SD-WAN Recommended Test Plan

The following test plan can be used to test and verify the functionality of the SD-WAN solution.

Test Outline

The suggested tests described below are:

1. Standard Tests
    a. Establishing Connectivity
    b. Seamless Failover
    c. Basic Load Balancing
    d. Basic QOS Prioritization
2. Advanced Tests
    a. Dynamic QOS
    b. Intelligent Load Balancing

Standard Tests

Establishing Connectivity

This test will show that the service is up and operational over all circuits

Test Procedure

1. Plug in all WAN ISP circuits
2. Plug in power and wait 5 minutes for it to boot and establish baseline monitoring data
3. Connect the CPE router to the test LAN network (via a router or firewall if desired)
4. Ping google.com from a test machine on the LAN
5. Confirm site status in the web app

Expected Results

1. The google.com ping should resolve to an IP address, and then the ping should return successful responses
2. The web app should show “up” status and all circuit alarms should be level-0

Seamless Failover

This test will show that WAN-to-WAN circuit failover occurs without significant interruption of user traffic.

Test Procedure

1. Establish connectivity over 2 WAN circuits, verifying both circuits show no alarms in the web app.
2. Establish sensitive session-based application connections from device(s) on the LAN out through the SD-WAN system to other internet based devices or services. For example: set up a remote desktop system to a remote server, set up an SSH tunnel to a server, start a VoIP call, etc.
3. While actively using the sensitive applications, unplug one of the WAN circuits.
4. Observe the behavior of the applications for 10 seconds
5. Plug the WAN circuit back in
6. Wait 3 minutes for the system to fully bring the disconnected circuit back in to use
7. While actively using the sensitive applications unplug the other WAN circuit.
8. Observe the behavior of the applications for 10 seconds
9. Plug the WAN circuit back in

Expected Results

1. When unplugging a circuit you will see a brief interruption from about 3.5 seconds of packet-loss. If the load-balancing system was not using that circuit for the traffic you're testing then you may notice no loss until you test with the other circuit.
2. After the 3.5-second failover period, applications should resume normal behavior without any session reset or other user intervention.

Optional test addition:

You can insert a switch in between any of the WAN circuits and the CPE router. Then you can unplug the WAN circuit from the switch instead of unplugging from the CPE router. This demonstrates how the system is not dependent on physical interface status to evaluate circuit conditions.

Basic Load Balancing

This test will demonstrate the session-based load balancing that the SD-WAN system performs

across multiple WAN circuits.

Test Procedure

1. Establish connectivity over 2 WAN circuits with similar configured throughput capacities (e.g. two 5M/5M circuits)
2. Connect the CPE router to the test LAN network (via a router or firewall if desired)
3. Create varied network load of differing types. For example: open up a YouTube video, start an SSH session to a server, open up an email client, and create a remote desktop session to another server.
4. Review the circuit bandwidth utilization graphs in the web app.

Expected Results

1. The web app circuit throughput graphs should both show active bandwidth utilization.
2. If failover or other intrusive tests were performed recently then it may take up to 3 minutes until traffic will be load balanced across both circuits.

Basic QOS Prioritization

This test will evaluate the effectiveness of the QOS Prioritization in the SD-WAN system

Test Procedure

1. Before you begin this test ensure that the SD-WAN system has been configured for the correct rated bandwidth of the WAN circuit that you'll be testing over
2. Establish connectivity over only 1 WAN circuit
3. Connect the CPE router to the test LAN network (via a router or firewall if desired)
4. Create a high-priority network connection, such as remote desktop, SSH, or VoIP
5. Note the behavior of the high-priority network connection, such as latency, packet-loss, and jitter.
6. Create a high-bandwidth (at least as high as the rated circuit capacity), low-priority network connection such as an iperf test or internet speed test. Note, if using iperf please use an alternate port such as 5000 since we recognize the default iperf port 5001 as a medium-priority real-time application since it's often used for some chat clients.
7. Verify that the WAN circuit is saturated, by reviewing the web app throughput graphs.
8. Test for several minutes, noting the behavior of the high-priority network connection, such as latency, packet-loss, and jitter.

Expected Results

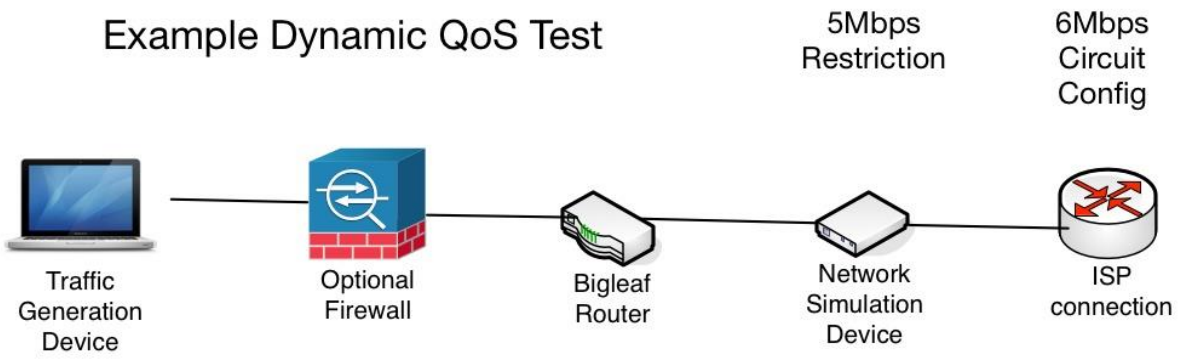
1. The SD-WAN QOS system should automatically prioritize most traffic types. The high-priority traffic stream should remain responsive, suffering little or no increase in latency, packet-loss, and jitter, even under full circuit saturation from the high-bandwidth traffic
2. The SD-WAN circuit speed adaptation may cause brief reductions in throughput while it detects the throughput capacity of the WAN circuit. These reductions should stabilize after 30 seconds or so of circuit saturation.

Advanced Tests

Note, these tests require a more extensive test setup to simulate

Dynamic QOS

This test will demonstrate the SD-WAN speed-adaptive QOS system that responds to changing circuit bandwidth during times of full circuit utilization



Test Procedure

1. Before you begin this test ensure that the SD-WAN system has been configured for the correct rated bandwidth of the single WAN circuit that you'll be testing over
2. Insert a bandwidth-limiting device, such as a router or managed switch, between a single WAN port on the CPE router and the WAN circuit handoff from the associated ISP. Initially configure the bandwidth-limiting device for a rate limit above the rated WAN circuit capacity.
3. Establish connectivity over the single WAN circuit that's passing through the bandwidth-restricting device and verify via the web app that the circuit shows no alarms.
4. Connect the CPE router to the test LAN network (via a router or firewall if desired)
5. Create a high-priority network connection, such as remote desktop, SSH, or VoIP, from

the LAN network out through the SD-WAN service.

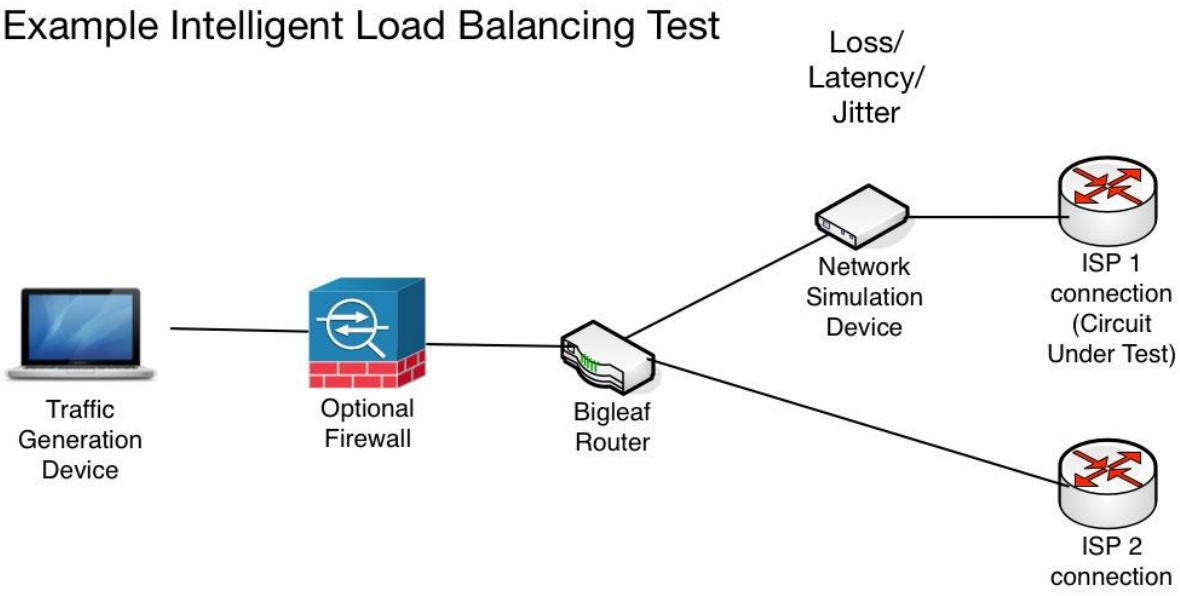
6. Note the behavior of the high-priority network connection, such as latency, packet-loss, and jitter.
7. Create a high-bandwidth (at least as high as the rated circuit capacity), low-priority network connection such as an iperf test or internet speed test. Note, if using iperf please use an alternate port such as 5000 since we recognize the default iperf port 5001 as a medium-priority real-time application since it's often used for some chat clients.
9. Verify that the WAN circuit is saturated, either through your own monitoring tools or by reviewing the web app throughput graphs.
8. Test for a minute or so, noting the behavior of the high-priority network connection, such as latency, packet-loss, and jitter.
9. Reduce the rate-limit for traffic passing through the bandwidth-limiting device to a value between 70%-90% of the rated capacity for the WAN circuit.
10. Test for a minute or two, noting the behavior of the high-priority network connection, such as latency, packet-loss, and jitter.

Expected Results

1. During all 3 bandwidth scenarios (un-saturated, saturated at full speed, saturated at reduced speed) the high-priority traffic should generally maintain similar latency, packet-loss, and jitter characteristics.
2. When the bandwidth is first restricted down to 70-90% of the rated circuit capacity it can take several seconds for the system to adapt to the new rate, so several seconds of higher latency, packet-loss, and/or jitter is expected. After the initial adaptation traffic should again stabilize back to normal performance
3. If the rate limit is further reduced after the initial reduction, or tested multiple times, there may be a delay in responsiveness due to a back-off timer built in to the system.

Intelligent Load Balancing

This test will provide a basic demonstration of the circuit monitoring and intelligent load-balancing system.



Test Procedure

1. Before you begin this test you will need to configure 2 WAN circuits:
    a. The “circuit under test” (CUT) should be configured for at least 1.5M/1.5M
    b. The “failover” circuit should be configured for 700kbps. This low bandwidth will ensure that this circuit isn’t used for normal load-balancing, but only when the “circuit under test” is degraded.
    c. The actual ISP circuits (from the CPE router out to the SD-WAN cluster) must support at least the configured bandwidths
2. Set up a performance simulation device capable of causing packet loss, jitter, and/or latency, such as Linux server with netem. Insert this device between the WAN port on the CPE router corresponding to the CUT and the WAN circuit handoff from the ISP. Initially configure the simulation device with no performance impacting settings.
3. Establish connectivity over both WAN circuits. Wait 5 minutes after establishing connectivity before beginning testing.
4. Connect the CPE router to the test LAN network (via a router or firewall if desired).
5. Create a medium to high priority network connection from the LAN network through the SD-WAN service that will demonstrate performance, such as a constant ping or VoIP call
6. Verify via the web app that both circuits show no alarms, and that more bandwidth is seen being used on the CUT than the “failover” circuit, indicating all traffic is load balanced on to the CUT.
7. Note the behavior and performance of the connection (general behavior, loss, latency, and/or jitter)

8. Immediate Response Test
    a. Use the performance simulation device to insert 10% packet loss, 50ms latency, or 60ms jitter on the test WAN circuit
    b. Note the behavior and performance of the connection for 30 seconds
    c. Observe the web app circuit throughput graphs
    d. Reset the simulation device back to no impact and wait 5 minutes
9. Low-Level Test
    a. Use the performance simulation device to insert 2% packet loss, 30ms latency, or 40ms jitter on the test WAN circuit
    b. Note the behavior and performance of the connection for 2 minutes
    c. Observe the web app circuit throughput graphs
    d. Reset the simulation device back to no impact

Expected Results

1. In the immediate response test, the test traffic should be moved off of the affected circuit within 10 seconds.
2. In the low-level test, the test traffic should be moved off of the affected circuit within 30-90 seconds.
3. Once the test traffic is moved over to the “failover” circuit, the simulated performance impact to the test traffic should be gone.
4. Some less stringent application traffic types such as web-based speed tests will not be moved between circuits as quickly, so higher severity performance impacts (e.g. 20% packet loss) may be required to see adaptation for that traffic.

Final Note

The SD-WAN system provides wonderful benefits, however like all technologies it’s not perfect. If in your testing you see any areas that could use improvement please let us know. We’re continually updating the code to improve performance and reliability, so we are glad to take your suggestions in to consideration.

Please also let us know if you have any trouble performing tests. We are glad to provide assistance to help ensure your comfort with the system.