

Pegasus Workflow Management System

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Scientific Workflows

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- Orchestrate complex, multi-stage scientific computations
- Often expressed as directed acyclic graphs (DAGs)
- Can execute in parallel on distributed resources
- Capture analysis pipelines for sharing and reuse



Large, Data-intensive Workflows



John Good (Caltech)

- Montage Galactic Plane Workflow
 - 18 million input images (~2.5 TB / wf)
 - 1000 output images (2.5 GB each, 2.4 TB / wf)
 - 10.5 million tasks (34,000 CPU hours)







Pegasus Workflow Management System (WMS)

- A collaboration between USC/ISI and the Condor
 - **Team at UW Madison**
 - Pegasus plans the workflow
 - DAGMan is the workflow engine
 - Condor schedules jobs and manages resources
- Started in 2001
- Actively used by many applications in a variety of domains
 - Earth science, physics, astronomy, bioinformatics, others
 - http://pegasus.isi.edu/applications





Pegasus WMS

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DAGMan – Directed Acyclic Graph Manager

- Enables dependencies between jobs
- Provides reliability
 - Retries for job-level failures
 - Rescue DAGs for workflow-level failures

Other features

- Throttling
- Priorities
- Pre- and Post-Scripts
- Workflow of workflows



JOB A a.submit JOB B b.submit JOB C c.submit JOB D d.submit PARENT A CHILD B C PARENT B C CHILD D





Pegasus Planner

- Pegasus planner compiles abstract workflows into executable workflows
 - Adds data management jobs (transfer, cleanup, registration)
 - Performs optimizations (task clustering, reduction, etc.)
 - Generates executable artifacts (DAG, submit scripts, etc.)
- Enables portability and optimization



Other Pegasus WMS Features

- Monitoring and Troubleshooting
 - Web GUI and command-line tools for reporting and investigating workflow progress and failures
- Hierarchical Workflows
 - "Workflow of Workflows"
- Provenance
 - Generates a database with information about when and where jobs were executed
- Others
 - MPI task clustering (pegasus-mpi-cluster)
 - Script generation
 - Notifications

- ...





Distributed Workflow Challenges/Requirements

- Security and identity management
 - Different credentials on different sites / clusters
 - Complexity of grid security, X.509
 - Firewall and network issues, e.g. when using Glideins
- Job submission
 - Local: Dedicated login node / submit host
 - Remote: Middleware, e.g. Globus GRAM
- Data transfer
 - Need high-performance transfer tools, e.g. GridFTP
 - Many different protocols/tools (scp, GridFTP, http, irods, srm, s3)
 - Complex storage configurations



Job Submission in Pegasus

- Personal Condor
- Local Condor pool
- Local Batch (PBS, SGE, etc.)
- Remote Condor pool (Condor-C, flocking)
- Batch using GRAM, UNICORE, ARC
- Glideins with BOSCO or glideinWMS
- Batch using SSH w/ BOSCO (scalability?)





Distributed Data Management in Pegasus



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Data Management Configurations





Workflows and Science Gateways

- HubZero
- Pegasus as a Service



Credit: Frank McKenna, UC Berkeley, NEES, HUBzero





More Information

- Website: http://pegasus.isi.edu
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CC-NIE: ADAMANT

