

The background of the slide is a photograph of a modern interior space. It features a white ceiling with several long, rectangular, illuminated light fixtures hanging from it. The ceiling also has some dark, angular structural elements. Track lighting is visible on the right side of the ceiling. The overall aesthetic is clean and architectural.

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PAN-OS Best Practices Workshop

ZACHRY SUM - DIRECTOR OF TECHNICAL SERVICES, DIGITAL SCEPTER
COLEMAN NUGENT - SYSTEMS ENGINEER
JON ROBINSON - PRESIDENT, DIGITAL SCEPTER

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About Digital Scepter

-
- Security focused network integrator
 - Palo Alto Networks experts since 2007
 - Specialized in K-12 deployments
 - Working with over 100 districts, COEs, cities and counties



Service Catalog

- Firewall migrations
- Firewall operations - mass upgrades, backups, change/remove/add
- Firewall Healthchecks
- Panorama design
- Zero Trust Network Access
- Network Segmentation
- MFA
- SSL Decryption
- Inbound SSL Inspection
- Remote Access (“Always on”)
- Securing Cloud infrastructure
- Dual ISP redundancy
- Network engineering
- Endpoint Security/EDR/MDR



Contracts

- CMAS
- NASPO
- SPURR
- OMNIA Partners



Vendors

- Palo Alto Networks
 - CrowdStrike
 - SentinelOne
 - Okta
 - Arista
 - Juniper
 - HPe/Aruba
- AWS
 - Microsoft/Azure
 - Proofpoint
 - Zscaler
 - Gigamon
 - Rapid7
 - Knowbe4
 - Netskope

Agenda

- **Advanced Subscriptions** - difference compared to original subscriptions
- **Best Practices** - recommendations for different features across the platform
- **Zero Trust** - defined and how to configure
- **SSL Decryption** - breakdown of SSL outbound and inbound inspection
- **Network Segmentation** - brief overview of benefits to network segmentation and methods of implementation
- **GUI Walkthrough/Demos** - Review location of configuration items discussed and feature demonstrations

Advanced Subscriptions

Advanced URL Filtering

- Adds inline analysis for javascript exploits and phishing attacks
- Adds inline analysis of the SSL handshake to block traffic sooner based on SNI
- Delivered in real-time, without impacting the user
- These will be expanded in the future

Advanced URL Filtering will uncover attackers that were cloaking their attacks from web-crawlers and attacks that use new and unknown domains and URLs for phishing attacks.

Advanced URL Filtering

URL Filtering Profile

Name

url_outbound

Description

☐ Shared

☐ Disable override

Categories

URL Filtering Settings

User Credential Detection

HTTP Header Insertion

Inline Categorization

☒ Enable local inline categorization

☒ Enable cloud inline categorization

Exceptions

☐ CUSTOM URL CATEGORY/EDL

+ Add

- Delete

OK

Cancel

Advanced Threat Prevention

- Advanced Threat Prevention is integrated with Palo Alto's cloud-based threat analysis infrastructure, like Advanced URL filtering
- The ML-Models now run deep-learning on live traffic
- First ML-models focus on command-and-control (C2) tactics like those used by Cobalt Strike. Stops 96% of these new tactics. 48% improvement over regular TP tactics
- PAN-OS Nova (11.0) adds ML models to focus on injection attacks. 90% of attacks stopped on unpatched systems and 60% improvement on 0-day injection attacks.
- ML models have to be trained. Palo Alto has the largest pile of threat analysis thanks to Wildfire and a huge customer base. The cloud security infrastructure will be improved with more threat models in the future.

Advanced Threat Prevention

Action plan:

- License Advanced Threat Prevention
- Enable inline ML models on anti-spyware and vulnerability protection security profiles
- Enable outbound/inbound SSL Decrypt to ensure threat prevention is applied to encrypted traffic

Advanced Threat Prevention

Anti-Spyware Profile

Name

as_standard

Description

☐ Shared

☐ Disable override

Signature Policies

Signature Exceptions

DNS Policies

DNS Exceptions

Inline Cloud Analysis

☒ Enable cloud inline analysis

Available Analysis Engines

5 items

MODEL	DESCRIPTION	ACTION
HTTP Command and Control detector	Machine Learning engine to detect HTTP based command and control traffic	reset-both
HTTP2 Command and Control detector	Machine Learning engine to detect HTTP2 based command and control traffic	reset-both
SSL Command and Control detector	Machine Learning engine to detect SSL based command and control traffic	reset-both
Unknown-TCP Command and Control detector	Machine Learning engine to detect Unknown-TCP based command and control traffic	reset-both
Unknown-UDP Command and Control detector	Machine Learning engine to detect Unknown-UDP based command and control traffic	reset-both

Exclude from Inline Cloud Analysis

☐ EDL URL

☐ IP ADDRESS

OK

Cancel

Advanced Threat Prevention

Vulnerability Protection Profile

Name

vp_standard

Description

☐ Shared

☐ Disable override

Rules

Exceptions

Inline Cloud Analysis

☒ Enable cloud inline analysis

Available Analysis Engines

2 items

→

×

MODEL	DESCRIPTION	ACTION
	attacker inserts SQL queries into an applications request	
Command Injection	Detects a common hacking technique that allows an attacker to execute arbitrary operating system (OS) commands on the server	reset-both

Exclude from Inline Cloud Analysis

☐ EDL URL ^

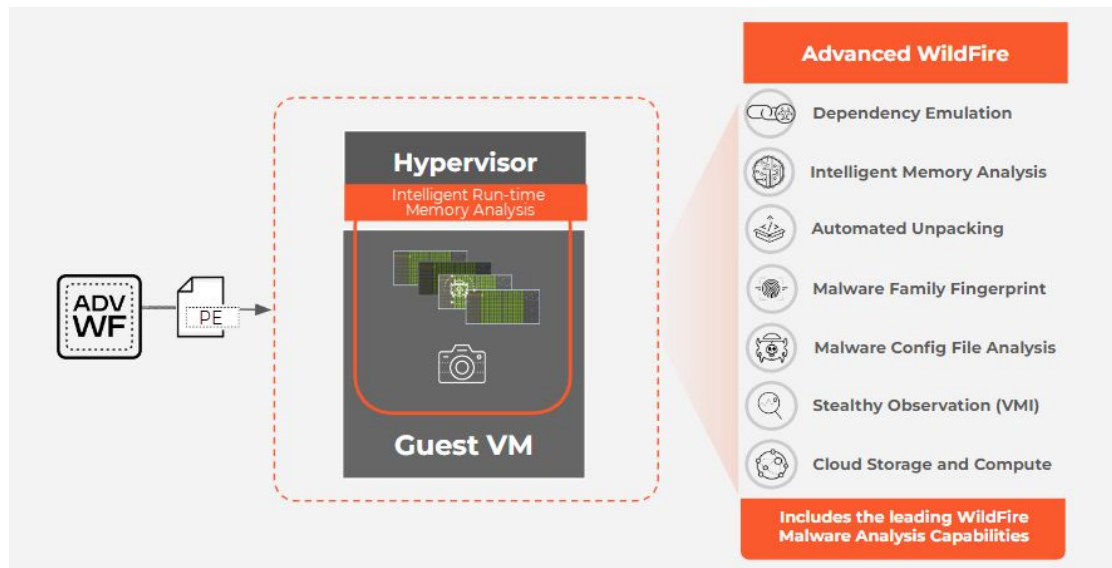
☐ EDL IP ^

OK

Cancel

Advanced Wildfire

- Adds Intelligent Run-time Memory Analysis to Wildfire submissions



Best Practices

Security Profiles

- Create security profile groups based on direction of traffic flow, e.g. inbound, outbound, or internal traffic
- Likewise, create security profile groups based on direction and attach these to appropriate policies
- Exceptions on security profiles should be made as specific as possible to avoid broadly disabling protections

Antivirus

- Reset-both should be default for http, http2, ftp, and smb
- Reset-both can and should be set for imap, pop3, and smtp if it won't interfere with corporate mail flow—this should be handled by spam filter so you don't lose quarantine capability
- Signature Action column requires TP or advanced TP subscription, Wildfire Action columns require WF subscription

Antivirus Profile ⓘ

Name

Description

☐ Shared

☐ Disable override

Action | Signature Exceptions | WildFire Inline ML

☐ Enable Packet Capture

Decoders

PROTOCOL ^	SIGNATURE ACTION	WILDFIRE SIGNATURE ACTION	WILDFIRE INLINE ML ACTION
ftp	reset-both	reset-both	reset-both
http	reset-both	reset-both	reset-both
http2	reset-both	reset-both	reset-both
imap	alert	alert	alert
pop3	alert	alert	alert
smb	reset-both	reset-both	reset-both
smtp	alert	alert	alert

Anti-Spyware

- Reset-both should be used for critical, high, and medium
- Default (not alert) should be set for low and informational
- This requires Threat Prevention or Advanced Threat Prevention subscription

Anti-Spyware Profile ?

Name

as_outbound

Description

☐ Shared

☐ Disable override

Signature Policies

Signature Exceptions

DNS Policies

DNS Exceptions

Inline Cloud Analysis

<input type="checkbox"/>	POLICY NAME	SEVERITY	ACTION	PACKET CAPTURE
<input type="checkbox"/>	Block-Critical-High-Medium	high critical medium	reset-both	single-packet
<input type="checkbox"/>	Default-Low-Info	low informational	default	disable

Anti-Spyware

- Default-paloalto-dns signature source should be set to sinkhole. Block is also okay here, but sinkhole can offer additional visibility into infected endpoints on your network
- This requires Threat Prevention or Advanced Threat Prevention subscription

Anti-Spyware Profile ?

Name

Description

☐ Shared

☐ Disable override

Signature Policies | Signature Exceptions | **DNS Policies** | DNS Exceptions | Inline Cloud Analysis

DNS Policies

10 items

<input type="checkbox"/>	SIGNATURE SOURCE	LOG SEVERITY	POLICY ACTION	PACKET CAPTURE
	Palo Alto Networks Content			
<input type="checkbox"/>	default-paloalto-dns		sinkhole	single-packet

URL Filtering

At a minimum, it is recommended to block the following URL categories:

- Adult
- Command-and-control
- Copyright-infringement
- Dynamic-dns
- Encrypted-dns
- Extremism
- Grayware
- Hacking
- Malware
- Parked
- Phishing
- Proxy-avoidance-and-anonymizers
- Ransomware
- Unknown (should review unknown URL logs prior to blocking this category)

URL Filtering

A note on blocking unknown URLs:

This is a great way to block new URLs that phishing attacks are using, but any of your apps using IP addresses instead of domain names may be categorized as unknown. Public sites that utilize source-based whitelisting will also show as unknown. Run a report ahead of time to see what this will block and make adjustments to security profiles to except them. Using separate profiles for internet traffic from datacenter traffic is recommended.

URL Filtering

It is recommended to consider blocking these URL categories:

- Newly-registered-domain
- Questionable

URL Filtering

It is recommended to alert on the remaining URL categories:

Important Note: Real-time-detection (requires Advanced URL sub) should be set to alert

URL Filtering

- Log container page only should be turned off if you want to maximize visibility
- HTTP Header Logging should be used if there are proxies on the network

URL Filtering Profile

Name

url_outbound

Description

☐ Shared

☐ Disable override

Categories

URL Filtering Settings

User Credential Detection

HTTP Header Insertion

Inline Categorization

☐ Log container page only

☐ Safe Search Enforcement

HTTP Header Logging

☒ User-Agent

☒ Referer

☒ X-Forwarded-For

OK

Cancel

URL Filtering

- Credential Theft Prevention should be enabled utilizing domain credential filter
- This requires a Server 2019 RODC on your network and works best in tandem with SSL Decryption

The screenshot shows the 'URL Filtering Profile' configuration window. At the top, the title bar reads 'URL Filtering Profile' with a help icon. Below the title bar, there are fields for 'Name' (containing 'url_outbound') and 'Description'. Under the 'Description' field, there are two checkboxes: 'Shared' and 'Disable override', both of which are unchecked. Below these fields is a horizontal tab bar with five tabs: 'Categories', 'URL Filtering Settings', 'User Credential Detection' (which is selected and highlighted with a blue underline), 'HTTP Header Insertion', and 'Inline Categorization'. Under the 'User Credential Detection' tab, there is a section titled 'User Credential Detection' containing a dropdown menu labeled 'Use Domain Credential Filter'. Below this, there is a section titled 'Log Severity' containing a dropdown menu labeled 'Valid Username Detected Log Severity' with the value 'high' selected. At the bottom right of the window, there are two buttons: 'OK' (in blue) and 'Cancel' (in white with a grey border).

URL Filtering

Action plan:

- Make sure categories are not set to 'allow' (use 'alert' instead)
- Make sure any rules that permit traffic to leave your network have your outbound security profile group applied
- Leverage User-ID groups for permitting varying levels of internet access
- Enable Credential Theft Prevention to further reduce risk of phishing attacks and password reuse

File Blocking

At a minimum, it is recommended to block the following file types:

- Chm - Microsoft Compiled HTML Help file
- Hlp - Windows Help file
- Multi-level-encoding - File that's been compressed 4+ times
- Ocx - Windows ActiveX Control file
- Scr - Windows screensaver file
- Torrent

Everything else should be set to alert

Wildfire

- Forward all supported file types to Wildfire for analysis
- Wildfire submission isn't necessarily required for internal traffic, although there are benefits

WildFire Analysis Profile ?

Name

wf_standard

Description

☐ Shared

☐ Disable override

NAME

APPLICATIONS

FILE TYPES

DIRECTION

ANALYSIS

1 item

→

×

☐

Forward-All

any

any

both

public-cloud

+

Add

-

Delete

OK

Cancel

Wildfire

- Wildfire Signature action and inline ML action should be set identically to your antivirus signature action
- Wildfire Inline ML models should all be enabled

Antivirus Profile

Name

av_outbound

Description

☐ Shared

☐ Disable override

Action

Signature Exceptions

WildFire Inline ML

☐ Enable Packet Capture

Decoders

PROTOCOL ^	SIGNATURE ACTION	WILDFIRE SIGNATURE ACTION	WILDFIRE INLINE ML ACTION
ftp	reset-both	reset-both	reset-both
http	reset-both	reset-both	reset-both
http2	reset-both	reset-both	reset-both
imap	alert	alert	alert
pop3	alert	alert	alert
smb	reset-both	reset-both	reset-both
smtp	alert	alert	alert

Antivirus Profile

Name

av_outbound

Description

☐ Shared

☐ Disable override

Action

Signature Exceptions

WildFire Inline ML

Available Models

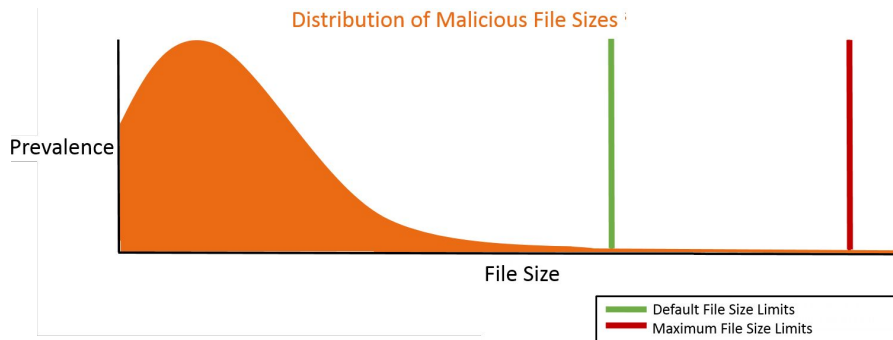
Q

6 items → ×

MODEL	DESCRIPTION	ACTION SETTING
Windows Executables	Machine Learning engine to dynamically identify malicious PE files	enable (inherit per-protocol actions)
PowerShell Script 1	Machine Learning engine to dynamically detect malicious PowerShell scripts with known length	enable (inherit per-protocol actions)
PowerShell Script 2	Machine Learning engine to dynamically detect malicious PowerShell scripts without known	enable (inherit per-protocol actions)

Wildfire

- PAN recommends setting file size limits to default values based on observed distribution of malware



FILE TYPE	PAN-OS 9.0 AND LATER FILE-FORWARDING MAXIMUM SIZE RECOMMENDATIONS	PAN-OS 8.1 FILE-FORWARDING MAXIMUM SIZE RECOMMENDATIONS
pe	16MB	10MB
apk	10MB	10MB
pdf	3,072KB	1,000KB
ms-office	16,384KB	2,000KB
jar	5MB	5MB
flash	5MB	5MB
MacOSX	10MB	1MB
archive	50MB	10MB
linux	50MB	10MB
script	20KB	20KB

Wildfire

- Allow forwarding of decrypted content
 - Device > Setup > Content-ID

Content-ID Settings

☒

Allow forwarding of decrypted content

Extended Packet Capture Length (packets)

25

☐

Forward segments exceeding TCP App-ID inspection queue

☐

Forward segments exceeding TCP content inspection queue

☐

Forward datagrams exceeding UDP content inspection queue

☐

Allow HTTP partial response

OK

Cancel

DNS Security

- DNS is fundamental to using any network
- Controlling DNS you can stop attacks at the beginning of the attack lifecycle but also in the middle and the end
- Palo Alto had a list of bad domains on the firewall based on intel from Wildfire, etc. but DNS Security now moves it to the cloud-based security architecture, which means the list size is basically infinite and takes advantage of the ML model architecture like the other subscriptions

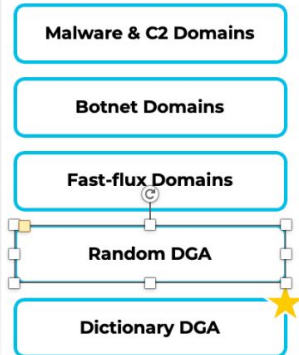
DNS Security

- More than just blocking bad domains
- Looks at malicious usage of the protocol, e.g. tunneling
- Can see all DNS traffic through the box, not just from systems configured to use your approved DNS servers

DNS Security

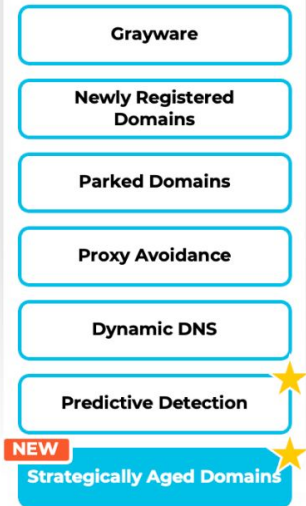
Callback Domains

DNS-based indirection for reliable phone-home



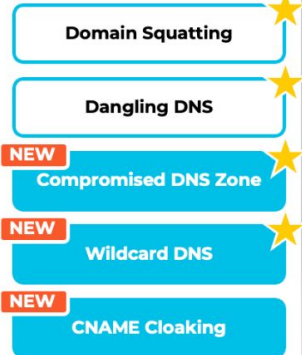
High Risk Domains

Proactive protection from likely malicious domains



DNS Record Attacks

Domain takeovers through DNS zone hacks and abuse



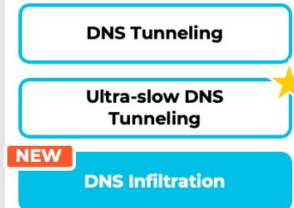
DNS Protocol Attacks

DDoS, exploitation, and lateral movement



Covert Channels

Abuse of DNS protocol for stealthy data theft and C2



★ Industry First

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DNS Security

- Since malicious DNS requests are indicators of compromise, it's a good input for automating response, e.g. adding the IP address to a block list for limited network access, send to endpoint tools, etc.

DNS Security

Anti-Spyware Profile

NameSinkhole

Description

Signature Policies | Signature Exceptions | DNS Policies | DNS Exceptions | Inline Cloud Analysis

DNS Policies

10 items

<input type="checkbox"/>	SIGNATURE SOURCE	LOG SEVERITY	POLICY ACTION	PACKET CAPTURE
▼	Palo Alto Networks Content			
<input type="checkbox"/>	default-paloalto-dns		sinkhole	extended-capture
▼	DNS Security			
<input type="checkbox"/>	Ad Tracking Domains	default (informational)	default (allow)	disable
<input type="checkbox"/>	Command and Control Domains	default (high)	default (block)	disable
<input type="checkbox"/>	Dynamic DNS Hosted Domains	default (informational)	default (allow)	disable
<input type="checkbox"/>	Grayware Domains	default (low)	default (block)	disable
<input type="checkbox"/>	Malware Domains	default (medium)	default (block)	disable
<input type="checkbox"/>	Parked Domains	default (informational)	default (allow)	disable
<input type="checkbox"/>	Phishing Domains	default (low)	default (block)	disable

DNS Sinkhole Settings

Sinkhole IPv4Palo Alto Networks Sinkhole IP (sinkhole.paloaltonetworks.com)

Sinkhole IPv6IPv6 Loopback IP (::1)

Block DNS Record Types

☐ SVCB☐ HTTPS☐ ANY

OK

Cancel

External Dynamic Lists

- Make sure you have rules blocking the predefined EDL's inbound and outbound

<input type="text"/>				
<input type="checkbox"/>	NAME	LOCATION	DESCRIPTION	SOURCE
▼ Dynamic IP Lists				
<input type="checkbox"/>	Palo Alto Networks - Tor exit IP addresses	Predefined	IP addresses supplied by multiple providers and validated with Palo Alto Networks threat intelligence data as active Tor exit nodes. Traffic from Tor exit nodes can serve a legitimate purpose, however, is disproportionately associated with malicious activity, especially in enterprise environments.	Palo Alto Networks - Tor exit IP addresses
<input type="checkbox"/>	Palo Alto Networks - Bulletproof IP addresses	Predefined	IP addresses that are provided by bulletproof hosting providers. Because bulletproof hosting providers place few, if any, restrictions on content, attackers can use these services to host and distribute malicious, illegal, and unethical material.	Palo Alto Networks - Bulletproof IP addresses
<input type="checkbox"/>	Palo Alto Networks - High risk IP addresses	Predefined	IP addresses that have recently been featured in threat activity advisories distributed by high-trust organizations. However, Palo Alto Networks does not have direct evidence of maliciousness for these IP addresses.	Palo Alto Networks - High risk IP addresses
<input type="checkbox"/>	Palo Alto Networks - Known malicious IP addresses	Predefined	IP addresses that are currently used almost exclusively by malicious actors for malware distribution, command-and-control, and for launching various attacks.	Palo Alto Networks - Known malicious IP addresses

Device Settings

Check	Location	Recommended Setting	Default?
Rematch Sessions	Device > Setup > Session > Session Settings	Enabled	Yes (as of PAN-OS 5.0)
Management TLS Mode set to TLS 1.3 only	Device > Setup > Management > General Settings	TLS 1.3 only (1.2 if pre-PAN-OS 11)	No
Enable log on high DP load	Device > Setup > Management > Logging and Reporting > Log Export and Reporting	Enabled	No
Log Admin Activity (sends to a syslog server)	Device > Setup > Management > Logging and Reporting > Log Export and Reporting	Enabled	No
Forward segments exceeding content inspection queues	Device > Setup > Content-ID > Content-ID Settings	Disabled	No
Forward segments exceeding TCP out of order queue	Device > Setup > Session > TCP Settings	Enabled	No

Device Settings

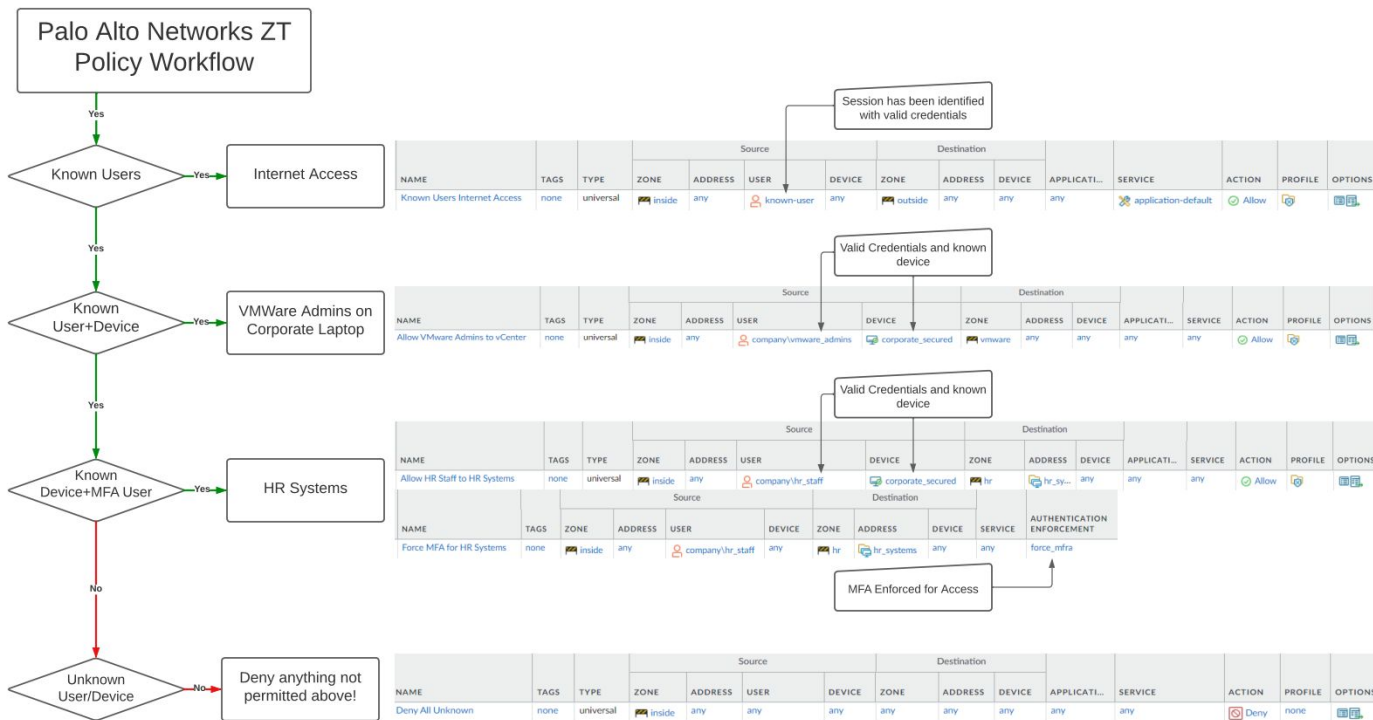
Check	Location	Recommended Setting	Default?
Log traffic not scanned	Device > Setup > Content-ID > URL Inline Cloud Categorization Device > Setup > Content-ID > Threat Prevention Inline Cloud Analysis	Enabled	No
Strip-X-Forwarded-For header	Device > Setup > Content-ID > X-Forwarded-For-Headers	Enabled	No

Zero Trust

What is Zero Trust?

- Zero trust is a concept that no user or device should be inherently trusted, whether inside or outside of a corporate network. Instead **all** traffic should be, by default, dropped. Required traffic flows should then be explicitly permitted based on principles of least privilege. Traffic should be validated against the following:
 - **Known User** - authenticated frequently with multiple factors
 - **Known Device** - corporate managed and secured with next-gen antivirus
 - **Source/Destination** - specific source and destination address
 - **Service** - nailed down for static ports, or application-default for dynamic ports
 - **Application** - static list of applications as required for inbound/internal traffic, application filters for outbound access
 - **URL Category** - an optional match condition that can be used in place of or in conjunction with a destination address

Zero Trust Policy Flow



Zero Trust Journey

The idea of getting to a zero trust model can be overwhelming. Try to break it into manageable chunks of work. For example:

- Enable inbound inspection and convert inbound rules to use App-id
- Create internet access rules based on application filters
- Add User-ID to policies that enable access to critical systems
- Add MFA to GlobalProtect
- Analyze the rulebase and try to find 3 things that you can change to improve security

Zero Trust Prioritization

1. MFA for remote access
 - Email or SMS alerts for successful logins from outside of the US
(status eq 'success') and (srcregion neq 'US') and ((eventid eq 'portal-auth') or (eventid eq 'gateway-auth'))
2. Security Profiles
3. User-ID
4. SSL Decryption
5. App-ID
6. Device-ID

SSL Decryption

SSL Decryption Benefits

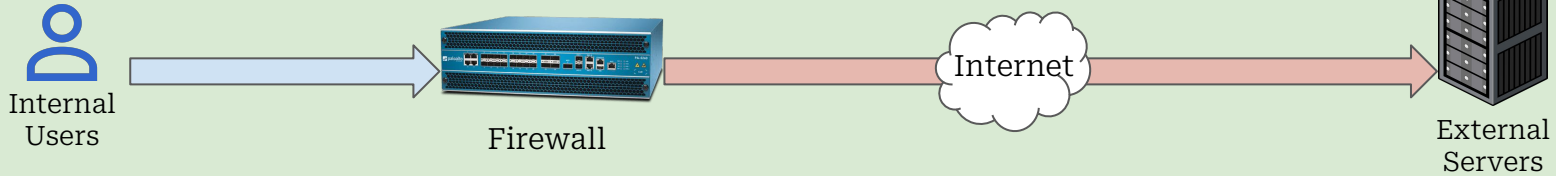
- App-ID visibility
- Granular app control
- Threat Prevention
- Full URL visibility
- File download/upload visibility

Types of Decryption

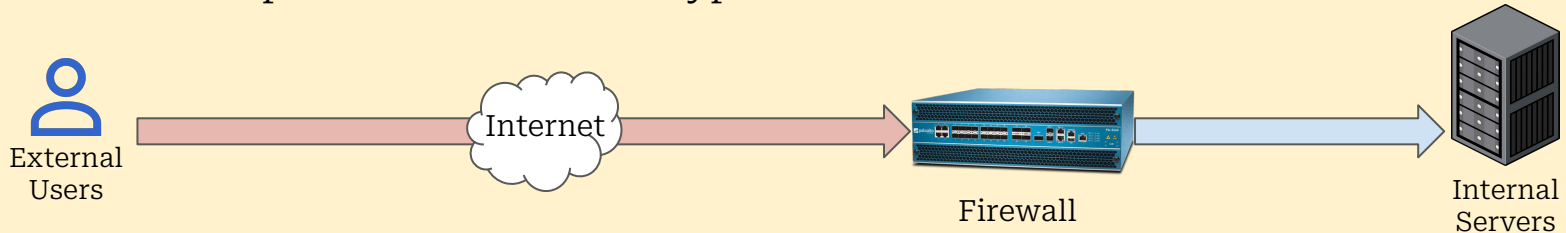
- SSL Forward Proxy (Outbound Decryption)
 - Provides the firewall with visibility into encrypted traffic originating from users within your network
- SSL Inbound Inspection (Inbound Decryption)
 - Provides the firewall with visibility into encrypted traffic originating from the internet destined to servers on your network

Inbound vs Outbound

SSL Forward Proxy (Outbound Decryption)



SSL Inbound Inspection (Inbound Decryption)



What the firewall sees *without* decryption

```
.....uJ...l.>k.;.;g.....1.....k.}>l.h.>.o0...|.....~  
.. ".....+./.....,0.  
...../.....5.....example.com.....  
.....#.....h2.http/1.1.....".  
.....3.k.i..  
X.-DS..!c..>...d.....fG.9..}.....A...Q...   }.[G.....Nr}r...6S!y.....5.!,..!...o..E.S.Zte\../...+.....  
.....-.....@.....x..{t....'..{.....*..bs  
j.S ...k.}>l.h.>.o0...|.....~  
.....O.+.....3.E...A..r...0{.(.....!@.L.....0:.....-.....~....Loep.\.".....<k.T.7v...u....Mm.H|.  
tal.IXB.....a _M[K..!..*...9.....5.U.....^/W.b :r...s.]n.@.....d...5.w....  
.....5..dx..0..O.Lm.....w.yo.....Ep.....c1EL...2.q.f.3.O.t.=C.Y.k.n...fw.r.?9.=T..>.....O~...d,QB.m.kl.a.Q.  
...YUM.y.n...4=..[.g...h...}.....<..6.&7..."..B.T.;L.i.E.<r.""../.Snx..K..  
..rj..zBX.sE.u.....{~.A.Z@L.Y.  
..{...`Ynh..*;;!.....&2.T.V2e.,B....J...^!"v.teC..W!'..k....  
..X.L..~NUw.....S..Hc"|....7...9...7A.@.+...F...u.d...6.Q...z..R.5.C.....z_..*D..F....*Ct9J.....by.....,jh.|.&/E.GfOY]...;-...(kE.a.....  
..s...?....&d.)....C.....e.#3f.a...:D.....U...1..Ut..)?.?....P.V\ ".....  
....<...r3[.....,R.
```

What the firewall sees *without* decryption

Detailed Log View

Detailed Log View												
General					Source				Destination			
Session ID 1487					Source User				Destination User			
Action allow					Source 10.9.20.50				Destination 10.1.64.50			
Action Source from-policy					Source DAG				Destination DAG			
Host ID					Country 10.0.0.0-10.255.255.255				Country 10.0.0.0-10.255.255.255			
Application ssl					Port 61208				Port 443			
Rule Allow Nugent and Sum In Through SDWAAAAAN					Zone sdwan				Zone demolition			
Rule UUID 3ba1a9c5-12ce-4945-af72-a1c7e889d9be					Interface ae1.912				Interface ae1.1646			
CAP	RECEIVE TIME ^	TYPE	APPLICATION	ACTION	RULE	RULE UUID	BYTES	SEVERITY	CATEGORY	URL CATEGORY LIST	VERDICT	URL
	2023/10/10 19:46:57	end	ssl	allow	Allow Nugent and Sum In Through SDWAAAAAN	3ba1a9c5-12ce-49...	230373		computer-and-internet-info			
	2023/10/10 19:46:48	url	ssl	alert	Allow Nugent and Sum In Through SDWAAAAAN	3ba1a9c5-12ce-49...		informational	computer-and-internet-info	computer-and-internet-info,low-risk		demolition.int.digit...
	2023/10/10 19:46:48	url	ssl	alert	Allow Nugent and Sum In Through SDWAAAAAN	3ba1a9c5-12ce-49...		informational	computer-and-internet-info	computer-and-internet-info,low-risk		demolition.int.digit...
	2023/10/10 19:46:48	url	ssl	alert	Allow Nugent and Sum In Through SDWAAAAAN	3ba1a9c5-12ce-49...		informational	computer-and-internet-info	computer-and-internet-info,low-risk		demolition.int.digit...

What the firewall sees *with* decryption

GET /classes/details?id=CS101 DROP TABLE STUDENTS; HTTP/1.1

Host: example.com

User-Agent: Mozilla/5.0 (X11; Ubuntu; Linux x86_64; rv:98.0) Gecko/20100101 Firefox/98.0

Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/avif,image/webp,*/*;q=0.8

Accept-Language: en-US,en;q=0.5

Accept-Encoding: gzip, deflate

Connection: keep-alive

Upgrade-Insecure-Requests: 1

Pragma: no-cache

Cache-Control: no-cache

HTTP/1.1 200 OK

Content-Encoding: gzip

Accept-Ranges: bytes

Age: 460608

Cache-Control: max-age=604800

Content-Type: text/html; charset=UTF-8

Date: Mon, 21 Mar 2022 23:54:11 GMT

What the firewall sees *with* decryption

Detailed Log View

General				Source				Destination				
Session ID 11533				Source User				Destination User				
Action allow				Source 10.6.0.100				Destination 10.1.64.50				
Action Source from-policy				Source DAG				Destination DAG				
Host ID				Country 10.0.0.0-10.255.255.255				Country 10.0.0.0-10.255.255.255				
Application web-browsing				Port 53776				Port 443				
Rule Allow Nugent and Sum In Through SDWAAAAAN				Zone nugent				Zone demolition				
Rule UUID 3ba1a9c5-12ce-4945-af72-a1c7e889d9be				Interface tunnel3				Interface ae1.1646				
Session End Reason threat				X-Forwarded-For IP 0.0.0.0								
PCAP	RECEIVE TIME ^	TYPE	APPLICATION	ACTION	RULE	RULE UUID	BYTES	SEVERITY	CATEGORY	URL CATEGORY LIST	VERDICT	URL
	2023/10/10 20:03:12	end	web-browsing	allow	Allow Nugent and Sum In Through SDWAAAAAN	3ba1a9c5-12ce-4...	83820		computer-and-internet-info			
	2023/10/10 20:01:51	vulnerability	web-browsing	reset-both	Allow Nugent and Sum In Through SDWAAAAAN	3ba1a9c5-12ce-4...		high	computer-and-internet-info			demolition.int.digit...
	2023/10/10 20:01:51	url	incomplete	alert	Allow Nugent and Sum In Through SDWAAAAAN	3ba1a9c5-12ce-4...		informational	computer-and-internet-info	computer-and-internet-info,low-risk		demolition.int.digit...
	2023/10/10 20:01:51	url	web-browsing	alert	Allow Nugent and Sum In Through SDWAAAAAN	3ba1a9c5-12ce-4...		informational	computer-and-internet-info	computer-and-internet-info,low-risk		demolition.int.digit...

SSL Forward Proxy - What's Required

- Private CA Certificate trusted by all endpoints/browsers
- Periodic exclusions for sites that don't support decryption
 - Certificate pinning
 - Client-cert authentication

SSL Forward Proxy - Certificate Authority Options

- PAN firewall Self-Signed Certificate
 - Less secure, but doesn't require in-house certificate infrastructure
 - Requires distribution of PAN certificate to machines
- Subordinate CA template to PAN firewall from enterprise CA
 - Simple revocation if PAN private key is compromised
 - Does not need to be distributed to domain-joined machines since enterprise CA should already be trusted

SSL Forward Proxy - What to Decrypt

- Decrypt all URL categories except those that contain sensitive, private data, such as:
 - Financial-services
 - Health-and-medicine
 - Shopping
- Start with a test group as shown below. Only three users are being decrypted. As testing progresses, expand test group

	Name	Tags	Source			Destination		URL Category	Service	Action	Type
			Zone	Address	User	Zone	Address				
1	Protect Confidential	none	 inside  vpn	any	any	 outside	any	financial-services health-and-medic.. shopping	any	no-decrypt	ssl-forward-proxy
2	Decrypt Users	none	 inside  vpn	any	 ds\jrobinson  ds\maverick  ds\zsum	 outside	any	any	any	decrypt	ssl-forward-proxy

SSL Forward Proxy - Important Settings

- Decrypted files should be sent to WildFire
 - Device > Setup > Content-ID > Content-ID Settings

Content-ID Settings



Allow forwarding of decrypted content

Extended Packet Capture Length (packets)



25



Forward segments exceeding TCP App-ID inspection queue



Forward segments exceeding TCP content inspection queue



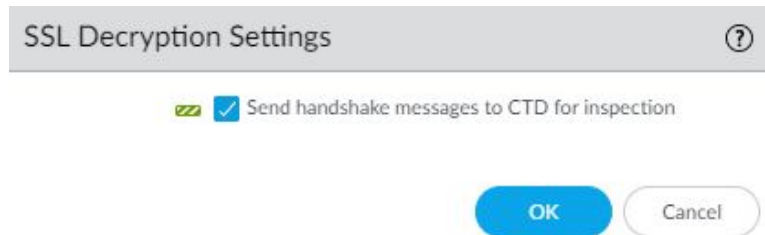
Forward datagrams exceeding UDP content inspection queue



Allow HTTP partial response

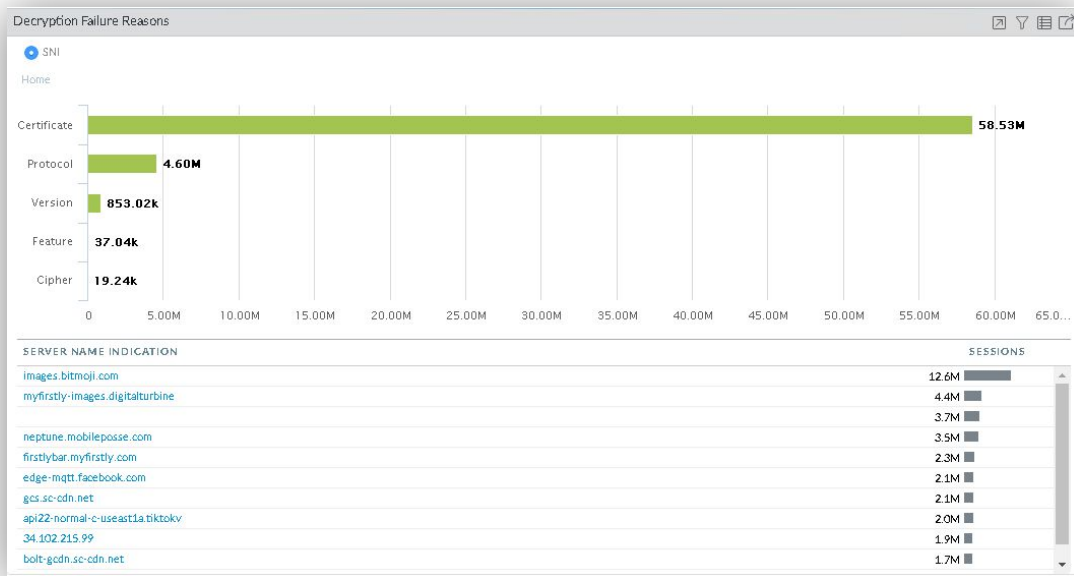
SSL Forward Proxy - Important Settings

- (PAN-OS 11 only) Enable inspection of SSL handshake messages
 - Device > Setup > Session > SSL Decryption Settings



SSL Forward Proxy - Decryption Failures

- Find unsupported sites
- Decide if exclusions should be made
- Create exclusion globally or on a per-user/per-IP basis



SSL Inbound Inspection - What's Required

- Certificates for servers you want to inspect, e.g. company wildcard, www, etc.
- Endpoint, PAN firewall, and server all need to support common cipher suite

SSL Decryption - Time to Configure

- It is recommended to be running PAN-OS $\geq 10.1.0$ for better cipher support with inbound inspection
- Get a list of all the services you want to decrypt
- Identify any need for specific TLS versions or ciphers
- Gather certificates for all services
- Import all certificates into the firewall
- Create a decryption profile
- Create decryption rules to decrypt inbound/outbound connections
- Validate that applications work as expected

SSL Decryption - Time to Configure

NAME	LOCATION	TAGS	Source				Destination			URL CATEGORY	SERVICE	ACTION		TYPE
			ZONE	ADDRESS	USER	DEVICE	ZONE	ADDRESS	DEVICE					
inspect github	labfw01	none	globalprotect	any	any	any	inside	10.1.131.35/32	any	any	any	decrypt		ssl-inbound-inspection

Decryption Policy Rule

General | Source | Destination | Service/URL Category | **Options** | Target

Action: Decrypt

Type: SSL Inbound Inspection

Certificates: ☐ CERTIFICATES ^

☐ github

+ Add - Delete

Decryption Profile: dp_standard

Log Settings: ☐ Log Successful SSL Handshake

☒ Log Unsuccessful SSL Handshake

Log Forwarding: If standard

Packet Broker Profile: None

To decrypt and forward TLS traffic on PAN-OS (Seattle version or later), use Network packet Broker Policy. Decryption Broker configurations work only on PAN-OS 10.0 and earlier.

OK

Cancel

GENERATE TIME	TYPE	FROM ZONE	TO ZONE	SOURCE	SOURCE USER	DESTINATION	DECRYPTED	TO PORT	APPLICATION	ACTION	RULE	SESSION END REASON
03/31 17:13:57	end	vpn	inside	172.21.2.7	ds\zsum	10.1.131.35	yes	443	websocket	allow	Allow Admins to Inside	tcp-fin
03/31 16:51:45	end	vpn	inside	172.21.2.7	ds\zsum	10.1.131.35	yes	443	git-base	allow	Allow Admins to Inside	aged-out
03/31 16:51:34	end	vpn	inside	172.21.2.7	ds\zsum	10.1.131.35	yes	443	github-base	allow	Allow Admins to Inside	aged-out
03/31 16:51:33	end	vpn	inside	172.21.2.7	ds\zsum	10.1.131.35	yes	443	github-base	allow	Allow Admins to Inside	aged-out
03/31 16:46:28	end	vpn	inside	172.21.2.7	ds\zsum	10.1.131.35	yes	443	github-base	allow	Allow Admins to Inside	aged-out
03/31 16:41:54	end	vpn	inside	172.21.2.7	ds\zsum	10.1.131.35	yes	443	websocket	allow	Allow Admins to Inside	tcp-fin
03/31 16:41:23	end	vpn	inside	172.21.2.7	ds\zsum	10.1.131.35	yes	443	github-base	allow	Allow Admins to Inside	aged-out
03/31 16:36:20	end	vpn	inside	172.21.2.7	ds\zsum	10.1.131.35	yes	443	github-base	allow	Allow Admins to Inside	aged-out
03/31 16:31:17	end	vpn	inside	172.21.2.7	ds\zsum	10.1.131.35	yes	443	github-base	allow	Allow Admins to Inside	aged-out
03/31 16:26:45	end	vpn	inside	172.21.2.7	ds\zsum	10.1.131.35	yes	8443	github-base	allow	Allow Admins to Inside	aged-out
03/31 16:26:45	end	vpn	inside	172.21.2.7	ds\zsum	10.1.131.35	yes	8443	github-base	allow	Allow Admins to Inside	aged-out
03/31 16:26:13	end	vpn	inside	172.21.2.7	ds\zsum	10.1.131.35	yes	443	github-base	allow	Allow Admins to Inside	aged-out
03/31 16:21:19	end	vpn	inside	172.21.2.7	ds\zsum	10.1.131.35	yes	443	git-base	allow	Allow Admins to Inside	aged-out
03/31 16:21:08	end	vpn	inside	172.21.2.7	ds\zsum	10.1.131.35	yes	443	github-base	allow	Allow Admins to Inside	aged-out
03/31 16:21:07	end	vpn	inside	172.21.2.7	ds\zsum	10.1.131.35	yes	443	github-base	allow	Allow Admins to Inside	aged-out
03/31 16:16:03	end	vpn	inside	172.21.2.7	ds\zsum	10.1.131.35	yes	443	github-base	allow	Allow Admins to Inside	aged-out
03/31 16:10:59	end	vpn	inside	172.21.2.7	ds\zsum	10.1.131.35	yes	443	github-base	allow	Allow Admins to Inside	aged-out

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Network Segmentation

Overview

- Network segmentation is the process of classifying assets into unique subnets on your network with the intent of firewalling between these subnets
- Firewalling these subnets is generally achieved by making the firewall the default gateway for the subnets assets are on, but another common option is using VRFs to force inter-subnet traffic through a firewall

Benefits

- Content inspection between subnets
 - Prevent lateral spread of threats
- App-ID and User-ID between subnets
- Visibility into traffic flows between subnets
- Ability to easily isolate assets that may be compromised

Methods of Implementation

- Option 1 - Migrate server vlan interfaces from core switch and place them on firewall
 - Quicker to implement
 - May need to migrate ACLs from switch
 - May need to further segment existing subnets
- Option 2 - Create new server subnets on firewall and migrate applications to new subnets
 - Migrating applications to new subnets is a large effort that carries risk (services using IP address versus hostname will break)
 - Will require rulebase updates for IP changes, but will lead to cleaner rulebase
 - Applications can be moved one at a time allowing slow, methodical approach

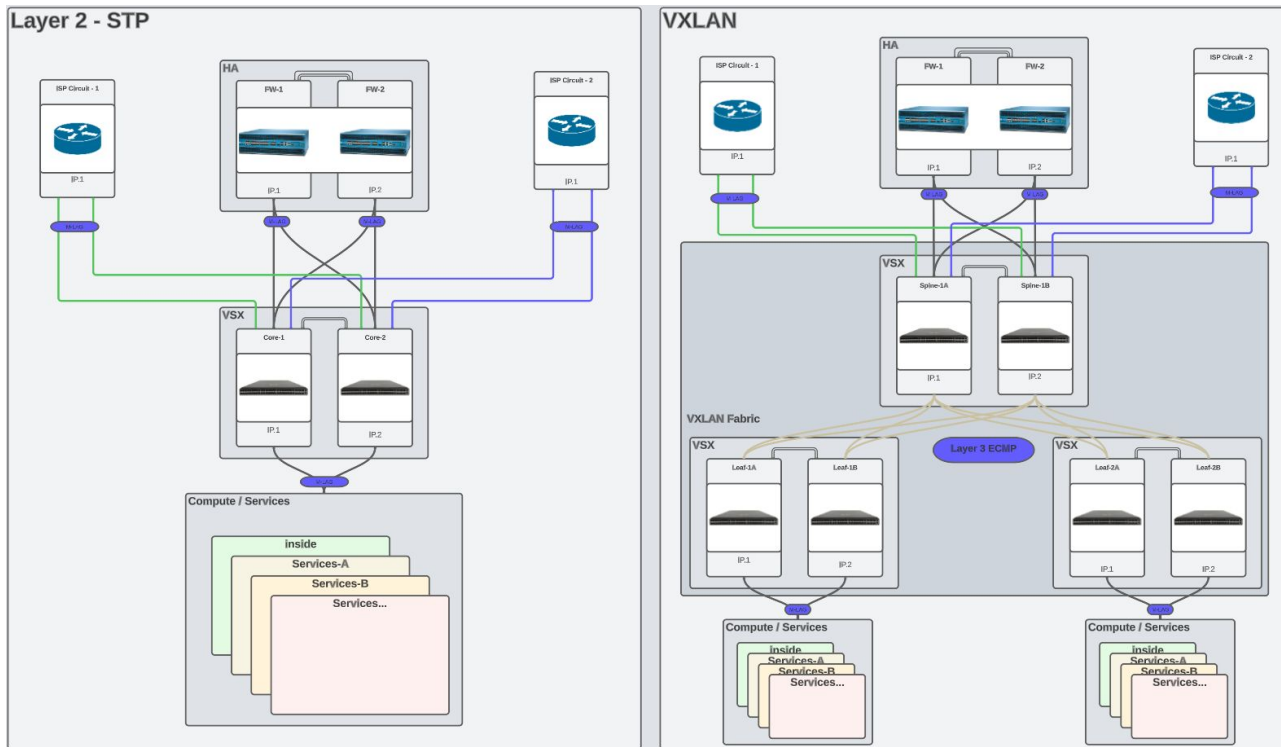
Recommendations

- If there are just a few server subnets
 - Option 1, followed by option 2
 - This will allow instant improvement of security posture by getting subnets on the firewall
 - Option 2 can then be implemented over time to continue improving posture
- If there are significant server subnets
 - Option 1
 - If assets are already properly categorized into subnets, migrating the subnets straight to the firewall should be all that is needed
 - Make sure ACLs are properly migrated prior to migrating

Considerations

- Security and NAT policies will need to be updated to reflect changes to zones
- Load balancers can lead to asymmetric routes and will need to be considered before migrating subnets

Example Diagrams



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What is Falco?

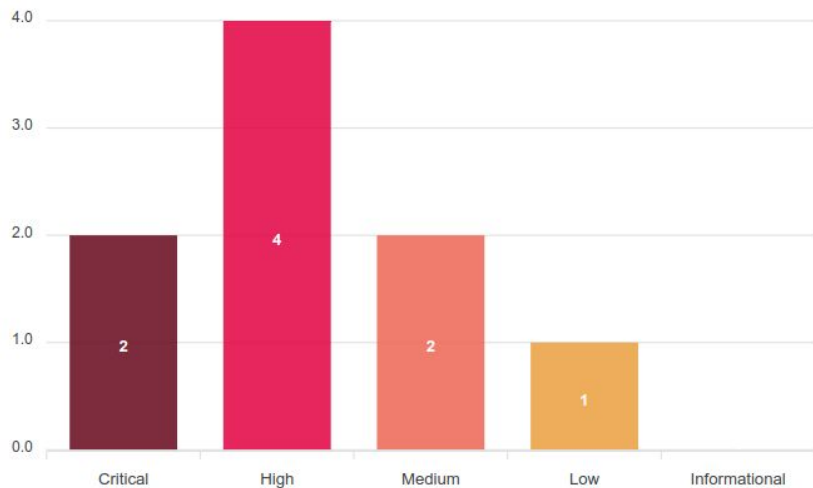
- A tool to detect configuration issues
- A managed service to assist with fixing them



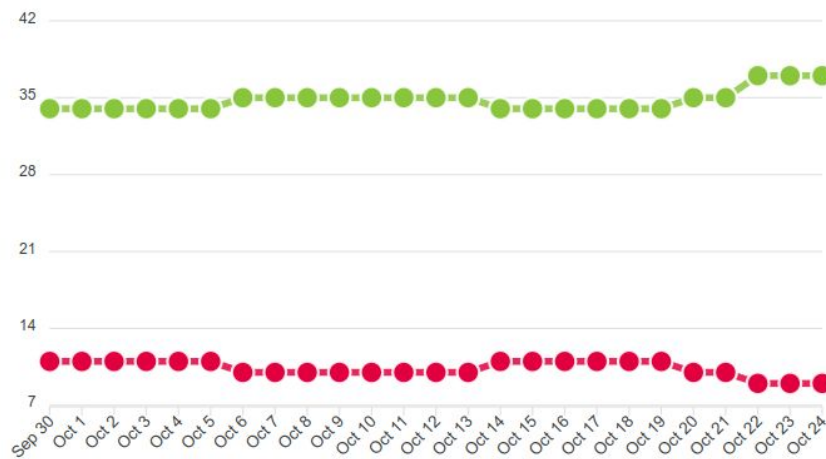
FALCO

[Summary](#) [Policies](#) [Objects](#) [Network](#) [Device](#)Device PA5250-1 80% passed
1 Devices Audited1/1 devices
Recommended ReleasesNo Vulnerabilities
No Known Vulnerabilities FoundSupport Licenses
All Devices Have Valid Support
Licenses

Failed Check Severity



Report History



A photograph of a modern interior space, possibly a museum or gallery, with a teal color overlay. The scene features several long, rectangular light fixtures hanging from the ceiling, and a few spotlights are visible on the right side. The overall aesthetic is clean and contemporary.

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sales@digitalscepter.com
(888) 299-3718

digitalscepter.com