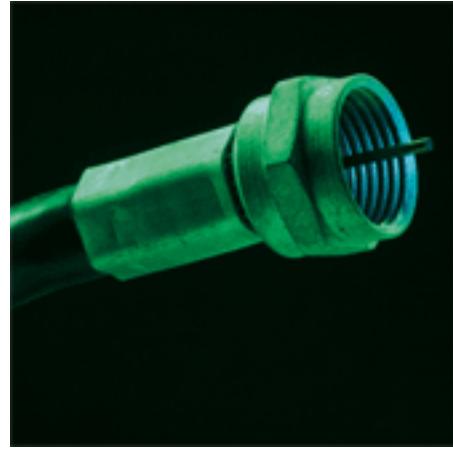




The Verification Experts



MPLS-TP Overview

Rev. A00



MPLS-TP Technology Primer

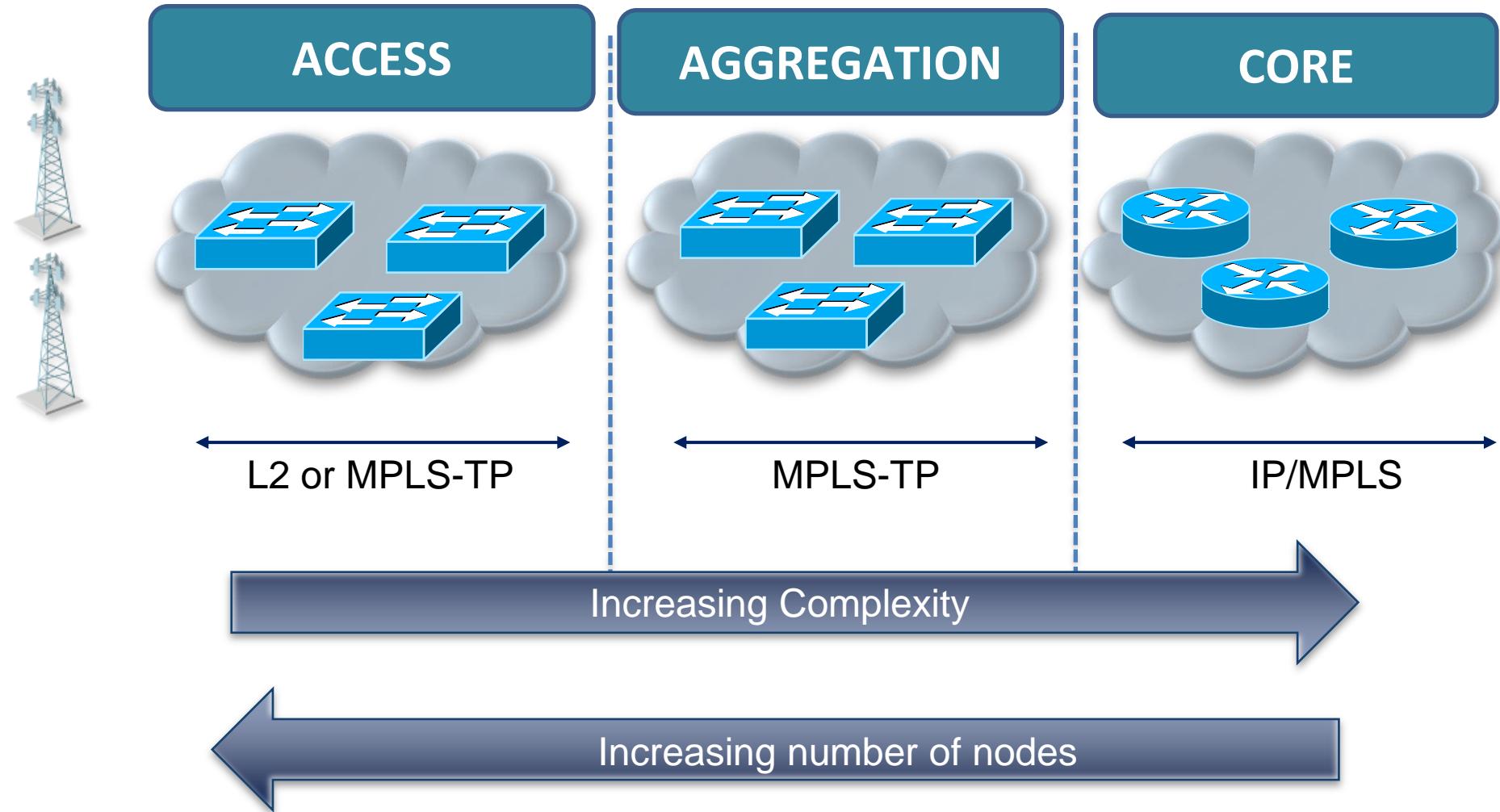


- MPLS-TP = MPLS Transport Profile
- MPLS-TP is a Layer 2 technology
- Combines the benefits of MPLS and removes the complexity of IP networking
- Uses MPLS Label switching mechanism but with static route provisioning (no Label Distribution Protocol LDP or RSVP-TE)
- Supports an advanced set of OAM functions and path protection mechanisms
- In-band OAM traffic on same path as data traffic

Where does MPLS-TP fit in the Network?

- MPLS-TP deployments are targeted for the Access and Aggregation networks
- MPLS-TP suited for Circuit Switched evolution
 - Packet switched network efficiency
 - Multi-service capabilities
 - Extensive set of OAM tools
- MPLS-TP suited for Mobile backhaul deployment
 - Handle multiple traffic types (e.g., TDM, ATM, Ethernet, IP)
 - Support multiple classes of service
 - Operational simplicity with static service provisioning through management
 - Fault resiliency with sub-50 ms recovery mechanism

MPLS-TP in the Mobile Backhaul

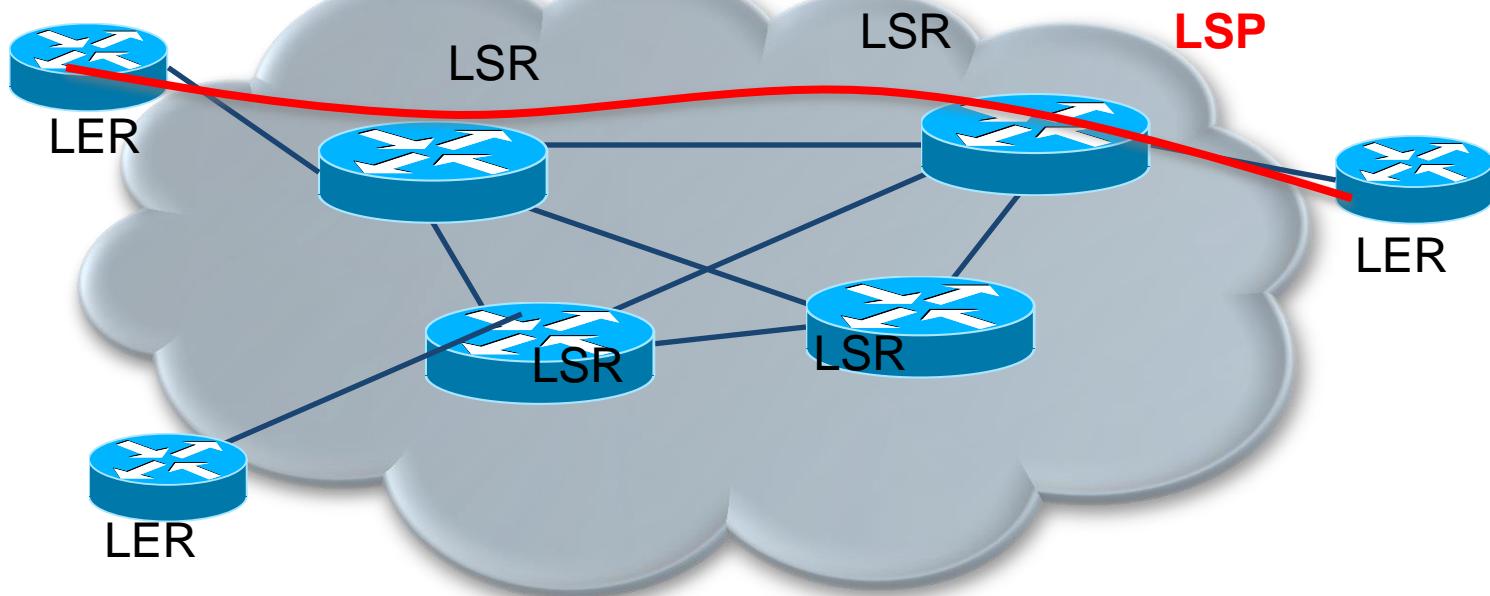


MPLS-TP

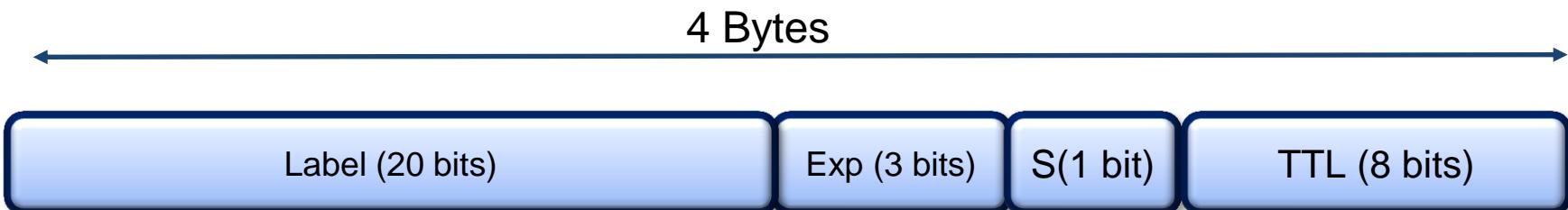
- [RFC 5654](#): MPLS-TP Requirements
- [RFC 5960](#): MPLS Transport Profile Data Plane Architecture
- [RFC 5921](#): A Framework for MPLS in Transport Networks

MPLS-TP OAM

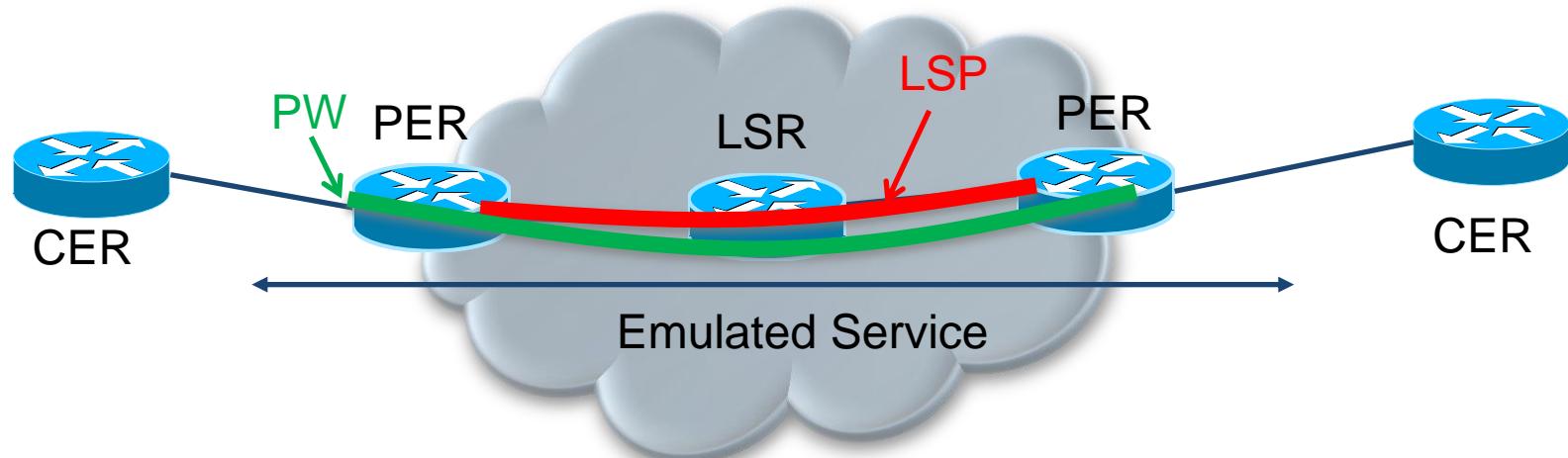
- [RFC 6427](#): MPLS Fault Management Operations, Administration, and Maintenance (OAM)
- [RFC5586](#): MPLS Generic Associated Channel
- [ITU-T G.8113.1](#): Operations, administration and maintenance mechanism for MPLS-TP in packet transport networks



- **LER:** Label Edge Router. Entrance/Exit point to the MPLS Cloud. Pushes or Pops MPLS Label
- **LSR:** Label Switch Router. Intermediate point in the MPLS Cloud. Swaps MPLS Label
- **LSP:** Label Switch Path. Statically configured path from Ingress to Egress LER through LSR network

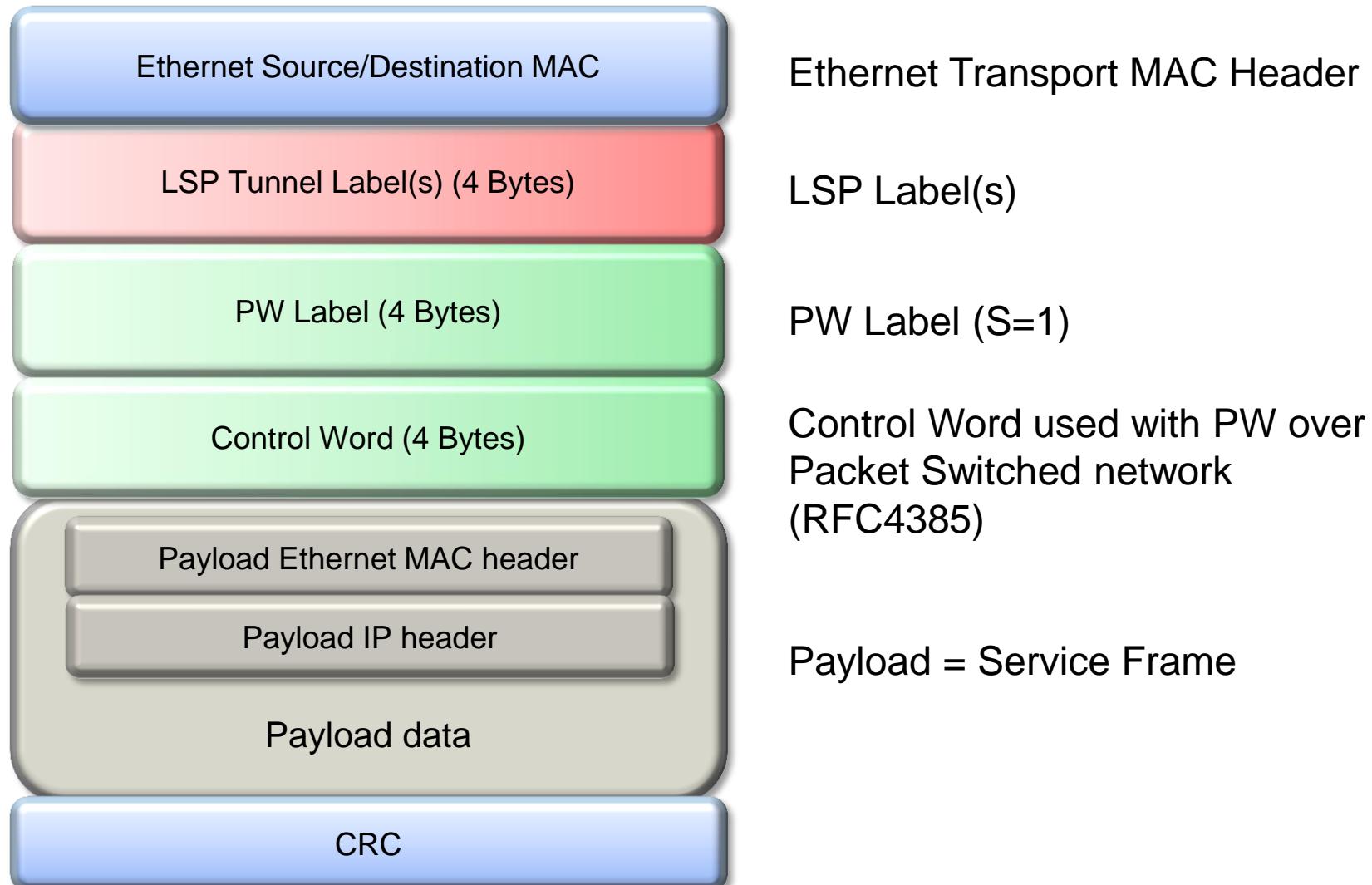


- **Label:** 20 bits to identify label value
- **Exp:** Experimental bit, used for Class of Service (CoS) indication
- **S:** S=0 indicates there are additional labels, S= 1 indicates bottom of stack, no additional label
- **TTL:** Time To Live, decremented by 1 at each hop. Frame is not forwarded after TTL reaches 0.

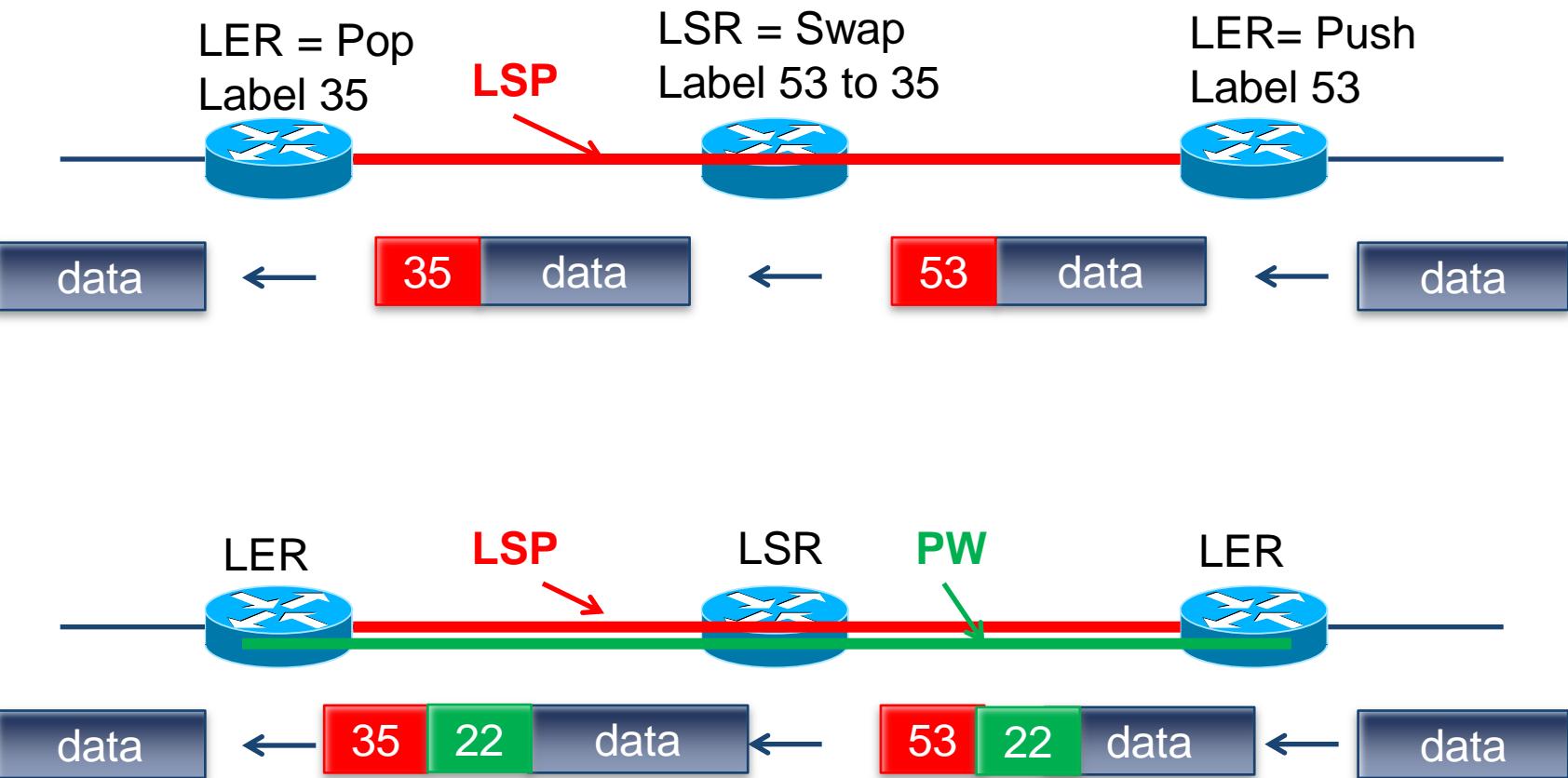


- **CER:** Customer Edge Router. A device where one end of a service originates and/or terminates. The CE is not aware that it is using an emulated service rather than a native service.
- **PER:** Provider Edge Router. A device that provides pseudo-wire emulation to the customer edge. It is the interface between customer network and MPLS core.
- **PW:** Pseudo-Wire. Service mechanism that carries an emulated service from one PE to another PE over a packet switched network.

MPLS-TP over Ethernet with PW Label



LSP and PW Label Examples



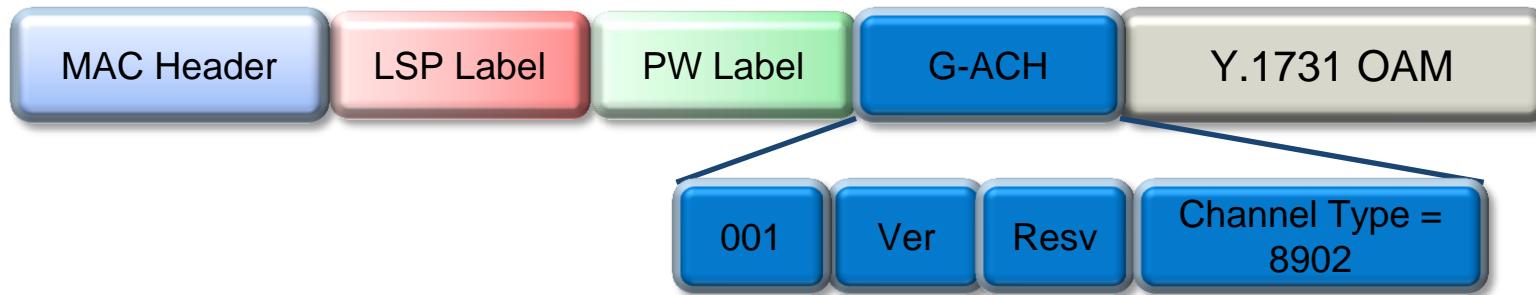
- MPLS-TP OAM follows ITU-T G.8113.1
- MPLS-TP OAM travels on the same path as data traffic
- MPLS-TP OAM uses G-Ach an GAL labels to differentiate from customer traffic per RFC 5586
- OAM format follows Y.1731
- OAM functionalities follow Y.1731
 - CCM Messages
 - Loopback Message/Loopback Response
 - DMM/LMM
 - ...

Connectivity Fault Management Functions

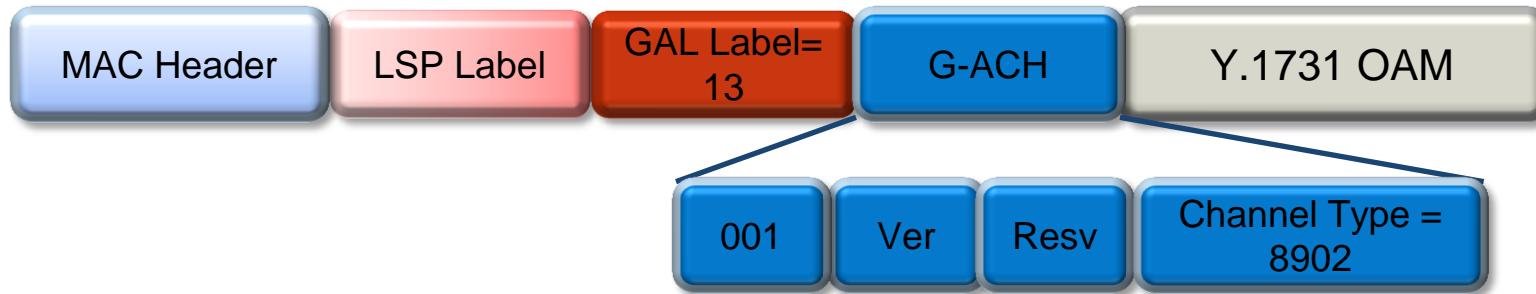
- Fault Detection – Continuity Check
 - CCM “heartbeat” messages transmitted at a configurable periodic interval by MEPs
- Fault Notification – RDI
 - Upon detection of fault condition, MEP encodes RDI flag in CCM message
- Network/Path Discovery – Link trace message
 - Equivalent to “traceroute” test. MIPs and MEPs along the path send a response
- Fault verification and isolation – Loopback
 - Verify connectivity to a specific point in the message. Equivalent to “ping” test

Performance Monitoring Functions

- Packet Loss Measurement - LMM
- Delay Measurement - DMM



- For Pseudo-wires, the G-ACh uses the first four bits of the PW control word to provide the initial discrimination between data packets and packets belonging to the associated channel, as described in RFC4385.

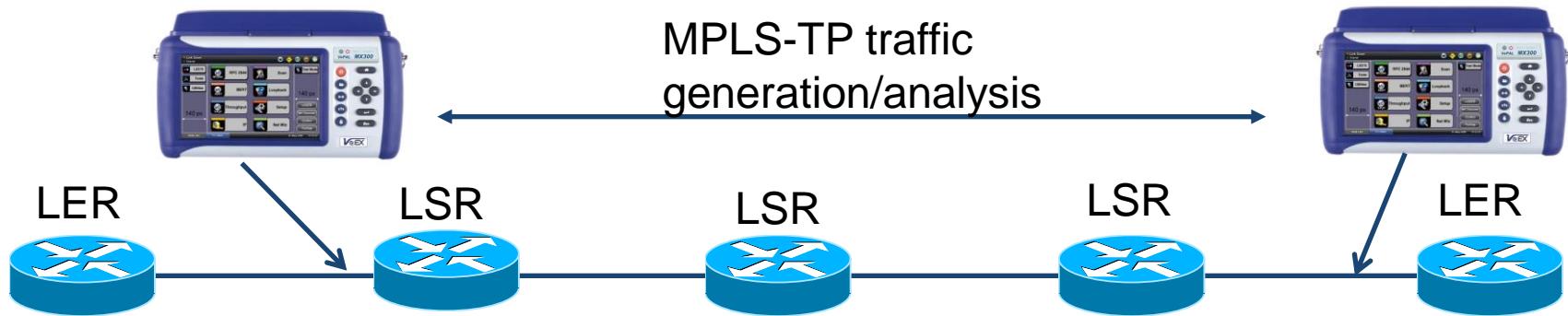


- For LSP, it is necessary to provide an indication in the packet that the payload is something other than a client data packet. This is achieved by including a reserved label with a value of 13 at the bottom of the label stack. This reserved label is referred to as the G-ACh Label (GAL) and is defined in RFC5586.

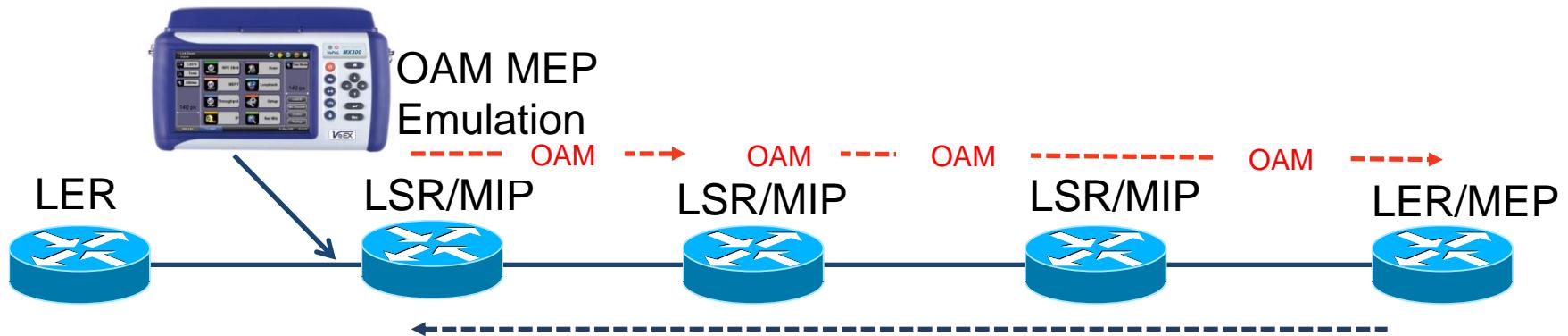


MPLS-TP Option for the TX300



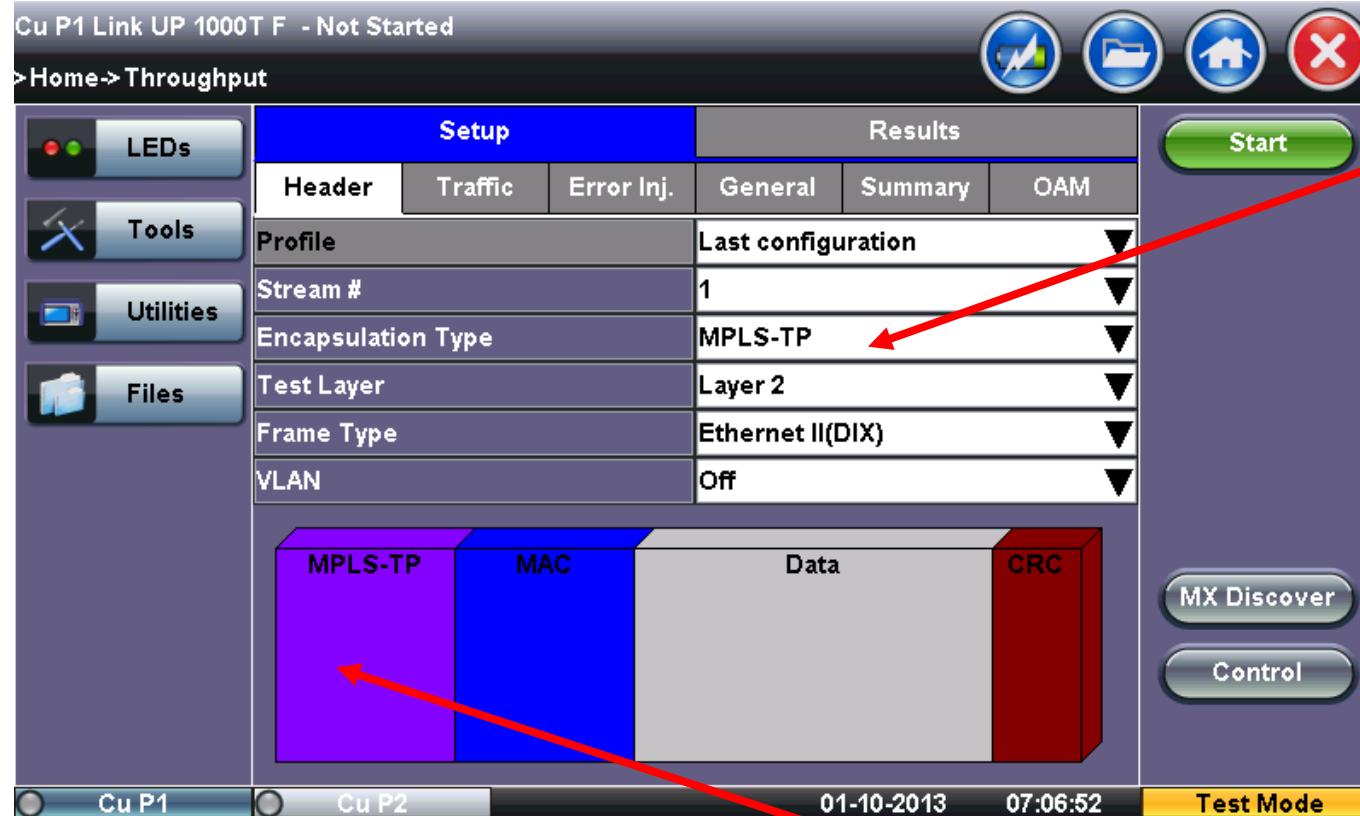


- MPLS-TP line rate traffic generation on any test port from 10BT to 10GE
 - Fully configurable MPLS-TP header fields, LSP and PW
 - Dual Port MPLS-TP traffic generation
 - MPLS-TP traffic analysis, including all SLA key parameters (frame loss, delay, jitter, ...)
 - MPLS-TP support for all Ethernet tests: RFC2544, V-SAM (Y.1564), Multi-stream throughput test and BERT



- OAM support per ITU-T G.8113.1 including G-ACH and GAL support per RFC 4385 and RFC 5586
- Y.1731 Connectivity Fault Management and Performance Monitoring functions:
 - CCM, Loop Back, Link Trace, Loss Measurement and Delay Measurement OAM frames support
- OAM functions can be enabled simultaneously with MPLS-TP traffic generation
- OAM support in Dual Port mode

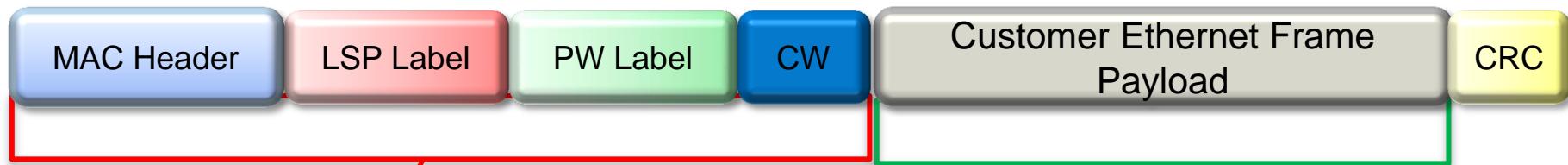
MPLS-TP Encapsulation Selection



MPLS-TP encapsulation requires MPLS-TP option

Tap on graph to configure MPLS-TP header

MPLS-TP Frame Configuration



Cu P1 Link UP 1000T F - Not Started

Data Pattern

	MPLS-TP	MAC	DATA	RX Filter	
LEDs	<input type="checkbox"/>	00-00-00-00-00-A			<input type="button" value="Start"/>
Tools		00-00-00-00-00-B			
Utilities		88-47			
Files					
	<input type="checkbox"/> MPLS-TP VLAN	ID 1082	Priority 6	Type 88a8	
	LSP	Label=428	S= 0	CoS=5	TTL= 128
	<input checked="" type="checkbox"/> PW	Label=10	S= 1	CoS=0	TTL= 128
	CW	Flags=0000	Len=000000	FRG=00	Seq#=0000
					<input type="button" value="MX Discover"/>
					<input type="button" value="Control"/>
					<input type="button" value="Apply to All"/>

Cu P1 Cu P2 01-10-2013 07:07:27 Test Mode

Configure MPLS-TP Header and Ethernet Frame payload independently

MPLS-TP Header Configuration

Cu P1 Link UP 1000T F - Not Started

Data Pattern

MPLS-TP		MAC		DATA		RX Filter			
<input type="checkbox"/> MPLS-TP VLAN	ID 1082	<input checked="" type="checkbox"/> Priority	6	<input type="checkbox"/> Type	88a8	<input type="checkbox"/> CoS=5	<input type="checkbox"/> TTL=128	<input type="checkbox"/> S=0	<input type="checkbox"/> Len=000000
<input checked="" type="checkbox"/> PW	Label=428	<input type="checkbox"/> S=1	<input type="checkbox"/> CoS=0	<input type="checkbox"/> TTL=128	<input type="checkbox"/> Label=10	<input type="checkbox"/> S=1	<input type="checkbox"/> CoS=0	<input type="checkbox"/> TTL=128	<input type="checkbox"/> ERG=00
CW	Flags=0000	<input type="checkbox"/> Len=000000	<input type="checkbox"/> ERG=00	<input type="checkbox"/> Seq#=0000	<input type="checkbox"/> Flags=0000	<input type="checkbox"/> Len=000000	<input type="checkbox"/> ERG=00	<input type="checkbox"/> Seq#=0000	<input type="checkbox"/> Flags=0000

Apply to All

Cu P1 Cu P2 01-10-2013 07:07:27 Test Mode

Configurable
MPLS-TP VLAN
can be
enabled/disabled

Configurable LSP
with configurable
Label, CoS/EXP
and TTL

Optional PW with
configurable
Label, CoS/EXP
and TTL

CW automatically
enabled when PW
selected

Cu P2 Link UP 1000T F - Running ...

> Home > Throughput

Setup		Results			
Global		Per Stream		OAM	
Summary	Errors	Events	Traffic	Delay	Rates
LSP Label: N/A	Stream #	1			

Frame Type: Test Frames

Frame Size: 1 Traffic

0%

Frames		Frame Size	
RX Frames	#	%	
Total	893365	100	
Test	893365	100.000000	
SP-VLAN Frame	0	0.000000	
MPLS LSP Frame	893365	100.000000	
MPLS PW Frames	893365	100.000000	
CE-VLAN Frames	0	0.000000	
TX Frames	#		
Total	893364		

LEDs

- Signal
- Frame
- Pattern
- ALM/ERR

Tools

Utilities

Files

Cu P1 Cu P2

MX Discover

Control

01-10-2013 07:10:40 Test Mode

Per-Stream detailed Test Statistics

Additional counters detecting MPLS-TP LSP/PW frames

Cu P1 Link UP 1000T F - Running ...

>Home-> Throughput

Setup **Results**

Global		Per Stream		OAM	
Summary	Errors	Events	Traffic	Delay	Rates
LSP Label: 589	Stream #	1			

Frame Type: Test Frames

Frame Size: 1 Traffic

0%

LEDs

- Signal
- Frame
- Pattern
- ALM/ERR

Tools

Utilities

Files

Cu P1 Cu P2

Setup **Results**

Frames		Frame Size	
RX Frames	#	%	
Total	893365	100	
Test	893365	100.000000	
SP-VLAN Frame	0	0.000000	
MPLS LSP Frame	893365	100.000000	
MPLS PW Frames	893365	100.000000	
CE-VLAN Frames	0	0.000000	
TX Frames	#		
Total	893364		

LEDs

- Signal
- Frame
- Pattern
- ALM/ERR

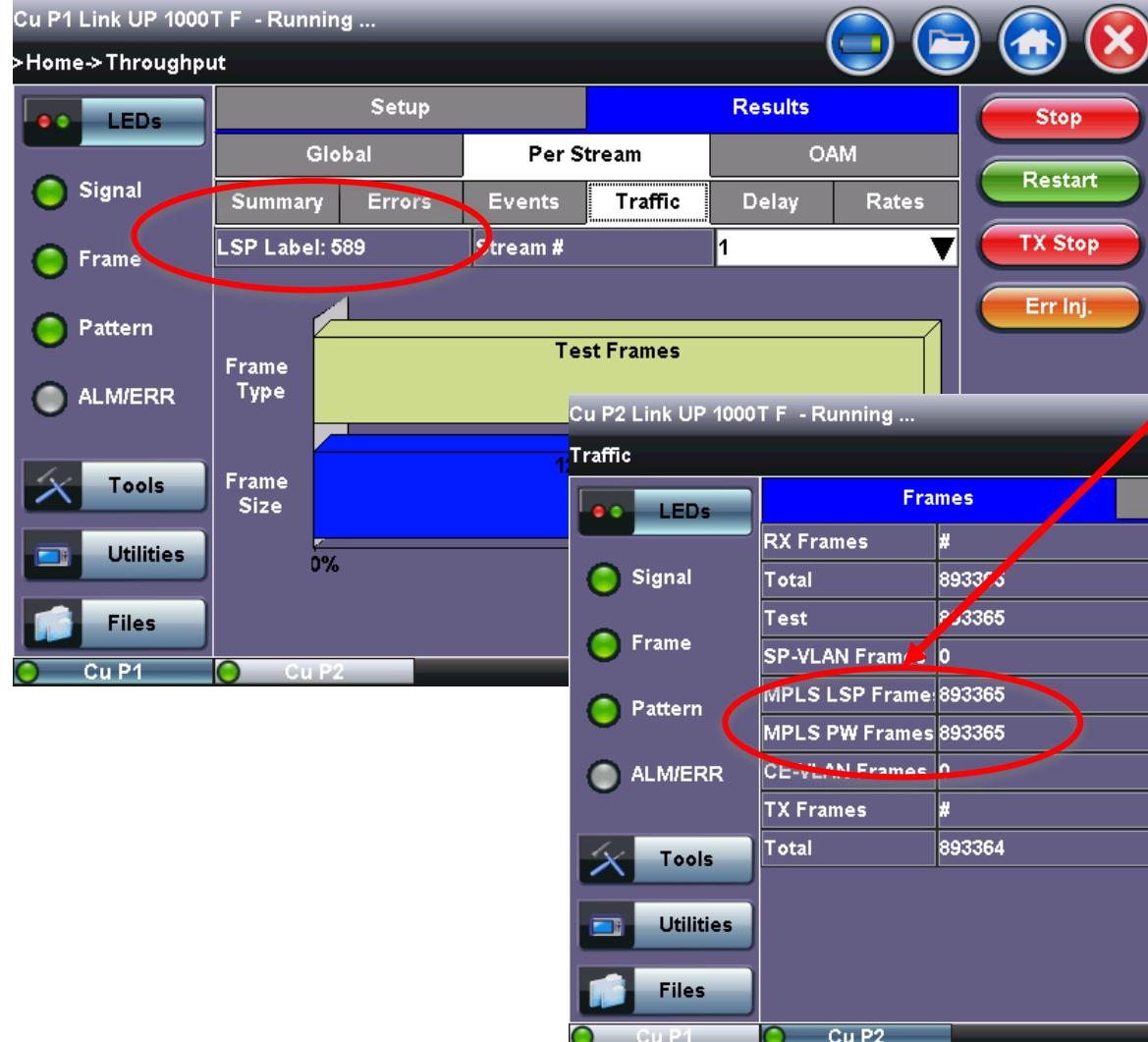
Tools

Utilities

Files

Cu P1 Cu P2

01-10-2013 07:10:40 Test Mode



Per-Stream detailed Test Statistics

Additional counters detecting MPLS-TP LSP/PW frames



Requires MPLS-TP option and Y.1731 option

Configure Y.1731 MEP parameters

Refer to Ethernet OAM training presentation for details on Y.1731 Configuration

OAM Configuration (Page 2)

Cu P1 Link UP 1000T F - Not Started

>Home->Throughput

Setup		Results				Start																																									
Header	Traffic	Error Inj.	General	Summary	OAM																																										
Link OAM			Service Level OAM																																												
MPLS-TP <table border="1"> <thead> <tr> <th colspan="8">LSP/PW from</th> </tr> <tr> <th>LSP:</th> <th><input checked="" type="checkbox"/></th> <th>Label</th> <th>5555</th> <th>CoS</th> <th>0</th> <th>TTL</th> <th>128</th> </tr> </thead> <tbody> <tr> <td>PW:</td> <td><input type="checkbox"/></td> <td>Label</td> <td>888</td> <td>CoS</td> <td>0</td> <td>TTL</td> <td>128</td> </tr> <tr> <td>GAL:</td> <td></td> <td>Label</td> <td>13</td> <td>TC</td> <td>2</td> <td>TTL</td> <td>1</td> </tr> <tr> <td>ACH:</td> <td></td> <td>Version</td> <td>0</td> <td>Channel Type</td> <td colspan="3">89-02</td> </tr> </tbody> </table>								LSP/PW from								LSP:	<input checked="" type="checkbox"/>	Label	5555	CoS	0	TTL	128	PW:	<input type="checkbox"/>	Label	888	CoS	0	TTL	128	GAL:		Label	13	TC	2	TTL	1	ACH:		Version	0	Channel Type	89-02		
LSP/PW from																																															
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GAL:		Label	13	TC	2	TTL	1																																								
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		Page 2 of 2																																													
Cu P1	Cu P2	21-10-2013 22:37:43				Test Mode																																									

Copy LSP/PW from existing Stream

Configurable LSP/PW parameters

GAL and ACH label automatically added as needed

Cu P1 Link UP 1000T F - Not Started

>Home->Throughput

Setup		Results			Start
Header	Traffic	Error Inj.	General	Summary	
Link OAM			Service Level OAM		
802.1ag: <input type="checkbox"/>	Y.1731: <input type="checkbox"/>	G.8113.1 <input checked="" type="checkbox"/>			
MAC Source		00-00-00-00-00-AA			
MD Format	None	▼	MD Name	N/A	
MA/MEG Format	String	▼	MA/MEG Name	veexMA	
Local MEP ID	15		MD Level	5	
Primary VLAN ID	35		VLAN Type	S-VLAN	
Destination MEP ID	151		Direction	Up	

◀ Page 1 of 4 ▶

Cu P1 Cu P2 21-10-2013 22:47:54 Test Mode

After Configuration
add checkmark to
enable G.8113.1
functions

Cu P1 Link UP 1000T F - Not Started

>Home->Throughput

Setup		Results																																						
Header	Traffic	Error Inj.	General	Summary	OAM																																			
Link OAM		Service Level OAM																																						
MPLS-TP <table border="1"> <thead> <tr> <th colspan="4">LSP/PW from</th> <th>Copy</th> </tr> <tr> <th>LSP:</th> <td><input checked="" type="checkbox"/></td> <th>Label</th> <td>5555</td> <th>CoS</th> <td>0</td> <th>TTL</th> <td>128</td> </tr> </thead> <tbody> <tr> <th>PW:</th> <td><input type="checkbox"/></td> <th>Label</th> <td>888</td> <th>CoS</th> <td>0</td> <th>TTL</th> <td>128</td> </tr> <tr> <th>GAL:</th> <td>Label</td> <td>13</td> <th>TC</th> <td>2</td> <th>TTL</th> <td>1</td> </tr> <tr> <th>ACH:</th> <td>Version</td> <td>0</td> <th>Channel Type</th> <td colspan="3">89-02</td> </tr> </tbody> </table>						LSP/PW from				Copy	LSP:	<input checked="" type="checkbox"/>	Label	5555	CoS	0	TTL	128	PW:	<input type="checkbox"/>	Label	888	CoS	0	TTL	128	GAL:	Label	13	TC	2	TTL	1	ACH:	Version	0	Channel Type	89-02		
LSP/PW from				Copy																																				
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GAL:	Label	13	TC	2	TTL	1																																		
ACH:	Version	0	Channel Type	89-02																																				
CCM <table border="1"> <tr> <td>Type</td> <td>Unicast</td> <td>MAC</td> <td>00-00-00-00-00-BB</td> <td>Copy</td> </tr> <tr> <td>Priority</td> <td>7</td> <td>Tx Interval</td> <td>1 sec</td> <td></td> </tr> </table>						Type	Unicast	MAC	00-00-00-00-00-BB	Copy	Priority	7	Tx Interval	1 sec																										
Type	Unicast	MAC	00-00-00-00-00-BB	Copy																																				
Priority	7	Tx Interval	1 sec																																					
<input type="button" value="MX Discover"/> <input type="button" value="Control"/>																																								
Page 2 of 4																																								

Cu P1 Cu P2 21-10-2013 22:50:07 Test Mode

Enable CCM
Messages

Refer to Ethernet OAM training presentation for details on CCM

Cu P2 Link UP 1000T F - Running ...

>Home->Throughput

Setup			Results		
Header	Traffic	Error Inj.	General	Summary	OAM
Link OAM			Service Level OAM		
Loopback (LBM/LBR)					
Destination Type	MEP	▼	Destination MAC	00-00-00-00-00-00	
Priority	7		# Messages	5	
Link Trace (LTM/LTR)					
Destination Type	MEP	▼	Destination MAC	00-00-00-00-00-00	
Priority	7		# Send	10	

LEDs

Signal

Frame

Pattern

ALM/ERR

Tools

Utilities

Files

Cu P1 Cu P2

Start

Stop

Restart

TX Stop

Err Inj.

OAM Loopback and Linktrace

OAM Loss
Measurement and
Delay Measurement

Cu P2 Link UP 1000T F - Running ...

>Home->Throughput

Setup			Results		
Header	Traffic	Error Inj.	General	Summary	OAM
Link OAM			Service Level OAM		
Loss Measurement (LMM/LMR)					
Destination Type	MEP	▼	Destination MAC	00-00-00-00-00-00	
# Send	10		Rate (ms)	500	
Priority	7		Delay Measurement (DMM/DMR)		
Destination Type	MEP	▼	Destination MAC	00-00-00-00-00-00	
# Send	10		Rate (ms)	500	
Priority	7				

LEDs

Signal

Frame

Pattern

ALM/ERR

Tools

Utilities

Files

Cu P1 Cu P2

Start

Stop

Restart

TX Stop

Err Inj.

MX Discover

Control

Page 4 of 4

Test Mode

01-10-2013 07:13:18

- **499-05-304:** MPLS-TP Tags
 - Includes MPLS-TP Traffic Generation/Analysis on all TX300 Test ports, including 10GE ports
- **499-05-305:** MPLS-TP OAM ITU-T G.8113.1 (requires 499-05-199)
 - OAM option requires MPLS-TP option and Y.1731 option

Thank you.

Any questions?

