Integrating Proof Analysis in Cloud and Batch Clusters

Ana Y. Rodríguez-Marrero1,2, Isidro González-Caballero2, Alberto Cuesta-Noriega2, Enol Fernández-del-Castillo1, Álvaro López-García1, Jesús Marco-de-Lucas1, Francisco Matorras-Weing1

1Instituto de Física de Cantabria (UC-CSIC), 2Universidad de Oviedo
3arodrig@ifca.unican.es

Deployment Modes of Proof Analysis Framework (PAF)

PROOF® enables interactive analysis of large datasets taking profit of parallel execution on clusters or many-core machines. The Proof Analysis Framework (PAF) provides a user-friendly environment to run analysis by automatically managing the PROOF resources and by providing typical objects and macros that simplify the development of the analysis code.

Instead of using dedicated multi-core machines configured to run the PROOF daemons, PAF is able to adapt to the dynamic nature of interactive usage by automatically deploying the PROOF services on top of the available resources in a transparent way for the user. This work presents the backend of PAF that manages the resource allocation and the PROOF services deployment.

For more details see poster: A Proof Analysis Framework

PAF Usage in Production

Users have incorporated PAF in their daily analysis routine using Cluster and PoD modes on computing infrastructures at IFCA and Univ. Oviedo.

IFCA
2000+ cores managed with SGE
GPFS shared filesystem

Univ. de Oviedo
100 cores managed with Torque
Hadoop shared filesystem

New pilot service for PAF users at IFCA on test phase:

IFCA Cloud
OpenStack cloud on 8-core machines with Xen hypervisor

PAF on Real CMS Data

Performance of an analysis on real LHC collisions (CMS top physics group) with two different datasets:

Scaleability limited by the filesystem performance (I/O bounded analysis):

Users are satisfied with the time reduction of their executions, that allows them to analyze big amounts of data in a few minutes.

References

1. PROOF: http://root.cern.ch/drupal/content/proof
3. PROOF on Demand (PoD): http://pod.gsi.de/
4. Son of Grid Engine: https://arc.liv.ac.uk/rac/SGE
5. OpenStack: http://openstack.org

P AF Cloud Integration

1 Master VM is instantiated (1 core 2GB RAM)
2 Volume(s) with data attached to master VM
3 Worker VMs are instantiated (8 core 14GB RAM)
4 NFS server exports volume data to worker VMs
5 Create proof configuration & start exec'd in all VMs
6 PAF starts PROOF session connecting to master VM

OpenStack Compute

PAF Backend

PROOF Workers

Image Repository
Stones PROOF SLS = ROOT image

Volume Server
Permanent storage for data

Master & NFS Server

P AF Batch System Integration

1 Job submitted requiring the desired slots
2 stdin spawned & workers added to PROOF cluster
3 PAF starts PROOF session connecting to the master

Scheduler Policies

- PAF jobs limited to 2 hours
- avoids use of backfilling
- avoids starvation and abuses

Range based slots allocation
- adapts to cluster load
- fair use of resources

Suspension of batch jobs
- PAF sessions available during high load periods of the cluster

PAF on CMS Real Data

Performance of an analysis on real LHC collisions (CMS top physics group) with two different datasets:

Scaleability limited by the filesystem performance (I/O bounded analysis):

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References

1. PROOF: http://root.cern.ch/drupal/content/proof
2. A.Y. Rodríguez Marrero et al., Interactive Analysis using PROOF in a Grid infrastructure, CHEP 2010.
3. PROOF on Demand (PoD): http://pod.gsi.de/
4. Son of Grid Engine: https://arc.liv.ac.uk/rac/SGE
5. OpenStack: http://openstack.org