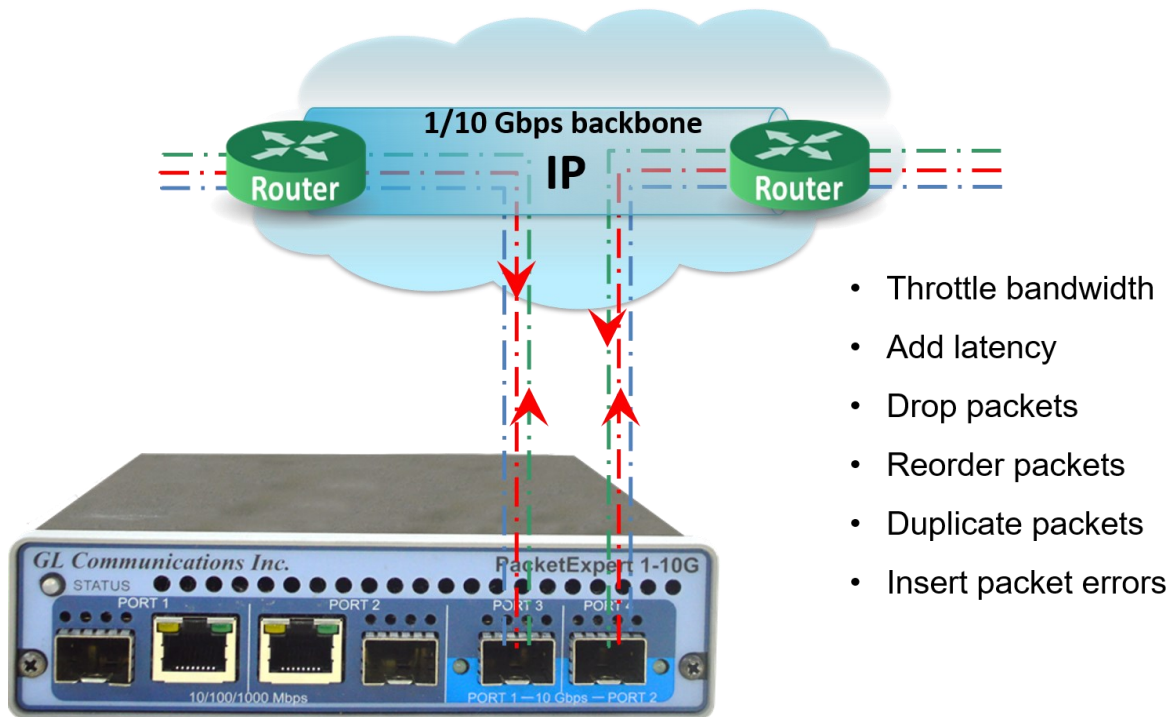


# IP WAN Emulator

PacketExpert™ 10GX (10G/1G)



## Overview

GL's [IPNetSim™](#) and [IPLinkSim™](#) are optional applications available with in [PacketExpert™ 10GX](#) platform with additional IPN507 licenses.

Each hardware unit includes two 10/1 Gbps Optical/Electrical ports, and two 10/100/1000 Mbps Electrical/Optical capable ports. The 10/1 Gbps ports can be down-shifted to support 1 Gbps Electrical ports, thus offering 4 Electrical / 4 Optical 1 Gbps ports for ethernet testing. The same two 10 Gbps ports can now be converted to 2.5 Gbps ports with appropriate SFP.

IPNetSim™ application is supported on 1G, 2.5G, and 10G ports on PacketExpert™ 10GX unit:

- Requires PXN100 + IPN507 licenses for 1 GigE
- Requires PXN101 + IPN507 licenses for 2.5/10 GigE

The emulator is connected to the two end points of a WAN link. It can be configured to act either as a transparent bidirectional Ethernet link or a simple Ethernet bridge between two end points. The links are emulated between Port 1 (P1) and Port 2 (P2). The application emulates an IP network of 10 Gbps full duplex link or a 10/100/1000 Mbps full duplex link.

In IPNetSim™, the incoming traffic can be classified into separate streams (up to 16 streams for 1 Gbps pipe and up to 4 streams for 10 Gbps pipe). These user defined streams can be modified to simulate network impairments like bandwidth control, delay, jitter, packet loss, packet duplication, dropped packets, packet corruption, error insertion, etc.

IPLinkSim™ option supports a single stream 10 Gbps or a 10/100/1000 Mbps full duplex WAN IP Link emulation, where all the incoming traffic is streamed as a single link which can be modified to simulate network conditions.

PacketExpert™ 10GX is also available in [mTOP™ rack mount](#) platforms. The PacketExpert™ mTOP™ enclosure unit can be easily deployed and securely fixed to an equipment rack to provide extraordinary scalability to test switches, routers and end-to-end networks.

For more information, please visit [IP WAN Emulator](#) webpage.



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## Main Features

### Network Interfaces

- Supported on 1G, 2.5G, 10G Electrical/Optical ports with appropriate SFP
- IPNetSim™ and IPLinkSim™ applications are supported on both Portable and Rack-mount mTOP™ PacketExpert™ 10GX units

### WAN Emulation

- IPNetSim™ operates in multi-stream mode. Emulates unique bi-directional multi-streams (up to 16 streams on 1G ports and 4 streams on 10G ports)
- IPLinkSim™ operates in a single stream mode and emulates only 1 bidirectional WAN Link per unit
- Various WAN parameters can be configured on each bidirectional streams separately and independently
- Acts as a transparent bi-directional link or a simple Ethernet Bridge for easy integration with any test setup
- Check the stability or performance of the network with various real world impairments such as Bandwidth throttling, Latency, Packet-Loss, Error Insertion, Reordering, and Duplication
- Supports both periodic and random impairments such as packet loss, packet reordering, packet duplication, and error insertion
- Burst Loss for Packet Loss to emulate real-world impairment conditions
- Manual Packet Drop, Reorder, Duplication and Error Insertion impairments at run-time
- Bandwidth control features to mimic slower WAN links like RS232/DSL/Modem/T1/E1/T3/E3 etc.
- Introduce bi-directional delay in milliseconds increments
- Scheduler to automate the stream impairment using pre-defined csv file

### Stream Definition in feature in IPNetSim™

- Traffic on each port can be classified into separate user defined streams (16 streams on 1G ports and 4 streams on 10G ports)
- **Packet** and **Raw** modes of stream configurations
- Streams can be defined based on various fields like Source/Destination MAC Address, VLAN Id, MPLS Label, Source/Destination IPv4 Address, Source/Destination UDP ports
- Stream definition feature flexibility to define mask at bit level, so that each bit can either be compared or ignored
- Up to 120 bytes wide stream definitions that covers almost entire packet header up to UDP
- User defined offset configuration to compare and identify the stream from anywhere within the frame (starting from MAC Destination Address field till the end of Payload)

### Statistics

- Easily monitor the bandwidth performance using live throughput graphs for each stream
- Provides real-time statistics for unique multi-streams (16 bidirectional unique streams on 1G ports and 4 streams on 10G ports)
- Provides port level statistics like Total Frames/Bytes Received, Rx Frame Rate, Rx Data Rate, etc.

## Software Specification

Multi-streams WAN Emulation - IPNetSim™	Single-stream WAN Emulation - IPLinkSim™
<b>Stream Definition</b> <ul style="list-style-type: none"> <li>• Hardware wire-speed filters (up to 16 links)</li> <li>• Packet Mode (field headers)</li> <li>• Raw Mode (bit level)</li> </ul> <b>Parameters</b> <ul style="list-style-type: none"> <li>• IP Source and Destination Address Range, UDP Source and Destination Port Range, MAC Addresses, VLAN ID and MPLS Label</li> </ul>	NA
<b>WAN Emulation Parameters</b> <ul style="list-style-type: none"> <li>• Bandwidth control – 1 Kbps up to 10 Gbps</li> <li>• Latency/Delay <ul style="list-style-type: none"> <li>– 100 microseconds up to 5000 milliseconds per stream (for 1Gbps link) and 100 microseconds up to 1250 milliseconds per stream (for 10/2.5 Gbps link)</li> <li>– single delay, uniform, random distributions</li> </ul> </li> <li>• Packet Loss Rate - 0 – 50%</li> <li>• Packet Reordering Rate -0-50% with Delay range &lt;=2 seconds</li> <li>• Packet Duplication Rate - 0 - 50%</li> <li>• Logic Error Insertion Rate - <math>10^{-1}</math> to <math>10^{-9}</math></li> <li>• Maximum Frame Size Supported – 2048 bytes</li> </ul>	<b>WAN Emulation Parameters</b> <ul style="list-style-type: none"> <li>• Bandwidth control - 10 Kbps up to 1000 Mbps</li> <li>• Latency/Delay <ul style="list-style-type: none"> <li>– 100 microseconds to 4000 milliseconds (for 1Gbps link)</li> <li>– 100 microseconds to 2000 milliseconds (for 10/2.5Gbps link)</li> <li>– single delay, uniform, random distributions</li> </ul> </li> <li>• Congestion Emulation with Background traffic (% of total bandwidth) <ul style="list-style-type: none"> <li>– Link Utilization Rate -0 – 50%, Burst Size - 64 – 1,000,000 bytes</li> </ul> </li> <li>• Packet Loss Rate - 0–50%, Packet Reordering Rate - 0-50% with Delay range &lt;= 8 seconds</li> <li>• Packet Duplication Rate - 0 - 50%,</li> <li>• Logic Error Insertion Rate - <math>10^{-1}</math> to <math>10^{-9}</math></li> </ul>

## Working Principle

PacketExpert™ is connected to the two end points of a WAN link. It can be configured to act either as a transparent bidirectional Ethernet link or a simple Ethernet bridge between two end points. The links are emulated between Port 1 (P1) and Port 2 (P2). The bandwidth can be controlled to simulate various WAN link speeds (RS232/DSL/Modem/T1/E1/T3/E3 etc.).

P1 -> P2 is one link and in the reverse direction, i.e., P2 -> P1 forms the other link. By default, P1 and P2 work in pass-through mode, and pass all frames across to the other port. Frames arriving at P1 are carried over to P2 and frames arriving at P2 are carried over to P1.

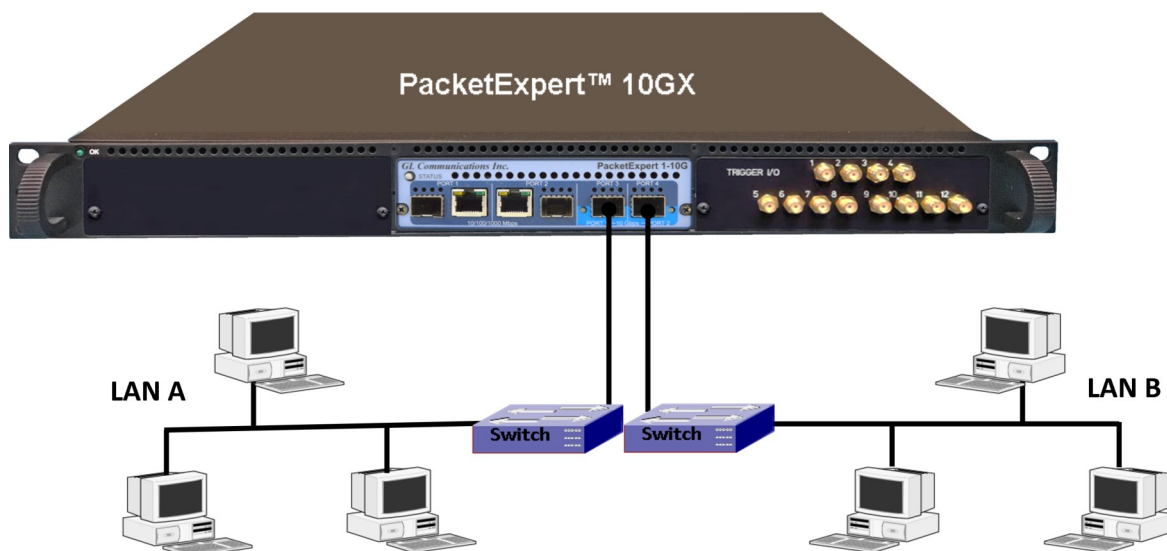
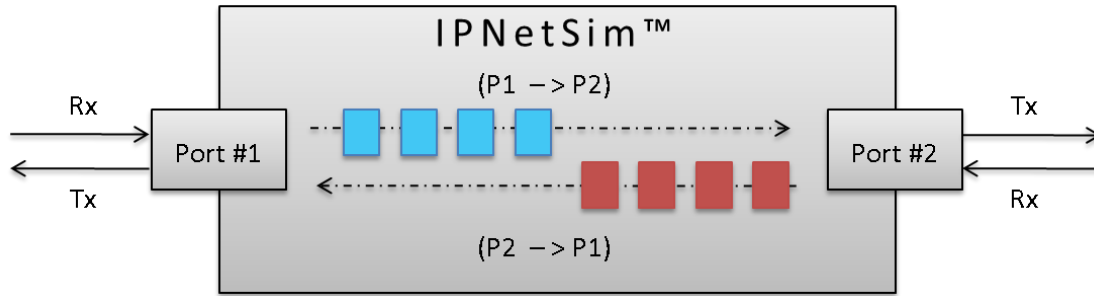


Figure: IP WAN Emulator connecting LAN 1 and LAN 2

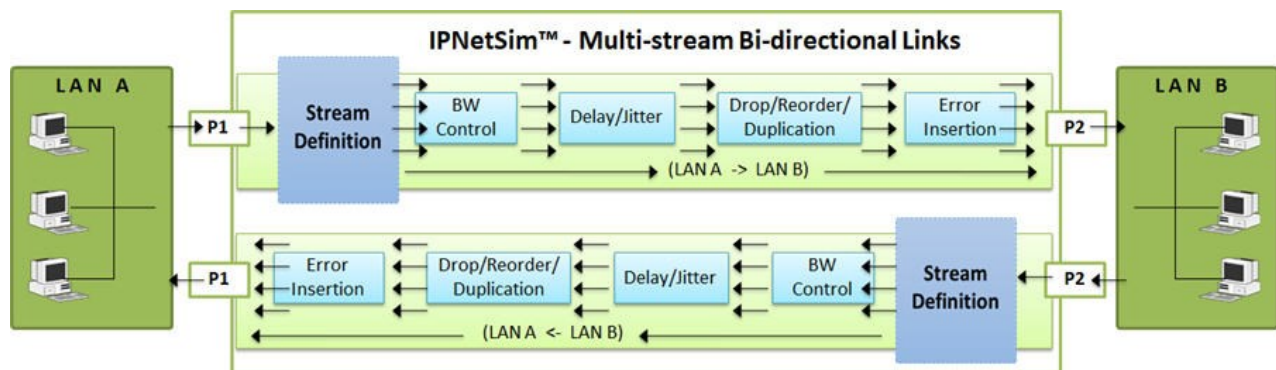


**Figure: Bidirectional Link (P1-P2)/(P2-P1)**

In multi-stream mode (IPNetSim™), user can define multiple streams in each direction (based on various header fields) to classify traffic into multiple streams. For each stream, a different set of WAN Emulation parameters can be applied, a single IPNetSim™ can emulate different WAN scenarios like Head Office to Data Center, Head Office to Branch Office etc.

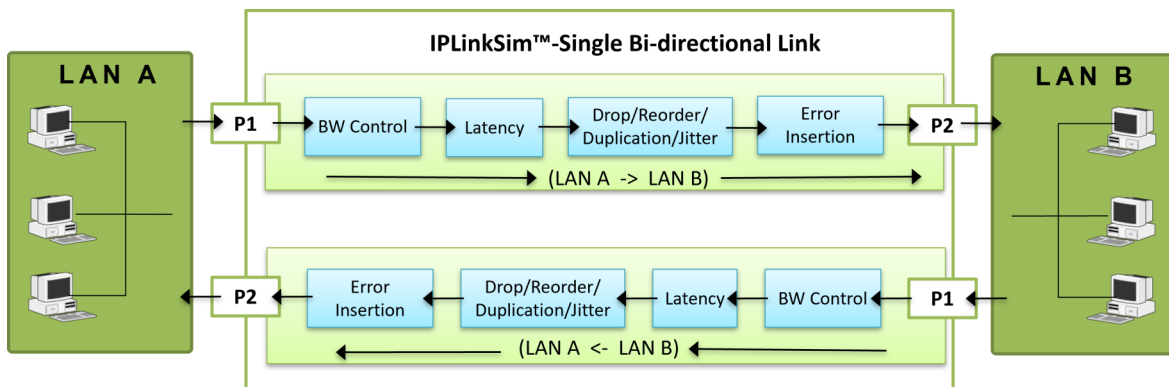
WAN Emulation includes various real-world impairments such as Bandwidth, Delay/Jitter, Packet-Loss, Error Insertion, Reordering, and Duplication, to check the performance of end equipment to real world impairments. These settings can be applied for the selected 16 unique streams on 1 Gbps link and 4 unique streams on 10 Gbps link independently in each direction.

Traffic (bidirectional streams) can be processed at wirespeed (1 Gbps or 10 Gbps). Bidirectional streams can be configured as a symmetrical (identical WAN impairments in both directions) or asymmetrical (different WAN impairments in each direction). WAN impairments can be configured independently for each stream. When WAN Emulation is started by the user, the impairments are introduced into the traffic as shown below.



**Figure: Impairing Multi-streams over P1→P2 and P2→P1 Link**

In single stream mode (IPLinkSim™), all the incoming traffic is streamed as a single link, which can be impaired with various link conditions such as Bandwidth Control, Delay/Jitter, Packet Loss, Packet Reordering, Packet Duplication, Error Insertion emulating real-world scenarios.



**Figure: Impairing Single stream over P1→P2 and P2→P1 Link**

## WAN Impairments

PacketExpert™ is connected to the two end points of a WAN link. It can be configured to act either as a transparent bidirectional Ethernet link or a simple Ethernet bridge between two end points. The links are emulated between Port 1 (P1) and Port 2 (P2). The bandwidth can be controlled to simulate various WAN link speeds (RS232/DSL/Modem/T1/E1/T3/E3 etc.).

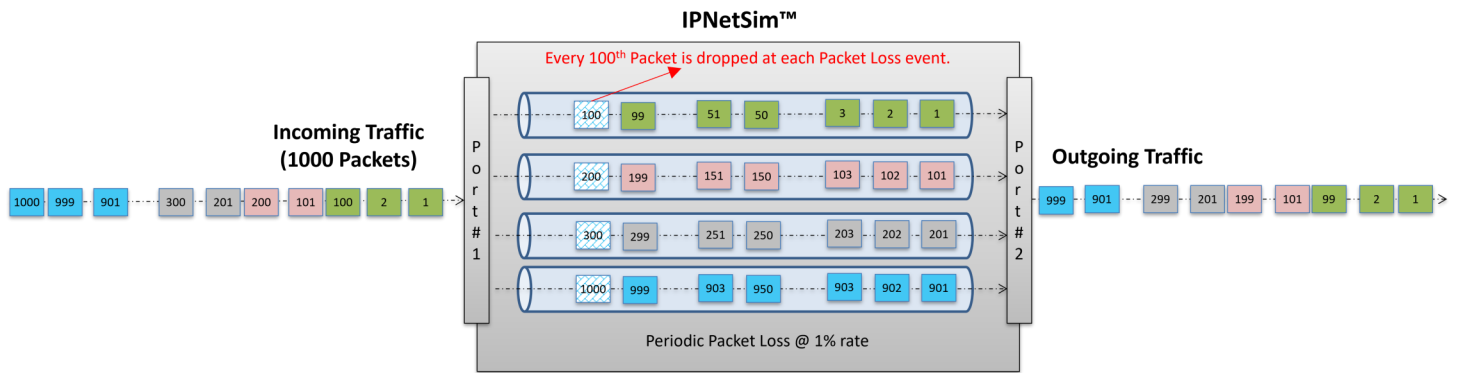
P1 -> P2 is one link and in the reverse direction, i.e., P2 -> P1 forms the other link. By default, P1 and P2 work in pass-through mode, and pass all frames across to the other port. Frames arriving at P1 are carried over to P2 and frames arriving at P2 are carried over to P1.

WAN link emulator is capable of emulating a WAN link, and introducing typical WAN impairments like Bandwidth Throttling, Latency, Jitter, Packet Loss, Packet Reordering, Packet Duplication, Packet Corruption, Logic and FCS Error Insertion.

IPLinkSim™ supports single stream only and applies the impairments to the traffic. In addition to the impairments as in multi-stream (IPNetSim™) application, IPLinkSim™ also supports congestion emulation by generating background traffic.

Bandwidth control	<ul style="list-style-type: none"> <li>1G - varying rates from 1 Kbps to 1000 Mbps</li> <li>10G - varying rates from 1 Kbps to 10 Gbps</li> </ul>
Latency/Delay	<ul style="list-style-type: none"> <li>100 microseconds to 5000 milliseconds per stream for 1 Gbps</li> <li>100 microseconds to 1250 milliseconds per stream for 10/2.5 Gbps</li> <li>Constant, uniform, normal distributions</li> </ul>
Packet Loss	<ul style="list-style-type: none"> <li>Fixed loss rate % of total packets 0–50%</li> </ul>
Packet Reordering	<ul style="list-style-type: none"> <li>Manual Packet Reordering - Manual packet reorder maintaining the specified delay offset</li> <li>Reordering rate (0-50%) with Min and Max (up to 2 secs) time Delay offset and Min and Max packet offset</li> </ul>
Packet Duplication	<ul style="list-style-type: none"> <li>Rate Packet Duplication - Periodic or Random packet duplication at specified rate</li> <li>Percentage of total packets duplicated (0 - 50%)</li> </ul>
Error Insertion	<ul style="list-style-type: none"> <li>Periodic error insertion at specified rate (<math>10^{-1}</math> to <math>10^{-9}</math> error rate) within Ethernet packet</li> </ul>

Figure: WAN Emulation Configurations in IPNetSim™



**Figure: Periodic Packet Loss in IPNetSim**

User can impair the stream at regular intervals of time by configuring the Loss rate, where the packet drops will be regular and predictable.

**Link Configuration**

WAN Stream Type ☐ Symmetrical ☒ Asymmetrical Status

Parameters	P1 -> P2	P1 -> P2 Manual	P2 -> P1	P2 -> P1 Manual
Traffic Bandwidth	10000.00 Mbps		10000.00 Mbps	
Background Traffic Ba...	50.00 %, 100 bytes		75.00 %, 100 bytes	
Latency	Single Delay, 100.000 msec		Uniform, 0.000 msec - 2000.0...	
Packet Loss	10.000 %	<input type="button" value="Drop"/>	20.000 %	<input type="button" value="Drop"/>
Packet Reordering	1 out of 5 packets	<input type="button" value="Reorder"/>	1 out of 10 packets	<input type="button" value="Reorder"/>
Packet Duplication	10.000 %	<input type="button" value="Duplicate"/>	5.000 %	<input type="button" value="Duplicate"/>
Logic Error Insertion	10 <sup>-2</sup>	<input type="button" value="Insert"/>	10 <sup>-3</sup>	<input type="button" value="Insert"/>
FCS Error Insertion	None		None	

**P1 -> P2**

Logic Error Insertion

Rate ☒ Periodic ☐ Random

Packet Error Rate  ▼

Bytes Offset  Beginning of frame

Bytes Offset  End of frame

**P2 -> P1**

Logic Error Insertion

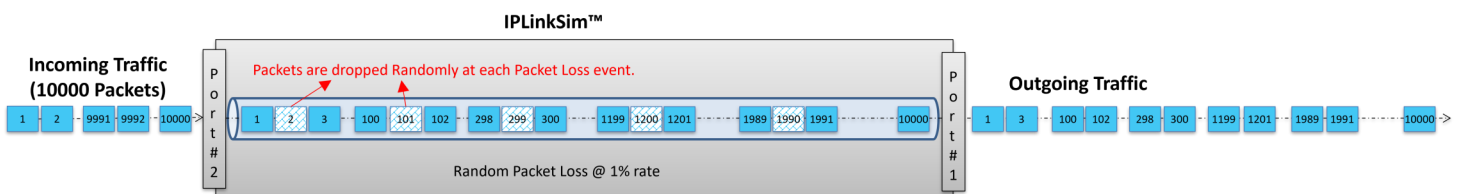
Rate ☒ Periodic ☐ Random

Packet Error Rate  ▼

Bytes Offset  Beginning of frame

Bytes Offset  End of frame

**Figure: WAN Emulation Configurations in IPLinkSim™**



**Figure: Random Packet Loss in IPLinkSim**

User can also configure the stream impairment for random packet loss, where the packet will be dropped randomly. For both periodic as well as random packet loss, the overall packet loss rate is maintained.



## Stream Definition

IPNetSim™ application includes a powerful “Stream Definition” feature that allows user to configure MAC, IP, VLAN, MPLS, UDP header fields to classify the traffic into multiple streams.

- Traffic on each port (Port1 and Port2) are classified into separate stream as per the user stream definition
- For each stream, fields can be defined within a 120 byte window, anywhere within the frame, and can be set separately for each direction (P1 → P2 and P2 → P1)
- Streams can be defined based on various fields like Source/Destination MAC Address, VLAN Id, MPLS Label, Source/Destination IPv4/IPv6 Address, Source/Destination UDP ports etc.
- Raw mode stream definition allows user to define a corresponding 120 byte Hex mask, setting each bit to ‘Compare’ or ‘don’t care’ conditions.
- For each stream definition, offset can be set to any byte within the packet (from 0 to 2047) which gives flexibility to define any fields within any protocol headers, and even the payload.

Stream Config

Stream Definition | WAN Emulation Parameters | Scheduler

Filter Mode: ☒ Packet Mode ☐ Raw Mode

MAC ☐ VLAN ☒ MPLS ☒ IP ☐ UDP

Layer (Click to edit)	Layer Summary
VLAN	VLAN Id = 100 - 200 , VLAN Stack = 1
MPLS	MPLS Label = 1000 - 1100 , MPLS Stack = 1
IP	192.168.1.28 -> 192.168.1.100 - 192.168.1.200

Source IP Address: ☒ Fixed ☐ Range ☐ Any  
IP Address: 192.168.1.28

Destination IP Address: ☐ Fixed ☒ Range ☐ Any  
From: 192.168.1.100 To: 192.168.1.200

Apply

Figure: Stream Configuration in Packet Mode

Stream Config

Stream Definition | WAN Emulation Parameters | Scheduler

Filter Mode: ☐ Packet Mode ☒ Raw Mode Offset: 0

Bytes: 0 1 2 3 4 5 6 7

Value: 00 00 00 00 01 02 00 00

Mask: FF FF FF FF FF FF FF FF

Apply

Bytes	Value	Mask
0-7	00 00 00 00 01 02 00 00	FF FF FF FF FF FF FF FF
8-15	00 00 01 03 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

Figure: Stream Configuration in Raw Mode

## Per Stream and Per Port Statistics

Real-time traffic statistics per stream are displayed. The statistics includes Tx Rx Frames, Dropped Packets (due to Bandwidth Control), No. of Packets with Errors, Dropped Packets (due to Packet Loss), Packet Loss, Duplicated Packets, and Reordered Packets.

In addition to link statistics, detailed per port Tx Rx frame statistics is also provided.

Stream Statistics						
#	Stream Name	Statistic	Value P1->P2	Percent P1->P2	Value P2->P1	Percent P2->P1
1	Stream1	Tx Bytes	86 833 789 480	NA	77 444 882 692	NA
2	Stream2	10 Sec Average Throughput	9999.971	NA	8916.056	NA
3	Stream3	1 Min Average Throughput	9999.978	NA	8916.063	NA
4	Stream4	10 Min Average Throughput	0.000	NA	0.000	NA
		Rx Frames	42 395 938	NA	42 366 224	NA
		Tx Frames	42 397 628	NA	37 813 319	NA
		Dropped Packets (Bandwidth C...	0	0.000	0	0.000
		No Of Packets With Errors	42 358	0.100	3 781	0.009
		Dropped Packets (Packet Loss)	2 028 703	4.785	6 355 530	15.001
		Duplicated Packets	3 854 756	9.092	1 800 836	4.251
		Reordered Packets	0	0.000	0	0.000

Figure: Stream Statistics (4 streams on 10G ports)

Port Statistics		
Port Selection	Port 2	Reset
Description	Tx	Rx
Total Frames	644 980 425	644 980 425
Valid Frames	644 980 425	644 980 425
Bad Frames	0	0
Number Of Bytes	978 923 722 606	978 923 722 606
Link Utilisation(%)	0.000	0.000
Data Rate(Mbps)	0.000	0.000
Frame Rate(Frames/sec)	0	0
Non Test Frames	0	123
Broadcast Frames	62	62
Multicast Frames	644 980 363	61
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	61	61
65-127 Byte Length Frames	107 913	107 913
128-255 Byte Length Frames	0	0
256-511 Byte Length Frames	0	0
512-1023 Byte Length Frames	0	0
1024-1518 Byte Length Frames	644 872 451	644 872 451
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	-	644 980 302
IPv6 Packets	-	0
IP in IP Packets	-	0
UDP in IP Packets	-	0
TCP in IP Packets	-	644 980 302
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	-	0

Figure: Port Statistics



## Stream Throughput Graph

The real-time Throughput of each stream, plotted as rate against time and is displayed in the form of line graph. All the 16 streams on 1G ports and 4 streams on 10G ports throughput can be viewed together, or user can select or deselect each stream to view it separately. Graphing is supported from 5 seconds up to 12 Hours.

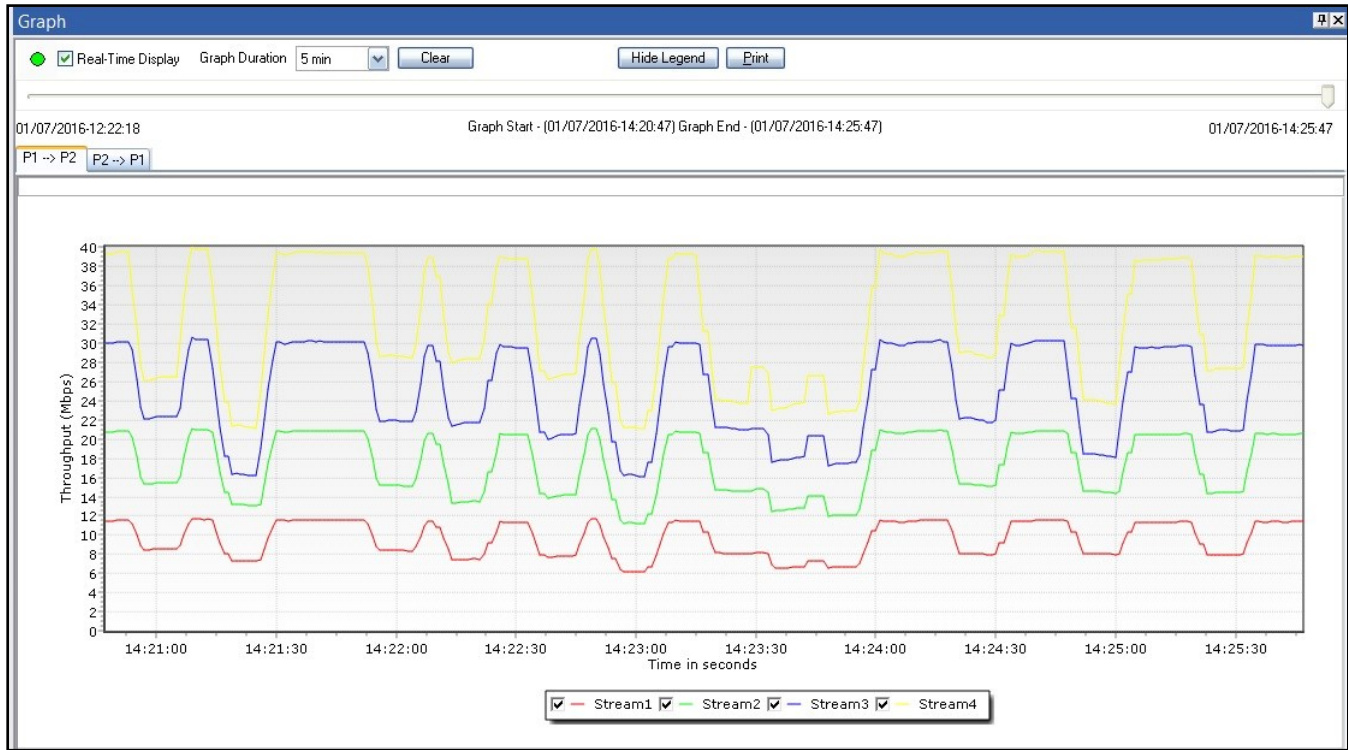


Figure: Stream Throughput Graph (10G)

## Link Statistics

This option provides real-time transmission statistics of the traffic over the emulated link (P1-P2)/(P2-P1) in each direction. The statistics parameters include Dropped Packets (Bandwidth Control), No. of Packets with Errors, Dropped Packets (Packet Loss), Duplicated Packets, Reordered Packets, and Background Traffic Bandwidth, for varying durations.

Link Statistics				
Statistics	Value P1->P2	Percent P1->P2	Value P2->P1	Percent P2->P1
TxBytes	320 048 205 480	NA	320 059 352 154	NA
10 Sec Average Throughput	989.830	NA	989.849	NA
1 Min Average Throughput	989.831	NA	989.847	NA
10 Min Average Throughput	989.831	NA	989.847	NA
RxFrames	210 834 686	NA	210 842 030	NA
TxFrames	210 835 062	NA	210 842 405	NA
Dropped Frames(Bandwidth Control)	0	0.000	0	0.000
Dropped Packets (Packet Loss)	0	0.000	0	0.000
Reordered Packets	0	0.000	0	0.000
Duplicated Packets	0	0.000	0	0.000
No of Packets With Errors	0	0.000	0	0.000
Inserted Bursts for BKG Traffic	0.00 bps	NA	0.00 bps	NA
No of Packets With FCS Errors	0	0.000	2	0.000

Figure: Link Statistics (10G)

## Impairment Scheduler

Stream impairment is scheduled using predefined csv file for both the link direction (P1->P2)/(P2->P1). Users can configure Time Duration (sec) for which the impairments - Bandwidth (Mbps), Packet Loss (%), Latency (msec) is applied on the stream. The applied impairments for each stream can be viewed graphically as well.

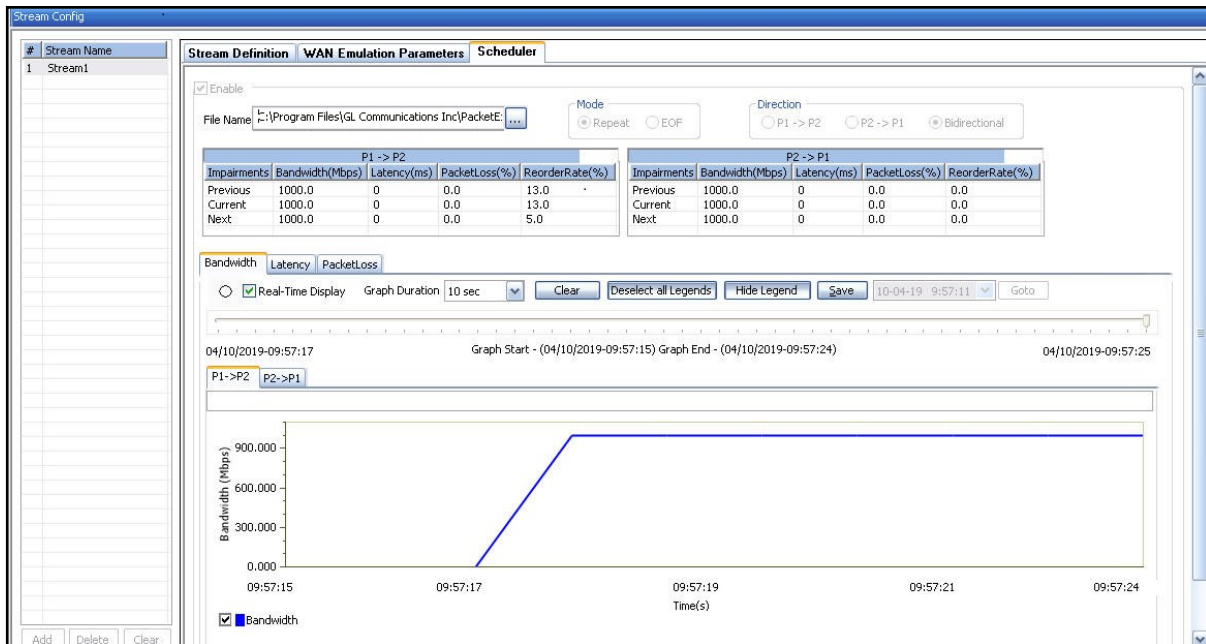


Figure: WAN Emulation with Scheduler

## Testing Satellite WAN Links

All wireless networks, including satellite networks, introduce impairments into traffic streams due to environmental conditions and interference. Impairments include bandwidth reduction, excessive latency, packet loss, jitter, and bit errors. Customers often need to test their applications under emulated impairment conditions to determine degradations in user experience. GL provides WAN Network Emulation within the PacketExpert™ platform.

GL's PacketExpert™ is a comprehensive Ethernet tester that can introduce precise impairments, such as bandwidth throttling, added latency, packet loss, packet corruption, packet duplication, and packet reordering. The impairments can be selectively applied to various traffic streams. Users can introduce impairments continuously, periodically, or manually at run time. Users can view real time graphs of throughput as well as up to the second statistics on the impaired traffic.

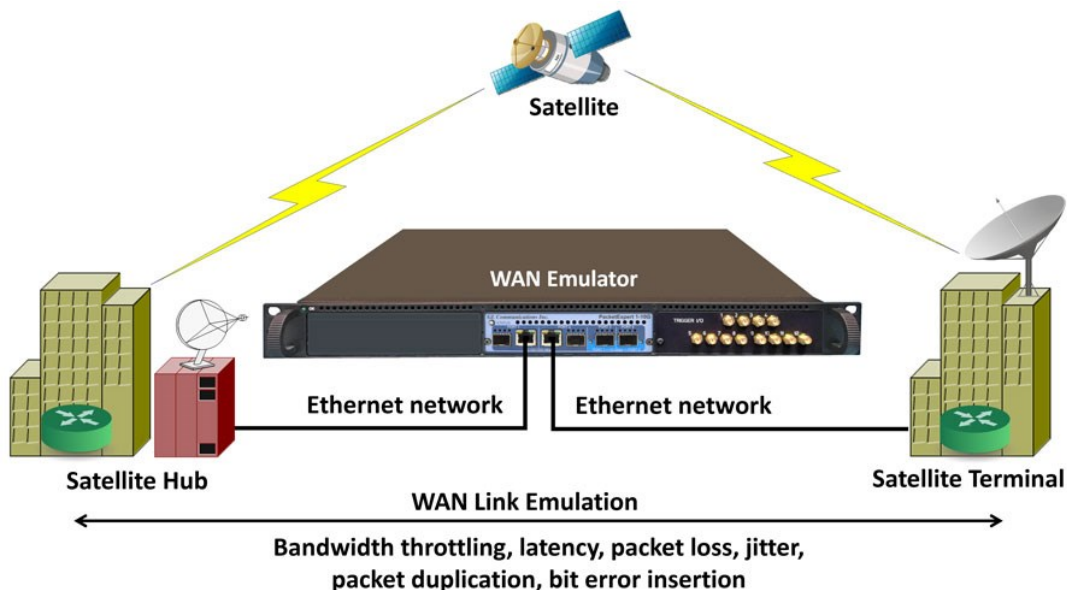
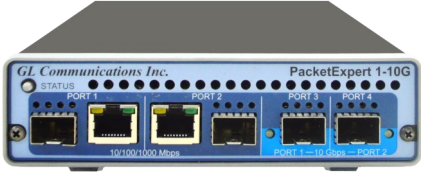
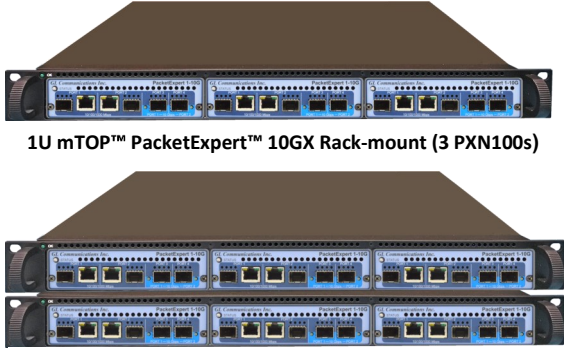




Figure: Testing Satellite WAN Links

## Hardware Specifications

 <p><b>Portable 10GX Hardware Unit</b></p>	 <p><b>1U mTOP™ PacketExpert™ 10GX Rack-mount (3 PXN100s)</b></p> <p><b>Stacked 1U mTOP™ PacketExpert™ 10GX Rack-mount</b></p>	 <p><b>PacketExpert™ 10GX mTOP™ Probe</b></p>
<p><b>Physical Specification:</b>  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. (0.75 kg)</p>	<ul style="list-style-type: none"> <li>• <b>Dimension:</b> 1U/2U mTOP™ - 19" W x 16" L</li> <li>• 1U mTOP™ Rack-mount Enclosure can support up to 3 PXN100s</li> <li>• 2U mTOP™ Rack-mount Enclosure can support up to 6 PXN100s</li> <li>• Optional 4 to 12 Port SMA Jack Trigger Board (TTL Input/Output)</li> <li>• <b>Weight:</b> (not including the rails)  1U with 3x PXN100 : 11 lbs  2U with 6x PXN100 : 22 lbs</li> </ul>	<p><b>Physical Specification:</b>  Length: 10.4 in. (264.16 mm)  Width: 8.4 in. (213.36 mm)  Height: 3.0 in. (76.2 mm)</p>
<p><b>Bus Interface:</b> USB 3.0  <b>External Power Supply:</b></p> <ul style="list-style-type: none"> <li>• +12 Volts (Medical Grade), 3 Amps (For portable units having serial number ≥ 188400)</li> <li>• +9 Volts, 2 Amps (For portable units having serial number &lt; 188400)</li> <li>• Optional 4-Port SMA Jack Trigger Board (TTL Input/Output)</li> </ul>	<p><b>SBC Specifications:</b></p> <ul style="list-style-type: none"> <li>• Intel Core i3 or optional i7 NUC Equivalent,</li> <li>• Windows® 11 64-bit Pro Operating System</li> <li>• USB 3.0 and USB 2.0 Ports, ATX Power Supply</li> <li>• USB Type C Ports, Ethernet 2.5GigE port</li> <li>• 256 GB Hard drive, 8G Memory (Min)</li> <li>• Two HDMI ports</li> </ul>	<p><b>SBC Specifications:</b></p> <ul style="list-style-type: none"> <li>• Intel Core i3 or optional i7 NUC Equivalent,</li> <li>• Windows® 11 64-bit Pro Operating System</li> <li>• USB 3.0 and USB 2.0 Ports,</li> <li>• 12V/9A Power Supply</li> <li>• USB Type C Ports, Ethernet 2.5GigE port</li> <li>• 256 GB Hard drive, 8G Memory (Min)</li> <li>• Two HDMI ports</li> </ul>
<p><b>Temperature:</b> Operating Temperature  0° C to +50° C (only up to operating altitude of 5000 feet, and for Optical SFPs only i.e. Non Electrical SFPs)  +5° to +40° C (for operating altitude up to 10,000 feet, and for both Electrical and Optical SFPs)  Non-Operating Temperature: -30° to +60° C</p> <p><b>Humidity:</b> Operating Humidity: 0% to 80% RH  Non-Operating Humidity: 0% to 95% RH</p> <p><b>Altitude:</b> Operating Altitude: up to 10,000 feet  Non-Operating Altitude: up to 50,000 feet</p> <p><b>Interfaces:</b>  4 x 1G Base-X Optical OR 10/100/1000 Base-T Electrical  2 x 100Mbps Base-FX Optical  2 x 2.5 Gbps Optical/Electrical Interface  2 x 10G Base-SR, -LR -ER Optical/Electrical Interface  Single Mode or Multi Mode Fiber SFP support with LC connector</p> <p><b>Protocols:</b>  IEEE 802.3ae LAN PHY compliance  RFC 2544 compliance</p> <div data-bbox="1117 1497 1511 1927">  <p><b>Pelican Carry Case</b></p> </div>		

**Buyer's Guide**

Item No	Product Description
<a href="#">IPN507</a>	IPNetSim™ and IPLinkSim™ option for PXN100X
Item No	Related Hardware
<a href="#">PXN100</a>	PacketExpert™ 10GX
<a href="#">PXN101</a>	10G and 2.5G option for PacketExpert™ 10GX (PXN100)
<a href="#">PXN104</a>	PacketExpert™ 10GX (4-Port) - Rack-mount
<a href="#">PXN112G</a>	PacketExpert™ 10GX (12-Port) - Rack-mount
<a href="#">PXN124G</a>	PacketExpert™ 10GX (24-Port) - Rack-mount
<a href="#">MT001</a>	mTOP™ 1U rack mount w/ SBC (Intel i3 Core)
<a href="#">MT001E</a>	mTOP™ 1U rack mount w/ SBC (Intel i7 Core)
<a href="#">MT002</a>	mTOP™ 1U rack mount w/o SBC
<a href="#">MT005</a>	mTOP™ Probe (Intel i3 Core)
<a href="#">MT005E</a>	mTOP™ Probe (Intel i7 Core)
<a href="#">CXE100</a>	CLI Server for PXE100
<a href="#">CXN100</a>	CLI Server for PXN100

**Note:** PCs which include GL hardware/software require Intel or AMD processors for compliance.

For more information, please visit [IP WAN Emulator](#) webpage.



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