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”

Spirent SD-WAN TestPack Specification

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Spirent SD-WAN TestPack Specification

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	• Path Selection

Spirent SD-WAN TestPack Specification

	• 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)

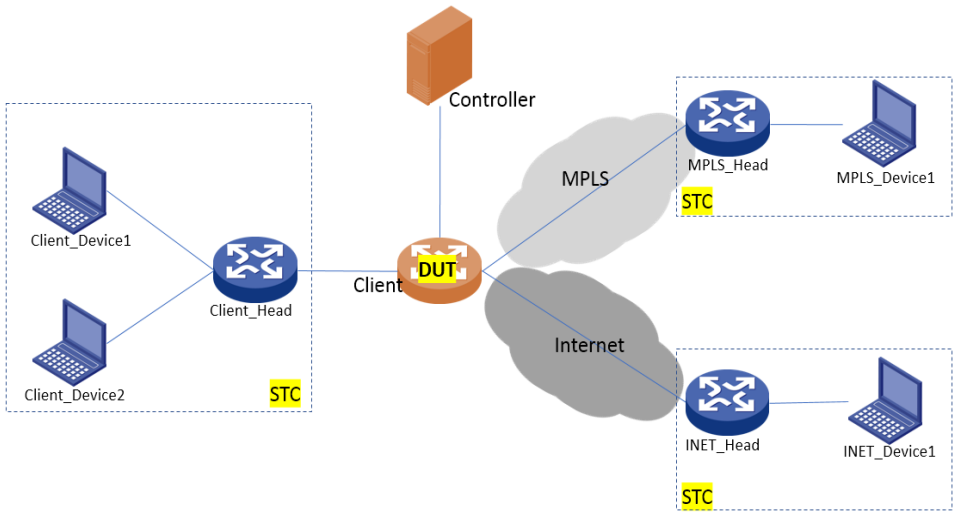
Test Case Specification

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

Spirent SD-WAN TestPack Specification

Topology



Test Instrument

Spirent Test Center

Prerequisites

Connect Spirent Test Center (STC) and DUT as per test topology.

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_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	
	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	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

<DUT 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
Internet	150.0.2.2	255.255.255.0

Proper policies must be applied to DUT to steer stream 1, 4, 5, 7 towards Internet link and steer stream 2, 3, 6 ,8 towards MPLS 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

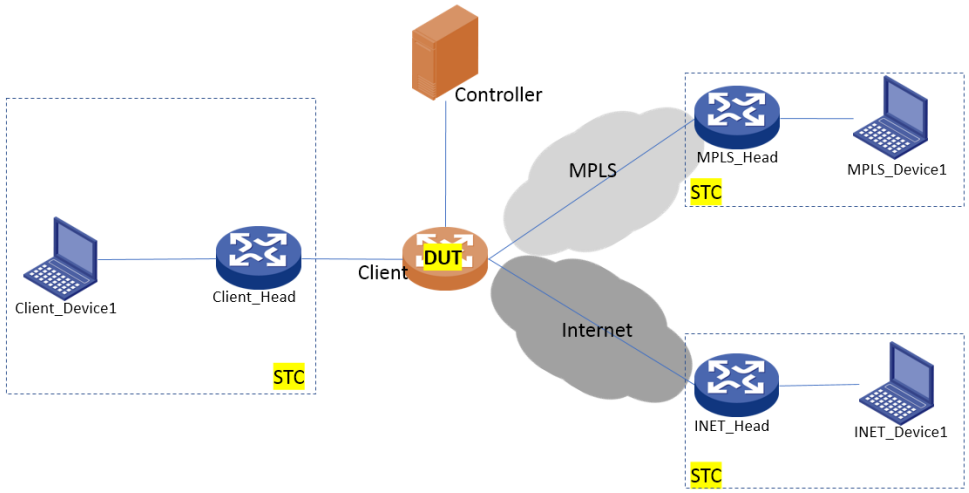
Spirent SD-WAN TestPack Specification

	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.			

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

Spirent SD-WAN TestPack Specification

<table>
<tr><td>Test Area</td><td>Path Selection</td></tr>
<tr><td>Test Objective</td><td>Validate DUT can steer traffic among WAN links by using application aware traffic classification method.</td></tr>
<tr><td>Test Type</td><td>Functional</td></tr>
<tr><td>Topology</td><td> 
</td></tr>
<tr><td>Test Instrument</td><td>Spirent Test Center</td></tr>
<tr><td>Prerequisites</td><td>Connect Spirent Test Center (STC) and DUT as per test topology.</td></tr>
<tr><td>Pre-Configuration</td><td><STC configuration>
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<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>101.0.0.1~101.0.0.10</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>
</table></td></tr>
</table>

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	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_Device1	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. Transcations 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
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

Spirent SD-WAN TestPack Specification

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:

Lode 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	Repetitions	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>

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 application aware policies must be applied to DUT to steer HTTP traffic towards Internet link and steer SIP/RTP/RTCP traffic towards MPLS link.

Spirent SD-WAN TestPack Specification

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 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

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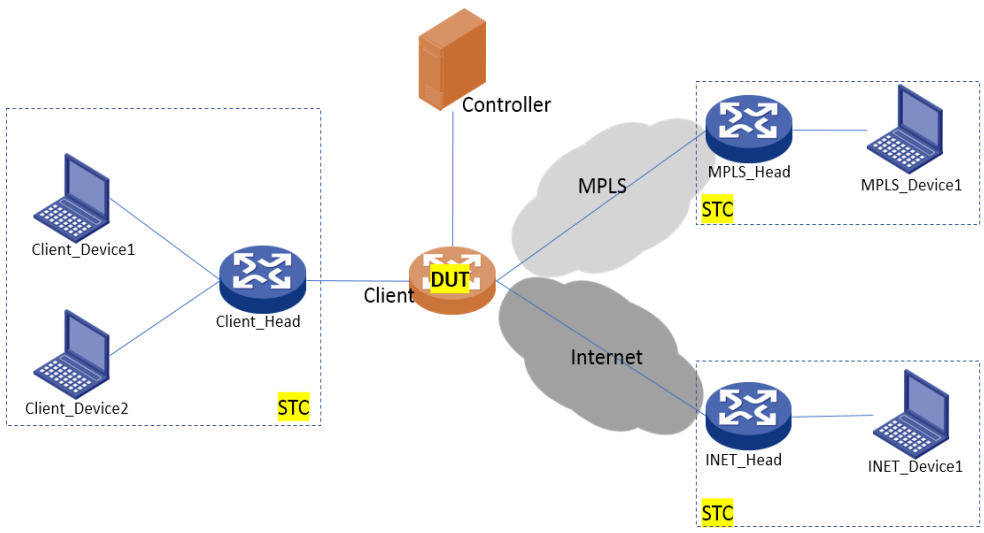
	8	Check	Check SIP related results	a. All SIP calls are finished without failure, Call Success Percentage should be 100% b. All SIP calls (including SIP/RTP/RTCP) are targeted to MPLS_Device1 c. No packet loss.
Result Content	1. STC Configuration 2. Script output 3. STC detailed results (get it by using “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.			

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_blackout.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 Internet link and vice versa.
Test Type	Functional

Spirent SD-WAN TestPack Specification

Topology



Test Instrument

Spirent Test Center

Prerequisites

Connect Spirent Test Center (STC) and DUT as per test topology.

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_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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	INET_Device1	200.0.0.1~200.0.0.200	255.255.255.0	L3 forwarding link to INET_Head

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.

<DUT 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
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 Internet link down is detected by DUT, DUT should steer stream 1 and 3 to MPLS link
- After Internet link resume, stream 1 and 3 should be steered back to Internet link

Spirent SD-WAN TestPack Specification

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	
	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	1. STC Configuration 2. Script output			

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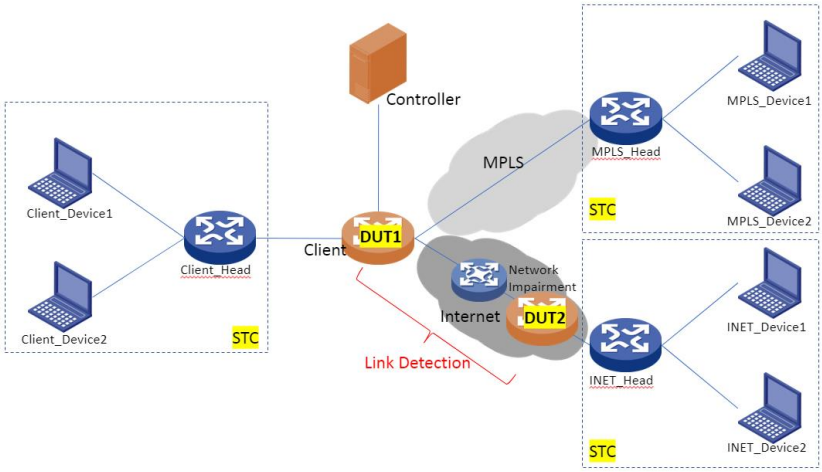
	3. STC detailed results (get it by using “Save Results” command), result view “Stream Block Results”, “Stream Block Results” and “Port Traffic Results” must be included. 4. Out of service time and recovery time 5. STC logs (BLL/IL/Chassis) 6. DUT logs if possible
Test Verdict	PASS criteria: stream 1 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_blackout.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 Internet link and vice versa.
Test Type	Functional

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

<STC configuration>

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	
	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	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 DUT1 to:

- 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.

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	Link status detection method (such as BFD) should be configured between client edge device (DUT1) and Internet edge device (DUT2) to detect link failure. **<SNE configuration>** SNE Idle traffic flow setting should be “Actively route traffic whilst unit is idle”.			
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: Bring STC facing port down or 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	
	6	Action	Start traffic on all STC ports	All generators are started successfully

Spirent SD-WAN TestPack Specification

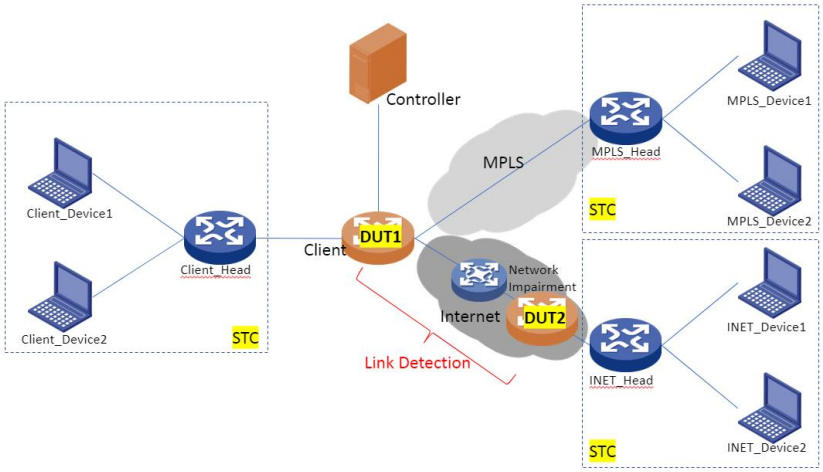
	7	Action	Impairment tool bring STC facing port up and/or stop impairment	DUT detect the link is up, steer stream 1 and 3 back to Internet link
	8	Check	Record recovery time	
Result Content	1. STC Configuration 2. Script output 3. STC detailed results (get it by using “Save Results” command), result view “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 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_brownout.001
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 exceed threshold and vice versa.
Test Type	Functional

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

<STC configuration>

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	
	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:

- 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.

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	• After Internet link packet loss ratio reduced to < 2%, steer stream 1 and 3 back to Internet link. Link status detection method should be configured between client edge device (DUT1) and Internet edge device (DUT2) to detect packet loss. **<SNE configuration>** SNE Idle traffic flow setting should be “Actively route traffic whilst unit is idle”.			
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 3% 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
	7	Action	Stop impairment	DUT detect the packet loss ratio is below threshold, steer stream 1 and 3 back to Internet link

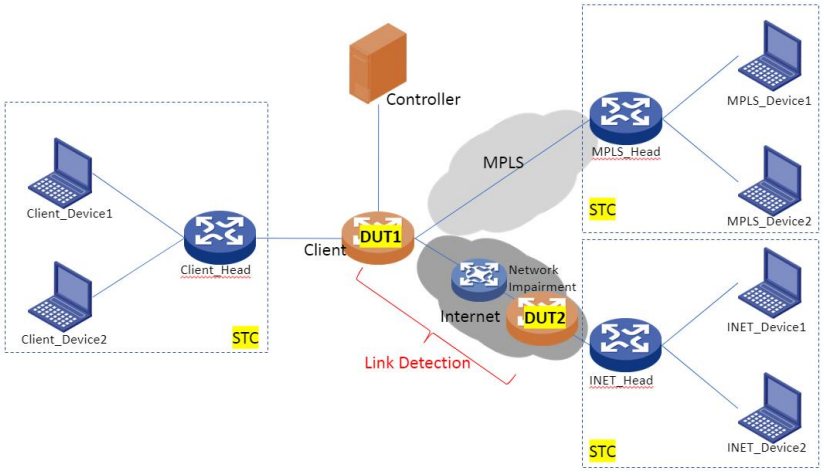
Spirent SD-WAN TestPack Specification

	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_brownout.002
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 exceed threshold and vice versa.
Test Type	Functional

Spirent SD-WAN TestPack Specification

<table>
<tr><td>Topology</td><td> 
</td></tr>
<tr><td>Test Instrument</td><td>Spirent Test Center, Spirent Network Emulator</td></tr>
<tr><td>Prerequisites</td><td>Connect Spirent Test Center (STC) and DUT as per test topology.</td></tr>
<tr><td>Pre-Configuration</td><td><STC configuration>
<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_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>
<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></td></tr>
</table>

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

	• After Internet link one-way delay reduced to < 200ms, steer stream 1 and 3 back to Internet link. Link status detection method should be configured between client edge device (DUT1) and Internet edge device (DUT2) to detect two-way delay. **<SNE configuration>** SNE Idle traffic flow setting should be “Actively route traffic whilst unit is idle”.			
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

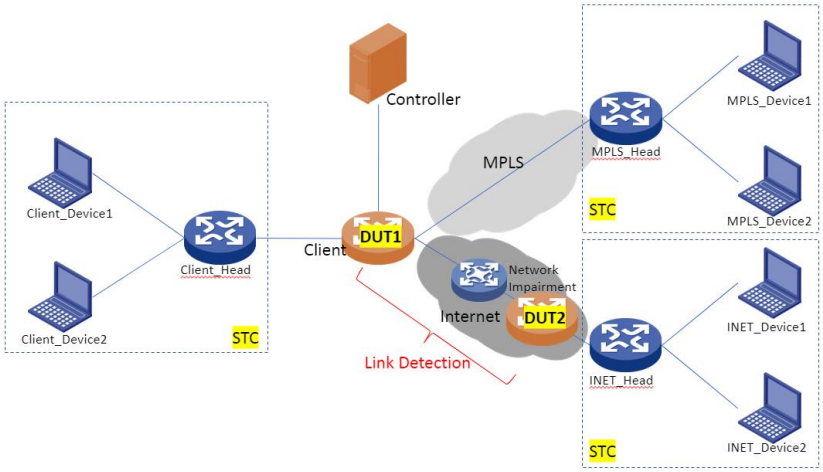
	8	Check	Record recovery time	
Result Content	1. STC Configuration 2. Script output 3. STC detailed results (get it by using “Save Results” command), result view “Stream Block Results”, “Stream Block Results” and “Port Traffic Results” must be included. 4. Out of service time and recovery time 5. STC 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_brownout.003
Test Area	Resiliency link brownout
Test Objective	Validate DUT can steer traffic from Internet link to MPLS link if jitter on Internet link exceed threshold and vice versa.
Test Type	Functional

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

<STC configuration>

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	
	INET_Device1	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 jitter of Internet link is > 50ms, steer stream 1 and 3 to MPLS link.

Spirent SD-WAN TestPack Specification

	• After Internet link jitter reduced to < 50ms, steer stream 1 and 3 back to Internet link. Link status detection method should be configured between client edge device (DUT1) and Internet edge device (DUT2) to detect jitter. **<SNE configuration>** SNE Idle traffic flow setting should be “Actively route traffic whilst unit is idle”.			
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 link is up, steer stream 1 and 3 back to Internet link

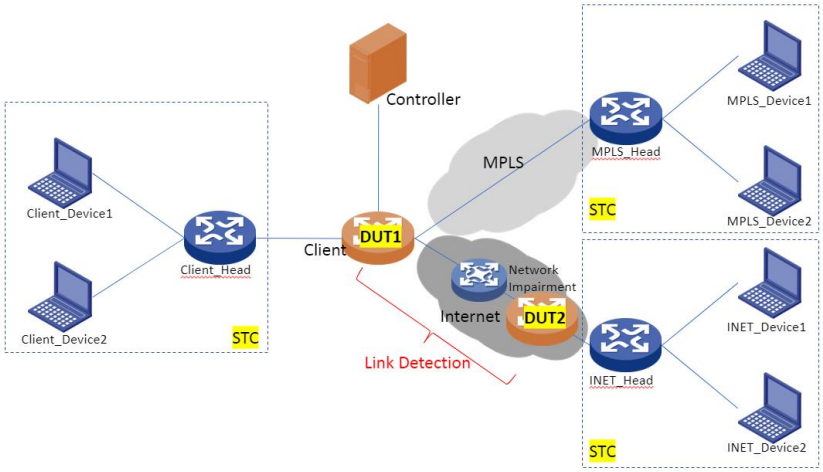
Spirent SD-WAN TestPack Specification

	8	Check	Record recovery time	
Result Content	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_Out-of-order
Test Case ID	sd-wan.resiliency_link_brownout.004
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 exceed threshold and vice versa.
Test Type	Functional

Spirent SD-WAN TestPack Specification

<table>
<tr><td>Topology</td><td> 
</td></tr>
<tr><td>Test Instrument</td><td>Spirent Test Center, Spirent Network Emulator</td></tr>
<tr><td>Prerequisites</td><td>Connect Spirent Test Center (STC) and DUT as per test topology.</td></tr>
<tr><td>Pre-Configuration</td><td><STC configuration>
<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_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>
<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></td></tr>
</table>

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

	• After Internet packet out-of-order ratio reduced to < 5%, steer stream 1 and 3 back to Internet link. Link status detection method should be configured between client edge device (DUT1) and Internet edge device (DUT2) to packet out-of-order. **<SNE configuration>** SNE Idle traffic flow setting should be “Actively route traffic whilst unit is idle”.			
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

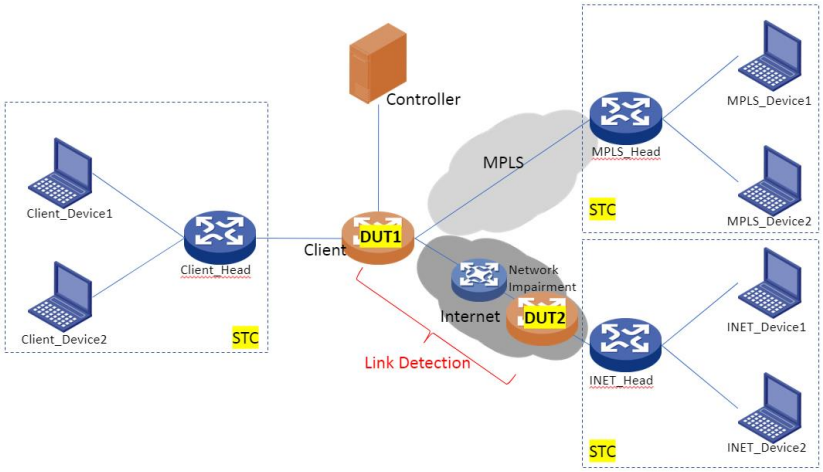
				stream 1 and 3 back to Internet link
	8	Check	Record recovery time	
Result Content	1. STC Configuration 2. Script output 3. STC detailed results (get it by using “Save Results” command), result view “Stream Block Results”, “Stream Block Results” and “Port Traffic Results” must be included. 4. Out of 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_brownout.005
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 exceed threshold and vice versa.
Test Type	Functional

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

<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	101.0.0.1~101.0.0.100	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_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	
	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 packet duplication ratio of Internet link is > 5%, steer stream 1 and 3 to MPLS link.

Spirent SD-WAN TestPack Specification

	• After Internet packet duplication ratio reduced to < 5%, steer stream 1 and 3 back to Internet link. Link status detection method should be configured between client edge device (DUT1) and Internet edge device (DUT2) to packet duplication. **<SNE configuration>** SNE Idle traffic flow setting should be “Actively route traffic whilst unit is idle”.			
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 duplication	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 duplication 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	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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