



SOFTWARE-DEFINED WIDE AREA NETWORK (SD-WAN) COMPARATIVE REPORT

Network Value Map™ (NVM)

June 19, 2019

Authors – Thomas Skybakmoen, Ahmed Basheer

Tested Products¹

Barracuda Networks Barracuda CloudGen Firewall F82 v7.2.3

Citrix Systems Citrix SD-WAN 2100-1000-SE v10.0.0.6

Forcepoint NGFW 1101 SMC 6.5.3 and Engine 6.5.2

Fortinet FortiGate 61E v6.0.4 GA Build 0231

Oracle Talari SD-WAN E1000 v7.3

Silver Peak Unity EdgeConnect EC-M VXOA 8.1.7

Versa Networks FlexVNF V220 v16.1R2-S6

VMware SD-WAN by VeloCloud Edge 2000 v3.2.1

Environment

NSS Labs Software-Defined Wide Area Network (SD-WAN) Test Methodology v2.0

¹ NSS was unable to measure the effectiveness and determine the suitability of SD-WAN products from two market leaders and therefore cautions against their deployment without a comprehensive evaluation.

Overview

Empirical data from Test Reports and Comparative Reports is used to create the NSS Labs Network Value Map™ (NVM). The NVM illustrates the relative value of SD-WAN investment options by mapping the mean opinion score (MOS) and the *TCO per Mbps* of tested product configurations. The terms *TCO per Mbps* and *Value* are used interchangeably throughout the NVM Comparative Report.

Test Reports are available for each product tested and can be found at www.nsslabs.com. The SD-WAN Comparative Report provides detailed comparisons across all tested products for three use cases: Manageability & Cost, Performance, and Security.

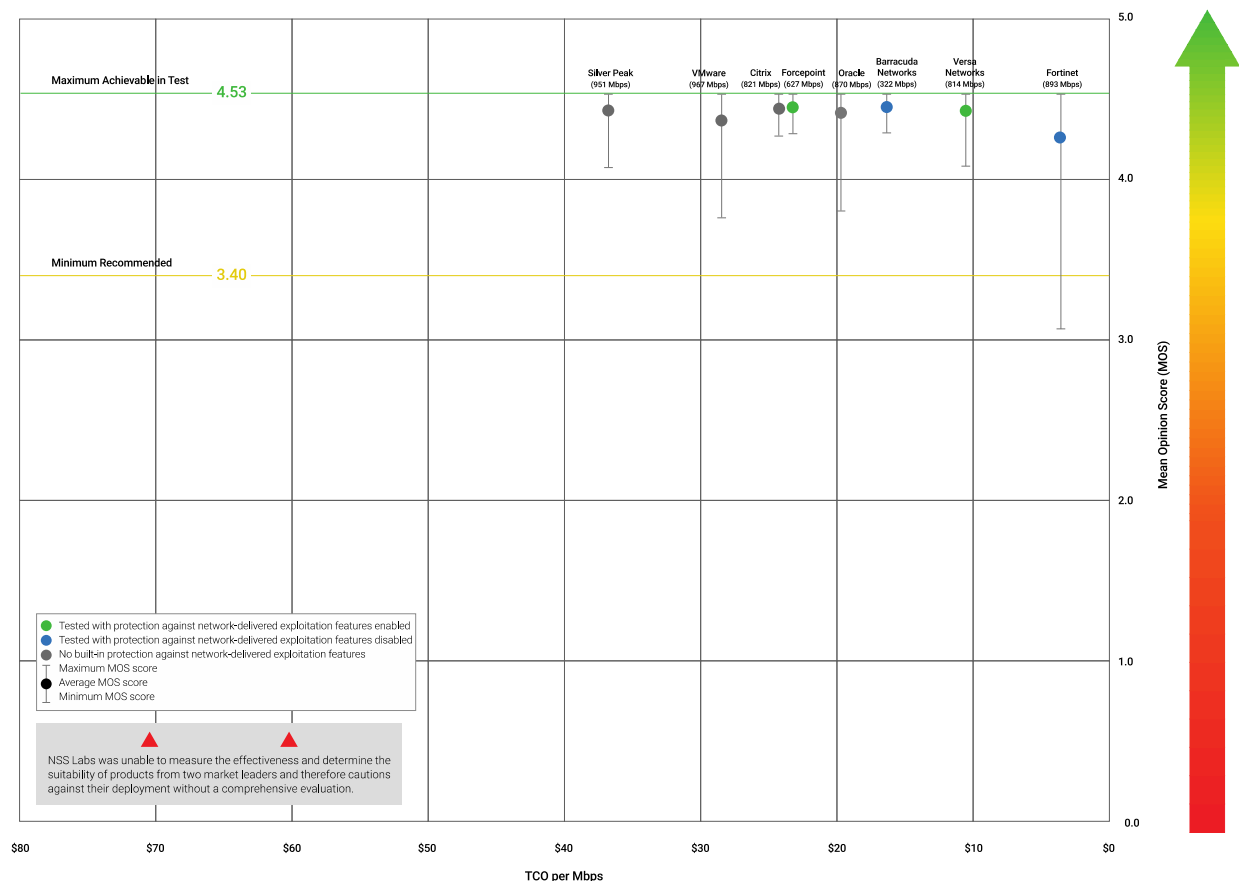


Figure 1 – NSS Labs 2019 Network Value Map for Software-Defined Wide Area Network (SD-WAN)

Key Findings

- All eight products tested met the use case for quality of experience (QoE) for VoIP and Video, scoring above the 3.4 minimum recommended by NSS Labs.
- On a MOS scale of 1 – 5 for VoIP, the test average ranged from 4.36 to 4.41, with 4.41 being the maximum achievable in this test.
- On a MOS scale of 1 – 5 for video, the test average ranged from 4.15 to 4.51, with 4.51 being the maximum achievable in this test.

- Of the eight products tested, five demonstrated an average MOS deviation of less than 5% from the baseline; two demonstrated a deviation of 10% or more.
- Two products with built-in protection against network-delivered exploitation were tested with the functionality enabled; both products performed equal to or better than products without this functionality enabled.
- TCO per Mbps ranged from US\$4 to US\$37, with most tested products costing less than US\$25 per Mbps.

Product Rating

The *Overall Rating* in Figure 2 is determined by how each SD-WAN scored in each use case. Product ratings are calculated using a combination of 3-Year TCO, throughput, and MOS. Products are rated as *Recommended*, *Verified*, or *Caution*. For more information on how the NVM is constructed, see the section titled How to Read the NSS Labs Network Value Map.

Vendor	VoIP MOS		Video MOS		TCO per Mbps	Overall Rating
	Average	Use Case	Average	Use Case		
Barracuda Networks	4.40	Above Use Case	4.49	Above Use Case	\$16	Recommended
Citrix Systems	4.40	Above Use Case	4.48	Above Use Case	\$24	Recommended
Forcepoint	4.40	Above Use Case	4.51	Above Use Case	\$23	Recommended
Fortinet	4.36	Above Use Case	4.15	Above Use Case	\$4	Recommended
Oracle (Talari)	4.40	Above Use Case	4.42	Above Use Case	\$20	Recommended
Silver Peak	4.41	Above Use Case	4.45	Above Use Case	\$37	Recommended
Versa Networks	4.41	Above Use Case	4.44	Above Use Case	\$10	Recommended
VMware	4.40	Above Use Case	4.34	Above Use Case	\$28	Recommended

Figure 2 – NSS Labs 2019 Recommendations for Software-Defined Wide Area Network (SD-WAN)

Table of Contents

Tested Products	1
Environment	1
Overview	2
Key Findings	2
Product Rating	3
How to Read the NSS Labs Network Value Map	5
<i>The x axis</i>	6
<i>The y axis</i>	6
Analysis	7
Recommended	7
<i>Barracuda Networks Barracuda CloudGen Firewall F82 v7.2.3</i>	7
<i>Citrix Systems Citrix SD-WAN 2100-1000-SE v10.0.0.6</i>	7
<i>Forcepoint NGFW 1101 SMC 6.5.3 and Engine 6.5.2</i>	7
<i>Fortinet FortiGate 61E v6.0.4 GA Build 0231</i>	7
<i>Oracle Talari SD-WAN E1000 v7.3</i>	8
<i>Silver Peak Unity EdgeConnect EC-M VXOA 8.1.7</i>	8
<i>Versa Networks FlexVNF V220 v16.1R2-S6</i>	8
<i>VMware SD-WAN by VeloCloud Edge 2000 v3.2.1</i>	8
Verified	8
Caution	8
Unverified	9
Test Methodology	10
Contact Information	10

Table of Figures

Figure 1 – NSS Labs 2019 Network Value Map for Software-Defined Wide Area Network (SD-WAN)	2
Figure 2 – NSS Labs 2019 Recommendations for Software-Defined Wide Area Network (SD-WAN)	3
Figure 3 – Example NVM	5

How to Read the NSS Labs Network Value Map

The NVM depicts the value of a typical deployment of 75 sites configured for HA and with a central management system (CMS), since this provides a more accurate reflection of cost than a model with 1 HQ DC and 2 Branches. For additional deployment models, please see the NSS Labs SD-WAN Comparative Report at www.nsslabs.com.

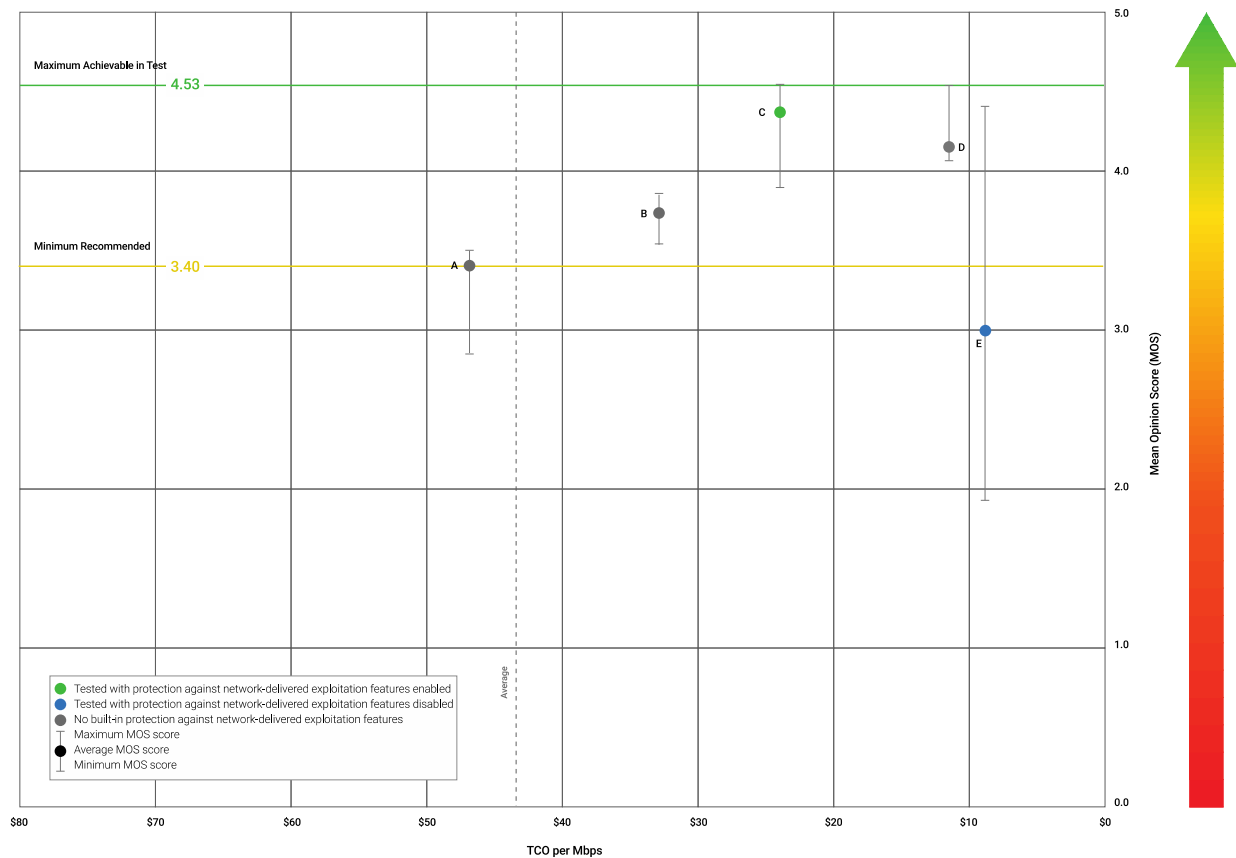


Figure 3 – Example NVM

No two SD-WAN products deliver the same quality of QoE, throughput, or TCO, making precise comparisons extremely difficult. In order to determine relative performance, understand relative cost, and facilitate accurate comparisons of SD-WANs on the market, NSS has developed a total cost of ownership (TCO) model. This model provides a data point against which the actual value of each product tested can be compared.

The *TCO per Megabits per Second (Mbps)* metric provides guidance as to whether the price for an SD-WAN is higher or lower than an alternative, such as an MPLS or a competing SD-WAN product. A high price could indicate a premium based on features, bandwidth, service level agreements (SLA), brand recognition, or level of customer service. Conversely, a high price could also be a penalty for purchasing an underperforming product. For additional information, please see the NSS Labs SD-WAN Comparative Report at www.nsslabs.com.

The **x axis** displays *TCO per Mbps* in US dollars, which decreases from left to right.

This metric incorporates 3-Year TCO with *NSS-Tested VPN Throughput* and MOS to provide a data point against which the actual value of each product tested can be compared. The following formula is used:

$$\text{TCO per Mbps} = \frac{3\text{-Year TCO}^2 / (\text{NSS-Tested VPN Throughput (Mbps)} * \text{MOS Deviations}^3)}{\text{Number of Sites}}$$

The TCO incorporates capital expenditure (capex) costs over a three-year period, including initial acquisition and deployment costs and annual maintenance and update costs (software and hardware updates). For more details on TCO, see the NSS Labs SD-WAN Comparative Report at www.nsslabs.com.

The MOS is used to calculate the QoE that enterprises can expect when deploying SD-WAN products. Relative (video) MOS is an estimated perceptual quality score that considers the effects of codec; the impact of IP impairments (such as packet loss) on the group of pictures (GoP) structure and video content; and the effectiveness of loss concealment methods. The encoding specifications for video codec are used as guidelines and conformance, and vendors are free to design encoders to improve video quality and reduce the number of transmission bits. Simply put, MOS for video (relative MOS) can vary based on different advancements in the video estimation or encoding techniques. In the video used for the test, the maximum achievable MOS was 4.53.

VoIP (real-time protocol [RTP]) MOS, on the other hand, measures the MOS for VoIP calls based on the speech codec being used. The setup used a G711 codec, which produces a maximum achievable MOS of 4.41 for an excellent VoIP call. Any MOS below 3.5 represents a significantly degraded voice call or video stream. NSS considers a MOS below 3.4 as failing to meet the use case. In each test case, background traffic was introduced to populate links with sufficient activity so as to represent typical enterprise network communications. These measurements provide guidance on the behavior of sensitive applications in a network that uses SD-WANs.

The **y axis** displays each SD-WAN's performance on a MOS scale of 1–5 with the maximum achievable MOS of 4.53. The minimum MOS recommended by NSS to meet the use case was 3.4.

Each product's MOS is represented by three data points: maximum, minimum, and average.

Products are rated on the NVM as either *Recommended*, *Verified*, or *Caution*:

- **Recommended:** These products provide a high level of quality and value for money, consistently scoring equal to or above the market during NSS testing.
- **Verified:** These products provide a high level of quality and value for money, providing a good experience relative to the market during NSS testing.
- **Caution:** These products provide limited value for money since their three-year TCO for the use cases and their QoE for VoIP and/or video is below the market.

SD-WAN deployments have varying requirements for performance and value that can extend beyond throughput and VoIP and video QoE. Clients can schedule an inquiry call with NSS analysts to discuss other value metrics and normalized values for other deployment use cases.

² The 3-Year TCO is based on a 75 sites configured for high availability. Please see the NSS Labs SD-WAN Comparative Report for additional detail.

³ NSS calculated the average deviation from the maximum achievable MOS in test for VoIP (4.41) and Video (4.53).

Analysis

Each product tested may fall into one of three categories based on its rating in the NVM: *Recommended*, *Verified*, or *Caution*. Each product receives a single rating. Vendors are listed alphabetically within each section.

Recommended

Barracuda Networks Barracuda CloudGen Firewall F82 v7.2.3

VoIP MOS and Video MOS	Using the recommended policy, the CloudGen Firewall F82 achieved a VoIP MOS of 4.40 and a Video MOS of 4.49 out of maximum achievable scores of 4.41 and 4.53, respectively.
NSS-Tested VPN Throughput	The product is rated by NSS at 322 Mbps VPN throughput out of a maximum achievable throughput of 1,092 Mbps per the NSS Labs SD-WAN Test Methodology.

Citrix Systems Citrix SD-WAN 2100-1000-SE v10.0.0.6

VoIP MOS and Video MOS	Using the recommended policy, the 2100-1000-SE achieved a VoIP MOS of 4.40 and a Video MOS of 4.48 out of maximum achievable scores of 4.41 and 4.53, respectively.
NSS-Tested VPN Throughput	The product is rated by NSS at 821 Mbps VPN throughput out of a maximum achievable throughput of 1,092 Mbps per the NSS Labs SD-WAN Test Methodology.

Forcepoint NGFW 1101 SMC 6.5.3 and Engine 6.5.2

VoIP MOS and Video MOS	Using the recommended policy, the NGFW 1101 achieved a VoIP MOS of 4.40 and a Video MOS of 4.51 out of maximum achievable scores of 4.41 and 4.53, respectively.
NSS-Tested VPN Throughput	The product is rated by NSS at 627 Mbps VPN throughput out of a maximum achievable of 1,092 Mbps per the NSS Labs SD-WAN Test Methodology.

Fortinet FortiGate 61E v6.0.4 GA Build 0231

VoIP MOS and Video MOS	Using the recommended policy, the FortiGate 61E achieved a VoIP MOS of 4.36 and a Video MOS of 4.15 out of maximum achievable scores of 4.41 and 4.53, respectively.
NSS-Tested VPN Throughput	The FortiGate 61E is rated by NSS at 893 Mbps VPN throughput out of a maximum achievable throughput of 1,092 Mbps per the NSS Labs SD-WAN Test Methodology.

Oracle Talari SD-WAN E1000 v7.3

VoIP MOS and Video MOS	Using the recommended policy, the E1000 achieved a VoIP MOS of 4.40 and a Video MOS of 4.42 out of maximum achievable scores of 4.41 and 4.53, respectively.
NSS-Tested VPN Throughput	The product is rated by NSS at 870 Mbps VPN throughput out of a maximum achievable throughput of 1,092 Mbps per the NSS Labs SD-WAN Test Methodology.

Silver Peak Unity EdgeConnect EC-M VXOA 8.1.7

VoIP MOS and Video MOS	Using the recommended policy, the Unity EdgeConnect EC-M achieved a VoIP MOS of 4.41 and a Video MOS of 4.45 out of maximum achievable scores of 4.41 and 4.53, respectively.
NSS-Tested VPN Throughput	The product is rated by NSS at 951 Mbps VPN throughput out of a maximum achievable of 1,092 Mbps per the NSS Labs SD-WAN Test Methodology.

Versa Networks FlexVNF V220 v16.1R2-S6

VoIP MOS and Video MOS	Using the recommended policy, the FlexVNF V220 achieved a VoIP MOS of 4.41 and a Video MOS of 4.44 out of maximum achievable scores of 4.41 and 4.53, respectively.
NSS-Tested VPN Throughput	The product is rated by NSS at 814 Mbps VPN throughput out of a maximum achievable of 1,092 Mbps per the NSS Labs SD-WAN Test Methodology.

VMware SD-WAN by VeloCloud Edge 2000 v3.2.1

VoIP MOS and Video MOS	Using the recommended policy, the Edge 2000 achieved a VoIP MOS of 4.40 and a Video MOS of 4.34 out of maximum achievable scores of 4.41 and 4.53, respectively.
NSS-Tested VPN Throughput	The product is rated by NSS at 967 Mbps VPN throughput out of a maximum achievable of 1,092 Mbps per the NSS Labs SD-WAN Test Methodology.

Verified

No vendor received a *Verified* rating.

Caution

No vendor received a *Caution* rating.

Unverified

NSS was unable to assess and determine the suitability of two market leaders for SD-WAN deployments and therefore cautions against their deployment without comprehensive evaluation.

Test Methodology

NSS Labs Software-Defined Wide Area Network (SD-WAN) Test Methodology v2.0

Contact Information

3711 South Mopac Expressway
Building 1, Suite 400
Austin, TX 78746
info@nsslabs.com
www.nsslabs.com

This and other related documents are available at: **www.nsslabs.com**. To receive a licensed copy or report misuse, please contact NSS Labs.

© 2019 NSS Labs, Inc. All rights reserved. No part of this publication may be reproduced, copied/scanned, stored on a retrieval system, e-mailed or otherwise disseminated or transmitted without the express written consent of NSS Labs, Inc. (“us” or “we”). Please read the disclaimer in this box because it contains important information that binds you. If you do not agree to these conditions, you should not read the rest of this report but should instead return the report immediately to us. “You” or “your” means the person who accesses this report and any entity on whose behalf he/she has obtained this report.

1. The information in this report is subject to change by us without notice, and we disclaim any obligation to update it.
2. The information in this report is believed by us to be accurate and reliable at the time of publication, but is not guaranteed. All use of and reliance on this report are at your sole risk. We are not liable or responsible for any damages, losses, or expenses of any nature whatsoever arising from any error or omission in this report.
3. NO WARRANTIES, EXPRESS OR IMPLIED ARE GIVEN BY US. ALL IMPLIED WARRANTIES, INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT, ARE HEREBY DISCLAIMED AND EXCLUDED BY US. IN NO EVENT SHALL WE BE LIABLE FOR ANY DIRECT, CONSEQUENTIAL, INCIDENTAL, PUNITIVE, EXEMPLARY, OR INDIRECT DAMAGES, OR FOR ANY LOSS OF PROFIT, REVENUE, DATA, COMPUTER PROGRAMS, OR OTHER ASSETS, EVEN IF ADVISED OF THE POSSIBILITY THEREOF.
4. This report does not constitute an endorsement, recommendation, or guarantee of any of the products (hardware or software) tested or the hardware and/or software used in testing the products. The testing does not guarantee that there are no errors or defects in the products or that the products will meet your expectations, requirements, needs, or specifications, or that they will operate without interruption.
5. This report does not imply any endorsement, sponsorship, affiliation, or verification by or with any organizations mentioned in this report.
6. All trademarks, service marks, and trade names used in this report are the trademarks, service marks, and trade names of their respective owners.