Introduction to Grid and Highthroughput Computing

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Overview

- Motivation for this Field
- General Introduction of Important Terms
- The Condor System
- The Globus Toolkit
- Condor-G

Motivation

- Climate scientists visualize, annotate, & analyze terabyte simulation datasets
- 1,000 physicists worldwide pool resources for petaop analyses of petabytes of data
- A home user invokes architectural design functions at an application service provider
- An application service provider purchases cycles from compute cycle providers
- Or, I simply want to encode my videos faster ☺

Terms in this Field

- Distributed Computing
- Cluster Computing
- High Performance Computing
- High Throughput Computing
- Grid Computing
- Scientific Computing
- …

The Condor System

- Developed by the University of Wisconsin – Madison
- Operational since 1986
- Manages more than 1300 CPUs at UW-Madison
- Software available free on the web
- Unix and NT/W2k/XP

What is Condor?

- Batchsystem for serial and parallel jobs – **Condor Pool**
- You can use it for:
  - For normal Workstation PCs
  - Cluster with compute nodes
- Support for a lot of platforms:
  - **Linux (2.0.x, 2.2.x, 2.4.x) – Intel x86**
  - **Windows (NT 4.0, 2000, XP?)**
  - **Solaris (2.5.1, 2.6, 2.7, 8) – Sparc**
  - **HP Unix 10.20 – PA RISC**
  - **Digital Unix 4.0 – Alpha**
  - **Irix 6.5 – SGI Mips**
- Open Source License **– Condor Public License**

Features of Condor

- Relatively easy to install
- Flexible to configurate
- A login account on other workstations is not necessary
- Global filesystem possible (e.g. NFS) but not necessary
- Mixed architectures: Automatic selection of the appropriate binary
- Jobs can run in different *Condor Universes* (standard, vanilla, …)
- PVM and MPI (MPICH) supported
- You don't have to change the source
- Checkpointing and Job Migration
- Flexible Resource Matching through *ClassAds*
- Version for Grid Computing with the Globus Toolkit – *Condor-G*
- Linking of different Condor Pools is possible – *Condor Flocking*

Condor Universes (1)

- Standard (default)
  - Checkpoint and Restart (same architecture)
  - Remote System Calls (job seems to run on the submitter machine)
  - New Linking of the program is necessary
  - I/O files are transferred
- Vanilla
  - Not new linked programs, shell scripts
  - No Checkpointing and Restart, no Remote System Calls
  - You need for data files a global filesystem

Condor Universes (2)

- PVM
  - Dynamical management of machines via Condor
- MPI
  - Only dedicated nodes – Jobs run without interruption
- Java
  - Java jobs run on “all” platforms
  - I/O files are automatically transferred
- Globus (Condor-G)
  - Condor is working together with the Globus Toolkit

Grid Computing – Main Ideas

- Computing power is EVERYWHERE, let us make it usable by EVERYBODY.
- Computing power should be a resource like electric current.
  I don't have to know where it comes from.
  I can have as much as I "want".

The Grid Problem

- Flexible, secure, coordinated resource sharing among dynamic collections of individuals, institutions, and resource

  From "The Anatomy of the Grid: Enabling Scalable Virtual Organizations"

- Enable communities ("virtual organizations") to share geographically distributed resources as they pursue common goals -- *assuming the absence* of…
  - central location,
  - central control,
  - omniscience,
  - existing trust relationships.

Elements of the Problem

- Resource sharing
  - Computers, storage, sensors, networks, …
  - Sharing always conditional: issues of trust, policy, negotiation, payment, …
- Coordinated problem solving
  - Beyond client-server: distributed data analysis, computation, collaboration, …
- Dynamic, multi-institutional virtual orgs
  - Community overlays on classic org structures
  - Large or small, static or dynamic

Why Now?

- Moore's law improvements in computing produce highly functional endsystems
- The Internet and wireless provide universal connectivity
- Changing modes of working and problem solving emphasize teamwork, computation
- Network exponentials produce dramatic changes in geometry and geography

Network Exponentials

- Network vs. computer performance
  - Computer speed doubles every 18 months
  - Network speed doubles every 9 months
- 1986 to 2000
  - Computers: x 500
  - Networks: x 340,000
- 2001 to 2010
  - Computers: x 60
  - Networks: x 4000

The Globus Project

- Close collaboration with real Grid projects in science and industry
- Development and promotion of standard Grid protocols to enable interoperability and shared infrastructure
- Development and promotion of standard Grid software APIs and SDKs to enable portability and code sharing
- The Globus Toolkit™: Open source, reference software base for building grid infrastructure and applications
- Global Grid Forum: Development of standard protocols and APIs for Grid computing

Globus Toolkit™

- A software toolkit addressing key technical problems in the development of Grid enabled tools, services, and applications
  - Offer a modular “bag of technologies”
  - Enable *incremental* development of grid-enabled tools and applications
  - Implement standard Grid protocols and APIs
  - Make available under liberal open source license

General Approach

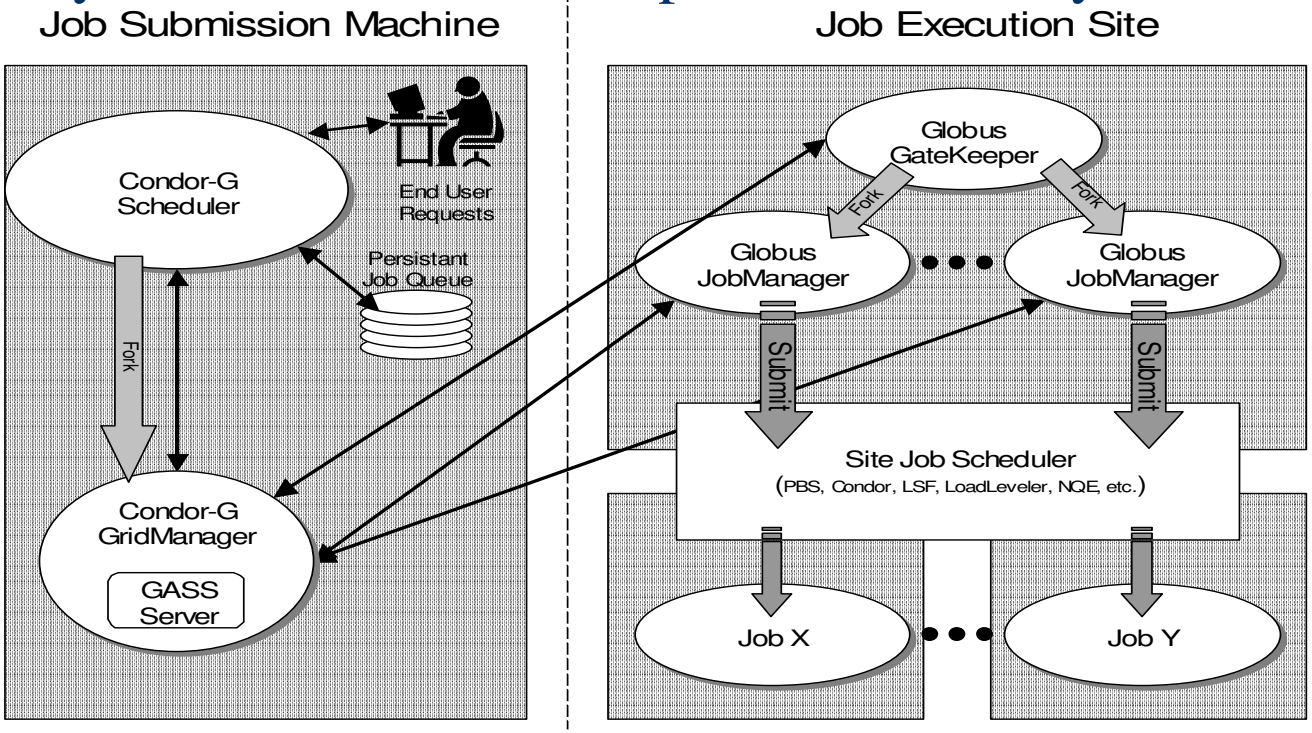
- Define Grid protocols & APIs
  - Protocol-mediated access to remote resources
  - Integrate and extend existing standards
  - “On the Grid” = speak “Intergrid” protocols
- Develop a reference implementation
  - Open source Globus Toolkit
  - Client and server SDKs, services, tools, etc.
- Grid-enable wide variety of tools
  - Globus Toolkit, FTP, SSH, Condor, SRB, MPI, …
- Learn through deployment and applications

Four Key Protocols

- The Globus Toolkit™ centers around four key protocols
  - Connectivity layer:
    - *Security*: Grid Security Infrastructure (GSI)
  - Resource layer:
    - *Resource Management*: Grid Resource Allocation Management (GRAM)
    - *Information Services*: Grid Resource Information Protocol (GRIP)
    - *Data Transfer*: Grid File Transfer Protocol (GridFTP)

Condor-G

Layered over Globus as "personal batch system:



References

- Slides from Dr. Rudolf Lohner (thanks for further support)
- http://www.cs.wisc.edu/condor
- http://www.globus.org
- http://www.globus.org/training/