Directory Uses

- A directory can be used in may ways
  - Employee database
  - Equipment inventory
  - List or groups
    - Email list
    - Organizational groups
  - NIS replacement
  - Software distribution

Connecting

- Connection is performed as part of the object constructor

```
$ldap = Net::LDAP->new($hostname);
```

- Options can be passed after the hostname

```
$ldap = Net::LDAP->new($hostname,
          port    => $port, # default: 389
          debug   => 3,     # default: 0
          timeout => 60,    # default: 120
          version => 3      # default: 2
        );
```

Authentication

- Referred to a bind-ing
- LDAP supports several methods
  - Anonymous
  - Simple
  - SASL

Anonymous Authentication

- Supported in both version 2 and 3

```
$r = $ldap->bind;
```

- Not required in version 3, but...

```
$r = $ldap->bind(version => 3);
```

Simple Authentication

- Supported in both version 2 and 3

```
$r = $ldap->bind($DN, password => $pw);
```

- This method of authentication passes your password in CLEAR text over the network

SASL Authentication

- SASL is a framework for providing challenge-response authentication
- Requires version 3 server

```
use Authen::SASL;
$sasl = Authen::SASL->new( 'CRAM-MD5'
          password => $password
        );
$r = $ldap->bind($DN,
       sasl    => $sasl,
       version => 3
     );
```

Return Values

- Most methods in Net::LDAP return an object, this object provides methods to obtain the results of the operation that was performed
- A result code is returned by the method `->code`
- An error message is returned by the method `->error`
- In most cases a success gives a result code of zero

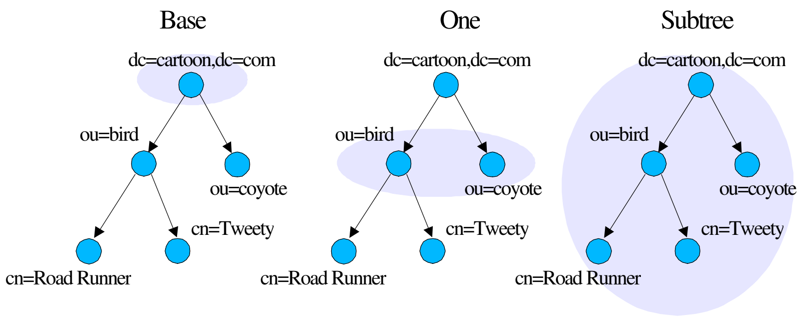
```
warn $r->error if $r->code != LDAP_SUCCESS;
```


Searching

- To perform a search there are three basic things you must know.
  - Search base
    - The name of a DN within the directory where the search will begin
  - Scope
    - How to perform the search
  - Filter
    - The criteria an entry must match to be returned

Scope

- LDAP servers support three different scopes for searching



Filter

- A filter is the criteria that an entry must match to be returned
- Boolean expression of assertions on the attributes of the entry
  - Examples

```
(&(ou=bird)(cn=*Runner))

(objectClass=Person)

(&(objectClass=ipService)
  (cn=ldap)(ipServiceProtocol=tcp))
```

Basic Filter Syntax

- LDAP filters use a prefix syntax, described in RFC2254
  - Equality, existance and sub-string

```
(cn=Road Runner)
(cn=*)
(cn=Road*)
(cn=*Runner)
(cn=R*R*r)
```

  - Relational

```
(age>=18)
(age<=16)
```

  - Approximate

```
(weight~=180)
```


Complex Filters

- Filters may be combined using simple boolean logic
  - And

```
(&(ou=bird)(cn=Road Runner))

(&(objectClass=ipService)
  (cn=ldap)(ipServiceProtocol=tcp))
```

  - Or

```
(|(cn=Tweety)(cn=Road Runner))
```

  - Not

```
(!(cn=Tweety))
```

Extensible Filters

- Extensible filters allow us to change the way a match is performed
- Change how value comparison is done

```
(cn:2.5.13.5:=Road Runner)
(cn:caseExactMatch:=Road Runner)
```

- Filters only match the attributes of an entry, not the DN components, unless specified

```
(ou:dn:=bird)
(ou:dn:caseIgnoreMatch:=coyote)
```


Performing a search

```
$r = $ldap->search(
      base   => 'dc=cartoon,dc=com',
      scope  => 'subtree',
      filter => '(cn=Road Runner)'
);

die $r->error if $r->code;
```

- The result object also contains the matching entries

```
foreach my $entry ($r->entries) {
  process_entry( $entry );
}
```

The Entry object

- Used for both creating new entries and in retrieval of existing objects
  - dn
    - Returns the DN for the entry

```
$DN = $entry->dn;
```

  - exists
    - Test if an attribute exists within the entry

```
do_something() if $entry->exists('cn');
```


The Entry object - cont.

  - get_value
    - Obtain the value for an attribute in the entry

```
$value = $entry->get_value('cn');
```

    - For multi-valued attributes get_value will return the first value in a scalar context and all of them in a list context

```
$first  = $entry->get_value('objectClass');

@values = $entry->get_value('objectClass');

$values = $entry->get_value('objectClass',
                                asref => 1);
```

The Entry object - cont.

- attributes
  - Return a list of attribute names that the entry contains

```
@attrs = $entry->attributes;
```

- NOTE: Attribute names should be treated as case-insensetive

Displaying an entry

- If you know that all values in your entry are printable, the following could be used to display the entry contents

```
sub display_entry {
  my $entry = shift;

  my @attrs = $entry->attributes;

  foreach my $attr (@attrs) {
    my @value = $entry->get_value( $attr );

    foreach my $value (@value) {
      print "$attr: $value\n";
    }
  }
}
```

Controlling what's returned

- Obtaining just attribute names
  - By default an LDAP server will return the attributes and their values for each entry
  - Asking for only the types, the server will return the same entries as before, but the value for each attribute will be an empty list

```
$r = $ldap->search(
       base      => 'dc=cartoon,dc=com',
       filter    => '(cn=Road*)',
       typesonly => 1
);
```


Controlling what's returned

- Which attributes are returned depend on your permissions. You can override this by giving a list of attributes

```
$r = $ldap->search(
       base   => 'dc=cartoon, dc=com',
       filter => '(cn=Road*)'
       attrs  => [qw(cn)]
);
```

- This can be combined with types only to determine if entries have certain attributes

Referrals

- A referral is returned by the server when the whole request needs to be resent to a different server
- A referral can be returned in response to any operation, except unbind and abandon
- Detected by a result code of LDAP_REFERRAL

```
$r = $ldap->search( ... );
@ref = $r->referrals if $r->code == LDAP_REFERRAL;
```

- Each referral is an LDAP URL
- Net::LDAP does not provide the option to automatically follow referrals

References

- A reference is returned by the server when part of the request must be sent to a different server
- A reference can only be returned by a search operation
- There is no result code to detect these

```
$r = $ldap->search( ... );
@ref = $r->references;
```

- Each reference is an LDAP URL
- Net::LDAP does not provide the option to automatically follow references

Adding

- There are four different ways that Net::LDAP supports adding new entries into a directory
  - The add method
  - The Entry class
  - LDIF
    - Same as adding with the Entry class, except the Entry is read from a file via the LDIF module
  - DSML
    - Same as adding with the Entry class, except the Entry is read from a file via the DSML module

Adding – the add method

- Data structure of entry is passed directly to the add method

```
$DN = 'cn=Road Runner, ou=bird, dc=cartoon, dc=com';

$r = $ldap->add( $DN,
      attrs => [
            cn          => 'Road Runner',
            objectClass => 'cartoonCharacter',
            food        => 'Bird Seed'
      ]
);
```

Adding – the Entry class

- An Entry is built and passed to the add method

```
$DN = 'cn=Road Runner, ou=bird, dc=cartoon, dc=com';

$e = Net::LDAP::Entry->new( $DN );

$e->add( cn => 'Road Runner' );

$e->add(
       objectClass => 'cartoonCharacter',
       food         => 'Bird Seed'
);

$r = $ldap->add( $e );
```


Deleting

- To delete an Entry you need to know the DN of the entry to be deleted

```
$DN = 'cn=Road Runner, ou=bird, dc=cartoon, dc=com';
$ldap->delete( $DN );
```

- Alternatively, like many Net::LDAP methods, an Entry can be passed where a DN is expected

```
$entry = find_entry_to_delete();
$ldap->delete( $entry );
```

Modifying

- The modify operation has three sub-operations
  - Add
    - Add new attributes
    - Add values to existing multi-valued attributes
  - Delete
    - Delete whole attributes
    - Delete values from within existing attributes
  - Replace
    - Replace existing attributes, or add if necessary

Modify – add

- To add a new attribute to an entry, or value to an existing attribute

```
$r = $ldap->modify( $DN,
              add => { mail => 'rr@cartoon.com' }
       );
```

- An error will be returned if
  - If the attribute exists and is not multi-valued
  - If the attribute exists and is multi-valued and the value already exists
  - The schema does not allow the attribute to be added

Modify – delete

- To delete whole attributes

```
$r = $ldap->modify( $DN,
      delete => [ 'mail' ]
);
```

- Or, specific values from an attribute

```
$r = $ldap->modify( $DN,
      delete => { mail => [ 'tweety@cartoon.com' ] }
);
```

- If deleting specific values from an attribute leaves the attribute with an empty list, the attribute is deleted
- If the given attribute does not exist, the error code LDAP_NO_SUCH_ATTRIBUTE is returned

Modify – replace

- Replace allows you to replace whole attributes
  - Single value

```
$r = $ldap->modify( $DN,
      replace => { mail => 'bird@cartoon.com' }
);
```

  - Multi-valued

```
$r = $ldap->modify( $DN,
      replace => {
            mail => ['bird@cartoon.com','bird@acme.com']
      }
);
```

  - Delete

```
$r = $ldap->modify( $DN, replace => { mail => [] } );
```

Renaming an Entry

- moddn allows an entry to be moved within the tree

```
$DN = 'cn=Road Runner, ou=bird, dc=cartoon, dc=com';
$r = $ldap->moddn( $DN,
       newrdn => 'cn=Lunch'
);
```

- An entry can also be moved to another branch of the tree

```
$DN = 'cn=Wile E. Coyote, ou=coyote, dc=cartoon, dc=com';
$r = $ldap->moddn( $DN,
       newrdn      => 'cn=Isac Newton',
       newsuperior => 'ou=genius, dc=cartoon, dc=com'
);
```

- An error will be returned if the new entry already exists

Comparing

- Compare allows the value of an attribute to be compared with a value following the comparison rules specified in the directory schema

```
$DN = 'cn=Thieves Hideout, ou=cave, dc=cartoon, dc=com';
$r = $ldap->compare( $DN,
       attr  => 'userPassword',
       value => 'opensesame'
);
```

- On success `$r->code` will be either LDAP_COMPARE_TRUE or LDAP_COMPARE_FALSE
- Some systems impose access rules on some attributes that allow them to be compared but not read, eg userPassword

Groups

- In a directory a group is implemented as an entry with a multi-valued attribute
- This attribute is normally called member
- The contents of the attribute are the DNs of the members

```
$DN = "cn=Animaniacs, ou=Groups, dc=cartoon, dc=com";
$r = $ldap->modify($DN,
        add => {
          member => [
               "cn=Wakko, ou=character, dc=cartoon, dc=com",
               "cn=Yakko, ou=character, dc=cartoon, dc=com",
               "cn=Dot, ou=character, dc=cartoon, dc=com"
          ]
        ]
);
```


LDIF

- LDIF is a text format used to represent entries within a directory

```
dn: cn=Road Runner, ou=bird, dc=cartoon, dc=com
objectClass: cartoonCharacter
cn: Road Runner
food: Bird Seed
```

- It can also be used as a command language to manipulate existing directory entries

```
dn: cn=Road Runner, ou=bird, dc=cartoon, dc=com
changetype: modify
replace: mail
mail: road.runner@cartoon.com
```

Reading LDIF

- LDIF files can be read using the Net::LDAP::LDIF class

```
$ldif = Net::LDAP::LDIF->new($filename, "r");

while ($entry = $ldif->read_entry) {
      $r = $ldap->add( $entry );
      warn $entry->dn,": ",$r->error if $r->code;
}
warn "Error reading $filename" unless $ldif->eof;
```

- The `$filename` passed to `->new` may alternatively be a file handle

```
$ldif = Net::LDAP::LDIF->new( \*STDIN, "r");
```


Writing LDIF

- The same class can be used to write LDIF

```
$ldif = Net::LDAP::LDIF->new( $filename, "w");
$ldif->write_entry( $entry );
```

- Appending can be done by passing `"a"` instead of `"w"`

Controls

- Version 3 made the protocol extendable by adding controls
- Most Net::LDAP methods accept a list of controls. This is passed as an array reference using the `control` named parameter
- Net::LDAP currently implements
  - Paged Search Results
  - Sorted Search Results
  - Virtual List View
  - Proxy Authentication

Paged Search Results

- Allows the results of a search to be returned in blocks instead of all at once

```
$page = Net::LDAP::Control::Paged->new( size => 5 );
@args = (
       base     => "DC=cartoon, DC=com",
       scope    => "subtree",
       filter   => "(cn=road*)",
       control  => [ $page ]
);
while(1) {
       $r = $ldap->search( @args );
       $r->code and last;
       $ctrl = $mesg->control( LDAP_CONTROL_PAGED )
              or last;
       $cookie = $ctrl->cookie or last;
       $page->cookie($cookie);
       process_entries( $r ) or last;
}
```

Paged Search Results – cont.

```
# If we terminated early tell the server we are finished

if ($cookie) {
       $page->cookie($cookie);
       $page->size(0);
       $ldap->search( @args );
}
```


Sorted Search Results

- Controls the order of the entries returned from a search

```
$sort = Net::LDAP::Control::Sort->new(
       order => "cn -phone"
);

$r = $ldap->search( @args, control => [ $sort ]);

($ctrl) = $mesg->control( LDAP_CONTROL_SORTRESULT );

print "Results are sorted\n"
       if $ctrl and !$ctrl->result;

@entries = $r->entries;
```

Virtual List Views

- Controls a search to only return a subset of the matching entries using a moving window
- A sort control must be passed with the VLV control

```
$vlv  = Net::LDAP::Control::VLV->new(
  offset  => 1,  # Target entry is the first
  before  => 0,  # No entries from before target entry
  after   => 19, # 19 entries after target entry
);

$sort = Net::LDAP::Control::Sort->new( sort => 'cn' );
```


Virtual List View – cont

```
@args = (
      base     => "dc=cartoon, dc=com",
      scope    => "subtree",
      filter   => "(objectClass=*)",
      control  => [ $vlv, $sort ]
);

$r = $ldap->search( @args );
($ctrl)  = $mesg->control( LDAP_CONTROL_VLVRESPONSE )
      or die;
$vlv->response( $ctrl );

$vlv->end;
$r = $ldap->search( @args );
($ctrl)  = $mesg->control( LDAP_CONTROL_VLVRESPONSE )
      or die;
$vlv->response( $ctrl );
```

Virtual List View – cont

- Other VLV methods include
  - Move to the start of the list

```
$vlv->start;
```

  - Scroll through the list

```
$vlv->scroll_page(1);
$vlv->scroll_page(-1);
```

  - Move to a particular entry

```
$vlv->assert("B");
```

  - Query

```
$offset  = $vlv->offset;
$content = $vlv->content;
$before  = $vlv->before;
$after   = $vlv->after;
```


Proxy Authentication

- Allows a bound client to assume the identity of another entity
- Requires access control permission from the assumed identity

```
$proxyDN =
    "cn=Friz Freleng, ou=animator, dc=cartoon, dc=com";

$ctrl = Net::LDAP::Control::ProxyAuth->new(
            proxyDN => $proxyDN
);

$DN = "cn=Sylvester, ou=cat, dc=cartoon, dc=com";

$r = $ldap->modify($DN,
       delete => { food => 'birds' }
);
```

Schema

- The schema for a directory is stored in an entry within the directory
- Net::LDAP provides a single method for obtaining the directory schema

```
$schema = $ldap->schema;
```

- The result is a Net::LDAP::Schema object
- Net::LDAP::Schema provides an API for querying the content of the schema
- Net::LDAP does not provide a method to modify schema

Handling Errors

- The Message object returned by most methods contains the status of the operation performed
- The code method will return a status code. For most operations a success will be represented as a zero in this field
  - Net::LDAP::Constant exports LDAP_SUCCESS as zero
- The error method will return a short error message. This may be either a message actually returned by the server, or a default message that corresponds to the code returned by the server

Handling Errors – cont

- In most simple cases the result code should be LDAP_SUCCESS, or in the case of compare LDAP_COMPARE_FALSE or LDAP_COMPARE_TRUE
- Net::LDAP can be told to call a subroutine whenever an unexpected result is returned
- The following will cause Net::LDAP to die when an unexpected result is returned

```
$ldap = Net::LDAP->new($server, onerror => 'die');
```


Handling Errors – cont

- Other handlers are
  - `'warn'` – Net::LDAP will call warn with an error messages, but will continue as normal
  - `'undef'` – Net::LDAP will call warn with an error if `-w` is in effect. The method called will then return undef instead of the usual message object
- onerror may also be passed a sub reference. This sub will be called with the message object. The return value from this sub is what will be returned by the method that was called

Net::LDAP::Util

- The Net::LDAP::Util module contains many utility functions
  - ldap_error_name - Given an error code it will return the name associated with that code

```
warn ldap_error_name(0); # "LDAP_SUCCESS"
```

  - ldap_error_message - Given an error code it will return a short error message

```
warn ldap_error_message(0); # "Success"
```

  - ldap_error_text - Given an error code it will return the text from the Net::LDAP::Constant POD for the given error

Net::LDAP::Util

- Distinguished Names can be represented in many forms, so comparing two DNs is not as simple as using eq. For this reason Net::LDAP::Util provides canonical_dn
- canonical_dn performs the following actions on a DN
  - Downcase any hexadecimal codes
  - Upcase all type names
  - Remove the letters OID from any OID
  - Escape all special characters
  - Escapes all leading and trailing spaces
  - Orders the parts within any multi-part RDN

Using callbacks

- LDAP returns results to the client in multiple packets. Each packet will contain a single entry, a reference or a result code
- Net::LDAP accumulates all packets for a transaction before a methods returns
- Callbacks allow the entries to be processed as they arrive, instead of waiting for the completion
- This can result in less memory consumption and also faster processing

Using callbacks – cont

```
$r = $ldap->search( $DN,
      filter   => '(objectClass=*)',
      callback => \&process
);
```

- `process` will be called for each packet received
- The first argument passed will be the message object
- If the packet was an entry, then there will be a second argument, which will be a Net::LDAP::Entry object
- If the packet was a reference, there will be a second argument, which will be a Net::LDAP::Reference object

Using callbacks – cont

```
sub process {
  my ($r, $obj) = @_;

  if (!$obj) {
    print $r->error,"\n";
  }
  elsif ($obj->isa('Net::LDAP::Entry')) {
    print $obj->dn,"\n";
    $r->pop_entry;
  }
  else {
    foreach my $ref ($obj->references) {
      print $ref,"\n";
    }
  }
}
```


LDAP and XML

- Directory Service Markup Language (DSML) is the XML standard for representing directory service information in XML
- DSML is still very new
- DSML cannot be used as a command language like LDIF

Client Software

- perl-ldap
  - http://perl-ldap.sourceforge.net/
- PerLDAP
  - http://www.mozilla.org/directory/perldap.html
- Netscape
  - http://www.iplanet.com/
- Sun JNDI
  - http://www.java.sun.com/jndi/

Open Source Servers

- OpenLDAP
  - http://www.openldap.org/
- JavaLDAP
  - http://javaldap.sourceforge.net/

Commercial Servers

- Iplanet
  - http://www.iplanet.com/
- Messaging Direct
  - http://www.messagingdirect.com/
- Nexor
  - http://www.nexor.com/
- Critical Path
  - http://www.cp.net/

perl-ldap resources

- Homepage
  - http://perl-ldap.sourceforge.net/
- Online documentation
  - http://perl-ldap.sourceforge.net/doc/
- FAQ
  - http://perl-ldap.sourceforge.net/FAQ.html
- Mailing list
  - perl-ldap-dev@lists.sourceforge.net