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Communications

FIPS 140-2 Non-Proprietary Security Policy

Acme Packet 1100 [1] and Acme Packet 3900 [2]

FIPS 140-2 Level 1 Validation

Hardware Version: 1100 [1] and 3900 [2]

Firmware Version: S-Cz8.2.0

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TABLE OF CONTENTS

List of Tables

List of Figures

1. Introduction

1.1 Overview

This document is the Security Policy for the Acme Packet 1100 [1] and Acme Packet 3900 [2] appliances manufactured by Oracle Communications. Acme Packet 1100 [1] and Acme Packet 3900 [2] are also referred to as "the module" or "module". This Security Policy specifies the security rules under which the module shall operate to meet the requirements of FIPS 140-2 Level 1. It also describes how the Acme Packet 1100 [1] and Acme Packet 3900 [2] appliances function to meet the FIPS requirements, and the actions that operators must take to maintain the security of the modules.

This Security Policy describes the features and design of the Acme Packet 1100 [1] and Acme Packet 3900 [2] modules using the terminology contained in the FIPS 140-2 specification. *FIPS 140-2, Security Requirements for Cryptographic Modules* specifies the security requirements that will be satisfied by a cryptographic module utilized within a security system protecting sensitive but unclassified information. The NIST/CCCS Cryptographic Module Validation Program (CMVP) validates cryptographic modules to FIPS 140-2. Validated products are accepted by the Federal agencies of both the USA and Canada for the protection of sensitive or designated information.

1.2 Document Organization

The Security Policy document is one document in a FIPS 140-2 Submission Package. The Submission Package contains:

- Oracle Non-Proprietary Security Policy
- Oracle Vendor Evidence document
- Finite State Machine
- Entropy Assessment Document
- Other supporting documentation as additional references

With the exception of this Non-Proprietary Security Policy, the FIPS 140-2 Validation Documentation is proprietary to Oracle and is releasable only under appropriate non-disclosure agreements. For access to these documents, please contact Oracle.

2. Acme Packet 1100 & 3900

2.1 Functional Overview

The Acme Packet 1100 [1] and Acme Packet 3900 [2] appliances are specifically designed to meet the unique price performance and manageability requirements of the small to medium sized enterprise and remote office/ branch office. Ideal for small site border control and Session Initiation Protocol (SIP) trunking service termination applications, the Acme Packet 1100 [1] and Acme Packet 3900 [2] appliances deliver Oracle's industry leading ESBC capabilities in a small form factor appliance. With support for high availability (HA) configurations, TDM fallback, hardware assisted transcoding and Quality of Service (QoS) measurement, the Acme Packet 1100 [1] and Acme Packet 3900 [2] appliances are a natural choice when uncompromising reliability and performance are needed in an entry-level appliance. With models designed for the smallest branch office to the largest data center, the Acme Packet ESBC product family supports distributed, centralized, or hybrid SIP trunking topologies.

Acme Packet 1100 [1] and Acme Packet 3900 [2] appliances address the unique connectivity, security, and control challenges enterprises often encounter when extending real-time voice, video, and UC sessions to smaller sites. The appliances also help enterprises contain voice transport costs and overcome the unique regulatory compliance challenges associated with IP telephony. TDM fallback capabilities ensure continuous dial out service at remote sites in the event of WAN or SIP trunk failures. Stateful high availability configurations protect against link and hardware failures. An embedded browser based graphical user interface (GUI) simplifies setup and administration

3. Cryptographic Module Specification

3.1 Definition of the Cryptographic Module

The module consists of the Acme Packet 1100 [1] and Acme Packet 3900 [2] appliances running firmware version S-Cz8.2.0 on the 1100 and 3900 hardware platforms. The module is classified as a multi-chip standalone cryptographic module. The physical cryptographic boundary for the Acme Packet 1100 is defined as the module case and all components within the case. The physical cryptographic boundary for the Acme Packet 3900 is all components with exception of the removable power supplies.

A representation of the cryptographic boundary is defined below:

Figure 1: Acme Packet 1100

Figure 2: Acme Packet 3900

3.2 FIPS 140-2 Validation Scope

The Acme Packet 1100 and Acme Packet 3900 appliances are being validated to overall FIPS 140-2 Level 1 requirements. See Table 1 below.

The Acme Packet 1100 and 3900	Level
Cryptographic Module Specification	1
Cryptographic Module Ports and Interfaces	1
Roles and Services and Authentication	2
Finite State Machine Model	1
Physical Security	1
Operational Environment	N/A
Cryptographic Key Management	1
EMI/EMC	1
Self-Tests	1
Design Assurance	3
Mitigation of Other Attacks	N/A

Table 1: FIPS 140-2 Security Requirements

3.3 Approved or Allowed Security Functions

The Acme Packet 1100 [1] and Acme Packet 3900 [2] appliances contain the following FIPS Approved Algorithms listed in Table 2 (Oracle Acme Packet Cryptographic Library Acme Packet 1100 and 3900) and Table 3 (Oracle Acme Packet Mocana Cryptographic Library Acme Packet 1100 and 3900):

	Approved or Allowed Security Functions	Certificate
Symmetric Algorithms		
AES	CBC, ECB, CTR, GCM; Encrypt/Decrypt; Key Size = 128, 256	C 140
Triple DES[1]	CBC; Encrypt/Decrypt; Key Size = 192	C 140
Secure Hash Standard (SHS)		
SHS	SHA-1, SHA-256, SHA-384, SHA-512	C 140
Data Authentication Code		
HMAC	HMAC-SHA-1, HMAC-SHA-256, HMAC-SHA-384, HMAC-SHA-512	C 140
Asymmetric Algorithms		

[1] Triple-DES was CAVP tested but is not utilized by the services associated with the Oracle Acme Packet Cryptographic Library.

RSA	RSA: FIPS186-4: 186-4 KEY(gen): FIPS186-4_Random_e ALG[ANSIX9.31] SIG(gen) (2048 SHA(1, 256 , 384) ALG[ANSIX9.31] SIG(Ver) (2048 SHA(1, 256, 384)) RSA: FIPS186-2 : ALG[ANSIX9.31] SIG(gen) (4096 SHA (256,384)) ALG[ANSIX9.31] SIG(Ver) (2048 SHA(1, 256, 384)), (4096 SHA (1, 256, 384)) RSA: FIPS186-4: 186-4 KEY(gen): FIPS186-4_Random_e ALG[ANSIX9.31] SIG(gen) (2048 SHA(1, 256 , 384), (4096 SHA (256,384)) SIG(Ver) (2048 SHA(1, 256, 384)) RSA: FIPS186-2 Signature Verification 9.31: Modulus lengths: 2048, 4096 SHAs: SHA-1, SHA-256, SHA-384	C 140
ECDSA	FIPS186-4 PKG: CURVES (P-256, P-384 Testing Candidates) SigGen: CURVES (P-256: (SHA-256, 384) P-384: (SHA-256, 384) SigVer: CURVES (P-256: (SHA-256, 384) P-384: (SHA-256, 384))	C 140
Random Number Generation		
DRBG	CTR_DRBG: [Prediction Resistance Tested: Not Enabled; BlockCipher_Use_df: (AES-256)] Hash_Based DRBG: [Prediction Resistance Tested: Not Enabled (SHA-1)	C 140
Key establishment		
Key Derivation	SNMP KDF, SRTP KDF, TLS KDF	C 140
Key Transport		
KTS	KTS (AES Cert. # C 140 and HMAC Cert. # C 140; key establishment methodology provides 128 or 256 bits of encryption strength);	

Table 2: Approved and Allowed Security Functions for Oracle Acme Packet Cryptographic Library

	Approved or Allowed Security Functions	Certificate
Symmetric Algorithms		
AES	CBC; Encrypt/Decrypt; Key Size = 128, 256	C 139
Triple DES[2]	CBC; Encrypt/Decrypt; Key Size = 192	C 139
Secure Hash Standard (SHS)		
SHS	SHA-1, SHA-256, SHA-384, SHA-512	C 139
Data Authentication Code		
HMAC	HMAC-SHA-1, HMAC-SHA-256, HMAC-SHA-384, HMAC-SHA-512	C 139

[2] Per IG A.13 the same Triple-DES key shall not be used to encrypt more than 2^20 64-bit blocks of data.

Asymmetric Algorithms		
RSA	RSA: 186-4: 186-4 KEY(gen): FIPS186-4_Random_e PKCS1.5: SIG(Ver) (1024 SHA(1); (2048 SHA (1))	C 139
Key Establishment		
Key Derivation	SSH KDF, IKEv1/IKEv2 KDF	C 139
Key Transport		
KTS	KTS (AES Cert. # C 139 and HMAC Cert. # C 139; key establishment methodology provides 128 or 256 bits of encryption strength);	

Table 3: Approved and Allowed Security Functions for Oracle Acme Packet Mocana Cryptographic Library

Note: P-384 for ECDSA was CAVP tested but is not utilized by the module's services.

3.4 Non-Approved But Allowed Security Functions

The following are considered non-Approved but allowed security functions:

Algorithm	Usage
EC-Diffie-Hellman	CVL Certs. #C:140 and #C:139 key agreement; key establishment methodology provides 128 or 192 bits of encryption strength
Diffie-Hellman	CVL Certs. #C:140 and #C:139 key agreement; key establishment methodology provides 112 bits of encryption strength
RSA Key Wrapping	Key wrapping, key establishment methodology provides 112-bits of encryption strength
NDRNG	Used for seeding the NIST SP 800-90A Hash_DRBG and CTR_DRBG. Per FIPS 140-2 IG 7.14 scenario 1 (a). The module provides a minimum of 440 bits of entropy input for the Hash_DRBG. The input length for the CTR_DRBG depends on the size of the AES key used. If the AES key length is 128 bits, the seed size is 256 bits. If the AES key length is 256 bits, then the seed size is 384 bits.
MD5 (TLS 1.0/1.1/1.2)	MACing: HMAC MD5, Hashing: MD5

Table 4: Non-Approved but Allowed Security Functions

3.5 Non-Approved Security Functions and Services

The following services are considered non-Approved and may not be used in a FIPS-approved mode of operation:

Service	Non-Approved Security Functions
SSH	Asymmetric Algorithms: DSA, Symmetric Algorithms: Rijndael, AES GCM, 192-Bit AES CTR
SNMP	Hashing: MD5, Symmetric Algorithms: DES
SRTP	Hashing: MD5
IKEv1, IKEv2	Hashing: MD5, Symmetric Algorithms: 192-Bit AES CBC
TLS 1.0/1.1/1.2	Symmetric Algorithms: DES
Diffie-Hellman	Key agreement, less than 112 bits of encryption strength.
RSA Key Wrapping	Key wrapping, less than 112 bits of encryption strength.

Table 5: Non-Approved Disallowed Functions

Services listed in the previous table make use of non-compliant cryptographic algorithms. Use of these algorithms are prohibited in a FIPS-approved mode of operation. Some of these services may be allowed in FIPS mode when using allowed algorithms (as specified in section 9.1).

3.6 Vendor Affirmed Security Functions

The following services are considered non-Approved and may not be used in a FIPS-approved mode of operation:

Algorithm	Vendor Affirmed Security Functions
CKG	In accordance with FIPS 140-2 IG D.12, the cryptographic module performs Cryptographic Key Generation (CKG) as per SP800-133 (vendor affirmed). The resulting generated symmetric keys and the seed used in the asymmetric key generation are the unmodified output from an NIST SP 800-90A DRBG.

Table 6: Vendor Affirmed Functions

4. Module Ports and Interfaces

The module interfaces can be categorized as follows the FIPS 140-2 Standard:

- Data Input Interface
- Data Output Interface
- Control Input interface
- Status Output Interface
- Power Interface

The table below provides a mapping of ports for the Acme Packet 1100 and Acme Packet 3900:

Logical Interface	Physical Port 1100	Physical Port 3900	Information Input/Output
Data Input	Ethernet INT/EXT Ports TDM Ports Ethernet MGT Port USB Port	Ethernet SFP Ports P0,1,2,3 Ethernet MGT Ports T1/E1 TDM ports USB Port	Cipher text Plain text
Data Output	Ethernet INT/EXT Ports TDM Ports Ethernet MGT Port USB Port	Ethernet SFP Ports P0,1,2,3 T1/E1 TDM ports Ethernet MGT Ports USB Port	Cipher text Plain text
Control Input	Console Port Reset Pinhole T1/E1 TDM port Ethernet MGT Port Ethernet INT/EXT Ports USB Port	Console Port Reset Button Power Switch T1/E1 TDM ports Ethernet MGT Ports Ethernet SFP Ports P0,1,2,3 USB Port	Plaintext control input via console port (configuration commands, operator passwords) Ciphertext control input via network management (EMS control, CDR accounting, CLI management)
Status Output	Console Port Ethernet MGT Ports Ethernet INT/EXT Ports T1/E1 TDM port LEDs	Console Port Ethernet MGT Ports Ethernet SFP Ports P0,1,2,3 T1/E1 TDM ports LEDs	Plaintext status output via console port. Ciphertext status output via network management
Power	Power Plug	Power Plug	N/A

Table 7: Mapping of FIPS 140 Logical Interfaces to Physical Ports

The table below provides a mapping of ports for the Acme Packet 1100 and Acme Packet 3900:

Physical Interface	Number of Ports 1100	Number of Ports 3900	Description / Use
Console Port	1	1	Provides console access to the module. The module supports only one active serial console connection at a time. Console port communication is used for administration and maintenance purposes from a central office (CO) location. Tasks conducted over a console port include: • Configuring the boot process and management network • Creating the initial connection to the module • Accessing and using functionality available via the ACLI • Performing in-lab system maintenance (services described below) • Performing factory-reset to zeroize nvram and keys in Flash
USB Ports	2	2	This port is used for recovery only by Oracle. e.g. system re-installation after zeroization.
Management Ethernet ports	1	3	Used for EMS control, CDR accounting, CLI management, and other management functions
Signaling and Media Ethernet ports	2 (INT/EXT)	4 (SFP P0,1,2,3)	Provide network connectivity for signaling and media traffic. These ports are also used for incoming and outgoing data (voice) connections.
Reset Pinhole – Reset Button	1	1	Provides reset functionality
TDM Ports	4	4	Used to convert analog signals to digital signals

Table 8: Physical Ports

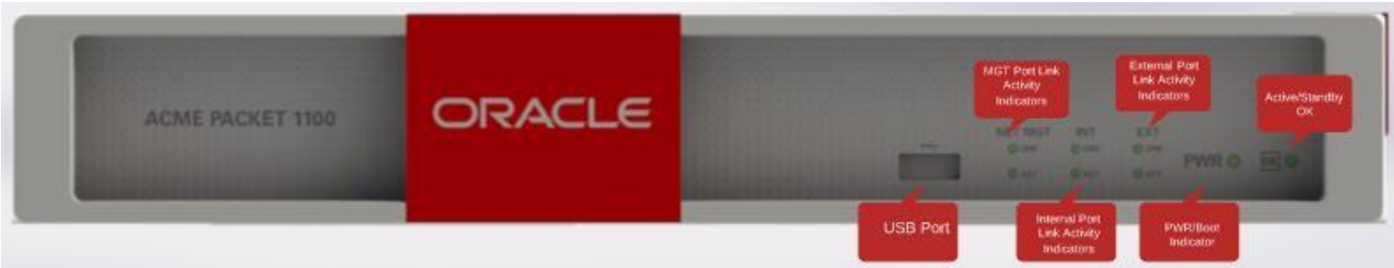

Figure 3: Acme Packet 1100 – Front View

Figure 4: Acme Packet 1100 – Rear View

Figure 5: Acme Packet 3900 – Front View

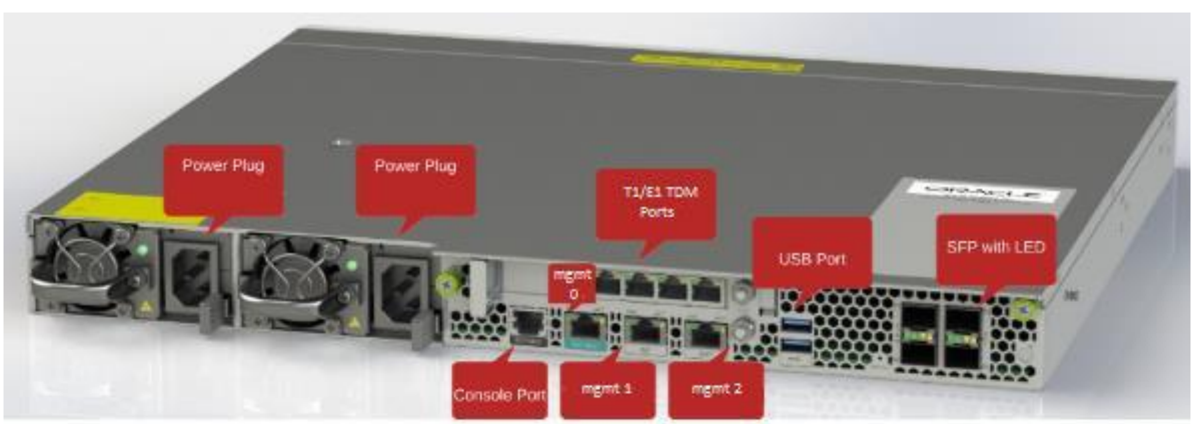

Figure 6: Acme Packet 3900 – Rear View

5. Physical Security

The module's physical embodiment is that of a multi-chip standalone device that meets Level 1 Physical Security requirements. The module is completely enclosed in a rack mountable chassis.

6. Operational Environment

The modules support a limited modifiable operational environment as per the FIPS 140-2 Section 4.6.

7. Roles and Services

As required by FIPS 140-2 Level 2, there are three roles (a Crypto Officer Role, User Role, and Unauthenticated Role) in the module that operators may assume. The module supports role-based authentication, and the respective services for each role are described in the following sections.

The below table gives a high-level description of all services provided by the module and lists the roles allowed to invoke each service.

Operator Role	Summary of Services
User	• View configuration versions and system performance data • Test pattern rules, local policies, and session translations • Display system alarms.
Crypto-Officer	• Allowed access to all system commands and configuration privileges
Unauthenticated	• Request Authentication • Show Status • Initiate self-tests

Table 9: Service Summary

7.1 Operator Services and Descriptions

The below table provides a full description of all services provided by the module and lists the roles allowed to invoke each service.

U	CO	Service Name	Service Description	Keys and CSP(s)	Access Type(s)
	X	Configure	Initializes the module for FIPS mode of operation	HMAC-SHA-256 key	R, W, X
	X	Zeroize CSP's	Clears keys/CSPs from memory and disk	All CSP's	Z
	X	Firmware Update	Updates firmware	Firmware Integrity Key (RSA)	R, X
	X	Bypass	Configure bypass using TCP or UDP and viewing bypass service status	HMAC-SHA-256 Bypass Key	R, W, X

U	CO	Service Name	Service Description	Keys and CSP(s)	Access Type(s)
X	X	Decrypt	Decrypts a block of data Using AES or Triple-DES in FIPS Mode	TLS Session Keys (AES128) TLS Session Keys (AES256) SSH Session Key (AES128) SSH Session Key (AES256) SRTP Session Key (AES-128) SNMP Privacy Key (AES-128) IKE Session Encryption Key (Triple-DES, AES-128, AES-256) IPsec Session Encryption Key (Triple-DES, AES-128 or AES-256)	X X X X X X X X
X	X	Encrypt	Encrypts a block of data Using AES or Triple-DES in FIPS Mode	TLS Session Keys (AES128) TLS Session Keys (AES256) SSH Session Key (AES128) SSH Session Key (AES256) SRTP Session Key (AES-128) SNMP Privacy Key (AES-128) IKE Session Encryption Key (Triple-DES, AES-128, AES-256) IPsec Session Encryption Key (Triple-DES, AES-128 or AES-256)	X X X X X X X X
X	X	Generate Keys	Generates AES or Triple-DES for encrypt/decrypt operations.	TLS Session Keys (AES128) TLS Session Keys (AES256) SSH Session Key (AES128) SSH Session Key (AES256) SRTP Session Key (AES-128) SNMP Privacy Key (AES-128) IKE Session Encryption Key (Triple-DES, AES-128, AES-256) IPsec Session Encryption Key (Triple-DES, AES-128 or AES-256)	R, W R, W R, W R, W R, W R, W R, W R, W

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U	CO	Service Name	Service Description	Keys and CSP(s)	Access Type(s)
			Generates Diffie-Hellman, EC Diffie-Hellman, and RSA keys for key transport/key establishment.	Diffie-Hellman Public Key (DH) Diffie-Hellman Private Key (DH) EC Diffie-Hellman Public Key (ECDH) EC Diffie-Hellman Private Key (ECDH) SSH authentication private Key (RSA) SSH authentication public key (RSA) TLS authentication private Key (ECDSA/RSA) TLS authentication public key (ECDSA/RSA) TLS premaster secret, TLS Master secret, SRTP Master key IKE Private Key (RSA) IKE Public Key (RSA) SKEYSEED SKEYID SKEYID_d	R, W R, W R, W R, W R, W R, W R, W R, W R, W R, W R, W R, W R, W R, W R, W R, W
X	X	Verify	Used as part of the TLS, SSH protocol negotiation	SSH authentication private Key (RSA) SSH authentication public key (RSA) TLS authentication private Key (ECDSA/RSA) TLS authentication public key (ECDSA/RSA) Diffie-Hellman Public Key (DH) Diffie-Hellman Private Key (DH) EC Diffie-Hellman Public Key (ECDH) EC Diffie-Hellman Private Key (ECDH)	X X X X X X X X
X	X	Generate Seed	Generate an entropy_input for Hash_DRBG, CTR DRBG	DRBG Seed DRBG Entropy Input String	R, W, X
X	X	Generate Random Number	Generate random number.	DRBG C DRBG V DRBG Key	R, W, X R, W, X R, W, X
X	X	HMAC	Generate HMAC	SNMP Authentication Key SRTP Authentication Key SSH Integrity Keys TLS Integrity Keys IPsec Session Authentication Key IKE Session Authentication Key	X X X X X X
X	X	Generate Certificate	Generate certificate	Web UI Certificate	R, W, X

U	CO	Service Name	Service Description	Keys and CSP(s)	Access Type(s)
X	X	Authenticate	Authenticate Users	Operator Password	R, W, X

R – Read, W – Write, X – Execute, Z - Zeroize

Table 10: Operator Services and Descriptions

7.2 Unauthenticated Services and Descriptions

The below table provides a full description of the unauthenticated services provided by the module:

Service Name	Service Description
On-Demand Self-Test Initialization	This service initiates the FIPS self-test when requested.
Show Status	This service shows the operational status of the module
Factory Reset Service	This service restores the module to factory defaults.

Table 11: Operator Services and Description

Note: TLS, SRTP and SNMP protocols use the Oracle Acme Packet Cryptographic library.
Note: SSH, IKEv2 and IPSec use the Oracle Acme Packet Mocana Cryptographic library.

7.3 Operator Authentication

7.3.1 Crypto-Officer: Password-Based Authentication

In FIPS-approved mode of operation, the module is accessed via Command Line Interface over the Console ports or via SSH, SNMPv3 or HTTPS over the Network Management Ports. Other than status functions available by viewing the Status LEDs, the services described are available only to authenticated operators.

Method	Probability of a Single Successful Random Attempt	Probability of a Successful Attempt within a Minute
Password-Based (CO and User Authentication to management interfaces)	Passwords must be a minimum of 8 characters. The password can consist of alphanumeric values, {a-z, A-Z, 0-9, and special characters], yielding 94 choices per character. The probability of a successful random attempt is 1/94^8, which is less than 1/1,000,000.	Passwords must be a minimum of 8 characters. The password can consist of alphanumeric values, {a-z, A-Z, 0-9, and special characters], yielding 94 choices per character Assuming 10 attempts per second via a scripted or automatic attack, the probability of a success with multiple attempts in a one-minute period is 600/94^8, which is less than 1/100,000.
SNMPv3 Passwords	Passwords must be a minimum of 8 characters. The password can consist of alphanumeric values, {a-z, A-Z, 0-9, and special characters], yielding 94 choices per character.	Passwords must be a minimum of 8 characters. The password can consist of alphanumeric values, {a-z, A-Z, 0-9, and special characters], yielding 94 choices per character. Assuming 10 attempts per second

Method	Probability of a Single Successful Random Attempt	Probability of a Successful Attempt within a Minute
	The probability of a successful random attempt is 1/94^8, which is less than 1/1,000,000.	via a scripted or automatic attack, the probability of a success with multiple attempts in a one-minute period is 600/94^8, which is less than 1/100,000.
Password-Based (SIP Authentication Challenge Response)	Passwords must be a minimum of 12 numeric characters. 0-9, yielding 10 choices per character. The probability of a successful random attempt is 1/10^12, which is less than 1/1,000,000.	Passwords must be a minimum of 12 numeric characters. 0-9, yielding 10 choices per character. Assuming 10 attempts per second via a scripted or automatic attack, the probability of a success with multiple attempts in a one-minute period is 600/10^12, which is less than 1/100,000.

Table 12: Crypto-Officer Authentication

7.3.2 User: Certificate-Based Authentication

The module also supports authentication via digital certificates for the User Role as implemented by the TLS and SSH protocols. The module supports a public key-based authentication with 2048-bit RSA and 2048-bit ECDSA keys.

Method	Probability of a Single Successful Random Attempt	Probability of a Successful Attempt within a Minute
Certificate-Based	A 2048-bit RSA/ECDSA key has at least 112-bits of equivalent strength. The probability of a successful random attempt is 1 /2^112, which is less than 1/1,000,000.	Assuming the module can support 60 authentication attempts in one minute, the probability of a success with multiple consecutive attempts in a one-minute period is 60/2^112, which is less than 1/100,000.

Table 13: User Authentication

7.4 Key and CSP Management

The following keys, cryptographic key components and other critical security parameters are contained in the module. No parts of the SSH, TLS, IKEv1/IKEv2, SNMP or SRTP protocols, other than the KDF, have been tested by the CAVP and CMVP.

CSP Name	Generation/Input	Establishment/ Export	Storage	Use
Operator Passwords	Generated by the crypto officer as per the module policy	**Agreement**: NA **Entry**: Manual entry via console or SSH management session **Output**: Output as part of HA direct physical connection to another box	Non-Volatile RAM	Authentication of the crypto officer and user

CSP Name	Generation/Input	Establishment/ Export	Storage	Use
Firmware Integrity Key (RSA)	Generated externally	**Entry**: RSA (2048 bits) entered as part of Firmware image **Output:** Output as part of HA direct physical connection to another box	Flash	Public key used to verify the integrity of firmware and updates
DRBG Entropy Input String	Generated internally from hardware sources	**Agreement**: NA **Entry**: NA **Output**: None	Volatile RAM	Used in the random bit generation process
DRBG Seed	Generated internally from hardware sources	**Agreement**: NA **Entry**: NA **Output**: None	Volatile RAM	Entropy used in the random bit generation process
DRBG C	Internal value used as part of SP 800-90a HASH_DRBG	**Agreement**: NA **Entry**: NA **Output**: None	Volatile RAM	Used in the random bit generation process
DRBG V	Internal value used as part of SP 800-90A HASH_DRBG	**Agreement**: NA **Entry**: NA **Output**: None	Volatile RAM	Used in the random bit generation process
DRBG V	Internal value used as part of SP 800-90A CTR_DRBG	**Agreement**: NA **Entry**: NA **Output**: None	Volatile RAM	Used in the random bit generation process

CSP Name	Generation/Input	Establishment/ Export	Storage	Use
DRBG Key	Internal value used as part of SP 800-90A CTR DRBG	**Agreement**: NA **Entry**: NA **Output**: None	Volatile RAM	Used in the random bit generation process
Diffie-Hellman Public Key (DH) 2048-bit	Internal generation by FIPS approved CTR_DRBG in firmware	**Agreement**: Diffie-Hellman **Entry**: NA **Output**: None	Volatile RAM	Used to derive the secret session key during DH key agreement protocol
Diffie-Hellman Private Key (DH) 224-bit	Internal generation by FIPS-approved CTR_DRBG	**Agreement**: NA **Entry**: NA **Output**: None	Volatile RAM	Used to derive the secret session key during DH key agreement protocol
ECDH Public Key (P-256)	Internal generation by FIPS-approved CTR_DRBG in firmware	**Agreement:** EC Diffie-Hellman. **Entry: NA** **Output: None**	Volatile RAM	Used to derive the secret session key during ECDH key agreement protocol
ECDH Private Key (P-256)	Internal generation by FIPS-approved CTR_DRBG in firmware	**Agreement:** EC Diffie-Hellman. **Entry: NA** **Output: None**	Volatile RAM	Used to derive the secret session key during ECDH key agreement protocol
SNMP Privacy Key (AES-128)	NIST SP 800-135 KDF	**Agreement**: NIST SP 800-135 KDF **Entry**: NA **Output**: Output as part of HA direct physical connection to another box	Volatile RAM	For encryption / decryption of SNMP session traffic

CSP Name	Generation/Input	Establishment/ Export	Storage	Use
SNMP Authentication Key (HMAC-SHA1)	Internal generation by FIPS-approved CTR_DRBG in firmware	**Agreement**: NA **Output**: Output as part of HA direct physical connection to another box	Volatile RAM	160-bit HMAC-SHA-1 for message authentication and verification in SNMP
SRTP Master Key (AES-128)	Internal generation by FIPS-approved Hash_DRBG in firmware	**Agreement**: Diffie-Hellman **Entry**: NA **Output**: encrypted or output as part of HA direct physical connection to another box	Volatile RAM	Generation of SRTP session keys
SRTP Session Key (AES-128)	NIST SP 800-135 KDF	**Agreement**: NIST SP 800-135 KDF **Entry**: NA **Output**: Output as part of HA direct physical connection to another box	Volatile RAM	For encryption / decryption of SRTP session traffic
SRTP Authentication Key (HMAC-SHA1)	Derived from the master key	**Agreement**: NA **Output:** Output as part of HA direct physical connection to another box	Volatile RAM	160-bit HMAC-SHA-1 for message authentication and verification in SRTP
SSH Authentication Private Key (RSA)	Internal generation by FIPS-approved Hash_DRBG	**Agreement**: RSA (2048/3072 bits) **Output:** Output as part of HA direct physical connection to another box	Flash Memory	RSA private key for SSH authentication

CSP Name	Generation/Input	Establishment/ Export	Storage	Use
SSH Authentication Public Key (RSA)	Internal generation by FIPS-approved Hash_DRBG	**Agreement**: RSA (2048/3072 bits) **Output:** Output as part of HA direct physical connection to another box	Flash Memory	RSA public key for SSH authentication.
SSH Session Keys (AES-128, AES-256)	Derived via SSH KDF. Note: These keys are generated via SSH (IETF RFC 4251). This protocol enforces limits on the number of total possible encryption/decryption operations.	**Agreement**: Diffie-Hellman	Volatile RAM	Encryption and decryption of SSH session
SSH Integrity Keys (HMAC-SHA1)	Derived via SSH KDF.	**Agreement**: NA **Output:** Output as part of HA direct physical connection to another box	Volatile RAM	160-bit HMAC-SHA-1 for message authentication and verification in SSH
TLS Authentication Private Key (ECDSA/RSA)	Internal generation by FIPS-approved CTR_DRBG	**Agreement**: RSA (2048bits); ECDSA (P- 256/P-384) **Output:** Output as part of HA direct physical connection to another box	Flash Memory	ECDSA/RSA private key for TLS authentication
TLS Authentication Public Key (ECDSA/RSA)	Internal generation by FIPS-approved CTR_DRBG	**Agreement**: RSA (2048bits); ECDSA (P- 256/P-384) **Output:** Output as part of HA direct physical connection to another box	Volatile RAM	ECDSA/RSA public key for TLS authentication.

CSP Name	Generation/Input	Establishment/ Export	Storage	Use
TLS Premaster Secret (48 Bytes)	Internal generation by FIPS-approved CTR_DRBG in firmware	**Agreement**: NA **Entry**: Input during TLS negotiation **Output**: Output to peer encrypted by Public Key	Volatile RAM	Establishes TLS master secret
TLS Master Secret (48 Bytes)	Derived from the TLS Pre-Master Secret	**Agreement**: NA	Volatile RAM	Used for computing the Session Key
TLS Session Keys (AES-128, AES-256)	Derived from the TLS Master Secret Note: These keys are generated via TLS (IETF RFC 5246). This protocol enforces limits on the number of total possible encryption/decryption operations.	**Agreement**: RSA key transport	Volatile RAM	Used for encryption & decryption of TLS session
TLS Integrity Keys (HMAC-SHA1)	Internal generation by FIPS-approved CTR_DRBG in firmware	**Agreement**: NA **Output**: Output as part of HA direct physical connection to another box	Volatile RAM	160-bit HMAC-SHA-1 for message authentication and verification in TLS
SKEYSEED (20 Bytes)	Derived by using key derivation function defined in SP800-135 KDF (IKEv2).	**Agreement**: NIST SP 800-135 KDF **Entry**: NA **Output**: Output as part of HA direct physical connection to another box	Volatile RAM	160 bit shared secret known only to IKE peers. Used to derive IKE session keys

CSP Name	Generation/Input	Establishment/ Export	Storage	Use
SKEYID (20 Bytes)	Derived by using key derivation function defined in SP800-135 KDF (IKEv2).	**Agreement**: NIST SP 800-135 KDF **Entry**: NA **Output**: Output as part of HA direct physical connection to another box	Volatile RAM	160 bit secret value used to derive other IKE secrets
SKEYID_d (20 Bytes)	Derived using SKEYID, Diffie Hellman shared secret and other non-secret values through key derivation function defined in SP800-135 KDF (IKEv1/IKEv2).	**Agreement**: NIST SP 800-135 KDF **Entry**: NA **Output**: Output as part of HA direct physical connection to another box	Volatile RAM	160 bit secret value used to derive IKE session keys
IKE Pre-Shared Key	Preloaded by the Crypto Officer.	**Agreement**: NA **Output:** Output as part of HA direct physical connection to another box	Flash Memory	Secret used to derive IKE skeyid when using pre-shared secret authentication
IKE Session Encryption Key (Triple-DES, AES-128, AES-256 bit)	Derived via key derivation function defined in SP800-135 KDF (IKEv1/IKEv2)	**Agreement**: NIST SP 800-135 KDF **Entry**: NA **Output**: Output as part of HA direct physical connection to another box	Volatile RAM	Triple-DES, AES 128 and 256 key used to encrypt data

CSP Name	Generation/Input	Establishment/ Export	Storage	Use
IKE Session Authentication Key (HMAC-SHA-512)	Derived via key derivation function defined in SP800-135 KDF (IKEv1/IKEv2)	**Agreement**: NIST SP 800-135 KDF **Entry**: NA **Output**: Output as part of HA direct physical connection to another box	Volatile RAM	512 bit key HMAC-SHA-512 used for data authentication
IKE Private Key (RSA 2048 bit)	Internal generation by FIPS-approved CTR_DRBG in firmware	**Agreement**: RSA (2048 bits) **Output:** Output as part of HA direct physical connection to another box	Volatile RAM	RSA 2048 bit key used to authenticate the module to a peer during IKE
IKE Public Key (RSA 2048-bit)	Internal generation by FIPS-approved CTR_DRBG in firmware	**Agreement**: RSA (2048 bits) **Output:** Output as part of HA direct physical connection to another box	Volatile RAM	RSA 2048 bit public key for TLS authentication
IPsec Session Encryption Key (Triple-DES, AES-128 or AES-256 bit)	Derived via a key derivation function defined in SP800-135 KDF (IKEv1/IKEv2).	**Agreement**: NIST SP 800-135 KDF **Entry**: NA **Output**: Output as part of HA direct physical connection to another box	Volatile RAM	Triple-DES, AES 128 or 256 bit key used to encrypt data

CSP Name	Generation/Input	Establishment/ Export	Storage	Use
IPsec Session Authentication Key (HMAC-SHA-512)	Derived via a key derivation function defined in SP800-135 KDF (IKEv1/IKEv2).	**Agreement**: NIST SP 800-135 KDF **Entry**: NA **Output**: Output as part of HA direct physical connection to another box	Volatile RAM	512 bit HMAC-SHA-512 key used for data authentication for IPsec traffic
Web UI Certificate	Internal generation by FIPS approved CTR_DRBG in firmware	**Agreement:** NA **Output:** TLS session with operator	Flash	Web server certificate
Bypass Key (HMAC-SHA-256)	HMAC-SHA-256 Bypass	**Agreement:** NA **Output:** NA	Flash	256-bit HMAC-SHA-256 key used by Bypass service

Table 14: CSP Table

Note: When the module generates symmetric keys or seeds used for generating asymmetric keys, unmodified DRBG output is used as the symmetric key or as the seed for generating the asymmetric keys.

Note: All keys generated by the module use the direct output of a FIPS approved DRBG. This meets the requirements of SP 800-133.

8. Self-Tests

The modules include an array of self-tests that are run during startup and conditionally during operations to prevent any secure data from being released and to ensure all components are functioning correctly. Self-tests may be run on-demand by power cycling the module.

8.1 Power-Up Self-Tests

Acme Packet 1100 and Acme Packet 3900 appliances perform the following power-up self-tests when power is applied to the module. These self-tests require no inputs or actions from the operator:

8.1.1 Firmware Integrity Test

- Firmware Integrity Test (RSA 2048/SHA-256)

8.1.2 Mocana Cryptographic Library Self-Tests

- AES (Encrypt/Decrypt) Known Answer Test;
- Triple-DES (Encrypt/Decrypt) Known Answer Test;
- SHA-1 Known Answer Test;
- SHA-256 Known Answer Test;
- SHA-384 Known Answer Test;
- SHA-512 Known Answer Test;
- HMAC-SHA-1 Known Answer Test;
- HMAC-SHA-256 Known Answer Test;
- HMAC-SHA-384 Known Answer Test;
- HMAC-SHA-512 Known Answer Test; and
- RSA verify Known Answer Test.

8.1.3 Oracle Acme Packet Cryptographic Library Self-tests

- SHA-1 Known Answer Test;
- SHA-256 Known Answer Test;
- SHA-512 Known Answer Test;
- HMAC-SHA-1 Known Answer Test;
- HMAC-SHA-256 Known Answer Test;
- HMAC-SHA-384 Known Answer Test;
- HMAC-SHA-512 Known Answer Test;
- AES (Encrypt/Decrypt) Known Answer Test;
- AES GCM (Encrypt/Decrypt) Known Answer Test;
- SP 800-90A HASH DRBG Known Answer Test;
- SP 800-90A CTR DRBG Known Answer Test;
- RSA sign/verify Known Answer Test; and
- ECDSA sign/verify Known Answer Test.

When the module is in a power-up self-test state or error state, the data output interface is inhibited and remains inhibited until the module can transition into an operational state. While the CO may attempt to restart the module in an effort to clear an error, the module will require re-installation in the event of a hard error such as a failed self-test.

8.2 Critical Functions Self-Tests

Acme Packet 1100 [1] and Acme Packet 3900 [2] appliances perform the following critical self-tests. These critical function tests are performed for each SP 800-90A DRBG implemented within the module.

- SP 800-90A Instantiation Test
- SP 800-90A Generate Test
- SP 800-90A Reseed Test
- SP 800-90A Uninstantiate Test

8.3 Conditional Self-Tests

The module performs the following conditional self-tests when called by the module.

- Pair Wise consistency tests to verify that the asymmetric keys generated for RSA, and ECDSA work correctly by performing a sign and verify operation;
- Continuous Random Number Generator test to verify that the output of approved-DRBG is not the same as the previously generated value for both DRBGs;
- Continuous Random Number Generator test to verify that the output of entropy is not the same as the previously generated value;
- Bypass conditional test using HMAC-SHA-256 to ensure the mechanism governing media traffic is functioning correctly, and;
- Firmware Load test using a 2048-bit/SHA-256 RSA-Based integrity test to verify firmware to be loaded into the module.

9. Crypto-Officer and User Guidance

FIPS Mode is enabled by a license installed by Oracle, which will open/lock down features where appropriate. This section describes the configuration, maintenance, and administration of the cryptographic module.

9.1 Secure Setup and Initialization

The operator shall set up the device as defined in the Session Border Controller ACLI Configuration Guide. The Crypto-Officer shall also:

- Verify that the firmware version of the module is Version S-Cz8.2.0.
- A new account for the Crypto-Officer and User shall be created as part of Setup and Initialization process. Upon creation of the new CO and User accounts the "default" accounts shipped with the module shall be disabled.
- Ensure all traffic is encapsulated in a TLS, SSH, or SRTP tunnel as appropriate.
- HTTPS shall be enabled and configure the web server certificate prior to connecting to the WebUI over TLS.
- Ensure that SNMP V3 is configured with AES-128/HMAC only.
- Ensure IKEv1 and IKEv2 is using AES CBC or CTR mode for encryption and HMAC-SHA-512 for authentication
- Ensure SSH is configured to use AES CTR mode for encryption.
- Ensure SSH and IKEv1/IKEv2 only use Diffie-Hellman group 14 in FIPS approved mode.
- Ensure all management traffic is encapsulated within a trusted session (i.e., Telnet should not be used in FIPS mode of operation).
- Ensure RSA keys are at least 2048-bit keys for TLS, IKEv1/IKEv2. No 512-bit or 1024-bit keys can be used in FIPS mode of operation.
- All operator passwords must be a minimum of 8 characters in length.
- Ensure use of FIPS-approved algorithms for TLS:
  - TLS_ECDHE_ECDSA_WITH_AES_256_GCM_SHA384
  - TLS_ECDHE_ECDSA_WITH_AES_128_GCM_SHA256
  - TLS_ECDHE_RSA_WITH_AES_256_GCM_SHA384
  - TLS_ECDHE_RSA_WITH_AES_128_GCM_SHA256
  - TLS_ECDHE_RSA_WITH_AES_256_CBC_SHA384
  - TLS_ECDHE_RSA_WITH_AES_128_CBC_SHA256
  - TLS_DHE_RSA_WITH_AES_256_GCM_SHA384
  - TLS_DHE_RSA_WITH_AES_128_GCM_SHA256
  - TLS_DHE_RSA_WITH_AES_128_CBC_SHA256
  - TLS_DHE_RSA_WITH_AES_256_CBC_SHA256
- Be aware that when configuring High Availability (HA), only a local HA configuration to a directly connected box via a physical cable over the management port is allowed in FIPS Approved Mode. Remote HA is not allowed in FIPS Approved mode.
- Be aware that HA configuration data that contains keys and CSP's must never be transported over an untrusted network. Ensure that the HA ports used for the transport of HA data (including keys and CSP's) are bound to a private IP address range during setup.
- Be aware that only the HA state transactions between the two devices over the direct physical connection are permitted over those dedicated ports.
- RADIUS and TACACS+ shall not be used in FIPS approved mode.
- Any firmware loaded into this module that is not shown on the module certificate, is out of the scope of this validation and requires a separate FIPS 140-2 validation.

Services in Table 5 of Section 3.5 make use non-compliant cryptographic algorithms. Use of these algorithms will place the module in a non-Approved mode of operation.

9.2 AES-GCM IV Construction/Usage

The AES-GCM IV is used in the following protocols:

- TLS: The TLS AES-GCM IV is generated in compliance with TLSv1.2 GCM cipher suites as specified in RFC 5288 and section 3.3.1 of NIST SP 800-52rev1. Per RFC 5246, when the nonce_explicit part of the IV exhausts the maximum number of possible values for a given session key, the module will trigger a handshake to establish a new encryption key.

In case the module's power is lost and then restored, the key used for the AES GCM encryption or decryption shall be redistributed.

Note: IKE/IPSec does not use AES GCM.

10. Mitigation of Other Attacks

The module does not mitigate attacks beyond those identified in FIPS 140-2.

Acronyms, Terms and Abbreviations

Term	Definition
AES	Advanced Encryption Standard
CMVP	Cryptographic Module Validation Program
CDR	Call Data Record
CSEC	Communications Security Establishment Canada
CSP	Critical Security Parameter
DHE	Diffie-Hellman Ephemeral
DRBG	Deterministic Random Bit Generator
ECDSA	Elliptic Curve Digital Signature Algorithm
ESBC	Enterprise Session Border Controller
EDC	Error Detection Code
EMS	Enterprise Management Server
HA	High Availability
HMAC	(Keyed) Hash Message Authentication Code
IKE	Internet Key Exchange
KAT	Known Answer Test
KDF	Key Derivation Function
LED	Light Emitting Diode
MGT	Management
NIST	National Institute of Standards and Technology
NVRAM	Non-Volatile RAM
POST	Power-On Self-Test
PUB	Publication
RAM	Random Access Memory
ROM	Read Only Memory
SHA	Secure Hash Algorithm
SIP	Session Initiation Protocol
SNMP	Simple Network Management Protocol
SRTP	Secure Real Time Protocol
TDM	Time Division Multiplexing
TLS	Transport Layer Security

Table 15: Acronyms, Terms, and Abbreviations

References

The FIPS 140-2 standard, and information on the CMVP, can be found at http://csrc.nist.gov/groups/STM/cmvp/index.html.
More information describing the module can be found on the Oracle web site at https://www.oracle.com/industries/communications/enterprise/products/session-border-controller/index.html.
This Security Policy contains non-proprietary information. All other documentation submitted for FIPS 140-2 conformance testing and validation is "Oracle - Proprietary" and is releasable only under appropriate non-disclosure agreements.

Document	Author	Title
FIPS PUB 140-2	NIST	FIPS PUB 140-2: Security Requirements for Cryptographic Modules
FIPS IG	NIST	Implementation Guidance for FIPS PUB 140-2 and the Cryptographic Module Validation Program
FIPS PUB 140-2 Annex A	NIST	FIPS 140-2 Annex A: Approved Security Functions
FIPS PUB 140-2 Annex B	NIST	FIPS 140-2 Annex B: Approved Protection Profiles
FIPS PUB 140-2 Annex C	NIST	FIPS 140-2 Annex C: Approved Random Number Generators
FIPS PUB 140-2 Annex D	NIST	FIPS 140-2 Annex D: Approved Key Establishment Techniques
DTR for FIPS PUB 140-2	NIST	Derived Test Requirements (DTR) for FIPS PUB 140-2, Security Requirements for Cryptographic Modules
NIST SP 800-67	NIST	Recommendation for the Triple Data Encryption Algorithm TDEA Block Cypher
FIPS PUB 197	NIST	Advanced Encryption Standard
FIPS PUB 198-1	NIST	The Keyed Hash Message Authentication Code (HMAC)
FIPS PUB 186-4	NIST	Digital Signature Standard (DSS)
FIPS PUB 180-4	NIST	Secure Hash Standard (SHS)
NIST SP 800-131A	NIST	Recommendation for the Transitioning of Cryptographic Algorithms and Key Sizes
PKCS#1	RSA Laboratories	PKCS#1 v2.1: RSA Cryptographic Standard

Table 16: References