Grid Computing: An Industry View
Vision, Strategy, Software, Examples

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Agenda

• Grid Computing: Vision & Strategy
• Architecture Building Blocks
• Examples: Grids & Partner Projects
• N1, the Network Operating System
• The Big Picture: Grid - N1 - Web Services
Our Vision:
The Grid: Computing as a Utility

Electricity, Water, Telephony, Computing

What's a Utility?

• You get what you need, when you need it
• You don't care where it comes from, and how
• You pay as you go, for what you used
How Grids Help

- **Access**: seamless, transparent, remote, secure, wireless access to computing, data, sensors, experiments, instruments . . .
- **Virtualization**: access to compute/data services, not servers
- **On Demand**: get resources you need, when you need them
- **Sharing**: enable collaboration over the network
- **Failover**: migrate and restart applications automatically
- **Heterogeneity**: platforms, operating systems, devices, software
- **Utilization**: increase resource utilization, from 20% to 80+%
- ... and more!
HPC Grids vs Commercial Grids

HPC Research & Engng Grids
- High Performance
- High Performance
- High Performance
- Collaboration
- Communication

Commercial Grids
- Scalability
- Manageability
- Availability
- Reliability
- Transparency

> SMART
Technical vs Commercial Grids

- raw performance
- downtime acceptable
- proprietary solutions

- low integration
- focus on computation
- software niche players
- no strict economics constraints

- mature market

- Performance, robustness, manageability, availability
- downtime unacceptable
- purchased applications, standardized solutions
- tightly integrated with other enterprise systems

- focus on databases and transactions
- enterprise software
- demands quantifiable ROI
- market mostly unknown, on the verge of strong growth
Our Evolutionary Grid Strategy

Cluster Grid
Departmental Computing
- Simplest Grid deployment
- Maximum utilization of departmental resources
- Resources allocated based on priorities

Enterprise Grid
Enterprise Computing
- Resources shared within the enterprise
- Policies ensure computing on demand
- Gives multiple groups seamless access to enterprise resources

Global Grid
Internet Computing
- Resources shared over the Internet
- Global view of distributed datasets
- Growth path for enterprise Grids
Example: Sun Grid Services Environment

**Web User Interface**
Sun Grid Engine Portal & Sun ONE Portal Server

**SysAdmin Tools**
- N1
- Sun Mgmnt Center
- Sun Control Station

**Development Tools**
- Sun ONE Developer Studio
- Sun HPC Cluster Tools

**Global Grid Layer**
- Sun ONE Web Services
- Globus/Avaki
- OGSA

**Distributed Resource Management**
Sun Grid Engine Family

**Operating Environment**
Solaris/Linux/AIX/HP-UX/TRUE64/IRIX/…

**Throughput and HPC Clusters, Enterprise Servers**
Storage Systems
Desktops and Information Appliances
Sun Grid Engine Family
Distributed Resource Management in Cluster & Enterprise Grids

• Multi-platform, open source, standards
  - 7000+ grids today (departmental, enterprise, global grids), 51% Solaris, 25% Linux, 24% Mix

• Sun Grid Engine, SGE, free Web downloads for Solaris & Linux
  - Identifies best-suited, least loaded resource for your work
  - Queuing, prioritizing, scheduling

• Sun Grid Engine, Enterprise Edition
  - Equitable, enforceable sharing between groups and projects
  - Alignment of resources with business goals via policies
Managing Grid Resources: Grid Engine, Enterprise Edition

Policy-based resource allocation & sharing

Department 1

Department 2

Department 3

Department 4

Department 5

User 1

User 2

Contractor X

Team B

Project A

Project C

Department resource access

Campus wide resource demand
The Portal: Access to Grid and Web Services

Key Services...

Aggregated for...

Targeted Communities

- Employees
- Suppliers
- Partners
- Customers

- Computation
- Collaboration
- Communication
- Commerce
- Customer Care

Sun ONE Portal Server

Portal prototype “open source”
Globus & Avaki over multiple Grid Engine Clusters

1. SGE cluster mgmnt within an admin domain & file system area
2. Globus/Avaki knits together resources, handles files, binary management, and high level resource selection
UK e-Science Grid

$180 & 180 Mio in 3 & 3 years for science and engineering

Our Grid Centers in UK:
Edinburgh EPCC, Sun CoE HPC & Grid
Cambridge, 2TeraFlops 10 SF15K
Oxford, Computational Finance
London IC, Sun CoE e-Science
London UCL, Sun CoE Networks
Manchester, MyGrid (BioGrid)
Leads, Sheffield, York: White Roses Grid
Durham: Cosmology Engine Grid
....

Cambridge
Newcastle
Edinburgh
Glasgow
DL
RAL
Hinxton

London
Oxford
Manchester
Cambridge

Southampton

London IC, Sun CoE e-Science
Applications for The Grid

- **Single-CPU Jobs**: jobmix, many users, many serial applications, suitable for grid (e.g. in universities and research centers)

- **Array Jobs**: 100s/1000s of jobs, one user, one serial application, varying input parameters, suitable for grid (e.g. parameter studies in Optimization, CAE, Genomics, Finance)

- **Massively Parallel Jobs**: one job, one user, one parallel application, no/low communication, scalable, fine-tune for grid (time-explicit algorithms, film rendering, pattern recognition)

- **Parallel Jobs**: one job, one user, one parallel application, high interprocs communication, not suitable for distribution over the grid, but for parallel system in the grid (time-implicit algorithms, direct solvers, large linear algebra equation systems)
Example: White Rose Grid in England

- Leeds, York + Sheffield Universities
- Deliver stable, well-managed HPC resources supporting multi-disciplinary research
- Deliver a Metropolitan Grid across the Universities
WRG Hardware

Maxima

Snowdon

Pascali

Titania
WRG Architecture Overview
WRG Key Components

- **Globus Toolkit 2.0**
  
  Provides a **secure** means for inter-campus actions
  
  - Transferring jobs
  - Moving data
  - Gathering information about resources

- **Grid Engine Enterprise Edition**
  
  Manages the campus grid compute resources
  
  - Delivers a single interface for a heterogeneous grid
  - Guarantees a share of campus resource for grid and local users
WRG Key Components

• Grid Portal Development Kit
  Provides a portal interface into Globus Toolkit
  • Transferring jobs
  • Moving data
  • Gathering information about resources

• MyProxy
  MyProxy provides a server with client-side utilities to store and retrieve delegated X.509 credentials via the Grid Security Infrastructure (GSI).

White Rose Grid
Our Grid Partner Projects, Examples

- ICENI, Imperial College e-Science Netw. Infrastructure, London
- GRIDS, Grid Computing & Distributed Systems Lab, Melbourne
- EZ-Grid, Sun Center of Excellence for Grid Computing, Houston
- White Rose Grid, Universities of Leeds, Sheffield, York, UK
- NCSV, Nanyang Center for Supercomp.& Visualization, Singapore
- EPCC Edinburgh Sun Data & Compute Grid Project
- HPCVL Canada, Secure innovative HPC/Grid environment
- GridLab European Project for Grid Application Infrastructure
- myGrid Infrastructure for an e-Biologist Workbench, Manchester
- OSC Grid, Sun Center of Excellence for BioInformatics, Ohio
- AIST Advanced Industrial Science & Technology Institute, Tokyo
- and . . .
- many . . .
- more . . .
The Grid increases Complexity!

What we did inside the F15K box...

- Domains
- Interdomain resource mgmt
- Routing
- “Soft cabling” within the box

...we are now doing to the network

Solaris

N1

N1: The Network Operating System For The Datacenter
Virtualization of Resources

Service 1
Storage Network

Service 2
Storage

Service 3
Storage

Vertical
Horizontal

Compute & Data Grid

Compute & Service
N1: managing services, not servers
The N1 Effect on Efficiency
Radical improvement in costs & uptime

- **Sys Utilization**: 6-15% to 80+%
- **Server/Admin**: 15-30 to 500+
- **Terabytes/DBA**: 1TB to 100TB
- **Ports/Admin**: 50-100 to 500+
- **Availability**: 99.9% to 99.999+%
- **Time to Deploy**: Hours to Weeks

Costs
Grid & Web Services & N1

Developers & Users View: Sun ONE

The Grid

Sysadmin View:
N1
Thank You!

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