
Comprehensive Ethernet Testing Solutions



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GL Communications Inc. - Overview

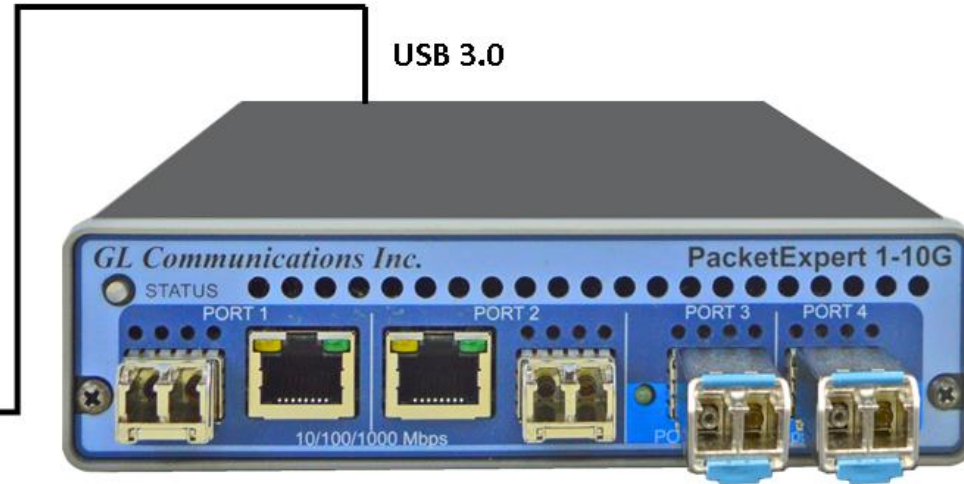
- Headquartered in Gaithersburg, Maryland USA
- Founded in 1986
- Engineering Consulting Services
- Test & Measurement Equipment
 - Analog, TDM, Ethernet/IP, SONET/SDH, Wireless (2G, 3G, 4G, 5G)
 - Analysis, monitoring, visualization, capture, long term storage



PacketExpert™ Software



Windows 7/8/10 64-bit OS



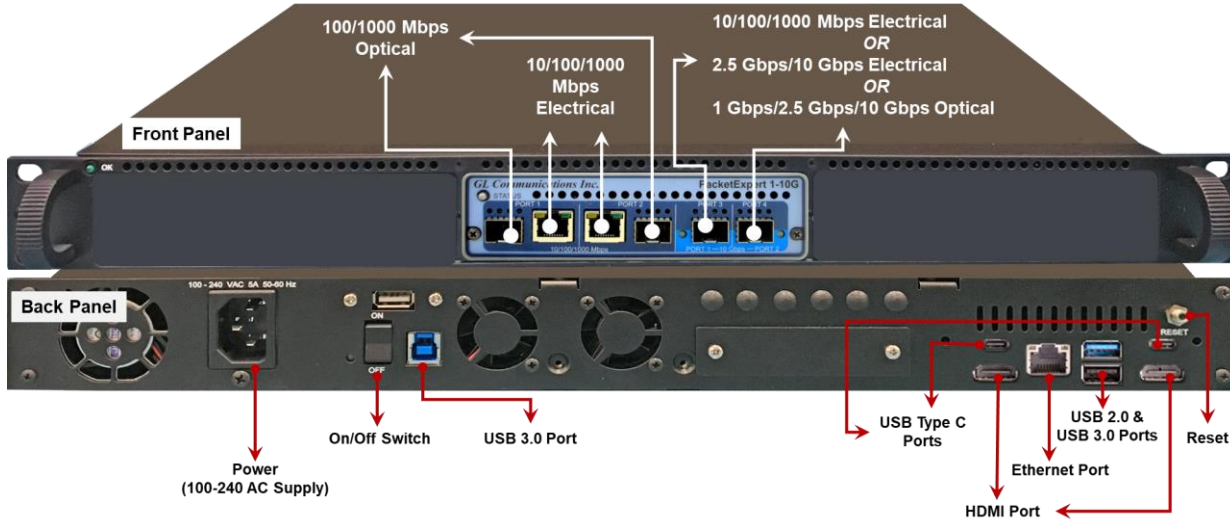
USB 3.0

USB 3.0

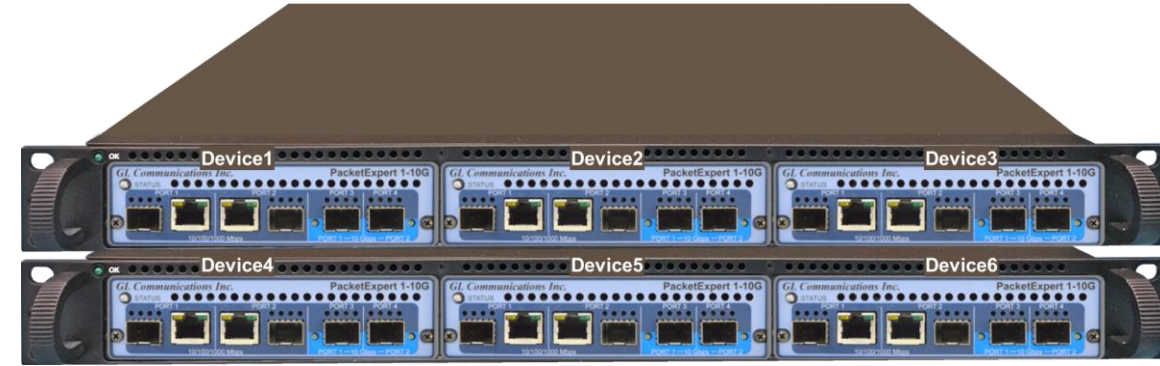
- ❖ BERT
- ❖ RFC 2544
- ❖ Smart Loopback
- ❖ IPNetSim™
- ❖ IPLinkSim™
- ❖ ITU-T Y.1564 (ExpertSAM™)
- ❖ Wire-Speed Record / Playback
- ❖ PacketBroker™
- ❖ Multi-Stream Traffic Generator Analyzer
- ❖ RFC-6349 based TCP Throughput Testing (ExpertTCP™)

mTOP™ Rack and mTOP™ Probe Units with 10GX Hardware

High Density 1U Rack option



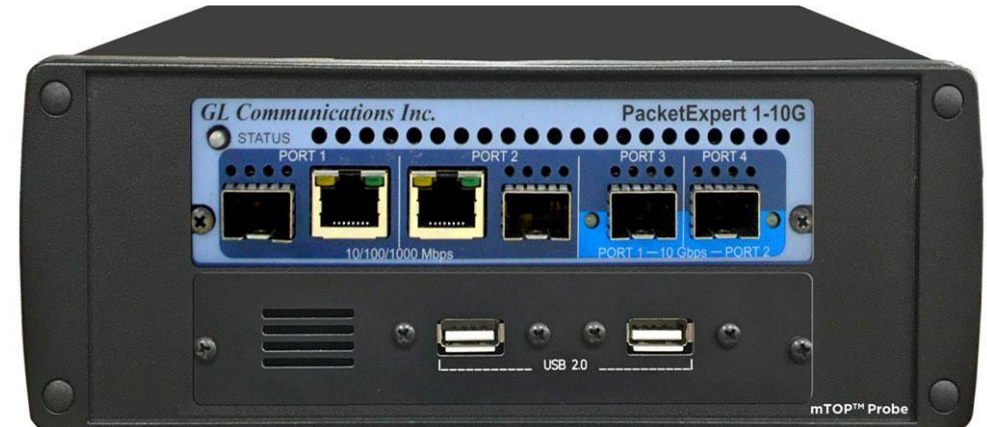
Stacked High Density 1U Rack option



mTOP™ 1U Rack Option with 12 TTL



mTOP™ Probe Unit

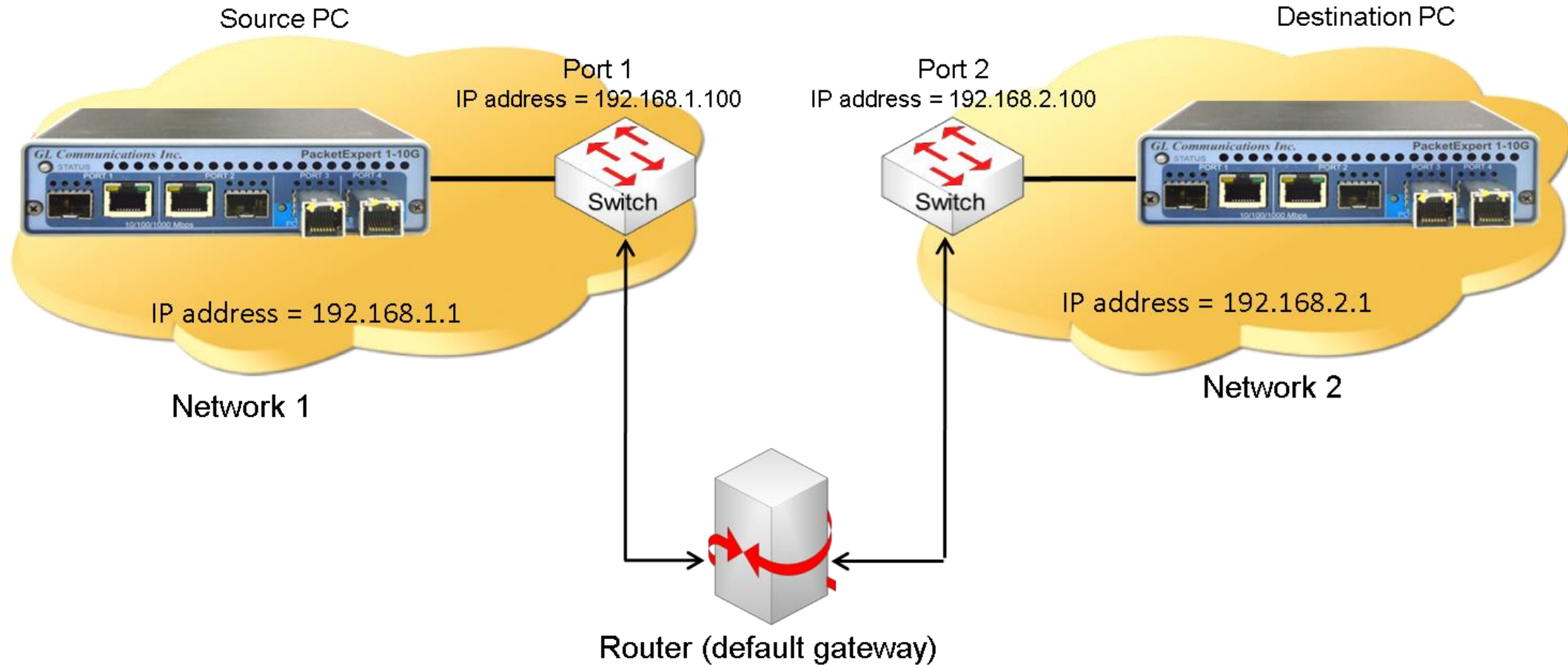


Ethernet IP Testing

- Wirespeed BERT
- Smart Loopback
- RFC 2544
- ITU-T Y.1564 (ExpertSAM™)
- Multi-Stream Traffic Generator Analyzer UDP/TCP
- Wire-Speed Record / Playback
- PacketBroker™
- Network Emulation – IPNetSim™, IPLinkSim™

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

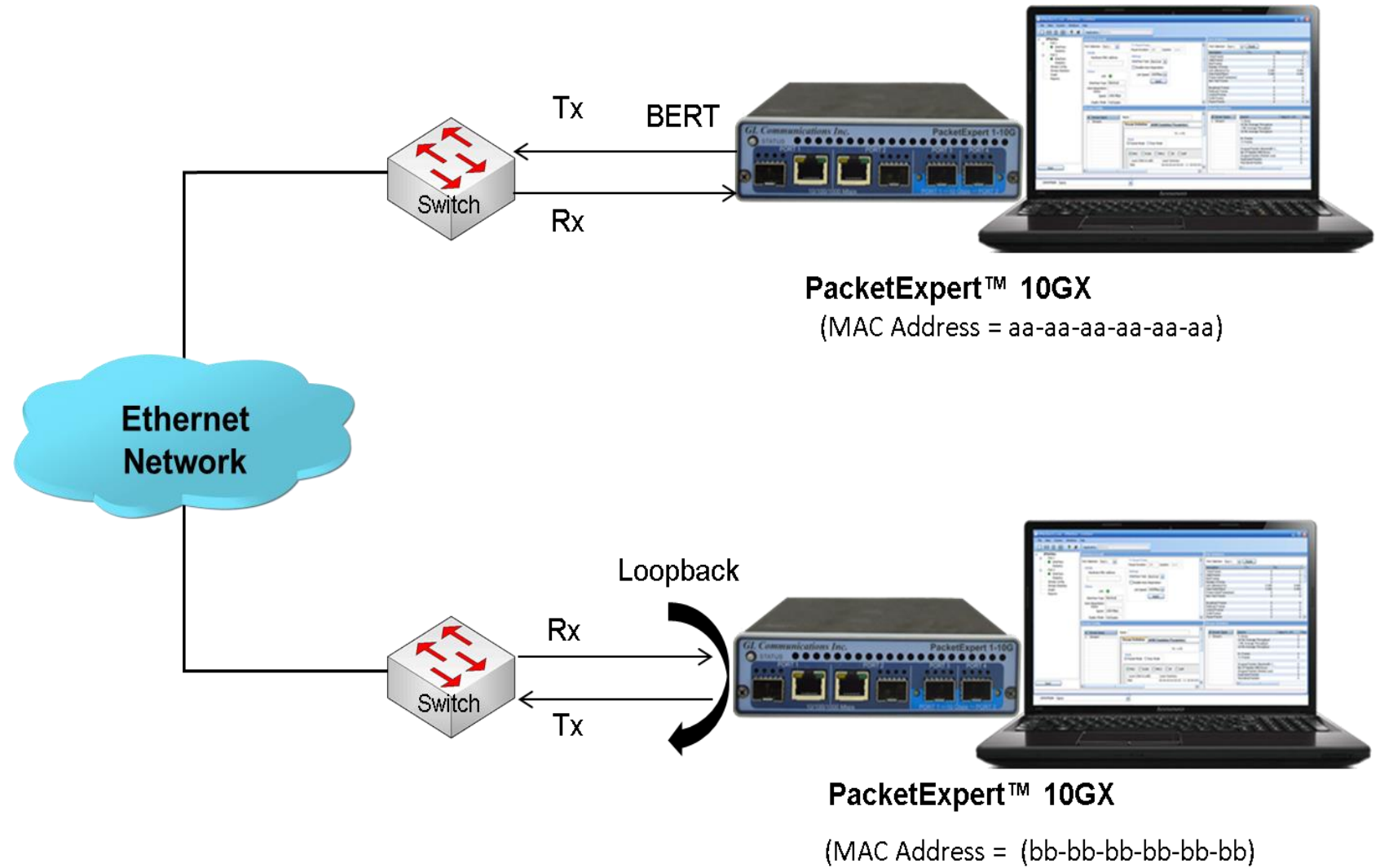
- Optional Sequence number insertion allows detecting Out-of-sequence packets and packet loss
- Detailed BERT statistics like the Bit Error Count, Bit Error Rate, Bit Error Seconds etc., are provided
- Bit Error Count is displayed in both Tabular and Graphical formats



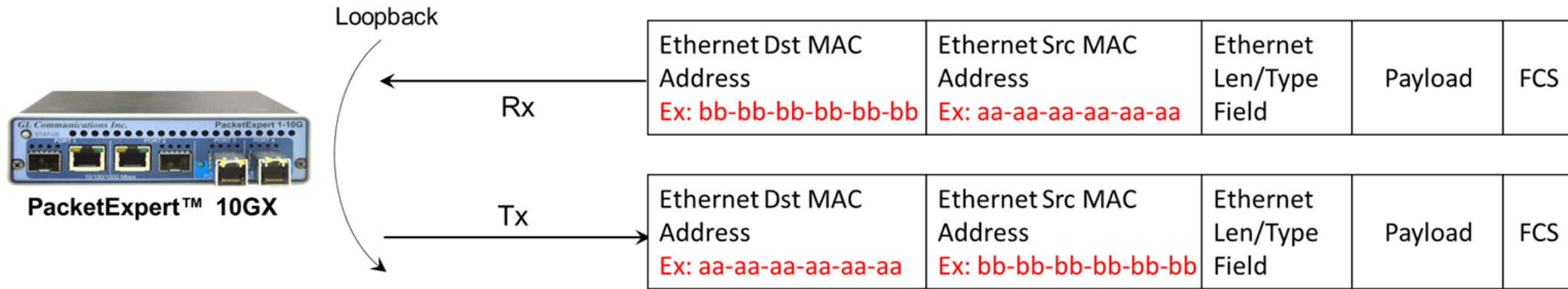
All Ports			
Options			
Tx	Port 1	Port 2	
Total Frames	941 285	941 282	
Valid Frames	941 285	941 282	
Bad Frames	0	0	
Number Of Bytes	1 425 105 490	1 425 100 948	
Link Utilisation(%)	0.400	0.400	
Data Rate(Mbps)	39.470	39.470	
Frame Rate(Frames/sec)	3 259	3 259	
Non Test Frames	-	-	
Rx	Port 1	Port 2	
Valid Frames	940 916	941 336	
Bad Frames	0	0	
Number Of Bytes	1 424 546 824	1 425 182 704	
Link Utilisation(%)	0.400	0.400	
Data Rate(Mbps)	39.485	39.485	
Frame Rate(Frames/sec)	3 260	3 260	
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	00:04:49	00:04:49	
Bits Received	11 036 318 320	11 039 083 920	
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	

2 Ports BERT and Loopback

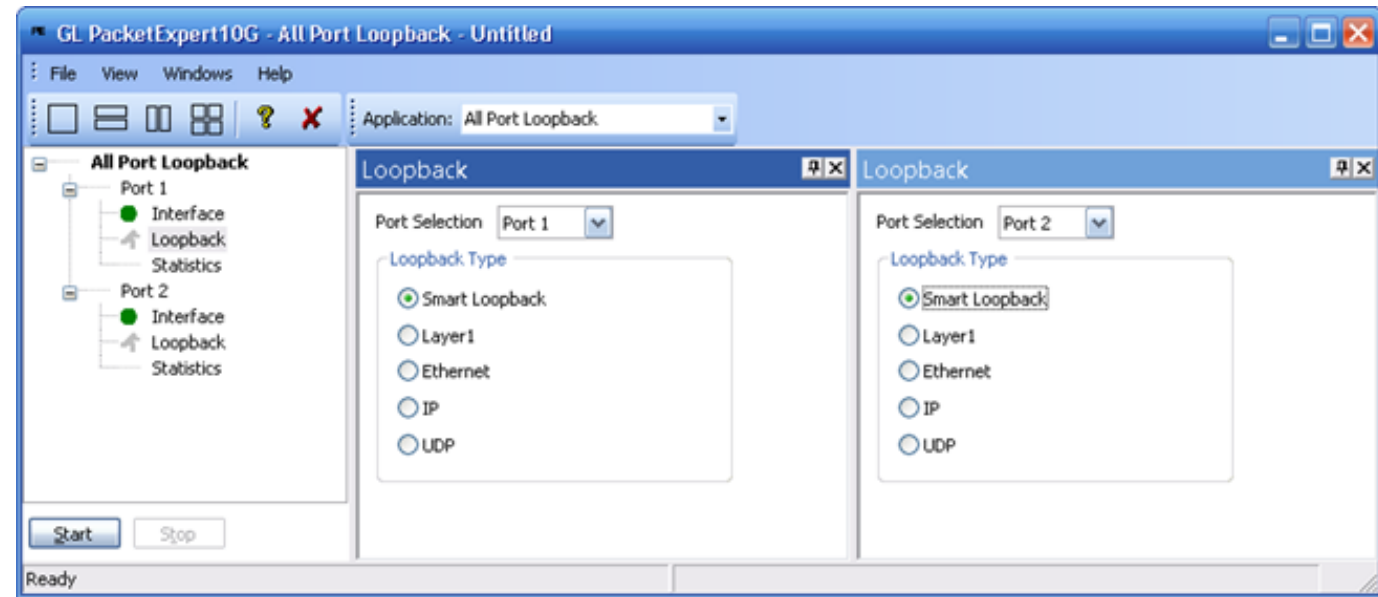
- Loopback helps in easy test setup, especially in end-to-end testing, when the other end is in a remote place
- In such cases, one PacketExpert™ 10GX can be put in constant Loopback at the remote end, and BERT tests can be started / stopped anytime at the local end



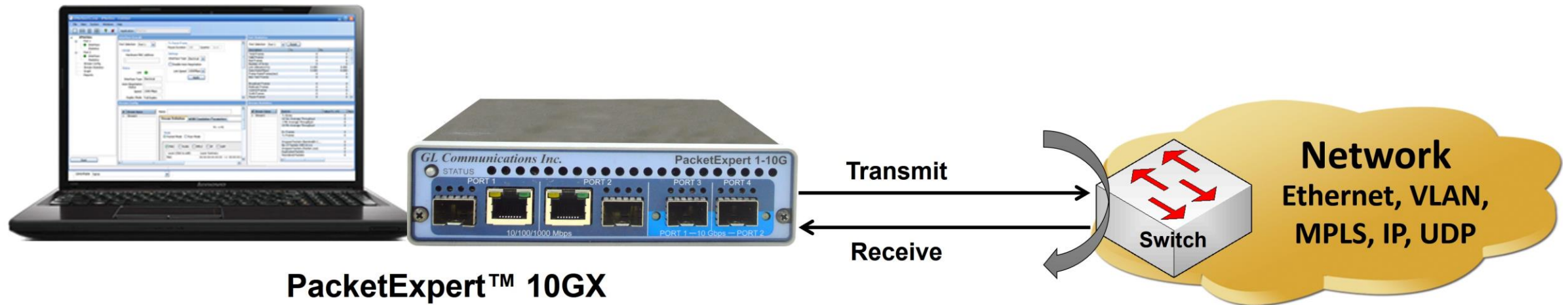
Layer 2 - Ethernet Loopback Types



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



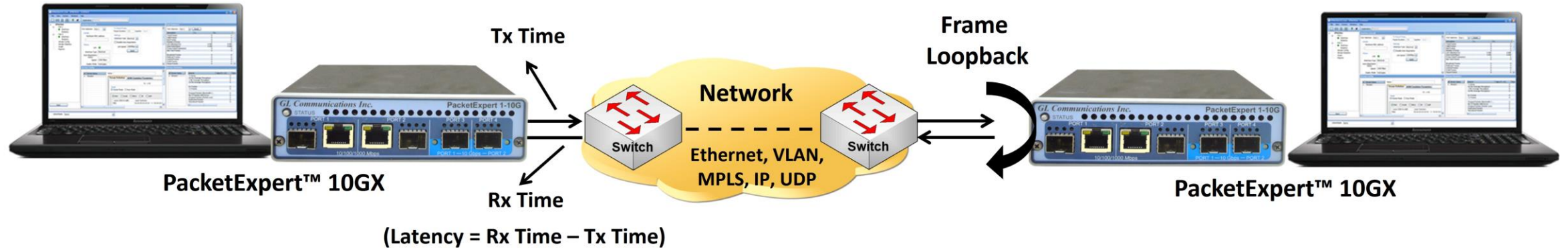
Dual RFC 2544 Testing



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

Configurations

Global Configuration

Global Configuration

Port Selection P1 -> P2

Minimum Frame Length

Max Frame Length

Test Procedure

Throughput

Latency

Frame Loss

Back-To-Back

Frame Size

Quantity 20

64	352	640	928	1216
136	424	712	1000	1288
208	496	784	1072	1360
280	568	856	1144	1432

Port Selection

East Port	Direction	West Port
P1	<-->	P2

Individual Test Configuration Details

Throughput

Port Selection P1 -> P2

Tx Configuration

Trial Duration (sec)

Number Of Trials

Port2 To Port3

Min Bandwidth %

Max Bandwidth %

Port3 To Port2

Min Bandwidth %

Max Bandwidth %

Latency

Port Selection Port 2

Tx Configuration

Trial Duration (sec)

Number Of Trials

Use Throughput Value

Port 2 To Port 2

Bandwidth %

Frame Loss

Port Selection P1 -> P2

Tx Configuration

Trial Duration (sec)

Number Of Trials

Port2 To Port3

Min Bandwidth %

Max Bandwidth %

Port3 To Port2

Min Bandwidth %

Max Bandwidth %

Back-to-Back

Port Selection P1 -> P2

Tx Configuration

Trial Duration (sec)

Number Of Trials

Port2 To Port3

Burst Size msec

No Of Bursts

Port3 To Port2

Burst Size msec

No Of Bursts

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 Results

Port Selection: P1 -> P2 View: Statistics Dir: P1-->P2

Status: **Throughput** Latency BacktoBack Frameloss

Frame Size	Results
98	100.00% 8304.25 Mbps
209	100.00% 9125.72 Mbps
354	100.00% 9464.29 Mbps
499	100.00% 9613.68 Mbps
644	100.00% 9697.83 Mbps
789	100.00% 9751.81 Mbps
934	100.00% 9789.38 Mbps
1079	100.00% 9817.03 Mbps
1224	100.00% 9838.24 Mbps
1369	100.00% 9855.03 Mbps

RFC Results

Port Selection: P1 -> P2 View: Statistics Dir: P1-->P2

Status: Throughput Latency **BacktoBack** Frameloss

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

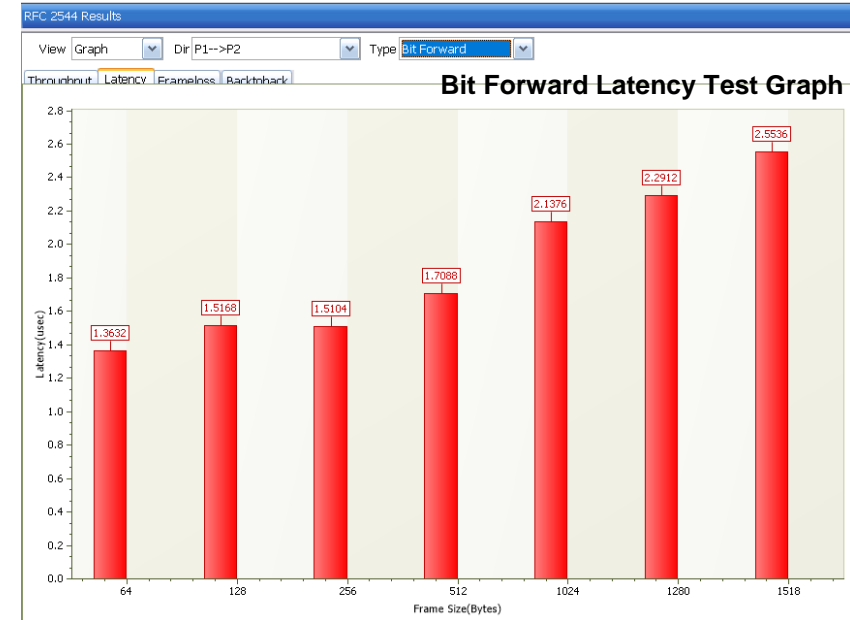
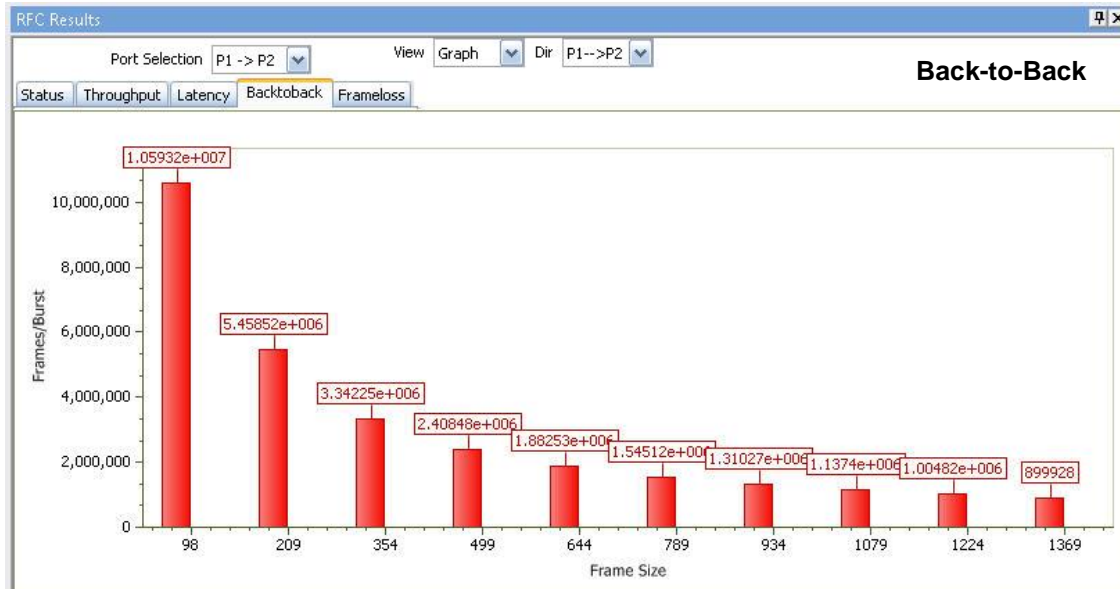
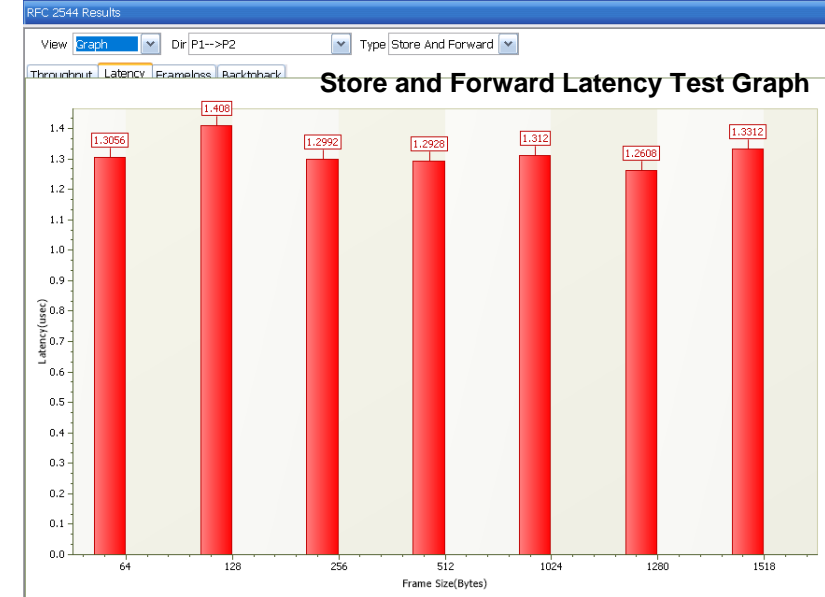
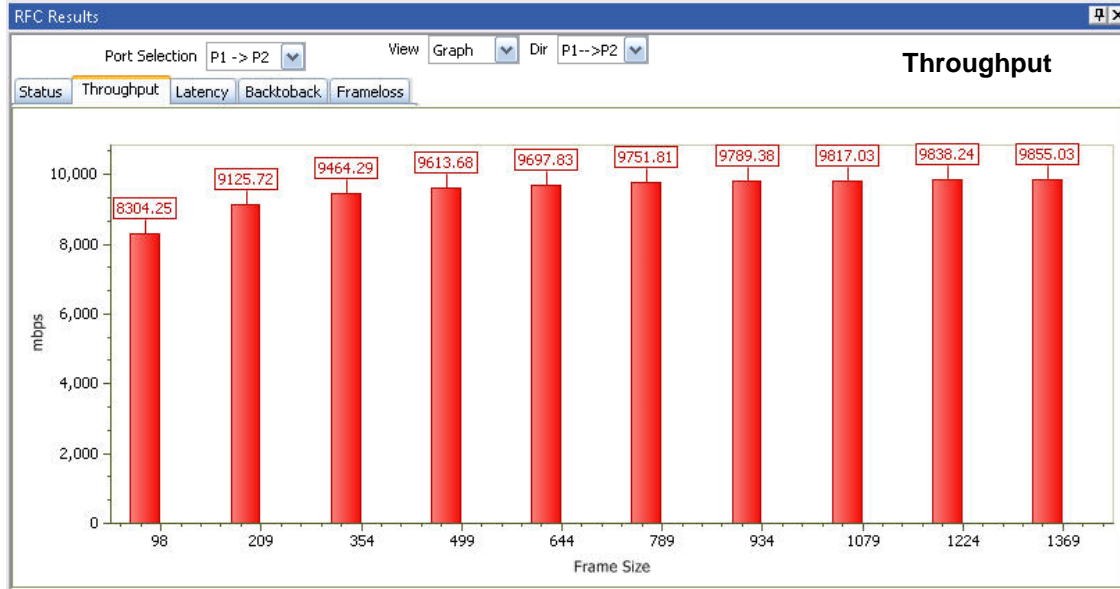
RFC Results

Port Selection: P1 -> P2 View: Statistics Dir: P1-->P2

Status: Throughput Latency BacktoBack **FrameLoss**

Frame Size	Results
64	100.00 % 100.00 % 100.00 % 100.00 %
	90.00 % 100.00 % 90.00 % 100.00 %
	80.00 % 100.00 % 80.00 % 100.00 %
	70.00 % 100.00 % 70.00 % 100.00 %
	60.00 % 100.00 % 60.00 % 100.00 %
	50.00 % 100.00 % 50.00 % 100.00 %
	40.00 % 100.00 % 40.00 % 100.00 %
	30.00 % 100.00 % 30.00 % 100.00 %
	20.00 % 100.00 % 20.00 % 100.00 %
	10.00 % 100.00 % 10.00 % 100.00 %
128	100.00 % 100.00 % 100.00 % 100.00 %
	90.00 % 100.00 % 90.00 % 100.00 %
	80.00 % 100.00 % 80.00 % 100.00 %
	70.00 % 100.00 % 70.00 % 100.00 %
	60.00 % 100.00 % 60.00 % 100.00 %
	50.00 % 100.00 % 50.00 % 100.00 %
	40.00 % 100.00 % 40.00 % 100.00 %
	30.00 % 100.00 % 30.00 % 100.00 %
	20.00 % 100.00 % 20.00 % 100.00 %
	10.00 % 100.00 % 10.00 % 100.00 %
256	100.00 % 100.00 % 100.00 % 100.00 %
	90.00 % 100.00 % 90.00 % 100.00 %
	80.00 % 100.00 % 80.00 % 100.00 %
	70.00 % 100.00 % 70.00 % 100.00 %
	60.00 % 100.00 % 60.00 % 100.00 %
	50.00 % 100.00 % 50.00 % 100.00 %
	40.00 % 100.00 % 40.00 % 100.00 %
	30.00 % 100.00 % 30.00 % 100.00 %
	20.00 % 100.00 % 20.00 % 100.00 %
	10.00 % 100.00 % 10.00 % 100.00 %
512	100.00 % 100.00 % 100.00 % 100.00 %
	90.00 % 100.00 % 90.00 % 100.00 %
	80.00 % 100.00 % 80.00 % 100.00 %
	70.00 % 100.00 % 70.00 % 100.00 %

Graphs



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

Generate Reports

Reports

Choose Format: PDF

Title: PacketExpert

User Comments: Generate RFC 2544 result

Header: RFC2544-Throughput

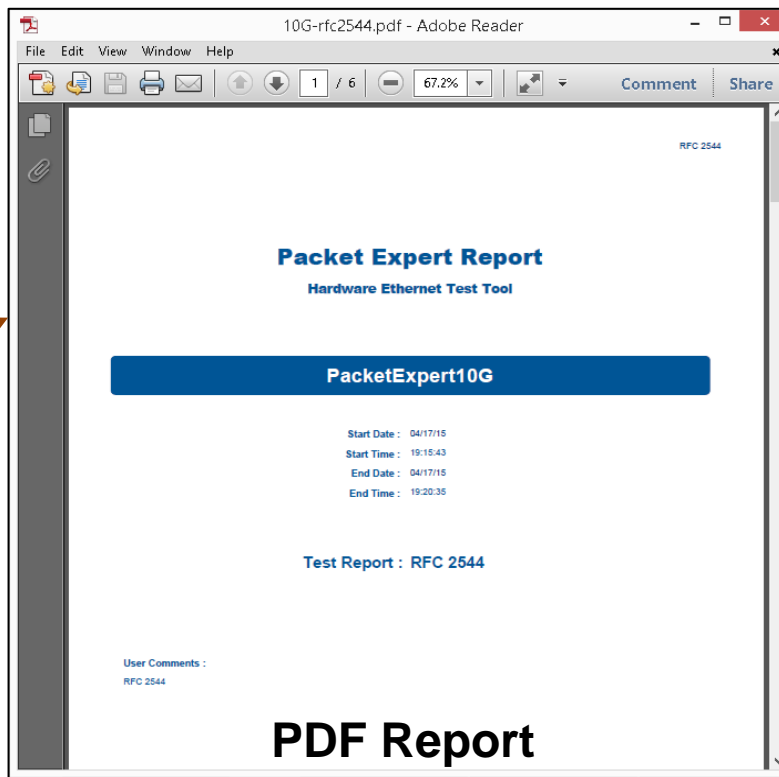
Footer: GL Communications

User Logo: Expert\GL_Logo.JPG

File name: PacketExpert\report1

Generate Report

Configuration



10g-rfc2544.csv - Excel

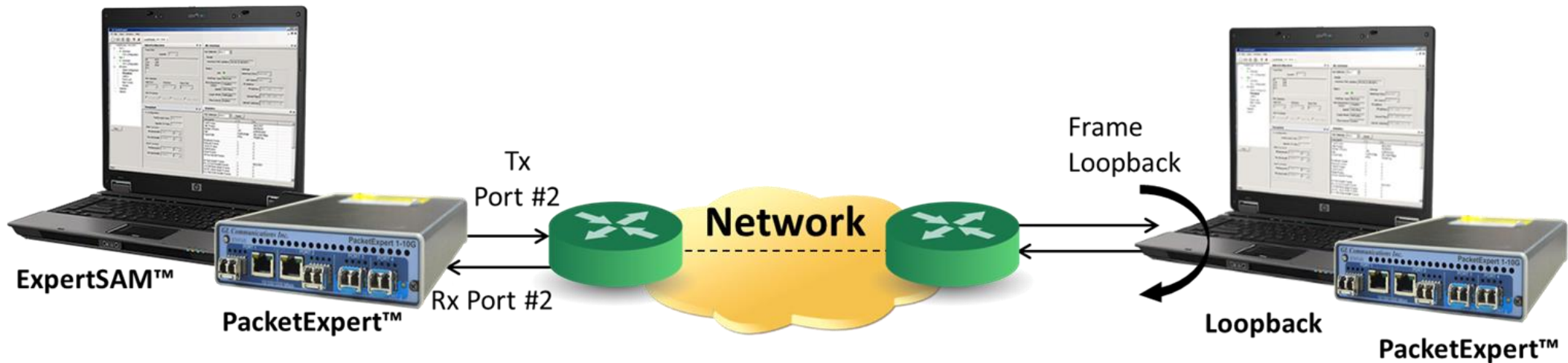
FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW ADD-INS

A1

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1		THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi
2	P1->P2	8304.25	100	9125.72	100	9464.29	100	9613.68	100	9697.82	100	9751.8	100	9789.37	100	9817.03	100	9838.24
3																		
4																		
5																		
6																		
7																		
8																		

CSV Report

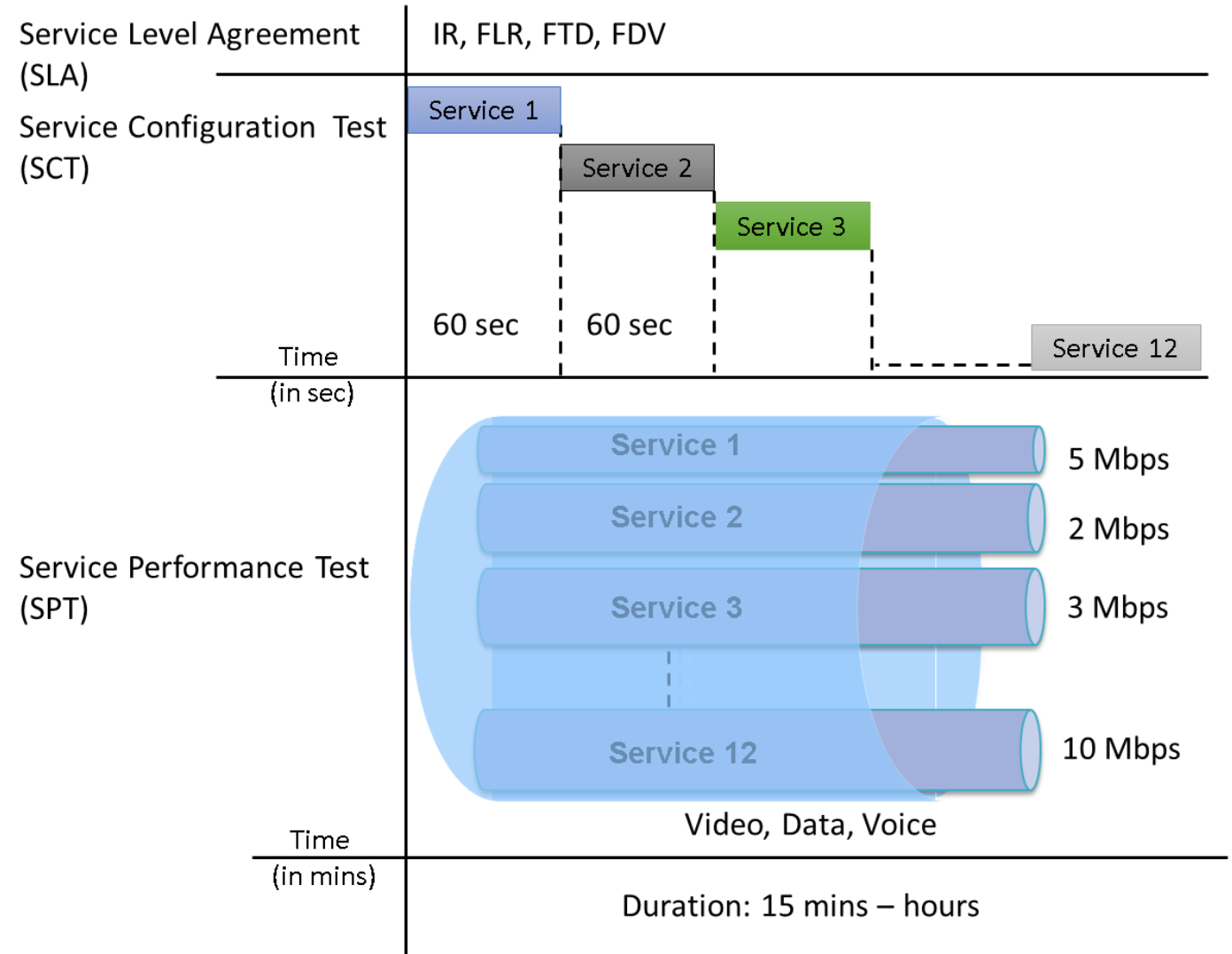
Ethernet Network Testing



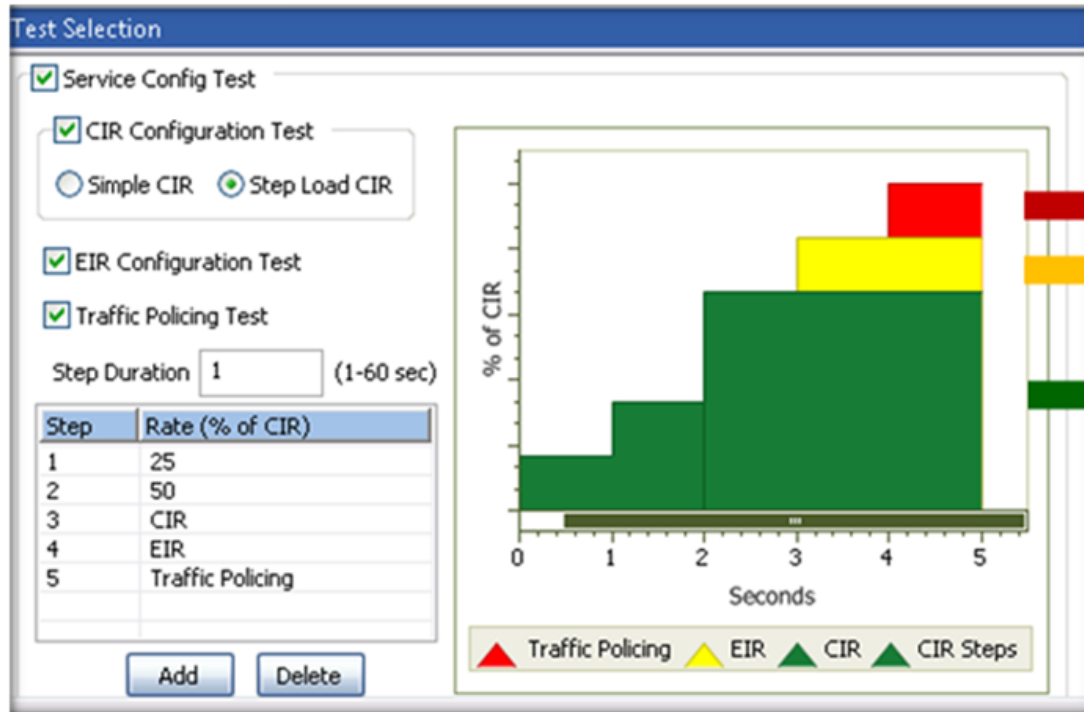
- A single test to validate service-level agreements (SLAs) as per ITU-T Y.1564 standard
- ITU-T Y.1564 completes this testing in two phases based on the SLA parameters:
 - Service Level Agreement Parameters: Information Rate (IR), Frame Transfer Delay (FTD), Frame Delay Variation (FDV), Frame Loss Ratio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



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

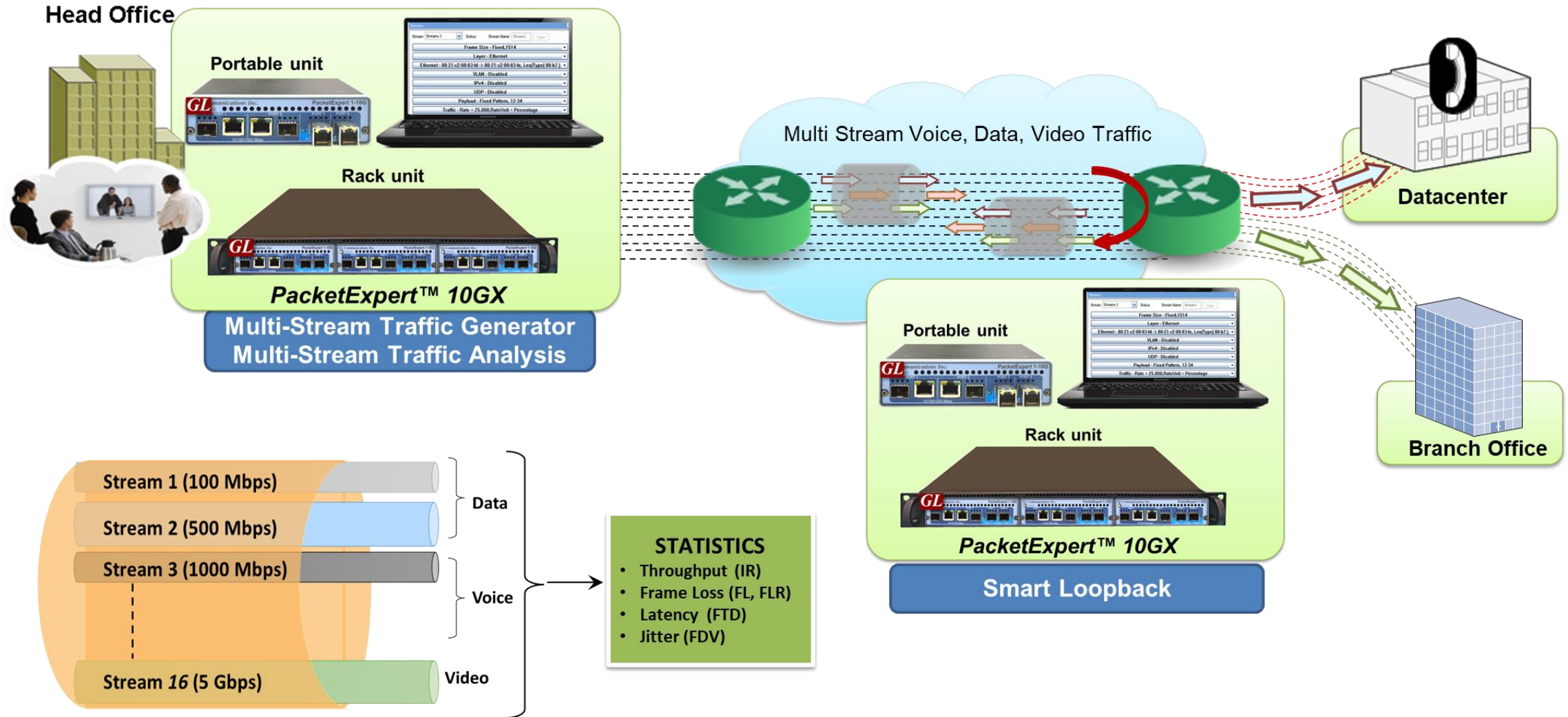
Service Performance and Configuration Test Results

Service Performance Results																	
IR(Mbps), FLR(%), FTD(msec), FDV(msec)														Test Time		12:06:55	
Test	Verdict	IR (Curr)	IR (Min)	IR (Mean)	IR (Max)	FLR	FLR (Rate)	FTD (Curr)	FTD (Min)	FTD (Mean)	FTD (Max)	FDV (Curr)	FDV (Min)	FDV (Mean)	FDV (Max)		
1	PASS	97.92	97.62	98.02	98.38	0	0.00	0.0992	0.0891	0.1148	0.1027	0.001521	0.001500	0.001564	0.001645		
2	PASS	48.92	48.79	49.01	49.24	0	0.00	0.1020	0.0000	0.6723	0.1020	0.002252	0.002157	0.002239	0.002354		
3	PASS	206.04	205.35	205.81	206.33	0	0.00	0.0992	0.0889	0.1039	0.1030	0.000924	0.000902	0.000934	0.000989		
4	PASS	68.50	68.29	68.60	68.90	0	0.00	0.0992	0.0916	0.1020	0.1030	0.001921	0.001838	0.001920	0.002037		
5	PASS	88.34	87.85	88.19	88.47	0	0.00	0.0992	0.0924	0.1005	0.1030	0.001688	0.001615	0.001673	0.001767		
6	PASS	39.23	38.99	39.19	39.39	0	0.00	0.0992	0.0906	0.1025	0.1030	0.002453	0.002330	0.002437	0.002617		
7	PASS	34.44	34.09	34.30	34.49	0	0.00	0.0992	0.0937	0.1023	0.1030	0.002569	0.002393	0.002541	0.002669		
8	PASS	49.22	48.82	49.03	49.24	0	0.00	0.0992	0.0908	0.1022	0.1030	0.002290	0.002142	0.002235	0.002369		
9	PASS	53.90	53.67	53.90	54.14	0	0.00	0.0992	0.0876	0.1019	0.1030	0.002162	0.002049	0.002146	0.002291		
10	PASS	68.68	68.24	68.60	68.87	0	0.00	0.0992	0.0907	0.1002	0.1030	0.001914	0.001854	0.001925	0.002025		
11	PASS	146.84	146.57	146.95	147.49	0	0.00	0.0992	0.0902	0.0983	0.1027	0.001218	0.001170	0.001213	0.001288		
12	PASS	78.27	78.12	78.38	78.75	0	0.00	0.0992	0.0906	0.1001	0.1030	0.001785	0.001710	0.001786	0.001881		

Service Performance Test Done

Service Configuration Results Overview							
Overview							
#	Service Name	Verdict	Current Step	Max IR(Mbps)	FLR(%)	Max FTD(msec)	Max FDV(msec)
1	↑ Service 1	✓	-	625.00	0.000	0.0014	0.000038
2	↑ Service 2	✓	-	625.00	0.000	0.0014	0.000038
3	↑ Service 3	✓	-	625.00	0.000	0.0014	0.000038
4	↑ Service 4	✓	-	625.00	0.000	0.0014	0.000038
5	↑ Service 5	✓	-	625.00	0.000	0.0014	0.000038
6	↑ Service 6	✓	-	625.00	0.000	0.0014	0.000038
7	↑ Service 7	✓	-	625.00	0.000	0.0014	0.000038
8	↑ Service 8	✓	-	625.00	0.000	0.0014	0.000038
9	↑ Service 9	✓	-	625.00	0.000	0.0014	0.000038
10	↑ Service 10	✓	-	625.00	0.000	0.0014	0.000038
11	↑ Service 11	✓	-	625.00	0.000	0.0014	0.000038
12	↑ Service 12	✓	-	625.00	0.000	0.0014	0.000038
13	↑ Service 13	✓	-	625.00	0.000	0.0014	0.000038
14	↑ Service 14	✓	-	625.00	0.000	0.0014	0.000038
15	↑ Service 15	✓	-	625.00	0.000	0.0014	0.000038
16	↑ Service 16	✓	-	625.00	0.000	0.0014	0.000038

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



Multi-Stream Traffic Generator and Analyzer Results

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)	
<input checked="" type="checkbox"/>	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
<input checked="" type="checkbox"/>	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
<input checked="" type="checkbox"/>	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
<input checked="" type="checkbox"/>	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
<input checked="" type="checkbox"/>	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
<input checked="" type="checkbox"/>	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
<input checked="" type="checkbox"/>	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
<input checked="" type="checkbox"/>	8	55	5 216 779	5 121 928	5 244 854 272	94 851	1.818									
<input checked="" type="checkbox"/>	9	55	1 535 124	1 507 212	771 692 544	27 912	1.818									
<input checked="" type="checkbox"/>	10	55	3 434 715	3 372 265	674 453 000	62 450	1.818									
<input checked="" type="checkbox"/>	11	55	3 176 550	3 118 794	405 443 220	57 756	1.818									
<input checked="" type="checkbox"/>	12	55	9 085 290	8 920 101	1 159 613 130	165 189	1.818									
<input checked="" type="checkbox"/>	13	55	9 844 599	9 665 605	5 841 891 662	178 994	1.818									
<input checked="" type="checkbox"/>	14	55	27 539 785	27 039 059	16 342 406 346	500 726	1.818									
<input checked="" type="checkbox"/>	15	55	395 501	388 310	793 705 640	7 191	1.818									
<input checked="" type="checkbox"/>	16	55	1 090 764	1 090 764	658 606 880	0	0.000									

Horizontal View

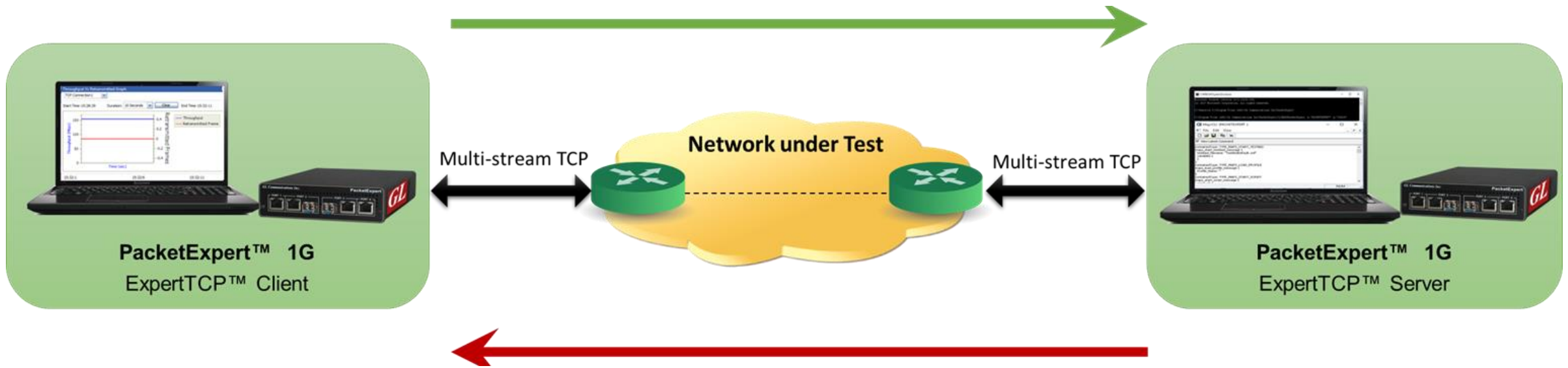
Multi-Stream Traffic Generator & Analyzer Results

IR(Mbps), FLR(%), FTD(msec), FDV(msec) Test Time 00:01:55 Horizontal Horizontal FTD Unit msec FDV Unit msec Activate All DeActivate All

Stream No.	1	2	3	4	5	6	7	8	9	10	11
Stream Sel...	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Seconds	117	117	117	117	117	117	117	117	117	117	117
TxFrames	2 438 342	2 720 661	12 406 605	2 584 417	330 075	38 742 374	31 028 451	11 097 542	3 265 635	7 306 595	6 757 407
RxFrames	2 438 342	2 720 661	12 406 605	2 584 417	330 075	38 742 374	31 028 451	11 097 542	3 265 635	7 306 595	6 757 407
RxBytes	1 473 018 618	1 392 978 432	17 121 114	3 566 495 460	341 297 550	5 036 508 620	42 819 262	11 363 883	1 672 005 120	1 461 319 000	878 462 910
FL Count	0	0	0	0	0	0	0	0	0	0	0
FLR	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
IR (Curr)	104.05	98.97	1187.65	247.40	23.79	397.36	2970.26	792.20	118.79	109.91	69.31
IR (Min)	104.03	98.94	1187.30	247.33	23.79	397.24	2969.39	791.97	118.76	109.88	69.29
IR (Max)	104.06	98.97	1187.65	247.41	23.80	397.36	2970.26	792.20	118.79	109.91	69.31
IR (Avg)	136.79	130.10	1561.28	325.23	31.27	522.37	3904.70	1041.42	156.16	144.49	91.11
FTD (Curr)	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
FTD (Min)	0.001	0.001	0.002	0.002	0.002	0.001	0.002	0.002	0.001	0.001	0.001
FTD (Max)	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003	0.003
FTD (Avg)	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002
FDV (Curr)	< 1us	< 1us	< 1us	< 1us	< 1us	< 1us	< 1us	< 1us	< 1us	< 1us	< 1us
FDV (Min)	0.000	0.000	0.000	< 1us	< 1us	0.000	0.000	0.000	0.000	0.000	0.000
FDV (Max)	0.001	0.001	< 1us	< 1us	< 1us	0.001	< 1us	< 1us	0.001	0.001	0.001
FDV (Avg)	< 1us	< 1us	< 1us	< 1us	< 1us	< 1us	< 1us	< 1us	< 1us	< 1us	< 1us

Vertical View

ExpertTCP™ (RFC-6349 Testing)



ExpertTCP™ Main Screen

The screenshot displays the ExpertTCP main interface with the following components:

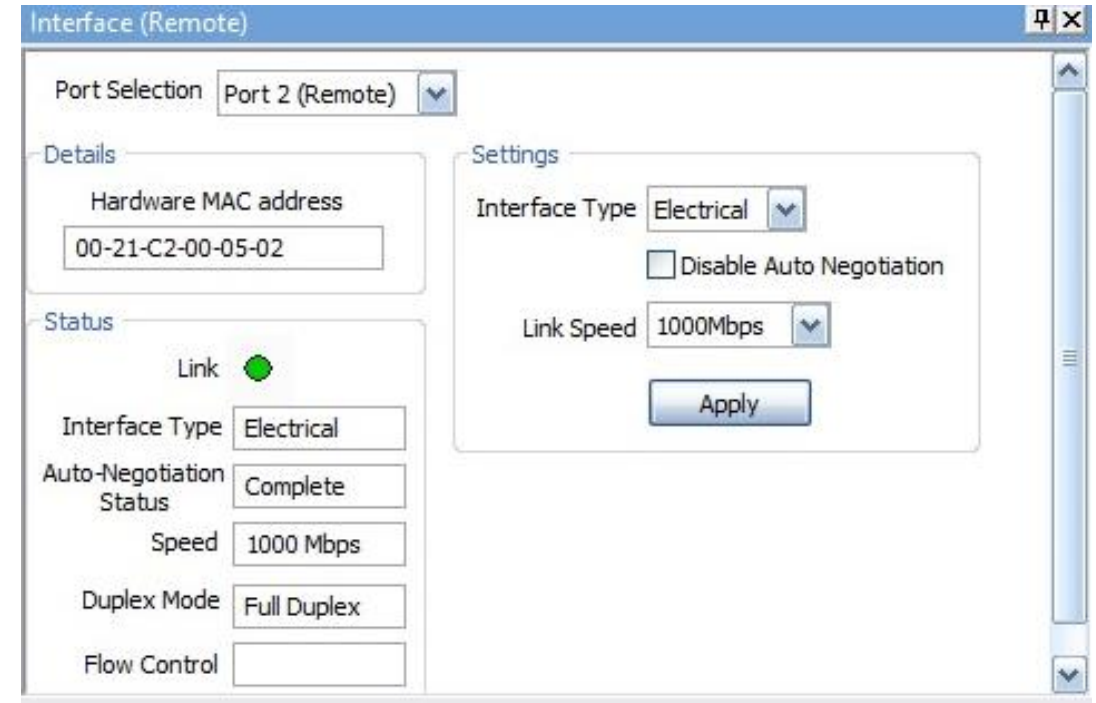
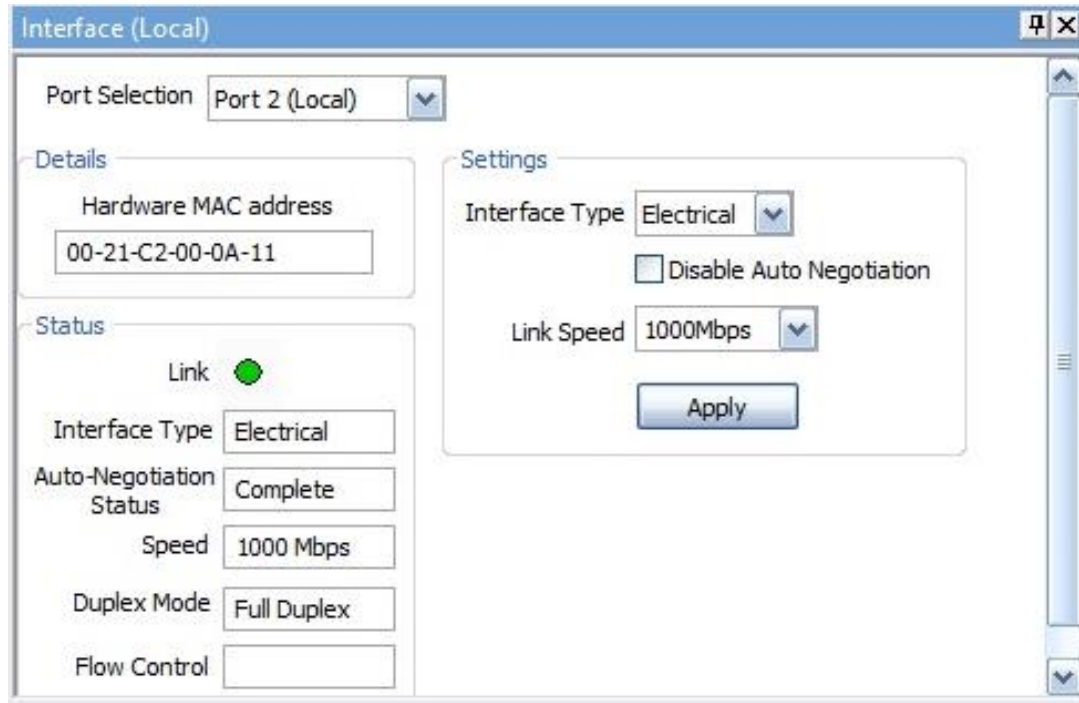
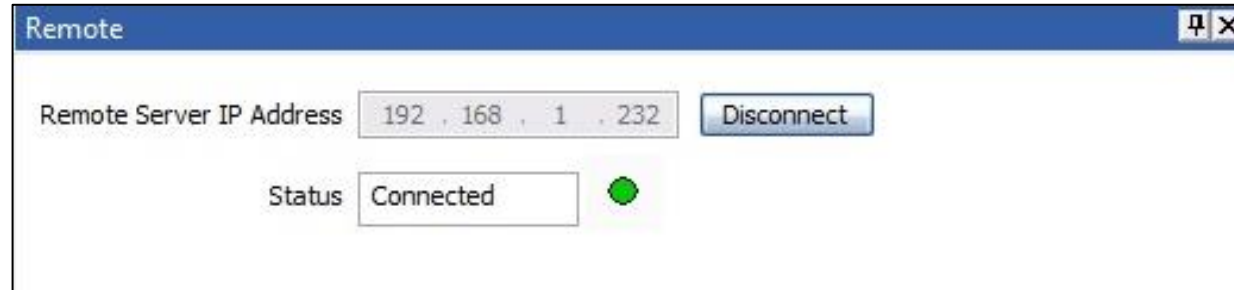
- Network Setup:** A diagram showing a Client (Local) connected to a Network Under Test, which is connected to a Server (Remote).
 - Client (Local):** MAC Address: 00-21-c2-00-05-02 (User Defined); IP Address: 192.168.1.111; Subnet Mask: 255.255.255.0; Default Gateway: 192.168.1.1.
 - Network Under Test:** Link Type: Symmetrical; Upstream CIR: 10 Mbps; Downstream CIR: 10 Mbps.
 - Server (Remote):** MAC Address: 00-21-c2-00-06-1e (User Defined); IP Address: 192.168.1.232; Subnet Mask: 255.255.255.0; Default Gateway: 192.168.1.1.
- Test Setup:** Direction: Upstream; Transfer Size: 100,000 MBytes; Test Selection: Run Throughput Test, Run Path MTU Test (Upstream/Downstream MTU: 1500 Bytes), Run Baseline RTT Test (Upstream/Downstream RTT: 50,000 msec).
- TCP Setup:** No of TCP Connection: 8; TCP Port Configuration: Automatic. A table lists 8 connections with Client and Server ports.
- Remote:** Remote Server IP Address: 192.168.1.232; Status: Connected.

Table: TCP Connection Configuration

TCP Connection...	Client Port	Server Port
1	5000	6000
2	5001	6001
3	5002	6002
4	5003	6003
5	5004	6004
6	5005	6005
7	5006	6006
8	5007	6007

Network Setup

All settings configured locally on the client side



Status and Results

Overall Status

Test Status: Done

Current Direction: -

Current Test

Test	Status	Result
Path MTU (Upstream)	↑	✓
Baseline RTT (Upstream)	↑	✓
Throughput (Upstream)	↑	✓

TCP Connection Status:

Connection No.	Source Port	Destination Port	Status
0	5000	6000	Connection Closed

Path MTU results

Upstream Downstream

Path MTU: 1500 Bytes

Baseline RTT Results

Upstream Downstream

Trial Duration: 91

Average RTT: 50.018 msec

Minimum RTT: 50.015 msec

Maximum RTT: 50.040 msec

Baseline RTT Value Selected: 50.015 msec

Test Parameter Summary

Upstream Downstream

Baseline RTT: 50.015 msec

Calculated BDP: 625.190 KBytes

TCP Window: 65535 Bytes

Path MTU: 1500 Bytes

MSS Used: 1448 Bytes

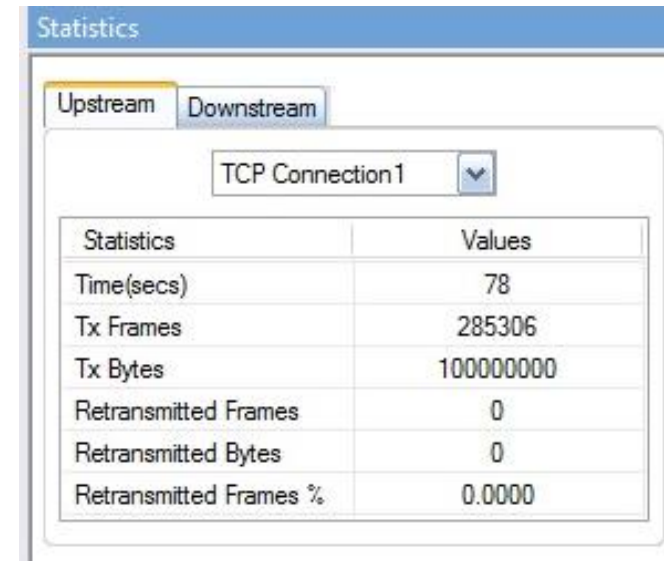
No of TCP Connection: 1

Transfer Size: 100.000 MBytes

Statistics and Periodic Results

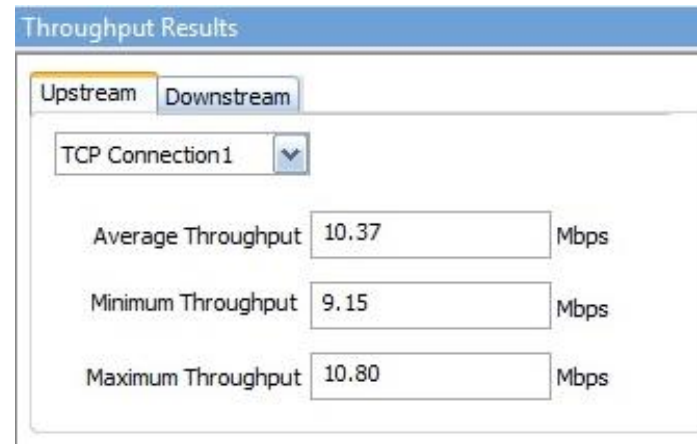
Statistics are updated every second and includes -

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

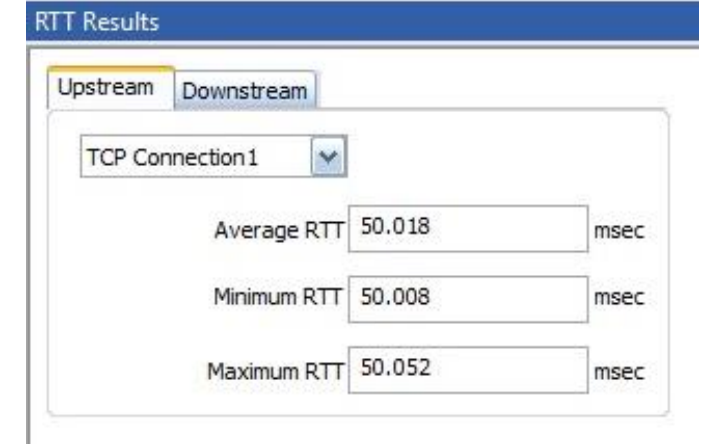


Statistics	Values
Time(secs)	78
Tx Frames	285306
Tx Bytes	100000000
Retransmitted Frames	0
Retransmitted Bytes	0
Retransmitted Frames %	0.0000

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



Average Throughput	10.37	Mbps
Minimum Throughput	9.15	Mbps
Maximum Throughput	10.80	Mbps



Average RTT	50.018	msec
Minimum RTT	50.008	msec
Maximum RTT	50.052	msec

Final Results

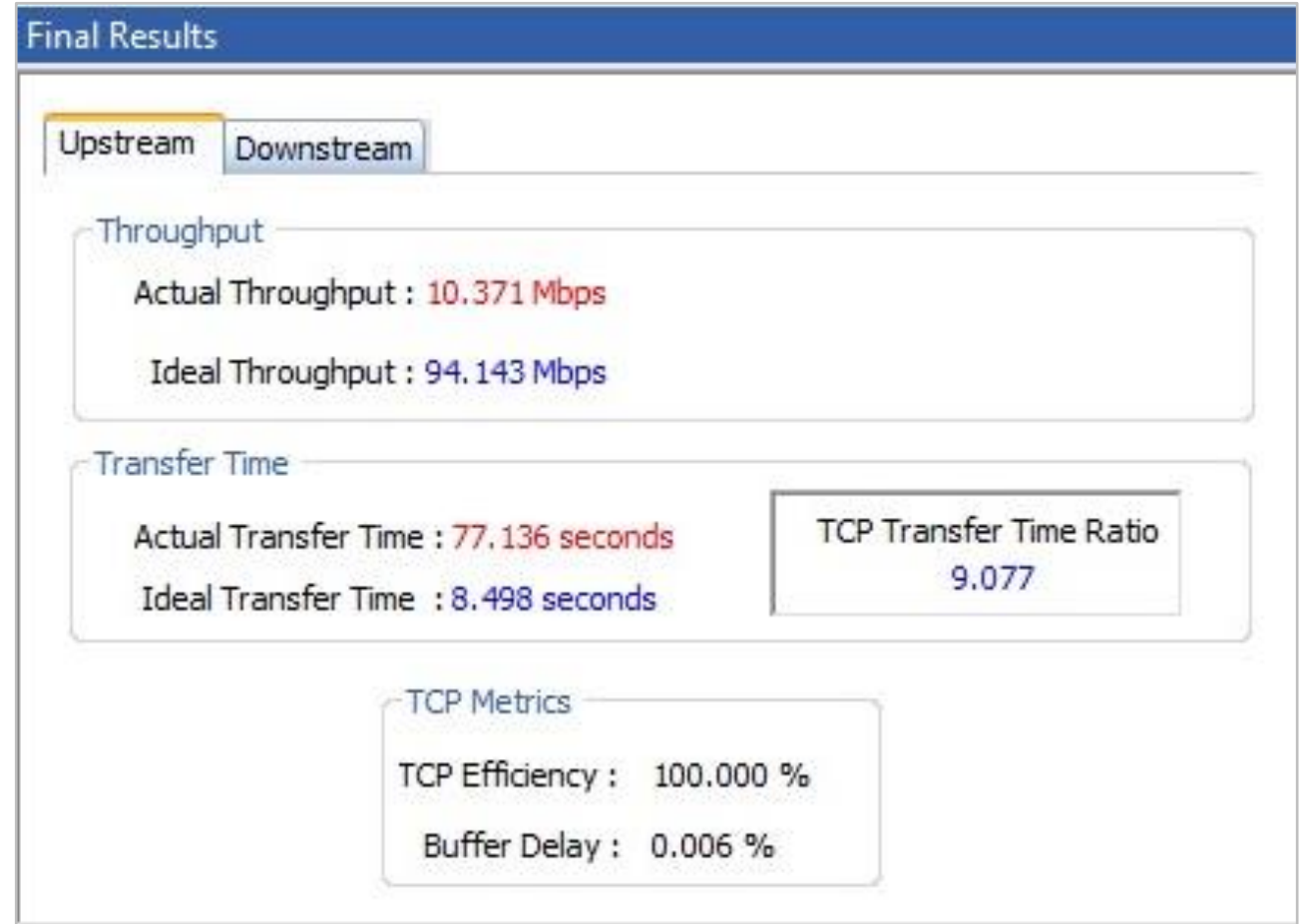
Ideal Throughput - the maximum possible TCP throughput for the given CIR

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

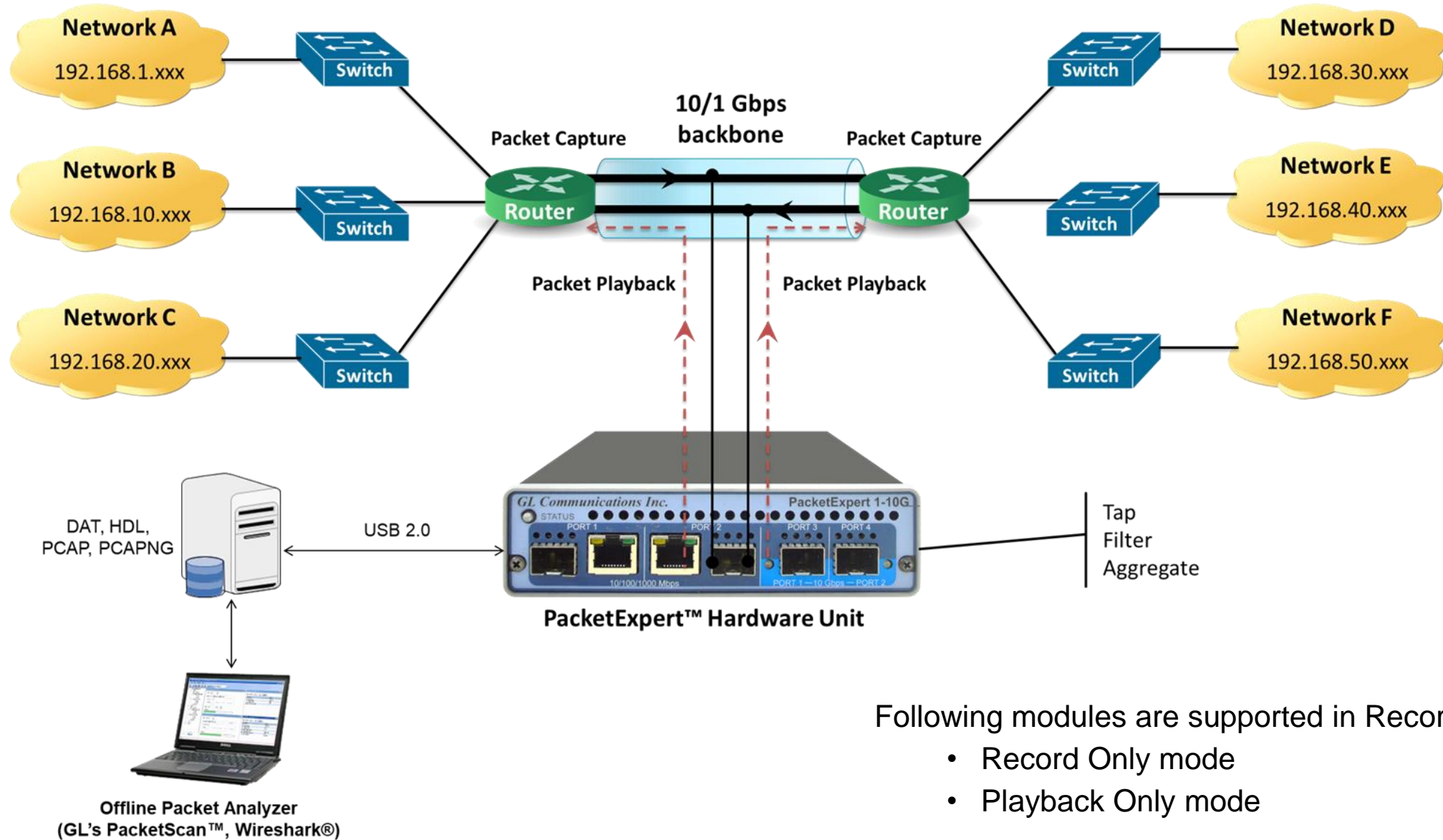
TCP Transfer Time Ratio - Measure of how much Actual transfer time is greater than the Ideal transfer time

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



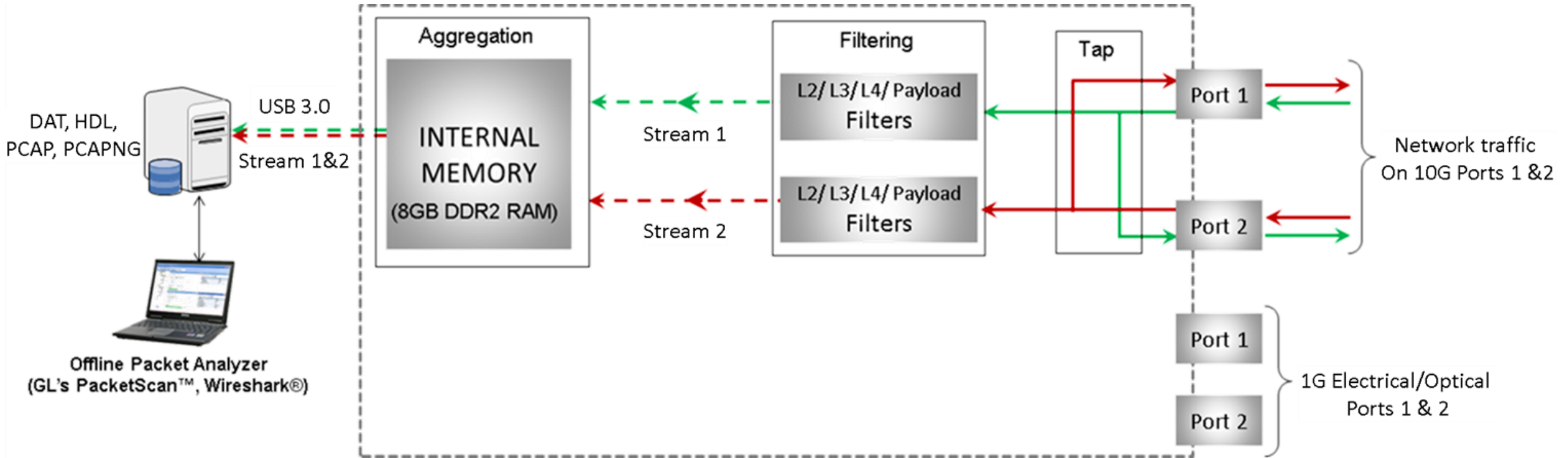
Wire-Speed Record/Playback



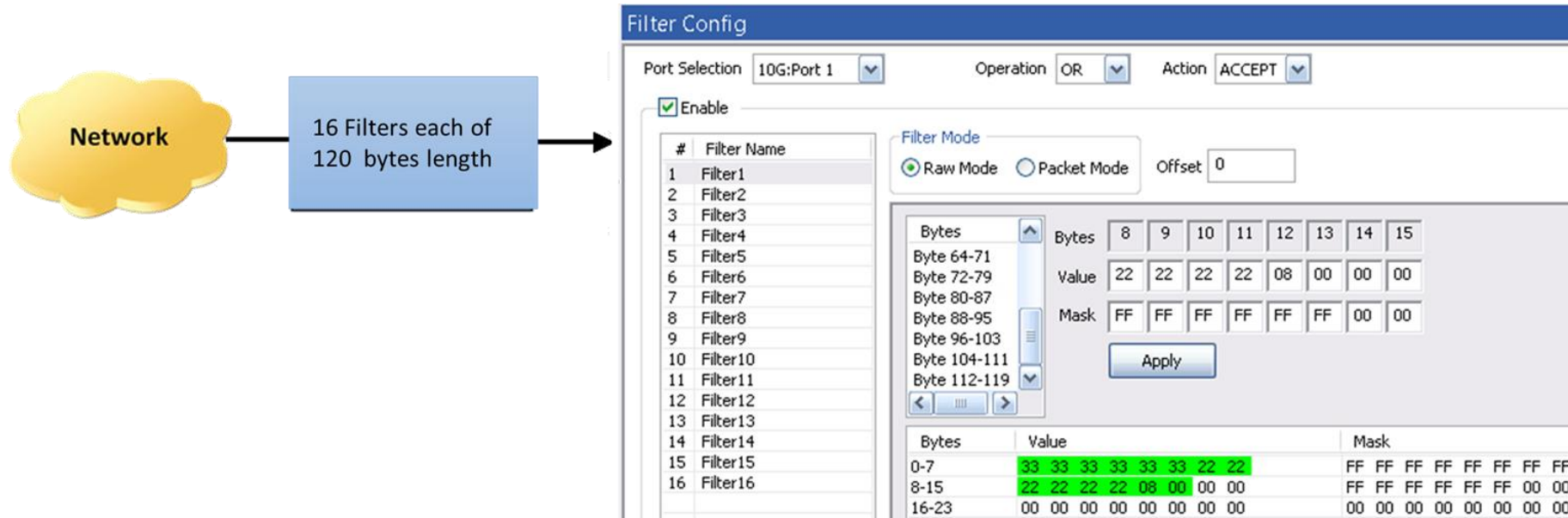
Following modules are supported in Record/Playback:

- Record Only mode
- Playback Only mode

Working Principle

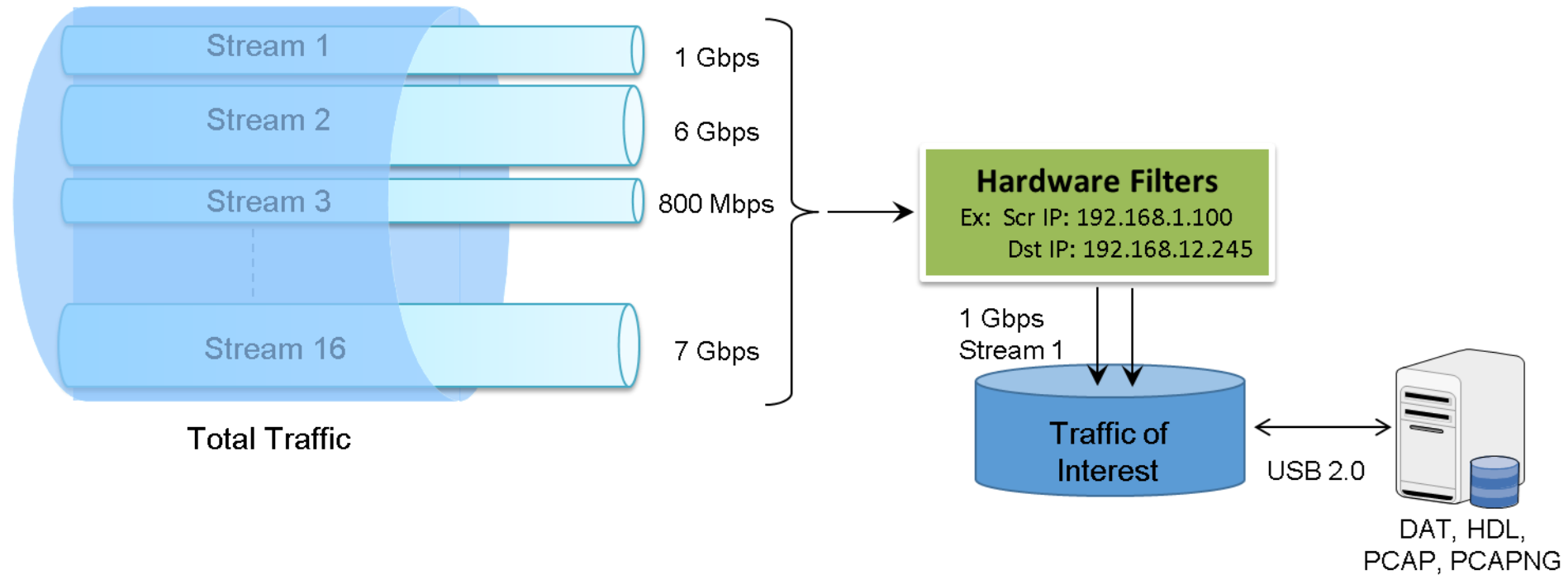


Wireshark Packet Filters and Triggers



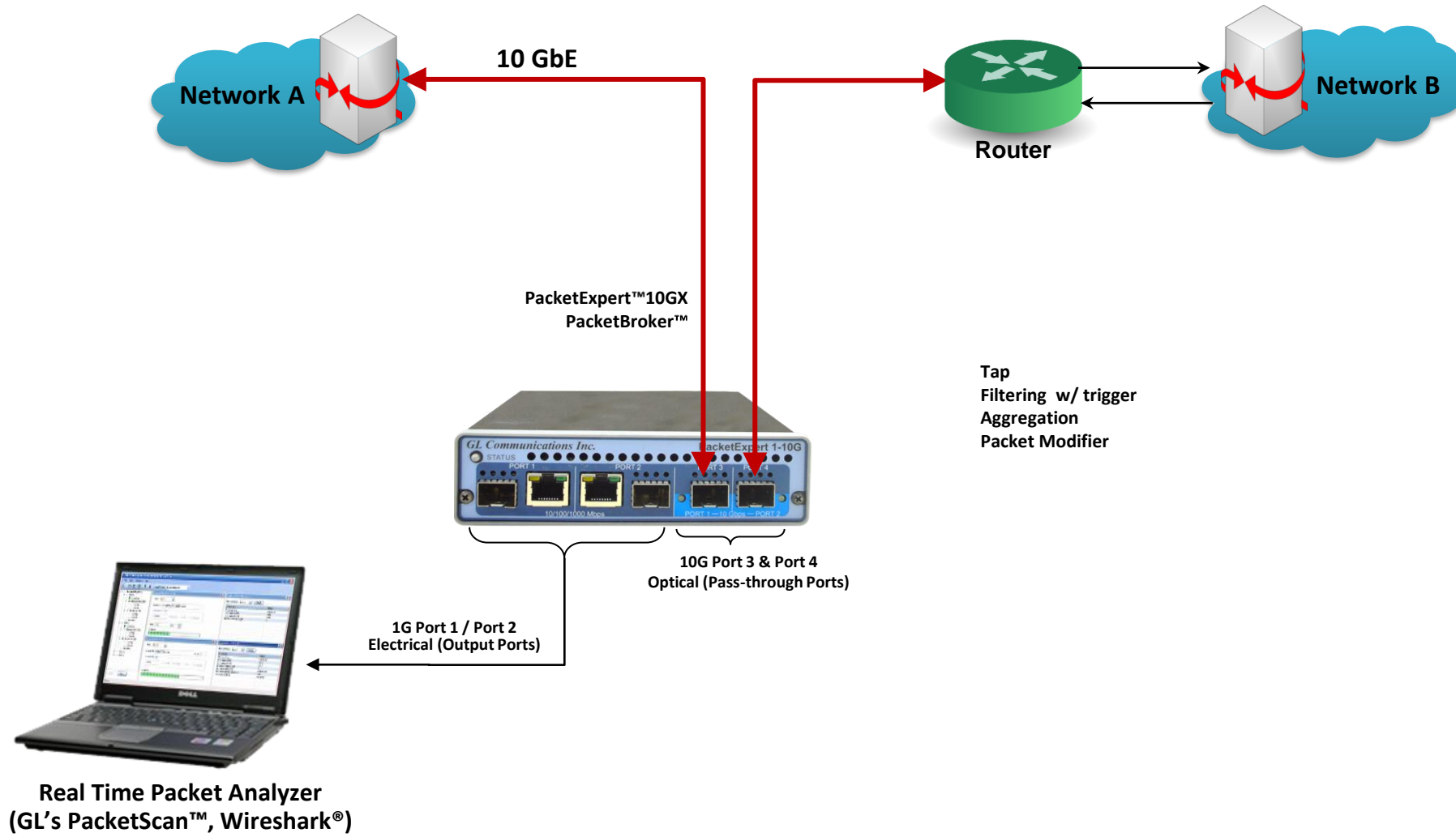
- Filter packets and record only packets of interest
- Capture simultaneously on 2 ports with 120 bytes deep filter per port (for record application) and set filter on any one of the ports or all ports
- Packet filtering can be based on all Layer 2 (Ethernet), Layer 3 (IP) Layer 4 (UDP/TCP) Headers
- 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

Capture Traffic of Interest

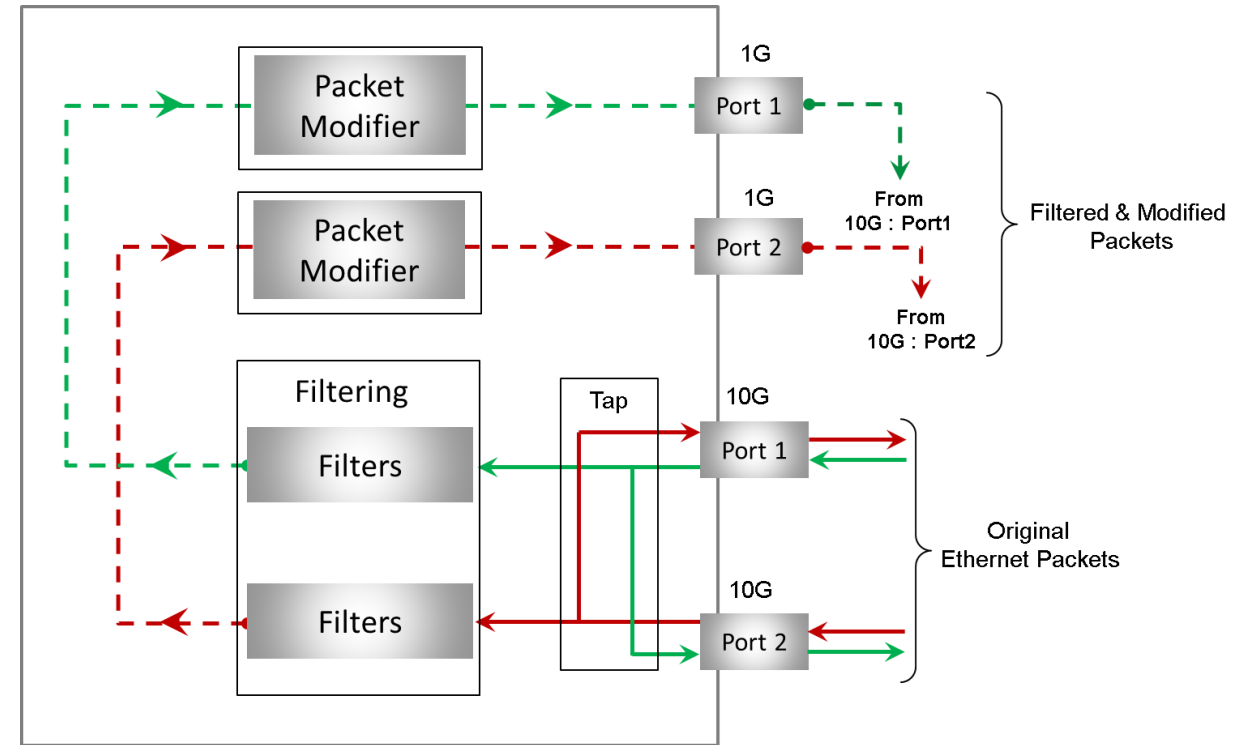
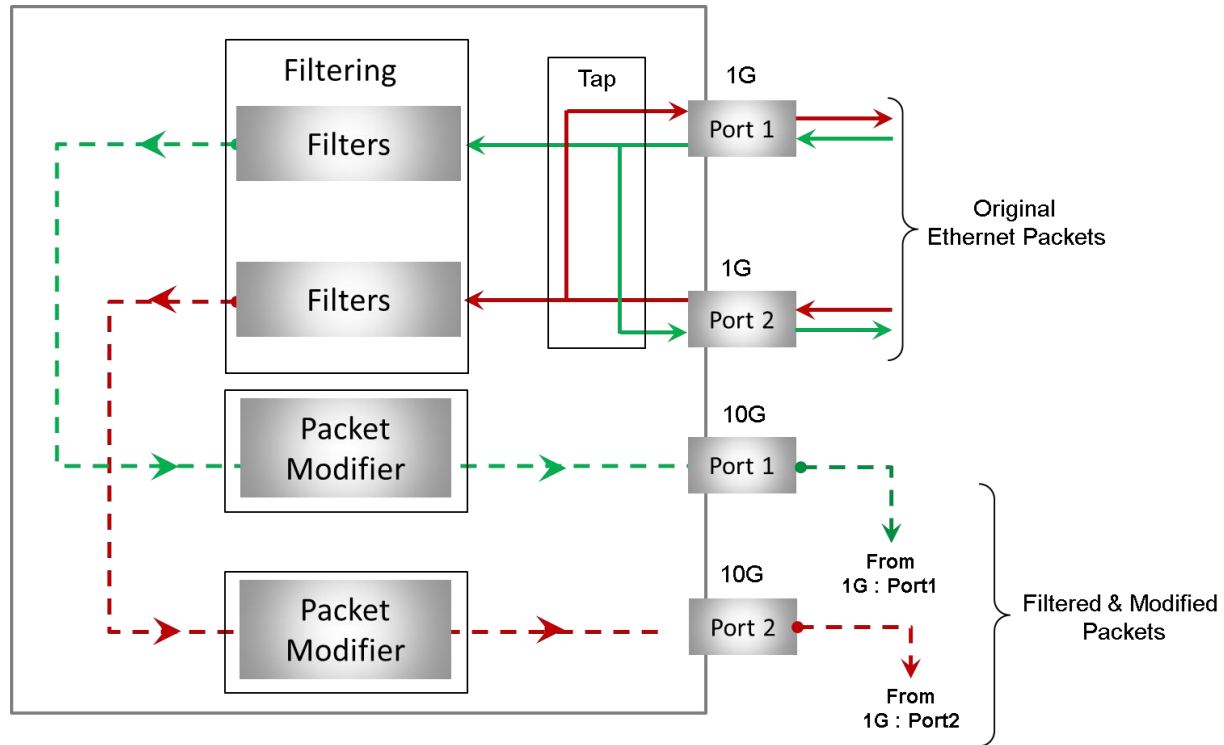


- The network traffic containing n streams of varying data rate is filtered at the PacketExpert™ hardware as per the filter settings. The overall transmit rate is limited to the USB 2.0 transfer rate
- Transmit rate can go up to 350 Mbps depending on the host PC configuration

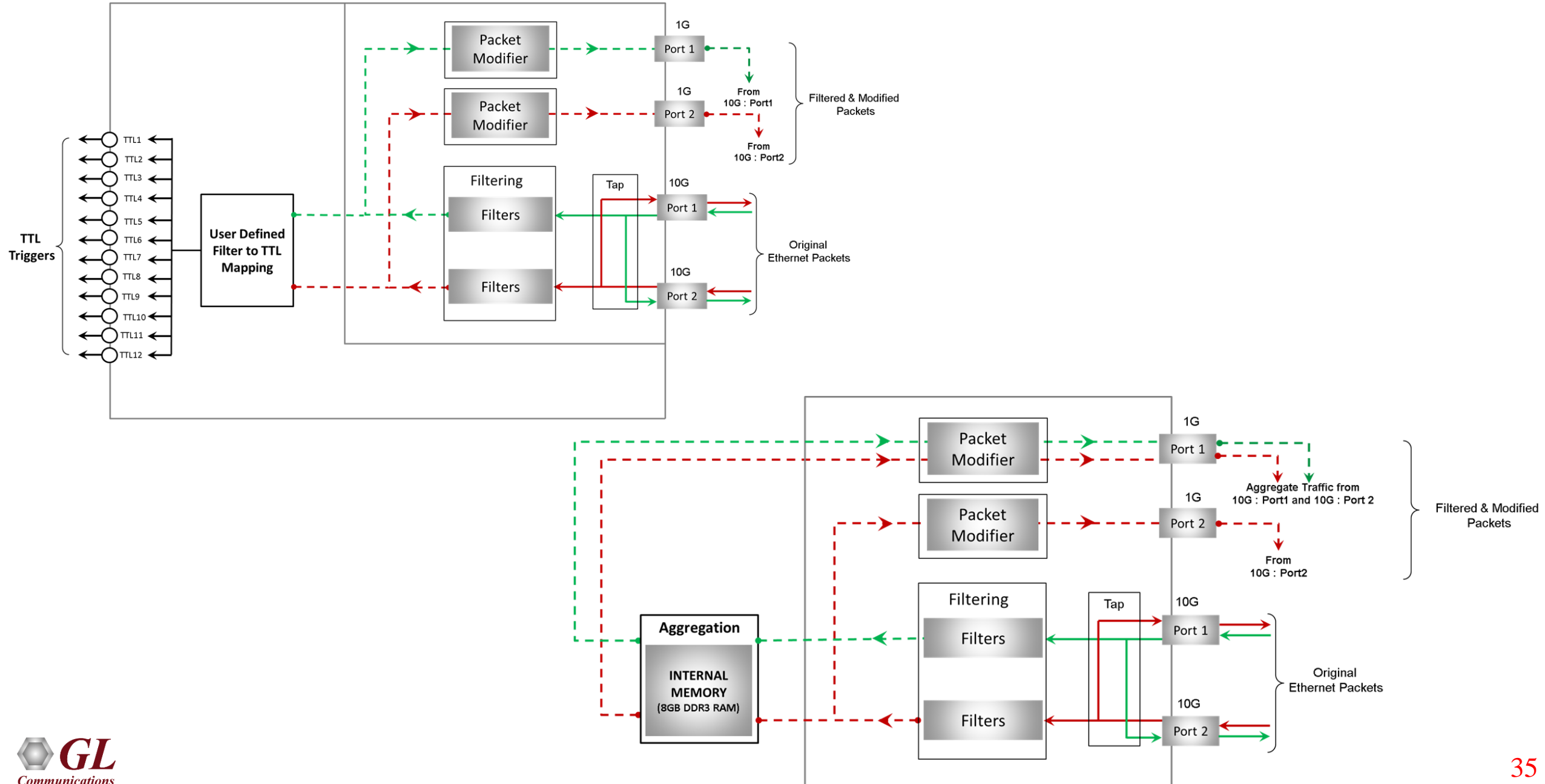
PacketBroker™ in Network



Packet Tap, Filter, Modification, and Output (1G and 10G)

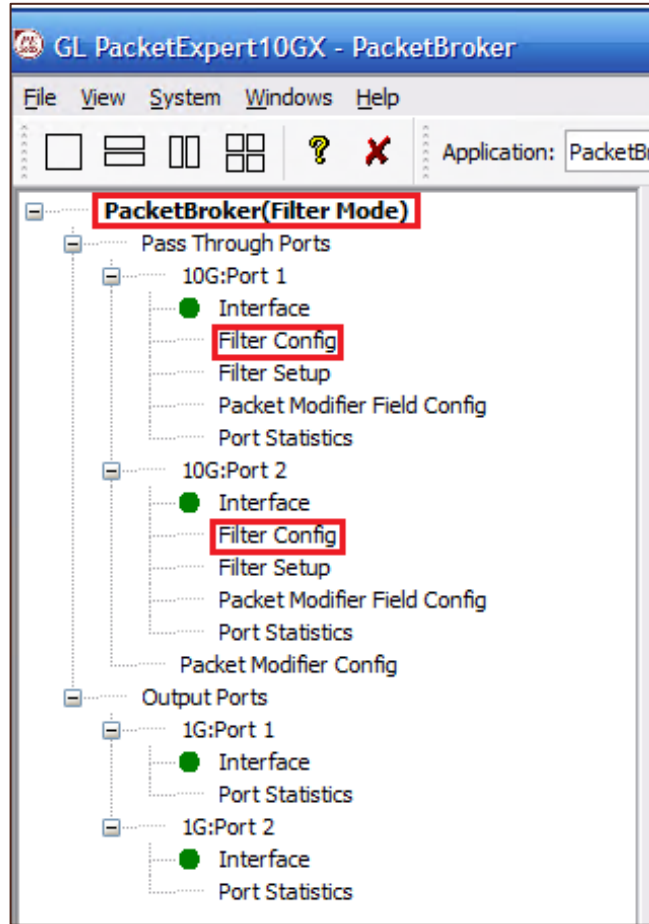


Filtering with TTL Generation and Aggregation

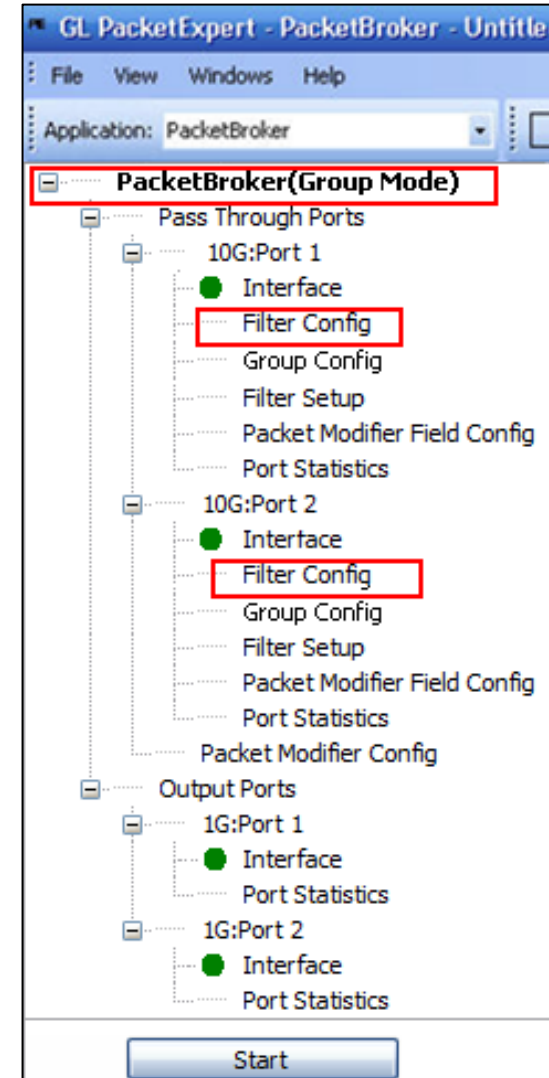


Filter Configuration Menu

Basic Mode Filtering



Group Mode Filtering



Filter Configuration

Packet Mode Filtering

The screenshot displays the 'Filter Config' window for 'Port 1'. On the left, a list of 16 filters is shown, with a red bracket and the text '16 Filters' below it. The main configuration area is divided into several sections:

- Filter Selection:** A tree view under 'Layers' showing selected protocols: MAC, VLAN Layer, MPLS Layer, IP, UDP, TCP, TCP Source Port, and TCP Destination Port. A red arrow labeled 'Packet Layers' points to this section.
- Filters:** A section with a checked box for 'Enable TCP Destination Port'. Underneath, 'TCP Destination Port' is set to 'Fixed' with a value of '2123'. A red arrow labeled 'Header fields' points to this section.
- Packet Layer Summary:** A table at the bottom summarizing the filter's configuration across various layers. A red arrow labeled 'Packet Layer Summary' points to this table.

Layer	Layer Summary
MAC	22-22-22-22-22-22 --> 33-33-33-33-33-33
VLAN	12 - 22 --> 1 - 7
MPLS	1 - 1048575
IPv4	0(TOS) --> X --> (==)192.168.1.28 --> (!=)192.168.1.44
UDP	4000 - 5000 --> 5500 - 6000
TCP	2000 - 3200 --> (==)2123

Filter Configuration

Raw Mode Filtering

Port Selection: Port 1

NOT

Filter Selection

- Layers
 - MAC
 - VLAN Layer
 - MPLS Layer
 - IP
 - UDP
 - TCP
 - Framesize
 - RAW Mode
 - RAW Mode

Enable RAW Mode

RAW Mode Offset: 0

Offset (0-15999)

Bytes	Value	Mask
0-7	22 22 22 22 22 22 00 00	FF FF FF FF FF FF 00 00
8-15	33 33 33 08 00 00 00 00	FF FF FF FF 00 00 00 00
16-23	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
24-31	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
32-39	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
40-47	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
48-55	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
56-63	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
64-71	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
72-79	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
80-87	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
88-95	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
96-103	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
104-111	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
112-119	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00

120 Bytes Raw Data/Mask Bytes

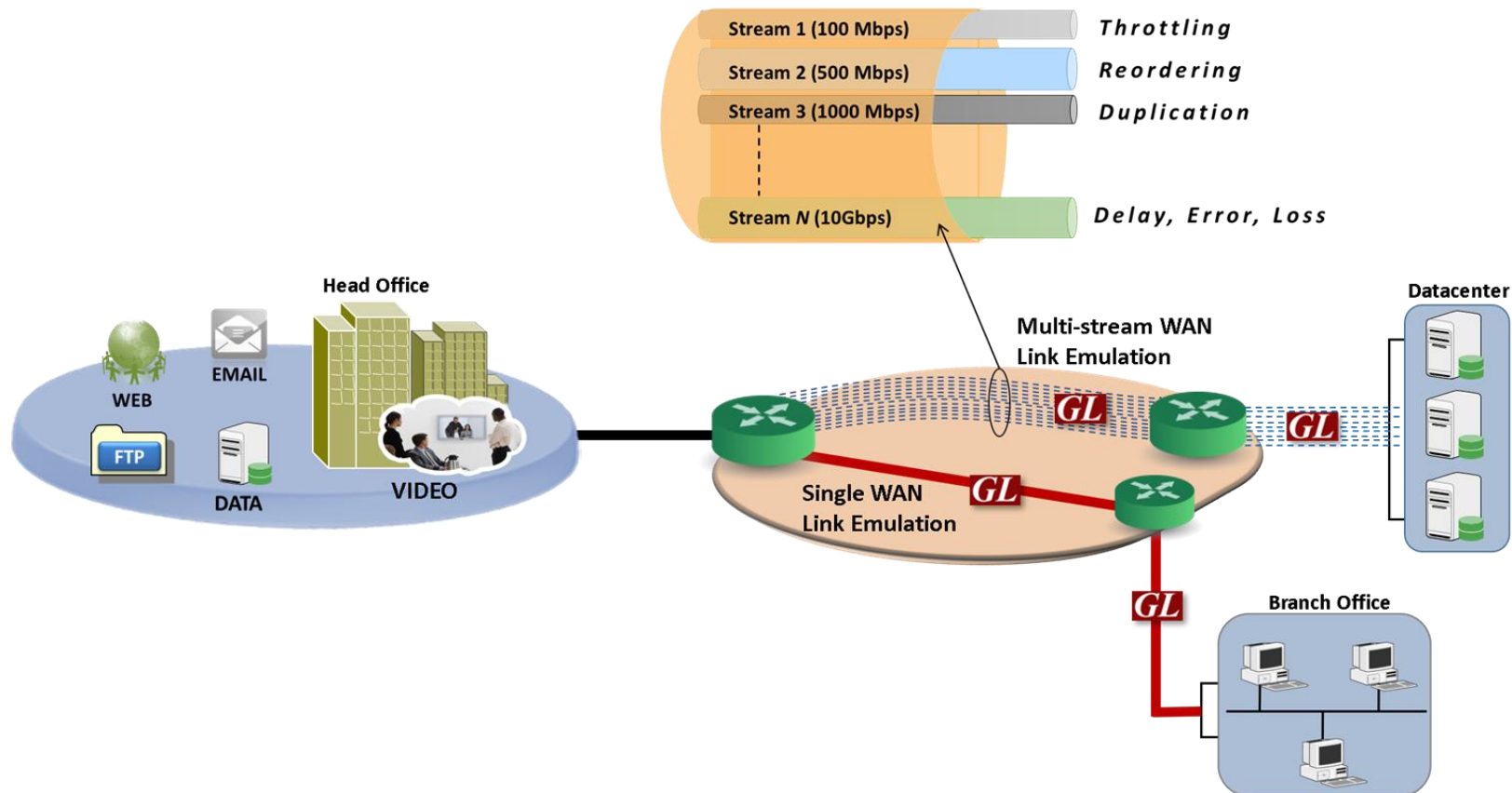
Layer	Layer Summary
MAC	00-00-00-00-00-00 --> 00-00-00-00-00-00
VLAN	(==)0 --> (==)X
MPLS	(==)0
IPv4	X(TOS)--> X --> (==)X.X.X.X --> (==)0.0.0.0
UDP	(==)X --> (==)0

16 Filters

Overview

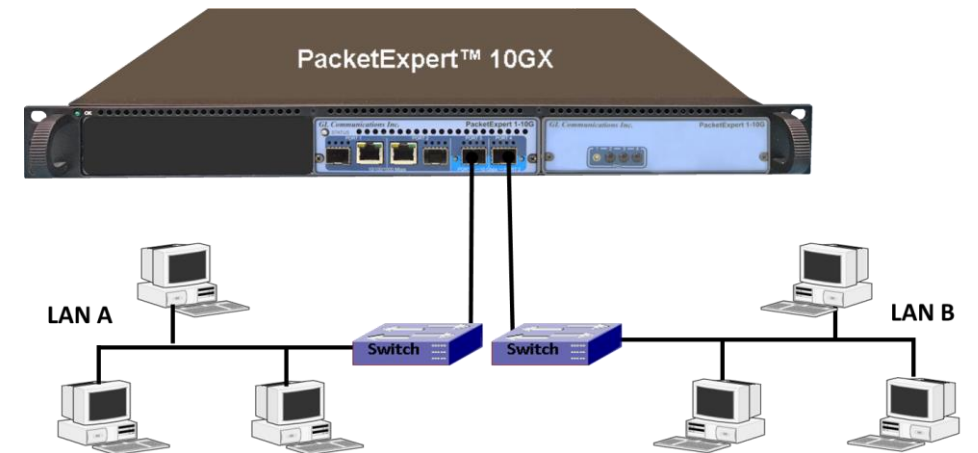
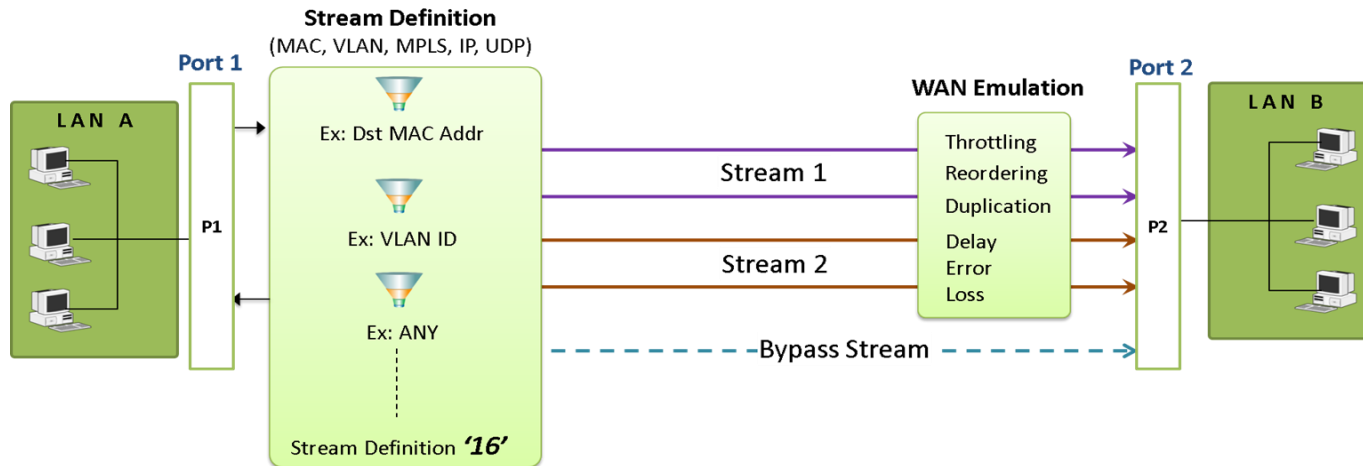
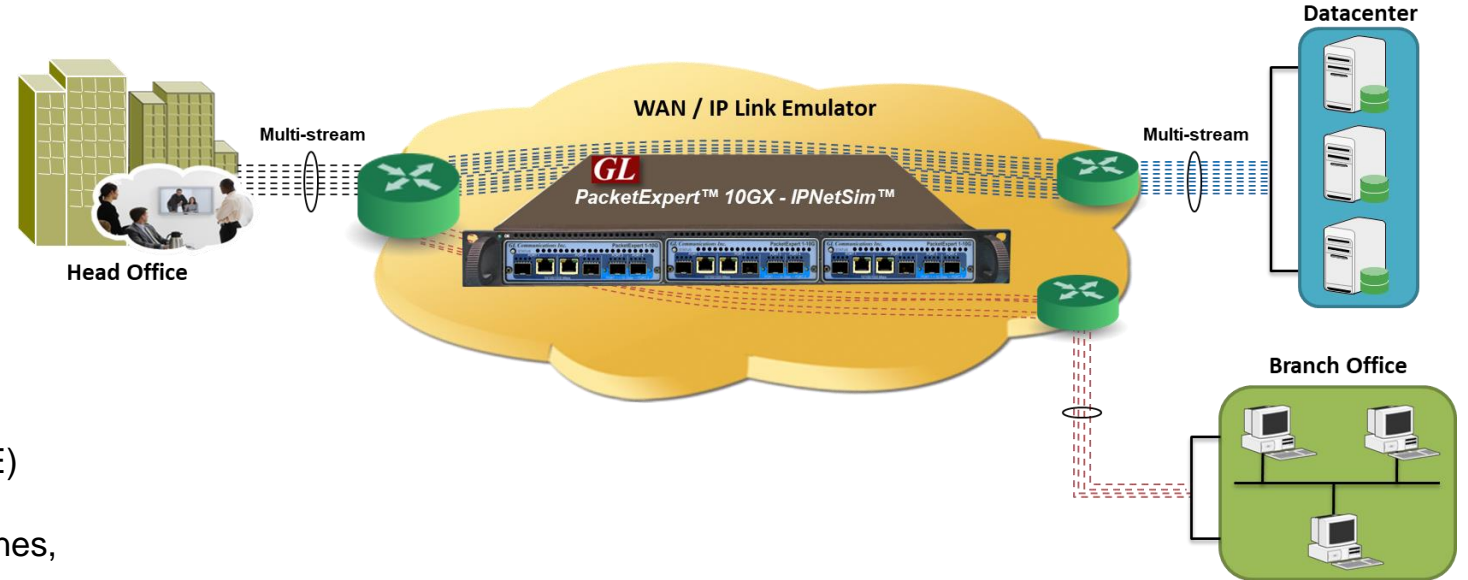
How does GL simulate real-world IP Networks? What is GL's IPNetSim™?

- 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 and Stream 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)



Define Streams in Packet Mode and Raw Mode

Stream Definition | WAN Emulation Parameters | Scheduler

P1 -> P2

Mode
 Packet Mode Raw Mode

MAC VLAN MPLS IP UDP

Layer (Click to edit)	Layer Summary
MAC	00-1F-D0-DC-20-A2 --> XX-XX-XX-XX-XX-XX
VLAN	100 - 200
MPLS	1234
IP	192.168.1.201 - 192.168.1.210 --> 192.168.1.101
UDP	20000 --> 30000

Source IP Address
 Fixed Range Any
 From To

Destination IP Address
 Fixed Range Any
 IP Address

Apply

Mode
 Raw Mode Packet Mode Offset

Bytes

Bytes	Value	Mask
Byte 0-7	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
Byte 8-15	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
Byte 16-23	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
Byte 24-31	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
Byte 32-39	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
Byte 40-47	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
Byte 48-55	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
Byte 56-63	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
Byte 64-71	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
Byte 72-79	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
Byte 80-87	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
Byte 88-95	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
Byte 96-103	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
Byte 104-111	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
Byte 112-119	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00

Apply

Impairments and Configurations

Stream Definition | WAN Emulation Parameters | Scheduler

WAN Stream Type Symmetrical Asymmetrical

Parameters	P1 -> P2	P2 -> P1
Traffic Bandwidth	100.00 Mbps	800.00 Mbps
Latency	Uniform, 0 - 8000 ms	
Packet Loss	None	
Packet Reordering	None	
Packet Duplication	None	
Logic Error Insertion	None	

P1 -> P2 Traffic Bandwidth: Mbps

P1 -> P2 Traffic Bandwidth: Mbps

Stream Definition | WAN Emulation Parameters | Scheduler

WAN Stream Type Symmetrical Asymmetrical

Parameters	P1 -> P2	P2 -> P1
Traffic Bandwidth	100.00 Mbps	800.00 Mbps
Latency	Random Exp. , 0 - 8000 ms	Random Exp. , 0 - 8000 ms
Packet Loss	None	None
Packet Reordering	None	None
Packet Duplication	None	None
Logic Error Insertion	None	None

P1 -> P2 Latency: Single Delay Min msec
 Uniform Distribution Max msec
 Random Exponential Distribution

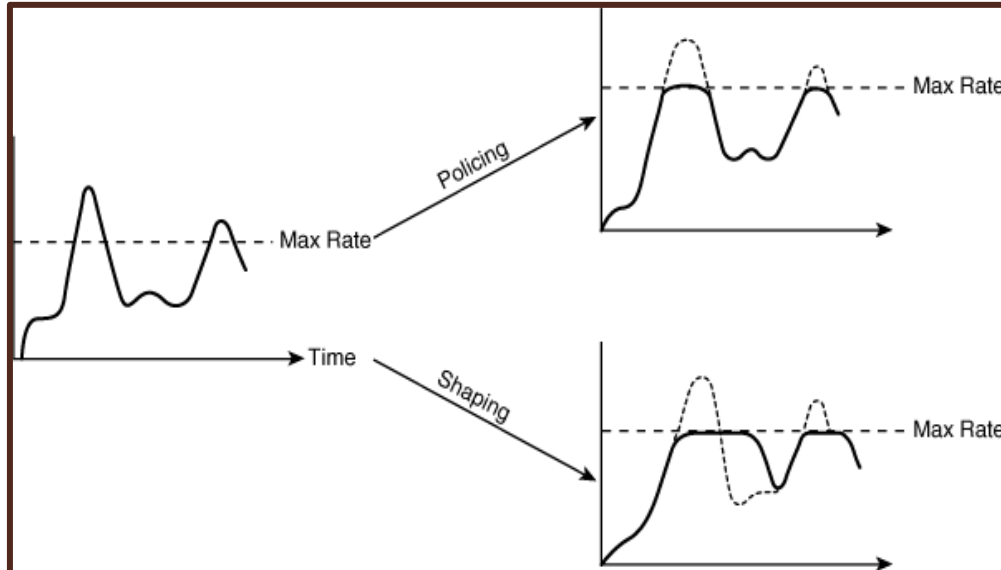
Stream Definition | WAN Emulation Parameters | Scheduler

WAN Stream Type Symmetrical Asymmetrical

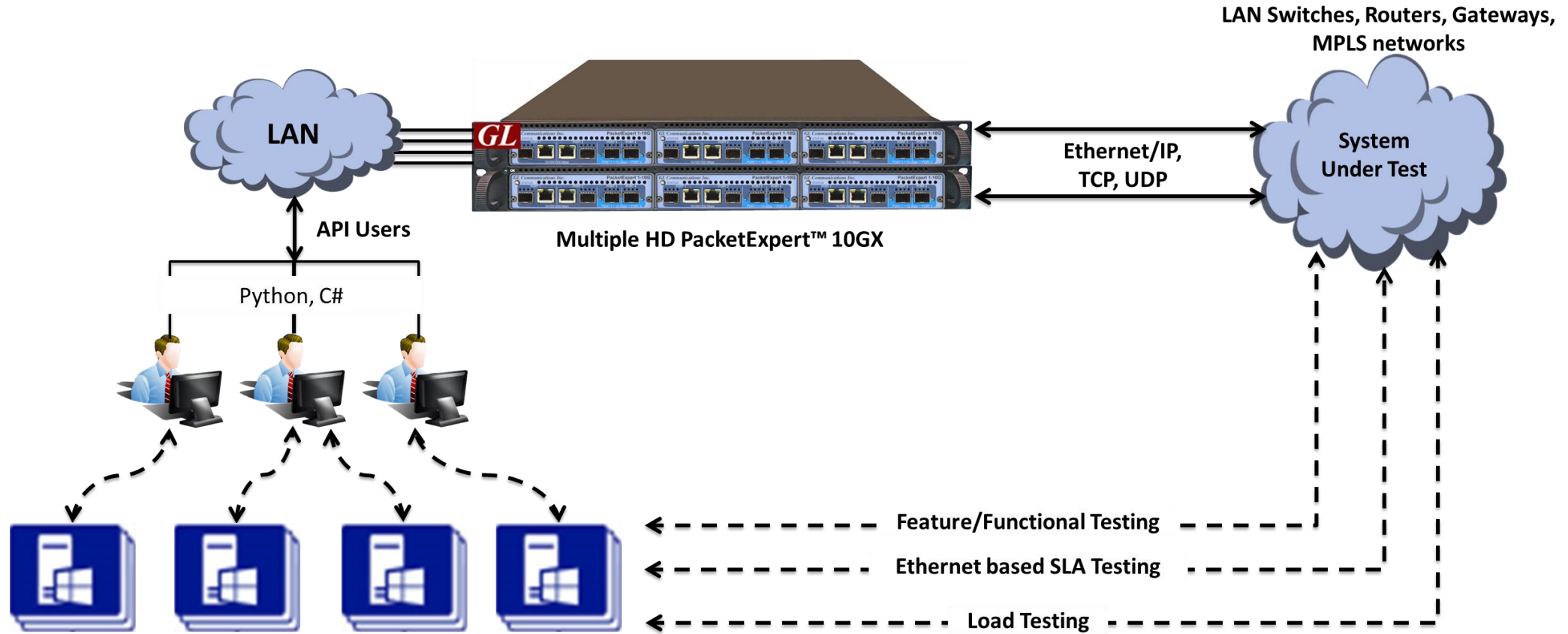
Parameters	P1 -> P2	P2 -> P1
Traffic Bandwidth	1000.00 Mbps	100.00 Mbps
Latency	Single Delay, 100 ms	None
Packet Loss	10.000 %	20.000 %
Packet Reordering	1 out of 10 packets	1 out of 20 packets
Packet Duplication	None	None
Logic Error Insertion	None	None

P1 -> P2 Packet Reordering(Single Packet)
 Reorder 1 packet out of packets
 Delay Offset (Time) Min ms Max ms

P2 -> P1 Packet Reordering(Single Packet)
 Reorder 1 packet out of packets
 Delay Offset (Time) Min ms Max ms



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

Thank you!

For more information contact us at info@gl.com

(Please subscribe to our newsletter: <https://www.gl.com/subscribe.php>)