Sync-based Replication :

Protocol and OpenLDAP Implementation

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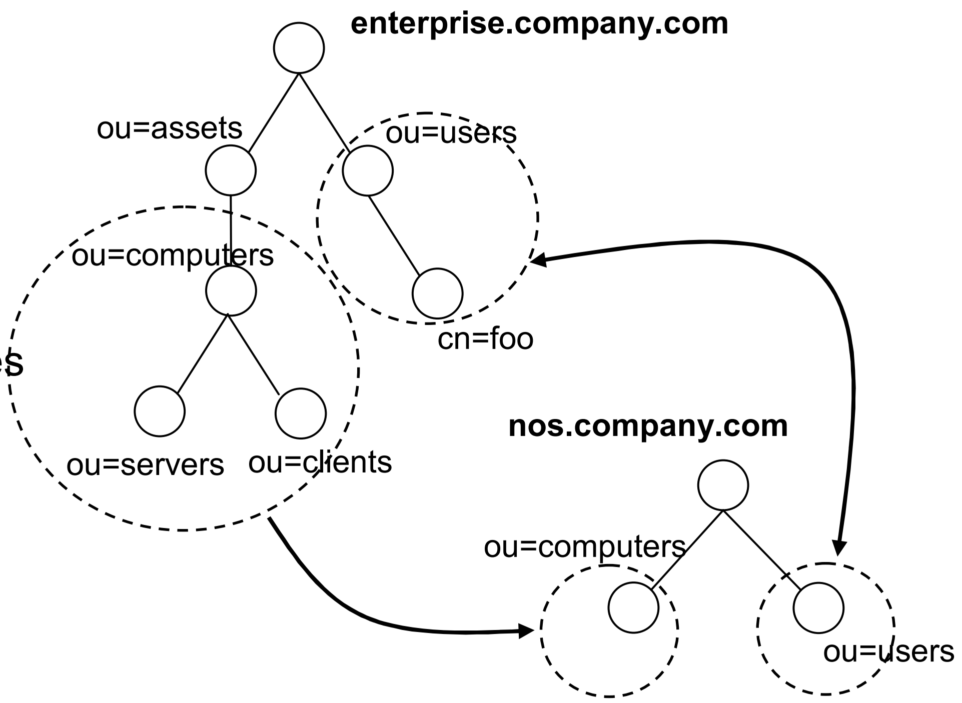
Agenda

- Directory Replication / Synchronization
  - Replication
  - Synchronization
  - OpenLDAP Slurpd
- LDAP Content Synchronization Protocol
  - Why not LCUP ?
  - Basic Protocol Description
  - Optimized Protocol for Traffic Reduction
- SyncRepl : A New Replication Engine
  - Sync-based Replication Engine Design
  - Client-based Replication Engine Design
- Target Applications
- Summary

Directory Replication

- Replication for High Availability, Performance, Security, Locality …
- When the directory is updated in a replicated setup, replicas need to be synchronized to each other to provide a single directory image
- Partition : unit of replication
  Replica : copy of a partition
- Master-slave vs. Multi-master
  - -Distributed directories via referral
    : referral chasing or chaining
  - -Separate masters for different roles
- Partial vs. Whole replication
- Replication topology

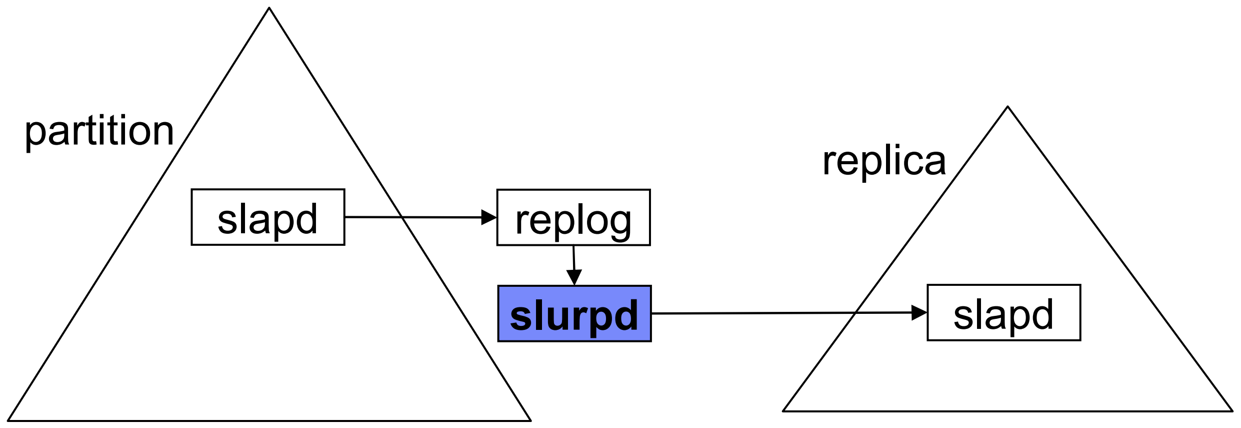


Directory Synchronization

- Keeping multiple directories up-to-date with each other
- Stateful vs. Stateless
  - Stateful : synchronization action is based on replica status
  - Stateless : provider assumes the replica status and synchronize accordingly
- State-based vs. History-based
  - State-based : synchronization action is determined based on the current replica status
  - History-based : history lookup is required for synchronization
- Incremental vs. Full Reload
  - Incremental : only changes made after last sync be transmitted
  - Full Reload : requires full reloads per every (or most) sync
- Push vs. Pull : provider-initiated or consumer-initiated
- Polling vs. Listening : periodic sync or event-driven sync
- Unit of synchronization : Entry-level vs. Attribute-level

Slurpd

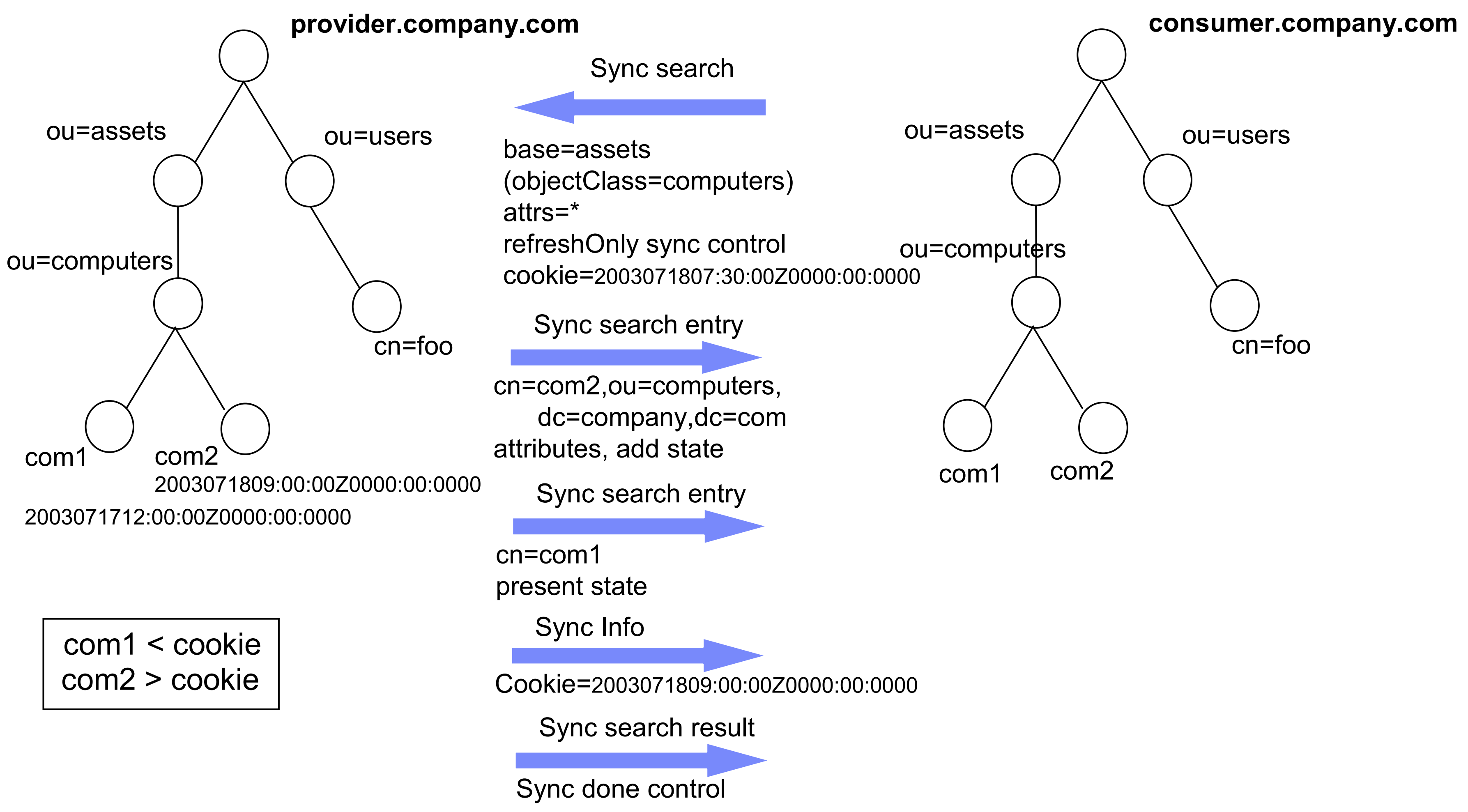
- Slurpd : standalone LDAP Update Replication Daemon
  - Master-slave
  - Multi-master for one level replication only
    without predefined URP (Update Reconciliation Protocol)
  - Stateless, History (replog) based, Push, Incremental synchronization
- Example
  1. Initial replication (db copy or ldif load) with master read-only
  2. Promote master to read-write
  3. Incremental synchronization



LDAP Content Synchronization Protocol

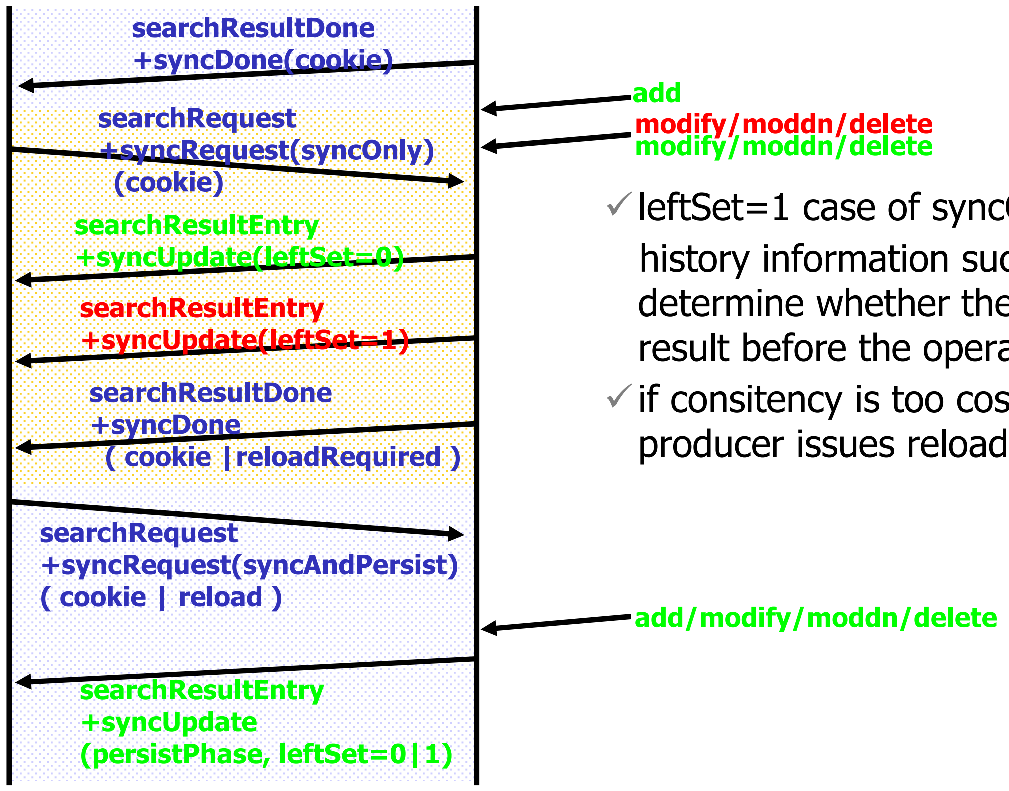
- Stateful : cookie represents current replica status
- State-based : does not mandate history store
- Incremental : only changes after last sync are to be transmitted
- Pull : clients initiate synchronization sessions
- Polling & Listening : refreshOnly & refreshAndPersist
- Partial replication : supports arbitrary search specification
- Eventual consistency
- Unit of synchronization : entry
- Does not require predefined synchronization arrangement
  per-consumer information
  history

LDAP Sync : Example



Why not LCUP ?

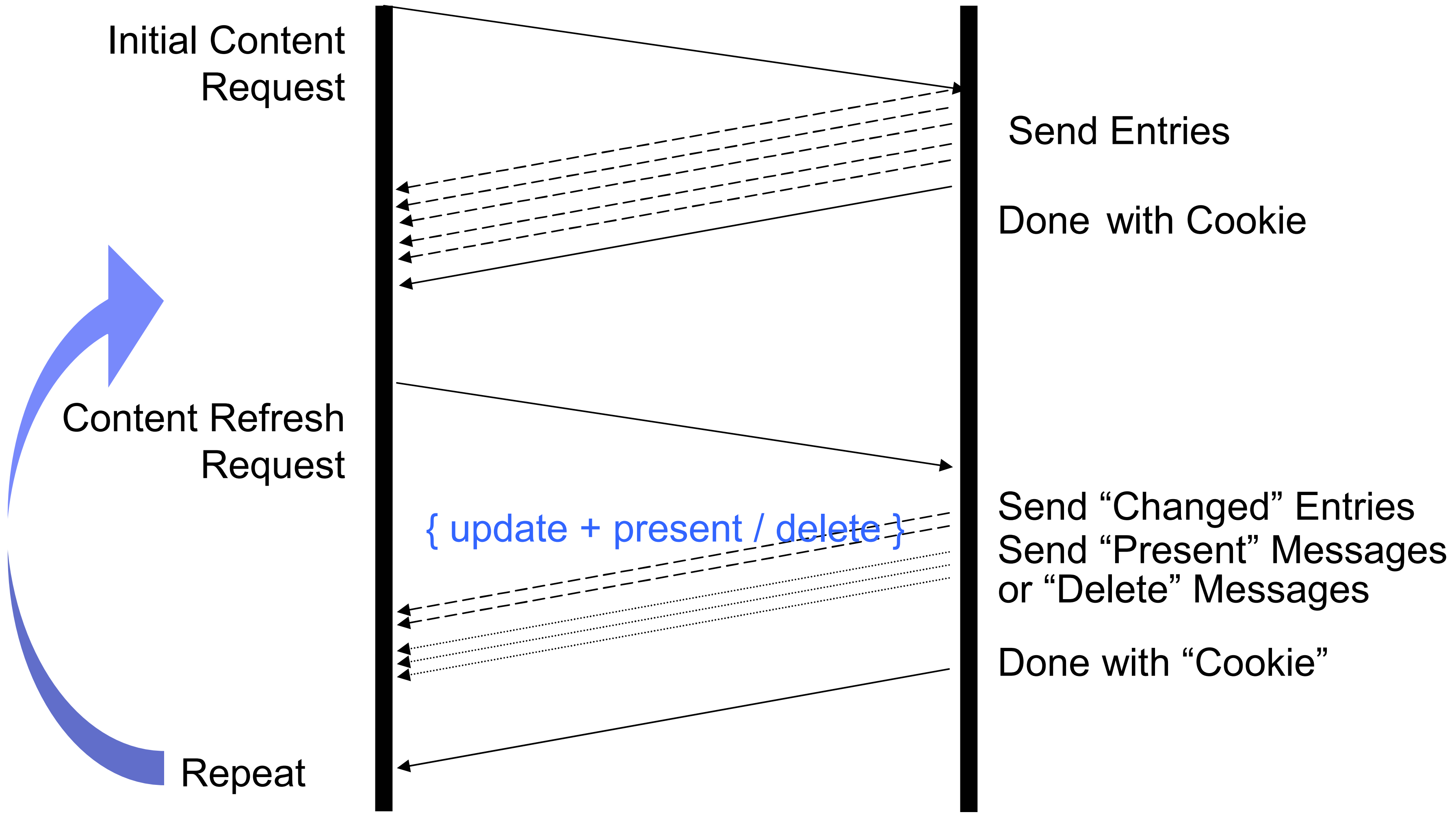
- LCUP (LDAP Client Update Protocol)
  - Sends {updates + deletes}
  - Requires history information for reasonably efficient implementation
  - OpenLDAP doesn't maintain history information (tombstone, changelog …)



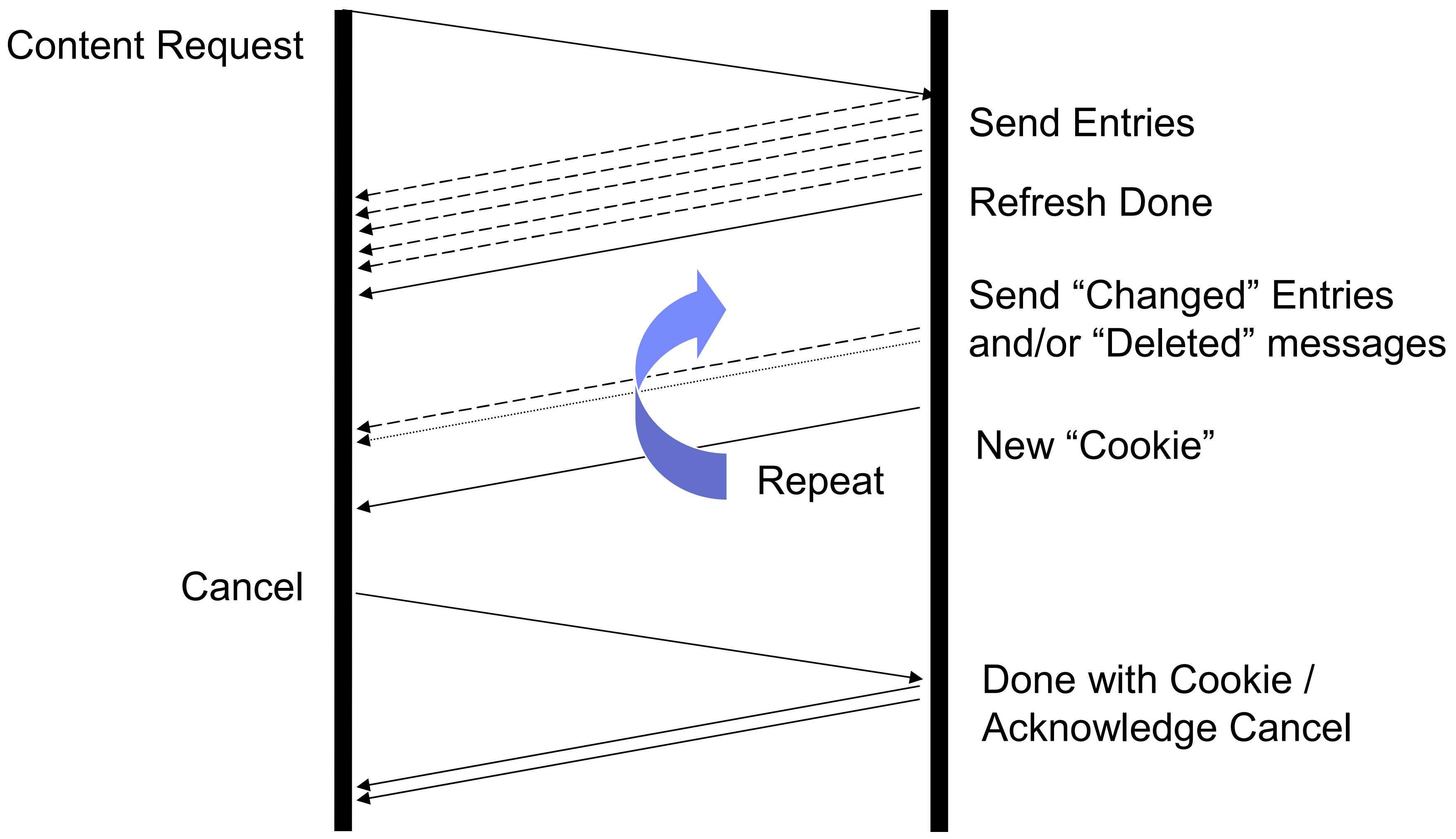
✓ leftSet=1 case of syncOnly requires history information such as log or tombstone to determine whether the entry was within the search result before the operation

✓ if consitency is too costly or impossible to achieve, producer issues reloadRequired

Basic Protocol : Refresh

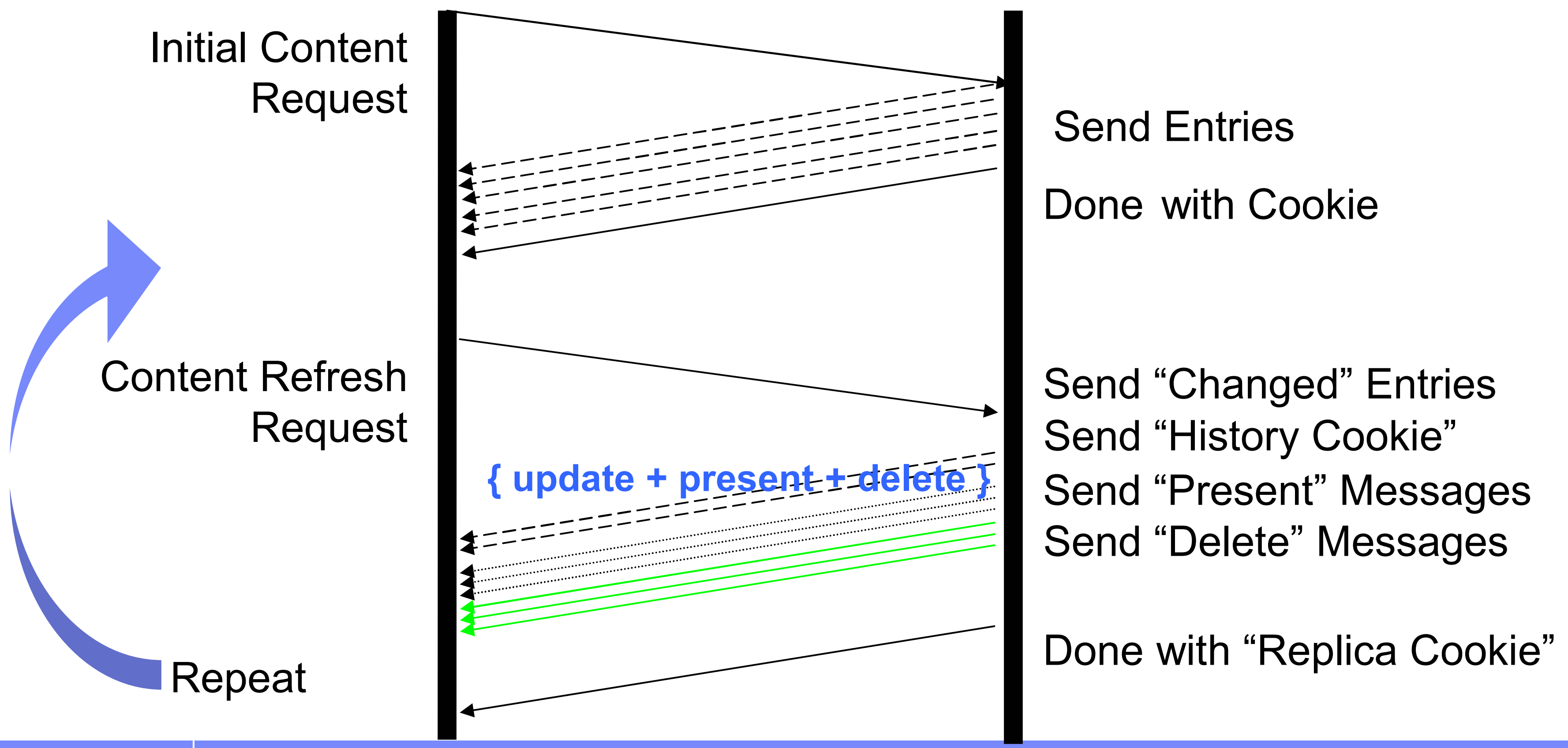


Basic Protocol : Refresh & Persist


Content Request
Send Entries
Refresh Done
Send “Changed” Entries and/or “Deleted” messages
New “Cookie”
Repeat
Cancel
Done with Cookie / Acknowledge Cancel

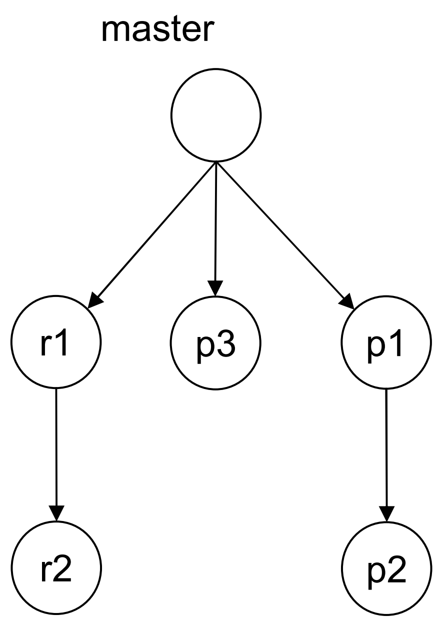
Protocol Optimization (Present Phase + Delete Phase)

- Delete mode : requires full reload if replica state is out of history
- Present mode : requires present entry transmission even if replica is within history
- Present + Delete : sends deletes for the scope-outs covered by the history store
  sends presents for those not covered by the history



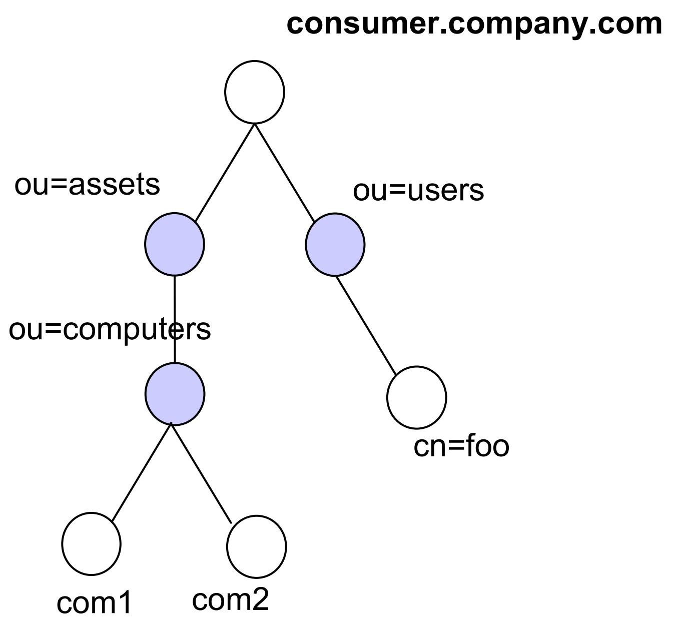
Replication Engine Design

- Periodic execution of refresh tasks :
  scheduling facility in `slapd_daemon_task()`
  simple runqueue implementation
- Storage of sync cookie in consumer :
  Subentry : `syncConsumerSubentry`
- Operational attributes :
  `Regenerated at replica as needed`
- structuralObjectClass :
  generate on-the-fly in `slap_mods_opattrs()`
- UUID, CSN based implementation
  UUID : stable entry identifier
  CSN as cookies
- Configuration example
  test017 : refreshOnly, test018 : refreshAndPersist, test020 : cascading



Replication Engine Design : Glueing

- Glues : Naming entries for holes in DIT
  - Delivery can be out of hierarchy order after several rounds of updates
  - Partial replication
- Glue construction
  - syncrepl_add_glue()
  - Find first non-glue superior object
  - Create glues from down to the entry



- Schema checking bypass for glues (rdn attribute requirement)
- Glueing for LDAP Proxy Cache

Client-based Replication Engine

- Heterogeneous replication
  - SyncRepl engine needs to talk to generic LDAP servers

- Synchronization without LDAP Content Synchronization
  1. Search for (&(original filter)) asking only UUID and CSN attributes - Present phase
  2. Delete replica entries not returned by (1)
  3. Search for (&(original filter)(entryCSN>cookie)(entryCSN=<maxCSN(1))
     asking replicated attributes + UUID + CSN - Update phase

  - Replica is synchronized to the point maxCSN(1)

- Comparison with SyncRepl with LDAP Content Synchronization
  - Only supports polling
  - Extra requests / replies
  - Extra traffic (only present mode)

Target Applications

- Slurpd replacement
  - OpenLDAP to OpenLDAP replication based on LDAP content sync protocol
  - Heterogeneous replication by using client-based replication engine
- LDAP Proxy Cache synchronization
  - Replace current TTL based scheme
  - Replication and Caching
- IBM Directory Integrator Connector
  - Heterogeneous Directory Synchronization : Meta-directory

Summary

- LDAP Content Sync Protocol
  - draft-zeilenga-ldup-sync-xx.txt
- OpenLDAP SyncRepl Engine
  - servers/slapd/syncrepl.c
  - tests/data/slapd-syncrepl-master.conf
  - slapd-syncrepl-slave-xxxxx.conf
- Any Questions ?