From swarm to swarm-mode in the CERN container service

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OpenStack Magnum

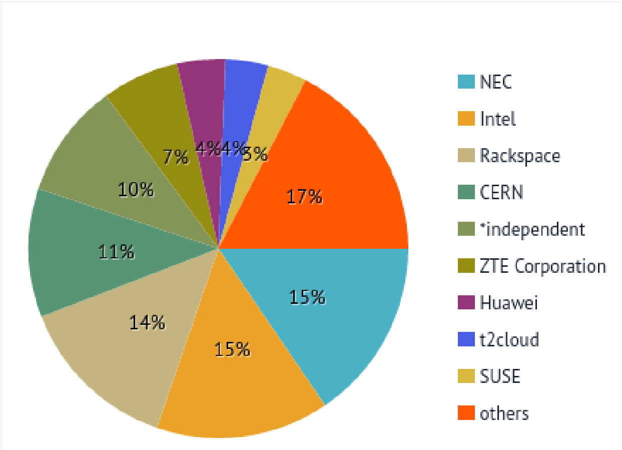
OpenStack Magnum #openstack-containers

Kubernetes, Docker Swarm, Apache Mesos, DC/OS (experimental) aaS

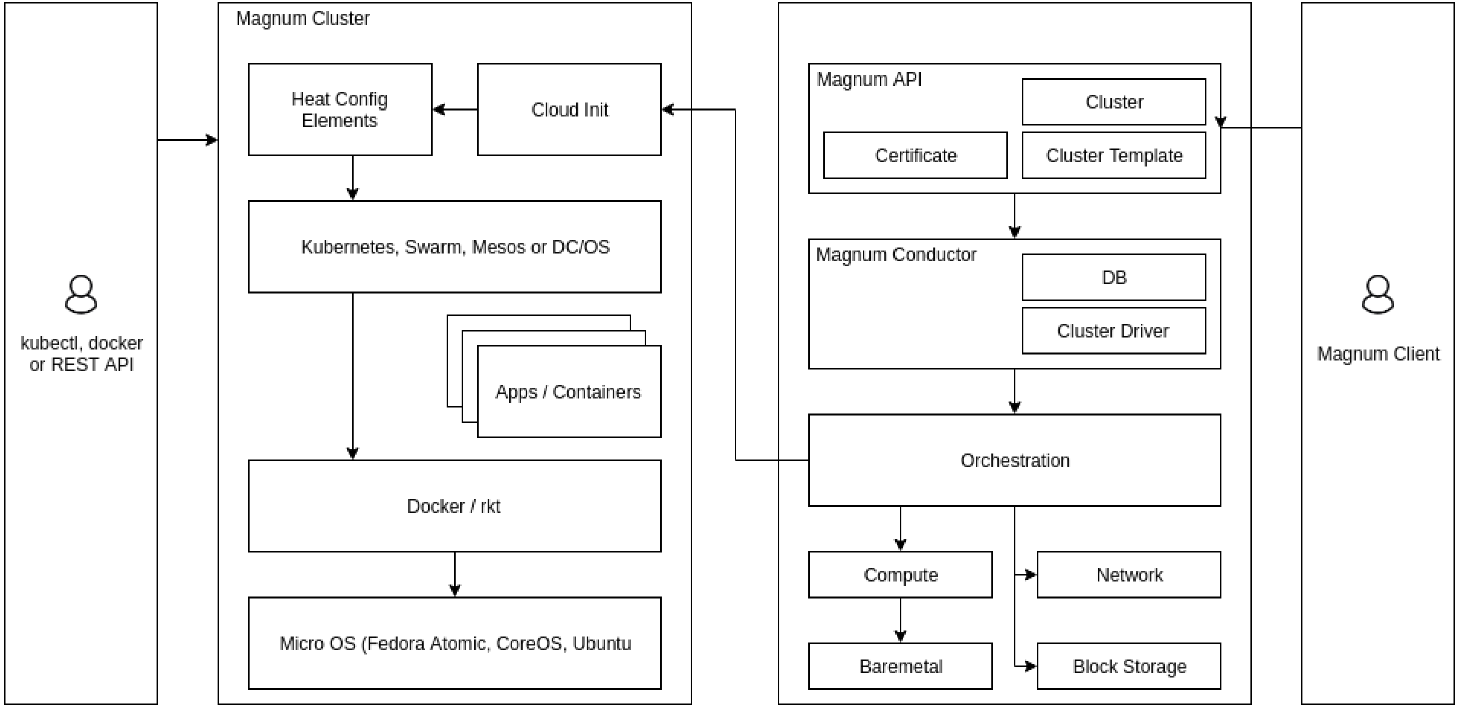
Deep integration of OpenStack with Container technologies:

- Compute Instances
- Networks, Load Balancers
- Storage
- Security
- Native Container API
- Lifecycle cluster operations
  - Scale cluster up and down
  - More WIP

Contribution by companies



OpenStack Magnum Architecture

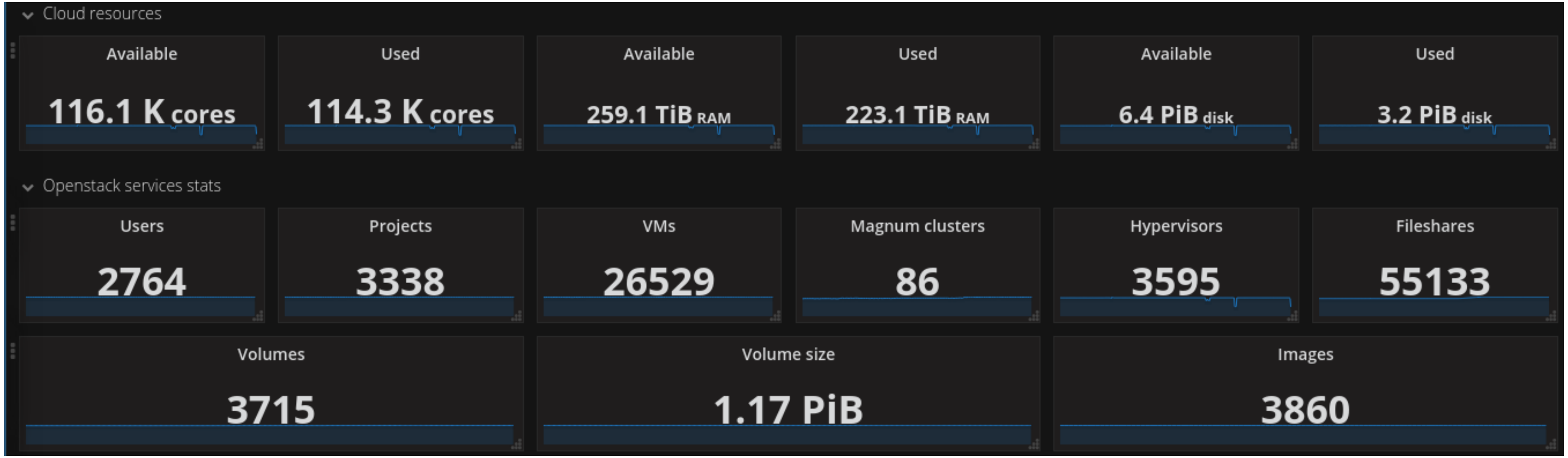


Containers and the CERN Cloud

CERN OpenStack Infrastructure

Production since 2013

~ 116.000 cores ~4 million vms created ~200 vms per hour



Cloud resources

Available	Used	Available	Used	Available	Used
116.1 K cores	114.3 K cores	259.1 TiB RAM	223.1 TiB RAM	6.4 PiB disk	3.2 PiB disk

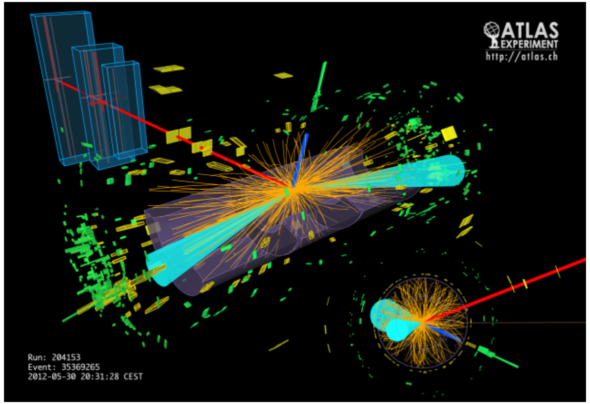
Openstack services stats

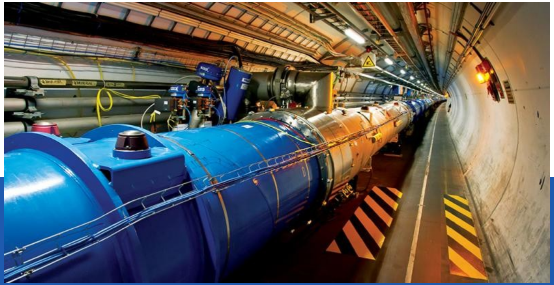
Users	Projects	VMs	Magnum clusters	Hypervisors	Fileshares
2764	3338	26529	86	3595	55133

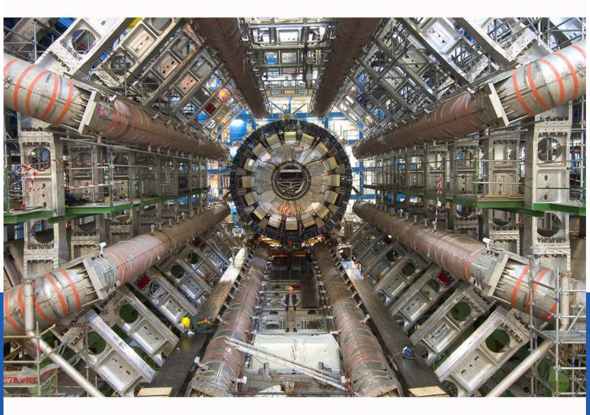
Volumes	Volume size	Images
3715	1.17 PiB	3860

CERN Container Use Cases

- Batch Processing
- End user analysis / Jupyter Notebooks
- Machine Learning / TensorFlow / Keras
- Infrastructure Management
  - Data Movement, Web servers, PaaS …
- Continuous Integration / Deployment
- And many others

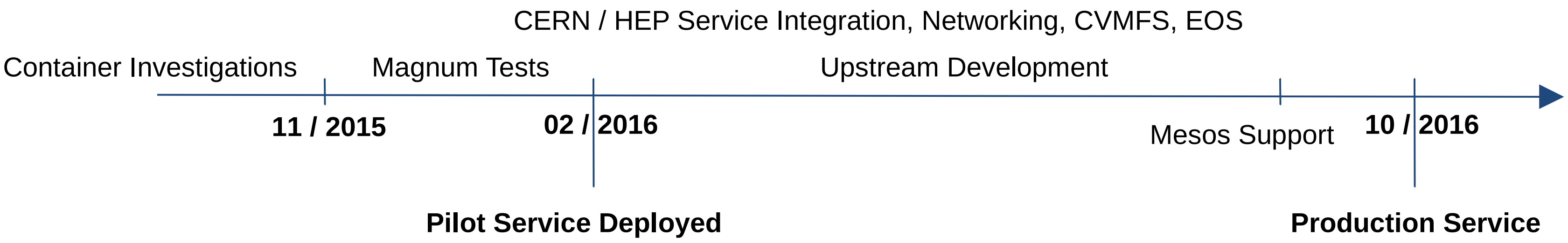






CERN Magnum Deployment

- Integrate containers in the CERN cloud
  - Shared identity, networking integration, storage access, …
- Add CERN services in *system* containers with atomic (WIP)
- **Fast, Easy to use**



CERN / HEP Service Integration, Networking, CVMFS, EOS

Container Investigations

Magnum Tests

Upstream Development

11 / 2015

02 / 2016

Mesos Support

10 / 2016

Pilot Service Deployed

Production Service

CERN Magnum Deployment

- Clusters are described by *cluster templates*
- Shared/public templates for most common setups, customizable by users

```
$ magnum cluster-template-list
+------+---------------------------+
| uuid | name                      |
+------+---------------------------+
| .... | swarm                     |
| .... | swarm-ha                  |
| .... | kubernetes                |
| .... | kubernetes-ha             |
| .... | mesos                     |
| .... | mesos-ha                  |
| .... | dcos                      |
+------+---------------------------+
```

CERN Magnum Deployment

- Clusters are described by *cluster templates*
- Shared/public templates for most common setups, customizable by users

```
$ magnum cluster-create --name myswarmcluster --cluster-template swarm --node-count 100
      ~ 5 mins later
$ magnum cluster-list
+------+----------------+------------+--------------+----------------------------+
| uuid | name           | node_count | master_count | keypair  | status          |
+------+----------------+------------+--------------+----------------------------+
| .... | myswarmcluster | 100        | 1            | mysshkey | CREATE_COMPLETE |
+------+----------------+------------+--------------+----------------------------+
$ $(magnum cluster-config myswarmcluster --dir magnum/myswarmcluster)
$ docker info / ps / ...
$ docker service create --mount 'type=volume,volume-driver=cvmfs,source=cms.cern.ch@trunk-
previous,destination=/cvmfs/cms.cern.ch' busybox sleep 10000
```

Magnum Benchmarks

Rally Benchmarks and resource scalability

- Benchmark the Magnum service
  - How fast can I get my container cluster?
  - Use Rally to measure to performance like any other OpenStack service
- Benchmark the resources
  - Ok, it was reasonably fast, what can I do with it?
  - Use a demo provided by Google to measure the performance of the cluster
    - Rally tests for container are under development and near completion

Deployment Setup at CERN and CNCF

CERN

- 240 hypervisors
  - 32 cores, 64 GB RAM, 10Gb inks
- Container storage in our CEPH cluster
- Magnum / Heat setup
  - Dedicated 3 node controllers, dedicated 3 node RabbitMQ cluster
- Flat Network for vms

CNCF

- 100 hypervisors
  - 24 cores, 128 GB RAM
- Container storage in local disk
- Magnum / Heat setup
  - Shared 3 node controllers, shared 5 node RabbitMQ cluster
- Private networks with linux bridge

Cluster Creation benchmark

CERN cloud

Cluster Size (Nodes)	Concurrency	Deployment Time (min)
2	50	2.5
16	10	4
32	10	4
128	5	5.5
512	1	14
1000	1	23

CNCF testing cloud

Cluster Size (Nodes)	Concurrency	Number of Clusters	Deployment Time (min)
2	10	100	3.02
2	10	1000	Able to create 219 clusters
32	5	100	Able to create 28 clusters

Swarm Mode

Before swarm mode, legacy swarm

- Manager and Agent were running in containers
- Required a key-value store eg etcd, consul
    - Magnum was using etcd
- No concept of services
- No secret management
- Difficult to expose services

Legacy swarm: cluster architecture

- 1 to m identical master nodes, running swarm manager and etcd
    - Optional haproxy the swarm and etcd APIs
- Selection between docker and flannel network driver
- 1 to n identical worker nodes
- Master nodes were configured first, then etcd’s API IP and swarm manager’s API IP was passed to the to node to join the swarm
- Workers couldn’t be promoted to managers
- TLS protected swarm endpoint and TLS protected etcd
- Based on Fedora Atomic 25

Swarm mode: new features

- Services! With Replicas!
- Workers can easily be promoted to managers
- Ingress mesh enabled out of the box
- Drain nodes
- Stacks (1.13+)
- Secrets (1.13+)

Swarm mode: cluster architecture

- Create a new magnum Cluster Driver
- 1 to m identical master nodes
  - Optional haproxy the masters' docker API
- 1 to n identical worker nodes
- Create a primary master, then pass the primary master IP to the rest manager nodes and the worker nodes to join the swarm
- Docker-only network driver
- Based on Fedora Atomic 25 (docker 1.12.6)

Swarm mode: caveats and WIP

- Magnum needs to monitor for master changes
  - If present, update haproxy too
- Add monitoring with Prometheus and Grafana
- Cluster Upgrades with zero down time
- Enable centralized logging, pushing docker logs to Elastic Search / InfluxDB
  - Applies for our Kubernetes and Mesos clusters as well

Custom CVFMS volume-driver

- Plugin implemented in golang
- Doesn’t require authentication as it mount read-only data
    - How to implement plugins that require authentication
- Runs as a docker container (600mb docker image :( )
    - Problems on node reboot, when docker starts and tries to mount volumes with the cvmfs volume driver, the plugin isn’t running yet

Notes on Docker Swarm

- Usually the orchestration tool that new users select
- Before swarm mode and lack of replicated services
    - We had application that just scale horizontally
    - Gitlab CI Runners is a great example
    - Usage is ramping up again
- Users love the docker API

Notes on Operations

- Moving from puppet workflows to containerized application is totally different mindset
  - How to monitor the software for security?
    - https://developers.redhat.com/blog/2016/05/02/introducing-atomic-scan-container-vulnerability-detection/
    - https://github.com/coreos/clair
    - All images based on a golden image approach. What about “FROM alpine/scratch” images?