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# IP WAN Link Emulator - IPLinkSim™ - 1G/10G/2.5Gbps

Single Stream IP WAN Link Emulator

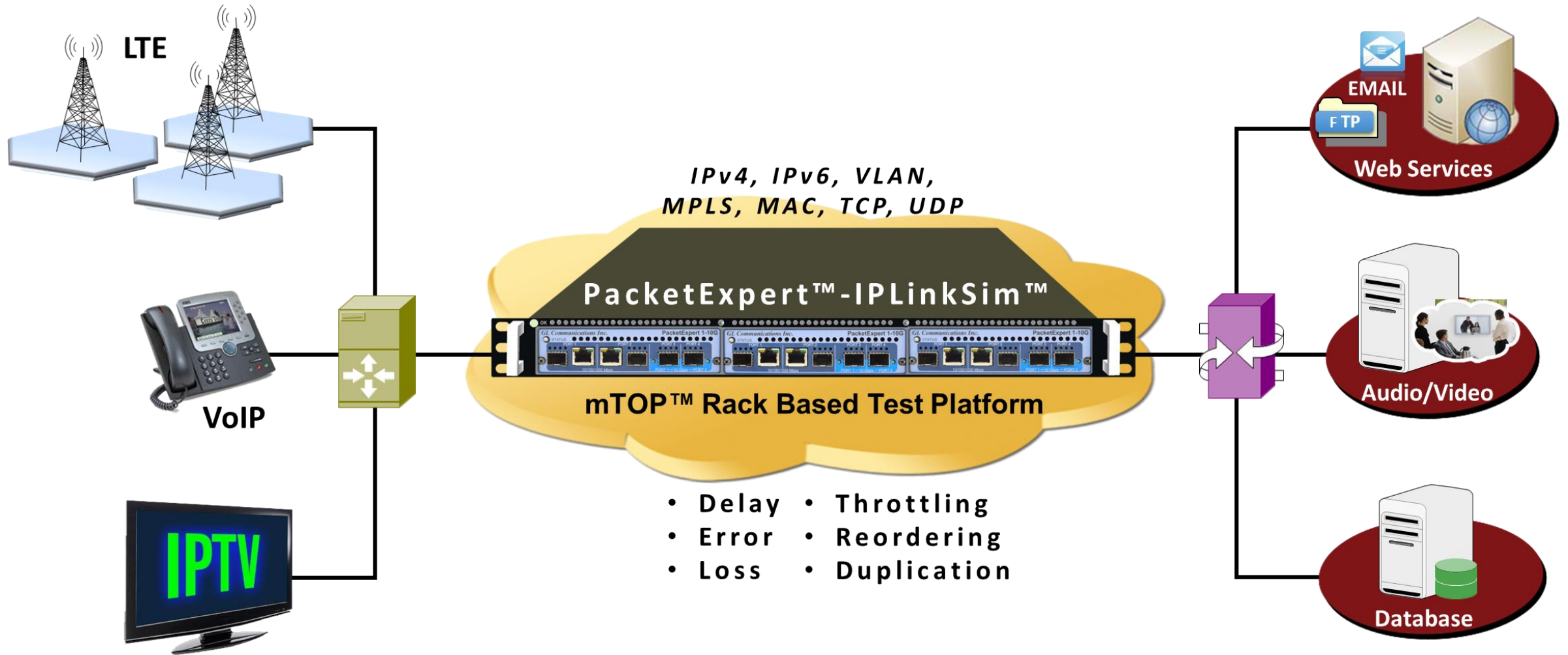
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# IP WAN Link Emulator



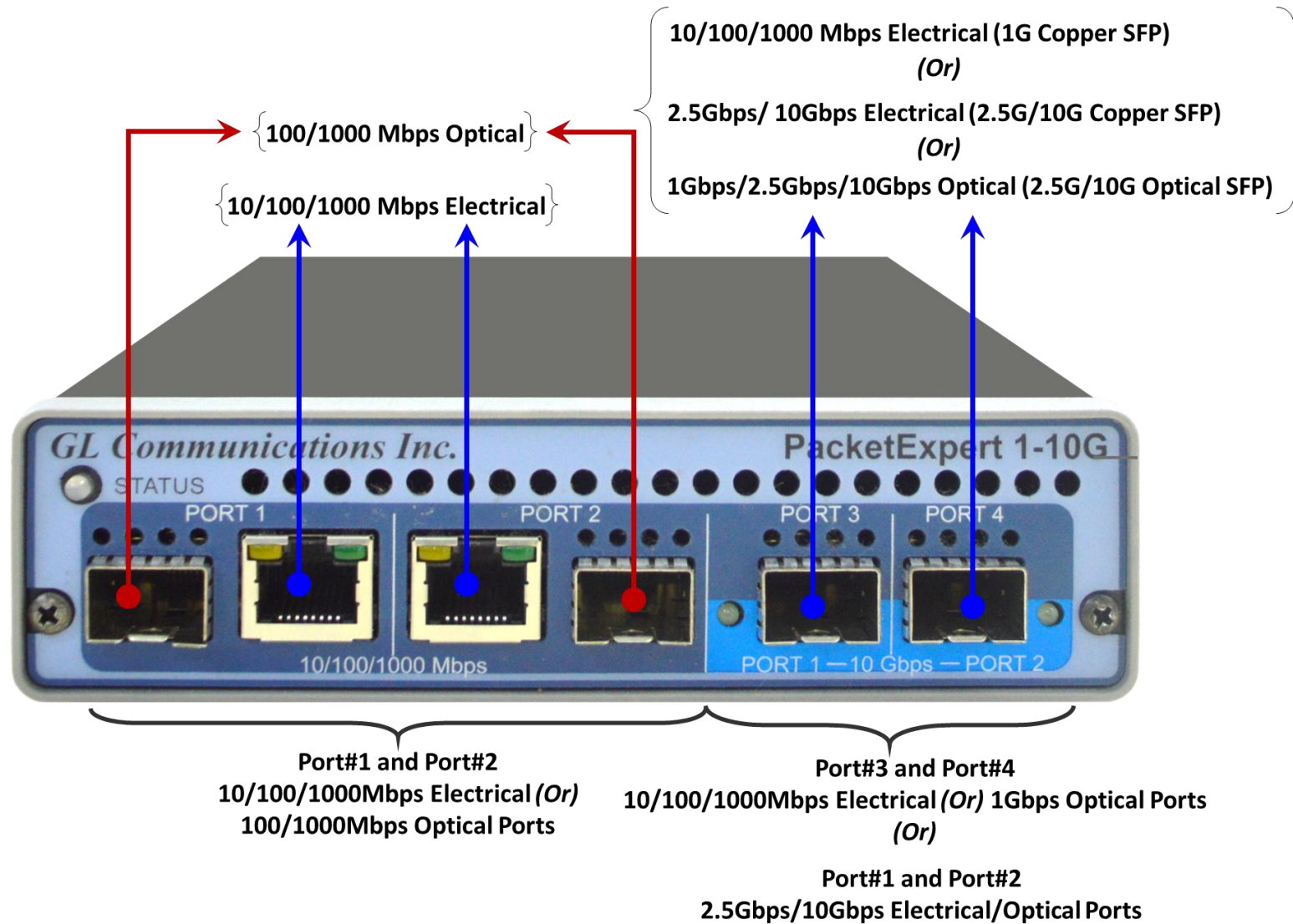
# Features

- Easy-to-use portable hardware based WAN Link Emulator
- Emulates 1 bi-directional WAN link per IPLinkSim™ unit (port 2 <-> port 3). With high density IPLinkSim™ up to 6 WAN links emulation per unit is possible
- Supported on both Electrical and Optical (10 /100/1000 Mbps and 1/2.5/10Gbps) interfaces
- Emulate WAN link conditions separately and independently for each direction. Acts as a transparent bidirectional link or a simple Ethernet Bridge for easy integration with any test setup
- Easily monitor the bandwidth performance using live throughput graphs (up to 7 days), and per-port or per-link statistics
- Introduce bi-directional impairments independently on each port
- Remote access and automation through Python, C# and MAPS CLI client/server architecture

# Features (Contd.)

- Bandwidth control (300 bps up to 1000 Mbps) to emulate various WAN link speeds (Modem, DSL, T1/E1/T3/E3/OC3/OC12 etc.)
- Supports transmission of Ethernet Pause frame with user-defined quanta used to throttle Ethernet link overload
- Check the stability or performance of the network with various real-world impairments:
  - Bandwidth control (300 bps up to 1000 Mbps)
  - Latency/Delay (100 microseconds to 4000 milliseconds (for 1Gbps) and 2000 milliseconds (for 10/2.5 Gbps))
  - Packet Loss (loss rate % of total packets 0–100%)
  - Packet Reordering (reordering rate (0-100%) with Min and Max Delay range)
  - Packet Duplication (percentage of total packets duplicated 0 - 100%)
  - Logic Error and FCS Error insertion ( $10^{-1}$  to  $10^{-9}$  error rate)

# Portable Unit



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



RJ45/SFP

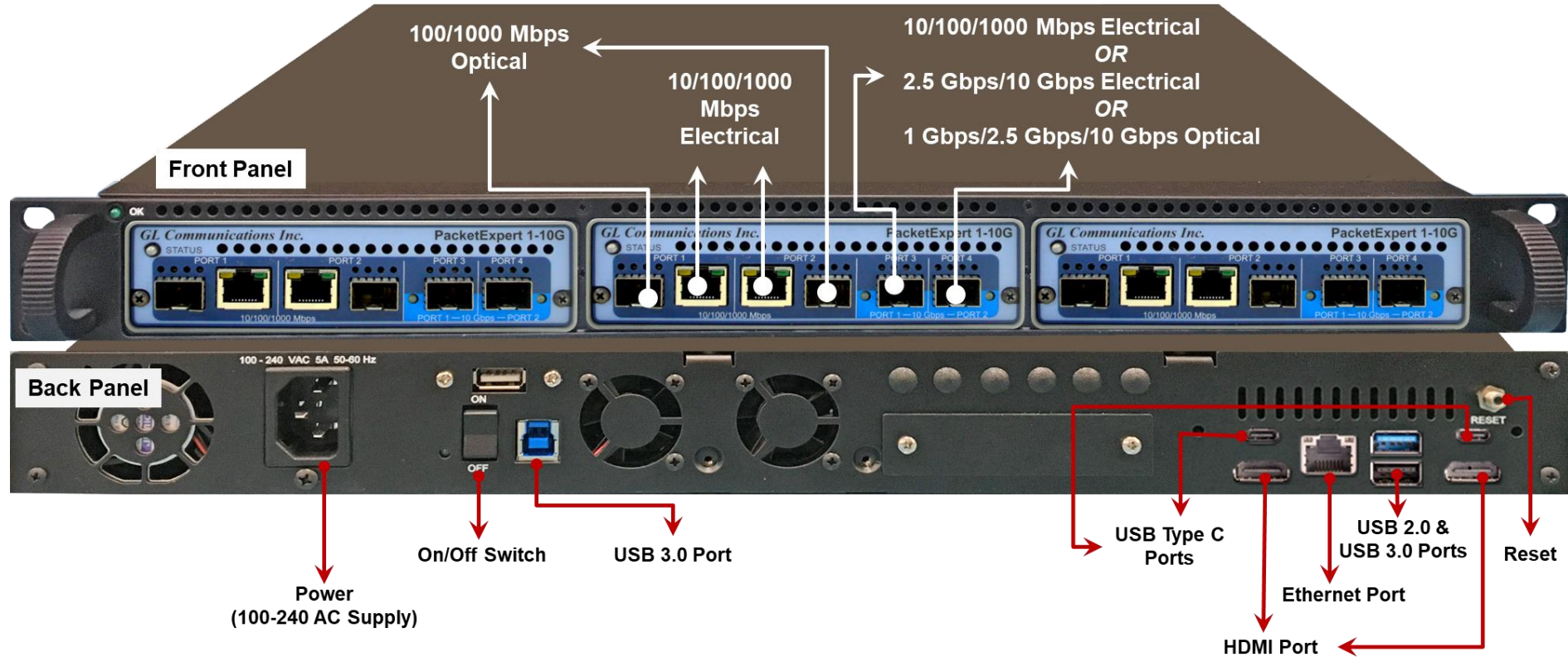
RJ45/SFP

SFP+

SFP+

Physical Specifications	<ul style="list-style-type: none"> <li>• Length: 8.45 in (214.63 mm)</li> <li>• Width: 5.55 in (140.97 mm)</li> <li>• Height: 1.60 in (40.64 mm)</li> <li>• Weight: 1.713 lbs</li> </ul>
External Power Supply	<ul style="list-style-type: none"> <li>• +12 Volts (Medical Grade), 3 Amps (For portable units having serial number <math>\geq</math> 188400)</li> <li>• +9 Volts, 2 Amps (For portable units having serial number <math>&lt;</math> 188400)</li> </ul>
BUS Interface	<ul style="list-style-type: none"> <li>• USB 3.0</li> <li>• Optional 4-Port SMA Jack Trigger Board(TTL Input/Output)</li> </ul>
Protocols	<ul style="list-style-type: none"> <li>• IEEE 802.3ae LAN PHY compliance</li> <li>• RFC 2544 compliance</li> </ul>

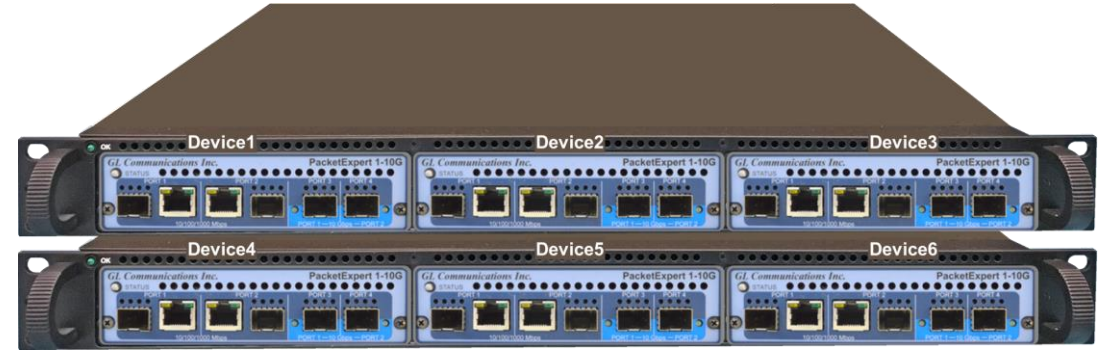
# 1U Rack Option



# MTOP™ Rack Units



**High Density 1U Rack option**

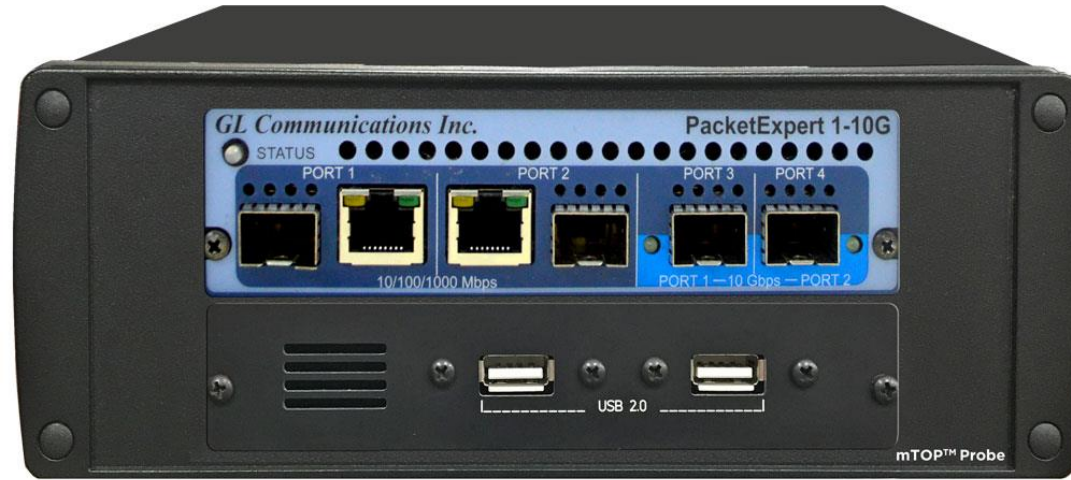


**Stacked High Density 1U Rack option**

Physical Specifications	<ul style="list-style-type: none"> <li>• Length: 16 in (406.4)</li> <li>• Width: 19 in (482.6)</li> <li>• Height: 1U / 2U</li> </ul>
External Power Supply	<ul style="list-style-type: none"> <li>• ATX Power Supply</li> </ul>
BUS Interface	<ul style="list-style-type: none"> <li>• 1U mTOP™ (MT001 + 3x PXN100)                             <ul style="list-style-type: none"> <li>➤ Rackmount Enclosure can support up to 3 PXN100s</li> </ul> </li> <li>• 2U Rack Mount (with 6x PXN100)                             <ul style="list-style-type: none"> <li>➤ Rackmount Enclosure can support up to 6 PXN100s</li> </ul> </li> <li>• Optional 4 to 12 Port SMA Jack Trigger Board (TTL Input/Output)</li> </ul>
SBC Specifications	<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>• USB Type C Ports, Ethernet 2.5GigE port</li> <li>• 256 GB Hard drive, 8G Memory (Min)</li> <li>• Two HDMI ports</li> </ul>



# mTOP™ Probe with 10GX Hardware Unit + SBC



Physical Specifications	<ul style="list-style-type: none"><li>• Length: 10.4 in. (264.16 mm)</li><li>• Width: 8.4 in. (213.36 mm)</li><li>• Height: 3.0 in. (76.2 mm)</li><li>• Optional 4-Port SMA Jack Trigger Board (TTL Input/Output)</li><li>• External USB based Wi-Fi adaptor</li></ul>
External Power Supply	<ul style="list-style-type: none"><li>• +12 Volts (Medical Grade), 3 Amps</li></ul>
SBC Specifications	<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>• USB Type C Ports, Ethernet 2.5GigE port</li><li>• 256 GB Hard drive, 8G Memory (Min)</li><li>• Two HDMI ports</li></ul>

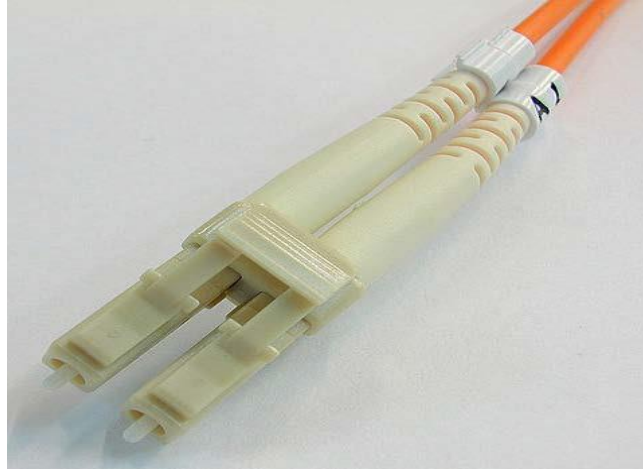
# Software Specification

## 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
- Packet Loss Rate - 0–50%
- Packet Reordering Rate - 0-50% with Delay range of up to 8 seconds
- Packet Duplication Rate - 0 - 50%
- Logic Error Insertion Rate -  $10^{-1}$  to  $10^{-9}$
- FCS Error insertion Rate -  $10^{-1}$  to  $10^{-9}$

# Optical Connectors and SFP Transceivers

**LC Connectors**



**850nm/1310nm/1550nm  
SFP Module**



- PacketExpert™ 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.

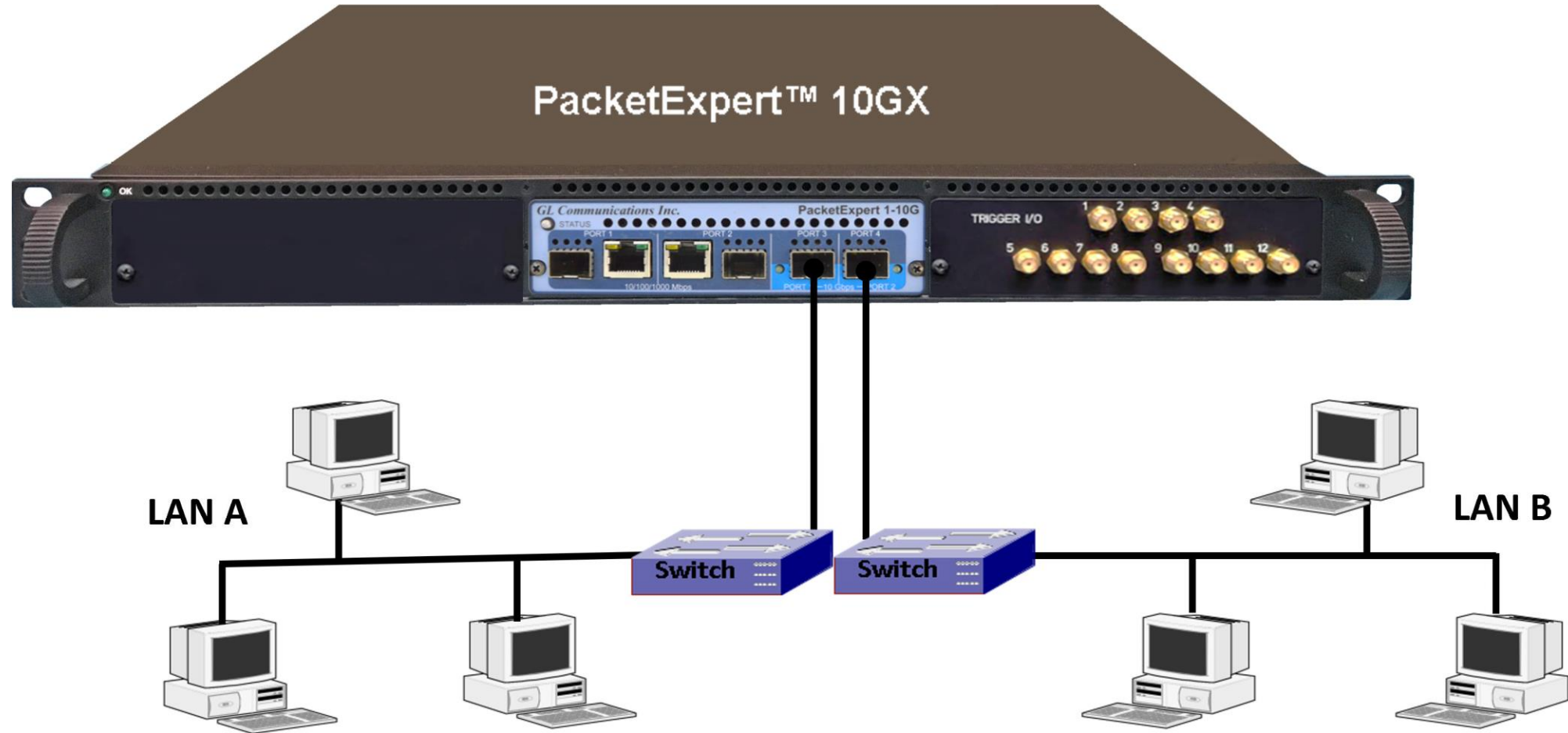
# Applications

- Emulate WAN links to estimate the optimum link bandwidth
- Use IPLinkSim™ to find out if equipment upgrade improves performance
- Pinpoint problems and validate solutions prior to network deployment
- Test the working of client/server applications at remote locations
- Verify the responsiveness of your website and e-commerce systems.
- Verify quality requirements to deploy VoIP in real-world conditions.
- With the High-density IPLinkSim™ (supports up to 6 WAN links) directly compare and demonstrate application performance on multiple independent WAN links

# Who uses the IPLinkSim™?

- IPLinkSim™ is designed for anyone who needs an accurate, easy-to-use, cost-effective way to simulate WAN IP Link conditions, including:
  - Application and equipment developers
  - Networking equipment resellers and system integrators
  - Quality Assurance teams and Test labs

# Connecting IPLinkSim™



Since IPLinkSim™ acts as a transparent bi-directional link, it can be connected wherever an Ethernet link or a simple bridge can be connected. The configurable link emulation conditions includes Bandwidth Control, Latency, and Error Insertion

# Easy-to-use Interface

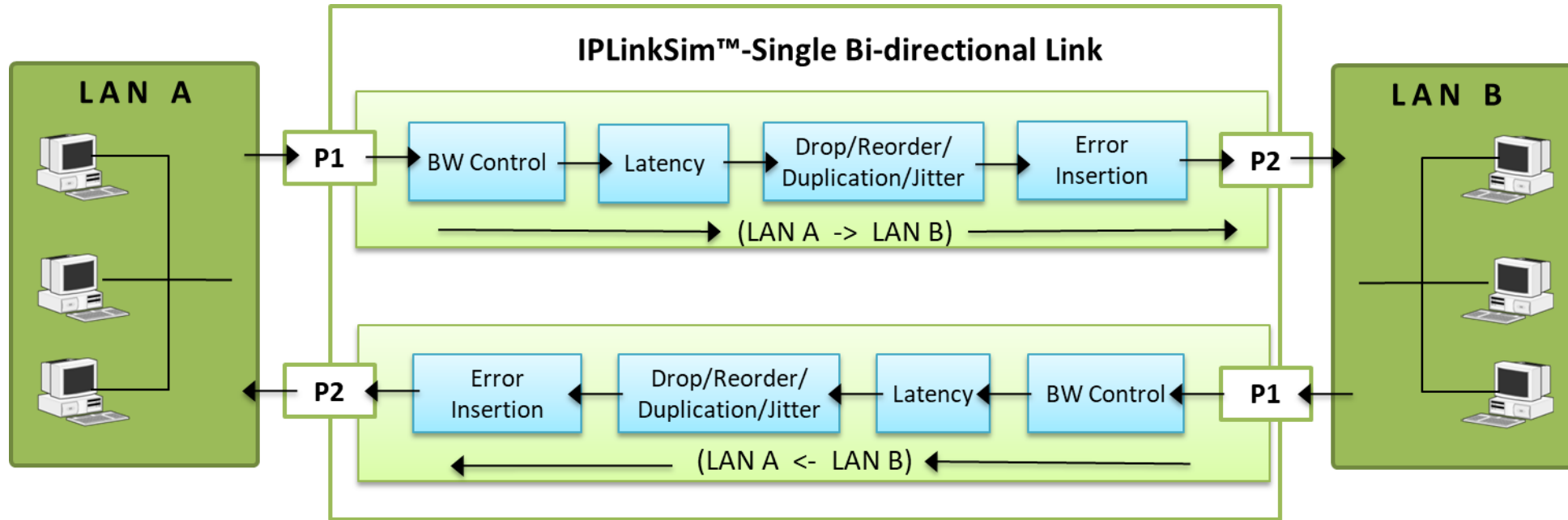
- IPLinkSim™ is an important and simple to use tool that simulates IP WAN links using a portable hardware unit
- It features an easy-to-use interface to quickly get started with testing WAN and applications in real-time

The screenshot displays the 'GL PacketExpert10GX - IPLinkSim' application window. The interface includes a menu bar (File, View, System, Windows, Help), a toolbar, and a main workspace. The workspace is divided into several sections:

- Left Sidebar:** A tree view showing the project structure: IPLinkSim, Port 1, Port 2, Interface Statistics, Link Configuration, and Link Statistics Graph.
- Interface Pane:** Contains configuration options for the selected port (Port 1). It includes a 'Details' section for the Hardware MAC address, a 'Settings' section for Interface Type (Optical) and Link Speed (10000Mbps), and a 'Status' section showing Link status (Up), Interface Type (Optical), Auto-Negotiation Status, Speed (10000 Mbps), Duplex Mode (Full Duplex), and Flow Control (Enabled). An 'Apply' button is present.
- Link Configuration Pane:** Shows 'WAN Stream Type' set to Asymmetrical. Below is a table of parameters for traffic flow between ports P1 and P2.
- Port Statistics Pane:** Displays a table of statistics for the selected port (Port 1), including Total Frames, Valid Frames, Bad Frames, Number of Bytes, Link Utilisation(%), Data Rate(Mbps), Frame Rate(Frames/sec), Non Test Frames, Broadcast Frames, Multicast Frames, Control Frames, VLAN Frames, Pause Frames, and Wrong Opcode Frames.
- Link Statistics Pane:** Displays a table of link-level statistics, including TxBytes, 10 Sec Average Throughput, 1 Min Average Throughput, 10 Min Average Throughput, RxFrames, TxFrames, Dropped Frames, Dropped Packets, Reordered Packets, Duplicated Packets, No of Packets With Errors, and Inserted Bursts for Backlog.

A 'Start' button is located at the bottom left of the interface. The status bar at the bottom indicates 'Ready'.

# Link Emulation



- Emulates a bi-directional WAN link between the ports 2 and 3
- Each direction acts as a separate and independent WAN Link
- Each link can be configured independently for all the link emulation characteristics



# Traffic Bandwidth

- Used to emulate various WAN links (Modem, DSL, T1, E1, T3, E3, OC-3/STM-1, OC-12/STM-4 etc) of varying speeds 10 Mbps to 10 Gbps
- On the 1G ports, the unit supports simulation of 1 bidirectional WAN link, with 1 Gbps in each direction to an aggregate of 2 Gbps

The screenshot displays the 'GL PacketExpert10G1G - IPLinkSim' application window. The 'Link Configuration' tab is active, showing the 'WAN Stream Type' set to 'Asymmetrical'. Below this, a table lists parameters for two directions: P1 -> P2 and P2 -> P1. The 'Traffic Bandwidth' is set to 1000.00 Mbps for both directions. Other parameters like Latency, Packet Loss, Packet Reordering, Packet Duplication, Logic Error Insertion, and FCS Error Insertion are set to 'None'. Manual configuration buttons (Drop, Reorder, Duplicate, Insert) are available for each direction. At the bottom, there are input fields for 'Traffic Bandwidth' for both directions, both set to 1000.000000 Mbps. A 'Start' button is located at the bottom left of the configuration area.

Parameters	P1 -> P2	P1 -> P2 Manual	P2 -> P1	P2 -> P1 Manual
Traffic Bandwidth	1000.00 Mbps		1000.00 Mbps	
Latency	None		None	
Packet Loss	None	Drop	None	Drop
Packet Reordering	None	Reorder	None	Reorder
Packet Duplication	None	Duplicate	None	Duplicate
Logic Error Insertion	None	Insert	None	Insert
FCS Error Insertion	None	Insert	None	Insert

# Latency

Link Configuration

WAN Stream Type  Symmetrical  Asymmetrical    Status

Parameters	P1 -> P2	P1 -> P2 Manual	P2 -> P1	P2 -> P1 Manual
Traffic Bandwidth	1000.00 Mbps		1000.00 Mbps	
Latency	Single Delay, 100.000 msec		Single Delay, 100.000 msec	
Packet Loss	None	<input type="button" value="Drop"/>	None	<input type="button" value="Drop"/>
Packet Reordering	None	<input type="button" value="Reorder"/>	None	<input type="button" value="Reorder"/>
Packet Duplication	None	<input type="button" value="Duplicate"/>	None	<input type="button" value="Duplicate"/>
Logic Error Insertion	None	<input type="button" value="Insert"/>	None	<input type="button" value="Insert"/>
FCS Error Insertion	None	<input type="button" value="Insert"/>	None	<input type="button" value="Insert"/>

P1 -> P2

Latency

Single Delay    Min  msec

Uniform Distribution    Max  msec

Random Exponential Distribution

P2 -> P1

Latency

Single Delay    Min  msec

Uniform Distribution    Max  msec

Random Exponential Distribution

- Latency/Delay to emulate various wired, wireless, and network elements
  - Single Delay
  - Uniform Distributions
  - Random Distributions

# Packet Loss

- Packet Loss can be introduced either Automatically (as a Rate) or Manually.
- For both automatic and manual, user can choose to drop a single packet or a burst of packets, at a time
  - **Rate:** User can configure the Loss rate, and packets will be dropped at that rate
  - **Manual Drop:** This allows user to manually drop either a single packet or burst of packets at run time
  - **Periodic vs Random Drop:** In the case of Periodic drop, the packets chosen for dropping remain constant and predictable. However, in real-world scenarios, Packet Drop is unpredictable as it occurs randomly. To help emulate true real-life Packet loss, option for "Random Packet Loss" can be used.'

The screenshot displays the 'Link Configuration' window in the GL PacketExpert10G1G - IPLinkSim application. The 'WAN Stream Type' is set to 'Asymmetrical'. A table below shows configuration parameters for four directions: P1 -> P2, P1 -> P2 Manual, P2 -> P1, and P2 -> P1 Manual. The 'Packet Loss' row is highlighted with a red border, showing a rate of 1.000% and a manual 'Drop' option for both directions. Below the table, two panels provide detailed settings for 'Packet Loss' for each direction. Each panel includes radio buttons for 'Automatic' and 'Manual', and sub-options for 'Periodic', 'Random', 'Rate', and 'Window'. A 'Rate' input field is set to '1.000' with a warning message: 'WARNING: Packet Loss Rate range is between 0.002% to 50%. For rates between 0.002% and 0.098%, entered values must be in multiples of 0.002%. Eg: 0.002%, 0.004%, 0.006% and so on till 0.098%'. Below the input, it states '1 packets will be dropped for 100 packets'. A 'Start' button is visible at the bottom left of the configuration area.

Parameters	P1 -> P2	P1 -> P2 Manual	P2 -> P1	P2 -> P1 Manual
Traffic Bandwidth	1000.00 Mbps		1000.00 Mbps	
Latency	Uniform, 0.000 msec - 4000.000 msec		None	
Packet Loss	1.000 %	Drop	1.000 %	Drop
Packet Reordering	None	Reorder	None	Reorder
Packet Duplication	None	Duplicate	None	Duplicate
Logic Error Insertion	None	Insert	None	Insert
FCS Error Insertion	None	Insert	None	Insert

# Packet Reordering

- Packet reordering model includes Periodic and Random Packet Reordering options
- In **Periodic option**, the packets are reordered at constant specified rate
- While in **Random option**, packets are randomized for reordering, but still maintain the specified Reorder rate

The screenshot shows the 'Link Configuration' window in the GL PacketExpert10G1G - IPLinkSim application. The 'WAN Stream Type' is set to 'Asymmetrical'. The configuration table below shows settings for P1 -> P2 and P2 -> P1 directions.

Parameters	P1 -> P2	P1 -> P2 Manual	P2 -> P1	P2 -> P1 Manual
Traffic Bandwidth	1000.00 Mbps		1000.00 Mbps	
Latency	Single Delay, 100.000 msec		Single Delay, 100.000 msec	
Packet Loss	Manual impairment	Drop	Manual impairment	Drop
Packet Reordering	1 out of 5 packets	Reorder	1 out of 10 packets	Reorder
Packet Duplication	None	Duplicate	None	Duplicate
Logic Error Insertion	None	Insert	None	Insert
FCS Error Insertion	None	Insert	None	Insert

Below the table, the 'Packet Reordering' settings for P1 -> P2 and P2 -> P1 are detailed:

- P1 -> P2:** Packet Reordering is set to 'Automatic' and 'Periodic'. The reorder rate is '1 out of 5 packets'. The 'Delay Offset' is set to 'Frames' with a minimum of 0 and a maximum of 10 frames.
- P2 -> P1:** Packet Reordering is set to 'Automatic' and 'Periodic'. The reorder rate is '1 out of 10 packets'. The 'Delay Offset' is set to 'Frames' with a minimum of 0 and a maximum of 10 frames.

# Packet Duplication

- Packet Duplication model also includes Periodic and Random Packet Duplication options
- In **Periodic Duplication** option, the packets are duplicated at specified rate periodically
- In **Random Duplication** option, the selected packet is duplicated (based on the rate) randomly but maintaining the duplication rate

GL PacketExpert10G1G - IPLinkSim

Application: IPLinkSim

WAN Stream Type  Symmetrical  Asymmetrical Status ↑

Parameters	P1 -> P2	P1 -> P2 Manual	P2 -> P1	P2 -> P1 Manual
Traffic Bandwidth	1000.00 Mbps		1000.00 Mbps	
Latency	Single Delay, 10.000 msec		Single Delay, 10.000 msec	
Packet Loss	Manual impairment	Drop	Manual impairment	Drop
Packet Reordering	Manual impairment	Reorder	Manual impairment	Reorder
Packet Duplication	1.000 %	Duplicate	1.000 %	Duplicate
Logic Error Insertion	None	Insert	None	Insert
FCS Error Insertion	None	Insert	None	Insert

P1 -> P2 Duplication

Automatic  Manual

Rate

WARNING: Packet Duplication Rate range is between 0.002% to 50%. For rates between 0.002% and 0.098%, entered values must be in multiples of 0.002%. Eg: 0.002%, 0.004%, 0.006% and so on till 0.098%

Periodic  Random

Rate  %

P2 -> P1 Duplication

Automatic  Manual

Rate

WARNING: Packet Duplication Rate range is between 0.002% to 50%. For rates between 0.002% and 0.098%, entered values must be in multiples of 0.002%. Eg: 0.002%, 0.004%, 0.006% and so on till 0.098%

Periodic  Random

Rate  %

Start

Ready

# Logic Error Insertion

- In **Periodic Error Insertion** option, the start of frame and end of frame byte offsets specifies where exactly in the frame to inject errors
- In the **Random Error Insertion** option, the packet will be randomly selected for error insertion (based on the rate), but the error insertion rate is maintained
- But in Manual Error Insertion option, error is introduced into a single packet at run time manually

The screenshot displays the 'Link Configuration' window. At the top, 'WAN Stream Type' is set to 'Asymmetrical'. Below this is a table of parameters for two directions: P1 -> P2 and P2 -> P1. The 'Logic Error Insertion' row is highlighted in red. Below the table, there are two detailed configuration panels for 'Logic Error Insertion' for each direction.

Parameters	P1 -> P2	P1 -> P2 Manual	P2 -> P1	P2 -> P1 Manual
Traffic Bandwidth	1000.00 Mbps		1000.00 Mbps	
Latency	Single Delay, 100.000 msec		Single Delay, 100.000 msec	
Packet Loss	10.000 %	Drop	10.000 %	Drop
Packet Reordering	1 out of 1000 packets	Reorder	1 out of 10000 packets	Reorder
Packet Duplication	10.000 %	Duplicate	5.000 %	Duplicate
Logic Error Insertion	10 <sup>-2</sup>	Insert	10 <sup>-3</sup>	Insert
FCS Error Insertion	None	Insert	None	Insert

**P1 -> P2 Logic Error Insertion Settings:**  
- Mode: Automatic (selected), Manual  
- Rate: Periodic (selected), Random  
- Packet Error Rate: 10<sup>-2</sup>  
- Bytes Offset: 100 (Beginning of frame), 200 (End of frame)

**P2 -> P1 Logic Error Insertion Settings:**  
- Mode: Automatic (selected), Manual  
- Rate: Periodic (selected), Random  
- Packet Error Rate: 10<sup>-3</sup>  
- Bytes Offset: 50 (Beginning of frame), 300 (End of frame)

# FCS Error Insertion

- FCS (Frame Check Sequence) is the extra checksum characters added to a frame for error detection.
- This option is used to emulate the errors normally caused interference or incompatible device, or by edge devices such as gateways, where FCS can be recomputed. Here, the FCS bytes within the frames are corrupted.
- FCS Error can be inserted **Automatically** or **Manually**

The screenshot shows the 'Link Configuration' window with the following settings:

- WAN Stream Type:  Symmetrical  Asymmetrical
- Status:

Parameters	P1 -> P2	P1 -> P2 Manual	P2 -> P1	P2 -> P1 Manual
Traffic Bandwidth	1000.00 Mbps		1000.00 Mbps	
Latency	None		None	
Packet Loss	None	Drop	None	Drop
Packet Reordering	None	Reorder	None	Reorder
Packet Duplication	10.000 %	Duplicate	5.000 %	Duplicate
Logic Error Insertion	None	Insert	None	Insert
FCS Error Insertion	10 <sup>-3</sup>	Insert	10 <sup>-2</sup>	Insert

Below the table, there are two detailed configuration sections:

- P1 -> P2:** FCS Error Insertion is set to  Automatic and  Manual. The Error Rate is set to 10<sup>-3</sup>.
- P2 -> P1:** FCS Error Insertion is set to  Automatic and  Manual. The Error Rate is set to 10<sup>-2</sup>.

# Link Statistics

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

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

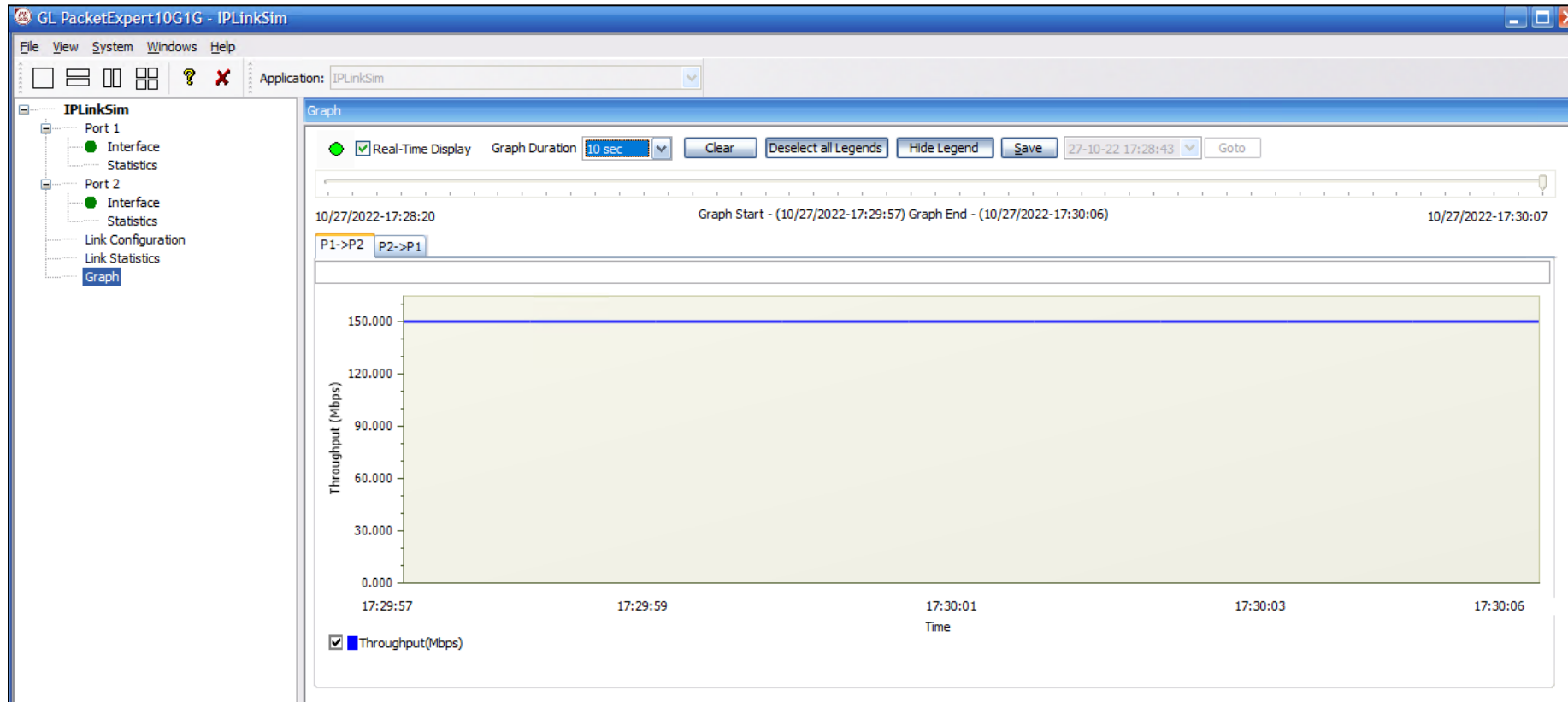


# Port Statistics

Port Selection

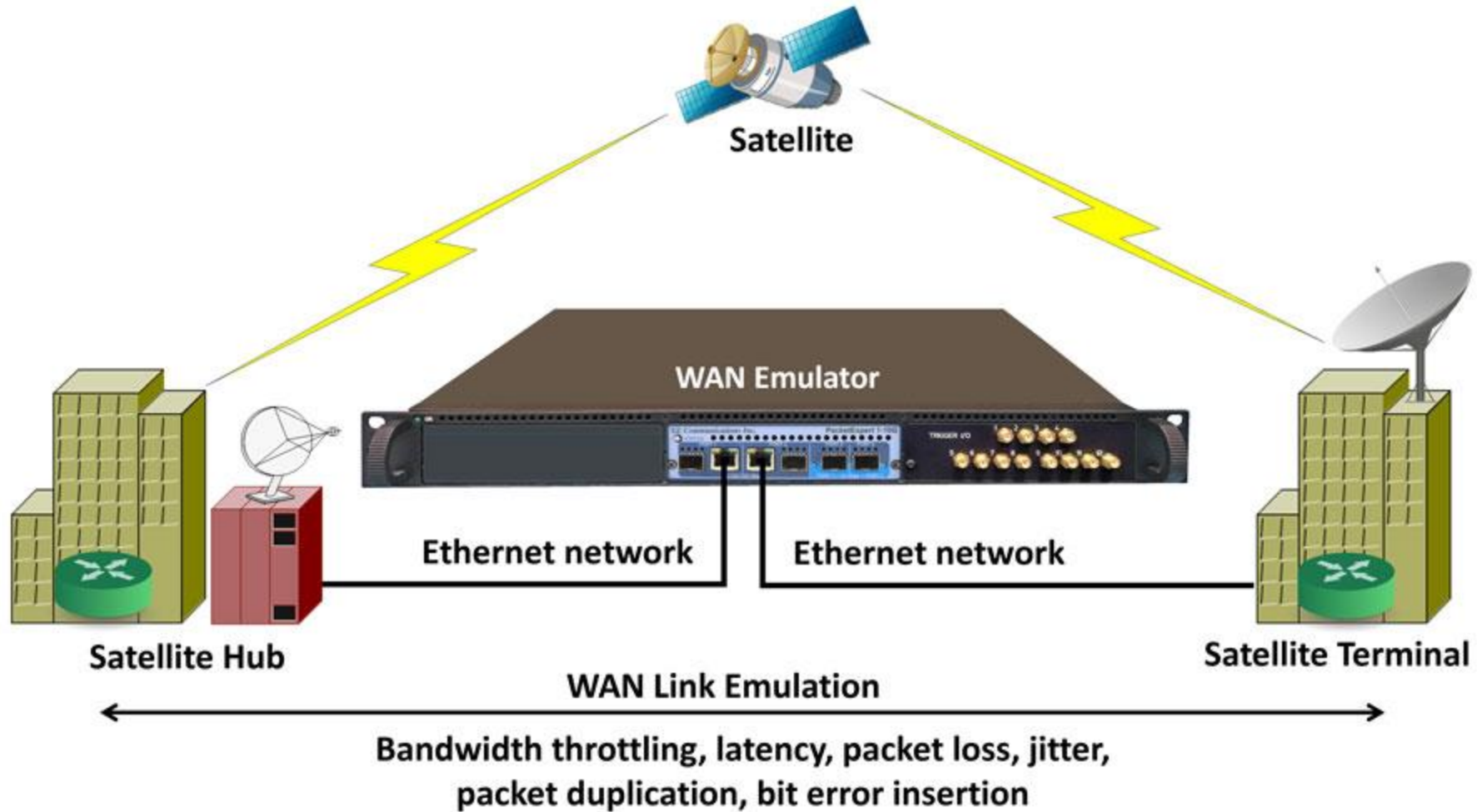
Description	Tx	Rx
Total Frames	1 242 533 879	1 243 070 654
Valid Frames	1 242 533 879	1 243 070 654
Bad Frames	0	0
Number of Bytes	79 522 168 256	79 556 521 856
Link Utilisation(%)	0.000	0.000
Data Rate(Mbps)	0.000	0.000
Frame Rate(Frames/sec)	0	0
Non Test Frames	0	0
Broadcast Frames	0	0
Multicast Frames	0	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	1 242 533 879	1 243 070 654
65-127 Byte Length Frames	0	0
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	0	0
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	-	1 243 070 654
IPv6 Packets	-	0
IP in IP Packets	-	0
UDP in IP Packets	-	1 243 070 654
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	-	1 243 070 654

# Throughput Graph



- A real time display of Throughput of the link, plotted as the rate against time, in the form of a line graph. The Graph can be viewed for a single link or both the links together

# Satellite Network Link Emulation



**Thank you**