Linux Kernel Crypto API User Space Interface Library

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Linux Kernel Crypto API User Space Interface Library
by Stephan Mueller

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Chapter 1. libkcapi - Linux Kernel Crypto API User Space Interface Library

This documentation applies to version 1.3.1.

The Linux kernel exports a network interface of type AF_ALG to allow user space to utilize the kernel crypto API.

libkcapi uses this network interface and exports easy to use APIs so that a developer does not need to consider the low-level network interface handling.

The library does not implement any cipher algorithms. All consumer requests are sent to the kernel for processing. Results from the kernel crypto API are returned to the consumer via the library API.

The kernel interface and therefore this library can be used by unprivileged processes.

Version Number Schema

The version numbers for this library have the following schema: MAJOR.MINOR.PATCHLEVEL

Changes in the major number implies API and ABI incompatible changes, or functional changes that require consumer to be updated (as long as this number is zero, the API is not considered stable and can change without a bump of the major version).

Changes in the minor version are API compatible, but the ABI may change. Functional enhancements only are added. Thus, a consumer can be left unchanged if enhancements are not considered. The consumer only needs to be recompiled.

Patchlevel changes are API / ABI compatible. No functional changes, no enhancements are made. This release is a bug fixe release only. The consumer can be left unchanged and does not need to be recompiled.

Purpose Of AF_ALG

With the presence of numerous user space cryptographic libraries, one may ask why is there a need for the kernel to expose its kernel crypto API to user space. As there are system calls and potentially memory copies needed before a cipher can be invoked, it should be typically slower than user space shared libraries.

There are several reasons for AF_ALG:

- The first and most important item is the access to hardware accelerators and hardware devices whose technical interface can only be accessed from the kernel mode / supervisor state of the processor. Such support cannot be used from user space except through AF_ALG.
- When using user space libraries, all key material and other cryptographic sensitive parameters remains in the calling application's memory even when the application supplied the information to the library. When using AF_ALG, the key material and other sensitive parameters are handed to the kernel. The calling application now can reliably erase that information from its memory and just use the cipher handle to perform the cryptographic operations. If the application is cracked an attacker cannot obtain the key material.
- On memory constrained systems like embedded systems, the additional memory footprint of a user space cryptographic library may be too much. As the kernel requires the kernel crypto API to be present, reusing existing code should reduce the memory footprint.

Chapter 2. Programming Guidelines

A consumer has to use the kcapi.h header file to link with libkcapi. The linking has to be performed using -lkcapi.

In case a consumer does not want a shared library, the libkcapi C file and header file can also just copied to the consumer code and compiled along with it.

A general requirement must be observed: setting of keys must be performed before any operation. Re-setting of keys is only permissible once all data in flight (sent to the kernel but the kernel's result is not yet obtained) is processed, i.e. no data is in flight any more.

Convenience Functions

To support various use cases, the API provided with libkcapi is extensive. Though, some developers want to simply use a given cipher without any specific details. To accommodate such users, libkcapi provides convenience functions or convenience wrappers.

The convenience functions provide exactly one function call to perform one complete cipher operation, such as an AES CBC encryption operation or a SHA-256 hashing. The caller only needs to provide the input and output buffers of his data. The entire intrinsic operation of libkcapi is hidden from the user.

Convenience functions are provided for the different cipher types. They are clearly marked in the API specification below.

Synchronous Symmetric Cipher API

Symmetric ciphers can be used in the following different ways:

- One-shot API: The one-shot API performs an encryption operation with one API call. With that API call, the caller provides the input data and immediately receives the output from the cipher operation.
- Stream API: With the stream API, the caller can implement independent calls to send data to the kernel and receive data from the kernel. Multiple send calls can be inter-mixed with multiple receive calls. If the kernel buffer is full, the caller of a subsequent send call will be put to sleep. Conversely, if the buffer is empty, a caller trying to read data resulting from a cipher operation will be put to sleep. Sleeping callers will be woken up by the kernel once buffer space becomes available or data becomes available, respectively. The detached nature of the sending/receiving operation allows the implementation of multi-threaded applications where one or more threads send data and one or more threads receive data. The threads must operate on the same cipher handle. However, access to that cipher handle does not need to be serialized when the stream API calls are invoked as the API calls only read the cipher handle.

Asynchronous Symmetric Cipher API

In addition to the symmetric cipher API, an asynchronous API is offered with the kcapi_cipher_*_aio and kcapi_aead_*_aio API calls. The concept of that API is to perform parallel operations of multiple encryption or decryption data streams.

To use the AIO API, the caller must use the KCAPI_INIT_AIO with the kcapi_cipher_init function call to set up all additional logistics for handing AIO. That means, users which are not interested in AIO will not suffer from the additional memory overhead including the time required to allocate that memory required for AIO.

This implies that the asynchronous API handles the scatter-gather lists referenced by the IOVECs differently compared to the synchronous APIs. Whereas the synchronous API references different parts of plaintext or ciphertext that are processed with one cipher operation, the IOVECs of the asynchronous API references plaintext or ciphertext where each IOVEC is processed with an independent cipher operation. I.e. when using AES-CBC with the synchronous API and the scatter-gather lists, all input data is sent to one invocation of the AES-CBC cipher. Conversely, the asynchronous API invokes one individual AES-CBC operation for each individual IOVEC.

The asynchronous API is designed to perform an in-place operation where the buffers for the input data are used to store the output data.

The asynchronous API in libkcapi as well as the kernel has a higher overhead for setting the cipher operation up. That means that if the caller only uses a one IOVEC with one associated cipher operation, the asynchronous API is expected to be slower compared to the synchronous API. But already with two or three combined cipher operations, the AIO API should be faster than the synchronous API. You may test the difference in performance with the test/kcapi test application by using the options -f for measuring the time of cipher operations in nanoseconds, -d for the number of parallel invocations and -x 1 for a symmetric one-shot cipher invocation and -x 9 for an asymmetric cipher operation with the given input data.

The kernel offers the AIO interface since kernel version 4.1 (symmetric ciphers) and 4.7 (AEAD ciphers). The libkcapi implements a transparent fallback to use the synchronous cipher API in case the AIO support is not present for the current kernel. This allows the calling users to be agnostic of the kernel support. Nonetheless, libkcapi with report the lack of AIO support if AIO is requested as the fallback implementation has a slight performance overhead.

AEAD Cipher API

AEAD ciphers implement a very similar API approach as the symmetric ciphers:

- One-shot API: The one-shot API performs an encryption operation with one API call. With that API call, the caller provides the input data and immediately receives the output from the cipher operation.
- Stream API: With the stream API, the caller can implement independent calls to send data to the kernel and receive data from the kernel. However, unlike the symmetric cipher API, one AEAD cipher operation must be considered as one unit as the integrity value is calculated for one encryption or decryption operation. The caller can use multiple calls to provide the input data. The last chunk of data must be sent to the kernel with the API call marking the last submission. Then, the cipher operation can be triggered with the recvmsg invocation. It is possible to implement a multi-threaded application as the thread triggering the cipher operation is put to sleep until the last block is received. Once the last block is received, the caller waiting on the cipher operation is woken up to obtain the data.

Aynchronous AEAD Cipher API

Similarly to the symmetric cipher API, the AEAD API supports asynchronous operation as well. The same concept regarding the IOVECs applies as discussed for the asynchronous symmetric cipher API above.

AEAD Memory Structure

When using the stream API for AEAD, the caller must observe a particular order of data components. It is permissible that for each of the following data components multiple send calls are used. But in total, all send calls must send the AEAD data in the requested sequence. That sequence has changed with kernel 4.9. The following sequence is applicable to kernel versions up to and including 4.8:

1. Associated Authentication Data: The AAD must be provided as a first chunk.
2. Plaintext / Ciphertext: Following the AAD, the entire plaintext or ciphertext is provided that shall be encrypted and integrity protected or decrypted and whose integrity shall be verified.
3. Authentication Tag: Regardless of an encryption or decryption, the authentication tag memory must be provided.

The caller must provide memory that is identical in size for the input and output data, even parts of the memory is unused. For example, for encryption, the AEAD cipher operation only needs the AAD and the plaintext. Nonetheless, the interface requires that the memory is big enough to hold the tag as well. This requirement particularly aids the in-place cipher operation.

Starting with kernel 4.9, the interface changed slightly such that the authentication tag memory is only needed in the output buffer for encryption and in the input buffer for decryption.

To allow the calling application to be agnostic about the differences in the kernel interface, the calling application is offered additional API calls which should be used as follows:

1. Obtain the required input buffer length for the cryptographic operation using the calls kcapi_aead_inbuflen_enc or kcapi_aead_inbuflen_dec.
2. Obtain the required output buffer length for the cryptographic operation using the APIs of kcapi_aead_outbuflen_enc or kcapi_aead_outbuflen_dec.
3. For an in-place operation with a linear buffer, do the following (for an example, see test/kcapi-main.c:cavs_aead()):
    a. allocate memory that is max(inbuflen, outbuflen),
    b. call to kcapi_aead_getdata_input and kcapi_aead_getdata_output with the allocated memory pointer to obtain the pointers into that allocated memory where the AAD, plaintext / ciphertext and tag is to be provided,
    c. fill these AAD, plaintext/ciphertext and tag pointers with the respective data if they are non-NULL -- note, a NULL pointer may be returned for the tag pointer,
    d. invoke the crypto operation with the pointer to the allocated buffer and inbuflen is supplied to the.
4. For for separate, potentially non-contiguous buffers, do the following (for an example, see test/kcapi-main.c:cavs_aead_stream()):
    a. ensure that your total buffer size for input and output complies with the result from the buffer lengths supplied by the aforementioned API calls,
    b. call to kcapi_aead_getdata_input and kcapi_aead_getdata_output with NULL pointers for the memory buffers to obtain the lengths for the AEAD data components,
    c. initialize the IOVECs and/or invoke the stream API with the independent buffers with the AAD, plaintext/ciphertext and tag if the associated length values are non-zero.

If the caller chooses to not implement an in-place operation, the kernel will copy the AAD data into the output buffer, so that the destination buffer will hold the the ciphertext or plaintext, the AAD data and the authentication tag (encryption only). The memory structure of the destination buffer is identical to the source buffer. (This is currently not yet implemented for all ciphers and will be fixed in future kernel versions.)

Message Digest API

Again, like for the symmetric ciphers, the message digest API implements the one-shot and the stream use cases. In addition, convenience wrapper functions for SHA-1 through SHA-512 are provided where the caller only provides its input data and the return buffer for obtaining a message digest or keyed message digest.

Asymmetric Cipher API

The asymmetric cipher API provides access to the raw asymmetric operations (i.e. modular exponentiation).

Zero Copy

When using the one-shot API for symmetric ciphers, AEAD ciphers, as well as message digests, the library uses the zero copy interface to provide the input data to the kernel. That means, the kernel operates on the user space pages.

To ensure the efficiency of this zero copy approach, the caller should use a page-aligned data buffer for the input data. Non-aligned buffers would work also, but the kernel would need to perform more page accesses, lowering the throughput. Such an aligned buffer can be created, for example, using the following call - the value 4096 should be the size of one page on the system:

```
unsigned char buf[4096] __attribute__((__aligned__(4096)));


unsigned char *buf;
posix_memalign((void *)&buf, PAGE_SIZE, buflen);
```

Memory Allocation

The library libkcapi uses the data structure struct kcapi_handle as the cipher handle that allows the consumer to operate with the various function calls of this library.

Unlike other crypto libraries, libkcapi does not allocate any memory or performs operations that implies memory allocation. struct kcapi_handle only holds pointers to the consumer-provided buffers with sensitive data. That means that the buffers holding sensitive data like keys are under full control of the consumer. Therefore, this library does not offer any memory allocation or secure memory clearing functions.

The consumer must ensure that the memory is appropriately sanitized. The caller does not need to sanitize struct kcapi_handle as it does not contain any sensitive data.

Asynchronous I/O Use Cases and Libkcapi

The kernel crypto API user space interface supports different use cases with the asynchronous I/O operations which are illustrated in the following sections. These sections also illustrate the API calls to be used to follow the respective use cases.

All APIs that perform synchronous operation do not have different purposes and thus do not require special precautions when using them.

The different use cases round asynchronous I/O revolve around different ways how to send data to the kernel and to retrieve processed data.

Multiple Staged Cipher Operations

Using the kcapi_cipher_*_aio and kcapi_aead_*_aio API calls, a caller can supply one or more IOVECs of data to the kernel. However, the caller can only supply one IV to the kernel.

The API calls only allow specifying one integer defining the number of IOVECs in the arrays of the input data as well as the output data. The libkcapi library uses the input and output IOVECs as pairs. I.e. the first IOVEC of the input array relate to the first IOVEC of the output array, and so on.

The kernel invokes the cipher operation when a recvmsg system call is processed. The AIO handling transforms each output IOVEC into one separate invocation of the recvmsg handler that processes the data submitted with the corresponding input IOVEC. This means, each output IOVEC will trigger one cipher operation. When multiple IOVECs are processed by the kernel's AIO handling, all resulting recvmsg calls are invoked with the in the data same order specified by the list of IOVECs.

WARNING: Currently, it is not guaranteed that the drivers perform the proper serialization of the parallel processing of the different IOVECs. For example, when providing two IOVECs, they may be both using the initially set IV. Thus, they are not chained. User space is able to serialize the AIO operation in this case by invoking the AIO API calls with input/output IOVEC arrays holding one entry each only. However, this would imply that this type of invocation will not be different from a synchronous invocation.

Multiple Separate Cipher Operations

The kernel and thus libkcapi supports the use case where several of the aforementioned multiple staged cipher operations are can be performed in parallel which are totally isolated from each other. In this case, different IVs are used.

Using the kcapi_handle_reinit libkcapi API call, the caller can obtain a new cipher handle from an existing handle. Both share the same key and cipher -- the kernel crypto API maintains the same TFM data structure for both. However, both cipher handles can now encrypt or decrypt data completely isolated from each other. Specifically, the following data of a cipher operation is isolated between the different cipher handles -- this is all data that is not set with a setsockopt(2) system call:

- Input: plaintext (encryption) or ciphertext (decryption)
- Output: plaintext (decryption) or ciphertext (encryption)
- IV
- AEAD: associated authenticated data (AAD) and its length
- AEAD: tag

The following data is shared between the different cipher handles -- this covers all data that can be set with a setsockopt(2) system call:

- Key

- AEAD: Tag length

This means that the "multiple staged cipher operations" discussed above can be performed with each cipher handle independently.

The call kcapi_handle_reinit does not open another socket, but implies that only a new accept(2) system call is performed.

Kernel Interfaces

Depending on the version of your kernel, some of the kernel interfaces the library depends on are not available. When using the respective library API functions, an error is returned during initialization of the cipher handle. The following interfaces are available:

- kcapi_md_* usable since kernel version 3.0
- kcapi_cipher_* usable since kernel version 3.0
- kcapi_rng_* kernel interface integrated into kernel version 4.0
- kcapi_aead_* kernel interface added to cryptodev-2.6 tree and should be usable with kernel version 4.2.
- kcapi_akcipher_* kernel interface is discussed for inclusion to the cryptodev-2.6 kernel tree.

Kernel Configuration

To use libkcapi, the following kernel options need to be enabled:

- CONFIG_CRYPTO_USER enables the NETLINK_CRYPTO interface to allow obtaining information about the loaded ciphers. When compiled as module in older kernels (pre 3.18) the resulting crypto_user kernel module must be loaded manually.
- CONFIG_CRYPTO_USER_API enables the core functionality of the user space interface handler.
- CONFIG_CRYPTO_USER_API_HASH enables the "hash" interface (i.e. allows the use of all message digest and keyed message digest ciphers).
- CONFIG_CRYPTO_USER_API_SKCIPHER enables the "skcipher" interface to use symmetric cipher algorithms.
- CONFIG_CRYPTO_USER_API_AEAD enables the "aead" interface to use AEAD cipher algorithms. This support is currently discussed on LKML and therefore not present in the mainline kernel.
- CONFIG_CRYPTO_USER_API_RNG enables the "rng" interface to use the random number generators.
- CONFIG_CRYPTO_USER_API_AKCIPHER enables the "akcipher" interface to use the asymmetric ciphers. This support is currently discussed on LKML and therefore not present in the mainline kernel.

In addition, the following patch must be applied if a kernel less than 3.19-rc1 or the cryptodev-2.6 kernel tree is used: https://git.kernel.org/cgit/linux/kernel/git/herbert/cryptodev-2.6.git/commit/?id=5d4a5e770d97d87082067886e7097c920b338da5

In addition, the following patch must be applied if a kernel less than 3.19-rc1 or the cryptodev-2.6 kernel tree is used: https://git.kernel.org/cgit/linux/kernel/git/herbert/cryptodev-2.6.git/commit/?id=af8e80731a94ff9de9508b01d9e5d931d538dc6b

In addition, the following patch must be applied if a kernel less than 3.19-rc1 or the cryptodev-2.6 kernel tree is used:

https://git.kernel.org/cgit/linux/kernel/git/herbert/cryptodev-2.6.git/commit/?id=25fb8638e919bc7431a73f2fb4a9713818ae2c9d

Example Code

Example code covering all available API calls is provided with the test code in the test/ directory.

Chapter 3. Programming Interface

Common API

The following API calls are common to all cipher types.

kcapi_set_verbosity

LINUX

libkcapi ManualApril 2022

Name

`kcapi_set_verbosity` — set the verbosity level of the library

Synopsis

```
void kcapi_set_verbosity (enum kcapi_verbosity level);
```

Arguments

`level`

[in] verbosity level:

LOG_ERR

only log error messages (default)

LOG_WARN

log warnings and error messages

LOG_VERBOSE

log verbose messages, warnings and error messages

LOG_DEBUG

log all details of library operation

kcapi_versionstring

LINUX

libkcapi ManualApril 2022

Name

`kcapi_versionstring` — obtain version string of kcapi library

Synopsis

```
void kcapi_versionstring (char * buf, uint32_t buflen);
```

Arguments

buf
: [out] buffer to place version string into

buflen
: [in] length of buffer

kcapi_version

LINUX

libkcapi ManualApril 2022

Name

`kcapi_version` — return machine-usable version number of kcapi library

Synopsis

```
uint32_t kcapi_version ( void);
```

Arguments

void
: no arguments

Description

The function returns a version number that is monotonic increasing for newer versions. The version numbers are multiples of 100. For example, version 1.2.3 is converted to 1020300 -- the last two digits are reserved for future use.

The result of this function can be used in comparing the version number in a calling program if version-specific calls need to be make.

return Version number of kcapi library

kcapi_pad_iv

LINUX

libkcapi ManualApril 2022

Name

`kcapi_pad_iv` — realign the IV as necessary for cipher

Synopsis

```
int kcapi_pad_iv (struct kcapi_handle * handle, const uint8_t * iv,
uint32_t ivlen, uint8_t ** newiv, uint32_t * newivlen);
```

Arguments

handle
: [in] cipher handle

iv
: [in] current IV buffer

ivlen
: [in] length of IV buffer

newiv
: [out] buffer of aligned IV

newivlen
: [out] length of newly aligned IV

Description

The function pads the least significant bits of the provided IV up to the block size of the cipher with zeros. In case the provided IV is longer than the block size, the least significant bits are truncated to the block size.

The function allocates memory for newiv in case the return code indicates success. The consumer must free the memory after use.

return 0 for success; a negative errno-style error code if an error occurred

kcapi_memset_secure

LINUX

libkcapi ManualApril 2022

Name

`kcapi_memset_secure` — `memset` implementation that will not be optimized away by the compiler

Synopsis

```
void kcapi_memset_secure (void * s, int c, size_t n);
```

Arguments

s
: [in] see memset(3)

c
: [in] see memset(3)

n
: [in] see memset(3)

Description

The parameters, he logic and the return code is identical to memset(3).

kcapi_handle_reinit

LINUX

libkcapi ManualApril 2022

Name

`kcapi_handle_reinit` — re-initialize a new kernel interface

Synopsis

```
int kcapi_handle_reinit (struct kcapi_handle ** newhandle, struct
kcapi_handle * existing, uint32_t flags);
```

Arguments

newhandle
: [out] cipher handle filled during the call

existing

[in] existing cipher handle from which a new handle shall be re-initialized

flags

[in] flags specifying the type of cipher handle

Description

The kernel crypto API interface operates with two types of file descriptors, the TFM file descriptor and the OP file descriptor.

The TFM file descriptor receives the cipher-operation static information: the key, and the AEAD tag size.

The OP file descriptor receives the volatile data, such as the plaintext / ciphertext, the IV, or the AEAD AD size.

The kernel crypto API AF_ALG interface supports the concept that one TFM file descriptor can operate with multiple OP file descriptors. The different OP file descriptors can perform completely separate cipher operations using the same key which can execute in parallel. The parallel execution can be performed in the same or different process threads.

`kcapi_handle_reinit` function allows the allocation of a new cipher handle with a new OP file descriptor but using the same TFM file descriptor. To obtain a reference to the TFM file descriptor, an *existing* cipher handle is used as source. `kcapi_handle_reinit` can be invoked multiple times. Each resulting cipher handle must be deallocated with `kcapi_cipher_destroy`. The deallocation ensures that the TFM resource is only released if the last handle using this TFM resource is released.

return 0 upon success; -EINVAL - accept syscall failed -ENOMEM - cipher handle cannot be allocated

kcapi_set_maxsplicesize

LINUX

libkcapi ManualApril 2022

Name

`kcapi_set_maxsplicesize` — Set maximum buffer size for splice

Synopsis

```
int kcapi_set_maxsplicesize (struct kcapi_handle * handle, unsigned
int size);
```

Arguments

handle

[in] cipher handle allocated by caller.

size

[in] New maximum buffer size in bytes

Description

When using vmsplice/splice to avoid copying of data into the kernel, the kernel enforces a maximum number of bytes which can be spliced. If larger data is to be processed, sendmsg will be used.

Using this call, the buffer size can be increased.

NOTE

Splice uses a pipe pair. Therefore, the maximum number of bytes that can be stored with the pipe governs the maximum data size to be spliced. Increasing the pipe buffer size is only allowed up to the maximum specified with /proc/sys/fs/pipe-max-size.

return 0 upon success; a negative errno-style error code if an error occurred

kcapi_get_maxsplicesize

LINUX

libkcapi ManualApril 2022

Name

`kcapi_get_maxsplicesize` — Get maximum buffer size for splice

Synopsis

```
int kcapi_get_maxsplicesize (struct kcapi_handle * handle);
```

Arguments

handle

[in] cipher handle allocated by caller.

Description

The call returns the maximum number of bytes that can be handled with splice.

return Maximum buffer size in bytes

Symmetric Cipher API - Generic

These generic API for symmetric ciphers calls are to be used for both, the one-shot and the stream encryption/decryption operations.

API function calls used to invoke symmetric ciphers.

kcapi_cipher_init

LINUX

libkcapi ManualApril 2022

Name

`kcapi_cipher_init` — initialize cipher handle

Synopsis

```
int kcapi_cipher_init (struct kcapi_handle ** handle, const char *
ciphername, uint32_t flags);
```

Arguments

handle

[out] cipher handle filled during the call

ciphername

[in] kernel crypto API cipher name as specified in /proc/crypto

flags

[in] flags specifying the type of cipher handle

Description

This function provides the initialization of a symmetric cipher handle and establishes the connection to the kernel.

On success, a pointer to kcapi_handle object is returned in *handle. Function `kcapi_cipher_destroy` should be called afterwards to free resources.

return 0 upon success; -ENOENT - algorithm not available; -EOPNOTSUPP - AF_ALG family not available; -EINVAL - accept syscall failed -ENOMEM - cipher handle cannot be allocated

kcapi_cipher_destroy

LINUX

libkcapi ManualApril 2022

Name

`kcapi_cipher_destroy` — close the cipher handle and release resources

Synopsis

```
void kcapi_cipher_destroy (struct kcapi_handle * handle);
```

Arguments

handle
: [in] cipher handle to release

kcapi_cipher_setkey

LINUX

libkcapi ManualApril 2022

Name

`kcapi_cipher_setkey` — set the key for the cipher handle

Synopsis

```
int kcapi_cipher_setkey (struct kcapi_handle * handle, const uint8_t
* key, uint32_t keylen);
```

Arguments

handle
: [in] cipher handle

key
: [in] key buffer

keylen
: [in] length of key buffer

Description

With this function, the caller sets the key for subsequent encryption or decryption operations.

After the caller provided the key, the caller may securely destroy the key as it is now maintained by the kernel.

return 0 upon success (in case of an akcipher handle, a positive integer is returned that denominates the maximum output size of the cryptographic operation -- this value must be used as the size of the output buffer for one cryptographic operation); a negative errno-style error code if an error occurred

kcapi_cipher_ivsize

LINUX

libkcapi ManualApril 2022

Name

`kcapi_cipher_ivsize` — return size of IV required for cipher

Synopsis

```
uint32_t kcapi_cipher_ivsize (struct kcapi_handle * handle);
```

Arguments

handle

[in] cipher handle

Description

return > 0 specifying the IV size; 0 on error

kcapi_cipher_blocksize

LINUX

libkcapi ManualApril 2022

Name

`kcapi_cipher_blocksize` — return size of one block of the cipher

Synopsis

```
uint32_t kcapi_cipher_blocksize (struct kcapi_handle * handle);
```

Arguments

handle
: [in] cipher handle

Description

return > 0 specifying the block size; 0 on error

Synchronous Symmetric Cipher API - One Shot

kcapi_cipher_encrypt

LINUX

libkcapi ManualApril 2022

Name

`kcapi_cipher_encrypt` — encrypt data (synchronous one shot)

Synopsis

```
ssize_t kcapi_cipher_encrypt (struct kcapi_handle * handle, const
uint8_t * in, size_t inlen, const uint8_t * iv, uint8_t * out,
size_t outlen, int access);
```

Arguments

handle
: [in] cipher handle

in
: [in] plaintext data buffer

inlen
: [in] length of in buffer

iv
: [in] IV to be used for cipher operation

out
: [out] ciphertext data buffer

outlen
: [in] length of out buffer

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE - use vmsplice access; KCAPI_ACCESS_SENDMSG - sendmsg access)

Description

It is perfectly legal to use the same buffer as the plaintext and ciphertext pointers. That would mean that after the encryption operation, the plaintext is overwritten with the ciphertext.

The memory should be aligned at the page boundary using posix_memalign(sysconf(_SC_PAGESIZE)), If it is not aligned at the page boundary, the vmsplice call may not send all data to the kernel.

The IV buffer must be exactly `kcapi_cipher_ivsize` bytes in size.

return number of bytes encrypted upon success; a negative errno-style error code if an error occurred

kcapi_cipher_decrypt

LINUX

libkcapi ManualApril 2022

Name

`kcapi_cipher_decrypt` — decrypt data (synchronous one shot)

Synopsis

```
ssize_t kcapi_cipher_decrypt (struct kcapi_handle * handle, const
uint8_t * in, size_t inlen, const uint8_t * iv, uint8_t * out,
size_t outlen, int access);
```

Arguments

handle

[in] cipher handle

in

[in] ciphertext data buffer

inlen

[in] length of in buffer

iv

[in] IV to be used for cipher operation

out

[out] plaintext data buffer

outlen

[in] length of out bufferS

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE - use vmsplice access; KCAPI_ACCESS_SENDMSG - sendmsg access)

Description

It is perfectly legal to use the same buffer as the plaintext and ciphertext pointers. That would mean that after the encryption operation, the ciphertext is overwritten with the plaintext.

The memory should be aligned at the page boundary using posix_memalign(sysconf(_SC_PAGESIZE)), If it is not aligned at the page boundary, the vmsplice call may not send all data to the kernel.

The IV buffer must be exactly `kcapi_cipher_ivsize` bytes in size.

return number of bytes decrypted upon success; a negative errno-style error code if an error occurred

Symmetric Cipher API - Convenience

kcapi_cipher_enc_aes_cbc

LINUX

libkcapi ManualApril 2022

Name

`kcapi_cipher_enc_aes_cbc` — Convenience function for AES CBC encryption

Synopsis

```
ssize_t kcapi_cipher_enc_aes_cbc (const uint8_t * key, uint32_t
keylen, const uint8_t * in, size_t inlen, const uint8_t * iv,
uint8_t * out, size_t outlen);
```

Arguments

key

[in] key buffer

keylen

[in] length of key buffer

in

[in] plaintext data buffer

inlen

[in] length of in buffer

iv

[in] IV to be used for cipher operation

out

[out] ciphertext data buffer

outlen

[in] length of out buffer

Description

The convenience function performs an AES CBC encryption operation using the provided key, the given input buffer and the given IV. The output is stored in the out buffer.

Note, AES CBC requires an input data that is a multiple of 16 bytes. If you have data that is not guaranteed to be multiples of 16 bytes, either add zero bytes at the end of the buffer to pad it up to a multiple of 16 bytes. Otherwise, the CTR mode encryption operation may be usable.

The output buffer must be at least as large as the input buffer.

The IV must be exactly 16 bytes in size.

The AES type (AES-128, AES-192 or AES-256) is determined by the size of the given key. If the key is 16 bytes long, AES-128 is used. A 24 byte key implies AES-192 and a 32 byte key implies AES-256.

return number of bytes generated upon success; a negative errno-style error code if an error occurred

kcapi_cipher_dec_aes_cbc

LINUX

libkcapi ManualApril 2022

Name

`kcapi_cipher_dec_aes_cbc` — Convenience function for AES CBC decryption

Synopsis

```
ssize_t kcapi_cipher_dec_aes_cbc (const uint8_t * key, uint32_t
keylen, const uint8_t * in, size_t inlen, const uint8_t * iv,
uint8_t * out, size_t outlen);
```

Arguments

key

[in] key buffer

keylen

[in] length of key buffer

in

[in] ciphertext data buffer

inlen

[in] length of in buffer

iv

[in] IV to be used for cipher operation

out

[out] plaintext data buffer

outlen

[in] length of out buffer

Description

The convenience function performs an AES CBC decryption operation using the provided key, the given input buffer and the given IV. The output is stored in the out buffer.

Note, AES CBC requires an input data that is a multiple of 16 bytes. If you have data that is not guaranteed to be multiples of 16 bytes, either add zero bytes at the end of the buffer to pad it up to a multiple of 16 bytes. Otherwise, the CTR mode encryption operation may be usable.

The output buffer must be at least as large as the input buffer.

The IV must be exactly 16 bytes in size.

The AES type (AES-128, AES-192 or AES-256) is determined by the size of the given key. If the key is 16 bytes long, AES-128 is used. A 24 byte key implies AES-192 and a 32 byte key implies AES-256.

return number of bytes generated upon success; a negative errno-style error code if an error occurred

kcapi_cipher_enc_aes_ctr

LINUX

libkcapi ManualApril 2022

Name

`kcapi_cipher_enc_aes_ctr` — Convenience function for AES CTR encryption

Synopsis

```
ssize_t kcapi_cipher_enc_aes_ctr (const uint8_t * key, uint32_t
keylen, const uint8_t * in, size_t inlen, const uint8_t * ctr,
uint8_t * out, size_t outlen);
```

Arguments

key
: [in] key buffer

keylen
: [in] length of key buffer

in
: [in] plaintext data buffer

inlen
: [in] length of in buffer

ctr
: [in] start counter value to be used for cipher operation

out
: [out] ciphertext data buffer

outlen
: [in] length of out buffer

Description

The convenience function performs an AES counter mode encryption operation using the provided key, the given input buffer and the given IV. The output is stored in the out buffer.

The input buffer can be of arbitrary length.

The output buffer must be at least as large as the input buffer.

The start counter can contain all zeros (not a NULL buffer!) and must be exactly 16 bytes in size.

The AES type (AES-128, AES-192 or AES-256) is determined by the size of the given key. If the key is 16 bytes long, AES-128 is used. A 24 byte key implies AES-192 and a 32 byte key implies AES-256.

return number of bytes generated upon success; a negative errno-style error code if an error occurred

kcapi_cipher_dec_aes_ctr

LINUX

libkcapi ManualApril 2022

Name

`kcapi_cipher_dec_aes_ctr` — Convenience function for AES CTR decryption

Synopsis

```
ssize_t kcapi_cipher_dec_aes_ctr (const uint8_t * key, uint32_t
keylen, const uint8_t * in, size_t inlen, const uint8_t * ctr,
uint8_t * out, size_t outlen);
```

Arguments

key
: [in] key buffer

keylen
: [in] length of key buffer

in
: [in] ciphertext data buffer

inlen
: [in] length of in buffer

ctr
: [in] start counter value to be used for cipher operation

out
: [out] plaintext data buffer

outlen
: [in] length of out buffer

Description

The convenience function performs an AES counter mode encryption operation using the provided key, the given input buffer and the given IV. The output is stored in the out buffer.

The input buffer can be of arbitrary length.

The output buffer must be at least as large as the input buffer.

The start counter can contain all zeros (not a NULL buffer!) and must be exactly 16 bytes in size.

The AES type (AES-128, AES-192 or AES-256) is determined by the size of the given key. If the key is 16 bytes long, AES-128 is used. A 24 byte key implies AES-192 and a 32 byte key implies AES-256.

return number of bytes generated upon success; a negative errno-style error code if an error occurred

Asynchronous Symmetric Cipher API - One Shot

kcapi_cipher_encrypt_aio

LINUX

libkcapi ManualApril 2022

Name

`kcapi_cipher_encrypt_aio` — encrypt data (asynchronous one shot)

Synopsis

```
ssize_t kcapi_cipher_encrypt_aio (struct kcapi_handle * handle,
struct iovec * iniov, struct iovec * outiov, size_t iovlen, const
uint8_t * iv, int access);
```

Arguments

handle

[in] cipher handle

iniov

[in] head of scatter-gather list array holding the plaintext

outiov

[out] head of scatter-gather list of the destination buffers filled with ciphertext

iovlen

[in] number of scatter-gather list entries

iv

[in] IV to be used for cipher operation

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE - use vmsplice access; KCAPI_ACCESS_SENDMSG - sendmsg access)

Description

The individual scatter-gather list entries are processed with separate invocations of the the given cipher.

The memory should be aligned at the page boundary using posix_memalign(sysconf(_SC_PAGESIZE)), If it is not aligned at the page boundary, the vmsplice call may not send all data to the kernel.

The IV buffer must be exactly `kcapi_cipher_ivsize` bytes in size.

return number of bytes encrypted upon success; a negative errno-style error code if an error occurred

kcapi_cipher_decrypt_aio

LINUX

libkcapi ManualApril 2022

Name

`kcapi_cipher_decrypt_aio` — decrypt data (asynchronous one shot)

Synopsis

```
ssize_t kcapi_cipher_decrypt_aio (struct kcapi_handle * handle,
struct iovec * iniov, struct iovec * outiov, size_t iovlen, const
uint8_t * iv, int access);
```

Arguments

handle

[in] cipher handle

iniov

[in] head of scatter-gather list array holding the ciphertext

outiov

[out] head of scatter-gather list with the destination buffers for the plaintext

iovlen

[in] number of scatter-gather list entries

iv

[in] IV to be used for cipher operation

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE - use vmsplice access; KCAPI_ACCESS_SENDMSG - sendmsg access)

Description

The individual scatter-gather list entries are processed with separate invocations of the the given cipher.

The memory should be aligned at the page boundary using posix_memalign(sysconf(_SC_PAGESIZE)), If it is not aligned at the page boundary, the vmsplice call may not send all data to the kernel.

The IV buffer must be exactly `kcapi_cipher_ivsize` bytes in size.

return number of bytes decrypted upon success; a negative errno-style error code if an error occurred

Synchronous Symmetric Cipher API - Stream

The stream API requires that first the cipher operation type is set with the init call, followed by an arbitrary number and mix of the update and op calls.

kcapi_cipher_stream_init_enc

LINUX

libkcapi ManualApril 2022

Name

`kcapi_cipher_stream_init_enc` — start an encryption operation (stream)

Synopsis

```
ssize_t kcapi_cipher_stream_init_enc (struct kcapi_handle * handle,
const uint8_t * iv, struct iovec * iov, size_t iovlen);
```

Arguments

handle

[in] cipher handle

iv

[in] IV to be used for cipher operation

iov

[in] scatter/gather list with data to be encrypted. This is the pointer to the first iov entry if an array of iov entries is supplied. See sendmsg(2) for details on how iov is to be used. This pointer may be NULL if no data to be encrypted is available at the point of the call.

iovlen

[in] number of scatter/gather list elements. If iov is NULL, this value must be zero.

Description

A stream encryption operation is started with this call. Multiple successive `kcapi_cipher_stream_update` function calls can be invoked to send more plaintext data to be encrypted. The kernel buffers the input until `kcapi_cipher_stream_op` picks up the encrypted data. Once plaintext is encrypted during the `kcapi_cipher_stream_op` it is removed from the kernel buffer.

The function calls of `kcapi_cipher_stream_update` and `kcapi_cipher_stream_op` can be mixed, even by multiple threads of an application.

The IV buffer must be exactly `kcapi_cipher_ivsize` bytes in size.

return number of bytes sent to the kernel upon success; a negative errno-style error code if an error occurred

kcapi_cipher_stream_init_dec

LINUX

libkcapi ManualApril 2022

Name

`kcapi_cipher_stream_init_dec` — start a decryption operation (stream)

Synopsis

```
ssize_t kcapi_cipher_stream_init_dec (struct kcapi_handle * handle,
const uint8_t * iv, struct iovec * iov, size_t iovlen);
```

Arguments

handle

[in] cipher handle

iv

[in] IV to be used for cipher operation

iov

[in] scatter/gather list with data to be encrypted. This is the pointer to the first iov entry if an array of iov entries is supplied. See sendmsg(2) for details on how iov is to be used. This pointer may be NULL if no data to be encrypted is available at the point of the call.

iovlen

[in] number of scatter/gather list elements. If iov is NULL, this value must be zero.

Description

A stream decryption operation is started with this call. Multiple successive `kcapi_cipher_stream_update` function calls can be invoked to send more ciphertext data to be decrypted. The kernel buffers the input until `kcapi_cipher_stream_op` picks up the decrypted data. Once ciphertext is decrypted during the `kcapi_cipher_stream_op` it is removed from the kernel buffer.

The function calls of `kcapi_cipher_stream_update` and `kcapi_cipher_stream_op` can be mixed, even by multiple threads of an application.

The IV buffer must be exactly `kcapi_cipher_ivsize` bytes in size.

return number of bytes sent to the kernel upon success; a negative errno-style error code if an error occurred

kcapi_cipher_stream_update

LINUX

libkcapi ManualApril 2022

Name

`kcapi_cipher_stream_update` — send more data for processing (stream)

Synopsis

```
ssize_t kcapi_cipher_stream_update (struct kcapi_handle * handle,
struct iovec * iov, size_t iovlen);
```

Arguments

handle

[in] cipher handle

iov

[in] scatter/gather list with data to be processed by the cipher operation.

iovlen

[in] number of scatter/gather list elements.

Description

Using this function call, more plaintext for encryption or ciphertext for decryption can be submitted to the kernel.

This function may cause the caller to sleep if the kernel buffer holding the data is getting full. The process will be woken up once more buffer space becomes available by calling `kcapi_cipher_stream_op`.

Note

with the separate API calls of `kcapi_cipher_stream_update` and `kcapi_cipher_stream_op` a multi-threaded application can be implemented where one thread sends data to be processed and one thread picks up data processed by the cipher operation.

IMPORTANT NOTE

The kernel will only process sysconf(_SC_PAGESIZE) * ALG_MAX_PAGES at one time. If your input data is larger than this threshold, you MUST segment it into chunks of at most sysconf(_SC_PAGESIZE) * ALG_MAX_PAGES and invoke the `kcapi_cipher_stream_update` on that segment followed by `kcapi_cipher_stream_op` before the next chunk is processed. If this rule is not obeyed, the thread invoking `kcapi_cipher_stream_update` will be put to sleep until another thread invokes `kcapi_cipher_stream_op`.

WARNING

The memory referenced by *iov* is not accessed by the kernel during this call. The memory is first accessed when kcapi_cipher_stream_op is called. Thus, you MUST make sure that the referenced memory is still present at the time kcapi_cipher_stream_op is called.

return number of bytes sent to the kernel upon success; a negative errno-style error code if an error occurred

kcapi_cipher_stream_update_last

LINUX

libkcapi ManualApril 2022

Name

kcapi_cipher_stream_update_last — send last data for processing (stream)

Synopsis

```
ssize_t kcapi_cipher_stream_update_last (struct kcapi_handle *
handle, struct iovec * iov, size_t iovlen);
```

Arguments

handle

[in] cipher handle

iov

[in] scatter/gather list with data to be processed by the cipher operation.

iovlen

[in] number of scatter/gather list elements.

Description

Using this function call, more plaintext for encryption or ciphertext for decryption can be submitted to the kernel.

This call is identical to the kcapi_cipher_stream_update call with the exception that it marks the last data buffer before the cipher operation is triggered. This is call is important for stream ciphers like CTR or CTS mode when providing the last block. It is permissible to provide a zero buffer if all data including the last block is already provided by kcapi_cipher_stream_update.

WARNING

If this call is not made for stream ciphers with input data that is not a multiple of the block size of the block cipher, the kernel will not return the last block that contains less data than the block size of the block cipher. For example, sending

257 bytes of data to be encrypted with ctr(aes), the kernel will return only 256 bytes without this call.

return number of bytes sent to the kernel upon success; a negative errno-style error code if an error occurred

kcapi_cipher_stream_op

LINUX

libkcapi ManualApril 2022

Name

`kcapi_cipher_stream_op` — obtain processed data (stream)

Synopsis

```
ssize_t kcapi_cipher_stream_op (struct kcapi_handle * handle, struct
iovec * iov, size_t iovlen);
```

Arguments

handle

[in] cipher handle

iov

[out] scatter/gather list pointing to buffers to be filled with the resulting data from a cipher operation.

iovlen

[in] number of scatter/gather list elements.

Description

This call can be called interleaved with `kcapi_cipher_stream_update` to fetch the processed data.

This function may cause the caller to sleep if the kernel buffer holding the data is empty. The process will be woken up once more data is sent by calling `kcapi_cipher_stream_update`.

Note, when supplying buffers that are not multiple of block size, the buffers will only be filled up to the maximum number of full block sizes that fit into the buffer.

The kernel supports multithreaded applications where one or more threads send data via the `kcapi_cipher_stream_update` function and another thread collects the processed data via kcapi_cipher_stream_op. The kernel, however, will return data via `kcapi_cipher_stream_op` as soon as it has some data available. For example, one thread sends 1000 bytes to be encrypted and another thread already waits for the ciphertext. The kernel may send only, say, 500 bytes back to the waiting process during one `kcapi_cipher_stream_op` call. In a subsequent calls to `kcapi_cipher_stream_op` more ciphertext is returned. This implies that when the receiving thread shall collect all data there is, `kcapi_cipher_stream_op` must be called in a loop until all data is received.

return number of bytes obtained from the kernel upon success; a negative errno-style error code if an error occurred

AEAD Cipher API - Generic

These generic API for symmetric ciphers calls are to be used for both, the one-shot and the stream encryption/decryption operations.

The following API calls allow using the Authenticated Encryption with Associated Data.

kcapi_aead_init

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_init` — initialization of cipher handle

Synopsis

```
int kcapi_aead_init (struct kcapi_handle ** handle, const char *
ciphername, uint32_t flags);
```

Arguments

handle

[out] cipher handle filled during the call

ciphername

[in] kernel crypto API cipher name as specified in /proc/crypto

flags

[in] flags specifying the type of cipher handle

Description

This function initializes an AEAD cipher handle and establishes the connection to the kernel.

On success, a pointer to kcapi_handle object is returned in *handle. Function kcapi_aead_destroy should be called afterwards to free resources.

return 0 upon success; -ENOENT - algorithm not available; -EOPNOTSUPP - AF_ALG family not available; -EINVAL - accept syscall failed -ENOMEM - cipher handle cannot be allocated

kcapi_aead_destroy

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_destroy` — close the AEAD handle and release resources

Synopsis

```
void kcapi_aead_destroy (struct kcapi_handle * handle);
```

Arguments

handle
: [in] cipher handle to release

kcapi_aead_setkey

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_setkey` — set the key for the AEAD handle

Synopsis

```
int kcapi_aead_setkey (struct kcapi_handle * handle, const uint8_t *
key, uint32_t keylen);
```

Arguments

handle
: [in] cipher handle

key
: [in] key buffer

keylen
: [in] length of key buffer

Description

With this function, the caller sets the key for subsequent encryption or decryption operations.

After the caller provided the key, the caller may securely destroy the key as it is now maintained by the kernel.

return 0 upon success; a negative errno-style error code if an error occurred

kcapi_aead_setassoclen

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_setassoclen` — set authentication data size

Synopsis

```
void kcapi_aead_setassoclen (struct kcapi_handle * handle, size_t
assoclen);
```

Arguments

handle

[in] cipher handle

assoclen

[in] length of associated data length

Description

The associated data is retained in the cipher handle. During initialization of a cipher handle, it is sent to the kernel. The kernel cipher implementations may verify the appropriateness of the authentication data size and may return an error during initialization if the authentication size is not considered appropriate.

kcapi_aead_settaglen

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_settaglen` — set authentication tag size

Synopsis

```
int kcapi_aead_settaglen (struct kcapi_handle * handle, uint32_t
taglen);
```

Arguments

handle

[in] cipher handle

taglen

[in] length of authentication tag

Description

Set the authentication tag size needed for encryption operation. The tag is created during encryption operation with the size provided with this call.

return 0 upon success; a negative errno-style error code if an error occurred

kcapi_aead_ivsize

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_ivsize` — return size of IV required for cipher

Synopsis

```
uint32_t kcapi_aead_ivsize (struct kcapi_handle * handle);
```

Arguments

handle

[in] cipher handle

Description

return > 0 specifying the IV size; 0 on error

kcapi_aead_blocksize

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_blocksize` — return size of one block of the cipher

Synopsis

```
uint32_t kcapi_aead_blocksize (struct kcapi_handle * handle);
```

Arguments

handle
: [in] cipher handle

Description

return > 0 specifying the block size; 0 on error

kcapi_aead_authsize

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_authsize` — return the maximum size of the tag

Synopsis

```
uint32_t kcapi_aead_authsize (struct kcapi_handle * handle);
```

Arguments

handle
: [in] cipher handle

Description

The returned maximum is the largest size of the authenticaation tag that can be produced by the AEAD cipher. Smaller tag sizes may be chosen depending on the AEAD cipher type.

return > 0 specifying the block size; 0 on error

kcapi_aead_inbuflen_enc

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_inbuflen_enc` — return minimum encryption input buffer length

Synopsis

```
size_t kcapi_aead_inbuflen_enc (struct kcapi_handle * handle, size_t
inlen, size_t assoclen, size_t taglen);
```

Arguments

handle
: [in] cipher handle

inlen
: [in] size of plaintext

assoclen
: [in] size of associated data (AD)

taglen
: [in] size of authentication tag

Description

return minimum size of input data length in bytes

kcapi_aead_inbuflen_dec

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_inbuflen_dec` — return minimum decryption input buffer length

Synopsis

```
size_t kcapi_aead_inbuflen_dec (struct kcapi_handle * handle, size_t
inlen, size_t assoclen, size_t taglen);
```

Arguments

handle
: [in] cipher handle

inlen
: [in] size of ciphertext

assoclen
: [in] size of associated data (AD)

taglen
: [in] size of authentication tag

Description

return minimum size of output data length in bytes

kcapi_aead_outbuflen_enc

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_outbuflen_enc` — return minimum encryption output buffer length

Synopsis

```
size_t kcapi_aead_outbuflen_enc (struct kcapi_handle * handle,
size_t inlen, size_t assoclen, size_t taglen);
```

Arguments

handle
: [in] cipher handle

inlen
: [in] size of plaintext

assoclen
: [in] size of associated data (AD)

taglen
: [in] size of authentication tag

Description

return minimum size of output data length in bytes

kcapi_aead_outbuflen_dec

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_outbuflen_dec` — return minimum decryption output buffer length

Synopsis

```
size_t kcapi_aead_outbuflen_dec (struct kcapi_handle * handle,
size_t inlen, size_t assoclen, size_t taglen);
```

Arguments

handle
: [in] cipher handle

inlen
: [in] size of ciphertext

assoclen
: [in] size of associated data (AD)

taglen
: [in] size of authentication tag

Description

return minimum size of output data length in bytes

kcapi_aead_ccm_nonce_to_iv

LINUX

libkcapi ManualApril 2022

Name

kcapi_aead_ccm_nonce_to_iv — convert CCM nonce into IV

Synopsis

```
int kcapi_aead_ccm_nonce_to_iv (const uint8_t * nonce, uint32_t
noncelen, uint8_t ** iv, uint32_t * ivlen);
```

Arguments

nonce

[in] buffer with nonce

noncelen

[in] length of nonce

iv

[out] newly allocated buffer with IV

ivlen

[out] length of IV

Description

This service function converts a CCM nonce value into an IV usable by the kernel crypto API.

Caller must free iv.

return 0 upon success; < 0 upon failure

kcapi_aead_getdata_input

LINUX

Name

`kcapi_aead_getdata_input` — get the pointers into input buffer

Synopsis

```
void kcapi_aead_getdata_input (struct kcapi_handle * handle, uint8_t
* encdata, size_t encdatalen, int enc, uint8_t ** aad, size_t *
aadlen, uint8_t ** data, size_t * datalen, uint8_t ** tag, size_t *
taglen);
```

Arguments

handle

[in] cipher handle

encdata

[in] data buffer returned by the encryption operation

encdatalen

[in] size of the encryption data buffer

enc

[in] does output buffer hold encryption or decryption result?

aad

[out] AD buffer pointer; when set to NULL, no data pointer is returned

aadlen

[out] length of AD; when aad was set to NULL, no information is returned

data

[out] pointer to output buffer from AEAD encryption operation when set to NULL, no data pointer is returned

datalen

[out] length of data buffer; when data was set to NULL, no information is returned

tag

[out] tag buffer pointer; when set to NULL, no data pointer is returned

taglen

[out] length of tag; when tag was set to NULL, no information is returned

Description

This function is a service function to the consumer to locate the right ciphertext buffer offset holding the authentication tag. In addition, it provides the consumer with the length of the tag and the length of the ciphertext.

kcapi_aead_getdata_output

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_getdata_output` — get the pointers into output buffer

Synopsis

```
void kcapi_aead_getdata_output (struct kcapi_handle * handle,
uint8_t * encdata, size_t encdatalen, int enc, uint8_t ** aad,
size_t * aadlen, uint8_t ** data, size_t * datalen, uint8_t ** tag,
size_t * taglen);
```

Arguments

handle

[in] cipher handle

encdata

[in] data buffer returned by the encryption operation

encdatalen

[in] size of the encryption data buffer

enc

[in] does output buffer hold encryption or decryption result?

aad

[out] AD buffer pointer; when set to NULL, no data pointer is returned; returned pointer may also be NULL

aadlen

[out] length of AD; when aad was set to NULL, no information is returned

data

[out] pointer to output buffer from AEAD encryption operation when set to NULL, no data pointer is returned

datalen

[out] length of data buffer; when data was set to NULL, no information is returned

tag

[out] tag buffer pointer; when set to NULL, no data pointer is returned; returned pointer may also be NULL

taglen

[out] length of tag; when tag was set to NULL, no information is returned

Description

This function is a service function to the consumer to locate the right ciphertext buffer offset holding the authentication tag. In addition, it provides the consumer with the length of the tag and the length of the ciphertext.

Synchronous AEAD Cipher API - One Shot

kcapi_aead_encrypt

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_encrypt` — synchronously encrypt AEAD data (one shot)

Synopsis

```
ssize_t kcapi_aead_encrypt (struct kcapi_handle * handle, const
uint8_t * in, size_t inlen, const uint8_t * iv, uint8_t * out,
size_t outlen, int access);
```

Arguments

handle

[in] cipher handle

in

[in] plaintext data buffer

inlen

[in] length of plaintext buffer

iv

[in] IV to be used for cipher operation

out

[out] data buffer holding cipher text and authentication tag

outlen

[in] length of out buffer

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE - use vmsplice access; KCAPI_ACCESS_SENDMSG - sendmsg access)

Description

The AEAD cipher operation requires the furnishing of the associated authentication data. In case such data is not required, it can be set to NULL and length value must be set to zero.

It is perfectly legal to use the same buffer as the plaintext and ciphertext pointers. That would mean that after the encryption operation, the plaintext is overwritten with the ciphertext.

The memory should be aligned at the page boundary using posix_memalign(sysconf(_SC_PAGESIZE)), If it is not aligned at the page boundary, the vmsplice call may not send all data to the kernel.

The IV buffer must be exactly `kcapi_cipher_ivsize` bytes in size.

After invoking this function the caller should use `kcapi_aead_getdata_output` to obtain the resulting ciphertext and authentication tag references.

IMPORTANT NOTE

The kernel will only process sysconf(_SC_PAGESIZE) * ALG_MAX_PAGES at one time. Longer input data cannot be handled by the kernel.

return number of bytes encrypted upon success; a negative errno-style error code if an error occurred

kcapi_aead_decrypt

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_decrypt` — synchronously decrypt AEAD data (one shot)

Synopsis

```
ssize_t kcapi_aead_decrypt (struct kcapi_handle * handle, const
uint8_t * in, size_t inlen, const uint8_t * iv, uint8_t * out,
size_t outlen, int access);
```

Arguments

handle

[in] cipher handle

in

[in] ciphertext data buffer

inlen

[in] length of in buffer

iv

[in] IV to be used for cipher operation

out

[out] plaintext data buffer

outlen

[in] length of out buffer

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE use vmsplice access; KCAPI_ACCESS_SENDMSG sendmsg access)

Description

The AEAD cipher operation requires the furnishing of the associated authentication data. In case such data is not required, it can be set to NULL and length value must be set to zero.

It is perfectly legal to use the same buffer as the plaintext and ciphertext pointers. That would mean that after the encryption operation, the ciphertext is overwritten with the plaintext.

The memory should be aligned at the page boundary using posix_memalign(sysconf(_SC_PAGESIZE)), If it is not aligned at the page boundary, the vmsplice call may not send all data to the kernel.

The IV buffer must be exactly `kcapi_cipher_ivsize` bytes in size.

To catch authentication errors (i.e. integrity violations) during the decryption operation, the return value of this call should be checked. If this function returns -EBADMSG, an authentication error was detected.

IMPORTANT NOTE

The kernel will only process sysconf(_SC_PAGESIZE) * ALG_MAX_PAGES at one time. Longer input data cannot be handled by the kernel.

return number of bytes decrypted upon success; a negative errno-style error code if an error occurred

Aynchronous AEAD Cipher API - One Shot

kcapi_aead_encrypt_aio

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_encrypt_aio` — asynchronously encrypt AEAD data (one shot)

Synopsis

```
ssize_t kcapi_aead_encrypt_aio (struct kcapi_handle * handle, struct
iovec * iniov, struct iovec * outiov, size_t iovlen, const uint8_t
* iv, int access);
```

Arguments

handle

[in] cipher handle

iniov

[in] array of scatter-gather list with input buffers

outiov

[out] array of scatter-gather list with output buffers

iovlen

[in] number of IOVECs in array

iv

[in] IV to be used for cipher operation

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE - use vmsplice access; KCAPI_ACCESS_SENDMSG - sendmsg access)

Description

The AEAD cipher operation requires the furnishing of the associated authentication data. In case such data is not required, it can be set to NULL and length value must be set to zero.

Each IOVEC is processed with its individual AEAD cipher operation. The memory holding the input data will receive the processed data.

The memory should be aligned at the page boundary using posix_memalign(sysconf(_SC_PAGESIZE)), If it is not aligned at the page boundary, the vmsplice call may not send all data to the kernel.

The IV buffer must be exactly `kcapi_cipher_ivsize` bytes in size.

After invoking this function the caller should use `kcapi_aead_getdata_output` to obtain the resulting ciphertext and authentication tag references.

IMPORTANT NOTE

The kernel will only process sysconf(_SC_PAGESIZE) * ALG_MAX_PAGES at one time. Longer input data cannot be handled by the kernel.

return number of bytes encrypted upon success; a negative errno-style error code if an error occurred

kcapi_aead_decrypt_aio

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_decrypt_aio` — asynchronously decrypt AEAD data (one shot)

Synopsis

```
ssize_t kcapi_aead_decrypt_aio (struct kcapi_handle * handle, struct
iovec * iniov, struct iovec * outiov, size_t iovlen, const uint8_t
* iv, int access);
```

Arguments

handle

[in] cipher handle

iniov

[in] array of scatter-gather list with input buffers

outiov

[out] array of scatter-gather list with output buffers

iovlen

[in] number of IOVECs in array

iv

[in] IV to be used for cipher operation

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE - use vmsplice access; KCAPI_ACCESS_SENDMSG - sendmsg access)

Description

The AEAD cipher operation requires the furnishing of the associated authentication data. In case such data is not required, it can be set to NULL and length value must be set to zero.

Each IOVEC is processed with its individual AEAD cipher operation. The memory holding the input data will receive the processed data.

The memory should be aligned at the page boundary using posix_memalign(sysconf(_SC_PAGESIZE)), If it is not aligned at the page boundary, the vmsplice call may not send all data to the kernel.

The IV buffer must be exactly `kcapi_cipher_ivsize` bytes in size.

To catch authentication errors (i.e. integrity violations) during the decryption operation, the return value of this call should be checked. If this function returns -EBADMSG, an authentication error was detected.

IMPORTANT NOTE

The kernel will only process sysconf(_SC_PAGESIZE) * ALG_MAX_PAGES at one time. Longer input data cannot be handled by the kernel.

return number of bytes encrypted upon success; a negative errno-style error code if an error occurred

Synchronous AEAD Cipher API - Stream

kcapi_aead_stream_init_enc

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_stream_init_enc` — start an encryption operation (stream)

Synopsis

```
ssize_t kcapi_aead_stream_init_enc (struct kcapi_handle * handle,
const uint8_t * iv, struct iovec * iov, size_t iovlen);
```

Arguments

handle

[in] cipher handle

iv

[in] IV to be used for cipher operation

iov

[in] scatter/gather list with data to be encrypted. This is the pointer to the first iov entry if an array of iov entries is supplied. See sendmsg(2) for details on how iov is to be used. This pointer may be NULL if no data to be encrypted is available at the point of the call.

iovlen

[in] number of scatter/gather list elements. If iov is NULL, this value must be zero.

Description

A stream encryption operation is started with this call. Multiple successive `kcapi_aead_stream_update` function calls can be invoked to send more plaintext data to be encrypted. The kernel buffers the input until `kcapi_aead_stream_op` picks up the encrypted data. Once plaintext is encrypted during the `kcapi_aead_stream_op` it is removed from the kernel buffer.

Note, unlike the corresponding symmetric cipher API, the function calls of `kcapi_aead_stream_update` and `kcapi_aead_stream_op` cannot be mixed! This due to the nature of AEAD where the cipher operation ensures the integrity of the entire data (decryption) or calculates a message digest over the entire data (encryption).

When using the stream API, the caller must ensure that data is sent in the correct order (regardless whether data is sent in multiple chunks using `kcapi_aead_stream_init_enc` or `kcapi_cipher_stream_update`): (i) the complete associated data must be provided, followed by (ii) the plaintext.

The IV buffer must be exactly `kcapi_cipher_ivsize` bytes in size.

return number of bytes sent to the kernel upon success; a negative errno-style error code if an error occurred

kcapi_aead_stream_init_dec

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_stream_init_dec` — start a decryption operation (stream)

Synopsis

```
ssize_t kcapi_aead_stream_init_dec (struct kcapi_handle * handle,
const uint8_t * iv, struct iovec * iov, size_t iovlen);
```

Arguments

handle

[in] cipher handle

iv

[in] IV to be used for cipher operation

iov

[in] scatter/gather list with data to be encrypted. This is the pointer to the first iov entry if an array of iov entries is supplied. See sendmsg(2) for details on how iov is to be used. This pointer may be NULL if no data to be encrypted is available at the point of the call.

iovlen

[in] number of scatter/gather list elements. If iov is NULL, this value must be zero.

Description

A stream decryption operation is started with this call. Multiple successive `kcapi_aead_stream_update` function calls can be invoked to send more ciphertext data to be encrypted. The kernel buffers the input until

`kcapi_aead_stream_op` picks up the decrypted data. Once ciphertext is decrypted during the `kcapi_aead_stream_op` it is removed from the kernel buffer.

Note, unlike the corresponding symmetric cipher API, the function calls of `kcapi_aead_stream_update` and `kcapi_aead_stream_op` cannot be mixed! This due to the nature of AEAD where the cipher operation ensures the integrity of the entire data (decryption) or calculates a message digest over the entire data (encryption).

When using the stream API, the caller must ensure that data is sent in the correct order (regardless whether data is sent in multiple chunks using `kcapi_aead_stream_init_enc` or `kcapi_cipher_stream_update`): (i) the complete associated data must be provided, followed by (ii) the plaintext. For decryption, also (iii) the tag value must be sent.

The IV buffer must be exactly `kcapi_cipher_ivsize` bytes in size.

return number of bytes sent to the kernel upon success; a negative errno-style error code if an error occurred

kcapi_aead_stream_update

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_stream_update` — send more data for processing (stream)

Synopsis

```
ssize_t kcapi_aead_stream_update (struct kcapi_handle * handle,
struct iovec * iov, size_t iovlen);
```

Arguments

handle

[in] cipher handle

iov

[in] scatter/gather list with data to be processed by the cipher operation.

iovlen

[in] number of scatter/gather list elements.

Description

Using this function call, more plaintext for encryption or ciphertext for decryption can be submitted to the kernel.

Note, see the order of input data as outlined in `kcapi_aead_stream_init_dec`.

This function may cause the caller to sleep if the kernel buffer holding the data is getting full. The process will be woken up once more buffer space becomes available by calling `kcapi_aead_stream_op`.

Note

The last block of input data MUST be provided with `kcapi_aead_stream_update_last` as the kernel must be informed about the completion of the input data.

With the separate API calls of `kcapi_aead_stream_update` and `kcapi_aead_stream_op` a multi-threaded application can be implemented where one thread sends data to be processed and one thread picks up data processed by the cipher operation.

WARNING

The memory referenced by *iov* is not accessed by the kernel during this call. The memory is first accessed when `kcapi_cipher_stream_op` is called. Thus, you MUST make sure that the referenced memory is still present at the time `kcapi_cipher_stream_op` is called.

return number of bytes sent to the kernel upon success; a negative errno-style error code if an error occurred

kcapi_aead_stream_update_last

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_stream_update_last` — send last data for processing (stream)

Synopsis

```
ssize_t kcapi_aead_stream_update_last (struct kcapi_handle * handle,
struct iovec * iov, size_t iovlen);
```

Arguments

handle

[in] cipher handle

iov

[in] scatter/gather list with data to be processed by the cipher operation.

iovlen

[in] number of scatter/gather list elements.

Description

Using this function call, more plaintext for encryption or ciphertext for decryption can be submitted to the kernel.

This call is identical to the `kcapi_aead_stream_update` call with the exception that it marks the last data buffer before the cipher operation is triggered. Typically, the tag value is provided with this call.

WARNING

The memory referenced by *iov* is not accessed by the kernel during this call. The memory is first accessed when `kcapi_cipher_stream_op` is called. Thus, you MUST make sure that the referenced memory is still present at the time `kcapi_cipher_stream_op` is called.

return number of bytes sent to the kernel upon success; a negative errno-style error code if an error occurred

kcapi_aead_stream_op

LINUX

libkcapi ManualApril 2022

Name

`kcapi_aead_stream_op` — obtain processed data (stream)

Synopsis

```
ssize_t kcapi_aead_stream_op (struct kcapi_handle * handle, struct
iovec * iov, size_t iovlen);
```

Arguments

handle

[in] cipher handle

iov

[out] scatter/gather list pointing to buffers to be filled with the resulting data from a cipher operation.

iovlen

[in] number of outiov scatter/gather list elements.

Description

This function may cause the caller to sleep if the kernel buffer holding the data is empty. The process will be woken up once more data is sent by calling `kcapi_cipher_stream_update`.

Note, when supplying buffers that are not multiple of block size, the buffers will only be filled up to the maximum number of full block sizes that fit into the buffer.

return number of bytes obtained from the kernel upon success; a negative errno-style error code if an error occurred

Message Digest Cipher API - Generic

kcapi_md_init

LINUX

libkcapi ManualApril 2022

Name

`kcapi_md_init` — initialize cipher handle

Synopsis

```
int kcapi_md_init (struct kcapi_handle ** handle, const char *
ciphername, uint32_t flags);
```

Arguments

handle

[out] cipher handle filled during the call

ciphername

[in] kernel crypto API cipher name as specified in /proc/crypto

flags

[in] flags specifying the type of cipher handle

Description

This function provides the initialization of a (keyed) message digest handle and establishes the connection to the kernel.

On success, a pointer to kcapi_handle object is returned in *handle. Function kcapi_md_destroy should be called afterwards to free resources.

return 0 upon success; -ENOENT - algorithm not available; -EOPNOTSUPP - AF_ALG family not available; -EINVAL - accept syscall failed; -ENOMEM - cipher handle cannot be allocated

kcapi_md_destroy

LINUX

libkcapi ManualApril 2022

Name

`kcapi_md_destroy` — close the message digest handle and release resources

Synopsis

```
void kcapi_md_destroy (struct kcapi_handle * handle);
```

Arguments

handle
: [in] cipher handle to release

kcapi_md_setkey

LINUX

libkcapi ManualApril 2022

Name

`kcapi_md_setkey` — set the key for the message digest handle

Synopsis

```
int kcapi_md_setkey (struct kcapi_handle * handle, const uint8_t *
key, uint32_t keylen);
```

Arguments

handle
: [in] cipher handle

key
: [in] key buffer

keylen
: [in] length of key buffer

Description

With this function, the caller sets the key for subsequent hashing operations. This call is applicable for keyed message digests.

After the caller provided the key, the caller may securely destroy the key as it is now maintained by the kernel.

return 0 upon success; a negative errno-style error code if an error occurred

kcapi_md_digestsize

LINUX

libkcapi ManualApril 2022

Name

`kcapi_md_digestsize` — return the size of the message digest

Synopsis

```
uint32_t kcapi_md_digestsize (struct kcapi_handle * handle);
```

Arguments

handle
: [in] cipher handle

Description

The returned message digest size can be used before the kcapi_md_final function invocation to determine the right memory size to be allocated for this call.

return > 0 specifying the block size; 0 on error

Message Digest Cipher API - One Shot

kcapi_md_digest

LINUX

libkcapi ManualApril 2022

Name

`kcapi_md_digest` — calculate message digest on buffer (one-shot)

Synopsis

```
ssize_t kcapi_md_digest (struct kcapi_handle * handle, const
uint8_t * in, size_t inlen, uint8_t * out, size_t outlen);
```

Arguments

handle
: [in] cipher handle

in
: [in] buffer with input data

inlen
: [in] length of input buffer

out
: [out] buffer for message digest

outlen
: [in] length of out

Description

With this one-shot function, a message digest of the given buffer is generated. The output buffer must be allocated by the caller and have at least the length of the message digest size for the chosen message digest.

The message digest handle must have been initialized, potentially by also setting the key using the generic message digest API functions.

The input buffer can be at most INT_MAX in size.

return size of message digest upon success; -EIO - data cannot be obtained; -ENOMEM - buffer is too small for the complete message digest, the buffer is filled with the truncated message digest

Message Digest Cipher API - Convenience

kcapi_md_sha1

LINUX

libkcapi ManualApril 2022

Name

`kcapi_md_sha1` — SHA-1 message digest on one buffer

Synopsis

```
ssize_t kcapi_md_sha1 (const uint8_t * in, size_t inlen, uint8_t *
out, size_t outlen);
```

Arguments

in

[in] buffer with input data

inlen

[in] length of input buffer

out

[out] buffer for message digest

outlen

[in] length of out

Description

With this one-shot convenience function, a message digest of the given buffer is generated. The output buffer must be allocated by the caller and have at least the length of the message digest size for the chosen message digest.

return size of message digest upon success; -EIO - data cannot be obtained; -ENOMEM - buffer is too small for the complete message digest, the buffer is filled with the truncated message digest

kcapi_md_sha224

LINUX

libkcapi ManualApril 2022

Name

`kcapi_md_sha224` — SHA-224 message digest on one buffer

Synopsis

```
ssize_t kcapi_md_sha224 (const uint8_t * in, size_t inlen, uint8_t *
out, size_t outlen);
```

Arguments

in

[in] buffer with input data

inlen

[in] length of input buffer

out

[out] buffer for message digest

outlen

[in] length of out

Description

With this one-shot convenience function, a message digest of the given buffer is generated. The output buffer must be allocated by the caller and have at least the length of the message digest size for the chosen message digest.

return size of message digest upon success; -EIO - data cannot be obtained; -ENOMEM - buffer is too small for the complete message digest, the buffer is filled with the truncated message digest

kcapi_md_sha256

LINUX

libkcapi ManualApril 2022

Name

`kcapi_md_sha256` — SHA-256 message digest on one buffer

Synopsis

```
ssize_t kcapi_md_sha256 (const uint8_t * in, size_t inlen, uint8_t *
out, size_t outlen);
```

Arguments

in

[in] buffer with input data

inlen

[in] length of input buffer

out

[out] buffer for message digest

outlen

[in] length of out

Description

With this one-shot convenience function, a message digest of the given buffer is generated. The output buffer must be allocated by the caller and have at least the length of the message digest size for the chosen message digest.

return size of message digest upon success; -EIO - data cannot be obtained; -ENOMEM - buffer is too small for the complete message digest, the buffer is filled with the truncated message digest

kcapi_md_sha384

LINUX

libkcapi ManualApril 2022

Name

`kcapi_md_sha384` — SHA-384 message digest on one buffer

Synopsis

```
ssize_t kcapi_md_sha384 (const uint8_t * in, size_t inlen, uint8_t *
out, size_t outlen);
```

Arguments

in

[in] buffer with input data

inlen

[in] length of input buffer

out

[out] buffer for message digest

outlen

[in] length of out

Description

With this one-shot convenience function, a message digest of the given buffer is generated. The output buffer must be allocated by the caller and have at least the length of the message digest size for the chosen message digest.

return size of message digest upon success; -EIO - data cannot be obtained; -ENOMEM - buffer is too small for the complete message digest, the buffer is filled with the truncated message digest

kcapi_md_sha512

LINUX

libkcapi ManualApril 2022

Name

`kcapi_md_sha512` — SHA-512 message digest on one buffer

Synopsis

```
ssize_t kcapi_md_sha512 (const uint8_t * in, size_t inlen, uint8_t *
out, size_t outlen);
```

Arguments

in

[in] buffer with input data

inlen

[in] length of input buffer

out

[out] buffer for message digest

outlen

[in] length of out

Description

With this one-shot convenience function, a message digest of the given buffer is generated. The output buffer must be allocated by the caller and have at least the length of the message digest size for the chosen message digest.

return size of message digest upon success; -EIO - data cannot be obtained; -ENOMEM - buffer is too small for the complete message digest, the buffer is filled with the truncated message digest

kcapi_md_hmac_sha1

LINUX

libkcapi ManualApril 2022

Name

`kcapi_md_hmac_sha1` — HMAC SHA-1 keyed message digest on one buffer

Synopsis

```
ssize_t kcapi_md_hmac_sha1 (const uint8_t * key, uint32_t keylen,
const uint8_t * in, size_t inlen, uint8_t * out, size_t outlen);
```

Arguments

key

[in] buffer with HMAC key

keylen
: [in] length of HMAC key buffer

in
: [in] buffer with input data

inlen
: [in] length of input buffer

out
: [out] buffer for message digest

outlen
: [in] length of out

Description

With this one-shot convenience function, a keyed message digest of the given buffer is generated. The output buffer must be allocated by the caller and have at least the length of the message digest size for the chosen keyed message digest.

return size of message digest upon success; -EIO - data cannot be obtained; -ENOMEM - buffer is too small for the complete message digest, the buffer is filled with the truncated message digest

kcapi_md_hmac_sha224

LINUX

libkcapi ManualApril 2022

Name

`kcapi_md_hmac_sha224` — HMAC SHA-224 keyed message digest on one buffer

Synopsis

```
ssize_t kcapi_md_hmac_sha224 (const uint8_t * key, uint32_t keylen,
const uint8_t * in, size_t inlen, uint8_t * out, size_t outlen);
```

Arguments

key
: [in] buffer with HMAC key

keylen
: [in] length of HMAC key buffer

in
: [in] buffer with input data

inlen

[in] length of input buffer

out

[out] buffer for message digest

outlen

[in] length of out

Description

With this one-shot convenience function, a keyed message digest of the given buffer is generated. The output buffer must be allocated by the caller and have at least the length of the message digest size for the chosen keyed message digest.

return size of message digest upon success; -EIO - data cannot be obtained; -ENOMEM - buffer is too small for the complete message digest, the buffer is filled with the truncated message digest

kcapi_md_hmac_sha256

LINUX

libkcapi ManualApril 2022

Name

`kcapi_md_hmac_sha256` — HMAC SHA-256 keyed message digest on one buffer

Synopsis

```
ssize_t kcapi_md_hmac_sha256 (const uint8_t * key, uint32_t keylen,
const uint8_t * in, size_t inlen, uint8_t * out, size_t outlen);
```

Arguments

key

[in] buffer with HMAC key

keylen

[in] length of HMAC key buffer

in

[in] buffer with input data

inlen

[in] length of input buffer

out

[out] buffer for message digest

outlen

[in] length of out

Description

With this one-shot convenience function, a keyed message digest of the given buffer is generated. The output buffer must be allocated by the caller and have at least the length of the message digest size for the chosen keyed message digest.

return size of message digest upon success; -EIO - data cannot be obtained; -ENOMEM - buffer is too small for the complete message digest, the buffer is filled with the truncated message digest

kcapi_md_hmac_sha384

LINUX

libkcapi ManualApril 2022

Name

`kcapi_md_hmac_sha384` — HMAC SHA-384 keyed message digest on one buffer

Synopsis

```
ssize_t kcapi_md_hmac_sha384 (const uint8_t * key, uint32_t keylen,
const uint8_t * in, size_t inlen, uint8_t * out, size_t outlen);
```

Arguments

key

[in] buffer with HMAC key

keylen

[in] length of HMAC key buffer

in

[in] buffer with input data

inlen

[in] length of input buffer

out

[out] buffer for message digest

outlen

[in] length of out

Description

With this one-shot convenience function, a keyed message digest of the given buffer is generated. The output buffer must be allocated by the caller and have at least the length of the message digest size for the chosen keyed message digest.

return size of message digest upon success; -EIO - data cannot be obtained; -ENOMEM - buffer is too small for the complete message digest, the buffer is filled with the truncated message digest

kcapi_md_hmac_sha512

LINUX

libkcapi ManualApril 2022

Name

`kcapi_md_hmac_sha512` — HMAC SHA-512 keyed message digest on one buffer

Synopsis

```
ssize_t kcapi_md_hmac_sha512 (const uint8_t * key, uint32_t keylen,
const uint8_t * in, size_t inlen, uint8_t * out, size_t outlen);
```

Arguments

key
: [in] buffer with HMAC key

keylen
: [in] length of HMAC key buffer

in
: [in] buffer with input data

inlen
: [in] length of input buffer

out
: [out] buffer for message digest

outlen
: [in] length of out

Description

With this one-shot convenience function, a keyed message digest of the given buffer is generated. The output buffer must be allocated by the caller and have at least the length of the message digest size for the chosen keyed message digest.

return size of message digest upon success; -EIO - data cannot be obtained; -ENOMEM - buffer is too small for the complete message digest, the buffer is filled with the truncated message digest

Message Digest Cipher API - Stream

kcapi_md_update

LINUX

libkcapi ManualApril 2022

Name

`kcapi_md_update` — message digest update function (stream)

Synopsis

```
ssize_t kcapi_md_update (struct kcapi_handle * handle, const
uint8_t * buffer, size_t len);
```

Arguments

handle

[in] cipher handle

buffer

[in] holding the data to add to the message digest

len

[in] buffer length

Description

The input buffer can be at most INT_MAX in size.

return 0 upon success; a negative errno-style error code if an error occurred

kcapi_md_final

LINUX

libkcapi ManualApril 2022

Name

`kcapi_md_final` — message digest finalization function (stream)

Synopsis

```
ssize_t kcapi_md_final (struct kcapi_handle * handle, uint8_t *
buffer, size_t len);
```

Arguments

handle

[in] cipher handle

buffer

[out] filled with the message digest

len

[in] buffer length

Description

return size of message digest upon success; -EIO - data cannot be obtained; -ENOMEM - buffer is too small for the complete message digest, the buffer is filled with the truncated message digest

Random Number API

kcapi_rng_init

LINUX

libkcapi ManualApril 2022

Name

kcapi_rng_init — initialize cipher handle

Synopsis

```
int kcapi_rng_init (struct kcapi_handle ** handle, const char *
ciphername, uint32_t flags);
```

Arguments

handle

[out] cipher handle filled during the call

ciphername

[in] kernel crypto API cipher name as specified in /proc/crypto

flags

[in] flags specifying the type of cipher handle (unused for RNG)

Description

This function provides the initialization of a random number generator handle and establishes the connection to the kernel.

On success, a pointer to kcapi_handle object is returned in *handle. Function kcapi_rng_destroy should be called afterwards to free resources.

return 0 upon success; -ENOENT - algorithm not available; -EOPNOTSUPP - AF_ALG family not available; -EINVAL - accept syscall failed -ENOMEM - cipher handle cannot be allocated

kcapi_rng_destroy

LINUX

libkcapi ManualApril 2022

Name

`kcapi_rng_destroy` — close the RNG handle and release resources

Synopsis

```
void kcapi_rng_destroy (struct kcapi_handle * handle);
```

Arguments

handle

[in] cipher handle to release

kcapi_rng_seed

LINUX

libkcapi ManualApril 2022

Name

`kcapi_rng_seed` — seed the RNG

Synopsis

```
int kcapi_rng_seed (struct kcapi_handle * handle, uint8_t * seed,
uint32_t seedlen);
```

Arguments

handle

[in] cipher handle

seed

[in] seed data

seedlen

[in] size of seed

Description

Note, this call must be called to initialize the selected RNG. When the SP800-90A DRBG is used, this call causes the DRBG to seed itself from the internal noise sources.

Note, in case of using the SP800-90A DRBG, the seed buffer may be NULL. If it is not NULL, the DRBG uses the given data either as personalization string in case of the initial seeding or additional data for reseeding.

return 0 upon success; a negative errno-style error code if an error occurred

kcapi_rng_generate

LINUX

libkcapi ManualApril 2022

Name

`kcapi_rng_generate` — generate a random number

Synopsis

```
ssize_t kcapi_rng_generate (struct kcapi_handle * handle, uint8_t *
buffer, size_t len);
```

Arguments

handle

[in] cipher handle

buffer

[out] filled with the random number

len

[in] buffer length

Description

return size of random number generated upon success; -EIO - data cannot be obtained

kcapi_rng_seedsize

LINUX

libkcapi ManualApril 2022

Name

`kcapi_rng_seedsize` — return required seed size of DRNG

Synopsis

```
uint32_t kcapi_rng_seedsize (struct kcapi_handle * handle);
```

Arguments

handle

[in] cipher handle

Description

return > 0 specifying the block size; 0 on error

Random Number API - Convenience

kcapi_rng_get_bytes

LINUX

libkcapi ManualApril 2022

Name

`kcapi_rng_get_bytes` — Convenience function to generate random bytes

Synopsis

```
ssize_t kcapi_rng_get_bytes (uint8_t * buffer, size_t outlen);
```

Arguments

buffer

[out] filled with the random number

outlen

[in] buffer length

Description

This convenience function generates random bytes of the size of outlen and stores them into the provided buffer.

return size of random number generated upon success; -EIO - data cannot be obtained

Asymmetric Cipher API - Generic

API function calls used to invoke asymmetric ciphers.

kcapi_akcipher_init

LINUX

libkcapi ManualApril 2022

Name

`kcapi_akcipher_init` — initialize cipher handle

Synopsis

```
int kcapi_akcipher_init (struct kcapi_handle ** handle, const char *
ciphername, uint32_t flags);
```

Arguments

handle

[out] cipher handle filled during the call

ciphername

[in] kernel crypto API cipher name as specified in /proc/crypto

flags

[in] flags specifying the type of cipher handle

Description

This function provides the initialization of an asymmetric cipher handle and establishes the connection to the kernel.

On success, a pointer to kcapi_handle object is returned in *handle. Function kcapi_akcipher_destroy should be called afterwards to free resources.

return 0 upon success; -ENOENT - algorithm not available; -EOPNOTSUPP - AF_ALG family not available; -EINVAL - accept syscall failed -ENOMEM - cipher handle cannot be allocated

kcapi_akcipher_destroy

LINUX

libkcapi ManualApril 2022

Name

`kcapi_akcipher_destroy` — close the cipher handle and release resources

Synopsis

```
void kcapi_akcipher_destroy (struct kcapi_handle * handle);
```

Arguments

handle

[in] cipher handle to release

kcapi_akcipher_setkey

LINUX

libkcapi ManualApril 2022

Name

`kcapi_akcipher_setkey` — set the private key for the cipher handle

Synopsis

```
int kcapi_akcipher_setkey (struct kcapi_handle * handle, const
uint8_t * key, uint32_t keylen);
```

Arguments

handle

[in] cipher handle

key

[in] key buffer in DER format

keylen

[in] length of key buffer

Description

With this function, the caller sets the key for subsequent cipher operations.

The key must be in DER format as follows

SEQUENCE { version INTEGER, n INTEGER ({ rsa_get_n }), e INTEGER ({ rsa_get_e }), d INTEGER ({ rsa_get_d }), prime1 INTEGER, prime2 INTEGER, exponent1 INTEGER, exponent2 INTEGER, coefficient INTEGER }

After the caller provided the key, the caller may securely destroy the key as it is now maintained by the kernel.

return upon success the value of the maximum size for the asymmetric operation is returned (e.g. the modulus size); a negative errno-style error code if an error occurred

kcapi_akcipher_setpubkey

LINUX

libkcapi ManualApril 2022

Name

`kcapi_akcipher_setpubkey` — set the public key for the cipher handle

Synopsis

```
int kcapi_akcipher_setpubkey (struct kcapi_handle * handle, const
uint8_t * key, uint32_t keylen);
```

Arguments

handle

[in] cipher handle

key

[in] key buffer in DER format

keylen

[in] length of key buffer

Description

With this function, the caller sets the key for subsequent cipher operations.

The key must be in DER format as follows

SEQUENCE { n INTEGER ({ rsa_get_n }), e INTEGER ({ rsa_get_e }) }

After the caller provided the key, the caller may securely destroy the key as it is now maintained by the kernel.

return upon success the value of the maximum size for the asymmetric operation is returned (e.g. the modulus size); a negative errno-style error code if an error occurred

Synchronous asymmetric Cipher API - One Shot

kcapi_akcipher_encrypt

LINUX

libkcapi ManualApril 2022

Name

`kcapi_akcipher_encrypt` — encrypt data

Synopsis

```
ssize_t kcapi_akcipher_encrypt (struct kcapi_handle * handle, const
uint8_t * in, size_t inlen, uint8_t * out, size_t outlen, int
access);
```

Arguments

handle

[in] cipher handle

in

[in] plaintext data buffer

inlen

[in] length of in buffer

out

[out] ciphertext data buffer

outlen

[in] length of out buffer

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE - use vmsplice access; KCAPI_ACCESS_SENDMSG - sendmsg access)

Description

It is perfectly legal to use the same buffer as the plaintext and ciphertext pointers. That would mean that after the encryption operation, the plaintext is overwritten with the ciphertext.

The memory should be aligned at the page boundary using posix_memalign(sysconf(_SC_PAGESIZE)), If it is not aligned at the page boundary, the vmsplice call may not send all data to the kernel.

If the output size is insufficiently large, -EINVAL is returned. The output buffer must be at least as large as the modululs of the uses key.

return number of bytes returned by the encryption operation upon success; a negative errno-style error code if an error occurred

kcapi_akcipher_decrypt

LINUX

libkcapi ManualApril 2022

Name

`kcapi_akcipher_decrypt` — decrypt data

Synopsis

```
ssize_t kcapi_akcipher_decrypt (struct kcapi_handle * handle, const
uint8_t * in, size_t inlen, uint8_t * out, size_t outlen, int
access);
```

Arguments

handle

[in] cipher handle

in

[in] ciphertext data buffer

inlen

[in] length of in buffer

out

[out] plaintext data buffer

outlen

[in] length of out buffer

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE - use vmsplice access; KCAPI_ACCESS_SENDMSG - sendmsg access)

Description

It is perfectly legal to use the same buffer as the plaintext and ciphertext pointers. That would mean that after the decryption operation, the ciphertext is overwritten with the plaintext.

The memory should be aligned at the page boundary using posix_memalign(sysconf(_SC_PAGESIZE)), If it is not aligned at the page boundary, the vmsplice call may not send all data to the kernel.

If the output size is insufficiently large, -EINVAL is returned. The output buffer must be at least as large as the modululs of the uses key.

return number of bytes returned by the decryption operation upon success; a negative errno-style error code if an error occurred

kcapi_akcipher_sign

LINUX

libkcapi ManualApril 2022

Name

`kcapi_akcipher_sign` — signature generation

Synopsis

```
ssize_t kcapi_akcipher_sign (struct kcapi_handle * handle, const
uint8_t * in, size_t inlen, uint8_t * out, size_t outlen, int
access);
```

Arguments

handle

[in] cipher handle

in

[in] message data buffer

inlen

[in] length of in buffer

out

[out] signature data buffer

outlen

[in] length of out buffer

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE - use vmsplice access; KCAPI_ACCESS_SENDMSG - sendmsg access)

Description

It is perfectly legal to use the same buffer as the message and signature pointers. That would mean that after the signature generation operation, the message is overwritten with the signature.

The memory should be aligned at the page boundary using posix_memalign(sysconf(_SC_PAGESIZE)), If it is not aligned at the page boundary, the vmsplice call may not send all data to the kernel.

If the output size is insufficiently large, -EINVAL is returned. The output buffer must be at least as large as the modululs of the uses key.

return number of bytes returned by the signature gen operation upon success; a negative errno-style error code if an error occurred

kcapi_akcipher_verify

LINUX

libkcapi ManualApril 2022

Name

`kcapi_akcipher_verify` — signature verification

Synopsis

```
ssize_t kcapi_akcipher_verify (struct kcapi_handle * handle, const
uint8_t * in, size_t inlen, uint8_t * out, size_t outlen, int
access);
```

Arguments

handle

[in] cipher handle

in

[in] message data buffer

inlen

[in] length of in buffer

out

[out] signature data buffer

outlen

[in] length of out buffer

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE - use vmsplice access; KCAPI_ACCESS_SENDMSG - sendmsg access)

Description

It is perfectly legal to use the same buffer as the message and signature pointers. That would mean that after the signature generation operation, the message is overwritten with the signature.

The memory should be aligned at the page boundary using posix_memalign(sysconf(_SC_PAGESIZE)), If it is not aligned at the page boundary, the vmsplice call may not send all data to the kernel.

If the output size is insufficiently large, -EINVAL is returned. The output buffer must be at least as large as the modululs of the uses key.

To catch signature verification errors, the return value of this call should be checked. If this function returns -EBADMSG, the verification of the signature failed.

return number of bytes returned by the signature ver operation upon success; a negative errno-style error code if an error occurred

Aynchronous asymmetric Cipher API - One Shot

kcapi_akcipher_encrypt_aio

LINUX

libkcapi ManualApril 2022

Name

`kcapi_akcipher_encrypt_aio` — encrypt data (asynchronous one shot)

Synopsis

```
ssize_t kcapi_akcipher_encrypt_aio (struct kcapi_handle * handle,
struct iovec * iniov, struct iovec * outiov, size_t iovlen, int
access);
```

Arguments

handle

[in] cipher handle

iniov

[in] head of scatter-gather list array holding the plaintext

outiov

[out] head of scatter-gather list of the destination buffers filled with ciphertext

iovlen

[in] number of scatter-gather list entries

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE - use vmsplice access; KCAPI_ACCESS_SENDMSG - sendmsg access)

Description

The individual scatter-gather list entries are processed with separate invocations of the the given cipher.

The memory should be aligned at the page boundary using posix_memalign(sysconf(_SC_PAGESIZE)), If it is not aligned at the page boundary, the vmsplice call may not send all data to the kernel.

return number of bytes encrypted upon success; a negative errno-style error code if an error occurred

kcapi_akcipher_decrypt_aio

LINUX

libkcapi ManualApril 2022

Name

`kcapi_akcipher_decrypt_aio` — decrypt data (asynchronous one shot)

Synopsis

```
ssize_t kcapi_akcipher_decrypt_aio (struct kcapi_handle * handle,
struct iovec * iniov, struct iovec * outiov, size_t iovlen, int
access);
```

Arguments

handle

[in] cipher handle

iniov

[in] head of scatter-gather list array holding the plaintext

outiov

[out] head of scatter-gather list of the destination buffers filled with ciphertext

iovlen

[in] number of scatter-gather list entries

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE - use vmsplice access; KCAPI_ACCESS_SENDMSG - sendmsg access)

Description

The individual scatter-gather list entries are processed with separate invocations of the the given cipher.

The memory should be aligned at the page boundary using posix_memalign(sysconf(_SC_PAGESIZE)), If it is not aligned at the page boundary, the vmsplice call may not send all data to the kernel.

return number of bytes decrypted upon success; a negative errno-style error code if an error occurred

kcapi_akcipher_sign_aio

LINUX

libkcapi ManualApril 2022

Name

`kcapi_akcipher_sign_aio` — sign data (asynchronous one shot)

Synopsis

```
ssize_t kcapi_akcipher_sign_aio (struct kcapi_handle * handle,
struct iovec * iniov, struct iovec * outiov, size_t iovlen, int
access);
```

Arguments

handle

[in] cipher handle

iniov

[in] head of scatter-gather list array holding the plaintext

outiov

[out] head of scatter-gather list of the destination buffers filled with ciphertext

iovlen

[in] number of scatter-gather list entries

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE - use vmsplice access; KCAPI_ACCESS_SENDMSG - sendmsg access)

Description

The individual scatter-gather list entries are processed with separate invocations of the the given cipher.

The memory should be aligned at the page boundary using posix_memalign(sysconf(_SC_PAGESIZE)), If it is not aligned at the page boundary, the vmsplice call may not send all data to the kernel.

return number of bytes signed upon success; a negative errno-style error code if an error occurred

kcapi_akcipher_verify_aio

LINUX

libkcapi ManualApril 2022

Name

`kcapi_akcipher_verify_aio` — verify data (asynchronous one shot)

Synopsis

```
ssize_t kcapi_akcipher_verify_aio (struct kcapi_handle * handle,
struct iovec * iniov, struct iovec * outiov, size_t iovlen, int
access);
```

Arguments

handle

[in] cipher handle

iniov

[in] head of scatter-gather list array holding the plaintext

outiov

[out] head of scatter-gather list of the destination buffers filled with ciphertext

iovlen

[in] number of scatter-gather list entries

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE - use vmsplice access; KCAPI_ACCESS_SENDMSG - sendmsg access)

Description

The individual scatter-gather list entries are processed with separate invocations of the the given cipher.

The memory should be aligned at the page boundary using posix_memalign(sysconf(_SC_PAGESIZE)), If it is not aligned at the page boundary, the vmsplice call may not send all data to the kernel.

return number of bytes verify upon success; a negative errno-style error code if an error occurred

Asymmetric Cipher API - Stream

kcapi_akcipher_stream_init_enc

LINUX

libkcapi ManualApril 2022

Name

`kcapi_akcipher_stream_init_enc` — start an encryption operation (stream)

Synopsis

```
ssize_t kcapi_akcipher_stream_init_enc (struct kcapi_handle * handle,
struct iovec * iov, size_t iovlen);
```

Arguments

handle

[in] cipher handle

iov

[in] scatter/gather list with data to be encrypted. This is the pointer to the first iov entry if an array of iov entries is supplied. See sendmsg(2) for details on how iov is to be used. This pointer may be NULL if no data to be encrypted is available at the point of the call.

iovlen

[in] number of scatter/gather list elements. If iov is NULL, this value must be zero.

Description

A stream encryption operation is started with this call. Multiple successive `kcapi_akcipher_stream_update` function calls can be invoked to send more plaintext data to be encrypted. The last invocation to supply data must be done with `kcapi_akcipher_stream_update_last`. The kernel buffers the input until `kcapi_akcipher_stream_op` picks up the encrypted data. Once plaintext is encrypted during the `kcapi_cipher_stream_op` it is removed from the kernel buffer.

The function calls of `kcapi_akcipher_stream_update` and `kcapi_akcipher_stream_op` can be mixed, even by multiple threads of an application.

return number of bytes sent to the kernel upon success; a negative errno-style error code if an error occurred

kcapi_akcipher_stream_init_dec

LINUX

libkcapi ManualApril 2022

Name

`kcapi_akcipher_stream_init_dec` — start an decryption operation (stream)

Synopsis

```
ssize_t kcapi_akcipher_stream_init_dec (struct kcapi_handle * handle,
struct iovec * iov, size_t iovlen);
```

Arguments

handle

[in] cipher handle

iov

[in] scatter/gather list with data to be decrypted. This is the pointer to the first iov entry if an array of iov entries is supplied. See sendmsg(2) for details on how iov is to be used. This pointer may be NULL if no data to be decrypted is available at the point of the call.

iovlen

[in] number of scatter/gather list elements. If iov is NULL, this value must be zero.

Description

A stream decryption operation is started with this call. Multiple successive `kcapi_akcipher_stream_update` function calls can be invoked to send more plaintext data to be decrypted. The last invocation to supply data must be done with `kcapi_akcipher_stream_update_last`. The kernel buffers the input until `kcapi_akcipher_stream_op` picks up the encrypted data. Once plaintext is decrypted during the `kcapi_cipher_stream_op` it is removed from the kernel buffer.

The function calls of `kcapi_akcipher_stream_update` and `kcapi_akcipher_stream_op` can be mixed, even by multiple threads of an application.

return number of bytes sent to the kernel upon success; a negative errno-style error code if an error occurred

kcapi_akcipher_stream_init_sgn

LINUX

libkcapi ManualApril 2022

Name

`kcapi_akcipher_stream_init_sgn` — start an signing operation (stream)

Synopsis

```
ssize_t kcapi_akcipher_stream_init_sgn (struct kcapi_handle * handle,
struct iovec * iov, size_t iovlen);
```

Arguments

handle

[in] cipher handle

iov

[in] scatter/gather list with data to be signed. This is the pointer to the first iov entry if an array of iov entries is supplied. See sendmsg(2) for details on how iov is to be used. This pointer may be NULL if no data to be signed is available at the point of the call.

iovlen

[in] number of scatter/gather list elements. If iov is NULL, this value must be zero.

Description

A stream signing operation is started with this call. Multiple successive `kcapi_akcipher_stream_update` function calls can be invoked to send more plaintext data to be signed. The last invocation to supply data must be done with `kcapi_akcipher_stream_update_last`. The kernel buffers the input until

kcapi_akcipher_stream_op picks up the signed data. Once plaintext is signed during the kcapi_cipher_stream_op it is removed from the kernel buffer.

The function calls of kcapi_akcipher_stream_update and kcapi_akcipher_stream_op can be mixed, even by multiple threads of an application.

return number of bytes sent to the kernel upon success; a negative errno-style error code if an error occurred

kcapi_akcipher_stream_init_vfy

LINUX

libkcapi ManualApril 2022

Name

kcapi_akcipher_stream_init_vfy — start an signature verification operation (stream)

Synopsis

```
ssize_t kcapi_akcipher_stream_init_vfy (struct kcapi_handle * handle,
struct iovec * iov, size_t iovlen);
```

Arguments

handle

[in] cipher handle

iov

[in] scatter/gather list with data to be verified. This is the pointer to the first iov entry if an array of iov entries is supplied. See sendmsg(2) for details on how iov is to be used. This pointer may be NULL if no data to be verified is available at the point of the call.

iovlen

[in] number of scatter/gather list elements. If iov is NULL, this value must be zero.

Description

A stream signature verification operation is started with this call. Multiple successive kcapi_akcipher_stream_update function calls can be invoked to send more plaintext data to be verified. The last invocation to supply data must be done with kcapi_akcipher_stream_update_last. The kernel buffers the input until kcapi_akcipher_stream_op picks up the verified data. Once plaintext is verified during the kcapi_cipher_stream_op it is removed from the kernel buffer.

The function calls of kcapi_akcipher_stream_update and kcapi_akcipher_stream_op can be mixed, even by multiple threads of an application.

return number of bytes sent to the kernel upon success; a negative errno-style error code if an error occurred

kcapi_akcipher_stream_update

LINUX

libkcapi ManualApril 2022

Name

`kcapi_akcipher_stream_update` — send more data for processing (stream)

Synopsis

```
ssize_t kcapi_akcipher_stream_update (struct kcapi_handle * handle,
struct iovec * iov, size_t iovlen);
```

Arguments

handle

[in] cipher handle

iov

[in] scatter/gather list with data to be processed by the cipher operation.

iovlen

[in] number of scatter/gather list elements.

Description

Using this function call, more data can be submitted to the kernel.

This function may cause the caller to sleep if the kernel buffer holding the data is getting full. The process will be woken up once more buffer space becomes available by calling `kcapi_akcipher_stream_op`.

Note

with the separate API calls of `kcapi_akcipher_stream_update` and `kcapi_akcipher_stream_op` a multi-threaded application can be implemented where one thread sends data to be processed and one thread picks up data processed by the cipher operation.

WARNING

The memory referenced by *iov* is not accessed by the kernel during this call. The memory is first accessed when `kcapi_cipher_stream_op` is called. Thus, you MUST make sure that the referenced memory is still present at the time `kcapi_cipher_stream_op` is called.

return number of bytes sent to the kernel upon success; a negative errno-style error code if an error occurred

kcapi_akcipher_stream_op

LINUX

libkcapi ManualApril 2022

Name

`kcapi_akcipher_stream_op` — obtain processed data (stream)

Synopsis

```
ssize_t kcapi_akcipher_stream_op (struct kcapi_handle * handle,
struct iovec * iov, size_t iovlen);
```

Arguments

handle

[in] cipher handle

iov

[in/out] scatter/gather list pointing to buffers to be filled with the resulting data from a cipher operation.

iovlen

[in] number of scatter/gather list elements.

Description

This call can be called interleaved with `kcapi_akcipher_stream_update` to fetch the processed data.

This function may cause the caller to sleep if the kernel buffer holding the data is empty. The process will be woken up once more data is sent by calling `kcapi_cipher_stream_update`.

Note, when supplying buffers that are not multiple of block size, the buffers will only be filled up to the maximum number of full block sizes that fit into the buffer.

return number of bytes obtained from the kernel upon success; a negative errno-style error code if an error occurred

Key Protocol Primitives API - Generic

kcapi_kpp_init

LINUX

libkcapi ManualApril 2022

Name

`kcapi_kpp_init` — initialize cipher handle

Synopsis

```
int kcapi_kpp_init (struct kcapi_handle ** handle, const char *
ciphername, uint32_t flags);
```

Arguments

handle

[out] cipher handle filled during the call

ciphername

[in] kernel crypto API cipher name as specified in /proc/crypto

flags

[in] flags specifying the type of cipher handle

Description

This function provides the initialization of a KPP cipher handle and establishes the connection to the kernel.

On success, a pointer to kcapi_handle object is returned in *handle. Function kcapi_kpp_destroy should be called afterwards to free resources.

return 0 upon success; -ENOENT - algorithm not available; -EOPNOTSUPP - AF_ALG family not available; -EINVAL - accept syscall failed -ENOMEM - cipher handle cannot be allocated

kcapi_kpp_destroy

LINUX

libkcapi ManualApril 2022

Name

`kcapi_kpp_destroy` — close the cipher handle and release resources

Synopsis

```
void kcapi_kpp_destroy (struct kcapi_handle * handle);
```

Arguments

handle
: [in] cipher handle to release

kcapi_kpp_dh_setparam_pkcs3

LINUX

libkcapi ManualApril 2022

Name

`kcapi_kpp_dh_setparam_pkcs3` — set the PG parameters using PKCS3 format

Synopsis

```
int kcapi_kpp_dh_setparam_pkcs3 (struct kcapi_handle * handle, const
uint8_t * pkcs3, uint32_t pkcs3len);
```

Arguments

handle
: [in] cipher handle

pkcs3
: [in] parameter buffer in DER format

pkcs3len
: [in] length of key buffer

Description

With this function, the caller sets the PG parameters for subsequent cipher operations.

The parameter set must be in DER format as follows

SEQUENCE { prime INTEGER ({ dh_get_p }), base INTEGER ({ dh_get_g }) }

The following command generates such parameter set where the output

file content is has the correct DER structure

openssl dhparam -outform DER -out dhparam.der 2048

Note, this function defines that the subsequent key generation and shared secret operation performs an FFC Diffie-Hellman operation.

After the caller provided the key, the caller may destroy the parameter as it is now maintained by the kernel.

return upon success the value of the maximum size for the KPP operation is returned (e.g. the prime size); a negative errno-style error code if an error occurred

kcapi_kpp_ecdh_setcurve

LINUX

libkcapi ManualApril 2022

Name

`kcapi_kpp_ecdh_setcurve` — set the ECC curve to be used for ECDH

Synopsis

```
int kcapi_kpp_ecdh_setcurve (struct kcapi_handle * handle, unsigned
long curve_id);
```

Arguments

handle

[in] cipher handle

curve_id

[in] ID of the ECC curve

Description

With this function, the caller sets the ECC curve for subsequent cipher operations. The curve ID is one of the ECC_CURVE_* identifiers.

Note, this function defines that the subsequent key generation and shared secret operation performs an ECC Diffie-Hellman operation.

return 0 upon success; a negative errno-style error code if an error occurred

kcapi_kpp_setkey

LINUX

Name

`kcapi_kpp_setkey` — set the private key of the DH / ECDH operation

Synopsis

```
int kcapi_kpp_setkey (struct kcapi_handle * handle, const uint8_t *
key, uint32_t keylen);
```

Arguments

handle

[in] cipher handle

key

[in] key buffer

keylen

[in] length of key buffer

Description

With this function, the caller sets the key for subsequent DH / ECDH public key generation or shared secret generation operations.

If the key / keylen is zero, the kernel tries to generate the private key itself and retains it internally. This is useful if the DH / ECDH operation shall be performed on ephemeral keys where the caller is only interested in eventually obtain the shared secret.

After the caller provided the key, the caller may securely destroy the key as it is now maintained by the kernel.

Note, the key can only be set after the DH parameters or the ECC curve has been set.

return in case of success a positive integer is returned that denominates the maximum output size of the cryptographic operation -- this value must be used as the size of the output buffer for one cryptographic operation); a negative errno-style error code if an error occurred -- the error -EOPNOTSUPP is returned in case a kernel-triggered private key generation is requested, but the underlying cipher implementation does not support this operation.

Synchronous Key Protocol Primitives API - One Shot

kcapi_kpp_keygen

LINUX

libkcapi ManualApril 2022

Name

`kcapi_kpp_keygen` — generate a public key

Synopsis

```
ssize_t kcapi_kpp_keygen (struct kcapi_handle * handle, uint8_t *
pubkey, size_t pubkeylen, int access);
```

Arguments

handle

[in] cipher handle

pubkey

[out] generated public key

pubkeylen

[in] length of key buffer

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE - use vmsplice access; KCAPI_ACCESS_SENDMSG - sendmsg access)

Description

return number of bytes returned by the key generation operation upon success; a negative errno-style error code if an error occurred

kcapi_kpp_ssgen

LINUX

libkcapi ManualApril 2022

Name

`kcapi_kpp_ssgen` — generate a shared secret

Synopsis

```
ssize_t kcapi_kpp_ssgen (struct kcapi_handle * handle, const
uint8_t * pubkey, size_t pubkeylen, uint8_t * ss, size_t sslen, int
access);
```

Arguments

handle

[in] cipher handle

pubkey

[in] public key of peer that shall be used to generate the shared secret with

pubkeylen

[in] length of the public key buffer

ss

[out] generated shared secret

sslen

[in] length of key buffer

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE - use vmsplice access; KCAPI_ACCESS_SENDMSG - sendmsg access)

Description

return number of bytes returned by the shared secret generation operation upon success; a negative errno-style error code if an error occurred

Asynchronous Key Protocol Primitives API - One Shot

kcapi_kpp_keygen_aio

LINUX

libkcapi ManualApril 2022

Name

`kcapi_kpp_keygen_aio` — generate a public key (asynchronous one shot)

Synopsis

```
ssize_t kcapi_kpp_keygen_aio (struct kcapi_handle * handle, struct
iovec * outiov, size_t iovlen, int access);
```

Arguments

handle

[in] cipher handle

outiov

[out] head of scatter-gather list of the destination buffers filled with the generated public key

iovlen

[in] number of scatter-gather list entries

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE - use vmsplice access; KCAPI_ACCESS_SENDMSG - sendmsg access)

Description

The individual scatter-gather list entries are processed with separate invocations of the the given cipher.

The memory should be aligned at the page boundary using posix_memalign(sysconf(_SC_PAGESIZE)), If it is not aligned at the page boundary, the vmsplice call may not send all data to the kernel.

return number of bytes verify upon success; a negative errno-style error code if an error occurred

kcapi_kpp_ssgen_aio

LINUX

libkcapi ManualApril 2022

Name

`kcapi_kpp_ssgen_aio` — generate a shared secret (asynchronous one shot)

Synopsis

```
ssize_t kcapi_kpp_ssgen_aio (struct kcapi_handle * handle, struct
iovec * iniov, struct iovec * outiov, size_t iovlen, int access);
```

Arguments

handle

[in] cipher handle

iniov

[in] head of scatter-gather list of the source buffers with the public keys of the peer

outiov

[out] head of scatter-gather list of the destination buffers filled with the generated shared secret

iovlen

[in] number of scatter-gather list entries

access

[in] kernel access type (KCAPI_ACCESS_HEURISTIC - use internal heuristic for fastest kernel access; KCAPI_ACCESS_VMSPLICE - use vmsplice access; KCAPI_ACCESS_SENDMSG - sendmsg access)

Description

The individual scatter-gather list entries are processed with separate invocations of the the given cipher.

The memory should be aligned at the page boundary using posix_memalign(sysconf(_SC_PAGESIZE)), If it is not aligned at the page boundary, the vmsplice call may not send all data to the kernel.

return number of bytes verify upon success; a negative errno-style error code if an error occurred

Key Derivation Functions

API function calls used to invoke a KDF. The KDF functions are based on a message digest or keyed message digest function. The caller must have the handle allocated with kcapi_md_init. If the caller wishes to use a keyed message digest, the caller must invoke kcapi_md_setkey before those functions.

kcapi_kdf_dpi

LINUX

libkcapi ManualApril 2022

Name

`kcapi_kdf_dpi` — Double Pipeline Mode Key Derivation Function

Synopsis

```
ssize_t kcapi_kdf_dpi (struct kcapi_handle * handle, const uint8_t
* src, size_t slen, uint8_t * dst, size_t dlen);
```

Arguments

handle

[in] cipher handle allocated by caller. This cipher handle must be allocated with `kcapi_md_init`. If the caller is interested in a KDF using a keyed message digest, the caller should also call `kcapi_md_setkey` before invoking this function.

src

[in] Input data that should be transformed into a key (see below).

slen

[in] Length of the src input data.

dst

[out] Buffer to store the generated key in,

dlen

[in] Length of the dst buffer. This value defines the number of bytes generated by the KDF.

Description

This function is an implementation of the KDF in double pipeline iteration mode according with counter to SP800-108 section 5.3.

The caller must provide Label || 0x00 || Context in src. This src pointer may also be NULL if the caller wishes not to provide anything.

return 0 upon success; a negative errno-style error code if an error occurred

kcapi_kdf_fb

LINUX

libkcapi ManualApril 2022

Name

`kcapi_kdf_fb` — Feedback Mode Key Derivation Function

Synopsis

```
ssize_t kcapi_kdf_fb (struct kcapi_handle * handle, const uint8_t *
src, size_t slen, uint8_t * dst, size_t dlen);
```

Arguments

handle

[in] cipher handle allocated by caller. This cipher handle must be allocated with `kcapi_md_init`. If the caller is interested in a KDF using a keyed message digest, the caller should also call `kcapi_md_setkey` before invoking this function.

src

[in] Input data that should be transformed into a key (see below).

slen

[in] Length of the src input data.

dst

[out] Buffer to store the generated key in,

dlen

[in] Length of the dst buffer. This value defines the number of bytes generated by the KDF.

Description

This function is an implementation of the KDF in feedback mode with a non-NULL IV and with counter according to SP800-108 section 5.2. The IV is supplied with src and must be equal to the digestsize of the used cipher.

In addition, the caller must provide Label || 0x00 || Context in src. This src pointer must not be NULL as the IV is required. The ultimate format of the src pointer is IV || Label || 0x00 || Context where the length of the IV is equal to the block size (i.e. the digest size of the underlying hash) of the PRF.

return 0 upon success; a negative errno-style error code if an error occurred

kcapi_kdf_ctr

LINUX

libkcapi ManualApril 2022

Name

`kcapi_kdf_ctr` — Counter Mode Key Derivation Function

Synopsis

```
ssize_t kcapi_kdf_ctr (struct kcapi_handle * handle, const uint8_t
* src, size_t slen, uint8_t * dst, size_t dlen);
```

Arguments

handle

[in] cipher handle allocated by caller. This cipher handle must be allocated with `kcapi_md_init`. If the caller is interested in a KDF using a keyed message digest, the caller should also call `kcapi_md_setkey` before invoking this function.

src

[in] Input data that should be transformed into a key (see below).

slen

[in] Length of the src input data.

dst

[out] Buffer to store the generated key in,

dlen

[in] Length of the dst buffer. This value defines the number of bytes generated by the KDF.

Description

This function is an implementation of the KDF in counter mode according to SP800-108 section 5.1 as well as SP800-56A section 5.8.1 (Single-step KDF).

SP800-108: The caller must provide Label || 0x00 || Context in src. This src pointer may also be NULL if the caller wishes not to provide anything.

SP800-56A: If a keyed MAC is used, the key shall NOT be the shared secret from the DH operation, but an independently generated key. The src pointer is defined as Z || other info where Z is the shared secret from DH and other info is an arbitrary string (see SP800-56A section 5.8.1.2).

return 0 upon success; a negative errno-style error code if an error occurred

kcapi_pbkdf

LINUX

libkcapi ManualApril 2022

Name

`kcapi_pbkdf` — Password-based Key Derivation Function

Synopsis

```
ssize_t kcapi_pbkdf (const char * hashname, const uint8_t * pw,
uint32_t pwlen, const uint8_t * salt, size_t saltlen, uint32_t
count, uint8_t * key, size_t keylen);
```

Arguments

hashname

[in] kernel crypto API name of a keyed hash (e.g. hmac(sha1))

pw

[in] Password a key shall be derived from

pwlen

[in] Length of password string

salt

[in] Salt as defined in SP800-132

saltlen

[in] Length of salt buffer

count

[in] Numbers of iterations to be performed for the PBKDF

key

[out] Buffer to store the generated key in

keylen

[in] Size of the key to be generated (i.e. length of the key buffer)

Description

This function is an implementation of the PBKDF as defined in SP800-132.

return 0 upon success; a negative errno-style error code if an error occurred

kcapi_pbkdf_iteration_count

LINUX

libkcapi ManualApril 2022

Name

`kcapi_pbkdf_iteration_count` — Calculate numbers of iterations for a PBKDF

Synopsis

```
uint32_t kcapi_pbkdf_iteration_count (const char * hashname, uint64_t
timeshresh);
```

Arguments

hashname

[in] kernel crypto API name of a keyed hash (e.g. hmac(sha1))

timeshresh

[in] Time duration in nanoseconds that the PBKDF operation shall at least require. If that value is 0, a default of (1<<27) nanoseconds is used.

Description

The function measures the time the PBKDF operation takes for different round counts for the given keyed message digest type.

The result should be taken as the iteration count for a PBKDF operation.

If an error occurs with the PBKDF calculation, a value of 1<<18 is returned.

return number of iterations a PBKDF should take on this computer.

kcapi_hkdf

LINUX

libkcapi ManualApril 2022

Name

`kcapi_hkdf` — Extract-and-Expand HKDF (RFC5869)

Synopsis

```
ssize_t kcapi_hkdf (const char * hashname, const uint8_t * ikm,
size_t ikmlen, const uint8_t * salt, uint32_t saltlen, const
uint8_t * info, size_t infolen, uint8_t * dst, size_t dlen);
```

Arguments

hashname

[in] kernel crypto API name of a keyed hash (e.g. hmac(sha1))

ikm

[in] Input Keying Material (IKM) -- must be provided

ikmlen

[in] IKM buffer length -- must be non-zero

salt

[in] salt buffer -- may be NULL

saltlen

[in] salt buffer length -- may be zero

info

[in] info buffer -- may be NULL

infolen

[in] info buffer length -- may be zero

dst

[out] Buffer to store the generated key in,

dlen

[in] Length of the dst buffer. This value defines the number of bytes generated by the KDF.

Description

Perform the key-derivation function according to RFC5869. The input data is defined in sections 2.2 und 2.3 of RFC5869.

return 0 upon success; a negative errno-style error code if an error occurred