



Finding the Best WAN Edge Solution for Your Enterprise

Criteria for Evaluating SD-WAN

Table of contents

The Value of SD-WAN	3
Resiliency and Performance	4
Application Experience	6
WAN Optimization	7
Security	7
Deployment Options and Scaling	8
Administration and Troubleshooting	9
Vendor Track Record and Support	9
Conclusions	9
SD-WAN Major Features Checklist	11

Finding the Best WAN Edge Solution for Your Enterprise: Criteria for Evaluating SD-WAN

Selecting the optimal SD-WAN solution for your enterprise WAN Edge is not easy. With vendors and industry analysts all talking about the same topics using the same buzzwords, it's hard to decide what features are most important, and how to differentiate between products. This paper lays out some important factors to consider when selecting an SD-WAN solution.

SD-WAN (Software Defined Wide Area Network) can help enterprises improve application performance, lower WAN costs, and strengthen business continuity. But as you consider deploying SD-WAN, it's important to understand the differences between solutions. Identifying which features matter to your enterprise is essential in making this selection.

This paper discusses the most important considerations and outlines capabilities that separate "just okay" products from really good ones. While this paper does not compare specific products, it does include examples of features from Citrix SD-WAN, one of the leading WAN Edge solutions in the industry.

The Value of SD-WAN

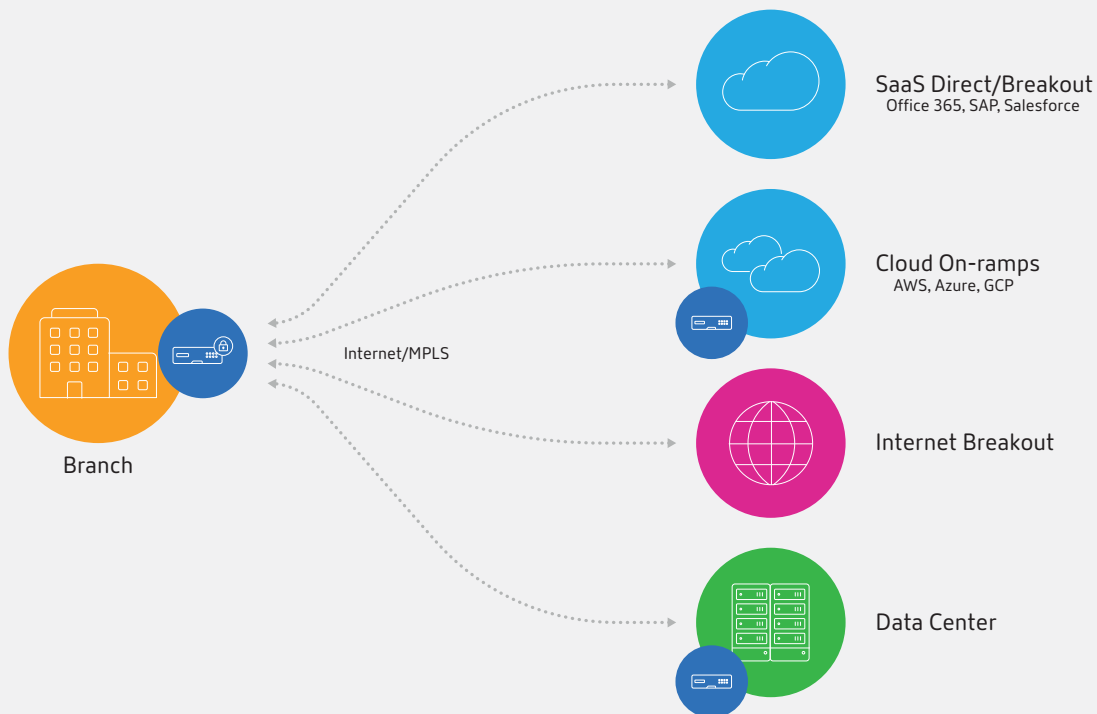
Wide Area Networks are a critical component of today's enterprise digital infrastructure. But WANs suffer from many problems, including congestion, jitter, packet loss, and outages. To add to that, private WAN technology such as MPLS is costly, inflexible, and wasn't built for the cloud. Adding capacity doesn't address issues such as outages or poor application performance due to latency. When applications don't perform well, it frustrates users, especially for latency sensitive applications like VoIP, video conferencing, video streaming, and virtualized applications and desktops. Complex WANs are also difficult to manage and troubleshoot. But, low-cost and easy to deploy alternatives like broadband and 4G/LTE are readily available. The key is to make it more reliable, and that's where SD-WAN comes in.

SD-WAN provides high-quality application experiences by making the WAN more reliable and performant. Appliances (physical or virtual) are placed in remote and branch offices, larger offices, corporate data centers, and increasingly on cloud platforms. SD-WAN solutions can:

- Deliver a better user experience for SaaS, cloud, and virtual apps
- Allow enterprises to leverage low-cost and flexible Internet and 4G/LTE network connections in place of MPLS links.
- Accelerate the move to the cloud with automated on-ramps
- Route traffic on the fastest available paths between any two points
- Mitigate costly outages in branches

- Prioritize business-critical applications
- Improve network & cloud security, while allowing secure local traffic breakout
- Simplify administration for remote and branch offices
- Provide visibility into WAN paths, links, users and applications for troubleshooting

SD-WAN: Architecture for Digital Transformation



The Difference Is in the Details

Although most SD-WAN solutions address the same problems, they provide very different levels of capabilities. Enterprises evaluating SD-WAN solutions should understand the different levels of functionality available to solve different problems, determine what level they require, and look for products that offer those capabilities.

Resiliency and Performance

SD-WAN solutions are essential tools for improving resiliency and providing fast failover even with broadband. The failure of a network link can put users “out of commission.” Losing access to mission-critical applications can reduce productivity and affect customer service. Manually rerouting traffic to back-up links can take time and create even more user dissatisfaction. More commonly, brownouts such as congested links may be undetectable but negatively affect the application experience. Imagine VoIP calls with customers dropping and lost VDI sessions, for example.

Reliable Packet Delivery

SD-WAN solutions make application performance more reliable by routing network traffic at the packet level along the most optimal paths between two points, based on factors like the requirements and priority of each application and the capacity and quality of the available paths.

Some SD-WANs rely on administrators to pre-define paths for all applications, and to make manual adjustments when contention and low quality are detected on a path. Most SD-WAN products, however, automatically assign paths based on factors such as latency (i.e., the time required for a ping to make a round trip between the locations). The highest-priority applications are reassigned to the lowest-latency paths.

Problems can still arise, however, when the selection criteria are too narrow, when thresholds are set too high or too low, or when it takes the product more than a few seconds to detect that the path has deteriorated or failed.

More sophisticated SD-WAN solutions select paths using algorithms based on multiple factors such as packet loss, jitter, and congestion as well as latency. These solutions use a dynamic analysis of multiple criteria, rather than fixed thresholds, to determine when paths need to be changed. The highest-priority applications are re-assigned to the lowest-latency paths. These capabilities do a better job of matching high-priority applications with the highest quality paths, and making adjustments faster when path quality deteriorates.

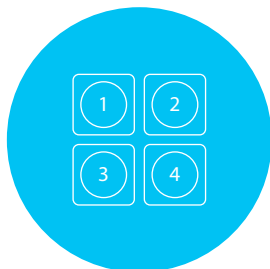
Loss Concealment

Loss is often caused by congestion. The higher the loss, the more packets are needed to rebuild the lost packets. The more packets sent, the more bandwidth required, so FEC can worsen the problem it is attempting to resolve. Without the ability to mitigate loss, SD-WANs may use a pre-defined level set on the SD-WAN device if the amount of loss on a WAN link is less than the static. Then, the end sites will use TCP flow control which was not designed to work over a WAN which causes data transmission to slow substantially when loss is present. FEC exacerbates congestion by trading bandwidth for the potential loss of data. Without the ability to adapt to congestion, the loss is exacerbated. To avoid loss, more sophisticated SD-WAN solutions use all of the bandwidth on the best path, instantly shifting traffic away from lossy links, and duplicate packets for a subset of real-time traffic. In addition to these comprehensive loss prevention techniques, the system detects loss using built-in sequence numbering and can optionally re-transmit both UDP and TCP packets under appropriate conditions.

Real-time Detection of Outages

When a network link goes down, lost connectivity can interfere with critical business processes and frustrate users. Even a short interruption can cause users to hang up on a VoIP call or video conference to try and restart applications. It can also disrupt virtual desktop sessions, backups, large file transfers, and other applications.

SD-WAN solutions can detect outages of network links and reroute traffic to alternate paths. The best products can identify outages and take corrective actions in a second or less, making the outages imperceptible to users (see the Sub-second Detection of Path Outages example below).



Dynamic Path Selection for Failover

When a path outage is detected, some SD-WAN products redirect traffic to a pre-defined backup link. More sophisticated solutions intelligently reroute traffic from high-priority applications to the remaining paths with the best performance and the lowest packet loss and jitter, and traffic from lower priority applications to the next-best path with available capacity. This ensures that high-priority applications not only continue to function, but in most cases suffer no performance degradation.

Application Experience

Not all applications need the same levels of service from the network. Some applications require high performance, high reliability, and high-quality links in order to deliver the expected user experience.

For example, many users will get very angry if quality is erratic for VoIP or video streaming, or if performance deteriorates for virtualized applications and desktops. In these situations, poor quality can cause users to stop and restart the phone call, the download, or the virtualized application, making network performance even worse. But what SD-WAN capabilities can ensure excellent QoS for key applications?

Application Fluency and Video Delivery Optimization

“Application fluency” refers to a technology that can parse application traffic and leverage knowledge about features in specific applications, rather than treating all application traffic as an undifferentiated stream (See the Microsoft Apps and Virtualized Apps example below).

SD-WAN solutions can optimize video delivery by identifying, classifying and caching video files based on video format, as well as by object-level compression of video files. This can result in major bandwidth savings and performance improvements when multiple people at the one location view the same video.

Application Prioritization

Most SD-WAN solutions allow administrators to assign applications to a series of categories that range from “high priority” to “low priority,” or from “real-time” to “bulk.” More sophisticated solutions allow administrators to prioritize applications at an even more granular level by creating rules based on parameters such as the application, protocol, or source and destination IP address. In cases where companies are using Citrix Virtual Applications/Desktops, only one SD-WAN solution stands apart by being able to prioritize streams in the ICA protocol even over a single port.

Traffic Shaping and Bandwidth Reservation

Some SD-WAN products include features for traffic shaping and dynamic bandwidth reservation. For example, a minimum bandwidth can be specified for a certain class of application on a given path. This feature ensures that no matter how congested a path becomes, no important application class will ever be forced below a minimum bandwidth allocation.

A refinement on this approach is to also specify a “share” for each class of

application, so that when capacity is limited, bandwidth will be allocated between them based on their relative shares.

Another traffic shaping technique is detecting “backpressure” from a destination. If the SD-WAN appliance at the destination indicates that there is no spare capacity, the appliance at the source will hold back traffic to that location, and use the resulting free bandwidth to send traffic somewhere else. This promotes efficient use of overall bandwidth while preventing the destination from becoming even more overloaded.

Dual-ended QoS

Dual-ended QoS measures latency, packet loss, and jitter at both the sending end and destination. Administrators configure QoS globally from a single source and senders only send at the peers advertised receive rate. Unidirectional local measurements are shared with peer devices in the network. All sites get their fair share of bandwidth preventing oversubscription and wasted utilization.

Packet Duplication

An advanced SD-WAN solution can ensure high application performance and zero packet loss by sending duplicate packets from the source location to the destination via two independent paths. The first packet to reach the destination is used and the second is discarded. This approach uses some extra bandwidth, but it is a powerful tool for ensuring very high reliability and quality for applications like VoIP, video conferencing, and virtualized desktops.



WAN Optimization

Basic Compression and Caching

Some SD-WAN products provide basic compression (removing unneeded and repetitive characters) and basic caching (storing copies of frequently used files at the destination node so they don't have to be retrieved multiple times across the WAN). These capabilities improve application performance, which makes users happy, and decreases congestion on networks which reduces networking costs.

Advanced Deduplication and Protocol Acceleration with WAN Optimization

Some SD-WAN solutions provide advanced techniques for application optimization on top of basic compression and caching.

Advanced deduplication includes the ability to cache and reuse individual blocks and bytes, in addition to entire file objects. A related feature is storing in memory small, frequently used data streams so they can be accessed extremely fast.

With protocol acceleration, details of specific protocols can be used to eliminate unnecessary actions that take up network capacity. Examples include proxying client-server handshakes, reducing protocol chattiness, and optimizing payloads.



Security

Most SD-WAN solutions use IPsec encryption to protect data in motion. Some include additional security features such as rotating keys, and splitting designated application traffic across multiple links so it can't be understood even if a hacker

can eavesdrop on one network segment.

A few SD-WAN solutions can also inspect SSL/TLS encrypted tunnels. This allows them to apply traffic shaping to traffic from Facebook, YouTube, Twitter, Google Apps, Box, Salesforce.com, GitHub, and the many other web applications that use SSL/TLS encryption.

Built-in Layer 4 Stateful Firewall (ICSA certified)

Some SD-WAN vendors have an integrated branch firewall while others require a separate solution. Integrated branch firewall that provides visibility and control of the traffic that is either going directly to the internet or getting backhauled to the head-end. The network is segmented into multiple firewall zones to control the traffic between them. It uses the deep packet inspection to identify the type of application and apply the configured firewall policy to its traffic. This integration of firewall on the branch appliance helps reduce the unnecessary traffic getting backhauled and wasting valuable WAN resources only to be blocked at the head-end.

Automated service/connection provisioning

While many SD-WAN solutions have the ability to connection to secure web gateways, they are not automated and admins must manually configure the IPsec tunnels to the cloud security services. A joint solution help reduce the surface attacks at the branch offices tremendously. An added functionality is being able to redirect internet traffic to a secure web gateway for next-generation firewall by automatic creation of IPsec tunnels from the branch to the secure web gateway using API integration. APIs synchronize with the management systems of partners such as Zscaler and Palo Alto Networks to enable fast and effortless cloud security setup from Citrix SD-WAN.

Next-gen firewall as VNF

For customers who require a strong perimeter security and compliance with stringent healthcare or financial regulations, an SD-WAN solution that offers an SDN/ NFV ready platform capable of hosting several industry-leading next-generation virtual firewalls is important. The combined solution is optimized to deliver high performance of App-ID enabled firewall in a compact footprint.



Deployment Options and Scaling

Most SD-WAN solutions are available as pre-configured appliances. However, some vendors offer a choice of deployment options that includes pre-configured appliances (easy to deploy), virtual appliances that run on the enterprise's existing hardware (low cost and easy to upgrade), and virtual appliances on cloud platforms (see the Cloud Deployment callout box). SD-WAN solutions can also help enterprises scale their WANs very cost-effectively, by adding capacity with broadband and 4G/LTE connections, rather than by investing in expensive additional MPLS circuits.

Zero-Touch Deployment/Provisioning

Most SD-WAN solutions offer a way for administrators to remotely setup SD-WAN appliances in branches. Zero Touch Deployment (ZTD) as a cloud service which



allows discovery of new appliances in the SD-WAN network, primarily focused on streamlining the deployment process for SD-WAN at branch or cloud service office locations. The service is publicly accessible from any point in a network via public Internet access and is accessed over Secure Socket Layer (SSL) Protocol. This allows customers to get new sites up and running quickly.

Administration and Troubleshooting

Some SD-WAN products need more effort to configure and manage. Administrators should be concerned about solutions that use command-line type commands for some activities, depend on manual selection of paths, or require configuration tasks on each individual appliance. More advanced solutions provide an easy-to-use GUI interface, use algorithms to select paths automatically, and include tools to push out configuration changes quickly to multiple appliances.

Administrators should also evaluate the analysis and troubleshooting tools that work with the SD-WAN solution. Some even offer provisioning and management capabilities as a SaaS solution.

Desirable features include:

- A dashboard with useful charts, maps and diagrams.
- Visibility into the status, utilization and performance of individual network segments.
- Visibility into the end-to-end performance of a wide range of applications.
- Integration with third party analytics and troubleshooting tools.
- The ability to replay traffic flows over time and observe the effect of changes in application usage and network conditions.

Vendor Track Record and Support

SD-WAN technology is improving rapidly, and the vendor landscape is changing. To maximize their return on investment now and in the future, enterprises should look for vendors who have longstanding track records for industry leadership and customer satisfaction, as well as world-class support, sales, and channel organizations.

Conclusions

SD-WAN solutions have been proven to increase application performance and reliability and to dramatically reduce the costs of expanding and managing wide area networks. But not all SD-WAN solutions are the same. Evaluators should weigh alternatives based on the features and levels of capabilities outlined in this paper in the areas of:

- Resiliency and performance
- Application experience
- WAN optimization
- Security

-
- Deployment options and scaling
 - Administration and troubleshooting
 - Vendor track record and support

You can use the checklist below to compare several products using these criteria. Of course, potential buyers should also validate the capabilities most important to them by looking at each vendor's customer base and performing hands-on trials where appropriate.

Citrix invites you to explore how an advanced SD-WAN solution can address the business and technical requirements of your enterprise. For more information, visit www.citrix.com/sdwan, or read more in the following resources:

- Citrix SD-WAN Product Overview
- Citrix SD-WAN Data Sheet
- Building a Software-defined WAN with Citrix SD-WAN
- WAN Optimization with Citrix SD-WAN
- Ensure VoIP & Skype for Business Call Quality and Reliability with Citrix SD-WAN



Enterprise Sales

North America | 800-424-8749

Worldwide | +1 408-790-8000

Locations

Corporate Headquarters | 851 Cypress Creek Road Fort Lauderdale, FL 33309, United States

Silicon Valley | 4988 Great America Parkway Santa Clara, CA 95054, United States

©2019 Citrix Systems, Inc. All rights reserved. Citrix, the Citrix logo, and other marks appearing herein are property of Citrix Systems, Inc. and/or one or more of its subsidiaries, and may be registered with the U.S. Patent and Trademark Office and in other countries. All other marks are the property of their respective owner(s).

SD-WAN Major Features Checklist

Feature	Citrix SD-WAN	Option X	Option Y
Resiliency and Performance			
Reliable packet delivery	✓		
Real-time detection of outages	✓		
Dynamic path selection for failover	✓		
Quality of Service			
Application prioritization	✓		
Traffic shaping and dynamic bandwidth reservation	✓		
Allocate relative “shares” to application classes	✓		
Backpressure from destinations	✓		
Packet duplication	✓		
Multiple paths per session	✓		
Dynamic point-to-point connections across multiple nodes	✓		
Application Optimization			
Basic compression and caching	✓		
Advanced deduplication	✓		
Application fluency	✓		
Video delivery optimization	✓		
Security			
Data security	✓		
Inspect SSL/TLS tunnels	✓		
Built-in Layer 4 Stateful Firewall (ICSA compliant)	✓		
Next-gen firewall as VNF	✓		
Deployment and Scaling			
Appliance and virtual appliance options	✓		
Cloud platform virtual appliance	✓		
Scale by adding broadband & 4G/LTE connections instead of MPLS	✓		
Zero-Touch Deployment	✓		
Administration and Troubleshooting			
Dashboard (charts, maps, diagrams)	✓		
Visibility into network segments	✓		
Visibility into end-to-end application performance	✓		
Integrate with third party analytics & troubleshooting tools	✓		
Replay traffic flows over time	✓		
Vendor Track Record & Support			
Track record for industry leadership and customer satisfaction	✓		
Worldwide support, sales, and channel organizations	✓		