

Spirent SD-WAN TestPack Specification

Revision History

Rev	Date	Author	Purpose
0.1	3/13/2019	Samuel Yuan	Initial draft
0.2	3/15/2019	Samuel Yuan	Update pre-configuration of link black and link brownout cases
0.3	3/19/2019	Samuel Yuan	Update application aware path selection case according to review comments
0.4	3/27/2019	Samuel Yuan	Update 1. Stream packet pattern from random to constant 2. Stream UDP port range update
0.5	4/25/2019	Samuel Yuan	Specify SNE "Idle Traffic flow Settings" in every SNE-related case
0.6	5/8/2019	Samuel Yuan	1. Update section "Overview" and "Test Pack Specification" 2. Remove redundant content in test cases 3. Remove section "Implement Notes" and "Delivery Notes"
0.7	5/21/2019	Eric Zhang	1. Update test case IDs 2. Minor updates

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Overview

Software-defined networking (SDN) technology is an approach to cloud computing that facilitates network management and enables programmatically efficient network configuration in order to improve network performance and monitoring. SDN is meant to address the fact that the static architecture of traditional networks is decentralized and complex while current networks require more flexibility and easy troubleshooting. SDN attempts to centralize network intelligence in one network component by disassociating the forwarding process of network packets (data plane) from the routing process (control plane). The control plane consists of one or more controllers which are considered as the brain of SDN network where the whole intelligence is incorporated. However, the intelligence centralization has its own drawbacks when it comes to security, scalability and elasticity and this is the main issue of SDN.

An SD-WAN is a Wide Area Network (WAN) managed using the principles of software defined networking. The main driver of SD-WAN is to lower WAN costs using more affordable and commercially available leased lines, as an alternative or partial replacement of more expensive MPLS lines. Control and management are administered separately from the hardware with central controllers allowing for easier configuration and administration.

Test Pack Specification

Testing and evaluate SD-WAN device and SD-WAN service is challenge for many SD-WAN subscribers. Many SD-WAN subscribers don't have too much experience on network testing, they need a packaged SD-WAN test suite, the test suite which should be:

- Easy to deploy
- Easy to use
- With clear result output

Based on powerful test instrument and rich test experience, Spirent SD-WAN Test Pack provides a series of test cases for users to evaluate functionality and performance of their SD-WAN device and SD-WAN service.

Attribute	Description
Test Pack Name	SD-WAN
Test Areas	<ul style="list-style-type: none">● Path Selection

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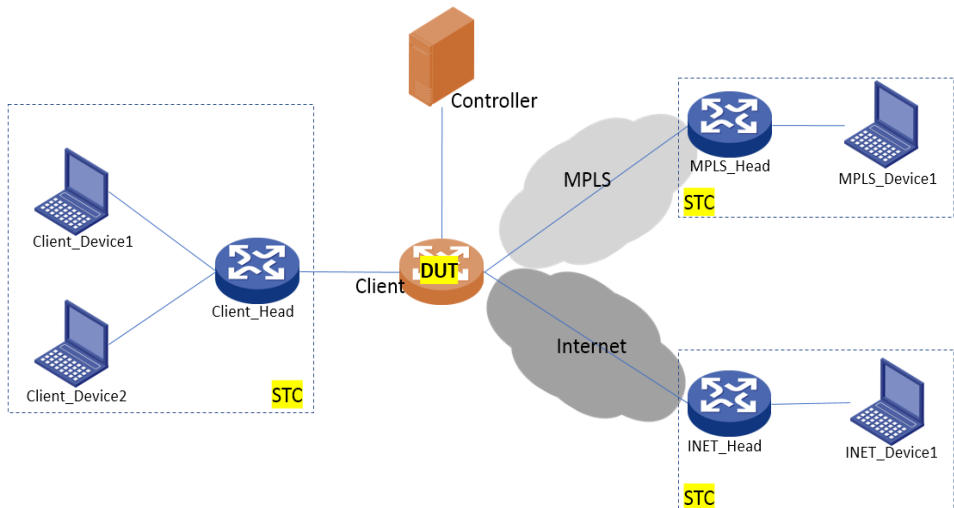
	<ul style="list-style-type: none"> • Resiliency -- Link Brownout • Resiliency -- Link Blackout
Test Case Count	9 cases
Test Case list	SD-WAN_Path_Selection_L2_To_L4_Steering SD-WAN_Path_Selection_Application_Aware_Steering SD-WAN_Resiliency_Link_Blackout_Local_No_Congestion SD-WAN_Resiliency_Link_Blackout_Remote_No_Congestion SD-WAN_Resiliency_Link_Brownout_Packet_Loss SD-WAN_Resiliency_Link_Brownout_Packet_Delay SD-WAN_Resiliency_Link_Brownout_Jitter SD-WAN_Resiliency_Link_Brownout_Packet_Out_Of_Order SD-WAN_Resiliency_Link_Brownout_Packet_Duplication
DUT/SUT	Not specified
Test Instrument	Spirent Test Center (STC), Spirent Network Emulator (SNE)

Test Case Specification

SD-WAN_Path_Selection_L2_To_L4_Steering

Test Case Name	SD-WAN_Path_Selection_L2_To_L4_Steering
Test Case ID	sd-wan.path_selection.001
Test Area	Path Selection
Test Objective	Validate DUT is able to steer traffic among WAN links by using traditional L2/L3/L4 traffic classification method.
Test Type	Functional

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Topology Name	3stc_1dut_type01																																			
Topology																																				
Test Instrument	Spirent Test Center																																			
Prerequisites	Connect Spirent Test Center (STC) and DUT as per test topology.																																			
Pre-Configuration	<div><STC configuration></div> <table><tr><th>Port</th><th>Device Block</th><th>IPv4 address</th><th>IPv4 subnet mask</th><th>Link</th></tr><tr><td>Client</td><td>Client_Head</td><td>150.0.0.1</td><td>255.255.255.0</td><td></td></tr><tr><td></td><td>Client_Device1</td><td>101.0.0.1~101.0.0.100</td><td>255.255.255.0</td><td>L3 forwarding link to Client_Head</td></tr><tr><td></td><td>Client_Device2</td><td>102.0.0.1~102.0.0.100</td><td>255.255.255.0</td><td>L3 forwarding link to Client_Head</td></tr><tr><td>MPLS</td><td>MPLS_Head</td><td>150.0.1.1</td><td>255.255.255.0</td><td></td></tr><tr><td></td><td>MPLS_Device1</td><td>200.0.0.1~200.0.0.200</td><td>255.255.255.0</td><td>L3 forwarding link to MPLS_Head</td></tr><tr><td>Internet</td><td>INET_Head</td><td>150.0.2.1</td><td>255.255.255.0</td><td></td></tr></table>	Port	Device Block	IPv4 address	IPv4 subnet mask	Link	Client	Client_Head	150.0.0.1	255.255.255.0			Client_Device1	101.0.0.1~101.0.0.100	255.255.255.0	L3 forwarding link to Client_Head		Client_Device2	102.0.0.1~102.0.0.100	255.255.255.0	L3 forwarding link to Client_Head	MPLS	MPLS_Head	150.0.1.1	255.255.255.0			MPLS_Device1	200.0.0.1~200.0.0.200	255.255.255.0	L3 forwarding link to MPLS_Head	Internet	INET_Head	150.0.2.1	255.255.255.0	
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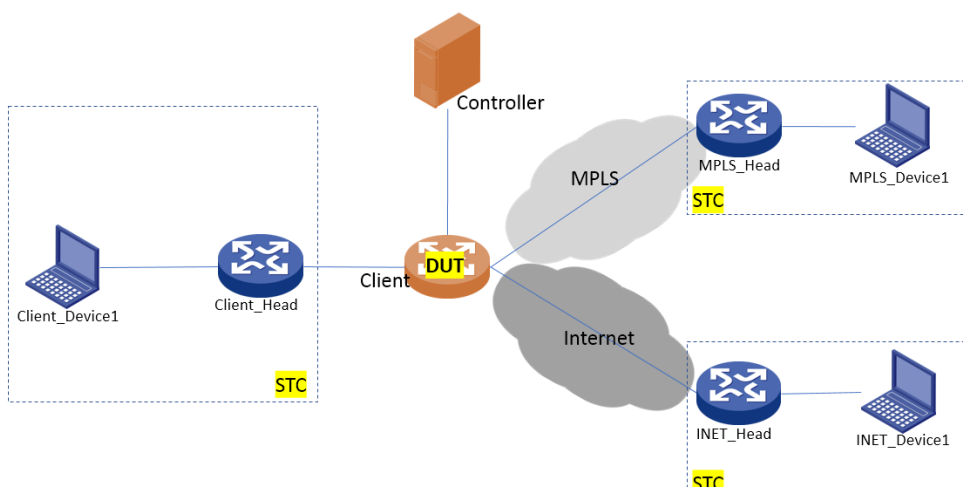
<div><div>INET_Device1200.0.0.1~200.0.0.200255.255.255.0L3 forwarding link to INET_Head</div></div>																																																																																									
<table><thead><tr><th>Stream</th><th>Source endpoint</th><th>Destination endpoint</th><th>Packet length</th><th>Protocol</th><th>port number</th><th>Packet pattern</th><th>Traffic rate</th><th>Duration</th></tr></thead><tbody><tr><td>1</td><td>Client_Device1</td><td>INET_Device1</td><td>iMix (JMIX Upstream)</td><td>TCP</td><td>80</td><td>Constant (0000)</td><td>1Mbps</td><td>60sec</td></tr><tr><td>2</td><td>Client_Device2</td><td>MPLS_Device1</td><td>iMix (JMIX Upstream)</td><td>TCP</td><td>80</td><td>Constant (0000)</td><td>1Mbps</td><td>60sec</td></tr><tr><td>3</td><td>Client_Device1</td><td>MPLS_Device1</td><td>iMix (JMIX Upstream)</td><td>UDP</td><td>5060</td><td>Constant (0000)</td><td>1Mbps</td><td>60sec</td></tr><tr><td>4</td><td>Client_Device2</td><td>INET_Device1</td><td>iMix (JMIX Upstream)</td><td>UDP</td><td>5060</td><td>Constant (0000)</td><td>1Mbps</td><td>60sec</td></tr><tr><td>5</td><td>Client_Device1</td><td>INET_Device1</td><td>512</td><td>UDP</td><td>50050 to 50098, even</td><td>Constant (0000)</td><td>1Mbps</td><td>60sec</td></tr><tr><td>6</td><td>Client_Device2</td><td>MPLS_Device1</td><td>512</td><td>UDP</td><td>50050 to 50098, even</td><td>Constant (0000)</td><td>1Mbps</td><td>60sec</td></tr><tr><td>7</td><td>Client_Device1</td><td>INET_Device1</td><td>iMix (JMIX Upstream)</td><td>UDP</td><td>50050 to 50100, odd</td><td>Constant (0000)</td><td>1Mbps</td><td>60sec</td></tr><tr><td>8</td><td>Client_Device2</td><td>MPLS_Device1</td><td>iMix (JMIX Upstream)</td><td>UDP</td><td>50050 to 50100, odd</td><td>Constant (0000)</td><td>1Mbps</td><td>60sec</td></tr></tbody></table>									Stream	Source endpoint	Destination endpoint	Packet length	Protocol	port number	Packet pattern	Traffic rate	Duration	1	Client_Device1	INET_Device1	iMix (JMIX Upstream)	TCP	80	Constant (0000)	1Mbps	60sec	2	Client_Device2	MPLS_Device1	iMix (JMIX Upstream)	TCP	80	Constant (0000)	1Mbps	60sec	3	Client_Device1	MPLS_Device1	iMix (JMIX Upstream)	UDP	5060	Constant (0000)	1Mbps	60sec	4	Client_Device2	INET_Device1	iMix (JMIX Upstream)	UDP	5060	Constant (0000)	1Mbps	60sec	5	Client_Device1	INET_Device1	512	UDP	50050 to 50098, even	Constant (0000)	1Mbps	60sec	6	Client_Device2	MPLS_Device1	512	UDP	50050 to 50098, even	Constant (0000)	1Mbps	60sec	7	Client_Device1	INET_Device1	iMix (JMIX Upstream)	UDP	50050 to 50100, odd	Constant (0000)	1Mbps	60sec	8	Client_Device2	MPLS_Device1	iMix (JMIX Upstream)	UDP	50050 to 50100, odd	Constant (0000)	1Mbps	60sec
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Test Sequence	Step	Type	Description	Expected Result																																																																																					

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	1	Action	Perform ARP on all STC devices and all stream blocks	All ARPs are resolved successfully
	2	Action	Start traffic on all STC ports	All generators are started successfully
	3	Action	Wait for traffic to stop	All generators are stopped successfully
	4	Check	Check stream related results	a. Stream 1, 4, 5, 7 are received only on Internet STC port b. Stream 2, 3, 6, 8 are received only on MPLS port c. No packet loss
Result Content	1. STC Configuration 2. Script output 3. STC detailed results (get it by using "Save Results" command), result view "Stream Block Results", "Stream Block Results" and "Port Traffic Results" must be included. 4. STC logs (BLL/IL/Chassis) 5. DUT logs if possible			
Test Verdict	PASS criteria: all stream blocks are steered towards expected link without packet loss.			

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SD-WAN_Path_Selection_Application_Aware_Steering

Test Case Name	SD-WAN_Path_Selection_Application_Aware_Steering
Test Case ID	sd-wan.path_selection.002
Test Area	Path Selection
Test Objective	Validate DUT can steer traffic among WAN links by using application aware traffic classification method.
Test Type	Functional
Topology Type	3stc_1dut_type01
Topology	
Test Instrument	Spirent Test Center
Prerequisites	Connect Spirent Test Center (STC) and DUT as per test topology.

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Pre-Configuration

<STC configuration>

Port	Device Block	IPv4 address	IPv4 subnet mask	Link
Client	Client_Head	150.0.0.1	255.255.255.0	
	Client_Device 1	101.0.0.1~101.0.0.10	255.255.255.0	L3 forwarding link to Client_Head
MPLS	MPLS_Head	150.0.1.1	255.255.255.0	
	MPLS_Device1	200.0.0.1~200.0.0.20	255.255.255.0	L3 forwarding link to MPLS_Head
Internet	INET_Head	150.0.2.1	255.255.255.0	
	INET_Device 1	200.0.0.1~200.0.0.20	255.255.255.0	L3 forwarding link to INET_Head

Configure HTTP client on Client_Device1

HTTP Client Configuration	Connected Server	Max. Transactions Per Server
	MPLS_Device1	10

Client HTTP Profile: Default profile

Client Load Profile:

Load Type	Random Seed	Max Connections Attempted	Max. Open Connections	Max. Transactions Attempt
Connection Per Time Unit	123456	1500	20	4294967295

Phase	Load Pattern	Duration Unit	Repetitions	Height	Ramp Time	Steady Time	Period
Delay (1)	Flat	Seconds	NA	0	0	5	NA
Ramp Up (2)	Stair	Seconds	1	10	10	0	NA
Stair Step (3)	Stair	Seconds	5	4	5	5	NA

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Steady Step (4)							
Stair	Seconds	1	0	0	30	NA	
Ramp Down (5)							
Flat	Seconds	NA	0	0	20	NA	

Configure HTTP Server on MPLS_Device1 and INET_Device1

HTTP server configuration	Max Requests per Client	Max Simultaneous Clients
	10	4294967295

Server Profile: default profile

Configure SIP Caller on Client_Device1

SIP Caller	Callee Side	Other parameters
	MPLS_Device 1	Leave all other parameters default

SIP UA Client Profile: use default
profile

SIP load
Profile:

Code Type	Random Seed	Max Connections Attempted	Max. Open Connections	Max. Transactions Attempt
Connection Per Time Unit	123456	200	10	4294967295

Phase	Load Pattern	Duration Unit	Repetitio ns	Height	Ramp Time	Steady Time	Period
1	Flat	Seconds	NA	4	180	0	NA

Configure SIP Callee on MPLS_Device1 and INET_Device1

SIP UA Client Profile: use default

UA number format of the two devices must be identical.

<DUT configuration>

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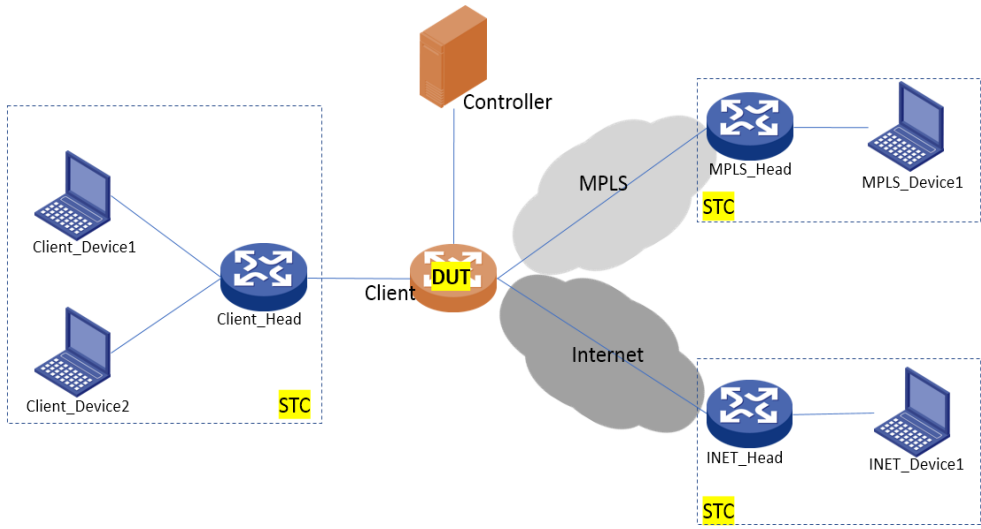
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	Internet	150.0.2.2	255.255.255.0													
Test Sequence	Step	Type	Description	Expected Result												
	1	Action	Perform ARP on all STC devices and all stream blocks	All ARPs are resolved successfully												
	2	Action	Start HTTP servers	All HTTP servers are started successfully												
	3	Action	Start HTTP client	HTTP client is started successfully												
	4	Action	Wait till all HTTP connections and transactions are done	HTTP connection count is 1500, HTTP transaction count is 15000												
	5	Check	Check HTTP related results	a. All HTTP connections and transactions are finished without failure												

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				b. All HTTP connections and transactions are targeted to INET_Device1 c. No packet loss
	6	Action	Start SIP caller	SIP client is started successfully
	7	Action	Wait till all SIP calls are done (Totally 200 calls)	200 calls are attempted
	8	Check	Check SIP related results	a. All SIP calls are finished without failure, Call Success Percentage should be 100% b. All SIP calls (including SIP/RTP/RTCP) are targeted to MPLS_Device1 c. No packet loss.
Result Content	1. STC Configuration 2. Script output 3. STC detailed results (get it by using "Save Results" command), result view "HTTP Client Results", "HTTP Server Results", "SIP UA Results", "Stream Block Results", "Stream Block Results" and "Port Traffic Results" must be included. 4. STC logs (BLL/IL/Chassis) 5. DUT logs if possible			
Test Verdict	PASS criteria: all HTTP traffic are steered towards Internet link without packet loss; all SIP/RTP/RTCP traffic are steered towards MPLS link without packet loss.			

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SD-WAN_Resiliency_Link_Blackout_Local_No_Congestion

Test Case Name	SD-WAN_Resiliency_Link_Blackout_Local_No_Congestion
Test Case ID	sd-wan.resiliency_link.001
Test Area	Resiliency link blackout
Test Objective	Validate DUT can steer traffic from Internet link to MPLS link if link blackout was detected on local side of Internet link and vice versa.
Test Type	Functional
Topology Type	3stc_1dut_type01
Topology	 <p>The diagram illustrates a network topology for testing SD-WAN resiliency. A central DUT (Device Under Test) is connected to a Controller and a Client. The Client is connected to two networks: MPLS and Internet. The MPLS network includes an MPLS Head (STC) and an MPLS Device1. The Internet network includes an INET Head (STC) and an INET Device1. The Client is also connected to a Client Head (STC) which is connected to Client_Device1 and Client_Device2.</p>
Test Instrument	Spirent Test Center

Spirent SD-WAN TestPack Specification

Prerequisites	Connect Spirent Test Center (STC) and DUT as per test topology.																																												
Pre-Configuration	<STC configuration>																																												
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	Internet	INET_Head	150.0.2.1	255.255.255.0																																									
		INET_Device1	200.0.0.1~200.0.0.200	255.255.255.0	L3 forwarding link to INET_Head																																								
<table><tr><th>Stream</th><th>Source endpoint</th><th>Destination endpoint</th><th>Packet length</th><th>Protocol</th><th>port number</th><th>Packet pattern</th><th>Traffic rate</th><th>Duration</th></tr><tr><td>1</td><td>Client_Device1</td><td>MPLS_Device1</td><td>512</td><td>TCP</td><td>80</td><td>Constant (0000)</td><td>1Mbps</td><td>continuous</td></tr><tr><td>2</td><td>Client_Device2</td><td>MPLS_Device1</td><td>512</td><td>TCP</td><td>80</td><td>Constant (0000)</td><td>1Mbps</td><td>continuous</td></tr><tr><td>3</td><td>Client_Device1</td><td>MPLS_Device1</td><td>512</td><td>UDP</td><td>50050 to 50098, even</td><td>Constant (0000)</td><td>1Mbps</td><td>continuous</td></tr><tr><td>4</td><td>Client_Device2</td><td>MPLS_Device1</td><td>512</td><td>UDP</td><td>50050 to 50098, even</td><td>Constant (0000)</td><td>1Mbps</td><td>continuous</td></tr></table>	Stream	Source endpoint	Destination endpoint	Packet length	Protocol	port number	Packet pattern	Traffic rate	Duration	1	Client_Device1	MPLS_Device1	512	TCP	80	Constant (0000)	1Mbps	continuous	2	Client_Device2	MPLS_Device1	512	TCP	80	Constant (0000)	1Mbps	continuous	3	Client_Device1	MPLS_Device1	512	UDP	50050 to 50098, even	Constant (0000)	1Mbps	continuous	4	Client_Device2	MPLS_Device1	512	UDP	50050 to 50098, even	Constant (0000)	1Mbps	continuous
Stream	Source endpoint	Destination endpoint	Packet length	Protocol	port number	Packet pattern	Traffic rate	Duration																																					
1	Client_Device1	MPLS_Device1	512	TCP	80	Constant (0000)	1Mbps	continuous																																					
2	Client_Device2	MPLS_Device1	512	TCP	80	Constant (0000)	1Mbps	continuous																																					
3	Client_Device1	MPLS_Device1	512	UDP	50050 to 50098, even	Constant (0000)	1Mbps	continuous																																					
4	Client_Device2	MPLS_Device1	512	UDP	50050 to 50098, even	Constant (0000)	1Mbps	continuous																																					
Stream duration may need to be changed if DUT may take longer time to detect link status change.																																													

Spirent SD-WAN TestPack Specification

	<DUT configuration>															
	<table><tr><th>Port</th><th>IPv4 address</th><th>IPv4 subnet mask</th></tr><tr><td>Client</td><td>150.0.0.2</td><td>255.255.255.0</td></tr><tr><td>MPLS</td><td>150.0.1.2</td><td>255.255.255.0</td></tr><tr><td>Internet</td><td>150.0.2.2</td><td>255.255.255.0</td></tr></table>				Port	IPv4 address	IPv4 subnet mask	Client	150.0.0.2	255.255.255.0	MPLS	150.0.1.2	255.255.255.0	Internet	150.0.2.2	255.255.255.0
	Port	IPv4 address	IPv4 subnet mask													
	Client	150.0.0.2	255.255.255.0													
	MPLS	150.0.1.2	255.255.255.0													
Internet	150.0.2.2	255.255.255.0														
Proper policies must be applied to DUT to:																
<ul style="list-style-type: none">Steer stream 1 and 3 towards Internet link and steer stream 2 and 4 towards MPLS link.If Internet link down is detected by DUT, DUT should steer stream 1 and 3 to MPLS linkAfter Internet link resume, stream 1 and 3 should be steered back to Internet link																
Test Sequence	Step	Type	Description	Expected Result												
	1	Action	Perform ARP on all STC devices and all stream blocks	All ARPs are resolved successfully												
	2	Action	Start traffic on all STC ports	All generators are started successfully												
	3	Action	Bring link of STC Internet port down	DUT detect the link failure, steer stream 1 and 3 to MPLS link												
	4	Action	Stop traffic	All generators are stopped successfully												
	5	Check	Record out of service time													

Spirent SD-WAN TestPack Specification

	6	Action	Start traffic on all STC ports	All generators are started successfully
	7	Action	Bring link of STC Internet port up	DUT detect the link is up, steer stream 1 and 3 back to Internet link
	8	Check	Record recovery time	
Result Content	<ol style="list-style-type: none"> 1. STC Configuration 2. Script output 3. STC detailed results (get it by using “Save Results” command), result view “Stream Block Results”, “Stream Block Results” and “Port Traffic Results” must be included. 4. Out of service time and recovery time 5. STC logs (BLL/IL/Chassis) 6. DUT logs if possible 			
Test Verdict	PASS criteria: stream 1 and 3 are correctly steered in link blackout and resume.			

SD-WAN_Resiliency_Link_Blackout_Remote_No_Congestion

Test Case Name	SD-WAN_Resiliency_Link_Blackout_Remote_No_Congestion
Test Case ID	sd-wan.resiliency_link.002
Test Area	Resiliency link blackout
Test Objective	Validate DUT can steer traffic from Internet link to MPLS link if link blackout was detected on remote side of Internet link and vice versa.
Test Type	Functional

Spirent SD-WAN TestPack Specification

Topology Type	3stc_1sne_2dut_type01																																
Topology																																	
Test Instrument	Spirent Test Center, Spirent Network Emulator																																
Prerequisites	Connect Spirent Test Center (STC) and DUT as per test topology.																																
Pre-Configuration	<div><STC configuration></div> <table><tr><th>Port</th><th>Device Block</th><th>IPv4 address</th><th>IPv4 subnet mask</th><th>Link</th></tr><tr><td rowspan="3">Client</td><td>Client_Head</td><td>150.0.0.1</td><td>255.255.255.0</td><td></td></tr><tr><td>Client_Device1</td><td>101.0.0.1~101.0.0.100</td><td>255.255.255.0</td><td>L3 forwarding link to Client_Head</td></tr><tr><td>Client_Device2</td><td>102.0.0.1~102.0.0.100</td><td>255.255.255.0</td><td>L3 forwarding link to Client_Head</td></tr><tr><td rowspan="2">MPLS</td><td>MPLS_Head</td><td>150.0.1.1</td><td>255.255.255.0</td><td></td></tr><tr><td>MPLS_Device1</td><td>200.0.0.1~200.0.0.200</td><td>255.255.255.0</td><td>L3 forwarding link to MPLS_Head</td></tr><tr><td>Internet</td><td>INET_Head</td><td>150.0.2.1</td><td>255.255.255.0</td><td></td></tr></table>	Port	Device Block	IPv4 address	IPv4 subnet mask	Link	Client	Client_Head	150.0.0.1	255.255.255.0		Client_Device1	101.0.0.1~101.0.0.100	255.255.255.0	L3 forwarding link to Client_Head	Client_Device2	102.0.0.1~102.0.0.100	255.255.255.0	L3 forwarding link to Client_Head	MPLS	MPLS_Head	150.0.1.1	255.255.255.0		MPLS_Device1	200.0.0.1~200.0.0.200	255.255.255.0	L3 forwarding link to MPLS_Head	Internet	INET_Head	150.0.2.1	255.255.255.0	
Port	Device Block	IPv4 address	IPv4 subnet mask	Link																													
Client	Client_Head	150.0.0.1	255.255.255.0																														
	Client_Device1	101.0.0.1~101.0.0.100	255.255.255.0	L3 forwarding link to Client_Head																													
	Client_Device2	102.0.0.1~102.0.0.100	255.255.255.0	L3 forwarding link to Client_Head																													
MPLS	MPLS_Head	150.0.1.1	255.255.255.0																														
	MPLS_Device1	200.0.0.1~200.0.0.200	255.255.255.0	L3 forwarding link to MPLS_Head																													
Internet	INET_Head	150.0.2.1	255.255.255.0																														

Spirent SD-WAN TestPack Specification

<div>INET_Device e1200.0.0.1~200.0.0.200255.255.255.0</div>						L3 forwarding link to INET_Head		
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Stream	Source endpoint	Destination endpoint	Packet length	Protocol	port number	Packet pattern	Traffic rate	Duration
1	Client_Device e1	MPLS_Device e1	512	TCP	80	Constant (0000)	1Mbps	Continuous
2	Client_Device e2	MPLS_Device e1	512	TCP	80	Constant (0000)	1Mbps	Continuous
3	Client_Device e1	MPLS_Device e1	512	UDP	50050 to 50098, even	Constant (0000)	1Mbps	Continuous
4	Client_Device e2	MPLS_Device e1	512	UDP	50050 to 50098, even	Constant (0000)	1Mbps	Continuous

Stream duration may need to be changed if DUT may take longer time to detect link status change.

<DUT1 configuration>

Port	IPv4 address	IPv4 subnet mask
Client	150.0.0.2	255.255.255.0
MPLS	150.0.1.2	255.255.255.0
To DUT2	Real or simulated internet	

<DUT2 configuration>

Port	IPv4 address	IPv4 subnet mask
To DUT1	Real or simulated internet	
Internet	150.0.2.2	255.255.255.0

Proper policies must be applied to DUT1 to:

Spirent SD-WAN TestPack Specification

	<ul style="list-style-type: none"> Steer stream 1 and 3 towards Internet link and steer stream 2 and 4 towards MPLS link. If Internet link down is detected by DUT, steer stream 1 and 3 to MPLS link. After Internet link resume, steer stream 1 and 3 back to Internet link. <p>Link status detection method (such as BFD) should be configured between client edge device (DUT1) and Internet edge device (DUT2) to detect link failure.</p> <p><SNE configuration> SNE Idle traffic flow setting should be “Actively route traffic whilst unit is idle”.</p>			
Test Sequence	Step	Type	Description	Expected Result
	1	Action	Perform ARP on all STC devices and all stream blocks	All ARPs are resolved successfully
	2	Action	Start traffic on all STC ports	All generators are started successfully
	3	Action	Impairment tool: Emulate packet sinkhole (drop all packets)	DUT detect the link failure, steer stream 1 and 3 to MPLS link
	4	Action	Stop traffic	All generators are stopped successfully
	5	Check	Record out of service time	

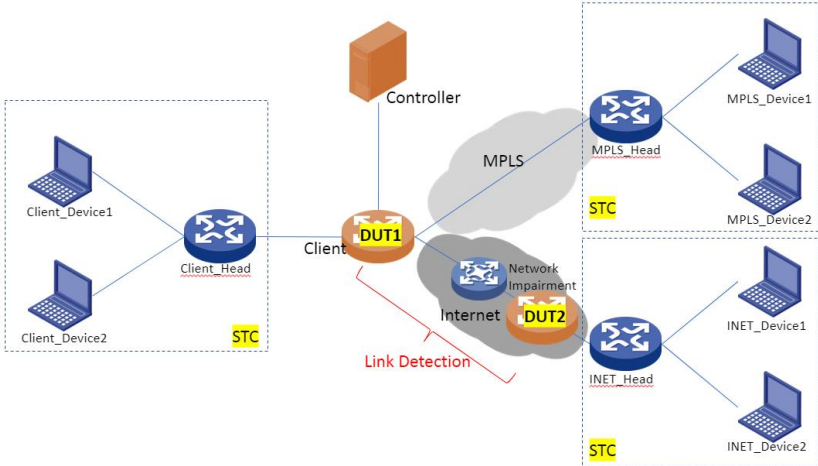
Spirent SD-WAN TestPack Specification

	6	Action	Start traffic on all STC ports	All generators are started successfully
	7	Action	Stop impairment	DUT detect the link is recovered, steer stream 1 and 3 back to Internet link
	8	Check	Record recovery time	
Result Content	<ol style="list-style-type: none"> 1. STC Configuration 2. Script output 3. STC detailed results (get it by using “Save Results” command), result view “Stream Block Results”, “Stream Block Results” and “Port Traffic Results” must be included. 4. Out of service time and recovery time 5. STC logs (BLL/IL/Chassis) 6. DUT logs if possible 			
Test Verdict	PASS criteria: stream 1 and 3 are correctly steered in link blackout and resume.			

SD-WAN_Resiliency_Link_Brownout_Packet_Loss

Test Case Name	SD-WAN_Resiliency_Link_Brownout_Packet_Loss
Test Case ID	sd-wan.resiliency_link.003
Test Area	Resiliency link brownout
Test Objective	Validate DUT can steer traffic from Internet link to MPLS link if packet loss ratio on Internet link exceeds threshold and vice versa.
Test Type	Functional

Spirent SD-WAN TestPack Specification

Topology Type	3stc_1sne_2dut_type01																																			
Topology																																				
Test Instrument	Spirent Test Center, Spirent Network Emulator																																			
Prerequisites	Connect Spirent Test Center (STC) and DUT as per test topology.																																			
Pre-Configuration	<div><STC configuration></div> <table><tr><th>Port</th><th>Device Block</th><th>IPv4 address</th><th>IPv4 subnet mask</th><th>Link</th></tr><tr><td>Client</td><td>Client_Head</td><td>150.0.0.1</td><td>255.255.255.0</td><td></td></tr><tr><td></td><td>Client_Device1</td><td>101.0.0.1~101.0.0.100</td><td>255.255.255.0</td><td>L3 forwarding link to Client_Head</td></tr><tr><td></td><td>Client_Device2</td><td>102.0.0.1~102.0.0.100</td><td>255.255.255.0</td><td>L3 forwarding link to Client_Head</td></tr><tr><td>MPLS</td><td>MPLS_Head</td><td>150.0.1.1</td><td>255.255.255.0</td><td></td></tr><tr><td></td><td>MPLS_Device1</td><td>200.0.0.1~200.0.0.200</td><td>255.255.255.0</td><td>L3 forwarding link to MPLS_Head</td></tr><tr><td>Internet</td><td>INET_Head</td><td>150.0.2.1</td><td>255.255.255.0</td><td></td></tr></table>	Port	Device Block	IPv4 address	IPv4 subnet mask	Link	Client	Client_Head	150.0.0.1	255.255.255.0			Client_Device1	101.0.0.1~101.0.0.100	255.255.255.0	L3 forwarding link to Client_Head		Client_Device2	102.0.0.1~102.0.0.100	255.255.255.0	L3 forwarding link to Client_Head	MPLS	MPLS_Head	150.0.1.1	255.255.255.0			MPLS_Device1	200.0.0.1~200.0.0.200	255.255.255.0	L3 forwarding link to MPLS_Head	Internet	INET_Head	150.0.2.1	255.255.255.0	
Port	Device Block	IPv4 address	IPv4 subnet mask	Link																																
Client	Client_Head	150.0.0.1	255.255.255.0																																	
	Client_Device1	101.0.0.1~101.0.0.100	255.255.255.0	L3 forwarding link to Client_Head																																
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	MPLS_Device1	200.0.0.1~200.0.0.200	255.255.255.0	L3 forwarding link to MPLS_Head																																
Internet	INET_Head	150.0.2.1	255.255.255.0																																	

Spirent SD-WAN TestPack Specification

INET_Device1		200.0.0.1~200.0.0.200		255.255.255.0		L3 forwarding link to INET_Head		
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Stream	Source endpoint	Destination endpoint	Packet length	Protocol	port number	Packet pattern	Traffic rate	Duration
1	Client_Device1	MPLS_Device1	512	TCP	80	Constant (0000)	1Mbps	120sec
2	Client_Device2	MPLS_Device1	512	TCP	80	Constant (0000)	1Mbps	120sec
3	Client_Device1	MPLS_Device1	512	UDP	50050 to 50098, even	Constant (0000)	1Mbps	120sec
4	Client_Device2	MPLS_Device1	512	UDP	50050 to 50098, even	Constant (0000)	1Mbps	120sec

Stream duration may need to be changed if DUT may take longer time to detect link status change.

<DUT1 configuration>

Port	IPv4 address	IPv4 subnet mask
Client	150.0.0.2	255.255.255.0
MPLS	150.0.1.2	255.255.255.0
To DUT2	Real or simulated internet	

<DUT2 configuration>

Port	IPv4 address	IPv4 subnet mask
To DUT1	Real or simulated internet	
Internet	150.0.2.2	255.255.255.0

Proper policies must be applied to DUT to:

Spirent SD-WAN TestPack Specification

	<ul style="list-style-type: none"> Steer stream 1 and 3 towards Internet link and steer stream 2 and 4 towards MPLS link. If packet loss ratio of Internet link is > 2%, steer stream 1 and 3 to MPLS link. After Internet link packet loss ratio reduced to < 2%, steer stream 1 and 3 back to Internet link. <p>Link status detection method should be configured between client edge device (DUT1) and Internet edge device (DUT2) to detect packet loss.</p> <p><SNE configuration> SNE Idle traffic flow setting should be "Actively route traffic whilst unit is idle".</p>			
Test Sequence	Step	Type	Description	Expected Result
	1	Action	Perform ARP on all STC devices and all stream blocks	All ARPs are resolved successfully
	2	Action	Start traffic on all STC ports	All generators are started successfully
	3	Action	Impairment tool drop 5% packets	DUT detect the link failure, steer stream 1 and 3 to MPLS link
	4	Action	Wait for traffic to stop	All generators are stopped successfully
	5	Check	Record out of service time	
	6	Action	Start traffic on all STC ports	All generators are started successfully

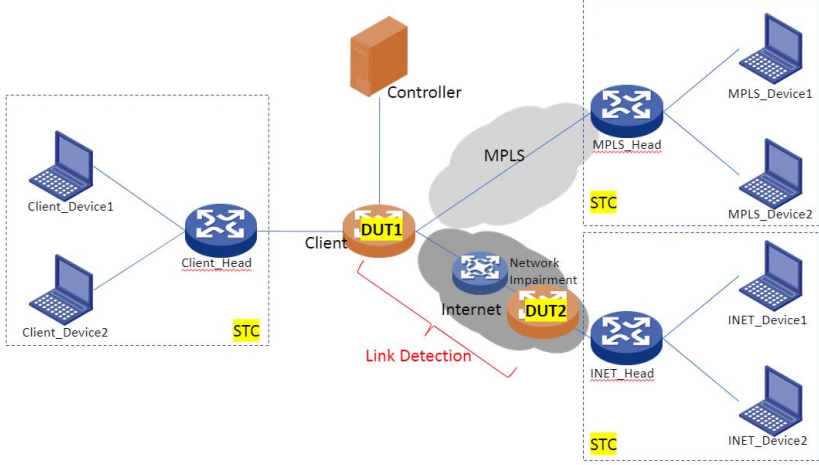
Spirent SD-WAN TestPack Specification

	7	Action	Stop impairment	DUT detect the packet loss ratio is below threshold, steer stream 1 and 3 back to Internet link
	8	Check	Record recovery time	
Result Content	1. STC Configuration 2. Script output 3. STC detailed results (get it by using “Save Results” command), result view “Stream Block Results”, “Stream Block Results” and “Port Traffic Results” must be included. 4. Out of service time and recovery time 5. STC logs (BLL/IL/Chassis) 6. DUT logs if possible			
Test Verdict	PASS criteria: stream 1 and 3 are correctly steered in link brownout and resume.			

SD-WAN_Resiliency_Link_Brownout_Packet_Delay

Test Case Name	SD-WAN_Resiliency_Link_Brownout_Packet_Delay
Test Case ID	sd-wan.resiliency_link.004
Test Area	Resiliency link brownout
Test Objective	Validate DUT can steer traffic from Internet link to MPLS link if two-way delay (from DUT1 to DUT2) on Internet link exceeds threshold and vice versa.
Test Type	Functional
Topology Type	3stc_1sne_2dut_type01

Spirent SD-WAN TestPack Specification

Topology																																									
Test Instrument	Spirent Test Center, Spirent Network Emulator																																								
Prerequisites	Connect Spirent Test Center (STC) and DUT as per test topology.																																								
Pre-Configuration	<div><STC configuration></div> <table><tr><th>Port</th><th>Device Block</th><th>IPv4 address</th><th>IPv4 subnet mask</th><th>Link</th></tr><tr><td>Client</td><td>Client_Head</td><td>150.0.0.1</td><td>255.255.255.0</td><td></td></tr><tr><td></td><td>Client_Device 1</td><td>101.0.0.1~101.0.0.100</td><td>255.255.255.0</td><td>L3 forwarding link to Client_Head</td></tr><tr><td></td><td>Client_Device 2</td><td>102.0.0.1~102.0.0.100</td><td>255.255.255.0</td><td>L3 forwarding link to Client_Head</td></tr><tr><td>MPLS</td><td>MPLS_Head</td><td>150.0.1.1</td><td>255.255.255.0</td><td></td></tr><tr><td></td><td>MPLS_Device 1</td><td>200.0.0.1~200.0.0.200</td><td>255.255.255.0</td><td>L3 forwarding link to MPLS_Head</td></tr><tr><td>Internet</td><td>INET_Head</td><td>150.0.2.1</td><td>255.255.255.0</td><td></td></tr><tr><td></td><td>INET_Device 1</td><td>200.0.0.1~200.0.0.200</td><td>255.255.255.0</td><td>L3 forwarding link to INET_Head</td></tr></table>	Port	Device Block	IPv4 address	IPv4 subnet mask	Link	Client	Client_Head	150.0.0.1	255.255.255.0			Client_Device 1	101.0.0.1~101.0.0.100	255.255.255.0	L3 forwarding link to Client_Head		Client_Device 2	102.0.0.1~102.0.0.100	255.255.255.0	L3 forwarding link to Client_Head	MPLS	MPLS_Head	150.0.1.1	255.255.255.0			MPLS_Device 1	200.0.0.1~200.0.0.200	255.255.255.0	L3 forwarding link to MPLS_Head	Internet	INET_Head	150.0.2.1	255.255.255.0			INET_Device 1	200.0.0.1~200.0.0.200	255.255.255.0	L3 forwarding link to INET_Head
Port	Device Block	IPv4 address	IPv4 subnet mask	Link																																					
Client	Client_Head	150.0.0.1	255.255.255.0																																						
	Client_Device 1	101.0.0.1~101.0.0.100	255.255.255.0	L3 forwarding link to Client_Head																																					
	Client_Device 2	102.0.0.1~102.0.0.100	255.255.255.0	L3 forwarding link to Client_Head																																					
MPLS	MPLS_Head	150.0.1.1	255.255.255.0																																						
	MPLS_Device 1	200.0.0.1~200.0.0.200	255.255.255.0	L3 forwarding link to MPLS_Head																																					
Internet	INET_Head	150.0.2.1	255.255.255.0																																						
	INET_Device 1	200.0.0.1~200.0.0.200	255.255.255.0	L3 forwarding link to INET_Head																																					

Spirent SD-WAN TestPack Specification

Stream	Source endpoint	Destination endpoint	Packet length	Protocol	Port number	Packet pattern	Traffic rate	Duration
1	Client_Device1	MPLS_Device1	512	TCP	80	Constant (0000)	1Mbps	Continuous
2	Client_Device2	MPLS_Device1	512	TCP	80	Constant (0000)	1Mbps	Continuous
3	Client_Device1	MPLS_Device1	512	UDP	50050 to 50098, even	Constant (0000)	1Mbps	Continuous
4	Client_Device2	MPLS_Device1	512	UDP	50050 to 50098, even	Constant (0000)	1Mbps	Continuous

Stream duration may need to be changed if DUT may take longer time to detect link status change.

<DUT1 configuration>

Port	IPv4 address	IPv4 subnet mask
Client	150.0.0.2	255.255.255.0
MPLS	150.0.1.2	255.255.255.0
To DUT2	Real or simulated internet	

<DUT2 configuration>

Port	IPv4 address	IPv4 subnet mask
To DUT1	Real or simulated internet	
Internet	150.0.2.2	255.255.255.0

Proper policies must be applied to DUT to:

- Steer stream 1 and 3 towards Internet link and steer stream 2 and 4 towards MPLS link.
- If one-way delay of Internet link is > 200ms, steer stream 1 and 3 to MPLS link.

Spirent SD-WAN TestPack Specification

	<ul style="list-style-type: none"> After Internet link one-way delay reduced to < 200ms, steer stream 1 and 3 back to Internet link. <p>Link status detection method should be configured between client edge device (DUT1) and Internet edge device (DUT2) to detect two-way delay.</p> <p><SNE configuration> SNE Idle traffic flow setting should be “Actively route traffic whilst unit is idle”.</p>			
Test Sequence	Step	Type	Description	Expected Result
	1	Action	Perform ARP on all STC devices and all stream blocks	All ARPs are resolved successfully
	2	Action	Start traffic on all STC ports	All generators are started successfully
	3	Action	Impairment tool increase latency to > 200ms	DUT detect the link failure, steer stream 1 and 3 to MPLS link
	4	Action	Stop traffic	All generators are stopped successfully
	5	Check	Record out of service time	
	6	Action	Start traffic on all STC ports	All generators are started successfully
	7	Action	Stop impairment	DUT detect packet delay is below threshold, steer stream 1 and 3 back to Internet link

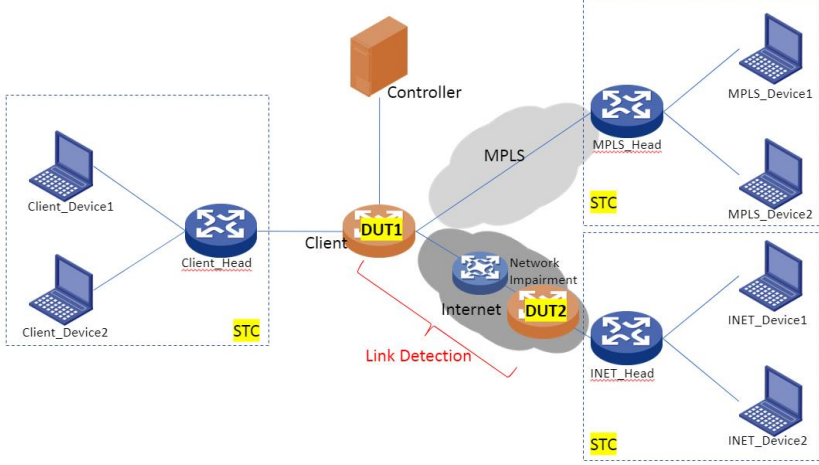
Spirent SD-WAN TestPack Specification

	8	Check	Record recovery time	
Result Content	<ol style="list-style-type: none"> 1. STC Configuration 2. Script output 3. STC detailed results (get it by using “Save Results” command), result view “Stream Block Results”, “Stream Block Results” and “Port Traffic Results” must be included. 4. Out of service time and recovery time 5. STC logs (BLL/IL/Chassis) 6. DUT logs if possible 			
Test Verdict	PASS criteria: stream 1 and 3 are correctly steered in link brownout and resume.			

SD-WAN_Resiliency_Link_Brownout_Jitter

Test Case Name	SD-WAN_Resiliency_Link_Brownout_Jitter
Test Case ID	sd-wan.resiliency_link.005
Test Area	Resiliency link brownout
Test Objective	Validate DUT can steer traffic from Internet link to MPLS link if jitter on Internet link exceeds threshold and vice versa.
Test Type	Functional
Topology Type	3stc_1sne_2dut_type01

Spirent SD-WAN TestPack Specification

Topology																																									
Test Instrument	Spirent Test Center, Spirent Network Emulator																																								
Prerequisites	Connect Spirent Test Center (STC) and DUT as per test topology.																																								
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Spirent SD-WAN TestPack Specification

Stream	Source endpoint	Destination endpoint	Packet length	Protocol	port number	Packet pattern	Traffic rate	Duration
1	Client_Device1	MPLS_Device1	512	TCP	80	Constant (0000)	1Mbps	Continuous
2	Client_Device2	MPLS_Device1	512	TCP	80	Constant (0000)	1Mbps	Continuous
3	Client_Device1	MPLS_Device1	512	UDP	50050 to 50098, even	Constant (0000)	1Mbps	Continuous
4	Client_Device2	MPLS_Device1	512	UDP	50050 to 50098, even	Constant (0000)	1Mbps	Continuous

Stream duration may need to be changed if DUT may take longer time to detect link status change.

<DUT1 configuration>

Port	IPv4 address	IPv4 subnet mask
Client	150.0.0.2	255.255.255.0
MPLS	150.0.1.2	255.255.255.0
To DUT2	Real or simulated internet	

<DUT2 configuration>

Port	IPv4 address	IPv4 subnet mask
To DUT1	Real or simulated internet	
Internet	150.0.2.2	255.255.255.0

Proper policies must be applied to DUT to:

- Steer stream 1 and 3 towards Internet link and steer stream 2 and 4 towards MPLS link.
- If jitter of Internet link is > 50ms, steer stream 1 and 3 to MPLS link.

Spirent SD-WAN TestPack Specification

	<ul style="list-style-type: none"> After Internet link jitter reduced to < 50ms, steer stream 1 and 3 back to Internet link. <p>Link status detection method should be configured between client edge device (DUT1) and Internet edge device (DUT2) to detect jitter.</p> <p><SNE configuration> SNE Idle traffic flow setting should be “Actively route traffic whilst unit is idle”.</p>			
Test Sequence	Step	Type	Description	Expected Result
	1	Action	Perform ARP on all STC devices and all stream blocks	All ARPs are resolved successfully
	2	Action	Start traffic on all STC ports	All generators are started successfully
	3	Action	Impairment tool increase jitter to > 50ms	DUT detect the link failure, steer stream 1 and 3 to MPLS link
	4	Action	Stop traffic	All generators are stopped successfully
	5	Check	Record out of service time	
	6	Action	Start traffic on all STC ports	All generators are started successfully
	7	Action	Stop impairment	DUT detect the jitter is below threshold, steer stream 1 and 3 back to Internet link

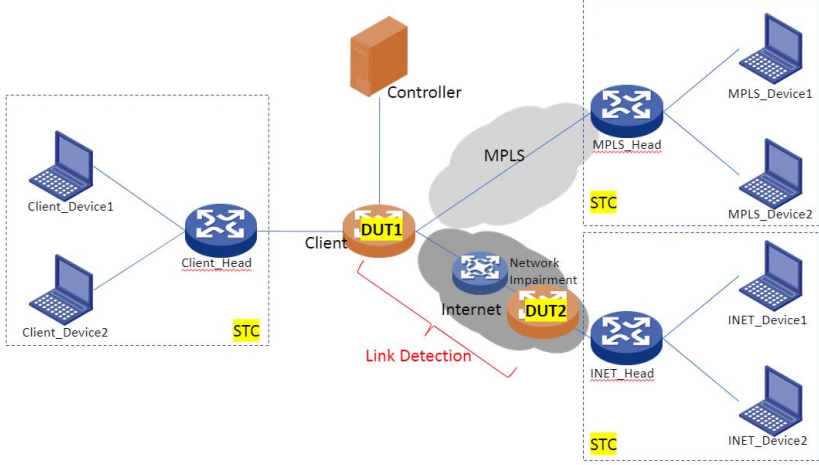
Spirent SD-WAN TestPack Specification

	8	Check	Record recovery time	
Result Content	<ol style="list-style-type: none"> 1. STC Configuration 2. STC detailed results (get it by using “Save Results” command), result view “Stream Block Results”, “Stream Block Results” and “Port Traffic Results” must be included. 3. Out of service time and recovery time 4. STC logs (BLL/IL/Chassis) 5. DUT logs if possible 			
Test Verdict	PASS criteria: stream 1 and 3 are correctly steered in link brownout and resume.			

SD-WAN_Resiliency_Link_Brownout_Packet_Out_Of_Order

Test Case Name	SD-WAN_Resiliency_Link_Brownout_Packet_Out_Of_Order
Test Case ID	sd-wan.resiliency_link.006
Test Area	Resiliency link brownout
Test Objective	Validate DUT can steer traffic from Internet link to MPLS link if packet out-of-order ratio on Internet link exceeds threshold and vice versa.
Test Type	Functional
Topology Type	3stc_1sne_2dut_type01

Spirent SD-WAN TestPack Specification

Topology																																									
Test Instrument	Spirent Test Center, Spirent Network Emulator																																								
Prerequisites	Connect Spirent Test Center (STC) and DUT as per test topology.																																								
Pre-Configuration	<div><STC configuration></div> <table><tr><th>Port</th><th>Device Block</th><th>IPv4 address</th><th>IPv4 subnet mask</th><th>Link</th></tr><tr><td>Client</td><td>Client_Head</td><td>150.0.0.1</td><td>255.255.255.0</td><td></td></tr><tr><td></td><td>Client_Device 1</td><td>101.0.0.1~101.0.0.100</td><td>255.255.255.0</td><td>L3 forwarding link to Client_Head</td></tr><tr><td></td><td>Client_Device 2</td><td>102.0.0.1~102.0.0.100</td><td>255.255.255.0</td><td>L3 forwarding link to Client_Head</td></tr><tr><td>MPLS</td><td>MPLS_Head</td><td>150.0.1.1</td><td>255.255.255.0</td><td></td></tr><tr><td></td><td>MPLS_Device 1</td><td>200.0.0.1~200.0.0.200</td><td>255.255.255.0</td><td>L3 forwarding link to MPLS_Head</td></tr><tr><td>Internet</td><td>INET_Head</td><td>150.0.2.1</td><td>255.255.255.0</td><td></td></tr><tr><td></td><td>INET_Device 1</td><td>200.0.0.1~200.0.0.200</td><td>255.255.255.0</td><td>L3 forwarding link to INET_Head</td></tr></table>	Port	Device Block	IPv4 address	IPv4 subnet mask	Link	Client	Client_Head	150.0.0.1	255.255.255.0			Client_Device 1	101.0.0.1~101.0.0.100	255.255.255.0	L3 forwarding link to Client_Head		Client_Device 2	102.0.0.1~102.0.0.100	255.255.255.0	L3 forwarding link to Client_Head	MPLS	MPLS_Head	150.0.1.1	255.255.255.0			MPLS_Device 1	200.0.0.1~200.0.0.200	255.255.255.0	L3 forwarding link to MPLS_Head	Internet	INET_Head	150.0.2.1	255.255.255.0			INET_Device 1	200.0.0.1~200.0.0.200	255.255.255.0	L3 forwarding link to INET_Head
Port	Device Block	IPv4 address	IPv4 subnet mask	Link																																					
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Spirent SD-WAN TestPack Specification

Stream	Source endpoint	Destination endpoint	Packet length	Protocol	Port number	Packet pattern	Traffic rate	Duration
1	Client_Device1	MPLS_Device1	512	TCP	80	Constant (0000)	1Mbps	Continuous
2	Client_Device2	MPLS_Device1	512	TCP	80	Constant (0000)	1Mbps	Continuous
3	Client_Device1	MPLS_Device1	512	UDP	50050 to 50098, even	Constant (0000)	1Mbps	Continuous
4	Client_Device2	MPLS_Device1	512	UDP	50050 to 50098, even	Constant (0000)	1Mbps	Continuous

Stream duration may need to be changed if DUT may take longer time to detect link status change.

<DUT1 configuration>

Port	IPv4 address	IPv4 subnet mask
Client	150.0.0.2	255.255.255.0
MPLS	150.0.1.2	255.255.255.0
To DUT2	Real or simulated internet	

<DUT2 configuration>

Port	IPv4 address	IPv4 subnet mask
To DUT1	Real or simulated internet	
Internet	150.0.2.2	255.255.255.0

Proper policies must be applied to DUT to:

- Steer stream 1 and 3 towards Internet link and steer stream 2 and 4 towards MPLS link.
- If packet out-of-order ratio of Internet link is > 5%, steer stream 1 and 3 to MPLS link.

Spirent SD-WAN TestPack Specification

	<ul style="list-style-type: none"> After Internet packet out-of-order ratio reduced to < 5%, steer stream 1 and 3 back to Internet link. <p>Link status detection method should be configured between client edge device (DUT1) and Internet edge device (DUT2) to packet out-of-order.</p> <p><SNE configuration> SNE Idle traffic flow setting should be “Actively route traffic whilst unit is idle”.</p>			
Test Sequence	Step	Type	Description	Expected Result
	1	Action	Perform ARP on all STC devices and all stream blocks	All ARPs are resolved successfully
	2	Action	Start traffic on all STC ports	All generators are started successfully
	3	Action	Impairment tool introduce > 5% packet reordering	DUT detect the link failure, steer stream 1 and 3 to MPLS link
	4	Action	Stop traffic	All generators are stopped successfully
	5	Check	Record out of service time	
	6	Action	Start traffic on all STC ports	All generators are started successfully
	7	Action	Stop impairment	DUT detect packet out-of-order ratio is below threshold, steer

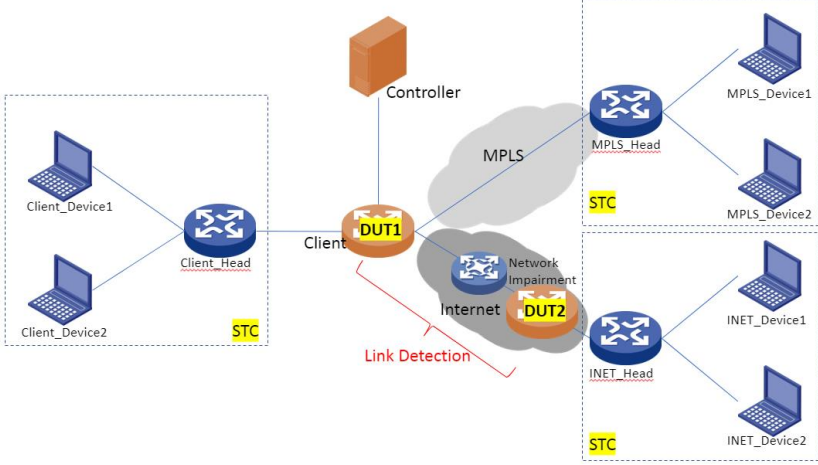
Spirent SD-WAN TestPack Specification

				stream 1 and 3 back to Internet link
	8	Check	Record recovery time	
Result Content	<ol style="list-style-type: none"> 1. STC Configuration 2. Script output 3. STC detailed results (get it by using “Save Results” command), result view “Stream Block Results”, “Stream Block Results” and “Port Traffic Results” must be included. 4. Out of service time and recovery time 5. STC logs (BLL/IL/Chassis) 6. DUT logs if possible 			
Test Verdict	PASS criteria: stream 1 and 3 are correctly steered in link brownout and resume.			

SD-WAN_Resiliency_Link_Brownout_Packet_Duplication

Test Case Name	SD-WAN_Resiliency_Link_Brownout_Duplication
Test Case ID	sd-wan.resiliency_link.007
Test Area	Resiliency link brownout
Test Objective	Validate DUT can steer traffic from Internet link to MPLS link if packet duplication ratio on Internet link exceeds threshold and vice versa.
Test Type	Functional
Topology Type	3stc_1sne_2dut_type01

Spirent SD-WAN TestPack Specification

Topology																																									
Test Instrument	Spirent Test Center, Spirent Network Emulator																																								
Prerequisites	Connect Spirent Test Center (STC) and DUT as per test topology.																																								
Pre-Configuration	<div><STC configuration></div> <table><tr><th>Port</th><th>Device Block</th><th>IPv4 address</th><th>IPv4 subnet mask</th><th>Link</th></tr><tr><td>Client</td><td>Client_Head</td><td>150.0.0.1</td><td>255.255.255.0</td><td></td></tr><tr><td></td><td>Client_Device 1</td><td>101.0.0.1~101.0.0.100</td><td>255.255.255.0</td><td>L3 forwarding link to Client_Head</td></tr><tr><td></td><td>Client_Device 2</td><td>102.0.0.1~102.0.0.100</td><td>255.255.255.0</td><td>L3 forwarding link to Client_Head</td></tr><tr><td>MPLS</td><td>MPLS_Head</td><td>150.0.1.1</td><td>255.255.255.0</td><td></td></tr><tr><td></td><td>MPLS_Device 1</td><td>200.0.0.1~200.0.0.200</td><td>255.255.255.0</td><td>L3 forwarding link to MPLS_Head</td></tr><tr><td>Internet</td><td>INET_Head</td><td>150.0.2.1</td><td>255.255.255.0</td><td></td></tr><tr><td></td><td>INET_Device 1</td><td>200.0.0.1~200.0.0.200</td><td>255.255.255.0</td><td>L3 forwarding link to INET_Head</td></tr></table>	Port	Device Block	IPv4 address	IPv4 subnet mask	Link	Client	Client_Head	150.0.0.1	255.255.255.0			Client_Device 1	101.0.0.1~101.0.0.100	255.255.255.0	L3 forwarding link to Client_Head		Client_Device 2	102.0.0.1~102.0.0.100	255.255.255.0	L3 forwarding link to Client_Head	MPLS	MPLS_Head	150.0.1.1	255.255.255.0			MPLS_Device 1	200.0.0.1~200.0.0.200	255.255.255.0	L3 forwarding link to MPLS_Head	Internet	INET_Head	150.0.2.1	255.255.255.0			INET_Device 1	200.0.0.1~200.0.0.200	255.255.255.0	L3 forwarding link to INET_Head
Port	Device Block	IPv4 address	IPv4 subnet mask	Link																																					
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Spirent SD-WAN TestPack Specification

Stream	Source endpoint	Destination endpoint	Packet length	Protocol	Port number	Packet pattern	Traffic rate	Duration
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2	Client_Device2	MPLS_Device1	512	TCP	80	Constant (0000)	1Mbps	Continuous
3	Client_Device1	MPLS_Device1	512	UDP	50050 to 50098, even	Constant (0000)	1Mbps	Continuous
4	Client_Device2	MPLS_Device1	512	UDP	50050 to 50098, even	Constant (0000)	1Mbps	Continuous

Stream duration may need to be changed if DUT may take longer time to detect link status change.

<DUT1 configuration>

Port	IPv4 address	IPv4 subnet mask
Client	150.0.0.2	255.255.255.0
MPLS	150.0.1.2	255.255.255.0
To DUT2	Real or simulated internet	

<DUT2 configuration>

Port	IPv4 address	IPv4 subnet mask
To DUT1	Real or simulated internet	
Internet	150.0.2.2	255.255.255.0

Proper policies must be applied to DUT to:

- Steer stream 1 and 3 towards Internet link and steer stream 2 and 4 towards MPLS link.
- If packet duplication ratio of Internet link is > 5%, steer stream 1 and 3 to MPLS link.

Spirent SD-WAN TestPack Specification

	<ul style="list-style-type: none"> After Internet packet duplication ratio reduced to < 5%, steer stream 1 and 3 back to Internet link. <p>Link status detection method should be configured between client edge device (DUT1) and Internet edge device (DUT2) to packet duplication.</p> <p><SNE configuration> SNE Idle traffic flow setting should be “Actively route traffic whilst unit is idle”.</p>			
Test Sequence	Step	Type	Description	Expected Result
	1	Action	Perform ARP on all STC devices and all stream blocks	All ARPs are resolved successfully
	2	Action	Start traffic on all STC ports	All generators are started successfully
	3	Action	Impairment tool introduce 100% packet duplication (Simple duplication mode in SNE)	DUT detect the link failure, steer stream 1 and 3 to MPLS link
	4	Action	Stop traffic	All generators are stopped successfully
	5	Check	Record out of service time	
	6	Action	Start traffic on all STC ports	All generators are started successfully

Spirent SD-WAN TestPack Specification

	7	Action	Stop impairment	DUT detect packet duplication ratio is below threshold, steer stream 1 and 3 back to Internet link
	8	Check	Record recovery time	
Result Content	<ol style="list-style-type: none"> 1. STC Configuration 2. Script output 3. STC detailed results (get it by using "Save Results" command), result view "Stream Block Results", "Stream Block Results" and "Port Traffic Results" must be included. 4. Out of service time and recovery time 5. STC logs (BLL/IL/Chassis) 6. DUT logs if possible 			
Test Verdict	PASS criteria: stream 1 and 3 are correctly steered in link brownout and resume.			

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