MOVEit Crypto
FIPS 140-2
Non-proprietary
Security Policy

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Introduction

This document describes the security policy for MOVEit Crypto, to meet the FIPS 140-2 requirements. This document is non-proprietary and may be distributed freely.

MOVEit Crypto is a compact and fast encryption library that provides an API featuring the latest NIST-approved encryption, hashing, and pseudo-random number generation algorithms. The easy-to-use programming interface allows applications to be written without special code for block size and padding mode.

MOVEit Crypto is a member of the MOVEit security and file transfer product family. For more information, see http://www.ipswitch.com/.

Cryptographic Module and Cryptographic Boundary

MOVEit Crypto is a dynamically linked library that provides encryption services to applications. Separate versions exist for Microsoft Windows operating systems, and the Linux operating system. MOVEit Crypto is supported on Windows 2003 / 2003R2 / Vista / 2008 / 7 / 2008R2 / 8 / 8.1 / 2012 / 2012R2 / 10, and Linux, and is supplied in both 32-bit and 64-bit versions. It was tested on the following platforms, in single-user mode:

- Windows Server 2008 (x86)
- Windows Server 2008 (x64)
- Red Hat Enterprise Linux 5 (x86)
- Red Hat Enterprise Linux 5 (x64)

No claim is made as to the correct operation of the module or the security strengths of the generated keys when MOVEit Crypto is run in an operational environment which is not listed on the validation certificate.

MOVEit Crypto is purely a software product. In FIPS 140-2 terms, MOVEit Crypto is a multi-chip standalone module, consisting of the file MOVEitCrypto.dll (on Windows) or libmoveitcrypto.so.1.2 (on Linux). It is intended to meet FIPS 140-2 security level 1.

The following table summarizes the FIPS security levels met by MOVEit Crypto. The requirements are those listed in Section 4, Security Requirements, of FIPS PUB 140-2:
The cryptographic boundary for MOVEit Crypto is defined as the enclosure of the computer on which the cryptographic module is installed. As a software product, MOVEit Crypto provides no physical security by itself. The computer itself must be appropriately physically secured.

**Single Operator Only**

MOVEit Crypto runs in Single User Mode. Multiple concurrent operators are not supported.

**Boundary Diagram**

This diagram represents the module’s cryptographic and logical boundaries:
Roles

MOVEit Crypto implements the Cryptographic Officer and User roles. There is no Maintenance role.

The module does not provide any identification or authentication of its own, and does not by itself provide a way to restrict a user to one role or the other.

**User**

The user is any entity that can access services provided by the module. All services are available to a user. See the Services section of this document. The User role is implicitly selected when a process calls any API function in the module.

**Cryptographic Officer**

The cryptographic officer is any entity that can install the module onto the computer system, configure the operating system, or access services provided by the module. The cryptographic officer may access all services, the same as a user.

The cryptographic officer has no special access to any keys or data.

The cryptographic officer role is implicitly selected when installing the module or configuring the operating system.
Installation is accomplished by running an installation program. The cryptographic officer must have permission to write the file constituting the module into the installation directory; typically, this requires administrator access within the operating system. On Windows, the installation directory is the Windows System directory and the cryptographic officer typically should be a member of the Administrators group. On Linux, the installation directory is /usr/lib and the cryptographic officer should have root access.

The cryptographic officer should ensure that the operating system runs in single user mode. For Windows, this can be done by disabling the Server and RunAsService services using the Control Panel. The paging file must be configured to be on a local drive, not a network drive.

For Linux, a running system can be placed into single-user mode via the command /sbin/shutdown now. Alternatively, Linux can be configured to always boot into single-user mode. This is done by editing the file /etc/inittab. Change the line that looks like

\texttt{id:x:initdefault (where x is a number, usually 3, 4, or 5) to id:1:initdefault. When the system is rebooted, it will run in single-user mode.}

\section*{Services}

MOVEit Crypto's services consist entirely of an Application Programming Interface (API), which is a collection of functions that can be called from an operating system process. All services provided by the module are described in this section, and both the User and Crypto-officer roles have access to all of these services.

\section*{Overview of Functions and Modes of Operation}

\subsection*{FIPS-140-2 Approved Modes of Operation}

MOVEit Crypto provides the following FIPS 140-2 approved algorithms:

- **Encryption:** AES, as described in FIPS PUB 197, with 128-, 192-, and 256-bit keys. MOVEit Crypto’s AES certificate number is 1226.

- **Hashing:** SHA-1, SHA-256, SHA-384, and SHA-512, as described in FIPS PUB 180-4. MOVEit Crypto’s SHA (Secure Hash Standard, or SHS) certificate number is 1126.

- **Keyed hashing:** HMAC-SHA-1, SHA-256, SHA-384, and SHA-512, as described in FIPS PUB 198-1. MOVEit Crypto’s HMAC certificate number is 716.

MOVEit Crypto is operating in a FIPS-approved mode when its implementation of one of the above algorithms is being used.

Note: HMAC-SHA-1 with key lengths less than 112 bits is disallowed for usage in HMAC Generation, and is considered "Legacy-use" for HMAC Verification. This means that HMAC-SHA-1 with a key length less than 112 bits can be used in a FIPS approved mode only if being used to verify an old HMAC-SHA-1 signature.

\subsection*{FIPS-140-2 Non-Approved modes of Operation}

MOVEit Crypto provides the following algorithms that are not approved by FIPS 140-2:

- **Hashing:** RSA Data Security, Inc. MD5 Message-Digest Algorithm, as described in Internet RFC 1321

- **Keyed hashing:** HMAC-MD5, as described in Internet RFC 2104
**Pseudo-random number generation:** RNG using the algorithm described in FIPS PUB 186-2, Change Notice 1.

MOVEit Crypto is **not** operating in a FIPS-approved mode when its implementation of one of these algorithms is being used.

Thus, the indication of when the module is operating in a non-FIPS-approved mode is when:

- The algorithm MC_ALG_MD5 is being used via MCHashInit() or MCKeyedHashInit(), or
- Any of the MCRNGxxx functions are being used.

The module is in FIPS-approved mode at all other times.

**Function Descriptions**

All functions have names starting with the string MC. The functions are implemented using a C language interface, in order to make them available to the greatest number of programming languages. Although the documentation below is provided in C language terms, the functions can be called from any language that can access a dynamically-linked library.

In the function descriptions below, a C-style function prototype is followed by a description of the parameters and return value. Input parameters are marked with [in], output parameters are marked with [out], and parameters used for both input and output are marked with [in, out].

**Data Types**

The following data types are used throughout the API. The definitions of these types and their values are provided in a separate source code header file, MOVEitCrypto.h.

**MC_CONTEXT**

MC_CONTEXT is a data type passed to nearly all functions in the API. It stores information on pending cryptographic operations. The individual fields in this data type are not exposed to the user. MC_CONTEXT stores all key information and any partial plaintext or ciphertext blocks. Only the user-provided MC_CONTEXT buffer is used to store this information; the module does not maintain its own copy. The user must pass the same MC_CONTEXT buffer for all operations on a given message.

**MC_ERROR**

MC_ERROR is an enumerated type used as the return type by most functions. It specifies the error returned by a function. The possible values are:

<table>
<thead>
<tr>
<th>Value</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MC_ERROR_NONE</strong></td>
<td>Success. This value is guaranteed to be zero for all future versions of the module, so an application can test against 0 to determine whether a function succeeded.</td>
</tr>
<tr>
<td><strong>MC_ERROR_DISABLED</strong></td>
<td>MOVEit Crypto has been disabled due to failing a self-test.</td>
</tr>
<tr>
<td><strong>MC_ERROR_UNLICENSED</strong></td>
<td>MOVEit Crypto has been disabled because a valid license key has not been supplied.</td>
</tr>
<tr>
<td>Error Code</td>
<td>Description</td>
</tr>
<tr>
<td>----------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>MC_ERROR_BAD_CONTEXT</td>
<td>The context is invalid.</td>
</tr>
<tr>
<td>MC_ERROR_BAD_ALGID</td>
<td>The algorithm identifier is invalid.</td>
</tr>
<tr>
<td>MC_ERROR_BAD_MODE</td>
<td>The cipher mode parameter is invalid.</td>
</tr>
<tr>
<td>MC_ERROR_BAD_COUNT</td>
<td>A count parameter is invalid; for instance, a count is negative.</td>
</tr>
<tr>
<td>MC_ERROR_BAD_DATA</td>
<td>The data being encrypted or decrypted is invalid. For example, the last block of a padded message being decrypted contains invalid padding.</td>
</tr>
<tr>
<td>MC_ERROR_MISC</td>
<td>A miscellaneous error has occurred.</td>
</tr>
</tbody>
</table>

### MC_ALG

MC_ALG is an enumerated type that specifies an algorithm.

<table>
<thead>
<tr>
<th>Value</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC_ALG_AES_128</td>
<td>AES cipher with 128-bit keys and 16-byte blocks.</td>
</tr>
<tr>
<td>MC_ALG_AES_192</td>
<td>AES cipher with 192-bit keys and 16-byte blocks.</td>
</tr>
<tr>
<td>MC_ALG_AES_256</td>
<td>AES cipher with 256-bit keys and 16-byte blocks.</td>
</tr>
<tr>
<td>MC_ALG_SHA1</td>
<td>SHA-1 hash function.</td>
</tr>
<tr>
<td>MC_ALG_MD5</td>
<td>MD5 hash function.</td>
</tr>
<tr>
<td>MC_ALG_SHA256</td>
<td>SHA-256 hash function.</td>
</tr>
<tr>
<td>MC_ALG_SHA384</td>
<td>SHA-384 hash function.</td>
</tr>
<tr>
<td>MC_ALG_SHA512</td>
<td>SHA-512 hash function.</td>
</tr>
</tbody>
</table>

### MC_CIPHER_MODE

MC_CIPHER_MODE is an enumerated type that specifies a cipher mode.

<table>
<thead>
<tr>
<th>Value</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC_CIPHER_MODE_ECB</td>
<td>Electronic Code Book mode, in which each block is enciphered individually.</td>
</tr>
<tr>
<td>MC_CIPHER_MODE_CBC</td>
<td>Cipher Block Chaining mode, in which each block of plaintext is XORed with the previous ciphertext block (or with an initialization vector) prior to encryption.</td>
</tr>
</tbody>
</table>

### MC_PADDING

MC_PADDING is an enumerated type that specifies the padding mode of a block cipher.

<table>
<thead>
<tr>
<th>Value</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC_PADDING_NONE</td>
<td>No padding is done to the last cipher block. The input must be a multiple of the block size.</td>
</tr>
<tr>
<td>MC_PADDING_RFC2040</td>
<td>The last block of a message is padded to fill a complete block. If the message is a multiple of the block size, an entire block of padding is added to the ciphertext. Each byte of padding is the number of unused bytes at the end of the block.</td>
</tr>
</tbody>
</table>
MC_STATE

MC_STATE is an enumerated type that describes the state of MOVEit Crypto for the current process.

<table>
<thead>
<tr>
<th>Value</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC_STATE_DISABLED</td>
<td>The module is disabled. The process has not attached to the DLL.</td>
</tr>
<tr>
<td>MC_STATE_SELF_TEST</td>
<td>The module is undergoing power-up self-test and is not available for cryptographic operations. (Note: this state is strictly internal; MOVEit Crypto will never return this state to the user because it is not possible to be attached to the module in this state.)</td>
</tr>
<tr>
<td>MC_STATE_UNLICENSED</td>
<td>The module has passed self-test, but no valid license key has been entered.</td>
</tr>
<tr>
<td>MC_STATE_OPERATE</td>
<td>The module is available for all services.</td>
</tr>
<tr>
<td>MC_STATE_ERROR</td>
<td>An error has occurred during operation. Cryptographic services are not available.</td>
</tr>
</tbody>
</table>

Initialization Functions

MCSetLicenseKey

Checks the caller-supplied license key, and enables the module if it's valid. This function must be called with a valid license key before any cryptographic services can be used.

**MC_ERROR MCSetLicenseKey(const char *szLicenseKey)**

- **szLicenseKey** [in] is a vendor-supplied zero-terminated ASCII license key to activate the product.
- **Returns** an MC_ERROR code (0 for success). If the module is in an error state, the function returns an error without checking the key. Otherwise, it enables or disables the module depending whether the key is valid.

Encryption / Decryption Functions

MCEncryptInit

Initializes a context for encryption.

**MC_ERROR MCEncryptInit(MC_CONTEXT *context, MC_ALG AlgID, MC_CIPHER_MODE cipherMode, MC_PADDING padding, void *key, void *IV)**

- **context** [out] points to a context to initialize.
- **AlgID** [in] is the encryption algorithm ID (MC_ALG_xxx value).
- **cipherMode** [in] specifies ECB vs. CBC (MC_CIPHER_MODE_xxx value).
- **padding** [in] is the padding type (MC_PADDING_xxx value).
- **key** [in] is the key. The size is implied by AlgID.
IV  [in] is the initialization vector. A NULL pointer implies a vector of all zeros. The size is always the blocksize of the cipher. The IV is ignored if the mode is ECB.

Returns  an MC_ERROR code (0 for success). If success, context has been initialized, else it's been zeroed.

MCEncrypt

Encrypts a buffer of bytes. This function can be called repeatedly with buffers of any size.

\[MC_ERROR MCEncrypt(MC_CONTEXT *context, void *inbuf, int nBytesIn, void *outbuf, int *pnBytesOut)\]

context  [in, out] points to a context that's been initialized.
inbuf  [in] is a buffer of plaintext.
nBytesIn  [in] is the number of plaintext bytes. This can be any number >= 0. If necessary, MOVEit Crypto will store a partial block in the context.
outbuf  [out] may contain some output bytes.
pnBytesOut  [out] points to the number of output bytes. This may be more or less than nBytesIn, due to internal buffering of blocks. It will not be more than 16 greater than nBytesIn.

Returns  an MC_ERROR code (0 for success). If failure, context has been zeroed.

MCEncryptFinal

Finishes the encryption of a message.

\[MC_ERROR MCEncryptFinal(MC_CONTEXT *context, void *outbuf, int *pnBytesOut)\]

ccontext  [in, out] points to a context that's been initialized.
outbuf  [out] may contain some output bytes, depending on the padding mode and whether MOVEit Crypto has had to buffer any bytes internally during previous MCEncrypt calls.
pnBytesOut  [out] points to the number of output bytes. It will not be more than 16, and may be as small as 0 if no internal buffering was done by previous calls.

Returns  an MC_ERROR code (0 for success). If failure, context has been zeroed.

MCDecryptInit

Initializes a context for decryption.

\[MC_ERROR MCDecryptInit(MC_CONTEXT *context, MC_ALG AlgID, MC_CIPHER_MODE cipherMode, MC_PADDING padding, void *key, void *IV)\]

ccontext  [out] points to a context to initialize.
AlgID  [in] is the encryption algorithm ID (MC_ALG_xxx value).
cipherMode  [in] specifies ECB vs. CBC (MC_CIPHER_MODE_xxx value).
padding  [in] is the padding type (MC_PADDING_xxx value).
key  [in] is the key. The size is implied by AlgID.
IV  
[in] is the initialization vector. A NULL pointer implies a vector of all zeros. The size is always the blocksize of the cipher. This is ignored if the mode is ECB.

Returns  an MC_ERROR code (0 for success). If success, context has been initialized, else it's been zeroed.

MCDecrypt

Decrypts a buffer of bytes. This function can be called repeatedly with any size input. If padding is in effect, the function does not decrypt the last block's worth of bytes, because it might be the last block, which would contain padding that needs to be handled differently.

\[MC_ERROR MCDecrypt(MC_CONTEXT *context, void *inbuf, int nBytesIn, void *outbuf, int *pnBytesOut)\]

context  [in, out] points to a context that has been initialized for decryption.
inbuf  [in] is a buffer of encrypted bytes.
nBytesIn  [in] is the number of input bytes. It can be 0, and does not need to be a multiple of the blocksize.

outbuf  [out] may contain some decrypted plaintext.
pnBytesOut  [out] points to the number of decrypted bytes that have been placed in outbuf. One block's worth of plaintext may be buffered in the context, so you may get up to 15 more or fewer output bytes than input bytes.

Returns  an MC_ERROR code (0 for success). If failure, context has been zeroed.

MCDecryptFinal

Finishes the decryption process by decrypting the last buffered block of bytes and zeroing the context.

\[MC_ERROR MCDecryptFinal(MC_CONTEXT *context, void *outbuf, int *pnBytesOut)\]

context  [in, out] points to a context that has been initialized for decryption.

outbuf  [out] may contain decrypted bytes.
pnBytesOut  [out] points to the number of decrypted bytes, which will be from 0 to 16.

Returns  an MC_ERROR code (0 for success). context has been zeroed.

Hashing Functions

MCHashInit

Initializes a context for hashing.

\[MC_ERROR MCHashInit(MC_CONTEXT *context, MC_ALG AlgID)\]

collection  [out] points to the context to initialize.
AlgID  [in] is the hash algorithm to use (MC_ALG_xxx value)

Returns  an MC_ERROR code (0 for success). If success, context has been initialized, else the hash portions have been zeroed.
MCHashUpdate

Hashes some data into an initialized context.

\[ MC\_ERROR\ \text{MCHashUpdate}(\text{MC\_CONTEXT}\ \ast context, \ \text{void}\ \ast inbuf, \ \text{int}\ nBytesIn) \]

- **context** [in, out] points to the context.
- **inbuf** [in] points to the bytes to hash.
- **nBytesIn** [in] is the number of bytes to hash.

Returns an MC_ERROR code (0 for success). If success, context has been updated with the bytes, else the hash portions of the context have been zeroed.

MCHashFinal

Completes the hash process, producing the final hash.

\[ MC\_ERROR\ \text{MCHashFinal}(\text{MC\_CONTEXT}\ \ast context, \ \text{void}\ \ast outbuf, \ \text{int}\ \ast pnBytesOut) \]

- **context** [in, out] points to the context into which data has been hashed.
- **outbuf** [out] contains the hash. On input, this buffer must be big enough to hold the hash. Currently, the largest hash size implemented is 64 bytes, which is larger than the 20-byte limit for MOVEit Crypto 1.1.0.0 and earlier versions.
- **pnBytesOut** [out] points to an integer which has been set to the hash size in bytes. This is provided so you don't have to know the exact hash size of the algorithm you chose.

Returns an MC_ERROR code (0 for success). In all cases, the hash portion of context has been zeroed.

MCKeyedHashInit

Initializes a context for a keyed hash.

\[ MC\_ERROR\ \text{MCKeyedHashInit}(\text{MC\_CONTEXT}\ \ast context, \ \text{MC\_ALG}\ \text{AlgID}, \ \text{void}\ \ast key, \ \text{int}\ nKeyBytes) \]

- **context** [in, out] points to a context to initialize.
- **AlgID** [in] is the hash algorithm on which to base the keyed hash.
- **key** [in] points to the key.
- **nKeyBytes** [in] is the number of bytes in the key.

Returns an MC_ERROR code (0 for success). If success, context has been initialized, else it has been zeroed.

MCKeyedHashUpdate

Hashes data into a context. The algorithm is the one described in Internet RFC 2202.

\[ MC\_ERROR\ \text{MCKeyedHashUpdate}(\text{MC\_CONTEXT}\ \ast context, \ \text{void}\ \ast inbuf, \ \text{int}\ nBytesIn) \]

- **context** [in, out] is a context that has been initialized by MCKeyedHashInit.
- **inbuf** [in] points to bytes which will be hashed.
- **nBytesIn** [in] is the number of bytes to hash.
Returns an MC_ERROR code (0 for success). If success, context reflects the input bytes, else it has been zeroed.

MCKeysedHashFinal

Completes the keyed hashing process, producing the final hash.

\[ \text{MC_ERROR MCKeysedHashFinal(MC_CONTEXT *context, void *outbuf, int *pnBytesOut)} \]

- **context** [in, out] is the context into which bytes have been hashed by MCKeysedHashUpdate.
- **outbuf** [out] contains the hash. On input, the buffer must be big enough to hold the hash.
- **pnBytesOut** [out] points to an integer which has been set to the hash size in bytes. This is provided so you don't have to know the exact hash size of the algorithm you chose.

Returns an MC_ERROR code (0 for success). context has been zeroed.

**Non-approved Pseudo-Random Number Generation Functions**

Note that the module is not operating in a non-FIPS-approved mode when any of the pseudo-random number generation functions are used. When security is a concern, use a more modern random number generator from a different module, as is done by MOVEit products.

MCRNGInit

Initializes a context for random number generation. This function sets the FIPS 186-2 random number generator’s key and seed each to 20 bytes of 0. The key and seed can be subsequently changed; see MCRNGSetKey and MCRNGSetSeed.

\[ \text{MC_ERROR MCRNGInit(MC_CONTEXT *context)} \]

- **context** [in, out] points to a context to initialize.

Returns an MC_ERROR code (0 for success). If failure, the context has been zeroed.

MCRNGSetKey

Set the random number generator’s key. The seed data is not changed, but users should note that that the size of the seed must always the same as the size of the key, so the current seed will be truncated or zero-padded if the key size is changed by this function. The algorithm’s definition requires the key size to be between 20 and 64 bytes, inclusive.

\[ \text{MC_ERROR MCRNGSetKey(MC_CONTEXT *context, void *keyBytes, int nBytesIn)} \]

- **context** [in, out] points to a context that has been initialized.
- **keyBytes** [in] is a buffer of 0 to 64 bytes, to be used as the new key. For instance, you might use the time-of-day, the thread id, the amount of free disk space, etc.
- **nBytesIn** [in] is the number of bytes in keyBytes. If it is less than 20, zeros will be appended to the key, and the key size will be set to 20. Otherwise, nBytesIn will be the new key size. If nBytesIn is greater than 64, an error will be returned, and the key will be unchanged.

Returns an MC_ERROR code (0 for success).
MCRNGSetSeed

Set the random number generator’s seed. Note that the algorithm’s definition requires the seed size to be the same as the key size. This function changes the contents of the seed, but not the length of the seed. Use MCRNGSetKey if you need to change the size of the key and seed. Calling MCRNGSetSeed is optional; if it is not called, the seed will be an array of zero bytes the same size as the key.

\[MC\_ERROR \ MCRNGSetSeed(MC\_CONTEXT *context, void *seedBytes, int nBytesIn)\]

\textbf{context}  \quad \text{[in, out]} points to a context that has been initialized.

\textbf{seedBytes}  \quad \text{[in]} is a buffer of 0 to 64 bytes, to be used as the new seed. For instance, you might use the time-of-day, the thread id, the amount of free disk space, etc.

\textbf{nBytesIn}  \quad \text{[in]} is the number of bytes in seedBytes. If it is greater than the current key (and seed) size, an error will be returned, and the seed will be unchanged. If it is less than the current key size, zeros will be appended to the supplied seed to make it the same size as the key. Otherwise, the seed will be set to seedBytes without modification.

\textbf{Returns}  \quad \text{an MC\_ERROR code (0 for success).}

MCRNGUpdate

Updates the random number generator with external values. This is a routine can be called repeatedly, at any time after initialization, to supply the generator with additional input. The input is hashed into the existing key, and the seed is unchanged.

This is a convenience function that is not necessary for the correct operation of the RNG. It is provided because often the caller will have a large amount of low-entropy data, rather than a small amount of high-entropy data as would normally be desired for a key. This function allows a large amount of data to be added into the key. The alternative to calling MCRNGUpdate is for the user to distill the large amount of data into a small block of data--possibly by calling a hash function--and then call MCRNGSetKey with the distilled data.

\[MC\_ERROR \ MCRNGUpdate(MC\_CONTEXT *context, void *userBytes, int nBytesIn)\]

\textbf{context}  \quad \text{[in, out]} points to a context that has been initialized.

\textbf{userBytes}  \quad \text{[in]} is a buffer with information to be incorporated into the key. For instance, you might use the time-of-day, the thread id, the amount of free disk space, etc.

\textbf{nBytesIn}  \quad \text{[in]} is the number of bytes in userBytes.

\textbf{Returns}  \quad \text{an MC\_ERROR code (0 for success). If failure, the context has been zeroed. Otherwise, the key information has been merged into the appropriate portion of the context.}

MCRNGGenerate

Generates a user-specified number of pseudo-random bytes. If no calls are made to MCRNGSetKey, MCRNGSetSeed, or MCRNGUpdate prior to MCRNGGenerate, the numbers generated by MCRNGGenerate will be a specific, predictable sequence.

\[MC\_ERROR \ MCRNGGenerate(MC\_CONTEXT *context, int nBytesDesired, void *bufout)\]
context [in, out] points to a context that has been initialized and, preferably, also updated via MCRNGSetKey, MCRNGSetSeed, and/or MCRNGUpdate.

nBytesDesired [in] is the number of random bytes desired.
bufout [out] holds the generated bytes.
Returns an MC_ERROR code (0 for success). If failure, the context has been zeroed.

MCRNGFinal
Finalizes the random number generation process. This simply zeros the context.

\[MC_ERROR MCRNGFinal(MC\_CONTEXT *context)\]
context [out] is a context to zeroize.
Returns MC_ERROR_NONE.

Miscellaneous Functions

MCGetState
Returns the current state. This is the "Show Status Service."

\[MC\_STATE MCGetState()\]
Returns the current state, as a MC\_STATE_xxx value. Note that not all states can be returned, because in some states, the module cannot be attached and therefore the function cannot be called. This function works even if the module is in an error or unlicensed state.

MCZeroizeContext
Zeroizes the context.

\[MC\_ERROR MCZeroizeContext(MC\_CONTEXT *context)\]
context [out] has been zeroed.
Returns an MC_ERROR code (0 for success).

MCGetVersion
Returns the version number of the module.

\[char * MCGetVersion()\]
Returns a pointer to a zero-terminated ASCII string in the form a.b.c.d, where a, b, c, and d are integers from 0 to 65535. This function returns the version even if the module is unlicensed or in an error state, in order to assist the user in problem resolution.

MCSelfTest
Performs a self-test of the module--the same self-test as performed at power-up. This is the "Self-Test Service."

\[MC\_ERROR MCSelfTest()\]
Returns an MC_ERROR code (0 for success). If the test fails, the module has entered the error state.

**C++ Wrapper Class**

For the convenience of C++ developers, the authors of MOVEit Crypto have provided a simple C++ class that acts as a very thin wrapper to the C-based API. This class, CMOVEitCrypto, contains methods with the same names and parameters as the MCxxx functions described above, except that there is no context parameter, and the letters "MC" are stripped from the names of the functions. The context is maintained in a member variable, which is automatically zeroed in the destructor.

CMOVEitCrypto is defined entirely within MOVEitCrypto.h, and is therefore **not part of the cryptographic module**. Thus, the CMOVEitCrypto class is not validatable.

The methods of this wrapper class are:

```cpp
CMOVEitCrypto(); // Constructor
~CMOVEitCrypto(); // Destructor

MC_ERROR EncryptInit(MC_ALG EncAlgID,
                     MC_CIPHER_MODE cipherMode, MC_PADDING padding, void *key, void *IV);
MC_ERROR Encrypt(void *inbuf, int nBytesIn, void *outbuf, int *pnBytesOut);
MC_ERROR EncryptFinal(void *outbuf, int *pnBytesOut);
MC_ERROR DecryptInit(MC_ALG EncAlgID,
                     MC_CIPHER_MODE cipherMode, MC_PADDING padding, void *key, void *IV);
MC_ERROR Decrypt(void *inbuf, int nBytesIn, void *outbuf, int *pnBytesOut);
MC_ERROR DecryptFinal(void *outbuf, int *pnBytesOut);
MC_ERROR HashInit(MC_ALG HashAlgID);
MC_ERROR HashUpdate(const void *inbuf, int nBytesIn);
MC_ERROR HashFinal(void *outbuf, int *pnBytesOut);
MC_ERROR KeyedHashInit(MC_ALG HashAlgID, const void *key, int nKeyBytes);
MC_ERROR KeyedHashUpdate(const void *inbuf, int nBytesIn);
MC_ERROR KeyedHashFinal(void *outbuf, int *pnBytesOut);
MC_ERROR RNGInit();
MC_ERROR RNGSetKey(void *keyBytes, int nBytesIn);
MC_ERROR RNGSetSeed(void *seedBytes, int nBytesIn);
MC_ERROR RNGUpdate(void *userBytes, int nBytesIn);
MC_ERROR RGGGenerate(int nBytesDesired, void *bufout);
MC_ERROR RNGFinal();
MC_ERROR ZeroizeContext();
MC_STATE GetState();
char *GetVersion();
MC_ERROR SetLicenseKey(const char *szLicenseKey);
MC_ERROR SelfTest();
```

**Key Management**

MOVEit Crypto performs limited key management, as described below.

Because the module is a dynamically-linked library, each process requesting access is provided its own instance of the module. Each process has full access to all the keys and data within the module.
The module contains only keys or data placed into the module via the services described in this document. No keys or data are automatically maintained by the module, or maintained after a process detaches from the module.

**Key Generation**

The module does not provide key generation. All keys must be entered by the user.

**Key Material and Key Storage**

The module does not provide any persistent storage of key material. Keys are entered by the user only via API calls. Key material is stored in the context, which is maintained in a user-supplied data structure passed in each API call. No key material is maintained inside the module between API calls. All key material is passed into and out of the module in plaintext form.

The only key material used by the module outside of the user-supplied context is that stored temporarily in local variables on the stack. Any local variables containing sensitive information are zeroed by the module before a function call returns to the user's code.

The module relies upon operating system memory protection to prevent processes from accessing each other's key material. To ensure that other processes cannot access keys and data, the caller must not use shared memory. Also, the operating system page file must not be configured to reside on a network drive.

**Key Zeroization**

Each MOVEit Crypto API call zeros the context before returning to the user, if the context is no longer needed (as in the Final calls), or if an error occurs. Additionally, the user may call MCZeroizeContext at any time to zero a context. Ordinarily, this is not necessary, since the user will normally call one of the Final functions at the end of processing.

**Self-Tests**

As required by FIPS 140-2, MOVEit Crypto automatically performs both power-up self-tests, and for certain algorithms, continuous self-tests during operation.

**Power-up Self-Tests**

For this module, "power-up" is when a process attempts to attach to the module. At this time, MOVEit Crypto performs these types of tests:

**Software integrity test.** MOVEit Crypto computes a keyed hash of the module and compares it to an embedded keyed hash that was placed into the module when it was produced. If the computed keyed hash differs from the keyed hash hard-coded into the module, the test fails. The HMAC-SHA-1 algorithm described in FIPS PUB 198-1 is used.

**Known Answer Test.** MOVEit Crypto performs known answer tests for the approved algorithms AES, SHA-1, SHA-256, SHA-384, SHA-512, HMAC-SHA-1, HMAC-SHA-256, HMAC-SHA-384, and HMAC-SHA-512. Known answer tests are also done for the unapproved algorithms MD5, HMAC-MD5, and FIPS PUB 186-2 Change Notice 1 random number generation. If the computed result differs from the expected result hard-coded into the module, the test fails. The random number generation test is performed by entering a fixed seed and comparing the resulting pseudo-random numbers to a known result. MOVEit Crypto also performs an encrypt/decrypt test in which a buffer is encrypted and decrypted in chunks. The
decrypted result is compared to the original plaintext. If the decrypted result is different than the original plaintext, the test fails.

If any of these tests fails, MOVEit Crypto returns to the disabled state, and in the case of the Windows version, refuses to allow the process to attach to the module. Thus, the cryptographic services are not available. To correct the problem, the cryptographic officer should reinstall the module.

**Conditional Self-Tests**

During operation, MOVEit Crypto performs one type of ongoing test. Whenever a block of pseudo-random bytes is generated as a result of a call to MCRNGGenerate, the block is compared to the previous block. If the two match, the module enters the error state, and will no longer perform any cryptographic services. (Certain non-cryptographic utility functions remain available, namely MCGetState and MCGetVersion.) Once the module is in the error state, it remains in the error state until the process detaches from the module. To correct the problem, a process should detach from and reattach to the module.

**User Guidance**

**Choice of Algorithms and Key Lengths**

The recommended values for AES encryption parameters are:

<table>
<thead>
<tr>
<th>Key size</th>
<th>256 bits. There is only a small performance penalty associated with longer AES key sizes. Encryption with 256-bit keys is about 25% slower than with 128-bit keys.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cipher mode</td>
<td>CBC. CBC is much more secure than ECB, as it hides plaintext patterns from attackers. The extra performance overhead of CBC is negligible.</td>
</tr>
<tr>
<td>Padding</td>
<td>Application dependent; RFC 2040 padding is more convenient for most applications, because it does not force you to restrict your messages to multiples of the block size. The extra performance overhead of RFC 2040 padding is minor.</td>
</tr>
</tbody>
</table>

For example:

```c
MC_ERROR mcerror = MCEncryptInit(&context, MC_ALG_AES_256, MC_CIPHER_MODE_CBC, MC_PADDING_RFC2040, key, IV);
```

**Non-approved Pseudo-Random Number Generator Seeds**

A calling application can request the module's pseudo-random number generator (RNG) whenever it requires random data. (Note that the module is not operating in a FIPS-approved mode when RNG functions are called.) If the RNG is used for key generation or other cryptographic operations, it is important that the generator be seeded with unpredictable values. There are many sources of pseudo-random data on a computer, including the time-of-day, the number of milliseconds since boot, the amount of time it takes to create a thread, the contents and attributes of files, the values of performance counters, and even the hardware RNG on some Intel
Celeron and Pentium III chipsets. For cryptographic applications, it is important to use as much pseudo-random data as reasonably possible when seeding a RNG.

One simple way of obtaining reasonably high-quality seed data is to use Microsoft's Crypto API, which is installed on most Windows systems. The following sample code demonstrates how the module can be used to generate a random seed:

```c
#include <windows.h>
#include <wincrypt.h>
#include <stdio.h>
#include "moveitcrypto.h"

int main(int argc, char *argv[]) {
  MC_CONTEXT context;
  MC_ERROR mcerror;
  unsigned char seed[256], ranbytes[10];
  int j;

  /* Use the MS Crypto API to generate a seed. */
  HCRYPTPROV hProv = 0;
  CryptAcquireContext(&hProv, 0, 0, PROV_RSA_FULL, CRYPT_VERIFYCONTEXT);
  CryptGenRandom(hProv, sizeof(seed), seed);
  /* Now the seed is in "seed". Release the MS Crypto API context. */
  CryptReleaseContext(hProv, 0);

  /* Set the license key. (Don't use this dummy key in your code.) */
  mcerror=MCSetLicenseKey("12345-12345-12345");
  /* Initialize the RNG. */
  mcerror=MCRNGInit(&context);
  /* Feed the seed to MOVEit Crypto, then zero the local copy. */
  mcerror=MCRNGUpdate(&context, seed, sizeof(seed));
  memset(seed, 0, sizeof(seed));
  /* Now it's OK to call the RNG. */
  mcerror=MCRNGGenerate(&context, sizeof(ranbytes), ranbytes);
  if(mcerr or printf("MCRNGGenerate returned %d\n", mcerror);
    /* Insert code here to use ranbytes. */
    printf("Got random bytes:\n");
    for(j=0; j<sizeof(ranbytes); j++) printf(" %2.2x", ranbytes[j]);
  /* Clear the context. */
  mcerror=MCRNGFinal(&context);

  return 0;
}
```

On a Linux system, a program can obtain reasonably high-quality seed data by reading the file `/dev/random`.

### Protecting Keys and Data

Although MOVEit Crypto is careful to zeroize its own copies of sensitive information, it has no control over keys and data managed by the calling application. For maximum security, be sure to zeroize all copies of key material and plaintext data when they are no longer needed by the application. This applies to memory, disk, and other forms of storage. Be aware that simply deleting files or returning allocated memory buffers to the system will not destroy the data.
**MOVEit Crypto Context**

The layout of MC_CONTEXT may change from one release of the module to another. For this reason, and for security reasons, the context must not be saved between invocations of a program.

**Crypto Officer Guidance**

With respect to the MOVEit Crypto module, the responsibilities that apply to a cryptographic officer that do not apply to a user are:

- Installing or uninstalling the module.
- Configuring the operating system.

Since MOVEit Crypto does not, by itself, persistently store any keys or sensitive information on the system, no special action need be taken to administratively protect such information. However, be aware that applications using the module may store sensitive information on their own.

**Guidance for Windows**

MOVEit Crypto is installed only as part of installation programs for certain other products. You must be logged in as an Administrative user to install the module, and you must have write access to the Windows system directory, as well as other directories selectable during the install.

To uninstall the module, use the Control Panel Add/Remove Programs applet and uninstall the product with which MOVEit Crypto was installed. If multiple products containing MOVEit Crypto have been installed, you must uninstall them all to remove MOVEit Crypto.

It is recommended that the cryptographic officer configure the operating system to minimize the likelihood that an attacker could obtain sensitive information from system paging or dump files. This can be done by setting certain registry values:

- Set HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\CrashControl\CrashDumpEnabled to 0. This is a REG_DWORD value.
- Set HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\Session Manager\Memory Management\ClearPageFileAtShutdown to 1. This is a REG_DWORD value.

**Guidance for Linux**

Install / Uninstall

MOVEit Crypto is installed only as part of installation programs for certain other products. You must be logged in as a root user to install the module.

To uninstall the module, follow the instructions for uninstalling the product with which MOVEit Crypto was distributed.

Preventing core Files

It is recommended that the cryptographic officer ensure that users are not configured to produce "core dump" files when their application faults, unless this capability is necessary during development and testing. The resulting core dump files can contain sensitive information, including keys and data.
Many systems are configured to not create core files by default, but the cryptographic operator may want to modify the user's configuration to ensure this. The method of preventing "core" files from being produced depends on which shell is being used by the user in question.

For users running the bash shell, which is the default under Red Hat Linux, the cryptographic officer can add the line

```
ulimit -c 0
```

to the end of the .bashrc file for the user in question to prevent creation of core dump files.

For users running csh or tsch, the cryptographic officer can add the line

```
limit coredumpsize 0
```

to the end of the .cshrc file for the user in question to prevent creation of core dump files.

**Other Linux Security Measures**

The cryptographic officer should ensure that the file /etc/ld.so.preload does not exist (by default it does not exist). This will help prevent other libraries from usurping the functions used by MOVEit Crypto.

**Miscellaneous**

**Mitigation of Specific Attacks**

MOVEit Crypto is not designed to mitigate specific attacks.

**Tabular Summaries**

As required by FIPS 140-2 Derived Test Requirements, here are tables summarizing certain aspects of the security policy:

<table>
<thead>
<tr>
<th>Role</th>
<th>Type of Authentication</th>
<th>Authentication Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>User</td>
<td>None</td>
<td>N/A</td>
</tr>
<tr>
<td>Crypto Officer</td>
<td>None</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**Roles and Required Identification and Authentication**

<table>
<thead>
<tr>
<th>Authentication Mechanism</th>
<th>Strength of Mechanism</th>
</tr>
</thead>
<tbody>
<tr>
<td>User</td>
<td>None</td>
</tr>
<tr>
<td>Crypto Officer</td>
<td>None</td>
</tr>
</tbody>
</table>

**Strengths of Authentication Mechanisms**

<table>
<thead>
<tr>
<th>Role</th>
<th>Authorized Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>User</td>
<td>All</td>
</tr>
<tr>
<td>Crypto Officer</td>
<td>All</td>
</tr>
</tbody>
</table>
### Services Authorized for Roles

<table>
<thead>
<tr>
<th>Service</th>
<th>Cryptographic Keys and Critical Security Parameters</th>
<th>Type(s) of Access (e.g., Read, Write, Execute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MCEncryptInit, MCDecryptInit</td>
<td>Encryption keys</td>
<td>W</td>
</tr>
<tr>
<td>MCEncrypt, MCDecrypt</td>
<td>Encryption keys</td>
<td>E</td>
</tr>
<tr>
<td>MCEncryptFinal, MCDecryptFinal</td>
<td>Encryption keys</td>
<td>WE (W to zeroize only)</td>
</tr>
<tr>
<td>MCKeyedHashInit</td>
<td>HMAC keys</td>
<td>W</td>
</tr>
<tr>
<td>MCKeyedHashUpdate</td>
<td>HMAC keys</td>
<td>E</td>
</tr>
<tr>
<td>MCKeyedHashFinal</td>
<td>HMAC keys</td>
<td>WE (W to zeroize only)</td>
</tr>
<tr>
<td>MCZeroizeContext</td>
<td>Encryption keys and HMAC keys</td>
<td>W (to zeroize only)</td>
</tr>
<tr>
<td>MCSelfTest</td>
<td>Built-in HMAC key for software/firmware test</td>
<td>E</td>
</tr>
<tr>
<td>All other</td>
<td>None</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Access Rights within Services

<table>
<thead>
<tr>
<th>Physical Security Mechanisms</th>
<th>Recommended Frequency of Inspection / Test</th>
<th>Inspection / Test Guidance Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Inspection/Testing of Physical Security Mechanisms

<table>
<thead>
<tr>
<th>Other Attacks</th>
<th>Mitigation Mechanism</th>
<th>Specific Limitations</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Mitigation of Other Attacks