Workflow, Planning and Performance

Information, information, information

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17th March 2006
Outline

Where does this work come from?
Types of workflow
Workflow Pipeline
The Planner
Information, Information, Information
Using Information
Component Deployment
Conclusion
Where does this work come from?

Performance

Workflow

Execution

JSDL-WG

OGSA-WG

GGF
ICENI: Imperial College e-Science Network Infrastructure

- Integrated end2end Grid Middleware Solution
- Interoperability between architectures, APIs
- Added value layer to other middleware
- Usability: Interactive Grid Workflows
- Role and policy driven security
- Foundation for higher-level Services and Autonomous Composition
- ICENI Open Source licence (extended SISSL)
- Collect and provide relevant Grid Meta-Data
- Pluggable architecture
- Test Architecture for Grid Research

The Iceni, under Queen Boudicca, united the tribes of South-East England in a revolt against the occupying Roman forces in AD60.
GridSAM Overview

Grid Job Submission And Monitoring Service

What is GridSAM?
Funded by the OMII Managed Programme (Started in Sept, 04)

Client Perspective
- Job Submission and Monitoring Web Service that bridges to existing systems (e.g. Condor, SGE)
- Job described in *Job Submission Description Language*
- File input and output staging
- Tools and simplified Java API for submission and monitoring

Developer Perspective
- Extensible JobManager API interfacing with existing Distributed Resource Managers (DRM)
- Fault-tolerance and persistence
- Can be used as an embedded library (e.g. in Job Submission Portal, Grid Applications)

Part of ICENI II
What is GRIDCC

Grid enabled Remote Instrumentation with Distributed Control and Computation

Adding real time control of instruments to the Grid

What makes this unique:

- Instruments may only be ready at specific times
- Reservations
- Need to ensure other Grid services are available with instruments
  - Reservations / SLA’s
- Real-time visualisation of live results and steering
  - Through Virtual Control Room (VCR)
  - Reservations / SLA’s
Types of Workflow

Different users of the Grid have different views of what a workflow is
The Scientists Plan

Conceptual Workflow
The Scientists Plan

Middleware Workflow
Workflow mapping

components

user

workflow

VCR

Control Process

CE

SE

Data Process
Abstract Workflow Pipeline

Decompose into interacting levels

- Specification
- Planning
- Execution
- Observation
- Security
Workflow Pipeline

The stages that the workflow will go through from the users concept through to the executing application.
OGSA Architecture

Execution

- Provisioning
  - Deployment
  - Configuration
- Reservation
- Service Container
- Data Container
- Accounting Services

Planning

- Candidate Set Generator (Work - Resource mapping)
- Information Services
- Execution Planning Services
- Job Manager

Optimisation & Scheduling

Observation
The Planner

Tasked with deciding where each part of the workflow should be deployed
A good planner should be able to select an “optimal” set of resources and implementations of components

- Execution of workflows on the Grid is an NP-Hard problem
  - Large number of resources available for use
  - Multiple implementations of code that can be deployed onto resources
- Performance aware scheduling goes a long way to achieving a good selection
Workflow Scheduling with Performance
However:

- Algorithms for determining the “best” resources and implementations become slow as the search space increases
  - Performance Information is often slow to obtain
  - Current status of resources is often slow to obtain
    - thus out of date by the time you get it
- We need to reduce the search space before doing performance aware planning
Information, Information, Information

There is a vast amount of information available

Lots of systems throw this information away
Using the Information

Using this information to better perform the tasks that the user requires
Using information for Optimisation

We can use Information for:

- **Validation of the Workflow**
  - Make sure that only “correct” workflows are submitted

- **Workflow Optimisation**
  - By altering the workflow to make it more optimal

- **Resource Optimisation**
  - Pruning the set of resources that are considered
Workflow Validation

Goal: Ensure that a workflow is correct before it is accepted into the Grid.

- Reduce the chance of “wasted time”

Requirements: Only look at the workflow and component information

Achieve the goal through:

- Syntactic Validation
- Semantic Validation
Syntactic Validation

Verify that the connections between components can be made

- An in-port can accept the data produced by the connected out-port
- Size and shape of the data matches

Information from the component description and workflow document
Semantic Validation

The use of problem space knowledge

- To determine if the workflow
  - Makes sense
  - Will produce what the user intended
- Can equate to grammar checking
- Problem space knowledge exists for Mathematics already
  - Need to expand to other areas
  - Can be collected from Users and domain experts
Workflow Optimisation

Goal: optimise the runtime execution of workflow before it is executed

Requirements: No performance or resource information is used

Achieves the goal through:
- Re-ordering of components
- Substitution of components
- Addition of components
- Pruning of the workflow
Component Re-ordering

Workflows (often composed from composite workflows) may contain non-optimal ordering of components

Use re-ordering to improve performance

- Domain knowledge

```
Matrix Gen
Matrix Gen
Vector Gen
```

```
Matrix Gen
Matrix Gen
Vector Gen
```

```
Matrix Gen
Vector Gen
```

multiply

multiply

multiply

multiply

multiply
Component Substitution

A Jacobi Iteration linear solver replaced by Conjugate Gradient linear solver according to the output of the Discretizer (FEM)

Based on observing the meta-data associated with previous components

A (sparse and diagonally dominant)

\[
\begin{array}{c}
\text{FEM} \\
b \\
\text{JI linear solver}
\end{array}
\]
To use an optimal component it may be necessary to transform the output of a previous component

- Need to identify optimal alternatives
  - How to transform data for input
- Allows more optimal components to be used together

![Diagram](image-url)

- C1: Output in LP format → LP to MPS → Input required in MPS format → C2
Workflow Pruning

Workflows may contain unused components

Especially when composed from other sub-workflows

Remove redundant components

Diagram:

- a → b → d
- f → e → c
- c is marked as not needed
- d is also marked as not needed

Legend:
- Green arrow: Not needed
Resource Optimisation

Goal: Reduce the number of resources that are considered for use

Requirements: No workflow or resource current state information is used

Achieves the goal through:
- Authorisation
- Hardware / Software requirements
- Problem Specific requirements
- Out of bounds
Component Deployment

Abstracting the component developer from the underlying heterogeneity of the Grid
Deployment & Virtualisation

Component transfers

Deployment Service

Workflow Pipeline

deploy

monitor

Inter component communication

Prepare

instantiate

Service Container

Virtualised Operating System

Operating System

Hardware
Conclusion

- Information can be practically used to help in the manipulation and optimisation of workflows
  - This is by no means a completed task
  - Much more information can be collected
  - There are other ways in which the information can be used
Any Questions?

Thank you for listening