
laurelin Documentation

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Laurelin is a pure-Python ORM-esque LDAP client. Check out the [user docs](#) to get started. View the source on [GitHub](#).

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1.1 Features Overview

- Fully compliant with RFC 4510 and its children.
- Pure Python codebase, meaning that it can be used with Python implementations other than CPython.

- Tested against CPython 2.7, 3.3, 3.4, 3.5, 3.6, PyPy, and PyPy3.
- Simplified filter syntax (optional, standard filter syntax is fully supported and used by default)
- Pythonic attributes input and presentation. It's just a dictionary.
- Exceedingly easy relative searching. All objects have a suite of search methods which will automatically pass the object's DN as the search base. In many cases, you won't have to pass *any* arguments to search methods.
- Similarly, all objects have a suite of modify methods which allow you to change attributes on already-queried objects without having to pass their DN again.
- Intelligent modification will never send existing attribute values to the server, nor will it request deletion of attribute values that do not exist. This prevents many unnecessary server errors. Laurelin will go as far as to query the object for you before modifying it to ensure you don't see pointless errors (if you want it to).
- Custom validation. You can define validators which check new objects and modify operations for correctness before sending them to the server. Since you control this code, this can be anything from a simple regex check against a particular attribute value, to a complex approval queue mechanism.
- Highly extensible. New methods can easily and safely be bound to base classes.
- Seamless integration of controls. Once defined, these are just new keyword arguments on particular methods, and additional attributes on the response object.
- Includes Python implementations of standard schema elements. This conveys many benefits:
 - Allows changes to be validated *before* sending the server
 - Allows matching rules to be used to compare attribute values locally. Many attribute types are case-insensitive and have other rules meaning that the standard Python `==` or `in` operators won't tell you what you want to know. Laurelin makes them work according to these rules.

1.2 Missing/incomplete features

Some lesser-used features of the LDAP protocol have not yet been implemented or are incomplete. Check the [GitHub issues](#) to see if your use case is affected. Please add a comment if so, or open a new issue if you spot anything else. PRs are always welcome.

1.3 Walkthrough

Note: I'm assuming that if you're here, you're already pretty familiar with LDAP fundamentals. If you don't know how to write a search filter, you may want to do some more reading on LDAP before continuing.

1.3.1 Navigating

Just about everything you need for routine user tasks is available in the `laurelin.ldap` package. `laurelin.ldap.exceptions` contains all exception definitions which you may need to import to catch, but even some common ones are included in `laurelin.ldap`. Beyond that, you should not need to get into the sub-modules unless you are defining controls, extensions, schema, or validators.

Built-in extensions are stored in the `laurelin.extensions` package.

1.3.2 Getting Started

The first thing you should typically do after importing is configure logging and/or warnings. There is a lot of useful information available at all log levels:

```
from laurelin.ldap import LDAP

LDAP.enable_logging()
# Enables all log output on stderr
# It also accepts an optional log level argument, e.g. LDAP.enable_logging(logging.
↳ERROR)
# The function also returns the handler it creates for optional further manual_
↳handling

import logging

logger = logging.getLogger('laurelin.ldap')
# Manually configure the logger and handlers here using the standard logging module
# Submodules use the logger matching their name, below laurelin.ldap

LDAP.log_warnings()
# emit all LDAP warnings as WARN-level log messages on the laurelin.ldap logger
# all other warnings will take the default action

LDAP.disable_warnings()
# do not emit any LDAP warnings
# all other warnings will take the default action
```

You can then initialize a connection to an LDAP server. Pass a URI string to the `LDAP` constructor:

```
with LDAP('ldap://dir.example.org:389') as ldap:
    # do stuff...

# Its also possible, but not recommended, to not use the context manager:
ldap = LDAP('ldap://dir.example.org:389')
```

This will open a connection and query the server to find the “base DN” or DN suffix. An empty `LDAPObject` will be created with the base DN and stored as the `base` attribute on the `LDAP` instance. More on this later. For now we will briefly cover the basic LDAP interface which may seem somewhat familiar if you have used the standard python-ldap client before.

1.3.3 LDAP Methods Intro

`LDAP.search()` sends a search request and returns an iterable over instances of `LDAPObject`. Basic arguments are described here (listed in order):

- `base_dn` - the absolute DN to start the search from
- `scope` - One of:
 - `Scope.BASE` - only search `base_dn` itself
 - `Scope.ONE` - search `base_dn` and its immediate children
 - `Scope.SUB` - search `base_dn` and all of its descendents (default)
- `filter` - standard LDAP filter string
- `attrs` - a list of attributes to return for each object

Use `LDAP.get()` if you just need to get a single object by its DN. Also accepts an optional list of attributes.

`LDAP.add()` adds a new object, and returns the corresponding `LDAPObject`, just pass the full, absolute DN and an *attributes dict*

`LDAP.delete()` deletes an entire object. Just pass the full, absolute DN of the object to delete.

The following methods are preferred for modification, however raw *modify methods* are also provided.

All accept the absolute DN of the object to modify, and an *attributes dictionary*.

`LDAP.add_attrs()` adds new attributes.

`LDAP.delete_attrs()` deletes attribute values. Pass an empty values list in the attributes dictionary to delete all values for an attribute.

`LDAP.replace_attrs()` replaces all values for the given attributes with the values passed in the attributes dictionary. Attributes that are not mentioned are not touched. Passing an empty list removes all values.

For `LDAP.delete_attrs()` and `LDAP.replace_attrs()` you can specify the constant `LDAP.DELETE_ALL` in place of an empty attribute value list to remove all values for the attribute. For example:

```
ldap.replace_attrs('cn=foo,dc=example,dc=org', {'someAttribute': LDAP.DELETE_ALL})
```

If you wish to require the use of the constant instead of an empty list, pass `error_empty_list=True` to the `LDAP` constructor. You can also pass `ignore_empty_list=True` to silently prevent these from being sent to the server (this will be the default behavior in a future release).

1.3.4 LDAPObject Methods Intro

Great, right? But specifying absolute DNs all the time is no fun. Enter `LDAPObject`, and keep in mind the base attribute mentioned earlier.

`LDAPObject` inherits from `AttrsDict` to present attributes. This interface is documented [here](#).

`LDAPObject` defines methods corresponding to all of the `LDAP` methods, but pass the object's dn automatically, or only require the RDN prefix, with the object's dn automatically appended to obtain the absolute DN.

`LDAPObject.search()` accepts all the same arguments as `LDAP.search()` except `base_dn` and `scope`. The object's own DN is always used for `base_dn`, and the `relative_search_scope` is always used as the `scope`.

`LDAPObject.find()` is more or less a better `LDAPObject.get_child()`. It looks at the object's `relative_search_scope` property to determine the most efficient way to find a single object below this one. It will either do a `BASE` search if `relative_seach_scope=Scope.ONE` or a `SUBTREE` search if `relative_search_Scope=Scope.SUB`. It is an error to use this method if `relative_search_scope=Scope.BASE`.

`LDAPObject.get_child()` is analagous to `LDAP.get()` but it only needs the RDN, appending the object's own DN as mentioned earlier. (Note that `LDAPObject.get()` inherits from the native `dict.get()`)

`LDAPObject.add_child()` is analagous to `LDAP.add()` again accepting an RDN in place of a full absolute DN.

Use `LDAPObject.get_attr()` like `dict.get()` except an empty list will always be returned as default if the attribute is not defined.

`LDAPObject`'s modify methods update the server first, then update the local attributes dictionary to match if successful. `LDAPObject.add_attrs()`, `LDAPObject.delete_attrs()`, and `LDAPObject.replace_attrs()` require only a new attributes dictionary as an argument, of the same format as for the matching `LDAP` methods.

`LDAPObject` Examples:

```

people = ldap.base.get_child('ou=people')

print(people['objectClass'])
# ['top', 'organizationalUnit']

people.add_attrs({'description':['Contains all users']})

# list all users
for user in people.search(filter='(objectClass=posixAccount)'):
    print(user['uid'][0])

```

1.4 Relative Searching

All objects have `LDAPObject.search()` and `LDAPObject.find()` methods which utilize the `relative_search_scope` attribute of the object. `relative_search_scope` can be passed as a keyword to any method that creates new objects, including `LDAP.obj()`, `LDAP.get()`, `LDAP.search()`, `LDAP.add()`, `LDAPObject.obj()`, `LDAPObject.find()`, `LDAPObject.search()`, `LDAPObject.get_child()`, and `LDAPObject.add_child()`.

When you create an object from another `LDAPObject` and you *don't* specify the `relative_search_scope`, it is automatically inherited from the parent object. When you create an object from an `LDAP` method, it defaults to `Scope.SUB`.

The real win with this feature is when your tree is structured such that you can set this to `Scope.ONE` as this conveys significant performance benefits, especially when using `LDAPObject.find()`. This allows laurelin to construct the absolute DN of the child object and perform a highly efficient `BASE` search.

1.5 Attributes Dictionaries

This common interface is used both for input and output of LDAP attributes. In short: dict keys are attribute names, and dict values are a list of attribute values. For example:

```

{
    'objectClass': ['posixAccount', 'inetOrgPerson'],
    'uid': ['ashafer01'],
    'uidNumber': ['1000'],
    'gidNumber': ['100'],
    'cn': ['Alex Shafer'],
    'homeDirectory': ['/home/ashafer01'],
    'loginShell': ['/bin/zsh'],
    'mail': ['ashafer01@example.org'],
}

```

Note that there is an `AttrsDict` class defined - there is **no requirement** to create instances of this class to pass as arguments, though you are welcome to if you find the additional methods provided this class convenient, such as `AttrsDict.get_attr()`. Further, it overrides dict special methods to enforce type requirements and enable case-insensitive keys.

Also note that when passing an attributes dictionary to `LDAP.replace_attrs()` or `LDAP.delete_attrs()` it is legal to specify the constant `LDAP.DELETE_ALL` in place of a value list.

1.6 Modify Operations

1.6.1 Raw modify methods

`LDAP.modify()` and `LDAPObject.modify()` work similarly to the modify functions in `python-ldap`, which in turn very closely align with how modify operations are described at the protocol level. A list of `Mod` instances is required with 3 arguments:

1. One of the `Mod` constants which describe the operation to perform on an attribute:
 - `Mod.ADD` adds new attributes/values
 - `Mod.REPLACE` replaces all values for an attribute, creating new attributes if necessary
 - `Mod.DELETE` removes attributes/values.
2. The name of the attribute to modify. Each entry may only modify one attribute, but an unlimited number of entries may be specified in a single modify operation.
3. A list of attribute values to use with the modify operation or the constant `LDAP.DELETE_ALL`:
 - The list may be empty for `Mod.REPLACE` and `Mod.DELETE`, both of which will cause all values for the given attribute to be removed from the object. The list may not be empty for `Mod.ADD`. You can also specify the constant `LDAP.DELETE_ALL` in place of any empty list. If you wish to warn about empty lists or require the use of the constant, pass `warn_empty_list=True` or `error_empty_list=True` to the `LDAP` constructor. You can also pass `ignore_empty_list=True` to silently prevent these from being sent to the server (this will be the default behavior in a future release).
 - A non-empty list for `Mod.ADD` lists all new attribute values to add
 - A non-empty list for `Mod.DELETE` lists specific attribute values to remove
 - A non-empty list for `Mod.REPLACE` indicates ALL new values for the attribute - all others will be removed.

Example custom modify operation:

```
from laurelin.ldap.modify import Mod

ldap.modify('uid=ashafer01,ou=people,dc=example,dc=org', [
    Mod(Mod.ADD, 'mobile', ['+1 401 555 1234', '+1 403 555 4321']),
    Mod(Mod.ADD, 'homePhone', ['+1 404 555 6789']),
    Mod(Mod.REPLACE, 'homeDirectory', ['/export/home/ashafer01']),
])
```

Using an `LDAPObject` instead:

```
ldap.base.obj('uid=ashafer01,ou=people').modify([
    Mod(Mod.DELETE, 'mobile', ['+1 401 555 1234']),
    Mod(Mod.DELETE, 'homePhone', LDAP.DELETE_ALL), # delete all homePhone values
])
```

Again, an arbitrary number of `Mod` entries may be specified for each `modify` call.

1.6.2 Strict modification and higher-level modify functions

The higher-level modify functions (`add_attrs`, `delete_attrs`, and `replace_attrs`) all rely on the concept of *strict modification* - that is, to only send the modify operation, and to never perform an additional search. By default, strict modification is **disabled**, meaning that, if necessary, an extra search **will** be performed before sending a modify request.

You can enable strict modification by passing `strict_modify=True` to the `LDAP` constructor.

With strict modification disabled, the `LDAP` modify functions will engage a more intelligent modification strategy after performing the extra query: for `LDAP.add_attrs()`, no duplicate values are sent to the server to be added. Likewise for `LDAP.delete_attrs()`, deletion will not be requested for values that are not known to exist. This prevents many unnecessary failures, as ultimately the final semantic state of the object is unchanged with or without such failures. (Note that with `LDAP.replace_attrs()` no such failures are possible)

With the `LDAPObject` modify functions, the situation is slightly more complex. Regardless of the `strict_modify` setting, the more intelligent modify strategy will always be used, using at least any already-queried attribute data stored with the object (which could be complete data depending on how the object was originally obtained). If `strict_modify` is disabled, however, another search *may* still be performed to fill in any missing attributes that are mentioned in the passed attributes dict.

The raw modify functions on both `LDAP` and `LDAPObject` are unaffected by the `strict_modify` setting - they will always attempt the modify operation exactly as specified.

1.7 Global Defaults, LDAP instance attributes, and LDAP constructor arguments

All of the `LDAP` constructor arguments are set to `None` by default. In the constructor, any explicitly is `None` arguments are set to their associated global default. These are attributes of the `LDAP` class, have the same name as the argument, upper-cased, and with a `DEFAULT_` prefix (but the prefix wont be repeated).

For example, the `server` argument has global default `LDAP.DEFAULT_SERVER`, and `default_criticality` is `LDAP.DEFAULT_CRITICALITY`.

Most arguments also have an associated instance property. A complete table is below:

Global Default	LDAP instance attribute	LDAP constructor keyword
<code>LDAP.DEFAULT_SERVER</code>	<code>host_uri</code>	<code>server</code>
<code>LDAP.DEFAULT_BASE_DN</code>	<code>base_dn</code>	<code>base_dn</code>
<code>LDAP.DEFAULT_FILTER</code>	<code>none</code>	<code>none</code>
<code>LDAP.DEFAULT_DEREF_ALIASES</code>	<code>default_deref_aliases</code>	<code>deref_aliases</code>
<code>LDAP.DEFAULT_SEARCH_TIMEOUT</code>	<code>default_search_timeout</code>	<code>search_timeout</code>
<code>LDAP.DEFAULT_CONNECT_TIMEOUT</code>	<code>sock_params[0]</code>	<code>connect_timeout</code>
<code>LDAP.DEFAULT_STRICT_MODIFY</code>	<code>strict_modify</code>	<code>strict_modify</code>
<code>LDAP.DEFAULT_REUSE_CONNECTION</code>	<code>none</code>	<code>reuse_connection</code>
<code>LDAP.DEFAULT_SSL_VERIFY</code>	<code>ssl_verify</code>	<code>ssl_verify</code>
<code>LDAP.DEFAULT_SSL_CA_FILE</code>	<code>ssl_ca_file</code>	<code>ssl_ca_file</code>
<code>LDAP.DEFAULT_SSL_CA_PATH</code>	<code>ssl_ca_path</code>	<code>ssl_ca_path</code>
<code>LDAP.DEFAULT_SSL_CA_DATA</code>	<code>ssl_ca_data</code>	<code>ssl_ca_data</code>
<code>LDAP.DEFAULT_FETCH_RESULT_REFS</code>	<code>default_fetch_result_refs</code>	<code>fetch_result_refs</code>
<code>LDAP.DEFAULT_FOLLOW_REFERRALS</code>	<code>default_follow_referrals</code>	<code>follow_referrals</code>
<code>LDAP.DEFAULT_SASL_MECH</code>	<code>default_sasl_mech</code>	<code>default_sasl_mech</code>
<code>LDAP.DEFAULT_SASL_FATAL_DOWNGRADE_CHECK</code>	<code>default_sasl_fatal_downgrade_check</code>	<code>sasl_fatal_downgrade_check</code>
<code>LDAP.DEFAULT_CRITICALITY</code>	<code>default_criticality</code>	<code>default_criticality</code>
<code>LDAP.DEFAULT_VALIDATORS</code>	<code>validators</code>	<code>validators</code>
<code>LDAP.DEFAULT_WARN_EMPTY_LIST</code>	<code>warn_empty_list</code>	<code>warn_empty_list</code>
<code>LDAP.DEFAULT_ERROR_EMPTY_LIST</code>	<code>error_empty_list</code>	<code>error_empty_list</code>
<code>LDAP.DEFAULT_IGNORE_EMPTY_LIST</code>	<code>ignore_empty_list</code>	<code>ignore_empty_list</code>
<code>LDAP.DEFAULT_FILTER_SYNTAX</code>	<code>default_filter_syntax</code>	<code>filter_syntax</code>
<code>LDAP.DEFAULT_BUILT_IN_EXTENSIONS</code>	<code>none/public</code>	<code>built_in_extensions_only</code>

The `LDAP` instance attributes beginning with `default_` are used as the defaults for corresponding arguments on other methods. `default_sasl_mech` is used with `LDAP.sasl_bind()`, `default_criticality` is the default criticality of all controls, the other `default_` attributes are used with `LDAP.search()`.

The `ssl_` prefixed instances attributes are used as the defaults for `LDAP.start_tls()`, as well as the socket configuration when connecting to an `ldaps://` socket.

1.8 Basic usage examples

1.8.1 1. Connect to local LDAP instance and iterate all objects

```
from laurelin.ldap import LDAP

with LDAP('ldapi:///') as ldap:
    ldap.sasl_bind()
    for obj in ldap.base.search():
        print(obj.format_ldif())
```

`LDAP.sasl_bind()` defaults to the EXTERNAL mechanism when an `ldapi:` URI is given, which uses the current user for authorization via the unix socket (Known as “autobind” with 389 Directory Server)

CHAPTER 2

Simple Search Filters

Laurelin provides an alternate syntax for search filters that is much simpler than the standard, RFC 4515-compliant, filter syntax. In short, it is a hybrid between SQL logic expressions and standard LDAP filter comparisons.

In the simplest case of a single comparison, the two syntaxes are identical:

Standard	Simple
(gidNumber=100)	(gidNumber=100)

But when it comes to expressing logic, the Laurelin simplified filter differs quite a bit:

Standard	Simple
(&(gidNumber<=1000) (! (memberUid=*)))	(gidNumber<=1000) AND NOT (memberUid=*)

Feel free to include parentheses in your simple filters if it helps clarify the logic:

Simple (without extra parens)	Simple (equivalent with extra parens)
(gidNumber<=1000) AND NOT (memberUid=*)	(gidNumber<=1000) AND (NOT (memberUid=*))

Some more equivalent standard and simple filters:

Standard	Simple
(&(abc=foo) ((def=bar) (ghi=jkl)))	(abc=foo) AND ((def=bar) OR (ghi=jkl))
((abc=foo) (& (def=bar) (ghi=jkl)))	(abc=foo) OR (def=bar) AND (ghi=jkl)
(&(abc=foo) ((def=bar) (ghi=jkl)) (xyz=abc))	(abc=foo) AND ((def=bar) OR (ghi=jkl)) AND (xyz=abc)

By default, Laurelin will interpret your filters with the **unified** filter syntax, meaning you can embed a full RFC 4515-compliant filter anywhere you see a simple comparison in the above examples. This includes as the only element in the filter, making this fully backwards compatible with RFC 4515 standard filters.

Currently available syntaxes are `FilterSyntax.STANDARD` to limit to RFC 4515, `FilterSyntax.SIMPLE` to limit to only simple comparisons within SQL-style logic, and the default `FilterSyntax.UNIFIED`.

If you wish to restrict the syntax, you can do one of the following:

1. Pass `filter_syntax=` to `LDAP.search()` or any other search method:

```
from laurelin.ldap import LDAP, FilterSyntax

with LDAP() as ldap:
    search = ldap.search('o=foo', filter='(abc=foo) AND (def=bar)', filter_
    ↪syntax=FilterSyntax.SIMPLE)
```

2. Pass `filter_syntax=` to the `LDAP` constructor:

```
from laurelin.ldap import LDAP, FilterSyntax

with LDAP(filter_syntax=FilterSyntax.SIMPLE) as ldap:
    search1 = ldap.search('o=foo', filter='(abc=foo) AND (def=bar)')
    search2 = ldap.search('o=bar', filter='(xyz=foo) OR (abc=bar)')
```

3. Set the global default `LDAP.DEFAULT_FILTER_SYNTAX` before instantiating any `LDAP` instances:

```
from laurelin.ldap import LDAP, FilterSyntax

LDAP.DEFAULT_FILTER_SYNTAX = FilterSyntax.STANDARD

with LDAP() as ldap:
    search = ldap.search('o=foo', filter='(&(abc=foo)(def=bar))')

with LDAP('ldap://localhost:10389') as ldap:
    search = ldap.search('o=bar', filter='(|(xyz=foo)(abc=bar))')
```

4. Do either of the two above using *Config Files*.

Note: How is this possible?

Doesn't the filter get sent to the server and parsed there like SQL? No! In LDAP, it is up to the client to parse the filter string into a set of objects that are encoded and sent to the server. If you've got any other ideas for alternate filter syntaxes, please submit a PR!

The following class documents show names of available extensions on different instances.

3.1 Laurelin Extensions

Every defined extension has a property in this class. An instance is accessible at `laurelin.ldap.extensions`. For example, to require the base schema:

```
from laurelin.ldap import extensions
extensions.base_schema.require()
```

class `laurelin.ldap.extensible.laurelin_extensions.Extensions`

Bases: `laurelin.ldap.extensible.base.ExtensionsBase`

base_schema

The standard base schema from various RFCs

Return type *laurelin.extensions.base_schema.LaurelinExtension*

descattrs

The built-in description attributes extension

Return type *laurelin.extensions.descattrs.LaurelinExtension*

netgroups

The built-in NIS netgroups extension

Return type *laurelin.extensions.netgroups.LaurelinExtension*

paged_results

Built-in extension defining standard paged results control for search

Return type *laurelin.extensions.pagedresults.LaurelinExtension*

3.2 LDAP Extensions

These properties are available on *LDAP* instances.

class `laurelin.ldap.extensible.ldap_extensions.LDAPExtensions`

Bases: `laurelin.ldap.extensible.base.ExtensibleClass`

netgroups

The built-in NIS netgroups extension

Return type *laurelin.extensions.netgroups.LaurelinLDAPExtension*

3.3 LDAPObject Extensions

These properties are available on *LDAPObject* instances.

class `laurelin.ldap.extensible.ldapobject_extensions.LDAPObjectExtensions`

Bases: `laurelin.ldap.extensible.base.ExtensibleClass`

descattrs

The built-in description attributes extension

Return type *laurelin.extensions.descattrs.LaurelinLDAPObjectExtension*

netgroups

The built-in NIS netgroups extension

Return type *laurelin.extensions.netgroups.LaurelinLDAPObjectExtension*

CHAPTER 4

Config Files

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4.1 Intro

Laurelin config files may be YAML or JSON formatted out of the box. You can also supply your own custom decoding function to handle arbitrary formats. The important part is that the file contents decode to a dictionary. Below is an example YAML file:

```
global:
  SSL_CA_PATH: /etc/ldap/cacerts
  IGNORE_EMPTY_LIST: true
extensions:
  - laurelin.extensions.descattrs
  - laurelin.extensions.netgroups
connection:
  server: ldap://dir01.example.org
  start_tls: true
  simple_bind:
```

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```
username: testuser
passwd: testpassword
connect_timeout: 30
objects:
- rdn: ou=people
  tag: posix_user_base
- rdn: ou=groups
  tag: posix_group_base
- rdn: ou=netgroups
  tag: netgroup_base
```

You can load and apply such a file by using `config.load_file()`. If a connection section was specified, a new connection will be established and returned from the function.

4.2 Global Section

Each key in the global section must correspond to one of the `DEFAULT_` prefixed attributes on `LDAP`. As you can see in the example, the `DEFAULT_` prefix is optional. Not demonstrated by the example is that keys are case-insensitive (that is, they will be upper-cased for you).

4.3 Extensions Section

This is simply a list of extension module names which will get activated when the config file is loaded.

4.4 Connection Section

Keys here are *mostly* corresponding to `LDAP` constructor arguments, however there are a few special ones:

- `start_tls` A boolean option, if set to `true` will execute `LDAP.start_tls()` after opening the connection
- `simple_bind` A dictionary of parameters to pass to `LDAP.simple_bind()`
- `sasl_bind` A dictionary of parameters to pass to `LDAP.sasl_bind()`

Note that `simple_bind` and `sasl_bind` are both optional, and mutually exclude each other. In other words, it is an error to specify both of these keys.

Note that `start_tls` will always occur before any bind (if requested).

4.5 Objects Section

Note: You cannot specify `objects` without also specifying a connection

This is a list of dicts where keys correspond to `LDAP.obj()` or `LDAPObject.obj()` arguments. You *must* specify exactly one of `dn` or `rdn`. If `dn` is specified, this will be taken as the full, absolute DN of the object, and parameters will be passed to `LDAP.obj()`. If `rdn` is specified, this will be taken as the RDN relative to the connection's base object, or the base of the tree, and parameters will be passed to `LDAPObject.obj()`.

Also required for all objects is the `tag` key. This is how you will access created objects. For example, to access the first object in the config file example above:

```
ldap = config.load_file('/path/to/file.yaml')
posix_users = ldap.tag('posix_user_base')
```

Its important to note that the server is not queried when creating these objects, so they will not have any local attributes. If you require local attributes, you can all `LDAPObject.refresh()` on the object.

4.6 Global vs. Connection

As mentioned elsewhere in the docs, there is a global config parameter associated with every connection parameter, meaning in a config file you can define your connection parameters in either section. This *does not* have the exact same end functionality, though. In general you should prefer `connection` for the following reasons:

- The connection will not be created when the config file is loaded if you configure everything in `global`
- You cannot define `objects` without defining a `connection`
- You cannot specify `start_tls` or `bind` parameters globally

However there are cases where it may be desirable to specify everything as a global default. Taking this approach allows you to use the `LDAP` constructor with as few as zero arguments after loading the config. You can still bind as usual by calling `LDAP.simple_bind()` or `LDAP.sasl_bind()` on the connection. You can also manually create objects with `obj()` methods.

4.7 Load Order

Sections are loaded and applied in a specific order:

1. `global`
2. `extensions`
3. `connection`
4. `objects`

You can specify sections in whatever order is convenient in your file. They will *always* be used in the above order.

4.8 Using Dicts Directly

If you already have your configuration parameters in one or more dictionaries, you can apply them directly without going through the file interface. You can pass a dictionary of the same format as in a config file to `config.load_config_dict()`. Like `load_file()`, this will establish and return the new connection if one was defined.

You can also use the other `config` methods to apply dictionary configurations piecemeal. These process fragments of the larger config dictionary. Check the reference docs for details if you need to do this.

Creating Extensions

- *Extension System*
 - *Extension Classes*
 - *Schema and Controls Classes*
 - *Depending on Extensions*
 - *Publishing Extensions*
- *LDAP Extensions*
- *Controls*
- *Schema*
 - *Object Classes and Attribute Types*
 - *Matching Rules*
 - *Syntax Rules*
 - *Schema/Controls Registration System*
- *OIDs*
- *Validators*
 - *SchemaValidator*
- *Class Diagram*

The most important thing to note about “extensions” is that they are not necessarily LDAP extensions. In *laurelin*, they are simply a module that does any combination of: defining new schema elements, defining new controls, or defining new methods to be attached to *LDAP* or *LDAPObject*.

5.1 Extension System

Extensions live in any importable module or package. They must at minimum define a class called `LaurelinExtension` as follows:

```
from laurelin.ldap import BaseLaurelinExtension

class LaurelinExtension(BaseLaurelinExtension):
    NAME = 'some_name'
```

You'll notice the `BaseLaurelinExtension` here - this is required. It is one of many weapons at your disposal.

5.1.1 Extension Classes

All of these share the same common end-user interface of being exposed as either a property or dynamic attribute on some other instance that the user typically will already use normally. Which class they are attached to depends on the name and base class of the defined extension class. Whether they are accessible as a property (with IDE auto-complete support) or a dynamic attribute depends on how the extension is loaded and defined (more below), but the user API is unchanged either way.

class LaurelinExtension(`BaseLaurelinExtension`): As described above, this is where you define the name of the property or dynamic attribute where all instances of these extension classes can be accessed. One instance of this class is created per Python interpreter when the extension is first added or used (more on this later) and it is accessible to users at `laurelin.ldap.extensions.<NAME>`.

class LaurelinLDAPExtension(`BaseLaurelinLDAPExtension`): This is where you can bind methods, attributes, etc. that will be attached to `LDAP` by way of property or dynamic attribute with name corresponding to your `LaurelinExtension.NAME`. You can access the parent `LDAP` instance at `self.parent`. Up to one instance is created per `LDAP` instance when the property or dynamic attribute is first accessed on a particular instance.

class LaurelinLDAPObjectExtension(`BaseLaurelinLDAPObjectExtension`): This is where you can bind methods, attributes, etc. that will be attached to `LDAPObject` by way of property or dynamic attribute with name corresponding to your `LaurelinExtension.NAME`. You can access the parent `LDAPObject` instance at `self.parent`. Up to once instance is created per `LDAPObject` instance when the property or dynamic attribute is first accessed on a particular instance.

5.1.2 Schema and Controls Classes

These two simply attempt to register all public attributes defined within them as schema elements or controls. More about actually defining these below, the class signatures should look like this, though:

class LaurelinSchema(`BaseLaurelinSchema`): Define all `SyntaxRule` and `EqualityMatchingRule` classes as local classes within this class. Directly instantiate `ObjectClass` and `AttributeType` with standard spec strings and assign them to class attributes.

class LaurelinControls(`BaseLaurelinControls`): Define all `Control` classes as local classes within this class.

Note that the placement of schema and control definitions is fairly flexible and are not restricted to these 2 classes (but this kind of organization or a variation upon it is suggested). See the Schema and Controls sections below for more details.

Also note that if your schema depends on the base schema, you must require it at the top of your extension like so:


```
from laurelin.ldap import extensions

extensions.base_schema.require()
```

5.1.3 Depending on Extensions

Extension authors may want to duplicate and tailor some or all of this information in their own documentation for users.

There are two ways laurelin can be made aware of extensions:

1. By passing a module name string to `add_extension()`. This will cause the extension class instances to be made available as dynamic attributes.
2. By being defined in `Extensible.AVAILABLE_EXTENSIONS`. A script will automatically generate properties that are inherited by the appropriate parent class (`LDAP` or `LDAPObject`). This has the benefit that IDEs can auto-complete extension instances if the extension is installed (tested with PyCharm). Also defined with your extension is the string module name, so your users do not need to copy this themselves, as well as the pip package name, which will be included in the exception if users attempt to use your extension when its not installed.

There are clear pros and cons to each approach, and extension authors are welcome to instruct users to take either approach. #1 may be preferred during development, or if you do not intend to publish your extension publicly.

One caveat to #2 above if you define schema or controls, is your users will need to explicitly require your extension like so:

```
from laurelin.ldap import extensions

extensions.<NAME>.require()
```

This happens implicitly in the following situations:

- When `add_extension()` is called, as in #1 above
- When the user accesses your `<NAME>` extension property/attribute on `LDAP` or `LDAPObject`, if you defined any extensions to those classes
- Technically happens implicitly when `extensions.<NAME>` is accessed, so if you define any other user-exposed attributes on your `LaurelinExtension` class that all users *must* access, you can instruct them to use that instead.

So if you **require** any of these of your users by way of your own documentation, you can also have them skip the explicit `require()` call.

Regardless of whether your extension is added or defined, your users will need to explicitly add the dependency to their own package. Laurelin will *never* depend on an extension module, and only built-in extensions are guaranteed to be available.

5.1.4 Publishing Extensions

If you are planning on defining any standard LDAP extensions, schema, or controls, I suggest packaging your module under `laurelin.extensions`, which is a [namespace package](#). This allows an exceedingly simple and easy path to eventual merging in as a built-in extension. You are welcome to package under any importable module, though.

If you choose to instruct your users to add your extension, please be sure to write clear and accessible documentation for them.

If you choose to define your extension, please submit a pull request on GitHub. You should include ONLY a ~5 line addition to `Extensible.AVAILABLE_EXTENSIONS`. The dict key should match your `LaurelinExtension.NAME`. The keys in the sub-dictionary should be pretty self-explanatory. Below is a contrived example patch:

```
diff --git a/laurelin/ldap/extensible/base.py b/laurelin/ldap/extensible/base.py
index 593e64b..bd7b233 100644
--- a/laurelin/ldap/extensible/base.py
+++ b/laurelin/ldap/extensible/base.py
@@ -132,6 +132,11 @@ class Extensible(object):
     'pip_package': None, # built-in
     'docstring': 'Built-in extension defining standard paged results control_
->for search'
+    },
+    'some_ext': {
+        'module': 'your.extension.module',
+        'pip_package': 'laurelin-some-ext',
+        'docstring': 'A contrived example laurelin extension'
+    },
+    },
+    },

     ADDITIONAL_EXTENSIONS = {}
```

Please keep your docstrings short. They will be rendered in laurelin’s documentation. You may include a Sphinx-formatted shortlink to your own docs.

If you have any questions, problems, or concerns, please open an issue on GitHub.

5.2 LDAP Extensions

When defining an actual LDAP extension with an OID and requiring server support, you’ll create the laurelin extension as shown above, but you’ll be calling the `LDAP.send_extended_request()` method from your extension methods within your `LaurelinLDAPExtension` or `LaurelinLDAPObjectExtension`.

`LDAP.send_extended_request(oid, value=None, **kws)`

Send an extended request, returns instance of `ExtendedResponseHandle`

This is mainly meant to be called by other built-in methods and client extensions. Requires handling of raw rpyasn1 protocol objects.

Parameters

- **oid** (*str*) – The OID of the extension. Must be declared as supported by the server in the root DSE.
- **value** (*str* or *bytes* or *None*) – The request value (optional)

Returns An iterator yielding tuples of the form (`rfc4511.IntermediateResponse`, `rfc4511.Controls`) or (`rfc4511.ExtendedResponse`, `rfc4511.Controls`).

Return type *ExtendedResponseHandle*

Raises

- ***LDAPSupportError*** – if the OID is not listed in the `supportedExtension` attribute of the root DSE
- ***TypeError*** – if the *value* parameter is not a valid type

Additional keyword arguments are handled as *Controls* and then passed through into the `ExtendedResponseHandle` constructor.

As you can see, this accepts the OID of the LDAP extension and an optional request value. You can also pass control keywords, and the `require_success` keyword, which will automatically check for success on the final `extendedResponse` message (and raise an `LDAPError` on failure).

If your LDAP extension expects `intermediateResponse` messages, you can iterate the return from `LDAP.send_extended_request()`. You can also call `ExtendedResponseHandle.recv_response()` to get only one message at a time (preferred to iteration if you only expect the one `extendedResponse` message).

The built-in `LDAP.who_am_i()` method is an excellent example of a simple LDAP extension:

```
from laurelin.ldap import LDAP
from laurelin.ldap.protoutils import get_string_component

def who_am_i(self):
    handle = self.send_extended_request(LDAP.OID_WHOAMI, require_success=True,
    **ctrl_kwds)
    xr, res_ctrls = handle.recv_response()
    return get_string_component(xr, 'responseValue')
```

As a laurelin extension this might look like:

```
from laurelin.ldap import BaseLaurelinLDAPExtension

# ...

class LaurelinLDAPExtension(BaseLaurelinLDAPExtension):
    def who_am_i(self):
        handle = self.parent.send_extended_request(...)
        # ...
```

Note the use of `self.parent` to access `LDAP.send_extended_request()`.

5.3 Controls

Extensions may wish to define controls for use on existing methods. You will need to define one or more `Control` classes, see [Defining Controls](#) for more information about this. The important part for the purposes of this document is where to place those class definitions in your extension module.

You must define a subclass of `LaurelinTransiter`, or the more semantically appropriate but functionally identical `BaseLaurelinControls`. Your subclass must then have local `Control` subclasses defined within it. For example:

```
from laurelin.ldap import BaseLaurelinExtension, BaseLaurelinControls, Control

class LaurelinExtension(BaseLaurelinExtension):
    NAME = 'your_name'

class LaurelinControls(BaseLaurelinControls):
    class YourControl(Control):
        method = ('search',)
        keyword = 'some_kwd'
        REQUEST_OID = '1.2.3.4'
```

Note that controls may alternatively be defined directly in your `LaurelinExtension` class.

5.4 Schema

Extensions may be associated with a set of new schema elements, including object classes, attribute types, matching rules, and syntax rules. Once defined, these will get used automatically by other parts of laurelin, including the *SchemaValidator*, and for comparing items in attribute value lists within an *LDAPObject*.

Like controls, all extension schema elements must be defined as attributes on a subclass of *LaurelinTransiter*. The more semantically appropriate *BaseLaurelinSchema* is provided as well. You can use these base classes to organize your schema and controls however appropriate. Alternatively, you may also define schema elements directly in your *LaurelinExtension* class.

If your schema depends on the laurelin built-in base schema, you must explicitly call `laurelin.ldap.extensions.base_schema.require()` near the top of your extension module.

Below is a simple example of defining a new object class depending on the base schema:

```
from laurelin.ldap import BaseLaurelinExtension, BaseLaurelinControls, ObjectClass, \
↳ extensions

extensions.base_schema.require()

class LaurelinExtension(BaseLaurelinExtension):
    NAME = 'your_name'

class LaurelinSchema(BaseLaurelinSchema):
    MY_COMPANY_USER = ObjectClass('''
    ( 1.2.3.4 NAME 'myCompanyUser' SUP inetOrgPerson STRUCTURAL
      MUST ( companyAttribute $ anotherAttribute )
      MAY description
    ''')
```

The superclass of `inetOrgPerson` makes this example require the base schema. All schema instance elements must be defined as class attributes in this manner (for object classes and attribute types), and all class elements must be defined below the *LaurelinSchema* class (for syntax rules and matching rules).

5.4.1 Object Classes and Attribute Types

Creating object classes and attribute types is very simple. Just take the standard LDAP specification and pass it to the appropriate class constructor. Examples from the `netgroups` extension:

```
from laurelin.ldap.objectclass import ObjectClass
from laurelin.ldap.attributetype import AttributeType

ObjectClass('''
( 1.3.6.1.1.1.2.8 NAME 'nisNetgroup' SUP top STRUCTURAL
  MUST cn
  MAY ( nisNetgroupTriple $ memberNisNetgroup $ description ) )
''')

AttributeType('''
( 1.3.6.1.1.1.1.14 NAME 'nisNetgroupTriple'
  DESC 'Netgroup triple'
  EQUALITY caseExactMatch
  SYNTAX 1.3.6.1.1.1.0.0 )
''')
```

5.4.2 Matching Rules

Defining matching rules takes a little more effort. Matching rules must subclass `EqualityMatchingRule`. Required class attributes include:

- `OID` - the numeric OID of this rule (see section below about OIDs).
- `NAME` - the name of the rule. Must also be globally unique. This is usually how matching rules are referenced in attribute type specs (see `caseExactMatch` in above example).
- `SYNTAX` - the numeric OID of the syntax rule that assertion values must match.

Matching rule classes may also optionally define the following attribute:

- `prep_methods` - a sequence of callables that will be used to prepare both the attribute value and assertion value for comparison. These will typically be defined in `laurelin.ldap.rfc4518`. The initial attribute/assertion value will be passed into the first item in the sequence, and the return from each is passed into the next item.

If you prefer, you can also override the `MatchingRule.prepare()` method on your matching rule class.

You may also wish to override `EqualityMatchingRule.do_match()`. This is passed the two prepared values and must return a boolean. Overriding `MatchingRule.match()` is *not recommended*.

Below is an example matching rule from `laurelin.extensions.base_schema`:

```
from laurelin.ldap.rules import EqualityMatchingRule
from laurelin.ldap import rfc4518

class numericStringMatch(EqualityMatchingRule):
    OID = '2.5.13.8'
    NAME = 'numericStringMatch'
    SYNTAX = '1.3.6.1.4.1.1466.115.121.1.36'
    prep_methods = (
        rfc4518.Transcode,
        rfc4518.Map.characters,
        rfc4518.Normalize,
        rfc4518.Prohibit,
        rfc4518.Insignificant.numeric_string,
    )
```

5.4.3 Syntax Rules

Syntax rules must subclass `SyntaxRule`, although in almost all cases you can use `RegexSyntaxRule`. If you do not use a regular expression, you must override `SyntaxRule.validate()`, which receives a single string argument, and must raise `InvalidSyntaxError` when it is incorrect.

In all cases, you must define the following attributes on your syntax rule class:

- `OID` - the numeric OID of the rule (See section below about OIDs).
- `DESC` - a brief description of the rule. This is mainly used in exception messages.

Regex syntax rules must also define:

- `regex` - the regular expression.

Below are examples from `laurelin.extensions.base_schema`:

```
from laurelin.ldap.rules import SyntaxRule, RegexSyntaxRule
from laurelin.ldap.exceptions import InvalidSyntaxError
import six

class DirectoryString(SyntaxRule):
    OID = '1.3.6.1.4.1.1466.115.121.1.15'
    DESC = 'Directory String'

    def validate(self, s):
        if not isinstance(s, six.string_types) or (len(s) == 0):
            raise InvalidSyntaxError('Not a valid {}'.format(self.DESC))

class Integer(RegexSyntaxRule):
    OID = '1.3.6.1.4.1.1466.115.121.1.27'
    DESC = 'INTEGER'
    regex = r'^-?[1-9][0-9]*$'
```

5.4.4 Schema/Controls Registration System

Schema and controls go through an identical 2-step registration system. The *LaurelinTransiter* class first stores a list of all schema and control attributes mapped to the module name that defined them. This occurs when the class is defined, i.e. at import time.

The *LaurelinRegistrar.require()* method then invokes the *.register()* method on each schema element or control class defined in the same module. This causes the element to be mapped according to its class, name, and OID - which are ultimately what is needed for laurelin to make use of the object.

5.5 OIDs

Controls and schema elements all need an OID to be defined. You should obtain a [Private Enterprise Number](#) from IANA for any OIDs that you publish to the internet (and probably for any that you don't as well). This is completely free and usually only takes a few days to process.

The OID you get from IANA should be used as the root of your namespace, and you can define the structure below it as you see fit.

5.6 Validators

Validators must subclass *Validator*. The public interface includes *Validator.validate_object()* and *Validator.validate_modify()*. You will usually just want to override these, however they do include a default implementation which checks all attributes using the abstract *Validator._validate_attribute()*. Check method docs for more information about how to define these.

When defining validators in your extension, you can ensure your users don't need to import the module again by attaching the class to your *LaurelinExtension* class like so:

```
from laurelin.ldap import BaseLaurelinExtension, Validator

class LaurelinExtension(BaseLaurelinExtension):
    NAME = 'my_ext'
```

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```
class MyValidator(Validator):  
    # ...  
    pass
```

Users can then access it like so:

```
from laurelin.ldap import LDAP, extensions  
  
with LDAP('ldaps://dir.example.org', validators=[extensions.my_ext.MyValidator]) as   
↳ ldap:  
    # do stuff
```

5.6.1 SchemaValidator

Laurelin ships with *SchemaValidator* which, when applied to a connection, automatically checks write operations for schema validity *before* sending the request to the server. This includes any schema you define in your extensions. Users can enable this like so:

```
from laurelin.ldap import LDAP  
from laurelin.ldap.schema import SchemaValidator  
  
with LDAP('ldaps://dir.example.org', validators=[SchemaValidator]) as ldap:  
    # do stuff
```

5.7 Class Diagram

The extension subsystem has several interconnecting classes. Blue are auto-generated classes, and green are defined in extension modules. Unlabeled arrows indicate class inheritance or are self-explanatory.

- *Using Controls*
- *Defining Controls*

Many LDAP users may be unfamiliar with controls. RFC4511 defines *controls* as “providing a mechanism whereby the semantics and arguments of existing LDAP operations may be extended.” In other words, they can:

1. Instruct the server to process a method differently
2. Add new arguments to methods to control the altered processing
3. Add additional data to the response to a method call

It is important to note that both the server and client must mutually support all controls used. Laurelin will automatically check for server support when using controls.

6.1 Using Controls

Once controls have been *defined*, they are very easy to use. Each control has a keyword and optionally a `response_attr`.

The keyword can be passed as a keyword argument to specific methods. The value type and format is up to the control implementation. Whatever value the control expects can be wrapped in *critical* or *optional* to declare the criticality of the control.

If defined, the `response_attr` will be set as an attribute on the object returned from the method call.

For search response controls, the control value will be set on the individual *LDAPObject* if it appeared on the associated search result entry. If it appeared on the search results done message, the control value will be set on the iterator object.

In the highly unusual case that a response control is set on a search result reference message, the control values will be inaccessible if `fetch_result_refs` is set to `True`. A warning will be issued in this case.

If `fetch_result_refs` is set to `False`, the response control values will be set on the `SearchReferenceHandle` that is yielded from the results iterator.

```
class laurelin.ldap.critical(value)
```

Bases: `object`

used to mark controls with criticality

```
class laurelin.ldap.optional(value)
```

Bases: `object`

used to mark controls as not having criticality

An `LDAPSUnsupportedError` will be raised if the control is marked critical and the server does not support it.

6.2 Defining Controls

Controls must subclass `Control`. As soon as they are defined as a subclass of `Control`, they are ready to use. Controls must define at least:

- `Control.method`, a tuple of method names that this control supports. Current method names are `bind`, `search`, `compare`, `add`, `delete`, `mod_dn`, `modify`, and `ext` (extended request). Note that these method names do not necessarily correspond directly to `LDAP` method names. Even when they do, other methods may call the base method and pass through control keywords. For example, `LDAPObject.find()` ends up passing any control keywords through into `LDAP.search()` (which matches the `search` method). The `bind` method is used by both `LDAP.simple_bind()` and `LDAP.sasl_bind()`.
- `Control.keyword`, the keyword argument to be used for the request control.
- `Control.REQUEST_OID` the OID of the request control. If the control has criticality, the OID must be listed in the `supportedControl` attribute of the root DSE of the server at runtime.

If there is an associated response control, also define the following:

- `Control.response_attr`, the name of the attribute which will be set on objects returned from the method.
- `Control.RESPONSE_OID` the OID of the response control. This may be equal to `Control.REQUEST_OID` depending on the spec. This must match the `controlType` of the response control to be properly set.

Most controls will not need to override methods if only strings are used for request and response values. However, if it is desirable to use a more complex data structure as a control value, you can override the `Control.prepare()` method to accept this structure as its first argument. You will need to process this into a single string for transmission to the server, and pass it into, and return, the base `Control.prepare()`. The second argument is a boolean describing criticality, and must also be passed into the base method.

To return a more complex value for the response, you can override the `Control.handle()` method. This will be passed the response control value string, and the return will be assigned to the `response_attr` attribute on the returned object.

```
class laurelin.ldap.controls.Control
```

Bases: `object`

Request controls are exposed by allowing an additional keyword argument on a set of methods. The `prepare()` method takes the value passed in as a keyword argument and returns an `rfc4511.Control`.

Response controls are returned by setting an additional attribute on whichever object is returned by the called method. The raw response control value is passed to the `handle()` method, and any appropriate value may be returned.

Leave the `RESPONSE_OID` and `response_attr` attributes as a `False` value if there is no response control specified.

REQUEST_OID = ''

Request OID of the control

RESPONSE_OID = ''

Response OID of the control (may be equal to `REQUEST_OID`; may be left empty)

handle (*ctrl_value*)

Accepts raw response *ctrl_value* and may return any useful value.

There is no need to call this base function when overriding.

Parameters **ctrl_value** (*str*) – The string response control value received from the server.

Returns The string *ctrl_value* unchanged by default. May be overridden to return any relevant value/type/structure.

keyword = ''

keyword argument name

method = ()

name(s) of the method which this control is used with

prepare (*ctrl_value*, *criticality*)

Accepts string controlValue and returns an `rfc4511.Control` instance

When overriding this function, you must always call and return this base function.

Parameters

- **ctrl_value** (*str or bytes*) – The string request control value to send to the server
- **criticality** (*bool*) – True if the control has criticality. This is indicated by wrapping the keyword argument in `critical` or `optional`, and by the *default_criticality* keyword passed to the `LDAP` constructor, and global default `LDAP.DEFAULT_CRITICALITY`.

Returns The protocol-level control object ready for transmission to the server

Return type `rfc4511.Control`

classmethod **register** ()

response_attr = ''

Name of the attribute where return of `handle()` will be stored

7.1 2.0.2

Released 2019.02.12

- Fix: make extension requirements align with specification
- Update documentation with OID information

7.2 2.0.1

Released 2019.02.09

- Fix: Correctly request no attributes be returned for `LDAP.exists()`

7.3 2.0.0

Released 2018.11.17

- Empty lists in a `replace` or `delete` modify operation are now **ignored by default**
 - To delete all attribute values in a `replace` or `delete`, use `DELETE_ALL` introduced in version 1.2.0.
 - To restore the previous functionality, you can set the global default `LDAP.DEFAULT_IGNORE_EMPTY_LIST = False`, or restore on a per-connection basis by passing `ignore_empty_list=False` to the `LDAP()` constructor.
 - The rationale for this change is a) improved semantics, and b) eliminates unexpected behavior in cases like applying a filter to determine a list to remove (which may result in an empty list, meaning no items should be removed)
- Extensions API has been changed, both for users and creators of extensions:

- Rather than attaching new attributes directly to the LDAP or LDAPObject class, a property (or dynamic attribute) is made available on those classes for each extension, which provides access to an object exposing those same attributes.
- Many extension attributes have been renamed to avoid semantic duplication introduced by this change. For example `ldap.get_netgroup_users()` should be replaced with `ldap.netgroups.get_users()`.
- The `descattrs` extension has been changed slightly to work better with these new changes. Description attributes can now be accessed and modified like so (no additional imports necessary):

```
o = ldap.base.obj('cn=metadata')
print(o.descattrs['some_attr'])
# ['value1', 'value2']

o.descattrs.add({'some_attr': ['value3']})
print(o.descattrs['some_attr'])
# ['value1', 'value2', 'value3']

# these also work now:

'some_attr' in o.descattrs

for attr in o.descattrs:
```

- Docs have been updated with information about creating extensions.
 - Internal changes around loading of schema elements and controls
- Base schema changes:
 - The base schema will now be automatically loaded when needed. At present, this includes:
 - * When checking for the presence of a value in an attribute list
 - * When a `SchemaValidator` is initialized
 - * When the `netgroups` extension is used
 - The base schema is no longer defined in `laurelin.ldap.schema`. It now is housed in a built-in extension. If previously using `import laurelin.ldap.schema` or similar to enable client-side schema checking, this should be replaced with something like the following:

```
from laurelin.ldap import extensions
extensions.base_schema.require()
```

However, as stated above, this will not be necessary for almost all use cases.

- Properly documented the public API definition

7.4 1.5.3

Release 2018.08.30

- Add python 3.7 support

7.5 1.5.2

Released 2018.06.15

1.5.1 was built off of the wrong branch and will be removed.

- Minor fix: Added FilterSyntax to all
- Doc update: added dependent info section to readme

7.6 1.5.0

Released 2018.06.09

- Added new simple filter syntax
- Switched default filter syntax to UNIFIED which should be backwards compatible with standard RFC 4515 filters

Special thanks to @jpypi for authoring the new grammar

7.7 1.4.1

Released 2018.05.31

- Fix: Checked for failed import of AF_UNIX to improve Windows support
- Fix: Required latest pure-sasl

7.8 1.4.0

Released 2018.05.29

- Validation updates:
 - Added `LDAP.disable_validation()` which creates a context with any or all validators skipped
 - Added an `ldap_conn` attribute to validator instances to allow validators to query the server
 - Allowed passing a class as well as an instance with the `validators` constructor keyword
- Greatly improved handling of unsolicited messages (message ID 0)
- Fix: enforce maximum length for attribute types
- Fix: SASL auth issues with pure-sasl 0.5.1+

7.9 1.3.1

Released 2018.04.01

- Fixed logic bug in `SchemaValidator` when an object has two or more object classes that require one or more of the same attributes
- Fixed: allowed string `some.module.Class` specification for validators in config files

7.10 1.3.0

Released 2018.03.22

- Added config file support, see *laurelin.ldap.config*
- Fixed: ensured extensions can be safely activated multiple times
- Fixed: *Mod* constants *repr* updated for consistency

7.11 1.2.0

Released 2018.03.16

- Add `DELETE_ALL` to use as an attribute value list with `modify`, `replace_attrs`, and `delete_attrs`
- Added new constructor keywords to alter the behavior of empty value lists for `modify`, `replace_attrs`, and `delete_attrs`:
 - `ignore_empty_list` to silently ignore empty value lists and not send them to the server. This will be enabled by default in a future release.
 - `error_empty_list` to raise an exception when an empty value list is passed.
 - `warn_empty_list` to emit a warning when an empty value list is passed.

7.12 1.1.0

Released 2018.03.12

Initial stable API.

8.1 laurelin package

8.1.1 Subpackages

8.1.1.1 laurelin.extensions package

Submodules

laurelin.extensions.base_schema module

```
class laurelin.extensions.base_schema.LaurelinExtension (modname=None)
    Bases: laurelin.ldap.extensible.user_base.BaseLaurelinExtension
    NAME = 'base_schema'

class laurelin.extensions.base_schema.LaurelinSchema
    Bases: laurelin.ldap.extensible.user_base.BaseLaurelinSchema
    ACCOUNT = <ObjectClass "account">
    ALIAS = <ObjectClass "alias">
    ALIASED_OBJECT_NAME = <AttributeType "aliasedObjectName">
    ALT_SERVER = <AttributeType "altServer">
    APPLICATION_PROCESS = <ObjectClass "applicationProcess">
    ASSOCIATED_DOMAIN = <AttributeType "associatedDomain">
    ASSOCIATED_NAME = <AttributeType "associatedName">
    ATTRIBUTE_TYPES = <AttributeType "attributeTypes">
    AUDIO = <AttributeType "audio">
```

```
class AttributeTypeDescription
    Bases: laurelin.ldap.rules.RegexSyntaxRule

    DESC = 'Attribute Type Description'

    OID = '1.3.6.1.4.1.1466.115.121.1.3'

    regex = "^\\( *(?P<oid>[0-9]+(?:\\. [0-9]+)+) (? : +NAME +(?P<name>(?: '[A-Za-z] [A-Za-"
```

BUILDING_NAME = <AttributeType "buildingName">

BUSINESS_CATEGORY = <AttributeType "businessCategory">

```
class Binary
    Bases: laurelin.ldap.rules.SyntaxRule

    DESC = 'Binary'

    OID = '1.3.6.1.4.1.1466.115.121.1.5'

    validate(s)
        Validate a string. Must be implemented by subclasses.
        Parameters s – Candidate string
        Returns Any useful value for the rule
        Raises InvalidSyntaxError – if the string is invalid

class BitString
    Bases: laurelin.ldap.rules.RegexSyntaxRule

    DESC = 'Bit String'

    OID = '1.3.6.1.4.1.1466.115.121.1.6'

    regex = "^[01]*'B$"
```

```
class BitStringMatch
    Bases: laurelin.ldap.rules.EqualityMatchingRule

    NAME = 'bitStringMatch'

    OID = '2.5.13.16'

    SYNTAX = '1.3.6.1.4.1.1466.115.121.1.6'
```

```
class Boolean
    Bases: laurelin.ldap.rules.SyntaxRule

    DESC = 'Boolean'

    OID = '1.3.6.1.4.1.1466.115.121.1.7'

    validate(s)
        Validate a string. Must be implemented by subclasses.
        Parameters s – Candidate string
        Returns Any useful value for the rule
        Raises InvalidSyntaxError – if the string is invalid

class BooleanMatch
    Bases: laurelin.ldap.rules.EqualityMatchingRule

    NAME = 'booleanMatch'

    OID = '2.5.13.13'

    SYNTAX = '1.3.6.1.4.1.1466.115.121.1.7'
```

C = <AttributeType "c">

```

CAR_LICENSE = <AttributeType "carLicense">
CN = <AttributeType "cn">
CO = <AttributeType "co">
COUNTRY = <ObjectClass "country">
CREATE_TIMESTAMP = <AttributeType "createTimestamp">
CREATORS_NAME = <AttributeType "creatorsName">

class CaseExactIA5Match
  Bases: laurelin.ldap.rules.EqualityMatchingRule
  NAME = 'caseExactIA5Match'
  OID = '1.3.6.1.4.1.1466.109.114.1'
  SYNTAX = '1.3.6.1.4.1.1466.115.121.1.26'
  prep_methods = (<function Transcode>, <function Map.characters>, <function Normalize>)

class CaseExactMatch
  Bases: laurelin.ldap.rules.EqualityMatchingRule
  NAME = 'caseExactMatch'
  OID = '2.5.13.5'
  SYNTAX = '1.3.6.1.4.1.1466.115.121.1.15'
  prep_methods = (<function Transcode>, <function Map.characters>, <function Normalize>)

class CaseIgnoreIA5Match
  Bases: laurelin.ldap.rules.EqualityMatchingRule
  NAME = 'caseIgnoreIA5Match'
  OID = '1.3.6.1.4.1.1466.109.114.2'
  SYNTAX = '1.3.6.1.4.1.1466.115.121.1.26'
  prep_methods = (<function Transcode>, <function Map.all>, <function Normalize>, <function Transcode>)

class CaseIgnoreListMatch
  Bases: laurelin.ldap.rules.EqualityMatchingRule
  NAME = 'caseIgnoreListMatch'
  OID = '2.5.13.11'
  SYNTAX = '1.3.6.1.4.1.1466.115.121.1.41'
  prep_methods = (<function Transcode>, <function Map.all>, <function Normalize>, <function Transcode>)

class CaseIgnoreMatch
  Bases: laurelin.ldap.rules.EqualityMatchingRule
  NAME = 'caseIgnoreMatch'
  OID = '2.5.13.2'
  SYNTAX = '1.3.6.1.4.1.1466.115.121.1.15'
  prep_methods = (<function Transcode>, <function Map.all>, <function Normalize>, <function Transcode>)

class Certificate
  Bases: laurelin.ldap.rules.SyntaxRule

```

```
DESC = 'Certificate'
OID = '1.3.6.1.4.1.1466.115.121.1.8'
validate(s)
    Validate a string. Must be implemented by subclasses.
    Parameters s – Candidate string
    Returns Any useful value for the rule
    Raises InvalidSyntaxError – if the string is invalid

class CountryString
    Bases: laurelin.ldap.rules.RegexSyntaxRule
    DESC = 'Country String'
    OID = '1.3.6.1.4.1.1466.115.121.1.11'
    regex = "^[A-Za-z0-9'()+,./:~ -]{2}$"
DC = <AttributeType "dc">
DC_OBJECT = <ObjectClass "dcObject">
DEPARTMENT_NUMBER = <AttributeType "departmentNumber">
DESCRIPTION = <AttributeType "description">
DESTINATION_INDICATOR = <AttributeType "destinationIndicator">
DEVICE = <ObjectClass "device">
DISPLAY_NAME = <AttributeType "displayName">
DISTINGUISHED_NAME = <AttributeType "distinguishedName">
class DITContentRuleDescription
    Bases: laurelin.ldap.rules.RegexSyntaxRule
    DESC = 'DIT Content Rule Description'
    OID = '1.3.6.1.4.1.1466.115.121.1.16'
    regex = "^\\( *(?P<oid>[0-9]+(?:\\. [0-9]+)+) (?: +NAME +(?: '[A-Za-z][A-Za-z0-9-]*' |"
class DITStructureRuleDescription
    Bases: laurelin.ldap.rules.RegexSyntaxRule
    DESC = 'DIT Structure Rule Description'
    OID = '1.3.6.1.4.1.1466.115.121.1.17'
    regex = "^\\( *(?:[0-9]+) (?: +NAME +(?: '[A-Za-z][A-Za-z0-9-]*' |\\( * '[A-Za-z][A-Za-z0-9-]*'"
DIT_CONTENT_RULES = <AttributeType "dITContentRules">
DIT_STRUCTURE_RULES = <AttributeType "dITStructureRules">
DN_QUALIFIER = <AttributeType "dnQualifier">
DOCUMENT = <ObjectClass "document">
DOCUMENT_AUTHOR = <AttributeType "documentAuthor">
DOCUMENT_IDENTIFIER = <AttributeType "documentIdentifier">
DOCUMENT_LOCATION = <AttributeType "documentLocation">
DOCUMENT_PUBLISHER = <AttributeType "documentPublisher">
```

```

DOCUMENT_SERIES = <ObjectClass "documentSeries">
DOCUMENT_TITLE = <AttributeType "documentTitle">
DOCUMENT_VERSION = <AttributeType "documentVersion">
DOMAIN = <ObjectClass "domain">
DOMAIN_RELATED_OBJECT = <ObjectClass "domainRelatedObject">
DRINK = <AttributeType "drink">

class DeliveryMethod
    Bases: laurelin.ldap.rules.RegexSyntaxRule

    DESC = 'Delivery Method'

    OID = '1.3.6.1.4.1.1466.115.121.1.14'

    regex = '^(?:any|mhs|physical|telex|teletext|g3fax|g4fax|ia5|videotext|telephone) (\
class DirectoryString
    Bases: laurelin.ldap.rules.SyntaxRule

    DESC = 'Directory String'

    OID = '1.3.6.1.4.1.1466.115.121.1.15'

    validate(s)
        Validate a string. Must be implemented by subclasses.
        Parameters s – Candidate string
        Returns Any useful value for the rule
        Raises InvalidSyntaxError – if the string is invalid

class DirectoryStringFirstComponentMatch
    Bases: laurelin.ldap.rules.EqualityMatchingRule

    NAME = 'directoryStringFirstComponentMatch'

    OID = '2.5.13.31'

    SYNTAX = '1.3.6.1.4.1.1466.115.121.1.15'

class DistinguishedName
    Bases: laurelin.ldap.rules.RegexSyntaxRule

    DESC = 'DN'

    OID = '1.3.6.1.4.1.1466.115.121.1.12'

    regex = '^(?:[A-Za-z][A-Za-z0-9-]*|[0-9]+(?:\\.[0-9]+)+)=(?: (?:[^\s,;<>\\\\0\\\\\\\\ #=]
class DistinguishedNameMatch
    Bases: laurelin.ldap.rules.EqualityMatchingRule

    NAME = 'distinguishedNameMatch'

    OID = '2.5.13.1'

    SYNTAX = '1.3.6.1.4.1.1466.115.121.1.12'

    do_match(attribute_value, assertion_value)
        Perform equality matching

EMPLOYEE_NUMBER = <AttributeType "employeeNumber">
EMPLOYEE_TYPE = <AttributeType "employeeType">

```

```
ENHANCED_SEARCH_GUIDE = <AttributeType "enhancedSearchGuide">
EXTENSIBLE_OBJECT = <ExtensibleObjectClass "extensibleObject">

class EnhancedGuide
    Bases: laurelin.ldap.rules.SyntaxRule

    DESC = 'Enhanced Guide'

    OID = '1.3.6.1.4.1.1466.115.121.1.21'

    validate(s)
        Validate a string. Must be implemented by subclasses.
        Parameters s – Candidate string
        Returns Any useful value for the rule
        Raises InvalidSyntaxError – if the string is invalid

FACSIMILIE_TELEPHONE_NUMBER = <AttributeType "facsimileTelephoneNumber">
FRIENDLY_COUNTRY = <ObjectClass "friendlyCountry">

class FacsimilieTelephoneNumber
    Bases: laurelin.ldap.rules.SyntaxRule

    DESC = 'Facsimile Telephone Number'

    OID = '1.3.6.1.4.1.1466.115.121.1.22'

    validate(s)
        Validate a string. Must be implemented by subclasses.
        Parameters s – Candidate string
        Returns Any useful value for the rule
        Raises InvalidSyntaxError – if the string is invalid

class Fax
    Bases: laurelin.ldap.rules.SyntaxRule

    DESC = 'Fax'

    OID = '1.3.6.1.4.1.1466.115.121.1.23'

    validate(s)
        Validate a string. Must be implemented by subclasses.
        Parameters s – Candidate string
        Returns Any useful value for the rule
        Raises InvalidSyntaxError – if the string is invalid

GENERATION_QUALIFIER = <AttributeType "generationQualifier">
GIVEN_NAME = <AttributeType "givenName">
GOVERNING_STRUCTURAL_RULE = <AttributeType "governingStructureRule">
GROUP_OF_NAMES = <ObjectClass "groupOfNames">
GROUP_OF_UNIQUE_NAMES = <ObjectClass "groupOfUniqueNames">

class GeneralizedTime
    Bases: laurelin.ldap.rules.RegexSyntaxRule

    DESC = 'Generalized Time'

    OID = '1.3.6.1.4.1.1466.115.121.1.24'

    regex = '^([0-9]{4})([0-9]{2})([0-9]{2})([0-9]{2})([0-9]{2})?([0-9]{2})?([.][0-9]{1,2})?'
```

```

    validate(s)
        Validate a string against the regular expression.
        Parameters s – Candidate string
        Returns The regex match object
        Return type MatchObject
        Raises InvalidSyntaxError – if the string does not match

class GeneralizedTimeMatch
    Bases: laurelin.ldap.rules.EqualityMatchingRule

    NAME = 'generalizedTimeMatch'

    OID = '2.5.13.27'

    SYNTAX = '1.3.6.1.4.1.1466.115.121.1.24'

    do_match(attribute_value, assertion_value)
        Perform equality matching

class Guide
    Bases: laurelin.extensions.base_schema.EnhancedGuide

    DESC = 'Guide'

    OID = '1.3.6.1.4.1.1466.115.121.1.25'

    validate(s)
        Validate a string. Must be implemented by subclasses.
        Parameters s – Candidate string
        Returns Any useful value for the rule
        Raises InvalidSyntaxError – if the string is invalid

HOME_PHONE = <AttributeType "homePhone">
HOME_POSTAL_ADDRESS = <AttributeType "homePostalAddress">
HOST = <AttributeType "host">
HOUSE_IDENTIFIER = <AttributeType "houseIdentifier">

class IA5String
    Bases: laurelin.ldap.rules.RegexSyntaxRule

    DESC = 'IA5 String'

    OID = '1.3.6.1.4.1.1466.115.121.1.26'

    regex = '^[\x00-\x7f]*$'

INET_ORG_PERSON = <ObjectClass "inetOrgPerson">
INFO = <AttributeType "info">
INITIALS = <AttributeType "initials">
INTERNATIONAL_ISDN_NUMBER = <AttributeType "internationalISDNNumber">

class Integer
    Bases: laurelin.ldap.rules.RegexSyntaxRule

    DESC = 'INTEGER'

    OID = '1.3.6.1.4.1.1466.115.121.1.27'

    regex = '^-[1-9][0-9]*$'

```

```
class IntegerFirstComponentMatch
    Bases: laurelin.ldap.rules.EqualityMatchingRule

    NAME = 'integerFirstComponentMatch'

    OID = '2.5.13.29'

    SYNTAX = '1.3.6.1.4.1.1466.115.121.1.27'

class IntegerMatch
    Bases: laurelin.ldap.rules.EqualityMatchingRule

    NAME = 'integerMatch'

    OID = '2.5.13.14'

    SYNTAX = '1.3.6.1.4.1.1466.115.121.1.27'

class JPEG
    Bases: laurelin.ldap.rules.SyntaxRule

    DESC = 'JPEG'

    OID = '1.3.6.1.4.1.1466.115.121.1.28'

    validate(s)
        Validate a string. Must be implemented by subclasses.
        Parameters s – Candidate string
        Returns Any useful value for the rule
        Raises InvalidSyntaxError – if the string is invalid

JPEG_PHOTO = <AttributeType "jpegPhoto">

L = <AttributeType "l">

LABELED_URI = <AttributeType "labeledURI">

class LDAPSyntaxDescription
    Bases: laurelin.ldap.rules.RegexSyntaxRule

    DESC = 'LDAP Syntax Description'

    OID = '1.3.6.1.4.1.1466.115.121.1.54'

    regex = '^\\( *(?P<oid>[0-9]+(?:\\. [0-9]+)+) (? : +DESC +'(?:\\\\\\\\5[Cc]|\\\\\\\\27|[^\\\\\\\\

LDAP_SYNTAXES = <AttributeType "ldapSyntaxes">

LOCALITY = <ObjectClass "locality">

MAIL = <AttributeType "mail">

MANAGER = <AttributeType "manager">

MATCHING_RULES = <AttributeType "matchingRules">

MATCHING_RULES_USE = <AttributeType "matchingRuleUse">

MEMBER = <AttributeType "member">

MOBILE = <AttributeType "mobile">

MODIFIERS_NAME = <AttributeType "modifiersName">

MODIFY_TIMESTAMP = <AttributeType "modifyTimestamp">

class MatchingRuleDescription
    Bases: laurelin.ldap.rules.RegexSyntaxRule
```



```

DESC = 'Matching Rule Description'
OID = '1.3.6.1.4.1.1466.115.121.1.30'
regex = '^\\( *(?P<oid>[0-9]+(?:\\. [0-9]+)+) (? : +NAME +(?: '[A-Za-z] [A-Za-z0-9-]* '
class MatchingRuleUseDescription
    Bases: laurelin.ldap.rules.RegexSyntaxRule
    DESC = 'Matching Rule Use Description'
    OID = '1.3.6.1.4.1.1466.115.121.1.31'
    regex = '^\\( *(?P<oid>[0-9]+(?:\\. [0-9]+)+) (? : +NAME +(?: '[A-Za-z] [A-Za-z0-9-]* '
NAME = <AttributeType "name">
NAME_FORMS = <AttributeType "nameForms">
NAMING_CONTEXTS = <AttributeType "namingContexts">
class NameAndOptionalUID
    Bases: laurelin.ldap.rules.RegexSyntaxRule
    DESC = 'Name And Optional UID'
    OID = '1.3.6.1.4.1.1466.115.121.1.34'
    regex = '^(?:[A-Za-z] [A-Za-z0-9-]*|[0-9]+(?:\\. [0-9]+)+)=(?: (?: ['^"+, ; <> \\0\\\\\\\\ #=]
class NameFormDescription
    Bases: laurelin.ldap.rules.RegexSyntaxRule
    DESC = 'Name Form Description'
    OID = '1.3.6.1.4.1.1466.115.121.1.35'
    regex = '^\\( *(?:[0-9]+(?:\\. [0-9]+)+) (? : +NAME +(?: '[A-Za-z] [A-Za-z0-9-]* ' | \\( *
class NumericString
    Bases: laurelin.ldap.rules.RegexSyntaxRule
    DESC = 'Numeric String'
    OID = '1.3.6.1.4.1.1466.115.121.1.36'
    regex = '^[0-9 ]+$'
class NumericStringMatch
    Bases: laurelin.ldap.rules.EqualityMatchingRule
    NAME = 'numericStringMatch'
    OID = '2.5.13.8'
    SYNTAX = '1.3.6.1.4.1.1466.115.121.1.36'
    prep_methods = (<function Transcode>, <function Map.characters>, <function Normaliz
O = <AttributeType "o">
OBJECT_CLASS = <AttributeType "objectClass">
OBJECT_CLASSES = <AttributeType "objectClasses">
class OID
    Bases: laurelin.ldap.rules.RegexSyntaxRule
    DESC = 'OID'

```

```
OID = '1.3.6.1.4.1.1466.115.121.1.38'
regex = '^(?:[A-Za-z][A-Za-z0-9-]*|[0-9]+(?:\\. [0-9]+)+)$'
ORGANIZATION = <ObjectClass "organization">
ORGANIZATIONAL_PERSON = <ObjectClass "organizationalPerson">
ORGANIZATIONAL_ROLE = <ObjectClass "organizationalRole">
ORGANIZATIONAL_STATUS = <AttributeType "organizationalStatus">
ORGANIZATIONAL_UNIT = <ObjectClass "organizationalUnit">
OU = <AttributeType "ou">
OWNER = <AttributeType "owner">
class ObjectClassDescription
    Bases: laurelin.ldap.rules.RegexSyntaxRule
    DESC = 'Object Class Description'
    OID = '1.3.6.1.4.1.1466.115.121.1.37'
    regex = '^\\( * (?P<oid>[0-9]+(?:\\. [0-9]+)+) (? : +NAME + (?P<name> (? : ' [A-Za-z] [A-Za-
```

```
class ObjectIdentifierFirstComponentMatch
    Bases: laurelin.ldap.rules.EqualityMatchingRule
    NAME = 'objectIdentifierFirstComponentMatch'
    OID = '2.5.13.30'
    SYNTAX = '1.3.6.1.4.1.1466.115.121.1.38'
class ObjectIdentifierMatch
    Bases: laurelin.ldap.rules.EqualityMatchingRule
    NAME = 'objectIdentifierMatch'
    OID = '2.5.13.0'
    SYNTAX = '1.3.6.1.4.1.1466.115.121.1.38'
class OctetString
    Bases: laurelin.ldap.rules.SyntaxRule
    DESC = 'Octet String'
    OID = '1.3.6.1.4.1.1466.115.121.1.40'
    validate(s)
        Validate a string. Must be implemented by subclasses.
        Parameters s – Candidate string
        Returns Any useful value for the rule
        Raises InvalidSyntaxError – if the string is invalid
class OctetStringMatch
    Bases: laurelin.ldap.rules.EqualityMatchingRule
    NAME = 'octetStringMatch'
    OID = '2.5.13.17'
    SYNTAX = '1.3.6.1.4.1.1466.115.121.1.40'
```

```

class OtherMailbox
    Bases: laurelin.ldap.rules.RegexSyntaxRule

    DESC = 'Other Mailbox'

    OID = '1.3.6.1.4.1.1466.115.121.1.39'

    regex = "^[A-Za-z0-9'()+,./:~ -]+\\$[\\x00-\\x7f]*$"

PAGER = <AttributeType "pager">
PERSON = <ObjectClass "person">
PERSONAL_TITLE = <AttributeType "personalTitle">
PHOTO = <AttributeType "photo">
PHYSICAL_DELIVERY_OFFICE_NAME = <AttributeType "physicalDeliveryOfficeName">
POSTAL_ADDRESS = <AttributeType "postalAddress">
POSTAL_CODE = <AttributeType "postalCode">
POST_OFFICE_BOX = <AttributeType "postOfficeBox">
PREFERRED_DELIVERY_METHOD = <AttributeType "preferredDeliveryMethod">
PREFERRED_LANGUAGE = <AttributeType "preferredLanguage">

class PostalAddress
    Bases: laurelin.ldap.rules.RegexSyntaxRule

    DESC = 'Postal Address'

    OID = '1.3.6.1.4.1.1466.115.121.1.41'

    regex = "^(\\\\\\\\5[cC]|\\\\\\\\24|[^\\\\\\\\$])+\\\\$ (\\\\\\\\5[cC]|\\\\\\\\24|[^\\\\\\\\$])+$"

class PrintableString
    Bases: laurelin.ldap.rules.RegexSyntaxRule

    DESC = 'Printable String'

    OID = '1.3.6.1.4.1.1466.115.121.1.44'

    regex = "^[A-Za-z0-9'()+,./:~ -]+$"

REGISTERED_ADDRESS = <AttributeType "registeredAddress">
RESIDENTIAL_PERSON = <ObjectClass "residentialPerson">
RFC822_LOCAL_PORT = <ObjectClass "rFC822localPart">
ROLE_OCCUPANT = <AttributeType "roleOccupant">
ROOM = <ObjectClass "room">
ROOM_NUMBER = <AttributeType "roomNumber">
SEARCH_GUIDE = <AttributeType "searchGuide">
SECRETARY = <AttributeType "secretary">
SEE_ALSO = <AttributeType "seeAlso">
SERIAL_NUMBER = <AttributeType "serialNumber">
SIMPLE_SECURITY_OBJECT = <ObjectClass "simpleSecurityObject">
SN = <AttributeType "sn">

```

```
ST = <AttributeType "st">
STREET = <AttributeType "street">
STRUCTURAL_OBJECT_CLASS = <AttributeType "structuralObjectClass">
SUBSCHEMA = <ObjectClass "subschem">
SUBSCHEMA_SUBENTRY = <AttributeType "subschemSubentry">
SUPPORTED_CONTROL = <AttributeType "supportedControl">
SUPPORTED_EXTENSION = <AttributeType "supportedExtension">
SUPPORTED_FEATURES = <AttributeType "supportedFeatures">
SUPPORTED_LDAP_VERSION = <AttributeType "supportedLDAPVersion">
SUPPORTED_SASL_MECHANISMS = <AttributeType "supportedSASLMechanisms">

class SubstringAssertion
    Bases: laurelin.ldap.rules.RegexSyntaxRule
    DESC = 'Substring Assertion'
    OID = '1.3.6.1.4.1.1466.115.121.1.58'
    regex = '(?: (\\\\\\\\5[cC]|\\\\\\\\2[aA]| [^\\\\\\\\*])+) ?\\\\* (?: (\\\\\\\\5[cC]|\\\\\\\\2[aA]| [^\\\\\\\\*])+) ?'

TELEPHONE_NUMBER = <AttributeType "telephoneNumber">
TELETEX_TERMINAL_IDENTIFIER = <AttributeType "teletexTerminalIdentifier">
TELEX_NUMBER = <AttributeType "telexNumber">
TITLE = <AttributeType "title">
TOP = <ObjectClass "top">

class TelephoneNumber
    Bases: laurelin.ldap.rules.SyntaxRule
    DESC = 'Telephone Number'
    OID = '1.3.6.1.4.1.1466.115.121.1.50'
    validate(s)
        Validate a string. Must be implemented by subclasses.
        Parameters s – Candidate string
        Returns Any useful value for the rule
        Raises InvalidSyntaxError – if the string is invalid

class TelephoneNumberMatch
    Bases: laurelin.ldap.rules.EqualityMatchingRule
    NAME = 'telephoneNumberMatch'
    OID = '2.5.13.20'
    SYNTAX = '1.3.6.1.4.1.1466.115.121.1.50'
    prep_methods = (<function Transcode>, <function Map.all>, <function Normalize>, <fu

class TeletextTerminalIdentifier
    Bases: laurelin.ldap.rules.RegexSyntaxRule
    DESC = 'Teletex Terminal Identifier'
    OID = '1.3.6.1.4.1.1466.115.121.1.51'
```

laurelin.extensions.descattrs module

This implements the common pattern of storing arbitrary key=value data in description fields, but presents an attribute-like interface to access and change them.

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```
attr_vals = result.descattrs.get_attr('foo')
print(attr_vals)
# ['one', 'two']

result.descattrs.replace({'foo': ['one', 'two', 'three']})
result.descattrs.delete({'foo': ['two']})

attr_vals = result.descattrs.get_attr('foo')
print(attr_vals)
# ['one', 'three']

print(result.format_ldif())
# ...
# description: foo=one
# description: foo=three
# ...
```

`laurelin.extensions.descattrs.DESC_ATTR_DELIM = '='`

Key/value delimiter in description attrs. If this character is not present in the description value, then it will be considered unstructured and ignored.

class `laurelin.extensions.descattrs.LaurelinExtension` (*modname=None*)

Bases: `laurelin.ldap.extensible.user_base.BaseLaurelinExtension`

NAME = `'descattrs'`

class `laurelin.extensions.descattrs.LaurelinLDAPObjectExtension` (*parent*)

Bases: `laurelin.ldap.extensible.user_base.BaseLaurelinLDAPObjectExtension`

add (*attrs_dict*)

Add new description attributes.

Parameters *attrs_dict* (*dict(str, list[str])* or *AttrsDict*) – Dictionary of description attributes to add

Return type `None`

delete (*attrs_dict*)

Delete description attributes.

Parameters *attrs_dict* (*dict(str, list[str])* or *AttrsDict*) – Dictionary of description attributes to delete

Return type `None`

replace (*attrs_dict*)

Replace description attributes.

Parameters *attrs_dict* (*dict(str, list[str])* or *AttrsDict*) – Dictionary of description attributes to set

Return type `None`

laurelin.extensions.netgroups module

Extension adding netgroup support to laurelin.

Includes schema definitions.

You should begin by tagging the base object which all netgroups are below, and defining the RDN attribute and scope. If the structure is flat there is a performance advantage by setting `relative_search_scope=Scope.ONE`:

```
from laurelin.ldap import LDAP, Scope, extensions

with LDAP() as ldap:
    ldap.base.obj('ou=netgroups',
                  tag=extensions.netgroups.TAG,
                  relative_search_scope=Scope.ONE,
                  rdn_attr='cn')
```

Member Lists

This extension module allows a shortcut to specify members of netgroups. Any function with a `members` argument uses this feature.

The function name will tell you whether it expects users (e.g., `add_users`) or hosts (e.g. `add_hosts`). If you just specify a string in your member list, it will be assumed to be either a user or a host accordingly.

You can also specify a tuple with up to 3 elements for any member list entry. These fields must correspond to the `nisNetgroupTriple` fields: `host`, `user`, and `domain`. For user functions, at least the first 2 tuple elements must be specified. For host functions, only the first is required, the 2nd (user) field will be assumed as an empty string. In all cases, the domain can be specified for all members by passing the `domain` argument to the function (it defaults to an empty string).

The third option for member list entries is to specify the full `nisNetgroupTriple` yourself in a string.

Finally, you can specify a `memberNisNetgroup` by prefixing the entry with a `+` symbol. For example: `+users`.

Examples:

```
users = [
    'alice',
    'bob',
    ('dir.example.org', 'admin'),
    ('dir.example.org,manager,secrets.example.org'),
]

ldap.netgroups.add_users('cn=managers,ou=netgroups,dc=example,dc=org', users, domain=
    ↪ 'example.org')
# Adds the following nisNetgroupTriples:
# (,alice,example.org)
# (,bob,example.org)
# (dir.example.org,admin,example.org)
# (dir.example.org,manager,secrets.example.org)
# Does not add any memberNisNetgroups

hosts = [
    'dir1.example.org',
    'dir2.example.org',
    ('dir3.example.org,,'),
    ('dir4.example.org',),
    '+aws_backup_dir_servers',
]

ldap.netgroups.add_hosts('cn=dir_servers,ou=netgroups,dc=example,dc=org', hosts)
# Adds the following nisNetgroupTriples:
```

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```
# (dir1.example.org,,)
# (dir2.example.org,,)
# (dir3.example.org,,)
# (dir4.example.org,,)
# Adds the following memberNisNetgroup:
# aws_backup_dir_servers
```

```
class laurelin.extensions.netgroups.LaurelinExtension(modname=None)
    Bases: laurelin.ldap.extensible.user_base.BaseLaurelinExtension
```

```
    NAME = 'netgroups'
```

```
    TAG = 'netgroup_base'
```

```
class laurelin.extensions.netgroups.LaurelinLDAPExtension(parent)
    Bases: laurelin.ldap.extensible.user_base.BaseLaurelinLDAPExtension
```

```
    add_hosts(dn, members, domain="")
```

Add new hosts to a netgroup.

Parameters

- **dn** (*str*) – The absolute DN of the netgroup object
- **members** (*list or str or tuple*) – A Member List (see *laurelin.extensions.netgroups* doc) or single member list entry
- **domain** (*str*) – The default domain to use in nisNetgroupTriples where not already specified

Return type *None*

```
    add_users(dn, members, domain="")
```

Add new users to a netgroup.

Parameters

- **dn** (*str*) – The absolute DN of the netgroup object
- **members** (*list or str or tuple*) – A Member List (see *laurelin.extensions.netgroups* doc) or single member list entry
- **domain** (*str*) – The default domain to use in nisNetgroupTriples where not already specified

Return type *None*

```
    delete_hosts(dn, members, domain="")
```

Delete hosts from a netgroup.

Parameters

- **dn** (*str*) – The absolute DN of the netgroup object
- **members** (*list or str or tuple*) – A Member List (see *laurelin.extensions.netgroups* doc) or single member list entry
- **domain** (*str*) – The default domain to use in nisNetgroupTriples where not already specified

Return type *None*

```
    delete_users(dn, members, domain="")
```

Delete users from a netgroup.

Parameters

- **dn** (*str*) – The absolute DN of the netgroup object
- **members** (*list or str or tuple*) – A Member List (see [laurelin.extensions.netgroups](#) doc) or single member list entry
- **domain** (*str*) – The default domain to use in nisNetgroupTriples where not already specified

Return type `None`

get (*cn, attrs=None*)

Find a specific netgroup object.

This depends on the base object having been tagged and configured properly. See [laurelin.extensions.netgroups](#).

Parameters

- **cn** (*str*) – The name of the group or an RDN
- **attrs** (*list[str]*) – List of attribute names to get. Defaults to all netgroup attributes.

Returns The netgroup object

Return type `LDAPObject`

Raises `TagError` – if the base object has not been tagged.

get_hosts (*cn, recursive=True*)

Query a list of all host entries for a netgroup.

This depends on the base object having been tagged and configured properly. See [laurelin.extensions.netgroups](#).

Parameters

- **cn** (*str*) – The name of the group or an RDN
- **recursive** (*bool*) – Recursively get hosts by following memberNisNetgroups

Returns A list of hostnames

Return type `list[str]`

Raises `TagError` – if the base object has not been tagged.

get_obj_hosts (*ng_obj, recursive=True*)

Get a list of netgroup hosts from an already queried object, possibly querying for memberNisNetgroups if recursive=True (the default).

Parameters

- **ng_obj** (`LDAPObject`) – A netgroup LDAP object
- **recursive** (*bool*) – Set to False to only consider members of this group directly

Returns A list of hostnames

Return type `list[str]`

get_obj_users (*ng_obj, recursive=True*)

Get a list of netgroup users from an already queried object, possibly querying for memberNisNetgroups if recursive=True (the default).

Parameters

- **ng_obj** (`LDAPObject`) – A netgroup LDAP object
- **recursive** (`bool`) – Set to False to only consider members of this group directly

Returns A list of usernames

Return type `list[str]`

get_users (`cn`, `recursive=True`)

Get a list of all user entries for a netgroup.

This depends on the base object having been tagged and configured properly. See [laurelin.extensions.netgroups](#).

Parameters

- **cn** (`str`) – The name of the group or an RDN
- **recursive** (`bool`) – Recursively get users by following memberNisNetgroups

Returns A list of usernames

Return type `list[str]`

Raises `TagError` – if the base object has not been tagged.

replace_hosts (`dn`, `members`, `domain=""`)

Set new hosts on a netgroup.

Parameters

- **dn** (`str`) – The absolute DN of the netgroup object
- **members** (`list` or `str` or `tuple`) – A Member List (see [laurelin.extensions.netgroups](#) doc) or single member list entry
- **domain** (`str`) – The default domain to use in nisNetgroupTriples where not already specified

Return type `None`

replace_users (`dn`, `members`, `domain=""`)

Set new users on a netgroup.

Parameters

- **dn** (`str`) – The absolute DN of the netgroup object
- **members** (`list` or `str` or `tuple`) – A Member List (see [laurelin.extensions.netgroups](#) doc) or single member list entry
- **domain** (`str`) – The default domain to use in nisNetgroupTriples where not already specified

Return type `None`

search (`filter`, `attrs=None`)

Search for netgroups.

This depends on the base object having been tagged and configured properly. See [laurelin.extensions.netgroups](#).

Parameters

- **filter** (`str`) – A partial filter string. The nisNetgroup objectClass will automatically be included in the filter sent to the server.
- **attrs** (`list[str]`) – List of attribute names to get. Defaults to all netgroup attributes.

Returns An iterator over matching netgroup objects, yielding instances of *LDAPObject*.

Return type *SearchResultHandle*

Raises *TagError* – if the base object has not been tagged.

```
class laurelin.extensions.netgroups.LaurelinLDAPObjectExtension(parent)
    Bases: laurelin.ldap.extensible.user_base.BaseLaurelinLDAPObjectExtension
```

```
add_hosts(members, domain=")
```

Add new host netgroup entries to this netgroup object.

Parameters

- **members** (*list or str or tuple*) – A Member List (see *laurelin.extensions.netgroups* doc) or single member list entry
- **domain** (*str*) – The default domain to use in nisNetgroupTriples where not already specified

Return type *None*

Raises *RuntimeError* – if this object is missing the netgroup object class

```
add_users(members, domain=")
```

Add new user netgroup entries to this netgroup object.

Parameters

- **members** (*list or str or tuple*) – A Member List (see *laurelin.extensions.netgroups* doc) or single member list entry
- **domain** (*str*) – The default domain to use in nisNetgroupTriples where not already specified

Return type *None*

Raises *RuntimeError* – if this object is missing the netgroup object class

```
delete_hosts(members, domain=")
```

Delete host netgroup entries from this netgroup object.

Parameters

- **members** (*list or str or tuple*) – A Member List (see *laurelin.extensions.netgroups* doc) or single member list entry
- **domain** (*str*) – The default domain to use in nisNetgroupTriples where not already specified

Return type *None*

Raises *RuntimeError* – if this object is missing the netgroup object class

```
delete_users(members, domain=")
```

Delete user netgroup entries from this netgroup object.

Parameters

- **members** (*list or str or tuple*) – A Member List (see *laurelin.extensions.netgroups* doc) or single member list entry
- **domain** (*str*) – The default domain to use in nisNetgroupTriples where not already specified

Return type *None*

Raises **RuntimeError** – if this object is missing the netgroup object class

get_hosts (*recursive=True*)

Get all hosts in this netgroup object.

Parameters **recursive** (*bool*) – Set to False to ignore any memberNisNetgroups defined for this object.

Returns A list of hostnames

Return type *list[str]*

Raises **RuntimeError** – if this object is missing the netgroup object class

get_users (*recursive=True*)

Get all users in this netgroup object.

Parameters **recursive** (*bool*) – Set to False to ignore any memberNisNetgroups defined for this object.

Returns A list of usernames

Return type *list[str]*

Raises **RuntimeError** – if this object is missing the netgroup object class

replace_hosts (*members, domain=""*)

Set new host netgroup entries on this netgroup object.

Parameters

- **members** (*list or str or tuple*) – A Member List (see *laurelin.extensions.netgroups* doc) or single member list entry
- **domain** (*str*) – The default domain to use in nisNetgroupTriples where not already specified

Return type *None*

Raises **RuntimeError** – if this object is missing the netgroup object class

replace_users (*members, domain=""*)

Set new user netgroup entries on this netgroup object.

Parameters

- **members** (*list or str or tuple*) – A Member List (see *laurelin.extensions.netgroups* doc) or single member list entry
- **domain** (*str*) – The default domain to use in nisNetgroupTriples where not already specified

Return type *None*

Raises **RuntimeError** – if this object is missing the netgroup object class

class *laurelin.extensions.netgroups.LaurelinSchema*

Bases: *laurelin.ldap.extensible.user_base.BaseLaurelinSchema*

MEMBER_NIS_NETGROUP = *<AttributeType "memberNisNetgroup">*

NIS_NETGROUP = *<ObjectClass "nisNetgroup">*

NIS_NETGROUP_TRIPLE = *<AttributeType "nisNetgroupTriple">*

class *NisNetgroupTripleSyntax*

Bases: *laurelin.ldap.rules.RegexSyntaxRule*

```
DESC = 'NIS netgroup triple'
OID = '1.3.6.1.1.1.0.0'
regex = '^\\(([^,]*), ([^,]*), ([^,]*)\\)$'
```

laurelin.extensions.pagedresults module

RFC 2696 Simple Paged Results Manipulation

This adds a control to support paging results. Use the control keyword `paged` with search methods. Returns a cookie on the `page_cookie` response attribute which can be found on the results handle after all paged results have been received. See example below.

Note: Do not use this extension to simply limit the total number of results. The search methods accept a `limit` keyword out of the box for this purpose.

Example usage:

```
from laurelin.ldap import LDAP
LDAP.activate_extension('laurelin.extensions.pagedresults')

with LDAP() as ldap:
    search = ldap.base.search(paged=10)
    page1_results = list(search)

    search = ldap.base.search(paged=(10, search.page_cookie))
    page2_results = list(search)

    # ...

    if not search.page_cookie:
        print('Got all pages')
```

Note: When getting pages in a loop, you may set the cookie value to an empty string on the first iteration, e.g.:

```
ldap.base.search(paged=(10, ''))
```

```
class laurelin.extensions.pagedresults.Cookie (value=<NoValue object>, **kwargs)
    Bases: pyasn1.type.univ.OctetString
```

```
class laurelin.extensions.pagedresults.LaurelinExtension (modname=None)
    Bases: laurelin.ldap.extensible.user_base.BaseLaurelinExtension
```

```
    NAME = 'paged_results'
```

```
    OID = '1.2.840.113556.1.4.319'
```

```
class PagedResultsControl
```

```
    Bases: laurelin.ldap.controls.Control
```

```
    REQUEST_OID = '1.2.840.113556.1.4.319'
```

```
    RESPONSE_OID = '1.2.840.113556.1.4.319'
```

```
    handle (ctrl_value)
```

Accepts raw response `ctrl_value` and may return any useful value.

There is no need to call this base function when overriding.

Parameters `ctrl_value` (*str*) – The string response control value received from the server.

Returns The string *ctrl_value* unchanged by default. May be overridden to return any relevant value/type/structure.

keyword = 'paged'

method = ('search',)

prepare (*ctrl_value*, *criticality*)

Prepare the paged results control value

Parameters

- **ctrl_value** (*int* or *tuple*) – Either an integer page size or a tuple of (page size, cookie)
- **criticality** – True if the control is critical, false otherwise

Returns The protocol-level control object

response_attr = 'page_cookie'

class laurelin.extensions.pagedresults.RealSearchControlValue (**kwargs)

Bases: pyasn1.type.univ.Sequence

componentType = <NamedTypes object at 0x7f3350b05320 types <NamedType object at 0x7f3350b05320>>

class laurelin.extensions.pagedresults.Size (value=<NoValue object>, **kwargs)

Bases: laurelin.ldap.rfc4511.Integer0ToMax

Module contents

8.1.1.2 laurelin.ldap package

Submodules

laurelin.ldap.base module

Contains base classes for laurelin.ldap

class laurelin.ldap.base.CompareResponse (*compare_result*)

Bases: *laurelin.ldap.base.LDAPResponse*

Stores boolean compare result and any response control values. The `bool()` of this object gives the compare result.

class laurelin.ldap.base.ExtendedResponseHandle (*mid*, *ldap_conn*, *require_success=False*)

Bases: *laurelin.ldap.base.ResponseHandle*

Obtains `rfc4511.ExtendedResponse` or `rfc4511.IntermediateResponse` instances from the server for a particular message ID

recv_response ()

class laurelin.ldap.base.LDAP (*server=None*, *base_dn=None*, *reuse_connection=None*, *connect_timeout=None*, *search_timeout=None*, *deref_aliases=None*, *strict_modify=None*, *ssl_verify=None*, *ssl_ca_file=None*, *ssl_ca_path=None*, *ssl_ca_data=None*, *fetch_result_refs=None*, *default_sasl_mech=None*, *sasl_fatal_downgrade_check=None*, *default_criticality=None*, *follow_referrals=None*, *validators=None*, *warn_empty_list=None*, *error_empty_list=None*, *ignore_empty_list=None*, *filter_syntax=None*, *built_in_extensions_only=None*)

Bases: `laurelin.ldap.extensible.ldap_extensions.LDAPExtensions`

Provides the connection to the LDAP DB. All constructor parameters have a matching global default as a class property on `LDAP`

Parameters

- **server** (*str* or *LDAPSock*) – URI string to connect to or an *LDAPSock* to reuse
- **base_dn** (*str*) – The DN of the base object
- **reuse_connection** (*bool*) – Allows the socket connection to be reused and reuse an existing socket if possible.
- **connect_timeout** (*int*) – Number of seconds to wait for connection to be accepted.
- **search_timeout** (*int*) – Number of seconds to wait for a search to complete. Partial results will be returned when the timeout is reached. Can be overridden on a per-search basis by setting the `search_timeout` keyword on `LDAP.search()`.
- **deref_aliases** (*DerefAliases*) – One of the *DerefAliases* constants. Instructs the server how to handle alias objects in search results. Can be overridden on a per-search basis by setting the `deref_aliases` keyword on `LDAP.search()`.
- **strict_modify** (*bool*) – Use the strict modify strategy. If set to True, guarantees that another search will not take place before a modify operation. May potentially produce more server errors.
- **ssl_verify** (*bool*) – Validate the certificate and hostname on an SSL/TLS connection
- **ssl_ca_file** (*str*) – Path to PEM-formatted concatenated CA certificates file
- **ssl_ca_path** (*str*) – Path to directory with CA certs under hashed file names. See https://www.openssl.org/docs/man1.1.0/ssl/SSL_CTX_load_verify_locations.html for more information about the format of this directory.
- **ssl_ca_data** (*str* or *bytes*) – An ASCII string of one or more PEM-encoded certs or a bytes object containing DER-encoded certificates.
- **fetch_result_refs** (*bool*) – Fetch *searchResultRef* responses in search results. Can be overridden on a per-search basis by setting the `fetch_result_refs` keyword on `LDAP.search()`.
- **default_sasl_mech** (*str*) – Name of the default SASL mechanism. Bind will fail if the server does not support the mechanism. (Examples: DIGEST-MD5, GSSAPI)
- **sasl_fatal_downgrade_check** (*bool*) – Set to False to make potential downgrade attack check non-fatal.
- **default_criticality** (*bool*) – Set to True to make controls critical by default, set to False to make non-critical
- **follow_referrals** (*bool*) – Automatically follow referral results
- **validators** (*list* [*Validator*]) – A list of *Validator* instances to apply to this connection.
- **warn_empty_list** (*bool*) – Default False. Set to True to emit a warning when an empty value list is passed to `LDAP.modify()`, `LDAP.replace_attrs()`, or `LDAP.delete_attrs()` or their *LDAPObject* counterparts.

- **error_empty_list** (*bool*) – Default False. Set to True to raise an exception when an empty value list is passed to `LDAP.modify()`, `LDAP.replace_attrs()`, or `LDAP.delete_attrs()` or their LDAPObject counterparts.
- **ignore_empty_list** (*bool*) – Default False. Set to True to ignore empty value lists passed to `LDAP.modify()`, `LDAP.replace_attrs()`, or `LDAP.delete_attrs()` or their LDAPObject counterparts. This will be default True in a future release.
- **filter_syntax** (*FilterSyntax*) – The default search filter syntax selection. Must be one of the *FilterSyntax* constants. Can be overridden on a per-search basis by setting the `filter_syntax` keyword on `LDAP.search()`. Defaults to *FilterSyntax.STANDARD* for RFC4515-compliant filter string syntax.
- **built_in_extensions_only** (*bool*) – Set to True to raise an error when attempting to use a 3rd-party extension

The class can be used as a context manager, which will automatically unbind and close the connection when the context manager exits.

Example:

```
with LDAP() as ldap:
    raise Exception()
# ldap is closed and unbound

with LDAP() as ldap:
    print('hello')
# ldap is closed and unbound
```

```
DEFAULT_BASE_DN = None
DEFAULT_BUILT_IN_EXTENSIONS_ONLY = False
DEFAULT_CONNECT_TIMEOUT = 5
DEFAULT_CRITICALITY = False
DEFAULT_DEREF_ALIASES = DerefAliases.ALWAYS
DEFAULT_ERROR_EMPTY_LIST = False
DEFAULT_FETCH_RESULT_REFS = True
DEFAULT_FILTER = '(objectClass=*)'
DEFAULT_FILTER_SYNTAX = FilterSyntax.UNIFIED
DEFAULT_FOLLOW_REFERRALS = True
DEFAULT_IGNORE_EMPTY_LIST = True
DEFAULT_REUSE_CONNECTION = True
DEFAULT_SASL_FATAL_DOWNGRADE_CHECK = True
DEFAULT_SASL_MECH = None
DEFAULT_SEARCH_TIMEOUT = 0
DEFAULT_SERVER = 'ldap://localhost'
DEFAULT_SSL_CA_DATA = None
DEFAULT_SSL_CA_FILE = None
```



```
DEFAULT_SSL_CA_PATH = None
```

```
DEFAULT_SSL_VERIFY = True
```

```
DEFAULT_STRICT_MODIFY = False
```

```
DEFAULT_VALIDATORS = None
```

```
DEFAULT_WARN_EMPTY_LIST = False
```

```
DELETE_ALL = <delete all values>
```

Use with modify replace/delete in place of an attribute list to delete all values for the attribute

```
LOG_FORMAT = "[% (asctime)s] %(name)s %(levelname)s : %(message)s "
```

```
NO_ATTRS = '1.1'
```

```
OID_OBJ_CLASS_ATTR = '1.3.6.1.4.1.4203.1.5.2'
```

```
OID_STARTTLS = '1.3.6.1.4.1.1466.20037'
```

```
OID_WHOAMI = '1.3.6.1.4.1.4203.1.11.3'
```

```
add(dn, attrs_dict, **kws)
```

Add new object and return corresponding LDAPObject on success.

Parameters

- **dn** (*str*) – The new object's DN
- **attrs_dict** (*dict(str, list(str or bytes)) or AttrsDict*) – The new attributes for the object

Returns The new object

Return type *LDAPObject*

Raises

- *ConnectionUnbound* – if the connection has been unbound
- *TypeError* – if arguments are of invalid type
- *LDAPValidationError* – if the object fails any configured validator
- *LDAPError* – if we get a non-success result

Additional keyword arguments are handled as *Controls* and then passed through into *LDAP.obj()*.

```
add_attrs(dn, attrs_dict, current=None, **ctrl_kws)
```

Add new attribute values to existing object.

Parameters

- **dn** (*str*) – The DN of the object to modify
- **attrs_dict** (*dict(str, list(str or bytes)) or AttrsDict*) – The new attributes to add to the object
- **current** (*LDAPObject or None*) – The current known state of the object. Used for ensuring we don't send duplicate attributes to the server and for validation.

Returns A response object

Return type *LDAPResponse*

Additional keyword arguments are handled as *Controls*.

static add_extension (*modname*)

Import an extension and prepare it for binding under its internally-defined name to LDAP and/or LDAPObject depending which extension classes are defined. This is only needed for extensions not yet patched into AVAILABLE_EXTENSIONS.

Parameters **modname** (*str*) – The string module name containing an extension, can be any importable module, e.g. “laurelin.extensions.netgroups”

Return type *None*

add_if_not_exists (*dn, attrs_dict*)

Add object if it doesn’t exist

- Gets and returns the object at DN if it exists, otherwise create the object using the attrs dictionary
- Always returns an LDAPObject corresponding to the final state of the DB

Parameters

- **dn** (*str*) – The object DN
- **attrs_dict** (*dict(str, list[str or bytes]) or AttrsDict*) – The attributes to use if adding the object

Returns The new or existing object

Return type *LDAPObject*

add_or_mod_add_if_exists (*dn, attrs_dict*)

Add object if it doesn’t exist, otherwise add_attrs

- If the object at DN exists, perform an add modification using the attrs dictionary. Otherwise, create the object using the attrs dictionary.
- This ensures that, for the attributes mentioned in attrs, AT LEAST those values will exist on the given DN, regardless of prior state of the DB.
- Always returns an LDAPObject corresponding to the final state of the DB

Parameters

- **dn** (*str*) – The object DN
- **attrs_dict** (*dict(str, list[str or bytes]) or AttrsDict*) – The objects minimum attributes

Returns The new or modified object

Return type *LDAPObject*

add_or_mod_replace_if_exists (*dn, attrs_dict*)

Add object if it doesn’t exist, otherwise replace_attrs

- If the object at DN exists, perform a replace modification using the attrs dictionary. Otherwise, create the object using the attrs dictionary.
- This ensures that, for the attributes mentioned in attrs, ONLY those values will exist on the given DN regardless of prior state of the DB.
- Always returns an LDAPObject corresponding to the final state of the DB

Parameters

- **dn** (*str*) – The object DN

- **attrs_dict** (*dict(str, list[str or bytes]) or AttrsDict*) – The objects new required attributes

Returns The new or modified object

Return type *LDAPObject*

close (*force=False*)

Send an unbind request and close the socket.

Parameters **force** (*bool*) – Unbind and close the socket even if other objects still hold a reference to it.

Raises *ConnectionUnbound* – if the connection has already been unbound

compare (*dn, attr, value, **ctrl_kwds*)

Ask the server if a particular DN has a matching attribute value. The comparison will take place following the schema-defined matching rules and syntax rules.

Parameters

- **dn** (*str*) – The DN of the object
- **attr** (*str*) – The attribute name
- **value** (*str*) – The assertion value

Returns A response object, *bool()* evaluating to the result of the comparison

Return type *CompareResponse*

Raises

- *ConnectionUnbound* – if the connection has been unbound
- *LDAPError* – if we got a result other than compareTrue or compareFalse

Additional keyword arguments are handled as *Controls*.

static default_warnings ()

Always take the default action for warnings

delete (*dn, **ctrl_kwds*)

Delete an object.

Parameters **dn** (*str*) – The DN of the object to delete

Returns A response object

Return type *LDAPResponse*

Raises *ConnectionUnbound* – if the connection has been unbound

Additional keyword arguments are handled as *Controls*.

delete_attrs (*dn, attrs_dict, current=None, **ctrl_kwds*)

Delete specific attribute values from *attrs_dict*.

Specifying a 0-length entry will delete all values.

Parameters

- **dn** (*str*) – The DN of the object to modify
- **attrs_dict** (*dict(str, list[str or bytes]) or AttrsDict*) – The attributes to remove from the object. Specify an empty list for a value to delete all values.

- **current** (`LDAPObject` or `None`) – The current known state of the object. Used to ensure we don't request that the server delete attribute values that don't exist and for validation.

Returns A response object

Return type `LDAPResponse`

Additional keyword arguments are handled as *Controls*.

disable_validation (*disabled_validators=None*)

Returns a context manager which temporarily disables validation. If any server errors are generated, they will still be propagated.

Example:

```
from laurelin.ldap import LDAP
from laurelin.ldap.exceptions import LDAPValidationError
from laurelin.ldap.schema import SchemaValidator

with LDAP(validators=[SchemaValidator()]) as ldap:
    # make validated queries
    ldap.base.add_child('cn=foo', {<valid object>})

    try:
        ldap.base.add_child('cn=bar', {<invalid object>})
    except LDAPValidationError:
        pass

    with ldap.disable_validation(['SchemaValidator']):
        # make queries without validation
        ldap.base.add_child('cn=bar', {<invalid object>})
        # NOTE: if the object is actually invalid, a server error may still_
↪ occur

    # carry on with validation restored...
```

Parameters disabled_validators – Optional, a list of string class names or Validator classes to disable. By default all validators will be disabled.

Returns A context manager which temporarily disables validation

Return type `DisabledValidationContext`

static disable_warnings ()

Prevent all LDAP warnings from being shown - default action for others

static enable_logging (*level=10*)

Enable logging output to stderr

exists (*dn*)

Simply check if a DN exists.

Parameters dn (*str*) – The DN to check

Returns True if the object exists, False if not

Return type `bool`

get (*dn, attrs=None, **kws*)

Get a specific object by DN.

Performs a search with `Scope.BASE` and ensures we get exactly one result.

Parameters

- **dn** (*str*) – The DN of the object to query
- **attrs** (*list[str]* or *None*) – Optional. A list of attribute names to get, defaults to all user attributes

Returns The LDAP object

Return type *LDAPObject*

Raises

- *ConnectionUnbound* – if the connection has been unbound
- *NoSearchResults* – if no results are returned
- *MultipleSearchResults* – if more than one result is returned

Additional keyword arguments are passed through into *LDAP.search()*.

get_sasl_mechs()

Query root DSE for supported SASL mechanisms.

Returns The list of server-supported mechanism names.

Return type *list[str]*

static log_warnings()

Log all LDAP warnings rather than showing them - default action for others

mod_dn (*dn*, *new_rdn*, *clean_attr=True*, *new_parent=None*, ***ctrl_kwds*)

Change the DN and possibly the location of an object in the tree. Exposes all options of the protocol-level *rfc4511.ModifyDNRequest*

Parameters

- **dn** (*str*) – The current DN of the object
- **new_rdn** (*str*) – The new RDN of the object, e.g. *cn=foo*
- **clean_attr** (*bool*) – Remove the old RDN attribute from the object when changing
- **new_parent** (*str* or *None*) – The DN of the new parent object, or *None* to leave the location unchanged

Returns A response object

Return type *LDAPResponse*

Raises *ConnectionUnbound* – if the connection has been unbound

Additional keyword arguments are handled as *Controls*.

modify (*dn*, *modlist*, *current=None*, ***ctrl_kwds*)

Perform a series of modify operations on an object atomically

Parameters

- **dn** (*str*) – The DN of the object to modify
- **modlist** (*list[Mod]*) – A list of *Mod* instances, e.g. [*Mod*(*Mod.ADD*, 'someAttr', ['value1', 'value2'])]
- **current** (*LDAPObject* or *None*) – The current known state of the object for use in validation

Returns A response object

Return type *LDAPResponse*

Raises

- *ConnectionUnbound* – if the connection has been unbound
- *LDAPValidationError* – if the operation fails and configured validator

Additional keyword arguments are handled as *Controls*.

move (*dn*, *new_dn*, *clean_attr=True*, ***ctrl_kwds*)

Specify a new absolute DN for an object.

Parameters

- **dn** (*str*) – The current DN of the object
- **new_dn** (*str*) – The new absolute DN of the object, e.g. cn=foo,dc=example,dc=org
- **clean_attr** (*bool*) – Remove the old RDN attribute from the object when changing

Returns A response object

Return type *LDAPResponse*

Additional keyword arguments are handled as *Controls*.

obj (*dn*, *attrs_dict=None*, *tag=None*, ***kwds*)

Factory for LDAPObjects bound to this connection.

Note that this does not query the server. Use *LDAP.get()* to query the server for a particular DN.

Parameters

- **dn** (*str*) – The DN of the object.
- **attrs_dict** (*dict(str, list[str or bytes]) or AttrsDict or None*) – Optional. The object's attributes and values.
- **tag** (*str or None*) – Optional. The tag for this object. Tagged objects can be retrieved with *LDAP.tag()*.

Returns The new object bound to this connection.

Return type *LDAPObject*

Raises *TagError* – if the tag parameter is already defined

Additional keywords are passed through into the *LDAPObject* constructor.

process_ldif (*ldif_str*)

Process a basic LDIF

TODO: full RFC 2849 implementation. Missing:

- attribute options

Parameters **ldif_str** (*str*) – An RFC 2849 complying LDIF string

Returns A list with elements corresponding to the return of each described operation

Return type *list[LDAPResponse or LDAPObject]*

Raises

- *ValueError* – if the LDIF is malformed

- ***LDAPError*** – if an unimplemented feature is used
- ***LDAPSupportError*** – if a version other than 1 is specified or a critical control is undefined

recheck_sasl_mechs ()

Query the root DSE again after performing a SASL bind to check for a downgrade attack.

Raises ***LDAPError*** – If the downgrade attack check fails and `sasl_fatal_downgrade_check` has not been set to `False`.

refresh_root_dse ()

Update the local copy of the root DSE, containing metadata about the directory server. The root DSE is an `LDAPObject` stored on the `root_dse` attribute.

rename (*dn*, *new_rdn*, *clean_attr=True*, ***ctrl_kwds*)

Specify a new RDN for an object without changing its location in the tree.

Parameters

- ***dn*** (*str*) – The current DN of the object
- ***new_rdn*** (*str*) – The new RDN of the object, e.g. `cn=foo`
- ***clean_attr*** (*bool*) – Remove the old RDN attribute from the object when changing

Returns A response object

Return type ***LDAPResponse***

Additional keyword arguments are handled as *Controls*.

replace_attrs (*dn*, *attrs_dict*, *current=None*, ***ctrl_kwds*)

Replace all values on given attributes with the passed values

- Attributes not mentioned in `attrsDict` are not touched
- Attributes will be created if they do not exist
- Specifying a 0-length entry will delete all values for that attribute

Parameters

- ***dn*** (*str*) – The DN of the object to modify
- ***attrs_dict*** (*dict(str, list(str or bytes)) or AttrsDict*) – The new attributes to set on the object
- ***current*** (*LDAPObject or None*) – The current known state of the object for use in validation

Returns A response object

Return type ***LDAPResponse***

Additional keyword arguments are handled as *Controls*.

sasl_bind (*mech=None*, ***props*)

Perform a SASL bind operation.

Keywords are first taken as *Controls*. Required keyword args are dependent on the mechanism chosen.

Parameters ***mech*** (*str*) – The SASL mechanism name to use or `None` to negotiate best mutually supported mechanism.

Returns A response object

Return type *LDAPResponse*

Raises

- *ConnectionUnbound* – if the connection has been unbound/closed
- *ConnectionAlreadyBound* – if the connection has already been bound
- *LDAPSupportError* – if the given mech is not supported by the server
- *LDAPError* – if an error occurs during the bind process

search (*base_dn*, *scope*=*Scope.SUB*, *filter*=*None*, *attrs*=*None*, *search_timeout*=*None*, *limit*=0, *deref_aliases*=*None*, *attrs_only*=*False*, *fetch_result_refs*=*None*, *follow_referrals*=*None*, *filter_syntax*=*None*, ***kws*)

Sends search and return an iterator over results.

Parameters

- **base_dn** (*str*) – The DN of the base object of the search
- **scope** (*Scope*) – One of the *Scope* constants, default *Scope.SUB*. Controls the maximum depth of the search.
- **filter** (*str*) – A filter string. Objects must match the filter to be included in results. Default includes all objects and can be overridden globally by defining *LDAP.DEFAULT_FILTER*.
- **attrs** (*list[str]*) – A list of attribute names to include for each object. Default includes all user attributes. Use ['*', '+'] to get all user and all operational attributes.
- **search_timeout** (*int*) – The number of seconds the server should spend performing the search. Partial results will be returned if the server times out. The default can be set per connection by passing the *search_timeout* keyword to the *LDAP* constructor, or set the global default by defining *LDAP.DEFAULT_SEARCH_TIMEOUT*.
- **limit** (*int*) – The maximum number of objects to return.
- **deref_aliases** (*DerefAliases*) – One of the *DerefAliases* constants. This instructs the server what to do when it encounters an alias object. The default can be set per connection by passing the *deref_aliases* keyword to the *LDAP* constructor, or set the global default by defining *LDAP.DEFAULT_DEREF_ALIASES*.
- **attrs_only** (*bool*) – Default *False*. Set to *True* to only obtain attribute names and not any attribute values.
- **fetch_result_refs** (*bool*) – When the server returns a result which is a reference to an object on another server, automatically attempt to fetch the remote object and include it in the iterated results. The default can be set per connection by passing the *fetch_result_refs* keyword to the *LDAP* constructor, or set the global default by defining *LDAP.DEFAULT_FETCH_RESULT_REFS*.
- **follow_referrals** (*bool*) – When the server knows that the base object is present on another server, follow the referral and perform the search on the other server. The default can be set per connection by passing the *follow_referrals* keyword to the *LDAP* constructor, or set the global default by defining *LDAP.DEFAULT_FOLLOW_REFERRALS*.
- **filter_syntax** (*FilterSyntax*) – Select which filter syntax to use to parse the filter. The default can be set per connection by passing the *default_filter_syntax* keyword to the *LDAP* constructor, or set the global default by defining *LDAP.DEFAULT_FILTER_SYNTAX*.

Returns An iterator over the results of the search. May yield *LDAPObject* or possibly *SearchReferenceHandle* if *fetch_result_refs* is *False*.

Additional keywords are handled as *Controls* first and then passed through into `LDAP.obj()`.

This method may also be used as a context manager. If all results have not been read, the operation will automatically be abandoned when the context manager exits. You can also raise `Abandon` to abandon all results immediately and cleanly exit the context manager. You can also call `SearchResultHandle.abandon()` to abandon results.

Example:

```
# Dump the whole tree
with LDAP() as ldap:
    with ldap.base.search() as search:
        for result in search:
            print(result.format_ldif())
```

send_extended_request (*oid*, *value=None*, ***kwds*)

Send an extended request, returns instance of *ExtendedResponseHandle*

This is mainly meant to be called by other built-in methods and client extensions. Requires handling of raw pyasn1 protocol objects.

Parameters

- **oid** (*str*) – The OID of the extension. Must be declared as supported by the server in the root DSE.
- **value** (*str* or *bytes* or *None*) – The request value (optional)

Returns An iterator yielding tuples of the form (`rfc4511.IntermediateResponse`, `rfc4511.Controls`) or (`rfc4511.ExtendedResponse`, `rfc4511.Controls`).

Return type *ExtendedResponseHandle*

Raises

- **LDAPSupportError** – if the OID is not listed in the `supportedExtension` attribute of the root DSE
- **TypeError** – if the *value* parameter is not a valid type

Additional keyword arguments are handled as *Controls* and then passed through into the *ExtendedResponseHandle* constructor.

simple_bind (*username=""*, *password=""*, ***ctrl_kwds*)

Performs a simple bind operation

Leave arguments as their default (empty strings) to attempt an anonymous simple bind

Additional keywords are used as *Controls*.

Parameters

- **username** (*str*) – Bind DN/username or empty string for anonymous
- **password** (*str*) – Password to bind with or empty string for anonymous

Returns A response object

Return type *LDAPResponse*

Raises

- **ConnectionUnbound** – if the connection has been unbound/closed
- **ConnectionAlreadyBound** – if the connection has already been bound

start_tls (*verify=None, ca_file=None, ca_path=None, ca_data=None*)

Perform the StartTLS extended operation. This will instruct the server to begin encrypting this socket connection with TLS/SSL.

Parameters

- **verify** (*bool*) – Set to False to disable verification of the remote certificate. You can set the default per-connection by passing the *ssl_verify* keyword to the *LDAP* constructor, or set the global default by defining *LDAP.DEFAULT_SSL_VERIFY*.
- **ca_file** (*str*) – Path to PEM-formatted concatenated CA certificates file. You can set the default per-connection by passing the *ssl_ca_file* keyword to the *LDAP* constructor, or set the global default by defining *LDAP.DEFAULT_SSL_CA_FILE*.
- **ca_path** (*str*) – Path to directory with CA certs under hashed file names. See https://www.openssl.org/docs/man1.1.0/ssl/SSL_CTX_load_verify_locations.html for more information about the format of this directory. You can set the default per-connection by passing the *ssl_ca_path* keyword to the *LDAP* constructor, or set the global default by defining *LDAP.DEFAULT_SSL_CA_PATH*.
- **ca_data** (*str or bytes*) – An ASCII string of one or more PEM-encoded certs or a bytes object containing DER-encoded certificates. You can set the default per-connection by passing the *ssl_ca_data* keyword to the *LDAP* constructor, or set the global default by defining *LDAP.DEFAULT_SSL_CA_DATA*.

Return type *None*

tag (*tag*)

Get a tagged object.

Parameters **tag** (*str*) – The tag name to retrieve

Returns The object created with the given tag

Return type *LDAPObject*

Raises *TagError* – if the given tag is not defined

unbind (*force=False*)

Send an unbind request and close the socket.

Parameters **force** (*bool*) – Unbind and close the socket even if other objects still hold a reference to it.

Raises *ConnectionUnbound* – if the connection has already been unbound

validate_modify (*dn, modlist, current=None*)

Run all configured validators for the given modify operation

Parameters

- **dn** (*str*) – The DN of the object being modified
- **modlist** (*list [Mod]*) – The sequence of changes to be performed
- **current** (*LDAPObject*) – The current known state of the object

Return type *None*

Raises *LDAPValidationError* – if any validator fails the operation

validate_object (*obj, write=True*)

Run all configured validators for the given object.

Parameters

- **obj** (`LDAPObject`) – The object to validate
- **write** (`bool`) – True if this is for a write operation (e.g. an add)

Return type `None`

Raises `LDAPValidationError` – if any validator fails the object

who_am_i (`**ctrl_kwds`)

Perform the “Who Am I?” extended operation. This will confirm the identity that the connection is bound to.

Returns A string describing the bound identity. One common form is “dn:cn=foo,dc=example,dc=org” but this will vary by server configuration and bind type/parameters.

Return type `str`

Additional keyword arguments are handled as *Controls*.

class `laurelin.ldap.base.LDAPResponse`

Bases: `object`

Empty object for storing response control values

class `laurelin.ldap.base.LDAPURI (uri)`

Bases: `object`

Represents a parsed LDAP URI as specified in RFC4516

Supported extensions:

- “StartTLS”

Variables

- **scheme** (`str`) – urlparse standard
- **netloc** (`str`) – urlparse standard
- **host_uri** (`str`) – scheme://netloc for use with LDAPSocket
- **dn** (`str`) – Distinguished name
- **attrs** (`list[str]`) – list
- **scope** (`Scope`) – one of the Scope constants
- **filter** (`str`) – The filter string
- **starttls** (`bool`) – True if StartTLS was requested

DEFAULT_ATTRS = `['*']`

DEFAULT_FILTER = `'(objectClass=*)'`

DEFAULT_SCOPE = `Scope.BASE`

DEFAULT_STARTTLS = `False`

search (`**kwds`)

Perform the search operation described by the parsed URI

First opens a new connection with connection reuse disabled, then performs the search, and unbinds the connection. Server must allow anonymous read.

Additional keyword arguments are passed through into `LDAP.search()`.

class laurelin.ldap.base.**ResponseHandle** (*ldap_conn, mid*)

Bases: *laurelin.ldap.base.LDAPResponse*

Base for return from methods with multiple response messages.

abandon ()

Request to abandon an operation in progress

class laurelin.ldap.base.**SearchReferenceHandle** (*uris, obj_kwds*)

Bases: *object*

Returned when the server returns a SearchResultReference

fetch ()

Perform the reference search and return an iterator over results

class laurelin.ldap.base.**SearchResultHandle** (*ldap_conn, message_id, fetch_result_refs, follow_referrals, obj_kwds*)

Bases: *laurelin.ldap.base.ResponseHandle*

laurelin.ldap.config module

Provides support for establishing an LDAP connection and environment via config files and dicts

laurelin.ldap.config.**activate_extensions** (*config_dict*)

Activate the specified extensions. The dict must be formatted as follows:

```
{'extensions': [  
    <module name>,  
]  
}
```

Parameters *config_dict* (*dict*) – See above.

Return type *None*

laurelin.ldap.config.**create_connection** (*config_dict*)

Create a new connection from a config dict formatted as follows:

```
{'connection': {  
    'start_tls': <bool>, # optional, default False  
    'simple_bind': { # optional, default no bind; mutually exclusive with sasl_  
↪bind  
        'username': <string username or bind dn>,  
        'password': <string password>  
    },  
    'sasl_bind': { # optional, default no bind, mutually exclusive with simple_  
↪bind  
        'mech': <standard mech name>,  
        <mech prop>: <mech value>, # required props varies by mech  
    },  
    <constructor param>: <constructor value>,  
},  
'objects': [ # optional  
    {'dn': <object dn>, # OR...  
        'rdn': <dn relative to connection base object>,  
        'tag': <unique tag name>,  
        <object param>: <object value>,  
    },  
    ...  
]
```

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```

    },
    # ...
]
}

```

<constructor param> must be one of the [LDAP](#) constructor keyword arguments.

For validators you can optionally give the full path to the validator to use as a string, e.g. `['laurelin.ldap.schema.SchemaValidator']`

For `default_filter_syntax` give one of the strings “STANDARD” or “SIMPLE” (case-insensitive).

For objects (optional):

- If the `dn` parameter is specified, it is taken as an absolute DN.
- You can specify the `rdn` parameter instead to create the object as a child of the connection’s base object (the base of the tree).
- The `tag` parameter is required; this is how created objects are accessed ([LDAP.tag\(\)](#)).
- Additional <object param> will be passed as keywords to [LDAP.obj\(\)](#).
- If `relative_search_scope` is specified, use one of the strings *base*, *one*, or *sub*.
- The server will not be queried to create these objects, so they will have no local attributes. Call [LDAPObject.refresh\(\)](#) if you need to query attributes.

Note on binding: You can always manually call [LDAP.simple_bind\(\)](#) or [LDAP.sasl_bind\(\)](#) on the [LDAP](#) instance returned from this method if statically configuring bind credentials is not desirable.

Parameters `config_dict` – See above.

Returns The new LDAP instance with any objects created and tagged.

Raises `TypeError` – if any required object parameters are missing

`laurelin.ldap.config.load_config_dict` (*config_dict*)

Load config parameters from a dictionary. Must be formatted in the same was as `load_file`

Parameters `config_dict` (*dict*) – The config dictionary. See format in `load_file`.

Returns The LDAP connection if one was defined, None otherwise

Return type [LDAP](#) or None

`laurelin.ldap.config.load_file` (*path*, *file_decoder=None*)

Load a config file. Must decode to dict with all components described on other methods as optional sections/keys. A YAML example:

```

extensions:
- laurelin.extensions.descattrs
- laurelin.extensions.netgroups
global:
  SSL_CA_PATH: /etc/ldap/cacerts
  IGNORE_EMPTY_LIST: true
connection:
  server: ldap://dir01.example.org
  start_tls: true
  simple_bind:
    username: testuser
    passowrd: testpassword

```

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```

    connect_timeout: 30
objects:
- rdn: ou=people
  tag: posix_user_base
- rdn: ou=groups
  tag: posix_group_base
- rdn: ou=netgroups
  tag: netgroup_base

```

Parameters

- **path** – A path to a config file. Provides support for YAML and JSON format, or you can specify your own decoder that returns a dict.
- **file_decoder** – A callable returning a dict when passed a file-like object

Returns The LDAP connection if one was defined, None otherwise

Return type *LDAP* or None

Raises *RuntimeError* – if an unsupported file extension was given without the *file_decoder* argument.

`laurelin.ldap.config.normalize_global_config_param(key)`

Normalize a global config key. Does not check validity of the key.

Parameters **key** (*str*) – User-supplied global config key

Returns The normalized key formatted as an attribute of *LDAP*

Return type *str*

`laurelin.ldap.config.set_global_config(global_config_dict)`

Set the global defaults. The dict must be formatted as follows:

```

{'global': {
    <config param>: <config value>,
}}

```

<config param> must match one of the *DEFAULT_* attributes on *LDAP*. The *DEFAULT_* prefix is optional and dict keys are case-insensitive. Any parameters not specified will keep the hard-coded default.

Parameters **global_config_dict** (*dict*) – See above.

Return type None

Raises *KeyError* – if the dict is incorrectly formatted or contains unknown config parameters

laurelin.ldap.exceptions module

exception `laurelin.ldap.exceptions.Abandon`

Bases: *Exception*

Can be raised to cleanly exit a context manager and abandon unread results

exception `laurelin.ldap.exceptions.ConnectionAlreadyBound`

Bases: *laurelin.ldap.exceptions.InvalidBindState*

Only raised by *LDAP.*Bind* methods if the connection is already bound when called

exception `laurelin.ldap.exceptions.ConnectionUnbound`

Bases: `laurelin.ldap.exceptions.InvalidBindState`

Raised when any server operation is attempted after a connection is unbound/closed

exception `laurelin.ldap.exceptions.InvalidBindState`

Bases: `laurelin.ldap.exceptions.LDAPError`

Base class for exceptions related to bind state

exception `laurelin.ldap.exceptions.InvalidSyntaxError`

Bases: `laurelin.ldap.exceptions.LDAPValidationError`

Raised when syntax validation fails

exception `laurelin.ldap.exceptions.LDAPConnectionError`

Bases: `laurelin.ldap.exceptions.LDAPError`

Error occurred creating connection to the LDAP server

exception `laurelin.ldap.exceptions.LDAPError`

Bases: `Exception`

Base class for all exceptions raised by laurelin

exception `laurelin.ldap.exceptions.LDAPExtensionError`

Bases: `laurelin.ldap.exceptions.LDAPError`

Error occurred setting up an extension module

exception `laurelin.ldap.exceptions.LDAPSASLError`

Bases: `laurelin.ldap.exceptions.LDAPError`

Error occurred involving the SASL client

exception `laurelin.ldap.exceptions.LDAPSchemaError`

Bases: `laurelin.ldap.exceptions.LDAPError`

Error relating to setting up the LDAP schema

exception `laurelin.ldap.exceptions.LDAPSupportError`

Bases: `laurelin.ldap.exceptions.LDAPError`

A feature is not supported by the server

exception `laurelin.ldap.exceptions.LDAPTransactionError`

Bases: `laurelin.ldap.exceptions.LDAPError`

Raised by actions not included in a modify transaction

exception `laurelin.ldap.exceptions.LDAPUnicodeWarning`

Bases: `laurelin.ldap.exceptions.LDAPWarning`, `UnicodeWarning`

Warning category for unicode issues relating to LDAP

exception `laurelin.ldap.exceptions.LDAPUnsolicitedMessage` (*lm*, *exc_msg*)

Bases: `Exception`

Raised when a message with ID 0 is returned from the server

This may indicate an incompatibility between laurelin and your server distribution and thus is outside the normal exception inheritance chain.

exception `laurelin.ldap.exceptions.LDAPValidationError`

Bases: `laurelin.ldap.exceptions.LDAPError`

Raised when validation fails

exception `laurelin.ldap.exceptions.LDAPWarning`

Bases: `Warning`

Generic LDAP warning category

exception `laurelin.ldap.exceptions.MultipleSearchResults`

Bases: `laurelin.ldap.exceptions.UnexpectedSearchResults`

Got multiple search results when exactly one was required

exception `laurelin.ldap.exceptions.NoSearchResults`

Bases: `laurelin.ldap.exceptions.UnexpectedSearchResults`

Got no search results when one or more was required

exception `laurelin.ldap.exceptions.ProhibitedCharacterError`

Bases: `laurelin.ldap.exceptions.LDAPError`

Raised when a prohibited character is detected in RFC4518 string prep

exception `laurelin.ldap.exceptions.TagError`

Bases: `laurelin.ldap.exceptions.LDAPError`

Error with an object tag

exception `laurelin.ldap.exceptions.UnexpectedResponseType`

Bases: `laurelin.ldap.exceptions.LDAPError`

The response did not contain the expected protocol operation

exception `laurelin.ldap.exceptions.UnexpectedSearchResults`

Bases: `laurelin.ldap.exceptions.LDAPError`

Base class for unhandled search result situations

laurelin.ldap.ldapobject module

class `laurelin.ldap.ldapobject.LDAPObject` (*dn*, *attrs_dict=None*, *ldap_conn=None*,
relative_search_scope=Scope.SUB,
rdn_attr=None)
Bases: `laurelin.ldap.attrsdict.AttrsDict`, `laurelin.ldap.extensible.ldapobject_extensions.LDAPObjectExtensions`

Represents a single object with optional server affinity.

Many methods will raise an exception if used without a server connection. To instantiate an `LDAPObject` bound to a server connection, use `LDAP.obj()`.

Attributes and values are stored using the mapping interface inherited from `AttrsDict`, where dict keys are case-insensitive attribute names, and dict values are a list of attribute values.

Value lists are automatically wrapped in `AttrValueList`. This allows the use of any schema-defined matching and syntax rules for the attribute type in list operations.

Parameters

- **dn** (*str*) – The DN of the object
- **attrs_dict** (*dict(str, list[str or bytes]) or AttrsDict or None*) – The object's attributes
- **ldap_conn** (*LDAP or None*) – The optional LDAP connection to use

- **relative_search_scope** (*Scope*) – One of the *Scope* constants, this is the default scope used when using this object's *LDAPObject.search()* method. New objects created below this one will inherit this attribute by default. This attribute also defines the behavior of *LDAPObject.find()*.
- **rdn_attr** (*str* or *None*) – The default attribute name used in RDN's for descendants of this object. If specified, this allows you to only specify the value for methods that have an *rdn* argument. You can always specify a full *attr=value* for *rdn* arguments as well to override this behavior. New objects created below this one will inherit this attribute by default.

add_attrs (*attrs_dict*, ***ctrl_kwds*)

Add new attribute values to this object.

Parameters **attrs_dict** (*dict*(*str*, *list*[*str* or *bytes*]) or *AttrsDict*) – The new attributes to add to the object

Return type *None*

Additional keywords are passed through into *LDAPObject.modify()*.

add_child (*rdn*, *attrs_dict*, ***kwds*)

Create a new object below this one.

Parameters

- **rdn** (*str*) – The RDN, or RDN value if *rdn_attr* is defined for this object
- **attrs_dict** (*dict*(*str*, *list*[*str* or *bytes*]) or *AttrsDict* or *None*) – The attributes for the object

Returns The new object

Return type *LDAPObject*

Additional keyword arguments are passed through into *LDAP.add()*

compare (*attr*, *value*)

Ask the server if this object has a matching attribute value. The comparison will take place following the schema-defined matching rules and syntax rules.

Parameters

- **attr** (*str*) – The attribute name
- **value** (*str*) – The assertion value

Returns A response object, *bool()* evaluating to the result of the comparison

Return type *CompareResponse*

Raises *RuntimeError* – if this object is not bound to an LDAP connection

delete (***ctrl_kwds*)

Delete the entire object from the server, and render this instance useless.

Additional keywords are passed through into *LDAP.delete()*.

Return type *None*

Raises *RuntimeError* – if this object is not bound to an LDAP connection

delete_attrs (*attrs_dict*, ***ctrl_kwds*)

Delete specific attribute values given in *attrs_dict*. Specifying a zero-length list for any attribute will delete all values for that attribute.

Parameters `attrs_dict` (`dict(str, list[str or bytes])` or `AttrsDict`) – The attributes to delete from the object

Return type `None`

Additional keywords are passed through into `LDAPObject.modify()`.

delete_child (`rdn`, `**ctrl_kwds`)

Delete a child object below this one.

Parameters `rdn` (`str`) – The RDN, or RDN value if `rdn_attr` is defined for this object

Returns The `LDAPResponse` from the delete operation

Return type `LDAPResponse`

Additional keyword arguments are treated as controls.

find (`rdn`, `attrs=None`, `**kwds`)

Obtain a single object below this one with the most efficient means possible.

The strategy used is based on the `relative_search_scope` property of this object.

- If it is `Scope.BASE`, this method will always raise an `LDAPError`.
- If it is `Scope.ONE`, then the absolute DN for the child object will be constructed, and a `Scope.BASE` search will be performed to get the object.
- If it is `Scope.SUB`, then a subtree search will be performed below this object, using the RDN as a search filter.

Additional keywords are passed through into `LDAPObject.search()`.

Parameters

- `rdn` (`str`) – The RDN, or RDN value if `rdn_attr` is defined for this object
- `attrs` (`list[str]`) – Optional. The list of attribute names to obtain.

Returns The LDAP object

Return type `LDAPObject`

Raises

- `LDAPError` – if this object's `relative_search_scope` is `Scope.BASE`.
- `NoSearchResults` – if no object could be found matching `rdn`.
- `MultipleSearchResults` – if more than one object was found.
- `RuntimeError` – if this object is not bound to an LDAP connection
- `ValueError` – if the `relative_search_scope` is set to an invalid value.

format_ldif ()

Format the object as an LDIF string.

Returns The object encoded as an LDIF.

Return type `str`

get_child (`rdn`, `attrs=None`, `**kwds`)

Query the server for a child object.

Parameters

- `rdn` (`str`) – The RDN, or RDN value if `rdn_attr` is defined for this object

- **attrs** (*list[str] or None*) – The list of attributes to query

Returns The object populated with data from the server

Return type *LDAPObject*

Raises **RuntimeError** – if this object is not bound to an LDAP connection

Additional keywords are passed through into `LDAP.search()` and *LDAPObject*

has_object_class (*object_class*)

A convenience method which checks if this object has a particular objectClass. May query the server for the objectClass attribute if it is not yet known.

Parameters **object_class** – The objectClass to check for.

Returns True if the objectClass is present, False otherwise

Return type **bool**

mod_dn (*new_rdn, clean_attr=True, new_parent=None, **ctrl_kwds*)

Change the object DN, and possibly its location in the tree.

Parameters

- **new_rdn** (*str*) – The new RDN of the object
- **clean_attr** (*bool*) – Optional, default True. Remove the attribute associated with the RDN when changing it.
- **new_parent** (*str*) – Optional. The absolute DN of the object's new parent.

Return type **None**

Raises **RuntimeError** – if this object is not bound to an LDAP connection

Additional keywords are passed through into `LDAP.mod_dn()`.

mod_transaction ()

Begin a modify transaction on this object. Important: This IS NOT an RFC 5805 transaction.

Return type *ModTransactionObject*

modify (*modlist, **ctrl_kwds*)

Perform a series of modify operations on this object atomically.

Parameters **modlist** (*list[Mod]*) – A list of *Mod* instances, e.g. [*Mod*(*Mod*.ADD, 'someAttr', ['value1', 'value2'])]

Return type **None**

Raises **RuntimeError** – if this object is not bound to an LDAP connection

Additional keywords are passed through into `LDAP.modify()`.

move (*new_dn, clean_attr=True, **ctrl_kwds*)

Specify the complete new absolute DN for this object.

Parameters

- **new_dn** (*str*) – The new absolute DN for the object
- **clean_attr** (*bool*) – Optional, default True. Remove the attribute associated with the RDN when changing it.

Return type **None**

Additional keywords are passed through into `LDAPObject.mod_dn()`.

obj (*rdn*, *attrs_dict=None*, *tag=None*, ***kws*)

Create a new object below this one.

Parameters

- **rdn** (*str*) – The RDN, or RDN value if *rdn_attr* is defined for this object
- **attrs_dict** (*dict(str, list[str or bytes])* or *AttrsDict* or *None*) – The attributes for the object
- **tag** (*str* or *None*) – Optional tag for the object

Returns The new object

Return type *LDAPObject*

Raises *LDAPError* – if a *tag* is specified but this object is not bound to an LDAP connection

Additional keywords are passed through into *LDAP.obj()* or the *LDAPObject* constructor.

rdn (*rdn*)

Return an absolute DN from an RDN or RDN value

Parameters **rdn** (*str*) – The RDN, or RDN value if *rdn_attr* is defined for this object

Returns The absolute DN

Return type *str*

refresh (*attrs=None*)

Query the server to update the attributes on this object.

Parameters **attrs** (*list[str]*) – Optional. A list of attribute names to query. If not specified, will query the server for all user attributes.

Return type *None*

Raises *RuntimeError* – if this object is not bound to an LDAP connection

refresh_all ()

Query the server to update all user and operational attributes on this object.

Return type *None*

Raises *RuntimeError* – if this object is not bound to an LDAP connection

refresh_missing (*attrs*)

Potentially query the server for any listed attributes that are not yet defined on this object. If no listed attributes aren't defined, the query will not be performed. If a subset of the list is undefined, only those attributes will be queried.

Parameters **attrs** (*list[str]*) – A list of attribute names to check, and possibly query for.

Return type *None*

rename (*new_rdn*, *clean_attr=True*, ***ctrl_kws*)

Change the object's RDN without changing its location in the tree.

Parameters

- **new_rdn** (*str*) – The new RDN of the object
- **clean_attr** (*bool*) – Optional, default True. Remove the attribute associated with the RDN when changing it.

Return type *None*

Additional keywords are passed through into *LDAPObject.mod_dn()*.

replace_attrs (*attrs_dict*, ***ctrl_kwds*)

Replace all values on the given attributes with the passed values.

Parameters *attrs_dict* (*dict* (*str*, *list* [*str* or *bytes*]) or *AttrsDict*) –

The new attributes to set on the object

Return type *None*

Additional keywords are passed through into *LDAPObject.modify()*.

search (*filter=None*, *attrs=None*, ***kwds*)

Perform a search below this object.

Parameters

- **filter** (*str*) – Optional. The filter string to use to filter returned objects.
- **attrs** (*list* [*str*]) – Optional. The list of attribute names to retrieve.

Returns An iterator over *LDAPObject* and possibly *SearchReferenceHandle*. See *LDAP.search()* for more details.

Return type *SearchResultHandle*

Additional keywords are passed through into *LDAP.search()*.

validate()

Validate the object, assuming all attributes are present locally

validate_modify (*modlist*)

Validate a modification list.

Parameters *modlist* (*list* [*Mod*]) – The list of modify operations to validate.

class *laurelin.ldap.ldapobject.ModTransactionObject* (*ldap_object*)

Bases: *laurelin.ldap.ldapobject.LDAPObject*

Provides a transaction-like construct for building up a single modify operation. Users should use *LDAPObject.mod_transaction()* rather than instantiating this directly.

Inherits all modify methods from *LDAPObject*, allowing users to utilize the familiar interface for modifications, but overrides the base *modify* method so that changes are not immediately applied on the server.

The state of attributes is mutated within this transaction object with each higher-level modify call (e.g., *LDAPObject.add_attrs()*) allowing the state to be inspected. When *ModTransactionObject.commit()* is invoked, the built-up series of raw modify operations is sent to the server, and the state of the underlying *LDAPObject* is mutated.

Since this ultimately constructs only one modify operation per commit, the transaction is atomic.

You can also call *mod_transaction()* on a transaction object to create a “checkpoint”. The local state of the transaction will be copied into a new transaction object. To “roll back”, just delete the new object without committing.

Example:

```
from laurelin.ldap import LDAP

with LDAP() as ldap:
    obj = ldap.base.get_child('cn=someobject')
    print(obj.get_attr('memberUid'))
    # ['foo', 'bar']
    with obj.mod_transaction() as trans:
        trans.add_attrs({'memberUid': ['foobar']})
```

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```

print(trans.get_attr('memberUid'))
# ['foo', 'bar', 'foobar']
print(obj.get_attr('memberUid'))
# ['foo', 'bar']

trans.delete_attrs({'memberUid': ['bar']})
print(trans.get_attr('memberUid'))
# ['foo', 'foobar']
print(obj.get_attr('memberUid'))
# ['foo', 'bar']

with trans.mod_transaction() as checkpoint:
    print(checkpoint.get_attr('memberUid'))
    # ['foo', 'foobar']
    print(trans.get_attr('memberUid'))
    # ['foo', 'foobar']
    print(obj.get_attr('memberUid'))
    # ['foo', 'bar']

    checkpoint.delete_attrs({'memberUid': ['foo']})
    print(checkpoint.get_attr('memberUid'))
    # ['foobar']
    print(trans.get_attr('memberUid'))
    # ['foo', 'foobar']
    print(obj.get_attr('memberUid'))
    # ['foo', 'bar']

    # Note: no commit on checkpoint, meaning we will be rolled back to_
    ↳the pre-checkpoint state

    # Now in rolled-back (actually just unchanged) state
    print(trans.get_attr('memberUid'))
    # ['foo', 'foobar']
    print(obj.get_attr('memberUid'))
    # ['foo', 'bar']

trans.commit()

# Transaction was committed, we can now see changes reflected in the original_
↳object:
print(obj.get_attr('memberUid'))
# ['foo', 'foobar']

```

You can also raise *Abandon* from within a transaction context manager to cleanly abandon the transaction and exit the context manager.

add_child (*rdn, attrs_dict, **kws*)

Raises an error if used in a transaction. Transactions can only modify one object at a time.

Raises *LDAPTransactionError* – if this method is called.

commit ()

Send the modify operation to the server and update the original local *LDAPObject*.

Return type *None*

delete (***ctrl_kws*)

Raises an error if used in a transaction. Transactions can only modify one object at a time.

Raises `LDAPTransactionError` – if this method is called.

delete_child (*rdn*, ***ctrl_kwds*)

Raises an error if used in a transaction. Transactions can only modify one object at a time.

Raises `LDAPTransactionError` – if this method is called

format_mod_ldif ()

Format the modify operation as an LDIF

Returns The LDIF string describing the modify operation to be performed

Return type `str`

mod_dn (*new_rdn*, *clean_attr=True*, *new_parent=None*, ***ctrl_kwds*)

Raises an error if used in a transaction. Transactions can only modify one object at a time.

Raises `LDAPTransactionError` – if this method is called.

modify (*modlist*, ***kwds*)

Process and validate a partial transaction, and mutate the transaction object's local attributes. Does not send anything to the server.

Parameters **modlist** (*list* [*Mod*]) – A partial list of modify operations to include in the transaction.

Return type `None`

Raises `TypeError` – if any extra keyword arguments are passed to this function.

laurelin.ldap.protoutils module

`laurelin.ldap.protoutils.get_string_component` (*obj*, *name*)

Try to get a string component from a PyASN1 object, or an empty string on error

`laurelin.ldap.protoutils.pack` (*mid*, *op*, *obj*, *controls=None*)

Pack an object into an LDAPMessage envelope

`laurelin.ldap.protoutils.parse_qdescriptors` (*spec*)

Parse an rfc4512.qdescriptors to a tuple

`laurelin.ldap.protoutils.seq_to_list` (*seq*)

Convert a pyasn1 sequence to a list of strings

`laurelin.ldap.protoutils.unpack` (*op*, *ldap_message*)

Unpack an object from an LDAPMessage envelope

Module contents

Imports and defines the core of the public API

`laurelin.ldap.get_attribute_type` (*ident*)

Get an instance of `AttributeType` associated with either a name or OID.

Parameters **ident** (*str*) – Either the numeric OID of the desired attribute type spec or any one of its specified names

Returns The `AttributeType` containing a parsed specification

Return type `AttributeType`

class `laurelin.ldap.AttributeType` (*spec*)

Bases: `object`

Parses an LDAP attribute type specification and implements supertype inheritance.

Each instantiation registers the names and OIDs specified so that the `spec` can be accessed using `get_attribute_type()`.

See the `laurelin.ldap.schema` module source for example usages.

Parameters `spec` (*str*) – The LDAP specification for an Attribute Type.

Raises `LDAPSchemaError`: * if the specification is invalid * if the OID has already been defined * if one of the names has already been defined

Variables

- **oid** (*str*) – The OID of the attribute type
- **names** (*tuple* (*str*)) – A tuple containing all possible names for the attribute type
- **supertype** (*str*) – The specified supertype. If the `spec` does not define optional properties, they will pass through into the supertype.
- **equality_oid** (*str*) – The OID of the equality matching rule
- **syntax_oid** (*str*) – The OID of the syntax matching rule
- **syntax_length** (*int*) – The suggested maximum length of a value
- **obsolete** (*bool*) – The type has been flagged as obsolete. Will cause a warning from the `SchemaValidator` if an obsolete attribute type is used.
- **single_value** (*bool*) – The attribute may only have one value.
- **collective** (*bool*) – The attribute has been marked collective.
- **no_user_mod** (*bool*) – The attribute may not be modified by users (e.g., for operational attributes). Will cause a validation failure from the `SchemaValidator` if a write operation is attempted on attribute types with this property set to True.
- **usage** (*str*) – A string describing the attribute’s usage. May be one of `userApplications`, `directoryOperation`, `distributedOperation`, or `dSAOperation`.

equality

Gets the `EqualityMatchingRule` for this attribute type.

index (*value_list*, *assertion_value*)

Finds the index of a value in a list of attribute values. Raises a `ValueError` if the value is not found in the list. Assumes values in `value_list` are already validated.

Parameters

- **value_list** (*list* [*str*]) – The list of attribute values. Assumes values are already validated.
- **assertion_value** (*str*) – The value to look for in `value_list`.

Returns The index of `assertion_value` in `value_list`.

Return type `int`

Raises

- **ValueError** – if `assertion_value` is not found or if `value_list` is empty.

- **`InvalidSyntaxError`** – if `assertion_value` does not meet the syntax requirements of this attribute type

register()

syntax

Gets the *`SyntaxRule`* for this attribute type.

validate(value)

Validate a value according to the attribute type's syntax rule.

Parameters **value** (*str*) – The potential attribute value

Returns A truthy value.

Raises **`InvalidSyntaxError`** – if the value is invalid.

```
class laurelin.ldap.LDAP(server=None, base_dn=None, reuse_connection=None, connect_timeout=None, search_timeout=None, deref_aliases=None, strict_modify=None, ssl_verify=None, ssl_ca_file=None, ssl_ca_path=None, ssl_ca_data=None, fetch_result_refs=None, default_sasl_mech=None, sasl_fatal_downgrade_check=None, default_criticality=None, follow_referrals=None, validators=None, warn_empty_list=None, error_empty_list=None, ignore_empty_list=None, filter_syntax=None, built_in_extensions_only=None)
```

Bases: *`laurelin.ldap.extensible.ldap_extensions.LDAPExtensions`*

Provides the connection to the LDAP DB. All constructor parameters have a matching global default as a class property on *`LDAP`*

Parameters

- **server** (*str* or *`LDAPSocket`*) – URI string to connect to or an *`LDAPSocket`* to reuse
- **base_dn** (*str*) – The DN of the base object
- **reuse_connection** (*bool*) – Allows the socket connection to be reused and reuse an existing socket if possible.
- **connect_timeout** (*int*) – Number of seconds to wait for connection to be accepted.
- **search_timeout** (*int*) – Number of seconds to wait for a search to complete. Partial results will be returned when the timeout is reached. Can be overridden on a per-search basis by setting the `search_timeout` keyword on *`LDAP.search()`*.
- **deref_aliases** (*`DerefAliases`*) – One of the *`DerefAliases`* constants. Instructs the server how to handle alias objects in search results. Can be overridden on a per-search basis by setting the `deref_aliases` keyword on *`LDAP.search()`*.
- **strict_modify** (*bool*) – Use the strict modify strategy. If set to True, guarantees that another search will not take place before a modify operation. May potentially produce more server errors.
- **ssl_verify** (*bool*) – Validate the certificate and hostname on an SSL/TLS connection
- **ssl_ca_file** (*str*) – Path to PEM-formatted concatenated CA certificates file
- **ssl_ca_path** (*str*) – Path to directory with CA certs under hashed file names. See https://www.openssl.org/docs/man1.1.0/ssl/SSL_CTX_load_verify_locations.html for more information about the format of this directory.

- **ssl_ca_data** (*str* or *bytes*) – An ASCII string of one or more PEM-encoded certs or a bytes object containing DER-encoded certificates.
- **fetch_result_refs** (*bool*) – Fetch searchResultRef responses in search results. Can be overridden on a per-search basis by setting the `fetch_result_refs` keyword on `LDAP.search()`.
- **default_sasl_mech** (*str*) – Name of the default SASL mechanism. Bind will fail if the server does not support the mechanism. (Examples: DIGEST-MD5, GSSAPI)
- **sasl_fatal_downgrade_check** (*bool*) – Set to False to make potential downgrade attack check non-fatal.
- **default_criticality** (*bool*) – Set to True to make controls critical by default, set to False to make non-critical
- **follow_referrals** (*bool*) – Automatically follow referral results
- **validators** (*list*[*Validator*]) – A list of *Validator* instances to apply to this connection.
- **warn_empty_list** (*bool*) – Default False. Set to True to emit a warning when an empty value list is passed to `LDAP.modify()`, `LDAP.replace_attrs()`, or `LDAP.delete_attrs()` or their LDAPObject counterparts.
- **error_empty_list** (*bool*) – Default False. Set to True to raise an exception when an empty value list is passed to `LDAP.modify()`, `LDAP.replace_attrs()`, or `LDAP.delete_attrs()` or their LDAPObject counterparts.
- **ignore_empty_list** (*bool*) – Default False. Set to True to ignore empty value lists passed to `LDAP.modify()`, `LDAP.replace_attrs()`, or `LDAP.delete_attrs()` or their LDAPObject counterparts. This will be default True in a future release.
- **filter_syntax** (*FilterSyntax*) – The default search filter syntax selection. Must be one of the *FilterSyntax* constants. Can be overridden on a per-search basis by setting the `filter_syntax` keyword on `LDAP.search()`. Defaults to *FilterSyntax.STANDARD* for RFC4515-compliant filter string syntax.
- **built_in_extensions_only** (*bool*) – Set to True to raise an error when attempting to use a 3rd-party extension

The class can be used as a context manager, which will automatically unbind and close the connection when the context manager exits.

Example:

```
with LDAP() as ldap:
    raise Exception()
# ldap is closed and unbound

with LDAP() as ldap:
    print('hello')
# ldap is closed and unbound
```

DEFAULT_BASE_DN = None

DEFAULT_BUILT_IN_EXTENSIONS_ONLY = False

DEFAULT_CONNECT_TIMEOUT = 5

DEFAULT_CRITICALITY = False

```

DEFAULT_DEREF_ALIASES = DerefAliases.ALWAYS
DEFAULT_ERROR_EMPTY_LIST = False
DEFAULT_FETCH_RESULT_REFS = True
DEFAULT_FILTER = '(objectClass=*)'
DEFAULT_FILTER_SYNTAX = FilterSyntax.UNIFIED
DEFAULT_FOLLOW_REFERRALS = True
DEFAULT_IGNORE_EMPTY_LIST = True
DEFAULT_REUSE_CONNECTION = True
DEFAULT_SASL_FATAL_DOWNGRADE_CHECK = True
DEFAULT_SASL_MECH = None
DEFAULT_SEARCH_TIMEOUT = 0
DEFAULT_SERVER = 'ldap://localhost'
DEFAULT_SSL_CA_DATA = None
DEFAULT_SSL_CA_FILE = None
DEFAULT_SSL_CA_PATH = None
DEFAULT_SSL_VERIFY = True
DEFAULT_STRICT_MODIFY = False
DEFAULT_VALIDATORS = None
DEFAULT_WARN_EMPTY_LIST = False
DELETE_ALL = <delete all values>
LOG_FORMAT = "[% (asctime)s] %(name)s %(levelname)s : %(message)s"
NO_ATTRS = '1.1'
OID_OBJ_CLASS_ATTR = '1.3.6.1.4.1.4203.1.5.2'
OID_STARTTLS = '1.3.6.1.4.1.1466.20037'
OID_WHOAMI = '1.3.6.1.4.1.4203.1.11.3'

```

add (*dn*, *attrs_dict*, ***kws*)

Add new object and return corresponding LDAPObject on success.

Parameters

- **dn** (*str*) – The new object's DN
- **attrs_dict** (*dict*(*str*, *list*[*str* or *bytes*]) or *AttrsDict*) – The new attributes for the object

Returns The new object

Return type *LDAPObject*

Raises

- *ConnectionUnbound* – if the connection has been unbound
- *TypeError* – if arguments are of invalid type

- `LDAPValidationError` – if the object fails any configured validator
- `LDAPError` – if we get a non-success result

Additional keyword arguments are handled as *Controls* and then passed through into `LDAP.obj()`.

add_attrs (*dn*, *attrs_dict*, *current=None*, ***ctrl_kwds*)

Add new attribute values to existing object.

Parameters

- **dn** (*str*) – The DN of the object to modify
- **attrs_dict** (*dict(str, list[str or bytes]) or AttrsDict*) – The new attributes to add to the object
- **current** (*LDAPObject or None*) – The current known state of the object. Used for ensuring we don't send duplicate attributes to the server and for validation.

Returns A response object

Return type *LDAPResponse*

Additional keyword arguments are handled as *Controls*.

static add_extension (*modname*)

Import an extension and prepare it for binding under its internally-defined name to LDAP and/or LDAPObject depending which extension classes are defined. This is only needed for extensions not yet patched into AVAILABLE_EXTENSIONS.

Parameters **modname** (*str*) – The string module name containing an extension, can be any importable module, e.g. “laurelin.extensions.netgroups”

Return type *None*

add_if_not_exists (*dn*, *attrs_dict*)

Add object if it doesn't exist

- Gets and returns the object at DN if it exists, otherwise create the object using the attrs dictionary
- Always returns an LDAPObject corresponding to the final state of the DB

Parameters

- **dn** (*str*) – The object DN
- **attrs_dict** (*dict(str, list[str or bytes]) or AttrsDict*) – The attributes to use if adding the object

Returns The new or existing object

Return type *LDAPObject*

add_or_mod_add_if_exists (*dn*, *attrs_dict*)

Add object if it doesn't exist, otherwise add_attrs

- If the object at DN exists, perform an add modification using the attrs dictionary. Otherwise, create the object using the attrs dictionary.
- This ensures that, for the attributes mentioned in attrs, AT LEAST those values will exist on the given DN, regardless of prior state of the DB.
- Always returns an *LDAPObject* corresponding to the final state of the DB

Parameters

- **dn** (*str*) – The object DN
- **attrs_dict** (*dict*(*str*, *list*[*str* or *bytes*]) or *AttrsDict*) – The objects minimum attributes

Returns The new or modified object

Return type *LDAPObject*

add_or_mod_replace_if_exists (*dn*, *attrs_dict*)

Add object if it doesn't exist, otherwise replace_attrs

- If the object at DN exists, perform a replace modification using the attrs dictionary Otherwise, create the object using the attrs dictionary
- This ensures that, for the attributes mentioned in attrs, ONLY those values will exist on the given DN regardless of prior state of the DB.
- Always returns an *LDAPObject* corresponding to the final state of the DB

Parameters

- **dn** (*str*) – The object DN
- **attrs_dict** (*dict*(*str*, *list*[*str* or *bytes*]) or *AttrsDict*) – The objects new required attributes

Returns The new or modified object

Return type *LDAPObject*

close (*force=False*)

Send an unbind request and close the socket.

Parameters **force** (*bool*) – Unbind and close the socket even if other objects still hold a reference to it.

Raises *ConnectionUnbound* – if the connection has already been unbound

compare (*dn*, *attr*, *value*, ***ctrl_kwds*)

Ask the server if a particular DN has a matching attribute value. The comparison will take place following the schema-defined matching rules and syntax rules.

Parameters

- **dn** (*str*) – The DN of the object
- **attr** (*str*) – The attribute name
- **value** (*str*) – The assertion value

Returns A response object, *bool* () evaluating to the result of the comparison

Return type *CompareResponse*

Raises

- *ConnectionUnbound* – if the connection has been unbound
- *LDAPError* – if we got a result other than compareTrue or compareFalse

Additional keyword arguments are handled as *Controls*.

static default_warnings ()

Always take the default action for warnings

delete (*dn*, ***ctrl_kwds*)

Delete an object.

Parameters *dn* (*str*) – The DN of the object to delete

Returns A response object

Return type *LDAPResponse*

Raises *ConnectionUnbound* – if the connection has been unbound

Additional keyword arguments are handled as *Controls*.

delete_attrs (*dn*, *attrs_dict*, *current=None*, ***ctrl_kwds*)

Delete specific attribute values from *attrs_dict*.

Specifying a 0-length entry will delete all values.

Parameters

- *dn* (*str*) – The DN of the object to modify
- *attrs_dict* (*dict(str, list(str or bytes))* or *AttrsDict*) – The attributes to remove from the object. Specify an empty list for a value to delete all values.
- *current* (*LDAPObject* or *None*) – The current known state of the object. Used to ensure we don't request that the server delete attribute values that don't exist and for validation.

Returns A response object

Return type *LDAPResponse*

Additional keyword arguments are handled as *Controls*.

disable_validation (*disabled_validators=None*)

Returns a context manager which temporarily disables validation. If any server errors are generated, they will still be propagated.

Example:

```
from laurelin.ldap import LDAP
from laurelin.ldap.exceptions import LDAPValidationError
from laurelin.ldap.schema import SchemaValidator

with LDAP(validators=[SchemaValidator()]) as ldap:
    # make validated queries
    ldap.base.add_child('cn=foo', {<valid object>})

    try:
        ldap.base.add_child('cn=bar', {<invalid object>})
    except LDAPValidationError:
        pass

    with ldap.disable_validation(['SchemaValidator']):
        # make queries without validation
        ldap.base.add_child('cn=bar', {<invalid object>})
        # NOTE: if the object is actually invalid, a server error may still_
↪ occur

    # carry on with validation restored...
```

Parameters `disabled_validators` – Optional, a list of string class names or Validator classes to disable. By default all validators will be disabled.

Returns A context manager which temporarily disables validation

Return type DisabledValidationContext

static `disable_warnings()`

Prevent all LDAP warnings from being shown - default action for others

static `enable_logging(level=10)`

Enable logging output to stderr

exists (`dn`)

Simply check if a DN exists.

Parameters `dn` (`str`) – The DN to check

Returns True if the object exists, False if not

Return type bool

get (`dn`, `attrs=None`, `**kws`)

Get a specific object by DN.

Performs a search with `Scope.BASE` and ensures we get exactly one result.

Parameters

- `dn` (`str`) – The DN of the object to query
- `attrs` (`list[str]` or `None`) – Optional. A list of attribute names to get, defaults to all user attributes

Returns The LDAP object

Return type `LDAPObject`

Raises

- `ConnectionUnbound` – if the connection has been unbound
- `NoSearchResults` – if no results are returned
- `MultipleSearchResults` – if more than one result is returned

Additional keyword arguments are passed through into `LDAP.search()`.

get_sasl_mechs ()

Query root DSE for supported SASL mechanisms.

Returns The list of server-supported mechanism names.

Return type `list[str]`

static `log_warnings()`

Log all LDAP warnings rather than showing them - default action for others

mod_dn (`dn`, `new_rdn`, `clean_attr=True`, `new_parent=None`, `**ctrl_kws`)

Change the DN and possibly the location of an object in the tree. Exposes all options of the protocol-level `rfc4511.ModifyDNRequest`

Parameters

- `dn` (`str`) – The current DN of the object
- `new_rdn` (`str`) – The new RDN of the object, e.g. `cn=foo`

- **clean_attr** (*bool*) – Remove the old RDN attribute from the object when changing
- **new_parent** (*str* or *None*) – The DN of the new parent object, or *None* to leave the location unchanged

Returns A response object

Return type *LDAPResponse*

Raises *ConnectionUnbound* – if the connection has been unbound

Additional keyword arguments are handled as *Controls*.

modify (*dn*, *modlist*, *current=None*, ***ctrl_kwds*)

Perform a series of modify operations on an object atomically

Parameters

- **dn** (*str*) – The DN of the object to modify
- **modlist** (*list* [*Mod*]) – A list of *Mod* instances, e.g. [*Mod*(*Mod*.ADD, 'someAttr', ['value1', 'value2'])]
- **current** (*LDAPObject* or *None*) – The current known state of the object for use in validation

Returns A response object

Return type *LDAPResponse*

Raises

- *ConnectionUnbound* – if the connection has been unbound
- *LDAPValidationError* – if the operation fails and configured validator

Additional keyword arguments are handled as *Controls*.

move (*dn*, *new_dn*, *clean_attr=True*, ***ctrl_kwds*)

Specify a new absolute DN for an object.

Parameters

- **dn** (*str*) – The current DN of the object
- **new_dn** (*str*) – The new absolute DN of the object, e.g. cn=foo,dc=example,dc=org
- **clean_attr** (*bool*) – Remove the old RDN attribute from the object when changing

Returns A response object

Return type *LDAPResponse*

Additional keyword arguments are handled as *Controls*.

obj (*dn*, *attrs_dict=None*, *tag=None*, ***kwds*)

Factory for LDAPObjects bound to this connection.

Note that this does not query the server. Use *LDAP.get()* to query the server for a particular DN.

Parameters

- **dn** (*str*) – The DN of the object.
- **attrs_dict** (*dict*(*str*, *list*[*str* or *bytes*]) or *AttrsDict* or *None*) – Optional. The object's attributes and values.
- **tag** (*str* or *None*) – Optional. The tag for this object. Tagged objects can be retrieved with *LDAP.tag()*.

Returns The new object bound to this connection.

Return type *LDAPObject*

Raises *TagError* – if the tag parameter is already defined

Additional keywords are passed through into the *LDAPObject* constructor.

process_ldif (*ldif_str*)

Process a basic LDIF

TODO: full RFC 2849 implementation. Missing:

- attribute options

Parameters *ldif_str* (*str*) – An RFC 2849 complying LDIF string

Returns A list with elements corresponding to the return of each described operation

Return type *list*[*LDAPResponse* or *LDAPObject*]

Raises

- *ValueError* – if the LDIF is malformed
- *LDAPError* – if an unimplemented feature is used
- *LDAPSupportError* – if a version other than 1 is specified or a critical control is undefined

recheck_sasl_mechs ()

Query the root DSE again after performing a SASL bind to check for a downgrade attack.

Raises *LDAPError* – If the downgrade attack check fails and *sasl_fatal_downgrade_check* has not been set to False.

refresh_root_dse ()

Update the local copy of the root DSE, containing metadata about the directory server. The root DSE is an *LDAPObject* stored on the *root_dse* attribute.

rename (*dn*, *new_rdn*, *clean_attr=True*, ***ctrl_kwds*)

Specify a new RDN for an object without changing its location in the tree.

Parameters

- *dn* (*str*) – The current DN of the object
- *new_rdn* (*str*) – The new RDN of the object, e.g. cn=foo
- *clean_attr* (*bool*) – Remove the old RDN attribute from the object when changing

Returns A response object

Return type *LDAPResponse*

Additional keyword arguments are handled as *Controls*.

replace_attrs (*dn*, *attrs_dict*, *current=None*, ***ctrl_kwds*)

Replace all values on given attributes with the passed values

- Attributes not mentioned in *attrsDict* are not touched
- Attributes will be created if they do not exist
- Specifying a 0-length entry will delete all values for that attribute

Parameters

- **dn** (*str*) – The DN of the object to modify
- **attrs_dict** (*dict(str, list[str or bytes]) or AttrsDict*) – The new attributes to set on the object
- **current** (*LDAPObject or None*) – The current known state of the object for use in validation

Returns A response object

Return type *LDAPResponse*

Additional keyword arguments are handled as *Controls*.

sasl_bind (*mech=None, **props*)

Perform a SASL bind operation.

Keywords are first taken as *Controls*. Required keyword args are dependent on the mechanism chosen.

Parameters **mech** (*str*) – The SASL mechanism name to use or None to negotiate best mutually supported mechanism.

Returns A response object

Return type *LDAPResponse*

Raises

- *ConnectionUnbound* – if the connection has been unbound/closed
- *ConnectionAlreadyBound* – if the connection has already been bound
- *LDAPSupportError* – if the given mech is not supported by the server
- *LDAPError* – if an error occurs during the bind process

search (*base_dn, scope=Scope.SUB, filter=None, attrs=None, search_timeout=None, limit=0, deref_aliases=None, attrs_only=False, fetch_result_refs=None, follow_referrals=None, filter_syntax=None, **kws*)

Sends search and return an iterator over results.

Parameters

- **base_dn** (*str*) – The DN of the base object of the search
- **scope** (*Scope*) – One of the *Scope* constants, default *Scope.SUB*. Controls the maximum depth of the search.
- **filter** (*str*) – A filter string. Objects must match the filter to be included in results. Default includes all objects and can be overridden globally by defining *LDAP.DEFAULT_FILTER*.
- **attrs** (*list[str]*) – A list of attribute names to include for each object. Default includes all user attributes. Use ['*', '+'] to get all user and all operational attributes.
- **search_timeout** (*int*) – The number of seconds the server should spend performing the search. Partial results will be returned if the server times out. The default can be set per connection by passing the *search_timeout* keyword to the *LDAP* constructor, or set the global default by defining *LDAP.DEFAULT_SEARCH_TIMEOUT*.
- **limit** (*int*) – The maximum number of objects to return.
- **deref_aliases** (*DerefAliases*) – One of the *DerefAliases* constants. This instructs the server what to do when it encounters an alias object. The default can be set per connection by passing the *deref_aliases* keyword to the *LDAP* constructor, or set the global default by defining *LDAP.DEFAULT_DEREF_ALIASES*.

- **attrs_only** (*bool*) – Default False. Set to True to only obtain attribute names and not any attribute values.
- **fetch_result_refs** (*bool*) – When the server returns a result which is a reference to an object on another server, automatically attempt to fetch the remote object and include it in the iterated results. The default can be set per connection by passing the `fetch_result_refs` keyword to the `LDAP` constructor, or set the global default by defining `LDAP.DEFAULT_FETCH_RESULT_REFS`.
- **follow_referrals** (*bool*) – When the server knows that the base object is present on another server, follow the referral and perform the search on the other server. The default can be set per connection by passing the `follow_referrals` keyword to the `LDAP` constructor, or set the global default by defining `LDAP.DEFAULT_FOLLOW_REFERRALS`.
- **filter_syntax** (*FilterSyntax*) – Select which filter syntax to use to parse the filter. The default can be set per connection by passing the `default_filter_syntax` keyword to the `LDAP` constructor, or set the global default by defining `LDAP.DEFAULT_FILTER_SYNTAX`.

Returns An iterator over the results of the search. May yield `LDAPObject` or possibly `SearchReferenceHandle` if `fetch_result_refs` is False.

Additional keywords are handled as *Controls* first and then passed through into `LDAP.obj()`.

This method may also be used as a context manager. If all results have not been read, the operation will automatically be abandoned when the context manager exits. You can also raise `Abandon` to abandon all results immediately and cleanly exit the context manager. You can also call `SearchResultHandle.abandon()` to abandon results.

Example:

```
# Dump the whole tree
with LDAP() as ldap:
    with ldap.base.search() as search:
        for result in search:
            print(result.format_ldif())
```

send_extended_request (*oid*, *value=None*, ***kwargs*)

Send an extended request, returns instance of `ExtendedResponseHandle`

This is mainly meant to be called by other built-in methods and client extensions. Requires handling of raw pyasn1 protocol objects.

Parameters

- **oid** (*str*) – The OID of the extension. Must be declared as supported by the server in the root DSE.
- **value** (*str or bytes or None*) – The request value (optional)

Returns An iterator yielding tuples of the form (`rfc4511.IntermediateResponse`, `rfc4511.Controls`) or (`rfc4511.ExtendedResponse`, `rfc4511.Controls`).

Return type `ExtendedResponseHandle`

Raises

- `LDAPSupportError` – if the OID is not listed in the `supportedExtension` attribute of the root DSE
- `TypeError` – if the *value* parameter is not a valid type

Additional keyword arguments are handled as *Controls* and then passed through into the `ExtendedResponseHandle` constructor.

simple_bind (*username*=", *password*", ***ctrl_kwds*)

Performs a simple bind operation

Leave arguments as their default (empty strings) to attempt an anonymous simple bind

Additional keywords are used as *Controls*.

Parameters

- **username** (*str*) – Bind DN/username or empty string for anonymous
- **password** (*str*) – Password to bind with or empty string for anonymous

Returns A response object

Return type *LDAPResponse*

Raises

- *ConnectionUnbound* – if the connection has been unbound/closed
- *ConnectionAlreadyBound* – if the connection has already been bound

start_tls (*verify*=None, *ca_file*=None, *ca_path*=None, *ca_data*=None)

Perform the StartTLS extended operation. This will instruct the server to begin encrypting this socket connection with TLS/SSL.

Parameters

- **verify** (*bool*) – Set to False to disable verification of the remote certificate. You can set the default per-connection by passing the *ssl_verify* keyword to the *LDAP* constructor, or set the global default by defining *LDAP.DEFAULT_SSL_VERIFY*.
- **ca_file** (*str*) – Path to PEM-formatted concatenated CA certificates file. You can set the default per-connection by passing the *ssl_ca_file* keyword to the *LDAP* constructor, or set the global default by defining *LDAP.DEFAULT_SSL_CA_FILE*.
- **ca_path** (*str*) – Path to directory with CA certs under hashed file names. See https://www.openssl.org/docs/man1.1.0/ssl/SSL_CTX_load_verify_locations.html for more information about the format of this directory. You can set the default per-connection by passing the *ssl_ca_path* keyword to the *LDAP* constructor, or set the global default by defining *LDAP.DEFAULT_SSL_CA_PATH*.
- **ca_data** (*str* or *bytes*) – An ASCII string of one or more PEM-encoded certs or a bytes object containing DER-encoded certificates. You can set the default per-connection by passing the *ssl_ca_data* keyword to the *LDAP* constructor, or set the global default by defining *LDAP.DEFAULT_SSL_CA_DATA*.

Return type *None*

tag (*tag*)

Get a tagged object.

Parameters **tag** (*str*) – The tag name to retrieve

Returns The object created with the given tag

Return type *LDAPObject*

Raises *TagError* – if the given tag is not defined

unbind (*force*=False)

Send an unbind request and close the socket.

Parameters **force** (*bool*) – Unbind and close the socket even if other objects still hold a reference to it.

Raises *ConnectionUnbound* – if the connection has already been unbound

validate_modify (*dn, modlist, current=None*)

Run all configured validators for the given modify operation

Parameters

- **dn** (*str*) – The DN of the object being modified
- **modlist** (*list [Mod]*) – The sequence of changes to be performed
- **current** (*LDAPObject*) – The current known state of the object

Return type *None*

Raises *LDAPValidationError* – if any validator fails the operation

validate_object (*obj, write=True*)

Run all configured validators for the given object.

Parameters

- **obj** (*LDAPObject*) – The object to validate
- **write** (*bool*) – True if this is for a write operation (e.g. an add)

Return type *None*

Raises *LDAPValidationError* – if any validator fails the object

who_am_i (***ctrl_kwds*)

Perform the “Who Am I?” extended operation. This will confirm the identity that the connection is bound to.

Returns A string describing the bound identity. One common form is “dn:cn=foo,dc=example,dc=org” but this will vary by server configuration and bind type/parameters.

Return type *str*

Additional keyword arguments are handled as *Controls*.

class `laurelin.ldap.LDAPURI` (*uri*)

Bases: *object*

Represents a parsed LDAP URI as specified in RFC4516

Supported extensions:

- “StartTLS”

Variables

- **scheme** (*str*) – urlparse standard
- **netloc** (*str*) – urlparse standard
- **host_uri** (*str*) – scheme://netloc for use with LDAPSocket
- **dn** (*str*) – Distinguished name
- **attrs** (*list [str]*) – list
- **scope** (*Scope*) – one of the *Scope* constants

- **filter** (*str*) – The filter string
- **starttls** (*bool*) – True if StartTLS was requested

DEFAULT_ATTRS = ['*']

DEFAULT_FILTER = '(objectClass=*)'

DEFAULT_SCOPE = **Scope.BASE**

DEFAULT_STARTTLS = **False**

search (***kws*)

Perform the search operation described by the parsed URI

First opens a new connection with connection reuse disabled, then performs the search, and unbinds the connection. Server must allow anonymous read.

Additional keyword arguments are passed through into `LDAP.search()`.

class laurelin.ldap.**Scope**

Bases: `object`

Scope constants. These instruct the server how far to take a search, relative to the base object

BASE = **Scope.BASE**

Only search the base object

ONE = **Scope.ONE**

Search the base object and its immediate children

ONELEVEL = **Scope.ONE**

SUB = **Scope.SUB**

Search the base object and all of its descendants

SUBTREE = **Scope.SUB**

static constant (*c*)

translate constants to RFC4516 URL scope string

static string (*str*)

translate RFC4516 URL scope strings to constant

class laurelin.ldap.**DerefAliases**

Bases: `object`

DerefAliases constants. These instruct the server when to automatically resolve an alias object, rather than return the alias object itself

ALWAYS = **DerefAliases.ALWAYS**

dereferences both the search base object and results

BASE = **DerefAliases.BASE**

dereferences the search base object, but not search results

NEVER = **DerefAliases.NEVER**

always return the alias object

SEARCH = **DerefAliases.SEARCH**

dereferences search results, but not the base object itself

class laurelin.ldap.**FilterSyntax**

Bases: `object`

Filter syntax selection constants. Used to determine which filter syntax to use when parsing a search filter.

```

SIMPLE = FilterSyntax.SIMPLE
STANDARD = FilterSyntax.STANDARD
UNIFIED = FilterSyntax.UNIFIED

static string (str)
    Convert filter syntax string to constant

```

class laurelin.ldap.Control

Bases: `object`

Request controls are exposed by allowing an additional keyword argument on a set of methods. The `prepare()` method takes the value passed in as a keyword argument and returns an `rfc4511.Control`.

Response controls are returned by setting an additional attribute on whichever object is returned by the called method. The raw response controlValue is passed to the `handle()` method, and any appropriate value may be returned.

Leave the `RESPONSE_OID` and `response_attr` attributes as a False value if there is no response control specified.

```

REQUEST_OID = ''
    Request OID of the control

RESPONSE_OID = ''
    Response OID of the control (may be equal to REQUEST_OID; may be left empty)

handle (ctrl_value)
    Accepts raw response ctrl_value and may return any useful value.

    There is no need to call this base function when overriding.

    Parameters ctrl_value (str) – The string response control value received from the server.

    Returns The string ctrl_value unchanged by default. May be overridden to return any relevant
        value/type/structure.

keyword = ''
    keyword argument name

method = ()
    name(s) of the method which this control is used with

prepare (ctrl_value, criticality)
    Accepts string controlValue and returns an rfc4511.Control instance

    When overriding this function, you must always call and return this base function.

    Parameters
        • ctrl_value (str or bytes) – The string request control value to send to the server
        • criticality (bool) – True if the control has criticality. This is indicated
            by wrapping the keyword argument in critical or optional, and by the default_criticality
            keyword passed to the LDAP constructor, and global default LDAP.DEFAULT_CRITICALITY.

    Returns The protocol-level control object ready for transmission to the server

    Return type rfc4511.Control

classmethod register ()

response_attr = ''
    Name of the attribute where return of handle() will be stored

```

class `laurelin.ldap.critical` (*value*)

Bases: `object`

used to mark controls with criticality

class `laurelin.ldap.optional` (*value*)

Bases: `object`

used to mark controls as not having criticality

exception `laurelin.ldap.LDAPError`

Bases: `Exception`

Base class for all exceptions raised by laurelin

exception `laurelin.ldap.NoSearchResults`

Bases: `laurelin.ldap.exceptions.UnexpectedSearchResults`

Got no search results when one or more was required

exception `laurelin.ldap.Abandon`

Bases: `Exception`

Can be raised to cleanly exit a context manager and abandon unread results

`laurelin.ldap.add_extension` (*modname*)

Import an extension and prepare it for binding under its internally-defined name to LDAP and/or LDAPObject depending which extension classes are defined. This is only needed for extensions not yet patched into AVAILABLE_EXTENSIONS.

Parameters *modname* (*str*) – The string module name containing an extension, can be any importable module, e.g. “laurelin.extensions.netgroups”

Return type `None`

class `laurelin.ldap.BaseLaurelinExtension` (*modname=None*)

Bases: `laurelin.ldap.extensible.registration.LaurelinRegistrar`, `laurelin.ldap.extensible.registration.LaurelinTransiter`

Base class for basic extension class. Can house schema and controls definitions.

INSTANCE = `None`

NAME = `'__undefined__'`

class `laurelin.ldap.BaseLaurelinSchema`

Bases: `laurelin.ldap.extensible.registration.LaurelinTransiter`

Optional base class for a class defining schema elements - only subclassing `LaurelinTransiter` is required

class `laurelin.ldap.BaseLaurelinControls`

Bases: `laurelin.ldap.extensible.registration.LaurelinTransiter`

Optional base class for a class defining controls - only subclassing `LaurelinTransiter` is required

class `laurelin.ldap.BaseLaurelinLDAPExtension` (*parent*)

Bases: `object`

Base class for extensions to the LDAP class

class `laurelin.ldap.BaseLaurelinLDAPObjectExtension` (*parent*)

Bases: `object`

Base class for extensions to the LDAPObject class


```
class laurelin.ldap.LaurelinTransiter
```

Bases: `object`

Base class for classes in extensions defining schema elements or controls

```
class laurelin.ldap.LaurelinRegistrar (modname=None)
```

Bases: `object`

The `require()` method on this class registers all schema and controls in a module.

If this class is subclassed in an extension module (such as with `LaurelinExtension`), there is no need to pass an argument to the constructor. However, for extensions with many schema elements or controls, it may be desirable to break up these objects into multiple submodules that are imported on end-user request.

In such a setup, an instance of `LaurelinRegistrar` would need to be created and exposed to the end-user for each submodule so that they can call `.require()` on it. This constructor would need to be passed `__name__`.

Note that if this is applied to a package, `require()` will function on all imported submodules of the package.

require()

Register schema elements and controls defined in any `LaurelinTransiter` subclass in the same module as the calling class. If the calling class is defined in an `__init__.py`, also register schema/controls for submodules that have been imported.

```
laurelin.ldap.escape (text)
```

Escape special characters

```
class laurelin.ldap.LDAPObject (dn, attrs_dict=None, ldap_conn=None, relative_search_scope=Scope.SUB, rdn_attr=None)
Bases: laurelin.ldap.attrsdict.AttrsDict, laurelin.ldap.extensible.Ldapobject_extensions.LDAPObjectExtensions
```

Represents a single object with optional server affinity.

Many methods will raise an exception if used without a server connection. To instantiate an `LDAPObject` bound to a server connection, use `LDAP.obj()`.

Attributes and values are stored using the mapping interface inherited from `AttrsDict`, where dict keys are case-insensitive attribute names, and dict values are a list of attribute values.

Value lists are automatically wrapped in `AttrValueList`. This allows the use of any schema-defined matching and syntax rules for the attribute type in list operations.

Parameters

- **dn** (*str*) – The DN of the object
- **attrs_dict** (*dict(str, list[str or bytes]) or AttrsDict or None*) – The object's attributes
- **ldap_conn** (*LDAP or None*) – The optional LDAP connection to use
- **relative_search_scope** (*Scope*) – One of the `Scope` constants, this is the default scope used when using this object's `LDAPObject.search()` method. New objects created below this one will inherit this attribute by default. This attribute also defines the behavior of `LDAPObject.find()`.
- **rdn_attr** (*str or None*) – The default attribute name used in RDN's for descendants of this object. If specified, this allows you to only specify the value for methods that have an `rdn` argument. You can always specify a full `attr=value` for `rdn` arguments as well to override this behavior. New objects created below this one will inherit this attribute by default.

add_attrs (*attrs_dict*, ***ctrl_kwds*)

Add new attribute values to this object.

Parameters **attrs_dict** (*dict* (*str*, *list* [*str* or *bytes*]) or *AttrsDict*) – The new attributes to add to the object

Return type *None*

Additional keywords are passed through into *LDAPObject.modify()*.

add_child (*rdn*, *attrs_dict*, ***kwds*)

Create a new object below this one.

Parameters

- **rdn** (*str*) – The RDN, or RDN value if *rdn_attr* is defined for this object
- **attrs_dict** (*dict* (*str*, *list* [*str* or *bytes*]) or *AttrsDict* or *None*) – The attributes for the object

Returns The new object

Return type *LDAPObject*

Additional keyword arguments are passed through into *LDAP.add()*

compare (*attr*, *value*)

Ask the server if this object has a matching attribute value. The comparison will take place following the schema-defined matching rules and syntax rules.

Parameters

- **attr** (*str*) – The attribute name
- **value** (*str*) – The assertion value

Returns A response object, *bool()* evaluating to the result of the comparison

Return type *CompareResponse*

Raises *RuntimeError* – if this object is not bound to an LDAP connection

delete (***ctrl_kwds*)

Delete the entire object from the server, and render this instance useless.

Additional keywords are passed through into *LDAP.delete()*.

Return type *None*

Raises *RuntimeError* – if this object is not bound to an LDAP connection

delete_attrs (*attrs_dict*, ***ctrl_kwds*)

Delete specific attribute values given in *attrs_dict*. Specifying a zero-length list for any attribute will delete all values for that attribute.

Parameters **attrs_dict** (*dict* (*str*, *list* [*str* or *bytes*]) or *AttrsDict*) – The attributes to delete from the object

Return type *None*

Additional keywords are passed through into *LDAPObject.modify()*.

delete_child (*rdn*, ***ctrl_kwds*)

Delete a child object below this one.

Parameters **rdn** (*str*) – The RDN, or RDN value if *rdn_attr* is defined for this object

Returns The *LDAPResponse* from the delete operation

Return type *LDAPResponse*

Additional keyword arguments are treated as controls.

find (*rdn*, *attrs=None*, ***kws*)

Obtain a single object below this one with the most efficient means possible.

The strategy used is based on the `relative_search_scope` property of this object.

- If it is *Scope.BASE*, this method will always raise an *LDAPError*.
- If it is *Scope.ONE*, then the absolute DN for the child object will be constructed, and a *Scope.BASE* search will be performed to get the object.
- If it is *Scope.SUB*, then a subtree search will be performed below this object, using the RDN as a search filter.

Additional keywords are passed through into *LDAPObject.search()*.

Parameters

- **rdn** (*str*) – The RDN, or RDN value if `rdn_attr` is defined for this object
- **attrs** (*list[str]*) – Optional. The list of attribute names to obtain.

Returns The LDAP object

Return type *LDAPObject*

Raises

- *LDAPError* – if this object's `relative_search_scope` is *Scope.BASE*.
- *NoSearchResults* – if no object could be found matching `rdn`.
- *MultipleSearchResults* – if more than one object was found.
- *RuntimeError* – if this object is not bound to an LDAP connection
- *ValueError* – if the `relative_search_scope` is set to an invalid value.

format_ldif ()

Format the object as an LDIF string.

Returns The object encoded as an LDIF.

Return type *str*

get_child (*rdn*, *attrs=None*, ***kws*)

Query the server for a child object.

Parameters

- **rdn** (*str*) – The RDN, or RDN value if `rdn_attr` is defined for this object
- **attrs** (*list[str] or None*) – The list of attributes to query

Returns The object populated with data from the server

Return type *LDAPObject*

Raises *RuntimeError* – if this object is not bound to an LDAP connection

Additional keywords are passed through into *LDAP.search()* and *LDAPObject*

has_object_class (*object_class*)

A convenience method which checks if this object has a particular objectClass. May query the server for the objectClass attribute if it is not yet known.

Parameters `object_class` – The objectClass to check for.

Returns True if the objectClass is present, False otherwise

Return type `bool`

mod_dn (*new_rdn*, *clean_attr=True*, *new_parent=None*, ***ctrl_kwds*)

Change the object DN, and possibly its location in the tree.

Parameters

- **new_rdn** (*str*) – The new RDN of the object
- **clean_attr** (*bool*) – Optional, default True. Remove the attribute associated with the RDN when changing it.
- **new_parent** (*str*) – Optional. The absolute DN of the object's new parent.

Return type `None`

Raises `RuntimeError` – if this object is not bound to an LDAP connection

Additional keywords are passed through into `LDAP.mod_dn()`.

mod_transaction ()

Begin a modify transaction on this object. Important: This IS NOT an RFC 5805 transaction.

Return type `ModTransactionObject`

modify (*modlist*, ***ctrl_kwds*)

Perform a series of modify operations on this object atomically.

Parameters **modlist** (*list* [*Mod*]) – A list of *Mod* instances, e.g. [*Mod*(*Mod*.ADD, 'someAttr', ['value1', 'value2'])]

Return type `None`

Raises `RuntimeError` – if this object is not bound to an LDAP connection

Additional keywords are passed through into `LDAP.modify()`.

move (*new_dn*, *clean_attr=True*, ***ctrl_kwds*)

Specify the complete new absolute DN for this object.

Parameters

- **new_dn** (*str*) – The new absolute DN for the object
- **clean_attr** (*bool*) – Optional, default True. Remove the attribute associated with the RDN when changing it.

Return type `None`

Additional keywords are passed through into `LDAPObject.mod_dn()`.

obj (*rdn*, *attrs_dict=None*, *tag=None*, ***kwds*)

Create a new object below this one.

Parameters

- **rdn** (*str*) – The RDN, or RDN value if *rdn_attr* is defined for this object
- **attrs_dict** (*dict* (*str*, *list* [*str* or *bytes*]) or *AttrsDict* or *None*) – The attributes for the object
- **tag** (*str* or *None*) – Optional tag for the object

Returns The new object

Return type *LDAPObject*

Raises *LDAPError* – if a `tag` is specified but this object is not bound to an LDAP connection

Additional keywords are passed through into *LDAP.obj()* or the *LDAPObject* constructor.

rdn (*rdn*)

Return an absolute DN from an RDN or RDN value

Parameters **rdn** (*str*) – The RDN, or RDN value if *rdn_attr* is defined for this object

Returns The absolute DN

Return type *str*

refresh (*attrs=None*)

Query the server to update the attributes on this object.

Parameters **attrs** (*list[str]*) – Optional. A list of attribute names to query. If not specified, will query the server for all user attributes.

Return type *None*

Raises *RuntimeError* – if this object is not bound to an LDAP connection

refresh_all ()

Query the server to update all user and operational attributes on this object.

Return type *None*

Raises *RuntimeError* – if this object is not bound to an LDAP connection

refresh_missing (*attrs*)

Potentially query the server for any listed attributes that are not yet defined on this object. If no listed attributes aren't defined, the query will not be performed. If a subset of the list is undefined, only those attributes will be queried.

Parameters **attrs** (*list[str]*) – A list of attribute names to check, and possibly query for.

Return type *None*

rename (*new_rdn, clean_attr=True, **ctrl_kwds*)

Change the object's RDN without changing its location in the tree.

Parameters

- **new_rdn** (*str*) – The new RDN of the object
- **clean_attr** (*bool*) – Optional, default True. Remove the attribute associated with the RDN when changing it.

Return type *None*

Additional keywords are passed through into *LDAPObject.mod_dn()*.

replace_attrs (*attrs_dict, **ctrl_kwds*)

Replace all values on the given attributes with the passed values.

Parameters **attrs_dict** (*dict(str, list[str or bytes]) or AttrsDict*) – The new attributes to set on the object

Return type *None*

Additional keywords are passed through into *LDAPObject.modify()*.

search (*filter=None, attrs=None, **kwds*)

Perform a search below this object.

Parameters

- **filter** (*str*) – Optional. The filter string to use to filter returned objects.
- **attrs** (*list[str]*) – Optional. The list of attribute names to retrieve.

Returns An iterator over *LDAPObject* and possibly *SearchReferenceHandle*. See *LDAP.search()* for more details.

Return type *SearchResultHandle*

Additional keywords are passed through into *LDAP.search()*.

validate()

Validate the object, assuming all attributes are present locally

validate_modify(modlist)

Validate a modification list.

Parameters **modlist** (*list[Mod]*) – The list of modify operations to validate.

class *laurelin.ldap.Mod* (*op, attr, vals*)

Bases: *object*

Describes a single modify operation

ADD = *Mod.ADD*

DELETE = *Mod.DELETE*

REPLACE = *Mod.REPLACE*

static op_to_string(op)

Convert one of the *Mod* constants to a string, e.g. “ADD”, “REPLACE”, “DELETE”.

static string(op)

Translte LDIF changetype strings to constant. e.g. “replace” -> *Mod.REPLACE*

laurelin.ldap.get_object_class(ident)

Get an instance of *ObjectClass* associated with either a name or an OID

Parameters **ident** (*str*) – Either the numeric OID of the desired object class spec or one of its specified names

Returns The *ObjectClass* associated with the name/OID

Return type *ObjectClass*

class *laurelin.ldap.ObjectClass* (*spec*)

Bases: *object*

Parses an LDAP object class specification and implements superclass inheritance.

Each instantiation registers the names and OID specified so that they can later be access with *get_object_class()*.

See the *laurelin.ldap.schema* module source for example usages.

Parameters **spec** (*str*) – The LDAP specification for an object class

Raises *LDAPSchemaError* –

- if the schema is syntactically invalid
- if the OID specified has already been registered
- if one of the names specified has already been registered

Variables

- **oid** (*str*) – The specified OID
- **names** (*tuple* (*str*)) – All specified names
- **superclasses** (*list* [*str*]) – The list of all specified superclass names/OIDs.
- **kind** (*str*) – One of *ABSTRACT*, *STRUCTURAL*, or *AUXILIARY*
- **obsolete** (*bool*) – True if the objectClass has been marked obsolete.
- **my_must** (*list* [*str*]) – The list of required attribute types for this class
- **my_may** (*list* [*str*]) – The list of allowed attribute types for this class

allowed_attr (*name*)

Check if the given attribute type name is allowed.

Parameters **name** – The name of the attribute type to check**Returns** True if the given attribute type is allowed.**Return type** *bool***may**

Obtains all allowed attribute types after ascending the superclass specifications

must

Obtains all required attribute types after ascending the superclass specifications

register ()**required_attr** (*name*)

Check if the given attribute type name is required.

Parameters **name** – The name of the attribute type to check**Returns** True if the given attribute type is required.**Return type** *bool***class** laurelin.ldap.**ExtensibleObjectClass** (*spec*)

Bases: laurelin.ldap.objectclass.ObjectClass

The *extensibleObject* auxiliary objectClass allows entries that belong to it to hold any user attribute.**allowed_attr** (*name*)

Check if the given attribute type name is allowed.

Parameters **name** – The name of the attribute type to check**Returns** True if the given attribute type is allowed.**Return type** *bool***class** laurelin.ldap.**SyntaxRule**Bases: *object*

Base class for all syntax rules

DESC = ''

Short text description of the rule. Must be defined by subclasses.

OID = ''

The globally unique numeric OID of the syntax rule. Referenced in attribute type and matching rule specs. Must be defined by subclasses.

classmethod `register()`

validate (*s*)

Validate a string. Must be implemented by subclasses.

Parameters *s* – Candidate string

Returns Any useful value for the rule

Raises *InvalidSyntaxError* – if the string is invalid

class `laurelin.ldap.RegexSyntaxRule`

Bases: `laurelin.ldap.rules.SyntaxRule`

For validating rules based on a regular expression. Most syntax rules can inherit from this.

regex = ''

The regular expression defining the rule. Subclasses must define this attribute.

validate (*s*)

Validate a string against the regular expression.

Parameters *s* – Candidate string

Returns The regex match object

Return type `MatchObject`

Raises *InvalidSyntaxError* – if the string does not match

class `laurelin.ldap.MatchingRule`

Bases: `object`

Base class for all matching rules

NAME = ''

Globally unique name for the matching rule. Most attribute type specs will reference rules using the name, but they can also use the OID. This must be defined by subclasses.

OID = ''

Globally unique numeric OID for the matching rule. This must be defined by subclasses.

SYNTAX = ''

The numeric OID for the syntax rule that assertion values must comply with. Subclasses must define this.

do_match (*attribute_value*, *assertion_value*)

Perform the match operation

match (*attribute_value*, *assertion_value*)

Prepare values and perform the match operation. Assumes values have already been validated.

prep_methods = ()

A tuple of callables used to prepare attribute and asserion values. Subclasses may optionally define this.

prepare (*value*)

Prepare a string for matching

classmethod `register()`

validate (*value*)

Perform validation according to the matching rule's syntax

class `laurelin.ldap.EqualityMatchingRule`

Bases: `laurelin.ldap.rules.MatchingRule`

Base class for all EQUALITY matching rules

do_match (*attribute_value*, *assertion_value*)
Perform equality matching

class laurelin.ldap.**Validator**

Bases: `object`

Abstract base class for a validator. All validators must inherit from here and ensure the public interface is fully implemented.

validate_modify (*dn*, *modlist*, *current*)
Validate a modify operation.

By default, validate all attributes for writing.

Parameters

- **dn** (*str*) – The DN of the object being modified
- **modlist** (*list* [*Mod*]) – The list of modify operations to be performed this transaction
- **current** (*LDAPObject* or *None*) – The known state of the object prior to modification

Returns `None`

Raises `LDAPValidationError` – if any modify operation is invalid

validate_object (*obj*, *write=True*)
Validate an object when all attributes are present.

By default, validate all attributes on the object.

Parameters

- **obj** (*LDAPObject*) – An LDAP object with all attributes defined
- **write** (*bool*) – True if we are validating a write operation to the database

Returns `None`

Raises `LDAPValidationError` – if the object is invalid in any way

class laurelin.ldap.**SchemaValidator**

Bases: `laurelin.ldap.validation.Validator`

Ensures parameters conform to the available defined schema

validate_object (*obj*, *write=True*)
Validates an object when all attributes are present

- Requires the `objectClass` attribute
- Checks that all attributes required by the `objectClass` are defined
- Checks that all attributes are allowed by the `objectClass`
- Performs validation against the attribute type spec for all attributes

`laurelin.ldap.dc` (*domain*)

Convert a DNS dotted domain name to a DN with domain components

`laurelin.ldap.domain` (*dc*)

Convert a DN with domain components to a DNS dotted domain name

8.1.2 Module contents

Laurelin OID Space

Laurelin IANA Registered Private Enterprise Number:

1.3.6.1.4.1.53450

Any OID with this prefix that is not explicitly mentioned in this document should be considered **unstable** and not used for any purpose.

9.1 Namespaces

OID Prefix: 1.3.6.1.4.1.53450

OID Suffix	Description
.1	LDAP
.1.1	Controls
.1.2	Extensions
.1.3	Syntax rules
.1.4	Matching rules
.1.5	Attribute types
.1.6	Object classes

9.2 Objects

None currently assigned.

CHAPTER 10

Testing Setup

Warning: Testing has been moved to docker using public images. Check `.travis.yml` for details. This page is maintained for historical documentation purposes.

10.1 System

- Digital Ocean VPS with Debian 7.9
- OpenLDAP 2.4.31
- Cyrus SASL 2.1.25
- 389 Directory Server 1.3.6

10.2 SASL

10.2.1 SASL config ldif

```
dn: cn=config
changetype: modify
replace: olcAuthzRegexp
olcAuthzRegexp: uid=([^\,]+),.* cn=$1,dc=example,dc=org
-
add: olcSaslAuxprops
olcSaslAuxprops: sasldb
-
add: olcSaslRealm
olcSaslRealm: example.org
-
add: olcSaslHost
```

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```
olcSaslHost: example.org
-
```

10.2.2 Adding sasl user password with

```
saslpasswd2 -u example.org -c $USER
```

10.2.3 SASL auth control test case

```
% ldapwhoami -Y DIGEST-MD5 -U admin -H ldap://127.0.0.1
SASL/DIGEST-MD5 authentication started
Please enter your password:
SASL username: admin
SASL SSF: 128
SASL data security layer installed.
dn:cn=admin,dc=example,dc=org
```

10.3 LDAPS/StartTLS

- Certs set up following this [Stack Overflow answer](#).
- Configured OpenLDAP as follows:

```
dn: cn=config
changetype: modify
replace: olcTLSCertificateKeyFile
olcTLSCertificateKeyFile: /certs/serverkey.pem
-
replace: olcTLSCertificateFile
olcTLSCertificateFile: /certs/servercert.pem
-
replace: olcTLSCACertificateFile
olcTLSCACertificateFile: /certs/cacert.pem
```

- Added `ldaps://127.0.0.1:636` to `SLAPD_SERVICES` in `/etc/default/slapd`

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