whamcloud

Imperative Recovery

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Agenda

- Recovery 101
- Why is recovery slow
- How does imperative recovery help

Recovery 101 1/2

- Lustre is a distributed file system built on multiple nodes
- Nodes are connected by networks
- Everything can fail:
  - Node power outage
  - Network partition
  - Software bugs
- Servers will rejoin the cluster after restarting
  - Recovery restores system consistent

Recovery 101 2/2

- Service can't be interrupted during failures
- POSIX semantics have to be maintained always
- Recovery stages
  - Connection recovery
  - Transaction recovery
  - Llog is used to keep multiple nodes transactions in sync

What makes recovery slow?

- Server must wait for all clients to reconnect
  - Recovery replays uncommitted client transactions
    - Must be executed in original order – transno
  - No new transactions until recovery completes
    - Could invalidate recovery transactions
- Clients slow to detect server death
  - Only fault detection is in-band RPC timeout
    - Includes both network and service latency
    - Server under heavy load hard to distinguish from dead server
  - Ping not scalable
    - Ping overhead O(#servers * #clients / ping_interval)
    - Ping interval must increase with system size
  - A client may know the server failure after ping interval + RPC timeout

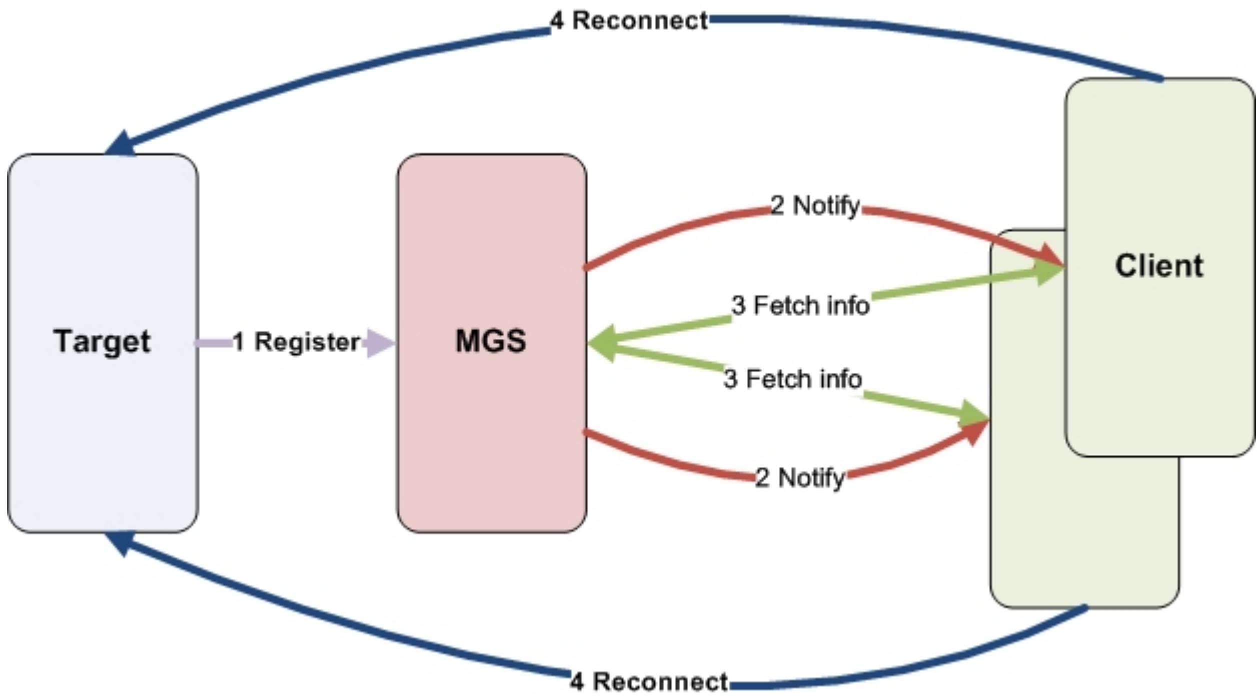
Introduction of Imperative Recovery

- Accelerate reconnection by notifying clients of server restarts, no longer use timeout
- MGS is used to reflect server failure event to clients
  - Notify clients when a restarted target registers itself to MGS
  - Clients will do reconnection
- Imperative recovery depends on MGS, it's a best-effort service
  - Not impede normal recovery from happening
  - It's important to identify which instance of targets the clients are connecting
- Failover server support

Implementation - overall

- The MGS maintains a target NIDs table
  - This table records what NID the targets live on
  - Upon receiving a target register message, MGS changes the table
- There is an ldlm resource for each running file system on MGS
  - Recovlock on the resource
  - Clients hold shared mode recovlocks on this resource to cache the NID table
  - Whenever MGS updates the table, it enqueues an EXCL recovlock so the clients will be notified
- After being notified, clients will query MGS and then update its cache copy
  - Reconnecting to the target by NEW nid

Implementation - overall



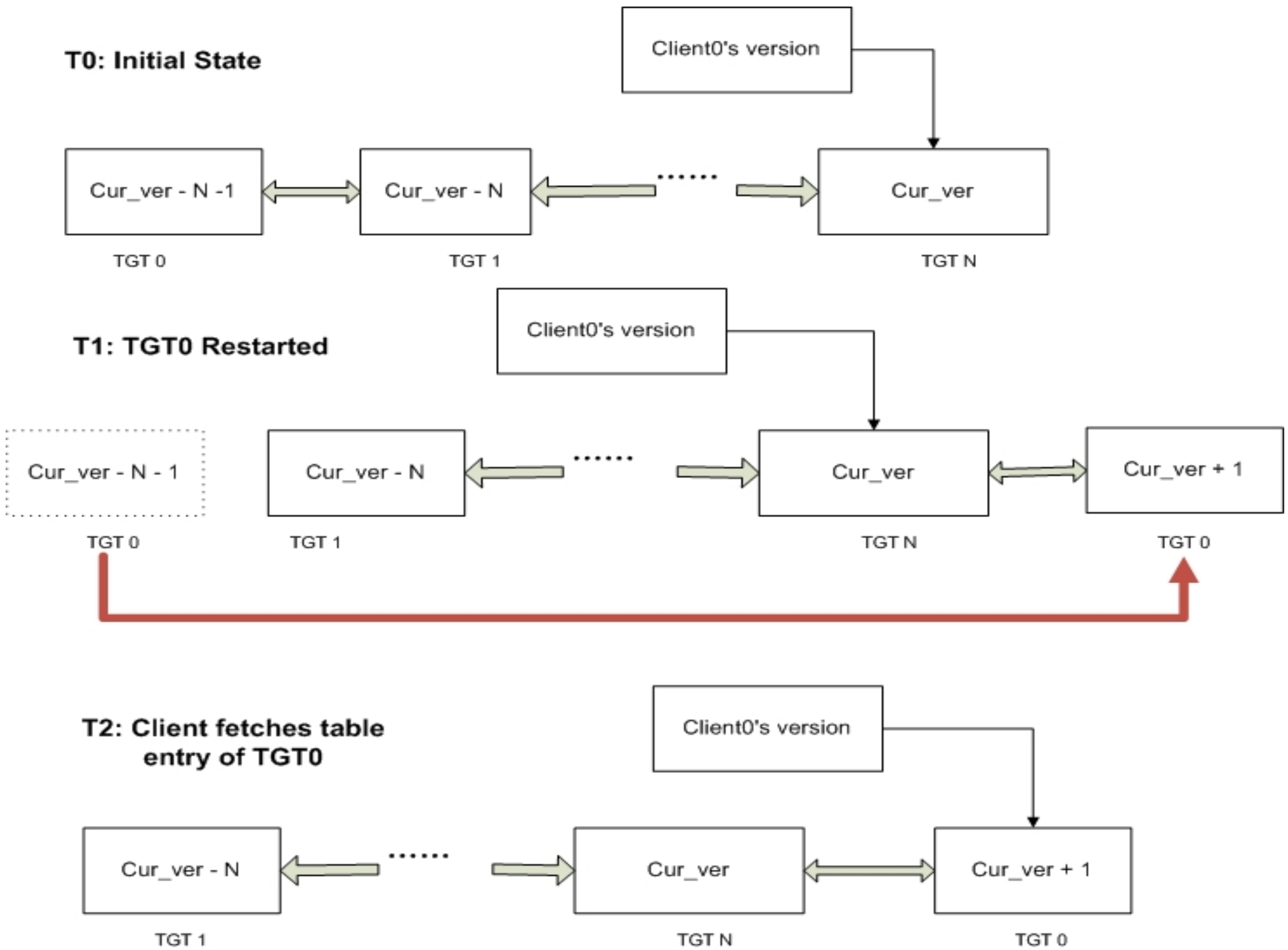
Implementation – Target NID Table

- Version of Target NID Table
  - Version is increased by 1 whenever the Table is changed
  - Clients cache the target NID table locally with a version
  - Latest version has to be written into persistent storage
- Each living target has a entry in the table
- What info should be included in the NID table entry
  - Target name
  - Target server index – ost index or mdt index
  - # of target NIDs and NID list
    - 128 bytes per NID for lnet_nid6_t
  - Table version when the entry was last updated
  - Target instance number – uniquely identify a running target

Implementation – Target NID Table

- The target NID table may be large
  - In a large cluster with 1K targets, it's impractical to transfer the whole table in one RPC
  - Only updated entries will be transferred
  - Should use bulk transfer
- MGS maintains table in a linked list with the increasing version # of entries
- Sync the table between the MGS and clients
  - When being notified, clients will provide their versions to the MGS, the MGS only returns the entries whose version # is greater than their version
  - Only a few entries will be fetched

Implementation – Target NID Table



Procfs - IR state

- IR state on the MGS

  [root@wolf6 tests]# lctl get_param –n mgs.MGS.live.lustre
  […]
  Imperative Recovery Status:
      state: full, nonir clients: 0
      nidtbl version: 5
      notify total/max/count: 0.000000/0.000000/3

- IR state on clients

  [root@wolf6 tests]# lctl get_param -n mgc.*.ir_state
  IR: ON
  Fs Cli State:
    fscli: lustre-client, nidtbl version: 5

- Nidtbl version should match

Procfs – Target instance number

- Target instance number

  [root@wolf6 tests]# lctl get_param obdfilter.lustre-OST0000.instance

  obdfilter.lustre-OST0000.instance=133

- Instance number seen by OSC import

  lctl get_param osc.lustre-OST0000-*-[^M]*.import |grep instance

  instance: 133

- Instance numbers should match

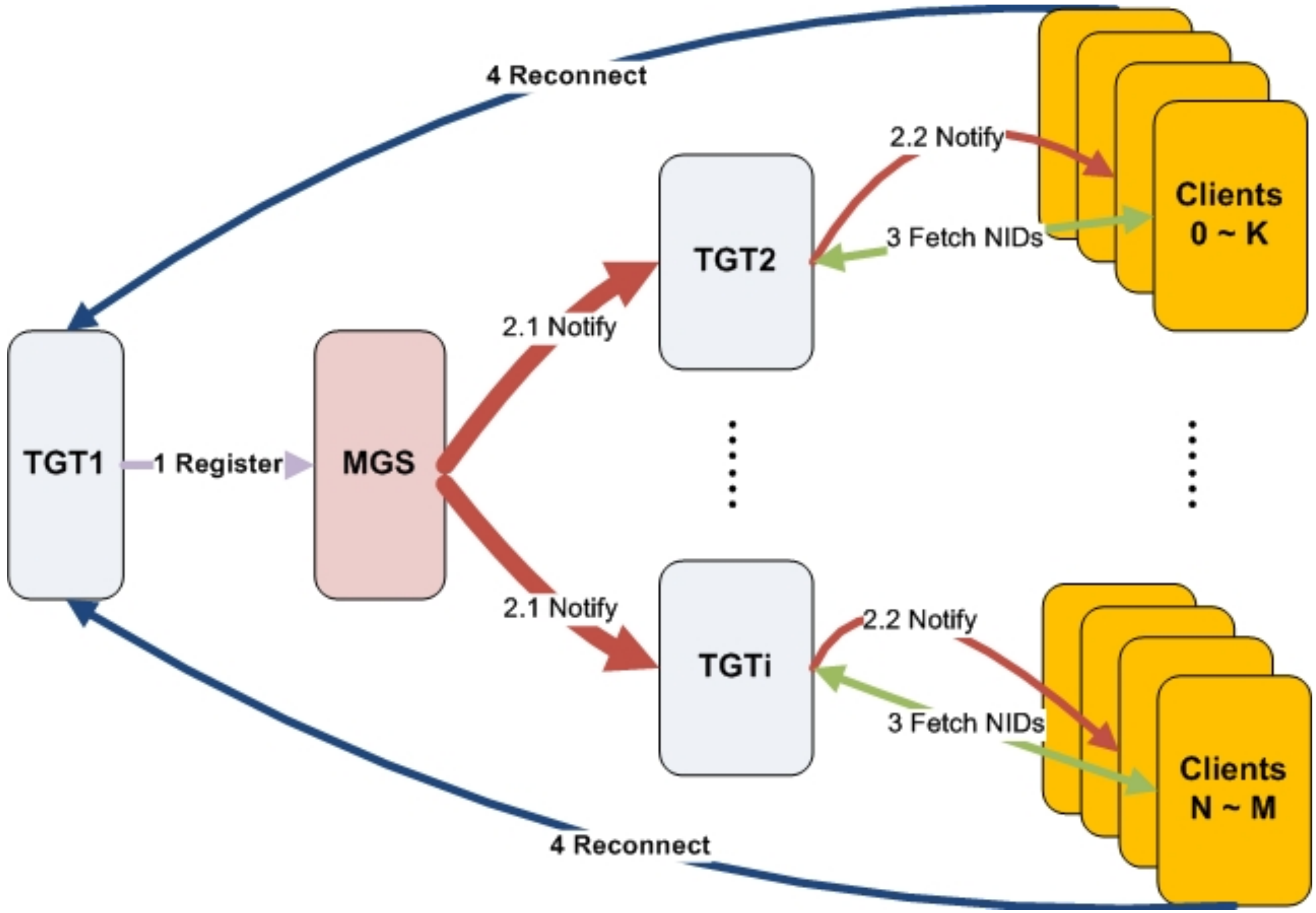
Performance

- A restarting target is able to finish recovery within 66 seconds
  - 125 client nodes, 600 mountpoints on each node, 75K clients in total
  - No workload in the cluster
- As a comparison, it took ~300 seconds w/o IR

Implementation – Future work

- Problems of current implementation
  - MGS is the single point of failure
    - If MGS is down, imperative recovery won't work, but normal recovery is not affected
  - If the cluster is really big(100K clients?), it would be slow for the MGS to notify clients
    - MGS needs to send 100K RPCs to notify clients
    - Clients fetch update of entries with 100K RPC in total
    - Recovlock requeue overhead
- Solutions
  - Health network
  - Map/Reduce similar algorithm on MGS

Implementation – Future work



Work in Progress

- Planned to release in Q2 of 2012
- Sponsored by ORNL

Thank You

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