OCFS2

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Oracle

What is OCFS2?

- General purpose cluster file system
  - Shared disk model
  - Symmetric architecture
  - Almost POSIX compliant
    - `fcntl(2)` locking
    - Shared writeable mmap
- Cluster stack
  - Small, suitable only for a file system

Design Principles

- Many learned from kernel community
- Avoid useless abstraction layers
  - Use VFS object life times.
  - Mimic the kernel API.
  - Keep necessary abstractions as thin layers.
- Copy good ideas
  - JBD, Ext3 directory code, group allocation
- Keep file system operations local
  - Reduces lock contention

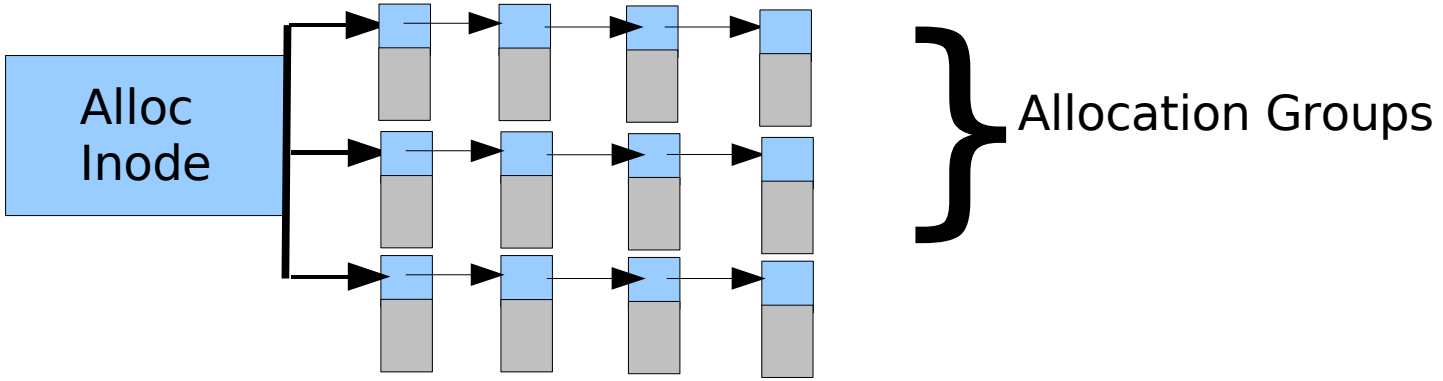
File Allocation

- Allocate meta data in blocks (.5K - 4K)
- Allocate data in clusters (4K – 1M)
- Extent based allocation
  - Requires less accounting for large files
  - Extents arranged in a b+ tree
  - Small #’s of extents stored in a list
- Directories are normal files.
  - Contain an array of records (thanks, Ext3!)
  - Indexing to be implemented soon

System Files

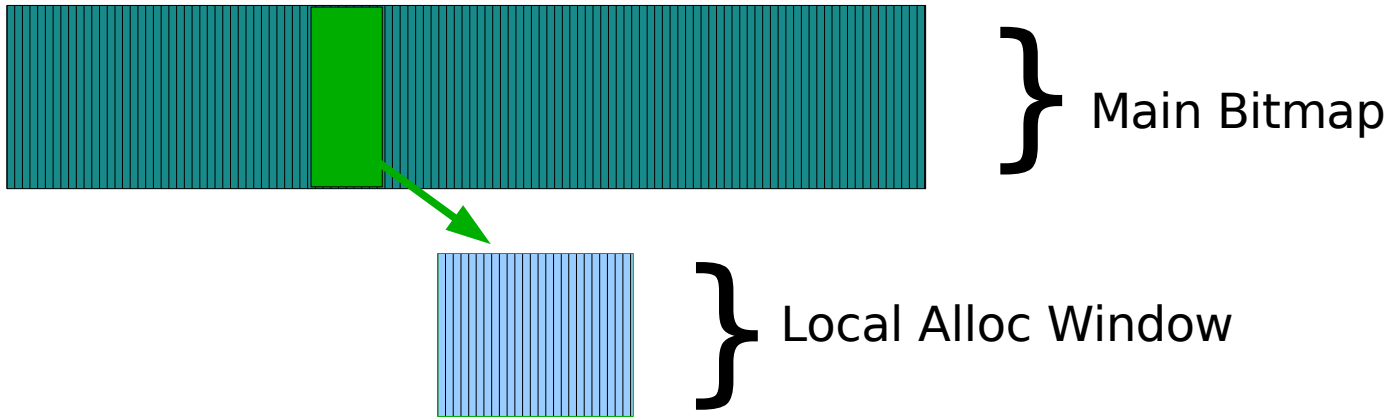
- System files reference all fs meta data
  - Linked into file system via hidden system dir
  - Allows a very dynamic layout
- Global system files
  - Generally accessible by any node at any time
- Node local system files
  - One per mounted node (each node gets a unique “*slot number”)*
  - Reduce contention on resources
  - Some are never locked by another node

Chain Allocators



- Group descriptor contains a bitmap, next group ptr., etc.
- Chains are self optimizing – we can move empty groups to the beginning of their chain as we allocate from them.
- Main bitmap formatted to cover entire volume at mkfs time. Units in clusters.
- Suballocators use block size units but get their groups from the main bitmap as needed.
- Block allocators grow as needed.

Local Alloc



- Node local.
- Reduces contention on main bitmap.
- All bits in window are set on main bitmap, local alloc starts clean.
- As space is used, local alloc bits are set.
- Unused bits are returned to bitmap on shutdown, recovery, or on a window move.

Truncate Log

- Similar performance goals to local alloc
- Used for deallocation
- Single block array of “truncate records”
  - Cluster Offset, Extent Length
- Flushed at specific times
  - When full
  - 2 seconds after most recent truncate
  - On demand via `sync(2)`

Journaling

- Block journaling via JBD
- Journals are node local system files
- JBD was chosen for two main reasons
  - Stability
  - Time - journaling is hard to get right!

Clustered UpToDate

- Small amount of code (550 lines)
- Mimic buffer_uptodate() within cluster
- Stores info using a per-inode list or rbtree
- Simple rules:
  - Meta data changes are journaled under cluster lock
  - Meta data reads have at least RO cluster lock
  - Getting a new cluster lock means you destroy the cache
  - Don’t need to pin buffer_heads – just record block number

A Short DLM Overview

- Pared down VMS style API
  - Operations are asynchronous
  - Supports NL, PR and EX lock levels
  - Supports lock value blocks (LVB)
  - Use callbacks to indicate lock state changes
- A node can
  - Create a new lock
  - Up convert a lock to a higher level
  - Down convert a lock to a lower level
  - Drop the lock completely

DLM Glue

- FS Internal abstraction for cluster locking
- Implements *lock caching*
- Up converts and down converts locks
  - If down converting to PR, will not block read only locks
  - Likewise, will not block compatible requests during up convert
- Lifetimes left up to container objects
- Only concerned with cluster locking
- Lock specific actions via a set of callbacks

Inode Locks

- `ip_rw_lockres`
  - serializes `read(2), write(2)`
- `ip_meta_lockres`
  - Protects inode meta data
  - Refreshes `struct inode` when necessary
  - Use LVB for most common inode fields
  - Might checkpoint journal before dropping EX
- `ip_data_lockres`
  - Protects inode data
  - Might sync pages before dropping EX

Messaging (“votes”)

- Very few fs messages left
  - Last few will be replaced by cluster locks
- Handle hard cases by broadcast message
  - Rename / Unlink – remove a dentry
  - Query an inode delete
  - Mount/Unmount notification
- Messages related to a given inode are serialized by the meta data lock

Node Liveness

- Disk Heartbeat
  - Final arbiter of “liveness”
- Network Keepalive
  - Majority based quorum
- Self-fencing mechanism
  - Simple, but harsh
  - Makes timing between disk and network complicated
  - Real hardware fencing in the future

Recovery

A. FS is notified, blocks meta data locking
B. DLM is notified, completes lock recovery
C. FS begins journal recovery
    A. One node wins race to lock journal
    B. Journal Recovery
    C. Clear local alloc and truncate log
    D. Unlock Journal, re-enable meta data locking
D. Recover local alloc, truncate log, and orphan dir

Questions

- Cluster File System BOF
- Today, 6PM