

LDAP

Lightweight Directory Access Protocol

wangth

國立陽明交通大學資工系資訊中心

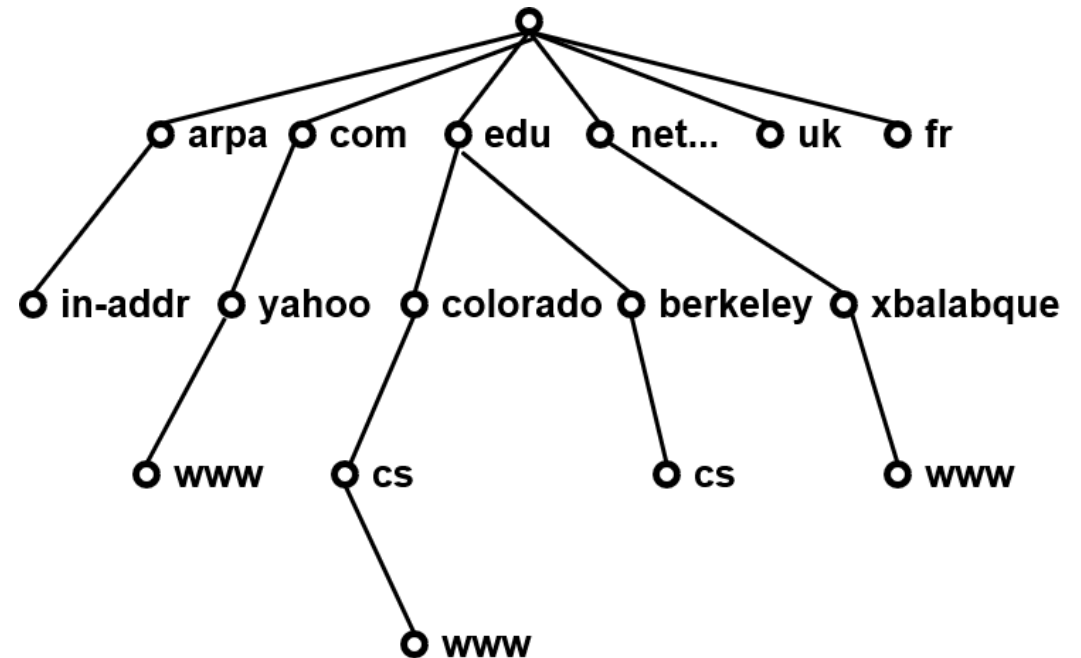
Computer Center of Department of Computer Science, NYCU

What is Directory Service?

□ What is Directory Service (目錄服務)

- Highly optimized for reads
- Implements a distributed model for storing information
- Can extend the type of information it stores
- Has advanced search capabilities
- Has loosely consistent replication among directory servers

□ Domain Name Service



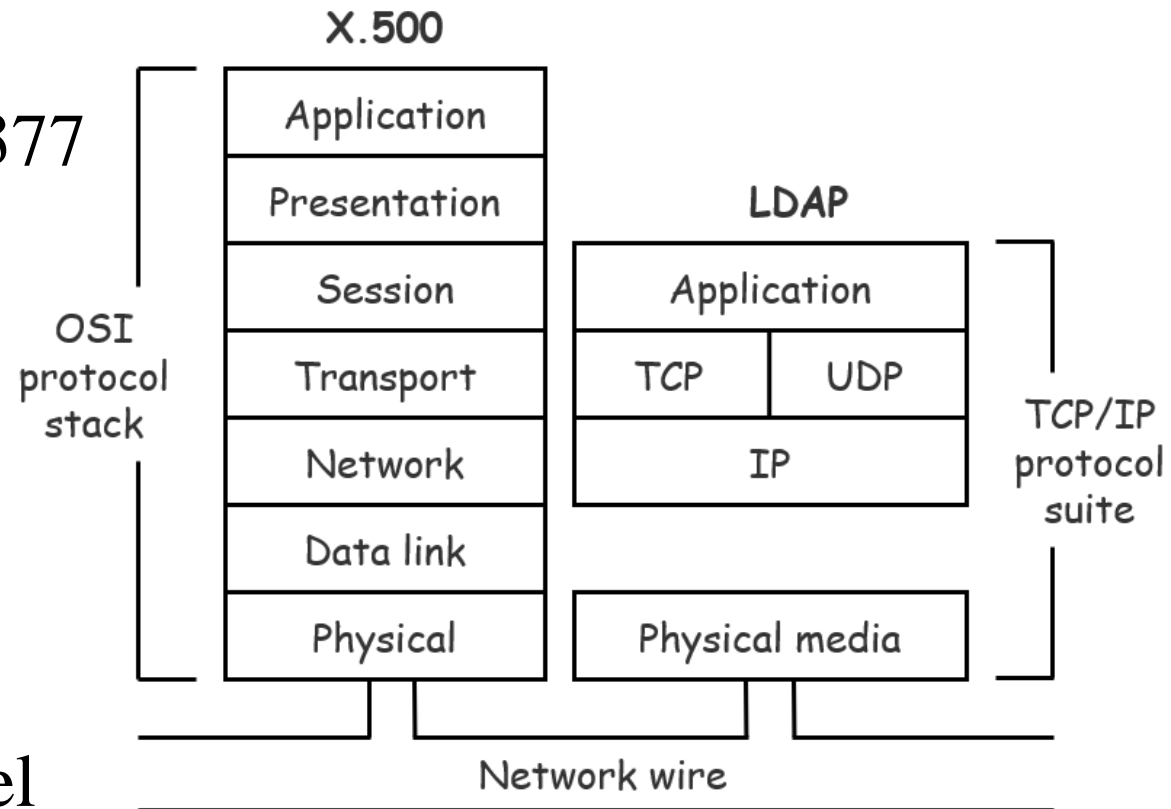
What is LDAP?

□ Lightweight Directory Access Protocol (LDAP)

- LDAPv3: RFC 3377
- RFC 2251-2256, 2829, 2830, 3377

□ Why **L**LDAP is lightweight

- A subset of the X.500 standard
- X.500 is based on OSI model
- LDAP is based on TCP/IP model
- LDAP omits many X.500 operations that are rarely used
- Provides a smaller and simpler set of operations



LDAP Directory Information Tree (DIT)

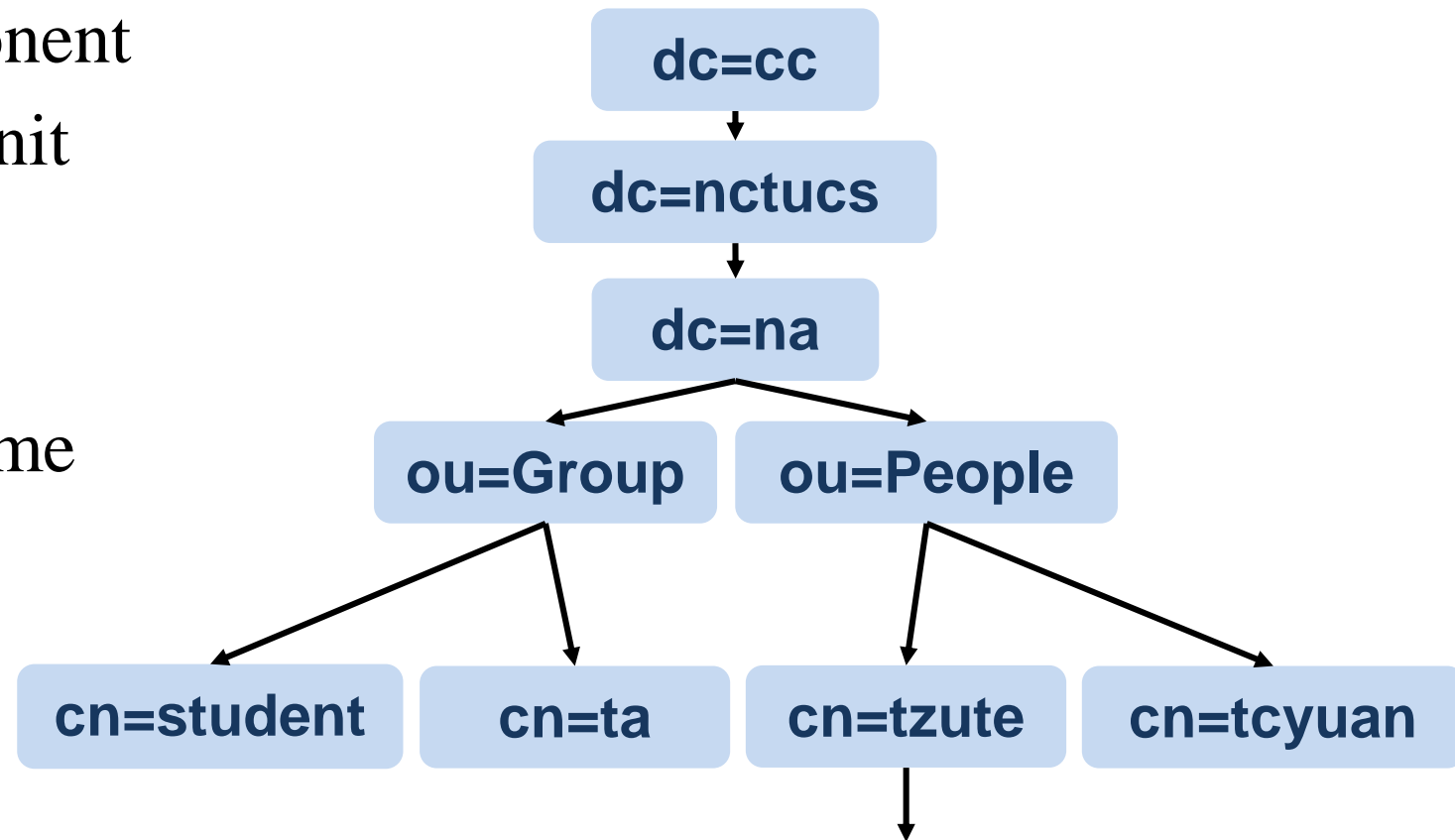
dc: domain component

ou: organization unit

cn: common name

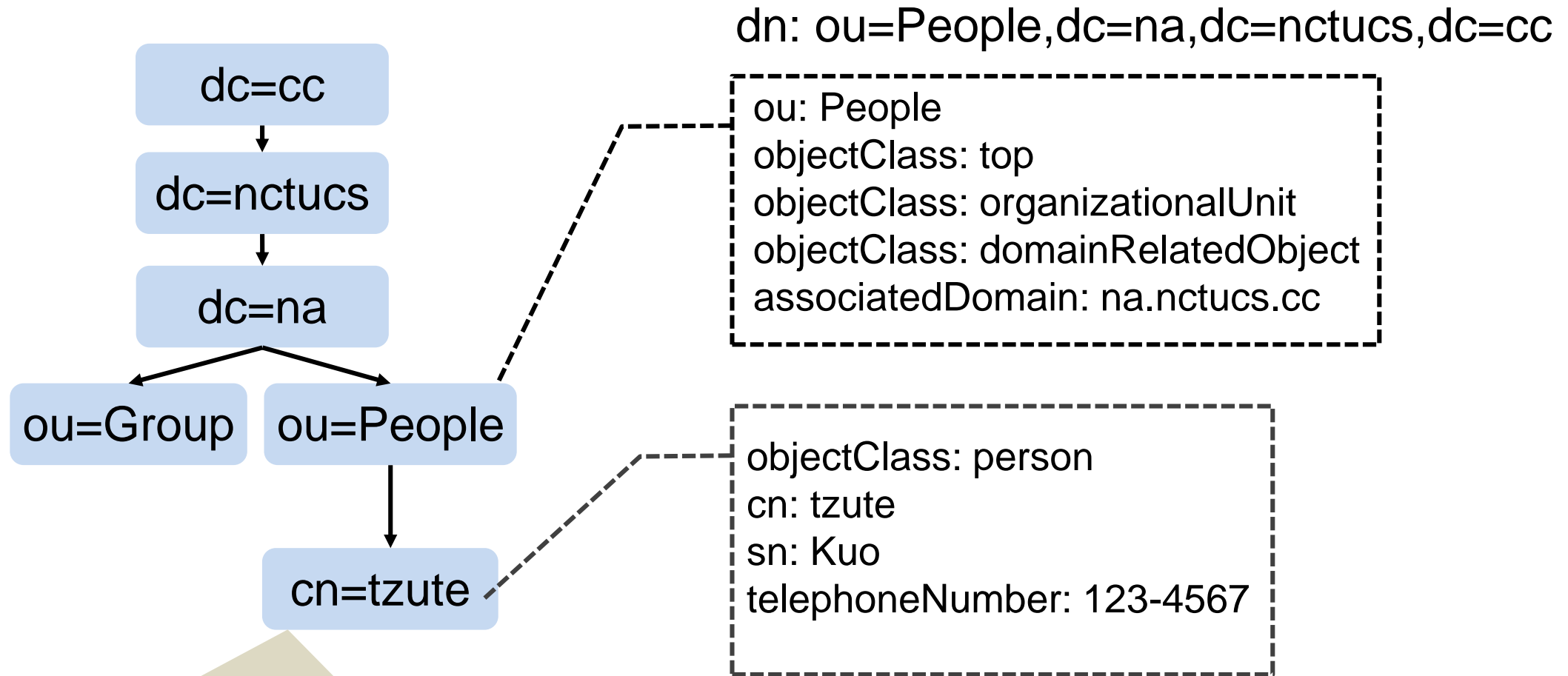
o: organizationName

c: countryName



cn=tzute,ou=People,dc=na,dc=nctucs,dc=cc
o="na, nctucs, cc", c=TW
o=na.nctucs.cc

LDAP Directory Information Tree (DIT)



DN (distinguished name):
cn=tzute,ou=People,dc=na,dc=nctucs,dc=cc

RDN: Relative Distinguished Name

LDAPv3 Overview – LDIF (1/4)

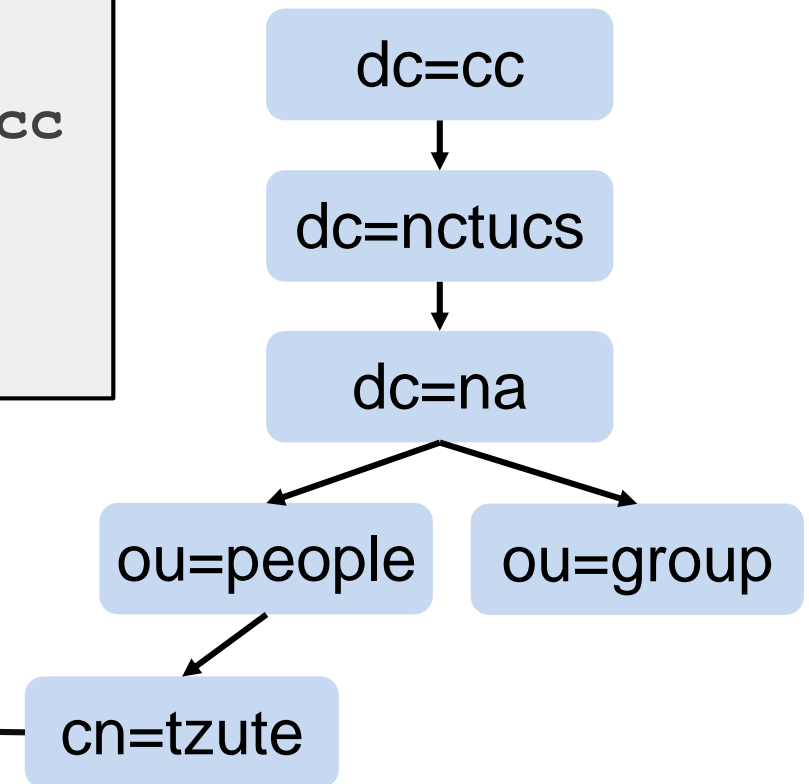
□ LDAP Interchange Format (LDIF)

- Defined in RFC 2849
- Standard text file format for storing LDAP configuration information and directory contents
- An LDIF file is
 1. A collection of entries separated from each other by blank lines
 2. A mapping of attribute names to values
 3. A collection of directives that instruct the parser how to process the information
- The data in the LDIF file must obey the schema rules of your LDAP directory

LDAPv3 Overview – LDIF (2/4)

□ Sample LDIF

```
# A sample entry
# Format: <Attribute>: <Value>
dn: cn=tzute,ou=people,dc=na,dc=nctucs,dc=cc
objectClass: person
cn: tzute
telephoneNumber: 123-4567
```



LDAPv3 Overview – LDIF (3/4)

□ Sample LDIF – Modify one DN

```
# Modify user info
dn: cn=tzute,ou=people,dc=na,dc=nctucs,dc=cc
changetype: modify
add: description
description: NA TA
-
replace: telephoneNumber
telephoneNumber: 0987654321
```

objectClass: person
cn: tzute
sn: abc
telephoneNumber : 123-
4567

objectClass: person
cn: tzute
sn: abc
description : NA TA
telephoneNumber : 0987654321

LDAPv3 Overview – LDIF (4/4)

□ Sample LDIF – Modify more than one DN

```
# Modify user info
dn: cn=tzute,ou=people,dc=na,dc=nctucs,dc=cc
changetype: modify
add: description
description: NA TA

```

```
dn: cn=tcyuan,ou=people,dc=na,dc=nctucs,dc=cc
changetype: modify
add: description
description: NA TA
```

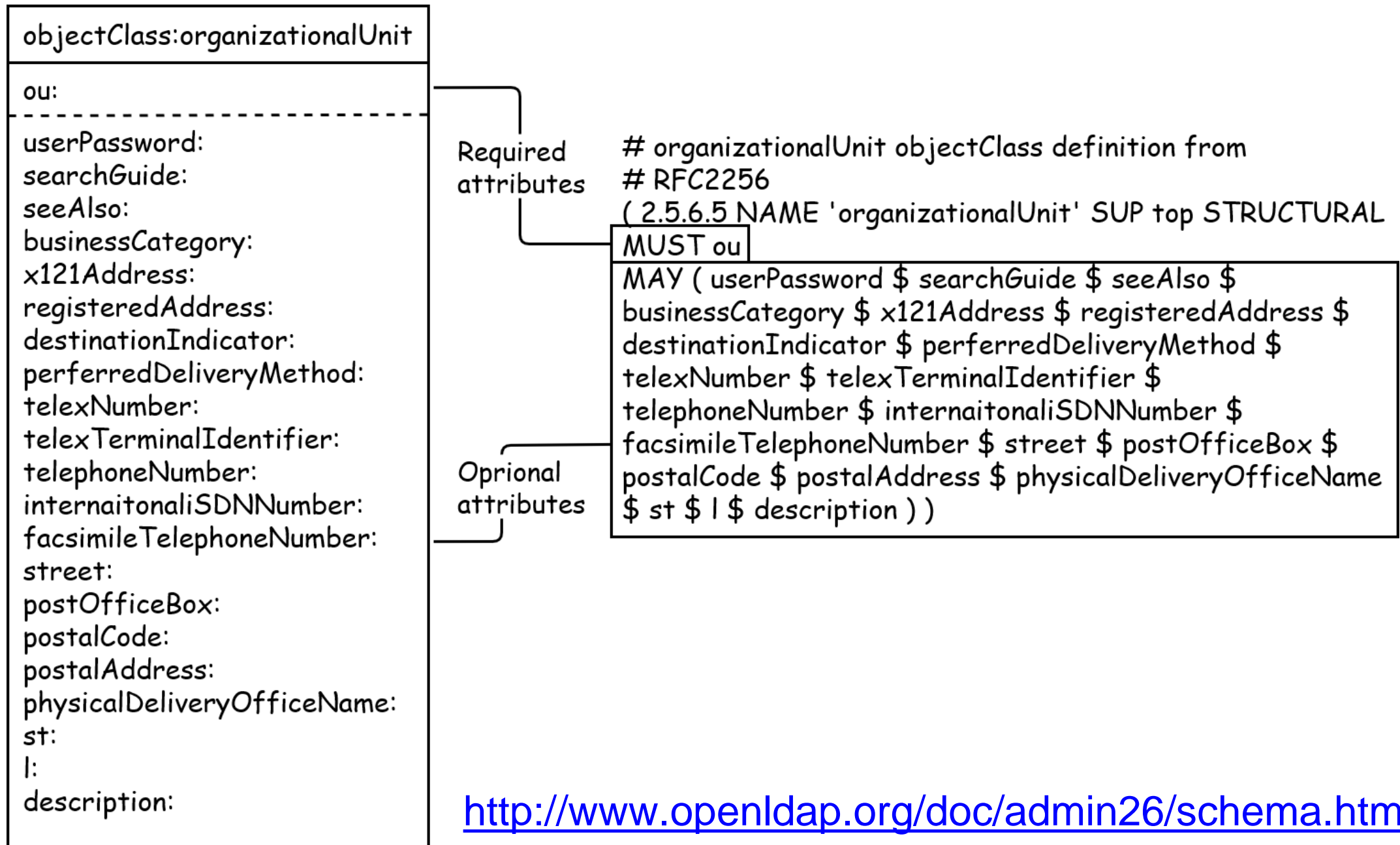
LDAPv3 Overview – objectClass

□ /usr/local/etc/openldap/schema/core.schema

```
objectclass ( 2.5.6.6 NAME 'person'  
  DESC 'RFC2256: a person'  
  SUP top STRUCTURAL  
  MUST ( sn $ cn )  
  MAY ( userPassword & telephoneNumber & seeAlso & description ))
```

ObjectClassDescription = "(" whsp
 numericoid whsp ; ObjectClass identifier
 ["Name" qdescrs]
 ["DESC" qdstring]
 ["OBSOLETE" whsp]
 ["SUP" oids] ; Superior ObjectClasses
 [("ABSTRACT" / "STRUCTURAL" / "AUXILIARY") whsp]
 ; default structural
 ["MUST" oids] ; AttributeTypes
 ["MAY" oids] ; AttributeTypes <http://www.openldap.org/doc/admin26/schema.html>
 Whsp ")"

LDAPv3 Overview – objectClass (Cont.)



LDAPv3 Overview – Attribute

```
Attributetype ( 2.5.4.20 NAME `telephoneNumber'  
DESC `RFC2256: Telephone Number'  
Matching Rules EQUALITY telephoneNumberMatch  
SUBSTR telephobeNumberSubstringsMatch  
Types SYNTAX 1.3.6.1.4.1.1466.115.121.1.50{32} )
```

Table 8.3: Commonly Used Syntaxes

| Name | OID | Description |
|-------------------|-------------------------------|------------------------|
| boolean | 1.3.6.1.4.1.1466.115.121.1.7 | boolean value |
| directoryString | 1.3.6.1.4.1.1466.115.121.1.15 | Unicode (UTF-8) string |
| distinguishedName | 1.3.6.1.4.1.1466.115.121.1.12 | LDAP DN |
| integer | 1.3.6.1.4.1.1466.115.121.1.27 | integer |
| numericString | 1.3.6.1.4.1.1466.115.121.1.36 | numeric string |
| OID | 1.3.6.1.4.1.1466.115.121.1.38 | object identifier |
| octetString | 1.3.6.1.4.1.1466.115.121.1.40 | arbitrary octets |

Server should support values of this length

<https://www.openldap.org/doc/admin26/schema.html>

Comparison with relational databases

- ❑ It is tempting to think that having a RDBMS backend to the directory solves all problems. However, it is wrong.
- ❑ This is because the data models are very different. Representing directory data with a relational database is going to require splitting data into multiple tables.

OpenLDAP



An open source implementation of the Lightweight Directory Access Protocol

國立陽明交通大學資工系資訊中心

Computer Center of Department of Computer Science, NYCU

OpenLDAP on FreeBSD

❑ Three main components

- slapd – stand-alone LDAP daemon and associated modules and tools
- libraries implementing the LDAP protocol and ASN.1 Basic Encoding Rules (BER)
- client software: ldapsearch, ldapadd, ldapdelete, and others

❑ Installation

- pkg install openldap-server
- cd /usr/ports/net/openldap-server26; make install clean

❑ slapd.conf

- Blank lines and lines beginning with a pound sign (#) are ignored
- Parameters and associated values are separated by whitespace characters
- A line with a blank space in the first column is considered to be a continuation of the previous one.

slapd.conf

```
include                /usr/local/etc/openldap/schema/core.schema
pidfile                /var/run/openldap/slapd.pid
argsfile               /var/run/openldap/slapd.args
loglevel               256
modulepath             /usr/local/libexec/openldap
moduleload             back_mdb
moduleload             back_ldap

database               mdb
maxsize                1073741824
suffix                 "dc=na,dc=nctucs,dc=cc"
rootdn                 "cn=Manager,dc=na,dc=nctucs,dc=cc"
rootpw                 <generated by slappasswd>
directory              /var/db/openldap-data

# Indices to maintain
index                  objectClass eq
# ACL rules here for specific database
```


Directory ACL

```
# access to <what> [ by <who> [<accesslevel>] [<control>] ]+
access to dn.exact="cn=Manager,dc=na,dc=nctucs,dc=cc"
    by peername.ip="127.0.0.1" auth
    by users none
    by anonymous none
    by * none

access to attrs=userPassword
    by self write
    by anonymous auth
    by dn.base="cn=Manager,dc=na,dc=nctucs,dc=cc" write
    by * none

access to attrs=englishname,birthdate
    by self write
    by users read
    by anonymous read
```

If one access directive is more specific than another in terms of the entries it selects, it should appear first in the configuration

Directory ACL

<http://www.openldap.org/doc/admin26/access-control.html>

□ Access Entity Specifiers (Who)

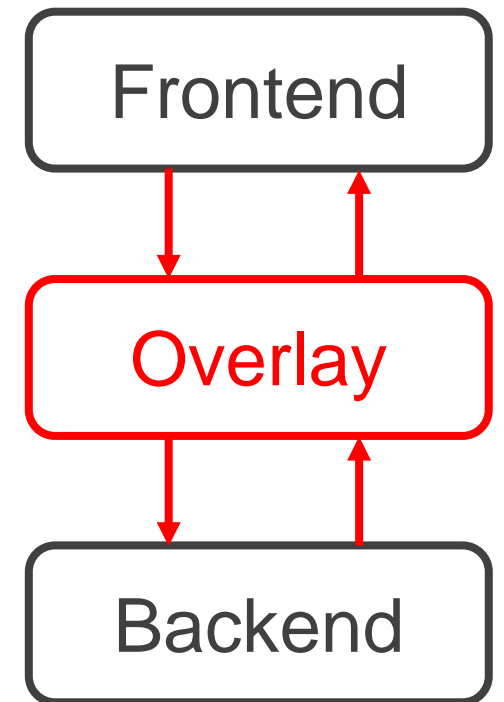
| Specifier | Entities |
|----------------------------|--|
| * | All, including anonymous and authenticated users |
| anonymous | Anonymous (non-authenticated) users |
| users | Authenticated users |
| self | User associated with target entry |
| dn[.<basic-style>]=<regex> | Users matching a regular expression |
| dn.<scope-style>=<DN> | Users within scope of a DN |

□ Access Levels

| Level | Privileges | Description |
|------------|------------|--|
| none = | ∅ | no access |
| disclose = | d | needed for information disclosure on error |
| auth = | dx | needed to authenticate (bind) |
| compare = | cdx | needed to compare |
| search = | scdx | needed to apply search filters |
| read = | rscdx | needed to read search results |
| write = | wrscdx | needed to modify/rename |
| manage = | mwrscdx | needed to manage |

Overlays

- ❑ Software components that provide hooks to functions analogous to those provided by backends, which can be stacked on top of the backend calls and as callbacks on top of backend responses to alter their behavior
- ❑ Frontend
 - handles network access and protocol processing
- ❑ Backend
 - deals strictly with data storage

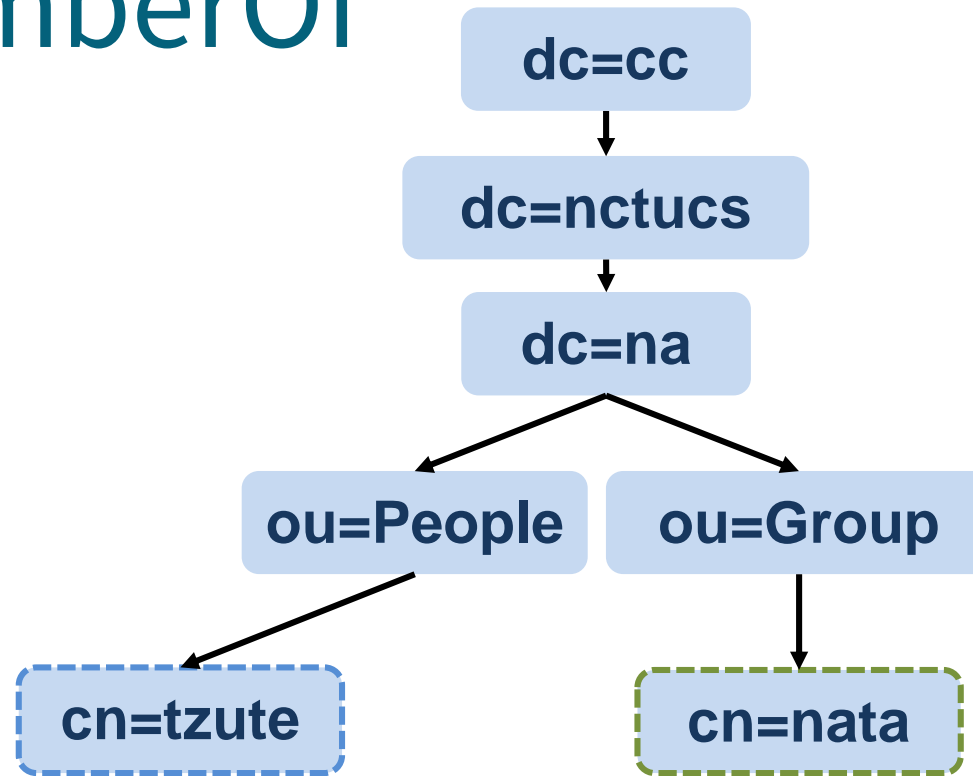


<https://www.openldap.org/doc/admin26/overlays.html>

<https://en.wikipedia.org/wiki/OpenLDAP#Overlays>

Overlays – memberOf

□ Membership



objectClass: posixGroup
objectClass: top
objectClass: posixAccount
cn: tzute
gidNumber: 1234

objectClass: posixGroup
objectClass: top
cn: nata
displayName: nata
description: Domain Unix group
gidNumber: 1234

Overlays – memberOf

□ Installation

- Ports
- make config → enable option

```
+ [ ] LMPASSWD      With LM hash password support (DEPRECATED)
+ [x] MDB           With Memory-Mapped DB backend
+ [ ] MEMBEROF     With Reverse Group Membership overlay
+ [ ] ODBC         With SQL backend
+ [ ] OUTLOOK      Force caseIgnoreOrderingMatch on name attribute
+ [ ] PASSWD       With Passwd backend
+ [ ] PERL         With Perl backend
+ [ ] PPOLICY      With Password Policy overlay
+ [ ] PROXYCACHE   With Proxy Cache overlay
+ [ ] REFINT       With Referential Integrity overlay
+ [ ] RELAY        With Relay backend
+ [ ] RETCODE      With Return Code testing overlay
+ [ ] BLOCKUPS     With reverse lookup of client hostnames
```

<https://www.openldap.org/doc/admin26/overlays.html>

Overlays – memberOf

- ❑ Edit /usr/local/etc/openldap/slapd.conf

```
# MemberOf  
Overlay memberof
```

- ❑ restart slapd
- ❑ Query Result

```
dn: cn=nata,ou=MemberGroup,dc=na,dc=nctucs,dc=cc  
objectclass: groupOfNames  
cn: nata  
member: cn=tzute,ou=People,dc=na,dc=nctucs,dc=cc
```

<https://www.openldap.org/doc/admin26/overlays.html>

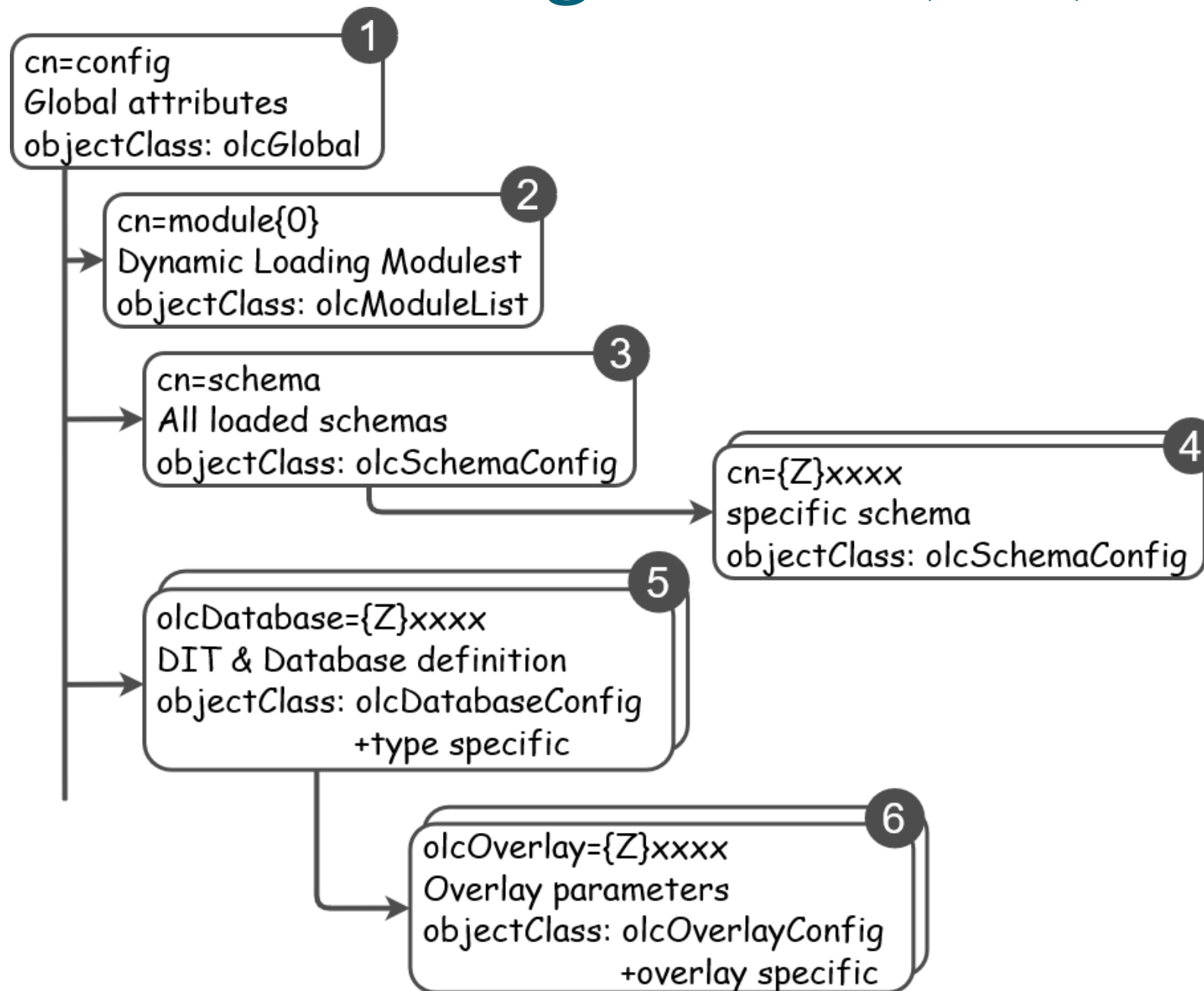
OLC – Online Configuration (1/3)

- ❑ OpenLDAP 2.3 and later have transitioned to using a dynamic runtime configuration engine
- ❑ Uses a configuration DIT to control the operational configuration
- ❑ Modifying entries in this DIT immediate changes to slapd's operational behavior
- ❑ Note: Configuration changes should be performed via LDAP operations. DON'T edit any of the LDIF files directly.

<https://www.openldap.org/doc/admin26/slapdconf2.html>

<https://www.zytrax.com/books/ldap/ch6/slapd-config.html>

OLC – Online Configuration (2/3)



OLC – Online Configuration (3/3)

```
# {1}mdb, config
dn: olcDatabase={1}mdb,cn=config
objectClass: olcDatabaseConfig
objectClass: olcMdbConfig
olcDatabase: {1}mdb
olcDbDirectory: /var/db/openldap-data/na
olcSuffix: dc=na,dc=nctucs,dc=cc
olcAddContentAcl: FALSE
olcLastMod: TRUE
olcMaxDerefDepth: 15
olcReadOnly: FALSE
olcRootDN: cn=Manager,dc=na,dc=nctucs,dc=cc
olcRootPW: secret
```

Enable slapd

- ❑ Edit `/etc/rc.conf`
 - `slapd_enable="YES"`
 - `slapd_flags` for specific options

- ❑ `service slapd start`

<http://www.openldap.org/doc/admin26/runningslapd.html>

slapd tools

❑ slapcat

- This tool reads records from a slapd database and writes them to a file or standard output

❑ slapadd

- This tool reads LDIF entries from a file or standard input and writes the new records to a slapd database

❑ slapindex

- This tool regenerates the indexes in a slapd database

❑ slappasswd

- This tool generates a password hash suitable for use as an `AuthSource` in `slapd.conf`

LDAP tools

- ❑ ldapsearch
 - This tool issues LDAP search queries to directory servers
- ❑ ldapadd, ldapmodify
 - These tools send updates to directory servers
- ❑ ldapcompare
 - This tool server to compare two values
- ❑ ldapdelete
 - This tool deletes entries from an LDAP directory

ldapsearch

□ Options

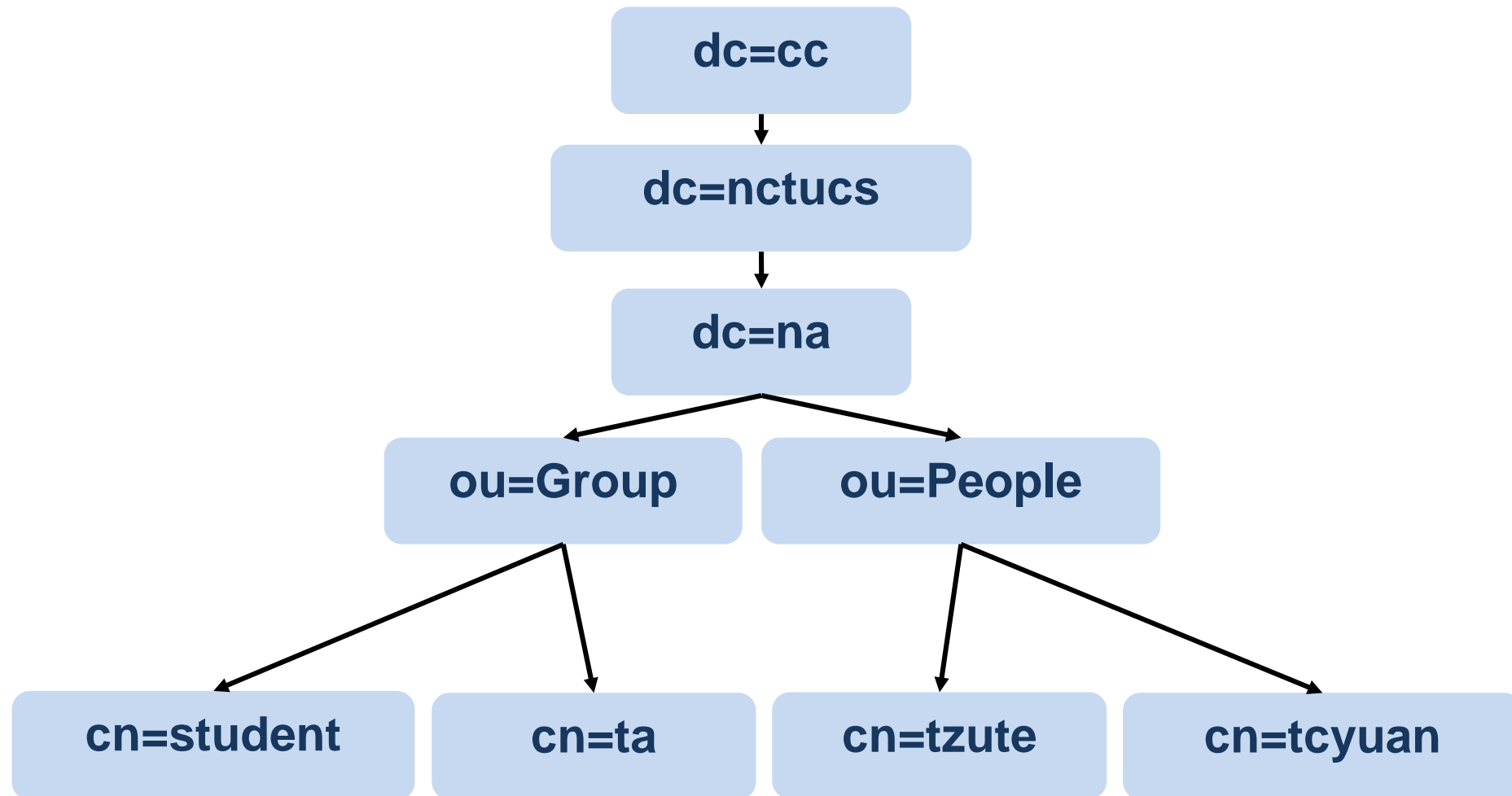
- -b searchbase
- -s {base|one|sub|children} # default is sub
- -D binddn
- -x # Use simple authentication instead of SASL
- -W # password for simple authentication
- -H ldapuri

□ ldapsearch [options] filter

- default filter, (objectClass=*)
- ldapsearch -H ldap://ldap.na.nctucs.cc
-D "cn=tzute,dc=na,dc=nctucs,dc=cc"
-b "dc=na,dc=nctucs,dc=cc" -s one

□ man ldapsearch

Ldapsearch (Cont.)



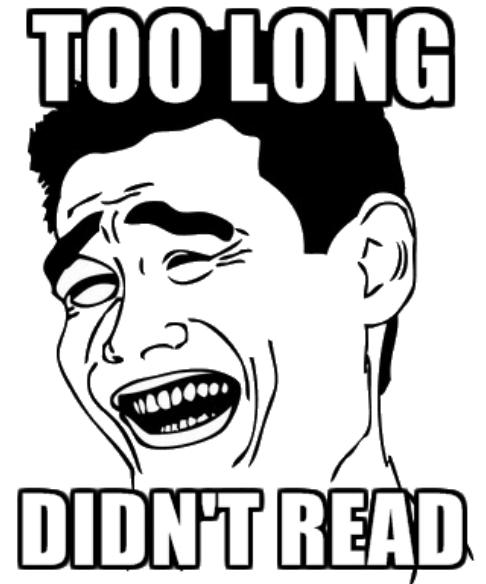
ldap.conf

❑ `ldapsearch -H ldap://ldap.na.nctucs.cc
-b "dc=na,dc=nctucs,dc=cc" cn=tzute`

❑ Edit `/usr/local/etc/openldap/ldap.conf`

```
# See ldap.conf(5) for details
# This file should be world readable but not world writable.
BASE      dc=na,dc=nctucs,dc=cc
URI       ldap://ldap.na.nctucs.cc
```

=> `ldapsearch -x "cn=tzute"`



ldapsearch – searchbase vs. filter

❑ Search by dn

```
# ldapsearch dn="cn=tzute,dc=na,dc=nctucs,dc=cc"
```

- It does not work!

❑ Use search base

```
# ldapsearch -b "cn=tzute,dc=na,dc=nctucs,dc=cc" -s base
```

- It works!

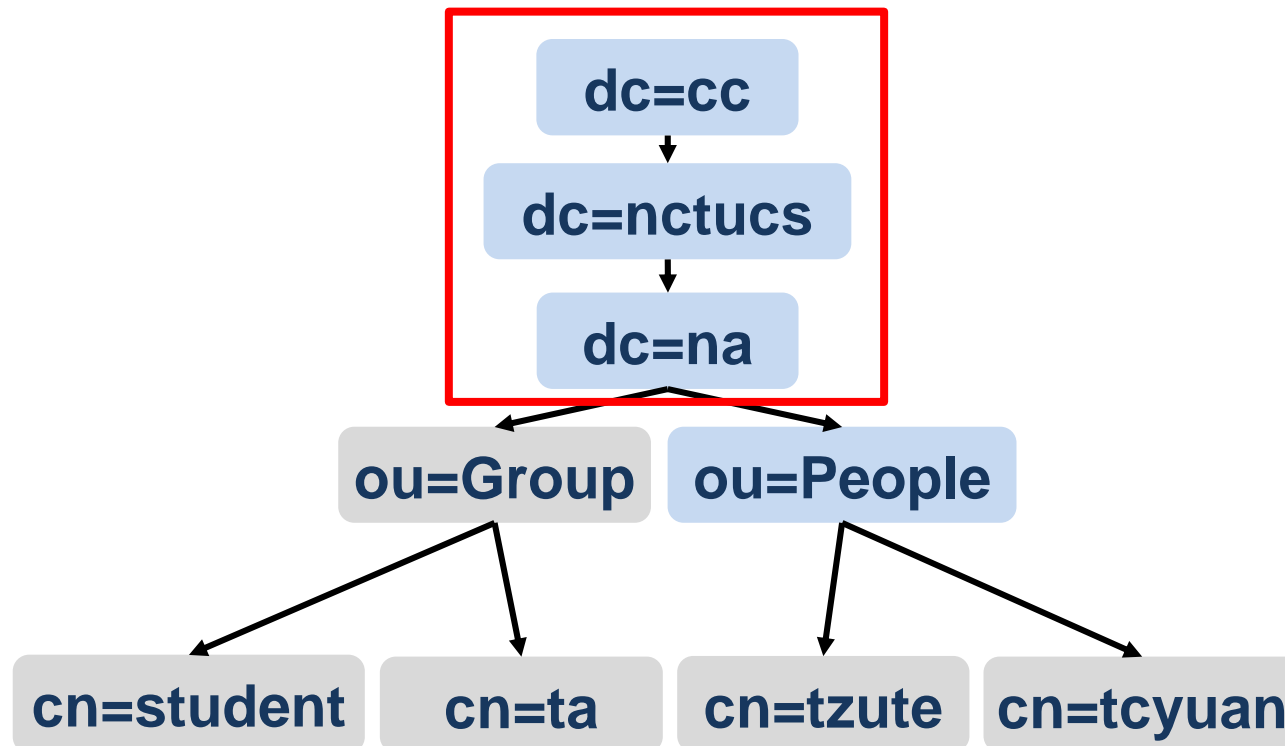
❑ Why?

- You have got full dn, don't need to search

Ldapsearch – searchbase vs. filter

□ Example

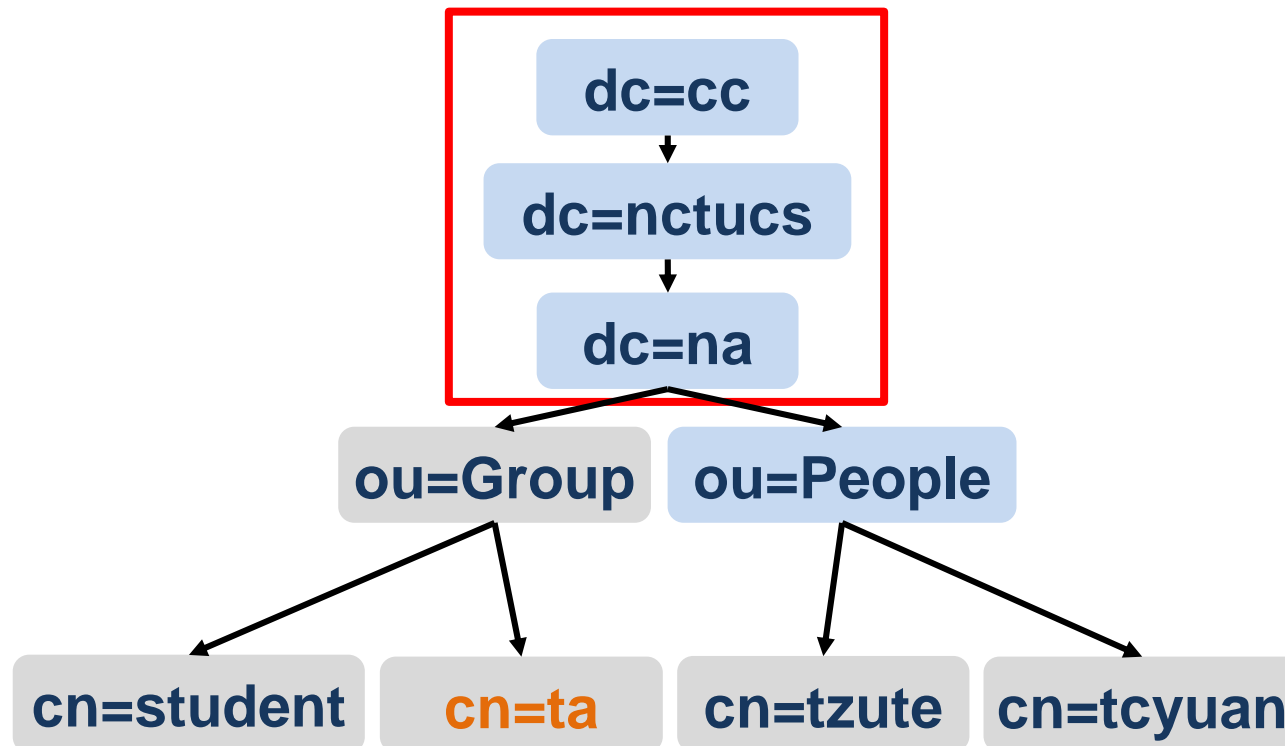
- Assume there are two kinds of searchbase
- **dc=na,dc=nctucs,dc=cc**
- **ou=People, dc=na,dc=nctucs,dc=cc**



Ldapsearch – searchbase vs. filter

□ Example (Cont.)

- filter – search for all entries that have cn=nata
- **cn=nata**
- **cn=nata** → Can't be found, because the cn=nata is not in this subtree



LDAP Authentication

國立陽明交通大學資工系資訊中心

Computer Center of Department of Computer Science, NYCU

LDAP Authentication (1/3)

- ❑ `pkg install nss-pam-ldapd`
- ❑ Edit `/usr/local/etc/nslcd.conf`
- ❑ Edit `/etc/nsswitch.conf`
- ❑ Edit `/etc/pam.d/system`

LDAP Authentication (2/3)

- ❑ Edit `/usr/local/etc/nslcd.conf`
 - Just like `ldap.conf`

```
# The user and group nslcd should run as.  
uid nslcd  
gid nslcd  
uri ldap://ldap.na.nctucs.cc  
base dc=na,dc=nctucs,dc=cc
```

LDAP Authentication (3/3)

□ Edit /etc/nsswitch.conf

<https://www.freebsd.org/doc/en/articles/ldap-auth/client.html>

```
# nsswitch.conf(5) - name service switch configuration file
# $FreeBSD: releng/11.1/etc/nsswitch.conf
group: files ldap
passwd: files ldap
```

References

- ❑ Understanding Directory Services
 - Beth Sheresh, Doug Sheresh - Sams Publishing
- ❑ LDAP System Administration: Putting Directories to Work
 - Gerald Carter - O'Reilly Media, Inc.
- ❑ The Lightweight Directory Access Protocol: X.500 Lite
 - Timothy A. Howes
- ❑ Internet protocol suite – Wikipedia
 - https://en.wikipedia.org/wiki/Internet_protocol_suite#Comparison_of_TCP/IP_and_OSI_layering