BNL RACF Site Report

Ofer Rind
Fall HEPiX, Tsukuba, Japan
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RACF Overview

• Located at Brookhaven National Laboratory on Long Island, NY

• Provides full service computing mainly for the two RHIC experiments — STAR, PHENIX — and for ATLAS (US Tier-1), along with some smaller groups: LSST, Daya Bay, DUNE, EIC, etc.

  • RHIC Run 17 completed in June

• BNL has reached an agreement with DOE to host Belle II Tier-1 Center

  • Year-long transition of services from PNNL, completion by Sept. 30, 2018
  • Currently provisioning compute, storage and infrastructure resources for Belle II and exercising entire data processing chain as part of this gradual (and seamless) transition

  • Further details at future HEPiX meetings
HPC Efforts

- RACF is the main component of the Scientific Data & Computing Center (SDCC) within the lab’s Computational Science Initiative (CSI)
- SDCC also includes two new HPC components (see Tony Wong presentation on Wednesday for additional detail)
  - Institutional Cluster - 126 x 36 core Broadwell nodes; EDR Infiniband
    - 108 with 2 x Nvidia K80 GPU
    - 18 with 2 x Nvidia P100 GPU, increasing to 108 (two racks shipping this month, with remainder expected in Spring 2018)
  - KNL Cluster - 144 x 64 core (256 HT) Xeon Phi 7230 1.3 GHz nodes; OPA interconnect
    - Stability and performance issues, mostly due to OPA, now under control
    - HS06 Benchmarking of KNL indicates factor 3 lower performance compared to Skylake
    - Benchmarking with non-optimized ATLAS-MP simulation jobs gave similar results; working with ATLAS software developers to optimize code for HPC environments
HPC Cluster Usage

SDCC CPU Usage

IC queue length
73

KNL queue length
20

U.S. Department of Energy
Brookhaven National Laboratory
Scientific Data and Computing Center

70 Years of Discovery
A Century of Service
Linux Farm

• New equipment purchased (expected Nov. delivery)
  • RHIC - 34 Dell PowerEdge R740xd Servers, 2448 Job Slots, ~35 kHS06
  • ATLAS - 90 Dell PowerEdge R640 Servers, 6480 Job Slots, ~93 kHS06
    • 2 Xeon Gold 6150 (Skylake) 2.7 GHz CPUs (72 logical cores total)
    • 192 GB DDR4 2666 MHz RAM
  • RHIC
    • 10 x 3.5" 8TB 7.2k RPM 6 Gbps SATA HW RAID5
    • 2 x 240 GB SSDs (for OS - HW RAID1)
    • PERC H730P+ RAID Card
    • 10 Gbps ethernet
  • ATLAS
    • 4 x 3.5" 4TB 7.2k RPM 6 Gbps SATA
    • PERC HBA330 Storage controller
    • 1 Gbps ethernet

• This will bring RACF total to 65K logical cores; ongoing discussion of resource sharing model (see Tony Wong presentation on Wednesday)
Linux Farm

• Belle II - 56 retired and repurposed Dell PowerEdge R620 servers (44 in production, 1408 job slots, ~13 kHS06)
  • 2 Xeon E5-2660 (Sandy Bridge) 2.2 GHz CPUs (32 logical cores total)
  • 64 GB DDR3 1600 MHz RAM
  • 8 x 2.5" 500 GB 6 Gbps SATA
  • PERC H310 Storage controller
  • 1 Gbps ethernet
• Systems built with SL7, jobs running in SL6 Singularity containers
Linux Farm

• SL7 Upgrade Status and Plans
  • RHIC
    • SL7 migration planned for Nov/Dec
    • New farm equipment will be built with SL7
  • ATLAS
    • Phased migration to SL7
    • One rack of equipment already migrated
    • New equipment will be built with SL7
    • Jobs on SL7 hosts forced to run in SL6 Singularity containers for now
  • Condor upgrade 8.4 → 8.6 concurrent with SL7 migration

• Singularity ([http://singularity.lbl.gov/](http://singularity.lbl.gov/))
  • Created SL6 compute containers for ATLAS, Belle II, and RHIC
  • Actively being used in production for all of Belle II and some of ATLAS
  • Utilizing Singularity to allow ATLAS jobs to run on our SL7 KNL cluster
  • Version 2.2.1 installed for production use, testing 2.3.x
  • See Chris Hollowell’s talk on Wednesday for additional information
Network Reconfiguration Update

- US Atlas Tier-1 facility was migrated outside of BNL campus network earlier this year.
- RHIC facility migration outside of BNL campus network and a merge of RHIC and ATLAS front ends planned for December.
- Migration to 25/50/100 GbE switching infrastructure has begun with new ATLAS dCache and Tier-3 GPFS storage.
- All facility storage systems are being migrated to dedicated "storage block" within next 6 months.
Network Reconfiguration Update

- 1 GbE attached compute nodes migrating to Equal Cost Multi Path (ECMP) "spine and leaf" (TOR switch based) network infrastructure
  - Beginning with ATLAS Tier-1 and Belle II, eventually including ATLAS Tier-3
  - Allows for better flexibility in re-tasking compute racks and simpler life cycle management of compute resources
- Multiple ongoing network connectivity upgrades for several facility subsystems: ATLAS dCache, Ceph, HPSS, CVMFS, RHEV
Distributed Storage

- **ATLAS Tier-1 dCache**
  - With recently added storage, dCache (3.0.11) now managing 17.5 PB of unique data
  - Developed a new non-polling HSM backend component to reduce resource usage on pools
    - Deployment awaiting resolution of a dCache space reservation bug that emerged under stress testing
- **Belle II Tier-1 dCache**
  - 0.8 PB deployed (retired ATLAS hardware)
  - 40 Gbps WAN
- **STAR XRootD**
  - 8 PB local storage on farm, increasing with new purchase
  - Ongoing development (N2N library) and testing in preparation for major upgrade to v4.6
Status of CEPH Clusters

**CephFS/BNLBox cluster:** Provide CephFS capacity for BNL Box
- 5.1 PB, Luminous 12.2 release
- Add’l disk will provide 6.8 PB by year’s end
- 12 Gb/s SAS attached RAIDInc JBOD arrays
- Public Network: dual attached 10/40 GbE; OSD network: dual attached 4x FDR IB (56 Gbps) with 1+1 redundancy

**Ceph ATLAS Prod cluster (commissioning, available by end of 2017):** Support AMZ/S3 clients (ATLAS Event Service)
- 4.5 PB, Luminous 12.2 release
- 8 GB/s FC and HW RAID Nexsan arrays retired by BNL ATLAS dCache system earlier this year
- Public Network: 10/40 GbE; OSD Network: 4X FDR IB (56 Gbps)

**Ceph ATLAS Test cluster:** Support AMZ/S3 and Swift clients
- 0.45 PB, Kraken 11.2 release
- 4 Gb/s FC and HW RAID Nexsan arrays (retired by BNL ATLAS dCache three years ago)
- Public Network: 10/40 GbE; OSD network: 4X FDR IB (56 Gbps)
Centralized Storage

- IBM Spectrum scale (GPFS)
  - Completed major update for RHIC GPFS clusters to v4.1.1.13, along with RHEL 6.9 → 7.3
  - 5 PB of raw data storage for Phenix and STAR
    - New servers: HP DL380 gen9, 2 X 40 Gbe Mellanox ConnectX-3 network adapters
    - Heavy production usage during last few months, throughput frequently peaks at 240 Gbps.
- New dedicated GPFS cluster for ATLAS Tier-3
  - ~ 1 PB raw capacity
  - Three HP DL380 gen9 servers, Mellanox 25 Gbe ConnectX-4
Centralized Storage

• RHEV Cluster
  • Redhat Enterprise Virtualization Cluster now runs on GPFS storage for both RHIC and ATLAS.
    • Currently hosts 350+ VMs, mostly infrastructure services — OpenAFS, auth, web, ssh gateways, ATLAS grid gatekeepers, etc.
  • Updated to RHEV 4.1 from 3.6 (RHEL 6.8 → 7.3)
  • ATLAS RHEV cluster hardware update: 15 hypervisors on HP DL360G9 servers (512 GB mem, 2 X 10 Gbe)
  • RHIC RHEV cluster hardware update: 12 hypervisors on IBM x3650 M4 servers (256 GB mem, 2 X 10 Gbe)

• CVMFS
  • BNL Stratum 0 providing custom repository for local ATLAS production jobs
  • Using CVMFS 2.3.5 packages in production on Strata 0 and 1
    • Upgrading to latest branch (2.4.x) soon
    • CVMFS on worker nodes to be upgraded from 2.0.19 in conjunction with SL7 update
HPSS

• Running v7.4.3 since November 2016
• ~105 PB on 55K tapes
• Ready to accept Belle-II data
HPSS

• Both STAR and ATLAS currently using LTO-7
  • PHENIX DST remaining on LTO-6 due to lower volume and lack of available LTO-7 drives

• Reclaimed 11K cartridge slots since April through migration of old LTO-4 (800 GB) data to dual-copy LTO-7 (6 TB) cartridges
  • Completed migration of STAR RAW
  • Now processing PHENIX RAW and STAR DST
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