Ethernet Tester – PacketExpert
10 Gbps, 2.5 Gbps, or 1 Gbps™

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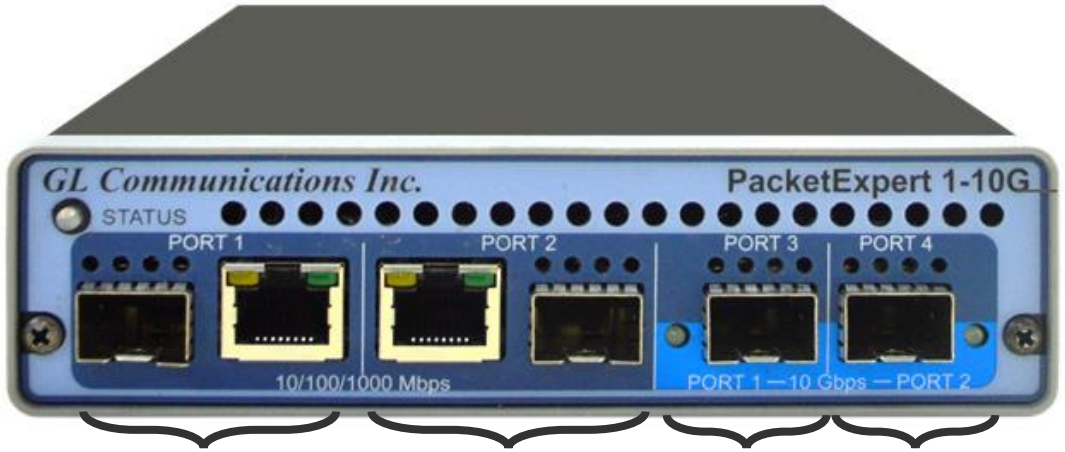
PacketExpert™ 10GX - Portable Unit (PXN100, PXN101)



Physical Specifications	• Length: 8.45 in (214.63 mm) • Width: 5.55 in (140.97 mm) • Height: 1.60 in (40.64 mm) • Weight: 1.713 lbs
External Power Supply	• +12 Volts (Medical Grade), 3 Amps (For portable units having serial number ≥ 188400) • +9 Volts, 2 Amps (For portable units having serial number < 188400)
BUS Interface	• USB 3.0 • Optional 4-Port SMA Jack Trigger Board(TTL Input/Output)
Protocols	• IEEE 802.3ae LAN PHY compliance • RFC 2544 compliance

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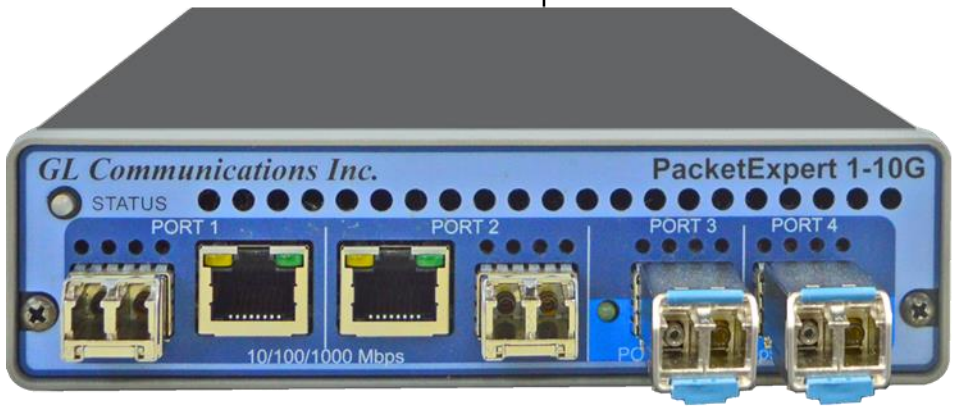
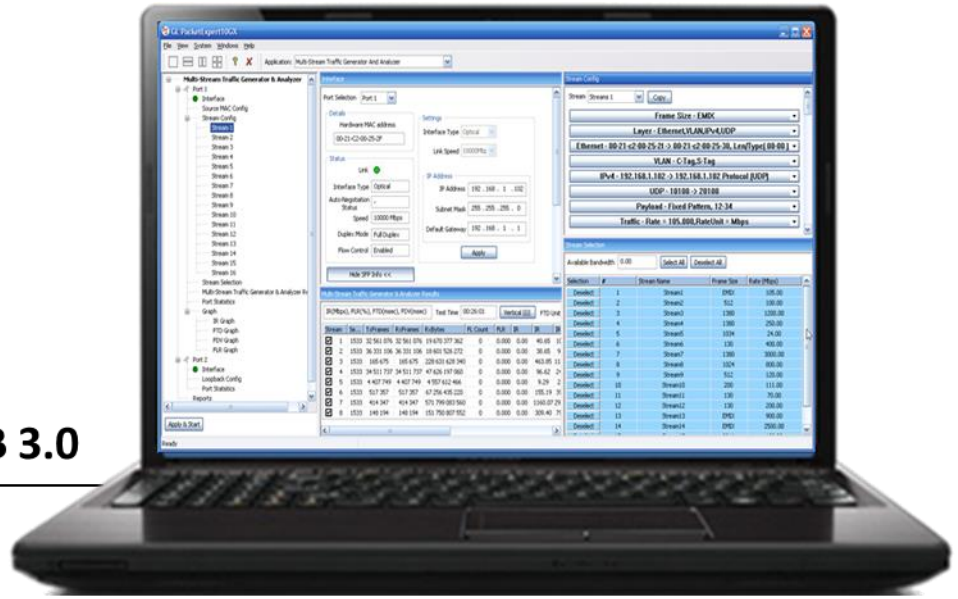
PacketExpert™ Software



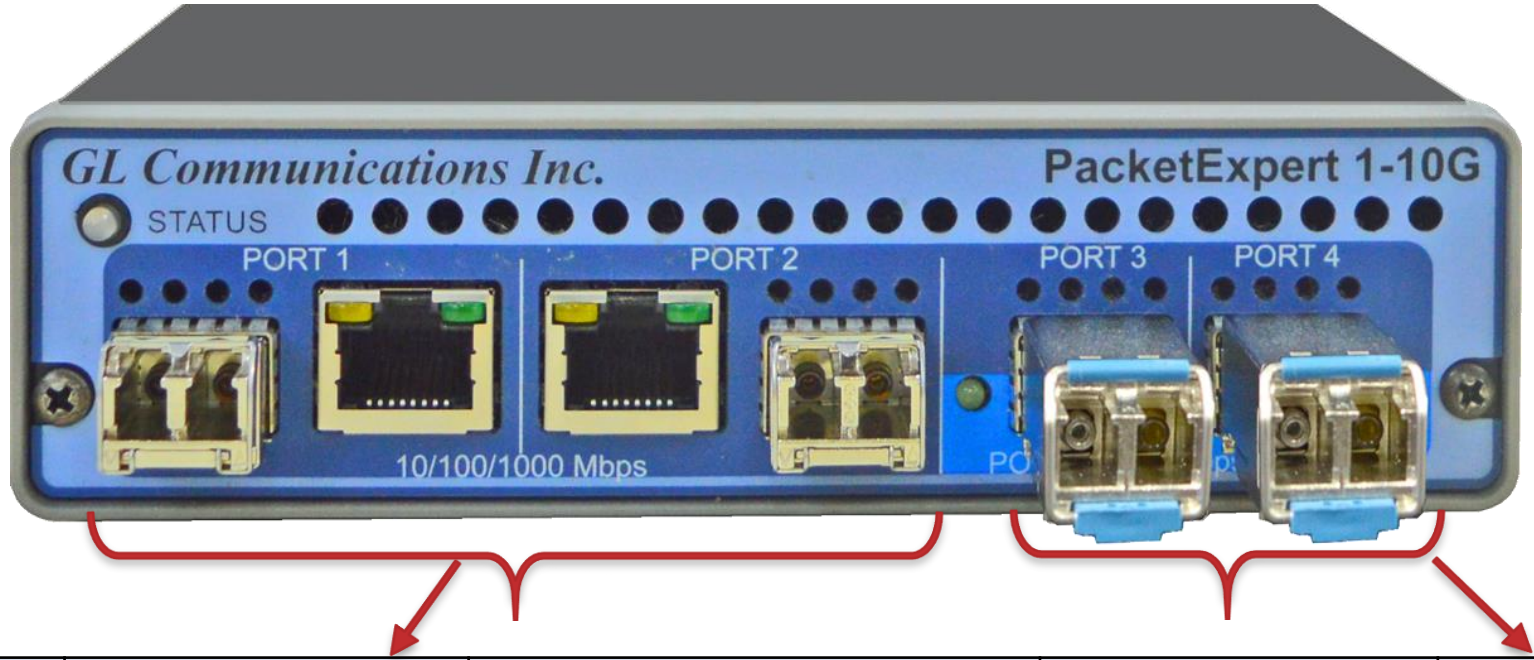
USB 3.0



PacketExpert™ 10GX
(10/2.5/1Gbps)
(10/100/1000 Mbps)

Windows 10/11 64-bit OS

PacketExpert™ 10GX – 1 Gbps Mode



Ports		Port 1		Port 2		Port 3	Port 4
Interface Type		SFP	RJ45	SFP	RJ45	SFP+	SFP+
Electrical	Speeds	10/100/1000 Mbps		10/100/1000 Mbps		10/100/1000 Mbps	10/100/1000 Mbps
	Designations	10BASE-T 100BASE-TX 1000BASE-T		10BASE-T 100BASE-TX 1000BASE-T		10BASE-T 100BASE-TX 1000BASE-T	10BASE-T 100BASE-TX 1000BASE-T
Optical	Speeds	100/1000 Mbps		100/1000 Mbps		1000 Mbps	1000 Mbps
	Designations	100BASE-FX 1000BASE-X		100BASE-FX 1000BASE-X		1000BASE-X	1000BASE-X

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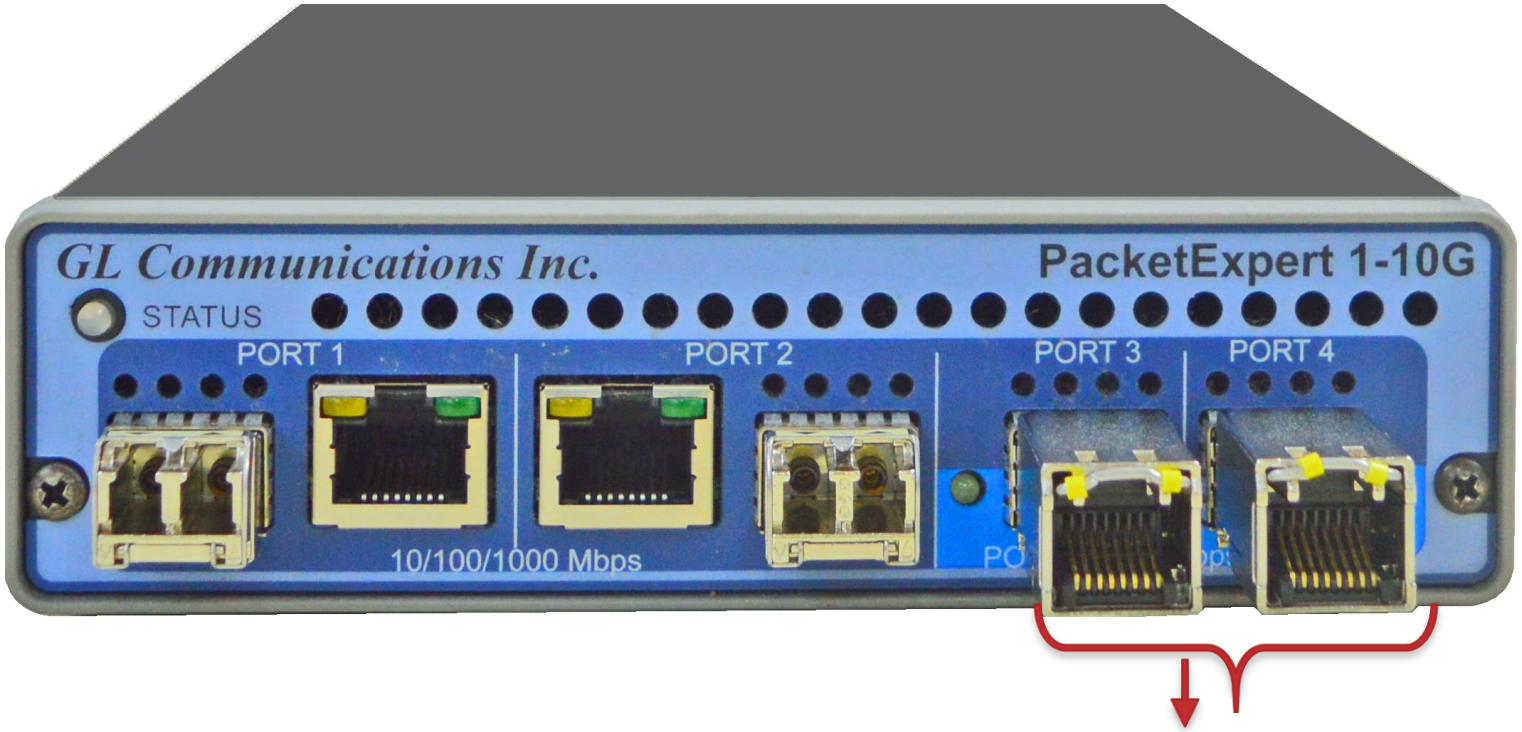
PacketExpert™ 10GX – 2.5 Gbps Mode



Ports		Port 1	Port 2
Interface Type		SFP+	SFP+
Electrical	Speeds	2.5 Gbps	2.5 Gbps
	Designations	2500BASE-T	2500BASE-T
Optical	Speeds	2.5 Gbps	2.5 Gbps
	Designations	2500BASE-X	2500BASE-X

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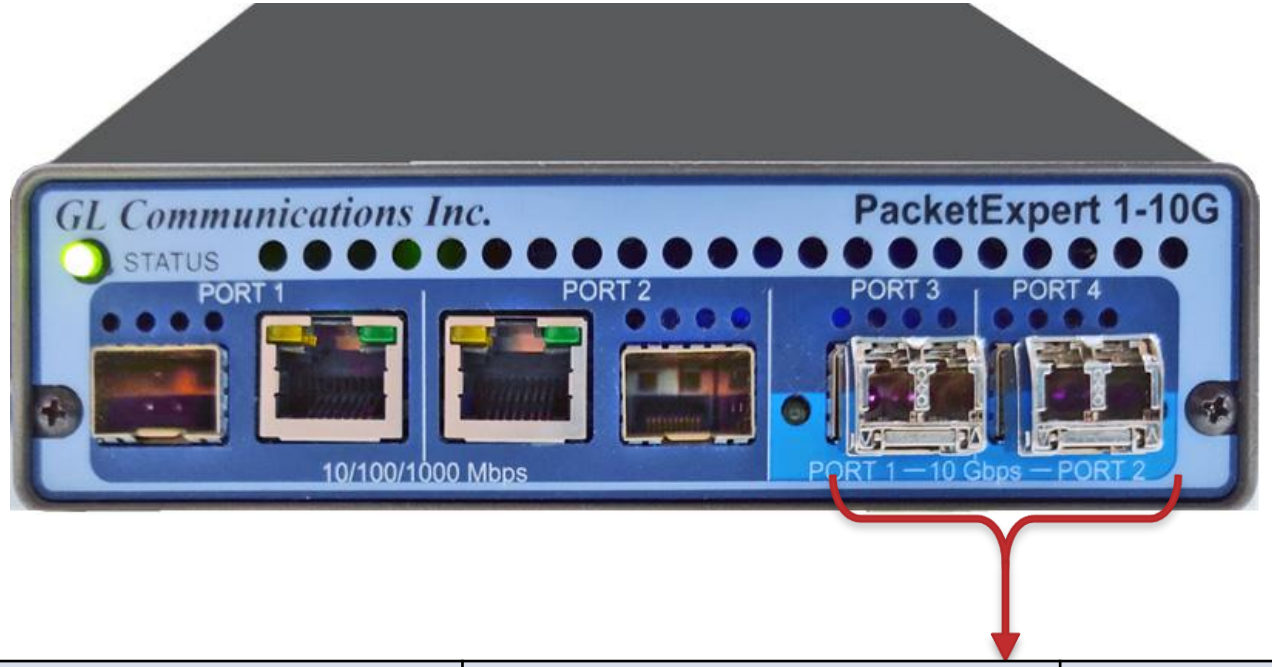
PacketExpert™ 10GX – 10 Gbps Mode



Port		Port 1	Port 2
Interface Type		**SFP+**	**SFP+**
Electrical	Speeds	10 Gbps	10 Gbps
	Designations	10GBASE-T	10GBASE-T
Optical	Speeds	10 Gbps	10 Gbps
	Designations	10GBASE-R	10GBASE-R

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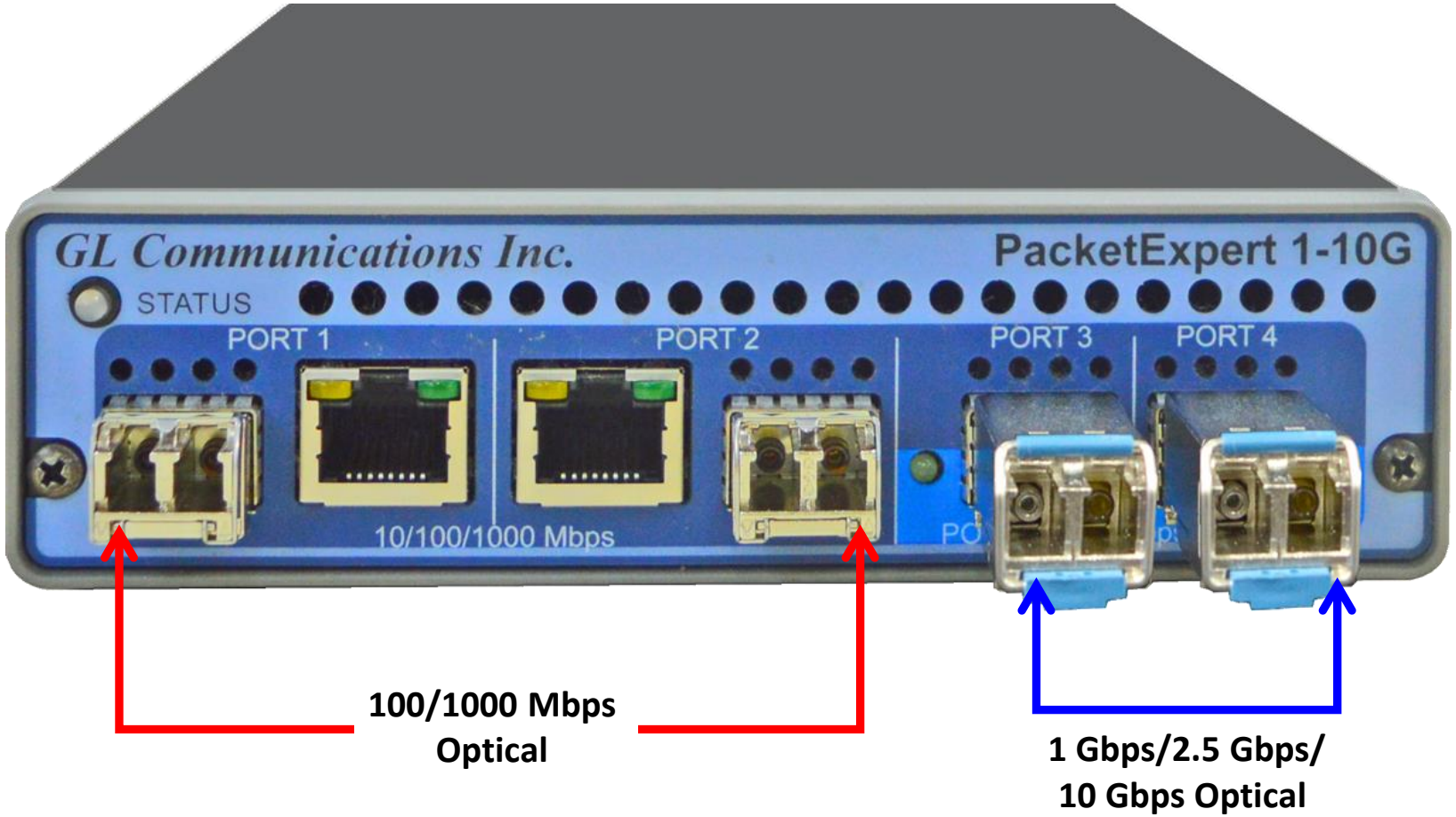
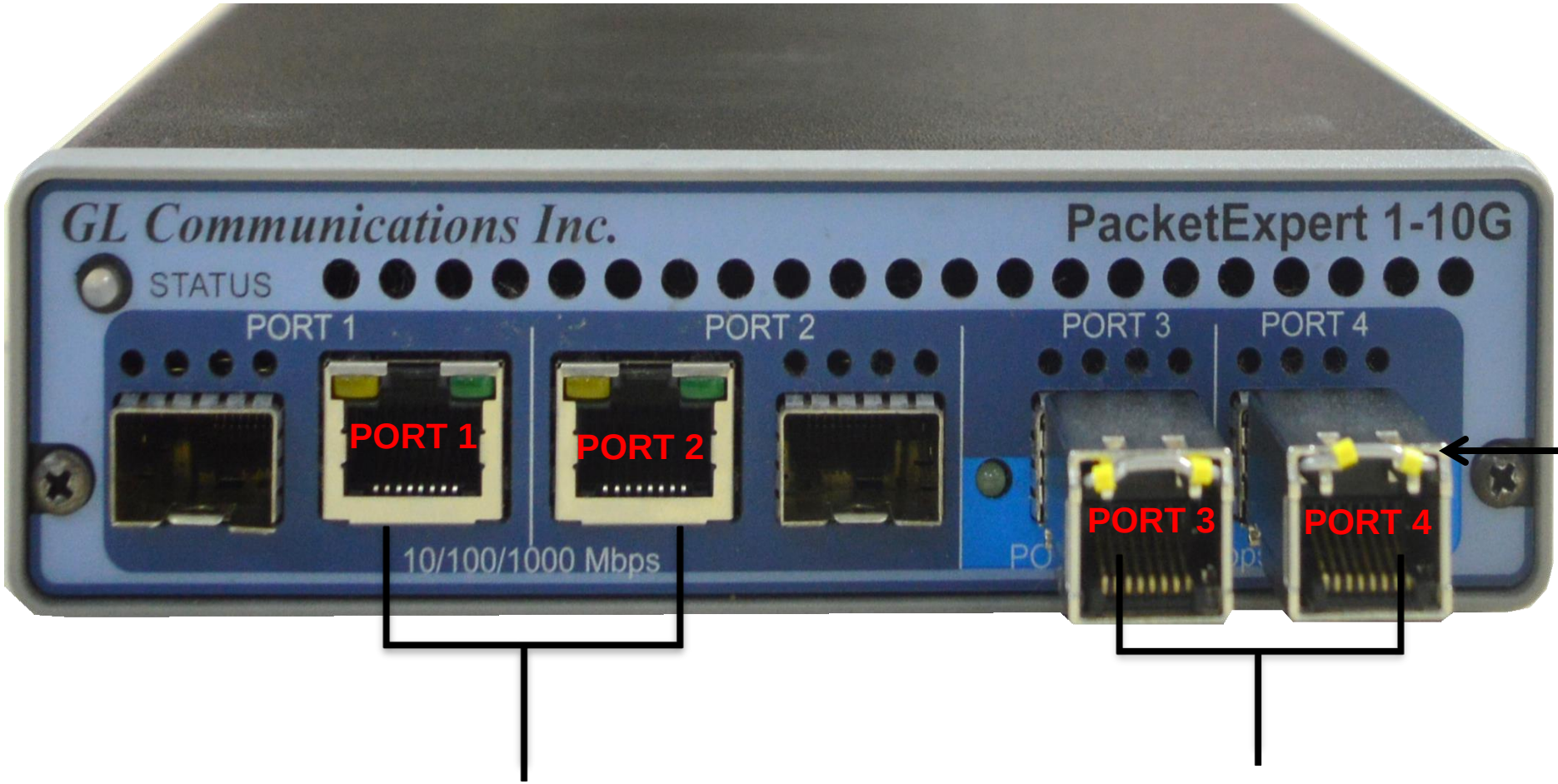
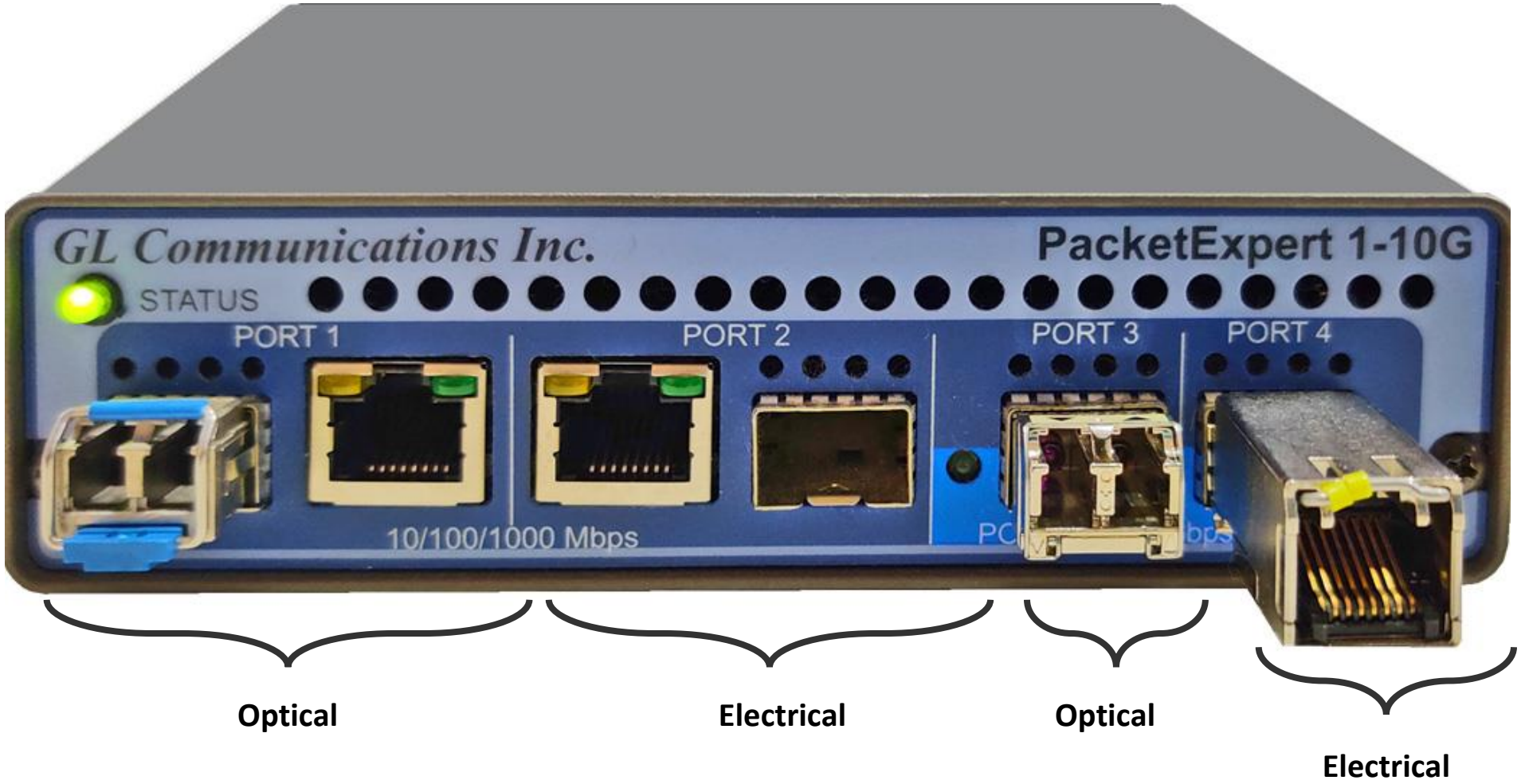
PacketExpert™ 10GX - Optical Ports



PacketExpert™ 10GX - Electrical Ports



PacketExpert™ 10GX – Mix and Match



MTOP™ Rack Units

High Density 1U Rack option

Stacked High Density 1U Rack option

Physical Specifications	• Length: 16 in (406.4) • Width: 19 in (482.6) • Height: 1U / 2U
External Power Supply	• ATX Power Supply
BUS Interface	• 1U mTOP™ (MT001 + 3x PXN100) ➢ Rackmount Enclosure can support up to 3 PXN100s • 2U Rack Mount (with 6x PXN100) ➢ Rackmount Enclosure can support up to 6 PXN100s • Optional 4 to 12 Port SMA Jack Trigger Board (TTL Input/Output)
SBC Specifications	• Intel Core i3, Windows® 11 Pro 64-bit OS • USB 3.0 and USB 2.0 Hub, ATX Power Supply • USB Type C ports, Ethernet 2.5GigE port • Min 256GB Hard drive, 8G Memory • Two HDMI ports

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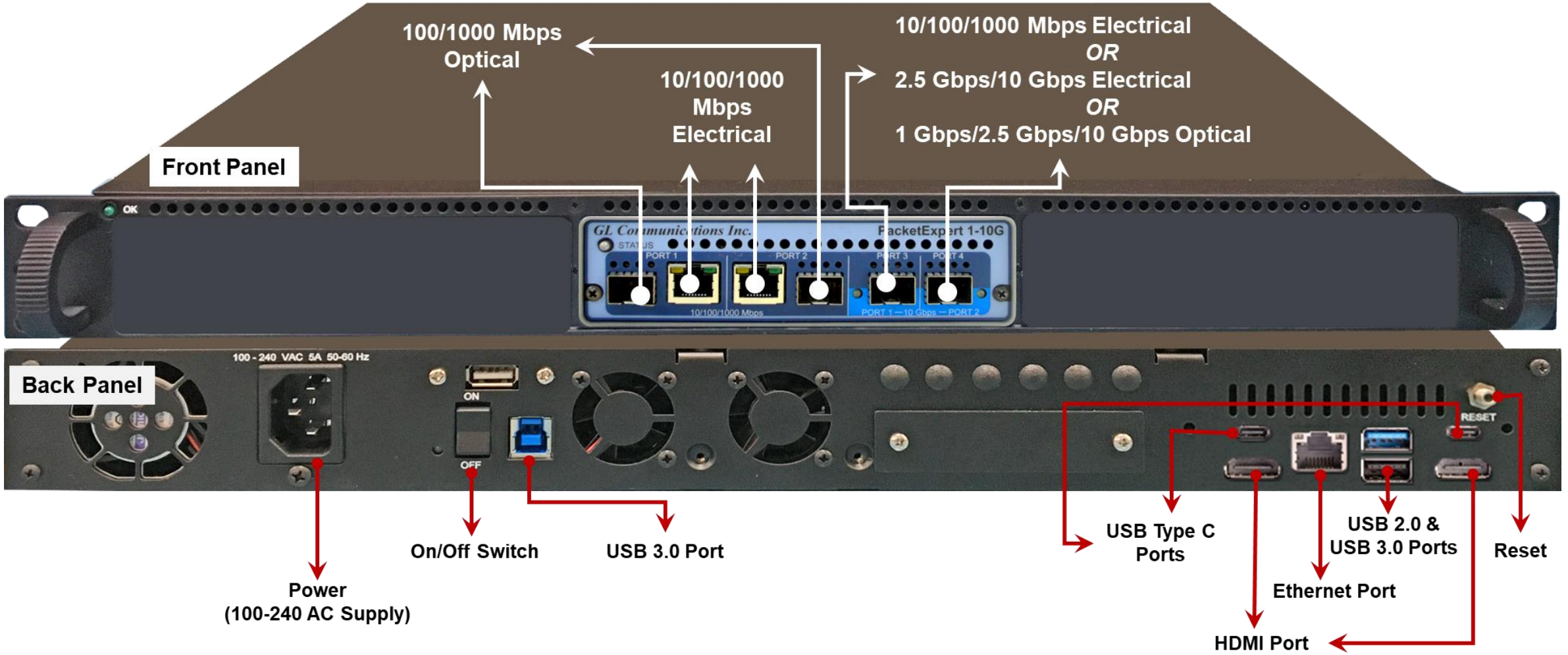
mTOP™ 1U Rack Option with Built in SBC



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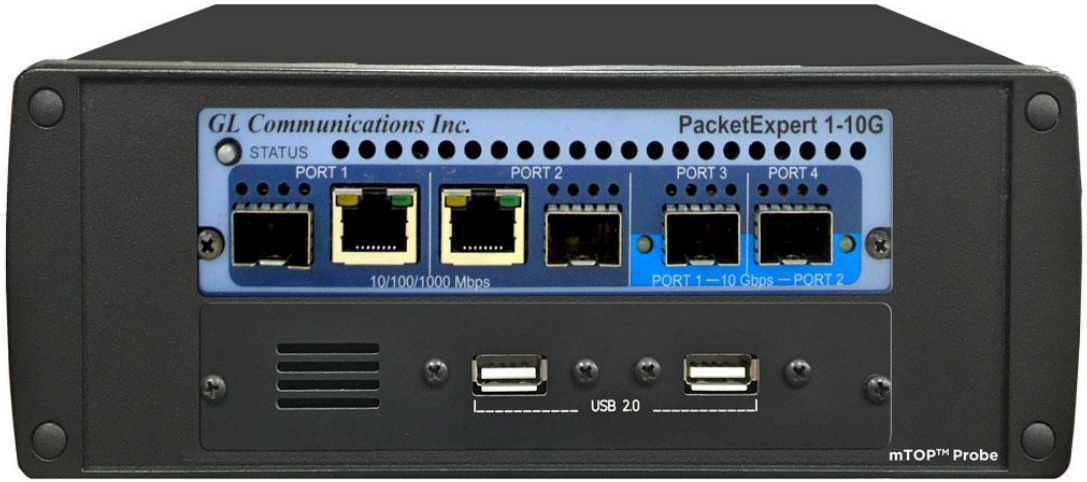
mTOP™ 1U Rack Option with 12 TTL

mTOP™ Probe with 10GX Hardware Unit + SBC



Physical Specifications	• Length: 10.4 in. (264.16 mm) • Width: 8.4 in. (213.36 mm) • Height: 3.0 in. (76.2 mm) • Optional 4-Port SMA Jack Trigger Board (TTL Input/Output) • External USB based Wi-Fi adaptor
External Power Supply	• +12 Volts (Medical Grade), 3 Amps
SBC Specifications	• Intel Core i3 or optional i7 NUC Equivalent, • Windows® 11 64-bit Pro Operating System • USB 3.0 and USB 2.0 Ports, 12V/3Amps Power Supply • USB Type C ports, Ethernet 2.5GigE port • 256 GB Hard drive, 8G Memory (Min) • Two HDMI ports

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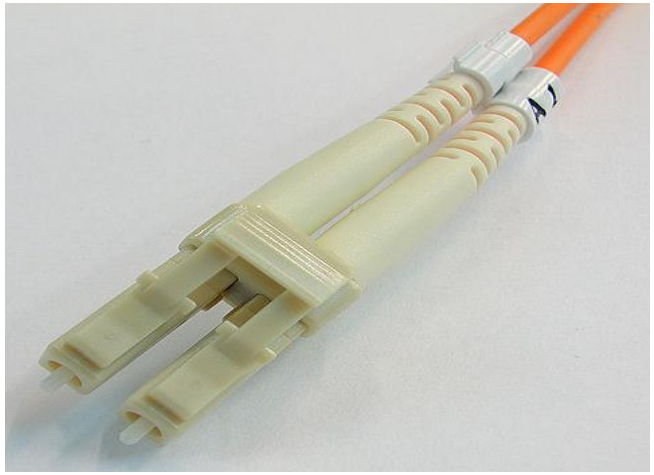
Optical Connectors and SFP Transceivers

LC Connectors



850nm /1310nm/1550nm

SFP Modules

- PacketExpert™ 10GX supports LC connectors and 850nm/1310nm/1550nm SFP (Small Factor Pluggable) modules

Note: In case customer have different type of connectors, then we need converters like LC-to-SC, LC-to-FC and vice-versa.

Applications

- Test and verify QoS Parameters of network devices like Switches/Routers etc.
- End to end testing of network paths for QoS parameters
- In-depth troubleshooting of the Carrier network in the event of network failures or impairments
- QoS testing of Triple-play services to ensure that they fully qualify SLA parameters
- Terrestrial wireless, satellite, and other WAN technologies network validations
- Test VoIP network in real-time conditions to verify if it meets the quality requirements before you deploy
- Testing video on IP networks by emulating the loss and congestion characteristics
- SPF support can be used for Broadband aggregation applications, Metro edge switching, Metro and access multi-service platforms, and are suitable for Fast Ethernet applications

PacketExpert™10GX-Ethernet / IP Tester

- BERT
- RFC 2544
- Smart Loopback
- ITU-T Y.1564 (ExpertSAM™)
- Multi-Stream Traffic Generator Analyzer
- RFC-6349 based TCP Throughput Testing (ExpertTCP™)
- WAN Emulation (Single stream) - IPLinkSim
- WAN Emulation (Multi-Stream) - IPNetSim
- Wire-Speed Record / Playback
- PacketBroker

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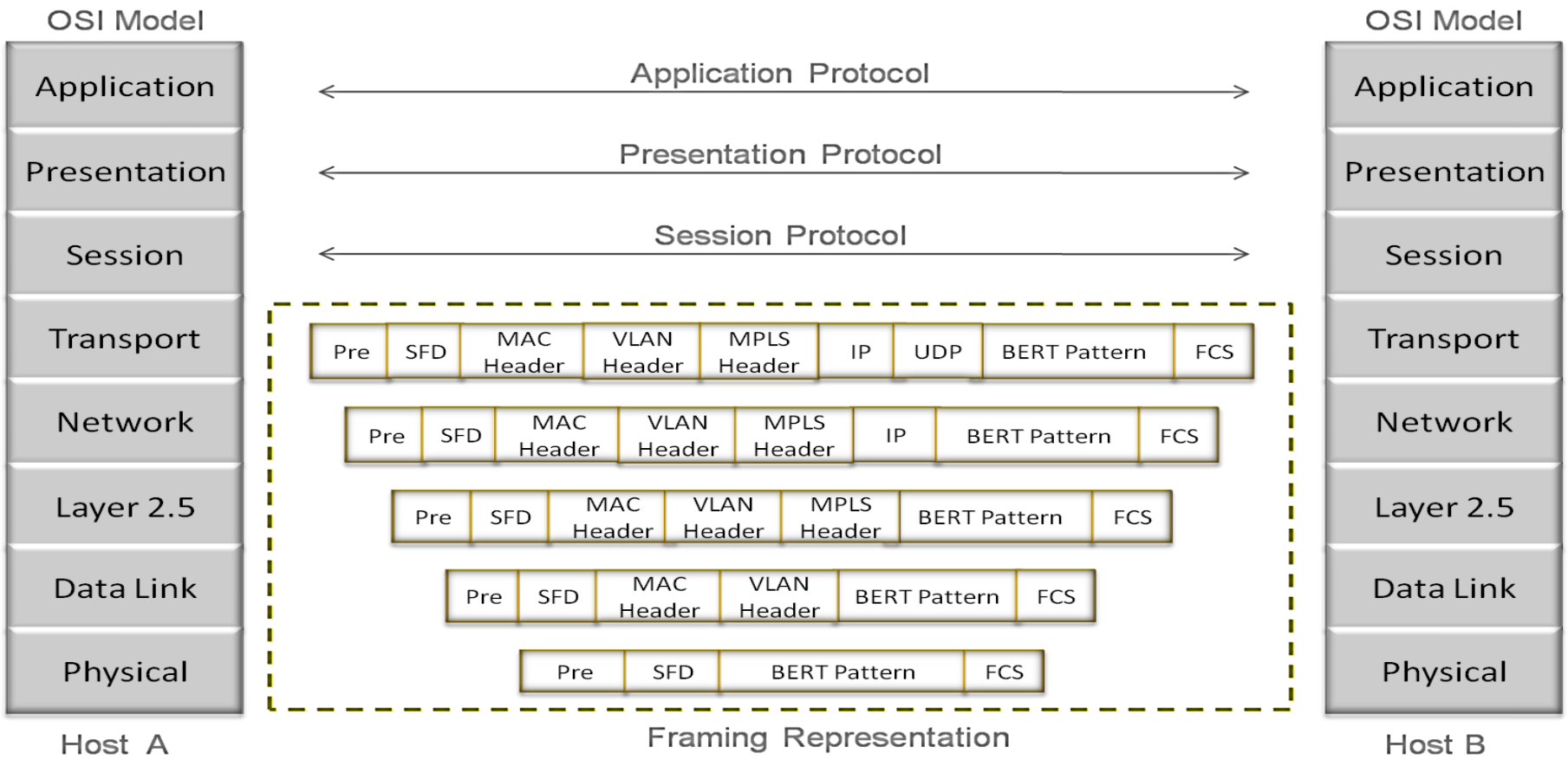
Wirespeed BERT

OSI Model



Preamble – 7 Bytes
Start Frame Delimiter – (SFD)- 1 Byte
MAC Header –

- Dest/Src MAC Address – 6 Bytes
- Ether Length/Type – 2 Bytes (0x0800) IP
- VLAN Header – 4 bytes each

MPLS Header – 4 bytes each
IP Header – 20 Bytes
UDP Header – 8 Bytes
Payload – BER Test Pattern
Frame Check Sum – (FCS) – 4 Bytes

} Ethernet Payload

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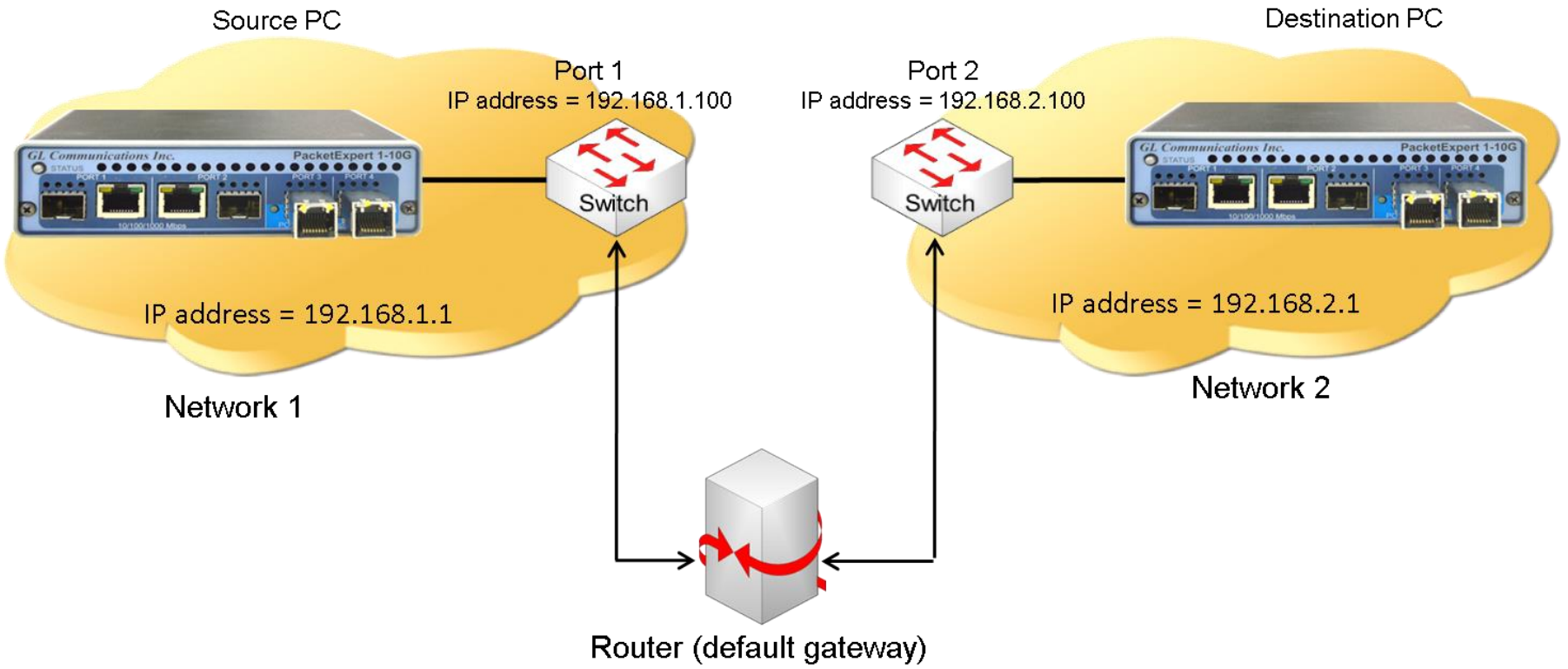
BER Test Setup at Layer 3 / 4

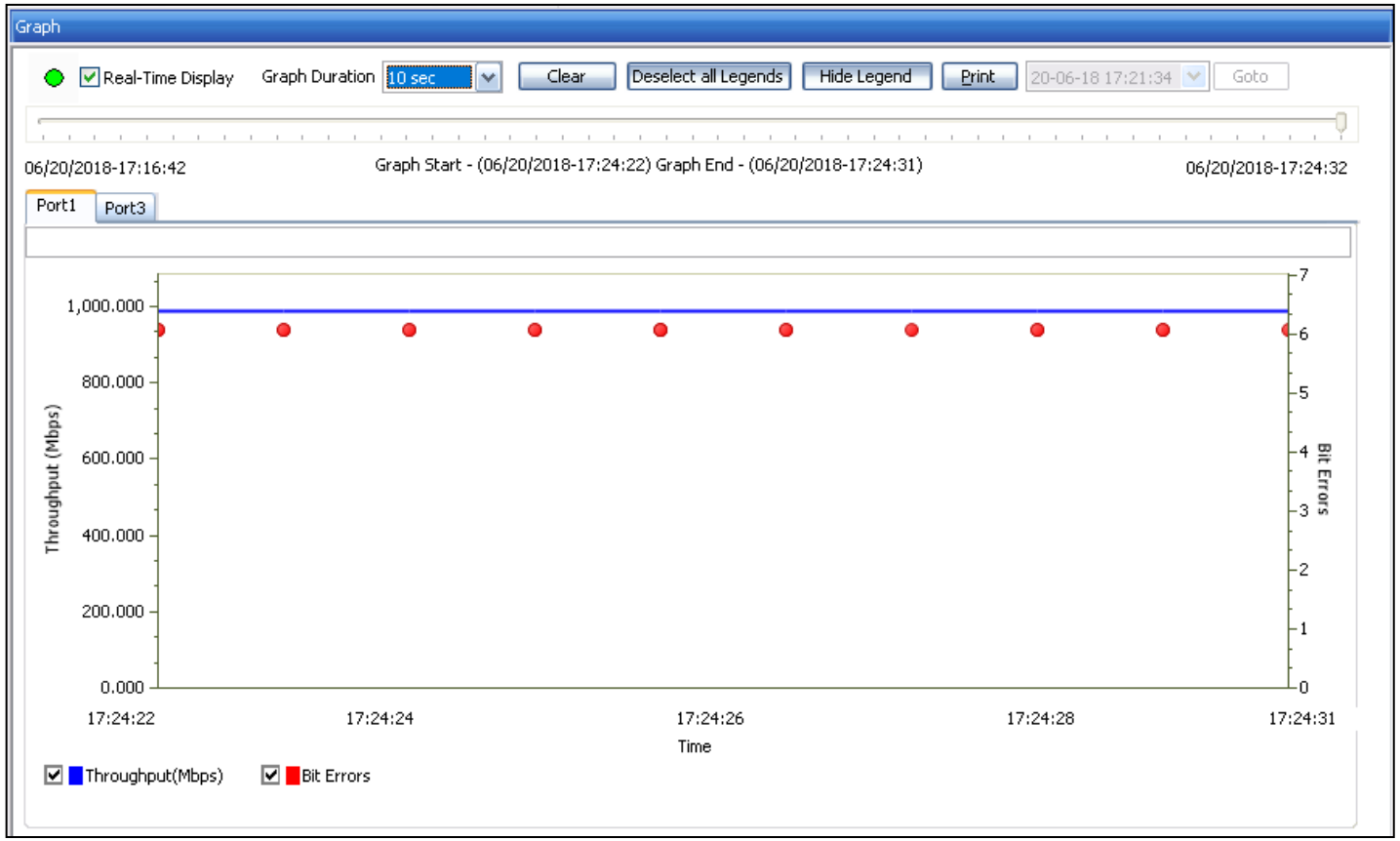
Layer 3 Testing between PacketExpert™ located in different IP Networks



In this case, Source and the Destination PacketExpert™ applications are located in different IP networks. These 2 networks are connected through a router. A simple example above shows 2 LANs connected through a router.

BERT Results (with LEDs) and Graph

- Optional Sequence number insertion allows detecting Out-of-sequence packets and packet loss
- Detailed BERT statistics like the Bit Error Count, Bit Error Rate, Bit Error Seconds etc., are provided
- Bit Error Count is displayed in both Tabular and Graphical formats



All Ports Result

All Ports

Options

Tx	Port 1	Port 2
Total Frames	48 397 778	48 465 000
Valid Frames	48 398 858	48 466 070
Bad Frames	0	0
Number of Bytes	73 277 416 806	73 379 206 032
Link Utilisation(%)	100.000	100.000
Data Rate(Mbps)	9869.621	9869.621
Frame Rate(Frames/sec)	814864	814863
Non Test Frames	0	0

Rx	Port 1	Port 2
Total Frames	48 414 936	48 485 825
Valid Frames	48 415 988	48 486 885
Bad Frames	0	0
Number of Bytes	73 304 838 352	73 412 173 404
Link Utilisation(%)	100.000	100.000
Data Rate(Mbps)	9869.621	9869.621
Frame Rate(Frames/sec)	814863	814863
Non Test Frames	0	0

Bert Status	Port 1	Port 2
Rx Traffic	●	●
Sync Status	●	●
Bit Errors	●	●
Out Of Sequence Packets	●	●

Bert Statistics	Port 1	Port 2
Bert Status	Sync	Sync
Test Time	00:00:59	00:00:59
Bits Received	562 588 769 680	562 895 355 984
Bit Error Count	0	0
Bit Error Rate	0.000E+000	0.000E+000
Bit Error Seconds	0	0
Sync Loss Count	0	0
Sync Loss Seconds	0	0

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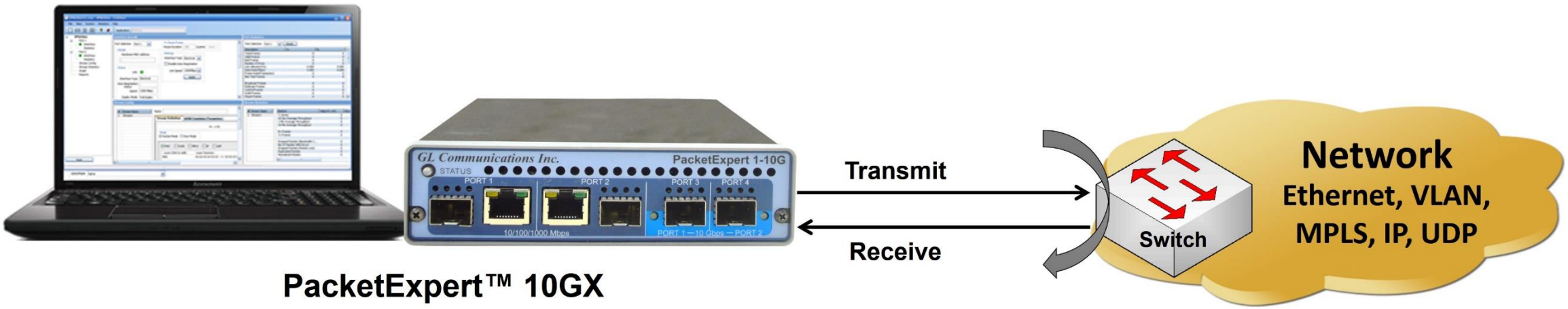
RFC 2544 Testing

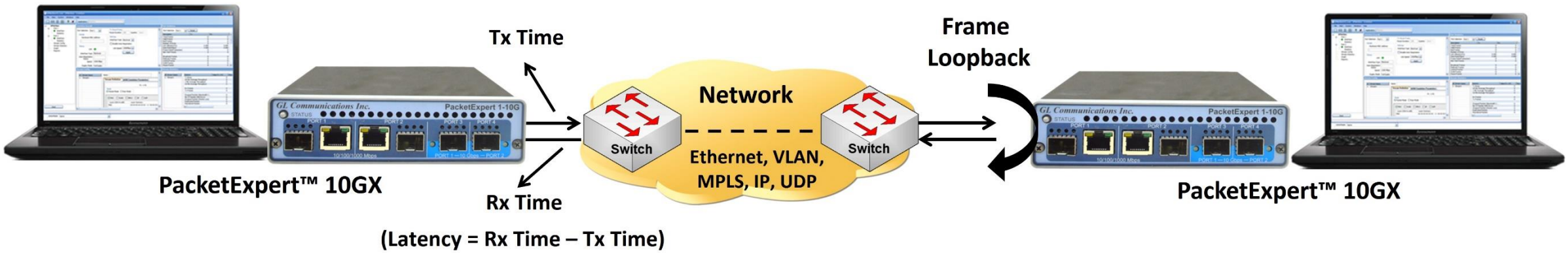
Dual RFC 2544 Testing



RFC 2544 test application includes the following tests:

- **Throughput** - Maximum number of frames per second that can be transmitted without any error
- **Latency** - Measures the time required for a frame to travel from the originating device through the network to the destination device
- **Frame Loss** - Measures the network's response in overload conditions
- **Back-to-Back** - It measures the maximum number of frames received at full line rate before a frame is lost

Single Port RFC 2544



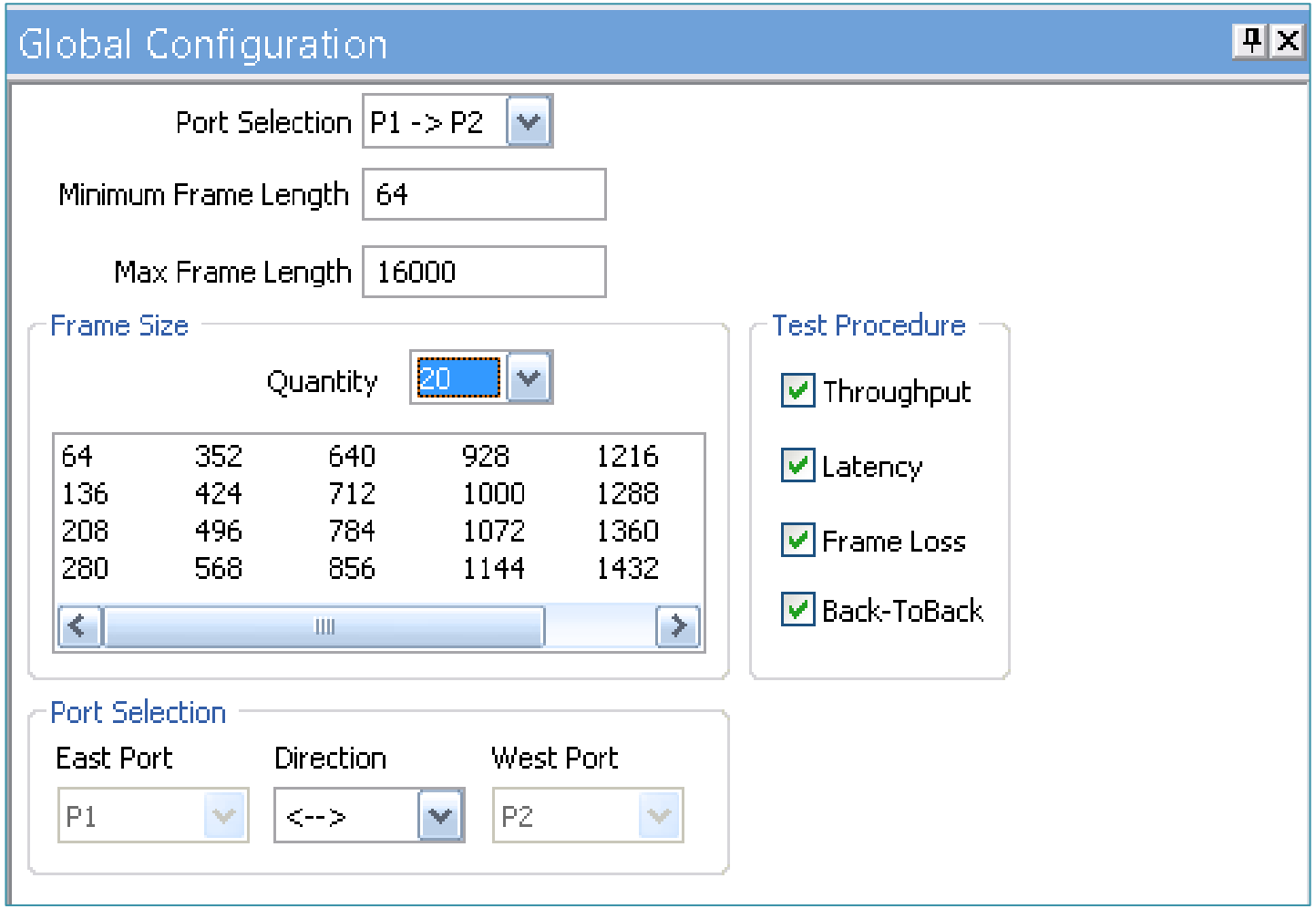
In single port RFC 2544 test,

- For PacketExpert™ 1G, the RFC 2544 test can be done either on Port #2 or Port #3 at a time and it is not possible to run RFC 2544 test on both the ports (Port #2, Port #3) simultaneously
- For PacketExpert™ 10G or 10GX, the RFC 2544 test can be done either on Port #1 or Port #2 at a time and it is not possible to run RFC 2544 test on both the ports (Port #1, Port #2) simultaneously

Highlights

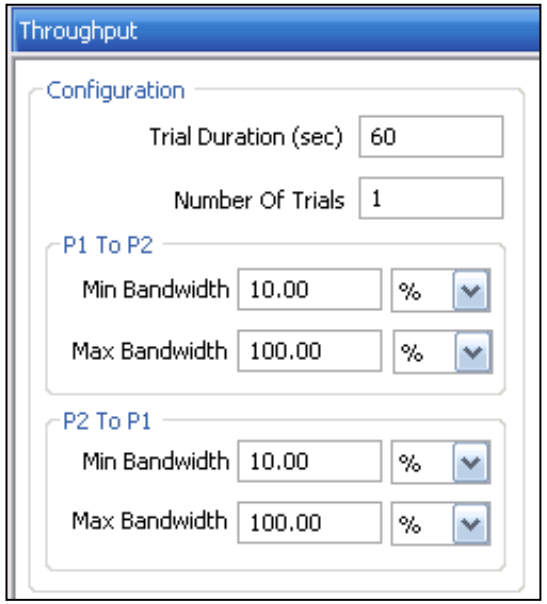
- Throughput, back-to-back, latency and frame loss testing supporting uni-directional and bi-directional traffic between ports
- Supports RFC 2544 on electrical / optical (1000Mbps) ports and optical only (10G) ports
- Includes various parameter configurations such as Test Selection, Frame Sizes selection, Unidirectional/Bidirectional, Number of trials, Trial Duration, and many more
- User-defined options to configure various packet header parameters, like MAC addresses, IP addresses, UDP ports, VLAN ID, MPLS Labels, and more
- Results are displayed in both tabular as well as graphical format

Global Configurations

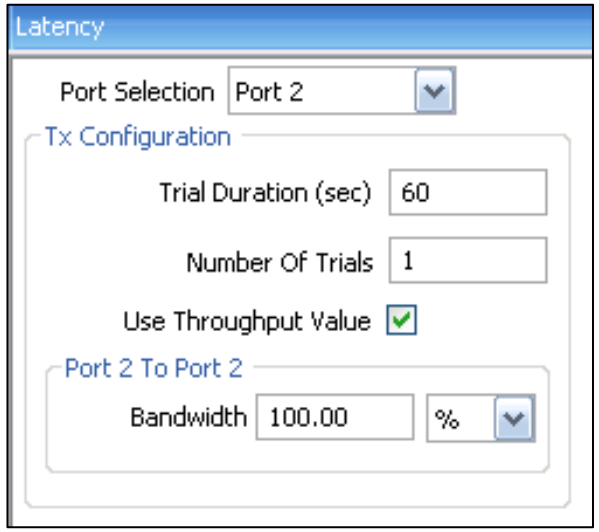


Individual Test Configuration Details

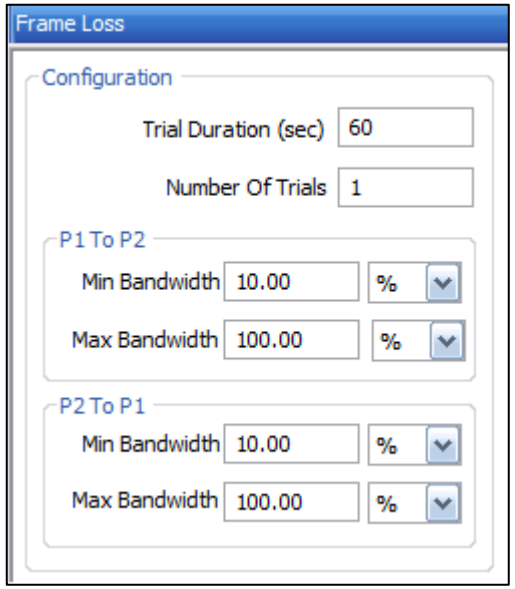
Throughput



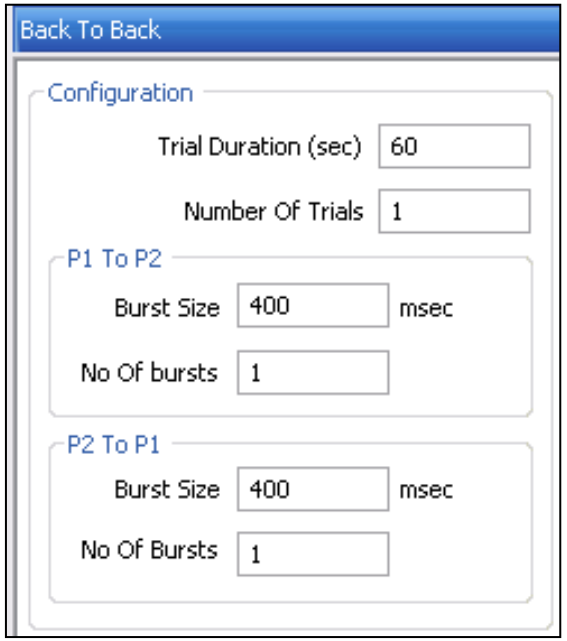
Latency



Frame Loss



Back-to-Back



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Results

- **Throughput** – Both relative (% of link speed) and absolute (in Mbps) throughput values are displayed
- **Latency** – displayed in Microseconds
- **Back-to-Back** – Displayed in Frames/Burst
- **Frame Loss** – Displays the Frame Loss Rate (in %) against attempted Frame Rate (in % of link speed)

RFC 2544 Results

View: Statistics Dir: P1-->P2

Status | Throughput | Latency | Frameloss | Backtoback

Frame Size	P1-->P2	P2-->P1
64	100.00% 7619.05 Mbps	100.00% 7619.05 Mbps
128	100.00% 8648.65 Mbps	100.00% 8648.65 Mbps
256	100.00% 9275.36 Mbps	100.00% 9275.36 Mbps
512	100.00% 9624.06 Mbps	100.00% 9624.06 Mbps
1024	100.00% 9808.43 Mbps	100.00% 9808.43 Mbps
1280	100.00% 9846.15 Mbps	100.00% 9846.15 Mbps
1518	100.00% 9869.96 Mbps	100.00% 9869.96 Mbps

RFC 2544 Results

View: Statistics Dir: P1-->P2

Status | Throughput | Latency | Frameloss | Backtoback

Frame Size	P1-->P2	P2-->P1
64	14 880 952 Frames\Burst	14 880 952 Frames\Burst
128	8 445 945 Frames\Burst	8 445 945 Frames\Burst
256	4 528 985 Frames\Burst	4 528 985 Frames\Burst
512	2 349 624 Frames\Burst	2 349 624 Frames\Burst
1024	1 197 318 Frames\Burst	1 197 318 Frames\Burst
1280	961 538 Frames\Burst	961 538 Frames\Burst
1518	812 743 Frames\Burst	812 743 Frames\Burst

RFC 2544 Results

View: Statistics Dir: P1-->P2

Status | Throughput | Latency | Frameloss | Backtoback

Frame Size	P1-->P2 (Store And Forward , Bit Forward)	P2-->P1 (Store And Forward , Bit Forward)
64	100.000% 1.306 us, 1.363 us	100.000% 1.280 us, 1.338 us
128	100.000% 1.408 us, 1.517 us	100.000% 1.274 us, 1.382 us
256	100.000% 1.299 us, 1.510 us	100.000% 1.267 us, 1.478 us
512	100.000% 1.293 us, 1.709 us	100.000% 1.254 us, 1.670 us
1024	100.000% 1.312 us, 2.138 us	100.000% 1.274 us, 2.099 us
1280	100.000% 1.261 us, 2.291 us	100.000% 1.248 us, 2.278 us
1518	100.000% 1.331 us, 2.554 us	100.000% 1.293 us, 2.515 us

RFC 2544 Results

View: Statistics Dir: P1-->P2

Status | Throughput | Latency | Frameloss | Backtoback

Frame Size	P1-->P2	P2-->P1
64	100.00 % 0.000 %	100.00 % 0.000 %
	90.00 % 0.000 %	90.00 % 0.000 %
	80.00 % 0.000 %	80.00 % 0.000 %
	70.00 % 0.000 %	70.00 % 0.000 %
	60.00 % 0.000 %	60.00 % 0.000 %
	50.00 % 0.000 %	50.00 % 0.000 %
	40.00 % 0.000 %	40.00 % 0.000 %
	30.00 % 0.000 %	30.00 % 0.000 %
	20.00 % 0.000 %	20.00 % 0.000 %
	10.00 % 0.000 %	10.00 % 0.000 %
	1.00 % 0.000 %	1.00 % 0.000 %
128	100.00 % 0.000 %	100.00 % 0.000 %
	90.00 % 0.000 %	90.00 % 0.000 %
	80.00 % 0.000 %	80.00 % 0.000 %
	70.00 % 0.000 %	70.00 % 0.000 %
	60.00 % 0.000 %	60.00 % 0.000 %
	50.00 % 0.000 %	50.00 % 0.000 %
	40.00 % 0.000 %	40.00 % 0.000 %
	30.00 % 0.000 %	30.00 % 0.000 %
	20.00 % 0.000 %	20.00 % 0.000 %
	10.00 % 0.000 %	10.00 % 0.000 %
	1.00 % 0.000 %	1.00 % 0.000 %
256	100.00 % 0.000 %	100.00 % 0.000 %
	90.00 % 0.000 %	90.00 % 0.000 %
	80.00 % 0.000 %	80.00 % 0.000 %
	70.00 % 0.000 %	70.00 % 0.000 %
	60.00 % 0.000 %	60.00 % 0.000 %
	50.00 % 0.000 %	50.00 % 0.000 %
	40.00 % 0.000 %	40.00 % 0.000 %
	30.00 % 0.000 %	30.00 % 0.000 %
	20.00 % 0.000 %	20.00 % 0.000 %
	10.00 % 0.000 %	10.00 % 0.000 %
	1.00 % 0.000 %	1.00 % 0.000 %
512	100.00 % 0.000 %	100.00 % 0.000 %

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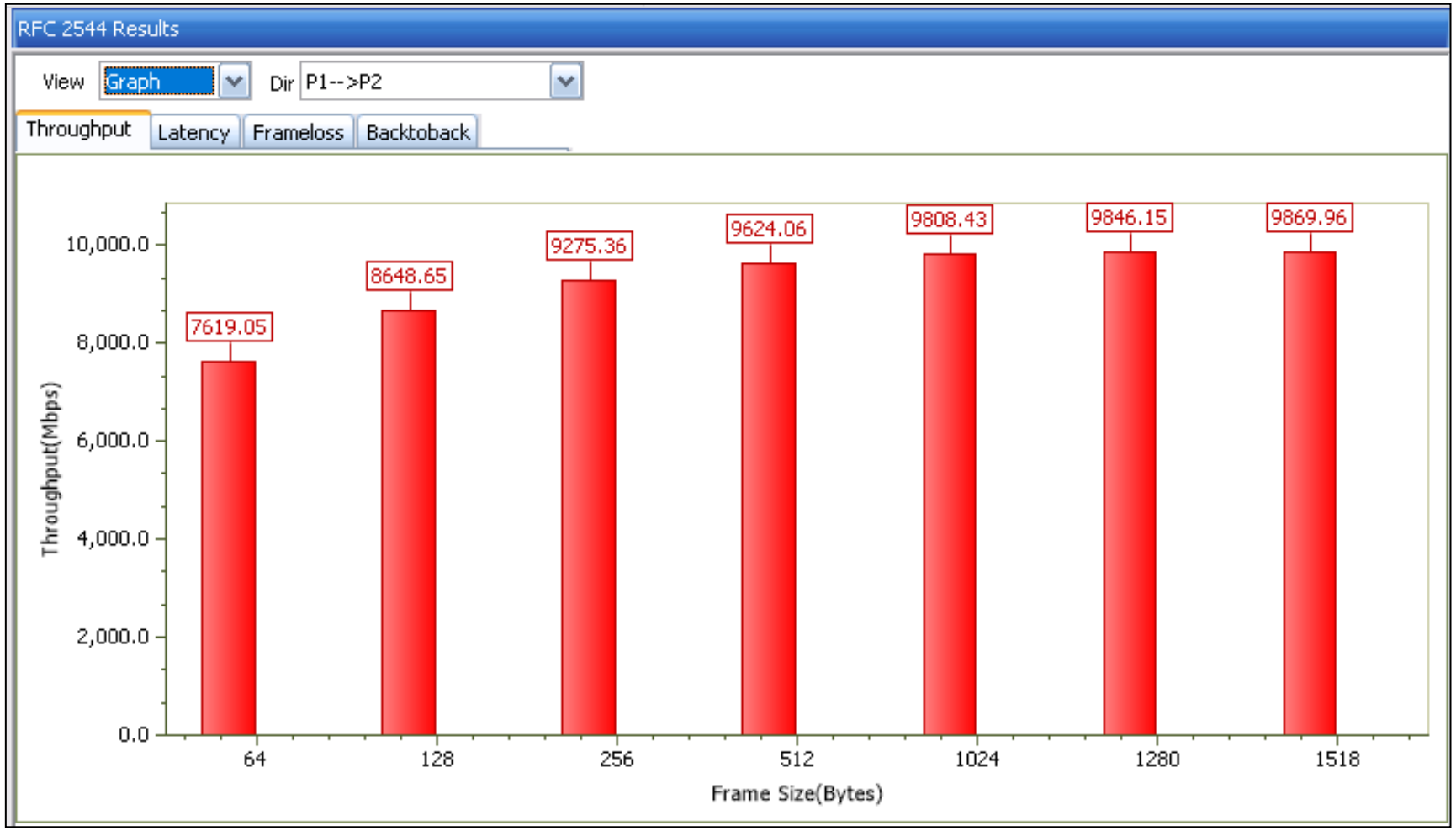
Graphs

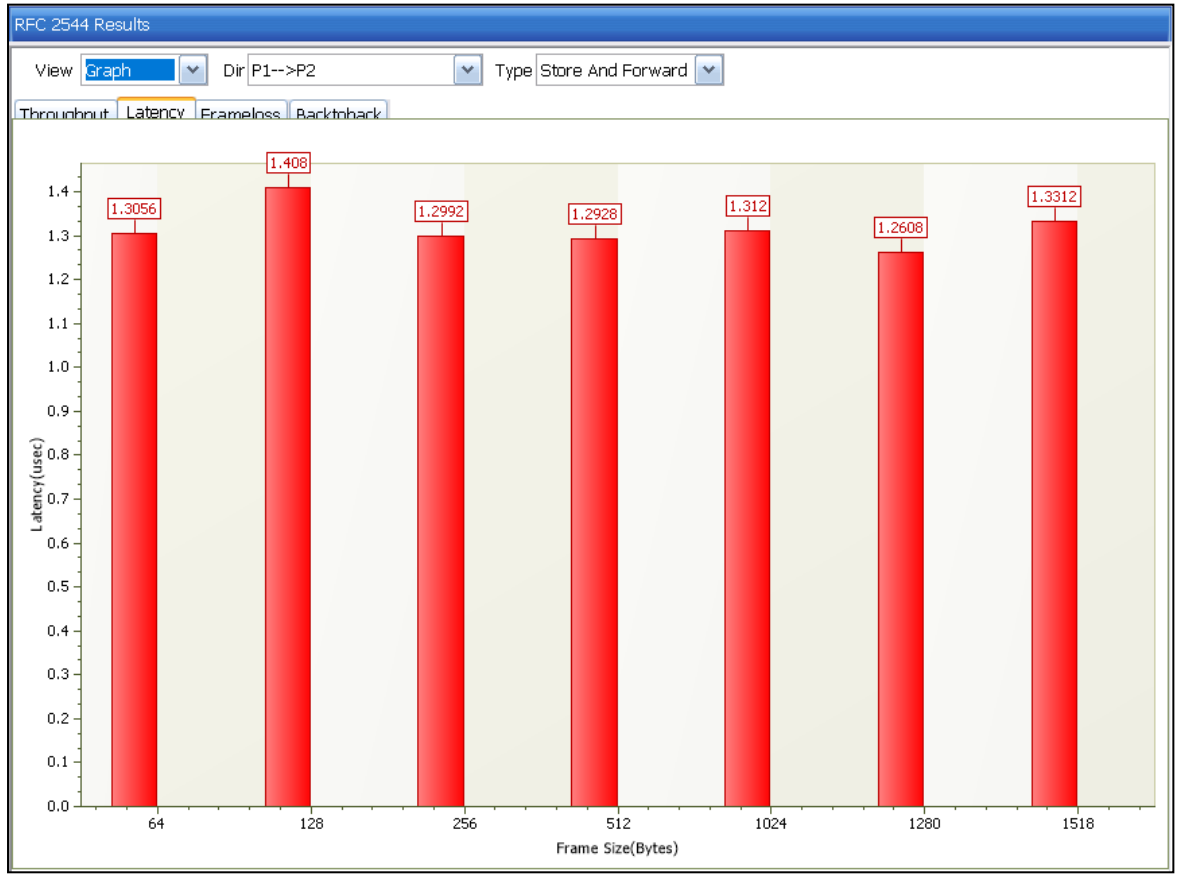
Throughput



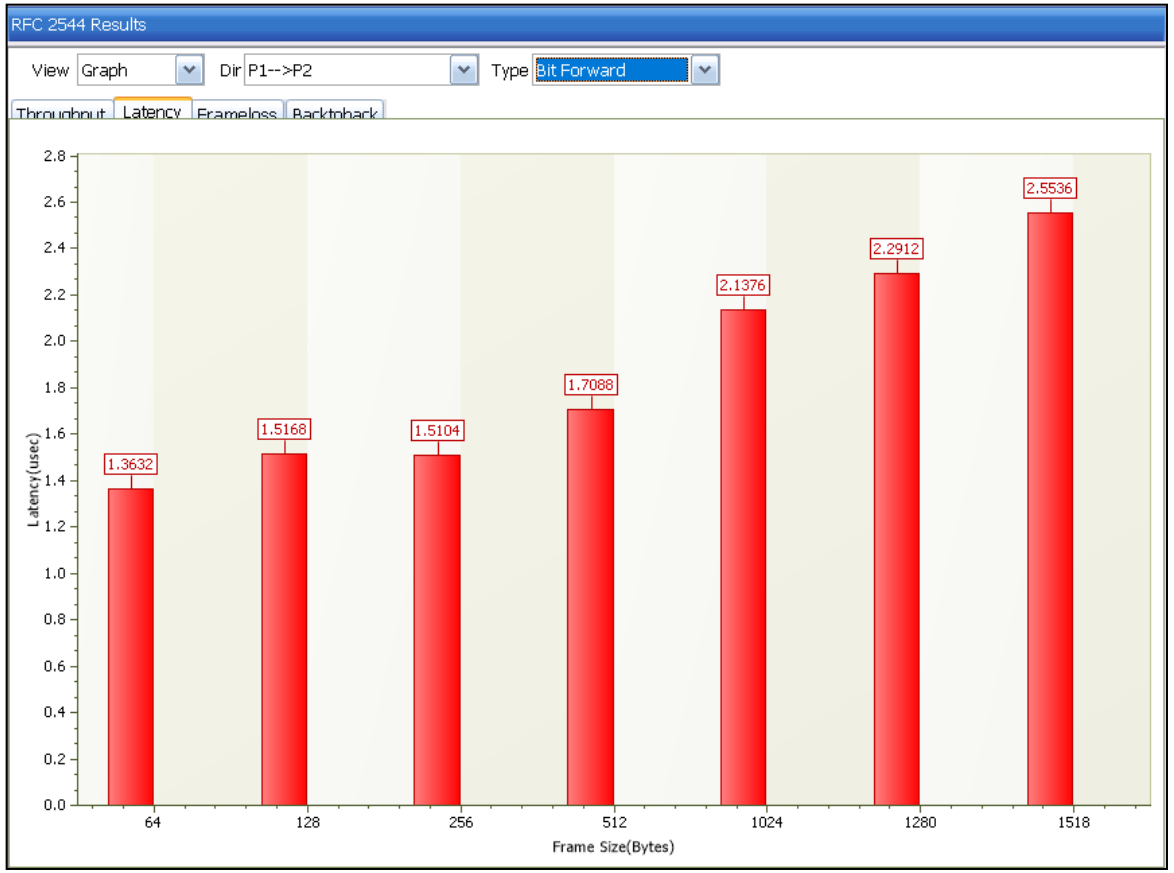
Graphs

Latency

Store and Forward Latency Test Graph



Bit Forward Latency Test Graph



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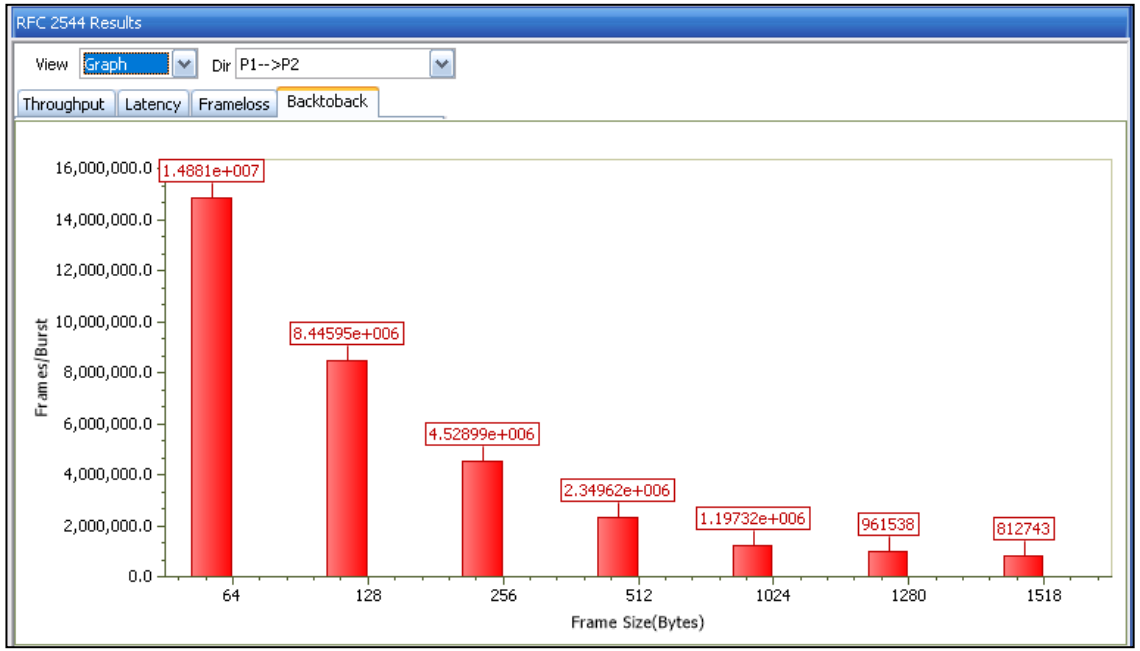
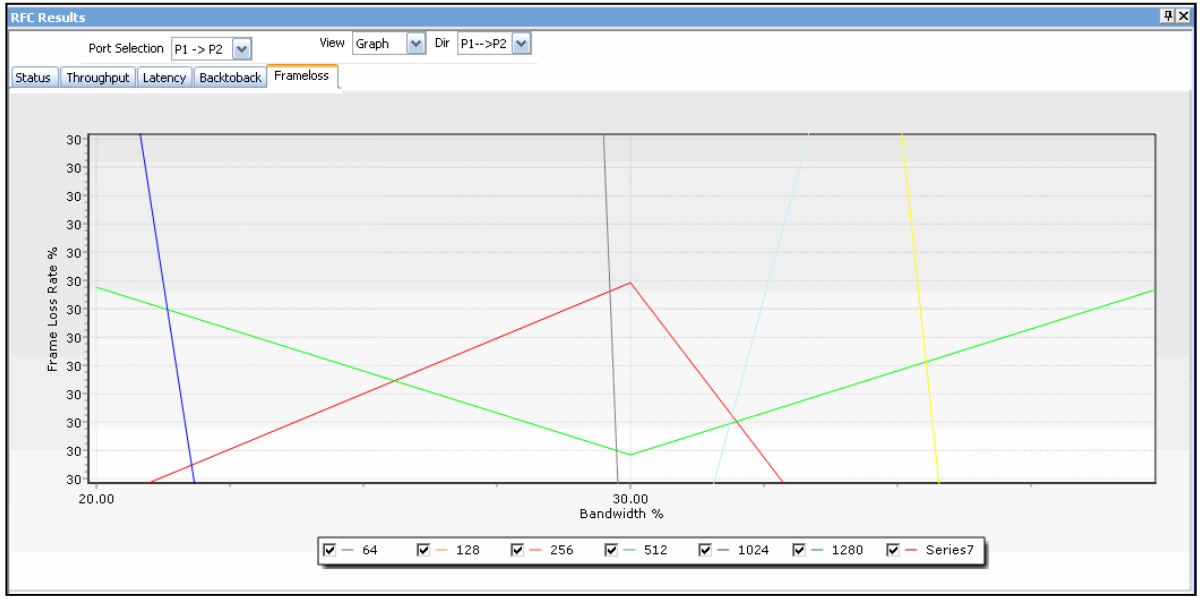
Graphs

Back-to-Back

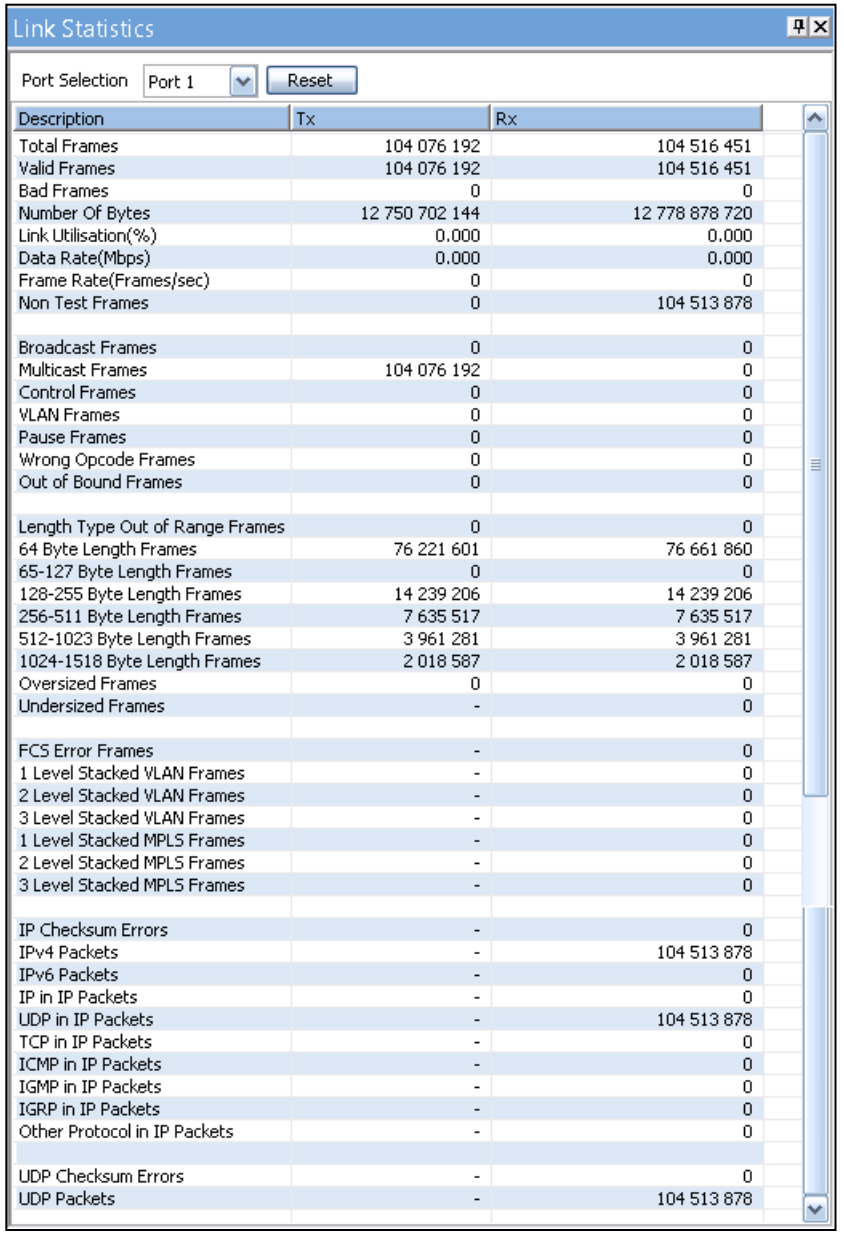


Frame Loss



Port Statistics

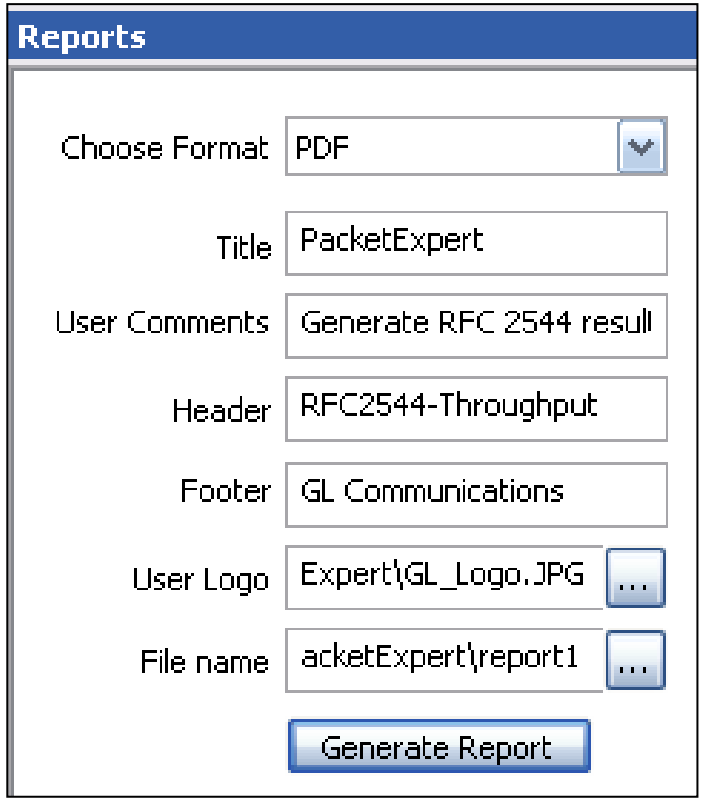
- Per port detailed statistics are provided –
  - Tx / Rx Frame count
  - Number of Bytes transmitted & received
  - Tx & Rx Frame Rate
  - Broadcast, Multicast, Control, VLAN, Pause Frame count
  - Frame count for byte lengths 64/65-127
  - MPLS and VLAN Frame count for various stack level
  - IPv4/ UDP packet count
  - Oversized / Undersized Error frame count
  - FCS error count
  - IP/UDP checksum error count and others



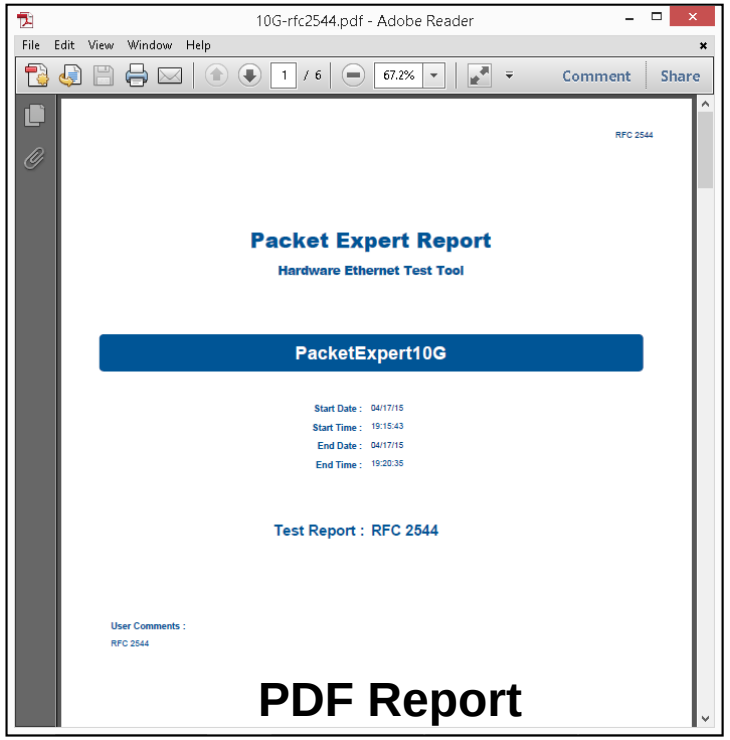
Description	Tx	Rx
Total Frames	104 076 192	104 516 451
Valid Frames	104 076 192	104 516 451
Bad Frames	0	0
Number Of Bytes	12 750 702 144	12 778 878 720
Link Utilisation(%)	0.000	0.000
Data Rate(Mbps)	0.000	0.000
Frame Rate(Frames/sec)	0	0
Non Test Frames	0	104 513 878
Broadcast Frames	0	0
Multicast Frames	104 076 192	0
Control Frames	0	0
VLAN Frames	0	0
Pause Frames	0	0
Wrong Opcode Frames	0	0
Out of Bound Frames	0	0
Length Type Out of Range Frames	0	0
64 Byte Length Frames	76 221 601	76 661 860
65-127 Byte Length Frames	0	0
128-255 Byte Length Frames	14 239 206	14 239 206
256-511 Byte Length Frames	7 635 517	7 635 517
512-1023 Byte Length Frames	3 961 281	3 961 281
1024-1518 Byte Length Frames	2 018 587	2 018 587
Oversized Frames	0	0
Undersized Frames	-	0
FCS Error Frames	-	0
1 Level Stacked VLAN Frames	-	0
2 Level Stacked VLAN Frames	-	0
3 Level Stacked VLAN Frames	-	0
1 Level Stacked MPLS Frames	-	0
2 Level Stacked MPLS Frames	-	0
3 Level Stacked MPLS Frames	-	0
IP Checksum Errors	-	0
IPv4 Packets	-	104 513 878
IPv6 Packets	-	0
IP in IP Packets	-	0
UDP in IP Packets	-	104 513 878
TCP in IP Packets	-	0
ICMP in IP Packets	-	0
IGMP in IP Packets	-	0
IGRP in IP Packets	-	0
Other Protocol in IP Packets	-	0
UDP Checksum Errors	-	0
UDP Packets	-	104 513 878

GL Communications

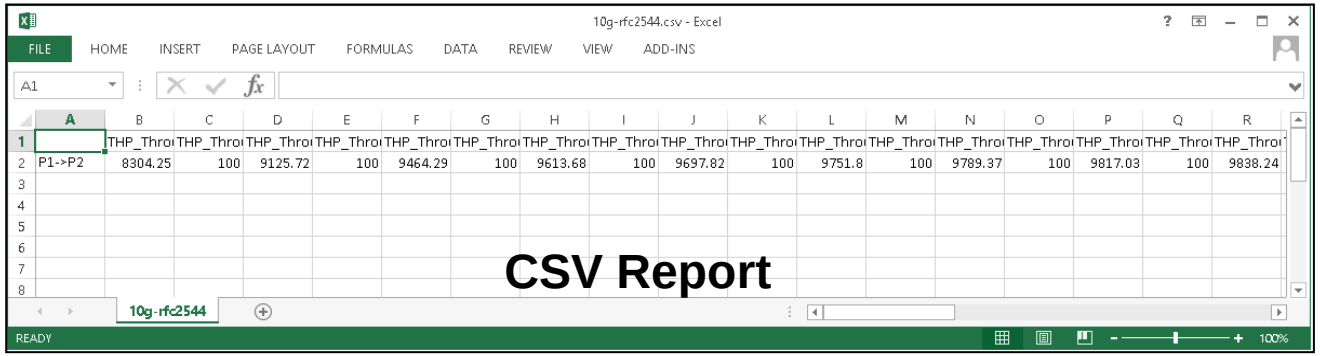
Generate Reports



Configuration



PDF Report



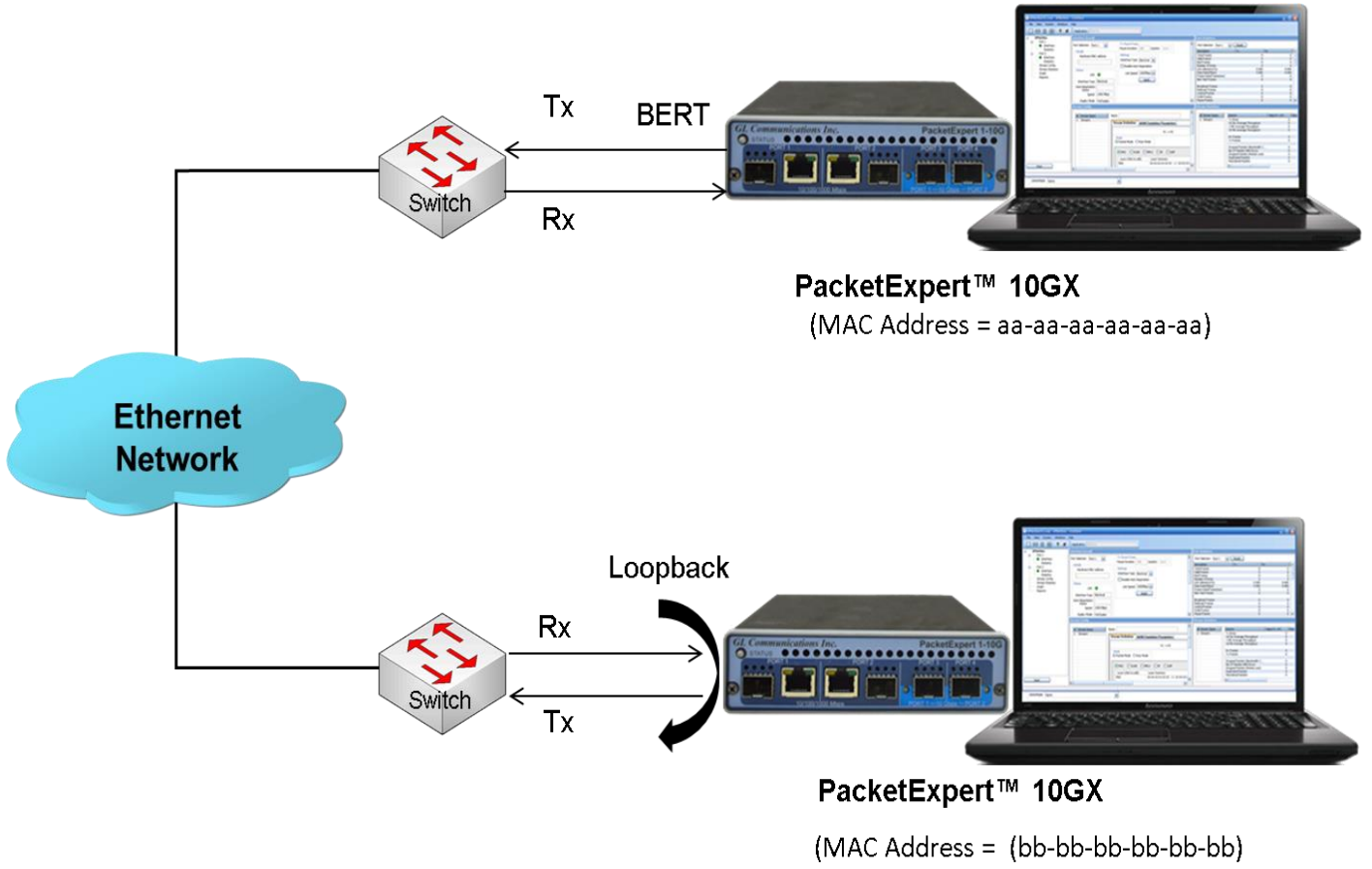
CSV Report

GL Communications

Smart Loopback

2 Ports BERT and Loopback

- Loopback helps in easy test setup, especially in end-to-end testing, when the other end is in a remote place
- In such cases, one PacketExpert™ 10GX can be put in constant Loopback at the remote end, and BERT tests can be started / stopped anytime at the local end



Layer 2 - Ethernet Loopback Types

PacketExpert™ 10GX

Loopback

Rx

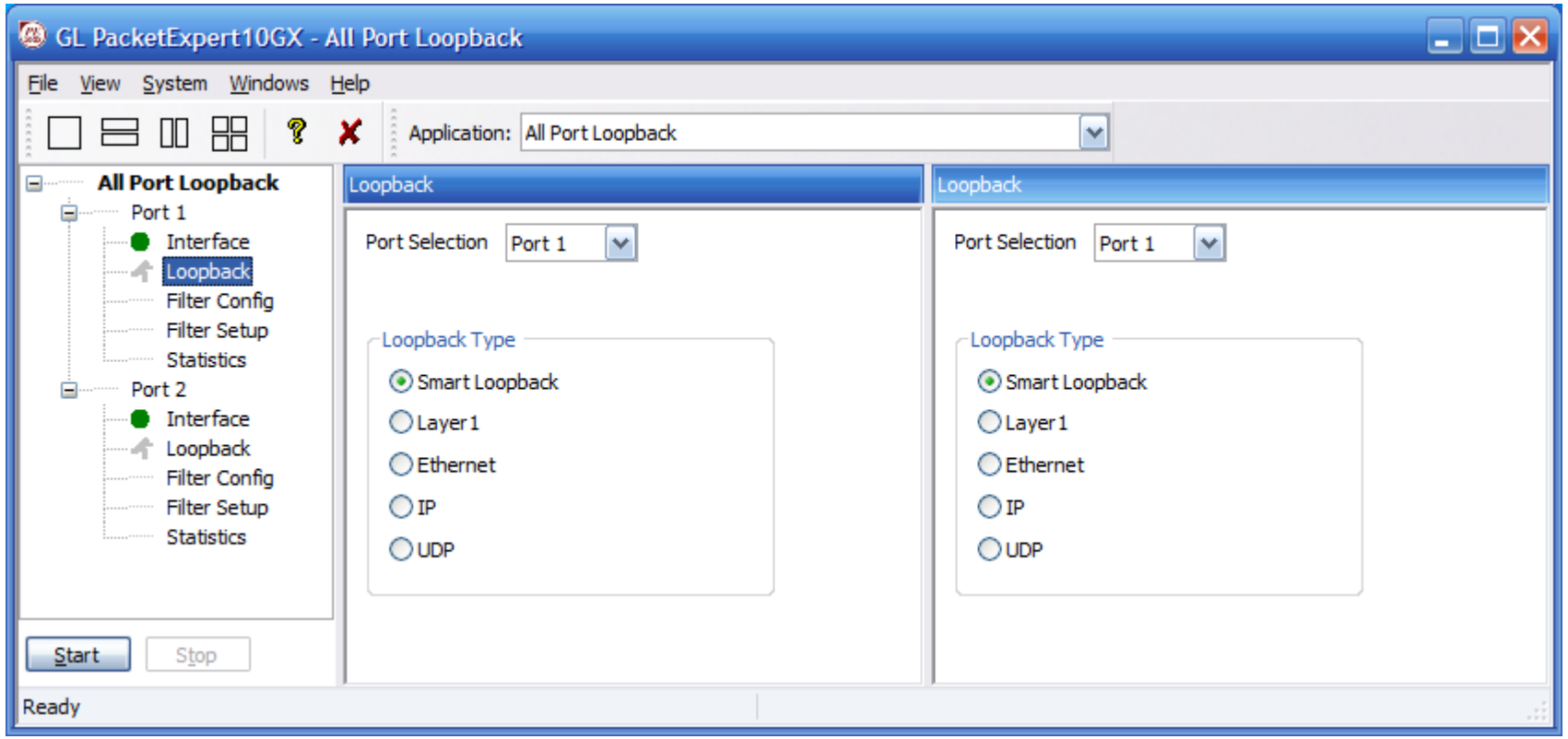
Ethernet Dst MAC Address Ex: bb-bb-bb-bb-bb-bb	Ethernet Src MAC Address Ex: aa-aa-aa-aa-aa-aa	Ethernet Len/Type Field	Payload	FCS

Tx

Ethernet Dst MAC Address Ex: aa-aa-aa-aa-aa-aa	Ethernet Src MAC Address Ex: bb-bb-bb-bb-bb-bb	Ethernet Len/Type Field	Payload	FCS

- PacketExpert™ 10GX has all ports or 2 ports Loopback capability
- PacketExpert™ 10GX supports Layer-wise Loopback as well as Smart Loopback
- The above picture depicts the Ethernet Loopback type, swaps Source and Destination MAC addresses before sending back the packet

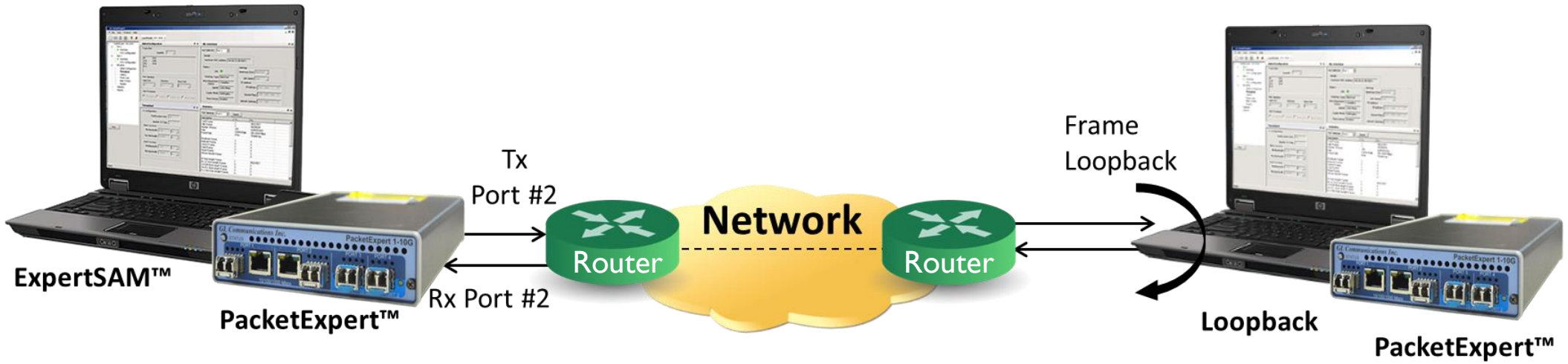
Loopback Testing (all ports or 2 ports)



- Supports Loopback on 10G / 1G ports
- Loopback Types – Smart Loopback, Layer 1, Ethernet, IP, UDP
- General statistics per port (similar to BERT port level statistics)

ITU-T Y.1564 (ExpertSAM™)

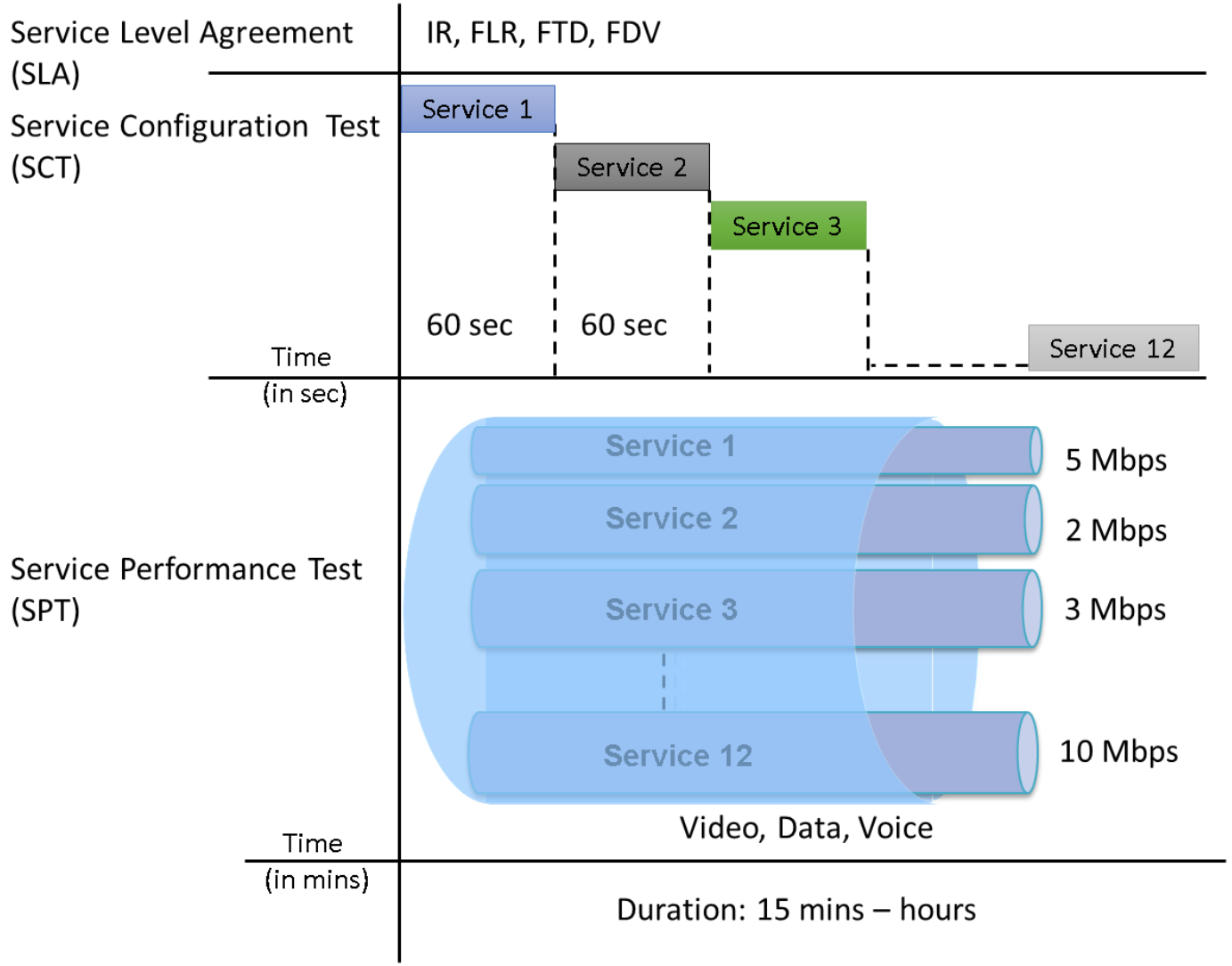
Ethernet Network Testing



- A single test to validate service-level agreements (SLAs) as per ITU-T Y.1564 standard.
- ITU-T Y.1564 completes this testing in two phases based on the SLA parameters:
  - Service Level Agreement Parameters: Information Rate (IR), Frame Transfer Delay (FTD), Frame Delay Variation (FDV), Frame Loss Ratio (FLR)
  - Service Configuration Test
  - Service Performance Test

ITU-T Y.1564 (ExpertSAM™)

- **Service Configuration Test** - confirms the end-to-end configuration with the SLA parameters for all configured traffic streams
- **Service Performance Test** - transmits all configured traffic streams simultaneously CIR confirming all traffic is able to transverse the network under full load with the above-mentioned parameters.



Highlights

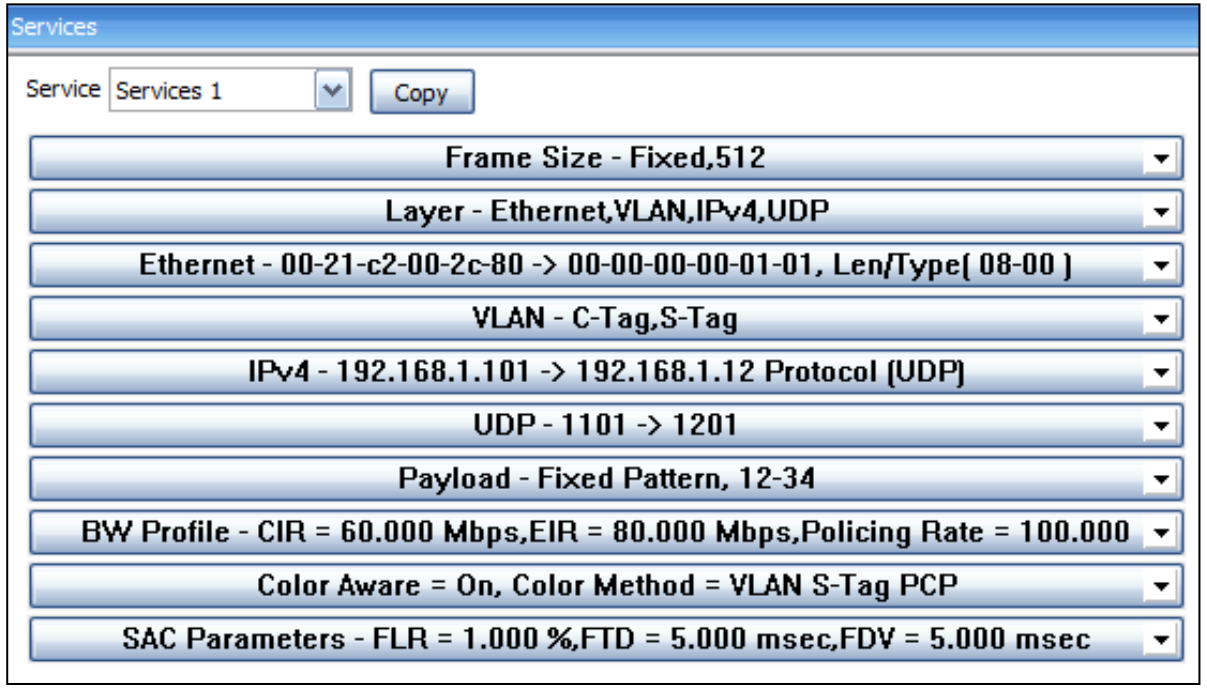
- Complete validation of Ethernet service-level agreements (SLAs) in a single test
- ITU-T Y.1564 standard compliance
- Service Configuration and Service Performance tests methodology supported
- KPIs like Information Rate (IR) or Throughput, Frame Loss Ratio (FLR), Frame Transfer Delay (FTD) or Latency, and Frame Delay Variation (FDV) or Jitter, measured simultaneously for multi streams, and Pass/Fail verdict declared.
- Capability to generate traffic at throughput of CIR (guaranteed traffic), EIR (best effort bandwidth), and traffic policing (dropped bandwidth) rates ensuring Key performance indicators (KPI) validation
- EMIX frame sizes supported per service – up to 7 frame sizes can be defined per service
- Supports multiple services with varying performance requirements that meets full load conditions
- Stacked VLAN supported – C-Tag and S-Tag to simulate Carrier Ethernet traffic
- Simultaneous validation of all the services quality over time

RFC 2544 VS Y.1564 (ExpertSAM™)

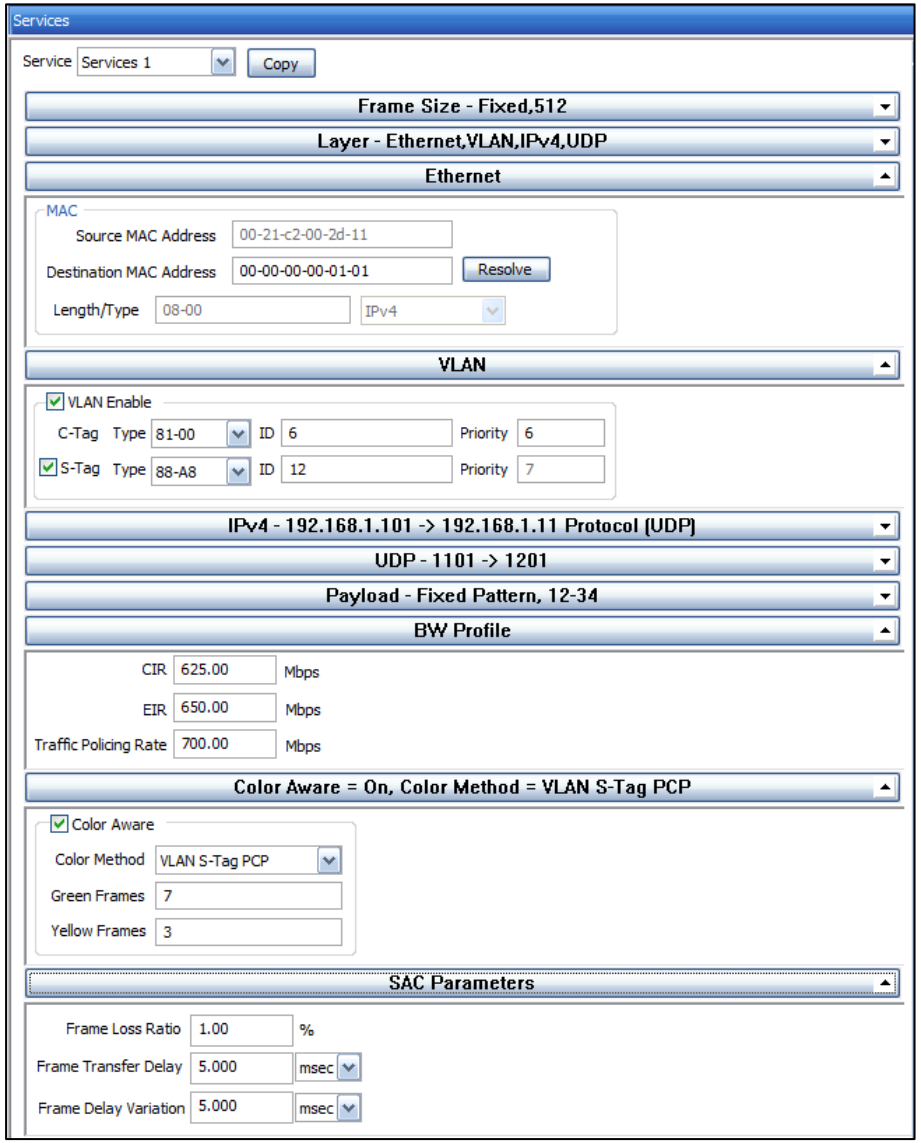
	RFC 2544	Y.1564
Measurements	Throughput, burstability, frame loss and latency	Throughput, burstability, frame loss, latency, packet jitter, QoS
Services	Link level	Multiple concurrent service levels
Performance	Measuring maximum performance	Key performance indicators (KPI) validation
Throughput	No separation of the committed and excess traffic	CIR, EIR and Traffic Policing constantly ensuring that KPI are met during the test
Frame Delay	Tests one frame in every test time and does not consider any latency variation that might occur over a longer test period.	Latency is measured during the test on all the generated frames measuring any deviation out of the defined range
Frame loss	Frame loss is measured during rate distribution throughput test where the frame loss distribution doesn't align with committed rate without complying to the KPI	Frame loss measurement during throughput test
Frame Delay Variation	Frame delay variation is not measured	Frame delay variation is measured for traffic generated up to the CIR ensuring proper traffic prioritization

Service Configurations

Service Configuration Collapsed Summary View



Service Configuration Expanded View



GL Communications

Service Configuration Test Results

Service Result Overview

Service Configuration Results Overview

Overview

#	Service Name	Verdict	Current Step	Max IR(Mbps)	FLR(%)	Max FTD(msec)	Max FDV(msec)
1	Service1	✓	-	625.00	0.000	0.0014	0.000038
2	Service2	✓	-	625.00	0.000	0.0014	0.000038
3	Service3	✓	-	625.00	0.000	0.0014	0.000038
4	Service4	✓	-	625.00	0.000	0.0014	0.000038
5	Service5	✓	-	625.00	0.000	0.0014	0.000038
6	Service6	✓	-	625.00	0.000	0.0014	0.000038
7	Service7	✓	-	625.00	0.000	0.0014	0.000038
8	Service8	✓	-	625.00	0.000	0.0014	0.000038
9	Service9	✓	-	625.00	0.000	0.0014	0.000038
10	Service10	✓	-	625.00	0.000	0.0014	0.000038
11	Service11	✓	-	625.00	0.000	0.0014	0.000038
12	Service12	✓	-	625.00	0.000	0.0014	0.000038
13	Service13	✓	-	625.00	0.000	0.0014	0.000038
14	Service14	✓	-	625.00	0.000	0.0014	0.000038
15	Service15	✓	-	625.00	0.000	0.0014	0.000038
16	Service16	✓	-	625.00	0.000	0.0014	0.000038

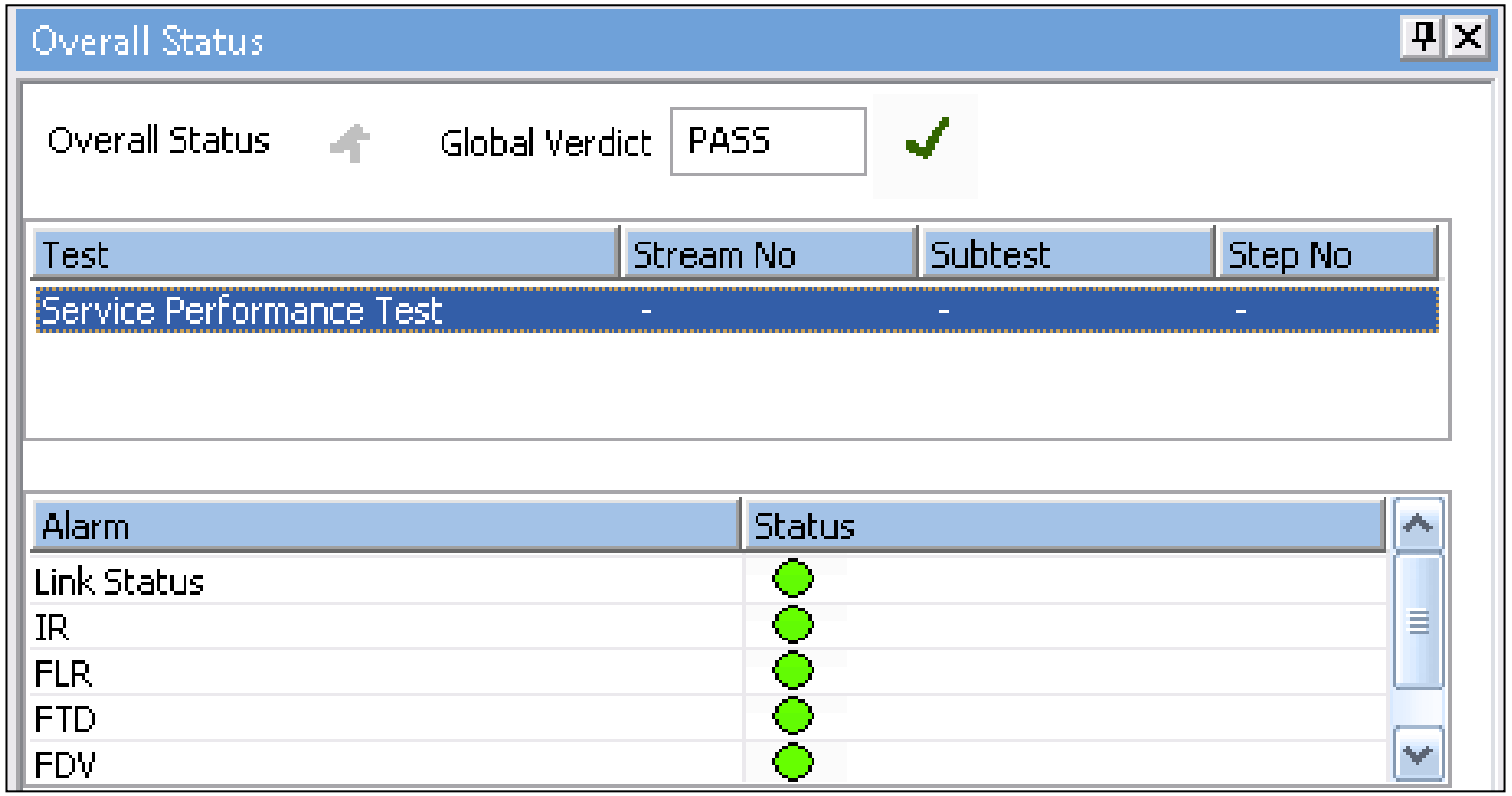
Service Detail Results

Service Configuration Results Details

Service: Service1 | IR(Mbps), FLR(%), FTD(ms), FDV(ms) | Vertical | FTD Unit: msec | FDV Unit: msec

Test	Verdict	IR (Curr)	IR (Min)	IR (Avg)	IR (Max)	FL (Count)	FLR (Rate)	FTD (Curr)	FTD (Min)	FTD (Avg)	FTD (Max)	FDV (Curr)	FDV (Min)	FDV (Avg)	FDV (Max)
CIR	PASS	624.99	624.99	625.00	625.00	0	0.000	0.001	0.001	0.002	0.001	< 1us	0.000	< 1us	< 1us
EIR	PASS	649.99	649.99	650.00	650.00	1	0.000	0.001	0.001	0.002	0.001	< 1us	0.000	< 1us	< 1us

Service Performance Test Overall Status



Service Performance Test Results

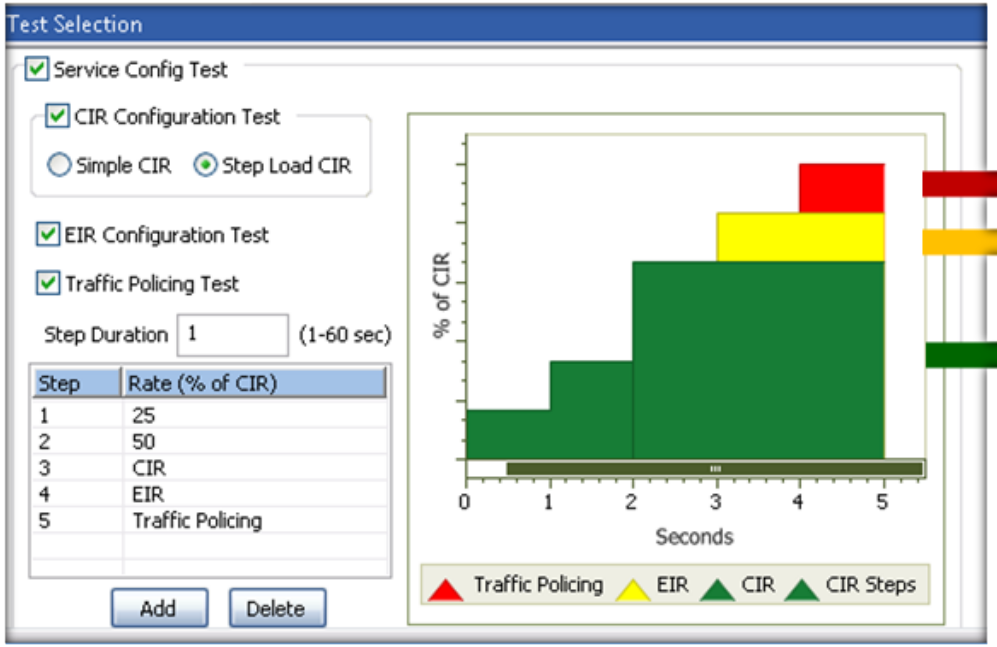
Service Performance Results

IR(Mbps), FLR(%), FTD(msec), FDV(msec) | Test Time 00:00:16 | Vertical | FTD Unit msec | FDV Unit usec

Service	Verdict	IR (Curr)	IR (Min)	IR (Avg)	IR (Max)	FL (Count)	FLR (Rate)	FTD (Curr)	FTD (Min)	FTD (Avg)	FTD (Max)	FDV (Curr)	FDV (Min)	FDV (Avg)	FDV (Max)
1	PASS	625.00	625.00	625.00	625.00	2	0.000	0.018	0.001	0.015	0.021	0.003000	0.003000	0.003000	8.122000
2	PASS	625.00	625.00	625.00	625.00	2	0.000	0.018	0.001	0.015	0.021	0.003000	0.003000	0.003000	8.115000
3	PASS	625.00	625.00	625.00	625.00	3	0.000	0.018	0.001	0.015	0.021	0.003000	0.003000	0.003000	8.115000
4	PASS	625.00	625.00	625.00	625.00	3	0.000	0.018	0.001	0.015	0.021	0.003000	0.003000	0.003000	8.122000
5	PASS	625.00	625.00	625.00	625.00	3	0.000	0.018	0.001	0.015	0.021	0.003000	0.003000	0.003000	8.122000
6	PASS	625.00	625.00	625.00	625.00	3	0.000	0.018	0.001	0.015	0.021	0.003000	0.003000	0.003000	8.128000
7	PASS	625.00	625.00	625.00	625.00	3	0.000	0.018	0.001	0.015	0.021	0.003000	0.003000	0.003000	8.115000
8	PASS	625.00	625.00	625.00	625.00	3	0.000	0.018	0.001	0.015	0.021	0.003000	0.003000	0.003000	8.122000
9	PASS	625.00	625.00	625.00	625.00	3	0.000	0.018	0.001	0.015	0.021	0.003000	0.003000	0.003000	8.122000
10	PASS	625.00	625.00	625.00	625.00	3	0.000	0.018	0.001	0.015	0.021	0.003000	0.003000	0.003000	8.122000
11	PASS	625.00	625.00	625.00	625.00	3	0.000	0.018	0.001	0.015	0.021	0.003000	0.003000	0.003000	8.115000
12	PASS	625.00	625.00	625.00	625.00	3	0.000	0.018	0.001	0.015	0.021	0.003000	0.003000	0.003000	8.122000
13	PASS	625.00	625.00	625.00	625.00	3	0.000	0.018	0.001	0.015	0.021	0.003000	0.003000	0.003000	8.122000
14	PASS	625.00	625.00	625.00	625.00	3	0.000	0.018	0.001	0.015	0.021	0.003000	0.003000	0.003000	8.122000
15	PASS	625.00	625.00	625.00	625.00	2	0.000	0.018	0.001	0.015	0.021	0.003000	0.003000	0.003000	8.122000
16	PASS	624.95	624.94	624.95	624.95	2	0.000	0.018	0.001	0.015	0.021	0.003000	0.003000	0.003000	8.128000

GL Communications

ITU-T Y.1564 (ExpertSAM™) Graph



Dropped bandwidth (everything over EIR)

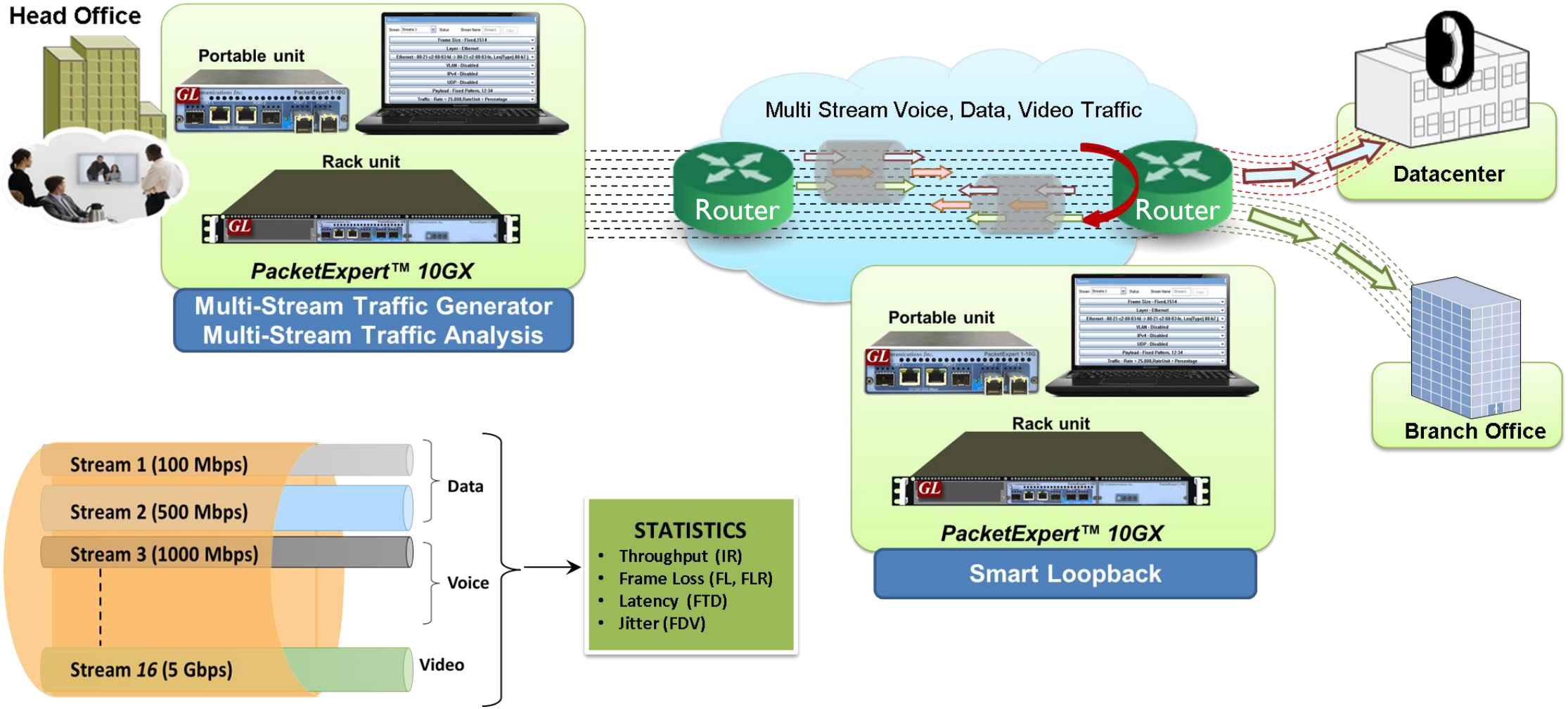
Best effort bandwidth (everything between CIR and EIR)

Guaranteed bandwidth (everything under CIR)

- Committed information rate or CIR is the average bandwidth guaranteed by a service provider. At any given time, the bandwidth should not fall below this committed figure.
- Excess Information Rate or EIR is the CIR plus excess rate that service provider claims to provide on a 'best-effort' basis.

Multi-Stream Traffic Generator and Analyzer

Multi-Stream Traffic Generator and Analyzer (1 Gbps, 2.5 Gbps, or 10 Gbps)



Multi-Stream Traffic Generator & Analyzer Results
(Horizontal View)

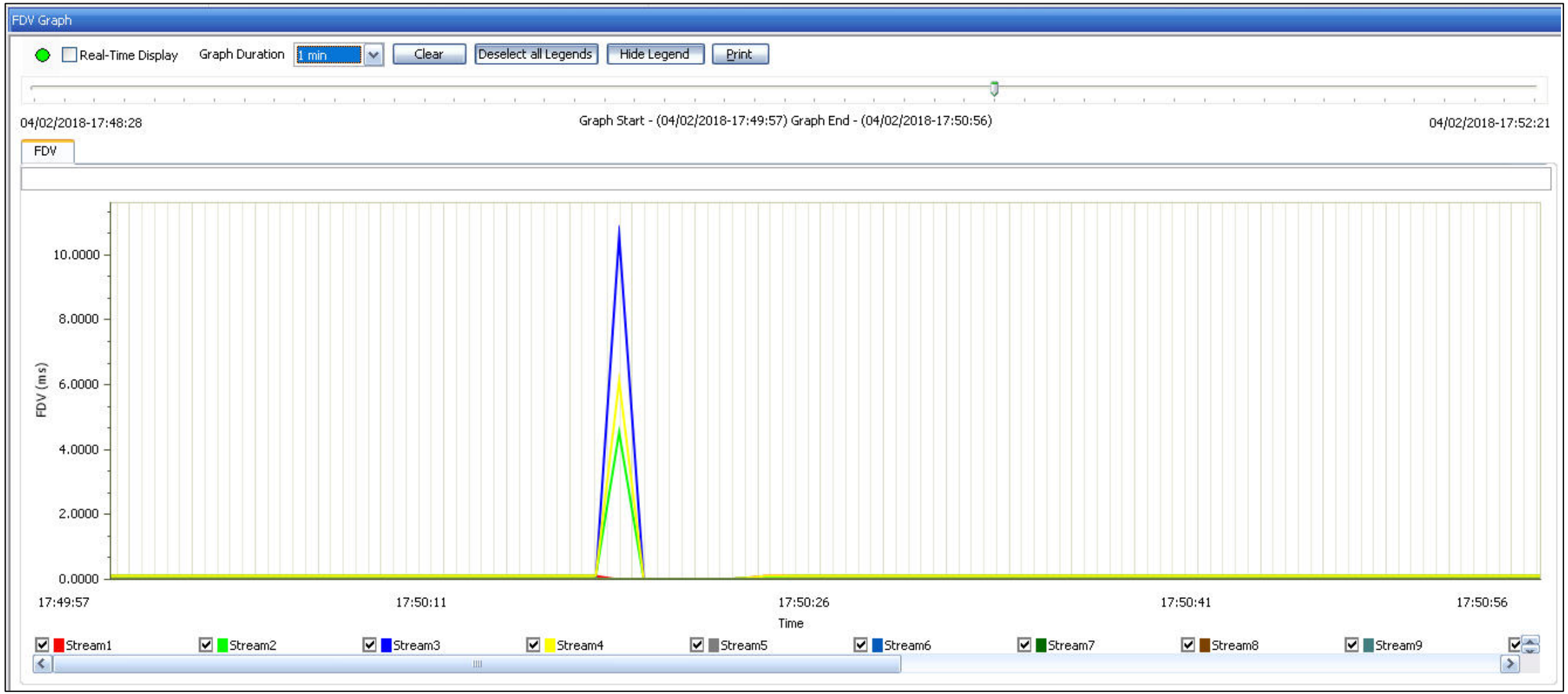
Multi-Stream Traffic Generator & Analyzer Results

IR(Mbps), FLR(%), FTD(msec), FDV(msec) | Test Time 00:00:53 | Vertical |||| | FTD Unit msec | FDV Unit msec | Activate All | DeActivate All

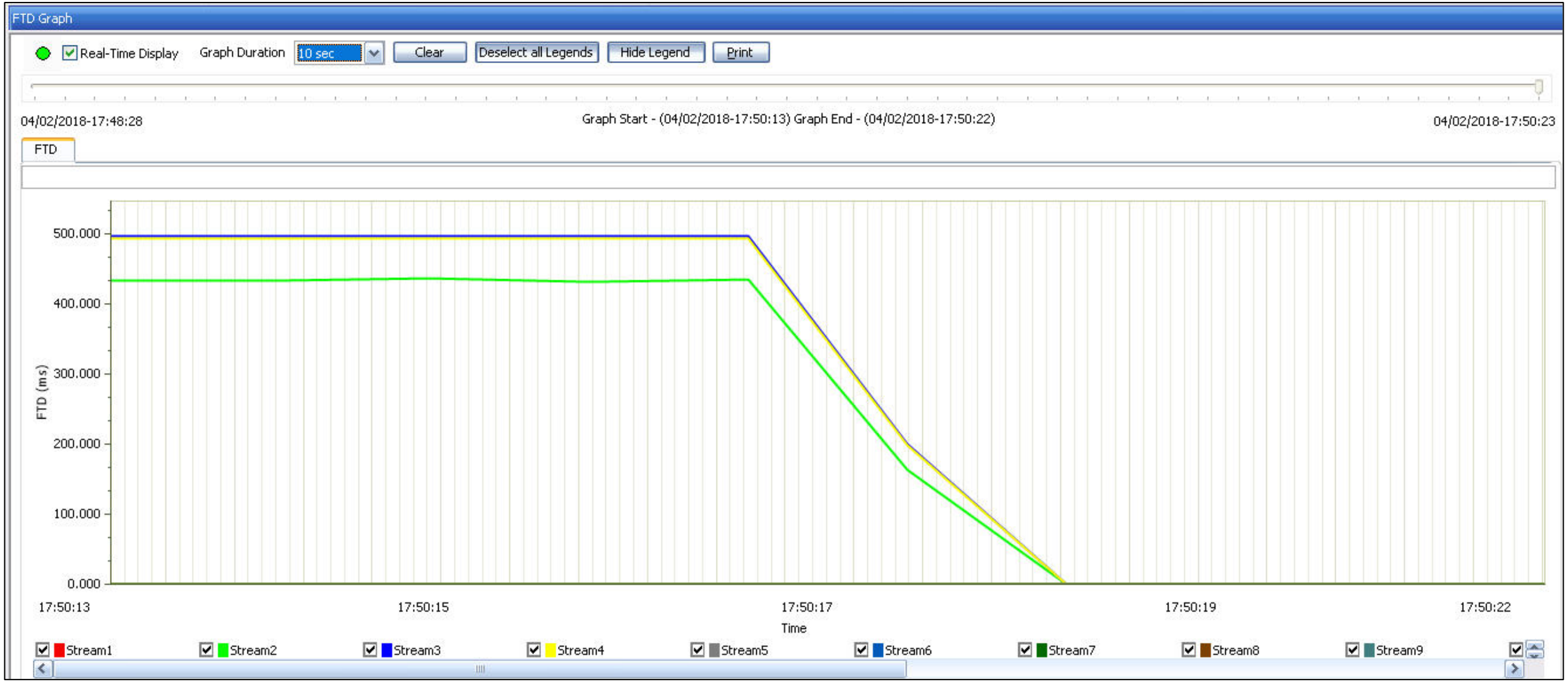
Stream No	Seconds	TxFrames	RxFrames	RxBytes	FL Count	FLR	IR (Curr)	IR (Min)	IR (Max)	IR (Avg)	FTD	FTD	FTD	FTD	FDV (Curr)	FDV (Min)	FDV (Max)	FDV (Avg)
☑ 1	55	1 146 226	1 125 387	679 852 618	20 839	1.818	104.05	104.03	104.06	133.78	0.002	0.001	0.003	0.002	< 1us	0.000	0.001	< 1us
☑ 2	55	1 278 940	1 255 686	642 911 232	23 254	1.818	98.97	98.94	98.97	127.24	0.002	0.001	0.003	0.002	< 1us	0.000	0.001	< 1us
☑ 3	55	5 832 149	5 726 109	7 902 030 420	106 040	1.818	1187.65	1187.30	1187.65	1526.96	0.002	0.002	0.003	0.002	< 1us	0.000	< 1us	< 1us
☑ 4	55	1 214 894	1 192 804	1 646 069 520	22 090	1.818	247.40	247.33	247.41	318.08	0.002	0.002	0.003	0.002	< 1us	< 1us	< 1us	< 1us
☑ 5	55	155 163	152 342	157 521 628	2 821	1.818	23.79	23.79	23.80	30.58	0.002	0.002	0.003	0.002	< 1us	< 1us	< 1us	< 1us
☑ 6	55	18 212 176	17 881 043	2 324 535 590	331 133	1.818	397.36	397.24	397.36	510.89	0.002	0.001	0.003	0.002	< 1us	0.000	0.001	< 1us
☑ 7	55	14 585 983	14 320 782	19 762 679 160	265 201	1.818	2970.25	2969.39	2970.26	3818.88	0.002	0.002	0.003	0.002	< 1us	0.000	< 1us	< 1us
☑ 8	55	5 216 779	5 121 928	5 244 854 272	94 851	1.818	792.20	791.97	792.20	1018.53	0.002	0.002	0.003	0.002	< 1us	0.000	< 1us	< 1us
☑ 9	55	1 535 124	1 507 212	771 692 544	27 912	1.818	118.79	118.76	118.79	152.73	0.002	0.001	0.003	0.002	< 1us	0.000	0.001	< 1us
☑ 10	55	3 434 715	3 372 265	674 453 000	62 450	1.818	109.91	109.88	109.91	141.31	0.002	0.001	0.003	0.002	< 1us	0.000	0.001	< 1us
☑ 11	55	3 176 550	3 118 794	405 443 220	57 756	1.818	69.31	69.29	69.31	89.11	0.002	0.001	0.003	0.002	< 1us	0.000	0.001	< 1us
☑ 12	55	9 085 290	8 920 101	1 159 613 130	165 189	1.818	198.22	198.17	198.23	254.86	0.002	0.002	0.003	0.002	< 1us	0.000	< 1us	< 1us
☑ 13	55	9 844 599	9 665 605	5 841 891 662	178 994	1.818	894.11	893.85	894.12	1149.56	0.002	0.001	0.003	0.002	< 1us	0.000	0.001	< 1us
☑ 14	55	27 539 785	27 039 059	16 342 406 346	500 726	1.818	2501.23	2500.50	2501.23	3215.84	0.002	0.001	0.003	0.002	< 1us	0.000	0.001	< 1us
☑ 15	55	395 501	388 310	793 705 640	7 191	1.818	118.74	118.71	118.74	152.66	0.003	0.002	0.003	0.003	< 1us	0.000	< 1us	< 1us
☑ 16	55	1 090 764	1 090 764	658 606 880	0	0.000	98.97	98.94	98.98	129.60	0.002	0.002	0.003	0.002	< 1us	0.000	< 1us	< 1us

Throughput (IR) Graph

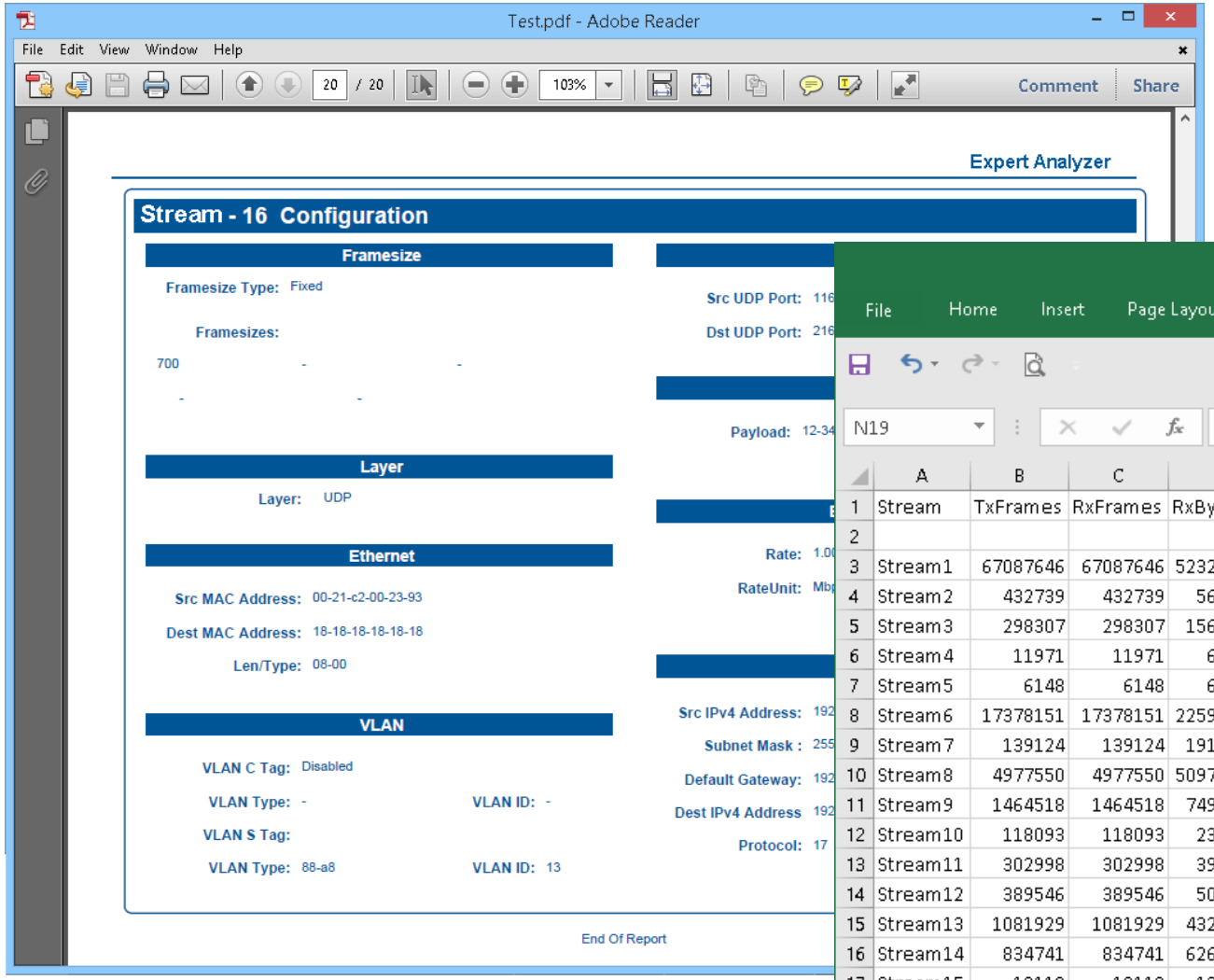
Frame Delay Variation – FDV Graph

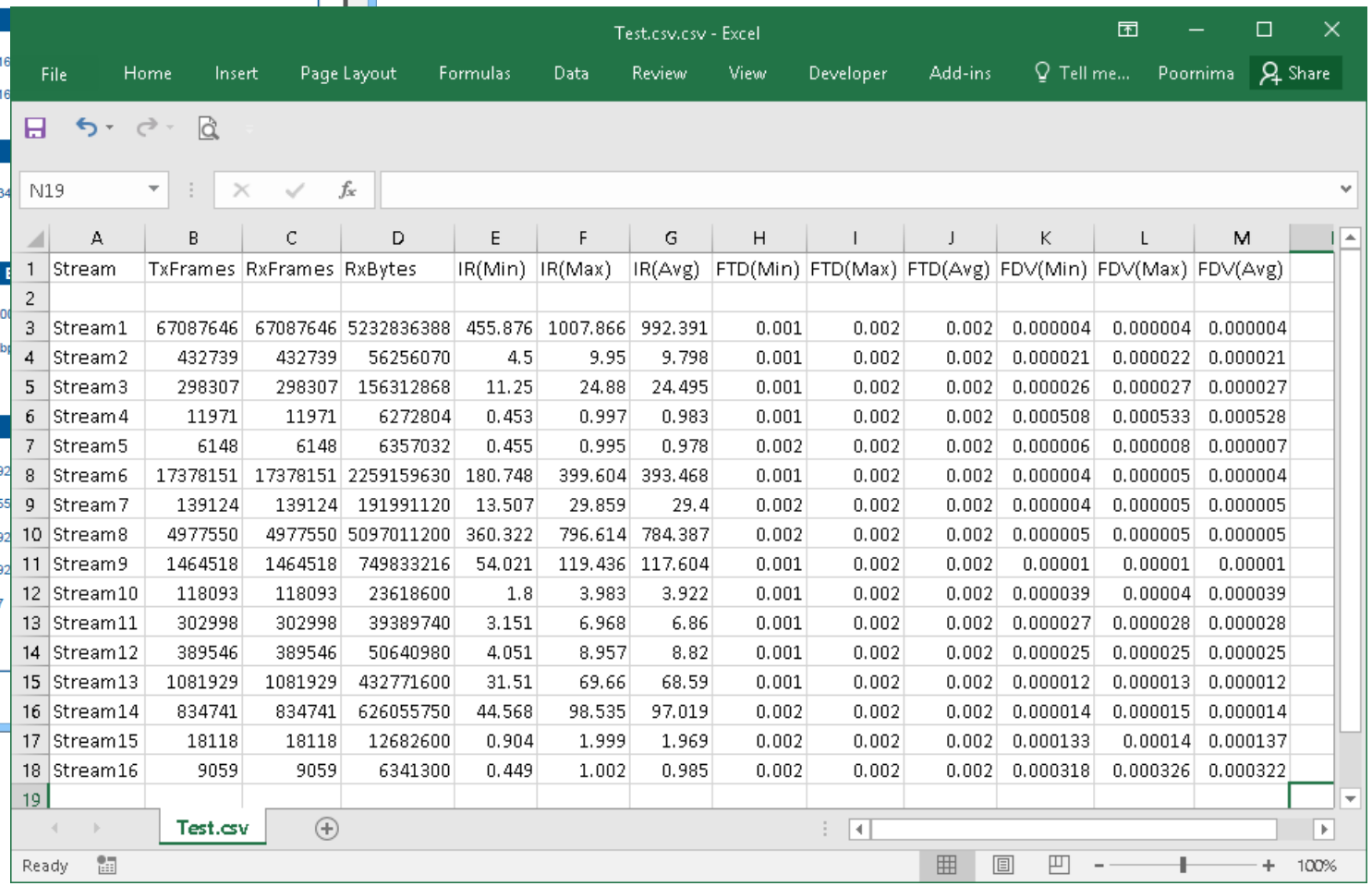


Frame Transfer Delay – FTD Graph



Report Generation in PDF and CSV Format



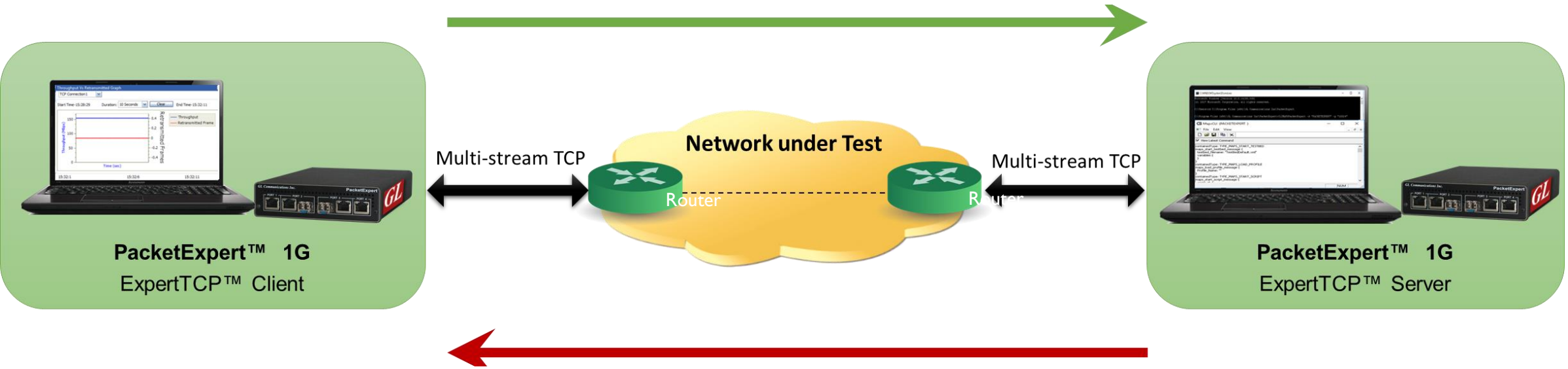


Stream	TxFrames	RxFrames	RxBytes	IR(Min)	IR(Max)	IR(Avg)	FTD(Min)	FTD(Max)	FTD(Avg)	FDV(Min)	FDV(Max)	FDV(Avg)
Stream1	67087646	67087646	5232836388	455.876	1007.866	992.391	0.001	0.002	0.002	0.000004	0.000004	0.000004
Stream2	432739	432739	56256070	4.5	9.95	9.798	0.001	0.002	0.002	0.000021	0.000022	0.000021
Stream3	298307	298307	156312868	11.25	24.88	24.495	0.001	0.002	0.002	0.000026	0.000027	0.000027
Stream4	11971	11971	6272804	0.453	0.997	0.983	0.001	0.002	0.002	0.000508	0.000533	0.000528
Stream5	6148	6148	6357032	0.455	0.995	0.978	0.002	0.002	0.002	0.000006	0.000008	0.000007
Stream6	17378151	17378151	2259159630	180.748	399.604	393.468	0.001	0.002	0.002	0.000004	0.000005	0.000004
Stream7	139124	139124	191991120	13.507	29.859	29.4	0.002	0.002	0.002	0.000004	0.000005	0.000005
Stream8	4977550	4977550	5097011200	360.322	796.614	784.387	0.002	0.002	0.002	0.000005	0.000005	0.000005
Stream9	1464518	1464518	749833216	54.021	119.436	117.604	0.001	0.002	0.002	0.00001	0.00001	0.00001
Stream10	118093	118093	23618600	1.8	3.983	3.922	0.001	0.002	0.002	0.000039	0.00004	0.000039
Stream11	302998	302998	39389740	3.151	6.968	6.86	0.001	0.002	0.002	0.000027	0.000028	0.000028
Stream12	389546	389546	50640980	4.051	8.957	8.82	0.001	0.002	0.002	0.000025	0.000025	0.000025
Stream13	1081929	1081929	432771600	31.51	69.66	68.59	0.001	0.002	0.002	0.000012	0.000013	0.000012
Stream14	834741	834741	626055750	44.568	98.535	97.019	0.002	0.002	0.002	0.000014	0.000015	0.000014
Stream15	18118	18118	12682600	0.904	1.999	1.969	0.002	0.002	0.002	0.000133	0.00014	0.000137
Stream16	9059	9059	6341300	0.449	1.002	0.985	0.002	0.002	0.002	0.000318	0.000326	0.000322

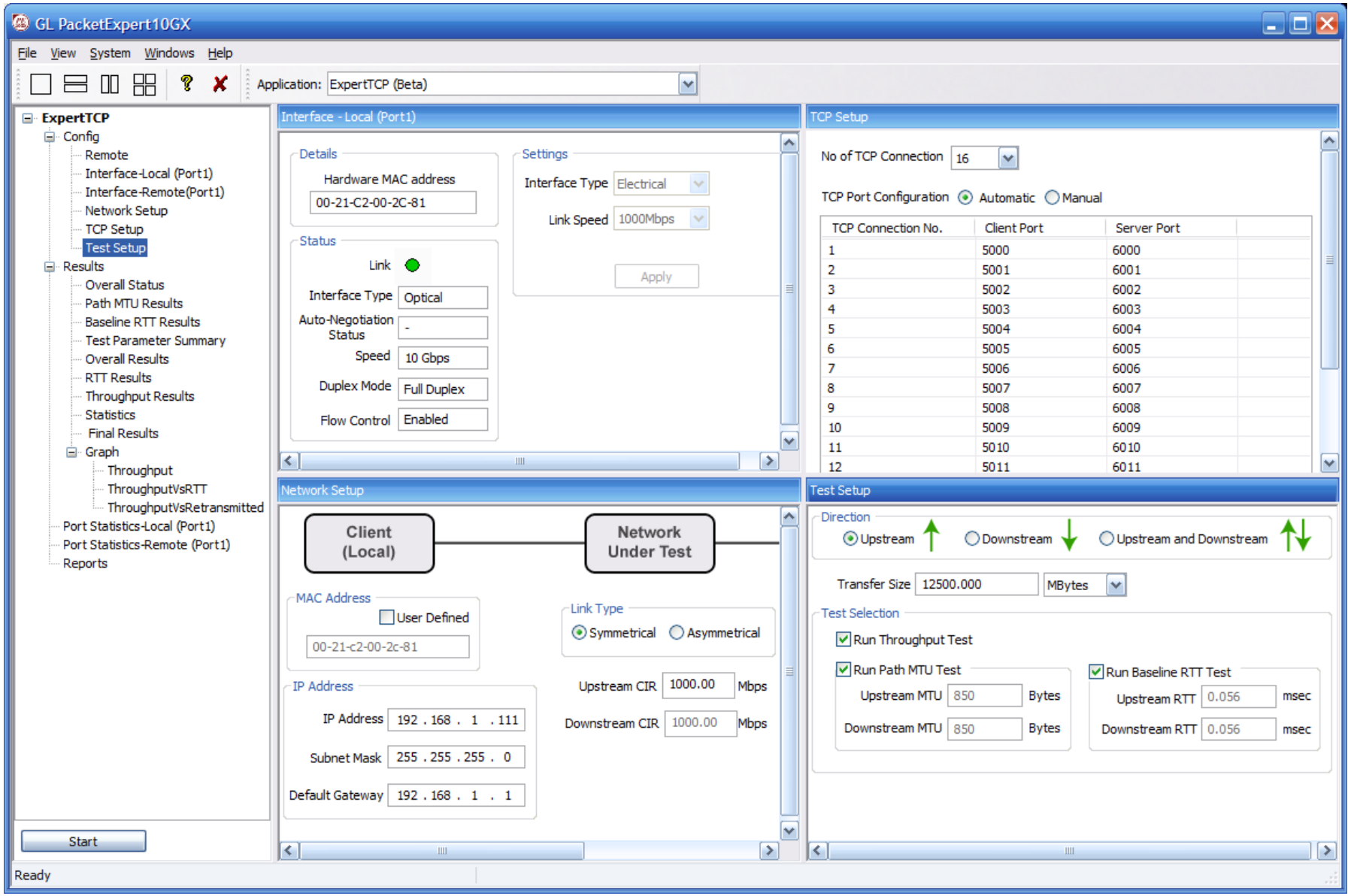
GL Communications

ExpertTCP™-TCP Throughput Testing (RFC 6349)

ExpertTCP™ (RFC-6349 Testing)

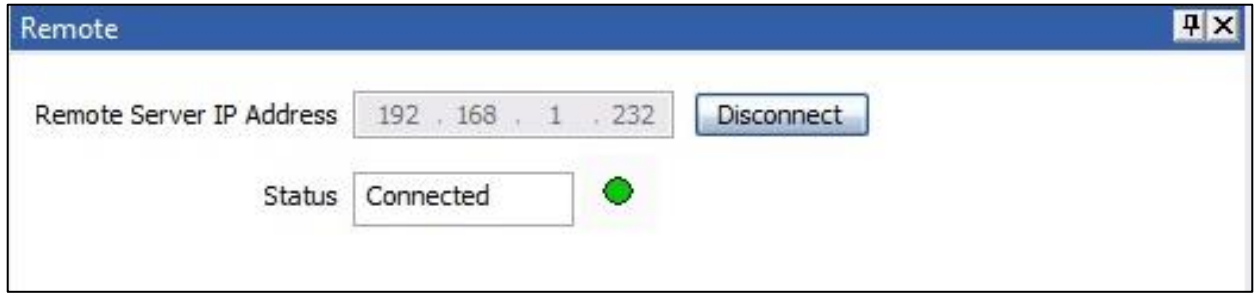


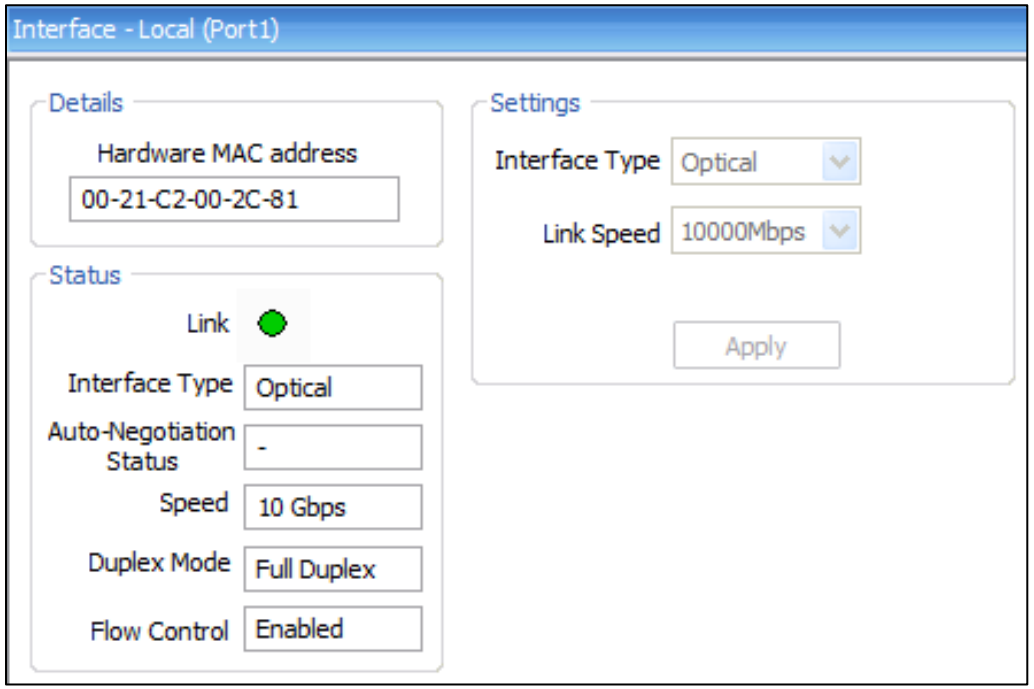
ExpertTCP™ Main Screen

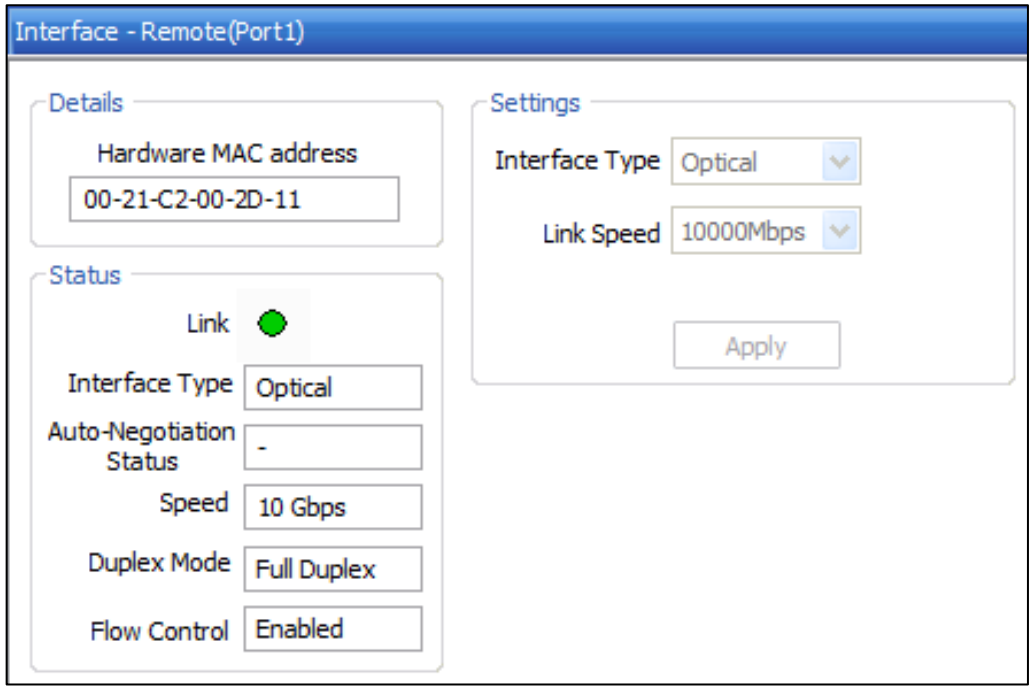


Network Setup

All settings configured locally on the client side

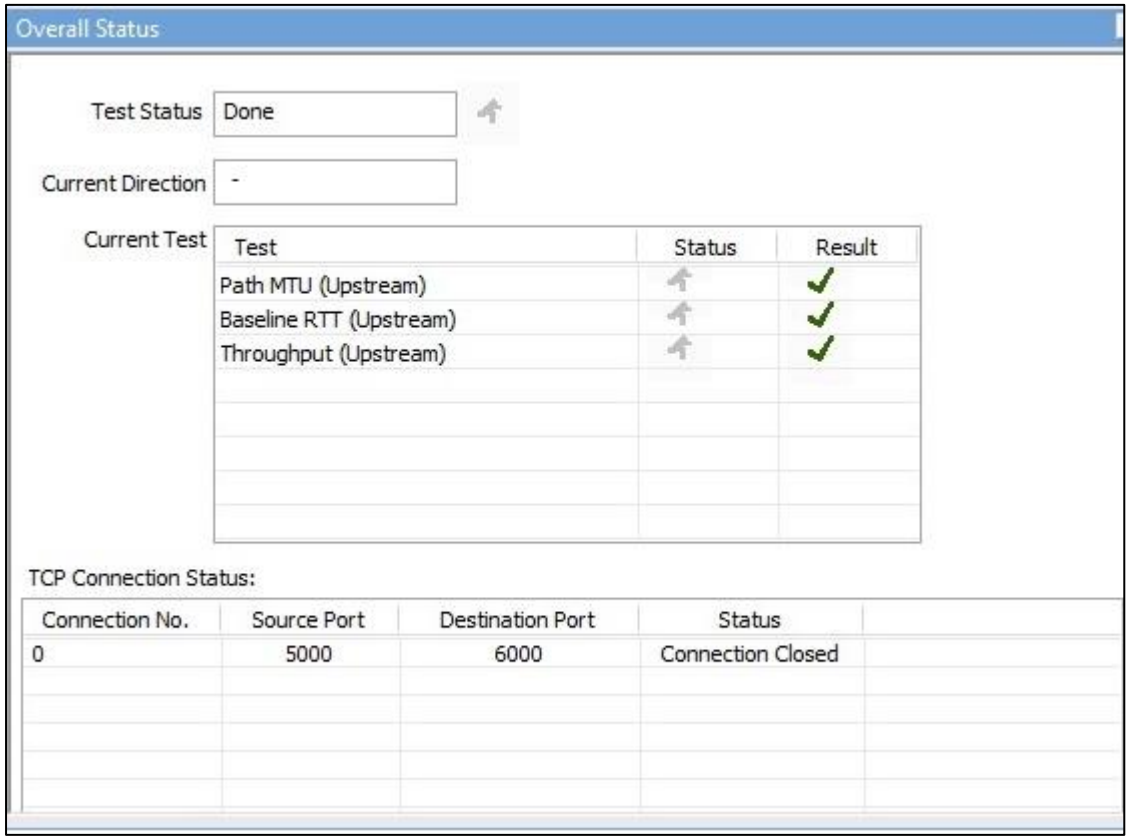


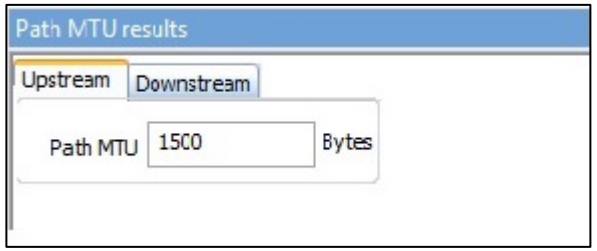


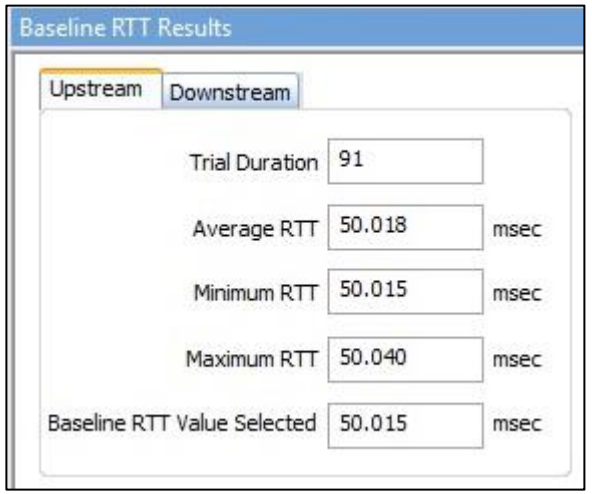


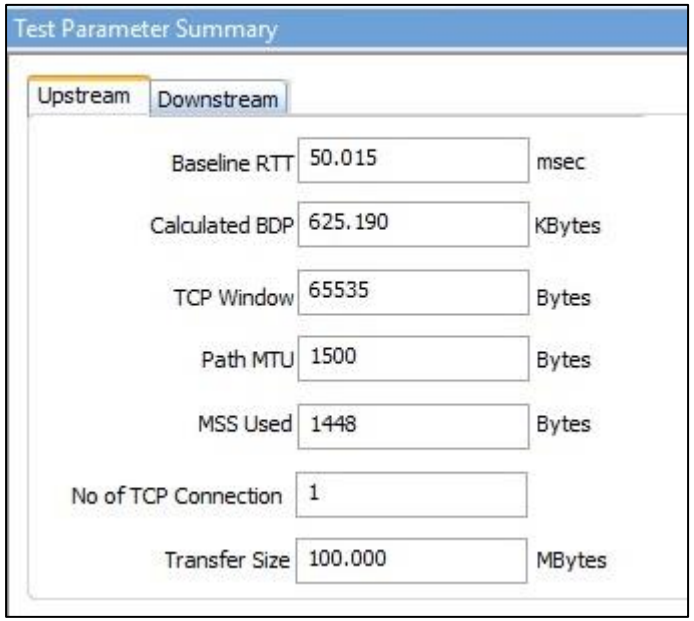
GL Communications

Status and Results









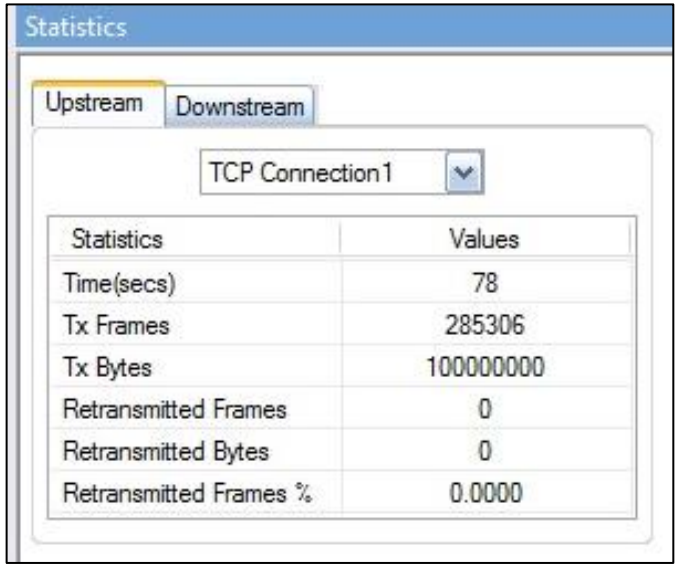
GL Communications

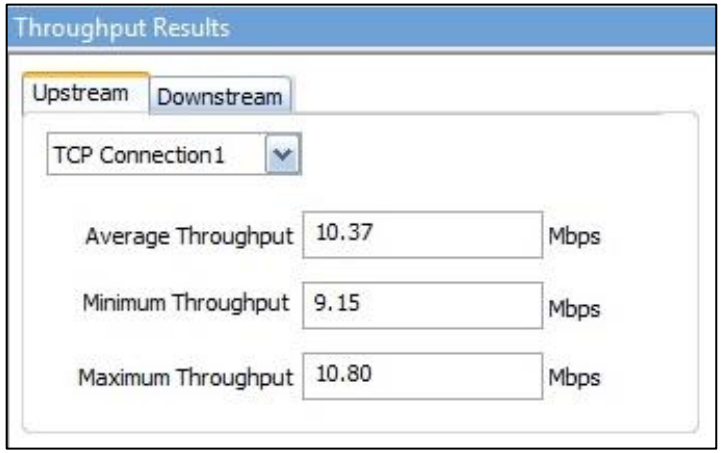
Statistics and Periodic Results

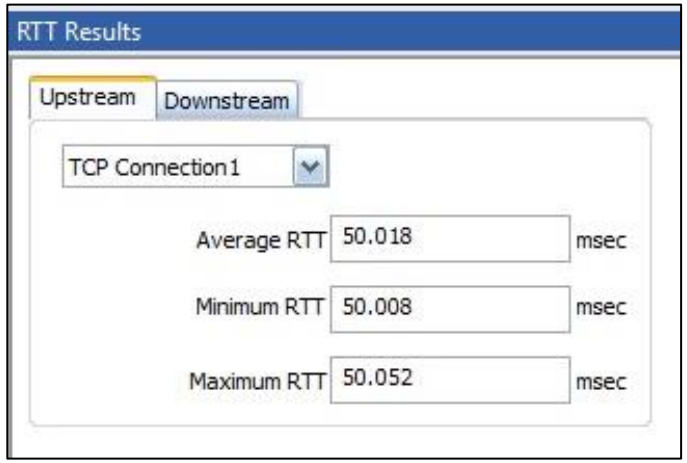
Statistics are updated every second and includes -

- TCP Transmitted Frames/Bytes
- TCP Retransmitted Frames/Bytes
- Retransmitted Bytes Percentage

Throughput and RTT values are calculated every second and displayed. Minimum, Maximum and Average Values are displayed







Final Results

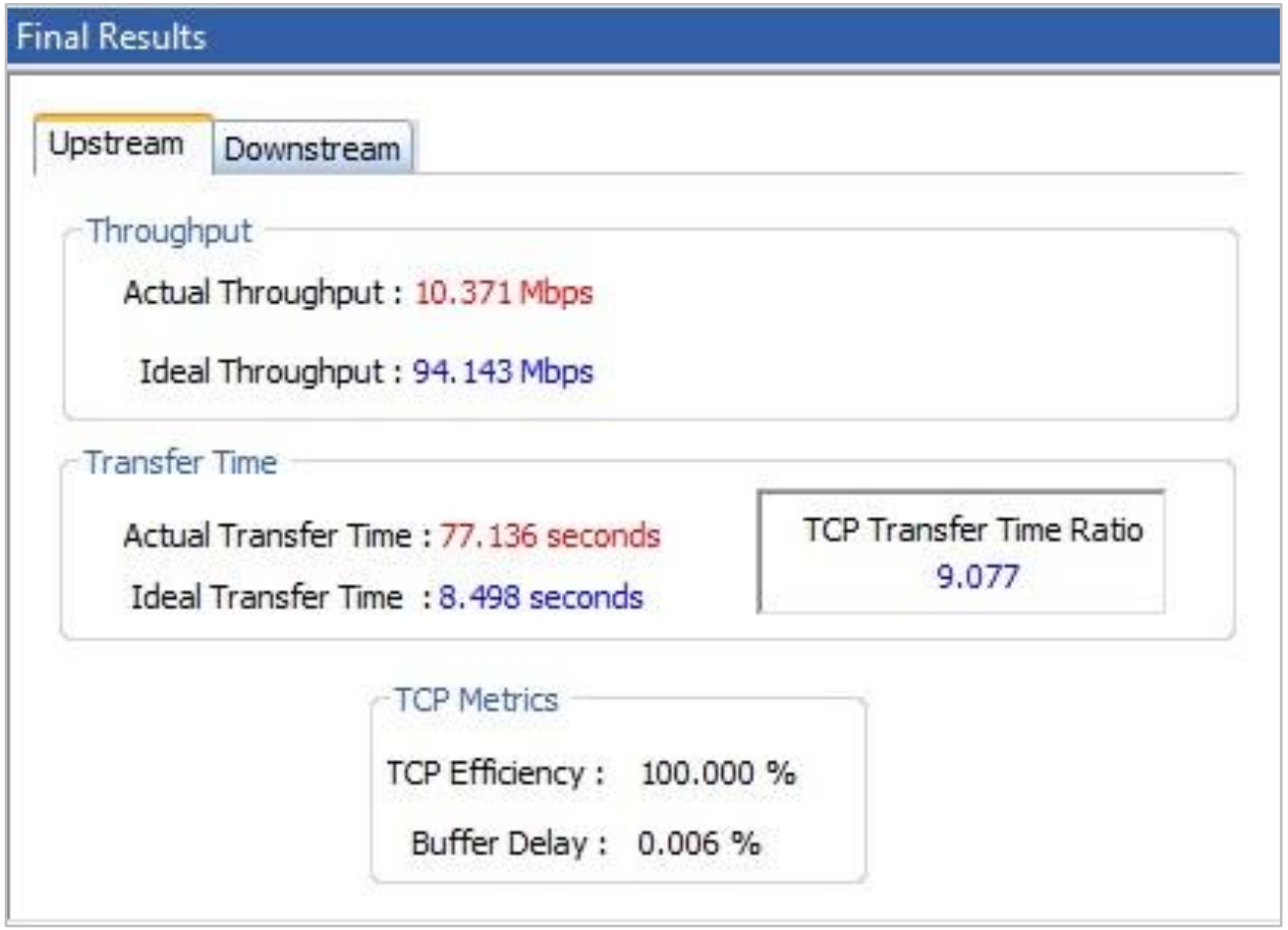
Ideal Throughput - the maximum possible TCP throughput for the given CIR

Ideal Transfer Time - the time taken to transfer the test data size at the ideal throughput

TCP Transfer Time Ratio - Measure of how much Actual transfer time is greater than the Ideal transfer time

TCP Efficiency - measure of the number of Transmitted bytes compared to the retransmitted bytes

Buffer Delay - measure of how much the RTT increases during the actual TCP Throughput test compared to the Baseline RTT



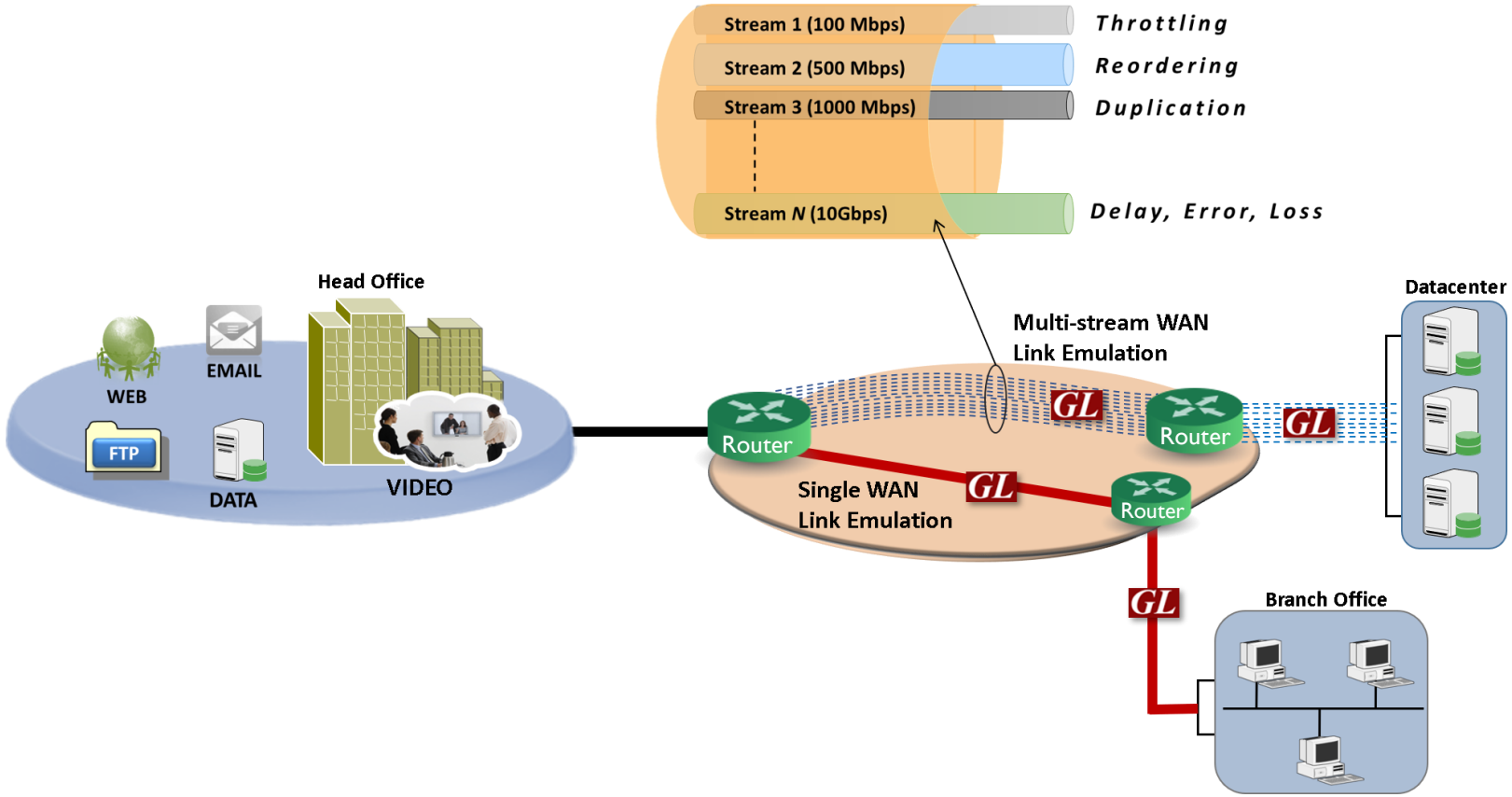
GL Communications

Simulate Real-World IP Network
Impairments, Delay, Errors, Loss, Optical, Electrical

Overview

How does GL simulate real-world IP Networks? What is GL's IPNetSim?

- Lab Testing Solution - application and automation
- Emulate Full Duplex 1 Gbps and 10 Gbps networks
- Real-world network conditions by imposing impairments
- Multiple streams independently configured



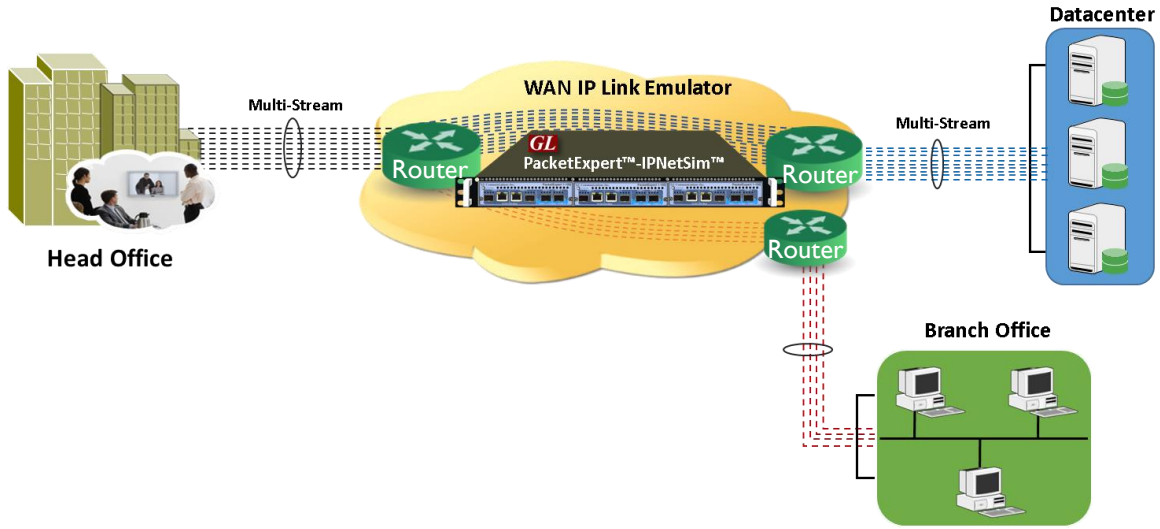
Application Overview

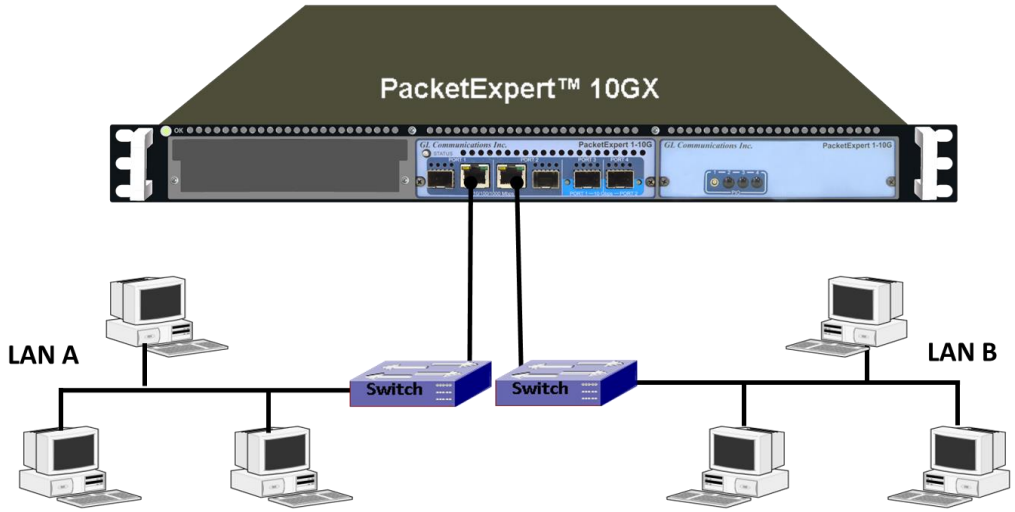
- Test Enterprise and Individual-level applications…
  - Audio and video streaming (VoIP, IMS, HDT, IPTV)
  - Storage services (Critical Data Access)
  - Cloud and web services
  - FTP / HTTP

- Simulate backhaul network
  - Static and dynamic networks
  - Satellite + other long delay networks

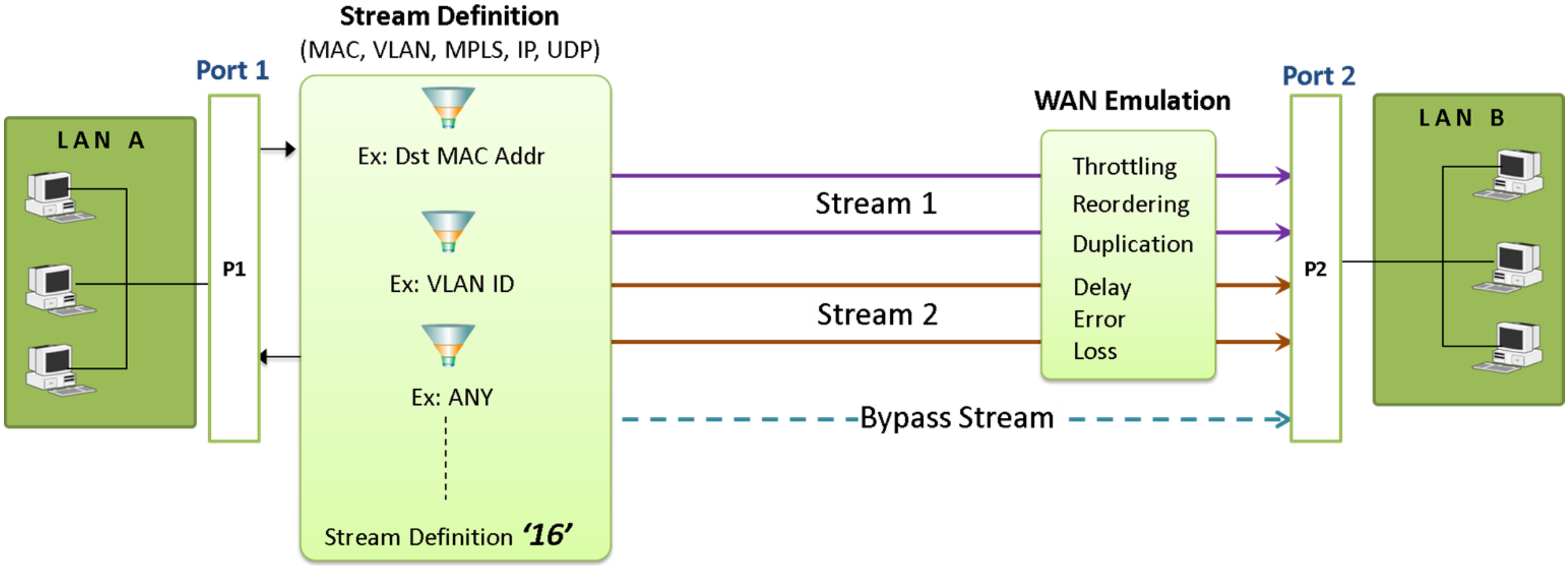
- Test Quality of Service (QoS) and Quality of Experience (QoE)

- Evaluate the stability of network devices (switches, VoIP Phones, VoIP PBXs, Set-top boxes and VoD Servers

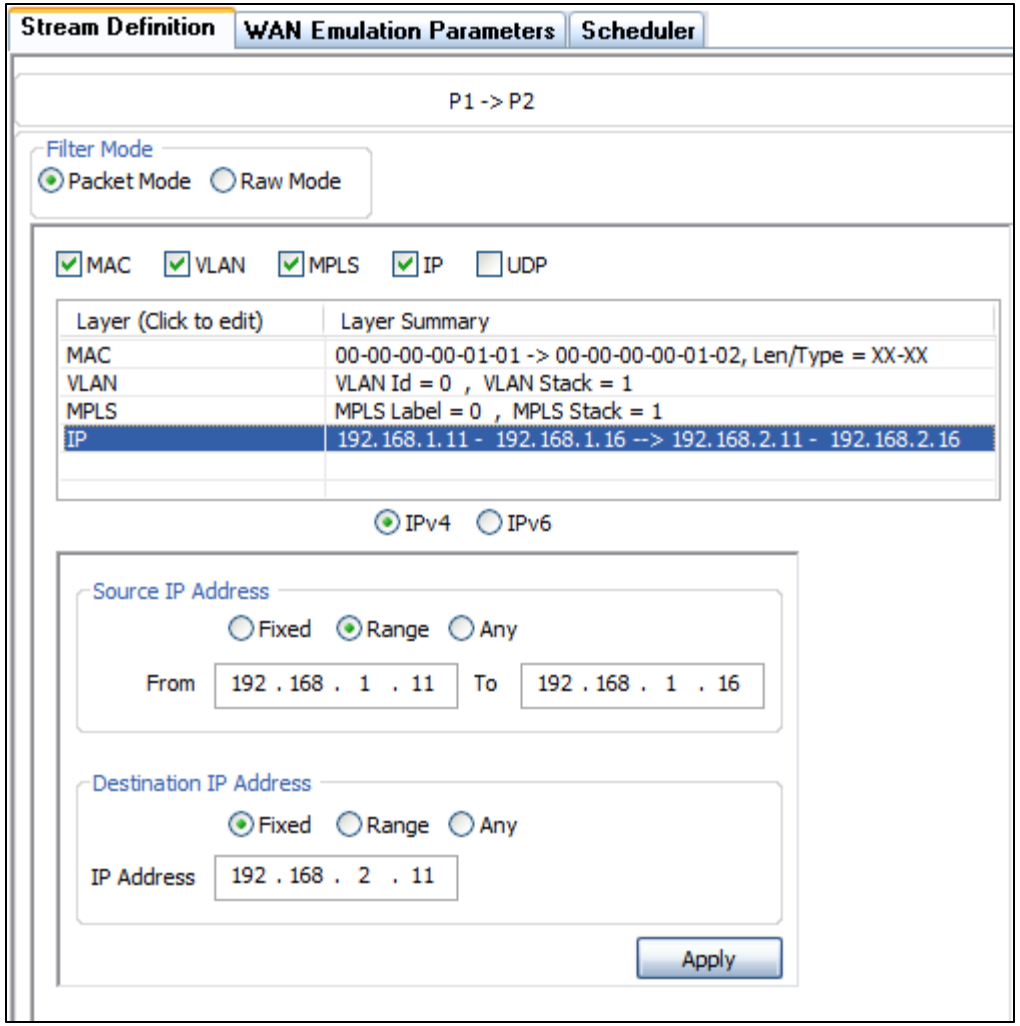




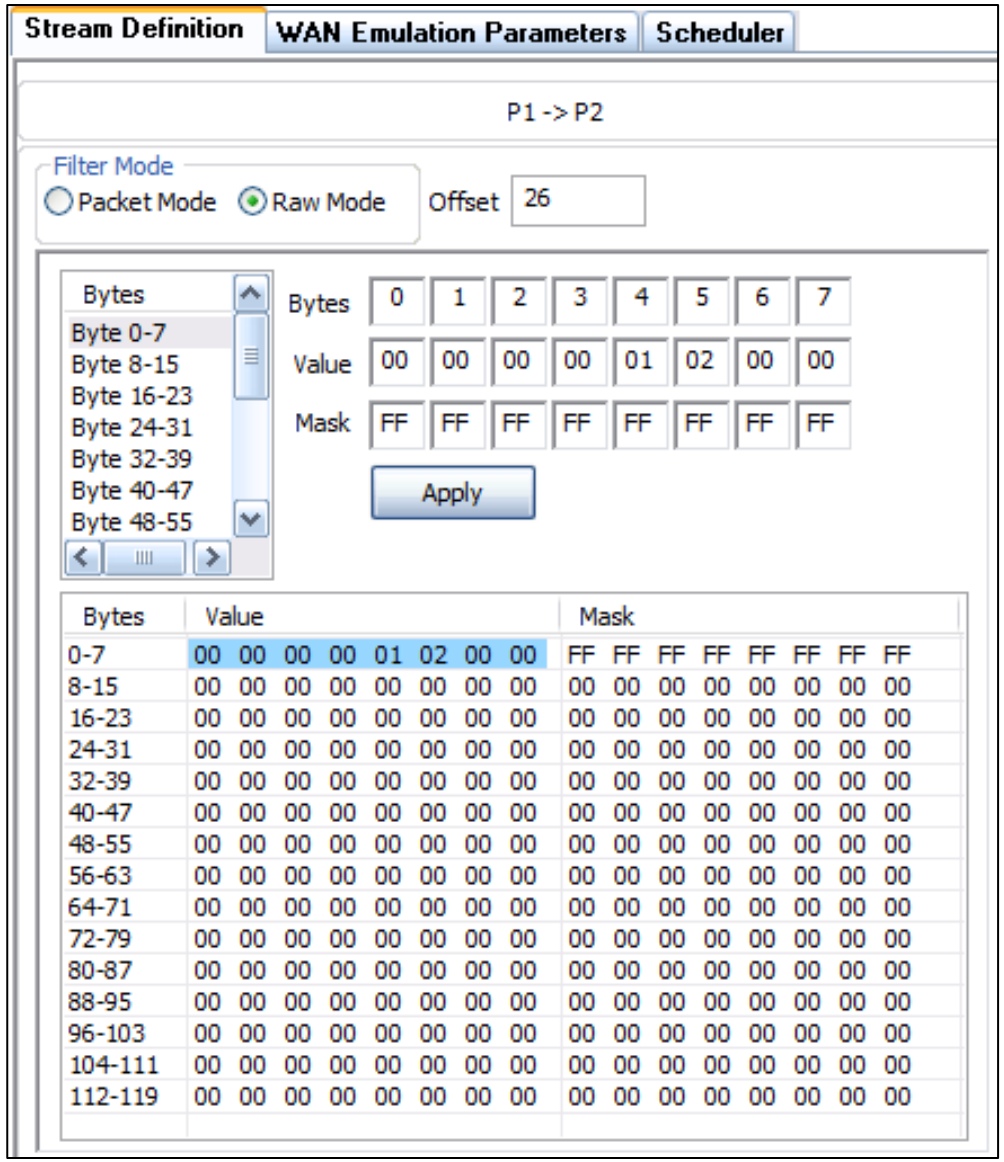
“Stream” Overview



Define Streams in Packet Mode



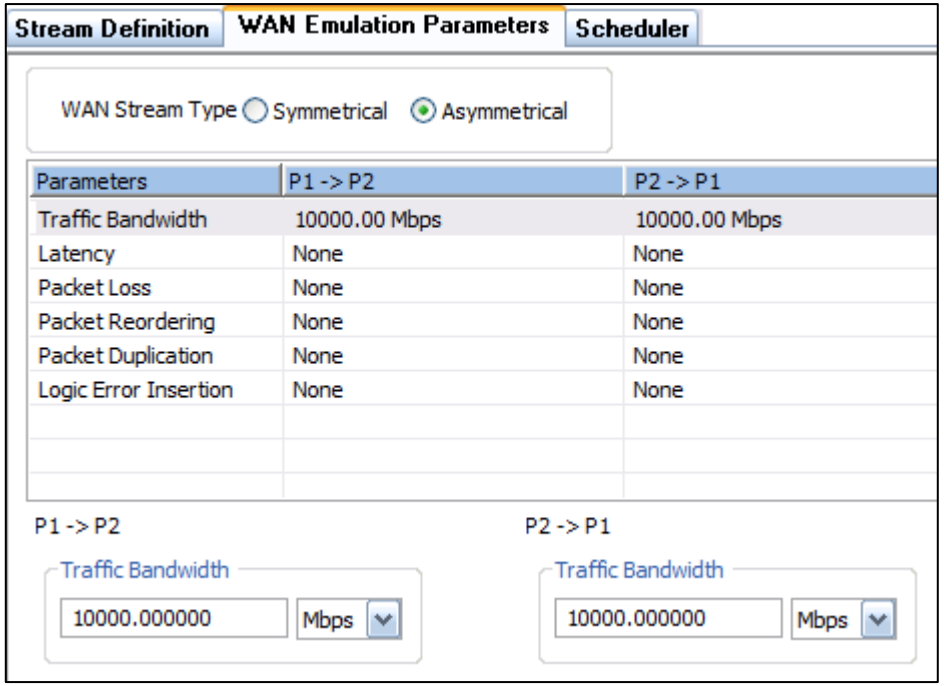
Define Streams in Raw Mode



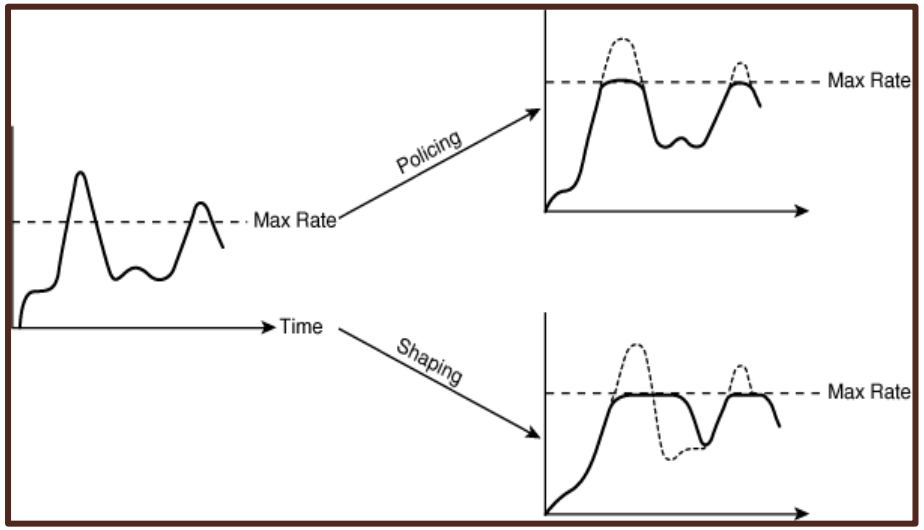
GL Communications

Traffic Bandwidth

- Traffic which exceeds the stated rate is **silently dropped**
- UDP Applications will experience **data loss**
- TCP Applications should adapt via **congestion-avoidance algorithms**



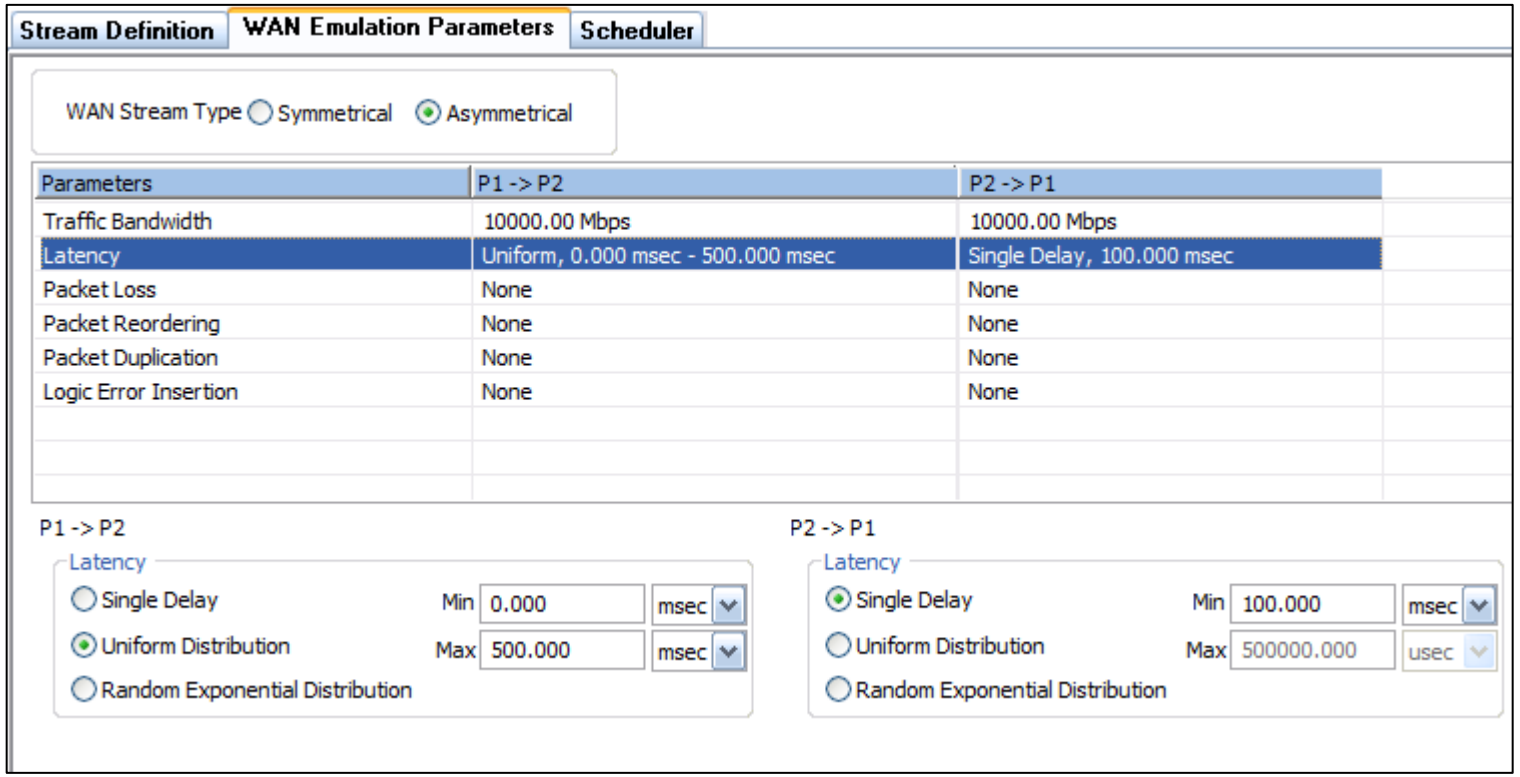
- Simulate WAN Applications where **Traffic Policing Policies** may be in effect, **i.e. Service Level Agreements** between Provider and Customer



GL Communications

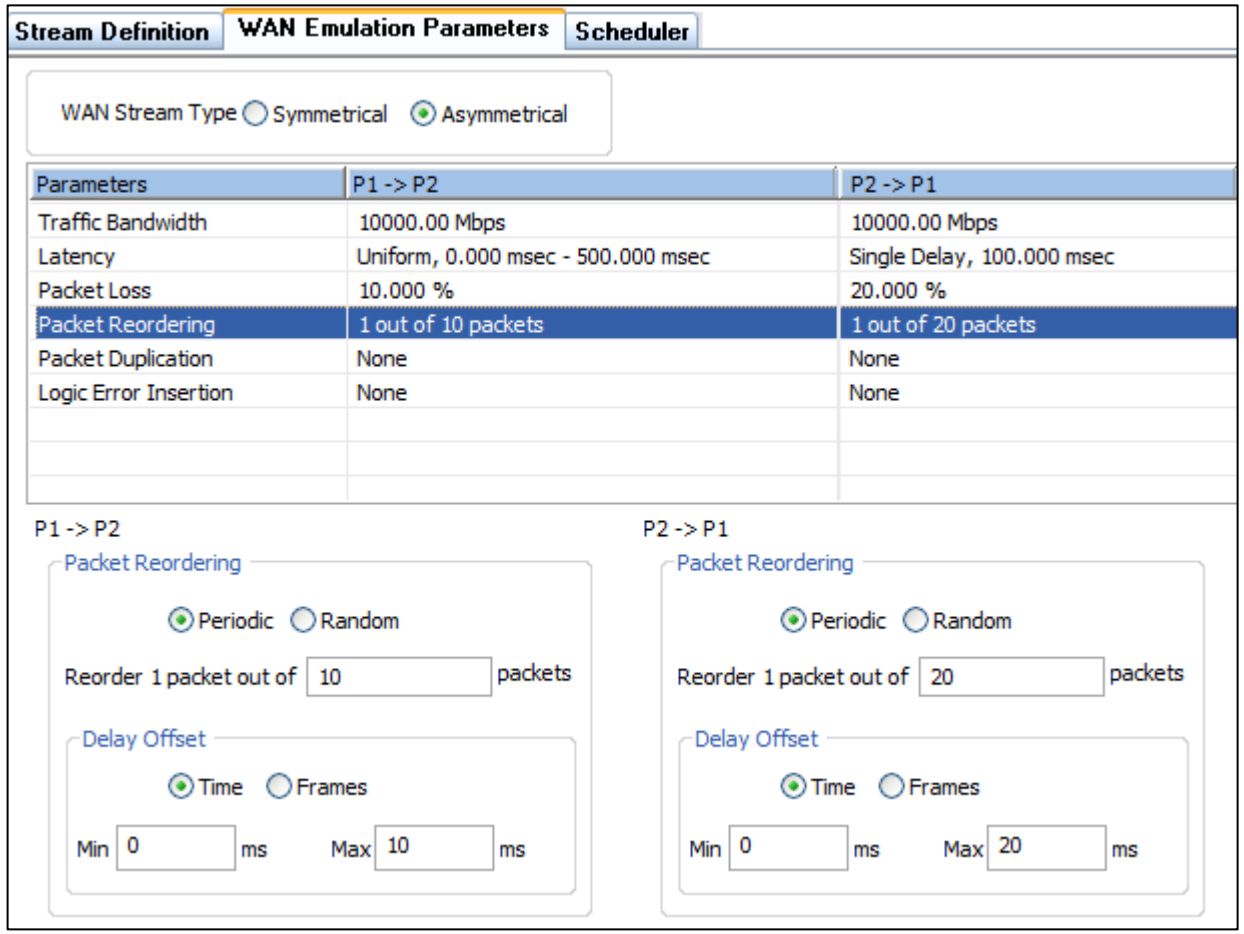
Latency / Jitter

- Apply **Static** Delay, or a **Uniform** or **Exponential** distribution between a minimum and maximum
- Delay a packet **up to 8000 ms** in 1ms increments



Packet Reordering

- Reorder 1 out of every X packets
- Set a minimum time in ms to hold the reordered packet
- Set a maximum time in ms to hold the reordered packet



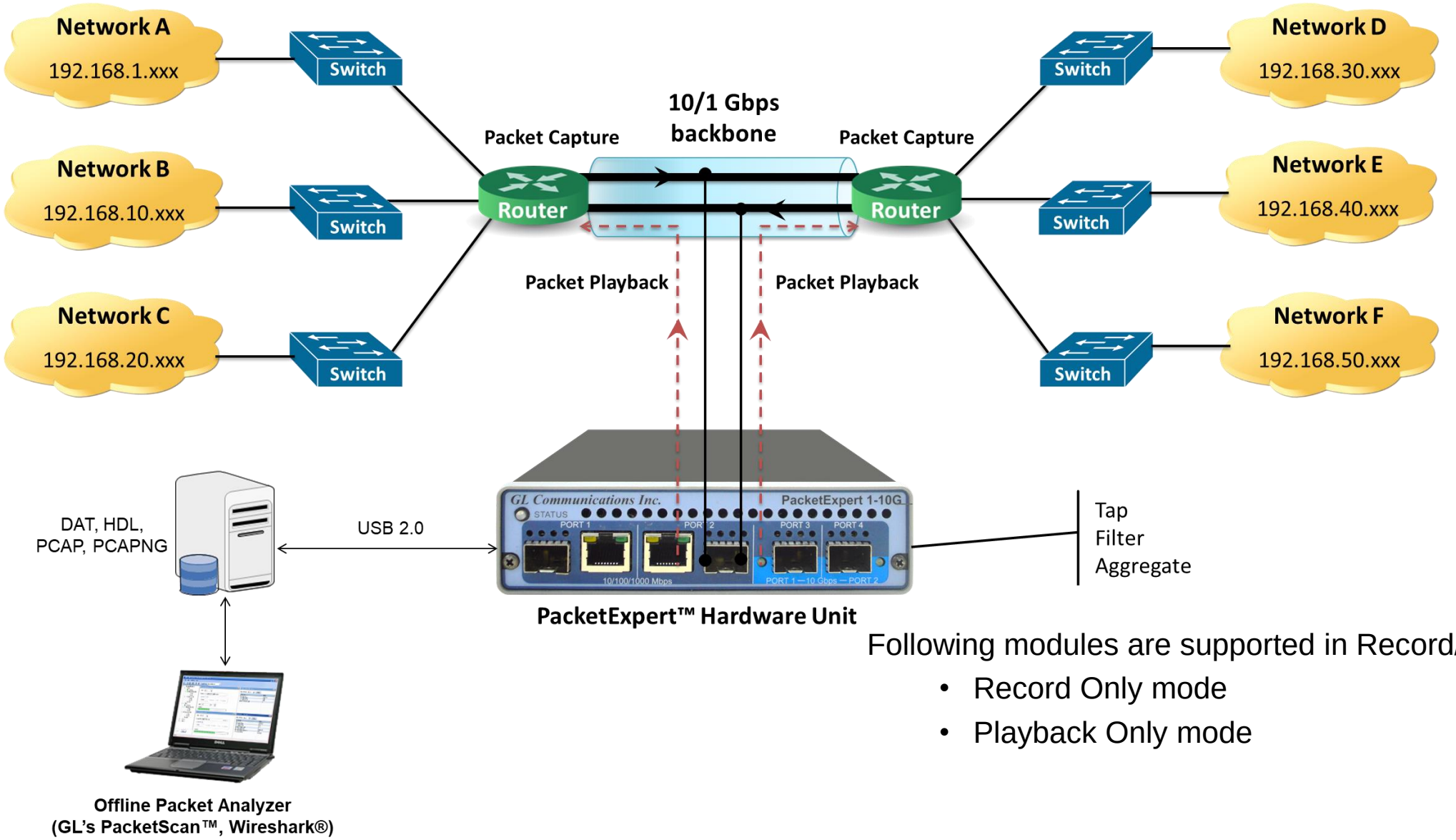
Software Specification

Multi-streams WAN Emulation - IPNetSim™	Single-stream WAN Emulation - IPLinkSim™
Stream Definition • Hardware wire-speed filters (up to 16 links) ➢ Packet Mode (field headers) ➢ Raw Mode (bit level) **Parameters** • IP Source and Destination Address Range • UDP Source and Destination Port Range • MAC Addresses • VLAN ID • MPLS Label	-NA-
WAN Emulation Parameters • Bandwidth control – 1 Kbps up to 10 Gbps • Latency/Delay ➢ 0 milliseconds up to 1.25 seconds (1250 msec) per stream (for 1Gbps link) ➢ 0 milliseconds up to 0.5 seconds (500 msec) per stream (for 10 Gbps link) ➢ single delay, uniform, random distributions • Packet Loss Rate - 0–100% • Packet Reordering Rate - 0-100% with Delay range of up to 2 seconds • Packet Duplication Rate - 0 - 100% • Logic Error Insertion Rate - 10^{-1} to 10^{-9} • Maximum Frame Size Supported – 2048 bytes	**WAN Emulation Parameters** • Bandwidth control - 10 Kbps up to 1000 Mbps • Latency/Delay ➢ 0 milliseconds to 8 seconds (8000 milliseconds) (for 1G/10 Gbps link) ➢ single delay, uniform, random distributions • Congestion Emulation with Background traffic (% of total bandwidth) ➢ Link Utilization Rate –0 – 100% ➢ Burst Size - 64 – 1,000,000 bytes • Packet Loss Rate - 0–100% • Packet Reordering Rate - 0-100% with Delay range of up to 8 seconds • Packet Duplication Rate - 0 - 100% • Logic Error Insertion Rate - 10^{-1} to 10^{-9} • FCS Error insertion Rate - 10^{-1} to 10^{-9}

GL Communications

Wirespeed Ethernet Packet Capture and Playback with Hardware Filtering

Wire-Speed Record/Playback

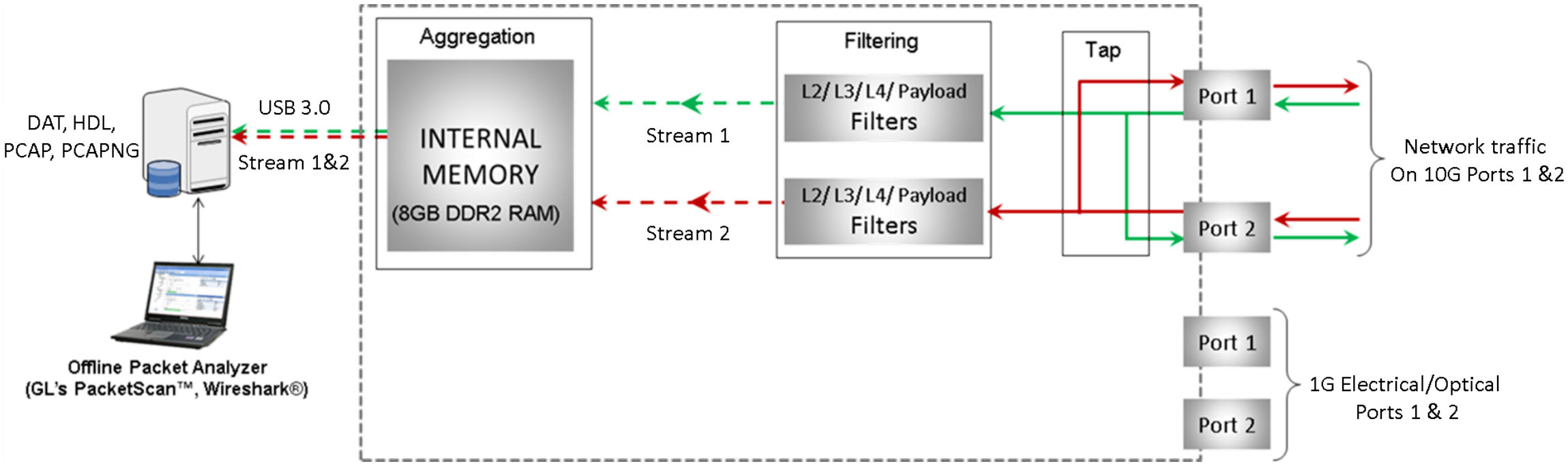


Following modules are supported in Record/Playback:

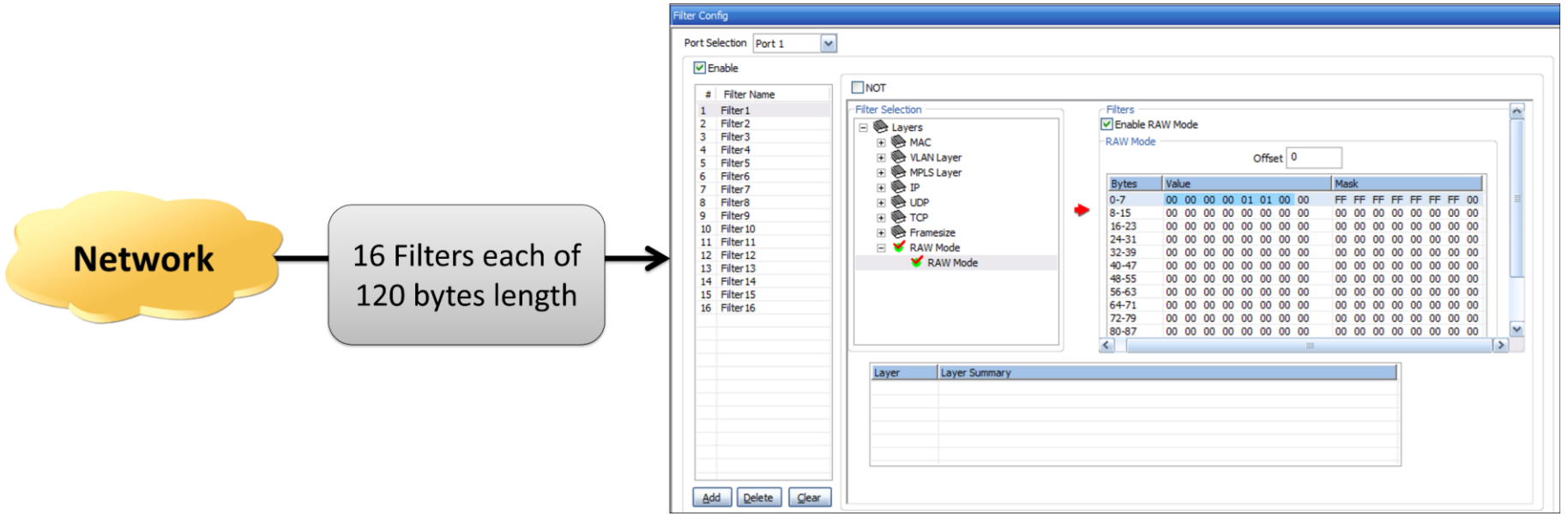
- Record Only mode
- Playback Only mode

GL Communications

Working Principle



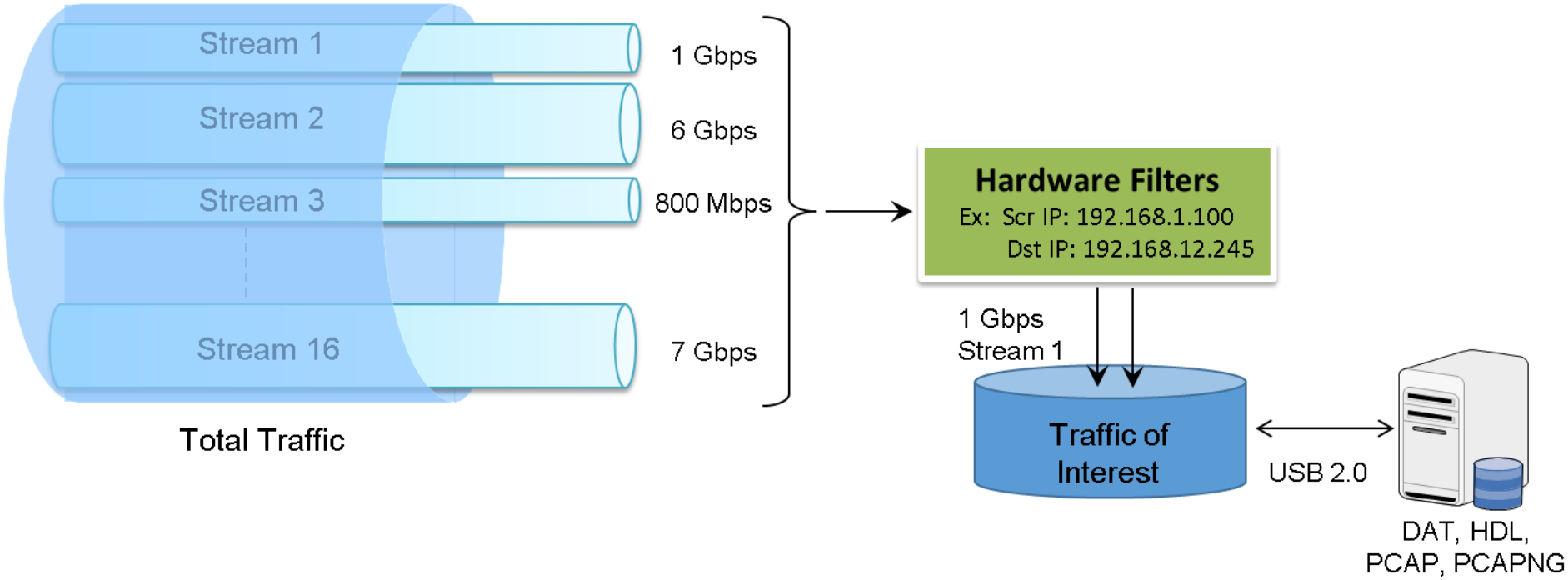
Wirespeed Packet Filters and Triggers



- Filter packets and record only packets of interest
- Capture simultaneously on 2 ports with 120 bytes deep filter per port (for record application) and set filter on any one of the ports or all ports
- Packet filtering can be based on all Layer 2 (Ethernet), Layer 3 (IP) Layer 4 (UDP/TCP) Headers
- Up to 16 filters can be defined per port. Each filter is up to 120 bytes wide
- Filter can be set to each bit in the packet (Raw mode) or each field (Packet Mode)
- Generates a trigger (1 Microsecond pulse) for each packet that passes the filter
- Filter on various header fields like Source/Destination MAC Address, VLAN Id, MPLS Label, Source/Destination Ipv4 Address, Source/Destination UDP ports

GL Communications

Capture Traffic of Interest

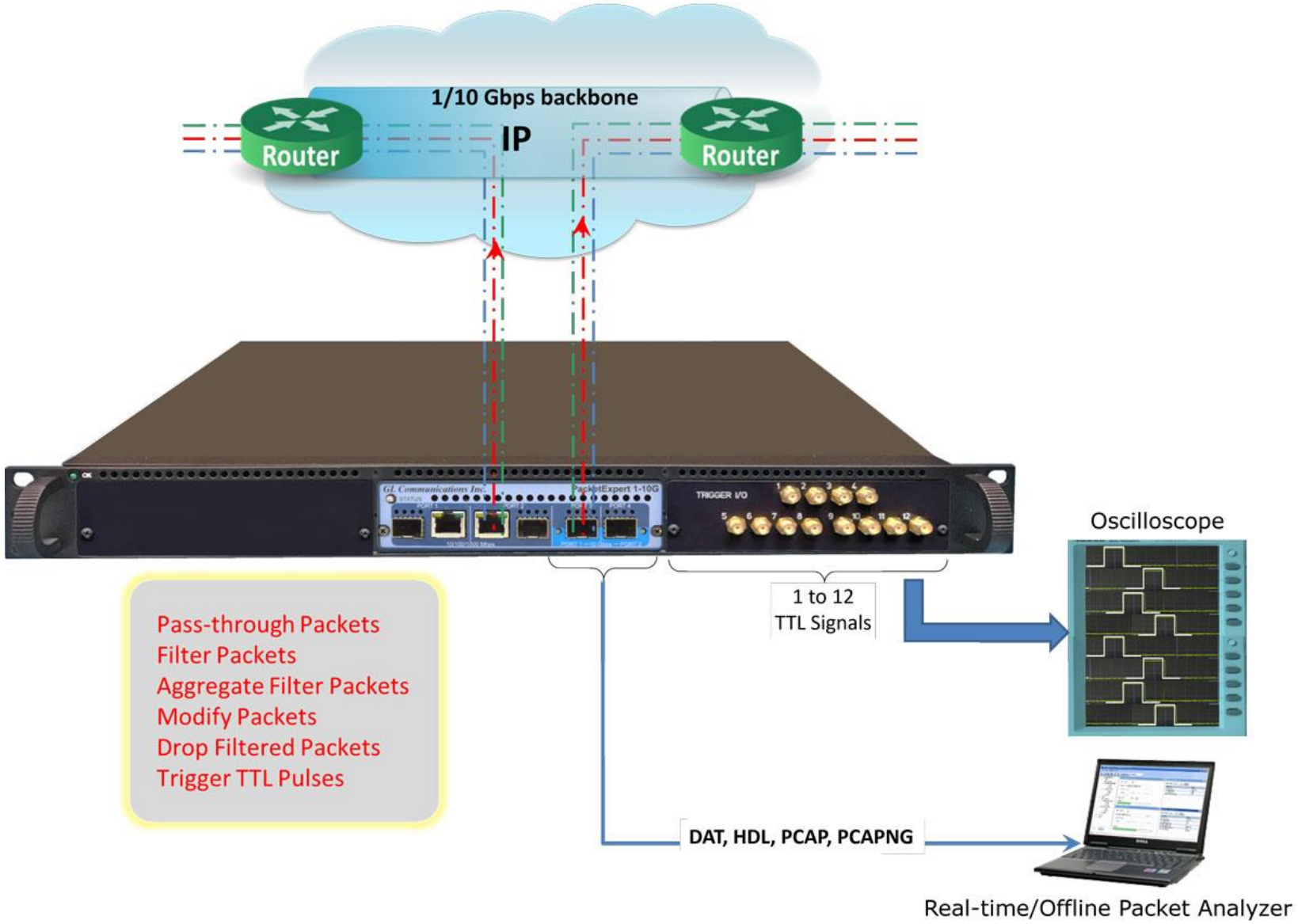


The network traffic containing n streams of varying data rate is filtered at the PacketExpert™ hardware as per the filter settings. The overall transmit rate is limited to the USB 2.0 transfer rate.

Transmit rate can go up to 350 Mbps depending on the host PC configuration.

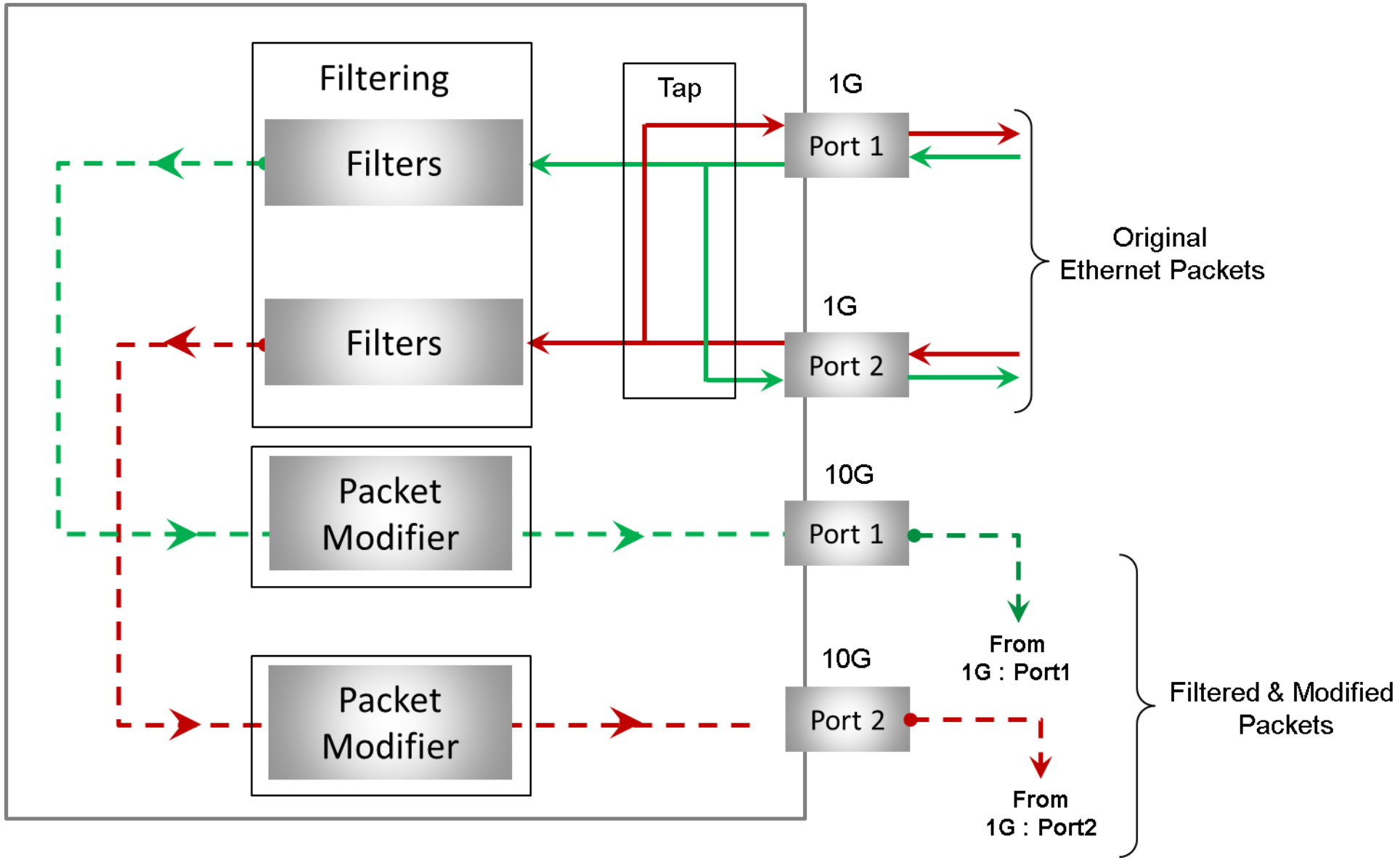
PacketBroker™ – Passive Ethernet Tap

PacketBroker™ in Network

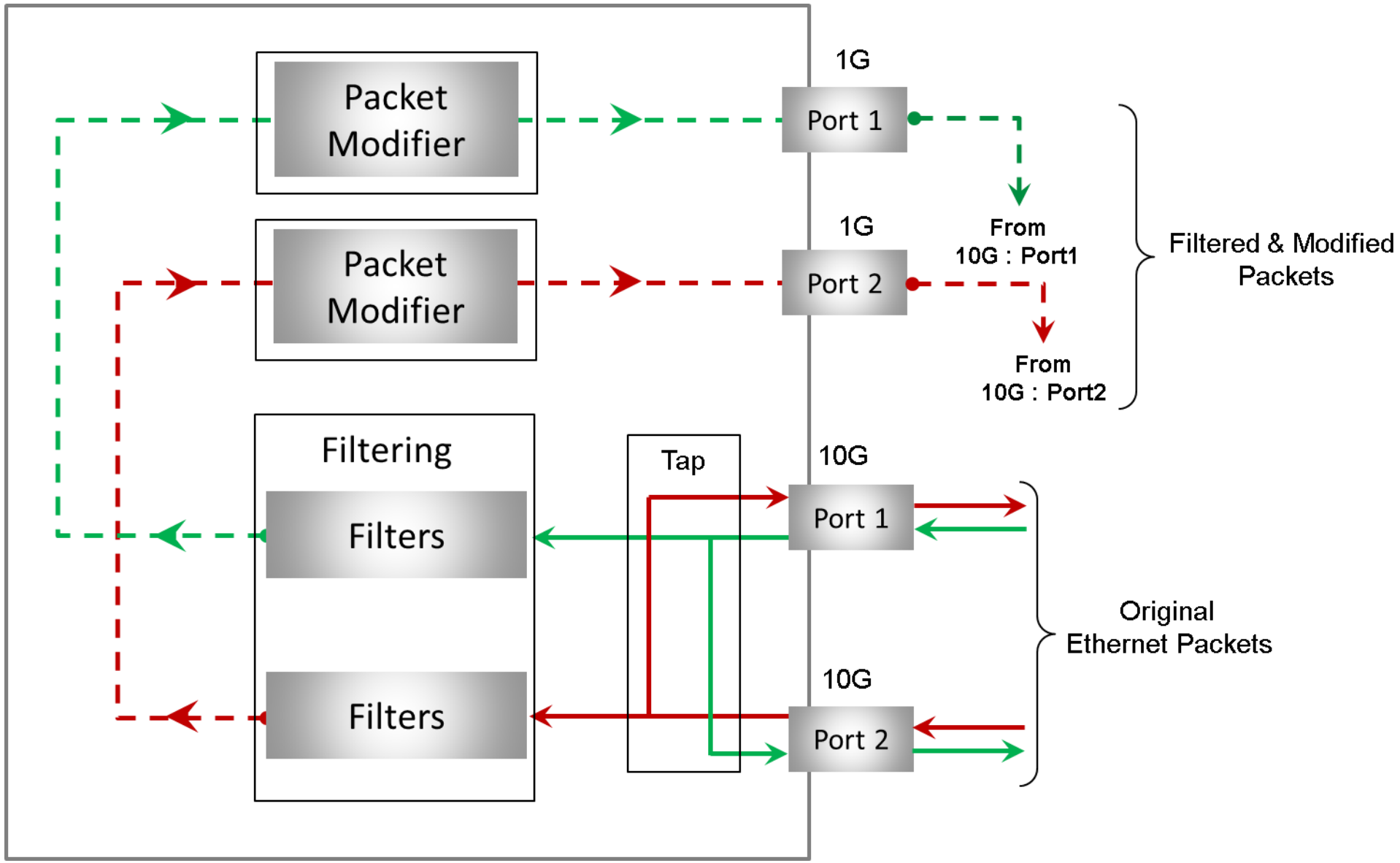


GL Communications

Packet Tap, Filter, Modification, and Output

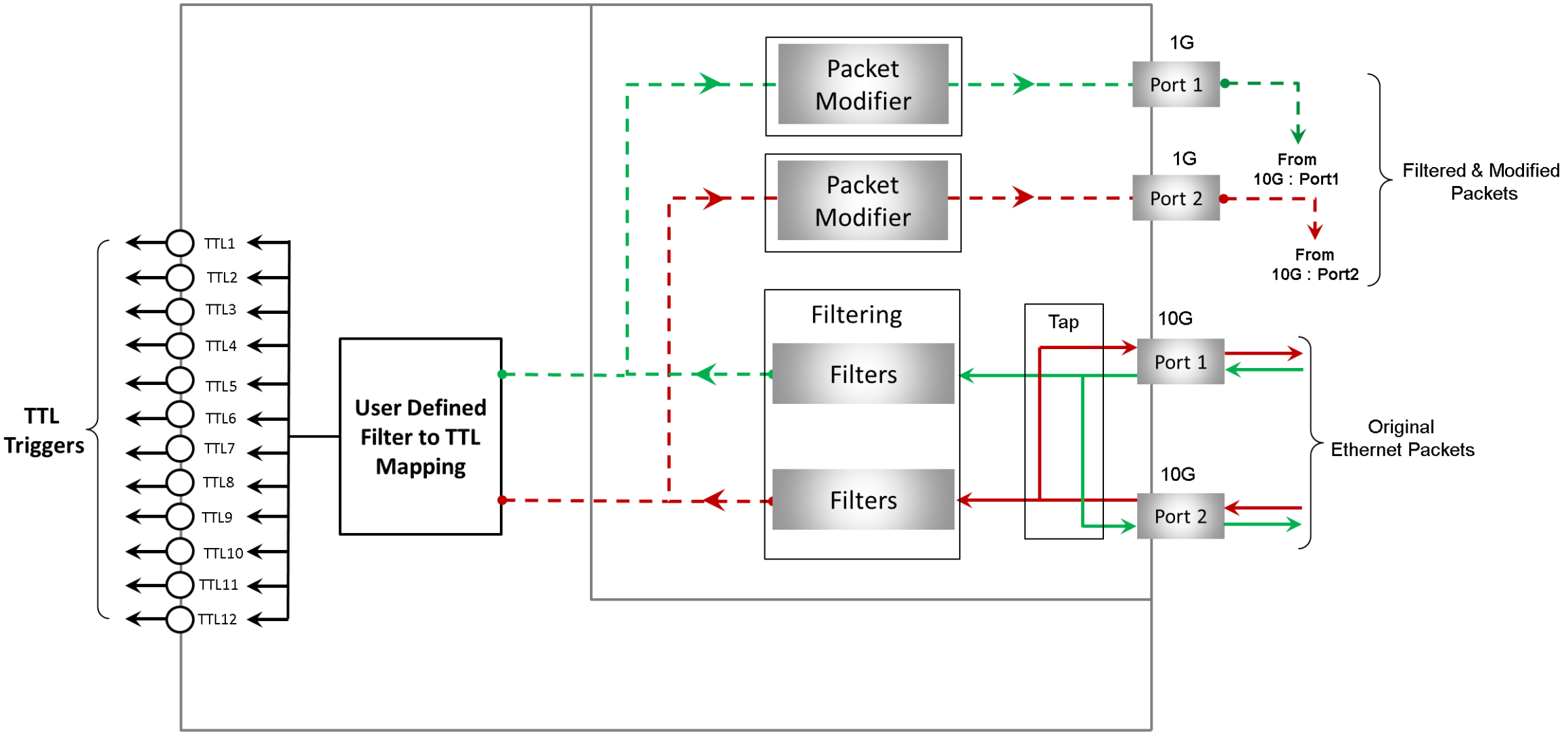


PacketBroker 10G mode

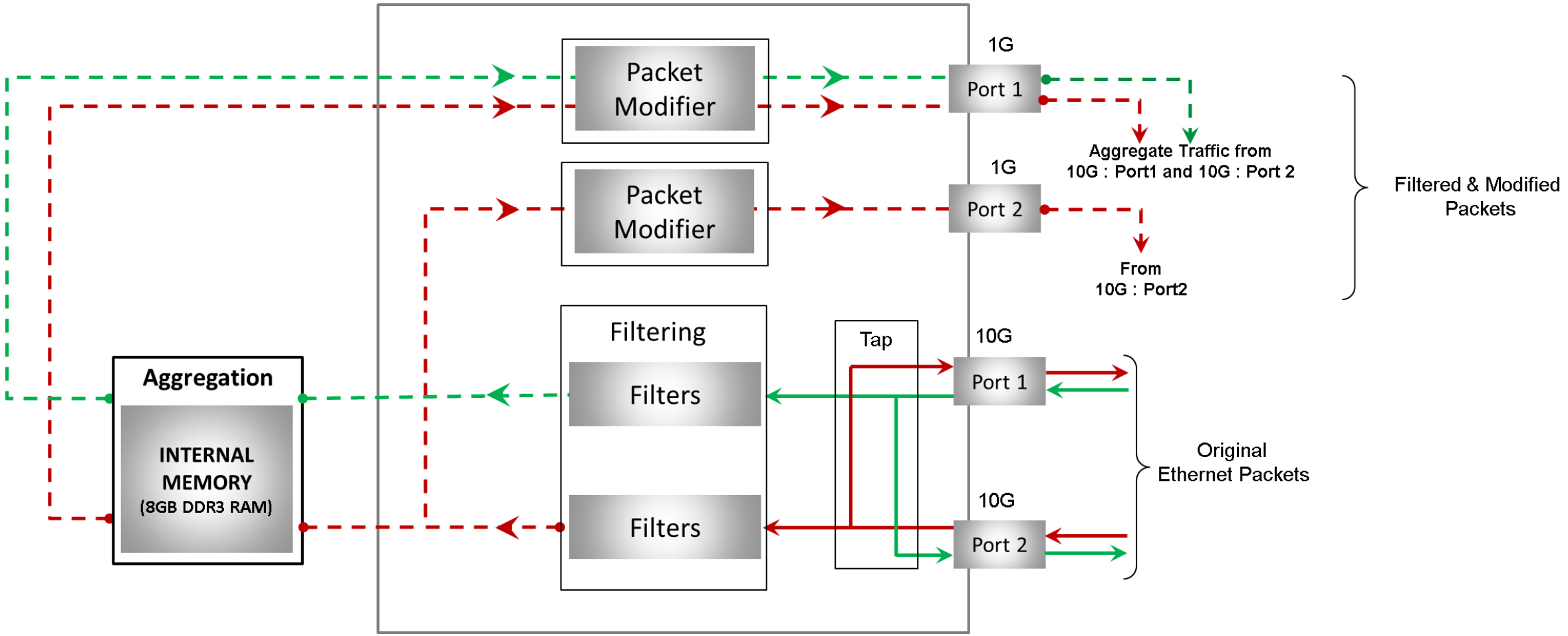


GL Communications

Filtering with TTL Generation

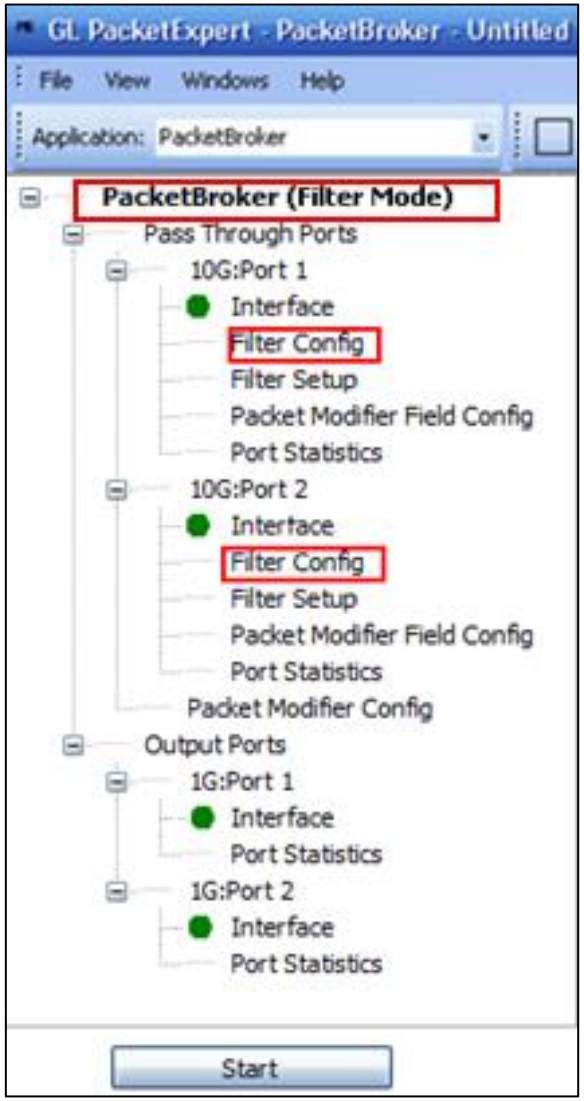


Aggregation

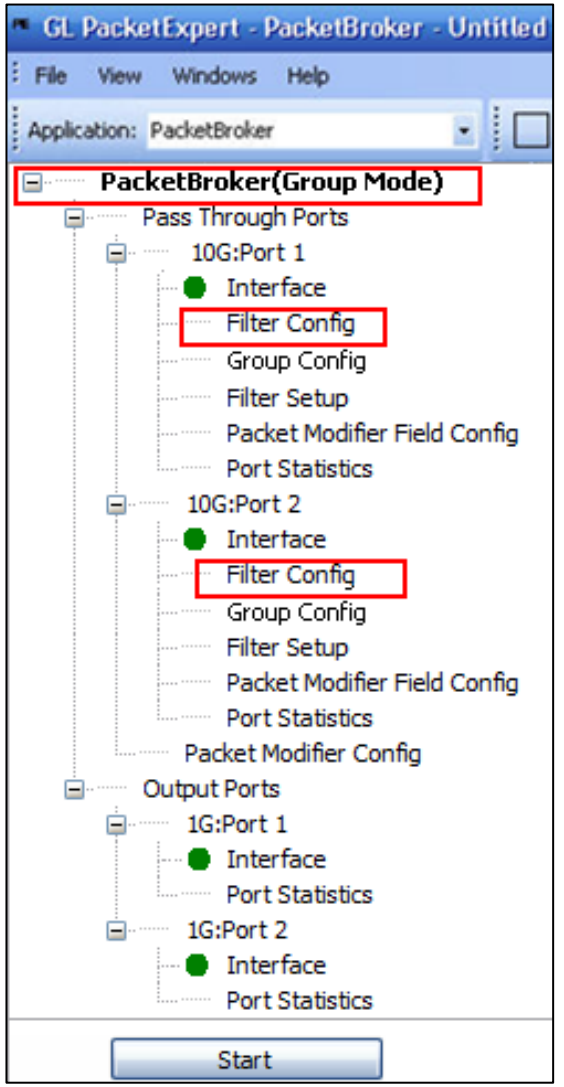


Filter Configuration Menu

Basic Mode Filtering



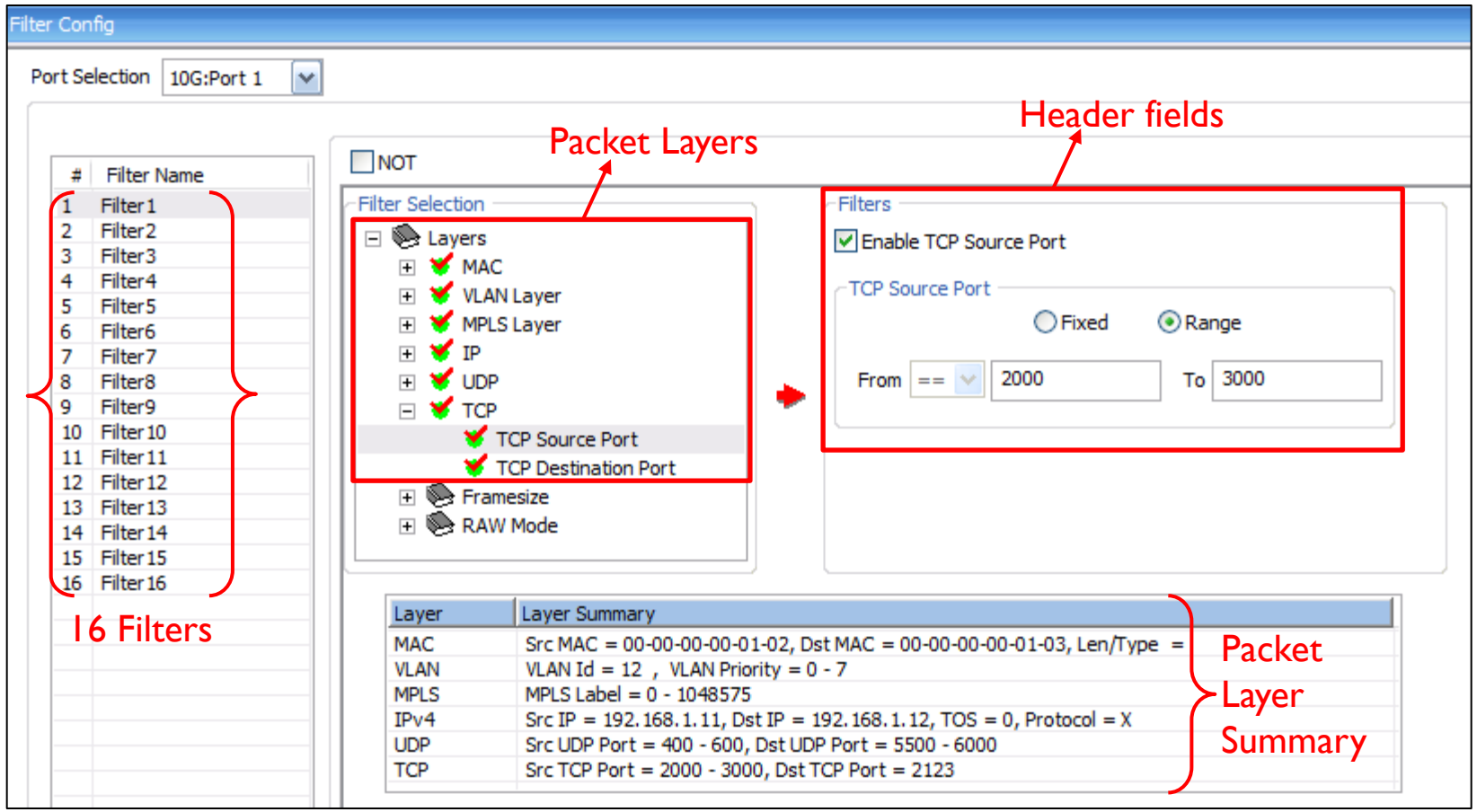
Group Mode Filtering



GL Communications

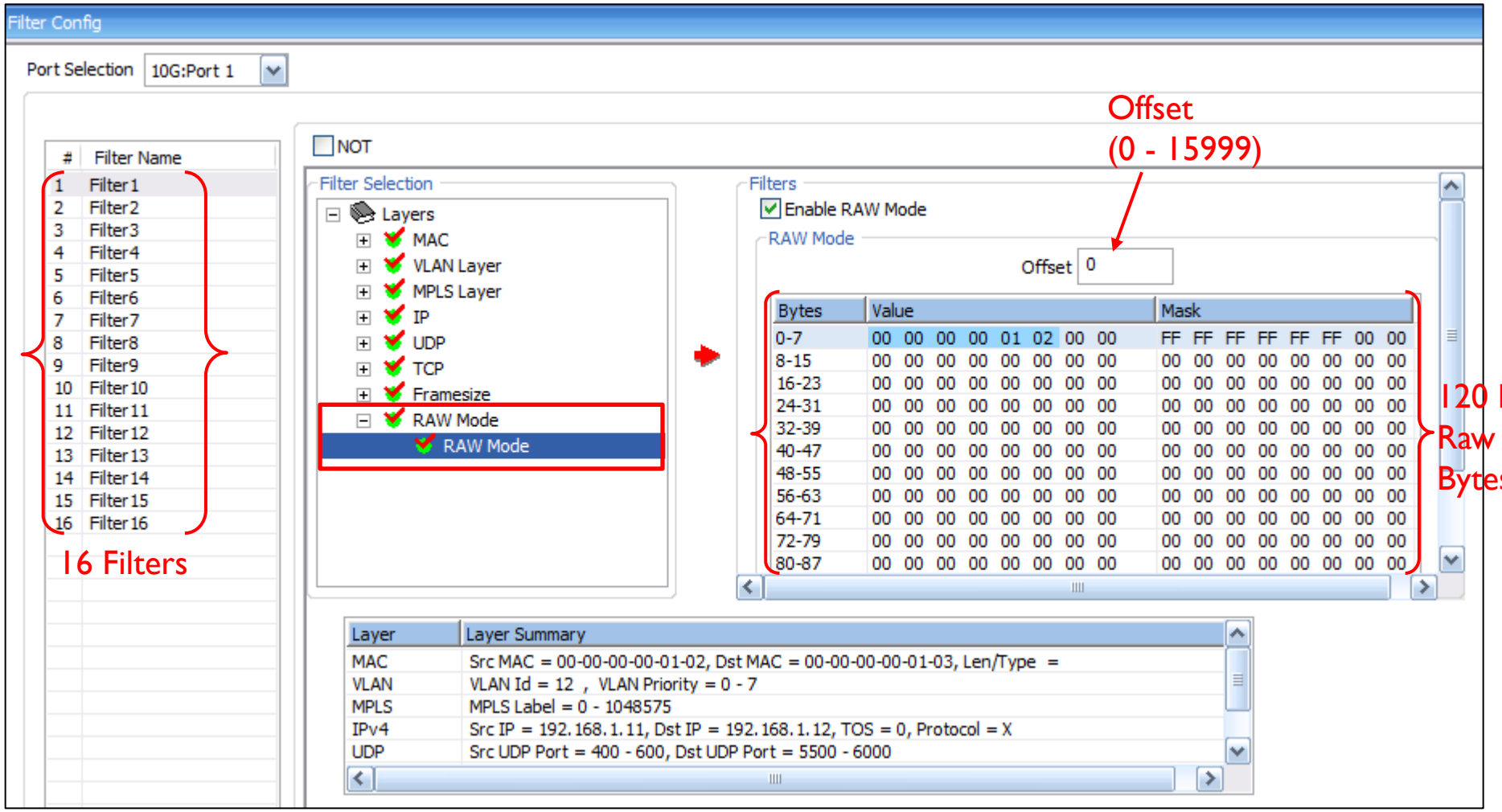
Filter Configuration

Packet Mode Filtering



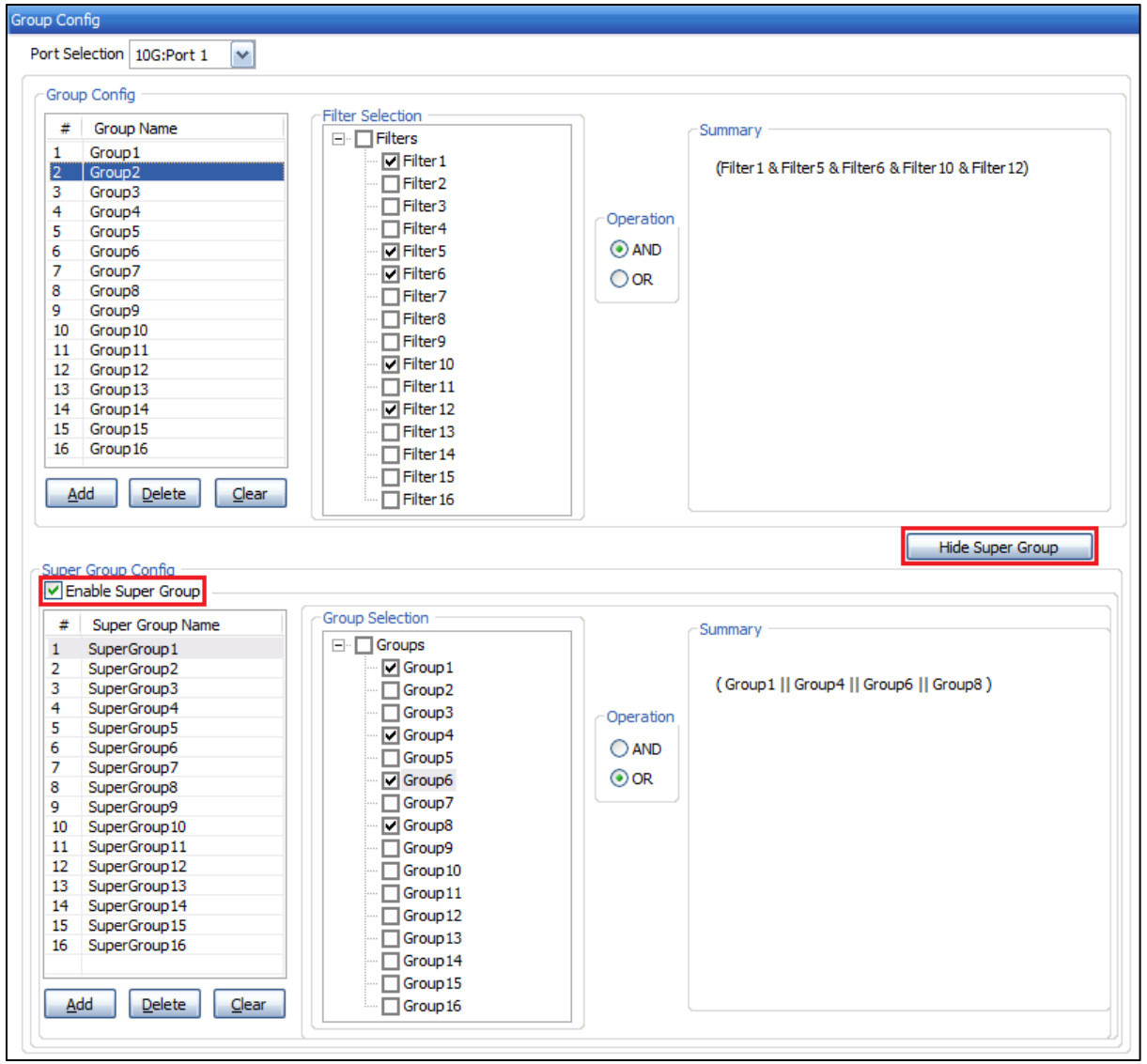
Filter Configuration

Raw Mode Filtering

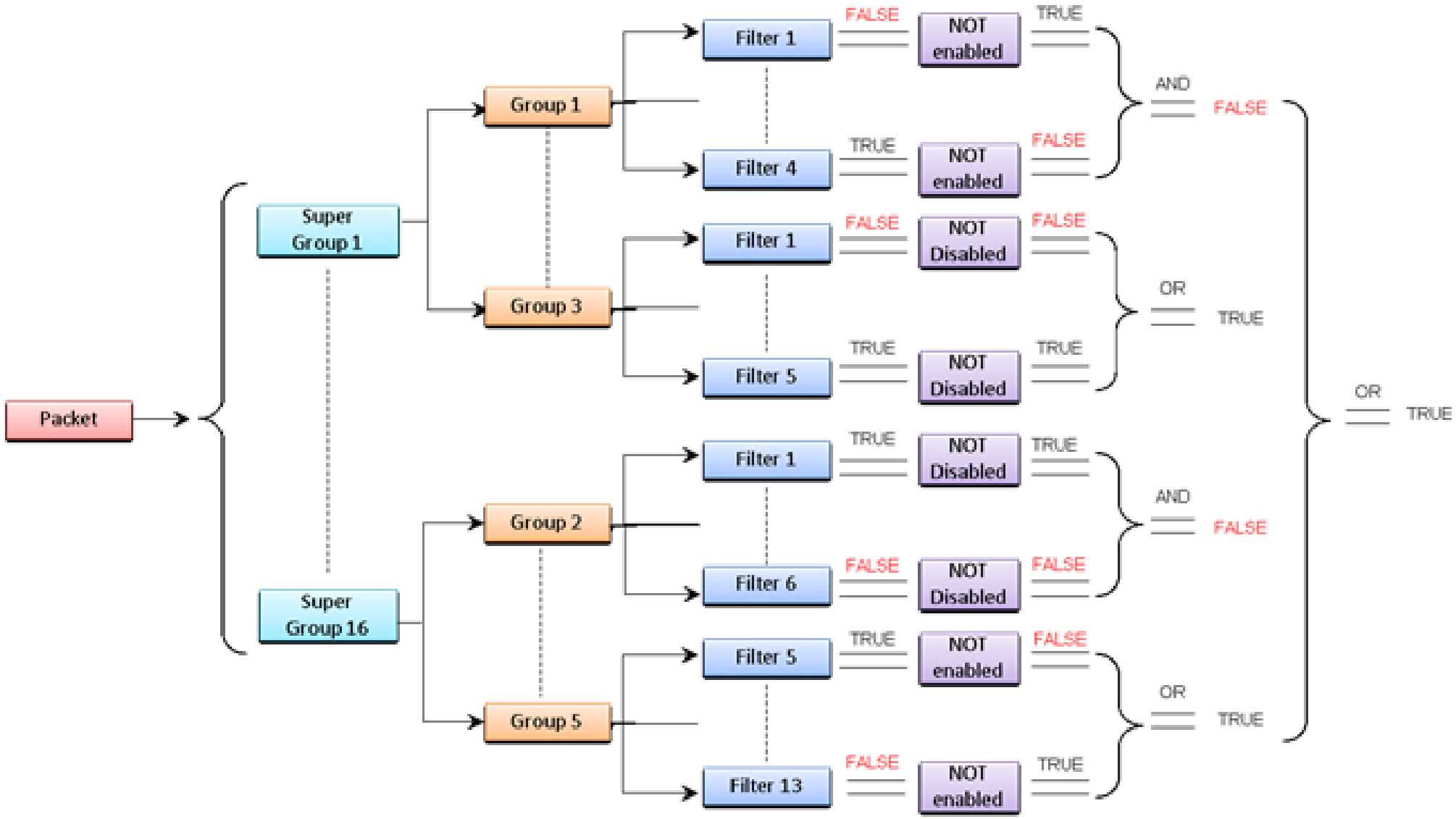


Group Mode Filter configuration

- PacketBroker™ includes an option to group the configured filters
- Any number of individual filters can be selected to form a group. Using “AND” and “OR” operators and any combination of filter groups can be created
- The multiple filter Groups created can be further grouped to form Super Groups using “AND” or “OR” operators
- The result of all the filters within the group is taken and either “OR”ed or “AND”ed and a final single Group result - TRUE or FALSE is obtained

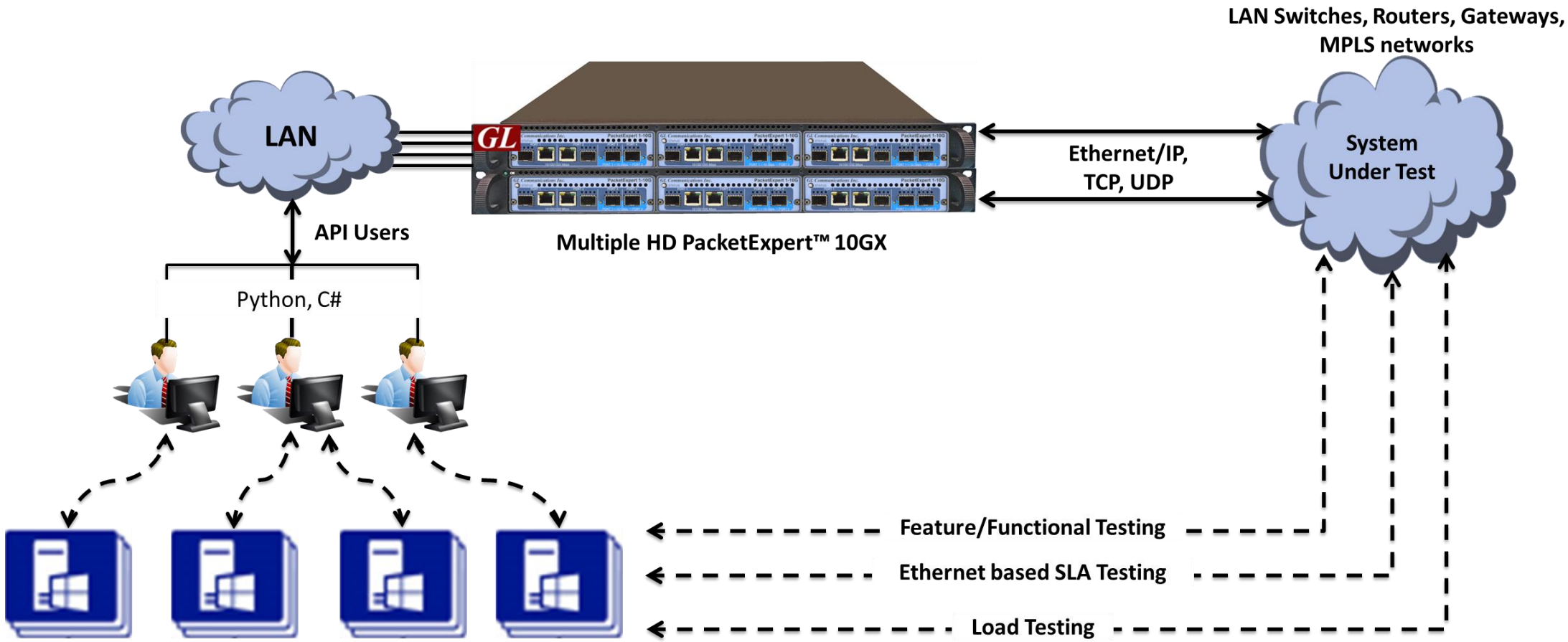


Working Principle of Filter, Group and Super Group



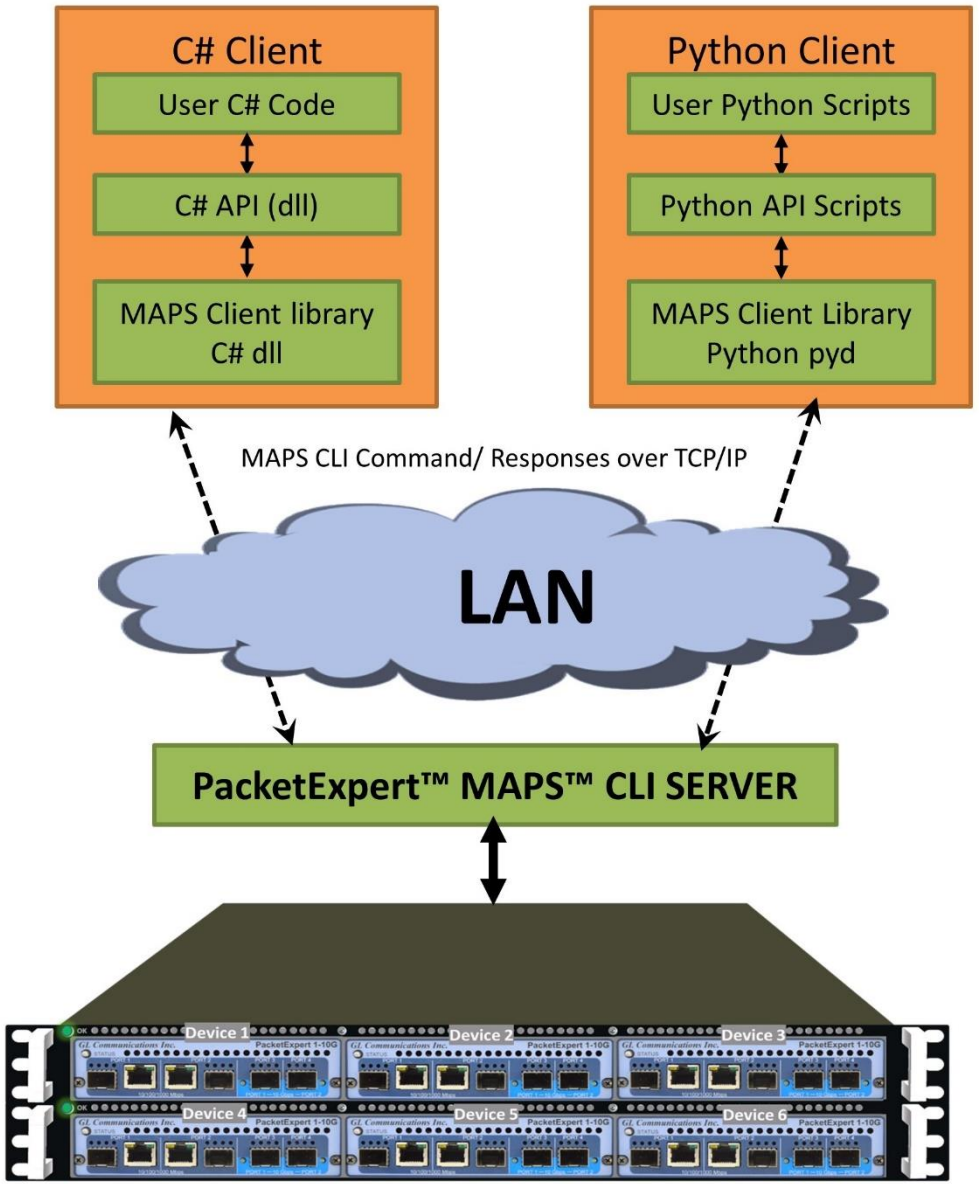
Command Line Interface (CLI)

MAPS™ CLI Client/Server Architecture



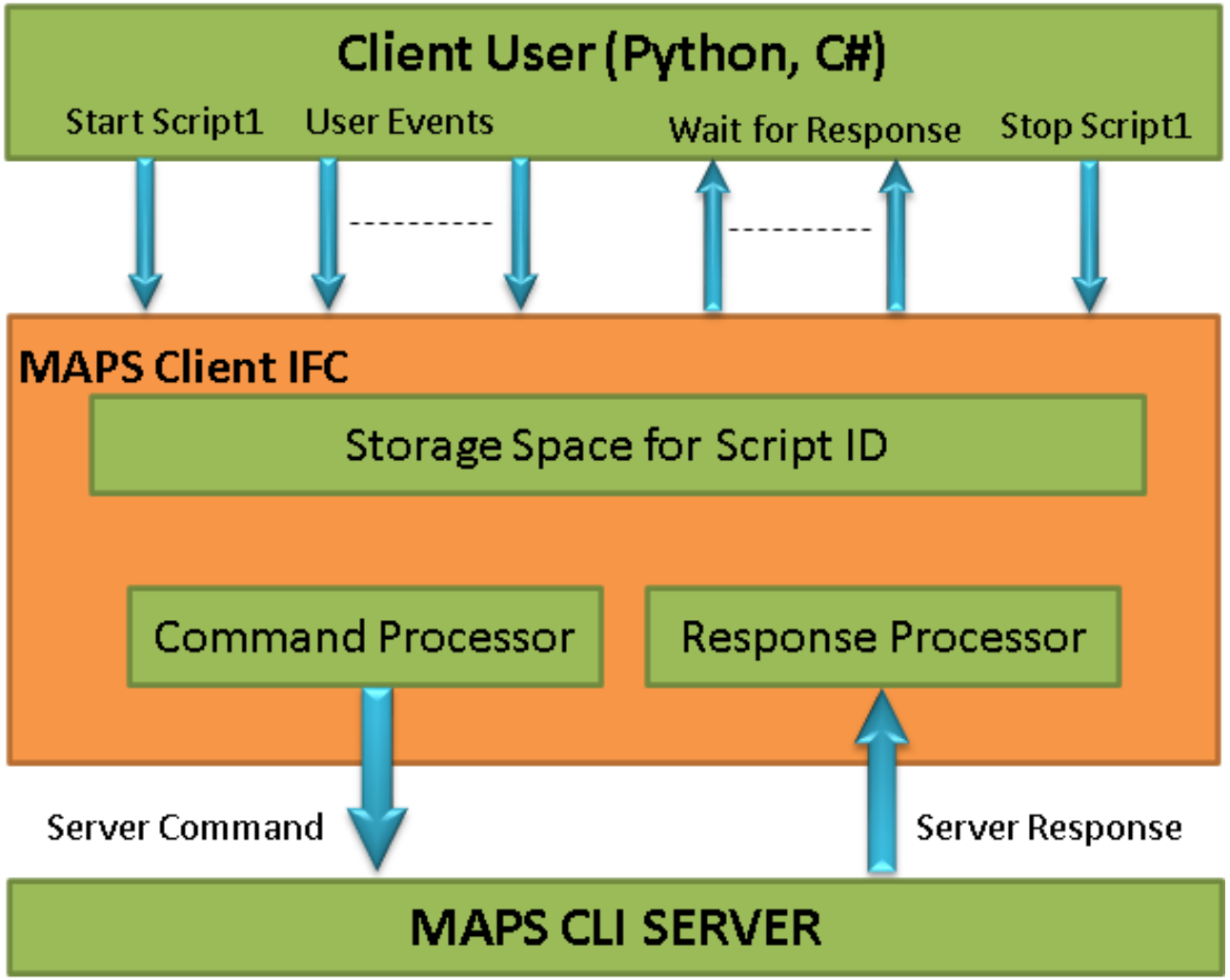
- PacketExpert™ 10GX also supports Command line Interface (CLI) to access all the functionalities remotely such as Bert, Loopback, RFC 2544, Record Playback, IPNetSim™, ExpertSAM™, PacketBroker™, and Multi Stream Traffic Generator and Analyzer using Python, C# client APIs and MAPS™ CLI Client/Server architecture

Working Principle of MAPS™ CLI

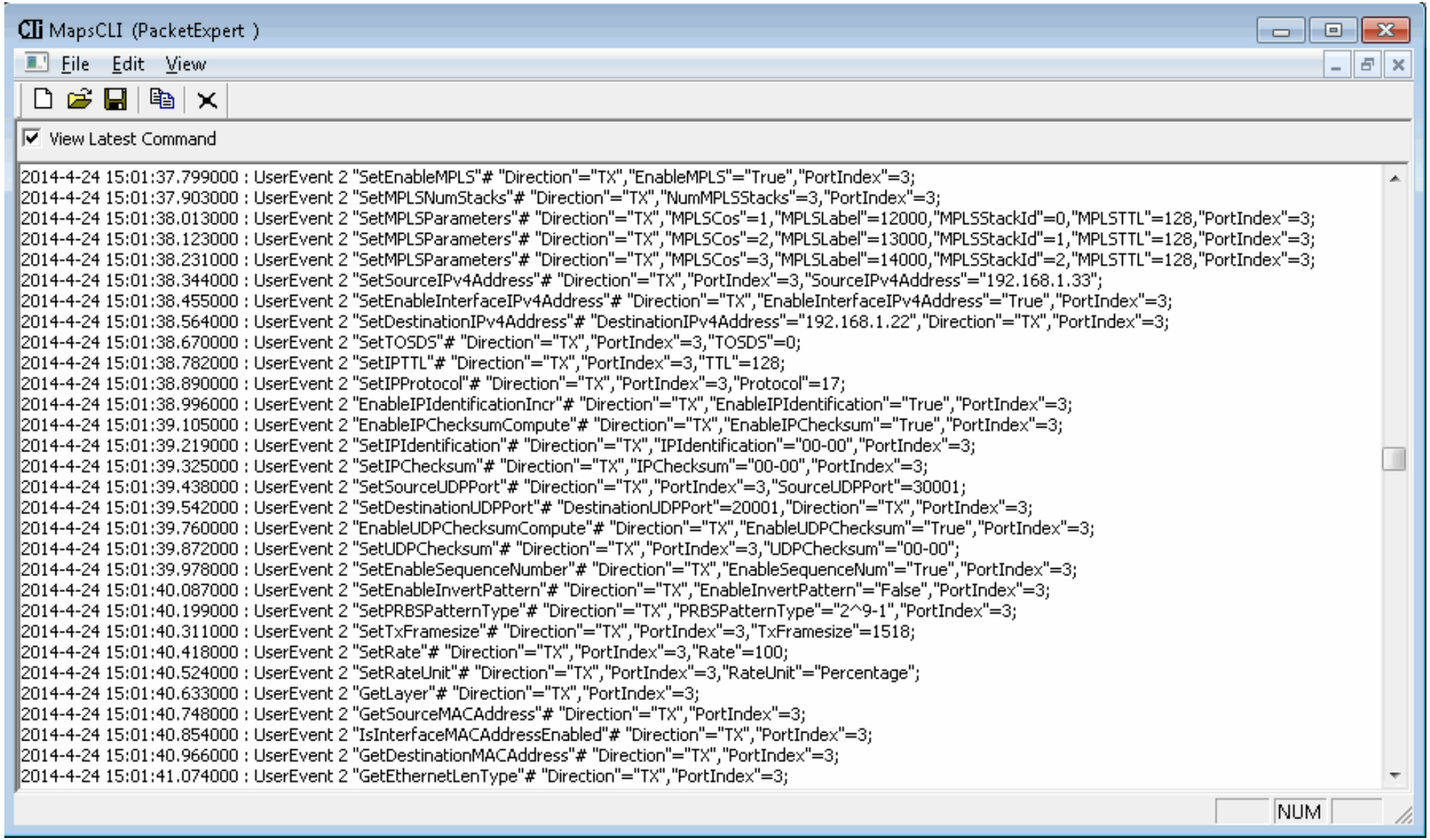


GL Communications

Working Principle of MAPS™ CLI



MAPS™ CLI Server



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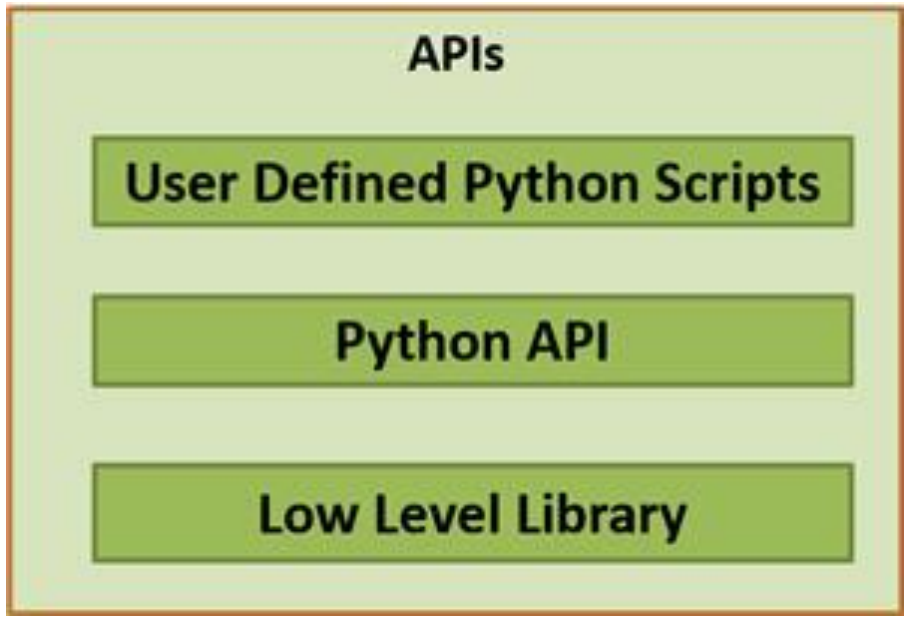
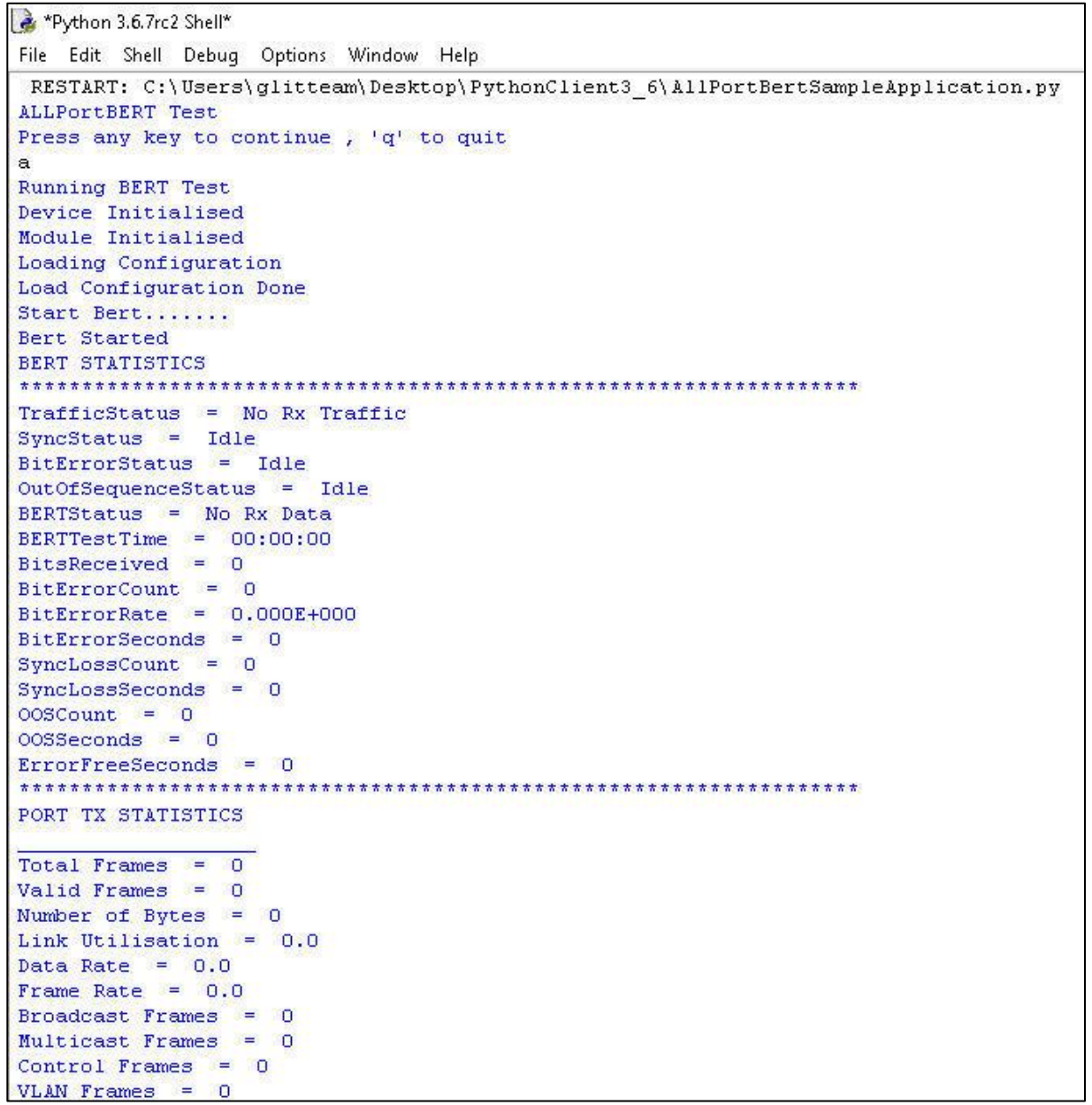
Python Client and Scripting

- The Python Client consists of following components:
- Python API scripts, that provide High Level APIs, using which all the PacketExpert™ functionalities are accessible to the users
- These APIs in turn use a low level library to communicate with the PacketExpert™ MAPS™ server



Python Client



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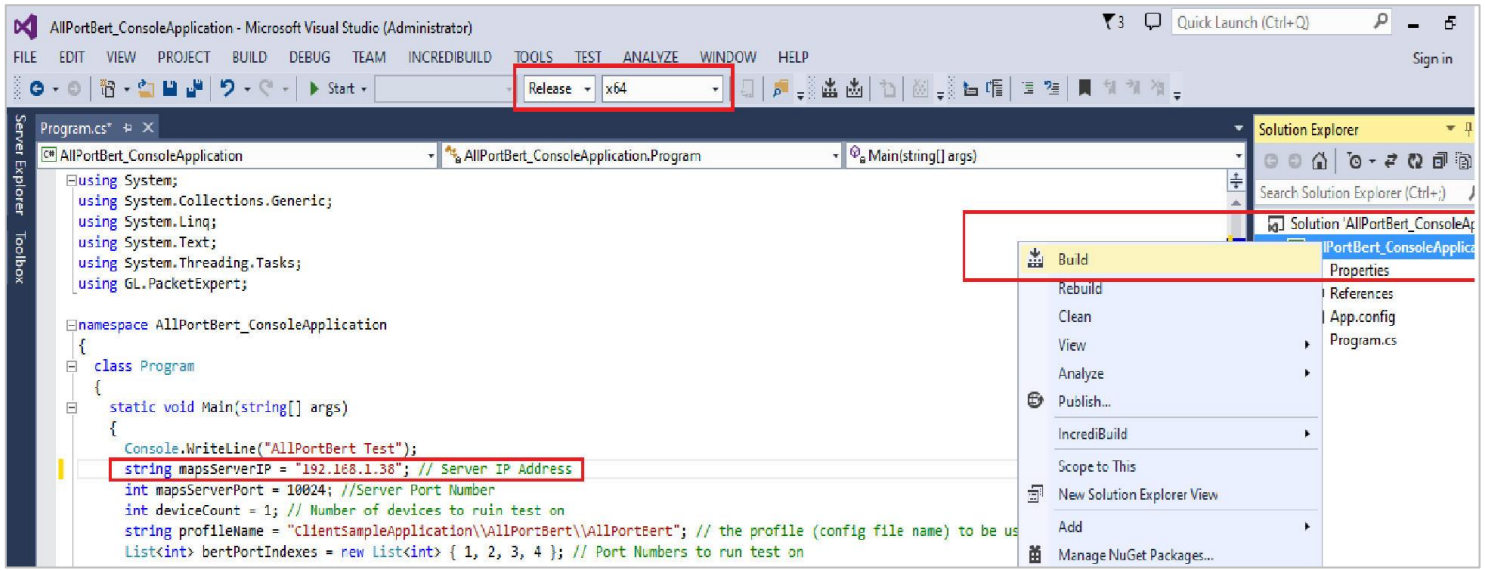
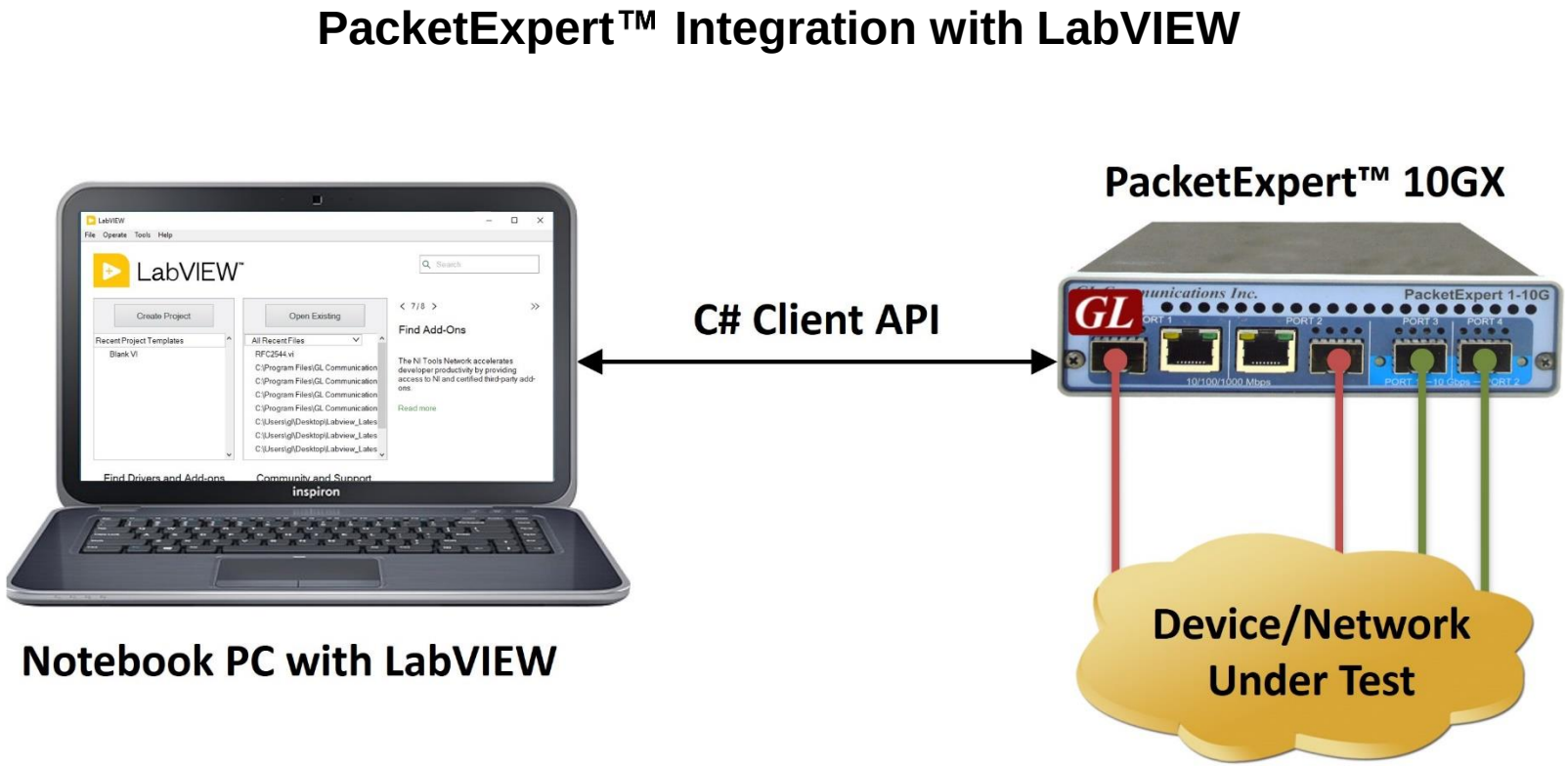
C# Client

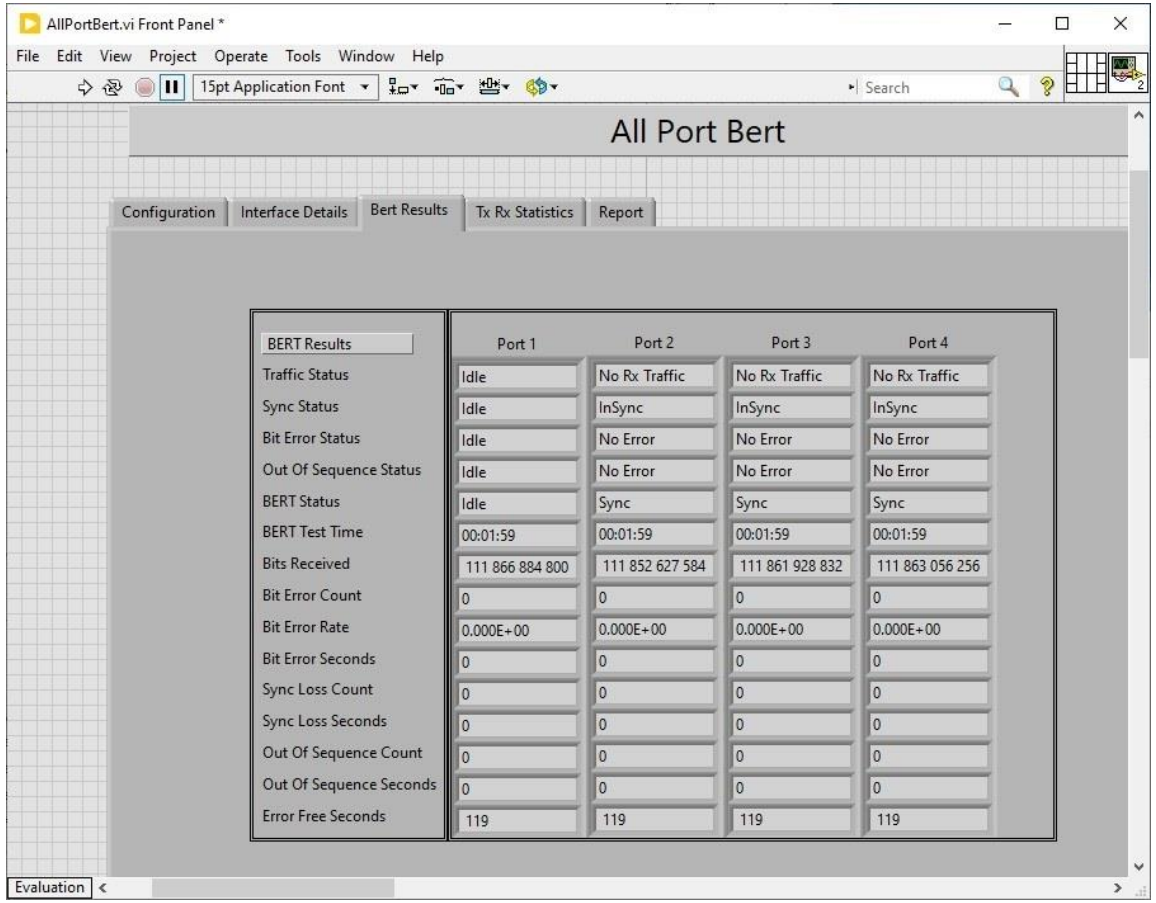

AllPortBert_ConsoleApplication - Microsoft Visual Studio (Administrator)
Quick Launch (Ctrl+Q)
FILE EDIT VIEW PROJECT BUILD DEBUG TEAM INCREDIBUILD TOOLS TEST ANALYZE WINDOW HELP
Sign in
Start
Release
x64
Program.cs*
AllPortBert_ConsoleApplication
AllPortBert_ConsoleApplication.Program
Main(string[] args)
Server Explorer
Toolbox
using System;
using System.Collections.Generic;
using System.Linq;
using System.Text;
using System.Threading.Tasks;
using GL.PacketExpert;
namespace AllPortBert_ConsoleApplication
{
class Program
{
static void Main(string[] args)
{
Console.WriteLine("AllPortBert Test");
string mapsServerIP = "192.168.1.38"; // Server IP Address
int mapsServerPort = 10024; //Server Port Number
int deviceCount = 1; // Number of devices to ruin test on
string profileName = "ClientSampleApplication\\AllPortBert\\AllPortBert"; // the profile (config file name) to be us
List<int> bertPortIndexes = new List<int> { 1, 2, 3, 4 }; // Port Numbers to run test on
Solution Explorer
Search Solution Explorer (Ctrl+;)
Solution 'AllPortBert_ConsoleAp
IPortBert_ConsoleApplic
Properties
References
App.config
Program.cs
Build
Rebuild
Clean
View
Analyze
Publish...
IncrediBuild
Scope to This
New Solution Explorer View
Add
Manage NuGet Packages...

PacketExpert™ Integration with LabVIEW using C# Client



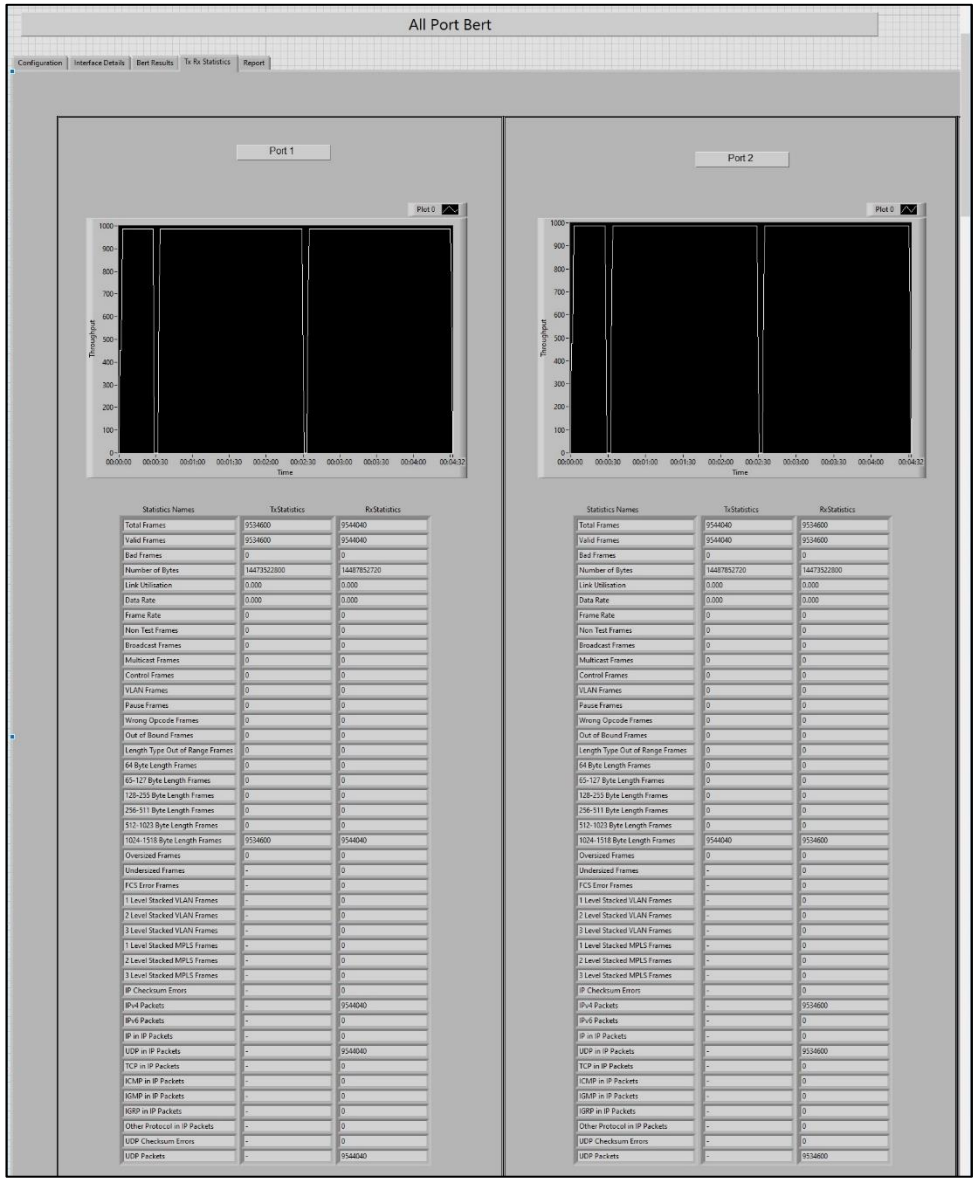
PacketExpert™ Integration with LabVIEW using C# Client

BERT Results



BERT Results	Port 1	Port 2	Port 3	Port 4
Traffic Status	Idle	No Rx Traffic	No Rx Traffic	No Rx Traffic
Sync Status	Idle	InSync	InSync	InSync
Bit Error Status	Idle	No Error	No Error	No Error
Out Of Sequence Status	Idle	No Error	No Error	No Error
BERT Status	Idle	Sync	Sync	Sync
BERT Test Time	00:01:59	00:01:59	00:01:59	00:01:59
Bits Received	111 866 884 800	111 852 627 584	111 861 928 832	111 863 056 256
Bit Error Count	0	0	0	0
Bit Error Rate	0.000E+00	0.000E+00	0.000E+00	0.000E+00
Bit Error Seconds	0	0	0	0
Sync Loss Count	0	0	0	0
Sync Loss Seconds	0	0	0	0
Out Of Sequence Count	0	0	0	0
Out Of Sequence Seconds	0	0	0	0
Error Free Seconds	119	119	119	119

BERT Statistics



GL Communications

Thank you