Building access layers to Cloud and HPC from the facility

Gavin McCance
CERN IT Compute and Monitoring Group

Burt Holzman
Fermilab Scientific Computing Division
CERN private cloud

- CERN has large private Openstack cloud
- Batch service almost fully migrated to HTCondor now

More Than 300,000 cores

More Than 350,000 physics jobs per day

Batch: ~77% of cloud capacity
Exploring hybrid cloud since 2013 through various projects

Have partnered with many EU-based vendors
CERN Hybrid cloud

- Focus on external resources has been cloud rather than HPC
- Initial efforts focused on understanding workloads rather than operations
- Since 2017, efforts have been focused on bringing hybrid cloud into our standard site operations and on understanding the procurement model
- Primarily procuring flat IaaS capacity within scope of these projects
  - Both as VMs and federated Kubernetes
- Recently \(\approx O(10-15k)\) cores, about 5% of our capacity

- HTCondor makes integration easy!
  - As per CMS global pool, very easy to use integrate external resources dynamically
Overall approach

• Single logical HTCondor pool, routing jobs to all underlying resources, internal and external
Standardised Operations

- To reduce costs, as much as possible, we try to use the same ops tooling internally and externally
  - though devil in the details sometimes e.g. NAT setups, etc
  - generally a one-off standing cost to integrating a new cloud
Workloads

• Various experiment workloads tried
  • Monte Carlo, reconstruction from data @CERN, analysis; some GPU
  • Monte Carlo still most common workload
• Challenges on how to identify appropriate workload automatically, and route
  • Routing it manually via ”the special CE”, per project, per experiment, is not very efficient
Consolidated multi-cloud

- Within recent HNSciCloud project, we had 8 WLCG sites with grants in the “buyer’s group”
  - Chose to consolidate these in a “single WLCG” queue managed @CERN via our HTCondor
- Ops economy of scale
- Single entry point for experiments
- Successful, though some challenges
  - Managing fair-share across multi-clouds / grants
    - For HNSci project, we just used the CERN default batch shares
  - Accounting back to the buyer / grant-holder
Summary

• Strategy of hiding complexity and offering HTCondor as the platform over multiple clouds works well
  • One-off onboarding cost per cloud (sometimes significant) but handled by one ops team
  • Fits well with public procurement model

• Smaller pools of grants can be operationally consolidated
  • Economy of scale and simpler for experiments
  • Need to meet needs of grant holder and show-back that you really have met those needs; solid accounting
Cloud Challenges

- Public procurement with suitable discount
  - TCO advantage is still not obvious
  - Not all clouds are the same level of maturity
- Challenges in making business-as-usual
  - Project-driven "specials" e.g. extra monitoring and reporting are expensive on sites and experiments
- Cost control is critical
  - Tagging appropriate payloads and identifying which are the expensive ones e.g. data costs
  - Accounting back to the users
Common CERN/FNAL Approach

• Expand the facility to include off-premises resources
Fermilab Architecture (HEPCloud)

- Workflow (resource provisioning trigger)
- Facility Interface
- Authentication and Authorization
- Decision Engine
- Monitoring
- Provisioner
- Monitoring takes input from all components
- Local Resources
- HPC Resources
- Grid Resources
- Cloud Resources
Standardized Operations

- Different tools when necessary for external vs. internal resources

On-premises

- Platform
  - HTC

- Configuration & Monitoring
  - puppet
  - CHECK_MK
  - Grafana
  - Prometheus

- Personalization
  - puppet

- Provisioning
  - okd

Off-premises

- Platform
  - HTC

- Configuration & Monitoring
  - cloud-init

- Provisioning
  - SHIFTER
Provisioning HPC with HTCondor

HTCondor-G
GlideinWMS Factory

ssh

grid

grid

Open Science Grid

Open Science Grid

Hosted Compute Element

Hosted Compute Element

NERSC

Stampede2

BRIDGES

Job

Job

Job

WLCG JLAB 2019
Does it scale?

2M threads @ NERSC

Different colors correspond to
NERSC Cori-1, Cori-2, Edison; PSC Bridges;
TACC Stampede2
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Accounting @ Cloud

Cost in Last Day
$39.52

Cost Rate in Last Day
$1.65 / hour

Cost Rate per Hour In Last Day

Balance


$4.30K $4.25K $4.20K $4.15K $4.10K $4.05K $4.00K

max $3.36 avg $1.97 current $1.65

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Accounting @ HPC (NERSC)

Total Allocation: 82.00 Mil hours
Amount Charged: 27.71 Mil hours
Remaining: 54.29 Mil hours

Balance

Usage hours by username

CMS.m2612.uscmsg 54.293 Mil

Fermilab
Cloud HPC Challenges

- HPC facilities generally are built for a different compute/data model
HPC Challenges - Data

- HPC Centers are built for large IOPS between local compute and storage, not over the WAN

NERSC provided 500 TB of space for CMS input data
Cloud HPC Challenges

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  - Work with sites to meet experimental needs (high performance streaming over WAN?)
  - Use common data management/handling frameworks (e.g. Rucio) to prestage data
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- HPC sites prefer large parallel workflows
Leadership sites prefer Leadership jobs

Argonne Leadership Computing Facility
an Office of Science user facility

Production Queues

- Priority is given to jobs using at least 20% of Theta (>=802 nodes) (previously >=848 nodes)
- There is a global limit of ten (10) jobs running per user
- There is a global limit of twenty (20) jobs in queue per user
- There is a minimum job time of thirty (00:30:00) minutes for the default queue
- Wall-clock limits are a step-wise function designed to encourage scaling:
  - node count >= 128 nodes (minimum allocation): maximum 3:00:00 hours
  - node count >= 256 nodes: maximum 6:00:00 hours
  - node count >= 384 nodes: maximum 9:00:00 hours
  - node count >= 640 nodes: maximum 12:00:00 hours
  - node count >= 802 nodes: maximum 24:00:00 hours
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  – Can use late-binding scheduling to aggregate smaller workflows
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• HPC allocations – most are annual proposal awards, targeting solving specific scientific problems
ASCR Leadership Computing Challenge (ALCC)

Current Awards

- **Eric Lancon** (Brookhaven National Laboratory), **Taylor Childers** (Argonne National Laboratory), **Paolo Calafiura** (Lawrence Berkeley National Laboratory) received 80,000,000 core-hours on Theta and 80,000,000 core-hours on Titan for "Scaling LHC proton-proton collision simulations in the ATLAS detector."
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- HPC allocations – most are annual proposal awards, targeting solving specific scientific problems
  - Successes in this program – but we should work with agencies and facilities to establish a better fitting path for HEP