

APS	HODL	Spare

APS: Automatic Protection Switching
HODL: Higher-Order Data Link

G1:

REI	RDI	E-RDI	Spare

REI (Remote Error Indication) BIP-8 violation count
RDI (Remote Defect Indication) is sent back
E-RDI (Enhanced RDI information)
(RDI=0) 10: Payload defect (PLM)
(RDI=1) 01: Server defect (AIS, LOP),
(RDI=1) 10: Connectivity defect (TIM, UNEQ)

multiframe

N1:

IEC	TC REI	OEI	TC-API, TC-RDI ODI, reserved

IEC Incoming Error Count, BIP-8 errors in Tandem Conn.
TC-REI: Remote Error Indication in a TC subnetwork
OEI: Outgoing Error Indication
Multiframe: TC-API (Access Point Identifier)
TC-RDI (RDI in Tandem Connection)
ODI (Outgoing Defect Indication)

H4:

x	x	1	1	x	x	LO Seq

LO Multiframe Sequence
xx11xx00: pointer to V1
xx11xx01: pointer to V2
xx11xx10: pointer to V3
xx11xx11: pointer to V4

H4:

MFI2 (frames 0 and 1) SQ (frames 14 and 15)	Multiframe Indicator 1

VC-3/4-Xv sequence
bit 5-8: MFI1 multiframe indicator (0 to 15)
frame 0 bit 1-4 MFI2 MSB Multiframe Indicator 2
frame 1 bit 1-4 MFI2 LSB
frame 14 bit 1-4 SQ MSB sequence indicator
frame 15 bit 1-4 SQ LSB sequence indicator

Figure 6 Nine bytes Path Overhead is attached to VC3, VC4 and VC4-Xc.

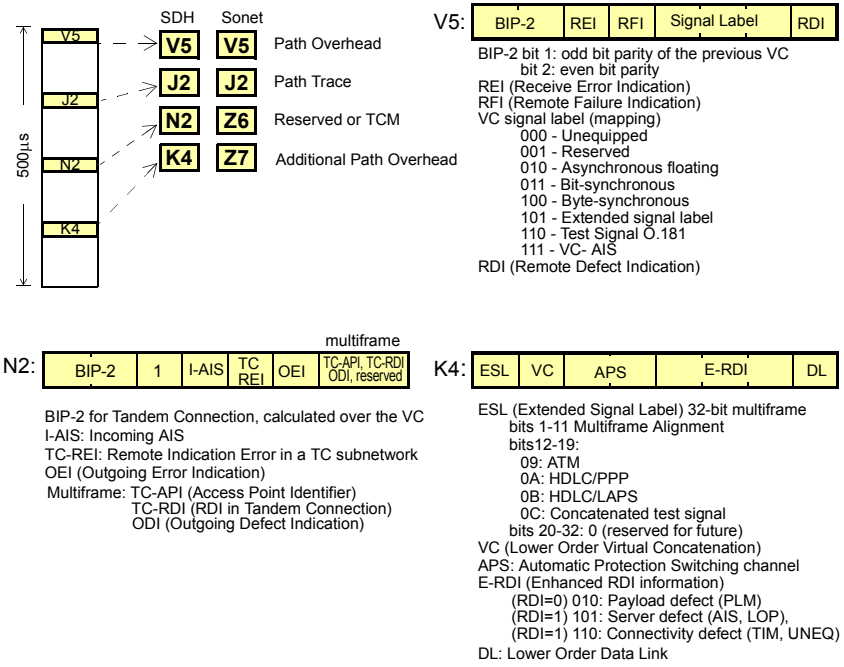


Figure 7 Four bytes Path Overhead is attached to VC11, VC12 and VC2.

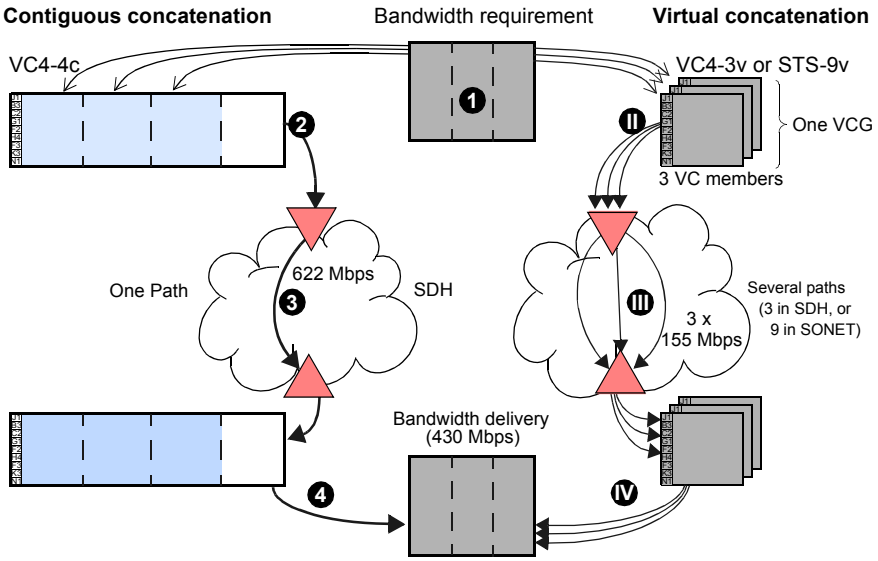


Figure 8 Contiguous concatenation requires support by all the nodes. Virtual concatenation allocates bandwidth more efficiently, and it can be supported by legacy installations.

SDH	SONET	SONET	Size (Bytes)	Rate (Mbps)	Acronym	Capacity Samples
STM-0	STS-1	OC-1	9 x 90	51.840	52M	28DS-1, DS-3, E3, 21E1
STM-1	STS-3	OC-3	9 x 270	155.520	155M	84DS-1, 3DS-3, E4, 3E3, 2E3+21E2, E3+42E2, 63E2
STM-4	STS-12	OC-12	9 x 1080	622.080	622M	4OC-3, 4 STM-1
STM-16	STS-48	OC-48	9 x 4320	2488.320	2.5G	16OC-3, 16 STM-1
STM-64	STS-192	OC-192	9 x 17280	9953.280	10G	64OC-3, 64 STM-1
STM-256	STS-768	OC-768	9 x 69120	39814.120	40G	256OC-3, 256 STM-1

Table 1 Signals and information combinations

SDH	SONET	Bandwidth	Payload
VC-11	VT 1.5 SPE	1,664 kbps	1,600 kbps
VC-12	VT 2 SPE	2,240 kbps	2,176 kbps
VC-2	VT 6 SPE	6,848 kbps	6,784 kbps
VC-3	STS-1 SPE	48,960 kbps	48,384 kbps
VC-4	STS-3c SPE	150,336 kbps	149,760 kbps
VC-4-4c	STS-12c SPE	601,344 kbps	599,040 kbps
VC-4-16c	STS-48c SPE	2,405,376 kbps	2,396,160 kbps
VC-4-64c	STS-192c SPE	9,621,50 kbps	9,584,640 kbps
VC-4-256c	STS-768c SPE	38,486,016 kbps	38,338,560 kbps

Table 2 VC types and capacity

SDH	SONET	X	Capacity	Justification Unit	Transport
VC-4	STS3c-SPE	1	149,760 kbps	3 bytes	STM-1/OC-3
VC-4-4c	STS12c-SPE	4	599,040 kbps	12 bytes	STM-4/OC-12
VC-4-16c	STS48c-SPE	16	2,396,160 kbps	48 bytes	STM-16/OC-48
VC-4-64c	STS192c-SPE	64	9,584,640 kbps	192 bytes	STM-64/OC-192
VC-4-256c	STS768c-SPE	256	38,338,560 kbps	768 bytes	STM-256/OC-768

Table 3 Contiguous concatenation of VC-4-Xc. X indicates the number of VC-*n*

SDH	SONET	Individual Capacity	Number (X)	Virtual Capacity
VC-11	VT.15 SPE	1,600 kbps	1 to 64	1,600 to 102,400 kbps
VC-12	VT2 SPE	2,176 kbps	1 to 64	2,176 to 139,264 kbps
VC-2	VT6 SPE	6,784 kbps	1 to 64	6,784 to 434,176 kbps
VC-3	STS-1 SPE	48,384 kbps	1 to 256	48,384 to 12,386 kbps
VC-4	STS-3c SPE	149,760 kbps	1 to 256	149,760 to 38,338,560 kbps

Table 4 Capacity of virtually concatenated SDH VC-n-Xv or SONET STS-3Xv SPE

Service	Bit Rate	Contiguous Concatenation	Virtual Concatenation
Ethernet	10 Mbit/s	VC-3 (20%)	VC-11-7v (89%)
Fast Ethernet	100 Mbit/s	VC-4 (67%)	VC-3-2v (99%)
Gigabit Ethernet	1000 Mbit/s	VC-4-16c (42%)	VC-4-7v (95%)
Fiber Channel	1700 Mbit/s	VC-4-16c (42%)	VC-4-12v (90%)
ATM	25 Mbit/s	VC-3 (50%)	VC-11-16c (98%)
DVB	270 Mbit/s	VC-4-4c (37%)	VC-3-6v (93%)
ESCON	160 Mbit/s	VC-4-4c (26%)	VC-3-4v (83%)

Table 5 Comparison between Contiguous and Virtual Concatenation efficiency

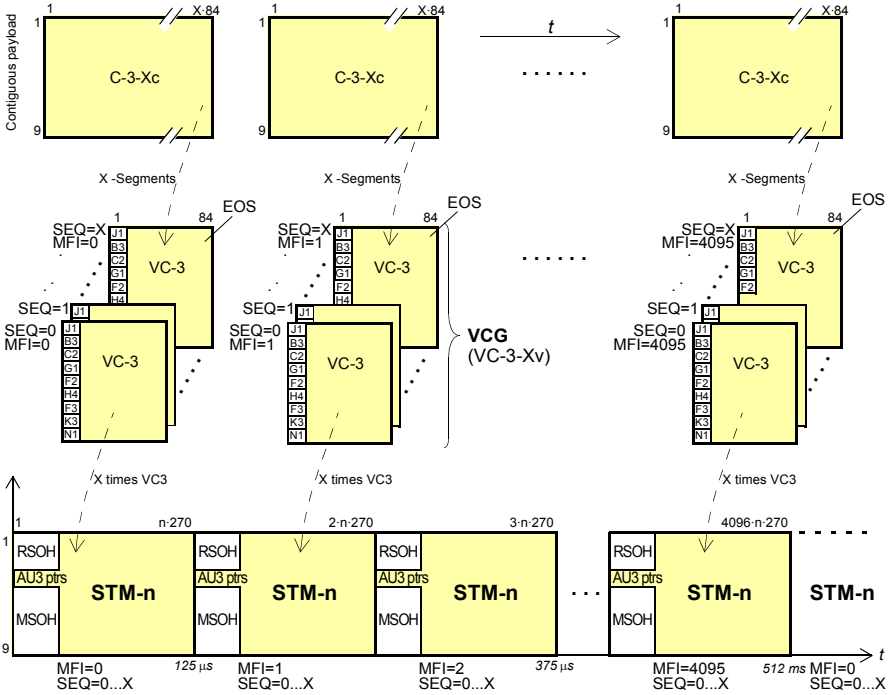


Figure 9 Graphical example of virtual concatenation using VC-3-6v (X=6) with graphical representation of sequence (SQ) and multiframe indicator (MFI) coded on H4.

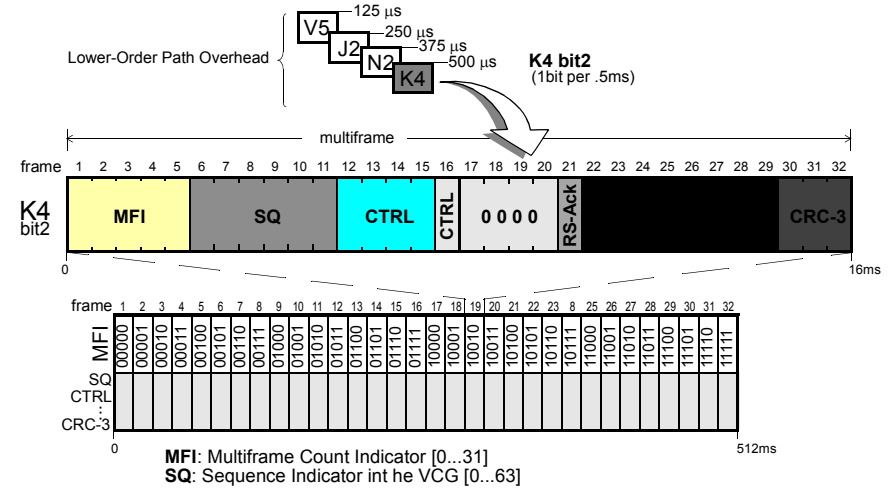


Figure 10 H4 and K4 codification of Multiframes, Sequence and LCAS usage. H4 is repeated every 125 µs, but note that K4 is part of the LO-PO multiframe repeated every 500 µs, then the multiframe created with 32 times the bit-2 needs 500 x 32=16 ms. The whole sequence of 32 multiframes takes 512 ms to repeat.

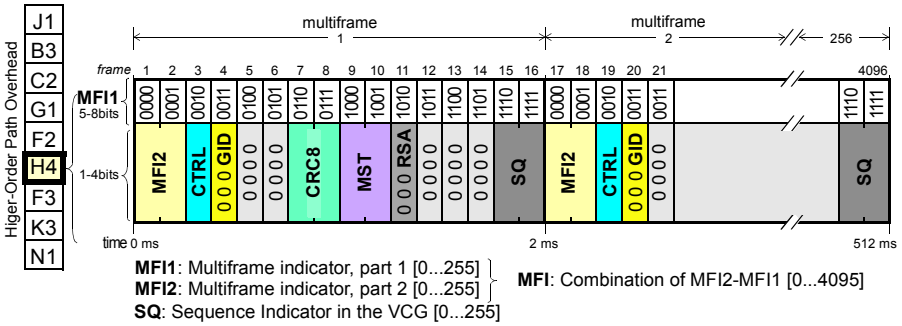
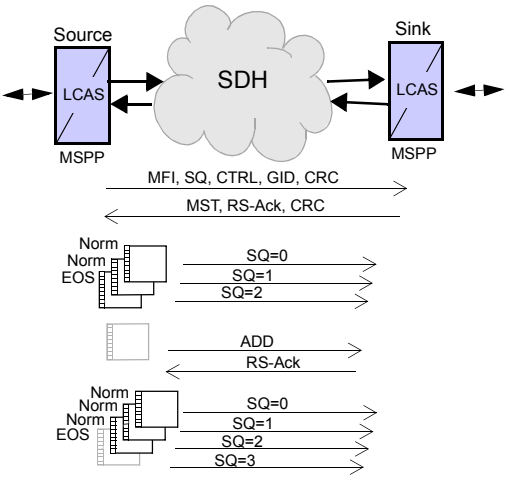


Figure 11 H4 codification for VCAT Multiframes, Sequence, and LCAS usage



LCAS protocol

CNTRL: Control
- 0000 FIXED Non-LCAS mode
- 0001 ADD Member will be added to group
- 0010 NORM Normal LCAS transmission
- 0011 EOS End of Sequence, highest member in group
- 0101 IDLE Member will be removed or not in group
- 1111 DNU Do Not Use, receive side reported MST FAIL status

GID: Group Id. constant value for all members of a VCG.
CRC-3: Generated on the K4 over the previous frames.
MST: Member Status multiframe, one bit per each VCG member
- 0 = OK
- 1 = FAIL

RS-Ack: Re-Sequence Acknoledge

Figure 12 LCAS example: a new member is ADDed to one existing VCG channel to increase the bandwidth of the channel. The network management system orders the source to add this new link to the existing channel

Acronyms

AIS	Alarm Indication Signal
API	Access Path Identifier
APS	Automatic Protection Switching
ATM	Asynchronous Transfer Mode
AU	Administrative Unit
AUG	Administrative Unit Group
BIP	Bit Interleaved Parity
CV	Code Violation
DQDB	Distributed Queue Dual Bus
DVB	Digital Video Broadcasting
EOS	End of Sequence
ESCON	Enterprise Systems Connection
ESL	Extended Signal Label
FCS	Frame Check Sum
FDDI	Fibre Digital Data Interface
FICON	Fibre Channel
FEC	Forward Error Correction
HDLC	High-level Data Link Control
HEC	Header Error Check
HODL	Higher-Order Data Link
HP	Higher-Order Path
IP	Internet Protocol
LAPS	Link Access Procedure – SDH
LCAS	Link Capacity Adjustment Scheme
LO Path	Lower-Order Path
LOF	Loss of Framing
LOH	Lower-Order Overhead
LOM	Loss Of Muliframing
LOP	Loss Of Pointer
LOS	Loss Of Signal
LP	Lower-Order Path
MAPOS	Multiple-Access Protocol over SDH
MFI	Multiframe Indicator
MS	Multiplexor Section
MSOH	Multiplexor Section Overhead
MUX	Multiplexor
MSB	Most Significant Bit
MSSP	Multi-Service Switching Platform
NDF	New Data Flag
OA&M	Operation, Administration and Maintenance
OC-*n*	Optical Carrier level *n*
ODI	Outgoing Defect Indication
OEI	Outgoing Error Indication
OTN	Optical Transport Network
PLM	Payload Mismatch
POH	Path Overhead
PPP	Point-to-Point Protocol
PTI	Payload Type Identifier
RDI	Remote Defect Indication
REI	Remote Error Indication
RFI	Remote Failure Indication
RS	Regenerator Section
RSOH	Regenerator Section Overhead
SAN	Storage Area Network
SDH	Synchronous Digital Hierarchy
SDL	Simplified Data Link
SOH	Section Overhead
SONET	Synchronous Optical Network
SPE	Synchronous Payload Envelope
STM-*n*	Synchronous Transport Module level *n*
STS-*n*	Synchronous Transport Signal level *n*
TC	Tandem Connection
TIM	Trace Identifier Mismatch
TS	Time Slot
TU	Tributary Unit
TUG	Tributary Unit Group
VC	Virtual Container
VCAT	Virtual Concatenation
VLAN	Virtual Local Area Network
VPLS	Virtual Private LAN Services
VT	Virtual Tributary

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More information in:
Installation and Maintenance of SDH/SONET, ATM, xDSL, and Synchronization Networks.
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Trend Communications Ltd.
Whitebrook Park,
Lower Cookham Road,
Maidenhead,
Berkshire, SL6 8XY, UK

TrendCommunications

International: +44 1628 503500
United Kingdom: 01628 503531
France: 01 69 35 54 70
Deutschland: 089 32 30 09 30
España: 93 300 3313
India: 11 25554161
Canada /Latin America: 1 256 461 0790
US Toll Free: 1 877 78TREND
Email: infoline@trendcomms.com
Web: www.trendcomms.com