Gearing the DECam Analysis Pipeline for Multi-Messenger Astronomy using Pegasus Workflows

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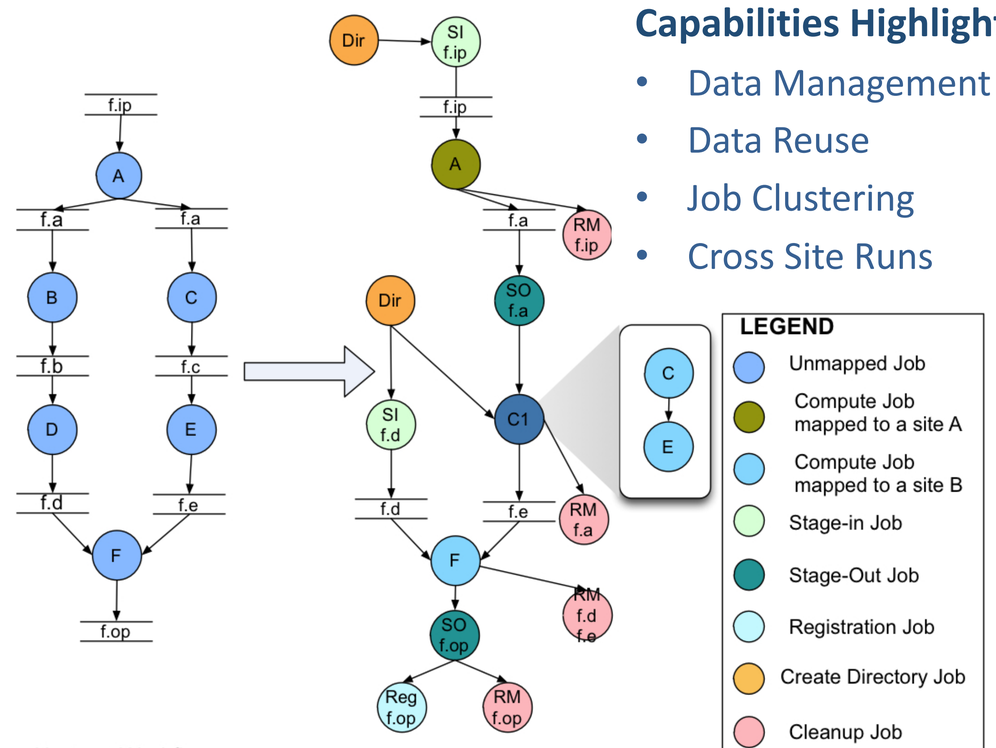
Pegasus WMS

- Pegasus is a system for mapping and executing abstract application workflows over a range of execution environments.
- The same abstract workflow can, at different times, be mapped different execution environments such as XSEDE, OSG, commercial and academic clouds, campus grids, and clusters.
- Pegasus can easily scale both the size of the workflow, and the resources that the workflow is distributed over. Pegasus runs workflows ranging from just a few computational tasks up to 1 million.
- Stores static and runtime metadata associated with workflow, files and tasks. Accessible via command line tools and web based dashboard.
- Pegasus-MPI-Cluster enables fine-grained task graphs to be executed efficiently on HPC resources.



Capabilities Highlighted

- Data Management
- Data Reuse
- Job Clustering
- Cross Site Runs

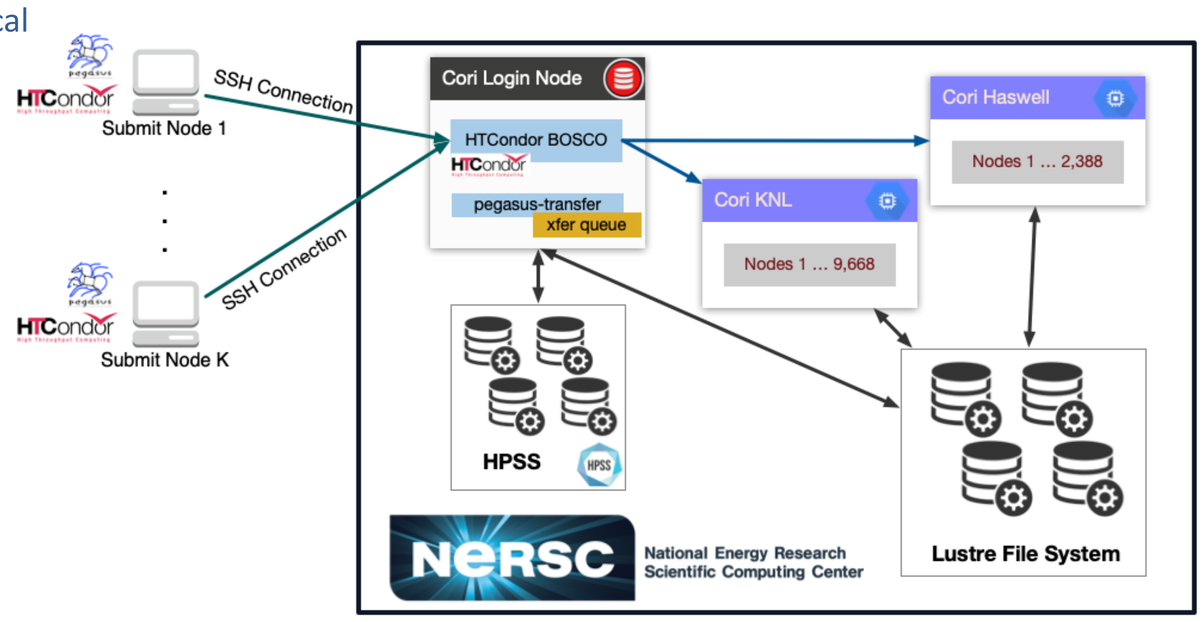
DECam Analysis Pipeline

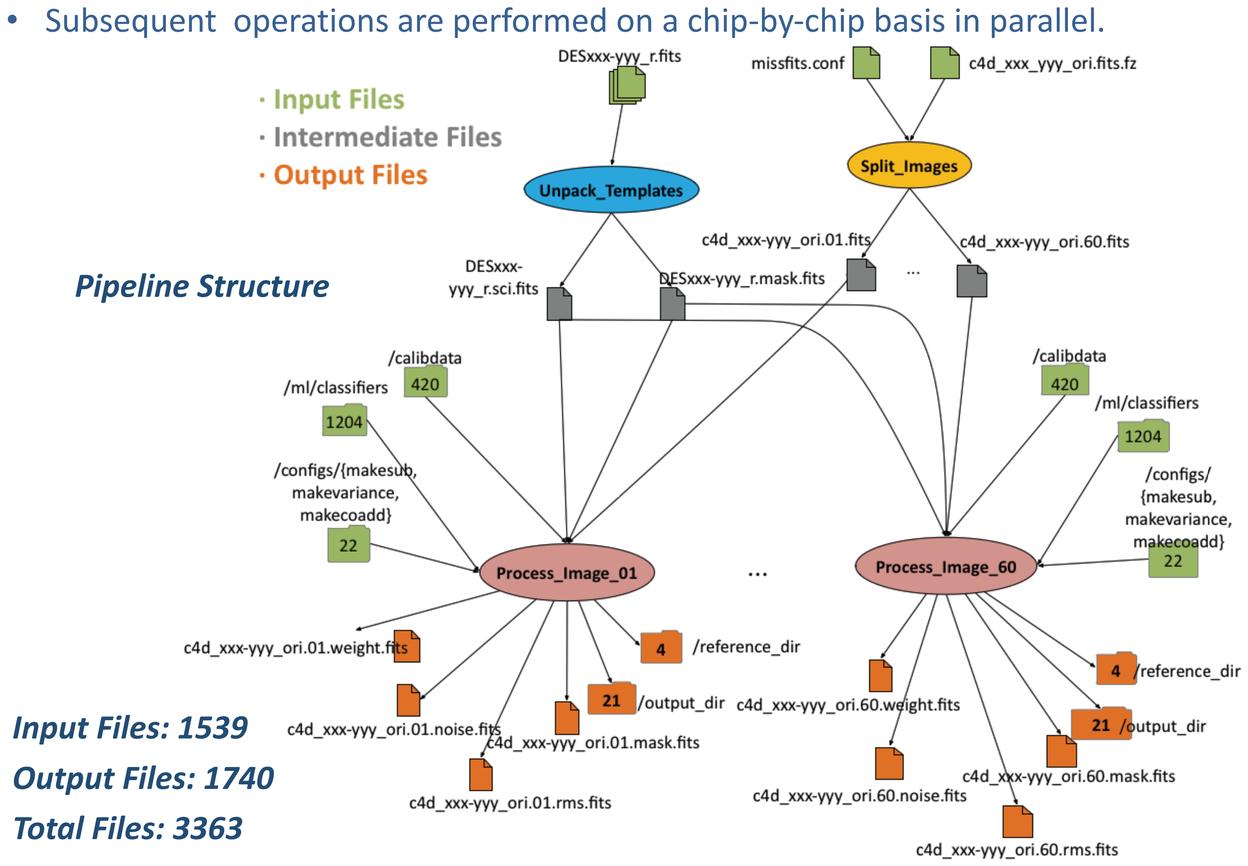
Motivation

- Verify gravitational waves (GWs) discoveries with their electromagnetic (EM) optical counterparts in near real-time.

Pipeline

- Employs sophisticated machine learning algorithms to sift the data and identify events for scientists to follow up on.
- Processing begins by splitting the packed images into chips, applying crosstalk corrections, and performing standard bias/overscan subtraction and flat fielding.
- Subsequent operations are performed on a chip-by-chip basis in parallel.





Pipeline Structure

Input Files: 1539
Output Files: 1740
Total Files: 3363

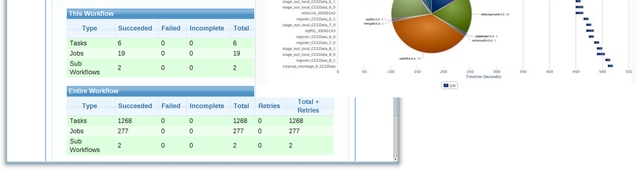
Deployment Setup

- Workflows are submitted from a submit node at USC to CORI (CRAY XC40 Super Computing Cluster at NERSC).
- Jobs are submitted over SSH using BOSCO.
- Each job executes a Shifter container containing the science codes.
- Historical data collected from the Victor Blanco telescope + DECam imager. Most of the dataset(~500 TB) archived at NERSC.
- Input datasets are retrieved automatically from HPSS tape storage.
- Each LIGO trigger requires analysis of hundred of GB's of data.
- Outputs are brought automatically back to the submit node

Monitoring and Debugging

At runtime, Pegasus populates a database with workflow and task runtime provenance, including which software was used and with what parameters, execution environment, runtime statistics and exit status.

Pegasus comes with command line monitoring and debugging tools. A web dashboard now allows users to monitor their running workflows and check jobs status and output.

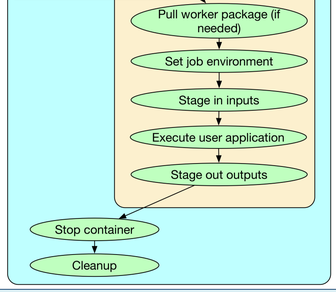


Containers

- Application containers provides a solution to package software with complex dependencies to be used during workflow execution
- Users have the option of either using a **different container for each executable** or **same container for all executables**

Container Execution Model

- Container image is put in the job directory along with input data.
- Loads the container if required on the node (applicable for Docker)
- Run a script in the container that sets up Pegasus in the container and job environment
- Stage-in job input data
- Launches user application
- Ship out the output data generated by the application
- Shut down the
- Cleanup the job directory



Future Work

- Setup the production pipeline to run on Open Science Grid a highly distributed computing platform that is opportunistic using Singularity containers.
- Use the workflow as a benchmark tool for understanding the workflow performance of a variety of compute facilities.
- Instrument the workflow to capture performance metrics related to networking, node-to-node communication, database queries, system I/O (allowing tests of archival tape storage, spinning disk and/or burst buffer) and compute (with both parallel and serial components)

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