Palo Alto Networks PA-200, PA-500, PA-2000 Series, PA-3000 Series, PA-4000 Series, PA-5000 Series, PA-7000 Series, VM Series, Next-Generation Firewall with PAN-OS v7.0.8 and v7.1.3

Security Target

Version 1.2
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1. Security Target Introduction

This section identifies the Security Target (ST) and Target of Evaluation (TOE) identification, ST conventions, ST conformance claims, and the ST organization. The TOE is the next-generation firewall running PAN-OS v7.0.8 or PAN-OS v7.1.3, with the User Identification Agent 7.0 provided by Palo Alto Networks Inc.

The next-generation firewall includes the PA-200, PA-500, PA-2020, PA-2050, PA-3020, PA-3050, PA-3060, PA-4020, PA-4050, PA-4060, PA-5020, PA-5050, PA-5060, PA-7050, and PA-7080 appliances and the virtual appliances in the VM-Series VM-100, VM-200, VM-300, VM-1000-HV which are used to manage enterprise network traffic flows using function specific processing for networking, security, and management. The next-generation firewalls identify which applications are flowing across the network, irrespective of port, protocol, or SSL encryption. The User Identification Agent 7.0 (installed on a PC in the network) communicates with the domain controller to retrieve user-specific information. It allows the next-generation firewall to automatically collect user information and include it in policies and reporting.

The focus of this evaluation is on the TOE functionality supporting the claims in the Protection Profile for Network Devices with the inclusion of the Stateful Traffic Filter Firewall and the VPN Gateway Extended Packages (See section 1.2 for specific version information). The only capabilities covered by the evaluation are those specified in the aforementioned Protection Profiles, all other capabilities are not covered in the evaluation. The security functionality specified in [NDPP], the [STFF], and the [VPNGW] includes protection of communications between TOE components and trusted IT entities, identification and authentication of administrators, auditing of security-relevant events, ability to verify the source and integrity of updates to the TOE, the implementation of firewall-related security features, the termination of IPsec VPN tunnels, and specifies FIPS-validated cryptographic mechanisms.

The Security Target contains the following additional sections:

- TOE Description (Section 2)
- Security Problem Definition (Section 3)
- Security Objectives (Section 4)
- IT Security Requirements (Section 5)
- TOE Summary Specification (Section 6)
- Protection Profile Claims (Section 7)
- Rationale (Section 8).

1.1 Security Target, TOE and CC Identification

ST Title – Palo Alto Networks PA-200, PA-500, PA-2000 Series, PA-3000 Series, PA-4000 Series, PA-5000 Series, PA-7000 Series, VM Series, Next-Generation Firewall with PAN-OS v7.0.8 and v7.1.3 Security Target

ST Version – Version 1.2

ST Date – 2 November 2016

TOE Identification – Palo Alto Networks PA-200, PA-500, PA-2000 Series, PA-3000 Series, PA-4000 Series, PA-5000 Series, PA-7000 Series, VM Series, Next-Generation Firewall with PAN-OS v7.0.8 or PAN-OS 7.1.3. The specific Firewall appliance models include:

1. PA-200
2. PA-500
3. PA-2000
    a. PA-2020
    b. PA-2050
4. PA-3000
    a. PA-3020

   b. PA-3050
   c. PA-3060
5. PA-4000
   a. PA-4020
   b. PA-4050
   c. PA-4060
6. PA-5000
   a. PA-5020
   b. PA-5050
   c. PA-5060
7. PA-7000
   a. PA-7050
   b. PA-7080
8. VM-Series—the following virtual appliances when installed on a specified hardware platform (see below) that includes VMware ESXi 5.5 hypervisor and an Intel Core or Xeon processor based on the Ivy Bridge or Haswell microarchitectures, which implement Intel Secure Key:
   a. VM-1000-HV
   b. VM-300
   c. VM-200
   d. VM-100

   Note, the NDPP specifies requirements for a network device—a device composed of hardware and software that is connected to the network and has an infrastructure role on the network. Therefore, the VM-Series virtual appliances are considered to be in their evaluated configuration only when installed on the following specified hardware platforms and are not evaluated for deployment on any other platforms.

   - Dell PowerEdge R430, R530, R630, R730, R730xd and R930 Servers
   - Equivalent platforms i.e., Intel Ivy Bridge or Haswell-based processor with Broadcom or Intel Network Interface Controllers supported by the server

   In addition, the VM-Series virtual appliance must be the only guest running in the virtualized environment. Evaluation testing included the VM-300 installed on a Dell PowerEdge R730 Server running VMware ESXi 5.5 on an Intel Xeon E5-2630 v3 (Haswell microarchitecture) processor with Broadcom 5720 NIC.

TOE Developer – Palo Alto Networks, Inc.

Evaluation Sponsor – Palo Alto Networks, Inc.

CC Identification – *Common Criteria for Information Technology Security Evaluation, Version 3.1, Revision 4, September 2012*

1.2 Conformance Claims

This TOE is conformant to the following CC specifications:

- This ST is conformant to:
  - *Protection Profile for Network Devices*, Version 1.1, 8 June 2012 (NDPP) as amended by Errata #3 dated 3 November 2014 and CSfC Selections for VPN Gateways,
  - *Network Device Protection Profile (NDPP) Extended Package Stateful Traffic Filter Firewall, Version 1.0, 19 December 2011* (STFF)
  - *Network Device Protection Profile (NDPP) Extended Package VPN Gateway, Version 1.1, 12 April 2013* (VPNGW) as amended by CSfC Selections for VPN Gateways (CSfC).
- Common Criteria for Information Technology Security Evaluation Part 2: Security functional components, Version 3.1, Revision 4, September 2012.
  - Part 2 Extended

- Common Criteria for Information Technology Security Evaluation Part 3: Security assurance components, Version 3.1 Revision 4, September 2012.
    - Part 3 Conformant.

1.3 Conventions

The following conventions have been applied in this document:

- Security Functional Requirements – Part 2 of the CC defines the approved set of operations that may be applied to functional requirements: iteration, assignment, selection, and refinement.
    - Iteration: allows a component to be used more than once with varying operations. In the ST, iteration is indicated by a number in parentheses placed at the end of the component. For example FDP_ACC.1 (1) and FDP_ACC.1 (2) indicate that the ST includes two iterations of the FDP_ACC.1 requirement, (1) and (2).
    - Assignment: allows the specification of an identified parameter. Assignments are indicated using bold and are surrounded by brackets (e.g., [**assignment**]). Note that an assignment within a selection would be identified in italics and with embedded bold brackets (e.g., [***[selected-assignment]***]).
    - Selection: allows the specification of one or more elements from a list. Selections are indicated using bold italics and are surrounded by brackets (e.g., [***selection***]).
    - Refinement: allows the addition of details. Refinements are indicated using bold, for additions, and strike-through, for deletions (e.g., "… **all** objects …" or "… ~~some~~ **big** things …"). Note that 'cases' that are not applicable in a given SFR have simply been removed without any explicit identification.
- The NDPP uses an additional convention – the 'case' – which defines parts of an SFR that apply only when corresponding selections are made or some other identified conditions exist. Only the applicable cases are identified in this ST and they are identified using **bold** text.
- Other sections of the ST – Other sections of the ST use bolding to highlight text of special interest, such as captions.

1.3.1 Terminology

The following terms and abbreviations are used in this ST:

Security policy Provides the firewall rule sets that specify whether to block or allow network connections.

Security profile A security profile specifies protection rules to apply when processing network traffic. The profiles supported by the TOE include the IPSec crypto Security profile, and the IKE Network profile.

Security zone A grouping of TOE interfaces. Each TOE interface must be assigned to a zone before it can process traffic.

Virtual system Virtual systems are separate, logical firewall instances within a single physical Palo Alto Networks firewall. Virtual systems allow the TOE administrator to customize administration, networking, and security policies for network traffic belonging to specific user groupings (such as departments or customers).

1.3.2 Acronyms

AES	Advanced Encryption Standard
CBC	Cipher-Block Chaining
CC	Common Criteria for Information Technology Security Evaluation
CEM	Common Evaluation Methodology for Information Technology Security
CM	Configuration Management

CLI	Command Line Interface
CPU	Central Processing Unit
DH	Diffie-Hellman
EEPROM	Electrically Erasable Programmable Read-Only Memory
EP	Extended Package
FIA	Identification and Authentication CC Class
FIPS	Federal Information Processing Standard
FMT	Security Management CC Class
FSP	Functional Specification
FTP	File Transfer Protocol
GUI	Graphical User Interface
HMAC	Hashed Message Authentication Code
HTTP(S)	Hypertext Transfer Protocol (Secure)
IKE	Internet Key Exchange
IPsec	Internet Protocol Security
IP	Internet Protocol
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
IPSEC	Internet Protocol Security
NDPP	Protection Profile for Network Devices
NAT	Network Address Translation
NIST	National Institute of Standards and Technology
PP	Protection Profile
QoS	Quality of Service
REST	Representational State Transfer
RSA	Rivest, Shamir and Adleman (algorithm for public-key cryptography)
SA	Security Association
SAR	Security Assurance Requirement
SFP	Security Function Policy
SFR	Security Functional Requirement
SHA	Secure Hash Algorithm
SM	Security Management
SMR	Security Management Roles
SMTP	Simple Mail Transfer Protocol
SNMP	Simple Network Management Protocol
SSH	Secure Shell
SSL	Secure Socket Layer Protocol
ST	Security Target
STFF	Stateful Traffic Filter Firewall (EP)
TCP	Transmission Control Protocol
TLS	Transport Layer Security
TOE	Target of Evaluation
TSF	TOE Security Functions
TSP	TOE Security Policy
UDP	User Data Protection
URL	Uniform Resource Locator
VLAN	Virtual Local Area Network
VM	Virtual Machine
VPN	Virtual Private Network
VPNGW	VPN Gateway (EP)

2. TOE Description

The Target of Evaluation (TOE) is Palo Alto Networks next-generation firewall that includes the PA-200, PA-500, PA-2020, PA-2050, PA-3020, PA-3050, PA-3060, PA-4020, PA-4050, PA-4060, PA-5020, PA-5050, PA-5060, PA-7050, PA-7080 appliances and the virtual appliances in the VM-Series VM-100, VM-200, VM-300, VM-1000-HV, with PAN-OS v7.0.8 or PAN-OS v7.1.3. The next-generation firewall provides policy-based application visibility and control to protect traffic flowing through the enterprise network.

2.1 TOE Overview

The next-generation firewalls are network firewall appliances and virtual appliances on specified hardware used to manage enterprise network traffic flow using function specific processing for networking, security, and management. The next-generation firewalls let the administrator specify security policies based on an accurate identification of each application seeking access to the protected network. The next-generation firewall uses packet inspection and a library of applications to distinguish between applications that have the same protocol and port, and to identify potentially malicious applications that use non-standard ports. The next-generation firewall also supports the establishment of Virtual Private Network (VPN) connections to other next-generation firewalls or third party security devices.

A next-generation firewall is typically installed between an edge router or other device facing the Internet and a switch or router connecting to the internal network. The Ethernet interfaces on the firewall can be configured to support various networking environments, including: Layer 2 switching and VLAN environments; Layer 3 routing environments; transparent in-line deployments; and combinations of the three.

The next-generation firewalls provide granular control over the traffic allowed to access the protected network. They allow an administrator to define security policies for specific applications, rather than rely on a single policy for connections to a given port number. For each identified application, the administrator can specify a security policy to block or allow traffic based on the source and destination zones, source and destination addresses, or application services. The next-generation firewalls also support the following types of policy:

- Secure Socket Layer (SSL) decryption policies
- SSH Decryption is checked using the SSH application signature, a policy lookup will occur on the decrypt rule to see if this session should be decrypted.
- Application Override policies
- User Identification Agent (UIA) policy enforcement - the UIA provides the firewall with the capability to automatically collect user-specific information, and provides mapping information between IP addresses and network users, that is used in security policy enforcement and reporting. The user id can be an attribute specified in the TOE security policies upon which they are enforced. The UIA works only for IPv4 addresses.

Security policies can include specification of one or more security profiles, which provide additional protection and control. Security profiles are configured and applied to firewall policy. Each security policy can specify one or more of the following security profiles:

- Antivirus profiles
- Antispyware profiles
- Vulnerability Protection profiles
- File blocking profiles
- URL filtering profiles
- Data Filtering profiles
- DoS Protection profiles

- IPSec crypto Security profiles
- IKE Network profiles

The next-generation firewall products provide the following features:

- Application-based policy enforcement — the product uses a traffic classification technology named App-ID to classify traffic by application content irrespective of port or protocol. Protocol and port can be used in conjunction with application identification to control what ports an application is allowed to run on. High risk applications can be blocked, as well as high-risk behavior such as file-sharing. SSL encrypted traffic can be decrypted and inspected.
- Threat prevention — the firewall includes threat prevention capabilities that can protect the network from viruses, worms, spyware, and other malicious traffic.
- Traffic visibility — the firewall includes the capability to generate extensive reports, logs, and notification mechanisms that provide detailed visibility into network application traffic and security events.
- Fail-safe operation — the firewall can be configured for fault-tolerant operations, where the firewall can be deployed in active/passive pairs so that if the active firewall fails for any reason, the passive firewall becomes active automatically with no loss of service.
- Management — each firewall can be managed through a Graphical User Interface (GUI). The interface provides an administrator with the ability to establish policy controls, provide the means to control what applications network users are allowed access to, and to control logging and reporting. The interface also provides dynamic visibility tools that enable views into the actual applications running on the network. The GUI can identify the applications with the most traffic and the highest security risks. When configured in a Common Criteria mode of operation, the GUI is secured using HTTP over TLS.

Firewall Policy Enforcement

The App-ID classification technology uses four classification techniques to determine exactly what applications are traversing the network irrespective of port number. As traffic flows through the TOE, App-ID identifies traffic using the following classification engines.

- Application Protocol/Port: App-ID identifies the protocol (such as TCP or UDP) and the port number of the traffic. Protocol/Port information is primarily used for policy enforcement, such as allowing or blocking a specific application over a specific protocol or port number, but is sometimes used in classification, such as ICMP traffic where the protocol is the primary classification method used.
- Application Protocol Decoding: App-ID's protocol decoders determine if the application is using a protocol as a normal application transport (such as HTTP for web browsing applications), or if it is only using the apparent protocol to hide the real application protocol (for example, Yahoo! Instant Messenger might hide inside HTTP).
- Application Signatures: App-ID uses context-based signatures, which look for unique application properties and related transaction characteristics to correctly identify the application regardless of the protocol and port being used.
- Heuristics: App-ID requires multi-packet heuristics for identifying some encrypted applications like Skype and encrypted Bittorrent. This component of App-ID identifies patterns across multiple packets to identify these more complex applications.

The application-centric nature of App-ID means that it cannot only identify and control traditional applications such as SMTP, FTP, and SNMP, but it can also accurately identify many more applications through the use of protocol decoders and application signatures. These applications are categorized in order to simplify the process of building a security policy that matches an organization's information security policy.

Threat Prevention

The next-generation firewall includes a real-time threat prevention engine that inspects the traffic traversing the network for a wide range of threats. The threat prevention engine scans for all types of threats with a uniform signature format, and can identify and block a wide range of threats across a broad set of applications in a single pass. The threats that can be detected by the threat prevention engine include: viruses; spyware (inbound file scanning, and connections to infected web sites); application vulnerability exploits; and phishing/malicious URLs.

App-ID and Threat Prevention Signature Updates

App-ID and threat prevention signatures (collectively known as content updates) may be updated periodically using the dynamic updates feature of the firewall. The TOE can be instructed to contact Palo Alto Networks' update server to download new content updates as they are made available. The connection to the update server is secured with TLS using FIPS-approved algorithms. For an additional layer of protection, Palo Alto Networks has chosen to sign (using RSA-2048) and encrypt (using AES-256) all content that is downloaded to the firewall however this has not been tested in the evaluated configuration.

Management

The next-generation firewall provides both direct and remote connections for the Web Management interface. The Web interface provides administrators with the ability to manage, configure and monitor the TOE either through a direct connection or via HTTPS from an Internet Explorer (IE, Release 7 and later, recommended IE Release 10 and later), Firefox (version 3.6 or later), Safari (version 5 or later), and Chrome (version 11 or later) browser.

User Identification Agent (UIA)

The UIA is client software installed on one or more PCs in the operational environment on the protected network. The UIA provides the firewall with the capability to automatically collect user-specific information that is used in security policy enforcement and reporting. The UIA is not related to Identification and Authentication.

Fault Tolerance

Fault-tolerant operation is provided when the TOE is deployed in active/passive pairs so that if the active firewall fails for any reason, the passive firewall becomes active automatically with no loss of service. A failover can also occur if selected Ethernet links fail or if one or more specified destinations cannot be reached by the active firewall.

The active firewall continuously synchronizes its configuration and session information with the passive firewall over two dedicated high availability (HA) interfaces. If one HA interface fails, synchronization continues over the remaining interface. HA has not been tested in the evaluated configuration.

Common Criteria Compliant Mode of Operation

The TOE is compliant with the capabilities outlined in this Security Target only when operated in Common Criteria mode. Common Criteria mode is a special operational mode in which the FIPS 140-2 requirements for startup and conditional self-tests as well as algorithm selection are enforced. In this mode, only FIPS-approved and FIPS-allowed cryptographic algorithms are available.

2.2 TOE Architecture

The firewalls' architecture is divided into three subsystems: the control plane; the data plane; and the User Identification Agent. The control plane provides system management functionality while the data plane handles all data processing on the network; both reside on the firewall appliance. The User Identification Agent is installed on a separate dedicated PC on the network and communicates with the domain controller to retrieve user-specific information. It allows the next-generation firewall to automatically collect user information and include it in policies and reporting.

The following diagram depicts both the hardware and software architecture of the next-generation firewall. The User Identification Agent is in the operational environment.

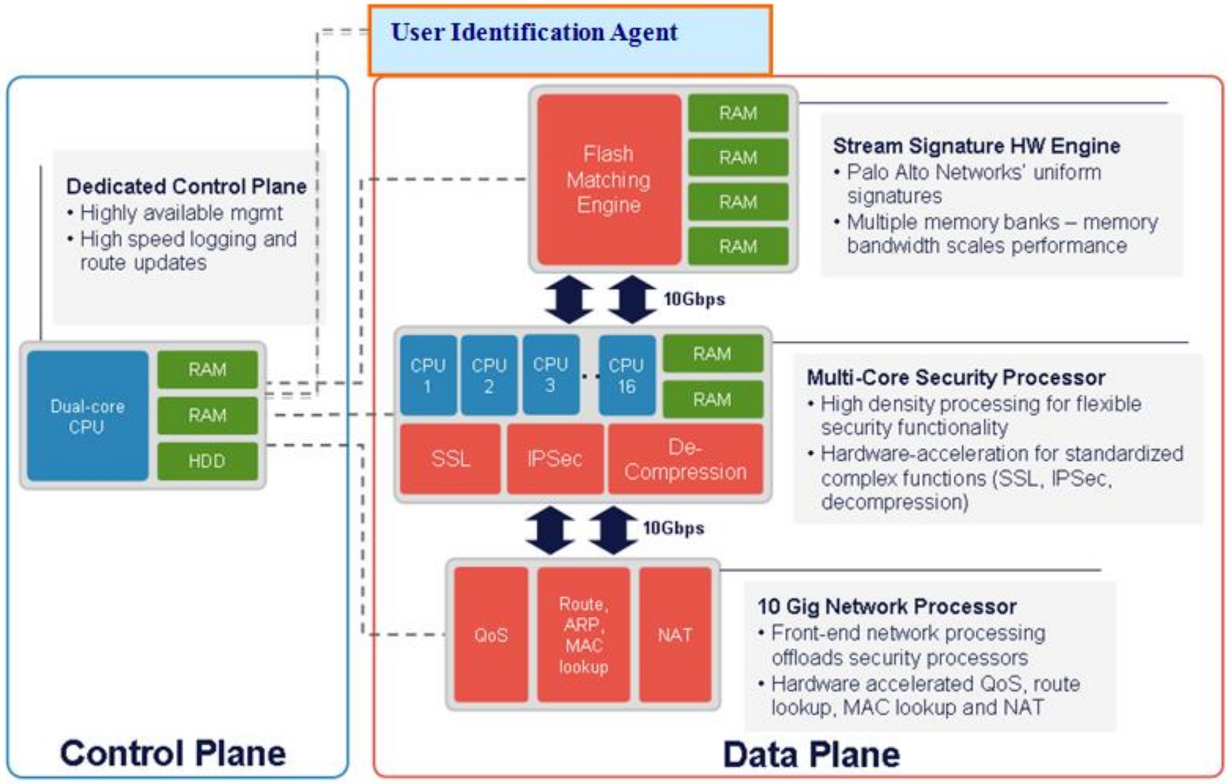

User Identification Agent
Flash Matching Engine
RAM
RAM
RAM
RAM
Stream Signature HW Engine
• Palo Alto Networks' uniform signatures
• Multiple memory banks – memory bandwidth scales performance
10Gbps
Dedicated Control Plane
• Highly available mgmt
• High speed logging and route updates
Dual-core CPU
RAM
RAM
HDD
CPU 1
CPU 2
CPU 3
CPU 16
RAM
RAM
SSL
IPSec
De-Compression
Multi-Core Security Processor
• High density processing for flexible security functionality
• Hardware-acceleration for standardized complex functions (SSL, IPSec, decompression)
10Gbps
QoS
Route, ARP, MAC lookup
NAT
10 Gig Network Processor
• Front-end network processing offloads security processors
• Hardware accelerated QoS, route lookup, MAC lookup and NAT
Control Plane
Data Plane

Figure 1: TOE Architecture

The control plane includes a dual core CPU, with dedicated memory and a hard drive for local log, configuration, and software storage. The data plane includes three components—the network processor, the security processor, and the stream signature processor—each with its own dedicated memory and hardware processing.

In summary, the functionality provided by each component of the system is as follows:

Control Plane

The control plane provides all device management functionality, including:

- All management interfaces – provide a both direct and remote connection for the Web Interface GUI.
- Configuration management of the device, such as controlling the changes made to the device configuration, as well as the compilation and pushing to the dataplane of a configuration change
- Logging infrastructure for traffic, threat, alarm, configuration, and system logs
- Reporting infrastructure for reports, monitoring tools, and graphical visibility tools
- Administration controls, including administrator authentication and audit trail information for administrators logging in, logging out, and configuration changes.
- Interactions with the UIA to retrieve the user to IP address mapping information that is used for policy enforcement.

Data Plane

The data plane provides all data processing and security detection and enforcement, including:

- All networking connectivity, packet forwarding, switching, routing, and network address translation
- Application identification, using the content of the applications, not just port or protocol
- SSL forward proxy, including decryption and re-encryption

- Policy lookups to determine what security policy to enforce and what actions to take, including scanning for threats, logging, and packet marking
- Application decoding, threat scanning for all types of threats and threat prevention
- Logging, with all logs sent to the control plane for processing and storage

The product's SSL decryption feature uses an SSL proxy to establish itself as a man-in-the-middle proxy, which decrypts and controls the traffic within the SSL tunnel that traverses the TOE. The SSL proxy acts as a forward proxy (internal client to an external server). The certificates used by the TOE during forward proxying include as much relevant data from the external server's original certificate as possible (i.e., validity dates, certificate purpose, common name, and subject information). For inbound connections (external client to internal server), the TOE can decrypt incoming traffic and control the traffic within the SSL tunnel. SSL decryption is configured as a rulebase in which match criteria include zone, IP address, and User-ID. SSL proxy is configured by creating a Certificate Authority certificate (CA cert) on the firewall. When a client attempts to connect with a remote server, if a decryption policy is matched, the firewall will create a connection with the server and another connection with the client, inserting itself in the middle. The firewall will copy the subject information, validity information, and common name into a new certificate that is signed by the CA cert. If the firewall trusts the issuer of the server's certificate, it will sign the newly generated server cert with a trusted CA cert. If the firewall does not trust the issuer of the server's certificate, it will sign the newly generated server cert with an untrusted CA cert, thereby relaying the untrusted nature of the certificate to the client. A new public/private key pair is generated for each new SSL server to which the client's connect.

SSH Decryption is checked using the SSH application signature, a policy lookup will occur on the decrypt rule to see if this session should be decrypted. If yes, the TOE will set up a man-in-the middle to decrypt the session and decide if any port-forwarding request is sent in that session. As soon as any port forwarding is detected, the application becomes an SSH-tunnel, and based on the policy, the session might get denied.

Site-to-site IPsec VPN supports IPv4 or IPv6 site-to-site connections. That is, you can establish IKE and IPsec Security Associations (SAs) between IPv4 or IPv6 endpoints. The web interface can be used to enable, disable, restart, or refresh an IKE gateway or an IPsec VPN tunnel to simplify troubleshooting.

User Identification Agent

The user identification agent is a client software program installed on one or more PCs on the protected network to obtain user-specific information. The agent can be installed on any PC running Windows Vista, or Windows Server 2003 32bit with SP2 (or higher than SP2), or Windows Server 2008 32bit and 64bit. The agent communicates with a Microsoft Windows Domain Controller to obtain user information (such as user groups, users, and machines deployed in the domain) and makes the information available to the firewall, which uses it for policy enforcement and reporting. The UIA maintains mapping information received from the Domain Controller, which it synchronizes to the firewall table. The UIA provides the firewall with the capability to automatically collect user-specific information, and provides mapping information between IP addresses and network users. Policy enforcement decisions regarding whether or not a packet is allowed through the firewall are made based on the packet's IP addresses. The UIA allows firewall policies to be constructed using user identifiers as well as IP addresses. The UIA enables scaling of VPN deployments and maintains mapping information received from the Domain Controller, which it synchronizes to the firewall table. The UIA only works with IPv4 addresses and does not work with IPv6 addresses. The User Identification Agent is in the operational environment.

VM-Series

The VM-Series on specified hardware supports the exact same next-generation firewall and advanced threat prevention features that are available in the physical form factor appliances, allowing an administrator to safely enable applications flowing into, and across private, public and hybrid cloud computing environments.

Automation features such as VM monitoring, dynamic address groups and a REST-based API permit proactively monitoring VM changes and dynamically feeding that context into security policies, thereby eliminating the policy lag that may occur when your VMs change.

Each VM-Series virtual appliance in its evaluated configuration is installed on a hardware platform as specified in Section 1.1 that includes VMware ESXi 5.5 hypervisor, an Intel Core or Xeon processor based on the Ivy Bridge or

Haswell microarchitectures that implement Intel Secure Key, and Network Interface Controllers supported by the Server.

2.2.1 Physical Boundaries

The TOE consists of the following components:

- Hardware appliance-includes the physical port connections on the outside of the appliance cabinet and a time clock that provides the time stamp used for the audit records.
- Virtualized Firewalls installed on specified hardware - the VM-Series supports the exact same next-generation firewall and advanced threat prevention features available in the physical form factor appliances, allowing an administrator to safely enable applications flowing into, and across your private, public and hybrid cloud computing environments. The VM software and the appliances are both included in the TOE. The time clock, as well as CPU, ports, etc., are provided by VM environment (hypervisor) hosting the PAN-OS VMs. VMs are deployed in the system using Intel CPUs.
- PAN-OS v7.0.8 or v7.1.3 – the software/firmware component that runs the appliance. For VMs PAN-OS is software and for hardware appliances PAN-OS is firmware. PAN-OS is built on top of a Linux kernel and runs along with Appweb (the web server that Palo Alto Networks uses), crond, syslogd, and various vendor-developed applications that implement PAN-OS capabilities. PAN-OS provides the logical interfaces for network traffic. PAN-OS runs on both the Control Plane and the Data Plane and provides all firewall functionalities provided by the TOE, including the threat prevention capabilities as well as the identification and authentication of users and the management functions. PAN-OS provides unique functionality on the two planes based on the applications that are executing. The Control Plane provides a GUI Web management interface to access and manage the TOE functions and data. The Data Plane provides the external interface between the TOE and the external network to monitor network traffic so that the TSF can enforce the TSF security policy.

The physical boundary of the TOE comprises the firewall appliance (PA-200, PA-500, PA-2020, PA-2050, PA-3020, PA-3050, PA-3060, PA-4020, PA-4050, PA-4060, PA-5020, PA-5050, PA-5060, PA-7050, PA-7080); and the virtual appliances on specified hardware in the VM-Series VM-100, VM-200, VM-300, VM-1000-HV. The next-generation firewall models differ in their performance capability, but they provide the same security functionality.

Virtualized systems are supported by default (without an additional license) on the PA-500, PA-2020, PA-2050, PA-3020, PA-3050, PA-3060, PA-4020, PA-4050, PA-4060, PA-5020, PA-5050, PA-5060, PA-7050, and PA-7080. The PA-200 cannot support virtual systems. Virtual systems specify a collection of physical and logical firewall interfaces that should be isolated. Each virtual system contains its own security policy and its own set of logs that will be kept separate from all other virtual systems.

The firewall appliance attaches to a physical network and includes the following ports:

- PA-200: 8 RJ-45 10/100/1000 ports for network traffic (Ethernet ports); 1 RJ-45 port to access the device GUI through an Ethernet interface (management ports); and 1 RJ-45 port for connecting a serial console (management console port)
- PA-500: 8 RJ-45 10/100/1000 ports for network traffic (Ethernet ports); 1 RJ-45 port to access the device GUI through an Ethernet interface (management ports); and 1 RJ-45 port for connecting a serial console (management console port)
- PA-2020: 12 RJ-45 10/100/1000 ports for network traffic (Ethernet ports); 2 Small Form-Factor Pluggable (SFP) Gbps ports for network traffic, 1 RJ-45 port to access the device GUI through an Ethernet interface (management ports); and 1 RJ-45 port for connecting a serial console (management console port)
- PA-2050: 16 RJ-45 10/100/1000 ports for network traffic (Ethernet ports); 4 Small Form-Factor Pluggable (SFP) Gbps ports for network traffic, 1 RJ-45 port to access the device GUI through an Ethernet interface (management ports); and 1 RJ-45 port for connecting a serial console (management console port)
- PA-3020/PA-3050: 12 RJ-45 10/100/1000 ports for network traffic (Ethernet ports); 8 Small Form-Factor Pluggable (SFP) Gbps ports for network traffic, 1 RJ-45 port to access the device GUI through an Ethernet

interface (management ports); 1 RJ-45 port for connecting a serial console (management console port); and 2 RJ-45 ports for high-availability (HA) control and synchronization

- PA-3060: 8 RJ-45 10/100/1000 ports for network traffic (Ethernet ports); 8 Small Form-Factor Pluggable (SFP) Gbps ports for network traffic, 1 RJ-45 port to access the device GUI through an Ethernet interface (management ports); 1 RJ-45 port for connecting a serial console (management console port); and 2 RJ-45 ports for high-availability (HA) control and synchronization.
- PA-4020/4050: 16 RJ-45 10/100/1000 ports for network traffic (Ethernet ports); 8 Small Form-Factor Pluggable (GFP) Mbps ports for network traffic, 1 RJ-45 port to access the device GUI through an Ethernet interface (management ports); 1 DB-9 port for connecting a serial console (management console port); and 2 RJ-45 ports for high-availability (HA) control and synchronization
- PA-4060: 4 XFP 10 Gbps ports for management traffic; 4 Small Form-Factor Pluggable (SFP) Mbps ports for network traffic, 1 RJ-45 port to access the device CLI or GUI through an Ethernet interface (management ports); 1 DB-9 port for connecting a serial console (management console port); and 2 RJ-45 ports for high-availability (HA) control and synchronization
- PA-5020: 12 RJ-45 10/100/1000 ports for network traffic. 8 Small Form-Factor Pluggable (SFP) ports for network traffic. One RJ-45 port to access the device management interfaces through an Ethernet interface. One RJ-45 port for connecting a serial console. Two RJ-45 ports for high-availability (HA) control and synchronization.
- PA-5050: 12 RJ-45 10/100/1000 ports for network traffic. Eight Small Form-Factor Pluggable (SFP) ports for network traffic. Four SFP+ ports for network traffic. One RJ-45 port to access the device management interfaces through an Ethernet interface. One RJ-45 port for connecting a serial console. Two RJ-45 ports for high-availability (HA) control and synchronization.
- PA-5060: 12 RJ-45 10/100/1000 ports for network traffic. Eight Small Form-Factor Pluggable (SFP) ports for network traffic. Four SFP+ ports for network traffic. One RJ-45 port to access the device management interfaces through an Ethernet interface. One RJ-45 port for connecting a serial console. Two RJ-45 ports for high-availability (HA) control and synchronization.
- PA-7050: 12 gig copper ports for network traffic, eight Small Form-Factor Pluggable (SFP) ports for network traffic and four SFP+ ports for network traffic per blade OR two Quad Small Form-Factor Pluggable (QSFP) for network traffic per blade and twelve SFP+ ports for network traffic per blade (6 blades max). One RJ-45 port to access the device management interfaces through an Ethernet interface. One RJ-45 port for connecting a serial console. Two QSFP ports for high-availability (HA) control and synchronization.
- PA-7080: 12 gig copper ports for network traffic, eight Small Form-Factor Pluggable (SFP) ports for network traffic and four SFP+ ports for network traffic per blade OR two Quad Small Form-Factor Pluggable (QSFP) for network traffic per blade and twelve SFP+ ports for network traffic per blade (10 blades max). One RJ-45 port to access the device management interfaces through an Ethernet interface. One RJ-45 port for connecting a serial console. Two QSFP ports for high-availability (HA) control and synchronization.

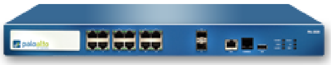
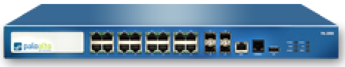
In the evaluated configuration, the TOE can be managed by:

- A computer either directly connected or remotely connected to the Management port via an RJ-45 Ethernet cable. The Management port is an out-of-band management port that provides access to the GUI via HTTPS. The computer is part of the operational environment and required to have a web browser (for accessing the GUI).

Traffic logs, which record information about each traffic flow or problems with the network traffic, are logged locally by default. However, the product offers the capability to send the logs as SNMP traps, Syslog messages, or email notifications. Traffic logging and the use of email notifications and the SNMP and SMTP servers have not been subject to testing in the evaluated configuration.

The operational environment includes a syslog server, update server, and VPN gateway peer(s).

The operational environment includes a domain controller and the User Identification Agent is installed on one or more PCs in the operational environment, and is supported on Windows XP with SP2 (or higher than SP2), or Windows Vista, or Windows Server 2003 32bit with SP2 (or higher than SP2), or Windows Server 2008 32bit and 64bit.

Product Identification	Illustration	Description
PA-200		• 100 Mbps firewall throughput(App-ID enabled • 50 Mbps threat prevention throughput • 50 Mbps IPsec VPN throughput • 64,000 max sessions • 1,000 new sessions per second • 25 IPsec VPN tunnels/tunnel interfaces • 25 SSL VPN Users • 10 security zones • 250 max number of policies
PA-500		• 250 Mbps firewall throughput (App-ID enabled1) • 100 Mbps threat prevention throughput • 50 Mbps IPsec VPN throughput • 64,000 max sessions • 7,500 new sessions per second • 250 IPsec VPN tunnels/tunnel interfaces • 100 SSL VPN Users • 3 virtual routers • N/A virtual systems (base/max) • 20 security zones • 1,000 max number of policies
PA-2020		• 500 Mbps firewall throughput (App-ID enabled1) • 200 Mbps threat prevention throughput • 200 Mbps IPsec VPN throughput • 125,000 max sessions • 15,000 new sessions per second • 1,000 IPsec VPN tunnels/tunnel interfaces • 500 SSL VPN Users • 10 virtual routers • 1/6 virtual systems (base/max) • 40 security zones • 2,500 max number of policies
PA-2050		• 1 Gbps firewall throughput (App-ID enabled) • 500 Mbps threat prevention throughput • 300 Mbps IPsec VPN throughput • 250,000 max sessions

		15,000 new sessions per second 2,000 IPsec VPN tunnels/tunnel interfaces 1,000 SSL VPN Users 10 virtual routers 1/6 virtual systems (base/max) 40 security zones 5,000 max number of policies
PA-3020		2 Gbps firewall throughput (App-ID enabled) 1 Gbps threat prevention throughput 500 Mbps IPsec VPN throughput 250,000 max sessions 50,000 new sessions per second 1,000 IPsec VPN tunnels/tunnel interfaces 1,000 SSL VPN Users 10 virtual routers 1/6 virtual systems (base/max) 40 security zones 2,500 max number of policies
PA-3050		4 Gbps firewall throughput (App-ID enabled) 2 Gbps threat prevention throughput 500 Mbps IPsec VPN throughput 500,000 max sessions 50,000 new sessions per second 2,000 IPsec VPN tunnels/tunnel interfaces 2,000 SSL VPN Users 10 virtual routers 1/6 virtual systems (base/max) 40 security zones 5,000 max number of policies
PA-3060		4 Gbps firewall throughput (App-ID enabled1) 2 Gbps threat prevention throughput 500 Mbps IPsec VPN throughput 500,000 max sessions 50,000 new sessions per second 2,000 IPsec VPN tunnels/tunnel interfaces 2,000 SSL VPN Users 10 virtual routers 1/6 virtual systems (base/max) 40 security zones 5,000 max number of policies

PA-4020		• 2 Gbps firewall throughput (App-ID enabled) • 2 Gbps threat prevention throughput • 1 Gbps IPsec VPN throughput • 500,000 max sessions • 60,000 new sessions per second • 2,000 IPsec VPN tunnels/tunnel interfaces • 5,000 SSL VPN Users • 20 virtual routers • 10/20 virtual systems (base/max2) • 80 security zones 10,000 max number of policies
PA-4050		• 10 Gbps firewall throughput (App-ID enabled) • 5 Gbps threat prevention throughput • 2 Gbps IPsec VPN throughput • 2,000,000 max sessions • 60,000 new sessions per second • 4,000 IPsec VPN tunnels/tunnel interfaces • 10,000 SSL VPN Users • 125 virtual routers • 25/125 virtual systems (base/max2) • 500 security zones • 20,000 max number of policies
PA-4060		• 10 Gbps firewall throughput (App-ID enabled) • 5 Gbps threat prevention throughput • 2 Gbps IPsec VPN throughput • 2,000,000 max sessions • 60,000 new sessions per second • 4,000 IPsec VPN tunnels/tunnel interfaces • 10,000 SSL VPN Users 125 virtual routers • 125 virtual routers • 25/125 virtual systems (base/max2) • 500 security zones • 20,000 max number of policies
PA-5020		• 5 Gbps firewall throughput (App-ID enabled1) • 2 Gbps threat prevention throughput • 2 Gbps IPsec VPN throughput • 1,000,000 max sessions • 120,000 new sessions per second • 2,000 IPsec VPN tunnels/tunnel interfaces • 5,000 SSL VPN Users

		• 20 virtual routers • 10/20 virtual systems (base/max) • 80 security zones • 10,000 max number of policies
PA-5050		• 10 Gbps firewall throughput (App-ID enabled1) • 5 Gbps threat prevention throughput • 4 Gbps IPsec VPN throughput • 2,000,000 max sessions • 120,000 new sessions per second • 4,000 IPsec VPN tunnels/tunnel interfaces • 10,000 SSL VPN Users • 125 virtual routers • 25/125 virtual systems (base/max) • 500 security zones • 20,000 max number of policies
PA-5060		• 20 Gbps firewall throughput (App-ID enabled1) • 10 Gbps threat prevention throughput • 4 Gbps IPsec VPN throughput • 4,000,000 max sessions • 120,000 new sessions per second • 8,000 IPsec VPN tunnels/tunnel interfaces • 20,000 SSL VPN Users • 225 virtual routers • 25/225 virtual systems (base/max) • 900 security zones • 40,000 max number of policies
PA-7050		• 120 Gbps Firewall throughput (App-ID enabled) • 100 Gbps Threat prevention throughput (DSRI Enabled2) • 60 Gbps Threat prevention throughput • 48 Gbps IPsec VPN throughput • 24,000,000 Max sessions • 720,000 New sessions per second • 25/225 Virtual systems (base/max)

PA-7080		• 200 Gbps Firewall throughput (App-ID enabled) • 160 Gbps Threat prevention throughput (DSRI Enabled2) • 100 Gbps Threat prevention throughput • 80 Gbps IPsec VPN throughput • 40,000,000 Max sessions • 1,200,000 New sessions per second • 25/225 Virtual systems (base/max)
Virtual Appliances		
VM-100		• 50,000 max sessions • 25 IPsec VPN tunnels/tunnel interfaces • 25 SSL VPN Users • 10 security zones • 250 max number of policies • 2,500 address objects • 1Gbps Firewall Throughput (App-ID enabled) • 600 Mbps Threat Prevention Throughput • 250 Mbps IPsec VPN Throughput • 8,000 New sessions per second
VM-200		• 100,000 max sessions • 500 IPsec VPN tunnels/tunnel interfaces • 200 SSL VPN Users • 20 security zones • 2,000 max number of policies • 4,000 address objects • 1Gbps Firewall Throughput (App-ID enabled) • 600 Mbps Threat Prevention Throughput • 250 Mbps IPsec VPN Throughput • 8,000 New sessions per second
VM-300		• 250,000 max sessions • 2,000 IPsec VPN tunnels/tunnel interfaces • 500 SSL VPN Users • 40 security zones • 5,000 max number of policies • 10,000 address objects • 1Gbps Firewall Throughput (App-ID enabled) • 600 Mbps Threat Prevention Throughput • 250 Mbps IPsec VPN Throughput • 8,000 New sessions per second

VM-1000-HV		• 250,000 max sessions • 2,000 IPsec VPN tunnels/tunnel interfaces • 500 SSL VPN Users • 40 security zones • 10,000 max number of policies • 10,000 address objects • 1Gbps Firewall Throughput (App-ID enabled) • 600 Mbps Threat Prevention Throughput • 250 Mbps IPsec VPN Throughput • 8,000 New sessions per second

2.2.2 Logical Boundaries

This section summarizes the security functions provided by the TOE:

- Security audit
- Cryptographic support
- User data protection
- Identification and authentication
- Security management
- Protection of the TSF
- TOE access
- Trusted path/channels
- Stateful traffic filtering
- Packet filtering

2.2.2.1 Security audit

The TOE is designed to be able to generate logs for a wide range of security relevant events including the events specified in NDPP. The TOE can be configured to store the logs locally so they can be accessed by an administrator and can also be configured to send the logs to a designated external log server.

2.2.2.2 Cryptographic support

The TOE implements NIST-validated cryptographic algorithms that provide key management, random bit generation, encryption/decryption, digital signature and cryptographic hashing and keyed-hash message authentication features in support of higher level cryptographic protocols, including IPsec and TLS. Note that to be in the evaluated configuration, the TOE must be configured in Common Criteria mode, which ensures the TOE's configuration is consistent with the FIPS 140-2 standard. All physical and virtual appliance included in the TOE are FIPS 140-2 validated, as follows:

- The PA-200, PA-500, PA-2000 Series, PA-3000 Series (except the PA-3060), PA-4000 Series, PA-5000 Series and PA-7050 Firewall appliances with PAN-OS 7.0.8 are covered by CMVP certificate #2637

- The PA-3060 and PA-7080 Firewall appliances with PAN-OS 7.0.8 are covered by CMVP certificate #2616

- The Palo Alto Networks VM-Series virtual appliances with PAN-OS 7.0.8 are covered by CMVP certificate #2620

- The PA-200, PA-500, PA-2000 Series, PA-3000 Series (except the PA-3060), PA-4000 Series, PA-5000 Series and PA-7050 Firewall appliances with PAN-OS 7.1.3 are covered by CMVP certificate #2799

- The PA-3060 and PA-7080 Firewall appliances with PAN-OS 7.1.3 are covered by CMVP certificate #2797
- The Palo Alto Networks VM-Series virtual appliances with PAN-OS 7.1.3 are covered by CMVP certificate #2800.

2.2.2.3 User data protection

The TOE is designed to ensure that it does not inadvertently reuse data found in network traffic.

2.2.2.4 Identification and authentication

The TOE requires all users accessing the TOE user interfaces to be successfully identified and authenticated before they can access any security management functions available in the TOE. The TOE offers network accessible (HTTP over TLS) and direct connections to the GUI for interactive administrator sessions.

The TOE supports the local (i.e., on device) definition and authentication of administrators with username, password, and role (set of privileges), which it uses to authenticate the human user and to associate that user with an authorized role. In addition, the TOE can authenticate users using X509 certificates and can be configured to lock a user out after a configurable number of unsuccessful authentication attempts.

2.2.2.5 Security management

The TOE provides a GUI to access the wide range of security management functions. Security management commands are limited to administrators and are available only after they have provided acceptable user identification and authentication data to the TOE. The TOE provides access to the GUI locally via direct RJ-45 Ethernet cable connection and remotely using an HTTPS/TLS client.

The TOE provides a number of management functions and restricts them to users with the appropriate privileges. The management functions include the capability to create new user accounts, configure the audit function, configure the information flow control rules, and review the audit trail. The TOE provides pre-defined Security Administrator, Audit Administrator, and Cryptographic Administrator roles. These administrator roles are all considered Security Administrator as defined in the NDPP for the purposes of this ST.

2.2.2.6 Protection of the TSF

The TOE implements a number of features designed to protect itself to ensure the reliability and integrity of its security features.

It protects particularly sensitive data such as stored passwords and cryptographic keys so that they are not accessible even by an administrator. It also provides its own timing mechanism to ensure that reliable time information is available (e.g., for log accountability).

The TOE includes functions to perform self-tests so that it might detect when it is failing. It also includes mechanisms so that the TOE itself can be updated while ensuring that the updates will not introduce malicious or other unexpected changes in the TOE.

2.2.2.7 TOE access

The TOE provides the capabilities for both TOE- and user-initiated locking of interactive sessions and for TOE termination of an interactive session after a period of inactivity. The TOE will display an advisory and consent warning message regarding unauthorized use of the TOE before establishing a user session.

2.2.2.8 Trusted path/channels

The TOE protects interactive communication with remote administrators using IPsec or HTTP over TLS. IPsec and TLS ensures both integrity and disclosure protection.

The TOE protects communication with the UIA, update server using TLS connections; the external log server with IPsec or TLS, and remote VPN gateways/peers using IPsec to prevent unintended disclosure or modification of the transferred data.

2.2.2.9 Stateful traffic filtering

The TOE provides a stateful traffic filter firewall for layers 3 and 4 (IP and TCP/UDP) network traffic optimized through the use of stateful packet inspection.

An administrator can configure the TOE to control the type of information that is allowed to pass through the TOE. The administrator defines the security zone and applies security policies to network traffic attempting to traverse the TOE to determine what actions to take.

The TOE groups interfaces into security zones. Each zone identifies one or more interfaces on the TOE. Separate zones must be created for each type of interface (Layer 2, Layer 3, or virtual wire), and each interface must be assigned to a zone before it can process traffic. Security policies provide the firewall rule sets that specify whether to block or allow network connections, based on the source and destination zones, and addresses, and the application service (such as UDP port 67 or TCP port 80). Security policy rules are processed in sequence, applying the first rule that matches the incoming traffic.

2.2.2.10 Packet filtering

The TOE provides packet filtering and secure IPsec tunneling. The tunnels can be established between two trusted VPN peers as well as between remote VPN clients and the TOE. An administrator can configure security policies that determine whether to block, allow, or log a session based on traffic attributes such as the source and destination security zone, the source and destination IP address, the application, user, and the service.

2.3 TOE Documentation

Palo Alto Networks Inc. offers a series of documents that describe the installation of Palo Alto Networks next-generation firewalls as well as guidance for subsequent use and administration of the applicable security features.

For PAN-OS v7.0.8, these documents include:

- Palo Alto Networks Common Criteria Evaluated Configuration Guide (CCECG) for PAN-OS v7.0, Version 1.1, 9 September 2016
- Palo Alto Networks PAN-OS Administrator's Guide Version 7.0
- Palo Alto Networks Web Interface Reference Guide, Version 7.0.

For PAN-OS v7.1.3, these documents include:

- Palo Alto Networks Common Criteria Evaluated Configuration Guide (CCECG) for PAN-OS v7.1, Version 1.0, 9 September 2016
- Palo Alto Networks PAN-OS Administrator's Guide Version 7.1
- Palo Alto Networks Web Interface Reference Guide, Version 7.1.

3. Security Problem Definition

This security target includes by reference the Security Problem Definition (composed of organizational policies, threat statements, and assumption) from NDPP, STFF and VPNGW.

In general, the NDPP has presented a Security Problem Definition appropriate for network infrastructure devices, such as firewalls, and as such is applicable to the Palo Alto TOE. Likewise, the STFF has presented a Security Problem definition appropriate for Stateful Traffic Filter Firewalls; and the VPNGW has presented a Security Problem definition appropriate for VPN Gateways, as such both are applicable to the Palo Alto TOE.

4. Security Objectives

Like the Security Problem Definition, this security target includes by reference the Security Objectives from the NDPP, STFF, and the VPNGW. The security objectives for the operational environment are reproduced below, since these objectives characterize technical and procedural measures each consumer must implement in their operational environment.

In general, the NDPP, STFF, and the VPNGW have presented Security Objectives appropriate for network infrastructure devices, such as firewalls, Stateful Traffic Filter Firewalls, and VPN Gateways and as such are applicable to the Palo Alto TOE.

4.1 Security Objectives for the Operational Environment

OE.NO_GENERAL_PURPOSE	There are no general-purpose computing capabilities (e.g., compilers or user applications) available on the TOE, other than those services necessary for the operation, administration and support of the TOE.
OE.PHYSICAL	Physical security, commensurate with the value of the TOE and the data it contains, is provided by the environment.
OE.TRUSTED_ADMIN	TOE Administrators are trusted to follow and apply all administrator guidance in a trusted manner.
OE.CONNECTIONS	TOE administrators will ensure that the TOE is installed in a manner that will allow the TOE to effectively enforce its policies on network traffic flowing among attached networks.

5. IT Security Requirements

This section defines the Security Functional Requirements (SFRs) and Security Assurance Requirements (SARs) that serve to represent the security functional claims for the Target of Evaluation (TOE) and to scope the evaluation effort.

The SFRs have all been drawn from the Protection Profile (PP): *Protection Profile for Network Devices, Version 1.1, 8 June 2012* (NDPP), as amended by Errata #3, Network Device Protection Profile (NDPP) Extended Package Stateful Traffic Filter Firewall, Version 1.0, 19 December 2011 (STFF), and the Network Device Protection Profile (NDPP) Extended Package VPN Gateway, Version 1.1, 12 April 2013 (VPNGW). As a result, refinements and operations already performed in that PP are not identified (e.g., highlighted) here, rather the requirements have been copied from that PP and any residual operations have been completed herein. Of particular note, the NDPP made a number of refinements and completed some of the SFR operations defined in the CC and that PP should be consulted to identify those changes if necessary.

The SARs are the set of SARs specified in NDPP, STFF, and VPNGW.

5.1 Extended Requirements

All of the extended requirements in this ST have been drawn from the NDPP, STFF, and VPNGW. The NDPP, STFF, and VPNGW define the following extended SFRs and since they are not redefined in this ST, the NDPP, STFF, and VPNGW should be consulted for more information in regard to those CC extensions.

- FAU_STG_EXT.1: External Audit Trail Storage
- FCS_CKM_EXT.4: Cryptographic Key Zeroization
- FCS_HTTPS_EXT.1: Explicit: HTTPS
- FCS_IPSEC_EXT.1: Explicit: IPSEC
- FCS_RBG_EXT.1: Extended: Cryptographic Operation (Random Bit Generation)
- FCS_TLS_EXT.1: Explicit: TLS
- FFW_RUL_EXT.1 Stateful Traffic Filtering
- FIA_PMG_EXT.1: Password Management
- FIA_UAU_EXT.2: Extended: Password-based Authentication Mechanism
- FIA_UIA_EXT.1: User Identification and Authentication
- FIA_X509_EXT.1 Extended: X.509 Certificates
- FPF_RUL_EXT.1 Packet Filtering
- FPT_APW_EXT.1: Extended: Protection of Administrator Passwords
- FPT_SKP_EXT.1: Extended: Protection of TSF Data (for reading of all symmetric keys)
- FPT_TST_EXT.1: TSF Testing
- FPT_TUD_EXT.1: Extended: Trusted Update
- FTA_SSL_EXT.1: TSF-initiated Session Locking

5.2 TOE Security Functional Requirements

The following table identifies the SFRs that are satisfied by the Palo Alto firewall.

Requirement Class	Requirement Component
FAU: Security audit	FAU_GEN.1: Audit Data Generation
	FAU_GEN.2: User identity association
	FAU_STG_EXT.1: External Audit Trail Storage
FCS: Cryptographic support	FCS_CKM.1(1): Cryptographic Key Generation (for asymmetric keys)
	FCS_CKM.1(2): Cryptographic Key Generation (for asymmetric keys)
	FCS_CKM_EXT.4: Cryptographic Key Zeroization
	FCS_COP.1(1): Cryptographic Operation (for data encryption/decryption)
	FCS_COP.1(2): Cryptographic Operation (for cryptographic signature)
	FCS_COP.1(3): Cryptographic Operation (for cryptographic hashing)
	FCS_COP.1(4): Cryptographic Operation (for keyed-hash message authentication)
	FCS_HTTPS_EXT.1: Explicit: HTTPS
	FCS_IPSEC_EXT.1: Explicit: IPSEC
	FCS_RBG_EXT.1: Extended: Cryptographic Operation (Random Bit Generation)
	FCS_TLS_EXT.1: Explicit: TLS
FDP: User data protection	FDP_RIP.2: Full Residual Information Protection
FIA: Identification and authentication	FIA_AFL.1 Authentication Failure Handling
	FIA_PMG_EXT.1: Password Management
	FIA_UAU.7: Protected Authentication Feedback
	FIA_UAU_EXT.2: Extended: Password-based Authentication Mechanism
	FIA_UIA_EXT.1: User Identification and Authentication
	FIA_X509_EXT.1 Extended: X.509 Certificates
FFW: Stateful Traffic Filtering	FFW_RUL_EXT.1 Stateful Traffic Filtering
FMT: Security management	FMT_MTD.1: Management of TSF Data (for general TSF data)
	FMT_MOF.1 Management of Security Functions Behavior
	FMT_SMF.1: Specification of Management Functions
	FMT_SMR.2: Restrictions on Security Roles
FPF: Packet Filtering	FPF_RUL_EXT.1 Packet Filtering
FPT: Protection of the TSF	FPT_APW_EXT.1: Extended: Protection of Administrator Passwords
	FPT_FLS.1 Fail Secure
	FPT_SKP_EXT.1: Extended: Protection of TSF Data (for reading of all symmetric keys)
	FPT_STM.1: Reliable Time Stamps

Requirement Class	Requirement Component
	FPT_TST_EXT.1: TSF Testing
	FPT_TUD_EXT.1: Extended: Trusted Update
FTA: TOE access	FTA_SSL.3: TSF-initiated Termination
	FTA_SSL.4: User-initiated Termination
	FTA_SSL_EXT.1: TSF-initiated Session Locking
	FTA_TAB.1: Default TOE Access Banners
FTP: Trusted path/channels	FTP_ITC.1: Trusted Channel
	FTP_TRP.1: Trusted Path

Table 1 TOE Security Functional Components

5.2.1 Security Audit (FAU)

FAU_GEN.1 – Audit data generation

FAU_GEN.1.1 The TSF shall be able to generate an audit record of the following auditable events:

a) Start-up and shutdown of the audit functions;
b) All auditable events for the not specified level of audit; and
c) All administrative actions;
d) Specifically defined auditable events listed in **Table 2**.

FAU_GEN.1.2 The TSF shall record within each audit record at least the following information:

a) Date and time of the event, type of event, subject identity, and the outcome (success or failure) of the event; and
b) For each audit event type, based on the auditable event definitions of the functional components included in the PP/ST, information specified in column three of **Table 2**.

Requirement	Auditable Events	Additional Audit Record Contents
FAU_GEN.1	None.	
FAU_GEN.2	None.	
FAU_STG_EXT.1	None.	
FCS_CKM.1 (1)	None.	
FCS_CKM.1(2)	None.	
FCS_CKM_EXT.4	None.	
FCS_COP.1(1)	None.	
FCS_COP.1(2)	None.	
FCS_COP.1(3)	None.	
FCS_COP.1(4)	None.	
FCS_HTTPS_EXT.1	Failure to establish an HTTPS session. Establishment/Termination of an HTTPS session.	Reason for failure
	Establishment/Termination of an HTTPS session.	Non-TOE endpoint of connection (IP address) for both successes and failures.

Requirement	Auditable Events	Additional Audit Record Contents
FCS_IPSEC_EXT.1	Failure to establish an IPsec SA.	Reason for failure.
	Establishment/Termination of an IPsec SA.	Non-TOE endpoint of connection (IP address) for both successes and failures.
	Session Establishment with peer	Source and destination addresses Source and destination ports TOE Interface
FCS_RBG_EXT.1	None.	
FCS_TLS_EXT.1	Failure to establish a TLS session. Establishment/Termination of a TLS session.	Reason for failure
	Establishment/Termination of a TLS session.	Non-TOE endpoint of connection (IP address) for both successes and failures.
FDP_RIP.2	None.	
FIA_PMG_EXT.1	None.	
FIA_UAU_EXT.2	All use of the authentication mechanism.	Origin of the attempt (e.g., IP address).
FIA_UIA_EXT.1	All use of the authentication and authentication mechanism.	Provided user identity, origin of the attempt (e.g., IP address).
FIA_UAU.7	None.	
FIA_X509_EXT.1	Establishing session with CA	Source and destination addresses Source and destination ports TOE Interface
FFW_RUL_EXT.1	Application of rules configured with the ‘log’ operation	Source and destination addresses Source and destination ports Transport Layer Protocol TOE Interface
	Indication of packets dropped due to too much network traffic	TOE interface that is unable to process packets
FMT_MTD.1	None.	
FMT_SMF.1	None.	
FMT_SMR.2	None.	
FPF_RUL_EXT.1	Application of rules configured with the ‘log’ operation	Source and destination addresses Source and destination ports Transport Layer Protocol TOE Interface
	Indication of packets dropped due to too much network traffic	TOE interface that is unable to process packets

Requirement	Auditable Events	Additional Audit Record Contents
FPT_APW_EXT.1	None.	
FPT_SKP_EXT.1	None.	
FPT_STM.1	Changes to the time.	The old and new values for the time. Origin of the attempt (e.g., IP address).
FPT_TUD_EXT.1	Initiation of update.	No additional information.
FPT_TST_EXT.1	None.	
FTA_SSL_EXT.1	Any attempts at unlocking of an interactive session.	No additional information.
FTA_SSL.3	The termination of a remote session by the session locking mechanism.	No additional information.
FTA_SSL.4	The termination of an interactive session.	No additional information.
FTA_TAB.1	None.	
FTP_ITC.1	Initiation of the trusted channel. Termination of the trusted channel. Failure of the trusted channel functions.	Identification of the initiator and target of failed trusted channels establishment attempt.
FTP_TRP.1	Initiation of the trusted channel. Termination of the trusted channel. Failures of the trusted path functions.	Identification of the claimed user identity.

Table 2 Auditable Events

FAU_GEN.2 – User identity association

FAU_GEN.2.1 For audit events resulting from actions of identified users, the TSF shall be able to associate each auditable event with the identity of the user that caused the event.

FAU_STG_EXT.1 – External audit trail storage

FAU_STG_EXT.1.1 The TSF shall be able to [***transmit the generated audit data to an external IT entity***] using a trusted channel implementing the [***IPsec, TLS***] protocol.

5.2.2 Cryptographic Support (FCS)

FCS_CKM.1(1) – Cryptographic key generation (for asymmetric keys)

FCS_CKM.1.1(1) Refinement: The TSF shall generate asymmetric cryptographic keys used for key establishment in accordance with

- NIST Special Publication 800-56A, "Recommendation for Pair-Wise Key Establishment Schemes Using Discrete Logarithm Cryptography" for elliptic curve-based key establishment schemes and implementing "NIST curves" P-256, P-384 and [***no other curves***] (as defined in FIPS PUB 186-3, "Digital Signature Standard"
- NIST Special Publication 800-56A, "Recommendation for Pair-Wise Key Establishment Schemes Using Discrete Logarithm Cryptography" for finite field-based key establishment schemes;
- [***NIST Special Publication 800-56B, "Recommendation for Pair-Wise Key Establishment Schemes Using Integer Factorization Cryptography" for RSA-based key establishment schemes***]

and specified cryptographic key sizes equivalent to, or greater than, a symmetric key strength of 112 bits.

FCS_CKM.1(2) – Cryptographic key generation (for asymmetric keys)

FCS_CKM.1.1(2) Refinement: The TSF shall generate asymmetric cryptographic keys used for IKE peer authentication in accordance with a: [

- ***FIPS PUB 186-3, "Digital Signature Standard (DSS)", Appendix B.3 for RSA schemes;***
- ***FIPS PUB 186-3, "Digital Signature Standard (DSS)", Appendix B.4 for ECDSA schemes and implementing "NIST curves" P-256, P-384 and*** [***no other curves***];

]

and specified cryptographic key sizes equivalent to, or greater than, a symmetric key strength of 112 bits.

FCS_CKM_EXT.4 – Cryptographic key zeroization

FCS_CKM_EXT.4.1 The TSF shall zeroize all plaintext secret and private cryptographic keys and CSPs when no longer required.

FCS_COP.1(1) – Cryptographic operation (for data encryption/decryption)

FCS_COP.1(1).1 Refinement: The TSF shall perform encryption and decryption in accordance with a specified cryptographic algorithm AES operating in CBC, GCM, [**no other modes**] and cryptographic key sizes 128-bits and 256-bits that meet the following:

- FIPS PUB 197, "Advanced Encryption Standard (AES)"
- NIST SP 800-38A, NIST SP 800-38D, [***no other standards***].

FCS_COP.1(2) – Cryptographic operation (for cryptographic signature)

FCS_COP.1(2).1 Refinement: The TSF shall perform cryptographic signature services in accordance with a:[

(1) RSA Digital Signature Algorithm (RSA) with a key size (modulus) of 2048 bits or greater that meets FIPS PUB 186-2 or FIPS PUB 186-3, "Digital Signature Standard",

(2) Elliptic Curve Digital Signature Algorithm (ECDSA) with a key size of 256 bits or greater] that meets FIPS PUB 186-3, "Digital Signature Standard" with "NIST curves" P-256, P-384 and [no other curves] (as defined in FIPS PUB 186-3, "Digital Signature Standard")].

FCS_COP.1(3) – Cryptographic operation (for cryptographic hashing)

FCS_COP.1(3).1 Refinement: The TSF shall perform cryptographic hashing services in accordance with a specified cryptographic algorithm [***SHA-1, SHA-224, SHA-256, SHA-384, SHA-512***] and message digest sizes [***160, 224, 256, 384, 512***] bits that meet the following: FIPS Pub 180-3, 'Secure Hash Standard.'

FCS_COP.1(4) – Cryptographic operation (for keyed-hash message authentication)

FCS_COP.1(4).1 Refinement: The TSF shall perform keyed-hash message authentication in accordance with a specified cryptographic algorithm HMAC-[***SHA-1, SHA-256, SHA-384, SHA-512***], key size [**160, 256, 384, 512 bits**], and message digest sizes [***160, 256, 384, 512***] bits that meet the following: FIPS Pub 198-1, 'The Keyed-Hash Message Authentication Code', and FIPS Pub 180-3, 'Secure Hash Standard.'

FCS_IPSEC_EXT.1 – Explicit: IPsec

FCS_IPSEC_EXT.1.1 The TSF shall implement the IPsec architecture as specified in RFC 4301.

FCS_IPSEC_EXT.1.2 The TSF shall implement [***tunnel mode***].

FCS_IPSEC_EXT.1.3 The TSF shall have a nominal, final entry in the SPD that matches anything that is otherwise unmatched, and discards it.

FCS_IPSEC_EXT.1.4 The TSF shall implement the IPsec protocol ESP as defined by RFC 4303 using the cryptographic algorithms AES-GCM-128, AES-GCM-256 as specified in RFC 4106 [***AES-CBC-128, AES-CBC-256 (both specified by RFC 3602), together with a Secure Hash Algorithm (SHA)-based HMAC, no other algorithm***].

FCS_IPSEC_EXT.1.5 The TSF shall implement the protocol: [***IKEv1as defined in RFCs 2407, 2408, 2409, RFC 4109,*** [***RFC 4304 for extended sequence numbers***] and [***no other RFCs for hash functions***]; ***IKEv2 as defined in RFCs 5996 (with mandatory support for NAT traversal as specified in section 2.23)*** and [RFC ***4868 for hash functions***]].

FCS_IPSEC_EXT.1.6 The TSF shall ensure the encrypted payload in the [***IKEv1, IKEv2***] protocol uses the cryptographic algorithms AES-CBC-128, AES-CBC-256 as specified in RFC 6379 and [***AES-GCM-128, AES-GCM-256 as specified in RFC 5282***].

FCS_IPSEC_EXT.1.7 The TSF shall ensure that IKEv1 Phase 1 exchanges use only main mode.

FCS_IPSEC_EXT.1.8 The TSF shall ensure that **[*IKEv2 SA lifetimes can be configured by an administrator based on number of packets or length of time, where the time values can be limited to: 24 hours for Phase 1 SAs and 8 hours for Phase 2 SAs*]; *IKEv1 SA lifetimes can be configured by an administrator based on number of packets* or *length of time, where the time values can be limited to: 24 hours for Phase 1 SAs and 8 hours for Phase 2 SAs*]]**.

FCS_IPSEC_EXT.1.9 The TSF shall generate the secret value x used in the IKE Diffie-Hellman key exchange ("x" in g^x mod p) using the random bit generator specified in FCS_RBG_EXT.1, and having a length of at least [**224 (for DH Group 14), 256 (for DH Group 19, 384 (for DH Group 20)**] bits.

FCS_IPSEC_EXT.1.10 The TSF shall generate nonces used in IKE exchanges in a manner such that the probability that a specific nonce value will be repeated during the life a specific IPsec SA is less than 1 in 2^[**112 (for DH Group 14), 2^128 (for DH Group 19), and 2^192 (for DH Group 20)**].

FCS_IPSEC_EXT.1.11 The TSF shall ensure that all IKE protocols implement DH Groups 14 (2048-bit MODP), 19 (256-bit Random ECP), and [***20 (384-bit Random ECP)***].

FCS_IPSEC_EXT.1.12 The TSF shall ensure that all IKE protocols perform peer authentication using a [***RSA, ECDSA***] that use X.509v3 certificates that conform to RFC 4945 and [***no other method***].

FCS_IPSEC_EXT.1.13 The TSF shall be able to ensure by default that the strength of the symmetric algorithm (in terms of the number of bits in the key) negotiated to protect the [***IKEv1 Phase 1, IKEv2 IKE_SA***] connection is greater than or equal to the strength of the symmetric algorithm (in terms of the number of bits in the key) negotiated to protect the [***IKEv1 Phase 2, IKEv2 CHILD_SA***] connection.

FCS_RBG_EXT.1 – Extended: Cryptographic operation (random bit generation)

FCS_RBG_EXT.1.1 The TSF shall perform all random bit generation (RBG) services in accordance with [***NIST Special Publication 800-90 using*** [***CTR_DRBG (AES)***]] seeded by an entropy source that accumulates entropy from a TSF-hardware based noise source, and [***a software-based noise source***].

FCS_RBG_EXT.1.2 The deterministic RBG shall be seeded with a minimum of [***256 bits***] of entropy at least equal to the greatest security strength of the keys and hashes that it will generate.

FCS_HTTPS_EXT.1 – Extended: HTTP Security (HTTPS)

FCS_HTTPS_EXT.1.1 The TSF shall implement the HTTPS protocol that complies with RFC 2818.

FCS_HTTPS_EXT.1.2 The TSF shall implement HTTPS using TLS as specified in FCS_TLS_EXT.1.

FCS_TLS_EXT.1 – Explicit: TLS

FCS_TLS_EXT.1.1 The TSF shall implement one or more of the following protocols [***TLS 1.0 (RFC 2246), TLS 1.1 (RFC 4346), TLS 1.2 (RFC 5246)***] supporting the following ciphersuites:

Mandatory Ciphersuites:
TLS_RSA_WITH_AES_128_CBC_SHA

Optional Ciphersuites:
[
TLS_RSA_WITH_AES_256_CBC_SHA
TLS_DHE_RSA_WITH_AES_128_CBC_SHA
TLS_DHE_RSA_WITH_AES_256_CBC_SHA
TLS_RSA_WITH_AES_128_CBC_SHA256
TLS_RSA_WITH_AES_256_CBC_ SHA256
TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256
TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384
].

5.2.3 User Data Protection (FDP)

FDP_RIP.2 – Full residual information protection

FDP_RIP.2.1 The TSF shall ensure that any previous information content of a resource is made unavailable upon the [***allocation of the resource to***] all objects.

5.2.4 Identification and Authentication (FIA)

FIA_AFL.1 – Authentication failure handling

FIA_AFL.1.1 Refinement: The TSF shall detect when an Administrator configurable positive integer of successive unsuccessful authentication attempts occur related to administrators attempting to authenticate remotely.

FIA_AFL.1.2 When the defined number of unsuccessful authentication attempts has been **met**, the TSF shall [prevent ***the offending remote administrator from successfully authenticating until [an Administrator defined time period has elapsed or until an administrator re-enables the locked account]*** is taken by a local Administrator].

FIA_PMG_EXT.1 – Password management

FIA_PMG_EXT.1.1 The TSF shall provide the following password management capabilities for administrative passwords:

1. Passwords shall be able to be composed of any combination of upper and lower case letters, numbers, and the following special characters: [***“!”, “@”, “#”, “$”, “%”, “^”, “&”, “*”, “(”, “)”, [“'”, “+”, “,”, “-”, “.”, “/”, “:”, “;”, “<”, “=”, “>”, “[”, “\”, “]”, “_”, “`”, “{”, “}”, and “~”]***];
2. Minimum password length shall settable by the Security Administrator, and support passwords of 15 characters or greater;

FIA_UAU.7 – Protected authentication feedback

FIA_UAU.7.1 The TSF shall provide only obscured feedback to the administrative user while the authentication is in progress at the local console.

FIA_UAU_EXT.2 – Extended: Password-based authentication mechanism

FIA_UAU_EXT.2.1 The TSF shall provide a local password-based authentication mechanism, [***X509 certificates***] to perform administrative user authentication.

FIA_UIA_EXT.1 – User identification and authentication

FIA_UIA_EXT.1.1 The TSF shall allow the following actions prior to requiring the non-TOE entity to initiate the identification and authentication process:

- Display the warning banner in accordance with FTA_TAB.1;
- [***no other actions***].

FIA_UIA_EXT.1.2 The TSF shall require each administrative user to be successfully identified and authenticated before allowing any other TSF-mediated actions on behalf of that administrative user.

FIA_X509_EXT.1 – Extended: X.509 certificates[1]

FIA_X509_EXT.1.1 The TSF shall use X.509v3 certificates as defined by RFC 5280 to support authentication for IPsec and [***TLS***] connections.

FIA_X509_EXT.1.2 The TSF shall store and protect certificate(s) from unauthorized deletion and modification.

FIA_X509_EXT.1.3 The TSF shall provide the capability for authenticated Administrators to load X.509v3 certificates into the TOE for use by the security functions specified in this PP.

FIA_X509_EXT.1.4 The TSF shall generate a Certificate Request Message as specified in RFC 2986 and be able to provide the following information in the request: public key, Common Name, Organization, Organizational Unit, and Country.

FIA_X509_EXT.1.5 The TSF shall validate the certificate using [***the Online Certificate Status Protocol (OCSP) as specified in RFC 2560, a Certificate Revocation List (CRL) as specified in RFC 5759***].

FIA_X509_EXT.1.6 The TSF shall validate a certificate path by ensuring the presence of the basicConstraints extension is present and the cA flag is set to TRUE for all CA certificates.

FIA_X509_EXT.1.7 The TSF shall not treat a certificate as a CA certificate if the basicConstraints extension is not present or the cA flag is not set to TRUE.

FIA_X509_EXT.1.8 The TSF shall not establish an SA if a certificate or certificate path is deemed invalid.

FIA_X509_EXT.1.9 The TSF shall support peer identifiers of the following types: [***IP address, Fully Qualified Domain Name (FQDN), user FQDN, Distinguished Name (DN)***] and [***no other reference identifier type***].

FIA_X509_EXT.1.10 The TSF shall not establish an SA if the presented identifier does not match the configured reference identifier of the peer.

FIA_X509_EXT.1.11 When the TSF cannot establish a connection to determine the validity of a certificate, the TSF shall [***allow the administrator to choose whether to accept the certificate in these cases***].

5.2.5 Stateful Traffic Filtering (FFW)

FFW_RUL_EXT.1 – Stateful traffic filtering

FFW_RUL_EXT.1.1 The TSF shall perform Stateful Traffic Filtering on network packets processed by the TOE.

FFW_RUL_EXT.1.2 The TSF shall process the following network traffic protocols:

- Internet Control Message Protocol version 4 (ICMPv4)
- Internet Control Message Protocol version 6 (ICMPv6)
- Internet Protocol (IPv4)
- Internet Protocol version 6 (IPv6)
- Transmission Control Protocol (TCP)
- User Datagram Protocol (UDP)

[1] FIA_X509_EXT.1 has been modified to comply with TD 0037. Please see Section 7 **Table 6** for more details.

and be capable of inspecting network packet header fields defined by the following RFCs to the extent mandated in the other elements of this SFR

- RFC 792 (ICMPv4)
- RFC 4443 (ICMPv6)
- RFC 791 (IPv4)
- RFC 2460 (IPv6)
- RFC 793 (TCP)
- RFC 768 (UDP).

FFW_RUL_EXT.1.3 The TSF shall allow the definition of Stateful Traffic Filtering rules using the following network protocol fields:

- ICMPv4
  - Type
  - Code
- ICMPv6
  - Type
  - Code
- IPv4
  - Source address
  - Destination Address
  - Transport Layer Protocol
- IPv6
  - Source address
  - Destination Address
  - Transport Layer Protocol
- TCP
  - Source Port
  - Destination Port
- UDP
  - Source Port
  - Destination Port.

and distinct interface.

FFW_RUL_EXT.1.4 The TSF shall allow the following operations to be associated with Stateful Traffic Filtering rules: permit, deny, and log.

FFW_RUL_EXT.1.5 The TSF shall allow the Stateful Traffic Filtering rules to be assigned to each distinct network interface.

FFW_RUL_EXT.1.6 The TSF shall:

a) accept a network packet without further processing of Stateful Traffic Filtering rules if it matches an allowed established session for the following protocols: TCP, UDP, [***ICMP***] based on the following network packet attributes:
   1. TCP: source and destination addresses, source and destination ports, sequence number, Flags;
   2. UDP: source and destination addresses, source and destination ports;
   3. [***ICMP: source and destination addresses, [type, code]***].

b) Remove existing traffic flows from the set of established traffic flows based on the following: [s***ession inactivity timeout, completion of the expected information flow***].

FFW_RUL_EXT.1.7 The TSF shall be able to process the following network protocols:

1. FTP,
2. [***no other protocols***],

to dynamically define rules or establish sessions allowing network traffic of the following types:

- FTP: TCP data sessions in accordance with the FTP protocol as specified in RFC 959,
- [***none***].

FFW_RUL_EXT.1.8 The TSF shall enforce the following default Stateful Traffic Filtering rules on all network traffic:

1. The TSF shall reject and be capable of logging packets which are invalid fragments;
2. The TSF shall reject and be capable of logging fragmented IP packets which cannot be re-assembled completely;
3. The TSF shall reject and be capable of logging network packets where the source address of the network packet is equal to the address of the network interface where the network packet was received;
4. The TSF shall reject and be capable of logging network packets where the source address of the network packet does not belong to the networks associated with the network interface where the network packet was received;
5. The TSF shall reject and be capable of logging network packets where the source address of the network packet is defined as being on a broadcast network;
6. The TSF shall reject and be capable of logging network packets where the source address of the network packet is defined as being on a multicast network;
7. The TSF shall reject and be capable of logging network packets where the source address of the network packet is defined as being a loopback address;
8. The TSF shall reject and be capable of logging network packets where the source address of the network packet is a multicast;
9. The TSF shall reject and be capable of logging network packets where the source or destination address of the network packet is a link-local address;
10. The TSF shall reject and be capable of logging network packets where the source or destination address of the network packet is defined as being an address “reserved for future use” as specified in RFC 5735 for IPv4;
11. The TSF shall reject and be capable of logging network packets where the source or destination address of the network packet is defined as an “unspecified address” or an address “reserved for future definition and use” as specified in RFC 3513 for IPv6;
12. The TSF shall reject and be capable of logging network packets with the IP options: Loose Source Routing, Strict Source Routing, or Record Route specified; and
13. [***no other rules***].

FFW_RUL_EXT.1.9 When FFW_RUL_EXT.1.6 or FFW_RUL_EXT.1.7 do not apply, the TSF shall process the applicable Stateful Traffic Filtering rules (as determined in accordance with FFW_RUL_EXT.1.5) in the following order: administrator-defined.

FFW_RUL_EXT.1.10 When FFW_RUL_EXT.1.6 or FFW_RUL_EXT.1.7 do not apply, the TSF shall deny packet flow if a matching rule is not identified.

5.2.6 Security Management (FMT)

FMT_MOF.1 – Management of security functions behavior

FMT_MOF.1.1 Refinement: The TSF shall restrict the ability to enable, disable, determine and modify the behavior of all of the security functions of the TOE identified in this VPNGW EP to an authenticated Administrator.

FMT_MTD.1 – Management of TSF data (for general TSF data)

FMT_MTD.1.1 The TSF shall restrict the ability to manage the TSF data to the Security Administrators.

FMT_SMF.1 – Specification of management functions

FMT_SMF.1.1 The TSF shall be capable of performing the following management functions:

- *Ability to administer the TOE locally and remotely;*
- *Ability to update the TOE, and to verify the updates using [**digital signature**, **published hash**] capability prior to installing those updates;*

- [***Ability to configure the list of TOE-provided services available before an entity is identified and authenticated, as specified in FIA_UIA_EXT.1***]
- Ability to configure the cryptographic functionality,
- Ability to configure the IPsec functionality,
- Ability to enable, disable, determine and modify the behavior of all the security functions of the TOE identified in this VPNGW EP to the Administrator,
- Ability to configure all security management functions identified in other sections of this VPNGW EP.
- Configure the reference identifier for the peer
- Configure Firewall rules.

FMT_SMR.2 – Restrictions on security roles

FMT_SMR.2.1 The TSF shall maintain the roles:

- Authorized Administrator.

FMT_SMR.2.2 The TSF shall be able to associate users with roles.

FMT_SMR.2.3 The TSF shall ensure that the conditions

- Authorized Administrator role shall be able to administer the TOE locally;
- Authorized Administrator role shall be able to administer the TOE remotely;

are satisfied.

5.2.7 Packet Filtering (FPF)

FPF_RUL_EXT.1 – Packet filtering

FPF_RUL_EXT.1.1 The TSF shall perform Packet Filtering on network packets processed by the TOE.

FPF_RUL_EXT.1.2 The TSF shall process the following network traffic protocols:

- Internet Protocol (IPv4)
- Internet Protocol version 6 (IPv6)
- Transmission Control Protocol (TCP)
- User Datagram Protocol (UDP)

and be capable of inspecting network packet header fields defined by the following RFCs to the extent mandated in the other elements of this SFR

- RFC 791 (IPv4)
- RFC 2460 (IPv6)
- RFC 793 (TCP)
- RFC 768 (UDP).

FPF_RUL_EXT.1.3 The TSF shall allow the definition of Packet Filtering rules using the following network protocol fields:

- IPv4
  - Source address
  - Destination Address
  - Protocol
- IPv6
  - Source address
  - Destination Address
  - Next Header (Protocol)
- TCP
  - Source Port
  - Destination Port
- UDP
  - Source Port
  - Destination Port

and distinct interface.

FPF_RUL_EXT.1.4 The TSF shall allow the following operations to be associated with Packet Traffic Filtering rules: permit, deny, and log.

FPF_RUL_EXT.1.5 The TSF shall allow the Packet Traffic Filtering rules to be assigned to each distinct network interface.

FPF_RUL_EXT.1.6 The TSF shall process the applicable Packet Filtering rules (as determined in accordance with FPF_RUL_EXT.1.5) in the following order: Administrator-defined.

FPF_RUL_EXT.1.7 The TSF shall deny packet flow if a matching rule is not identified.

5.2.8 Protection of the TSF (FPT)

FPT_FLS.1 – Fail secure

FPT_FLS.1.1 Refinement: The TSF shall shutdown when the following types of failures occur: failure of the power-on self-tests, failure of integrity check of the TSF executable image, failure of noise source health tests.

FPT_APW_EXT.1 – Extended: Protection of administrator passwords

FPT_APW_EXT.1.1 The TSF shall store passwords in non-plaintext form.

FPT_APW_EXT.1.2 The TSF shall prevent the reading of plaintext passwords.

FPT_SKP_EXT.1 – Extended: Protection of TSF data (for reading of all symmetric keys)

FPT_SKP_EXT.1.1 The TSF shall prevent reading of all pre-shared keys, symmetric key, and private keys.

FPT_STM.1 – Reliable time stamps

FPT_STM.1.1 The TSF shall be able to provide reliable time stamps for its own use.

FPT_TST_EXT.1 – TSF testing

FPT_TST_EXT.1.1 The TSF shall run a suite of self tests during initial start-up (on power on) to demonstrate the correct operation of the TSF.

FPT_TST_EXT.1.2 The TSF shall provide the capability to verify the integrity of stored TSF executable code when it is loaded for execution through the use of the TSF-provided cryptographic service specified in FCS_COP.1(2).

FPT_TUD_EXT.1 – Extended: Trusted update

FPT_TUD_EXT.1.1 The TSF shall provide security administrators the ability to query the current version of the TOE firmware/software.

FPT_TUD_EXT.1.2 The TSF shall provide security administrators the ability to initiate updates to TOE firmware/software.

FPT_TUD_EXT.1.3 The TSF shall provide a means to verify firmware/software updates to the TOE using a digital signature mechanism and [***published hash***] prior to installing those updates.

5.2.9 TOE Access (FTA)

FTA_SSL.3 – TSF-initiated termination

FTA_SSL.3.1 Refinement: The TSF shall terminate a remote interactive session after a Security Administrator-configurable time interval of session inactivity.

FTA_SSL.4 – User-initiated termination

FTA_SSL.4.1 The TSF shall allow Administrator-initiated termination of the Administrator's own interactive session.

FTA_SSL_EXT.1 – TSF-initiated session locking

FTA_SSL_EXT.1.1 The TSF shall, for local interactive sessions, [***terminate the session***] after a Security Administrator-specified time period of inactivity.

FTA_TAB.1 – Default TOE access banners

FTA_TAB.1.1 Refinement: Before establishing an administrative user session the TSF shall display a Security Administrator-specified advisory notice and consent warning message regarding use of the TOE.

5.2.10 Trusted Path/Channels (FTP)

FTP_ITC.1 – Trusted channel

FTP_ITC.1.1 Refinement: The TSF shall use [***IPsec, TLS***] to provide a trusted communication channel between itself and authorized IT entities supporting the following capabilities: audit server, [***[update server, connections with UIA, VPN Gateway/peer connections]***] that is logically distinct from other communication channels and provides assured identification of its end points and protection of the channel data from disclosure and detection of modification of the channel data.

FTP_ITC.1.2 The TSF shall permit the TSF, or the authorized IT entities to initiate communication via the trusted channel.

FTP_ITC.1.3 The TSF shall initiate communication via the trusted channel for [

- **Connecting with remote VPN gateways/peers using IPsec,**
- **transmitting audit records to an audit server using IPsec or TLS,**
- **to retrieve the IP address mapping information with UIA using TLS,**
- **receiving TOE updates, App-ID and threat prevention signatures from the update server using TLS**].

FTP_TRP.1 – Trusted path

FTP_TRP.1.1 Refinement: The TSF shall use [***IPsec, TLS/HTTPS***] **to** provide a trusted communication path between itself and remote administrators that is logically distinct from other communication paths and provides assured identification of its end points and protection of the communicated data from disclosure and detection of modification of the communicated data.

FTP_TRP.1.2 Refinement: The TSF shall permit remote administrators to initiate communication via the trusted path.

FTP_TRP.1.3 The TSF shall require the use of the trusted path for initial administrator authentication and all remote administrative actions.

5.3 TOE Security Assurance Requirements

The security assurance requirements for the TOE are included by reference to the NDPP, STFF, and VPNGW.

Requirement Class	Requirement Component
ADV: Development	ADV_FSP.1 Basic functional specification
AGD: Guidance documents	AGD_OPE.1: Operational user guidance
	AGD_PRE.1: Preparative procedures
ALC: Life-cycle support	ALC_CMC.1 Labelling of the TOE
	ALC_CMS.1 TOE CM coverage
ATE: Tests	ATE_IND.1 Independent testing - conformance
AVA: Vulnerability assessment	AVA_VAN.1 Vulnerability survey

Table 3 Assurance Components

Consequently, the assurance activities specified in NDPP, STFF, and VPNGW apply to the TOE evaluation.

6. TOE Summary Specification

This chapter describes the security functions:

- Security audit
- Cryptographic support
- User data protection
- Identification and authentication
- Security management
- Protection of the TSF
- TOE access
- Trusted path/channels
- Packet Filtering
- Stateful Traffic Filtering

6.1 Security Audit

The TOE is designed to be able to generate log records for a wide range of security relevant and other events as they occur. The events that can cause an audit record to be logged include starting and stopping the audit function, any use of an administrator command via the Web Interface, as well as all of the events identified in Table 2 (which corresponds to the audit events specified in the NDPP and the STFF and VPNGW Extended Packages). Note that the only protocol (i.e., HTTPS, TLS) failures auditable by the TOE are authentication failures for user-level connections.

The logged audit records identify the date and time, the nature or type of the triggering event, an indication of whether the event succeeded or failed, and the identity of the user responsible for the event. The logged audit records also include event-specific content that includes at least all of the content required in Table 2 .

The audit trail generated by the TOE comprises several logs, which are locally stored in the PAN-OS file system on the hard disk:

- Configuration logs—include events such as when an administrator configures the security policies, and when an administrator configures which events gets audited
- System logs—record user login and logout
- Traffic logs—record the traffic flow events
- Threat logs—record the detection and blocking of threats

The size of each log file is administrator configurable from the Web Interface by specifying the percentage of space allocated to each log type on the hard disk. If the log size is reduced, the firewall removes the oldest logs when the changes are committed. When a log reaches the maximum size, the firewall starts overwriting the oldest log entries with the new log entries. Maximum disk space is platform dependent and it depends on the hard disk drive installed on the system. For example, for a 120GB drive approximately 83GB is allocated for logging. Platform capabilities range from a limit of 3-4GB for the PA-200 which has a 16GB flash drive and up for the larger platforms.

The TOE stores the audit records locally and protects them from unauthorized deletion by allowing only users in the pre-defined Audit Administrator role to access the audit trail with delete privileges. The pre-defined Audit Administrator role is part of the Security Administrator role as defined by the NDPP. The TOE does not provide an interface where a user can modify the audit records, thus it prevents modification to the audit records.

The TOE can be configured to send generated audit records to an external Syslog server using TLS. When configured to send audit records to a syslog server, audit records are also written to the external syslog as they are written locally to the internal logs.

The Security Audit security function is designed to satisfy the following security functional requirements:

- FAU_GEN.1—the TOE can generate audit records for events include starting and stopping the audit function, administrator commands, and all other events identified in **Table 2**. Furthermore, each audit record identifies the date/time, event type, outcome of the event, responsible subject/user, as well as the additional event-specific content indicated in **Table 2**.

- FAU_GEN.2—the TOE identifies the responsible user for each event based on the specific administrator or network entity (identified by IP address) that caused the event.
- FAU_STG_EXT.1—the TOE can be configured to export audit records to an external Syslog server and can be configured to use TLS for communication with the Syslog server.

6.2 Cryptographic Support

The TOE includes NIST-validated cryptographic algorithms providing supporting cryptographic functions. The following functions have been certified in accordance with the identified standards.

Functions	**Standards**	**Certificates**
Asymmetric key generation		
FFC key pair generation (key size 2048 bits)	NIST Special Publication 800-56A	**Appliances:** Component #564, Component #849 **VMs:** Component #568, Component #844
ECC key pair generation (NIST curves P-256, P-384)	NIST Special Publication 800-56A	**Appliances:** Component #564, #567, Component #849, #874 **VMs:** Component #568, #569, Component #844, #845
RSA key generation (key size 2048 bits), with reference to 'FIPS 186-4'	NIST Special Publication 800-56B	**Appliances:** RSA #1782, #2064 **VMs:** RSA #1797, #2062
Encryption/Decryption		
AES CBC, GCM (128, 256 bits)	FIPS PUB 197 NIST SP 800-38A NIST SP 800-38D	**Appliances:** AES #3475, #4020 **VMs:** AES #3501, #4019
Cryptographic signature services		
RSA Digital Signature Algorithm (rDSA) (modulus 2048)	FIPS PUB 186-4	**Appliances:** RSA #1782, #2064 **VMs:** RSA #1797, #2062

Functions	Standards	Certificates
ECDSA (NIST curves P-256 and P-384)	FIPS PUB 186-4	**Appliances:** ECDSA #713, #896 Component #566, #873 **VMs:** ECDSA #714, #895 Component #571, #846
Cryptographic hashing		
SHA-1, SHA-224, SHA-256, SHA-384 and SHA-512 (digest sizes 160, 224, 256, 384 and 512 bits)	FIPS Pub 180-4	**Appliances:** SHS #2870, #3316 **VMs:** SHS #2888, #3315
Keyed-hash message authentication		
• HMAC-SHA-1 (block size 512 bits, key size 160 bits and digest size 160 bits) • HMAC-SHA-256 (block size 512 bits, key Size 256 bits and digest size 256 bits) • HMAC-SHA-384 (block size 1024 bits, key Size 384 bits and digest size 384 bits) • HMAC-SHA-512 (block size 1024 bits, key Size 512 bits and digest size 512 bits)	FIPS Pub 198-1 FIPS Pub 180-4	**Appliances:** HMAC #2220, #2622 **VMs:** HMAC #2235, #2621
Random bit generation		
CTR_DRBG (AES) from a hardware based noise source with one independent software-based noise source of 256 bits of non-determinism	NIST Special Publication 800-90	**Appliances:** DRBG #870, #1198 **VMs:** DRBG #871, #1197

Table 4 Cryptographic Functions

The TOE implements the NIST SP 800-90 Deterministic Random Bit Generator (DRBG) based on the AES 256 block cipher in counter mode (CTR_DRBG(AES)). The TOE instantiates the DRBG with maximum security strength, obtaining the 256 bit seed from the underlying Linux kernel pseudo-random number generator (PRNG). Entropy inputs are injected into the PRNG for initialization and through an updating mechanism. Entropy inputs are derived from the timing of IRQ event-driven interrupts (e.g., disk I/O completion events) and from a hardware-based noise source. On Palo Alto network devices, the noise source is a Cavium Octeon CPU, which is assumed to provide a full 256 bits of entropy per 256 random bits. On VM appliances, the noise source is the RDRAND instruction available on Intel Ivy Bridge architecture CPUs, which is assumed to provide 128 bits of entropy per 256 bits.

The TOE generates asymmetric cryptographic keys for elliptic curve-based key establishment schemes in accordance with Sections 5 and 6 of SP 800-56A and for RSA-based key establishment schemes in accordance with Sections 5 through 8 of SP 800-56B.

CSP#	Key Name	Type	Description
1	Web interface private keys	RSA	Decrypts TLS session key and provides authentication services (admin web interface, captive portal, SSL VPN, packet inspection)
2	TLS PreMaster Secret	TLS PreMaster Secret TLS	Secret value used to derive the TLS session keys
3	TLS DH Private Components	DH	Diffie Hellman (Group 14) 2048 bit private component used in key establishment
4	TLS-HMAC	HMAC-SHA-1	Authentication keys used in all https connections to the security module's web interface.
5	TLS session keys	AES	Used in all https connections to the security module's web interface.
6	SSH-Firewall private key	RSA	Used to identify the security appliance in SSH. The security modules support 512, 1024, and 2048 bit keys and only 2048 bit keys are supported in CC (FIPS) mode.
7	SSH-HMAC	HMAC-SHA-1	Authentication keys used in all SSH connections to the security module's command line interface.
8	SSH session keys	AES	Used in all SSH connections to the security module's command line interface.
9	SSH DH Private Components	DH	Diffie Hellman (Group 14) 2048 bit private component used in key establishment
10	S-S VPN IPsec/IKEv1 authentication	HMACSHA-1	Used to authenticate the peer in an IKE/IPSec tunnel connection.
11	S-S VPN IPsec/IKEv1session key	AES	Used to encrypt IKE/IPSec data. These are AES (128 bit, 192 bit, 256 bit) keys.
12	S-S VPN IPsec/IKEv1 Diffie Hellman Private Components	DH	Diffie Hellman (Group 14) 2048 bit private component used in key establishment
13	S-S VPN IPSEC preshared	Part of HMAC	Used in authentication.
14	RA VPN IPsec session	AES-128	Used to encrypt remote access sessions utilizing IPSec
15	RA VPN IPsec authentication HMAC	HMAC-SHA-1	Used in authentication of remote access IPsec data.
16	Firmware code integrity check	HMAC-SHA-256	Used to check the integrity of crypto-related code.
17	Firmware Content encryption key	AES-256	AES-256 Used to decrypt firmware, software, and content
18	CO, User, RA VPN Password	Password	Entered by the Operator.

CSP#	Key Name	Type	Description
19	Master Key	AES-256	Used to encrypt crypto-related files on the firewall.
20	RNG seed key	AES	Seed key used in RNG.
21	RNG seed value	NDRNG	Seed used to initialize RNG.
22	DLP Private key	RSA	Used to encrypt DLP data. Only 2048 bit keys are supported.

Table 5 Private Keys and CSPs

The TOE performs a key error detection check on each internal, intermediate transfer of a key. The TOE stores persistent secret and private keys in encrypted form when not in use. The TOE zeroizes non-persistent cryptographic keys as soon as their associated session has terminated. In addition, the TOE recognizes when a private key expires and promptly zeroizes the key on expiration. The TOE does not permit expired private signature keys to be archived.

Private cryptographic keys, plaintext cryptographic keys, and all other critical security parameters stored in intermediate locations for the purposes of transferring the key/critical security parameters (CSPs) to another location are zeroized immediately following the transfer. Zeroization is done by overwriting the storage location with a random pattern, followed by a read-verify. Note that plaintext cryptographic keys and CSPs are only ever stored in volatile memory. For non-volatile memories other than EEPROM and Flash, the zeroization is executed by overwriting three or more times using a different alternating data pattern each time.

For volatile memory and non-volatile EEPROM and Flash memories, the zeroization is executed by a single direct overwrite consisting of a pseudo random pattern, followed by a read-verify.

The algorithms used are AES (CBC, GCM) 128, and 256 bit ciphers, in conjunction with HMAC-SHA-1, HMAC-SHA-256, HMAC-SHA-384 and HMAC-SHA-512 (see block and digest sizes in table 4), SHA-1, SHA-224, SHA-256, SHA-384 and SHA-512 (digest sizes 160, 224, 256, 384 and 512 bits) and RSA or ECDSA signature verification: see **Table 4**. The implementations are in accordance with FIPS PUB 186-3, “Digital Signature Standard”, FIPS Pub 180-3, “Secure Hash Standard”, and FIPS Pub 198-1, “The Keyed-Hash Message Authentication Code”.

The TOE’s HTTPS protocol complies with RFC 2818 and is implemented using TLS 1.0 (RFC 2246), TLS 1.1 (RFC 4346), TLS 1.2 (RFC 5246) supporting the following ciphersuites:

- TLS_RSA_WITH_AES_128_CBC_SHA
- TLS_RSA_WITH_AES_256_CBC_SHA
- TLS_DHE_RSA_WITH_AES_128_CBC_SHA
- TLS_DHE_RSA_WITH_AES_256_CBC_SHA
- TLS_RSA_WITH_AES_128_CBC_SHA256
- TLS_RSA_WITH_AES_256_CBC_ SHA256
- TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256
- TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384

The TOE includes an implementation of IPsec in accordance with RFC 4301. The primary cryptographic algorithms used by the TOE include AES-CBC-128, AES-CBC-256 (both specified by RFC 3602); and AES-GCM-128, AES-GCM-256 as specified in RFC 4106 along with IKEv1 as defined in RFCs 2407, 2408, 2409, RFC 4109; and IKEv2 as defined in RFCs 5996 (with mandatory support for NAT traversal as specified in section 2.23), and 4868 for hash functions. Note that the TOE supports both main and aggressive modes, though aggressive mode should be disabled in the evaluated configuration. The modes can be configured using the GUI to auto, main, or aggressive; the default mode is “auto”. The CC guidance document instructs the administrator to set it “main”. The TOE supports tunnel mode and uses the SHA-based HMAC algorithms as specified in FCS_COP.1(4) Cryptographic Operations (for keyed-hash message authentication).

The TOE provides mechanisms to implement an IPsec Security Policy Database (SPD) and to process packets to satisfy the behavior of DISCARD, BYPASS and PROTECT packet processing as described in RFC 4301. This is achieved through the administrator configuring appropriately specified access control lists (ACLs). The ACLs consist of policy rules and profiles. The TOE compares packets in turn against each rule in the Security ACL to determine if the packet matches the rule. Packets can be matched based on protocol (e.g., TCP, UDP), source IP address and destination IP address. The first rule that matches the traffic is applied. If a policy rule matching the traffic attributes is not found, or if it is found and it specifies a deny action, then the packet is dropped (or DISCARDed) and the session is deleted. If the application flow is allowed and no further security profiles are applied then it is forwarded (it is allowed to BYPASS the tunnel). If the application is allowed and there are additional security profiles set, it will be sent to the stream signature processor. The traffic matching the IPSec crypto Security profile would then flow through the IPSec tunnel and be classified as "PROTECTED". If there is no SA that the IPsec can use to protect this traffic to the peer, IPsec uses IKE to negotiate with the remote peer to set up the necessary IPsec SAs on behalf of the data flow. The negotiation uses information specified in the IKE Network Profiles. If the TOE receives a packet that does not match any rules in the SPD the TOE discards the packet. By default, the TOE is configured to allow all intrazone (within the zone) traffic and deny all interzone (between zones) traffic. Typically interzone traffic is considered to be trusted however, both intrazone and interzone traffic can be configured to deny all traffic if there is no rule match by clicking on the security policy and clicking on the Override button on the bottom on the **Policy > Security** screen. In the evaluated configuration, the default deny all rule for interzone traffic should not be modified.

The Palo Alto Networks firewall uses route-based VPNs where the firewall makes a routing decision based on the destination IP address. It is not necessary to define special rules or to make explicit reference to a VPN tunnel; routing and encryption decisions are determined only by the destination IP address. Packets matching the destination IP address are permitted otherwise they are denied. The TOE also supports Network Address Translation (NAT) policies where policies can be defined to specify whether source or destination IP addresses and ports are converted between public and private addresses and ports. For example, private source addresses can be translated to public addresses on traffic sent from an internal (trusted) zone to a public (untrusted) zone. NAT policy rules are based on the source and destination zones, the source and destination addresses, and the application service. The NAT policy rules are compared against the incoming traffic in sequence; the first rule that matches the incoming traffic is applied. If no rules match, then the flow is denied.

IKEv2 SA lifetime and volume limits can be configured by an authorized administrator and can be limited to 24 hours for phase 1 and 8 hours for phase 2 SAs. IKEv1 SA lifetime is configurable as well and the range of time value is same as for IKEv2. Both IKEv1 and IKEv2 SA lifetimes can be established based on number of packets or bytes.

The IKEv1 and IKEv2 protocols implemented by the TOE include DH Group 14 (2048-bit MODP), DH Groups 19 (256-bit Random ECP), and 20 (384-bit Random ECP), using RSA (aka rDSA) and ECDSA peer authentication. In the IKEv1 phase 1 and phase 2 exchanges, the TOE and peer will agree on the best DH group both can support. When the TOE initiates IKE negotiation, the DH group is sent in order according to the peer's configuration. When the TOE receives an IKE proposal, it will select the first match and the negotiation will fail if there is no match. During IKEv1 phase 1 authentication is based on a verifiable signature as described in RFC2409.

The keys are generated using the AES-CTR Deterministic Random Bit Generator (DRBG), as specified in SP 800-90, and the following corresponding key sizes (in bits) are used: 224 (for DH Group 14), 256 (for DH Group 19), 384 (for DH Group 20) bits.

The nonces used in IKE exchanges are generated such that the probability that a specific nonce value will be repeated during the life of a specific IPsec SA is less than 1 in 2^112 bits (for DH Group 14), 2^128 bits (for DH Group 19), and 2^192 bits (for DH Group 20)].

The TOE provides AES-CBC-128, AES-CBC-256, AES-GCM-128 and AES-GCM-256 for encrypting IKEv1 and IKEv2 payloads. The administrator is instructed to ensure that the size of key used for ESP must be less than or equal to the key size used to protect the IKE payload.

The Cryptographic Support security function is designed to satisfy the following security functional requirements:

- FCS_CKM.1(1), (2)—see table above.
- FCS_CKM_EXT.4—see table above.
- FCS_COP.1(1)—see table above.
- FCS_COP.1(2)—see table above.

- FCS_COP.1(3)—see table above.
- FCS_COP.1(4)—see table above.
- FCS_IPSEC_EXT.1—the TOE supports IPsec cryptographic network communication protection.
- FCS_HTTPS_EXT.1—the TOE supports HTTPS web-based secure administrator sessions.
- FCS_RBG_EXT.1—see table above.
- FCS_TLS_EXT.1—the TOE supports HTTP over TLS web-based secure administrator sessions. The TOE uses TLS for transmitting audit records to an audit server; for retrieving the IP address mapping information with UIA; and for receiving TOE updates and App-ID and threat prevention signatures from the update server.

6.3 User Data Protection

The TSF allocates and releases the memory resources used for network packet objects. Both when it receives data from the network and when it transmits data to the network, it ensures that the buffers are not padded out with previously transmitted or otherwise residual information by overwriting unused parts of the buffer with 0s.

The User Data Protection security function is designed to satisfy the following security functional requirements:

- FDP_RIP.2—the TOE always overwrites resources when allocated for use in objects.

6.4 Identification and Authentication

The TOE is designed to require users to be identified and authenticated before they can access any of the TOE functions. The only capabilities allowed prior to users authenticating are the display of the warning banner before authentication.

The TOE maintains user accounts which it uses to control access to the firewall. When creating a new user account, the administrator specifies a user name (i.e., user identity), a password or X509 certificate/common access card, and a role. To enable certificate-based authentication, the TOE must be configured to use a client certificate profile using the Device > Certificate Management > Certificate Profile tab. When a client certificate profile is enabled, each administrator must use a client certificate for access to the TOE via IPSec and TLS. Only one role is specified in the user account per user. The TOE uses the user name and password attributes to identify and authenticate the user when the user logs in via the GUI. With certificate-based authentication, a digital signature is exchanged and verified, in lieu of a password. The TOE does not echo passwords as they are entered. It uses the role attribute to specify user permissions and control what the user can do with the GUI.

The administrator can logon to the GUI by using a secure connection (https) from a web browser. The administrator enters the IP address of the TOE and their username and password or alternatively the TOE may be configured to require a certificate . The credentials may be supplied by a CAC or retrieved from the client computer.

In order for an administrator to log to the GUI using IPSec, an IPSec tunnel has to be established between the client laptop/management station and the TOE. The administrator uses a third party IPSec client for setting up an IPSec tunnel to the TOE. Authentication is performed using the pre-shared keys or the certificates. The administrator runs a web browser and establishes TLS over IPSec. The authentication method for the user can be performed using a password or a certificate. If the user is using a CAC, the card must be inserted into the card reader. Regardless of whether the certificate is on a CAC or not, there is no difference in how the TOE uses the client certificate to authenticate the user; besides the use of the CAC reader and accessing the credential on the card.

Regardless of whether a user logs in using an HTTPS or IPsec connection, a logon is successful when the username and password provided by the user matches a defined account on the TOE; or when the username and digital signature on the certificate is validated by the TOE.

Passwords can be composed of upper and lower case letters, numbers and special characters. There are no restrictions on any password field character sets. The minimum password length is configurable by the administrator up to a maximum length of 31 characters.

The TOE logs all unsuccessful authentication attempts in the System Log. The device can be configured to lock a user or authorized IT entity out after a configurable number (1 – 10) of unsuccessful authentication attempts. The lock can be configured such that a Security Administrator must manually re-enable the account or it can be configured to last a specified amount of time (0 – 60 minutes). These settings can be configured for both HTTPS/TLS and IPSec remote administration connections and applies to password and certificate based authentication.

The TOE uses X.509v3 certificates as defined by RFC 5280 to support authentication for IPsec, and TLS connections. Public key infrastructure (PKI) credentials, such as Rivest, Shamir, and Adelman (RSA) keys and certificates are stored in the TOE's underlying file system on the appliance. Certificates and their associated private key are stored in a single container: the Certificate File. The PKCS#12 file consists of an Encrypted Private Key and X509 Certificate. By default all the private keys are protected since they are always stored in encrypted format using AES-256. The physical security of the appliance (A.Physical) protects the appliance and the certificates from being tampered with or deleted. In addition, the TOE identification and authentication security functions protect an unauthorized user from gaining access to the TOE.

The TOE supports Open Certificate Status Protocol (OCSP) and Certificate Revocation List (CRL) status verification for certificate profiles. If both are configured, the devices first try the OCSP method; if the OCSP server is unavailable, the devices use the CRL method.

The TOE downloads and caches OCSP status information for every CA listed in the trusted CA list of the firewall. The OCSP status is cached for the 'next update time' that is configured on the OCSP responder. The TOE uses this received value as the cache time. OCSP responders can also be configured for other external devices if someone decides to use it. The TOE uses a hard coded 1 hour as next update time (cached time) in this case. Caching only applies to validated certificates; if a firewall never validated a certificate, the firewall cache does not store the OCSP information for the issuing CA. To use Open Certificate Status Protocol (OCSP) for verifying the revocation status of certificates, you must configure the firewall to access an OCSP responder (server). The entity that manages the OCSP responder can be a third-party certificate authority (CA) or, if your enterprise has its own public key infrastructure (PKI), the firewall itself.

The TOE downloads and caches the last-issued CRL for every CA listed in the trusted CA list of the firewall. Caching only applies to validated certificates; if a firewall never validated a certificate, the firewall cache does not store the CRL for the issuing CA. Also, the cache only stores a CRL until it expires. The firewall supports CRLs only in Distinguished Encoding Rules (DER) format.

The authorized administrator may generate a self-signed root CA certificate as specified in RFC 2986 and provide the following information in the request: public key, Common Name, Organization, Organizational Unit, Country, State, Locality, Department, Email, and Host Name. The administrator may also import a certificate and private key into the firewall from an enterprise certificate authority or obtain a certificate from an external CA. The TOE provides the ability for administrators to generate a Certificate Signing Request (CSR) with a multi-level organizational unit.

The TOE validates a certificate path by ensuring the presence of the basicConstraints extension is present and the cA flag is set to TRUE for all CA certificates. The TOE forms a Certificate trust path by ensuring that the basic constraints are met, proper key usage parameters exist, the CA flag exists, performing a revocation check of each certificate in the path and performing the validity of the CA certificate. The TOE will not treat a certificate as a CA certificate if the basicConstraints extension is not present or the cA flag is not set to TRUE.

The TOE compares a peer's presented identifier to the reference identifier as follows.

- CAC (Common Access Card) or client certs for authentication of users prior to accessing systems - An x.509 certificate is provided by the user/client upon connecting to a secured resource. Using that certificate, the identity of the user is established and that information is used to determine what level of access should be allowed. If the Subject Alternate name (SAN) is present in the certificate then it is used as a username to perform verification. The TOE performs DNS lookup for usernames that are FQDNs. If the SAN is not present then we use the subject DN in the certificate as the username. This username can then be used to lookup group membership info in a directory located in TOE files. In order to validate the cert, the TOE checks whether the issuing CA is a trusted issuer by PAN-OS. If the client-certificate section is specified and use-crl and/or use-ocsp are specified, the validity of the client certificate will be verified based on the methods specified. The order is always OCSP followed by CRL if both are set. Device authentications occur as follows.

- For trusted channel connections with remote VPN gateways/peers, the TOE requires the IKE peer id to be configured for certificate authentication: if the type is DN, the TOE checks the peer id against subject DN; otherwise it is checked against the SAN field.
- Device authentication for the transmission of audit records to an audit server using IPsec or TLS occurs as follows. If the server certificate provided by the audit server has Subject Alternate Name or multiple names (SANs) then each one of those names are verified against the server name/ip configured. If the SAN or SANs is not present in the certificate then the certificate subject DN is checked for a match against the configured server.
- Connections with the UIA to retrieve the IP address mapping information use TLS 1.2 with RSA_With_AES_256_GCM_SHA384 with hardcoded/predefined, self-signed certificate. The use of pre-defined self-signed internal certs renders the certificate subject name not applicable as it would always be the same.
- For connections with the update server, if the server certificate provided by the update server has Subject Alternate Name or multiple names (SANs) then each one of those defined names are verified against the update server name/ip configured. If the SAN or SANs is not present in the certificate then the TOE compares the certificate subject DN and matches that against the configured update server.

The TOE will not establish an SA if a certificate or certificate path is deemed invalid; or if the presented identifier does not match the configured reference identifier of the peer as described above. If the TOE cannot establish a connection to determine the validity of a certificate, the administrator may establish the SA or disallow the establishment of the SA.

The Identification and Authentication security function is designed to satisfy the following security functional requirements:

- FIA_UAU_EXT.2.1—the TOE provides local password-based authentication to perform administrative user authentication.
- FIA_UAU.7—the TOE does not echo passwords as they are entered.
- FIA_AFL.1—the TOE can detect when an Administrator configurable positive integer of successive unsuccessful authentication attempts occurred and lockout the user for an administrator configurable time period.
- FIA_PMG_EXT.1—the TOE implements a set of password composition constraints as described above.
- FIA_UIA_EXT.1—the TOE displays the warning banner prior to a user being identified and authenticated.
- FIA_X509_EXT.1—the TOE protects, stores and allows authorized administrators to load X.509v3 certificates for use to support authentication.

6.5 Security Management

The TOE provides a GUI management interface to support security management of the TOE. The GUI is accessible via direct connection to the management port on the device, or remotely over HTTPS or IPsec. The management interfaces enable the authorized administrators to configure the TOE functions and to manipulate TOE data.

The TOE controls user access to commands and resources based on user role. Users are given permission to access a set of commands and resources based on their user role. By default, the TOE has the following pre-defined custom administrator roles: auditadmin, cryptoadmin, and securityadmin. These administrator roles are all considered Security Administrator as defined in the NDPP for the purposes of this ST. All roles can administer the TOE both locally and remotely.

The guidance documentation for the evaluated version of the TOE indicates the Superuser role is intended only for initial configuration, to create the administrator accounts for the Security Administrator, Audit Administrator, and Cryptographic Administrator, and that during normal operation the Superuser, Superuser (read-only), Device Administrator, Device Administrator (read-only), Virtual System Administrator, and Virtual System Administrator (read-only) admin roles are not to be assigned to administrators.

- auditadmin—the Audit Administrator is responsible for the regular review of the firewall's audit data.
- cryptoadmin—the Cryptographic Administrator is responsible for the configuration and maintenance of cryptographic elements related to the establishment of secure connections to the firewall.
- securityadmin—the Security Administrator is responsible for all other administrative tasks (e.g. creating the firewall's security policy) not addressed by the other two administrative roles.

The security management functions provided by the TOE are:

- Manage authentication failure handling
- Configure the cryptographic functionality
- Configure the IPsec functionality
- Configure the Firewall rules
- Enable, disable, determine and modify the behavior of all of the security functions of the TOE via the GUI
- Manage TOE access banner
- Update the TOE
- Verify TOE updates

The Security Management security function is designed to satisfy the following security functional requirements:

- FMT_MOF.1—the TSF restricts the ability to enable, disable, determine and modify the behavior of all of the security functions of the TOE to an authenticated Administrator.
- FMT_MTD.1—the TOE restricts the access to manage TSF data that can affect the security functions of the TOE to Security Administrators.
- FMT_SMF.1—the TOE includes the functions necessary to administer the TOE locally and remotely, to manage the cryptomodule and associated functions, and to manage and verify updates of the TOE.
- FMT_SMR.2—the TOE includes three predefined roles that have been configured to access the security management functions of the TOE corresponding to the required 'Security Administrator'.

6.6 Protection of the TSF

The TOE meets FIPS 140-2 requirements and therefore provides self-tests at start-up (which are also on-demand tests available to administrators) to demonstrate the correct operation of: key error detection, cryptographic algorithms, and RNG. Conditional self-tests are also run during the course of normal operation. The self-tests verify the integrity of stored TSF executable code and TSF data. The TOE performs the following Power-on self-tests:

- AES Encrypt Known Answer Test
- AES Decrypt Known Answer Test
- CCM Known Answer Test
- RSA Sign Known Answer Test
- RSA Verify Known Answer Test
- HMAC-SHA-1 Known Answer Test
- HMAC-SHA-256 Known Answer Test
- SHA-1 Known Answer Test
- SHA-256 Known Answer Test
- SHA-384 Known Answer Test
- SHA-512 Known Answer Test
- RNG Known Answer Test
- Firmware Integrity Test – A 128 bit EDC (using MD5) is calculated on non-security related code. Security related code is verified with HMAC-SHA-256. If the calculated result does not equal the previously generated result, the software/firmware test shall fail.

A known-answer test involves operating the cryptographic algorithm on data for which the correct output is already known and comparing the calculated output with the previously generated output (the known answer). If the calculated output does not equal the known answer, the known-answer test shall fail.

The TOE performs the following Conditional Self-Tests within the cryptographic module when the conditions specified for the tests occur:

1. Continuous Random Number Generator (RNG) test – performed on NDRNG and RNG, 128 bits
2. RSA Pairwise Consistency Test
3. Firmware Load Test – Verify RSA 2048 signature on firmware at time of load. . If the digital signature cannot be verified, the test shall fail.

The RNG continuous random number generator test is performed on each RNG and tests for failure to a constant value as follows:

1. If each call to a RNG produces blocks of n bits (where n > 15), the first n-bit block generated after power-up, initialization, or reset shall not be used, but shall be saved for comparison with the next n-bit block to be generated. Each subsequent generation of an n-bit block shall be compared with the previously generated block. The test shall fail if any two compared n-bit blocks are equal.
2. If each call to a RNG produces fewer than 16 bits, the first n bits generated after power-up, initialization, or reset (for some n > 15) shall not be used, but shall be saved for comparison with the next n generated bits. Each subsequent generation of n bits shall be compared with the previously generated n bits. The test fails if any two compared n-bit sequences are equal.

The TOE performs the following pair-wise consistency tests for public and private keys:

1. If the keys are used to perform an approved key transport method or encryption, then the public key shall encrypt a plaintext value. The resulting ciphertext value shall be compared to the original plaintext value. If the two values are equal, then the test shall fail. If the two values differ, then the private key shall be used to decrypt the ciphertext and the resulting value shall be compared to the original plaintext value. If the two values are not equal, the test shall fail.
2. If the keys are used to perform the calculation and verification of digital signatures, then the consistency of the keys shall be tested by the calculation and verification of a digital signature. If the digital signature cannot be verified, the test shall fail.

Failed self-tests comply with FIPS 140-2 requirements, i.e., a generated key shall not be used, the cryptographic module shall react as required by FIPS PUB 140-2 for failing a self-test, and this event will be audited. If a self-test fails, the TOE enters an error state and outputs an error indicator. The TOE doesn’t perform any cryptographic operations while in the error state. All data output from the TOE is inhibited when an error state exists. Should one or more power-up self-tests fail the module will reboot and enter a state in which the reason for the reboot can be determined.

Whenever a failure occurs within the TOE that results in the TOE ceasing operation, the TOE securely disables its interfaces to prevent the unintentional flow of any information to or from the TOE and reboots. It will stop booting up the TOE and enter a state in which the reason for the reboot can be determined. System administrator can check the failure and boot up the TOE.   So long as the failures persist, the TOE will continue to reboot. This functionally prevents any failure from causing an unauthorized information flow. There are no failures that circumvent this protection.

Certificates and their associated private key are stored in a single container: the Certificate File.   The PKCS#12 file consists of an Encrypted Private Key and X509 Certificate. By default all the private keys are protected since they are always stored in encrypted format using AES-256. The TOE prevents the reading of all keys by encrypting them with a Master Key using AES-256. The TOE does not provide an interface to read the Master Key. The TOE is designed specifically to prevent access to locally-stored cryptographically protected passwords and does not disclose any keys stored in the TOE. The TOE protects the confidentiality of user passwords by encrypting the password using AES-256.   The TOE does not offer any functions that will disclose to any users a stored cryptographic key or password.

The TOE is a hardware appliance or a virtual appliance image installed on a hardware appliance that includes a hardware-based real-time clock. The TOE’s embedded OS manages the clock and exposes administrator clock-related functions. The clock is used for audit record time stamps, measuring session activity for termination, and for cryptographic operations based on time/date.

Authorized administrators may query the current software/firmware version of the TOE. Note that the TOE is firmware and software. When updates are available from Palo Alto, an administrator can obtain and install those updates from *updates.paloaltonetworks.com*. The secured connection to the Palo Alto server supports TLS v1.0, TLS v1.1, TLS v1.2 and uses FIPS-approved algorithms. For an additional layer of protection, Palo Alto Networks has chosen to sign (using RSA-2048) and encrypt (using AES-256) all content that is downloaded to the firewall.

When the TOE update package and its corresponding digital signature is downloaded; the digital signature is checked automatically by PAN-OS by verifying the signature using the public key (corresponding to the RSA key used to create the signature). Certificates and keys are stored on the TOE's file system. If the signature is verified, the update is performed; otherwise the update is not performed. The administrator may also verify the download manually by checking the hash value against the publically published hash on the support site. If the hashes match, the update can be performed; however if they do not match, the update should not be performed.

The Protection of the TSF security function is designed to satisfy the following security functional requirements:

- FPT_FLS.1.1—the TOE shuts down when the following types of failures occur: failure of the power-on self-tests, failure of integrity check of the TSF executable image, failure of noise source health tests.
- FPT_APW_EXT.1—the TOE does not offer any functions that will disclose to any user a plain text password. Note that passwords are stored encrypted with a Master Key using AES-256.
- FPT_SKP_EXT.1—the TOE does not offer any functions that will disclose to any users a stored cryptographic key.
- FPT_STM.1—the TOE provides its own reliable time stamps for its own use.
- FPT_TST_EXT.1—the TOE includes self-tests at start-up (which are also on-demand tests available to administrators) on all cryptographic functions. Conditional self-tests are also run during the course of normal operation.
- FPT_TUD_EXT.1—the administrator may initiate software/firmware updates for the TOE. The download is verified using a digital signature and optionally by a manual verification of a published hash.

6.7 TOE Access

The TOE can be configured to display an informative banner that will appear prior to authentication when accessing the TOE via either a direct or remote connection to the management port in order to access the Web Interface (GUI). The TOE subsequently will enforce an administrator-defined inactivity timeout value after which the inactive session will be terminated.

The TOE can be configured by an administrator to set an interactive session timeout value (any integer value in minutes and also optionally in seconds, with 0 disabling the timeout) – the default timeout is 10 minutes. A remote session that is inactive (i.e., no commands issuing from the remote client) for the defined timeout value will be terminated. A local session that is similarly inactive for the defined timeout period will be terminated. The user will be required to re-enter their user id and their password so they can establish a new session once a session is terminated. If the user id and password match those of the user that was locked, the session is reconnected with the console and normal input/output can again occur for that user.

The TOE provides both local and remote users the ability to logout (or terminate) their sessions as directed by the user.

The TOE Access security function is designed to satisfy the following security functional requirements:

- FTA_SSL.3—the TOE terminates remote sessions that have been inactive for an administrator-configured period of time.
- FTA_SSL.4—the TOE provides the function to logout (or terminate) both local and remote user sessions as directed by the user.

- FTA_SSL_EXT.1—the TOE terminates local sessions that have been inactive for an administrator-configured period of time.
- FTA_TAB.1—the TOE can be configured to display administrator-defined advisory banners before establishing an administrative user session.

6.8 Trusted path/channels

The TOE can be configured to export audit records to an external Syslog server using IPsec or TLS . The TOE uses TLS to protect communications between itself and the UIA, and with the update server for TOE updates, App-ID and threat prevention signature updates. The TOE can be instructed to contact Palo Alto Networks' update server to download new content or TOE software updates. The TOE uses IPsec to protect communications between VPN Gateways/peers.

To support secure remote administration, the TOE includes an implementation of HTTPS and supports IPsec. An authorized administrator can establish secure remote connections with the TOE using HTTP over TLS or by establishing an IPsec connection. To successfully establish an interactive administrative session, the administrator must be able to provide acceptable user credentials (e.g., certificate; or user id, password, and role), after which they will be able to access the GUI features. The TOE requires the use of the trusted path for initial administrator authentication and all subsequent remote administrative actions.

The secure protocols are supported by NIST-validated cryptographic mechanisms included in the TOE implementation.

The Trusted Path/Channels security function is designed to satisfy the following security functional requirements:

- FTP_ITC.1—the TOE can be configured to ensure that exported audit records are sent only to the configured Syslog server using IPsec or TLS so they are not subject to inappropriate disclosure or modification. The TOE uses TLS for the communication channel with the UIA to retrieve the user to IP address mapping information that is used for policy enforcement. The TOE uses IPsec to protect VPN communications with remote devices. The TOE permits the TSF to initiate communication with the Syslog server and the update server, and the authorized IT entities to initiate communication using either TLS or the IPsec trusted channel.
- FTP_TRP.1—the TOE provides IPsec and HTTP over TLS to support secure remote administration. Administrators can initiate a remote session that is secured (from disclosure and modification) using NIST-validated cryptographic operations, and all remote security management functions require the use of this secure channel.

6.9 Packet Filtering

The Packet Filtering function is a subset of the Stateful Traffic Filtering function. This section provides a brief overview and summary of the packet filtering function. The Stateful Traffic Filtering function Section 6.10 contains additional detail relevant to this function.

On the Palo Alto Networks firewall, security policies determine whether to block or allow a session based on traffic attributes such as the source and destination security zone, the source and destination IP address, the application, user, and the service.

All traffic passing through the firewall is matched against a session and each session is matched against a security policy. When a session match occurs, the security policy is applied to bi-directional traffic (client to server and server to client) in that session. For traffic that doesn't match any defined rules, a final configurable deny or allow rule is applied. The default rules allow all intrazone (within the zone) traffic and deny all interzone (between zones) traffic. Typically interzone traffic is considered to be trusted however both intrazone and interzone traffic can be configured to deny all traffic if there is no rule match by clicking on the security policy and clicking on the Override button on the bottom on the Policy ->Security screen. In the evaluated configuration, the default deny all rule for interzone traffic should not be modified. Each rule can be configured to generate a log record when the traffic matches the defined rule using the 'policy->Security->options' selection. The logging option can be configured to log at the start of a session, or at the end of a session or both.

Security policies are evaluated left to right and from top to bottom in a packet filtering table format. A packet is matched against the first rule that meets the defined criteria; after a match is triggered the subsequent rules are not evaluated. Therefore, the more specific rules must precede more generic ones in order to enforce the best match criteria. Traffic that matches a rule generates a log entry at the end of the session in the traffic log, if logging is enabled for that rule.

The TOE will drop the packets if one of its interfaces is overwhelmed by network traffic. The 7000 series provides higher performance, in order to compensate the FPGA is designed to drop IPv6 with "zero" destination in the initial ingress packet processing. This event is logged in the FPGA counter log "flow_fpga_rcv_igr_IPV6DSTZERO"..

The security policy rules that determine whether a packet is transferred from one interface to another is based on:

1. IP address of source as defined as the original IP address in the packet.
2. IP address of destination as defined as the original IP address in the packet.
3. Service used allows Layer 4 selection (TCP or UDP) port for the application.
4. Source Zone from which the traffic originates.
5. Destination Zone at which the traffic terminates.

The Packet Filtering security function is designed to satisfy the following security functional requirements:

- FPF_RUL_EXT.1—the TOE performs packet filtering on network packets processed by the TOE.

6.10 Stateful Traffic Filtering

An authorized administrator may configure the TOE to apply stateful traffic filtering rules of permit, deny, and log on the following protocols:

- Internet Control Message Protocol version 4 (ICMPv4)
- Internet Control Message Protocol version 6 (ICMPv6)
- Internet Protocol (IPv4)
- Internet Protocol version 6 (IPv6)
- Transmission Control Protocol (TCP)
- User Datagram Protocol (UDP)

Conformance with the RFC 792 (ICMPv4), RFC 4443 (ICMPv6), RFC 791(IPv4), RFC 2460 (IPv6), RFC 793 (TCP), RFC 768 (UDP) protocols is verified by Palo Alto through regular quality assurance, regression, and interoperability testing.

An administrator can configure the TOE to control the type of information that is allowed to pass through the TOE. The administrator defines the security zone and applies security policies and security profiles to network traffic attempting to traverse the TOE to determine what actions to take.

Security Zones

The TOE groups interfaces into security zones. Each zone identifies one or more interfaces on the TOE. Separate zones must be created for each type of interface (Layer 2, Layer 3, or virtual wire), and each interface must be assigned to a zone before it can process traffic.

Security Policies

Security policies provide the firewall rule sets that specify whether to block or allow network connections, based on the source and destination zones, addresses, and the application service (such as UDP port 67 or TCP port 80). Security policy rules are processed in sequence, applying the first rule that matches the incoming traffic.

Security policies can be defined only between zones of the same type. However, the administrator can create a VLAN interface for one or more VLANs and then apply a security policy between the VLAN interface zone and a

Layer 3 interface zone. This has the same effect as applying policies between the Layer 2 and Layer 3 interface zones.

Each rule can be configured to generate a log record when the traffic matches the defined rule using the 'policy->Security->options' selection. The logging option can be configured to log at the start of a session, or at the end of a session or both..

The TOE enforces the stateful traffic filtering rules based on the following subject and information security attributes:

- Source security zone to which the physical network interface is assigned
- Destination security zone to which the network interface is assigned
- Information specifiable in security policies, which provide the information flow rule sets:
    - presumed identity of source subject—source address information within the packet
    - identity of destination subject—destination address information within the packet
    - transport layer protocol (e.g., TCP, UDP)
    - Internet layer protocol (e.g., ICMP type, code)
    - source subject service identifier (e.g., source port number)
    - destination subject service identifier (e.g., destination port number)
- Information security attributes for stateful packet inspection—for connection-oriented protocols (e.g., TCP), the sequence number, acknowledgement number, and flags (SYN, ACK, RST, FIN); and for connectionless protocols (e.g., UDP), the source and destination network identifiers; and source and destination service identifiers. Note that the TOE uses an IP-based network stack.

The TOE supports the Transmission Control Protocol (TCP) (RFC 793) which performs a handshake during session setup to initiate and acknowledge a session. After the data is transferred, the session is closed in an orderly manner, where each side transmits a FIN packet and acknowledges it with an ACK packet. The handshake that initiates the TCP session is often a three-way handshake (an exchange of three messages) between the initiator and the listener, or it could be a variation, such as a four-way or five-way split handshake or a simultaneous open. The TOE supports the TCP Split Handshake Drop feature, which can prevent TCP Split Handshake Session Establishment.

The TOE keeps state about connections or pseudo-connections and uses the information to permit or deny information flow. The TOE permits information flow between two subjects (i.e., from the physical interface on which network traffic entered to the physical interface determined by the destination address in the network packet) only where a security policy is defined between the source and destination zones that includes a rule that grants permission, based on the information security attributes listed above and the corresponding settings in the policy rule.

A security policy rule includes the following attributes against which network packets can be compared:

- Source Zone, Destination Zone—zones must be of the same type (Layer 2, Layer 3, or Virtual Wire). Multiple zones can be specified in a single rule to simplify management
- Source Address, Destination Address—the IPv4 or IPv6 addresses for which the rule applies. Addresses must first be defined by the administrator, who specifies a name for the address and the actual IPv4 or IPv6 addresses to be associated with that name. Addresses can be specified as a single address, an address with a mask, or an address range. Addresses can also be combined into address groups to simplify management
- Service—specifies services to limit applications to specific protocols and port numbers.

A security policy rule also includes the following attributes that determine what the TOE does with the network packet:

- Action—can be 'allow' or 'deny'

- Profiles—specifies any checking to be performed by the security profiles such as IPSec crypto Security and IKE Network Security. These profile allow/require the network traffic to be PROTECTed.)
- Options—specifies the following additional processing options for network packets matching the rule:
    - Log Setting—generate log entries in the local traffic log
    - Schedule—limits the days and times when the rule is in effect (e.g., an 'allow' rule might be active only during normal business hours)
    - QoS Marking—change the Quality of Service (QoS) marking on packets matching the rule
    - Disable Server Response Inspection—disables packet inspection from the server to the client, which may be useful under heavy server load conditions.

Prior to matching packets with the policy rules, fragmented packets are reassembled. Upon receiving a packet that is not associated with an established session (a packet with the SYN flag set without a corresponding ACK flag being set), the packet will be matched to the security rules to make a determination of whether to allow or deny the information flow. If the packet is associated with an established session (packet sequence number, acknowledgment number, and flags match an existing session record), the information flow is permitted.

The TOE uses a patented technology called App-ID to identify and control applications based on knowing exactly what the application is by evaluating the content of the traffic. This unique approach to traffic classification allows the TOE to provide visibility and control of the actual application, besides the ports or protocols that are allowed. App-ID is session "state" aware which allows the TOE to allow or block subsequent packets in a session. The TOE maintains a session "state" table for all sessions as part of the traffic processing layer of the device. If a packet doesn't match an existing session, then it is forced through the policy lookup process to determine if it should be allowed or not. If allowed, a session will be created. The logging can be enabled as well.

The application decoder builds the state table based on the relevant RFCs.

The TOE creates dynamic rules, maintaining the session states to support processing the FTP network protocol traffic for TCP data sessions in accordance with the FTP protocol as specified in RFC 959 using the FTP App-ID. Logging can be enabled in the security policy rule configured to control the FTP traffic.

The device provides a setting such that the Security Administrator can enable or disable ICMP and SNMP for all users.

The TOE rejects requests for access or services when received on an interface that is not associated with the source address from which the information flow is sourced (by administrator configured "Strict IP address check" in the Zone Protection Profile"). Traffic is dropped if the source address of the incoming traffic correspond to the IP address of an external broadcast network or loopback network; if the incoming traffic is received from the external network but has a source address that correspond to the internal network; or if traffic is received from the internal network but has a source address that correspond to the external network. The TOE rejects packets where the source address is equal to the address of the network interface where the network packet was received. Access or service requests are also rejected when the presumed source identity specifies a broadcast identity or a loopback identifier. Security rules to block, permit or log are applied to multicast traffic. The TOE rejects and logs packets where the source address of the network packet is defined as being on a multicast network. The TOE discards and logs strict source routing, loose source routing, and record route packets. In addition, requests in which the information received contains the set of host network identifiers by which information is to travel from the source subject to the destination subject are rejected.

Following is a more detailed description of the TOE's firewall capability.

When the TOE receives a packet, it first determines if it represents a new connection or if it is part of an existing session. If it is part of an existing session, the traffic is processed based on the parameters of the existing session. If it is a new connection, the TOE retrieves the source and destination zones and performs an initial policy lookup. If a policy is defined for the zone pair (i.e., source and destination zones) a session is created and packet processing proceeds. By default, traffic between each pair of security zones is blocked until at least one rule is added to allow traffic between the two zones. Sessions are not created for a new connection if there is no policy defined for the zone pair; or if there is an initial deny rule for the application service (i.e. service-HTTP, service-https) matching the traffic with no applications defined.

The TOE performs the following steps when processing traffic:

- The traffic is passed through the Application Identification and Application Decoders to determine what type of application is creating the session.
- Once the application is known, the TOE performs a policy lookup with the following information:
    - The source/destination IP address
    - The source/destination security zone
    - The application and service (port and protocol)
    - The source user[2] (when available)
  - If a security policy is found, the policy rules are compared against the incoming traffic in sequence and the first rule that matches the traffic is applied. If a policy rule matching all of the traffic attributes listed above is not found, or if it is found and it specifies a deny action, then the packet is dropped (or DISCARDed) and the session is deleted.
  - If the application flow is allowed and no further security profiles are applied then it is forwarded (it is allowed to BYPASS the tunnel).
  - If the application is allowed and there are additional security profiles set, it will be sent to the stream signature processor. The traffic matching the IPSec crypto Security profile would then flow through the IPSec tunnel and be classified as "PROTECTED".
    - If there is no SA that the IPsec can use to protect this traffic to the peer, IPsec uses IKE to negotiate with the remote peer to set up the necessary IPsec SAs on behalf of the data flow. The negotiation uses information specified in the IKE Network Profiles.

Security policies can also specify security profiles that may be used to protect against viruses, spyware, and other threats after the connection is established.

Security Profiles

Each security policy can include specification of one or more security profiles, which provide additional protection and control. Security profiles are configured and applied to firewall policy. Each security policy can specify one or more of the following security profiles:

- IPSec crypto Security profile
- IKE Network profile

The TOE can remove existing traffic flows from the set of established traffic flows based on the session inactivity timeout and completion of the expected information flow. The timeout period due to inactivity is administrator configurable from 1 – 6044800 seconds. Session removal becomes effective before the next packet that might match the session is processed.

The TOE implements an implicit "deny-all" rule to interfaces where a traffic filtering rule has been applied. If a policy rule matching all of the traffic attributes described is not found, or if it is found and it specifies a deny action, then the packet is dropped and the session is deleted. Session removal becomes effective before the next packet that might match the session is processed.

The PAN-OS performs Strict IP Address check, reject, and is capable of logging network packets where the source or destination address of the network packet is defined as being an address "reserved for future use" as specified in RFC 5735 for IPv4. The administrator may also configure the TOE to reject and log network packets where the source or destination address of the network packet is defined as a link-local address, an "unspecified address" or an address "reserved for future definition and use" as specified in RFC 3513 for IPv6. The TOE rejects and is capable of logging invalid and fragmented IP packets which cannot be re-assembled completely. The TOE detects all invalid fragmented packets, such as a fragmented packet that partially overlaps a previously received fragment, or a fragmented packet with invalid length, and drops and/or logs them as configured in the Zone Protection Profiles. Optionally, the TOE can be configured to consider any fragmented packet as invalid and to drop and log them.

[2] Source user in policies is not within the scope of the evaluation.

IP fragments will be parsed, be reassembled by defragmentation process and fed back to parser starting with IP header. A fragment may be discarded due to tear-drop attack (overlapping fragments).

The network traffic can go through the TOE only if the Policy Enforcement Module is fully functional and it is enforcing all policies. During start-up and initialization, the TOE runs a series of system checks and the FIPS 140-2 power up self- tests to ensure the system is functioning correctly. If these tests run successfully, the TOE will bring up the control plane and data-plane system modules. The Policy Enforcement Module (running on dataplane) uses the policy configuration information created from the Management Server Module (running on the control plane). The configuration information includes all of the policies required by the Policy Enforcement Module. Policies are used to control information flow on the network. Only once the Policy Enforcement Module running on the data-plane is up and running and the TOE's system configuration is applied to enforce all security policies, can the TOE pass the traffic.

The TOE implements the following safeguards that prevent packets from flowing through the TOE without applying the ruleset in the event of a component failure. The traffic can go through the TOE only if the Policy Enforcement Module is fully functional and enforcing all policies as described above. The Policy Enforcement Module can be configured to stop traffic when the traffic or system logs are full. Whenever a failure occurs within the TOE that results in the TOE ceasing operation, the TOE securely disables its interfaces to prevent the unintentional flow of any information to or from the TOE and reloads.

The Policy Enforcement Module uses the policy configuration information created from the Management Server Module. The configuration information includes all of the policies required by the Policy Enforcement Module. Policies are used to control information flow on the network.

The Stateful Traffic Filtering security function is designed to satisfy the following security functional requirements:

- FFW_RUL_EXT.1—an authorized administrator may configure the TOE to apply stateful traffic filtering rules of permit, deny, and log on the following protocols: ICMPv4, ICMPv6, IPv4, IPv6, TCP, UDP.

7. Protection Profile Claims

This ST is conformant to the *Protection Profile for Network Devices, Version 1.1, 8 June 2012* (NDPP), as amended by Errata #3 – with the optional IPsec, HTTPS, and TLS SFRs, the *Network Device Protection Profile (NDPP) Extended Package Stateful Traffic Filter Firewall, Version 1.0, 19 December 2011* (STFF), and the *Network Device Protection Profile (NDPP) Extended Package VPN Gateway, Version 1.1, 12 April 2013* (VPNGW) as amended by CSfC Selections for VPN Gateways (CSfC).

The TOE is a stateful traffic filter firewall appliance with VPN Gateway functionality. As such, the TOE is a network device making the NDPP with STFF and VPNGW claims valid and applicable.

As explained in section 3, Security Problem Definition, the Security Problem Definitions of the NDPP, STFF, and VPNGW have been included by reference into this ST.

As explained in section 4, Security Objectives, the Security Objectives of the NDPP with STFF and VPNGW have been included by reference into this ST.

The following table identifies all the Security Functional Requirements (SFRs) in this ST. Each SFR is reproduced from the NDPP, VPNGW, or STFF and operations completed as appropriate. The source is determined first by any applicable TDs, second by EP, and third by PP. In some instances the EPs require additional information be combined with the PP (e.g. FMT_SMF.1). In these cases all of the sources drawn from are identified.

Requirement Class	Requirement Component	Source
FAU: Security audit	FAU_GEN.1: Audit Data Generation	NDPP, VPNGW, TFFW
	FAU_GEN.2: User identity association	NDPP
	FAU_STG_EXT.1: External Audit Trail Storage	NDPP
FCS: Cryptographic support	FCS_CKM.1(1): Cryptographic Key Generation (for asymmetric keys)	VPNGW
	FCS_CKM.1(2): Cryptographic Key Generation (for asymmetric keys)	VPNGW
	FCS_CKM_EXT.4: Cryptographic Key Zeroization	NDPP
	FCS_COP.1(1): Cryptographic Operation (for data encryption/decryption)	VPNGW
	FCS_COP.1(2): Cryptographic Operation (for cryptographic signature)	VPNGW
	FCS_COP.1(3): Cryptographic Operation (for cryptographic hashing)	NDPP
	FCS_COP.1(4): Cryptographic Operation (for keyed-hash message authentication)	NDPP
	FCS_HTTPS_EXT.1: Explicit: HTTPS	NDPP
	FCS_IPSEC_EXT.1: Explicit: IPSEC	VPNGW
	FCS_RBG_EXT.1: Extended: Cryptographic Operation (Random Bit Generation)	VPNGW
	FCS_TLS_EXT.1: Explicit: TLS	NDPP
FDP: User data protection	FDP_RIP.2: Full Residual Information Protection	NDPP
FIA: Identification and authentication	FIA_AFL.1: Authentication Failure Handling	VPNGW
	FIA_PMG_EXT.1: Password Management	NDPP
	FIA_UAU.7: Protected Authentication Feedback	NDPP
	FIA_UAU_EXT.2: Extended: Password-based Authentication Mechanism	NDPP
	FIA_UIA_EXT.1: User Identification and Authentication	NDPP
	FIA_X509_EXT.1 Extended: X.509 Certificates	VPNGW, elements 9 and 11 (10 prior to applying TD0037) amended

Requirement Class	Requirement Component	Source
		by TDs 0037 and 0041
FFW: Stateful Traffic Filtering	FFW_RUL_EXT.1 Stateful Traffic Filtering	STFF
FMT: Security Management	FMT_MOF.1 Management of Security Functions Behavior	VPNGW
	FMT_MTD.1: Management of TSF Data (for general TSF data)	NDPP
	FMT_SMF.1: Specification of Management Functions	NDPP, VPNGW, TFFW, TD0037
	FMT_SMR.2: Restrictions on Security Roles	NDPP
FPF: Packet Filtering	FPF_RUL_EXT.1: Packet Filtering	VPNGW
FPT: Protection of the TSF	FPT_SKP_EXT.1: Extended: Protection of TSF Data (for reading of all symmetric keys)	NDPP
	FPT_FLS.1 Fail Secure	VPNGW
	FPT_APW_EXT.1: Extended: Protection of Administrator Passwords	NDPP
	FPT_STM.1: Reliable Time Stamps	NDPP
	FPT_TST_EXT.1: TSF Testing	NDPP, VPNGW
	FPT_TUD_EXT.1: Extended: Trusted Update	NDPP, VPNGW
FTA: TOE access	FTA_SSL.3: TSF-initiated Termination	NDPP
	FTA_SSL.4: User-initiated Termination	NDPP
	FTA_SSL_EXT.1: TSF-initiated Session Locking	NDPP
	FTA_TAB.1: Default TOE Access Banners	NDPP
FTP: Trusted path/channels	FTP_ITC.1: Trusted Channel	NDPP (TD0035)
	FTP_TRP.1: Trusted Path	NDPP

Table 6 SFR Protection Profile Sources

8. Rationale

This security target includes by reference the NDPP, STFF, and VPNGW Security Problem Definition, Security Objectives, and Security Assurance Requirements. The security target makes no additions to the NDPP, STFF, and VPNGW assumptions. Security functional requirements have been reproduced with the protection profile operations completed. Operations on the security requirements follow NDPP, STFF, and VPNGW application notes and assurance activities. Consequently, NDPP, STFF, and VPNGW rationale applies but is incomplete. The TOE Summary Specification rationale below serves to complete the rationale required for the security target.

8.1 TOE Summary Specification Rationale

Each subsection in Section 6, the TOE Summary Specification, describes a security function of the TOE. Each description is followed with rationale that indicates which requirements are satisfied by aspects of the corresponding security function. The set of security functions work together to satisfy all of the security functions and assurance requirements. Furthermore, all of the security functions are necessary in order for the TSF to provide the required security functionality.

This Section in conjunction with Section 6, the TOE Summary Specification, provides evidence that the security functions are suitable to meet the TOE security requirements. The collection of security functions work together to provide all of the security requirements. The security functions described in the TOE summary specification are all necessary for the required security functionality in the TSF. **Table 7 Security Functions vs. Requirements Mapping** demonstrates the relationship between security requirements and security functions.

	Security audit	Cryptographic support	User data protection	Identification and authentication	Security management	Protection of the TSF	TOE access	Trusted path/channels	Stateful Traffic Filtering	Packet Filtering
FAU_GEN.1	X									
FAU_GEN.2	X									
FAU_STG_EXT.1	X									
FCS_CKM.1(1)		X								
FCS_CKM.1(2)		X								
FCS_CKM_EXT.4		X								
FCS_COP.1(1)		X								
FCS_COP.1(2)		X								
FCS_COP.1(3)		X								
FCS_COP.1(4)		X								
FCS_HTTPS_EXT.1		X								
FCS_IPSEC_EXT.1		X								
FCS_RBG_EXT.1		X								
FCS_TLS_EXT.1		X								
FDP_RIP.2			X							
FIA_AFL.1				X						
FIA_PMG_EXT.1				X						
FIA_UAU.7				X						
FIA_UAU_EXT.2				X						
FIA_UIA_EXT.1				X						
FIA_X509_EXT.				X						
FMT_MOF.1					X					
FMT_MTD.1					X					
FMT_SMF.1					X					
FMT_SMR.2					X					
FPT_APW_EXT.1						X				
FPT_FLS.1						X				
FPT_SKP_EXT.1						X				
FPT_STM.1						X				
FPT_TST_EXT.1						X				
FPT_TUD_EXT.1						X				
FTA_SSL.3							X			
FTA_SSL.4							X			
FTA_SSL_EXT.1							X			
FTA_TAB.1							X			
FTP_ITC.1								X		
FTP_TRP.1								X		
FFW_RUL_EXT.1									X	
FPF_RUL_EXT.1										X

Table 7 Security Functions vs. Requirements Mapping

8.2 CSfC Selections for VPN Gateways

The security functional requirements include operations completed to conform to CSfC Selections for VPN Gateways. For some NDPP requirements, it is not obvious how to apply simultaneously Errata #3, VPN GW EP, and *CSfC Selections for VPN Gateways* to SFRs. Table 8 describes the approach taken in this ST for each SFR in *CSfC Selections for VPN Gateways*.

Requirement	**Explanation of Operations**
FAU_STG_EXT.1.1	*CSfC Selections for VPN Gateways* completes all NDPP operations. The ST uses the CSfC operations.
FCS_CKM.1(1)	VPN GW EP requires elliptic curve-based and finite field-based key establishment schemes as well as allowing RSA-based key establishment schemes. *CSfC Selections for VPN Gateways* indicates that elliptic curve-based schemes are mandatory while leaving the selection of curve P-251 optional. The ST includes all three key establishment schemes and completes the remaining operations.
FCS_CKM.1(2)	VPN GW EP requires at least one of FIPS PUB 186-3 RSA key generation, FIPS PUB 186-3 elliptic curve key generation, and ANSI X9.31-1998 RSA key generation for IKE peer keys. *CSfC Selections for VPN Gateways* indicates that elliptic curve key generation is mandatory while leaving the selection of curve P-251 optional. The ST includes the two FIPS PUB 186-3 key generation schemes and completes the remaining operations.
FCS_COP.1(1)	Errata #3 removes the option of using 192-bit keys. VPN GW EP makes CBC and GCM modes mandatory. *CSfC Selections for VPN Gateways* consolidates the changes from Errata #3 and VPN GW EP. The ST includes the requirement as in CSfC and completes the operations.
FCS_COP.1(2)	NDPP requires DSA, RSA, or ECDSA cryptographic signature services, while specifying corresponding key sizes and standards. VPN GW EP disallows DSA services at the same time reformatting the presentation of the RSA and ECDSA service options. *CSfC Selections for VPN Gateways* indicates that ECDSA services are mandatory using both presentations (for NDPP evaluations and VPN GW EP evaluations, respectively). The ST includes RSA and ECDSA cryptographic signature services using the presentation from VPN GW EP.
FCS_COP.1.1(3)	*CSfC Selections for VPN Gateways* indicates that SHA-256 and SHA-384 are mandatory. The ST includes the two mandatory SHA variants.
FCS_IPSEC_EXT.1.1	Errata #3 reordered elements in FCS_IPSEC_EXT.1 so that FCS_IPSEC_EXT.1.1 in *CSfC Selections for VPN Gateways* corresponds to FCS_IPSEC_EXT.1.4 in Errata #3 and VPN GW EP. VPN GW EP makes AES-GCM-128 and AES-GCM-256 mandatory. CSfC indicates AES-CBC-128 and AES-CBC-256 are mandatory. The ST includes all four cipher-mode-key size combinations and completes the operations. The ST completes the operations consistent with VPN GW EP, Errata #3 and CSfC.
NDPP FCS_IPSEC_EXT.1.5 VPN GW EP FCS_IPSEC_EXT.1.11	Errata #3 reordered elements in FCS_IPSEC_EXT.1 so that FCS_IPSEC_EXT.1.5 in *CSfC Selections for VPN Gateways* corresponds to FCS_IPSEC_EXT.1.9 in Errata #3 and to FCS_IPSEC_EXT.11 in VPN GW EP. VPN GW EP makes group 19 mandatory. CSfC makes both groups 19 and 20 mandatory. The ST includes both groups 19 and 20.

Requirement	Explanation of Operations
NDPP FCS_IPSEC_EXT.1.6 VPN GW EP FCS_IPSEC_EXT.1.12	Errata #3 and VPN GW EP reordered elements in FCS_IPSEC_EXT.1 so that FCS_IPSEC_EXT.1.6 in *CSfC Selections for VPN Gateways* corresponds to FCS_IPSEC_EXT.1.12 in Errata #3 and VPN GW EP. VPN GW EP adds use of X.509 certificates. *CSfC Selections for VPN Gateways* indicates ECDSA is mandatory. The ST incorporates both restrictions.
FCS_RBG_EXT.1	VPN GW EP makes a hardware noise source mandatory. *CSfC Selections for VPN Gateways* indicates 256 bits of entropy is mandatory for seeding the RBG. The ST completes the operations consistent with VPN GW EP and CSfC.
FTP_ITC.1.1	VPN GW EP makes IPsec mandatory for all authorized IT entities. Technical Decision 0035 states, "FTP_ITC.1.1 in the NDPP was updated by Errata #3, which is what CSfC cites in their selections. FTP_ITC.1.1 in the VPN GW EP should have been updated at the same time so that it inherited the list of "authorized IT entities" in NDPP." Errata #3 indicates the requirement allows the following selections: IPsec, SSH, TLS, TLS/HTTPS. *CSfC Selections for VPN Gateways* indicates IPsec is mandatory. The ST completes the operations consistent with NDPP Errata #3 and CSfC.
FTP_TRP.1.1	NDPP Errata #3 indicates FTP_TRP.1.1 allows the following selections: IPsec, SSH, TLS, TLS/HTTPS. *CSfC Selections for VPN Gateways* indicates IPsec must be supported for communication between the TOE and remote administrators. The ST completes the operations consistent with NDPP Errata #3 and CSfC.

Table 8 Operations for *CSfC Selections for VPN Gateways*