

The National Grid Cyberinfrastructure Open Science Grid and TeraGrid

John-Paul “JP” Navarro
TeraGrid Area Co-Director for Software Integration

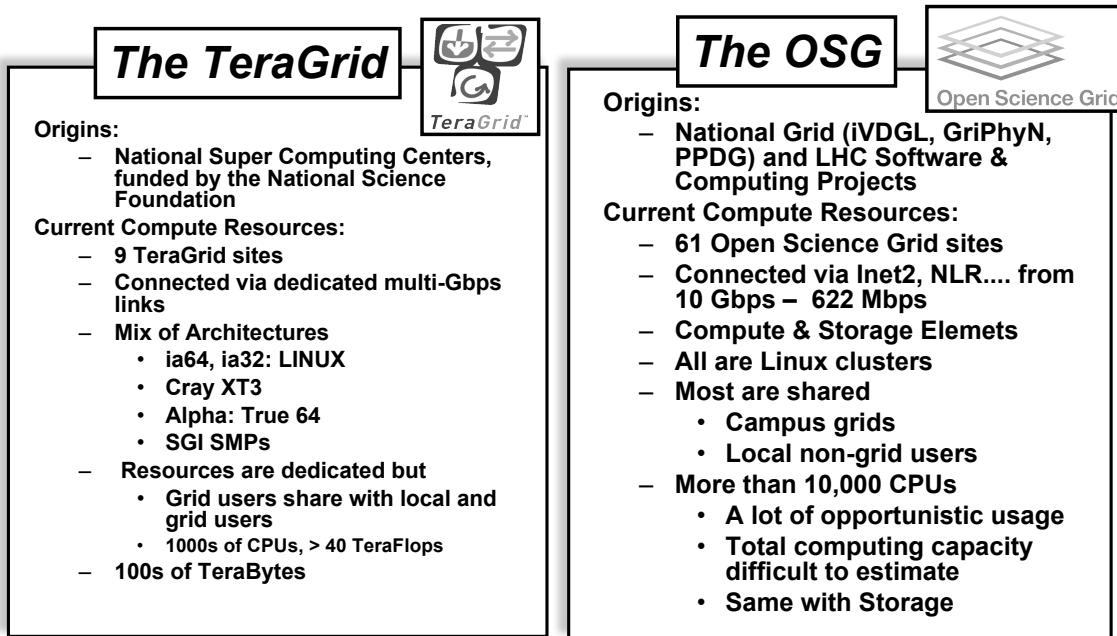
Mike Wilde
Open Science Grid Education Coordinator
University of Chicago/Argonne National Laboratory
March 25, 2007



Introduction

- What we've already learned
 - What are grids, why we want them and who is using them: Intro
 - Grid Authentication and Authorization
 - Harnessing CPU cycles with condor
 - Data Management and the Grid
- In this lecture
 - Fabric level infrastructure: Grid building blocks
 - National Grid efforts in the US
 - TeraGrid
 - The Open Science Grid

Grid Resources in the US



March 24-25, 2007

3

Grid Building Blocks

- Computational Clusters
- Storage Devices
- Networks
- Grid Resources and Layout:
 - User Interfaces
 - Computing Elements
 - Storage Elements
 - Monitoring Infrastructure...

March 24-25, 2007

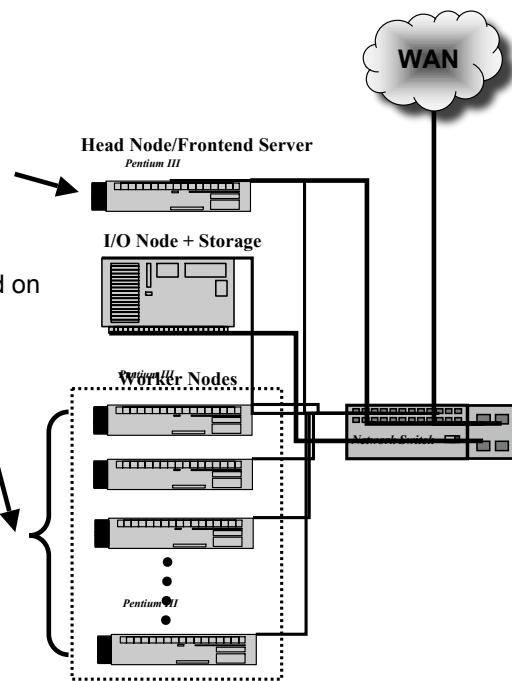
4

Computation on a Clusters

- Batch scheduling systems
 - Submit many jobs through a head node


```
#!/bin/sh
for each i in $list_o_jobscripts
do
  /usr/local/bin/condor_submit $i
done
```
 - Execution done on worker nodes
- Many different batch systems are deployed on the grid
 - condor (highlighted in lecture 5)
 - pbs, lsf, sge...

Primary means of controlling CPU usage, enforcing allocation policies and scheduling of jobs on the local computing infrastructure

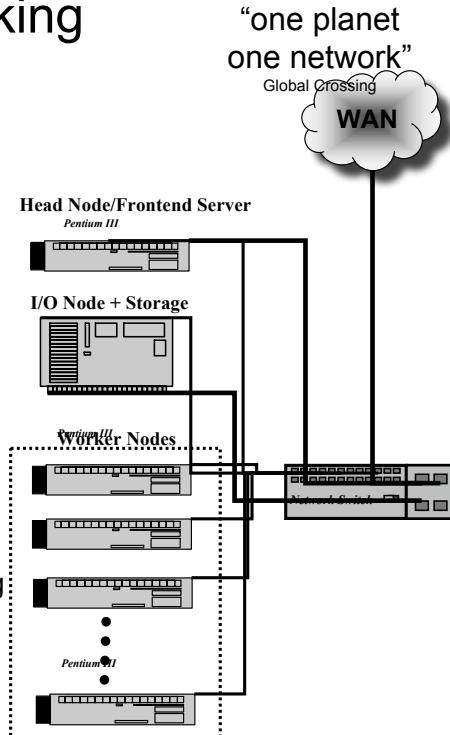


March 24-25, 2007

5

Networking

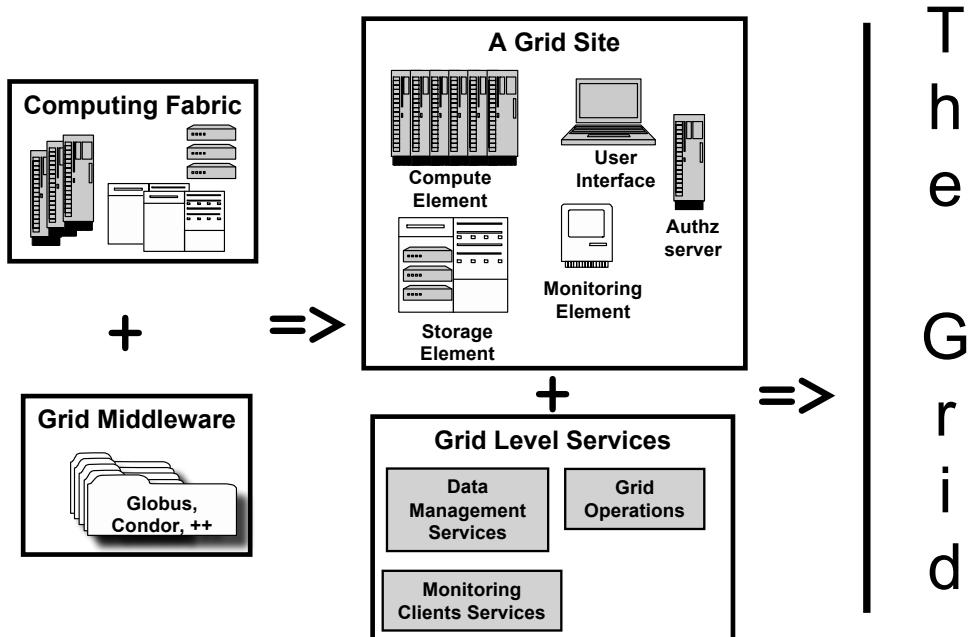
- Internal Networks (LAN)
 - Private, accessible only to servers inside a facility
 - Some sites allow outbound connectivity via **Network Address Translation**
 - Typical technologies used
 - Ethernet (0.1, 1 & 10 Gbps)
 - HP, Low Latency interconnects
 - Myrinet: 2, 10 Gbps
 - Infiniband: max at 120Gbps
- External connectivity
 - Connection to Wide Area Network
 - Typically achieved via same switching fabric as internal interconnects



March 24-25, 2007

6

Layout of Typical Grid Site

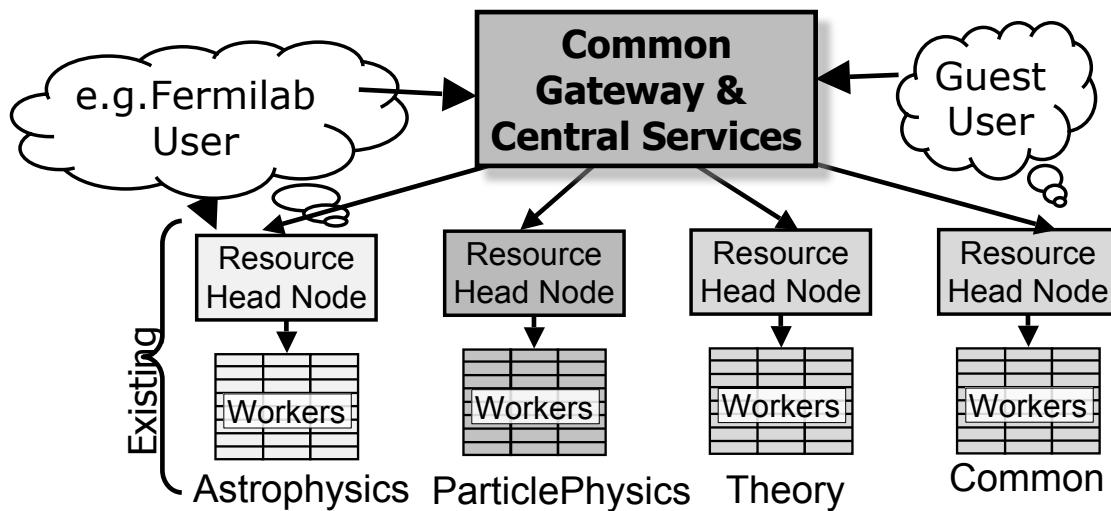


March 24-25, 2007

7

Local Grid with adaptor to national grid

- Central Campus wide Grid Services
- Enable efficiencies and sharing across internal farms and storage
- Maintain autonomy of individual resources



**Next Step: Campus Infrastructure Days - new activity
OSG, Internet2 and TeraGrid**

March 24-25, 2007

8

Grid Monitoring & Information Services

To efficiently use a Grid, you must locate and monitor its resources.

- Check the availability of different grid sites
- Discover different grid services
- Check the status of “jobs”
- Make better scheduling decisions with information maintained on the “health” of sites

Monitoring provides information for several purposes

- Operation of Grid
 - Monitoring and testing Grid
- Deployment of applications
 - What resources are available to me? (Resource discovery)
 - What is the state of the grid? (Resource selection)
 - How to optimize resource use? (Application configuration and adaptation)
- Information for other Grid Services to use

March 24-25, 2007

11

Monitoring information is either static or dynamic, broadly.

- Static information about a site:
 - Number of worker nodes, processors
 - Storage capacities
 - Architecture and Operating systems
- Dynamic information about a site
 - Number of jobs currently running
 - CPU utilization of each worker node
 - Overall site “availability”
- Time-varying information is critical for scheduling of grid jobs
- More accurate info costs more: it's a tradeoff.

March 24-25, 2007

12



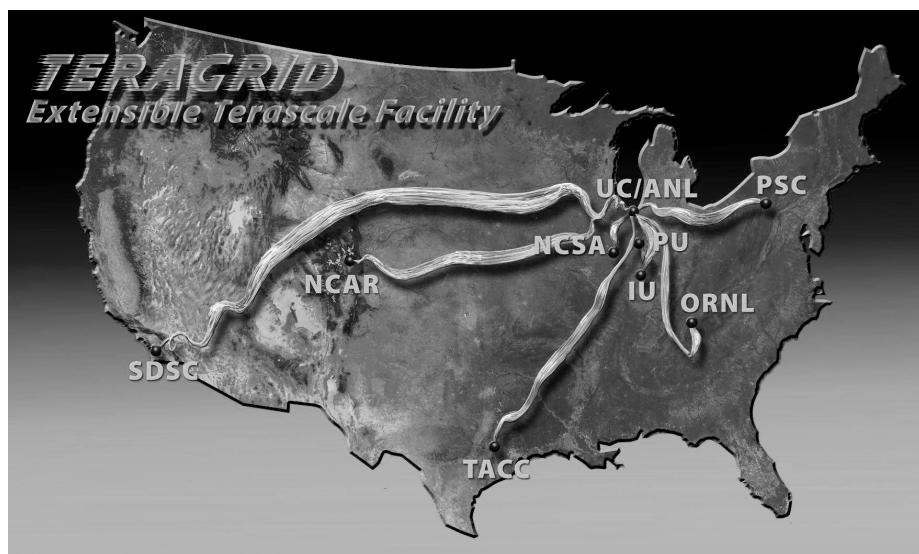
TeraGrid Overview



Open Science Grid

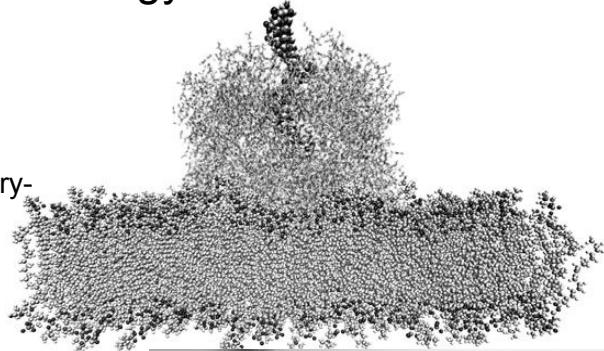
What is the TeraGrid?

Technology + Support = Science



TeraGrid's 3-pronged strategy to further science

- DEEP Science: Enabling Terascale Science
 - Make science more productive through an integrated set of very-high capability resources
 - ASTA projects
- WIDE Impact: Empowering Communities
 - Bring TeraGrid capabilities to the broad science community
 - Science Gateways
- OPEN Infrastructure, OPEN Partnership
 - Provide a coordinated, general purpose, reliable set of services and resources
 - Grid interoperability working group



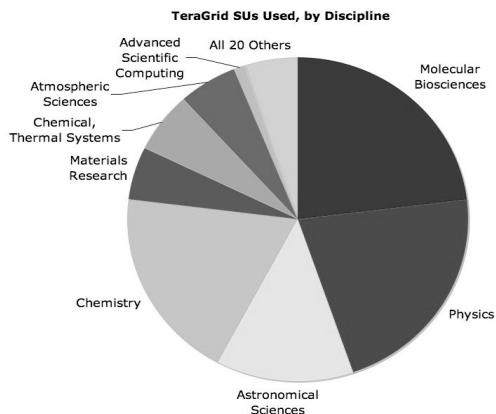
March 24-25, 2007

15

TeraGrid Science

NSF Funded Research

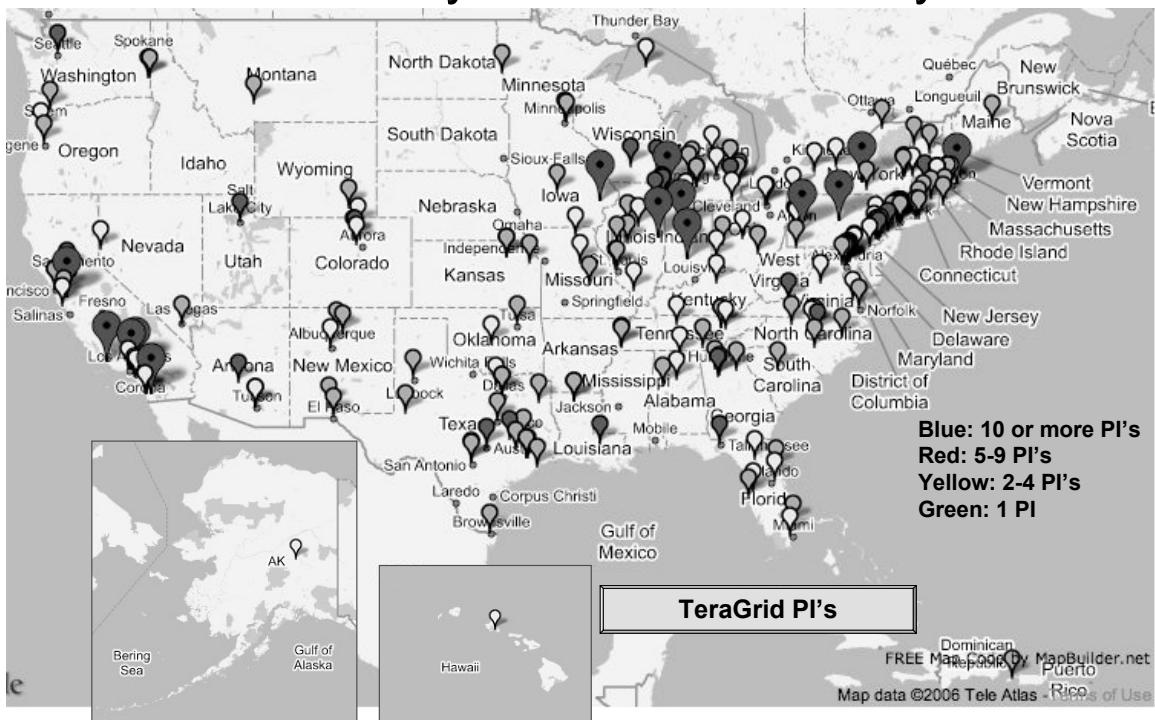
- NSF-funded program to offer high end compute, data and visualization resources to the nation's academic researchers
- Proposal-based, researchers can use resources at no cost
- Variety of disciplines



March 24-25, 2007

17

TeraGrid PI's By Institution as of May 2006



March 24-25, 2007

18

TeraGrid Technology

TeraGrid Hardware Components

- High-end compute hardware
 - Intel/Linux clusters
 - Alpha SMP clusters
 - IBM POWER3 and POWER4 clusters
 - SGI Altix SMPs
 - SUN visualization systems
 - Cray XT3
 - IBM Blue Gene/L
- Large-scale storage systems
 - hundreds of terabytes for secondary storage
- Visualization hardware
- Very high-speed network backbone (40Gb/s)
 - bandwidth for rich interaction and tight coupling

TeraGrid Resources

	ANL/UC	IU	NCSA	ORNL	PSC	Purdue	SDSC	TACC
Computational Resources	Itanium 2 (0.5 TF) IA-32 (0.5 TF)	Itanium2 (0.2 TF) IA-32 (2.0 TF)	Itanium2 (10.7 TF) SGI SMP (7.0 TF) Dell Xeon (17.2TF) IBM p690 (2TF) Condor Flock (1.1TF)	IA-32 (0.3 TF)	XT3 (10 TF) TCS (6 TF) Marvel SMP (0.3 TF)	Hetero (1.7 TF) IA-32 (11 TF) <i>Opportunistic</i>	Itanium2 (4.4 TF) Power4+ (15.6 TF) Blue Gene (5.7 TF)	IA-32 (6.3 TF)
100+ TF 8 distinct architectures 3 PB Online Disk								
Online Storage	20 TB	32 TB	1140 TB	1 TB	300 TB	26 TB	1400 TB	50 TB
Mass Storage			1.2 PB	5 PB		2.4 PB	1.3 PB	6 PB
Net Gb/s, Hub	30 CHI	10 CHI	30 CHI	10 ATL	30 CHI	10 CHI	10 LA	10 CHI
Data Collections # collections Approx total size Access methods		5 Col. >3.7 TB URL/DB/ GridFTP	> 30 Col. URL/SRB/DB/ GridFTP			4 Col. 7 TB SRB/Portal/ GFS/SRB/ DB/GridFTP	>70 Col. >1 PB SRB/Web Services/ URL	4 Col. 2.35 TB SRB/Web Services/ URL
Instruments		Proteomics X-ray Cryst.		SNS and HFIR Facilities				
Visualization Resources RI: Remote Interact RB: Remote Batch RC: RI/Collab	RI, RC, RB IA-32, 96 GeForce 6600GT		RB SGI Prism, 32 graphics pipes; IA-32		RI, RB IA-32 + Quadro4 980 XGL	RB IA-32, 48 Nodes	RB	RI, RC, RB UltraSPARC IV, 512GB SMP, 16 gfx cards

March 24-25, 2007

21

TeraGrid Software Components

- Coordinated TeraGrid Software and Services
“CTSS”
 - Grid services
 - Supporting software
- Community Owned Software Areas “CSA”
- Advanced Applications

March 24-25, 2007

22

Coordinated TeraGrid Software & Services 4

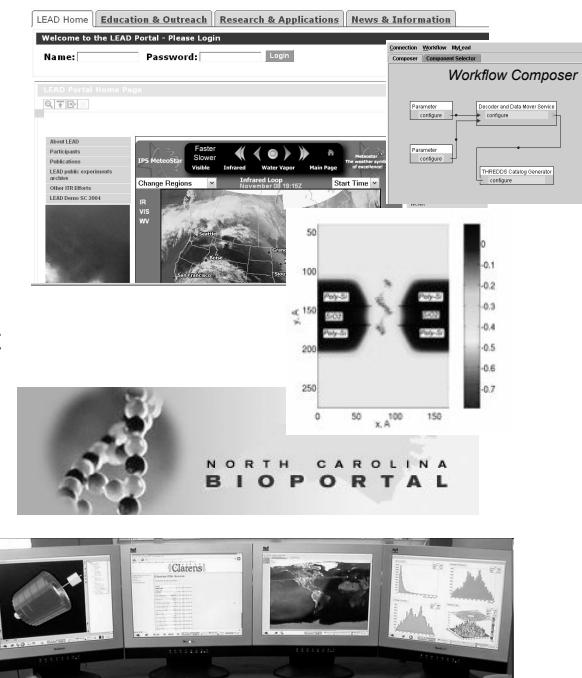
- CTSS 4 Core Integration Capability
 - Authorization/Accounting/Security
 - Policy
 - Software deployment
 - Information services
- Remote Compute Capability Kit
- Data Movement and Management Capability Kit
- Remote Login Capability Kit
- Local Parallel Programming Capability Kit
- Grid Parallel Programming Capability Kit
- <more capability kits>

March 24-25, 2007

23

Science Gateways *A new initiative for the TeraGrid*

- Increasing investment by communities in their own cyberinfrastructure, but heterogeneous:
 - Resources
 - Users – from expert to K-12
 - Software stacks, policies
- Science Gateways
 - Provide “TeraGrid Inside” capabilities
 - Leverage community investment
- Three common forms:
 - Web-based Portals
 - Application programs running on users' machines but accessing services in TeraGrid
 - Coordinated access points enabling users to move seamlessly between TeraGrid and other grids.



March 24-25, 2007

24

Gateways are growing in numbers

- 10 initial projects as part of TG proposal
 - >20 Gateway projects today
 - No limit on how many gateways can use TG resources
 - Prepare services and documentation so developers can work independently
 - Open Science Grid (OSG)
 - Special PRiority and Urgent Computing Environment (SPRUCE)
 - National Virtual Observatory (NVO)
 - Linked Environments for Atmospheric Discovery (LEAD)
 - Computational Chemistry Grid (GridChem)
 - Computational Science and Engineering Online (CSE-Online)
 - GEON(GEOsciences Network)
 - Network for Earthquake Engineering Simulation (NEES)
 - SCEC Earthworks Project
 - Network for Computational Nanotechnology and nanoHUB
 - GIScience Gateway (GISolve)
 - Biology and Biomedicine Science Gateway
 - Open Life Sciences Gateway
 - The Telescience Project
 - Grid Analysis Environment (GAE)
 - Neutron Science Instrument Gateway
 - TeraGrid Visualization Gateway, ANL
 - BIRN
 - Gridblast Bioinformatics Gateway
 - Earth Systems Grid
 - Astrophysical Data Repository (Cornell)
- Many others interested
 - SID Grid
 - HASTAC



March 24-25, 2007

25

TeraGrid Support

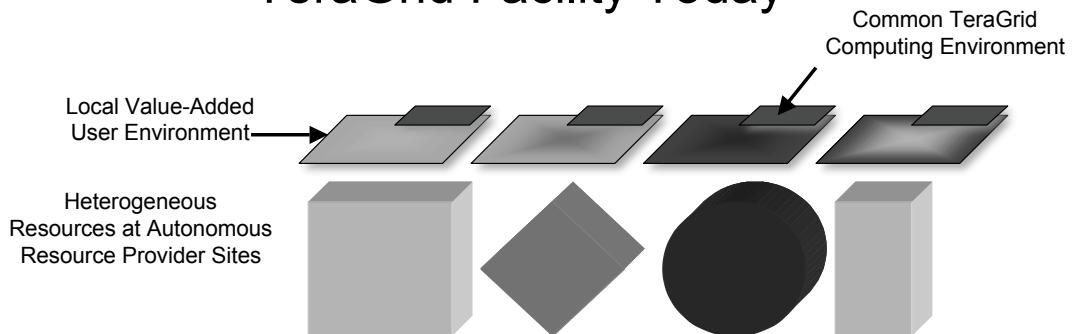
The TeraGrid Facility

- Grid Infrastructure Group (GIG)
 - University of Chicago
 - TeraGrid integration, planning, management, coordination
 - Organized into areas
 - User Services
 - Operations
 - Gateways
 - Data/Visualization/Scheduling
 - Education Outreach & Training
 - Software Integration
- Resource Providers (RP)
 - Currently NCSA, SDSC, PSC, Indiana, Purdue, ORNL, TACC, UC/ANL
 - Systems (resources, services) support, user support
 - Provide access to resources via policies, software, and mechanisms coordinated by and provided through the GIG.

March 24-25, 2007

27

TeraGrid Facility Today



- **A single point of contact for help**
- **Integrated documentation and training**
- **A common allocation process**
- **Coordinated Software and Services**
- **A common baseline user environment**

March 24-25, 2007

28

Useful links

- TeraGrid website
 - <http://www.teragrid.org>
- Policies/procedures posted at:
 - <http://www.paci.org/Allocations.html>
- TeraGrid user information overview
 - <http://www.teragrid.org/userinfo/index.html>
- Summary of TG Resources
 - http://www.teragrid.org/userinfo/guide_hardware_table.html
- Summary of machines with links to site-specific user guides (just click on the name of each site)
 - http://www.teragrid.org/userinfo/guide_hardware_specs.html
- Email: help@teragrid.org

March 24-25, 2007

29

Open Science Grid Overview

The OSG is supported by the National
Science Foundation and the U.S.
Department of Energy's Office of
Science.

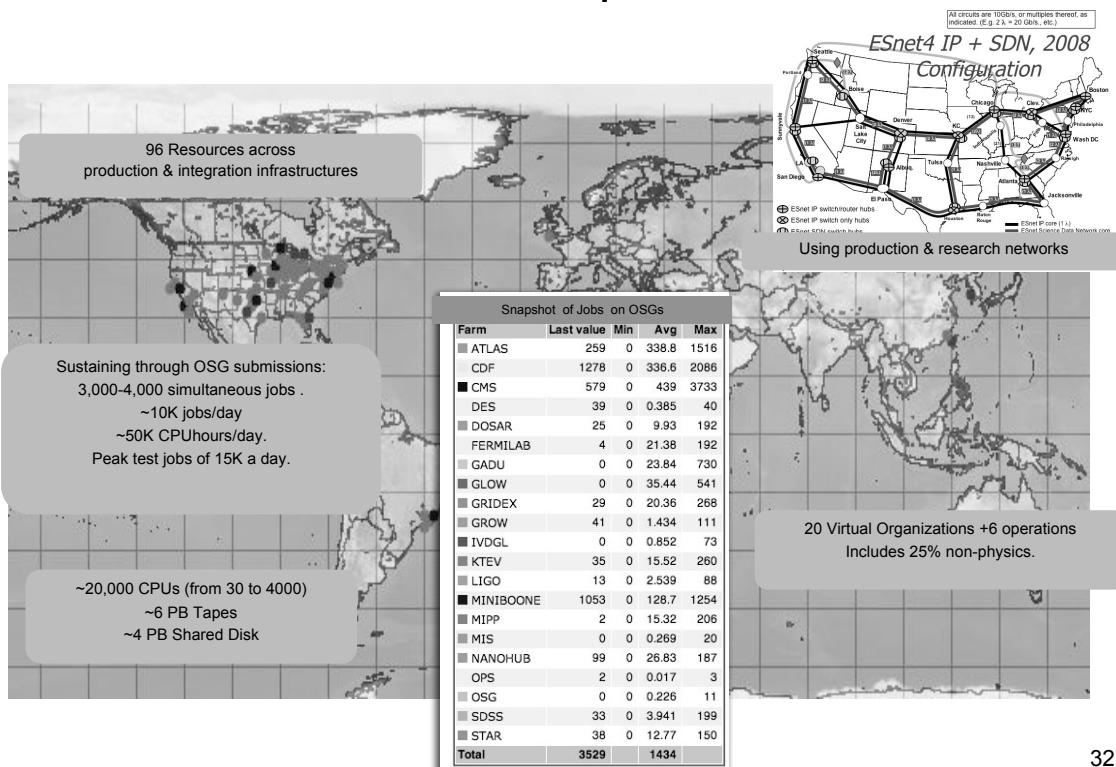
The Open Science Grid Consortium brings:

- **the grid service providers** - middleware developers, cluster, network and storage administrators, local-grid communities
- **the grid consumers** - from global collaborations to the single researcher, through campus communities to under-served science domains
- into a **cooperative to share and sustain** a common heterogeneous **distributed facility** in the US and beyond.
- Grid providers serve multiple communities, Grid consumers use multiple grids.

March 24-25, 2007

31

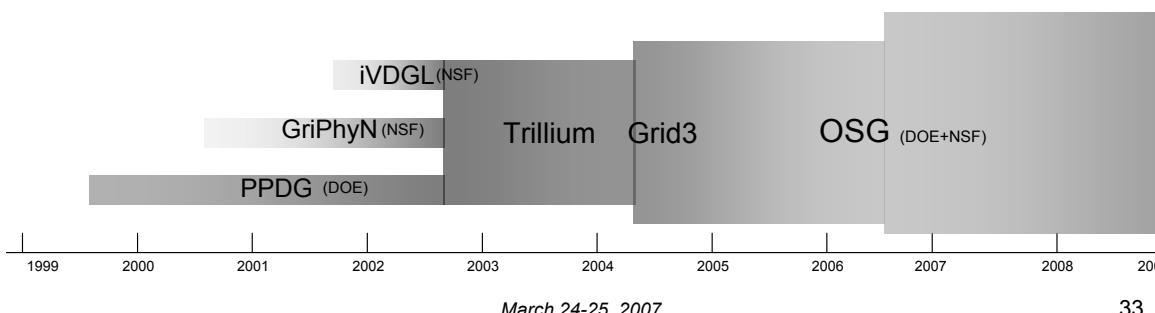
OSG Snapshot



32

OSG - a Community Consortium

- **DOE Laboratories and DOE, NSF, other, University Facilities** contributing computing farms and storage resources, infrastructure and user services, user and research communities.
- **Grid technology groups:** Condor, Globus, Storage Resource Management, NSF Middleware Initiative.
- **Global research collaborations:** High Energy Physics - including Large Hadron Collider, Gravitational Wave Physics - LIGO, Nuclear and Astro Physics, Bioinformatics, Nanotechnology, CS research....
- **Partnerships:** with peers, development and research groups Enabling Grids for EScience (EGEE), TeraGrid, Regional & Campus Grids (NYSGGrid, NWICG, TIGRE, GLOW..)
- **Education:** I2U2/Quarknet sharing cosmic ray data, Grid schools...

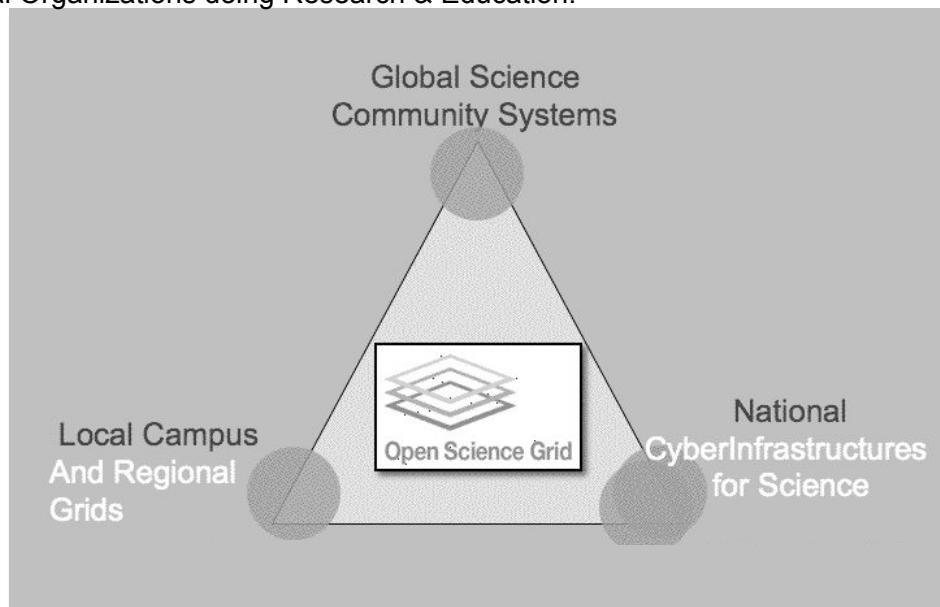


33

OSG sits in the middle of an environment of a Grid-of-Grids from Local to Global Infrastructures

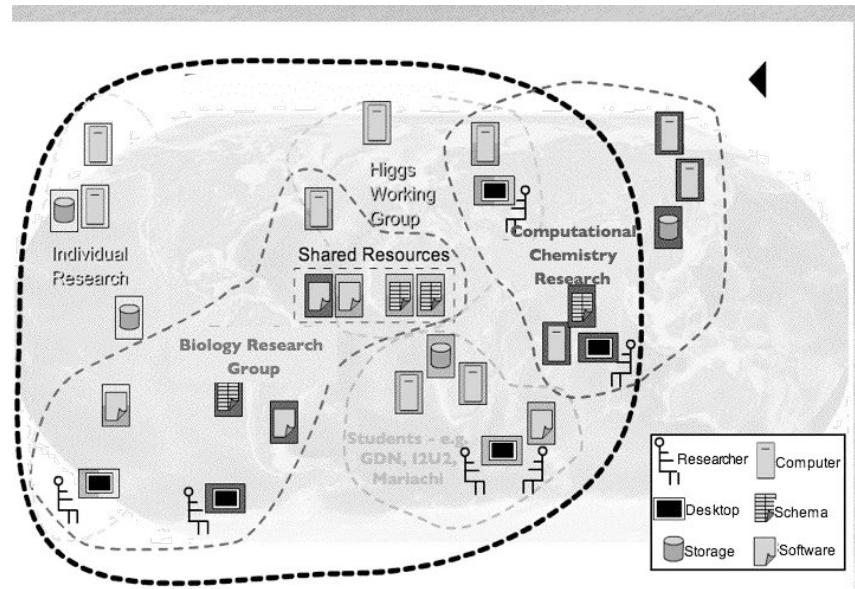
Inter-Operating and Co-Operating Grids: Campus, Regional, Community, National, International.

Virtual Organizations doing Research & Education.



34

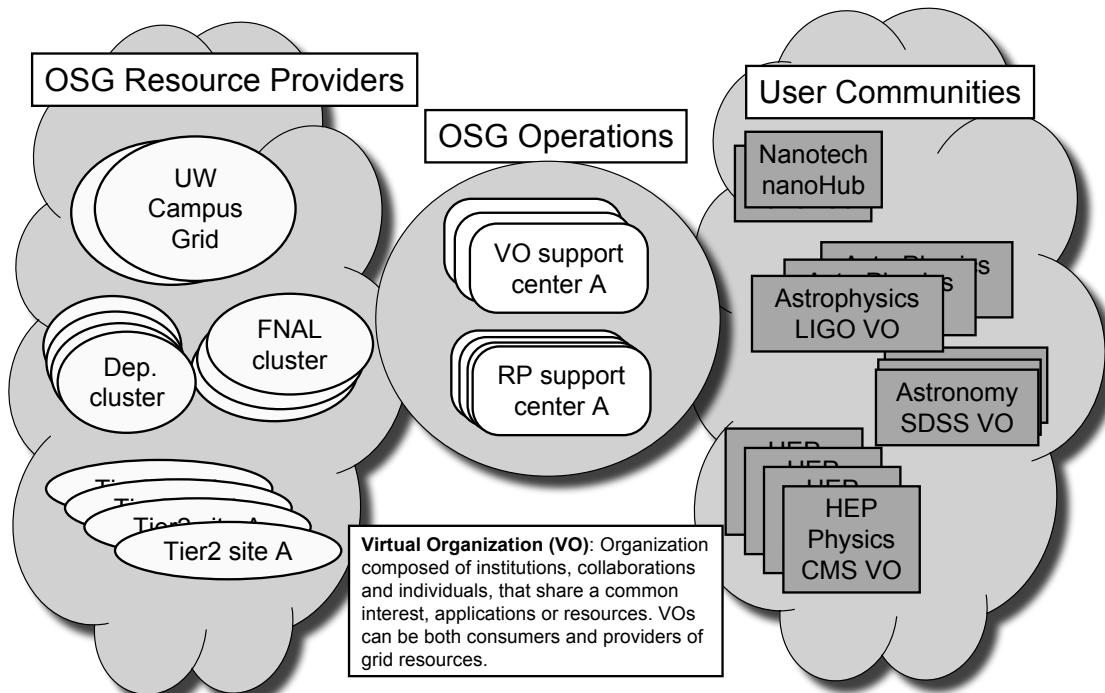
Overlaid by virtual computational environments of single to large groups of researchers local to worldwide



March 24-25, 2007

35

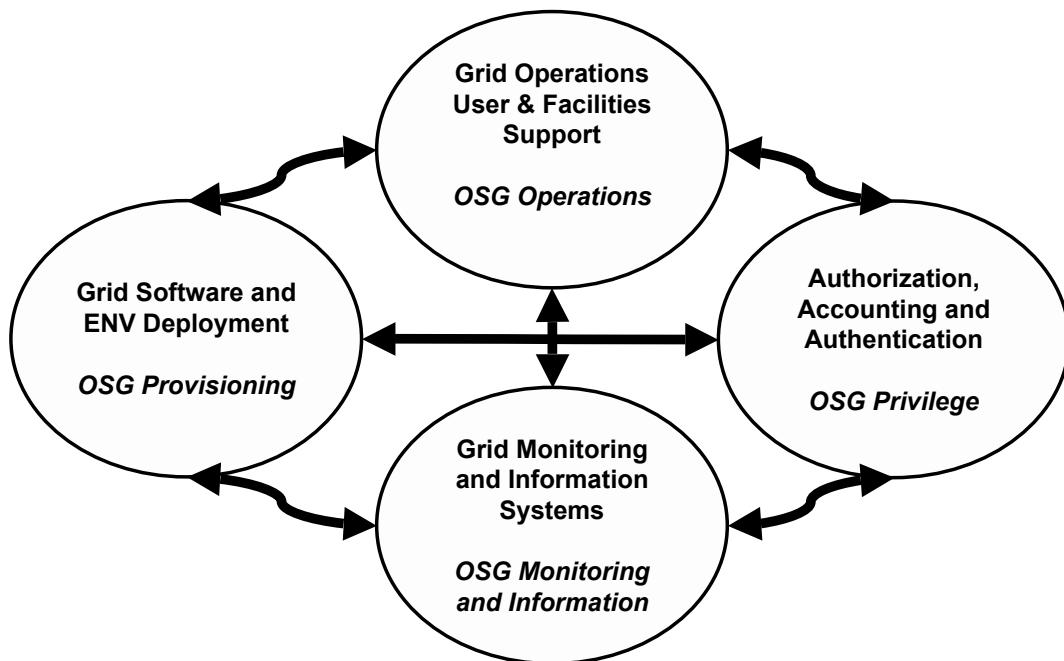
The Open Science Grid



March 24-25, 2007

36

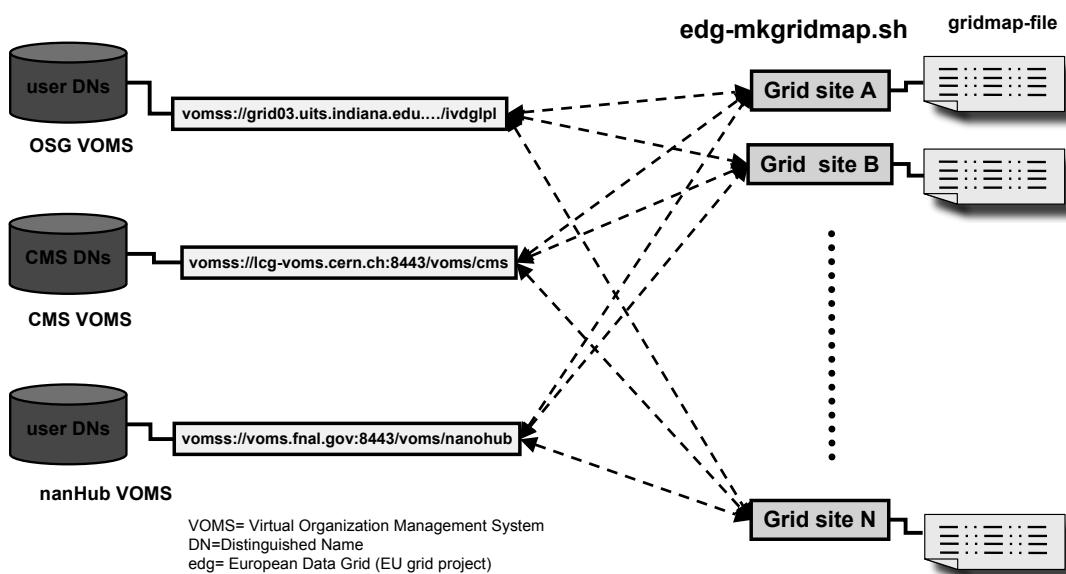
The OSG: A High Level View



March 24-25, 2007

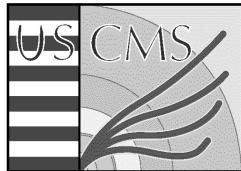
37

OSG Authentication (2)



March 24-25, 2007

38



The Privilege Project



Application of a Role Based Access Control model for OSG

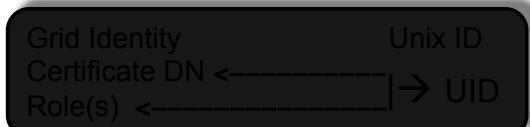
An advanced authorization mechanism

March 24-25, 2007

39

The Privilege Project Provides

- A more flexible way to assign DNs to local UNIX qualifiers, (uid, gid...)
 - VOMSes are still used to store grid identities
 - But gone are the static gridmap-files
 - voms-proxy-init replaces grid-proxy-init
 - Allows a user to specify a role along with unique ID
 - Access rights granted based on user's
 - VO membership
 - User selected role(s)

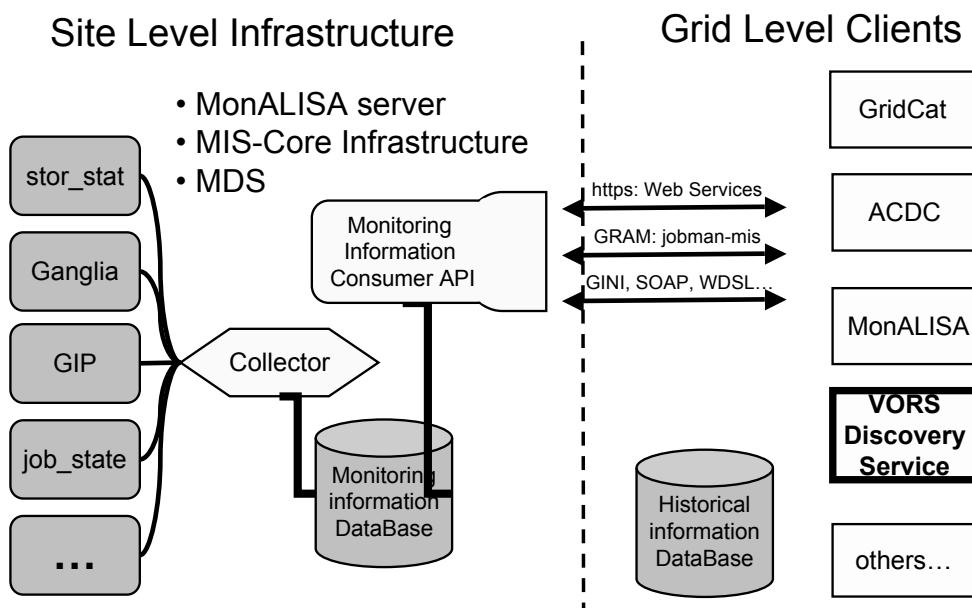


March 24-25, 2007

40

OSG Grid Monitoring

OSG Grid Monitoring



Virtual Organization Resource Selector

Open Science Grid

All OSG TeraGrid EGEE OSG-ITB

Virtual Organization Selection

All	CDF	CMS	CompBioGrid	DES	DOSAR	DZero	Engage	Fermilab	fMRI	GADU
All	geant4	GLOW	GPN	GRASE	GridChem	GridEx	GROW	i2u2	iVDCL	LIGO
mariachi	MIS	nanoHUB	NWICG	Ops	OSG	OSGEDU	SDSS	STAR	USATLAS	

Resources

Name	Gatekeeper	Type	Grid	Status	Last Test Date
BNL_ATLAS_1	gridgk01.racl.bnl.gov:2119	compute	OSG	PASS	2006-12-08 14:57:13
BNL_ATLAS_2	gridgk02.racl.bnl.gov:2119	compute	OSG	PASS	2006-12-08 14:58:43
BU_ATLAS_Tier2	atlas.bu.edu:2119	compute	OSG	PASS	2006-12-08 15:00:44

Virtual Organization Resource Selector - VORS

- Custom web interface to a grid scanner that checks services and resources on:
 - Each Compute Element
 - Each Storage Element
- Very handy for checking:
 - Paths of installed tools on Worker Nodes.
 - Location & amount of disk space for planning a workflow.
 - Troubleshooting when an error occurs.



VORS entry for OSG_LIGO_PSU

Gatekeeper: grid3.aset.psu.edu

Scheduler Types	jobmanager is of type fork jobmanager-fork is of type fork jobmanager-mis is of type mis jobmanager-pbs is of type pbs
Path to Condor Binaries	
Path to MIS Binaries	/opt/osg-ce-0.4.1/MIS-CI/bin
MDS Port	2135
VDT Version	1.3.10b
VDT Location	/opt/osg-ce-0.4.1
\$APP Location	/usr1/grid3/app
\$DATA Location	/usr1/grid3/data
\$TMP Location	/usr1/grid3/data
\$WN TMP Location	/tmp
\$OSG_GRID Location	/usr1/grid3/osg-wn-0.4.1
\$APP Space Available	179.065 GB
\$DATA Space Available	179.065 GB
\$TMP Space Available	179.065 GB



OSG Consortium Mtg March 2007
Quick Start Guide to the OSG
March 24-25, 2007

45

VORS is developing a grid-scanner for Storage Elements (coming soon) for OSG 0.6.0

```
Testing for SE SRM control protocol : YES control type = srm_v1 end
point = srm://fndca1.fnal.gov:8443/ full path =
/pnfs/fnal.gov/usr/fermigrid/volatile/mis executing srmls -retry_num=0
srm://fndca1.fnal.gov:8443//pnfs/fnal.gov/usr/fermigrid/volatile/mis 2>&1
....
```

```
Testing srmls : PASS - read 12 lines 512
srm://fndca1.fnal.gov:8443//pnfs/fnal.gov/usr/fermigrid/volatile/mis 1715
srm://fndca1.fnal.gov:8443//pnfs/fnal.gov/usr/fermigrid/volatile/mis/file1
1715
srm://fndca1.fnal.gov:8443//pnfs/fnal.gov/usr/fermigrid/volatile/mis/file2
41767
....
```

```
Testing srmcp (from SE) : FAIL - returns error code 256
```



OSG Consortium Mtg March 2007
Quick Start Guide to the OSG
March 24-25, 2007

46

GridCat

<http://osg-cat.grid.iu.edu>

Status	Site Name	Grid Version	Jobs	Disks	Service	Loc	Facility	CPU's
●	Purdue_Physics	osg 0.2.1			CS	IN	PURDUE	57
●	Purdue_ITaP	osg 0.1.5			CS	IN	PURDUE	1092
●	CIT_CMS_PG	osg 0.2.1			CS	CA	CALTECH	116
●	NERSC_PDSF	osg 0.2.1			CS	CA	NERSC	116
●	GRASE_CCR_ACDC	osg 0.1.6			CS	NY	BUFFALO	68
●	FNAL_DDS2	osg 0.2.1			CS	IL	FNAL	1
●	FNAL_GFARM	osg 0.2.1			CS	IL	FNAL	29
●	FNAL_FERMIGRID	osg 0.2.1			CS	IL	FNAL	4
●	UIOWA_OSG_PROD	osg 0.2.1			CS	IA	UIOWA	6
●	UCSan Diego_OSG_Prod	osg 0.2.1			CS	CA	SDSC	403
●	GRASE_CCR_U2	osg 0.2.1			CS	NY	BUFFALO	1024
●	USCMS_FNAL_WC1_CE	osg 0.2.1			CS	IL	FNAL	562
●	IU_ATLAS_Tier2	osg 0.2.1			CS	IN	IU	384

Total CPUs: 3862

<http://www.ivdgl.org/grid3/gridcat>

Status	Site Name	Grid Version	Jobs	Disks	Service	Loc	Facility	CPU's
●	STAR_SAO_PAULO	osg 0.4.1			CS	WS	BRAZIL	USP
●	SPIRACE	osg 0.4.0			CS	BRAZIL	UNESP	
●	IEERJ_HEPGRID	osg 0.2.1			CS	BRAZIL	UERJ	
●	NERSC_PDSF	osg 0.4.0			CS	CA	NERSC	
●	osg_gw_2_0_uscd_edu	osg 0.4.1			CS	WS	UCSD	
●	PROD_SLAC	osg 0.4.0			CS	WS	SLAC	
●	CIT_CMS_T2	osg 0.4.1			CS	WS	CA	
●	CALTECH_PG	osg 0.4.1			CS	WS	CALTECH	
●	UCSan Diego_OSG_v1	osg 0.4.1			CS	CA	SDSC	
●	CIT_CMS_T2dm_v1	osg 0.4.0			CS	WS	CALTECH	
●	UFFlorida_PG	osg 0.4.1			CS	WS	FL	
●	FIU_PG	osg 0.4.1			CS	WS	FL	
●	UFFlorida_BHEPA	osg 0.4.1			CS	WS	FL	
●	UFFlorida_PGcom_v1	osg 0.4.1			CS	WS	FL	
●	UIOWA_OSG_PROD	osg 0.4.1			CS	WS	IA	
●	grow_UMPLP	osg 0.4.1			CS	WS	IA	
●	FNAL_GFARM	osg 0.4.1			CS	WS	IL	
●	FNAL_FERMIGRID	osg 0.4.1			CS	WS	IL	
●	USCMS_FNAL_WC1_CE	osg 0.4.1			CS	WS	IL	
●	SDSS_TAM	osg 0.4.1			CS	WS	IL	
●	UC_Teraport	osg 0.4.1			CS	WS	IL	
●	UC_ATLAS_MWT2	osg 0.4.1			CS	WS	IL	
●	FNAL_LOCID	osg 0.4.0			CS	WS	IL	
●	OSG_INSTALL_TEST_2	osg 0.4.1			CS	WS	IL	

Set Jul. 9 18:00:00 GMT 2005
Sat Jul. 9 16:55:07 GMT 2005

March 24-25, 2007 <http://www.ivdgl.org/gridcat/home/>

GridCat

Functions as:
OSG Site Catalog
Site Basic Functionality Tests

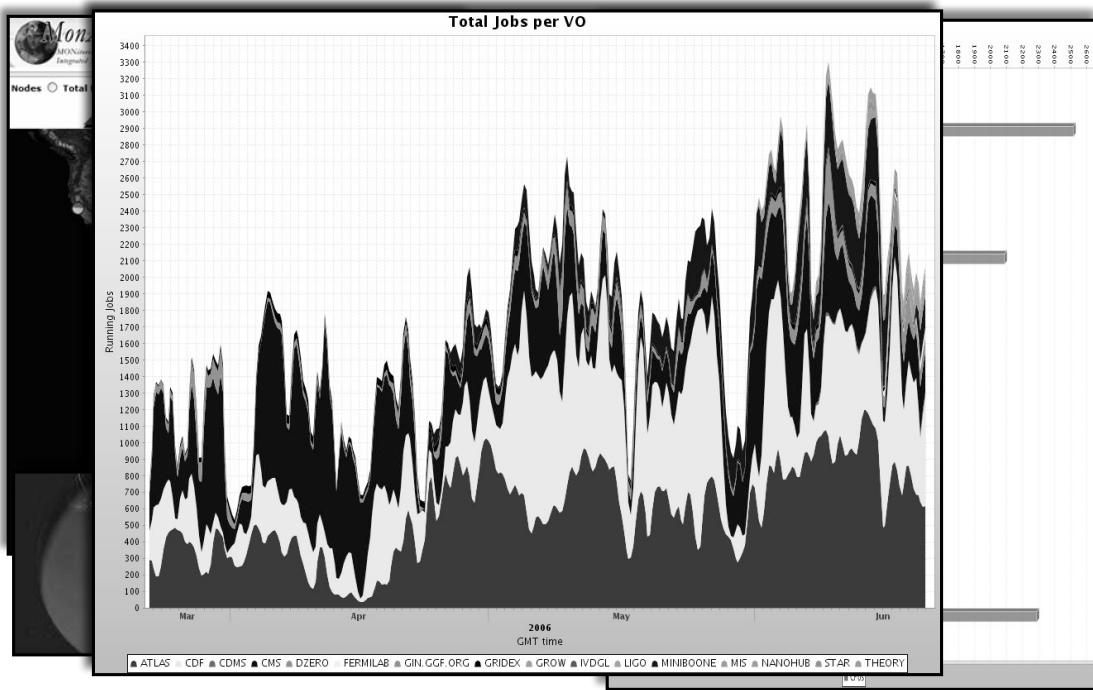
Status	Site Name	Grid Version	Jobs	Disks	Service	Loc	Facility	
●	STAR_SAO_PAULO	osg 0.4.1			CS	WS	BRAZIL	USP
●	SPIRACE	osg 0.4.0			CS	BRAZIL	UNESP	
●	IEERJ_HEPGRID	osg 0.2.1			CS	BRAZIL	UERJ	
●	NERSC_PDSF	osg 0.4.0			CS	CA	NERSC	
●	osg_gw_2_0_uscd_edu	osg 0.4.1			CS	WS	UCSD	
●	PROD_SLAC	osg 0.4.0			CS	WS	SLAC	
●	CIT_CMS_T2	osg 0.4.1			CS	WS	CA	
●	CALTECH_PG	osg 0.4.1			CS	WS	CALTECH	
●	UCSan Diego_OSG_v1	osg 0.4.1			CS	CA	SDSC	
●	CIT_CMS_T2dm_v1	osg 0.4.0			CS	WS	CALTECH	
●	UFFlorida_PG	osg 0.4.1			CS	WS	FL	
●	FIU_PG	osg 0.4.1			CS	WS	FL	
●	UFFlorida_BHEPA	osg 0.4.1			CS	WS	FL	
●	UFFlorida_PGcom_v1	osg 0.4.1			CS	WS	FL	
●	UIOWA_OSG_PROD	osg 0.4.1			CS	WS	IA	
●	grow_UMPLP	osg 0.4.1			CS	WS	IA	
●	FNAL_GFARM	osg 0.4.1			CS	WS	IL	
●	FNAL_FERMIGRID	osg 0.4.1			CS	WS	IL	
●	USCMS_FNAL_WC1_CE	osg 0.4.1			CS	WS	IL	
●	SDSS_TAM	osg 0.4.1			CS	WS	IL	
●	UC_Teraport	osg 0.4.1			CS	WS	IL	
●	UC_ATLAS_MWT2	osg 0.4.1			CS	WS	IL	
●	FNAL_LOCID	osg 0.4.0			CS	WS	IL	
●	OSG_INSTALL_TEST_2	osg 0.4.1			CS	WS	IL	

WORLD US ASIA SAMERICA EUROPE

Wed Jun 21 03:55:39 GMT 2006

March 24-25, 2007

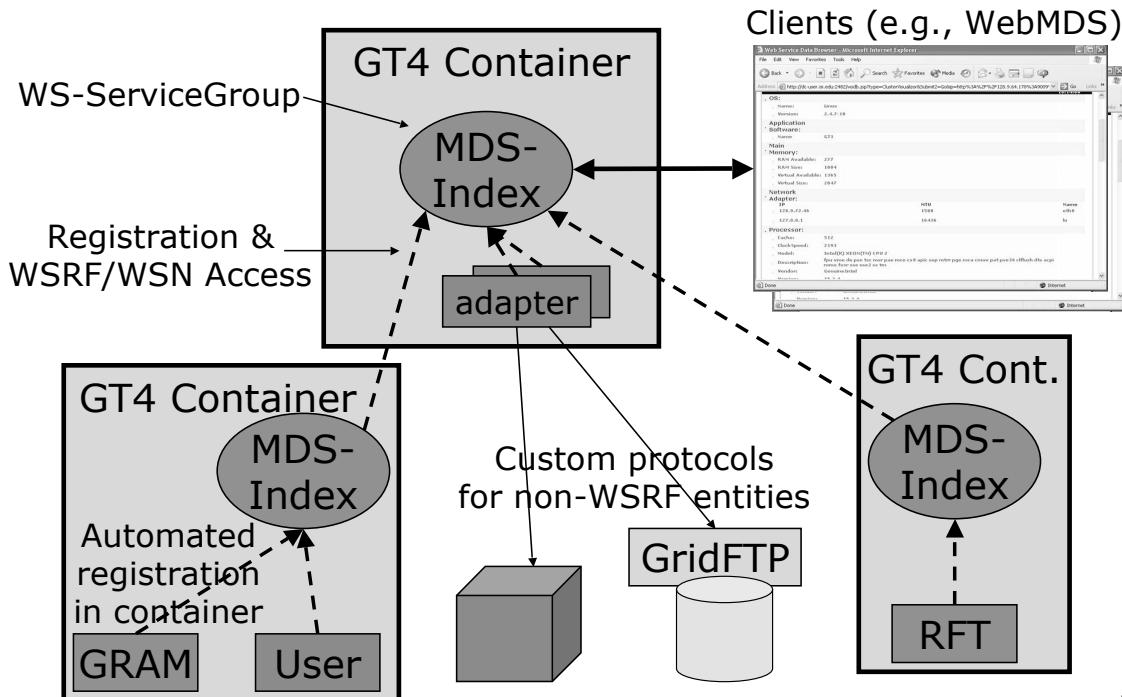
MonALISA



March 24-25, 2007

49

Monitoring and Discovery Services



March 24-25, 2007

50

The OSG ENVironment

A screenshot of a Mozilla Firefox browser window displaying the 'SITE INFO' page from the OSG ENVIRONMENT. The page shows various system parameters and their values. The 'Check Date:' is listed as 'Fri Jun 23 10:43:38 UTC 2006'. Other parameters include:

Parameter	Value
Batch System:	condor
Batch Slots Running:	1
All Batch Slots:	20
Grid Dir. (\$GRID):	/share/eo/osg-0.4.1
Application Dir. (\$APP):	/raid/raid4/eo/app
Data Dir. (\$DATA):	/raid/raid4/eo/data
Tmp Dir. (\$TMP):	/raid/raid4/eo/data
Worker-Node Tmp Dir. (\$WNTMP):	/state/partition1/wntmp
Services:	gram gsiftp ldap wsgram
GLOBUS LOCATION (\$GLOBUS_LOCATION):	/share/eo/osg-0.4.1/globus
Worker-Node Client Dir.:	/share/eo/osg-0.4.1
Site Read-Only Dir.:	/raid/raid4/eo/tmp
Site Read/Write Dir.:	/raid/raid4/eo/tmp
Default Storage Element:	UNAVAILABLE

March 24-25, 2007

51

OSG MDS: GIP and BDII

A screenshot of a Mozilla Firefox browser window displaying the 'OSG GIP Validate' page from the GROW (Grid Research and Education Group at Iowa) website. The page shows a grid of test results for various sites across different service categories. The categories are:

- Search
- Glue
- Site
- Cluster
- SubCluster
- ComputingElement
- VOView
- StorageElement
- SFAccess
- CSEBnode
- CSEBnodeCE
- SiteRWW

The grid rows list various sites, including:

- ASGC_OSG (osgc01.grid.sinica.edu.tw)
- BNL_ATLAS_1 (gridgk01.racf.bnl.gov)
- BNL_ATLAS_2 (gridgk02.racf.bnl.gov)
- BU_ATLAS_Tier2 (atlas.bu.edu)
- CIT_CMS_T2 (cit-gatekeeper.ultralight.org)
- DARTMOUTH (pbs-01.grid.dartmouth.edu)
- FIU-PG (flupg.ampath.net)
- FNAL_FERMIGRID (fermigrd1.fnal.gov)
- FNAL_GFARM (fnpp-osg.fnal.gov)
- FNAL_LQCD (lqcd.fnal.gov)

The grid cells are colored according to the test status: yellow for skipped tests, green for successful tests, and red for failed tests.

March 24-25, 2007

52

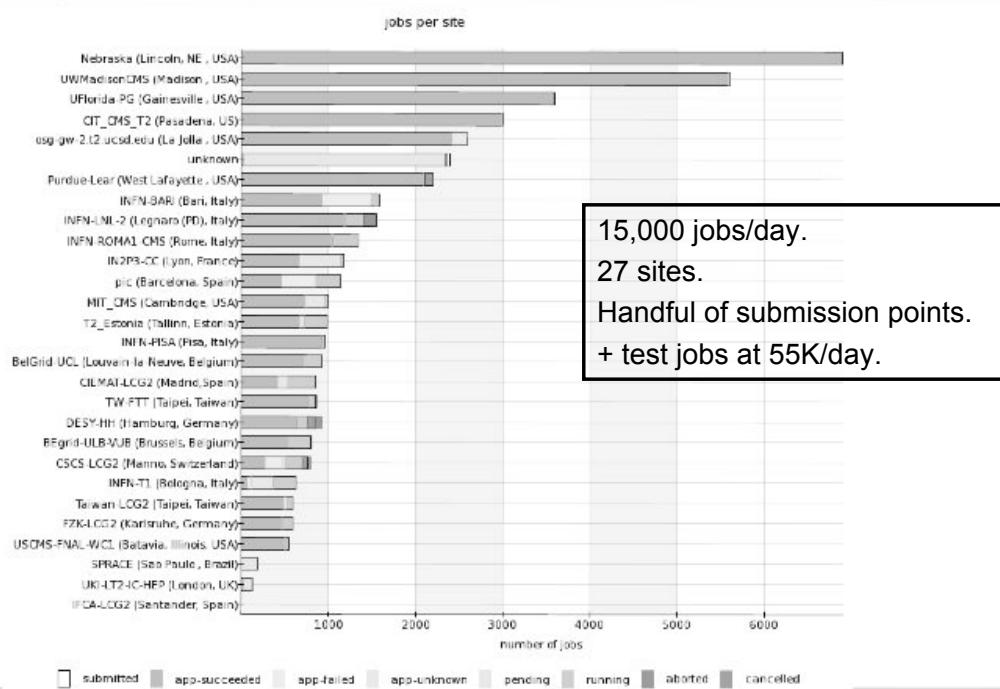
OSG Grid Level Clients

- Tools provide basic information about OSG resources
 - Resource catalog: official tally of OSG sites
 - Resource discovery: what services are available, where are they and how do I access it
 - Metrics Information: Usage of resources over time
- Used to assess scheduling priorities
 - Where and when should I send my jobs?
 - Where can I put my output?
- Used to monitor health and status of the Grid

March 24-25, 2007

53

Submitting Locally, Executing Remotely:



March 24-25, 2007

10 Nov, 2006 10
54

Managing Storage

- A Solution: SRM (Storage Resource Manager)
- Grid enabled interface to put data on a site
 - Provides scheduling of data transfer requests
 - Provides reservation of storage space

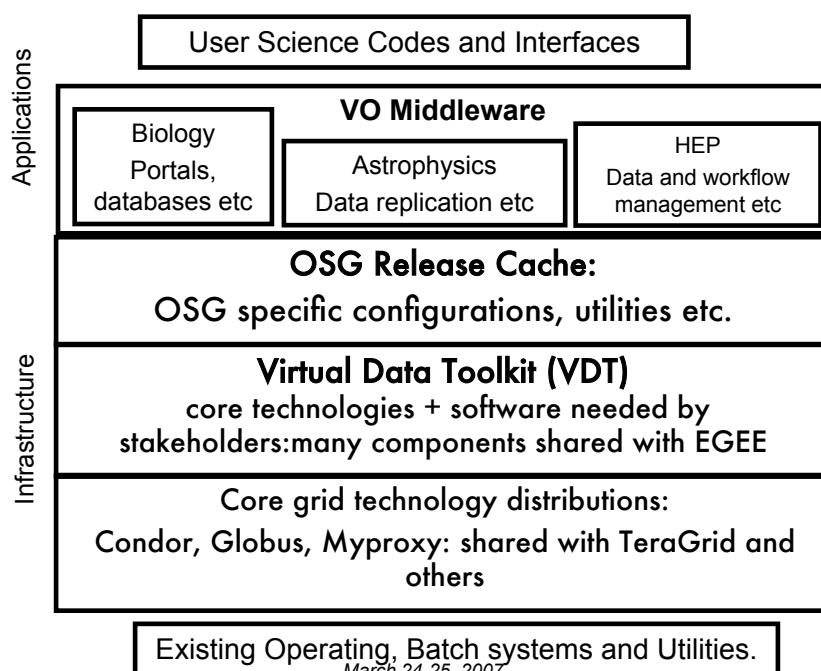
```
$> globus-url-copy srm://ufdcache.phys.ufl.edu/cms/foo.rfz \
gsiftp://cit.caltech.edu/data/bar.rfz
```

- Technologies in the OSG pipeline
 - dCache/SRM (disk cache with SRM)
 - Provided by DESY & FNAL
 - SE(s) available to OSG as a service from the USCMS VO
 - DRM (Disk Resource Manager)
 - Provided by LBL
 - Can be added on top of a normal UNIX file system

March 24-25, 2007

55

OSG Middleware



March 24-25, 2007

56

The OSG Software Cache

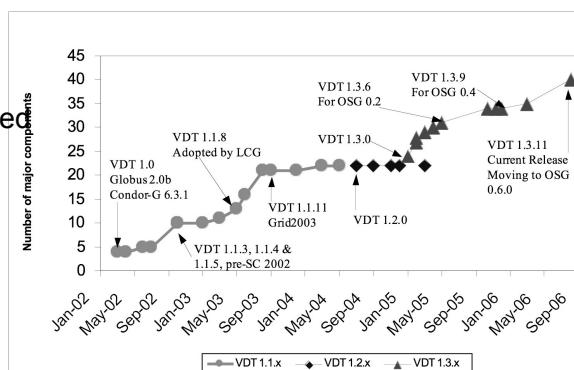
- Most software comes from the Virtual Data Toolkit (VDT)
- OSG components include
 - VDT configuration scripts
 - Some OSG specific packages too
- Pacman is the OSG Meta-packager
 - This is how we deliver the entire cache to Resource Providers

March 24-25, 2007

57

What is the VDT?

- A collection of software
 - Grid software: Condor, Globus and lots more
 - Virtual Data System: Origin of the name “VDT”
 - Utilities: Monitoring, Authorization, Configuration
 - Built for >10 flavors/versions of Linux
- Automated Build and Test: Integration and regression testing.
- An easy installation:
 - Push a button, everything just works.
 - Quick update processes.
- Responsive to user needs:
 - process to add new components based on community needs.
- A support infrastructure:
 - front line software support,
 - triaging between users and software providers for deeper issues.



March 24-25, 2007

58

What is in the VDT? (A lot!)

Condor Group	ISI & UC	Core software
Condor/Condor-G	Chimera & Pegasus	User Interface
DAGMan		Computing Element
Fault Tolerant Shell		Storage Element
ClassAds		Authz System
NeST		Monitoring System
Globus (pre WS & GT4 WS)		
Job submission (GRAM)		
Information service (MDS)		
Data transfer (GridFTP)		
Replica Location (RLS)		
EDG & LCG		
Make Gridmap		US LHC
Cert. Revocation list updater		GUMS
Glue & Gen. Info. provider		PRIMA
VOMS		Others
	PyGlobus	KX509 (U. Mich.)
	Netlogger	Java SDK (Sun)
	DRM	Apache HTTP/Tomcat
	Caltech	MySQL
	MonALISA	Optional packages
	jClarens (WSR)	Globus-Core {build}
	VDT	Globus job-manager(s)
	VDT System Profiler	
	Configuration software	

March 24-25, 2007

59

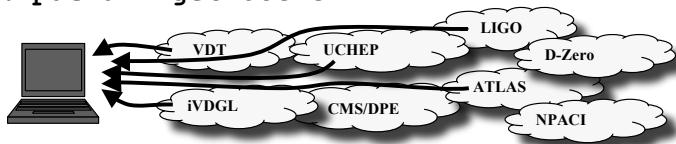
Pacman

- **Pacman is:**
 - a software environment installer (or Meta-Packager)
 - a language for defining software environments
 - an interpreter that allows creation, installation, configuration, update, verification and repair of installation environments
 - takes care of dependencies
- **Pacman makes installation of all types of software easy**

LCG/Scram	Globus/GPT	Nordugrid/RPM
ATLAS/CMT	NPACI/TeraGrid/tar/make	
LIGO/tar/make	D0/UPS-UPD	Commercial/tar/make
OpenSource/tar/make	CMS DPE/tar/make	

Enables us to easily and coherently combine and manage software from arbitrary sources.

```
% pacman -get OSG:CE
```



Enables remote experts to define installation config updating for everyone at once.

March 24-25, 2007

60

Pacman Installation

1. Download Pacman

- <http://physics.bu.edu/~youssef/pacman/>

2. Install the “package”

- cd <install-directory>
- pacman -get OSG:OSG_CE_0.2.1
- ls
 - condor/ globus/ post-install/ setup.sh
 - edg/ gpt/ replica/ vdt/
 - ftsh/ perl/ setup.csh vdt-install.log
 - /monalisa ...

March 24-25, 2007

61

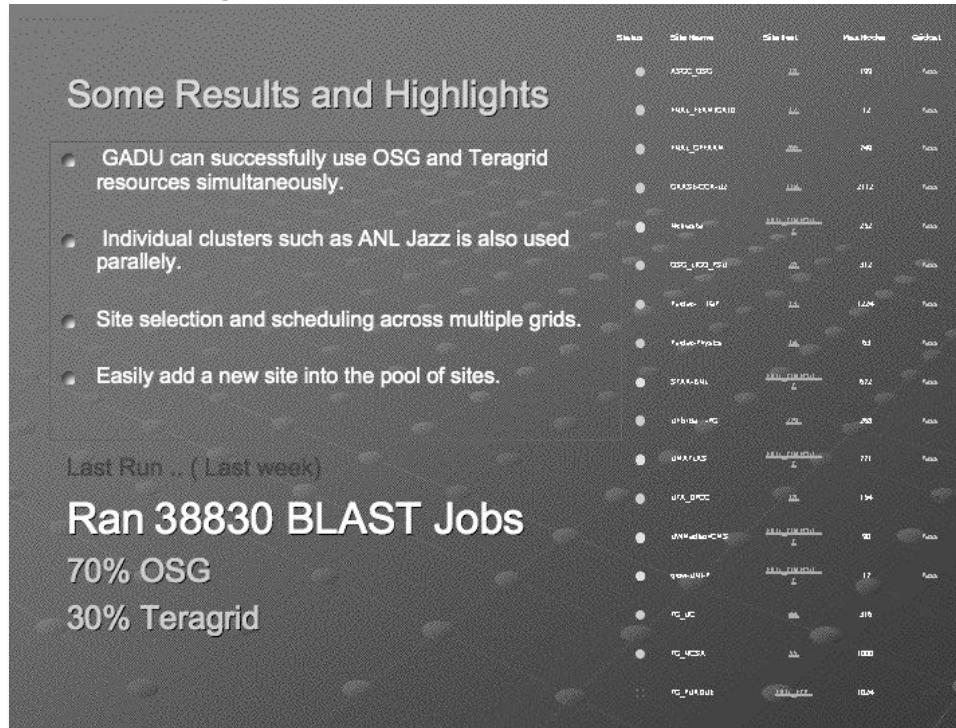
Grid Operations Center

- Based at Indiana University and provides a central repository of staff and monitoring systems for:
 - Real time grid monitoring.
 - Problem tracking via a trouble ticket system.
 - Support for developers and sys admins.
 - Maintains infrastructure – VORS, MonALISA and registration DB.
 - Maintains OSG software repositories.



Applications can cross infrastructures

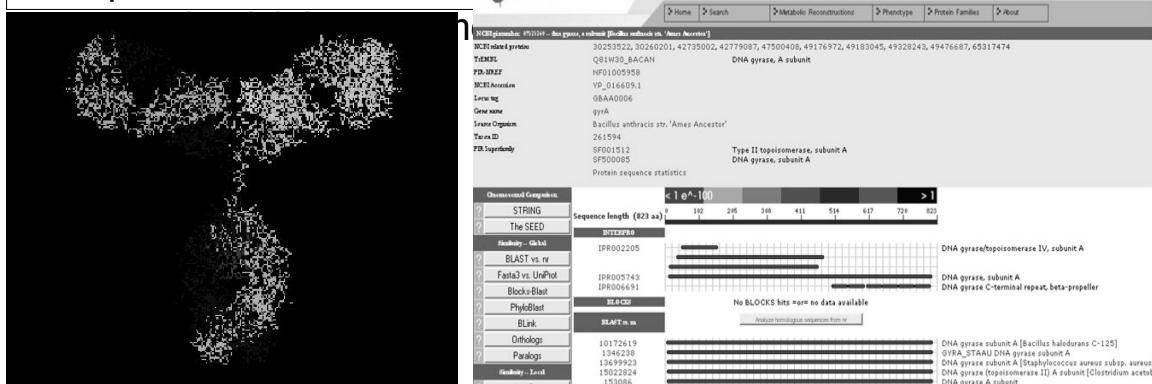
e.g: OSG and TeraGrid



63

Genome Analysis and Database Update system

- Runs across TeraGrid and OSG. Uses the Virtual Data System (VDS) workflow & provenance.
- Pass through public DNA and protein databases for new and newly updated genomes of different organisms and runs BLAST, Blocks, Chisel. 1200 users of resulting DB.
- Request: 1000 CPUs for



Summary of OSG today

- Providing core services, software and a distributed facility for an increasing set of research communities.
- Helping Virtual Organizations access resources on many different infrastructures.
- Reaching out to others to collaborate and contribute our experience and efforts.

March 24-25, 2007

65

it's the people...that make the grid a community!

