Grid Computing Case Studies

The White Rose Grid in England
GridLab & Progress at PSNC Poznan
Imperial College LeSC in London

Wolfgang Gentzsch, Director Grid Computing
Sun Microsystems
Sun's Evolutionary Grid Strategy

From Department Grids, to Enterprise Grids, to Global Grids, to THE GRID
Critical Customer Requirements

✓ More Compute Power
✓ Improved Resource Access
✓ Increased Productivity
✓ Better Utilization of Existing Resources
✓ Reduced Costs
✓ Reduced Management Complexity

Sun Grid Technology meets these needs today!
Grid Computing Benefits

- **Access:** transparent, remote, secure
- **Virtualization:** access services, not servers
- **On Demand:** resources at your finger tip
- **Sharing:** collaboration over the net
- **Failover:** migrate/restart applications
- **Heterogeneity:** platforms, OS's, software
- **Utilization:** increase from 20% to 80+% 
- **Productivity:** more work in shorter time
Grid Computing & Web Services Environment

Web Interface
Sun Grid Engine Portal / Sun ONE Portal Server

Systems & Application Administration

N1
Sun Control Station
Sun Management Center

Development Tools and Runtime Lib

Sun ONE Studio
Sun HPC Cluster Tools

Global Grid Layer

Globus/Avaki/SGEEE
Web Services
SunONE
OGSA

Distributed Resource Management
Sun Grid Engine Family

Solaris/Linux/... Operating Environment

Throughput and HPC Clusters, Enterprise Servers
Storage Systems
Desktops and Information Appliances
Sun Grid Products Roadmap

**Global Grid**
Grid standards (OGSA), Globus GT3, research collaborations

**Department & Enterprise**
ClusterGrid SW Stack:
- Grid appliance, preload, software product.
- Avaki/SGE/Portal

**Sun Grid Engine 6.0**
- Scalability, analysis, monitoring, accounting, ease of installation, administration, scheduler, standards

- H1FY04
- H2FY04
- H1FY05
- H2FY05
The Changing Grid Landscape

- HPTC Grid
- Web Svcs
- Sys Mgmt

Standards

Developer View:
Write here
Run anywhere
Service Composition

Public SOA

Technologies

Enterprise
IT Mgmt
Products

Market making / Productization

Enabled Business Models

- Utility Computing
- OnDemand
- “Compute Power from the wall socket”
- Outsourcing/Hosting
- Software as a Svc
Grid Components: Compute Grid Racks “Grid-Ready”

An engineered, tested, integrated and supported Compute Grid Solution

- 1U-form-factor servers
- Gbit-E switch(es)
- Terminal server
- KVM
- Management Node with monitoring and management software
- Delivered in a rack

Part of Sun's new “Grid Infrastructure Solutions” Program
Sun Grid Manager

- SGEEE as dynamic job load manager
- SCS as integrated automatic grid install and config
- Software, image, inventory, and lights-out management
- Health and performance monitoring
- Automatic resource discovery via SCS/Jxta
- Single control/management grid interface (remote access)
- System setup/configuration in minutes (instead of days)
- Immediately utilize additional grid resources
Department Grid

Browser to CGM
(Remote Server Setup & Configuration)

Compute Grid Manager
SGEEE/SCS

Auto Download of Modules

Solaris Servers

Workstations
(Linux or Solaris)

Workload & System Mgmnt:
Auto OS Deployment
Grid Installation/Mgmt
Central Server Mgmt
Load balancing
Resource Matching

Linux Servers

Corporate Firewall
Enterprise Grids

Optional Control Network (Gbit-E)

Data Network (Gbit-E)

Browser Access via GEP

SunRay Access

Servers, Blades, & VIZ

Myrinet

Myrinet

Servers, Blades, & VIZ

Myrinet

Servers, Blades, & VIZ

Sun Fire Link

Gbit-E switch

V240 / V880 NFS

V240 / V880 NFS

V240 / V880 NFS

SunRay Access

Grid Manager

Linux Racks

Gbit-E switch

V880 QFS/NFS Server

V880 QFS/NFS Server

Gbit-E switch

Gbit-E switch

V880 QFS/NFS Server

Gbit-E switch

FC Switch

Workstation Access

Myrinet

Myrinet

Workstations

NAS/NFS

Simple NFS

HA NFS

Scalable QFS/NFS

Workstation Access

Browser Access via GEP

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Sun Global Grid Partner Projects

- **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 Leads, 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 more...
Global Grid Example: White Rose in England

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

Other Examples: AIST Japan, Nanyang Singapore, Houston, HPCVL, Poznan, GlobeXplorer, Imperial, ...
- Slides courtesy of Tom Jackson, DAME project manager, York
• The White Rose Grid - Grid Infrastructure developed between the Universities of York, Sheffield and Leeds. Investment of £3.0m, linked to YHMAN (£1.3m)

• Production architecture is currently based on Globus Toolkit 2.4.3 with mix of Grid Services architecture from GT3.0. Test-grid runs in parallel with full GT3.0 implementation.

• Sun Grid Engine Enterprise Edition for Dynamic Resource Management

• Access portals are developed using jet stream/struts technology.
WRG Key Components

Globus Toolkit 2.0

Secure means for inter-campus actions

Grid Engine Enterprise Edition

Manages campus grid compute resources

Grid Portal Development Kit

Provides a portal interface into Globus Toolkit

MyProxy

Store and retrieve delegated X.509 credentials via the Grid Security Infrastructure (GSI)
• Universities
  – Departmental use
    • Biology, Chemistry, Computing; Environment; Food Science; Maths; Mechanical Engineering; Physics and Materials Engineering - most fall into category of HPC users.
  – Collaborative Research and Development
    • Computation fluid dynamics; bone modelling; skin disease; digital preservation; elastohydrodynamic lubrication; visualisation.
• **Commercial users**
  
  – **Research Labs**
    • Central Science Laboratory
  
  – **Small Medium Enterprises**
    • Glass manufacture; digital media enterprise; software developers; IT solutions providers for libraries; computational fluid dynamics.
  
  – **Large Enterprises**
    • Aircraft maintenance; agrichemical; automotive; tool cutters; oil industry.
• **Experiences**
  - Implementations through several versions of Globus Toolkit have caused regular problems;
  - software portability – local variations in host environment mean that portability of code is not guaranteed;
  - Firewalls and security policies have been a barrier to progress;
  - End users do not want to interact with GT, hence a lot of effort required to build access portals for application hosting;
  - Scalability – unwieldy process for addition of new users and very limited scope to dynamically add new compute resource;
  - Software licensing issues are complex.
• Grid Wish List
  – End Users need far better support. GT too low level, and require desktop support for managing Grid applications;
  – Improved methods for handling heterogeneity of Grid infrastructures; to facilitate portability of code/applications;
  – Rapid development of security mechanisms and policies for Grid infrastructures.
GridLab and Progress Testbeds Working Together

Slides courtesy of Jarek Nabrzyski, PSNC
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- Heterogeneous
- Europe-wide
- From clusters to supercomputers
- Globus 2.2.4

- homogeneous
- Poland-wide
- Clusters
- Globus 2.2.4
Applications

- GridLab
  1. Cactus & Triana
  2. Dynamic scenarios (migration, dynamic staging, look ahead, spawn off independent tasks)
  3. Enabling applications on the grid through Grid Application Toolkit

- Progress
  1. Bioinformatics
  2. Other domains coming
  3. Workflow jobs
  4. Enabling applications on the grid through Application Management Services
Moving towards Web Services World

- **GridLab**
  1. currently all the services are Web Services based
  2. current focus is on the GAT
  3. OGSA will be addressed in the final year of GridLab
  4. GAT allows to use whatever services

- **Progress**
  - Currently all the services are Web Services based
  - OGSA is coming in 2004
  - Grid Service Provider allows to use Web Services, OGSA interface is to be added
How might OGSI/WS-agreement affect the next steps?

- It would allow to build a real global grid, with negotiations on all levels (costs, dynamic users, scheduling criteria, user preferences, resource usage policies etc.)
- Would allow to have even more decentralized architecture, with more autonomies for local centers
- Security is still an issue and is still behind.../ underestimated
Grid wish list, what next, what needs to be done?

- Security
- Grid user accounting
- Application support technologies (Application Toolkits, grid programming environments)
- Knowledge-based grids
- Fault tolerance, performance, production environments
Globus Grids in Production

Slides courtesy of Steven Newhouse, Technical Director
London e-Science Centre
London e-Science Centre

‘Enabling the e-Scientist’

• Established applied multi-disciplinary research
• Industrial Collaborations:
  – Sun Centre of Excellence in e-Science
  – Intel Virtual European Centre of Grid Computing
• Cross-campus collaborations:
  – Bioinformatics
  – High Energy Physics
  – Computational Engineering
• Specialisation: Next Generation Grid Middleware
• http://www.lesc.imperial.ac.uk/
SGEEE
sunshine V880
codon V880
rhea V880

SGE and Globus integration:
http://www.lesc.ic.ac.uk/projects/epic-gt-sge.html

LeSC Grid Resources

SGE

Teaching machines

Globus

Condor

SGE and Globus integration:
http://www.lesc.ic.ac.uk/projects/epic-gt-sge.html

Condor 6.4.x

LeSC Firewall

Imperial Firewall

sunshine V880
codon V880
rhea V880

SGEEE

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GT2.4

G
GT3.0

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Condor 6.4.x

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The Problem: Thermohaline circulation

- Ocean transports heat through the “global conveyor belt.”
- Heat transport controls global climate.
- Wish to investigate strength of model ocean circulation as a function of two external parameters.
  - Wish to perform \(31 \times 31 = 961\) individual simulations.
  - Use GENIE-Trainer.
  - Each simulation takes \(~4\) hours to execute on typical Intel P3/1GHz, 256MB RAM, machine \(\Rightarrow\) time taken for 961 sequential runs \(\approx 163\) days!!!
The Results: Scientific Achievements

Intensity of the thermohaline circulation as a function of freshwater flux between Atlantic and Pacific oceans (DFWX), and mid-Atlantic and North Atlantic (DFWY).

Surface air temperature difference between extreme states (off - on) of the thermohaline circulation.

North Atlantic 2°C colder when the circulation is off.

time taken for 961 runs over ~200 machines ≈ 3 days
ICENI: IC e-Science Networked Infrastructure

- Developed by LeSC Grid Middleware Group
- Use to define and develop higher-level services
- Collect and provide relevant Grid meta-data
- Interaction with other frameworks: OGSI, Jxta etc.
- Available under extended open source SISSL:
  - http://www.lesc.ic.ac.uk/iceni
The Future

• Highly stable production quality fabric
  – Intel+SPARC/Linux+Solaris/Sun Grid Engine
  – SGE and GT2 & GT3 integration
    http://www.lesc.ic.ac.uk/projects/epic-gt-sge.html

• Highly unstable grid layer
  – Is GT3 just a reference implementation?
  – What focus should be placed on production quality?

• Link WSA to elements of the Grid fabric
  – SGE 6.0
The New Time Machine

Thank You!

The Grid Engine

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http://www.sun.com/grid