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# Distributed Systems – Techs

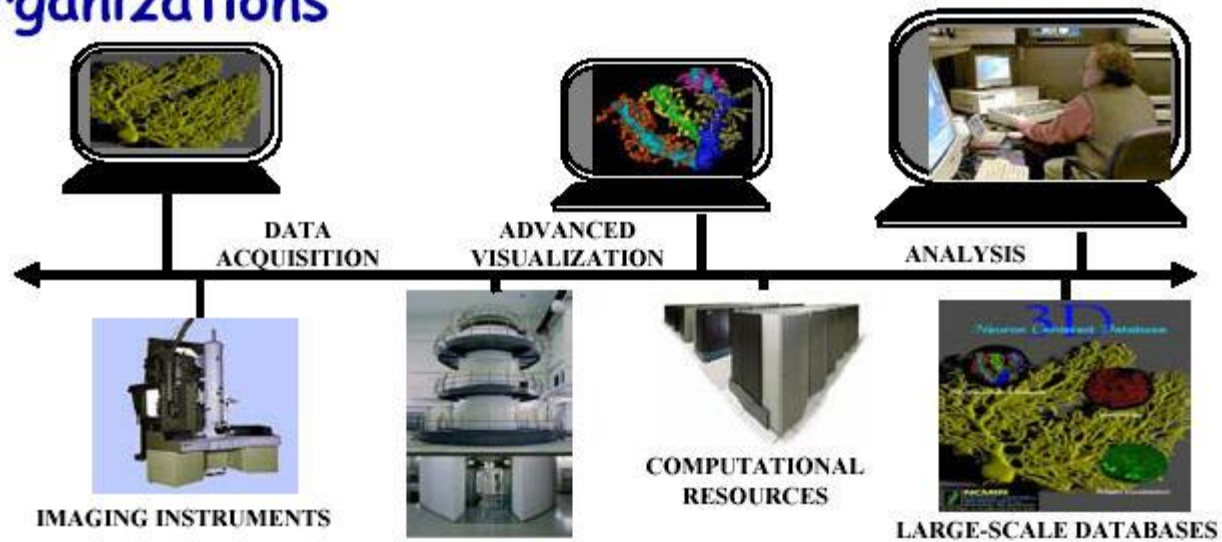
## 3. Grids

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# Grid Computing is About ...

Resource sharing & coordinated problem solving  
in dynamic, multi-institutional virtual  
organizations



"Telescience Grid", Courtesy of Mark Ellisman

# Definition

A type of **distributed system** that enables the sharing, selection, & aggregation of geographically distributed resources:

- ❑ **Computers** – PCs, workstations, clusters, supercomputers, laptops, notebooks, mobile devices, PDA, etc;
- ❑ **Software** – e.g., ASPs renting expensive special purpose applications on demand;
- ❑ **Catalogued data and databases** – e.g. transparent access to human genome database;
- ❑ **Special devices/instruments** – e.g., radio telescope – SETI@Home searching for life in galaxy.
- ❑ **People/collaborators.**

depending on their availability, capability, cost, and user QoS requirements

for solving large-scale problems/applications.

**thus enabling the creation of “virtual organization” (VOs)**

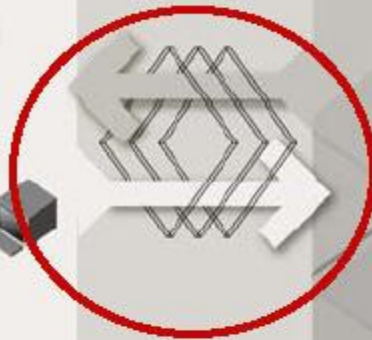
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# The Grid



## PROBLEM SOLVING ENVIRONMENTS

Scientists and engineers using computation to accomplish lab missions



## HARDWARE

Heterogeneous collection of high-performance computer hardware and software resources



## SOFTWARE

Software applications and components for computational problems



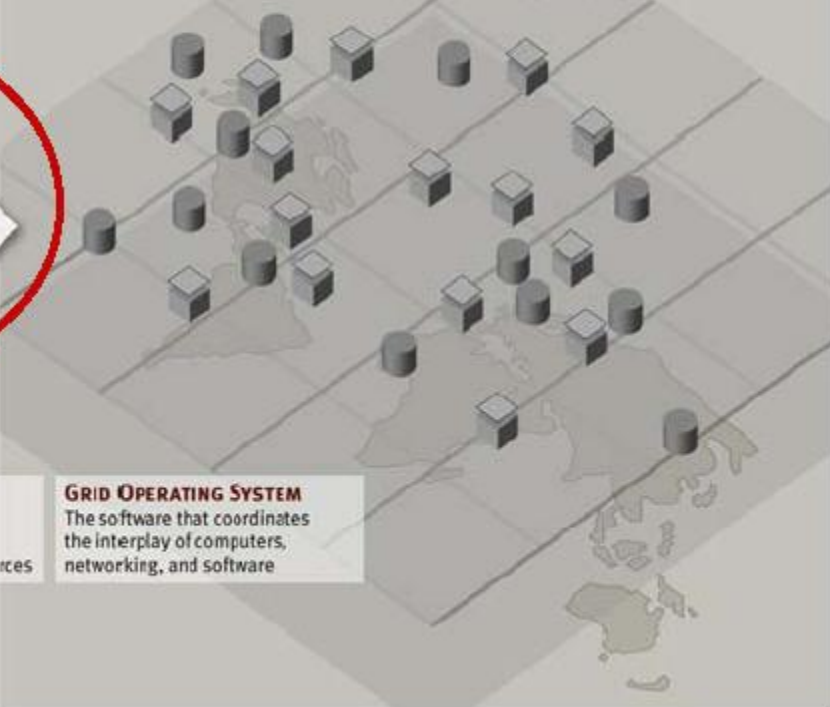
## NETWORKING

The hardware and software that permits communication among distributed users and computer resources



## MASS STORAGE

A collection of devices and software that allow temporary and long-term archival storage of information



## INTELLIGENT INTERFACE

A knowledge-based environment that offers users guidance on complex computing tasks

## MIDDLEWARE

Software tools that enable interaction among users, applications, and system resources

## GRID OPERATING SYSTEM

The software that coordinates the interplay of computers, networking, and software

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# Grid's main idea

- To treat CPU cycles and software like commodities.
  - Enable the coordinated use of geographically distributed resources – *in the absence of central control and existing trust relationships*.
  - Computing power is produced much like utilities such as power and water are produced for consumers.
  - Users will have access to “power” *on demand*
  - “When the Network is as fast as the computer’s internal links, the machine disintegrates across the Net into a set of special purpose appliances” – Gilder Technology Report June 2000
-

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# Computational Grids and Electric Power Grids

- **Power Grid analogy**
    - Power producers: machines, software, networks, storage systems
    - Power consumers: user applications
  - **Applications draw power from the Grid the way appliances draw electricity from the power utility.**
    - Seamless, High-performance, Ubiquitous, Dependable
  - **Why the Computational Grid is like the Electric Power Grid**
    - Electric power is ubiquitous
    - Don't need to know the source of the power (transformer, generator) or the power company that serves it
  - **Why the Computational Grid is different from the Electric Power Grid**
    - Wider spectrum of performance
    - Wider spectrum of services
    - Access governed by more complicated issues: Security, Performance
-

Alessandro Volta in Paris in 1801 inside French National Institute shows the battery while in the presence of Napoleon I



Fresco by N. Cianfanelli (1841)

(Zoological Section "La Specula" of National History Museum of Florence University)



Oh, mon  
Dieu !

What ?!?!  
This is a mad man...

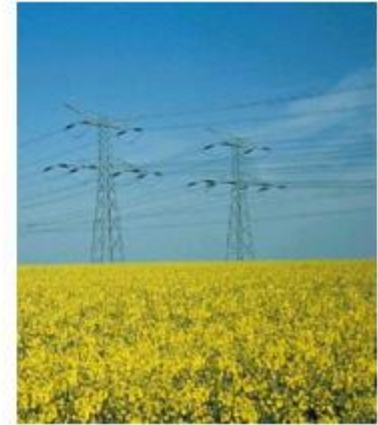
...and in the future,  
I imagine a  
Worldwide  
Power (Electrical)  
Grid .....





2002 - 1801 = 201 Years

1801



2002



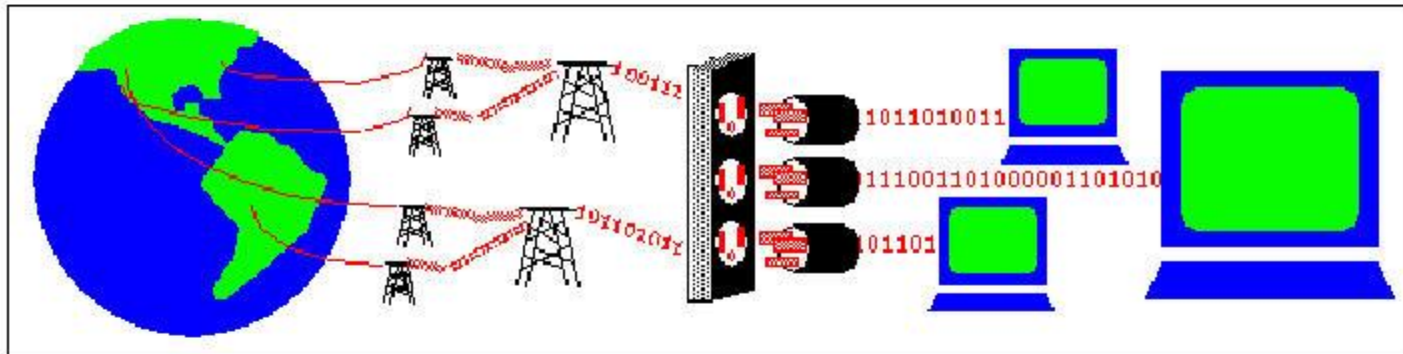


# IPG: Analogy to Electric Power Grid



Principal benefits:

- load sharing/balancing
- fault tolerance, minimum loss-of-service
- economies of scale



Principal risks/challenges:

- possible fault domino effect
- reliance on facilities under other's control
- negotiation of agreements
- standards development and compliance policing

# Distributed and Parallel Systems



- Gather (unused) resources
- Steal cycles
- System SW manages resources
- System SW adds value
- 10% - 20% overhead is OK
- Resources drive applications
- Time to completion is not critical
- Time-shared

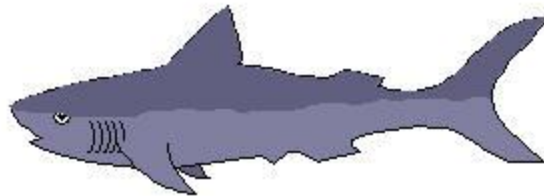
- Bounded set of resources
- Apps grow to consume all cycles
- Application manages resources
- System SW gets in the way
- 5% overhead is maximum
- Apps drive purchase of equipment
- Real-time constraints
- Space-shared

# Early 1990 Computer Food Chain

(hitting wall soon)



Mini Computer



Mainframe



Workstation

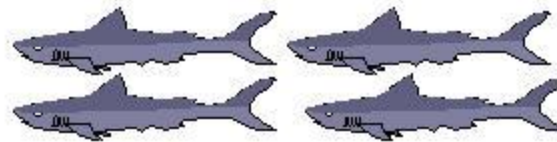


PC

(future is bleak)

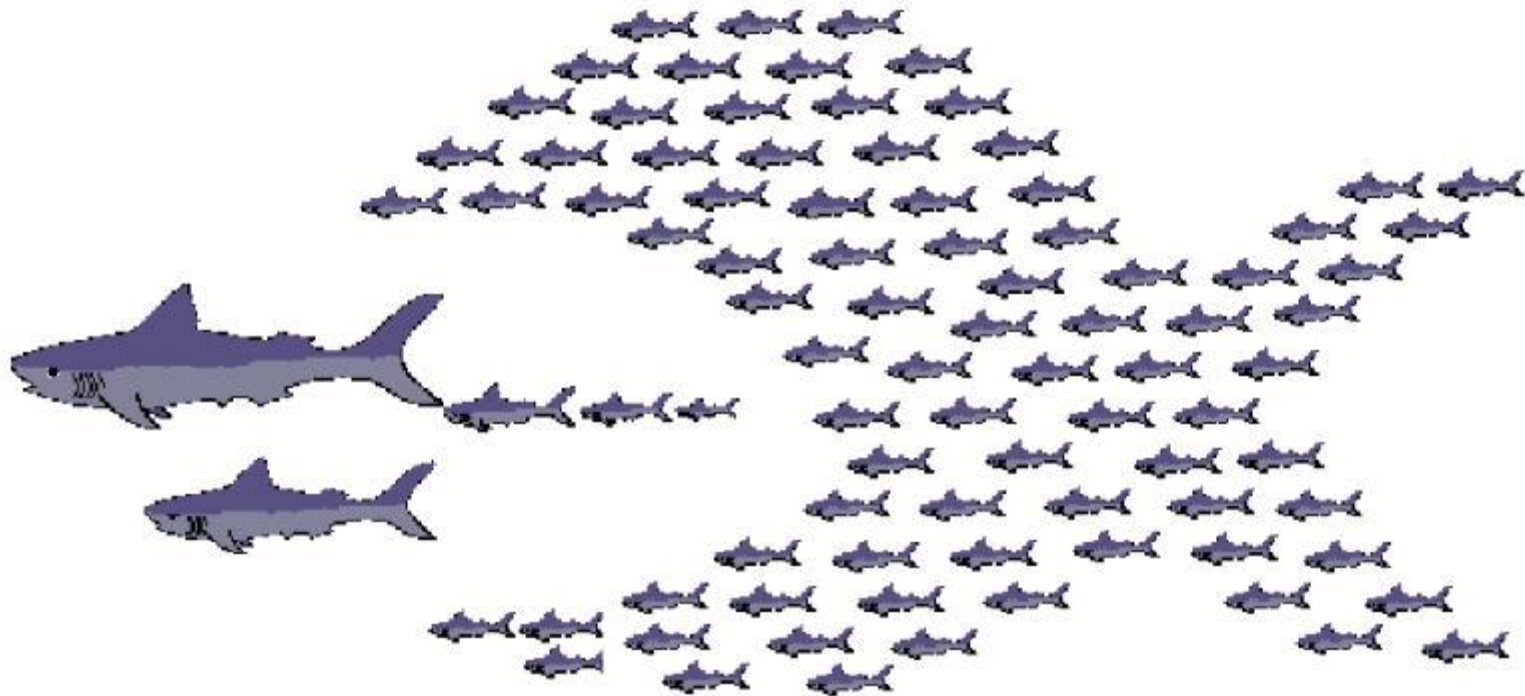


Vector Supercomputer



MPP

# Replacing Big Irons





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# P2P, Cluster, Internet computing vs. Grid computing

- **Peer-to-peer** networks (eg Kazaa) fall within the definition of grid computing (the resource shared is the storage capacity of each node)  
P2P Working Group part of Global Grid Forum
  - A **cluster** is a resource that can be shared- a grid is a cluster of clusters
  - **Internet computing**: a VO is assembled for a particular project and disbanded once the project is complete -the shared resource is the Internet connected desktop
-

# Grid evolution: 1<sup>st</sup> generation

## Grid Evolution - Metacomputing



### □ Different Supercomputing Resources

- ❖ geographically distributed
- ❖ used as a single **powerful** parallel machine (clear, High-Performance orientation)

## Metacomputing

□ The word metacomputing was coined to describe this new computational approach

California Institute for Telecommunications and Information Technology

□ Reference:

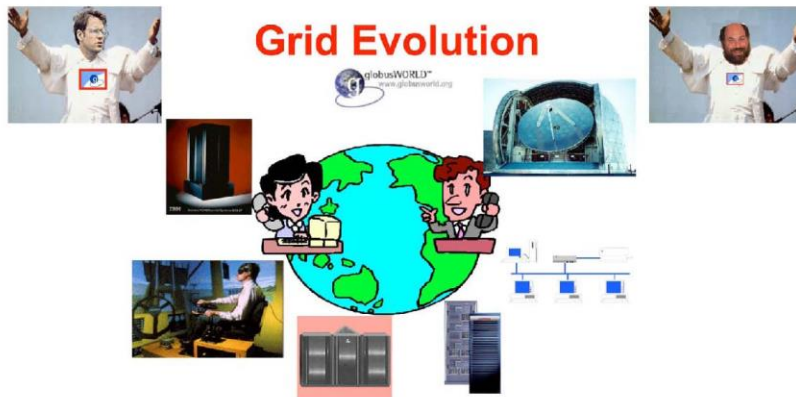
□ Larry Smarr & Charles E. Catlett

□ **Metacomputing**

❖ Communications of the ACM, 35(6):45-52, June 1992



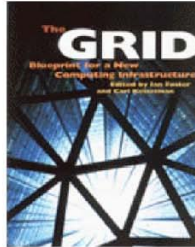
# Grid computing: 2<sup>nd</sup> generation



Grid computing has emerged as an important new field, distinguished from conventional distributed computing by its focus on large-scale resource sharing, innovative applications, and, in some cases, high-performance orientation.

## Grid Applications

- ❑ **Distributed Supercomputing**
  - ❖ Stellar Dynamics, Ab initio chemistry, ...
- ❑ **High Throughput**
  - ❖ Chip design, Parametric studies, ...
- ❑ **On Demand**
  - ❖ Medical instrumentation, network-enabled solvers, .....
- ❑ **Data Intensive**
  - ❖ Sky survey, Physics data, Data Mining, .....
- ❑ **Collaborative**
  - ❖ Collaborative design, data exploration, education, ...



# Grid computing: 3<sup>rd</sup> generation

## Grid Evolution



The marriage of the **Web technology** with the **2nd Generation Grid technology** led to new and generic Grid Services

## The Physiology of the Grid

An Open Grid Services Architecture for Distributed Systems Integration  
I. Foster, C. Kesselman, J. Nick, S. Tuecke, January, 2002



<http://www.globus.org/research/papers/ogsa.pdf>

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# OGSA services

- Open Grid Service Architecture,
    - defined by GGF group
    - In ubiquitous Grid platform, there is common need for some essential set of interfaces, behaviors, resource models, and bindings
    - defines the core set of services essential for grid, their functionality and interrelationships
    - Core services: service interaction, management, communication, security
    - Non-core: data, program execution, resource management
  - Grid service is a Web service with extensions, which are:
    - Name (handle GSH, reference GSR)
    - Lifetime management (factories, persistent and transient services)
    - State (Service Data)
    - Notification as well as querying
-



# CoreGrid Definition of GRID

Core ~~GRID~~

A fully distributed,  
dynamically reconfigurable,  
scalable and autonomous  
infrastructure to provide  
location independent,  
pervasive, reliable,  
secure and efficient  
access

Core ~~GRID~~

to a coordinated set of  
services encapsulating and  
virtualizing resources  
(computing power, storage,  
instruments, data, etc.)  
in order to generate  
knowledge.

2006

# De facto-middleware: Globus Toolkit



## Globus: Milestones

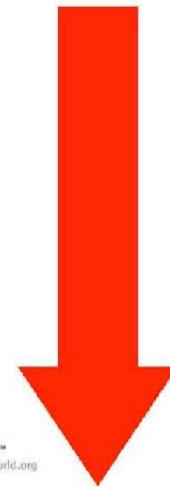
- ❑ Start-up: **1996**
- ❑ GT1.0: 1998
- ❑ GT2.0: 2001
- ❑ GT3/T.Preview: Apr-Dec 2002
- ❑ GT3.0 Alpha: Jan 2003
- ❑ GT3 Production: June 2003
- ❑ GT3.9.2 August 2004 **α-quality**
- ❑ GT3.9.2 December 2004 **β-quality**
- ❑ GT4.0 January 2005 **Stable Release**

**2<sup>nd</sup>**

**3<sup>rd</sup>**

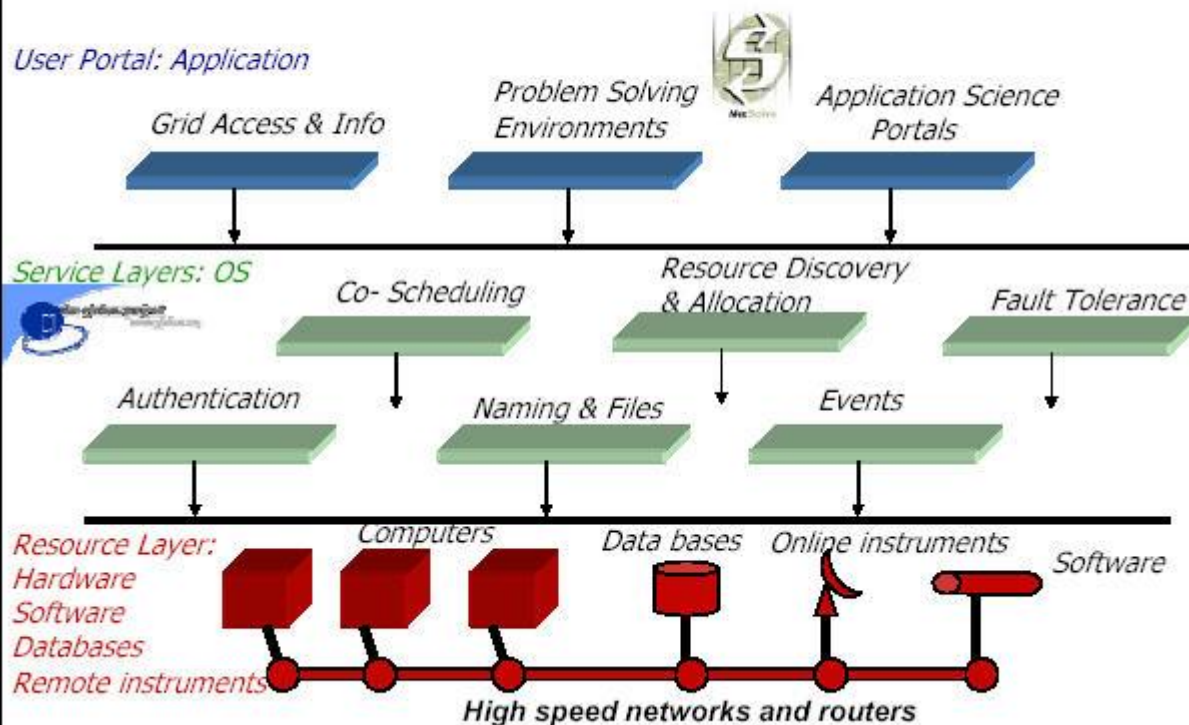


**9 YEARS..**



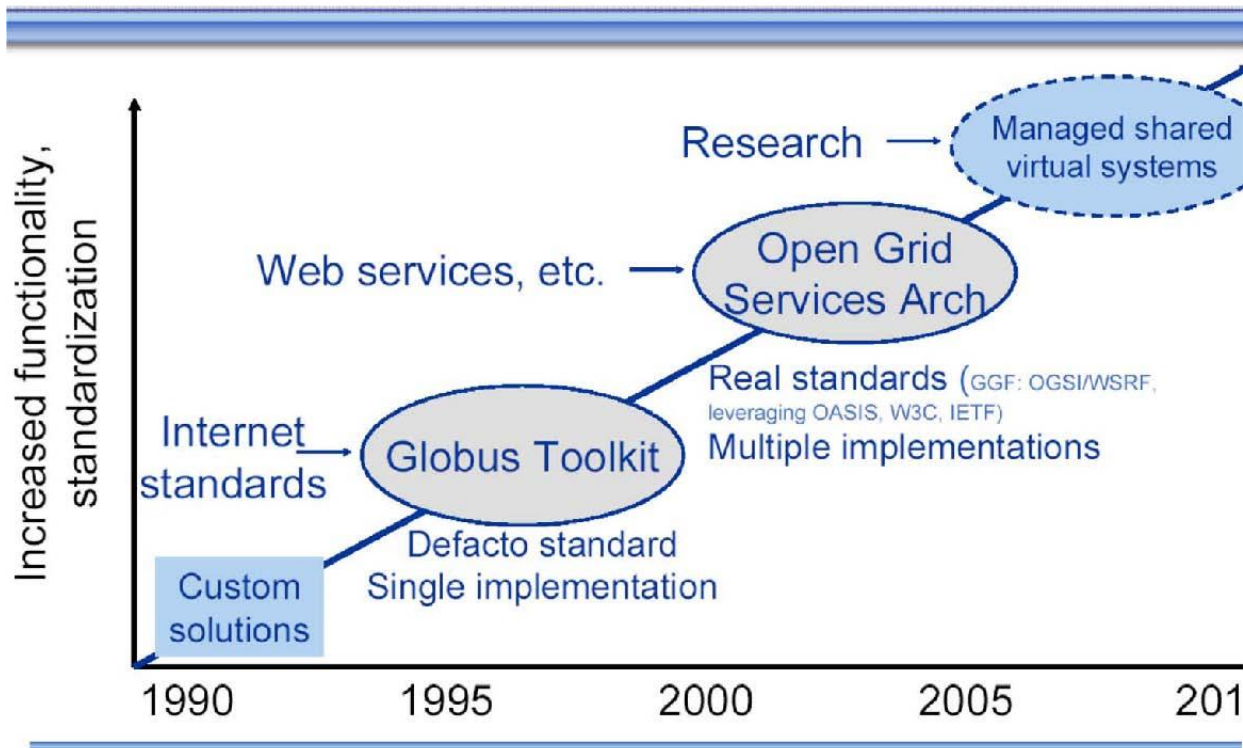


# The Grid Architecture Picture



# The future?

## Developing Grid Standards



Source: Ian Foster - foster@mcs.anl.gov

From the source..

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# What do users want ?

## ■ Grid Consumers

- ❑ Execute jobs for solving varying problem size and complexity
- ❑ Benefit by selecting and aggregating resources wisely
- ❑ Tradeoff timeframe and cost

## ■ Grid Providers

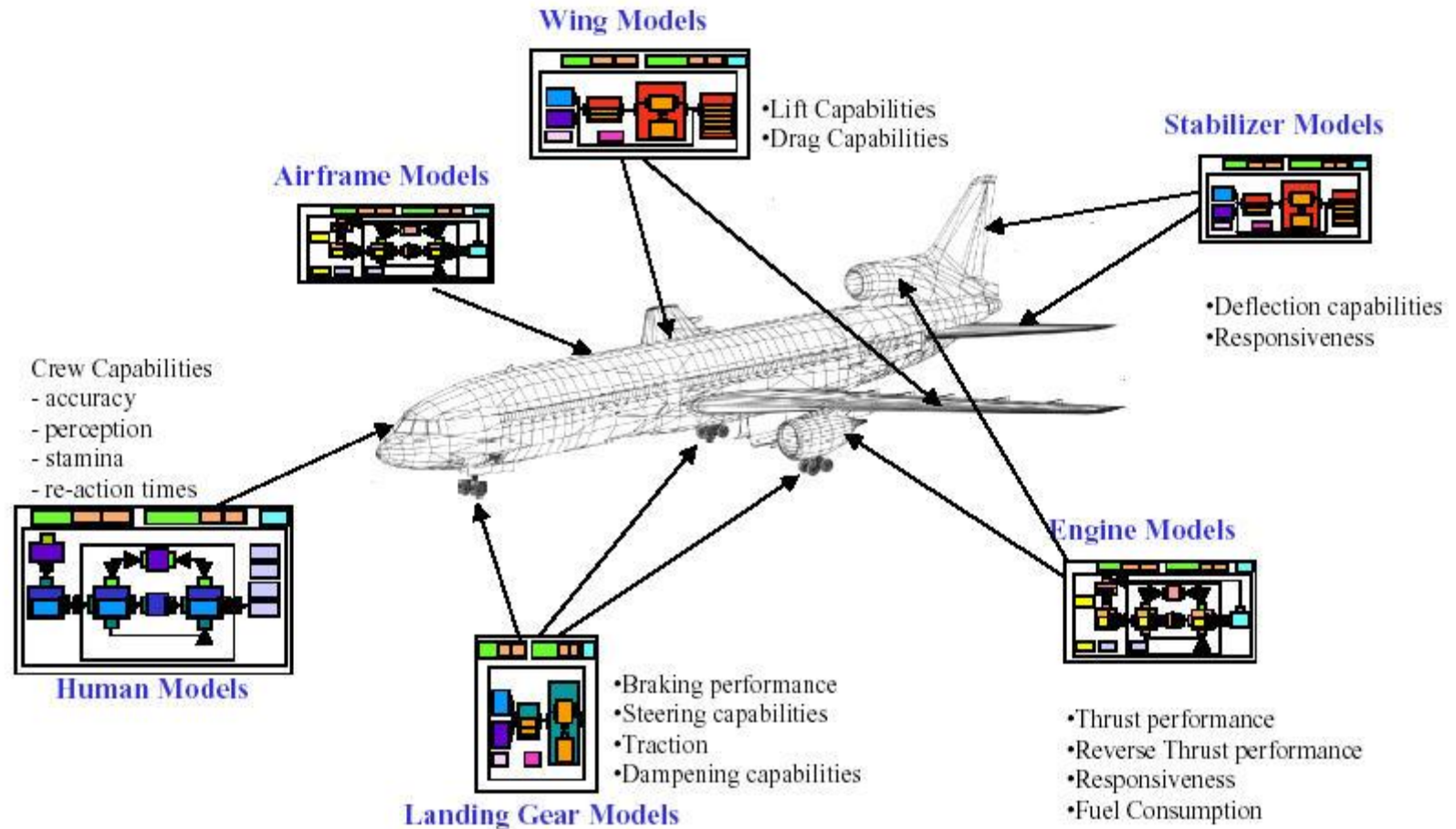
- ❑ Contribute (“idle”) resource for executing consumer jobs
  - ❑ Benefit by maximizing resource utilization
  - ❑ Tradeoff local requirements & market opportunity
-



# Grid Applications

- ***Distributed HPC (Supercomputing):***
    - Computational science.
  - ***High-Capacity/Throughput Computing:***
    - Large scale simulation/chip design & parameter studies.
  - ***Content Sharing (free or paid)***
    - Sharing digital contents among peers (e.g., Napster)
  - ***Remote software access/renting services:***
    - Application service provides (ASPs) & Web services.
  - ***Data-intensive computing:***
    - Drug Design, Particle Physics, Stock Prediction...
  - ***On-demand, real-time computing:***
    - Medical instrumentation & Mission Critical.
  - ***Collaborative Computing:***
    - Collaborative design, Data exploration, education.
  - ***Service Oriented Computing (SOC):***
    - Towards economic-based Utility Computing: New paradigm, new applications, new industries, and new business.
-

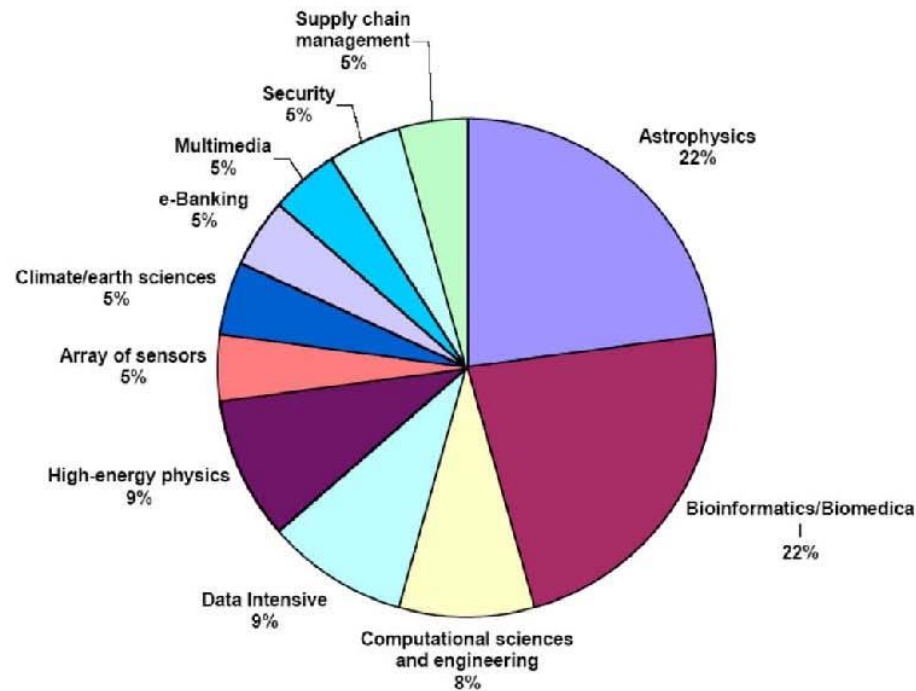
# Multi-disciplinary Simulations



*Whole system simulations are produced by coupling all of the sub-system simulations*

# GridCoord Survey

## *Applications by Topic*

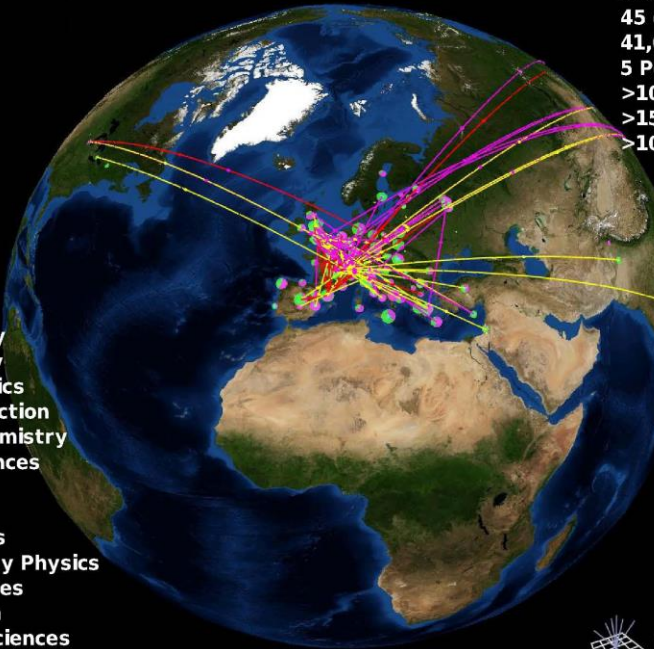


# EGEE – largest European Grid & LHC

**egee**  
Enabling Grids  
for E-scienceE

240 sites  
45 countries  
41,000 CPUs  
5 PetaBytes  
>10,000 users  
>150 VOs  
>100,000 jobs/day

Archeology  
Astronomy  
Astrophysics  
Civil Protection  
Comp. Chemistry  
Earth Sciences  
Finance  
Fusion  
Geophysics  
High Energy Physics  
Life Sciences  
Multimedia  
Material Sciences  
...



**egee**  
Enabling Grids for E-scienceE

## Disciplines and users

### Astrophysics and astroparticle physics

argo  
inaf  
pamela  
astro.vo.eu-egee.org  
planck  
virgo  
magic  
auger

### Earth sciences

trgridc  
esr

### Geophysics

egeode

### Finance

egrid

### Fusion

fusion

~8000 users  
listed in  
registered  
VOs

### Biomedical and bioinformatics information

libi  
bio  
biomed  
embrace

### High Energy Physics

calice  
hone  
ific  
ildg  
minos.vo.gridpp.ac.uk  
pheno  
supernemo.vo.eu-egee.org  
vo.lal.in2p3.fr  
vo.llr.in2p3.fr  
vo.lpnhe.in2p3.fr  
vo.sbg.in2p3.fr  
hermes  
vo.dapnia.cea.fr  
alice  
atlas  
babar  
belle  
cdf  
cms  
dzero  
gridpp  
lic  
lhcb  
na48  
zeus  
ghep  
desy

### Computational chemistry

enmr.eu  
trgrida  
compchem  
gaussian

### Infrastructure

edteam  
euindia  
ops  
pvier  
rdteam  
rgstest  
swetest  
vo.deploymenttest.cea.fr  
vo.e-ca.es  
vo.grif.fr  
infngrid  
eela  
eumed  
dteam  
vo.plgrid.pl  
balticgrid  
dech  
see  
seegrid  
twgrid  
trgrida/b/c/d/e  
voce

### Others

aegis  
apesci  
astron  
cesga  
enea  
grid-it  
gridmosi.ici.ro  
lights.infn.it  
ncf  
vo.agata.org  
vo.ipno.in2p3.fr  
vo.northgrid.ac.uk  
webcom  
geant4  
imath.cesga.es  
proactive  
cosmo  
crypto.swing-grid.ch  
diligent  
cycllops  
geclipse  
gridcc

Digital libraries, disaster  
recovery, computational  
sciences, etc.

<http://cic.gridops.org/index.php?section=home&page=volist> or visit CIC portal demo



# EGEE usage

## egEE NEWS RELEASE

Embargoed until 4 May 2006, 18:00 CCT (10:00 GMT, 12:00 MEST)

### EGEE GRID ATTACKS AVIAN FLU

During April, a collaboration of Asian and European laboratories has analysed 300,000 possible drug components against the avian flu virus H5N1 using the EGEE Grid infrastructure. The goal was to find potential compounds that can inhibit the activities of an enzyme on the surface of the influenza virus, the so-called neuraminidase, subtype N1. Using the Grid to identify the most promising leads for biological tests could speed up the development process for drugs against the influenza virus.

One of the targets of existing drugs today on the market is viral neuraminidase, an enzyme that helps the virus to proliferate and infect more cells. As this protein is known to evolve into variants if it comes under drug stress, drug resistance becomes a potential concern in case of an influenza pandemic.

# egEE Users and resources distribution

Enabling Grids for E-science



EGEE-II INFOS-RI-031688

Bob Jones - EGEE User Forum, 11-14 February 2008

11



What is the Grid? | How it works | What it can do | A brief history | The Grid and you | Grid @ CERN | Grid projects worldwide

### What is grid computing?

#### The short answer...

The short answer is this: **grid computing is a service for sharing computer power and data storage capacity** over the Internet. Grid computing is making big contributions to scientific research, helping scientists around the world to analyze and store massive amounts of data.

The **grid computing dream** began with talk of creating an all-powerful "Grid": one grid comprised of many smaller grids joined together, forming a global network of computers that can operate as one vast computational resource.

In **grid computing reality**, there are already hundreds of grids around the world, each one created to help a specific group of researchers, or a particular group of users. And across the world, researchers and software engineers are working to bring "The Grid" closer to achieving the **dream**.

#### WANT THE LONG ANSWER?

Take a walk through the rest of this website! Find out [how grid computing works](#), [what grid computing can do](#), [what it could mean for you](#), and much more...

*How is grid computing different from the World Wide Web? Simple. Grid computing allows computers to share power over the Internet, while the Web allows them to share information over the Internet.*

*Grid computing is more than just communicating between computers: it is a way to share computing power.*



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## ISGTW INTERNATIONAL SCIENCE GRID THIS WEEK

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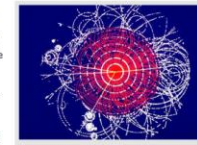


Home > [ISGTW 10 September 2008](#) > ISGTW Editorial - Beam Day

### Editorial - Beam Day

Today, after more than a decade of meticulous preparation in the high-energy physics world—in theoretical frameworks, detector research and development, site construction, data simulations, analysis software, distributed computing infrastructures, networks and more—CERN's Large Hadron Collider proton beam turns on and will begin circulating through its entire 27-km length.

*International Science Grid This Week* congratulates the scientists, engineers, technicians, software developers, managers, coordinators, students, secretaries and all the other hard-working, talented and dedicated participants whose effort made this happen. The sheer volume of data that the LHC experiments will need to process became the driving force for developing the World-wide LHC Grid (WLCG), and hence Enabling Grids for E-Science (EGEE) in Europe and Open Science Grid in the United States. ISGTW celebrates with them, and thanks them, as this publication is an offspring of that collaboration.



Simulation of the detection of a Higgs Boson. Image courtesy of CERN.



The Time Projection Chamber of ATLAS (A Large Ion Collider Experiment).

#### In the beginning

OSG—the primary grid computing infrastructure for US-based scientists in CMS and ATLAS—started *Science Grid This Week*, with Katie Yurkiewicz as editor, to feature grid-enabled science achievements in America. EGEE teamed up a year later, and *International Science Grid This Week* was born. After a time, Katie moved on and Danielle Venton took over as editor, followed by the arrival of Cristy Burne. As Cristy moved to GridTalk, Dan Drolette and Anne Heavey came on board as European and American co-editors, respectively.

ISGTW strives to balance coverage of grid-related research from around the globe, from physics, chemistry and biology to storm prediction and ancient literature. LHC news is just one part of all the grid-related news in this publication, but we continue to recognize the LHC as the driving force in enabling other research to benefit from the power of grid computing.

To acknowledge this significant event, we feature a special LHC section for the next few weeks, at the top of the right vertical column, where you can easily find past LHC-related coverage from our publications.

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enter query...

Browse by subject

LHC and the grid

21 October 2008

LHC INNOVATION

LHC coverage in ISGTW

ISGTW 15 October 2008

Feature - Opportunistic storage increases grid success rates

Feature - Tracking maliana vacuums

Opinion - Reaching for the exascale

Link - LHC Innovation

Image - CMS

Announcement

Call for tutorials, HPC, Boulder Colorado

Abstracts deadline, 30 Nov, Terena Conference

WorldGrid, 27-31 Oct, Budapest

Jobs in grid this week

Mark your calendar

October 2008

13-15, 8th Croatia Grid Workshop, Krakow, Poland

16-17, Cyberinfrastructures and Archaeology, Tuscani, Italy

18-24, Grid, CMS and HEPX Fall 2008 Meeting, Tepe,



# RO in EGEE, SEE-Grid & other Grids

seeGRID GStat: 21:39:54 04/03/08 GMT - @wgc01 - Mozilla Firefox

Zimbra: [Gridmos] Plan Gridmos | seeGRID GStat: 21:39:54 04/03/08 GMT

No	Site Reports	GIIS Host	bnode	cernse	gperf	sanity	serv	serEntry	version	sclust	totalCPU	freeCPU	runJob	waitJob	seAvail TB	seUsed TB	maxCPU	avgCPU	DI	alice
1	<a href="#">AEGIS01-PHY-SCL</a>	ce.phy.bg.ac.yu	ok	ok	ok	ok	ok	ok	GLITE-3 1 0	ScientificSL 4.6	826	2	824	3927	25.06	0.01	826	627	ok	ok
2	<a href="#">AEGIS02-RCUB</a>	grid01.rcub.bg.ac.yu	ok	ok	ok	ok	ok	ok	GLITE-3 1 0	ScientificSL 4.5	12	2	7	0	0.04	0.01	12	11	ok	ok
3	<a href="#">AEGIS03-ELEF-LEDA</a>	grid01.elfak.ni.ac.yu	ok	ok	ok	ok	ok	ok	GLITE-3 0 2	Scientific Linux 3.0.8	4	3	0	0	0.00	0.00	4	3	ok	ok
4	<a href="#">AEGIS04-KG</a>	cluster1.csk.kg.ac.yu	ok	ok	ok	ok	ok	ok	GLITE-3 1 0	ScientificSL 4.5	42	14	10	0	0.85	0.00	42	41	ok	ok
5	<a href="#">AEGIS05-ETFBG</a>	rti29.etf.bg.ac.yu	ok	ok	ok	ok	ok	ok	GLITE-3 0 2	Scientific Linux 3.0.8	28	25	0	10	0.03	0.00	28	27	ok	ok
6	<a href="#">AEGIS06-AOB</a>	grid01.aob.bg.ac.yu	ok	ok	ok	error	ok	ok	na	na						0	0	ok	ok	
7	<a href="#">AL-01-INIMA</a>	prof.salla6.inima.al	ok	ok	ok	error	ok	ok	na	na						0	0	ok	ok	
8	<a href="#">AL-02-FIE</a>	seegrid2.fie.upt.al	ok	ok	ok	error	ok	ok	na	na						0	0	ok	ok	
9	<a href="#">AM-01-IIAP-NAS-RA</a>	ce.seegridtest.sci.am	ok	ok	ok	ok	ok	ok	GLITE-3 0 2	ScientificSL 4.5	2	1	1	1	0	0	2	1	ok	ok
10	<a href="#">BA-01-ETFBG</a>	c01.grid.etfbg.net	ok	ok	ok	ok	ok	ok	GLITE-3 0 2	Scientific Linux 3.0.8	10	0	12	1	0.49	0.00	10	9	ok	ok
11	<a href="#">BA-02-ETFIS</a>	g01.etf.unssa.rs.ba	ok	ok	ok	ok	ok	ok	na	na						0	0	ok	ok	
12	<a href="#">BA-03-ETFSA</a>	n00.grid.etf.unsa.ba	ok	ok	ok	error	ok	ok	na	na						0	0	ok	ok	
13	<a href="#">BA-04-PMFSA</a>	ce.grid.pmf.unsa.ba	ok	ok	ok	ok	ok	ok	GLITE-3 1 0	ScientificSL 4.5	16	2	4	3	0.07	0.00	19	16	ok	ok
14	<a href="#">BG01-IPP</a>	ce002.ipp.acad.bg	ok	ok	ok	ok	ok	ok	GLITE-3 1 0	ScientificSL 4.5	22	17	5	50	0.82	0.08	22	15	ok	ok
15	<a href="#">BG02-IM</a>	ce001.imbm.bas.bg	ok	ok	ok	ok	ok	ok	GLITE-3 1 0	ScientificSL 4.5	21	11	8	11	0.01	0.04	21	20	ok	info
16	<a href="#">BG04-ACAD</a>	ce02.grid.acad.bg	ok	ok	ok	ok	ok	ok	GLITE-3 1 0	ScientificSL 4.5	80	9	71	27	1.59	0.06	80	76	ok	ok
17	<a href="#">BG05-SUGrid</a>	ce001.grid.uni-sofia.bg	ok	ok	ok	ok	ok	ok	GLITE-3 1 0	ScientificCERNSLC 4.5	22	4	3	56	0.02	0.05	24	22	ok	ok
18	<a href="#">BG06-FMI</a>	ce001.fmi.uni-sofia.bg	ok	ok	ok	error	ok	ok	na	na						3	2	ok	ok	
19	<a href="#">HG-01-GRNET</a>	ce01.isabella.grnet.gr	ok	ok	ok	ok	ok	ok	GLITE-3 0 2	Scientific Linux 3.0.3	64	2	51	20	1.50	3.28	64	63	ok	ok
20	<a href="#">HG-03-AUTH</a>	ce01.afroditi.hellasgrid.gr	ok	ok	ok	ok	ok	ok	GLITE-3 0 2	Scientific Linux 3.0.9	120	3	94	57	1.24	1.88	120	118	ok	info
21	<a href="#">HR-01-RBI</a>	grid1.irb.hr	ok	ok	ok	ok	ok	ok	GLITE-3 0 0	Debian 4.0	18	5	3	2	0.06	0.00	18	18	ok	ok
22	<a href="#">MD-01-TUM</a>	ce01.grid.renam.md	ok	ok	ok	ok	ok	ok	GLITE-3 1 0	ScientificSL 4.5	1	2	0	65	0	0	1	0	ok	ok
23	<a href="#">MK-01-UKIM_II</a>	grid-ce.ii.edu.mk	ok	ok	ok	ok	ok	ok	GLITE-3 1 0	ScientificSL 4.5	4	7	7	39	1.05	0.05	4	3	er	info
24	<a href="#">MK-02-ETF</a>	grid-ce.feit.ukim.edu.mk	ok	ok	ok	ok	ok	ok	GLITE-3 0 2	Scientific Linux 3.0.9	12	18	6	0	0.95	0.00	12	12	ok	ok
25	<a href="#">MREN-01-CIS</a>	grid01.cg.ac.yu	ok	ok	ok	error	ok	ok	na	na						12	7	ok	ok	
26	<a href="#">RO-01-ICI</a>	testbed002.grid.ici.ro	ok	ok	ok	ok	ok	ok	GLITE-3 1 0	CentOS 4.6	12	0	11	42	0.32	0.00	12	8	ok	ok
27	<a href="#">RO-03-UPB</a>	gw01.seegrid.grid.pub.ro	ok	ok	ok	ok	ok	ok	GLITE-3 1 0	ScientificCERNSLC 4.6	32	62	3	0	0.27	0.01	34	26	ok	ok
28	<a href="#">RO-07-NIPNE</a>	tbit01.nipne.ro	ok	ok	ok	ok	ok	ok	GLITE-3 1 0	ScientificCERNSLC 4.6	356	69	230	79	3073.40	1.47	356	335	ok	ok
29	<a href="#">RO-08-UVT</a>	ce01.grid.info.uvt.ro	ok	ok	ok	ok	ok	ok	GLITE-3 1 0	ScientificCERNSLC 4.6	28	19	8	0	0.89	0	28	18	sd	ok
30	<a href="#">RO-09-UTCN</a>	ce01.mosigrid.utcluj.ro	ok	ok	ok	ok	ok	ok	GLITE-3 1 0	ScientificSL 4.5	18	18	0	1333332	0.21	0.01	20	18	ok	ok
31	<a href="#">RO-10-TUIASI</a>	ce.grid.tuiasi.ro	ok	ok	ok	ok	ok	ok	GLITE-3 1 0	Scientific Linux 3.0.8	1	1	0	10	0.03	0.00	1	0	ok	ok
32	<a href="#">SZTAKI</a>	n31.hpc.sztaki.hu	ok	ok	ok	warn	ok	ok	GLITE-3 1 0	ScientificSL 4.5	2	16	0	0	0.18	0	16	5	ok	ok
33	<a href="#">TR-01-ULAKBIM</a>	ce.ulakbim.gov.tr	ok	ok	ok	ok	ok	ok	GLITE-3 1 0	ScientificSL 4.5	66	60	6	0	1.35	2.09	67	64	ok	ok
34	<a href="#">TR-03-METU</a>	cox01.grid.metu.edu.tr	ok	ok	ok	ok	ok	ok	GLITE-3 1 0	ScientificSL 4.5	300	13	88	44	8.43	3.09	300	298	ok	ok
35	<a href="#">TR-05-BOUN</a>	yildirim.grid.boun.edu.tr	ok	ok	ok	ok	ok	ok	GLITE-3 1 0	ScientificSL 4.5	60	4	40	8	0.58	0.13	60	60	ok	ok

totalCPU freeCPU runJob waitJob seAvail TB seUsed TB maxCPU avgCPU

Come to: SEE-Grid-SCI training in December 19<sup>th</sup>, 2008 !!!

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# Grid Requirements

- Identity & authentication
  - Authorization & policy
  - Resource discovery
  - Resource characterization
  - Resource allocation
  - (Co-)reservation, workflow
  - Distributed algorithms
  - Remote data access
  - High-speed data transfer
  - Performance guarantees
  - Monitoring Adaptation
  - Intrusion detection
  - Resource management
  - Accounting & payment
  - Fault management
  - System evolution
  - Etc.
-

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# Some Grid Requirements – User Perspective

- Single *allocation*: if any at all
  - Single *sign-on*: authentication to any Grid resources authenticates for all others
  - Single *compute space*: one scheduler for all Grid resources
  - Single *data space*: can address files and data from any Grid resources
  - Single *development environment*: Grid tools and libraries that work on all grid resources
-

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# The Security Problem

- Resources being used may be extremely valuable & the problems being solved extremely sensitive
  - Resources are often located in distinct administrative domains
    - Each resource may have own policies & procedures
  - The set of resources used by a single computation may be large, dynamic, and/or unpredictable
    - Not just client/server
  - It must be broadly available & applicable
    - Standard, well-tested, well-understood protocols
    - Integration with wide variety of tools
-

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# The Resource Management Problem

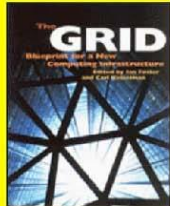
Enabling secure, controlled remote access to computational resources and management of remote computation

- Authentication and authorization
  - Resource discovery & characterization
  - Reservation and allocation
  - Computation monitoring and control
-



# Conclusions

The idea that each species has been independently created is erroneous



## FUTURE WATCH Ubiquitous computing

Technical advances in bandwidth, routing, and backbone technologies promise to dramatically change the shape and focus of the Internet, opening up new b-to-b and b-to-c communication and sales channels for businesses, increase choice for consumers, and reduce bandwidth bottlenecks. On the downside, it will raise privacy and intellectual property rights issues. Ubiquitous computing will become viable in five to 10 years.



## Utility Computing

UtilityComputing.com    OnDemandComputing.com

88 August 2003

- Understand the business drivers behind the growing trend of Utility Computing
- Learn what the major vendors are offering. What are their offerings and who is best positioned for success?
- What does Utility Computing mean for IT?
- Cloud, Medium or Small Companies: Who has the most to gain?

"The North American IT utility (computing) market will grow to \$4.6 billion by 2007" - The Gartner Group

Next Publication: 01/03/2004, \$19.95

## The Vision of Autonomic Computing

Systems manage themselves according to an administrator's goals. New components integrate as effortlessly as a new cell establishes itself in the human body. These ideas are not science fiction, but elements of the grand challenge to create self-managing computing systems.



## NEWSLETTER

The "Disappearing Computer II" Proactive initiative

18 February 2003

Convergence is a need !

