

What makes workflows work in an opportunistic environment?

1. introduction

- **Workflows :**
 - enable scientists to systematically express complex analysis, reason about the overall application
 - and to provide provenance information adequate for the interpretation of the derived results.
- **An opportunistic environment:the grid**

1. introduction

- We focus on a particular problem of the interplay in middlewares between decision-making and execution services:
 - **The planner**:Pegasus
 - **The manager** consists of :
DAGMan ,Condor-G and Stork.

2. Background

- GriPhyN
- Chimera
- Pegasus

2.1 GriphyN

- At the heart of GriphyN is the idea of **virtual data** where data can exist in some storage system or can exist in a workflow.
- When a user request a data set, the system evaluates the request and generates an abstract workflow, performs the necessary resource assignment and execute the request.

2.2 Chimera

- As part of GriphyN; several middleware services can take a high-level partial workflow description, map it to a concrete form and execute on the grid.
- **Chimera system** takes a VDL provided by the user and constructs an abstract workflow.
- The abstract workflow details the application components and their input and output data at an abstract level.

2.3 Pegasus

Pegasus take the abstract description from the Chimera

- queries a variety of grid information services
- and makes decisions about where to execute the application components and where to access the data.

2.3 Pegasus

- **Pegasus** may decide to reduce the abstract workflow if intermediate data products are already available.
- **Pegasus** augments the workflow with data movement, in order to stage data in and out of the application component.
- The resulting concrete workflow is given to a workflow execution system (DAGMan)
- The execution sys interacts with a variety of resource managers.

3.Workflow Mapping and Execution

- DAGs
- DAGMan
- Batch schedulers

3.1 Workflow Mapping

- For simplicity
- Assume that the workflow are structured as **directed acyclic graphs(DAGs)**
- jobs are represented as **nodes**
- the dependencies between jobs are represented as **directed arcs** between the respective nodes.

3.2 Execution

- To perform the management of the DAGs , we employ the **DAGMan** which is a service for executing multiple jobs with dependencies between them.
- a directed graph manager
 - takes the workflows
 - orders the jobs according to their dependencies
 - submits the jobs ready for execution to the corresponding batch schedulers.

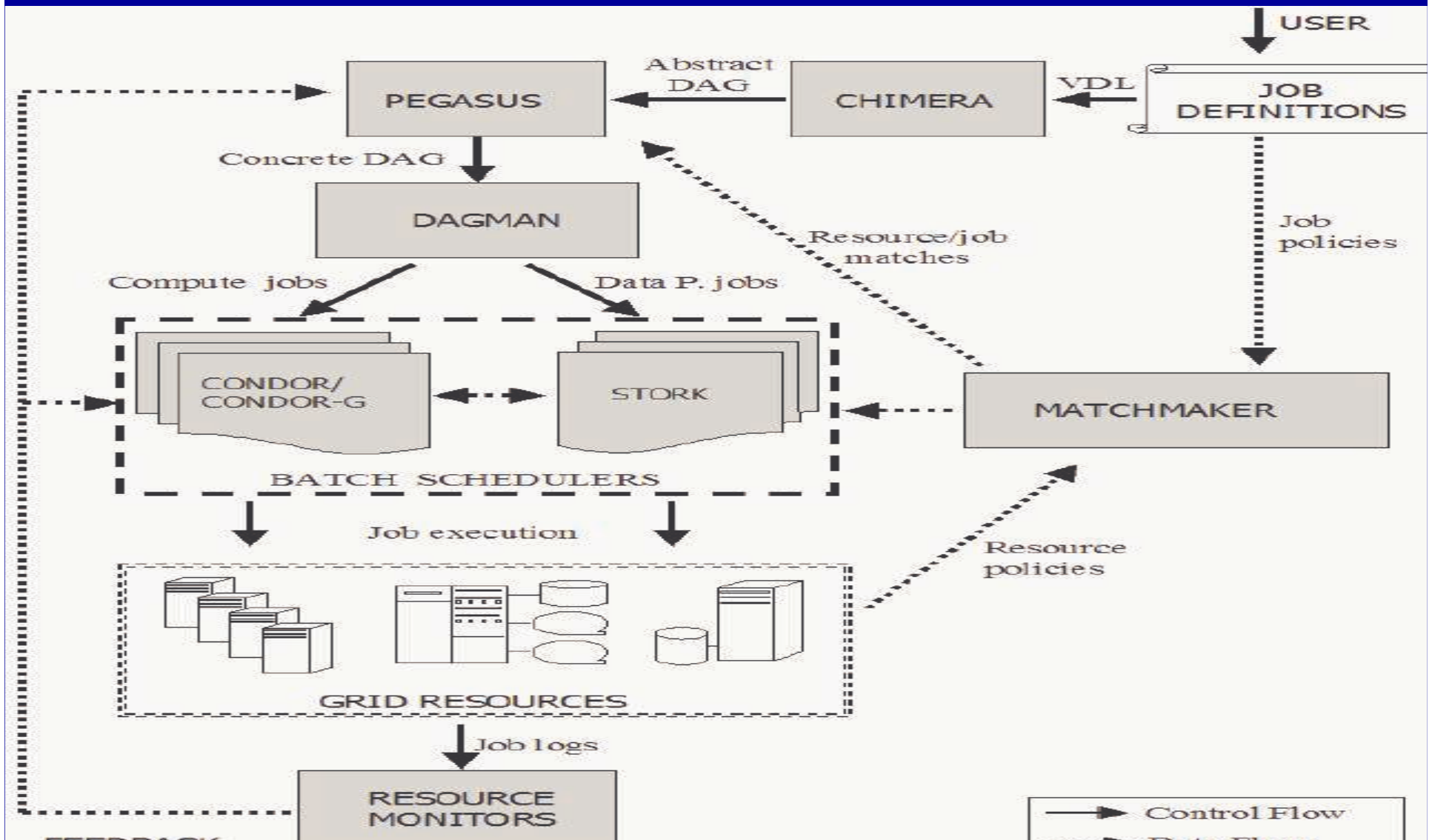
3.1 Workflow Mapping

- Different batch schedulers can be used according to the requirements or characteristics of the jobs in the workflow.
- In our framework, we use two specialized batch schedulers:
 - one for **computation**(condor/condor-G)
 - one for **data placement**(Stork)

3.2 Execution

- **Condor** is a scheduler for computational jobs.
- **Condor-G**
- **Stork** is a specialized scheduler for data placement activities

3.2 Execution



4. Data Management issues

- The data moving decisions
- Data placement

4.1 The data moving decisions

- Data movement decisions are made in our system by Pegasus.
- Avoid the risk of running out of disk space at the execution site
- Pegasus may **allocate space** before transferring the input data there
- **Release the space** after it moves out the output data from there.

4.2 Data placement

- The data placement scheduler can **understand the characteristics** of the data placement jobs and **can make smart scheduling decisions** accordingly
- The data placement component **schedules the jobs** according to the information it gets from the high-level planner and from the resource broker/policy enforcer

5. Interactions between Workflow Planning and Execution

- Planning decision points
- Decision specification level
- Reacting to the changing environment and recovering from failures.

5.1 Planning decision points

- In general, because of the highly dynamic aspects of the underlying execution environment, it may be beneficial to postpone the binding of a task to a physical resource until the very last moment.
- Not all decisions can be postponed to the end.

5.1 Planning decision points

- The final decision of allocation of a particular activity may occur at three distinct points in time.
 - Workflow Delegation Time
 - Activity Scheduling Time
 - Resource Availability Time

5.1.1 Workflow Delegation Time

- Decisions can be made at the time that the execution of the workflow is delegated to the manager
- eager planning

5.1.2 Activity Scheduling Time

- The decision of resource assignment is made when a particular activity or activity set is ready to be released into the system.
- deferred planning

5.1.3 Resource Availability Time

- it is possible that at the time an activity is ready to execute, there are no resources available to execute that activity or difficult to determine the « best » resources at that time.
- **just-in-time planning**
- Decisions to be made when resources needed to execute the activity become available.

5.2 Decision Specification Level

- The level of specification is dependent on the capabilities of each of these components .
- On one end of the spectrum, the planner may be able to structure the workflow then push all the decision making to the manager
- On the other end of the spectrum, we can have a manager where need to rely on the planner to make all the decisions.

5.3 Reaction to the Changing Environment and Recovering from Failures

- Interaction are not solely geared towards delegating work from the planner to the manager.
- it is necessary for the workflow manager to communicate the failure,as well as success to th planner.

5.3 Reaction to the Changing Environment and Recovering from Failures

- **Flow back**: the flow back of the information from the manager to the planner.
- Based on the information provided by the manager, the planner can decide how to proceed, whether to reschedule a particular activity and possibly its dependents.

5.3 Reaction to the Changing Environment and Recovering from Failures

- The level of sophistication of the planner and manager plan important role.
- It determines how much recovery is placed within the responsibility of the components.
- In general, in case of failures, the planner may want to re-plan the mapping of the workflow.

6. Related work

- There have been a number of efforts within the Grid community to develop generalpurpose workflow management solutions.
- WebFlow ;GridFlow;AppLeS;Beck et .al. Thain et.al;etc!