Harvester
An edge service harvesting heterogeneous resources for ATLAS

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Introduction

➢ PanDA used to rely on server-pilot paradigm
  - Worked well for the grid with 250k cores 24x7 as underlying resources are not very heterogeneous

➢ Not very well for opportunistic resources, especially for HPCs
  - A different edge service and operational policy at each HPC center, leading to over-stretched pilot architecture and incoherence in implementation at different HPCs
  - Too many manual interventions to effectively fill available CPU resources at all HPC centers

➢ New project launched in Dec 2016 to address the issue
Introduction (cont’d)

➢ **New model: server-harvester-pilot**
  - Harvester is a resource-facing service between PanDA server and collection of pilots (workers)
  - Stateless service plus database (sqlite or MariaDB) for local bookkeeping
  - Modular design for different resource types and workflows
  - Many harvester instances running in parallel

➢ **Objectives**
  - A common machinery for pilot provisioning on all computing resources
  - Coherent implementations for HPCs
  - Timely optimization of CPU allocation among various resource types and removal of batch-level partitioning
  - Better resource monitoring
  - Tight integration between PanDA system and resources for new workflows
Harvester in PanDA System

- **PanDA Server**
  - get, update, kill job
  - request job or pilot

- **Harvester**
  - get, update, kill job
  - request job or pilot

- **Edge node**
  - submit, monitor, kill pilot
  - subset of pilot components

- **CE**
  - compute nodes

- **HPC center**

- **Cloud**
  - VM
  - pilot
  - spin-up

- **Grid site**
  - submit pilot
  - pilot scheduler or CE

- **Node**
  - submit, monitor, kill pilot
  - submit, monitor, kill pilot
  - increase or throttle or submit pilots
  - get/update job
  - kill pilot
  - request job or pilot

- **Worker = pilot, VM, MPI worker, batch worker**

Harvester uses whatever available at the resource → No requirement or constraint for Harvester deployment
Main Functions of Harvester

➢ Submission and monitoring of workers
  - With batch systems, computing elements, submission services, orchestration services, ...
  - Utilization of real-time information on resources

➢ Communication with PanDA
  - Getting jobs and reporting their status
  - Sending requests and receiving commands

➢ Bridge service between PanDA and workers
  - Propagating heartbeats and commands
  - Dynamic optimization of payload size

➢ Data management
  - Asynchronous pre-staging and shipping-out of data

➢ Cleanup
  - Disk cleanup, database cleanup, deletion or killing of (orphaned) workers
Harvester Architecture

- Central + local DBs for scalability
- Multiprocessing, multithreading, multi-nodes
- One core component (agent) per action
  - Action: job fetching, pre-staging, worker submission, ...
- Taking actions based on transition of job/worker status in local DB
- No direct communication (messaging) between agents
- Plugins developed by each resource experts
Current Status
The Grid

➢ Status
- Ongoing migration for large scale production at CERN, BNL and Taiwan
- Evaluating two submission engines, condor-C and aCT
- Migration of runtime tests for ATLAS offline software to harvester due to intermittent workload submission

➢ Goals
- Full migration to Harvester as a single mechanism for pilot provisioning on all ATLAS grid resources
- Dynamic resource partitioning based on current physics needs while getting rid of static batch-level partitioning
  - Details in CHEP poster: F H Barreiro Megino, ATLAS Global Shares Implementation in the PanDA Workload Management System
- Better site description for more optimal resource usage
Cloud

➢ Production status
- Condor-based cloud resources at CERN + Leibniz + Edinburgh with 1.2k CPU cores in production

➢ Two major developments
- Condor-based for ATLAS High Level Trigger (HLT) CPU farm with 50k cores, aka Sim@P1
  • Resource availability depending on needs for the original usage
  • Proactive assignment of workload to the resource for quick ramp up before the resource becomes available
  • Details in CHEP Talk: F Berghaus, Sim@P1: Using Cloudscheduler for offline processing on the ATLAS HLT farm
- Using native cloud API for GCE and EC2
  • Use-cases
    ➢ In context of the data ocean project with GCE + GCE API + Google Storage + preemptible VMs
    ➢ Openstack instance with EC2 API at Taiwan for non-ATLAS
  • New plugins with Kubernetes to be developed

Effect of switching from normal VMS to preemptible VMs on GCE
Production status

- US DOE HPCs
  - In production since Feb 2018 with a mechanism to dynamically combine many PanDA jobs to a single batch submission
  - Theta/ALCF, Titan/OLCF, Cori/NERSC

The total number of events (in M events) processed for ATLAS simulation production for last 6 months at US DOE HPCs

- KNL cluster at BNL
  - In production but the resource availability is intermittent

- ASGC
  - In production for non-ATLAS experiments

- EU or US NSF HPCs
  - Under discussion
Current developments
- Jumbo payload with event service on HPC, a.k.a Yoda
  • Local site policies drive the need for large payloads
  • Event-level bookkeeping as a protection against early termination due to preemption and/or inaccurate estimation of execution
  • In validation
- HPC + computing element
  • Integration of HPC resources to the grid with HTCondor or ARC CE
- Dynamic payload sizing based on real-time information from HPC batch system
  • Usage of preemptible resources without a capability of event-level bookkeeping
- Caching
  • Streaming service + local cache service to deliver data to compute nodes on demand
  • To be coherent with developments for ATLAS Event Streaming service which is reported in a CHEP talk: N Magini, Towards an Event Streaming Service for ATLAS data processing.
Beyond ATLAS

➢ 6 instances of harvester configured and ready to use for non-ATLAS experiment in BigPanDA project
  - One regional instance at Thomas Jefferson Lab maintained by TJLab team
➢ Tested for nEDM, LQCD, LSST, also with Next Generation Executer (NGE)
➢ The first LQCD production successful at BNL
➢ Details in CHEP talk: P Svirin, PanDA and RADICAL-Pilot Integration: Enabling the Pilot Paradigm on HPC Resources
Plans

➢ Migration of the entire ATLAS grid to harvester
➢ Dynamic resource partitioning based on current physics needs in ATLAS
➢ Seamless integration of HPCs with other resources without any manual interventions by using jumbo payload + Yoda
➢ Full integration of ATLAS HLT farm to harvester with proactive workload assignment
➢ Expanding harvester usage beyond ATLAS
Summary

➢ Harvester project was launched in Dec 2016
   - Wide collaboration of resource and PanDA experts
➢ Many development activities in parallel with various resources
   - Coherent implementations to meet different requirements
➢ Already in production for various resources
➢ Still a lot of challenges to come
   - Further optimization and automation
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