Silver Peak Application Performance Torture Test

Run Business-Critical Applications without Interruption Over Consumer Broadband - Even During Severely Degraded Conditions or Outages.

EXECUTIVE SUMMARY

A key benefit delivered by an SD-WAN is the ability to actively utilize low-cost broadband services. However, even business-grade broadband connections often perform poorly due to packet loss when congestion occurs.

Silver Peak recently conducted application performance tests - torture tests - with the Unity EdgeConnect SD-WAN solution to demonstrate how a business intent overlay configured using multi-link tunnel bonding and path conditioning techniques can deliver superior application performance, even across consumer-grade broadband services and during severe brownouts. Test results also demonstrated that with multi-link tunnel bonding and dynamic path control with sub-second failover, uninterrupted application availability is possible during an outage, as long as one or more links comprising the tunnel remain active.

For the torture test, a bonded tunnel was created using two WAN services. Varying amounts of packet loss were injected, and link failures were also introduced. A stringent pass/fail packet loss criterion of

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0.01% at the application overlay was defined – ten times more stringent than the packet loss recommendation from Microsoft for the Skype for Business real-time Unified Communications (UC) application. A variety of test cases were conducted with packet loss on one or both links ranging from 1% to 30%. Link failure was simulated by simply unplugging a cable. A real-time video was also transmitted throughout the testing.

In all test cases, Silver Peak tunnel bonding and path conditioning improved packet loss at the application overlay by more than 100x, maintaining full performance of the real-time video application, even during WAN service brownouts. In the link failure test case, the video application continued without interruption or artifacts.

Actively Use Broadband Even During Brownouts

One of the many benefits of an SD-WAN is the ability to actively use multiple WAN transport services including lower-cost consumer-grade broadband, and use them simultaneously, even for the same application session. Competitive SD-WAN implementations are limited to selecting the highest quality path available and sending all traffic down that path. Some solutions send traffic from one higher priority application down the best quality path and lower priority traffic down the lower quality path based on latency, loss and jitter measurements. With more than a decade of experience helping customers build better WANs, Silver Peak has developed capabilities that do not force a reroute around the internet when conditions deteriorate.

The Silver Peak Unity EdgeConnect SD-WAN solution can be configured to load-balance traffic across two or more WAN transport services simultaneously, even for a single application session. The feature is called multi-link tunnel bonding. While some alternative SD-WAN solutions utilize multiple transport links on a flow-by-flow basis, Silver Peak provides much higher granularity by sending traffic across multiple links on a packet-by-packet basis for maximum efficiency, quality and performance. Another benefit of packet-by-packet load sharing is an inherent, rapid failover mechanism. If one of the transport services experiences an outage, the EdgeConnect dynamic path control feature steers application traffic to the remaining link(s) of the bonded tunnel in less than a second, resulting in no interruption to the application. For the High Availability link bonding policy recommended for critical voice and video applications (and the policy utilized in the torture tests described in this document), data and error correction packets traverse different links providing instantaneous failover at the application layer.

Another promise of an SD-WAN is the ability to incorporate broadband internet services into the enterprise WAN transport mix. One of the key challenges is overcoming packet loss inherent to broadband services, especially with lower-cost consumer-grade broadband due to congestion or brownouts during heavy usage periods. Silver Peak path conditioning technologies correct for lost and out-of-order packets without requiring retransmission delivering peak application performance and availability, even during brownouts or outages.

Stringent Requirements for Real-time Applications

Real-time applications that are critical for ongoing business operations represent the most stringent test case for an SD-WAN. However, real-time applications such as Unified Communications (UC) can experience performance degradation when running over broadband services due to packet loss or packets received out-of-order. Even a single lost packet can cause a perceptible voice call dropout or a glitch in a video conference. A burst of multiple lost packets can halt an application, requiring a counter-productive – and very annoying – re-initialization of the session.

For one of the more popular UC applications, Skype for Business, Microsoft specifies specific and very stringent network Quality of Service (QoS) parameters including packet loss less than 0.1% and out-of-order packet rates less than 0.01%. These packet loss and out-of-order rates are difficult to sustain even with an MPLS service and not possible with consumer-grade broadband during times of congestion unless advanced path conditioning techniques are employed.

Network performance requirements from your network Edge to Microsoft network Edge

The following are the network performance targets or thresholds that are required for the connection between your network Edge and the Microsoft network Edge. The segment of the network excludes the customers internal network or WAN, and is intended as guidance when testing your network traffic that is sent over the internet, or through an ExpressRoute partner network that can also be used when negotiating a performance Service Level Agreement (SLA) with your ExpressRoute provider.

CAUTION: CONNECTIVITY BETWEEN YOUR COMPANY NETWORK EDGE TO THE MICROSOFT NETWORK MUST MEET THESE FOLLOWING NETWORK PERFORMANCE REQUIREMENTS AND THRESHOLDS.

Metric	Target
Latency (one way)	< 30ms
Latency (RTT)	< 60ms
Burst packet loss	< 1% during any 200ms interval
Packet loss	< 0.1% during any 15s interval
Packet inter-arrival Jitter	< 15ms during any 15s interval
Packet reorder	< 0.01% out-of-order packets

Table 1, Source: Media Quality and Network Connectivity Performance in Skype for Business Online, https://support.office.com/en-us/article/Media-Quality-and-Network-Connectivity-Performance-in-Skype-for-Business-Online-5fe3e01b-34cf-44e0-b897-b0b2a83f0917?ui=en-US&rs=en-US&ad=US, November 2016.

Silver Peak EdgeConnect utilizes several technologies that deliver peak application performance, even when WAN services experience packet loss, excessive latency, jitter or other brownout conditions. Combined, these features provide private line-like performance even over consumer-grade broadband services.

- Multi-link bonded tunnels
- Business intent overlays
- Dynamic path control with sub-second failover
- Forward error correction (FEC)
- Packet order correction (POC)

By combining two or more WAN transport services as a primary bonded tunnel and employing path conditioning, Silver Peak significantly reduces the effective packet loss at the overlay, delivering business-class UC application performance, even over consumer-grade broadband services.

A Real-world Torture Test

Silver Peak recently performed stress tests, aptly named a "torture test," to measure the effectiveness of multi-link bonded tunnels combined with path conditioning and dynamic path control to keep applications running at peak performance, even during transport brownouts or outages. For the tests, a virtual WAN overlay, or business intent overlay, was defined with QoS parameters appropriate for real-time applications. Multiple test scenarios were run with varying amounts of packet loss to simulate different real-world WAN transport conditions. For example, congestion was simulated by injecting extremely high levels of packet loss in one direction.

The Unity Orchestrator Live View feature was utilized to monitor real-time packet loss in the underlying transports and packet loss for the business intent overlay after FEC and POC were applied – the effective packet loss experienced by the application. In addition, a real-time video stream was transmitted across the overlay to provide a qualitative measure of the technology; real-time video provides a more stringent test case than transmitting pre-recorded, well-behaved compressed video files.

Test Methodology

An EdgeConnect business intent overlay was configured between two sites with appropriate policies to carry video traffic with high performance and availability. The overlay utilized a primary bonded tunnel composed of two different WAN transport services, MPLS and internet. When creating a bond-

ed tunnel, a bonding policy is specified. For non-stop application performance, required for real-time voice and video applications, the High Availability link bonding policy mode was selected. The High Availability bonding policy sends data packets across one link and FEC packets across the other. Packet Order Correction is automatically enabled to account for latency variations between the two transport services. Even if multiple packets are lost on either link, the Silver Peak FEC algorithms can reconstruct them without requiring retransmission, thereby eliminating application degradation or interruption.

Silver Peak ran a variety of packet loss scenarios ranging from 0% to 100% across the two transport services, symmetrically and asymmetrically. See Table 2 below for a summary of test cases and results.

To quantify the improvement delivered by Silver Peak FEC and POC path conditioning, the application-level packet loss at the overlay was measured after error correction and divided by the average injected packet loss on the underlying transports. See Figure 1 below. The defined "Pass" criterion was less than 0.01% packet loss – ten times more stringent than the packet loss recommended by Microsoft for the Skype for Business application.

Test	MPLS (W>E)	MPLS (E>W)	Internet (W>E)	Internet (E>W)	Packet Loss < 0.01%
Test 1	0% Loss	0% Loss	0% Loss	0% Loss	PASS
Test 2	0% Loss	0% Loss	10% Loss	0% Loss	PASS
Test 3	0% Loss	0% Loss	10% Loss	10% Loss	PASS
Test 4	10% Loss	0% Loss	0% Loss	0% Loss	PASS
Test 5	10% Loss	10% Loss	0% Loss	0% Loss	PASS
Test 6	2% Loss	2% Loss	2% Loss	10% Loss	PASS
Test 7	1% Loss	1% Loss	1% Loss	5% Loss	PASS
Test 8	5% Loss	5% Loss	5% Loss	5% Loss	PASS
Test 9	0.25% Loss	0.25% Loss	30% Loss	30% Loss	PASS
Test 10	0.25% Loss	0.25% Loss	100% Loss	100% Loss	PASS

Table 2: Packet Loss Test Case Scenarios

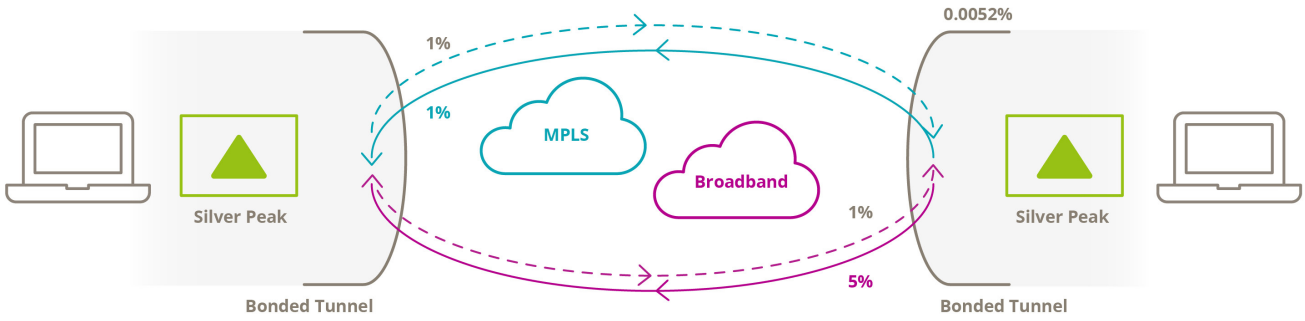

Figure 1: Test Case 7: Silver Peak stress test example shows a bonded tunnel configured to utilize MPLS + Broadband. A 1% packet loss rate was injected for each service, in each direction except 5% packet loss in the East-West direction for broadband. With FEC and POC applied, application overlay packet loss was reduced to 0.0052%, a 384x improvement over the average transport packet loss of 2% and far below the 0.1% packet loss level specified by Microsoft for the Skype for Business application.

Three Example Test Case Results Explained

Test Case 8 demonstrates the performance of EdgeConnect when there is severe packet loss on both transport services which is an extreme scenario in practice. In this test case, 5% packet loss was injected on the MPLS and internet transports in both directions. The combination of Silver Peak tunnel bonding and path conditioning resulted in less than 0.01% application packet loss at the overlay – a more than a 500X improvement of the packet loss experienced by both underlying transport services.

The different traces in the Live View screen shown in Figure 2, below display bandwidth and loss for the application overlay (business intent overlay) and the bandwidth and loss for the two underlying transport services; Live View can also display similar traces for latency and jitter. In this scenario, high loss on the internet connection always exceeds pre-programmed thresholds for a brown-out condition and is displayed as the orange areas on the underlay trace. The internet connection also experiences occasional blackout conditions shown by the red areas.

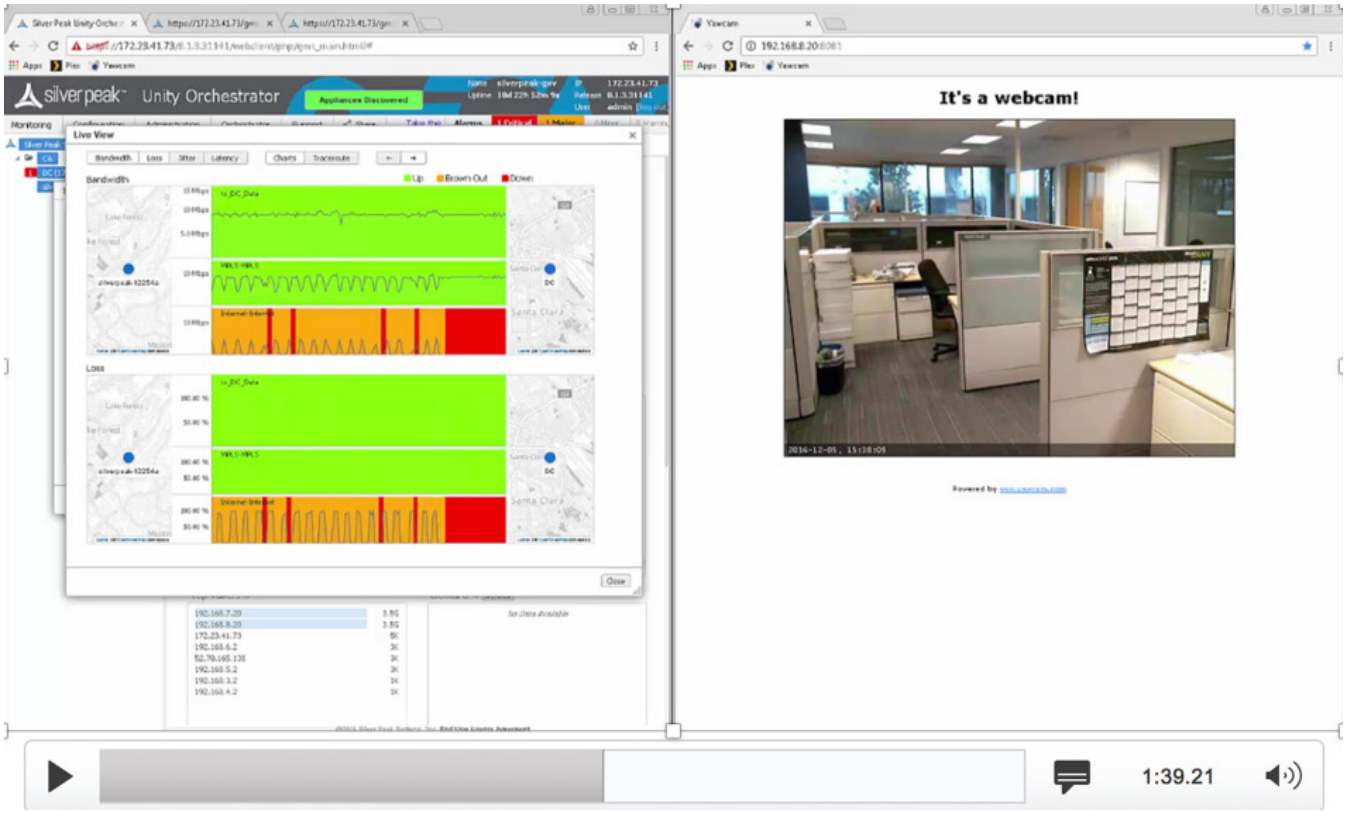

Figure 2: Screenshot of Live View and streaming video for Test Cases 9 and 10. Test Case 10 simulates the complete failure of the internet connection and occurs approximately 3/4 of the way through the Live View screenshot shown in the figure. The application continues uninterrupted.

Figure 2, above shows a screenshot of the result from Test Cases 9 and 10. Test Case 9 injects a small amount of loss for the MPLS transport and 30% loss for the internet connection, simulating an extremely high level of congestion for the broadband connection. Once again, tunnel bonding and path conditioning resulted in less than 0.01% effective packet loss for the application and no perceptible interruption of the video stream.

Test Case 10 simulates the complete failure of the internet connection, 100% packet loss, which occurs about three-quarters of the way through screen capture as shown by the persistent red underlay trace for the internet link in Figure 2. In both test cases, tunnel bonding and sub-second failover capabilities coupled with path conditioning result in less than 0.01% packet loss for the business intent overlay, and the live video streaming application experiences no interruption as shown by the solid green overlay trace.

EdgeConnect SD-WAN Solution

- Deliver high application availability even during periods of heavy congestion
- Effectively use lower cost, consumer-grade broadband - even for business-critical applications
- Enhance end-user productivity by reducing or eliminating application interruption

Increase Employee Productivity and Business Continuity While Lowering WAN Costs

With multi-link tunnel bonding, dynamic path control and advanced FEC and POC, the high-performance Silver Peak EdgeConnect SD-WAN solution improves the effective packet loss rate by more than two orders of magnitude. This level of correction at the application overlay makes it possible for organizations to reliably run high-performance business applications, including loss-sensitive UC applications, over consumer-grade broadband services, even during periods of congestion and brownouts. Multi-link tunnel bonding also provides a rapid failover capability in the event of a transport blackout, significantly improving application availability.

With Silver Peak, there is no routing around the internet when performance degrades. EdgeConnect enables distributed enterprises to use consumer-grade broadband with confidence, even for the most critical business applications.

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