Recent Improvements in the ATLAS PanDA Pilot

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Abstract

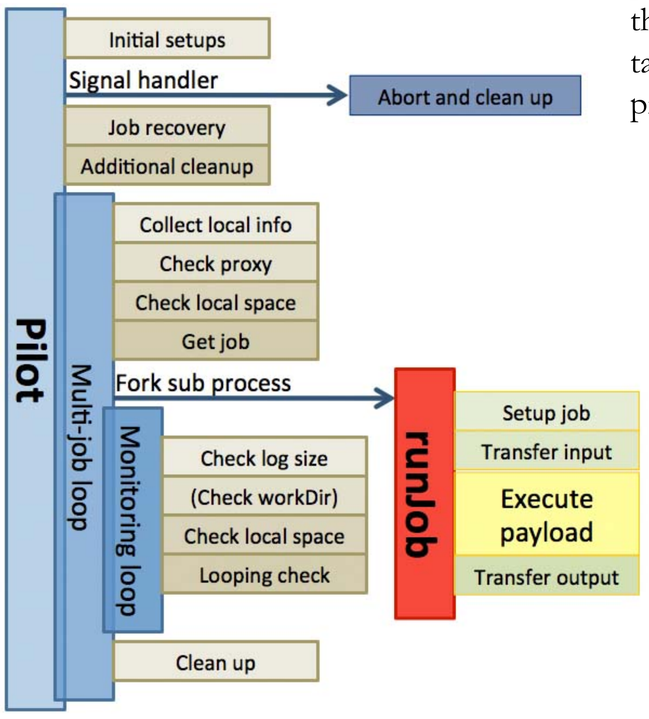
The Production and Distributed Analysis system (PanDA) [1] in the ATLAS experiment [2] uses pilots to execute submitted jobs on the worker nodes. The pilots are designed to deal with different runtime conditions and failure scenarios, and support many storage systems. This talk will give a brief overview of the PanDA pilot [3] system and will present major features and recent improvements including CernVM [4] File System integration, the job retry mechanism, advanced job monitoring including JEM technology [5], and validation of new pilot code using the HammerCloud stress-testing system. PanDA is used for all ATLAS distributed production and is the primary system for distributed analysis. It is currently used at over 100 sites world-wide. We analyze the performance of the pilot system in processing LHC data on the OSG [6], EGI [7] and Nordugrid [8] infrastructures used by ATLAS, and describe plans for its further evolution.

Introduction

A generic approach in grid computing is to use pilot jobs. Instead of submitting jobs directly to the grid gatekeepers, pilot factories are used to submit special lightweight jobs known as pilot wrappers that are executed on the worker nodes. In the case of ATLAS, the pilot wrappers perform initial checks, download the main pilot code and launch it. The pilot is responsible for downloading the actual payload and any input files from the SE, executing the payload, uploading the output to the SE, and sending the final job status to the PanDA server.

PanDA, *Production and Distributed Analysis*, is the pilot-based workload management system used by the ATLAS Experiment. It was developed to meet the needs of ATLAS distributed computing. The PanDA system has proven to be very successful in managing the ATLAS distributed production and analysis requirements on all three ATLAS grids; today PanDA is being used to incorporate cloud computing resources into ATLAS computing [9].

Pilot Workflow



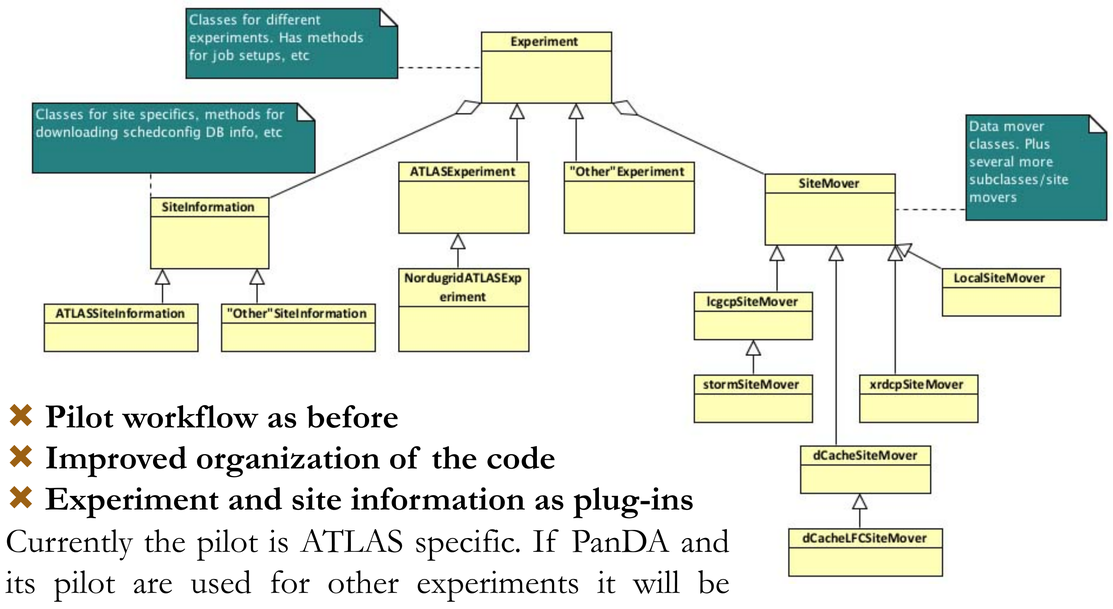
Upon launch, the pilot starts with performing initial setups and creates the signal handler. It can optionally take care of found remnants of previously failed jobs.

For each job the pilot runs, special criteria have to be met; enough local resources have to be available and the lifetime of the proxy must be long enough to last until the end of the job.

A sub process is forked for the job and is monitored by the pilot until it ends.

The sub process determines the proper setup for the job before any input is transferred. It executes the payload and transfers the output at the end of the job.

Next Generation Pilot



- **Pilot workflow as before**
- **Improved organization of the code**
- **Experiment and site information as plug-ins**

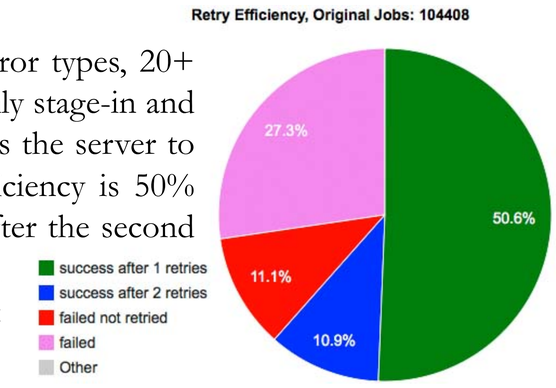
Currently the pilot is ATLAS specific. If PanDA and its pilot are used for other experiments it will be appropriate to have the code organized accordingly; e.g. the ATLASExperiment class will have a setup() method that defines how an ATLAS job should be setup

- **SiteMover classes will be refactored**
- **Major classes are implemented as singletons**

Recent Improvements

- **Job Retries**

The pilot can identify 100 different error types, 20+ of which are considered retriable (mainly stage-in and stage-out problems). The pilot instructs the server to automatically retry such jobs. The efficiency is 50% success after the first retry and 27% after the second retry. Currently, jobs are being retried at the same site. Retries on different sites are in development

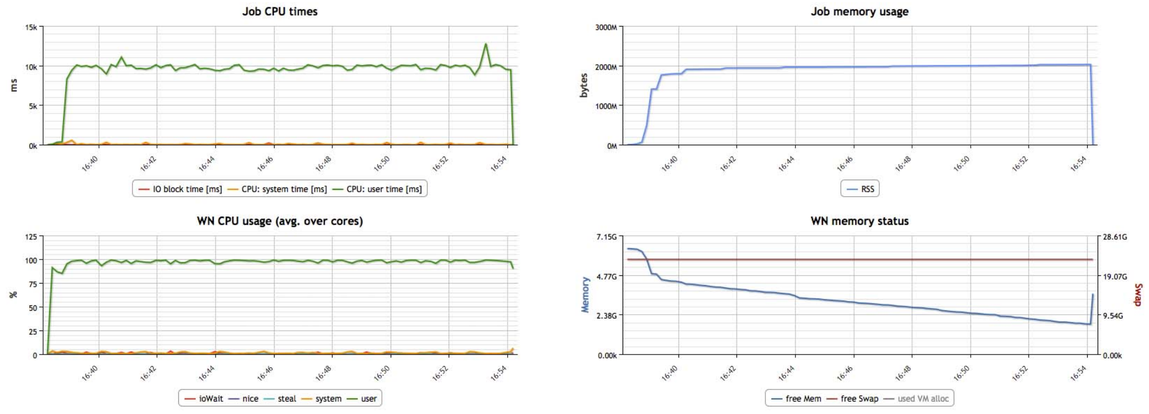


- **CernVM File System integration**

CernVM [4] is a baseline Virtual Software Appliance for the participants of the CERN LHC experiments., with a goal to remove a need for the installation of the experiment software and to minimize the number of platforms. Many ATLAS sites are already using the CernVM File System (CVMFS) to distribute releases, special files and other software (e.g. the PanDA pilot)

- **JEM technology**

The Job Execution Monitor [5] is a monitoring system running in user space. Users can submit their jobs with a special option that allows them to follow the job while it runs. JEM measures parameters like cpu load, incoming and outgoing network traffic, free RAM, free disk space on several file systems, etc. JEM can be reached from the standard PanDA monitor [10] job page

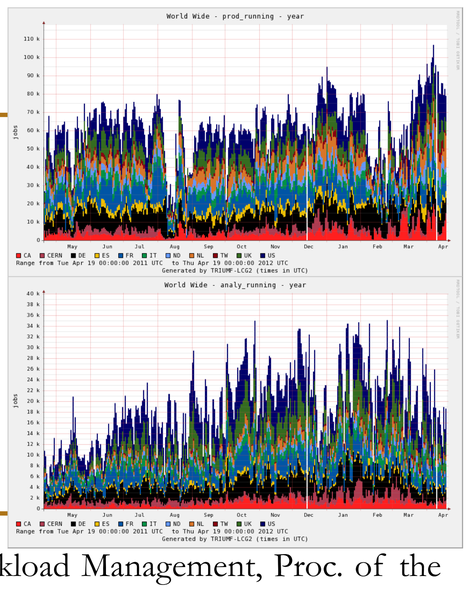


- **HammerCloud stress-testing system**

HammerCloud [11] is a Distributed Analysis testing system used by several experiments. In ATLAS it is used not only to send standard test jobs to sites but also for sending special jobs for testing release candidates of the pilot. The progress can be followed on the HammerCloud and PanDA monitor pages. Most problems are thus spotted before the development version of the pilot is released

Performance

The PanDA system is concurrently serving up to 100k production jobs and 35k user analysis jobs. The error rate in the entire system is at the level of 10 percent. The majority of these errors are site or system related, while the rest are problems with ATLAS software.



References

[1] T. Maeno, Overview of ATLAS PanDA Workload Management, Proc. of the 18th Int. Conf. on Computing in High Energy and Nuclear Physics (CHEP2010)
[2] The ATLAS Experiment: http://atlas.web.cern.ch/Atlas
[3] P. Nilsson, The ATLAS PanDA Pilot in Operation, Proc. of the 18th Int. Conf. on Computing in High Energy and Nuclear Physics (CHEP2010)
[4] CernVM: http://cernvm.cern.ch
[5] JEM: http://jem.physik.uni-wuppertal.de/JEM
[6] Open Science Grid: http://www.opensciencegrid.org
[7] European Grid Initiative: http://www.egi.eu
[8] NorduGrid: http://www.nordugrid.org
[9] F. Barreiro et al, Exploiting Virtualization and Cloud Computing in ATLAS, Proc. of the 19th Int. Conf. on Computing in High Energy and Nuclear Physics (CHEP2012)
[10] PanDA Monitor: http://panda.cern.ch
[11] HammerCloud: http://hammercloud.cern.ch