Happy Key: HPKE implementation (RFC9180)

https://github.com/sftcd/happykey

Generated by Doxygen 1.9.1

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Here is a list of all documented files with brief descriptions:

Chapter 3

Data Structure Documentation

3.1 OSSL_HPKE_SUITE Struct Reference

ciphersuite combination

`#include <hpke.h>`

Data Fields

- uint16_t kem_id
  Key Encryption Method id.
- uint16_t kdf_id
  Key Derivation Function id.
- uint16_t aead_id
  AEAD alg id.

3.1.1 Detailed Description

ciphersuite combination

The documentation for this struct was generated from the following file:

- hpke.h

Chapter 4

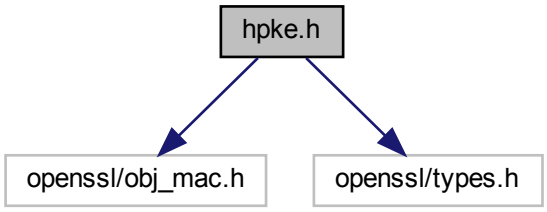
File Documentation

4.1 hpke.h File Reference

APIs and data structures for HPKE (RFC9180).

```
#include <openssl/obj_mac.h>
#include <openssl/types.h>
```

Include dependency graph for hpke.h:



Data Structures

- struct OSSL_HPKE_SUITE

  ciphersuite combination

Macros

- #define OSSL_HPKE_MODE_BASE 0

  Base mode

- #define OSSL_HPKE_MODE_PSK 1

  Pre-shared key mode.

- #define OSSL_HPKE_MODE_AUTH 2

Authenticated mode.

- #define OSSL_HPKE_MODE_PSKAUTH 3

  PSK+authenticated mode.
- #define OSSL_HPKE_KEM_ID_RESERVED 0x0000

  not used
- #define OSSL_HPKE_KEM_ID_P256 0x0010

  NIST P-256.
- #define OSSL_HPKE_KEM_ID_P384 0x0011

  NIST P-384.
- #define OSSL_HPKE_KEM_ID_P521 0x0012

  NIST P-521.
- #define OSSL_HPKE_KEM_ID_X25519 0x0020

  Curve25519.
- #define OSSL_HPKE_KEM_ID_X448 0x0021

  Curve448.
- #define OSSL_HPKE_KDF_ID_RESERVED 0x0000

  not used
- #define OSSL_HPKE_KDF_ID_HKDF_SHA256 0x0001

  HKDF-SHA256.
- #define OSSL_HPKE_KDF_ID_HKDF_SHA384 0x0002

  HKDF-SHA384.
- #define OSSL_HPKE_KDF_ID_HKDF_SHA512 0x0003

  HKDF-SHA512.
- #define OSSL_HPKE_AEAD_ID_RESERVED 0x0000

  not used
- #define OSSL_HPKE_AEAD_ID_AES_GCM_128 0x0001

  AES-GCM-128.
- #define OSSL_HPKE_AEAD_ID_AES_GCM_256 0x0002

  AES-GCM-256.
- #define OSSL_HPKE_AEAD_ID_CHACHA_POLY1305 0x0003

  Chacha20-Poly1305.
- #define OSSL_HPKE_AEAD_ID_EXPORTONLY 0xFFFF

  export-only fake ID
- #define OSSL_HPKE_MODESTR_BASE "base"

  base mode (1)
- #define OSSL_HPKE_MODESTR_PSK "psk"

  psk mode (2)
- #define OSSL_HPKE_MODESTR_AUTH "auth"

  sender-key pair auth (3)
- #define OSSL_HPKE_MODESTR_PSKAUTH "pskauth"

  psk+sender-key pair (4)
- #define OSSL_HPKE_KEMSTR_P256 "P-256"

  KEM id 0x10.
- #define OSSL_HPKE_KEMSTR_P384 "P-384"

  KEM id 0x11.
- #define OSSL_HPKE_KEMSTR_P521 "P-521"

  KEM id 0x12.
- #define OSSL_HPKE_KEMSTR_X25519 SN_X25519

  KEM id 0x20.
- #define OSSL_HPKE_KEMSTR_X448 SN_X448

  KEM id 0x21.

- #define OSSL_HPKE_KDFSTR_256 "hkdf-sha256"

  KDF id 1.
- #define OSSL_HPKE_KDFSTR_384 "hkdf-sha384"

  KDF id 2.
- #define OSSL_HPKE_KDFSTR_512 "hkdf-sha512"

  KDF id 3.
- #define OSSL_HPKE_AEADSTR_AES128GCM LN_aes_128_gcm

  AEAD id 1.
- #define OSSL_HPKE_AEADSTR_AES256GCM LN_aes_256_gcm

  AEAD id 2.
- #define OSSL_HPKE_AEADSTR_CP LN_chacha20_poly1305

  AEAD id 3.
- #define OSSL_HPKE_AEADSTR_EXP "exporter"

  AEAD id 0xff.
- #define OSSL_HPKE_SUITE_DEFAULT

  Suite constants, use this like: OSSL_HPKE_SUITE myvar = OSSL_HPKE_SUITE_DEFAULT;.

Typedefs

- typedef struct ossl_hpke_ctx_st OSSL_HPKE_CTX

  opaque type for HPKE contexts

Functions

- OSSL_HPKE_CTX * OSSL_HPKE_CTX_new (int mode, OSSL_HPKE_SUITE suite, OSSL_LIB_CTX *libctx, const char *propq)

  context creator
- void OSSL_HPKE_CTX_free (OSSL_HPKE_CTX *ctx)

  free up storage for a HPKE context
- int OSSL_HPKE_CTX_set1_psk (OSSL_HPKE_CTX *ctx, const char *pskid, const unsigned char *psk, size_t psklen)

  set a PSK for an HPKE context
- int OSSL_HPKE_CTX_set1_ikme (OSSL_HPKE_CTX *ctx, const unsigned char *ikme, size_t ikmelen)

  set a sender IKM for key DHKEM generation
- int OSSL_HPKE_CTX_set1_authpriv (OSSL_HPKE_CTX *ctx, EVP_PKEY *privp)

  set a sender private key for HPKE authenticated modes
- int OSSL_HPKE_CTX_set1_authpub (OSSL_HPKE_CTX *ctx, const unsigned char *pub, size_t publen)

  set a public key for HPKE authenticated modes
- int OSSL_HPKE_CTX_get0_seq (OSSL_HPKE_CTX *ctx, uint64_t *seq)

  ask for the state of the sequence of seal/open calls
- int OSSL_HPKE_CTX_set1_seq (OSSL_HPKE_CTX *ctx, uint64_t seq)

  set the sequence value for seal/open calls
- int OSSL_HPKE_encap (OSSL_HPKE_CTX *ctx, unsigned char *enc, size_t *enclen, unsigned char *pub, size_t publen, const unsigned char *info, size_t infolen)

  sender encapsulation function
- int OSSL_HPKE_decap (OSSL_HPKE_CTX *ctx, const unsigned char *enc, size_t enclen, EVP_PKEY *recippriv, const unsigned char *info, size_t infolen)

  recipient decapsulation function
- int OSSL_HPKE_seal (OSSL_HPKE_CTX *ctx, unsigned char *ct, size_t *ctlen, const unsigned char *aad, size_t aadlen, const unsigned char *pt, size_t ptlen)

new sender seal function

- int OSSL_HPKE_open (OSSL_HPKE_CTX *ctx, unsigned char *pt, size_t *ptlen, const unsigned char *aad, size_t aadlen, const unsigned char *ct, size_t ctlen)

  new sender seal function
- int OSSL_HPKE_export (OSSL_HPKE_CTX *ctx, unsigned char *secret, size_t secretlen, const unsigned char *label, size_t labellen)

  generate a given-length secret based on context and label
- int OSSL_HPKE_keygen (OSSL_LIB_CTX *libctx, const char *propq, unsigned int mode, OSSL_HPKE_SUITE suite, const unsigned char *ikm, size_t ikmlen, unsigned char *pub, size_t *publen, EVP_PKEY **priv)

  generate a key pair
- int OSSL_HPKE_suite_check (OSSL_HPKE_SUITE suite)

  check if a suite is supported locally
- int OSSL_HPKE_get_grease_value (OSSL_LIB_CTX *libctx, const char *propq, OSSL_HPKE_SUITE *suite_in, OSSL_HPKE_SUITE *suite, unsigned char *pub, size_t *pub_len, unsigned char *ciphertext, size_t ciphertext_len)

  get a (possibly) random suite, public key and ciphertext for GREASErs
- int OSSL_HPKE_str2suite (const char *str, OSSL_HPKE_SUITE *suite)

  map a string to a HPKE suite
- size_t OSSL_HPKE_get_ciphertext_size (OSSL_HPKE_SUITE suite, size_t clearlen)

  tell the caller how big the cipertext will be
- size_t OSSL_HPKE_get_public_encap_size (OSSL_HPKE_SUITE suite)

  tell the caller how big the public value `enc` will be
- size_t OSSL_HPKE_recommend_ikmelen (OSSL_HPKE_SUITE suite)

  recommend an IKM size in octets for a given suite

4.1.1 Detailed Description

APIs and data structures for HPKE (RFC9180).

4.1.2 Macro Definition Documentation

4.1.2.1 OSSL_HPKE_SUITE_DEFAULT

```
#define OSSL_HPKE_SUITE_DEFAULT
```

Value:

```
{\
    OSSL_HPKE_KEM_ID_X25519, \
    OSSL_HPKE_KDF_ID_HKDF_SHA256, \
    OSSL_HPKE_AEAD_ID_AES_GCM_128 \
}
```

Suite constants, use this like: OSSL_HPKE_SUITE myvar = OSSL_HPKE_SUITE_DEFAULT;.

4.1.3 Function Documentation

4.1.3.1 OSSL_HPKE_CTX_free()

```
void OSSL_HPKE_CTX_free (
            OSSL_HPKE_CTX * ctx )
```

free up storage for a HPKE context

Parameters

ctx	is the pointer to be free'd (can be NULL)

4.1.3.2 OSSL_HPKE_CTX_get0_seq()

```
int OSSL_HPKE_CTX_get0_seq (
            OSSL_HPKE_CTX * ctx,
            uint64_t * seq )
```

ask for the state of the sequence of seal/open calls

Parameters

ctx	is the pointer for the HPKE context
seq	returns the positive integer sequence number

Returns

1 for success, 0 for error

The value returned is the next one to be used when sealing or opening (so as we start at zero this will be 1 after the first successful call to seal or open)

seq is a uint64_t as that's what two other implementations chose

4.1.3.3 OSSL_HPKE_CTX_new()

```
OSSL_HPKE_CTX* OSSL_HPKE_CTX_new (
            int mode,
            OSSL_HPKE_SUITE suite,
            OSSL_LIB_CTX * libctx,
            const char * propq )
```

context creator

Parameters

mode	is the desired HPKE mode
suite	specifies the KEM, KDF and AEAD to use
libctx	is the library context to use
propq	is a properties string for the library

Returns

pointer to new context or NULL if error

4.1.3.4 OSSL_HPKE_CTX_set1_authpriv()

```
int OSSL_HPKE_CTX_set1_authpriv (
            OSSL_HPKE_CTX * ctx,
            EVP_PKEY * privp )
```

set a sender private key for HPKE authenticated modes

Parameters

ctx	is the pointer for the HPKE context
privp	is an EVP_PKEY form of the private key

Returns

1 for success, 0 for error

4.1.3.5 OSSL_HPKE_CTX_set1_authpub()

```
int OSSL_HPKE_CTX_set1_authpub (
            OSSL_HPKE_CTX * ctx,
            const unsigned char * pub,
            size_t publen )
```

set a public key for HPKE authenticated modes

Parameters

ctx	is the pointer for the HPKE context
pub	is an buffer form of the public key
publen	is the length of the above

Returns

1 for success, 0 for error

In all these APIs public keys are passed as buffers whereas private keys as passed as EVP_PKEY pointers.

4.1.3.6 OSSL_HPKE_CTX_set1_ikme()

```
int OSSL_HPKE_CTX_set1_ikme (
            OSSL_HPKE_CTX * ctx,
            const unsigned char * ikme,
            size_t ikmelen )
```

set a sender IKM for key DHKEM generation

Parameters

ctx	is the pointer for the HPKE context
ikme	is a buffer for the IKM
ikmelen	is the length of the above

Returns

1 for success, 0 for error

4.1.3.7 OSSL_HPKE_CTX_set1_psk()

```
int OSSL_HPKE_CTX_set1_psk (
            OSSL_HPKE_CTX * ctx,
            const char * pskid,
            const unsigned char * psk,
            size_t psklen )
```

set a PSK for an HPKE context

Parameters

ctx	is the pointer for the HPKE context
pskid	is a string identifying the PSK
psk	is the PSK buffer
psklen	is the size of the PSK

Returns

1 for success, 0 for error

4.1.3.8 OSSL_HPKE_CTX_set1_seq()

```
int OSSL_HPKE_CTX_set1_seq (
            OSSL_HPKE_CTX * ctx,
            uint64_t seq )
```

set the sequence value for seal/open calls

Parameters

ctx	is the pointer for the HPKE context
seq	set the positive integer sequence number

Returns

1 for success, 0 for error

The next seal or open operation will use this value.

4.1.3.9 OSSL_HPKE_decap()

```
int OSSL_HPKE_decap (
            OSSL_HPKE_CTX * ctx,
            const unsigned char * enc,
            size_t enclen,
            EVP_PKEY * recippriv,
            const unsigned char * info,
            size_t infolen )
```

recipient decapsulation function

Parameters

ctx	is the pointer for the HPKE context
enc	is the sender's ephemeral public value
enclen	is the size the above
recippriv	is the EVP_PKEY form of recipient private value
info	is the info parameter
infolen	is the size the above

Returns

1 for success, 0 for error

Following this, OSSL_HPKE_CTX_export can be called.

4.1.3.10 OSSL_HPKE_encap()

```
int OSSL_HPKE_encap (
            OSSL_HPKE_CTX * ctx,
            unsigned char * enc,
            size_t * enclen,
            unsigned char * pub,
            size_t publen,
            const unsigned char * info,
            size_t infolen )
```

sender encapsulation function

Parameters

ctx	is the pointer for the HPKE context
enc	is the sender's ephemeral public value
enclen	is the size the above
pub	is the recipient public key octets
publen	is the size the above
info	is the info parameter
infolen	is the size the above

Returns

1 for success, 0 for error

4.1.3.11 OSSL_HPKE_export()

```
int OSSL_HPKE_export (
            OSSL_HPKE_CTX * ctx,
            unsigned char * secret,
            size_t secretlen,
            const unsigned char * label,
            size_t labellen )
```

generate a given-length secret based on context and label

Parameters

ctx	is the HPKE context
secret	is the resulting secret that will be of length...
secretlen	is the desired output length
label	is a buffer to provide separation between secrets
labellen	is the length of the above

Returns

1 for good, 0 for error

The context has to have been used already for one encryption or decryption for this to work (as this is based on the negotiated "exporter_secret" estabilshed via the HPKE operation).

4.1.3.12 OSSL_HPKE_get_ciphertext_size()

```
size_t OSSL_HPKE_get_ciphertext_size (
            OSSL_HPKE_SUITE suite,
            size_t clearlen )
```

tell the caller how big the cipertext will be

Parameters

suite	is the suite to be used
clearlen	is the length of plaintext

Returns

the length of the related ciphertext or zero on error

AEAD algorithms add a tag for data authentication. Those are almost always, but not always, 16 octets long, and who know what'll be true in the future. So this function allows a caller to find out how much data expansion they'll see with a given suite.

4.1.3.13 OSSL_HPKE_get_grease_value()

```
int OSSL_HPKE_get_grease_value (
            OSSL_LIB_CTX * libctx,
            const char * propq,
            OSSL_HPKE_SUITE * suite_in,
            OSSL_HPKE_SUITE * suite,
            unsigned char * pub,
            size_t * pub_len,
            unsigned char * ciphertext,
            size_t ciphertext_len )
```

get a (possibly) random suite, public key and ciphertext for GREASErs

Parameters

libctx	is the context to use (normally NULL)
propq	is a properties string
suite_in	specifies the preferred suite or NULL for a random choice
suite	is the chosen or random suite
pub	a random value of the appropriate length for a sender public value
pub_len	is the length of pub (buffer size on input)
ciphertext	is a random value of the appropriate length for ciphertext
ciphertext_len	is the length of cipher

Returns

1 for success, otherwise failure

If suite_in is provided that will be used (if supported). If suite_in is NULL, a random suite (from those supported) will be selected. In all cases the output pub and cipher values will be appropriate random values for the selected suite.

4.1.3.14 OSSL_HPKE_get_public_encap_size()

```
size_t OSSL_HPKE_get_public_encap_size (
            OSSL_HPKE_SUITE suite )
```

tell the caller how big the public value `enc` will be

Parameters

suite	is the suite to be used

Returns

size of public encap or zero on error

AEAD algorithms add a tag for data authentication. Those are almost always, but not always, 16 octets long, and who know what'll be true in the future. So this function allows a caller to find out how much data expansion they'll see with a given suite.

4.1.3.15 OSSL_HPKE_keygen()

```
int OSSL_HPKE_keygen (
             OSSL_LIB_CTX * libctx,
             const char * propq,
             unsigned int mode,
             OSSL_HPKE_SUITE suite,
             const unsigned char * ikm,
             size_t ikmlen,
             unsigned char * pub,
             size_t * publen,
             EVP_PKEY ** priv )
```

generate a key pair

Parameters

libctx	is the context to use (normally NULL)
propq	is a properties string
mode	is the mode (currently unused)
suite	is the ciphersuite (currently unused)
ikm	is IKM, if supplied
ikmlen	is the length of IKM, if supplied
pub	is the public value
publen	is the size of the public key buffer (exact length on output)
priv	is the private key

Returns

1 for success, other for error (error returns can be non-zero)

Used for entities that will later receive HPKE values to decrypt or that want a private key for an AUTH mode. Currently, only the KEM from the suite is significant here. The `pub` output will typically be published so that others can encrypt to the private key holder using HPKE. (Or authenticate HPKE values from that sender.)

4.1.3.16 OSSL_HPKE_open()

```
int OSSL_HPKE_open (
             OSSL_HPKE_CTX * ctx,
             unsigned char * pt,
             size_t * ptlen,
             const unsigned char * aad,
             size_t aadlen,
```

```
            const unsigned char * ct,
            size_t ctlen )
```

new sender seal function

Parameters

pt	is the plaintext
ptlen	is the size the above
ctlen	is the size the above
aad	is the aad parameter
aadlen	is the size the above
ctx	is the pointer for the HPKE context
ct	is the ciphertext output

Returns

1 for success, 0 for error

This can be called multiple times

4.1.3.17 OSSL_HPKE_recommend_ikmelen()

```
size_t OSSL_HPKE_recommend_ikmelen (
            OSSL_HPKE_SUITE suite )
```

recommend an IKM size in octets for a given suite

Parameters

suite	is the suite to be used

Returns

the recommended size or zero on error

Today, this really only uses the KEM to recommend the number of random octets to use based on the size of a private value. In future, it could also factor in e.g. the AEAD.

4.1.3.18 OSSL_HPKE_seal()

```
int OSSL_HPKE_seal (
            OSSL_HPKE_CTX * ctx,
            unsigned char * ct,
            size_t * ctlen,
            const unsigned char * aad,
            size_t aadlen,
            const unsigned char * pt,
            size_t ptlen )
```

new sender seal function

Parameters

ctx	is the pointer for the HPKE context

Parameters

ct	is the ciphertext output
ctlen	is the size the above
aad	is the aad parameter
aadlen	is the size the above
pt	is the plaintext
ptlen	is the size the above

Returns

1 for success, 0 for error

This can be called multiple times

4.1.3.19 OSSL_HPKE_str2suite()

```
int OSSL_HPKE_str2suite (
            const char * str,
            OSSL_HPKE_SUITE * suite )
```

map a string to a HPKE suite

Parameters

str	is the string value
suite	is the resulting suite

Returns

1 for success, otherwise failure

An example good string is "x25519,hkdf-sha256,aes-128-gcm" Symbols are #define'd for the relevant labels, e.g. OSSL_HPKE_KEMSTR_X25519. Numeric (decimal or hex) values with the relevant IANA codepoint values from RFC9180 may be used, e.g., "0x20,1,1" represents the same suite as the first example.

4.1.3.20 OSSL_HPKE_suite_check()

```
int OSSL_HPKE_suite_check (
            OSSL_HPKE_SUITE suite )
```

check if a suite is supported locally

Parameters

suite	is the suite to check

Returns

1 for success, other for error (error returns can be non-zero)

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