Ordo

0.3.0

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Contents

Chapter 1

Main Page

Symmetric Cryptography Library

This is the github repository for Ordo, a minimalist cryptography library with an emphasis on symmetric cryptography, which strives to meet high performance, portability, and security standards, while remaining modular in design to facilitate adding new features and maintaining existing ones. The library is written in standard C with system-specific features, but some sections are assembly-optimized for efficiency. Note that while the library is technically usable at this point, it is still very much a work in progress and mustn't be deployed in security-sensitive applications.

Status

`![Build Status](https://travis-ci.org/TomCrypto/Ordo.png?branch=master)`

What's new in 0.3.0:

- completely new API, now fully static (no dynamic allocation ever happens), less indirection levels, and improved C89 conformance
- the test driver is being reworked (work in progress)
- the HMAC module has been slightly changed to apply the hash parameters on the outer hash instance, which allows for variable output length parameters
- all functions have been namespaced, to prevent declaration and linking conflicts

Feature Map

This table doesn't include every single feature but gives a high level overview of what is available so far:

Block Ciphers	Stream Ciphers	Hash Functions	Modes	Authentication	Key Derivation	Misc
AES	RC4	MD5	ECB	HMAC	PBKDF2	CSPRNG
Threefish-256	-	SHA-256	CBC	-	-	-
-	-	Skein-256	OFB	-	-	-
-	-	-	CFB	-	-	-
-	-	-	CTR	-	-	-

Documentation

Ordo is documented for Doxygen, and you can automatically generate all documentation by using the `doc` build target, if deemed available on your system (you will need `doxygen`, and `pdflatex` with a working TeX environment for the LaTeX output). The HTML documentation will be generated in `doc/html`, and the LaTeX documentation will be generated in `doc/latex`, which you can then typeset using the generated makefile.

You can also access a recent version of the documentation online through the `project page`.

How To Build

We support recent versions of MSVC, GCC, MinGW, and Clang. Other compilers are not officially supported. The build system used is CMake, which has a few configuration options to tweak the library according to your needs. A `build` folder is provided for you to point CMake to. Python 2.x (probably 2.7+) is also required.

- `LTO`: use link-time optimization, this should be enabled for optimal performance.
- `ARCH`: the architecture to use, pick the one most appropriate for your hardware.
- `NATIVE`: tune the build for the current hardware (e.g. `-march` for GCC).
- `COMPAT`: remove some advanced compiler settings for older compiler versions (for GCC only, if this is enabled `LTO` has no effect)

Note the system is autodetected and automatically included in the build. Additional options, such as the use of special hardware instructions, may become available once an architecture is selected, if they are supported. Link-time optimization may not be available on older compilers (it will let you know).
If you are not using the `cmake-gui` utility, the command-line options to configure the library are:

```
cd build && cmake .. [-DARCH=arch] [[-DFEATURE=on] ...] [-DLTO=off] [-DNATIVE=off] [-DCOMPAT=on]
```

For instance, a typical configuration for x86_64 machines with the AES-NI instructions could be:

```
cd build && cmake .. -DARCH=amd64 -DAES_NI=on
```

The test driver is in the `test` folder, the sample programs are in the `samples` folder.

Assembly Support

We use the NASM assembler for our assembly files. For Linux and other Unix-based operating systems this should work out of the box after installing the assembler. For MSVC on Windows using the Visual Studio generators, custom build rules have been set up to autodetect NASM and get it to automatically compile assembly files, but they have not been tested (and may not necessarily work) for all versions of Visual Studio.

Static Linking

If you wish to link statically to the library, please define the `ORDO_STATIC_LIB` preprocessor token in your project so that the Ordo headers can configure themselves accordingly (otherwise, they will assume you are linking to a shared library, which may raise some unwelcome compiler warnings as well as forbidding access to the internal headers).

Compatibility

The library will run everywhere a near-C89 compiler (i.e. with `stdint.h` and `long long` support) is available, however system-dependent modules will not be available without an implementation for these platforms. For better performance, specialized algorithm implementations may be available for your system and processor architecture.

The test driver requires partial C99 support, the library build system requires CMake and Python.

Conclusion

Of course, do not use Ordo for anything other than testing or contributing for now! It can only be used once it has been completed and extensively checked (and even then, there may still be flaws and bugs, as in any other software).

Chapter 2

README

This directory stores system implementations which are applicable to multiple systems without modifications. Systems, or system groups, in this directory are not intended to be directly added to the build, but are to be symlinked as needed by the proper system implementations. This mechanism greatly reduces code duplication and improves maintainability.

As an example, much of the `unix` directory is referenced from `linux`, `freebsd`, `openbsd`, `netbsd`, and `darwin`, as they usually share the same ABI and have many system features in common (such as `/dev/urandom`). An exception is the `endianness.c` source file which differs slightly across those systems.

Chapter 3

Data Structure Index

3.1 Data Structures

Here are the data structures with brief descriptions:

Chapter 4

File Index

4.1 File List

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

Chapter 5

Data Structure Documentation

5.1 AES_PARAMS Struct Reference

AES block cipher parameters.

```
#include <block_params.h>
```

Data Fields

- size_t rounds

5.1.1 Detailed Description

AES block cipher parameters.

5.1.2 Field Documentation

5.1.2.1 size_t rounds

The number of rounds to use.

Warning

The defaults are 10 for a 128-bit key, 12 for a 192-bit key, 14 for a 256-bit key, and are standardized. It is **strongly** discouraged to lower the number of rounds below the defaults.

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

- /ssd/Ordo/include/ordo/primitives/block_ciphers/block_params.h

5.2 CBC_PARAMS Struct Reference

CBC parameters.

```
#include <mode_params.h>
```

Data Fields

- int padding

5.2.1 Detailed Description

CBC parameters.

5.2.2 Field Documentation

5.2.2.1 int padding

Whether padding should be used.

Remarks

> Set to 0 to disable padding, and 1 to enable it.
> Padding is enabled by default if parameters are not used.

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

- /ssd/Ordo/include/ordo/primitives/block_modes/mode_params.h

5.3 ECB_PARAMS Struct Reference

ECB parameters.

```
#include <mode_params.h>
```

Data Fields

- int padding

5.3.1 Detailed Description

ECB parameters.

5.3.2 Field Documentation

5.3.2.1 int padding

Whether padding should be used.

Remarks

> Set to 0 to disable padding, and 1 to enable it.
> Padding is enabled by default if parameters are not used.

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

- /ssd/Ordo/include/ordo/primitives/block_modes/mode_params.h

5.4 ORDO_VERSION Struct Reference

Library version information.

```
#include <version.h>
```

Data Fields

- unsigned int id
- const char ∗ version
- const char ∗ system
- const char ∗ arch
- const char ∗ build
- const char ∗const ∗ features
- const char ∗ feature_list

5.4.1 Detailed Description

Library version information.

Contains version information for the library.

5.4.2 Field Documentation

5.4.2.1 unsigned int id

The version as an integer of the form XXYYZZ, e.g. 30242 == 3.2.42.

5.4.2.2 const char∗ version

The version e.g. "2.7.0".

5.4.2.3 const char∗ system

The target system e.g. "linux".

5.4.2.4 const char∗ arch

The target architecture e.g. "amd64".

5.4.2.5 const char∗ build

A string which contains version, system and architecture.

5.4.2.6 const char∗ const∗ features

A null-terminated list of targeted features.

5.4.2.7 const char∗ feature_list

The list of features, as a space-separated string.

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

- /ssd/Ordo/include/ordo/common/version.h

5.5 RC4_PARAMS Struct Reference

RC4 stream cipher parameters.

```
#include <stream_params.h>
```

Data Fields

- size_t drop

5.5.1 Detailed Description

RC4 stream cipher parameters.

5.5.2 Field Documentation

5.5.2.1 size_t drop

The number of keystream bytes to drop prior to encryption.

Remarks

Setting this implements the given RC4-drop variant.
If this `RC4_PARAMS` structure is **not** passed to the RC4 stream cipher primitive, the default drop amount is 2048.

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

- /ssd/Ordo/include/ordo/primitives/stream_ciphers/stream_params.h

5.6 SKEIN256_PARAMS Struct Reference

Skein-256 hash function parameters.

```
#include <hash_params.h>
```

Data Fields

- uint8_t schema [4]
- uint8_t version [2]
- uint8_t reserved [2]
- uint64_t out_len
- uint8_t unused [16]

5.6.1 Detailed Description

Skein-256 hash function parameters.

Remarks

Refer to the Skein specification to know more about what each of these parameter fields stand for.

Warning

This structure is **packed**, to improve performance while hashing the configuration block, be careful when taking pointers to it.

5.6.2 Field Documentation

5.6.2.1 uint8_t schema[4]

The schema identifier, on four bytes.

5.6.2.2 uint8_t version[2]

The version number, on two bytes.

5.6.2.3 uint8_t reserved[2]

Reserved, should be left zero according to the Skein specification.

5.6.2.4 uint64_t out_len

Desired output length, in **bits**.

Warning

This parameter affects the hash function's digest length.
The actual output length will be in bytes, and this parameter **will** be truncated to a byte boundary, so this should be a multiple of 8 to avoid any surprises.

5.6.2.5 uint8_t unused[16]

Unused, should be left zero according to the Skein specification.

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

- /ssd/Ordo/include/ordo/primitives/hash_functions/hash_params.h

5.7 THREEFISH256_PARAMS Struct Reference

Threefish-256 block cipher parameters.

```
#include <block_params.h>
```

Data Fields

- uint64_t tweak [2]

5.7.1 Detailed Description

Threefish-256 block cipher parameters.

5.7.2 Field Documentation

5.7.2.1 uint64_t tweak[2]

The tweak word, on a pair of 64-bit words.

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

- /ssd/Ordo/include/ordo/primitives/block_ciphers/block_params.h

Chapter 6

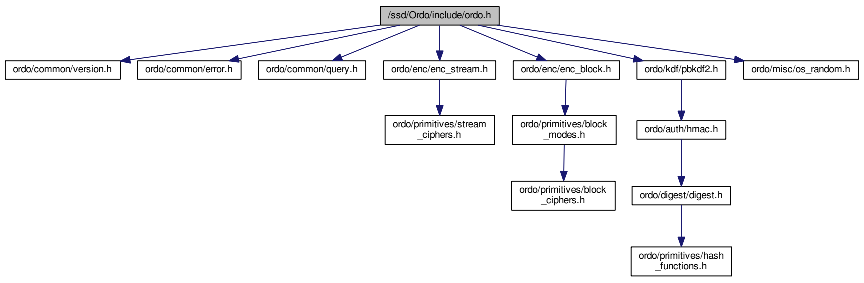
File Documentation

6.1 /ssd/Ordo/include/ordo.h File Reference

Wrapper.

```
#include "ordo/common/version.h"
#include "ordo/common/error.h"
#include "ordo/common/query.h"
#include "ordo/enc/enc_stream.h"
#include "ordo/enc/enc_block.h"
#include "ordo/kdf/pbkdf2.h"
#include "ordo/misc/os_random.h"
```

Include dependency graph for ordo.h:



Functions

- ORDO_PUBLIC int ordo_enc_block (prim_t cipher, const void ∗cipher_params, prim_t mode, const void ∗mode_params, int direction, const void ∗key, size_t key_len, const void ∗iv, size_t iv_len, const void ∗in, size_t in_len, void ∗out, size_t ∗out_len)
- ORDO_PUBLIC int ordo_enc_stream (prim_t cipher, const void ∗params, const void ∗key, size_t key_len, void ∗inout, size_t len)
- ORDO_PUBLIC int ordo_digest (prim_t hash, const void ∗params, const void ∗in, size_t in_len, void ∗digest)
- ORDO_PUBLIC int ordo_hmac (prim_t hash, const void ∗params, const void ∗key, size_t key_len, const void ∗in, size_t in_len, void ∗fingerprint)

6.1.1 Detailed Description

Wrapper. This is the highest-level API for Ordo, which forgoes the use of cryptographic contexts completely, resulting in more concise code at the cost of reduced flexibility - in other words, if you can afford to use them, you probably want to do so.

Usage snippet (compare to snippet in `digest.h`):

```
const char x[] = "Hello, world!";
unsigned char out[32]; // 256 bits
int err = ordo_digest(HASH_SHA256, 0, x, strlen(x), out);
if (err) printf("Error encountered!\n");
// out = 315f5bdb76d0...
```

Some specialized headers are *not* included by this header - these are the endianness header & all primitive headers (their parameters are included), if you need their functionality please include them explicitly.

6.1.2 Function Documentation

6.1.2.1 ORDO_PUBLIC int ordo_enc_block (prim_t *cipher*, const void ∗ *cipher_params*, prim_t *mode*, const void ∗ *mode_params*, int *direction*, const void ∗ *key*, size_t *key_len*, const void ∗ *iv*, size_t *iv_len*, const void ∗ *in*, size_t *in_len*, void ∗ *out*, size_t ∗ *out_len*)

Encrypts or decrypts data using a block cipher with a mode of operation.

Parameters

in	*cipher*	The block cipher to use.
in	*cipher_params*	The block cipher parameters.
in	*mode*	The mode of operation to use.
in	*mode_params*	The mode of operation parameters.
in	*direction*	1 for encryption, 0 for decryption.
in	*key*	The cryptographic key to use.
in	*key_len*	The length in bytes of the key.
in	*iv*	The initialization vector.
in	*iv_len*	The length in bytes of the IV.
in	*in*	The input plaintext/ciphertext buffer.
in	*in_len*	The length of the input buffer.
out	*out*	The output ciphertext/plaintext buffer.
out	*out_len*	The length of the output buffer.

Returns

`ORDO_SUCCESS` on success, else an error code.

Remarks

The `out` buffer should be large enough to accomodate the entire ciphertext which may be larger than the plaintext if a mode where padding is enabled and used, see padding notes in `enc_block.h`.

6.1.2.2 ORDO_PUBLIC int ordo_enc_stream (prim_t *cipher*, const void ∗ *params*, const void ∗ *key*, size_t *key_len*, void ∗ *inout*, size_t *len*)

Encrypts or decrypts data using a stream cipher.

Parameters

in	*cipher*	The stream cipher to use.
in	*params*	The stream cipher parameters.
in,out	*inout*	The plaintext or ciphertext buffer.
in	*len*	The length, in bytes, of the buffer.
in	*key*	The cryptographic key to use.
in	*key_len*	The length, in bytes, of the key.

Returns

ORDO_SUCCESS on success, else an error code.

Remarks

Stream ciphers do not strictly speaking require an initialization vector - if such a feature is needed, it is recommended to use a key derivation function to derive an encryption key from a master key using a pseudorandomly generated nonce.
Encryption is always done in place. If you require out-of-place encryption, make a copy of the plaintext prior to encryption.

Warning

By design, encryption and decryption are equivalent for stream ciphers - an implication is that encrypting a message twice using the same key yields the original message.

6.1.2.3 ORDO_PUBLIC int ordo_digest (prim_t *hash,* const void ∗ *params,* const void ∗ *in,* size_t *in_len,* void ∗ *digest*)

Calculates the digest of a buffer using any hash function.

Parameters

in	*hash*	The hash function to use.
in	*params*	The hash function parameters.
in	*in*	The input buffer to hash.
in	*in_len*	The length in bytes of the buffer.
out	*digest*	The output buffer for the digest.

Returns

ORDO_SUCCESS on success, else an error code.

6.1.2.4 ORDO_PUBLIC int ordo_hmac (prim_t *hash,* const void ∗ *params,* const void ∗ *key,* size_t *key_len,* const void ∗ *in,* size_t *in_len,* void ∗ *fingerprint*)

Calculates the HMAC fingerprint of a buffer using any hash function.

Parameters

in	*hash*	The hash function to use.
in	*params*	The hash function parameters.
in	*key*	The key to use for authentication.

in	*key_len*	The length in bytes of the key.
in	*in*	The input buffer to authenticate.
in	*in_len*	The length, in bytes, of the input buffer.
out	*fingerprint*	The output buffer for the fingerprint.

Returns

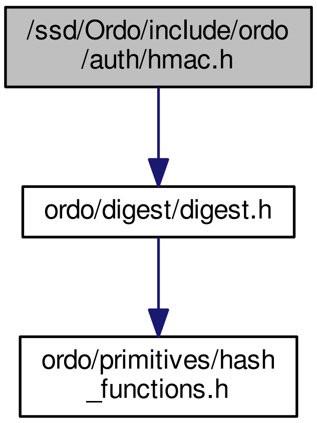
ORDO_SUCCESS on success, else an error code.

6.2 /ssd/Ordo/include/ordo/auth/hmac.h File Reference

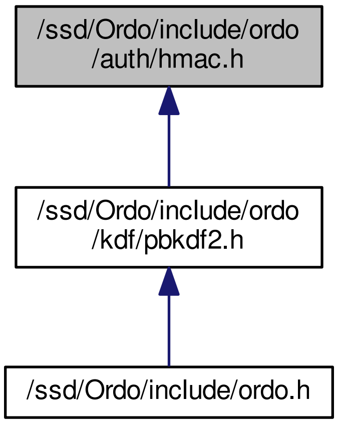
Module.

```
#include "ordo/digest/digest.h"
```

Include dependency graph for hmac.h:



This graph shows which files directly or indirectly include this file:



Functions

- ORDO_PUBLIC int hmac_init (struct HMAC_CTX ∗ctx, const void ∗key, size_t key_len, prim_t hash, const void ∗params)
- ORDO_PUBLIC void hmac_update (struct HMAC_CTX ∗ctx, const void ∗in, size_t in_len)
- ORDO_PUBLIC int hmac_final (struct HMAC_CTX ∗ctx, void ∗fingerprint)

6.2.1 Detailed Description

Module. Module for computing HMAC's (Hash-based Message Authentication Codes), which securely combine a hash function with a cryptographic key securely in order to provide both authentication and integrity, as per RFC 2104.

6.2.2 Function Documentation

6.2.2.1 ORDO_PUBLIC int hmac_init (struct HMAC_CTX ∗ *ctx,* const void ∗ *key,* size_t *key_len,* prim_t *hash,* const void ∗ *params*)

Initializes an HMAC context, provided optional parameters.

Parameters

in	*ctx*	An allocated HMAC context.
in	*key*	The cryptographic key to use.
in	*key_len*	The size, in bytes, of the key.
out	*hash*	A hash function primitive to use.
out	*params*	Hash function specific parameters.

Returns

`ORDO_SUCCESS` on success, else an error code.

Remarks

The hash parameters apply to the outer hash operation only, which is the one used to hash the processed message and masked key.

6.2.2.2 ORDO_PUBLIC void hmac_update (struct HMAC_CTX ∗ *ctx,* const void ∗ *in,* size_t *in_len*)

Updates an HMAC context, feeding more data into it.

Parameters

in	*ctx*	An initialized HMAC context.
in	*in*	The data to feed into the context.
in	*in_len*	The length, in bytes, of the data.

Remarks

This function has the same properties, with respect to the input buffer, as the `digest_update()` function.

6.2.2.3 ORDO_PUBLIC int hmac_final (struct HMAC_CTX ∗ *ctx,* void ∗ *fingerprint*)

Finalizes a HMAC context, returning the final fingerprint.

Parameters

in	*ctx*	An initialized HMAC context.
out	*fingerprint*	The output buffer for the fingerprint.

Returns

`ORDO_SUCCESS` on success, else an error code.

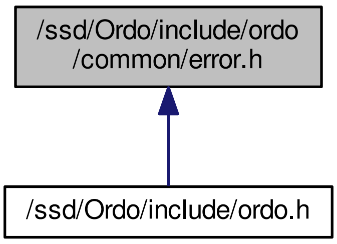
Remarks

The fingerprint length is equal to the underlying hash function's digest length, which must be queried via `hash_digest_length()`, or to the provided length, if a parameter which modified the hash function's output length was passed to `hmac_init()`.

6.3 /ssd/Ordo/include/ordo/common/error.h File Reference

Utility.

This graph shows which files directly or indirectly include this file:



Enumerations

- enum ORDO_ERROR {
  ORDO_SUCCESS, ORDO_FAIL, ORDO_LEFTOVER, ORDO_KEY_LEN,
  ORDO_PADDING, ORDO_ARG }

Functions

- ORDO_PUBLIC const char ∗ ordo_error_msg (int code)

6.3.1 Detailed Description

Utility. This header exposes error codes emitted by the library. Code which uses the library should always use the explicit error codes to check for errors, with the sole exception of `ORDO_SUCCESS` which is guaranteed to be zero.

6.3.2 Enumeration Type Documentation

6.3.2.1 enum ORDO_ERROR

Error codes used by the library.

Enumerator

ORDO_SUCCESS The function succeeded

Remarks

This is always defined as zero and is returned if a function encountered no error, unless specified otherwise.

ORDO_FAIL The function failed due to an external error.

Remarks

This often indicates failure of an external component, such as the pseudorandom number generator provided by the OS (see os_random). The library is not responsible for this error.

ORDO_LEFTOVER User input was left over unprocessed.

Remarks

This applies to block cipher modes of operation for which padding has been disabled. If the input plaintext length is not a multiple of the cipher's block size, then the remaining incomplete block cannot be handled without padding, which is an error as it generally leads to inconsistent behavior on the part of the user.

ORDO_KEY_LEN The key length provided is invalid.

Remarks

This occurs if you provide a key of an invalid length, such as passing a 128-bit key into a cipher which expects a 192-bit key. Primitives either have a range of possible key lengths (often characterized by a minimum and maximum key length, but this varies among algorithms) or only one specific key length. If you need to accept arbitrary length keys, you should consider hashing your key in some fashion before using it for encryption, for instance using a KDF.
The `block_query()` function can be used to select a good key length for a given block cipher via the `KEY_LEN_Q` query code. For stream ciphers, use `stream_query()`.

ORDO_PADDING The padding was not recognized and decryption could not be completed.

Remarks

This applies to block cipher modes for which padding is enabled. If the last block containing padding information is malformed, the padding will generally be unreadable and the correct message length cannot be retrieved, making correct decryption impossible. Note this is not guaranteed to occur if the padding block is corrupted. In other words, if `ORDO_PADDING` is returned, the padding block is certainly corrupted, however it may still be even if the library returns success (the returned plaintext will then be incorrect). If you **must** ensure the plaintext is decrypted correctly - and you probably should - you will want to use a MAC (Message Authentication Code) along with encryption, or an authenticated block cipher mode of operation.

ORDO_ARG An invalid argument was passed to a function.

Remarks

This is a generic error which is returned when the library finds an invalid parameter which would lead to inconsistent, undefined, or profoundly insecure behavior. Make sure your arguments are correct and do not contradict one another.
Keep in mind that the library cannot possibly catch all such errors, and you should still read the documentation if you are not sure what you are doing is valid.

6.3.3 Function Documentation

6.3.3.1 ORDO_PUBLIC const char∗ ordo_error_msg (int *code*)

Generates a readable error message from an error code.

Parameters

`in`	*code*	The error code to interpret.

Returns

A null-terminated string containing the error description.

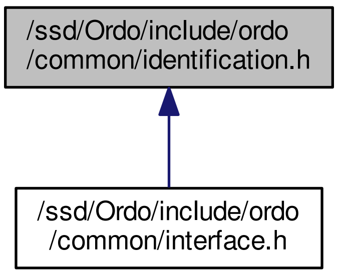
Remarks

This function is intended for debugging purposes.

6.4 /ssd/Ordo/include/ordo/common/identification.h File Reference

Utility.

This graph shows which files directly or indirectly include this file:


/ssd/Ordo/include/ordo /common/identification.h
/ssd/Ordo/include/ordo /common/interface.h

Typedefs

- typedef int prim_t

    Data type which holds a primitive identifier.

Enumerations

- enum PRIM_TYPE

Functions

- ORDO_PUBLIC int prim_avail (prim_t prim)
- ORDO_PUBLIC const char ∗ prim_name (prim_t prim)
- ORDO_PUBLIC enum PRIM_TYPE prim_type (prim_t prim)
- ORDO_PUBLIC prim_t prim_from_name (const char ∗name)
- ORDO_PUBLIC const prim_t ∗ prims_by_type (enum PRIM_TYPE type)

6.4.1 Detailed Description

Utility. This header contains definitions assigning an identifier to each primitive in the library - hash functions, block ciphers, modes of operation, and so on - which can then be used in higher level API's for abstraction purposes and more expressive code. This header also provides functionality relating to primitive management, e.g. which primitives are available, etc...

Note the zero ID will always stand for an error situation e.g. a primitive is not available. The zero ID is **never** a valid primitive identifier.

This also allows for a quick overview of what is implemented in Ordo.

6.4.2 Enumeration Type Documentation

6.4.2.1 enum **PRIM_TYPE**

Enumerates the different types of primitives (values start at 1).

6.4.3 Function Documentation

6.4.3.1 ORDO_PUBLIC int prim_avail (**prim_t** *prim*)

Checks whether a primitive is available.

Parameters

`in`	*prim*	A primitive identifier.

Returns

0 if the primitive is not available, 1 otherwise.

6.4.3.2 ORDO_PUBLIC const char∗ prim_name (**prim_t** *prim*)

Returns the name of a primitive.

Parameters

`in`	*prim*	A primitive identifier.

Returns

The name of the primitive as a human-readable string, or zero, if the primitive does not exist (i.e. invalid identifier passed).

Remarks

Do not rely on this being constant, use it for display only.

Warning

Will **not** work if the primitive is not available.

6.4.3.3 ORDO_PUBLIC enum PRIM_TYPE prim_type (prim_t *prim*)

Returns the type of a given primitive.

Parameters

`in`	*prim*	A primitive identifier.

Returns

The type of the primitive, or zero on error.

Warning

Will **not** work if the primitive is not available.

6.4.3.4 ORDO_PUBLIC prim_t prim_from_name (const char ∗ *name*)

Returns a primitive identifier from a name.

Parameters

`in`	*name*	A primitive name.

Returns

The corresponding primitive identifier, or zero on error.

Warning

Will **not** work if the primitive is not available.

6.4.3.5 ORDO_PUBLIC const prim_t∗ prims_by_type (enum PRIM_TYPE *type*)

Returns a list of available primitives of a given type.

Parameters

`in`	*type*	A primitive type.

Returns

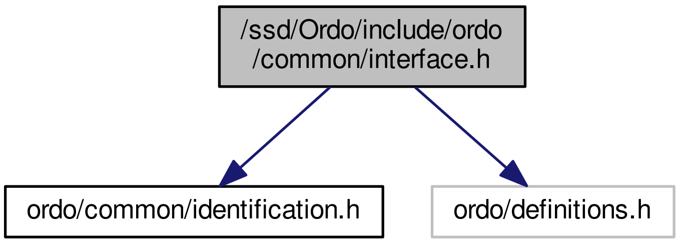
A zero-terminated list of such primitives.

6.5 /ssd/Ordo/include/ordo/common/interface.h File Reference

API.

```
#include "ordo/common/identification.h"
#include "ordo/definitions.h"
```

Include dependency graph for interface.h:



6.5.1 Detailed Description

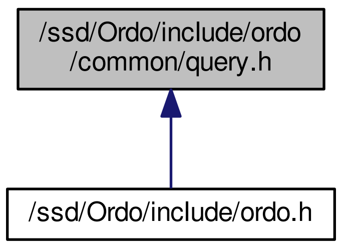
API. This header contains some preprocessor definitions which try to abstract compiler-specific features (such as packing, export mechanisms, hot code sections), and will be included in every other header in the library.

The definitions.h header is autogenerated by the build system, and depends on the architecture and the primitives built into the library.

6.6 /ssd/Ordo/include/ordo/common/query.h File Reference

Utility.

This graph shows which files directly or indirectly include this file:



Enumerations

- enum ORDO_QUERY { KEY_LEN_Q, BLOCK_SIZE_Q, DIGEST_LEN_Q, IV_LEN_Q }

6.6.1 Detailed Description

Utility. This header contains declarations for query codes used when querying information from primitives or other library objects. The query must return a length or something relating to size, which is why it is used for key lengths and related quantities.

The query codes provide a lightweight mechanism to select suitable parameters when using the library, and, alternatively, iterating over all possible parameters when necessary, while still retaining some level of abstraction in user code.

All query functions take the following arguments:

- query code (one of the codes defined here)
- suggested value (type `size_t`)

They have the following properties (where `X` stands for the relevant quantity of the concerned primitive, e.g. "valid key length for some block cipher"):

- `query(code, 0)` returns the **smallest** `X`.
- `query(code, (size_t)-1)` returns the **largest** `X`.
- if `query(code, n) == n` then `n` is an `X`.
- if `n` is less than the largest `X`, then `query(code, n) > n`.
- if `query(code, n + 1) == n` then `n` is the **largest** `X`. Otherwise `query(code, n + 1)` returns the next `X` (in increasing order).

The motivation for designing this interface in this fashion is to ensure no information loss occurs when user input is provided to the library. For instance, if the user provides a 160-bit key to AES, he will first query the block cipher key length using `KEY_LEN_Q`, suggesting a 160-bit key, and the AES cipher will correctly identify the ideal key length as 192 bits, and not 128 bits (which would lead to part of the key being unused). This allows software using the library to dynamically adjust to whatever cryptographic primitives are in use without compromising security.

6.6.2 Enumeration Type Documentation

6.6.2.1 enum ORDO_QUERY

Query codes used by the library. These end in `_Q`.

Enumerator

KEY_LEN_Q Query code to retrieve a key length.

Applicable to:

- block ciphers
- stream ciphers

BLOCK_SIZE_Q Query code to retrieve a block size.

Applicable to:

- block ciphers
- hash functions

Remarks

For hash functions, this is taken to be the input size of the message block to the compression function or, more formally, the amount of data required to trigger a compression function iteration. This may not be meaningful for all hash functions.

DIGEST_LEN_Q Query code to retrieve the default digest length of a hash function.

Remarks

The suggested value is ignored for this query code.

Applicable to:

- hash functions

IV_LEN_Q Query code to retrieve an initialization vector length.

Applicable to:

- block modes

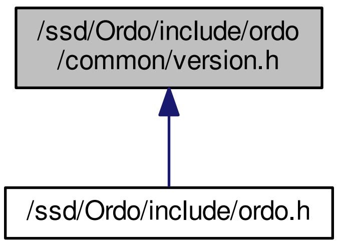
Remarks

As the block mode of operation primitives use block ciphers internally, the returned initialization vector length might depend on the block cipher (likely its block size).

6.7 /ssd/Ordo/include/ordo/common/version.h File Reference

Utility.

This graph shows which files directly or indirectly include this file:



Data Structures

- struct ORDO_VERSION

  Library version information.

Functions

- ORDO_PUBLIC const struct ORDO_VERSION ∗ ordo_version (void)

6.7.1 Detailed Description

Utility. This header exposes functionality relating to the library's version.

6.7.2 Function Documentation

6.7.2.1 ORDO_PUBLIC const struct **ORDO_VERSION**∗ ordo_version (void)

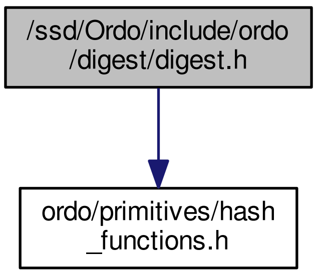
Returns an `ORDO_VERSION` structure for this library build.

6.8 /ssd/Ordo/include/ordo/digest/digest.h File Reference

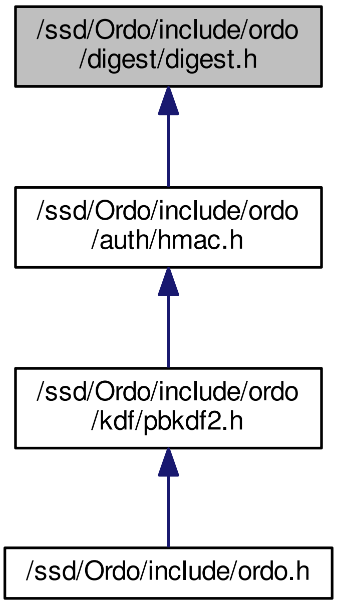
Module.

```
#include "ordo/primitives/hash_functions.h"
```

Include dependency graph for digest.h:



This graph shows which files directly or indirectly include this file:


/ssd/Ordo/include/ordo /digest/digest.h
/ssd/Ordo/include/ordo /auth/hmac.h
/ssd/Ordo/include/ordo /kdf/pbkdf2.h
/ssd/Ordo/include/ordo.h

Macros

- #define ordo_digest_init
- #define ordo_digest_update
- #define ordo_digest_final

Functions

- ORDO_PUBLIC size_t digest_length (prim_t hash)

6.8.1 Detailed Description

Module. Module to compute cryptographic digests, using cryptographic hash function primitives (as a pointer to a `HASH_FUNCTION` structure).

The advantage of using this digest module instead of the hash function abstraction layer is this keeps track of the hash function primitive for you within an opaque `DIGEST_CTX` context structure, simplifying code and making it less error-prone.

Usage snippet:

```
struct DIGEST_CTX ctx;

int err = digest_init(ctx, HASH_SHA256, 0);
if (err) printf("Got error!\n");

const char x[] = "Hello, world!";
digest_update(ctx, x, strlen(x));

unsigned char out[32];
digest_final(ctx, out);
// out = 315f5bdb76d0...
```

6.8.2 Macro Definition Documentation

6.8.2.1 #define ordo_digest_init

Initializes a digest context.

Parameters

`in,out`	*ctx*	A digest context.
`in`	*primitive*	A hash function primitive.
`in`	*params*	Hash function parameters.

Returns

`ORDO_SUCCESS` on success, else an error code.

Remarks

It is always valid to pass `0` into `params` if you don't want to use special features offered by a specific hash function.

Warning

It is **not** valid to initialize digest contexts more than once before calling `digest_final()`, this is because some algorithms may allocate additional memory depending on the parameters given.

6.8.2.2 #define ordo_digest_update

Feeds data into a digest context.

Parameters

`in,out`	*ctx*	An initialized digest context.
`in`	*in*	The data to feed into the context.
`in`	*in_len*	The length, in bytes, of the data.

Remarks

This function has the same property as `hash_update()`, in that it will concatenate the input buffers of successive calls.
It is valid to pass a zero-length buffer (`in_len == 0`), which will do nothing (if this is the case, `in` may be `0`).

6.8.2.3 #define ordo_digest_final

Finalizes a digest context, returning the digest of all the data fed into it through successive `digest_update()` calls.

Parameters

`in,out`	*ctx*	An initialized digest context.
`out`	*digest*	The output buffer for the digest.

Remarks

The `digest` buffer should be large enough to accomodate the digest - you can query the hash function's default digest length in bytes by the `digest_length()` function, note if you provided parameters which modify the hash function's digest length, then you should already know how long the digest will be (refer to the parameter's documentation).
Calling this function immediately after `digest_init()` is valid and will return the so-called "zero-length" digest, which is the digest of the input of length zero.

Warning

After this function returns, you may not call `digest_update()` again until you reinitialize the context using `digest_init()`.

6.8.3 Function Documentation

6.8.3.1 ORDO_PUBLIC size_t digest_length (prim_t *hash*)

Returns the default digest length of a hash function.

Parameters

`in`	*hash*	A hash function primitive.

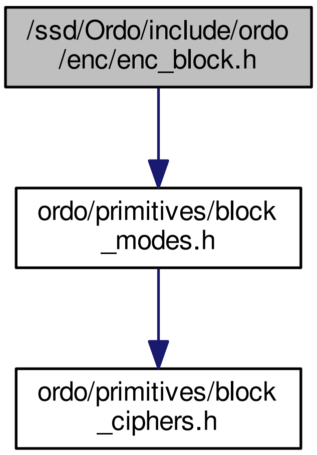
Returns

The length of the digest to be written in the `digest` parameter of `digest_final()`, if no parameters which affect output length were provided to `digest_init()`.

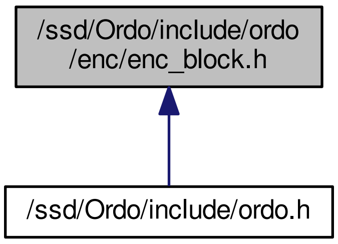
6.9 /ssd/Ordo/include/ordo/enc/enc_block.h File Reference

Module.

```
#include "ordo/primitives/block_modes.h"
```
Include dependency graph for enc_block.h:


/ssd/Ordo/include/ordo/enc/enc_block.h
ordo/primitives/block_modes.h
ordo/primitives/block_ciphers.h

This graph shows which files directly or indirectly include this file:



Functions

- ORDO_PUBLIC int enc_block_init (struct ENC_BLOCK_CTX ∗ctx, const void ∗key, size_t key_len, const void ∗iv, size_t iv_len, int direction, prim_t cipher, const void ∗cipher_params, prim_t mode, const void ∗mode_-params)
- ORDO_PUBLIC void enc_block_update (struct ENC_BLOCK_CTX ∗ctx, const void ∗in, size_t in_len, void ∗out, size_t ∗out_len)
- ORDO_PUBLIC int enc_block_final (struct ENC_BLOCK_CTX ∗ctx, void ∗out, size_t ∗out_len)
- ORDO_PUBLIC size_t enc_block_key_len (prim_t cipher, size_t key_len)
- ORDO_PUBLIC size_t enc_block_iv_len (prim_t cipher, prim_t mode, size_t iv_len)

6.9.1 Detailed Description

Module. Module to encrypt plaintext and decrypt ciphertext with different block ciphers and modes of operation. Note it is always possible to skip this API and directly use the lower-level functions available in the individual mode of operation headers, but this interface abstracts away some of the more boilerplate details and so should be preferred.

If you wish to use the lower level API, you will need to manage your block cipher contexts yourself, which can give more flexibility in some particular cases but is often unnecessary.

The padding algorithm for modes of operation which use padding is PKCS7 (RFC 5652), which appends N bytes of value `N`, where `N` is the number of padding bytes required, in bytes (between 1 and the block cipher's block size).

6.9.2 Function Documentation

6.9.2.1 ORDO_PUBLIC int enc_block_init (struct ENC_BLOCK_CTX ∗ *ctx*, const void ∗ *key*, size_t *key_len*, const void ∗ *iv*, size_t *iv_len*, int *direction*, prim_t *cipher*, const void ∗ *cipher_params*, prim_t *mode*, const void ∗ *mode_params*)

Initializes a block encryption context.

Parameters

`in,out`	*ctx*	A block encryption context.
`in`	*key*	The cryptographic key to use.

in	*key_len*	The length, in bytes, of the key.
in	*iv*	The initialization vector to use.
in	*iv_len*	The length, in bytes, of the IV.
in	*direction*	1 for encryption, 0 for decryption.
in	*cipher*	The block cipher primitive to use.
in	*cipher_params*	Block cipher specific parameters.
in	*mode*	The block mode primitive to use.
in	*mode_params*	Mode of operation specific parameters.

Returns

`ORDO_SUCCESS` on success, else an error code.

Remarks

The initialization vector may be 0, if the mode of operation does not require one - consult the documentation of the mode to know what it expects.

6.9.2.2 ORDO_PUBLIC void enc_block_update (struct ENC_BLOCK_CTX ∗ *ctx,* const void ∗ *in,* size_t *in_len,* void ∗ *out,* size_t ∗ *out_len*)

Encrypts or decrypts a data buffer.

Parameters

in,out	*ctx*	A block encryption context.
in	*in*	The plaintext or ciphertext buffer.
in	*in_len*	Length, in bytes, of the input buffer.
out	*out*	The ciphertext or plaintext buffer.
out	*out_len*	The number of bytes written to `out`.

Remarks

This function might not immediately encrypt all data fed into it, and will write the amount of input bytes effectively encrypted in `out_len`. However, it does **not** mean that the plaintext left over has been "rejected" or "ignored". It **has** been taken into account but the corresponding ciphertext simply can't be produced until more data is fed into it (or until `enc_block_final()` is called).
Some modes of operation always process all input data, in which case they may allow `out_len` to be 0 - check the documentation of the relevant mode of operation.

6.9.2.3 ORDO_PUBLIC int enc_block_final (struct ENC_BLOCK_CTX ∗ *ctx,* void ∗ *out,* size_t ∗ *out_len*)

Finalizes a block encryption context.

Parameters

in,out	*ctx*	A block encryption context.
out	*out*	The ciphertext or plaintext buffer.
out	*out_len*	The number of bytes written to `out`.

Returns

`ORDO_SUCCESS` on success, else an error code.

Remarks

The function will return up to one block size's worth of data and may not return any data at all. For example, for the CBC mode of operation (with padding on), this function will, for encryption, append padding bytes to the final plaintext block, and return the padding block, whereas for decryption, it will take that padding block and strip the padding off, returning the last few bytes of plaintext.
Some modes of operation always process all input data, in which case they may allow `out_len` to be 0 - check the documentation of the relevant mode of operation.

6.9.2.4 ORDO_PUBLIC size_t enc_block_key_len (prim_t *cipher,* size_t *key_len*)

Queries the key length of a block cipher.

Parameters

`in`	*cipher*	A block cipher primitive.
`in`	*key_len*	A suggested key length.

Returns

A suitable key length to use for this cipher.

6.9.2.5 ORDO_PUBLIC size_t enc_block_iv_len (prim_t *cipher,* prim_t *mode,* size_t *iv_len*)

Queries the IV length of a block mode and block cipher.

Parameters

`in`	*cipher*	A block cipher primitive.
`in`	*mode*	A block mode primitive.
`in`	*iv_len*	A suggested IV length.

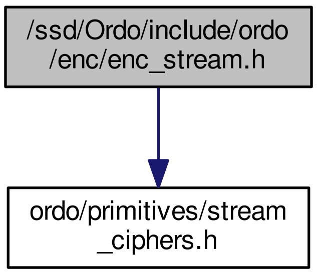
Returns

A suitable IV length to use for this mode and cipher.

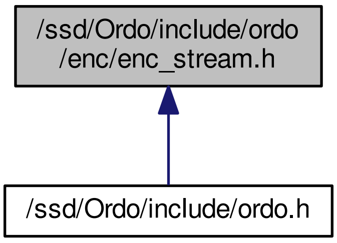
6.10 /ssd/Ordo/include/ordo/enc/enc_stream.h File Reference

Module.

```
#include "ordo/primitives/stream_ciphers.h"
```
Include dependency graph for enc_stream.h:


/ssd/Ordo/include/ordo/enc/enc_stream.h
ordo/primitives/stream_ciphers.h

This graph shows which files directly or indirectly include this file:



Macros

- #define ordo_enc_stream_init
- #define ordo_enc_stream_update
- #define ordo_enc_stream_final

Functions

- ORDO_PUBLIC size_t enc_stream_key_len (prim_t cipher, size_t key_len)

6.10.1 Detailed Description

Module. Interface to encrypt plaintext and decrypt ciphertext with various stream ciphers.

6.10.2 Macro Definition Documentation

6.10.2.1 #define ordo_enc_stream_init

Initializes a stream encryption context.

Parameters

`in,out`	*ctx*	A stream encryption context.
`in`	*key*	The cryptographic key to use.
`in`	*key_size*	The size, in bytes, of the key.
`in`	*params*	Stream cipher specific parameters.

Returns

`ORDO_SUCCESS` on success, else an error code.

6.10.2.2 #define ordo_enc_stream_update

Encrypts or decrypts a data buffer.

Parameters

`in,out`	*ctx*	A stream encryption context.
`in,out`	*buffer*	The plaintext or ciphertext buffer.
`in`	*len*	Number of bytes to read from the buffer.

Warning

By nature, stream ciphers encrypt and decrypt data the same way, in other words, if you encrypt data twice, you will get back the original data.

Remarks

Stream encryption is always done in place by design.

6.10.2.3 #define ordo_enc_stream_final

Finalizes a stream encryption context.

Parameters

`in,out`	*ctx*	A stream encryption context.

6.10.3 Function Documentation

6.10.3.1 ORDO_PUBLIC size_t enc_stream_key_len (prim_t *cipher,* size_t *key_len*)

Queries a stream cipher for its key length.

Parameters

`in`	*cipher*	The stream cipher to query.
`in`	*key_len*	A suggested key length.

Returns

`key_len` if and only if `key_len` is a valid key length for this stream cipher. Otherwise, returns the nearest valid key length greater than `key_len`. However, if no such key length exists, it will return the largest key length admitted by the stream cipher.

6.11 /ssd/Ordo/include/ordo/internal/alg.h File Reference

Internal, Utility

Macros

- #define bits(n)
- #define bytes(n)
- #define offset(ptr, len)

Functions

- ORDO_HIDDEN int pad_check (const unsigned char ∗buffer, uint8_t padding)
- ORDO_HIDDEN void xor_buffer (void ∗dst, const void ∗src, size_t len)
- ORDO_HIDDEN void inc_buffer (unsigned char ∗buffer, size_t len)

6.11.1 Detailed Description

Internal, Utility This header provides various utility functions which are used by some library modules and a few convenience macros. It is not to be used outside the library, and this is enforced by an include guard. If you really must access it, define the `ORDO_INTERNAL_ACCESS` token before including it.

6.11.2 Macro Definition Documentation

6.11.2.1 #define bits(*n*)

Converts bits into bytes (rounded down to the nearest byte boundary).

Remarks

As an example, `bits(256)` returns 32 (bytes).

6.11.2.2 #define bytes(*n*)

Converts bytes into bits (as a multiple of 8 bits).

Remarks

As an example, `bytes(32)` returns 256 (bits).

6.11.2.3 #define offset(*ptr,* *len*)

Computes a byte-based offset.

Parameters

in	*ptr*	Base pointer.
in	*len*	Offset (in bytes).

Returns

The pointer exactly `len` bytes after `ptr`.

Remarks

This is a dangerous macro, in the sense it can lead to accessing data at unaligned addresses, and so should be used carefully.

6.11.3 Function Documentation

6.11.3.1 ORDO_HIDDEN int pad_check (const unsigned char ∗ *buffer,* uint8_t *padding*)

Checks whether a buffer conforms to PKCS padding.

Parameters

`in`	*buffer*	The buffer to check, starting at the first padding byte.
`in`	*padding*	The padding byte value to check this buffer against (between 1 and 255).

Returns

`1` if the buffer is valid, `0` otherwise.

Remarks

PKCS padding is defined as appending `N` bytes of padding data at the end of the message, each with binary value `N`, with `N` between `1` and the block size of the block cipher used such that the length of the message plus `N` is a multiple of the block cipher's block size.

Warning

This implies the buffer must be at least `padding` bytes long.

6.11.3.2 ORDO_HIDDEN void xor_buffer (void ∗ *dst,* const void ∗ *src,* size_t *len*)

Performs a bitwise exclusive-or of one buffer onto another.

Parameters

`in,out`	*dst*	The destination buffer.
`in`	*src*	The source buffer.
`in`	*len*	The number of bytes to process.

Remarks

This is conceptually equivalent to `dst ^= src`.

Warning

The source and destination buffers may be the same (in which case the buffer will contain `len` zeroes), but otherwise they cannot overlap.

6.11.3.3 ORDO_HIDDEN void inc_buffer (unsigned char ∗ *buffer,* size_t *len*)

Increments a buffer of arbitrary length, as though it were a `len` byte integer stored as a byte array.

Parameters

`in,out`	*buffer*	The buffer to increment in-place.
`in`	*len*	The size, in bytes, of the buffer.

Remarks

Carry propagation is done left-to-right.

6.12 /ssd/Ordo/include/ordo/internal/implementation.h File Reference

Internal, API

6.12.1 Detailed Description

Internal, API This header contains some compiler-dependent macros, for defining various semantics which the users of this library should not depend on. It is an error to include this header in any code outside the Ordo implementation.

Every source file will include this header.

6.13 /ssd/Ordo/include/ordo/internal/sys.h File Reference

Internal, Utility

6.13.1 Detailed Description

Internal, Utility This header provides system-dependent functionality and is internal to the library. It probably shouldn't ever be used from outside the library.

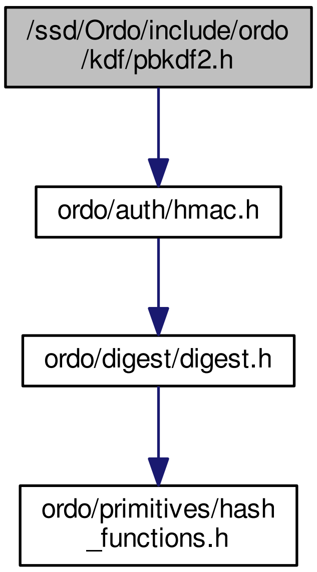
See `alg.h` about internal headers.

6.14 /ssd/Ordo/include/ordo/kdf/pbkdf2.h File Reference

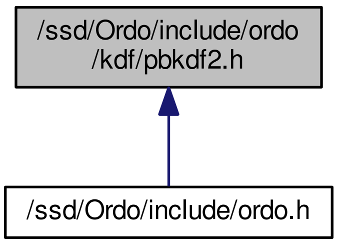
Module.

```
#include "ordo/auth/hmac.h"
```

Include dependency graph for pbkdf2.h:


/ssd/Ordo/include/ordo/kdf/pbkdf2.h
ordo/auth/hmac.h
ordo/digest/digest.h
ordo/primitives/hash_functions.h

This graph shows which files directly or indirectly include this file:



Functions

- ORDO_PUBLIC int kdf_pbkdf2 (prim_t hash, const void ∗params, const void ∗password, size_t password_-len, const void ∗salt, size_t salt_len, size_t iterations, void ∗out, size_t out_len)

6.14.1 Detailed Description

Module. Module for the PBKDF2 algorithm (Password-Based Key Derivation Function v2) which combines a keyed PRF (here HMAC) with a salt in order to generate secure cryptographic keys, as per RFC 2898. Also features a variable iteration count (work factor) to help thwart brute-force attacks.

Unlike most other cryptographic modules, the PBKDF2 API does not follow the traditional init/update/final pattern but is a context-free function as its inputs are almost always known in advance. As such this module does not benefit from the use of contexts.

6.14.2 Function Documentation

6.14.2.1 ORDO_PUBLIC int kdf_pbkdf2 (prim_t *hash*, const void ∗ *params*, const void ∗ *password*, size_t *password_len*, const void ∗ *salt*, size_t *salt_len*, size_t *iterations*, void ∗ *out*, size_t *out_len*)

Derives a key using PBKDF2.

Parameters

`in`	*hash*	The hash function to use (the PRF used will be an instantiation of HMAC with it)
`in`	*params*	Hash-specific parameters.
`in`	*password*	The password to derive a key from.
`in`	*password_len*	The length in bytes of the password.
`in`	*salt*	The cryptographic salt to use.
`in`	*salt_len*	The length in bytes of the salt.
`in`	*iterations*	The number of PBKDF2 iterations to use.
`out`	*out*	The output buffer for the derived key.
`in`	*out_len*	The required length, in bytes, of the key.

Returns

`ORDO_SUCCESS` on success, else an error code.

Warning

There is a maximum output length of 2^32 - 1 multiplied by the digest length of the chosen hash function, but it is unlikely to be reached as derived keys are generally no longer than a few hundred bits. Reaching the limit will result in an `ORDO_ARG` error code. This limit is mandated by the PBKDF2 specification.

Remarks

The `out` buffer should be at least `out_len` bytes long.

Warning

Do not use hash parameters which modify the output length or this function's behavior is undefined (use `out_len` instead).

6.15 /ssd/Ordo/include/ordo/misc/endianness.h File Reference

Utility.

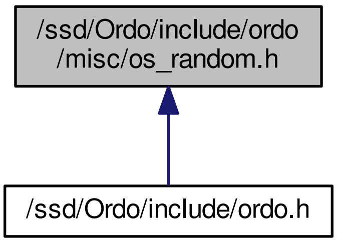
6.15.1 Detailed Description

Utility. This header provides endianness functionality. You may use it freely as it has a stable API and is public. Only supports little/big endian for now.

6.16 /ssd/Ordo/include/ordo/misc/os_random.h File Reference

Module.

This graph shows which files directly or indirectly include this file:



Functions

- ORDO_PUBLIC int os_random (void ∗out, size_t len)
- ORDO_PUBLIC int os_secure_random (void ∗out, size_t len)

6.16.1 Detailed Description

Module. Exposes the OS CSPRNG (Cryptographically Secure PseudoRandom Number Generator) interface, which is basically a cross-platform wrapper to the OS-provided entropy pool. To learn more about how it is implemented, go to the source code or find out what facilities your operating system provides for entropy gathering.

6.16.2 Function Documentation

6.16.2.1 ORDO_PUBLIC int os_random (void ∗ *out,* size_t *len*)

Generates cryptographically secure pseudorandom numbers.

Parameters

`out`	*out*	The destination buffer.
`in`	*len*	The number of bytes to generate.

Returns

`ORDO_SUCCESS` on success, else an error code.

Remarks

This function uses the CSPRNG provided by your operating system.
If the platform does not provide this feature, this function will always fail with the `ORDO_FAIL` error message, and any data in the buffer should be discarded as indeterminate.

6.16.2.2 ORDO_PUBLIC int os_secure_random (void ∗ *out,* size_t *len*)

Generates cryptographically secure pseudorandom numbers, the function will make a best effort attempt to access the operating system entropy pool and so, ideally, should return exactly `len` bytes of entropy, whereas the `os_random()` function need only return enough entropy for the output stream to be computationally indistinguishable from a non-random stream. However, keep in mind that this function is **not required** to behave as such.

Parameters

`out`	*out*	The destination buffer.
`in`	*len*	The number of bytes to generate.

Returns

`ORDO_SUCCESS` on success, else an error code.

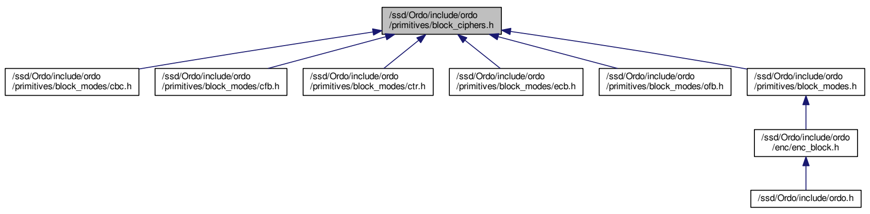
Warning

If your platform doesn't provide this feature, this function will fall back to `os_random()` (there is no way to know whether this feature is available, this is by design).
You should not need to know whether this feature is available, as this function will make a "best effort" attempt to obtain entropy from the operating system - you should use this function for high security uses such as generating private keys (it has a high cost so don't use it for e.g. nonces and initialization vectors).

6.17 /ssd/Ordo/include/ordo/primitives/block_ciphers.h File Reference

Abstraction Layer.

This graph shows which files directly or indirectly include this file:


/ssd/Ordo/include/ordo /primitives/block_ciphers.h
/ssd/Ordo/include/ordo /primitives/block_modes/cbc.h
/ssd/Ordo/include/ordo /primitives/block_modes/cfb.h
/ssd/Ordo/include/ordo /primitives/block_modes/ctr.h
/ssd/Ordo/include/ordo /primitives/block_modes/ecb.h
/ssd/Ordo/include/ordo /primitives/block_modes/ofb.h
/ssd/Ordo/include/ordo /primitives/block_modes.h
/ssd/Ordo/include/ordo /enc/enc_block.h
/ssd/Ordo/include/ordo.h

Functions

- ORDO_PUBLIC int block_init (struct BLOCK_STATE ∗state, const void ∗key, size_t key_len, prim_t primitive, const void ∗params)
- ORDO_PUBLIC void block_forward (const struct BLOCK_STATE ∗state, void ∗block)
- ORDO_PUBLIC void block_inverse (const struct BLOCK_STATE ∗state, void ∗block)
- ORDO_PUBLIC void block_final (struct BLOCK_STATE ∗state)
- ORDO_PUBLIC size_t block_query (prim_t primitive, int query, size_t value)

6.17.1 Detailed Description

Abstraction Layer. This abstraction layer declares all the block ciphers, and also makes them available to higher level modules. This does not actually do encryption at all but simply abstracts block cipher permutations, the encryption modules are in the `enc` folder: `enc_block.h`.

6.17.2 Function Documentation

6.17.2.1 ORDO_PUBLIC int block_init (struct BLOCK_STATE ∗ *state*, const void ∗ *key*, size_t *key_len*, prim_t *primitive*, const void ∗ *params*)

Initializes a block cipher state.

Parameters

in,out	*state*	A block cipher state.
in	*key*	The cryptographic key to use.
in	*key_len*	The length, in bytes, of the key.
in	*primitive*	A block cipher primitive.
in	*params*	Block cipher specific parameters.

Returns

ORDO_SUCCESS on success, else an error code.

6.17.2.2 ORDO_PUBLIC void block_forward (const struct BLOCK_STATE ∗ *state*, void ∗ *block*)

Applies a block cipher's forward permutation.

Parameters

in	*state*	An initialized block cipher state.
in,out	*block*	A data block to permute.

Remarks

The block should be the size of the block cipher's block size.

6.17.2.3 ORDO_PUBLIC void block_inverse (const struct BLOCK_STATE ∗ *state*, void ∗ *block*)

Applies a block cipher's inverse permutation.

Parameters

in	*state*	An initialized block cipher state.
in,out	*block*	A data block to permute.

Remarks

The block should be the size of the block cipher's block size.

6.17.2.4 ORDO_PUBLIC void block_final (struct BLOCK_STATE ∗ *state*)

Finalizes a block cipher state.

Parameters

in,out	*state*	A block cipher state.

6.17.2.5 ORDO_PUBLIC size_t block_query (prim_t *primitive*, int *query*, size_t *value*)

Queries a block cipher for suitable parameters.

Parameters

`in`	*primitive*	A block cipher primitive.
`in`	*query*	A query code.
`in`	*value*	A suggested value.

Returns

A suitable parameter of type `query` based on `value`.

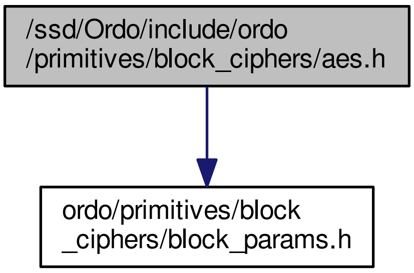
See Also

query.h

6.18 /ssd/Ordo/include/ordo/primitives/block_ciphers/aes.h File Reference

Primitive.

`#include "ordo/primitives/block_ciphers/block_params.h"`
Include dependency graph for aes.h:



Functions

- ORDO_PUBLIC int aes_init (struct AES_STATE ∗state, const void ∗key, size_t key_len, const struct AES_PARAMS ∗params)
- ORDO_PUBLIC void aes_forward (const struct AES_STATE ∗state, uint8_t ∗block)
- ORDO_PUBLIC void aes_inverse (const struct AES_STATE ∗state, uint8_t ∗block)
- ORDO_PUBLIC void aes_final (struct AES_STATE ∗state)
- ORDO_PUBLIC size_t aes_query (int query, size_t value)

6.18.1 Detailed Description

Primitive. AES (Advanced Encryption Standard) is a block cipher. It has a 128-bit block size and three possible key sizes, namely 128, 192 and 256 bits. It is based on the Rijndael cipher and was selected as the official encryption standard on November 2001 (FIPS 197).

6.18.2 Function Documentation

6.18.2.1 ORDO_PUBLIC int aes_init (struct AES_STATE ∗ *state,* const void ∗ *key,* size_t *key_len,* const struct AES_PARAMS ∗ *params*)

See Also

`block_init()`

Return values

ORDO_KEY_LEN	if the key length is not 16, 24, or 32 (bytes).
ORDO_ARG	if parameters were provided and requested zero rounds or more than 20 rounds.

6.18.2.2 ORDO_PUBLIC void aes_forward (const struct AES_STATE ∗ *state,* uint8_t ∗ *block*)

See Also

`block_forward()`

6.18.2.3 ORDO_PUBLIC void aes_inverse (const struct AES_STATE ∗ *state,* uint8_t ∗ *block*)

See Also

`block_inverse()`

6.18.2.4 ORDO_PUBLIC void aes_final (struct AES_STATE ∗ *state*)

See Also

`block_final()`

6.18.2.5 ORDO_PUBLIC size_t aes_query (int *query,* size_t *value*)

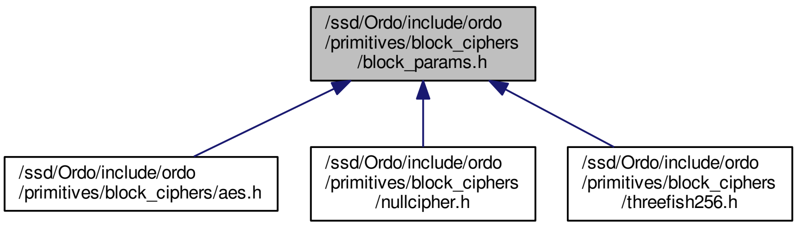
See Also

`block_query()`

6.19 /ssd/Ordo/include/ordo/primitives/block_ciphers/block_params.h File Reference

Primitive Parameters.

This graph shows which files directly or indirectly include this file:



Data Structures

- struct THREEFISH256_PARAMS

  Threefish-256 block cipher parameters.
- struct AES_PARAMS

  AES block cipher parameters.

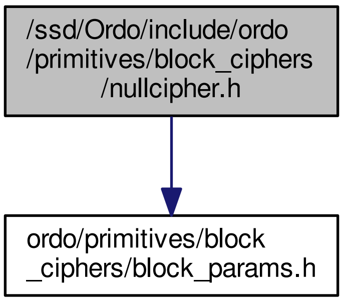
6.19.1 Detailed Description

Primitive Parameters. This header contains parameter structures for all block ciphers.

6.20 /ssd/Ordo/include/ordo/primitives/block_ciphers/nullcipher.h File Reference

Primitive.

```
#include "ordo/primitives/block_ciphers/block_params.h"
```
Include dependency graph for nullcipher.h:


/ssd/Ordo/include/ordo/primitives/block_ciphers/nullcipher.h
ordo/primitives/block_ciphers/block_params.h

Functions

- ORDO_PUBLIC int nullcipher_init (struct NULLCIPHER_STATE ∗state, const void ∗key, size_t key_len, const void ∗params)
- ORDO_PUBLIC void nullcipher_forward (const struct NULLCIPHER_STATE ∗state, void ∗block)
- ORDO_PUBLIC void nullcipher_inverse (const struct NULLCIPHER_STATE ∗state, void ∗block)
- ORDO_PUBLIC void nullcipher_final (struct NULLCIPHER_STATE ∗state)
- ORDO_PUBLIC size_t nullcipher_query (int query, size_t value)

6.20.1 Detailed Description

Primitive. This cipher is only used to debug the library and does absolutely nothing, in other words, it is the identity permutation. It accepts no key, that is it only accepts a key length of zero bytes. Its block size is 128 bits and is arbitrarily chosen.

6.20.2 Function Documentation

6.20.2.1 ORDO_PUBLIC int nullcipher_init (struct NULLCIPHER_STATE ∗ *state*, const void ∗ *key*, size_t *key_len*, const void ∗ *params*)

See Also

`block_init()`

Return values

ORDO_KEY_LEN	if the key length is not zero.

6.20.2.2 ORDO_PUBLIC void nullcipher_forward (const struct NULLCIPHER_STATE ∗ *state*, void ∗ *block*)

See Also

`block_forward()`

6.20.2.3 ORDO_PUBLIC void nullcipher_inverse (const struct NULLCIPHER_STATE ∗ *state*, void ∗ *block*)

See Also

`block_inverse()`

6.20.2.4 ORDO_PUBLIC void nullcipher_final (struct NULLCIPHER_STATE ∗ *state*)

See Also

`block_final()`

6.20.2.5 ORDO_PUBLIC size_t nullcipher_query (int *query*, size_t *value*)

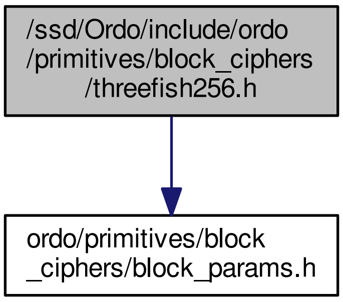
See Also

`block_query()`

6.21 /ssd/Ordo/include/ordo/primitives/block_ciphers/threefish256.h File Reference

Primitive.

`#include "ordo/primitives/block_ciphers/block_params.h"`
Include dependency graph for threefish256.h:



Functions

- ORDO_PUBLIC int threefish256_init (struct THREEFISH256_STATE ∗state, const uint64_t ∗key, size_t key-_len, const struct THREEFISH256_PARAMS ∗params)
- ORDO_PUBLIC void threefish256_forward (const struct THREEFISH256_STATE ∗state, uint64_t ∗block)
- ORDO_PUBLIC void threefish256_inverse (const struct THREEFISH256_STATE ∗state, uint64_t ∗block)
- ORDO_PUBLIC void threefish256_final (struct THREEFISH256_STATE ∗state)
- ORDO_PUBLIC size_t threefish256_query (int query, size_t value)

6.21.1 Detailed Description

Primitive. Threefish-256 is a block cipher with a 256-bit block size and a 256-bit key size. It also has an optional 128-bit tweak, which can be set through the cipher parameters.

The Threefish ciphers were originally designed to be used as a building block for the Skein hash function family.

6.21.2 Function Documentation

6.21.2.1 ORDO_PUBLIC int threefish256_init (struct THREEFISH256_STATE ∗ *state*, const uint64_t ∗ *key*, size_t *key_len*, const struct THREEFISH256_PARAMS ∗ *params*)

See Also

`block_init()`

Return values

ORDO_KEY_LEN	if the key length is not 32 (bytes).

6.21.2.2 ORDO_PUBLIC void threefish256_forward (const struct THREEFISH256_STATE ∗ *state*, uint64_t ∗ *block*)

See Also

`block_forward()`

6.21.2.3 ORDO_PUBLIC void threefish256_inverse (const struct THREEFISH256_STATE ∗ *state*, uint64_t ∗ *block*)

See Also

`block_inverse()`

6.21.2.4 ORDO_PUBLIC void threefish256_final (struct THREEFISH256_STATE ∗ *state*)

See Also

`block_final()`

6.21.2.5 ORDO_PUBLIC size_t threefish256_query (int *query*, size_t *value*)

See Also

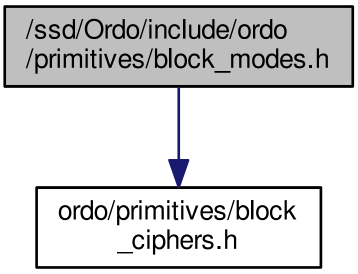
`block_query()`

6.22 /ssd/Ordo/include/ordo/primitives/block_modes.h File Reference

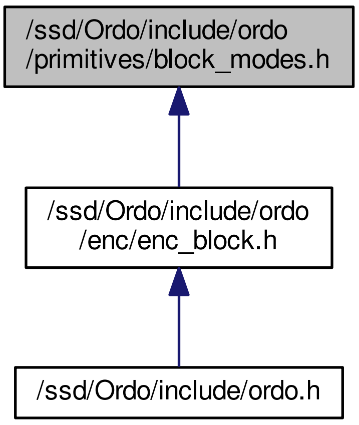
Abstraction Layer.

`#include "ordo/primitives/block_ciphers.h"`

Include dependency graph for block_modes.h:


/ssd/Ordo/include/ordo/primitives/block_modes.h
ordo/primitives/block_ciphers.h

This graph shows which files directly or indirectly include this file:


/ssd/Ordo/include/ordo /primitives/block_modes.h
/ssd/Ordo/include/ordo /enc/enc_block.h
/ssd/Ordo/include/ordo.h

Functions

- ORDO_PUBLIC int block_mode_init (struct BLOCK_MODE_STATE ∗state, struct BLOCK_STATE ∗cipher_-state, const void ∗iv, size_t iv_len, int direction, prim_t primitive, const void ∗params)
- ORDO_PUBLIC void block_mode_update (struct BLOCK_MODE_STATE ∗state, struct BLOCK_STATE ∗cipher_state, const void ∗in, size_t in_len, void ∗out, size_t ∗out_len)
- ORDO_PUBLIC int block_mode_final (struct BLOCK_MODE_STATE ∗state, struct BLOCK_STATE ∗cipher-_state, void ∗out, size_t ∗out_len)
- ORDO_PUBLIC size_t block_mode_query (prim_t mode, prim_t cipher, int query, size_t value)

6.22.1 Detailed Description

Abstraction Layer. This abstraction layer declares all the block modes of operation in the library, making them available to higher level modules.

Note "block cipher mode of operation" is shortened to "block mode" in code and documentation to minimize noise and redundancy.

6.22.2 Function Documentation

6.22.2.1 ORDO_PUBLIC int block_mode_init (struct BLOCK_MODE_STATE ∗ *state,* struct BLOCK_STATE ∗ *cipher_state,* const void ∗ *iv,* size_t *iv_len,* int *direction,* prim_t *primitive,* const void ∗ *params*)

Initializes a block mode state.

Parameters

`in,out`	*state*	A block mode state.
`in`	*cipher_state*	A block cipher state.

in	*iv*	The initialization vector to use.
in	*iv_len*	The length, in bytes, of the IV.
in	*direction*	1 for encryption, 0 for decryption.
in	*primitive*	A block mode primitive.
in	*params*	Block mode specific parameters.

Returns

ORDO_SUCCESS on success, else an error code.

6.22.2.2 ORDO_PUBLIC void block_mode_update (struct BLOCK_MODE_STATE ∗ *state*, struct BLOCK_STATE ∗ *cipher_state*, const void ∗ *in*, size_t *in_len*, void ∗ *out*, size_t ∗ *out_len*)

Encrypts or decrypts a buffer.

Parameters

in,out	*state*	A block mode state.
in	*cipher_state*	A block cipher state.
in	*in*	The input buffer.
in	*in_len*	The length, in bytes, of the input.
out	*out*	The output buffer.
out	*out_len*	A pointer to an integer to which to write the number of output bytes that can be returned to the user. Remaining input data has **not** been ignored and should not be passed again.

Warning

In-place encryption (by letting `in` be the same buffer as `out`) is always supported, however the buffers may **not** overlap.

6.22.2.3 ORDO_PUBLIC int block_mode_final (struct BLOCK_MODE_STATE ∗ *state*, struct BLOCK_STATE ∗ *cipher_state*, void ∗ *out*, size_t ∗ *out_len*)

Finalizes a block mode state.

Parameters

in,out	*state*	A block mode state.
in	*cipher_state*	A block cipher state.
out	*out*	The output buffer.
out	*out_len*	A pointer to an integer to which to store the number of bytes written to `out`.

Returns

ORDO_SUCCESS on success, else an error code.

Remarks

This function will return any input bytes which were not returned by calls to `block_mode_update()` (in the correct order).

6.22.2.4 ORDO_PUBLIC size_t block_mode_query (prim_t *mode*, prim_t *cipher*, int *query*, size_t *value*)

Queries a block mode for suitable parameters.

Parameters

in	*mode*	A block mode primitive.
in	*cipher*	A block cipher primitive.
in	*query*	A query code.
in	*value*	A suggested value.

Returns

A suitable parameter of type `query` based on `value`.

See Also

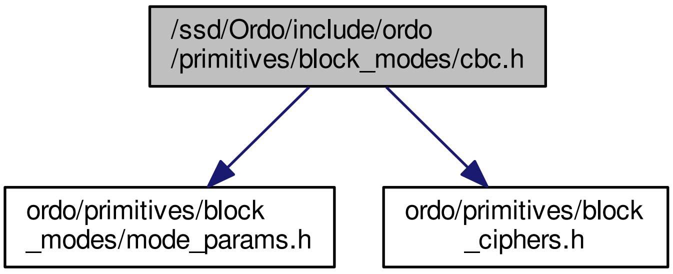
query.h

6.23 /ssd/Ordo/include/ordo/primitives/block_modes/cbc.h File Reference

Primitive.

```
#include "ordo/primitives/block_modes/mode_params.h"
#include "ordo/primitives/block_ciphers.h"
```

Include dependency graph for cbc.h:



Functions

- ORDO_PUBLIC int cbc_init (struct CBC_STATE ∗state, struct BLOCK_STATE ∗cipher_state, const void ∗iv, size_t iv_len, int dir, const struct CBC_PARAMS ∗params)
- ORDO_PUBLIC void cbc_update (struct CBC_STATE ∗state, struct BLOCK_STATE ∗cipher_state, const unsigned char ∗in, size_t in_len, unsigned char ∗out, size_t ∗out_len)
- ORDO_PUBLIC int cbc_final (struct CBC_STATE ∗state, struct BLOCK_STATE ∗cipher_state, unsigned char ∗out, size_t ∗out_len)
- ORDO_PUBLIC size_t cbc_query (int cipher, int query, size_t value)

6.23.1 Detailed Description

Primitive. The CBC mode divides the input message into blocks of the cipher's block size, and encrypts them in a sequential fashion, where each block depends on the previous one (and the first block depends on the initialization vector). If the input message's length is not a multiple of the cipher's block size, a padding mechanism is enabled by default which will pad the message to the correct length (and remove the extra data upon decryption). If padding is explicitly disabled through the mode of operation's parameters, the input's length must be a multiple of the cipher's block size.

If padding is enabled, `cbc_final()` requires a valid pointer to be passed in the `outlen` parameter and will always return a full blocksize of data, containing the last few ciphertext bytes containing the padding information.

If padding is disabled, `outlen` is also required, and will return the number of unprocessed plaintext bytes in the context. If this is any value other than zero, the function will also fail with `ORDO_LEFTOVER`.

6.23.2 Function Documentation

6.23.2.1 ORDO_PUBLIC int cbc_init (struct CBC_STATE ∗ *state,* struct BLOCK_STATE ∗ *cipher_state,* const void ∗ *iv,* size_t *iv_len,* int *dir,* const struct CBC_PARAMS ∗ *params*)

See Also

`block_mode_init()`

6.23.2.2 ORDO_PUBLIC void cbc_update (struct CBC_STATE ∗ *state,* struct BLOCK_STATE ∗ *cipher_state,* const unsigned char ∗ *in,* size_t *in_len,* unsigned char ∗ *out,* size_t ∗ *out_len*)

See Also

`block_mode_update()`

6.23.2.3 ORDO_PUBLIC int cbc_final (struct CBC_STATE ∗ *state,* struct BLOCK_STATE ∗ *cipher_state,* unsigned char ∗ *out,* size_t ∗ *out_len*)

See Also

`block_mode_final()`

6.23.2.4 ORDO_PUBLIC size_t cbc_query (int *cipher,* int *query,* size_t *value*)

See Also

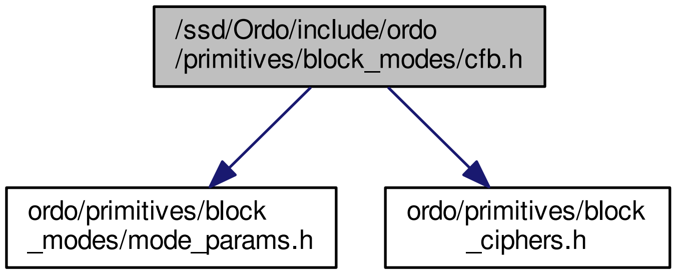
`block_mode_query()`

6.24 /ssd/Ordo/include/ordo/primitives/block_modes/cfb.h File Reference

Primitive.

```
#include "ordo/primitives/block_modes/mode_params.h"
#include "ordo/primitives/block_ciphers.h"
```

Include dependency graph for cfb.h:



Functions

- ORDO_PUBLIC int cfb_init (struct CFB_STATE ∗state, struct BLOCK_STATE ∗cipher_state, const void ∗iv, size_t iv_len, int dir, const void ∗params)
- ORDO_PUBLIC void cfb_update (struct CFB_STATE ∗state, struct BLOCK_STATE ∗cipher_state, const unsigned char ∗in, size_t in_len, unsigned char ∗out, size_t ∗out_len)
- ORDO_PUBLIC int cfb_final (struct CFB_STATE ∗state, struct BLOCK_STATE ∗cipher_state, unsigned char ∗out, size_t ∗out_len)
- ORDO_PUBLIC size_t cfb_query (int cipher, int query, size_t value)

6.24.1 Detailed Description

Primitive. The CFB mode generates a keystream by repeatedly encrypting an initialization vector and mixing in the plaintext, effectively turning a block cipher into a stream cipher. As such, CFB mode requires no padding, and the ciphertext size will always be equal to the plaintext size.

Note that the CFB keystream depends on the plaintext fed into it, as opposed to OFB mode. This also means the block cipher's inverse permutation is never used.

`cfb_final()` accepts 0 as an argument for `outlen`, since by design the CFB mode of operation does not produce any final data. However, if a valid pointer is passed, its value will be set to zero as expected.

6.24.2 Function Documentation

6.24.2.1 ORDO_PUBLIC int cfb_init (struct CFB_STATE ∗ *state,* struct BLOCK_STATE ∗ *cipher_state,* const void ∗ *iv,* size_t *iv_len,* int *dir,* const void ∗ *params*)

See Also

`block_mode_init()`

6.24.2.2 ORDO_PUBLIC void cfb_update (struct CFB_STATE ∗ *state,* struct BLOCK_STATE ∗ *cipher_state,* const unsigned char ∗ *in,* size_t *in_len,* unsigned char ∗ *out,* size_t ∗ *out_len*)

See Also

`block_mode_update()`

6.24.2.3 ORDO_PUBLIC int cfb_final (struct CFB_STATE ∗ *state,* struct BLOCK_STATE ∗ *cipher_state,* unsigned char ∗ *out,* size_t ∗ *out_len*)

See Also

`block_mode_final()`

6.24.2.4 ORDO_PUBLIC size_t cfb_query (int *cipher,* int *query,* size_t *value*)

See Also

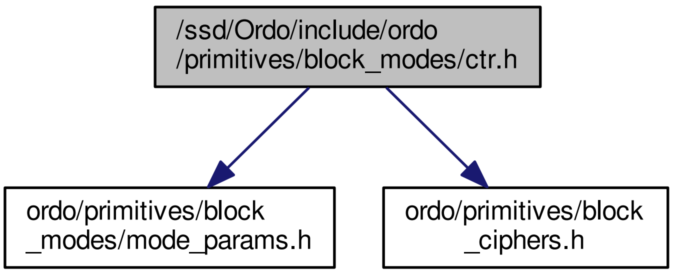
`block_mode_query()`

6.25 /ssd/Ordo/include/ordo/primitives/block_modes/ctr.h File Reference

Primitive.

```
#include "ordo/primitives/block_modes/mode_params.h"
#include "ordo/primitives/block_ciphers.h"
```

Include dependency graph for ctr.h:



Functions

- ORDO_PUBLIC int ctr_init (struct CTR_STATE ∗state, struct BLOCK_STATE ∗cipher_state, const void ∗iv, size_t iv_len, int dir, const void ∗params)
- ORDO_PUBLIC void ctr_update (struct CTR_STATE ∗state, struct BLOCK_STATE ∗cipher_state, const unsigned char ∗in, size_t in_len, unsigned char ∗out, size_t ∗out_len)

- ORDO_PUBLIC int ctr_final (struct CTR_STATE ∗state, struct BLOCK_STATE ∗cipher_state, unsigned char ∗out, size_t ∗out_len)
- ORDO_PUBLIC size_t ctr_query (int cipher, int query, size_t value)

6.25.1 Detailed Description

Primitive. The CTR mode generates a keystream by repeatedly encrypting a counter starting from some initialization vector, effectively turning a block cipher into a stream cipher. As such, CTR mode requires no padding, and outlen will always be equal to inlen.

Note that the CTR keystream is independent of the plaintext, and is also spatially coherent (using a given initialization vector on a len-byte message will "use up" len bytes of the keystream) so care must be taken to avoid reusing the initialization vector in an insecure way. This also means the block cipher's inverse permutation is never used.

`ctr_final()` accepts 0 as an argument for `outlen`, since by design the CTR mode of operation does not produce any final data. However, if a valid pointer is passed, its value will be set to zero as expected.

6.25.2 Function Documentation

6.25.2.1 ORDO_PUBLIC int ctr_init (struct CTR_STATE ∗ *state,* struct BLOCK_STATE ∗ *cipher_state,* const void ∗ *iv,* size_t *iv_len,* int *dir,* const void ∗ *params*)

See Also

`block_mode_init()`

6.25.2.2 ORDO_PUBLIC void ctr_update (struct CTR_STATE ∗ *state,* struct BLOCK_STATE ∗ *cipher_state,* const unsigned char ∗ *in,* size_t *in_len,* unsigned char ∗ *out,* size_t ∗ *out_len*)

See Also

`block_mode_update()`

6.25.2.3 ORDO_PUBLIC int ctr_final (struct CTR_STATE ∗ *state,* struct BLOCK_STATE ∗ *cipher_state,* unsigned char ∗ *out,* size_t ∗ *out_len*)

See Also

`block_mode_final()`

6.25.2.4 ORDO_PUBLIC size_t ctr_query (int *cipher,* int *query,* size_t *value*)

See Also

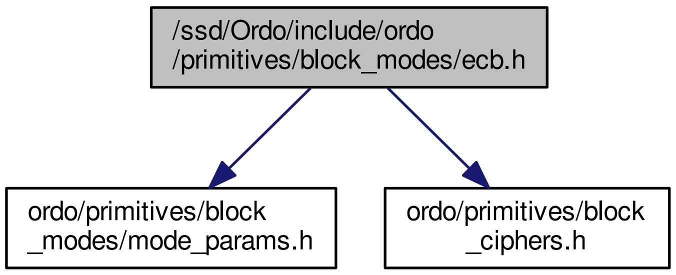
`block_mode_query()`

6.26 /ssd/Ordo/include/ordo/primitives/block_modes/ecb.h File Reference

Primitive.

```
#include "ordo/primitives/block_modes/mode_params.h"
#include "ordo/primitives/block_ciphers.h"
```

Include dependency graph for ecb.h:



Functions

- ORDO_PUBLIC int ecb_init (struct ECB_STATE ∗state, struct BLOCK_STATE ∗cipher_state, const void ∗iv, size_t iv_len, int dir, const struct ECB_PARAMS ∗params)
- ORDO_PUBLIC void ecb_update (struct ECB_STATE ∗state, struct BLOCK_STATE ∗cipher_state, const unsigned char ∗in, size_t in_len, unsigned char ∗out, size_t ∗out_len)
- ORDO_PUBLIC int ecb_final (struct ECB_STATE ∗state, struct BLOCK_STATE ∗cipher_state, unsigned char ∗out, size_t ∗out_len)
- ORDO_PUBLIC size_t ecb_query (int cipher, int query, size_t value)

6.26.1 Detailed Description

Primitive. The ECB mode divides the input message into blocks of the cipher's block size, and encrypts them individually and independently. If the input message's length is not a multiple of the cipher's block size, a padding mechanism is enabled by default which will pad the message to the correct length (and remove the extra data upon decryption). Padding may be disabled via `ECB_PARAMS`, putting constraints on the input message.

The ECB mode does not require an initialization vector.

Note that the ECB mode is insecure in almost all situations and is not recommended for general purpose use.

6.26.2 Function Documentation

6.26.2.1 ORDO_PUBLIC int ecb_init (struct ECB_STATE ∗ *state,* struct BLOCK_STATE ∗ *cipher_state,* const void ∗ *iv,* size_t *iv_len,* int *dir,* const struct ECB_PARAMS ∗ *params*)

See Also

`block_mode_init()`

6.26.2.2 ORDO_PUBLIC void ecb_update (struct ECB_STATE ∗ *state,* struct BLOCK_STATE ∗ *cipher_state,* const unsigned char ∗ *in,* size_t *in_len,* unsigned char ∗ *out,* size_t ∗ *out_len*)

See Also

`block_mode_update()`

6.26.2.3 ORDO_PUBLIC int ecb_final (struct ECB_STATE ∗ *state,* struct BLOCK_STATE ∗ *cipher_state,* unsigned char ∗ *out,* size_t ∗ *out_len*)

See Also

`block_mode_final()`

6.26.2.4 ORDO_PUBLIC size_t ecb_query (int *cipher,* int *query,* size_t *value*)

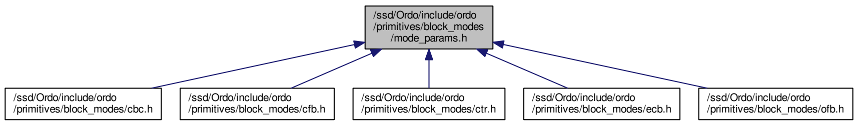
See Also

`block_mode_query()`

6.27 /ssd/Ordo/include/ordo/primitives/block_modes/mode_params.h File Reference

Primitive Parameters.

This graph shows which files directly or indirectly include this file:



Data Structures

- struct ECB_PARAMS

    ECB parameters.

- struct CBC_PARAMS

    CBC parameters.

6.27.1 Detailed Description

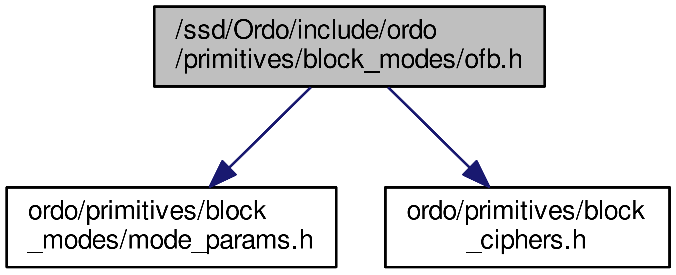
Primitive Parameters. This header contains parameter structures for all block modes.

6.28 /ssd/Ordo/include/ordo/primitives/block_modes/ofb.h File Reference

Primitive.

```
#include "ordo/primitives/block_modes/mode_params.h"
#include "ordo/primitives/block_ciphers.h"
```

Include dependency graph for ofb.h:



Functions

- ORDO_PUBLIC int ofb_init (struct OFB_STATE ∗state, struct BLOCK_STATE ∗cipher_state, const void ∗iv, size_t iv_len, int dir, const void ∗params)
- ORDO_PUBLIC void ofb_update (struct OFB_STATE ∗state, struct BLOCK_STATE ∗cipher_state, const unsigned char ∗in, size_t in_len, unsigned char ∗out, size_t ∗out_len)
- ORDO_PUBLIC int ofb_final (struct OFB_STATE ∗state, struct BLOCK_STATE ∗cipher_state, unsigned char ∗out, size_t ∗out_len)
- ORDO_PUBLIC size_t ofb_query (int cipher, int query, size_t value)

6.28.1 Detailed Description

Primitive. The OFB mode generates a keystream by repeatedly encrypting an initialization vector, effectively turning a block cipher into a stream cipher. As such, OFB mode requires no padding, and outlen will always be equal to inlen.

Note that the OFB keystream is independent of the plaintext, so a key/iv pair must never be used for more than one message. This also means the block cipher's inverse permutation is never used.

`ofb_final()` accepts 0 as an argument for `outlen`, since by design the OFB mode of operation does not produce any final data. However, if a valid pointer is passed, its value will be set to zero as expected.

6.28.2 Function Documentation

6.28.2.1 ORDO_PUBLIC int ofb_init (struct OFB_STATE ∗ *state,* struct BLOCK_STATE ∗ *cipher_state,* const void ∗ *iv,* size_t *iv_len,* int *dir,* const void ∗ *params*)

See Also

`block_mode_init()`

6.28.2.2 ORDO_PUBLIC void ofb_update (struct OFB_STATE ∗ *state,* struct BLOCK_STATE ∗ *cipher_state,* const unsigned char ∗ *in,* size_t *in_len,* unsigned char ∗ *out,* size_t ∗ *out_len*)

See Also

`block_mode_update()`

6.28.2.3 ORDO_PUBLIC int ofb_final (struct OFB_STATE ∗ *state,* struct BLOCK_STATE ∗ *cipher_state,* unsigned char ∗ *out,* size_t ∗ *out_len*)

See Also

block_mode_final()

6.28.2.4 ORDO_PUBLIC size_t ofb_query (int *cipher,* int *query,* size_t *value*)

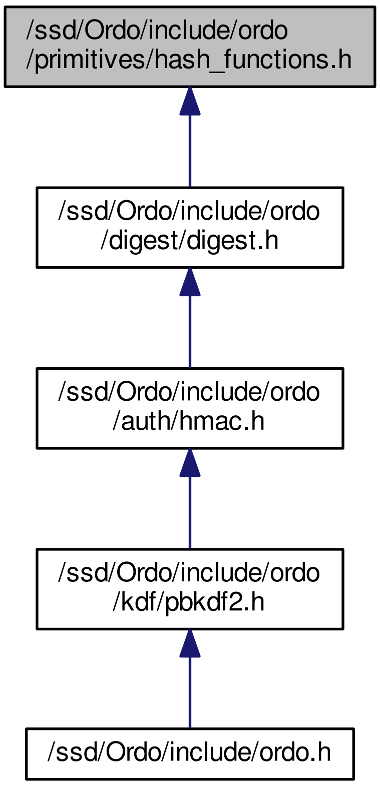
See Also

block_mode_query()

6.29 /ssd/Ordo/include/ordo/primitives/hash_functions.h File Reference

Abstraction Layer.

This graph shows which files directly or indirectly include this file:


/ssd/Ordo/include/ordo /primitives/hash_functions.h
/ssd/Ordo/include/ordo /digest/digest.h
/ssd/Ordo/include/ordo /auth/hmac.h
/ssd/Ordo/include/ordo /kdf/pbkdf2.h
/ssd/Ordo/include/ordo.h

Functions

- ORDO_PUBLIC int hash_init (struct HASH_STATE ∗state, prim_t primitive, const void ∗params)
- ORDO_PUBLIC void hash_update (struct HASH_STATE ∗state, const void ∗buffer, size_t len)

- ORDO_PUBLIC void hash_final (struct HASH_STATE ∗state, void ∗digest)
- ORDO_PUBLIC size_t hash_query (prim_t primitive, int query, size_t value)

6.29.1 Detailed Description

Abstraction Layer. This abstraction layer declares all the hash functions and also makes them available to higher level modules - for a slightly more convenient wrapper to this interface, you can use `digest.h`.

6.29.2 Function Documentation

6.29.2.1 ORDO_PUBLIC int hash_init (struct HASH_STATE ∗ *state*, prim_t *primitive*, const void ∗ *params*)

Initializes a hash function state.

Parameters

`in,out`	*state*	A hash function state.
`in`	*primitive*	A hash function primitive.
`in`	*params*	Hash function specific parameters.

Returns

`ORDO_SUCCESS` on success, else an error code.

6.29.2.2 ORDO_PUBLIC void hash_update (struct HASH_STATE ∗ *state*, const void ∗ *buffer*, size_t *len*)

Updates a hash function state by appending a buffer to the message this state is to calculate the cryptographic digest of.

Parameters

`in,out`	*state*	An initialized hash function state.
`in`	*buffer*	A buffer to append to the message.
`in`	*len*	The length, in bytes, of the buffer.

Remarks

This function has the property that doing `update(x)` followed by `update(y)` is equivalent to `update(x || y)`, where || denotes concatenation.

6.29.2.3 ORDO_PUBLIC void hash_final (struct HASH_STATE ∗ *state*, void ∗ *digest*)

Finalizes a hash function state, outputting the final digest.

Parameters

`in,out`	*state*	An initialized hash function state.
`out`	*digest*	A buffer in which to write the digest.

Remarks

The `digest` buffer should be as large as the hash function's digest length (unless you changed it via custom parameters).

6.29.2.4 ORDO_PUBLIC size_t hash_query (prim_t *primitive*, int *query*, size_t *value*)

Queries a hash function for suitable parameters.

Parameters

`in`	*primitive*	A hash function primitive.
`in`	*query*	A query code.
`in`	*value*	A suggested value.

Returns

A suitable parameter of type `query` based on `value`.

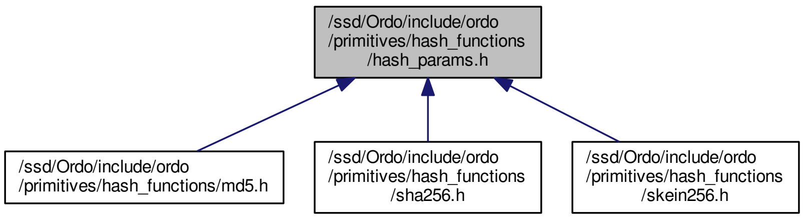
See Also

query.h

6.30 /ssd/Ordo/include/ordo/primitives/hash_functions/hash_params.h File Reference

Primitive Parameters.

This graph shows which files directly or indirectly include this file:



Data Structures

- struct SKEIN256_PARAMS

  Skein-256 hash function parameters.

Functions

- ORDO_PUBLIC struct SKEIN256_PARAMS skein256_default (void)

6.30.1 Detailed Description

Primitive Parameters. This header contains parameter structures for all hash functions.

6.30.2 Function Documentation

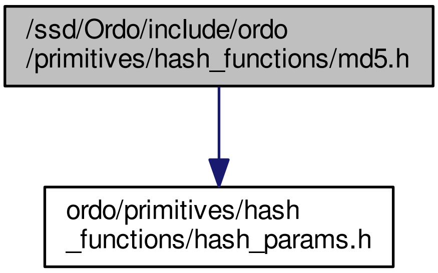
6.30.2.1 ORDO_PUBLIC struct SKEIN256_PARAMS skein256_default (void)

Returns the default Skein-256 configuration block (parameters).

6.31 /ssd/Ordo/include/ordo/primitives/hash_functions/md5.h File Reference

Primitive.

`#include "ordo/primitives/hash_functions/hash_params.h"`
Include dependency graph for md5.h:



Functions

- ORDO_PUBLIC int md5_init (struct MD5_STATE ∗state, const void ∗params)
- ORDO_PUBLIC void md5_update (struct MD5_STATE ∗state, const void ∗buffer, size_t len)
- ORDO_PUBLIC void md5_final (struct MD5_STATE ∗state, void ∗digest)
- ORDO_PUBLIC size_t md5_query (int query, size_t value)

6.31.1 Detailed Description

Primitive. The MD5 hash function, which produces a 128-bit digest.

6.31.2 Function Documentation

6.31.2.1 ORDO_PUBLIC int md5_init (struct MD5_STATE ∗ *state,* const void ∗ *params*)

See Also

`hash_init()`

Remarks

The `params` parameter is ignored.

6.31.2.2 ORDO_PUBLIC void md5_update (struct MD5_STATE ∗ *state,* const void ∗ *buffer,* size_t *len*)

See Also

`hash_update()`

6.31.2.3 ORDO_PUBLIC void md5_final (struct MD5_STATE ∗ *state*, void ∗ *digest*)

See Also

`hash_final()`

6.31.2.4 ORDO_PUBLIC size_t md5_query (int *query*, size_t *value*)

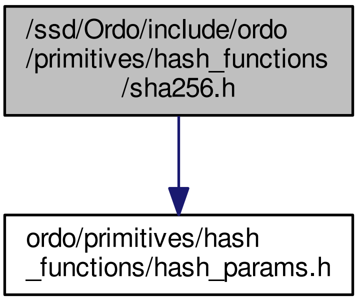
See Also

`hash_query()`

6.32 /ssd/Ordo/include/ordo/primitives/hash_functions/sha256.h File Reference

Primitive.

`#include "ordo/primitives/hash_functions/hash_params.h"`
Include dependency graph for sha256.h:


/ssd/Ordo/include/ordo/primitives/hash_functions/sha256.h
ordo/primitives/hash_functions/hash_params.h

Functions

- ORDO_PUBLIC int sha256_init (struct SHA256_STATE ∗state, const void ∗params)
- ORDO_PUBLIC void sha256_update (struct SHA256_STATE ∗state, const void ∗buffer, size_t len)
- ORDO_PUBLIC void sha256_final (struct SHA256_STATE ∗state, void ∗digest)
- ORDO_PUBLIC size_t sha256_query (int query, size_t value)

6.32.1 Detailed Description

Primitive. The SHA-256 hash function, which produces a 256-bit digest.

6.32.2 Function Documentation

6.32.2.1 ORDO_PUBLIC int sha256_init (struct SHA256_STATE ∗ *state*, const void ∗ *params*)

See Also

`hash_init()`

Remarks

The `params` parameter is ignored.

6.32.2.2 ORDO_PUBLIC void sha256_update (struct SHA256_STATE ∗ *state,* const void ∗ *buffer,* size_t *len*)

See Also

`hash_update()`

6.32.2.3 ORDO_PUBLIC void sha256_final (struct SHA256_STATE ∗ *state,* void ∗ *digest*)

See Also

`hash_final()`

6.32.2.4 ORDO_PUBLIC size_t sha256_query (int *query,* size_t *value*)

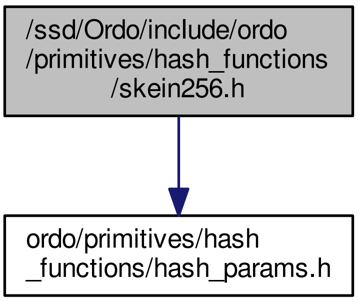
See Also

`hash_query()`

6.33 /ssd/Ordo/include/ordo/primitives/hash_functions/skein256.h File Reference

Primitive.

`#include "ordo/primitives/hash_functions/hash_params.h"`
Include dependency graph for skein256.h:


/ssd/Ordo/include/ordo/primitives/hash_functions/skein256.h
ordo/primitives/hash_functions/hash_params.h

Functions

- ORDO_PUBLIC int skein256_init (struct SKEIN256_STATE ∗state, const struct SKEIN256_PARAMS ∗params)

- ORDO_PUBLIC void skein256_update (struct SKEIN256_STATE ∗state, const void ∗buffer, size_t len)
- ORDO_PUBLIC void skein256_final (struct SKEIN256_STATE ∗state, void ∗digest)
- ORDO_PUBLIC size_t skein256_query (int query, size_t value)

6.33.1 Detailed Description

Primitive. This is the Skein-256 hash function, which produces a 256-bit digest by default (but has parameters to output a longer digest) and has a 256-bit internal state. This implementation supports messages up to a length of 2^64 - 1 bytes instead of the 2^96 - 1 available, but we trust this will not be an issue. This is a rather flexible hash with lots of options. Currently, the only options supported are:

- arbitrary output length (see `SKEIN256_PARAMS`)
- free access to configuration block (in fact, `SKEIN256_PARAMS` is the configuration block, and a default one is used if not provided)

6.33.2 Function Documentation

6.33.2.1 ORDO_PUBLIC int skein256_init (struct SKEIN256_STATE ∗ *state,* const struct SKEIN256_PARAMS ∗ *params*)

See Also

`hash_init()`

Return values

ORDO_ARG	if parameters were provided, but requested an output length of zero bytes.

6.33.2.2 ORDO_PUBLIC void skein256_update (struct SKEIN256_STATE ∗ *state,* const void ∗ *buffer,* size_t *len*)

See Also

`hash_update()`

6.33.2.3 ORDO_PUBLIC void skein256_final (struct SKEIN256_STATE ∗ *state,* void ∗ *digest*)

See Also

`hash_final()`

Remarks

If no parameters are provided, the digest buffer must be at least 32 bytes (256 bits) large. If parameters are provided, the buffer must be sufficiently large to store the output length required by the parameters (note the parameters specified an output length in **bits**).

6.33.2.4 ORDO_PUBLIC size_t skein256_query (int *query,* size_t *value*)

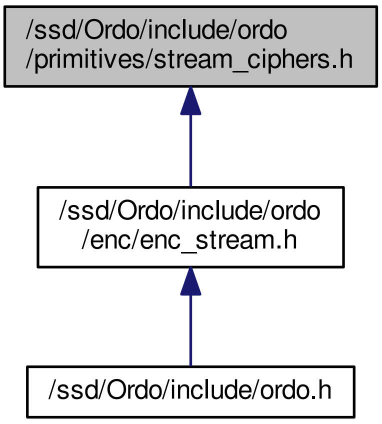
See Also

`hash_query()`

6.34 /ssd/Ordo/include/ordo/primitives/stream_ciphers.h File Reference

Abstraction Layer.

This graph shows which files directly or indirectly include this file:


/ssd/Ordo/include/ordo/primitives/stream_ciphers.h
/ssd/Ordo/include/ordo/enc/enc_stream.h
/ssd/Ordo/include/ordo.h

Functions

- ORDO_PUBLIC int stream_init (struct STREAM_STATE ∗state, const void ∗key, size_t key_len, prim_t primitive, const void ∗params)
- ORDO_PUBLIC void stream_update (struct STREAM_STATE ∗state, void ∗buffer, size_t len)
- ORDO_PUBLIC void stream_final (struct STREAM_STATE ∗state)
- ORDO_PUBLIC size_t stream_query (prim_t primitive, int query, size_t value)

6.34.1 Detailed Description

Abstraction Layer. This abstraction layer declares all the stream ciphers and also makes them available to higher level modules. This does not actually do encryption at all but simply abstracts the stream cipher primitives - encryption modules are in the `enc` folder: `enc_stream.h`.

6.34.2 Function Documentation

6.34.2.1 ORDO_PUBLIC int stream_init (struct STREAM_STATE ∗ *state*, const void ∗ *key*, size_t *key_len*, prim_t *primitive*, const void ∗ *params*)

Initializes a stream cipher state.

Parameters

`in,out`	*state*	A stream cipher state.

in	*key*	The cryptographic key to use.
in	*key_len*	The length, in bytes, of the key.
in	*primitive*	A stream cipher primitive.
in	*params*	Stream cipher specific parameters.

Returns

ORDO_SUCCESS on success, else an error code.

6.34.2.2 ORDO_PUBLIC void stream_update (struct STREAM_STATE ∗ *state*, void ∗ *buffer*, size_t *len*)

Encrypts or decrypts a buffer using a stream cipher state.

Parameters

in,out	*state*	An initialized stream cipher state.
in,out	*buffer*	The buffer to encrypt or decrypt.
in	*len*	The length, in bytes, of the buffer.

Remarks

Encryption and decryption are equivalent, and are done in place.
This function is stateful and will update the passed state (by generating keystream material), unlike block ciphers, which are deterministic permutations.

6.34.2.3 ORDO_PUBLIC void stream_final (struct STREAM_STATE ∗ *state*)

Finalizes a stream cipher state.

Parameters

in,out	*state*	An initialized stream cipher state.

6.34.2.4 ORDO_PUBLIC size_t stream_query (prim_t *primitive*, int *query*, size_t *value*)

Queries a stream cipher for suitable parameters.

Parameters

in	*primitive*	A stream cipher primitive.
in	*query*	A query code.
in	*value*	A suggested value.

Returns

A suitable parameter of type `query` based on `value`.

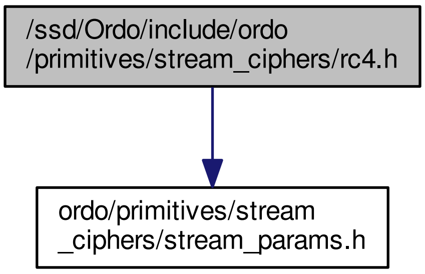
See Also

query.h

6.35 /ssd/Ordo/include/ordo/primitives/stream_ciphers/rc4.h File Reference

Primitive.

`#include "ordo/primitives/stream_ciphers/stream_params.h"`
Include dependency graph for rc4.h:



Functions

- ORDO_PUBLIC int rc4_init (struct RC4_STATE ∗state, const uint8_t ∗key, size_t key_len, const struct RC4-_PARAMS ∗params)
- ORDO_PUBLIC void rc4_update (struct RC4_STATE ∗state, uint8_t ∗buffer, size_t len)
- ORDO_PUBLIC void rc4_final (struct RC4_STATE ∗state)
- ORDO_PUBLIC size_t rc4_query (int query, size_t value)

6.35.1 Detailed Description

Primitive. RC4 is a stream cipher, which accepts keys between 40 and 2048 bits (in multiples of 8 bits only). It accepts a parameter consisting of the number of initial keystream bytes to drop immediately after key schedule, effectively implementing RC4-drop[n]. If no drop parameter is passed, the implementation drops 2048 bytes by default.

6.35.2 Function Documentation

6.35.2.1 ORDO_PUBLIC int rc4_init (struct RC4_STATE ∗ *state*, const uint8_t ∗ *key*, size_t *key_len*, const struct RC4_PARAMS ∗ *params*)

See Also

`stream_init()`

Return values

ORDO_KEY_LEN	if the key length was less than 40 bits (5 bytes) or more than 2048 bits (256 bytes).

Remarks

The amount of keystream bytes to drop can be set via the `params` argument, see `RC4_PARAMS`. By default, 2048 bytes are dropped.

6.35.2.2 ORDO_PUBLIC void rc4_update (struct RC4_STATE ∗ *state,* uint8_t ∗ *buffer,* size_t *len*)

See Also

`stream_update()`

6.35.2.3 ORDO_PUBLIC void rc4_final (struct RC4_STATE ∗ *state*)

See Also

`stream_final()`

6.35.2.4 ORDO_PUBLIC size_t rc4_query (int *query,* size_t *value*)

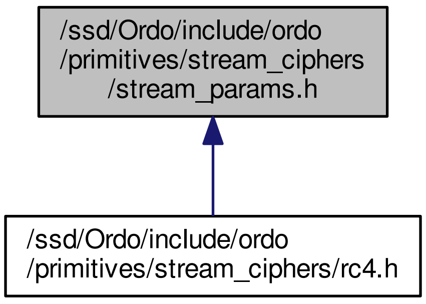
See Also

`stream_query()`

6.36 /ssd/Ordo/include/ordo/primitives/stream_ciphers/stream_params.h File Reference

Primitive Parameters.

This graph shows which files directly or indirectly include this file:



Data Structures

- struct RC4_PARAMS

  RC4 stream cipher parameters.

6.36.1 Detailed Description

Primitive Parameters. This header contains parameter structures for all stream ciphers.

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