Ethernet Tester - PacketExpert™
10 Gbps, 2.5 Gbps, or 1 Gbps
PacketExpert™ 10GX - Portable Unit (PXN100, PXN101)

- **Physical Specification**
  - Length: 8.45 in. (214.63 mm)
  - Width: 5.55 in. (140.97 mm)
  - Height: 1.60 in (40.64 mm)

- **External Power Supply** - +9 volts, 2.0 Amps

- **Protocols**
  - IEEE 802.3ae LAN PHY compliance
  - RFC 2544 compliance

- **Bus Interface** - USB 3.0
  - Optional 4-Port SMA Jack Trigger Board (TTL Input/Output)
# PacketExpert™ 10GX - 1 Gbps Mode

<table>
<thead>
<tr>
<th>Ports</th>
<th>Port 1</th>
<th>Port 2</th>
<th>Port 3</th>
<th>Port 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interface Type</strong></td>
<td>SFP</td>
<td>RJ45</td>
<td>SFP</td>
<td>RJ45</td>
</tr>
<tr>
<td><strong>Electrical</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speeds</td>
<td>10/100/1000 Mbps</td>
<td>10/100/1000 Mbps</td>
<td>10/100/1000 Mbps</td>
<td>10/100/1000 Mbps</td>
</tr>
<tr>
<td>Designations</td>
<td>10BASE-T</td>
<td>10BASE-T</td>
<td>10BASE-T</td>
<td>10BASE-T</td>
</tr>
<tr>
<td></td>
<td>100BASE-TX</td>
<td>100BASE-TX</td>
<td>100BASE-TX</td>
<td>100BASE-TX</td>
</tr>
<tr>
<td></td>
<td>1000BASE-T</td>
<td>1000BASE-T</td>
<td>1000BASE-T</td>
<td>1000BASE-T</td>
</tr>
<tr>
<td><strong>Optical</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speeds</td>
<td>100/1000 Mbps</td>
<td>100/1000 Mbps</td>
<td>1000 Mbps</td>
<td>1000 Mbps</td>
</tr>
<tr>
<td>Designations</td>
<td>100BASE-FX</td>
<td>100BASE-FX</td>
<td>1000BASE-X</td>
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<td></td>
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## PacketExpert™ 10GX - 2.5 Gbps Mode

<table>
<thead>
<tr>
<th>Ports</th>
<th>Port 1</th>
<th>Port 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interface Type</strong></td>
<td><strong>SFP+</strong></td>
<td><strong>SFP+</strong></td>
</tr>
<tr>
<td><strong>Electrical</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speeds</td>
<td>2.5 Gbps</td>
<td>2.5 Gbps</td>
</tr>
<tr>
<td>Designations</td>
<td>2500BASE-T</td>
<td>2500BASE-T</td>
</tr>
<tr>
<td><strong>Optical</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speeds</td>
<td>2.5 Gbps</td>
<td>2.5 Gbps</td>
</tr>
<tr>
<td>Designations</td>
<td>2500BASE-X</td>
<td>2500BASE-X</td>
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</table>
### PacketExpert™ 10GX - 10 Gbps Mode

<table>
<thead>
<tr>
<th>Port</th>
<th>Port 1</th>
<th>Port 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interface Type</strong></td>
<td>SFP+</td>
<td>SFP+</td>
</tr>
<tr>
<td><strong>Electrical</strong></td>
<td>10 Gbps</td>
<td>10 Gbps</td>
</tr>
<tr>
<td>Speeds</td>
<td>10 Gbps</td>
<td>10 Gbps</td>
</tr>
<tr>
<td>Designations</td>
<td>10GBASE-T</td>
<td>10GBASE-T</td>
</tr>
<tr>
<td><strong>Optical</strong></td>
<td>10 Gbps</td>
<td>10 Gbps</td>
</tr>
<tr>
<td>Speeds</td>
<td>10 Gbps</td>
<td>10 Gbps</td>
</tr>
<tr>
<td>Designations</td>
<td>10GBASE-R</td>
<td>10GBASE-R</td>
</tr>
</tbody>
</table>
PacketExpert™ 10GX - Electrical Ports
PacketExpert™ 10GX - Mix and Match
mTOP™ 1U/2U Rack Option

- 19” rack option, w/ Embedded Single Board Computer (SBC)
- SBC Specs: Intel Core i3 Equivalent, Windows® 10 64-bit Pro, USB 3.0 Hub, ATX Power Supply, 240GB Hard drive, 8G Memory (Min), Two HDMI ports for display
Optical Connectors and SFP Transceivers

- PacketExpert™ 10GX supports LC connectors and 850/1310 nm SFP (Small Factor Pluggable) modules
- Note: In case customer have different type of connectors, then we need converters like LC-to-SC, LC-to-FC and vice-versa.
Applications

• Test and verify QoS Parameters of network devices like Switches/Routers etc.
• End to end testing of network paths for QoS parameters
• In-depth troubleshooting of the Carrier network in the event of network failures or impairments
• QoS testing of Triple-play services to ensure that they fully qualify SLA parameters
• Terrestrial wireless, satellite, and other WAN technologies network validations.
• Test VoIP network in real-time conditions to verify if it meets the quality requirements before you deploy.
• Testing video on IP networks by emulating the loss and congestion characteristics
• SPF support can be used for Broadband aggregation applications, Metro edge switching, Metro and access multi-service platforms, and are suitable for Fast Ethernet applications.
PacketExpert™ 10GX-Ethernet / IP Tester

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

Application Protocol

Presentation Protocol

Session Protocol

Framing Representation

Pre SFD MAC Header VLAN Header MPLS Header IP UDP BERT Pattern FCS

Pre SFD MAC Header VLAN Header MPLS Header IP BERT Pattern FCS

Pre SFD MAC Header VLAN Header BERT Pattern FCS

Pre SFD BERT Pattern FCS

Preamble – 7 Bytes
Start Frame Delimiter – (SFD)- 1 Byte
MAC Header –
  • Dest/Src MAC Address – 6 Bytes
  • Ether Length/Type – 2 Bytes (0x0800)
  • IP
  • VLAN Header – 4 bytes each
MPLS Header – 4 bytes each
IP Header – 20 Bytes
UDP Header – 8 Bytes
Payload – BER Test Pattern
Frame Check Sum – (FCS) – 4 Bytes

Ethernet Payload

Host A

OSI Model

Application
Presentation
Session
Transport
Network
Layer 2.5
Data Link
Physical

OSI Model

Application
Presentation
Session
Transport
Network
Layer 2.5
Data Link
Physical

Host B
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.
Optional Sequence number insertion allows detecting Out-of-sequence packets and packet loss.

Detailed BERT statistics like the Bit Error Count, Bit Error Rate, Bit Error Seconds etc., are provided.

Bit Error Count is displayed in both Tabular and Graphical formats.
All Ports Result

<table>
<thead>
<tr>
<th></th>
<th>Port 1</th>
<th>Port 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tx</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Frames</td>
<td>941 266</td>
<td>941 232</td>
</tr>
<tr>
<td>Valid Frames</td>
<td>941 266</td>
<td>941 232</td>
</tr>
<tr>
<td>Bad Frames</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number Of Bytes</td>
<td>1,425,105,690</td>
<td>1,425,100,946</td>
</tr>
<tr>
<td>Link Utilisation(%)</td>
<td>0.400%</td>
<td>0.400%</td>
</tr>
<tr>
<td>Data Rate(Mbps)</td>
<td>39.470</td>
<td>39.470</td>
</tr>
<tr>
<td>Frame Rate(Frames/sec)</td>
<td>3,259</td>
<td>3,259</td>
</tr>
<tr>
<td><strong>Rx</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valid Frames</td>
<td>940,916</td>
<td>941,336</td>
</tr>
<tr>
<td>Bad Frames</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number Of Bytes</td>
<td>1,424,946,824</td>
<td>1,425,182,714</td>
</tr>
<tr>
<td>Link Utilisation(%)</td>
<td>0.400%</td>
<td>0.400%</td>
</tr>
<tr>
<td>Data Rate(Mbps)</td>
<td>39.485</td>
<td>39.485</td>
</tr>
<tr>
<td>Frame Rate(Frames/sec)</td>
<td>3,260</td>
<td>3,260</td>
</tr>
<tr>
<td><strong>Error Status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rx Traffic</td>
<td>✈️</td>
<td>✈️</td>
</tr>
<tr>
<td>Sync Status</td>
<td>✈️</td>
<td>✈️</td>
</tr>
<tr>
<td>Bit Errors</td>
<td>✈️</td>
<td>✈️</td>
</tr>
<tr>
<td>Out Of Sequence Packets</td>
<td>✈️</td>
<td>✈️</td>
</tr>
<tr>
<td><strong>Error Statistics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test Time</td>
<td>00:04:49</td>
<td>00:04:49</td>
</tr>
<tr>
<td>Bits Received</td>
<td>11,036,318,320</td>
<td>11,039,083,920</td>
</tr>
<tr>
<td>Bit Error Count</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Bit Error Rate</td>
<td>-0.000E+00</td>
<td>-0.000E+00</td>
</tr>
<tr>
<td>Bit Error Seconds</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sync Loss Count</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sync Loss Seconds</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
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/2 ports Loopback capability.
- PacketExpert™ 10GX supports Layer-wise Loopback as well as Smart Loopback.
- The above picture depicts the Ethernet Loopback type, swaps Source and Destination MAC addresses before sending back the packet.
Loopback Testing (all ports/2 ports)

- Supports Loopback on 10G / 1G ports
- Loopback Types – Smart Loopback, Layer 1, Ethernet, IP, UDP
- General statistics per port (similar to BERT port level statistics)
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.
In single port RFC 2544 test,

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

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

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

Throughput

- Port Selection: P1 -> P2
- Tx Configuration
  - Trial Duration (sec): 60
  - Number Of Trials: 1
  - Port2 To Port3
    - Min Bandwidth: 1.00
    - Max Bandwidth: 99.00
  - Port3 To Port2
    - Min Bandwidth: 1.00
    - Max Bandwidth: 99.00

Latency

- Port Selection: P1 -> P2
- Tx Configuration
  - Trial Duration (sec): 10
  - Number Of Trials: 1
  - Port2 To Port3
    - Bandwidth: 100.00
  - Port3 To Port2
    - Bandwidth: 100.00

Frame Loss

- Port Selection: P1 -> P2
- Tx Configuration
  - Trial Duration (sec): 10
  - Number Of Trials: 1
  - Port2 To Port3
    - Min Bandwidth: 1.00
    - Max Bandwidth: 100.00
  - Port3 To Port2
    - Min Bandwidth: 1.00
    - Max Bandwidth: 100.00

Back-to-Back

- Port Selection: P1 -> P2
- Tx Configuration
  - Trial Duration (sec): 10
  - Number Of Trials: 1
  - Port2 To Port3
    - Burst Size: 400
    - No Of Bursts: 1
  - Port3 To Port2
    - Burst Size: 400
    - No Of Bursts: 1
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).
Graphs

Throughput

Latency
Graphs

Back-to-Back

Frame Loss
Port Statistics

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

Configuration

PDF Report

CSV Report

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: PacketExpert10G

Generate Report
ITU-T Y.1564 (ExpertSAM)
Ethernet Network Testing

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

• **Service Performance Test** - transmits all configured traffic streams simultaneously CIR confirming all traffic is able to transverse the network under full load with the above-mentioned parameters.
Highlights

• Complete validation of Ethernet service-level agreements (SLAs) in a single test

• ITU-T Y.1564 standard compliance

• Service Configuration and Service Performance tests methodology supported.

• KPIs like Information Rate (IR) or Throughput, Frame Loss Ratio (FLR), Frame Transfer Delay (FTD) or Latency, and Frame Delay Variation (FDV) or Jitter, measured simultaneously for multi streams, and Pass/Fail verdict declared.

• Capability to generate traffic at throughput of CIR (guaranteed traffic), EIR (best effort bandwidth), and traffic policing (dropped bandwidth) rates ensuring Key performance indicators (KPI) validation

• EMIX frame sizes supported per service – up to 7 frame sizes can be defined per service

• Supports multiple services with varying performance requirements that meets full load conditions

• Stacked VLAN supported – C-Tag and S-Tag to simulate Carrier Ethernet traffic

• Simultaneous validation of all the services quality over time
## RFC 2544 VS Y.1564 (ExpertSAM)

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

Service Configuration Collapsed Summary View

Service Configuration Expanded View
## Service Configuration Test Results

### Service Result Overview

<table>
<thead>
<tr>
<th>#</th>
<th>Service Name</th>
<th>Verdict</th>
<th>Current Step</th>
<th>Max IR (Mbps)</th>
<th>FLR (%)</th>
<th>Max FTD (msec)</th>
<th>FTD (Max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Service1</td>
<td>✓</td>
<td></td>
<td>99.9256</td>
<td>0.0000</td>
<td>0.0010</td>
<td>0.0001</td>
</tr>
<tr>
<td>2</td>
<td>Service2</td>
<td>✓</td>
<td></td>
<td>10.0001</td>
<td>0.0000</td>
<td>0.0009</td>
<td>0.0001</td>
</tr>
<tr>
<td>3</td>
<td>Service3</td>
<td>✓</td>
<td></td>
<td>4.0000</td>
<td>0.0000</td>
<td>0.0131</td>
<td>0.0001</td>
</tr>
<tr>
<td>4</td>
<td>Service4</td>
<td>✓</td>
<td></td>
<td>99.9256</td>
<td>0.0000</td>
<td>0.0016</td>
<td>0.0001</td>
</tr>
<tr>
<td>5</td>
<td>Service5</td>
<td>✓</td>
<td></td>
<td>99.9256</td>
<td>0.0000</td>
<td>0.0016</td>
<td>0.0001</td>
</tr>
<tr>
<td>6</td>
<td>Service6</td>
<td>✓</td>
<td></td>
<td>99.9256</td>
<td>0.0000</td>
<td>0.0017</td>
<td>0.0001</td>
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<tr>
<td>7</td>
<td>Service7</td>
<td>✓</td>
<td></td>
<td>59.9482</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0001</td>
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<tr>
<td>8</td>
<td>Service8</td>
<td>✓</td>
<td></td>
<td>199.8890</td>
<td>0.0000</td>
<td>0.0016</td>
<td>0.0001</td>
</tr>
<tr>
<td>9</td>
<td>Service9</td>
<td>✓</td>
<td></td>
<td>7.0011</td>
<td>0.0000</td>
<td>0.0016</td>
<td>0.0001</td>
</tr>
<tr>
<td>10</td>
<td>Service10</td>
<td>✓</td>
<td></td>
<td>77.9629</td>
<td>0.0000</td>
<td>0.00015</td>
<td>0.0001</td>
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<tr>
<td>11</td>
<td>Service11</td>
<td>✓</td>
<td></td>
<td>199.8890</td>
<td>0.0000</td>
<td>0.0016</td>
<td>0.0001</td>
</tr>
<tr>
<td>12</td>
<td>Service12</td>
<td>✓</td>
<td></td>
<td>41.9642</td>
<td>0.0000</td>
<td>0.0015</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

### Service Configuration Results Details

<table>
<thead>
<tr>
<th>Test</th>
<th>Verdict</th>
<th>IR (Cum)</th>
<th>IR (Min)</th>
<th>IR (Max)</th>
<th>FLR (Cum)</th>
<th>FLR (Min)</th>
<th>FTD (Cum)</th>
<th>FTD (Min)</th>
<th>FTD (Max)</th>
<th>FDV (Cum)</th>
<th>FDV (Min)</th>
<th>FDV (Max)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step1</td>
<td>PASS</td>
<td>29.96</td>
<td>29.96</td>
<td>29.96</td>
<td>0.15</td>
<td>0.02135</td>
<td>0.02135</td>
<td>0.02135</td>
<td>0.02135</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>Step2</td>
<td>PASS</td>
<td>49.95</td>
<td>49.95</td>
<td>49.95</td>
<td>10.00</td>
<td>0.02135</td>
<td>0.02135</td>
<td>0.02135</td>
<td>0.02135</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>CIR</td>
<td>PASS</td>
<td>99.99</td>
<td>99.99</td>
<td>99.99</td>
<td>10.00</td>
<td>0.02135</td>
<td>0.02135</td>
<td>0.02135</td>
<td>0.02135</td>
<td>0.000000</td>
<td>0.000000</td>
<td>0.000000</td>
</tr>
<tr>
<td>EIR(Green)</td>
<td>PASS</td>
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Service Performance Test Overall Status

Overall Status: PASS

Test: Service Performance Test
Stream No: -
Subtest: -
Step No: -

Alarm
Link Status
IR
FLR
FTD
FDV

Status: All green
### Service Performance Test Results

<table>
<thead>
<tr>
<th>Test</th>
<th>Verdict</th>
<th>IR (Curr)</th>
<th>IR (Min)</th>
<th>IR (Mean)</th>
<th>IR (Max)</th>
<th>FLR</th>
<th>FLR (Rate)</th>
<th>FLT (Curr)</th>
<th>FLT (Min)</th>
<th>FLT (Mean)</th>
<th>FLT (Max)</th>
<th>FDV (Curr)</th>
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<th>FDV (Mean)</th>
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<td>0.001961</td>
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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.
Wirespeed Ethernet Packet Capture and Playback with Hardware Filtering
Following modules are supported in Record/Playback:

- Record Only mode
- Playback Only mode
- Record and Playback mode
- Record and Playback (per port) mode
Wirespeed Packet Filters and Triggers

- Filter packets and record only packets of interest
- Capture simultaneously on 2 ports with 120 bytes deep filter per port (for record application) and set filter on any one of the ports or all ports
- Packet filtering can be based on all Layer 2 (Ethernet), Layer 3 (IP) Layer 4 (UDP/TCP) Headers
- Up to 16 filters can be defined per port. Each filter is up to 120 bytes wide
- Filter can be set to each bit in the packet (Raw mode) or each field (Packet Mode)
- Generates a trigger (1 Microsecond pulse) for each packet that passes the filter
- Filter on various header fields like Source/Destination MAC Address, VLAN Id, MPLS Label, Source/Destination IPv4 Address, Source/Destination UDP ports
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.
Results - Record and Playback Mode

<table>
<thead>
<tr>
<th>Playback Statistics</th>
<th>Values</th>
<th>Rx Results</th>
<th>Values</th>
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<td>Capture Duration</td>
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<td>Total Rx Frames</td>
<td>92</td>
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<tr>
<td>Total Frames transmitted</td>
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<tr>
<td></td>
<td></td>
<td>Frames matched to f...</td>
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<td>Overflowed Frames</td>
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<td></td>
<td></td>
<td>Overflowed Count</td>
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<td></td>
<td>Transferred Frames</td>
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<td></td>
<td>Disk Write Rate (Byt...</td>
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<td></td>
<td>Disk Write Buffer Util...</td>
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<td></td>
<td></td>
<td>Capture File Size (By...</td>
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<tr>
<td></td>
<td></td>
<td>Captured Frames</td>
<td>92</td>
</tr>
</tbody>
</table>
SIMULATE REAL-WORLD IP NETWORKS
Impairments, Delay, Errors, Loss, Optical, Electrical...
Overview
How does GL simulate real-world IP Networks? What is GL’s IPNetSim?

❖ Lab Testing Solution - application and automation
❖ Emulate Full Duplex 1 Gbps and 10 Gbps networks

❖ Real-world network conditions by imposing impairments
❖ Multiple streams independently configured
Application Overview

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

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

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

❖ Evaluate the stability of network devices (switches, VoIP Phones, VoIP PBXs, Set-top boxes and VoD Servers.)
“Stream” Overview

Stream Definition
(MAC, VLAN, MPLS, IP, UDP)

- Ex: Dst MAC Addr
- Ex: VLAN ID
- Ex: ANY

Stream Definition ‘16’

WAN Emulation
- Throttling
- Reordering
- Duplication
- Delay
- Error
- Loss

Port 1 → P1 → LAN A → Stream 1 → Stream 2 → Bypass Stream → Stream 1 → Stream 2 → LAN B → Port 2
Define Streams in Packet Mode
Define Streams in *Raw Mode*
Traffic which exceeds the stated rate is **silently** dropped.

- UDP Applications will experience **data loss**.
- TCP Applications should adapt via **congestion-avoidance algorithms**.

- Simulate WAN Applications where **Traffic Policing Policies** may be in effect, ie **Service Level Agreements** between Provider and Customer.
Apply **Static** Delay, or a **Uniform** or **Exponential** distribution between a minimum and maximum.

- Delay a packet **up to 8000 ms** in 1ms increments.
❖ Reorder 1 out of every X packets.
❖ Set a minimum time in ms to hold the reordered packet
❖ Set a maximum time in ms to hold the reordered packet
# Software Specification

<table>
<thead>
<tr>
<th>Multi-streams WAN Emulation - IPNetSim™</th>
<th>Single-stream WAN Emulation - IPLinkSim™</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stream Definition</strong></td>
<td>-NA-</td>
</tr>
<tr>
<td>• Hardware wire-speed filters (up to 16 links)</td>
<td></td>
</tr>
<tr>
<td>➢ Packet Mode (field headers)</td>
<td></td>
</tr>
<tr>
<td>➢ Raw Mode (bit level)</td>
<td></td>
</tr>
<tr>
<td><strong>Parameters</strong></td>
<td></td>
</tr>
<tr>
<td>• IP Source and Destination Address Range</td>
<td></td>
</tr>
<tr>
<td>• UDP Source and Destination Port Range</td>
<td></td>
</tr>
<tr>
<td>• MAC Addresses</td>
<td></td>
</tr>
<tr>
<td>• VLAN ID</td>
<td></td>
</tr>
<tr>
<td>• MPLS Label</td>
<td></td>
</tr>
<tr>
<td><strong>WAN Emulation Parameters</strong></td>
<td><strong>WAN Emulation Parameters</strong></td>
</tr>
<tr>
<td>• Bandwidth control – 1 Kbps up to 10 Gbps</td>
<td>• Bandwidth control - 10 Kbps up to 1000 Mbps</td>
</tr>
<tr>
<td>• Latency/Delay</td>
<td>• Latency/Delay</td>
</tr>
<tr>
<td>➢ 0 milliseconds up to 1.25 seconds (1250 msec) per stream (for 1Gbps link)</td>
<td>➢ 0 milliseconds to 8 seconds (8000 milliseconds) (for 1G/10 Gbps link)</td>
</tr>
<tr>
<td>➢ 0 milliseconds up to 0.5 seconds (500 msec) per stream (for 10 Gbps link)</td>
<td>➢ single delay, uniform, random distributions</td>
</tr>
<tr>
<td>➢ single delay, uniform, random distributions</td>
<td></td>
</tr>
<tr>
<td>• Packet Loss Rate - 0–100%</td>
<td>• Packet Loss Rate - 0–100%</td>
</tr>
<tr>
<td>• Packet Reordering Rate - 0-100% with Delay range of up to 2 seconds</td>
<td>• Packet Reordering Rate - 0-100% with Delay range of up to 8 seconds</td>
</tr>
<tr>
<td>• Packet Duplication Rate - 0 - 100%</td>
<td>• Packet Duplication Rate - 0 - 100%</td>
</tr>
<tr>
<td>• Logic Error Insertion Rate - $10^{-1}$ to $10^{-9}$</td>
<td>• Logic Error Insertion Rate - $10^{-1}$ to $10^{-9}$</td>
</tr>
<tr>
<td>• Maximum Frame Size Supported – 2048 bytes</td>
<td>• FCS Error insertion Rate - $10^{-1}$ to $10^{-9}$</td>
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</tbody>
</table>
PacketBroker - Passive Ethernet Tap
PacketBroker in Network

Pass-through Packets
Filter Packets
Aggregate Filter Packets
Modify Packets
Drop Filtered Packets
Trigger TTL Pulses
Packet Tap, Filter, Aggregation, Modification, & Output

- **Packet Modifier**
- **Filtering**
  - L2/ L3/ L4/ Payload Filters
- **Aggregation**

**INTERNAL MEMORY**
(2GB DDR2 RAM)

**Port 1**
Filtered, Aggregated, & Modified Traffic from Port 2 & Port 3

**Port 2**
Filtered, Aggregated, & Modified Traffic from Port 3 only

**Port 3**
Original Ethernet Packet Fields

**Port 4**
Filter Configuration Menu

Basic Mode Filtering

Group Mode Filtering
Filter Configuration

Raw Mode Filtering

- 16 Filters
- Offset (0-15999)
- 120 Bytes Raw Data/Mask Bytes
Filter Configuration

Packet Mode Filtering

16 Filters

Packet Layers

Header fields

Packet Layer Summary
Group Mode Filter configuration

- PacketBroker includes an option to group the configured filters.
- Any number of individual filters can be selected to form a group. Using “AND” and “OR” operators and any combination of filter groups can be created.
- The multiple filter Groups created can be further grouped to form Super Groups using “AND” or “OR” operators.
- The result of all the filters within the group is taken and either “OR”ed or “AND”ed and a final single Group result - TRUE or FALSE is obtained.
ExpertTCP™ -TCP Throughput Testing (RFC 6349)
ExpertTCP™ (RFC-6349 Testing)
TCP Principle
(Packet Loss and Waiting for ACK Reduces Throughput)
Network Setup

All settings configured locally on the client side
Statistics and Periodic Results

Statistics are updated every second and includes -

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

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

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

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

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

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

Buffer Delay - measure of how much the RTT increases during the actual TCP Throughput test compared to the Baseline RTT
Multi-Stream Traffic Generator and Analyzer
(1 Gbps, 2.5 Gbps, or 10 Gbps)
### Multi-Stream Traffic Generator & Analyzer Results

**Horizontal View**

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<th>Stream No</th>
<th>Seconds</th>
<th>TFrames</th>
<th>RXFrames</th>
<th>RXBytes</th>
<th>FL Count</th>
<th>FLR</th>
<th>IR (Cur)</th>
<th>IR (Avg)</th>
<th>FTD Unit</th>
<th>FTD</th>
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<td>0.00</td>
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</tr>
</tbody>
</table>
Throughput (IR) Graph
Frame Delay Variation - FDV Graph
Frame Transfer Delay - FTD Graph
Report Generation in PDF and CSV Format
Command Line Interface (CLI)
MAPS™ CLI Client/Server Architecture

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

- C# Client
  - User C# Code
  - C# API (dll)
  - MAPS Client Library C# dll

- Python Client
  - User Python Scripts
  - Python API Scripts
  - MAPS Client Library Python pyd

- TCL Client
  - User TCL Scripts
  - TCL API Scripts
  - MAPS Client Library C dll

MAPS CLI Command/Responses Over TCP/IP

LAN

PacketExpert™ MAPSTM CLI SERVER
Working Principle of MAPS™ CLI

Client User (TCL, Python, C#)
- Start Script1
- User Events
- Wait for Response
- Stop Script1

MAPS Client IFC
- Storage Space for Script ID
- Command Processor
- Response Processor

MAPS CLI SERVER
- Server Command
- Server Response
MAPS™ CLI Server

CLI Maps:CLI (PacketExpert)

View Latest Command

2014-04-24 15:00:37.799000: UserEvent 2: "SetEnableMPLS" # "Direction"="TX", "EnableMPLS"="True", "PortIndex"=3;
2014-04-24 15:00:39.030000: UserEvent 2: "SetMLSPnumStacks" # "Direction"="TX", "NumMLSPStacks"=3, "PortIndex"=3;
2014-04-24 15:00:39.301000: UserEvent 2: "SetMLSPParameters" # "Direction"="TX", "MPLSconfig"=10000, "MPLSValue"="1200", "MLPSStacks"=0, "MLSTTL"=120, "PortIndex"=3;
2014-04-24 15:00:39.823000: UserEvent 2: "SetMLSPParameters" # "Direction"="TX", "MPLSconfig"=10000, "MPLSValue"="1200", "MLPSStacks"=0, "MLSTTL"=120, "PortIndex"=3;
2014-04-24 15:00:39.848000: UserEvent 2: "SetMLSPParameters" # "Direction"="TX", "MPLSconfig"=10000, "MPLSValue"="1200", "MLPSStacks"=0, "MLSTTL"=120, "PortIndex"=3;
2014-04-24 15:00:39.975000: UserEvent 2: "EnableLDPChksumCompute" # "Direction"="TX", "EnableIPv6Identification"="True", "PortIndex"=3;
2014-04-24 15:00:39.978000: UserEvent 2: "SetIPv6Address" # "Direction"="TX", "IPv6Address"="fe80::1/64", "IPv6Address"="fe80::1/64", "IPv6Address"="fe80::1/64", "PortIndex"=3;
2014-04-24 15:00:39.978000: UserEvent 2: "SetIPv6Address" # "Direction"="TX", "IPv6Address"="fe80::1/64", "IPv6Address"="fe80::1/64", "IPv6Address"="fe80::1/64", "PortIndex"=3;
2014-04-24 15:00:39.978000: UserEvent 2: "SetIPv6Address" # "Direction"="TX", "IPv6Address"="fe80::1/64", "IPv6Address"="fe80::1/64", "IPv6Address"="fe80::1/64", "PortIndex"=3;
TCL Client
PacketExpert™ Integration with TestShell using TCL Client

TestShell Integration using CLI—Execution of RFC2544 Tests
The Python Client consists of following components:

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

```
Restart: C:\Users\glitteam\desktop\PythonClient_3.5\AllPortBertSampleApplication.py

All PortBert Test
Press any key to continue, 'q' to quit

Running BERT Test
Device Initialized
Module Initialized
Loading Configuration
Load Configuration Done
Start Test........

Bert Started
BERT STATISTICS

TrafficStatus = No Rx Traffic
SyncStatus = Idle
ErrDirStatus = Idle
OutOfSequenceStatus = Idle
RETSStatus = No Rx Data
BERTTime = 00:00:00
BitsReceived = 0
ErrDirCount = 0
ErrDirBytes = 0.0000+000
ErrDirSeconds = 0
SyncLossCount = 0
SyncLossSeconds = 0
OCSCount = 0
OCSSeconds = 0
ErrFrameSeconds = 0

PORT TX STATISTICS

Total Frames = 0
Valid Frames = 0
Number of Bytes = 0
Link Utilization = 0.0
Data Rate = 0.0
Frame Rate = 0.0
Broadcast Frames = 0
Multicast Frames = 0
Control Frames = 0
VLAN Frames = 0
```
C# Client
PacketExpert™ Integration with LabVIEW using C# Client

PacketExpert™ Integration with LabVIEW

Carrier Ethernet (MPLS, VLAN, Q-in-Q)

IP (IP, UDP)

LabVIEW

PacketExpert C# Client API

IP (IP, UDP)
PacketExpert Test System (eg: for RFC 2544), consists of the following –

- TestShell is communicating via the .NET/CLI client
- PacketExpert™ system, i.e, the host PC on which the PacketExpertCSAPI.dll or CLI is running, and the PacketExpert™ hardware, connected to the PC through the USB interface.
Thank you