Lustre HSM Project

Lustre User Advanced Seminars

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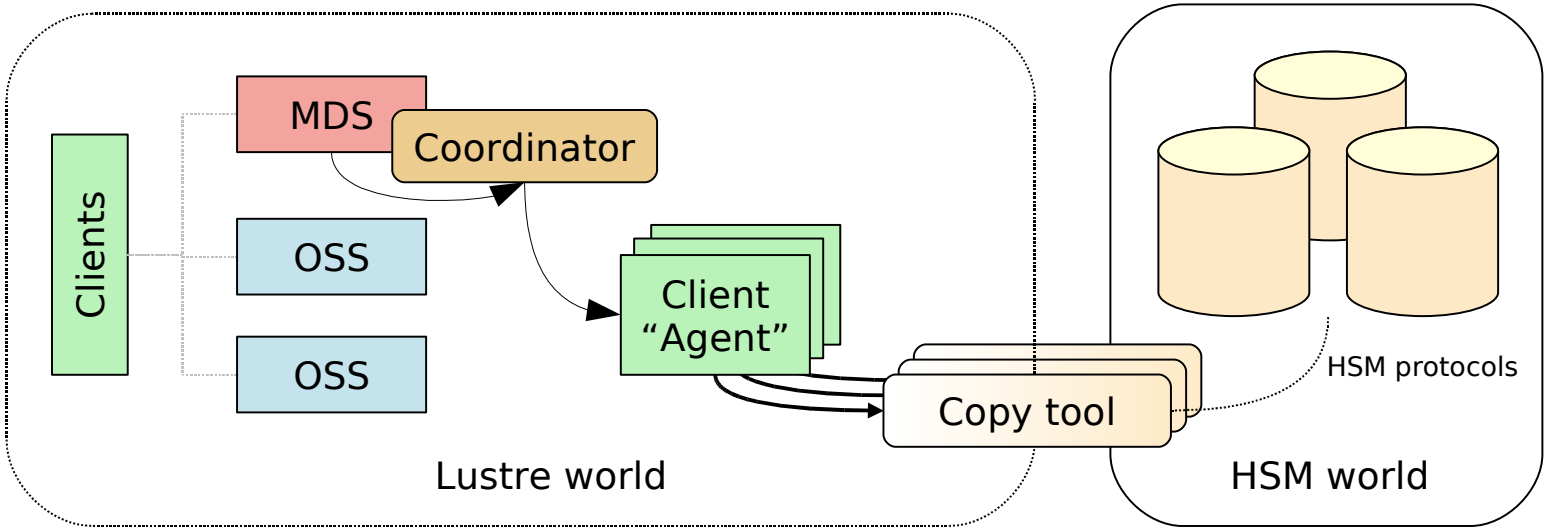
Outline

- **Presentation**
  - Architecture
- **Usage**
  - Start Lustre/HSM
  - New file states
  - Coordinator and HSM requests
  - Multiple HSM backends
- **Policy Engine – Robinhood**
  - Presentation
  - Policies
  - Reports
- **Internals**
  - Archive request sequence
  - APIs

Presentation

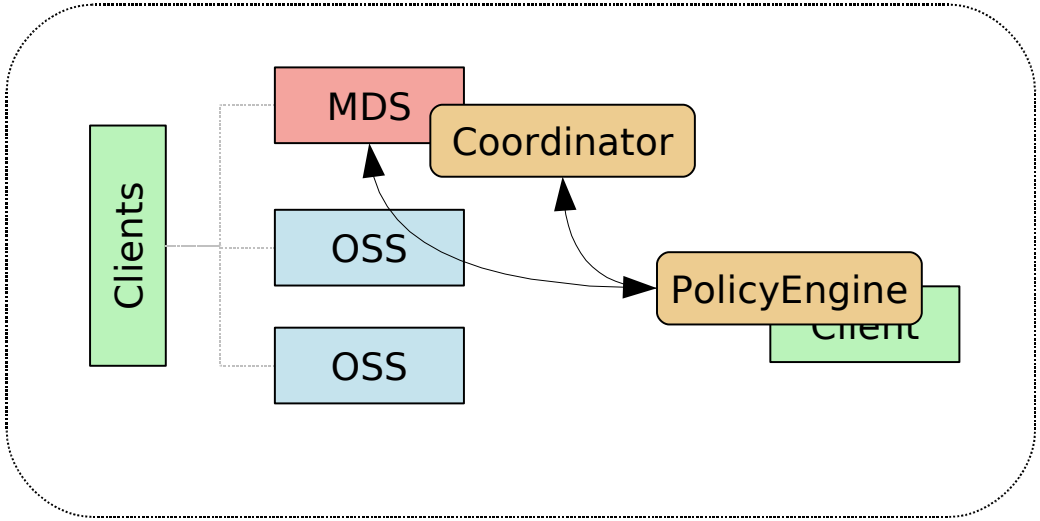
- **Features**
  - Migrate data to an external storage (HSM)
  - Free disk space when needed
  - Bring back data on cache-miss
  - Policy management (migration, purge, soft rm,…)
  - Import from existing backend
  - Disaster recovery (restore Lustre filesystem from backend)
- **New components**
  - Coordinator
  - Archiving tool (backend specific user-space daemon)
  - Policy Engine (user-space daemon)

Architecture (1/2)



- **New components: Coordinator, Agent and copy tool**
  - The coordinator gathers archiving requests and dispatches them to agents.
  - Agent is a client which runs a copytool which transfers data between Lustre and the HSM.

Architecture (2/2)



- **PolicyEngine manages pre-migration and purge policies.**
  - A user-space tool which communicates with the MDT and the coordinator.
  - Watch the filesystem changes (using Changelogs).
  - Trigger actions like pre-migration, purges and removal in backend.

New HSM file states

- **Files have new possible states and special flags**
  - *Exist*: Some copy exists in a HSM (may be incomplete)
  - *Archived*: A full copy was done for this file.
  - *Dirty*: The Lustre file has been modified since last copy.
  - New file state: *Released*
    - A *released* file still has its inode in MDT.
    - But LOV information and LOV objects on OST are removed.
- **Manually set flags**
  - *Lost*: The file copy has been lost. The file could not be restored.
  - *No release*, *no archive*: Policy flags
- **Users could manually set some of them**
  - *No release*, *no archive*, *dirty*

How-to start

- **Format your devices as usual**
- **Start your MDT with additional mount option**
  - # mount -t lustre … -o hsm_cdt
- **On each node which will act as a transfer node (Agent), starts a copytool**
  - # hsm_copytool_posix --hsm_root /tmp/arc lustre
- **Your filesystem is ready to archive, try:**
  - # lfs hsm_archive /mnt/lustre/my_file

lfs hsm commands

- **Get and change HSM states**

```
$ lfs hsm_state /mnt/lustre/my_file
    /mnt/lustre/my_file
    states: (0x00000009) exists archived
$ lfs hsm_set --norelease /mnt/lustre/my_file
$ lfs hsm_clear --noarchive /mnt/lustre/my_file
```

HSM request handler: coordinator

- **New thread on MDT component.**
  - Centralize HSM requests. Ignore duplicate ones.
  - Dispatch and balance them on available copytools.
- **Manage internally a llog of all requests.**
  - Replay request if MDT has crashed.
  - Can be manually canceled
  - Behavior is tunable
    - Can be stopped, resumed, purged
    - Retry/No retry on error
    - Timeouts, number of simultaneous requests, ...
- **Information/Tunings**
  - lctl get_param mdt.lustre-MDT0000.hsm.*

HSM requests

- **Archive**
  - Archiving a file means pre-copying a file from Lustre to an external HSM.
  - A copytool reads file content and copy it in its HSM.
  - File is ready to be released.
- **Release**
  - Remove all file data objects.
  - Synchronous action which does not involve copytool nor coordinator.
- **Restore**
  - All file accesses are blocked until the file is fully restored.
  - Copytool will write file data back.
  - File data accesses are unblocked when restore is finished.

Manage requests

- **Manual HSM requests**
  - lfs hsm_archive /mnt/lustre/my_file
  - lfs hsm_release /mnt/lustre/my_file
  - lfs hsm_restore /mnt/lustre/my_file
    - Asynchronous, non-blocking restore.
    - File open also restores it, but it is synchronous and blocking.
  - lfs hsm_cancel /mnt/lustre/my_file
- **Display current request info**
  - lctl get_param mdt.*.hsm.requests

```
fid=[0x200000400:0x2:0x0] compound/cookie=0x4ba73f88/0x4ba73f87
action=ARCHIVE archive#=0 extent=0x0-0xffffffffffffffff gid=0x0
```

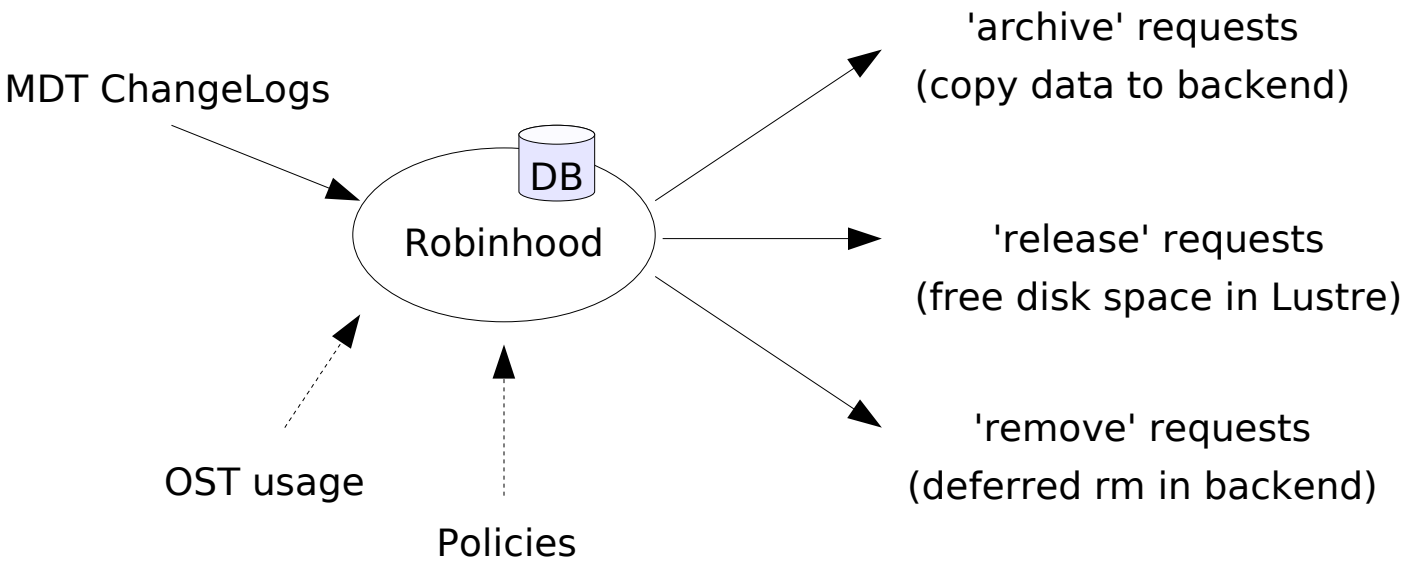
Robinhood

- **Robinhood is a user-space daemon for managing temporary filesystems**
  - Purge oldest files when needed
  - Custom policies
- **With a database backend**
  - Persistent, avoid scanning for each action
  - Currently MySQL and SQLite are supported.
- **Supports and use Lustre features like:**
  - File striping, disk usage per OST, per pool
  - Lustre FID (2.0), Changelogs (2.0)
- **Adapted for Lustre/HSM binding purpose.**
  - To control/schedule file archiving, release, …
- **Flexible policy language**
- **Largest filesystem currently managed: 100 million entries**

Robinhood policies

- **Robinhood manages 3 kinds of policies**
  - Migration policy
  - Purge policy
  - Removal policy
- **Policies**
  - File class definitions, associated to policies
  - Based on file attributes (path, size, owner, age, xattrs, …)
  - Rules can be combined with boolean operators
  - LRU-based migration/purge policies
  - Entries can be white-listed

Robinhood as Lustre/HSM binding PolicyEngine



Robinhood: example of migration policy

- **File classes:**

```
Filesets {
      FileClass small_files {
          definition { tree == "/mnt/lustre/project" and size < 1MB }
          migration_hints = "cos=12" ;
…
      }
}
```

- **Policy definitions:**

```
Migration_Policies {
      ignore { size == 0 or xattr.user.no_copy == 1 }
      ignore { tree == "/mnt/lustre/logs" and name=="*.log" }

      policy migr_small {
                target_fileclass = small_files;
                condition { last_mod > 6h or last_copyout > 1d }
      }
      …
      policy default {
                condition { last_mod > 12h }
                migration_hints = "cos=42";
      }
}
```

Robinhood: example of purge policy

- **Triggers:**

```
Purge_trigger {
   trigger_on = ost_usage;
   high_watermark_pct = 80%;
   low_watermark_pct = 70%;
}
```

- **Policy definitions:**

```
Purge_Policies {
   ignore { size < 1KB }
   ignore { xattr.user.no_release = 1 or owner == "root" }

   policy purge_quickly{
         target_fileclass = classX;
         condition { last_access > 1min }
   }
   …

   policy default {
         condition { last_access > 1h }
   }
}
```

Robinhood administration

- **Control actions: rh-hsm**
  - Robinhood daemon reads events and applies policies.
  - Could be used to manually apply specific purges or migration
    - # rh-hsm --purge-ost=2,10
    - # rh-hsm --sync
- **Display reports/status: rh-hsm-report**
  - Uses Robinhood database to generate reports on the filesystem:
    - Statistics per user, group, largest files, disk space consumers
    - List files per user, group, OST, ...
- **Full administration guide:**
  - See “Documentation” on: http://robinhood.sf.net/

Copytool

- **It is the interface between Lustre and the HSM.**
- **It reads and writes data between them. It is HSM specific.**
- **It stands on a standard Lustre client (called Agent).**
- **2 of them are already availables:**
  - HPSS copytool. (HPSS 7.3+). CEA development which is freely available to all HPSS sites.
  - Posix copytool. Can be used with any system supporting a posix interface. (supports SAM/QFS)
- **More supported HSM to come**
  - DMF
  - Enstore

Import existing HSM

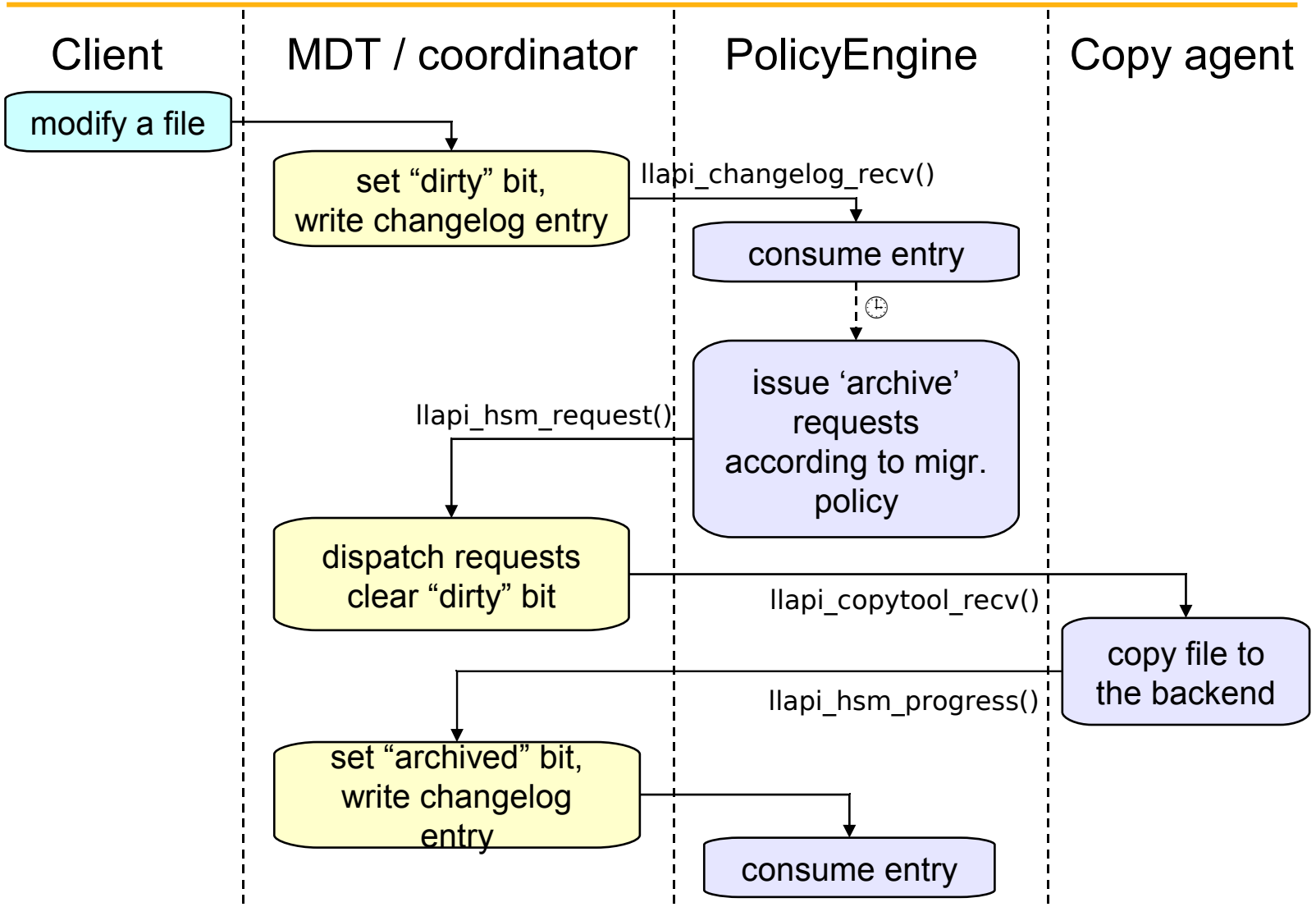
- **It is possible to import an existing HSM namespace into a Lustre filesystem.**
- **All files are imported as *released* and are ready to be restored at first access.**
- **Importing should be implemented for each HSM backend.**
- **Similar mechanism for recovery.**

Multiple HSM backends

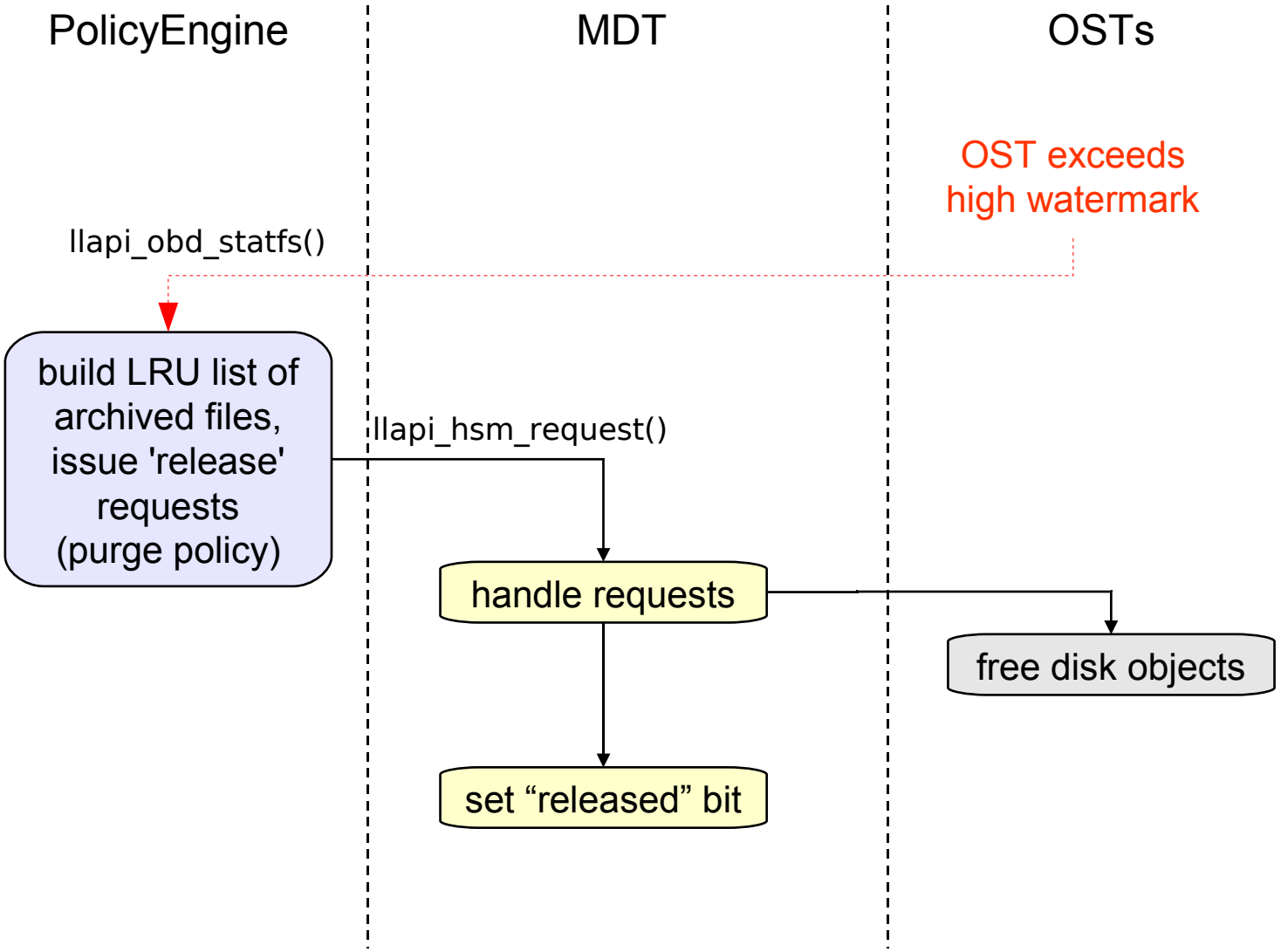
- **Start copytools with different archive number:**
  - gateway1# hsm_copytool_posix --hsm_root /tmp/arc1 --archive 1
  - gateway2# hsm_copytool_posix --hsm_root /tmp/arc2 --archive 2
- Migrate precising which backend you want to use:
  - $ lfs hsm_archive /mnt/lustre/my_file --archive 2
- This can be specified in RobinHood policies:

```
# user files in /mnt/lustre/project_A
FileClass user_files_A
{
      definition
      {
         tree == "/mnt/lustre/project_A"
         and
         owner != "root"
      }
      migration_hints = "cos=14" ;
      # target storage backend
      archive_num = 2;
}
```

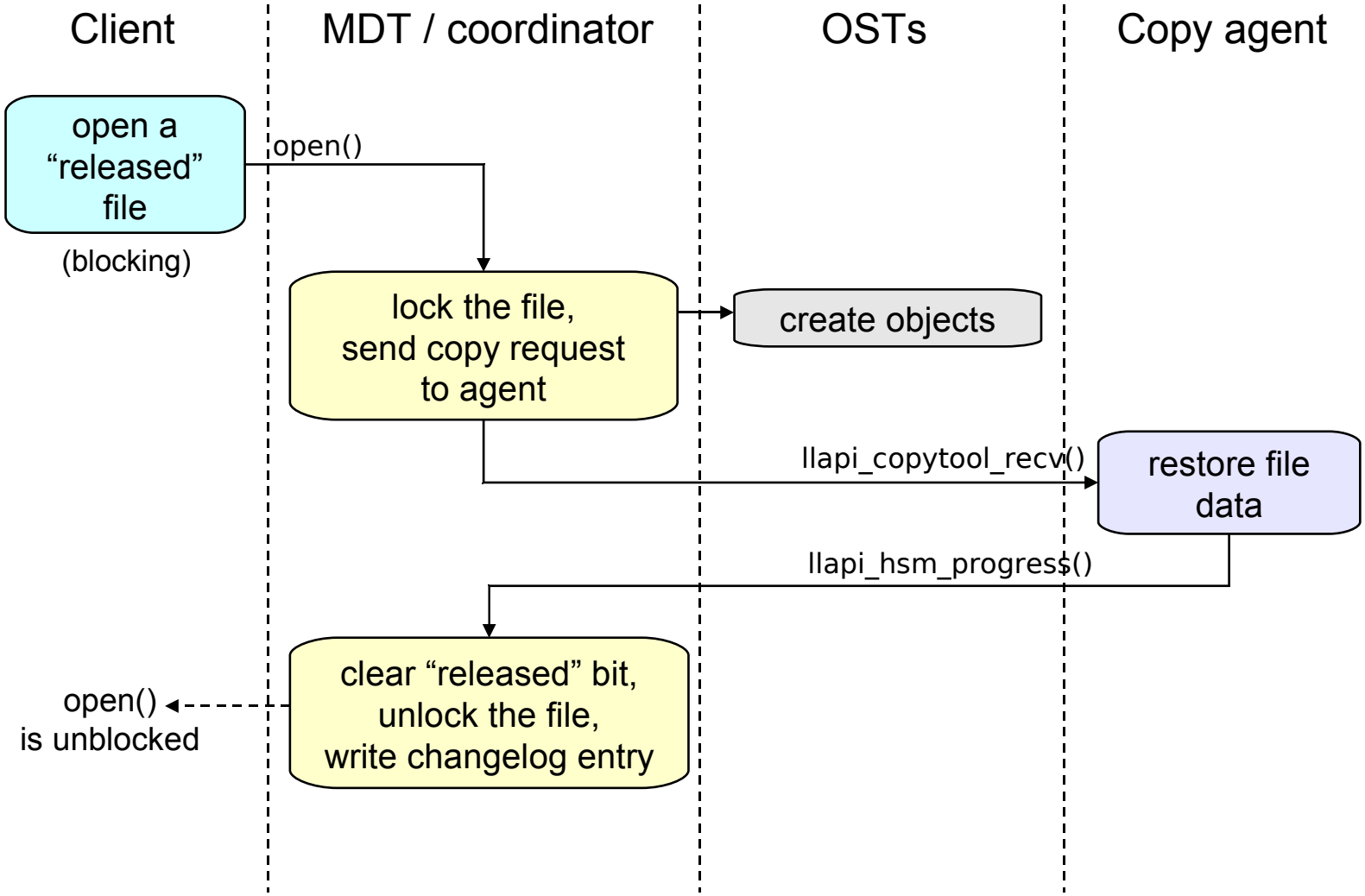
Internals: archive modified file



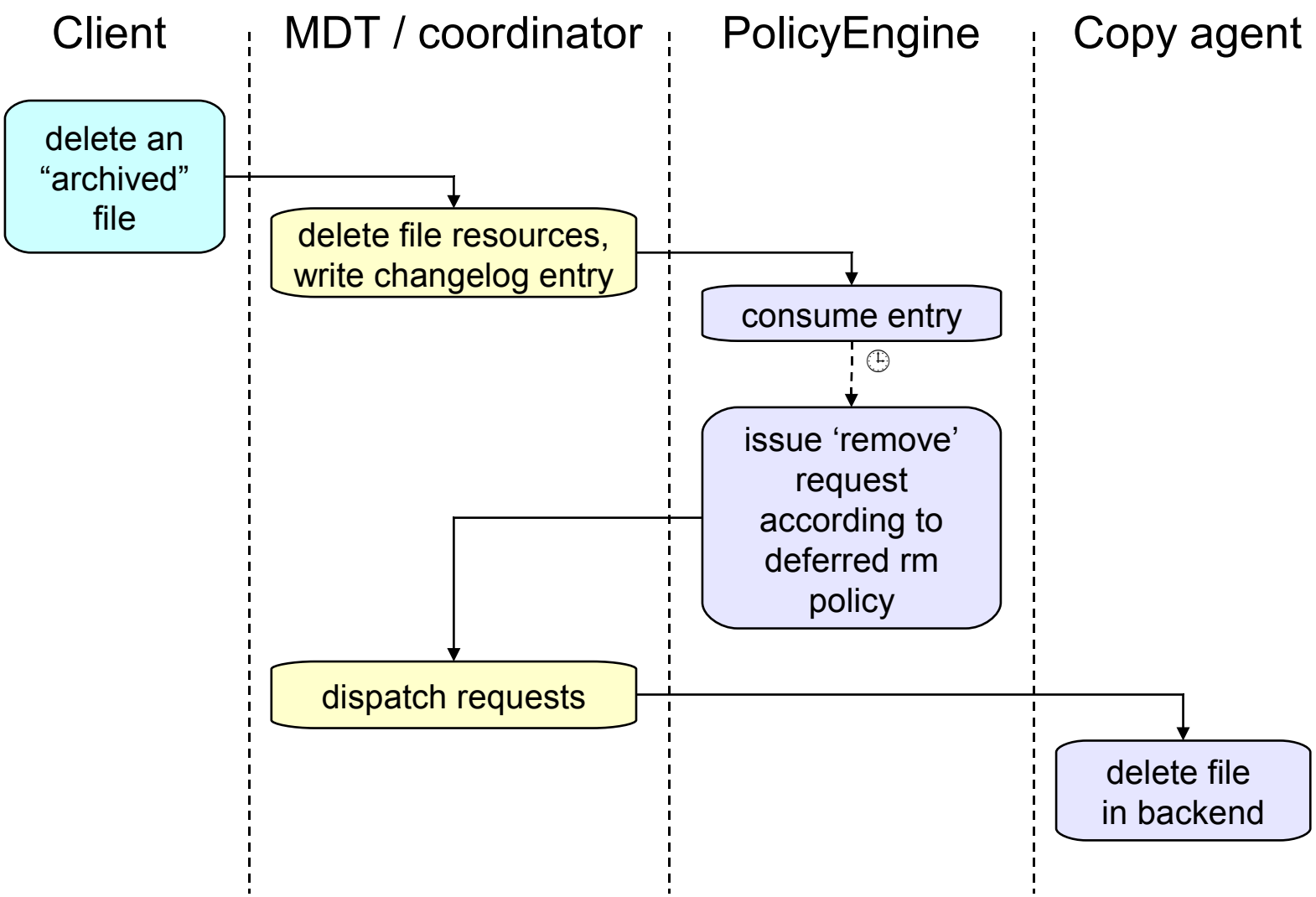
Internals: release OST disk space



Internals: restore released file on read



Internal: deferred rm in backend



Lustre/HSM binding API (1)

- **Interactions with Lustre/HSM binding:**
  - Classic POSIX access in Lustre (*open*, *read*, *stat*...)
  - liblustreapi / lfs command
- **liblustreapi**
  - Monitor file status (*dirty*, *released*...)
    - llapi_hsm_state_get()
    - llapi_hsm_state_set()
  - Perform hsm requests (*archive*, *release*...)
    - llapi_hsm_request()

Lustre/HSM binding API (2)

- **Changelogs**
  - To get HSM events, you just need to read Lustre changelogs
  - Example:

```
1078 01CREAT 12:29:31.704664916 2010.04.02 0x0 t=[0x200000400:0xff:0x0] p=[0x7a19:0x19634843:0x0] TEST_FILE
1079 16HSM   12:30:04.53633335 2010.04.02 0x1 t=[0x200000400:0xff:0x0]
1080 16HSM   12:30:25.492272785 2010.04.02 0x2 t=[0x200000400:0xff:0x0]
1081 06UNLNK 12:37:01.980434725 2010.04.02 0x3 t=[0x200000400:0xff:0x0] p=[0x7a19:0x19634843:0x0] TEST_FILE
```

  - Using command line:
    - lfs changelog
  - Using liblustreapi:
    - llapi_changelog_start()
    - llapi_changelog_recv()
    - llapi_changelog_clear()
    - ...

Lustre/HSM binding API (3)

- **Developing your own copytool**
  - Simply read in one place, write in another place.
  - Use liblustreapi to read requests from coordinator.
  - Inform the coordinator of copy progress/status.
- **liblustreapi**
  - llapi_copytool_start()
  - llapi_copytool_recv()
  - llapi_copytool_fini()
  - llapi_hsm_progress()
  - llapi_hsm_import()

Project status

- **Status**
  - Prototype is working
  - Coding is finishing
  - Integration tests, debugging, stress tests

Questions ?