Spirent SD-WAN Functional Test Suite Specification

Spirent SD-WAN Functional Test Suite Specification

Table of Contents

Spirent SD-WAN Functional Test Suite 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.

SD-WAN Functional Test Suite

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 functional 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 Functional Test Suite 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 Suite Name	Spirent SD-WAN Functional Test Suite
Test Areas	• Path Selection

Spirent SD-WAN Functional Test Suite Specification

	• Resiliency -- Link Blackout • Resiliency -- Link Brownout
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	SD-WAN router, virtual appliance and SDN controller
Test Instrument	Spirent Test Center (STC), Spirent Network Emulator (SNE)

Test Configuration

STC Configuration

Device configuration #1

Port	Device Block	Device Count	IPv4 address	IPv4 prefix length	Link
Client	Client_Head	1	150.0.0.1	24	
	Client_Device1	100	101.0.0.1 to 101.0.0.100	24	L3 forwarding link to Client_Head
	Client_Device2	100	102.0.0.1 to 102.0.0.100	24	L3 forwarding link to Client_Head
MPLS	MPLS_Head	1	150.0.1.1	24	
	MPLS_Device1	200	200.0.0.1 to 200.0.0.200	24	L3 forwarding link to MPLS_Head
Internet	INET_Head	1	150.0.2.1	24	
	INET_Device1	200	200.0.0.1 to 200.0.0.200	24	L3 forwarding link to INET_Head

Device configuration #2

Port	Device Block	Device Count	IPv4 address	IPv4 prefix length	Link

Spirent SD-WAN Functional Test Suite Specification

Client	Client_Head	1	150.0.0.1	24	
	Client_Device1	10	101.0.0.1 to 101.0.0.10	24	L3 forwarding link to Client_Head
	Client_Device2	10	102.0.0.1 to 102.0.0.10	24	L3 forwarding link to Client_Head
MPLS	MPLS_Head	1	150.0.1.1	24	
	MPLS_Device1	20	200.0.0.1 to 200.0.0.20	24	L3 forwarding link to MPLS_Head
Internet	INET_Head	1	150.0.2.1	24	
	INET_Device1	20	200.0.0.1 to 200.0.0.20	24	L3 forwarding link to INET_Head

Stream configuration #1

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

Stream configuration #2

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

HTTP Client load profile #1

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

Spirent SD-WAN Functional Test Suite Specification

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

SIP load profile #1

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

SUT Configuration

SD-WAN edge device configuration #1

SD-WAN edge

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

SD-WAN edge device configuration #2

SD-WAN edge 1

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 SD-WAN edge 2	Real or simulated internet	
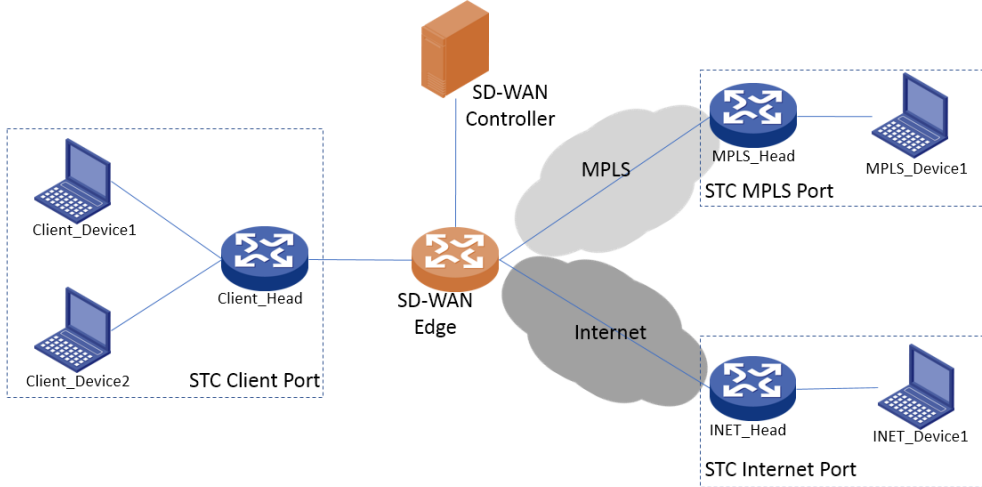
SD-WAN edge 2

Port	IPv4 address	IPv4 subnet mask
To SD-WAN edge 1	Real or simulated internet	
Internet	150.0.2.2	255.255.255.0

Test Case Specification

Spirent SD-WAN Functional Test Suite 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
Topology Name	3stc_1dut_type01
Topology	
Test Instrument	Spirent Test Center
Prerequisites	Connect Spirent Test Center (STC) and DUT as per test topology.

Spirent SD-WAN Functional Test Suite Specification

Pre-Configuration				

Pre-Configuration	**\<STC Configuration\>**
	  Device: Device configuration #1
	  Stream: Stream configuration #1
	\<SUT Configuration\>
	  SD-WAN edge: SD-WAN edge device configuration #1
	  SD-WAN Controller:
	    Proper policies must be applied to SD-WAN edge to steer stream 1, 4, 5, 7 towards Internet link and steer stream 2, 3, 6 ,8 towards MPLS link.			

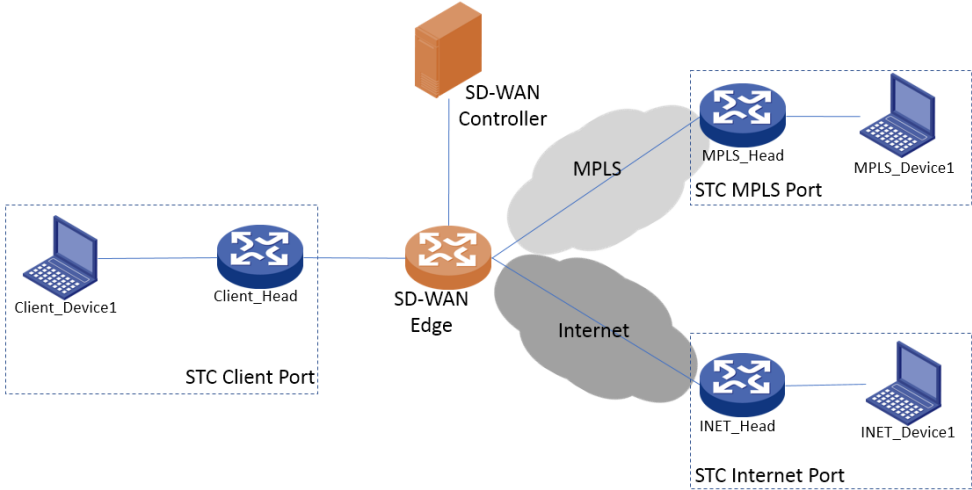| Test Sequence	Step	Type	Description	Expected Result
	1	Action	Perform ARP on all STC devices and all stream blocks	All ARPs are resolved successfully
	2	Action	Start traffic on all STC ports	All generators are started successfully
	3	Action	Wait for traffic to stop	All generators are stopped successfully
	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

Spirent SD-WAN Functional Test Suite Specification

Results and Outputs	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
PASS/FAIL Criteria	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
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

Spirent SD-WAN Functional Test Suite Specification

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

Pre-Configuration	**<STC Configuration>**
	Device: Device configuration #2
	HTTP client on Client_Device1:
	    Connected Server: MPLS_Device1
	    Client HTTP Profile: default profile
	    Client Load Profile: HTTP Client load profile #1
	HTTP Server on MPLS_Device1 and INET_Device1
	    Max Requests per Client: 10
	    Max Simultaneous Clients: 4294967295
	    Server HTTP Profile: default profile
	SIP Caller on Client_Device1
	    Callee Side: MPLS_Device1
	    SIP UA Client Profile: default profile
	    SIP Load Profile: SIP load profile #1
	Configure SIP Callee on MPLS_Device1 and INET_Device1
	    SIP UA Client Profile: default profile
	    UA number format on the two devices must be identical.

Spirent SD-WAN Functional Test Suite Specification

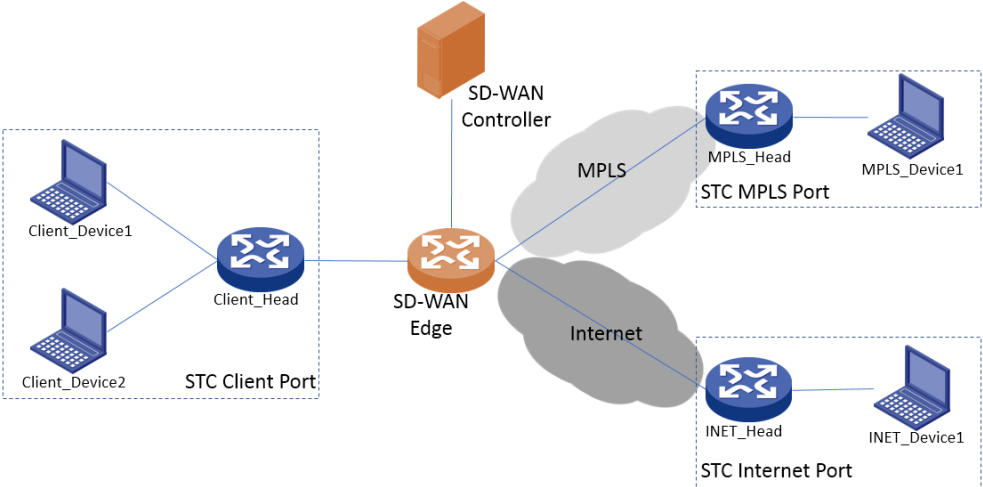|				
	<SUT Configuration> SD-WAN edge: SD-WAN edge device configuration #1 SD-WAN Controller: Proper application aware policies must be applied to SD-WAN edge to steer HTTP traffic towards Internet link and steer SIP/RTP/RTCP traffic towards MPLS link.			
Test Sequence	**Step**	**Type**	**Description**	**Expected Result**
	1	Action	Perform ARP on all STC devices and all stream blocks	All ARPs are resolved successfully
	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

Spirent SD-WAN Functional Test Suite Specification

	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.
Results and Outputs	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			
PASS/FAIL Criteria	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.001

Spirent SD-WAN Functional Test Suite Specification

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

Pre-Configuration	**<STC Configuration>**
	    Device: Device configuration #1
	    Stream: Stream configuration #2
	<SUT Configuration>
	    SD-WAN edge: SD-WAN edge device configuration #1

Spirent SD-WAN Functional Test Suite Specification

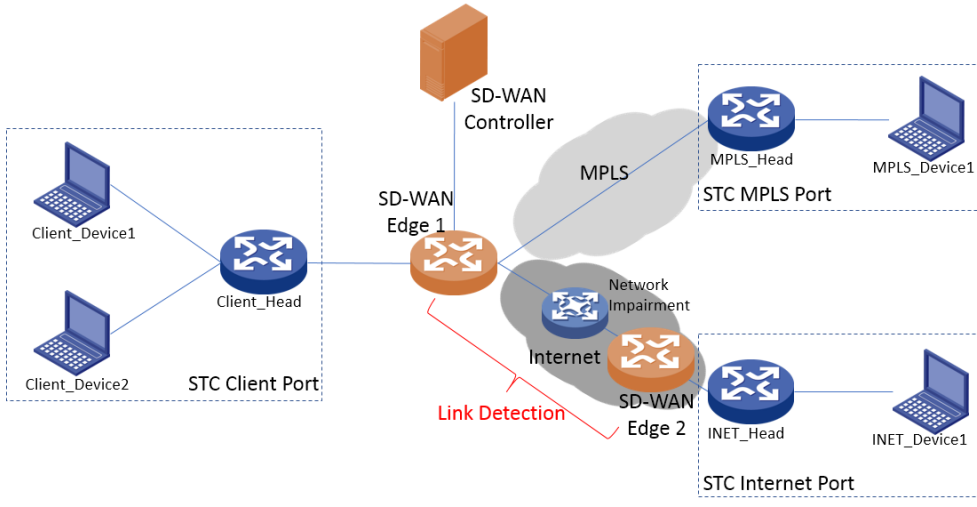|				
	SD-WAN Controller: Proper policies must be applied to SD-WAN edge to: • Steer stream 1 and 3 towards Internet link and steer stream 2 and 4 towards MPLS link. • If Internet link down is detected by SD-WAN edge, SD-WAN edge should steer stream 1 and 3 to MPLS link • After Internet link resume, 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	
	6	Action	Start traffic on all STC ports	All generators are started successfully

Spirent SD-WAN Functional Test Suite Specification

	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	
Results and Outputs	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			
PASS/FAIL Criteria	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
Topology Type	3stc_1sne_2dut_type01

Spirent SD-WAN Functional Test Suite 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>** 　　Device: Device configuration #1 　　Stream: Stream configuration #2 **<SUT Configuration>** 　　SD-WAN edge: SD-WAN edge device configuration #2 　　　　Link status detection method (such as BFD) should be configured between SD-WAN edge 1 and SD-WAN edge 2 to detect link failure. 　　SD-WAN Controller: 　　　　Proper policies must be applied to SD-WAN edge 1 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 SD-WAN edge 1, steer stream 1 and 3 to MPLS link. 　　　　　• After Internet link resume, steer stream 1 and 3 back to Internet link.

Spirent SD-WAN Functional Test Suite Specification

	<SNE configuration> Set SNE 'Idle traffic flow setting' to "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: 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
	7	Action	Stop impairment	DUT detect the link is recovered, steer stream 1 and 3 back to Internet link
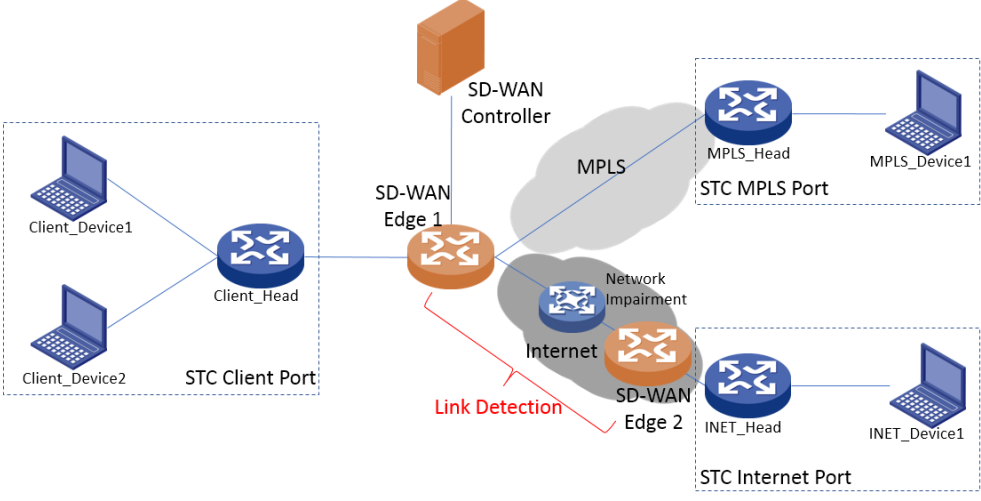
Spirent SD-WAN Functional Test Suite Specification

	8	Check	Record recovery time	
Results and Outputs	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			
PASS/FAIL Criteria	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
Topology Type	3stc_1sne_2dut_type01

Spirent SD-WAN Functional Test Suite 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>**
	    Device: Device configuration #1
	    Stream: Stream configuration #2
	<SUT Configuration>
	    SD-WAN edge: SD-WAN edge device configuration #2
	        Link status detection method should be configured between SD-WAN edge 1 and SD-WAN edge 2 to detect packet loss.
	    SD-WAN Controller:
	        Proper policies must be applied to SD-WAN edge 1 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.
	        • After Internet link packet loss ratio reduced to < 2%, steer stream 1 and 3 back to Internet link.
	<SNE configuration>

Spirent SD-WAN Functional Test Suite Specification

Test Sequence		Set SNE 'Idle traffic flow setting' to "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 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
	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	

Spirent SD-WAN Functional Test Suite Specification

Results and Outputs	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
PASS/FAIL Criteria	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 Functional Test Suite 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\>**
	    Device: Device configuration #1
	    Stream: Stream configuration #2
	\<SUT Configuration\>
	    SD-WAN edge: SD-WAN edge device configuration #2
	        Link status detection method should be configured between SD-WAN edge 1 and SD-WAN edge 2 to detect two-way delay.
	    SD-WAN controller:
	        Proper policies must be applied to SD-WAN edge 1 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.
	        • After Internet link one-way delay reduced to < 200ms, steer stream 1 and 3 back to Internet link.

Spirent SD-WAN Functional Test Suite Specification

	<SNE configuration> Set SNE 'Idle traffic flow setting' to "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
	8	Check	Record recovery time	
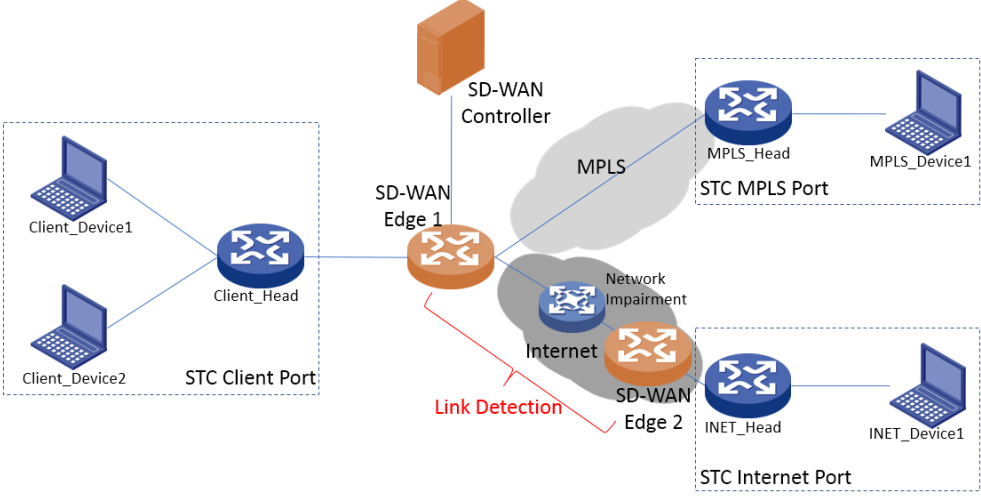
Spirent SD-WAN Functional Test Suite Specification

Results and Outputs	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
PASS/FAIL Criteria	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 Functional Test Suite 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>**
	    Device: Device configuration #1
	    Stream: Stream configuration #2
	<SUT Configuration>
	    SD-WAN edge: SD-WAN edge device configuration #2
	        Link status detection method should be configured between SD-WAN edge 1 and SD-WAN edge 2 to detect jitter.
	    SD-WAN controller:
	        Proper policies must be applied to SD-WAN edge 1 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. - After Internet link jitter reduced to < 50ms, steer stream 1 and 3 back to Internet link. **<SNE configuration>**

Spirent SD-WAN Functional Test Suite Specification

Test Sequence		Set SNE 'Idle traffic flow setting' to "Actively route traffic whilst unit is idle".		
	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
	8	Check	Record recovery time	
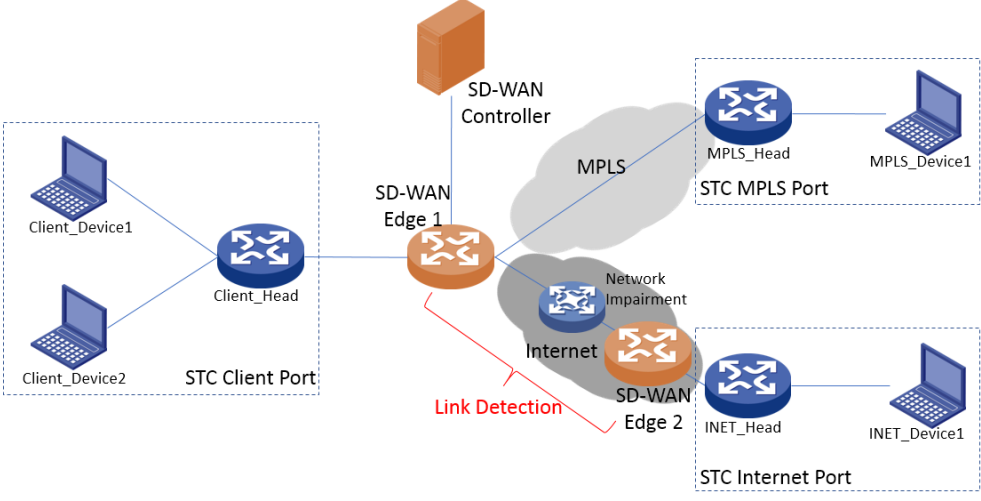
Spirent SD-WAN Functional Test Suite Specification

Results and Outputs	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
PASS/FAIL Criteria	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 Functional Test Suite 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>**
	    Device: Device configuration #1
	    Stream: Stream configuration #2
	<SUT Configuration>
	    SD-WAN edge: SD-WAN edge device configuration #2
	        Link status detection method should be configured between SD-WAN edge 1 and SD-WAN edge 2 to packet out-of-order.
	    SD-WAN controller:
	        Proper policies must be applied to SD-WAN edge 1 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.
	        • After Internet packet out-of-order ratio reduced to < 5%, steer stream 1 and 3 back to Internet link.
	<SNE configuration>

Spirent SD-WAN Functional Test Suite Specification

			Set SNE 'Idle traffic flow setting' to "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 stream 1 and 3 back to Internet link
	8	Check	Record recovery time	

Spirent SD-WAN Functional Test Suite Specification

Results and Outputs	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
PASS/FAIL Criteria	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 Packet 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 Functional Test Suite 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\>** 　　Device: Device configuration #1 　　Stream: Stream configuration #2 **\<SUT Configuration\>** 　　SD-WAN edge: SD-WAN edge device configuration #2 　　　　Link status detection method should be configured between SD-WAN edge 1 and SD-WAN edge 2 to detect packet duplication. 　　SD-WAN controller: 　　　　Proper policies must be applied to SD-WAN edge 1 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. 　　　　　• After Internet packet duplication ratio reduced to < 5%, steer stream 1 and 3 back to Internet link.

Spirent SD-WAN Functional Test Suite Specification

	<SNE configuration> Set SNE 'Idle traffic flow setting' to "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 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
	7	Action	Stop impairment	DUT detect packet duplication ratio is below threshold, steer

Spirent SD-WAN Functional Test Suite Specification

				stream 1 and 3 back to Internet link
	8	Check	Record recovery time	

Results and Outputs	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
PASS/FAIL Criteria	PASS criteria: stream 1 and 3 are correctly steered in link brownout and resume.