Building A Campus Grid: Concepts & Technologies

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About this presentation

- Overview of a paper written by several institutions
  - UAB, GSU, UMich TACC, TTU, USC, UVA
- Context of their work:
  - Institutions were involved in their own grid building efforts
  - Also contributing campus resources to SURAgrid* *a multi-institutional, multi-user grid infrastructure for the Southeastern United States
- Illuminate common approaches & lessons learned

What is a Campus Grid?

- Truly heterogeneous - resources & user needs
- Leverages centralized campus AuthN & AuthZ
- Driver behind the grid is often to share something:
  - Unique, scarce, physically isolated, under utilized
  - Dispersed across administrative boundaries
- In these cases, based on Globus
- Built from two or more loosely coupled…
  - Clusters, SMP or cycle scavenging installations
  - Connected across administrative domains
- Can be focusd on computational or data sharing, or both

Basic Elements of a Campus Grid

- Minimum functional elements:
  - Accessibility (typically via Portals)
  - Data movement
  - Resource management
  - Job submission
  - Monitoring
  - Some level of centralized administration
  - Metascheduling & Accounting desirable

Who Needs a Campus Grid?

- Campus user types
  - Researchers (often the early adopters)
  - Educators
  - Administrative & other campus staff
- Campus application types
  - Require significant computing cycles
  - Have significant data handling requirements (e.g., access to or transfer of large or distributed data sets)
  - Visualization-intensive applications

Who *Else* Needs a Campus Grid?

- Campuses should cast a broad net
  - Most likely user is from applied sciences or mathematics & knows they need HPC resources
  - But look beyond…
    - Social sciences
    - The arts
  - Many disciplines have databases of increasing size & need visualization capabilities

Building a Campus Grid

- Requirements
  - Buy-in at multiple levels & across departments
  - Perseverance – it will not be quick
  - In addition to technology, must address
    - Policies
    - Organizational structure
    - Culture
  - Human & technical resources

Where to begin?

- Pick the low hanging fruit
  - An enthusiastic researcher
  - A willing administration
  - Visionary IT staff
  - A critical collaborative project
  - A timely technology acquisition

Low-hanging fruit (continued)

- Start with cycle-scavenging
  - Make use of unused cycles in public labs
  - Match these with a cycle hungry project
- Publicize the work
  - Must be able to demonstrate the potential value of the campus grid
  - Must conduct outreach to encourage future participation & support

Creating a Campus Grid Initiative

- Varies based on campus circumstances
- Typical models from these campuses
  - Top down: Leader such as president, CIO, VPR encourage grid development
  - Bottom up: IT staff and/or CS researchers develop grid & evangelize it across departments & up campus chain
  - Combination of above: A more ideal scenario!

Developing Policies for Sharing

- Campus grid leaders should
  - Encourage users to express concerns
  - Cooperate with users to develop policies
- Address two primary user concerns
  - "We'll lose control of our jobs or resources."
    - Give them current & appropriate tools
  - "Grids are less secure than other resources."
    - Authors found grids no more likely to be attacked, security exposures similar

Tools to Facilitate Sharing

- Find best mapping of functionality to polices
  - E.g., Preempt jobs ONLY when resource OWNER specifies
- Schedulers a focal point at time of this writing
- Accounting packages also popular
  - Often allow more complex policy enforcement
  - Should show usage (who, how much), real-time & historic
  - Often home-grown since products & standards are not mature
- New or low traffic grids may not need these (yet!)

Understand Application Needs

- Grid-aware/grid-enabled apps
  - Designed to take advantage of distributed resources
  - Not all apps will be able to benefit from grids
- Education, experience & collaboration needed
  - Grid-design & support staff
  - Application users
  - Programmers

Application Analysis

- Can the inquiry or problem being addressed be solved more effectively through access to grid-based resources?
  - How might specific functions be enabled or improved?
    - Increased speed through parallelization
    - Increased speed via simultaneous processing
    - Managed access to unique or highly distributed resources, including data

Grid-enabling Applications

- Need a translator
  - Someone who can speak the “language of the science” and the “language of the grid”
- Motivating researchers, users or departments
  - Need to address
    - View of what is possible in pursuit of the science
    - Additional resources needed to re-tool
  - Two tactics that can catalyze adoption
    - Provide references, templates, tips and training
    - Provide more tangible incentive for early adopters to rewrite their code

Technology Selection

- Open source vs. commercial or proprietary
- Not all products offer same or complete set of grid services
- Type of grid resources (e.g., dedicated vs. shared, contentious vs. “first come, first served”) defines technology will be useful

But…

- Type of grid technology defines resources that can be used and the nature of the resulting grid

Technology Selection

- Common design considerations
  - Articulate user needs in policy statements
  - Select enforcement tools
    - Balance needs with tool complexity
    - Modular packages preferred
    - Need products “hooks” to campus specifics
- Budget considerations
  - Technical staff available & their skills
  - More funds for staff or technology?

Central Campus Integration

- **Strongly** Suggested: Campus ID Integration
  - Use existing campus ID system where possible
  - Establish Certification Authority (required by Globus)
    - Provides secure authentication
    - Can facilitate inter-institutional sharing
    - CA Options:
      - *Use existing CA as the one Globus will require*
      - *If no existing CA, ask the IT department/central ID department to create one*
      - *If CA creation is not an option through other unit(s), grid team should create one - "ready for the future"*

Central Campus Integration

- Suggested: Campus File System Integration
  - How will users access data and applications from grid nodes?
    - Data, libraries & executables typically need to be staged by user
    - Easier if grid can access a distributed file system (e.g., NFS, AFS)
    - Shared file system can span grid clusters or whole campus if desired (very user-friendly)
    - Authors used various file systems and integration on their campuses

Identifying Grid Resources

- Identify initial resources
  - Use a creative approach
    - Buy a resource & keep under your control if application owners lack funds
    - Cycle-scavenge where possible
    - Group older, abandoned or retired machines to form a grid cluster
  - Collaborate in a regional or other external grid
    - Campuses in SURAgrid gain access to other campuses' resources (www.sura.org/suragrid)

Adding Grid Resources

- Adding dedicated compute clusters to run HPC applications
  - Method depends of grid technology & resource type - our grid technology is *Globus*
  - Several packages for installing Globus (e.g., GRIDS Center, VDT, IBM Grid Toolbox, Rocks Grid Roll)
- Non-dedicated (e.g., desktops, shared clusters)
  - Best for applications that are fault tolerant, don't need low latency, can use opportunistic timing
  - Various packages in use by authors (e.g., Condor, United Devices, BIONIC)

Managing Grid Resources

- Accounting
  - Skip if usage is low & focus instead items like test resources, PKI integration, user portals
- Monitoring
  - Allow user or application to choose resource (based on availability, load, type of resource)
  - Like scheduler, the busier the grid the more important and necessary this tool becomes
- Metascheduling
  - Provides resource brokering
  - User no longer has to choose resource themselves

Build Critical Mass – Outreach

- Coordinate design & planning with stakeholders early
- Pay particular attention to integrating with central campus components
- Snowball effect – the more apps deployed & users on grid, the easier it is to gather more
- Ultimate goal - ensure grid is broadly useful across research domains & user groups
  - Create Grid user group. Add grid reps to IT planning groups
- Use personal contacts plus existing campus political & communication tools (e.g., committees, newsletters)

Build Critical Mass – User Concerns

- "Grid technology too bleeding edge."
- "Moving to grids is too time-consuming, hard."
- "My cluster **is** a grid" (old view of grids)
- "My project/application **has** compute resources"

- Combat concerns by using your "translator" to explain new definition & potential of grids
  - Gain access to high-burst compute power they don't currently have
  - "Each acquire their own resources" is not sustainable nor does it benefit campus as a whole

Build Critical Mass – The Demo

- Assemble a generic demo of grid functionality (e.g., log-in, submit job, move & visualize data)
- Best if demo can be tailored to show the science of each target demo audience
- Demo monitor & accounting tools to help dispel user concerns
- Putting demo on a test grid keeps it simple – test grid also useful for grid development and maintenance

The Production Campus Grid

- Production grid = grid meets functional expectations of builders & users
  - Fault handling, error recovery & reporting
  - Reliable, stable, robust resources
  - Secure
  - Interoperable across resources & applications
- Current vs. Future services
  - What is required, what is optional?
    - Answer is unique to each campus
    - Possible to go production with some grid services while learning & watching others mature

The Production Campus Grid

- User interfaces are key
  - Out of the box, Globus user interfaces are minimal
  - Much is left for user to learn and do; authors have built portals and metaschedulers to remedy this
- Maintenance & support
  - Our sites use different approaches
  - Clear trend is integrating grid with other IT support
  - Consensus of the authors that going production with the campus grid did not require excessive resources

For More Information

- This paper:
  - http://www.sura.org/programs/docs/bldg_campus_grids.pdf
- SURAgrid:
  - http://www.sura.org/programs/sura_grid.html
- NMI Integration Testbed Case Study Series:
  - http://www.sura.org/programs/nmi_testbed.html#NMI
- SURAgrid Bridge Certificate Authority:
  - https://www.pki.virginia.edu/sura-bridge/
- Globus:
  - http://www.globus.org

Questions or comments?

For more information or to join SURAgrid:

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