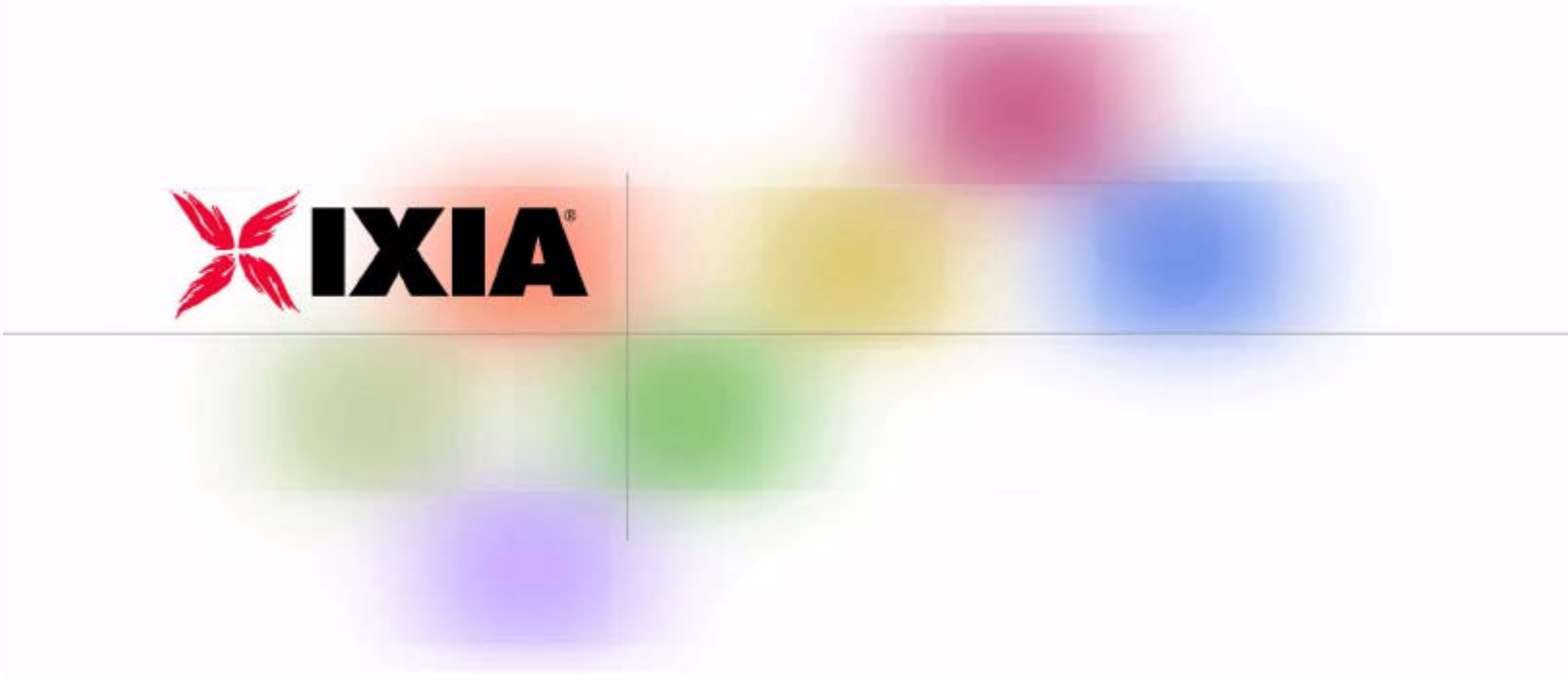
Virtual Private LAN Service (VPLS)
Conformance and Performance Testing
Sample Test Plans



Contents

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Virtual Private LAN Service (VPLS) Conformance and Performance Testing: Sample Test Plans

Overview

These test plans include several functional and performance tests geared toward network and QA engineers testing VPLS devices and systems. These tests are intended to provide a baseline for developing quality network test methodology.

1. VPLS Traffic CoS Test

Objective. Validates that the desired traffic throughput rate is sustainable through a Device Under Test (DUT) acting as a PE router during high loads of traffic for a specific Class of Service (CoS). The device's policy and ability to prioritize under the exceeded load threshold of the policy is verified.

Setup. Two tester ports are connected to the DUT– one representing a P/PE and the other representing a CE. OSPF, LDP basic, and LDP targeted VPLS sessions are emulated from the tester's P/PE port. Traffic is sent through the network from the tester's P/PE port. Ixia's IxExplorer application can be used to construct the topology and fulfill the control and data plane requirements for this test.

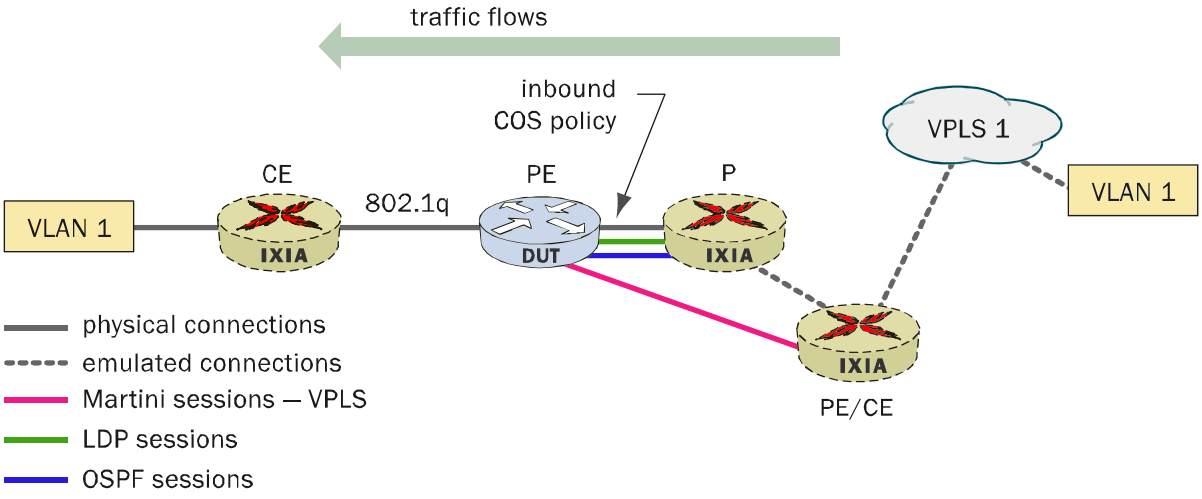

Figure 1. VPLS traffic CoS test topology.

Input Parameters

Table 1. VPLS traffic CoS test input parameters

Parameter	Description
Policy	A policy configured on the DUT that applies bandwidth or prioritization to MPLS traffic. Uses the MPLS EXP bits.
Traffic rate	Rate at which traffic is sent through the DUT and configured policy.

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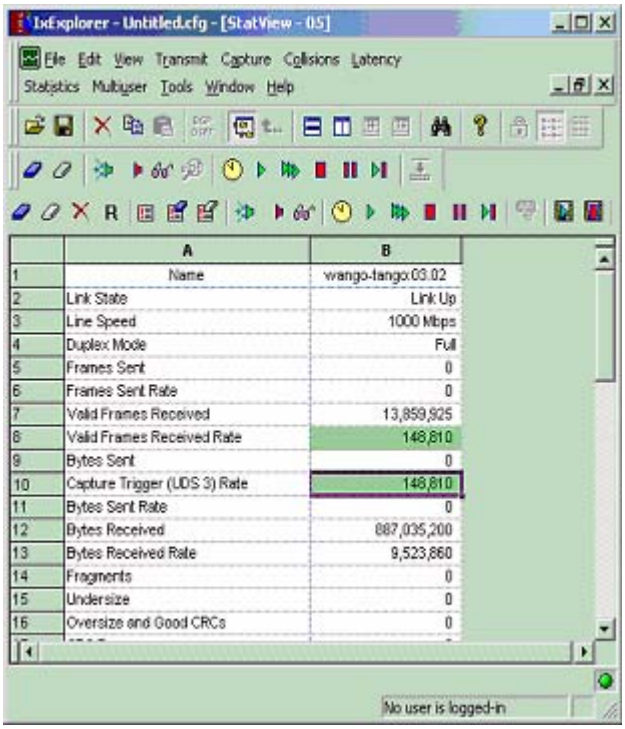
Methodology

1. The tester port representing the P/PE routers brings up OSPF, LDP, and LDP extended Martini sessions with the DUT. VPLS pseudowires are established between the emulated PE router and the DUT. This creates an emulated remote site VPN.
2. Both tester ports send MAC learning streams to the DUT to build the MAC-to-VC binding table.
3. Traffic shaping policies are created on the DUT and applied to the PE side inbound interfaces. The policies must be able to prioritize incoming traffic based on the MPLS EXP field bits, providing greater bandwidth to higher priority traffic.
4. MPLS traffic consisting of multiple priority flows is sent from the tester's PE side interface to the DUT where it is matched against the configured policies. The total traffic rate of the flows should be high enough to overrun the applied policy, forcing lower priority traffic to be dropped. The traffic flows should be configured to match the priorities in the policy.

Results. Verify that the DUT is properly regulating the forwarding rate of traffic by policy. The rate should be confirmed on the receive (CE) port. Figure 2 shows a statistical view of the expected results using Ixia's IxExplorer application. The receive rate should reflect that of the policy's configuration threshold. In this example, the expected result is a throughput of 10% of 1000 Mbps full line rate.



	A	B
1	Name	wango-tango:03.02
2	Link State	Link Up
3	Line Speed	1000 Mbps
4	Duplex Mode	Full
5	Frames Sent	0
6	Frames Sent Rate	0
7	Valid Frames Received	13,859,925
8	Valid Frames Received Rate	148,810
9	Bytes Sent	0
10	Capture Trigger (UDS 3) Rate	148,810
11	Bytes Sent Rate	0
12	Bytes Received	887,035,200
13	Bytes Received Rate	9,523,860
14	Fragments	0
15	Undersize	0
16	Oversize and Good CRCs	0

Figure 2. VPLS traffic CoS test results.

2. VPLS VSI Isolation Test

Objective. Verify that a DUT acting as a PE router properly contains traffic between multiple Virtual Switching Instances (VSIs). In this test, the DUT learns the same multicast groups on different VSIs. It is verified that multicast traffic on a given VSI is only forwarded to the same VSI.

Setup. Two tester ports are required for this test. The first emulates a CE router transmitting multicast traffic. The second emulates P/PE routers and builds the control plane emulating OSPF, LDP basic and LDP targeted VPLS sessions. The second port also is used to advertise remote multicast destinations from two VPLS VSIs. Traffic is sent from the emulated CE side to the remote destinations. Ixia's IxExplorer application can be used to construct the topology and fulfill the control and data plane requirements for this test.

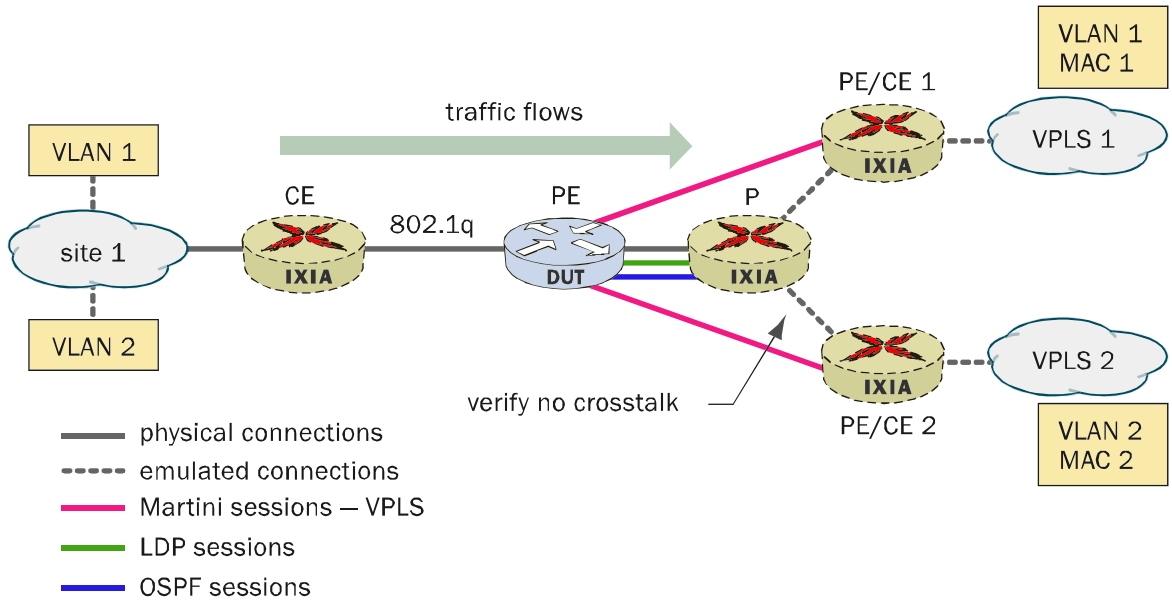


Figure 3. VPLS VSI isolation test setup.

Input Parameters

Table 2. VPLS VSI isolation test input parameters

Parameter	Description
Number of VSIs	Number of VPLS instances to which traffic will be sent
Traffic rate	Rate at which traffic is sent through the DUT.

Methodology

1. The PE side tester port advertises two emulated PEs, each representing a separate VPLS VSI with one remote site. OSPF, LDP basic, and two LDP extended sessions are established and associated VPLS pseudowires are built.
2. Multicast groups are statically configured on each VLAN from the DUT, or advertised from the tester.
3. The CE side tester port is configured with two flows, each with a different VLAN ID corresponding to the respective VSI, but each with the same destination IP multicast group.
4. Two traffic flows are sent at a known rate to each multicast group on separate VLANs, for example two flows each with a rate of 1000 packets per second.

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Results. Verification of the proper receive rate of each flow on the tester receive port. If the receive rate per VLAN is larger than the specified transmit rate, crosstalk is taking place between the VSIs. Figure 4 shows a statistical view in Ixia's IxExplorer application showing color-coded thresholds set on the receive rate for the two different VSIs. The IxExplorer GUI provides the option to configure threshold levels to statistical parameters and generate visual or audible warnings when they fall out of range.

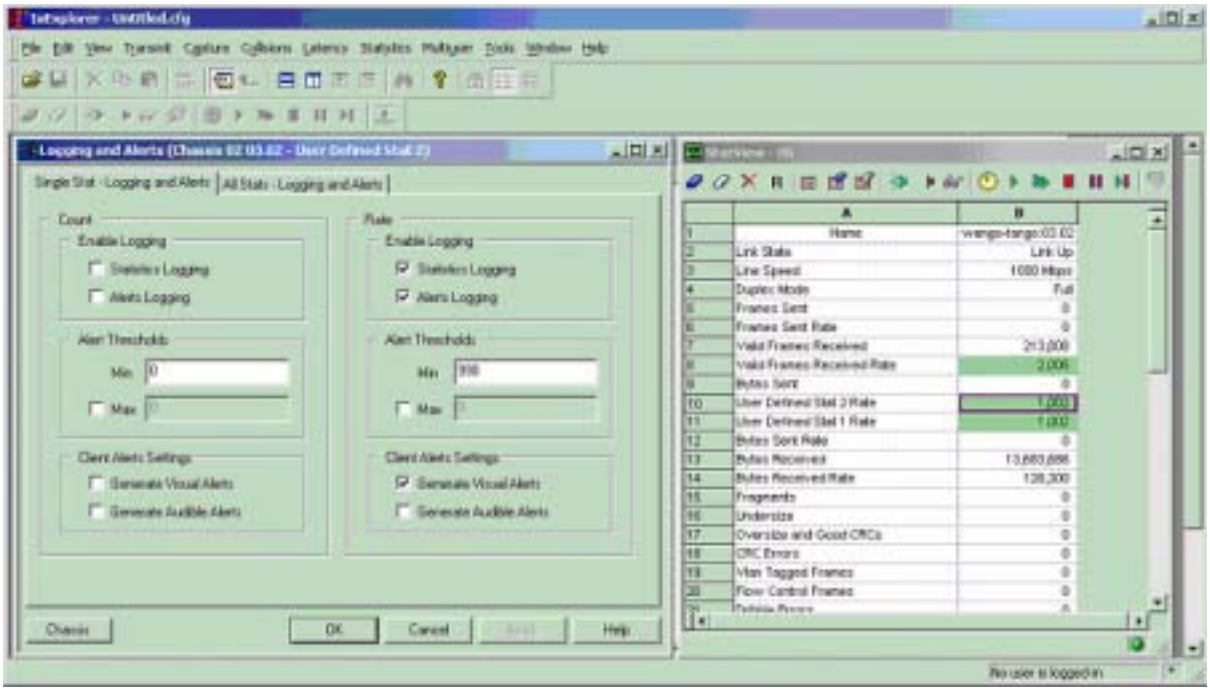

Figure 4. VPLS VSI isolation statistical verification.

3. VPLS MAC Address Purge Test

Objective. Confirm that the DUT correctly purges dynamically learned MAC addresses using the VPLS MAC TLV. The DUT is tested by verifying that traffic destined to addresses that are purposefully withdrawn is not forwarded.

Setup. Two tester ports are required – one to emulate network protocols and the other for transmitting traffic flows. Control plane protocols are brought up and an LDP targeted VPLS session is established between the emulated PE and the DUT acting as a PE. Ixia's IxExplorer application can be used to construct the topology and perform the traffic generation for this test.

Input Parameters

Table 3. Test input parameters

Parameter	Description
Number of VSIs	Number of VPLS instances configured in the system
Traffic rate	Rate at which traffic is sent through the DUT

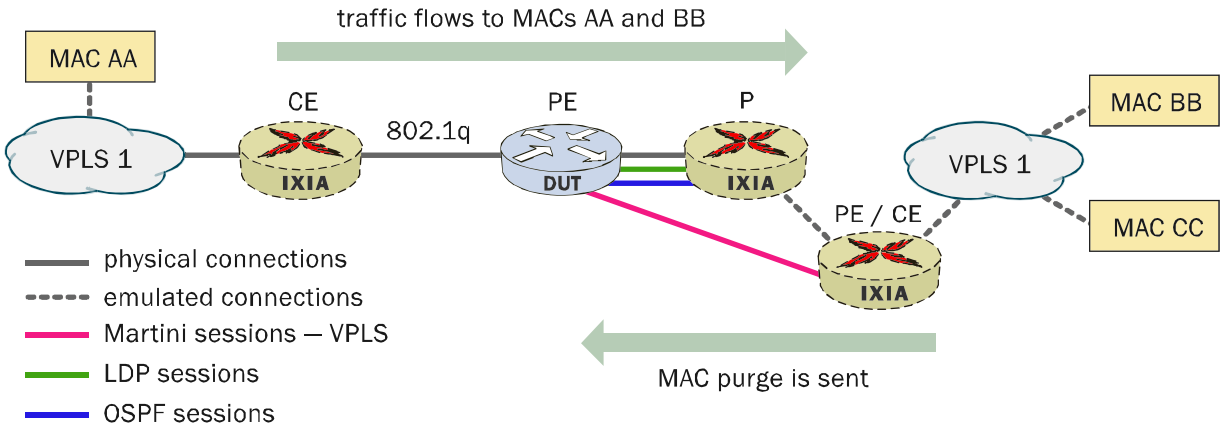

Figure 5. Topology example.

Methodology

1. The P/PE tester port emulates a VPLS topology establishing OSPF, LDP, and LDP targeted VPLS sessions with the DUT. A correct configuration is verified when the tunnel and VC labels have been learned and the Martini pseudowire is up.
2. Traffic is sent from both the P/PE and CE side test interfaces to build a MAC table on the DUT. The MAC table will learn two MACs from the PE side and 1 MAC from the CE side.
3. Two traffic flows are sent to the DUT from the CE side, each with a destination address corresponding to one of the MACs in the P/PE side VSI.
4. Verification is made that each flow is being received on the P/PE port and at the proper rate.
5. A MAC address purge is performed on one of the two MAC addresses advertised from the P/PE side by sending a MAC TLV to the DUT.
6. The DUT should purge this MAC from its forwarding table. This will cause the packets being sent to the purged address to be flooded by the DUT.

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Results. The received rate of traffic should decrease to one half of the original rate being received. A successful test will validate that the MAC purging feature is properly working. Figure 6 shows an example of this test using Ixia's IxExplorer application. An original received rate of 2000 packets per second is shown on the graph at the left. The rate is reduced by half when the MAC purge occurs. In this case, filters on the MAC SA were set to separate unicast from broadcast frames.

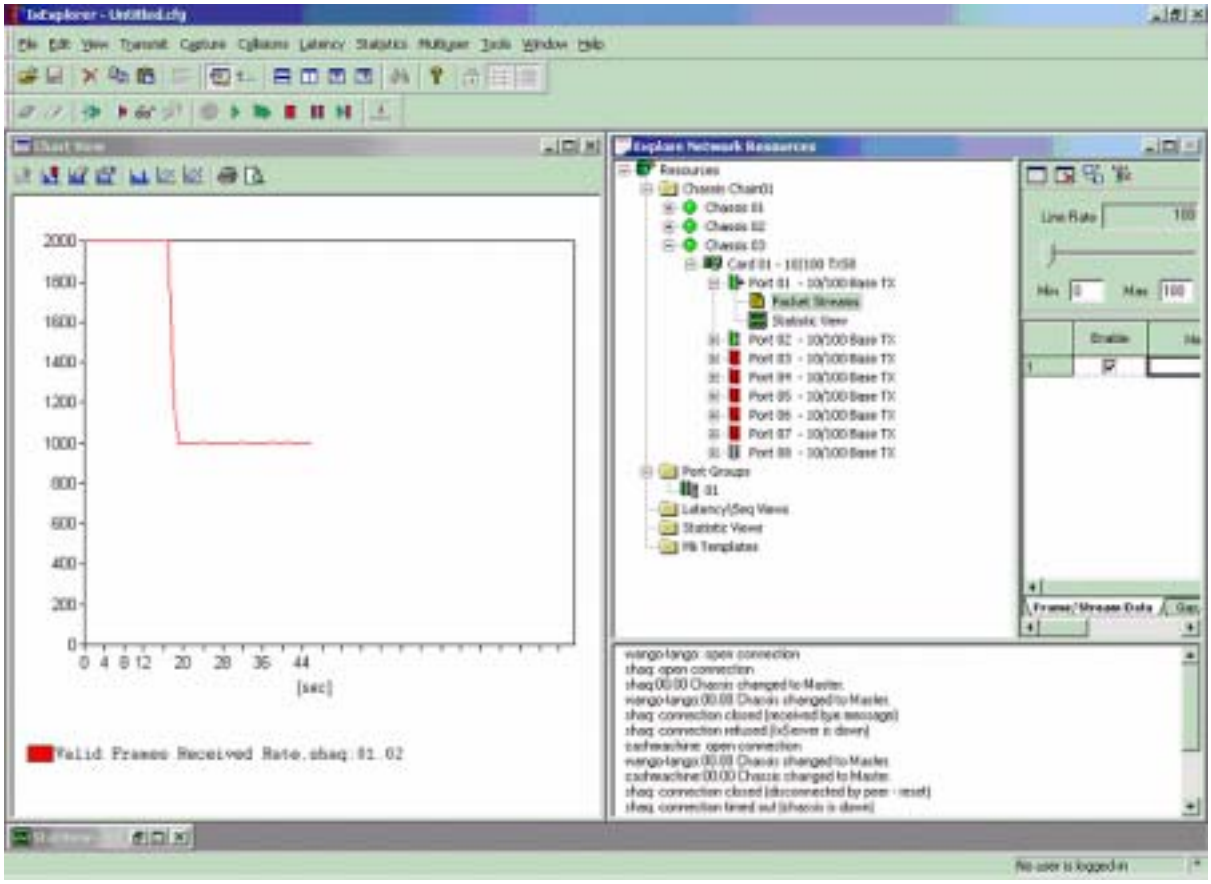

Figure 6. VPLS MAC purge test results.

4. VPLS MAC Address Rate Test

Objective. Determine the rate at which a VPLS-enabled DUT can learn the MAC addresses of VPLS hosts. This test uses a one–to-one traffic map in which each port transmits to a single destination port representing PE or CE devices in the network.

Setup. The test requires at least two test ports – one to transmit traffic and one to emulate OSPF, LDP basic and LDP targeted VPLS sessions with the DUT. The DUT, acting as a PE, and the simulated PEs build VPLS VCs between each other. Traffic is sent from the CE side test port. Ixia's IxExplorer application can be used to provide the control and data plane functions for this test. Alternatively, IxScriptMate provides an automated script for executing this test.

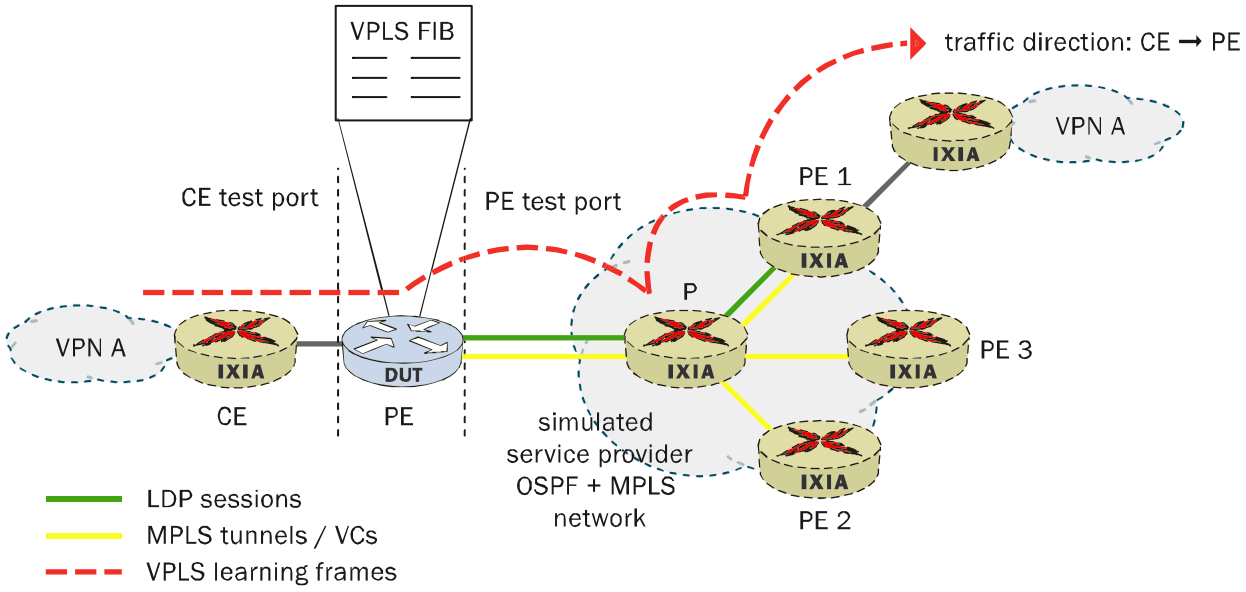

Figure 7. VPLS address rate test topology.

Input Parameters

Table 4. VPLS address rate test input parameters.

Parameter	Description
Traffic rate	Rate at which traffic is sent to the destination MACs
Number of ports	The number of transmit (CE) and receive (PE) pairs
Table size	MAC address table sent to the DUT
Number of PEs	The number of emulated PE routers advertised and originating targeted sessions with the DUT
Number of CEs per PE	Number of VCs per PE to be advertised
MAC learning rate	Rate at which MAC learning frames are sent
Tolerance	The tolerance the test will accept before providing results

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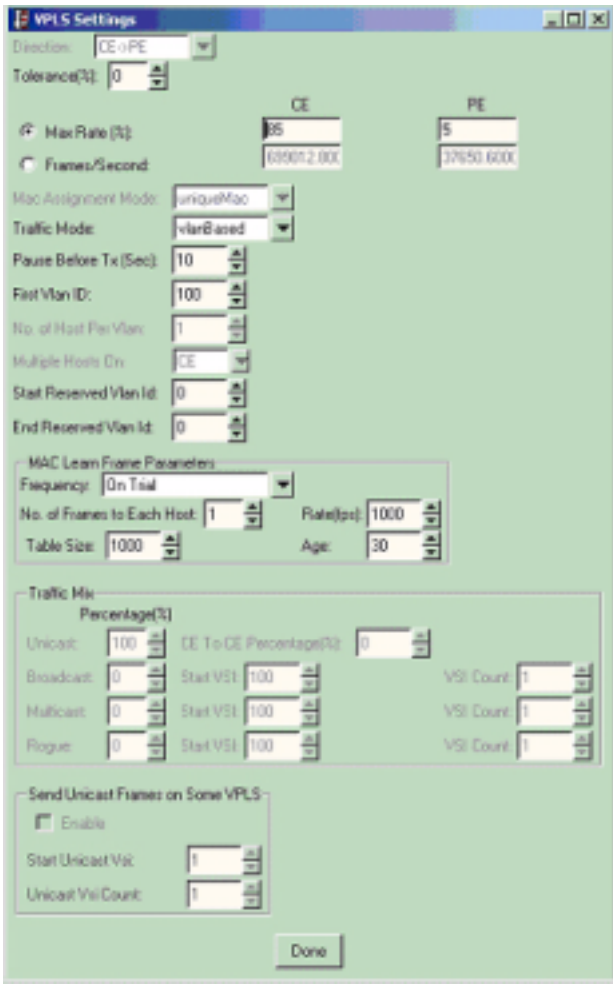

Figure 8. VPLS address rate test configuration example.

Methodology

1. OSPF and LDP basic sessions are established between the PE side test port and the DUT. The PE side test port then establishes LDP targeted VPLS sessions representing multiple VPLS remote sites and multiple VSIs per site.
2. Learning frames are sent into the network from the CE side test port and the MAC table on the DUT is built. The parameter “MAC learning rate” is used control the sending rate of learning frames.
3. bidirectional traffic load is then sent to the DUT at the rate specified by the “Traffic rate” parameter (PE->CE, CE->PE). The traffic load does not need to be line rate.
4. The test ports verify packets are received are within the defined “Tolerance”. Each tester port on the receive side must verify both unicast and broadcast frames. Unicast frames are successfully learned frames while broadcasts are unlearned frames.
5. If the unlearned frames fall under the specified “Tolerance” level, the rate of the learning frames is increased and the test repeated. A binary search algorithm of incrementing and decrementing rates to determine the result should be used.
6. The test is repeated from steps 2-5 until the maximum address learning rate is determined and the VPLS MAC table sustained.

Results. The result for this test is the maximum rate the DUT can learn MAC addresses, achieved on the last successful iteration of the test. Several statistics should be gathered when formulating the result, including total frames transmitted, total frames received, throughput as a percentage of line rate, total data errors, and total rogue frames. Figure 9 shows example results for the IxScriptMate VPLS address rate test. The results show an 800,000 MAC address table was built on the DUT and that it was able to successfully handle a learning rate of 100,000 frames per second. Latency and errors are also reported by the IxScriptMate application.

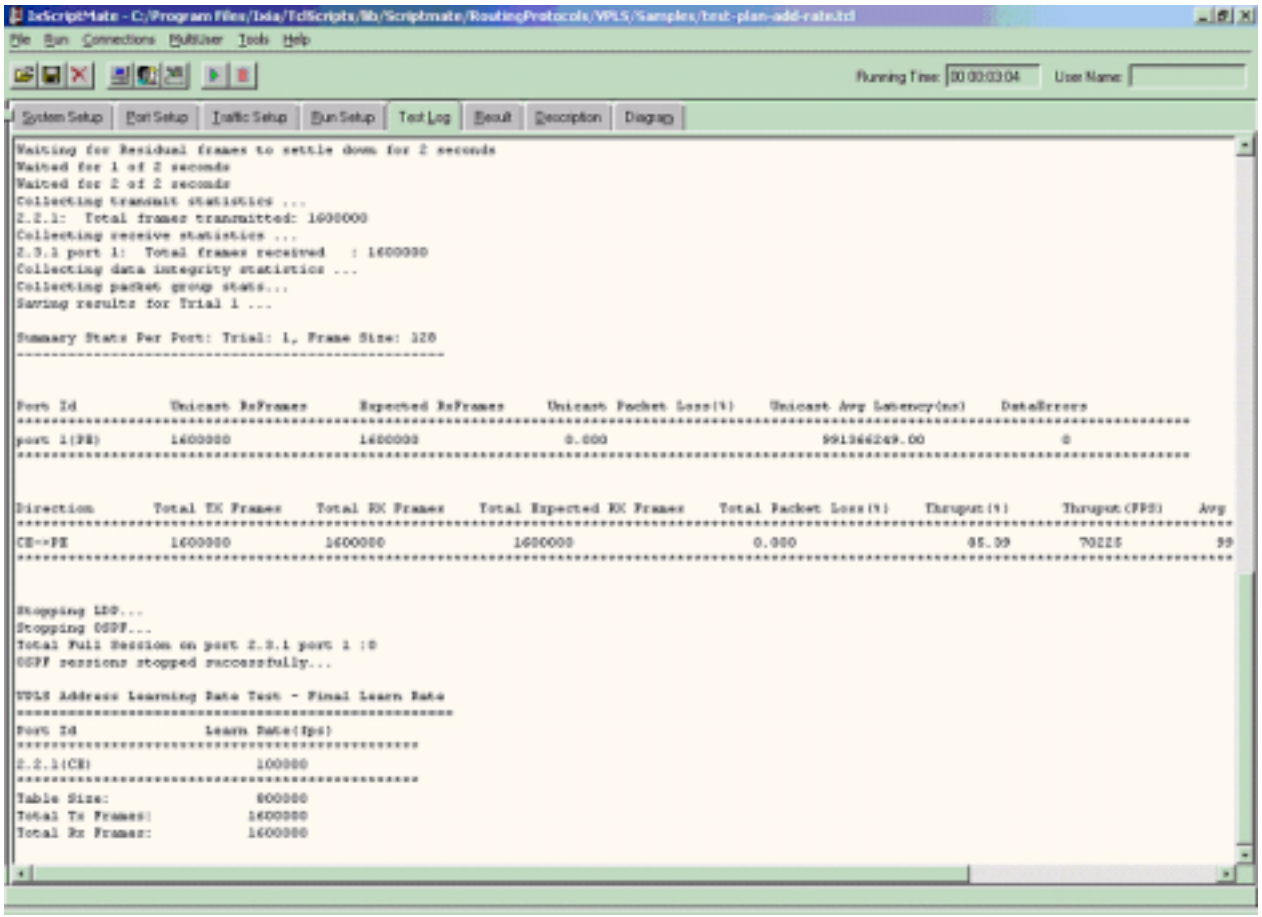

Figure 9. VPLS MAC address rate test results.

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5. VPLS Peer-to-Peer Throughput Test

Objective. Determine the traffic throughput sustainable by a DUT configured as a PE router with Martini/VPLS targeted sessions. This test uses a one-to-one traffic map in which each port transmits to a single destination port emulating network destinations.

Setup. This test requires at least two tester ports – one to transmit and one to emulate OSPF, LDP basic and LDP targeted VPLS sessions. VPLS VCs are established between the DUT and emulated PEs.

Traffic is sent either unidirectionally or bidirectionally through the system. Ixia's IxExplorer application can be used to provide the control and data plane functions for this test. Alternatively, IxScriptMate provides an automated script for executing this test using a binary search algorithm. Figure 10 and Figure 11 show an example topology and configuration dialog for the IxScriptMate Peer-to-Peer Throughput Test.

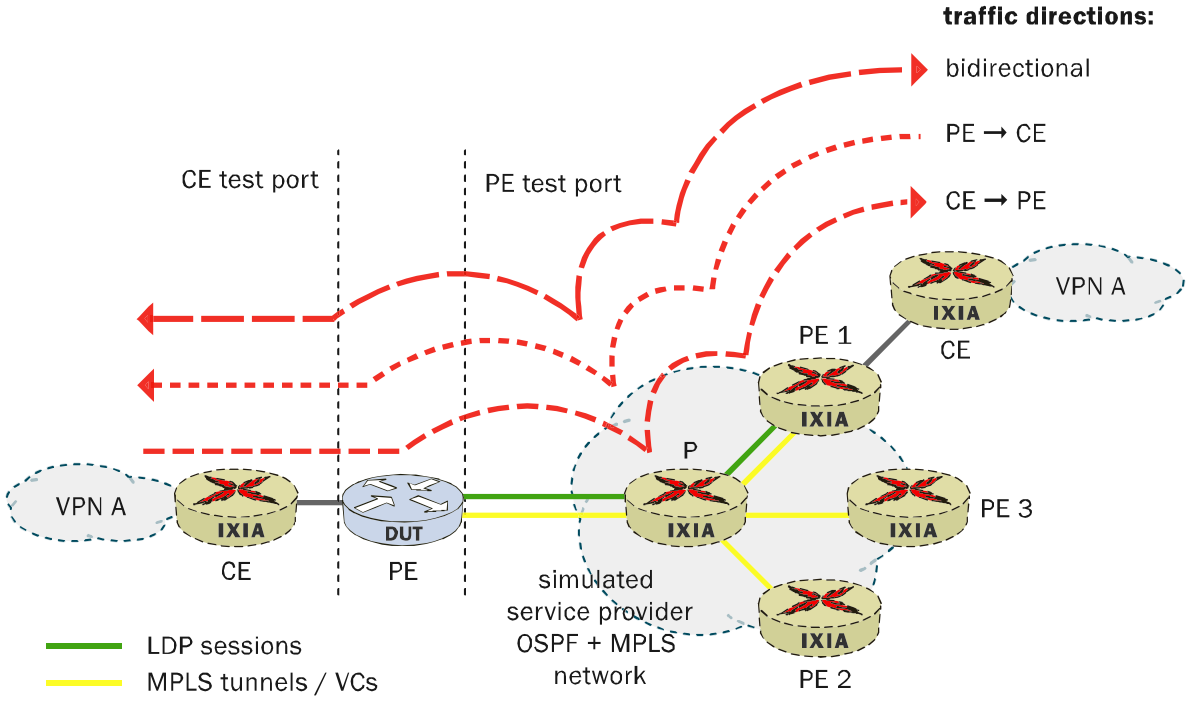

Figure 10. Example VPLS peer-to-peer throughput test topology.

Input Parameters

Table 5. VPLS peer-to-peer throughput test input parameters

Parameter	Description
Traffic rate	Initial rate at which traffic is sent to the destination MAC
Number of ports	The number of CE and PE port pairs
Traffic direction	Either unidirectional (PE->CE or CE->PE) or bidirectional
Number of PEs	The number of emulated PE routers advertised and originating targeted sessions to the DUT
Number of CEs per PE	Number of VCs per PE to be advertised
Number of MACs	Number of MAC addresses advertised from each CE (VLAN) and PE (remote site)
Tolerance	The tolerance the test will accept before providing results

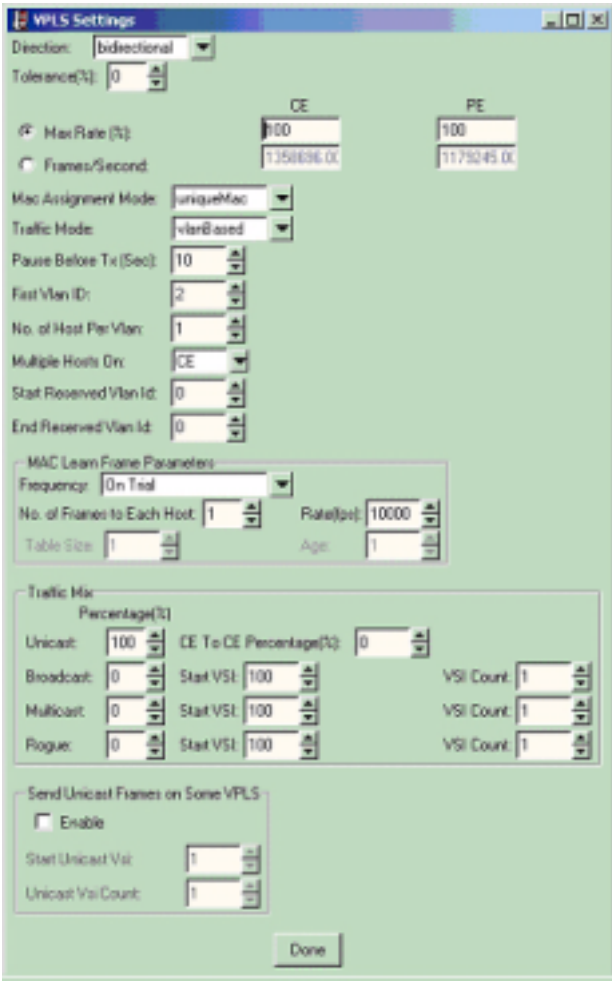

Figure 11. VPLS peer-to-peer throughput test configuration.

Methodology

1. OSPF and LDP basic sessions are established between the PE side test ports and the DUT. The PE side test ports then establish LDP targeted sessions representing multiple VPLS remote sites and multiple VSIs per site.
2. Learning frames are sent based on the specified “Number of MACs” parameter. The addresses are learned by the DUT which builds a MAC table for both PE and CE destinations.
3. Traffic load is sent to the DUT, either unidirectionally or bidirectionally as specified. The starting traffic rate is specified by the “Traffic rate” parameter.
4. The test ports verify packets received are within the defined “Tolerance”. Each receiving port verifies the throughput and frame loss.
5. The test either ends with a maximum traffic throughput result or iterates repeating steps 2-4. Each iteration alternately raises and lowers the traffic rate until maximum throughput is achieved.

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Results. The maximum peer-to-peer traffic throughput is determined when the device can successfully forward at a specified rate and receive every packet within the loss tolerance specified. Throughput statistics are collected at the end of the test with results for different frame sizes. Figure 12 provides an example of a VPLS peer-to-peer throughput test executed from Gigabit Ethernet to Fast Ethernet ports using IxScriptMate. The results are shown for one set of PE/CE ports. Notice the percentage in throughput differs depending on traffic direction - 11% from Gigabit to Fast Ethernet and100% from Fast Ethernet to Gigabit Ethernet.

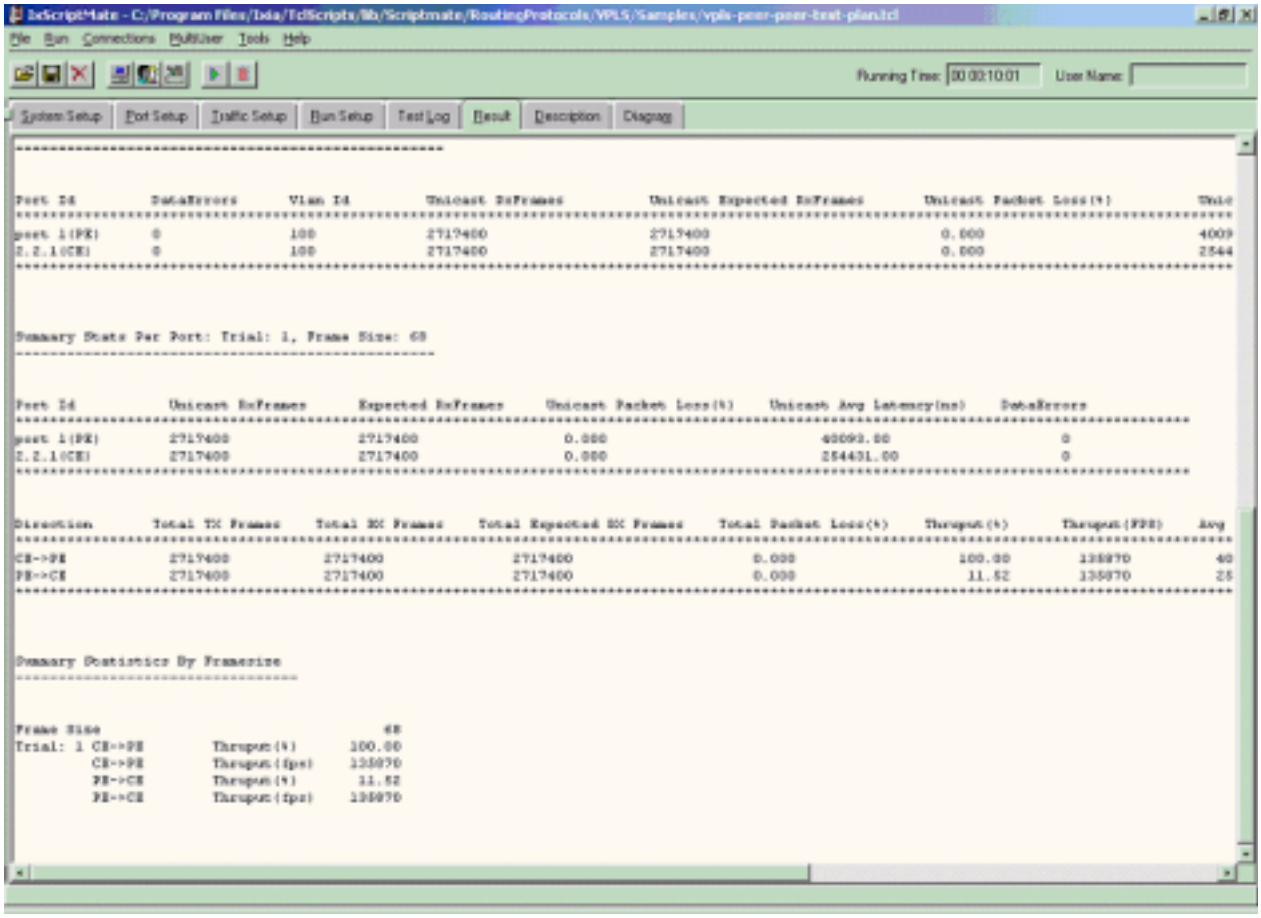

Figure 12. VPLS peer-to-peer throughput test results.

6. VPLS Partially Meshed Throughput Test

Objective. Determine the traffic throughput sustainable by a DUT configured as a PE router with Martini/VPLS targeted sessions. This test uses a partially meshed traffic map configuration in which multiple port transmit to similar destinations.

Setup. The test requires at least three test ports – one or more to transmit and one or more to receive and emulate OSPF, LDP basic and LDP targeted VPLS sessions. The DUT and simulated PEs build VPLS VCs between each other. Traffic is sent either unidirectionally or bidirectionally through the system. Ixia's IxExplorer application can be used to provide the control and data plane functions for this test. Alternatively, IxScriptMate provides an automated script for executing this test using a binary search algorithm. Figure 13 and Figure 14 show an example topology and configuration dialog for the IxScriptMate Partially Meshed Throughput Test.

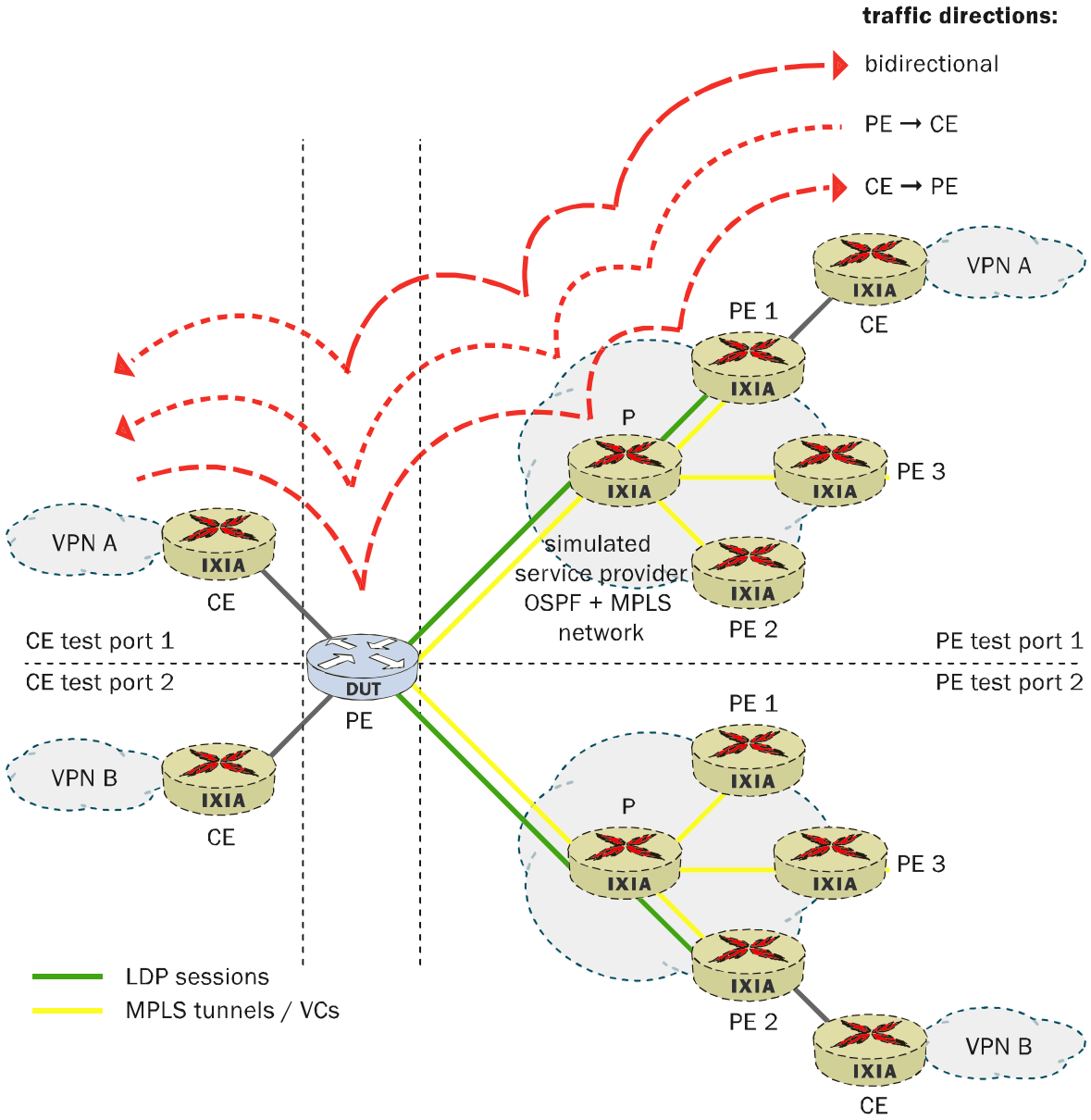

Figure 13. VPLS partially meshed throughput test topology example.

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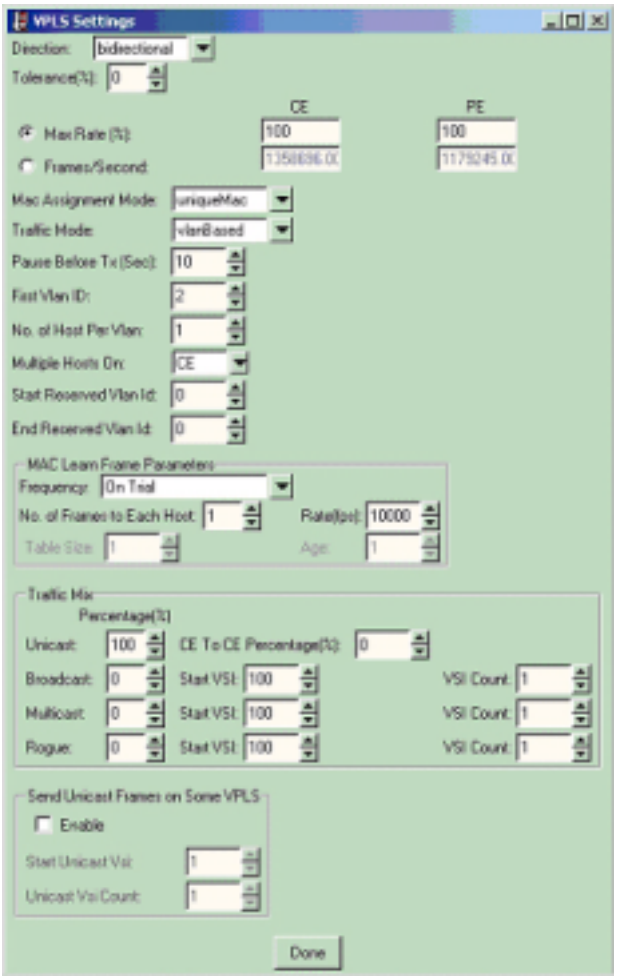

Figure 14. VPLS partially meshed throughput test configuration example.

Input Parameters

Table 6. VPLS partially meshed throughput test input parameters.

Parameter	Description
Traffic rate	Initial rate at which traffic is sent to the destination MAC
Number of ports	The number of CE and PE port pairs
Traffic direction	Either unidirectional (PE->CE or CE->PE) or bidirectional
Number of PEs	The number of emulated PE routers advertised and originating targeted sessions to the DUT
Number of CEs per PE	Number of VCs per PE to be advertised
Number of MACs	Number of MAC addresses advertised from each CE (VLAN) and PE (remote site)
Tolerance	The tolerance the test will accept before providing results

Methodology

1. OSPF and LDP basic sessions are established between the PE side test ports and the DUT. The PE side test ports then establish LDP targeted sessions representing multiple VPLS remote sites and multiple VSIs per site.
2. Learning frames are sent based on the specified “Number of MACs” parameter. The addresses are learned by the DUT which builds a MAC table for both PE and CE destinations.
3. Traffic load is sent to the DUT, either unidirectionally or bidirectionally as specified. The starting traffic rate is specified by the “Traffic rate” parameter. A mix of traffic is sent between CEs and PEs (as opposed to one-to-one) to present a meshed traffic topology.
4. The test ports verify packets received are within the defined “Tolerance”. Each receiving port verifies the throughput and frame loss.
5. The test either ends with a maximum traffic throughput result or iterates, repeating steps 2-4. Each iteration alternately raises and lowers the traffic rate until maximum throughput is achieved. Figure 15 shows an iteration of the IxScriptMate Partially Meshed Throughput Test showing traffic loss.

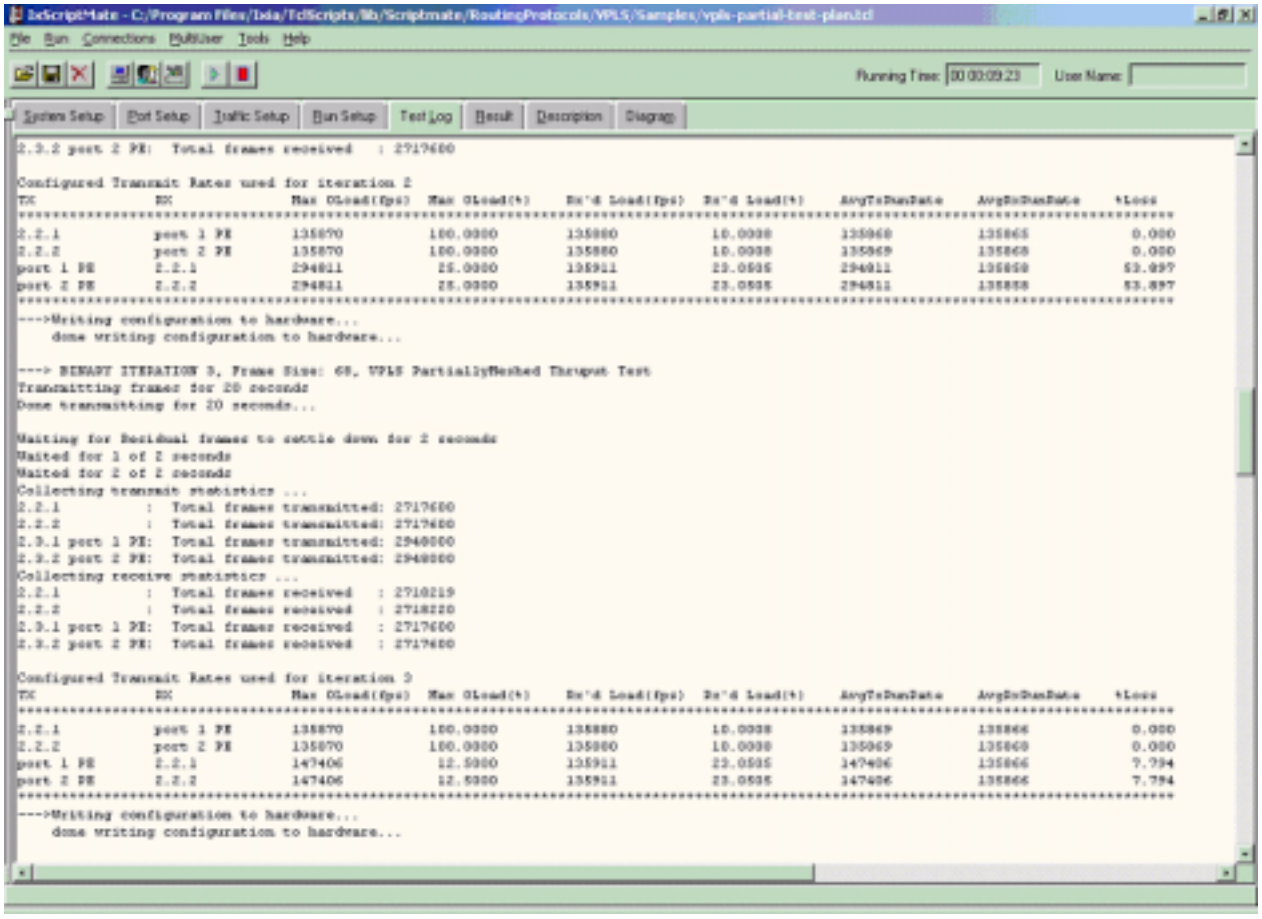

Figure 15. Iteration of VPLS partially meshed throughput test showing loss.

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Results. The maximum partially meshed traffic throughput is determined when the device can successfully forward at a specified rate and receive every packet within the loss tolerance specified on all ports. Throughput statistics are collected at the end of the test with results for different frame sizes. Figure 16 provides an example of a VPLS partially meshed throughput test using 4 ports, with 2 each being Gigabit Ethernet and Fast Ethernet, using IxScriptMate. The test results reflect the mesh of 4 ports transmitting to each other and the maximum throughput obtained.

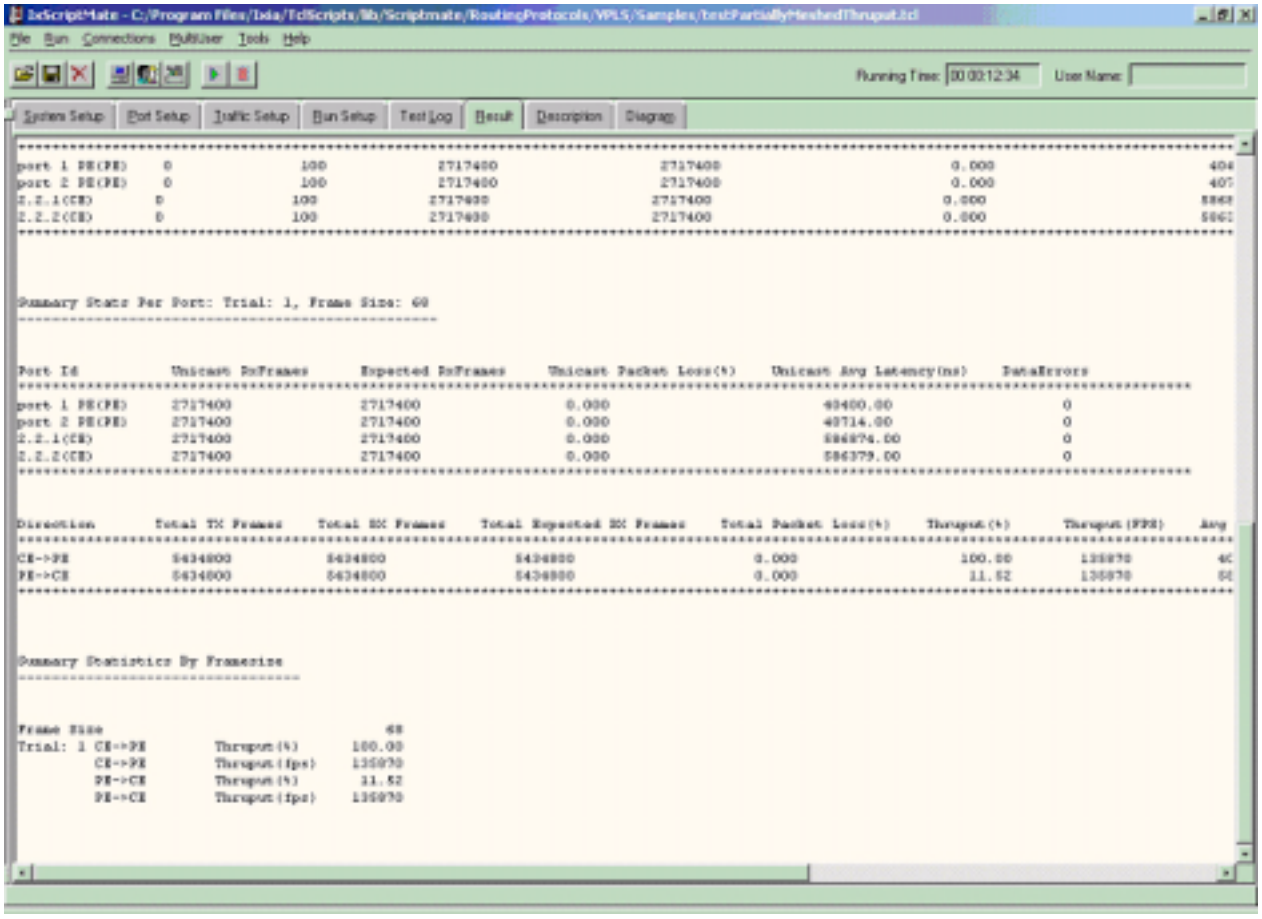

Figure 16. VPLS partially meshed throughput test results.