Citrix Deployment using NetScaler SD-WAN with Internet as WAN Transport

July 2017
## Contents

Abstract.................................................................................................................................................. 3
Challenge.................................................................................................................................................. 3
Leveraging NetScaler SD-WAN Technology ............................................................................................. 3
Observations and Benefits ....................................................................................................................... 8
Conclusion............................................................................................................................................... 12
Abstract

Increasing the reliability of Internet-based WAN links has captured the interest of various organizations in using those WAN links as a potential alternative to MPLS-based links. Citrix Systems, as part of using its own NetScaler SD-WAN technology in its enterprise network, deployed NetScaler SD-WAN in its East Coast data center and new Contact Center branch office with a goal of utilizing pure internet-based links as WAN transport.

Previously the Citrix branch office in that city was using only DMVPN to provide connectivity between that office and the Citrix network. This required enabling a Cisco proprietary feature to provide automatic traffic routing, but the solution did not allow Citrix to perform per-packet load balancing across multiple circuits. When Citrix moved to a new office, they decided to change the network and utilize NetScaler SD-WAN to maintain voice quality, increase the site tolerance to outages and improve application performance by providing higher bandwidth.

Challenge

The old and now decommissioned Citrix branch office was first deployed using DMVPN technology and utilizing two 100 Mbps Dedicated Internet Access (DIA) links. One of the links was active, while the other link was on standby which resulted into an effective bandwidth that was half of the total available bandwidth from both links at any given time. (Adding path intelligence is available in DMVPN but it requires involved configuration.) The number of users for this branch was expected to increase in the coming months. Therefore, when the new office was opening, it was important to leverage all available bandwidth.

It is equally important to recognize that this branch site is one of Citrix geographically-dispersed Contact Center locations providing customers support. There was a strong requirement that voice quality and other critical applications remain within acceptable standards by providing a quick response in light of network disruptions. In other words, network issues should be as transparent as possible so Support Engineers are able to work with no downtime and customer support calls were never disconnected.

Leveraging NetScaler SD-WAN Technology

Figure 1 shows a high-level diagram of Citrix NetScaler SD-WAN deployment using Internet links. It shows two Internet links, ISP 1 and ISP 2, on both data center and branch locations. This results in four unidirectional possible WAN paths between the SD-WAN sites. These paths are bundled into one virtual path for WAN traffic at each site. NetScaler SD-WAN measures the link characteristics of each WAN path in each direction to make application traffic decisions.
Citrix is leveraging the following NetScaler SD-WAN features to maintain enterprise-grade quality in this deployment.

**Dynamic Path Selection**
NetScaler SD-WAN does not differentiate how it works depending on the type of WAN transport (i.e. MPLS, Internet, LTE, etc.). What it makes sure is that it is able to provide intelligent path selection to ensure mission-critical applications will leverage the best path at all times. Leveraging this feature is very important for this deployment due to the fact that it is using Internet links only.

**Sub-second WAN link failover**
Citrix is utilizing this NetScaler SD-WAN feature to provide a quick failover. If one of the deployed Internet circuits suffers an issue, user connections must seamlessly transfer to the remaining good internet link.

**Protecting mission-critical applications**
Internet and real-time applications do not mix well together from an enterprise standpoint. This statement is not specific to Citrix but to other enterprises as well. Citrix is applying the NetScaler SD-WAN Quality of Service (QoS) to protect its VoIP, Skype for Business and other critical application traffic. Citrix has classified its traffic based on three NetScaler SD-WAN class categories. These are Realtime, Interactive and Bulk.

Citrix, like many other businesses, has an existing QoS policy to transition from. To ensure that all Citrix-used applications are correctly classified into the above three categories, Rules are configured for these various applications, which may be defined using one or combination of the following fields:
- Source/destination IP
- UDP/TCP ports
- DSCP tags
- VLAN tags

**DSCP tag Preservation**
Preserving DSCP tags on the Internet is not needed or helpful since there is no direct control as to how packets are handled on the provider side. However, Citrix requires DSCP tags preserved or set on the LAN side to ensure other network devices such as routers will be able to correctly prioritize a traffic to be routed to underlying network infrastructure.
Packet Transmission Modes
NetScaler SD-WAN can deliver traffic across the Virtual Path using different transmit modes, which are Load Balance Path, Duplicate Path, Persistent Path or Override Service. The majority of Citrix traffic is configured to leverage Load Balance Path and Realtime traffic will utilize Duplicate Path. In Figure 2, Load Balance Path is applied for traffic falling under Interactive and Bulk categories.

![Load Balance Transmission Path](image)

Figure 2. Load Balance Transmission Path

Load Balance Path will first utilize the best path (solid green line) and if extra bandwidth is needed, it will leverage the remaining paths (dotted green line).

For Realtime traffic class, Citrix configured Duplicate Paths as shown in Figure 3:

![Packet Duplicated](image)

Figure 3. Duplicate Path

Under Duplicate Path, the source NetScaler SD-WAN appliance sends duplicate copies of every packet in the session along different, independent internet paths. The receiving NetScaler SD-WAN appliance uses the first packet received and ignores the second packet.

Citrix-specific Classes and Rules Configurations
Existing Citrix QoS policies were transposed into SD-WAN QoS format to maintain consistency with the rest of the network. This option is available aside from utilizing default QoS policies incorporated in NetScaler SD-WAN.

The following screenshots show representative deployment configuration to setup Rules that will allow classification of traffic, configuration of Transmission Mode and preservation or setting of DSCP tags in line with existing Citrix QoS policies. NetScaler SD-WAN detailed standard configuration steps is available on this [link](#) referencing the latest NetScaler SD-WAN software as of this writing.
Class and Rule Configurations were created globally in NetScaler SD-WAN GUI to allow easy application to data center and branch sites. See Figure 4

Figure 4 shows hard-set bandwidth for Realtime Class (i.e. ID 10) traffic. The value is set per site depending on the number of users at that site. When in there is contention for bandwidth, Realtime class will receive the guaranteed rate and the remaining available bandwidth is shared with the remaining two classes; Interactive and Bulk. Interactive traffic is assigned to varying Interactive class levels, where the levels closer to the top have higher priorities (i.e. interactive_high_class is higher than interactive_low_class). Percentage bandwidth values were assigned on different interactive class levels based on existing Citrix QoS policies. During contention, the bandwidth remaining after the Realtime traffic has been serviced is available for Interactive Class to be used on a fair share basis. Lastly, Bulk classes, usually used for file transfers, uses the available bandwidth after Realtime and Interactive have been serviced is available for its use on a fair share basis.

**Note:** When there is no bandwidth contention, all the three Classes will be serviced at Virtual Path Rate.
Figure 5. Citrix Class Configuration

Figure 6 shows sample Class and Rule configuration sections. Rule configuration in blue enclosure shows what criteria will trigger an application to fall into this rule. Packet transmission is covered in green enclosure to determine whether it will use Load Balance Path or Duplicate Path. Note, Persistent Path is not used in Citrix configuration. Retransmit Lost Packets was checked to ensure reliable transmission on any transmission mode. Orange enclosure determines the Class the application falling under a specific rule. Purple enclosure pertains to Random Early Detection (RED). Citrix NetScaler SD-WAN Product Team recommended enabling this feature which prevents traffic queues from filling up and causing tail-drop actions. It prevents needless queuing by the virtual path scheduler, without affecting the throughput that a TCP connection can achieve.

Figure 6. Rules, Transmission Mode and Class Handling Configuration
Figure 7 shows the final stage of Citrix custom configuration. This is to ensure correct DSCP tag is applied before packet reaches LAN side of any NetScaler SD-WAN appliance. In green enclosure, the desired DSCP tag that is in line with existing Citrix QoS policy is selected to ensure proper prioritization by LAN-side network devices.

![WAN to LAN DSCP tagging](image)

### Observations and Benefits

**Bandwidth Aggregation**

NetScaler SD-WAN was able to leverage both Internet links at the same time to provide higher available bandwidth for Support Engineers use in the new Citrix branch office.

The following screenshots provide comparison of traffic utilization from old and new Citrix branch sites. Figure 8 shows year 2016 traffic utilization from old Citrix branch office which wasn’t using SD-WAN and that was therefore leveraging only a single active internet circuit (ISP 2) using DMVPN technology. It showed traffic was capped at only 100 Mbps.

![Year 2016 traffic utilization from old Citrix branch office](image)

Note: Weekly averaging may have cut off traffic utilization closer to 100 Mbps.

Figure 9 shows May 2017 (deployment month) traffic utilization from the new Citrix office leveraging two internet links (ISP1 – 100 Mbps and ISP2 – 100 Mbps) using NetScaler SD-WAN technology. It showed over 150 Mbps utilization.
Note: Daily averaging may have cut off even higher utilization.

Figure 10 shows a granular graph from NetScaler SD-WAN management view on the branch appliance. It shows over 250 Mbps of traffic from Citrix East Coast Data Center to the new Citrix branch office utilizing four multiple WAN paths (color-coded as shown in left hand box) through ISP 1 and ISP 2 internet links.

ISP 2 internet link through DMVPN was used most of the time in old Citrix branch site and it was only providing up to 100 Mbps. Now, with NetScaler SD-WAN technology in the new branch site, they are receiving higher bandwidth through aggregation of two internet links.

**Application Quality and Performance**

The increase in available bandwidth and QoS resulted in on site users reporting increased application performance compared to the previous Citrix branch. Site users compared their VDI performance from old to new Citrix branch site with below observations
• VDI users reported a 30-50% increase in performance as compared to the old branch site
• Non-VDI users reported 10-20% increase in performance as compared to the old branch site

Using internal monitoring tools, Voice Mean Opinion Score (MOS) value was consistent at 4.42 in the new Citrix branch site. This is compared to MOS value hovering from 4.27 to 4.42, when it was monitored in the old Citrix branch site.

Outage Tolerance
Citrix NetScaler SD-WAN averted an outage situation by maintaining excellent DC-branch connectivity even when one of the two ISPs was having an issue. This Citrix Contact Center branch handles upwards of 3000 inbound and outbound monthly calls. Any outage issues affecting this site could have directly impacted service to Citrix partners and customers.

On 21-Jun 2017, a review of monitoring tools in NetScaler SD-WAN, showed that ISP 2 was experiencing an abnormal behavior

• Jitter increased from 0-4 milliseconds average to 30 milliseconds
• One-way latency increased from usual 28 milliseconds to 80 milliseconds
• Very high packet loss up to 75% was seen on both traffic directions

A review of NetScaler SD-WAN Loss Report showed a packet loss of as high as 75% on ISP 2 (Branch to Data Center traffic flow). See Figure 11

Figure 11. High Packets Loss up to 75% in one of the WAN Paths for ISP 2

Figure 12, which was taken from NetScaler SD-WAN GUI around this time (i.e. 21- Jun 2017 at 14:36H Pacific time) by going to NetScaler SD-WAN Events report showed that ISP 2 Internet link went down.
The same similar Internet link down event was available from NetScaler SD-WAN Center (more info on NetScaler SD-WAN Center is available on this link) by navigating to NetScaler SD-WAN Center Event Viewer. See Figure 13

Findings were,

- ISP 2, which is a global provider, experienced issues within their backbone
- ISP 1, which is used only at the Citrix branch, was operating normally
- Both circuits at the Citrix East Coast data center were operating normally

Most importantly, Support Engineers on this new branch site were able to continuously use their applications without any interruption in spite of the issues with ISP 2.
Further analysis of the effective loss on the Virtual Path during the ISP 2 issue showed that it seemed low. Figure 14 below illustrates this observation where effective Virtual Pass loss was at only 0.99%. This means that even while the loss on one of the network links spiked to 75%, the loss seen on the virtual path was only 0.99%.

**Figure 14. Effective Virtual Path loss during ISP 2 issue**

**Investment Value**
The above benefits discussion provided a consequential advantage. Citrix was able to maximize its investment for the two Internet links by using both simultaneously. Basic configuration on NetScaler SD-WAN allowed Citrix to gain full benefits of link aggregation without having to resort to potential complex reconfiguration. In turn, additional recurring cost for increasing Internet link bandwidth that could have not been avoided in the old Citrix branch site may not be needed in the near future for expansion of the new branch site.

**Conclusion**
NetScaler SD-WAN has empowered Citrix to gain a more agile network without any additional operational overhead. For instance, the internet link degradation would have required the Operations Group to provide active engagement, but because of NetScaler SD-WAN it turned out to be a transparent, retroactive investigation to determine the ISP issue without affecting any of its users.

Citrix experience in implementing its own NetScaler SD-WAN technology has been very positive. The cycle from conceptual to application phases were a smooth journey thanks to the availability of features such as link aggregation and fast link failover that worked well with minimal configuration.

While this is a case of Citrix using its own product, it is using the standard release and the experience documented here is similar to what occurs in other customers sites around the world.