Layout Lock

High Performance Data Division

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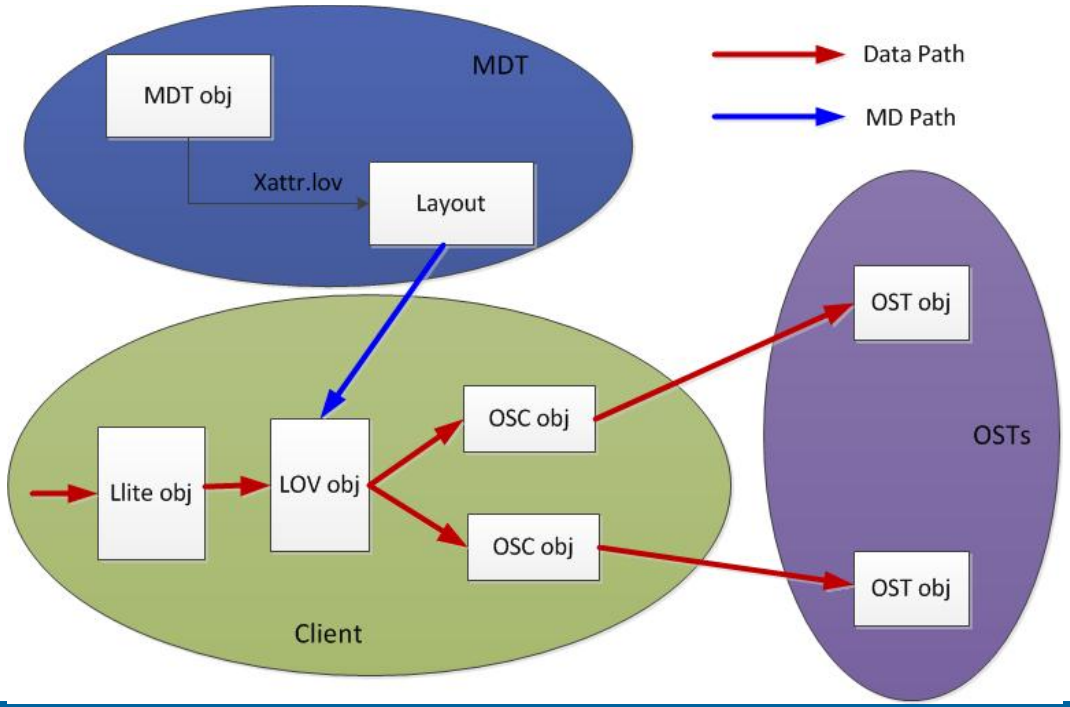
Agenda

- What is the data layout of Lustre?
- Requirement of layout lock
- Implementation details
- Use cases

What's data layout

- Data layout determines how to place data to OSTs
- Stored as xattr of trusted.lov on MDT
- Interpreted at the LOV layer
- Used to be immutable



Why do we need layout lock?

- Cache layout on client for speed IO
- Requirements of changing layout on the fly
  - HSM
  - Replication
  - Data on MDS
  - Restriping, a.k.a. migration
- Fundamental of all above data placement features
  - They all need to update layout

Layout lock attributes

- An IBITS lock: MDS_INODEBITS_LAYOUT
- Required to cache layout on the client
  - When layout lock is cancelled, layout will be invalidated
  - Losing layout lock usually won't cause reconfiguration of IO stack
- IO depends on Layout lock
  - Make sure Layout is correct before IO starts
- Capability connect flags: OBD_CONNECT_LAYOUTLOCK
  - Supported in Lustre 2.4

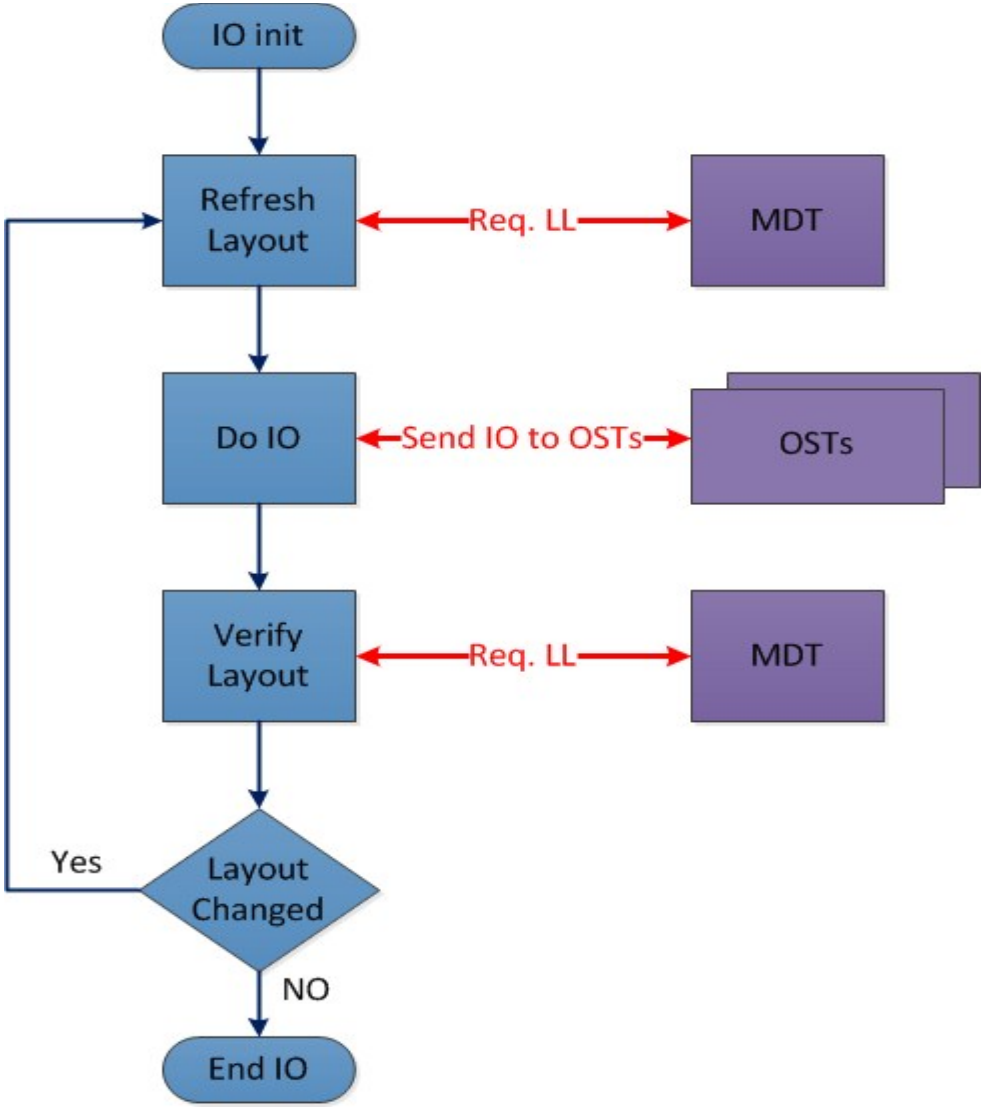
Layout lock requesting

- Usually piggybacked by IT_GETATTR or IT_OPEN
  - Does not add overhead for extra lock RPCs
  - To make sure statahead runs quickly
  - Only piggybacked if there is contention to layout lock
    - mdt_object_lock_try() is invented for this purpose
- Otherwise layout lock can be explicitly requested by IT_LAYOUT
  - Normal DLM request handling on the MDT
  - Layout will be returned in LVB of DLM reply, or completion AST

A tricky case about layout lock

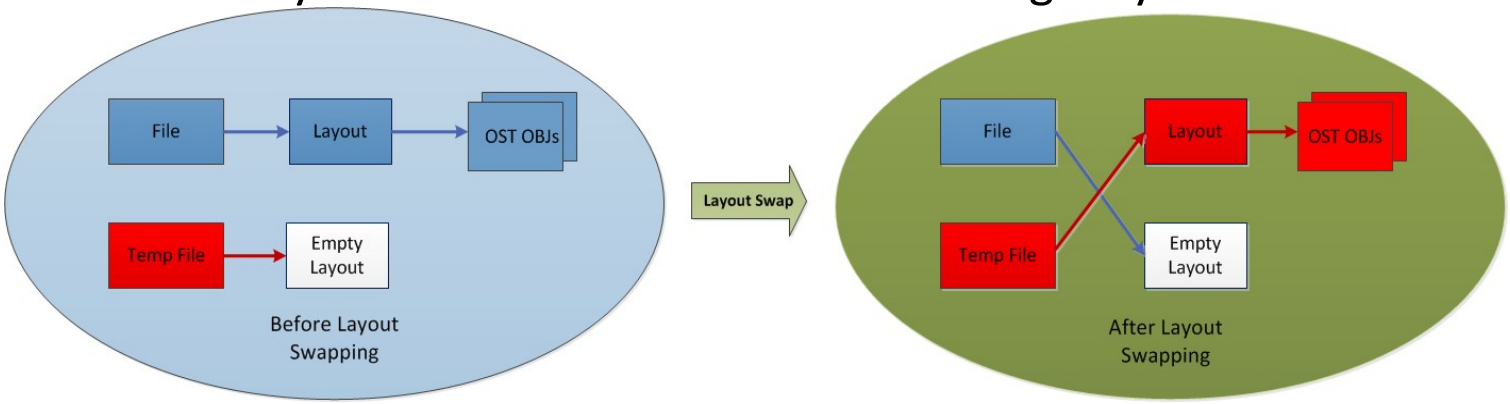
- Layout lock is an IBITS lock but mainly used in IO path
  - We can't hold layout lock to do IO to avoid being evicted by the MDT
    - Reason: Client holds layout lock, then tries to access OSTs; If OSTs are unreachable, and layout lock is being cancelled by the MDT, the client will be evicted because it can't release layout lock in time
    - Layout lock can be lost/revoked any time during an IO
  - But have to make sure IO is done on correct layout
    - Contradictory by themselves
  - Think about it carefully to make sure you're doing the right thing

IO Handling with Layout



Use cases

- Layout swap – to swap layouts of two files
  - MDT operation: MDS_SWAP_LAYOUTS
  - Revoke layout lock on both files and exchange layout



- Restriping (a.k.a Migration) – to change stripe number of a file
  - Create temporary file with desired stripe count and OSTs
  - Copy file content to temporary file
  - Swap layouts and delete temporary file (which now has old objects)
  - From now on, all IO to original file will use new layout, even for file handles which are opening during restriping

Use cases – cont.

- Data on MDS - small files on MDT and move to OSTs if too big
  - Allocate OST object(s) to form a layout
  - Migrate (small) data from MDT inode to OST(s)
  - Revoke layout lock for the update of layout
- Replication – to store the same data on multiple OSTs
  - If one replica failed to write, MDT is notified to take replica out of layout
  - Clients are notified of new layout, ignoring stale replica
  - New replica is created and layout is updated again
- HSM
  - Layout lock is needed to restore and release files