
aiocoap
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The aiocoap package is an implementation of CoAP, the [Constrained Application Protocol](#).

It is written in Python 3 using its [native asyncio](#) methods to facilitate concurrent operations while maintaining an easy to use interface.

aiocoap is originally based on [txThings](#). If you want to use CoAP in your existing Twisted application, or can not migrate to Python 3 yet, that is probably more useful to you than aiocoap.

CHAPTER 1

Usage

For how to use the aiocoap library, have a look at the *Guided Tour through aiocoap*, or at the *Usage Examples* and *CoAP tools* provided.

A full reference is available in the *API documentation*.

All examples can be run directly from a source code copy. If you prefer to install it, the usual Python mechanisms apply (see *Installing aiocoap*).

Features / Standards

This library supports the following standards in full or partially:

- **RFC7252** (CoAP): Supported for clients and servers. Multicast is supported on the server side, and partially for clients. DTLS is supported for clients, but lacking some security properties. No caching is done inside the library.
- **RFC7641** (Observe): Basic support for clients and servers. Reordering, re-registration, and active cancellation are missing.
- **RFC7959** (Blockwise): Supported both for atomic and random access.
- **RFC8323** (TCP, WebSockets): Supports CoAP over TCP, TLS, and WebSockets (both over HTTP and HTTPS). The TLS parts are server-certificate only; preshared, raw public keys and client certificates are not supported yet.
- **RFC7967** (No-Response): Supported.
- **RFC8132** (PATCH/FETCH): Types and codes known, FETCH observation supported.
- **draft-ietf-core-resource-directory**: A standalone resource directory server is provided along with a library function to register at one. They lack support for groups and security considerations, and are generally rather simplistic.
- **RFC8613** (OSCORE): Full support client-side; protected servers can be implemented based on it but are not automatic yet.
- **draft-ietf-core-oscure-groupcomm-10** (Group OSCORE): Supported for both group and pairwise mode in groups that are fully known. (The lack of an implemented joining or persistence mechanism makes this impractical for anything but experimentation.)

If something described by one of the standards but not implemented, it is considered a bug; please file at the [github issue tracker](#). (If it's not on the list or in the excluded items, file a wishlist item at the same location).

CHAPTER 3

Dependencies

Basic aiocoap works out of the box on [Python 3.7](#) or newer (also works on [PyPy3](#)). For full support (DTLS, OSCORE and link-format handling) follow the [Installing aiocoap](#) instructions as these require additional libraries.

aiocoap provides different network backends for different platforms. The most featureful backend is available for Linux, but most operations work on BSDs, Windows and macOS as well. See the [FAQ](#) for more details.

If your library depends on aiocoap, it should pick the required extras (as per [Installing aiocoap](#)) and declare a dependency like `aiocoap[linkheader,oscore] >= 0.4b2`.

CHAPTER 4

Development

aiocoap tries to stay close to [PEP8](#) recommendations and general best practice, and should thus be easy to contribute to.

Bugs (ranging from “design goal” and “wishlist” to typos) are currently tracked in the [github issue tracker](#). Pull requests are welcome there; if you start working on larger changes, please coordinate on the issue tracker.

Documentation is built using [sphinx](#) with `./setup.py build_sphinx`; hacks used there are described in `./doc/README.doc`.

Unit tests are implemented in the `./tests/` directory and easiest run using [tox](#) (though still available through `./setup.py test` for the time being); complete test coverage is aimed for, but not yet complete (and might never be, as the error handling for pathological network partners is hard to trigger with a library designed not to misbehave). The tests are regularly run at the [CI suite at gitlab](#), from where [coverage reports](#) are available.

CHAPTER 5

Relevant URLs

- <https://github.com/chrysn/aiocoap>

This is where the latest source code can be found, and bugs can be reported. Generally, this serves as the project web site.

- <http://aiocoap.readthedocs.org/>

Online documentation built from the sources.

- <http://coap.technology/>

Further general information on CoAP, the standard documents involved, and other implementations and tools available.

aiocoap is published under the MIT License, see *LICENSE* for details.

When using aiocoap for a publication, please cite it according to the output of `./setup.py cite [--bibtex]`.

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6.1 Installing aiocoap

Note: The commands here will install aiocoap in your current environment. By default, that is your platform's user install directory.

To keep that clean, or to use different sets or versions of libraries for different purposes, you may want to look into the [venv documentation](#), which explains both the concept of virtual environments and how they are used on different platforms.

In most situations, it is recommended to install the latest released version of aiocoap. This is done using a simple:

```
$ pip3 install --upgrade "aiocoap[all]"
```

(In some cases, the program is called `pip` only).

If `pip3` is not available on your platform, you can manually download and unpack the latest `.tar.gz` file from the [Python package index](#) and run

```
$ ./setup.py install
```

6.1.1 Development version

If you want to play with aiocoap's internals or consider contributing to the project, the suggested way of operation is getting a Git checkout of the project:

```
$ git clone https://github.com/chrysn/aiocoap
$ cd aiocoap
```

You can then use the project from that location, or install it with

```
$ pip3 install --upgrade ".[all,docs]"
```

If you need to install the latest development version of aiocoap but do not plan on editing (eg. because you were asked in the course of a bug report to test something against the latest aiocoap version), you can install it directly from the web:

```
$ pip3 install --upgrade "git+https://github.com/chrysn/aiocoap#egg=aiocoap[all]"
```

With the `-e` option, that is also a viable option if you want to modify aiocoap and pip’s [choice of checkout directories](#) is suitable for you.

6.1.2 Common errors

When upstream libraries change, or when dependencies of used libraries are not there (eg. no C compiler, C libraries missing), the installation process can fail.

In those cases, it is helpful to not install with all extras, but replace the `all` with the extras you actually want from the list below. For example, if you see errors from `DTLSocket`, rather than installing with `[all, docs]`, you can leave out the `tinydtls` extra and install with `[linkheader, oscore, prettyprint, docs]`.

6.1.3 Slimmer installations

As aiocoap does not strictly depend on many of the libraries that are installed when following the above recommendations, a setup can be stripped down by entering any combination of the below “extras” in the place of the `all` in the above lines, or leaving out the `[all]` expression for a minimal installation.

The extras currently supported are:

- `linkheader`: Needed for generating and parsing files in [RFC6690](#) link format, eg. `.well-known/core` files. Running or interacting with a Resource Directory is impossible without this module, as are many other discovery steps that applications will want to do.
- `oscore`: Required for the `aiocoap.transports.oscore` transport.
- `tinydtls`: Required for using CoAP over DTLS.
- `ws`: Required for using CoAP over WebSockets.
- `prettyprint`: Allows using the `--color` and `--pretty-print` options of `aiocoap-client`.
- `docs`: Installs tools needed to build the documentation (not part of `all`).

Which libraries and versions are pulled in by this exactly is documented in the `setup.py` file.

6.2 Guided Tour through aiocoap

This page gets you started on the concepts used in aiocoap; it will assume rough familiarity with what CoAP is, and a working knowledge of Python development, but introduce you to asynchronous programming and explain some CoAP concepts along with the aiocoap API.

If you are already familiar with asynchronous programming and/or some other concepts involved, or if you prefer reading code to reading tutorials, you might want to go after the *Usage Examples* instead.

6.2.1 First, some tools

Before we get into programming, let's establish tools with which we can probe a server, and a server itself. If you have not done it already, *install aiocoap for development*.

Start off with the sample server by running the following in a terminal inside the aiocoap directory:

```
$ ./server.py
```

Note: The \$ sign indicates the prompt; you enter everything after it in a terminal shell. Lines not starting with a dollar sign are the program output, if any. Later on, we'll see lines starting with >>>; those are run inside a Python interpreter.

I recommend that you use the [IPython](#) interpreter. One useful feature for following through this tutorial is that you can copy full lines (including any >>> parts) to the clipboard and use the `%paste` IPython command to run it, taking care of indentation etc.

This has started a CoAP server with some demo content, and keeps running until you terminate it with Ctrl-C.

In a separate terminal, use *the aiocoap-client tool* to send a GET request to the server:

```
$ ./aiocoap-client coap://localhost/.well-known/core
</time>; obs, </.well-known/core>; ct=40, </other/separate>, </other/block>
```

The address we're using here is a resource on the local machine (`localhost`) at the well-known location `.well-known/core`, which in CoAP is the go-to location if you don't know anything about the paths on the server beforehand. It tells that there is a resource at the path `/time` that has the observable attribute, a resource at the path `/.well-known/core`, and two more at `/other/separate` and `/other/block`.

Note: Getting "5.00 Internal Server Error" instead? Install the [link_header module](#) and restart the server, or trust me that the output would look like that if it were installed and proceed.

Note: There can be a "(No newline at end of message)" line below your output. This just makes sure your prompt does not start in the middle of the screen. I'll just ignore that.

Let's see what `/time` gives us:

```
$ ./aiocoap-client coap://localhost/time
2016-12-07 10:08
```

The response should have arrived immediately: The client sent a message to the server in which it requested the resource at `/time`, and the server could right away send a message back. In contrast, `/other/separate` is slower:

```
$ ./aiocoap-client coap://localhost/other/separate
Three rings for the elven kings [abbreviated]
```

The response to this message comes back with a delay. Here, it is simulated by the server; in real-life situations, this delay can stem from network latency, servers waiting for some sensor to read out a value, slow hard drives etc.

6.2.2 A request

In order to run a similar request programmatically, we'll need a request message:

```
>>> from aiocoap import *
>>> msg = Message(code=GET, uri="coap://localhost/other/separate")
>>> print(msg)
<aiocoap.Message at 0x0123deadbeef: no mtype, GET (no MID, empty token) remote None,
↳2 option(s)>
```

The message consists of several parts. The non-optional ones are largely handled by aiocoap (message type, ID, token and remote are all None or empty here and will be populated when the message is sent). The options are roughly equivalent to what you might know as HTTP headers:

```
>>> msg.opt
<aiocoap.options.Options at 0x0123deadbef0: URI_HOST: localhost, URI_PATH: other /
↳separate>
```

You might have noticed that the Uri-Path option has whitespace around the slash. This is because paths in CoAP are not a structured byte string with slashes in it (as they are in HTTP), but actually repeated options of a (UTF-8) string, which are represented as a tuple in Python:

```
>>> msg.opt.uri_path
('other', 'separate')
```

Now to send that network as a request over the network, we'll need a network protocol object. That has a request method, and can give a response (**bear with me, these examples don't actually work**):

```
>>> protocol.request(msg).response
<Future pending cb=[Request._response_cancellation_handler()]>
```

That is obviously not a proper response – yet. If the protocol returned a finished response, the program couldn't do any work in the meantime. Because a Future is returned, the user can start other requests in parallel, or do other processing in the meantime. For now, all we want is to wait until the response is ready:

```
>>> await protocol.request(msg).response
<aiocoap.Message at 0x0123deadbef1: Type.CON 2.05 Content (MID 51187, token 00008199)
↳remote <UDP6EndpointAddress [::ffff:127.0.0.1]:5683 with local address>, 186
↳byte(s) payload>
```

Here, we have a successful message (“2.05 Content” is the rough equivalent of HTTP’s “200 OK”, and the 186 bytes of payload look promising). Until we can dissect that, we'll have to get those asynchronous things to work properly, though.

6.2.3 Asynchronous operation

The interactive Python shell does not work in an asynchronous fashion (*yet?*) – it follows a strict “read, evaluate, print” loop (REPL), similar to how a Python program as a whole is executed. To launch asynchronous processing, we'll use the following shorthand:

```
>>> import asyncio
>>> run = asyncio.get_event_loop().run_until_complete
```

With that, we can run asynchronous functions; note that any function that `await`s anything is itself asynchronous and has to be declared accordingly. Now we can run what did not work before:

```
>>> async def main():
...     protocol = await Context.create_client_context()
...     msg = Message(code=GET, uri="coap://localhost/other/separate")
...     response = await protocol.request(msg).response
...     print(response)
>>> run(main())
<aiocoap.Message at 0x0123deadbef1: Type.CON 2.05 Content (MID 51187, token 00008199)
↳remote <UDP6EndpointAddress [::ffff:127.0.0.1]:5683 with local address>, 186
↳byte(s) payload>
```

That's better!

(Now the protocol object could also be created. That doesn't actually take a long time, but could, depending on the operating system).

6.2.4 The response

To dissect the response, let's make sure we have it available:

```
>>> protocol = run(Context.create_client_context())
>>> msg = Message(code=GET, uri="coap://localhost/other/separate")
>>> response = run(protocol.request(msg).response)
>>> print(response)
<aiocoap.Message at 0x0123deadbef1: Type.CON 2.05 Content (MID 51187, token 00008199)
↳remote <UDP6EndpointAddress [::ffff:127.0.0.1]:5683 with local address>, 186
↳byte(s) payload>
```

The response obtained in the main function is a message like the request message, just that it has a different code (2.05 is of the successful 2.00 group), incidentally no options (because it's a very simple server), and actual data.

The response code is represented in Python by an enum with some utility functions; the remote address (actually remote-local address pair) is an object too:

```
>>> response.code
<Successful Response Code 69 "2.05 Content">
>>> response.code.is_successful()
True
>>> response.remote.hostinfo
' [::ffff:127.0.0.1] '
>>> response.remote.is_multicast
False
```

The actual response message, the body, or the payload of the response, is accessible in the payload property, and is always a bytestring:

```
>>> response.payload
b'Three rings for the elven kings [ abbreviated ]'
```

aiocoap does not yet provide utilities to parse the message according to its content format (which would be accessed as `response.opt.content_format` and is numeric in CoAP).

More asynchronous fun

The other examples don't show simultaneous requests in flight, so let's have one with parallel requests:

```

>>> async def main():
...     responses = [
...         protocol.request(Message(code=GET, uri=u)).response
...         for u
...         in ("coap://localhost/time", "coap://vs0.inf.ethz.ch/obs",
↳"coap://coap.me/test")
...     ]
...     for f in asyncio.as_completed(responses):
...         response = await f
...         print("Response from {}: {}".format(response.get_request_uri(),
↳ response.payload))
>>> run(main())
Response from coap://localhost/time: b'2016-12-07 18:16'
Response from coap://vs0.inf.ethz.ch/obs: b'18:16:11'
Response from coap://coap.me/test: b'welcome to the ETSI plugtest! last_
↳change: 2016-12-06 16:02:33 UTC'

```

This also shows that the response messages do keep some information of their original request (in particular, the request URI) with them to ease further parsing.

This is currently the end of the guided tour; see the [aiocoap.resource](#) documentation for the server side until the tour covers that is complete.

6.3 OSCORE in aiocoap

6.3.1 Introducing OSCORE

OSCORE (RFC8613) is an end-to-end security mechanism available for CoAP and implemented in aiocoap.

Its main advantage over lower-layer protection (IPsec, (D)TLS) is that it can leverage any CoAP transport (as well as HTTP), can traverse proxies preserving some of their features (like block-wise fragmentation and retransmission) and supports multicast and other group communication scenarios (implemented, but not covered here as it needs even more manual actions so far).

By itself, OSCORE has no key exchange protocol; it relies on other protocols to establish keys (there is ongoing work on a lightweight key exchange named EDHOC, and the [ACE-OSCORE](#) profile goes some way). Until those are implemented and wide-spread, OSCORE contexts can be provisioned manually to devices.

6.3.2 OSCORE state

Unless an add-on mode (sometimes called B2 mode as it's describe in OSCORE's Appendix B.2) is used, some run-time information needs to be stored along with an OSCORE key.

This allows instantaneous zero-round-trip trusted requests with just a single round-trip (ie. a client can shut down, wake up with a different network address, and still the first UDP package it sends to the server can be relied and acted upon immediately). In this mode, there is no need for the device to have a reliable source of entropy.

In practice, this means that OSCORE keys need to reside in writable directories, are occasionally written to (the mechanisms of Appendix B.1 ensure that writes are rare: they happen at startup, shutdown, and only occasionally at runtime).

Warning: This also means that stored OSCORE contexts must never be copied, only moved (or have the original deleted right after a copy).

Where copies are unavoidable (eg. as part of a system backup), they must not be used unless it can be proven that the original was not written to at all after the backup was taken.

When that can not be proven, the context must be deemed lost and reestablished by different means.

6.3.3 OSCORE credentials

As an experimental format, OSCORE uses JSON based credentials files that describes OSCORE or (D)TLS credentials.

For client, they indicate which URIs should be accessed using which OSCORE context. For servers, they indicate the available OSCORE contexts clients could use, and provide labels for them.

The keys and IDs themselves are stored in a directory referenced by the credentials file; this allows the state writes to be performed independently.

6.3.4 OSCORE example

This example sets up encrypted access to the file server demo from the generic command line client.

Note: Manual provisioning of OSCORE contexts is not expected to be a long-term solution, and meant primarily for initial experimentation.

Do not expect the security contexts set up here to be usable indefinitely, as the credentials and security context format used by aiocoap is still in flux. Moreover, the example will change over time to reflect the best use of OSCORE possible with the current implementation.

First, create a pair of security contexts:

client1/for-fileserver/settings.json:

```
{
  "sender-id_hex": "01",
  "recipient-id_ascii": "file",

  "secret_ascii": "Correct Horse Battery Staple"
}
```

server/from-client1/settings.json:

```
{
  "recipient-id_hex": "01",
  "sender-id_ascii": "file",

  "secret_ascii": "Correct Horse Battery Staple"
}
```

A single secret must only be used once – please use something more unique than the [standard passphrase](#).

With each of those goes a credentials map:

client1.json:

```
{
  "coap://localhost/*": { "oscore": { "contextfile": "client1/for-fileserver/" } }
}
```

server.json:

```
{
  ":client1": { "oscore": { "contextfile": "server/from-client1/" } }
}
```

Then, the server can be started:

```
$ ./aiocoap-fileserver data-to-be-served/ --credentials server.json
```

And queried using the client:

```
$ ./aiocoap-client coap://localhost/ --credentials client1.json
<subdirectory/>; ct="40",
<other-directory/>; ct="40",
<README>
```

Note that just passing in those credentials does not on its own make the server require encrypted communication, let alone require authorization. Requests without credentials still work, and in this very example it'd need a network sniffer (or increased verbosity) to even be sure *that* the request was protected.

Ways of implementing access controls, mandatory encryption and access control are being explored - as are extensions that simplify the setup process.

6.4 The aiocoap API

6.4.1 API stability

In preparation for a [semantically versioned 1.0](#) release, some parts of aiocoap are described as stable.

The library does not try to map the distinction between “public API” and internal components in the sense of semantic versioning to Python’s “public” and “private” (`_`-prefixed) interfaces – tying those together would mean intrusive refactoring every time a previously internal mechanism is stabilized.

Neither does it only document the public API, as that would mean that library development would need to resort to working with code comments; that would also impede experimentation, and migrating comments to docstrings would be intrusive again. All modules’ documentation can be searched or accessed via modindex.

Instead, functions, methods and properties in the library should only be considered public (in the semantic versioning sense) if they are described as “stable” in their documentation. The documentation may limit how an interface may be used or what can be expected from it. (For example, while a method may be typed to return a particular class, the stable API may only guarantee that an instance of a particular abstract base class is returned).

The `__all__` attributes of aiocoap modules try to represent semantic publicity of its members (in accordance with PEP8); however, the documentation is the authoritative source.

6.4.2 Modules with stable components

aiocoap module

The aiocoap package is a library that implements CoAP, the [Constrained Application Protocol](#).

If you are reading this through the Python documentation, be aware that there is additional documentation available [online](#) and in the source code's `doc` directory.

Module contents

This root module re-exports the most commonly used classes in aiocoap: `Context`, `Message` as well as all commonly used numeric constants from `numbers`; see their respective documentation entries.

The presence of `Message` and `Context` in the root module is stable.

aiocoap.protocol module

This module contains the classes that are responsible for keeping track of messages:

- `Context` roughly represents the CoAP endpoint (basically a UDP socket) – something that can send requests and possibly can answer incoming requests.
- a `Request` gets generated whenever a request gets sent to keep track of the response
- a `Responder` keeps track of a single incoming request

```
class aiocoap.protocol.Context (loop=None,      serversite=None,      loggename='coap',
                                client_credentials=None)
Bases: aiocoap.interfaces.RequestProvider
```

Applications' entry point to the network

A `Context` coordinates one or more network `transports` implementations and dispatches data between them and the application.

The application can start requests using the message dispatch methods, and set a `resources.Site` that will answer requests directed to the application as a server.

On the library-internals side, it is the prime implementation of the `interfaces.RequestProvider` interface, creates `Request` and `Response` classes on demand, and decides which transport implementations to start and which are to handle which messages.

Context creation and destruction

The following functions are provided for creating and stopping a context:

Note: A typical application should only ever create one context, even (or especially when) it acts both as a server and as a client (in which case a server context should be created).

A context that is not used any more must be shut down using `shutdown()`, but typical applications will not need to because they use the context for the full process lifetime.

```
classmethod create_client_context (*, loggename='coap', loop=None)
    Create a context bound to all addresses on a random listening port.
```

This is the easiest way to get a context suitable for sending client requests.

```
classmethod create_server_context (site, bind=None, *, loggename='coap-server',
                                   loop=None, _ssl_context=None, multicast=[])
    Create a context, bound to all addresses on the CoAP port (unless otherwise specified in the bind argument).
```

This is the easiest way to get a context suitable both for sending client and accepting server requests.

The `bind` argument, if given, needs to be a 2-tuple of IP address string and port number, where the port number can be `None` to use the default port.

If `multicast` is given, it needs to be a list of (multicast address, interface name) tuples, which will all be joined. (The IPv4 style of selecting the interface by a local address is not supported; users may want to use the `netifaces` package to arrive at an interface name for an address).

As a shortcut, the list may also contain interface names alone. Those will be joined for the ‘all CoAP nodes’ groups of IPv4 and IPv6 (with scopes 2 and 5) as well as the respective ‘all nodes’ groups in IPv6.

Under some circumstances you may already need a context to pass into the site for creation; this is typically the case for servers that trigger requests on their own. For those cases, it is usually easiest to pass `None` in as a site, and set the fully constructed site later by assigning to the `serversite` attribute.

shutdown()

Take down any listening sockets and stop all related timers.

After this coroutine terminates, and once all external references to the object are dropped, it should be garbage-collectable.

This method may take the time to inform communications partners of stopped observations (but currently does not).

Dispatching messages

CoAP requests can be sent using the following functions:

request (*request_message*, *handle_blockwise=True*)

Create and act on a *Request* object that will be handled according to the provider’s implementation.

Note that the request is not necessarily sent on the wire immediately; it may (but, depend on the transport does not necessarily) rely on the response to be waited for.

If more control is needed, you can create a *Request* yourself and pass the context to it.

Other methods and properties

The remaining methods and properties are to be considered unstable even when the project reaches a stable version number; please file a feature request for stabilization if you want to reliably access any of them.

(Sorry for the duplicates, still looking for a way to make autodoc list everything not already mentioned).

render_to_plumbing_request (*plumbing_request*)

Satisfy a plumbing request from the full `render()` / `needs_blockwise_assembly()` / `add_observation()` interfaces provided by the site.

request (*request_message*, *handle_blockwise=True*)

Create and act on a *Request* object that will be handled according to the provider’s implementation.

Note that the request is not necessarily sent on the wire immediately; it may (but, depend on the transport does not necessarily) rely on the response to be waited for.

classmethod create_client_context (*, *logname='coap'*, *loop=None*)

Create a context bound to all addresses on a random listening port.

This is the easiest way to get a context suitable for sending client requests.

classmethod create_server_context (*site*, *bind=None*, *, *logname='coap-server'*, *loop=None*, *_ssl_context=None*, *multicast=[]*)

Create a context, bound to all addresses on the CoAP port (unless otherwise specified in the `bind` argument).

This is the easiest way to get a context suitable both for sending client and accepting server requests.

The `bind` argument, if given, needs to be a 2-tuple of IP address string and port number, where the port number can be `None` to use the default port.

If `multicast` is given, it needs to be a list of (multicast address, interface name) tuples, which will all be joined. (The IPv4 style of selecting the interface by a local address is not supported; users may want to use the `netifaces` package to arrive at an interface name for an address).

As a shortcut, the list may also contain interface names alone. Those will be joined for the ‘all CoAP nodes’ groups of IPv4 and IPv6 (with scopes 2 and 5) as well as the respective ‘all nodes’ groups in IPv6.

Under some circumstances you may already need a context to pass into the site for creation; this is typically the case for servers that trigger requests on their own. For those cases, it is usually easiest to pass `None` in as a site, and set the fully constructed site later by assigning to the `serversite` attribute.

find_remote_and_interface (*message*)

shutdown ()

Take down any listening sockets and stop all related timers.

After this coroutine terminates, and once all external references to the object are dropped, it should be garbage-collectable.

This method may take the time to inform communications partners of stopped observations (but currently does not).

class `aiocoap.protocol.BaseRequest`

Bases: `object`

Common mechanisms of *Request* and *MulticastRequest*

class `aiocoap.protocol.BaseUnicastRequest`

Bases: `aiocoap.protocol.BaseRequest`

A utility class that offers the *response_raising* and *response_nonraising* alternatives to waiting for the response future whose error states can be presented either as an unsuccessful response (eg. 4.04) or an exception.

It also provides some internal tools for handling anything that has a response future and an observation

response_nonraising

An awaitable that rather returns a 500ish fabricated message (as a proxy would return) instead of raising an exception.

Experimental Interface.

response_raising

An awaitable that returns if a response comes in and is successful, otherwise raises generic network exception or a *error.ResponseWrappingError* for unsuccessful responses.

Experimental Interface.

class `aiocoap.protocol.Request` (*plumbing_request, loop, log*)

Bases: `aiocoap.interfaces.Request, aiocoap.protocol.BaseUnicastRequest`

class `aiocoap.protocol.BlockwiseRequest` (*protocol, app_request*)

Bases: `aiocoap.protocol.BaseUnicastRequest, aiocoap.interfaces.Request`

class `aiocoap.protocol.ClientObservation`

Bases: `object`

An interface to observe notification updates arriving on a request.

This class does not actually provide any of the observe functionality, it is purely a container for dispatching the messages via callbacks or asynchronous iteration. It gets driven (ie. populated with responses or errors including observation termination) by a Request object.

register_callback (*callback*)

Call the callback whenever a response to the message comes in, and pass the response to it.

register_errback (*callback*)

Call the callback whenever something goes wrong with the observation, and pass an exception to the callback. After such a callback is called, no more callbacks will be issued.

callback (*response*)

Notify all listeners of an incoming response

error (*exception*)

Notify registered listeners that the observation went wrong. This can only be called once.

cancel ()

Cease to generate observation or error events. This will not generate an error by itself.

on_cancel (*callback*)

class aiocoap.protocol.**ServerObservation**

Bases: object

accept (*cancellation_callback*)

deregister (*reason=None*)

trigger (*response=None, *, is_last=False*)

Send an updated response; if None is given, the observed resource's rendering will be invoked to produce one.

is_last can be set to True to indicate that no more responses will be sent. Note that an unsuccessful response will be the last no matter what *is_last* says, as such a message always terminates a CoAP observation.

aiocoap.message module

class aiocoap.message.**Message** (**, mtype=None, mid=None, code=None, payload=b'', token=b'', uri=None, **kwargs*)

Bases: object

CoAP Message with some handling metadata

This object's attributes provide access to the fields in a CoAP message and can be directly manipulated.

- Some attributes are additional data that do not round-trip through serialization and deserialization. They are marked as “non-roundtrippable”.
- Some attributes that need to be filled for submission of the message can be left empty by most applications, and will be taken care of by the library. Those are marked as “managed”.

The attributes are:

- *payload*: The payload (body) of the message as bytes.
- *mtype*: Message type (CON, ACK etc, see *numbers.types*). Managed unless set by the application.
- *code*: The code (either request or response code), see *numbers.codes*.
- *opt*: A container for the options, see *options.Options*.
- *mid*: The message ID. Managed by the *Context*.

- `token`: The message's token as bytes. Managed by the `Context`.
- `remote`: The socket address of the other side, managed by the `protocol.Request` by resolving the `.opt.uri_host` or `unresolved_remote`, or the Responder by echoing the incoming request's. Follows the `interfaces.EndpointAddress` interface. Non-roundtrippable.

While a message has not been transmitted, the property is managed by the `Message` itself using the `set_request_uri()` or the constructor `uri` argument.

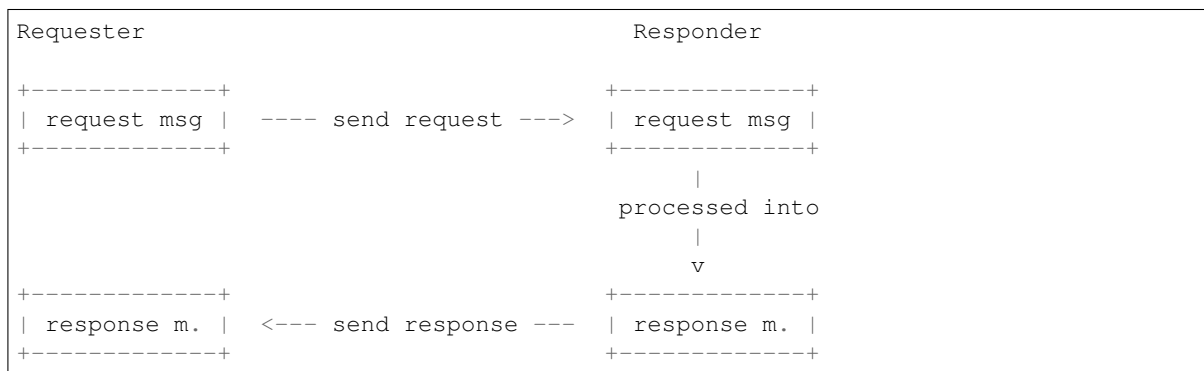
- `request`: The request to which an incoming response message belongs; only available at the client. Managed by the `interfaces.RequestProvider` (typically a `Context`).

These properties are still available but deprecated:

- `requested_*`: Managed by the `protocol.Request` a response results from, and filled with the request's URL data. Non-roundtrippable.
- `unresolved_remote`: `host[:port]` (strictly speaking; `hostinfo` as in a URI) formatted string. If this attribute is set, it overrides `.RequestManageropt.uri_host` (and `__port`) when it comes to filling the `remote` in an outgoing request.

Use this when you want to send a request with a host name that would not normally resolve to the destination address. (Typically, this is used for proxying.)

Options can be given as further keyword arguments at message construction time. This feature is experimental, as future message parameters could collide with options.



The above shows the four message instances involved in communication between an aiocoap client and server process. Boxes represent instances of `Message`, and the messages on the same line represent a single CoAP as passed around on the network. Still, they differ in some aspects:

- The requested URI will look different between requester and responder if the requester uses a host name and does not send it in the message.
- If the request was sent via multicast, the response's requested URI differs from the request URI because it has the responder's address filled in. That address is not known at the responder's side yet, as it is typically filled out by the network stack.
- It is yet unclear whether the response's URI should contain an IP literal or a host name in the unicast case if the `Uri-Host` option was not sent.
- Properties like Message ID and token will differ if a proxy was involved.
- Some options or even the payload may differ if a proxy was involved.

`copy (**kwargs)`

Create a copy of the `Message`. `kwargs` are treated like the named arguments in the constructor, and update the copy.

classmethod decode (*rawdata, remote=None*)

Create Message object from binary representation of message.

encode ()

Create binary representation of message from Message object.

get_cache_key (*ignore_options=()*)

Generate a hashable and comparable object (currently a tuple) from the message's code and all option values that are part of the cache key and not in the optional list of *ignore_options* (which is the list of option numbers that are not technically NoCacheKey but handled by the application using this method).

```
>>> from aiocoap.numbers import GET
>>> m1 = Message(code=GET)
>>> m2 = Message(code=GET)
>>> m1.opt.uri_path = ('s', '1')
>>> m2.opt.uri_path = ('s', '1')
>>> m1.opt.size1 = 10 # the only no-cache-key option in the base spec
>>> m2.opt.size1 = 20
>>> m1.get_cache_key() == m2.get_cache_key()
True
>>> m2.opt.etag = b'000'
>>> m1.get_cache_key() == m2.get_cache_key()
False
>>> from aiocoap.numbers.optionnumbers import OptionNumber
>>> ignore = [OptionNumber.ETAG]
>>> m1.get_cache_key(ignore) == m2.get_cache_key(ignore)
True
```

get_request_uri (*, *local_is_server=False*)

The absolute URI this message belongs to.

For requests, this is composed from the options (falling back to the remote). For responses, this is largely taken from the original request message (so far, that could have been tracked by the requesting application as well), but – in case of a multicast request – with the host replaced by the responder's endpoint details.

This implements Section 6.5 of RFC7252.

By default, these values are only valid on the client. To determine a message's request URI on the server, set the *local_is_server* argument to True. Note that determining the request URI on the server is brittle when behind a reverse proxy, may not be possible on all platforms, and can only be applied to a request message in a renderer (for the response message created by the renderer will only be populated when it gets transmitted; simple manual copying of the request's remote to the response will not magically make this work, for in the very case where the request and response's URIs differ, that would not catch the difference and still report the multicast address, while the actual sending address will only be populated by the operating system later).

set_request_uri (*uri, *, set_uri_host=True*)

Parse a given URI into the *uri_** fields of the options.

The remote does not get set automatically; instead, the remote data is stored in the *uri_host* and *uri_port* options. That is because name resolution is coupled with network specifics the protocol will know better by the time the message is sent. Whatever sends the message, be it the protocol itself, a proxy wrapper or an alternative transport, will know how to handle the information correctly.

When *set_uri_host=False* is passed, the host/port is stored in the *unresolved_remote* message property instead of the *uri_host* option; as a result, the unresolved host name is not sent on the wire, which breaks virtual hosts but makes message sizes smaller.

This implements Section 6.4 of RFC7252.

unresolved_remote
requested_scheme
requested_proxy_uri
requested_hostinfo
requested_path
requested_query

`aiocoap.message.NoResponse = <NoResponse>`

Result that can be returned from a render method instead of a Message when due to defaults (eg. multicast link-format queries) or explicit configuration (eg. the No-Response option), no response should be sent at all. Note that per RFC7967 section 2, an ACK is still sent to a CON request.

Deperated; set the `no_response` option on a regular response instead (see [interfaces.Resource.render\(\)](#) for details).

aiocoap.options module

class `aiocoap.options.Options`

Bases: `object`

Represent CoAP Header Options.

decode (*rawdata*)

Passed a CoAP message body after the token as rawdata, fill self with the options starting at the beginning of rawdata, an return the rest of the message (the body).

encode ()

Encode all options in option header into string of bytes.

add_option (*option*)

Add option into option header.

delete_option (*number*)

Delete option from option header.

get_option (*number*)

Get option with specified number.

option_list ()

uri_path

Iterable view on the URI_PATH option.

uri_query

Iterable view on the URI_QUERY option.

location_path

Iterable view on the LOCATION_PATH option.

location_query

Iterable view on the LOCATION_QUERY option.

block2

Single-value view on the BLOCK2 option.

block1

Single-value view on the BLOCK1 option.

content_format
Single-value view on the CONTENT_FORMAT option.

etag
Single ETag as used in responses

etags
List of ETags as used in requests

if_none_match
Presence of the IF_NONE_MATCH option.

observe
Single-value view on the OBSERVE option.

accept
Single-value view on the ACCEPT option.

uri_host
Single-value view on the URI_HOST option.

uri_port
Single-value view on the URI_PORT option.

proxy_uri
Single-value view on the PROXY_URI option.

proxy_scheme
Single-value view on the PROXY_SCHEME option.

size1
Single-value view on the SIZE1 option.

object_security
Single-value view on the OBJECT_SECURITY option.

max_age
Single-value view on the MAX_AGE option.

if_match
Iterable view on the IF_MATCH option.

no_response
Single-value view on the NO_RESPONSE option.

echo
Single-value view on the ECHO option.

request_tag
Iterable view on the REQUEST_TAG option.

request_hash
Single-value view on the REQUEST_HASH option.

aiocoap.interfaces module

This module provides interface base classes to various aiocoap services, especially with respect to request and response handling.

```
class aiocoap.interfaces.MessageInterface  
    Bases: object
```


A `MessageInterface` is an object that can exchange addressed messages over unreliable transports. Implementations send and receive messages with message type and message ID, and are driven by a `Context` that deals with retransmission.

Usually, an `MessageInterface` refers to something like a local socket, and send messages to different remote endpoints depending on the message's addresses. Just as well, a `MessageInterface` can be useful for one single address only, or use various local addresses depending on the remote address.

send (*message*)

Send a given `Message` object

determine_remote (*message*)

Return a value suitable for the message's remote property based on its `.opt.uri_host` or `.unresolved_remote`.

May return `None`, which indicates that the `MessageInterface` can not transport the message (typically because it is of the wrong scheme).

shutdown ()

Deactivate the complete transport, usually irrevertably. When the coroutine returns, the object must have made sure that it can be destructed by means of ref-counting or a garbage collector run.

class `aiocoap.interfaces.EndpointAddress`

Bases: `object`

An address that is suitable for routing through the application to a remote endpoint.

Depending on the `MessageInterface` implementation used, an `EndpointAddress` property of a message can mean the message is exchanged “with [2001:db8::2:1]:5683, while my local address was [2001:db8:1::1]:5683” (typical of UDP6), “over the connected <Socket at 0x1234>, wherever that's connected to” (simple6 or TCP) or “with participant 0x01 of the OSCAP key 0x... , routed over <another EndpointAddress>”.

`EndpointAddresses` are only constructed by `MessageInterface` objects, either for incoming messages or when populating a message's `.remote` in `MessageInterface.determine_remote()`.

There is no requirement that those address are always identical for a given address. However, incoming addresses must be hashable and hash-compare identically to requests from the same context. The “same context”, for the purpose of `EndpointAddresses`, means that the message must be eligible for request/response, blockwise (de)composition and observations. (For example, in a DTLS context, the hash must change between epochs due to RFC7252 Section 9.1.2).

So far, it is required that hash-identical objects also compare the same. That requirement might go away in future to allow equality to reflect finer details that are not hashed. (The only property that is currently known not to be hashed is the local address in UDP6, because that is *unknown* in initially sent packages, and thus disregarded for comparison but needed to round-trip through responses.)

hostinfo

The authority component of URIs that this endpoint represents when request are sent to it

Note that the presence of a `hostinfo` does not necessarily mean that globally meaningful or even syntactically valid URI can be constructed out of it; use the `uri` property for this.

hostinfo_local

The authority component of URIs that this endpoint represents when requests are sent from it.

As with `hostinfo`, this does not necessarily produce sufficient input for a URI; use `uri_local` instead.

uri

Deprecated alias for `uri_base`

uri_base

The base URI for the peer (typically scheme plus `.hostinfo`).

This raises `error.AnonymousHost` when executed on an address whose peer coordinates can not be expressed meaningfully in a URI.

uri_base_local

The base URI for the local side of this remote.

This raises `error.AnonymousHost` when executed on an address whose local coordinates can not be expressed meaningfully in a URI.

is_multicast

True if the remote address is a multicast address, otherwise false.

is_multicast_locally

True if the local address is a multicast address, otherwise false.

scheme

The that is used with addresses of this kind

This is usually a class property. It is applicable to both sides of the communication. (Should there ever be a scheme that addresses the participants differently, a `scheme_local` will be added.)

maximum_block_size_exp = 6

The maximum negotiated block size that can be sent to this remote.

maximum_payload_size = 1024

The maximum payload size that can be sent to this remote. Only relevant if `maximum_block_size_exp` is 7. This will be removed in favor of a maximum message size when the block handlers can get serialization length predictions from the remote. Must be divisible by 1024.

as_response_address ()

Address to be assigned to a response to messages that arrived with this message

This can (and does, by default) return `self`, but gives the protocol the opportunity to react to create a modified copy to deal with variations from multicast.

authenticated_claims

Iterable of objects representing any claims (e.g. an identity, or generally objects that can be used to authorize particular accesses) that were authenticated for this remote.

This is experimental and may be changed without notice.

Its primary use is on the server side; there, a request handler (or resource decorator) can use the claims to decide whether the client is authorized for a particular request. Use on the client side is planned as a requirement on a request, although (especially on side-effect free non-confidential requests) it can also be used in response processing.

class aiocoap.interfaces.MessageManager

Bases: `object`

The interface an entity that drives a `MessageInterface` provides towards the `MessageInterface` for callbacks and object acquisition.

dispatch_message (message)

Callback to be invoked with an incoming message

dispatch_error (errno, remote)

Callback to be invoked when the operating system indicated an error condition from a particular remote.

This interface is likely to change soon to something that is not limited to `errno`-style errors, and might allow transporting additional data.

client_credentials

A `CredentialsMap` that transports should consult when trying to establish a security context

class aiocoap.interfaces.TokenInterface

Bases: object

send_message (*message*, *messageerror_monitor*) → Optional[Callable[[], None]]

Send a message. If it returns a callable, the caller is asked to call in case it no longer needs the message sent, and to dispose of if it doesn't intend to any more.

messageerror_monitor is a function that will be called at most once by the token interface: When the underlying layer is indicating that this concrete message could not be processed. This is typically the case for RSTs on from the message layer, and used to cancel observations. Errors that are not likely to be specific to a message (like retransmission timeouts, or ICMP errors) are reported through *dispatch_error* instead. (While the information which concrete message triggered that might be available, it is not likely to be relevant).

Currently, it is up to the TokenInterface to unset the *no_response* option in response messages, and to possibly not send them.

fill_or_recognize_remote (*message*)

Return True if the message is recognized to already have a *.remote* managed by this TokenInterface, or return True and set a *.remote* on message if it should (by its unresolved remote or Uri-* options) be routed through this TokenInterface, or return False otherwise.

class aiocoap.interfaces.TokenManager

Bases: object

class aiocoap.interfaces.RequestInterface

Bases: object

request (*request: PlumbingRequest*)

fill_or_recognize_remote (*message*)

class aiocoap.interfaces.RequestProvider

Bases: object

request (*request_message*)

Create and act on a *Request* object that will be handled according to the provider's implementation.

Note that the request is not necessarily sent on the wire immediately; it may (but, depend on the transport does not necessarily) rely on the response to be waited for.

class aiocoap.interfaces.Request

Bases: object

A CoAP request, initiated by sending a message. Typically, this is not instantiated directly, but generated by a *RequestProvider.request()* method.

response = 'A future that is present from the creation of the object and fulfilled with'

class aiocoap.interfaces.Resource

Bases: object

Interface that is expected by a *protocol.Context* to be present on the serversite, which renders all requests to that context.

needs_blockwise_assembly (*request*)

Indicator to the *protocol.Responder* about whether it should assemble request blocks to a single request and extract the requested blocks from a complete-resource answer (True), or whether the resource will do that by itself (False).

render (*request*)

Return a message that can be sent back to the requester.

This does not need to set any low-level message options like `remote`, `token` or `message type`; it does however need to set a response code.

A response returned may carry a `no_response` option (which is actually specified to apply to requests only); the underlying transports will decide based on that and its code whether to actually transmit the response.

class `aiocoap.interfaces.ObservableResource`

Bases: `aiocoap.interfaces.Resource`

Interface the `protocol.ServerObservation` uses to negotiate whether an observation can be established based on a request.

This adds only functionality for registering and unregistering observations; the notification contents will be retrieved from the resource using the regular `render()` method from crafted (fake) requests.

add_observation (*request*, *serverobservation*)

Before the incoming request is sent to `render()`, the `add_observation()` method is called. If the resource chooses to accept the observation, it has to call the `serverobservation.accept(cb)` with a callback that will be called when the observation ends. After accepting, the `ObservableResource` should call `serverobservation.trigger()` whenever it changes its state; the `ServerObservation` will then initiate notifications by having the request rendered again.

aiocoap.error module

Common errors for the aiocoap library

exception `aiocoap.error.Error`

Bases: `Exception`

Base exception for all exceptions that indicate a failed request

exception `aiocoap.error.RenderableError`

Bases: `aiocoap.error.Error`

Exception that can meaningfully be represented in a CoAP response

to_message ()

Create a CoAP message that should be sent when this exception is rendered

exception `aiocoap.error.ResponseWrappingError` (*coapmessage*)

Bases: `aiocoap.error.Error`

An exception that is raised due to an unsuccessful but received response.

A better relationship with `numbers.codes` should be worked out to do except `UnsupportedMediaType` (similar to the various `OSError` subclasses).

to_message ()

exception `aiocoap.error.ConstructionRenderableError` (*message=None*)

Bases: `aiocoap.error.RenderableError`

`RenderableError` that is constructed from class attributes `code` and `message` (where the can be overridden in the constructor).

to_message ()

Create a CoAP message that should be sent when this exception is rendered

code = `<Response Code 160 "5.00 Internal Server Error">`

Code assigned to messages built from it

message = ''

Text sent in the built message's payload

```

exception aiocoap.error.NotFound (message=None)
    Bases: aiocoap.error.ConstructionRenderableError

    code = <Response Code 132 "4.04 Not Found">

exception aiocoap.error.MethodNotAllowed (message=None)
    Bases: aiocoap.error.ConstructionRenderableError

    code = <Response Code 133 "4.05 Method Not Allowed">

exception aiocoap.error.UnsupportedContentFormat (message=None)
    Bases: aiocoap.error.ConstructionRenderableError

    code = <Response Code 143 "4.15 Unsupported Media Type">

exception aiocoap.error.Unauthorized (message=None)
    Bases: aiocoap.error.ConstructionRenderableError

    code = <Response Code 129 "4.01 Unauthorized">

exception aiocoap.error.BadRequest (message=None)
    Bases: aiocoap.error.ConstructionRenderableError

    code = <Response Code 128 "4.00 Bad Request">

exception aiocoap.error.NoResource
    Bases: aiocoap.error.NotFound

    Raised when resource is not found.

    message = 'Error: Resource not found!'

exception aiocoap.error.UnallowedMethod (message=None)
    Bases: aiocoap.error.MethodNotAllowed

    Raised by a resource when request method is understood by the server but not allowed for that particular resource.

    message = 'Error: Method not allowed!'

exception aiocoap.error.UnsupportedMethod (message=None)
    Bases: aiocoap.error.MethodNotAllowed

    Raised when request method is not understood by the server at all.

    message = 'Error: Method not recognized!'

exception aiocoap.error.NotImplemented
    Bases: aiocoap.error.Error

    Raised when request is correct, but feature is not implemented by library. For example non-sequential blockwise transfers

exception aiocoap.error.RequestTimedOut
    Bases: aiocoap.error.Error

    Raised when request is timed out.

exception aiocoap.error.WaitingForClientTimedOut
    Bases: aiocoap.error.Error

    Raised when server expects some client action:
    
```

- sending next PUT/POST request with block1 or block2 option
- sending next GET request with block2 option

but client does nothing.

exception `aiocoap.error.ResourceChanged`

Bases: `aiocoap.error.Error`

The requested resource was modified during the request and could therefore not be received in a consistent state.

exception `aiocoap.error.UnexpectedBlock1Option`

Bases: `aiocoap.error.Error`

Raised when a server responds with block1 options that just don't match.

exception `aiocoap.error.UnexpectedBlock2`

Bases: `aiocoap.error.Error`

Raised when a server responds with another block2 than expected.

exception `aiocoap.error.MissingBlock2Option`

Bases: `aiocoap.error.Error`

Raised when response with Block2 option is expected (previous response had Block2 option with More flag set), but response without Block2 option is received.

exception `aiocoap.error.NotObservable`

Bases: `aiocoap.error.Error`

The server did not accept the request to observe the resource.

exception `aiocoap.error.ObservationCancelled`

Bases: `aiocoap.error.Error`

The server claimed that it will no longer sustain the observation.

exception `aiocoap.error.UnparsableMessage`

Bases: `aiocoap.error.Error`

An incoming message does not look like CoAP.

Note that this happens rarely – the requirements are just two bit at the beginning of the message, and a minimum length.

exception `aiocoap.error.LibraryShutdown`

Bases: `aiocoap.error.Error`

The library or a transport registered with it was requested to shut down; this error is raised in all outstanding requests.

exception `aiocoap.error.AnonymousHost`

Bases: `aiocoap.error.Error`

This is raised when it is attempted to express as a reference a (base) URI of a host or a resource that can not be reached by any process other than this.

Typically, this happens when trying to serialize a link to a resource that is hosted on a CoAP-over-TCP or -WebSockets client: Such resources can be accessed for as long as the connection is active, but can not be used any more once it is closed or even by another system.

exception `aiocoap.error.NetworkError`

Bases: `aiocoap.error.Error`

Base class for all “something went wrong with name resolution, sending or receiving packages”.

Errors of these kinds are raised towards client callers when things went wrong network-side, or at context creation. They are often raised from `socket.gaierror` or similar classes, but these are wrapped in order to make catching them possible independently of the underlying transport.

exception `aiocoap.error.ResolutionError`

Bases: `aiocoap.error.NetworkError`

Resolving the host component of a URI to a usable transport address was not possible

exception `aiocoap.error.MessageError`

Bases: `aiocoap.error.NetworkError`

Received an error from the remote on the CoAP message level (typically a RST)

aiocoap.defaults module

This module contains helpers that inspect available modules and platform specifics to give sane values to aiocoap defaults.

All of this should eventually be overridable by other libraries wrapping/using aiocoap and by applications using aiocoap; however, these overrides do not happen in the defaults module but where these values are actually accessed, so this module is considered internal to aiocoap and not part of the API.

The `_missing_modules` functions are helpers for inspecting what is reasonable to expect to work. They can influence default values, but should not be used in the rest of the code for feature checking (just raise the `ImportErrors`) unless it's directly user-visible ("You configured OSCORE key material, but OSCORE needs the following unavailable modules") or in the test suite to decide which tests to skip.

`aiocoap.defaults.get_default_clienttransports (*, loop=None, use_env=True)`

Return a list of transports that should be connected when a client context is created.

If an explicit `AIOCOAP_CLIENT_TRANSPORT` environment variable is set, it is read as a colon separated list of transport names.

By default, a DTLS mechanism will be picked if the required modules are available, and a UDP transport will be selected depending on whether the full `udp6` transport is known to work.

`aiocoap.defaults.get_default_servertransports (*, loop=None, use_env=True)`

Return a list of transports that should be connected when a server context is created.

If an explicit `AIOCOAP_SERVER_TRANSPORT` environment variable is set, it is read as a colon separated list of transport names.

By default, a DTLS mechanism will be picked if the required modules are available, and a UDP transport will be selected depending on whether the full `udp6` transport is known to work. Both a `simple6` and a `simplesocketserver` will be selected when `udp6` is not available, and the `simple6` will be used for any outgoing requests, which the `simplesocketserver` could serve but is worse at.

`aiocoap.defaults.has_reuse_port (*, use_env=True)`

Return true if the platform indicates support for `SO_REUSEPORT`.

Can be overridden by explicitly setting `AIOCOAP_REUSE_PORT` to 1 or 0.

`aiocoap.defaults.dtls_missing_modules ()`

Return a list of modules that are missing in order to use the DTLS transport, or a false value if everything is present

`aiocoap.defaults.oscore_missing_modules ()`

Return a list of modules that are missing in order to use OSCORE, or a false value if everything is present

`aiocoap.defaults.ws_missing_modules ()`

Return a list of modules that are missing in order to use CoAP-over-WS, or a false value if everything is present

`aiocoap.defaults.linkheader_missing_modules ()`

Return a list of modules that are missing in order to use `link_header` functionality (eg. running a resource directory), or a false value if everything is present.

`aiocoap.defaults.prettyprint_missing_modules()`

Return a list of modules that are missing in order to use pretty printing (ie. full aiocoap-client)

aiocoap.transports module

Container module for transports

Transports are expected to be the modular backends of aiocoap, and implement the specifics of eg. TCP, WebSockets or SMS, possibly divided by backend implementations as well.

Transports are not part of the API, so the class descriptions in the modules are purely informational.

Multiple transports can be used in parallel in a single *Context*, and are loaded in a particular sequence. Some transports will grab all addresses of a given protocol, so they might not be practical to combine. Which transports are started in a given Context follows the `defaults.get_default_clienttransports()` function.

The available transports are:

aiocoap.transports.generic_udp module

class `aiocoap.transports.generic_udp.GenericMessageInterface` (*ctx*: *aio-coap.interfaces.MessageManager*, *log*, *loop*)

Bases: `aio-coap.interfaces.MessageInterface`

`GenericMessageInterface` is not a standalone implementation of a message interface. It does implement everything between the `MessageInterface` and a not yet fully specified interface of “bound UDP sockets”.

determine_remote (*request*)

Return a value suitable for the message’s remote property based on its `.opt.uri_host` or `.unresolved_remote`.

May return `None`, which indicates that the `MessageInterface` can not transport the message (typically because it is of the wrong scheme).

shutdown ()

Deactivate the complete transport, usually irrevertably. When the coroutine returns, the object must have made sure that it can be destructed by means of ref-counting or a garbage collector run.

send (*message*)

Send a given `Message` object

aiocoap.transports.oscore module

This module implements a `RequestProvider` for OSCORE. As such, it takes routing ownership of requests that it has a security context available for, and sends off the protected messages via another transport.

This transport is a bit different from the others because it doesn’t have its dedicated URI scheme, but purely relies on preconfigured contexts.

So far, this transport only deals with outgoing requests, and does not help in building an OSCORE server. (Some code that could be used here in future resides in `contrib/oscore-plugtest/plugtest-server` as the `ProtectedSite` class.

In outgoing request, this transport automatically handles Echo options that appear to come from RFC8613 Appendix B.1.2 style servers. They indicate that the server could not process the request initially, but could do so if the client retransmits it with an appropriate Echo value.

Unlike other transports that could (at least in theory) be present multiple times in `aiocoap.protocol.Context.request_interfaces` (eg. because there are several bound sockets), this is only useful once in there, as

it has no own state, picks the OSCORE security context from the CoAP `aiocoap.protocol.Context.client_credentials` when populating the remote field, and handles any populated request based on its `remote.security_context` property alone.

class `aiocoap.transports.oscore.OSCOREAddress`

Bases: `aiocoap.transports.oscore._OSCOREAddress`, `aiocoap.interfaces.EndpointAddress`

Remote address type for **:cls:'TransportOSCORE'**.

hostinfo

The authority component of URIs that this endpoint represents when request are sent to it

Note that the presence of a `hostinfo` does not necessarily mean that globally meaningful or even syntactically valid URI can be constructed out of it; use the `uri` property for this.

hostinfo_local

The authority component of URIs that this endpoint represents when requests are sent from it.

As with `hostinfo`, this does not necessarily produce sufficient input for a URI; use `uri_local` instead.

uri_base

The base URI for the peer (typically scheme plus `.hostinfo`).

This raises `error.AnonymousHost` when executed on an address whose peer coordinates can not be expressed meaningfully in a URI.

uri_base_local

The base URI for the local side of this remote.

This raises `error.AnonymousHost` when executed on an address whose local coordinates can not be expressed meaningfully in a URI.

scheme

The that is used with addresses of this kind

This is usually a class property. It is applicable to both sides of the communication. (Should there ever be a scheme that addresses the participants differently, a `scheme_local` will be added.)

authenticated_claims

Iterable of objects representing any claims (e.g. an identity, or generally objects that can be used to authorize particular accesses) that were authenticated for this remote.

This is experimental and may be changed without notice.

Its primary use is on the server side; there, a request handler (or resource decorator) can use the claims to decide whether the client is authorized for a particular request. Use on the client side is planned as a requirement on a request, although (especially on side-effect free non-confidential requests) it can also be used in response processing.

is_multicast = False

maximum_payload_size = 1024

maximum_block_size_exp = 6

class `aiocoap.transports.oscore.TransportOSCORE` (*context, forward_context*)

Bases: `aiocoap.interfaces.RequestProvider`

request (*request*)

Create and act on a `Request` object that will be handled according to the provider's implementation.

Note that the request is not necessarily sent on the wire immediately; it may (but, depend on the transport does not necessarily) rely on the response to be waited for.

```
fill_or_recognize_remote (message)  
shutdown ()
```

aiocoap.transports.rfc8323common module

Common code for the tcp and the ws modules, both of which are based on RFC8323 mechanisms, but differ in their underlying protocol implementations (asyncio stream vs. websockets module) far enough that they only share small portions of their code

```
class aiocoap.transports.rfc8323common.RFC8323Remote
```

```
    Bases: object
```

```
    Mixin for Remotes for all the common RFC8323 processing
```

```
    Implementations still need the per-transport parts, especially a _send_message and an _abort_with implementation.
```

```
    is_multicast = False
```

```
    is_multicast_locally = False
```

```
    hostinfo
```

```
    hostinfo_local
```

```
    uri_base
```

```
    uri_base_local
```

```
    maximum_block_size_exp
```

```
    maximum_payload_size
```

```
    abort (errormessage=None, bad_csm_option=None)
```

aiocoap.transports.simple6 module

This module implements a MessageInterface for UDP based on the asyncio DatagramProtocol.

This is a simple version that works only for clients (by creating a dedicated unbound but connected socket for each communication partner) and probably not with multicast (it is assumed to be unsafe for multicast), which can be expected to work even on platforms where the `udp6` module can not be made to work (Android, OSX, Windows for missing `recvmsg` and socket options, or any event loops that don't have an `add_reader` method).

Note that the name of the module is a misnomer (and the module is likely to be renamed): Nothing in it is IPv6 specific; the socket is created using whichever address family the OS chooses based on the given host name.

One small but noteworthy detail about this transport is that it does not distinguish between IP literals and host names. As a result, requests and responses from remotes will appear to arrive from a remote whose netloc is the requested name, not an IP literal.

This transport is experimental, likely to change, and not fully tested yet (because the test suite is not yet ready to matrix-test the same tests with different transport implementations, and because it still fails in proxy blockwise tests).

For one particular use case, this may be usable for servers in a sense: If (and only if) all incoming requests are only ever sent from clients that were previously addressed as servers by the running instance. (This is generally undesirable as it greatly limits the usefulness of the server, but is used in LwM2M setups). As such a setup makes demands on the peer that are not justified by the CoAP specification (in particular, that it send requests from a particular port), this should still only be used for cases where the `udp6` transport is unavailable due to platform limitations.

```

class aiocoap.transports.simple6.MessageInterfaceSimple6 (ctx:
                                                    aio-
                                                    coap.interfaces.MessageManager,
                                                    log, loop)
    Bases: aiocoap.transports.generic_udp.GenericMessageInterface
    classmethod create_client_transport_endpoint (ctx, log, loop)
    recognize_remote (remote)

```

aiocoap.transports.simplesocketserver module

This module implements a MessageInterface for UDP based on the asyncio DatagramProtocol.

This is a simple version that works only for servers bound to a single unicast address. It provides a server backend in situations when *udp6* is unavailable and *simple6* needs to be used for clients.

While it is in theory capable of sending requests too, it should not be used like that, because it won't receive ICMP errors (see below).

Shortcomings

- This implementation does not receive ICMP errors. This violates the CoAP standard and can lead to unnecessary network traffic, bad user experience (when used for client requests) or even network attack amplification.
- The server can not be used with the “any-address” (: : , 0 . 0 . 0 . 0). If it were allowed to bind there, it would not receive any indication from the operating system as to which of its own addresses a request was sent, and could not send the response with the appropriate sender address.

(The *udp6* transport does not suffer that shortcoming, *simplesocketserver* is typically only used when that is unavailable).

With *simplesocketserver*, you need to explicitly give the IP address of your server in the *bind* argument of *aiocoap.protocol.Context.create_server_context()*.

- This transport is experimental and likely to change.

```

class aiocoap.transports.simplesocketserver.MessageInterfaceSimpleServer (ctx:
                                                    aio-
                                                    coap.interfaces.MessageM
                                                    log,
                                                    loop)
    Bases: aiocoap.transports.generic_udp.GenericMessageInterface
    classmethod create_server (bind, ctx: aiocoap.interfaces.MessageManager, log, loop)
    recognize_remote (remote)

```

aiocoap.transports.tcp module

```

class aiocoap.transports.tcp.TcpConnection (ctx, log, loop, *, is_server)
    Bases: asyncio.protocols.Protocol, aiocoap.transports.rfc8323common.
    RFC8323Remote, aiocoap.interfaces.EndpointAddress

```

scheme

The that is used with addresses of this kind

This is usually a class property. It is applicable to both sides of the communication. (Should there ever be a scheme that addresses the participants differently, a *scheme_local* will be added.)

connection_made (*transport*)

Called when a connection is made.

The argument is the transport representing the pipe connection. To receive data, wait for `data_received()` calls. When the connection is closed, `connection_lost()` is called.

connection_lost (*exc*)

Called when the connection is lost or closed.

The argument is an exception object or `None` (the latter meaning a regular EOF is received or the connection was aborted or closed).

data_received (*data*)

Called when some data is received.

The argument is a bytes object.

eof_received ()

Called when the other end calls `write_eof()` or equivalent.

If this returns a false value (including `None`), the transport will close itself. If it returns a true value, closing the transport is up to the protocol.

pause_writing ()

Called when the transport's buffer goes over the high-water mark.

Pause and resume calls are paired – `pause_writing()` is called once when the buffer goes strictly over the high-water mark (even if subsequent writes increases the buffer size even more), and eventually `resume_writing()` is called once when the buffer size reaches the low-water mark.

Note that if the buffer size equals the high-water mark, `pause_writing()` is not called – it must go strictly over. Conversely, `resume_writing()` is called when the buffer size is equal or lower than the low-water mark. These end conditions are important to ensure that things go as expected when either mark is zero.

NOTE: This is the only Protocol callback that is not called through `EventLoop.call_soon()` – if it were, it would have no effect when it's most needed (when the app keeps writing without yielding until `pause_writing()` is called).

resume_writing ()

Called when the transport's buffer drains below the low-water mark.

See `pause_writing()` for details.

class `aiocoap.transports.tcp.TCPServer`

Bases: `aiocoap.transports.tcp._TCPPooling`, `aiocoap.interfaces.TokenInterface`

classmethod `create_server` (*bind*, *tman*: `aiocoap.interfaces.TokenManager`, *log*, *loop*, *, *_server_context*=`None`)

fill_or_recognize_remote (*message*)

Return `True` if the message is recognized to already have a `.remote` managed by this `TokenInterface`, or return `True` and set a `.remote` on message if it should (by its unresolved `remote` or `Uri-*` options) be routed through this `TokenInterface`, or return `False` otherwise.

shutdown ()**class** `aiocoap.transports.tcp.TCPClient`

Bases: `aiocoap.transports.tcp._TCPPooling`, `aiocoap.interfaces.TokenInterface`

classmethod `create_client_transport` (*tman*: `aiocoap.interfaces.TokenManager`, *log*, *loop*, *credentials*=`None`)

fill_or_recognize_remote (*message*)

Return `True` if the message is recognized to already have a `.remote` managed by this `TokenInterface`, or

return True and set a `.remote` on message if it should (by its unresolved remote or `Uri-*` options) be routed through this `TokenInterface`, or return False otherwise.

shutdown()

aiocoap.transports.tinydtls module

This module implements a `MessageInterface` that handles `coaps://` using a wrapped `tinydtls` library.

This currently only implements the client side. To have a test server, run:

```
$ git clone https://github.com/obgm/libcoap.git --recursive
$ cd libcoap
$ ./autogen.sh
$ ./configure --with-tinydtls --disable-shared --disable-documentation
$ make
$ ./examples/coap-server -k secretPSK
```

(Using `TinyDTLS` in `libcoap` is important; with the default `OpenSSL` build, I've seen `DTLS1.0` responses to `DTLS1.3` requests, which are hard to debug.)

The test server with its built-in credentials can then be accessed using:

```
$ echo '{"coaps://localhost/*": {"dtls": {"psk": {"ascii": "secretPSK"}, "client-identity": {"ascii": "client_Identity"}}}}' > testserver.json
$ ./aiocoap-client coaps://localhost --credentials testserver.json
```

While it is planned to allow more programmatical construction of the credentials store, the currently recommended way of storing `DTLS` credentials is to load a structured data object into the `client_credentials` store of the context:

```
>>> c = await aiocoap.Context.create_client_context() # doctest: +SKIP
>>> c.client_credentials.load_from_dict(
...     {'coaps://localhost/*': {'dtls': {
...         'psk': b'secretPSK',
...         'client-identity': b'client_Identity',
...     }}}) # doctest: +SKIP
```

where, compared to the `JSON` example above, byte strings can be used directly rather than expressing them as `'ascii'/'hex'` (`'hex': '30383135'` style works as well) to work around `JSON`'s limitation of not having raw binary strings.

Bear in mind that the `aiocoap` `CoAPS` support is highly experimental; for example, while requests to this server do complete, error messages are still shown during client shutdown.

exception `aiocoap.transports.tinydtls.CloseNotifyReceived`

Bases: `Exception`

The `DTLS` connection a request was sent on raised was closed by the server while the request was being processed

exception `aiocoap.transports.tinydtls.FatalDTLSError`

Bases: `Exception`

The `DTLS` connection a request was sent on raised a fatal error while the request was being processed

class `aiocoap.transports.tinydtls.DTLSClientConnection` (*host, port, pskId, psk, coap-transport*)

Bases: `aiocoap.interfaces.EndpointAddress`

is_multicast = `False`

```
is_multicast_locally = False
```

```
uri_base
```

```
uri_base_local
```

```
scheme = 'coaps'
```

```
hostinfo_local
```

The authority component of URIs that this endpoint represents when requests are sent from it.

As with *hostinfo*, this does not necessarily produce sufficient input for a URI; use *uri_local* instead.

```
hostinfo = None
```

```
send(message)
```

```
log
```

```
shutdown()
```

```
class SingleConnection(parent)
```

Bases: `object`

```
classmethod factory(parent)
```

```
parent = None
```

`DTLSClientConnection`

```
connection_made(transport)
```

```
connection_lost(exc)
```

```
error_received(exc)
```

```
datagram_received(data, addr)
```

```
class aiocoap.transports.tinydtls.MessageInterfaceTinyDTLS(ctx: aio-  
coap.interfaces.MessageManager,  
log, loop)
```

Bases: `aiocoap.interfaces.MessageInterface`

```
classmethod create_client_transport_endpoint(ctx: aio-  
coap.interfaces.MessageManager,  
log, loop)
```

```
determine_remote(request)
```

Return a value suitable for the message's remote property based on its `.opt.uri_host` or `.unresolved_remote`.

May return `None`, which indicates that the `MessageInterface` can not transport the message (typically because it is of the wrong scheme).

```
recognize_remote(remote)
```

```
shutdown()
```

Deactivate the complete transport, usually irrevertably. When the coroutine returns, the object must have made sure that it can be destructed by means of ref-counting or a garbage collector run.

```
send(message)
```

Send a given `Message` object

aiocoap.transports.tls module

CoAP-over-TLS transport (early work in progress)

Right now this is running on self-signed, hard-coded certificates with default SSL module options.

To use this, generate keys as with:

```
$ openssl req -x509 -newkey rsa:4096 -keyout key.pem -out cert.pem -days 5 -nodes
```

and state your hostname (eg. localhost) when asked for the Common Name.

class aiocoap.transports.tls.TLSServer

Bases: aiocoap.transports.tls._TLSMixIn, *aiocoap.transports.tcp.TCPServer*

classmethod create_server (*bind, tman, log, loop, server_context*)

class aiocoap.transports.tls.TLSClient

Bases: aiocoap.transports.tls._TLSMixIn, *aiocoap.transports.tcp.TCPClient*

aiocoap.transports.udp6 module

This module implements a MessageInterface for UDP based on a variation of the asyncio DatagramProtocol.

This implementation strives to be correct and complete behavior while still only using a single socket; that is, to be usable for all kinds of multicast traffic, to support server and client behavior at the same time, and to work correctly even when multiple IPv6 and IPv4 (using V4MAPPED addresses) interfaces are present, and any of the interfaces has multiple addresses.

This requires using some standardized but not necessarily widely ported features: AI_V4MAPPED to support IPv4 without resorting to less standardized mechanisms for later options, IPV6_RECVPKTINFO to determine incoming packages' destination addresses (was it multicast) and to return packages from the same address, IPV6_JOIN_GROUP for multicast membership management and recvmsg to obtain data configured with the above options.

To the author's knowledge, there is no standardized mechanism for receiving ICMP errors in such a setup. On Linux, IPV6_RECVERR and MSG_ERRQUEUE are used to receive ICMP errors from the socket; on other platforms, a warning is emitted that ICMP errors are ignored. Using a *simple6* for clients is recommended for those when working as a client only.

Exceeding for the above error handling, no attempts are made to fall back to a kind-of-correct or limited-functionality behavior if these options are unavailable, for the resulting code would be hard to maintain ("ifdef hell") or would cause odd bugs at users (eg. servers that stop working when an additional IPv6 address gets assigned). If the module does not work for you, and the options can not be added easily to your platform, consider using the *simple6* module instead.

class aiocoap.transports.udp6.InterfaceOnlyPktinfo

Bases: bytes

A thin wrapper over bytes that represent a pktinfo built just to select an outgoing interface.

This must not be treated any different than a regular pktinfo, and is just tagged for better debug output. (Ie. if this is replaced everywhere with plain *bytes*, things must still work).

class aiocoap.transports.udp6.UDP6EndpointAddress (*sockaddr, interface, *, pkt-*
info=None)

Bases: *aiocoap.interfaces.EndpointAddress*

Remote address type for **:cls:'MessageInterfaceUDP6'**. Remote address is stored in form of a socket address; local address can be roundtripped by opaque pktinfo data.

For purposes of equality (and thus hashing), the local address is *not* checked. Neither is the scopeid that is part of the socket address.

```

>>> interface = type("FakeMessageInterface", (), {})
>>> if1_name = socket.if_indextoname(1)
>>> local = UDP6EndpointAddress(socket.getaddrinfo('127.0.0.1', 5683, type=socket.
↳SOCK_DGRAM, family=socket.AF_INET6, flags=socket.AI_V4MAPPED)[0][-1], interface)
>>> local.is_multicast
False
>>> local.hostinfo
'127.0.0.1'
>>> all_coap_link1 = UDP6EndpointAddress(socket.getaddrinfo('ff02:0:0:0:0:0:fd%1
↳', 1234, type=socket.SOCK_DGRAM, family=socket.AF_INET6)[0][-1], interface)
>>> all_coap_link1.is_multicast
True
>>> all_coap_link1.hostinfo == '[ff02::fd%{}]:1234'.format(if1_name)
True
>>> all_coap_site = UDP6EndpointAddress(socket.getaddrinfo('ff05:0:0:0:0:0:fd',
↳1234, type=socket.SOCK_DGRAM, family=socket.AF_INET6)[0][-1], interface)
>>> all_coap_site.is_multicast
True
>>> all_coap_site.hostinfo
'[ff05::fd]:1234'
>>> all_coap4 = UDP6EndpointAddress(socket.getaddrinfo('224.0.1.187', 5683,
↳type=socket.SOCK_DGRAM, family=socket.AF_INET6, flags=socket.AI_V4MAPPED)[0][
↳1], interface)
>>> all_coap4.is_multicast
True

```

scheme = 'coap'

interface

netif

Textual interface identifier of the explicitly configured remote interface, or the interface identifier reported in an incoming link-local message. None if not set.

hostinfo

The authority component of URIs that this endpoint represents when request are sent to it

Note that the presence of a hostinfo does not necessarily mean that globally meaningful or even syntactically valid URI can be constructed out of it; use the *uri* property for this.

hostinfo_local

The authority component of URIs that this endpoint represents when requests are sent from it.

As with *hostinfo*, this does not necessarily produce sufficient input for a URI; use *uri_local* instead.

uri_base

The base URI for the peer (typically scheme plus .hostinfo).

This raises *error.AnonymousHost* when executed on an address whose peer coordinates can not be expressed meaningfully in a URI.

uri_base_local

The base URI for the local side of this remote.

This raises *error.AnonymousHost* when executed on an address whose local coordinates can not be expressed meaningfully in a URI.

is_multicast

True if the remote address is a multicast address, otherwise false.

is_multicast_locally

True if the local address is a multicast address, otherwise false.

as_response_address ()

Address to be assigned to a response to messages that arrived with this message

This can (and does, by default) return self, but gives the protocol the opportunity to react to create a modified copy to deal with variations from multicast.

class aiocoap.transports.udp6.**SockExtendedErr**

Bases: aiocoap.transports.udp6._SockExtendedErr

classmethod load (*data*)**class** aiocoap.transports.udp6.**MessageInterfaceUDP6** (*ctx:* *aio-*
coap.interfaces.MessageManager,
log, loop)

Bases: aiocoap.util.asyncio.recvmsg.RecvmsgDatagramProtocol, *aiocoap.interfaces.MessageInterface*

ready = None

Future that gets fulfilled by connection_made (ie. don't send before this is done; handled by create_..._context

send (*message*)

Send a given Message object

classmethod create_client_transport_endpoint (*ctx:* *aio-*
coap.interfaces.MessageManager,
log, loop)**classmethod** create_server_transport_endpoint (*ctx:* *aio-*
coap.interfaces.MessageManager,
log, loop, bind, multicast)**determine_remote** (*request*)

Return a value suitable for the message's remote property based on its .opt.uri_host or .unresolved_remote.

May return None, which indicates that the MessageInterface can not transport the message (typically because it is of the wrong scheme).

recognize_remote (*remote*)**shutdown** ()

Deactivate the complete transport, usually irrevertably. When the coroutine returns, the object must have made sure that it can be destructed by means of ref-counting or a garbage collector run.

connection_made (*transport*)

Implementation of the DatagramProtocol interface, called by the transport.

datagram_msg_received (*data, ancdata, flags, address*)

Implementation of the RecvmsgDatagramProtocol interface, called by the transport.

datagram_errqueue_received (*data, ancdata, flags, address*)

Called when some data is received from the error queue

error_received (*exc*)

Implementation of the DatagramProtocol interface, called by the transport.

connection_lost (*exc*)

Called when the connection is lost or closed.

The argument is an exception object or None (the latter meaning a regular EOF is received or the connection was aborted or closed).

aiocoap.transports.ws module

This module implements a TokenInterface for CoAP over WebSockets.

As with CoAP-over-TCP, while the transport distinguishes a connection initiator (“WebSocket (and TCP) client”) and a receiver (“WebSocket (and TCP) server”), both sides can take both roles in CoAP (ie. as a CoAP server and a CoAP client). As the WebSocket client can not possibly be connected to (even by the same server – once the connection is closed, it’s gone and even a new one likely has a different port), aiocoap does not allow expressing their addresses in URIs (given they wouldn’t serve their purpose as URLs and don’t provide any stability either). Requests to a CoAP-over-WS client can be made by assigning the remote to an outgoing request.

Port choice

Unlike the other transports, CoAP-over-WS is specified with a privileged port (port 80) as the default port. This is impractical for aiocoap servers for two reasons:

- Unless explicitly configured, aiocoap is typically run as an unprivileged user (and has no provisions in place to receive a socket by other means than opening it).
- Where a CoAP-over-WS proxy is run, there is often a “proper” website running on the same port on a full HTTP server. That server is usually capable of forwarding requests, whereas the `websockets` module used by aiocoap is in no position to either serve websites nor to proxy to an underlying server.

The recommended setup is therefore to run a full web server at port 80, and configure it to proxy incoming requests for WebSockets at `/.well-known/coap` to aiocoap’s server, which defaults to binding to port 8683.

The port choice of outgoing connections, or the interpretation of the protocol’s default port (ie. the port implied by `coap+ws://hostname/`) is of course unaffected by this.

Warning: Due to a shortcoming of aiocoap’s way of specifying ports to bind to, if a port is explicitly stated to bind to, CoAP-over-WS will bind to that port plus 3000 (resulting in the abovementioned 8683 for 5683). If TLS server keys are given, the TLS server is launched on the next port after the HTTP server (typically 8684).

```
class aiocoap.transports.ws.PoolKey(scheme, hostinfo)
    Bases: tuple
    hostinfo
        Alias for field number 1
    scheme
        Alias for field number 0

class aiocoap.transports.ws.WSRemote(pool, connection, loop, log, *, scheme, local_hostinfo=None, remote_hostinfo=None)
    Bases: aiocoap.transports.rfc8323common.RFC8323Remote, aiocoap.interfaces.EndpointAddress
    scheme = None

class aiocoap.transports.ws.WSPool(tman, log, loop)
    Bases: aiocoap.interfaces.TokenInterface
    classmethod create_transport(tman: aiocoap.interfaces.TokenManager, log, loop, *, client_credentials, server_bind=None, server_context=None)
    fill_or_recognize_remote(message)
        Return True if the message is recognized to already have a .remote managed by this TokenInterface, or
```

return True and set a `.remote` on message if it should (by its unresolved remote or Uri-* options) be routed through this TokenInterface, or return False otherwise.

shutdown ()

send_message (*message*, *messageerror_monitor*)

Send a message. If it returns a callable, the caller is asked to call in case it no longer needs the message sent, and to dispose of if it doesn't intend to any more.

`messageerror_monitor` is a function that will be called at most once by the token interface: When the underlying layer is indicating that this concrete message could not be processed. This is typically the case for RSTs on from the message layer, and used to cancel observations. Errors that are not likely to be specific to a message (like retransmission timeouts, or ICMP errors) are reported through `dispatch_error` instead. (While the information which concrete message triggered that might be available, it is not likely to be relevant).

Currently, it is up to the TokenInterface to unset the `no_response` option in response messages, and to possibly not send them.

aiocoap.proxy module

Container module, see submodules:

- `client` – using CoAP via a proxy server
- `server` – running a proxy server

aiocoap.proxy.client module

class `aiocoap.proxy.client.ProxyForwarder` (*proxy_address*, *context*)

Bases: `aiocoap.interfaces.RequestProvider`

Object that behaves like a Context but only provides the request function and forwards all messages to a proxy.

This is not a proxy itself, it is just the interface for an external one.

proxy

request (*message*, ***kwargs*)

Create and act on a Request object that will be handled according to the provider's implementation.

Note that the request is not necessarily sent on the wire immediately; it may (but, depend on the transport does not necessarily) rely on the response to be waited for.

class `aiocoap.proxy.client.ProxyRequest` (*proxy*, *app_request*, *exchange_monitor_factory*=<function *ProxyRequest.<lambda>>*>)

Bases: `aiocoap.interfaces.Request`

class `aiocoap.proxy.client.ProxyClientObservation`

Bases: `aiocoap.protocol.ClientObservation`

real_observation = None

cancel ()

Cease to generate observation or error events. This will not generate an error by itself.

aiocoap.proxy.server module

Basic implementation of CoAP-CoAP proxying

This is work in progress and not yet part of the API.

```
exception aiocoap.proxy.server.CanNotRedirect (message=None)
    Bases: aiocoap.error.ConstructionRenderableError

    message = 'Proxy redirection failed'

exception aiocoap.proxy.server.NoUriSplitting (message=None)
    Bases: aiocoap.proxy.server.CanNotRedirect

    code = <Response Code 161 "5.01 Not Implemented">

    message = 'URI splitting not implemented, please use Proxy-Scheme.'

exception aiocoap.proxy.server.IncompleteProxyUri (message=None)
    Bases: aiocoap.proxy.server.CanNotRedirect

    code = <Response Code 128 "4.00 Bad Request">

    message = 'Proxying requires Proxy-Scheme and Uri-Host'

exception aiocoap.proxy.server.NotAForwardProxy (message=None)
    Bases: aiocoap.proxy.server.CanNotRedirect

    code = <Response Code 165 "5.05 Proxying Not Supported">

    message = 'This is a reverse proxy, not a forward one.'

exception aiocoap.proxy.server.NoSuchHostname (message=None)
    Bases: aiocoap.proxy.server.CanNotRedirect

    code = <Response Code 132 "4.04 Not Found">

    message = ''

exception aiocoap.proxy.server.CanNotRedirectBecauseOfUnsafeOptions (options)
    Bases: aiocoap.proxy.server.CanNotRedirect

    code = <Response Code 130 "4.02 Bad Option">

aiocoap.proxy.server.raise_unless_safe (request, known_options)
    Raise a BAD_OPTION CanNotRedirect unless all options in request are safe to forward or known

class aiocoap.proxy.server.Proxy (outgoing_context, logger=None)
    Bases: aiocoap.interfaces.Resource

    interpret_block_options = False

    add_redirector (redirector)

    apply_redirection (request)

    needs_blockwise_assembly (request)
        Indicator to the protocol.Responder about whether it should assemble request blocks to a single request and extract the requested blocks from a complete-resource answer (True), or whether the resource will do that by itself (False).

    render (request)
        Return a message that can be sent back to the requester.

        This does not need to set any low-level message options like remote, token or message type; it does however need to set a response code.
```

A response returned may carry a `no_response` option (which is actually specified to apply to requests only); the underlying transports will decide based on that and its code whether to actually transmit the response.

```
class aiocoap.proxy.server.ProxyWithPooledObservations (outgoing_context, logger=None)
```

Bases: *aiocoap.proxy.server.Proxy*, *aiocoap.interfaces.ObservableResource*

```
add_observation (request, serverobservation)
```

As `ProxiedResource` is intended to be just the proxy's interface toward the Context, accepting observations is handled here, where the observations handling can be defined by the subclasses.

```
render (request)
```

Return a message that can be sent back to the requester.

This does not need to set any low-level message options like `remote`, `token` or `message_type`; it does however need to set a response code.

A response returned may carry a `no_response` option (which is actually specified to apply to requests only); the underlying transports will decide based on that and its code whether to actually transmit the response.

```
class aiocoap.proxy.server.ForwardProxy (outgoing_context, logger=None)
```

Bases: *aiocoap.proxy.server.Proxy*

```
apply_redirection (request)
```

```
class aiocoap.proxy.server.ForwardProxyWithPooledObservations (outgoing_context, logger=None)
```

Bases: *aiocoap.proxy.server.ForwardProxy*, *aiocoap.proxy.server.ProxyWithPooledObservations*

```
class aiocoap.proxy.server.ReverseProxy (*args, **kwargs)
```

Bases: *aiocoap.proxy.server.Proxy*

```
class aiocoap.proxy.server.ReverseProxyWithPooledObservations (*args, **kwargs)
```

Bases: *aiocoap.proxy.server.ReverseProxy*, *aiocoap.proxy.server.ProxyWithPooledObservations*

```
class aiocoap.proxy.server.Redirector
```

Bases: `object`

```
apply_redirection (request)
```

```
class aiocoap.proxy.server.NameBasedVirtualHost (match_name, target, rewrite_uri_host=False, use_as_proxy=False)
```

Bases: *aiocoap.proxy.server.Redirector*

```
apply_redirection (request)
```

```
class aiocoap.proxy.server.SubdomainVirtualHost (*args, **kwargs)
```

Bases: *aiocoap.proxy.server.NameBasedVirtualHost*

```
class aiocoap.proxy.server.UnconditionalRedirector (target, use_as_proxy=False)
```

Bases: *aiocoap.proxy.server.Redirector*

```
apply_redirection (request)
```

```
class aiocoap.proxy.server.SubresourceVirtualHost (path, target)
```

Bases: *aiocoap.proxy.server.Redirector*

```
apply_redirection (request)
```

aiocoap.numbers module

Module in which all meaningful numbers are collected. Most of the submodules correspond to IANA registries.

aiocoap.numbers.codes module

List of known values for the CoAP “Code” field.

The values in this module correspond to the IANA registry “CoRE Parameters”, subregistries “CoAP Method Codes” and “CoAP Response Codes”.

The codes come with methods that can be used to get their rough meaning, see the *Code* class for details.

class aiocoap.numbers.codes.Code

Bases: *aiocoap.util.ExtensibleIntEnum*

Value for the CoAP “Code” field.

As the number range for the code values is separated, the rough meaning of a code can be determined using the *is_request()*, *is_response()* and *is_successful()* methods.

EMPTY = <Code 0 "EMPTY">

GET = <Request Code 1 "GET">

POST = <Request Code 2 "POST">

PUT = <Request Code 3 "PUT">

DELETE = <Request Code 4 "DELETE">

FETCH = <Request Code 5 "FETCH">

PATCH = <Request Code 6 "PATCH">

iPATCH = <Request Code 7 "iPATCH">

CREATED = <Successful Response Code 65 "2.01 Created">

DELETED = <Successful Response Code 66 "2.02 Deleted">

VALID = <Successful Response Code 67 "2.03 Valid">

CHANGED = <Successful Response Code 68 "2.04 Changed">

CONTENT = <Successful Response Code 69 "2.05 Content">

CONTINUE = <Successful Response Code 95 "2.31 Continue">

BAD_REQUEST = <Response Code 128 "4.00 Bad Request">

UNAUTHORIZED = <Response Code 129 "4.01 Unauthorized">

BAD_OPTION = <Response Code 130 "4.02 Bad Option">

FORBIDDEN = <Response Code 131 "4.03 Forbidden">

NOT_FOUND = <Response Code 132 "4.04 Not Found">

METHOD_NOT_ALLOWED = <Response Code 133 "4.05 Method Not Allowed">

NOT_ACCEPTABLE = <Response Code 134 "4.06 Not Acceptable">

REQUEST_ENTITY_INCOMPLETE = <Response Code 136 "4.08 Request Entity Incomplete">

CONFLICT = <Response Code 137 "4.09 Conflict">

```

PRECONDITION_FAILED = <Response Code 140 "4.12 Precondition Failed">
REQUEST_ENTITY_TOO_LARGE = <Response Code 141 "4.13 Request Entity Too Large">
UNSUPPORTED_CONTENT_FORMAT = <Response Code 143 "4.15 Unsupported Media Type">
UNSUPPORTED_MEDIA_TYPE = <Response Code 143 "4.15 Unsupported Media Type">
UNPROCESSABLE_ENTITY = <Response Code 150 "4.22 Unprocessable Entity">
INTERNAL_SERVER_ERROR = <Response Code 160 "5.00 Internal Server Error">
NOT_IMPLEMENTED = <Response Code 161 "5.01 Not Implemented">
BAD_GATEWAY = <Response Code 162 "5.02 Bad Gateway">
SERVICE_UNAVAILABLE = <Response Code 163 "5.03 Service Unavailable">
GATEWAY_TIMEOUT = <Response Code 164 "5.04 Gateway Timeout">
PROXYING_NOT_SUPPORTED = <Response Code 165 "5.05 Proxying Not Supported">
CSM = <Code 225 "7.01 Csm">
PING = <Code 226 "7.02 Ping">
PONG = <Code 227 "7.03 Pong">
RELEASE = <Code 228 "7.04 Release">
ABORT = <Code 229 "7.05 Abort">

is_request ()
    True if the code is in the request code range

is_response ()
    True if the code is in the response code range

is_signalling ()

is_successful ()
    True if the code is in the successful subrange of the response code range

can_have_payload ()
    True if a message with that code can carry a payload. This is not checked for strictly, but used as an
    indicator.

class_
    The class of a code (distinguishing whether it's successful, a request or a response error or more).

```

```

>>> Code.CONTENT
<Successful Response Code 69 "2.05 Content">
>>> Code.CONTENT.class_
2
>>> Code.BAD_GATEWAY
<Response Code 162 "5.02 Bad Gateway">
>>> Code.BAD_GATEWAY.class_
5

```

dotted

The numeric value three-decimal-digits (c.dd) form

name_printable

The name of the code in human-readable form

name

The constant name of the code (equals name_printable readable in all-caps and with underscores)

aiocoap.numbers.constants module

Constants either defined in the CoAP protocol (often default values for lack of ways to determine eg. the estimated round trip time). Some parameters are invented here for practical purposes of the implementation (eg. DEFAULT_BLOCK_SIZE_EXP, EMPTY_ACK_DELAY).

`aiocoap.numbers.constants.COAP_PORT = 5683`

The IANA-assigned standard port for COAP services.

`aiocoap.numbers.constants.ACK_TIMEOUT = 2.0`

The time, in seconds, to wait for an acknowledgement of a confirmable message. The inter-transmission time doubles for each retransmission.

`aiocoap.numbers.constants.ACK_RANDOM_FACTOR = 1.5`

Timeout multiplier for anti-synchronization.

`aiocoap.numbers.constants.MAX_RETRANSMIT = 4`

The number of retransmissions of confirmable messages to non-multicast endpoints before the infrastructure assumes no acknowledgement will be received.

`aiocoap.numbers.constants.NSTART = 1`

Maximum number of simultaneous outstanding interactions that endpoint maintains to a given server (including proxies)

`aiocoap.numbers.constants.MAX_TRANSMIT_SPAN = 45.0`

Maximum time from the first transmission of a confirmable message to its last retransmission.

`aiocoap.numbers.constants.MAX_TRANSMIT_WAIT = 93.0`

Maximum time from the first transmission of a confirmable message to the time when the sender gives up on receiving an acknowledgement or reset.

`aiocoap.numbers.constants.MAX_LATENCY = 100.0`

Maximum time a datagram is expected to take from the start of its transmission to the completion of its reception.

`aiocoap.numbers.constants.PROCESSING_DELAY = 2.0`

“Time a node takes to turn around a confirmable message into an acknowledgement.

`aiocoap.numbers.constants.MAX_RTT = 202.0`

Maximum round-trip time.

`aiocoap.numbers.constants.EXCHANGE_LIFETIME = 247.0`

time from starting to send a confirmable message to the time when an acknowledgement is no longer expected, i.e. message layer information about the message exchange can be purged

`aiocoap.numbers.constants.DEFAULT_BLOCK_SIZE_EXP = 6`

Default size exponent for blockwise transfers.

`aiocoap.numbers.constants.EMPTY_ACK_DELAY = 0.1`

After this time protocol sends empty ACK, and separate response

`aiocoap.numbers.constants.REQUEST_TIMEOUT = 93.0`

Time after which server assumes it won't receive any answer. It is not defined by IETF documents. For human-operated devices it might be preferable to set some small value (for example 10 seconds) For M2M it's application dependent.

`aiocoap.numbers.constants.OBSERVATION_RESET_TIME = 128`

Time in seconds after which the value of the observe field are ignored.

This number is not explicitly named in RFC7641.

aiocoap.numbers.optionnumbers module

Known values for CoAP option numbers

The values defined in *OptionNumber* correspond to the IANA registry “CoRE Parameters”, subregistries “CoAP Method Codes” and “CoAP Response Codes”.

The option numbers come with methods that can be used to evaluate their properties, see the *OptionNumber* class for details.

class aiocoap.numbers.optionnumbers.**OptionNumber**

Bases: *aiocoap.util.ExtensibleIntEnum*

A CoAP option number.

As the option number contains information on whether the option is critical, and whether it is safe-to-forward, those properties can be queried using the *is_** group of methods.

Note that whether an option may be repeated or not does not only depend on the option, but also on the context, and is thus handled in the *Options* object instead.

```

IF_MATCH = <OptionNumber 1 "IF_MATCH">
URI_HOST = <OptionNumber 3 "URI_HOST">
ETAG = <OptionNumber 4 "ETAG">
IF_NONE_MATCH = <OptionNumber 5 "IF_NONE_MATCH">
OBSERVE = <OptionNumber 6 "OBSERVE">
URI_PORT = <OptionNumber 7 "URI_PORT">
LOCATION_PATH = <OptionNumber 8 "LOCATION_PATH">
URI_PATH = <OptionNumber 11 "URI_PATH">
CONTENT_FORMAT = <OptionNumber 12 "CONTENT_FORMAT">
MAX_AGE = <OptionNumber 14 "MAX_AGE">
URI_QUERY = <OptionNumber 15 "URI_QUERY">
ACCEPT = <OptionNumber 17 "ACCEPT">
LOCATION_QUERY = <OptionNumber 20 "LOCATION_QUERY">
BLOCK2 = <OptionNumber 23 "BLOCK2">
BLOCK1 = <OptionNumber 27 "BLOCK1">
SIZE2 = <OptionNumber 28 "SIZE2">
PROXY_URI = <OptionNumber 35 "PROXY_URI">
PROXY_SCHEME = <OptionNumber 39 "PROXY_SCHEME">
SIZE1 = <OptionNumber 60 "SIZE1">
NO_RESPONSE = <OptionNumber 258 "NO_RESPONSE">
OBJECT_SECURITY = <OptionNumber 9 "OBJECT_SECURITY">
ECHO = <OptionNumber 252 "ECHO">

```

```
REQUEST_TAG = <OptionNumber 292 "REQUEST_TAG">
REQUEST_HASH = <OptionNumber 548 "REQUEST_HASH">
is_critical()
is_elective()
is_unsafe()
is_safetoforward()
is_nocachekey()
is_cachekey()
format
```

create_option (*decode=None, value=None*)

Return an Option element of the appropriate class from this option number.

An initial value may be set using the *decode* or *value* options, and will be fed to the resulting object's *decode* method or *value* property, respectively.

aiocoap.numbers.types module

List of known values for the CoAP “Type” field.

As this field is only 2 bits, its valid values are comprehensively enumerated in the *Type* object.

class aiocoap.numbers.types.**Type**

Bases: `enum.IntEnum`

An enumeration.

CON = 0

NON = 1

ACK = 2

RST = 3

aiocoap.optiontypes module

class aiocoap.optiontypes.**OptionType** (*number, value*)

Bases: `object`

Interface for decoding and encoding option values

Instances of *OptionType* are collected in a list in a `Message.opt Options` object, and provide a translation between the CoAP octet-stream (accessed using the *encode()/decode()* method pair) and the interpreted value (accessed via the *value* attribute).

Note that *OptionType* objects usually don't need to be handled by library users; the recommended way to read and set options is via the *Options* object's properties (eg. `message.opt.uri_path = ('.well-known', 'core')`).

encode ()

Return the option's value in serialized form

decode (*rawdata*)

Set the option's value from the bytes in rawdata

class aiocoap.optiontypes.**StringOption** (*number, value=""*)

Bases: *aiocoap.optiontypes.OptionType*

String CoAP option - used to represent string options. Always encoded in UTF8 per CoAP specification.

encode ()

Return the option's value in serialized form

decode (*rawdata*)

Set the option's value from the bytes in rawdata

class aiocoap.optiontypes.**OpaqueOption** (*number, value=b""*)

Bases: *aiocoap.optiontypes.OptionType*

Opaque CoAP option - used to represent options that just have their uninterpreted bytes as value.

encode ()

Return the option's value in serialized form

decode (*rawdata*)

Set the option's value from the bytes in rawdata

class aiocoap.optiontypes.**UintOption** (*number, value=0*)

Bases: *aiocoap.optiontypes.OptionType*

Uint CoAP option - used to represent integer options.

encode ()

Return the option's value in serialized form

decode (*rawdata*)

Set the option's value from the bytes in rawdata

class aiocoap.optiontypes.**BlockOption** (*number, value=None*)

Bases: *aiocoap.optiontypes.OptionType*

Block CoAP option - special option used only for Block1 and Block2 options. Currently it is the only type of CoAP options that has internal structure.

That structure (BlockwiseTuple) covers not only the block options of RFC7959, but also the BERT extension of RFC8323. If the reserved size exponent 7 is used for purposes incompatible with BERT, the implementor might want to look at the context dependent option number interpretations which will hopefully be in place for Signaling (7.xx) messages by then.

class **BlockwiseTuple**

Bases: *aiocoap.optiontypes._BlockwiseTuple*

size

start

The byte offset in the body indicated by block number and size.

Note that this calculation is only valid for descriptive use and Block2 control use. The semantics of `block_number` and `size` in Block1 control use are unrelated (indicating the acknowledged block number in the request Block1 size and the server's preferred block size), and must not be calculated using this property in that case.

is_bert

True if the exponent is recognized to signal a BERT message.

is_valid_for_payload_size (*payloadsize*)

reduced_to (*maximum_exponent*)

Return a BlockwiseTuple whose exponent is capped to the given `maximum_exponent`

```

>>> initial = BlockOption.BlockwiseTuple(10, 0, 5)
>>> initial == initial.reduced_to(6)
True
>>> initial.reduced_to(3)
BlockwiseTuple(block_number=40, more=0, size_exponent=3)

```

value**encode()**

Return the option's value in serialized form

decode(rawdata)

Set the option's value from the bytes in rawdata

aiocoap.resource module

Basic resource implementations

A resource in URL / CoAP / REST terminology is the thing identified by a URI.

Here, a *Resource* is the place where server functionality is implemented. In many cases, there exists one persistent Resource object for a given resource (eg. a `TimeResource()` is responsible for serving the `/time` location). On the other hand, an aiocoap server context accepts only one thing as its serversite, and that is a Resource too (typically of the `Site` class).

Resources are most easily implemented by deriving from `Resource` and implementing `render_get`, `render_post` and similar coroutine methods. Those take a single request message object and must return a `aiocoap.Message` object or raise an `error.RenderableError` (eg. `raise UnsupportedMediaType()`).

To serve more than one resource on a site, use the `Site` class to dispatch requests based on the Uri-Path header.

`aiocoap.resource.hashing_etag(request, response)`

Helper function for `render_get` handlers that allows them to use ETags based on the payload's hash value

Run this on your request and response before returning from `render_get`; it is safe to use this function with all kinds of responses, it will only act on 2.05 Content messages (and those with no code set, which defaults to that for GET requests). The hash used are the first 8 bytes of the sha1 sum of the payload.

Note that this method is not ideal from a server performance point of view (a file server, for example, might want to hash only the `stat()` result of a file instead of reading it in full), but it saves bandwidth for the simple cases.

```

>>> from aiocoap import *
>>> req = Message(code=GET)
>>> hash_of_hello = b'\xaa\xf4\xc6\xd\xdc\xc5\xe8\xa2'
>>> req.opt.etags = [hash_of_hello]
>>> resp = Message(code=CONTENT)
>>> resp.payload = b'hello'
>>> hashing_etag(req, resp)
>>> resp
# doctest: +ELLIPSIS
<aiocoap.Message at ... 2.03 Valid ... 1 option(s)>

```

class aiocoap.resource.Resource

Bases: `aiocoap.resource._ExposesWellknownAttributes`, `aiocoap.interfaces.Resource`

Simple base implementation of the `interfaces.Resource` interface

The render method delegates content creation to `render_$method` methods (`render_get`, `render_put` etc), and responds appropriately to unsupported methods. Those messages may return messages without a response code, the default render method will set an appropriate successful code (“Content” for GET/FETCH, “Deleted” for DELETE, “Changed” for anything else). The render method will also fill in the request’s `no_response` code into the response (see `interfaces.Resource.render()`) if none was set.

Moreover, this class provides a `get_link_description` method as used by `.well-known/core` to expose a resource’s `.ct`, `.rt` and `.if_` (alternative name for `if` as that’s a Python keyword) attributes.

needs_blockwise_assembly (*request*)

Indicator to the `protocol.Responder` about whether it should assemble request blocks to a single request and extract the requested blocks from a complete-resource answer (True), or whether the resource will do that by itself (False).

render (*request*)

Return a message that can be sent back to the requester.

This does not need to set any low-level message options like `remote`, `token` or `message type`; it does however need to set a response code.

A response returned may carry a `no_response` option (which is actually specified to apply to requests only); the underlying transports will decide based on that and its code whether to actually transmit the response.

class `aiocoap.resource.ObservableResource`

Bases: `aiocoap.resource.Resource`, `aiocoap.interfaces.ObservableResource`

update_observation_count (*newcount*)

Hook into this method to be notified when the number of observations on the resource changes.

updated_state (*response=None*)

Call this whenever the resource was updated, and a notification should be sent to observers.

get_link_description ()

add_observation (*request, serverobservation*)

Before the incoming request is sent to `render()`, the `add_observation()` method is called. If the resource chooses to accept the observation, it has to call the `serverobservation.accept(cb)` with a callback that will be called when the observation ends. After accepting, the `ObservableResource` should call `serverobservation.trigger()` whenever it changes its state; the `ServerObservation` will then initiate notifications by having the request rendered again.

`aiocoap.resource.link_format_to_message` (*request, linkformat, default_ct=40*)

Given a `LinkFormat` object, render it to a response message, picking a suitable content format from a given request.

It returns a Not Acceptable response if something unsupported was queried.

It makes no attempt to modify the URI reference literals encoded in the `LinkFormat` object; they have to be suitably prepared by the caller.

class `aiocoap.resource.WKCResource` (*listgenerator, impl_info='https://christian.amsuess.com/tools/aiocoap/#version-0.4.1'*)

Bases: `aiocoap.resource.Resource`

Read-only dynamic resource list, suitable as `.well-known/core`.

This resource renders a `link_header.LinkHeader` object (which describes a collection of resources) as `application/link-format` (RFC 6690).

The list to be rendered is obtained from a function passed into the constructor; typically, that function would be a bound `Site.get_resources_as_linkheader()` method.

This resource also provides server [implementation information link](#); server authors are invited to override this by passing an own URI as the *impl_info* parameter, and can disable it by passing None.

```
ct = '40 64 504'
```

```
render_get(request)
```

```
class aiocoap.resource.PathCapable
```

```
Bases: object
```

Class that indicates that a resource promises to parse the *uri_path* option, and can thus be given requests for *render()* ing that contain a *uri_path*

```
class aiocoap.resource.Site
```

```
Bases: aiocoap.interfaces.ObservableResource, aiocoap.resource.PathCapable
```

Typical root element that gets passed to a *Context* and contains all the resources that can be found when the endpoint gets accessed as a server.

This provides easy registration of statical resources. Add resources at absolute locations using the *add_resource()* method.

For example, the site at

```
>>> site = Site()
>>> site.add_resource(["hello"], Resource())
```

will have requests to `</hello>` rendered by the new resource.

You can add another *Site* (or another instance of *PathCapable*) as well, those will be nested and integrally reported in a *WKCRResource*. The path of a site should not end with an empty string (ie. a slash in the URI) – the child site’s own root resource will then have the trailing slash address. Subsites can not have link-header attributes on their own (eg. *rt*) and will never respond to a request that does not at least contain a single slash after the the given path part.

For example,

```
>>> batch = Site()
>>> batch.add_resource(["light1"], Resource())
>>> batch.add_resource(["light2"], Resource())
>>> batch.add_resource([], Resource())
>>> s = Site()
>>> s.add_resource(["batch"], batch)
```

will have the three created resources rendered at `</batch/light1>`, `</batch/light2>` and `</batch/>`.

If it is necessary to respond to requests to `</batch>` or report its attributes in `.well-known/core` in addition to the above, a non-*PathCapable* resource can be added with the same path. This is usually considered an odd design, not fully supported, and for example doesn’t support removal of resources from the site.

```
add_observation(request, serverobservation)
```

Before the incoming request is sent to *render()*, the *add_observation()* method is called. If the resource chooses to accept the observation, it has to call the *serverobservation.accept(cb)* with a callback that will be called when the observation ends. After accepting, the *ObservableResource* should call *serverobservation.trigger()* whenever it changes its state; the *ServerObservation* will then initiate notifications by having the request rendered again.

```
needs_blockwise_assembly(request)
```

Indicator to the *protocol.Responder* about whether it should assemble request blocks to a single request and extract the requested blocks from a complete-resource answer (True), or whether the resource will do that by itself (False).

render (*request*)

Return a message that can be sent back to the requester.

This does not need to set any low-level message options like remote, token or message type; it does however need to set a response code.

A response returned may carry a `no_response` option (which is actually specified to apply to requests only); the underlying transports will decide based on that and its code whether to actually transmit the response.

add_resource (*path, resource*)**remove_resource** (*path*)**get_resources_as_linkheader** ()**aiocoap.util module**

Tools not directly related with CoAP that are needed to provide the API

class aiocoap.util.**ExtensibleEnumMeta** (*name, bases, dict*)

Bases: type

Metaclass for ExtensibleIntEnum, see there for detailed explanations

class aiocoap.util.**ExtensibleIntEnum**

Bases: int

Similar to Python's `enum.IntEnum`, this type can be used for named numbers which are not comprehensively known, like CoAP option numbers.

aiocoap.util.hostportjoin (*host, port=None*)

Join a host and optionally port into a hostinfo-style host:port string

```
>>> hostportjoin('example.com')
'example.com'
>>> hostportjoin('example.com', 1234)
'example.com:1234'
>>> hostportjoin('127.0.0.1', 1234)
'127.0.0.1:1234'
```

This is lax with respect to whether host is an IPv6 literal in brackets or not, and accepts either form; IP-future literals that do not contain a colon must be already presented in their bracketed form:

```
>>> hostportjoin('2001:db8::1')
'[2001:db8::1]'
>>> hostportjoin('2001:db8::1', 1234)
'[2001:db8::1]:1234'
>>> hostportjoin('[2001:db8::1]', 1234)
'[2001:db8::1]:1234'
```

aiocoap.util.hostportsplit (*hostport*)

Like `urllib.parse.splitport`, but return port as int, and as None if not given. Also, it allows giving IPv6 addresses like a netloc:

```
>>> hostportsplit('foo')
('foo', None)
>>> hostportsplit('foo:5683')
('foo', 5683)
>>> hostportsplit('[::1%eth0]:56830')
('::1%eth0', 56830)
```

`aiocoap.util.quote_nonascii(s)`

Like `urllib.parse.quote`, but explicitly only escaping non-ascii characters.

class `aiocoap.util.Sentinel` (*label*)

Bases: `object`

Class for sentinel that can only be compared for identity. No efforts are taken to make these singletons; it is up to the users to always refer to the same instance, which is typically defined on module level.

aiocoap.util.asyncio module

Extensions to `asyncio` and workarounds around its shortcomings

aiocoap.util.contenttype module

Helpers around content types

This uses the terminology clarified in 1, and primarily deals with content types in their usual string representation.

Unless content types get used a lot more in `aiocoap`, this provides only accessors to some of their relevant properties, without aiming to build semantically accessible objects to encapsulate them.

`aiocoap.util.contenttype.categorize(contenttype: str)`

Return 'cbor', 'json' or 'link-format' if the content type indicates it is that format itself or derived from it.

aiocoap.util.cli module

Helpers for creating server-style applications in `aiocoap`

Note that these are not particular to `aiocoap`, but are used at different places in `aiocoap` and thus shared here.

class `aiocoap.util.cli.ActionNoYes` (*option_strings*, *dest*, *default=True*, *required=False*, *help=None*)

Bases: `argparse.Action`

Simple action that automatically manages `--{no-}something` style options

class `aiocoap.util.cli.AsyncCLIDaemon` (**args*, ***kwargs*)

Bases: `object`

Helper for creating daemon-style CLI programs.

Note that this currently doesn't create a Daemon in the sense of doing a daemon-fork; that could be added on demand, though.

Subclass this and implement the `start()` method as an `async` function; it will be passed all the constructor's arguments.

When all setup is complete and the program is operational, return from the `start` method.

Implement the `shutdown()` coroutine and to do cleanup; what actually runs your program will, if possible, call that and await its return.

Typical application for this is running `MyClass.sync_main()` in the program's `if __name__ == "__main__":` section.

stop (*exitcode*)

Stop the operation (and exit `sync_main`) at the next convenience.

classmethod `sync_main` (**args*, ***kwargs*)

Run the application in an `AsyncIO` main loop, shutting down cleanly on keyboard interrupt.

aiocoap.util.socknumbers module

This module contains numeric constants that would be expected in the socket module, but are not exposed there.

This gathers both socket numbers that can be present in the socket module (eg. the PKTINFO constants) but are not in some versions (eg. on macOS before <https://bugs.python.org/issue35569> is fixed) and platform dependent constants that are not generally available at all (the ERR constants).

Where available, the CPython-private IN module is used to obtain some platform specific constants.

Any hints on where to get them from in a more reliable way are appreciated; possible options are parsing C header files (at build time?) or interacting with shared libraries for obtaining the symbols. The right way would probably be including them in Python in a “other constants defined on this platform for sockets” module or dictionary.

```
aiocoap.util.socknumbers.HAS_RECVERR = True
```

Indicates whether the discovered constants indicate that the Linux *setsockopt(IPV6, RECVERR) / recvmsg(..., MSG_ERRQUEUE)* mechanism is available

aiocoap.util.secrets module

This is a subset of what the Python 3.6 secrets module gives, for compatibility with earlier Python versions and for as long as there is no published & widespread backported version of it

aiocoap.util.uri module

Tools that I'd like to have in urllib.parse

```
aiocoap.util.uri.unreserved = 'abcdefghijklmnopqrstuvwxyzABCDEFGHIJKLMNOPQRSTUVWXYZ0123456789-._~'
“unreserved” characters from RFC3986
```

```
aiocoap.util.uri.sub_delims = "!$&'()*+,-;="
“sub-delims” characters from RFC3986
```

```
aiocoap.util.uri.quote_factory (safe_characters)
Return a quote function that escapes all characters not in the safe_characters iterable.
```

aiocoap.cli module

Container module for command line utilities bundled with aiocoap.

These modules are not considered to be a part of the aioCoAP API, and are thus subject to change even when the project reaches a stable version number. If you want to use any of that infrastructure, please file a feature request for stabilization in the project's issue tracker.

The tools themselves are documented in *CoAP tools*.

aiocoap.meta module

```
aiocoap.meta.version = '0.4.1'
Make library version internally
```

This is not supposed to be used in any decision-making process (use package dependencies for that) or workarounds, but used by command-line tools or the impl-info link to provide debugging information.

`aiocoap.meta.library_uri = 'https://christian.amsuess.com/tools/aiocoap/#version-0.4.1'`
URI used to describe the current version of the library

This is used the same way as *version* but when a URI is required, for example as a default value for `.well-known/core`'s `rel=impl-info` link.

aiocoap.oscore module

This module contains the tools to send OSCORE secured messages.

It only deals with the algorithmic parts, the security context and protection and unprotection of messages. It does not touch on the integration of OSCORE in the larger aiocoap stack of having a context or requests; that's what `aiocoap.transports.oscore` is for.

exception `aiocoap.oscore.NotAProtectedMessage` (*message, plain_message*)

Bases: `aiocoap.error.Error`, `ValueError`

Raised when verification is attempted on a non-OSCORE message

exception `aiocoap.oscore.ProtectionInvalid`

Bases: `aiocoap.error.Error`, `ValueError`

Raised when verification of an OSCORE message fails

exception `aiocoap.oscore.DecodeError`

Bases: `aiocoap.oscore.ProtectionInvalid`

Raised when verification of an OSCORE message fails because CBOR or compressed data were erroneous

exception `aiocoap.oscore.ReplayError`

Bases: `aiocoap.oscore.ProtectionInvalid`

Raised when verification of an OSCORE message fails because the sequence numbers was already used

exception `aiocoap.oscore.ReplayErrorWithEcho` (*secctx, request_id, echo*)

Bases: `aiocoap.oscore.ProtectionInvalid`, `aiocoap.error.RenderableError`

Raised when verification of an OSCORE message fails because the recipient replay window is uninitialized, but a 4.01 Echo can be constructed with the data in the exception that can lead to the client assisting in replay window recovery

to_message ()

Create a CoAP message that should be sent when this exception is rendered

exception `aiocoap.oscore.ContextUnavailable`

Bases: `aiocoap.error.Error`, `ValueError`

Raised when a context is (currently or permanently) unavailable for protecting or unprotecting a message

class `aiocoap.oscore.RequestIdentifiers` (*kid, partial_iv, nonce, can_reuse_nonce*)

Bases: `object`

A container for details that need to be passed along from the (un)protection of a request to the (un)protection of the response; these data ensure that the request-response binding process works by passing around the request's partial IV.

Users of this module should never create or interact with instances, but just pass them around.

get_reusable_nonce ()

Return the nonce if `can_reuse_nonce` is `True`, and set `can_reuse_nonce` to `False`.

class `aiocoap.oscore.Algorithm`

Bases: `object`

encrypt (*plaintext, aad, key, iv*)

Return ciphertext + tag for given input data

decrypt (*ciphertext_and_tag, aad, key, iv*)

Reverse encryption. Must raise ProtectionInvalid on any error stemming from untrusted data.

class aiocoap.oscore.AES_CCM

Bases: *aiocoap.oscore.Algorithm*

AES-CCM implemented using the Python cryptography library

classmethod **encrypt** (*plaintext, aad, key, iv*)

Return ciphertext + tag for given input data

classmethod **decrypt** (*ciphertext_and_tag, aad, key, iv*)

Reverse encryption. Must raise ProtectionInvalid on any error stemming from untrusted data.

class aiocoap.oscore.AES_CCM_16_64_128

Bases: *aiocoap.oscore.AES_CCM*

value = 10

key_bytes = 16

tag_bytes = 8

iv_bytes = 13

class aiocoap.oscore.AES_CCM_16_64_256

Bases: *aiocoap.oscore.AES_CCM*

value = 11

key_bytes = 32

tag_bytes = 8

iv_bytes = 13

class aiocoap.oscore.AES_CCM_64_64_128

Bases: *aiocoap.oscore.AES_CCM*

value = 12

key_bytes = 16

tag_bytes = 8

iv_bytes = 7

class aiocoap.oscore.AES_CCM_64_64_256

Bases: *aiocoap.oscore.AES_CCM*

value = 13

key_bytes = 32

tag_bytes = 8

iv_bytes = 7

class aiocoap.oscore.AES_CCM_16_128_128

Bases: *aiocoap.oscore.AES_CCM*

value = 30

key_bytes = 16

```
    tag_bytes = 16
    iv_bytes = 13
class aiocoap.oscore.AES_CCM_16_128_256
    Bases: aiocoap.oscore.AES_CCM
    value = 31
    key_bytes = 32
    tag_bytes = 16
    iv_bytes = 13
class aiocoap.oscore.AES_CCM_64_128_128
    Bases: aiocoap.oscore.AES_CCM
    value = 32
    key_bytes = 16
    tag_bytes = 16
    iv_bytes = 7
class aiocoap.oscore.AES_CCM_64_128_256
    Bases: aiocoap.oscore.AES_CCM
    value = 33
    key_bytes = 32
    tag_bytes = 16
    iv_bytes = 7
class aiocoap.oscore.AES_GCM
    Bases: aiocoap.oscore.Algorithm
    AES-GCM implemented using the Python cryptography library
    iv_bytes = 12
    classmethod encrypt (plaintext, aad, key, iv)
        Return ciphertext + tag for given input data
    classmethod decrypt (ciphertext_and_tag, aad, key, iv)
        Reverse encryption. Must raise ProtectionInvalid on any error stemming from untrusted data.
class aiocoap.oscore.A128GCM
    Bases: aiocoap.oscore.AES_GCM
    value = 1
    key_bytes = 16
    tag_bytes = 16
class aiocoap.oscore.A192GCM
    Bases: aiocoap.oscore.AES_GCM
    value = 2
    key_bytes = 24
    tag_bytes = 16
```

```

class aiocoap.oscore.A256GCM
    Bases: aiocoap.oscore.AES_GCM

    value = 3

    key_bytes = 32

    tag_bytes = 16

class aiocoap.oscore.ChaCha20Poly1305
    Bases: aiocoap.oscore.Algorithm

    value = 24

    key_bytes = 32

    tag_bytes = 16

    iv_bytes = 12

    classmethod encrypt (plaintext, aad, key, iv)
        Return ciphertext + tag for given input data

    classmethod decrypt (ciphertext_and_tag, aad, key, iv)
        Reverse encryption. Must raise ProtectionInvalid on any error stemming from untrusted data.

class aiocoap.oscore.AlgorithmCountersign
    Bases: object

    A fully parameterized COSE countersign algorithm

    An instance is able to provide all the alg_countersign, par_countersign and par_countersign_key parameters taht
    go into the Group OSCORE algorithms field.

    sign (body, external_aad, private_key)
        Return the signature produced by the key when using CounterSignature0 as describe in draft-ietf-cose-
        countersign-01

    verify (signature, body, external_aad, public_key)
        Verify a signature in analogy to sign

    generate ()
        Return a usable private key

    public_from_private (private_key)
        Given a private key, derive the publishable key

    staticstatic (private_key, public_key)
        Derive a shared static-static secret from a private and a public key

    signature_length
        The length of a signature using this algorithm

class aiocoap.oscore.Ed25519
    Bases: aiocoap.oscore.AlgorithmCountersign

    sign (body, aad, private_key)
        Return the signature produced by the key when using CounterSignature0 as describe in draft-ietf-cose-
        countersign-01

    verify (signature, body, aad, public_key)
        Verify a signature in analogy to sign

    generate ()
        Return a usable private key

```

public_from_private (*private_key*)

Given a private key, derive the publishable key

staticstatic (*private_key*, *public_key*)

Derive a shared static-static secret from a private and a public key

value_all_par = [-8, [[1], [1, 6]], [1, 6]]

signature_length = 64

class aiocoap.oscore.ECDSA_SHA256_P256

Bases: *aiocoap.oscore.AlgorithmCountersign*

from_public_parts (*x: bytes*, *y: bytes*)

Create a public key from its COSE values

from_private_parts (*x: bytes*, *y: bytes*, *d: bytes*)

sign (*body*, *aad*, *private_key*)

Return the signature produced by the key when using CounterSignature0 as describe in draft-ietf-cose-countersign-01

verify (*signature*, *body*, *aad*, *public_key*)

Verify a signature in analogy to sign

generate ()

Return a usable private key

public_from_private (*private_key*)

Given a private key, derive the publishable key

staticstatic (*private_key*, *public_key*)

Derive a shared static-static secret from a private and a public key

value_all_par = [-7, [[2], [2, 1]], [2, 1]]

signature_length = 64

class aiocoap.oscore.BaseSecurityContext

Bases: *object*

external_aad_is_group = **False**

authenticated_claims = []

class aiocoap.oscore.CanProtect

Bases: *aiocoap.oscore.BaseSecurityContext*

is_signing = **False**

responses_send_kid = **False**

protect (*message*, *request_id=None*, *, *kid_context=True*)

Given a plain CoAP message, create a protected message that contains message's options in the inner or outer CoAP message as described in OSCOAP.

If the message is a response to a previous message, the additional data from unprotecting the request are passed in as *request_id*. When request data is present, its partial IV is reused if possible. The security context's ID context is encoded in the resulting message unless *kid_context* is explicitly set to a **False**; other values for the *kid_context* can be passed in as byte string in the same parameter.

new_sequence_number ()

Return a new sequence number; the implementation is responsible for never returning the same value twice in a given security context.

May raise ContextUnavailable.

post_seqnoincrease ()

Ensure that sender_sequence_number is stored

context_from_response (*unprotected_bag*) → aiocoap.oscore.CanUnprotect

When receiving a response to a request protected with this security context, pick the security context with which to unprotect the response given the unprotected information from the Object-Security option.

This allow picking the right security context in a group response, and helps getting a new short-lived context for B.2 mode. The default behavior is returning self.

class aiocoap.oscore.CanUnprotect

Bases: *aiocoap.oscore.BaseSecurityContext*

unprotect (*protected_message*, *request_id=None*)

context_for_response () → aiocoap.oscore.CanProtect

After processing a request with this context, with which security context should an outgoing response be protected? By default, it's the same context.

class aiocoap.oscore.SecurityContextUtils

Bases: *aiocoap.oscore.BaseSecurityContext*

derive_keys (*master_salt*, *master_secret*)

Populate sender_key, recipient_key and common_iv from the algorithm, hash function and id_context already configured beforehand, and from the passed salt and secret.

get_oscore_context_for (*unprotected*)

Return a suitable context (most easily self) for an incoming request if its unprotected data (COSE_KID, COSE_KID_CONTEXT) fit its description. If it doesn't match, it returns None.

The default implementation just strictly checks for whether kid and any kid context match (not matching if a local KID context is set but none is given in the request); modes like Group OSCORE can spin up aspect objects here.

class aiocoap.oscore.ReplayWindow (*size*, *strike_out_callback*)

Bases: object

A regular replay window of a fixed size.

It is implemented as an index and a bitfield (represented by an integer) whose least significant bit represents the sequence number of the index, and a 1 indicates that a number was seen. No shenanigans around implicit leading ones (think floating point normalization) happen.

```
>>> w = ReplayWindow(32, lambda: None)
>>> w.initialize_empty()
>>> w.strike_out(5)
>>> w.is_valid(3)
True
>>> w.is_valid(5)
False
>>> w.strike_out(0)
>>> w.strike_out(1)
>>> w.strike_out(2)
>>> w.is_valid(1)
False
```

Jumping ahead by the window size invalidates older numbers:

```

>>> w.is_valid(4)
True
>>> w.strike_out(35)
>>> w.is_valid(4)
True
>>> w.strike_out(36)
>>> w.is_valid(4)
False

```

For every key, the replay window can only be initialized empty once. On later uses, it needs to be persisted by storing the output of `self.persist()` somewhere and loaded from that persisted data.

It is acceptable to store persistence data in the `strike_out_callback`, but that must then ensure that the data is written (flushed to a file or committed to a database), but that is usually inefficient.

This class is not considered for stabilization yet and an implementation detail of the `SecurityContext` implementation(s).

is_initialized()

initialize_empty()

initialize_from_persisted (*persisted*)

initialize_from_freshlyseen (*seen*)

Initialize the replay window with a particular value that is just being observed in a fresh (ie. generated by the peer later than any messages processed before state was lost here) message. This marks the seen sequence number and all preceding it as invalid, and all later ones as valid.

is_valid (*number*)

strike_out (*number*)

persist ()

Return a dict containing internal state which can be passed to `init` to recreate the replay window.

```

class aiocoap.oscore.FilesystemSecurityContext (basedir, sequence_number_chunksize_start=10,
                                                sequence_number_chunksize_limit=10000)

```

Bases: `aiocoap.oscore.CanProtect`, `aiocoap.oscore.CanUnprotect`, `aiocoap.oscore.SecurityContextUtils`

Security context stored in a directory as distinct files containing containing

- Master secret, master salt, sender and recipient ID, optionally algorithm, the KDF hash function, and replay window size (`settings.json` and `secrets.json`, where the latter is typically readable only for the user)
- sequence numbers and replay windows (`sequence.json`, the only file the process needs write access to)

The static parameters can all either be placed in `settings.json` or `secrets.json`, but must not be present in both; the presence of either file is sufficient.

Warning: Security contexts must never be copied around and used after another copy was used. They should only ever be moved, and if they are copied (eg. as a part of a system backup), restored contexts must not be used again; they need to be replaced with freshly created ones.

An additional file named `lock` is created to prevent the accidental use of a context by to concurrent programs.

Note that the sequence number file is updated in an atomic fashion which requires file creation privileges in the directory. If privilege separation between `settings/key` changes and sequence number changes is desired, one

way to achieve that on Linux is giving the aiocoap process's user group write permissions on the directory and setting the sticky bit on the directory, thus forbidding the user to remove the settings/secret files not owned by him.

Writes due to sent sequence numbers are reduced by applying a variation on the mechanism of RFC8613 Appendix B.1.1 (incrementing the persisted sender sequence number in steps of k). That value is automatically grown from `sequence_number_chunksize_start` up to `sequence_number_chunksize_limit`. At runtime, the receive window is not stored but kept indeterminate. In case of an abnormal shutdown, the server uses the mechanism described in Appendix B.1.2 to recover.

exception LoadError

Bases: `ValueError`

Exception raised with a descriptive message when trying to load a faulty security context

post_seqnoincrease()

Ensure that `sender_sequence_number` is stored

class aiocoap.oscore.GroupContext

Bases: `object`

is_signing = True

external_aad_is_group = True

responses_send_kid = True

private_key

Private key used to sign outgoing messages.

Contexts not designed to send messages may raise a `RuntimeError` here; that necessity may later go away if some more accurate class modelling is found.

recipient_public_key

Public key used to verify incoming messages.

Contexts not designed to receive messages (because they'd have aspects for that) may raise a `RuntimeError` here; that necessity may later go away if some more accurate class modelling is found.

class aiocoap.oscore.SimpleGroupContext (*algorithm, hashfun, alg_countersign, group_id, master_secret, master_salt, sender_id, private_key, peers*)

Bases: `aiocoap.oscore.GroupContext`, `aiocoap.oscore.CanProtect`, `aiocoap.oscore.CanUnprotect`, `aiocoap.oscore.SecurityContextUtils`

A context for an OSCORE group

This is a non-persistable version of a group context that does not support any group manager or rekeying; it is set up statically at startup.

It is intended for experimentation and demos, but aims to be correct enough to be usable securely.

private_key = None

recipient_public_key

Public key used to verify incoming messages.

Contexts not designed to receive messages (because they'd have aspects for that) may raise a `RuntimeError` here; that necessity may later go away if some more accurate class modelling is found.

derive_keys (*master_salt, master_secret*)

Populate `sender_key`, `recipient_key` and `common_iv` from the algorithm, hash function and `id_context` already configured beforehand, and from the passed salt and secret.

`post_seqnoincrease ()`

No-op because it's ephemeral

`context_from_response (unprotected_bag) → aiocoap.oscore.CanUnprotect`

When receiving a response to a request protected with this security context, pick the security context with which to unprotect the response given the unprotected information from the Object-Security option.

This allow picking the right security context in a group response, and helps getting a new short-lived context for B.2 mode. The default behavior is returning self.

`get_oscore_context_for (unprotected)`

Return a suitable context (most easily self) for an incoming request if its unprotected data (COSE_KID, COSE_KID_CONTEXT) fit its description. If it doesn't match, it returns None.

The default implementation just strictly checks for whether kid and any kid context match (not matching if a local KID context is set but none is given in the request); modes like Group OSCORE can spin up aspect objects here.

`pairwise_for (recipient_id)`

`for_sending_deterministic_requests (deterministic_id, target_server: Optional[bytes])`

`aiocoap.oscore.verify_start (message)`

Extract the unprotected COSE options from a message for the verifier to then pick a security context to actually verify the message. (Future versions may also report fields from both unprotected and protected, if the protected bag is ever used with OSCORE.).

Call this only requests; for responses, you'll have to know the security context anyway, and there is usually no information to be gained.

6.5 Usage Examples

These files can serve as reference implementations for a simplistic server and client. In order to test them, run `./server.py` in one terminal, and use `./clientGET.py` and `./clientPUT.py` to interact with it.

The programs' source code should give you a good starting point to get familiar with the library if you prefer reading code to reading tutorials. Otherwise, you might want to have a look at the [Guided Tour through aiocoap](#), where the relevant concepts are introduced and explained step by step.

Note: These example programs are not shipped in library version of aiocoap. They are present if you followed the [Development version](#) section of the installation instructions; otherwise, you can download them from the project website.

6.5.1 Client

```
1 import logging
2 import asyncio
3
4 from aiocoap import *
5
6 logging.basicConfig(level=logging.INFO)
7
8 async def main():
9     protocol = await Context.create_client_context()
```

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```

10 request = Message(code=GET, uri='coap://localhost/time')
11
12
13 try:
14     response = await protocol.request(request).response
15 except Exception as e:
16     print('Failed to fetch resource:')
17     print(e)
18 else:
19     print('Result: %s\n%r'%(response.code, response.payload))
20
21 if __name__ == "__main__":
22     asyncio.get_event_loop().run_until_complete(main())

```

```

1 import logging
2 import asyncio
3
4 from aiocoap import *
5
6 logging.basicConfig(level=logging.INFO)
7
8 async def main():
9     """Perform a single PUT request to localhost on the default port, URI
10     "/other/block". The request is sent 2 seconds after initialization.
11
12     The payload is bigger than 1kB, and thus sent as several blocks."""
13
14     context = await Context.create_client_context()
15
16     await asyncio.sleep(2)
17
18     payload = b"The quick brown fox jumps over the lazy dog.\n" * 30
19     request = Message(code=PUT, payload=payload, uri="coap://localhost/other/block")
20
21     response = await context.request(request).response
22
23     print('Result: %s\n%r'%(response.code, response.payload))
24
25 if __name__ == "__main__":
26     asyncio.get_event_loop().run_until_complete(main())

```

6.5.2 Server

```

1 import datetime
2 import logging
3
4 import asyncio
5
6 import aiocoap.resource as resource
7 import aiocoap
8
9
10 class BlockResource(resource.Resource):
11     """Example resource which supports the GET and PUT methods. It sends large

```

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```

12     responses, which trigger blockwise transfer."""
13
14     def __init__(self):
15         super().__init__()
16         self.set_content(b"This is the resource's default content. It is padded "\
17             b"with numbers to be large enough to trigger blockwise "\
18             b"transfer.\n")
19
20     def set_content(self, content):
21         self.content = content
22         while len(self.content) <= 1024:
23             self.content = self.content + b"0123456789\n"
24
25     async def render_get(self, request):
26         return aiocoap.Message(payload=self.content)
27
28     async def render_put(self, request):
29         print('PUT payload: %s' % request.payload)
30         self.set_content(request.payload)
31         return aiocoap.Message(code=aiocoap.CHANGED, payload=self.content)
32
33
34 class SeparateLargeResource(resource.Resource):
35     """Example resource which supports the GET method. It uses asyncio.sleep to
36     simulate a long-running operation, and thus forces the protocol to send
37     empty ACK first. """
38
39     def get_link_description(self):
40         # Publish additional data in .well-known/core
41         return dict(**super().get_link_description(), title="A large resource")
42
43     async def render_get(self, request):
44         await asyncio.sleep(3)
45
46         payload = "Three rings for the elven kings under the sky, seven rings "\
47             "for dwarven lords in their halls of stone, nine rings for "\
48             "mortal men doomed to die, one ring for the dark lord on his "\
49             "dark throne.".encode('ascii')
50         return aiocoap.Message(payload=payload)
51
52 class TimeResource(resource.ObservableResource):
53     """Example resource that can be observed. The `notify` method keeps
54     scheduling itself, and calls `update_state` to trigger sending
55     notifications. """
56
57     def __init__(self):
58         super().__init__()
59
60         self.handle = None
61
62     def notify(self):
63         self.updated_state()
64         self.reschedule()
65
66     def reschedule(self):
67         self.handle = asyncio.get_event_loop().call_later(5, self.notify)
68

```

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```

69     def update_observation_count(self, count):
70         if count and self.handle is None:
71             print("Starting the clock")
72             self.reschedule()
73         if count == 0 and self.handle:
74             print("Stopping the clock")
75             self.handle.cancel()
76             self.handle = None
77
78     async def render_get(self, request):
79         payload = datetime.datetime.now().\
80             strftime("%Y-%m-%d %H:%M").encode('ascii')
81         return aiocoap.Message(payload=payload)
82
83 class WhoAmI(resource.Resource):
84     async def render_get(self, request):
85         text = ["Used protocol: %s." % request.remote.scheme]
86
87         text.append("Request came from %s." % request.remote.hostinfo)
88         text.append("The server address used %s." % request.remote.hostinfo_local)
89
90         claims = list(request.remote.authenticated_claims)
91         if claims:
92             text.append("Authenticated claims of the client: %s." % ", ".join(repr(c)
↪ for c in claims))
93         else:
94             text.append("No claims authenticated.")
95
96         return aiocoap.Message(content_format=0,
97                                payload="\n".join(text).encode('utf8'))
98
99 # logging setup
100
101 logging.basicConfig(level=logging.INFO)
102 logging.getLogger("coap-server").setLevel(logging.DEBUG)
103
104 def main():
105     # Resource tree creation
106     root = resource.Site()
107
108     root.add_resource(['.well-known', 'core'],
109                      resource.WKCResource(root.get_resources_as_linkheader))
110     root.add_resource(['time'], TimeResource())
111     root.add_resource(['other', 'block'], BlockResource())
112     root.add_resource(['other', 'separate'], SeparateLargeResource())
113     root.add_resource(['whoami'], WhoAmI())
114
115     asyncio.Task(aiocoap.Context.create_server_context(root))
116
117     asyncio.get_event_loop().run_forever()
118
119 if __name__ == "__main__":
120     main()

```

6.6 CoAP tools

As opposed to the *Usage Examples*, programs listed here are not tuned to show the use of aiocoap, but are tools for everyday work with CoAP implemented in aiocoap. Still, they can serve as examples of how to deal with user-provided addresses (as opposed to the fixed addresses in the examples), or of integration in a bigger project in general.

6.6.1 aiocoap-client

aiocoap-client is a simple command-line tool for interacting with CoAP servers

```
usage: aiocoap-client [-h] [--non] [-m METHOD] [--observe]
                    [--observe-exec CMD] [--accept MIME]
                    [--proxy HOST[:PORT]] [--payload X]
                    [--payload-initial-szx SZX] [--content-format MIME]
                    [--no-set-hostname] [-v] [-q] [--interactive]
                    [--credentials CREDENTIALS] [--version] [--color]
                    [--pretty-print]
                    url
```

Positional Arguments

url CoAP address to fetch

Named Arguments

--non Send request as non-confirmable (NON) message
Default: False

-m, --method Name or number of request method to use (default: “GET”)
Default: “GET”

--observe Register an observation on the resource
Default: False

--observe-exec Run the specified program whenever the observed resource changes, feeding the response data to its stdin

--accept Content format to request

--proxy Relay the CoAP request to a proxy for execution

--payload Send X as request payload (eg. with a PUT). If X starts with an ‘@’, its remainder is treated as a file name and read from; ‘@-’ reads from the console. Non-file data may be recoded, see `-content-format`.

--payload-initial-szx Size exponent to limit the initial block’s size (0 16 Byte, 6 1024 Byte)

--content-format Content format of the `-payload` data. If a known format is given and `-payload` has a non-file argument, conversion is attempted (currently only JSON/Python-literals to CBOR).

--no-set-hostname Suppress transmission of Uri-Host even if the host name is not an IP literal
Default: True

-v, --verbose	Increase the debug output
-q, --quiet	Decrease the debug output
--interactive	Enter interactive mode
	Default: False
--credentials	Load credentials to use from a given file
--version	show program's version number and exit
--color, --no-color	Color output (default on TTYs if all required modules are installed)
--pretty-print, --no-pretty-print	Pretty-print known content formats (default on TTYs if all required modules are installed)

6.6.2 aiocoap-proxy

a plain CoAP proxy that can work both as forward and as reverse proxy

```
usage: aiocoap-proxy [-h] [--forward] [--reverse] [--bind BIND]
                   [--credentials CREDENTIALS]
                   [--tls-server-certificate CRT] [--tls-server-key KEY]
                   [--namebased NAME:DEST] [--subdomainbased NAME:DEST]
                   [--pathbased PATH:DEST] [--unconditional DEST]
```

mode

Required argument for setting the operation mode

--forward	Run as forward proxy
	Default: False
--reverse	Run as reverse proxy
	Default: False

details

Options that govern how requests go in and out

--bind	Host and/or port to bind to (see <code>--help-bind</code> for details)
--credentials	JSON file pointing to credentials for the server's identity/ies.
--tls-server-certificate	TLS certificate (chain) to present to connecting clients (in PEM format)
--tls-server-key	TLS key to load that supports the server certificate

Rules

Sequence of forwarding rules that, if matched by a request, specify a forwarding destination. Destinations can be prefixed to change their behavior: With an '@' sign, they are treated as forward proxies. With a '!' sign, the destination is set as Uri-Host.

--namebased	If Uri-Host matches NAME, route to DEST
--subdomainbased	If Uri-Host is anything.NAME, route to DEST

- pathbased** If a requested path starts with PATH, split that part off and route to DEST
- unconditional** Route all requests not previously matched to DEST

6.6.3 aiocoap-rd

A plain CoAP resource directory according to draft-ietf-core-resource-directory-25

Known Caveats:

- It is very permissive. Not only is no security implemented.
- This may and will make exotic choices about discoverable paths wherever it can (see StandaloneResourceDirectory documentation)
- Split-horizon is not implemented correctly
- Unless enforced by security (ie. not so far), endpoint and sector names (ep, d) are not checked for their lengths or other validity.
- Simple registrations don't cache .well-known/core contents

```
usage: aiocoap-rd [-h] [--bind BIND] [--credentials CREDENTIALS]
                 [--tls-server-certificate CRT] [--tls-server-key KEY]
```

Named Arguments

- bind** Host and/or port to bind to (see `--help-bind` for details)
- credentials** JSON file pointing to credentials for the server's identity/ies.
- tls-server-certificate** TLS certificate (chain) to present to connecting clients (in PEM format)
- tls-server-key** TLS key to load that supports the server certificate

6.6.4 aiocoap-fileserver

A simple file server that serves the contents of a given directory in a read-only fashion via CoAP. It provides directory listings, and guesses the media type of files it serves.

```
usage: aiocoap-fileserver [-h] [-v] [--register [RD-URI]] [--bind BIND]
                          [--credentials CREDENTIALS]
                          [--tls-server-certificate CRT]
                          [--tls-server-key KEY]
                          [path]
```

Positional Arguments

- path** Root directory of the server
- Default: .

Named Arguments

-v, --verbose	Be more verbose (repeat to debug) Default: 0
--register	Register with a Resource directory Default: False
--bind	Host and/or port to bind to (see <code>--help-bind</code> for details)
--credentials	JSON file pointing to credentials for the server's identity/ies.
--tls-server-certificate	TLS certificate (chain) to present to connecting clients (in PEM format)
--tls-server-key	TLS key to load that supports the server certificate

Those utilities are installed by `setup.py` at the usual executable locations; during development or when working from a git checkout of the project, wrapper scripts are available in the root directory. In some instances, it might be practical to access their functionality from within Python; see the `aiocoap.cli` module documentation for details.

All tools provide details on their invocation and arguments when called with the `--help` option.

6.6.5 contrib

Tools in the `contrib/` folder are somewhere inbetween *Usage Examples* and the tools above; the rough idea is that they should be generally useful but not necessarily production tools, and simple enough to be useful as an inspiration for writing other tools; none of this is set in stone, though, so that area can serve as a noncommittal playground.

These tools are currently present:

- `aiocoap-widgets`: Graphical software implementations of example CoAP devices as servers (eg. light bulb, switch). They should become an example of how CoRE interfaces and dynlinks can be used to discover and connect servers, and additionally serve as a playground for a more suitable Resource implementation.

The GUI is implemented in Gtk3 using the `gbulb` asyncio loop.

- `aiocoap-kivy-widget`: A similar (and smaller) widget implemented in `Kivy`.
As asyncio support is not merged in `Kivy` yet, be sure to build the library from [the asyncio pull request](#).
- `oscore-plugtest`: Server and client for the interoperability tests conducted during the development of OSCORE.

The programs in there are also used as part of the test suite.

- `rd-relay`: An experiment of how much a host must implement if it is to be discovered during a Resource Directory discovery process, but does not serve as the full resource directory itself and redirects the client there.

6.7 Frequently Answered Questions

(Not *actually* asked frequently – actually, this is a bunch of notes that users of the library should probably see at some point, while it is not clear where to better put them).

- **Which platforms are supported?**

aiocoap requires Python 3.7 (or PyPy 3.7), and should run on all operating systems supported by Python.

Development and automated tests run on Linux, and this is where all listed features are supported.

aiocoap generally runs on FreeBSD, Windows and macOS as well. Tests on FreeBSD are conducted manually; for Windows and macOS it's all largely relying on user feedback tracked in the [bug tracker for portability issues](#).

Note that the main CoAP-over-UDP transport `udp6` is only on-by-default on Linux because other platforms have no way of receiving network errors from an unconnected socket. The simpler UDP transports used on the other platforms do not support all features, and in particular lack multicast support.

aiocoap is agnostic of the backing `asyncio` implementation as long as it implements the functionality required by the transport (`add_reader` for `udp6`, `sockname` extra for role reversal on `simple6`). It is known to work with `uvloop` and `gbulb`.

- **How can a server be scaled up to use multiple cores?**

Python is often considered weak around threading. While setups with multiple `asyncio` worker should conceptually work, the easiest way to parallelize is just to have multiple instances of your server running at the same time. This works when transports and platform support the `SO_REUSEPORT` option (this is the case on Linux with the default transports, but never on Windows), with which incoming requests are dispatched to any of the processes serving the port by the operating system.

This requires an application design that has all its persistence managed outside the server process; that is typically the case with file system or database backed servers.

(aiocoap internally does hold some state, but that is always per client, and the load balancing typically ensures that requests from the same client wind up in the same process.)

- **Why do I get a “The transport can not be bound to any-address.” error message?**

For your platform, the `simplesocketserver` module was selected. See [the `simplesocketserver` documentation](#) for why it can not bind to that address.

- **How is multicast supported?**

Support for multicast is currently limited.

On the server side, things are mostly ready. Groups are joined [at server creation](#).

On the client side, requests to multicast addresses can be sent, and while they are treated adequately on the protocol level (eg. will not send CON requests), the [request interface](#) only exposes the first response. Thus, it can be used in discovery situations as long as only one response is processed, but not yet to its full power of obtaining data from multiple devices.

Note that multicast requests often require specification of an interface, as otherwise the request is underspecified. Thus, a typical command line request might look like this:

```
./aiocoap-client coap://'[ff02::fd%eth0]'/well-known/core --non
```

- **aiocoap fails to start if IPv6 is disabled system-wide.**

Yes. [Don't do that](#) It is not a supported mode of operation with the default implementation.

Background details:

The default transport of aiocoap uses APIs that are well specified for IPv6 and work there for both IPv4 and IPv6 packets. Explicitly re-implementing everything on v4 would not only be needless extra work, it would also be a portability problem as unlike for IPv6, the interfaces are not specified platform independently for IPv4. Moreover, that mode would be error prone because it wouldn't receive regular testing.

6.8 Change log

This summarizes the changes between released versions. For a complete change log, see the git history. For details on the changes, see the respective git commits indicated at the start of the entry.

6.8.1 Version 0.4.1

- Fix Python version reference to clearly indicate the 3.7 requirement everywhere.

A Python requirement of “>= 3.6.9” was left over in the previous release’s metadata from earlier intermediate steps that accomodated PyPy’s pre-3.7 version.

6.8.2 Version 0.4

Multicast improvements

- Multicast groups are not joined by default any more. Instead, groups and interfaces on which to join need to be specified explicitly. The previous mechanism was unreliable, and only joined on one (more or less random) interface.
- Network interfaces can now be specified in remotes of larger than link-local scope.
- In udp6, network interface are selected via PKTINFO now. They used to be selected using the socket address tuple, but that was limited to link-local addresses, but PKTINFO worked just as well for link-local addresses.
- Remote addresses in udp6 now have a *netif* property.

New features

- The simple6 transport can now indicate the local address when supported by the platform. This makes it a viable candidate for LwM2M clients as they often operate using role reversal.
- Servers (including the shipped examples) can now offer OSCORE through the OSCORE sitewrapper. Access control is only rudimentary in that the authorization information is not available in a convenient form yet.
- CoAP over WebSockets is now supported (in client and server role, with and without TLS). Please note that the default port bound to is not the HTTP default port but 8683.
- OSCORE group communication is now minimally supported (based on draft version 10). No automated ways of setting up a context are provided yet. This includes highly experimental support for deterministic requests.
- DTLS: Terminating connections are now handled correctly, and shut down when unused. The associated refactoring also reduces the resource usage of DTLS connections.

Tools updates

- aiocoap-client: New options to
 - set initial Block1 size (*-payload-initial-szx*), and to
 - elide the Uri-Host option from requests to named hosts.
- aiocoap-client: CBOR input now accepts Python literals or JSON automatically, and can thus produce numeric keys and byte strings.
- aiocoap-client: Preprocessed CBOR output now works for any CBOR-based content format.
- resource-directory: Updated to draft -25.
- resource-directory: Compatibility mode for LwM2M added.

- resource-directory: Proxying extension implemented. With this, and RD can be configured to allow access to endpoints behind a firewalls or NAT.
- Example server: Add /whoami resource.

Dependencies

- The minimum required Python version is now 3.7.
- The cbor library dependency was replaced with the cbor2 library.
- The dependency on the hkdf library was removed.
- The ge25519 library dependency was added to perform key conversion steps necessary for Group OSCORE.

Portability

- Several small adjustments were made to accomodate execution on Windows.
- FreeBSD was added to the list of supported systems (without any need for changes).

Fixes possibly breaking applications

- Some cases of OSError were previously raised in responses. Those are now all expressed as an `aiocoap.error.NetworkError`, so that an application only need to catch `aiocoap.error.Error` for anything that's expected to go wrong.

The original error cause is available in a chained exception.

- Responses are not deduplicated any more; as a result, less state is kept in the library.

As a result, separate responses whose ACKs get lost produce an RST the second time the CON comes. This changes nothing about the client-side handling (which is complete either way with the first response), but may upset servers that do not anticipate this allowed behavior.

Minor fixes

- The repr of udp6 addresses now shows all address components.
- Debug information output was increased in several spots.
- The `loop=` parameter was removed where it is deprecated by Python 3.8.
- asyncio Futures are created using `create_future` in some places.
- Binding to port 0 works again.
- The file server's registration at an RD was fixed.
- File server directories can now use block-wise transfer.
- Server errors from rendering exceptions to messages are now caught.
- Notifications now respect the block size limit.
- Several improvements to the test infrastructure.
- Refactoring around request processing internals (`PlumbingRequest`) alleviated potential memory leaks.
- Update option numbers from draft-ietf-echo-request-tag-10.

- Various proxying fixes and enhancements.
- TLS: Use SNI (Python ≥ 3.8), set correct hostinfo based on it.
- Internally used NoResponse options on responses are not leaked any more.
- Timeouts from one remote are now correctly propagated to all pending requests.
- Various logging improvements and changes.
- udp6: Show warnings when operating system fails to deliver pktinfo (happens with very old Linux kernels).
- Reduce installation clobber by excluding tests.
- Enhanced error reporting for erroneous *coap://2001:db8::1/* style URIs
- Improve OSCORE's shutdown robustness.
- Sending to IPv4 literals now does not send the Uri-Host automatically any more.

6.8.3 Version 0.4b3

Behavioral changes

- Responses to NON requests are now sent as NON.

Portability

- All uses of SO_REUSEPORT were changed to SO_REUSEADDR, as REUSEPORT is considered dangerous by some and removed from newer Python versions.

On platforms without support for that option, it is not set. Automatic load-balancing by running parallel servers is not supported there.

- The udp6 module is now usable on platforms without MSG_ERRQUEUE (ie. anything but Linux). This comes with caveats, so it is still only enabled by default on Linux.

The required constants are now shipped with aiocoap for macOS for the benefit of Python versions less than 3.9.

Minor fixes

- More effort is made to sync OSCORE persistence files to disk.
- Memory leakage fixes on server and client side.
- Option numbers for Echo and Request-Tag were updated according to the latest draft version.

Other

- FAQ section started in the documentation.
- With *./setup.py test* being phased out, tests are now run via tox.

6.8.4 Version 0.4b2

New features

- OSCORE: Implement Appendix B.1 recovery. This allows the aiocoap program to run OSCORE without writing sequence numbers and replay windows to disk all the time. Instead, they write pessimistic values to disk that are rarely updated, write the last values on shutdown. In the event of an unclean shutdown, the sender sequence number is advanced by some, and the first request from a client is sent back for another roundtrip using the Echo option.

An aiocoap client now also contains the code required to transparently resubmit requests if a server is in such a recovery situation.

- OSCORE: Security contexts are now protected against simultaneous use by multiple aiocoap processes. This incurs an additional dependency on the `filelock` package.

Breaking changes

- OSCORE: The file format of security context descriptions is changed. Instead of the previous roles concept, they now carry explicit sender and recipient IDs, and consequently do not take a role parameter in the credentials file any more.

The sequence number format has changed incompatibly.

No automatic conversion is available. It is recommended to replace old security contexts with new keys.

Minor fixes

- b4540f9: Fix workaround for missing definitions, restoring Python 3.5 support on non-amd64 platforms.
- b4b886d: Fix regression in the display of zone identifiers in IPv6 addresses.
- 5055bd5: The server now does not send RSTs in response to multicasts any more.
- OSCORE: The replay window used is now the prescribed 32bit large DTLS-like window.

6.8.5 Version 0.4b1

Tools

- aiocoap-client can now re-format binary output (hex-dumping binary files, showing CBOR files in JSON-like notation) and apply syntax highlighting. By default, this is enabled if the output is a terminal. If output redirection is used, data is passed on as-is.
- aiocoap-fileserver is now provided as a standalone tool. It provides directory listings in link format, guesses the content format of provided files, and allows observation.
- aiocoap-rd is now provided as a standalone tool and offers a simple CoRE Resource Directory server.

Breaking changes

- Client observations that have been requested by sending the Observe option must now be taken up by the client. The warning that was previously shown when an observation was shut down due to garbage collection can not be produced easily in this version, and will result in a useless persisting observation in the background. (See <https://github.com/chrysn/aiocoap/issues/104>)

- Server resources that expect the library to do handle blockwise by returning true to `needs_blockwise_assembly` do not allow random initial access any more; this this is especially problematic with clients that use a different source port for every package.

The old behavior was prone to triggering an action twice on non-safe methods, and generating wrong results in `block1+block2` scenarios when a later `FETCH block2:2/x/x` request would be treated as a new operation and return the result of an empty request body rather than being aligned with an earlier `FETCH block1:x/x/x` operation.

- `fdc8b024`: Support for Python 3.4 is dropped; minimum supported version is now 3.5.2.
- `0124ad0e`: The network dumping feature was removed, as it would have been overly onerous to support it with the new more flexible transports.
- `092cf49f`, `89c2a2e0`: The content type mapped to the content format 0 was changed from “text/plain” (which was incorrect as it was just the bare media type) to the actual content of the IANA registry, “text/plain;charset=utf8”. For looking up the content format, text/plain is still supported but deprecated.
- `17d1de5a`: Handling of the various components of a remote was unified into the `.remote` property of messages. If you were previously setting unresolved addresses or even a tuple-based remote manually, please set them using the `uri` pseudo-option now.
- `47863a29`: Re-raise transport specific errors as aiocoap errors as `aiocoap.error.ResolutionError` or `NetworkError`. This allows API users to catch them independently of the underlying transport.
- `f9824eb2`: Plain strings as paths in `add_resource` are rejected. Applications that did this are very unlikely to have produced the intended behavior, and if so can be easily fixed by passing in `tuple(s)` rather than `s`.

New features

- `88f44a5d`: TCP and TLS support added; TLS is currently limited to PKI certificates. This includes support for preserving the URI scheme in exchanges (`0b0214db`).
- `a50da1a8`: The credentials module was added to dispatch DTLS and OSCORE credentials
- `f302da07`: On the client side, OSCORE can now be used as a transport without any manual protection steps. It is automatically used for URIs for which a security context has been registered with the context’s client credentials.
- `5e5388ae`: Support for PyPy
- `0d09b2eb`: `NoResponse` is now handled automatically. Handlers can override the default handling by setting a No-Response option on their response messages, whose value will then be examined by the library to decide whether the message is actually sent; the No-Response option is stripped from the outgoing message in the course of that (as it’s actually not a response option).
- `b048a50a`: Some improvements on multicast handling. There is still no good support for sending a request to multicast and receiving the individual responses, but requests to multicast addresses are now unconditionally handled under the rules of multicast CoAP, even if they’re used over the regular request interface (ie. sending to multicast but processing only the first response).
- `c7ca0286`: The software version used to run the server (by default, aiocoap’s version) is now shown in `.well-known/core` using the `impl-info` relation.

Deprecations

- `0d09b2eb`: Returning a `NoResponse` sentinel value is now deprecated.

Assorted changes

- Additions to the contrib/ collection of aiocoap based tools:
 - widgets, kivy-widgets
 - rd-relay
- 95c681a5 and others: Internal interfaces were introduced for the various CoAP sublayers. This should largely not affect operation (though it does change the choice of tokens or message IDs); where it does, it's noted above in the breaking changes.
- 5e5388ae, 9e17180e, 60137bd8: Various fixes to the OSCORE implementation, which is not considered experimental any more.
- Various additions to the test suite
- 61843d41: Asynchronous `recvmsg` calling (as used by the `udp6` backend) was reworked from monkey-patching into using `asyncio`'s `add_reader` method, and should thus now be usable on all `asyncio` implementations, including `uvloop` and `gbulb`.
- 3ab14c49: `.well-known/core` filtering will now properly filter by content format (`ct=`) in the presence of multiple supported content types.
- 9bd612de: Fix encoding of block size 16.
- 029a8f0e: Don't enforce `V4MAPPED` addresses in the `simple6` backend. This makes the backend effectively a simple-any backend, as the address family can be picked arbitrarily by the operating system.
- 8e93eeb9: The `simple6` backend now reuses the most recently used 64 sockets.
- cb8743b6: Resolve the name given as binding server name. This enables creating servers bound exclusively to a link-local address.
- d6aa5f8c: `TinyDTLS` now pulls in a more recent version of `DTLSSocket` that has its version negotiation fixed, and can thus interoperate with recent versions of `libcoap` and `RIOT`'s the pending support for DTLS on `Gcoap`.
- 3d9613ab: Errors in URI encoding were fixed

6.8.6 Version 0.4a1

Security fixes

- 18ddf8c: Proxy now only creates log files when explicitly requested
- Support for secured protocols added (see Experimental Features)

Experimental features

- Support for OSCORE (formerly OSCOAP) and CoAP over DTLS was included
These features both lack proper key management so far, which will be available in a 0.4 release.
- Added implementations of Resource Directory (RD) server and endpoint
- Support for different transports was added. The transport backends to enable are chosen heuristically depending on operating system and installed modules.
 - Transports for platforms not supporting all POSIX operations to run CoAP correctly were added (`simple6`, `simplesocketserver`). This should allow running aiocoap on Windows, MacOS and using `uvloop`, but with some disadvantages (see the the respective transport documentations).

Breaking changes

- 8641b5c: Blockwise handling is now available as stand-alone responder. Applications that previously created a Request object rather than using Protocol.request now need to create a BlockwiseRequest object.
- 8641b5c: The `.observation` property can now always be present in responses, and applications that previously checked for its presence should now check whether it is None.
- cdfeaeb: The multicast interface using `queuewithend` was replaced with asynchronous iterators
- d168f44: Handling of sub-sites changed, subsites' root resources now need to reside at path (" ",)

Deprecations

- e50e994: Rename `UnsupportedMediaType` to `UnsupportedContentFormat`
- 9add964 and others: The `.remote` message property is not necessarily a tuple any more, and has its own interface
- 25cbf54, c67c2c2: Drop support for Python versions < 3.4.4; the required version will be incremented to 3.5 soon.

Assorted changes

- 750d88d: Errors from predefined exceptions like `BadRequest(...)` are now sent with their text message in the diagnostic payload
- 3c7635f: Examples modernized
- 97fc5f7: Multicast handling changed (but is still not fully supported)
- 933f2b1: Added support for the No-Response option (RFC7967)
- baa84ee: V4MAPPED addresses are now properly displayed as IPv4 addresses

Tests

- Test suite is now run at Gitlab, and coverage reported
- b2396bf: Test suite probes for usable hostnames for localhost
- b4c5b1d: Allow running tests with a limited set of extras installed
- General improvements on coverage

6.8.7 Version 0.3

Features

- 4d07615: ICMP errors are handled
- 1b61a29: Accept 'fe80::...%eth0' style addresses
- 3c0120a: Observations provide modern `async` for interface
- 4e4ff7c: New demo: file server
- ef2e45e, 991098b, 684ccdd: Messages can be constructed with options, modified copies can be created with the `.copy` method, and default codes are provided

- 08845f2: Request objects have `.response_nonraising` and `.response_raising` interfaces for easier error handling
- ab5b88a, c49b5c8: Sites can be nested by adding them to an existing site, catch-all resources can be created by subclassing `PathCapable`

Possibly breaking changes

- ab5b88a: Site nesting means that server resources do not get their original Uri-Path any more
- bc76a7c: Location-`{Path,Query}` were opaque (bytes) objects instead of strings; distinction between accidental and intentional opaque options is now clarified

Small features

- 2bb645e: `set_request_uri` allows URI parsing without sending Uri-Host
- e6b4839: Take `block1.size_exponent` as a sizing hint when sending `block1` data
- 9eafd41: Allow passing in a loop into context creation
- 9ae5bdf: `ObservableResource`: Add `update_observation_count`
- c9f21a6: Stop client-side observations when unused
- dd46682: Drop dependency on obscure built-in IN module
- a18c067: Add numbers from draft-ietf-core-etch-04
- fabcfd5: `.well-known/core` supports filtering

Internals

- f968d3a: All low-level networking is now done in `aiocoap.transports`; it's not really hotpluggable yet and only UDPv6 (with implicit v4 support) is implemented, but an extension point for alternative transports.
- bde8c42: `recvmsg` is used instead of `recvfrom`, requiring some asyncio hacks

Package management

- 01f7232, 0a9d03c: `aiocoap-client` and `-proxy` are entry points
- 0e4389c: Establish an extra requirement for `LinkHeader`

6.9 LICENSE

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