



PALO ALTO NETWORKS

PCNSE

STUDY GUIDE

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Palo Alto Networks PCNSE Study Guide

Welcome to the *Palo Alto Networks PCNSE Study Guide*. The purpose of this guide is to help you prepare for your PCNSE exam and achieve your PCNSE credential. This study guide is a summary of the key topic areas that you are expected to know to be successful at the PCNSE exam. It is organized based on the exam blueprint and key exam objectives.

Overview

The Palo Alto Networks Certified Network Security Engineer (PCNSE) is a formal, third-party proctored certification that indicates that those who have passed it possess the in-depth knowledge to design, install, configure, maintain, and troubleshoot most implementations based on the Palo Alto Networks platform.

This exam will certify that the successful candidate has the knowledge and skills necessary to implement the Palo Alto Networks next-generation firewall PAN-OS 9.1 platform in any environment.

More information is available from Palo Alto Networks at:

<https://www.paloaltonetworks.com/services/education/pcnse>

Exam Details

- Certification Name: Palo Alto Networks Certified Network Security Engineer
- Delivered through Pearson VUE: www.pearsonvue.com/paloaltonetworks
- Exam Series: PCNSE
- Seat Time: **80** minutes
- Number of items: **75**
- Format: Multiple Choice, Scenarios with Graphics, and Matching
- Languages: English and Japanese

Intended Audience

The PCNSE exam should be taken by anyone who wants to demonstrate a deep understanding of Palo Alto Networks technologies, including customers who use Palo Alto Networks products, value-added resellers, pre-sales system engineers, system integrators, and support staff.

Qualifications

Candidate should have three to five years' experience working in the Networking or Security industries and the equivalent of 6 to 12 months' experience deploying and configuring Palo Alto Networks NGFW within the Palo Alto Networks Security Operating Platform.

Skills Required

- You can plan, deploy, configure, operate, and troubleshoot Palo Alto Networks Security Operating Platform components.
- You have product expertise and understand the unique aspects of the Palo Alto Networks Security Operating Platform and how to deploy one appropriately.
- You understand networking and Security policies used by PAN-OS software.

Recommended Training

Palo Alto Networks strongly recommends that you attend the following instructor-led training courses or equivalent virtual digital learning courses:

- Firewall Essentials: Configuration and Management (EDU-210) or digital learning (EDU-110)
- Panorama: Managing Firewalls at Scale (EDU-220) or digital learning (EDU-120)
- Optional Training: Firewall: Optimizing Firewall Threat Prevention (EDU-214) or digital learning (EDU-114)
- Optional training: Firewall: Troubleshooting (EDU-330)

After you have completed the courses, practice on the platform to master the basics. Use the following resources to prepare for the exam. All resources can be found here:

<https://www.paloaltonetworks.com/services/education/certification.html#pcnse>

- Cybersecurity Skills Practice Lab
- PCNSE Study Guide and Practice Exam
- Administrator's Guide: specific configuration information and "best practice" settings
- Preparation videos and tutorials

About This Document

Efforts have been made to introduce all relevant information that might be found in a PCNSE Certification Test. However, other related topics also may appear on any delivery of the exam. This document should not be considered a definitive test preparation guide but an introduction to the knowledge required, and these guidelines may change at any time without notice. This document contains many references to outside information that should be considered essential to completing your understanding.

Disclaimer

This study guide is intended to provide information about the objectives covered by this exam, related resources, and recommended courses. The material contained within this study guide is not intended to guarantee that a passing score will be achieved on the exam. Palo Alto Networks recommends that a candidate thoroughly understand the objectives indicated in this guide and use the resources and courses recommended in this guide where needed to gain that understanding.

Preliminary Score Report

The score report notifies candidates that, regardless of pass or fail results, an exam score may be revised any time after testing if there is evidence of misconduct, scoring inaccuracies, or aberrant response patterns.

| Palo Alto Networks Certified Network Security Engineer - PCNSE Based on PAN-OS Version 9.1 | |
|---|------------|
| Domain | Weight (%) |
| Plan | 16% |
| Deploy and Configure | 23% |
| Operate | 20% |
| Configuration Troubleshooting | 18% |
| Core Concepts | 23% |
| Total | 100% |

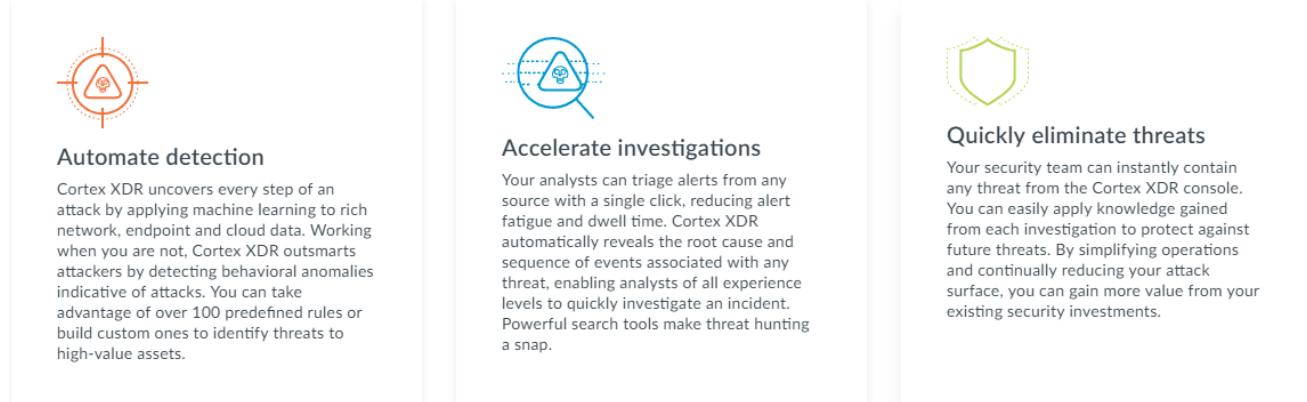
Exam Domain 1 – Plan

1.1 Identify how the Palo Alto Networks products work together to detect and prevent threats

Stop Sophisticated Attacks Across Your Network, Endpoint, and Cloud Assets

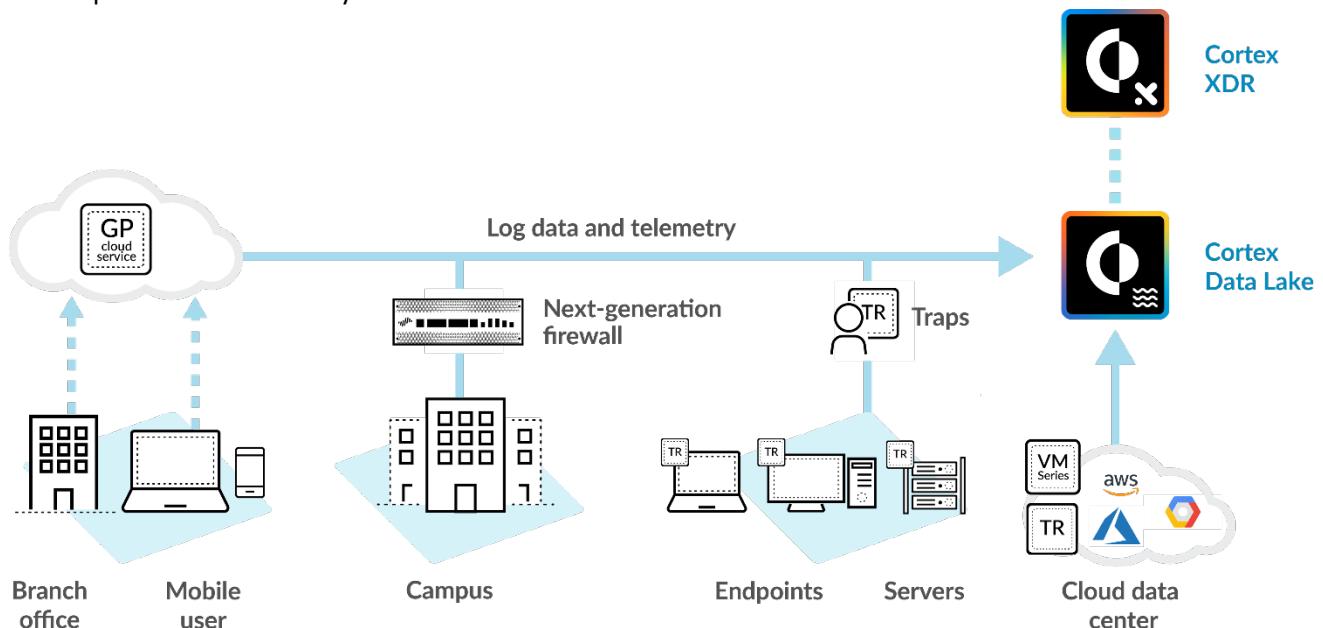
Tools in silos, such as endpoint detection and response (EDR) and network traffic analysis (NTA), force analysts to manually piece together information, which slows investigations and increases complexity. The Cortex XDR cloud-based detection and response apps remove security blind spots by combining network, endpoint, and cloud data.

Detect, Investigate, and Respond at Lightning Speed



Cortex and Cortex XDR

Cortex is the industry's only open and integrated artificial intelligence (AI)-based continuous security platform. It delivers radical simplicity and significantly improves security outcomes through automation and unprecedented accuracy.



Overview

Cortex can integrate Palo Alto Networks products into a cohesive threat detection and response system. Products can run alone or in conjunction with others, thus providing world-class security solutions. They can be unified with the Cortex subscription that aggregates their data for a holistic and comprehensive enterprise solution.

Cortex Data Lake automatically collects, integrates, and normalizes data across your security infrastructure. If your data is unified, you can run advanced AI and machine learning to radically simplify security operations with apps built on Cortex. Cortex Data Lake is augmented with data from Palo Alto Networks WildFire®, AutoFocus/MineMeld, and Unit 42 information sources.

Cortex XDR is a set of tools that works with Cortex Data Lake to identify threats manually. With AI, it determines root causes of security events and responds to threats by deploying response settings to enforcement products.

Palo Alto Networks products are organized into two areas of focus that are described in the following sections.

Securing the Enterprise

The first area of focus is that the products are grounded in the next-generation firewall and the services that enable it.

Next-generation firewalls: Next-generation firewalls secure your enterprise with a prevention-focused architecture and integrated innovations that are easy to deploy and use. Palo Alto Networks next-generation firewalls detect known and unknown threats, including those within encrypted traffic, using intelligence generated across many thousands of customer deployments. The firewalls reduce risks and prevent a broad range of attacks. For example, they enable users to access data and applications based on business requirements and they stop credential theft and an attacker's ability to use stolen credentials.

DNS Security: DNS security service applies predictive analytics, machine learning, and automation to block attacks that use DNS. Tight integration with the next-generation firewall gives you automated protections and eliminates the need for independent tools. DNS Security service makes malicious domain information available to your NGFW collected from WildFire, Unit 42, URL filtering, and the Cyber Threat Alliance.

WildFire: WildFire automatically prevents zero-day exploits and malware. Traditional malware analysis and sandboxing techniques are not adequate and cannot keep pace with new exploits. WildFire uses shared community-sourced threat data and advanced analysis, and immediately shares protections across the network, endpoint, and cloud. WildFire automatically delivers protections about every 5 minutes (by accessing a database that is updated every 5 minutes), thus preventing successful cyberattacks.

AutoFocus: AutoFocus contextual threat intelligence brings speed, consistency, and precision to threat investigation. It provides instant access to community-based threat data, enhanced with deep context and attribution from the Unit 42 threat research team, thus saving time and effort. Now your teams can

quickly investigate, correlate, and pinpoint malware's root cause without adding dedicated malware researchers or additional tools. Plus, automated protections make raw intelligence simple to turn into protection across your environment.

Traps: Traps advanced endpoint protection stops threats on the endpoint and coordinates enforcement with cloud and network security to prevent successful cyberattacks. Traps is the only solution that preemptively blocks security breaches such as ransomware attacks. It uses a unique multi-method approach that prevents known and unknown malware, exploits, and zero-day threats.

Threat Prevention: Threat Prevention capitalizes on the next-generation firewall's capability to inspect all traffic, and can prevent known threats, regardless of port, protocol, or SSL encryption. Threat Prevention automatically stops vulnerability exploits with IPS capabilities, offers inline malware protection, and blocks outbound command-and control-traffic. When Threat Prevention is combined with WildFire and URL filtering, organizations are protected at every stage of the attack lifecycle, including both known and zero-day threats. This service is consumed by other products and integrated into others.

Panorama: Panorama is an enterprise-level firewall management solution that simplifies, streamlines, and consolidates core tasks and capabilities, thus enabling you to use a single console to view all your firewall traffic, manage all aspects of device configuration, push global policies, and generate reports on traffic patterns or security incidents, all at enterprise scale.

MineMeld: MineMeld is an open-source application that streamlines the aggregation, enforcement, and sharing of threat intelligence. MineMeld is available for all users directly on GitHub or on pre-built virtual machines (VMs) for easy deployment. Anyone using the proper software can add to the MineMeld functionality by contributing code to the open-source repository. MineMeld integrates information from disparate sources, normalizes it for consumption, and can automate settings on managed products.

Expedition: Expedition is a free, virtual appliance that helps convert firewall configurations from leading vendors to Palo Alto Networks next-generation firewalls.

Securing the Cloud

The second area of focus is securing the cloud.

VM-Series next-generation firewalls: Palo Alto Networks virtualized next-generation firewalls protect your private and public cloud deployments by segmenting applications and preventing threats. VM-Series firewalls are available for many public and private cloud technologies and provide the same world-class level of detection and prevention of your physical next-generation firewalls.

Prisma SaaS: The use of software as a service (SaaS) applications is creating new risks and gaps in security visibility for malware propagation, data leakage, and regulatory non-compliance. Prisma SaaS provides complete visibility and granular enforcement across all user, folder, and file activity within sanctioned SaaS applications, thus providing detailed analysis and analytics about usage without requiring any additional hardware, software, or network changes.

Prisma Access: Prisma Access provides the full security capabilities of the Palo Alto Networks next-

generation firewall *delivered as a service*. You can protect users across your organization and prevent successful cyberattacks with scale and simplicity, and without compromise. Prisma Access automates the orchestration and rollout of security services, thus reducing deployment time. You can deploy new features, increase coverage, and scale globally with cloud infrastructure, which gives you a new level of flexibility.

Prisma Cloud: The Prisma Cloud security and compliance service uses machine learning to understand the role and behavior of each cloud resource and enriches visibility by correlating data from external sources such as vulnerability scanners, threat intelligence tools, and SIEMs. Information provided by Prisma Cloud provide security personnel with unmatched insight into the threats detected in their environment.

Cortex Data Lake: The cloud-delivered logging service allows you to easily collect large volumes of log data so that innovative apps can gain insight from your environment. You can simplify your log infrastructure, automate log management, and use the insights gained from your data to prevent attacks more effectively.

Cortex XDR – Analytics: Cortex XDR – Analytics behavioral analytics applies machine learning at a cloud scale to network, endpoint, and cloud data so that you can quickly find and stop targeted attacks, insider abuse, and compromised endpoints. Cortex XDR – Analytics uncovers the actions attackers cannot conceal by profiling user and device behavior and identifying anomalies that indicate active attacks. Cortex XDR – Analytics integrates rich metadata collected from the Security Operating Platform with attack detection algorithms and enables you to detect post-intrusion activity with precision.

Sample Questions

1. Which component of the integrated Palo Alto Networks security solution limits network-attached workstation access to a corporate mainframe?
 - A. threat intelligence cloud
 - B. advanced endpoint protection
 - C. next-generation firewall
 - D. tunnel inspection
2. Which Palo Alto Networks product is designed primarily to provide threat context with deeper information about attacks?
 - A. Prisma Cloud
 - B. WildFire
 - C. AutoFocus
 - D. Threat Prevention
3. Which Palo Alto Networks product is designed primarily to provide normalization of threat intelligence feeds with the potential for automated response?
 - A. MineMeld
 - B. WildFire
 - C. AutoFocus
 - D. Threat Prevention

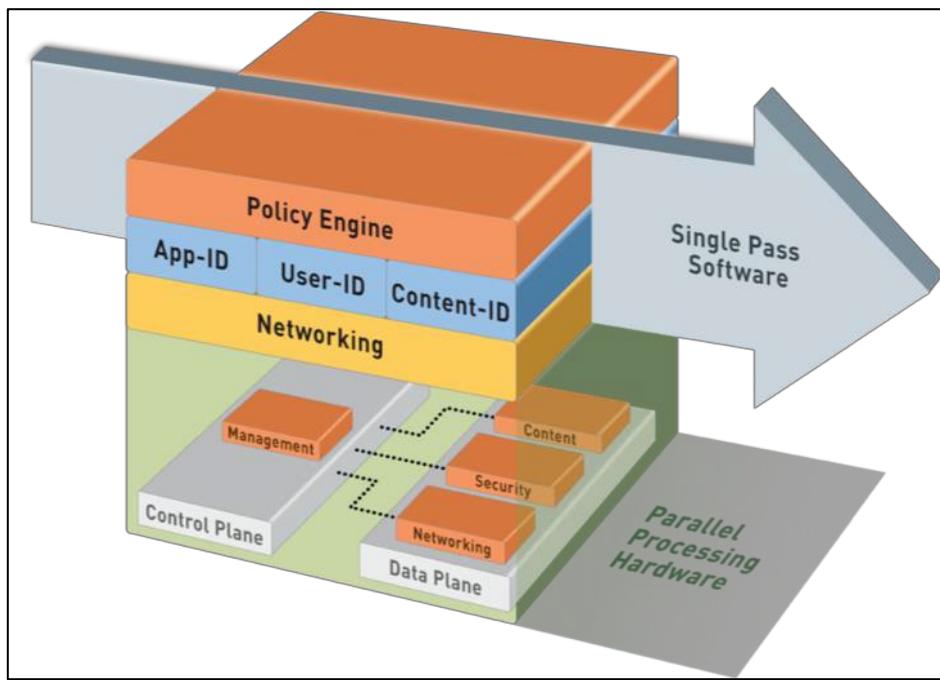
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4. Which Palo Alto Networks product is designed primarily to prevent endpoints from successfully running malware programs?
 - A. GlobalProtect
 - B. Cortex XDR - Analytics
 - C. Traps
 - D. Prisma Cloud
5. The Palo Alto Networks Cortex Data Lake can accept logging data from which two products? (Choose two.)
 - A. Traps
 - B. next-generation firewalls
 - C. Prisma SaaS
 - D. MineMeld
 - E. AutoFocus
6. Which Palo Alto Networks product is a cloud-based storage service designed to hold log information?
 - A. Prisma Cloud
 - B. Traps
 - C. next-generation firewall
 - D. Cortex Data Lake
7. Which product is an example of an application designed to analyze Cortex Data Lake information?
 - A. Cortex XDR - Analytics
 - B. Prisma Cloud
 - C. Cortex XDR – Automated Response
 - D. AutoFocus

1.2 Given a scenario, identify how to design an implementation of the firewall to meet business requirements that leverage the Palo Alto Networks Security Operating Platform

Choosing the Appropriate Firewall

Feature and performance requirements impact the choice of firewall model. All Palo Alto Networks firewalls run the same version of PAN-OS software, ensuring the same primary feature set. When you investigate which model fits a given need, evaluate throughput, maximum concurrent sessions, and connections per second with App-ID, threat prevention, and decryption features enabled. Note that there are two published throughput statistics: “firewall throughput” and “threat prevention throughput.” “Threat prevention throughput” is the expected throughput with most of the defensive options (App-ID, User-ID, IPS, antivirus, and anti-spyware) enabled, and “firewall throughput” is the throughput with no Content-ID defense options enabled. Additional services might be available as integrated products or service licenses that enrich logging data analysis. Overall, choosing a firewall is as much a selection of functions and services that drive proper sizing decisions to meet your needs.

A few features, such as the Decryption Broker, are supported only on firewalls that have larger compute resources. The following link provides a features summary of all firewall models, including throughput:
<https://www.paloaltonetworks.com/resources/datasheets/product-summary-specsheet>



The Palo Alto Networks firewall was designed to use an efficient system referred to as next-generation processing. Next-generation processing enables packet evaluation, application identification, policy decisions, and content scanning in a single efficient processing pass.

Palo Alto Networks firewalls contain the following primary next-generation features:

- App-ID: Scanning of traffic to identify the application that is involved, regardless of the protocol or port number used
- Content-ID: Scanning of traffic for security threats (e.g., data leak prevention and URL filtering, virus, spyware, unwanted file transfers, specific data patterns, vulnerability attacks, and appropriate browsing access)
- User-ID: Matching of a user to an IP address (or multiple IP addresses), allowing your Security policy to be based on who is behind the traffic, not the device

Security Policy

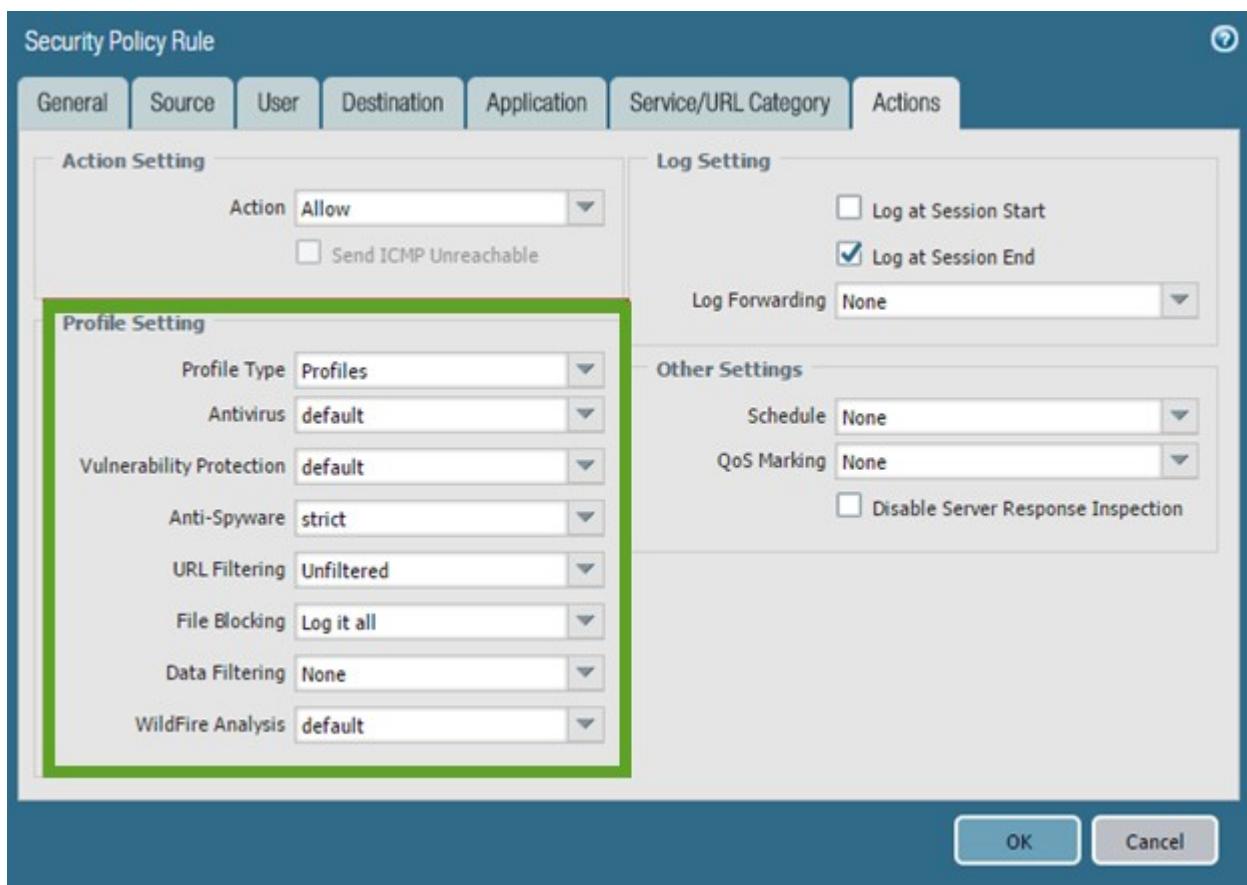
The Security policy consists of security rules that are the basis of the firewall's ability to enable or block sessions. Multiple match conditions can be used when you create these rules. Security zones, source and destination IP address, application (App-ID), source user (User-ID), service (port), HIP match, and URL categories in the case of web traffic all can serve as traffic matching criteria for decisions to allow or block. App-ID ensures the positive identification of applications regardless of their attempts at evasiveness. Allowed session traffic can be scanned further based on Security Profiles (Content-ID) to identify unwanted traffic content. These profiles use signatures to identify known threats. Unknown threats are identified by WildFire, which creates signatures to turn them into known threats.

Examples of creating a policy rule security rules and profile settings follow:

The screenshot shows the 'Security Policy Rule' configuration dialog. The top navigation bar includes tabs for General, Source, User, Destination, Application, Service/URL Category, and Actions. The General tab is selected. The form fields include:

- Name: Security Policy Rule
- Rule Type: universal (default)
- Description: (empty)
- Tags: (empty)
- Group Rules By Tag: None
- Audit Comment: (empty)
- Audit Comment Archive: (empty)

At the bottom right are OK and Cancel buttons.



Security Zones

Palo Alto Networks firewalls are zone-based. Zones designate a network segment where all nodes share similar network security requirements (i.e., Users, Data Center, DMZ Servers, and Remote Users). The firewall security model is based on evaluating traffic as it passes from one zone to another. These zones act as a logical way to group physical and virtual interfaces. Zones are required to control and log the traffic that traverses the interfaces. All defined interfaces should be assigned a zone that marks all traffic coming to or from the interface. Zones are defined for specific interface types (Tap, virtual wire, Layer 2, or Layer 3) and can be assigned to multiple interfaces of the same type only. An interface can be assigned only to a single zone.

All sessions on the firewall are defined by the source and destination zones. Rules can use these defined zones to allow or deny traffic, apply QoS, or perform NAT. All traffic can flow freely within a zone and is referred to as *intrazone* traffic. Traffic between zones (called *interzone* traffic) is denied by default. Security policy rules are required to modify these default behaviors. Traffic is allowed to traverse between zones only if a defined Security policy rule matches and allows the traffic. For interzone traffic, Security policy rules must reference a source zone and destination zone (not interfaces) to allow or deny traffic.

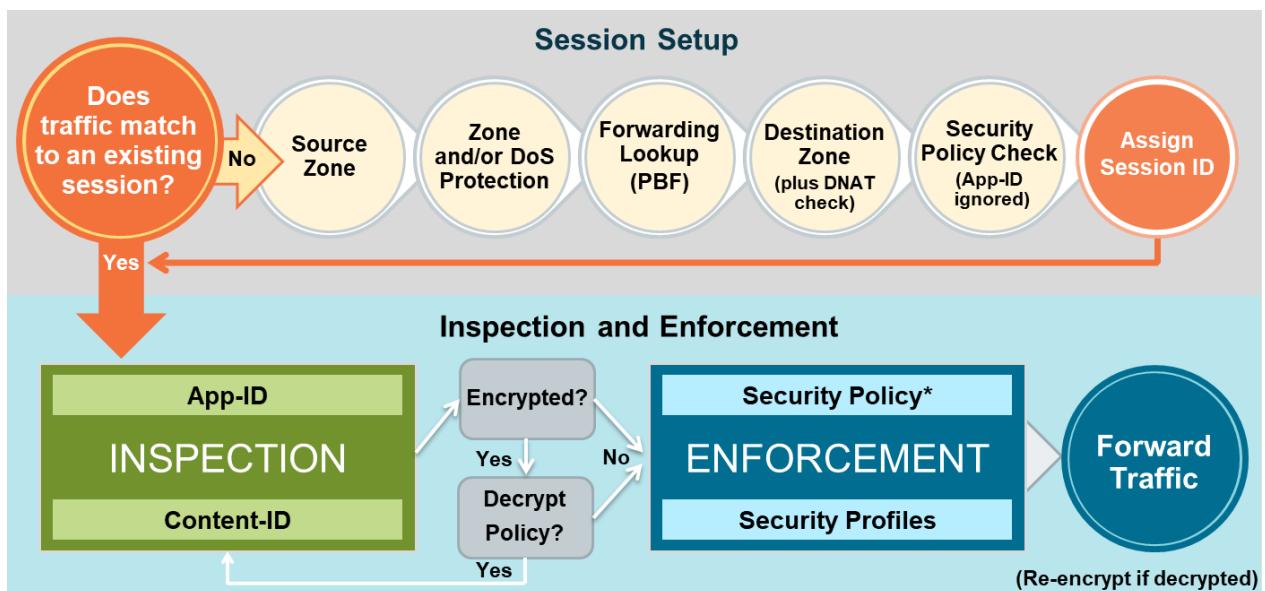
Security policies are used to create a positive (whitelist) and/or negative (blacklist) enforcement model for traffic flowing through the firewall. These rules are enumerated from the top down, and the first rule with the appropriate matching conditions will allow or deny the matching traffic. If logging is enabled on the matching rule, and the traffic crosses a zone, the action for that session is logged. These logs are

extremely useful for adjusting the positive/negative enforcement model. The log information can be used to characterize traffic, thus providing specific use information and allowing precise policy creation and control. Log entries can be forwarded to external locations including email and web servers, syslog servers, Panorama, and the Cortex Data Lake. Palo Alto Networks firewall logs, Application Command Center, App Scope, and other reporting tools all work to precisely describe traffic and use patterns.

Traffic Processing Sequence

Use the following graphical representation to visualize the Palo Alto Networks firewall processes. Your understanding of the linear version of the traffic flow can be useful when you create the initial configuration and when you adjust the rules after installation. Note that the graphical representation is a simplified version of the complete flow documented in the following article. Advanced analysis and discussion of the flow logic of the firewall is included in the *Firewall: Troubleshooting* (EDU-330) training class.

<https://knowledgebase.paloaltonetworks.com/KCSArticleDetail?id=kA10g000000CIVHCA0>



* Policy check relies on pre-NAT IP addresses

Enterprise Firewall Management

Palo Alto Networks next-generation firewalls are managed individually and have no native ability to be managed collectively from a single interface at an enterprise level. Panorama is the Palo Alto Networks enterprise management solution. Panorama can be scaled for the largest deployments when it is deployed in a “manager of managers” approach using the Panorama Interconnect plugin whereby Panorama is deployed to manage downstream Panoramas which, in turn, manage populations of firewalls.

Additional information about best practices in designing and deploying your Security policy when deploying a firewall as an edge device can be found here:

<https://docs.paloaltonetworks.com/best-practices/9-1/internet-gateway-best-practices.html>

Other deployment best practices can be found here:

<https://docs.paloaltonetworks.com/best-practices>

Virtual Firewalls in Clouds

Palo Alto Networks products include the VM-Series virtual firewalls for implementation in both private and public cloud architectures. They run the same version of PAN-OS and support the same core features as do physical firewall appliances. Some features might not be supported or are implemented using alternate techniques, depending on the capabilities of the hosting environment. For example, most public cloud vendors support only Layer-3 types of interfaces for connection to their virtual networks. Another example is the varying level of HA support in public cloud deployments. Some support native High Availability connection using a pair of VM-Series firewalls and others support the scaling of parallel implementations of VM-Series firewalls that have no High Availability configuration. Consult cloud-specific documentation for these differences.

Sample Questions

8. A potential customer says it wants to maximize the threat detection capability of its next-generation firewall. Which three additional services should it consider implementing to enhance its firewall's capability to detect threats? (Choose three.)
 - A. Traps
 - B. WildFire
 - C. URL Filtering
 - D. Expedition
 - E. DNS Security
9. A VM-Series virtual firewall differs from a physical Palo Alto Networks firewall in which way?
 - A. A VM-Series firewall cannot be managed by Panorama.
 - B. A VM-Series firewall supports fewer traffic interface types.
 - C. A VM-Series firewall cannot terminate VPN site-to-site tunnels.
 - D. A VM-Series firewall cannot use dynamic routing protocols.
10. Which product would best secure east-west traffic within a public cloud implementation?
 - A. Prisma Cloud
 - B. MineMeld
 - C. VM-Series firewall
 - D. Cortex

1.3 Given a scenario, identify how to design an implementation of firewalls in High Availability to meet business requirements that leverage the Palo Alto Networks Security Operating Platform

High Availability

You can set up two Palo Alto Networks firewalls as an HA pair. HA allows you to minimize downtime by ensuring that an alternate firewall is available if the peer firewall fails. HA pairs comprise two firewalls of identical model, configuration, and licensing. They should be physically close to each other, but geographical separation is supported. The firewalls in an HA pair use dedicated or in-band HA ports on the firewall to synchronize data—network, object, and policy configurations—and to maintain state information. Firewall-specific configuration such as the management interface IP address or administrator profiles, HA-specific configuration, log data, and the Application Command Center (ACC) information is not shared between peers. To get a consolidated application and log view across the HA pair, you must use Panorama, the Palo Alto Networks centralized management system. When a failure occurs on a firewall in an HA pair and the peer firewall takes over the task of securing traffic, the event is called a failover. The conditions that trigger a failover are:

- One or more of the monitored interfaces fail. (link monitoring)
- One or more of the destinations specified on the firewall cannot be reached. (path monitoring)
- The firewall does not respond to heartbeat and Hello messages. (heartbeat and Hello monitoring)
- A critical chip or software component fails. (packet path health monitoring)

HA Modes

Palo Alto Networks firewalls support stateful *active/passive* or *active/active* High Availability with session and configuration synchronization with a few exceptions:

- The PA-200 (a discontinued model) firewall supports HA Lite only. HA Lite is an active/passive deployment that provides configuration synchronization and some run-time data synchronization such as IPsec security associations. It does not support session synchronization (HA2), and therefore does not offer stateful failover.
- The VM-Series firewall in AWS supports active/passive HA only; if it is deployed with Amazon Elastic Load Balancing (ELB), it does not support HA (in this case ELB provides the failover capabilities).
- The VM-Series firewall in Microsoft Azure does support HA in PAN-OS 9x only.
- The VM-Series firewall deployed in Google Cloud Platform supports both active/active and active/passive HA.

Public cloud deployments of VM-Series firewalls also are supported in each vendor's version of a "scaled" implementation, thus allowing virtual firewalls to share the traffic load through a deployment of parallel firewall instances and the option to create or remove firewall instances in response to changes in traffic loads. These deployments all include the cloud vendor's load balancer deployed in front of the firewall "scale set" to manage the spreading of the traffic across the available firewalls. This same deployment practice also creates a High-Availability scenario in the sense that failing firewall instances can be removed from the "scale set" automatically using various detection abilities within the load balancer. A limitation of the "scale set" methods of High Availability is there typically is no synchronization between firewalls, so failovers are disruptive in the sense that existing sessions are terminated.

Active/Passive Clusters

Active/passive HA usually is the recommended deployment method. One firewall actively manages traffic while the other is synchronized and ready to transition to the active state if a failure occurs. In this mode, both firewalls share the same configuration settings, and one actively manages traffic until a path, link, or system failure occurs. When the active firewall fails, the passive firewall transitions to the active state, takes over seamlessly, and enforces the same policies to maintain network security. The firewalls synchronize their session state tables, thus allowing the passive partner to become active and continue servicing active sessions at failover. Active/passive HA is supported in the virtual wire, Layer 2, and Layer 3 deployments.

Because one firewall is handling traffic and both firewalls share the same traffic interface configuration, active/passive usually is much easier to manage.

Active/Active Clusters

Both firewalls in the pair are active and processing traffic and work synchronously to handle session setup and session ownership. Both firewalls individually maintain session tables and routing tables and synchronize to each other. Active/active HA is supported in virtual wire and Layer 3 deployments.

In active/active HA mode, the firewall HA interfaces cannot receive address via DHCP. Furthermore, only the active-primary firewall's traffic interface can function as a DHCP relay. The active-secondary firewall that receives DHCP broadcast packets drops them.

In a Layer 3 deployment of HA active/active mode, you can assign floating IP addresses, which move from one HA firewall to the other if a link or firewall fails. The interface on the firewall that owns the floating IP address responds to ARP requests with a virtual MAC address.

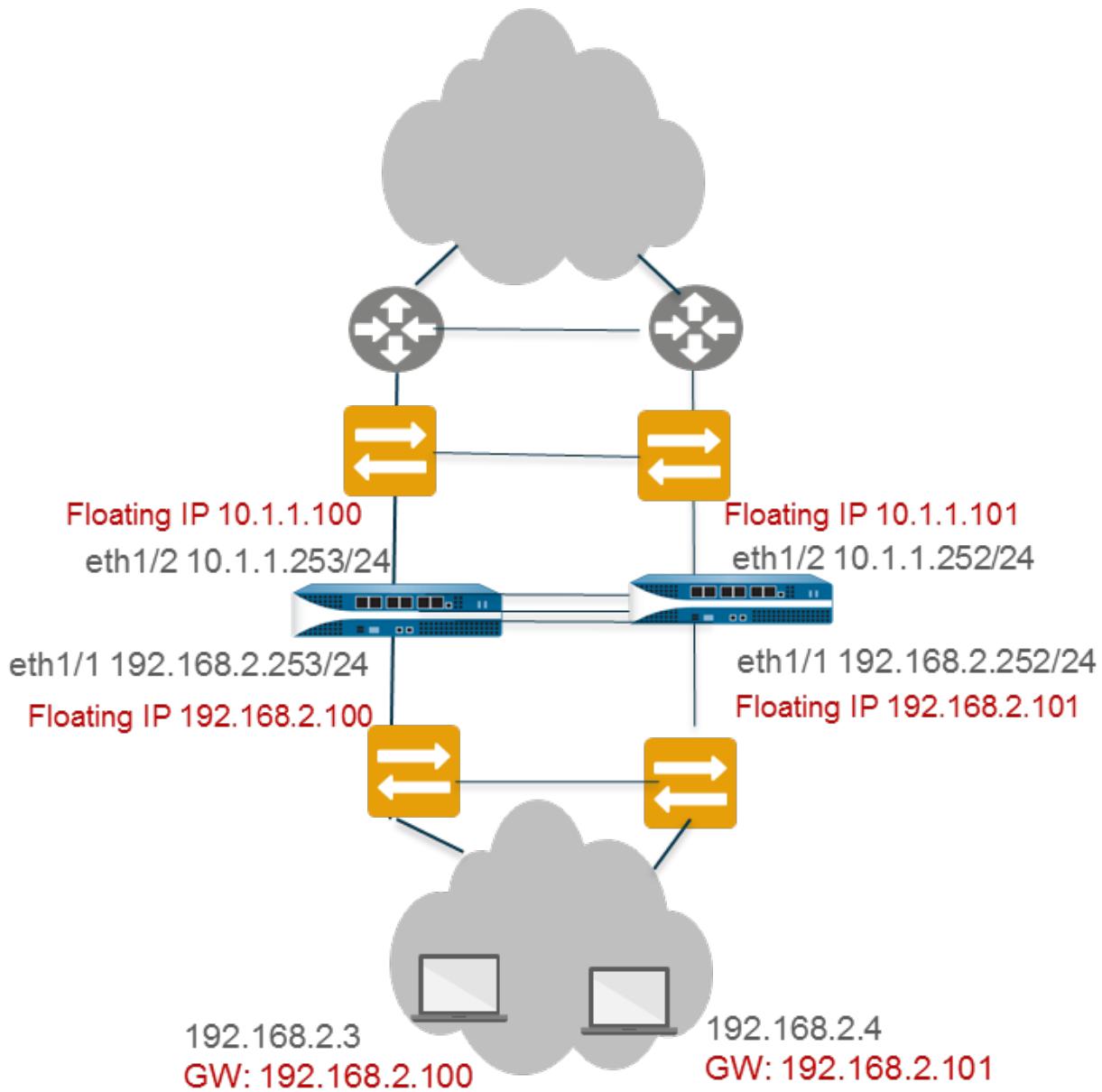
Floating IP addresses are recommended when you need functionality such as the Virtual Router Redundancy Protocol (VRRP). Floating IP addresses also can be used to implement VPNs and source NAT, thus allowing for persistent connections when a firewall offering those services fails.

As shown in the figure that follows, each HA firewall interface has its own IP address and floating IP address. The interface IP address remains local to the firewall, but the floating IP address moves between the firewalls upon firewall failure. You configure the end hosts to use a floating IP address as its default gateway, thus allowing you to load balance traffic to the two HA peers. You also can use external load balancers to load balance traffic.

If a link or firewall fails or a path monitoring event causes a failover, the floating IP address and virtual MAC address move over to the functional firewall. (In the figure that follows, each firewall has two floating IP addresses and virtual MAC addresses; they all move over if the firewall fails.) The functioning firewall sends a gratuitous ARP to update the MAC tables of the connected switches to inform them of the change in floating IP address and MAC address ownership to redirect traffic to itself.

After the failed firewall recovers, by default the floating IP address and virtual MAC address move back to firewall with the Device ID (0 or 1) to which the floating IP address is bound. More specifically, after the failed firewall recovers, it becomes online. The currently active firewall determines that the firewall is

back online and checks whether the floating IP address it is handling belongs natively to itself or to the other firewall. If the floating IP address originally was bound to the other Device ID, the firewall automatically gives it back. An example of a floating IP deployment follows:



Each firewall in the HA pair creates a virtual MAC address for each of its interfaces that has a floating IP address or ARP load-sharing IP address.

Choosing an HA Cluster Type

- Active/passive mode has simplicity of design; it is significantly easier to troubleshoot routing and traffic flow issues in active/passive mode.
- Both active/active and active/passive mode support a virtual wire deployment.
- Active/active mode requires advanced design concepts that can result in more complex networks. Depending on how you implement active/active HA, it might require additional

configuration such as activating networking protocols on both firewalls, replicating NAT pools, and deploying floating IP addresses to provide proper failover. Because both firewalls actively are processing traffic, the firewalls use additional concepts of session owner and session setup to perform Layer 7 content inspection.

- Active/active mode is recommended if each firewall needs its own routing instances and you require full, real-time redundancy out of both firewalls all the time. Active/active mode has faster failover and can handle peak traffic flows better than active/passive mode because both firewalls actively are processing traffic.
- In active/active mode, the HA pair can be used to temporarily process more traffic than what one firewall normally can handle. However, this situation should not be standard because a failure of one firewall causes all traffic to be redirected to the remaining firewall in the HA pair. Your design must allow the remaining firewall to process the maximum capacity of your traffic loads with content inspection enabled. If the design oversubscribes the capacity of the remaining firewall, high latency and/or application failure can occur.
- In cases of virtual firewall deployments, the cloud architecture might limit your deployment choices. Consult the design and deployment documentation specific to your chosen cloud vendor.

A use case illustrating an active/active deployment can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/high-availability/set-up-activeactive-ha/determine-your-activeactive-use-case/use-case-configure-activeactive-ha-with-floating-ip-address-bound-to-active-primary-firewall.html>

HA Links and Backup Links

The firewalls in an HA pair use HA links to synchronize data and maintain state information. Some models of the firewall have dedicated HA ports—Control link (HA1) and Data link (HA2)—and others require you to use the in-band ports as HA links.

- For firewalls with dedicated HA ports, use these ports to manage communication and synchronization between the firewalls. For details, see the link later in this section.
- For firewalls without dedicated HA ports such as the PA-220, and PA-220R, as a best practice use a data-plane port for the HA port and use the management port as the HA1 backup.

Because the HA ports synchronize data critical to proper HA failover, implementation of backup HA paths is a recommended best practice. In-band ports can be used for backup links for both HA1 and HA2 connections when dedicated backup links are not available. Consider the following guidelines when you configure backup HA links:

- The IP addresses of the primary and backup HA links must not overlap each other.
- HA backup links must be on a different subnet from the primary HA links.
- HA1-backup and HA2-backup ports must be configured on separate physical ports. The HA1-backup link uses ports 28770 and 28260.

More information about the purpose and setup of the HA links can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/high-availability/ha-concepts/ha-links-and-backup-links.html>

HA pair configuration synchronization is discussed here:

<https://knowledgebase.paloaltonetworks.com/KCSArticleDetail?id=kA10g000000CIXGCA0>

Information about data that is not synchronized between HA partners is at the following links:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/high-availability/reference-ha-synchronization/what-settings-dont-sync-in-activepassive-ha.html>

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/high-availability/reference-ha-synchronization/what-settings-dont-sync-in-activeactive-ha.html>

Sample Questions

11. Why would you recommend an active/active firewall cluster instead of an active/passive firewall cluster?
 - A. Active/active is the preferred solution when the firewall cluster is behind a load balancer that randomizes routing, thus requiring both firewalls to be active.
 - B. Active/active usually is the preferred solution because it allows for more bandwidth while both firewalls are up.
 - C. Active/active is the preferred solution when the PA-7000 Series is used. Use active/passive with the PA-5200 Series or smaller form factors.
 - D. Active/active is the preferred solution when the PA-5200 Series or smaller form factors are used. Use active/passive with the PA-7000 Series.
12. Which two events can trigger an HA pair failover event? (Choose two.)
 - A. An HA1 cable is disconnected from one of the firewalls.
 - B. A dynamic update fails to download and install.
 - C. The firewall fails to ping a path-monitored destination address successfully.
 - D. OSPF implemented on the firewall determines that an available route is now down.
 - E. RIP implemented on the firewall determines that an available route is now down.
13. Which two firewall features support floating IP addresses in an active/active HA pair? (Choose two.)
 - A. data-plane traffic interfaces
 - B. source NAT
 - C. VPN endpoints
 - D. loopback interfaces
 - E. management port
14. How are firewall configurations in an active/passive HA pair synchronized if the firewalls are not under Panorama control?
 - A. An administrator commits the changes to one, then commits them to the partner, at which time the changes are sent to the other.
 - B. An administrator pushes the configuration file to both firewalls, then commits them.
 - C. An administrator commits changes to one, which automatically synchronizes with the other.
 - D. An administrator schedules an automatic sync frequency in the firewall configurations.

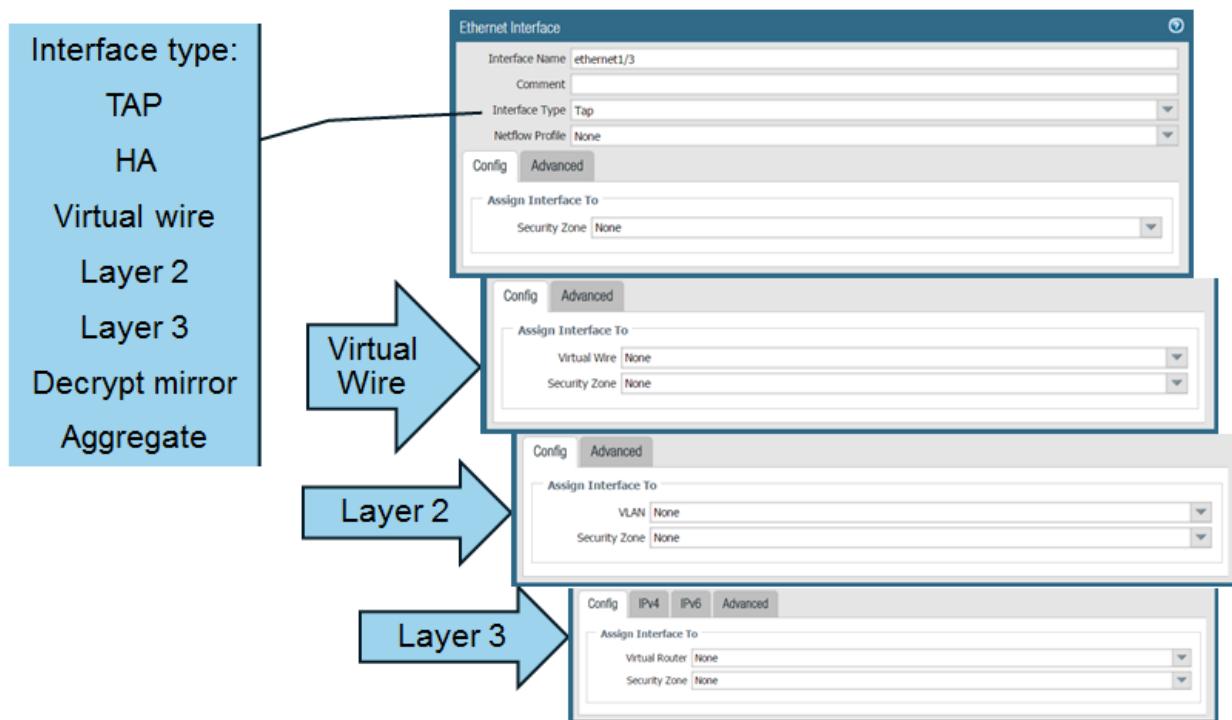
15. In which two ways is an active/passive HA pair configured in virtual firewalls deployed in public clouds? (Choose two.)
- A. The virtual firewalls are deployed in a cloud “scale set” with a cloud-supplied load balancer in front to detect and manage failover.
 - B. The virtual firewalls rely on a VM-Series plugin to map appropriate cloud functions to the firewall’s HA settings.
 - C. Virtual firewalls use PAN-OS HA configuration combined with appropriate cloud deployments of interfaces for HA use.
 - D. The virtual firewalls use an HA Compatibility module for the appropriate cloud technology.

1.4 Identify the appropriate interface type and configuration for a specified network deployment

Types of Interfaces

Palo Alto Networks firewalls support several different interface types: TAP mode, virtual wire mode, Layer 2, Layer 3, and aggregate. A single firewall can freely intermix interface types to meet any integration need. The decision about which interface configuration to choose depends on functional need and existing network integration requirements.

The following screenshot shows primary configuration options for interfaces:



Tap

A network tap is a device that provides a way to access data flowing across a computer network. TAP mode deployment allows you to passively monitor traffic flows across a network using a switch SPAN or mirror port.

A switch SPAN or mirror port permits the copying of traffic from ports on the switch to the tap interface of the firewall, providing a one-way flow of copied network traffic into the firewall. This configuration allows the firewall to perform detection of traffic and threats but prevents any enforcement action from taking place because the traffic does not flow through the firewall back to the environment.

By deploying the firewall in TAP mode, you can get visibility into which applications are running on the network without having to make any changes to your network design. When the firewall is in TAP mode, it also can identify threats on your network. Remember, however, that the traffic is not running through the firewall when the firewall is in TAP mode, so no action can be taken on the traffic, including blocking traffic with threats or applying QoS traffic control.

Details about configuring tap interfaces are here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/networking/configure-interfaces/tap-interfaces.html>

Virtual Wire

In a virtual wire deployment, you install a firewall transparently on a network segment by binding two firewall ports (interfaces) together. The virtual wire logically connects the two interfaces; hence, the virtual wire is internal to the firewall.

Use a virtual wire deployment only when you want to seamlessly integrate a firewall into a topology and the two connected interfaces on the firewall need not do any switching or routing. For these two interfaces, the firewall is considered a bump in the wire.

A virtual wire deployment simplifies firewall installation and configuration because you can insert the firewall into an existing topology without assigning MAC or IP addresses to the interfaces, redesigning the network, or reconfiguring surrounding network devices. The virtual wire supports blocking or allowing traffic based on virtual LAN (VLAN) tags. It also supports Security policy rules, App-ID, Content-ID, User-ID, decryption, LLDP, active/passive and active/active HA, QoS, zone protection (with some exceptions), non-IP protocol protection, DoS protection, packet buffer protection, tunnel content inspection, and NAT.

Each virtual wire interface is directly connected to a Layer 2 or Layer 3 networking device or host. The virtual wire interfaces have no Layer 2 or Layer 3 addresses. When one of the virtual wire interfaces receives a frame or packet, it ignores any Layer 2 or Layer 3 addresses for switching or routing purposes but applies your security or NAT policy rules before passing an allowed frame or packet over the virtual wire to the second interface and on to the network device connected to it.

You wouldn't use a virtual wire deployment for interfaces that need to support switching, VPN tunnels, or routing because they require a Layer 2 or Layer 3 address. A virtual wire interface doesn't use an Interface Management Profile, which controls services such as HTTP and ping and therefore requires the interface to have an IP address.

All firewalls shipped from the factory have two Ethernet ports (ports 1 and 2) preconfigured as virtual wire interfaces, and these interfaces allow all untagged traffic.

Details about configuring virtual wire interfaces are here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/networking/configure-interfaces/virtual-wire-interfaces.html>

Layer 2

In a Layer 2 deployment, the firewall provides switching between two or more networks. Devices are connected to a Layer 2 segment; the firewall forwards the frames to the proper port, which is associated with the MAC address identified in the frame. Configure a Layer 2 interface when switching is required.

Details about configuring Layer 2 interfaces are here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/networking/configure-interfaces/layer-2-interfaces.html>

Layer 3

In a Layer 3 deployment, the firewall routes traffic between multiple ports using TCP/IP addressing. Before you can configure Layer 3 interfaces, you must configure the virtual routers that you want the firewall to use to route the traffic for each Layer 3 interface.

Layer 3 deployments require more network planning and configuration preparation than do most other firewall interfaces but still are the most widely used in firewall deployments. Palo Alto Networks supports both IPv4 and IPv6 simultaneously through a *dual stack* implementation when IPv6 is required.

Each Layer 3 interface must be configured with an IPv4 and/or an IPv6 address, zone name assignment, and the attached virtual router that services the traffic on the interface. Options available to meet other connectivity requirements include:

- NetFlow integration
- MSS adjustment
- MTU adjustment
- Binding of firewall services (ping responses, web management interface availability, etc.)
- Neighbor discovery for IPv6
- Manual MAC address assignment
- LLDP enablement
- Dynamic DNS support
- Link negotiation settings

Details about configuring Layer 3 interfaces and its options can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/networking/configure-interfaces/layer-3-interfaces/configure-layer-3-interfaces.html>

Decrypt Mirror

Decrypt mirror is a special configuration supporting the routing of decrypted traffic copies through an external interface to a data loss prevention (DLP) service. Data loss prevention is a product category for products that scan internet-bound traffic for keywords and patterns that identify sensitive information.

Specific information is here:

<https://knowledgebase.paloaltonetworks.com/KCSArticleDetail?id=kA10g000000CIGDCA0>

Aggregate Interfaces

An aggregate Ethernet (AE) interface group uses IEEE 802.1AX link aggregation to combine multiple Ethernet interfaces into a single virtual interface that connects the firewall to another network device or another firewall. An AE interface group increases the bandwidth between peers by load balancing traffic across the combined interfaces. It also provides redundancy: When one interface fails, the remaining interfaces continue to support traffic.

Before you configure an AE interface group, you must configure its interfaces. Hardware media can differ among the interfaces assigned to any particular aggregate group. For example, you can mix fiber optic and copper. But the bandwidth (1Gbps, 10Gbps, 40Gbps, or 100Gbps) and interface type (HA3, virtual wire, Layer 2, or Layer 3) must be the same. You can add up to eight AE interface groups per firewall, and each group can have up to eight interfaces.

Aggregate interface creation begins with the definition of an Aggregate Interface group, after which individual interfaces are added to the group.

Information about the creation of the group can be found here:

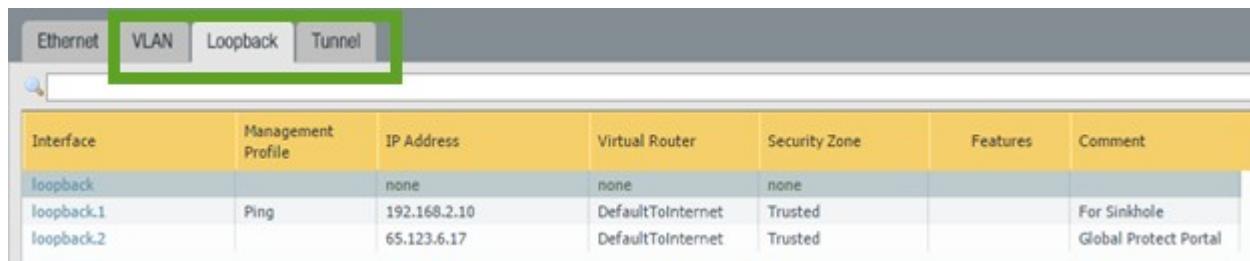
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-web-interface-help/network/network-interfaces/aggregate-ethernet-ae-interface-group.html>

Details about assigning interfaces to the group can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-web-interface-help/network/network-interfaces/aggregate-ethernet-ae-interface.html>

Virtual Interfaces

Palo Alto Networks firewalls also provide several virtual interface types for additional functionality:



| Interface | Management Profile | IP Address | Virtual Router | Security Zone | Features | Comment |
|------------|--------------------|--------------|-------------------|---------------|----------|-----------------------|
| loopback | | none | none | none | | |
| loopback.1 | Ping | 192.168.2.10 | DefaultToInternet | Trusted | | For Sinkhole |
| loopback.2 | | 65.123.6.17 | DefaultToInternet | Trusted | | Global Protect Portal |

VLAN Interfaces

VLANs are logical interfaces that specifically serve as interconnects between on-board virtual switches (VLANs) and virtual routers, which allows traffic to move from Layer 2 to Layer 3 within the firewall.

Specific information is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-web-interface-help/network/network-interfaces-vlan.html>

Loopback Interfaces

Loopback interfaces are Layer 3 interfaces that exist only virtually and connect to virtual routers in the firewall. Loopback interfaces are used for multiple network engineering and implementation purposes. They can be destination configurations for DNS sinkholes, GlobalProtect service interfaces (portals and gateways), routing identification, and more.

Specific information about configuring loopback interfaces can be found in the reference for Layer 3 interfaces.

Tunnel Interfaces

In a VPN tunnel setup, the Layer 3 interface at each end must have a logical tunnel interface for the firewall to connect to and establish a VPN tunnel. A tunnel interface is a logical (virtual) interface that is used to deliver traffic between two endpoints. If you configure any proxy IDs, the proxy ID is counted toward any IPsec tunnel capacity.

The tunnel interface must belong to a security zone to apply policy and it must be assigned to a virtual router to use the existing routing infrastructure. Ensure that the tunnel interface and the physical interface are assigned to the same virtual router so that the firewall can perform a route lookup and determine the appropriate tunnel to use.

The Layer 3 interface that the tunnel interface is attached to typically belongs to an external zone, for example, the untrust zone. Although the tunnel interface can be in the same security zone as the physical interface, for added security and better visibility you can create a separate zone for the tunnel interface. If you create a separate zone for the tunnel interface, such as a VPN zone, you will need to create Security policies to enable traffic to flow between the VPN zone and the trust zone.

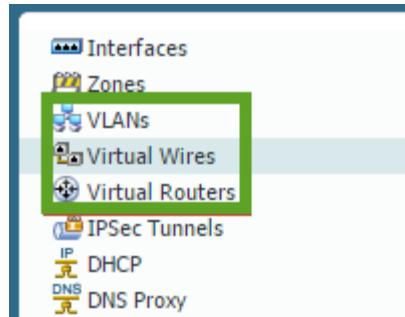
A tunnel interface does not require an IP address to route traffic between the sites. An IP address is required only if you want to enable tunnel monitoring or if you are using a dynamic routing protocol to route traffic across the tunnel. With dynamic routing, the tunnel IP address serves as the next hop IP address for routing traffic to the VPN tunnel.

If you are configuring the Palo Alto Networks firewall with a VPN peer that performs policy-based VPN, you must configure a local and remote proxy ID when setting up the IPsec tunnel. Each peer compares the proxy IDs configured on it with what actually is received in the packet to allow a successful IKE phase 2 negotiation. If multiple tunnels are required, configure unique proxy IDs for each tunnel interface; a tunnel interface can have a maximum of 250 proxy IDs. Each proxy ID counts toward the IPsec VPN tunnel capacity of the firewall, and the tunnel capacity varies by the firewall model.

Specific information about configuring tunnel interfaces can be found in the reference for Layer 3 interfaces.

Traffic Forwarding

All traffic that arrives at the firewall will be delivered either to an internal firewall process (destination traffic) or be passed through a traffic interface (transit traffic). All transit traffic must be handed off to the egress interface by a traffic handling object that matches the interface type. Examples of these objects are VLAN objects (VLANs) for Layer 2 traffic, virtual routers for Layer 3 traffic, and virtual wires for virtual wire interfaces.



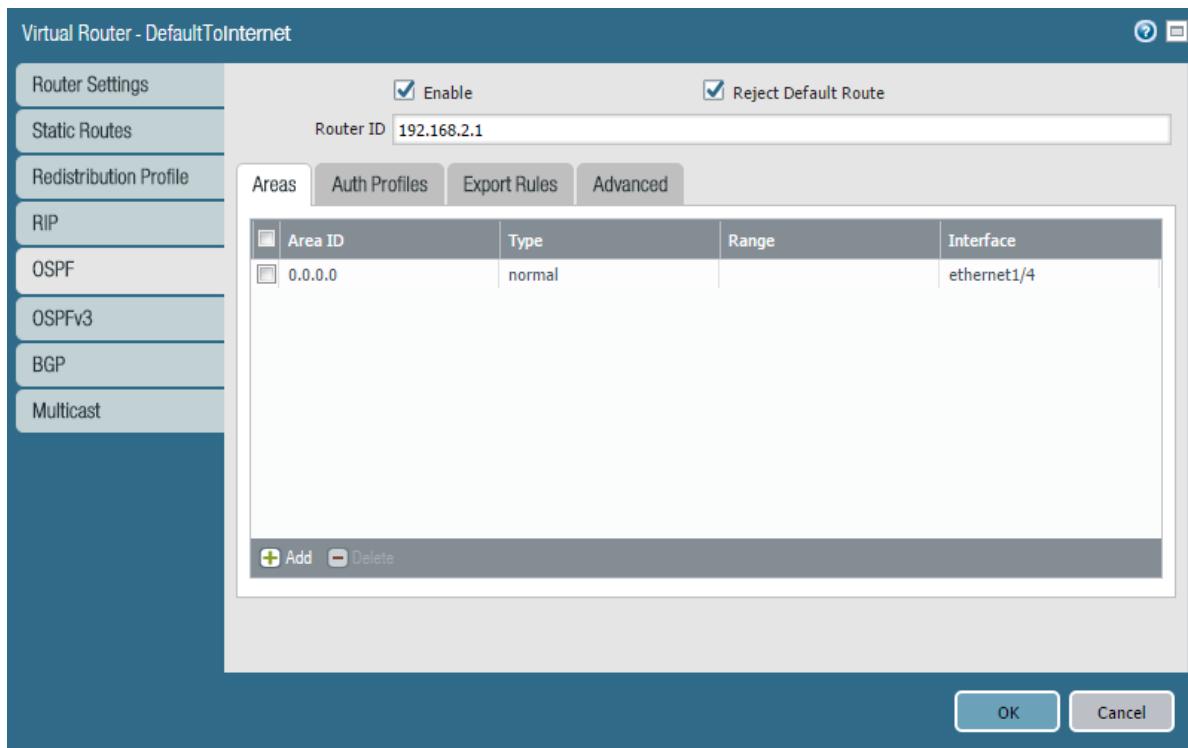
Simultaneous implementations of multiple traffic handler types in multiple quantities are possible. Each object contains configuration capability appropriate to its protocol-handling needs. Virtual routers implement various dynamic routing support if desired.

A screenshot of the "Virtual Router - DefaultToInternet" configuration dialog. The left sidebar shows "Router Settings" with "Static Routes" selected. The main area has tabs for "General" (selected) and "ECMP".

| Protocol | Administrative Distance |
|-------------|-------------------------|
| Static | 10 |
| Static IPv6 | 10 |
| OSPF Int | 30 |
| OSPF Ext | 110 |
| OSPFv3 Int | 30 |
| OSPFv3 Ext | 110 |
| IBGP | 200 |
| EBGP | 20 |
| RIP | 120 |

Buttons at the bottom include "OK" and "Cancel".

Each Layer 3 dynamic routing protocol includes appropriate specific configuration options. An example of OSPFv2 follows:



IPsec tunnels are considered Layer 3 traffic segments for implementation purposes and are handled by virtual routers as is any other network segment. Forwarding decisions are made by destination address, not by VPN policy.

Virtual Routers

Because Layer 3 interfaces and their associated virtual routers are the most widely used deployment options, a review of virtual routers follows.

A virtual router is a function of the firewall that participates in Layer 3 routing. The firewall uses virtual routers to obtain routes to other subnets after you manually define static routes or through participation in one or more Layer 3 routing protocols (dynamic routes). The routes that the firewall obtains through these methods populate the IP routing information base (RIB) on the firewall. When a packet is destined for a different subnet than the one it arrived on, the virtual router obtains the best route from the RIB, places it in the forwarding information base (FIB), and forwards the packet to the next hop router defined in the FIB. The firewall uses Ethernet switching to reach other devices on the same IP subnet. (An exception to adding only a single optimal route to the FIB occurs if you are using ECMP, in which case all equal-cost routes go in the FIB.)

The Ethernet, VLAN, and tunnel interfaces defined on the firewall receive and forward Layer 3 packets. The destination zone is derived from the outgoing interface based on the forwarding criteria, and the firewall consults policy rules to identify the Security policies that it applies to each packet. In addition to

routing to other network devices, virtual routers can route to other virtual routers within the same firewall if a next hop is specified to point to another virtual router.

You can configure Layer 3 interfaces on a virtual router to participate with dynamic routing protocols (BGP, OSPFv2, OSPFv3, or RIP) and add static routes. You also can create multiple virtual routers, each maintaining a separate set of routes that aren't shared between virtual routers, which enables you to configure different routing behaviors for different interfaces.

Each Layer 3 Ethernet, loopback, VLAN, and tunnel interface defined on the firewall must be associated with a virtual router. Although each interface can belong to only one virtual router, you can configure multiple routing protocols and static routes for a virtual router.

A firewall can have more than one router instance with each model supporting a different maximum. An interface can be attached to one virtual router at a time. Virtual routers can route directly to each other within the firewall.

Administrative Distance

Within the virtual router configuration, set administrative distances for types of routes as required for your network. A virtual router that has two or more different routes to the same destination uses administrative distance to choose the best path from different routing protocols and static routes by preferring a lower distance.

Route Redistribution

Route redistribution on the firewall is the process of making routes that the firewall learned from one routing protocol (or a static or connected route) available to a different routing protocol, thereby increasing the number of reachable networks. Without route redistribution, a router or virtual router advertises and shares routes only with other routers that run the same routing protocol. You can redistribute IPv4 or IPv6 BGP, connected, or static routes into the OSPF RIB and redistribute OSPFv3, connected, or static routes into the BGP RIB.

Route distribution means, for example, you can make specific networks that were once available only by manual static route configuration on specific routers available to BGP autonomous systems or OSPF areas. You also can advertise locally connected routes, such as routes to a private lab network, into BGP autonomous systems or OSPF areas.

You might want to give users on your internal OSPFv3 network access to BGP so they can access devices on the internet. In this case you would redistribute BGP routes into the OSPFv3 RIB.

Conversely, you might want to give your external users access to some parts of your internal network, so you can make internal OSPFv3 networks available through BGP by redistributing OSPFv3 routes into the BGP RIB.

Equal-Cost Multi-Path Routing

Equal-cost multi-path (ECMP) processing is a networking feature that enables the firewall to use up to four equal-cost routes to the same destination. Without this feature, the virtual router would select only a single route to a destination from the routing table and add it to its forwarding table; it will not use any of the other routes unless there is an outage in the chosen route.

Enablement of ECMP functionality on a virtual router allows the firewall to have up to four equal-cost paths to a destination in its forwarding table, which allows the firewall to:

- Load balance flows (sessions) to the same destination over multiple equal-cost links
- Efficiently use all available bandwidth on links to the same destination rather than leave some links unused
- Dynamically shift traffic to another ECMP member to the same destination if a link fails, rather than having to wait for the routing protocol or RIB table to elect an alternative path/route.
Dynamic failover can help reduce downtime when links fail.

Information about configuring ECMP can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/networking/ecmp>

GRE Tunnels

A GRE tunnel connects two endpoints (a firewall and another device) in a point-to-point, logical link. The firewall can terminate GRE tunnels; you can route or forward packets to a GRE tunnel. GRE tunnels are simple to use and often are the tunneling protocol of choice for point-to-point connectivity, especially to services in the cloud or to partner networks.

Create a GRE tunnel when you want to direct packets that are destined for an IP address to take a certain point-to-point path, for example, to a cloud-based proxy or to a partner network. The packets travel in the GRE tunnel (over a transit network such as the internet) to the cloud service while on their way to the destination address. Thus, the cloud service can enforce its services or policies on the packets.

After the firewall allows a packet (based on a policy match) and the packet egresses to a GRE tunnel interface, the firewall adds GRE encapsulation; it doesn't generate a session. The firewall does no Security policy rule lookup for the GRE-encapsulated traffic; therefore, you don't need a Security policy rule for the GRE traffic the firewall encapsulates. However, after the firewall receives GRE traffic, it generates a session and applies all policies to the GRE IP header in addition to the encapsulated traffic. The firewall treats the received GRE packet as it would any other packet.

If the firewall receives the GRE packet on an interface that has the same zone as the tunnel interface associated with the GRE tunnel (for example, tunnel.1), the source zone is the same as the destination zone. By default, traffic is allowed within a zone (intrazone traffic), so the ingress GRE traffic is allowed by default.

However, if you configured your own intrazone Security policy rule to deny such traffic, you must explicitly allow GRE traffic.

Likewise, if the zone of the tunnel interface associated with the GRE tunnel (for example, tunnel.1) is different from the zone of the ingress interface, you must configure a Security policy rule to allow the GRE traffic.

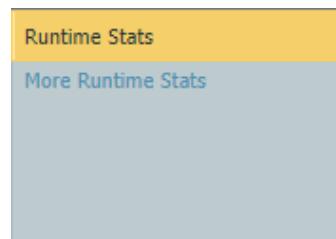
Because the firewall encapsulates the tunneled packet in a GRE packet, the additional 24 bytes of GRE header automatically results in a smaller maximum segment size (MSS) in the maximum transmission unit (MTU). If you don't change the IPv4 MSS Adjustment Size for the interface, by default the firewall reduces the MTU by 64 bytes (40 bytes of IP header + 24 bytes of GRE header).

This reduction means if the default MTU is 1,500 bytes, the MSS will be 1,436 bytes ($1,500 - 40 - 24 = 1,436$). If you configure an MSS adjustment size of 300 bytes, for example, the MSS will be only 1,176 bytes ($1,500 - 300 - 24 = 1,176$).

Routing of a GRE or IPsec tunnel to a GRE tunnel is not supported. However, you can route a GRE tunnel to an IPsec tunnel. A GRE tunnel does not support QoS. The firewall does not support a single interface acting as both a GRE tunnel endpoint and a decryption broker. GRE tunneling does not support NAT between GRE tunnel endpoints.

Routing Troubleshooting

The routing decisions made by a virtual router can be diagnosed easily. A virtual router maintains a RIB and a FIB, which can be displayed any time in the management web interface using the **Runtime Stats** link displayed on the virtual router summary line:



Click the **More Runtime Stats** link to get access to the routing table (RIB) and the forwarding table (FIB) with additional displays that contain the status of any enabled dynamic routing protocols.

A screenshot of the "Route Table" section of the Management Web Interface. The top navigation bar includes tabs for Routing, RIP, OSPF, OSPFv3, BGP, Multicast, and BFD Summary Information. Below this is a sub-navigation bar with tabs for Route Table, Forwarding Table, and Static Route Monitoring. The Route Table tab is selected. A search bar and filter dropdown are at the top of the table area. The table itself has columns: Destination, Next Hop, Metric, Weight, Flags, Age, and Interface. Data rows include:

| Destination | Next Hop | Metric | Weight | Flags | Age | Interface |
|------------------|-------------|--------|--------|------------|-----|-------------|
| 0.0.0.0/0 | [redacted] | 10 | 0 | A S A C | | ethernet1/8 |
| | 0.0.0.0 | 0 | 0 | A H | | ethernet1/8 |
| 192.168.1.0/24 | 192.168.1.1 | 0 | 0 | A C | | ethernet1/1 |
| 192.168.1.1/32 | 0.0.0.0 | 0 | 0 | A H | | |
| 192.168.1.10/32 | 0.0.0.0 | 0 | 0 | A H | | |
| 192.168.1.100/32 | 0.0.0.0 | 0 | 0 | A H | | |
| 192.168.3.0/24 | 192.168.3.1 | 0 | 0 | A C | | ethernet1/3 |
| 192.168.3.1/32 | 0.0.0.0 | 0 | 0 | A H | | |

At the bottom of the table area, there is a "Refresh" button and a legend explaining symbols: Active, ? loose, C connect, H host, S static, ~ internal, R rip, O OSPF, B bgp, O OSPF intra-area, O OSPF inter-area, O1 OSPF ext-type-1, O2 OSPF ext-type-2.

Sample Questions

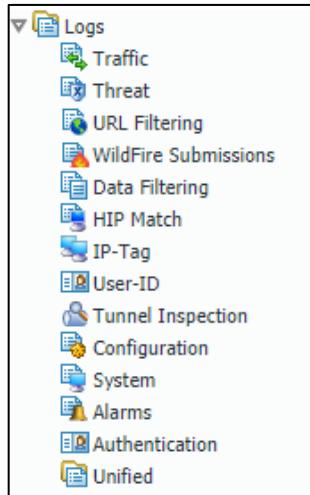
16. Without having to make network address configuration changes, you would use which type of network interface to insert a Palo Alto Networks firewall in front of a legacy port-based firewall to collect application information from incoming network traffic?
 - A. VLAN
 - B. tunnel
 - C. tap
 - D. virtual wire
 - E. Layer 2
 - F. Layer 3
17. Which type of interface do you use to connect Layer 2 and Layer 3 interfaces?
 - A. VLAN
 - B. tunnel
 - C. tap
 - D. virtual wire
 - E. Layer 2
 - F. Layer 3
18. Which three types of interfaces can the firewall's management web interface be bound to? (Choose three.)
 - A. VLAN
 - B. tunnel
 - C. tap
 - D. virtual wire
 - E. Layer 2
 - F. Layer 3
19. Which three types of interfaces connect to a virtual router? (Choose three.)
 - A. VLAN
 - B. tunnel
 - C. tap
 - D. virtual wire
 - E. Layer 2
 - F. Layer 3
20. Which dynamic routing protocol is *not* supported by the Palo Alto Networks firewall?
 - A. RIP
 - B. OSPF
 - C. OSPFv3
 - D. IGRP
 - E. BGP

21. Which action is *not* compatible with aggregate interface configuration?
- A. aggregating 12 Layer 3 interfaces
 - B. aggregating four virtual wire interfaces
 - C. aggregating interfaces in an HA pair
 - D. aggregating two 10Gbps optical and two 10Gbps copper Ethernet ports

1.5 Identify strategies for retaining logs using Distributed Log Collection

Event Logging on NGFWs

Palo Alto Networks next-generation firewalls automatically generate local log entries as a result of normal traffic processing.



A firewall's default behavior is to store these logs in locally available storage. Firewall appliances have fixed storage that can't be expanded (except the 7000 Series). This storage is used in a "circular" fashion, meaning that log entries are written until storage fills, at which point the oldest entries are overwritten. Because storage size is fixed and logging rates depend in part on Security policy rule settings and traffic rates, a firewall's log retention period before entries are overwritten is difficult to predict.

Distributed Log Collection

For centralized logging and reporting, you must forward the logs generated on the firewalls to your on-premises infrastructure that includes the Panorama management server or Log Collectors, or you must send the logs to the cloud-based Cortex Data Lake service. In addition to aggregating logs, Panorama can forward them as SNMP traps, email notifications, syslog messages, and HTTP payloads to an external server.

For centralized logging and reporting, you also can use the Cortex Data Lake that is designed to work seamlessly with Panorama. The Cortex Data Lake allows your managed firewalls to forward logs to the Cortex Data Lake infrastructure instead of to Panorama or to the managed Log Collectors, so you can augment your existing distributed log collection setup or scale your current logging infrastructure.

The Application Command Center (ACC) on Panorama provides a single pane for unified reporting across all the firewalls. It enables you to centrally monitor network activity to analyze, investigate, and report on traffic and security incidents. On Panorama, you can view logs and generate reports from logs forwarded to the Cortex Data Lake, to Panorama, or to the managed Log Collectors, if configured, or you can query the managed firewalls directly.

For example, you can generate reports about traffic, threat, and/or user activity in the managed network based on logs stored on Panorama (and the managed collectors) or by accessing the logs stored locally on the managed firewalls, or on the Cortex Data Lake.

If you don't configure Log Forwarding to Panorama or the Cortex Data Lake, you can schedule reports to run on each managed firewall and forward the results to Panorama for a combined view of user activity and network traffic. Although reports don't provide a granular drill-down on specific information and activities, they provide a unified monitoring approach.

Panorama uses Log Collectors to aggregate logs from managed firewalls. When Panorama generates reports, it queries the Log Collectors for log information that provides you visibility into all the network activity that your firewalls monitor. Because you use Panorama to configure and manage Log Collectors, they also are known as managed collectors. Panorama can manage two types of Log Collectors:

- Local Log Collector: This type of Log Collector runs locally on the Panorama management server. Only an M-600, M-500 appliance, M-200, M-100 appliance, or Panorama virtual appliance in Panorama mode supports a local Log Collector.

Note: If you forward logs to a Panorama virtual appliance in Legacy mode, it stores the logs locally without a Log Collector.

- Dedicated Log Collector: This is an M-600, M-500, M-200, M-100 appliance, or Panorama virtual appliance in Log Collector mode. You can use an M-Series appliance in Panorama mode or a Panorama virtual appliance in Panorama or Legacy (ESXi and vCloud Air) mode to manage Dedicated Log Collectors. Before you can use the Panorama web interface for managing Dedicated Log Collectors, you must add them as managed collectors. Otherwise, administrative access to a Dedicated Log Collector is available only through its CLI using the predefined administrative user (admin) account. Dedicated Log Collectors don't support additional administrative user accounts.

You can use either or both types of Log Collectors to achieve the best logging solution for your environment.

A Log Collector Group is 1 to 16 managed collectors that operate as a single logical log collection unit. If the Log Collector Group contains Dedicated Log Collectors, Panorama uniformly distributes the logs across all the disks in each Log Collector and across all Log Collectors in the group. This distribution optimizes the available storage space. To enable a Log Collector to receive logs, you must add it to a Log Collector Group. You can enable log redundancy by assigning multiple Log Collectors to a Log Collector Group. The Log Collector Group configuration specifies which managed firewalls can send logs to the Log Collectors in the group.

If an HA pair of Panoramas is configured to include Log Collectors, the Log Collectors function independently from the HA relationship and both are independently active. They can be added to different Collector Groups or to the same Collector Group.

More information about this topic can be found here:

<https://docs.paloaltonetworks.com/panorama/9-1/panorama-admin/panorama-overview/centralized-logging-and-reporting.html>

Sample Questions

22. In a Panorama environment, how do you create and view enterprise-wide reports that include data from all managed firewalls?
 - A. Run Panorama reports normally. Firewall summary reporting information is gathered automatically once the firewalls are managed by Panorama.
 - B. Configure log forwarding on the managed firewalls to forward logs to Panorama using syslog formatting.
 - C. Run custom Panorama reports and select **remote logs** as the information source.
 - D. Run custom Panorama reports and select **log collector** as the information source.
23. What must you configure to guarantee duplication of log data on Log Collectors?
 - A. Log Collector settings to include “Replicate Data”
 - B. Panorama HA settings to include “Duplicate Logs”
 - C. Log Collector settings to include “Enable log redundancy”
 - D. log forwarding settings of firewalls for two Log Collector destinations
24. Which three devices can be used as Log Collectors? (Choose three.)
 - A. Virtual Panorama
 - B. PA-220R
 - C. M-600
 - D. M-200
 - E. VM-300LC
25. Which statement is true regarding Log Collecting in a Panorama HA pair?
 - A. Both Panoramas cannot be configured to collect logs.
 - B. Log collecting is handled by the active HA Panorama until a failover occurs.
 - C. Both Panoramas collect independent logging traffic and are not affected by failover.
 - D. Both Panoramas receive the same logging traffic and synchronize in case of HA failover.

1.6 Given a scenario, identify the strategy that should be implemented for Distributed Log Collection

Log Collection Platform Choices

When centralized logging is implemented, one design criterion is whether log collection will happen in the Panorama management platform, a Panorama-managed Log Collector, or the Cortex Data Lake.

The choice of platform is driven by your anticipated logging volume and the network topology the logging data will traverse.

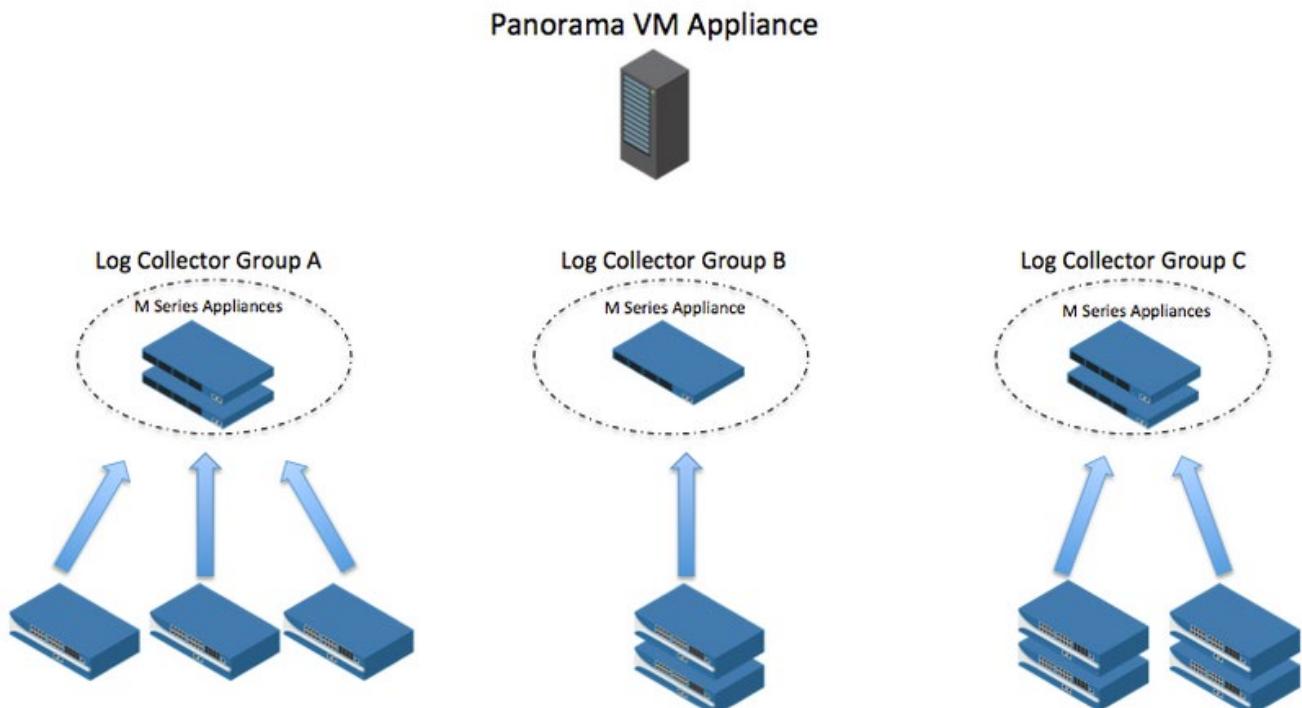
A complete discussions of log sizing and its impact on design can be found here:

<https://knowledgebase.paloaltonetworks.com/KCSArticleDetail?id=kA10g000000Clc8CAC>

On-Premises Log Collection

Log collection is collecting logs from one or multiple firewalls, either to a single Panorama or to a distributed log collection infrastructure. Reports can be generated based on that log data, whether it resides locally to the Panorama (e.g., single M-Series or VM appliance) or on a distributed logging infrastructure.

The Panorama solution allows for flexibility in design by assigning these functions to different physical pieces of the management infrastructure. For example, device management may be performed from a VM Panorama, while the firewalls forward their logs to collocated dedicated Log Collectors:



Cortex Data Lake

Palo Alto Networks Cortex Data Lake exists as a cloud-based storage mechanism for logs generated by the security platform. Log storage is an important consideration when you buy Palo Alto Networks devices or services. Sufficient log retention not only enables operations by ensuring data is available to administrators for troubleshooting and incident response, but it also enables the full suite services provided by the Cortex Data Lake.

Sample Questions

26. How are log retention periods on Palo Alto Networks firewalls increased?
 - A. add storage to any firewall model
 - B. increase the allocation for overall log storage within the firewall
 - C. turn on log compression
 - D. forward logs to external Log Collectors
27. How do you access and view firewall log data sent to the Cortex Data Lake?
 - A. direct viewing and searching with the Cortex gateway
 - B. Panorama using a Log Collector configuration for access
 - C. reporting in a firewall using a “remote data source” configuration
 - D. reporting in a firewall equipped with a “Remote Logging” plugin
28. Log retention is increased when a Dedicated Log Collector is used to collect logs from firewalls in which two ways? (Choose two.)
 - A. turning on “Log Compression” in the Log Collector
 - B. adding storage capacity to the Log Collector
 - C. enabling “Log Storage Sharing” between the Log Collector and Panorama
 - D. adding Log Collectors to the Log Collector Group

1.7 Identify how to use template stacks for administering Palo Alto Networks firewalls as a scalable solution using Panorama

Panorama Overview

Without Panorama, Palo Alto Networks firewalls have no direct knowledge of each other and must be managed as independent entities. Panorama offers several important integration functions that provide enterprise management for multiple firewalls.

The Panorama management server provides centralized monitoring and management of multiple Palo Alto Networks next-generation firewalls and of WildFire appliances and appliance clusters. It provides a single location from which you can oversee all applications, users, and content traversing your network, and then uses this knowledge to create application enablement policies that protect and control the network. Use of Panorama for centralized policy and firewall management increases operational efficiency in managing and maintaining a distributed network of firewalls.

The PCNSE certification requires the candidate taking the test to have knowledge of Panorama firewall management functions. The following information reviews these management concepts but does not cover the remaining Panorama features.

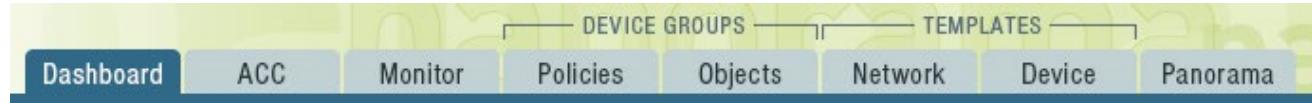
Panorama uses *device groups* and *templates* to group firewalls into logical sets that require similar configuration. You use device groups and templates to centrally manage all configuration elements, policies, and objects on the managed firewalls. Panorama also enables you to centrally manage licenses, software (PAN-OS software, SSL-VPN client software, GlobalProtect agent/app software), and content updates (Applications and threats, WildFire, and Antivirus).

Panorama's web interface management interface looks very much like the firewall's management web interface.

Firewall menus from management web interface:



Panorama menus from management web interface:



You can use the **Device** and **Network** tabs in Panorama to deploy a common base configuration to multiple firewalls that require similar settings using a template or a template stack (a combination of templates). When you manage firewall configurations with Panorama, you use a combination of device groups (to manage shared policies and objects) and templates (to manage shared device and network settings).

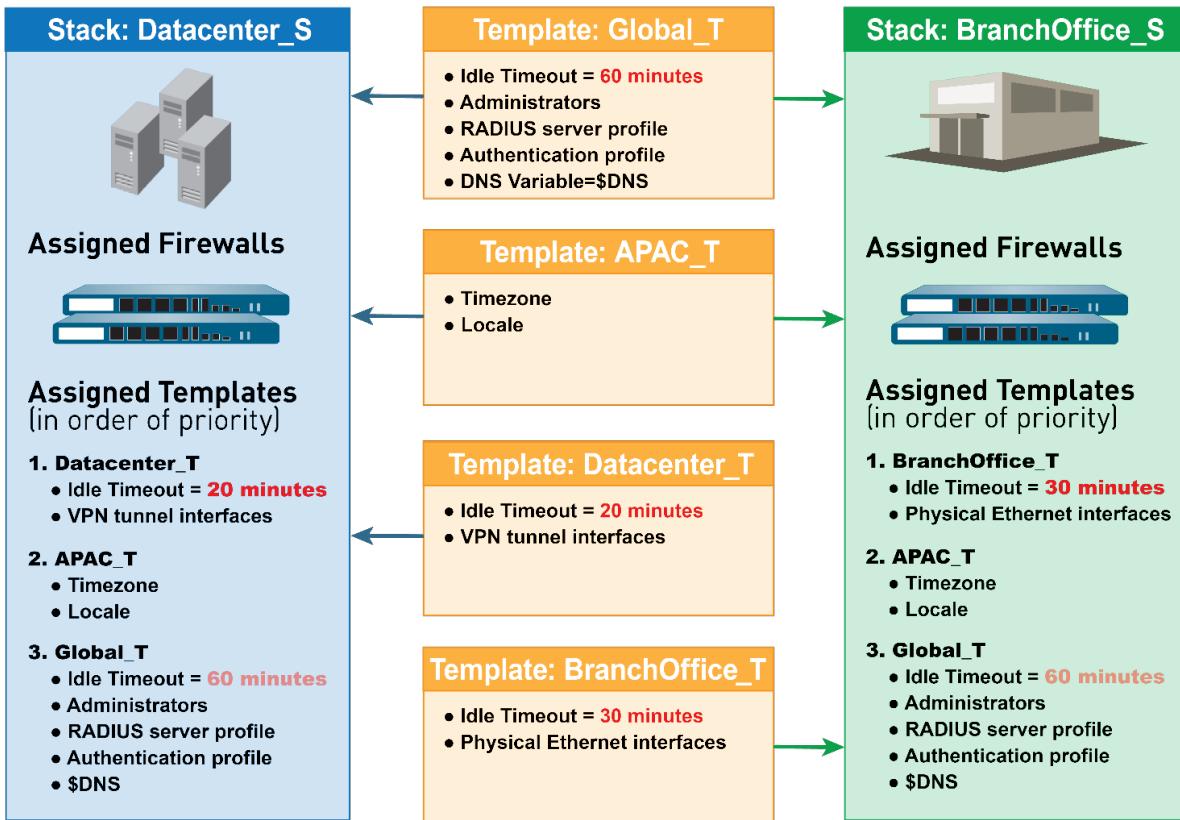
Templates and Template Stacks

You use templates and template stacks to configure the settings that enable firewalls to operate on the network. Templates are the basic building blocks you use to configure the **Network** and **Device** tabs on Panorama. You can use templates to define interface and zone configurations, to manage the server profiles for logging and syslog access, or to define VPN configurations. Template stacks enable you to layer multiple templates and create a combined configuration. Template stacks simplify management because they allow you to define a common base configuration for all devices attached to the template stack and they enable you to layer templates to create a combined configuration. Template stacks enable you to define templates with location-specific or function-specific settings and then stack the templates in descending order of priority so that firewalls inherit the settings based on the order of the templates in the stack.

Templates and template stacks both support variables. Variables allow you to create placeholder objects with their value specified in the template or template stack based on your configuration needs. Create a template or template stack variable to replace IP addresses, group IDs, and interfaces in your configurations. Template variables are inherited by the template stack and can be overridden to create a template stack variable. However, templates do not inherit variables defined in the template stack. When a variable is defined in the template or template stack and pushed to the firewall, the value defined for the variable is displayed on the firewall.

To accommodate firewalls that have unique settings, you can use templates to override the template stack configuration. Or you can push a broader, common base configuration and then override certain pushed settings with firewall-specific values on individual firewalls. When you override a setting on the firewall, the firewall saves that setting to its local configuration and Panorama no longer manages the setting.

When you define a template stack, consider assigning firewalls that are the same hardware model and require access to similar network resources, such as gateways and syslog servers. Grouping enables you to avoid the redundancy of adding every setting to every template stack. The following figure shows an example configuration in which you assign data center firewalls in the Asia-Pacific (APAC) region to a stack with global settings, one template with APAC-specific settings, and one template with data center-specific settings. To manage firewalls in an APAC branch office, you then can re-use the global and APAC-specific templates by adding them to another stack that includes a template with branch-specific settings. Templates in a stack have a configurable priority order that ensures Panorama pushes only one value for any duplicate setting. Panorama evaluates the templates listed in a stack configuration from top to bottom with higher templates having priority. The following figure also illustrates a data center stack in which the data center template has a higher priority than the global template: Panorama pushes the idle timeout value from the data center template and ignores the value from the global template.



Sample Questions

29. The Security policy for all of a customer's remote offices is the same, but different offices have different firewall models. If the remote offices are managed by Panorama, how might the offices share device groups and templates?
 - same device group and same template stack
 - same device group, different template stacks
 - different device groups, same template stack
 - different device groups and different template stacks
30. A Panorama template stack contains two templates and one configuration setting has a different value in each template. When Panorama pushes the template stack to the managed firewalls, which setting value will the firewalls receive?
 - value from the top template of the stack
 - value from the bottom template in the stack
 - value from the template designated as the parent
 - value an administrator selects from the two available values
31. Which two firewall settings are stored in Panorama templates? (Choose two.)
 - custom Application-ID signatures
 - Server Profile for an external LDAP server
 - services definitions
 - DoS Protection Profiles
 - data-plane interface configurations

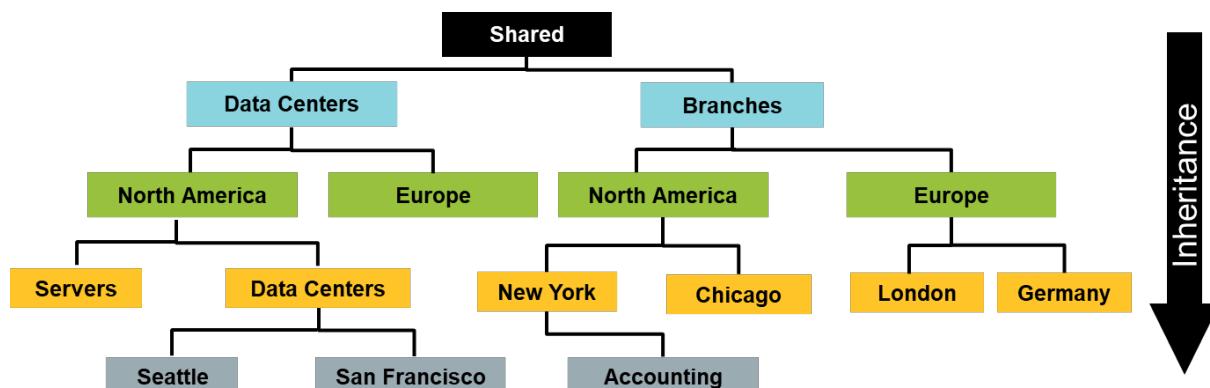
1.8 Identify how to use device group hierarchy for administering Palo Alto Networks firewalls as a scalable solution using Panorama

Device Groups

Before you can use Panorama effectively, you must group the firewalls in your network into logical units called device groups. A device group enables grouping based on network segmentation, geographic location, organizational function, or any other common aspect of firewalls that require similar policy configurations. You can use device groups to configure policy rules and the objects they reference. You can organize device group hierarchically, with shared rules and objects at the top and device group-specific rules and objects at subsequent levels. Organization enables you to create a hierarchy of rules that enforce how firewalls handle traffic. For example, you can define a set of shared rules as a corporate acceptable use policy. Then, to allow only regional offices to access peer-to-peer traffic such as BitTorrent, you can define a device group rule that Panorama pushes only to the regional offices (or define a shared security rule and target it to the regional offices).

You can create a device group hierarchy to nest device groups in a hierarchy of up to four levels, with lower-level groups inheriting the settings (policy rules and objects) of higher-level groups. At the bottom level, a device group can have parent, grandparent, and great-grandparent device groups (ancestors). At the top level, a device group can have child, grandchild, and great-grandchild device groups (descendants). All device groups inheriting settings from the Shared location, a container at the top of the hierarchy for configurations that are common to all device groups.

Creation of a device group hierarchy enables you to organize firewalls based on common policy requirements without redundant configuration. For example, you could configure shared settings that are global to all firewalls, configure device groups with function-specific settings at the first level, and configure device groups with location-specific settings at lower levels. Without a hierarchy, you would have to configure both function-specific and location-specific settings for every device group in a single level under Shared.



Device groups provide a way to implement a layered approach for managing policies across a network of managed firewalls. A firewall evaluates policy rules by layer (shared, device group, and local) and by type (pre-rules, post-rules, and default rules) in the order from top to bottom shown in the following figure. When the firewall receives traffic, it performs the action defined in the first evaluated rule that matches the traffic and disregards all subsequent rules. To change the evaluation order for rules within a particular layer, type, and rule base (for example, shared Security pre-rules). Whether you view rules on a firewall

or in Panorama, the web interface displays them in evaluation order. All the shared, device group, and default rules that the firewall inherits from Panorama are shaded orange. Local firewall rules display between the pre-rules and post-rules. The rules with the orange shading in the following figure were provided by Panorama and can be managed only from Panorama. They are read-only in local firewall displays.

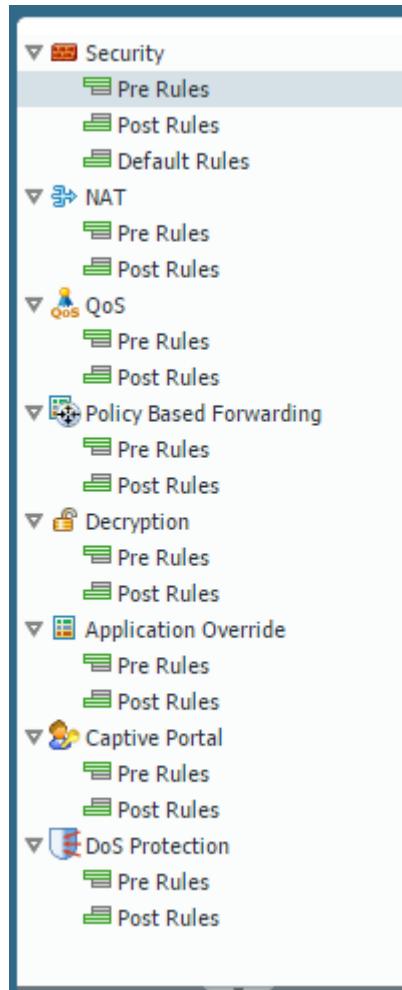
| Name | Tags | Type | Source | | | | Destination | | | | Rule Usage | | |
|-------------------|------|-----------|----------|---------|------|-------------|-------------|---------|-----------|---------------------|---------------------|--|--|
| | | | Zone | Address | User | HIP Profile | Zone | Address | Hit Count | Last Hit | First Hit | | |
| Allow Web | none | universal | Trust-L3 | any | any | any | Untrust-L3 | any | 2285 | 2017-11-14 20:17:53 | 2017-11-11 21:52:58 | | |
| Outbound FTP | none | universal | Trust-L3 | any | any | any | Untrust-L3 | any | 0 | - | - | | |
| Local Policy | none | universal | Trust-L3 | any | any | any | DMZ | any | - | - | - | | |
| Allow Facebook | none | universal | Trust-L3 | any | any | any | Untrust-L3 | any | 0 | - | - | | |
| intrazone-default | none | intrazone | any | any | any | any | (intrazone) | any | 6772 | 2017-11-14 20:17:23 | 2017-10-31 20:58:56 | | |
| interzone-default | none | interzone | any | any | any | any | any | any | 298702 | 2017-11-14 19:54:12 | 2017-10-31 21:02:50 | | |

Pre-Policy Rules
Local Policy Rules
Post-Policy Rules
Default Rules

Objects are configuration elements that policy rules reference, for example: IP addresses, URL categories, Security Profiles, users, services, and applications. Rules of any type (pre-rules, post-rules, default rules, and rules locally defined on a firewall) and any rulebase (Security, NAT, QoS, Policy Based Forwarding, Decryption, Application Override, Captive Portal, and DoS Protection) can reference objects. You can reuse an object in any number of rules that have the same scope as that object in the device group hierarchy.

For example, if you add an object to the Shared location, all rules in the hierarchy can reference that shared object because all device groups inherit objects from Shared. If you add an object to a particular device group, only the rules in that device group and its descendant device groups can reference that device group object. If object values in a device group must differ from those inherited from an ancestor device group, you can override inherited object values. You also can revert to inherited object values at any time. When you create objects for use in shared or device group policy once and use them many times, you reduce administrative overhead and ensure consistency across firewall policies.

When new policy rules are entered into a Panorama device group the device group and the pre or post designation must be decided. The pre and post designations are chosen through selection of the appropriate policy menu item, as shown in the following figure.



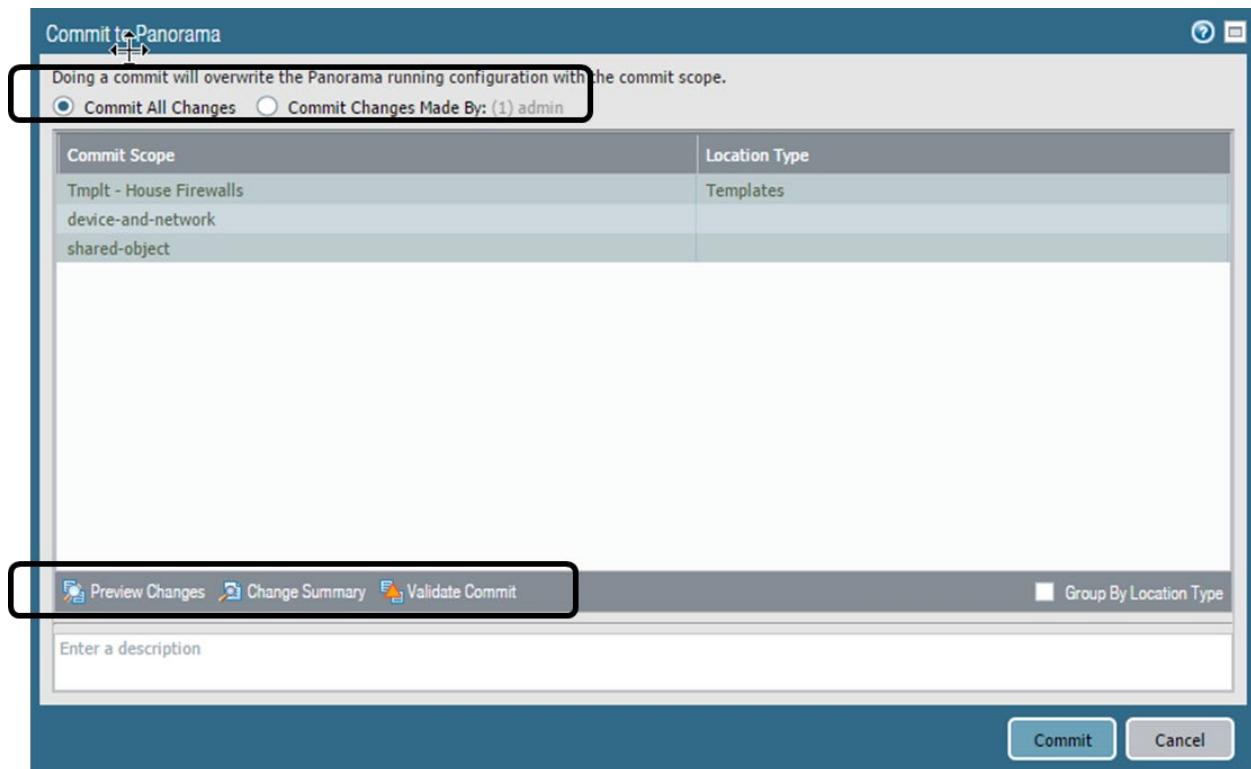
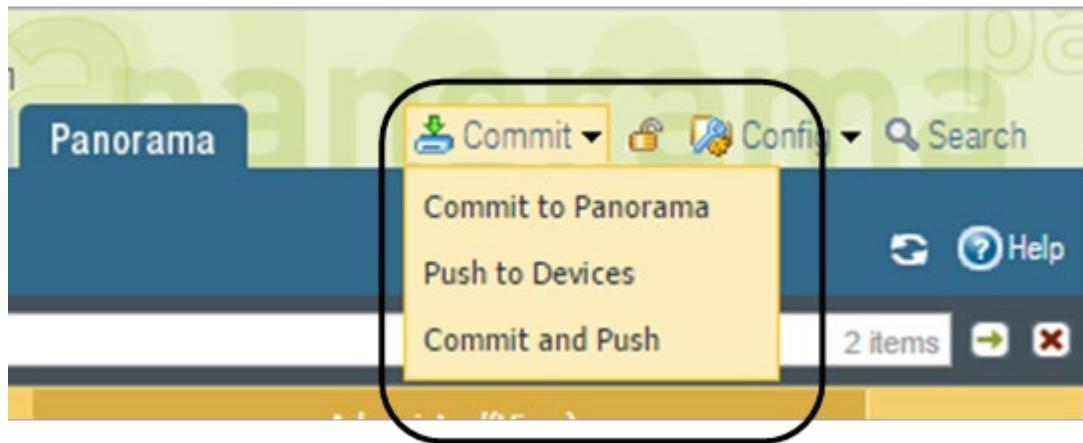
The *Panorama Administrator's Guide* can be found here:

<https://docs.paloaltonetworks.com/panorama/9-1/panorama-admin.html>

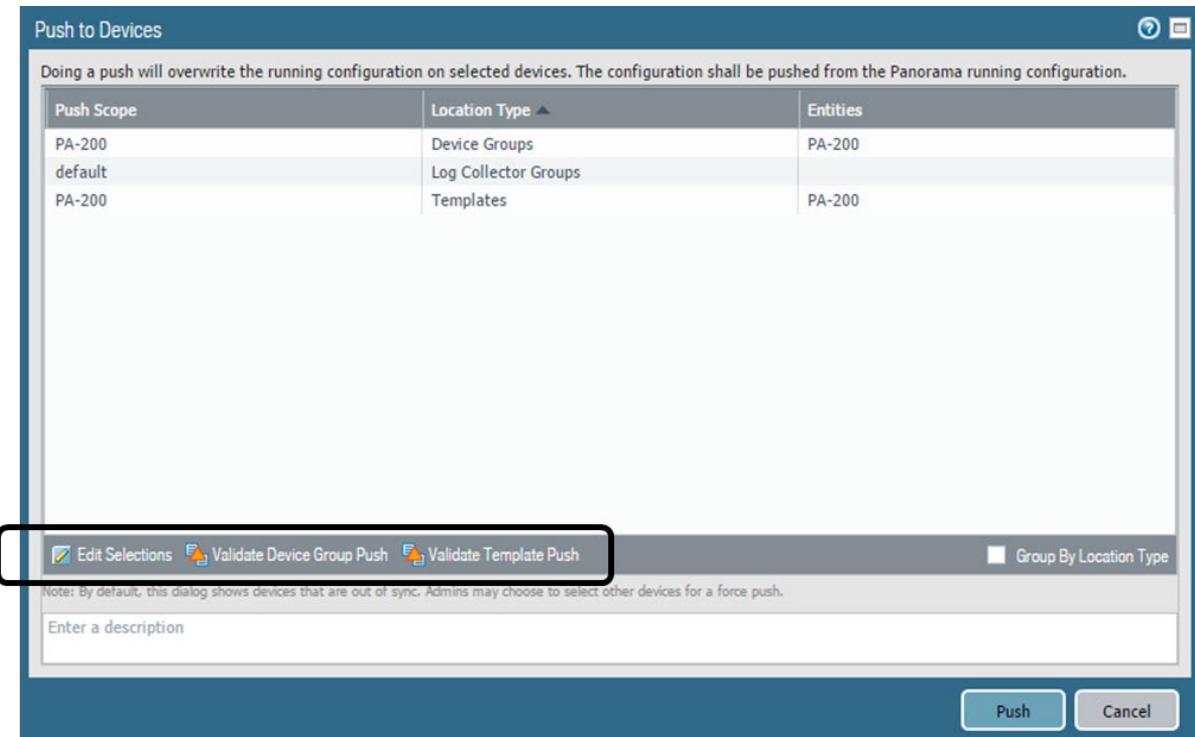
Committing Changes with Panorama

Panorama uses a similar commit concept to firewalls but uses a process with multiple phases. After changes have been made in Panorama, data must first be committed to Panorama and then pushed to devices. Both processes provide methods to push partial data.

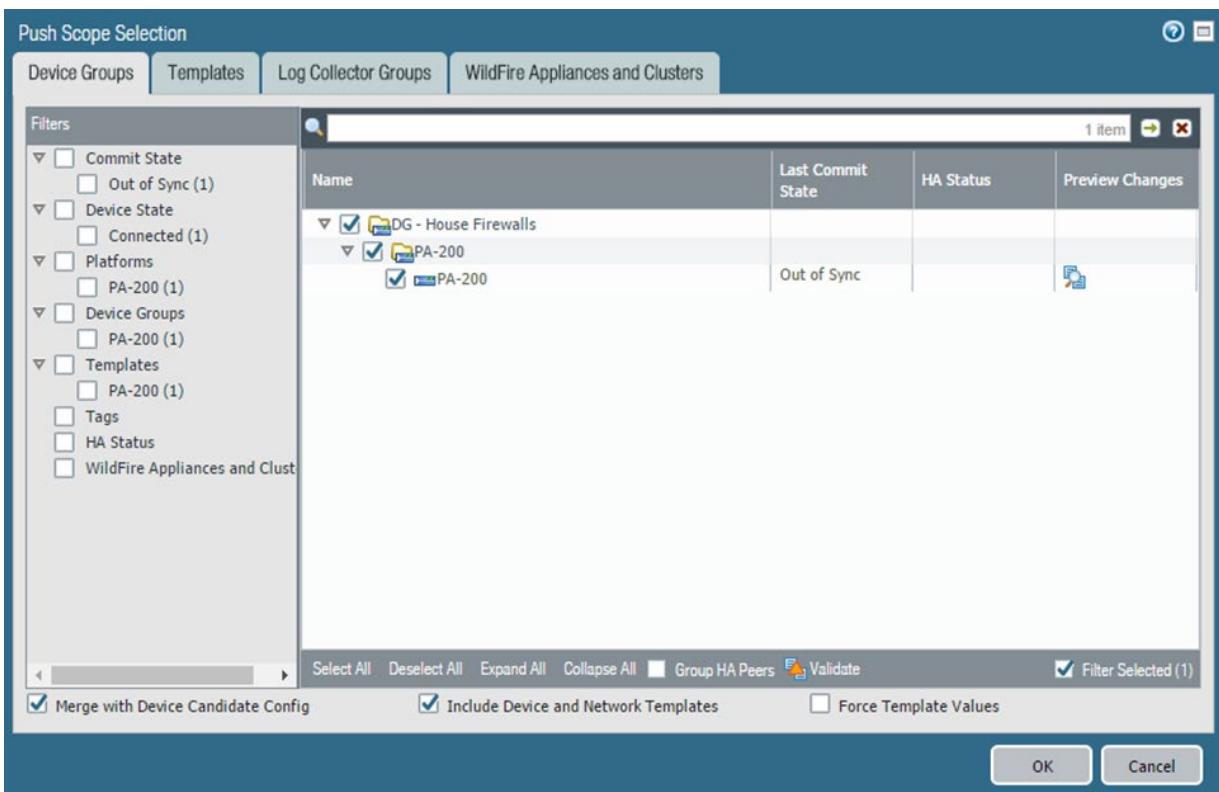
A commit to Panorama commits either the changes made by a chosen admin or all staged changes, as shown in the following figures.



After changes are committed to Panorama, they are pushed to firewalls according to their assigned device groups and template stacks. This push process either can push all queued changes or be done selectively for specific device groups or template stacks. And specific firewalls can be chosen for the update.



Select **Edit Selections** at the bottom of the window to get a granular selection of the data to be pushed.



More information about the commit and push operations can be found here:

<https://docs.paloaltonetworks.com/panorama/9-1/panorama-admin/panorama-overview/panorama-commit-validation-and-preview-operations.html>

Sample Questions

32. Where in Panorama do you enter Security policy rules to ensure that your new rules will take precedence over locally entered rule?
 - A. Security policy rules with a targeted firewall
 - B. default rules section of Security policy rules
 - C. pre-rules section of Security policy rules
 - D. post-rules section of Security policy rules
33. In Panorama, how would you make changes to a Security policy rule for a specific firewall?
 - A. log in to Panorama, clone the rule, modify the clone, and add a target firewall to the new rule
 - B. select the rule, click the override button, and enter the changes
 - C. create a new locally defined Security policy rule that is placed higher in the rule list than the rule to be overridden
 - D. log in to Panorama and modify the original rule
34. Which three firewall settings are stored in Panorama device groups? (Choose three.)
 - A. User Identification configuration
 - B. custom Application-ID signatures
 - C. services definitions
 - D. DoS Protection Profiles
 - E. data-plane interface configurations
 - F. Zone Protection Profiles
 - G. Server Profile for an external LDAP server

1.9 Identify planning considerations unique to deploying Palo Alto Networks firewalls in a public cloud

Virtual Firewalls

The VM-Series is a virtualized form factor of the Palo Alto Networks next-generation firewall that can be deployed in a range of public and private cloud computing environments. VM-Series firewalls run the same PAN-OS software as an appliance does, with the same features and capabilities. Each environment supports the full functionality of PAN-OS software with minor differences depending on the deployed cloud technology.

The VM-Series firewall is available in the following models: VM-50 (Lite), VM-50, VM-100, VM-200, VM-300, VM-500, VM-700, and VM-1000-HV.

All models can be deployed as guest virtual machines on VMware ESXi and vCloud Air, Citrix NetScaler SDX, KVM and KVM in OpenStack, and Microsoft Hyper-V. In the public cloud environments—Amazon Web Services, Azure, Google Cloud Platform, Oracle Cloud, Alibaba Cloud, and Cisco ACI—all models except the VM-50 are supported; on VMware NSX, only the VM-100, VM-200, VM-300, VM-500, and VM-1000-HV firewalls are supported. The software package (.xva, .ova, or .vhdx file) that is used to deploy the VM-Series firewall is common across all models.

All VM-Series firewalls require a capacity license to enable full firewall functionality. After you apply the capacity license on the VM-Series firewall, the model number and the associated capacities are implemented on the firewall. Capacity is defined in terms of the number of sessions, rules, security zones, address objects, IPsec VPN tunnels, and SSL VPN tunnels that the VM-Series firewall is optimized to handle. To make sure that you purchase the correct model for your network requirements, use the following table to learn the maximum capacity for each model and the capacity differences by model:

| Model | Sessions | Security Rules | Dynamic IP Addresses | Security Zones | IPsec VPN Tunnels | SSL VPN Tunnels |
|------------|------------|--|----------------------|----------------|---|---|
| VM-50 | 50,000 | <ul style="list-style-type: none">• 250• 200 in Lite mode | 1,000 | 15 | <ul style="list-style-type: none">• 250• 25 in Lite mode | <ul style="list-style-type: none">• 250• 25 in Lite mode |
| VM-100 | 250,000 | 1,500 | 2,500 | 40 | 1,000 | 500 |
| VM-200 | | | | | | |
| VM-300 | 800,000 | 10,000 | 100,000 | 40 | 2,000 | 2,000 |
| VM-1000-HV | | | | | | |
| VM-500 | 2,000,000 | 10,000 | 100,000 | 200 | 4,000 | 6,000 |
| VM-700 | 10,000,000 | 20,000 | 100,000 | 200 | 8,000 | 12,000 |

The standard VM-50 is the smallest model of the VM-Series and requires more resources than are available in some environments. The VM-50 Lite mode provides an alternative for environments where hardware resources are constrained. The VM-50 Lite requires 4.5GB of memory instead of the 5.5GB required by the standard VM-50. The VM-50 Lite uses the same license as the standard VM-50 but comes up in Lite mode when allocated 4.5GB of RAM.

Public Clouds

The virtual firewalls can be found in the public cloud marketplaces. Most public cloud marketplaces are populated with three virtual firewall choices that differ in their license requirements. A Bring Your Own License (BYOL) version is an unlicensed VM-Series firewall requiring the customer to provide their separately purchased capacity code and feature licenses after provisioning. The VM-Series Bundle 1 and 2 both are prelicensed versions of VM-300s. Bundle 1 is prelicensed for Threat Prevention only. Bundle 2 is pre-licensed for Threat Prevention, WildFire, URL Filtering, and GlobalProtect. Bundle 1 and 2 versions of the VM-300 incur a usage charge per hour of operation paid to the cloud vendor. The BYOL configuration contains no premium rates above the costs of the component cloud resources.

These preconfigured VM-Series firewalls provided by the cloud vendor application stores usually consist of three interfaces: one for management and one each for trusted and untrusted network traffic connections. Most cloud deployments provide a way to modify the configuration through addition of interface connections subjected to the methods and capacities of the cloud vendor.

Each VM-Series virtual firewall has a VM-Series plugin for the cloud vendor that implements certain functionality such as High Availability. See the deployment documentation specific to your cloud vendor for specific information: <https://docs.paloaltonetworks.com/vm-series/9-1/vm-series-deployment.html>

Sample Questions

35. Which part of a VM-Series firewall should be updated to provide maximum feature support for a public cloud?
 - A. latest PAN-OS update
 - B. latest VM-Series plugin
 - C. capacity license for the target public cloud
 - D. latest dynamic updates appropriate for the implemented PAN-OS version
36. Which two types of firewall interfaces are most likely to be supported in public cloud deployments? (Choose two.)
 - A. tap
 - B. virtual wire
 - C. Layer 3
 - D. tunnel
 - E. aggregate Ethernet

37. From where can you buy and download a VM-Series virtual firewall appliance for a public cloud deployment?
- A. Palo Alto Networks Support Portal
 - B. cloud vendor's "Solution Marketplace"
 - C. Using the download link supplied on the same site as the license server
 - D. Palo Alto Networks Product Download portal

1.10 Identify planning considerations unique to deploying Palo Alto Networks firewalls in a hybrid cloud

Hybrid Cloud

Hybrid cloud is a cloud computing environment that uses a mix of private cloud and public cloud services with orchestration between the two platforms. The VM-Series firewall provides a fully featured next-generation firewall solution for cloud deployments in both environments.

Public and private cloud deployments each have their own design and deployment considerations that must be considered individually. Regardless of the type of deployed environment, centralized monitoring, reporting, and management must be considered. The Panorama management solution can be deployed in either type of cloud and can manage across cloud boundaries if required communication channels are implemented.

Connectivity Considerations

Firewalls and Panorama each have connectivity requirements to reach outside services such as WildFire and to consume updates such as dynamic updates. When Panorama is used to manage firewalls, the devices must have a compatible communication channel between them. Hybrid deployments do not add any unique communication requirements of their own; each environment must be engineered to provide appropriate connectivity through its virtual networking environments as required. Engineering might include the use of the firewall to connect cloud environments with any required routing responsibility.

Site-to-site VPNs often are used to interconnect cloud-based virtual networks. The Palo Alto Networks firewalls can act as endpoints for these VPN connections and are subjected to VPN design and configuration considerations.

Sample Question

38. Which two conditions must be met to manage Palo Alto Networks firewalls deployed in multiple cloud environments from a central Panorama? (Choose two.)
 - A. The Panorama and firewall must be able to communicate.
 - B. The Panorama must be licensed for each cloud environment containing managed firewalls.
 - C. The firewalls must have the latest VM-Series plugin installed.
 - D. The firewalls and Panorama must be running the same version of PAN-OS software.
 - E. Firewalls must be running a version of PAN-OS software equal to or less than that on Panorama.

1.11 Identify planning considerations unique to deploying Palo Alto Networks firewalls in a private cloud

Private Clouds

The VM-Series virtual firewall runs on private cloud technologies. In these cases, a compatible virtual appliance (OVA-format) is downloaded from the Palo Alto Networks Support Portal, uploaded to the cloud, and deployed and configured according to the requirements of each private cloud. These virtual firewalls are unlicensed and require both a capacity code and that feature licenses be applied after installation.

Specific information about private cloud deployments can be found here:

<https://docs.paloaltonetworks.com/vm-series/9-1/vm-series-deployment.html>

Sample Questions

39. A private cloud has 20 VLANs spread over five ESXi hypervisors, managed by a single vCenter.
How many firewall VMs are needed to implement microsegmentation?
 - A. one
 - B. four
 - C. five
 - D. 20
40. When you deploy the Palo Alto Networks NGFW on NSX, packets coming to an application VM from VMs running on different hardware go through which modules?
 - A. network, vSwitch, NSX firewall, Palo Alto Networks NGFW, application VM
 - B. network, vSwitch, Palo Alto Networks NGFW, NSX firewall, application VM
 - C. network, vSwitch, NSX firewall, Palo Alto Networks NGFW, NSX firewall, application VM
 - D. vSwitch, network, Palo Alto Networks NGFW, NSX firewall, application VM
41. Which option shows the interface types that ESXi supports in the VM-Series firewalls?
 - A. tap, Layer 2, Layer 3, virtual wire
 - B. Layer 3 only
 - C. tap, Layer 2, Layer 3
 - D. Layer 3, virtual wire

1.12 Identify methods for authorization, authentication, and device administration

Administrative Accounts and Roles

Administrators can configure, manage, and monitor Palo Alto Networks firewalls and Panorama using the web interface, CLI, and XML API management interface. You can customize role-based administrative access to the management interfaces to delegate specific tasks or permissions to certain administrators.

Administrative accounts specify roles and authentication methods for the administrators of Palo Alto Networks firewalls and Panorama. Each device has a predefined default administrative account (admin) that provides full read-write access (also known as superuser access) to the firewall. Other administrative accounts can be created as needed.

You configure administrator accounts based on the security requirements of your organization, any existing authentication services that your network uses, and the required administrative roles. A role defines the type of system access that is available to an administrator. You can define and restrict access as broadly or granularly as required, depending on the security requirements of your organization. For example, you might decide that a data center administrator can have access to all device and networking configurations, but a security administrator can control only Security policy definitions, while other key individuals can have limited CLI or XML API access. The role types are:

- **Dynamic Roles:** These are built-in roles that provide access to Panorama and managed firewalls. After new features are added, the firewall and Panorama automatically update the definitions of dynamic roles; you never need to manually update them. The following table lists the access privileges associated with dynamic roles.

| DYNAMIC ROLE | PRIVILEGES |
|------------------------|---|
| Superuser | Full read-write access to Panorama |
| Superuser (read-only) | Read-only access to Panorama |
| Panorama administrator | Full access to Panorama except for the following actions: <ul style="list-style-type: none">• Create, modify, or delete Panorama or firewall administrators and roles.• Export, validate, revert, save, load, or import a configuration in the Device > Setup > Operations page.• Configure Scheduled Config Export functionality in the Panorama tab. |

- **Admin Role Profiles:** To provide more granular access control over the functional areas of the web interface, CLI, and XML API, you can create custom roles. After new features are added to the product, you must update the roles with corresponding access privileges: the firewall and Panorama do not automatically add new features to custom role definitions

Authentication

Authentication is a method for protecting services and applications by verifying the identities of users so that only legitimate users have access. Several firewall and Panorama features require authentication. Administrators authenticate to access the web interface, CLI, or XML API of the firewall and Panorama. End users authenticate through Captive Portal or GlobalProtect to access various services and

applications through the firewall. You can choose from several authentication services to protect your network and to accommodate your existing security infrastructure while ensuring a smooth user experience.

If you have a public key infrastructure, you can deploy certificates to enable authentication without users having to manually respond to login challenges. Alternatively, or in addition to certificates, you can implement interactive authentication, which requires users to authenticate using one or more methods.

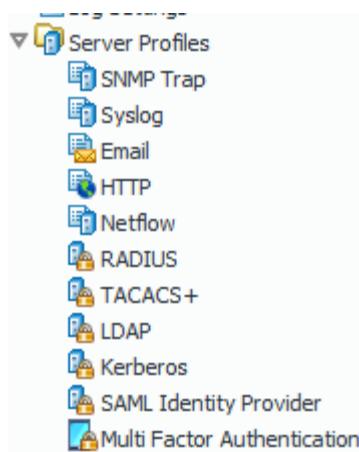
Supported authentication types include:

- Multi-factor
- SAML
- Single sign-on
- Kerberos
- TACACS+
- RADIUS
- LDAP
- Local

A complete discussion of these authentication types can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/authentication.html>

When user or administrative access is configured, one or more authentication methods must be specified. A user/administrator definition typically requires an Authentication Profile that specifies the desired authentication method. When more than one method is desired, you can instead use an Authentication Sequence, which is a list of Authentication Profiles. The first profile will be accessed. If it is not available, the next option will be tried. An Authentication Profile specifies a single Server Profile. A Server Profile contains specific configuration and access information necessary to reach the external authentication service.

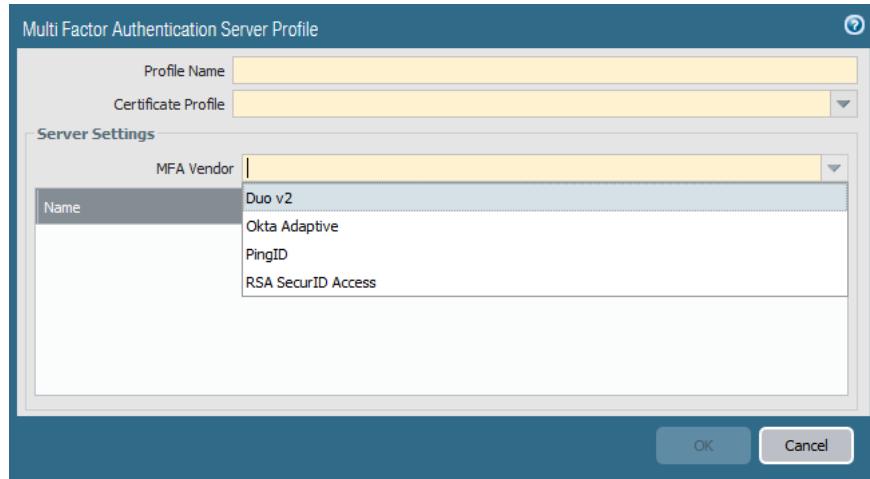


Detailed information about creating Authentication Profiles and sequences can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/authentication/configure-an-authentication-profile-and-sequence.html>

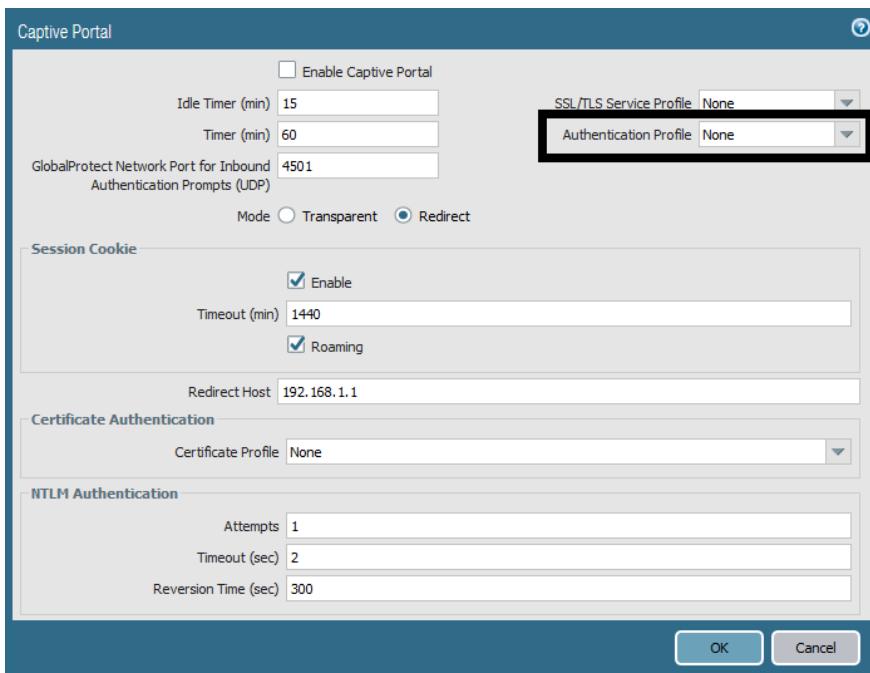
Special Note About Multi-Factor Authentication

Palo Alto Networks firewalls support multi-factor authentication. A Multi-Factor Authentication Server Profile is used to natively integrate a firewall with an external third-party MFA solution. MFA factors that the firewall supports include Push, Short Message Service (SMS), voice, and one-time password (OTP) authentication. This profile identifies the specific product with its configuration information.

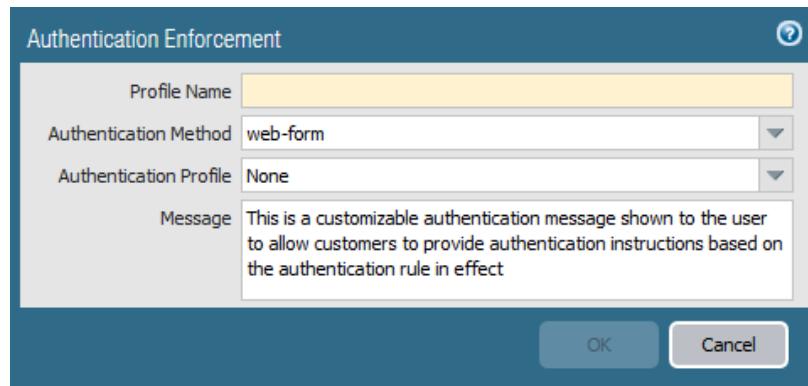


The Multi-Factor Authentication Server Profile shown can be a part of multiple authentication challenges that a user must respond to. For example, you can force users to enter a login password and then enter a verification code that they receive by phone before they can access critical financial documents.

The firewall challenges a user with a Captive Portal. Captive Portal configuration includes an Authentication Profile selected for base configuration that represents the first challenge a user must negotiate.



An Authentication Enforcement policy then is used to join the MFA product as a second required authentication. Selection of the MFA product's Authentication Profile adds it as a second authentication requirement for users.



Configuration of base Captive Portal is discussed here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/user-id/map-ip-addresses-to-users/map-ip-addresses-to-usernames-using-captive-portal/configure-captive-portal>

The complete MFA implementation process is discussed here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/authentication/configure-multi-factor-authentication>

Panorama Access Domains

Panorama access domains control the access that device group and template administrators have to specific device groups (to manage policies and objects), to templates (to manage network and device settings), and to the web interface of managed firewalls (through context switching). You can define up to 4,000 access domains and manage them locally or by using RADIUS Vendor-Specific Attributes (VSAs), TACACS+ VSAs, or SAML attributes.

More information about access domains can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-web-interface-help/panorama-web-interface/panorama-access-domains>

Sample Questions

42. To configure multi-factor authentication for users accessing services through the firewall, which three configuration pieces need to be addressed? (Choose three.)
 - A. GlobalProtect Portal
 - B. Captive Portal
 - C. Authentication Enforcement Profile
 - D. Authentication Profile
 - E. Response pages

43. Which firewall configuration component is used to configure access to an external authentication service?
- A. Local User Database
 - B. Server Profiles
 - C. VM Information source
 - D. admin roles
 - E. Authentication policy rules
44. Which two firewall functions are reserved only for administrators assigned the superuser dynamic role? (Choose two.)
- A. managing certificates
 - B. managing firewall admin accounts
 - C. editing the management interface settings
 - D. creating virtual systems within a firewall
 - E. accessing the configuration mode of the CLI

1.13 Identify the methods of certificate creation on the firewall

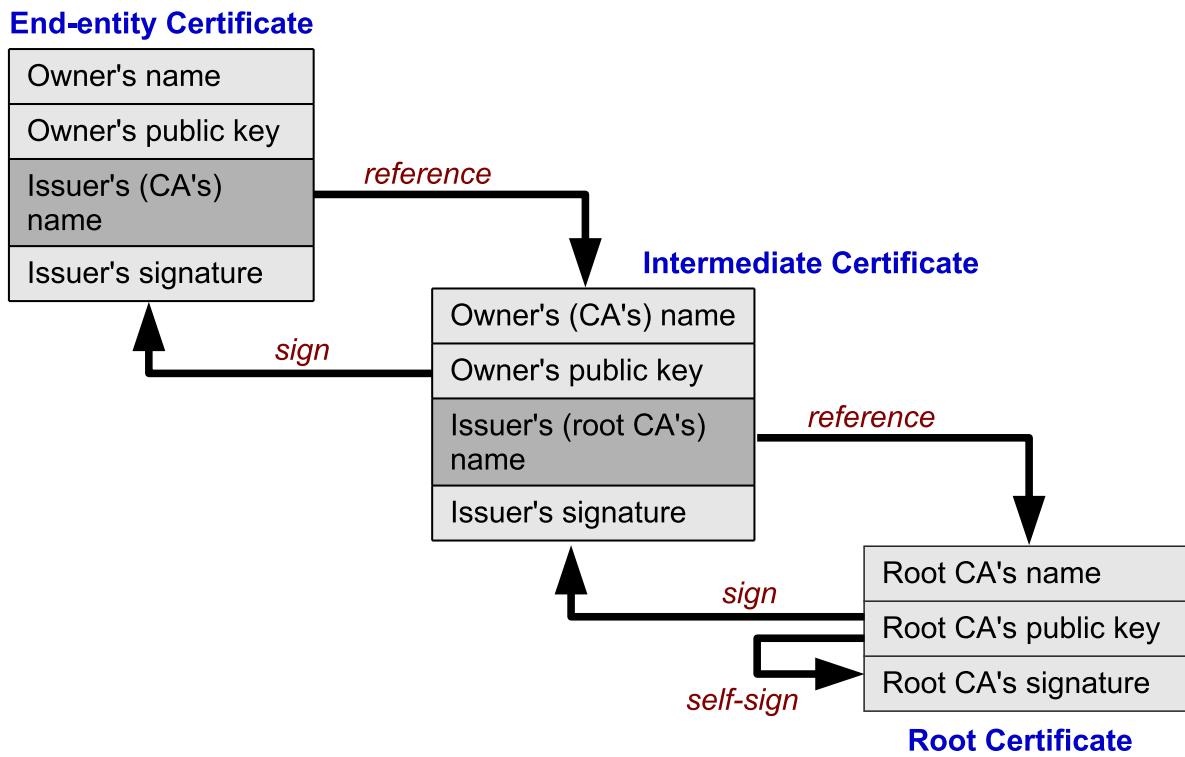
Certificate Background

In cryptography, a public key certificate, also known as a digital certificate or identity certificate, is an electronic document used to prove the ownership of a public key. The certificate includes information about the key, information about the identity of its owner (called the subject), and the digital signature of an entity that has verified the certificate's contents (called the issuer). If the signature is valid and the software examining the certificate trusts the issuer, then the software can use that key to communicate securely with the certificate's subject. In email encryption, code signing, and e-signature systems, a certificate's subject typically is a person or organization. However, in Transport Layer Security (TLS) a certificate's subject typically is a computer or other device, though TLS certificates may identify organizations or individuals in addition to their core role in identifying devices. TLS, sometimes called by its older name Secure Sockets Layer (SSL), is notable for being a part of HTTPS, a protocol for securely browsing the web.

In a typical public key infrastructure (PKI) scheme, the certificate issuer is a certificate authority (CA), usually a company that charges customers to issue certificates for them. Certificate authorities also can be created and managed by individuals and organizations requiring certificates for internal use.

A CA is responsible for signing certificates. These certificates act as an introduction between two parties, which means that a CA acts as a trusted third party. A CA processes requests from people or organizations requesting certificates (called subscribers), verifies the information, and potentially signs an end-entity certificate based on that information. To perform this role effectively, a CA needs to have one or more broadly trusted root certificates or intermediate certificates and the corresponding private keys. CAs may achieve this broad trust by having their root certificates included in popular software, or by obtaining a cross-signature from another CA delegating trust.

A receiving entity is responsible for validating the information contained in a certificate presented to it. Among the potential verification tests is a validation that the certificate was issued by the issuing CA information contained in the certificate. This verification requires the CA's signing key contained in its Root Certificate used to sign all issued certificates. This certificate must be locally available to the receiving entity to run the validation test. These CA Root Certificates often are kept in locally stored certificate caches in the hosting OS or a browser or program-managed certificate cache. The firewall also contains a CA Root Certificate cache.



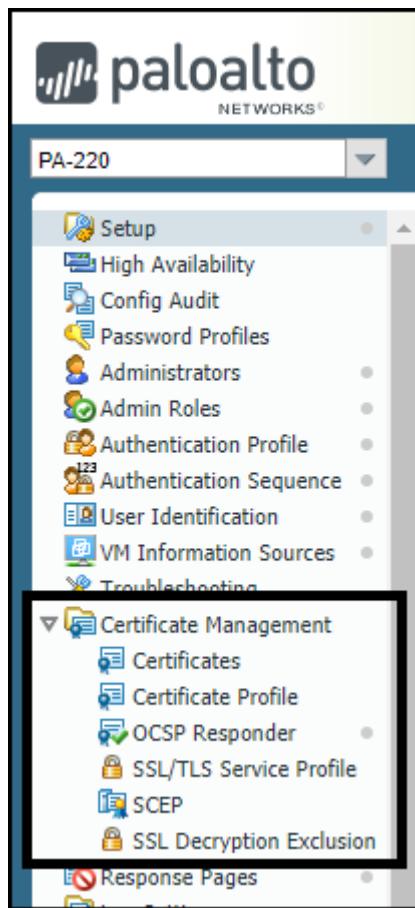
Certificate authorities also are responsible for maintaining up-to-date revocation information about certificates they have issued that indicate whether certificates still are valid. They provide this information through Online Certificate Status Protocol (OCSP) and/or certificate revocation lists (CRLs).

Certificates on the Firewall

Encryption and identity verification and their required certificates are used for many functions within the Palo Alto Networks firewall and Panorama. A partial list includes:

- SSL/TLS decryption
- Management (MGT) interface user authentication
- GlobalProtect:
 - Portal authentication
 - Gateway authentication
- Mobile Security Manager authentication
- Captive Portal user authentication
- IPsec VPN IKE authentication
- High Availability authentication
- Secure syslog authentication

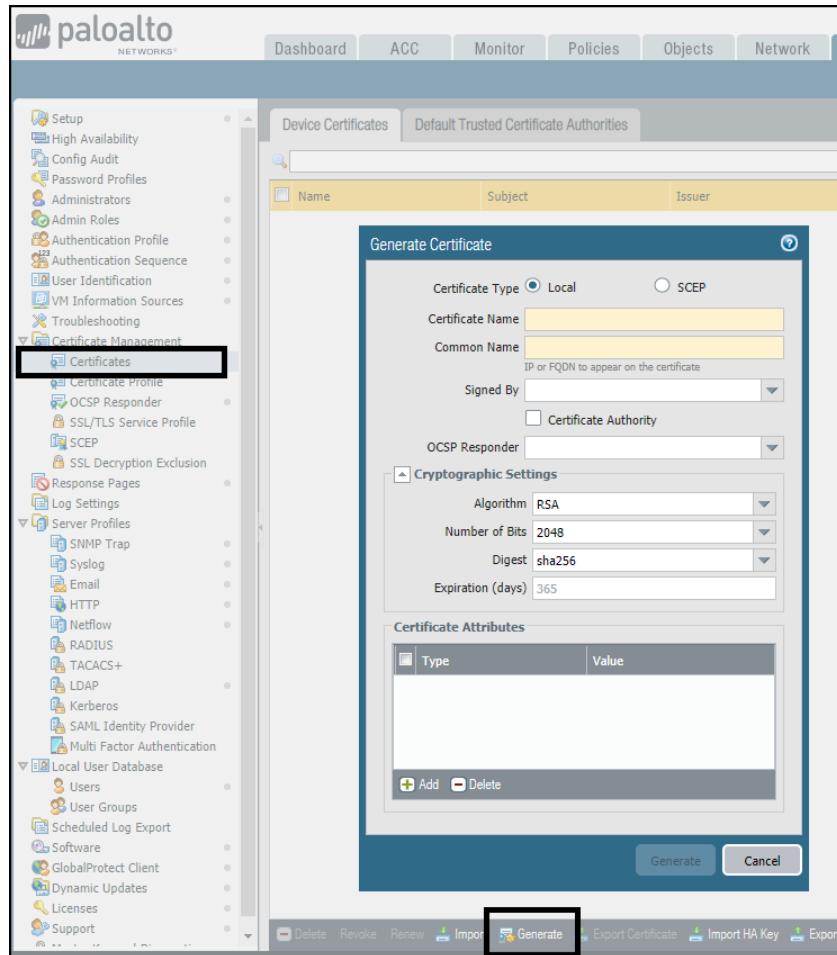
Because of this extensive use, certificate management functions are provided within the firewall's management web interface:



Certificate Creation and Import

The firewall's certificate management capability provides methods to create and manage certificates as a certificate authority and to import and manage certificates created by an external certificate authority. This functionality includes the creation of the certificate's associated public and private keys. If your enterprise has a Simple Certificate Enrollment Protocol (SCEP) server, you can configure an SCEP Profile to automate the generation and distribution of unique client certificates. SCEP operation is dynamic in the sense that the enterprise PKI generates a user-specific certificate when the SCEP client requests it and sends the certificate to the SCEP client. The SCEP client then transparently deploys the certificate to the client device.

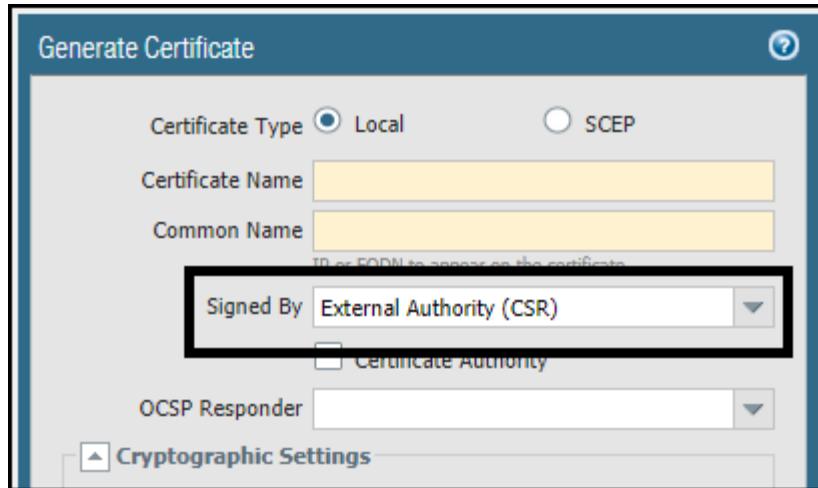
Basic required information must be provided when a new certificate is created directly on the firewall:



Included in this certificate information are settings that choose whether this certificate is self-signed or signed by another certificate stored in the firewall (the **Signed By** field). The **Certificate Authority** check box determines whether this certificate will have the rights to sign other certificates.

After you enter the appropriate data and click the **Generate** button, a new certificate is created and its private and public keys are added to the firewall's storage. The resultant certificate then can be exported with or without the private key for external use.

In cases where a certificate needs to be generated by an external CA, a certificate signing request (CSR) file can be created on the firewall that is exported and transferred to the CA. This file contains the required information for certificate creation. Select the **External Authority** option in the **Signed By** field to trigger this generation.



Selection of **External Authority** creates the CSR file and adds it to firewall storage, from where it can be exported and transmitted to the external CA. The certificate generated by the CA can be imported into the firewall, at which point the CSR file is replaced by the certificate in the firewall's certificate storage and listings.

More details about certificate management can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/certificate-management.html>

Sample Questions

45. A Palo Alto Networks firewall can obtain a certificate for its internal use through which three methods? (Choose three.)
 - A. import a certificate file generated by an external CA
 - B. reference an externally stored certificate by a URL configured in an SSL/TLS Service Profile
 - C. generate a certificate directly by manually entering certificate data
 - D. obtain a certificate from an SCEP server using an SCEP Profile
 - E. import a certificate from an external CA by using an Authentication Profile
46. Which two resources must be available to successfully run certificate validation tests on a certificate received from an external source? (Choose two.)
 - A. Root Certificate of the issuing CA
 - B. public key for the received certificate
 - C. OCSP connection address
 - D. existing Certificate Profile that matches the received certificate's CA identity

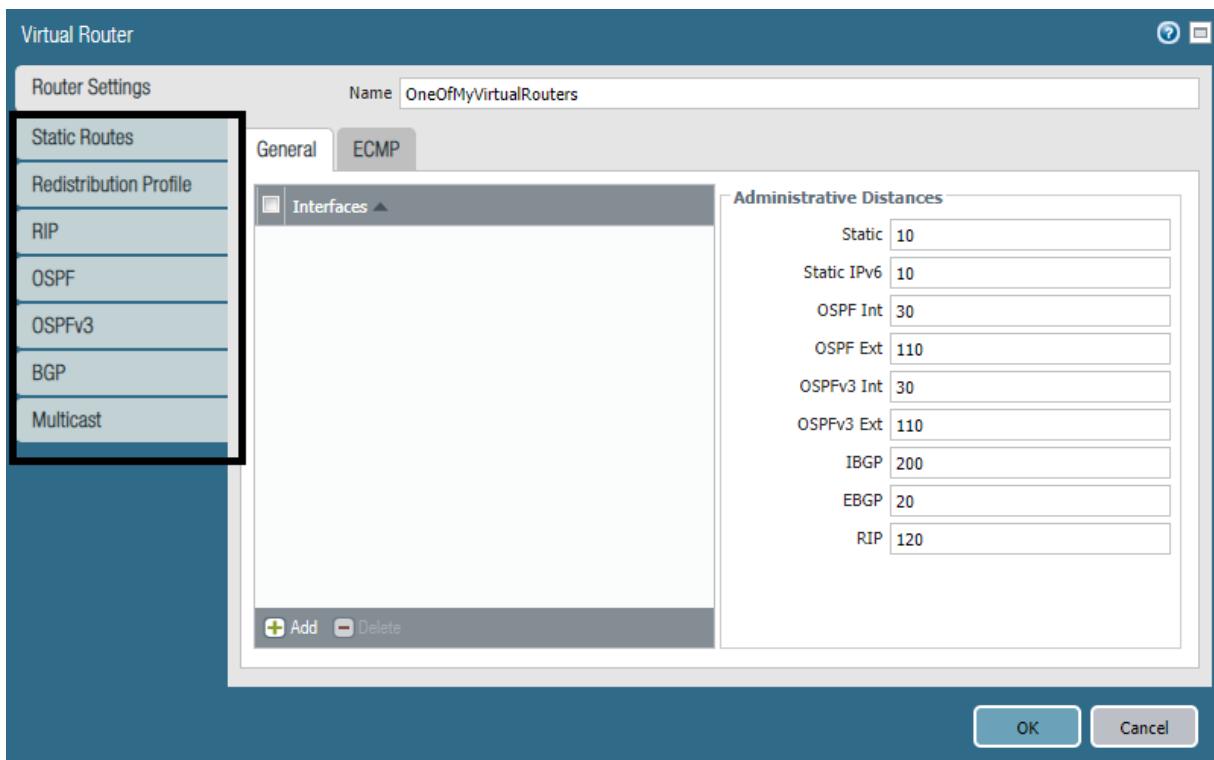
1.14 Identify options available in the firewall to support dynamic routing

Overview

All Palo Alto Networks firewalls provide a flexible networking architecture that includes support for dynamic routing, switching, and VPN connectivity, and enables you to deploy the firewall into nearly any networking environment. When you configure the Ethernet ports on your firewall, you can choose from virtual wire, Layer 2, or Layer 3 interface deployments. If you want to integrate into a variety of network segments, you can configure different types of interfaces on different ports. The firewalls also can participate in several routing protocols, including static routes. The dynamic routing protocols supported by the Palo Alto Networks firewalls are:

- RIP
- OSPF
- OSPFv3
- BGP
- Multicast

These routing protocols are implemented on TCP/IP networks and are supported as optional configurations in a firewall's virtual router.



Multiple router protocols can be enabled at the same time. Each routing protocol has its own configuration settings.

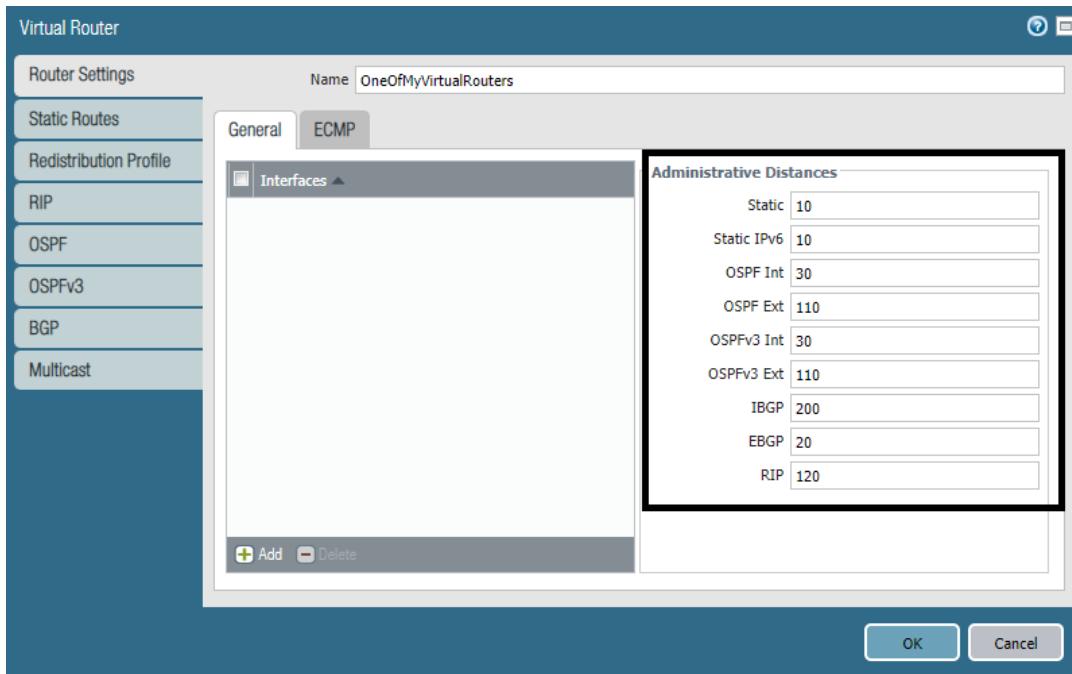
The screenshots illustrate the configuration of a virtual router instance. The left sidebar lists various routing protocols: Router Settings, Static Routes, Redistribution Profile, RIP, OSPF, OSPFv3, BGP, and Multicast. The top screenshot shows the OSPF configuration, specifically the 'Areas' tab, where you can enable OSPF, set the Router ID, and choose to reject default routes. The bottom screenshot shows the BGP configuration, including the 'General' tab where you can enable BGP, set the Router ID and AS Number, and configure various routing parameters like Reject Default Route, Install Route, Aggregate MED, and Path Selection.

Each virtual router instance can be configured separately for dynamic routing, with each router maintaining separate routing tables (RIBs). Each router instance has a RIB and forwarding table (FIB) that are used during packet processing to identify the appropriate interface for packet egress.

A virtual router can share routes between router protocols using Redistribution Profiles. You can redistribute IPv4 or IPv6 BGP, connected, or static routes into the OSPF RIB and redistribute OSPFv3, connected, or static routes into the BGP RIB.

Administrative Distance

Within the virtual router configuration, set administrative distances for types of routes as required for your network. A virtual router that has two or more different routes to the same destination from different routing protocols uses administrative distance to choose the best path from different routing protocols and static routes by preferring a lower distance.



Sample Questions

47. The firewall uses which information to determine which interface to use for a packet's egress?
 - A. manually configured static routes
 - B. routing information base (RIB)
 - C. appropriate Redistribution Profile
 - D. ECMP destination monitoring results
48. A virtual router can use a Redistribution Profile to share routes between which three routing protocols? (Choose three.)
 - A. static routes
 - B. IGRP
 - C. RIP
 - D. OSPF
 - E. multicast
49. How does a firewall determine which route to use when its RIB is populated with multiple routes to the same location, but the routes were added by different routing protocols?
 - A. according to the following precedence of route type: static, RIP, OSPF, BGP
 - B. using the virtual router's FIB
 - C. using the associated route's metric and choosing the lowest value
 - D. using the route's administrative distance and choosing the lowest value

1.15 Given a scenario, identify ways to mitigate resource exhaustion (because of denial-of-service) in application servers

Resource Exhaustion

Port scans and floods are common causes of resource exhaustion at the interface and system level for protected devices and the firewall interfaces themselves. Although PAN-OS software does have powerful protections, none of them is turned on by default, which leaves a firewall and network exposed to these attacks until protections are configured. Palo Alto Networks provides two protection mechanisms for resource exhaustion caused by these attacks, Zone Protection Profiles and DoS Protection policies and profiles.

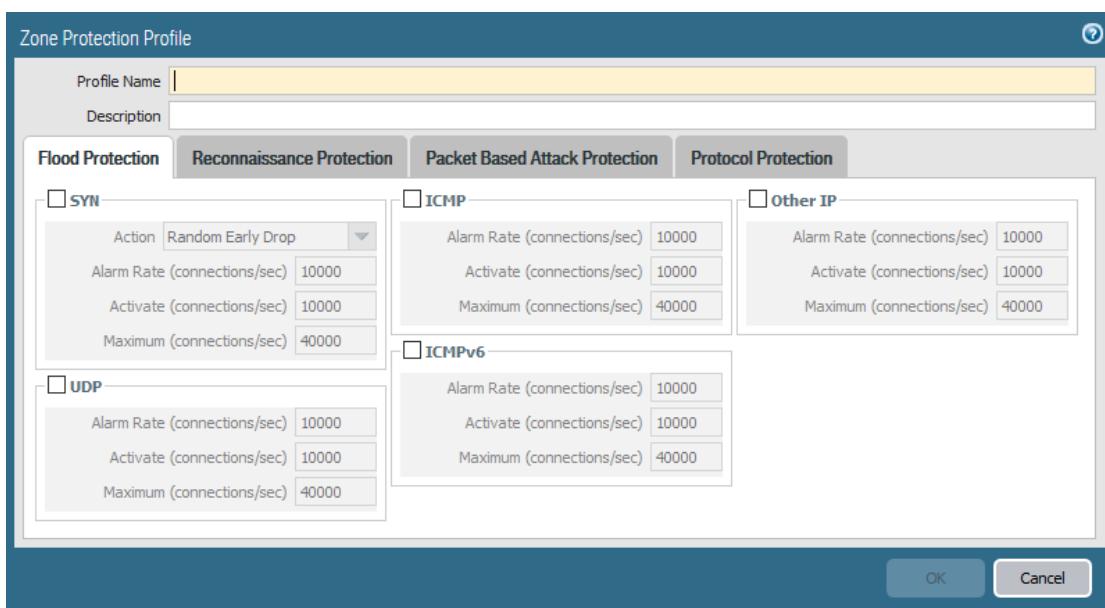
Zone Protection Profiles

Zone Protection Profiles defend the zone at the ingress zone edge against reconnaissance port scan and host sweep attacks, IP packet-based attacks, non-IP protocol attacks, and flood attacks by limiting the number of connections per second (CPS) of different packet types.

Zone design itself provides segmentation of networks, which magnifies the protection of Zone Protection Profiles. A discussion of zone design through the lens of protection can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/zone-protection-and-dos-protection/how-do-zones-protect-the-network.html>

Zone Protection Profiles provide a broad defense of the entire zone based on the aggregate traffic entering the zone, thus protecting against flood attacks and undesirable packet types and options. Zone Protection Profiles don't control traffic between zones, they control traffic only at the ingress zone. Zone Protection Profiles don't consider individual IP addresses because they apply to the aggregate traffic entering the zone (DoS Protection policy rules defend individual IP addresses in a zone). This protection occurs early in the traffic processing flow, thus minimizing firewall resource use.



A complete description of Zone Protection Profiles and details for its configuration are here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-web-interface-help/network/network-network-profiles/network-network-profiles-zone-protection.html>

Recommendations for Zone Protection Profile settings are here:

<https://knowledgebase.paloaltonetworks.com/KCSArticleDetail?id=kA10g000000ClVkCAK>

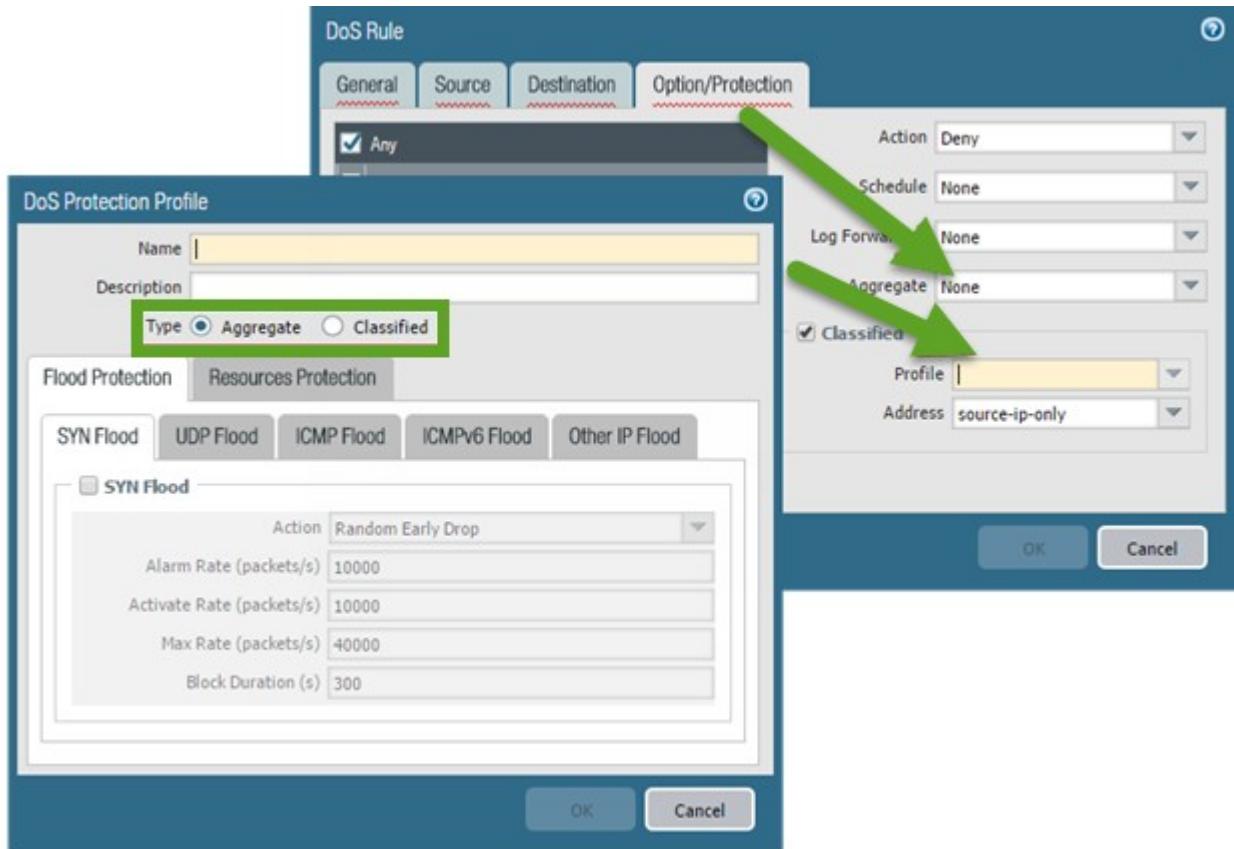
DoS Protection Profile

DoS Protection Profiles and DoS Protection policy rules combine to protect specific groups of critical resources and individual critical resources against session floods. Compared to Zone Protection Profiles, which protect only entire zones from flood attacks, DoS protection can provide granular defense for specific systems, especially critical systems that users access from the internet and often are attack targets, such as web servers and database servers. Apply both types of protection because if you apply only a Zone Protection Profile, then a DoS attack that targets a particular system in the zone can succeed if the total CPS doesn't exceed the zone's **Activate** and **Maximum** rates.

DoS Protection is resource-intensive, so use it only for critical systems. As is the case with Zone Protection Profiles, DoS Protection Profiles specify flood thresholds. DoS Protection policy rules determine the devices, users, zones, and services to which DoS Profiles apply.

DoS Protection Profiles set the protection thresholds to provide DoS protection against flooding of new sessions for IP floods (CPS limits) to provide resource protection (maximum concurrent session limits for specified endpoints and resources) and to configure whether the profile applies to aggregate or classified traffic. DoS Protection policy rules control where to apply DoS protection and which action to take when traffic matches the criteria defined in the rule.

Unlike a Zone Protection Profile, which protects only the ingress zone, DoS Protection Profiles and policy rules can protect specific resources inside a zone and traffic flowing between different endpoints and areas. Unlike the case with a Zone Protection Profile, which supports only aggregate traffic, you can configure aggregate or classified DoS Protection Profiles and policy rules.



Differences Between DoS Protection and Zone Protection

A DoS Protection policy can be used to accomplish some of the same protections a Zone Protection policy does, but there are a few key differences:

- A major difference is a DoS policy can be classified or aggregate. Zone Protection Profiles are aggregate only.
- A classified profile allows the creation of a threshold that applies to as little as a single source or destination IP address. For example, a per-IP maximum session can be specified for all traffic matching the policy, then the firewall can block any single IP address that exceeds the threshold.
- An Aggregate Profile allows the creation of a max session rate for all packets matching the policy. The threshold applies to a new session rate for all IPs combined. A triggered threshold would affect *all* traffic matching the policy.
- Zone Protection Profiles allow the use of flood protection and can protect against port scanning and sweeps and packet-based attacks. A few examples of packet-based attacks are IP spoofing, fragments, overlapping segments, and reject tcp-non-syn.
- Zone Protection Profiles may have less performance impact because they are applied pre-session and don't engage the policy engine.

Specific implementation information for DoS policy and profiles can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/zone-protection-and-dos-protection/zone-defense/dos-protection-profiles-and-policy-rules>

An exploration of DoS attacks and defending against them using Palo Alto Networks firewalls is here:

<https://knowledgebase.paloaltonetworks.com/KCSArticleDetail?id=kA10g000000CIOGCA0>

Sample Questions

50. For which two reasons are denial-of-service protections applied by zone? (Choose two.)
 - A. because denial-of-service protections are applied early in the processing, before much information is known about the connection but when the ingress interface already is known
 - B. because denial-of-service protections are applied only when manually turned on to avoid quota overload (which would make denial of service easier)
 - C. because denial-of-service protections can depend on only the zone, and never on port numbers or IP addresses
 - D. because denial-of-service protections on a Layer 3 interface are different from the denial-of-service protections available on a Layer 2 interface and interfaces on virtual wires
51. SYN flood protection provides flood protection from which protocol?
 - A. UDP
 - B. TCP
 - C. ICMP
 - D. GRE
52. To which two protocols does port scan reconnaissance protection apply? (Choose two.)
 - A. UDP
 - B. TCP
 - C. GRE
 - D. ICMP
 - E. IPX
53. In which two places do you configure flood protection? (Choose two.)
 - A. DoS Protection Profile
 - B. QoS Profile
 - C. Zone Protection Profile
 - D. SYN Protection Profile
 - E. XOFF Profile
54. Which two firewall features should be used to provide tailored DoS protection to a specific address? (Choose two.)
 - A. Zone Protection Profiles
 - B. virtual routers
 - C. Server Profiles
 - D. DoS policy rules
 - E. DoS Protection Profiles

1.16 Identify decryption deployment strategies

Packet Visibility

The use of encryption for all network applications is growing at a rapid rate. When traffic is encrypted, the Palo Alto Networks firewall loses visibility into packet contents, thus making Content-ID impossible. Because of this lack of visibility, malware might be able to pass unchallenged to an endpoint, at which point it is decrypted and able to attack. Decryption policies maximize the firewall's visibility into packet content to allow for content inspection.

Decryption

The Secure Sockets Layer (SSL) and Secure Shell (SSH) encryption protocols secure traffic between two entities, such as a web server and a client. SSL encapsulates traffic, encrypting data so that it is meaningless to entities other than the client and server with the certificates to affirm trust between the devices and the keys to decode the data. (SSH does not use certificates to encrypt or decrypt traffic.) Decrypt SSL and SSH traffic to:

- Prevent malware concealed as encrypted traffic from being introduced into your network. For example, an attacker compromises a website that uses SSL encryption. Employees visit that website and unknowingly download an exploit or malware. The malware then uses the infected employee endpoint to move laterally through the network and compromise other systems.
- Prevent sensitive information from moving outside the network
- Ensure the appropriate applications are running on a secure network
- Selectively decrypt traffic; for example, create a Decryption policy and profile to exclude traffic for financial or healthcare sites from decryption

Palo Alto Networks firewall decryption is policy-based and can decrypt, inspect, and control inbound and outbound SSL and SSH connections. A Decryption policy enables you to specify traffic to decrypt by destination, source, service, or URL category, and to block, restrict, or forward the specified traffic according to the security settings in the associated Decryption Profile. A Decryption Profile controls SSL protocols, certificate verification, and failure checks to prevent traffic that uses weak algorithms or unsupported modes from accessing the network. The firewall uses certificates and keys to decrypt traffic to plaintext, and then enforces App-ID and security settings on the plaintext traffic, including Decryption, Antivirus, Vulnerability, Anti-Spyware, URL Filtering, WildFire, and File Blocking Profiles. After decrypting and inspecting traffic, the firewall re-encrypts the plaintext traffic as it exits the firewall to ensure privacy and security.

The firewall provides three types of Decryption policy rules: SSL Forward Proxy to control outbound SSL traffic, SSL Inbound Inspection to control inbound SSL traffic, and SSH Proxy to control tunneled SSH traffic. You can attach a Decryption Profile to a policy rule to apply granular access settings to traffic, such as checks for server certificates, unsupported modes, and failures.

SSL decryption (both forward proxy and inbound inspection) requires certificates to establish the firewall as a trusted third party, and to establish trust between a client and a server to secure an SSL/TLS connection. You also can use certificates when excluding servers from SSL decryption for technical reasons (the site breaks decryption for reasons such as certificate pinning, unsupported ciphers, or mutual authentication). SSH decryption does not require certificates.

A review of decryption concepts can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/decryption/decryption-concepts.html>

A discussion of decryption best practices can be found here:

<https://docs.paloaltonetworks.com/best-practices/9-1/decryption-best-practices>

Decryption Broker

A firewall acting as a decryption broker uses dedicated decryption forwarding interfaces to send decrypted traffic to a security chain—a set of inline, third-party security appliances—for additional analysis. Two types of security chain networks are supported with a decryption broker (Layer 3 security chains and Transparent Bridge security chains), and you also can configure the firewall to direct traffic through the security chain unidirectionally or bidirectionally. A single firewall can distribute decrypted sessions among up to 64 security chains and can monitor security chains to ensure that they are effectively processing traffic.

A discussion of this capability is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/decryption/decryption-broker/decryption-broker-concepts>

Decryption Mirror

Palo Alto Networks firewalls can automatically send a copy of decrypted traffic to a specified interface using the Decryption Mirroring feature. This option can be licensed at no cost for midrange and high-end firewalls that can automatically forward copies of decrypted traffic to external DLP products.

A description of this feature can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/decryption/decryption-concepts/decryption-mirroring.html>

Keys and Certificates

Encryption technology uses keys to transform cleartext strings into ciphertext. These keys are generated using passwords and other shared secrets. Palo Alto Networks firewalls decrypt encrypted traffic by using the keys to transform encrypted strings into cleartext. Certificates are used to establish the firewall as a trusted third party and to create a secure connection. SSL decryption (both forward proxy and inbound inspection) requires certificates to establish trust between two entities to secure an SSL/TLS connection. Certificates also can be verified even when traffic is excluded from SSL decryption. You can integrate a hardware security module (HSM) with a firewall to enable enhanced security for the private keys used in SSL Forward Proxy and SSL Inbound Inspection decryption.

Palo Alto Networks firewall decryption is policy-based and can be used to decrypt, inspect, and control both inbound and outbound SSL and SSH connections. Decryption policies allow you to specify traffic for decryption according to destination, source, or URL category and to block or restrict the specified traffic according to your security settings. The firewall uses certificates and keys to decrypt the traffic specified

by the policy to plaintext, and then enforces App-ID and security settings on the plaintext traffic, including Decryption, Antivirus, Vulnerability, Anti-Spyware, URL Filtering, and File Blocking Profiles.

After traffic is decrypted and inspected on the firewall, the plaintext traffic is re-encrypted as it exits the firewall to ensure privacy and security.

Central to this discussion is the role of digital certificates to secure SSL encrypted data. Your understanding of this role and planning for proper certificate needs and deployment are important considerations in decryption use.

Concepts are discussed here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/decryption/decryption-concepts/keys-and-certificates-for-decryption-policies.html>

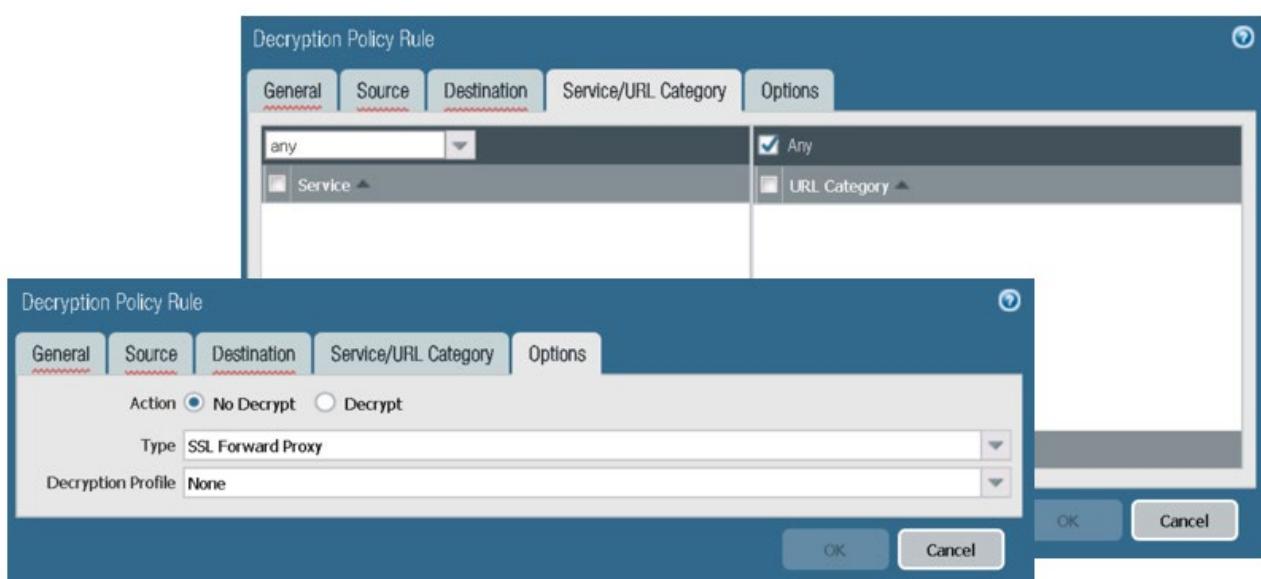
The use of certificates is central to other important firewall functions in addition to decryption. This need led to the implementation of extensive certificate management capabilities on the firewall.

A discussion of certificate use for all purposes in the firewall is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/certificate-management/keys-and-certificates.html>

Decryption Policies

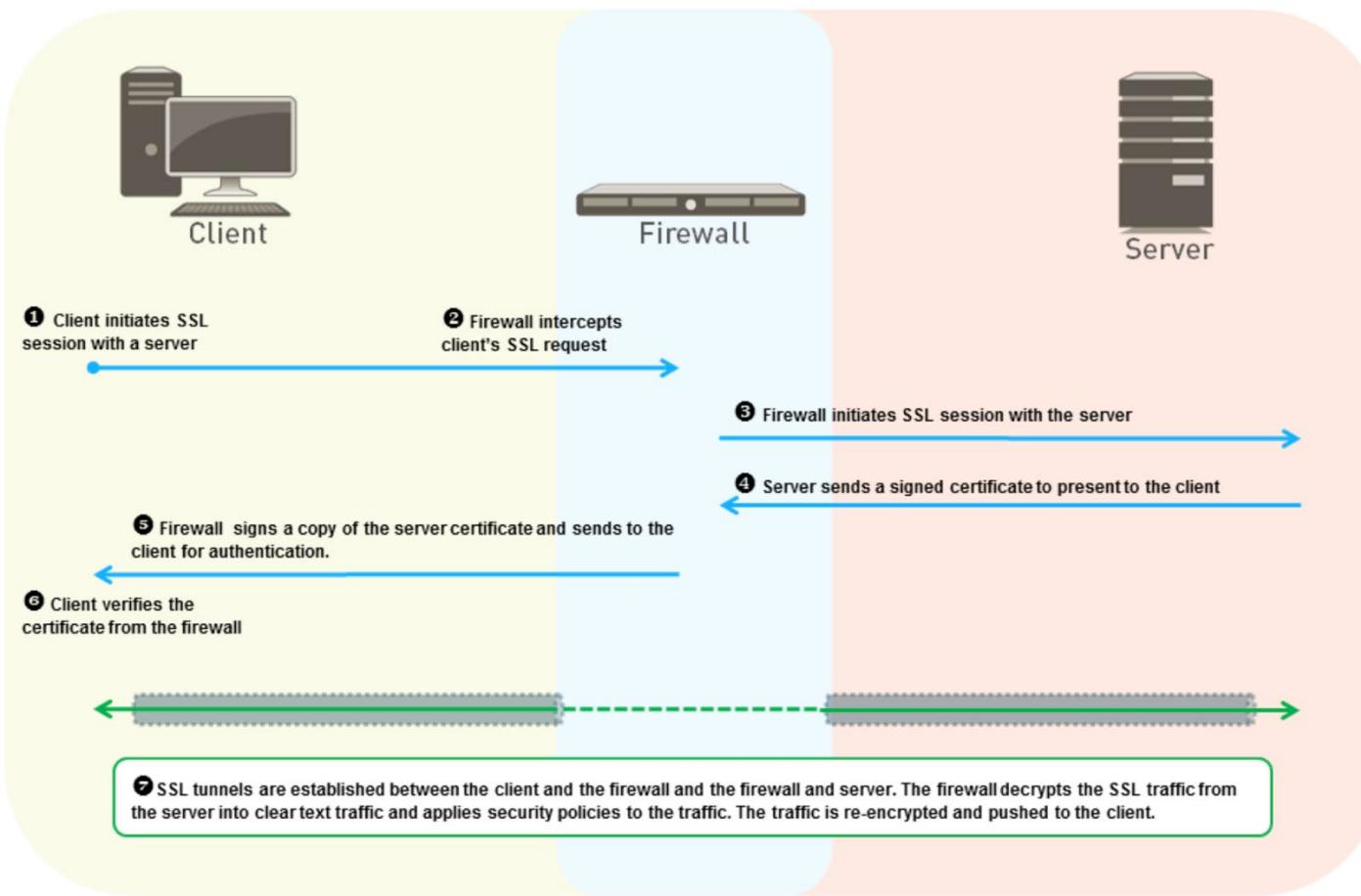
Ingress traffic decryption is controlled by Decryption policies. Palo Alto Networks firewalls automatically will detect encrypted traffic and react by evaluating the Decryption policy rules. If a matching policy rule is found, the firewall will attempt to decrypt the traffic according to the policy rule's specified decryption action. Normal packet processing resumes afterward.



SSL Forward Proxy

Decryption of outbound SSL traffic commonly is implemented and takes the form of SSL Forward Proxy, ©2016-2020, Palo Alto Networks, Inc.

which features the firewall as an intermediate communication node. This deployment commonly is referred to as a “man in the middle.” The following figure shows this functionality.

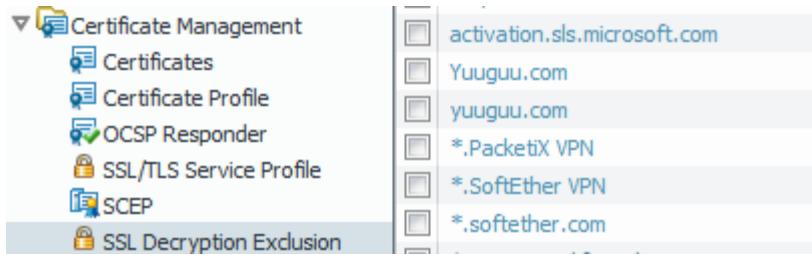


Note that SSL Forward Proxy replaces the original certificate from the server with one signed by a different key that then is delivered to the client.

Decryption Exclusions

A developer of a solution using SSL decryption can take extra programmatic steps to interrogate the certificate received at the client for specific characteristics present in the original certificate. When these characteristics are not found, the author often assumes that a decrypting process is in the middle of the conversation and may act to prevent full functionality and consider this presence a security risk. These products typically are not fully functional in a decrypting environment and must be added as exceptions to Decryption policy rules.

Palo Alto Networks recognizes this fact and provides a mechanism to mark certain encrypted traffic for decryption bypass. A list of SSL sites with known decryption issues is predefined on the Palo Alto Networks firewall. You can add sites to this list using the **SSL Decryption Exclusion** option in the management web interface. The firewall does not attempt to decrypt traffic to or from these sites.



A discussion of this topic and how to manage decryption exclusions is found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/decryption/decryption-exclusions>

App-ID and Encryption

The App-ID scanning engine's effectiveness often is compromised by encrypted traffic that prevents scanning packet contents for identifying elements. This traffic typically is given the App-ID of "ssl." In some cases, the App-ID engine can evaluate elements of the certificate that secures this data for specific identifying components, allowing the App-ID engine to properly assign App-IDs without scanning contents. Details about this process are here:

<https://knowledgebase.paloaltonetworks.com/KCSArticleDetail?id=kA10g000000CIVSCAO>

Sample Questions

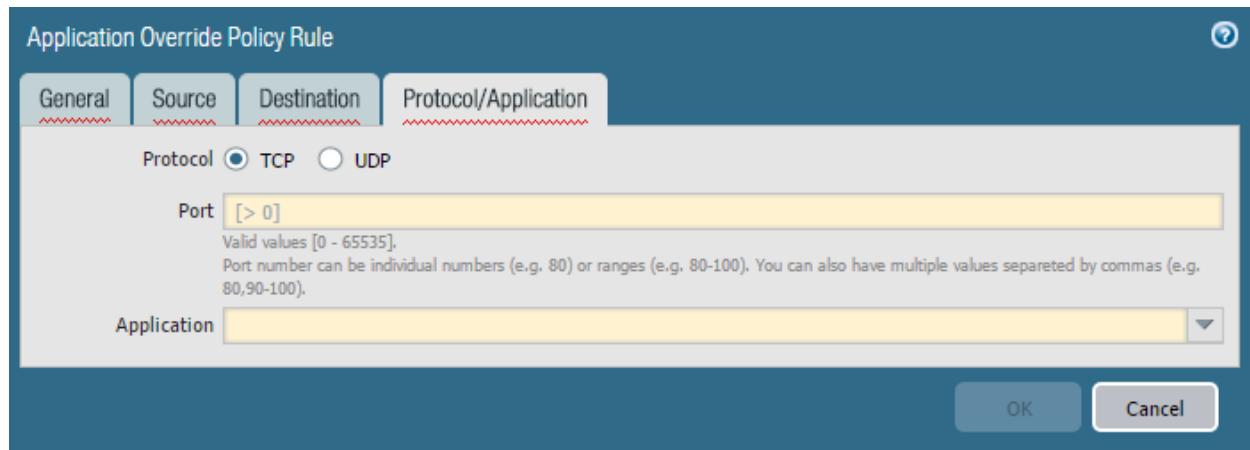
55. Which feature is not negatively affected by the lack of a Decryption policy?
 - A. antivirus
 - B. App-ID
 - C. file blocking
 - D. network address translation

56. How can the next-generation firewall inform web browsers that a web server's certificate is from an unknown CA?
 - A. show a "the certificate is untrusted, are you SURE you want to go there" response page before accessing the website
 - B. relay the untrusted certificate directly to the browser
 - C. have two certificates in the firewall, one used for sites whose original certificate is trusted, and the other for sites whose original certificate is untrusted
 - D. have two certificate authority certificates in the firewall, one used to produce certificates for sites whose original certificate is trusted and the other used for certificates for sites whose original certificate is untrusted

57. Which two firewall features can be used to support an organization's requirement of decrypting and recording all encrypted traffic? (Choose two.)
 - A. Decryption Broker
 - B. Policy Based Forwarding
 - C. Default Router setting of Forward Cleartext
 - D. Interface setting of Decryption Port Mirroring
 - E. Decryption policy rule action set to Forward Cleartext

1.17 Identify the impact of application override to the overall functionality of the firewall

Application Override policy rules specify the App-ID for matching traffic. Traffic matched to an Application Override policy rule also typically is bypassed for Layer 7 content scanning., which means that no further App-ID and Content-ID scanning happens on that traffic.



Unlike the App-ID engine, which inspects application packet contents for unique signature elements, the Application Override policy's matching conditions are limited to header-based data only. Traffic matched by an Application Override policy is identified by the App-ID entered in the **Application** field.

Choices are limited to applications currently in the App-ID database. Because an existing App-ID must be chosen for the policy, the administrator should add a new App-ID to the database for this purpose.

Details about creating an App-ID entry for this purpose can be found here:

<https://knowledgebase.paloaltonetworks.com/KCSArticleDetail?id=kA10g000000CIVLCA0>

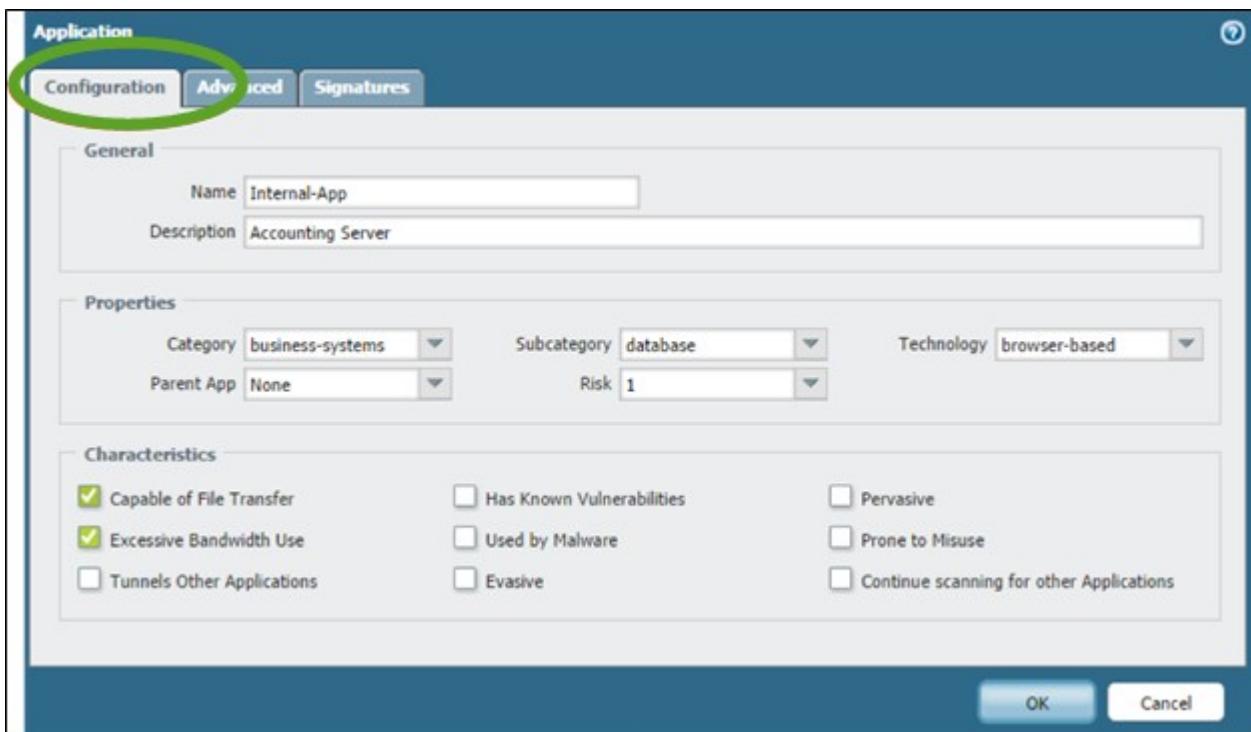
Because this traffic bypasses all Layer 7 inspection, the resulting security is that of a Layer 4 firewall. Thus, this traffic should be trusted without the need for Content-ID inspection. The resulting application assignment can be used in other firewall functions such as Security policy rules and QoS.

Use Cases

Three primary uses cases for Application Override policy are:

- To identify “Unknown” App-IDs with a different or custom application signature
- To re-identify an existing application signature
- To bypass the Signature Match Engine (within the SP3 architecture) to improve processing times

The following figures show the creation of a new App-ID for a custom internal application and its use in an Application Override policy that assigns it to appropriate traffic.



| Name | Source Zone | Address | Destination Zone | Address | Protocol | Port | Application |
|---------------------|-------------|---------|------------------|------------------|----------|------|-------------------|
| Internal-App-Policy | Trust-L3 | any | App-Zone | Acct-App-Servers | tcp | 8376 | Internal-Acct-App |

Name is displayed in ACC, logs, and reports

Sample Questions

58. An App-ID used in an Application Override policy rule should have which characteristic?
 - A. existing App-ID that uses the same decoder
 - B. new App-ID with no signature information
 - C. new App-ID with the “custom” property set to yes
 - D. any existing App-ID with compatible characteristics
59. Which type of identification is disabled by Application Override?
 - A. Protocol-ID
 - B. User-ID
 - C. Content-ID
 - D. URL Filtering

60. Application Override is triggered by which configuration setting?

- A. Custom App-ID
- B. Application Override policy rule
- C. Application Override definition in Custom Objects
- D. Application Filters

1.18 Identify the methods of User-ID redistribution

Every firewall that enforces user-based policy requires user mapping information. In a large-scale network, instead of configuring all your firewalls to directly query the mapping information sources, you can streamline resource usage by configuring some firewalls to collect mapping information through redistribution. Redistribution also enables the firewalls to enforce user-based policies when users rely on local sources for authentication (such as regional directory services) but need access to remote services and applications (such as global data center applications).

If you configure Authentication policy, your firewalls also must redistribute the authentication timestamps that are generated when users authenticate to access applications and services. Firewalls use the timestamps to evaluate the timeouts for Authentication policy rules. The timeouts allow a user who successfully authenticates to later request services and applications without authenticating again within the timeout periods. Redistribution of timestamps enables you to enforce consistent timeouts across all the firewalls in your network.

Firewalls share user mappings and authentication timestamps as part of the same redistribution flow; you don't have to configure redistribution for each information type separately.

User-ID Table Sharing

To enable a firewall or virtual system to serve as a User-ID agent that redistributes user mapping information along with the timestamps associated with authentication challenges, configure the collector name and pre-shared key.

Specific information about this configuration can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-web-interface-help/user-identification/device-user-identification-user-mapping/user-id-agent-setup/user-id-agent-setup-redistribution.html>

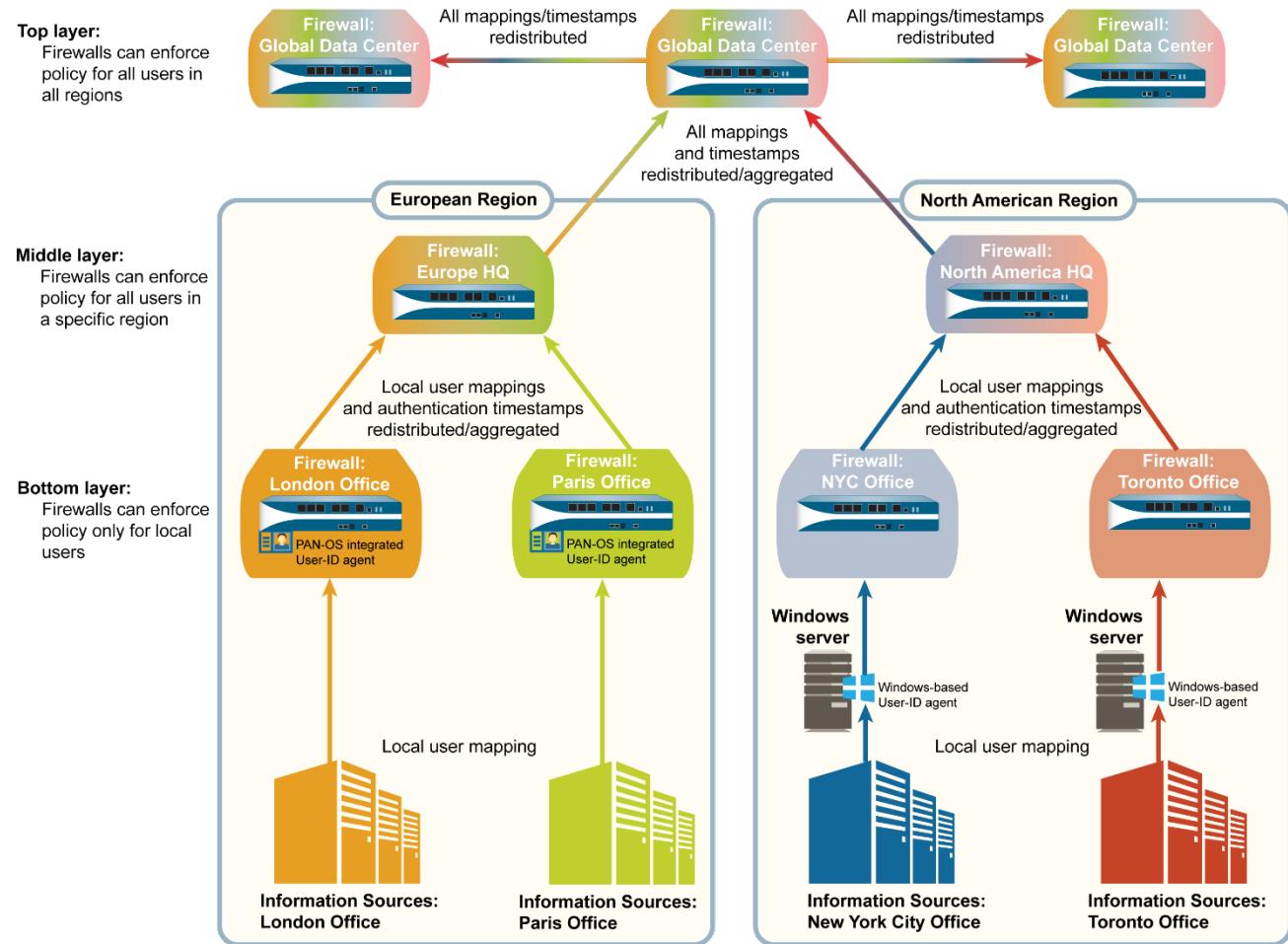
User-ID Table Consumption

To map IP addresses to usernames, User-ID agents monitor sources such as directory servers. The agents send the user mappings to firewalls, Log Collectors, or Panorama. Each appliance then can serve as redistribution points that forward the mappings to other firewalls, Log Collectors, or Panorama. Before a firewall or Panorama can collect user mappings, you must configure its connections to the User-ID agents or redistribution points.

More information about this topic can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-web-interface-help/user-identification/device-user-identification-user-id-agents>

Use Case Example



References

- Redistribute User Mappings and Authentication Timestamps
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/user-id/deploy-user-id-in-a-large-scale-network/redistribute-user-mappings-and-authentication-timestamps.html>
- User-ID Redistribution Using Panorama
<https://docs.paloaltonetworks.com/panorama/9-1/panorama-admin/panorama-overview/user-id-redistribution-using-panorama.html>

Sample Questions

61. Which configuration must be made on the firewall before it can read User-ID-to-IP-address mapping tables from external sources?
- Group Mapping Settings
 - Server Monitoring
 - Captive Portal
 - User-ID Agents

62. For an external device to consume a local User-ID-to-IP-address mapping table, which data is used for authentication between the devices?
 - A. source device's User-ID Collector Name and Pre-Shared Key
 - B. User-ID agent's Server Monitor Account information
 - C. Administrators account information on the source device with the User-ID role set
 - D. certificates added to the User-ID agent configuration
63. User-to IP-address-to-username mapping tables can be read by which product or service?
 - A. Traps
 - B. Panorama Log Collector
 - C. AutoFocus
 - D. Prisma Cloud

1.19 Identify VM-Series bootstrap components and their function

Bootstrapping

All Palo Alto Networks firewalls can automatically configure themselves during first boot using the bootstrapping feature. This feature provisions a specifically prepared storage volume (USB for physical appliances or storage accounts for the VM-Series) containing configuration data, licenses, dynamic updates, and PAN-OS updates that all are applied automatically during the boot process.

VM-Series Bootstrapping

Bootstrapping allows you to create a repeatable and streamlined process of deploying new VM-Series firewalls on your network because it allows you to create a package with the model configuration for your network and then use that package to deploy VM-Series firewalls anywhere. You can bootstrap the VM-Series firewall off an external device (such as a virtual disk, a virtual CD-ROM, or a storage bucket such as AWS S3 or Google Cloud bucket) to complete the process of configuring and licensing the VM-Series firewall. You can either bootstrap the firewall with basic initial configuration and licenses so that the firewall can register with Panorama and then retrieve its full configuration from Panorama, or you can bootstrap the complete configuration so that the firewall is fully configured on boot-up.

Bootstrap Package

The bootstrap process is initiated only when the firewall starts up in a factory default state. After you attach the virtual disk, virtual CD-ROM, or storage bucket to the firewall, the firewall scans for a bootstrap package and, if one exists, the firewall uses the settings defined in the bootstrap package. If you have included a Panorama server IP address in the file, the firewall connects with Panorama. If the firewall has internet connectivity, it contacts the licensing server to update the UUID and obtain the license keys and subscriptions. The firewall then is added as an asset in the Palo Alto Networks Support Portal. If the firewall does not have internet connectivity, it either uses the license keys you included in the bootstrap package or it connects to Panorama, which retrieves the appropriate licenses and deploys them to the managed firewalls.

The bootstrap package that you create must include the /config, /license, /software, and /content folders, even if empty:

- /config folder: Contains the configuration files. The folder can hold two files: init-cfg.txt and the bootstrap.xml.
Note: If you intend to pre-register VM-Series firewalls with Panorama with bootstrapping, you must generate a VM auth key on Panorama and include the generated key in the init-cfg file.
- /license folder: Contains the license keys or auth codes for the licenses and subscriptions that you intend to activate on the firewalls. If the firewall does not have internet connectivity, you must either manually obtain the license keys from the Palo Alto Networks Support portal or use the Licensing API to obtain the keys and then save each key in this folder.

Note: You must include an auth code bundle instead of individual auth codes so that the firewall or orchestration service can simultaneously fetch all license keys associated with a firewall. If you use individual auth codes instead of a bundle, the firewall will retrieve only the license key for the first auth code included in the file.

- /software folder: Contains the software images required to upgrade a newly provisioned VM-Series firewall to the desired PAN-OS version for your network. You must include all intermediate software versions between the Open Virtualization Format (OVF) version and the final PAN-OS software version to which you want to upgrade the VM-Series firewall.
- /content folder: Contains the Applications and Threats updates, WildFire updates, and the BrightCloud URL filtering database for the valid subscriptions on the VM-Series firewall. You must include the minimum content versions required for the desired PAN-OS version. Without the minimum required content version associated with the PAN-OS version, the VM-Series firewall cannot complete the software upgrade.
- /plugins folder: Optional folder contains a single VM-Series plugin image.

The bootstrapping volume must be prepared according to the specific information outlined here:

<https://docs.paloaltonetworks.com/vm-series/9-1/vm-series-deployment/bootstrap-the-vm-series-firewall.html>

Sample Questions

64. When will a firewall check for the presence of bootstrap volume?
 - A. each time it cold-boots
 - B. each time it boots from a factory default state
 - C. when a firewall is started in maintenance mode
 - D. each time it warm-boots
65. Where in the bootstrap volume directories is a required dynamic update file?
 - A. /config
 - B. /license
 - C. /software
 - D. /content
66. Can a firewall's PAN-OS software be updated by the bootstrap process?
 - A. Yes, by including a copy of the desired PAN-OS software in the /software folder of the bootstrap volume.
 - B. Yes, by including a copy of the desired PAN-OS software in the /content folder of the bootstrap volume.
 - C. No, it must be updated by an administrator after the firewall starts.
 - D. No, the firewall must be licensed first.

1.20 Identify the benefits of using dynamic user groups in policy rules

Dynamic User Groups

Dynamic user groups (DUGs) are a new feature in PAN-OS version 9.1. DUGs control access to resources managed by firewall policies, including the Security policy, Authentication policy, and Decryption policy. Dynamic user groups enable you to create policy rules that provide autoremediation for anomalous user behavior and malicious activity while maintaining user visibility. When you create a policy rule, you can add a DUG to the **Source User** field as a match criterion. In past PAN-OS releases you would have been able to add only a username or a static group name to the **Source User** field.

You must commit your firewall configuration after you have created a DUG and added it to a policy rule. However, you do not have to perform a commit when users are added to or removed from a DUG. User membership in a DUG is dynamic and controlled through tagging and untagging of usernames. Because updates to DUG membership are automatic, the use of DUGs instead of a static group (like an LDAP group) enables you to respond to changes in user behavior or potential threats without manual policy changes.

| | Name | Tags | Source | | | Destination | | | | Service | Action | Profile |
|---|--------------------|--------|--------|---------|--------------|-------------|---------|---------------------|--|---------------------|--------|---------|
| | | | Zone | Address | User | Zone | Address | Application | | | | |
| 1 | allow-temp-workers | egress | inside | any | temp-workers | outside | any | ssl web-browsing | | application-default | Allow | |

Only tagged users are members

Only DUG members get access

Several methods are available to tag or untag usernames. As shown in the following screenshot, you can manually tag and untag usernames using the web interface:

The screenshot shows the Palo Alto Networks web interface with the following details:

- Left Panel:** Shows navigation links for Addresses, Address Groups, Regions, Dynamic User Groups (selected), and Applications.
- Main Window:** Title: "Dynamic User Groups - sneaky-users". It displays a table with one row:

| Users |
|-------|
| |

Buttons at the bottom: Register New Users, Unregister Users, Close.
- Right Window:** Title: "Register tags for user".
 - Registration Source: Local
 - Tags: anonymous (with a delete button)
 - Timeout: 0
 - Users: steve (selected)
 - Buttons: Add, Delete, OK, Cancel.

A callout box points to the "Dynamic User Groups" link in the left sidebar with the text "Only tagged users are members". Another callout box points to the "OK" button in the right window with the text "Only DUG members get access".

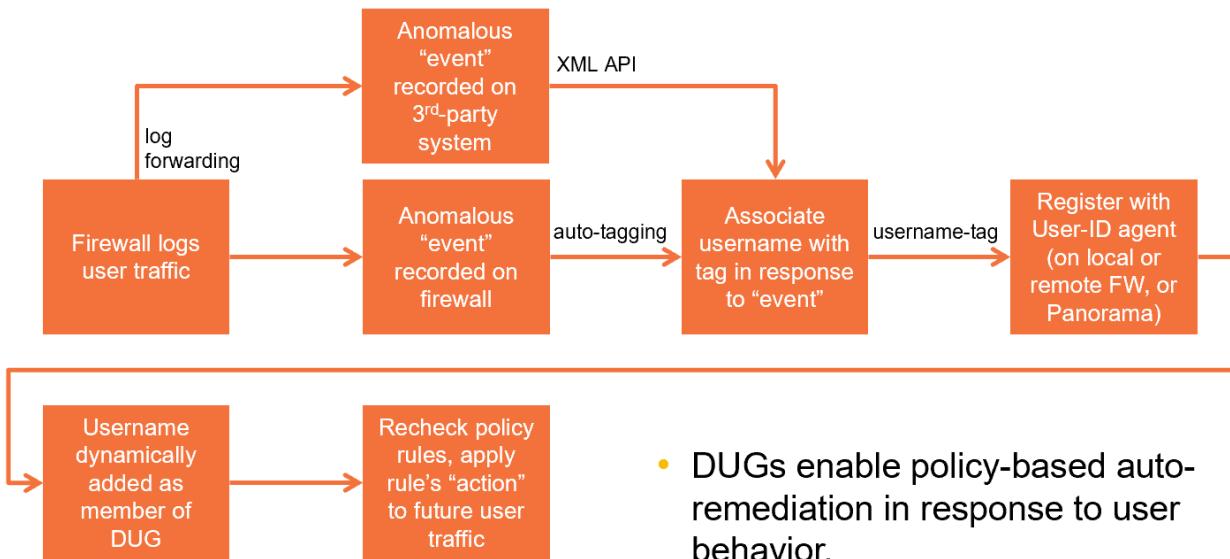
Usernames also can be tagged and untagged using the autotagging feature in a Log Forwarding Profile. You also can program another utility to invoke PAN-OS XML API commands to tag or untag usernames. In the web interface you can use logical AND or OR operators with the tags to better filter or match against. You can configure a timeout value that determines when a username will be untagged automatically.

DUG Operation

DUGs enable you to create a Security policy that provides autoremediation in response to user behavior and activity. Autoremediation reduces administrative burden by automating the firewall's response to user activity. Autoremediation using DUGs also reduces the firewall's response time to malicious activity, which provides better security for your environment.

In the illustration shown in the following screenshot, a user's traffic is recorded in the firewall logs. You can analyze these logs directly on the firewall or you can configure log forwarding to forward the logs to a third-party system for analysis. If logs are being analyzed locally on the firewall, the log forwarding configuration can invoke a new built-in action that will associate a tag with a username based on one or more events in a log. A third-party system also can associate a tag with a username using the PAN-OS XML API. Username-tag registrations are recorded in and maintained by a User-ID agent.

The firewall uses these username-tag pairs to determine which users are currently members of a DUG. When you configure a DUG you associate it with one or more tags. Any user that also is associated with a tag configured in a DUG becomes a member of the DUG. DUG membership then is used to determine future policy rule matches. As examples, a Security policy could block a user, an Authentication policy could force the user to use MFA, or a Decryption policy could force the user's traffic to be decrypted.



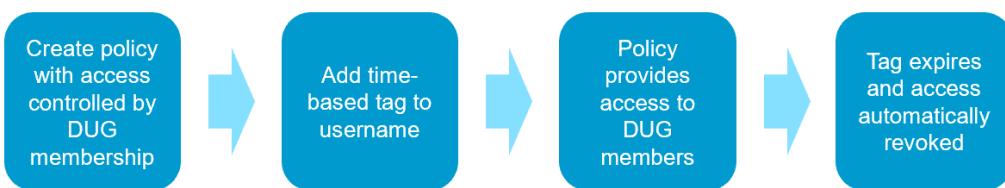
Example Use Cases

Here two DUG use case examples are shown:

Leverage User's Entire Known Security State



Use Time-Based User Access Controls



The first example illustrates use of a user's entire known security state, which is derived from various sources, to determine how the firewall will control or affect the user's access to network resources. In this case, the user's network traffic is logged so that it can be analyzed. User metadata also might be collected from other resources such as an LDAP server.

All this data can be analyzed in the firewall's logs, on a SIEM, in a *user and entity behavior analytics* system, or using a variety of tools available to a SOC. Any of these tools can be configured to tag or untag a username, depending on the results of the analysis. Tagging and untagging of a username determines whether it is a member of a DUG. Then DUG membership and policy configuration determine how the firewall should treat the user's network traffic.

The second example illustrates how to use a DUG to implement time-based access controls for workers that might require only short-term access to network resources. In this case, you create a DUG and add it to policies that control user access to network resources. You then can add a time-based tag to a username. A tagged username is a member of the DUG and network access is permitted by the DUG. When the time-based tag expires, the user's membership in the DUG is terminated along with the network access that was provided by the DUG.

1.21 Identify the requirements to support dynamic user groups

DUG Prerequisites

The dynamic user group feature was added to PAN-OS software starting with version 9.1. All firewalls must be upgraded to at least version 9.1 to use DUGs. If your firewalls will be managed by Panorama, then your Panorama device also must be upgraded to at least version 9.1.

You also must configure User-ID on your firewalls. The dynamic tags are registered and unregistered from the User-ID agent either on the local firewall, a remote firewall, or Panorama.

To use DUGs to invoke autoremediation, you will need to create at least two Security policy rules: one to allow initial traffic to populate the DUG and another rule to deny traffic for the activity you want to prevent. To ensure that users are tagged, the rule to allow traffic must have a higher rule number in your rulebase than the rule that denies traffic. The following screenshot illustrates how the two rules would be configured. The application is “any” for illustration purposes, but this configuration is not a recommended best practice:

| Name | Tags | Type | Source | | | Destination | | | Service | Action | Profile |
|------|----------------------|--------|-----------|---------|------|------------------|---------|-------------|---------------------|--------|---------|
| | | | Zone | Address | User | Zone | Address | Application | | | |
| 1 | block-sneaky-users | none | universal | inside | any | quarantine-group | inside | any | application-default | Deny | none |
| 2 | allow-infrastructure | none | universal | inside | any | any | outside | any | dns | Allow | none |
| 3 | egress-outside | egress | universal | inside | any | any | outside | any | application-default | Allow | none |

2. Subsequent traffic to external resources matches this rule. Username is tagged and added to DUG which ensures user traffic is blocked.

1. Initial traffic to external websites matches this rule. URL Filtering Profile logs access to anonymous proxy website and Log Forwarding Profile auto-tagging tags username.

For additional information about configuring and using DUGs, see the *PAN-OS® 9.1 Administrator’s Guide* at <https://docs.paloaltonetworks.com>.

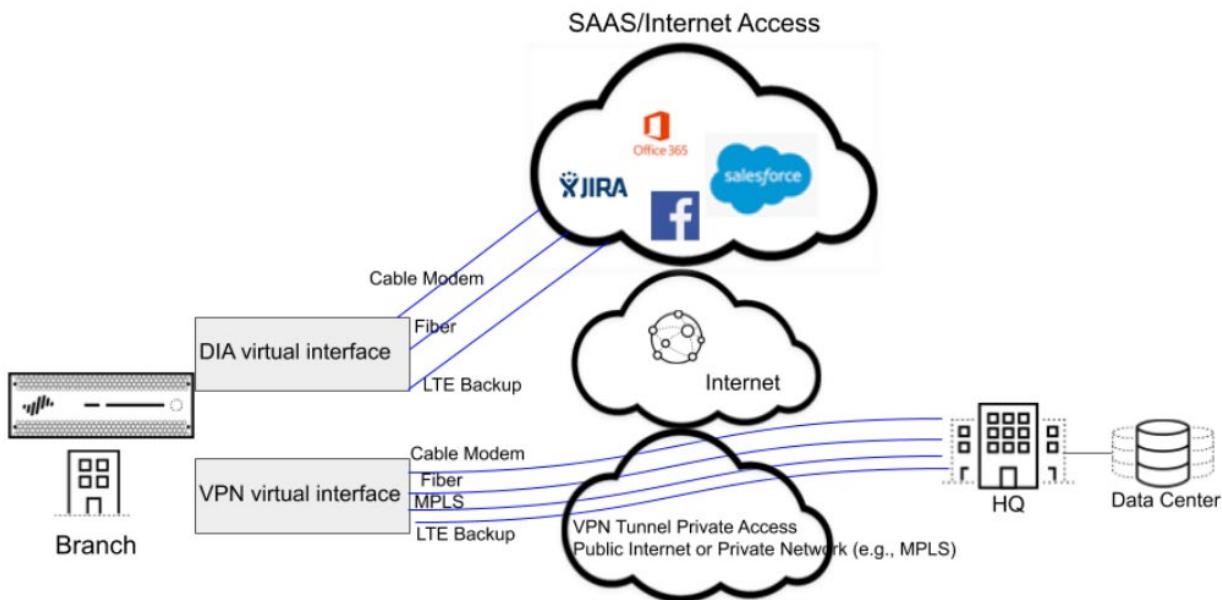
1.22 Identify the items for which you must plan when deploying SD-WAN

Software-defined wide-area network (SD-WAN) is a technology that enables you to use multiple internet services and private services to create an intelligent and dynamic WAN. The SD-WAN plugin is integrated with PAN-OS 9.1, which provides you with the security features of a PAN-OS 9.1 firewall combined with SD-WAN functionality. You can install the SD-WAN plugin on the Panorama management server. Panorama provides the means to centrally configure and manage your firewalls and SD-WAN environment. Panorama enables you to change and monitor your network configuration from a centralized location rather than configuring and monitoring each firewall individually. You can configure and manage your SD-WAN environment from the Panorama web interface or the Panorama REST API.

Initial Planning

Planning is a critical part of deploying your SD-WAN environment. In your SD-WAN configuration, you must configure one or more VPN clusters to determine which branch offices will communicate with which hub. A VPN creates a secure connection between the branch and hub devices. VPN clusters are a logical grouping of devices, and you should consider geographical location or function when you group your devices.

You also may have cloud-based services for which you want the internet traffic to flow directly from branch office to the cloud using direct internet access (DIA). Use of DIA can prevent SaaS, web browsing, or heavy-bandwidth applications from having to flow from branch office to the hub to the cloud and back.



During the initial planning stages, you will need to determine the ISP link types and maximum upload/download bandwidth that will be used at each branch and hub. ISP link types include ADSL/DSL, cable modem, Ethernet, fiber, LTE/3G/4G/5G, MPLS, microwave/radio, satellite, and WiFi.

You will need to gather the public IP addresses, private network prefixes, and serial numbers of your branch and hub firewalls. The firewall must have an internet-routable, public IP address to initiate and

terminate IPsec tunnels and route application traffic to and from the internet.

As part of the planning process you will decide on the naming conventions for your sites and SD-WAN devices. If you already have zones in place before configuring SD-WAN, you should decide how to map those zones to the predefined zones that SD-WAN uses for path selection. You will map an existing zone to a predefined zone named zone-internal, To_Hub, To_Branch, or zone-internet.

You can create Panorama templates using a CSV file and then push the configuration to the branch or hub firewalls. From Panorama you can export an empty SD-WAN device CSV file and then populate the CSV file with the branch and hub information. The information you will enter in to a CSV includes serial number, type of device (branch or hub), names of zones to map to predefined zones, loopback address, prefixes to redistribute, AS number if you use BGP dynamic routing, router ID, and virtual router name.

Link Bundles and VPN Security

A link bundle enables you to combine multiple physical links into one virtual SD-WAN interface for purposes of path selection and failover protection. By creating a bundle with more than one physical link, you maximize application quality in case a physical link deteriorates. You create a bundle by applying the same link tag to multiple links through an SD-WAN Interface Profile. The link tag identifies a bundle of links that have a similar type of access and a similar type of SD-WAN policy handling.

Applications and QoS Optimization

When you plan your SD-WAN deployment, you should identify which applications will use SD-WAN and which applications require QoS optimization. Identify the critical and the latency-sensitive business applications for which you will provide SD-WAN control and policies. Critical and latency-sensitive applications are applications that require a good user experience and are likely to fail under poor link conditions.

Next, identify the applications that require QoS policies so you can prioritize bandwidth. The applications that require QoS policies should be the same applications you identified as critical or latency-sensitive. Start with the most critical and latency-sensitive applications first because you can add applications after your SD-WAN is functioning smoothly.

Link Failover

Link failover enables you to determine how and when a link will fail over to a different link if the original link degrades or fails. You can determine which path monitoring mode to use for each link, although we recommend that you use the default setting for the link type:

- **Aggressive:** The firewall sends probe packets to the opposite end of the SD-WAN link at a constant frequency, five probes per second by default. Aggressive mode is appropriate for links where monitoring path quality is critical or where you need fast detection and failover for brownout and blackout conditions. Aggressive mode provides subsecond detection and failover.
- **Relaxed:** The firewall observes a configurable idle time between sending probe packets at the probe frequency you configure. Use relaxed mode to make path monitoring less frequent than aggressive mode. Relaxed mode is appropriate for links that have very low bandwidth, links that are expensive to operate, such as satellite or LTE, or when fast detection is not as important as preserving cost and bandwidth.

When you plan link failover, you should prioritize the order in which the firewall selects the first link for a new session and the order in which links should be a candidate to replace a link that is failing over, if there is more than one candidate.

For the applications and services, you should plan your path health thresholds at which you consider a path to have degraded enough in quality that you want the firewall to select a new path or fail over. The quality characteristics are latency (range is 10 to 2,000ms), jitter (range is 10 to 1,000ms), and packet loss percentage.

Routing

When you plan your SD-WAN environment, you should determine how your traffic will be routed between the branches and hubs. You can choose to use dynamic routing with BGP or static routing. If you choose dynamic routing, then plan BGP route information, including the four-byte autonomous system number (ASN). Each firewall site is in a separate AS and therefore must have a unique ASN. Each firewall also must have a unique Router ID. Panorama will push BGP configurations to the branches and hubs to dynamically route traffic between them.

If you do not want to use BGP dynamic routing, then plan to use the Panorama network configuration features to push out static routing configurations between the branches and hubs. Omit all of the BGP information in the Panorama plugin and use normal virtual router static routes to configure static routing.

References

- Planning Your SD-WAN Configuration
<https://docs.paloaltonetworks.com/sd-wan/1-0/sd-wan-admin/sd-wan-overview/plan-sd-wan-configuration.html>

Exam Domain 2 — Deploy and Configure

2.1 Identify the application meanings in the Traffic log (incomplete, insufficient data, non-syn TCP, not applicable, unknown TCP, unknown UDP, and unknown P2P)

To safely enable applications on your network, the Palo Alto Networks next-generation firewalls provide both an application and web perspective—App-ID and URL filtering—to protect against a full spectrum of legal, regulatory, productivity, and resource utilization risks.

App-ID enables visibility into the applications on the network so you can learn how they work and understand their behavioral characteristics and their relative risk. This knowledge about applications allows you to create and enforce Security policy rules to enable, inspect, and traffic shape desired applications and block unwanted applications. After you define policy rules to allow traffic, App-ID begins to classify traffic without any additional configuration.

App-ID is a patented traffic classification system available only in Palo Alto Networks firewalls. It determines what an application is, irrespective of port, protocol, encryption (SSH or SSL), or any other evasive tactic used by the application. It applies multiple classification mechanisms—application signatures, application protocol decoding, and heuristics—to your network traffic stream to accurately identify applications.

The App-ID engine is driven by pattern recognition features in the hardware and software of PAN-OS firewalls. It is based on scanning payloads and application headers only. Port numbers are used only as a secondary application recognition tool.

The signature database used by the App-ID scanning engine is updated periodically by Palo Alto Networks through the Applications and Threats updates.

The App-ID engine is fundamental to PAN-OS software and cannot be turned off. Even when App-ID is not being used as a part of Security policy rules, the Traffic logs show traffic classified by App-ID.

The App-ID engine also can look inside of protocols for “tunneling” applications. For example, the firewall recognizes the HTTP protocol as the App-ID “web-browsing.” But HTTP traffic that belongs to a specific application (e.g., Facebook) will be identified as such by App-ID.

Here's how App-ID identifies applications traversing your network:

1. Traffic is matched against policy to check whether it is allowed on the network. This check is based on information in the packet headers and the firewall ingress port.
2. Signatures then are applied to allowed traffic to identify the application based on unique application properties and related transaction characteristics. The signature also determines if the application is being used on its default port or if it is using a non-standard port. Traffic that is allowed by policy then is scanned for threats and is further analyzed to identify the application more granularly.

3. If App-ID determines that encryption (SSL or SSH) is in use, and if a Decryption policy rule is in place, the session is decrypted, and application signatures are applied again on the decrypted flow.
4. Decoders for known protocols then are used to apply additional context-based signatures to detect other applications that may be tunneling inside of the protocol (for example, Yahoo! Instant Messenger used across HTTP). Decoders validate that the traffic conforms to the protocol specification and provide support for NAT traversal and for opening dynamic pinholes for applications such as SIP and FTP.
5. For applications that are particularly evasive and cannot be identified through advanced signature and protocol analysis, heuristics or behavioral analysis may be used to determine the identity of the application.

After the application is identified, the policy check determines how to treat the application, for example—block, or allow and scan for threats, inspect for unauthorized file transfer and data patterns, or shape using QoS.

Over the course of a session each packet is evaluated for its App-ID. The state of App-ID recognition changes as a session progresses, and these states can be found in Traffic logs:

- **incomplete:** Either the three-way TCP handshake did not complete or the three-way TCP handshake did complete but there was no data after the handshake to identify the application. Traffic being seen is not really an application.
For example, if a client sends a server a TCP SYN packet and the Palo Alto Networks device creates a session for that SYN packet, but the server never sends a SYN ACK packet back to the client, then that session is “incomplete.”
- **insufficient data:** Not enough data to identify the application. So, for example, if the three-way TCP handshake completed and there was one data packet after the handshake but there was not enough data to match any signature, then the user will see “insufficient data” in the **Application** field of the Traffic log.
- **unknown-tcp:** The firewall captured the three-way TCP handshake, but the application was not identified, perhaps because of the use of a custom application for which the firewall does not have signatures.
- **unknown-udp:** Unknown UDP traffic
- **unknown-p2p:** Matches generic peer-to-peer (P2P) heuristics
- **not-applicable:** The Palo Alto Networks device has received data that will be discarded because the port or service that the traffic is coming in on is not allowed, or no rule or policy allows that port or service.

For example, if only one rule was on the Palo Alto Networks device and that rule allowed the application of web-browsing only on port/service 80, and traffic (web-browsing or any other application) is sent to the Palo Alto Networks device on any other port/service besides 80, then the traffic will be discarded or dropped and sessions with “not-applicable” will be in the **Application** field.

SaaS Applications

The App-ID engine identifies SaaS applications and provides additional functionality. A dedicated SaaS Application Usage report under **Monitor > PDF Reports > SaaS Application Usage** will help your

organization identify applications storing your data in external locations. The App-IDs for SaaS applications contain additional data about these applications and their providers to help you make decisions allowing access to them at the organizational level.

Palo Alto Networks firewalls include a feature within the URL Filtering engine that provides HTTP Header Insertion for certain SaaS applications that can prevent users from accessing private instances of a SaaS application while having access to the organization's sanctioned environment. A discussion of this feature can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-web-interface-help/objects/objects-security-profiles-url-filtering/http-header-insertion>

Note About Using App-ID

Because applications often can use non-standard ports for communication, a traffic enforcement technology based only on port numbers does not provide security administrators enough control over the actual application traffic entering their organizations. Because App-ID identifies applications based primarily on packet contents and not on port numbers, it provides a much higher level of capability. When you use Palo Alto Networks firewalls, your Security policy rules should use App-ID as selection criteria, not port numbers.

Sample Questions

67. An application using which protocol can receive an **incomplete** value in the Application field in the Traffic log?
 - A. UDP
 - B. TCP
 - C. ICMP
 - D. GRE
68. Session traffic being evaluated by a firewall is encrypted with SSL. If the firewall does not decrypt the traffic, how can the firewall make an App-ID determination?
 - A. evaluate the HTTP headers
 - B. evaluate the SSL Hello exchange
 - C. evaluate certificate contents used for encryption
 - D. use information in the SSL Decryption Exclusion cache
69. While a firewall is scanning an active session, how does it respond when it detects a change of application?
 - A. closes the session, opens a new one, and evaluates all Security policy rules again
 - B. closes the session, opens a new one, and evaluates the original matching Security policy rule only
 - C. updates the application in the existing session and evaluates all Security policy rules again
 - D. updates the application in the existing session and continues to use the original action from the first Security policy rule match

2.2 Given a scenario, identify the set of Security Profiles that should be used

Although Security policy rules enable you to allow or block traffic on your network, Security Profiles help you define an allow-but-scan rule, which scans allowed applications for threats such as viruses, malware, spyware, and DoS attacks. When traffic matches the allow rule defined in the Security policy, the Security Profile(s) attached to the rule are applied for further content inspection such as antivirus checks and data filtering. Security Profiles are the features that provide the services of the Content-ID feature of PAN-OS software.

Security Profiles are not used in the match criteria of a traffic flow. The Security Profile is applied to scan traffic after the application or category is allowed by the Security policy.

The firewall provides default Security Profiles that you can use out-of-the-box to begin protecting your network from threats. The Security Profiles attached to Security policy “allow” rules determine the type of threat detection performed on the traffic.

You can add Security Profiles that are commonly applied together to create a Security Profile Group; this set of profiles can be treated as a unit and added to Security policy rules in one step (or included in Security policy rules by default, if you choose to set up a default Security Profile Group).

Security Profile Types

Security Profiles manage particular types of threat detection:



Antivirus Profiles

Antivirus Profiles protect against viruses, worms, trojans, and spyware downloads. The Palo Alto Networks antivirus solution uses a stream-based malware prevention engine, which inspects traffic the moment the first packet is received, to provide protection for clients without significantly impacting the performance of the firewall. This profile scans for a wide variety of malware in executables, PDF files, HTML, and JavaScript viruses, and includes support for scanning inside compressed files and data encoding schemes. If you have enabled Decryption on the firewall, the profile also enables scanning of decrypted content.

The *default* profile inspects all the listed protocol decoders for viruses, and generates alerts for SMTP, IMAP, and POP3 protocols while blocking for FTP, HTTP, and SMB protocols. You can configure the action for a decoder or Antivirus signature and specify how the firewall responds to a threat event:

- default: For each threat signature and Antivirus signature that is defined by Palo Alto Networks, a default action is specified internally. Typically, the default action is an “alert” or a “reset-both.” The default action is displayed in parenthesis, for example, default (alert) in the threat or Antivirus signature.
- allow: Permits the application traffic
- alert: Generates an alert for each application traffic flow. The alert is saved in the Threat log.
- drop: Drops the application traffic
- reset -client: For TCP, resets the client-side connection. For UDP, drops the connection.
- reset-server: For TCP, resets the server-side connection. For UDP, drops the connection.
- reset-both: For TCP, resets the connection on both client and server ends. For UDP, drops the connection.

Customized profiles can be used to minimize antivirus inspection for traffic between trusted security zones, and to maximize the inspection of traffic received from untrusted zones, such as the internet, along with the traffic sent to highly sensitive destinations, such as server farms.

The Palo Alto Networks WildFire® system also provides signatures for persistent threats that are more evasive and have not yet been discovered by other antivirus solutions. As threats are discovered by WildFire, signatures are quickly created and then integrated into the standard Antivirus signatures that can be downloaded daily by Threat Prevention subscribers (sub-hourly for WildFire subscribers).

Anti-Spyware Profiles

Anti-Spyware Profiles block spyware on compromised hosts from trying to phone-home or beacon out to external command-and-control (C2) servers, thus allowing you to detect malicious traffic leaving the network from infected clients. You can apply various levels of protection between zones. For example, you may want to have custom Anti-Spyware Profiles that minimize inspection between trusted zones while maximizing inspection on traffic received from an untrusted zone such as an internet-facing zone.

You can define your own custom Anti-Spyware Profiles or choose one of the following predefined profiles when applying anti-spyware to a Security policy rule:

- Default: Uses the “default” action for every signature, as specified by Palo Alto Networks when the signature is created
- Strict: Overrides the “default” action of critical, high, and medium-severity threats to the block action, regardless of the action defined in the signature file. This profile still uses the default action for low and informational severity signatures.

After the firewall detects a threat event, you can configure the following actions in an Anti-Spyware Profile:

- default: For each threat signature and Anti-Spyware signature that is defined by Palo Alto Networks, a “default” action is specified internally. The default action typically is an “alert” “or a

“reset-both.” The “default” action is displayed in parenthesis, for example, “default” (alert) in the threat or Antivirus signature.

- allow: Permits the application traffic
- alert: Generates an alert for each application traffic flow. The alert is saved in the Threat log.
- drop: Drops the application traffic
- reset-client: For TCP, resets the client-side connection. For UDP, drops the connection.
- reset-server: For TCP, resets the server-side connection. For UDP, drops the connection.
- reset-both: For TCP, resets the connection on both client and server ends. For UDP, drops the connection.

Note: In some cases, when the profile action is set to “reset-both,” the associated Threat log might display the action as “reset-server,” which occurs when the firewall detects a threat at the beginning of a session and presents the client with a 503 block page. Because the block page disallows the connection, the client side does not need to be reset and only the server-side connection is reset.

- block IP: Blocks traffic from either a source or a source-destination pair. It is configurable for a specified period of time.

You also can enable the DNS Sinkholing action in Anti-Spyware Profiles to enable the firewall to forge a response to a DNS query for a known malicious domain, thus causing the malicious domain name to resolve to an IP address that you define. This feature helps to identify infected hosts on the protected network using DNS traffic. Infected hosts then can be easily identified in the Traffic logs and Threat logs because any host that attempts to connect to the sinkhole IP address most likely is infected with malware.

The procedure to configure Anti-Spyware Profiles and Vulnerability Protection Profiles is similar within the management web interface.

Vulnerability Protection Profiles

Vulnerability Protection Profiles stop attempts to exploit system flaws or gain unauthorized access to systems. Although Anti-Spyware Profiles help identify infected hosts as traffic leaves the network, Vulnerability Protection Profiles protect against threats entering the network. For example, Vulnerability Protection Profiles help protect against buffer overflows, illegal code execution, and other attempts to exploit system vulnerabilities. The *default* Vulnerability Protection Profile protects clients and servers from all known critical, high, and medium-severity threats. You also can create exceptions that allow you to change the response to a specific signature.

After the firewall detects a threat event, you can configure the following actions in an Anti-Spyware Profile:

- default: For each threat signature and Anti-Spyware signature that is defined by Palo Alto Networks, a “default” action is specified internally. The “default” action typically is an “alert” or a “reset-both.” The “default” action is displayed in parenthesis, for example, “default” (alert) in the threat or Antivirus signature.
- allow: Permits the application traffic
- alert: Generates an alert for each application traffic flow. The alert is saved in the Threat log.
- drop: Drops the application traffic

- reset-client: For TCP, resets the client-side connection. For UDP, drops the connection.
 - reset-server: For TCP, resets the server-side connection. For UDP, drops the connection.
 - reset-both: For TCP, resets the connection on both client and server ends. For UDP, drops the connection.
- Note:** In some cases, when the profile action is set to “reset-both,” the associated Threat log might display the action as “reset-server.” This occurs when the firewall detects a threat at the beginning of a session and presents the client with a 503 block page. Because the block page disallows the connection, the client side does not need to be reset and only the server-side connection is reset.
- Block IP—Blocks traffic from either a source or a source-destination pair. It is configurable for a specified period of time.

URL Filtering Profiles

URL Filtering Profiles enable you to monitor and control how users access the web over HTTP and HTTPS. The firewall comes with a *default* profile that is configured to block websites such as known malware sites, phishing sites, and adult content sites. You can use the default profile in a Security policy, clone it to be used as a starting point for new URL Filtering Profiles, or add a new URL Profile that will have all categories set to “allow” for visibility into the traffic on your network. You then can customize the newly added URL profiles and add lists of specific websites that always should be blocked or allowed, which provides more granular control over URL categories.

Data Filtering Profiles

Data Filtering Profiles prevent sensitive information such as credit card numbers or Social Security numbers from leaving a protected network. The Data Filtering Profile also allows you to filter on keywords, such as a sensitive project name or the word “confidential.” It should focus your profile on the desired file types to reduce false positives. For example, you may want to search only Word documents or Excel spreadsheets. You also may want to scan only web-browsing traffic or FTP.

You can create custom data pattern objects and attach them to a Data Filtering Profile to define the type of information about which you want to filter. Create data pattern objects based on:

- Predefined patterns: Filter for credit card numbers and Social Security numbers (with or without dashes) using predefined patterns
 - Regular expressions: Filter for a string of characters
 - File properties: Filter for file properties and values based on file type
- Note:** If you’re using a third-party, endpoint data loss prevention (DLP) solution to populate file properties to indicate sensitive content, this option enables the firewall to enforce your DLP policy.

File Blocking Profiles

The firewall uses File Blocking Profiles to block specified file types over specified applications and in the specified session flow direction (inbound/outbound/both). You can set the profile to “alert” or “block” on upload and/or download and you can specify which applications will be subject to the File Blocking Profile. You also can configure custom response pages that will appear when a user attempts to

download the specified file type. This response page allows the user to pause to consider whether they want to continue and download a file.

You can define your own custom File Blocking Profiles or choose one of the following predefined profiles when applying file blocking to a Security policy rule. The predefined profiles, which are available with content release version 653 and later, allow you to quickly enable best practice file blocking settings:

- Basic file blocking: Attach this profile to the Security policy rules that allow traffic to and from less sensitive applications to block files that commonly are included in malware attack campaigns or that have no real use case for upload or download. This profile blocks upload and download of PE files (.scr, .cpl, .dll, .ocx, .pif, .exe), Java files (.class, .jar), Help files (.chm, .hlp), and other potentially malicious file types, including .vbe, .hta, .wsf, .torrent, .7z, .rar, and .bat. It also prompts users to acknowledge when they attempt to download encrypted-rar or encrypted-zip files. This rule alerts on all other file types to give you complete visibility into all file types entering and leaving your network.
- Strict file blocking: Use this stricter profile on the Security policy rules that allow access to your most sensitive applications. This profile blocks the same file types as the basic file blocking profile, and blocks flash, .tar, multi-level encoding, .cab, .msi, encrypted-rar, and encrypted-zip files.

Configure a File Blocking Profile with the following actions:

- alert: After the specified file type is detected, a log is generated in the Data Filtering log.
- block: After the specified file type is detected, the file is blocked, and a customizable block page is presented to the user. A log also is generated in the Data Filtering log.
- continue: After the specified file type is detected, a customizable response page is presented to the user. The user can click through the page to download the file. A log also is generated in the Data Filtering log. Because this type of forwarding action requires user interaction, it is applicable only for web traffic.

WildFire Analysis Profiles

Use a WildFire Analysis Profile to enable the firewall to forward unknown files or email links for WildFire analysis. This detection is for zero-day threats contained in files. The firewall's anti-virus threat detection finds known viruses based on local resources. Specify files to be forwarded for analysis based on application, file type, and transmission direction (upload or download). Files matched to the profile rule are forwarded to either the WildFire public cloud or the WildFire private cloud (hosted with a WF-500 appliance), depending on the analysis location defined for the rule. If a profile rule is set to forward files to the WildFire public cloud, the firewall also forwards files that match existing Antivirus signatures, in addition to unknown files.

You also can use the WildFire Analysis Profiles to set up a WildFire hybrid cloud deployment. If you are using a WildFire appliance to analyze sensitive files locally (such as PDFs), you can specify for less sensitive file types (such as PE files) or file types that are not supported for WildFire appliance analysis (such as APKs) to be analyzed by the WildFire public cloud. Use of both the WildFire appliance and the WildFire cloud for analysis allows you to benefit from a prompt verdict for files that already have been processed by the cloud and for files that are not supported for appliance analysis, and frees the appliance capacity to process sensitive content.

DoS Protection Profiles

DoS Protection Profiles provide detailed control for DoS Protection policy rules. DoS Profiles allow you to control the number of sessions between interfaces, zones, addresses, and countries based on aggregate sessions or source and/or destination IP addresses. Palo Alto Networks firewalls support two DoS protection mechanisms:

- Flood protection: Detects and prevents attacks where the network is flooded with packets, which results in too many half-open sessions and/or services being unable to respond to each request. In this case the source address of the attack usually is spoofed.
- Resource protection: Detects and prevents session exhaustion attacks. In this type of attack, many hosts (bots) are used to establish as many fully established sessions as possible to consume all of a system's resources.

You can enable both types of protection mechanisms in a single DoS Protection Profile.

The DoS Profile is used to specify the type of action to take and the details on matching criteria for the DoS policy. The DoS Profile defines threshold settings for SYN, UDP, and ICMP floods; can enable resource protection; and defines the maximum number of concurrent connections. After you configure the DoS Protection Profile, you attach it to a DoS policy rule.

When you configure DoS protection, you should analyze your environment to set the correct thresholds based on your actual traffic rather than use the default values provided.

Sample Questions

70. Which profile do you use for DLP based on file content?
 - A. Antivirus
 - B. Anti-Spyware
 - C. Vulnerability Protection
 - D. URL Filtering
 - E. File Blocking
 - F. WildFire Analysis
 - G. Data Filtering
71. Which profile do you use to monitor DNS resolution lookups for sites associated with threat activity?
 - A. Antivirus
 - B. Anti-Spyware
 - C. Vulnerability Protection
 - D. URL Filtering
 - E. File Blocking
 - F. WildFire Analysis
 - G. Data Filtering

72. Which profile do you use to analyze files for zero-day malware?
- A. Antivirus
 - B. Anti-Spyware
 - C. Vulnerability Protection
 - D. URL Filtering
 - E. File Blocking
 - F. WildFire Analysis
 - G. Data Filtering
73. Which profile do you use to examine browsing traffic for appropriate browsing policy enforcement?
- A. Antivirus
 - B. Anti-Spyware
 - C. Vulnerability Protection
 - D. URL Filtering
 - E. File Blocking
 - F. WildFire Analysis
 - G. Data Filtering
74. Which profile do you use to detect and block an executable file from being transferred through the firewall?
- A. Antivirus
 - B. Anti-Spyware
 - C. Vulnerability Protection
 - D. URL Filtering
 - E. File Blocking
 - F. WildFire Analysis
 - G. Data Filtering

2.3 Identify the relationship between URL filtering and credential theft prevention

Phishing Prevention Overview

The Palo Alto Networks URL filtering solution complements App-ID by controlling access to web (HTTP and HTTPS) traffic and protecting your network from attack.

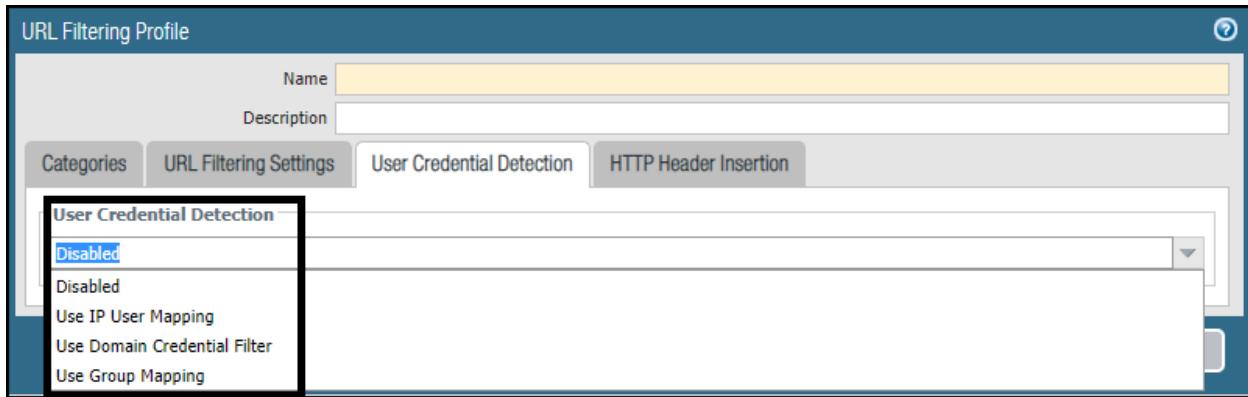
With URL filtering enabled, all web traffic is compared against the URL filtering database, which contains a list of millions of categorized websites. You can use these URL categories as a match criterion to enforce Security policy and to safely enable web access and control the traffic that traverses your network. You also can use URL filtering to enforce safe search settings for your users and to prevent credential phishing based on URL category.

Credential phishing prevention works by scanning username and password submissions to websites and comparing those submissions against valid corporate credentials. You can choose which websites you want to either allow or block corporate credential submissions based on the URL category of the website. When the firewall detects a user credential being transmitted to a site in a category you have restricted, it either displays a block response page that prevents the user from submitting credentials or presents a continue page that warns users against submitting credentials to sites classified in certain URL categories. But the firewall still allows the user to continue with the credential submission. You can customize these block pages to educate users against reusing corporate credentials, even on legitimate, non-phishing sites.

Credential Detection

Before you configure credential phishing protection, decide which method you want the firewall to use to identify credentials. Each method requires the configuration of *User-ID* technology. The *IP address-to-username mapping* and *group mapping* methods check for valid username submissions only. In these cases, the firewall blocks or allows the submission, based on your settings, regardless of the accompanying password submitted. The *domain credential filter* method checks for valid usernames and passwords submitted to a webpage:

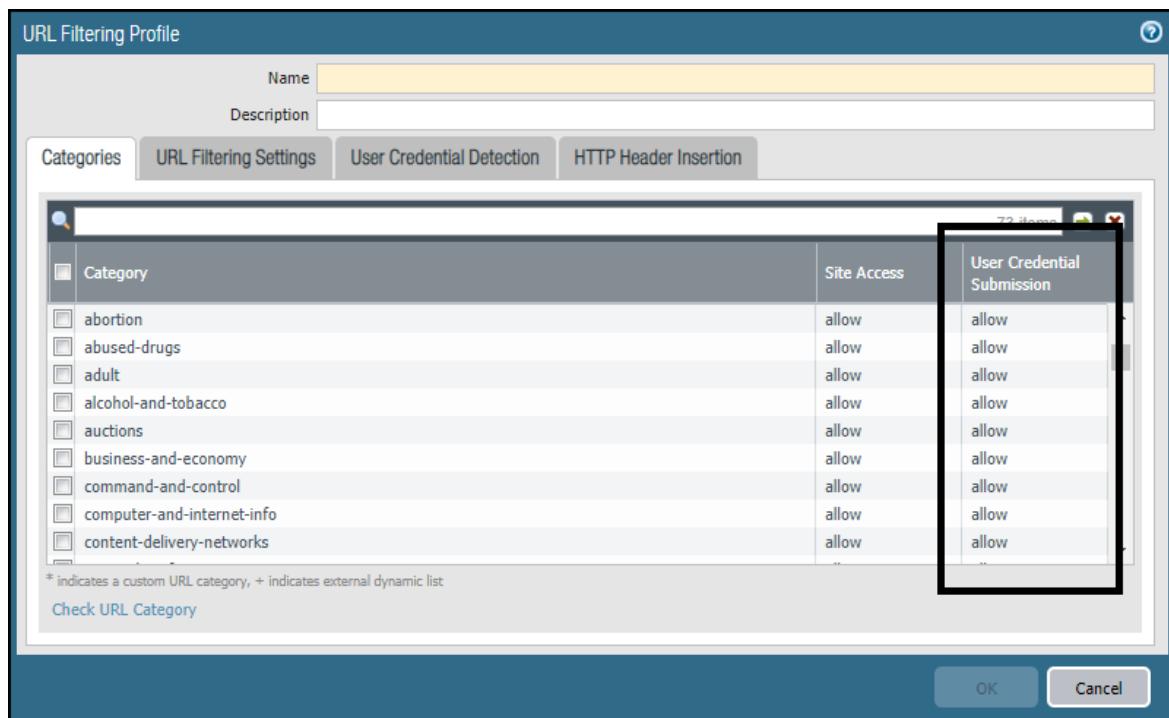
- IP address-to-username mapping: The firewall uses IP-address-to-user mappings that the PAN-OS integrated User-ID collects to check if a username submitted to a webpage matches the username of the logged-in user.
- Group mapping: The PAN-OS integrated User-ID agent collects group mapping information from a directory server and retrieves a list of groups and the corresponding group members. It compares usernames submitted to a webpage against the group member usernames.
- Domain credential filter: The Windows-based User-ID agent is installed on a Read-Only Domain Controller (RODC). The User-ID agent collects password hashes that correspond to users for which you want to enable credential detection and sends these mappings to the firewall. The firewall then checks if the source IP address of a session matches a username and if the password submitted to the webpage belongs to that username. With this mode, the firewall blocks or alerts on the submission only when the password submitted matches a user password.



Category Selection for Enforcement

After the detection method is chosen for the URL Filtering Profile, the enforcement action must be chosen for each appropriate browsing category. Custom categories can be created when flexibility is required in identifying specific category members. For each category, select how you want to treat user credential submissions:

- alert: Allow users to submit credentials to the website but generate a URL Filtering log each time a user submits credentials to sites in this URL category
- allow: (default) Allow users to submit credentials to the website
- block: Block users from submitting credentials to the website. When a user tries to submit credentials, the firewall displays the **Anti Phishing Block** page, which prevents the credential submission.
- continue: The firewall displays the **Anti Phishing Continue** page response page when a user attempts to submit credentials. Users must select **Continue** on the response page to continue with the submission.



When the firewall detects a user attempting to submit credentials to a site in a category you have restricted, it either displays a block response page that prevents the user from submitting credentials or presents a continue page that warns users against submitting credentials to sites classified in certain URL categories. But the firewall still allows the user to continue with the credential submission. You can customize these block pages to educate users against reusing corporate credentials, even on legitimate, non-phishing sites.

Sample Questions

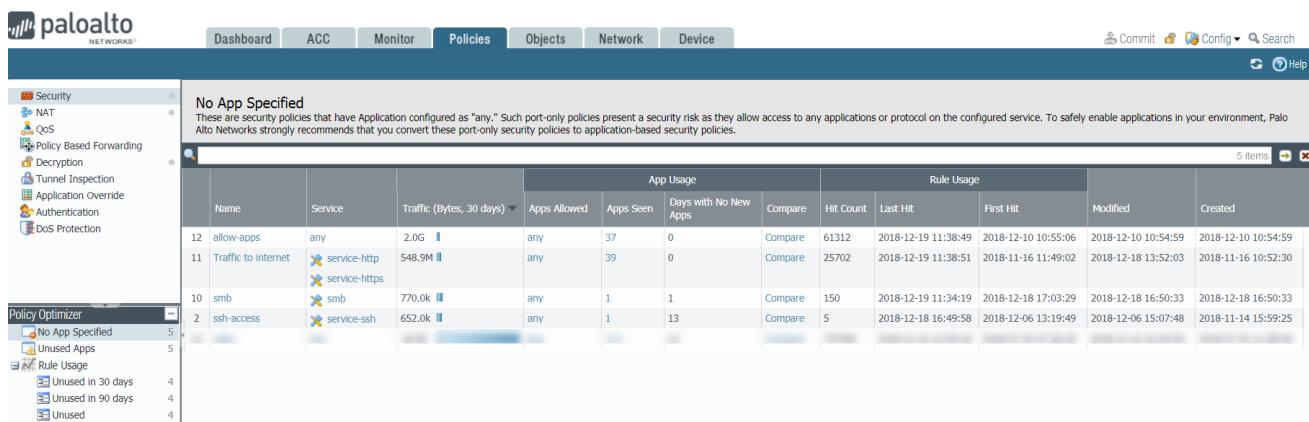
75. Which credential phishing prevention action allows users to choose to submit credentials to a site anyway?
 - A. alert
 - B. allow
 - C. block
 - D. continue
76. Which user credential detection method would work if multiple users share the same client IP address (for example, because of dynamic address translation done by a device on the internal side of the firewall)?
 - A. IP-to-user mapping
 - B. group mapping
 - C. domain credential filter
 - D. IP-and-port-to-user mapping
77. Which type of user credential detection must be used by a firewall administrator that wants to enable credential phishing prevention that blocks an attempt by a user to enter the organization's user ID and password?
 - A. IP-to-user mapping
 - B. domain credential filter
 - C. group mapping
 - D. Citrix mapping

2.4 Implement and maintain the App-ID lifecycle

When you transition from a legacy firewall to a Palo Alto Networks next-generation firewall, you inherit a large number of port-based rules that allow any application on the allowed ports, which increases the attack surface because any application can use an open port. Policy Optimizer identifies all applications seen on any legacy port-based Security policy rule and provides an easy workflow for selecting the applications you want to allow on that rule. Migrate port-based rules to application-based whitelist rules to reduce the attack surface and safely enable applications on your network. Use Policy Optimizer to maintain the rulebase as you add new applications.

Step 1: Identify Port-Based Rules

Port-based rules have no configured (whitelisted) applications. **Policies > Security > Policy Optimizer > No App Specified** displays all port-based rules (**Apps Allowed** is **any**).



The screenshot shows the Palo Alto Networks Policy Optimizer interface. The left sidebar has sections for Security, NAT, QoS, Policy Based Forwarding, Decryption, Tunnel Inspection, Application Override, Authentication, and DoS Protection. A 'Policy Optimizer' section is expanded, showing 'No App Specified' (5 items), 'Unused Apps' (5), and 'Rule Usage' (4 items: Unused in 30 days, Unused in 90 days, Unused). The main area is titled 'No App Specified' with a note about security risks. It contains a table with columns: Name, Service, Traffic (Bytes, 30 days), Apps Allowed, Apps Seen, Days with No New Apps, Compare, Hit Count, Last Hit, First Hit, Modified, and Created. The table lists four rules:

| Name | Service | Traffic (Bytes, 30 days) | Apps Allowed | Apps Seen | Days with No New Apps | Compare | Hit Count | Last Hit | First Hit | Modified | Created |
|------------------------|--|--------------------------|--------------|-----------|-----------------------|---------|-----------|---------------------|---------------------|---------------------|---------------------|
| 12 allow-apps | any | 2.0G | any | 37 | 0 | Compare | 61312 | 2018-12-19 11:38:49 | 2018-12-10 10:55:06 | 2018-12-10 10:54:59 | 2018-12-10 10:54:59 |
| 11 Traffic to internet | service- http , service- https | 548.9M | any | 39 | 0 | Compare | 25702 | 2018-12-19 11:38:51 | 2018-11-16 11:49:02 | 2018-12-18 13:52:03 | 2018-11-16 10:52:30 |
| 10 smb | smb | 770.0k | any | 1 | 1 | Compare | 150 | 2018-12-19 11:34:19 | 2018-12-18 17:03:29 | 2018-12-18 16:50:33 | 2018-12-18 16:50:33 |
| 2 ssh-access | service- ssh | 652.0k | any | 1 | 13 | Compare | 5 | 2018-12-18 16:49:58 | 2018-12-06 13:19:49 | 2018-12-06 15:07:48 | 2018-11-14 15:59:25 |

Step 2: Prioritize Which Port-Based Rules to Convert First

Policies > Security > Policy Optimizer > No App Specified enables you to sort rules without affecting their order in the rulebase and provides other information that helps you prioritize rules for conversion based on your business goals and risk tolerance.

- **Traffic (Bytes, 30 days):** (Click to reverse the sort order.) Displays rules with applications transferring the most data, which appear at the top of the list. Rules with applications transferring less data are shown at the bottom. This is the default application sorting order.
- **Apps Seen:** (Click to sort.) A large number of legitimate applications matching a port-based rule may indicate you should replace it with multiple application-based rules that tightly define the applications, users, and sources and destinations. For example, if a port-based rule controls traffic for multiple applications for different user groups on different sets of devices, create separate rules that pair applications with their legitimate users and devices to reduce the attack surface and increase visibility. (Click the **Apps Seen** number or **Compare** to display the applications that have matched the rule.)
- **Days with No New Apps:** (Click to reverse the sort order.) When the applications seen on a port-based rule stabilize, you can be more confident the rule is mature, conversion won't accidentally exclude legitimate applications, and no more new applications will match the rule. The **Created** and **Modified** dates help you evaluate a rule's stability because older rules that have not been modified recently also may be more stable.

- Hit Count: Displays rules with the most traffic matches over a selected time frame. You can exclude rules for which you reset the hit counter and specify the exclusion time period in days. Exclusion of rules with recently reset hit counters prevents misconceptions about rules that show fewer hits than you expect because you didn't know the counter was reset.

Step 3: Review the Apps Seen on Port-Based Rules, Starting with the Highest Priority Rules

On **No Apps Specified**, click **Compare** or the number in **Apps Seen** to open **Applications & Usage**, which lists applications that matched a port-based rule over a specified time frame, with each application's **Risk**, the date it was **First Seen**, the date it was **Last Seen**, and the amount of traffic over the last 30 days.

The screenshot shows the 'Applications & Usage' window. At the top, there is a dropdown menu labeled 'Applications seen' with the option 'Anytime' selected. Below this, a title bar says 'Apps on Rule' and 'Apps Seen 67'. A search bar is present. The main area is a table with the following columns: Applications, Subcategory, Risk, First Seen, Last Seen, and Traffic (30 days). The table lists several applications:

| Applications | Subcategory | Risk | First Seen | Last Seen | Traffic (30 days) |
|--------------------|------------------|------|------------|------------|-------------------|
| ssl | encrypted-tunnel | 4 | 2018-07-25 | 2018-08-02 | 1.8G |
| perforce | general-business | 2 | 2018-07-25 | 2018-08-02 | 1.1G |
| crashplan | storage-backup | 4 | 2018-07-25 | 2018-08-02 | 909.0M |
| outlook-web-online | email | 3 | 2018-07-25 | 2018-08-02 | 591.2M |
| ssh | encrypted-tunnel | 4 | 2018-07-25 | 2018-08-01 | 473.2M |
| web-browsing | internet-utility | 4 | 2018-07-25 | 2018-08-02 | 452.8M |
| boxnet-base | file-sharing | 3 | 2018-07-25 | 2018-08-02 | 293.6M |
| tanium | management | 1 | 2018-07-25 | 2018-08-02 | 77.5M |

At the bottom of the table, there is a note: 'The last new app was discovered 0 days ago.' Below the table are buttons for 'Browse', 'Add', 'Delete', 'Add to Rule', 'Create Cloned Rule', and 'Match Usage'. There are also 'OK' and 'Cancel' buttons at the bottom right.

You can check **Applications seen** on port-based rules over the past 7, 15, or 30 days, or over the rule's lifetime (**Anytime**). For migrating rules, **Anytime** provides the most complete assessment of applications that matched the rule.

You can search and filter the **Apps Seen** but remember that an hour or more is required to update **Apps Seen**. You also can order the **Apps Seen** by clicking the column headers. For example, you can click **Traffic (30 days)** to bring the applications with the most recent traffic to the top of the list or click **Subcategory** to organize the applications by subcategory.

Step 4: Clone or Add Applications to the Rule to Specify the Applications You Want to Allow on the Rule

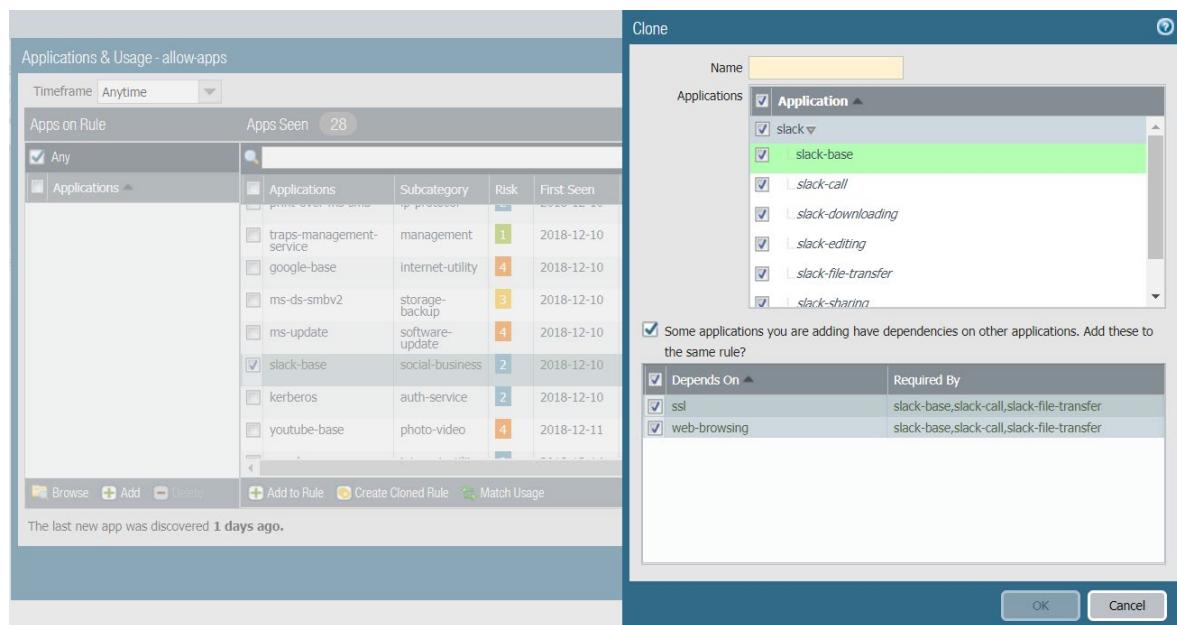
On **Applications & Usage**, convert a port-based rule to an application-based rule by:

- Cloning the rule: Preserves the original port-based rule and places the cloned application-based rule directly above it in the port-based rule
- Adding applications to the rule: Replaces the original port-based rule with the new application-based rule and deletes the original rule

Cloning is the safest way to migrate rules, especially when **Applications & Usage** shows more than a few well-known applications matching the rule. Cloning preserves the original port-based rule and places it below the cloned application-based rule, which eliminates the risk of losing application availability because traffic that doesn't match the cloned rule flows through to the port-based rule. When traffic from legitimate applications hasn't hit the port-based rule for a reasonable period of time, you can remove it to complete that rule's migration.

To **clone** a port-based rule:

1. In **Apps Seen**, click the check box next to each application you want in the cloned rule. Remember that an hour or more is required to update **Apps Seen**.
2. Click **Create Cloned Rule**. In the **Clone** dialog, **Name** the cloned rule and add other applications in the same container and application dependencies, if required. This figure shows how to clone a rule by selecting the slack-base application:



In the **Clone** window, the green row is the selected application to clone. The container application (**slack**) is in the gray row. The applications listed in italics are applications in the same container as the selected application but that have not been seen on the rule. Individual applications that have been seen on the rule are in normal font. All the applications are included in the cloned rule by default to help prevent the rule from breaking.

3. If the container app is a *tolerated* application (not an application sanctioned for business purposes) and you want to constrain access to some of the individual functional applications in the container, uncheck the box next to each individual application you don't want users to access. If the container app is a *sanctioned* business application, add the container app and its individual applications.
4. Leave the application dependencies checked, in this example, **ssl** and **web-browsing** (these are applications that the selected application requires).
5. Click **OK** to add the new application-based rule directly above the port-based rule in the rulebase.
6. **Commit** the configuration.

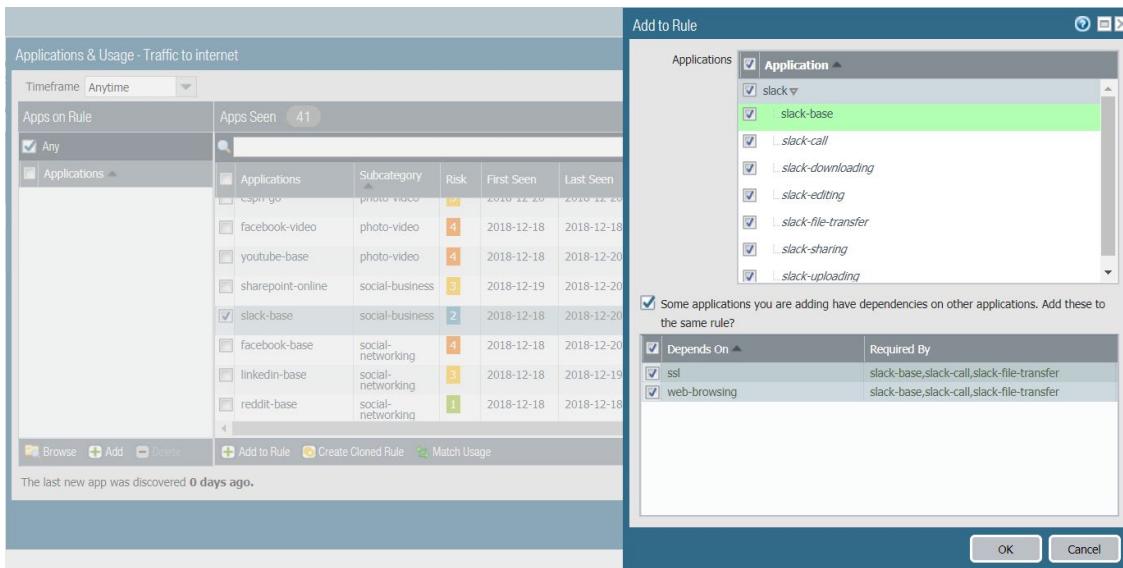
After you clone a rule and **Commit** the configuration, the applications you select for the cloned rule are removed from the original port-based rule's **Apps Seen** list. For example, if a port-based rule has 16 **Apps Seen** and you select two individual applications and one dependent application for the cloned rule, after cloning, the port-based rule shows 13 **Apps Seen** because the three selected applications have been removed from the port-based rule ($16 - 3 = 13$). The cloned rule shows the three added applications in **Apps on Rule**.

Creation of a cloned rule with a container app works a bit differently. For example, a port-based rule has 16 **Apps Seen** and you select one individual application and a container app for the cloned rule. The container app has five individual applications and has one dependent application. After cloning, the cloned rule shows seven **Apps on Rule**—the individual application, the five individual applications in the container app, and the dependent application for the container app. However, in the original port-based rule, **Apps Seen** shows 13 applications because only the individual application, the container app, and the container app's dependent application are removed from the port-based rule.

Unlike with cloning, addition of applications to a port-based rule replaces the rule with the resulting application-based rule. Addition of applications to a rule is simpler than cloning, but riskier because you may inadvertently miss applications that should be on the rule, and the original port-based rule isn't in the rulebase to identify accidental omissions. However, addition of applications to port-based rules that apply to only a few well-known applications migrates the rule quickly to an application-based rule. For example, for a port-based rule that controls only traffic to TCP port 22, the only legitimate application is SSH, so it's safe to add applications to the rule.

There are three ways to **add** applications to replace a port-based rule with an application-based rule: **Add to Rule**, **Match Usage in Apps Seen**, and **Add in Apps on Rule**:

- **Add to Rule** applications from **Apps Seen** (applications that matched the rule). Remember that an hour or more is required to update **Apps Seen**.
 1. Select applications from **Apps Seen** on the rule.
 2. Click **Add to Rule**. In the **Add to Rule** dialog, add other applications in the same container app and application dependencies, if required. For example, to add slack-base to a rule:



As is the case with the **Clone** dialog, the green row in the **Add to Rule** dialog is the selected application to add to the rule. The container app (**slack**) is in the gray row. The applications listed in italics are applications in the same container but that have not been seen on the rule. Individual applications that have been seen on the rule are in normal font. All the applications are included in the new rule by default to help prevent the rule from breaking.

3. If you are sure any of the italicized applications in the container that have not been seen on the rule will never be seen on the rule, you can uncheck the box next to them, so that they aren't included in the rule. If you uncheck a container app, its individual applications also are unchecked.
4. Leave the application dependencies checked, in this example **ssl** and **web-browsing** (these are applications that the selected application requires).
5. Click **OK** to replace the port-based rule with the new application-based rule.

When you **Add to Rule** and **Commit** the configuration, the applications you didn't add are removed from **Apps Seen** because the new application-based rule no longer allows them. For example, if a rule has 16 **Apps Seen** and you **Add to Rule** three applications, the resulting new rule shows only those three added applications in **Apps Seen**.

Add to Rule with a container app works a bit differently. For example, a port-based rule has 16 **Apps Seen** and you select one individual application and a container app to add to the new rule. The container app has five individual applications and has one dependent application. After you add the applications to the rule, the new rule shows seven **Apps on Rule**—the individual application, the five individual applications in the container app, and the dependent application for the container app. However, **Apps Seen** shows 13 applications because the individual application, the container app, and the container app's dependent application are removed from that list.

- Add all of the **Apps Seen** on the rule to the rule at one time with one click (**Match Usage**):
 1. In **Apps Seen**, click **Match Usage**. Remember that an hour or more is required to update **Apps Seen**. All the applications in **Apps Seen** are copied to **Apps on Rule**.
 2. Click **OK** to create the application-based rule and replace the port-based rule.

- If you know the applications you want on the rule, you can **Add** applications manually in **Apps on Rule**. However, this method is equivalent to using the traditional Security policy rule **Application** tab and does not change **Apps Seen** or **Apps on Rule**. To preserve accurate application usage information, convert rules using **Add to Rule**, **Create Cloned Rule**, or **Match Usage** in **Apps Seen**.
 1. In **Apps on Rule**, **Add** (or **Browse**) and select applications to add to the rule. This action is equivalent to adding applications on the **Application** tab.
 2. Click **OK** to add the applications to the rule and replace the port-based rule with the new application-based rule.

Step 5: For Each Application-Based Rule, Set the Service to application-default

If business needs require you to allow applications (for example, internal custom applications) on non-standard ports between particular clients and servers, restrict the exception to only the required application, sources, and destinations. Consider rewriting custom applications so they use the application default port.

Step 6: Commit the Configuration

Step 7: Monitor the Rules

- **Cloned rules:** Monitor the original port-based rule to ensure the application-based rule matches the desired traffic. If applications you want to allow match the port-based rule, add them to the application-based rule or clone another application-based rule for them. When only applications that you don't want on your network match the port-based rule for a reasonable period of time, the cloned rule is robust (it catches all the application traffic you want to control) and you can safely remove the port-based rule.
- **Rules with added applications:** Because you convert only port-based rules that have a few well-known applications directly to application-based rules, in most cases the rule operates properly from the beginning. Monitor the converted rule to see if the expected traffic matches the rule. If there's less traffic than expected, the rule may not allow all the necessary applications. If there's more traffic than expected, the rule may allow unwanted traffic. Listen to user feedback. If users can't access the applications they need for business purposes, the rule (or another rule) may be too restrictive.

Sample Questions

78. Which security risk is elevated when port-based Security policy rules are used?
- The firewall's resources will be negatively impacted by processing unwanted traffic.
 - Unwanted applications can get through the firewall, bringing their vulnerabilities with them.
 - The network is more vulnerable to TCP DoS attacks.
 - The firewall is more vulnerable to UDP DoS attacks.

79. What is the Palo Alto Networks suggested process for converting port-based Security policy rules to use App-ID?
- A. Use the Expedition tool to analyze Traffic logs against Security policy to suggest policy changes.
 - B. Use the built-in firewall reports to identify applications found in the traffic and update policy based on desired traffic.
 - C. Use the Policy Optimizer feature of the firewall to identify applications and update policy rules.
 - D. Use the firewall's New Applications Seen feature to identify applications and update policy rules.
80. If App-ID is implemented in Security policy rules, should port numbers also be included?
- A. No, App-ID-based Security policy rules detect and allow or block any desired application using the included port number values in the App-ID database.
 - B. Yes, including the port numbers as a *service*-matching condition can eliminate some traffic before App-ID processing, thus conserving firewall resources.
 - C. Yes, including an *application-default* setting in the *service*-matching condition requires that applications use only known or typical port numbers.
 - D. No, App-ID based Security policy rules detect and allow or block any desired application using the edited port number values in the App-ID database.

2.5 Identify how to create security rules to implement App-ID without relying on port-based rules

App-ID vs. Port-Based Security

Security policy rules based on evaluation of protocol type and port numbers are not accurate enough to effectively control application access through your firewall. Many applications use alternate or even multiple port numbers, which makes their detection even more difficult. For instance, allowing TCP port 80 provides access for all web-based applications with their associated vulnerabilities.

Palo Alto Networks App-ID technology provides for positive identification of applications regardless of port usage. App-ID allows you to safely enable access to only those applications that you want users to reach. This practice reduces your attack surface by eliminating unauthorized applications and their potential vulnerabilities.

Moving from Port-Based to App-ID Security

Moving from a port-based Security policy to an application-based Security policy may seem like a daunting task. However, the security risks of staying with a port-based policy far outweigh the effort required to implement an application-based policy. And, although legacy port-based Security policies may have thousands of rules (many of which have an unknown purpose), a best practice policy has a streamlined set of rules that align with your business goals, simplifying administration and reducing the chance of error. Because the rules in an application-based policy align with your business goals and acceptable use policies, you can quickly scan the policy to understand the reason for every rule.

As with any technology, usually there is a gradual approach to a complete implementation that consists of carefully planned deployment phases to make the transition as smooth as possible, with minimal impact to your end users. The general workflow for implementing a best practice internet gateway Security policy is as follows:

- Assess your business and identify what you need to protect: The first step in deploying a security architecture is to assess your business and identify your most valuable assets and the greatest threats to those assets. For example, if you are a technology company, your intellectual property is your most valuable asset. In this case, one of your biggest threats would be source code theft.
- Segment your network using interfaces and zones: Traffic cannot flow between zones unless there is a Security policy rule to allow it. One of the easiest defenses against lateral movement of an attacker that has made its way into your network is to define granular zones and allow access only to the specific user groups that need to access an application or resource in each zone. By segmenting your network into granular zones, you can prevent an attacker from establishing a communication channel within your network (either via malware or by exploiting legitimate applications), thereby reducing the likelihood of a successful attack on your network.
- Identify whitelist applications: Before you can create an internet gateway best practice Security policy, you must have an inventory of the applications you want to allow on your network and you must distinguish between those applications you administer and officially sanction and those that you want users to be able to use safely. After you identify the applications (including general types of applications) you want to allow, you can map them to specific best practice rules.

- Create user groups for access to whitelist applications: After you identify the applications you plan to allow, you must identify the user groups that require access to each one. Because compromising an end user's system is one of the cheapest and easiest ways for an attacker to gain access to your network, you can greatly reduce your attack surface by allowing access only to applications to the user groups that have a legitimate business need.
- Decrypt traffic for full visibility and threat inspection: You can't inspect traffic for threats if you can't see it in cleartext. And today SSL/TLS traffic flows account for 40 percent or more of the total traffic on a typical network, which is precisely why encrypted traffic is a common way for attackers to deliver threats. For example, an attacker may use a web application such as Gmail, which uses SSL encryption, to email an exploit or malware to employees accessing that application on the corporate network. Or, an attacker may compromise a website that uses SSL encryption to silently download an exploit or malware to site visitors. If you are not decrypting traffic for visibility and threat inspection, you are leaving a large surface open for attack.
- Create best practice Security Profiles for the internet gateway: Command-and-control traffic, CVEs, drive-by downloads of malicious content, phishing attacks, Advanced Persistent Threats (APTs) all are delivered via legitimate applications. To protect against known and unknown threats, you must attach stringent Security Profiles to all Security policy allow rules.
- Define the initial internet gateway Security policy: Using the application and user group inventory you conducted, you can define an initial policy that allows access to all the applications you want to whitelist by user or user group. The initial policy rulebase you create also must include rules for blocking known malicious IP addresses, temporary rules to prevent other applications you might not have known about from breaking, and identification of policy gaps and security holes in your existing design.
- Monitor and fine-tune the policy rulebase: After the temporary rules are in place, you can begin monitoring traffic that matches to them so that you can fine-tune your policy. Because the temporary rules are designed to uncover unexpected traffic on the network, such as traffic running on non-default ports or traffic from unknown users, you must assess the traffic matching these rules and adjust your application allow rules accordingly.
- Remove the temporary rules: After a monitoring period of several months, you should see less and less traffic hitting the temporary rules. When you reach the point where traffic no longer hits the temporary rules, you can remove them to complete your best practice internet gateway Security policy.
- Maintain the rulebase: Because the nature of applications is dynamic, you must continually monitor your application whitelist and adapt your rules to accommodate new applications that you decide to sanction and to determine how new or modified App-IDs impact your policy. Because the rules in a best practice rulebase align with your business goals and leverage policy objects for simplified administration, adding support for a new sanctioned application or new or modified App-ID often is as simple as adding or removing an application from an application group or modifying an application filter.

Palo Alto Networks has developed an innovative approach to securing networks that identifies all traffic by applications using a variety of techniques. This approach replaces conventional approaches that attempt to control traffic based on port numbers.

See section *2.4 Implement and maintain the App-ID lifecycle* for a complete description of features and their usage for converting port-based rules to use App-ID.

A web-based App-ID listing of all the existing App-IDs can be found here:

<https://applipedia.paloaltonetworks.com/>

Sample Questions

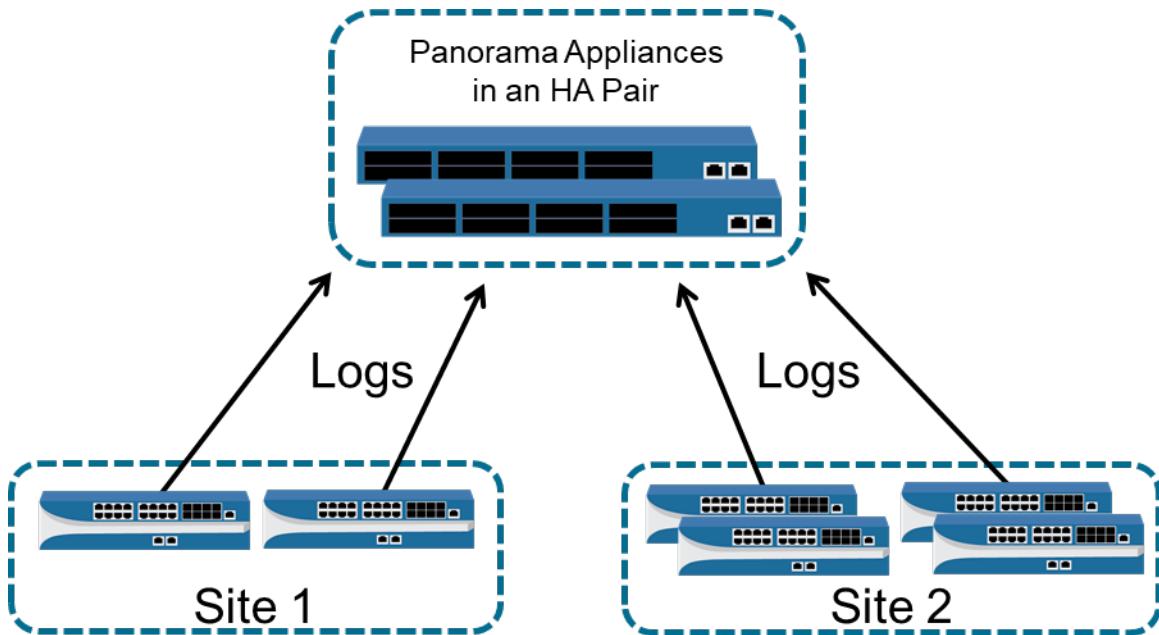
81. Which firewall tool provides settings and tools to convert policies from port-based to App-ID?
 - A. Network Monitor display under App Scope
 - B. Policy Optimizer under Policies
 - C. Application Hit Count under Policies
 - D. View Applications as Groups under Policies
82. An administrator creates a Security policy rule that allows office-on-demand traffic through the firewall. After the change is committed, the firewall issues the following warning:
“vsys1: Rule 'Allow Office apps' application dependency warning:
Application 'office-on-demand' requires 'ms-office365-base' be allowed
Application 'office-on-demand' requires 'sharepoint-online' be allowed
Application 'office-on-demand' requires 'ssl' be allowed
Application 'office-on-demand' requires 'web-browsing' be allowed”
Which action should the administrator take?
 - A. create an application chain that include the dependencies
 - B. add the listed applications to the same Security policy rule
 - C. set the Service action of the rule to “dependent application default”
 - D. create a new Security policy rule for each listed application with an “allow” action higher in the rule list

2.6 Identify configurations for distributed Log Collectors

Simple Log Collection Deployment

Logs are forwarded to the Panorama appliances in an HA pair.

The secondary Panorama appliance in HA can be used to store logs.



Note: In an HA pair, when both the Panorama VMs are operating in Panorama mode, the same log (from the firewalls) is sent to the active and passive Panorama appliances. Therefore, the log basically is replicated between the active and the passive appliances of the HA pair. This deployment option is recommended if the firewalls generate up to 10,000 logs per second.

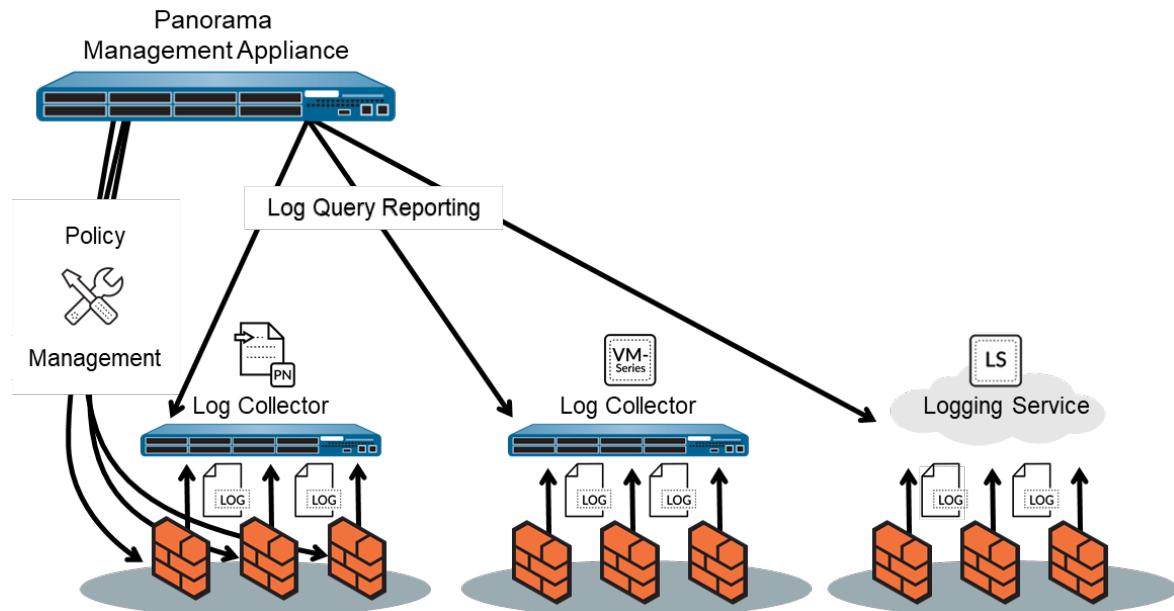
Log Collector Deployment

Dedicated Log Collectors are M-600, M-500, M-200, M-100, or virtual Panorama appliances in Log Collector mode. Because they perform only log collection, not firewall management, Dedicated Log Collectors allow for a more robust environment than local Log Collectors. Dedicated Log Collectors provide the following benefits:

- Enable the Panorama management server to use more resources for management functions instead of logging
- Provide high-volume log storage on a dedicated hardware appliance
- Enable higher logging rates
- Provide horizontal scalability and redundancy with RAID 1 storage
- Optimize bandwidth resources in networks where more bandwidth is available for firewalls to send logs to nearby Log Collectors than to a remote Panorama management server
- Enable you to meet regional regulatory requirements (for example, regulations might not allow logs to leave a particular region)

The Panorama management appliance always maintains management responsibility of the managed firewalls. Firewalls are configured to forward their logs to specific Log Collectors, where they are aggregated. The Panorama management appliance then sends queries to the Log Collectors to gather the data that is required for centralized log views and reporting purposes. Logging data remains in the Log Collectors and never is transmitted to the Panorama management appliance.

Log Collectors must be made a member of a Log Collector Group to be configured and receive forwarded log events. (Note that “Logging Service” shown in the following figure is now called “Cortex Data Lake.”)



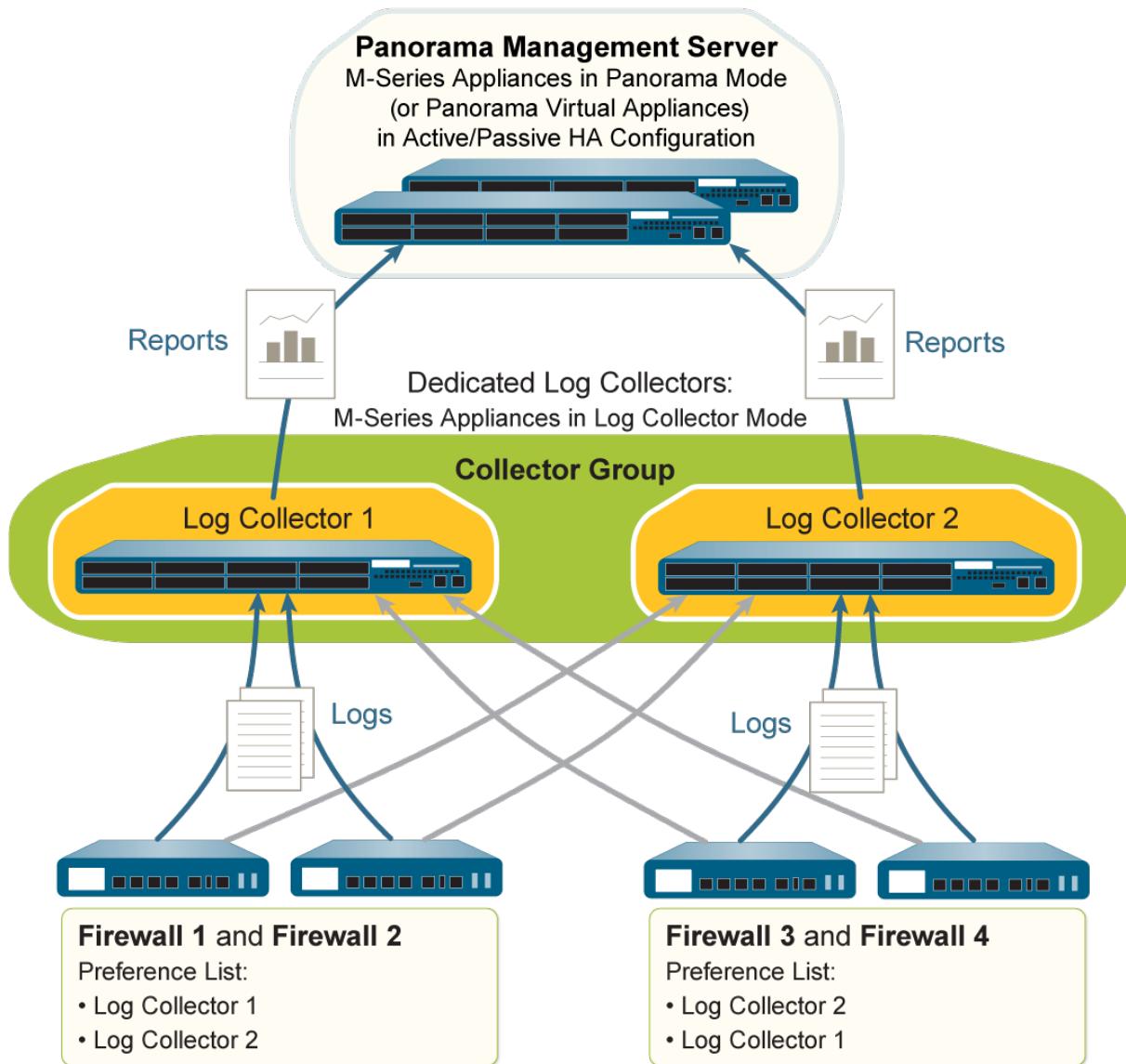
Log Collector Groups

Log Collectors are members of *Log Collector Groups*. A Log Collector Group can have more than one Log Collector device as a member. Log Collectors must meet the following requirements before they can become members of the same group:

- In any single Collector Group, all the Log Collectors must run on the same Panorama model: all M-600 appliances, all M-500 appliances, all M-200, all M-100 appliances, or all Panorama virtual appliances.
- Log redundancy is available only if each Log Collector has the same number of logging disks. Disks can be added to Log Collectors with remaining expansion capacity
- (Best Practice) All Log Collectors in the same Log Collector Group should be in the same local-area network (LAN). Avoid adding Log Collectors in the same or different wide-area networks (WANs) to the same Log Collector Group because network disruption is much more common and may result in log data loss. Log Collectors in the same Log Collector Group also should be physically near each other to allow Panorama to quickly query the Log Collectors when needed.

Log Collectors in a Log Collector Group appear as a single logical entity to devices forwarding logs. The Log Collector Group makes local log storage location decisions when multiple platforms are present, thus eliminating the need for an administrator to configure specific log storage behavior other than the optional use of *log redundancy* within the Collector Group.

When a Log Collector Group contains more than one Log Collector, firewalls can be configured to use a priority-based list of specific collectors within the group to use as logging destinations. The firewall automatically fails over to the next entry on the list when it cannot reach the preferred Log Collector. Firewalls also can be configured to use alternate Collector Groups as logging destinations when all Log Collectors of a preferred Log Collector Group become unavailable.



Cortex Data Lake (Formerly Logging Service)

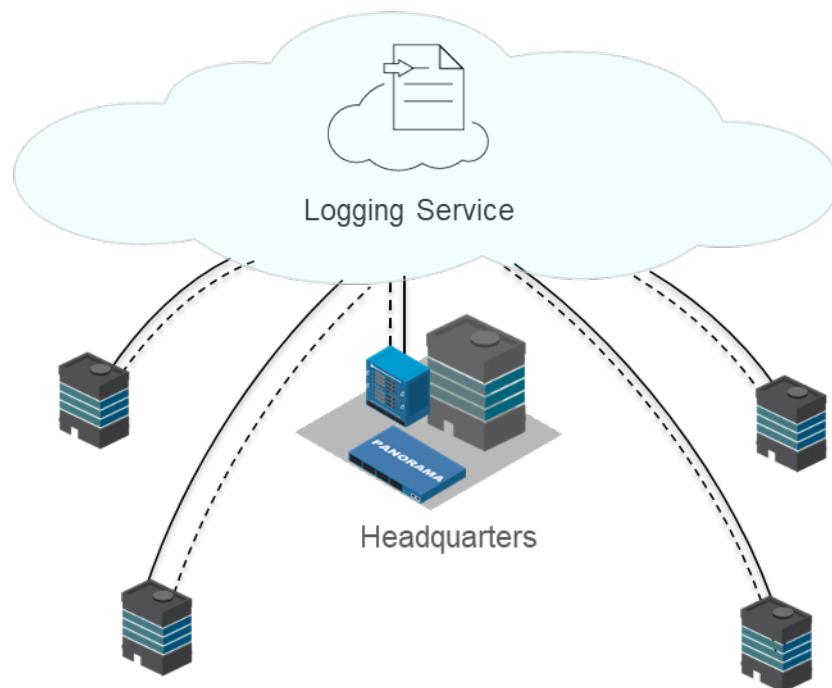
The Cortex Data Lake provides cloud-based, centralized log storage and aggregation for your on-premises and virtual (private cloud and public cloud) firewalls that can augment existing Log Collectors or function as deployed Log Collectors. Panorama provides an interface for the logs stored in the Cortex Data Lake, and it can show you an aggregated view of all logs stored there. You can generate reports and perform log analysis and forensics on the log data.

Cortex Data Lake is the central repository of all the logs generated from firewalls and the Traps endpoint server. It initiates queries, generates reports, and analyzes logs stored in the cloud via Panorama. It also

enables reporting, log viewing, and many other analytics-based applications on your logs. The Cortex Data Lake offers you flexible options to expand storage and log ingestion rates on demand, without the need for you to buy new hardware or manually provision new virtual machines.

The Cortex Data Lake provides the following functionality:

- Isolation: Your data is isolated to avoid any cross-contamination from the data of other customers.
- Redundancy: Multiple copies of your log database are stored to ensure redundancy.
- Regionalization: Logging facilities are in the Americas and Europe. You choose where to forward your data.
- Scalability: You can start with storage you need now and scale up as your storage needs grow. (Note that “Logging Service” shown in the following figure now is called “Cortex Data Lake.”)



Sample Questions

83. The use of Dedicated Log Collectors instead of a mixed-mode Panorama for log collection provides which benefit?
 - A. Log processing is offloaded from the Panorama(s) that are managing firewalls.
 - B. Dedicated Log Collectors can forward logs to external sources which Panorama cannot do.
 - C. Dedicated Log Collectors can have more disk drives installed to increase log storage and Panorama cannot.
 - D. Dedicated Log Collectors provide store-and-forward support of logging data being sent to Panorama.
84. Which statement is true about the Dedicated Log Collector's processing of firewall log data?
 - A. Dedicated Log Collectors receive, compress, and batch log data transmission to Panorama.
 - B. Dedicated Log Collectors process firewall logging data and send summary data to Panorama summary reporting databases.
 - C. Dedicated Log Collectors filter collected log data and forward desired alerts to Panorama.
 - D. Dedicated Log Collectors store firewall log data and provide query responses from Panorama on demand.
85. Which two options will provide an enterprise-wide log that can be viewed from Panorama?
(Choose two.)
 - A. Select firewalls are designated as Log Collectors and add logs forwarded from other firewalls to their own.
 - B. Panorama devices are configured as Dedicated Log Collectors that then are added to Log Collector Groups. Firewalls forward logs to a designated Log Collector within a Collector Group.
 - C. Cortex Data Lake is configured as a Log Collector in Panorama. Firewalls forward logs to Cortex Data Lake.
 - D. A Panorama device is configured in Management Mode and a Log Collector is defined on the Panorama appliance, which then is added to a Log Collector Group. Firewalls forward logs to a designated Log Collector within a Collector Group.

2.7 Identify the required settings and steps necessary to provision and deploy a next-generation firewall

By default, the firewall has an IP address of 192.168.1.1 and a username/password of admin/admin. For security reasons, you must change these settings before continuing with other firewall configuration tasks. You must perform these initial configuration tasks either from the MGT interface, even if you do not plan to use this interface for your firewall management, or by using a direct serial connection to the console port on the device.

Steps to Connect the Firewall

You can connect to the firewall in one of the following ways:

- Connect a serial cable from your computer to the console port and connect to the firewall using terminal emulation software (9600-8-N-1). Wait a few minutes for the boot-up sequence to complete. When the device is ready, the prompt changes to the name of the firewall, for example, PA-5260 login.
- Connect an RJ-45 Ethernet cable from your computer to the MGT port on the firewall. From a browser, go to <https://192.168.1.1>. Note that you may need to change the IP address on your computer to an address in the 192.168.1.0 network, such as 192.168.1.2, to access this URL.

For more information, see the initial sections at this link:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/getting-started>

Installing and Activating Licenses

The next configuration steps involve installing the proper licenses and activating subscriptions on the firewall. Use the resulting access to update PAN-OS software and dynamic update files as required.

You can activate licenses first on the Palo Alto Networks Support website and then communicate them to the firewall (assuming internet connectivity from the Management port). If connectivity is not available, you can enter licenses directly.

See this information for details:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/getting-started/register-the-firewall.html>

Dynamic Updates

Activated subscription licenses provide access to PAN-OS software updates and subscription data files (dynamic updates). The following information explains these licenses and the process for updating files and PAN-OS software:

Dynamic updates are explained here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/software-and-content-updates/dynamic-content-updates.html>

Downloading and configuring them for automatic update is discussed here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/software-and-content-updates/install-content-and-software-updates.html>

Firewall Configuration

After these initial deployment steps are taken, configuration becomes a task of implementing network connectivity and security settings to meet your specific requirements. These next steps can vary widely.

A complete discussion with implementation guidance is here:

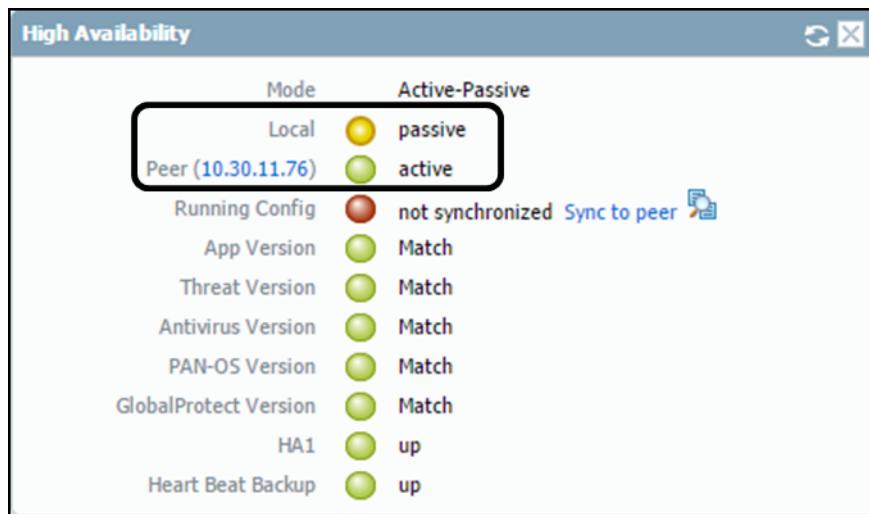
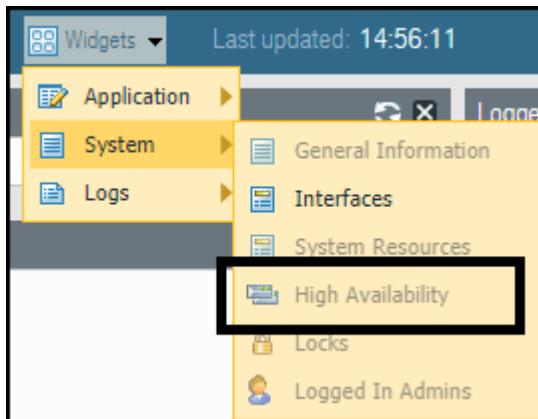
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/getting-started/register-the-firewall.html>

Sample Questions

86. Which configuration is performed first on a firewall with factory default settings, according to Palo Alto Networks best practices?
 - A. add licenses
 - B. update PAN-OS software
 - C. configure the management network port
 - D. update dynamic update files
87. You finished configuring the firewall's basic connectivity in the lab and are ready to put it in the data center. What do you have to remember to do before you power down the firewall?
 - A. Save the changes.
 - B. Commit the changes.
 - C. Create a restore thumb drive in case the configuration is deleted.
 - D. Verify that the configuration is correct. You do not need to do anything else if it is correct; the configuration is updated automatically.
88. The firewall's MGT port can be configured as which type of interface?
 - A. Layer 2
 - B. Layer 3
 - C. virtual wire
 - D. serial

2.8 Identify which device of an HA pair is the active partner

Two Palo Alto Networks firewalls configured as a *High Availability* (HA) pair can be deployed in an *active/passive* or *active/active* configuration. Palo Alto Networks provides an easy-to-use widget on the web interface **Dashboard** tab to monitor the status of the HA pair. Regardless of the deployment type, this widget will identify which firewalls of the HA pair are active and processing traffic.



The preceding figure identifies the firewall being viewed as the passive partner of an active/passive HA configuration.

Sample Questions

89. Which CLI command provides High Availability active/passive status of a firewall?
 - A. show high-availability all
 - B. show high-availability status
 - C. show system state
 - D. show system high-availability all
90. Which function can be performed directly in the High Availability widget?
 - A. synchronize dynamic update files
 - B. synchronize log files
 - C. synchronize firewall configurations
 - D. trigger an immediate failover
91. Which two steps must be completed to enable the display of the Dashboard's High Availability widget?
 - A. log in to the firewall management web interface and configure HA for active/active or active/passive
 - B. log in to the firewall management web interface and click the **Sync to peer** link in the firewall HA configuration settings
 - C. log in to the firewall's CLI and enter the **get management-server logging on** command
 - D. select and enable the **High Availability** widget in the firewall's management web interface **Dashboard** display

2.9 Identify various methods for authentication, authorization, and device administration within PAN-OS software for connecting to the firewall

See section *1.12 Identify methods for authorization, authentication, and device administration.*

2.10 Identify various methods for authentication, authorization, and device administration within PAN-OS software for connecting to services through the firewall

Protecting Service Access Through the Firewall

Authentication policy enables you to authenticate end users before they can access services and applications. Whenever a user requests a service or application (such as by visiting a webpage), the firewall evaluates Authentication policy. Based on the matching Authentication policy rule, the firewall then prompts the user to authenticate using one or more methods (factors), such as login and password, Voice, SMS, Push, or one-time password (OTP) authentication. For the first factor, users authenticate through a Captive Portal web form. For any additional factors, users authenticate through a multi-factor authentication (MFA) login page.

After the user authenticates for all factors, the firewall evaluates Security policy to determine whether to allow access to the service or application.

To reduce the frequency of authentication challenges that interrupt the user workflow, you can specify a timeout period during which a user authenticates only for initial access to services and applications, not for subsequent access. Authentication policy integrates with Captive Portal to record the timestamps used to evaluate the timeout and to enable user-based policies and reports.

Based on user information that the firewall collects during authentication, User-ID creates a new IP address-to-username mapping or updates the existing mapping for that user (if the mapping information has changed). The firewall generates User-ID logs to record the additions and updates. The firewall also generates an Authentication log for each request that matches an Authentication rule. If you favor centralized monitoring, you can configure reports based on User-ID or Authentication logs and forward the logs to Panorama or external services as you would for any other log types.

Configuring Authentication Policy

Perform the following steps to configure Authentication policy for end users who access services through Captive Portal. Before starting, ensure that your Security policy allows users to access the services and URL categories that require authentication.

1. Configure Captive Portal. If you use MFA services to authenticate users, you must set the **Mode** to **Redirect**.
2. Configure the firewall to use one of the following services to authenticate users.
 - External Authentication Services: Configure a Server Profile to define how the firewall connects to the service.
 - Local database authentication: Add each user account to the local user database on the firewall.
 - Kerberos single sign-on (SSO): Create a Kerberos keytab for the firewall. You can configure the firewall to use Kerberos SSO as the primary authentication service and, if SSO failures occur, fall back to an external service or local database authentication.

3. Configure an Authentication Profile and, optionally, an Authentication Sequence for each set of users and Authentication policy rules that require the same authentication services and settings.

Select the **Type** of authentication service and related settings:

- **External service:** Select the **Type** of external server and select the **Server Profile** you created for it.
- **Local database authentication:** Set the **Type** to **Local Database**. In the **Advanced** settings, **Add** the Captive Portal users and user groups you created.
- **Kerberos SSO:** Specify the **Kerberos Realm** and **Import** the **Kerberos Keytab**.

4. Configure an Authentication Enforcement object.

The object associates each Authentication Profile with a Captive Portal method. The method determines whether the first authentication challenge (factor) is transparent or requires a user response.

- Select **Objects > Authentication** and **Add** an object.
- Enter a **Name** to identify the object.
- Select an **Authentication Method** for the authentication service **Type** you specified in the Authentication Profile:
 - **browser-challenge:** Select this method if you want the client browser to transparently respond to the first authentication factor instead of having the user enter login credentials. For this method, you must have configured Kerberos SSO in the Authentication Profile or NT LAN Manager (NTLM) authentication in the Captive Portal settings. If the browser challenge fails, the firewall falls back to the web-form method.
 - **web-form:** Select this method if you want the firewall to display a Captive Portal web form for users to enter login credentials.
- Select the **Authentication Profile** you configured.
- Enter the **Message** that the Captive Portal web form will display to tell users how to authenticate for the first authentication factor.
- Click **OK** to save the object.

5. Configure an Authentication policy rule.

Create a rule for each set of users, services, and URL categories that require the same authentication services and settings.

- Select **Policies > Authentication** and **Add** a rule.
- Enter a **Name** to identify the rule.
- Select **Source** and **Add** specific zones and IP addresses or select **Any** zones or IP addresses. The rule applies only to traffic coming from the specified IP addresses or from interfaces in the specified zones.
- Select **User** and select or **Add** the source users and user groups to which the rule applies (default is **any**).
- Select or **Add** the **Host Information Profiles** to which the rule applies (default is **any**).

- Select **Destination** and **Add** specific zones and IP addresses or select **any** zones or IP addresses.
The IP addresses can be resources (such as servers) for which you want to control access.
 - Select **Service/URL Category** and select or **Add** the **services and service groups** for which the rule controls access (default is **service-http**).
 - Select or **Add** the **URL Categories** for which the rule controls access (default is **any**). For example, you can create a custom URL category that specifies your most sensitive internal sites.
 - Select **Actions** and select the **Authentication Enforcement** object you created.
 - Specify the **Timeout** period in minutes (default 60) during which the firewall prompts the user to authenticate only once for repeated access to services and applications.
 - Click **OK** to save the rule.
6. (MFA only) Customize the MFA login page.
- The firewall displays this page so that users can authenticate for any additional MFA factors.
7. Verify that the firewall enforces Authentication policy.
- Log in to your network as one of the source users specified in an Authentication policy rule.
 - Request a service or URL category that matches one specified in the rule.

The firewall displays the Captive Portal web form for the first authentication factor. For example:

Login Required

The resource you are trying to access requires proper user identification.
Please enter your credentials.

User

Password

LOGIN

- End the session for the service or URL you just accessed.
 - Start a new session for the same service or application. Be sure to perform this step within the **Timeout** period you configured in the Authentication rule.
The firewall allows access without re-authenticating.
 - Wait until the **Timeout** period expires and request the same service or application.
The firewall prompts you to re-authenticate.
8. (Optional) Redistribute user mappings and authentication timestamps to other firewalls that enforce Authentication policy to ensure they all apply the timeouts consistently for all users.

Sample Questions

92. Which firewall configuration object is used to specify more than one external authentication source for a user's log in attempt?
 - A. Multiple Server Profiles configured to failover
 - B. Authentication Sequence
 - C. Local User account set to failover
 - D. Account Sequence
93. Which object links the Captive Portal method with an Authentication Profile when multi-factor authentication is configured?
 - A. Multi-Factor Authentication Server Profile
 - B. Authentication policy rule
 - C. Authentication Sequence
 - D. Authentication Enforcement object
94. Which four firewall Server Profiles can provide first factor authentication for multi-factor authentication configurations? (Choose four.)
 - A. HTTP
 - B. Okta
 - C. PingID
 - D. Kerberos
 - E. RADIUS
 - F. SAML
 - G. LDAP
 - H. RSA SecureID Access

2.11 Identify how to configure and maintain certificates to support firewall features

Certificate Management

Certificates are used for a variety of purposes in Palo Alto Networks firewalls: securing SSL encryption, authenticating connections, and authenticating other SSL certificates. To augment certificate handling, the Palo Alto Networks firewall provides certificate management functions including import, export, and certificate creation.

A discussion of certificate use and management is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/certificate-management.html>

An exploration of many SSL certificate-related technical issues, including implementation and troubleshooting, is here:

<https://knowledgebase.paloaltonetworks.com/KCSArticleDetail?id=kA10g000000Cm5YCAS>

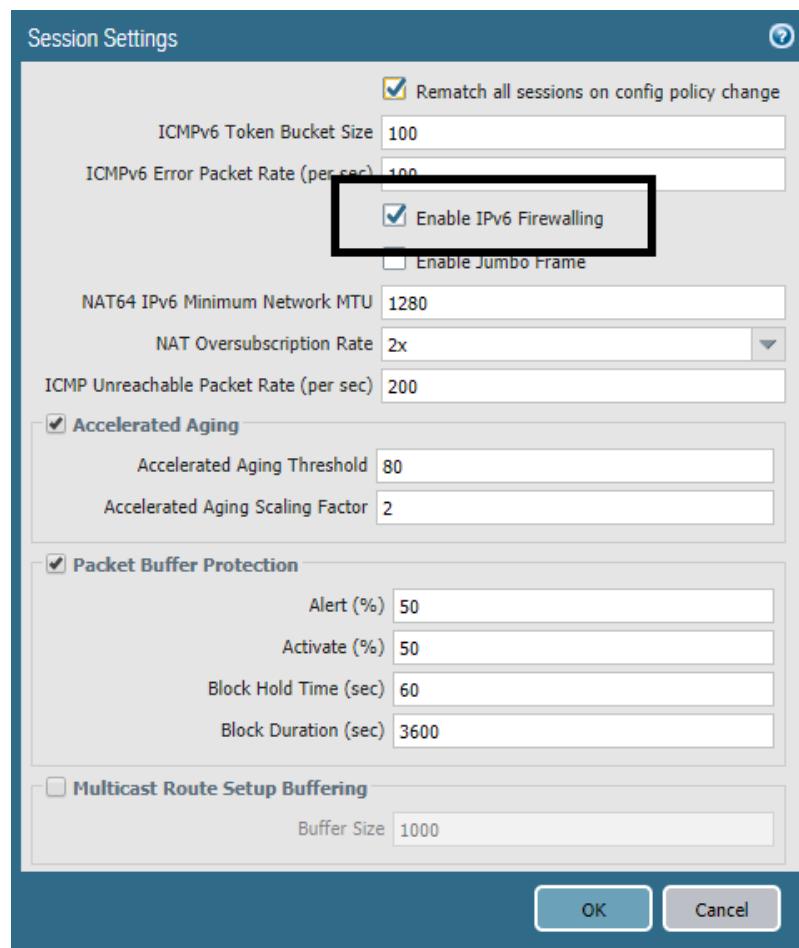
Sample Questions

95. How are updates made to the cache of root certificates that is used for certificate verification purposes and maintained by Palo Alto Networks?
 - A. The administrator reviews certificate status and replaces them manually.
 - B. The firewall automatically updates the certificates as it updates the associated CRL list.
 - C. The administrator installs PAN-OS software and dynamic content updates.
 - D. The firewall automatically installs new certificates using OCSP.
96. How does a firewall administrator that creates a certificate on the firewall mark it for use in an SSL Forward Proxy configuration?
 - A. add a certificate tag in the Decryption policy rule
 - B. configure a trust certificate in the Decryption Profile
 - C. set the Forward Trust Certificate property of the certificate itself
 - D. map the certificate to the URL in the SSL/TLS Service Profile
97. Administrators within the enterprise want to replace the default certificate used by the firewall to secure the management web interface traffic with a certificate generated by their existing certificate authority. Which certificate property must be set for their new certificate to function?
 - A. Certificate CN set to a domain name that resolves to any traffic port address of the firewall.
 - B. Certificate must be signed by the firewall root certificate.
 - C. Certificate must have the **Forward Trust Certificate** property set.
 - D. CN must be set to the management port of the firewall.

2.12 Identify the features that support IPv6

Firewall Support of IPv6

Palo Alto Networks firewalls support IPv6 addressing by implementing dual protocol stacks (IPv4 and IPv6) that simultaneously service many features of the firewall. Each firewall has a master switch that enables IPv6 support that is on by default. Navigate to **Device > Setup > Session > Session Settings** to find the following:



The following table lists the features that support IPv6 when IPv6 is enabled on a firewall:

| PAN-OS FEATURE | PAN-OS 7.1 | PAN-OS 8.0 | PAN-OS 8.1 | PAN-OS 9.0 | PAN-OS 9.1 |
|--|------------|------------|------------|------------|------------|
| Security | | | | | |
| App-ID and firewalls in Layer 2 and Layer 3 | ✓ | ✓ | ✓ | ✓ | ✓ |
| User-ID | ✓ | ✓ | ✓ | ✓ | ✓ |
| Content-ID | ✓ | ✓ | ✓ | ✓ | ✓ |
| Block IPv6 in IPv4 tunneling (via App-ID) | ✓ | ✓ | ✓ | ✓ | ✓ |
| Zone protection | ✓ | ✓ | ✓ | ✓ | ✓ |
| Packet-based attack protection | — | ✓ | ✓ | ✓ | ✓ |
| Reconnaissance protection | ✓ | ✓ | ✓ | ✓ | ✓ |
| URL filtering | ✓ | ✓ | ✓ | ✓ | ✓ |
| SSL decryption | ✓ | ✓ | ✓ | ✓ | ✓ |
| SSH decryption | ✓ | ✓ | ✓ | ✓ | ✓ |
| DoS rulebase | ✓ | ✓ | ✓ | ✓ | ✓ |
| IPv6 access to PAN-DB | ✓ | ✓ | ✓ | ✓ | ✓ |
| DNS Sinkhole | ✓ | ✓ | ✓ | ✓ | ✓ |
| External Dynamic List (EDL) | ✓ | ✓ | ✓ | ✓ | ✓ |
| Management and Panorama | | | | | |
| SSH management (dedicated MGT port) | ✓ | ✓ | ✓ | ✓ | ✓ |
| Web interface management (dedicated MGT port) | ✓ | ✓ | ✓ | ✓ | ✓ |
| Interface management (ping, Telnet, SSH, HTTP, HTTPS: all ports) | ✓ | ✓ | ✓ | ✓ | ✓ |
| Device to Panorama SSL TCP connection | ✓ | ✓ | ✓ | ✓ | ✓ |
| Panorama HA connection between peers | — | ✓ | ✓ | ✓ | — |
| DNS | ✓ | ✓ | ✓ | ✓ | ✓ |

| PAN-OS FEATURE | PAN-OS 7.1 | PAN-OS 8.0 | PAN-OS 8.1 | PAN-OS 9.0 | PAN-OS 9.1 |
|---|------------|------------|------------|------------|------------|
| Dynamic DNS support for firewall interfaces (DHCP-based interfaces) | — | — | — | ✓ | ✓ |
| RADIUS | ✓ | ✓ | ✓ | ✓ | ✓ |
| LDAP | ✓ | ✓ | ✓ | ✓ | ✓ |
| SYSLOG | ✓ | ✓ | ✓ | ✓ | ✓ |
| SNMP | ✓ | ✓ | ✓ | ✓ | ✓ |
| NTP | ✓ | ✓ | ✓ | ✓ | ✓ |
| Device DNS (device only) | ✓ | ✓ | ✓ | ✓ | ✓ |
| DNS proxy | ✓ | ✓ | ✓ | ✓ | ✓ |
| Reporting and visibility into IPv6 | ✓ | ✓ | ✓ | ✓ | ✓ |
| IPv6 address objects | ✓ | ✓ | ✓ | ✓ | ✓ |
| IPv6 FQDN address objects | ✓ | ✓ | ✓ | ✓ | ✓ |
| Networking | | | | | |
| IPv6 static routes | ✓ | ✓ | ✓ | ✓ | ✓ |
| PBF | ✓ | ✓ | ✓ | ✓ | ✓ |
| PBF next hop monitor (v6 endpoint) | | | | | |
| | ✓ | ✓ | ✓ | ✓ | ✓ |
| OSPFv3 | ✓ | ✓ | ✓ | ✓ | ✓ |
| MP-BGP | — | ✓ | ✓ | ✓ | ✓ |
| GRE tunneling support | — | — | — | ✓ | ✓ |
| ECMP | ✓ | ✓ | ✓ | ✓ | ✓ |
| Dual stack support for L3 interfaces | ✓ | ✓ | ✓ | ✓ | ✓ |
| QoS policy | ✓ | ✓ | ✓ | ✓ | ✓ |
| QoS marking | ✓ | ✓ | ✓ | ✓ | ✓ |
| DSCP (session based) | ✓ | ✓ | ✓ | ✓ | ✓ |
| Neighbor discovery and duplicate address detection | ✓ | ✓ | ✓ | ✓ | ✓ |
| Tunnel content inspection | — | ✓ | ✓ | ✓ | ✓ |
| Virtual wires | ✓ | ✓ | ✓ | ✓ | ✓ |
| NPTv6 (stateless prefix translation) | ✓ | ✓ | ✓ | ✓ | ✓ |
| NAT64 (IP-IPv6 protocol translation) | ✓ | ✓ | ✓ | ✓ | ✓ |

| PAN-OS FEATURE | PAN-OS 7.1 | PAN-OS 8.0 | PAN-OS 8.1 | PAN-OS 9.0 | PAN-OS 9.1 |
|--|------------|------------|------------|------------|------------|
| Link Layer Discovery Protocol (LLDP) | ✓ | ✓ | ✓ | ✓ | ✓ |
| Bidirectional Forwarding Detection | ✓ | ✓ | ✓ | ✓ | ✓ |
| VPN | | | | | |
| GlobalProtect | — | ✓ | ✓ | ✓ | ✓ |
| IKE/IPsec | ✓ | ✓ | ✓ | ✓ | ✓ |
| IKEv2 | ✓ | ✓ | ✓ | ✓ | ✓ |
| IPv6 over IPv4 IPsec tunnel | ✓ | ✓ | ✓ | ✓ | ✓ |
| Large Scale VPN (LSVPN) | — | ✓ | ✓ | ✓ | ✓ |
| Host Dynamic Address Configuration | | | | | |
| DHCPv6 relay | ✓ | ✓ | ✓ | ✓ | ✓ |
| SLAAC (router advertisements) | ✓ | ✓ | ✓ | ✓ | ✓ |
| SLAAC (router preference) | ✓ | ✓ | ✓ | ✓ | ✓ |
| SLAAC (RDNSS) | — | ✓ | ✓ | ✓ | ✓ |
| Device | | | | | |
| High Availability (HA) - active/active | ✓ | ✓ | ✓ | ✓ | ✓ |
| High Availability (HA) - active/passive | ✓ | ✓ | ✓ | ✓ | ✓ |
| High Availability (HA): IPv6 transport for HA1 and HA2 | ✓ | ✓ | ✓ | ✓ | ✓ |
| High Availability (HA) path monitoring (IPv6 Endpoint) | ✓ | ✓ | ✓ | ✓ | ✓ |
| User-ID | | | | | |
| Map IPv6 address to users | ✓ | ✓ | ✓ | ✓ | ✓ |
| Captive Portal for IPv6 | ✓ | ✓ | ✓ | ✓ | ✓ |
| Connection to User-ID agents over IPv6 | ✓ | ✓ | ✓ | ✓ | ✓ |
| User-ID XML API for IPv6 | ✓ | ✓ | ✓ | ✓ | ✓ |

| PAN-OS FEATURE | PAN-OS 7.1 | PAN-OS 8.0 | PAN-OS 8.1 | PAN-OS 9.0 | PAN-OS 9.1 |
|-----------------------------|------------|------------|------------|------------|------------|
| Terminal Servers agent IPv6 | ✓ | ✓ | ✓ | ✓ | ✓ |

Sample Questions

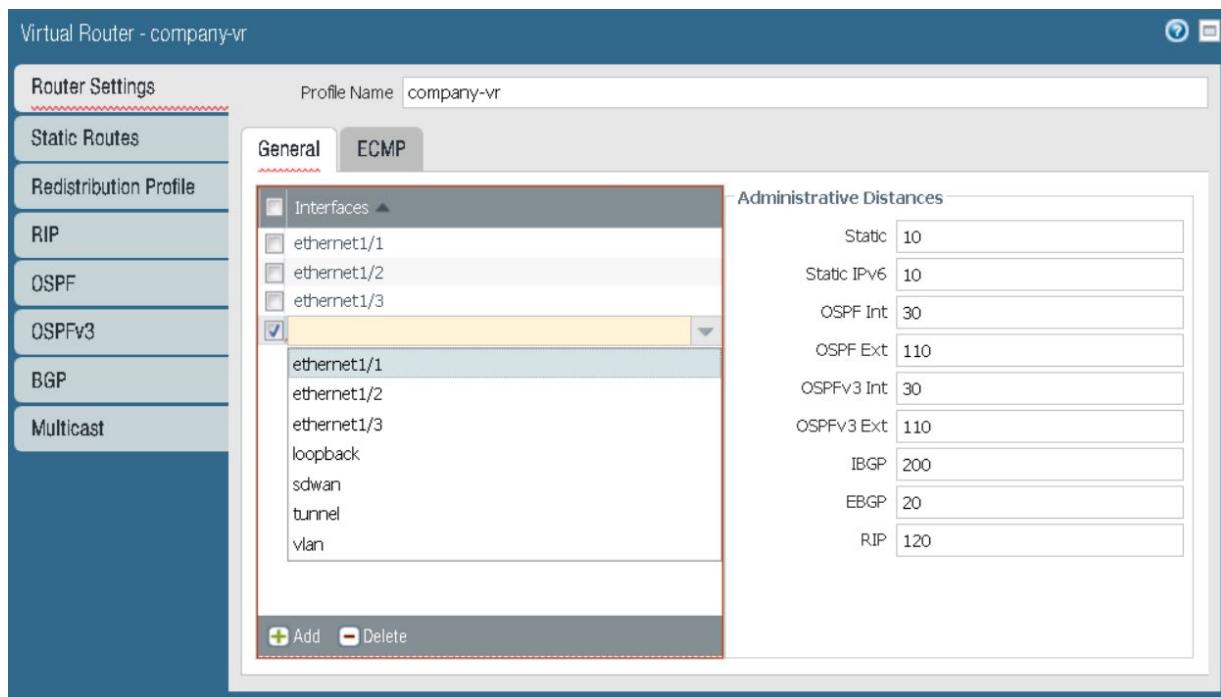
98. Which two configuration conditions must be met for a firewall to NAT between IPv4 and IPv6?
(Choose two.)
- A. select **NAT64** in the **Session** tab under **Device > Setup > Session**
 - B. choose the **NAT Type** of **nat64** in the **General** tab of a NAT policy rule
 - C. add an IPv6 addresses to the **Translated Packet** tab
 - D. add an IPv6 prefix in the nat64 configuration in the NAT policy rule
99. Which two configuration conditions must be met for a Palo Alto Networks firewall to send and receive IPv6 traffic? (Choose two.)
- A. **Enable IPv6** check box in the virtual router configuration is checked.
 - B. An Ethernet interface is configured for virtual wire.
 - C. An Ethernet interface is configured for Layer 3.
 - D. **Enable IPv6 Firewalling** check box under **Session Settings** is turned on.

2.13 Identify how to configure a virtual router

Routing Configuration

PAN-OS software supports static routes, BGP, OSPF, RIP, and multicast routing configured in the virtual router. There are limitations for the number of entries in the forwarding tables (FIBs) and routing tables (RIBs).

Different platform levels also can support varying numbers of virtual routers. The virtual router configuration is meant to match the existing routing infrastructure. In addition to protocol configuration, Redistribution Profiles can support protocol interoperability.



Virtual Router - company-vr

Router Settings

Static Routes

Redistribution Profile

RIP

OSPF

OSPFv3

BGP

Multicast

IPv4

Virtual Router - Static Route - IPv4

Name: default-route
Destination: 0.0.0.0/0
Interface: ethernet1/1
Next Hop: IP Address
203.0.113.1
Admin Distance: 10 - 240
Metric: 10
Route Table: Unicast
BFD Profile: Disable BFD

Path Monitoring

Failure Condition: Any All Preemptive Hold Time (min): 2

| Name | Enable | Source IP | Destination IP | Ping Interval(sec) | Ping Count |
|------|--------|-----------|----------------|--------------------|------------|
| | | | | | |

Add **Delete**

Virtual Router - company-vr

Router Settings

Enable Reject Default Route

Router ID: 10.193.20.178

BFD: None

Areas **Auth Profiles** **Export Rules** **Advanced**

| Area ID | Authentication | Type | Range | Interface |
|---------|----------------|--------|-------|-------------|
| 0.0.0.0 | | normal | | ethernet1/3 |

Add **Delete**

| Name | Interfaces | Configuration | RIP | OSPF | OSPFv3 | BGP | Multicast | Runtime Stats |
|------------|---|---|-----|------|--------|-----|-----------|------------------------------------|
| company-vr | ethernet1/1 ethernet1/2 ethernet1/3 | Static Routes: 1 ECMP status: Disabled | | | | | | More Runtime Stats |

A discussion of virtual routers and each of the supported dynamic routing protocols is here:
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-web-interface-help/network/network-virtual-routers.html>

Troubleshooting Routing

The CLI has advanced troubleshooting of routing functions. Output from the **debug routing ...** command provides insight into router processing, including advanced debugging logs and routing-specific packet captures.

Sample Questions

100. Under which condition can Layer 3 interfaces in the same firewall have the same IP address?
 - A. They must be connected to different virtual routers.
 - B. They must be connected to the same Ethernet network through a switch.
 - C. They must be subinterfaces of the same physical interface.
 - D. They must be in different zones.

101. How do two virtual routers on a firewall forward traffic to each other?
- A. Virtual router traffic is sent to an external router that routes it back to the second virtual router.
 - B. Both virtual routers pass traffic via a dedicated VLAN routing interface.
 - C. Both virtual routers pass traffic via a configurable shared routing interface.
 - D. Virtual routers forward traffic directly to each other within the firewall using routing table lookups.
102. A firewall's virtual router can connect to which three types of interfaces? (Choose three.)
- A. virtual wire
 - B. management
 - C. Layer 3 traffic
 - D. HA1
 - E. HA2
 - F. loopback
 - G. tunnel

2.14 Given a scenario, identify how to configure an interface as a DHCP relay agent

DHCP Overview

Dynamic Host Configuration Protocol (DHCP) is a network management protocol used on IP networks where a DHCP server dynamically assigns an IP address and other network configuration parameters to subscribing devices on a network so they can communicate with other IP networks.

DHCP operates in a client-server model where a client broadcasts a DHCP request that then is responded to by the server with previously configured settings. Because the service communication uses network broadcasts, a DHCP server can receive client requests from the local network segment only; DHCP queries normally cannot transit through a router to another network segment.

DHCP and DHCP Relay on the Firewall

A Palo Alto Networks firewall can function as a DHCP server on assigned interfaces. Interfaces also can be configured to listen for DHCP broadcasts and forward them (relay) to other network segments, thus bypassing the broadcast limitation of DHCP. This feature ensures that a client needing DHCP services can find them even when connected on other network segments.

Before you can enable a firewall interface to transmit DHCP messages between clients and servers, you must configure the firewall as a DHCP relay agent. The interface can forward messages to a maximum of eight external IPv4 DHCP servers and eight external IPv6 DHCP servers. A client DHCPDISCOVER message is sent to all configured servers, and the DHCPOFFER message of the first server that responds is relayed back to the requesting client.

Before you can configure a DHCP relay agent, make sure that you have configured a Layer 3 Ethernet or Layer 3 VLAN interface, and that the interface is assigned to a virtual router and a zone.

1. Select **DHCP Relay**.

Select **Network > DHCP > DHCP Relay**.

2. Specify the IP address of each DHCP server with which the DHCP relay agent will communicate.

- In the **Interface** field, select the interface you want to be the DHCP relay agent.
- Select either **IPv4** or **IPv6**, which indicates the type of DHCP server address you will specify.
- If you checked **IPv4**, in the **DHCP Server IP Address** field, **Add** the address of the DHCP server to and from which you will relay DHCP messages.
- If you checked **IPv6**, in the **DHCP Server IPv6 Address** field, **Add** the address of the DHCP server to and from which you will relay DHCP messages. If you specify a multicast address, also specify an outgoing **Interface**.
- (Optional) Repeat the steps in the prior three sub-bullets to enter a maximum of eight DHCP server addresses per IP address family.

3. Commit the configuration.

Click **OK** and **Commit**.

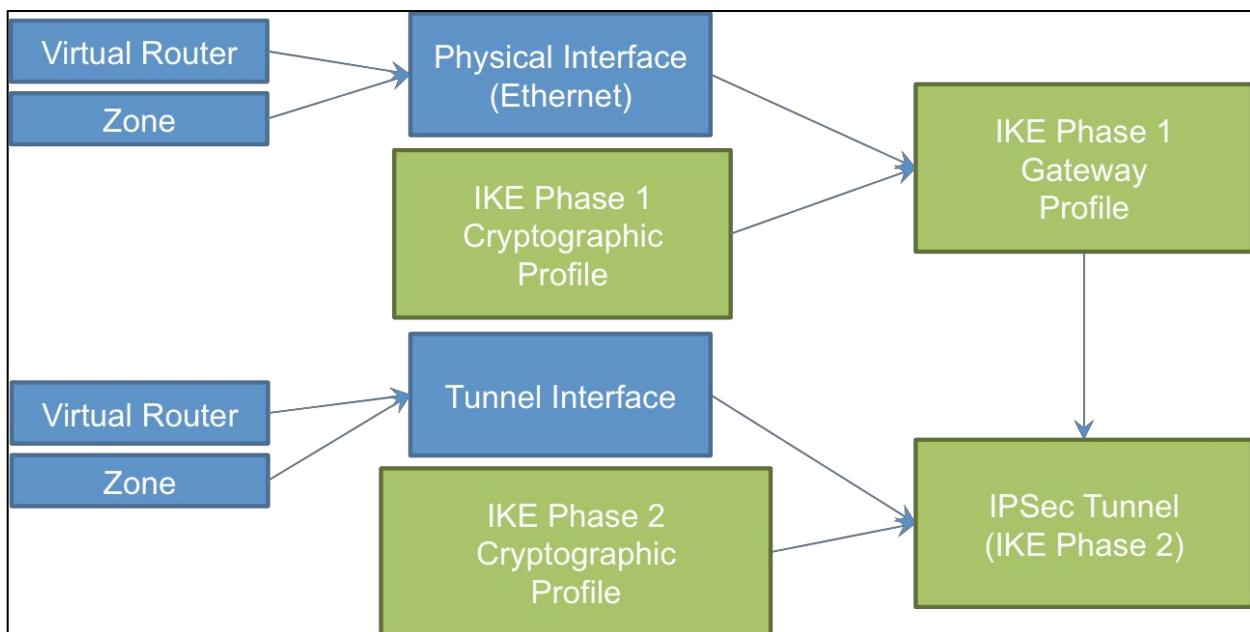
Sample Questions

103. A Palo Alto Networks firewall can forward DHCP packets to servers connected to which two kinds of networks? (Choose two.)
- A. virtual wire
 - B. Layer 2
 - C. Layer 3
 - D. aggregate
104. How does a Palo Alto Networks firewall configured to forward DHCP packets to multiple server destinations choose which reply to forward to the sender?
- A. The first server listed in the “Server Priority” DHCP configuration is forwarded until it fails to respond, then the next one is chosen.
 - B. A request is sent to all servers on the list, and the first responder is forwarded.
 - C. All DHCP server responses are forwarded, and the receiving client chooses which to accept.
 - D. The server that is the fewest network hops from the requesting client is chosen. When more than one server has the same hop count, all packets from the servers are forwarded to the client.

2.15 Identify the configuration settings for site-to-site VPN

IPsec Tunnel Interfaces

IPsec VPNs are terminated on Layer 3 tunnel interfaces. (These tunnel interfaces can be put into separate zones, thus allowing specific Security policy per zone.) These tunnels require IPsec and Crypto Profiles for Phase 1 and Phase 2 connectivity. PAN-OS software supports route-based VPNs, which means that the decision to route traffic through the VPN is made by the virtual router. Palo Alto Networks firewalls support connection to alternate policy-based VPNs requiring the use of proxy IDs for compatibility. The following figure shows the various objects involved in IPsec tunnel definitions.



A complete discussion of required settings is found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/vpns/set-up-site-to-site-vpn>

CLI Troubleshooting Commands

The CLI has **test** and **debug** commands for additional troubleshooting required for configuring and maintaining one or more tunnels. VPN events including errors are posted to the System log. The message quality is more thorough when the firewall is the recipient of VPN negotiation requests from other endpoints.

Sample Questions

105. In a site-to-site VPN configuration, what is an alternate method to the use of pre-shared keys to authenticate each device during connection setup?
- A. certificates
 - B. expected IP address of the partner's interface
 - C. known hexadecimal string configured in both endpoints
 - D. matching proxy ID definitions configured in both endpoints

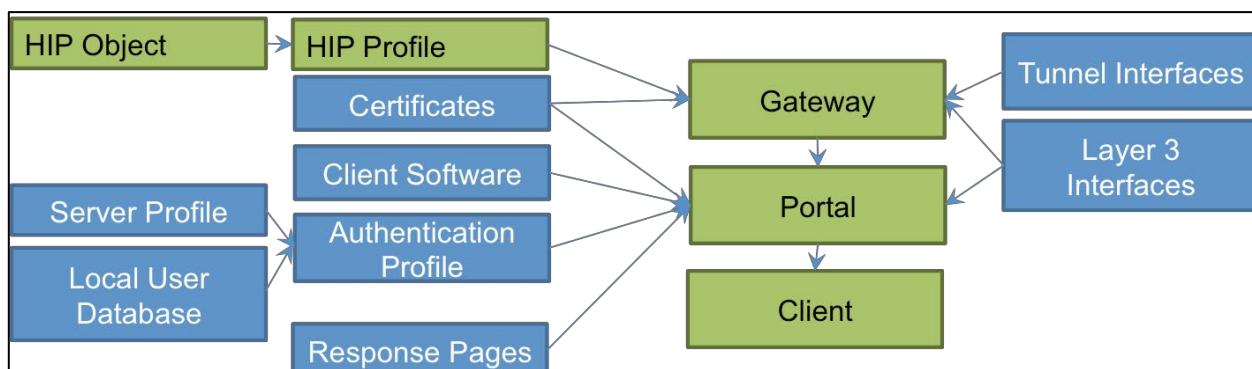
106. Which type of firewall interface can be associated with a tunnel interface?
- A. tap
 - B. virtual wire
 - C. Layer 2
 - D. Layer 3
107. A firewall administrator is deploying 50 Palo Alto Networks firewalls to protect remote sites. Each firewall must have a site-to-site IPsec VPN tunnel to each of three campus locations. Which configuration function is the basis for automatic site-to-site IPsec tunnels set up from each remote location to the three campuses?
- A. import of a settings table into the remote firewall's IPsec tunnel config
 - B. import of a settings table into the IPsec tunnel config of the three campuses
 - C. configuration of the GlobalProtect satellite settings of the campus and remote firewalls
 - D. entry of campus IPsec tunnel settings for each remote firewall's IPsec Profile

2.16 Identify the configuration settings for GlobalProtect

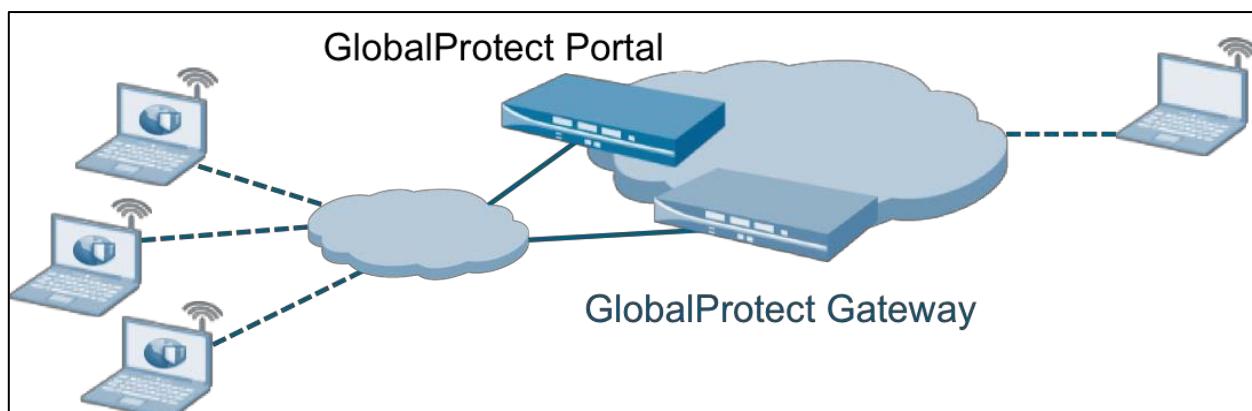
GlobalProtect Overview

GlobalProtect solves the security challenges of roaming users by extending the same next-generation firewall-based policies that are enforced within the physical perimeter to all users, no matter where they are located. GlobalProtect uses client software to build secure personal VPN tunnels to the firewall.

GlobalProtect comprises many different components. An understanding of those basic components is the starting point for a successful deployment. The GlobalProtect Portal performs the initial authentication of a client, downloads and upgrades the GlobalProtect client, performs a host information profile (HIP) check (if licensed), and provides a list of GlobalProtect Gateways for user traffic. The GlobalProtect Portal must be enabled on a Layer 3 or loopback interface with a reachable IP address. The GlobalProtect Gateway creates and maintains the VPN tunnels for user traffic in SSL or IPsec forms. The GlobalProtect Gateway distributes an IP address to each authenticated user. (This IP address-to-username mapping can be used for effective User-ID in Security policy.) A figure of the configuration elements follows:



Every Palo Alto Networks firewall can provide GlobalProtect connectivity support to Windows and Mac clients with no additional license requirement. Client software can be downloaded directly from the Portal.



Gateway traffic (SSL or IPsec encryption) can be terminated on a tunnel interface in a separate zone, which allows for specific policies to be enabled for that zone and user(s).

If you have the appropriate license, HIP checks can be performed by GlobalProtect agent software on the client platforms at connect time. The HIP Profile includes the OS version, patches installed, firewall and antivirus parameters, the process list, the registry, and other information that is useful to assess the security of an endpoint.

HIP Object

General

Configuration

Profile Name: [Yellow Box]

Description:

Host Info

| | |
|----------------|------|
| Managed | None |
| Domain | None |
| OS | None |
| Client Version | None |
| Host Name | None |
| Host ID | None |
| Serial Number | None |

Mobile Device Network Info

Network: None

This match criteria applies to mobile devices only.

The firewall can extract information from these reports and use them as part of the Security policy. In this way the firewall provides appropriate access, depending on endpoint configuration.

HIP fields are used to define HIP objects. For example, a HIP object might apply to all devices using Android 5.0, or all Samsung devices using Android 6.0.

| Name | Location | Category | Criteria | Vendor | Description |
|-------------|----------|-----------|-----------------------------------|---------------------|-------------|
| Android 5.0 | | host-info | os contains Google Android 5.0 | | |
| Android 6.0 | | host-info | os contains Google Android 6.0 | model contains S... | |

GlobalProtect Gateway license required for feature to function

These HIP objects then are used in HIP Profiles.

The screenshot shows the Palo Alto Networks GlobalProtect Admin interface. The left sidebar has a tree view with 'GlobalProtect' expanded, showing 'HIP Objects' and 'HIP Profiles'. The main pane displays a table titled 'HIP Profiles' with one item listed:

| Name | Location | Match | Description |
|-----------------|----------|--------------------------------|-------------|
| Allowed Android | | "Android 5.0" or "Android 6.0" | |

Below the table are buttons for 'Add', 'Delete', and 'Clone'. A note at the bottom states 'GlobalProtect Gateway license required for feature to function'. The bottom navigation bar shows 'admin | Logout | Last Login Time: 05/16/2018 16:50:20' and 'Tasks | Language'.

These HIP Profiles then can be required by Security policy rules:

The screenshot shows the 'Security Policy Rule' dialog with the 'Destination' tab selected. There are two dropdown menus: 'Source User' (set to 'any') and 'HIP Profiles' (set to 'any'). A large green arrow points from the text above to the 'HIP Profiles' dropdown. At the bottom are 'OK' and 'Cancel' buttons.

References

A discussion of GlobalProtect with links to configuration specifics can be found here:

<https://docs.paloaltonetworks.com/globalprotect/9-1/globalprotect-admin/globalprotect-overview>

HIP checking implementation and use is explored in detail here:

<https://docs.paloaltonetworks.com/globalprotect/9-1/globalprotect-admin/host-information/about-host-information>

Sample Questions

108. Which GlobalProtect configuration component contains the setting that specifies when the agent software starts on the client system?
 - A. Agent settings in the GlobalProtect Portal settings
 - B. General settings in the GlobalProtect Portal settings
 - C. Agent settings of the GlobalProtect Gateway
 - D. General settings of the GlobalProtect Gateway
109. Which configuration or service is required for an iOS device using the Global Protect license to connect to a Global Protect Gateway?
 - A. X-Auth configuration in the gateway settings
 - B. GlobalProtect Gateway license
 - C. firewall Authentication policy with an iOS setting
 - D. GlobalProtect client downloaded from the GlobalProtect Portal
110. A GlobalProtect Gateway is solely responsible for which function?
 - A. terminating SSL tunnels
 - B. authenticating GlobalProtect users
 - C. creating on-demand certificates to encrypt SSL
 - D. managing and updating GlobalProtect client configurations
 - E. managing GlobalProtect Gateway configurations

2.17 Identify how to configure items pertaining to denial-of-service protection and zone protection

See 1.15 Given a scenario, identify ways to mitigate resource exhaustion (because of denial-of-service) in application servers

2.18 Identify how to configure features of NAT policy rules

Network address translation (NAT) allows the organization to use internal IP addresses that are not exposed to the internet. NAT rules are based on source and destination zones, source and destination address, and application service (such as HTTP). As is the case with Security policy rules, NAT policy rules are compared against incoming traffic in sequence, and the first rule that matches the traffic is applied.

Reference

- Policies > NAT
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-web-interface-help/policies/policies-nat>

Sample Questions

111. Which two source address translation types can use a single IP address to NAT multiple IP addresses? (Choose two.)
 - A. Static IP
 - B. Dynamic IP
 - C. Dynamic IP and Port
 - D. Translated Address
 - E. Address Override
112. Which NAT type can be used to translate between IPv4 and IPv6?
 - A. ipv4
 - B. nat64
 - C. nptv6
 - D. ipv6
113. How does a firewall process a packet that has more than one NAT policy rule that matches the packet?
 - A. Each matching rule in the list is applied from the top down, with cumulative changes being processed at the end of the list.
 - B. The first rule matching the packet is applied and processed, skipping the others.
 - C. The firewall issues an error when committing NAT policy rules that can affect the same packet.
 - D. The last matching rule in the list is applied and processed.

2.19 Given a configuration example including DNAT, identify how to configure security rules

A Security policy allows you to enforce rules and actions and can be as general or specific as needed. The policy rules are compared against the incoming traffic in sequence, and because the first rule that matches the traffic is applied, the more specific rules must precede the more general ones. For example, a rule for a single application must precede a rule for all applications if all other traffic-related settings are the same.

Reference

- Policies > Security

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-web-interface-help/policies/policies-security.html>

Sample Questions

114. A server on the DMZ with a private NIC address has network access provided by a NAT policy rule whose **Bi-directional** check box is selected in the **Translated Packet** settings for static IP source address translation. Which Security policy rule must be created to allow bidirectional traffic to and from the DMZ server?
 - A. a rule for each direction of travel using the pre-NAT server IP address
 - B. a rule with the post-NAT source IP address
 - C. a rule for each direction of travel using the post-NAT server IP address
 - D. a rule with the pre-NAT source IP address
115. An internal web browser sends a packet to a server. The browser's connection has the source IP address 192.168.5.3, port 31415. The destination is 209.222.23.245, port 80. The firewall translates the source to 75.22.21.54, port 27182. Which three of these source IP addresses would cause a NAT policy rule to apply to this traffic? (Choose three.)
 - A. 192.168.5.0/24
 - B. 75.22.21.0/24
 - C. 192.168.4.0/23
 - D. 192.168.0.0/16
 - E. 75.22.0.0/17
 - F. 75.22.128.0/17

116. A NAT policy rule is created to change the destination address of any packets with a source of any address and a destination address of 10.10.10.10 (in the DMZ zone) to 192.168.3.45 (in the Trust zone). Which Security policy rule components are required for a packet that has this rule applied to match and allow this traffic?
- A. source address any, source zone any, destination address 192.168.3.45, destination zone Trust, action = allow
 - B. source address any, source zone any, destination address 10.10.10.10, destination zone Trust, action = allow
 - C. source address any, source zone any, destination address 192.168.3.45, destination zone DMZ, action = allow
 - D. source address any, source zone any, destination address 10.10.10.10, destination zone DMZ, action = allow

2.20 Identify how to configure decryption

You can configure the firewall to decrypt traffic for visibility, control, and granular security. Decryption policy rules can apply to Secure Sockets Layer (SSL) including SSL encapsulated protocols (such as IMAP(S), POP3(S), SMTP(S), FTP(S)) and to Secure Shell (SSH) traffic. SSH decryption can be used to decrypt outbound and inbound SSH traffic to assure that secure protocols are not being used to tunnel disallowed applications and content.

A Palo Alto Networks firewall also can act as a Decryption Broker for other external security services. This feature will decrypt traffic and forward it out of the selected interface to a specific security device or service (or chain of devices) that examines the cleartext traffic. The last service in the chain returns the packet to the firewall, which then encrypts it and forward it to the original destination.

Information about the use and configuration of this capability can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/decryption/decryption-broker/decryption-broker-concepts>

Special Decryption Implementations

Palo Alto Networks firewalls also can automatically send a copy of decrypted traffic to a specified interface using the Decryption Mirroring feature. This option is available at no cost to midrange and high-end firewalls that automatically forward copies of decrypted traffic to external DLP products. A description of this feature can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/decryption/decryption-concepts/decryption-mirroring.html>

Sample Questions

117. Which protocol is supported for traffic decryption matching a Decryption policy rule?
 - A. IPsec
 - B. SP3
 - C. SSH
 - D. NLSP
118. Where do you specify that a certificate is to be used for SSL Forward Proxy?
 - A. Certificate properties
 - B. Decryption Profile
 - C. Decryption policy
 - D. Security policy
119. Which feature must be configured to exclude sensitive traffic from decryption?
 - A. Security policy rule that includes the specific URL with an “allow” action
 - B. Decryption policy rule with the specific URL and “no decrypt” action
 - C. Application Override policy that matches the application URL and port number
 - D. Decryption Profile that includes the site’s URL

2.21 Given a scenario, identify an application override configuration and use case

To change how the firewall classifies network traffic into applications, you can specify Application Override policy rules. These policy rules attach the specified App-ID to matching traffic and bypass the normal App-ID processing steps in the firewall. This assigned application functions identically to an App-ID supplied application name and can be used in the same way. For example, if you want to control one of your custom applications, you can use an Application Override policy to identify traffic for that application according to zone, source, and destination address, port, and protocol. After an Application Override rule has assigned a custom application name to network traffic, that traffic can be controlled by the firewall through use of the custom application name in a Security policy rule.

Note that the App-ID bypass characteristic of Application Override also skips essential Content-ID processing, which could result in undetected threats. This feature should be used for trusted traffic only.

References

- Policies > Application Override
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-web-interface-help/policies/policies-application-override.html>
- Objects > Applications
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-web-interface-help/objects/objects-applications/defining-applications>

Sample Questions

120. Which option is not a parameter used to identify applications in an Application Override policy?
 - A. protocol
 - B. port number
 - C. first characters in the payload
 - D. destination IP address
121. How does the firewall resolve conflicting App-ID assignments to the same traffic between an Application Override policy rule and the firewall's built-in App-ID?
 - A. The firewall's regular App-ID is assigned.
 - B. The Application Override's App-ID is assigned.
 - C. The App-ID is set to **duplicate definitions**.
 - D. The App-ID is set to **not available**.
122. Which firewall process is bypassed when an Application Override policy matches traffic and assigns an App-ID?
 - A. QoS
 - B. IPsec
 - C. Content-ID
 - D. User-ID

2.22 Identify how to configure VM-Series firewalls for deployment

The VM-Series of virtual firewalls can be deployed to several public and private cloud technologies. Each environment has different deployment characteristics and requirements. Some require the uploading of the firewall's virtual appliance. Others provide it in an "Application Store" that is provisioned and configured.

Regardless of the deployed environment, every VM-Series firewall runs the same PAN-OS software. Some environments have specific limits and requirements (i.e., supported interface types).

Supported virtual technologies are outlined here:

<https://docs.paloaltonetworks.com/compatibility-matrix/vm-series-firewalls>

Details for implementation in each of these environments and a review of their specific requirements and limitations are here:

<https://docs.paloaltonetworks.com/vm-series/9-1/vm-series-deployment.html>

Sample Questions

123. Which virtual interface is used for management on a VM-Series firewall running on ESXi?
 - A. vNIC #1
 - B. vNIC #2
 - C. vNIC #9
 - D. vNIC #10
124. Which three items of information are required at a minimum to install and configure VM-Series firewalls? (Choose three.)
 - A. VLANs to be connected through the firewall
 - B. management port IP address
 - C. IP addresses for the data interfaces
 - D. management port default gateway
 - E. management port netmask
 - F. IP address for the external (internet-facing) interface
125. Compared to a physical firewall, VM-Series firewalls require you to apply which additional license?
 - A. Base Capacity
 - B. Cloud Services
 - C. Site License
 - D. VM Update
126. A VM-Series firewall being deployed in Azure can be automatically configured by bootstrapping. Azure requires which features for Bootstrapping to work?
 - A. Storage Account configured for Azure Files Service
 - B. PowerShell script that feeds a configuration file to the firewall
 - C. XML configuration file included in the base firewall provisioning
 - D. Azure Backup services configured with a config file and included in the firewall provisioning

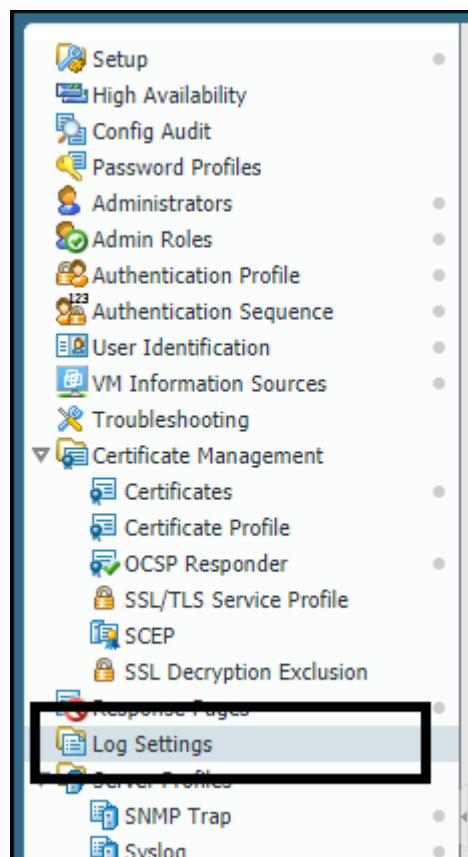
2.23 Identify how to configure firewalls to use tags and filtered log forwarding for integration with network automation

Log Forwarding, Filtering, and Tagging

The Palo Alto Networks firewall contains several important features to identify log events of interest and to forward the events in various formats to outside monitoring technology. The firewall also can extract IP addresses from the events and add tags to them, which could then include them in Dynamic Address Groups managed by the firewall. These groups can be used in Security policy rules to provide a higher level of security treatment.

Filtering and Forwarding Log Events

The Palo Alto Networks firewall has two primary methods to forward log events, depending on the log message type. Events associated with examined traffic use Log Forwarding Profiles. Events generally related to non-traffic specific firewall activity (e.g. Authentication, System, and HIP Match) can be filtered and forwarded using **Log Settings**. Navigate to **Device > Log Settings**.



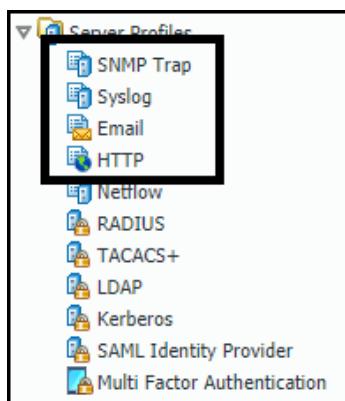
Log Forwarding Profiles can be used to filter and forward logs from the following firewall logs:

- Traffic
- Threat
- Tunnel
- URL Filtering
- WildFire Submissions
- Authentication
- Data Filtering

Log forwarding of any event type can send copies of log events to external destinations supporting the following data formats:

- SNMP
- Email
- Syslog
- HTTP

Each log forwarding destination is configured in the firewall with a Server Profile of the appropriate type. Navigate to **Device > Server Profiles** and create a profile for each specific destination.



After the destination's Server Profile is created, it can be used in a Log Forwarding Profile.

Log Forwarding Profiles

To maximize the efficiency of your incident response and monitoring operations, you now can create custom log forwarding filters based on any log attributes (such as threat type or source user). Instead of forwarding all logs or all logs of specific severity levels, you can use the filters to forward only the information you want to monitor or act on. For example, a security operations analyst that investigates malware attacks might be interested only in Threat logs with the type attribute set to wildfire-virus.

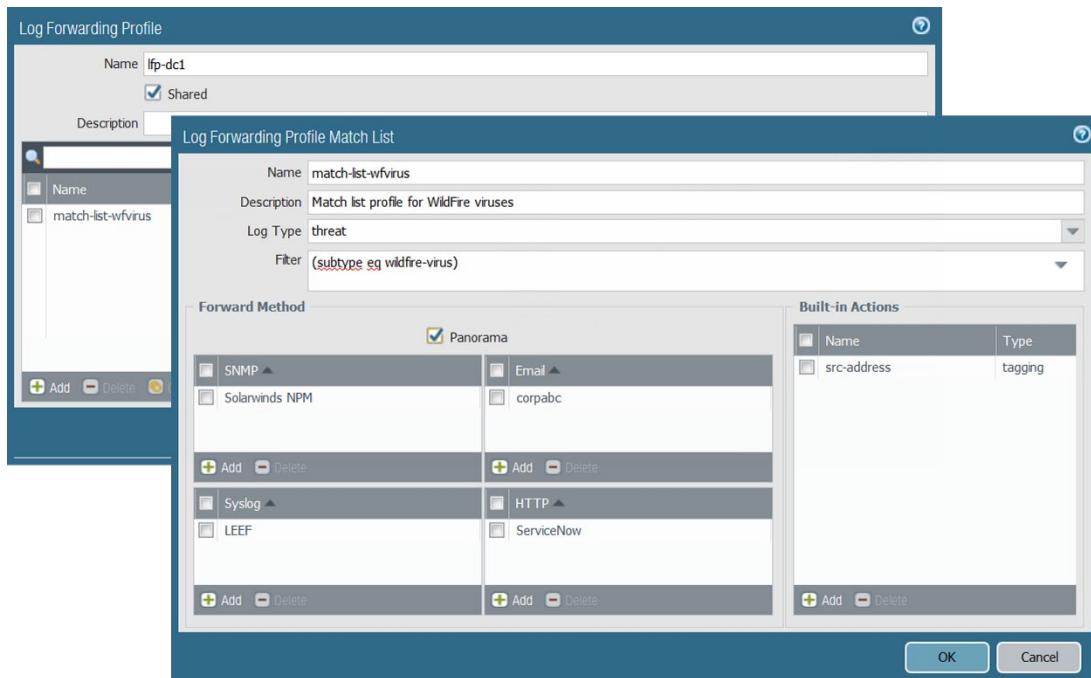
Steps:

1. Configure a Server Profile for each external service that will receive logs from the firewall. The profiles define how the firewall connects to the services.

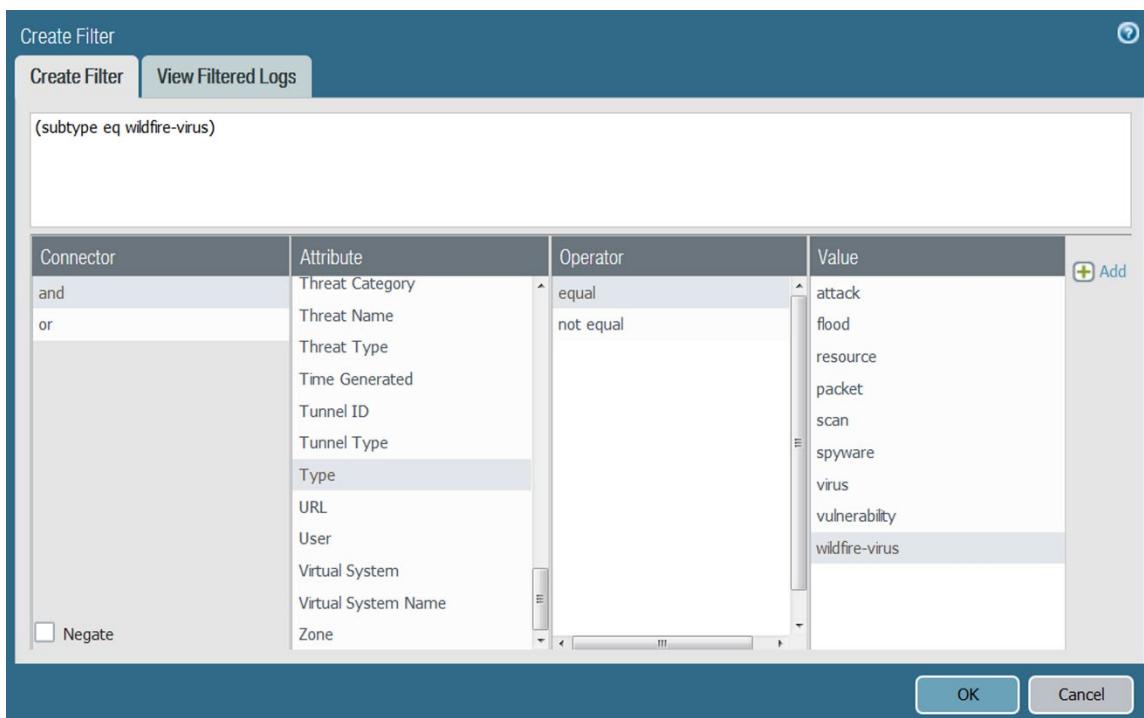
For example, to configure an HTTP Server Profile, select **Device > Server Profiles > HTTP** and **Add** the profile.

- Select **Objects > Log Forwarding** and **Add** a Log Forwarding Profile to define the destinations for Traffic, Threat, WildFire Submissions, URL Filtering, Data Filtering, Tunnel, and Authentication logs.

In each Log Forwarding profile, **Add** one or more match list profiles to specify log query filters, forwarding destinations, and automatic actions such as tagging.



In each match list profile, select **Filter > Filter Builder** and **Add** filters based on log attributes.



- Assign the Log Forwarding profile to policy rules and network zones.

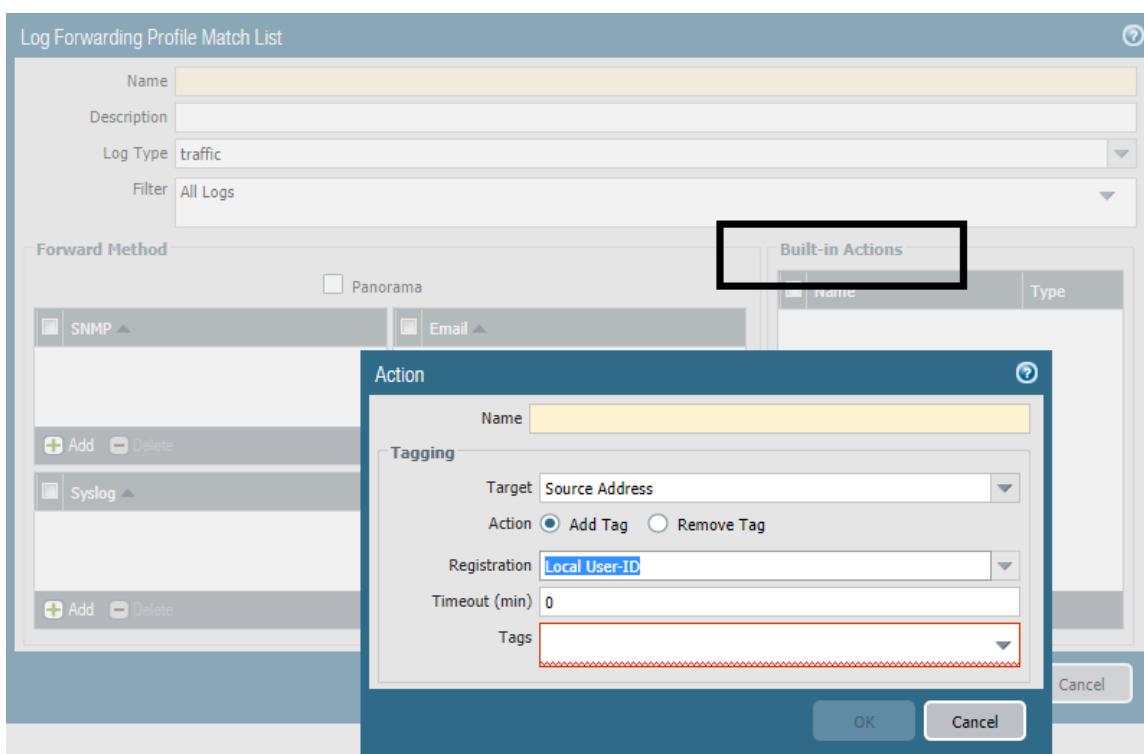
The firewall generates and forwards logs based on traffic that matches the rules and zones.

Security, authentication, and DoS protection rules support log forwarding. For example, to assign the profile to a Security rule, select **Policies > Security**, edit the rule, select **Actions**, and select the **Log Forwarding** profile you created.

- Select **Device > Log Settings** and configure the destinations for System, Configuration, User-ID, HIP Match, IP-Tag, and Correlation logs. For each log type that the firewall will forward, **Add** one or more match list profiles as you did in the Log Forwarding Profile.
- Commit** your changes.

Automated Actions and Tagging with Log Forwarding

Log Forwarding Profiles also provide a mechanism to collect the source or destination IP address of the event and tag it. The tag then can be used to assign the address to a Dynamic Address Group that is used in a Security policy rules.



Add the action to perform.

Add or remove a tag to the source or destination IP address in a log entry automatically and register the IP address and tag mapping to a User-ID agent on the firewall or Panorama, or to a remote User-ID agent so that you can respond to an event and dynamically enforce Security policy. The ability to tag an IP address and dynamically enforce policy using Dynamic Address Groups gives you better visibility, context, and control for consistently enforcing Security policy irrespective of where the IP address moves across your network.

Configure the following settings:

- Add an action and enter a name to describe it.
- Select the target IP address you want to tag: **Source Address** or **Destination Address**. You can take an action for all log types that include a source or destination IP address in the log entry. You can tag the source IP address only, in Correlation logs and HIP Match logs; you cannot configure an action for System logs and Configuration logs because the log type does not include an IP address in the log entry.
- Select the action: **Add Tag** or **Remove Tag**.
- Select whether to register the IP address and tag mapping to the **Local User-ID** agent on this firewall or **Panorama User-ID**, or to a **Remote User-ID** agent.
- To register the IP address and tag mapping to a **Remote User-ID** agent, select the HTTP Server Profile (**Device > Server Profiles > HTTP**) that will enable forwarding.
- Configure the IP-Tag **Timeout** to set, in minutes, the amount of time that IP address-to-tag mapping is maintained. Setting of the timeout to 0 means that the IP-Tag mapping does not time out (range is 0 to 43200 (30 days); default is 0).
- Enter or select the **Tags** you want to apply or remove from the target source or destination IP address. Within the Log Forwarding Profile, you can define a **Built-in Action**.

Sample Questions

127. Dynamic tags can be assigned to which kind of data in a log event?
 - A. source and destination address, source and destination zone name
 - B. source and destination address
 - C. interface, zone name
 - D. DNS name, zone name
128. How can the firewall use dynamically tagged objects to block traffic?
 - A. Add the object to an enforcement list of a Data Filtering object that then is attached to a Security policy rule.
 - B. Assign the object to a dynamic list, which then is included in the destination address matching condition of a Security policy rule.
 - C. Assign the object to a Dynamic Address Group object, which then is added to the destination address matching condition of a Security policy rule.
 - D. Add the object to an Application Group and use it in Security policy rules.
129. A tag can be dynamically assigned to data in which four types of logs? (Choose four.)
 - A. Traffic
 - B. Threat
 - C. URL Filtering
 - D. HIP Match
 - E. Tunnel Inspection
 - F. Configuration
 - G. System

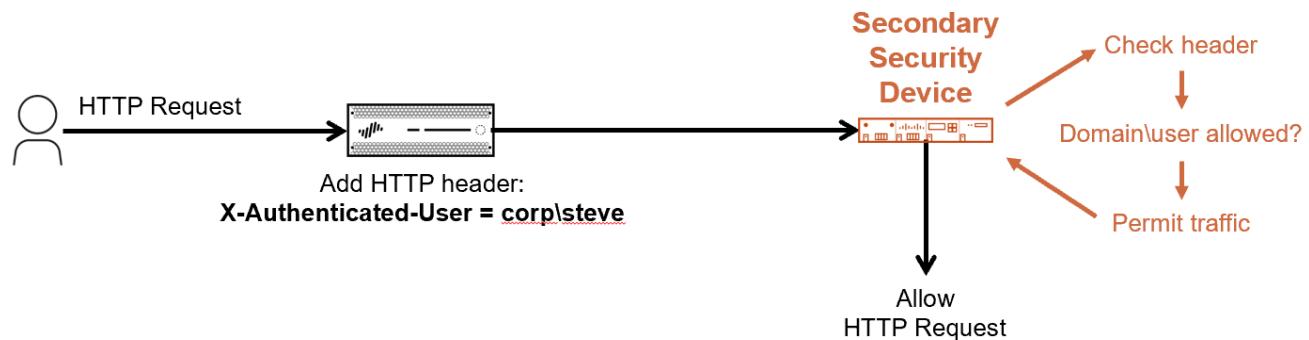
130. Dynamic tagging activity is recorded in which log?
- A. System
 - B. Configuration
 - C. IP-Tag
 - D. Data Filtering

2.24 Identify the use of username and domain name in HTTP header insertion

HTTP Header Insertion

Starting with PAN-OS version 9.1, the firewall now can add a user's name and a domain name into an HTTP packet header leaving the firewall. This HTTP header is designed to be consumed by a downstream device and typically is used to identify users and domains and to control access to an external resource. This new feature further augments the User-ID capabilities of the firewall to implement user-based security controls.

Previous PAN-OS versions starting with 8.1 included HTTP header insertion. New in PAN-OS version 9.1 is a specific new header named *X-Authenticated-User* that enables you to communicate user and domain information to a secondary, downstream security device of your choice. Using this new header to send username and domain name information to a secondary security device assumes that the device is programmed to read and interpret the information and to take action on it.



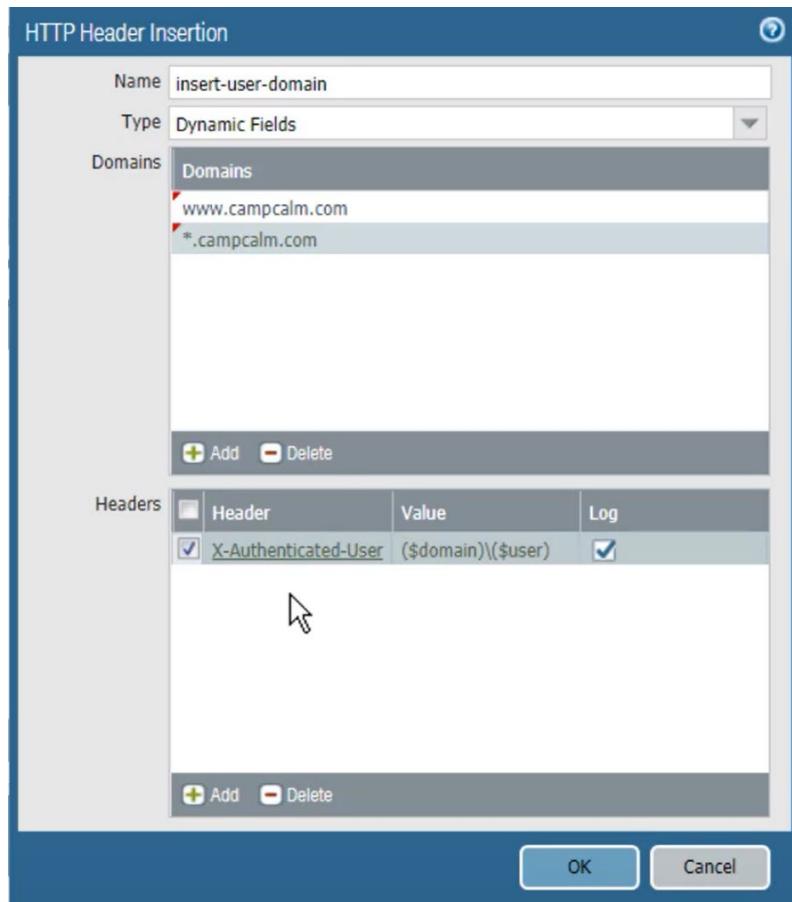
Note the following conditions about use of the new HTTP header insertion feature:

- You must enable User-ID on the firewall.
- Only HTTP version 1.x is supported. You cannot use the feature with HTTP version 2.
- Encrypted traffic must be decrypted before the firewall can insert a new header, which means that you must configure your Decryption policy to decrypt any traffic to a service or application for which you want to receive an inserted header.

The firewall inserts a header and value under specific conditions. First, the traffic must match a Security policy rule with HTTP header insertion configured in an attached URL Filtering Security Profile. Header insertion will not happen if either a Security policy rule or Security Profile blocks or denies the traffic. When you configure HTTP header insertion in the URL Filtering Security Profile, you specify the domain name of the destination service or application. The header is inserted only if the firewall determines that the traffic is being sent to the domain name specified in the URL Filtering Security Profile. The firewall determines the destination domain of the traffic by using the domain value found in the HTTP request's *Host:* header. For example, the *Host:* header could be *Host: www.google.com*, which means the destination domain is google.com. If google.com is the domain configured in the URL Filtering Security Profile, then the firewall would insert the configured HTTP header.

The following screenshot shows the result of browsing to **Objects > Security Profiles > URL Filtering**,

creating or editing a specific URL Filtering Profile and clicking the **HTTP Header Insertion** tab. If a user attempts to access the www.campcalm.com website or any page from campcalm.com, the firewall will insert the X-Authenticated-User header field and include the user's domain name and username.



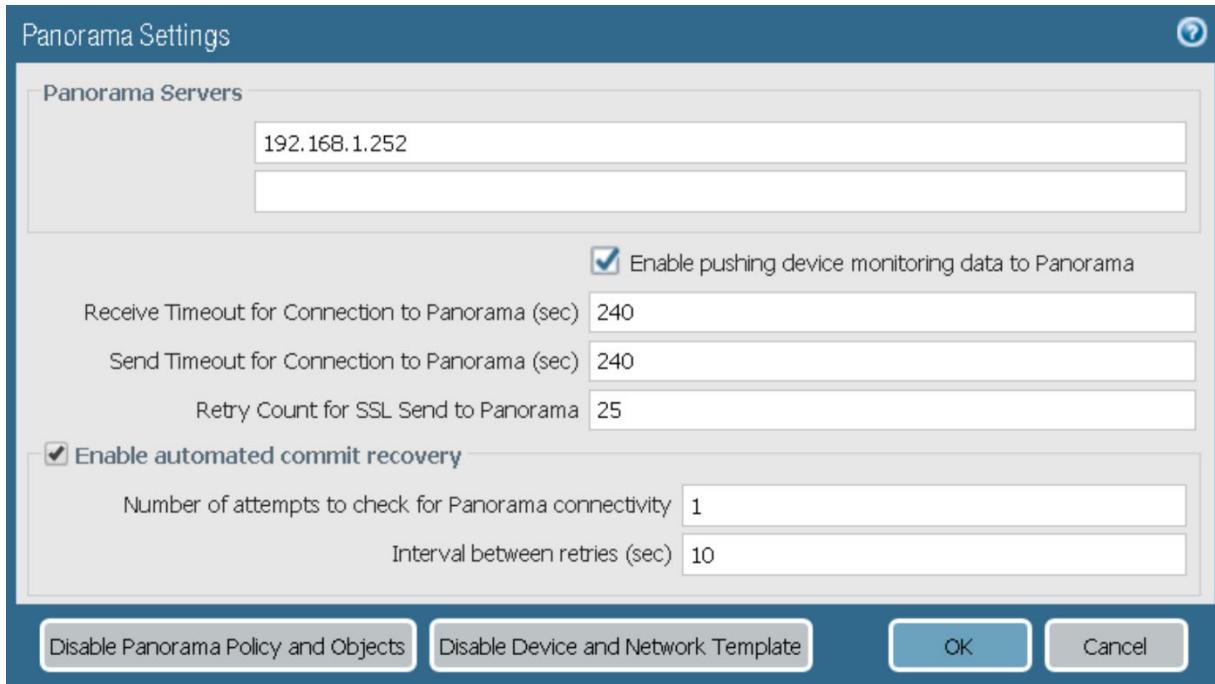
2.25 Identify the configuration settings for Panorama automatic commit recovery

PAN-OS 9.1 introduces the ability for managed firewalls to check for connectivity to the Panorama management server and to automatically revert to the last running configuration when the firewall is unable to communicate with Panorama.

Automatic commit recovery enables you to configure the firewall to attempt a specified number of connectivity tests and the interval at which each test occurs before the managed firewall automatically reverts its configuration to the previous running configuration after you push a configuration from Panorama or commit a configuration change locally on the firewall. The firewall also checks connectivity to Panorama every hour to ensure consistent communication if unrelated network configuration changes have disrupted connectivity between the firewall and Panorama or if implications to a pushed committed configuration have affected connectivity. If an hourly connectivity check fails, the firewall generates a system log to alert an administrator of a potential configuration or network connectivity issues.

Steps:

1. Log in to the Panorama web interface.
2. Select **Device > Setup > Management**.
3. In the **Template** context drop-down list, select the template or template stack that manages the devices for which you want to configure the automated commit recovery parameters. Configure the automated commit recovery settings:
 - a. Edit () the **Panorama Settings**.
 - b. Verify that **Enable automated commit recovery** is selected.
 - c. Enter a value in the **Number of attempts to check for Panorama connectivity** field.
 - d. Enter a value in the **Interval between retries** field.
 - b. Click **OK** to save your configuration changes.
4. Select **Commit** and **Commit and Push** your configuration changes.



Verify that the automated commit recovery feature is enabled on your managed firewalls.

5. Launch the firewall web interface.
6. Select **Device > Setup > Management**. In the **Panorama Settings**, verify that **Enable automated commit recovery** is selected.

References

Enable Automatic Commit Recovery:

https://docs.paloaltonetworks.com/content/dam/techdocs/en_US/pdf/panorama/9-1/panorama-admin/panorama-admin.pdf

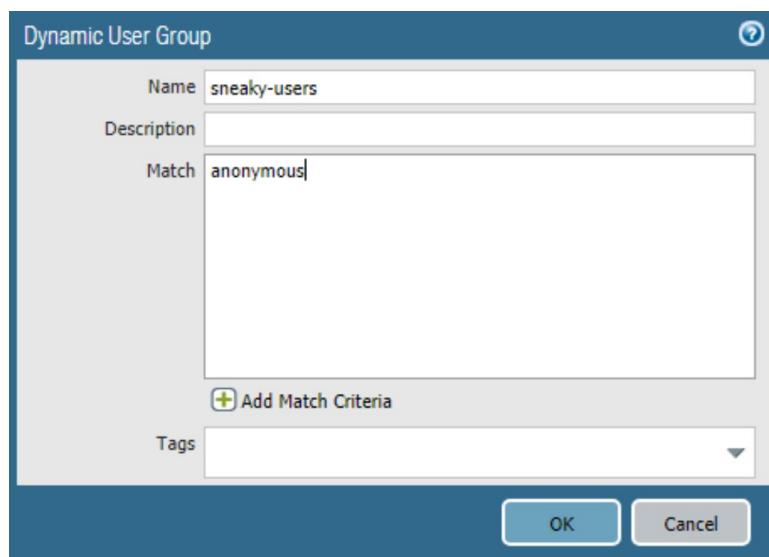
2.26 Identify the configuration settings for a dynamic user group

Configuring Dynamic User Groups

Before you can configure and use DUGs, first configure User-ID in your environment. The User-ID agent is used to maintain the list of which tags are associated with which usernames. To see the steps to configure User-ID, see the *PAN-OS® Administrator's Guide* at <https://docs.paloaltonetworks.com>.

Then configure the custom tags to use as match conditions for DUG membership. In the web interface, browse to **Objects > Tags** and create one or more custom tags that can be dynamically assigned to users. After you have created custom tags, create the DUGs.

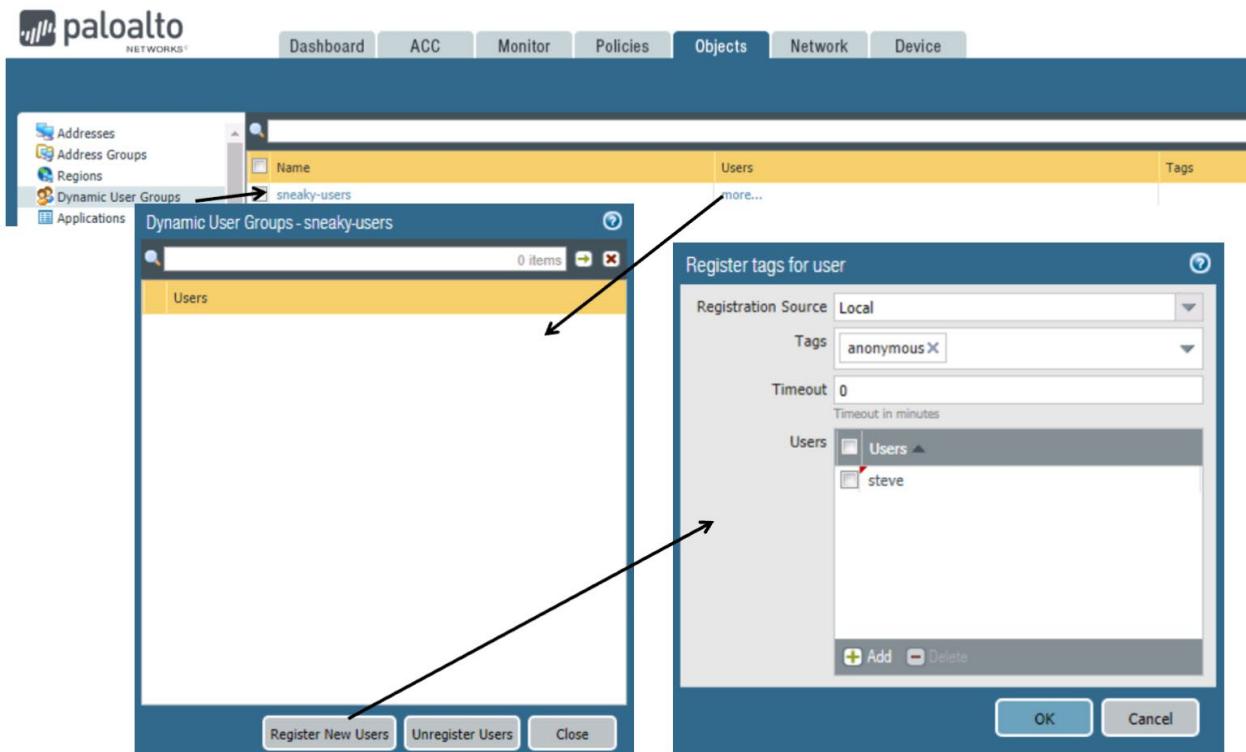
To create and configure a DUG, in the web interface browse to **Objects > Dynamic User Groups**. Then click **Add** to create a new group. Provide a **Name** for the new group, optionally provide a **Description**, and then in the **Match** field type one or more tags as match conditions. In the following example, the **Name** is **sneaky-users**, there is no **Description**, and the only **Match** condition is the tag named **anonymous**. If you click **Add Match Criteria**, then you can use the logical AND and OR operators to join multiple tags as match conditions. The **Tags** field value is the tag that is statically assigned to the DUG object itself and that is not assigned to a user and is not used as a match condition to identify users to add as members of the DUG.



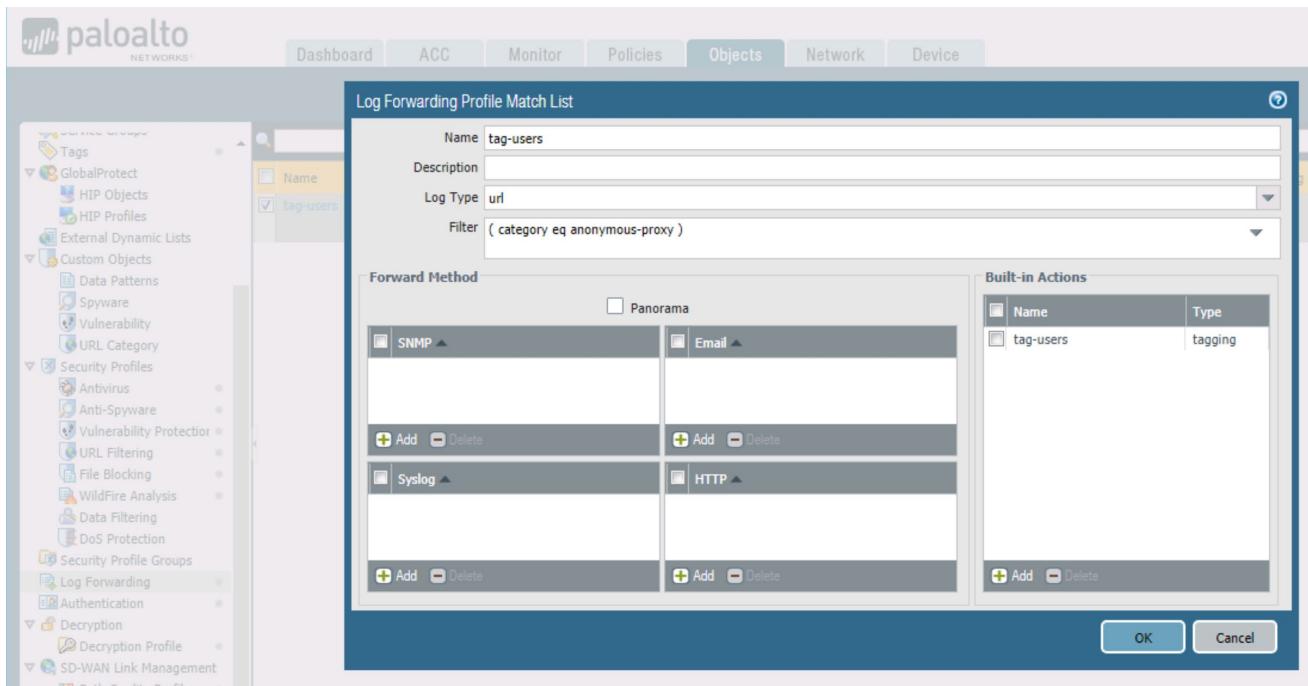
After you create the DUG, you must configure the firewall to use the DUG. Four options are available. To dynamically register a tag with a username, you can use Panorama, the XML API, a remote User-ID agent, or the web interface. A firewall can forward username and tag registration information to Panorama, and Panorama can distribute this information to other firewalls. Other applications can invoke firewall XML API commands to register username and tag associations. A remote User-ID agent can forward username and tag registrations to Panorama or other firewall User-ID agents. You also can use the web interface to register (or unregister) tags with usernames.

For example, the following screenshot illustrates use of the web interface to register or unregister tags from a username. Browse to **Objects > Dynamic User Groups** and click **more** next to a group name. In the window that opens click **Register New Users** to register a tag with a username. In the next window that

opens, select the **Registration Source**. You can choose the local User-ID agent, a remote User-ID agent, or Panorama. In the following example, the **Local** User-ID agent was selected. Then select the **Tags** to register with the user. The example uses the anonymous tag. If you want the tag to time out, which means the tag will be disassociated with the user, then choose a **Timeout** value in minutes. Then click **Add** and add one or more users to which to register the tag. To disassociate a tag from a username, start by clicking the **Unregister Users** button.



As a second example, you also can use a Log Forwarding Profile attached to a Security policy rule to autotag a username in response to a user's network behavior. In the following example, a Log Forwarding Profile named tag-users has been created. The profile is attached to a Security policy rule. If the rule matches an HTTP session and the URL Filtering log logs an entry where the URL category equals anonymous-proxy, then the Log Forwarding Profile invokes the built-in action that associates the tag *anonymous* with the username. The username is tagged and becomes a member of a DUG. Assuming that the DUG is used in the Security policy as a match condition, the firewall will modify what the user has access to.



For more information about using Panorama or the XML API to register and unregister tags, see the *PAN-OS® Administrator's Guide* at <https://docs.paloaltonetworks.com>.

2.27 Identify the configuration settings for SD-WAN

SD-WAN configuration is used to control which links your traffic takes by specifying the VPN tunnels or direct internet access (DIA) that certain applications or services take from a branch to a hub or from a branch to the internet. You group paths so that if one path deteriorates, the firewall selects a new best path.

Simplified management of multiple SD-WAN-enabled firewalls is enabled by installing the SD-WAN plugin on your Panorama management server. When Panorama is connected to the internet, you can download and install the SD-WAN plugin directly from the Panorama web interface. To install the SD-WAN plugin on Panorama when the internet is not connected, download the plugin from the Palo Alto Networks Customer Support Portal and upload the plugin to Panorama. The plugin needs to be installed only on the Panorama management server managing your SD-WAN firewalls, and not on the individual hub and branch firewalls.

For details about installing the SD-WAN plugin:

<https://docs.paloaltonetworks.com/sd-wan/1-0/sd-wan-admin/set-up-sd-wan/install-the-sd-wan-plugin/install-the-sd-wan-plugin-when-panorama-is-internet-connected.html>

<https://docs.paloaltonetworks.com/sd-wan/1-0/sd-wan-admin/set-up-sd-wan/install-the-sd-wan-plugin/install-the-sd-wan-plugin-when-panorama-is-not-internet-connected.html>

A tag name of your choice identifies a link; you apply the tag to the link (interface) by applying an Interface Profile to the interface. A link can have only one tag. Tags allow you to control the order that interfaces are used for traffic distribution. Tags allow Panorama to systematically configure many firewall interfaces with SD-WAN functionality.

When you plan how to group your links, consider the use or purpose of the links and group them accordingly. For example, if you are configuring links intended for low-cost or non-business-critical traffic, create a link tag and group these interfaces together to ensure that the intended traffic flows primarily on these links, and not on more expensive links that may impact business-critical applications or services.

For details about creating a tag:

<https://docs.paloaltonetworks.com/sd-wan/1-0/sd-wan-admin/configure-sd-wan/create-a-link-tag.html#ida9225fed-ea45-4abd-89a1-efab3a1dc4aa>

An SD-WAN Interface Profile specifies the tag that you apply to the physical interface, and the type of Link that interface is (ADSL/DSL, cable modem, Ethernet, fiber, LTE/3G/4G/5G, MPLS, microwave/radio, satellite, WiFi, or other). You create an SD-WAN Interface Profile to define the characteristics of ISP connections and to specify the speed of the links, how frequently the firewall monitors the link, and to specify a link tag for the link. When you specify the same link tag on multiple links, you are grouping those physical links into a link bundle. You must configure an SD-WAN Interface Profile and specify it for an Ethernet interface enabled with SD-WAN before you can save the Ethernet interface.

For details about creating a SD-WAN Interface Profile:

<https://docs.paloaltonetworks.com/sd-wan/1-0/sd-wan-admin/configure-sd-wan/configure-sd-wan-interface-profile.html>

In Panorama, you configure a physical, Layer 3 Ethernet interface and enable SD-WAN functionality. To configure a physical interface, you must assign it an IPv4 address, assign a next hop gateway, and assign an SD-WAN Interface Profile to the interface. An SD-WAN Interface Profile is assigned to the Layer 3 Ethernet interface to indicate the characteristics of the interface.

For details about creating a physical interface for SD-WAN:

<https://docs.paloaltonetworks.com/sd-wan/1-0/sd-wan-admin/configure-sd-wan/configure-a-physical-ethernet-interface-for-sd-wan.html>

A virtual SD-WAN interface is a VPN tunnel or DIA group of one or more interfaces that go to the same destination, such as to a specific hub or to the internet. All links in a virtual SD-WAN interface must be the same type, either all VPN tunnel links or all DIA links.

For details about creating an SD-WAN interface:

<https://docs.paloaltonetworks.com/sd-wan/1-0/sd-wan-admin/configure-sd-wan/configure-a-virtual-sd-wan-interface.html>

You create a Path Quality Profile for business-critical and latency-sensitive applications, application filters, application groups, services, service objects, and service group objects that have unique network quality or health requirements. A Path Quality Profile specifies maximum latency, jitter, and packet loss thresholds. Exceeding a threshold indicates that the path has deteriorated and the firewall needs to select a new path to the target. A sensitivity setting of high, medium, or low lets you indicate to the firewall which path monitoring parameter is more important for the applications. You can specify different thresholds for rules applied to packets that have different applications, services, sources, destinations, zones, and users.

For details about creating a Path Quality Profile:

<https://docs.paloaltonetworks.com/sd-wan/1-0/sd-wan-admin/configure-sd-wan/create-path-quality-profile.html>

In an SD-WAN topology, the firewall detects a brownout, a blackout, and path deterioration per application and selects a new path to ensure that you experience the best performance for your critical business applications. A Traffic Distribution Profile specifies how the firewall determines a new best path if the current preferred path exceeds a path quality threshold. You specify which tags the distribution method uses to narrow its selection of a new path. A Traffic Distribution Profile specifies the distribution method for the rule.

For details about creating a Traffic Distribution Profile:

<https://docs.paloaltonetworks.com/sd-wan/1-0/sd-wan-admin/configure-sd-wan/sd-wan-traffic-distribution-profiles.html>

An SD-WAN policy rule specifies the application(s) and/or service(s) and a Traffic Distribution Profile to determine how the firewall selects the preferred path for an incoming packet that doesn't belong to an existing session and that matches all other criteria, such as source and destination zones, source and

destination IP addresses, and source user. The SD-WAN policy rule also specifies a path quality profile of thresholds for latency, jitter, and packet loss. When one of the thresholds is exceeded, the firewall selects a new path for the application(s) and/or service(s).

For details about creating a SD-WAN policy:

<https://docs.paloaltonetworks.com/sd-wan/1-0/sd-wan-admin/configure-sd-wan/configure-sd-wan-policy-rule.html>

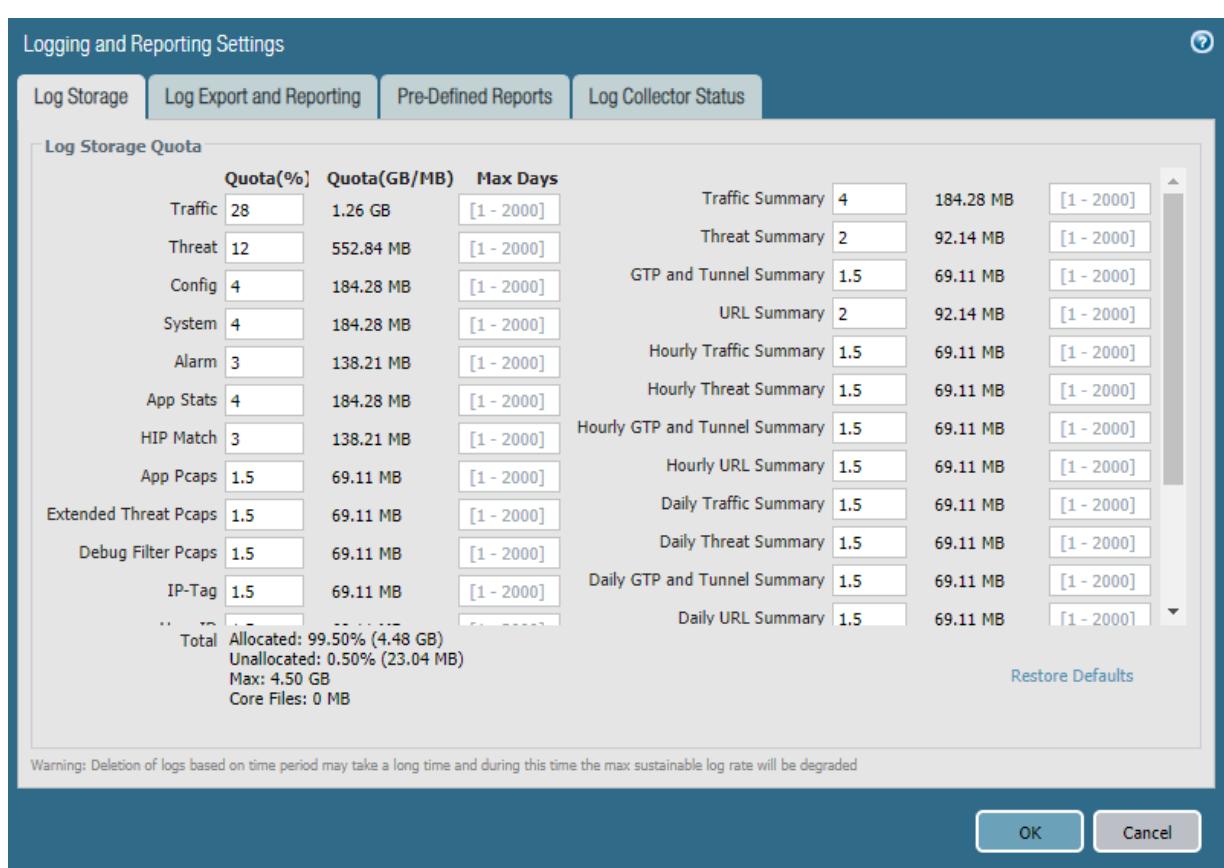
Exam Domain 3 – Operate

3.1 Identify considerations for configuring external log forwarding

Direct Firewall Log Forwarding

Use of an external service to monitor the firewall enables you to receive alerts for important events, archive monitored information on systems with dedicated long-term storage, and integrate with third-party security monitoring tools.

Local log storage on Palo Alto Networks firewalls is strictly allocated between different log files to ensure that no log is overrun by another. This allocation is user-controlled. Navigate to **Device > Setup > Management > Logging and Reporting Settings** for access to the following configuration settings:



Each log functions as a first-in, first-out log. When the physical storage space is filled, new entries will overwrite old ones. Space is cleared in blocks and messages are added to the System log.

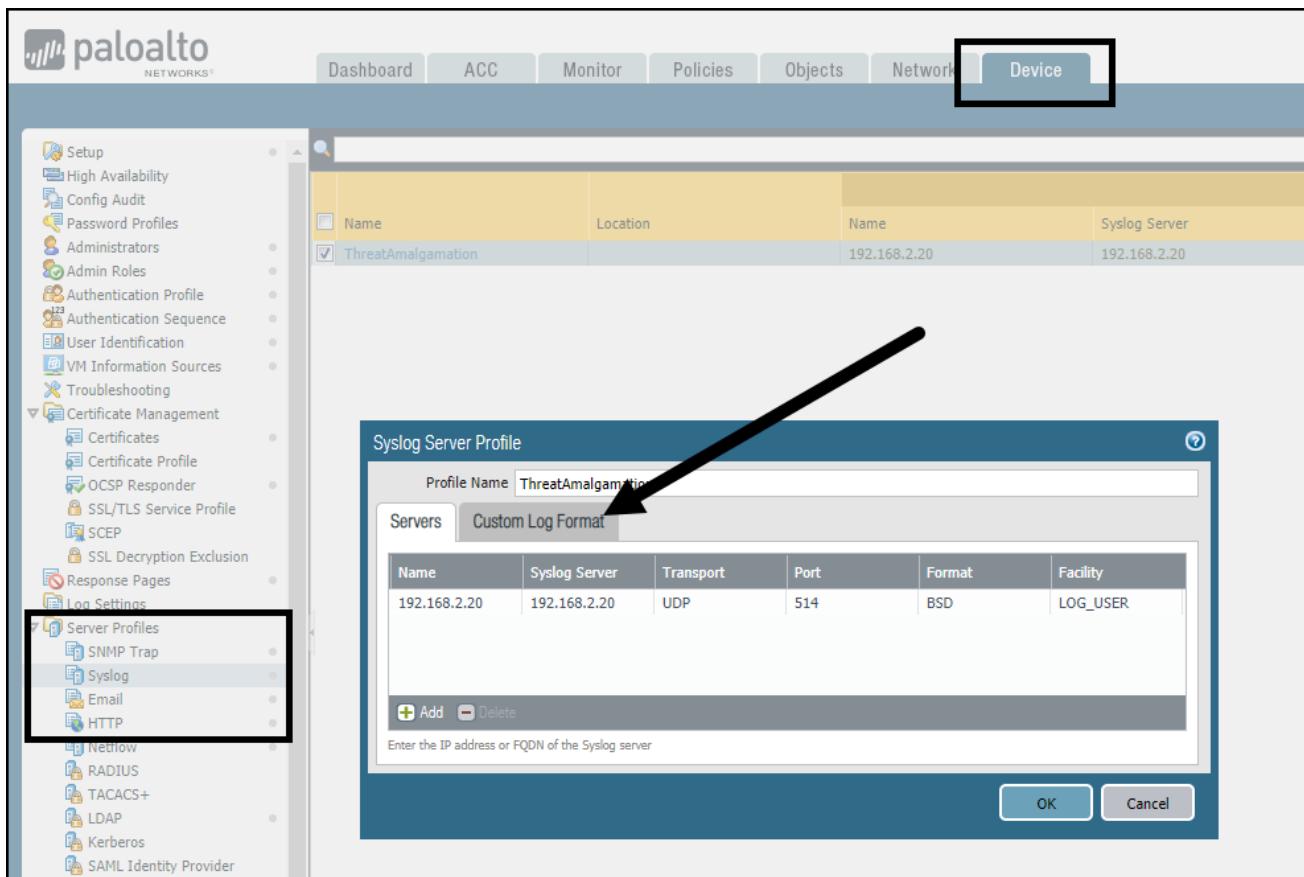
Before you can use Panorama or external systems to monitor the firewall, you must configure the firewall to forward its logs. Before the firewall forwards to external services, it automatically converts the logs to the necessary format: syslog messages, SNMP traps, HTTP, or email notifications. Before you start this procedure, ensure that Panorama or the external server that will receive the log data is running and can receive this traffic.

Destination Log Types and Formatting

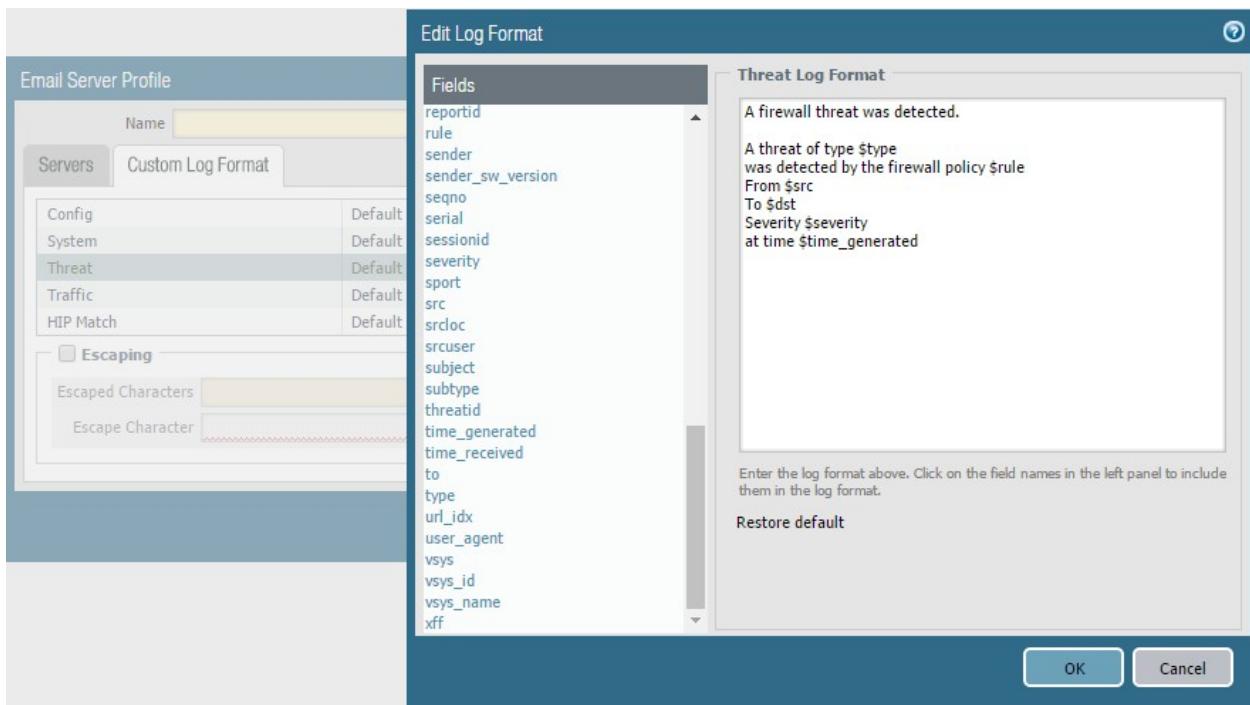
External forwarding supports the following types of destinations:

1. SNMP traps
2. syslog
3. HTTP server
4. email
5. Panorama

All types (other than Panorama) support customization of the message format. A typical destination configuration follows:



Email message formats can be customized. For example:



Any log event redirection causes a copy of the log event to be forwarded as specified. It is logged on the firewall as usual.

Methods Used to Forward Logs

Two main methods are used to forward log events, depending on the log message type. Log events destined for the System, Config, User-ID, HIP Match, IP-Tag, and logs are redirected using **Device > Log Settings** to choose event destination(s) for specific event types:

The screenshot shows the Palo Alto Networks Device interface with the 'Device' tab selected. On the left, there is a navigation tree with several collapsed sections like 'Setup', 'High Availability', 'Config Audit', 'Password Profiles', etc., and one expanded section 'Log Settings'. Under 'Log Settings', there are three tabs: 'System', 'Configuration', and 'User-ID'. The 'System' tab is active, displaying a table with five rows for log levels: 'system-informational', 'system-low', 'system-medium', 'system-high', and 'system-critical'. Each row has a 'Filter' column showing a severity expression and a 'Panorama' column with a checked checkbox. Below the table are 'Add', 'Delete', 'Clone', and 'PDF/CSV' buttons. The 'Configuration' and 'User-ID' tabs also have their own tables and similar filtering and export options.

The second method is the use of a Log Forwarding Profile to route Traffic, Threat, WildFire®, and other log events to other systems such as Panorama, SIEM products, and syslog server:

The screenshot shows the 'Log Forwarding Profile' configuration dialog. It has fields for 'Name' and 'Description'. A large central area is titled 'Log Forwarding Profile Match List' and contains fields for 'Name', 'Description', 'Log Type' (set to 'traffic'), and 'Filter' (set to 'All Logs'). Below this is a 'Forward Method' section with four columns: 'SNMP' (with 'Panorama' checked), 'Email', 'Syslog', and 'HTTP'. Each column has 'Add' and 'Delete' buttons. To the right is a 'Built-in Actions' section with a table for actions, which currently has no entries. At the bottom are 'OK' and 'Cancel' buttons.

Log Forwarding Profiles are attached to individual firewall Security policy rules to enable forwarding of the events associated with the processing of the specific policy. These profiles include one or more Log Forwarding Profile Match Lists. This granularity allows administrators specific control of forwarding and the potential of different forwarding for policies of differing importance.

All forwarded events are sent to their destination as they are generated on the firewall. A complete discussion of log forwarding configuration is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/monitoring/configure-log-forwarding>

Palo Alto Networks also offers a cloud-based Cortex Data Lake (formerly Logging Service) that can be a central repository for forwarded logs from multiple Palo Alto Networks devices. This central pool of log data is fully accessible to the owner and acts as an optional base for further third-party security applications through the Palo Alto Networks Cortex API.

Further information about this service can be found here:

<https://docs.paloaltonetworks.com/cortex/cortex-data-lake>

Sample Questions

131. A firewall can forward log events to which two types of log formats? (Choose two.)
 - A. XES
 - B. SNMP
 - C. Http
 - D. databases using xml format
 - E. NCSA
132. How does a firewall forward log events to an external destination?
 - A. They are sent in batches at the frequency specified in the destination's Server Profile.
 - B. They are queued and sent in batches at differing intervals, depending on the event severity.
 - C. They are sent as quickly as the required QoS policy rule governing log event traffic allows.
 - D. They are sent in real time as the firewall generates them.
133. Which two firewall logs can be exported using the Scheduled Log Export function? (Choose two.)
 - A. Configuration
 - B. System
 - C. Traffic
 - D. URL

3.2 Interpret log files, reports, and graphs to determine traffic and threat trends

Logging and reporting are critical components of any security network. The ability to log all network activity in a logical, organized, and easily segmented way makes logging even more valuable. Rapid, thorough, and accurate interpretation of events is critical to security. Security practitioners often suggest that security is only as good as the visibility that it provides. These reasons contribute to Palo Alto Networks information collection and display design.

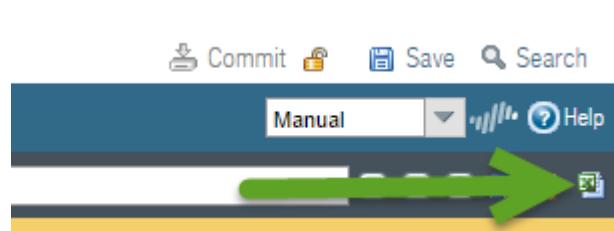
A discussion of available log data and making it into information that can be acted on is here:

https://www.paloaltonetworks.com/apps/pan/public/downloadResource?pagePath=/content/pan/en_US/resources/whitepapers/actionable-threat-intelligence

Log information generally is in the **Monitor** tab of the web interface. The reporting sections align with the general use of these reports. The **Log** section presents both detailed, real-time data and historical data (subjected to available storage). It is subdivided into sections that segment log data into related information. PAN-OS 9.1 includes a Unified log that collects copies of events from the Traffic, Threat, URL Filtering, Data Filtering, WildFire Submissions, Tunnel Inspection, Authentication, and IP-Tag logs into a single location for easy parsing of related data.

Each log provides similar features, which results in an organized presentation of desired data. Displayed log data can be exported in CSV format at any time.

The following figure shows the CSV export option available on any detailed log display:



This export will include all detail for the displayed record even if it isn't visible in the chosen column displays.

You can see the entries in various logs using **Monitor > Logs**. You can configure the columns to display and their order and width:

The screenshot shows the Palo Alto Networks Management Console interface. The top navigation bar includes tabs for Dashboard, ACC, Monitor (selected), Policies, and Objects. On the left, a sidebar titled 'Logs' lists categories such as Traffic, Threat, URL Filtering, WildFire Submissions, Data Filtering, HIP Match, IP-Tag, User-ID, Tunnel Inspection, Configuration, System, Alarms, Authentication, Unified, Packet Capture, App Scope, Session Browser, Botnet, and PDF Reports. The main content area displays a table of logs with columns for Receive Time, Type, and From Zone. A context menu is open over the last log entry, listing various filtering options like Receive Time, Type, From Zone, To Zone, Source, Destination, To Port, Application, Action, Rule, Session End Reason, Bytes, HTTP/2 Connection Session ID, Action Source, Bytes Received, Bytes Sent, Captive Portal, Client to Server, Count, and Decrpt Forwarded. Most items in the context menu have checkboxes next to them.

| | Receive Time | Type | From Zone |
|--|----------------|-------|-----------|
| | 04/12 14:32:09 | end | Trust |
| | 04/12 14:32:08 | end | Trust |
| | 04/12 14:32:07 | end | DMZ |
| | 04/12 14:32:07 | end | DMZ |
| | 04/12 14:32:07 | end | Trust |
| | 04/12 14:32:06 | start | DMZ |
| | 04/12 14:32:06 | start | DMZ |
| | 04/12 14:32:05 | end | Trust |
| | 04/12 14:32:05 | end | DMZ |
| | 04/12 14:32:04 | end | Trust |
| | 04/12 14:32:02 | end | DMZ |
| | 04/12 14:32:02 | end | DMZ |
| | 04/12 14:32:01 | end | Trust |
| | 04/12 14:32:01 | end | DMZ |

Each log display offers a powerful filtering capability that facilitates the display of specific desired data:

The screenshot shows the Palo Alto Networks Firewall interface. The top navigation bar includes tabs for Dashboard, ACC, Monitor (which is selected), Policies, and Objects. On the left, a sidebar titled 'Logs' lists various log categories: Traffic, Threat, URL Filtering, WildFire Submissions, Data Filtering, HIP Match, IP-Tag, User-ID, Tunnel Inspection, Configuration, System, Alarms, Authentication, Unified, Packet Capture, App Scope, and Summary. The main pane displays a table of log entries. A search bar at the top of the table area contains the filter '(addr.src in 192.168.1.12) and (app eq dns)'. The table columns are Receive Time, Type, From Zone, and To Zone. The data shows several log entries for DNS traffic from source address 192.168.1.12, with types including 'end', 'deny', and 'allow'.

| | Receive Time | Type | From Zone | To Zone |
|--|----------------|------|-----------|---------|
| | 04/12 14:30:55 | end | Trusted | Unt |
| | 04/12 14:30:20 | deny | Trusted | Unt |
| | 04/12 14:15:49 | end | Trusted | Unt |
| | 04/12 14:15:13 | deny | Trusted | Unt |
| | 04/12 14:14:42 | end | Trusted | Unt |
| | 04/12 14:14:36 | end | Trusted | Unt |
| | 04/12 14:14:06 | deny | Trusted | Unt |
| | 04/12 14:14:00 | deny | Trusted | Unt |
| | 04/12 14:01:16 | end | Trusted | Unt |

Filters can be added to eliminate the display of undesired entries.

Filters can be built and even stored for future use. Specific data about this functionality is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/monitoring/view-and-manage-logs>

While this log data is stored in detail in log storage, a firewall summarizes new log entries and adds the results to separate on-board reporting databases used as default sources by Application Command Center (ACC), App Scope, PDF Reports, and Custom Reports.

The scope of this summarization process can be controlled with settings on **Device > Setup > Management > Logging and Reporting Settings**:

Logging and Reporting Settings

Log Storage **Log Export and Reporting** **Pre-Defined Reports** **Log Collector Status**

| | | |
|-------------------------------------|------------|--|
| Number of Versions for Config Audit | 100 | <input type="checkbox"/> Stop Traffic when LogDb Full |
| Max Rows in CSV Export | 65535 | <input checked="" type="checkbox"/> Enable Threat Vault Access |
| Max Rows in User Activity Report | 5000 | <input type="checkbox"/> Enable Log on High DP Load |
| Average Browse Time (sec) | 60 | <input type="checkbox"/> Support UTF-8 For Log Output |
| Page Load Threshold (sec) | 20 | |
| Syslog HOSTNAME Format | FQDN | |
| Report Runtime | 02:00 | |
| Report Expiration Period (days) | [1 - 2000] | |

Warning: Deletion of logs based on time period may take a long time and during this time the max sustainable log rate will be degraded

OK **Cancel**

Logging and Reporting Settings

Log Storage **Log Export and Reporting** **Pre-Defined Reports** **Log Collector Status**

Pre-Defined Reports

| Application Reports | Traffic Reports | Threat Reports | URL Filtering Reports |
|--|---|--|---|
| <input checked="" type="checkbox"/> Applications | <input checked="" type="checkbox"/> Security Rules | <input checked="" type="checkbox"/> Threats | <input checked="" type="checkbox"/> URL Categories |
| <input checked="" type="checkbox"/> Application Categories | <input checked="" type="checkbox"/> Sources | <input checked="" type="checkbox"/> Threat Trend | <input checked="" type="checkbox"/> URL Users |
| <input checked="" type="checkbox"/> Technology Categories | <input checked="" type="checkbox"/> Source Countries | <input checked="" type="checkbox"/> Attacker Sources | <input checked="" type="checkbox"/> URL User Behavior |
| <input checked="" type="checkbox"/> HTTP Applications | <input checked="" type="checkbox"/> Destinations | <input checked="" type="checkbox"/> Attacker Destinations | <input checked="" type="checkbox"/> Web Sites |
| <input checked="" type="checkbox"/> Denied Applications | <input checked="" type="checkbox"/> Destination Countries | <input checked="" type="checkbox"/> Attackers By Source Countries | <input checked="" type="checkbox"/> Blocked Categories |
| <input checked="" type="checkbox"/> Risk Trend | <input checked="" type="checkbox"/> Connections | <input checked="" type="checkbox"/> Attackers By Destination Countries | <input checked="" type="checkbox"/> Blocked Users |
| <input checked="" type="checkbox"/> Bandwidth Trend | <input checked="" type="checkbox"/> Source Zones | <input checked="" type="checkbox"/> Victim Sources | <input checked="" type="checkbox"/> Blocked User Behavior |
| <input checked="" type="checkbox"/> SaaS Application Usage | <input checked="" type="checkbox"/> Destination Zones | <input checked="" type="checkbox"/> Victim Destinations | <input checked="" type="checkbox"/> Blocked Sites |
| | <input checked="" type="checkbox"/> Ingress Interfaces | <input checked="" type="checkbox"/> Victims By Source Countries | <input checked="" type="checkbox"/> Blocked Credential Post |
| | <input checked="" type="checkbox"/> Egress Interfaces | <input checked="" type="checkbox"/> Victims By Destination Countries | |
| | <input checked="" type="checkbox"/> Denied Sources | <input checked="" type="checkbox"/> Viruses | |
| | <input checked="" type="checkbox"/> Denied Destinations | <input checked="" type="checkbox"/> Spyware | |
| | <input checked="" type="checkbox"/> Unknown TCP Sessions | <input checked="" type="checkbox"/> Vulnerabilities | |
| | <input checked="" type="checkbox"/> Unknown UDP Sessions | <input checked="" type="checkbox"/> Malware Infected Hosts | |
| | <input checked="" type="checkbox"/> Risky Users | | |

Note: Group Reports and PDF Reports will have no data if a contained pre-defined report is disabled

Select All **Deselect All**

OK **Cancel**

PDF Reports

The PDF Reports section offers many predefined PDF reports that can be run as a group on a scheduled basis and delivered through email daily or weekly.

By default, these reports typically run once per day and summarize all activity on the firewall. A report browser of predefined reports appears on the right. In the following figure, chosen reports display their results for the previous day's traffic. The predefined report browser shows choices of categories and specific reports on the right:

| | Destination Country | Bytes | Sessions |
|----|-------------------------|--------|----------|
| 1 | United States | 13.7G | 182.3k |
| 2 | United Kingdom | 10.8M | 243 |
| 3 | Netherlands | 294.0M | 228 |
| 4 | Ireland | 2.7M | 213 |
| 5 | Germany | 3.7M | 116 |
| 6 | Canada | 4.3M | 71 |
| 7 | Japan | 226.3k | 42 |
| 8 | Hong Kong | 469.8k | 41 |
| 9 | Singapore | 135.3k | 35 |
| 10 | European Union | 164.0k | 33 |
| 11 | Asia Pacific Region | 42.5k | 26 |
| 12 | Poland | 7.5k | 22 |
| 13 | France | 40.0k | 20 |
| 14 | Australia | 4.6k | 20 |
| 15 | Austria | 2.8k | 16 |
| 16 | Brazil | 3.9k | 16 |
| 17 | China | 250.7k | 16 |
| 18 | Korea Republic Of | 2.3k | 15 |
| 19 | India | 2.3k | 15 |
| 20 | Russian Federation | 2.3k | 15 |
| 21 | 10.0.0.0-10.255.255.255 | 2.2k | 12 |
| 22 | Spain | 340 | 2 |
| 23 | Sweden | 170 | 1 |
| 24 | Luxembourg | 170 | 1 |

[Export to PDF](#) |
 [Export to CSV](#) |
 [Export to XML](#)

The PDF Reports section offers other important reporting tools. Custom reports can be created, stored, and run on-demand and/or a schedule basis. More information is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/monitoring/view-and-manage-reports/generate-custom-reports>

User/Group Activity Report

A predefined User Activity report provides complete application use and browsing activity reports for individuals or groups. Information is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/monitoring/view-and-manage-reports/generate-usergroup-activity-reports.html>

PDF Summary Report

A PDF Summary Report includes several top-5-oriented reports grouped to provide a general representation of the firewall's traffic during the previous day. Details are here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/monitoring/view-and-manage-reports/generate-usergroup-activity-reports>

App Scope Reports

App Scope reports focus on base-line performance comparisons of firewall use. These reports provide power tools to characterize changes in detected use patterns. They were designed for ad-hoc queries more than for scheduled report output. Detailed information is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/monitoring/use-the-app-scope-reports.html>

Application Command Center

The Application Command Center (ACC) is an interactive, graphical summary of the applications, users, URLs, threats, and content traversing your network. The ACC uses the firewall logs to provide visibility into traffic patterns and information about threats that can be acted on. The ACC layout includes a tabbed view of network activity, threat activity, and blocked activity. Each tab includes pertinent widgets for better visualization of network traffic. The graphical representation allows you to interact with the data and to see the relationships between events on the network so that you can uncover anomalies or find ways to enhance your network security rules. For a personalized view of your network, you can add a custom tab and include widgets that allow you to find the information that is most important to you.

Other reports and displays on the firewall often support click-through of data items to enable you to uncover more detail. This practice often results in a switch to the ACC with preset filters to focus only on the previously displayed data. Detailed use data is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/monitoring/use-the-application-command-center.html>

Automated Correlation Engine

The Automated Correlation Engine is an analytics tool that uses the logs on the firewall to detect events on your network that can be acted on. The engine correlates a series of related threat events that, when combined, indicate a likely compromised host on your network or some other higher-level conclusion. It pinpoints areas of risk, such as compromised hosts on the network, which allows you to assess the risk and act to prevent exploitation of network resources. The Automated Correlation Engine uses Correlation objects to analyze the logs for patterns, and when a match occurs it generates a correlated event.

Detailed information is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/monitoring/use-the-automated-correlation-engine.html>

Sample Questions

134. Which filter finds all log entries for traffic that originates from the internal device whose IP address is 172.17.1.3 and according to the header appears to be HTTP or HTTPS?
 - A. (addr.src in 172.17.1.3) and ((port.dst eq 80) or (port.dst eq 443))
 - B. ((addr.src in 172.17.1.3) and (port.dst eq 80)) or (port.dst eq 443)
 - C. (src.addr in 172.17.1.3) and ((dst.port eq 80) or (dst.port eq 443))
 - D. ((src.addr in 172.17.1.3) and (dst.port eq 80)) or (dst. port eq 443)
135. Which two log files would you use if you suspect that a rogue administrator is modifying the firewall's rulebase to allow and hide illicit traffic? (Choose two.)
 - A. Traffic
 - B. Threat
 - C. Data Filtering
 - D. Configuration
 - E. System
136. Which product is required to use event correlation?
 - A. next-generation firewall, PA-220
 - B. Advanced Endpoint Protection
 - C. Panorama
 - D. GlobalProtect

3.3 Identify scenarios in which there is a benefit from using custom signatures

Before you can create a custom application, you must define the application attributes: its characteristics, category and subcategory, risk, port, and timeout. You also must define patterns or values that the firewall can use to match to the traffic flows themselves (the signature). Finally, you can attach the custom application to a Security policy that allows or denies the application (or add it to an application group or match it to an application filter). You also can create custom applications to identify ephemeral applications of a topical interest.

References

- Manage Custom or Unknown Applications
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/app-id/manage-custom-or-unknown-applications>
- Create a Custom Application
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/app-id/use-application-objects-in-policy/create-a-custom-application>

Sample Questions

137. How would you configure the firewall to control access to a custom DNS application that operates differently from the standard DNS application?
 - A. You cannot do it with the next-generation firewall. You need to manually configure a proxy.
 - B. Create specific rules for the sources and destinations that run this application.
 - C. Create a custom DNS application and add it to separate Security policy rules.
 - D. Create an Application Override policy and specify the sources and destinations that run this application.
138. What are two results of using Application Override policies? (Choose two.)
 - A. prevent matching traffic from entering VPN tunnels
 - B. apply a specified App-ID label to matching traffic
 - C. prevent matching traffic from being logged
 - D. cause matching traffic to bypass Content-ID processing
 - E. route traffic to WildFire for scanning
139. Which two types of entities can have custom signatures? (Choose two.)
 - A. services
 - B. URL categories
 - C. user groups
 - D. applications
 - E. vulnerabilities

3.4 Given a scenario, identify the process to update a Palo Alto Networks system to the latest version of the software

Standalone Firewalls

For non-HA firewalls, software updates fall into two categories: subscription updates and PAN-OS upgrades.

Subscription updates are enabled through application of various licenses to the firewall. These updates are managed under **Device > Dynamic Updates**. Updates can be transferred directly from Palo Alto Networks on demand or by schedule control. In cases where the firewall does not have internet connectivity, these updates can be downloaded from the Palo Alto Networks **Dynamic Update** section of the Support portal site onto an administrator's system and uploaded through a management web interface connection and then applied.

This process is discussed here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/software-and-content-updates.html>

PAN-OS updates are managed in the **Device > Software** section of the web interface. New PAN-OS versions can be downloaded and even installed without user disruption. A final system reboot must be performed to put the new PAN-OS software into production. This reboot is disruptive and should be done during a change control window.

A firewall does not need to upgrade to each released PAN-OS software in sequence. Considerations for skipping releases are outlined here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-new-features/upgrade-to-pan-os-91/upgrade-the-firewall-to-pan-os-91/determine-the-upgrade-path.html#id85bdf6f4-2e83-49f0-8525-3eb2163f2d2e>

To ensure that software upgrades function as expected, you are required to install the latest dynamic updates before upgrading PAN-OS software.

You can undo PAN-OS upgrades if required. Details are here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-new-features/upgrade-to-pan-os-91/downgrade-from-pan-os-91.html#idc862ccf3-3758-472d-a0d6-8c182df62dba>

Updates to App-ID signature information sometimes can reclassify previously labeled traffic, which might impact user access to critical applications. The firewall provides several mechanisms to review changes to App-IDs prior to or immediately after their installation.

A discussion of this issue and deployment techniques can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/app-id/manage-new-app-ids-introduced-in-content-releases>

HA Firewalls

Dynamic updates are the responsibility of the individual firewalls to manage, even when they are in passive mode. This task can be difficult if dynamic updates have no network path to the Palo Alto

Networks update servers. Dynamic updates in HA clusters include an option to “Sync-to-peer” for use when the secondary firewall has no network route to the update server. Further discussion is here:
<https://knowledgebase.paloaltonetworks.com/KCSArticleDetail?id=kA10g000000ClrnCAC>

Firewalls in HA clusters must upgrade PAN-OS software individually. In active/passive clusters a firewall typically is put into suspend mode and then upgraded. After the upgrade is complete, the firewall is made active and the partner enters suspend mode and is upgraded.

A detailed discussion of this process appears here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-new-features/upgrade-to-pan-os-91/upgrade-the-firewall-to-pan-os-91/upgrade-an-ha-firewall-pair-to-pan-os-91.html#id961824af-bdce-4e36-a19d-48fcceb2908>

Upgrading Firewalls Under Panorama Management

Firewalls managed by Panorama can get dynamic updates from Panorama including scheduled updates. PAN-OS upgrades also can be managed from Panorama. A complete discussion is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-web-interface-help/panorama-web-interface/panorama-device-deployment/manage-software-and-content-updates>

Upgrade of Panorama-managed firewalls to PAN-OS 9.1 is discussed here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-new-features/upgrade-to-pan-os-91/upgrade-the-firewall-to-pan-os-91/upgrade-firewalls-using-panorama.html#id263f6c65-d987-48ab-a255-4a29ee83498a>

HA Cluster Firewall Updates Managed by Panorama

Panorama treats managed firewalls in HA pairs as individual firewalls for software update purposes.

Sample Questions

140. Match the upgrade step description with the correct step number.

| | |
|--------------------------------|--------|
| Upgrade PAN-OS software | Step 3 |
| Reboot the firewall | Step 4 |
| Update dynamic content | Step 2 |
| Activate subscription licenses | Step 1 |

141. Match each component with the order in which the component should be upgraded to a new version of PAN-OS software.

| | |
|---------------------|--------|
| HA active firewall | Step 4 |
| Panorama | Step 1 |
| Log Collector | Step 2 |
| HA passive firewall | Step 3 |

142. How do you upgrade an active/passive HA firewall pair to PAN-OS 9.1 while maintaining internet access?

- A. Upgrade the active firewall first, then the passive one.
- B. Upgrade the passive firewall first, then the active one.
- C. Run the upgrade on the active firewall. It will manage the process and upgrade the passive firewall.
- D. You must upgrade both members of the pair at the same time, which requires an upgrade window that allows downtime.

3.5 Identify how configuration management operations are used to ensure desired operational state of stability and continuity

Firewall settings are stored in XML configuration files that can be archived, restored, and otherwise managed.

Running Configuration and Candidate Configuration

A firewall contains both a running configuration that contains all settings currently active, and a candidate configuration. The candidate configuration is a copy of the running configuration that also includes settings changes not yet committed. Changes you make using the management web interface, the CLI, or the XML API are staged in the candidate configuration until you perform a commit operation. During a commit operation the candidate configuration replaces the running configuration.

If you back up versions of the running or candidate configuration, you can later restore those versions on the firewall. A discussion about the basic process is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/firewall-administration/manage-configuration-backups>

Guidelines for configuration management are here:

<https://knowledgebase.paloaltonetworks.com/KCSArticleDetail?id=kA10g000000CIRcCAK>

Sample Questions

143. What is the format of the firewall configuration files?
 - A. YAML
 - B. JSON
 - C. XML
 - D. CSV
144. Which method can be used to restore the previous configuration when a new configuration committed on a firewall has undesired consequences?
 - A. Use the **Load configuration version** to restore the previous configuration settings, and follow with a commit.
 - B. Use the **Rollback commit** link in the commit completion message.
 - C. Use the **Import device state** to restore the pre-commit configuration.
 - D. Use the **Load named configuration snapshot** to restore the previous configuration, and follow with a commit.
145. Which CLI command do you use to move a configuration file from an external server to a firewall's local storage?
 - A. **rdist**
 - B. **ssh**
 - C. **scp**
 - D. **rcp**

3.6 Identify the settings related to critical HA functions (link monitoring; path monitoring; HA1, HA2, and HA3 functionality; HA backup links; and differences between A/A and A/P)

A High Availability (HA) configuration is created when two firewalls are placed in a group and have their configuration synchronized to prevent a single point of failure on your network. A heartbeat connection between the firewall peers ensures seamless failover if a peer becomes non-operational. Configure two firewalls in an HA pair to provide redundancy and enable you to ensure business continuity.

References

- HA Concepts (including the subtopics)
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/high-availability/ha-concepts>
- What is HA-Lite on Palo Alto Networks PA-200?
<https://knowledgebase.paloaltonetworks.com/KCSArticleDetail?id=kA10g000000CIUzCAK>
- HA Links and Backup Links
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/high-availability/ha-concepts/ha-links-and-backup-links>
- Set Up Active/Passive HA
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/high-availability/set-up-activepassive-ha.html>
- Set Up Active/Active HA
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/high-availability/set-up-activeactive-ha.html>
- See additional information in section 1.3 *Given a scenario, identify how to design an implementation of firewalls in High Availability to meet business requirements that leverage the Palo Alto Networks Security Operating Platform.*

Sample Question

146. Which feature is an intended advantage of an active/passive firewall pair versus an active/passive pair?
- A. increased throughput
 - B. support of asynchronous routing
 - C. increased session count
 - D. shared dynamic updates

3.7 Identify the sources of information that pertain to HA functionality

Network monitoring applications use SNMP to query network components such as the next-generation firewall. The firewall has additional information specific to HA. You can monitor the dedicated HA1, HA2, HA2 backup, and HA3 interfaces. Use the IF-MIB and the interfaces MIB to see SNMP statistics for dedicated HA2 interfaces.

Panorama includes *Managed Device Health Monitoring* which displays limited HA status information in the summary display in the Panorama management web interface.

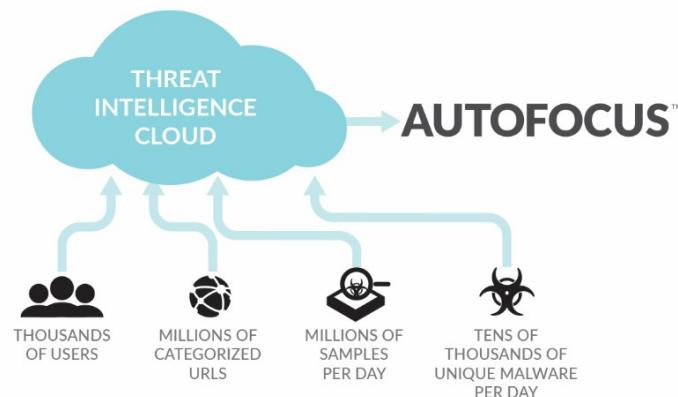
References

- SNMP Support
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/monitoring/snmp-monitoring-and-traps/snmp-support>
- Monitor Statistics Using SNMP
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/monitoring/snmp-monitoring-and-traps/monitor-statistics-using-snmp>
- Supported MIBs
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/monitoring/snmp-monitoring-and-traps/supported-mibs>
- Using Device Health Monitoring from Panorama
<https://docs.paloaltonetworks.com/panorama/9-1/panorama-admin/manage-firewalls/device-monitoring-on-panorama/monitor-device-health.html>

Sample Questions

147. Which configuration object does a firewall use to forward HA-related events to an external monitoring technology?
 - A. Device > Log Settings > System Log settings
 - B. Objects > Log Forwarding Profile > System Log Type
 - C. Device > High Availability > General > Event Forwarding
 - D. Dashboard > High Availability widget > Notification
148. Which two Panorama objects can display current HA state information about a managed firewall? (Choose two.)
 - A. firewall listings in **Monitor > HA Status**
 - B. firewall specific information in **Managed Devices > Health**
 - C. firewall listings in **Managed Devices > Summary**
 - D. firewall HA Status widget in **Dashboard > Widgets**
 - E. firewall HA status in **Panorama > High Availability**

3.8 Identify how to configure the firewall to integrate with AutoFocus and verify its functionality



AutoFocus is a threat intelligence service that provides an interactive, graphical interface for analyzing threats in your network. You can use AutoFocus to compare threats in your network to threat information collected from other networks in your industry or across the globe, within specific time frames. AutoFocus statistics are updated to include the most recent threat samples analyzed by Palo Alto Networks. Access to this information allows you to stay current with threat trends and to take a preventive approach to securing your network.

AutoFocus is a separately licensed product that is accessed in two primary ways: directly through the AutoFocus Portal, or by viewing AutoFocus-provided data in a firewall's web interface. The AutoFocus Portal is the primary access method for the evaluation of overall trends and characteristics of historical and current threats. This data can be used to characterize traffic seen on your network(s). Threats found by the firewall can be enriched by AutoFocus-provided contextual data. Additional threat context can be displayed for threats reported in your firewall logs.

Enablement of AutoFocus is a three-step process:

1. Enter your AutoFocus authorization code into the firewall's license management.
2. Ensure that the correct URL to access AutoFocus is configured in the firewall.
3. Log in to the AutoFocus Portal and add information about your firewalls.

Details about this process can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/threat-prevention/learn-more-about-and-assess-threats/assess-firewall-artifacts-with-autofocus/enable-autofocus-threat-intelligence>

References

- AutoFocus at a glance
<https://www.paloaltonetworks.com/resources/datasheets/autofocus-at-a-glance>
- AutoFocus Administrator's Guide, especially the dashboard
<https://docs.paloaltonetworks.com/autofocus/autofocus-admin>

Sample Questions

149. Which method is used to connect the firewall to AutoFocus to query data? (Choose two.)
- A. Click the AutoFocus link in the firewall management user interface under **Device > Licenses > AutoFocus**.
 - B. Click the link found in the log events under the firewall's **Monitor > Logs > AutoFocus**.
 - C. Configure the connection using the Dashboard's AutoFocus widget.
 - D. Click the link found in the log event under the firewall's **Monitor > <threat-related-log> > <threat-detail>**.
150. What is a principle benefit of the AutoFocus product?
- A. provide additional threat detection data to the firewall
 - B. manage access to SaaS applications through the firewall
 - C. provide additional context to previously discovered threats
 - D. examine Cortex Data Lake log data for undetected threats

3.9 Identify the impact of deploying dynamic updates

Palo Alto Networks maintains a Content Delivery Network (CDN) infrastructure for delivering content updates to Palo Alto Networks firewalls. The firewalls access the web resources in the CDN to perform various App-ID and Content-ID functions. By default, the firewalls use the management port to access the CDN infrastructure for application updates, threat and antivirus signature updates, and access to the Palo Alto Networks WildFire® cloud. To ensure that you are always protected from the latest threats (including those that have not yet been discovered), you must keep your firewalls up to date with the latest content and software updates published by Palo Alto Networks.

App-ID updates have a special impact because new application definitions might affect current Security policy rules. PAN-OS software provides features to review the App-ID updates and modify the Security policy rules.

If your firewalls are managed by Panorama, the Panorama device can be the source of dynamic updates for managed firewalls and can configure the update schedule.

References

- Configure Content and Software Updates
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/software-and-content-updates/app-and-threat-content-updates/configure-app-threat-updates>
- Manage New App-IDs Introduced in Content Releases
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/app-id/manage-new-app-ids-introduced-in-content-releases.html>
- Managing dynamic updates from Panorama
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-web-interface-help/panorama-web-interface/panorama-device-deployment/manage-software-and-content-updates>

Sample Questions

151. After an Applications and Threats dynamic update is downloaded to the firewall, where can information about changes to the App-IDs be found?
 - A. **Summary** link in the log event detail reporting the dynamic update file download
 - B. **Review Policies** link at the bottom of the Security policy rules display
 - C. **Review Apps** link appearing next to the downloaded Applications and Threats file
 - D. **Details** link in the dynamic file availability announcement appearing in the **News Feed** widget on the dashboard
152. The GlobalProtect Data File dynamic update contains which kinds of data?
 - A. GlobalProtect client package software updates for Windows and Macintosh
 - B. list of available connection points for Prisma Access
 - C. HIP check detection data for the GlobalProtect clients
 - D. updates to cypher suites used by the GlobalProtect client

153. When application details are viewed in the App-ID database, which field indicates that a recent change to the application might affect your Security policy rules?

- A. Name
- B. Depends on
- C. Previously Identified As
- D. App-ID Enabled

3.10 Identify the relationship between Panorama and devices as pertaining to dynamic updates versions and policy implementation and/or HA peers

You can use Panorama to qualify software and content updates by deploying them to a subset of firewalls, Dedicated Log Collectors, or WildFire appliances and appliance clusters before you install the updates on the rest of the firewalls. If you want to schedule periodic content updates, Panorama requires a direct internet connection. To deploy software or content updates on demand (unscheduled), the procedure differs based on whether Panorama is connected to the internet. Panorama displays a warning if you manually deploy a content update when a scheduled update process has started or will start within five minutes.

Panorama notifies the devices (firewalls, Log Collectors, and WildFire appliances) that updates are available. The devices then retrieve the update packages from Panorama. By default, devices retrieve updates over the management (MGT) interface on Panorama. However, you can configure Panorama to use multiple interfaces if you want to reduce the traffic load on the MGT interface by using another interface for devices to retrieve updates.

HA firewalls are expected to have the same version content updates. Firewalls that are in an HA pair each implement an update process. In cases of Panorama management of update files, Panorama should schedule an update for both HA peers individually.

Firewalls in an HA configuration normally automatically sync their configurations with each other. When one firewall performs a commit, the changes are communicated to the other firewall and a commit is automatically triggered, thus keeping them in sync. When Panorama manages an HA firewall set, this automatic update is disabled, with the sync responsibility now belonging to Panorama. An administrator must include the HA pair in any changes made and committed on Panorama.

Reference

- Managing dynamic updates from Panorama
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-web-interface-help/panorama-web-interface/panorama-device-deployment/manage-software-and-content-updates>

Sample Questions

154. How are HA firewall pairs kept in sync when Panorama pushes dynamic updates?
 - A. Panorama delivers the dynamic update to the active firewall(s) of the HA pair and updates the passive partner when a failover occurs in active/passive pairs.
 - B. Panorama delivers the update to one firewall, which syncs with its HA partner.
 - C. Panorama delivers the dynamic update to both firewalls simultaneously.
 - D. Panorama delivers the dynamic update to the active firewall, which triggers the passive partner to request the file from Panorama.
155. Which type of device can receive the Antivirus content update?
 - A. Log Collector
 - B. firewall
 - C. AutoFocus
 - D. MindMeld

156. Which requirement must a Panorama meet to update a managed firewall's antivirus signatures?
- A. The PAN-OS versions on the firewall and Panorama must be the same.
 - B. Panorama and the firewall must be able to connect to the Palo Alto Networks update server.
 - C. The update must be installed on Panorama before it is installed on any firewalls.
 - D. Panorama must download an antivirus file version compatible with the target firewall's PAN-OS version.

3.11 Identify the benefits and drawbacks to the various procedures to manage application-based rule application dependencies

Dependent Applications

Some applications within PAN-OS software depend on other applications, which means that if Application#1 is dependent on Application#2, then both Application#1 and Application#2 need to be allowed in the Security policy rule for the application to be allowed through the firewall. If applications dependencies are not included in a Security policy rule, then dependency warnings will appear in the **App Dependency** tab of the **Commit Status** window. For example, icloud-mail depends on icloud-base, therefore both applications need to be allowed in the Security policy for icloud-mail to work properly. Also, icloud-base depends on web-browsing, so the web-browsing application also needs to be added to the Security policy. Additional dependent applications are shown in the following figure.

Commit Warnings Due to Missing Dependencies

The screenshot shows the 'Commit Status' window with the following details:

- Operation:** Commit
- Status:** Completed
- Result:** Successful
- Details:** Configuration committed successfully

The 'App Dependency' tab is selected, highlighted by a black box. Below it, a table displays dependency information:

| Rule | Count | App | Detail |
|-------------|-------|-----------------------|--|
| allow-adobe | 3 | adobe-connectnow-base | <ul style="list-style-type: none">adobe-connectnow-base requires flash to be allowed.adobe-connectnow-base requires rtmp to be allowed.adobe-connectnow-base requires rttmp to be allowed. |

An arrow points from the number '3' in the 'Count' column to the 'Detail' section of the table.

Note: The **App Dependency** tab does not appear in the **Commit Status** window if there are no dependency warnings. Also note that the commit completed successfully even with an application missing a dependent application.

Determining Dependent Applications

You can see application dependencies when you are either creating or updating Security policy rule and when performing commits. When a policy does not include all application dependencies, you can directly access the associated Security policy rule to add the required applications. To determine whether an application has a dependency and what the dependency is before you create a Security policy rule,

navigate to **Objects > Applications**. The **Depends on** field will list whether an application has a dependency and which applications need to be included in your Security policy rule:

Application

Characteristics

- Name: icloud-mail
- Standard Ports: tcp/80,443,993,587
- Depends on: icloud-base, ssl, web-browsing
- Implicitly Uses:
- Deny Action: drop-reset
- Additional Information: iCloud Wikipedia Google Yahoo!

Dependencies

Options

- TCP Timeout (seconds): 3600
- TCP Half Closed (seconds): 120
- TCP Time Wait (seconds): 15
- App-ID Enabled: yes

SaaS Characteristics

- Certifications:
- Data Breaches: no
- IP Based Restrictions: no
- Poor Financial Viability: no
- Poor Terms Of Service: no

Classification

- Category: collaboration
- Subcategory: email
- Risk: 2

Tags

- Web App

Close

Another method to determine applications and their dependencies while creating or updating a Security policy rule is to use the **Depends On** panel on the **Applications** tab:

Security Policy Rule

General **Source** **User** **Destination** **Application** **Service/URL Category** **Actions**

Depends On

- flash
- rtmp
- rtmpt
- ssl
- web-browsing

Add To Current Rule **Add To Existing Rule**

Implicit Applications and Determining Implicit Applications

Some applications such as icloud depend on the web-browsing application to be specified in a Security policy. Sometimes you do not have to explicitly allow access to the dependent applications for the traffic to flow because the firewall can determine the dependencies and allow them implicitly. One example is google-base. To be able to use google-base, you do not have to add ssl or web-browsing to a Security policy.

To determine applications that specifically are used, navigate to **Objects > Applications**. The **Implicitly Uses** field will list the applications that are implicitly allowed as part of the application:

The screenshot shows the 'Application' configuration screen for the 'google-base' object. The 'Implicitly Uses' field contains 'ssl, web-browsing'. A blue arrow points from this field to the text 'Automatically permits'. Other fields shown include 'Name: google-base', 'Standard Ports: tcp/80,443,5222-5224,5228,5229', 'Depends on:', 'Deny Action: drop-reset', and 'Additional Information: Wikipedia Google Yahoo!'. The 'Characteristics' section includes fields like 'Evasive: no', 'Tunnels: yes', 'Other Applications: yes', 'Excessive Bandwidth Use: no', 'Prone to Misuse: no', 'Used by Malware: yes', 'Widely Used: no', 'Capable of File Transfer: yes', and 'Has Known Vulnerabilities: yes'. The 'Options' section includes 'TCP Timeout (seconds): 3600', 'TCP Half Closed (seconds): 120', 'TCP Time Wait (seconds): 15', and 'App-ID Enabled: yes'. The 'Classification' section lists 'Category: general-internet' and 'Subcategory: internet-utility'. The 'Risk' level is marked as 4. The 'Tags' section contains 'Web App'. Buttons for 'Edit' and 'Close' are at the bottom right.

References

Resolve Application Dependencies:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/app-id/use-application-objects-in-policy/resolve-application-dependencies.html>

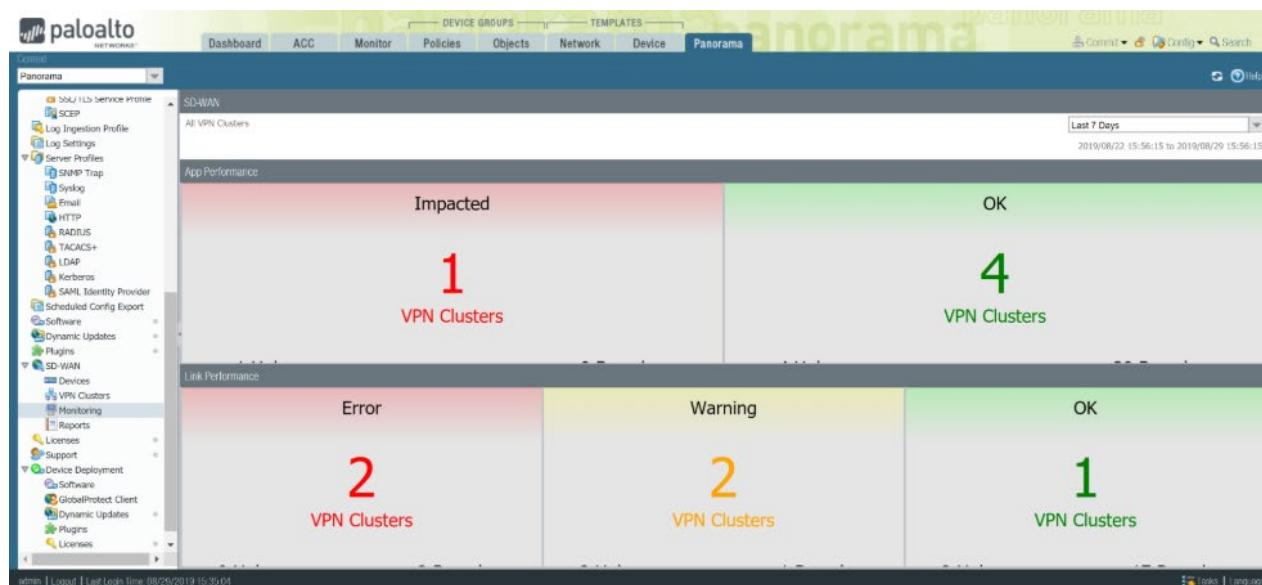
3.12 Identify how to monitor SD-WAN connection status and failovers in Panorama

You can monitor the application and link performance of your VPN clusters to troubleshoot issues by viewing summary information across all VPN clusters. You can gather more detailed information by drilling down to isolate the issues to affected sites, applications, and links. The landing dashboard displays the following information:

- **App Performance:**
 - **Impacted:** One or more applications in the VPN cluster meet or exceed the specified thresholds in the Path Quality Profile in the list of paths the firewall can choose from
 - **OK:** Number of VPN clusters, hubs, and branches that are experiencing no jitter, latency, or packet loss performance issues
- **Link Performance:**
 - **Error:** One or more sites in the VPN cluster have connectivity issues such as when a tunnel or a virtual interface (VIF) is down
 - **Warning:** Number of VPN clusters, hubs, and branches that have links with jitter, latency, or packet loss performance measurements that exceed the moving seven-day average value of the metric
 - **OK:** Number of VPN clusters, hubs, and branches that are experiencing no jitter, latency, or packet loss performance issues

From the landing dashboard, you can narrow the view to impacted applications or links that have the **Error** or **Warning** status. You then can select an affected site to view site-level details.

Select **Panorama > SD-WAN > Monitoring** on the landing dashboard to view health status summaries of your VPN clusters, hubs, and branches:



For more detailed information, click an **App Performance** or **Link Performance** summary that indicates **Impacted**, **Error**, or **Warning** counts to view a list of sites and their status based on latency, jitter, and packet loss:

The screenshot shows the Panorama SD-WAN monitoring interface. The left sidebar navigation includes: Dashboard, ACC, Monitor, Policies, Objects, Network, Device, and Panorama. Under the Panorama section, Monitoring is selected. The main content area displays a table titled 'SD-WAN' with the following columns: Sites, VPN Cluster, Profile, Links, Link Notifications, Latency, Jitter, Packet Loss, Apps, and Impacted Apps. The table lists various sites and their corresponding VPN clusters, profiles, and performance metrics. A search bar at the top allows filtering by 'Link Performance' or 'Error' and 'Sites'.

| Sites | VPN Cluster | Profile | Links | Link Notifications | Latency | Jitter | Packet Loss | Apps | Impacted Apps |
|--------------------|-------------|---------|-------|--------------------|-----------------|----------------------|-----------------|------|-----------------|
| cluster-1-site-4 | cluster-1 | branch | 4 | 0 | OK | OK | OK | 13 | 0 |
| cluster-1-site-5 | cluster-1 | branch | 4 | 0 | OK | OK | OK | 13 | 0 |
| cluster-3-site-1 | cluster-3 | hub | 4 | 0 | OK | OK | OK | 13 | 0 |
| cluster-1-site-2 | cluster-1 | branch | 4 | 338 | OK | OK | OK | 13 | 0 |
| cluster-1-site-3 | cluster-1 | branch | 4 | 0 | OK | OK | OK | 13 | 0 |
| cluster-1-site-1 | cluster-1 | hub | 4 | 0 | OK | OK | OK | 13 | 13 |
| cluster-3-site-4 | cluster-3 | branch | 4 | 0 | OK | OK | OK | 13 | 0 |
| + cluster-3-site-5 | cluster-3 | branch | 4 | 0 | OK | OK | OK | 13 | 0 |
| cluster-3-site-2 | cluster-3 | branch | 4 | 318 | OK | Warning | OK | 13 | 0 |
| cluster-3-site-3 | cluster-3 | branch | 4 | 0 | OK | OK | OK | 13 | 0 |

Click a site that displays **Warning** or **Error** to view the VPN cluster. The site data displays **App Performance** and **Link Performance**, including the impacted applications. Also use the **Sites** filter to view VPN clusters based on link notifications, latency deviations, jitter deviations, packet loss deviations, or impacted applications.

On the **App Performance** or **Link Performance** window, click **PDF/CSV** to export the detailed health information for the application or link in the VPN cluster in PDF or CSV format.

Monitor SD-WAN Application and Link Performance:

<https://docs.paloaltonetworks.com/sd-wan/1-0/sd-wan-admin/monitoring-and-reporting/monitor-sd-wan-application-and-link-performance.html#id0da9d23d-ddef-4a13-8041-4e12c6ff62ab>

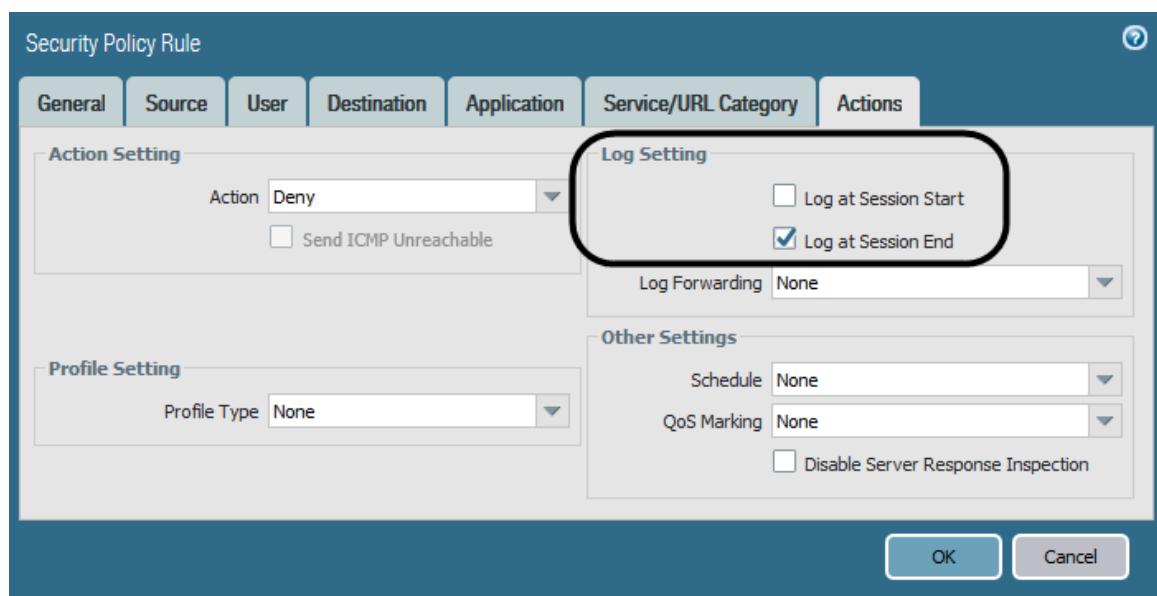
Exam Domain 4 – Configuration Troubleshooting

4.1 Identify system and traffic issues using the web interface and CLI tools

Palo Alto Networks firewall troubleshooting involves a wide range of specific knowledge that depends on the type of issue being presented. This section introduces a few principle tools and methods available for troubleshooting. The end of this section includes references for other tools and topics. Dedicated training classes for firewall troubleshooting also are available from Palo Alto Networks and Training Partners.

Transit Traffic Not Passing Through as Expected

If traffic is not transiting a firewall as expected, three primary information sources are available in the management web interface: the Traffic log, the Session Browser, and traffic capture features, which are described in the following sections.



If you believe that the traffic to be evaluated has been received by the firewall, initial investigation should begin with the Traffic log. The Traffic log can be found at **Monitor > Logs > Traffic**. The default behavior of the firewall is to create a summary entry for each session when it ends. This behavior is controlled by the **Log Setting** field included on the **Actions** tab of each Security policy rule. Because each Security policy rule has its own logging configuration, different rules can be configured to log information in different ways.

If the traffic in question includes at least one closed session, then an entry for the session should appear in the Traffic log. You can display detailed information about that session by clicking the **magnifying glass** icon in the left column:

| | Receive Time | Type | From Zone | To Zone | Source | Source User | Destination | To Port | Application | Action | Rule | Session End Reason | Bytes |
|---|----------------|------|-----------|------------|--------------|-------------|--------------|---------|-------------|--------|----------|--------------------|-------|
| 1 | 07/02 12:51:12 | end | Trusted | Untrust... | 192.168.1.30 | | 184.16.33.54 | 53 | dns | allow | Safe DNS | aged-out | 226 |
| 2 | 07/02 12:51:12 | end | Trusted | Untrust... | 192.168.1.30 | | 184.16.33.54 | 53 | dns | allow | Safe DNS | aged-out | 266 |
| 3 | 07/02 12:51:12 | end | Trusted | Untrust... | 192.168.1.30 | | 184.16.33.54 | 53 | dns | allow | Safe DNS | aged-out | 186 |

The following screenshot shows the details of one of the entries listed:

The screenshot displays the 'Detailed Log View' window with four main sections: General, Source, Destination, and Flags. The General section includes fields like Session ID (43209), Action (allow), and Rule (Safe DNS). The Source section shows details such as Source User (192.168.1.30), Country (United States), and Port (60185). The Destination section lists Destination User (184.16.33.54), Country (United States), and Port (53). The Flags section contains various checkboxes for session characteristics.

| General | | Source | | Destination | |
|--------------------|---------------------|-------------|---------------|------------------|-------------------|
| Session ID | 43209 | Source User | 192.168.1.30 | Destination User | 184.16.33.54 |
| Action | allow | Country | United States | Country | United States |
| Action Source | from-policy | Port | 60185 | Port | 53 |
| Application | dns | Zone | Trusted | Zone | UntrustedFrontier |
| Rule | Safe DNS | Interface | ethernet1/1 | Interface | ethernet1/8 |
| Session End Reason | aged-out | NAT IP | 50.53.174.178 | NAT IP | 184.16.33.54 |
| Category | any | NAT Port | 49719 | NAT Port | 53 |
| Virtual System | | | | | |
| Device SN | | | | | |
| IP Protocol | udp | | | | |
| Log Action | | | | | |
| Generated Time | 2018/07/02 12:51:12 | | | | |
| Start Time | 2018/07/02 12:50:43 | | | | |
| Receive Time | 2018/07/02 12:51:12 | | | | |
| Elapsed Time(sec) | 0 | | | | |
| Tunnel Type | N/A | | | | |

| Details | |
|------------------|-----|
| Type | end |
| Bytes | 226 |
| Bytes Received | 141 |
| Bytes Sent | 85 |
| Repeat Count | 1 |
| Packets | 2 |
| Packets Received | 1 |
| Packets Sent | 1 |

| Flags | |
|-------------------|--------------------------|
| Captive Portal | <input type="checkbox"/> |
| Proxy Transaction | <input type="checkbox"/> |
| Decrypted | <input type="checkbox"/> |
| Packet Capture | <input type="checkbox"/> |
| Client to Server | <input type="checkbox"/> |
| Server to Client | <input type="checkbox"/> |
| Symmetric Return | <input type="checkbox"/> |
| Mirrored | <input type="checkbox"/> |
| Tunnel Inspected | <input type="checkbox"/> |
| MPTCP Options | <input type="checkbox"/> |
| Recon excluded | <input type="checkbox"/> |
| Decrypt Forwarded | <input type="checkbox"/> |

The presence of a log entry confirms that properly formed traffic has reached the firewall and has been evaluated by a Security policy rule. Traffic could be processed without reaching a session end, which would result in no log entry yet. The Session Browser allows troubleshooting of open sessions that might not have been logged yet.

The detailed session information should be used to evaluate the handling of the traffic. The **Source** and **Destination** sections display header data and confirm potential NATs being applied. The **General** section confirms the action taken by the Security policy rule and the rule's name, App-ID, protocol, time seen, and the reason the session ended. The **Details** section shows the packet summary for the reported session, including counts and size.

Examination of this information often confirms the firewall's handling of the traffic and might show unexpected behavior to correct, as required.

After a session has not ended and no Traffic log entry has been made, you can use the Session Browser to display all open sessions currently known to the firewall. You can expand each session and examine details.

| Start Time | From Zone | To Zone | Source | Destination | From Port | To Port | Protocol | State | Application |
|----------------|-------------------|-------------------|--------------|----------------|-----------|---------|----------|---------|--------------|
| 07/02 13:08:49 | Trusted | UntrustedFrontier | 192.168.1.41 | 162.125.32.135 | 63235 | 443 | 6 | ACTIVE | dropbox-base |
| 07/02 12:40:10 | Trusted | UntrustedFrontier | 192.168.1.36 | 74.125.124.189 | 63017 | 443 | 6 | ACTIVE | google-base |
| 07/02 11:38:13 | Trusted | UntrustedFrontier | 192.168.1.35 | 74.125.69.188 | 47919 | 5228 | 6 | ACTIVE | google-base |
| 06/27 12:22:57 | Trusted | UntrustedFrontier | 192.168.1.68 | 34.205.245.8 | 60977 | 443 | 6 | ACTIVE | ssl |
| 07/02 13:08:10 | UntrustedFrontier | UntrustedFrontier | 46.161.27.30 | 50.53.174.178 | 35757 | 8545 | 6 | DISCARD | undecided |

When troubleshooting requires the examination of actual packet contents, a packet capture can be performed on the firewall and subsequently downloaded as a pcap-formatted file ready for external software consumption. Packet capture settings are found under **Monitor > Packet Capture**.

| Stage | File | Byte Count | Packet Count |
|---------|------|------------|--------------|
| receive | rx | | |

Following is a description of a suggested package capture use sequence.

Clearing Existing Settings

The **Clear All Settings** option turns off packet capture and clears all packet capture settings, including

filters and capture stages. It also clears settings for any advanced debug-level packet-diagnostics features, such as flow basic, for which there are no controls or status indicators in the web interface. Use of **Clear All Settings** does not turn off automated packet captures associated with any active Security Profiles.

Warning: If you manually clear just the filters while another firewall administrator is actively running a capture, the running capture will start to capture all packets, with no filters. Before you clear any existing filters, confirm that the filters are not being used. If another administrator has saved filters that are meant to be used later, you can disable those filters rather than delete them. Use of **Clear All Settings** will clear all filters and turn off all captures.

Configuring and Turning on the Filters

You must configure and turn on filtering and then turn on packet capture before any sessions that you want to capture have been initiated. Existing sessions will not be marked for capture.

Adding Stages and Filenames

Filtering alone is not resource-intensive, whereas turning on packet capture and/or turning on debug-level logging is resource intensive. Therefore, the decision whether to configure your capture stages before or after turning on filtering generally is not that important.

You can, for example, configure your filters, turn them on, and then monitor them using CLI commands for session volume before you complete the rest of the configuration. To monitor the number of marked sessions, use the CLI command **show counter global filter delta yes packet-filter yes**. Execute the command once and then a second time to see the difference (the delta) from the prior execution of the command.

Tip: To analyze “inside” and “outside” sessions within a single file, you can configure the receive and transmit stages to write to the same filename, which will result directly in a merged pcap file.

When you configure a capture stage, you can specify the maximum number of bytes and/or the maximum number of packets, after which capturing stops.

A brief description of the four available capture stages follows:

- **Receive stage:** The firewall produces receive-stage packet captures by applying the capture filter(s) on a packet-per-packet basis. Receive-stage captures include all packets captured by the firewall’s logical interfaces. Receive-stage captures can help you determine whether a packet is reaching the firewall.

However, because of potential hardware offloading and pre-parse discards, a receive-stage capture may not produce exactly the same results as would physically tapping the wire just outside the correct physical ingress port of the firewall.

The receive stage will not capture both flows of a session unless the filter configuration matches to traffic in each direction.

- **Firewall stage:** On firewalls running PAN-OS 8.0 and earlier, packets captured at the firewall and transmit stages will be captured when the corresponding session has been matched to a capture-filter statement. Firewalls running PAN-OS 8.1 and later capture packets at the firewall and

transmit stages by the same effective logic (though not exactly the same) as the receive stage, that is, only if the individual flow (c2s or s2c) matches the filter configuration.

Firewall-stage capture shows you what is inside the box. The firewall-stage capture point is post-ingress, post-session-setup, and pre-NAT.

The flow logic of the firewall stage itself applies NAT as the last or nearly last step of Layer 2-to-Layer 4 packet processing and before any Layer 7 packet-payload content analysis begins. The IP addresses of packets captured by the firewall stage will match the pre-NAT addressing as defined in the session table. Also, packets that the firewall drops because of Layer 2-to-Layer 4 processing (such as packets dropped because of a session-closed status) will appear in the drop-stage pcap with pre-NAT addressing.

Packets that the firewall drops because of a “deny” action triggered by a Security policy or Security Profile will appear in the drop-stage pcap with post-NAT addressing.

If NAT is involved, the packet-threading features or flow-following or stream-following features of packet analyzers will not work for firewall-stage pcaps. With NAT, packet threading is possible only if you configure the receive-stage and transmit-stage pcaps and then merge them. You can make the firewall automatically merge receive-stage and transmit-stage pcaps by configuring them with the same filename.

- **Drop stage:** The drop-stage packet capture is perhaps best thought of as the result of a logging event, instead of a traditional off-the-wire packet capture. Packets in the drop-stage capture are captured after the capture point of the stage that drops the packet. Thus, packets in the drop-stage capture also will be found in the pcap for the stage from which the packet was dropped.

A packet dropped in the receive stage will appear in both the drop-stage pcap and the receive-stage pcap. You also typically will find packets that fail the initial session setup process in both the receive-stage and drop-stage pcaps. Packets dropped by or subsequent to the firewall stage will be found in both the drop-stage and firewall-stage pcaps.

Drop-stage pcaps comprise copies of individual packets that are dropped. Drop-stage pcaps do not include prior or subsequent packets for contextual analysis. Drop-stage pcaps include only the exact packets dropped. If you want to better understand why a packet has been dropped, query the global counters, review log data, and run additional debug-level packet-diagnostic features such as flow basic.

- **Transmit stage:** Capture of packets at the transmit stage shows you packets as they egress from the firewall’s logical interface. In transmit-stage pcaps you can see block pages, resets, TCP MSS adjustments, and any other packets or packet transformations created by the firewall itself, including post-NAT addressing.

Pre-Parse-Match Option

After a packet enters the ingress port, the firewall performs several basic pre-processing tests to ensure that the packet is viable before it is received for subsequent session setup and/or additional firewall processing. The firewall discards packets that fail these basic tests before the packet reaches the point

where it is matched against the capture and debug-log filters. For example, if a route lookup fails, a packet never will reach even the initial (receive) capture filter.

To capture packets that normally would be discarded before the filter match, the system emulates an initial, “pre-parse” positive match for every packet entering the system. This initial “match” allows all packets to be filtered subsequently by the normal receive-stage filtering process. The pre-parse match option is resource intensive. You should consider using it only for advanced or otherwise rare troubleshooting purposes. Palo Alto Networks recommends that you use this option only under direct advice and guidance from technical support.

Troubleshooting of route-lookup failures is the typical use case that may require use of the pre-parse option. However, such errors typically are easy to identify using the firewall’s interface counters.

To enable the pre-parse match option in the CLI, use the command **debug dataplane packet-diag set filter pre-parse-match yes**.

Turning On Capture

After you turn on packet capture, you can monitor the capture in other ways to see if you are actively capturing any traffic:

- Refresh the Packet Capture page in the web interface and look first for the existence of new capture files, and then for their file size. You can refresh the page repetitively to monitor any growth in the file size.
- Use the CLI to show the current packet-diagnostics settings by running the **debug dataplane packet-diag show setting** command. The bottom of the settings summary includes the same data displayed in the **Captured Files** section of the Packet Capture page in the web interface.
- Monitor currently marked sessions, in addition to verifying that the capture-stage files are growing

Turning Off Capture and Then Filtering

Turn off the packet capture before turning off filtering to avoid suddenly capturing all packets. You also may want to monitor any currently marked sessions using the CLI to ensure that the session(s) that you want to capture have finished. To show marked sessions, use the **CLI command show counter global filter delta yes packet-filter yes**. To show the detailed status of a session, use the command **show session id [number]**.

Exporting and Downloading pcaps

Export of pcaps from the web interface is a simple matter of clicking the hyperlink associated with the filename of the pcap you want to export. You can export pcaps from the CLI and display them in a similar way as you would use **tcpdump** within a Linux console.

The Palo Alto Networks firewall CLI offers access to more debugging information and often is used by experienced administrators for troubleshooting. This section provides only a brief mention of basic CLI tools. See the “References” section for more complete information sources.

Connection to the CLI is possible using a serial console emulator or SSH connecting through the management port. The account used for firewall authenticating into the CLI must have CLI access enabled.

After you log in to the CLI, the command prompt by default is in *operational* mode. The commands available within the context of operational mode include basic networking commands such as **ping** and **traceroute**, basic system commands such as **show**, and more advanced system commands such as **debug**. Debug commands allow you to set parameters that, if improperly used, can cause system failure. Commands to shut down and restart the system also are available from within operational mode.

Configuration mode enables you to display and modify the configuration parameters of the firewall, verify candidate configuration, and commit the configuration. Access it by typing the command **configure** while in operational mode.

CLI mode offers access to data not available in the web interface. Additional log files written by various subsystems of the firewall are available. Large files such as log files can be displayed with four principle commands: **show**, **tail**, **less**, and **grep**. A partial list of useful log files for troubleshooting can be found in the “References” section.

The **show** command is the main method to display values and settings. In operational mode begin by typing show, a space, and then press the **Tab** key to invoke the autocomplete function, which show all available options for the **show** command. Examine this list and explore options to become familiar with accessing settings and values for troubleshooting. The command **show interface all** displays a summary of all configured interfaces, their link status, and assigned zones. The command **show system resources** displays the overall resources utilization status of the firewall. For troubleshooting purposes, the **test** command shows the results when simulated traffic is presented to various subsystems. For example, the command **test security-policy-match...** shows the security processing of the simulated traffic described at the end of the command. The command **test routing...** predicts the virtual router’s handling of the simulated traffic. Many **test** commands are available that can be found by entering **test** followed by a space and then the **Tab** key for the autocomplete listing of options.

Packet captures also can be performed at the command line level. The same packet capture engine explored earlier through the web interface can be accessed from the CLI. Each configuration step used in the web interface has a command line equivalent. See the “References” section for the location of a detailed discussion.

References

- Log Types and Severity Levels
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/monitoring/view-and-manage-logs/log-types-and-severity-levels.html>
- Monitor > Logs
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-web-interface-help/monitor/monitor-logs.html>

- CLI Cheat Sheet: Device Management
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-cli-quick-start/cli-cheat-sheets/cli-cheat-sheet-device-management.html>
- CLI Cheat Sheet: Networking
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-cli-quick-start/cli-cheat-sheets/cli-cheat-sheet-networking.html>
- Interpret VPN error messages
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/vpns/set-up-site-to-site-vpn/interpret-vpn-error-messages.html>

Sample Questions

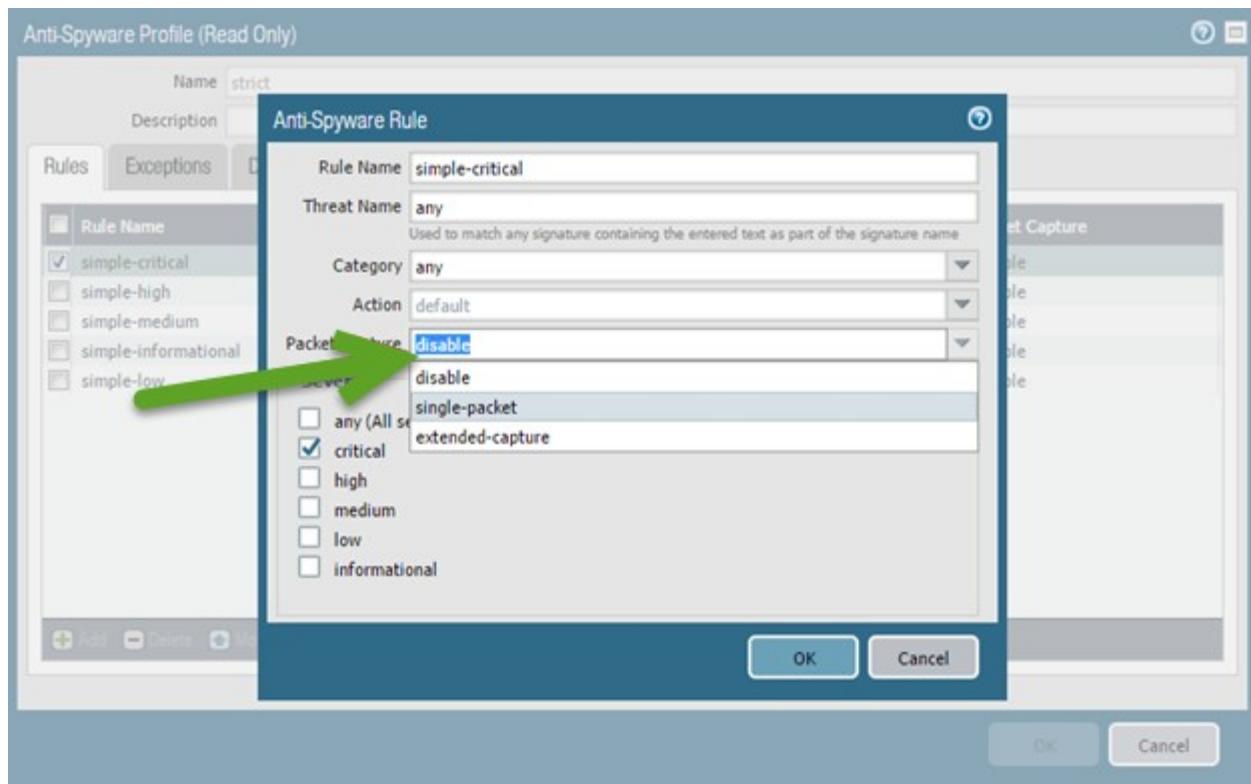
157. If users cannot access their Gmail accounts through the firewall, which log and filter do you use to troubleshoot the problem?
- A. Traffic, (app eq gmail)
 - B. Traffic, (app in gmail)
 - C. Configuration, (app eq gmail)
 - D. Configuration, (app in gmail)
158. You cannot access the firewall web interface. From the firewall CLI, how do you check to see if the web service is running?
- A. ps -aux | grep appweb
 - B. ps -aux | match appweb
 - C. show system software status | grep appweb
 - D. show system software status | match appweb
159. Which firewall log displays information about connection failures to an external LDAP authentication server?
- A. Traffic
 - B. System
 - C. User-ID
 - D. Authentication

4.2 Given a session output, identify the configuration requirements used to perform a packet capture

Palo Alto Networks firewalls can capture traffic automatically in response to threat detection or you can manually perform a packet capture on network threats. Packet capture tools are available in the web interface and CLI.

Automatic Threat Detection Captures

Automatic packet captures can be triggered in response to threat detection. When Security Profiles are created, configuration settings can include an automatic packet capture of the detected threat. All threat-detecting Security Profiles have this capability. The following figure displays how to configure an automatic packet capture response when spyware is detected:



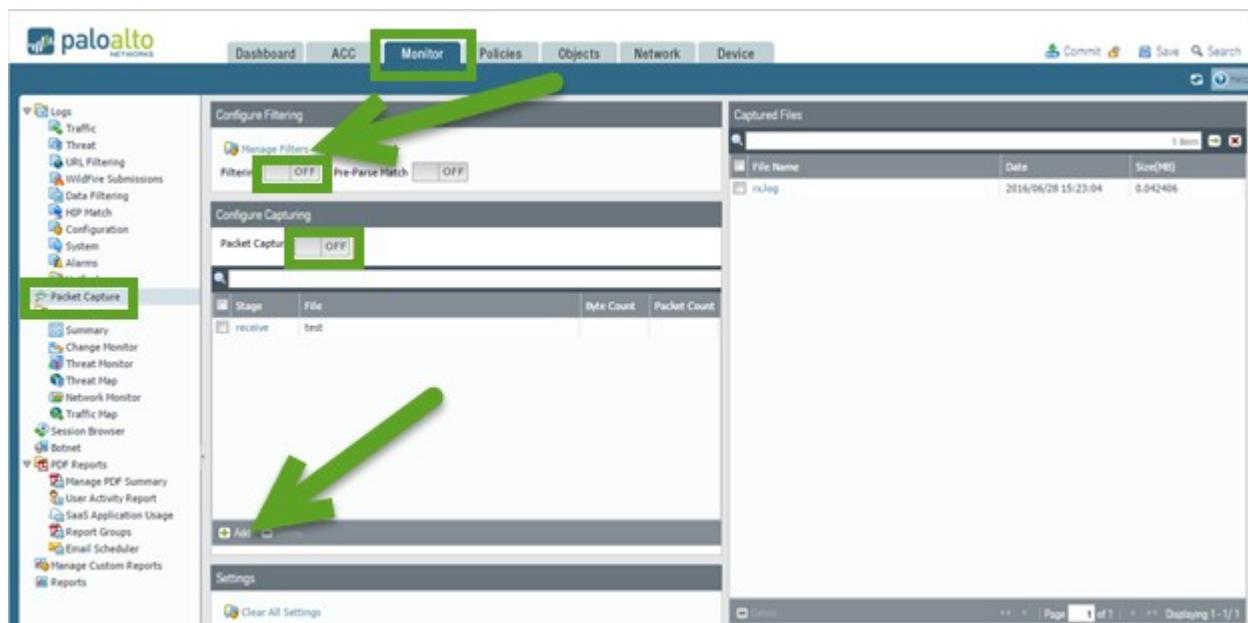
Information about configuring threat detection packet captures and accessing the captured data is here:
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/monitoring/take-packet-captures/take-a-threat-packet-capture.html>

Data Filtering Security Profiles can take captures of configured patterns. Because this data might be highly sensitive, special password protections are provided for these stored packet captures. Details are here:

<https://knowledgebase.paloaltonetworks.com/KCSArticleDetail?id=kA10g000000ClvICAC>

Manual Packet Captures

Packet captures can be conducted on demand both from the web interface and the CLI. Web interface captures are configured using the **Monitor > Packet Capture** option. This packet capture process will *not* capture management interface traffic. The following image shows configuration options to create a web interface capture and turn it on or off. Captured traffic is stored on the firewall and is available for download as a pcap file usable by many protocol analysis software packages. The capture configuration follows:



The PAN-OS web interface provides access to traffic packet captures. Additional pcap and debug tools are available through the CLI.

Complete information about the configuration and use of this feature is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/monitoring/take-packet-captures/take-a-custom-packet-capture.html>

Note: Some Palo Alto Networks firewalls include a Hardware Offload feature that optimizes the handling of traffic. Offloaded traffic will not appear in packet captures in either the web interface or the CLI. PA-3050, PA-3060, PA-5000 Series, PA-5200 Series, and PA-7000 Series firewalls have this feature. To guarantee that all packets are available for capture, a CLI command must be run to temporarily disable Hardware Offload. See the following information for details and disclosures about CPU impact.

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/monitoring/take-packet-captures/disable-hardware-offload.html>

Note: Management interface traffic cannot be captured by the previously mentioned CLI tools. The **tcpdump** command is the only tool with visibility to this traffic.

Sample Questions

160. Which Security Profile does not have a packet capture option?
 - A. Antivirus
 - B. Anti-spyware
 - C. Vulnerability Protection
 - D. URL Filtering
161. On a PA-7080, which feature do you need to disable to use packet capture?
 - A. NAT
 - B. hardware offload
 - C. hardware acceleration
 - D. decryption
162. When must you use **tcpdump** to capture traffic on the next-generation firewall?
 - A. on tunnel interface traffic
 - B. on data-plane interfaces
 - C. packets on the management interface
 - D. on IPsec negotiation traffic

4.3 Given a scenario, identify how to troubleshoot and configure interface components

PAN-OS software supports a variety of interface configuration options. The network interfaces on a firewall are in two general types: traffic ports and the management port.

Traffic Ports

Traffic ports provide multiple configuration options with the ability to pass traffic through to other ports via traffic-handling objects (virtual routers, virtual wires, and VLANs).

Management Port

The management port is isolated from internal connectivity for security purposes. If the management port requires internet access, its traffic must be routed out of the firewall and through other network infrastructure that provides this connectivity. The traffic often is routed back to a traffic port on the firewall requiring appropriate Security policy rules for access. This traffic is treated like any other transit traffic, which means that you must configure Security policy rules to allow the traffic to pass.

This management traffic can be routed through alternate ports. A discussion is here:

<https://knowledgebase.paloaltonetworks.com/KCSArticleDetail?id=kA10g000000CIGJCA0>

Troubleshooting Tools

There are several important tools for troubleshooting traffic flow through the firewall. A best practice in troubleshooting is to separate general connectivity issues from those of security. Connectivity issues should be resolved before security processing is evaluated.

The web interface provides several important tools. The path **Monitor > Logs > Traffic** provides session summary information. Log entries for traffic are generated as specified in Security policy rules. The typical configuration specifies that log entries are created when a session ends. Use the magnifying glass icon to examine this log entry for detail:

Detailed Log View

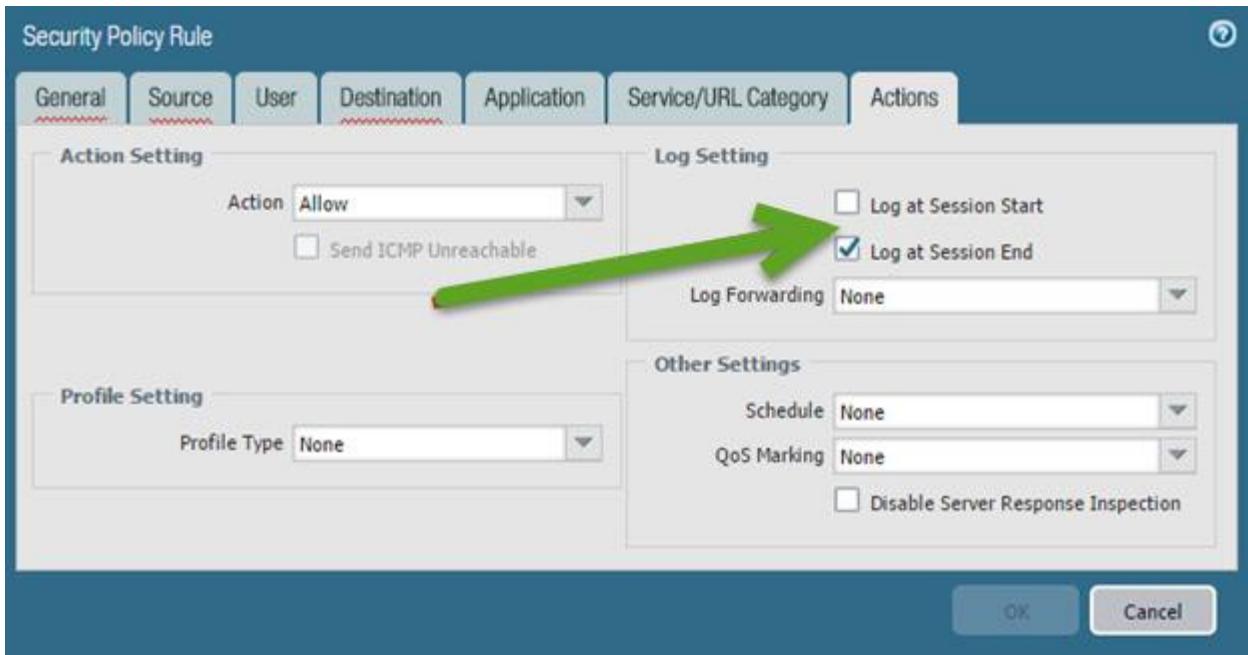
| General | Source | Destination | | | | | | | | |
|---|--|---|-------------|--------|-----------------|-------|----------|----------|-----|-----------|
| Session ID: 37892 Action: allow Action Source: from-policy Application: dns Rule: Safe DNS Access Session-End Reason: aged-out Category: any Virtual System: Device SN: IP Protocol: udp Log Action: Generated Time: 2016/07/26 09:34:43 Start Time: 2016/07/26 09:34:14 Receive Time: 2016/07/26 09:34:43 Elapsed Time(sec): 0 | User: 192.168.2.72 Address: 192.168.2.72 Country: United States Port: 2064 Zone: Trusted Interface: ethernet1/4 NAT IP: 192.168.1.100 NAT Port: 10849 | User: 198.224.167.135 Address: 198.224.167.135 Country: United States Port: 53 Zone: Untrusted_Verizon Interface: ethernet1/1 NAT IP: 198.224.167.135 NAT Port: 53 | | | | | | | | |
| Details Bytes: 470 Bytes Received: 315 Bytes Sent: 155 Repeat Count: 1 Packets: 4 Packets Received: 2 Packets Sent: 2 | | | | | | | | | | |
| Flags <input type="checkbox"/> Captive Portal <input type="checkbox"/> Proxy Transaction <input type="checkbox"/> Decrypted <input checked="" type="checkbox"/> Packet Capture <input type="checkbox"/> Client to Server <input type="checkbox"/> Server to Client <input type="checkbox"/> Symmetric Return <input type="checkbox"/> Mirrored | | | | | | | | | | |
| PCAP | Receive Time | Type | Application | Action | Rule | Bytes | Severity | Category | URL | File Name |
| | 2016/07/26 09:34:43 | end | dns | allow | Safe DNS Access | 470 | | any | | |

Close

Log Entry Detail

Log entry details include much information for troubleshooting: the Security action, the firewall policy allowing it through, the assigned App-ID, zones, and the ingress and egress interfaces. NAT details and flags attesting to other handling details also appear. Examine this data to get valuable insight into the firewall's processing of this traffic from both connectivity and security processing views.

This data typically is written at session end, but logging settings can specify log entries be created at session initiation time. This practice drives more log volume, but it can provide critical data in certain situations. Configure **Log at Session Start** temporarily during troubleshooting to provide more information and gain insight:



The temporary enabling of logging session initiation time can aid in troubleshooting.

You also can display open sessions using the **Monitor > Session Browser** display:

| Start Time | From Zone | To Zone | Source | Destination | From Port | To Port | Protocol | Application | Duration |
|-----------------------|-----------------|------------------|--------------|----------------|-----------|---------|----------|--------------------------|-------------|
| 07/26/09:29:07 | Trusted | Untrusted_Ce... | 192.168.2.24 | 166.78.79.129 | 51219 | 995 | 6 | sql | 0:00:00.000 |
| 07/26/09:43:34 | Trusted | Untrusted_Ver... | 192.168.2.1 | 205.171.3.65 | 43876 | 53 | 17 | dns | 0:00:00.000 |
| | | | | | | | | | |
| Detail | | | | | | | | | |
| Session ID | 38449 | | | | | | | | |
| Timeout | 30 | | | | | | | | |
| Virtual System | veyst1 | | | | | | | | |
| Application | dns | | | | | | | | |
| Protocol | 17 | | | | | | | | |
| Session Rule | Safe DNS Access | | | | | | | | |
| NAT Source | True | | | | | | | | |
| NAT Destination | False | | | | | | | | |
| NAT Rule | Verizon NAT | | | | | | | | |
| QoS Rule | N/A | | | | | | | | |
| QoS Rule | N/A | | | | | | | | |
| Created By Sym Cookie | | | | | | | | | |
| To Host Session | | | | | | | | | |
| Traverse Tunnel | | | | | | | | | |
| Captive Portal | | | | | | | | | |
| Session End Log | | | | | | | | | |
| Session Age | | | | | | | | | |
| Session From Ha | | | | | | | | | |
| | | | | | | | | | |
| 07/25/09:51:27 | Trusted | Untrusted_Ce... | 192.168.2.22 | 17.118.227.102 | 49613 | 5223 | 6 | apple-push-notifications | 0:00:00.000 |
| 07/26/09:43:39 | Trusted | Untrusted_Ce... | 192.168.2.24 | 157.56.144.216 | 61059 | 2544 | 17 | teredo | 0:00:00.000 |

The **Clear** check box at the end of a session summary line can be used to end the session immediately, which often generates the desired log entry.

The CLI **show** commands will assist with troubleshooting. The web interface traffic capture and CLI pcap and debug functions give greater visibility to system-level operation for troubleshooting. A complete discussion about packet captures is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/monitoring/take-packet-captures.html>

Connectivity issues often arise from unexpected traffic forwarding decisions. You can view forwarding decisions after you display the Layer 3 routing and forwarding tables in the web interface:

The screenshot shows a table titled "DefaultGateway" under the "Virtual Routers" section of the navigation menu. The table has columns for Name, Interfaces, Configuration, RSP, OSPF, OSPFv3, BGP, and Policies. The "Interfaces" column lists "ethernet1/1", "ethernet1/2", "ethernet1/3", "ethernet1/4", and "loopback0". The "Configuration" column shows "Static Routes: 5" and "EIGRP status: Disabled". A green button labeled "More Runtime Stats" is visible in the top right corner of the table area.

Display the specific virtual router's routing and forwarding tables with the **More Runtime Stats** link.

Note that policy-based forwarding (PBF) policy rules can override routing decisions and must be considered when you troubleshoot connectivity. The routing and forwarding tables mentioned do *not* show the effects of existing PBF policy rules. PBF troubleshooting is best done on the CLI; `show` commands can display existing PBF policies and whether they are active. The `test pbf-policy-match` command will show the application of existing PBF policies on modeled traffic.

Sample Questions

163. Where in the firewall web interface can you see whether sessions are going through a specific interface?
 - A. Dashboard
 - B. Application Command Center (ACC)
 - C. Session Log node on the **Monitor** tab
 - D. Session Browser on the **Monitor** tab
164. Communication through a specific interface works most of the time but fails when traffic throughput is at its highest. Which policy do you consult to identify the problem?
 - A. Security
 - B. DoS Protection
 - C. QoS
 - D. Application Override
165. Which interface type allows you to add a firewall with the least disruption to a network?
 - A. tap
 - B. Layer 3
 - C. Layer 2
 - D. virtual wire

4.4 Identify how to troubleshoot SSL decryption failures

PAN-OS software can decrypt and inspect inbound and outbound SSL connections going through the Palo Alto Networks firewall. SSL decryption can occur on interfaces in Virtual Wire, Layer 2, or Layer 3 mode by using the SSL rulebase to configure which traffic to decrypt. Decryption can be based on URL categories and source user and source or target addresses. After traffic is decrypted, tunneled applications can be detected and controlled, and the decrypted data can be inspected for threats, URL filtering, file blocking, or data filtering. Decrypted traffic never is sent off the device.

References

- Decryption Overview
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/decryption/decryption-overview.html>
- How to Implement and Test SSL Decryption
<https://knowledgebase.paloaltonetworks.com/KCSArticleDetail?id=kA10g000000CIEZCA0>

Sample Questions

166. Why would SSL decryption that has been working for a customer suddenly stop?
 - A. The firewall's CA certificate expired.
 - B. The firewall's IP address, which is encoded in the certificate, changed.
 - C. The firewall has been upgraded to a different model.
 - D. The firewall's decryption subscription expired.
167. A company uses a small SaaS application provider. This application is accessed through HTTPS but suddenly stops working through the firewall. However, when the application is accessed from home, users receive an error about the certificate. Which two situations would explain this behavior? (Choose two.)
 - A. The SaaS's certificate had expired. The firewall's decryption policy is configured to block connections with expired certificates.
 - B. The SaaS's certificate had expired. The firewall's decryption policy is configured to use the untrusted CA with expired certificates.
 - C. The SaaS's certificate was replaced with one whose certificate authority is not known to the firewall. The firewall's decryption policy is configured to block connections with certificates whose CA is not trusted.
 - D. The SaaS's certificate was replaced with one whose certificate authority is not known to the firewall. The firewall's decryption policy is configured to use the untrusted certificate for certificates whose CA is not trusted.
 - E. The firewall's own CA certificate needs to be updated.
168. Which encryption algorithm is not supported by the firewall and causes the firewall to drop the connection?
 - A. DES
 - B. 3DES
 - C. AES252-CBC
 - D. AES256-GCM

4.5 Identify issues with the certificate chain of trust

Keys are strings of numbers that typically are generated using a mathematical operation involving random numbers and large primes. Keys are used to transform other strings (such as passwords and shared secrets) from plaintext to ciphertext (a process called encryption) and from ciphertext to plaintext (a process called decryption). Keys can be symmetric (the same key is used to encrypt and decrypt) or asymmetric (one key is used for encryption and a mathematically related key is used for decryption). Any system can generate a key.

X.509 certificates are used to establish trust between a client and a server to establish an SSL connection. The certificate contains either the FQDN of the server or its IP address in the common name (CN) field. All certificates must be issued by a certificate authority (CA). After the CA verifies a client or server, the CA issues the certificate and signs it with the CA's private key. The client already has the CA's public key to verify those signatures.

With a Decryption policy configured, a session between the client and the server is established only if the firewall trusts the CA that signed the server certificate. To establish trust, the firewall must have the server root CA certificate in its certificate trust list (CTL) and use the public key contained in that root CA certificate to verify the signature. The firewall then presents a copy of the server certificate signed by the Forward Trust certificate for the client to authenticate. You also can configure the firewall to use an enterprise CA as a forward trust certificate for SSL Forward Proxy. If the firewall does not have the server root CA certificate in its CTL, the firewall will present a copy of the server certificate signed by the Forward Untrust certificate to the client. The Forward Untrust certificate ensures that clients are prompted with a certificate warning when they attempt to access sites hosted by a server with untrusted certificates.

References

- Keys and Certificates for Decryption Policies
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/decryption/decryption-concepts/keys-and-certificates-for-decryption-policies.html>
- Certificate Management
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/certificate-management.html>
- How to Install a Chained Certificate Signed by a Public CA
<https://knowledgebase.paloaltonetworks.com/KCSArticleDetail?id=kA10g000000ClkoCAC>

Sample Questions

169. Which condition could be a symptom of a certificate chain-of-trust issue?
- A. The firewall no longer decrypts HTTPS traffic.
 - B. The firewall no longer decrypts HTTPS traffic from a specific site.
 - C. The firewall still decrypts HTTPS traffic from all sites, but it re-encrypts it using the Forward Untrust certificate instead of the Forward Trust certificate.
 - D. The firewall still decrypts HTTPS traffic from a specific site, but it re-encrypts it using the Forward Untrust certificate instead of the Forward Trust certificate.

170. Which field is mandatory in the subject field of a certificate?
- A. Organization
 - B. Organizational Unit
 - C. Common Name
 - D. Locale
171. Which field in a certificate must include a value known to the firewall for the certificate to be considered valid by the firewall?
- A. Issuer
 - B. Subject
 - C. Key
 - D. Object

4.6 Given a scenario, identify how to troubleshoot traffic routing issues

Several methods to route traffic use the NGFW, as follows:

- Static routes require manual configuration on every router in the network, rather than a routing protocol automatically entering dynamic routes into the firewall's routing table. Even though static routes require manual configuration on all routers, static routes may be simpler and easier to troubleshoot in small networks rather than an administrator that needs to troubleshoot a dynamic routing protocol.
- Routing Information Protocol (RIP) is an interior gateway protocol (IGP) that was designed for small IP networks. RIP relies on hop count to determine routes; the best routes have the fewest number of hops. RIP is based on UDP and uses port 520 for route updates. The protocol limits routes to a maximum of 15 hops, and thus helps prevent the development of routing loops, but also limits the supported network size. If more than 15 hops are required, traffic is not routed. RIP also can take longer to converge than OSPF and other routing protocols.
- Open Shortest Path First (OSPF) is an IGP that most often is used to dynamically manage network routes in a large enterprise network. It determines routes dynamically by obtaining information from other routers and advertising routes to other routers by way of Link State Advertisements (LSAs). The information gathered from the LSAs is used to construct a topology map of the network. Each router builds its own topology map from received LSAs, and the map is used to populate the IP routing table with available routes.

Changes in the network topology are detected dynamically and are used to generate a new topology map within seconds. A shortest path tree is computed of each route. Metrics associated with each routing interface are used to calculate the best route. These metrics can include distance, network throughput, and link availability. These metrics also can be configured statically to direct the outcome of the OSPF topology map.

- Border Gateway Protocol (BGP) is the primary internet routing protocol. BGP determines network reachability based on IP prefixes that are available within autonomous systems, where an asynchronous system is a set of IP prefixes that a network provider has designated to be part of a single routing policy.

References

- Virtual Routers
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/networking/virtual-routers.html>
Site-to-Site VPN with Static and Dynamic Routing
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/vpns/site-to-site-vpn-quick-configs/site-to-site-vpn-with-static-and-dynamic-routing.html>
- Static Routes
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/networking/static-routes/static-route-overview.html>
- RIP
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/networking/rip.html>
- OSPF
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/networking/ospf.html>
- BGP
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/networking/bgp.html>

Sample Questions

172. Where do you find the dynamic routing configuration in the next-generation firewall's web interface?
- A. Device > Network > Virtual Router
 - B. Network > Virtual Router
 - C. Device > Network > Interfaces
 - D. Network > Interfaces
173. The organization has three redundant connections to the internet, and all three of them are available. What are two reasons why access to one set of IP addresses through the firewall consistently results in good performance while access to another set of IP addresses consistently results in poor performance? (Choose two.)
- A. The organization uses equal-cost multi-path (ECMP) routing to the internet and selects which path to use based on the source IP address, and some IP addresses get routed through a slower ISP.
 - B. The organization uses Policy Based Forwarding (PBF) and selects which route to use for the internet based on source IP address, and some IP addresses get routed through a slower ISP.
 - C. The organization uses the Routing Information Protocol (RIP), and some IP addresses get routed through a slower ISP.
 - D. The organization uses Border Gateway Protocol (BGP), and some IP addresses get routed through a slower ISP.
 - E. The organization uses Open Shortest Path First (OSPF), and some IP addresses get routed through a slower ISP.
174. An organization has two links to the internet, one 100Mbps and the other 10Mbps. The firewall balances them using ECMP in the virtual router. Which load balancing ECMP setting does the organization need to use to optimize network resources?
- A. Balanced Round Robin
 - B. Weighted Round Robin, with a weight of 10 for the fast connection and 100 for the slow one
 - C. IP Hash
 - D. Weighted Round Robin, with a weight of 100 for the fast connection and 10 for the slow one

4.7 Given a scenario, identify how to troubleshoot a bootstrap install process

Bootstrapping speeds up the process of configuring and licensing a physical or VM-Series firewall to make it operational on the network, with or without internet access. Bootstrapping enables you to configure the firewall using an init-cfg.txt configuration file that enables the firewall to connect to the network and Panorama, and then obtain its complete configuration from Panorama. You also can fully configure the firewall with the basic init-cfg.txt configuration file and a bootstrap.xml file. Information from these two files is combined and fully configures the firewall.

Bootstrapping enables you to create a repeatable and streamlined process of deploying new firewalls on your network because it enables you to create a package and then use that package to deploy firewalls anywhere. You can bootstrap a physical or VM-Series firewall off an external device to complete the process of configuring and licensing the firewall. External devices include a USB thumb drive, virtual disk, virtual CD-ROM, or a storage bucket such as AWS S3 or Google Cloud bucket.

For security reasons, you can only bootstrap a firewall when it is in factory default state. If your firewall will not bootstrap, ensure that it is in factory default mode. The following link contains the procedure to reset a firewall to its factory default settings. <https://docs.paloaltonetworks.com/pan-os/9-0/pan-os-admin/firewall-administration/reset-the-firewall-to-factory-default-settings.html>

If you intend for the firewall to receive a complete configuration at boot up rather than only a partial network configuration, ensure that you have created the optional bootstrap.xml file in the /config directory along with the init-cfg.txt file. The init-cfg.txt file contains only a partial firewall configuration that provides the basic information the firewall needs to connect to your network.

If any of the required network parameters are missing in the init-cfg.txt file, the firewall exits the bootstrap process and boots up using the default IP address, 192.168.1.1.

If you intend for Panorama to manage the bootstrapped firewall, then generate the VM auth key on Panorama and ensure that you place the key in the init-cfg.txt file. Otherwise Panorama will not be able to connect to and configure the bootstrapped firewall.

If your firewall is not licensed properly after bootstrapping, then ensure that you have used an auth code bundle in the /license directory instead of individual auth codes. Using a bundle enables the firewall or orchestration service to simultaneously fetch all license keys associated with a firewall. If you use individual auth codes instead of a bundle, the firewall will retrieve only the license key for the first auth code included in the file.

If you are bootstrapping a VM-Series firewall in KVM using the user-data method and a tar ball, then ensure that your version of OpenStack Platform 5 (Icehouse based) has been patched appropriately. Without the patch, use of a tar ball with the user-data method causes the nova boot command to fail. The patch is located at <https://bugs.launchpad.net/python-novaclient/+bug/1419859>.

Primary Troubleshooting Information Source

Troubleshooting of bootstrap errors differs between NGFW appliances and VM-Series firewalls. In both cases the console messages displayed during the firewall boot process are reviewed. The firewall platforms differ in the way the console messages must be accessed. In the case of an appliance, a device must be connected to the appliance running a terminal emulator while connected to the console port. During the boot process messages will be streamed to the emulator's screen.

Access to a VM-Series firewall's console messages varies with the hosting cloud technology. Cloud vendors might offer a real-time display of these messages through an emulated console or they might show the collected console output, which is downloaded after a firewall boot. You must consult your cloud vendor's available methods to determine how to access this information.

Verifying a Successful Bootstrap

A successful bootstrap process displays the following messages on the console. They might vary between VM-Series firewall and NGFW appliances.

```
Starting PAN Software: port_link: module license 'Proprietary' taints kernel.
```

```
Disabling lock debugging due to kernel taint
```

```
2017-01-22 16:17:03.709 -0800 INFO: Media detected, Starting media sanity check
```

```
2017-01-22 16:17:04.785 -0800 INFO: USB media sanity check passed
```

```
2017-01-22 16:17:04.800 -0800 INFO: System upgrade state: firstboot, starting upgrade mode
```

```
2017-01-22 16:17:04.803 -0800 INFO: Bootstrap media detection completed.
```

Note the absence of reported errors.

Verifying the Success of a Bootstrap

Verify bootstrap completion using the follow methods:

- If you included Panorama values (panorama-server, tplname, and dgname) in your init-cfg.txt file, check Panorama managed devices, device group, and template name.
- Verify the general system settings and configuration by accessing the web interface and selecting **Dashboard > Widgets > System** or by using the CLI operational commands **show system info** and **show config running**.
- Verify the license installation by selecting **Device > Licenses** or by using the CLI operational command **request license info**.
- If you have Panorama configured, manage the content versions and software versions from Panorama. If you do not have Panorama configured, use the web interface to manage content versions and software versions.

Identifying and Responding to the Error Messages

The following tables lists the most common error messages, their severity, and reasons:

| Error Message (Severity) | Reasons |
|---|---|
| Boot image error (high) | <ul style="list-style-type: none">• No external device was detected with the bootstrap package. <p>Or</p> <ul style="list-style-type: none">• A critical error happened while booting from the image on the external device. The bootstrap process was aborted. |
| No bootstrap config file on external device (high) | The external device did not have the bootstrap configuration file. |
| Bad or no parameters for mandatory networking information in the bootstrap config file (high) | The networking parameters required for bootstrapping either were incorrect or missing. The error message lists the value—IP address, netmask, default gateway—that caused the bootstrap failure. |
| Failed to install license key for file <license-key-filename> (high) | The license key could not be applied. This error indicates that the license key used was invalid. The output includes the name of the license key that could not be applied. |
| Failed to install license key using authcode <authcode> (high) | The license auth code could not be applied. This error indicates that the license auth code used was invalid. The output includes the name of the authcode that could not be applied. |
| Failed content update commits (high) | The content updates were not successfully applied. |
| USB media prepared successfully using given bundle (informational) | The bootstrap image was successfully compiled on the USB flash device. <username>: Successfully prepared the USB using bundle <bundlename>. |
| Successful bootstrap (informational) | The firewall was successfully provisioned with the bootstrap configuration file. The output includes the license keys installed and the filename of the bootstrap configuration. On the VM-Series firewalls only, the PAN-OS version and content update version also are displayed. |
| Skip Software image installation, not supported on physical devices (informational) | Bootstrapping with software image installation is supported <i>only</i> on the VM-Series firewall models. The physical firewalls <i>do not</i> support software image installation during the bootstrapping process. |

Reference

- Bootstrap error messages
<https://docs.paloaltonetworks.com/vm-series/9-1/vm-series-deployment/bootstrap-the-vm-series-firewall/bootstrap-errors>

Sample Questions

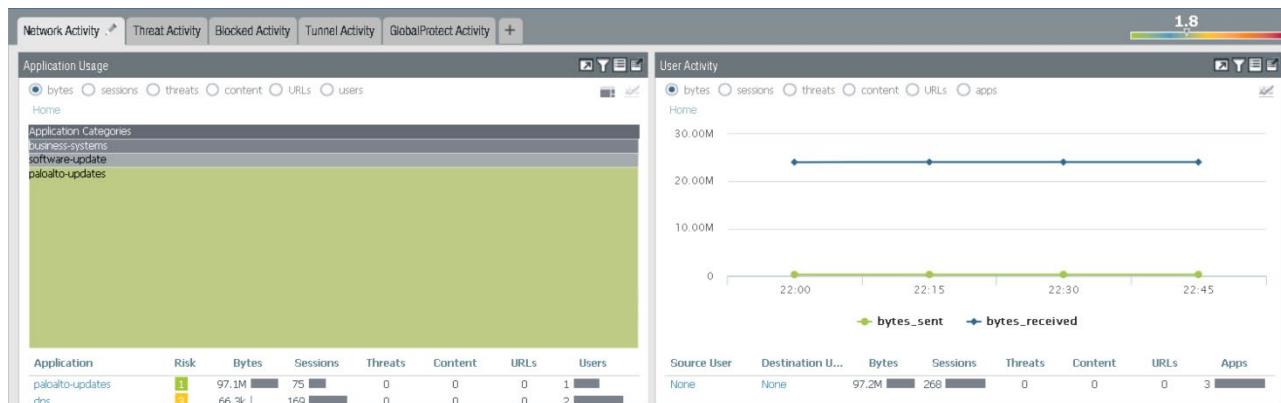
175. Which software image file does the bootstrap error “Skip Software image installation, not supported on physical devices” refer to?
- A. antivirus dynamic update
 - B. Applications and Threats dynamic update
 - C. PAN-OS update
 - D. VM-Series plugin
176. Where are bootstrap error messages found?
- A. bootstrapped device’s System log
 - B. text file written to the bootstrap volume
 - C. log file written to the bootstrapped device’s Configuration log
 - D. bootstrapped device’s console output
177. Which three network configuration settings must be included in the INIT-CFG-TXT bootstrap file to avoid the following bootstrap error: “Bad or no parameters for mandatory networking information in the bootstrap config file (high)”? (Choose three.)
- A. management port default gateway
 - B. firewall hostname
 - C. management interface next hop
 - D. management port IP address
 - E. management port netmask

4.8 Given a screenshot, identify ACC chart activities

The Application Command Center (ACC) is an interactive, graphical summary of the applications, users, URLs, threats, and content traversing your network. The ACC uses the firewall logs to provide visibility into traffic patterns and actionable information about threats. The ACC layout includes a tabbed view of **Network Activity**, **Threat Activity**, and **Blocked Activity**, and each tab includes pertinent widgets for better visualization of network traffic.

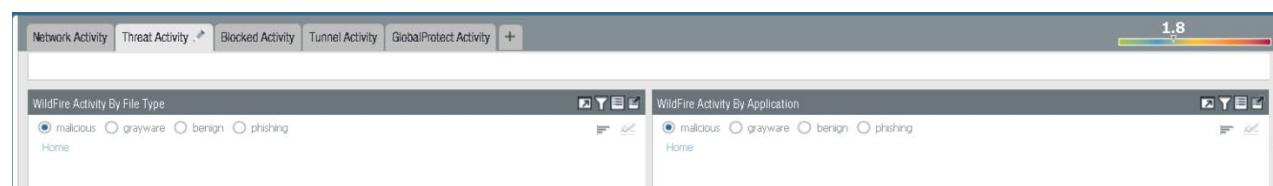
Network Activity

The **Network Activity** tab displays an overview of traffic and user activity on your network, including the top applications in use, the top users who generate traffic, and the most used security rules against which traffic matches occur. You also can view network activity by source or destination zone, region, IP address, ingress or egress interfaces, and GlobalProtect host information such as the operating systems of the devices most commonly used on the network:



Threat Activity

The **Threat Activity** tab displays an overview of the threats on the network, focusing on the top threats: vulnerabilities, spyware, viruses, hosts visiting malicious domains or URLs, top WildFire® submissions by file type and application, and applications that use non-standard ports. The **Compromised Hosts** widget in this tab (the widget is supported on some platforms only), supplements detection with better visualization techniques; it uses the information from the correlated events tab (**Automated Correlation Engine > Correlated Events**) to present an aggregated view of compromised hosts on your network by source users and IP addresses and sorted by severity:



Blocked Activity

The **Blocked Activity** tab focuses on traffic that was prevented from coming into the network. The widgets in this tab allow you to view activity denied by application name, username, threat name, blocked content (files and data that were blocked by a File Blocking Profile). It also lists the top security rules that were matched on to block threats, content, and URLs.



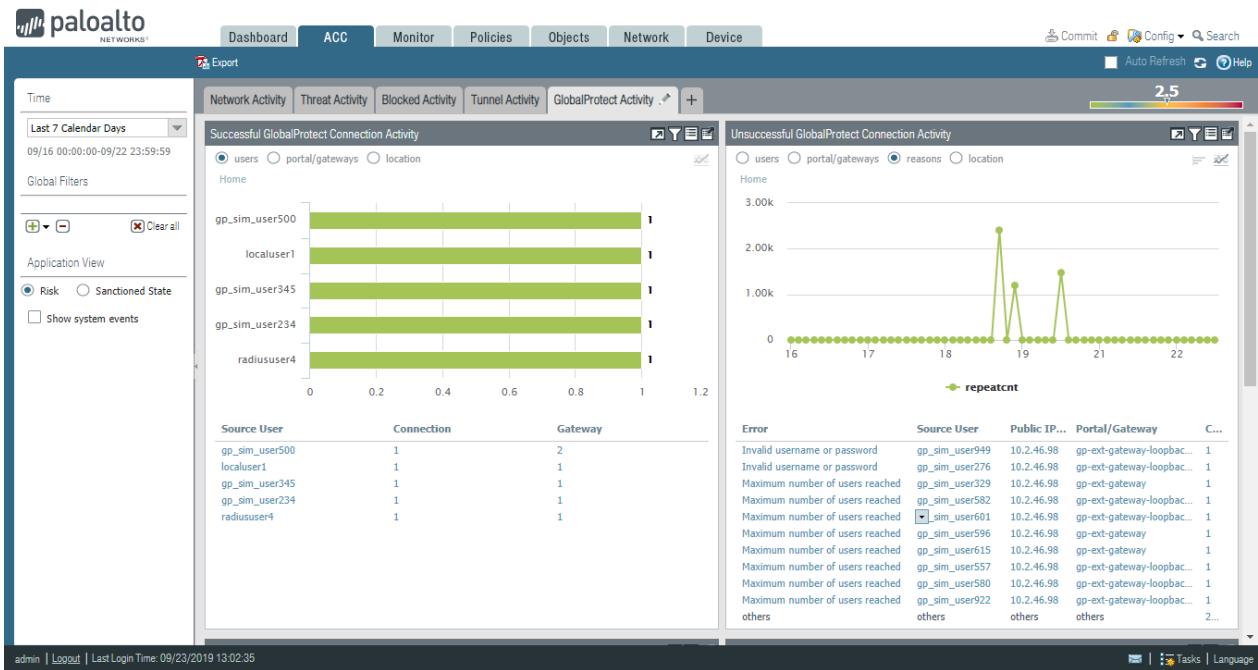
The **Tunnel Activity** tab displays the activity of tunnel traffic that the firewall inspected based on your tunnel inspection policies. Information includes tunnel usage based on tunnel ID, monitor tag, user, and tunnel protocols such as Generic Routing Encapsulation (GRE), general packet radio service (GPRS) Tunneling Protocol for User Data (GTP-U), and non-encrypted IPsec.



With the release of PAN-OS 9.1, the ACC displays a graphical view of user activity in your GlobalProtect deployment on the **GlobalProtect Activity** tab.

The following GlobalProtect charts are available:

- **Successful GlobalProtect Connection Activity:** Chart view of GlobalProtect connection activity over the selected time period. Use the toggle at the top of the chart to switch between connection statistics by users, portals and gateways, and location.
- **Unsuccessful GlobalProtect Connection Activity:** Chart view of unsuccessful GlobalProtect connection activity over the selected time period. Use the toggle at the top of the chart to switch between connection statistics by users, portals and gateways, and location. (To help you identify and troubleshoot connection issues, you also can view the reasons chart or graph.) For this chart, the ACC indicates the error, source user, public IP address and other information to help you identify and quickly resolve the issue.
- **GlobalProtect Deployment Activity:** Chart view summary of your deployment. Use the toggle at the top of the chart to view the distribution of users by authentication method, GlobalProtect app version, and operating system version.



The **GlobalProtect Activity** charts and graphs also are interactive and support similar drill-down functionality to other ACC charts and graphs.

The **GlobalProtect Host Information** widget under the **Network Activity** tab displays information about the state of the hosts on which the GlobalProtect agent is running; the host system is a GlobalProtect endpoint. This information is sourced from entries in the HIP match log that are generated when the data submitted by the GlobalProtect app matches a HIP object or a HIP Profile you have defined on the firewall. If you do not have HIP Match logs, this widget is blank.

References

Use the Application Command Center:

<https://docs.paloaltonetworks.com/pan-os/9-0/pan-os-admin/monitoring/use-the-application-command-center.html>

GlobalProtect Activity Charts:

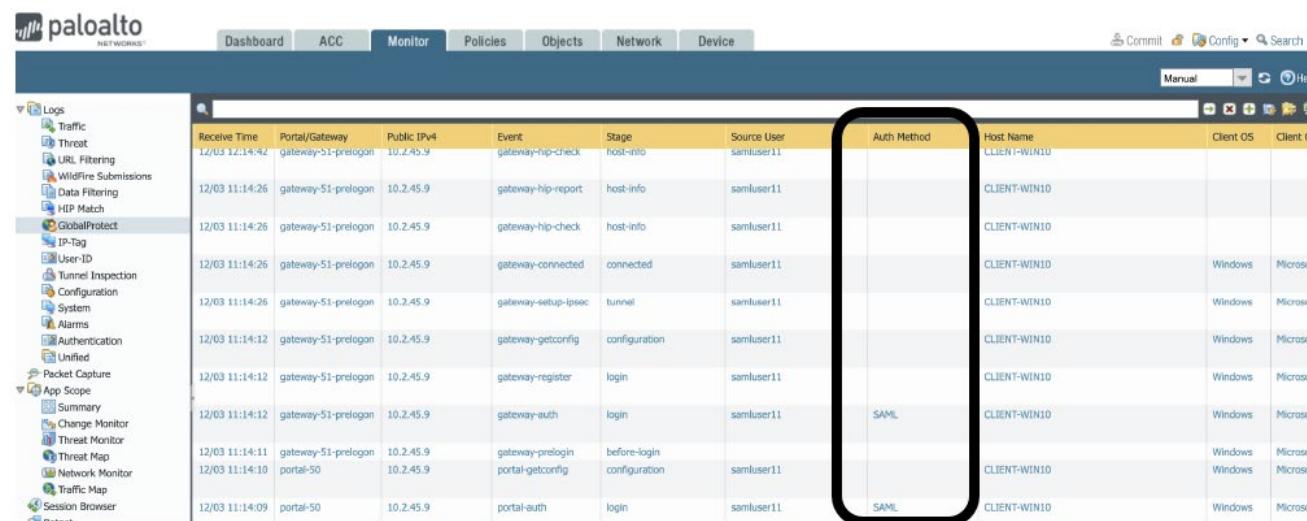
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-new-features/globalprotect-features/enhanced-logging-for-globalprotect.html>

4.9 Identify how to view GlobalProtect troubleshooting information

GlobalProtect Log Category

PAN-OS 9.1 moves GlobalProtect logs to a new dedicated page within **Monitor > Logs**. The GlobalProtect log page enables you to view the following GlobalProtect events in one place:

- System logs related to GlobalProtect. GlobalProtect authentication event logs remain in **Monitor > Logs > System**; however, the new GlobalProtect logs display information that shows the authentication method that is used. The following screenshot shows an example of log entries in the new **Monitor > Logs > GlobalProtect** page. Note that the **Auth Method** column displays the authentication method of SAML:



| Receive Time | Portal/Gateway | Public IPv4 | Event | Stage | Source User | Auth Method | Host Name | Client OS | Client C |
|----------------|---------------------|-------------|---------------------|---------------|-------------|-------------|--------------|-----------|----------|
| 12/03 12:14:42 | gateway-51-prelogin | 10.2.45.9 | gateway-hip-check | host-info | samluser11 | | CLIENT-WIN10 | | |
| 12/03 11:14:26 | gateway-51-prelogin | 10.2.45.9 | gateway-hip-report | host-info | samluser11 | | CLIENT-WIN10 | | |
| 12/03 11:14:26 | gateway-51-prelogin | 10.2.45.9 | gateway-hip-check | host-info | samluser11 | | CLIENT-WIN10 | | |
| 12/03 11:14:26 | gateway-51-prelogin | 10.2.45.9 | gateway-connected | connected | samluser11 | | CLIENT-WIN10 | Windows | Micros |
| 12/03 11:14:26 | gateway-51-prelogin | 10.2.45.9 | gateway-setup-ipsec | tunnel | samluser11 | | CLIENT-WIN10 | Windows | Micros |
| 12/03 11:14:12 | gateway-51-prelogin | 10.2.45.9 | gateway-getconfig | configuration | samluser11 | | CLIENT-WIN10 | Windows | Micros |
| 12/03 11:14:12 | gateway-51-prelogin | 10.2.45.9 | gateway-register | login | samluser11 | | CLIENT-WIN10 | Windows | Micros |
| 12/03 11:14:12 | gateway-51-prelogin | 10.2.45.9 | gateway-auth | login | samluser11 | SAML | CLIENT-WIN10 | Windows | Micros |
| 12/03 11:14:11 | gateway-51-prelogin | 10.2.45.9 | gateway-prelogin | before-login | samluser11 | | | Windows | Micros |
| 12/03 11:14:10 | portal-50 | 10.2.45.9 | portal-getconfig | configuration | samluser11 | | CLIENT-WIN10 | Windows | Micros |
| 12/03 11:14:09 | portal-50 | 10.2.45.9 | portal-auth | login | samluser11 | SAML | CLIENT-WIN10 | Windows | Micros |

- LVPN and satellite events
- GlobalProtect Portal and Gateway logs
- Clientless VPN logs

With PAN-OS 9.1, the new log category eliminates the need for using log queries to filter and locate GlobalProtect log entries. You can sort, filter, and query the GlobalProtect logs directly.

References

New GlobalProtect Log Category:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-new-features/globalprotect-features/enhanced-logging-for-globalprotect.html>

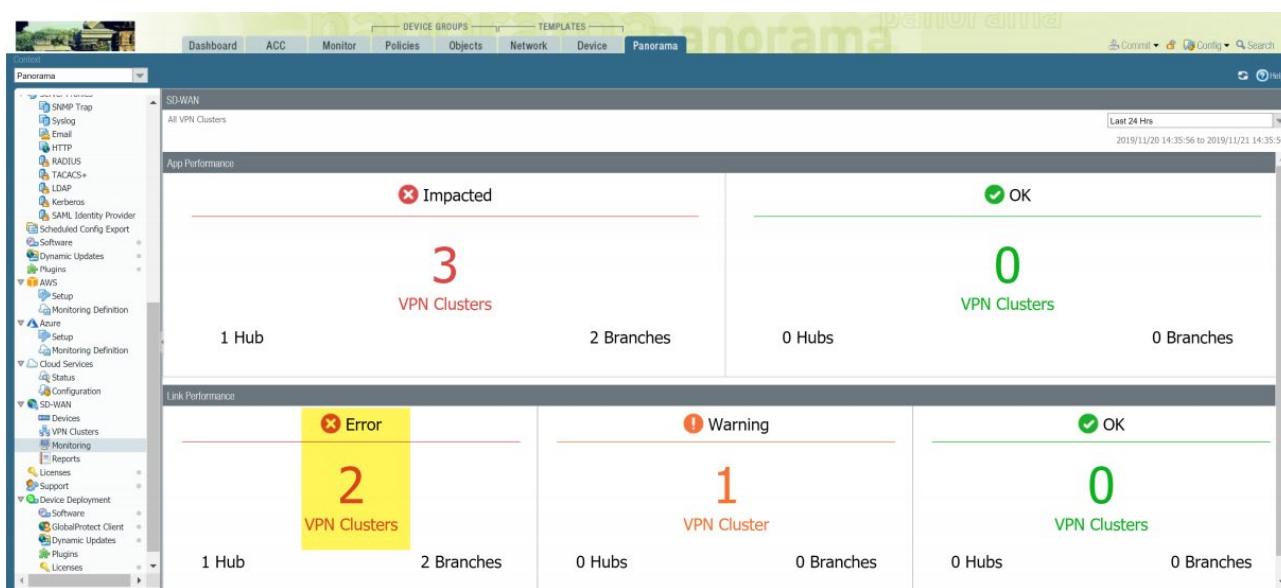
4.10 Identify how to determine when an SD-WAN path has failed

The SD-WAN subscription supports dynamic, intelligent link selection based on applications and services and the conditions of links that each application or service is allowed to use. The path health monitoring for each link includes latency, jitter, and packet loss. For example, granular application and service controls enable you to prioritize applications based on whether the application is mission-critical, is latency-sensitive, or meets certain health criteria. Dynamic path selection avoids brownout and node failure problems because sessions fail over to a better performing path in less than one second.

You must understand the cause of a degraded link performance to ensure the user experience during use of an app or service that is not impacted. Also, your understanding of why your VPN clusters have links that are impacted helps in fine-tuning your SD-WAN configuration to ensure the user experience during the use of apps and services that are not affected by links with degraded health.

Steps:

1. Select **Panorama > SD-WAN > Monitoring** and view the **Impacted** VPN clusters:



2. Filter the VPN clusters based on your preferred metric from the **Site** drop-down list and select the time frame. In this example, we are viewing **All Sites** containing impacted VPN clusters in the last 24 hours:



3. In the **Sites** column, select the impacted hub or branch firewall to view the impacted apps and the corresponding link performance:

SD-WAN - Link Performance - Error

| Sites | VPN Cluster | Profile | Links | Link Notifications | Latency | Jitter | Packet Loss | Apps | Impacted Apps |
|---------|-------------|---------|-------|--------------------|---------|---------|-------------|------|---------------|
| Hub | Cluster2 | hub | 3 | 3 | Warning | Warning | Warning | 1 | 1 |
| Branch1 | Cluster1 | branch | 6 | 6 | Warning | Warning | Warning | 3 | 3 |
| Branch1 | Cluster1 | branch | 6 | 6 | Warning | Warning | Warning | 248 | 212 |
| Branch1 | Cluster1 | hub | 3 | 2 | Warning | Warning | Warning | 1 | 1 |

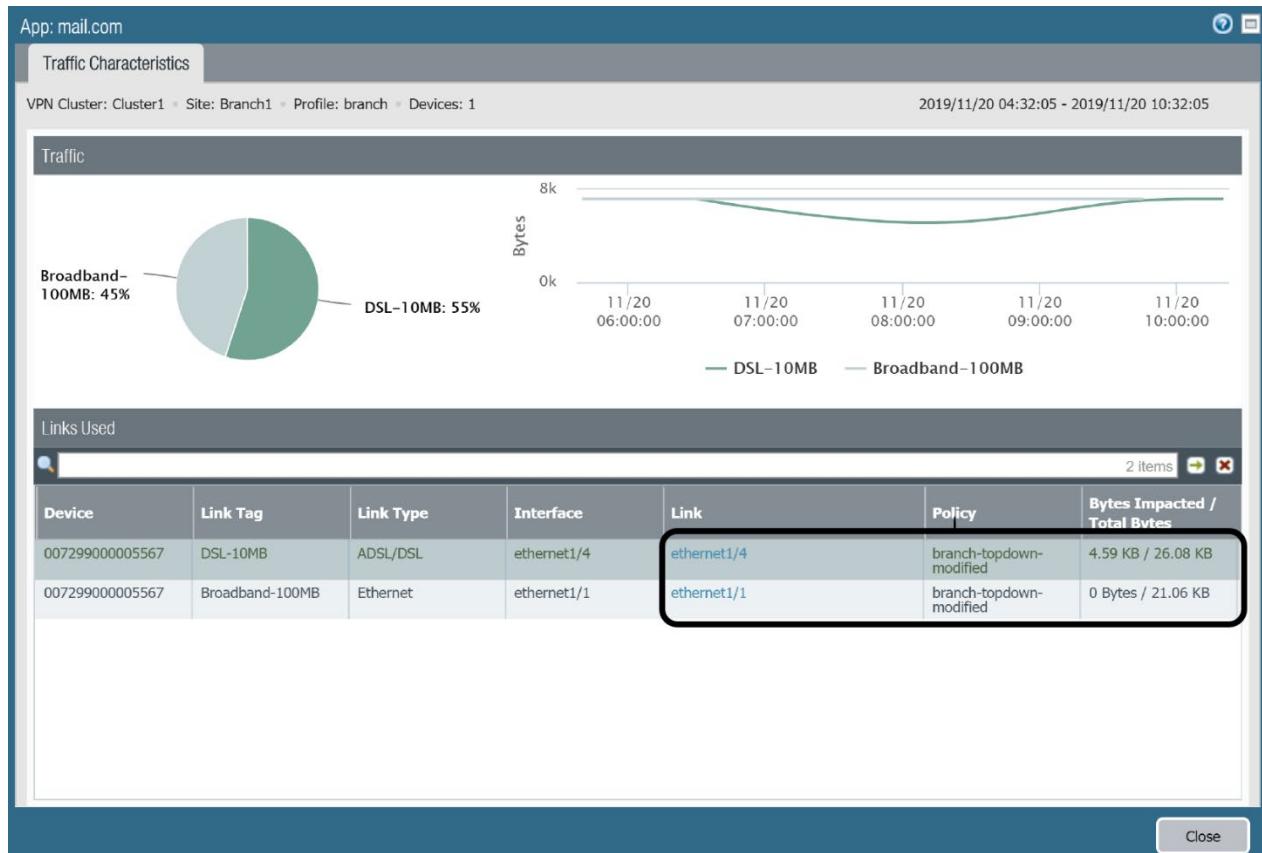
SD-WAN - App Performance

| App | SD-WAN Policies | App Health | Bytes | Impacted Sessions / Total Sessions | Link Tags |
|--------------|-------------------------|------------|-----------|------------------------------------|-----------------------------|
| cox-webmail | branch-topdown-modified | Impacted | 30.84 kB | 2 / 33 | Broadband-100MB DSL-10MB |
| daum-mail | branch-topdown-modified | Impacted | 90.58 kB | 9 / 68 | Broadband-100MB DSL-10MB |
| filemail | branch-topdown-modified | Impacted | 145.11 kB | 2 / 40 | Broadband-100MB DSL-10MB |
| inet-webmail | branch-topdown-modified | Impacted | 193.6 kB | 4 / 46 | Broadband-100MB DSL-10MB |
| mail.com | branch-topdown-modified | OK | 66.76 kB | 0 / 18 | Broadband-100MB |

SD-WAN - Link Performance

| Device | Link Tag | Link Type | Interface | Link | Link Notifications | Latency | Jitter | Packet Loss |
|--------------|-----------------|-----------|-------------|-----------------------------|--------------------|---------|---------|-------------|
| swwan-branch | LTE-50MB | Fiber | ethernet1/3 | tl_0193_00729900005568_0... | No Data | OK | Warning | Warning |
| swwan-branch | DSL-10MB | ADSL/DSL | ethernet1/4 | ethernet1/4 | No Data | Warning | OK | OK |
| swwan-branch | Broadband-100MB | Ethernet | ethernet1/1 | ethernet1/1 | No Data | OK | Warning | Warning |
| swwan-branch | LTE-50MB | Fiber | ethernet1/3 | ethernet1/3 | No Data | OK | Warning | Warning |
| swwan-branch | Broadband-100MB | Ethernet | ethernet1/1 | tl_0191_00729900005568_0... | 1 | OK | Warning | Warning |
| swwan-branch | DSL-10MB | ADSL/DSL | ethernet1/4 | tl_0194_00729900005568_0... | No Data | Warning | Warning | OK |

4. In the **App Performance** section, click an app to view detailed **Traffic Characteristic** information about the app traffic such as the internet service(s) and links used:
- Review the pie chart to understand the breakdown of app traffic across your internet services.
 - Review the **Links Used** section to understand which links the app traffic used and to understand how many bytes were impacted out of the total bytes in the selected time frame:



- Review each link in a line-graph to view latency, jitter, and packet loss:



References

Troubleshooting SD-WAN Link Performance:

<https://docs.paloaltonetworks.com/sd-wan/1-0/sd-wan-admin/monitoring-and-reporting/troubleshoot-link-performance.html#id35a14783-512a-4b4d-a595-0db6a42c5b76>

Troubleshooting SD-WAN App Performance:

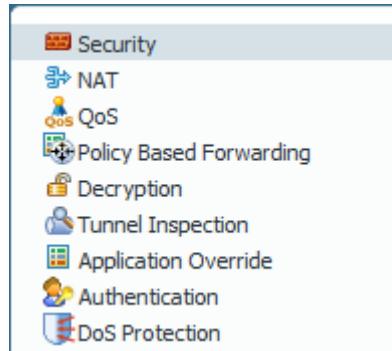
<https://docs.paloaltonetworks.com/sd-wan/1-0/sd-wan-admin/monitoring-and-reporting/troubleshoot-app-performance.html>

Exam Domain 5 – Core Concepts

5.1 Identify the correct order of the policy evaluation based on the packet flow architecture

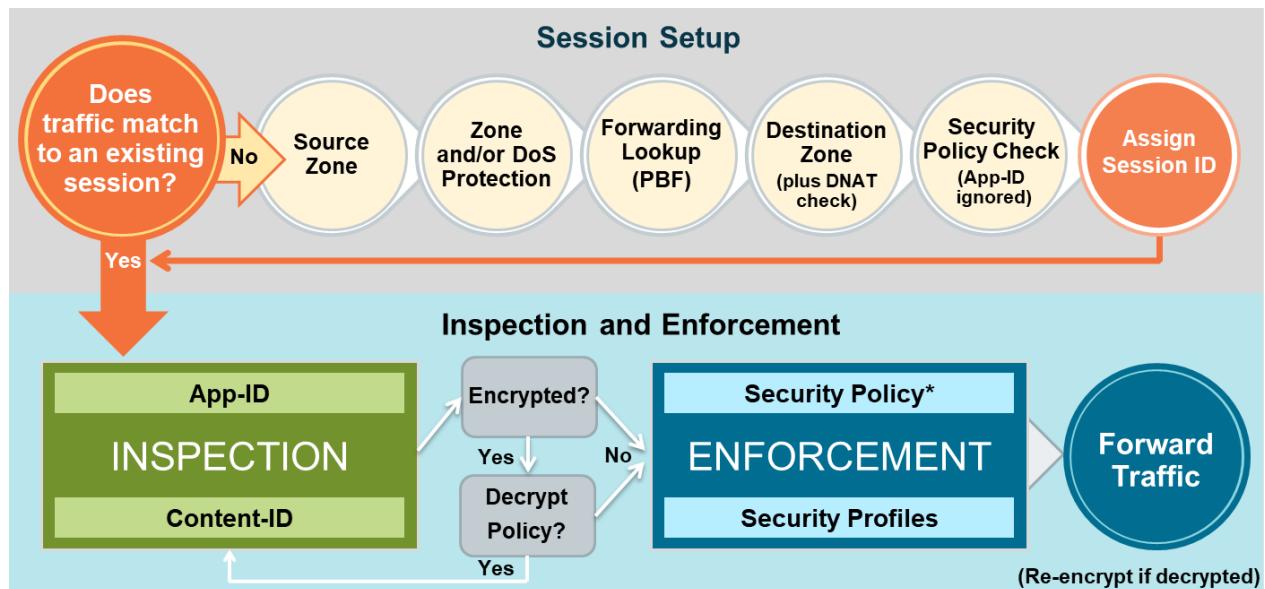
Policies

Palo Alto Networks firewalls implement several types of policies:



Types of Policies in a Palo Alto Networks Firewall

Every policy type contains a list of rules to match. For every connection, policy rules are matched from the top down and the first rule matched is applied, and that is the only rule from the policy that is applied to that connection. The order in which policy types are applied is based on the packet processing order:



All traffic processed by the firewall follows this sequence of events.

Evaluation Order

An example of the importance of evaluation order can be found with NAT and Security policies. NAT policy rules change IP addresses in packet headers. Security policy rules are required to allow the traffic in question to transit the firewall. The processing order indicates that addresses changed by NAT policy rules are done *after* Security policy rules are evaluated, resulting in Security policy rules being re-evaluated for pre-NAT packet addresses.

An overview of the different policy types is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/policy/policy-types.html>

Policy Match and Connectivity Tests

In PAN-OS 9.1, you can perform policy match and connectivity tests for firewalls from the web interface rather than the CLI. You can easily test the running configuration of your firewalls and verify traffic and connectivity to ensure that policy rules are matching traffic as expected to allow or deny traffic, and that firewalls can connect to network resources and external services such as WildFire®, Log Collectors, or the Content Distribution Network.

Details about using the management web interface for testing can be found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/policy/test-policy-rule-traffic-matches.html>

A dated but still useful article with examples for running the **test** command from the CLI is here:

<https://knowledgebase.paloaltonetworks.com/KCSArticleDetail?id=kA10g000000CIQSCAO>

Sample Questions

178. What is the correct order of evaluation between the Security policy and the NAT policy?
 - A. NAT policy evaluated, Security policy evaluated, NAT policy applied, Security policy applied
 - B. NAT policy evaluated, NAT policy applied, Security policy evaluated, Security policy applied
 - C. NAT policy evaluated, Security policy evaluated, Security policy applied, NAT policy applied
 - D. Security policy evaluated, NAT evaluated, NAT policy applied, Security policy applied
179. Which two statements are true regarding firewall policy? (Choose two.)
 - A. All policy rules are evaluated, and the most specific rule will match.
 - B. Policy rules are evaluated from the top down, and the first rule matched processes the traffic.
 - C. Interzone traffic is allowed by default.
 - D. Intrazone traffic is allowed by default.
 - E. Outbound traffic is allowed by default. Only inbound traffic is evaluated.

180. Which firewall operation order is correct?

- A. decryption, check allowed ports, App-ID identification, check Security policy
- B. decryption, App-ID identification, check allowed ports, check Security policy
- C. check allowed ports, decryption, App-ID identification, check Security policy
- D. decryption, App-ID identification, check Security policy, check allowed ports

5.2 Given an attack scenario, identify the appropriate Palo Alto Networks threat prevention component to prevent or mitigate the attack

Advanced Persistent Threats

Threats to your organization are growing in complexity and capability. Advanced persistent threats (APTs) represent the most difficult challenge to the security professional.

An overview of APTs as they relate to Palo Alto Networks firewalls is here:

<https://www.paloaltonetworks.com/features/apt-prevention>

Security Policy and Profiles

The primary firewall tools protecting users from threats are Security policy rules combined with Security Profiles implementing specific protections.

The first steps in creating a Security policy are found here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/getting-started/set-up-a-basic-security-policy.html>

The completion of these steps provides only a basic setup that is not comprehensive enough to protect your network. The next phase is here:

<https://docs.paloaltonetworks.com/best-practices/9-1/internet-gateway-best-practices.html>

Security Profiles are an important aspect of protection, detection, and prevention for specific types of threats. See the following document for more details:

<https://docs.paloaltonetworks.com/best-practices/9-1/internet-gateway-best-practices/best-practice-internet-gateway-security-policy/create-best-practice-security-profiles.html>

Sample Questions

181. A URL Filtering Profile is part of which type of identification?
 - A. App-ID
 - B. Content-ID
 - C. User-ID
 - D. Service
182. Which stage of the attack lifecycle is most likely to be stopped by dividing the network into separate security zones and enabling packet-based zone?
 - A. Reconnaissance
 - B. Execution
 - C. Lateral movement
 - D. Data exfiltration
183. Which component can tell you if an attack is an APT or a broad attack designed to produce a botnet for future abuse?
 - A. next-generation firewall
 - B. WildFire
 - C. MindMeld
 - D. AutoFocus

5.3 Identify methods for identifying users

User-ID and Mapping Users

The User-ID feature of the Palo Alto Networks NGFW enables you to create policy rules and perform reporting based on users and groups rather than on individual IP addresses.

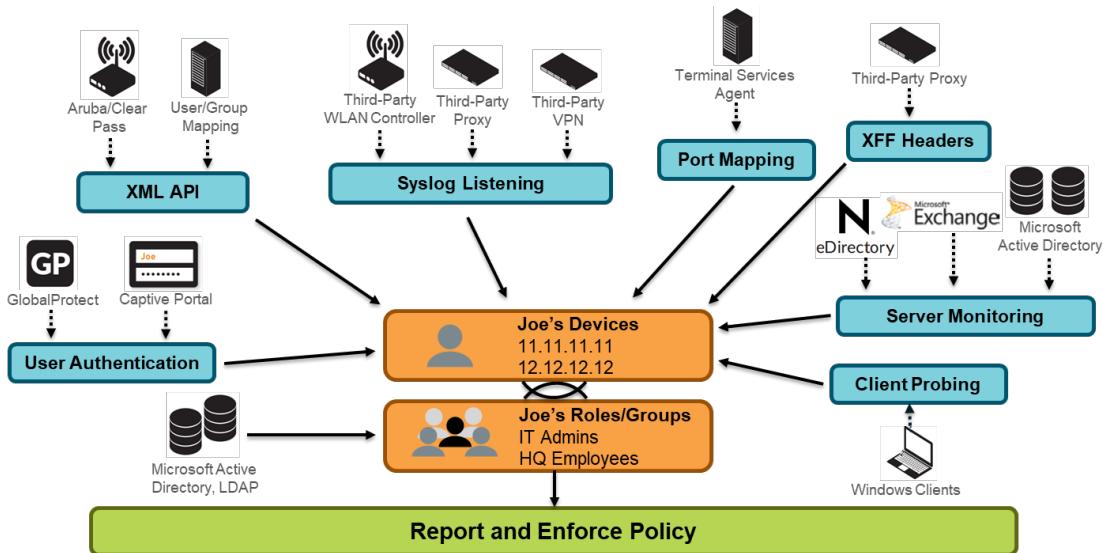
User-ID seamlessly integrates Palo Alto Networks firewalls with a range of enterprise directory and terminal services offerings, thus enabling you to associate application activity and policy rules to users and groups, not just IP addresses. Furthermore, with User-ID enabled, the Application Command Center (ACC), App Scope, reports, and logs all include usernames in addition to user IP addresses.

For user-based and group-based policies, the firewall requires a list of all available users and their corresponding group mappings that you can select when defining your policies. The firewall collects group mapping information by connecting directly to your LDAP directory server. No other types of directory services are supported for group mapping.

Before the firewall can enforce user-based and group-based policies, it must be able to map the IP addresses based in the packets it receives to usernames. User-ID provides many mechanisms to collect this user-based mapping information.

A User-ID agent process runs either on the firewall (agentless implementation) or is installed as a separate process on a Microsoft Windows-based host. This User-ID agent monitors various network technologies for authentication events and gathers the data, creating a master IP-address-to-user mapping table stored in the firewall. For example, the User-ID agent monitors server logs for login events, probes clients, and listens for syslog messages from authenticating services. To identify mappings for IP addresses that the agent didn't map, you can configure the firewall to redirect HTTP requests to a Captive Portal login. You can customize the user mapping mechanisms to suit your environment, and even use different mechanisms at different sites.

In complex environments, multiple User-ID agents can be deployed to work collaboratively on a master User-ID IP address-to-username mapping table. The following figure shows the main functionality of the User-ID agent:



PAN-OS software can use multiple information sources to map usernames to the IP address of a session.

References

A complete overview of User-ID is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/user-id.html>

Design and deployment considerations for complex environments are here:

https://knowledgebase.paloaltonetworks.com/servlet/fileField?entityId=ka10g000000D8S7AAK&field=Attachment_1_Body_s

- Best practices for User-ID implementations are here:

<https://knowledgebase.paloaltonetworks.com/KCSArticleDetail?id=kA10g000000CIF7CAK>

<https://knowledgebase.paloaltonetworks.com/KCSArticleDetail?id=kA10g000000CIVPCA0>

Sample Questions

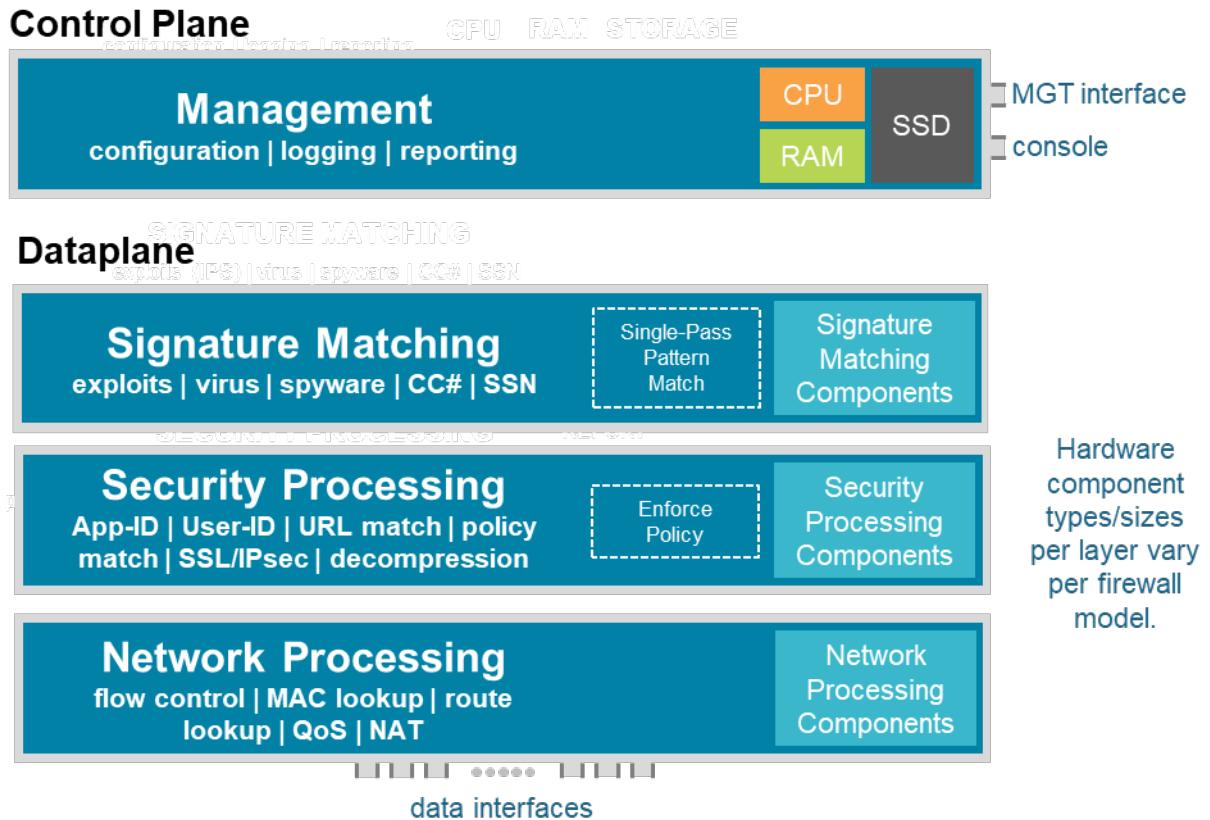
184. User-ID maps users to which type of information?
 - A. MAC addresses
 - B. IP addresses
 - C. IP address and port number
 - D. port numbers
185. User-ID uses which protocol to map between user identities and groups?
 - A. NetBIOS
 - B. LDAP
 - C. syslog
 - D. HTTPS
186. Which format do you use when calling the API to inform the firewall of a new IP address-to-username mapping?
 - A. XML
 - B. JSON

- C. YAML
- D. Base64

5.4 Identify the fundamental functions residing on the management plane and data plane of a Palo Alto Networks firewall

Management Planes and Data Planes

Whether the management plane and data-plane functionality is physical or virtual, it is integral to all Palo Alto Networks firewalls. These functions have dedicated hardware resources, which makes them independent of each other. The following figure details the architecture of a PA-220 firewall:



Palo Alto Networks maintains the management plane and data-plane separation to protect system resources.

Every Palo Alto Networks firewall assigns a minimum of these functions to the management plane:

- Configuration management
- Logging
- Reporting functions
- User-ID agent process
- Route updates

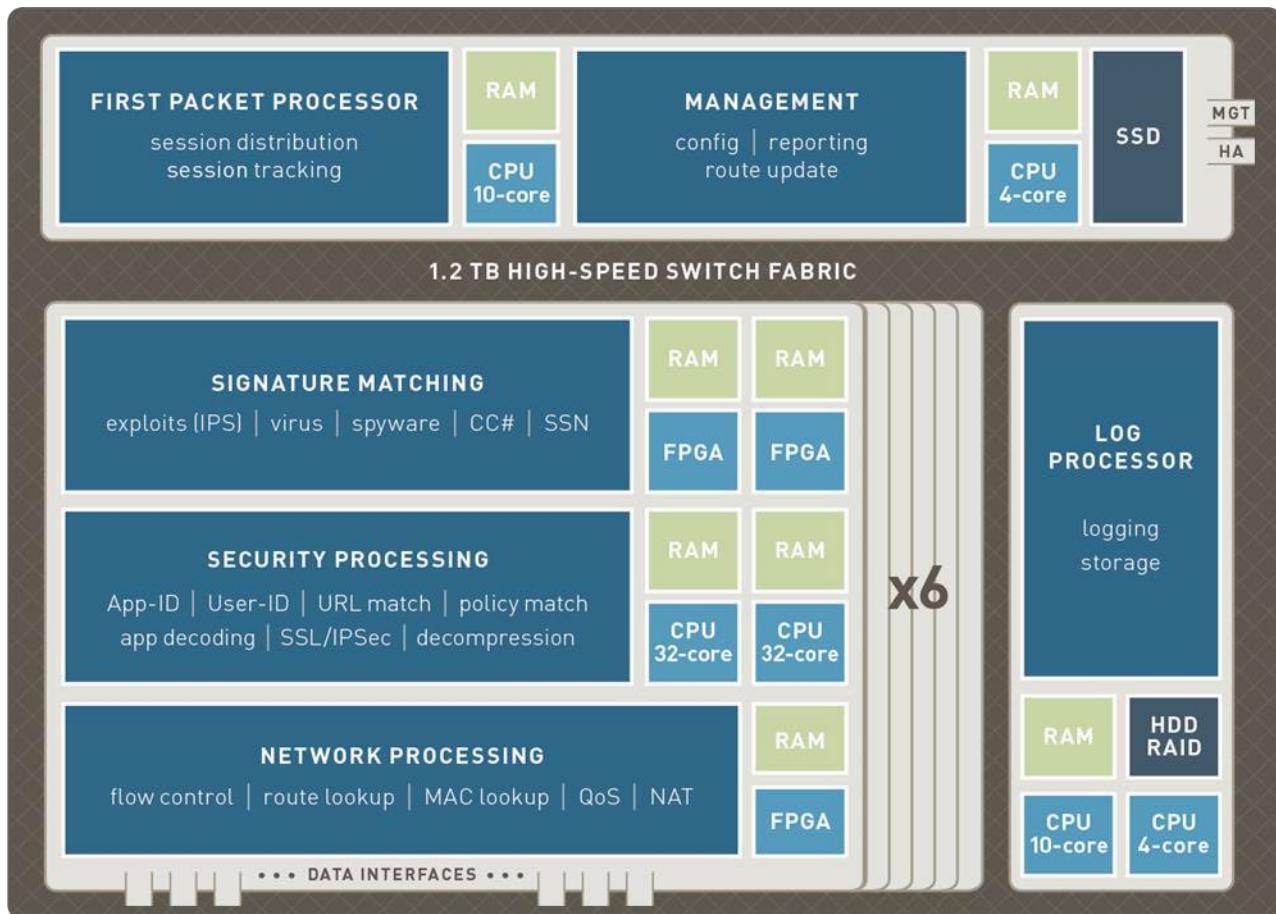
The management network and console connector terminates directly on this plane. The following functions are assigned to the data plane:

- Signature Match Processor:
 - All Content-ID and App-ID services
- Security Processors:
 - Session management
 - Encryption and decryption
 - Compression and decompression
 - Policy enforcement
- Network Processor:
 - Route
 - ARP
 - MAC lookup
 - QoS
 - NAT
 - Flow control

The data plane connects directly to the traffic interfaces. As more computing capability is added to more powerful firewall models, the management planes and data planes gain other functionality as required, sometimes implemented on dedicated cards. Several core functions gain field-programmable gate arrays (FPGAs) or custom application-specific integrated circuits (ASICs) for flexible high-performance processing. Additional management plane functions might include:

- First packet processing
- Switch fabric management

On the PA-7000 Series firewalls, dedicated log collection and processing is implemented on a separate card. The following figure provides an overview of the PA-7000 Series architecture:



Sample Questions

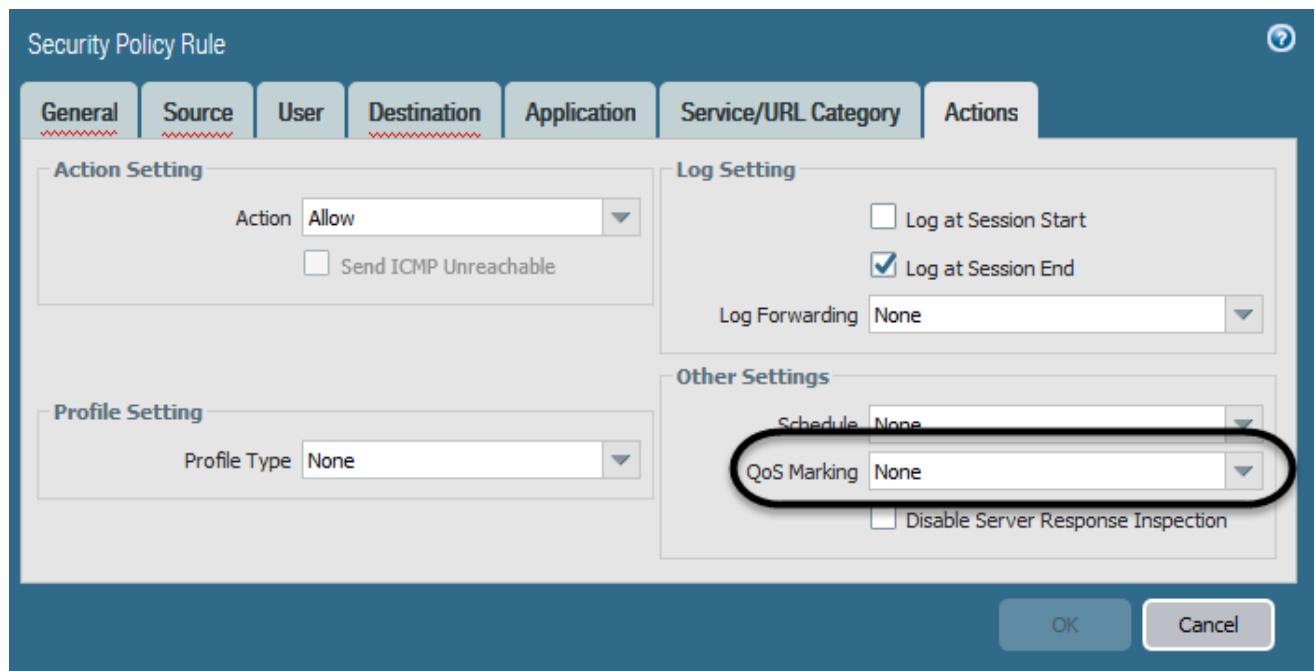
187. On a PA-7000 Series firewall, which management function runs on a separate, dedicated card?
 - A. configuration management
 - B. logging
 - C. reporting
 - D. management web service
188. Do some next-generation firewall models use FPGA chips?
 - A. no, never
 - B. yes, on the data plane, but only on higher-end models
 - C. yes, on the management plane, but only on higher-end models
 - D. on both data the data plane and the management plane, but only on higher-end models
189. Which function resides on the management plane?
 - A. App-ID matching
 - B. route lookup
 - C. policy match
 - D. logging

5.5 Given a scenario, determine how to control bandwidth use on a per-application basis

Quality of Service (QoS) is a set of technologies that work on a network to guarantee its ability to dependably run high-priority applications and traffic with shared network capacity. QoS technologies achieve this guarantee by providing differentiated handling and capacity allocation to specific flows in network traffic, which enables the network administrator to assign the order in which traffic is handled and the amount of bandwidth provided to traffic.

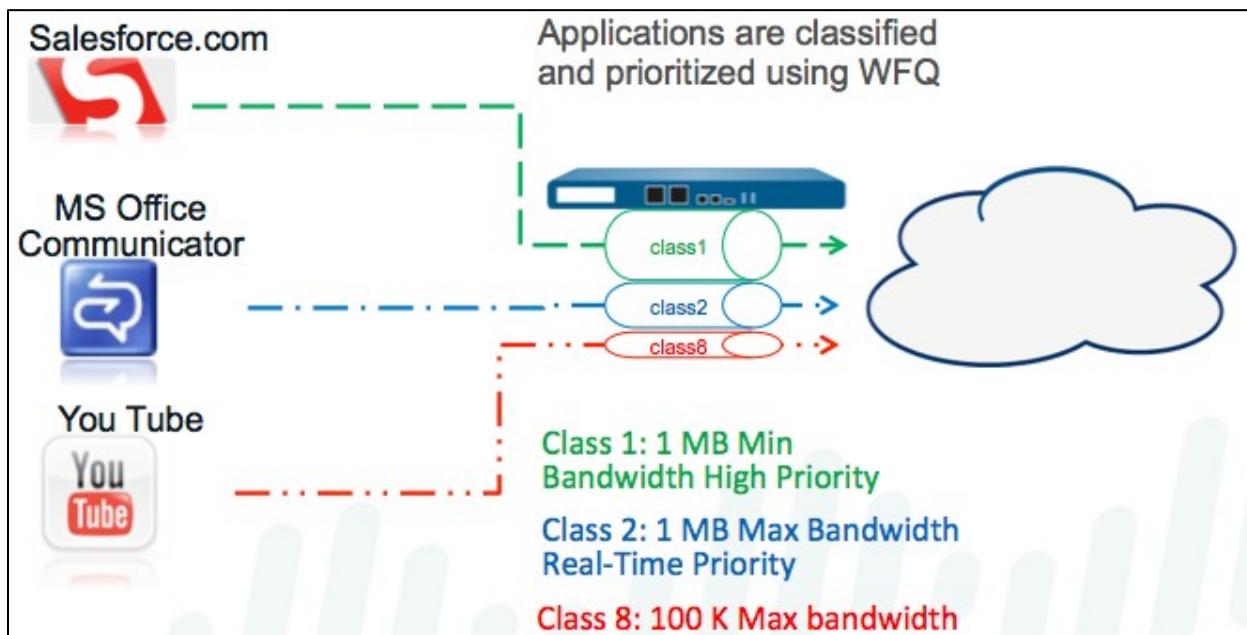
Palo Alto Networks QoS provides an “Application Aware” QoS service that can be driven by the traffic’s App-ID. The firewall’s QoS implementation is a self-contained system local to the firewall that can consider existing QoS packet markings but does not act directly on them. Traffic is evaluated against QoS policy rules that include existing QoS packet markings, App-ID, and other matching conditions to assign a traffic classification value of 1 through 8. These values are the basis for QoS decision making. QoS control of traffic is limited to egress traffic for the configured interface(s) only. Ingress traffic cannot be managed.

The method available to write QoS marking into packet headers is an additional action found in Security policy rules that applies to traffic that they process. This marking is not directly related to QoS processing in the firewall.



QoS implementation on a Palo Alto Networks firewall begins with three primary configuration components that support a full QoS solution: a QoS policy, a QoS Profile, and configuration of the QoS egress interface. Each option in the QoS configuration task facilitates a broader process that optimizes and prioritizes the traffic flow and allocates and ensures bandwidth according to configurable parameters.

QoS policies assign traffic classes (1 to 8) to traffic that matches the policy conditions. PAN-OS QoS functionality can use App-ID for specific bandwidth reservation.



QoS Profiles describe the priority to be given to the specified traffic when the interface becomes constrained. As priority decreases, more packets are randomly dropped until the constraint is cleared. The number of packets dropped is determined by their assigned Priority. A real-time Priority setting means no packet dropping will be performed. High-, medium-, and low-priority settings indicate that greater levels of random packet dropping are performed during movement down the scale. No packets are dropped until the egress traffic on the managed interface becomes constrained, meaning that outbound traffic queues for the interface are filling faster than they can be emptied.

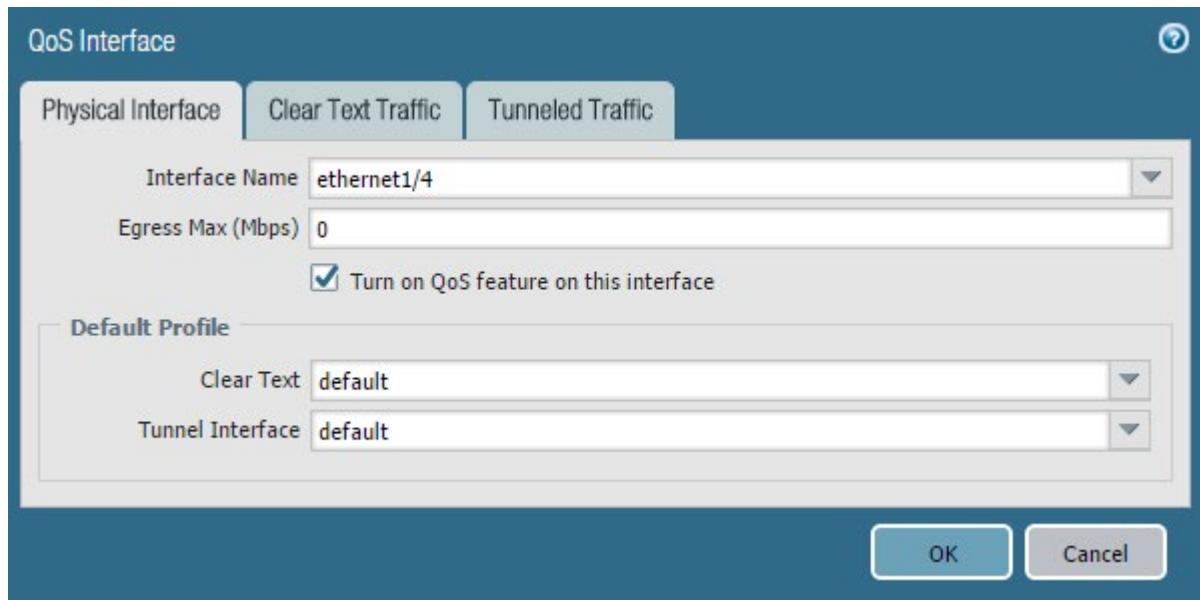
Profiles also specify the maximum bandwidth enforcement that is applied at all times. Bandwidth configured as the maximum limit can be used by all traffic until the interface becomes constrained. After an interface is constrained, then sessions might receive no more than their guaranteed bandwidth.

QoS Profiles prioritize specified traffic. The following figure shows the four possible priority values:

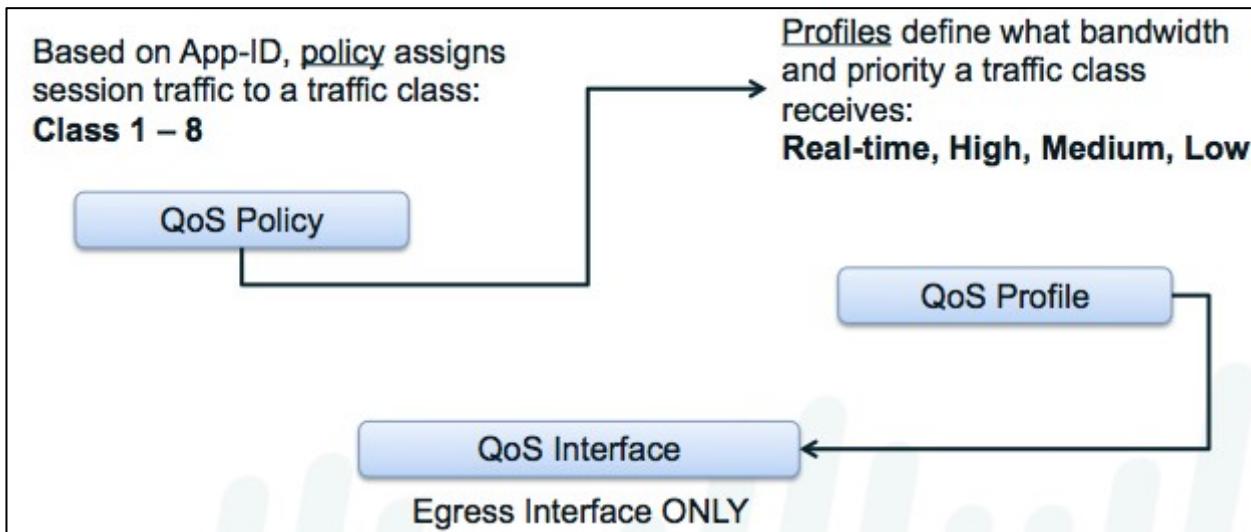
| Name | Guaranteed Egress (Mbps) | Maximum Egress (Mbps) | Priority |
|---------|--------------------------|-----------------------|-----------|
| default | | | |
| class1 | | | real-time |
| class2 | | | high |
| class3 | | | high |
| class4 | | | medium |
| class5 | | | medium |
| class6 | | | low |
| class7 | | | low |
| class8 | | | low |

To apply a QoS Profile, assign it to an interface. All traffic on an interface is split between VPN (tunnel interface) and everything else (cleartext). Each requires a QoS Profile assignment when present. Tabs are available for optional QoS management that include source interface, source subnet, and tunnel interface as matching conditions for the application of a QoS Profile.

Profiles are applied to interfaces to control their egress traffic. The following example shows a profile that has been applied with the interface ethernet1/4:



The interrelationship between the QoS Policies, traffic classes, QoS Profiles, and interfaces is shown in the following figure:



Reference

A detailed discussion of QoS is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/quality-of-service.html>

Sample Questions

190. Which parameter is important for QoS policy match decisions?
 - A. App-ID
 - B. Content-ID
 - C. User-ID
 - D. Ingress interface
191. What is the maximum number of QoS classes supported by the next-generation firewall?
 - A. 4
 - B. 8
 - C. 16
 - D. 32

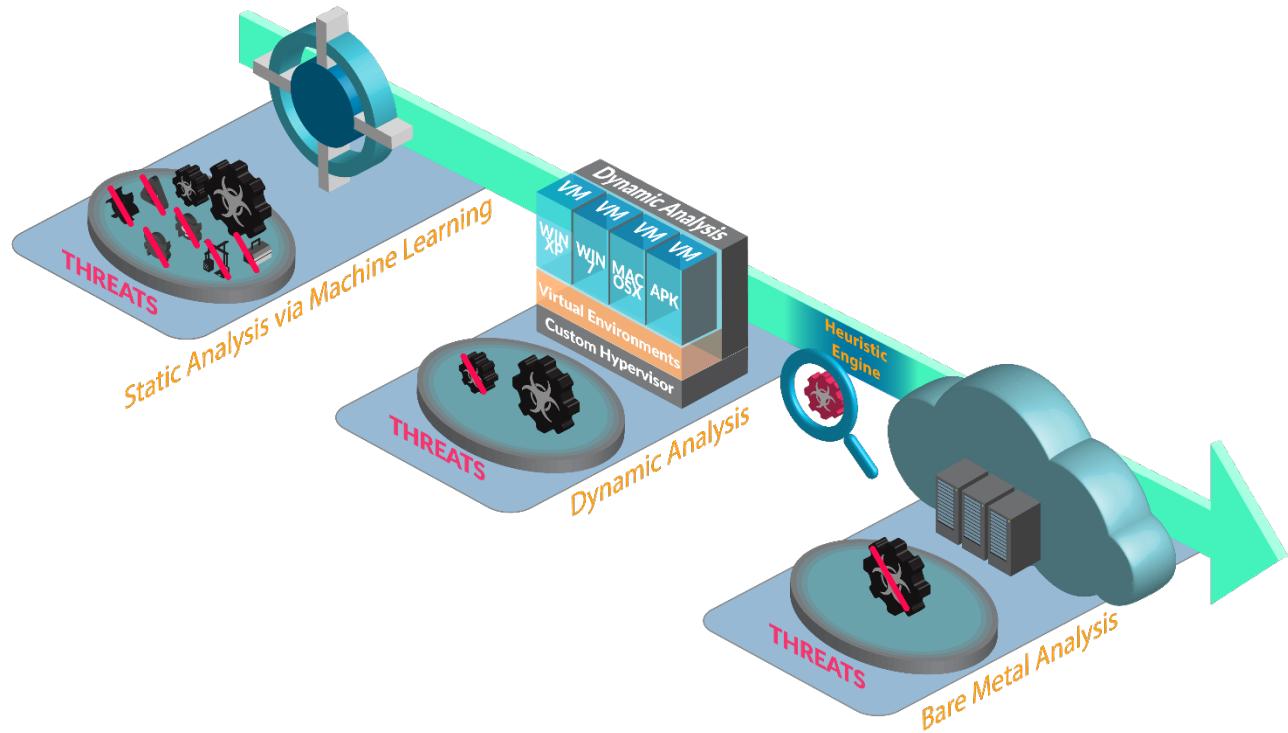
5.6 Identify the fundamental functions and concepts of WildFire

WildFire Overview

The WildFire Analysis sandbox identifies previously unknown malware and generates signatures that Palo Alto Networks firewalls can use to then detect and block the malware. When a Palo Alto Networks firewall is instructed to forward files and URLs via a WildFire Analysis Profile, the firewall can automatically forward the sample for WildFire analysis. WildFire determines the sample to be benign, grayware, phishing, or malicious based on the properties, behaviors, and activities that the sample displays when analyzed and executed in the WildFire sandbox. WildFire then generates signatures to recognize the newly discovered malware and makes the latest signatures globally available every five minutes. Firewalls without a WildFire subscription license get the signature updates the following day, and firewalls with WildFire license gain access to signatures within five minutes of generation. All Palo Alto Networks firewalls worldwide then can compare incoming samples against these signatures to automatically block the malware first detected by a single firewall.

WildFire is implemented in a Palo Alto Networks managed public cloud *or* a WF-500 appliance installed on a user's network.

The following figure shows the principal workflow of WildFire:



WildFire looks within files or URLs for malicious activities and renders a verdict with an analysis report. WildFire analyzes files and URLs using the following methods:

- Static analysis: Detects known threats by analyzing the characteristics of samples prior to execution

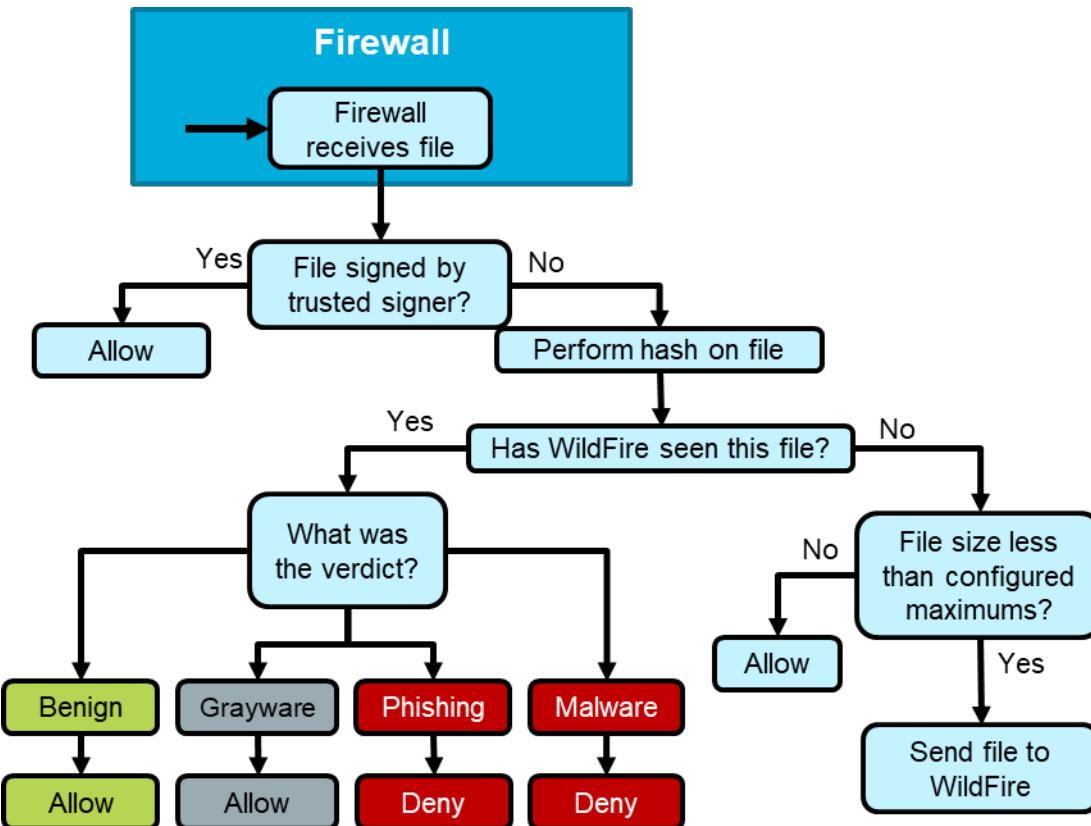
- Machine learning: Identifies variants of known threats by comparing malware feature sets against dynamically updated classification systems
- Dynamic analysis: A custom-built, evasion-resistant virtual environment in which previously unknown submissions are detonated to determine real-world effects and behavior
- Bare metal analysis (WildFire public cloud analysis only): A fully hardware-based analysis environment specifically designed for advanced VM-aware threats. Samples that display the characteristics of an advanced VM-aware threat are steered toward the bare metal appliance by the heuristic engine.

WildFire operates analysis environments that replicate the following operating systems:

- Microsoft Windows XP 32-bit
- Microsoft Windows 7 32-bit (supported as an option for the WildFire appliance only)
- Microsoft Windows 7 64-bit
- Microsoft Windows 10 64-bit (WildFire cloud analysis only)
- Mac OSX (WildFire cloud analysis only)
- Android (WildFire cloud analysis only)
- Linux (WildFire cloud analysis only)

The WildFire public cloud also analyzes samples using multiple versions of software to accurately identify malware that targets specific versions of client applications. The WildFire private cloud does not support multi-version analysis and does not analyze application-specific samples across multiple versions.

WildFire analysis of files is controlled by the configuration of a WildFire Analysis Profile attached to a Security policy allow rule. If the sample matches a rule, the firewall applies the WildFire forwarding evaluation shown in the following figure:



Files that are sent to WildFire for analysis are *not* quarantined in the firewall during the analysis process. They are forwarded normally to their destination. If WildFire detects malware, a notification can be sent, which should then be treated as an Incident Response appropriate to the organization's policies.

WildFire is available to every Palo Alto Networks firewall for use at no charge. A WildFire license is available that provides additional WildFire features.

References

- A detailed description of WildFire is here:
<https://docs.paloaltonetworks.com/wildfire/9-1/wildfire-admin.html>
- The use of WildFire in firewall profiles is outlined here:
<https://docs.paloaltonetworks.com/wildfire/9-1/wildfire-admin/submit-files-for-wildfire-analysis/forward-files-for-wildfire-analysis.html>

Sample Questions

192. Which file type is not supported by WildFire?
- A. iOS
 - B. Android
 - C. Windows PE
 - D. Microsoft Excel
193. The firewall will skip the upload to WildFire in which three cases? (Choose three.)
- A. The file has been signed by a trusted signer.
 - B. The file is being uploaded rather than downloaded.
 - C. The file is an attachment in an email.
 - D. The file hash matches a previous submission.
 - E. The file is larger than 50MB.
 - F. The file is transferred through HTTPS.
194. Which feature is *not* supported on the WF-500 appliance?
- A. bare metal analysis
 - B. Microsoft Windows XP 32-bit analysis
 - C. Microsoft Windows 7 64-bit analysis
 - D. static analysis

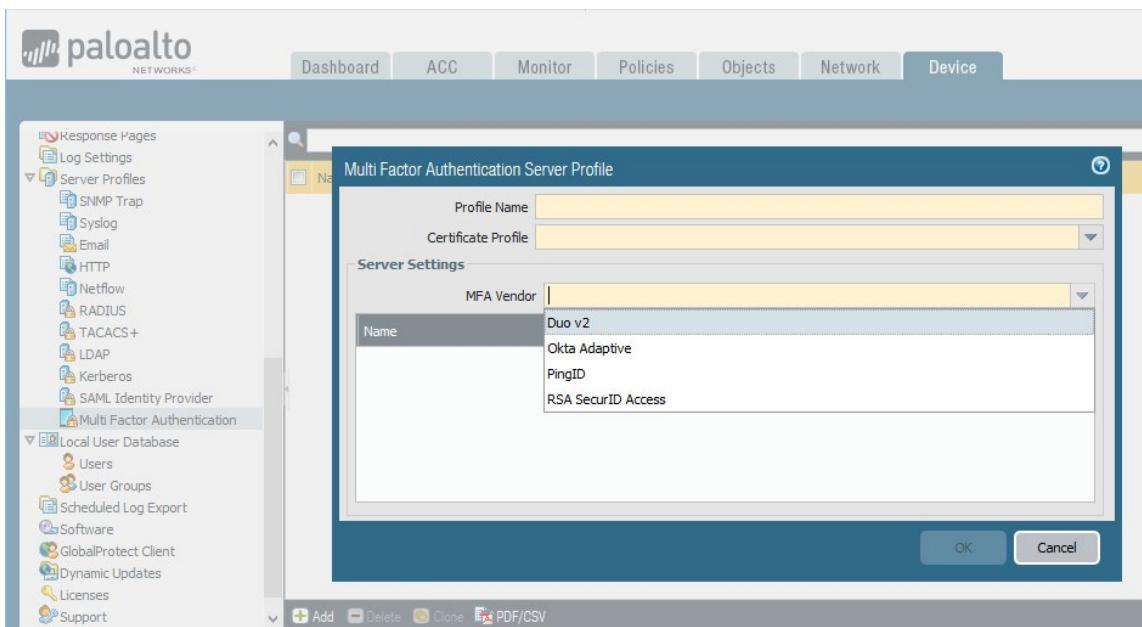
5.7 Identify the purpose of and use case for MFA and the Authentication policy

You can configure multi-factor authentication (MFA) to ensure that each user authenticates using multiple methods (factors) when it accesses highly sensitive services and applications. For example, you can force users to enter a login password and then enter a verification code that they receive by phone before allowing access to important financial documents. This approach helps to prevent attackers from accessing every service and application in your network just by stealing passwords.

For end-user authentication via Authentication policy, the firewall directly integrates with several MFA platforms (Duo v2, Okta Adaptive, PingID, and RSA SecurID) and integrates through RADIUS with other MFA platforms.

MFA is driven by an Authentication policy that allows precise application of appropriate authentication. These policy rules can invoke simple Captive Portal challenge pages for one-time authentication or can include one (or more) integrated MFA vendor Server Profiles that are included in Authentication Profiles for additional challenges.

Once a user successfully completes all challenges, an appropriate Security policy rule will be evaluated that allows access to that protected service.



References

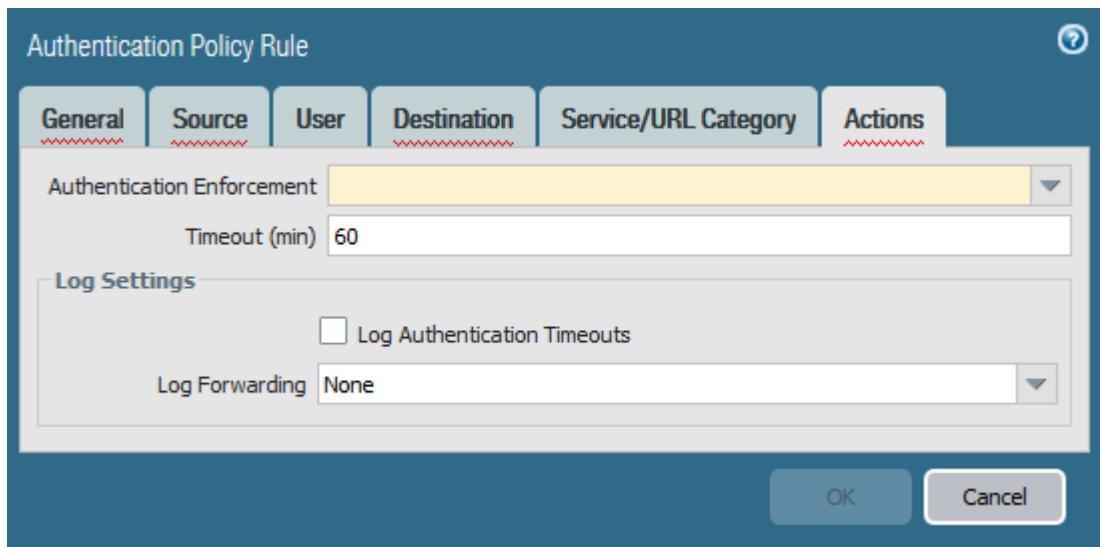
- Multi-Factor Authentication
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/authentication/authentication-types/multi-factor-authentication.html>
- Authentication Policy
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/authentication/authentication-policy.html>

Sample Questions

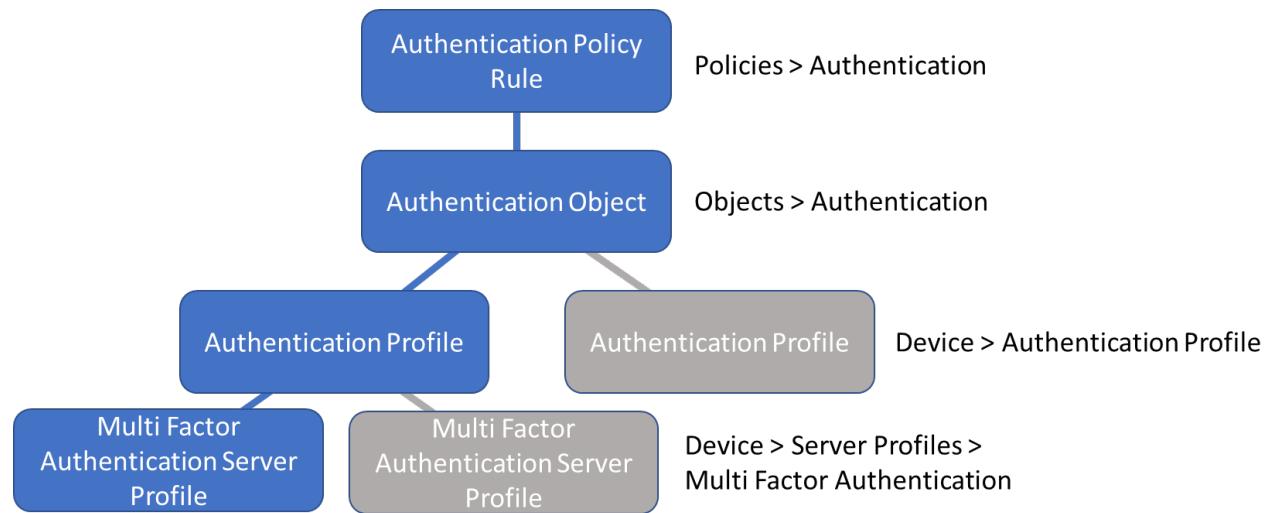
195. What are the two purposes of multi-factor authentication? (Choose two.)
 - A. reduce the value of stolen passwords
 - B. simplify password resets
 - C. reduce and prevent password sharing
 - D. ensure strong passwords
 - E. provide single sign-on functionality
196. Which MFA factor is *not* supported by the next-generation firewall?
 - A. voice
 - B. push
 - C. SMS
 - D. S/Key
197. What is the meaning of setting the source user to known-user in an Authentication policy rule?
 - A. The user identity is known (linked to an IP address), but the resource is sensitive enough to require additional authentication.
 - B. The next-generation firewall will demand user authentication, and only then will the resource be available.
 - C. The source device is a known device that is used only by a single person.
 - D. The firewall attempts to match only users defined in the firewall's local user database.

5.8 Identify the dependencies for implementing MFA

Before you can use MFA for protecting sensitive services and applications, you must configure several settings in the Palo Alto Networks firewall. MFA authentication is triggered when a user requests access to a service that appears in traffic that the firewall processes. The traffic first is evaluated by an Authentication policy rule. When a match is found, the authentication action of the rule is taken.



The following figure shows the relationship of the required objects to configure the Authentication policy rule.

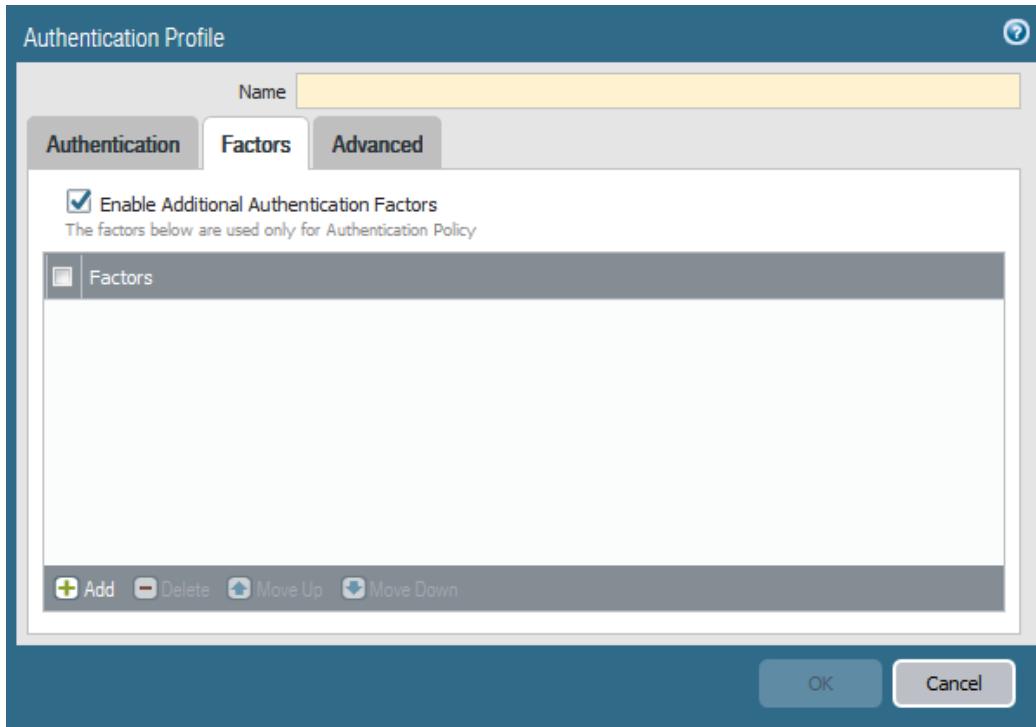


- Multi-Factor Authentication Server Profile: Defines the access method, location, and authentication for integrated MFA vendors. The **MFA Vendor** drop-down list shows supported vendors. A Certificate Profile is required to support the certificate used to validate the certificate used by the MFA solution to secure its communication with the firewall.

Multi Factor Authentication Server Profile

| | |
|------------------------|--|
| Profile Name | <input type="text"/> |
| Certificate Profile | <input type="button" value="▼"/> |
| Server Settings | |
| MFA Vendor | <input type="button" value="Duo v2"/> <input type="button" value="▼"/> |
| Name | Duo v2 |
| API Host | Okta Adaptive |
| Integration Key | PingID |
| Secret Key | RSA SecurID Access |
| Timeout (sec) | 30 [5 - 600] |
| Base URI | /auth/v2 |

- Authentication Profile: Specifies the authentication type and Server Profile for the first Captive Portal-driven authentication. The **Factors** tab incorporates the integrated MFA vendor defined in the Multi-Factor Authentication Server Profile. Multiple factors can be added that require the user to pass each challenge from the top down.



- Authentication Enforcement object: Specifies the Authentication Profile to use and is assigned to an Authentication policy rule. A Captive Portal authentication method also must be specified. A custom message can be included for the user that explains how to respond to the challenge.

References

- Configure Multi-Factor Authentication
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/authentication/configure-multi-factor-authentication.html>
- Map IP Addresses to Usernames Using Captive Portal
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/user-id/map-ip-addresses-to-users/map-ip-addresses-to-usernames-using-captive-portal.html>

Sample Questions

198. What are the two Captive Portal modes? (Choose two.)
- proxy
 - transparent
 - web form
 - certificate
 - redirect

199. Which action is not required when multi-factor authentication and a SAML Identity Provider (IdP) are configured?
- A. create an Authentication policy rule
 - B. configure NTLM settings
 - C. create an Authentication object
 - D. create an Authentication profile
200. An Authentication policy rule has a HIP Profile. Where are the users being authenticated coming from?
- A. internal devices, such as Linux workstations
 - B. external devices belonging to customers of the organization
 - C. internal servers running UNIX (Solaris, HPUX, AIX, etc.)
 - D. GlobalProtect connections through the internet

5.9 Given a scenario, identify how to forward traffic

In a Layer 2 deployment, the firewall provides switching between two or more networks. Devices are connected to a Layer 2 segment; the firewall forwards the frames to the proper port, which is associated with the MAC address identified in the frame.

In a Layer 3 deployment, the firewall uses virtual routers to obtain routes to other subnets by manually defining static routes or through participation in one or more Layer 3 routing protocols (dynamic routes). The routes that the firewall obtains through these methods populate the firewall's IP routing information base (RIB).

An interface configured as virtual wire will forward all traffic that meets the optional VLAN filter to its partner virtual wire interface. This packet handling is done invisibly to the packet (also known as a Bump in the Wire), which allows a firewall to be placed in an existing traffic path without requiring traffic engineering of the infrastructure.

Palo Alto Networks firewalls also support Policy Based Forwarding. A Policy Based Forwarding rule can be created that identifies specific traffic to forward to a specified interface bypassing any virtual router lookup.

References

- Layer 2 Interfaces
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/networking/configure-interfaces/layer-2-interfaces.html>
- Virtual Routers
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/networking/virtual-routers.html>
- PBF (Policy-Based Forwarding)
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/policy/policy-based-forwarding/pbf.html>
- Use Case: PBF for Outbound Access with Dual ISPs
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/policy/policy-based-forwarding/use-case-pbf-for-outbound-access-with-dual-isps.html>

Sample Questions

201. A company has strict security requirements that require inspection of every connection between two internal computers. Those internal computers are connected and disconnected by non-technical users in an environment without a DHCP server. How does traffic get forwarded between those internal computers?
- A. a switch
 - B. a firewall configured as a switch, with Layer 2 interfaces
 - C. a firewall configured as a router, with Layer 3 interfaces
 - D. a firewall in TAP mode or Virtual Mirror mode

202. Two links to the internet go through two ISPs (for backup purposes). Link A has a lower latency, and link B supports a higher bandwidth. How would you force a specific application to use only Link B when the route table enables the application to use either link?
- A. specify the application in a Policy Based Forwarding rule
 - B. specify the application in the virtual router's route table
 - C. specify the application in a QoS policy rule
 - D. specify the application in an Application Override policy rule
203. Can you put a device on each end of a VPN tunnel on the same Ethernet segment?
- A. No, because this requirement never happens.
 - B. No, because Ethernet at Layer 2 is a lower layer than a Layer 3 VPN tunnel.
 - C. Yes, if you tunnel Ethernet over IP.
 - D. Yes, because VPN tunnels can be Layer 2 tunnels.

5.10 Given a scenario, identify how to configure policies and related objects

Security Policy Overview

The firewall will not allow any traffic to flow from one zone to another unless there is a Security policy rule to allow it. When a packet enters a firewall interface, the firewall matches the attributes in the packet against the Security policy rules to determine whether to block or allow the session based on attributes such as the source and destination security zone, the source and destination IP address, the application, the user, and the service. The firewall evaluates incoming traffic against the Security policy rulebase from left to right and from top to bottom and then takes the action specified in the first security rule that matches (for example, whether to allow, deny, or drop the packet). Because processing occurs from top to bottom, you must order the rules in your Security policy rulebase so that more specific rules are at the top of the rulebase and more general rules are at the bottom, which ensures that the firewall enforces policy as expected.

The first steps in creating a Security policy are here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/getting-started/set-up-a-basic-security-policy.html>

The completion of these steps provides only a basic setup that is not comprehensive enough to protect your network. The next phase is here:

<https://docs.paloaltonetworks.com/best-practices/9-1/internet-gateway-best-practices.html>

Security Profiles are an important aspect of protection detection and prevention for specific types of threats. See the following document for more details:

<https://docs.paloaltonetworks.com/best-practices/9-1/internet-gateway-best-practices/best-practice-internet-gateway-security-policy/create-best-practice-security-profiles.html>

Security policy rules are matched from the top down. Up to two processing steps are in each Security policy match. Step 1 confirms that a match has been made based on the matching conditions provided in the Security policy. If a match is found in Step 1, the traffic is logged (based on that policy rule's configuration) and the chosen action (deny, allow, drop, reset) is performed. Once processing is complete, there will be no further matching in the Security policy rulebase.

Security Policy: Allow

If the action is "allow," Step 2 of the policy is evaluated. Step 2 is the application of configured Security Profiles. In Step 2, the content of sessions is scanned for various threat signatures. Also, URLs can be scanned for unauthorized destinations, and files can be scanned for malware.

If Panorama device groups are used to push Security policy to one or more firewalls, the Security policy list is expanded to include rules before (“Pre”) and after (“Post”) the local firewall rules. Panorama rules are merged with local firewall policies in the position chosen during Panorama rule creation.

| Name | Tags | Type | Source | | | | Destination | | | | Application | Service | Action | Profile |
|---------------------|------|-----------|----------|---------|------|-------------|-------------|-------------|--------------|------------------|-------------|---------|--------|---------|
| | | | Zone | Address | User | HIP Profile | Zone | Address | | | | | | |
| 1 Inbound FTP | none | universal | Trust-L3 | any | any | any | Trust-L3 | 172.16.11.1 | ftp | application-d... | Allow | none | | |
| 2 General Internet | none | universal | Trust-L3 | any | any | any | Untrust-L3 | any | dns | application-d... | Allow | none | | |
| | | | | | | | | | flash | | | | | |
| | | | | | | | | | ftp | | | | | |
| | | | | | | | | | ping | | | | | |
| | | | | | | | | | ssl | | | | | |
| | | | | | | | | | web-browsing | | | | | |
| 3 Allow YouTube | none | universal | Trust-L3 | any | any | any | Untrust-L3 | any | youtube | application-d... | Allow | none | | |
| 4 Allow Facebook | none | universal | Trust-L3 | any | any | any | Untrust-L3 | any | facebook | application-d... | Allow | none | | |
| 5 intrazone-default | none | intrazone | any | any | any | any | (intrazone) | any | any | any | Allow | none | | |
| 6 interzone-default | none | interzone | any | any | any | any | any | any | any | any | Deny | none | | |

Security policy should use App-ID for match criteria rather than solely use services (ports) as match criteria.

At the end of the list are two default policy rules: one for an intrazone allow and one for an interzone deny. Taken together they implement the default security behavior of the firewall to block interzone traffic and allow intrazone traffic. By default, traffic logging is disabled in both rules.

Security policy rules in PAN-OS software are configured by type: universal (default), interzone, and intrazone. (All policy rules – regardless of type – are evaluated top down, first match, then exit.) The universal type covers both interzone and intrazone.

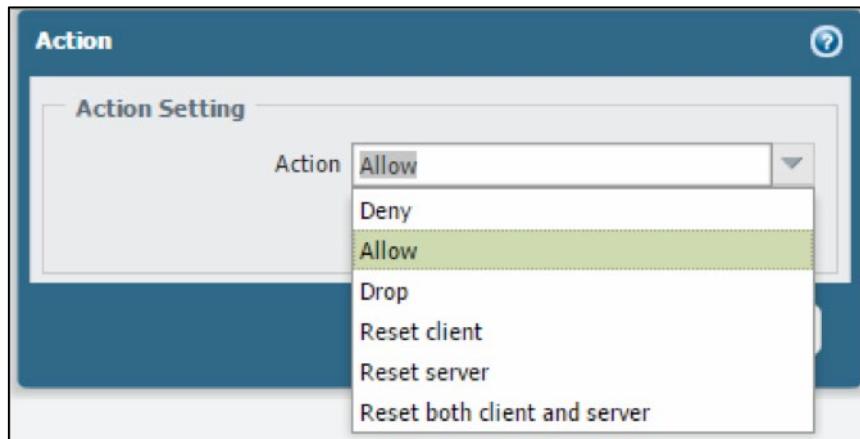
The screenshot shows the 'Security Policy Rule' configuration window. The 'Source' tab is active. The rule is named 'zone-to-zone-mgmt'. The 'Rule Type' is set to 'universal (default)'. The 'Description' field contains 'universal (default)', 'intrazone', and 'interzone'. The 'Tags' field is empty.

Security policy “rule type” selects the type of traffic the policy applies to.

Throughput performance is not changed based on how quickly a match is made. Because evaluation is top down, first match, then exit, exceptions to policy rules must appear before the general policy. Beyond this policy, order is based on administrative preference. Use tags, a Policy search bar, or a global find to quickly navigate to the policy or policy rules needed for moves, adds, changes, deletes, clones, and troubleshooting.

Security Policy: Deny

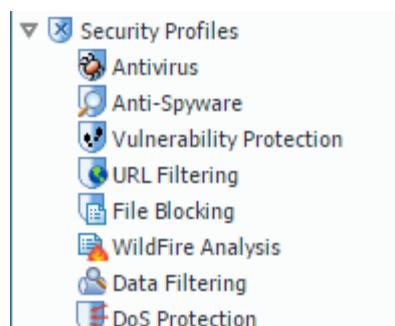
Among Security policy actions the “deny” choice requires an explanation. This is a legacy setting from prior versions of PAN-OS software that was the only choice to stop traffic. Prior to PAN-OS 7, a reference was made to the App-ID database for the matching session’s application to find the preferred method of stopping traffic, which ranged from blocking to reset. These choices now have been added directly to the list of action choices available. The settings continue to be present in the App-ID database and now are exposed for viewing. Firewall administrators now can choose the desired blocking action directly or can continue to rely on the Palo Alto Networks specification by choosing **Deny**.



Security Profile Overview

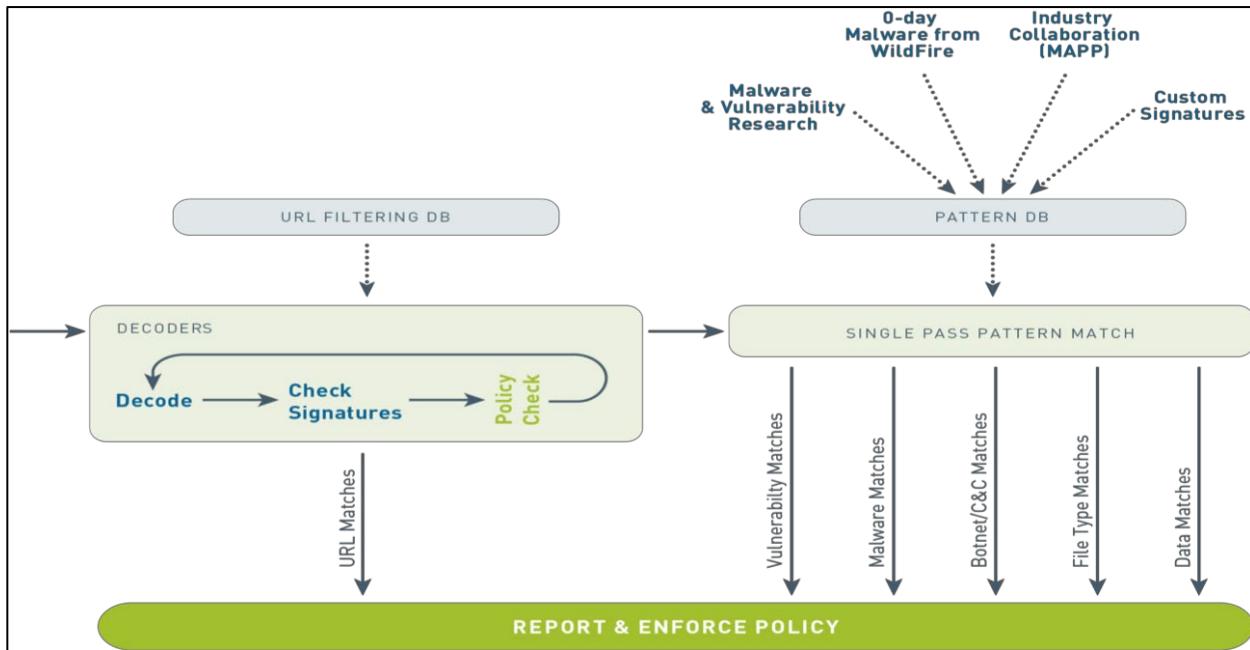
Security Profiles implement specific protections provided by the Palo Alto Networks Content-ID next-generation technology. After Security Profiles are created, they are attached to Security policy rules specifying Content-ID scans to be performed on traffic allowed by a policy rule. These profiles must be attached to Security policy rules to invoke their protections and will be applied only to the traffic handled by that particular rule.

Security Profiles include:



An overview of each Security Profile is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/policy/security-profiles.html>



All scanning is done by signature matching on a streaming basis (not file basis). These signatures are updated based on the configuration and licensing options. For example, with a WildFire® license, new virus and malware signatures can be installed as quickly as every 5 minutes. If the firewall has a Threat Prevention license but no WildFire license, signatures from WildFire would be updated only every 24 hours.

Content scanning it consumes firewall resources after it is enabled. Consult a firewall comparison chart to identify the model with appropriate “Threat Enabled” throughput.

WildFire Analysis Profiles

The WildFire cloud can scan your organization’s files using an appropriately configured WildFire Analysis Profile. A profile includes match conditions describing file characteristics you want to forward to WildFire for analysis. As files matching these conditions are transferred through your firewall, a copy is sent to WildFire for analysis.

Note: Files are *not* quarantined pending WildFire evaluation. In cases of positive malware findings, the security engineer must use information collected on the firewall and by WildFire to locate the file internally for remediation.

WildFire Profiles indicate which files are to be forwarded according to system-wide WildFire configuration settings. WildFire typically renders a verdict on a file within 5 to 10 minutes of receipt. WildFire analysis results in a detailed report including all aspects of the original file and the contained malware. This report is a valuable tool that describes the exact nature of the detected threat. Discussion of the report is here:

<https://docs.paloaltonetworks.com/wildfire/9-1/wildfire-admin/monitor-wildfire-activity/wildfire-analysis-reportsclose-up.html>

WildFire Profile setup details are here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-web-interface-help/objects/objects-security-profiles-wildfire-analysis.html>

A complete review of WildFire implementation considerations is here:

<https://docs.paloaltonetworks.com/wildfire/9-1/wildfire-admin.html>

An explanation of WildFire subscription benefits is here:

<https://docs.paloaltonetworks.com/wildfire/9-1/wildfire-admin/wildfire-overview/wildfire-subscription.html>

URL Filtering Profiles

A URL Filtering Profile is a collection of URL filtering controls that are applied to individual Security policy rules to enforce your web access policy. The firewall comes with a default profile that is configured to block threat-prone categories such as malware, phishing, and adult. You can use the default profile in a Security policy, clone it to be used as a starting point for new URL Filtering Profiles, or add a new URL Filtering Profile that will have all categories set to allow for visibility into the traffic on your network. You then can customize the newly added URL Filtering Profiles and add lists of specific websites that always should be blocked or allowed. This information provides more granular control over URL categories. For example, you may want to block social-networking sites but allow some websites that are part of the social-networking category.

URL filtering requires a URL Filtering subscription that keeps URL category classification information current. This subscription provides descriptive data as to which type of information is at a given URL. Profiles can implement various actions against categories that reflect the organization's use policies and risk posture.

After URL Filtering Profiles invoke an action, the user can be notified directly, thus reducing user confusion about the cause. These response pages can be modified to meet an organization's particular need:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/url-filtering/customize-the-url-filtering-response-pages.html>

An overview of URL filtering is provided here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/url-filtering.html>

URL filtering databases from Palo Alto Networks and BrightCloud are available for the firewall, but only one can be active at a given moment. Although they provide similar support to URL Filtering Profiles, the way each approach works within the firewall differs. A brief discussion of the two methods is here:

<https://docs.paloaltonetworks.com/pan-os/9-0/pan-os-admin/url-filtering/url-filtering-overview/url-filtering-vendors.html>

Specific information about implementing URL Filtering Profiles and their allowed actions is here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/url-filtering/configure-url-filtering.html>

Sample Questions

204. Which action specifies that Security Profiles are relevant in a policy rule?
 - A. deny
 - B. drop
 - C. reset
 - D. allow
205. Are files quarantined while WildFire checks if they are malware or legitimate?
 - A. always yes
 - B. always no
 - C. by default, yes, but you can change the settings
 - D. by default, no, but you can change the settings
206. Which feature of the next-generation firewall allows you to block websites that are not business-appropriate?
 - A. App-ID
 - B. File Blocking
 - C. Exploit Protection
 - D. URL Filtering

5.11 Identify the methods for automating the configuration of a firewall

Automated configuration of Palo Alto Networks firewalls can be accomplished with several options. A running firewall can be accessed through its API, from which configurations can be altered by an authenticated sender.

Details about this method appear here:

<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-panorama-api/about-the-pan-os-xml-api.html>

A complete firewall configuration can be read and applied via the Bootstrapping feature. You create a package with the model configuration for your network and then use that package to deploy firewalls (physical or virtual) anywhere. For physical firewalls, you use a USB drive. For virtual firewalls, you can use a virtual disk, a virtual CD-ROM, an Azure Storage Account, or an AWS S3 bucket. You either can bootstrap the firewall with basic initial configuration and licenses so that the firewall can register with Panorama and then retrieve its full configuration from Panorama, or you can bootstrap the complete configuration so that the firewall is fully configured on bootup.

References

- Prepare the Bootstrap Package
<https://docs.paloaltonetworks.com/vm-series/9-1/vm-series-deployment/bootstrap-the-vm-series-firewall/prepare-the-bootstrap-package.html>
- Bootstrap a Firewall using a USB Flash Drive
<https://docs.paloaltonetworks.com/pan-os/9-1/pan-os-admin/firewall-administration/bootstrap-the-firewall/bootstrap-a-firewall-using-a-usb-flash-drive.html>
- Bootstrap the VM-Series Firewall in Azure
<https://docs.paloaltonetworks.com/vm-series/9-1/vm-series-deployment/bootstrap-the-vm-series-firewall/bootstrap-the-vm-series-firewall-in-azure.html>
- Bootstrap the VM-Series Firewall in AWS
<https://docs.paloaltonetworks.com/vm-series/9-1/vm-series-deployment/bootstrap-the-vm-series-firewall/bootstrap-the-vm-series-firewall-in-aws.html>
- AWS CloudFormation
<https://aws.amazon.com/cloudformation/>
- Working with Managed Policies
https://docs.aws.amazon.com/IAM/latest/UserGuide/access_policies_manage.html#_create-managed-policy-console

Sample Questions

207. Which operating system do you select to use for a Palo Alto Networks firewall running in Microsoft Azure?
- A. Windows
 - B. BSD
 - C. Linux
 - D. UNIX
208. Which option lists the four component directories of a Palo Alto Networks bootstrap container?
- A. software, config, license, and content
 - B. software, config, lic, and content
 - C. software, configuration, license, and content
 - D. software, configuration, lic, and content
209. Which environment supports a USB drive for the firewall bootstrap?
- A. VMware ESXi
 - B. physical firewall
 - C. Microsoft Hyper-V
 - D. KVM

5.12 Describe the pros and cons of deploying distributed networking using SD-WAN

SD-WAN is a technology that enables you to use multiple internet services and private services to create an intelligent and dynamic WAN. The SD-WAN plugin is integrated with PAN-OS 9.1, which provides you with the security features of a PAN-OS 9.1 firewall combined with SD-WAN functionality. You can install the SD-WAN plugin on the Panorama management server. Panorama provides the means to centrally configure and manage your firewalls and SD-WAN environment. Panorama enables you to change and monitor your network configuration from a centralized location rather than configure and monitor each firewall individually. You can configure and manage your SD-WAN environment from the Panorama web interface or the Panorama REST API.

You can create Panorama templates using a CSV file and then push the configuration to the branch or hub firewalls. From Panorama you can export an empty SD-WAN device CSV file and then populate the CSV file with the branch and hub information. The information you will enter into a CSV includes serial number, type of device (branch or hub), names of zones to map to predefined zones, loopback address, prefixes to redistribute, AS number if you use BGP dynamic routing, router ID, and virtual router name.

Before you deploy your SD-WAN environment, you should determine the role of each firewall, either hub or branch, and determine which branches will communicate with which hubs. Branches and hubs that will communicate with each other are functionally grouped into a VPN cluster. You also may have cloud-based services and want the internet traffic to flow directly from branch office to the cloud using DIA. Use of DIA can prevent SaaS, web browsing, or heavy-bandwidth applications from having to flow from branch office to the hub to the cloud and back.

A link bundle enables you to combine multiple physical links into one virtual SD-WAN interface for purposes of path selection and failover protection. If you create a bundle with more than one physical link, you maximize application quality if a physical link deteriorates. You create a bundle by applying the same link tag to multiple links through an SD-WAN Interface Profile. The link tag identifies a bundle of links that have a similar type of access and a similar type of SD-WAN policy handling.

The SD-WAN subscription supports dynamic, intelligent link selection based on applications and services and the conditions of links that each application or service is allowed to use. The path health monitoring for each link includes latency, jitter, and packet loss. Dynamic path selection avoids brownout and node failure problems because sessions fail over to a better performing path in less than one second.

Link failover enables you to determine how and when a link will fail over to a different link if the original link degrades or fails. When you plan link failover, you should prioritize the order in which the firewall selects the first link for a new session and the order in which links should be a candidate to replace a link that is failing over, if there is more than one candidate.

For the applications and services, you should plan your path health thresholds at the point where you consider a path to have degraded enough in quality that you want the firewall to select a new path or fail over. The quality characteristics are latency (range is 10 to 2,000ms), jitter (range is 10 to 1,000ms), and packet loss percentage.

You can monitor the application and link performance of your VPN clusters to troubleshoot issues by

viewing summary information across all VPN clusters. You can gather more detailed information by drilling down to isolate the issues to affected sites, applications, and links.

References

SD-WAN Administrator's Guide:

<https://docs.paloaltonetworks.com/sd-wan/1-0/sd-wan-admin.html>

5.13 Identify how the Panorama commit recovery feature operates

When you initiate a commit, Panorama checks the validity of the changes before activating them. The validation output displays conditions that block the commit (errors) or that are important to know (warnings). For example, validation could indicate an invalid route destination that you need to fix for the commit to succeed. The validation process enables you to find and fix errors before you commit because no changes to the running configuration are made. This is useful if you have a fixed commit window and want to be sure the commit will succeed without errors.

Automatic commit recovery enables you to configure the firewall to attempt a specified number of connectivity tests after you push a configuration change from Panorama or commit a configuration change locally on the firewall. Automatic commit recovery is enabled by default, thus enabling the managed firewalls to locally test the configuration pushed from Panorama to verify that the new changes do not break the connection between Panorama and the managed firewall. If the committed configuration breaks the connection between Panorama and a managed firewall, then the firewall automatically fails the commit and the configuration is reverted to the previous running configuration.

The firewall also checks connectivity to Panorama every hour to ensure consistent communication if unrelated network configuration changes have disrupted connectivity between the firewall and Panorama or if implications to a pushed committed configuration may have affected connectivity. If an hourly connectivity check fails, the firewall generates a system log to alert administrators of potential configuration or network connectivity issues. An event is generated in the system log when you disable the setting, a connectivity test fails, or when a firewall configuration reverts to the last running configuration.

In high availability (HA) firewall configurations, each HA peer performs connectivity tests independently of each other, and HA config syncs may occur only after each HA successfully tests connectivity to Panorama and verifies its connection.

References

Panorama Commit, Validation, and Preview Operations:

<https://docs.paloaltonetworks.com/panorama/9-1/panorama-admin/panorama-overview/panorama-commit-validation-and-preview-operations.html#id1657d230-91b0-4ef0-99d2-dc344e5cf50f>

Appendix A: Sample Test

1. What is the last step of packet processing in the firewall?
 - A. check allowed ports
 - B. check Security Profiles
 - C. check Security policy
 - D. forwarding lookup
2. Which interface type requires you to configure where the next hop is for various addresses?
 - A. tap
 - B. virtual wire
 - C. Layer 2
 - D. Layer 3
3. How do you enable the firewall to be managed through a data-plane interface?
 - A. You specify Web UI in the interface properties.
 - B. You specify Management in the interface properties.
 - C. You specify HTTPS in the Interface Management Profile, and then specify in the interface properties to use that profile.
 - D. You specify Management in the Interface Management Profile, and then specify in the interface properties to use that profile.
4. Some devices managed by Panorama have their external interface on ethernet1/1, some on ethernet1/2. However, the zone definitions for the external zone are identical. What is the recommended solution in this case?
 - A. Create two templates: one for the ethernet1/1 devices, one for the ethernet1/2 devices. Use the same external zone definitions in both. Apply those two templates to the appropriate devices.
 - B. Create three templates: one for the ethernet1/1 devices, one for the ethernet1/2 devices, and one with the external zone definitions. Use those templates to create two template stacks, one with the ethernet1/1 and external zone, another with the ethernet1/2 and external zone. Apply those two template stacks to the appropriate devices.
 - C. Create three templates: one for the ethernet1/1 devices, one for the ethernet1/2 devices, and one with the external zone definitions. Apply the external zone template to all devices, and the ethernet1/1 and ethernet1/2 as appropriate (you can apply up to five templates per device).
 - D. Create three template stacks: one for the ethernet1/1 devices, one for the ethernet1/2 devices, and one with the external zone definitions. Apply the external zone template to all devices, and the ethernet1/1 and ethernet1/2 as appropriate (you can apply up to five templates per device).

5. In a Panorama managed environment, which two options show the correct order of policy evaluation (Choose two.)
 - A. device group pre-rules, shared pre-rules, local firewall rules, intrazone-default, interzone-default
 - B. device group pre-rules, local firewall rules, shared post-rules, device group post-rules, intrazone-default, interzone-default
 - C. device group pre-rules, local firewall rules, device group post-rules, shared post-rules, intrazone-default, interzone-default
 - D. device group pre-rules, local firewall rules, intrazone-default, interzone-default, device group post-rules, shared post-rules
 - E. shared pre-rules, device group pre-rules, local firewall rules, intrazone-default, interzone-default
6. When you deploy the Palo Alto Networks NGFW on NSX, how many virtual network interfaces does a VM-Series firewall need?
 - A. two, one for traffic input and output and one for management traffic
 - B. four, two for traffic input and output and two for management traffic (for High Availability)
 - C. three, one for traffic input, one for traffic output, and one for management traffic
 - D. six, two for traffic input, two for traffic output, and two for management traffic (for High Availability)
7. Which source of user information is *not* supported by the NGFW?
 - A. RACF
 - B. LDAP
 - C. Active Directory
 - D. SAML
8. What is the main mechanism of packet-based vulnerability attacks?
 - A. malformed packets that trigger software bugs when they are received
 - B. excess packets that fill up buffers, thus preventing legitimate traffic from being processed
 - C. packets that get responses that leak information about the system
 - D. packets that either fill up buffers or get responses that leak information
9. Which method is *not* a PAN-OS software decryption method?
 - A. SSH Proxy
 - B. SSL Proxy
 - C. SSL Forward Proxy
 - D. SSL Inbound Inspection
10. Which type of identification does an Application Override policy override?
 - A. App-ID
 - B. User-ID
 - C. Content-ID
 - D. Service

11. Which two types of protocols can cause an insufficient data value in the Application field in the Traffic log? (Choose two.)
 - A. UDP
 - B. TCP
 - C. ICMP
 - D. GRE
 - E. IGP
12. Which three profile types are used to prevent malware executables from entering the network? (Choose three.)
 - A. Antivirus
 - B. Anti-Spyware
 - C. WildFire Analysis
 - D. File Blocking
 - E. Vulnerability Protection
 - F. Zone Protection
13. Which user credential detection method does *not* require access to an external directory?
 - A. group mapping
 - B. domain credential filter
 - C. LDAP
 - D. Certificate
14. Which object type has a property to specify whether it can transfer files?
 - A. Application
 - B. Service
 - C. User
 - D. User group
15. When destination NAT rules are configured, the associated security rule is matched using which parameters?
 - A. pre-NAT source zone and post-NAT destination zone
 - B. post-NAT source zone and pre-NAT destination zone
 - C. pre-NAT source zone and post-NAT destination IP address
 - D. post-NAT source zone and post-NAT destination zone
16. What is the initial IP address for the management interface?
 - A. 10.0.0.1
 - B. 172.16.0.1
 - C. 192.168.1.1
 - D. 192.168.255.254
17. In a new firewall, which port provides web interface access by default?
 - A. data port #1
 - B. any data port
 - C. management port
 - D. console port

18. Which application requires you to import private keys?
- A. Captive Portal
 - B. Forward Trust
 - C. SSL Inbound Inspection
 - D. SSL Exclude Certificate
19. Under which conditions can two Layer 3 interfaces have the same IP address?
- A. They must be connected to a common VLAN object interface.
 - B. They must be connected to the same Ethernet network through a switch. This configuration can be used only for High Availability.
 - C. They must be connected to different virtual routers.
 - D. They must be subinterfaces of the same physical interface.
 - E. This feature is not supported.
20. Which two protocols are supported for site-to-site VPNs? (Choose two.)
- A. Authentication Header (AH)
 - B. Secure Socket Layer (SSL)
 - C. Encapsulating Security Payload (ESP)
 - D. Transport Layer Security (TLS)
 - E. Secure Shell (SSH)
21. GlobalProtect Portal is responsible for which two functions? (Choose two.)
- A. terminating SSL tunnels
 - B. authenticating GlobalProtect users
 - C. creating on-demand certificates to encrypt SSL
 - D. managing and updating GlobalProtect client configurations
 - E. managing GlobalProtect Gateway configurations
22. What is the preferred SYN flood defense action type?
- A. Random Drop
 - B. Random Early Drop
 - C. SYN Proxy
 - D. SYN Cookies
23. What would be a valid reason to allow non-SYN TCP packets at the start of a connection?
- A. Such packets could happen legitimately in the case of asymmetric routing.
 - B. Such packets could happen legitimately if there is load balancing across firewalls.
 - C. Such packets could happen legitimately because of either asymmetric routing or load balancing across firewalls.
 - D. Such packets could happen because of router bugs.
24. Where do you configure protection from malformed IP and TCP headers?
- A. DoS Profile
 - B. QoS Profile
 - C. Zone Protection Profile
 - D. Application Profile
25. Which parameter is *not* a valid criterion for the original packet in address translation?
- A. source zone
 - B. application
 - C. service

- D. destination address
26. Which parameter in a Security policy rule do you use to apply a rule to traffic coming in from a specific interface?
- A. source zone
 - B. source address
 - C. user
 - D. source interface
27. Where do you specify that certain URL categories are not to be decrypted(?)
- A. certificate properties
 - B. Decryption Profile
 - C. Decryption policy
 - D. Security policy
28. Where do you specify how the firewall should treat invalid certificates?
- A. certificate properties
 - B. Decryption Profile
 - C. Decryption policy
 - D. Security policy
29. Which two public cloud environments support pay-as-you-go (PAYG) firewall licensing?
(Choose two.)
- A. Microsoft Azure
 - B. Microsoft Hyper-V
 - C. Amazon AWS
 - D. VMware NSX
 - E. VMware ESXi
30. Which log type gets redirected in Device > Log Settings?
- A. Config
 - B. Traffic
 - C. Threat
 - D. WildFire Submission
31. Which tab of the firewall web interface gives you a consolidated picture of the security situation and the top-level threats?
- A. Dashboard
 - B. ACC
 - C. Monitor
 - D. Devices
32. A customer's custom application uses SMTP (email) to transfer directory information, which needs to be filtered in a different manner from normal SMTP. How do you configure this filtering?
- A. You cannot do it with the NGFW. You need to manually configure a proxy.
 - B. Create specific rules for the sources and destinations that run this application.
 - C. Create a custom signature and specify the SMTP fields that are different from normal SMTP use and patterns to identify when it is the custom application.
 - D. Create an Application Override policy and specify the sources and destinations that run this application.

33. Which kind of update requires a disruption in connectivity?
- A. downloading the PAN-DB seed file
 - B. dynamic content
 - C. PAN-OS software
 - D. WildFire subscription antivirus signatures
34. Which dedicated High Availability port is used for which plane?
- A. HA1 for the data plane, HA2 for the management plane
 - B. HA1 for the management plane, HA2 for the data plane
 - C. MGT for the management plane; HA2 as a backup
 - D. HA1 for the management plane, HA2 for the data plane in the PA-7000 Series
35. Which two protocols can AutoFocus use to retrieve log information from an NGFW? (Choose two.)
- A. syslog
 - B. Log transfer protocol, a Palo Alto Networks proprietary protocol
 - C. HTTP
 - D. HTTPS
 - E. SNMP
36. Palo Alto Networks publishes new applications at which approximate interval?
- A. every 30 minutes
 - B. hourly
 - C. daily
 - D. weekly
37. Which type of device can receive the GlobalProtect data files content update?
- A. Log Collector
 - B. firewall
 - C. WildFire
 - D. Antivirus
38. In which log will you see evidence that an administrator cannot log in to the firewall?
- A. Traffic
 - B. System
 - C. Configuration
 - D. Authentication
39. How do you reboot the firewall from the command line?
- A. restart system
 - B. reboot
 - C. request restart system
 - D. request reboot

40. Where in the user interface do you configure how many packets to capture when the extended-capture option is selected in an Anti-Spyware Profile or Vulnerability Profile?
- A. Device tab, as part of the Setup node
 - B. Security Profiles, because the desired number of captured packets can vary between profiles
 - C. as a default in the Device tab, as part of the Capture node. Then, exceptions can be configured in the Security Profiles.
 - D. Configure Capturing options for each defined capture file
41. You are preparing a bootstrap template for use with a VM-Series firewall hosted in a public cloud. You don't need to include the Content-ID files because the firewall will download the latest version when it is booted. How do you configure the bootstrap's content?
- A. create a content directory with an empty file named download latest leave it empty
 - B. delete it
 - C. rename it to content-null
 - D. add an empty file to it named no-download
42. Which format do you use for an AWS CloudFormation Template?
- A. XML
 - B. CSV
 - C. JSON
 - D. JSON or XML
43. In which order are Security policy rules from Panorama processed relative to local firewall policy rules?
- A. Local firewall policy rules are processed only during loss of Panorama connectivity.
 - B. All Panorama rules are processed first.
 - C. All local firewall policy rules are processed first.
 - D. Some Panorama rules are processed before the firewall's local rules, and some are processed after the local rules.
44. Which statement is true about Security Profiles?
- A. They are evaluated from top down, with the first match processing the traffic.
 - B. They are applied to all inbound traffic when they are enabled.
 - C. They enable a specific type of threat scanning (e.g., Virus, Spyware).
 - D. They can specify actions based on the username.
45. Which Captive Portal authentication method can be handled by the browser without affecting the user experience?
- A. web-challenge
 - B. browser-challenge
 - C. web-form
 - D. browser-form

46. The firewall of a defense contractor is not connected to the internet. However, it is connected to the classified SIPRNet. The contractor is concerned about getting malware files through that network. Can this defense contractor use the WildFire service for protection?
- A. No, because there is no network path to the WildFire cloud.
 - B. No, because all SIPRNet files are encrypted.
 - C. Yes, but only for PE-type file analysis.
 - D. Yes, it can use a WF-500 appliance.
47. How does the NGFW handle excess packets when there are QoS constraints?
- A. It buffers them until there is bandwidth to send them.
 - B. It drops a percentage of them randomly.
 - C. It replaces them with packets that tell the computer on the other side to slow down.
 - D. It sends a portion instead of the whole packet.
48. Which function is performed by the management plane?
- A. signature matching
 - B. VPN encryption
 - C. policy matching
 - D. User-ID group lookups
49. Which User-ID IP address-to-username mapping method can be visible to users?
- A. Captive Portal
 - B. monitoring Active Directory event logs
 - C. monitoring print server event logs
 - D. monitoring a Cisco WLAN controller
50. Which feature of the NGFW enables you to identify attempts to tunnel SSH over other ports?
- A. App-ID
 - B. Content-ID
 - C. User-ID
 - D. SSH Forward Proxy
51. What is the correct order of operations?
- A. check allowed ports, decrypt (if traffic is encrypted and the policy specifies to decrypt it), check Security policy, check Security Profiles, re-encrypt traffic
 - B. check allowed ports, decrypt (if traffic is encrypted and the policy specifies to decrypt it), check Security Profiles, check Security policy, re-encrypt traffic
 - C. decrypt (if traffic is encrypted and the policy specifies to decrypt it), check allowed ports, check Security policy, re-encrypt traffic
 - D. decrypt (if traffic is encrypted and the policy specifies to decrypt it), check allowed ports, check Security Profiles, check Security policy, re-encrypt traffic

Appendix B: Answers to Sample Questions

Exam Domain 1 – Plan

1.1 Identify how the Palo Alto Networks products work together to detect and prevent threats

1. Which component of the integrated Palo Alto Networks security solution limits network-attached workstation access to a corporate mainframe?
 - A. threat intelligence cloud
 - B. advanced endpoint protection
 - C. next-generation firewall**
 - D. tunnel inspection
2. Which Palo Alto Networks product is designed primarily to provide threat context with deeper information about attacks?
 - A. Prisma Cloud
 - B. WildFire
 - C. AutoFocus**
 - D. Threat Prevention
3. Which Palo Alto Networks product is designed primarily to provide normalization of threat intelligence feeds with the potential for automated response?
 - A. MineMeld**
 - B. WildFire
 - C. AutoFocus
 - D. Threat Prevention
4. Which Palo Alto Networks product is designed primarily to prevent endpoints from successfully running malware programs?
 - A. GlobalProtect
 - B. Cortex XDR – Analytics
 - C. Traps**
 - D. Prisma Cloud
5. The Palo Alto Networks Cortex Data Lake can accept logging data from which two products? (Choose two.)
 - A. Traps**
 - B. next-generation firewalls**
 - C. Prisma SaaS
 - D. MineMeld
 - E. AutoFocus
6. Which Palo Alto Networks product is a cloud-based storage service designed to hold log information?
 - A. Prisma Cloud
 - B. Traps
 - C. next-generation firewall
 - D. Cortex Data Lake**

7. Which product is an example of an application designed to analyze Cortex Data Lake information?

- A. **Cortex XDR - Analytics**
- B. Prisma Cloud
- C. Cortex XDR – Automated Response
- D. AutoFocus

1.2 Given a scenario, identify how to design an implementation of the firewall to meet business requirements that leverage the Palo Alto Networks Security Operating Platform

8. A potential customer says it wants to maximize the threat detection capability of its next-generation firewall. Which three additional services should it consider implementing to enhance its firewall's capability to detect threats? (Choose three.)

- A. Traps
 - B. **WildFire**
 - C. **URL Filtering**
 - D. Expedition
 - E. **DNS Security**
9. A VM-Series virtual firewall differs from a physical Palo Alto Networks firewall in which way?
- A. A VM-Series firewall cannot be managed by Panorama.
 - B. **A VM-Series firewall supports fewer traffic interface types.**
 - C. A VM-Series firewall cannot terminate VPN site-to-site tunnels.
 - D. A VM-Series firewall cannot use dynamic routing protocols.

10. Which product would best secure east-west traffic within a public cloud implementation?

- A. Prisma Cloud
- B. MineMeld
- C. **VM-Series firewall**
- D. Cortex

1.3 Given a scenario, identify how to design an implementation of firewalls in High Availability to meet business requirements that leverage the Palo Alto Networks Security Operating Platform

11. Why would you recommend an active/active firewall cluster instead of an active/passive firewall cluster?

- A. **Active/active is the preferred solution when the firewall cluster is behind a load balancer that randomizes routing, thus requiring both firewalls to be active.**
- B. Active/active usually is the preferred solution because it allows for more bandwidth while both firewalls are up.
- C. Active/active is the preferred solution when the PA-7000 Series is used. Use active/passive with the PA-5200 Series or smaller form factors.
- D. Active/active is the preferred solution when the PA-5200 Series or smaller form factors are used. Use active/passive with the PA-7000 Series.

12. Which two events can trigger an HA pair failover event? (Choose two.)
- A. **An HA1 cable is disconnected from one of the firewalls.**
 - B. A dynamic update fails to download and install.
 - C. **The firewall fails to ping a path-monitored destination address successfully.**
 - D. OSPF implemented on the firewall determines that an available route is now down.
 - E. RIP implemented on the firewall determines that an available route is now down.
13. Which two firewall features support floating IP addresses in an active/active HA pair? (Choose two.)
- A. data-plane traffic interfaces
 - B. **source NAT**
 - C. **VPN endpoints**
 - D. loopback interfaces
 - E. management port
14. How are firewalls configurations in an active/passive HA pair synchronized if the firewalls are not under Panorama control?
- A. An administrator commits the changes to one, then commits them to the partner, at which time the changes are sent to the other.
 - B. An administrator pushes the configuration file to both firewalls, then commits them.
 - C. **An administrator commits changes to one, which automatically synchronizes with the other.**
 - D. An administrator schedules an automatic sync frequency in the firewall configurations.
15. In which two ways is an active/passive HA pair configured in virtual firewalls deployed in any public clouds? (Choose two.)
- A. **The virtual firewalls are deployed in a cloud “scale set” with a cloud-supplied load balancer in front to detect and manage failover.**
 - B. **The virtual firewalls rely on a VM-Series plugin to map appropriate cloud functions to the firewall’s HA settings.**
 - C. Virtual firewalls use PAN-OS HA configuration combined with appropriate cloud deployments of interfaces for HA use.
 - D. The virtual firewalls use an HA Compatibility module for the appropriate cloud technology

1.4 Identify the appropriate interface type and configuration for a specified network deployment

16. Without having to make network address configuration changes, you would use which type of network interface to insert a Palo Alto Networks firewall in front of a legacy port-based firewall to collect application information from incoming network traffic?
- A. VLAN
 - B. tunnel
 - C. tap
 - D. virtual wire**
 - E. Layer 2
 - F. Layer 3

17. Which type of interface do you use to connect Layer 2 and Layer 3 interfaces?
- A. **VLAN**
 - B. tunnel
 - C. tap
 - D. virtual wire
 - E. Layer 2
 - F. Layer 3
18. Which three types of interfaces can the firewall's management web interface be bound to? (Choose three.)
- A. **VLAN**
 - B. **tunnel**
 - C. tap
 - D. virtual wire
 - E. Layer 2
 - F. **Layer 3**
19. Which three types of interfaces connect to a virtual router? (Choose three.)
- A. **VLAN**
 - B. **tunnel**
 - C. tap
 - D. virtual wire
 - E. Layer 2
 - F. **Layer 3**
20. Which dynamic routing protocol is not supported by the Palo Alto Networks firewall?
- A. RIP
 - B. OSPF
 - C. OSPFv3
 - D. **IGRP**
 - E. BGP
21. Which action is *not* compatible with aggregate interface configuration?
- A. **aggregating 12 Layer 3 interfaces**
 - B. aggregating four virtual wire interfaces
 - C. aggregating interfaces in an HA pair
 - D. aggregating two 10Gbps optical and two 10Gbps copper Ethernet ports

1.5 Identify strategies for retaining logs using Distributed Log Collection

22. In a Panorama environment, how do you create and view enterprise-wide reports that include data from all managed firewalls?
- A. **Run Panorama reports normally. Firewall summary reporting information is gathered automatically once the firewalls are managed by Panorama.**
 - B. Configure log forwarding on the managed firewalls to forward logs to Panorama using syslog formatting.
 - C. Run custom Panorama reports and select **remote logs** as the information source.
 - D. Run custom Panorama reports and select **log collector** as the information source.

23. What must you configure to guarantee duplication of log data on Log Collectors?
- A. Log Collector settings to include “Replicate Data”
 - B. Panorama HA settings to include “Duplicate Logs”
 - C. Log Collector settings to include “Enable log redundancy”**
 - D. log forwarding settings of firewalls for two Log Collector destinations
24. Which three devices can be used as Log Collectors? (Choose three.)
- A. Virtual Panorama**
 - B. PA-220R
 - C. M-600**
 - D. M-200**
 - E. VM-300LC
25. Which statement is true regarding Log Collecting in a Panorama HA pair?
- A. Both Panoramas cannot be configured to collect logs.
 - B. Log collecting is handled by the active HA Panorama until a failover occurs.
 - C. Both Panoramas collect independent logging traffic and are not affected by failover.**
 - D. Both Panoramas receive the same logging traffic and synchronize in case of HA failover.

1.6 Given a scenario, identify the strategy that should be implemented for Distributed Log Collection

26. How are log retention periods on Palo Alto Networks firewalls increased?
- A. add storage to any firewall model
 - B. increase the allocation for overall log storage within the firewall
 - C. turn on log compression
 - D. forward logs to external Log Collectors**
27. How do you access, and view firewall log data sent to the Cortex Data Lake?
- A. direct viewing and searching with the Cortex gateway
 - B. Panorama using a Log Collector configuration for access**
 - C. reporting in a firewall using a “remote data source” configuration
 - D. reporting in a firewall equipped with a “Remote Logging” plugin
28. Log retention is increased when a Dedicated Log Collector is used to collect logs from firewalls in which two ways? (Choose two.)
- A. turning on “Log Compression” in the Log Collector
 - B. adding storage capacity to the Log Collector**
 - C. enabling “Log Storage Sharing” between the Log Collector and Panorama
 - D. adding Log Collectors to the Log Collector Group**

1.7 Identify how to use template stacks for administering Palo Alto Networks firewalls as a scalable solution using Panorama

29. The Security policy for all of a customer's remote offices is the same, but different offices have different firewall models. If the remote offices are managed by Panorama, how might the offices share device groups and templates?
 - A. same device group and same template stack
 - B. same device group, different template stacks**
 - C. different device groups, same template stack
 - D. different device groups and different template stacks
30. A Panorama template stack contains two templates and one configuration setting has a different value in each template. When Panorama pushes the template stack to the managed firewalls, which setting value will the firewalls receive?
 - A. value from the top template of the stack**
 - B. value from the bottom template in the stack
 - C. value from the template designated as the parent
 - D. value an administrator selects from the two available values
31. Which two firewall settings are stored in Panorama templates? (Choose two.)
 - A. custom Application-ID signatures
 - B. Server Profile for an external LDAP server**
 - C. services definitions
 - D. DoS Protection Profiles
 - E. data-plane interface configurations**

1.8 Identify how to use device group hierarchy for administering Palo Alto Networks firewalls as a scalable solution using Panorama

32. Where in Panorama do you enter Security policy rules to ensure that your new rules will take precedence over locally entered rule?
 - A. Security policy rules with a targeted firewall
 - B. default rules section of Security policy rules
 - C. pre-rules section of Security policy rules**
 - D. post-rules section of Security policy rules
33. In Panorama, how would you make changes to a Security policy rule for a specific firewall?
 - A. log in to Panorama, clone the rule, modify the clone, and add a target firewall to the new rule**
 - B. select the rule, click the override button, and enter the changes
 - C. create a new locally defined Security policy rule that is placed higher in the rule list than the rule to be overridden
 - D. log in to Panorama and modify the original rule

34. Which three firewall settings are stored in Panorama device groups? (Choose three.)
- A. User Identification configuration
 - B. custom Application-ID signatures**
 - C. services definitions
 - D. DoS Protection Profiles**
 - E. data-plane interface configurations
 - F. Zone Protection Profiles
 - G. Server Profile for an external LDAP server

1.9 Identify planning considerations unique to deploying Palo Alto Networks firewalls in a public cloud

35. Which part of a VM-Series firewall should be updated to provide maximum feature support for a public cloud?
- A. latest PAN-OS update
 - B. latest VM-Series plugin**
 - C. capacity license for the target public cloud.
 - D. latest dynamic updates appropriate for the implemented PAN-OS version
36. Which two types of firewall interfaces are most likely to be supported in public cloud deployments? (Choose two.)
- A. tap
 - B. virtual wire
 - C. Layer 3**
 - D. tunnel**
 - E. aggregate Ethernet
37. From where can you buy and download a VM-Series virtual firewall appliance for a public cloud deployment?
- A. Palo Alto Networks Support Portal
 - B. cloud vendor's "Solution Marketplace"**
 - C. Using the download link supplied on the same site as the license server
 - D. Palo Alto Networks Product Download portal

1.10 Identify planning considerations unique to deploying Palo Alto Networks firewalls in a hybrid cloud

38. Which two conditions must be met to manage Palo Alto Networks firewalls deployed in multiple cloud environments from a central Panorama? (Choose two.)
- A. The Panorama and firewall must be able to communicate.**
 - B. The Panorama must be licensed for each cloud environment containing managed firewalls.
 - C. The firewalls must have the latest VM-Series plugin installed.
 - D. The firewalls and Panorama must be running the same version of PAN-OS software.
 - E. Firewalls must be running a version of PAN-OS software equal to or less than that on Panorama.**

1.11 Identify planning considerations unique to deploying Palo Alto Networks firewalls in a private cloud

39. A private cloud has 20 VLANs spread over five ESXi hypervisors, managed by a single vCenter. How many firewall VMs are needed to implement microsegmentation?
 - A. one
 - B. four
 - C. five**
 - D. 20
40. When you deploy the Palo Alto Networks NGFW on NSX, packets coming to an application VM from VMs running on different hardware go through which modules?
 - A. network, vSwitch, NSX firewall, Palo Alto Networks NGFW, application VM
 - B. network, vSwitch, Palo Alto Networks NGFW, NSX firewall, application VM
 - C. network, vSwitch, NSX firewall, Palo Alto Networks NGFW, NSX firewall, application VM**
 - D. vSwitch, network, Palo Alto Networks NGFW, NSX firewall, application VM
41. Which option shows the interface types that ESXi supports in the VM-Series firewalls?
 - A. tap, Layer 2, Layer 3, virtual wire**
 - B. Layer 3 only
 - C. tap, Layer 2, Layer 3
 - D. Layer 3, virtual wire

1.12 Identify methods for authorization, authentication, and device administration

42. To configure multi-factor authentication for users accessing services through the firewall, which three configuration pieces need to be addressed? (Choose three.)
 - A. GlobalProtect Portal
 - B. Captive Portal**
 - C. Authentication Enforcement Profile**
 - D. Authentication Profile**
 - E. Response pages
43. Which firewall configuration component is used to configure access to an external authentication service?
 - A. Local User Database
 - B. Server Profiles**
 - C. VM Information source
 - D. admin roles
 - E. Authentication policy rules
44. Which two firewall functions are reserved only for administrators assigned the superuser dynamic role? (Choose two.)
 - A. managing certificates
 - B. managing firewall admin accounts**
 - C. editing the management interface settings
 - D. creating virtual systems within a firewall**
 - E. accessing the configuration mode of the CLI

1.13 Identify the methods of certificate creation on the firewall

45. A Palo Alto Networks firewall can obtain a certificate for its internal use through which three methods? (Choose three.)
 - A. import a certificate file generated by an external CA
 - B. reference an externally stored certificate by a URL configured in an SSL/TLS Service Profile
 - C. generate a certificate directly by manually entering certificate data
 - D. obtain a certificate from an SCEP server using an SCEP Profile
 - E. importing a certificate from an external CA by using an Authentication Profile
46. Which two resources must be available to successfully run certificate validation tests on a certificate received from an external source? (Choose two.)
 - A. Root Certificate of the issuing CA
 - B. public key for the received certificate
 - C. OCSP connection address
 - D. existing Certificate Profile that matches the received certificate's CA identity

1.14 Identify options available in the firewall to support dynamic routing

47. The firewall uses which information to determine which interface to use for a packet's egress?
 - A. manually configured static routes
 - B. routing information base (RIB)
 - C. appropriate Redistribution Profile
 - D. ECMP destination monitoring results
48. A virtual router can use a Redistribution Profile to share routes between which three routing protocols? (Choose three.)
 - A. static routes
 - B. IGRP
 - C. RIP
 - D. OSPF
 - E. multicast
49. How does a firewall determine which route to use when its RIB is populated with multiple routes to the same location, but the routes were added by different routing protocol?
 - A. according to the following precedence of route type: static, RIP, OSPF, BGP
 - B. using the virtual router's FIB
 - C. using the associated route's metric and choosing the lowest value
 - D. using the route's administrative distance and choosing the lowest value

1.15 Given a scenario, identify ways to mitigate resource exhaustion (because of denial-of-service) in application servers

50. For which two reasons are denial-of-service protections applied by zone? (Choose two.)
 - A. because denial-of-service protections are applied early in the processing, before much information is known about the connection but when the ingress interface already is known
 - B. because denial-of-service protections are applied only when manually turned on to avoid quota overload (which would make denial of service easier)
 - C. because denial-of-service protections can depend on only the zone, and never on port numbers or IP addresses
 - D. because denial-of-service protections on a Layer 3 interface are different from the denial-of-service protections available on a Layer 2 interface and interfaces on virtual wires
51. SYN flood protection provides flood protection from which protocol?
 - A. UDP
 - B. TCP
 - C. ICMP
 - D. GRE
52. To which two protocols does port scan reconnaissance protection apply? (Choose two.)
 - A. UDP
 - B. TCP
 - C. GRE
 - D. ICMP
 - E. IPX
53. In which two places do you configure flood protection? (Choose two.)
 - A. DoS Protection Profile
 - B. QoS Profile
 - C. Zone Protection Profile
 - D. SYN Protection Profile
 - E. XOFF Profile
54. Which two firewall features should be used to provide tailored DoS protection to a specific address? (Choose two.)
 - A. Zone Protection Profiles
 - B. virtual routers
 - C. Server Profiles
 - D. DoS policy rules
 - E. DoS Protection Profiles

1.16 Identify decryption deployment strategies

55. Which feature is not negatively affected by the lack of a Decryption policy?
 - A. antivirus
 - B. App-ID
 - C. file blocking
 - D. network address translation

56. How can the next-generation firewall inform web browsers that a web server's certificate is from an unknown CA?
- A. show a "the certificate is untrusted, are you SURE you want to go there" response page before accessing the website
 - B. relay the untrusted certificate directly to the browser
 - C. have two certificates in the firewall, one used for sites whose original certificate is trusted, and the other for sites whose original certificate is untrusted
 - D. have two certificate authority certificates in the firewall, one used to produce certificates for sites whose original certificate is trusted and the other used for certificates for sites whose original certificate is untrusted**
57. Which two firewall features can be used to support an organization's requirement of decrypting and recording all encrypted traffic? (Choose two.)
- A. Decryption Broker**
 - B. Policy Based Forwarding
 - C. Default Router setting of Forward Cleartext
 - D. Interface setting of Decryption Port Mirroring**
 - E. Decryption policy rule action set to Forward Cleartext

1.17 Identify the impact of application override to the overall functionality of the firewall

58. An App-ID used in an Application Override policy rule should have which characteristic?
- A. existing App-ID that uses the same decoder
 - B. new App-ID with no signature information**
 - C. new App-ID with the "custom" property set to yes
 - D. any existing App-ID with compatible characteristics
59. Which type of identification is disabled by Application Override?
- A. Protocol-ID
 - B. User-ID
 - C. Content-ID**
 - D. URL Filtering
60. Application Override is triggered by which configuration setting?
- A. Custom App-ID
 - B. Application Override policy rule**
 - C. Application Override definition in Custom Objects
 - D. Application Filters

1.18 Identify the methods of User-ID redistribution

61. Which configuration must be made on the firewall before it can read User-ID-to-IP-address mapping tables from external source?
- A. Group Mapping Settings
 - B. Server Monitoring
 - C. Captive Portal
 - D. User-ID Agents**

62. For an external device to consume a local User-ID-to-IP-address mapping table, which data is used for authentication between the devices?
- A. **source device's User-ID Collector Name and Pre-Shared Key**
 - B. User-ID agent's Server Monitor Account information
 - C. Administrators account information on the source device with the User-ID role set.
 - D. certificates added to the User-ID agent configuration
63. User-ID-to-IP-address mapping tables can be read by which product or service?
- A. Traps
 - B. **Panorama Log Collector**
 - C. AutoFocus
 - D. Prisma Cloud

1.19 Identify VM-Series bootstrap components and their function

64. When will a firewall check for the presence of bootstrap volume?
- A. each time it cold-boots
 - B. **each time it boots from a factory default state**
 - C. when a firewall is started in maintenance mode
 - D. each time it warm-boots
65. Where in the bootstrap volume directories is a required dynamic update file?
- A. /config
 - B. /license
 - C. /software
 - D. **/content**
66. Can a firewall's PAN-OS software be updated by the bootstrap process?
- A. **Yes, by including a copy of the desired PAN-OS software in the /software folder of the bootstrap volume.**
 - B. Yes, by including a copy of the desired PAN-OS software in the /content folder of the bootstrap volume.
 - C. No, it must be updated by an administrator after the firewall starts.
 - D. No, the firewall must be licensed first.

Exam Domain 2 — Deploy and Configure

2.1 Identify the application meanings in the Traffic log (incomplete, insufficient data, non-syn TCP, not applicable, unknown TCP, unknown UDP, and unknown P2P)

67. An application using which protocol can receive an **incomplete** value in the Application field in the Traffic log?
- A. UDP
 - B. **TCP**
 - C. ICMP
 - D. GRE

68. Session traffic being evaluated by a firewall is encrypted with SSL. If the firewall does not decrypt the traffic, how can the firewall make an App-ID determination?
- A. evaluate the HTTP headers
 - B. evaluate the SSL Hello exchange
 - C. evaluate certificate contents used for encryption**
 - D. use information in the SSL Decryption Exclusion cache
69. While a firewall is scanning an active session, how does it respond when it detects a change of application?
- A. closes the session, opens a new one, and evaluates all Security policy rules again
 - B. closes the session, opens a new one, and evaluates the original matching Security policy rule only
 - C. updates the application in the existing session and evaluates all Security policy rules again**
 - D. updates the application in the existing session and continues to use the original action from the first Security policy rule match

2.2 Given a scenario, identify the set of Security Profiles that should be used

70. Which profile do you use for DLP based on file content?
- A. Antivirus
 - B. Anti-Spyware
 - C. Vulnerability Protection
 - D. URL Filtering
 - E. File Blocking
 - F. WildFire Analysis
 - G. Data Filtering**
71. Which profile do you use to monitor DNS resolution lookups for sites associated with threat activity?
- A. Antivirus
 - B. Anti-Spyware**
 - C. Vulnerability Protection
 - D. URL Filtering
 - E. File Blocking
 - F. WildFire Analysis
 - G. Data Filtering
72. Which profile do you use to analyze files for zero-day malware?
- A. Antivirus
 - B. Anti-Spyware
 - C. Vulnerability Protection
 - D. URL Filtering
 - E. File Blocking
 - F. WildFire Analysis**
 - G. Data Filtering

73. Which profile do you use to examine browsing traffic for appropriate browsing policy enforcement?
- A. Antivirus
 - B. Anti-Spyware
 - C. Vulnerability Protection
 - D. URL Filtering**
 - E. File Blocking
 - F. WildFire Analysis
 - G. Data Filtering
74. Which profile do you use to detect and block an executable file from being transferred through the firewall?
- A. Antivirus
 - B. Anti-Spyware
 - C. Vulnerability Protection
 - D. URL Filtering
 - E. File Blocking**
 - F. WildFire Analysis
 - G. Data Filtering

2.3 Identify the relationship between URL filtering and credential theft prevention

75. Which credential phishing prevention action allows users to choose to submit credentials to a site anyway?
- A. alert
 - B. allow
 - C. block
 - D. continue**
76. Which user credential detection method would work if multiple users share the same client IP address (for example, because of dynamic address translation done by a device on the internal side of the firewall)?
- A. IP-to-user mapping
 - B. group mapping
 - C. domain credential filter**
 - D. IP-and-port-to-user mapping
77. Which type of user credential detection must be used by a firewall administrator that wants to enable credential phishing prevention that blocks an attempt by a user to enter the organization's user ID and password?
- A. IP-to-user mapping
 - B. domain credential filter**
 - C. group mapping
 - D. Citrix mapping

2.4 Implement and maintain the App-ID lifecycle

78. Which security risk is elevated when port-based Security policy rules are used?
 - A. The firewall's resources will be negatively impacted by processing unwanted traffic.
 - B. Unwanted applications can get through the firewall, bringing their vulnerabilities with them.**
 - C. The network is more vulnerable to TCP DoS attacks.
 - D. The firewall is more vulnerable to UDP DoS attacks.
79. What is the Palo Alto Networks suggested process for converting port-based Security policy rules to use App-ID?
 - A. Use the Expedition tool to analyze Traffic logs against Security policy to suggest policy changes.
 - B. Use the built-in firewall reports to identify applications found in the traffic and update policy based on desired traffic.
 - C. Use the Policy Optimizer feature of the firewall to identify applications and update policy rules.**
 - D. Use the firewall's New Applications Seen feature to identify applications and update policy rules.
80. If App-ID is implemented in Security policy rules, should port numbers also be included?
 - A. No, App-ID-based Security policy rules detect and allow or block any desired application using the included port number values in the App-ID database.
 - B. Yes, including the port numbers as a *service-matching* condition can eliminate some traffic before App-ID processing, thus conserving firewall resources.
 - C. Yes, including an *application-default* setting in the *service-matching* condition requires that applications use only known or typical port numbers.**
 - D. No, App-ID based Security policy rules detect and allow or block any desired application using the edited port number values in the App-ID database.

2.5 Identify how to create security rules to implement App-ID without relying on port-based rules

81. Which firewall tool provides settings and tools to convert policies from port-based to App-ID?
 - A. Network Monitor display under App Scope
 - B. Policy Optimizer under Policies**
 - C. Application Hit Count under Policies
 - D. View Applications as Groups under Policies

82. An administrator creates a Security policy rule that allows office-on-demand traffic through the firewall. After the change is committed, the firewall issues the following warning:
“vsys1: Rule 'Allow Office apps' application dependency warning:
Application 'office-on-demand' requires 'ms-office365-base' be allowed
Application 'office-on-demand' requires 'sharepoint-online' be allowed
Application 'office-on-demand' requires 'ssl' be allowed
Application 'office-on-demand' requires 'web-browsing' be allowed”
Which action should the administrator take?
- A. create an application chain that include the dependencies
 - B. add the listed applications to the same Security policy rule**
 - C. set the Service action of the rule to “dependent application default”
 - D. create a new Security policy rule for each listed application with an “allow” action higher in the rule list

2.6 Identify configurations for distributed Log Collectors

83. The use of Dedicated Log Collectors instead of a mixed-mode Panorama for log collection provides which benefit?
- A. Log processing is offloaded from the Panorama(s) that are managing firewalls.**
 - B. Dedicated Log Collectors can forward logs to external sources which Panorama cannot do.
 - C. Dedicated Log Collectors can have more disk drives installed to increase log storage and Panorama cannot.
 - D. Dedicated Log Collectors provide store-and-forward support of logging data being sent to Panorama.
84. Which statement is true about the Dedicated Log Collector’s processing of firewall log data?
- A. Dedicated Log Collectors receive, compress and batch log data transmission to Panorama.
 - B. Dedicated Log Collectors process firewall logging data and send summary data to Panorama summary reporting databases.
 - C. Dedicated Log Collectors filter collected log data and forward desired alerts to Panorama.
 - D. Dedicated Log Collectors store firewall log data and provide query responses from Panorama on demand.**
85. Which two options will provide an enterprise-wide log that can be viewed from Panorama? (Choose two.)
- A. Select firewalls are designated as Log Collectors and add logs forwarded from other firewalls to their own.
 - B. Panorama devices are configured as Dedicated Log Collectors that then are added to Log Collector Groups. Firewalls forward logs to a designated Log Collector within a Collector Group.**
 - C. Cortex Data Lake is configured as a Log Collector in Panorama. Firewalls forward logs to Cortex Data Lake.**
 - D. A Panorama device is configured in Management Mode and a Log Collector is defined on the Panorama appliance, which then is added to a Log Collector Group. Firewalls forward logs to a designated Log Collector within a Collector Group.

2.7 Identify the required settings and steps necessary to provision and deploy a next-generation firewall

86. Which configuration is performed first on a firewall with factory default settings, according to Palo Alto Networks best practices?
 - A. add licenses
 - B. update PAN-OS software
 - C. configure the management network port**
 - D. update dynamic update files
87. You finished configuring the firewall's basic connectivity in the lab and are ready to put it in the data center. What do you have to remember to do before you power down the firewall?
 - A. Save the changes.
 - B. Commit the changes.**
 - C. Create a restore thumb drive in case the configuration is deleted.
 - D. Verify that the configuration is correct. You do not need to do anything else if it is correct; the configuration is updated automatically.
88. The firewall's MGT port can be configured as which type of interface?
 - A. Layer 2
 - B. Layer 3**
 - C. virtual wire
 - D. serial

2.8 Identify which device of an HA pair is the active partner

89. Which CLI command provides High Availability active/passive status of a firewall?
 - A. show high-availability all**
 - B. show high-availability status
 - C. show system state
 - D. show system high-availability all
90. Which function can be performed directly in the High Availability widget?
 - A. synchronize dynamic update files
 - B. synchronize log files
 - C. synchronize firewall configurations**
 - D. trigger an immediate failover
91. Which two steps must be completed to enable the display of the Dashboard's High Availability widget?
 - A. log in to the firewall management web interface and configure HA for active/active or active/passive
 - B. log in to the firewall management web interface and click the **Sync to peer** link in the firewall HA configuration settings
 - C. log in to the firewall's CLI and enter the **get management-server logging on** command
 - D. select and enable the High Availability widget in the firewall's management web interface Dashboard display**

2.9 Identify various methods for authentication, authorization, and device administration within PAN-OS software for connecting to the firewall

92. Which firewall configuration object is used to specify more than one external authentication source for a user's log in attempt?
 - A. Multiple Server Profiles configured to failover
 - B. Authentication Sequence**
 - C. Local User account set to failover
 - D. Account Sequence
93. Which object links the Captive Portal method with an Authentication Profile when multi-factor authentication is configured?
 - A. Multi-Factor Authentication Server Profile
 - B. Authentication policy rule
 - C. Authentication Sequence
 - D. Authentication Enforcement object**
94. Which four firewall Server Profiles can provide first factor authentication for multi-factor authentication configurations? (Choose four.)
 - A. HTTP
 - B. Okta
 - C. PingID
 - D. Kerberos**
 - E. RADIUS**
 - F. SAML**
 - G. LDAP**
 - H. RSA SecureID Access

2.11 Identify how to configure and maintain certificates to support firewall features

95. How are updates made to the cache of root certificates that is used for certificate verification purposes and maintained by Palo Alto Networks?
 - A. The administrator reviews certificate status and replaces them manually.
 - B. The firewall automatically updates the certificates as it updates the associated CRL list.
 - C. The administrator installs PAN-OS software and dynamic content updates.**
 - D. The firewall automatically installs new certificates using OCSP.
96. How does a firewall administrator that creates a certificate on the firewall mark it for use in an SSL Forward Proxy configuration?
 - A. add a certificate tag in the Decryption policy rule
 - B. configure a trust certificate in the Decryption Profile
 - C. set the Forward Trust Certificate property of the certificate itself**
 - D. map the certificate to the URL in the SSL/TLS Service Profile

97. Administrators within the enterprise want to replace the default certificate used by the firewall to secure the management web interface traffic with a certificate generated by their existing certificate authority. Which certificate property must be set for their new certificate to function?
- A. Certificate CN set to a domain name that resolves to any traffic port address of the firewall.
 - B. Certificate must be signed by the firewall root certificate.
 - C. Certificate must have the **Forward Trust Certificate** property set.
 - D. **CN must be set to the management port of the firewall.**

2.12 Identify the features that support IPv6

98. Which two configuration conditions must be met for a firewall to NAT between IPv4 and IPv6? (Choose two.)
- A. select NAT64 in the Session tab under Device > Setup > Session
 - B. **choose the NAT Type of nat64 in the General tab of a NAT policy rule**
 - C. **add an IPv6 addresses to the Translated Packet tab**
 - D. add an IPv6 prefix in the nat64 configuration in the NAT policy rule
99. Which two configuration conditions must be met for a Palo Alto Networks firewall to send and receive IPv6 traffic? (Choose two.)
- A. Enable IPv6 check box in the Virtual Router configuration is checked.
 - B. An Ethernet interface is configured for virtual wire.
 - C. **An Ethernet interface is configured for Layer 3.**
 - D. **Enable IPv6 Firewalling check box under Session Settings is turned on.**

2.13 Identify how to configure a virtual router

100. Under which condition can Layer 3 interfaces in the same firewall have the same IP address?
- A. **They must be connected to different virtual routers.**
 - B. They must be connected to the same Ethernet network through a switch.
 - C. They must be subinterfaces of the same physical interface.
 - D. They must be in different zones.
101. How do two virtual routers on a firewall forward traffic to each other?
- A. Virtual router traffic is sent to an external router that routes it back to the second virtual router.
 - B. Both virtual routers pass traffic via a dedicated VLAN routing interface.
 - C. Both virtual routers pass traffic via a configurable shared routing interface.
 - D. **Virtual routers forward traffic directly to each other within the firewall using routing table lookups.**

102. A firewall's virtual router can connect to which three types of interfaces? (Choose three.)
- A. virtual wire
 - B. management
 - C. Layer 3 traffic**
 - D. HA1
 - E. HA2
 - F. loopback
 - G. tunnel

2.14 Given a scenario, identify how to configure an interface as a DHCP relay agent

103. A Palo Alto Networks firewall can forward DHCP packets to servers connected to which two kinds of networks? (Choose two.)
- A. virtual wire
 - B. Layer 2
 - C. Layer 3**
 - D. aggregate**
104. How does a Palo Alto Networks firewall configured to forward DHCP packets to multiple server destinations choose which reply to forward to the sender?
- A. The first server listed in the "Server Priority" DHCP configuration is forwarded until it fails to respond, then the next one is chosen.
 - B. A request is sent to all servers on the list, and the first responder is forwarded.**
 - C. All DHCP server responses are forwarded, and the receiving client chooses which to accept.
 - D. The server that is the fewest network hops from the requesting client is chosen. When more than one server has the same hop count, all packets from the servers are forwarded to the client.

2.15 Identify the configuration settings for site-to-site VPN

105. In a site-to-site VPN configuration, what is an alternate method to the use of pre-shared keys to authenticate each device during connection setup?
- A. certificates**
 - B. expected IP address of the partner's interface
 - C. known hexadecimal string configured in both endpoints
 - D. matching Proxy ID definitions configured in both endpoints
106. Which type of firewall interface can be associated with a tunnel interface?
- A. tap
 - B. virtual wire
 - C. Layer 2
 - D. Layer 3**

107. A firewall administrator is deploying 50 Palo Alto Networks firewalls to protect remote sites. Each firewall must have a site-to-site IPsec VPN tunnel to each of three campus locations. Which configuration function is the basis for automatic site-to-site IPsec tunnels set up from each remote location to the three campuses?
- A. import of a settings table into the remote firewall's IPsec tunnel config
 - B. import of a settings table into the IPsec tunnel config of the three campuses
 - C. configuration of the GlobalProtect satellite settings of the campus and remote firewalls**
 - D. entry of campus IPsec tunnel settings for each remote firewall's IPsec Profile

2.16 Identify the configuration settings for GlobalProtect

108. Which GlobalProtect configuration component contains the setting that specifies when the agent software starts on the client system?
- A. Agent settings in the GlobalProtect Portal settings**
 - B. General settings in the GlobalProtect Portal settings
 - C. Agent settings of the GlobalProtect Gateway
 - D. General settings of the GlobalProtect Gateway
109. Which configuration or service is required for an iOS device using the GlobalProtect license to connect to a GlobalProtect Gateway?
- A. X-Auth configuration in the gateway settings
 - B. GlobalProtect Gateway license**
 - C. firewall Authentication policy with an iOS setting
 - D. GlobalProtect client downloaded from the GlobalProtect Portal
110. A GlobalProtect Gateway is solely responsible for which function?
- A. terminating SSL tunnels**
 - B. authenticating GlobalProtect users
 - C. creating on-demand certificates to encrypt SSL
 - D. managing and updating GlobalProtect client configurations
 - E. managing GlobalProtect Gateway configurations

2.18 Identify how to configure features of NAT policy rules

111. Which two source address translation types can use a single IP address to NAT multiple IP addresses? (Choose two.)
- A. Static IP
 - B. Dynamic IP**
 - C. Dynamic IP and Port**
 - D. Translated Address
 - E. Address Override
112. Which NAT type can be used to translate between IPv4 and IPv6?
- A. ipv4
 - B. nat64**
 - C. nptv6
 - D. ipv6

113. How does a firewall process a packet that has more than one NAT policy rule that matches a packet?

- A. Each matching rule in the list is applied from the top down, with cumulative changes being processed at the end of the list.
- B. The first rule matching the packet is applied and processed, skipping the others.**
- C. The firewall issues an error when committing NAT policy rules that can affect the same packet.
- D. The last matching rule in the list is applied and processed.

2.19 Given a configuration example including DNAT, identify how to configure security rules

114. A server on the DMZ with a private NIC address has network access provided by a NAT policy rule whose **Bi-directional** check box is selected in the Translated Packet settings for static IP source address translation. Which Security policy rule must be created to allow bi-directional traffic to and from the DMZ server?

- A. a rule for each direction of travel using the pre-NAT server IP address**
- B. a rule with the post-NAT source IP address
- C. a rule for each direction of travel using the post-NAT server IP address
- D. a rule with the pre-NAT source IP address

115. An internal web browser sends a packet to a server. The browser's connection has the source IP address 192.168.5.3, port 31415. The destination is 209.222.23.245, port 80. The firewall translates the source to 75.22.21.54, port 27182. Which three of these source IP addresses would cause a NAT policy rule to apply to this traffic? (Choose three.)

- A. 192.168.5.0/24**
- B. 75.22.21.0/24
- C. 192.168.4.0/23**
- D. 192.168.0.0/16**
- E. 75.22.0.0/17
- F. 75.22.128.0/17

116. A NAT policy rule is created to change the destination address of any packets with a source of any address and a destination address of 10.10.10.10 (in the DMZ zone) to 192.168.3.45 (in the Trust zone). Which Security policy rule components are required for a packet that has this rule applied to match and allow this traffic?

- A. source address any, source zone any, destination address 192.168.3.45, destination zone Trust, action = allow
- B. source address any, source zone any, destination address 10.10.10.10, destination zone Trust, action = allow**
- C. source address any, source zone any, destination address 192.168.3.45, destination zone DMZ, action = allow
- D. source address any, source zone any, destination address 10.10.10.10, destination zone DMZ, action = allow

2.20 Identify how to configure decryption

117. Which protocol is supported for traffic decryption matching a Decryption policy rule?
 - A. IPsec
 - B. SP3
 - C. SSH**
 - D. NLSP
118. Where do you specify that a certificate is to be used for SSL Forward Proxy?
 - A. Certificate properties**
 - B. Decryption Profile
 - C. Decryption policy
 - D. Security policy
119. Which feature must be configured to exclude sensitive traffic from decryption?
 - A. Security policy rule that includes the specific URL with an “allow” action
 - B. Decryption policy rule with the specific URL and “no decrypt” action**
 - C. Application Override policy that matches the application URL and port number
 - D. Decryption Profile that includes the site’s URL

2.21 Given a scenario, identify an application override configuration and use case

120. Which option is not a parameter used to identify applications in an Application Override policy?
 - A. protocol
 - B. port number
 - C. first characters in the payload**
 - D. destination IP address
121. How does the firewall resolve conflicting App-ID assignments to the same traffic between an Application Override policy rule and the firewall’s built-in App-ID?
 - A. The firewall’s regular App-ID is assigned.
 - B. The Application Override’s App-ID is assigned.**
 - C. The App-ID is set to duplicate definitions.
 - D. The App-ID is set to not available.
122. Which firewall process is bypassed when an Application Override policy matches traffic and assigns an App-ID?
 - A. QoS
 - B. IPsec
 - C. Content-ID**
 - D. User-ID

2.22 Identify how to configure VM-Series firewalls for deployment

123. Which virtual interface is the management on a VM-Series firewall running on ESXi?
 - A. vNIC #1**
 - B. vNIC #2
 - C. vNIC #9
 - D. vNIC #10

124. Which three items of information are required at a minimum to install and configure VM-Series firewalls? (Choose three.)
- A. VLANs to be connected through the firewall
 - B. management port IP address**
 - C. IP addresses for the data interfaces
 - D. management port default gateway**
 - E. management port netmask**
 - F. IP address for the external (internet-facing) interface
125. Compared to a physical firewall, VM-Series firewalls require you to apply which additional license?
- A. Base Capacity**
 - B. Cloud Services
 - C. Site License
 - D. VM Update
126. A VM-Series firewall being deployed in Azure can be automatically configured by bootstrapping. Azure requires which features for Bootstrapping to work?
- A. Storage Account configured for Azure Files Service**
 - B. PowerShell script that feeds a configuration file to the firewall
 - C. XML configuration file included in the base firewall provisioning
 - D. Azure Backup services configured with a config file and included in the firewall provisioning

2.23 Identify how to configure firewalls to use tags and filtered log forwarding for integration with network automation

127. Dynamic tags can be assigned to which kind of data in a log event?
- A. source and destination address, source and destination zone name
 - B. source and destination address**
 - C. interface, zone name
 - D. DNS name, zone name
128. How can the firewall use dynamically tagged objects to block traffic?
- A. Add the object to an enforcement list of a Data Filtering object that then is attached to a Security policy rule.
 - B. Assign the object to a dynamic list, which then is included in the destination address matching condition of a Security policy rule.
 - C. Assign the object to a Dynamic Address Group object, which then is added to the destination address matching condition of a Security policy rule.**
 - D. Add the object to an Application Group and use it in Security policy rules.

129. A tag can be dynamically assigned to data in which four types of logs? (Choose four.)
- A. Traffic
 - B. Threat
 - C. URL Filtering
 - D. HIP Match
 - E. Tunnel Inspection
 - F. Configuration
 - G. System
130. Dynamic tagging activity is recorded in which log?
- A. System
 - B. Configuration
 - C. IP-Tag
 - D. Data Filtering

Exam Domain 3 – Operate

3.1 Identify considerations for configuring external log forwarding

131. A firewall can forward log events to which two types of log formats? (Choose two.)
- A. XES
 - B. SNMP
 - C. Http
 - D. databases using xml format
 - E. NCSA
132. How does a firewall forward log events to an external destination?
- A. They are sent in batches at the frequency specified in the destination's Server Profile.
 - B. They are queued and sent in batches at differing intervals depending on the event severity.
 - C. They are sent as quickly as the required QoS policy rule governing log event traffic allows.
 - D. **They are sent in real time as the firewall generates them.**
133. Which two firewall logs can be exported using the Scheduled Log Export function? (Choose two.)
- A. Configuration
 - B. System
 - C. Traffic
 - D. URL

3.2 Interpret log files, reports, and graphs to determine traffic and threat trends

134. Which filter finds all log entries for traffic that originates from the internal device whose IP address is 172.17.1.3 and according to the header appears to be HTTP or HTTPS?
- A. (addr.src in 172.17.1.3) and ((port.dst eq 80) or (port.dst eq 443))
 - B. ((addr.src in 172.17.1.3) and (port.dst eq 80)) or (port.dst eq 443)
 - C. (src.addr in 172.17.1.3) and ((dst.port eq 80) or (dst.port eq 443))
 - D. ((src.addr in 172.17.1.3) and (dst.port eq 80)) or (dst. port eq 443)

135. Which two log files would you use if you suspect that a rogue administrator is modifying the firewall's rulebase to allow and hide illicit traffic? (Choose two.)

- A. Traffic
- B. Threat
- C. Data Filtering
- D. Configuration**
- E. System**

136. Which product is required to use event correlation?

- A. next-generation firewall, PA-220
- B. Advanced Endpoint Protection
- C. Panorama**
- D. GlobalProtect

3.3 Identify scenarios in which there is a benefit from using custom signatures

137. How would you configure the firewall to control access to a custom DNS application that operates differently from the standard DNS application?

- A. You cannot do it with the next-generation firewall. You need to manually configure a proxy.
- B. Create specific rules for the sources and destinations that run this application.
- C. Create a custom DNS application and add it to separate Security policy rules.**
- D. Create an Application Override policy and specify the sources and destinations that run this application.

138. What are two results of using Application Override policies? (Choose two.)

- A. prevent matching traffic from entering VPN tunnels
- B. apply a specified App-ID label to matching traffic**
- C. prevent matching traffic from being logged
- D. cause matching traffic to bypass Content-ID processing**
- E. route traffic to WildFire for scanning

139. Which two types of entities can have custom signatures? (Choose two.)

- A. services
- B. URL categories
- C. user groups
- D. applications**
- E. vulnerabilities**

3.4 Given a scenario, identify the process to update a Palo Alto Networks system to the latest version of the software

140. Match the upgrade step description with the correct step number.

| | |
|--------------------------------|--------|
| Upgrade PAN-OS software | Step 3 |
| Reboot the firewall | Step 4 |
| Update dynamic content | Step 2 |
| Activate subscription licenses | Step 1 |

141. Match each component with the order in which the component should be upgraded to a new version of PAN-OS software.

| | |
|---------------------|--------|
| HA active firewall | Step 4 |
| Panorama | Step 1 |
| Log Collector | Step 2 |
| HA passive firewall | Step 3 |

142. How do you upgrade an active/passive HA firewall pair to PAN-OS 9.1 while maintaining internet access?

- A. Upgrade the active firewall first, then the passive one.
- B. Upgrade the passive firewall first, then the active one.**
- C. Run the upgrade on the active firewall. It will manage the process and upgrade the passive firewall.
- D. You must upgrade both members of the pair at the same time, which requires an upgrade window that allows downtime.

3.5 Identify how configuration management operations are used to ensure desired operational state of stability and continuity

143. What is the format of the firewall configuration files?

- A. YAML
- B. JSON
- C. XML**
- D. CSV

144. Which method can be used to restore the previous configuration when a new configuration committed on a firewall has undesired consequences?

- A. Use the Load configuration version to restore the previous configuration settings, and follow with commit.**
- B. Use the Rollback commit link in the commit completion message.
- C. Use the Import device state to restore the pre-commit configuration.
- D. Use the Load named configuration snapshot to restore the previous configuration, and follow with a commit.

145. Which CLI command do you use to move a configuration file from an external server to a firewall's local storage?

- A. rdist
- B. ssh
- C. scp**
- D. rpc

3.6 Identify the settings related to critical HA functions (link monitoring; path monitoring; HA1, HA2, and HA3 functionality; HA backup links; and differences between A/A and A/P)

146. Which feature is an intended advantage of an active/active firewall pair versus an active/passive pair?
- A. increased throughput
 - B. support of asynchronous routing**
 - C. increased session count
 - D. shared dynamic updates

3.7 Identify the sources of information that pertain to HA functionality

147. Which configuration object does a firewall use to forward HA-related events to an external monitoring technology?
- A. Device > Log Settings > System Log settings**
 - B. Objects > Log Forwarding Profile > System Log Type
 - C. Device > High Availability > General > Event Forwarding
 - D. Dashboard > High Availability widget > Notification
148. Which two Panorama objects can display current HA state information about a managed firewall? (Choose two.)
- A. firewall listings in Monitor > HA Status
 - B. firewall specific information in Managed Devices > Health**
 - C. firewall listings in Managed Devices > Summary**
 - D. firewall HA Status widget in Dashboard > Widgets
 - E. firewall HA status in Panorama > High Availability

3.8 Identify how to configure the firewall to integrate with AutoFocus and verify its functionality

149. Which method is used to connect a firewall to AutoFocus to query data?
- A. Click the AutoFocus link in the firewall management user interface under Device > Licenses > AutoFocus
 - B. Click the link found in the log events under the firewall's Monitor > Logs > AutoFocus
 - C. Configure the connection using the Dashboard's AutoFocus widget
 - D. Click the link found in the log event under the firewall's Monitor > <threat-related log> > <threat detail>**
150. What is a principle benefit of the AutoFocus product?
- A. provide additional threat detection data to the firewall
 - B. manage access to SaaS applications through the firewall
 - C. provide additional context to previously discovered threats**
 - D. examine Cortex Data Lake log data for undetected threats

3.9 Identify the impact of deploying dynamic updates

151. After an Applications and Threats dynamic update is downloaded to the firewall, where can information about changes to the App-IDs be found?
 - A. Summary link in the log event detail reporting the dynamic update file download
 - B. Review Policies link at the bottom of the Security policy rules display
 - C. Review Apps link appearing next to the downloaded Applications and Threats file**
 - D. Details link in the dynamic file availability announcement appearing in the News Feed widget on the dashboard
152. The GlobalProtect Data File dynamic update contains which kinds of data?
 - A. GlobalProtect client package software updates for Windows and Macintosh
 - B. list of available connection points for Prisma Access
 - C. HIP check detection data for the GlobalProtect clients**
 - D. updates to cypher suites used by the GlobalProtect client
153. When application details are viewed in the App-ID database, which field indicates that a recent change to the application might affect your Security policy rules?
 - A. Name
 - B. Depends on
 - C. Previously Identified As**
 - D. App-ID Enabled

3.10 Identify the relationship between Panorama and devices as pertaining to dynamic updates versions and policy implementation and/or HA peers

154. How are HA firewall pairs kept in sync when Panorama pushes dynamic updates?
 - A. Panorama delivers the dynamic update to the active firewall(s) of the HA pair and updates the passive partner when a failover occurs in active/passive pairs.
 - B. Panorama delivers the update to one firewall, which syncs with its HA partner.
 - C. Panorama delivers the dynamic update to both firewalls simultaneously.**
 - D. Panorama delivers the dynamic update to the active firewall, which triggers the passive partner to request the file from Panorama.
155. Which type of device can receive the Antivirus content update?
 - A. Log Collector
 - B. firewall**
 - C. AutoFocus
 - D. MindMeld
156. Which requirement must a Panorama meet to update a managed firewall's antivirus signatures?
 - A. The PAN-OS versions on the firewall and Panorama must be the same.
 - B. Panorama and the firewall must be able to connect to the Palo Alto Networks update server.
 - C. The update must be installed on Panorama before it is installed on any firewalls.
 - D. Panorama must download an antivirus file version compatible with the target firewall's PAN-OS version.**

Exam Domain 4 – Configuration Troubleshooting

4.1 Identify system and traffic issues using the web interface and CLI tools

157. If users cannot access their Gmail accounts through the firewall, which log and filter do you use to troubleshoot the problem?
- A. **Traffic, (app eq gmail)**
 - B. Traffic, (app in gmail)
 - C. Configuration, (app eq gmail)
 - D. Configuration, (app in gmail)
158. You cannot access the firewall web interface. From the firewall CLI, how do you check to see if the web service is running?
- A. ps -aux | grep appweb
 - B. ps -aux | match appweb
 - C. show system software status | grep appweb
 - D. show system software status | match appweb**
159. Which firewall log displays information about connection failures to an external LDAP authentication server?
- A. Traffic
 - B. System**
 - C. User-ID
 - D. Authentication

4.2 Given a session output, identify the configuration requirements used to perform a packet capture

160. Which Security Profile does not have a packet capture option?
- A. Antivirus
 - B. Anti-spyware
 - C. Vulnerability Protection
 - D. URL Filtering**
161. On a PA-7080, which feature (do you need to disable to use packet capture)?
- A. NAT
 - B. hardware offload**
 - C. hardware acceleration
 - D. decryption
162. When must you use **tcpdump** to capture traffic on the next-generation firewall?
- A. on tunnel interface traffic
 - B. on data-plane interfaces**
 - C. on the management interface
 - D. on IPsec negotiation traffic

4.3 Given a scenario, identify how to troubleshoot and configure interface components

163. Where in the firewall web interface can you see whether any sessions are going through a specific interface?
- A. Dashboard
 - B. Application Command Center (ACC)
 - C. Session Log node on the Monitor tab
 - D. Session Browser node on the Monitor tab**
164. Communication through a specific interface works most of the time but fails when traffic throughput is at its highest. Which policy do you consult to identify the problem?
- A. Security
 - B. DoS Protection**
 - C. QoS
 - D. Application Override
165. Which interface type allows you to add a firewall with the least disruption to a network?
- A. tap
 - B. Layer 3
 - C. Layer 2
 - D. virtual wire**

4.4 Identify how to troubleshoot SSL decryption failures

166. Why would SSL decryption that has been working for a customer suddenly stop?
- A. The firewall's CA certificate expired.**
 - B. The firewall's IP address, which is encoded in the certificate, changed.
 - C. The firewall has been upgraded to a different model.
 - D. The firewall's decryption subscription expired.
167. A company uses a small SaaS application provider. This application is accessed through HTTPS but suddenly stops working through the firewall. However, when the application is accessed from home, users receive an error about the certificate. Which two situations would explain this behavior? (Choose two.)
- A. The SaaS's certificate had expired. The firewall's decryption policy is configured to block connections with expired certificates.**
 - B. The SaaS's certificate had expired. The firewall's decryption policy is configured to use the untrusted CA with expired certificates.
 - C. The SaaS's certificate was replaced with one whose certificate authority is not known to the firewall. The firewall's decryption policy is configured to block connections with certificates whose CA is not trusted.**
 - D. The SaaS's certificate was replaced with one whose certificate authority is not known to the firewall. The firewall's decryption policy is configured to use the untrusted certificate for certificates whose CA is not trusted.
 - E. The firewall's own CA certificate needs to be updated.

168. Which encryption algorithm is not supported by the firewall and causes the firewall to drop the connection?

- A. DES
- B. 3DES
- C. AES252-CBC
- D. AES256-GCM

4.5 Identify issues with the certificate chain of trust

169. Which condition could be a symptom of a certificate chain-of-trust issue?

- A. The firewall no longer decrypts HTTPS traffic.
- B. The firewall no longer decrypts HTTPS traffic from a specific site.
- C. The firewall still decrypts HTTPS traffic from all sites, but it re-encrypts it using the Forward Untrust certificate instead of the Forward Trust certificate.
- D. The firewall still decrypts HTTPS traffic from a specific site, but it re-encrypts it using the Forward Untrust certificate instead of the Forward Trust certificate.**

170. Which field is mandatory in the subject field of a certificate?

- A. Organization
- B. Organizational Unit
- C. Common Name**
- D. Locale

171. Which field in a certificate must include a value known to the firewall for the certificate to be considered valid by the firewall?

- A. Issuer**
- B. Subject
- C. Key
- D. Object

4.6 Given a scenario, identify how to troubleshoot traffic routing issues

172. Where do you find the dynamic routing configuration in the next-generation firewall's web interface?

- A. Device > Network > Virtual Router
- B. Network > Virtual Router**
- C. Device > Network > Interfaces
- D. Network > Interfaces

173. The organization has three redundant connections to the internet, and all three of them are available. What are two reasons why access to one set of IP addresses through the firewall consistently results in good performance while access to another set of IP addresses consistently results in poor performance? (Choose two.)
- A. **The organization uses equal-cost multi-path (ECMP) routing to the internet and selects which path to use based on the source IP address, and some IP addresses get routed through a slower ISP.**
 - B. **The organization uses Policy Based Forwarding (PBF) and selects which route to use for the internet based on source IP address, and some IP addresses get routed through a slower ISP.**
 - C. The organization uses the Routing Information Protocol (RIP), and some IP addresses get routed through a slower ISP.
 - D. The organization uses Border Gateway Protocol (BGP), and some IP addresses get routed through a slower ISP.
 - E. The organization uses Open Shortest Path First (OSPF), and some IP addresses get routed through a slower ISP.
174. An organization has two links to the internet, one 100Mbps and the other 10Mbps. The firewall balances them using ECMP in the virtual router. Which load balancing ECMP setting does the organization need to use to optimize network resources?
- A. Balanced Round Robin
 - B. Weighted Round Robin, with a weight of 10 for the fast connection and 100 for the slow one.
 - C. IP Hash
 - D. Weighted Round Robin, with a weight of 100 for the fast connection and 10 for the slow one**

4.7 Given a scenario, identify how to troubleshoot a bootstrap install process

175. Which software image file does the bootstrap error “Skip Software image installation, not supported on physical devices” refer to?
- A. antivirus dynamic update
 - B. Applications and Threats dynamic update
 - C. PAN-OS update**
 - D. VM-Series plugin
176. Where are bootstrap error messages found?
- A. bootstrapped device’s System log
 - B. text file written to the bootstrap volume
 - C. log file written to the bootstrapped device’s Configuration log
 - D. the bootstrapped device’s console output**

177. Which three network configuration settings must be included in the INIT-CFG-TXT bootstrap file to avoid the following bootstrap error: “Bad or no parameters for mandatory networking information in the bootstrap config file (high)”? (Choose three.)
- A. **management port default gateway**
 - B. firewall hostname
 - C. management interface next hop
 - D. **management port IP address**
 - E. **management port netmask**

Exam Domain 5 – Core Concepts

5.1 Identify the correct order of the policy evaluation based on the packet flow architecture

178. What is the correct order of evaluation between the Security policy and the NAT policy?
- A. NAT policy evaluated, Security policy evaluated, NAT policy applied, Security policy applied
 - B. NAT policy evaluated, NAT policy applied, Security policy evaluated, Security policy applied
 - C. **NAT policy evaluated, Security policy evaluated, Security policy applied, NAT policy applied**
 - D. Security policy evaluated, NAT evaluated, NAT policy applied, Security policy applied
179. Which two statements are true regarding firewall policy? (Choose two.)
- A. All policy rules are evaluated, and the most specific rule will match.
 - B. **Policy rules are evaluated from the top down, and the first rule matched processes the traffic.**
 - C. Interzone traffic is allowed by default.
 - D. **Intrazone traffic is allowed by default.**
 - E. Outbound traffic is allowed by default. Only inbound traffic is evaluated.
180. Which firewall operation order correct?
- A. decryption, check allowed ports, App-ID identification, check Security policy
 - B. decryption, App-ID identification, check allowed ports, check Security policy
 - C. **check allowed ports, decryption, App-ID identification, check Security policy**
 - D. decryption, App-ID identification, check Security policy, check allowed ports

5.2 Given an attack scenario, identify the appropriate Palo Alto Networks threat prevention component to prevent or mitigate the attack

181. A URL Filtering Profile is part of which type of identification?
- A. App-ID
 - B. **Content-ID**
 - C. User-ID
 - D. Service

182. Which stage of the attack lifecycle is most likely to be stopped by dividing the network into separate security zones and enabling packet-based zone protection?
- A. Reconnaissance
 - B. Execution
 - C. Lateral movement
 - D. Data exfiltration
183. Which component can tell you if an attack is an APT or a broad attack designed to produce a botnet for future abuse?
- A. next-generation firewall
 - B. WildFire
 - C. MindMeld
 - D. AutoFocus**

5.3 Identify methods for identifying users

184. User-ID maps users to which type of information?
- A. MAC addresses
 - B. IP addresses**
 - C. IP address and port number
 - D. port numbers
185. User-ID uses which protocol to map between user identities and groups?
- A. NetBIOS
 - B. LDAP**
 - C. syslog
 - D. HTTPS
186. What format do you use when calling the API to inform the firewall of a new IP address-to-User-ID mapping?
- A. XML**
 - B. JSON
 - C. YAML
 - D. Base64

5.4 Identify the fundamental functions residing on the management plane and data plane of a Palo Alto Networks firewall

187. On a PA-7000 Series firewall, which management function runs on a separate, dedicated card?
- A. configuration management
 - B. logging**
 - C. reporting
 - D. management web service
188. Do some next-generation firewall models use FPGA chips?
- A. no, never
 - B. yes, on the data plane, but only on higher-end models**
 - C. yes, on the management plane, but only on higher-end models
 - D. on both data the data plane and the management plane, but only on higher-end models

189. Which function resides on the management plane?
- A. App-ID matching
 - B. route lookup
 - C. policy match
 - D. **logging**

5.5 Given a scenario, determine how to control bandwidth use on a per-application basis

190. Which parameter is important for QoS policy match decisions?
- A. **App-ID**
 - B. Content-ID
 - C. User-ID
 - D. Ingress interface
191. What is the maximum number of QoS classes supported by the next-generation firewall?
- A. 4
 - B. **8**
 - C. 16
 - D. 32

5.6 Identify the fundamental functions and concepts of WildFire

192. Which file type is not supported by WildFire?
- A. **iOS**
 - B. Android
 - C. Windows PE
 - D. Microsoft Excel
193. The firewall will skip the upload to WildFire in which three cases? (Choose three.)
- A. **The file has been signed by a trusted signer.**
 - B. The file is being uploaded rather than downloaded.
 - C. The file is an attachment in an email.
 - D. **The file hash matches a previous submission.**
 - E. **The file is larger than 50MB.**
 - F. The file is transferred through HTTPS.
194. Which feature is *not* supported on the WF-500 appliance?
- A. **Bare metal analysis**
 - B. Microsoft Windows XP 32-bit analysis
 - C. Microsoft Windows 7 64-bit analysis
 - D. static analysis

5.7 Identify the purpose of and use case for MFA and the Authentication policy

195. What are the two purposes of multi-factor authentication? (Choose two.)
- A. **reduce the value of stolen passwords**
 - B. simplify password resets
 - C. **reduce and prevent password sharing**
 - D. ensure strong passwords
 - E. provide single sign-on functionality
196. Which MFA factor is *not* supported by the next-generation firewall?
- A. voice
 - B. push
 - C. SMS
 - D. **S/Key**
197. What is the meaning of setting the source user to known-user in an Authentication policy rule?
- A. **The user identity is known (linked to an IP address), but the resource is sensitive enough to require additional authentication.**
 - B. The next-generation firewall will demand user authentication, and only then will the resource be available.
 - C. The source device is a known device that is used only by a single person.
 - D. The firewall attempts to match only users defined in the firewall's local user database.

5.8 Identify the dependencies for implementing MFA

198. What are the two Captive Portal modes? (Choose two.)
- A. proxy
 - B. **transparent**
 - C. web form
 - D. certificate
 - E. **redirect**
199. Which action is not required when multi-factor authentication and a SAML Identity Provider (IdP) are configured?
- A. create an Authentication policy rule
 - B. **configure NTLM settings**
 - C. create an Authentication object
 - D. create an Authentication Profile
200. An Authentication policy rule has a HIP Profile. Where are the users being authenticated coming from?
- A. internal devices, such as Linux workstations
 - B. external devices belonging to customers of the organization
 - C. internal servers running UNIX (Solaris, HPUX, AIX, etc.)
 - D. **GlobalProtect connections through the internet**

5.9 Given a scenario, identify how to forward traffic

201. A company has strict security requirements that require inspection of every connection between two internal computers. Those internal computers are connected and disconnected by non-technical users in an environment without a DHCP server. How does traffic get forwarded between those internal computers?
- A. a switch
 - B. a firewall configured as a switch, with Layer 2 interfaces**
 - C. a firewall configured as a router, with Layer 3 interfaces
 - D. a firewall in TAP mode or Virtual Mirror mode
202. Two links to the internet go through two ISPs (for backup purposes). Link A has a lower latency, and link B supports a higher bandwidth. How would you force a specific application to use only Link B when the route table enables the application to use either link?
- A. specify the application in a Policy Based Forwarding rule**
 - B. specify the application in the virtual router's route table
 - C. specify the application in a QoS policy rule
 - D. specify the application in an Application Override policy rule
203. Can you put a device on each end of a VPN tunnel on the same Ethernet segment?
- A. No, because this requirement never happens.
 - B. No, because Ethernet at Layer 2 is a lower layer than a Layer 3 VPN tunnel.
 - C. Yes, if you tunnel Ethernet over IP.**
 - D. Yes, because VPN tunnels can be Layer 2 tunnels.

5.10 Given a scenario, identify how to configure policies and related objects

204. Which action specifies that Security Profiles are relevant in a policy rule?
- A. deny
 - B. drop
 - C. reset
 - D. allow**
205. Are files quarantined while WildFire checks if they are malware or legitimate?
- A. always yes
 - B. always no**
 - C. by default, yes, but you can change the settings
 - D. by default, no, but you can change the settings
206. Which feature of the next-generation firewall allows you to block websites that are not business-appropriate?
- A. App-ID
 - B. File Blocking
 - C. Exploit Protection
 - D. URL Filtering**

5.11 Identify the methods for automating the configuration of a firewall

207. Which operating system do you select to use for a Palo Alto Networks firewall running in Microsoft Azure?
 - A. Windows
 - B. BSD
 - C. Linux**
 - D. UNIX
208. What option lists the four component directories of a Palo Alto Networks bootstrap container?
 - A. software, config, license, and content**
 - B. software, config, lic, and content
 - C. software, configuration, license, and content
 - D. software, configuration, lic, and content
209. Which environment supports a USB drive for the firewall bootstrap?
 - A. VMware ESXi
 - B. physical firewall**
 - C. Microsoft Hyper-V
 - D. KVM

Appendix C: Answers to the Sample Test

1. What is the last step of packet processing in the firewall?
 - A. check allowed ports
 - B. check Security Profiles**
 - C. check Security policy
 - D. forwarding lookup
2. Which interface type requires you to configure where the next hop is for various addresses?
 - A. tap
 - B. virtual wire
 - C. Layer 2
 - D. Layer 3**
3. How do you enable the firewall to be managed through a data-plane interface?
 - A. You specify Web UI in the interface properties.
 - B. You specify Management in the interface properties.
 - C. You specify HTTPS in the Interface Management Profile, and then specify in the interface properties to use that profile.**
 - D. You specify Management in the Interface Management Profile, and then specify in the interface properties to use that profile.
4. Some devices managed by Panorama have their external interface on ethernet1/1, some on ethernet1/2. However, the zone definitions for the external zone are identical. What is the recommended solution in this case?
 - A. Create two templates: one for the ethernet1/1 devices, one for the ethernet1/2 devices. Use the same external zone definitions in both. Apply those two templates to the appropriate devices.**
 - B. Create three templates: one for the ethernet1/1 devices, one for the ethernet1/2 devices, and one with the external zone definitions. Use those templates to create two template stacks, one with the ethernet1/1 and external zone, another with the ethernet1/2 and external zone. Apply those two template stacks to the appropriate devices.
 - C. Create three templates: one for the ethernet1/1 devices, one for the ethernet1/2 devices, and one with the external zone definitions. Apply the external zone template to all devices, and the ethernet1/1 and ethernet1/2 as appropriate (you can apply up to five templates per device).
 - D. Create three template stacks: one for the ethernet1/1 devices, one for the ethernet1/2 devices, and one with the external zone definitions. Apply the external zone template to all devices, and the ethernet1/1 and ethernet1/2 as appropriate (you can apply up to five templates per device).

5. In a Panorama managed environment, which two options show the correct order of policy evaluation? (Choose two.)
 - A. device group pre-rules, shared pre-rules, local firewall rules, intrazone-default, interzone-default
 - B. device group pre-rules, local firewall rules, shared post-rules, device group post-rules, intrazone-default, interzone-default
 - C. **device group pre-rules, local firewall rules, device group post-rules, shared post-rules, intrazone-default, interzone-default**
 - D. device group pre-rules, local firewall rules, intrazone-default, interzone-default, device group post-rules, shared post-rules
 - E. **shared pre-rules, device group pre-rules, local firewall rules, intrazone-default, interzone-default**
6. When you deploy the Palo Alto Networks NGFW on NSX, how many virtual network interfaces does a VM-Series firewall need?
 - A. two, one for traffic input and output and one for management traffic
 - B. four, two for traffic input and output and two for management traffic (for High Availability)
 - C. **three, one for traffic input, one for traffic output, and one for management traffic**
 - D. six, two for traffic input, two for traffic output, and two for management traffic (for High Availability)
7. Which source of user information is *not* supported by the NGFW?
 - A. **RACF**
 - B. LDAP
 - C. Active Directory
 - D. SAML
8. What is the main mechanism of packet-based vulnerability attacks?
 - A. **malformed packets that trigger software bugs when they are received**
 - B. excess packets that fill up buffers, thus preventing legitimate traffic from being processed
 - C. packets that get responses that leak information about the system
 - D. packets that either fill up buffers or get responses that leak information
9. Which method is *not* a PAN-OS software decryption method?
 - A. SSH Proxy
 - B. **SSL Proxy**
 - C. SSL Forward Proxy
 - D. SSL Inbound Inspection
10. What type of identification does an Application Override policy override?
 - A. **App-ID**
 - B. User-ID
 - C. Content-ID
 - D. Service

11. Which two types of protocols can cause an insufficient data value in the Application field in the Traffic log? (Choose two.)
- A. **UDP**
 - B. **TCP**
 - C. ICMP
 - D. GRE
 - E. IGP
12. Which three profile types are used to prevent malware executables from entering the network? (Choose three.)
- A. **Antivirus**
 - B. Anti-Spyware
 - C. **WildFire Analysis**
 - D. **File Blocking**
 - E. Vulnerability Protection
 - F. Zone Protection
13. Which user credential detection method does *not* require access to an external directory?
- A. group mapping
 - B. domain credential filter
 - C. LDAP
 - D. **Certificate**
14. Which object type has a property to specify whether it can transfer files?
- A. **Application**
 - B. Service
 - C. User
 - D. User group
15. When destination NAT rules are configured, the associated security rule is matched using which parameters?
- A. **pre-NAT source zone and post-NAT destination zone**
 - B. post-NAT source zone and pre-NAT destination zone
 - C. pre-NAT source zone and post-NAT destination IP address
 - E. post-NAT source zone and post-NAT destination zone
16. What is the initial IP address for the management interface?
- A. 10.0.0.1
 - B. 172.16.0.1
 - C. **192.168.1.1**
 - D. 192.168.255.254
17. In a new firewall, which port provides web interface access by default?
- A. data port #1
 - B. any data port
 - C. **management port**
 - D. console port

18. Which application requires you to import private keys?
- A. Captive Portal
 - B. Forward Trust
 - C. SSL Inbound Inspection**
 - D. SSL Exclude Certificate
19. Under which conditions can two Layer 3 interfaces have the same IP address?
- A. They must be connected to a common VLAN object interface.
 - B. They must be connected to the same Ethernet network through a switch. This configuration can be used only for High Availability.
 - C. They must be connected to different virtual routers.
 - D. They must be subinterfaces of the same physical interface.
 - E. This feature is not supported.**
20. Which two protocols are supported for site-to-site VPNs? (Choose two.)
- A. Authentication Header (AH)**
 - B. Secure Socket Layer (SSL)
 - C. Encapsulating Security Payload (ESP)**
 - D. Transport Layer Security (TLS)
 - E. Secure Shell (SSH)
21. GlobalProtect Portal is responsible for which two functions? (Choose two.)
- A. terminating SSL tunnels
 - B. authenticating GlobalProtect users**
 - C. creating on-demand certificates to encrypt SSL
 - D. managing and updating GlobalProtect client configurations**
 - E. managing GlobalProtect Gateway configurations
22. What is the preferred SYN flood defense action type?
- A. Random Drop
 - B. Random Early Drop
 - C. SYN Proxy
 - D. SYN Cookies**
23. What would be a valid reason to allow non-SYN TCP packets at the start of a connection?
- A. Such packets could happen legitimately in the case of asymmetric routing.
 - B. Such packets could happen legitimately if there is load balancing across firewalls.**
 - C. Such packets could happen legitimately because of either asymmetric routing or load balancing across firewalls.
 - D. Such packets could happen because of router bugs.
24. Where do you configure protection from malformed IP and TCP headers?
- A. DoS Profile
 - B. QoS Profile
 - C. Zone Protection Profile**
 - D. Application Profile

25. Which parameter is *not* a valid criterion for the original packet in address translation?
- A. source zone
 - B. application**
 - C. service
 - D. destination address
26. Which parameter in a Security policy rule do you use to apply a rule to traffic coming in from a specific interface?
- A. source zone**
 - B. source address
 - C. user
 - D. source interface
27. Where do you specify that certain URL categories are not to be decrypted?
- A. certificate properties
 - B. Decryption Profile
 - C. Decryption policy**
 - D. Security policy
28. Where do you specify how the firewall should treat invalid certificates?
- A. certificate properties
 - B. Decryption Profile**
 - C. Decryption policy
 - D. Security policy
29. Which two public cloud environments support pay-as-you-go (PAYG) firewall licensing?
(Choose two.)
- A. Microsoft Azure**
 - B. Microsoft Hyper-V
 - C. Amazon AWS**
 - D. VMware NSX
 - E. VMware ESXi
30. Which log type gets redirected in **Device > Log Settings**?
- A. Config**
 - B. Traffic
 - C. Threat
 - D. WildFire Submission
31. Which tab of the firewall web interface gives you a consolidated picture of the security situation and the top-level threats?
- A. Dashboard
 - B. ACC**
 - C. Monitor
 - D. Devices

32. A customer's custom application uses SMTP (email) to transfer directory information, which needs to be filtered in a different manner from normal SMTP. How do you configure this filtering?
- A. You cannot do it with the NGFW. You need to manually configure a proxy.
 - B. Create specific rules for the sources and destinations that run this application.
 - C. Create a custom signature and specify the SMTP fields that are different from normal SMTP use and patterns to identify when it is the custom application.**
 - D. Create an Application Override policy and specify the sources and destinations that run this application.
33. Which kind of update requires a disruption in connectivity?
- A. downloading the PAN-DB seed file
 - B. dynamic content
 - C. PAN-OS software
 - D. WildFire subscription antivirus signatures
34. Which dedicated High Availability port is used for which plane?
- A. HA1 for the data plane, HA2 for the management plane
 - B. HA1 for the management plane, HA2 for the data plane**
 - C. MGT for the management plane; HA2 as a backup
 - D. HA1 for the management plane, HA2 for the data plane in the 7000 Series
35. Which two protocols can AutoFocus use to retrieve log information from an NGFW? (Choose two.)
- A. syslog
 - B. Log transfer protocol, a Palo Alto Networks proprietary protocol
 - C. HTTP**
 - D. HTTPS**
 - E. SNMP
36. Palo Alto Networks publishes new applications at which approximate interval?
- A. every 30 minutes
 - B. hourly
 - C. daily
 - D. weekly**
37. Which type of device can receive the GlobalProtect data files content update?
- A. Log Collector
 - B. firewall**
 - C. WildFire
 - D. Antivirus
38. In which log will you see evidence that an administrator cannot log in to the firewall?
- A. Traffic
 - B. System**
 - C. Configuration
 - D. Authentication

39. How do you reboot the firewall from the command line?
- A. restart system
 - B. reboot
 - C. request restart system**
 - D. request reboot
40. Where in the user interface do you configure how many packets to capture when the extended-capture option is selected in an Anti-Spyware Profile or Vulnerability Profile?
- A. Device tab, as part of the Setup node
 - B. Security Profiles, because the desired number of captured packets can vary between profiles
 - C. as a default in the Device tab, as part of the Capture node. Then, exceptions can be configured in the Security Profiles
 - D. Configure Capturing options for each defined capture file**
41. You are preparing a bootstrap template for use with a VM-Series firewall hosted in a public cloud. You don't need to include the Content-ID files because the firewall will download the latest version when it is booted anyway. How do you configure the bootstrap's content directory?
- A. leave it empty**
 - B. delete it
 - C. rename it to content-null
 - D. add an empty file to it named no-download
42. Which format do you use for an AWS CloudFormation Template?
- A. XML
 - B. CSV
 - C. JSON**
 - D. JSON or XML
43. In which order are Security policy rules from Panorama processed relative to local firewall policy rules?
- A. Local firewall policy rules are processed only during loss of Panorama connectivity.
 - B. All Panorama rules are processed first.
 - C. All local firewall policy rules are processed first.
 - D. Some Panorama rules are processed before the firewall's local rules, and some are processed after the local rules.**
44. Which statement is true about Security Profiles?
- A. They are evaluated from top down, with the first match processing the traffic.
 - B. They are applied to all inbound traffic when they are enabled.
 - C. They enable a specific type of threat scanning (e.g., Virus, Spyware).**
 - D. They can specify actions based on the username.
45. Which Captive Portal authentication method can be handled by the browser without affecting the user experience?
- A. web-challenge
 - B. browser-challenge**
 - C. web-form
 - D. browser-form

46. The firewall of a defense contractor is not connected to the internet. However, it is connected to the classified SIPRNet. The contractor is concerned about getting malware files through that network. Can this defense contractor use the WildFire service for protection?
- A. No, because there is no network path to the WildFire cloud.
 - B. No, because all SIPRNet files are encrypted.
 - C. Yes, but only for PE-type file analysis.
 - D. Yes, it can use a WF-500 appliance.
47. How does the NGFW handle excess packets when there are QoS constraints?
- A. It buffers them until there is bandwidth to send them.
 - B. It drops a percentage of them randomly.**
 - C. It replaces them with packets that tell the computer on the other side to slow down.
 - D. It sends a portion instead of the whole packet.
48. Which function is performed by the management plane?
- A. signature matching
 - B. VPN encryption
 - C. policy matching
 - D. User-ID group lookups**
49. Which User-ID IP address-to-username mapping method can be visible to users?
- A. Captive Portal
 - B. monitoring Active Directory event logs
 - C. monitoring print server event logs
 - D. monitoring a Cisco WLAN controller
50. Which feature of the NGFW enables you to identify attempts to tunnel SSH over other ports?
- A. App-ID**
 - B. Content-ID
 - C. User-ID
 - D. SSH Forward Proxy
51. What is the correct order of operations?
- A. check allowed ports, decrypt (if traffic is encrypted and the policy specifies to decrypt it), check Security policy, check Security Profiles, re-encrypt traffic**
 - B. check allowed ports, decrypt (if traffic is encrypted and the policy specifies to decrypt it), check Security Profiles, check Security policy, re-encrypt traffic
 - C. decrypt (if traffic is encrypted and the policy specifies to decrypt it), check allowed ports, check Security policy, re-encrypt traffic
 - D. decrypt (if traffic is encrypted and the policy specifies to decrypt it), check allowed ports, check Security Profiles, check Security policy, re-encrypt traffic

Appendix D: Glossary

Advanced Encryption Standard (AES): A symmetric block cipher based on the Rijndael cipher.

AES: See Advanced Encryption Standard (AES).

API: See application programming interface (API).

application programming interface (API): A set of routines, protocols, and tools for building software applications and integrations.

application whitelisting: A technique used to prevent unauthorized applications from running on an endpoint. Authorized applications are manually added to a list that is maintained on the endpoint. If an application is not on the whitelist, it cannot run on the endpoint. However, if it is on the whitelist the application can run, regardless of whether vulnerabilities or exploits are present within the application.

attack vector: A path or tool that an attacker uses to target a network.

BES: See bulk electric system (BES).

boot sector: Contains machine code that is loaded into an endpoint's memory by firmware during the startup process, before the operating system is loaded.

boot sector virus: Targets the boot sector or master boot record (MBR) of an endpoint's storage drive or other removable storage media. See also *boot sector* and *master boot record (MBR)*.

bot: Individual endpoints that are infected with advanced malware that enables an attacker to take control of the compromised endpoint. Also known as a zombie. See also *botnet*.

botnet: A network of bots (often tens of thousands or more) working together under the control of attackers using numerous command and control (CnC) servers. See also *bot*.

bring your own apps (BYOA): Closely related to BYOD, BYOA is a policy trend in which organizations permit end users to download, install, and use their own personal apps on mobile devices, primarily smartphones and tablets, for work-related purposes. See also *bring your own device (BYOD)*.

bring your own device (BYOD): A policy trend in which organizations permit end users to use their own personal devices, primarily smartphones and tablets, for work-related purposes. BYOD relieves organizations from the cost of providing equipment to employees but creates a management challenge due to the vast number and type of devices that must be supported. See also *bring your own apps (BYOA)*.

bulk electric system (BES): The large interconnected electrical system, consisting of generation and transmission facilities (among others), that comprises the “power grid.”

BYOA: See bring your own apps (BYOA).

BYOD: See bring your own device (BYOD).

child process: In multitasking operating systems, a sub-process created by a parent process that is currently running on the system.

CIP: See Critical Infrastructure Protection (CIP).

consumerization: A computing trend that describes the process that occurs as end users increasingly find personal technology and apps that are more powerful or capable, more convenient, less expensive, quicker to install, and easier to use, than enterprise IT solutions.

covered entity: Defined by HIPAA as a healthcare provider that electronically transmits PHI (such as doctors, clinics, psychologists, dentists, chiropractors, nursing homes, and pharmacies), a health plan (such as a health insurance company, health maintenance organization, company health plan, or government program including Medicare, Medicaid, military and veterans' healthcare), or a healthcare clearinghouse. See also *Health Insurance Portability and Accountability Act (HIPAA)* and *protected health information (PHI)*.

Critical Infrastructure Protection (CIP): Cybersecurity standards defined by NERC to protect the physical and cyber assets necessary to operate the bulk electric system (BES). See also *bulk electric system (BES)* and

North American Electric Reliability Corporation (NERC).

data encapsulation: A process in which protocol information from the OSI layer immediately above is wrapped in the data section of the OSI layer immediately below. See also *open systems interconnection (OSI) reference model*.

DDOS: See distributed denial-of-service (DDOS).

distributed denial-of-service (DDOS): A type of cyberattack in which extremely high volumes of network traffic such as packets, data, or transactions are sent to the target victim's network to make their network and systems (such as an e-commerce website or other web application) unavailable or unusable.

EAP: See extensible authentication protocol (EAP).

EAP-TLS: See extensible authentication protocol Transport Layer Security (EAP-TLS).

EHR: See electronic health record (EHR).

electronic health record (EHR): As defined by HealthIT.gov, an EHR "goes beyond the data collected in the provider's office and include[s] a more comprehensive patient history. EHR data can be created, managed, and consulted by authorized providers and staff from across more than one healthcare organization."

electronic medical record (EMR): As defined by HealthIT.gov, an EMR "contains the standard medical and clinical data gathered in one provider's office."

EMR: See electronic medical record (EMR).

endpoint: A computing device such as a desktop or laptop computer, handheld scanner, point-of-sale (POS) terminal, printer, satellite radio, security or videoconferencing camera, self-service kiosk, server, smart meter, smart TV, smartphone, tablet, or Voice over Internet Protocol (VoIP) phone. Although endpoints can include servers and network equipment, the term is generally used to describe end user devices.

Enterprise 2.0: A term introduced by Andrew McAfee and defined as "the use of emergent social software platforms within companies, or between companies and their partners or customers." See also *Web 2.0*.

exclusive or (XOR): A Boolean operator in which the output is true only when the inputs are different (for example, TRUE and TRUE equals FALSE, but TRUE and FALSE equals TRUE).

exploit: A small piece of software code, part of a malformed data file, or a sequence (string) of commands, that leverages a vulnerability in a system or software, causing unintended or unanticipated behavior in the system or software.

extensible authentication protocol (EAP): A widely used authentication framework that includes approximately 40 different authentication methods.

extensible authentication protocol Transport Layer Security (EAP-TLS): An Internet Engineering Task Force (IETF) open standard that uses the Transport Layer Security (TLS) protocol in Wi-Fi networks and PPP connections. See also *point-to-point protocol (PPP)* and *Transport Layer Security (TLS)*.

extensible markup language (XML): A programming language specification that defines a set of rules for encoding documents in a human- and machine-readable format.

false negative: In anti-malware, malware that is incorrectly identified as a legitimate file or application. In intrusion detection, a threat that is incorrectly identified as legitimate traffic. See also *false positive*.

false positive: In anti-malware, a legitimate file or application that is incorrectly identified as malware. In intrusion detection, legitimate traffic that is incorrectly identified as a threat. See also *false negative*.

favicon ("favorite icon"): A small file containing one or more small icons associated with a particular website or webpage.

Federal Information Security Management Act (FISMA): See *Federal Information Security Modernization Act (FISMA)*.

Federal Information Security Modernization Act (FISMA): A U.S. law that implements a comprehensive

framework to protect information systems used in U.S. federal government agencies. Known as the Federal Information Security Management Act prior to 2014.

Financial Services Modernization Act of 1999: See *Gramm-Leach-Bliley Act (GLBA)*.

FISMA: See Federal Information Security Modernization Act (FISMA).

floppy disk: A removable magnetic storage medium commonly used from the mid-1970s until approximately 2007, when they were largely replaced by removable USB storage devices.

generic routing encapsulation (GRE): A tunneling protocol developed by Cisco Systems® that can encapsulate various network layer protocols inside virtual point-to-point links.

GLBA: See Gramm-Leach-Bliley Act (GLBA).

Gramm-Leach-Bliley Act (GLBA): A U.S. law that requires financial institutions to implement privacy and information security policies to safeguard the non-public personal information of clients and consumers. Also known as the Financial Services Modernization Act of 1999.

GRE: See generic routing encapsulation (GRE).

hacker: Originally used to refer to anyone with highly specialized computing skills, without connoting good or bad purposes. However, common misuse of the term has redefined a hacker as someone that circumvents computer security with malicious intent, such as a cybercriminal, cyberterrorist, or hacktivist.

hash signature: A cryptographic representation of an entire file or program's source code.

Health Insurance Portability and Accountability Act (HIPAA): A U.S. law that defines data privacy and security requirements to protect individuals' medical records and other personal health information. See also *covered entity* and *protected health information (PHI)*.

heap spraying: A technique used to facilitate arbitrary code execution by injecting a certain sequence of bytes into the memory of a target process.

HIPAA: See Health Insurance Portability and Accountability Act (HIPAA).

indicator of compromise (IOC): A network or operating system (OS) artifact that provides a high level of confidence that a computer security incident has occurred.

initialization vector (IV): A random number used only once in a session, in conjunction with an encryption key, to protect data confidentiality. Also known as a nonce.

IOC: See indicator of compromise (IOC).

IV: See initialization vector (IV).

jailbreaking: Hacking an Apple® iOS device to gain root-level access to the device. This is sometimes done by end users to allow them to download and install mobile apps without paying for them, from sources, other than the App Store®, that are not sanctioned and/or controlled by Apple®. Jailbreaking bypasses the security features of the device by replacing the firmware's operating system with a similar, albeit counterfeit version, which makes it vulnerable to malware and exploits. See also *rooting*.

least privilege: A network security principle in which only the permission or access rights necessary to perform an authorized task are granted.

malware: Malicious software or code that typically damages, takes control of, or collects information from an infected endpoint. Malware broadly includes viruses, worms, Trojan horses (including Remote Access Trojans, or RATs), anti-AV, logic bombs, backdoors, rootkits, bootkits, spyware, and (to a lesser extent) adware.

master boot record (MBR): Contains information about how the logical partitions (or file systems) are organized on the storage media, and an executable boot loader that starts up the installed operating system.

MBR: See master boot record (MBR).

metamorphism: A programming technique used to alter malware code with every iteration, to avoid detection by signature-based anti-malware software. Although the malware payload changes with each

iteration – for example, by using a different code structure or sequence, or inserting garbage code to change the file size – the fundamental behavior of the malware payload remains unchanged.

Metamorphism uses more advanced techniques than polymorphism. See also *polymorphism*.

Microsoft Challenge-handshake authentication protocol (MS-CHAP): A protocol used to authenticate Microsoft Windows-based workstation, using a challenge-response mechanism to authenticate PPTP connections without sending passwords.

MS-CHAP: See Microsoft Challenge-handshake authentication protocol (MS-CHAP).

mutex: A program object that allows multiple program threads to share the same resource, such as file access, but not simultaneously.

NERC: See North American Electric Reliability Corporation (NERC).

Network and Information Security (NIS) Directive: A European Union (EU) directive that imposes network and information security requirements – to be enacted by national laws across the EU within two years of adoption in 2016 – for banks, energy companies, healthcare providers and digital service providers, among others.

NIS: See Network and Information Security (NIS) Directive.

nonce: See initialization vector (IV).

North American Electric Reliability Corporation (NERC): A not-for-profit international regulatory authority responsible for assuring the reliability of the bulk electric system (BES) in the continental U.S., Canada, and the northern portion of Baja California, Mexico. See also *bulk electric system (BES)* and *Critical Infrastructure Protection (CIP)*.

obfuscation: A programming technique used to render code unreadable. It can be implemented using a simple substitution cipher, such as an *exclusive or* (XOR) operation, or more sophisticated encryption algorithms, such as the *Advanced Encryption Standard* (AES). See also *Advanced Encryption Standard (AES)*, *exclusive or (XOR)*, and *packer*.

one-way (hash) function: A mathematical function that creates a unique representation (a hash value) of a larger set of data in a manner that is easy to compute in one direction (input to output), but not in the reverse direction (output to input). The hash function can't recover the original text from the hash value. However, an attacker could attempt to guess what the original text was and see if it produces a matching hash value.

open systems interconnection (OSI) reference model: Defines standard protocols for communication and interoperability using a layered approach in which data is passed from the highest layer (application) downward through each layer to the lowest layer (physical), then transmitted across the network to its destination, then passed upward from the lowest layer to the highest layer. See also *data encapsulation*.

OSI model: See open systems interconnection (OSI) reference model.

packer: A software tool that can be used to obfuscate code by compressing a malware program for delivery, then decompressing it in memory at run time. See also *obfuscation*.

packet capture (PCAP): A traffic intercept of data packets that can be used for analysis.

PAP: See password authentication protocol (PAP).

password authentication protocol (PAP): An authentication protocol used by PPP to validate users with an unencrypted password. See also *point-to-point protocol (PPP)*.

Payment Card Industry Data Security Standards (PCI DSS): A proprietary information security standard mandated and administered by the PCI Security Standards Council (SSC), and applicable to any organization that transmits, processes, or stores payment card (such as debit and credit cards) information. See also *PCI Security Standards Council (SSC)*.

PCAP: See packet capture (PCAP).

PCI: See Payment Card Industry Data Security Standards (PCI DSS).

PCI DSS: See Payment Card Industry Data Security Standards (PCI DSS).

PCI Security Standards Council (SSC): Comprised of Visa, MasterCard, American Express, Discover, and JCB,

the SSC maintains, evolves, and promotes PCI DSS. See also *Payment Card Industry Data Security Standards (PCI DSS)*.

Personal Information Protection and Electronic Documents Act (PIPEDA): A Canadian privacy law that defines individual rights with respect to the privacy of their personal information, and governs how private sector organizations collect, use, and disclose personal information during business.

Personally Identifiable Information (PII): Defined by the U.S. National Institute of Standards and Technology (NIST) as “any information about an individual maintained by an agency, including (1) any information that can be used to distinguish or trace an individual’s identity... and (2) any other information that is linked or linkable to an individual....”

PHI: See protected health information (PHI).

PII: See Personally Identifiable Information (PII).

PIPEDA: See Personal Information Protection and Electronic Documents Act (PIPEDA).

PKI: See public key infrastructure (PKI).

point-to-point protocol (PPP): A Layer 2 (data link) protocol layer used to establish a direct connection between two nodes.

polymorphism: A programming technique used to alter a part of malware code with every iteration, to avoid detection by signature-based anti-malware software. For example, an encryption key or decryption routine may change with every iteration, but the malware payload remains unchanged. See also *metamorphism*.

PPP: See point-to-point protocol (PPP).

pre-shared key (PSK): A shared secret, used in symmetric key cryptography which has been exchanged between two parties communicating over an encrypted channel.

promiscuous mode: Refers to Ethernet hardware used in computer networking, typically a network interface card (NIC), that receives all traffic on a network segment, even if the traffic is not addressed to the hardware.

protected health information (PHI): Defined by HIPAA as information about an individual’s health status, provision of healthcare, or payment for healthcare that includes identifiers such as names, geographic identifiers (smaller than a state), dates, phone and fax numbers, email addresses, Social Security numbers, medical record numbers, or photographs, among others. See also *Health Insurance Portability and Accountability Act (HIPAA)*.

public key infrastructure (PKI): A set of roles, policies, and procedures needed to create, manage, distribute, use, store, and revoke digital certificates and manage public key encryption.

QoS: See Quality of Service (QoS).

Quality of Service (QoS): The overall performance of specific applications or services on a network including error rate, bit rate, throughput, transmission delay, availability, jitter, etc. QoS policies can be configured on certain network and security devices to prioritize certain traffic, such as voice or video, over other, less performance-intensive traffic, such as file transfers.

RADIUS: See Remote Authentication Dial-In User Service (RADIUS).

rainbow table: A pre-computed table used to find the original value of a cryptographic hash function.

Remote Authentication Dial-In User Service (RADIUS): A client/server protocol and software that enables remote access servers to communicate with a central server to authenticate users and authorize access to a system or service.

remote procedure call (RPC): An inter-process communication (IPC) protocol that enables an application to be run on a different computer or network, rather than the local computer on which it is installed.

representational state transfer (REST): An architectural programming style that typically runs over HTTP, and is commonly used for mobile apps, social networking websites, and mashup tools.

REST: See representational state transfer (REST).

rooting: The Google Android equivalent of jailbreaking. See *jailbreaking*.

RPC: See remote procedure call (RPC). **SaaS:** See Software as a Service (SaaS).

salt: Randomly generated data that is used as an additional input to a one-way hash function that hashes a password or passphrase. The same original text hashed with different salts results in different hash values.

Sarbanes-Oxley (SOX) Act: A U.S. law that increases financial governance and accountability in publicly traded companies.

script kiddie: Someone with limited hacking and/or programming skills that uses malicious programs (malware) written by others to attack a computer or network.

Secure Sockets Layer (SSL): A cryptographic protocol for managing authentication and encrypted communication between a client and server to protect the confidentiality and integrity of data exchanged in the session.

service set identifier (SSID): A case sensitive, 32-character alphanumeric identifier that uniquely identifies a Wi-Fi network.

Software as a Service (SaaS): A cloud computing service model, defined by the U.S. National Institute of Standards and Technology (NIST), in which “the capability provided to the consumer is to use the provider’s applications running on a cloud infrastructure. The applications are accessible from various client devices through either a thin client interface, such as a web browser, or a program interface. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.”

SOX: See Sarbanes-Oxley (SOX) Act.

spare phishing: A highly targeted phishing attack that uses specific information about the target to make the phishing attempt appear legitimate.

SSID: See service set identifier (SSID).

SSL: See Secure Sockets Layer (SSL).

STIX: See structured threat information expression (STIX).

structured threat information expression (STIX): An XML format for conveying data about cybersecurity threats in a standardized format. See also *extensible markup language (XML)*.

threat vector: See *attack vector*.

TLS: See Transport Layer Security (TLS).

Tor (“The Onion Router”): Software that enables anonymous communication over the internet.

Transport Layer Security (TLS): The successor to SSL (although it is still commonly referred to as SSL). See also *Secure Sockets Layer (SSL)*.

uniform resource locator (URL): A unique reference (or address) to an internet resource, such as a webpage.

URL: See uniform resource locator (URL).

vulnerability: A bug or flaw that exists in a system or software and creates a security risk.

Web 2.0: A term popularized by Tim O'Reilly and Dale Dougherty, unofficially referring to a new era of the World Wide Web, which is characterized by dynamic or user-generated content, interaction, and collaboration, and the growth of social media. See also *Enterprise 2.0*.

XML: See extensible markup language (XML).

XOR: See exclusive or (XOR).

zero-day threat: The window of vulnerability that exists from the time a new (unknown) threat is released until security vendors release a signature file or security patch for the threat.

zombie: See *bot*.

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