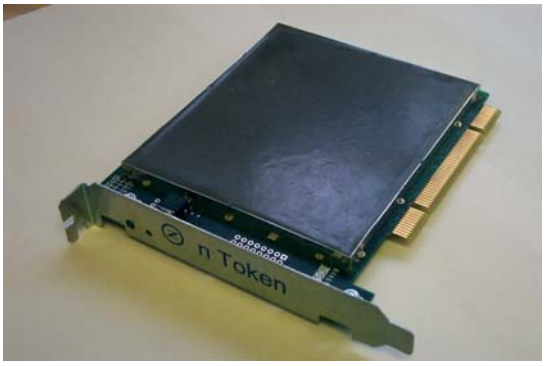
nToken Security Policy

nCIPHER™



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Patents

UK Patent GB9714757.3. Corresponding patents/applications in USA, Canada, South Africa, Japan and International Patent Application PCT/GB98/00142.

Contents

Chapter 1 Purpose

The nToken is a FIPS 140-2 level 2 module. It is designed to protect a single signing key used to identify a host. Use of this key proves to an nCipher NetHSM that the session was instigated by a client running on that host.

The module runs firmware provided by nCipher. There is the facility for the user to upgrade this firmware. In order to determine that the module is running the correct version of firmware they should use the Show Status service which reports the version of firmware currently loaded. The validated firmware versions is 2.22.6.

Provided that the nToken is only used with the FIPS approved firmware, it can only be operated in its FIPS approved mode of operation. It is possible to load new firmware. The user should ensure that any new firmware is FIPS validated before they load it into the module.

The nToken connects to the host computer via a PCI bus. The nToken must be accessed by a custom written application.

The nToken can be connected to a computer running one of the following operating systems:

- Windows 2000 and 2003
- Solaris
- HP-UX
- AIX
- Linux x86
- FreeBSD x86

Linux was used for the validation.

Initializing the nToken

When the module is initialized it generates a random AES key for use as a module key. This key is stored in the modules EEPROM and is never revealed. This step is usually performed in the nCipher factory.

In order to enrol an nToken the administrator runs the nTokenEnrol utility on a host computer, that is outside the security boundary.

The utility performs the following steps:

1. generates a DSA key pair (*Generate DSA key* service)
2. wraps the private half as a key blob protected by the module key (*Wrap key* service) and exports this blob to the hosts hard disk.
3. exports a certificate containing the public key and the nTokens Electronic Serial number to the nCipher NetHSM. (*Export* service)
4. displays the SHA-1 hash of the key on the host computer's display. (*Hash* service)

The utility then sends this data to the NetHSM that will rely on the nToken and adds the nToken public key and serial number and the identity of the host in which it is installed to the NetHSM's configuration file.

Using the nToken

Once the nToken is enrolled - whenever the nCipher server is started it loads the key blob created when the module was initialized obtaining a key ID for the signing key.

The nToken is used when a user wishes to open a connection form a host application to a NetHSM via the nCipher server. When the user attempts to open such a connection, the nCipher server obtains a nonce from the NetHSM and has the nToken sign a message containing this nonce to confirm the identity of the computer the application is running on. The nCipher server sends this message to the NetHSM. The NetHSM verifies the signature and can then determines whether the host is authorized.

Although the nToken uses the same firmware image as the nShield 500 and nShield lite, nToken modules are factory configured so that they can only perform a limited subset of operations.

The nCipher server can determine whether a module is an nToken using the Show Status service and if it determines that a module is an nToken will prevent a user from attempting to submit commands the nToken will not perform.

Upgrading Firmware

Although nCipher do not expect that the user will ever need to update the firmware in an nToken, nCipher provide a utility to perform this.

Verifying firmware

The administrator or user can use the fwcheck utility to check that the had been programmed with valid firmware. This utility takes a copy of the signed and encrypted firmware file and performs a zero knowledge check

Keys

For each type of key used by the nToken, the following section describes the access that a user has to the keys. The nToken refers to keys by their handle, an arbitrary number, or by its SHA-1 hash.

Module key

The Module key is an AES key used to protect other keys. This key is generated by the module key when it is initialized. If the module is re-initialized, the AES key is cleared and a new key must be generated before the module can be started in operational mode. nTokens are initialized by nCipher before they are supplied to the customer and do not normally need re-initializing. The module key is guaranteed never to have been known outside this module.

Authentication Key

When the nToken is enrolled it generates a DSA key pair used for signature generation. The public half of this key is exported in plain text and has to be transferred to the NetHSM.

The private half is encrypted under the module key and exported an an nCipher format key blob which is stored on the host computer's hard disk.

In order to use the signature key, the user loads the key blob. When the key is loaded in the module it is stored in RAM and identified by a random identifier that is specific to the user and session. The user can then have the module sign messages by providing this identifier.

Firmware Integrity Key

All firmware is signed using a DSA key pair. A module only loads new firmware if the signature decrypts and verifies correctly.

The private half of this key is stored at nCipher.

The public half is included in all firmware. The firmware is stored in flash memory when the module is switched off, this is copied to RAM as part of the start up procedure.

Firmware Confidentiality Key

All firmware is encrypted using Triple DES to prevent casual decompilation.

The encryption key is stored at nCipher's offices and is in the firmware. The firmware is stored in flash memory when the module is switched off, this is copied to RAM as part of the start up procedure.

nCipher Master Feature Enable Key

The nToken uses the same firmware and basically the same hardware as the nCipher nForce and nShield modules. However most functionality is disabled using nCipher's Feature Enable Mechanism. This controls features using certificates signed by the nCipher Master Feature Enable Key. Presenting such a certificate causes the module to set the appropriate bit in the FRAM.

The nCipher Master Feature Enable Key is a DSA key pair, The private half of this key pair is stored at nCipher's offices. The public half of the key pair is included in the firmware. The firmware is stored in flash memory when the module is switched off, this is copied to RAM as part of the start up procedure.

Roles

The module has two roles which implicitly assumes all services:

Administrator

The Administrator Role is an implicitly assumed role that is procedurally assumed as part of the setup and initialization procedures of the nToken. The Administrator generates or replaces the secret AES Master Key. This step is performed by nCipher before the module is shipped, but can be repeated by the customer as part of the setup and initialisation process.

Generates the signing key. To assume the administrator role you run the nTokenEnrol utility. Running this utility implicitly selects the administrator role. This destroys all stored keys and creates a new key blob that is used to authenticate the user role and exports the public key that can be used to verify messages.

After the module has been configured, and is operating in its FIPS mode, there is no further requirement for the administrator role to interact with the module and all further services interaction is are performed in the implicitly assumed Administrator / User Role.

User

The user role uses the key to sign messages.

To assume the user role you present the key blob generated by the administrator. If this blob load correctly you are returned an ObjectID for the signing key. To sign a message you send the Sign command with the KeyID and message. The module returns the signed message.

Services

The following services are provided by the nToken.

Service	Key type	Role	Description
Check Firmware	DSA and Triple DES	Admin / User	Performs a zero knowledge check of the firmware image.
Generate Key	AES	Admin	The module automatically generates a new AES key used as the master encryption key. This key is never exported. This is performed as part of the setup and initialisation procedure.
Generate Key	DSA	Admin	The module generates a DSA key pair, used to sign messages. This is performed as part of the setup and initialisation procedure.
Wrap Key	AES + HMAC	Admin	The private DSA key is wrapped as an nCipher key blob. Wrapping uses AES CBC mode for encryption and SHA-1 HMAC for integrity. This is performed as part of the setup and initialisation procedure.
Export	DSA public	Admin	The public half of the DSA key pair is exported in plain text. This is performed as part of the setup and initialisation procedure.
Hash	SHA-1	Admin	The module exports the SHA-1 hash of the DSA key to enable the key to be identified in other services. The hash can be calculated from either the private or public half of the key. This feature can be used to ensure the correct parts of a key pair are being used. This is performed as part of the setup and initialisation procedure.
Unwrap Key	AES + HMAC	User	The user presents the wrapped private key at the start of a session. If the key unwraps and the MAC verifies, the user is authorized.
Sign	DSA private	User	Once the user has loaded the private key they can use it to sign messages.
Zero	DSA private	Admin/User	Clears all unwrapped keys. The master key can be zeroed by repeating the Key Generation Service.
Show Status		Admin/User	Displays status information.
Loads Firmware	DSA and Triple DES	Admin	Replaces a firmware image with new firmware. The firmware is signed and encrypted with keys held at nCipher. The nToken must be re-initialized after loading firmware.

Rules

Object re-use

All objects stored in the module are referred to by a handle. The module's memory management functions ensure that a specific memory location can only be allocated to a single handle. The handle also identifies the object type, and all of the modules enforce strict type checking. When a handle is released the memory allocated to it is actively zeroed.

Error conditions

If the nToken cannot complete a command due to a temporary condition, the module returns a command block with no data and with the status word set to the appropriate value. The user can resubmit the command at a later time. The server program can record a log of all such failures.

If the nToken encounters an unrecoverable error it enters the error state. This is indicated by the status LED flashing in the Morse pattern SOS. As soon as the unit enters the error state all processors stop processing commands and no further replies are returned. In the error state the unit does not respond to commands. The unit must be reset.

Status information

The module has an LED that indicates the overall state of the module.

The module also returns a status message in the reply to every command. This indicates the status of that command.

Physical security

All security critical components of the nToken are covered by potting.

The module has a clear button. Pressing this button put the module into the self-test state, clearing all stored key objects and running all self-tests. The long term security critical parameters, module keys, module signing key can be cleared by re-initializing the nToken, as described above.

Checking the module

To ensure physical security, the administrator should regularly examine the metal cover over the epoxy resin security coating for obvious signs of damage.

Strength of functions

Attacking ObjectIDs

A user is authenticated by a key blob, which is encrypted by a 256-bit AES key with integrity provided by a 160-bit HMAC key. It is therefore almost impossible to spoof this authentication.

An attacker may however get the module to sign a message with the stored key by guessing the client and key key identifiers.

Connections are identified by a ClientID, a random 32 bit number.

Objects are identified by an ObjectID again this is a random 32 bit number.

In order to randomly gain access to a key loaded by another user you would need to guess two random 32 bit numbers. The module can process about 2^{16} commands per minute - therefore the chance of succeeding within a minute is $2^{16} / 2^{64} = 2^{-48}$.

Algorithms

Algorithms marked with an asterisk (*) are not enabled when the module is configured as a nToken.

- AES
  Certificate #258
- Triple DES
  Certificate #339
  Double and triple length keys
  Approved for Federal Government Use - Modes are CBC and ECB
- Triple DES MAC
  Certificate #339 vendor affirmed
  Verified implementation functions: genblk_signbegin,genblk_verifybegin, genblk_macdata, genblk_signend,genblk_verifyend
- DSA
  Certificate #136
- RSA
  Certificate #68
- ECDSA*
  Certificate #2
- SHA-1, SHA-256*, SHA-384* and SHA-512*
  Certificate #333
- HMAC SHA-1, HMAC SHA-256*, HMAC SHA-384* and HMAC SHA-512*
  HMAC certificate #68
  Although all the HMAC functions are included in the firmware, only HMAC SHA-1 is enabled when the module is configured as a nToken.
- Random Number Generator
  (FIPS 186-2 Change Notice 1 SHA-1) Certificate #91

Non-FIPS approved algorithms

Symmetric

- Arc Four (compatible with RC4)*
- Blowfish*
- CAST 5 (RFC2144)*
- CAST 6 (RFC2612)*
- DES*

Note *Non-compliant due to CAVP DES transition policy.*

- Serpent*
- SEED (Korean Data Encryption Standard) *
- Twofish*

Asymmetric

- Diffie-Hellman*
  (key agreement, key establishment methodology provides 80-bits to 256-bits of encryption strength)
- Elliptic Curve Diffie-Hellman*
  (key agreement, key establishment methodology provides 192 bits of encryption strength);
- El Gamal *
- RSA (key wrapping, key establishment methodology provides 80-bits to 256-bits of encryption strength)
- KCDSA*

Hash

- HAS-160*
- MD2*
- MD5*
- RIPEMD 160*

MAC

- HMAC (MD2, MD5, RIPEMD160)*

Other

- SSL/TLS master key derivation*
- PKCS #8 key wrapping*.

Note *TLS key derivation is approved for use by FIPS 140-2 validated modules - though there is as yet no validation test., MD5 may be used within TLS key derivation.*

nCipher addresses

nCipher Corporation Ltd.

Cambridge, UK

Jupiter House
Station Road
Cambridge
CB1 2JD
UK

Tel: +44 (0) 1223 723600
Fax: +44 (0) 1223 723601

E-mail: sales@ncipher.com
support@ncipher.com

nCipher Inc.

Boston Metro Region, USA

92 Montvale Avenue, Suite 4500
Stoneham, MA 02180
USA

Tel: 800-NCIPHER
800-6247437
+1 (781) 994 4000
Fax: +1 (781) 994 4001

E-mail: sales@us.ncipher.com
support@ncipher.com

Internet addresses

Web Site:	http://www.ncipher.com/
Online Documentation:	http://active.ncipher.com/documentation/

Note *nCipher also maintain international sales offices. Please contact the UK, or the US, head office for details of your nearest nCipher representative.*