Axway Inc.

Axway Security Kernel

(Software Version: 3.0)

FIPS 140-2
Non-Proprietary Security Policy

Level 1 Validation

Document Version 2.0

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Table of Contents

1.1 PURPOSE 4
1.2 REFERENCES 4
1.3 DOCUMENT ORGANIZATION 4

2 AXWAY SECURITY KERNEL 5
2.1 OVERVIEW 5
2.2 MODULE INTERFACES 8
2.3 ROLES AND SERVICES 11
2.3.1 Crypto Officer Role 11
2.3.2 User Role 12
2.3.3 Non-approved services 13
2.4 PHYSICAL SECURITY 15
2.5 OPERATIONAL ENVIRONMENT 16
2.6 CRYPTOGRAPHIC KEY MANAGEMENT 17
2.6.1 Key Generation 18
2.6.2 Key Input/Output 18
2.6.3 Key Storage 18
2.6.4 Key Zeroization 18
2.7 SELF-TESTS 19
2.8 DESIGN ASSURANCE 19
2.9 MITIGATION OF OTHER ATTACKS 19

3 SECURE OPERATION 20
3.1 CRYPTO OFFICER GUIDANCE 20
3.1.1 Operation System Configuration 20
3.1.2 Initialization 22
3.1.3 Zeroizaion 22
3.1.4 Management 22
3.2 USER GUIDANCE 22

4 ACRONYMS 23

Table of Figures

FIGURE 1 – LOGICAL CRYPTOGRAPHIC BOUNDARY 8
FIGURE 2 – LOGICAL CRYPTOGRAPHIC BOUNDARY AND INTERACTIONS WITH SURROUNDING COMPONENTS 9
FIGURE 3 – STANDARD PC PHYSICAL BLOCK DIAGRAM 10

Table of Tables

TABLE 1 – BINARY FORMS OF THE KERNEL 5
TABLE 2 – FIPS APPROVED ALGORITHMS 6
TABLE 3 – SECURITY LEVEL PER FIPS 140-2 SECTION 7
TABLE 4 – FIPS 140-2 LOGICAL INTERFACES 11
TABLE 5 – MODULE ROLES AND PRIVILEGES 11
TABLE 6 – CRYPTO OFFICER SERVICES 11
TABLE 7 – USER SERVICES 12
TABLE 8 – NON-APPROVED SERVICES 14
TABLE 9 – LIST OF CRYPTOGRAPHIC KEYS, CRYPTOGRAPHIC KEY COMPONENTS, AND CSPS 17
TABLE 10 – ACRONYMS 23

INTRODUCTION

1.1 Purpose

This document is a non-proprietary Cryptographic Module Security Policy for the Axway Security Kernel from Axway Inc. This Security Policy describes how the Axway Security Kernel meets the security requirements of FIPS 140-2 and how to run the module in a secure FIPS 140-2 mode. This policy was prepared as part of the Level 1 FIPS 140-2 validation of the module.

FIPS 140-2 (Federal Information Processing Standards Publication 140-2 – *Security Requirements for Cryptographic Modules*) details the U.S. and Canadian Government requirements for cryptographic modules. More information about the FIPS 140-2 standard and validation program is available on the National Institute of Standards and Technology (NIST) Cryptographic Module Validation Program (CMVP) website at: http://csrc.nist.gov/groups/STM/cmvp/index.html.

In this document, the Axway Security Kernel is referred to as the kernel or the module. The client application represents the software program linked with the cryptographic libraries provided by the Axway Security Kernel. The Validation Authority Suite and MailGate are currently the only applications making use of the Axway Security Kernel. However, it is expected that a range of products developed by Axway Inc., will be supported by the Axway Security Kernel in the future.

1.2 References

This document deals only with the operations and capabilities of the module in the technical terms of a FIPS 140-2 cryptographic module security policy. More information is available on the module from the following sources:

- The Axway website (http://www.axway.com) contains information on the full line of products from Axway.
- The CMVP website (http://csrc.nist.gov/groups/STM/cmvp/index.html) contains contact information for answers to technical or sales-related questions for the module.

1.3 Document Organization

The Security Policy document is one document in a FIPS 140-2 submission package. In addition to this document, the Submission Package contains:

- Vendor Evidence document
- Finite State Machine
- Other supporting documentation as additional references

This Security Policy and the other validation submission documentation were reviewed by InfoGard under contract to Axway. With the exception of this Non-Proprietary Security Policy, the FIPS 140-2 Validation Documentation is proprietary to Axway and is releasable only under appropriate non-disclosure agreements. For access to these documents, please contact Axway.

2 Axway Security Kernel

2.1 Overview

The Axway Security Kernel (version 3.0) is a software cryptographic module implemented as two dynamic link libraries (DLLs) on Windows or two Shared Objects (SOs) on Linux and SunOS. The Axway Security Kernel is a user space shared library. It does not modify or become part of the Operating System (OS) kernel. Table 1 gives the operating systems and corresponding file names of the kernel.

The module has been tested and validated on Microsoft Windows 2012 (64 bit) on a Dell PowerEdge R620 Server, RHEL 6.3 (64 bit) on a Dell PowerEdge R620 Server, Solaris 10 on a Sun Blade T6300 Server (64 bit) (each configured for single user mode). Compliance is maintained on following platforms including (but not limited to):

- Windows XP 32 and 64 bit
- Windows 2003 R2 32 and 64 bit
- Windows Vista 32 and 64 bit
- Windows 2008 32 and 64 bit
- Windows 7 32 and 64 bit
- Windows 2008 R2 64 bit
- Windows 2012 64bit
- Windows 8 32 and 64 bit
- RHEL 5.X 32 and 64 bit
- RHEL 6.X 32 and 64 bit
- SLES 10 64 bit
- SLES 11 64 bit
- Solaris 9/Zones Solaris 9 32 and 64 bit
- Solaris 10/Zones Solaris 10 32 and 64 bit
- Solaris 11/Zones Solaris 11 32 and 64 bit

The platforms supported by the module are binary compatible with the platforms used in the FIPS validation. The CMVP makes no statement as to the correct operation of the module on the operational environments for which testing was not performed.

Table 1 – Binary Forms of the Kernel

Operating Systems	Binary File Names
Windows XP 32 and 64 bit Windows 2003 R2 32 and 64 bit Windows Vista 32 and 64 bit Windows 2008 32 and 64bit Windows 7 32 and 64 bit Windows 2008 R2 64 bit Windows 2012 64bit Windows 8 32 and 64 bit	libeay32-TMWD.dll ssleay32-TMWD.dll
Linux kernel 2.6.13 and later versions RHEL 5.X 32 and 64 bit RHEL 6.X 32 and 64 bit SLES 10 and SLES 11 64 bit	libcrypto-TMWD.so.1.0.0 libssl-TMWD.so. 1.0.0
Solaris 9/ Zones Solaris 9 32 and 64 bit Solaris 10/ Zones Solaris 10 32 and 64 bit Solaris 11/Zones Solaris 11 32 and 64 bit	libcrypto-TMWD.so.1.0.0 libssl-TMWD.so.1.0.0

The kernel is built upon a custom version of OpenSSL 1.0.0k. As a cryptographic module, the Axway Security Kernel presents an identical application programming interface (API) to several products of the Axway Inc., including Axway Validation Authority Suite and MailGate.

The cryptographic capabilities of Validation Authority and MailGate are provided by the Axway Security Kernel. Validation Authority offers a comprehensive, scalable, and reliable framework for real-time validation of digital certifications for the Public Key Infrastructure (PKI). Governments and businesses worldwide rely on PKI and digital certificates issued by certificate authorities (CAs) to secure information transmissions on the internet. Not all certificates are valid. Some may be fake, expired, or revoked. Therefore, it is of vital importance to make sure that only valid certificates are trusted. Validation Authority provides a variety of PKI and certificate management functionality such as real-time validation of digital certificates issued by any CA. The MailGate platform is capable of performing tasks such as email encryption, secure file collaboration, network defense, content filtering, and data protection.

The Axway Security Kernel supports the following FIPS-approved algorithms:

Table 2 – FIPS Approved Algorithms

FIPS Approved Algorithms	
AES (Cert. #2446)	Encrypt/Decrypt - ECB, CBC, CFB128, OFB and CTR modes; 128,192 and 256 bits
TDES (Cert. #1511)	Triple-DES Encrypt/Decrypt: 112 bits (for 2-key) and 168 bits (for 3-key), in TECB, TCBC, TCFB64, and TOFB modes Note: the use of two-key Triple DES for encryption is **restricted** through December 31st, 2015: the total number of blocks of data encrypted with the same cryptographic key **shall not** be greater than 2^20. After December 31, 2015, two-key Triple DES **shall not** be used for encryption.
SHA (Cert. #2080)	SHA-1 SHA-2: SHA-224, SHA-256, SHA-384 and SHA-512
HMAC (Cert. #1510)	HMAC-SHA-1: 160-bit MAC and 512-bit key
DSA (Cert. #760)	FIPS 186-2 DSA using SHA-1: - Signature Verification; 1024-bit - PQG Verification; 1024-bit
ECDSA (Cert. #402)	FIPS 186-2 ECDSA using SHA-1: - Key Generation using curves P-224, K-233, and B-233 - PKV using curves P-192, P-224, B-163, and B-233 - Signature Verification using curves P-192, P-224, K-163, K-233, B-163, and B-233
RNG (Cert. #1196)	FIPS 186-2 Appendix 3.1
RSA (Cert. #1257)	FIPS 186-2 RSA: - ANSI X9.31 Key Generation; 2048 and 4096-bit - PKCS #1 V1.5 Signature Generation: 4096-bit using SHA-2 - PKCS #1 V1.5 Signature Verification: 1024, 2048, and 4096-bit using SHA-1 and SHA-2
CVL (Cert. #76)	SP 800-135 KDF

The Axway Security Kernel supports the following non-Approved but allowed algorithms:

- Diffie-Hellman 2048-bit - for key establishment in TLS sessions (key agreement; key establishment methodology provides 112 bits of encryption strength)
- EC Diffie-Hellman using P-224, P-256, P-384, P-521, K-233, K-283, K-409, K-571, B-233, B-283, B-409, and B-571 curves (key agreement; key establishment methodology provides between 112 and 256 bits of encryption strength)
- RSA 2048-bit - for key transport in TLS sessions (key wrapping; key establishment methodology provides 112 bits of encryption strength)
- MD5 for use within TLS only.

Apart from the tested algorithms, the Axway Security Kernel also provides the following non-approved algorithms:

- Algorithms Disallowed as of January 1, 2014 per the NIST SP 800-131A algorithm transitions:
  - FIPS 186-2 DSA using SHA-1: Signature generation, PQG generation, and Key generation; 1024-bit (Cert. #760)
  - FIPS 186-2 ECDSA using SHA-1: Signature generation (P-192, P-224, K-163, K-233, B-163, and B-233 curves), Key generation (P-192, K-163, and B-163 curves) (Cert. #402)
  - FIPS 186-2 RSA: ANSI X9.31 Key generation (1024-bit), PKCS #1 V1.5 Signature generation (1024-bit using SHA-1 and SHA-2; 4096-bit using SHA-1) (Cert. #1257)
  - Diffie-Hellman 1024-bit (key agreement; key establishment methodology provides 80 bits of encryption strength; non-compliant)
  - EC Diffie-Hellman using P-192, K-163 or B-163 curves (key agreement; key establishment methodology provides less than 112 bits of encryption strength; non-compliant)
  - RSA Encrypt/Decrypt 1024-bit (key wrapping; key establishment methodology provides 80 bits of encryption strength; non-compliant)
- Blowfish
- Camellia
- Cast
- DES
- des_old
- DTLS1
- ec, krb5_asn
- KSSL
- MD4, MD5
- MDC2, RC2, RC4
- RIPEMD,
- Seed
- Whirlpool

The Axway Security Kernel supports both a FIPS-Approved and non-Approved mode of operation. An operator can determine which mode the module is in based on the service being performed. Please see section 2.3 below for a list of Approved and non-Approved services.

The Axway Security Kernel is validated at FIPS 140-2 section levels shown in Table 2. Note that in Table 2, N/A indicates “Not Applicable”.

Table 3 – Security Level Per FIPS 140-2 Section

Section	Section Title	Level
1	Cryptographic Module Specification	1
2	Cryptographic Module Ports and Interfaces	1
3	Roles, Services, and Authentication	1
4	Finite State Model	1
5	Physical Security	N/A
6	Operational Environment	1
7	Cryptographic Key Management	1
8	EMI/EMC (Electromagnetic Interference/Compatibility)	1
9	Self-Tests	1
10	Design Assurance	1
11	Mitigation of Other Attacks	N/A

2.2 Module Interfaces

The Axway Security Kernel is a software module that meets overall level 1 of FIPS 140-2 requirements. The logical cryptographic boundary of the module consists of the Axway Security Kernel running on different OSs. The module is composed of two binary files cross-compiled on the OS. Table 1 summarizes the platforms and the binary files.

Figure 1 shows the logical cryptographic boundary of the kernel. The module provides a set of cryptographic services (API calls) in areas such as Transport Layer Security (TLS), RNG, and Public Key Cryptography Standard (PKCS) #12 certificate management.

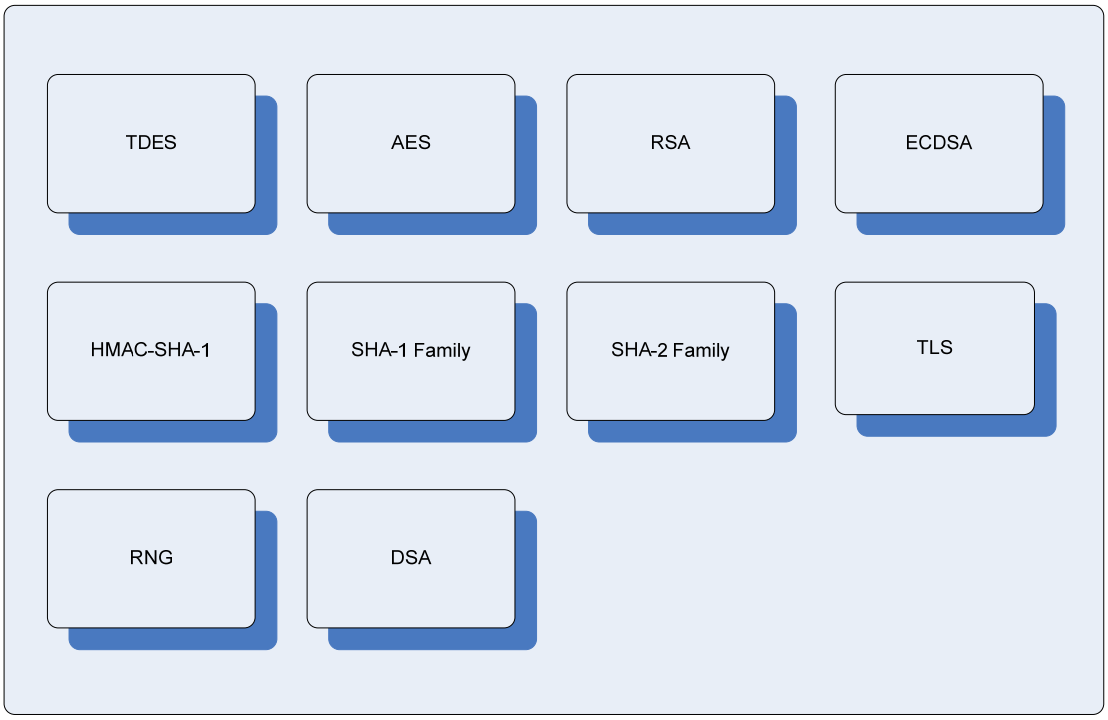


Figure 1 – Logical Cryptographic Boundary

The kernel's interactions with surrounding components, including the Central Processing Unit (CPU), hard-disk, memory, client application, and the OS are demonstrated in Figure 2.

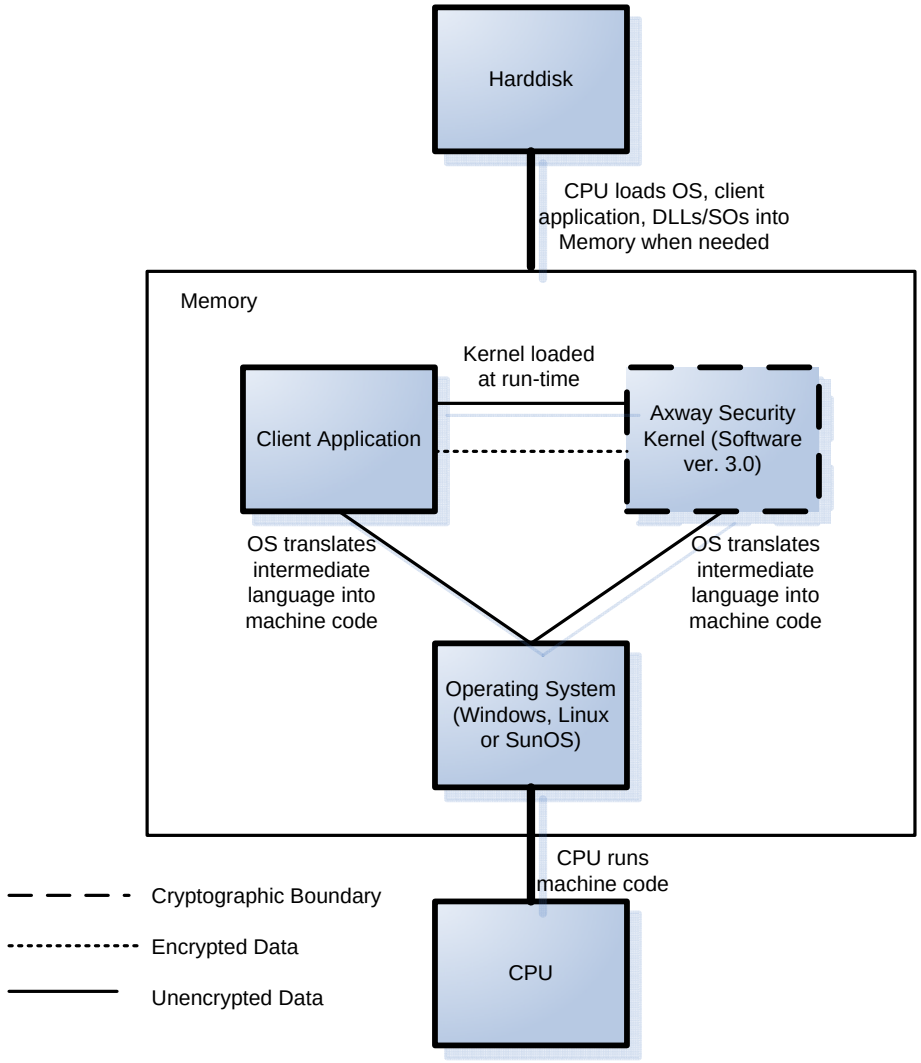
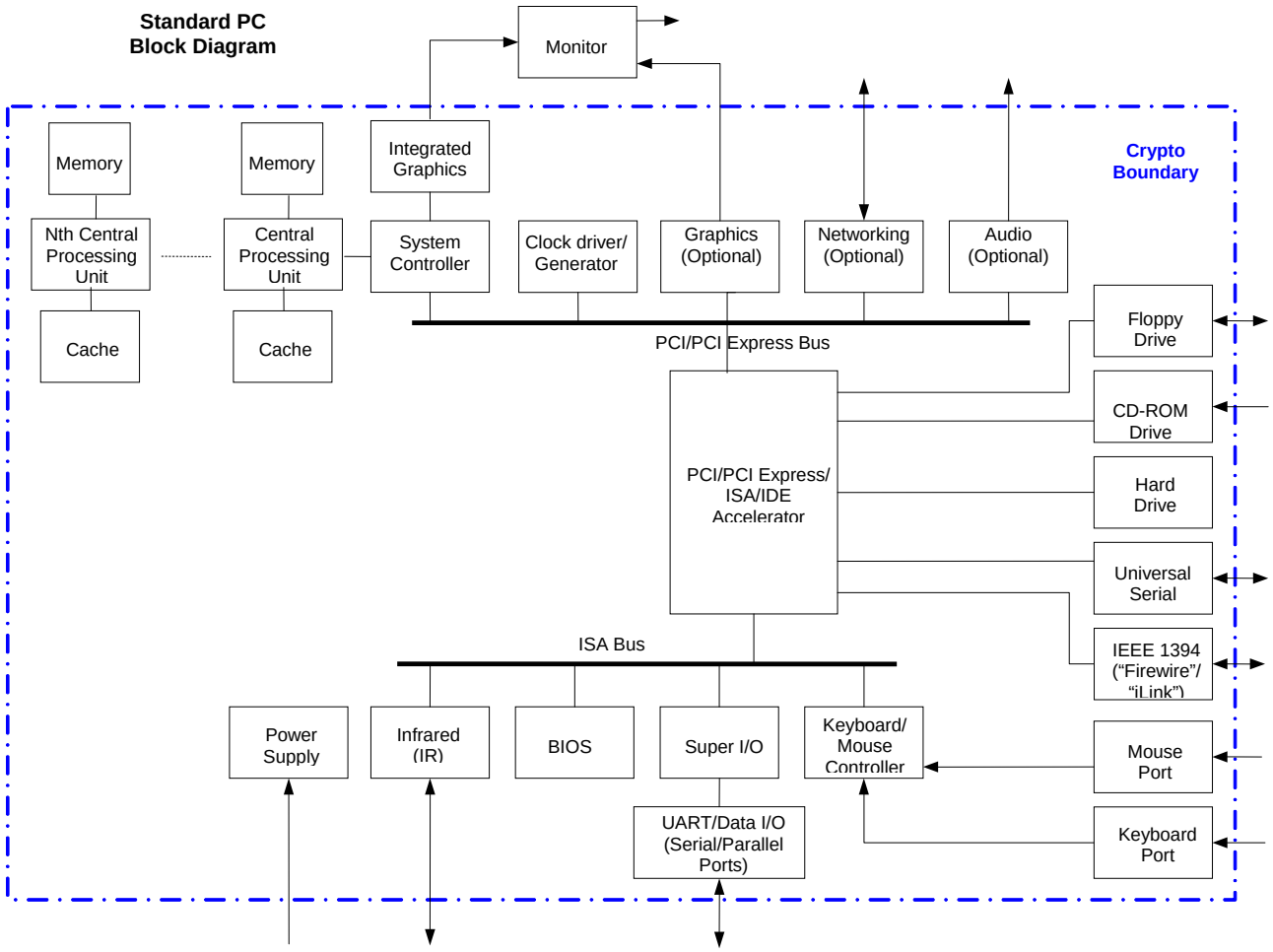


Figure 2 – Logical Cryptographic Boundary and Interactions with Surrounding Components

In addition to the binaries, the physical device consists of the integrated circuits of the motherboard, the CPU, Random Access Memory (RAM), Read-Only Memory (ROM), computer case, keyboard, mouse, video interfaces, expansion cards, and other hardware components included in the PC such as hard disk, floppy disk, Compact Disc ROM (CD-ROM) drive, power supply, and fans. The physical cryptographic boundary of the module is the hard opaque metal and plastic enclosure of the PC, server, or mainframe running the module. The block diagram for a standard PC is shown in Figure 3. The physical block diagram for a server or a mainframe is similar to Figure 3. Note that in this figure, I/O means Input/Output, BIOS stands for Basic Input/Output System, PCI stands for Peripheral Component Interconnect, ISA stands for Instruction Set Architecture, and IDE represents Integrated Drive Electronics.

Figure 3 – Standard PC Physical Block Diagram



All of these physical interfaces are separated into logical interfaces defined by FIPS 140-2, as described in Table 3.

Table 4 – FIPS 140-2 Logical Interfaces

Logical Interface	Axway Security Kernel Port/Interface	Module Mapping
Data Input Interface	Keyboard, mouse, CD-ROM, floppy disk, and serial/Universal Serial Bus (USB)/parallel/network ports	Arguments for API calls that contain data to be used or processed by the kernel
Data Output Interface	Hard Disk, floppy disk, monitor, and serial/USB/parallel/network ports	Arguments for API calls that contain kernel response data to be used or processed by the caller
Control Input Interface	Keyboard, CD-ROM, floppy disk, mouse, and serial/USB/parallel/network port	API function calls
Status Output Interface	Hard Disk, floppy disk, monitor, and serial/USB/parallel/network ports	Arguments for API calls, function return value, error message
Power Interface	Power Interface	Not Applicable

2.3 Roles and Services

The operators of the module can assume two roles as required by FIPS 140-2: a Crypto Officer role and a User role. The operator of the module assumes either of the roles based on the operations performed without any authentication. Table 5 gives a brief description of the roles and their privileges.

Table 5 – Module Roles and Privileges

Role Name	Role Privileges
Crypto Officer	1. Installing/uninstalling the kernel on the specific platform. 2. Initiating power-up self-tests.
User	Performing cryptographic services by making API calls to the kernel.

The following subsections detail both of the roles and their responsibilities.

2.3.1 Crypto Officer Role

The Crypto Officer role has the ability to install and uninstall the module and run power-up self-tests. Descriptions of the services available to the Crypto Officer role are provided in Table 6, where CSP refers to Critical Security Parameter.

Table 6 – Crypto Officer Services

Service	Description	Input	Output	CSP and Type of Access
Install kernel	Installs and configures the kernel	Command	Success or failure	None
Uninstall kernel	Remove the kernel from the OS	Command	Success or failure	None
Initiate power-up self-tests	Power-up self-tests include: (1) software integrity test; (2) Known Answer Tests (KATs) for TDES, AES, RSA, SHA-1, SHA-256, SHA-512, RNG, DSA, TLS-KDF; (3) pair-wise consistency test for ECDSA keys	Command	Pass or failure	None

2.3.2 User Role

The User role accesses the module's cryptographic services that include encryption, decryption, and authentication functionality. Descriptions of the services available to the User role are provided in Table 7.

Table 7 – User Services

Service	Description	Input	Output	CSP and Type of Access
TDES encryption Note: For 2-key TDES, the total number of blocks of data encrypted with the same key is not greater than 2^20.	Encrypt using TDES	Command, plaintext, keys	Status, ciphertext	TDES symmetric keys - READ
TDES decryption	Decrypt using TDES	Command, ciphertext, keys	Status, plaintext	TDES symmetric keys - READ
TDES key generation	Generate a TDES symmetric keys using FIPS 186-2 Appendix 3.1 RNG	Command, key length	Status, symmetric keys	TDES symmetric keys - READ/WRITE
AES encryption	Encrypt plaintext using AES	Command, plaintext, key	Status, ciphertext	AES symmetric key - READ
AES decryption	Decrypt AES-encrypted ciphertext	Command, ciphertext, key	Status, plaintext	AES symmetric key - READ
AES key generation	Generate an AES symmetric key using FIPS 186-2 Appendix 3.1 RNG and set the key schedule	Command, key length	Status, symmetric key	AES symmetric key - READ/WRITE
RSA encryption	Encrypt plaintext using RSA 2048-bit	Command, plaintext, RSA public key	Status, ciphertext	RSA public key - READ
RSA decryption	Decrypt RSA-encrypted ciphertext (2048-bit)	Command, ciphertext, RSA private key	Status, plaintext	RSA private key - READ
RSA signature generation	Sign data using RSA 4096-bit w/SHA-2	Command, data to be signed, RSA private key	Status, digital signature	RSA private key - READ
RSA signature verification	Verify an RSA signature (1024, 2048, or 4096-bit using SHA-1 or SHA-2)	Command, data and signature, RSA public key	Status, acceptance/denial	RSA public key - READ
RSA key-pair generation	Generate a RSA key-pair (2048 and 4096-bit)	Command, key length	Status, RSA private key and public key	RSA private key and public key - WRITE
ECDSA signature verification	Verify an ECDSA signature (using curves P-192, P-224, K-163, K-233, B-163, and B-233)	Command, data and signature	Status, acceptance/denial	ECDSA public key - READ

Service	Description	Input	Output	CSP and Type of Access
ECDSA key-pair generation	Generate an ECDSA key-pair (curves P-224, K-233, and B-233)	Command, key length	Status, ECDSA private key and public key	ECDSA private key and public key - WRITE
SHA-512 digest generation	Generate a SHA-512 digest	Command, message to be hashed	Status, 512-bit message digest	None
SHA-384 digest generation	Generate a SHA-384 digest	Command, message to be hashed	Status, 384-bit message digest	None
SHA-256 digest generation	Generate a SHA-256 digest	Command, message to be hashed	Status, 256-bit message digest	None
SHA-224 digest generation	Generate a SHA-224 digest	Command, message to be hashed	Status, 224-bit message digest	None
SHA-1 digest generation	Generate a SHA-1 digest	Command, message to be hashed	Status, 160-bit message digest	None
HMAC-SHA-1 key generation	Generate a HMAC-SHA-1 symmetric key	Command	Status, 512-bit HMAC-SHA-1 symmetric key	HMAC-SHA-1 key - WRITE
HMAC-SHA-1 digest generation	Generate a HMAC-SHA-1 digest	Command, message to be hashed, key	Status, 160-bit HMAC-SHA-1 message digest	HMAC-SHA-1 key - READ
DSA signature verification	Verify a DSA signature (1024-bit)	Command, data and signature	Status, acceptance/denial	DSA public key - READ
Random number generation	Generate a random number	Command, seed, length	Status, random number	Seed - READ/WRITE
Establish a TLS session Note: the TLS protocol has not been reviewed or tested by the CAVP or the CMVP.	Establish a new TLS session	Command	Status, session ID	None
Show status	Show status of a service (function call)	Command	Status	None
DH 2048-bit	Compute shared secret key	Command and key	Shared secret key	Shared secret key – READ
ECDH (using P-224, P-256, P-384, P-521, K-233, K-283, K-409, K-571, B-233, B-283, B-409, and B-571 curves)	Compute shared secret key	Command and key	Shared secret key	Shared secret key – READ
Load Seed	Loads RNG seed from calling application	Command and seeding data	None	Seed - READ/ WRITE

Note: The module generates cryptographic keys whose strengths are modified by available entropy. There is no assurance of the minimum strength of generated keys.

2.3.3 Non-Approved services

The following are the non-Approved services available for User role, these provide non-Approved cryptographic services that include encryption, decryption, and authentication functionality. Descriptions of the non-Approved services available to the User role are provided in Table 7.

Table 8 – Non-Approved Services

Service	Description	Input	Output
DSA signature generation	Sign data using DSA (1024-bit w/SHA-1)	Command, data to be signed	Status, digital signature
ECDSA signature generation	Sign data using ECDSA (P-192, P-224, K-163, K-233, B-163, and B-233 curves)	Command, data to be signed	Status, digital signature
ECDSA Key Generation	Generate an ECDSA key-pair (P-192, K-163, and B-163 curves)	Command, key length	Status, ECDSA private key and public key
RSA Key Generation	Generate an RSA key-pair (1024-bit)	Command, key length	Status, RSA private key and public key
RSA signature generation	Sign data using RSA (1024-bit using SHA-1 and SHA-2; 4096-bit using SHA-1)	Command, data to be signed	Status, digital signature
RSA encryption	Encrypt plaintext using RSA 1024-bit	Command, plaintext, RSA public key	Status, ciphertext
RSA decryption	Decrypt RSA-encrypted ciphertext (1024-bit)	Command, ciphertext, RSA private key	Status, plaintext
DH 1024- bit	Compute shared secret key	Command and key	Shared secret key
ECDH (P-192, K-163 or B-163 curves)	Compute shared secret key	Command and key	Shared secret key
Blowfish encryption	Encrypt plaintext using Blowfish	Command, plaintext, key	Status, ciphertext
Blowfish decryption	Decrypt Blowfish -encrypted ciphertext	Command, ciphertext, key	Status, plaintext
Blowfish key generation	Generate an Blowfish symmetric key using FIPS 186-2 Appendix 3.1 RNG and set the key schedule	Command, key length	Status, symmetric key
Camellia encryption	Encrypt plaintext using Camellia	Command, plaintext, key	Status, ciphertext
Camellia decryption	Decrypt Camellia -encrypted ciphertext	Command, ciphertext, key	Status, plaintext
Camellia key generation	Generate an Camellia symmetric key using FIPS 186-2 Appendix 3.1 RNG and set the key schedule	Command, key length	Status, symmetric key
CAST encryption	Encrypt plaintext using CAST	Command, plaintext, key	Status, ciphertext
CAST decryption	Decrypt CAST -encrypted ciphertext	Command, ciphertext, key	Status, plaintext
CAST key generation	Generate an CAST symmetric key using FIPS 186-2 Appendix 3.1 RNG and set the key schedule	Command, key length	Status, symmetric key
DES/DES-Old encryption	Encrypt plaintext using DES/DES-Old	Command, plaintext, key	Status, ciphertext

Service	Description	Input	Output
DES/DES-Old decryption	Decrypt DES/DES-Old - encrypted ciphertext	Command, ciphertext, key	Status, plaintext
DES/DES-Old key generation	Generate an DES/DES-Old symmetric key using FIPS 186-2 Appendix 3.1 RNG and set the key schedule	Command, key length	Status, symmetric key
Establish a DTLS session	Establish a new DTLS session	Command	Status, Session ID
KRB5	Generate Kerberos ticket	Command	Status, Ticket
Kernel-SSL(K-SSL)	Establish a new SSL session at OS kernel level	Command	Status, Session ID
MD4 digest generation	Generate a MD4 digest	Command, message to be hashed	Status, 128-bit message digest
MD5 digest generation	Generate a MD5 digest	Command, message to be hashed	Status, 128-bit message digest
MDC2 digest generation	Generate a MDC2 digest	Command, message to be hashed	Status, 128-bit message digest
RC2 encryption	Encrypt plaintext using RC2	Command, plaintext, key	Status, ciphertext
RC2 decryption	Decrypt RC2 -encrypted ciphertext	Command, ciphertext, key	Status, plaintext
RC2 key generation	Generate an RC2 symmetric key using FIPS 186-2 Appendix 3.1 RNG and set the key schedule	Command, key length	Status, symmetric key
RC4 encryption	Encrypt plaintext using RC4	Command, plaintext, key	Status, ciphertext
RC4 decryption	Decrypt RC4 -encrypted ciphertext	Command, ciphertext, key	Status, plaintext
RC4 key generation	Generate an RC4 symmetric key using FIPS 186-2 Appendix 3.1 RNG and set the key schedule	Command, key length	Status, symmetric key
RIPEMD digest generation	Generate a RIPEMD digest	Command, message to be hashed	Status, 128-bit message digest
SEED encryption	Encrypt plaintext using SEED	Command, plaintext, key	Status, ciphertext
SEED decryption	Decrypt SEED -encrypted ciphertext	Command, ciphertext, key	Status, plaintext
SEED key generation	Generate an SEED symmetric key using FIPS 186-2 Appendix 3.1 RNG and set the key schedule	Command, key length	Status, symmetric key
Whirlpool digest generation	Generate a Whirlpool digest	Command, message to be hashed	Status, 512-bit message digest

2.4 Physical Security

The Axway Security Kernel is a multi-chip standalone module. The physical security requirements do not apply to this module, since it is purely a software module and does not implement any physical security mechanisms.

Although the module consists entirely of software, the FIPS 140-2 evaluated platform is a standard PC, a server, or a mainframe, which has been tested for and meets applicable Federal Communication Commission (FCC) EMI and EMC requirements for business use as defined in Subpart B of FCC Part 15.

2.5 Operational Environment

The module runs on the general purpose Microsoft Windows, Linux and SunOS operating systems. See Column 1 of Table 1 for a list of OSs that are supported by the module. The OS being used must be configured for single user mode per NIST CMVP guidance. The module was tested and validated on Windows 2012 (64 bit), RHEL 6.3 (64 bit), Solaris 10 (64 bit). Single user mode configuration instructions for various OS can be found in Section 3.1.1 of this document.

2.6 Cryptographic Key Management

The module supports the following CSPs:

Table 9 – List of Cryptographic Keys, Cryptographic Key Components, and CSPs

Key	Key Type	Generation / Input	Output	Storage	Zeroization	Use
TDES keys	Symmetric key	1. Generated internally using FIPS 186-2 Appendix 3.1 RNG. 2. Generated using Diffie-Hellman key agreement. 3. Derived from TLS master secret. 4. Input in encrypted form.	In encrypted form.	Plaintext in volatile memory only	Zeroized after use	Encrypt plaintext/ Decrypt ciphertext
AES key	Symmetric key	1. Generated using FIPS 186-2 Appendix 3.1 RNG. 2. Generated using Diffie-Hellman key agreement. 3. Derived from TLS master secret. 4. Input in encrypted form.	Via TLS sessions in encrypted form.	Plaintext in volatile memory only	Zeroized after use	Encrypt plaintext/ Decrypt ciphertext
RSA private key	Private key	Generated internally using FIPS 186-2 Appendix 3.1 RNG.	Never output	Plaintext in hard disk	Zeroized when new key pair is generated	Decrypt ciphertext/ Sign messages (usually hash values)
RSA public key	Public key	1. Generated internally using FIPS 186-2 Appendix 3.1 RNG. 2. Imported in plaintext form.	Via TLS session in plaintext form	Plaintext in hard disk	Zeroized when new key pair is generated	Encrypt plaintext/ Verify signatures
ECDSA private key	Private key	Generated internally	Never output	Plaintext in hard disk	Zeroized when new key pair is generated	Sign messages (usually hash values)
ECDSA public key	Public key	1. Generated internally using FIPS 186-2 Appendix 3.1 RNG. 2. Imported in plaintext form.	Via TLS session in plaintext form	Plaintext in hard disk	Zeroized when new key pair is generated	Verify signatures
Diffie-Hellman public keys *p*,*g*	Public keys	1. Generated internally using FIPS 186-2 Appendix 3.1 RNG. 2. Input in plaintext form.	In plaintext form	Plaintext in volatile memory	Zeroized when new keys are generated	Establish symmetric keys
Diffie-Hellman private keys *a*,*b*	Private key	Generated internally using FIPS 186-2 Appendix 3.1 RNG.	Never output	Plaintext in volatile memory	Zeroized when new keys are generated	Establish symmetric keys

Key	Key Type	Generation / Input	Output	Storage	Zeroization	Use
FIPS 186-2 Appendix 3.1 RNG seed	RNG seed	Imported from client application in plaintext form	Never output	Plaintext in volatile memory only	Zeroized when new seed is fed	Generate random numbers
TLS master secret	TLS master secret	1. Generated internally using FIPS 186-2 Appendix 3.1 RNG. 2. Input via TLS sessions in encrypted form	Via TLS session in encrypted form	Plaintext in volatile memory only	Zeroized when TLS session is over	Derive keys in TLS sessions
HMAC Key	Log Signing key	Generated internally using FIPS 186-2 Appendix 3.1 RNG	Never output	Plaintext in volatile memory only	Zeroized when the server has signed the last log file before shutdown	Log file signing
DSA Private Key	Signature generation,	Generated internally using FIPS 186-2 Appendix 3.1 RNG.	Never output	Plaintext in hard disk	Zeroized when new key pair is generated	Decrypt ciphertext/ Sign messages (usually hash values)
DSA Public Key	Signature verification	1. Generated internally using FIPS 186-2 Appendix 3.1 RNG. 2. Imported in plaintext form.	Via TLS session in plaintext form	Plaintext in hard disk	Zeroized when new key pair is generated	Encrypt plaintext/ Verify signatures

2.6.1 Key Generation

The module uses NIST, FIPS 186-2 Appendix 3.1 RNG to generate cryptographic keys. This RNG is a FIPS 140-2 approved RNG as specified in Annex C to FIPS PUB 140-2.

2.6.2 Key Input/Output

RSA and ECDSA public keys are output from and input into the kernel in plaintext form. Symmetric keys are input into and output from the kernel in encrypted form.

2.6.3 Key Storage

Session keys are stored in volatile memory in plaintext. RSA and ECDSA key pairs are stored in hard disk in plaintext.

2.6.4 Key Zeroization

Keys are zeroized when they are no longer used; RSA, DSA and ECDSA key pairs are zeroized when new ones are generated.

The zeroization of the keys is carried out by overwriting the storage or memory with zeros.

2.7 Self-Tests

The Axway Security Kernel performs the following self-tests at power-up:

- Software integrity test using HMAC-SHA-1.
- TDES Encrypt KAT with 3 independent keys (56 bits each) in CBC mode.
- TDES Decrypt KAT with 3 independent keys (56 bits each) in CBC mode.
- AES Encrypt KAT with a 128-bit key in ECB mode.
- AES Decrypt KAT with a 128-bit key in ECB mode
- SHA-1 KAT.
- SHA-256 KAT. (also satisfies SHA-224 KAT).
- SHA-512 KAT. (also satisfies SHA-384 KAT).
- RSA Encrypt KAT with 1024-bit keys for encryption
- RSA Decrypt KAT with 1024-bit keys for decryption
- RSA Sign KAT with 1024-bit keys for signature generation
- RSA Verify KAT with 1024-bit keys for signature verification
- FIPS 186-2 Appendix 3.1 RNG KAT.
- Pair-wise consistency test for ECDSA keys.
- TLS KDF (Key Derivation Function) Test
- DSA Sign KAT
- DSA Verify KAT

The conditional self-test performed by the module include the following three tests.

- Pair-wise consistency test for RSA keys.
- Pair-wise consistency test for ECDSA keys.
- Pair-wise consistency test for DSA keys.
- Continuous RNG Test.

If the self-tests fail, an exception will be thrown on the failure. The user is then alerted that the self-tests failed, and the application will not load and will enter an error state. When in the error state, execution of the kernel is halted, which inhibits the output of data from the module.

2.8 Design Assurance

Axway uses the Subversion for configuration management of source code and documentation including Axway Security Kernel's FIPS documentation. See the SVN project website http://subversion.apache.org for more information. This software provides access control, versioning, and logging.

2.9 Mitigation of Other Attacks

This section is not applicable. The module does not claim to mitigate any attacks beyond the FIPS 140-2 level 1 requirements for this validation.

3 Secure Operation

The Axway Security Kernel meets Level 1 requirements for FIPS 140-2. The sections below describe how to place and keep the module in FIPS-approved mode of operation.

3.1 Crypto Officer Guidance

The Crypto Officer is responsible for installing, uninstalling, configuring, and managing the module and running the power-up self-tests. Before installing the module, the Crypto Officer should make sure that the specific OS is in single user mode.

3.1.1 Operation System Configuration

The Crypto Officer must maintain control of the installation media.

FIPS 140-2 mandates that a cryptographic module be limited to a single user at a time. Before the module can be installed, the Crypto Officer must have a standard PC or mainframe computer running on one of the OS listed in Column 1 of Table 1. The OS being used must be configured for single user mode and disallow remote login.

To configure Windows for single user mode, the Crypto Officer must ensure that all remote guest accounts are disabled in order to ensure that only one human operator can log into the Windows OS at a time. The services that need to be turned off for Windows are

- Fast-user switching (irrelevant if PC or server is a domain member)
- Terminal services
- Remote registry service
- Secondary logon service
- Telnet service
- Remote desktop and remote assistance service

Once the Windows OS has been properly configured, the Crypto Officer can use the system “Administrator” account to install software, uninstall software, and administrate the module.

The specific procedure to configure a Linux System for single user mode is described below.

1. Login as the “root” user.

2. Edit the system files /etc/passwd and /etc/shadow and remove all the users except “root” and the pseudo-users. Make sure the password fields in /etc/shadow for the pseudo-users are either a star (*) or double exclamation mark (!!). This prevents login as the pseudo-users.

3. Edit the system file /etc/nsswitch.conf and make “files” the only option for “passwd”, “group”, and “shadow”. This disables Network Information Service and other name services for users and groups.

4. In the /etc/xinetd.d directory, edit the files “rexec”, “rlogin”, “rsh”, “rsync”, “telnet”, and “wu-ftpd”, and set the value of “disable” to “yes”.

5. Reboot the system for the changes to take effect.

More information can be found at http://csrc.nist.gov/groups/STM/cmvp/documents/CMVPFAQ.pdf.

Once the operating system has been properly configured, the Crypto Officer can use the system “root” account to install/uninstall software and administrate the module.

The specific procedure to configure SunOS for single user mode is described below:

1. Login as the "root" user.

2. Edit the system files /etc/passwd and /etc/shadow and remove all the users except "root" and the pseudo-users (daemon users). Make sure the password fields in /etc/shadow for the pseudo-users are either a star (*) or double exclamation mark (!!). This prevents login as the pseudo-users. Also make sure the shell for daemon users is /dev/null, or something else that is not exploitable.

3. Edit the system file /etc/nsswitch.conf and make "files" the only option for "passwd", "group", and "shadow". This disables NIS and other name services for users and groups.

4. Edit the system file /etc/inet/inetd.conf, and comment out all unnecessary services (by prepending a hash ('#') sign to the beginning of each unnecessary service line).

   sadmind - Solstice network administration agent server
   rpc.ttdbserverd - Sun tool-talk server
   kcms_server - Kodak Color Management System server
   fs.auto - Sun font server
   cachefsd - NFS cache service
   rquotad - remote disk quota server
   rpc.metad - Disksuite remote metaset service
   rpc.metamhd - Disksuite remote multihost service
   rpc.metamedd - Disksuite component service
   ocfserv - Smartcard service
   dtspcd - Part of the CDE package
   rpc.cmsd - remote calendar server
   in.comsat - biff, mail notification server
   in.talkd - talk server
   gssd - RPC application authentication
   in.tnamed - deprecated name server
   rpc.smserverd - removable media device sensor service (disabling requires manual CD mounting)
   dcs - remote dynamic configuration server
   ftpd - ye olde FTP server
   ktkt_warnd - Kerberos warning server
   chargen - deprecated network service
   daytime - deprecated network time
   time - legacy time service
   discard - deprecated network service
   echo - network 'echo' service
   ufsd - part of RPC
   in.uucpd - unix-to-unix copy server

5. Disable service startup scripts within /etc/rc2.d. Many additional services (not bound to inetd) are started by default. To disable startup scripts, files can be renamed to make sure they do not begin with a capital ‘S’ (which denotes Startup). Disable startup scripts that are not pertinent to the setup.

   nscd - NIS-related
   snmpdx - SNMP services
   cachefs.daemon - NFS-caching
   rpc - Remote Procedure Call services
   sendmail – Sendmail
   lp - line printer daemon
   pppd - Point-to-point Protocol services

uucp - Unix-to-Unix copy daemon
ldap - LDAP services

6. Reboot the system for the changes to take effect.

Once the operating system has been properly configured, the Crypto Officer can use the system “root” account to install/uninstall software and administrating the module.

3.1.2 Initialization

The software module will be provided to the users by Axway Inc. along with the client applications, including Validation Authority and MailGate. The module is installed during installation of the client application. The installation procedure is described in the client application’s installation manual.

The module must be installed, configured, and started before operators may utilize its features.

3.1.3 Zeroizaion

Zeroization of keys and other CSPs is controlled and performed by client applications. Zeroization may be manually invoked by rebooting the computer on which the kernel is running. Uninstalling the client application also results in zeroization of all keys and other CSPs.

3.1.4 Management

The Crypto Officer does not perform any management of the kernel after installation and configuration. The management tasks are conducted by the client application.

3.2 User Guidance

The module’s cryptographic functionality and security services are provided via client applications. Only the algorithms listed in Section 2.6 should be used by the client application. End-user instructions and guidance are provided in the user manual and technical support documents of the individual client application software. Although the end-users do not have any ability to modify the configuration of the module, they should check that the client application is present and enabled and thereby providing cryptographic protection.

4 Acronyms

Table 10 – Acronyms

Acronym	Definition
AES	Advanced Encryption Standard
API	Application Programming Interface
BIOS	Basic Input/Output System
CA	Certificate Authority
CBC	Cipher Block Chaining
CD	Compact Disc
CFB	Cipher Feedback
CMVP	Cryptographic Module Validation Program
CPU	Central Processing Unit
CSP	Critical Security Parameter
CVS	Concurrent Versions System
DER	Distinguished Encoding Rules
DLL	Dynamic Link Library
DH	Diffie-Hellman
DSA	Digital Signature Algorithm
ECB	Electronic Codebook
ECDSA	Elliptic Curve Digital Signature Algorithm
EDI	Electronic Data Interchange
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
FCC	Federal Communication Commission
FIPS	Federal Information Processing Standard
HMAC	(Keyed-) Hash MAC
IDE	Integrated Drive Electronics
IP	Internet Protocol
ISA	Instruction Set Architecture
KAT	Known Answer Test
KDF	Key derivative function
MAC	Message Authentication Code
N/A	Not Applicable
NIST	National Institute of Standards and Technology
PEM	Privacy-enhanced Electronic Mail
OFB	Output Feedback
OS	Operating System

Acronym	Definition
PC	Personal Computer
PCI	Peripheral Component Interconnect
PKCS	Public Key Cryptography Standard
PKI	Public Key Infrastructure
RAM	Random Access Memory
RNG	Random Number Generator
ROM	Read Only Memory
RSA	Rivest, Shamir and Adleman
SHA	Secure Hash Algorithm
SO	Shared Object
TDES	Triple Data Encryption Standard
TLS	Transport Layer Security
USB	Universal Serial Bus
VSS	Visual Source Safe
XML	Extensible Markup Language