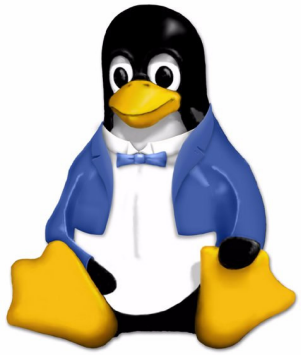

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Lightweight Replication for OpenLDAP

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OpenLDAP Replication

- **Slurpd**
  - ✓producer-initiated, log-based replication
  - ✓out-of-band replica management
- **A New Lightweight Replication**
  - ✓consumer-initiated, state-based, pull replication
  - ✓eventual consistency
  - ✓replication by search operation - no prior agreement
  - ✓minimal history information
  - ✓minimal consumer information in the producer side
  - ✓master-slave
  - ✓support partial replication (fractional and sparse)
  - ✓primary and secondary replication
  - ✓based on the client synchronization protocols
    - ✓draft-zeilenga-ldup-sync-01
    - ✓draft-ietf-ldup-lcup-04

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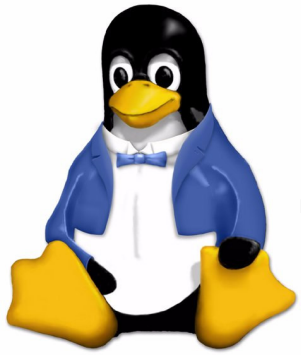

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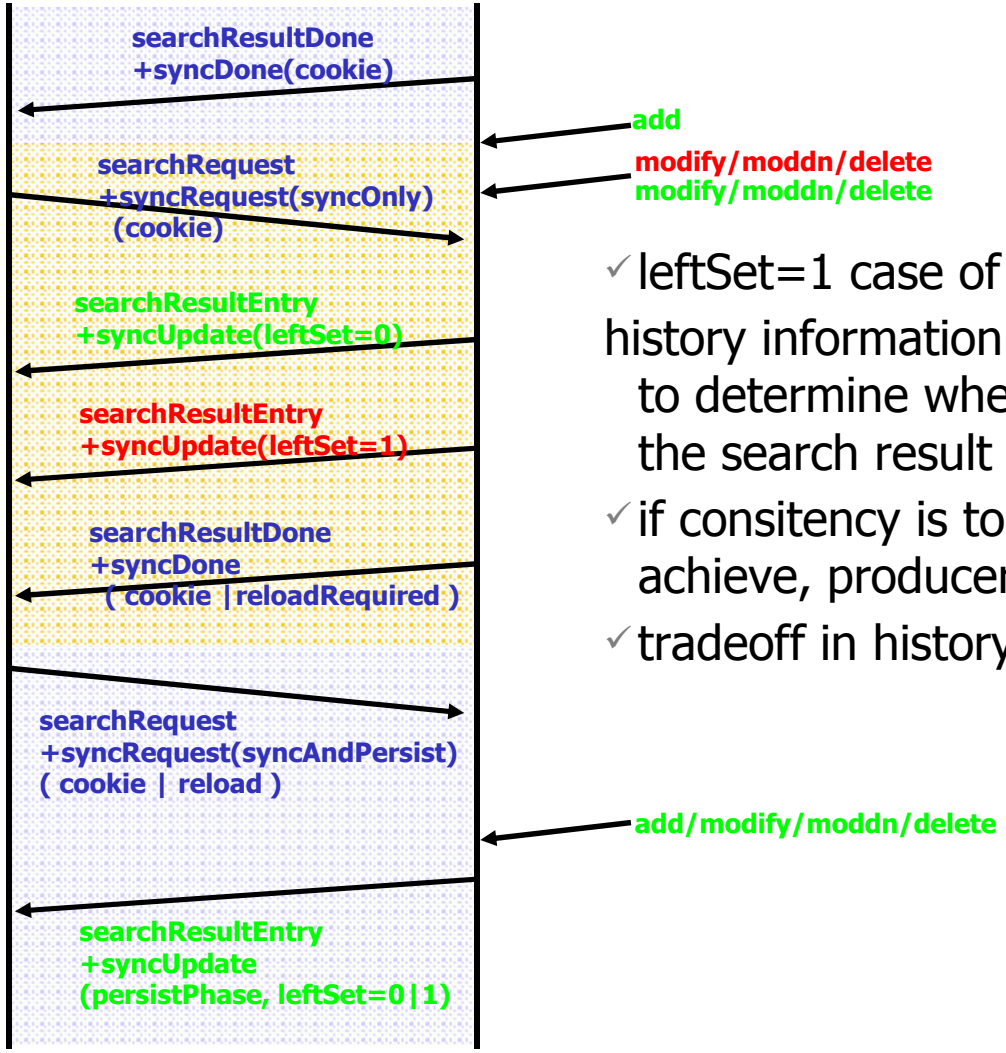
Sync Protocol - LCUP

- **LDAP Client Update Protocol** (Megginson et al.)
  - ✓synchronize directory entries, assume history information
  - ✓syncOnly, syncAndPersist, persistOnly



- ✓leftSet=1 case of syncOnly requires history information such as log or tombstone to determine whether the entry was within the search result before the operation
- ✓if consitency is too costly or impossible to achieve, producer issues reloadRequired
- ✓tradeoff in history info vs. chattiness

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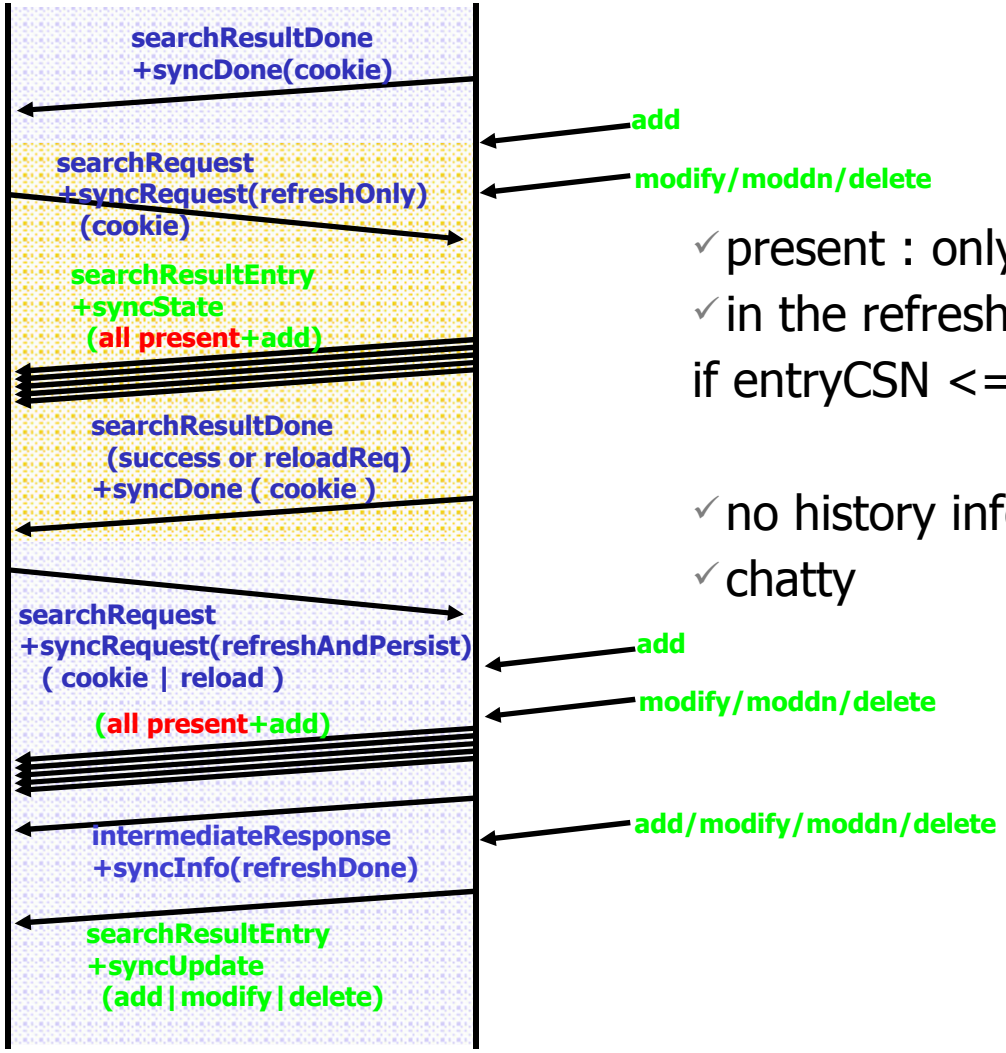
Sync Protocol - LDAP SYNC

LDAP Synchronization Protocol (Zeilenga and Choi)

- ✓synchronizing shadowed information, no history information assumed
- ✓refreshOnly, refreshAndPersist



- ✓present : only send DN and entryUUID
- ✓in the refresh phase,
  if entryCSN <= cookieCSN, send present
  else, send add
- ✓no history information is required
- ✓chatty

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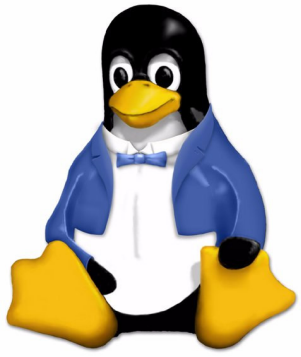

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LDAP SYNC - Chattiness Reduction

- **To reduce chattiness,**
  - ✓maintain lightweight history information
    for the finite number of refreshOnly consumers

replicaSubentry contains
  syncSearchSpec : {base, scope, filter, attrs, binddn}
  presentRange : {startCSN,endCSN}

  - ✓if an update causes an entry to leave one of the subtree refinement in the replicaSubentries under admPoint,
    add e.CSN before change as a presentRange attribute value
  - ✓when a refreshOnly of the same spec arrives,
    send present entries within the sync search result set
    only if (startCSN <= e.CSN <= endCSN)
    for each values of the presentRange attribute
  - ✓presentRange values shall be delivered as the syncInfo cookie
  - ✓tradeoff of consumer info vs. chattiness
    - ✓presentRange merge, open-ended presentRange value (0,inf)
    - ✓when consumer info is dropped -> presentRange = [0..inf]

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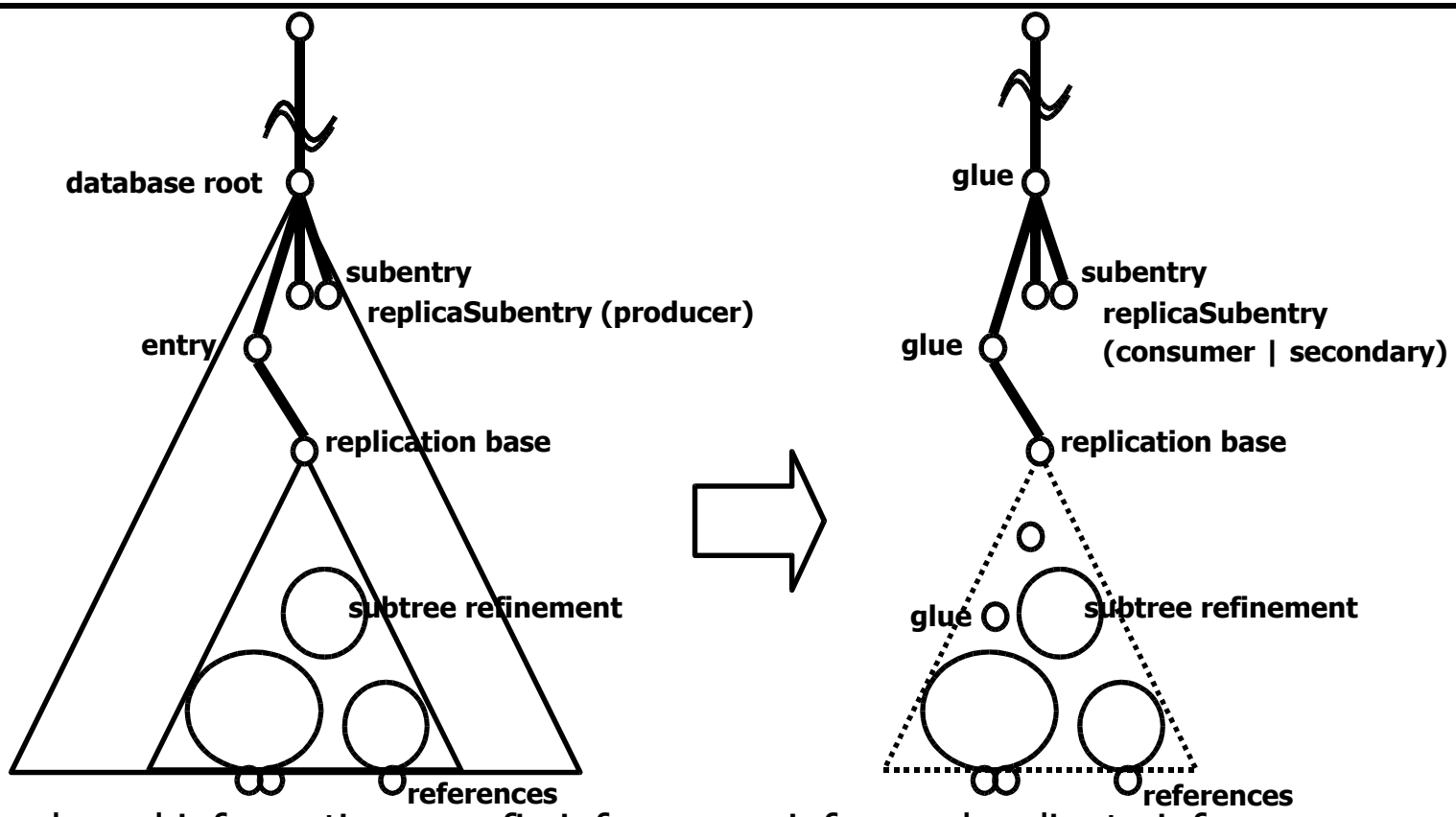
Information Model



- shadowed information : prefix info + area info + subordinate info
- objectClass
  - glue : only have naming information, objectClass attribute
  - replicaProducerSubentry : cn, replicaType, replicaStatus, replicationMode, syncSearchSpec, presentRange, secondaryConsumer, subtreeSpec
  - replicaConsumerSubentry : cn, replicaStatus, replicationMode, producer, binddn, bindmethod, credentials, interval, secondaryProducer, subtreeSpec
- replicaSubentries : rdns of all replicaSubentries subordinate to admPoint
- alias, reference : as in manageDsaIT

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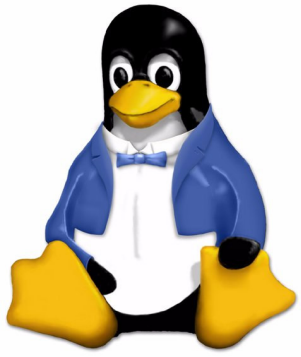

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CSN and UUID

Change Sequence Number

- ✓imposes total ordering of a sequence of updates
- ✓time#change count#replica id#modification number
- ✓20030321111:21:31z#0x00A7#1#0x0000
- ✓entryCSN, replicaCSN, startCSN, endCSN

CSN Generation

- ✓OpenLDAP generates CSN before backend update operation
- ✓max CSN of the committed update

may not be the max generated CSN

->replicaCSN may be greater than the actual replcia state

- ✓replicaCSN of the producer should be set to

the min outstanding CSN - δ

UUID : Universally Unique Identifier

- ✓DNs can change and so are unreliable
- ✓entryUUID

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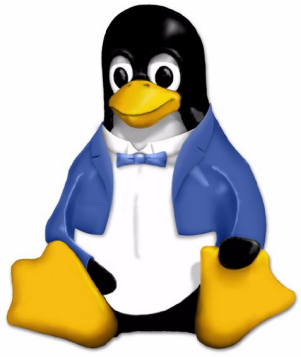

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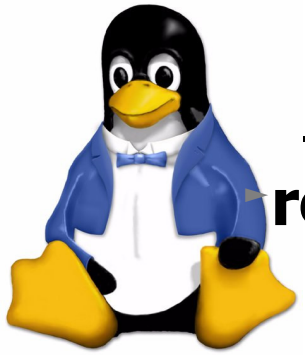
Configuration

- consumer configuration
  - ✓ slapd.conf

```
database        bdb
suffix          "o=ibm,c=us"
syncrepl id=1
        producer=ldap://producer.ibm.com:9009
        binddn="cn=repluser,o=ibm,c=us"
        bindmethod=simple
        credentials=secret
        replicationbase="ou=enterprise linux,o=ibm,c=us"
        filter="objectClass=organizationalPerson"
        attrs="cn sn description telephoneNumber l ou title"
        scope=sub
        type=refreshOnly
        interval=24h
```



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Replication Thread

replication thread pool of consumer

- ✓submit a replication thread

upon parsing a **`syncrepl`** line of slapd.conf

```
void *do_syncrepl( void *ctx, void *arg )
{
   get consumer replica cookie from replicaSubentry
   init connection to the producer
   bind to the producer
   ldap_search_ext(ld, si->base, si->scope, si->filterstr,
                   si->attrs, 0, NULL, NULL, NULL, -1, &msgid)
   while (msg) {
      if ( LDAP_RES_SEARCH_ENTRY ) {
         entry = msg_to_entry( msg, modlist, &rctrls )
         parse control ( &rctrls ) to get syncState, entryUUID, entryCSN
         syncrepl_entry ( entry, modlist )
      } else if ( LDAP_RES_SEARCH_RESULT ) {
         update consumer replica cookie
         delete entries within presentRange but not in si->presentlist
         reschedule do_syncrepl
      } else if ( LDAP_RES_INTERMEDIATE_RESP ) {
                  if ( syncInfo == cookie ) update consumer replica cookie
        else if ( syncInfo == presentRangeCookie ) update presentRange
      }
   }
```

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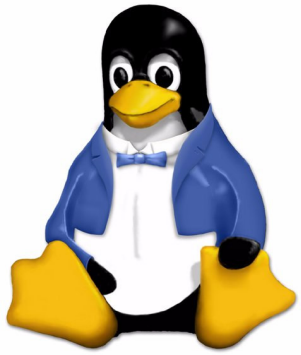

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Synchronization Update

- **synchronization update**
  - ✓internal modify and add with null callback functions

```
static int syncrepl_entry ( entry, modlist )
{
   set null_callback for 4 callbacks
   switch ( syncState ) {
   case LDAP_SYNC_PRESENT:
      avl_insert ( &si->presentlist, syncUUID )
   case LDAP_SYNC_ADD :
   case LDAP_SYNC_MODIFY :
      rc = be->be_modify ( &entry->e_name, modlist )
      if ( rc == LDAP_NO_SUCH_OBJECT ) {
         rc = be->be_add ( entry )
         if ( rc == LDAP_REFERRAL ) {
            syncrepl_add_glue ( entry )
         }
      }
   case LDAP_SYNC_DELETE :
      rc = be->be_delete ( &entry->e_name );
   }
}
```

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Summary

- **SyncRepl**
  - ✓a lightweight replication engine for OpenLDAP
- **Applications**
  - ✓Lightweight Directory Replication
  - ✓Synchronization for OpenLDAP Proxy Cache from IBM India Research
  - ✓IBM Directory Integrator Connector for OpenLDAP
- **Plans**
  - ✓Initial code available
  - ✓Initial source code contribution soon
  - ✓Solicit requirements from the community

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