Understanding BlueStore
Ceph’s New Storage Backend

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Introduction to Ceph (the short, short version)
Ceph Provides

- A resilient, scale-out storage cluster
  - On commodity hardware
  - No bottlenecks
  - No single points of failure

- Three interfaces
  - Object (radosgw)
  - Block (rbd)
  - Distributed Filesystem (cephfs)
Internally, Regardless of Interface

• All data stored as “objects”
  • Aggregated into Placement Groups

• Objects have:
  • Data (byte stream)
  • Attributes (key/value pairs)

• Objects live on Object Storage Devices
  • Managed by Ceph Object Storage Daemons

• An OSD is a disk, in a server
More Internally
Even *More* Internally

- **FileStore**
  - XFS (previously ext4, btrfs)
  - Placement Group → directory
  - Object → file
  - LevelDB for key/value data

/var/lib/ceph/osd/ceph-0/
current/
  0.1_head/
    object1
    object12
  0.7_head/
    object3
    object5
  0.a_head/
    object4
    object6
meta/
  # OSD maps
omap/
  # leveldb files
Problems with FileStore
Double Writes

• No atomic write/update on POSIX filesystems

• Solution: Ceph Journal
  • Write → OSD journal (O_DIRECT)
  • Write → OSD filesystem (buffered)
  • Sync filesystem, trim journal

• Throughput halved
Enumeration Sucks

- Objects distributed by 32-bit hash
- Enumerated for scrub, rebalance etc.
- POSIX readdir() isn’t ordered
- Directory tree with hash-value prefix
  - Split when > ~100 files
  - Merged when < ~50 files
- Complicated, odd performance issues

```
... 
/DIR_1
/DIR_1/DIR_0/obj-xxxxxxx01
/DIR_1/DIR_4/obj-xxxxxxx41
/DIR_1/DIR_8/obj-xxxxxxx81
/DIR_1/DIR_C/obj-xxxxxxC1
...
/DIR_A/DIR_1/obj-xxxxx1A
/DIR_A/DIR_5/obj-xxxxx5A
/DIR_A/DIR_9/obj-xxxxx9A
/DIR_A/DIR_D/obj-xxxxxD
...
```
Other Problems

- CPU utilization
- Unpredictable filesystem flushing
- Still finding bugs/issues with FileStore...
Solutions with BlueStore
BlueStore = Block + NewStore

- Raw block devices
- RocksDB key/value store for metadata
- Data written direct to block device
- 2-3x performance boost over FileStore
Internally

• All data and metadata on same block device by default

• Optionally can be split, e.g.:
  • Data on HDD
  • DB on SSD
  • WAL on NVRAM
Bonus!

- Pluggable block allocator
- Pluggable compression
- Checksums on reads
- RBD and CephFS usable with EC pools
Availability

- Early prototype in Ceph Jewel (April 2016)
- Stable on-disk format in Ceph Kraken (January 2017)
- Recommended default in Ceph Luminous (RSN)
- Can co-exist with FileStore
Migration Strategies
Several Approaches

• Fail in place
  • Fail FileStore OSD
  • Create new BlueStore OSD on same device

• Disk-wise replacement
  • Create new BlueStore OSD on spare disk
  • Stop FileStore OSD on same host

• Host-wise replacement
  • Provision entire new host with BlueStore OSDs
  • Swap into old host’s CRUSH position

• Evacuate and rebuild in place
  • Evacuate FileStore OSD, fail when empty
  • Create new BlueStore OSD on same device
Several Approaches

• Fail in place
  • Fail FileStore OSD
  • Create new BlueStore OSD on same device
  → period of reduced redundancy

• Disk-wise replacement
  • Create new BlueStore OSD on spare disk
  • Stop FileStore OSD on same host
  → reduced online redundancy, requires extra drive slot

• Host-wise replacement
  • Provision entire new host with BlueStore OSDs
  • Swap into old host's CRUSH position
  → no reduced redundancy, requires spare host

• Evacuate and rebuild in place
  • Evacuate FileStore OSD, fail when empty
  • Create new BlueStore OSD on same device
  → no reduced redundancy, requires free disk space
Questions?
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