
以太网测试仪 – PacketExpert™ 10 Gbps、2.5 Gbps 或 1 Gbps

 **GL Communications Inc.**

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PacketExpert™ 10GX – 便携单元 (PXN100, PXN101)

- **物理规范**

- 长: 8.45 in. (214.63 mm)
- 宽: 5.55 in. (140.97 mm)
- 高: 1.60 in (40.64 mm)

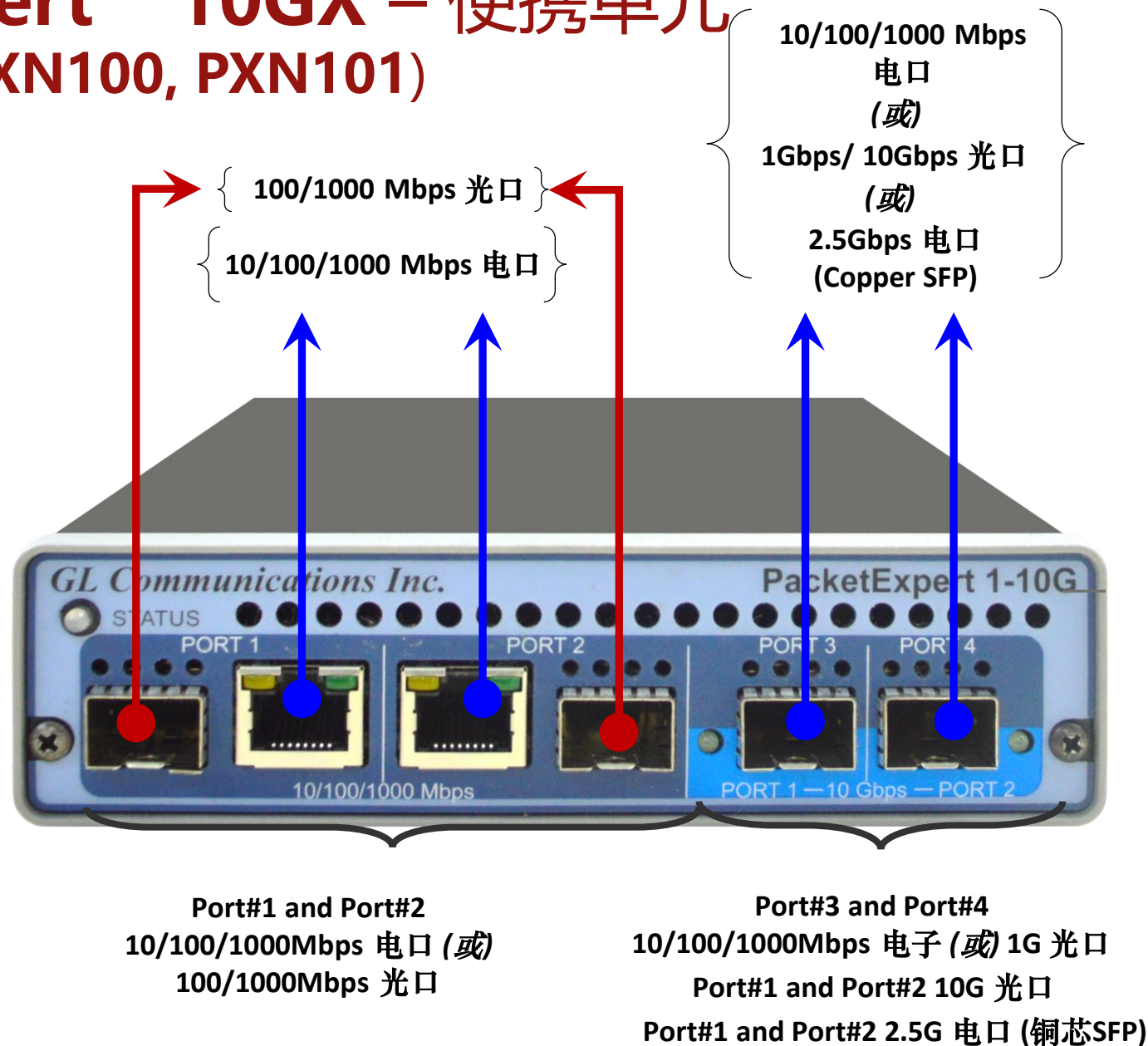
- **外接电源** - +9 volts, 2.0 Amps

- **协议**

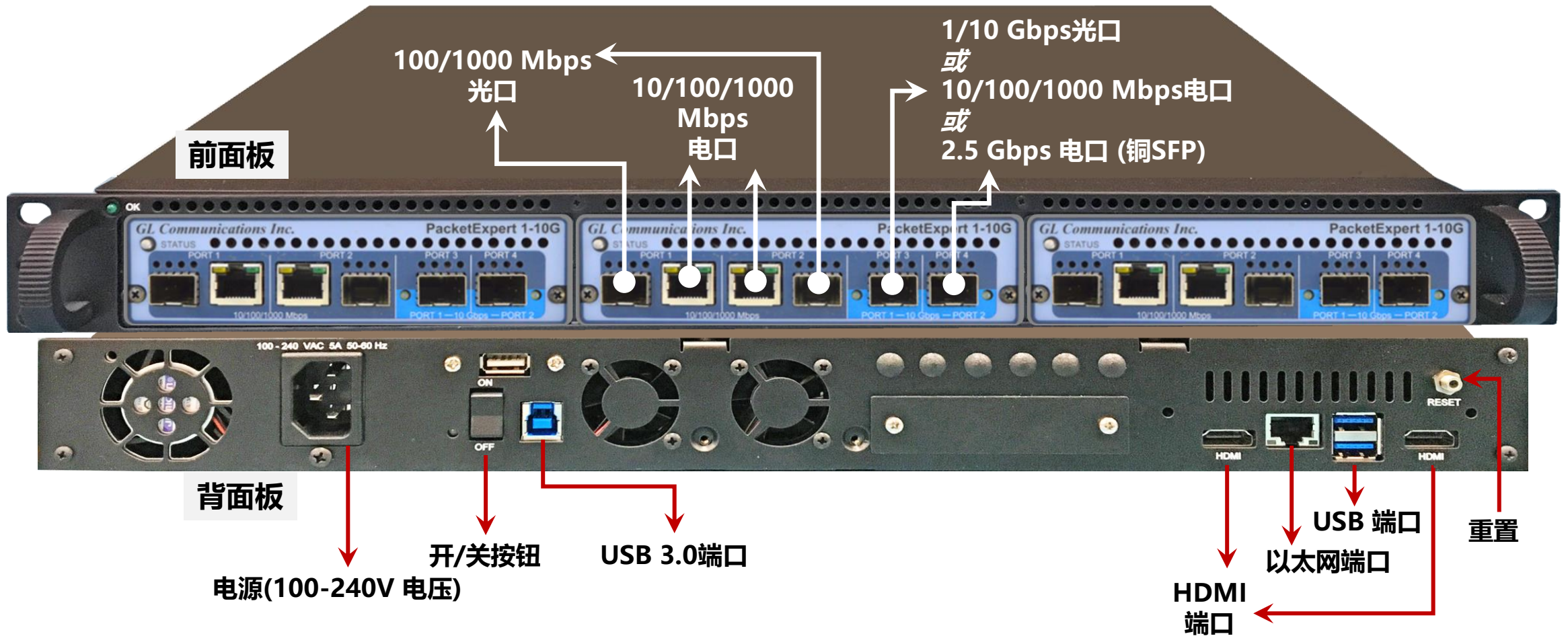
- IEEE 802.3ae LAN PHY 兼容
- RFC 2544 兼容

- **总线接口** - USB 3.0

- 可选 4-Port SMA Jack Trigger 板卡 (TTL 输入/输出)



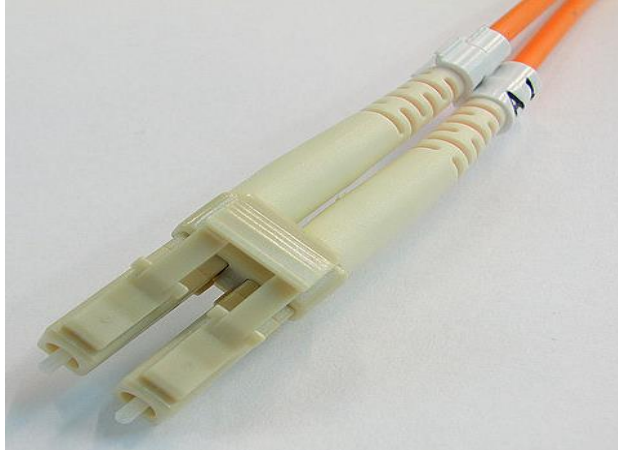
mTOP™ 1U/2U 机架选项



- 19" 机架式, 装有嵌入式单板计算机(SBC)
- SBC 规格: 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

光学连接器和 SFP 收发器

LC 连接



850/1310 nm SFP 模块



- PacketExpert™ 10GX 支持LC 连接器和850/1310 nm SFP (小巧可插拔) 模块
- **注意：**如果客户使用不同类型的连接器，那么我们需要转换器，例如LC-to-SC，LC-to-FC，反之亦然

应用领域

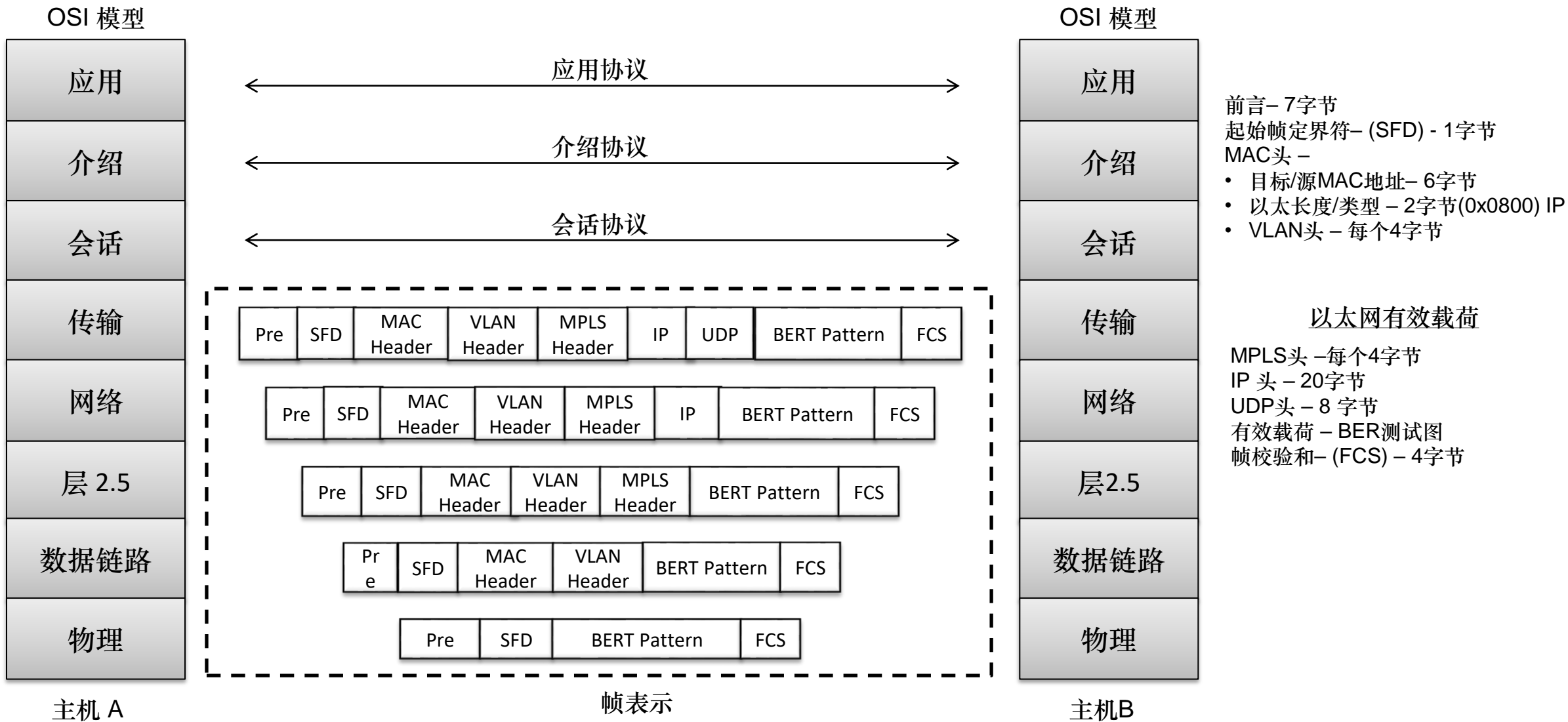
- 测试和验证诸如交换机/路由器等网络设备的QoS参数
- 端到端测试QoS参数的网络路径
- 在发生网络故障或损坏时，对运营商网络进行深入的故障排除
- 三重播放服务的QoS测试，以确保它们完全符合SLA参数
- 地面无线、卫星和其他WAN技术的网络验证
- 在部署之前，实时测试VoIP网络以验证其是否满足质量要求
- 通过模拟丢失和拥塞特性在IP网络上测试视频
- SPF支持可用于宽带聚合应用，城域边缘交换，城域和接入多服务平台，并且适用于快速以太网应用

PacketExpert™ 10GX-以太网/ IP测试仪

- ❖ 误码率测试
- ❖ RFC 2544
- ❖ 智能环回
- ❖ IPNetSim
- ❖ IPLinkSim
- ❖ ITU-T Y.1564 (ExpertSAM™)
- ❖ 线速记录 / 回放
- ❖ PacketBroker
- ❖ 多流流量发生分析仪
- ❖ 基于RFC-6349 的TCP吞吐量测试 (ExpertTCP™)

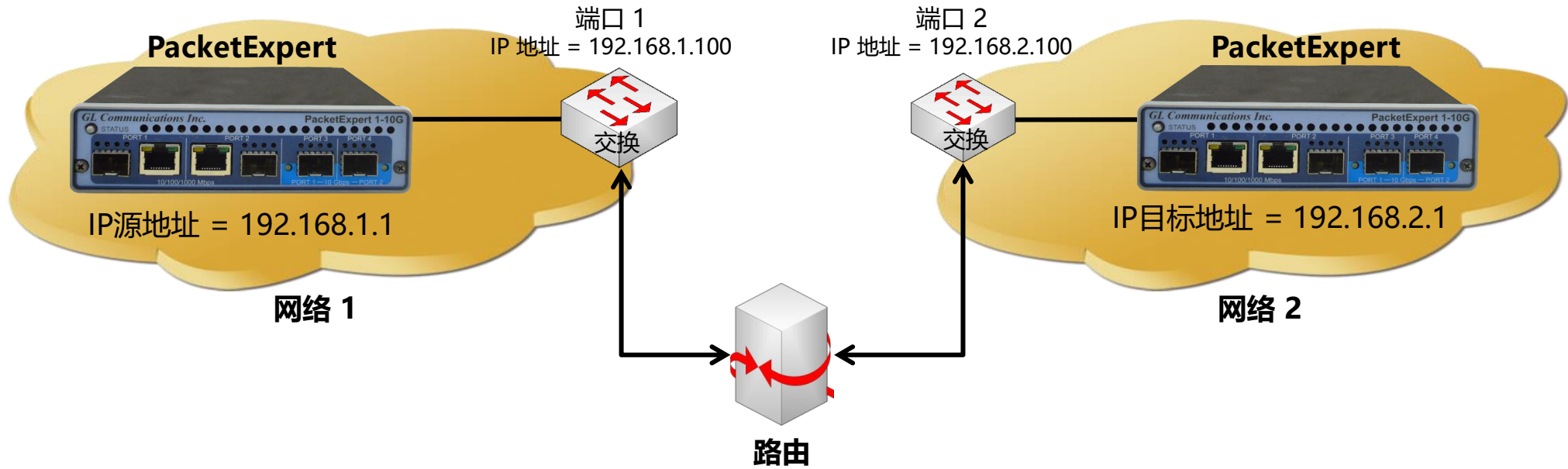
线速误码率测试

OSI 模型



第3/4层的BER测试设置...

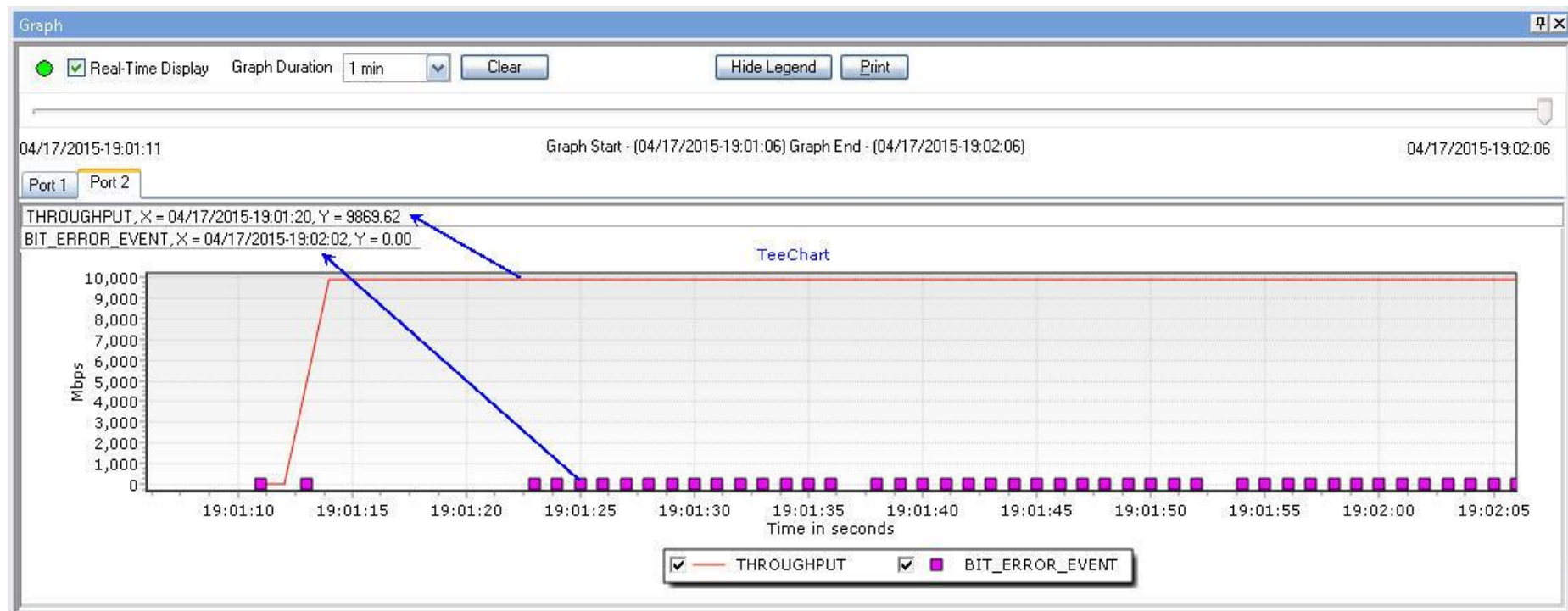
位于不同IP网络中的PacketExpert™之间的第3层测试



在这种情况下，源和目标的PacketExpert™应用程序位于不同的IP网络中。这两个网络通过路由器连接。上面的一个简单示例显示了通过路由器连接的2个LANs。

BERT结果（带有LED）和图表

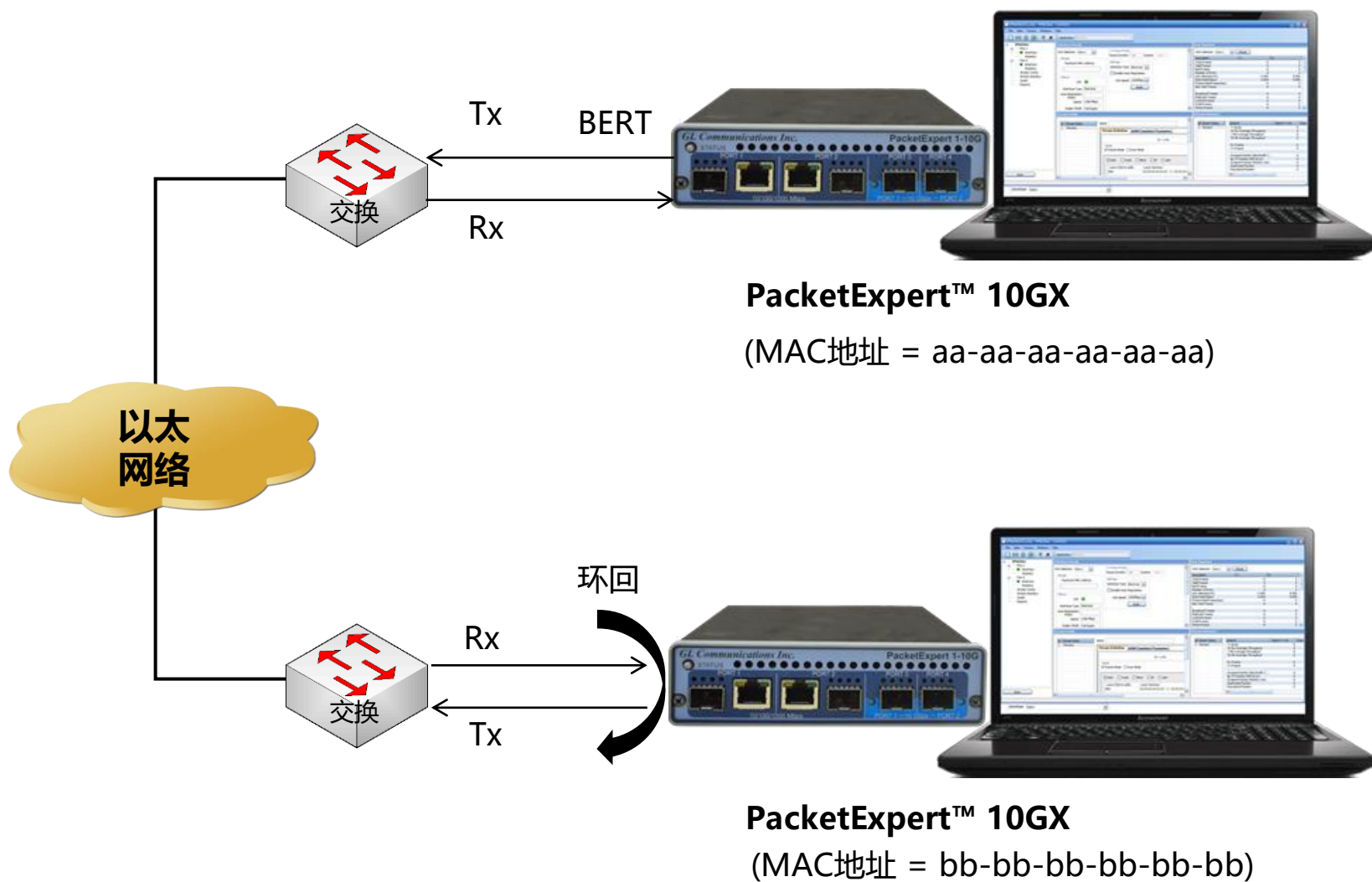
- 可选的序列号插入功能可以检测出乱序数据包和数据包丢失
- 提供了详细的BERT统计信息，例如误码计数，误码率，误码秒等
- 位错误计数以表格和图形格式显示



所有端口结果

All Ports			
Options			
Tx	Port 1	Port 2	
Total Frames		941 285	941 282
Valid Frames		941 285	941 282
Bad Frames		0	0
Number Of Bytes		1 425 105 490	1 425 100 948
Link Utilisation(%)		0.400	0.400
Data Rate(Mbps)		39.470	39.470
Frame Rate(Frames/sec)		3 259	3 259
Non Test Frames		-	-
Rx	Port 1	Port 2	
Valid Frames		940 916	941 336
Bad Frames		0	0
Number Of Bytes		1 424 546 824	1 425 182 704
Link Utilisation(%)		0.400	0.400
Data Rate(Mbps)		39.485	39.485
Frame Rate(Frames/sec)		3 260	3 260
Non Test Frames		0	0
Bert Status	Port 1	Port 2	
Rx Traffic	●	●	
Sync Status	●	●	
Bit Errors	●	●	
Out Of Sequence Packets	●	●	
Bert Statistics	Port 1	Port 2	
Bert Status		Sync	Sync
Test Time		00:04:49	00:04:49
Bits Received		11 036 318 320	11 039 083 920
Bit Error Count		0	0
Bit Error Rate		-0.000E+000	-0.000E+000
Bit Error Seconds		0	0
Sync Loss Count		0	0
Sync Loss Seconds		0	0

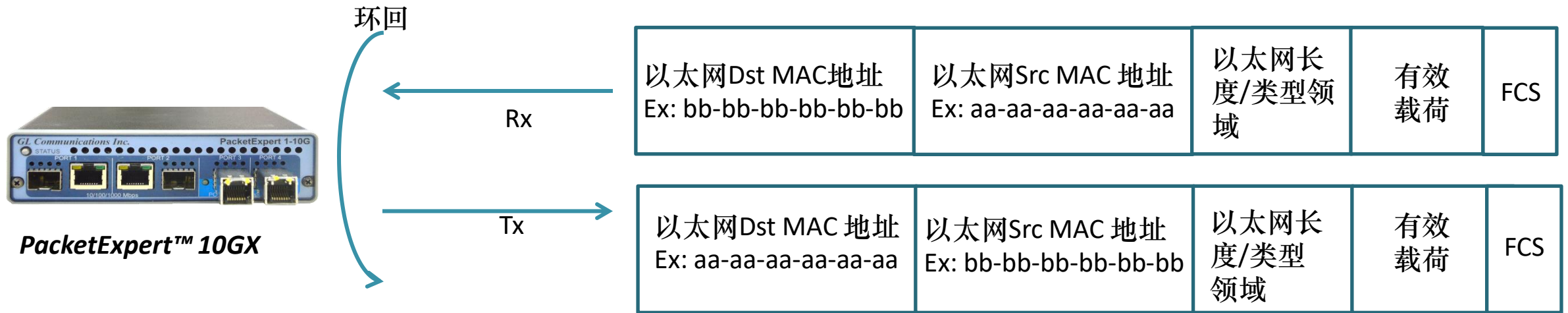
2端口误码率测试和环回



环回有助于轻松进行测试设置，尤其是在另一端位于远程位置的端到端测试中。

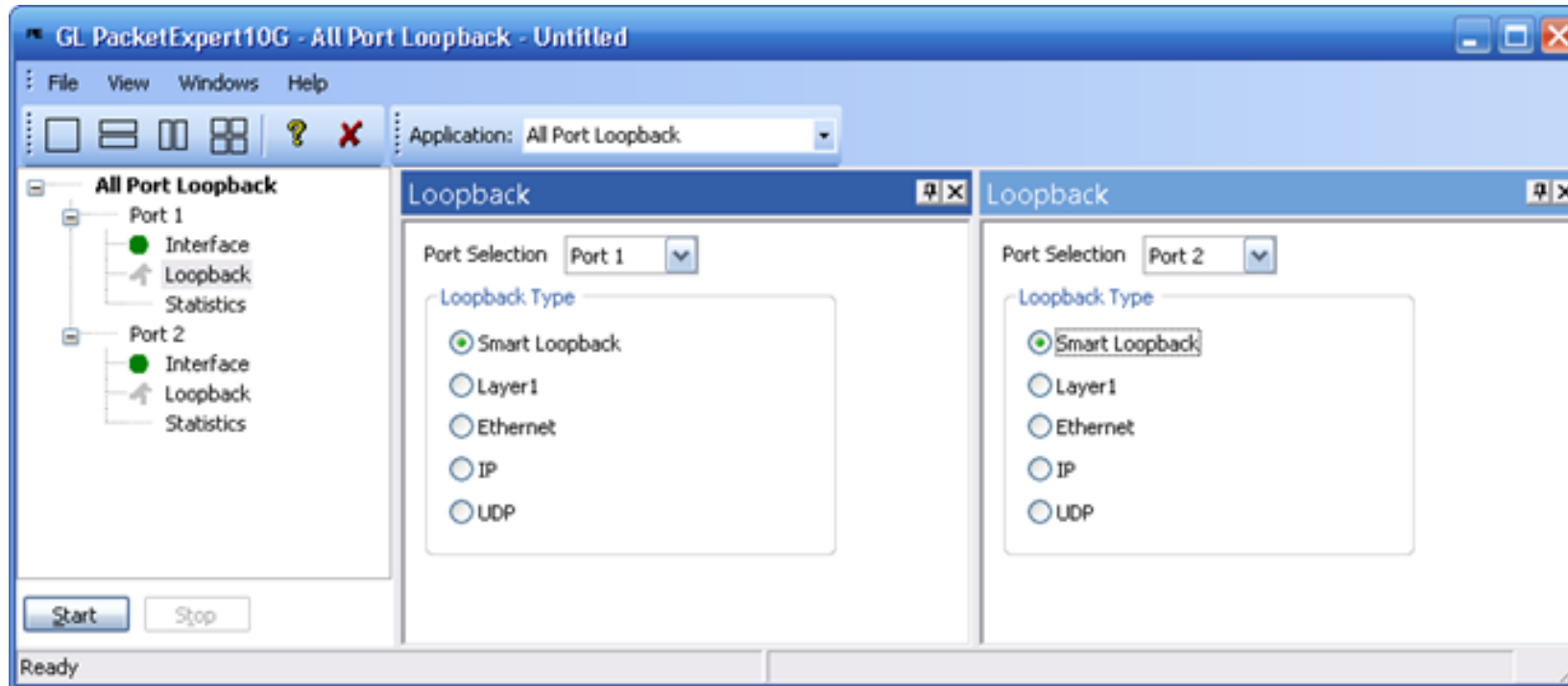
在这种情况下，一台PacketExpert™10GX可以在远端进行恒定的环回，而BERT测试可以在本地随时启动/停止。

层2 – 以太网环回类型



- PacketExpert™ 10GX具有所有端口/ 2个端口环回功能
- PacketExpert™ 10GX支持分层环回和智能环回
- 上图描绘了以太网环回类型，在发送回数据包之前交换源和目标MAC地址

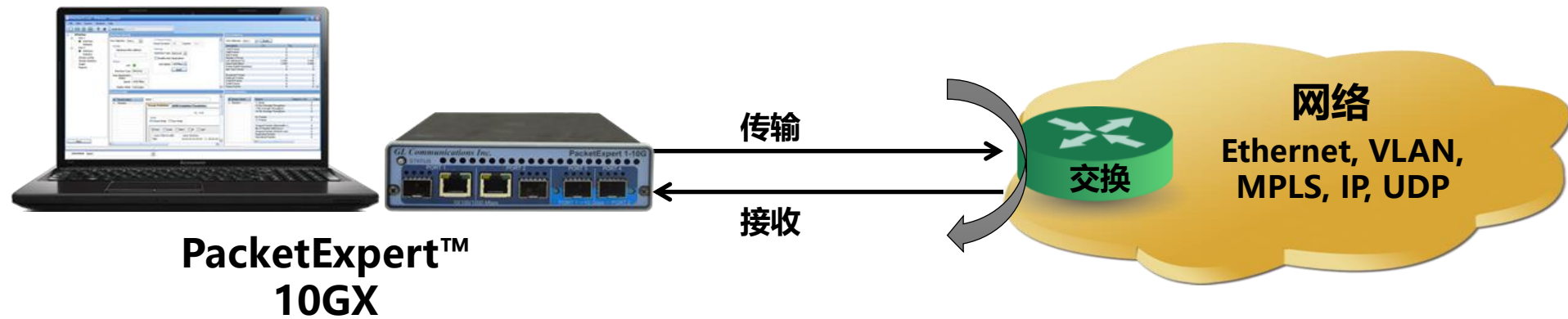
环回测试 (所有端口/2口)



- 支持10G / 1G口环回
- 环回类型 – 智能环回、层 1、以太网、IP、UDP
- 每个端口的常规统计信息 (类似于BERT端口级别的统计信息)

RFC 2544 测试

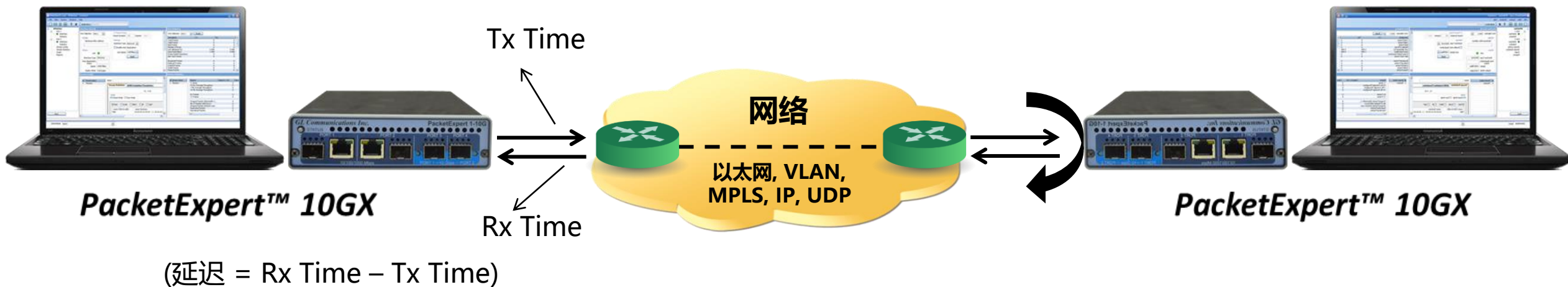
Dual RFC 2544 测试



RFC 2544测试应用程序包括以下测试:

- 吞吐量 — 每秒可传输的最大帧数, 无任何错误
- 延迟 — 测量帧从始发设备通过网络到达目标设备所需的时间
- 帧丢失 — 在过载情况下测量网络的响应
- 背靠背 — 它测量帧丢失之前以全线速接收的最大帧数

单口RFC 2544



单口RFC 2544测试

- 对于PacketExpert™1G，可以一次在端口2 或 端口3上进行RFC 2544测试，但是不可能同时在两个端口（端口2，端口3）上运行RFC 2544测试。
- 对于PacketExpert™10G或10GX，可以一次在端口1 或 端口2上进行RFC 2544测试，但是不可能同时在两个端口（端口1，端口2）上运行RFC 2544测试。

重点

- 吞吐量、背对背、延迟和帧丢失测试支持端口之间的单向和双向流量
- 在电/光（1000Mbps）端口和仅光（10G）端口上支持RFC 2544
- 包括各种参数配置，例如测试选择、帧大小选择、单向/双向、试验次数、试用持续时间等
- 用户定义的选项，用于配置各种数据包头参数，例如MAC地址、IP地址、UDP端口、VLAN ID、MPLS标签等
- 结果以表格和图形格式显示

全局配置

Global Configuration ⏏

Port Selection P1 -> P2 ▾

Minimum Frame Length 64

Max Frame Length 16000

Frame Size

Quantity 20 ▾

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

Test Procedure

- Throughput
- Latency
- Frame Loss
- Back-ToBack

Port Selection

East Port	Direction	West Port
P1 ▾	<--> ▾	P2 ▾

个别测试配置详细信息

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 % ▼

吞吐量

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 % ▼

延迟

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 % ▼

帧丢失

Back To Back ✕

Port Selection P1 -> P2 ▼

Tx Configuration

Trial Duration (sec) 10

Number Of Trials 1

Port2 To Port3

Burst Size 400 msec

No Of bursts 1

Port3 To Port2

Burst Size 400 msec

No Of Bursts 1

背对背

结果

- **吞吐量** - 显示相对 (链接速度的百分比) 和绝对 (以Mbps为单位) 的吞吐量值
- **延迟** - 以微秒为单位显示
- **背对背** - 以帧/突发显示
- **丢帧** - 显示帧丢失率 (%) 与尝试的帧率 (以链接速度%为单位)

RFC Results

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

Status: **Throughput** Latency Backtoback Frameloss

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

RFC Results

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

Status: Throughput **Latency** Backtoback Frameloss

Frame Size	Results
64	14 880 952 Frames\Burst 14 880 952 Frames\Burst
128	8 445 945 Frames\Burst 8 445 945 Frames\Burst
256	4 528 985 Frames\Burst 4 528 985 Frames\Burst
512	2 349 624 Frames\Burst 2 349 624 Frames\Burst
1024	1 197 318 Frames\Burst 1 197 318 Frames\Burst
1280	961 538 Frames\Burst 961 538 Frames\Burst
1518	812 743 Frames\Burst 812 743 Frames\Burst

RFC Results

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

Status: Throughput Latency **Backtoback** Frameloss

Frame Size	Results
64	0.059 us 0.059 us
128	0.059 us 0.059 us
256	0.059 us 0.060 us
512	0.059 us 0.059 us
1024	0.059 us 0.059 us

RFC Results

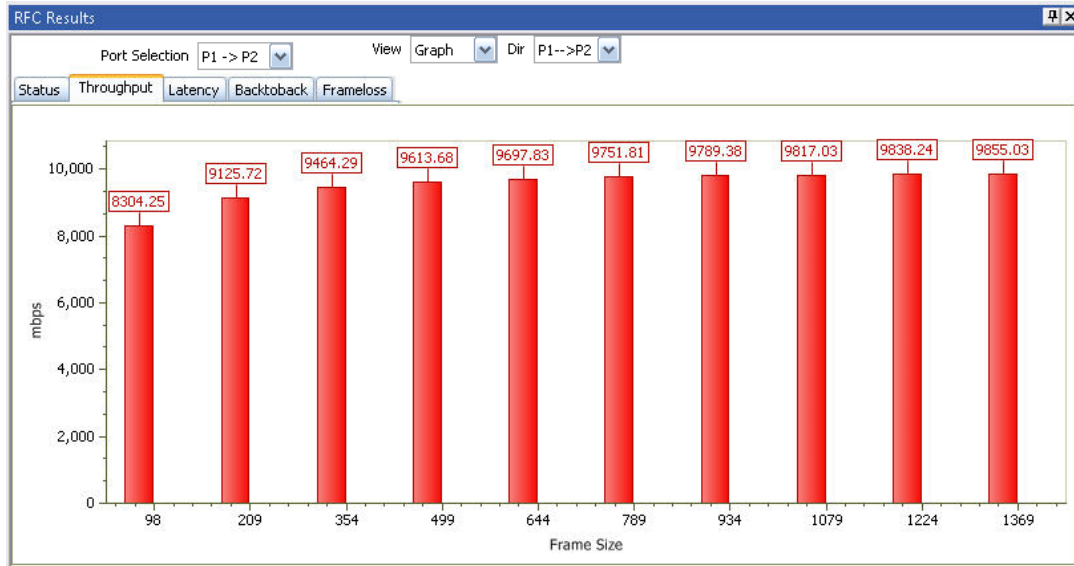
Port Selection: P1 -> P2 View: Statistics Dir: P1-->P2

Status: Throughput Latency Backtoback **Frameloss**

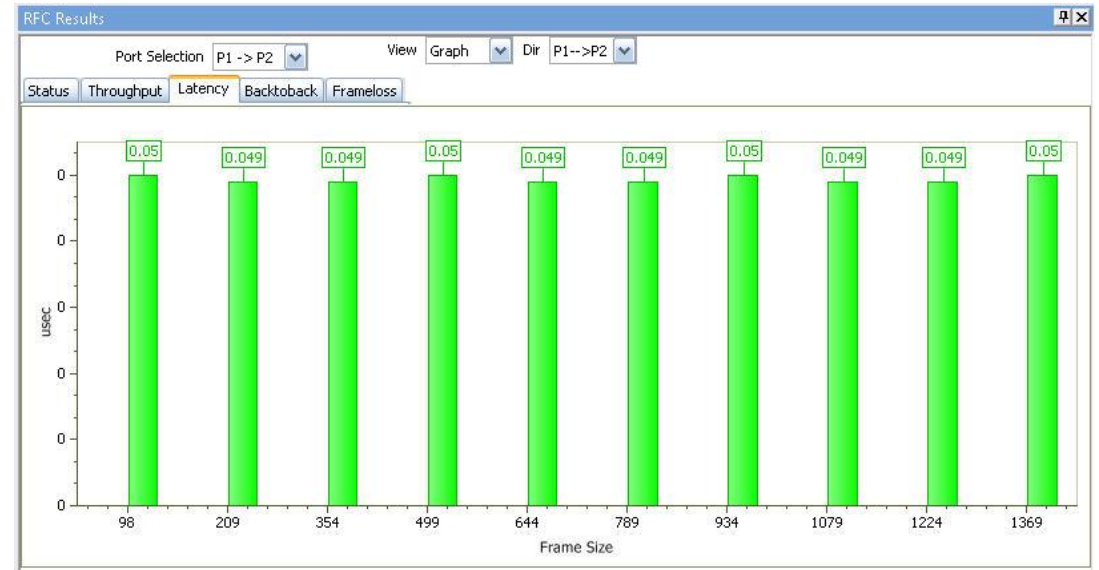
Frame Size	Results
64	100.00 % 100.00 % 100.00 % 100.00 %
	90.00 % 100.00 % 90.00 % 100.00 %
	80.00 % 100.00 % 80.00 % 100.00 %
	70.00 % 100.00 % 70.00 % 100.00 %
	60.00 % 100.00 % 60.00 % 100.00 %
	50.00 % 100.00 % 50.00 % 100.00 %
	40.00 % 100.00 % 40.00 % 100.00 %
	30.00 % 100.00 % 30.00 % 100.00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

图形

吞吐量

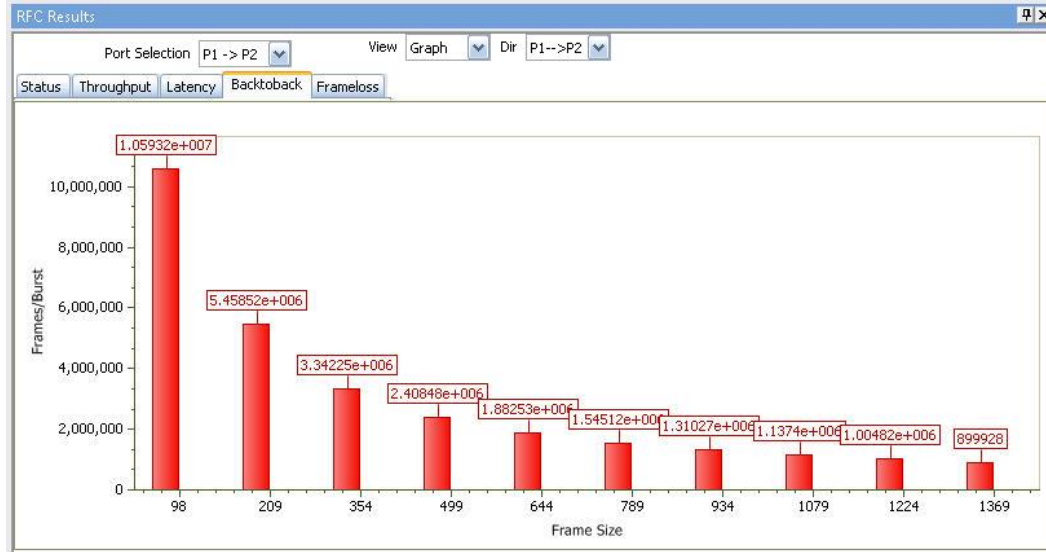


延迟

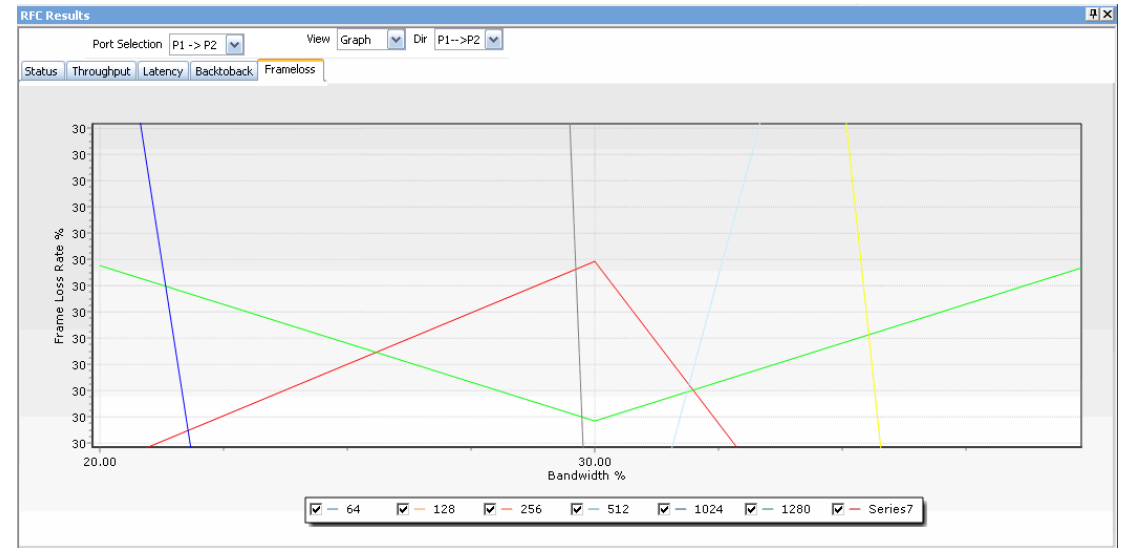


图形...

背对背

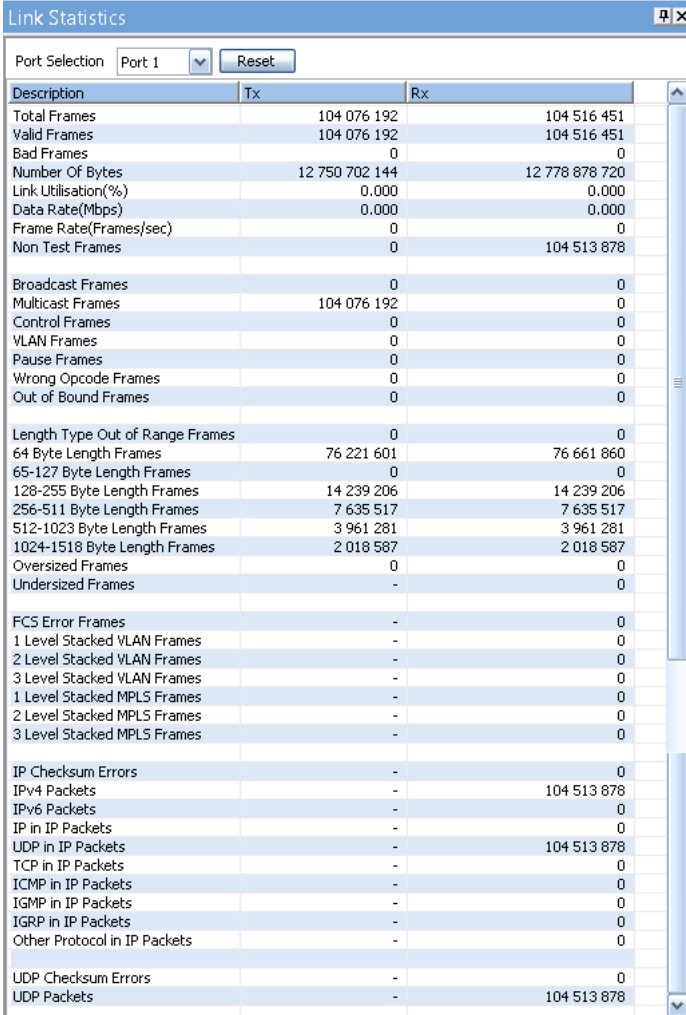


帧丢失



端口统计

- 提供每个端口的详细统计 –
 - Tx / Rx 帧计数
 - 传输和接收的字节数
 - 传输 & 接收帧速率
 - 广播、组播、控制、VLAN、暂停帧数
 - 64/65-127字节长度的帧计数
 - 各种堆栈级别的MPLS和VLAN帧计数
 - IPv4/ UDP数据包计数
 - 过大/ 过小错误帧数
 - FCS 错误计数
 - IP/UDP 校验和错误计数及其他



Link Statistics

Port Selection: Port 1 [Reset]

Description	Tx	Rx
Total Frames	104 076 192	104 516 451
Valid Frames	104 076 192	104 516 451
Bad Frames	0	0
Number Of Bytes	12 750 702 144	12 778 878 720
Link Utilisation(%)	0.000	0.000
Data Rate(Mbps)	0.000	0.000
Frame Rate(Frames/sec)	0	0
Non Test Frames	0	104 513 878
Broadcast Frames	0	0
Multicast Frames	104 076 192	0
Control Frames	0	0
VLAN Frames	0	0
Pause Frames	0	0
Wrong Opcode Frames	0	0
Out of Bound Frames	0	0
Length Type Out of Range Frames	0	0
64 Byte Length Frames	76 221 601	76 661 860
65-127 Byte Length Frames	0	0
128-255 Byte Length Frames	14 239 206	14 239 206
256-511 Byte Length Frames	7 635 517	7 635 517
512-1023 Byte Length Frames	3 961 281	3 961 281
1024-1518 Byte Length Frames	2 018 587	2 018 587
Oversized Frames	0	0
Undersized Frames	-	0
FCS Error Frames	-	0
1 Level Stacked VLAN Frames	-	0
2 Level Stacked VLAN Frames	-	0
3 Level Stacked VLAN Frames	-	0
1 Level Stacked MPLS Frames	-	0
2 Level Stacked MPLS Frames	-	0
3 Level Stacked MPLS Frames	-	0
IP Checksum Errors	-	0
IPv4 Packets	-	104 513 878
IPv6 Packets	-	0
IP in IP Packets	-	0
UDP in IP Packets	-	104 513 878
TCP in IP Packets	-	0
ICMP in IP Packets	-	0
IGMP in IP Packets	-	0
IGRP in IP Packets	-	0
Other Protocol in IP Packets	-	0
UDP Checksum Errors	-	0
UDP Packets	-	104 513 878

生成报告

Reports

Choose Format: PDF

Title: PacketExpert

User Comments: Generate RFC 2544 result

Header: RFC2544-Throughput

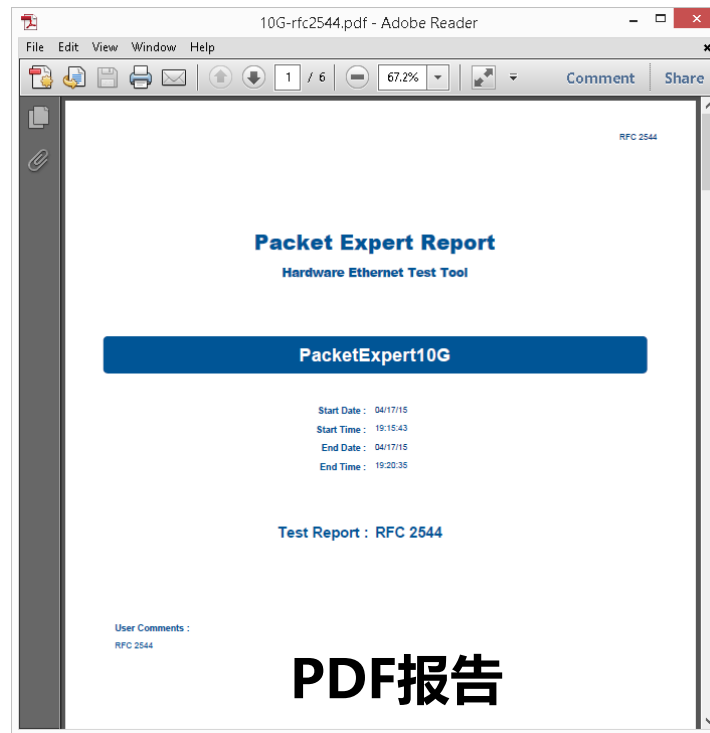
Footer: GL Communications

User Logo: Expert\GL_Logo.JPG

File name: PacketExpert\report1

Generate Report

配置



10g-rfc2544.csv - Excel

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

A1

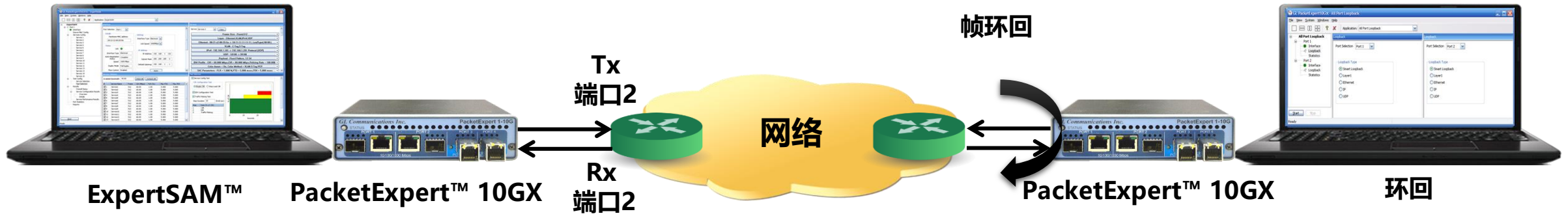
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1		THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi	THP_Throi
2	P1->P2	8304.25	100	9125.72	100	9464.29	100	9613.68	100	9697.82	100	9751.8	100	9789.37	100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

10g-rfc2544

CSV报告

ITU-T Y.1564 (ExpertSAM)

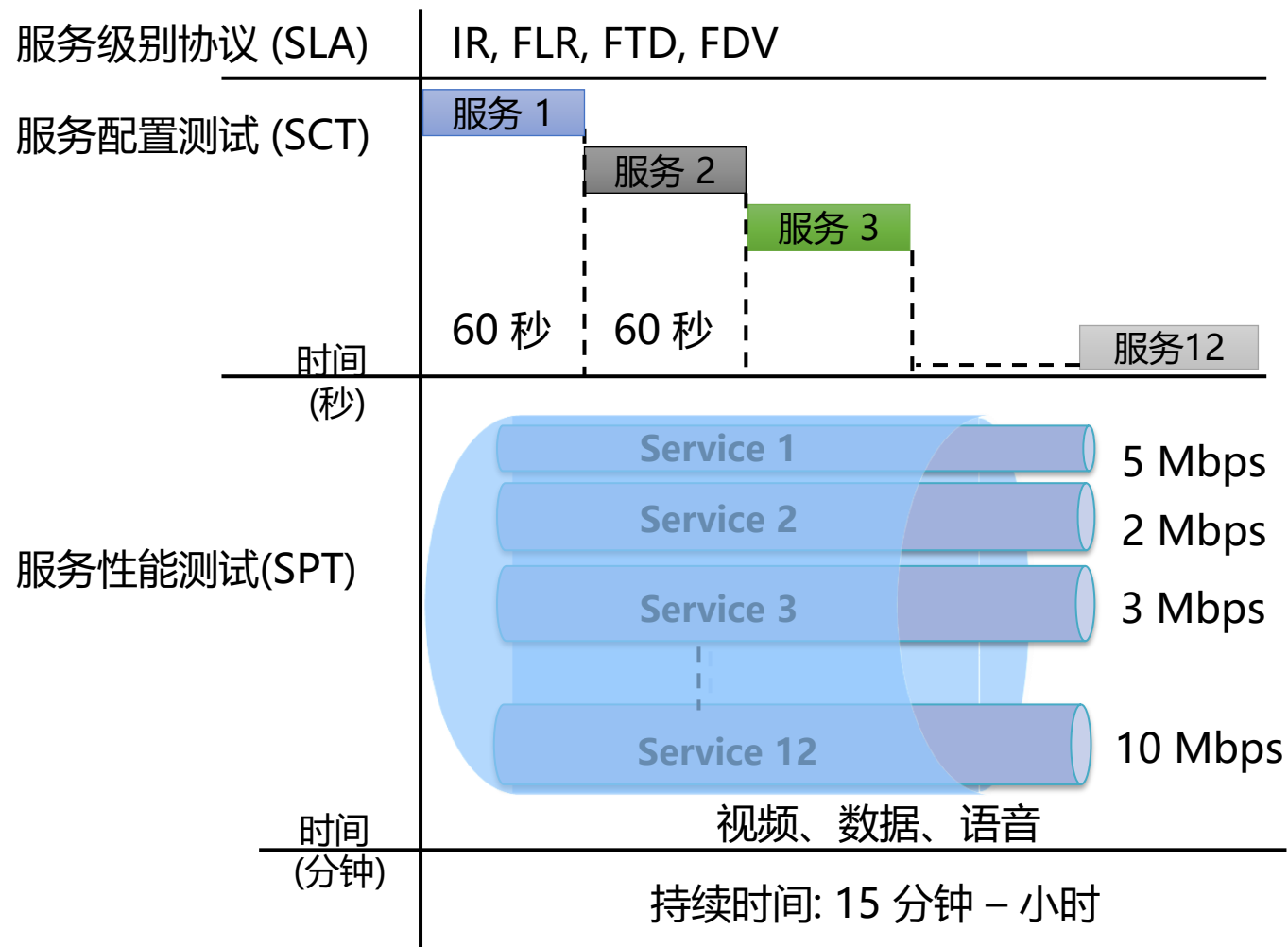
以太网网络测试



- 根据ITU-T Y.1564标准验证服务等级协议（SLA）的单一测试
- ITU-T Y.1564基于SLA参数分两个阶段完成了此测试：
 - 服务水平协议参数：信息速率（IR）、帧传输延迟（FTD）、帧延迟变化（FDV）、帧丢失率（FLR）
 - 服务配置测试
 - 服务性能测试

ITU-T Y.1564 (ExpertSAM)...

- **服务配置测试** - 使用所有已配置流量流的SLA参数确认端到端配置
- **服务性能测试** - 同时传输所有已配置的流量CIR, 以上述参数确定所有流量能够在满负载下横穿网络



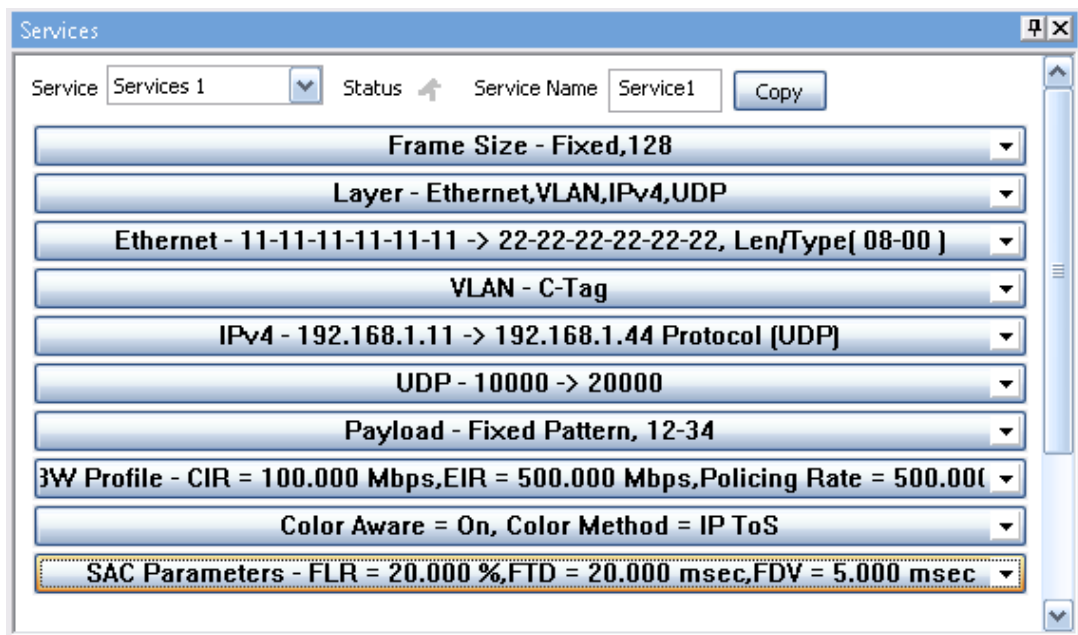
重点

- 一次测试即可完全验证以太网服务水平协议 (SLA)
- ITU-T Y.1564 符合标准
- 支持服务配置和服务性能测试方法
- 针对多流同时测量的KPI, 如信息速率 (IR) 或吞吐量、帧丢失率 (FLR)、帧传输延迟 (FTD) 或延迟以及帧延迟变化 (FDV) 或抖动), 并声明通过/失败判定
- 以CIR (确保的流量)、EIR (最大可能带宽) 和流量监管 (降低的带宽) 速率的吞吐量生成流量的能力, 确保关键性能指标 (KPI) 验证。
- 每个服务支持的EMIX帧大小—每个服务最多可以定义7个帧大小
- 支持具有完全满足满负荷条件的不同性能要求的多种服务
- 支持堆叠VLAN – C-Tag和S-Tag模拟运营商以太网流量
- 随着时间的推移同时验证所有服务质量

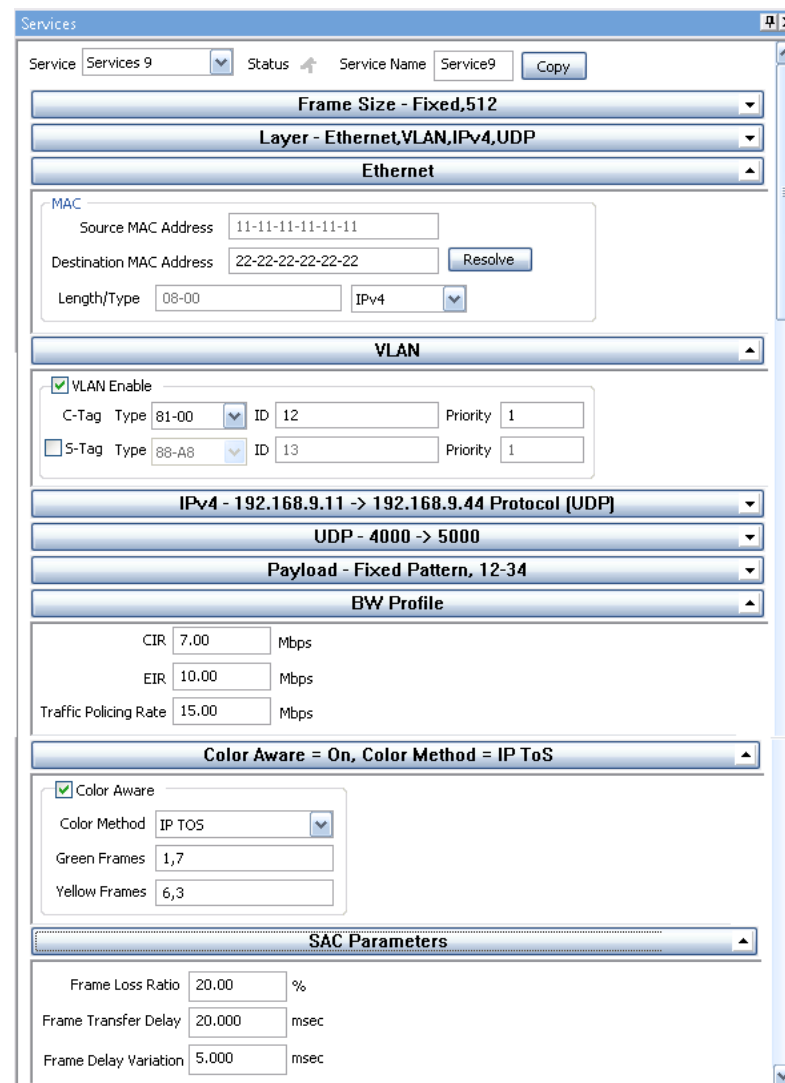
RFC 2544 VS Y.1564 (ExpertSAM)

	RFC 2544	Y.1564
测量	吞吐量, 突发性, 帧丢失和延迟	吞吐量, 突发性, 帧丢失, 延迟, 数据包抖动, QoS
服务	连结等级	多个并发服务级别
性能	测量最大性能	关键绩效指标 (KPI) 验证
吞吐量	不分离承诺流量和多余流量	CIR、EIR和流量监管不断确保在测试过程中满足KPI
帧延迟	在每个测试时间内测试一帧, 并且不考虑较长测试期间可能发生的任何延迟变化	在测试期间对所有生成的帧测量延迟, 以测量超出定义范围的任何偏差
帧丢失	帧丢失是在速率分布吞吐量测试期间测量的, 其中, 帧丢失分布不符合承诺的速率而未符合KPI	吞吐量测试期间的帧丢失测量
帧延迟变化	未测量帧延迟变化	测量直到CIR的流量的帧延迟变化, 以确保适当的流量优先级

服务配置



服务配置折叠的摘要视图



服务配置展开视图

服务配置测试结果

Service Configuration Results Overview							
Overview							
#	Service Name	Verdict	Current Step	Max IR(Mbps)	FLR(%)	Max FTD(msec)	Max
1	Service1	✓	-	99.9266	0.0000	0.0218	0.0001
2	Service2	✓	-	10.0001	0.0000	0.0089	0.0001
3	Service3	✓	-	4.0009	0.0000	0.0131	0.0001
4	Service4	✓	-	99.9266	0.0000	0.0216	0.0001
5	Service5	✓	-	99.9266	0.0000	0.0216	0.0001
6	Service6	✓	-	99.9266	0.0000	0.0217	0.0001
7	Service7	✓	-	59.9482	0.0000	0.0080	0.0001
8	Service8	✓	-	199.8490	0.0000	0.0216	0.0001
9	Service9	✓	-	7.0011	0.0000	0.0216	0.0001
10	Service10	✓	-	77.9699	0.0000	0.0215	0.0001
11	Service11	✓	-	199.8490	0.0000	0.0216	0.0001
12	Service12	✓	EIR	41.9642	0.0000	0.0215	0.0001



服务结果概述

Service Configuration Results Details															
Service		IR(Mbps), FLR(%), FTD(msec), FDV(msec)													
Test	Verdict	IR (Curr)	IR (Min)	IR (Mean)	IR (Max)	FLR (Count)	FLR (Rate)	FTD (Curr)	FTD (Min)	FTD (Mean)	FTD (Max)	FDV (Curr)	FDV (Min)	FDV (Mean)	FDV (Max)
Step1	PASS	24.96	24.96	24.98	25.00	9	0.15	0.02134	0.02132	0.02138	0.02168	0.000123	0.000118	0.000129	0.000133
Step2	PASS	49.95	49.92	49.96	49.97	10	0.09	0.02134	0.02131	0.02381	0.02180	0.000125	0.000122	0.000127	0.000131
CIR	PASS	99.91	99.88	99.91	99.93	18	0.08	0.02131	0.02131	0.02138	0.02182	0.000132	0.000127	0.000130	0.000132
EIR(Green)	PASS	99.15	99.15	99.84	99.94	0	0.00	0.02133	0.02131	0.02377	0.02197	0.000096	0.000093	0.000096	0.000098
EIR(Yellow)	--	9.92	9.92	9.98	10.00	0	0.00	0.00000	0.00000	0.00000	0.00000	0.000133	0.000131	0.000132	0.000134
TrafficPo...	--	99.74	99.74	99.91	99.94	0	0.00	0.02180	0.02131	0.03057	0.02180	0.000113	0.000112	0.000114	0.000116
TrafficPo...	--	49.87	49.87	49.95	49.97	0	0.00	0.00000	0.00000	0.00000	0.00000	0.000130	0.000126	0.000129	0.000130






服务详细结果

服务性能测试总体状况

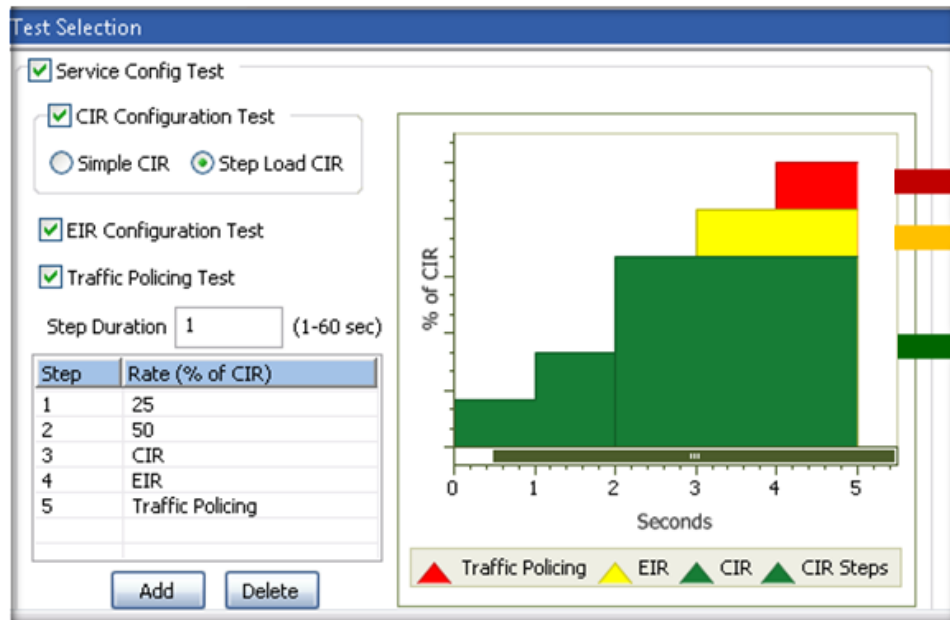
Overall Status

Overall Status  Global Verdict 

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

Alarm	Status
Link Status	
IR	
FLR	
FTD	
FDV	

ITU-T Y.1564 (ExpertSAM) 图形

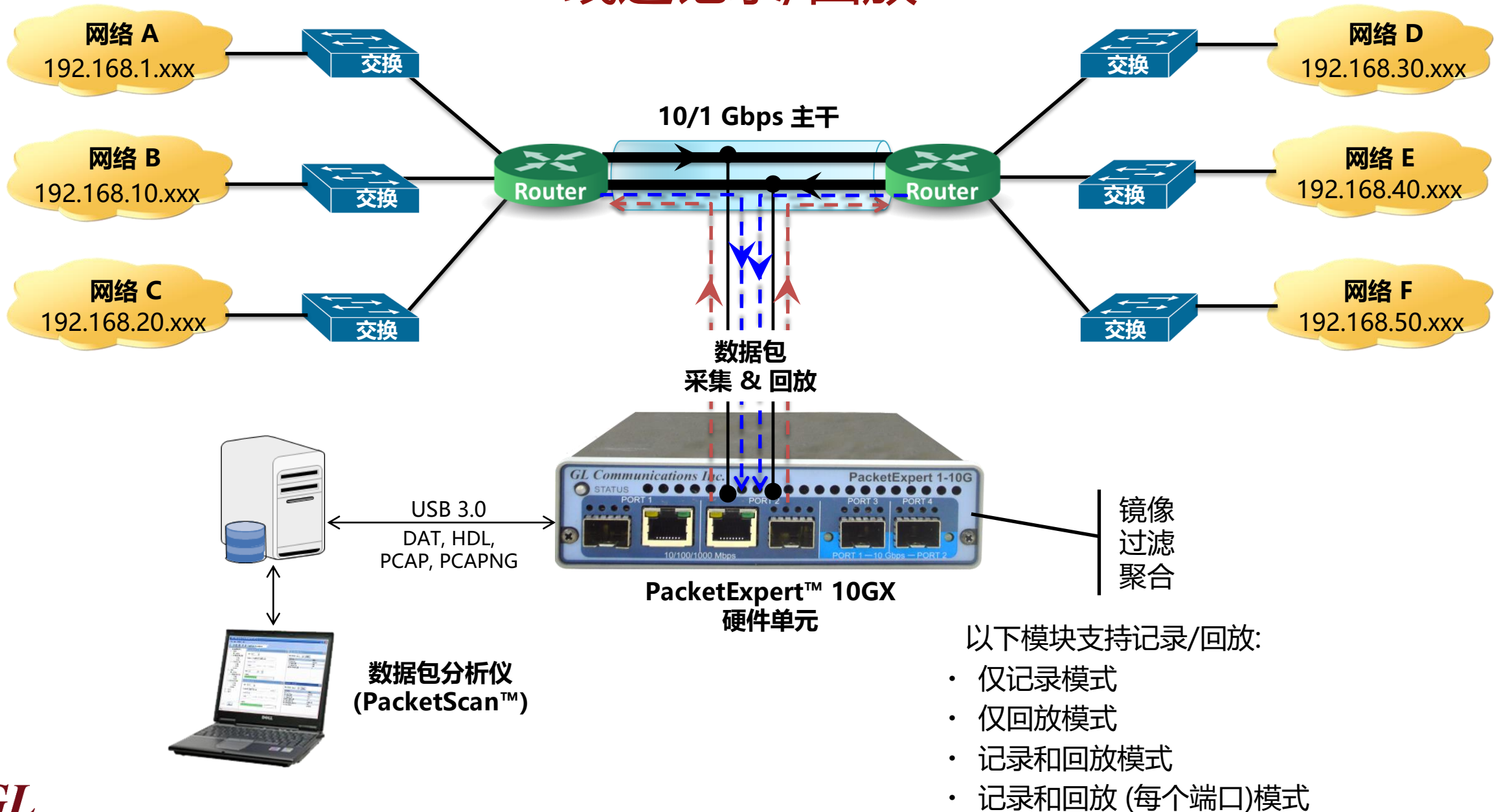


→ Dropped bandwidth (everything over EIR)
→ Best effort bandwidth (everything between CIR and EIR)
→ Guaranteed bandwidth (everything under CIR)

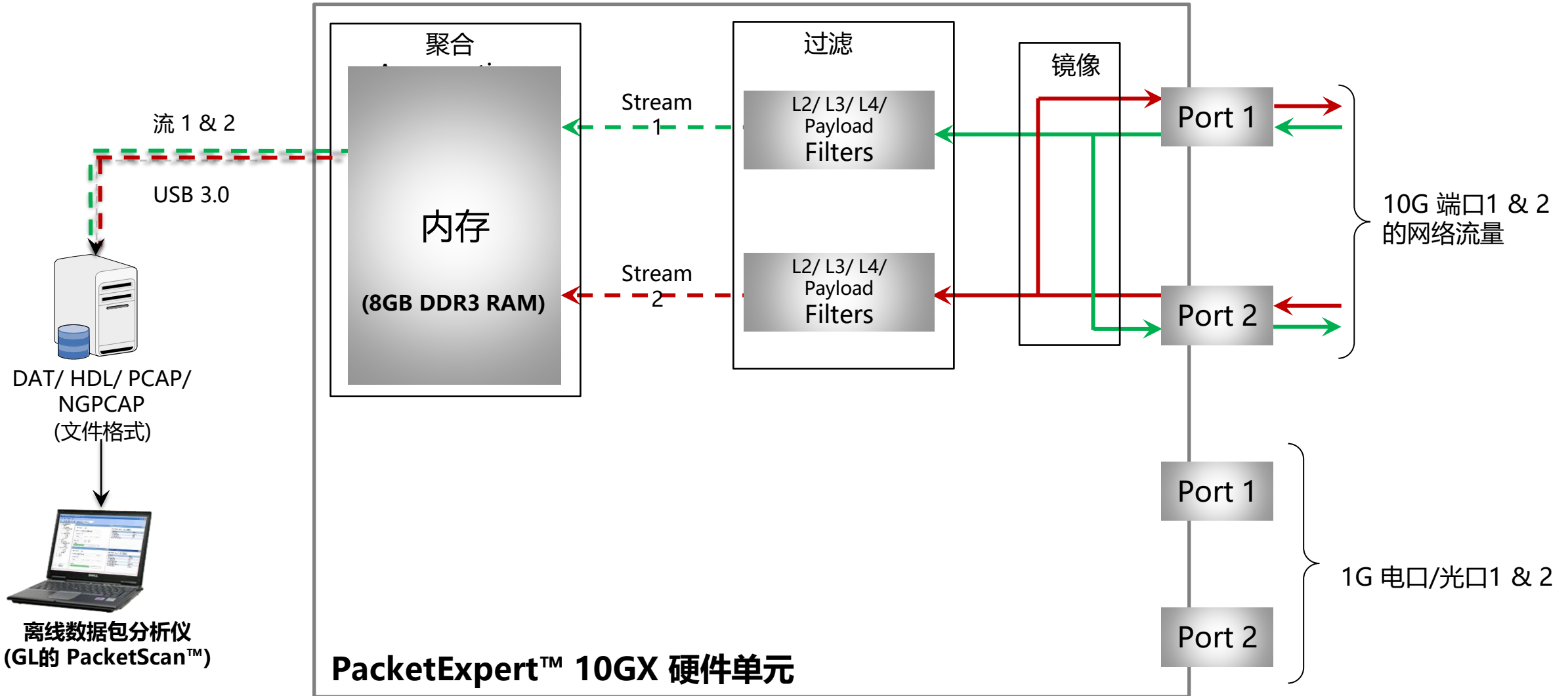
- 承诺信息率或CIR是服务提供商保证的平均带宽。在任何给定时间，带宽都不应低于此承诺数字
- 超出信息率或EIR是CIR加上服务提供商声称在“尽力而为”的基础上提供的超出率

具有硬件过滤功能的 以太网数据包线速捕获和回放

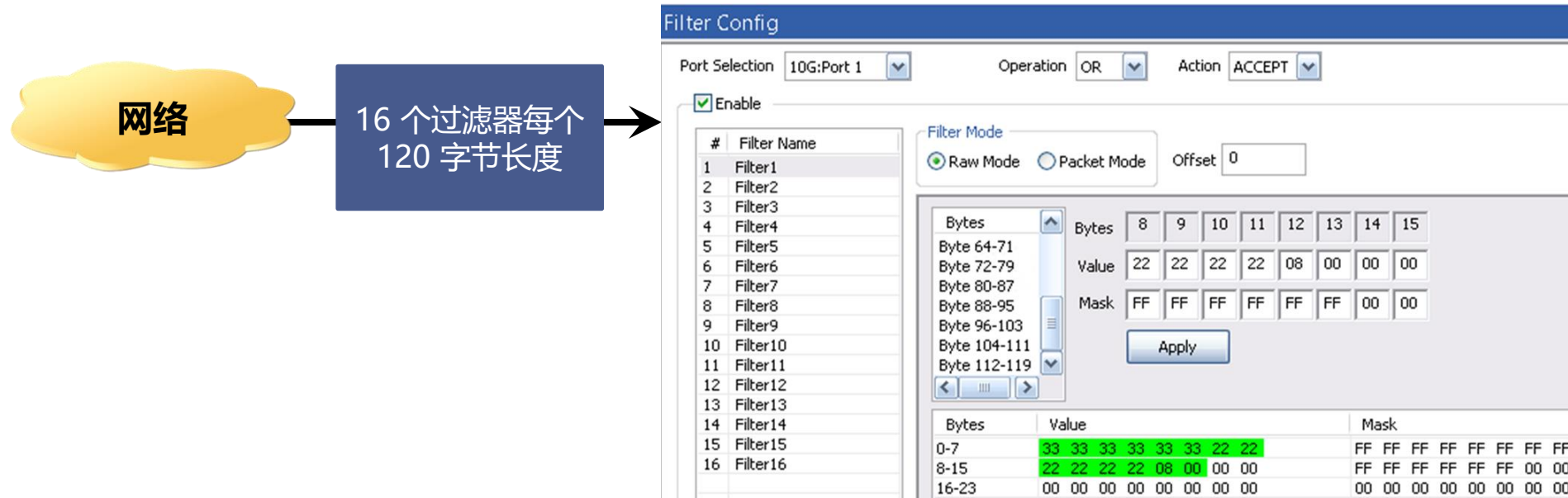
线速记录/回放



工作原理

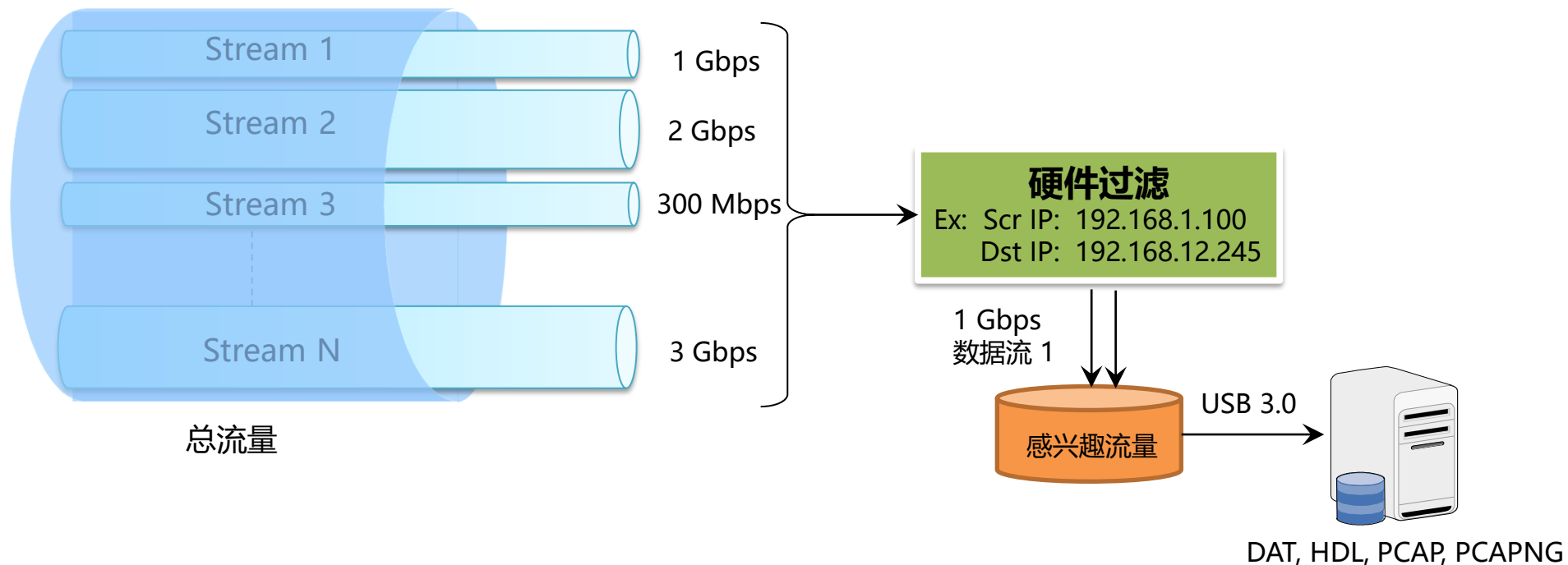


线速数据包过滤器和触发器



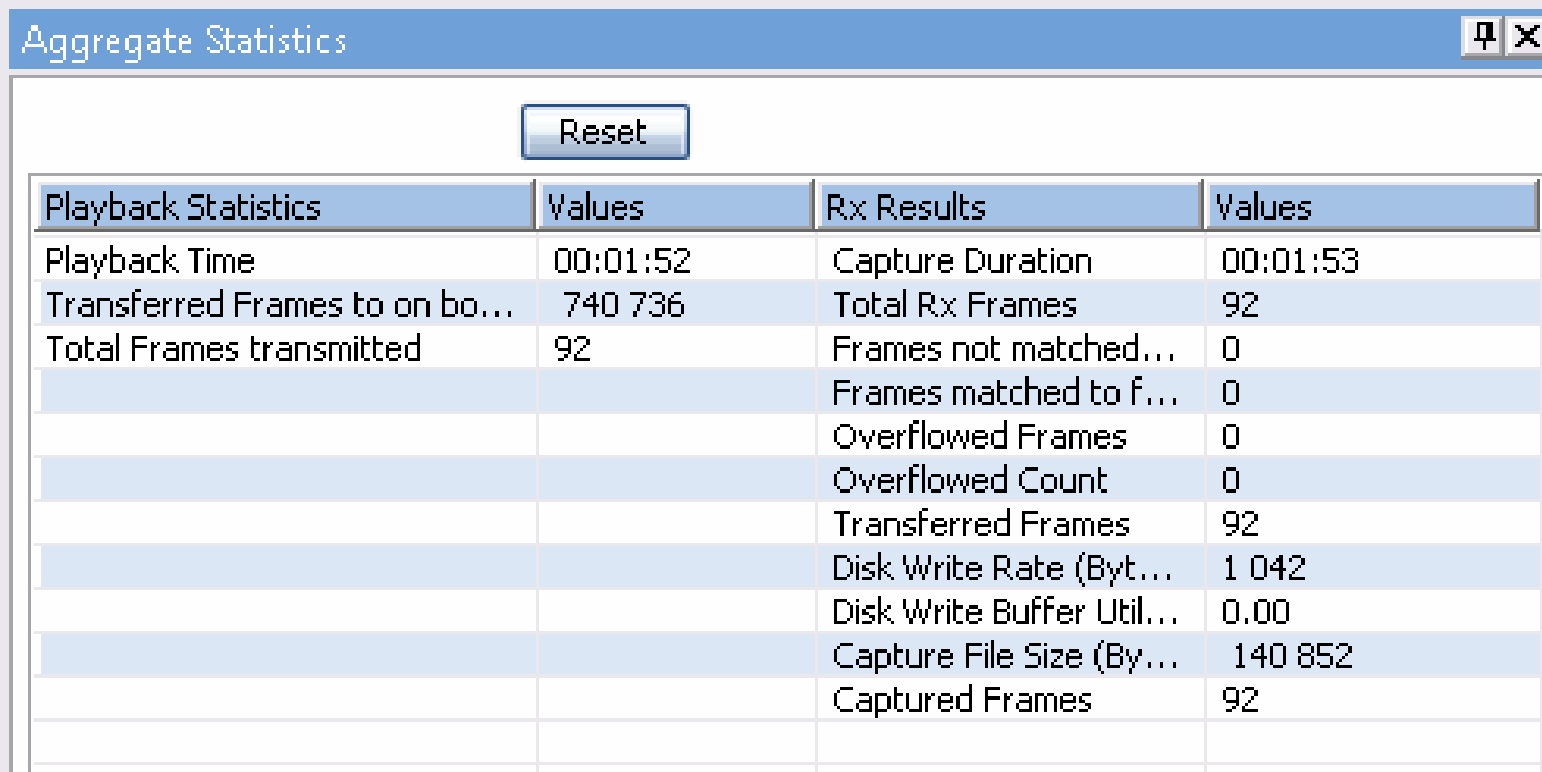
- 过滤数据包并仅记录感兴趣的数据包
- 同时捕获2个端口，每个端口具有120字节深的过滤器（用于记录应用），并在任何一个端口或所有端口上设置过滤器
- 数据包过滤可以基于所有第2层（以太网）、第3层（IP）第4层（UDP / TCP）标头
- 每个端口最多可以定义16个过滤器。每个过滤器的最大宽度为120个字节
- 可以将过滤器设置为数据包中的每个位（原始模式）或每个字段（数据包模式）
- 为每个通过过滤器的数据包生成一个触发器（1微秒脉冲）
- 过滤各种报头字段，例如源/目标MAC地址、VLAN ID、MPLS标签、源/目标Ipv4地址、源/目标UDP端口

捕获感兴趣流量



根据过滤器设置，在PacketExpert™硬件上过滤包含n个数据速率不同的流的网络流量。总体传输速率限制为USB 2.0传输速率。传输速率最高可达350 Mbps，具体取决于主机PC配置。

结果 - 记录和回放模式



The screenshot shows a window titled "Aggregate Statistics" with a "Reset" button and a table of statistics. The table is divided into two columns: "Playback Statistics" and "Rx Results", each with a "Values" sub-column.

Playback Statistics	Values	Rx Results	Values
Playback Time	00:01:52	Capture Duration	00:01:53
Transferred Frames to on bo...	740 736	Total Rx Frames	92
Total Frames transmitted	92	Frames not matched...	0
		Frames matched to f...	0
		Overflowed Frames	0
		Overflowed Count	0
		Transferred Frames	92
		Disk Write Rate (Byt...	1 042
		Disk Write Buffer Util...	0.00
		Capture File Size (By...	140 852
		Captured Frames	92

模拟真实世界IP网络的损伤

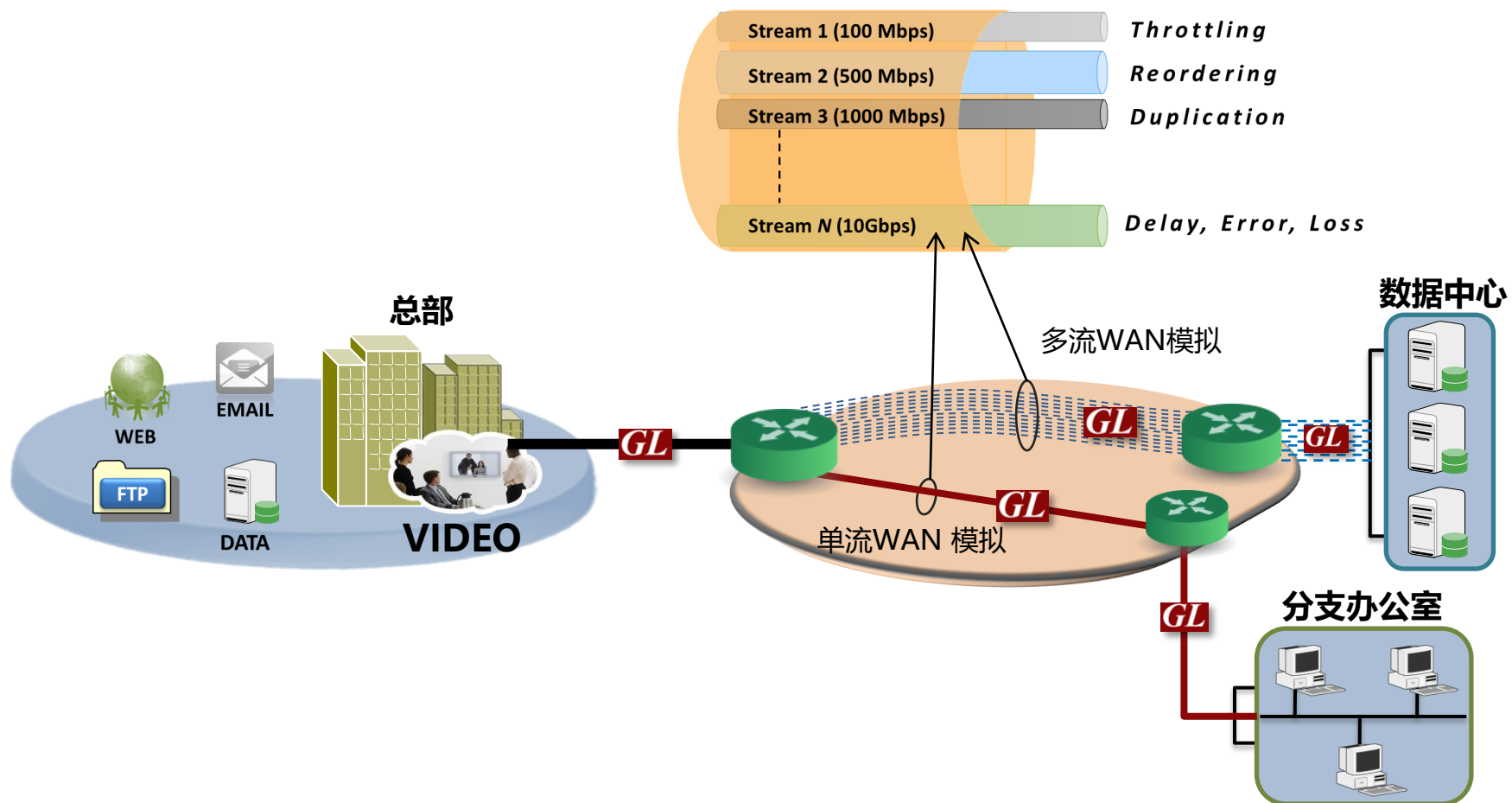
延迟、错误、损耗、光口、电口...

概述

GL如何模拟现实世界的IP网络？ GL的IPNetSim是什么？

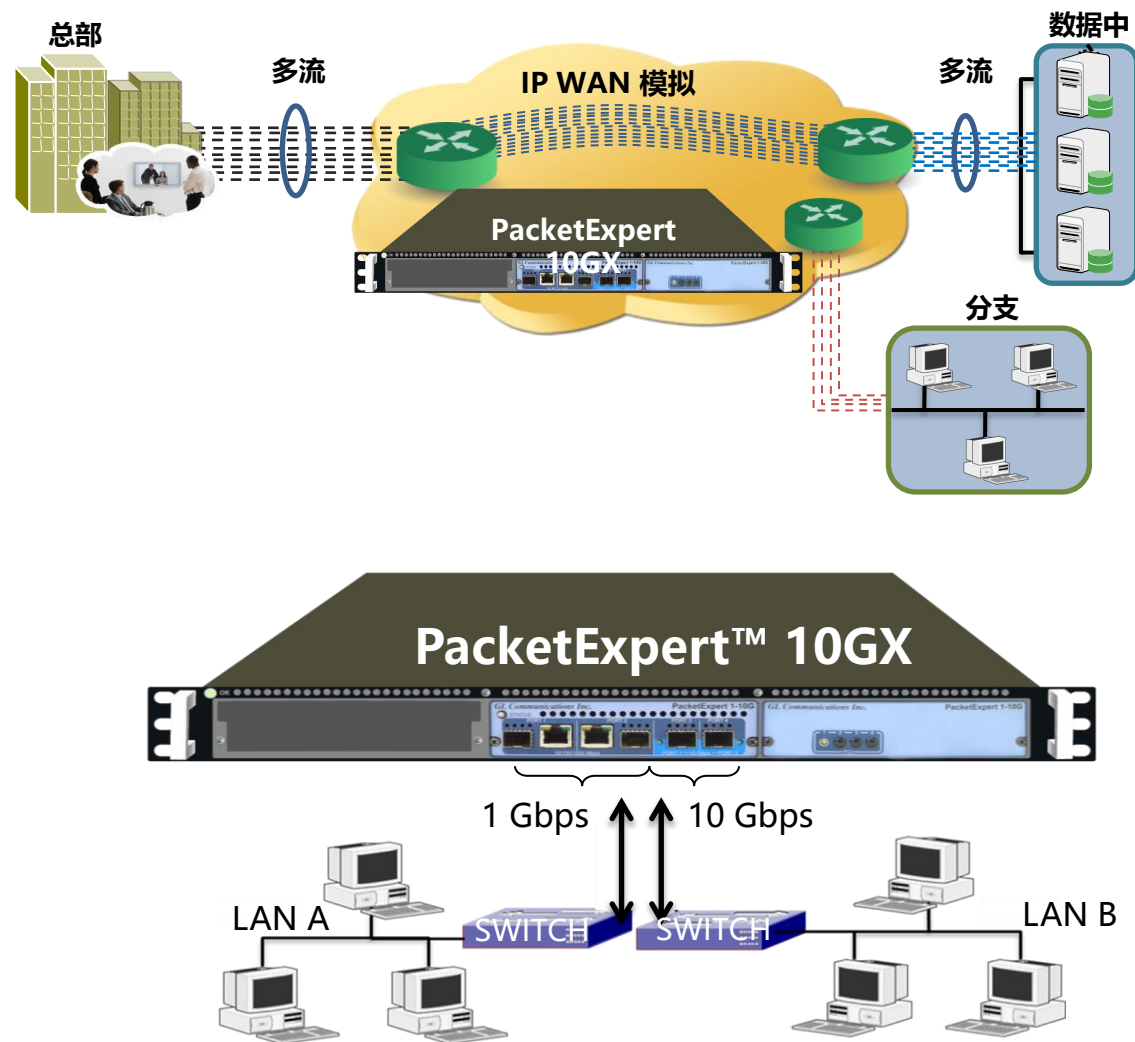
- ❖ 实验室测试解决方案-应用程序和自动化
- ❖ 模拟全双工 1Gbps 和 10Gbps 网络

- ❖ 通过施加损伤来实现实际网络条件
- ❖ 多个流独立配置

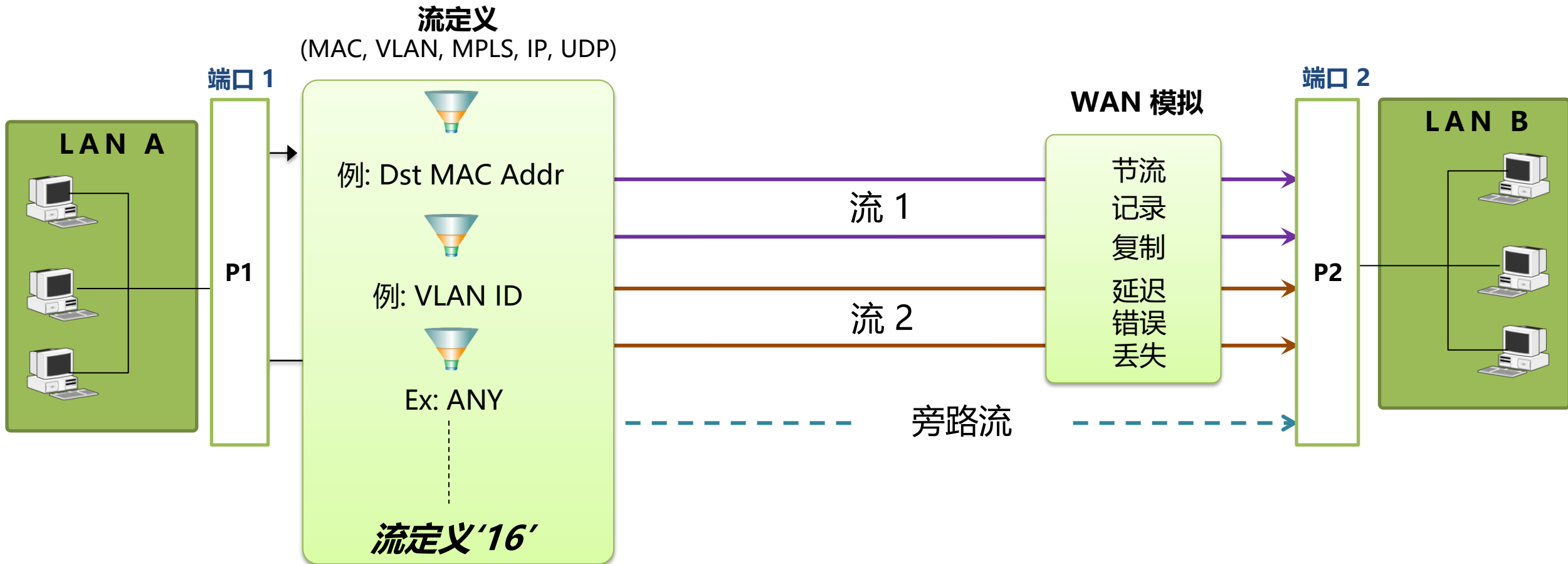


应用概述

- ❖ 测试企业和个人级别的应用程序...
 - 音频和视频流(VoIP, IMS, HDT, IPTV)
 - 存储服务 (关键数据访问)
 - 云和网络服务
 - FTP / HTTP
- ❖ 模拟回传网络
 - 静态和动态网络
 - 卫星+其他长时延网络
- ❖ 测试服务质量 (QoS) 和体验质量 (QoE)
- ❖ 评估网络设备 (交换机, VoIP电话, VoIP PBX, 机顶盒和VoD服务器) 的稳定性)



“流”概述



在数据包模式下定义流

Stream Definition WAN Emulation Parameters Scheduler

P1 -> P2

Mode
 Packet Mode Raw Mode

MAC VLAN MPLS IP UDP

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

Source IP Address
 Fixed Range Any
From 192 . 168 . 1 . 201 To 192 . 168 . 1 . 210

Destination IP Address
 Fixed Range Any
IP Address 192 . 168 . 1 . 101

Apply

在原始模式下定义流

Mode
 Raw Mode Packet Mode Offset

Bytes
Byte 0-7
Byte 8-15
Byte 16-23
Byte 24-31
Byte 32-39
Byte 40-47
Byte 48-55

Bytes	0	1	2	3	4	5	6	7
Value	00	00	00	00	00	00	00	00
Mask	00	00	00	00	00	00	00	00

Apply

Bytes	Value	Mask
0-7	00 00 00 00 00 00 00 00	00 00 00 00 00 00 00 00
8-15	00 00 00 00 00 00 00 00	00 00 00 00 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

流量带宽

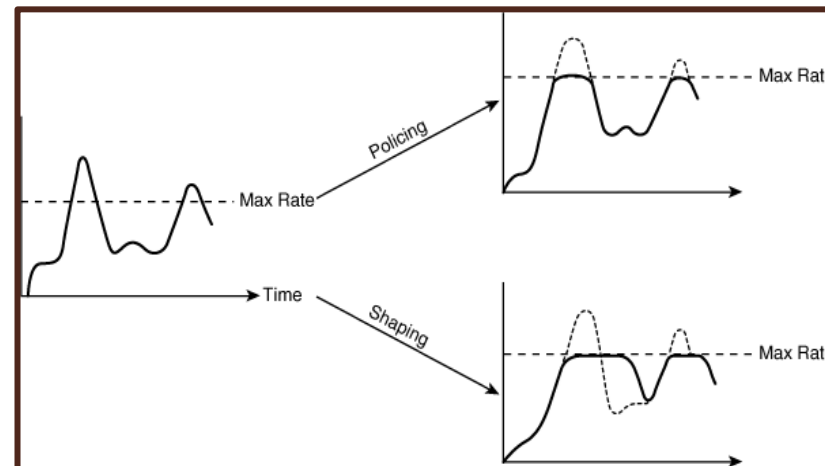
- ❖ 超出规定速率的流量将被静默丢弃
- ❖ UDP应用程序将遇到数据丢失
- ❖ TCP应用程序应通过拥塞避免算法进行调整

The screenshot shows the 'WAN Emulation Parameters' tab in a configuration tool. It features a 'WAN Stream Type' section with radio buttons for 'Symmetrical' and 'Asymmetrical' (selected). Below is a table of parameters for two directions: P1 -> P2 and P2 -> P1.

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

At the bottom, there are two input fields for 'Traffic Bandwidth' for the P1 -> P2 direction, both set to 100.000000 Mbps.

- ❖ 模拟可能适用流量监管策略的WAN应用，即提供
供应商与客户之间的服务水平协议



延迟 / 抖动

- ❖ 应用静态延迟或最小值和最大值之间的均匀或指数分布
- ❖ 将数据包延迟8000毫秒（以1毫秒为增量）

The screenshot shows the 'WAN Emulation Parameters' tab in a configuration tool. It features three tabs: 'Stream Definition', 'WAN Emulation Parameters', and 'Scheduler'. The 'WAN Stream Type' is set to 'Asymmetrical'. A table below lists parameters for 'P1 -> P2' and 'P2 -> P1'. The 'Latency' row is highlighted, showing 'Random Exp., 0 - 8000 ms' for both directions. Below the table, the 'P1 -> P2' section is expanded to show 'Latency' options: 'Single Delay', 'Uniform Distribution', and 'Random Exponential Distribution' (which is selected). To the right, 'Min' is set to 0 msec and 'Max' is set to 8000 msec.

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

P1 -> P2

Latency

Single Delay

Uniform Distribution

Random Exponential Distribution

Min msec

Max msec

数据包重新排序

- ❖ 每X个数据包重新排序1个
- ❖ 设置以毫秒为单位的最短时间来保存重新排序的数据包

The screenshot shows the 'WAN Emulation Parameters' tab in a configuration tool. It features a table for parameters and two detailed configuration panels below.

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

P1 -> P2 Configuration:

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

P2 -> P1 Configuration:

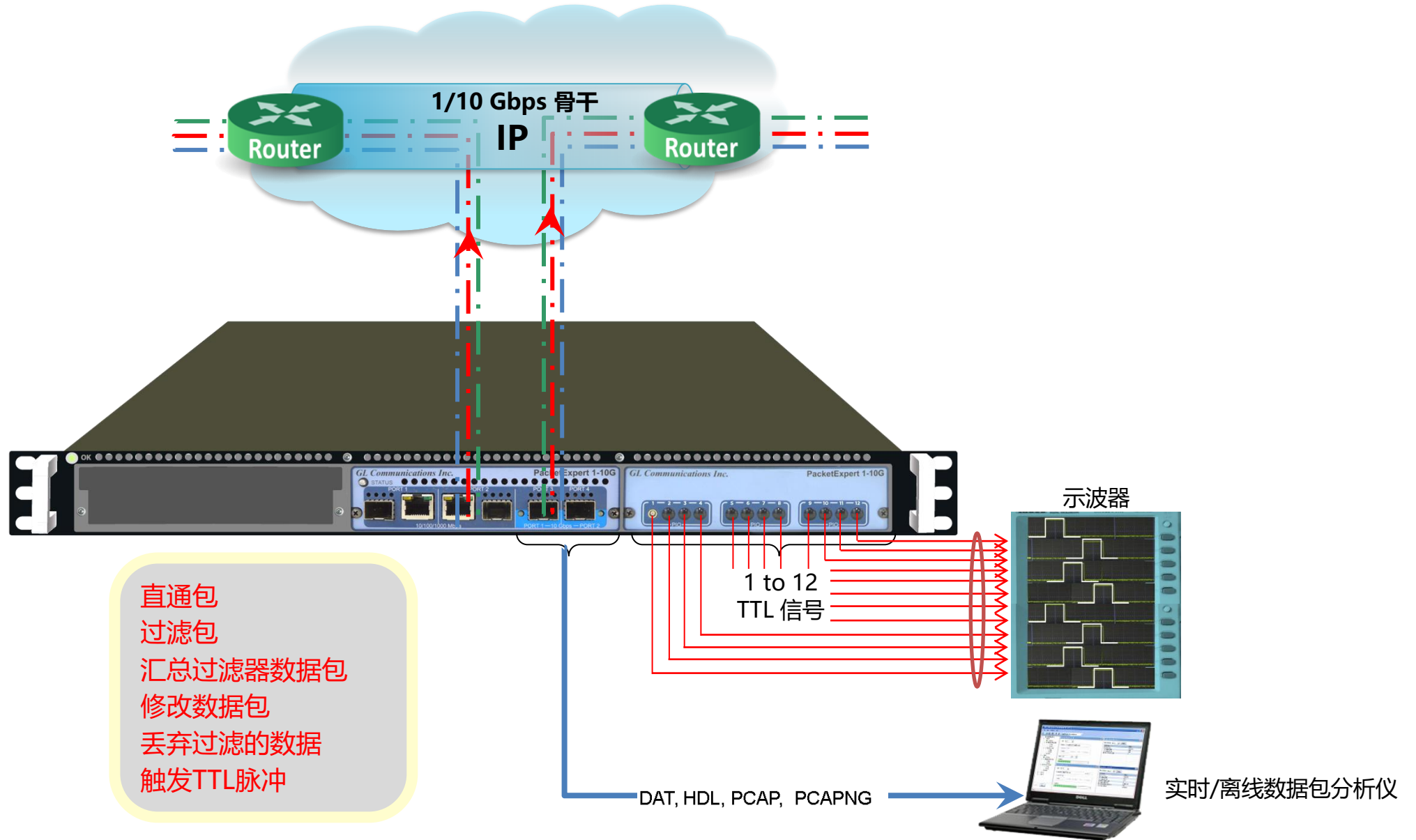
- Packet Reordering(Single Packet)
- Reorder 1 packet out of packets
- Delay Offset (Time)
- Min ms Max ms

软件规范

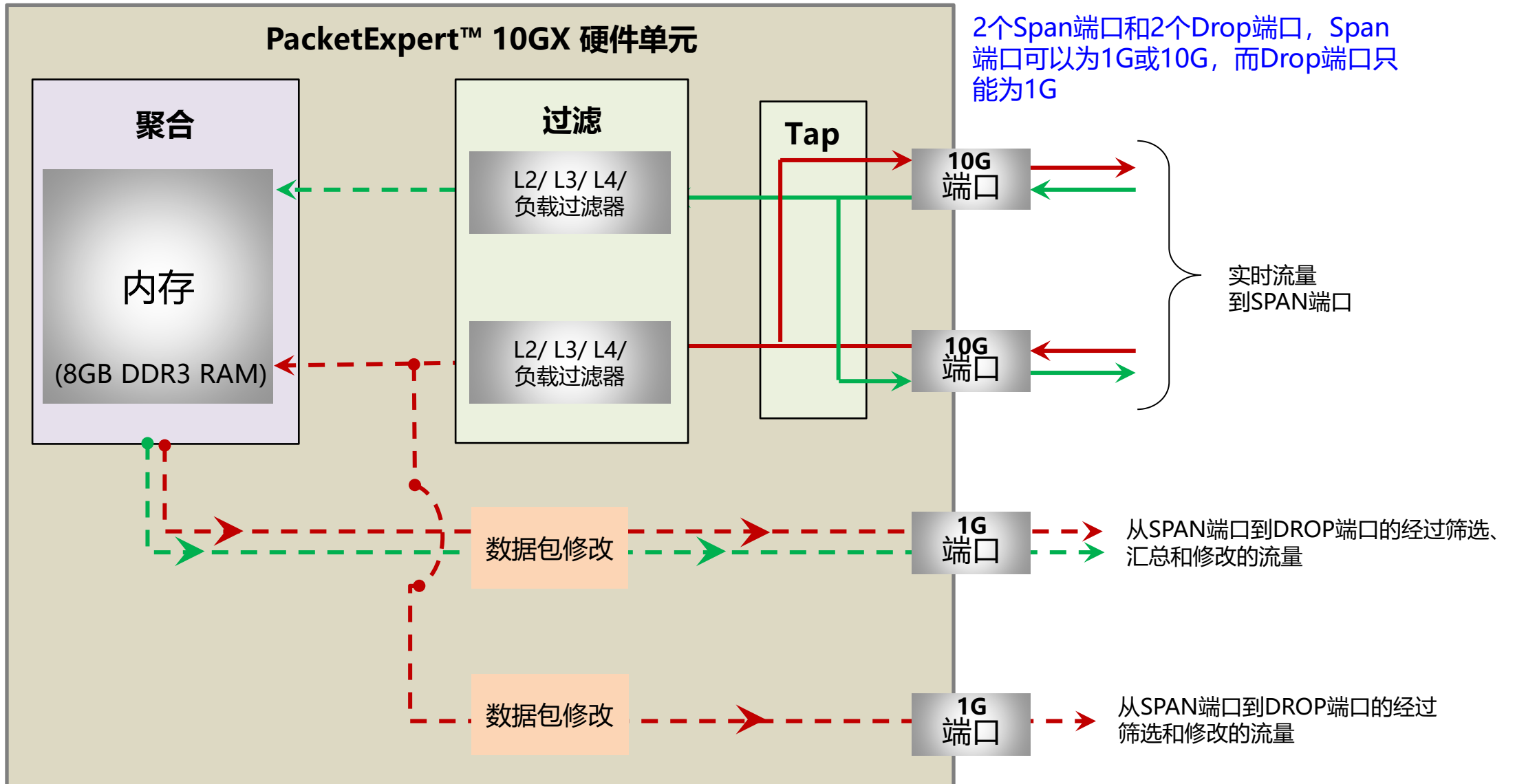
多流WAN 模拟 - IPNetSim™	单流WAN 模拟 - IPLinkSim™
<p>流定义</p> <ul style="list-style-type: none"> • 硬件线速过滤 (高达16 链路) <ul style="list-style-type: none"> ➢ 数据包模式(过滤标头) ➢ 原始模式(位级别) <p>参数</p> <ul style="list-style-type: none"> • IP源和目标地址范围 • UDP源和目标端口范围 • MAC地址 • VLAN ID • MPLS 标签 	<p>-NA-</p>
<p>WAN 模拟参数</p> <ul style="list-style-type: none"> • 带宽控制 – 1 Kbps up to 10 Gbps • 延迟 <ul style="list-style-type: none"> ➢ 每个流0毫秒至1.25秒（1250毫秒）（对于1Gbps链接） ➢ 每个流0毫秒，最高0.5秒（500毫秒）（用于10 Gbps链接） ➢ 单延迟，均匀，随机分布 ➢ Packet Loss Rate - 0–100% • 数据包重新排序率-0-100%，延迟范围长达2秒 • 封包重复率-0-100% • 逻辑错误插入率 - 10^{-1} to 10^{-9} • 支持的最大帧大小– 2048 bytes 	<p>WAN模拟参数</p> <ul style="list-style-type: none"> • 带宽控制 - 10 Kbps up to 1000 Mbps • 延迟 <ul style="list-style-type: none"> ➢ 0毫秒至8秒（8000毫秒）（用于1G / 10 Gbps链接） ➢ 单延迟，均匀，随机分布 • 具有后台流量的拥塞仿真（占总带宽的百分比） <ul style="list-style-type: none"> ➢ 链接利用率-0 – 100% ➢ 爆发大小- 64 – 1,000,000 bytes • 丢包率 - 0–100% • 数据包重新排序率-0-100%，延迟范围长达8秒 • 封包重复率- 0 - 100% • 逻辑错误插入率 - 10^{-1} to 10^{-9} • FCS 错误插入率 - 10^{-1} to 10^{-9}

PacketBroker – 无源以太网分接头

网络中的PacketBroker

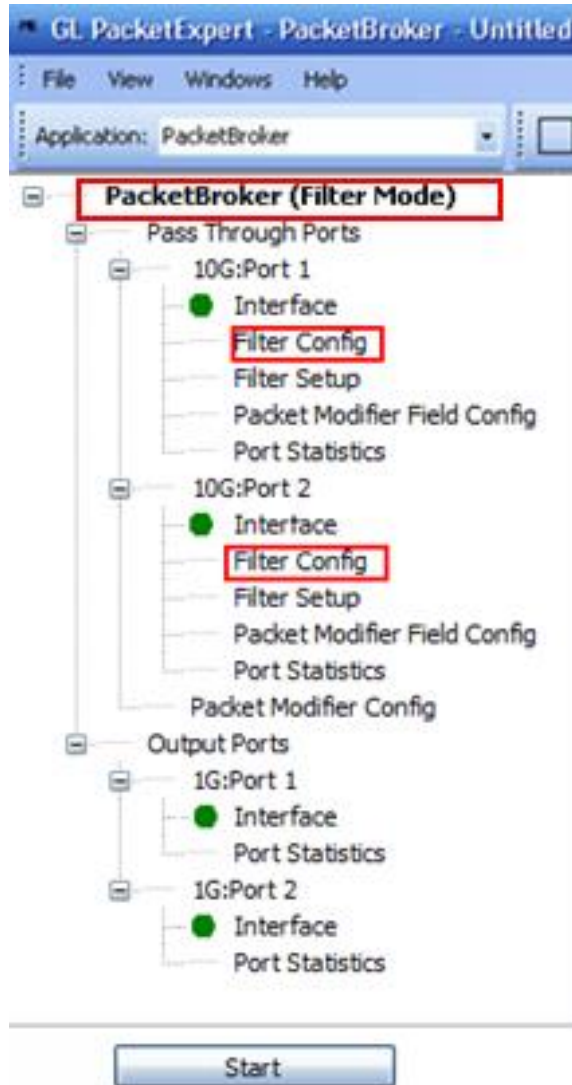


数据包分接、过滤、聚合、修改和输出

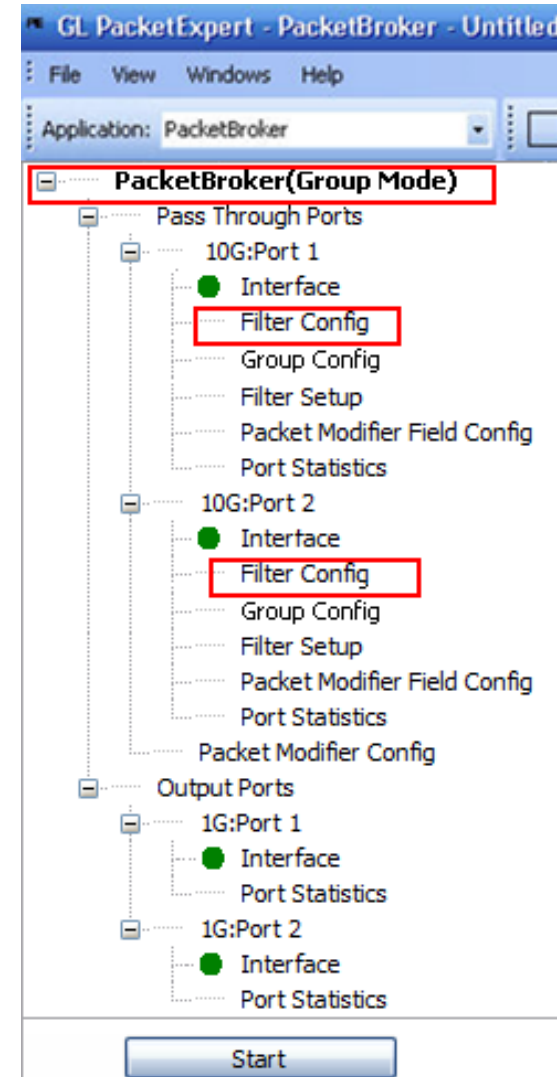


过滤器配置菜单

基本模式过滤



组模式过滤



过滤配置

原始模式过滤

Port Selection: Port 1

NOT

Filter Selection

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

Enable RAW Mode

RAW Mode Offset: 0

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

Layer Summary

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

16 Filters

Offset (0-15999)

120 Bytes Raw Data/Mask Bytes

过滤配置

数据包模式过滤

The screenshot displays the 'Filter Config' window for 'Port 1'. On the left, a list of 16 filters is shown, with a red bracket and the text '16 Filters' below it. The main area is divided into 'Filter Selection' and 'Filters' sections. The 'Filter Selection' section, labeled 'Packet Layers', shows a tree view of protocol layers with checkmarks: MAC, VLAN Layer, MPLS Layer, IP, UDP, TCP, TCP Source Port, and TCP Destination Port. The 'Filters' section, labeled 'Header fields', shows the configuration for the selected filter: 'Enable TCP Destination Port' is checked, and the 'TCP Destination Port' is set to 'Fixed' with a value of '2123'. At the bottom, a 'Packet Layer Summary' table provides a detailed overview of the filter's configuration across various layers.

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

组模式过滤器配置

- PacketBroker包括一个选项，可将已配置的过滤器分组
- 可以选择任意数量的单个过滤器以形成一个组。使用“ AND”和“ OR”运算符以及过滤器组的任何组合都可以创建
- 可以使用“ AND”或“ OR”运算符将创建的多个过滤器组进一步分组以形成超级组
- 获取组中所有过滤器的结果，然后进行“或”或“与”运算，并最终获得单个组结果-得出TRUE或FALSE

The screenshot displays the 'Group Config' interface, which is divided into two main sections: 'Group Config' and 'Super Group Config'.

Group Config Section:

- Port Selection:** Port 1
- Group Config Table:**

#	Group Name
1	Group1
2	Group2
3	Group3
4	Group4
5	Group5
6	Group6
7	Group7
8	Group8
9	Group9
10	Group10
11	Group11
12	Group12
13	Group13
14	Group14
15	Group15
16	Group16
- Filter Selection:** A list of filters from Filter1 to Filter16. Filter1, Filter5, Filter6, Filter10, and Filter12 are checked.
- Operation:** AND (selected), OR.
- Summary:** (Filter1 & Filter5 & Filter6 & Filter10 & Filter12)
- Buttons:** Add, Delete, Clear.

Super Group Config Section:

- Enable Super Group:** Checked (circled in red).
- Super Group Config Table:**

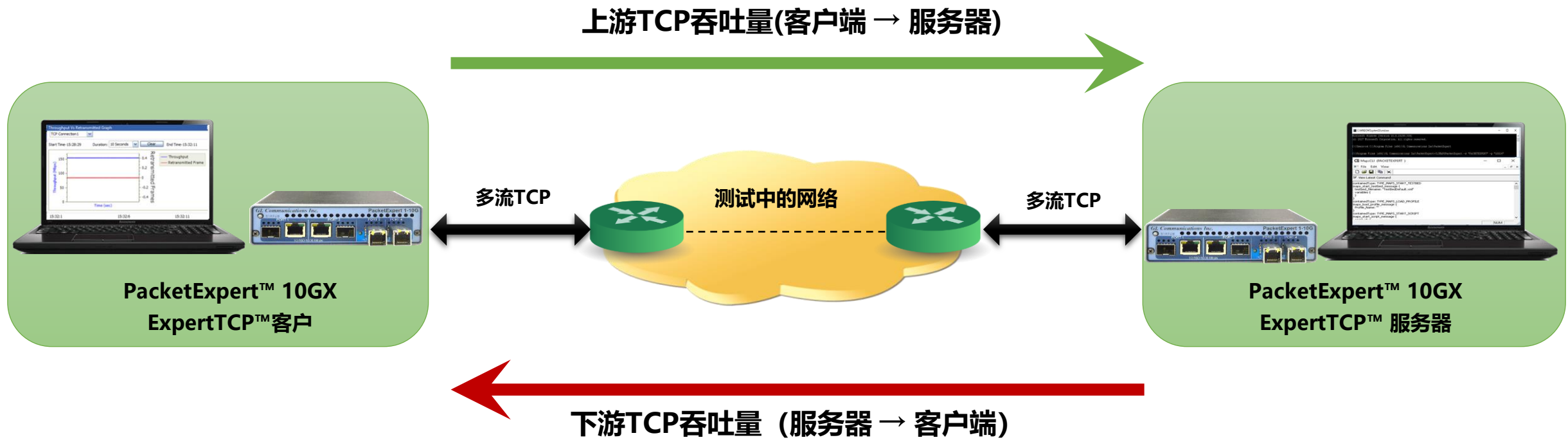
#	Super Group Name
1	SuperGroup1
2	SuperGroup2
3	SuperGroup3
4	SuperGroup4
5	SuperGroup5
6	SuperGroup6
7	SuperGroup7
8	SuperGroup8
9	SuperGroup9
10	SuperGroup10
11	SuperGroup11
12	SuperGroup12
13	SuperGroup13
14	SuperGroup14
15	SuperGroup15
16	SuperGroup16
- Group Selection:** A list of groups from Group1 to Group16. Group1, Group4, Group6, and Group8 are checked.
- Operation:** AND, OR (selected).
- Summary:** (Group1 || Group4 || Group6 || Group8)
- Buttons:** Add, Delete, Clear.

Additional UI Elements:

- A 'Hide Super Group' button is circled in red at the top right of the Super Group Config section.

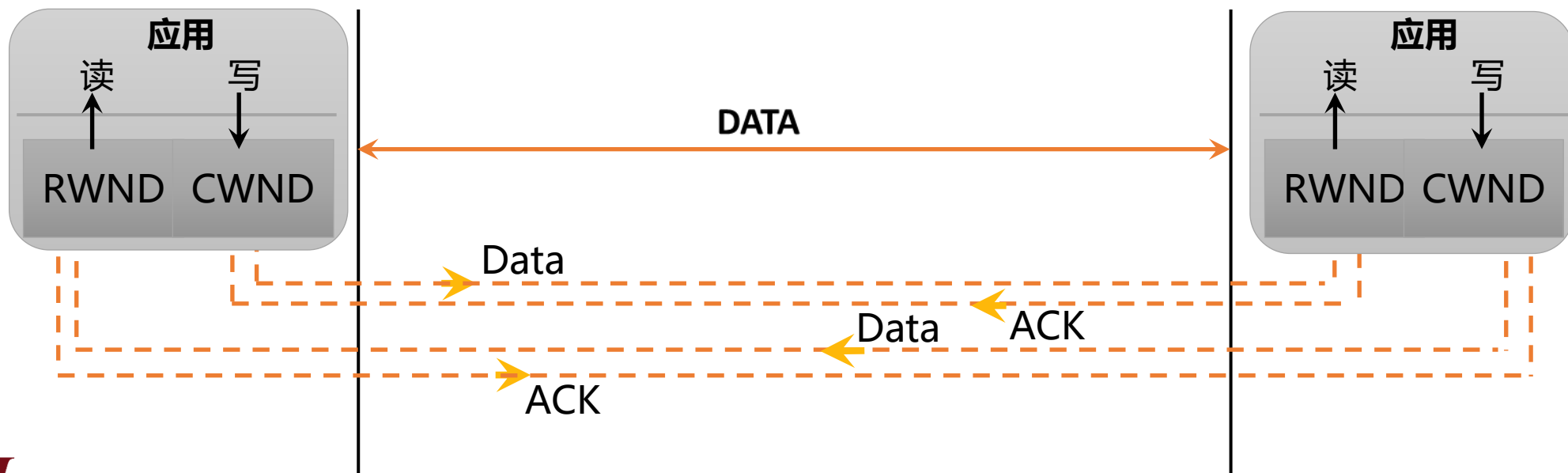
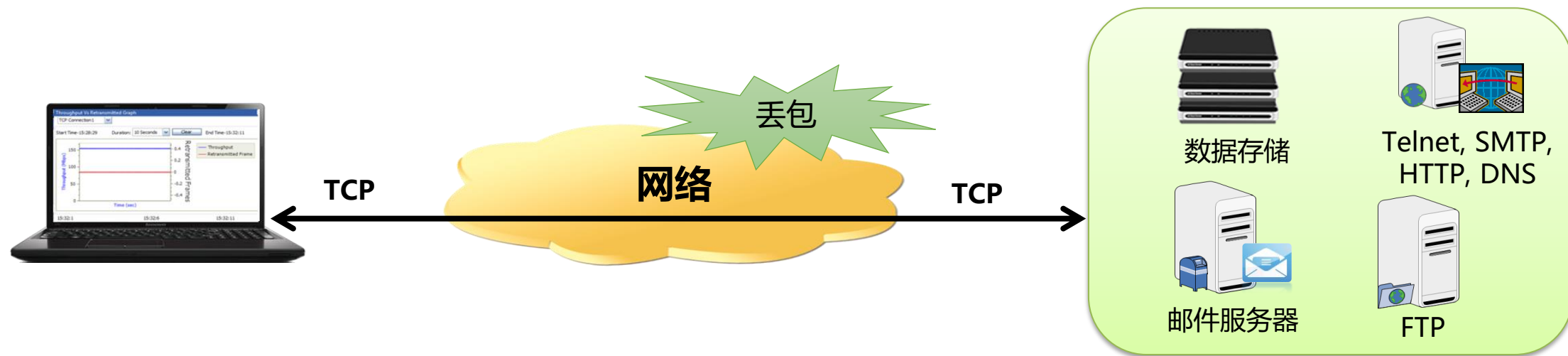
ExpertTCP™-TCP 吞吐量测试 (RFC 6349)

ExpertTCP™ (RFC-6349 测试)



TCP 原理

(数据包丢失和等待ACK会降低吞吐量)



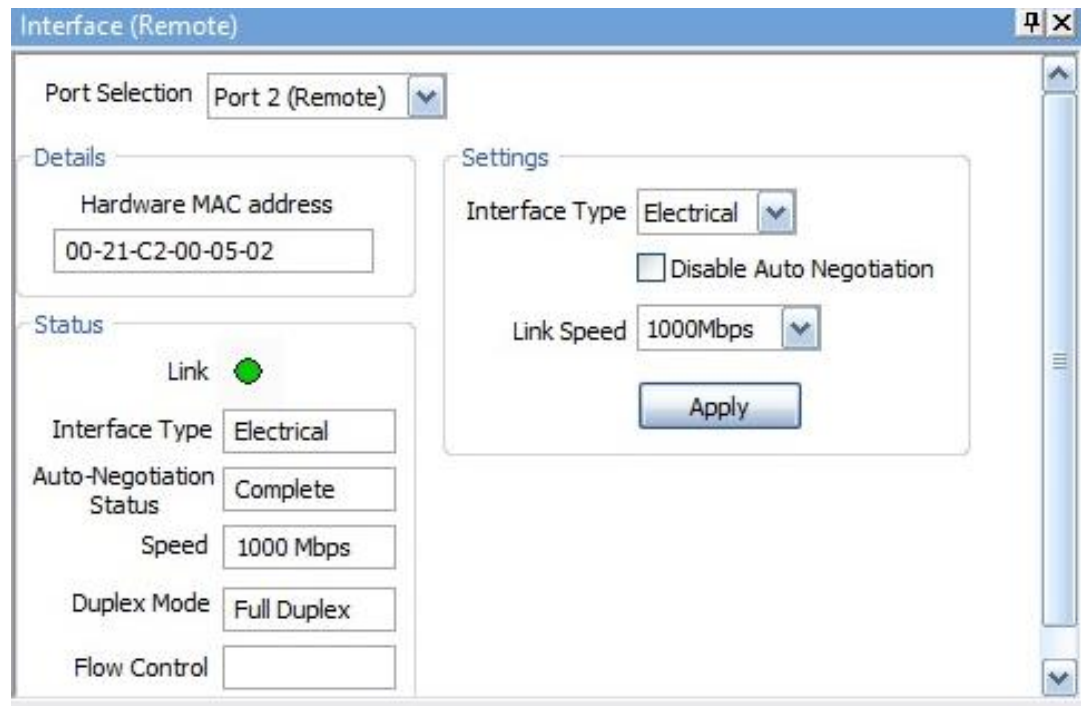
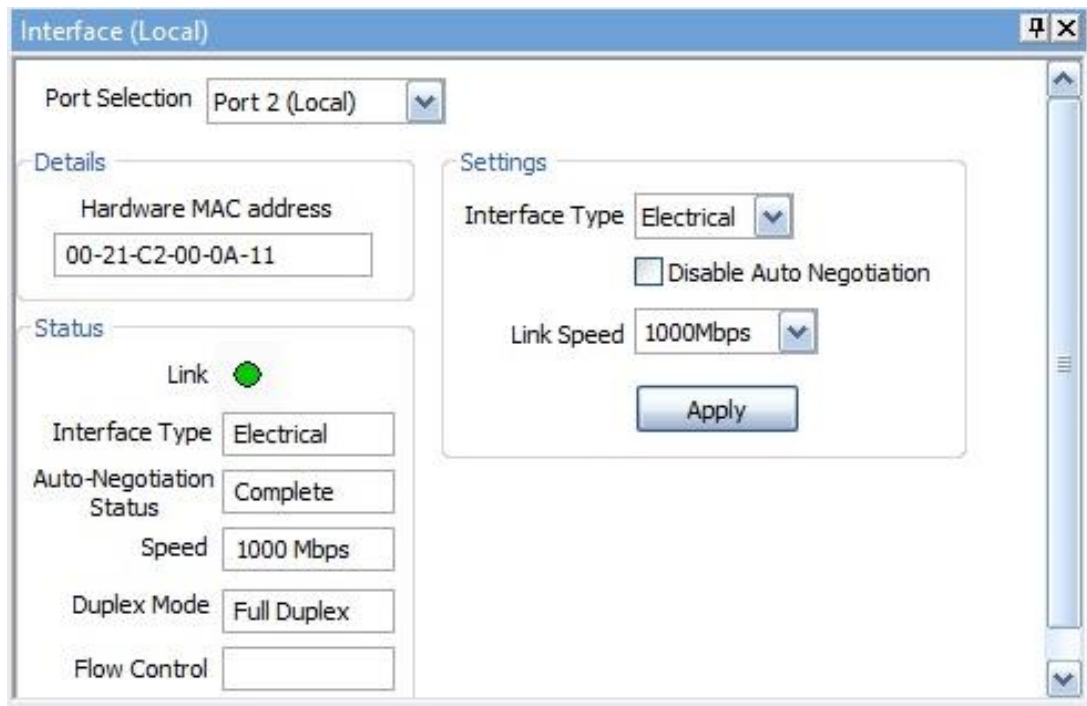
ExpertTCP™主界面

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

- Network Setup:** A diagram showing a Client (Local) connected to a Network Under Test, which is connected to a Server (Remote).
 - Client (Local):** MAC Address: 00-21-c2-00-05-02 (User Defined); IP Address: 192.168.1.111; Subnet Mask: 255.255.255.0; Default Gateway: 192.168.1.1.
 - Network Under Test:** Link Type: Symmetrical; Upstream CIR: 10 Mbps; Downstream CIR: 10 Mbps.
 - Server (Remote):** MAC Address: 00-21-c2-00-06-1e (User Defined); IP Address: 192.168.1.232; Subnet Mask: 255.255.255.0; Default Gateway: 192.168.1.1.
- Test Setup:** Direction: Upstream; Transfer Size: 100,000 MBytes; Test Selection: Run Throughput Test, Run Path MTU Test (Upstream/Downstream MTU: 1500 Bytes), Run Baseline RTT Test (Upstream/Downstream RTT: 50,000 msec).
- TCP Setup:** No of TCP Connection: 8; TCP Port Configuration: Automatic. A table lists 8 connections with Client Ports from 5000 to 5007 and Server Ports from 6000 to 6007.
- Remote:** Remote Server IP Address: 192.168.1.232; Status: Connected.

网络设置

在客户端本地配置的所有设置



状态和结果

Overall Status

Test Status: Done

Current Direction: -

Current Test

Test	Status	Result
Path MTU (Upstream)	⬆️	✔️
Baseline RTT (Upstream)	⬆️	✔️
Throughput (Upstream)	⬆️	✔️

TCP Connection Status:

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

Path MTU results

Upstream Downstream

Path MTU: 1500 Bytes

Baseline RTT Results

Upstream Downstream

Trial Duration: 91

Average RTT: 50.018 msec

Minimum RTT: 50.015 msec

Maximum RTT: 50.040 msec

Baseline RTT Value Selected: 50.015 msec

Test Parameter Summary

Upstream Downstream

Baseline RTT: 50.015 msec

Calculated BDP: 625.190 KBytes

TCP Window: 65535 Bytes

Path MTU: 1500 Bytes

MSS Used: 1448 Bytes

No of TCP Connection: 1

Transfer Size: 100.000 MBytes

统计和定期结果

Statistics

Upstream Downstream

TCP Connection 1

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

统计信息每秒更新一次，其中包括 -

- TCP传输的帧/字节
- TCP重新传输的帧/字节
- 重传的字节百分比

Throughput Results

Upstream Downstream

TCP Connection 1

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

RTT Results

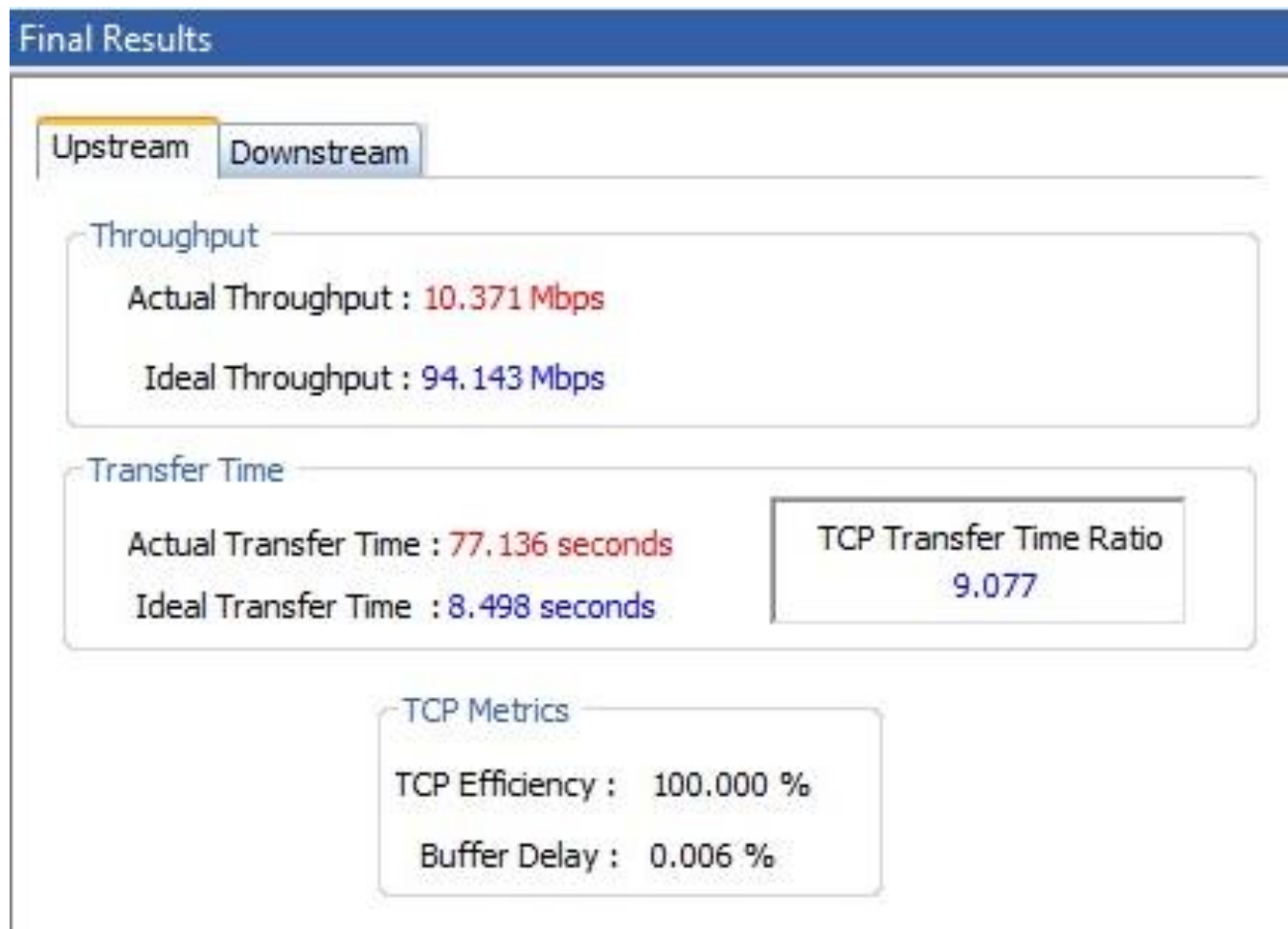
Upstream Downstream

TCP Connection 1

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

每秒计算吞吐量和RTT值并显示出来。
显示最小值、最大值和平均值

最终结果



理想吞吐量 -- 给定CIR的最大可能TCP吞吐量

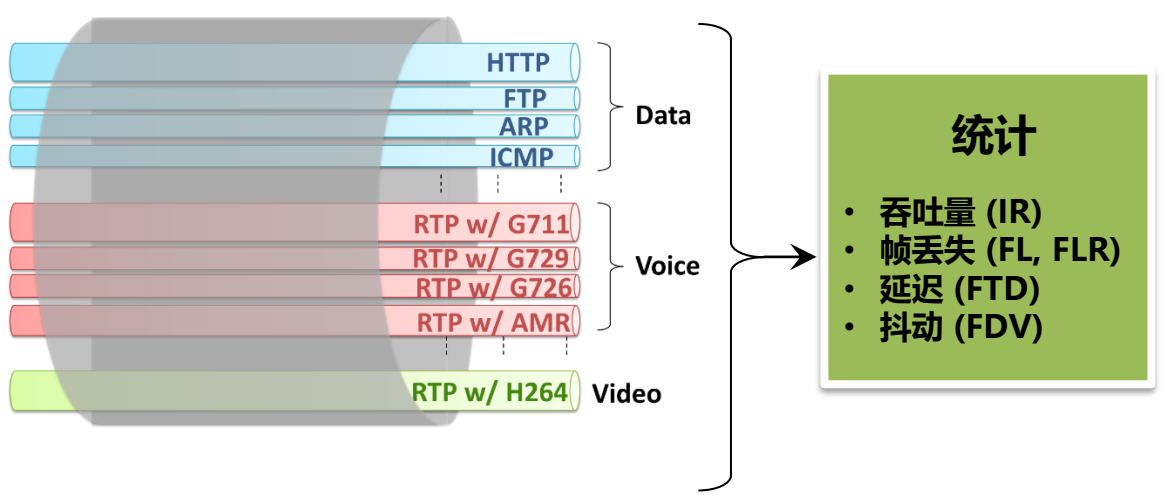
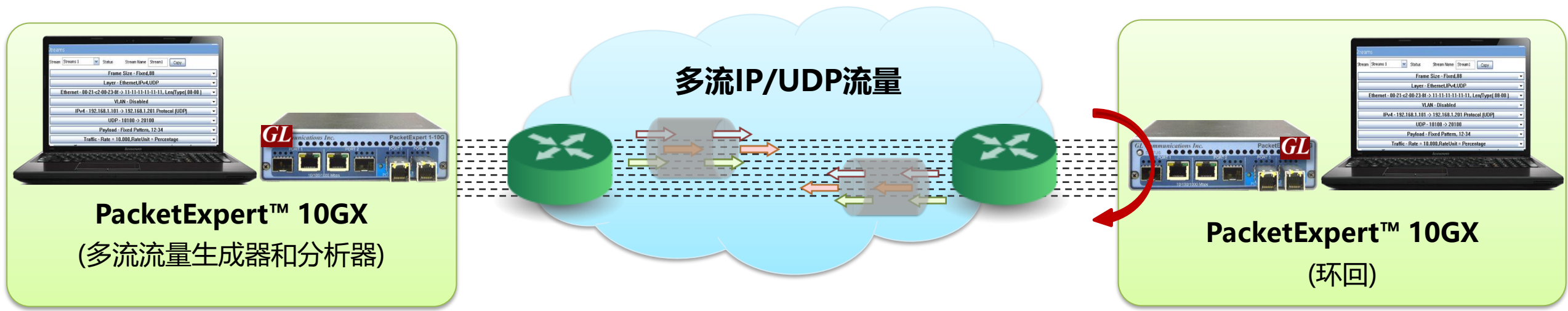
理想传输时间--以理想吞吐量传输测试数据大小所需的时间

TCP传输时间比率--测量实际传输时间大于理想传输时间的数量

CP效率-- 与重传字节相比的已传输字节数的度量

缓冲延迟-- 测量与基准RTT相比在实际TCP吞吐量测试期间RTT增加了多少量

多流流量生成器和分析器 (1 Gbps, 2.5 Gbps, or 10 Gbps)



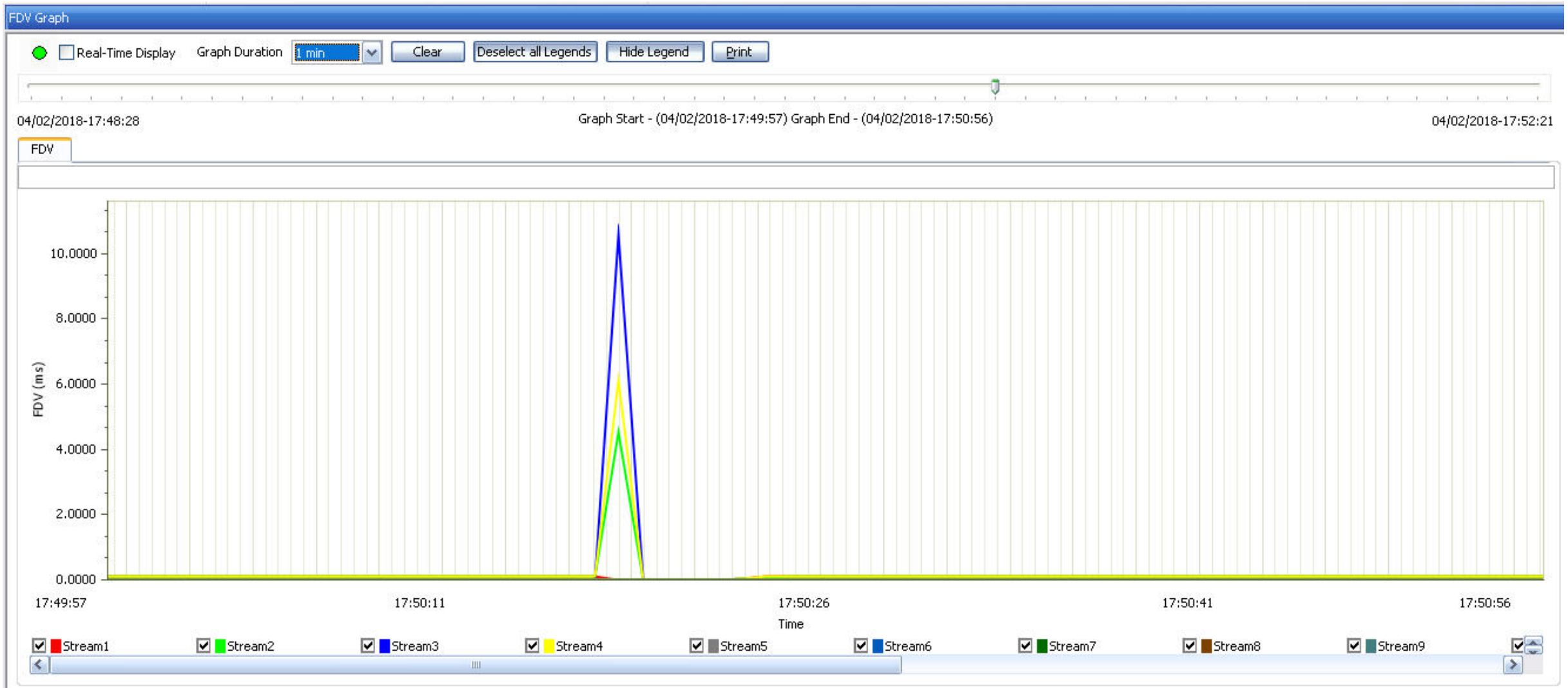
多流流量生成器和分析器结果 (水平视图)

Multi-Stream Traffic Generator & Analyzer Results																			
IR(Mbps), FLR(%), FTD(msec), FDV(msec)		Test Time 00:00:53		Vertical		FTD Unit msec		FDV Unit msec		Activate All		DeActivate All							
Stream No	Seconds	TxFrames	RxFrames	RxBytes	FL Count	FLR	IR (Curr)	IR (Min)	IR (Max)	IR (Avg)	FTD	FTD	FTD	FTD	FDV (Curr)	FDV (Min)	FDV (Max)	FDV (Avg)	
<input checked="" type="checkbox"/>	1	55	1 146 226	1 125 387	679 852 618	20 839	1.818	104.05	104.03	104.06	133.78	0.002	0.001	0.003	0.002	< 1us	0.000	0.001	< 1us
<input checked="" type="checkbox"/>	2	55	1 278 940	1 255 686	642 911 232	23 254	1.818	98.97	98.94	98.97	127.24	0.002	0.001	0.003	0.002	< 1us	0.000	0.001	< 1us
<input checked="" type="checkbox"/>	3	55	5 832 149	5 726 109	7 902 030 420	106 040	1.818	1187.65	1187.30	1187.65	1526.96	0.002	0.002	0.003	0.002	< 1us	0.000	< 1us	< 1us
<input checked="" type="checkbox"/>	4	55	1 214 894	1 192 804	1 646 069 520	22 090	1.818	247.40	247.33	247.41	318.08	0.002	0.002	0.003	0.002	< 1us	< 1us	< 1us	< 1us
<input checked="" type="checkbox"/>	5	55	155 163	152 342	157 521 628	2 821	1.818	23.79	23.79	23.80	30.58	0.002	0.002	0.003	0.002	< 1us	< 1us	< 1us	< 1us
<input checked="" type="checkbox"/>	6	55	18 212 176	17 881 043	2 324 535 590	331 133	1.818	397.36	397.24	397.36	510.89	0.002	0.001	0.003	0.002	< 1us	0.000	0.001	< 1us
<input checked="" type="checkbox"/>	7	55	14 585 983	14 320 782	19 762 679 160	265 201	1.818	2970.25	2969.39	2970.26	3818.88	0.002	0.002	0.003	0.002	< 1us	0.000	< 1us	< 1us
<input checked="" type="checkbox"/>	8	55	5 216 779	5 121 928	5 244 854 272	94 851	1.818	792.20	791.97	792.20	1018.53	0.002	0.002	0.003	0.002	< 1us	0.000	< 1us	< 1us
<input checked="" type="checkbox"/>	9	55	1 535 124	1 507 212	771 692 544	27 912	1.818	118.79	118.76	118.79	152.73	0.002	0.001	0.003	0.002	< 1us	0.000	0.001	< 1us
<input checked="" type="checkbox"/>	10	55	3 434 715	3 372 265	674 453 000	62 450	1.818	109.91	109.88	109.91	141.31	0.002	0.001	0.003	0.002	< 1us	0.000	0.001	< 1us
<input checked="" type="checkbox"/>	11	55	3 176 550	3 118 794	405 443 220	57 756	1.818	69.31	69.29	69.31	89.11	0.002	0.001	0.003	0.002	< 1us	0.000	0.001	< 1us
<input checked="" type="checkbox"/>	12	55	9 085 290	8 920 101	1 159 613 130	165 189	1.818	198.22	198.17	198.23	254.86	0.002	0.002	0.003	0.002	< 1us	0.000	< 1us	< 1us
<input checked="" type="checkbox"/>	13	55	9 844 599	9 665 605	5 841 891 662	178 994	1.818	894.11	893.85	894.12	1149.56	0.002	0.001	0.003	0.002	< 1us	0.000	0.001	< 1us
<input checked="" type="checkbox"/>	14	55	27 539 785	27 039 059	16 342 406 346	500 726	1.818	2501.23	2500.50	2501.23	3215.84	0.002	0.001	0.003	0.002	< 1us	0.000	0.001	< 1us
<input checked="" type="checkbox"/>	15	55	395 501	388 310	793 705 640	7 191	1.818	118.74	118.71	118.74	152.66	0.003	0.002	0.003	0.003	< 1us	0.000	< 1us	< 1us
<input checked="" type="checkbox"/>	16	55	1 090 764	1 090 764	658 606 880	0	0.000	98.97	98.94	98.98	129.60	0.002	0.002	0.003	0.002	< 1us	0.000	< 1us	< 1us

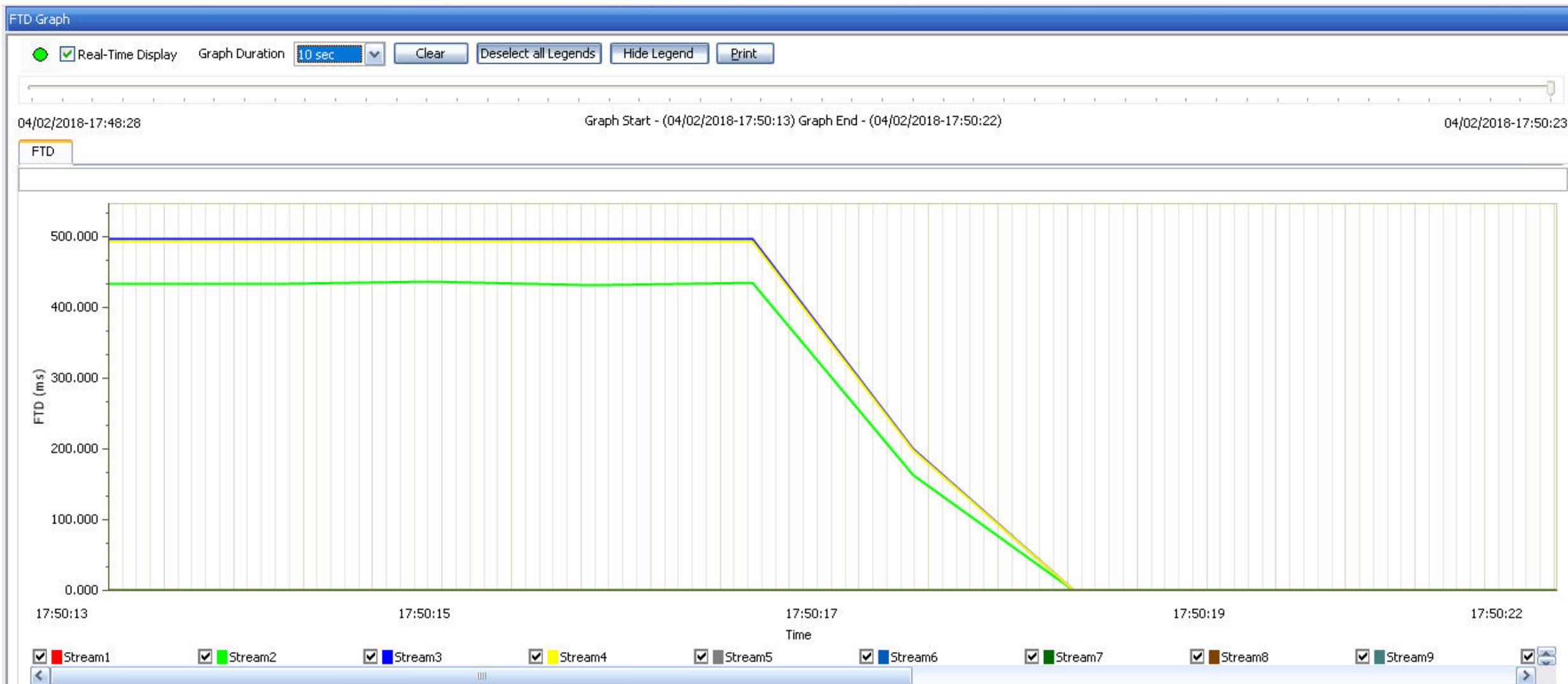
吞吐量 (IR)图



帧延迟变化- FDV图



帧传输延迟- FTD图



以PDF和CSV格式生成报告

Testpdf - Adobe Reader

File Edit View Window Help

Comment Share

Expert Analyzer

Stream - 16 Configuration

Framesize

Framesize Type: Fixed

Framesizes: 700

UDP

Src UDP Port: 11600

Dst UDP Port: 21600

Payload

Payload: 12-34

Layer

Layer: UDP

Ethernet

Src MAC Address: 00-21-c2-00-23-93

Dest MAC Address: 18-18-18-18-18-18

Len/Type: 08-00

VLAN

VLAN C Tag: Disabled

VLAN Type: -

VLAN S Tag: -

VLAN Type: 88-a8

VLAN ID: -

VLAN ID: 13

Src IPv4 Address: 192.168.1.116

Subnet Mask: 255.255.255.0

Default Gateway: 192.168.1.1

Dest IPv4 Address: 192.168.1.216

Protocol: 17

Rate: 1.000000

RateUnit: Mbps

Bandwidth

End Of Report

Test.csv.csv - Excel

File Home Insert Page Layout Formulas Data Review View Developer Add-ins Tell me... Poornima Share

N19

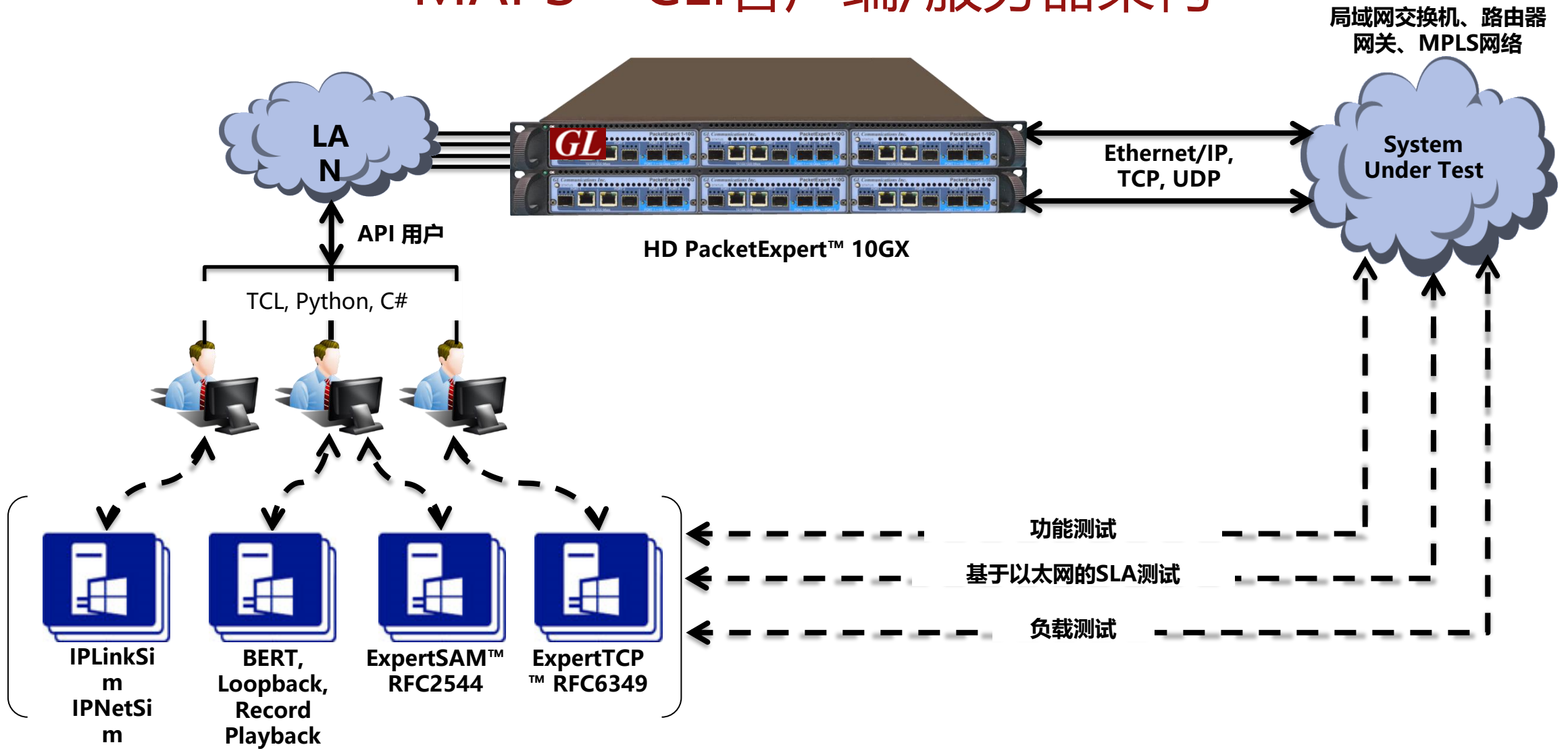
	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Stream	TxFrames	RxFrames	RxBytes	IR(Min)	IR(Max)	IR(Avg)	FTD(Min)	FTD(Max)	FTD(Avg)	FDV(Min)	FDV(Max)	FDV(Avg)
2													
3	Stream1	67087646	67087646	5232836388	455.876	1007.866	992.391	0.001	0.002	0.002	0.000004	0.000004	0.000004
4	Stream2	432739	432739	56256070	4.5	9.95	9.798	0.001	0.002	0.002	0.000021	0.000022	0.000021
5	Stream3	298307	298307	156312868	11.25	24.88	24.495	0.001	0.002	0.002	0.000026	0.000027	0.000027
6	Stream4	11971	11971	6272804	0.453	0.997	0.983	0.001	0.002	0.002	0.000508	0.000533	0.000528
7	Stream5	6148	6148	6357032	0.455	0.995	0.978	0.002	0.002	0.002	0.000006	0.000008	0.000007
8	Stream6	17378151	17378151	2259159630	180.748	399.604	393.468	0.001	0.002	0.002	0.000004	0.000005	0.000004
9	Stream7	139124	139124	191991120	13.507	29.859	29.4	0.002	0.002	0.002	0.000004	0.000005	0.000005
10	Stream8	4977550	4977550	5097011200	360.322	796.614	784.387	0.002	0.002	0.002	0.000005	0.000005	0.000005
11	Stream9	1464518	1464518	749833216	54.021	119.436	117.604	0.001	0.002	0.002	0.00001	0.00001	0.00001
12	Stream10	118093	118093	23618600	1.8	3.983	3.922	0.001	0.002	0.002	0.000039	0.00004	0.000039
13	Stream11	302998	302998	39389740	3.151	6.968	6.86	0.001	0.002	0.002	0.000027	0.000028	0.000028
14	Stream12	389546	389546	50640980	4.051	8.957	8.82	0.001	0.002	0.002	0.000025	0.000025	0.000025
15	Stream13	1081929	1081929	432771600	31.51	69.66	68.59	0.001	0.002	0.002	0.000012	0.000013	0.000012
16	Stream14	834741	834741	626055750	44.568	98.535	97.019	0.002	0.002	0.002	0.000014	0.000015	0.000014
17	Stream15	18118	18118	12682600	0.904	1.999	1.969	0.002	0.002	0.002	0.000133	0.00014	0.000137
18	Stream16	9059	9059	6341300	0.449	1.002	0.985	0.002	0.002	0.002	0.000318	0.000326	0.000322
19													

Test.csv

Ready

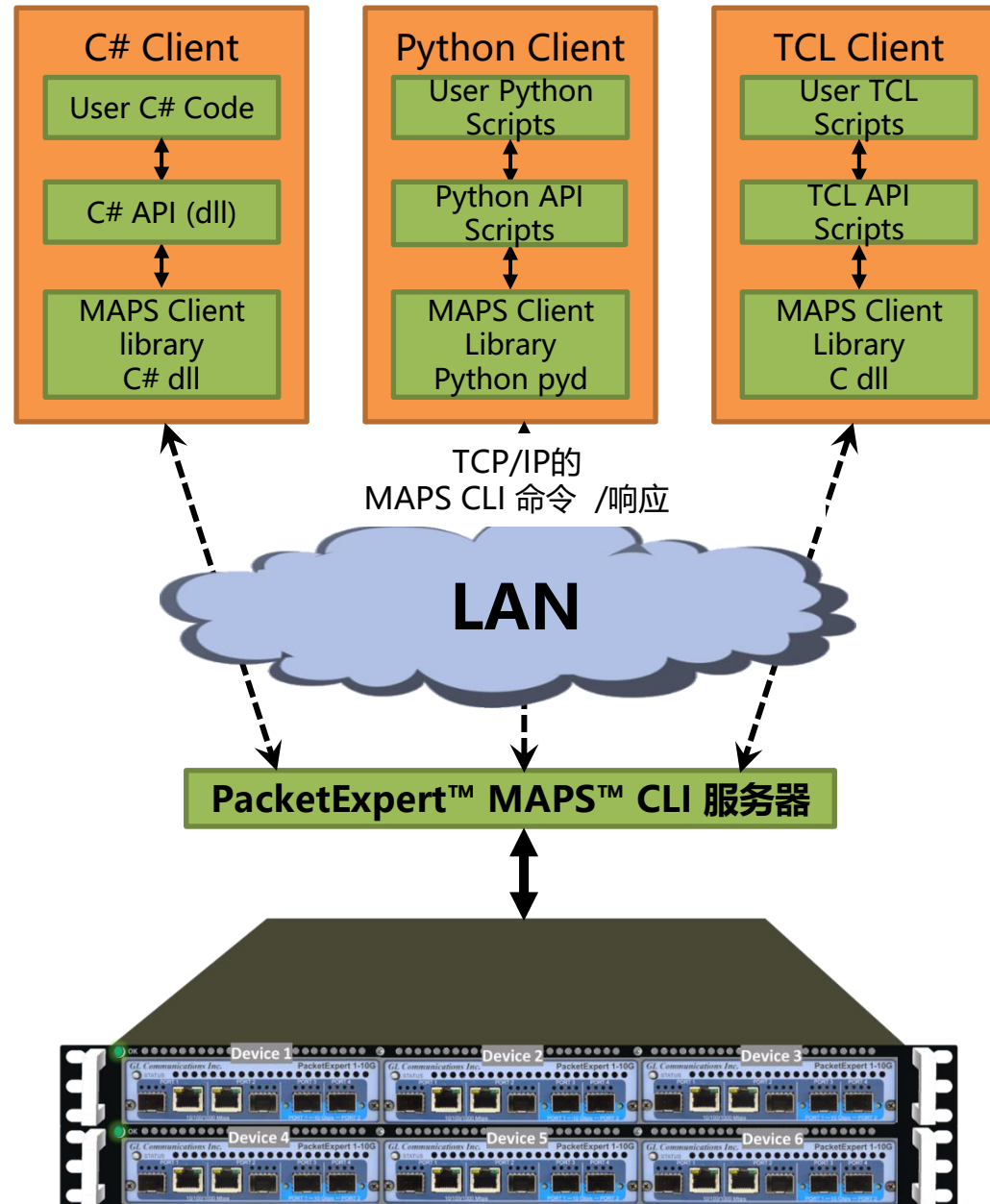
命令行接口(CLI)

MAPS™ CLI客户端/服务器架构

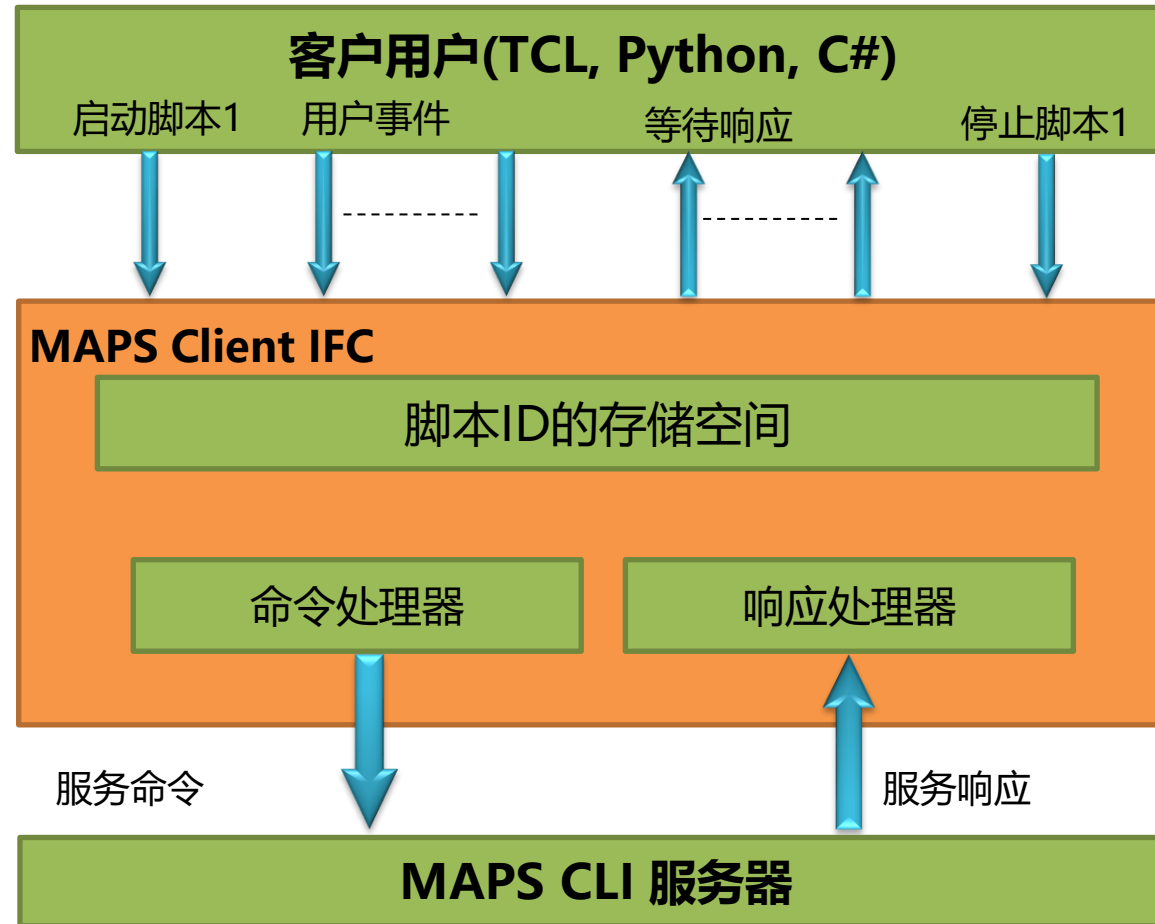


- PacketExpert™10GX还支持命令行界面（CLI），使用TCL、Python、C#客户端APIs和MAPS™CLI客户端/服务器体系结构远程访问所有功能

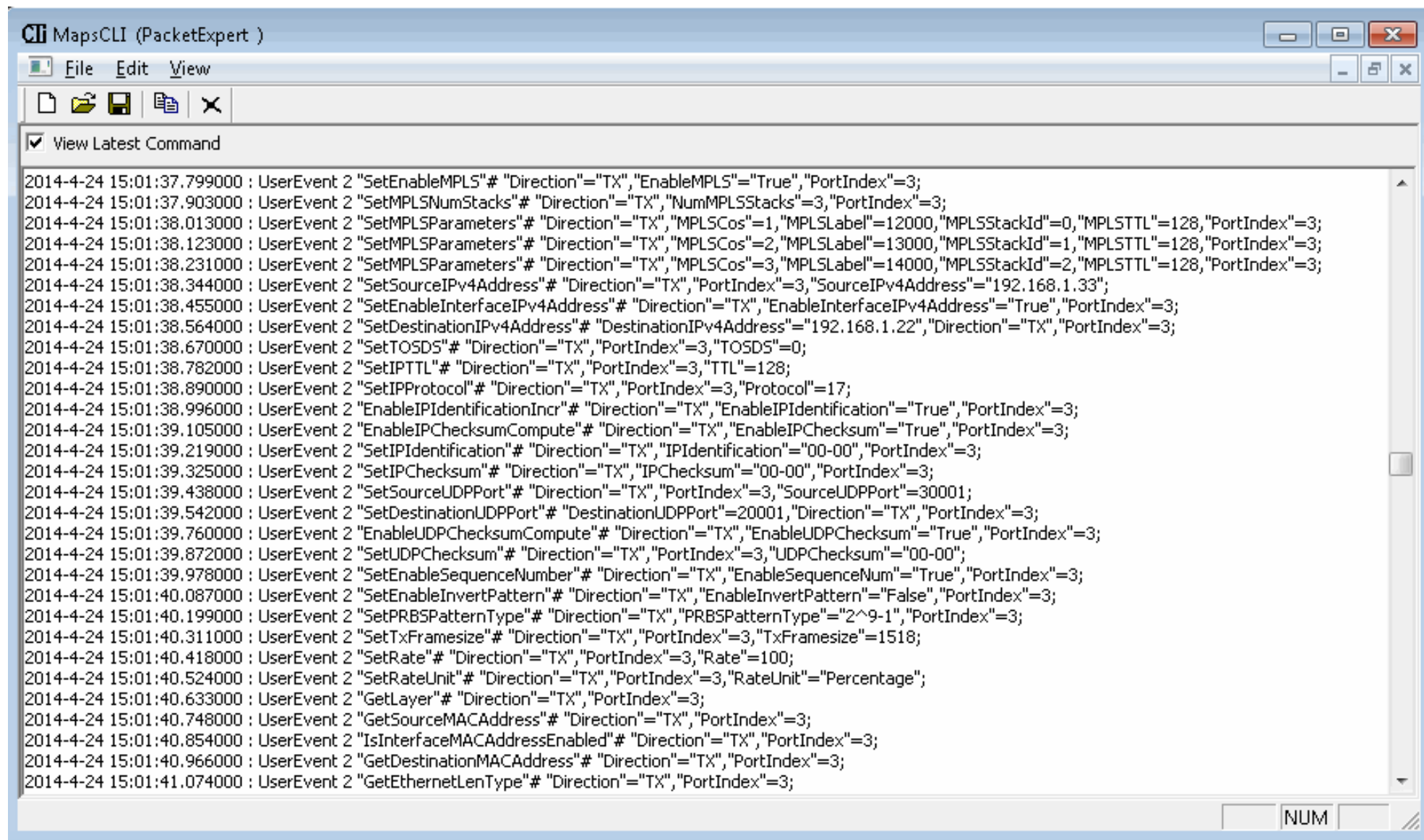
MAPS™ CLI的工作原理



MAPS™ CLI的工作原理



MAPS™ CLI 服务器...



The screenshot shows a window titled "CLI MapsCLI (PacketExpert)" with a menu bar (File, Edit, View) and a toolbar. A checkbox labeled "View Latest Command" is checked. The main area displays a list of 30 log entries, each starting with a timestamp and "UserEvent 2" followed by a command and its output. The commands include setting MPLS parameters, source and destination addresses, TOS, TTL, IP protocol, IP identification, IP checksum, UDP port, UDP checksum, sequence number, invert pattern, PRBS pattern type, Tx frame size, rate, layer, and MAC addresses. The window has standard Windows window controls (minimize, maximize, close) and a "NUM" button at the bottom right.

```
2014-4-24 15:01:37.799000 : UserEvent 2 "SetEnableMPLS"# "Direction"="TX","EnableMPLS"="True","PortIndex"=3;
2014-4-24 15:01:37.903000 : UserEvent 2 "SetMPLSNumStacks"# "Direction"="TX","NumMPLSStacks"=3,"PortIndex"=3;
2014-4-24 15:01:38.013000 : UserEvent 2 "SetMPLSParameters"# "Direction"="TX","MPLSCos"=1,"MPLSLabel"=12000,"MPLSStackId"=0,"MPLSTTL"=128,"PortIndex"=3;
2014-4-24 15:01:38.123000 : UserEvent 2 "SetMPLSParameters"# "Direction"="TX","MPLSCos"=2,"MPLSLabel"=13000,"MPLSStackId"=1,"MPLSTTL"=128,"PortIndex"=3;
2014-4-24 15:01:38.231000 : UserEvent 2 "SetMPLSParameters"# "Direction"="TX","MPLSCos"=3,"MPLSLabel"=14000,"MPLSStackId"=2,"MPLSTTL"=128,"PortIndex"=3;
2014-4-24 15:01:38.344000 : UserEvent 2 "SetSourceIPv4Address"# "Direction"="TX","PortIndex"=3,"SourceIPv4Address"="192.168.1.33";
2014-4-24 15:01:38.455000 : UserEvent 2 "SetEnableInterfaceIPv4Address"# "Direction"="TX","EnableInterfaceIPv4Address"="True","PortIndex"=3;
2014-4-24 15:01:38.564000 : UserEvent 2 "SetDestinationIPv4Address"# "DestinationIPv4Address"="192.168.1.22","Direction"="TX","PortIndex"=3;
2014-4-24 15:01:38.670000 : UserEvent 2 "SetTOSDS"# "Direction"="TX","PortIndex"=3,"TOSDS"=0;
2014-4-24 15:01:38.782000 : UserEvent 2 "SetIPTTL"# "Direction"="TX","PortIndex"=3,"TTL"=128;
2014-4-24 15:01:38.890000 : UserEvent 2 "SetIPProtocol"# "Direction"="TX","PortIndex"=3,"Protocol"=17;
2014-4-24 15:01:38.996000 : UserEvent 2 "EnableIPIdentificationIncr"# "Direction"="TX","EnableIPIdentification"="True","PortIndex"=3;
2014-4-24 15:01:39.105000 : UserEvent 2 "EnableIPChecksumCompute"# "Direction"="TX","EnableIPChecksum"="True","PortIndex"=3;
2014-4-24 15:01:39.219000 : UserEvent 2 "SetIPIdentification"# "Direction"="TX","IPIdentification"="00-00","PortIndex"=3;
2014-4-24 15:01:39.325000 : UserEvent 2 "SetIPChecksum"# "Direction"="TX","IPChecksum"="00-00","PortIndex"=3;
2014-4-24 15:01:39.438000 : UserEvent 2 "SetSourceUDPPort"# "Direction"="TX","PortIndex"=3,"SourceUDPPort"=30001;
2014-4-24 15:01:39.542000 : UserEvent 2 "SetDestinationUDPPort"# "DestinationUDPPort"=20001,"Direction"="TX","PortIndex"=3;
2014-4-24 15:01:39.760000 : UserEvent 2 "EnableUDPChecksumCompute"# "Direction"="TX","EnableUDPChecksum"="True","PortIndex"=3;
2014-4-24 15:01:39.872000 : UserEvent 2 "SetUDPChecksum"# "Direction"="TX","PortIndex"=3,"UDPChecksum"="00-00";
2014-4-24 15:01:39.978000 : UserEvent 2 "SetEnableSequenceNumber"# "Direction"="TX","EnableSequenceNum"="True","PortIndex"=3;
2014-4-24 15:01:40.087000 : UserEvent 2 "SetEnableInvertPattern"# "Direction"="TX","EnableInvertPattern"="False","PortIndex"=3;
2014-4-24 15:01:40.199000 : UserEvent 2 "SetPRBSPatternType"# "Direction"="TX","PRBSPatternType"="2^9-1","PortIndex"=3;
2014-4-24 15:01:40.311000 : UserEvent 2 "SetTxFrameSize"# "Direction"="TX","PortIndex"=3,"TxFrameSize"=1518;
2014-4-24 15:01:40.418000 : UserEvent 2 "SetRate"# "Direction"="TX","PortIndex"=3,"Rate"=100;
2014-4-24 15:01:40.524000 : UserEvent 2 "SetRateUnit"# "Direction"="TX","PortIndex"=3,"RateUnit"="Percentage";
2014-4-24 15:01:40.633000 : UserEvent 2 "GetLayer"# "Direction"="TX","PortIndex"=3;
2014-4-24 15:01:40.748000 : UserEvent 2 "GetSourceMACAddress"# "Direction"="TX","PortIndex"=3;
2014-4-24 15:01:40.854000 : UserEvent 2 "IsInterfaceMACAddressEnabled"# "Direction"="TX","PortIndex"=3;
2014-4-24 15:01:40.966000 : UserEvent 2 "GetDestinationMACAddress"# "Direction"="TX","PortIndex"=3;
2014-4-24 15:01:41.074000 : UserEvent 2 "GetEthernetLenType"# "Direction"="TX","PortIndex"=3;
```

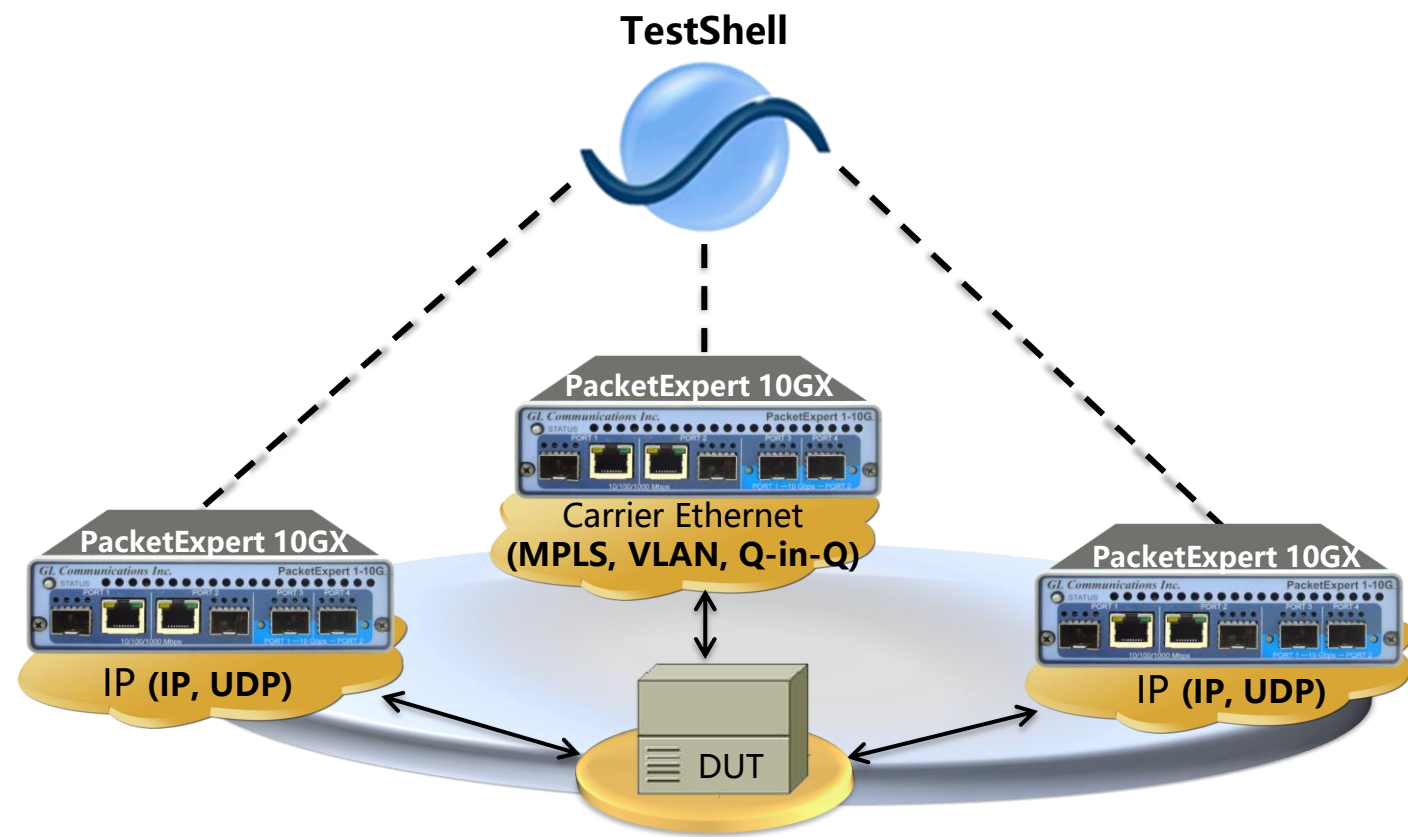
TCL 客户端...

```
C:\Program Files (x86)\GL Communications Inc\PacketExpert\Tcl Client\tclsh85.exe
Port 4 statistics
TxFrames = 13377311
PEXTxValidFrames = 13377361
PEXTxBytes = 20306926596
PEXTxRate = 986.778161
PEXTxFrameRate = 81249.873801
PEXTxBroadcastFrames = 0
PEXTxMulticastFrames = 13377529
PEXTxControlFrames = 0
PEXTxULANFrames = 13377610
PEXTxPauseFrames = 0
PEXTxWrongOpcodeFrames = 0
PEXTx64ByteLengthFrames = 0
PEXTx65_127ByteLengthFrames = 0
PEXTx128_255ByteLengthFrames = 0
PEXTx256_511ByteLengthFrames = 0
PEXTx512_1023ByteLengthFrames = 0
PEXTx1024_1518ByteLengthFrames = 13377935
PEXTxOversizedFrames = 0
PEXRxFrames = 13378745
PEXRxBytes = 20309073048
PEXRxRate = 986.992719
PEXRxFrameRate = 81253.407370
PEXRxBroadcastFrames = 0
PEXRxMulticastFrames = 0
PEXRxControlFrames = 0
PEXRxULANFrames = 13379029
PEXRxPauseFrames = 0
PEXRxWrongOpcodeFrames = 0
PEXRx64ByteLengthFrames = 0
PEXRx65_127ByteLengthFrames = 0
PEXRx128_255ByteLengthFrames = 0
PEXRx256_511ByteLengthFrames = 0
PEXRx512_1023ByteLengthFrames = 0
PEXRx1024_1518ByteLengthFrames = 13379354
PEXRxOversizedFrames = 0
PEXRxUndersizedFrames = 0
PEXRxFCSErrorFrames = 1
PEXRxNonTestFrames = 1
PEXRxNonTestULANFrames = 1
PEXRxNonTestMPLSFrames = 1
PEXRx1LevelStackedULANFrames = 0
PEXRx2LevelStackedULANFrames = 0
PEXRx3LevelStackedULANFrames = 13379719
PEXRx1LevelStackedMPLSFrames = 0
PEXRx2LevelStackedMPLSFrames = 0
PEXRx3LevelStackedMPLSFrames = 13379841
PEXRxIPChecksumErrors = 0
PEXRxIPv4Packets = 13379560
PEXRxIPv6Packets = 0
PEXRxIPNonTestPackets = 0
PEXRxIP_IPPackets = 0
PEXRxUDP_IPPackets = 13379723
PEXRxTCP_IPPackets = 0
PEXRxICMP_IPPackets = 0
PEXRxIGMP_IPPackets = 0
PEXRxIGRP_IPPackets = 0
```

使用TCL客户端将PacketExpert™与TestShell集成

PacketExpert™ 与TestShell集成

使用CLI进行TestShell集成-RFC2544测试的执行



```
C:\Program Files\GL Communications Inc\PacketExpert\PacketExpertCLI.exe
pxecli>runscript "C:\Program Files\GL Communications Inc\PacketExpert\CLI Script
s\RFC2544_Test.txt";
set RFC2544_FrameSizes <64> port <2-3>;
OK
set RFC2544_Tests Throughput port <2-3>;
OK
set ThroughputBWParams MinBandwidth 10.0 % MaxBandwidth 100.0 % port <2-3>;
OK
set ThroughputTrialParams NumberOfTrials 1 TrialDuration 2 port <2-3>;
OK
start rfc2544 port <2-3>;
OK
wait 10 sec;
OK
get rfc2544results status port <2-3>;
OK

-----
RFC2544 Test Status
-----
P2 -> P3
Status : Test Done
Test : -
Completed Tests : Throughput

Current Trial :
Status : -
Frame Size : -
Bandwidth : -
Trial No. : -
Tx Frames : -
Rx Frames : -

Last Trial :
Frame Size : 64 Bytes
Bandwidth : 100.0000 %
Trial No. : 1
Tx Frames : 2976190
Rx Frames : 2976190
```

Python客户端和脚本

- Python客户端包含以下组件:
- 提供高级API的Python API脚本, 用户可以使用所有PacketExpert功能.
- 这些API依次使用低级库与PacketExpert MAPS服务器进行通信



Python 客户端...

```
*Python 3.6.7rc2 Shell*
File Edit Shell Debug Options Window Help
RESTART: C:\Users\glitteam\Desktop\PythonClient3_6\AllPortBertSampleApplication.py
ALLPortBERT Test
Press any key to continue , 'q' to quit
a
Running BERT Test
Device Initialised
Module Initialised
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+000
BitErrorSeconds = 0
SyncLossCount = 0
SyncLossSeconds = 0
OOSCount = 0
OOSSeconds = 0
ErrorFreeSeconds = 0
*****
PORT TX STATISTICS
-----
Total Frames = 0
Valid Frames = 0
Number of Bytes = 0
Link Utilisation = 0.0
Data Rate = 0.0
Frame Rate = 0.0
Broadcast Frames = 0
Multicast Frames = 0
Control Frames = 0
VLAN Frames = 0
```

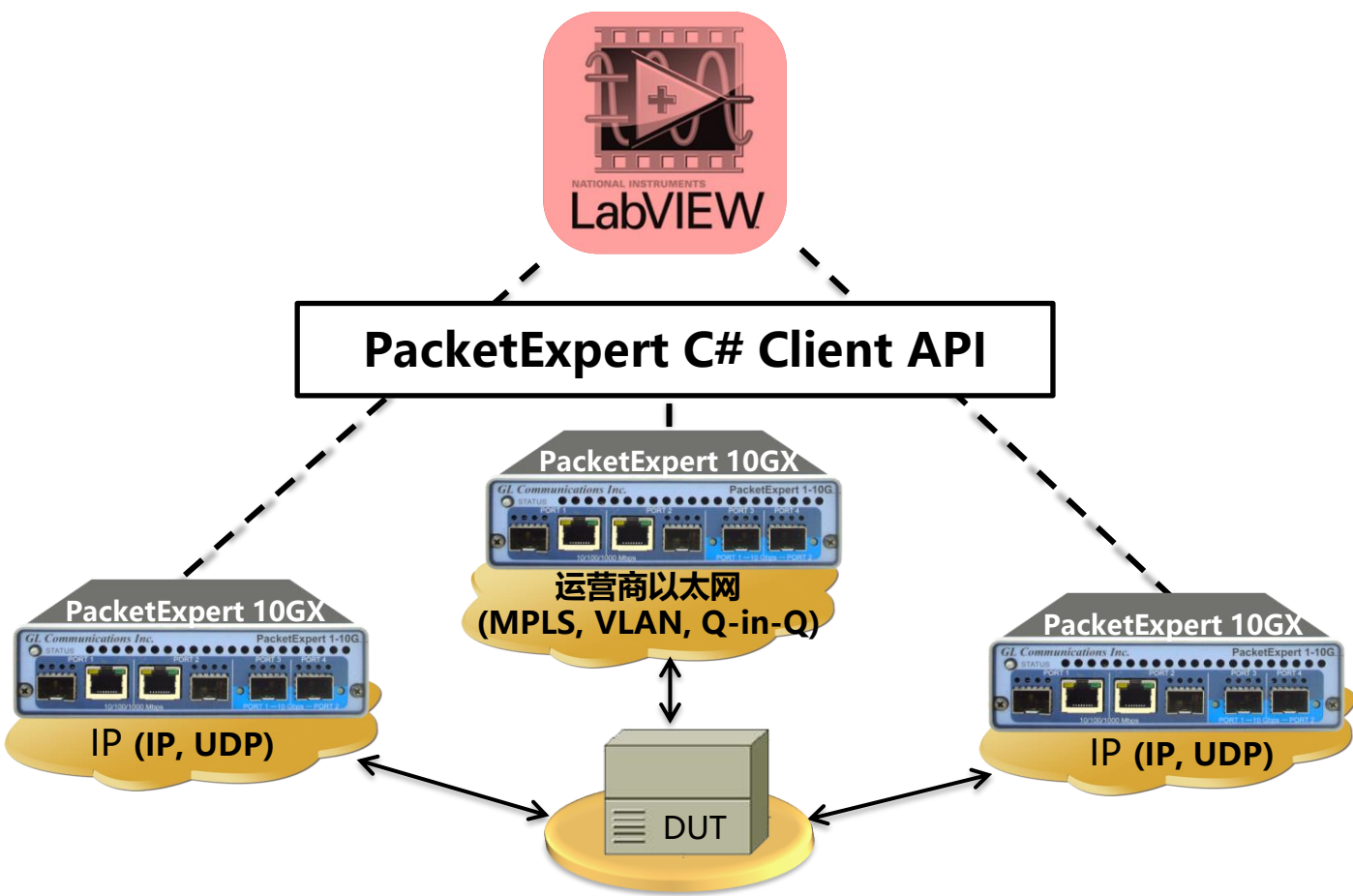
C# 客户端...

```
Program.cs
PacketExpertCSAPIConsoleApplication.Program2
Main(string[] args)
/**
 * @file Program.cs
 *
 */
using System;
using System.Collections.Generic;
using System.Text;
using PacketExpertCSAPI;
using System.Threading;

//This application is a simple console application to illustrate the use of PacketExpert C# APIs
//First, it initialises the APIs (and the hardware)
//Loads a previously saved configuration file(created from the GUI) to the hardware
//Starts BERT test on Ports 2 and 3
//While the test is running, queries and prints a few statistics
//Stops the test after 50 seconds
//Queries and prints the BERT results for Ports 2 and 3 after test stops
//Exits
namespace PacketExpertCSAPIConsoleApplication
{
    class Program2
    {
        static void Main(string[] args)
        {
            PXEAPI my_class = new PXEAPI();
            PacketExpertCSAPI.ErrorCode err = PacketExpertCSAPI.ErrorCode.PXE_NOT_INITIALISED;
            PacketExpertCSAPI.PacketExpertModule mod = PacketExpertCSAPI.PacketExpertModule.ALL_PORT_BERT;
            StringBuilder error_message = new StringBuilder(100);
            /**Initializing PacketExpert*/
            err = my_class.Init_(mod, error_message);
            if (err != PacketExpertCSAPI.ErrorCode.PXE_NO_ERROR)
            {
                Console.WriteLine(error_message);
                return;
            }
            else
                Console.WriteLine("All Port Bert module loaded");

            Int32 nports = 0;
            /**Gets Number of ports*/
            err = my_class.GetNoPorts_(ref nports, error_message);
            Console.WriteLine("No of Ports:");
            Console.WriteLine(nports);
        }
    }
}
```


使用C# 客户端将PacketExpert™与LabVIEW集成



PacketExpert™ 与LabVIEW集成

Port statistics

Port Number 1

Tx statistics		Rx statistics	
Total Frames 2	16466	Total Frames	17343
Valid Frames	16466	Valid Frames	17343
Number of Bytes	24929524	Number Of Bytes	26257302
Link Utilisation 2	-	Link Utilisation	-
Data Rate 2	0.0	Data Rate	0.0
Frame Rate	0.0	Frame rate	0.0
Broadcast Frames	0	Broadcast Frames	0
Multicast Frames 2	0	Multicast Frames	17343
Control Frames 2	0	Control Frames	0
VLAN Frames	0	VLAN Frames	0
Pause Frames	0	Pause Frames 2	0
Wrong Opcode Frames 2	0	Wrong Opcode Frames	0
64 Byte Length Frames 2	0	64 Byte Length Frames	0

BERT Results

Port Number 1

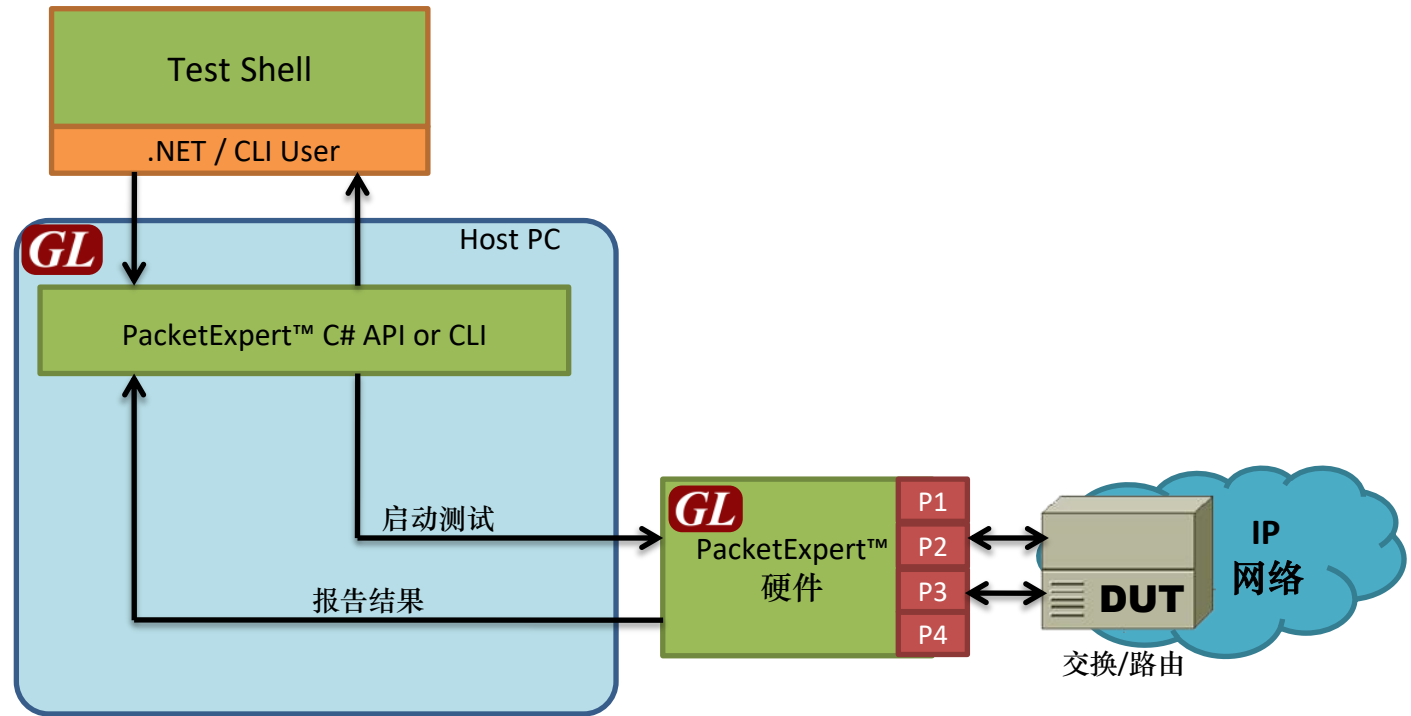
Traffic Status	No Rx Traffic	<input type="checkbox"/>
Sync Status	InSync	<input checked="" type="checkbox"/>
BitErrorStatus	No Error	<input checked="" type="checkbox"/>
OutOfSequenceStatus	No Error	<input checked="" type="checkbox"/>
BERTStatus	Sync	<input checked="" type="checkbox"/>
BERTTestTime	00:00:21	
BitsReceived	193142592	
BitErrorCount	0	
BitErrorRate	0.000E+000	
BitErrorSeconds	0	
SyncLossCount	0	
SyncLossSeconds	0	
OOSCount	0	
OOSSeconds	0	

典型的测试系统

PacketExpert™ 测试系统 (eg: for RFC 2544)

包含以下 –

- TestShell通过.NET / CLI客户端进行通信
- PacketExpert™系统, 即正在运行 PacketExpertCSAPI.dll或CLI的主机PC, 以及PacketExpert™硬件通过USB接口连接到 PC



谢 谢