

The Grid: What and Why

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Grids in Context

- Grid as infrastructure
 - research, private market forces, government all required
 - local infrastructures (e.g., PC clusters) lead to global infrastructure – the Grid
 - capacity distributed throughout the infrastructure
 - Example is NSF Extensible Terascale Facility (ETF) – the Teragrid – 5 supernodes + regional medium-sized nodes, with a common software infrastructure
 - Networking also distributed and hierarchical – 40Gb/sec between supernodes, down to 56Kb/sec to homes on dialup lines

Notes

- After today, for each class, send me questions (2-3) via email about the readings for that class – discussion topics
 - by midnight the night before!
- Class mailing list
 - sign the list to get account on Linux cluster, and email about class-related items
 - Give CS and preferred (if different) email address
- Need volunteers to present soon, after next week

Grid Users

- Computational scientists and engineers
 - to get at remote computers easily - to compute, visualize, steer computations
- Experimental scientists
 - to attach remote instruments to supercomputers, or visualization devices
- Corporations
 - to link people and resources at multiple sites within a corporate intranet

Grid Users (cont.)

- The environment (public policy makers)
 - to solve hard, multidisciplinary problems requiring a collaborative computational framework
- Remote training and education
 - virtual lecture rooms
 - Access Grid – Internet videoconferencing
- ...

Scientific Grid Users (cont.)

- Medical imagery - MRIs, CT scans, X-rays, etc. stored online digitally – hundreds of terabytes here, with more coming
 - allows comparing images across time for individuals and across populations
 - federating collections enable epidemiological studies – need to mine both images and metadata
 - security and privacy issues very important

Scientific Grid Users

- Data intensive applications
 - analyzing particle physics data from collider experiments – multiple petabytes per year, accessed and mined by physicists worldwide
 - NSF Grid Physics Network (GriPhyN)
 - DOE Particle Physics Data Grid (PPDG)
 - EU DataGrid
 - astronomy *digital sky surveys* – 100TB in the recent past, to petabytes soon
 - astronomers want to federate all the archive to create a single, globally distributed, repository spanning all wavelengths
 - a *virtual observatory*
 - this is happening in earth and space science too – data from satellites looking at both the earth and objects/phenomena in space

Scientific Grid Users (cont.)

- Computational science based on simulation
 - supercomputers as scientific instruments
 - Japanese Earth Simulator for Earth's climate, at 40Tflops/sec
 - DOE ASCI machines for nuclear bomb simulations
 - DOE Leadership Class Facilities for climate simulation, materials simulations, etc.
 - application areas include computational chemistry for creating and testing new compounds, life sciences for intelligent drug design, and function and structure of all known publicly available genome sequences
- Remote access to scientific instruments
 - e.g., Network for Earthquake Engineering Simulation, telemicroscopy (BIRN)

Industrial Grid Users

- Open Grid protocols like Internet standards
 - allow integration of technologies, applications, files, other resources
 - enable *global* sharing of the resources
 - *virtualize* the resources, to shield users from their complexity
 - eventually allow for delivery of computing services when and where needed – *on-demand*

Virtualization

- To allow sharing of physical resources, and applications and data
 - e.g. virtual machines (e.g., Java), virtual memory, virtual storage
- The challenge of the Grid is to “virtualize computing resources over the Internet”
 - use open Grid protocols on top of local OS (Linux, Windows, Solaris, or whatever)

Open Protocols

- Merger of Grid protocols with Web services is a big step forward – the Open Grid Services Architecture (OGSA)
 - merge Grid protocols with Web services, using WSDL (for defining services), UDDI (for discovering services) and SOAP (for sending messages) – all XML based
 - all this to allow *programs* to interact with other programs on the Grid

Quality of Service (QoS)

- Challenge for industry (e-business) is high QoS at a low price
 - requires end-to-end resource management
 - schedule multiple computers required for a given transaction (a path through a distributed application)
 - in the distributed, heterogeneous Grid infrastructure

On-Demand Computing

- Virtualize machines, servers (software), up to entire data center
 - so business can own its own infrastructure, or contract to an external service provider, or both
 - any authorized user can access the resources from anywhere, on demand
 - company can buy compute or data services for applications as needed, and only when needed