CLIO

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Problems with old client IO path

- Old code with a lot of obscurities;
- Inter-layer assumptions: lov, llite;
- Based on a huge obd-interface;
- Not easily expandable;
- Traditionally many bugs;
- High overhead: allocations, kms;
- Not very portable;
- Different from md server stack;
- Interaction between layers is not clear;

Client IO path clean-up requirements

- Reduce number of bugs in the IO path.
- Build an infrastructure for planned features.
- Clean up old code and interfaces.
- Specify precisely
  - state machines
  - Interactions
  - pre-, post-conditions and invariants.
- Don't lose performance.

CLIO design goals

- clear layering;
- controlled state sharing;
- simplified layer interface;
- real stacking;
- support for:
  - SNS;
  - read-only p2p caching;
  - lock-less IO and ost intents;
- reuse of mdt server layering;
- improved portability.

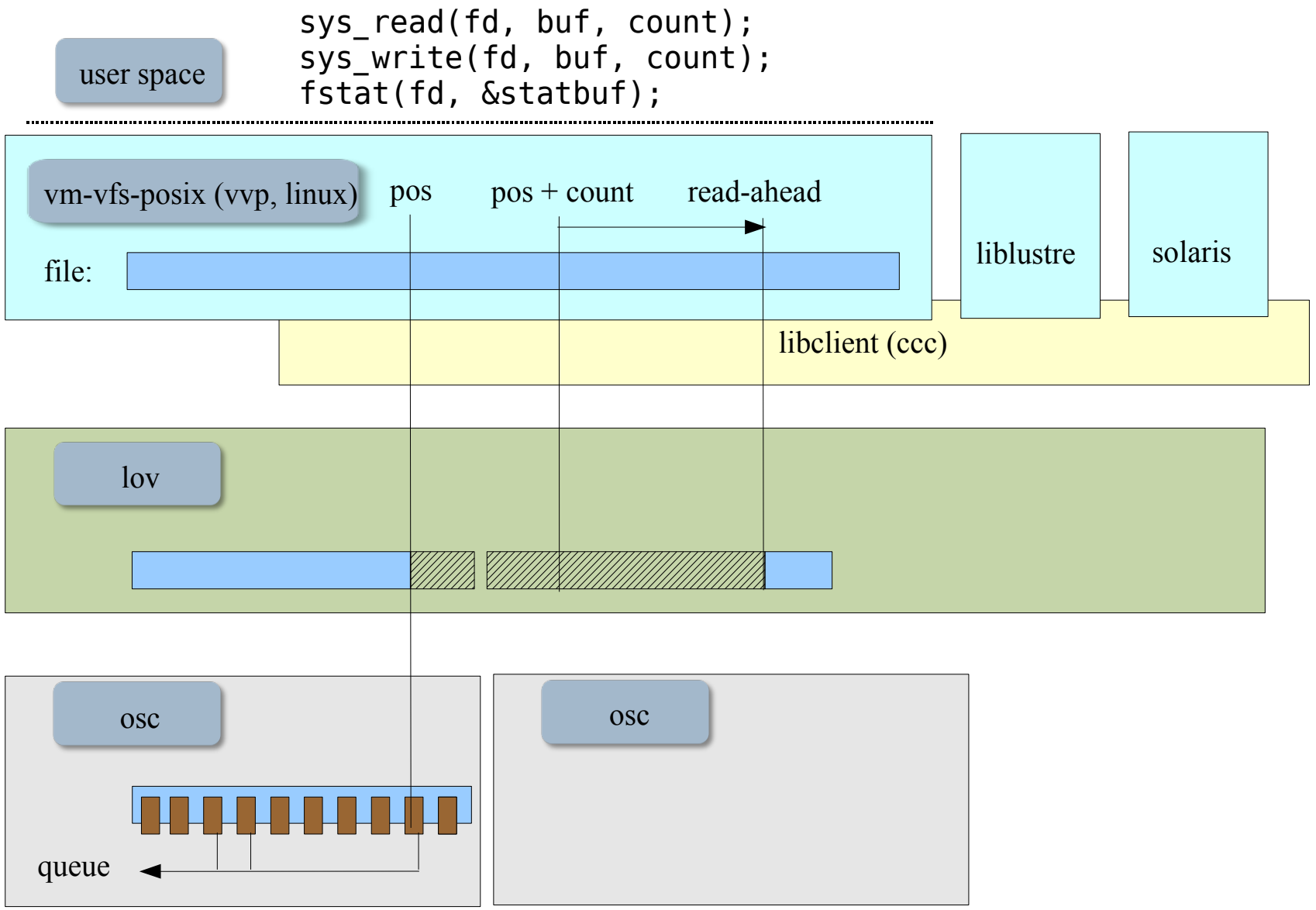
CLIO restrictions

- Not a complete re-write: only interface cleanup
- No new features, only new interfaces
- Only data IO path. Meta-data are left intact
- No changes to the DLM
- No changes to the recovery
- No changes to the RPC formation logic

Layers

- vvp: VFS and VM, converting system calls (read, write) into client api. POSIX operation semantics (short reads, flock, O_APPEND), read-ahead. This is mostly old llite.
- lov: raid0 striping: files/stripes, locks/sublocks
- sns: raid with parity declustering. raid-frame library (not implemented)
- osc: ptlrpc/lnet, DLM, RPC formation

Layers

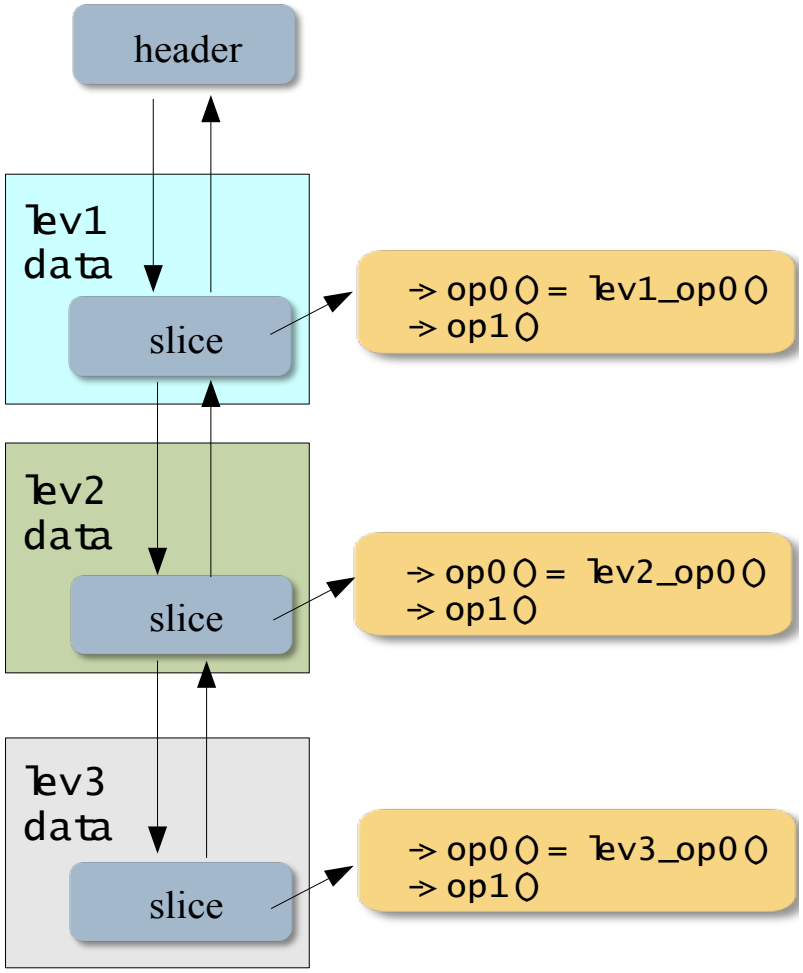

sys_read(fd, buf, count);
sys_write(fd, buf, count);
fstat(fd, &statbuf);
user space
vm-vfs-posix (vvp, linux)
pos
pos + count
read-ahead
file:
liblustre
solaris
libclient (ccc)
lov
osc
osc
queue

Fundamental data-types

- **cl_object** a file and a stripe, based on lu_object (fids, hashing, lru), caches pages, and tracks locks, can be composed of other objects.
- **cl_page** fixed-size chunk of file data, can be part of multiple cl_object's: file, and stripe of this file; uniquely identified by (object, index).
- **cl_lock** a region of a particular object, covered by a cluster lock.
- **cl_io** IO context. Contains IO state. Can be stopped, resumed. Collects locks and owns pages.
- **cl_req** RPC

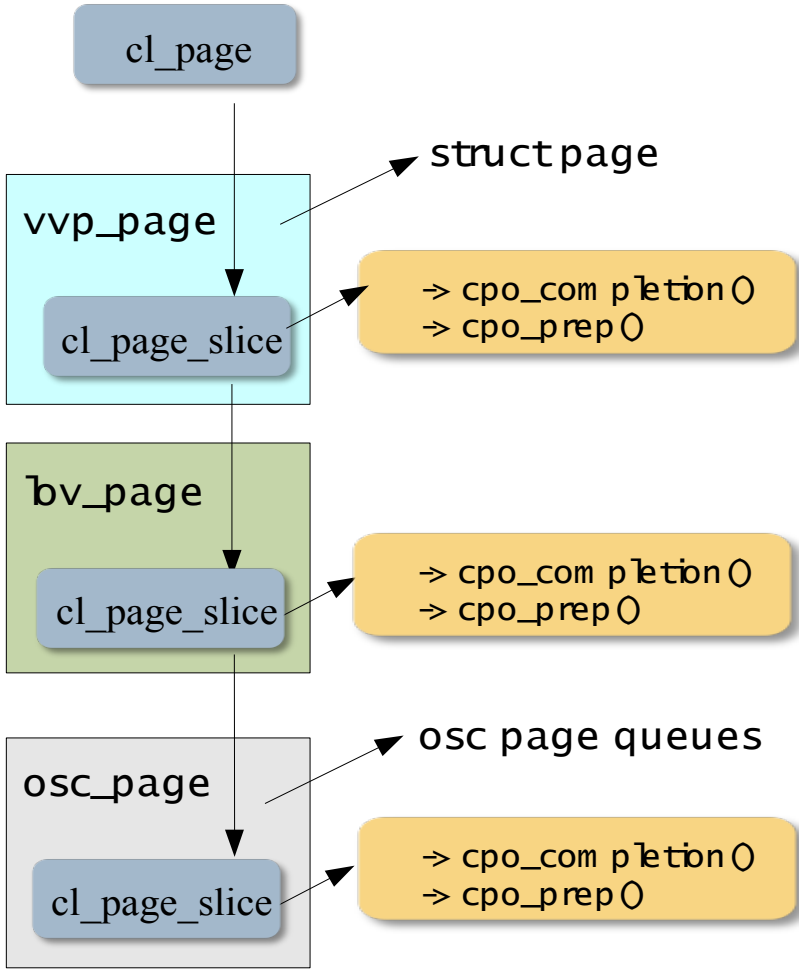
Layered objects

- Compound object: a header and a sequence of layers
- Layer-private state
- Per-layer operation vectors
- Generic code invokes operations on each layer, delegating behavior

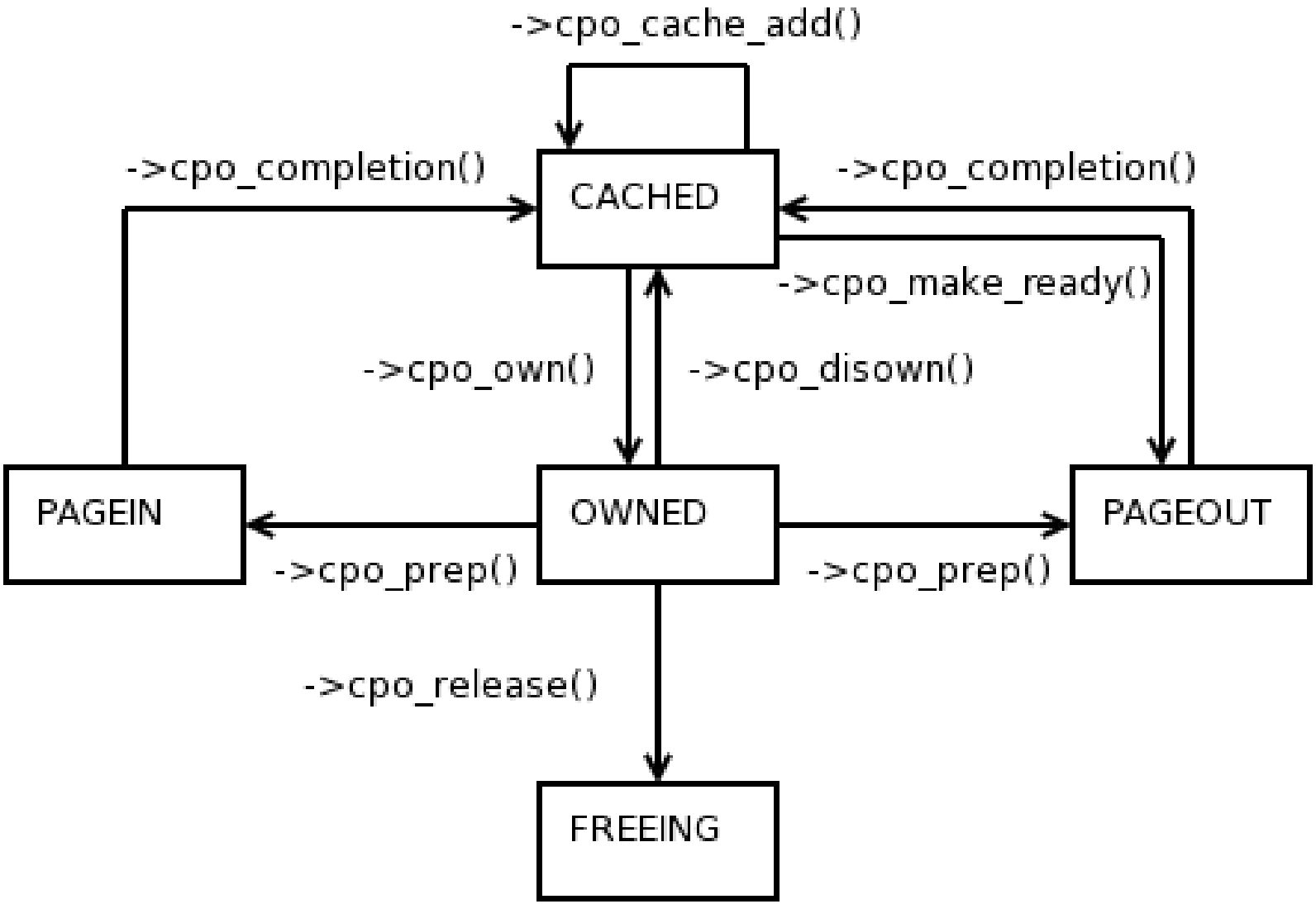


cl_page

- cached file data
- diffrent sizes of pages (DMU blocks)
- interaction with MM/VM (page locking, memory pressure)
- simple locking model, suitable for Lustre

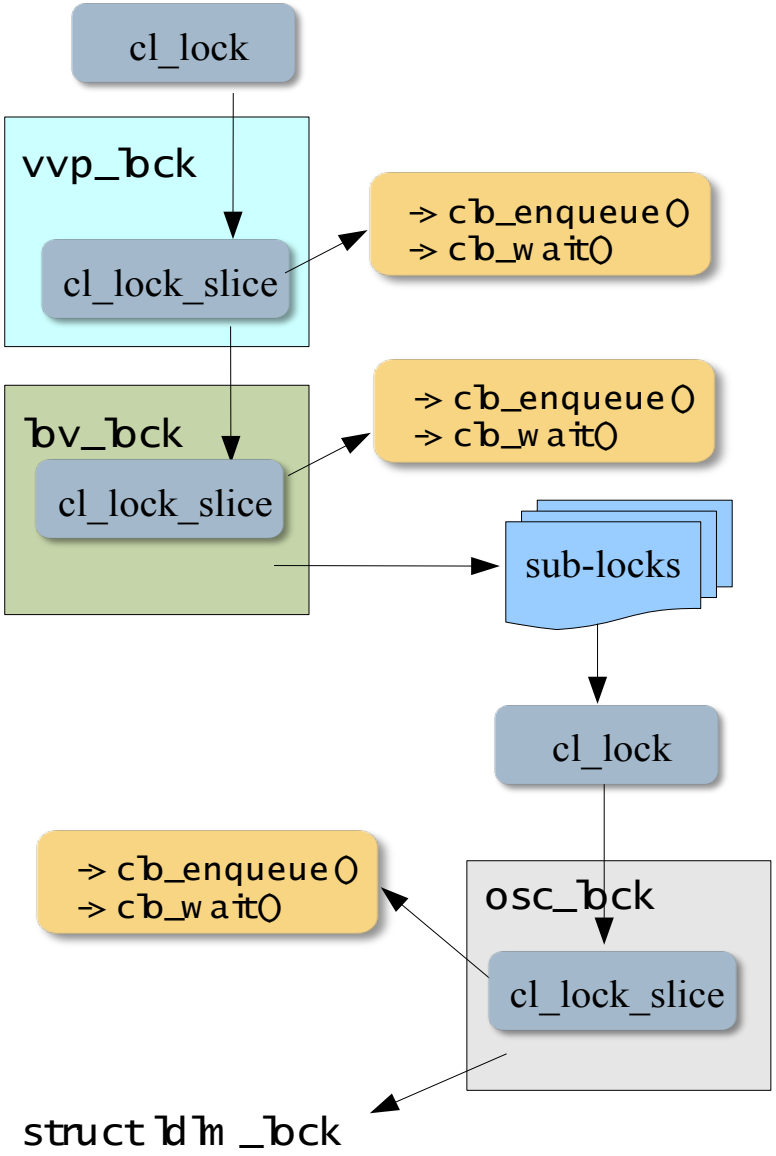


cl_page state machine



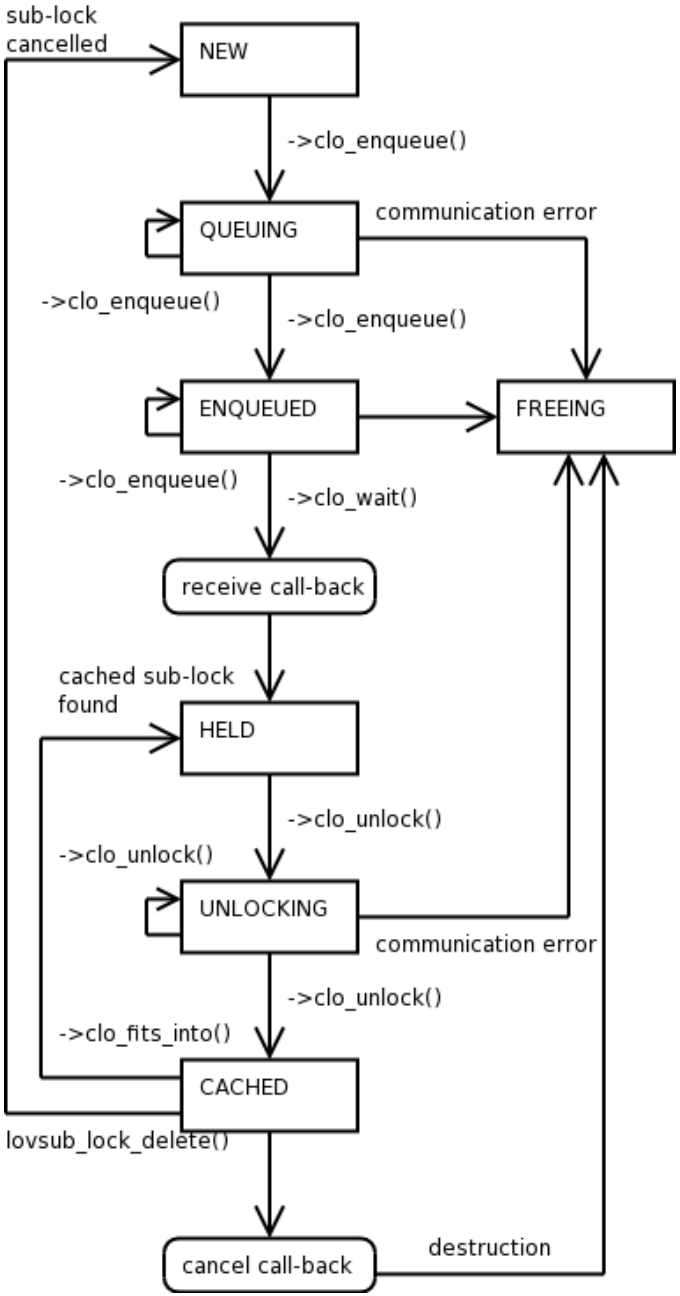
cl_lock

- extent read/write lock on file data
- top-lock on a file
- sub-locks on stripes
- based on DLM



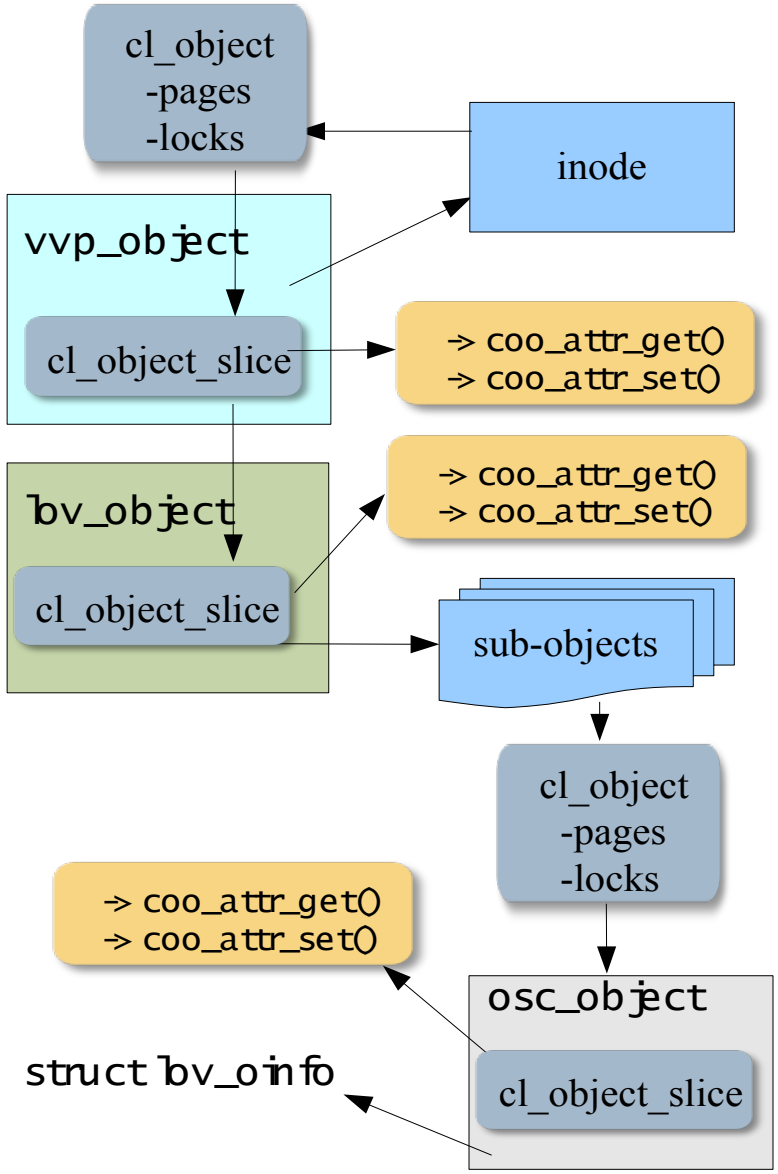
cl_lock state machine

- top-lock and sub-locks (N:M);
- caching of top-locks (short IO);
- non-blocking, asynchronous state-machine (parallel IO);

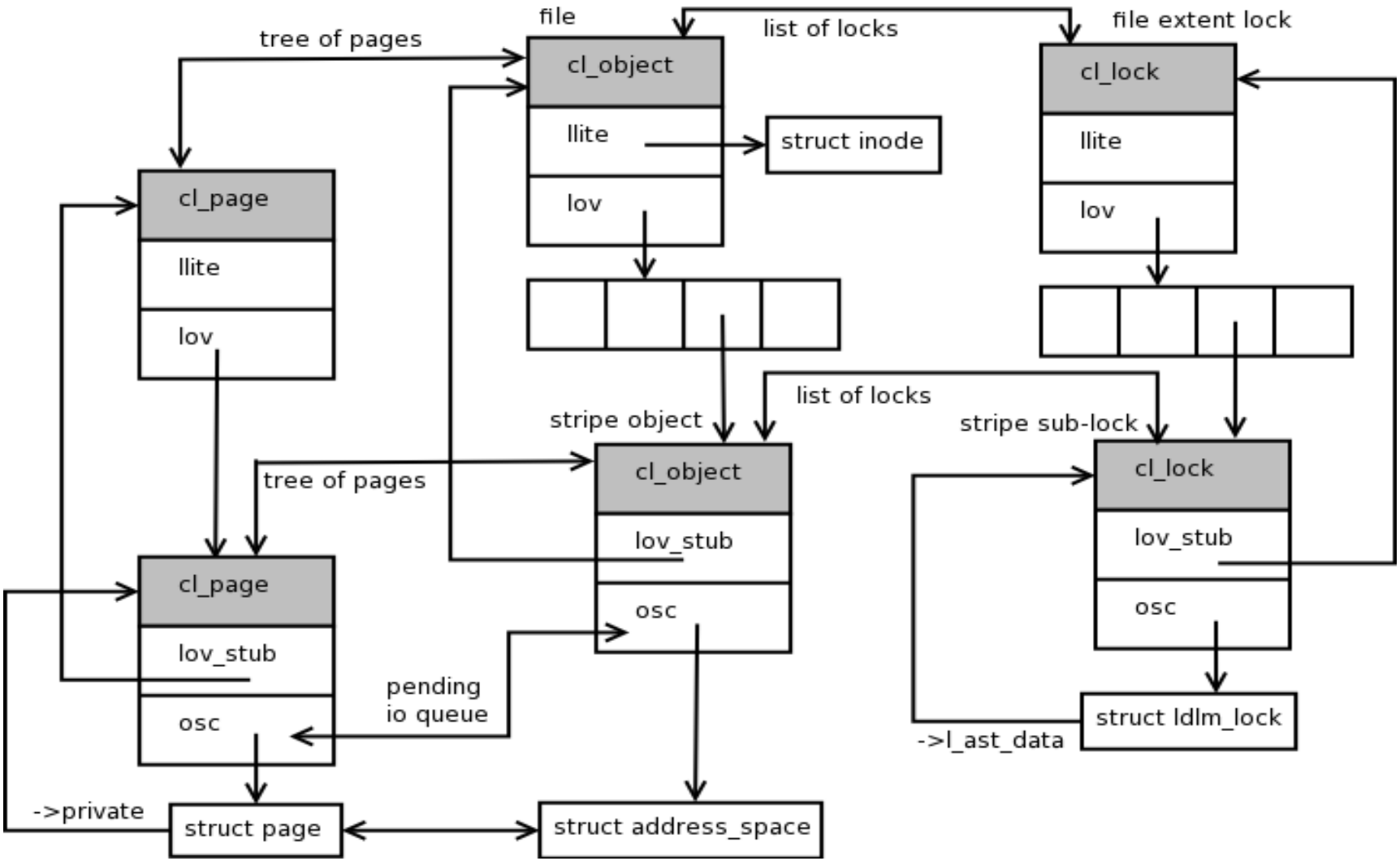


cl_object

- top-object: file
- sub-object: stripe
- uniquely identified by fid
- cached
- LRU
- tree of pages
- list of locks
- trivial state machine

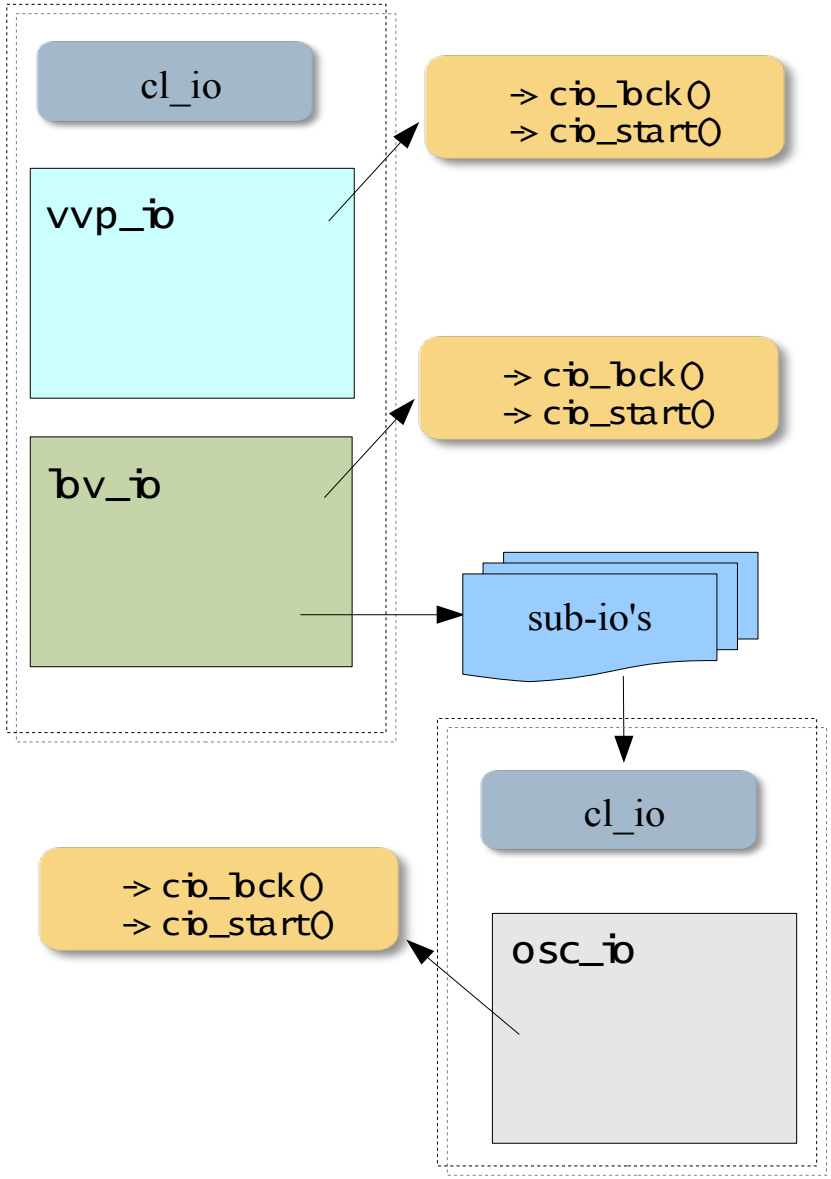


Files, locks, pages.



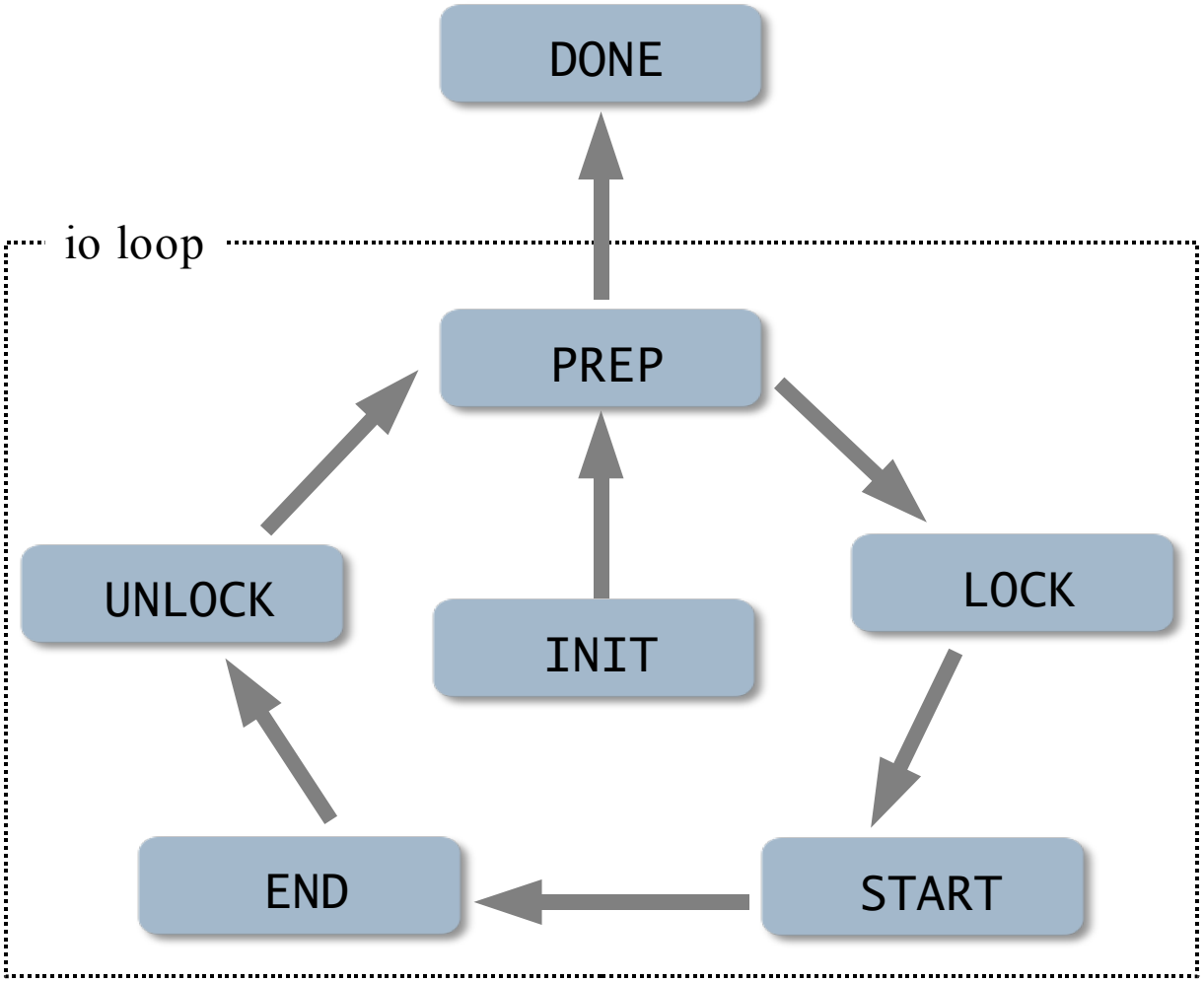
cl_io

- high level IO
- context for IO activity
- fast: no dynamic allocation
- state machine
- designed for “parallel IO”



cl_io state machine

- init: initialize layers
- prep: form iteration
- lock: collect locks
- start: do IO
- end: wait completion

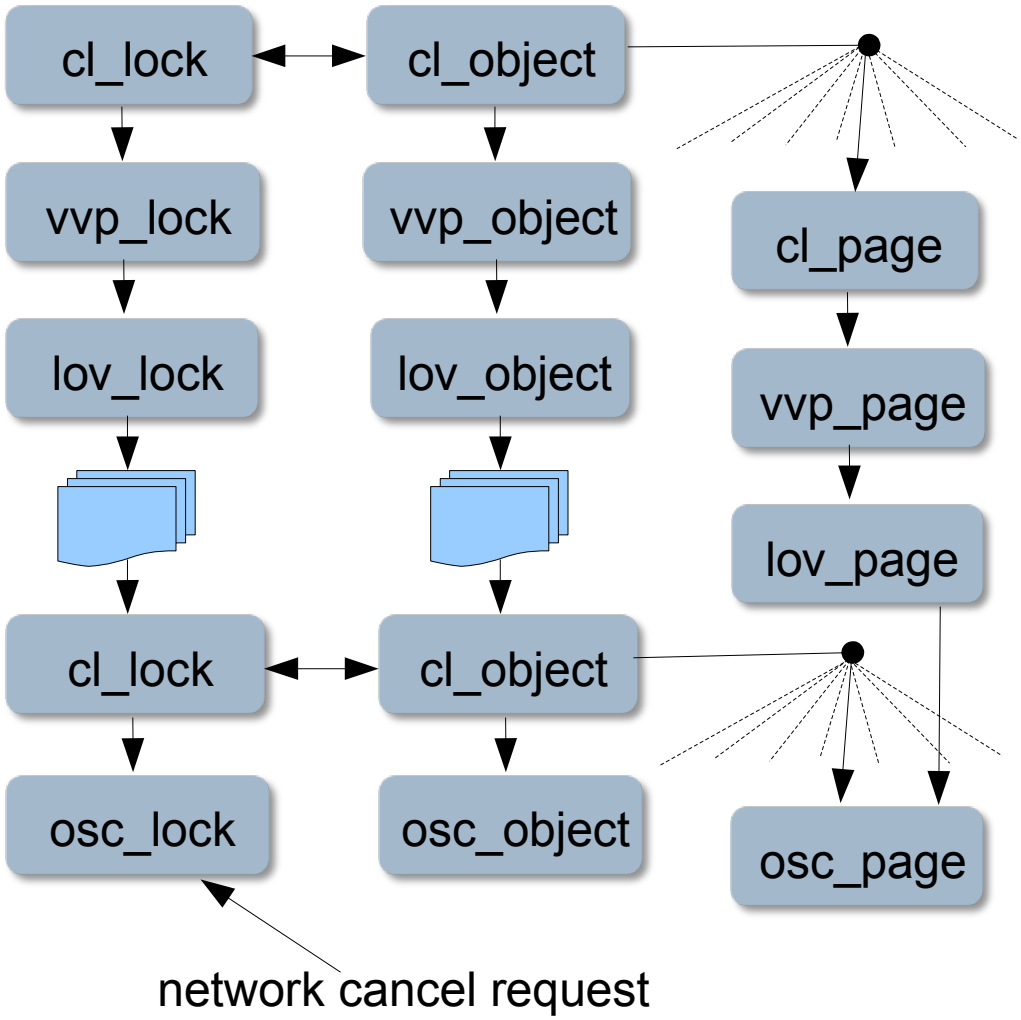


Use cases: file read

- sys_read(fd, buf, count);
- vvp: cl_io_init(); cl_io_prep():
  - lov_io_pre(): clip IO to one stripe
- cl_io_lock():
  - vvp_io_lock(): lock [pos, pos+count-1]
  - sns_io_lock(): lock parity block
  - generic: sort locks, enqueue
- cl_io_start():
  - vvp_io_start(): generic_file_read()
    - vvp_readpage(): read-ahead, cl_submit_io():
      - sns_submit_io(): parity ordering
      - osc_submit_io(): send RPC

Use cases: lock cancellation

- osc lock gets cancel
- find object
- find subtree of pages
- call cancel on each page, up to llite
- much simpler than existing logic



Clio, Greek: ?????, /ˈklaiou/, n:

> the muse of history also known as the Proclaimer. The name is from the root ????, meaning *recount* or *make famous*.

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