

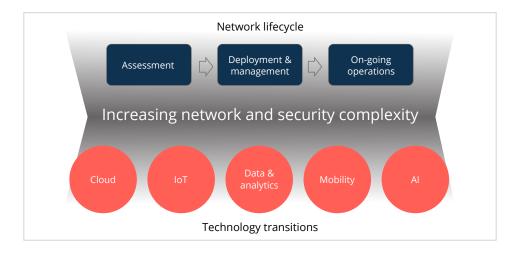
## SOLUTION OVERVIEW Simplify SD-WAN operations with greater visibility

Gain unmatched network and application visibility and control to deliver the highest quality of experience to users and simplify ongoing operations

## BACKGROUND

Ensuring continuous operations and high levels of application performance is a challenging and often time-consuming task for IT. The process of troubleshooting poor application performance — aka a poor user-experience — becomes more difficult as the network becomes more complex with new technology transitions such as the migration of applications to the cloud, IoT and mobility. These technology transitions have created an unprecedented amount of data to be consumed by users and also to be handled by the infrastructure (network, storage, compute). Optimizing the infrastructure is paramount to ensuring application performance and availability to ultimately deliver the highest end user quality of experience.

When users complain about poor application performance, it is often initially unclear to IT if the root cause is rooted in the network, a security breach, a misconfiguration, poor application design, insufficient allocation of resources to the application and so on. What can make troubleshooting even more challenging is the adoption of software-defined technologies like SDN and SD-WAN, which create multiple virtual networks that are decoupled from hardware. No one disputes the benefits of software-defined technologies in improving management, application performance and accelerating deployments among other benefits. However, a solution that doesn't provide embedded real-time visibility into network and application traffic burdens IT and increases time to resolution in addressing performance issues when they occur. It is estimated that 80 percent of IT resources are spent on IT operations — just keeping the infrastructure operating effectively (The Total Economic Impact of Cisco TrustSec, Forrester, Sept. 2016). Furthermore, 42 percent of IT time is spent troubleshooting problems. Another data point from Forrester Research reported that roughly one-third of application performance issues take more than a month to fix — or go unresolved entirely.





The separation of the control and data planes in softwaredefined technologies along with the virtualized layers carrying different traffic types traversing the wide area network has created blind spots in the infrastructure that are difficult to detect. Real-time visibility into network and application performance metrics can take the guesswork out and speed problem resolution, enabling organizations to run more efficiently by:

- Accelerating troubleshooting downtime or slow application performance can be due to congestion, packet loss or a security breach. Identifying the root cause of poor performance is rarely simple or easy. It often requires significant IT resources and time to determine if the cause of performance degradation is coming from the network, servers, storage or something else. You can't effectively address the problem until you identify and understand the root cause.
- Applying preventative measures having real-time visibility into network health and application flows, on a site by site basis, provides a visual basis to show where things went wrong and enable IT to proactively avoid future downtime.

## CAPABILITIES IN ARUBA EDGECONNECT ENTERPRISE THAT SIMPLIFY ONGOING OPERATIONS

Examining bits and bytes to identify and analyze the root cause of network issues or application performance degradation is frustrating, complex and time-consuming. The **Aruba EdgeConnect Enterprise** SD-WAN platform leverages adaptive intelligence and algorithmic measurements. The **Aruba Orchestrator** centralized management console collects and mines a vast amount of network data in realtime and presents it in a centralized dashboard.

For example, if a user is experiencing slow application response times, a network administrator can quickly identify the root cause of the problem in hours, if not minutes, versus days or weeks. First, Aruba Orchestrator classifies data points based on applications which makes it easier for IT to identify and initiate the troubleshooting process. Aruba Orchestrator enables network administrators to easily identify SD-WAN tunnels, overlays and applications, along with the WAN path attributes, including packet loss, latency and jitter. Aruba Orchestrator uses this information to generate a full map and view of the application path where the data is available to network administrators in tables and charts with filtering capabilities to quickly isolate the root cause. Service providers or enterprises can use the open API to send alarms or other data points to the network operations center (NOC) or other complementary analytical tools like Splunk, LogRhythm or SolarWinds to further streamline management.

This data provides all necessary aspects of monitoring critical services to maintain and operate the network with greater ease and efficiency. Furthermore, the platform creates a week's worth of data with context allowing IT to playback, similar to DVR, to see what has happened at that specific time and location.

Without this level of detail and real-time visibility, network administrators have a much more difficult time effectively monitoring and troubleshooting application performance negatively impacting service delivery and end-user quality of experience.

A comprehensive dashboard (Figure 1) provides a complete at-a-glance view along with customizable widgets to monitor network attributes and applications in real time. IT defined widgets provide granular details on SD-WAN appliances, including their location, active tunnels, logical topology, appliance health heatmap, top talkers, alarms, mean opinion score (MOS), applications and domains accessed, bandwidth consumed, flow count, latency, jitter, and packet loss (Figure 2).



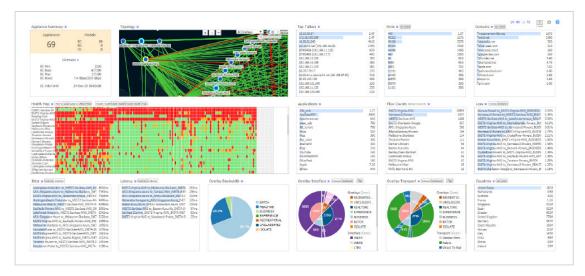


Figure 1: The Aruba Orchestrator dashboard provides complete observability of network health and application performance

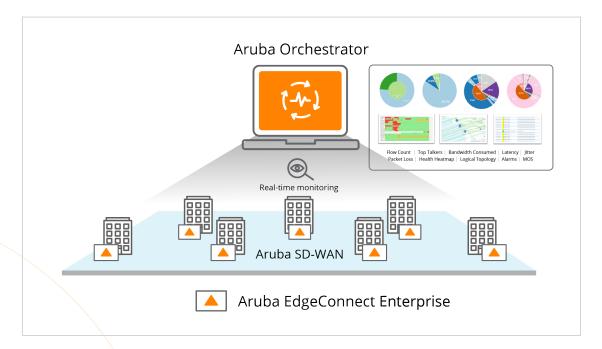
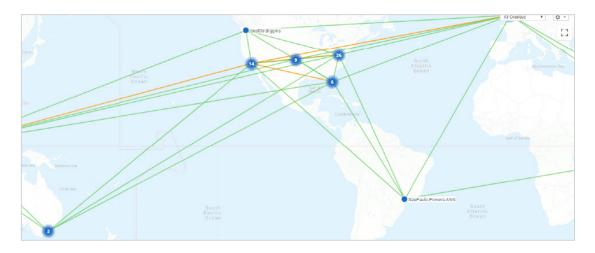


Figure 2: Real-time monitoring of appliances by location, tunnels, bandwidth, flow, jitter, latency, loss, application type, MOS, alarms



Aruba Orchestrator provides granular visibility into network and applications, including:

1. A topology map showing all IPsec tunnels across all appliances and geographic regions — displays an overview of appliance locations and the tunnels connecting them.



A network-wide health map — provides a high-level view of network health based on the configured filter threshold.
 Filters are available for packet loss, latency, jitter, MOS and alarms.

One hour color-coded blocks display the most severe events across the selected filters. Clicking a block displays a pop-up window with additional details about that event, the value that triggered it and any additional threshold breach for that appliance during the same hour.



## SIMPLIFY SD-WAN OPERATIONS WITH GREATER VISIBILITY



- 3. Loss, jitter and latency charts the loss chart shows which tunnels have experienced the highest percentage of dropped packets. The jitter chart displays which tunnels experienced the most jitter jitter can be caused by congestion across the LAN, firewall routers, access link bottlenecks, load sharing, route flapping, routing table updates and timing drifts. The latency chart shows which tunnels have experienced the highest transmission delay, generally as a result of congestion.
- **4. MOS** Mean opinion score is commonly used to measure the quality of audio and video. The value can be affected by loss, jitter and latency. The score can range from 1 to 5, a value of 4 is considered to be toll quality.

25 Rews							Search	
			<	>				
Appliance	Tunnel	Min MOS	Average MOS	Average MOS	Min MOS	Remote Tunnel	Remote Appliance	
DasMoines-Powars-Azure	to_EAST2-Virginia-AWS_REALTIME	0	1	4.38	0	to_DesMoines-Powers-Azure_REALTIME	EAST2-Virginia-AWS	
DesMoines-Powers-Azure	to_EAST2-Virginia-AWS_RECREATIONAL	0	1	4.38	0	to_DesMoines-Powers-Azure_RECREATIO	EAST2-Virginia-AW5	
DesMoines-Powers-Azure	to_EAST2-Virginia-AWS_ISOLATE	0	1	4,38	0	to_DesMoines-Powers-Azure_ISOLATE	EAST2-Virginia-AWS	
Cleveland-Campbell	to_EAST3-Charleston-Google_RECREATIO	0	1	4.37	0	to_Cleveland-Campbell_RECREATIONAL	EAST3-Charleston-Google	
EAST3-Charleston-Google	to_Richmond-Fehleisen_REALTIME	0	1	4.39	0	to_EAST3-Charleston-Google_REALTIME	Richmond-Fehleisen	
EAST3-Charleston-Google	to_SantaClara-Jaurigul_REALTIME	0	1		0	to_EAST3-Charleston-Google_REALTIME	SantaClara-Jaurigui	
EAST3-Charleston-Google	to_Wakefield-Thompson-A_REALTIME	0	1	4.33	0	to_EAST3-Charleston-Google_REALTIME	Wakefield-Thompson-A	
EAST3-Charleston-Google	to_Reading-Cook_REALTIME	0	1	4.32	0	to_EAST3-Charleston-Google_REALTIME	Reading-Cook	
EAST3-Charleston-Google	to_SantaClara-Jaurigui_RECREATIONAL	0	1		0	to_EAST3-Charleston-Google_RECREATIO	SantaClara-Jaurigui	
EAST3-Charleston-Google	to_Wakefield-Thompson-A_RECREATIONAL	0	1	4.33	0	to_EAST3-Charleston-Google_RECREATIO	Wakefield-Thompson-A	
EAST3-Charleston-Google	to_Reading-Cook_BUSINESS	0	1	4.34	0	to_EAST3-Charleston-Google_BUSINESS	Reading-Cook	
EAST3-Charleston-Google	to_Richmond-Fehleisen_BATCH	0	1	4.39	0	to_EAST3-Charleston-Google_BATCH	Richmond-Fehleisen	
EAST3-Charleston-Google	to_SantaClara-Jaurigui_BATCH	0	1		0	to_EAST3-Charleston-Google_BATCH	SantaClara-Jaurigui	
EAST3-Charleston-Google	to_Richmond-Fehleisen_BUSINESS	0	1	4.39	0	to_EAST3-Charleston-Google_BUSINESS	Richmond-Fehleisen	
EAST3-Charleston-Google	to_Kennesaw2-Powers_RECREATIONAL	0	1	4.38	0	to_EAST3-Charleston-Google_RECREATIO	Kennesaw2-Powers	
LosAngeles-Kollander1	to_EAST2-Virginia-AWS_BUSINESS	0	1	4.36	0	to_LosAngeles-Kollander1_BUSINESS	EAST2-Virginia-AWS	
EAST3-Charleston-Google	to_Richmond-Fehleisen_UNCLASSIFIED	0	1	4.39	0	to_EAST3-Charleston-Google_UNCLASSIF1	Richmond-Fehleisen	
EAST3-Charleston-Google	to. Wakefield-Thompson-A. BUSINESS	0	1	4.33	0	to EAST3-Charleston-Google BUSINESS	Wakefield-Thompson-A	

5. Alarms — for both Aruba Orchestrator and Aruba EdgeConnect Enterprise appliances with three filtering options: active, history and all. Alarms are categorized into four severity levels: critical, major, minor or warning. Critical alarms require immediate attention, while major alarms should be addressed within 24-hours. Minor and warning alarms can be addressed at a convenient time for IT. Email alarm recipients can be configured to receive either Aruba Orchestrator and/or appliance alarms.



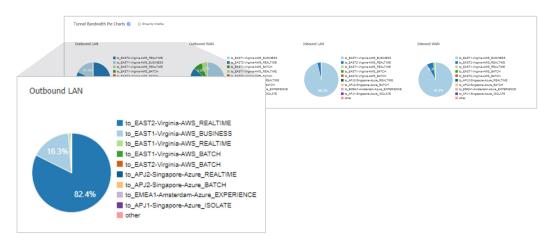
Health alarms summary of Aruba Orchestrator and appliances

Alarms 🕜	Alarm Email Reci				nge Sevenity Export C	
Active Hist	tory All					Select All Ack UnAck C
4 Rous						Search
Host Name	Nam Time	Severity	Source	Alarm Description	Recommended Action	
ianDiego-Vinc	19-Nov-18 10:25	Warning	/orchestrator/interfaces/o	Interface has bad IP address: wan0 interface has bad IP addre	No overlay tunnels will be built using this interface	
iantoClara-Ja	19-Nov-18 09:58	Plajor	/orchestrator/connectivity	Orchestrator cannot reach this appliance		
ianDiego-Vinc	16-Nov-18 20:55	Plajor	/orchestrator/orchestratio	Failed to apply templates	One or more templates failed to apply. Refer to Audit Lops for more details	
Drchestrator	16-Nov-18 20:52	Warning	/system/support	Silver Peak diagnostic remote access has been enabled from 2		

Alarms table describes each alarm and recommended action

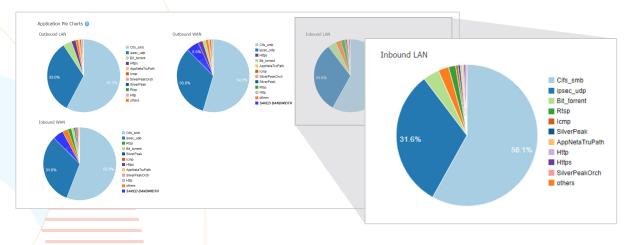


6. **Tunnel bandwidth pie charts** — show the proportion of bytes a tunnel consumes on the LAN and on the WAN. Mousing over the charts and the legends reveals additional information. The WAN charts identify the percentage of bandwidth the Aruba EdgeConnect Enterprise SD-WAN has saved by optimizing the traffic.



7. Application type and bandwidth consumption — application bandwidth charts show the amount of data transmitted and received by each application running across Aruba EdgeConnect Enterprise appliances on both the LAN and WAN sides of the network.

25 Rows			Search			
		Inbound	Outbound	Outbound		
Appliance	Reduction %	Bytes	Bytes	Reduction %		
EAST1-Virginia-AWS	0	21G	21G	0		
Tevatron-Powers	0	19G	4.6G	56.6		
Kennesaw2-Powers	21.2	1	.3G 20G	0		
WEST2-SanJose-AWS	53.2	4.4G	6.5G	17.5		
SauPaulo-Powers-AWS	29.0	6.9G	650M	52.1		
EAST3-Charleston-Google	0	1	101M 234M	0		
Denver1-Powers	0		76M 87M	0		
LakeForest-Amaya	0	1	150M 5.2M	0		
BentleyCreek-Barnhart	0		6.2M 85M	0		
Philly-Barnhart1-HA	0		89M 2.3M	0		
APJ1-Singapore-Azure	0		26M 19M	0		
EAST2-Virginia-AWS	0		31M 7.4M	0		
Boston-Kuruvilla	0		16M 8.5M	0		
Woodstock-Probst	0		13M 9.4M	0		
CrystalRiver-Powers	0		3.8M 18M	0		
Oceanport-Rodio	0		6.6M 2.6M	0		
Denver2-Powers	0		6.4M 2.6M	0		
Melbourne-Skarlatos	0		6.3M II 2.3M	0		





25 Rows					Search	
20110113					Jearch	
IPs			Inbound	Outbound		
	Domain	Top Destinations	Bytes	Bytes	Flows Started	Flows Ended
192.168.14.24	syn.siclid.net		422G	423G	248021	248168
192.168.17.7	57905456	11	402G	38)G	19464	19486
10.10.30.87			2346	234G	26105	26093
172.16.100.189			211G	212G	11527	11539
52.1.188.5			130G	2025	6	6
192.168.13.195			49G	231G	145710	145758
192.168.13.198		(III)	190G	17G	98247	98268
18.207.79.17			134G	71G	9	9
192.168.15.198			595	1+G	655	658
192.168.11.125	57905456		37G	35G	19168	19117
192.168.15.194		111 (III)	6.9G	38G	562	561
10.50.21.243			8.8G	28G	7889146	7889113
Others		<b>II</b>	176	166	8300051	8299345
192.168.14.111			136	12G	1064431	1064171
192.168.11.111		11m	9.95	116	652522	652692
192.168.45.4			9.26	9.26	1166	1142
192.168.11.77	57905456	(III)	9.7G	8.6G	3845725	3845710
4 35 238 237	neuhot mlah mlah3 iad05 measurement-lah orn	19	8.73	9.26	33	33

8. **Top-talker Charts** — list the IP addresses that have consumed the most bandwidth.

**9.** Flow counts by location — view, filter, and manage different types of flows for all or selected appliances. Network administrators can customize filters and options (i.e. host name, application, domain, protocol, VLAN ID, IP, Port, address map, location, inbound tunnel, outbound tunnel, etc.) to assist in troubleshooting and debugging.

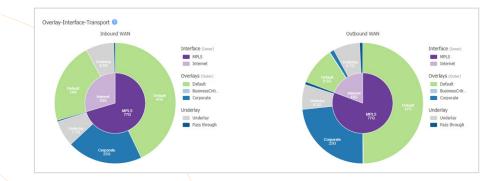
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1602 Broom													For	
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mator Powers	Oft mit			57905456(1992.568.57.79	49160	192,168,14,34	445	100	100	5254	189	to_EAST1-Vegeto-AVS_BATCH	to EAST1-Wrone-AWS BATCH	100 2500 36a
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AEST2-SanJose A/AS	Cifs_snib			10.20.20.07	51011	172.25.200.209	145	18		3.46 2724			to_SouPaulo Porrers /WS_B1TO1	20h 38m 31s
ContaGetevay-Powers	ipsec_udp	Ashburn United	Amazon Technolo		12556	\$2.1.198.5	11112	CE.		9.60 6.90		COPICAST (neidhop_10.0.0.1_via		3d 7h 45m 14s
tanta@stevay=Powers	ipsec_udp	Mountain View, U.			12556	25.105.40.104	11111	10		100 2.26		ATT (nedhop_45.30.43.1_wani		3d 7h 45m 54s
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KantaGatevay-Powers	iper_udp	Sen Francisco, Un.	Anazon Technolo	192.168.13.298	11101	\$2.52.103.139	11111	E.		875H 8.0G		ATT (nexthop_45.30.40.1_wan1	ATT	3d 7h 45m 15m



**10. Port Charts** — list the ports that have consumed the most bandwidth.

25 Rows			2	earch	
			Inbound	Outbound	
Ports	Description	Protocol	Bytes	Bytes	
445	Nicrosoft-ds	TCP	48G	489	
49160		ТСР	376	385	
11112	ipsec_udp	UDP	253	260	
11101	ipsec_udp	UDP	25G	2.00	
12556	ipsec_udp	UDP	932M	25G	
61915		тср	6.3G	6.4G	
6881	Bit_torrent	TCP	3.0G	3.26	
59974		TCP	2.50	2.56	
443	Https	TCP	2.36	2.6G	
0		TCP	2.16	2.2G	
60599		тср	1.86	1.8G	
0		ICMP	1.66	1.86	
50779		TCP	1.58	1.70	
51783		TCP	1.56	1.5G	
11111	ipsec_udp	UDP	729M	1.76	
554	Rtsp	тср	1.25	31M	
0		UDP	492M	545M	
3239	AppNetaTruPath	UDP	354M	446M	
45058		UDP	324M	417И	
12121		LIDP	235M	250/4	
49711		тор	278M	142M	
30	Http	TCP	267M	136M	
0		HOPOPT	132M		
51213		TCP	252M	3.3N	

**11. Overlay-Interface-Transport** — these charts display the distribution of traffic across three dimensions — overlays, interfaces, and transport. Each option can be viewed individually, or in relation to one another. For instance, for a given interface a network administrator is able to view how the overlay traffic is distributed. Also, administrators are also able to view how much traffic is transported from one Aruba EdgeConnect Enterprise appliance to another across the SD-WAN, in relation to how much traffic is broken out locally, direct to the internet.





Countries 📀		LAN WA				
25 Rows		Search				
	Inbound	Outbound				
Countries	Bytes	Bytes				
United States	326	32G				
Singapore	123M	121M				
lietherlands	29M	13M				
Ireland	4.1M	3.4N				
France	3.1M	3.1N				
United Kingdom	4.5M	1.3N				
Hong Kong	1.3M	1.3N				
Germany	1.6M	228K				
Austria	751K	523K				
Japan	401K	378K				
Canada	85K 196K					
Australia	58K	61K				
Thaland		14K				
Italy	15K	15K				
Taiwan Province of China		29K				
China	88	16K				
Brazil	608	1.1K				
Poland	76	304				
Iceland	76	304				
Czech Republic	168					
Russian Federation		127				
Ukraine		40				
Moldova Republic of		40				
Viet Nam	40	0				
Greece	0	32				

**12.** Country Charts — display bandwidth consumed by each country.

In summary, the Aruba EdgeConnect SD-WAN edge platform provides a wealth of contextual data that enables network managers to monitor the network and applications effortlessly and efficiently. The embedded real-time monitoring capabilities in the Aruba Orchestrator, enabling network administrators to operate and maintain the network with greater ease, efficiency and effectiveness.

By providing complete observability of the entire WAN through a single pane of glass, IT spends less time troubleshooting network and application bottlenecks and fielding support/help desk calls day and night. The Aruba EdgeConnect Enterprise platform ensures the highest quality of experience for both end users and IT. End users enjoy always-consistent, always-available application performance including the highest quality of voice and video, even over broadband. With adaptive local internet breakout, path conditioning and WAN optimization, Aruba enables IT to keep their application users productive and happy.

Aruba also frees IT to reclaim nights and weekends, with high availability and resiliency that keeps the network operational even when underlying transport links experience disruptions or outages. Centralized orchestration makes changes faster and easier, minimizing human errors that results in faster trouble resolution, ultimately making IT more responsive to the changing needs of the business.



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