
SonetExpert™ Channelized Analyzer



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Introduction

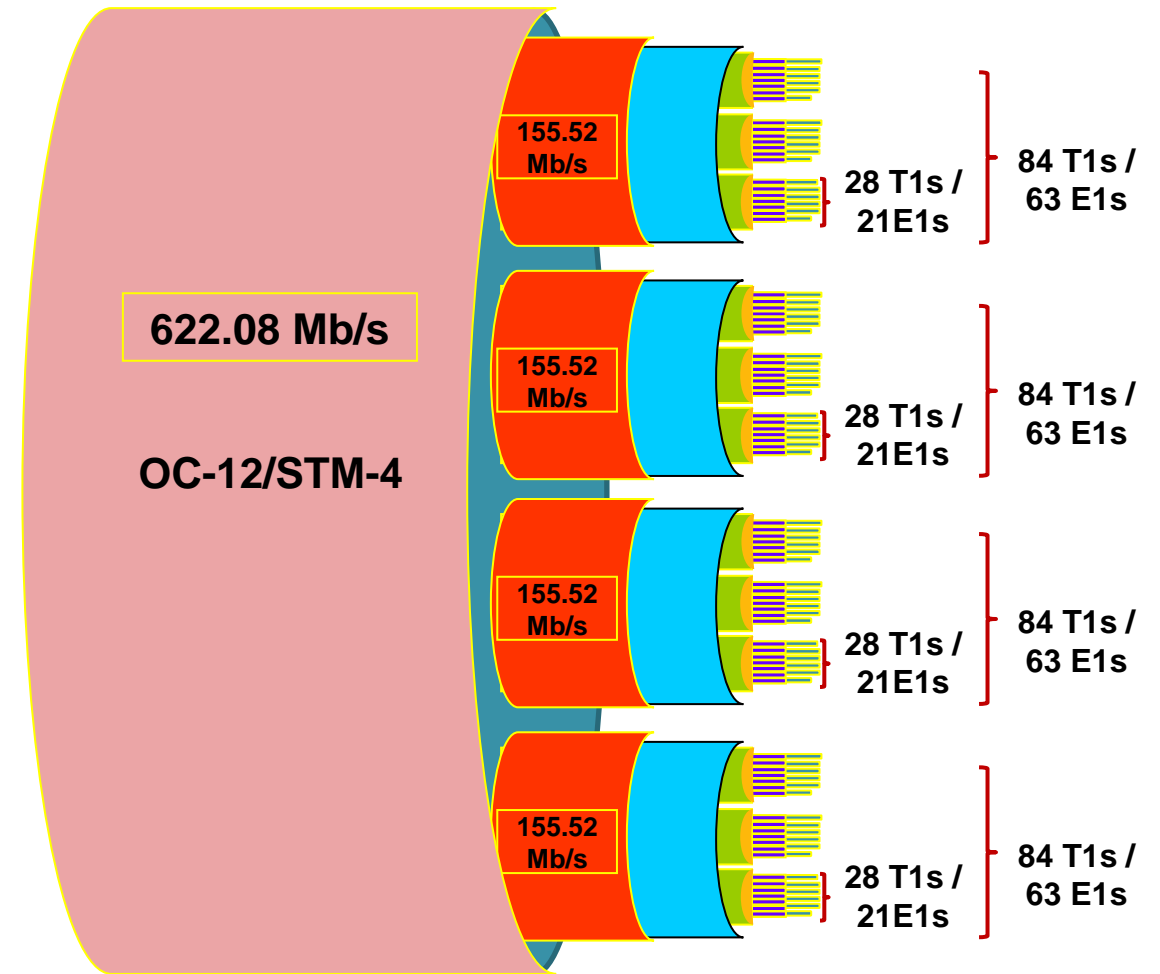
- SONET = Synchronous optical networking. Used in North America
- SDH = Synchronous digital hierarchy. Used in the rest of the world
- SONET and SDH are optical transmission protocols for high-speed data, voice and video traffic
- Data rates
 - SONET: Optical Carrier (OC) - N
 - SDH: Synchronous Transport Module (STM) - N
- SONET/SDH can carry channelized and unchannelized data
 - Channelized = T1 E1
 - OC-3/STM-1 supports 84 T1s or 63 E1s
 - OC-12/STM-4 supports 336 T1s or 252 E1s
 - Unchannelized = Packet over SONET (PoS), Asynchronous Transfer Mode (ATM)

SONET/SDH Line Rates

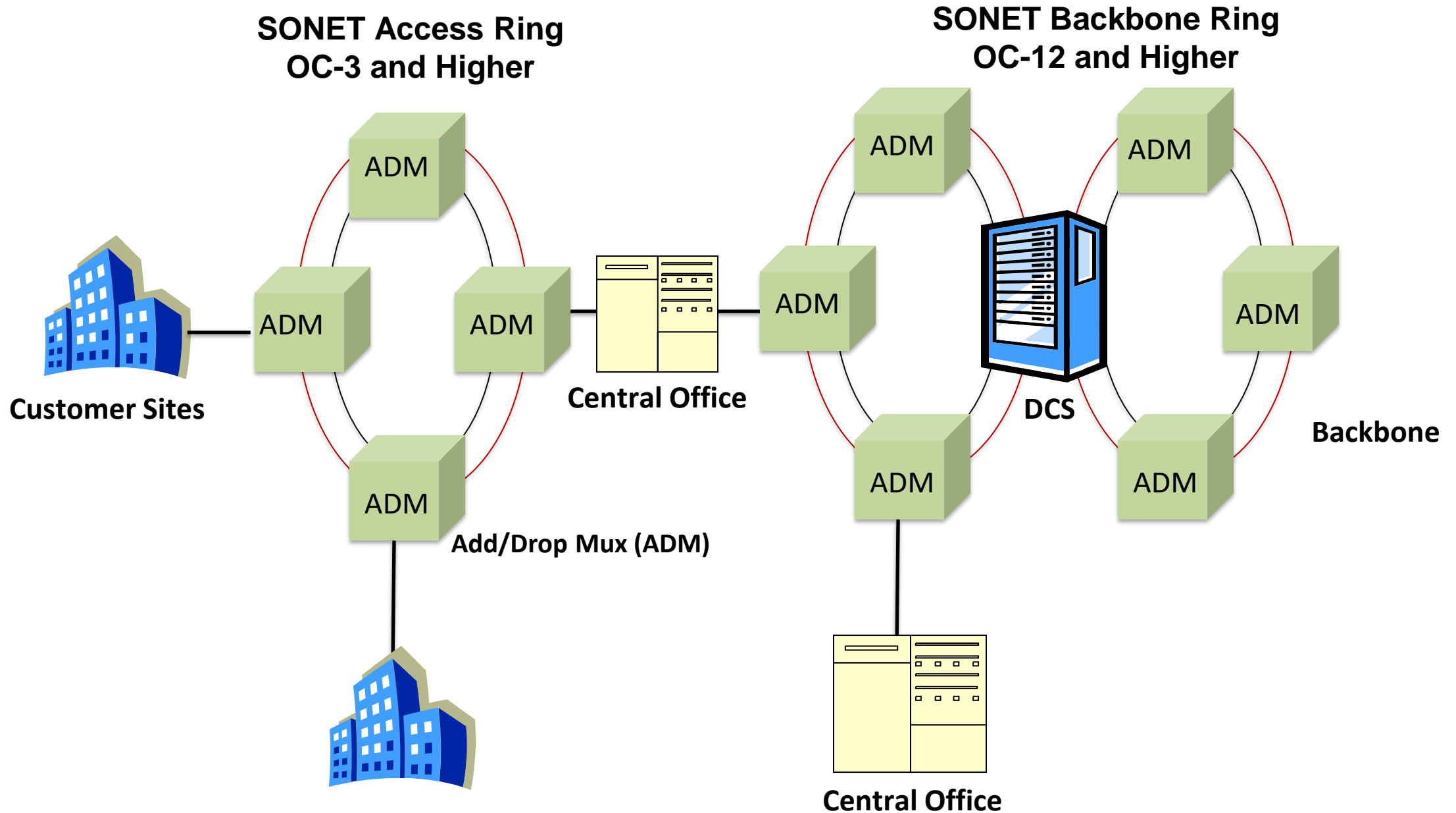
Electrical	Optical (SONET)	Line Rates	SDH Equivalent
STS-1	OC-1	51.84 Mbps	_____
STS-3	OC-3	155.52 Mbps	STM-1
STS-9	OC-9	466.56 Mbps	_____
STS-12	OC-12	622.08 Mbps	STM-4
STS-18	OC-18	933.12 Mbps	_____
STS-24	OC-24	1.2 Gbps	_____
STS-36	OC-36	1.9 Gbps	_____
STS-48	OC-48	2.5 Gbps	STM-16
STS-96	OC-96	5 Gbps	_____
STS-192	OC-192	10 Gbps	STM-64
STS-768	OC-768	40 Gbps	_____
STS-3072	OC-3072	160 Gbps	_____

Channelized OC-3/12 STM-1/4

- DS0 = Digital Signal 0 (64 Kbps)
 - Carries digital traffic (including voice)
- T1 = 24 DS0
- E1 = 32 DS0
- STM-1 = 84 T1 or 63 E1
- STM-4 = 4 STM-1
 - STM-4 = 336 T1
 - STM-4 = 252 E1
- STM-4/OC-12 can support ~ 8000 data streams (voice calls)



SONET Network Elements

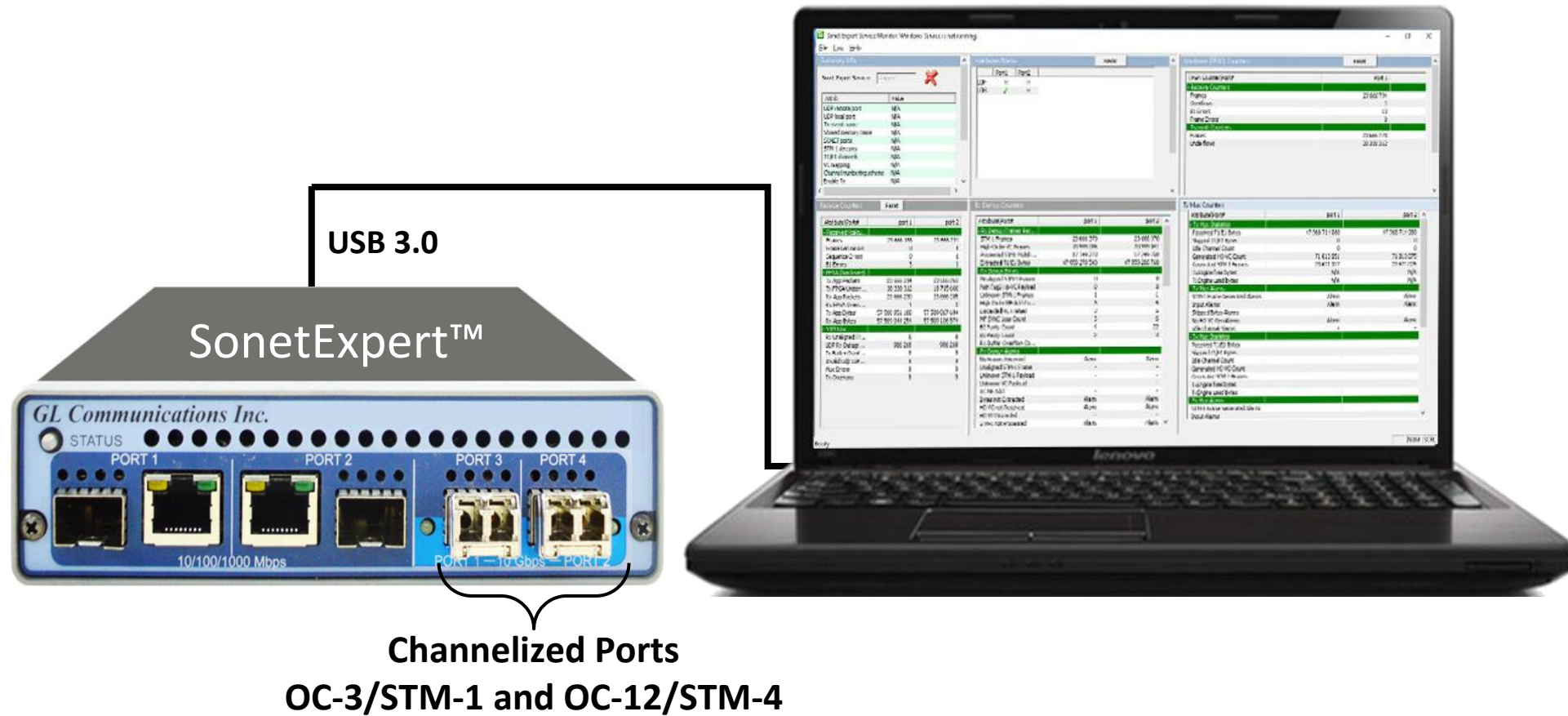


SONET/SDH Testing Scenarios

- Monitor T1s, E1s, and DS0s directly without requiring physical access
 - Accessing individual T1 / E1s on a SONET/SDH link
 - Readily identify traffic types within the complex SONET/SDH structure
 - Capturing and analyzing voice calls for call quality or surveillance
- Load testing SONET/SDH network by generating the maximum number of voice calls/data streams
- Real time alarm detection and management: Send SNMP traps at the individual T1 E1 level for network management

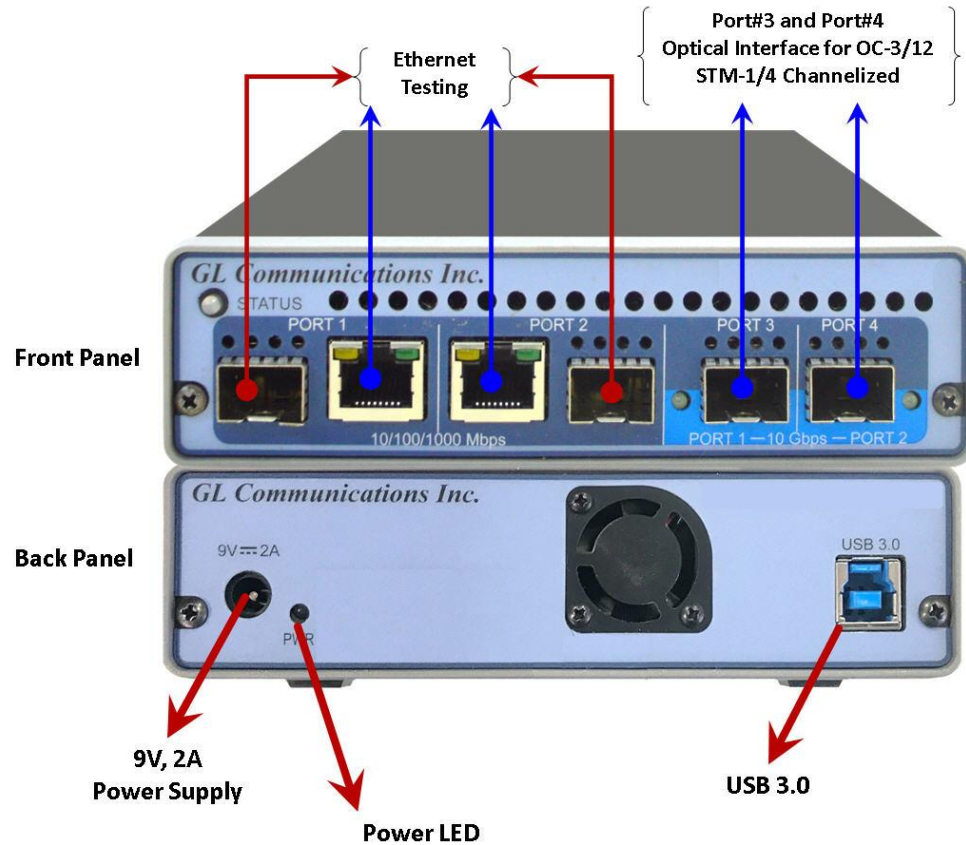
SonetExpert™ SONET/SDH Channelized Testing Solution

SonetExpert™



SonetExpert™ is configured from a Windows® 10 PC via USB 3.0 port

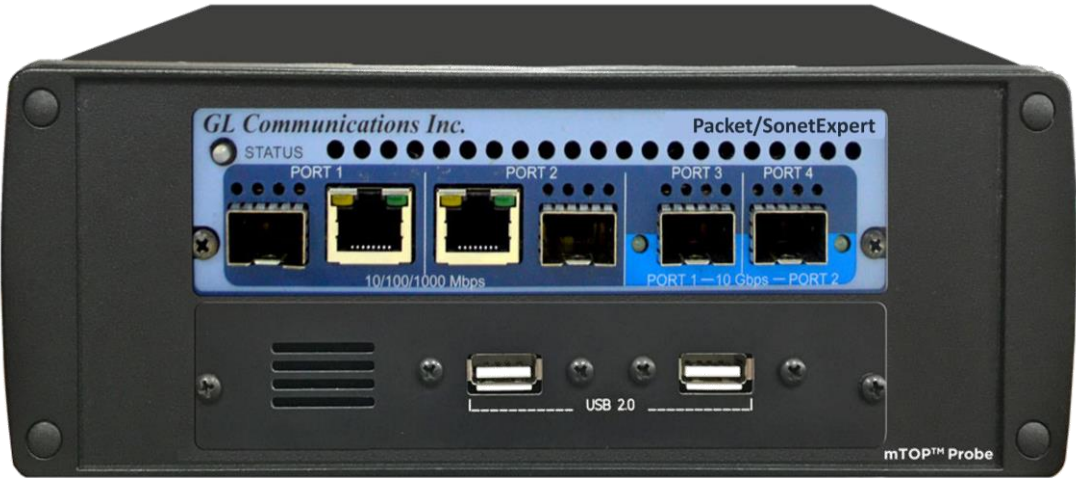
SonetExpert™ Portable Hardware Unit



Interfaces	<ul style="list-style-type: none"> • 2 x Channelized Ports (STM-1/STM-4) • Single Mode or Multi Mode Fiber SFP support with LC connector • USB 3.0 Port
T1 E1	<ul style="list-style-type: none"> • Sync Loss, HDB3 Violation, Carrier Loss, Frame Error, Remote, Distant MF, AIS, BPV Errors, CRC Errors, Frame Errors, Transmit Under Run, Receive Over Run
Power and Dimensions	<ul style="list-style-type: none"> • Length: 8.45 in. (214.63 mm) • Width: 5.55 in. (140.97 mm) • Height: 1.60 in (40.64 mm) • +9 volts, 2.0 Amps

SonetExpert™ mTOP™ Probe unit

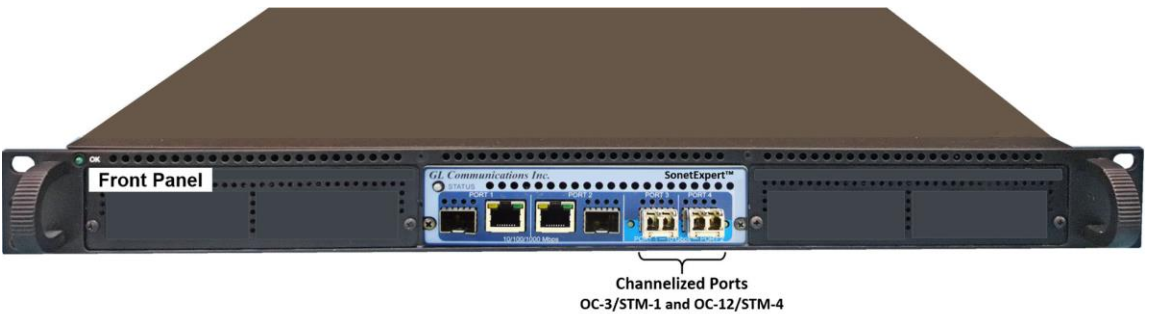
- PacketExpert™ hardware is used for both Packet/SonetExpert™)



Physical Specifications	<ul style="list-style-type: none">• Height: 3.0 Inches (76.2 mm)• Length: 10.4 Inches (264.16 mm)• Width: 8.4 Inches (213.36 mm)• Optional 4-Port SMA Jack Trigger Board (TTL Input/Output)• External USB based Wi-Fi adaptor
SonetExpert™ interfaces (1 unit)	<ul style="list-style-type: none">• 4x 1G Base-X Optical OR 10/100/1000 Base-T Electrical• 2x 10G Base-SR, -LR -ER Optical option• 2 x 100 Mbps Base-FX optical interface• Single Mode or Multi Mode Fiber SFP support with LC connector
External Power Supply	<ul style="list-style-type: none">• +12 Volts, 3 Amps
SBC Specifications	<ul style="list-style-type: none">• Intel Core i3 or optional i7 NUC Equivalent• Windows® 10 64-bit Pro Operating System• USB 2.0 or 3.0 Ports, ATX Power Supply• 256 GB Hard drive, 8G Memory (Min)• Two HDMI ports (Optional VGA to HDMI interface)

SonetExpert™ mTOP™ 1U Rack Solution

SonetExpert™ mTOP™ 1U rack solution
(Front Panel View)



SonetExpert™ mTOP™ 1U rack solution
(Back Panel View)

Physical Specifications	<ul style="list-style-type: none">• Height: 1U Rack• Length: 16 Inches• Width: 19 Inches• mTOP™ System (embedded SBC, 1x SonetExpert™)
SonetExpert™ interfaces (1 unit)	<ul style="list-style-type: none">• Two channelized Ports (STM-1/STM-4)• Single Mode or Multi Mode Fiber SFP support with LC connector
SBC Specifications	<ul style="list-style-type: none">• Intel Core i7, Windows® 10 64-bit Pro Operating System• USB 2.0 or 3.0 Ports, ATX Power Supply• 240GB Hard drive, 8G Memory (Min)

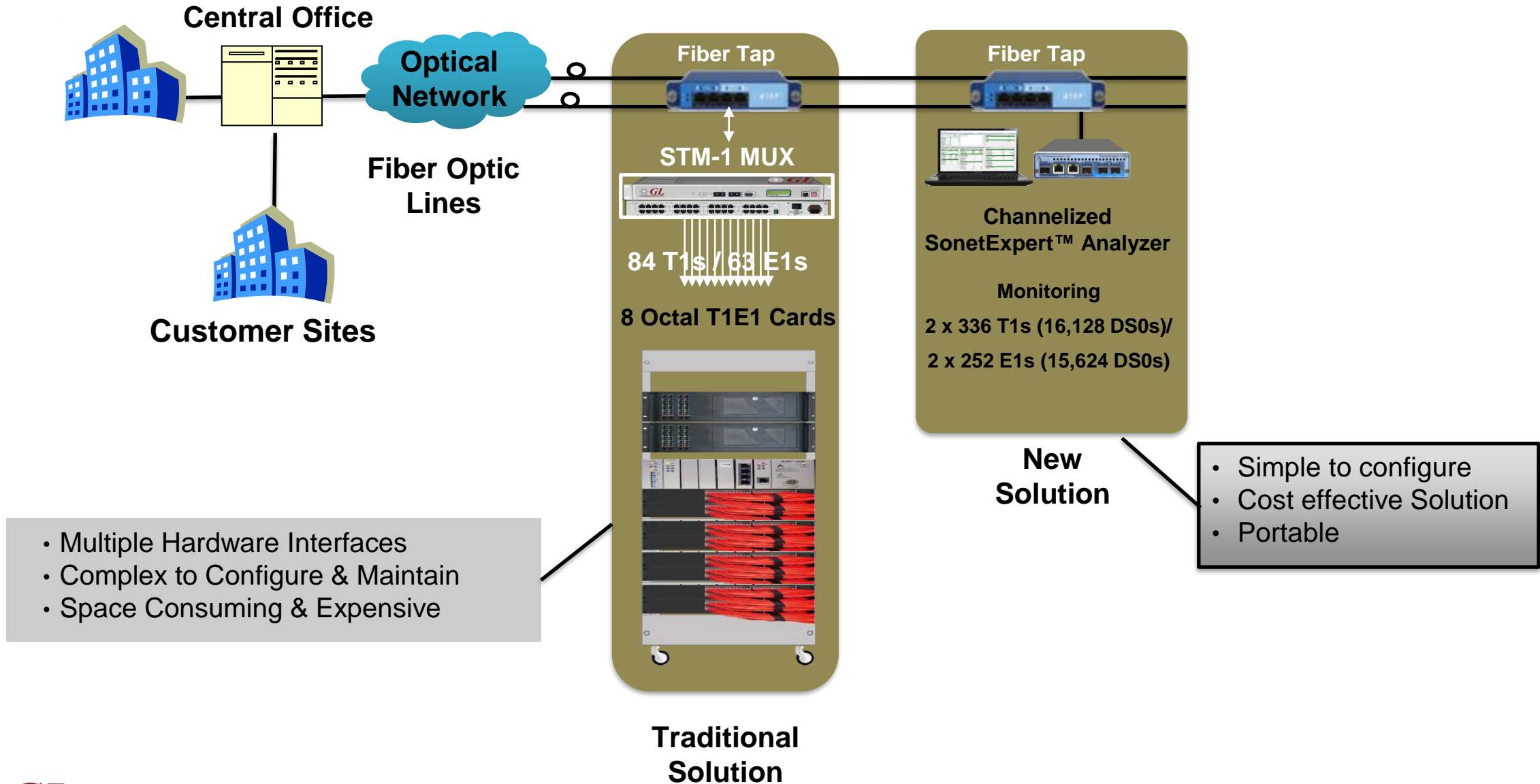
SonetExpert™ Features

- 2 Channelized Ports:
 - OC-3/STM-1 or OC-12/STM-4 interfaces
 - Simulate and monitor in both directions
- Configure the number of T1 E1 channels to be Multiplexed or Demultiplexed
- Analyze / emulate voice, data, fax, protocols, analog and digital signals, including echo and voice quality
- Comprehensive protocol analysis and emulation - HDLC, SS7, ISDN, CAS, PPP, Frame Relay, ATM and more
- Capture, transmit and process at wirespeed
- Broadcasts the selected T1 E1 channel data on all the 252 E1's or 336 T1's
- Direct access to any or all T1s and E1s
 - $2 \times 336 \text{ T1's} \times 24 = 16,128 \text{ DS0s}$
 - $2 \times 252 \text{ E1's} \times 31 = 15,624 \text{ DS0s}$

SonetExpert™ Features (Contd.)

- Pluggable SFPs allow Single Mode (SM), and Multi-mode (MM) fiber optic non-intrusive tap
- Supports any combination of DS0/64/56/16/8 kbps fractional T1 E1, and N x T1 E1 interface definitions (a total of 252 E1s or 336 T1s – in each port)
- Provides Loss of Signal (LOS) and Loss of Frames (LOF) Hardware Alarms indication, Service logging, External Clock, Line and Diagnostic Loopback options, Through mode and Port Swap Cross-port options
- Supports multiplexing multiple T1 or E1 channels to a single channelized OC-3/12 STM-1/4 line
- User configurable OC-3/12, STM-1/4 mapping
- Provides an option to restart the SEC service automatically

Channelized T1 E1 Monitoring



SonetExpert™ Analyzer GUI

Monitor all T1s / E1s

T1 Sonet Expert Channelized Analyzer 64-bit

File Config View Monitor IntrusiveTest Special Applications Window Help

Port Framing

135	ESF (193E)
136	ESF (193E)
137	ESF (193E)
138	ESF (193E)
139	ESF (193E)
140	ESF (193E)
141	ESF (193E)
142	ESF (193E)
143	ESF (193E)
144	ESF (193E)
145	ESF (193E)
146	ESF (193E)
147	ESF (193E)
148	ESF (193E)
149	ESF (193E)
150	ESF (193E)
151	ESF (193E)
152	ESF (193E)
153	ESF (193E)
154	ESF (193E)

Set all cards as selected

< Double-click to change values

T1/E1 Alarms

Reset	All Ports	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	#16	#17	#18	#19	#20	#21	#22	#23	#24	#25
Sync Loss	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Carrier Loss	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Frame Error	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Blue Alarm	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Yellow Alarm	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
AIS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

T1/E1 Statistics

Frequency (Hz)																										
Level (dBdsx)																										
CRC Errors		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Frame Errors		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Transmit Under Run		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Receive Over Run		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Ready

T1/E1 Sync Info

Protocol Analyzers

The screenshot displays the SS7 Protocol Analysis software interface. The main window shows a list of captured frames with columns for Dev, TSlot, SubCh, Frame#, TIME (Relative), Len, Error, OPC MTP3, DPC MTP3, Message Type ISUP, Circuit Identification Code ISUP, Called Address Signal ISUP, Calling Address Signal ISUP, and Cause Value ISUP. The frames show a sequence of messages: Initial address, Address complete, Answer, Release, and Release Complete.

A detailed frame analysis is shown for Card5 TimeSlot=31 Frame=0 at 00:00:07.756250 OK Len=38. The analysis includes HDLC Frame Data + FCS, MTP2 Layer details (BSN, BIB, FSN, FIB, LI), and MTP3 Layer details (Service Indicator, Priority Code, Sub-service field, DPC, OPC, Signalling Link Code).

The Protocol Capture Configuration window is also visible, showing options for Capture File Options, Card & Stream Selection, Capture Filter, and Gui & Protocol Options. The PORT ACTIONS table is expanded, showing 12 ports with various settings.

At the bottom, a table shows the status of various calls, including Call ID, Call Status, Disp, Calling Num, Called Num, Call Start Date & Time, Call Duration, and Release Complete. The status of the calls is 'completed'.

The bottom status bar indicates 'Running. Utilization 0.04%' and 'C:\Program Files\GL Communications Inc\Soft E1 Analyz Captured 2 089 frames'.

ISDN Call Capture and Analysis

Packet Data Analyzer - Summary View

File View Call Summary GUI Configurations Help

ISDN Show All Calls

Call #	StartTime	Caller	Callee	CallReference	SourcePort	DestinationPort	TimeSlot	BearerChannel	InterfaceType	InterfaceId	Result	ReleaseCause	Duration	BillingTime(mSec)	S
1	2019-03-04 16:36:24.426	8556782101	7685612901	2	1	2	16	1	Primary Rate Interface	0	Pass	Normal call clearing	00:01:01.489	60178	
2	2019-03-04 16:36:24.436	8556782102	7685612902	3	1	2	16	2	Primary Rate Interface	0	Pass	Normal call clearing	00:01:01.481	60175	
3	2019-03-04 16:36:24.443	8556782103	7685612903	4	1	2	16	3	Primary Rate Interface	0	Pass	Normal call clearing	00:01:01.476	60172	
4	2019-03-04 16:36:24.450	8556782104	7685612904	5	1	2	16	4	Primary Rate Interface	0	Pass	Normal call clearing	00:01:01.487	60185	
5	2019-03-04 16:36:24.458	8556782105	7685612905	6	1	2	16	5	Primary Rate Interface	0	Pass	Normal call clearing	00:01:01.489	60179	
6	2019-03-04 16:36:24.465	8556782106	7685612906	7	1	2	16	6	Primary Rate Interface	0	Pass	Normal call clearing	00:01:01.484	60176	

Column Width

TimeStamp	Frame Number	1	2
00.00.000	8	1:16	2:16
00.00.986	19	1:16	2:16
00.00.989	20	1:16	2:16
00.00.990	21	1:16	2:16
00.01.153	40	1:16	2:16
01.01.168	66	1:16	2:16
01.01.325	73	1:16	2:16
01.01.489	81	1:16	2:16

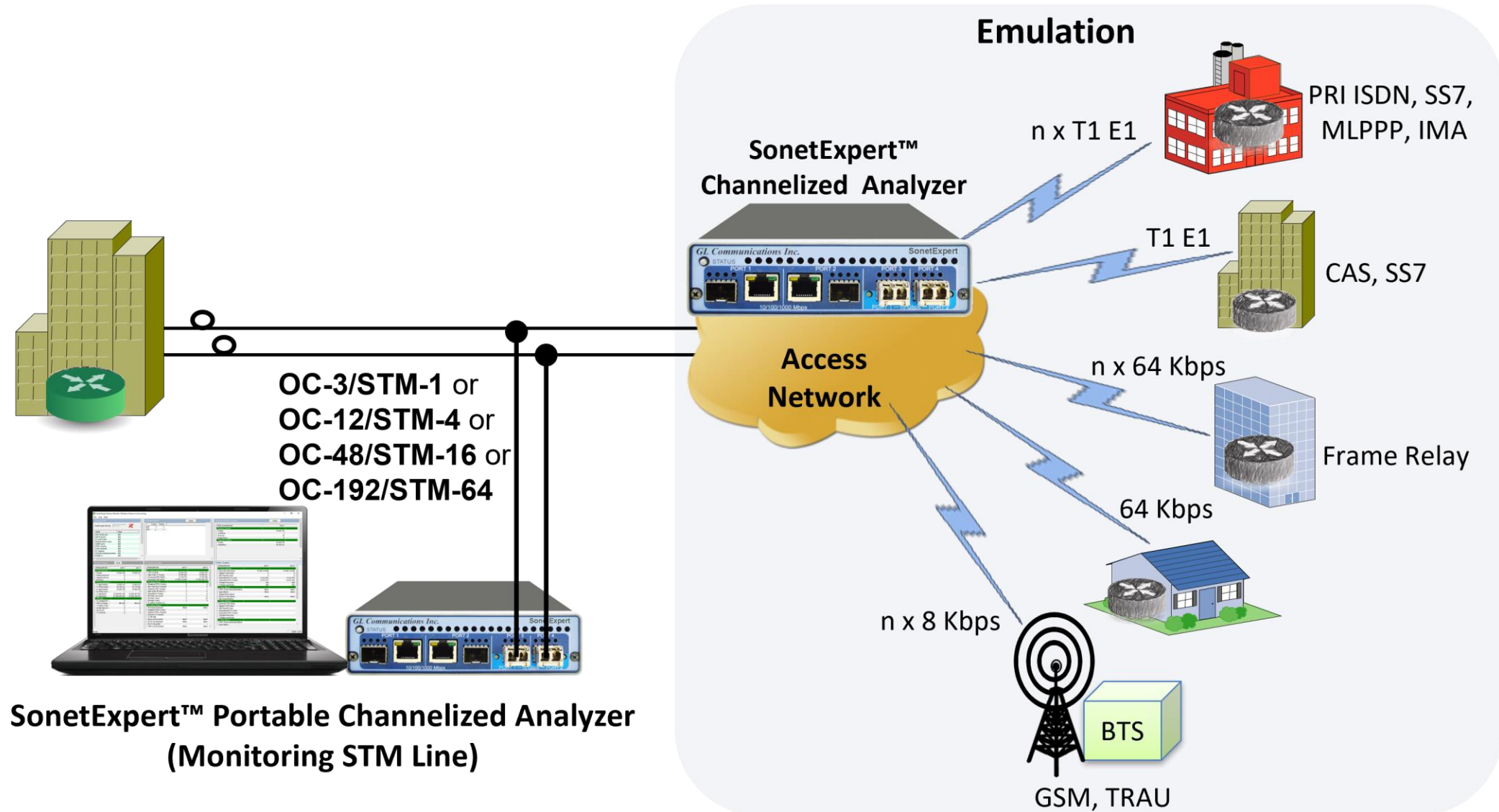
Find

```

===== LAPD Layer =====
C/R = .....0. Command(User) Response(Network)
SAPI = 000000.. (0)
TEI = 0000000. (0)
Ctl = .....0 Information
N(S) = 0000000. (0)
P = .....0 (0)
N(R) = 0000000. (0)
===== Q.931 Layer =====
Protocol Discriminator = 00001000 Q931/I.461 user-network call control
Call Reference Length = .....0010 (2)
Call Reference Value = 2 (.00000000 00000010)
Call Reference Flag = 0..... FROM side that originated call:
Message Type = 00000101 SETUP
IEI Bearer Capability = 00000100 Bearer Capability IE Identifier
IE Bearer Capability Length = 3 (x03)
Information Transfer Capability = ...00000 Speech
Coding Standard = .00..... ITU_T (CCITT) standardized coding
Information Transfer Rate = ...10000 64 kbit/s
Transfer Mode = .00..... Circuit Mode
User Information Layer 1 Protocol (LLC) = ...00011 A-law Rec G.711
User Information Layer 1 Protocol Ident = .01..... (1)
IEI Channel Identification = 00011000 Channel Identification IE Identifier
IE Channel Identification Length = 3 (x03)
    
```

Active Calls Graph Call Graph Call Summary

SonetExpert™ Channelized T1 E1 Emulation



MAPS™ Call Generation, Reception, and Statistics

- Generating 1890 calls continuously

The screenshot displays the MAPS (Message Automation Protocol Simulation) SSP (ISUP ITU) interface, which is used for generating, receiving, and analyzing calls. The interface is divided into several windows:

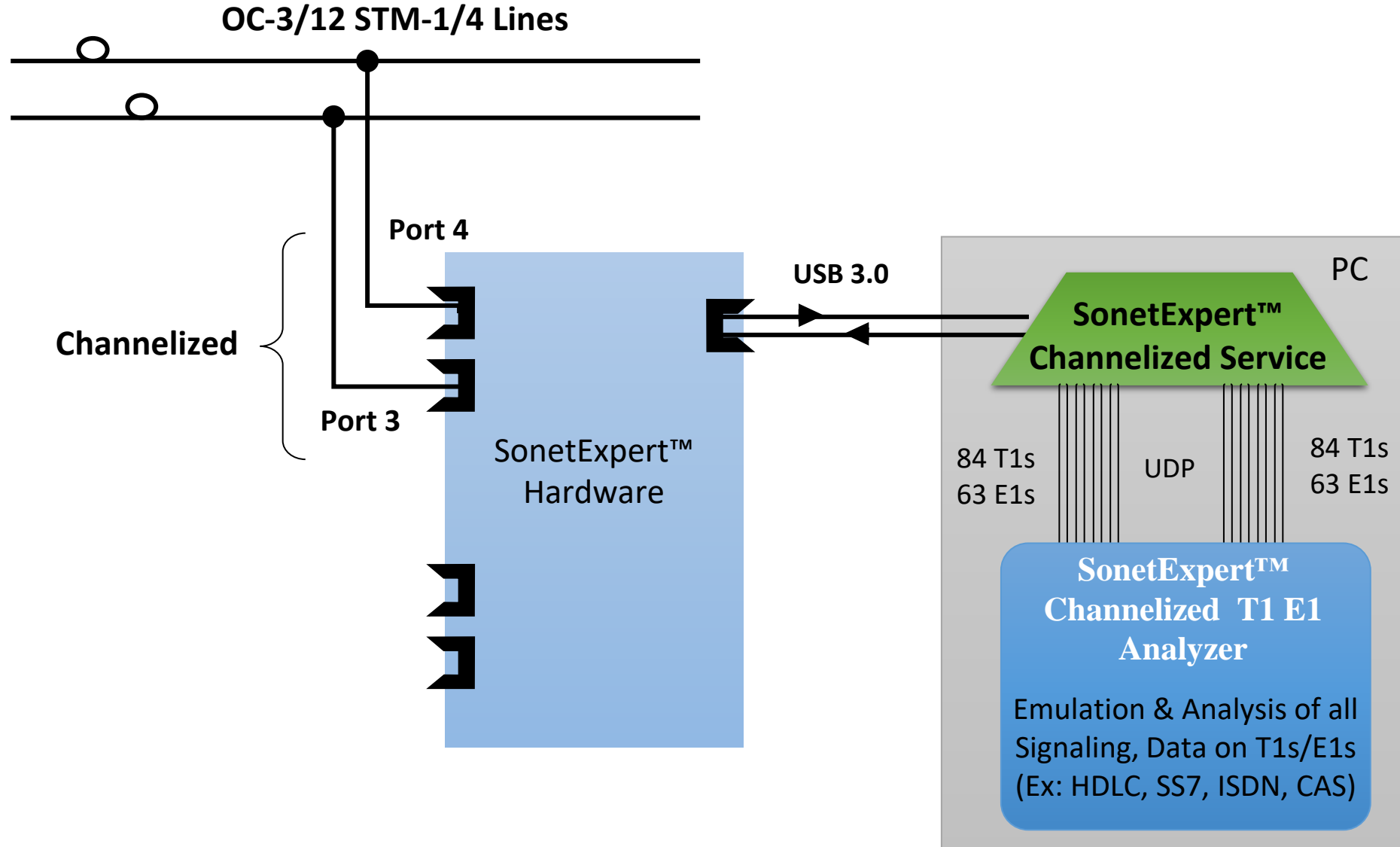
- Call Generation Window:** Shows a list of call generation scripts (Sr No, Script Name, Profile, Call Info, Script Execution, Status, Events, Events Profile, Result, Total Iterations, Completed Iterations). The list includes scripts for generating calls (e.g., Isup_Call.gls) and terminating calls (e.g., SLTM.gls).
- Call Reception Window:** Shows a list of call reception scripts (Sr No, Script Name, Profile, Call Info, Script Execution, Status, Events, Events Profile, Results). The list includes scripts for receiving calls (e.g., SLTM.gls) and terminating calls (e.g., Isup_Call.gls).
- Statistics Window:** Displays call statistics, including Total Calls, Active Calls, Completed Calls, Passed Calls, Failed Calls, and Calls/Sec. It also shows a Call Success Ratio graph and a Call Rate Distribution graph.
- Message Sequence Window:** Shows a sequence of messages (Initial Address, Address Complete, Answer, File Transmitted) and their corresponding timestamps.

The interface includes various toolbars and menus (Configurations, Emulator, Reports, Editor, Debug Tools, Windows, Help) for managing the simulation.

Statistic Name	Total Calls	Active Calls	Completed Calls	Passed Calls	Failed Calls	Calls/Sec
Default	343988	3898	342090	342090	0	0

Call Status	Count
Passed Calls	342090
Failed Calls	0

Working Principle




SonetExpert™ Monitor and Control Application

OC3 Sonet Expert Service Monitor

File Log Help

Summary Info

Sonet Expert Service: **RUNNING** 

Attrib	Value
UDP remote port	20012
UDP local port	20011
Tx event name	SECH_TX_EVENT
Shared memory name	SECH_SMEM
SONET ports	1-2
STM-1 streams	1
T1/E1 channels	1-63
VC mapping	E1_VC3
Channel numbering scheme	Lucent
Enable Tx	YES
Enable broadcast	no
Broadcast src channel	1
Broadcast source STM-1	1
Clock Port 1	Internal
Clock Port 2	Internal
Crossport 1	None
Crossport 2	None
Loopback 1	None
Loopback 2	None

Hardware Alarms

	Port1	Port2
LOF	✓	✓
LOS	✓	✓

Hardware (FPGA) Counters

FPGA Counter\Port#	Port 1	Port 2
- Receive Counters		
Frames	5 088 097	5 088 097
Overflows	0	0
B1 Errors	0	0
Frame Errors	0	0
- Transmit Counters		
Frames	5 088 098	5 088 097
Underflows	0	0

Receive Counters

Attribute\Port#	port 1	port 2
- Received (calcul...)		
Frames	5 072 184	5 072 158
Frame Len Errors	0	0
Sequence Errors	0	0
B1 Errors	0	0
- FPGA (hardware)		
Tx App Packets	5 072 173	5 072 173
Tx FPGA Underr...	0	0
Rx App Packets	5 072 173	5 072 174
Rx FPGA Overruns	0	0
Tx App Bytes	12 325 380 390	12 325 382 820
Rx App Bytes	12 325 382 820	12 325 382 820
- STM Info		
Rx Unaligned Fr...	0	0
UDP Rx Datagrams	317 014	317 014
Tx Buffer Overfl...	0	0

Rx Demux Counters

Attribute\Port#	port 1	port 2
- Rx Demux Frames ...		
STM-1 Frames	8 337 680	8 337 654
High-Order VC Frames	25 012 983	25 012 959
Processed STM1 Mul...	6 253 245	6 253 239
Extracted T1/E1 Bytes	16 804 118 016	16 804 279 296
- Rx Demux Errors		
Misaligned STM-1 Fr...	0	0
Non Tug2 Ho-VC Pa...	0	0
Unknown STM-1 Fra...	1	1
High-Order MF Add ...	3	0
Discarded VC Frames	3	0
MF SYNC Loss Count	3	0
B2 Parity Count	18	0
B3 Parity Count	3	0
Rx Buffer Overflow ...		
- Rx Demux Alarms		

Tx Mux Counters

Attribute\Port#	port 1	port 2
- Tx Mux Statistics		
Received T1/E1 B...	16 814 859 264	16 814 859 264
Skipped T1/E1 Bytes	0	0
Idle Channel Count	0	0
Generated HO VC ...	25 028 763	25 028 979
Generated STM-1 ...	8 342 921	8 342 993
TxEngine free bytes	N/A	N/A
TxEngine used bytes	N/A	N/A
- Tx Mux Alarms		
STM-1 Frame Gen...	Alarm	Alarm
Input Alarms	Alarm	Alarm
Skipped Bytes Alar...	-	-
No HO VC Gen Ala...	Alarm	Alarm
Idle Channel Alarms	-	-

Ready

NUM

Hardware (FPGA) Counters

Tx Mux Counters

SonetExpert™ Channelized Configuration Utility

- SONET/SDH parameters
- OC-3, T1 E1 ports, Channels and Mapping
- Clock setting of SONET/SDH ports
- Cross port and loopback settings

The image shows a screenshot of the 'Sonet Expert Configuration OC3' utility window. The window title is 'Sonet Expert Configuration OC3 (C:\GICommunications\...)'. The main area contains several expandable sections with configuration parameters:

- UDP Ports and Tx Event**
 - UDP remote port: 20012
 - UDP local port: 20011
 - Tx Event Name: SECH_TX_EVENT
 - Shared Memory Name: SECH_SMEM
- OC3, T1/E1 Ports, Channels and Mapping**
 - OC-3 Ports: 1-2
 - STM-1 Streams: 1
 - T1/E1 Channels: 1-63
 - VC Mapping: E1_VC3
 - Channel Numbering Scheme: Lucent
 - Enable Tx: ☒
- Broadcast Settings**
 - Enable Broadcast: ☐
 - Broadcast Source Channel: 1
 - Broadcast Source STM-1: 1
- Clock Settings**
 - Clock Port1: Internal
 - Clock Port2: Internal
- Crossport Settings**
 - Crossport Port1: None
 - Crossport Port2: None
- Loopback Settings**
 - Loopback Port1: None
 - Loopback Port2: None (highlighted in blue)

On the right side of the window, there are buttons for 'OK', 'Expand All', 'Collapse All', 'Set Default', and 'Cancel'. At the bottom, there is a section for 'Loopback Port2' with the text 'Loopback Settings Port 2'.

Optical Connectors and SFP Modules



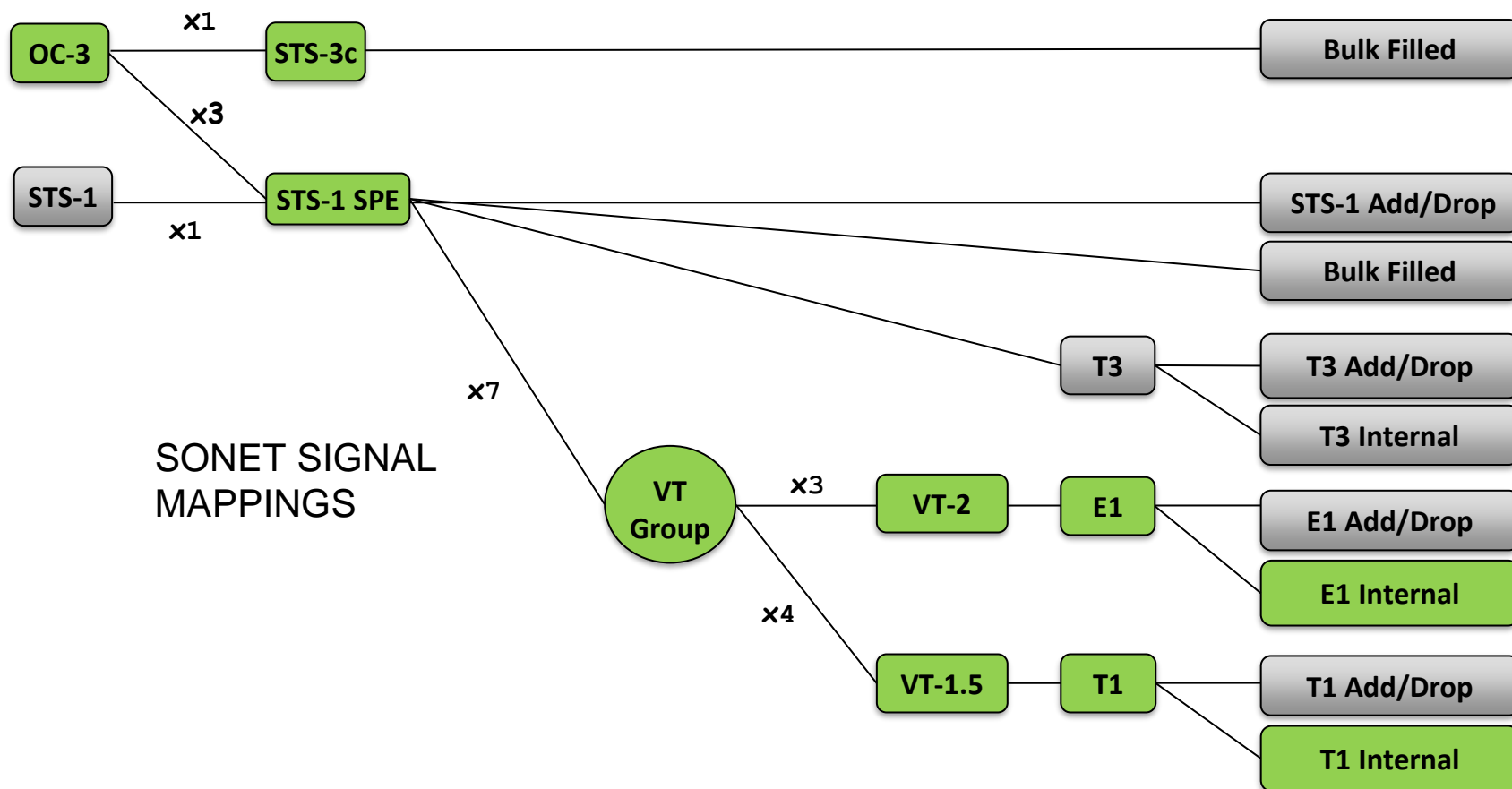
LC Connectors



850 1310 1550 nm SFP Module

VC Mapping and Channel Numbering Scheme

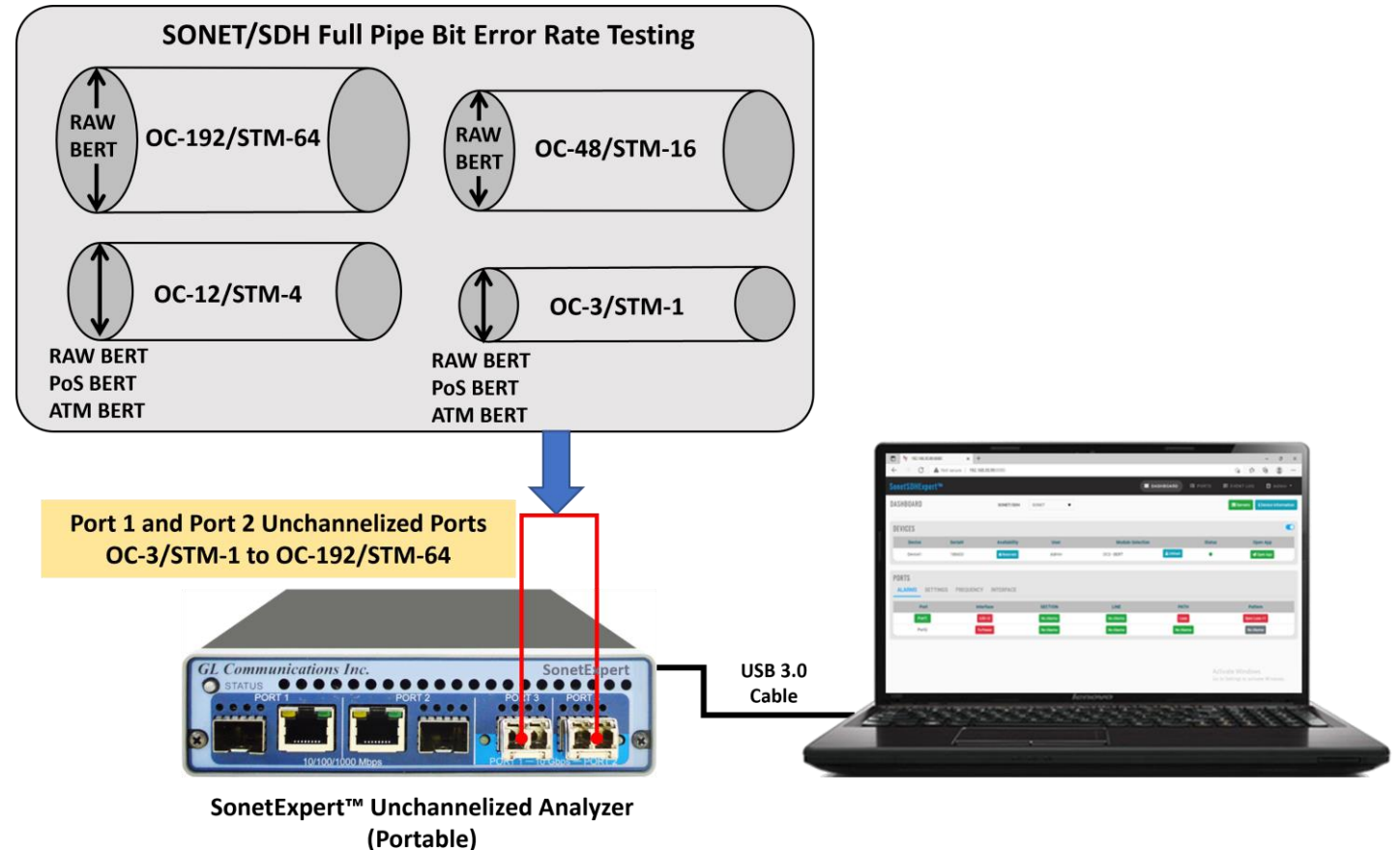
- The paths colored in green are currently supported on the GL's SonetExpert™ hardware



VT – Virtual Tributary
VTG – Virtual Container Group
STS – Synchronous Transport Signal
SPE – Synchronous Payload Envelope
STS-3c – Synchronous Transport Signal 3, concatenated

Unchannelized Analyzer

- Wirespeed processing of ATM, PoS or RAW data for Tx and Rx for both ports
- Supports BERT testing at rates from OC-3 to OC-192
- Ability to capture/playback to/from disk at full rate in both directions for all ports for detailed offline analysis
- Comprehensive transmit/receive testing capabilities; transmitting and verifying data with incrementing sequence numbers with each packet/cell
- Easy to use and flexible Bit Error Rate Test (BERT) application for ATM and POS
- ATM (AAL2, AAL5) Protocol Analyzer, UMTS Protocol Analyzer, PPP (IP and higher layer protocols) Protocol Analyzer
- ATM
 - ATM Forum User Network Interface Specification
 - ATM physical layer for Broadband ISDN according to CCITT Recommendation I.432
- PPP over SONET (PoS)
 - Point-to-Point Protocol (PPP) over SONET/SDH specification according to RFC 2615 (1619) / 1662 of the PPP Working Group of the Internet Engineering Task Force (IETF)
- OC-3/OC-12/STM-1/STM-4 Transparent Payload
 - Analyzer processes SONET/SDH payload in transparent (RAW) mode without any transport protocols



SonetExpert™ Monitor and Control GUI Functionalities

- Starting and stopping the SEC service
- Configuring SEC service
- Launching Soft T1 E1 Analyzer
- Viewing and clearing the SEC service log
- Displaying alarms, error counters and operational statistics

Thank you