ORGANIZATION DEVELOPING GRID COMPUTING TOOLKITS AND FRAMEWORK - I

CONDOR AND CONDOR-G

Condor [7] is a tool for harnessing the capacity of idle workstations for computational tasks. Condor is well suited for parameter studies and high throughput computing, where jobs generally do not need to communicate with each other.

We can classify Condor as a specialized workload management system for computation-intensive jobs. Like other full-featured batch systems, Condor provides a job queuing mechanism, scheduling policy, priority scheme, resource monitoring, and resource management. Upon receiving serial or parallel jobs from the user, the Condor system places them into a queue, chooses when and where to run the jobs based upon a policy, carefully monitors their progress, and ultimately informs the user upon completion.

We can make use of Condor to manage a cluster of dedicated compute nodes. It is suitable for effectively harnessing the CPU power from idle workstations. Condor has mechanisms for matching resource requests (jobs) with resource offers (machines).

While Condor software tools focus on harnessing the power of opportunistic and dedicated resources, Condor-G is a derivative software system, which leverages the software from Condor and Globus with major focus on the job management services for grid applications. This is a combination of interdomain resource management protocols of Globus (GRAM, Index Services) with the intradomain resource management methods of Condor. Figure 2.6 shows a sample usage of Condor-G in combination withGlobus. As shown, Condor-G contains a GASS Server, which is used to transfer jobs to and from the execution center. The Condor-G Grid

Condor software is used by both scientific and commercial organizations. The major scientific initiative that uses Condor includes NSF Middleware Initiative (NMI), Grid Physics Network (GriPhyN), International Virtual Data Grid laboratory (iVDGL), TerraGrid, and so on. Some of the prominent commercial uses of condor software involve solving computational Grid Computing problems, as done by Micron Technologies, CORE Digital Pictures, and NUG30 Optimization Problem Solver.

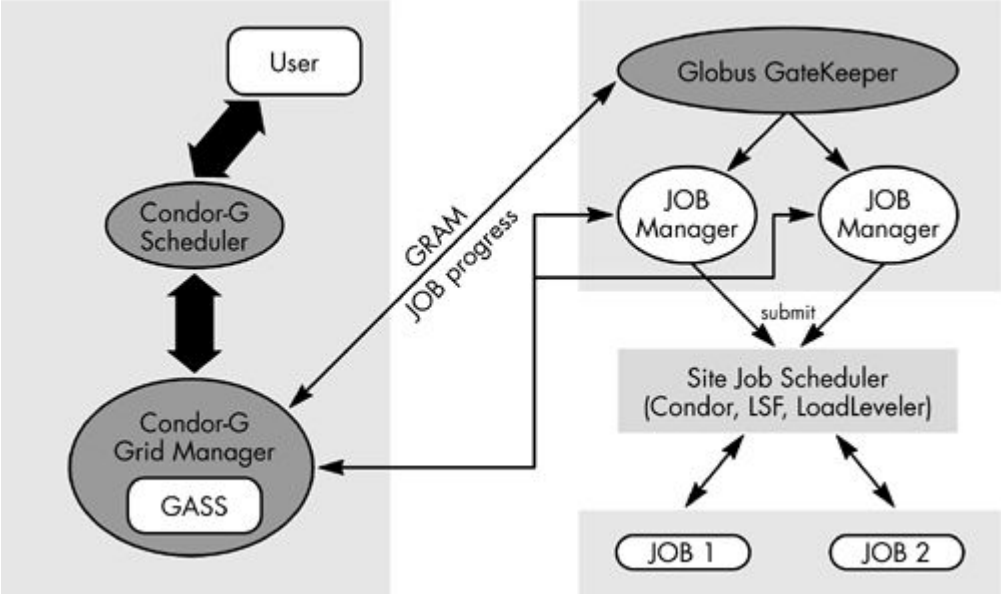

Figure 1.6. Remote execution of Condor-G on Globus-managed resource using Globus Job manager.

Nimrod

Nimrod [8] provides a user interface for describing the "parameter sweep" problems, with resulting independent jobs being submitted to a resource management system.

Nimrod-G is a derivative software system, which harnesses the software from Nimrod and Globus to harness multi-domain resources as if they all belong to the one personal domain. It provides a simple declarative parametric language for expressing the parameters for execution. This system exposes novel resource management and job scheduling algorithms based on the economic principles of computing. Such a set of resource trading services is called GRACE (Grid Architecture for Computational Economy). GRACE provides mechanisms to negotiate on the QoS parameters, deadlines, and computational costs. In addition, it offers incentive for relaxing requirements. We could see that depending on users' QoS requirements, these resource brokers dynamically lease Grid services at runtime depending on their cost, quality, and availability.

Leveraging the services provided by grid middleware systems develops the Nimrod-G toolkit and resource broker. These middleware systems include Globus, Legion, GRACE, and so forth.

As illustrated in Figure 2.7, the Nimrod architecture defines the following components :

1. **Nimrod-G clients , which can provide tools for creating parameter sweep applications, steering and control monitors, and customized end-user applications and GUIs**
2. The Nimrod-G resource broker, which consists of a Task farming engine (TFE), a scheduler that performs resource discovery, trading and scheduling features, a dispatcher and actuator, and agents for managing the jobs on the resource

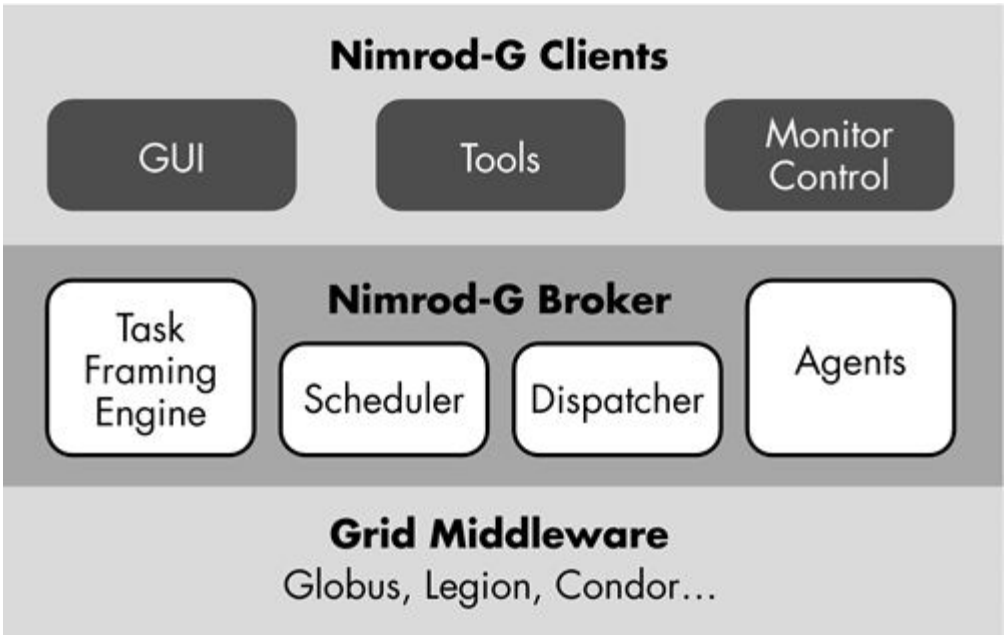

Figure 2.7. Architecture of Nimrod-G.

It is important to note that the Nimrod-G broker provides its services by leveraging the grid middleware systems including Globus, Legion, Condor, and so on.

As we have previously discussed, the core feature of the Nimrod-G toolkit is the support for user-defined deadlines. For example: "Get this simulation done in 10 minutes with a budget of USD 0." Also, budget constraint for scheduling optimizations is a part of the core features.
Nimrod-G facilitates the execution of the user requirement by managing supply and demand of resources in the grid using a set of resource trading services.

The most important scheduling algorithms used in Nimrod-G are:

- Cost optimization ” uses the cheapest resource
- Time optimizations ” results in parallel execution of the job
- Cost-time optimization ” similar to cost optimization but if there are multiple jobs with the same cost, then the time factor is taken into consideration
- Conservative time strategy ” similar to time optimization, but guarantees that each unprocessed job has a minimum budget per job

Parametric Computational Experiments

Parametric computational experiments are becoming increasingly important in science and engineering as a means of exploring the behavior of complex systems. For example, a flight engineer may explore the behavior of a wing by running a computational model of the airfoil multiple times while varying key parameters such as angle of attack, air speed, and so on.
The results of these multiple experiments yield a picture of how the wing behaves in different parts of parametric space.

Many practitioners of Grid Computing believe that economic policy/criteria-driven Grid Computing, as depicted by Nimrod-G, is a major interest to the utility computing world.

UNICORE (UNiform Interface to COmputer REsource)

The UNICORE [9] project is funded by the German Ministry of Education and Research with the design goal including a uniform and easy-access graphical user interface (GUI), open architecture based on the concept of an abstract job, a consistent security architecture, minimal interface with local administrative procedures, and exploitation of the existing and emerging technologies including Web and Java.
UNICOREpro was produced within the UNICORE to provide a uniform interface for job preparation and secure submission of the job similar to a portal. This enables users to create workflow for job execution and control execution behaviors. This is an open source project

developed using Java technology. The UNICOREpro server provides capabilities for authorization, job management, data transfer, and batch interface.

A project called GRIP (GRid Interoperability Project) was started in 2002 to achieve the interoperability between UNICORE and Globus. The EUROGRID software is based on the UNICORE system developed and used by the leading German HPC centers.

NSF Middleware Initiative (NMI)

NMI [10] was created by the National Science Foundation (NSF) to help scientists and researchers use the Internet to effectively share instruments, laboratories, and data and to collaborate with each other. Middleware is software that connects two or more otherwise separate applications across the Internet or local area networks.

Middleware makes resource sharing seem transparent to the end user, providing capabilities, consistency, security, and privacy.

NMI consists of two teams :

Grid Research Integration Deployment and Support (GRIDS) Center. The GRIDS [11] center is responsible for defining, developing, deploying, and supporting an integrated and stable middleware infrastructure created from a number of open source grid and other distributed computing technology frameworks. It intends to support 21st-century science and engineering applications by working closely with a number of universities and research organizations.

Some of the open source packages included in this middleware are Globus Toolkit, Condor-G, GSI-OpenSSH, Network Weather service, Grid Packaging Tools, GridConfig, MPICH-G2, MyProxy, and so on.

Enterprise and Desktop Integration Technologies (EDIT) Consortium. EDIT[12] develops tools, practices, and architectures to leverage campus infrastructures to facilitate multi-institutional collaboration.

EDIT provides software to support a wider variety of desktop security, video, and enterprise uses with a directory schema. This facilitates the federated model of directory-enabled interrealm authentication and authorization. In addition, they are responsible for conventions and best practice guidelines, architecture documents, policies, and to provide services to manage the middleware. Some of the open sources packages included in this middleware are: LDAP Operational ORCA Kollector (LOOK), Privilege and Role Management Infrastructure Standards Validation (PERMIS), openSAMIL, and others.