

## Finding the Best SD-WAN Solution for Your Enterprise: Guide for Evaluating SD-WAN Products



Selecting the optimal SD-WAN solution for your enterprise is not easy. While much has been written about the technology, it's hard to decide what features are most important and how to differentiate between products. This paper describes some of the critical features in more details and lays out some important factors to consider when selecting an SD-WAN solution for your enterprise.

### Using this Guide

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. In this paper, the various functionality groups considered are:

1. Resiliency and Failover
2. Quality of Service
3. Application Optimization
4. Routing
5. Data and Application Security
6. Deployment and Scaling
7. Administration and Troubleshooting
8. Vendor Experience and Level of Support

At the end of a paper, a checklist organized by these categories is available to help identify and highlight those features you care about and compare what different vendors provide in each category.

SD-WAN (Software Defined Wide Area Network) products have a very successful track record improving application performance, lowering WAN costs, and strengthening 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 describes key criteria for evaluating SD-WAN solutions. It discusses the most important issues, and outlines levels of capability that separate "just okay" products from really good ones. The paper does not compare specific products, but it does include examples of features from Citrix NetScaler SD-WAN, one of the leading solutions in this field.

### The Value of SD-WAN Solutions

Wide Area Networks are a critical component of today's enterprise computing infrastructure. But WANs suffer from many problems, including latency, congestion, jitter, packet loss, and outages. Erratic performance frustrates users, especially for real time applications like VoIP calling, video conferencing, video streaming, and virtualized applications and desktops. WAN capacity can be expensive and difficult to expand. And complex WANs are difficult to manage and troubleshoot.

SD-WAN products address these problems. Typically, the solution consists of appliances or virtual appliances placed in small remote and branch offices, larger offices, corporate data centers, and private and public cloud platforms. SD-WAN solutions can:

- Reduce WAN traffic
- Route traffic on the fastest available paths between any two points
- Provide better quality of service (QoS) for high-priority applications
- Improve network security
- Consolidate disparate network functions into one appliance with centralized configuration and policy definitions.
- Simplify administration for remote and branch offices
- Allow enterprises to leverage low-cost and flexible Internet and 4GE network connections in place of MPLS links.
- Provide visibility into WAN paths to help administrators troubleshoot performance issues

But different SD-WAN solutions have dramatically different ways of providing these features. The following sections present options to help you identify what is important to your enterprise.

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## Category 1: Resiliency and Failover

The failure of a network link can put users “out of business.” Losing access to mission-critical applications can reduce productivity and affect customer service. Rerouting traffic to back-up links can result in session disconnects and forces high-priority applications to contend with all other traffic for limited bandwidth, creating even more user dissatisfaction. SD-WAN products are essential tools for improving resiliency and providing fast failover when a network link failure occurs.

### Reliable Packet Delivery

SD-WAN solutions make packet delivery and application performance more reliable by routing network traffic along the optimal paths between two points, based on factors like the requirements and priority of the application and the capacity and quality of the available paths. While some SD-WAN products rely on administrators to pre-define paths for all applications, a better option is to look for SD-WAN products that automatically assign paths based on factors such as latency.

Problems can still arise, however, when only latency is used as the path selection criteria, when it's measured only as a round trip value, or when predefined thresholds are used to determine acceptable latency levels.

More sophisticated SD-WAN solutions select paths using algorithms based on multiple factors such as packet loss, jitter, and congestion as well as one-way latency. These solutions use a dynamic analysis of multiple criteria, rather than fixed thresholds, to determine which path should be used or when traffic needs to be moved to a better path. These solutions do a better job of matching high-priority applications with the highest quality paths, and of making adjustments faster when path quality deteriorates.

### Example: Fast Detection of a Link Outage

NetScaler SD-WAN appliances tag every packet they send with a sequence number and information about the packets to follow. This allows the appliance at the destination to detect path outages after just two or three missing packets, so traffic can be rerouted before users notice any disruption.

### Real-time Detection of Outages

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

SD-WAN solutions can detect outages of network links and reroute traffic to alternate paths. But the amount of time to detect the outage can vary widely. 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 callout box.) If preventing session disconnects and interrupted voice calls is important, look for a product that can detect the outage in less than a second.

An important differentiator is how outages are detected. Products that use a variant of ICMP Ping to detect an outage have to ramp up probe frequency to decrease the detection time, creating a trade off between bandwidth overhead and failover time. Products that detect outages based on actual application traffic are faster at detecting outages and don't incur high levels of wasted bandwidth.

### Lossless Failover

As important as it is to detect an outage quickly, the way in which traffic is moved is equally as important. The most basic SD-WAN solutions can only start new sessions on the remaining path(s), leaving any existing sessions to fail. In order to minimize the impact of an outage, it's important to select an SD-WAN product that can move existing sessions to a new path. As some applications are sensitive to either loss or jitter, ideally the existing traffic should be moved without loss or with packet retransmission and reordering. This will prevent the application from disconnecting or initiating flow control.

### Dynamic Path Selection for Failover

If there are more than two paths available when an outage occurs then the SD-WAN solution must select which path to move traffic to. Some SD-WAN products redirect traffic to a pre-defined backup link. More sophisticated solutions intelligently reroute traffic from high-priority

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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.

## Category 2: Quality of Service

Not all applications need the same levels of service from the network. For example, users often complain if quality is erratic for voice over IP (VoIP calling), audio and 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 features in SD-WAN solutions can guaranty excellent QoS for key applications?

### Application Prioritization

SD-WAN products should allow administrators to assign applications to a category such as "high priority," "low priority," "real-time" or "bulk."

More sophisticated solutions allow administrators to create new categories and to control the parameters of each category. For example, controlling queue depths and drop timers provides for more granular control over application performance and allows for optimization of individual application performance.

### 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 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.

### Dual Ended QoS

Another traffic shaping technique available 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 packets somewhere else. This promotes efficient use of overall bandwidth while preventing the destination from being even more overloaded.

### 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 calling, video conferencing, and virtualized desktops.

### Link Aggregation

Some advanced SD-WAN products allow traffic from a single session to be divided over two or more paths that are dynamically linked. This has two important benefits:

- Large tasks such as backups and large file transfers can be completed more quickly.
- High-priority applications can be given enough bandwidth to perform optimally, even if the primary path for the application reaches its capacity.

### Dynamic Point-to-Point Connections

Applications like VoIP calling, video conferencing and chat often require connections between

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two remote points. Sending that traffic through a corporate data center or a cloud platform, or forcing it to make multiple hops results in excessive latency that can affect application performance. An advanced SD-WAN solution can create an on-demand connection when one of these applications starts a session, which utilizes the shortest possible path and dynamically combines multiple links into a single virtual path. This results in better performance and more efficient bandwidth usage and is an important feature to look for if your business utilizes VoIP calling or video conferencing.

### Category 3: Application Optimization

Application optimization is accomplished via a set of features that were traditionally included in WAN Optimization products. These features are important for WANs with high latency or limited bandwidth, and are often now included in SD-WAN solutions. If your organization wants to take advantage of WAN Optimization, look for an SD-WAN vendor that includes it in an integrated solution.

#### Compression and Caching

Compression consists of removing unneeded and repetitive data and caching consists of 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 and decrease congestion on networks, which reduces networking costs.

#### Advanced Deduplication and Protocol Acceleration

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.

Another feature to look for is protocol acceleration, where the details of specific protocols is used to eliminate unnecessary actions that take up network capacity and slow down application performance. Examples include proxying client-server handshakes, reducing protocol chattiness, and optimizing payloads (see the Accelerating CIFS callout box).

#### 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 callout box.)

Video delivery can be optimized 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.

### Category 4: Routing

While SD-WAN started as a pure overlay technology, it has rapidly evolved to be more directly involved in the routing topology. Whether it acts as a router or just participates in routing, it's important to consider routing requirements in an SD-WAN selection process.

#### Route Learning and Advertising

Support for dynamic routing protocols helps with the insertion of an SD-WAN appliance into the network. By listening for route changes and advertising its own routes, the SD-WAN solution can easily adapt to changes to the network and eliminate the need for manual route changes. Some solutions only support static routing or support a limited number of protocols, making network insertion more difficult and creating a need for manual updates when subnets and routes change.

#### WAN Edge Mode

Many SD-WAN solutions can act as a router in the network, effectively replacing the existing

#### Example: Accelerating CIFS

CIFS is a protocol designed for Windows file sharing on LANs. A client requesting a large file using CIFS over a WAN might have a read limit as small as 4KB, forcing the user to wait several minutes to retrieve the entire file. NetScaler SD-WAN "understands" the CIFS protocol, so it can retrieve a file over the WAN in much larger chunks, dramatically reducing the user's wait time.

#### Example: Microsoft Apps and Virtualized Apps

NetScaler SD-WAN accelerates Microsoft applications and protocols like Microsoft 365, Microsoft Exchange, Microsoft SharePoint, and the CIFS and NFS protocols, as well as applications and desktops that have been virtualized by Citrix XenApp and XenDesktop. It accomplishes this with techniques that significantly reduce the WAN traffic required to update screens, move a mouse, drag and drop objects, copy files and folders, print files, and perform other common actions.

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WAN edge router with one that can provide traditional SD-WAN services and router services. Some vendors require their appliance to act as the edge router, some don't allow it, and some require all appliances in the network perform the same role. For enterprises with offices of many different sizes or who want to gradually replace their existing routers with SD-WAN appliances, it's important to look for a solution that can operate in a mixed mode.

### Category 5: Data and Application Security

#### Data Protection

It's important to secure data as it leaves the corporate perimeter. Most SD-WAN solutions use IP-SEC encryption to protect data on the WAN. Ideally the administrator has the ability to select encryption levels and to control whether data is encrypted across public and private links. Additional security features to look for are rotating encryption keys and data integrity checksums.

#### Tunnel Inspection

A few SD-WAN products 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.

#### Data Segmentation

An advanced security feature offered by some SD-WAN solution is data, or route, segmentation. This allows traffic to be segmented across the WAN, with different routes and policies applied to each segment. Data can be segmented by VLAN, application or source. Companies with guest WIFI, partner or vendor access or who process payment and health data may want to consider a solution with data segmentation.

### Category 6: Deployment Options and Scaling

#### Physical and Virtual Appliances

An important consideration when selecting a solution is the available form factors. Hardware solutions offer ease of installation and a single purchase point. Software solutions provide more flexibility and often a lower price point but require additional hardware purchases. Consider your requirements now and in the future, or choose a vendor with both form factors in order to maximize choice in the future.

#### Example: Cloud Deployment

NetScaler SD-WAN can be deployed as a virtual appliance on the cloud in environments such as Amazon Web Services (AWS). That allows NetScaler SD-WAN to provide latency-aware path selection, QoS, traffic shaping and other advanced features to traffic flowing to and from cloud-based applications.

Through its relationship with Equinix, NetScaler SD-WAN can also sit on the edge of the cloud and provide reliable and quality access to a hybrid cloud environment.

#### Cloud Appliances

As more applications and data move to the cloud, it's important to extend SD-WAN functionality to the edge of the cloud. While a virtual version can be deployed manually to the cloud, some vendors offer SD-WAN appliances in large private and public cloud vendors, including Amazon Web Services, Azure, Google Cloud and Equinix.

#### Zero-touch Deployment

A hallmark of SD-WAN solutions is the ability to centrally define configurations and policies, removing the need to configure individual appliances. Zero-touch deployment takes that a step farther and adds the ability for appliances to be easily added to a network without any technical staff involvement. The most common approach is for an appliance to contact the network controller upon turnup and automatically pull down its configuration information. This is a critical feature for large enterprises or those without IT support staff in remote locations.

### Category 7: 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. A few also implement a true "software defined networking" approach that

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allows all appliances and virtual appliances to be configured centrally based on application needs rather than underlying hardware.

### Example: Analytics

NetScaler Insight Center collects data from NetScaler SD-WAN appliances and provides visibility into the behavior of over 200 enterprise applications. It can use industry-standard AppFlow® data reporting formats to feed data to third party analytics tools from organizations like Splunk and Solarwinds. The HDX Insight™ module within Insight Center can provide extremely detailed reporting and analysis of XenApp and XenDesktop activity, including application launches, bandwidth usage, response times and errors by application, by user group, and by individual user.

Administrators should also evaluate the analysis and troubleshooting tools that work with the SD-WAN 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.

### Category 8: Vendor Experience and Level of 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 long-standing track records for industry leadership and customer satisfaction, as well as world-class support, sales, and channel organizations.

### Conclusions

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

- Resiliency and failover
- Prioritization and Quality of Service
- Application optimization
- Routing
- Data and application security
- Deployment options and scaling
- Administration and troubleshooting
- Vendor experience and level of support

You can use the checklist on the next page 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](http://www.citrix.com/sdwan).

## SD-WAN Major Features Checklist

Category	Feature	Citrix NetScaler SD-WAN	Vendor 2	Vendor 3
<b>Resiliency and Failover</b>	Reliable packet delivery	✓		
	Real-time detection of outages	✓		
	Lossless failover	✓		
	Dynamic path selection for failover	✓		
<b>Quality of Service</b>	Application prioritization	✓		
	Traffic shaping and bandwidth reservation	✓		
	Dual ended QoS	✓		
	Packet duplication	✓		
	Link aggregation	✓		
	Dynamic point-to-point connections	✓		
<b>Routing</b>	Route learning and advertising	✓		
	WAN edge mode	✓		
<b>Application Optimization</b>	Compression and caching	✓		
	Advanced deduplication	✓		
	Application fluency	✓		
	Video delivery optimization	✓		
<b>Security</b>	Data security	✓		
	Data segmentation	✓		
	Tunnel inspection	✓		
<b>Deployment and Scaling</b>	Physical and virtual appliance	✓		
	Cloud appliance	✓		
	Zero-touch deployment	✓		
<b>Administration and Troubleshooting</b>	Graphical dashboard	✓		
	Application visibility	✓		
	Integration with third party tools	✓		
<b>Vendor Experience and Level of Support</b>	Track record for industry leadership and customer satisfaction	✓		
	Worldwide support, sales, and channel organizations	✓		
<b>Overall Assessment:</b>				



### About Citrix

Citrix (NASDAQ:CTXS) is leading the transition to software-defining the workplace, uniting virtualization, mobility management, networking and SaaS solutions to enable new ways for businesses and people to work better. Citrix solutions power business mobility through secure, mobile workspaces that provide people with instant access to apps, desktops, data and communications on any device, over any network and cloud. With annual revenue in 2014 of \$3.14 billion, Citrix solutions are in use at more than 330,000 organizations and by over 100 million users globally. Learn more at [www.citrix.com](http://www.citrix.com).

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