Elastic resource allocation for HEP experiments in hybrid cloud

Haibo Li, Qiulan Huang, Yaodong Cheng, Zhenjing Cheng
IHEP Computing Center, CAS
10 July 2018
• Requirements of scientific computing
• System architecture and implementation
• Use case in LHAASO
• Summary
Large science facilities

- IHEP serves as the backbone of China’s large science facilities

  - Beijing Electron Positron Collider BEPCII/BESIII
  - Yangbajing Cosmic Ray Observatory
  - China Spallation Neutron Source (CSNS)
  - Hard X-ray Modulation Telescope (HXMT)
  - Jiangmen Neutrino Underground Observatory (JUNO)
  - Large High Altitude Air Shower Observatory (LHAASO)
  - Accelerator-driven Sub-critical System (ADS)
  - Under planning: BAPS, LHAASO, XTP, HERD, …
Requirements for cloud computing

• Each experiment has separate computing resources and no sharing
• Different experiments may have different peak times of resource usage
• Massive jobs with a little resource or vice versa
• Resources are distributed in different locations
• Remote site operation and maintenance ability is poor

Cloud computing is a good solution for scientific computing.
VCondor

- VCondor is a cloud scheduler providing elastic resource allocation service for hybrid cloud based on HTCondor
- A bridge between HTCondor and cloud resources
- Once the jobs submitted to HTCondor, VCondor will allocate dynamic resources for the jobs.

LEAF is a data cache and access system across remote sites. See talk: https://indico.cern.ch/event/567550/contributions/2628857/
vcondor

- JobMonitor: query and record job information
- NodeManager: use REST API to create and destroy virtual machines
- DAEMON: Main module, periodically executed

vmquota

- Computing resource share management system
Components

- **JobMonitor**
  - HTCondor set different groups for each experiment
  - Get job and job queue information periodically from HTCondor
  - Information includes: group name, total job number, running job number, idle job number, etc

- **Node Manager**
  - According to the scheduling policy to create or stop VMs in hybrid cloud

- **Load balancer**
  - Interact with Vmquota to realize resource sharing management
Scheduling policy

• Local cloud first, free cloud first
• The more resource the experiment shares, the more its jobs can be scheduled
• Jobs from free experiment have high priority
Resource management

- Each experiment has a queue in vmquota database

Queue attributes
- Each queue has a minimum and maximum resource threshold
- The number of minimum and maximum threshold is based on the contributions of experiments, the value is adjustable
Workflow

Resource expansion

- Group A’s job queueing
- Request resources for VCondor
- If there is free resources
  - N: Wait for the next scheduling
  - Y: Start VMS

Resource shrink

- Group A’s job is not queue
- Get vm pool list of A from HTCondor
- Delete idle vm from HTCondor
- Shutdown idle VMS
Remark

• **VM Image preparation**
  - Setup a VM Image with Condor installed
  - Different experiments may have different images
  - Essential softwares
    - AFS and CVMFS for user and software storage
    - LEAF client in outside cloud

• **Quota settings**
  - Set the minimum and maximum threshold for experiments in vmquota

• **User transparent**
  - User can use unified job tool and same job command
Current status

• Download VCondor from https://github.com/hep-gnu/VCondor.git
• Basic environment has been established at IHEP
• The primary version is applied to LHAASO
• Test with commercial clouds (such as Ali cloud) is ongoing
Use case in LHAASO (1/2)

- Large High Altitude Air Shower Observatory
- Located on Mt. Haizi (4410 MASL), Sichuan, China
- ~2 Petabytes (2 million Gigabytes) of data annually generated by the LHAASO detectors
  - 1.7PB of raw data, and >200TB of reconstruction data
  - Totally >20PB for ten years
- >2 Petabytes of data generated by MC simulation
- To build one distributed computing system containing about 6000 CPU cores to process the data
  - ~ 4500 CPU cores for reconstruction, analysis, …
  - ~ 1500 cores for production
Use case in LHAASO (1/2)

• Current Status:
  • Local cloud cluster, 1000 CPU cores
  • ~30,000 jobs, 250,000 CPU hours a week
  • Resource utilization reaches to 86.59%

LHAASO Resource Pool: Automatically Scale up and down on demand
Summary

• VCondor enables elastic resource management
  • Has been used in IHEP for LHAASO
  • Provide support for HEP application resource sharing plan

• Next steps
  • Federated resources cross domains
  • schedule job across regions transparently
Thanks for your attentions!