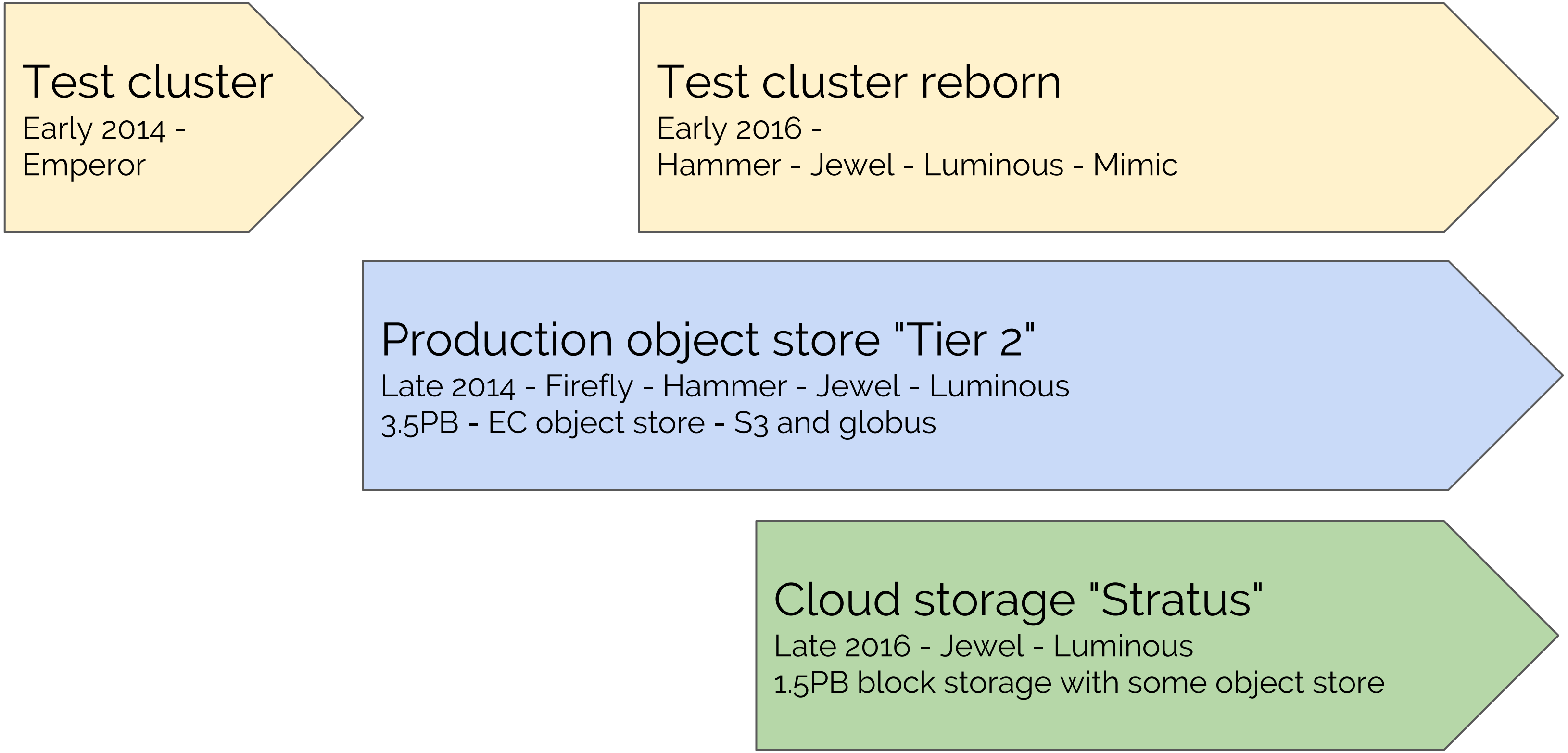
Experiences with ceph object store at MSI

Graham T. Allan
Minnesota Supercomputing Institute

Ceph at MSI - timeline



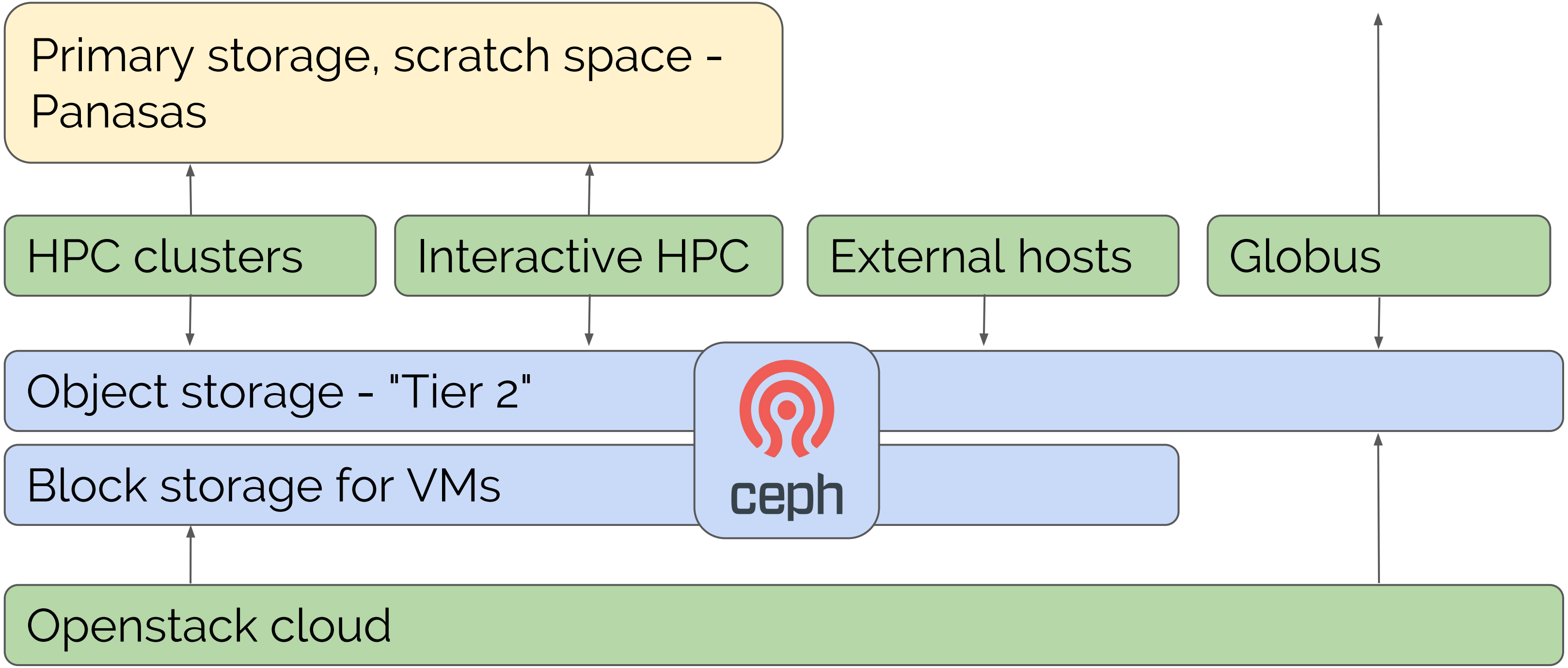
Test cluster
Early 2014 -
Emperor

Test cluster reborn
Early 2016 -
Hammer - Jewel - Luminous - Mimic

Production object store "Tier 2"
Late 2014 - Firefly - Hammer - Jewel - Luminous
3.5PB - EC object store - S3 and globus

Cloud storage "Stratus"
Late 2016 - Jewel - Luminous
1.5PB block storage with some object store

Ceph at MSI


Primary storage, scratch space - Panasas
HPC clusters
Interactive HPC
External hosts
Globus
Object storage - "Tier 2"
Block storage for VMs
ceph
Openstack cloud

Evolution of Tier-2 storage

2014-2015

- 7 Supermicro osd servers with 60x 6TB HDD, 12x 480GB SSD

2016

- additional 2 HPE Apollo osd servers, 60x 8TB HDD, 8x 480GB SSD

3 mons (VMs)

4 load balanced rgw nodes

Early 2018...

- Approaching 80% capacity
- Hardware warranty end

Time for refresh - goals...

- larger number of smaller hosts
- filestore -> bluestore
- dual-tree crush map -> unified with device classes
- ubuntu 14.04 -> Centos 7
- fstab+init driven osds -> ceph-volume

Refreshed storage architecture

Build on experience with Stratus...

15x HPE Apollo 4200 storage nodes
Also retain existing two Apollo 4510 nodes

HDD OSDs: 4.5PB raw

- Bluestore with co-located WAL/DB
- 4:2 erasure coded

SSD OSDs: 35TB raw

- object store indexes

mons also migrated from VMs to physical hardware (HPE moonshot cartridges)

Server provisioning

- kickstart+puppet
- OSDs created using basic "ceph-volume"

Revamped crush map

Rebuild using device class-based rules

- Started with two separate trees for hdd and ssd
- convert so all beneath a common root

New CRUSH rules

3 main crush rulesets to convert to device classes

- replicated_hdd
- replicated_ssd
- ecprofile42_hdd

Starting data migration

Early August 2018…

- About half the new hardware delivered and installed…
  - Space crunch - now at 85% utilization
- Update crush_ruleset for replicated pools
  - Gradually increase weight of new OSDs
  - All backfilled within a few minutes to days.

What about the EC pool?

- most of our data is here ~2PB

EC pool device class change

- Process not really documented (explicitly, at least)
- Creation of new crush rule also required a new EC profile
  - But, "can't change the EC profile for a pool"?
  - Does this just apply to the k+m values? New and old both 4+2
  - So is this change safe? (spoiler: Yes)

Original profile (firefly)

```
crush-failure-domain=host
directory=/usr/lib/x86_64-linux-gnu/ceph/erasure-code
k=4
m=2
plugin=jerasure
technique=reed_sol_van
```

New profile (luminous)

```
crush-device-class=hdd
crush-failure-domain=host
crush-root=default
jerasure-per-chunk-alignment=false
k=4
m=2
plugin=jerasure
technique=reed_sol_van
w=8
```

Another EC pool quirk

Noticed that "min_size" was set to 2 for our ec 4+2 pools…

What does min_size mean for an ec pool?

> min_size
>
> **Description:**
>
> Sets the minimum number of replicas required for I/O. See Set the Number of Object Replicas for further details. Replicated pools only.

It does really have the same meaning for ec pools as replicated…

- min_size=2 perhaps inherited from early pool creation (firefly)?

The value made no sense to me, so I set it to 4.

Migrating the EC pool

Finally started 5th September 2018

- New osds already at their final crush weight - very heavy backfill load.
- Mitigated by reducing `osd max backfills`, `osd recovery max active`, `osd max recovery threads`

- osds on the older systems would often die
  - no supervisor like systemd to restart them - need extreme babysitting
  - Mostly suicide timeouts etc
  - Several times an entire node (30 osds) would fail at once
- mons ran out of disk space (db grew to ~40GB)
  - db never trimmed due to degraded pgs
- After 36 hours backfill, the cluster suffered a peering storm.
  - Finally resolved by stopping all osds clusterwide, then restarting.

Cleanup after the storm...

pg stuck incomplete after hdd failure

Peering flaps meant the set of active OSDs changed rapidly

- "min_size=4": pg became active with only 4 osds - then we lost one.
- Fortunately no writes to the pg during the peering storm, so past intervals were consistent...
- Declaring the dead osd as "lost" brought the pg back to life.

- **pool min_size should be k+1 (5)**

Final challenges

another pg stuck incomplete...

OSDs would crash when starting backfill

- 3 different objects implicated across various osds

OSDs would stay running if "nobackfill" set

- Map s3 objects to the suspect filestore objects, and download via s3.
- On one file, calculated etag didn't match - determined corrupt - deleted via s3.

Several hours later all filestore shards were still there; osd would still crash on backfill.

Re-enabled backfill again next day - no crash!

- Magic? rgw queues object deletion for later processing - eventually the corrupt object was removed.

Calm waters ahead…?

Another 3 weeks from resolving these final problems, to complete the data migration and retire old osd nodes.

The EC pool migration process took ~2 months total.

Still have HEALTH_WARN because of large omap objects - Some buckets will need to be resharded to resolve this…

Bluestore tuning still to come…

Some Lessons

Migrating the EC pool separately after all new OSDs were active was probably a mistake.

incorrect min_size on pool compounded errors

Easy to trigger cluster flapping by making changes too quickly - eg when deleting old storage nodes and osds.

Change OSD crush weights gradually with a small delay between each change

Thank You

Any Questions?

Challenges with s3 use in HPC - data sharing

Data storage at MSI is based around research groups with a P.I.

Challenges with S3

- No concept of groups
- No easy equivalent of a chown
- Data lifecycle - P.I. has to have ownership of group user data
- Object acls via s3cmd too hard to use - no inheritance

Migrate towards primary allocation to P.I. (120TB), small allocations to group members.

- P.I. shares group buckets to members using bucket policies (via helper scripts)
- Still testing this with a handful of groups.
- Issues with this (eg lack of visibility in bucket lists)