Ethernet Tester – PacketExpert™

1 Gbps
Portable Unit

- Interfaces
  - 2 x 10/100/1000 Base-T Electrical only
  - 2 x 1000 Base-X Optical OR 10/100/1000 Base-T Electrical
  - Single Mode or Multi Mode Fiber SFP support with LC connector
  - Optional 4-Port SMA Jack Trigger Board (TTL Input/Output)

- Protocols:
  - RFC 2544 compliance
  - ITU-T Y.1564 (ExpertSAM)

- Power:
  - +9 volts, 2.2 Amps

- Bus Interface:
  - USB 2.0
1U Rack Option

- 19” rack option, w/ Embedded Single Board Computer (SBC)
- SBC Specs: Intel Atom CPU, 4GB RAM, Windows® 7, MSATA SSD, 4 USB Ports
PacketExpert™ mTOP™ Probe

- Portable Quad Port Ethernet/VLAN/MPLS/IP/UDP Tester with 4 Electrical Ethernet Ports (10/100/1000 Mbps) and 2 Optical Ports (100/1000 Mbps). Embedded with Single Board Computer (SBC).
- SBC Specs: Intel Core i3 or optional i7 Equivalent, Windows® 10 64-bit Pro Operating System
- Each GigE port provides independent Ethernet/VLAN/MPLS/IP/UDP testing at wire speed for applications such as BERT, RFC 2544, and Loopback. BERT is implemented for all layers.
- RFC 2544 is applicable for Layers 2, 2.5, and 3, and Loopback is applicable for Layers 2, 3, and 4.
PacketExpert SA (PXE112) is a 12-Port PacketExpert™ w/ Embedded Single Board Computer (SBC).

*SBC Specs:* Intel Core i3 or optional i7 Equivalent, 240GB Hard drive, 8G Memory (Min), Windows® 10 64-bit Pro OS, USB 2.0 or 3.0 Ports, ATX Power Supply. 19" 1U Rackmount Enclosure (If options, then x 3).

PacketExpert SA (PXE124) is a 24-Port PacketExpert™ w/ Embedded Single Board Computer (SBC).

*SBC Specs:* Intel Core i3 or optional i7 Equivalent, 240GB Hard drive, 8G Memory (Min), Windows® 10 64-bit Pro OS, USB 2.0 or 3.0 Ports, ATX Power Supply. 19" 2U Rackmount Enclosure (If options, then x 6).
PacketExpert 24 Ports – Hardware Specifications

- **Power (100-240 AC Supply)**
- **On/Off Switch**
- **USB 3.0 Port**
- **Ethemet Port**
- **HDMI Port**
- **USB 2.0**
- **Reset**
- **Back Panel**
- **Front Panel**

- **1000 Mbps Fiber Interface**
- **10/100/1000 Mbps CAT-5 Interface**

Front Panel:
- Port 1-12
- Port 13-24

Back Panel:
- Power
- On/Off Switch
- USB 3.0 Port
- Ethernet Port
- HDMI Port
- USB 2.0
- Reset
Different Applications loaded on same Platform

Note: Only one application can run at a time
Optical Connectors and SFP Transceivers

- PacketExpert™ 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.
PacketExpert™ - 24 Ports Unit
GL’s Appliances in Network

PacketExpert™ 1G
(Multi-Port Device)

PacketExpert™ 1G
(PacketBroker)

PacketExpert™ 1G
(Wirespeed Record Playback)

OC-192/STM-64
Network

IP/ MPLS
Core Network

PacketExpert™ 1G
(BERT, RFC2544, Y.1564, Loopback,
Multi-stream Traffic Generator &
Analyzer, RFC6349)

PacketExpert™ 1G

1Gbps Ethernet

mTOP™ Probe
PacketExpert 1G

PacketExpert™ 1G

1Gbps Ethernet

GL

PacketExpert™ 1G
Stand-alone Portable/ mTOP™ Rack / mTOP™ Probe Platforms
Hardware Based Ethernet / IP Tester
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™
Ethernet / IP Tester

- BERT
- RFC 2544
- Smart Loopback
- ExpertTCP™

- ITU-T Y.1564 (ExpertSAM™)
- Wire-Speed Record / Playback
- PacketBroker
- Multi Stream Traffic Generator and Analyzer
Wire-Speed BERT
### OSI Model

#### Framing Representation

<table>
<thead>
<tr>
<th>Layer</th>
<th>Header Components</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical</td>
<td>Pre, SFD, BERT Pattern, FCS</td>
</tr>
<tr>
<td>Layer 2.5</td>
<td>Pre, SFD, MAC Header, VLAN Header, BERT Pattern, FCS</td>
</tr>
<tr>
<td>Network</td>
<td>Pre, SFD, MAC Header, VLAN Header, MPLS Header, IP, UDP, BERT Pattern, FCS</td>
</tr>
<tr>
<td>Transport</td>
<td>Pre, SFD, MAC Header, VLAN Header, MPLS Header, IP, BERT Pattern, FCS</td>
</tr>
<tr>
<td>Session</td>
<td>Pre, SFD, MAC Header, VLAN Header</td>
</tr>
<tr>
<td>Presentation</td>
<td>Pre, SFD</td>
</tr>
<tr>
<td>Application</td>
<td>Pre, SFD</td>
</tr>
</tbody>
</table>

#### Protocol Layers

- **Application Protocol**: Communication between applications
- **Presentation Protocol**: Encodes data for transmission
- **Session Protocol**: Establishes, maintains, and terminates sessions
- **Transport Protocol**: Provides a reliable communication service
- **Network Protocol**: Provides network addressing and routing
- **Data Link Protocol**: Provides link-level communication
- **Physical Layer**: Transmits digital data over a physical medium

#### Framing Representation Details

- **Preamble**: 7 bytes
- **Start Frame Delimiter (SFD)**: 1 byte
- **MAC Header**:
  - Destination/Source 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**: BERT Test Pattern
- **Frame Check Sum (FCS)**: 4 bytes

---

**Ethernet Payload**
BER Testing at Layer 2

Source PC

MAC Address: aa-aa-aa-aa-aa-aa

Destination PC

MAC Address: bb-bb-bb-bb-bb-bb

Layer 2

Switch

Transmit

Receive
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.
PacketExpert™ 24 Ports - BERT

PacketExpert™ (PX124)

24 Bidirectional BERT streams, each full line rate, up to 1 Gbps

Network (Layer 2-Stack VLAN, MPLS, IP/UDP)

GL Communications
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

### TX

<table>
<thead>
<tr>
<th>Metric</th>
<th>Port 1</th>
<th>Port 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Frames</td>
<td>941 265</td>
<td>941 202</td>
</tr>
<tr>
<td>Valid Frames</td>
<td>941 265</td>
<td>941 265</td>
</tr>
<tr>
<td>Bad Frames</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number Of Bytes</td>
<td>1,425,105,490</td>
<td>1,425,100,940</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>
</tbody>
</table>

### RX

<table>
<thead>
<tr>
<th>Metric</th>
<th>Port 1</th>
<th>Port 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid Frames</td>
<td>940 916</td>
<td>940 336</td>
</tr>
<tr>
<td>Bad Frames</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Number Of Bytes</td>
<td>1,424,546,824</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>
</tbody>
</table>

### Status

<table>
<thead>
<tr>
<th>Metric</th>
<th>Port 1</th>
<th>Port 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rx Traffic</td>
<td><img src="#" alt="Green" /></td>
<td><img src="#" alt="Green" /></td>
</tr>
<tr>
<td>Sync Status</td>
<td><img src="#" alt="Green" /></td>
<td><img src="#" alt="Green" /></td>
</tr>
<tr>
<td>Bit Errors</td>
<td><img src="#" alt="Green" /></td>
<td><img src="#" alt="Green" /></td>
</tr>
<tr>
<td>Out Of Sequence Packets</td>
<td><img src="#" alt="Green" /></td>
<td><img src="#" alt="Green" /></td>
</tr>
</tbody>
</table>

### Statistics

<table>
<thead>
<tr>
<th>Metric</th>
<th>Port 1</th>
<th>Port 2</th>
</tr>
</thead>
<tbody>
<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>
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™ 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

<table>
<thead>
<tr>
<th>Loopback</th>
<th>Rx</th>
<th>Tx</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethernet Dst MAC Address</td>
<td>Ex: bb-bb-bb-bb-bb-bb</td>
<td>Ethernet Src MAC Address</td>
</tr>
<tr>
<td>Ethernet Len/Type Field</td>
<td></td>
<td>Ethernet Len/Type Field</td>
</tr>
<tr>
<td>Payload</td>
<td>FCS</td>
<td>Payload</td>
</tr>
</tbody>
</table>

- PacketExpert™ has all ports/2 ports Loopback capability. PacketExpert™ 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 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.
PacketExpert™ 24 Ports – RFC 2544

PacketExpert™ SA (PXE124)

6 simultaneous bidirectional RFC 2544 test at full line rate, up to 1 Gbps

Network
(Layer2 – StackVLAN, MPLS, IP/UDP)
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

<table>
<thead>
<tr>
<th>Port Selection</th>
<th>P1 -&gt; P2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tx Configuration</strong></td>
<td></td>
</tr>
<tr>
<td>Trial Duration (sec)</td>
<td>60</td>
</tr>
<tr>
<td>Number Of Trials</td>
<td>1</td>
</tr>
</tbody>
</table>

| Port2 To Port3       |          |
| Min Bandwidth        | 1.00     |
| Max Bandwidth        | 99.00    |

| Port3 To Port2       |          |
| Min Bandwidth        | 1.00     |
| Max Bandwidth        | 99.00    |

### Latency

<table>
<thead>
<tr>
<th>Port Selection</th>
<th>P1 -&gt; P2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tx Configuration</strong></td>
<td></td>
</tr>
<tr>
<td>Trial Duration (sec)</td>
<td>10</td>
</tr>
<tr>
<td>Number Of Trials</td>
<td>1</td>
</tr>
</tbody>
</table>

| Port2 To Port3       |          |
| Bandwidth            | 100.00   |

| Port3 To Port2       |          |
| Bandwidth            | 100.00   |

### Frame Loss

<table>
<thead>
<tr>
<th>Port Selection</th>
<th>P1 -&gt; P2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tx Configuration</strong></td>
<td></td>
</tr>
<tr>
<td>Trial Duration (sec)</td>
<td>10</td>
</tr>
<tr>
<td>Number Of Trials</td>
<td>1</td>
</tr>
</tbody>
</table>

| 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

<table>
<thead>
<tr>
<th>Port Selection</th>
<th>P1 -&gt; P2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tx Configuration</strong></td>
<td></td>
</tr>
<tr>
<td>Trial Duration (sec)</td>
<td>10</td>
</tr>
<tr>
<td>Number Of Trials</td>
<td>1</td>
</tr>
</tbody>
</table>

| Port2 To Port3       |          |
| Burst Size           | 400      |
| No Of Bursts         | 1        |

| Port3 To Port2       |          |
| Burst Size           | 400      |
| No Of Bursts         | 1        |
• **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**

- **Choose Format**: PDF
- **Title**: PacketExpert
- **User Comments**: Generate RFC 2544 result
- **Header**: RFC2544-Throughput
- **Footer**: GL Communications
- **User Logo**: Expert\{GL\_Logo.png
- **File name**: acketExpert\{report1

**PDF Report**

**CSV Report**
Command Line Interface (CLI)
APIs for Test Automation and Remote Access

LAN Switches, Routers, Gateways, MPLS networks

System Under Test

Ethernet/IP, TCP, UDP

LAN

API Users

TCL, Python, C#

API Links

IPLinkSim

BERT, Loopback, Record Playback

ExpertSAM™ RFC2544

ExpertTCP™ RFC6349

HD PacketExpert™ 1G

Ethernet based SLA Testing

Load Testing

Feature/Functional Testing
MAPS™ CLI Client/Server Architecture

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™ MAPS™ CLI SERVER

Device 1
Device 2
Device 3
Device 4
Device 5
Device 6
Working Principle of MAPS™ CLI

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

MAPS CLI SERVER
- Server Command
- Server Response
TCL Client...
PacketExpert™ Integration with TestShell using TCL Client

TestShell Integration using CLI—Execution of RFC2544 Tests

PacketExpert™ Integration with TestShell
C# Client…

```csharp
namespace PacketExpertCSAPIConsoleApplication
{
    class Program
    {
        static void Main(string[] args)
        {
            PIXAPI my_class = new PIXAPI();
            StringBuilder error_message = new StringBuilder(100);
            /**Initializing PixNetExpert/**
            err = my_class.Init_load(mod, error_message);
            if (err != PacketExpertCSAPI.ErrorCode.PE_NOERROR)
            {
                Console.WriteLine(error_message);
                return;
            }
            else
            {
                Console.WriteLine("All Port BERT module loaded.");
                int32 nports = 0;
                /**Get Number of ports/**
                err = my_class.GetNoPorts(ref nports, error_message);
                Console.WriteLine("No of Ports: ");
                Console.WriteLine(nports);
            }
        }
    }
}
```
PacketExpert™ Integration with LabVIEW using C# Client

PacketExpert™ Integration with LabVIEW

LabVIEW

PacketExpert C# Client API

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

DUT

IP (IP, UDP)

IP (IP, UDP)
Executing Python Script

```
File Edit Shell Debug Options Window Help

RESTART C:\Users\glitteam\Desktop\PythonClient_6\AllPortBertSampleApplication.py
ALLPortBert Test
Press any key to continue, 'q' to quit

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

TrafficStatus = No Rx Traffic
SyncStatus = Idle
BitErrorStatus = Idle
OutOfSequenceStatus = Idle
BERTStatus = No Rx Data
BERTTestTime = 00:00:00
BitsReceived = 0
BitErrorCount = 0
BitErrorRate = 0.000E+00
BitErrorSeconds = 0
SyncLossCount = 0
SyncLossSeconds = 0
OOSCount = 0
OOSSeconds = 0
InterFramSeconds = 0

PORT RX 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
```
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!