

Incontro GARR 15 Luglio 2004, CRUI, ROMA

“Armonizzazione delle strutture di rete e delle griglie computazionali”

ENEA-GRID: a production quality grid infrastructure

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ENEA INFO [Servizio Centralizzato Informatica e Reti], Roma

Outline

- ENEA-GRID Infrastructure and Resources
- Case studies: numerical simulations and support to experimental facilities
- GRID paradigm & ENEA-GRID
- Connection with other GRID projects

Italian Agency for New Technologies,
Energy and Environment.

12 research centres in Italy

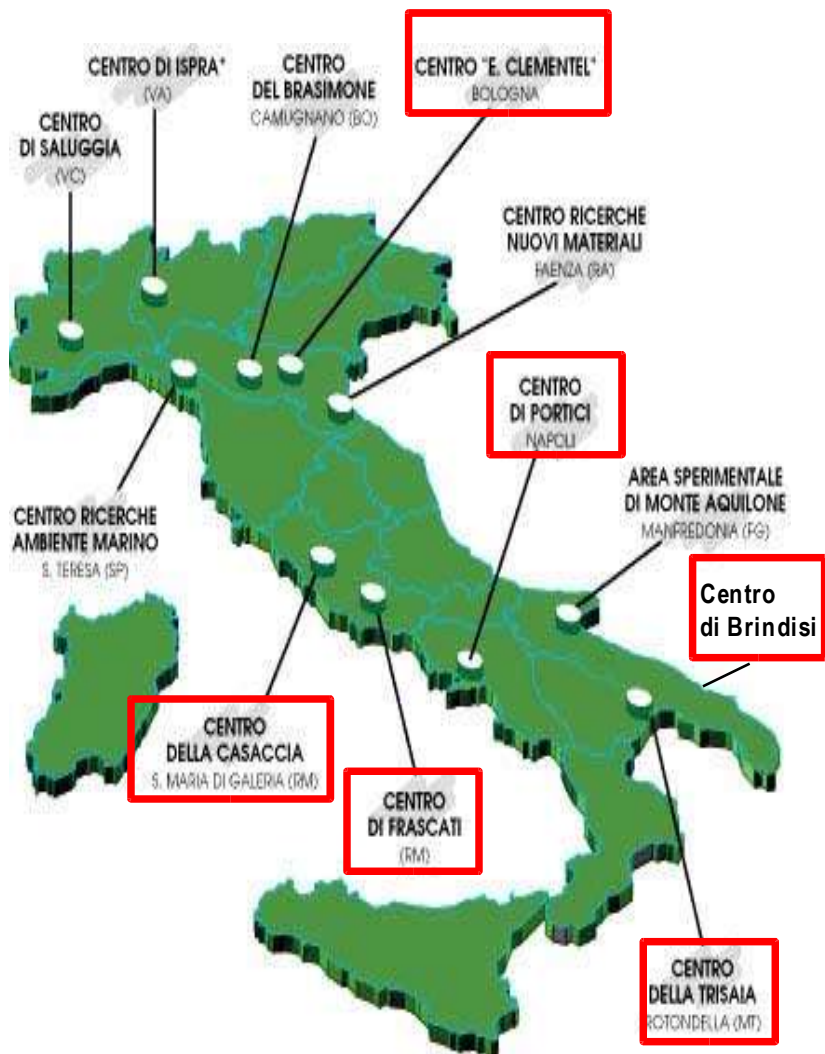
An ITC and Network Department
(INFO)

6 Computer Centres

Casaccia, Frascati, Bologna, Trisaia,
Portici, Brindisi

Multiplatform resources for serial &
parallel computation and graphical
post-processing.

Other computer resources in ENEA:
departments & individuals



ENEA GRID

ENEA-GRID has been in development since 1998 and is now an integrated infrastructure:

- offering a **production quality, service oriented system**
- covering most of the computational resources belonging to ENEA INFO Scientific Computation Service, connected in a **Wide Area Network**.
- providing a **unified user environment and an homogeneous access method** for all ENEA researchers irrespective of their location
- implementing tools to facilitate the integration of departments and individual resources and support to experimental facilities

ENEA GRID Services

Services for research activity in ENEA

- **Multiplatform Parallel systems:**
 - AIX, Linux (Alpha,x86), IRIX, [Unicos (Cray)]
- **Graphical simulation & code result post-processing:**
 - SGI + 3D immersive facilities
- **Software resources:**
 - Commercial Codes: Fluent, Gambit, Abacus, Catia, Ansys
 - Research codes: mcpn/x, eranos, fluka,...
 - Elaboration environments: IDL, Matlab, Mathematica, SAS
 - Windows applications

ENEA GRID Computational resources

Platform OS	#cpu	Gflops	Sites
AIX	92	275	Frascati(66), Bologna(8), Portici(18)
Linux x86	54	100	Frascati(28), Casaccia(14), Portici(4), Trisaia(4), Brindisi(4)
Linux Alpha	80	100	Casaccia
IRIX	26	40	Frascati(8), Casaccia(4), Portici(1), Trisaia(8), Brindisi(1), Bologna(5)
Solaris	8	10	Trisaia(4), Casaccia(2), Bologna(2)
Windows	18	50	Frascati(6), Portici(4), Trisaia(4), Brindisi(4)
Unicos[Cray]	16	19	Casaccia (SV1/1A)

Portici, Brindisi & Trisaia resources were recently increased in the framework of
TELEGRID Project [PON]

ENEA GRID Graphics and 3D resources

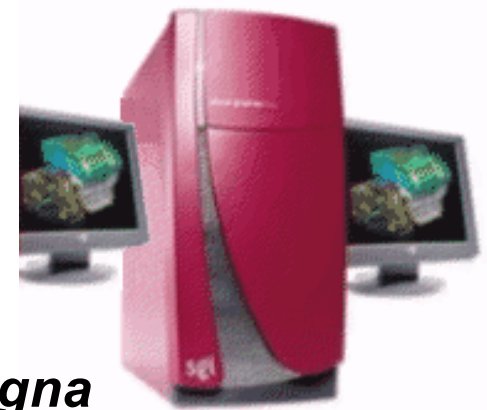
SGI systems are coupled with 3D immersive facilities together with 3D modelling and rendering software as CAVELIB, DV-Mockup, AVS



C.R. Casaccia



C.R. Frascati



C.R. Bologna

ENEA Network connection

ENEA computational resources are distributed over WAN, connected by GARR, the Italian Academic & Research Network

ENEA-GARR
9 PoP, 4-32 Mbps

Brindisi
Bologna
Casaccia
Frascati
Portici
Trisaia
Palermo
Pisa
Roma Sede



ENEA GRID ARCHITECTURE

A choice of **mature components** for reliability and easiness of support and maintenance:

Distributed File System: **AFS**

Job and resources manager: **LSF Multicluster**

Unified GUI access: **Java and Citrix Technologies**

Quality monitoring system: **Patrol**

Licence Servers

Integration with department and individual resources

Distributed File System: AFS for software and data

Licence pool sharing

Possible integration with other institutions

AFS: enea.it cell

AFS (Andrew File System), the distributed file system developed at Carnegie-Mellow University, commercialized by Transarc & IBM, Open Source dal 2001, www.openafs.org.

A mature Client/Server Architecture [scalable, multiplatform].

Optimized for WAN operation: native data replication on server, data cache transparent to the user on client.

Security: Kerberos authentication, native authorization management.

UNIFORM USER ENVIRONMENT

The user HOME directory is the same on all UNIX/Linux platform and it's also accessible by Windows system.

UNIFORM SOFTWARE DISTRIBUTION

Easy multiplatform management of WAN software installation.

LSF

Load Sharing Facility MultiCluster version
[www.platform.com]

Mature and supported multiplatform environment.

High scalability (ENEA GRID >200 cpu)

WAN enabled: multicluster.

Certified by main vendors (IBM, SGI,..) and integrated with commercial software.

Integration with AFS.

ENEA GRID 6 LSF clusters:

Frascati, Bologna, Casaccia, Trisaia, Portici, Brindisi

CITRIX (1)

Citrix Metaframe , now Citrix Presentation Center, has been used in ENEA-GRID to provide a **unified GUI to all resources**.

Citrix is a leader company in providing multiplatform access to remote computer resources using a client /server approach.

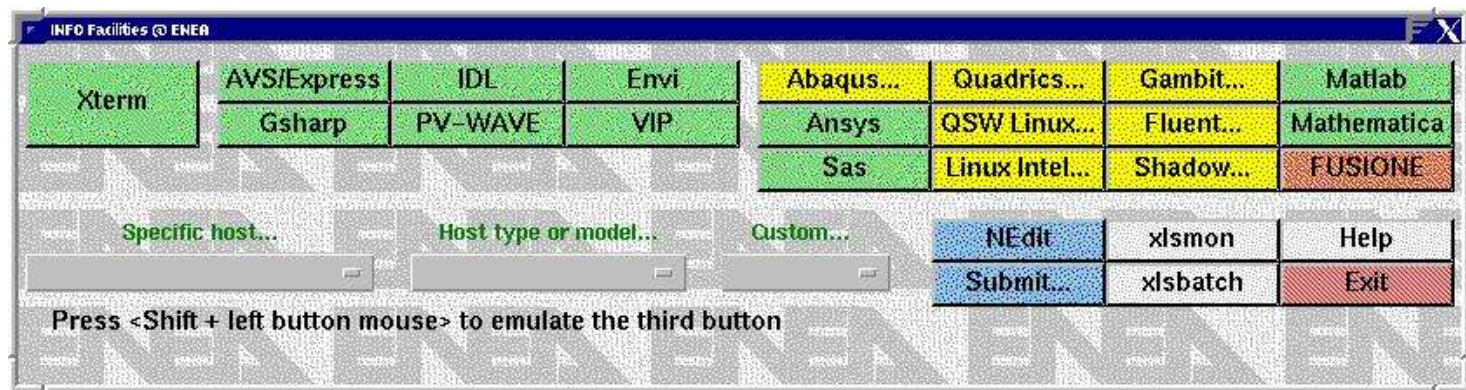
Citrix technology assures **WAN optimized performances and secure communication methods**.

ENEA GRID access is managed by 6 Citrix UNIX servers, one for each of the main computer centers: Bologna, Casaccia, Frascati, Trisaia, Portici, Brindisi. 4 Windows Citrix servers provide access to **Windows applications** (Frascati, Portici, Trisaia, Brindisi).

Citrix technology is also used to provide Web access to ENEA GRID offering a user/application oriented environment

CITRIX (2)

ENEA GRID makes use of Citrix Metaframe to publish an application providing all the available resources with a unified GUI interface

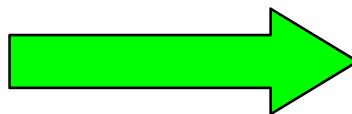
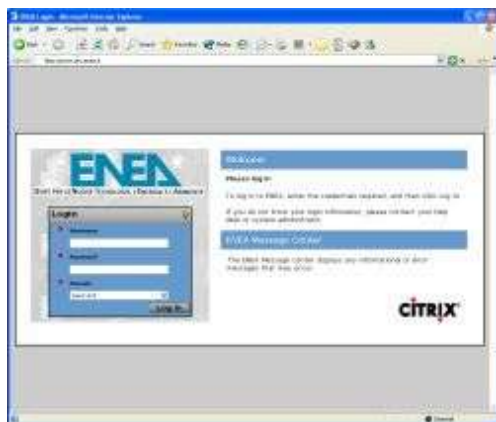


Application components:

- Java (GUI)
- shell scripts
- EnginFrame

CITRIX: ENEA GRID Web Access

<http://www.afs.enea.it>

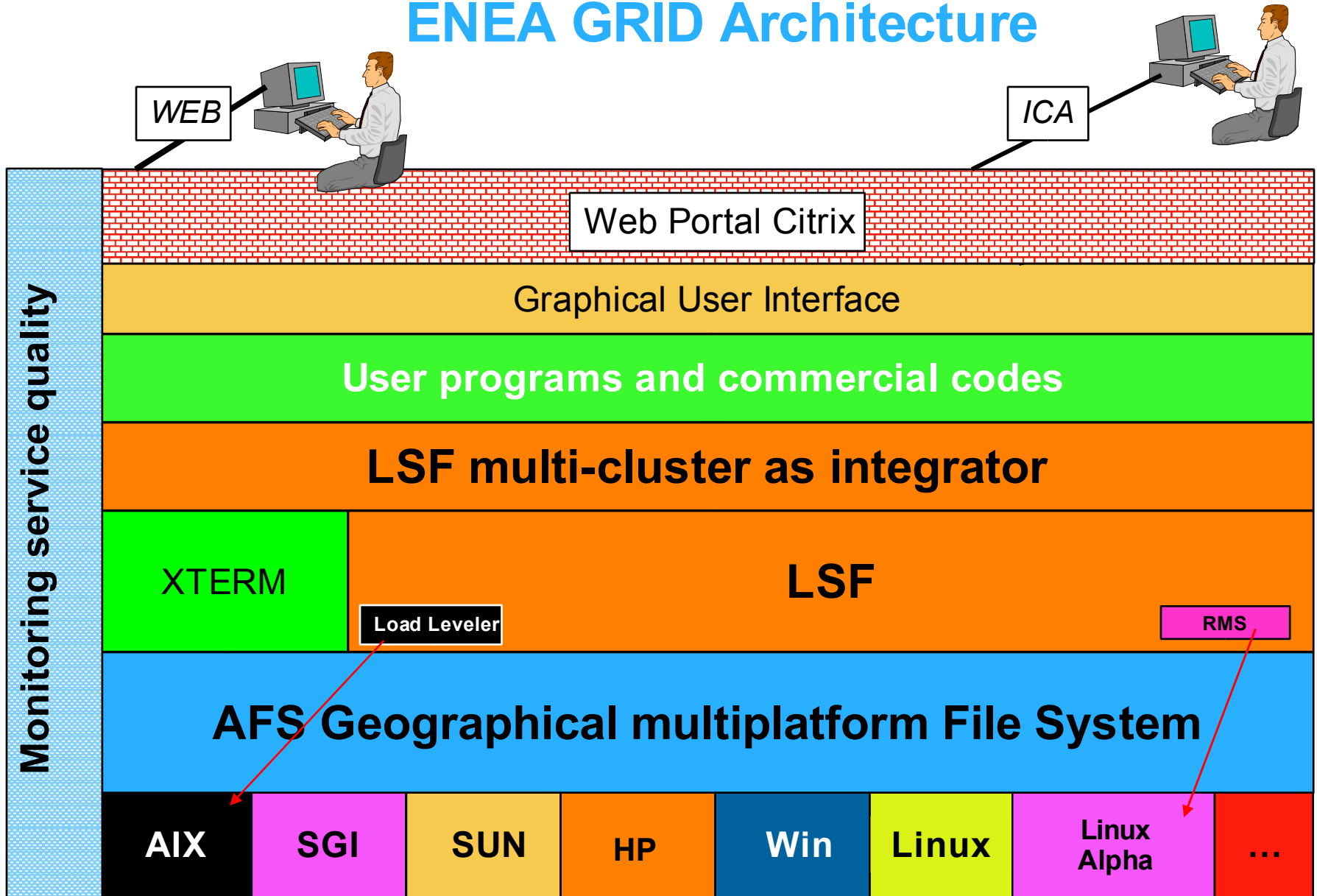


Windows services

Unix/Linux Services



ENEA GRID Architecture



GRID usage, examples and some case studies

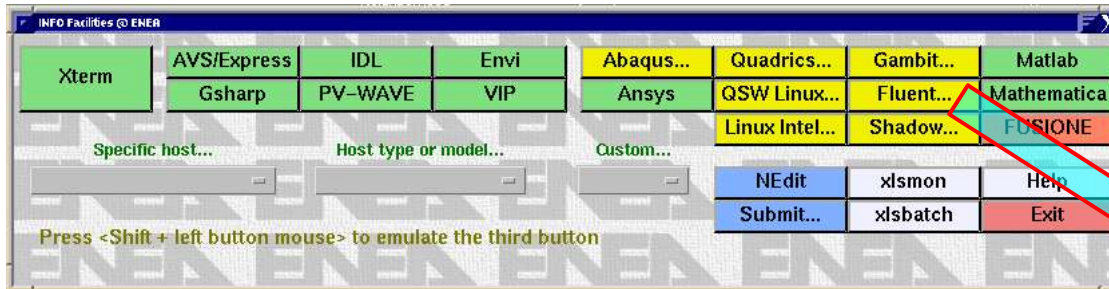
650 registered users

2 TB stored software/data out of 4 TB available in enea.it AFS cell

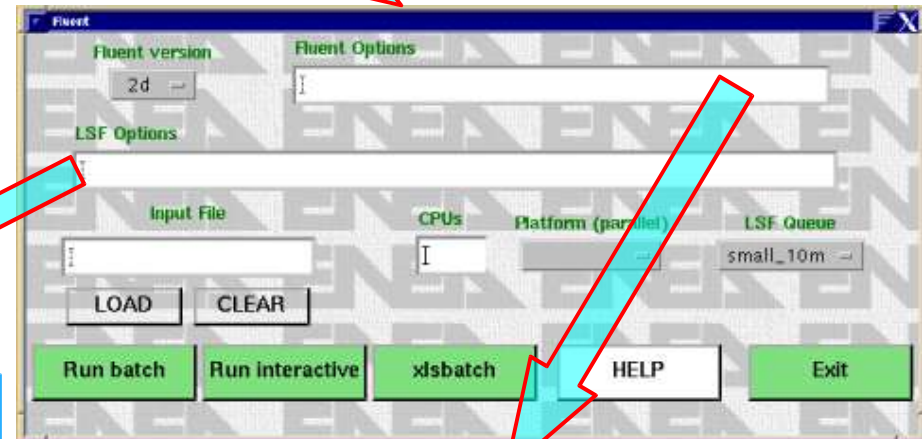
Examples and case studies

- Running FLUENT on ENEA GRID
- Support to department experimental research:
 - Biotechnology
 - Electron microscopy
 - Nuclear fusion research

FLUENT (CFD) code batch submission



A FLUENT case can be run from a dedicated GUI for submission



LSF Options

- o filename.%J - output file
- w "done(idjob)" - start after idjob
- u e-mail userid - output by E-mail
- b begintime - job start time

....

```
-cl following argument passed to fluent.  
-cxarg following argument passed to cortex.  
-cx host:plp2 connect to the specified cortex process.  
-driver [ gl | opengl | null | pex | sbx | x11 | xgl ],  
sets the graphics driver (available drivers vary by platform).  
-env show environment variables.  
-g run without gui or graphics.  
-gu run without gui.  
-gr run without graphics.  
-help this listing.  
-i journal read the specified journal file.  
-nocheck disable checks for valid license file and server.  
-post run a post-processing-only executable.  
-project x write project x start and end times to license log.  
-r list all releases.  
-rx specify release x.  
-v list all versions.  
-vx specify version x.  
-n no execute.  
-hcl following argument passed to fluent host.  
-loadx load app from host x.  
-manspa manually spawn compute nodes.  
-nel following argument passed to fluent node.  
-px specify communicator x.  
-pathx specify root path x to Fluent,Inc.  
-tx specify number of processors x.
```


Monitoring job status by xlsbatch (LSF)

xlsbatch information

Jobid

Users

Job status

Queues

Submission host

Run host

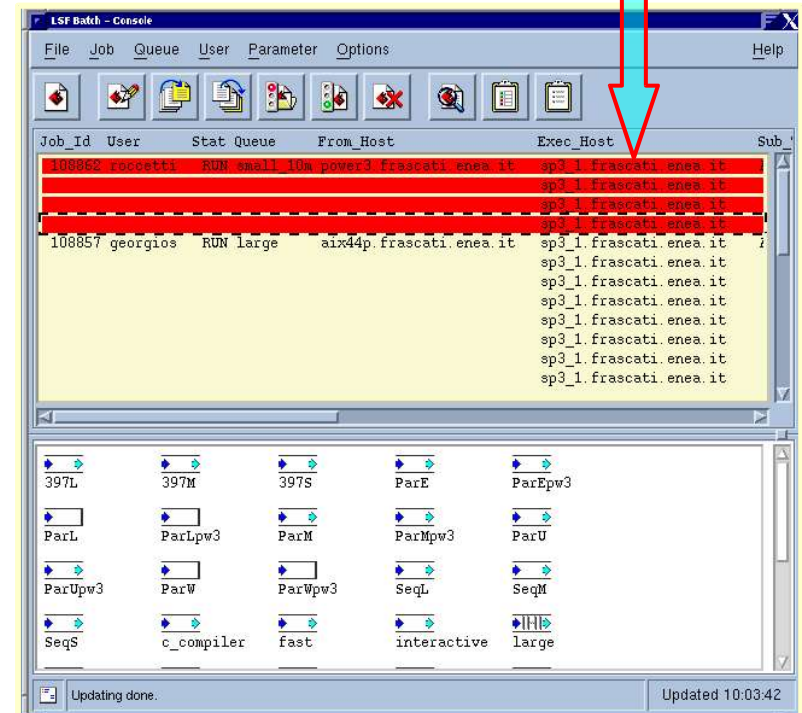
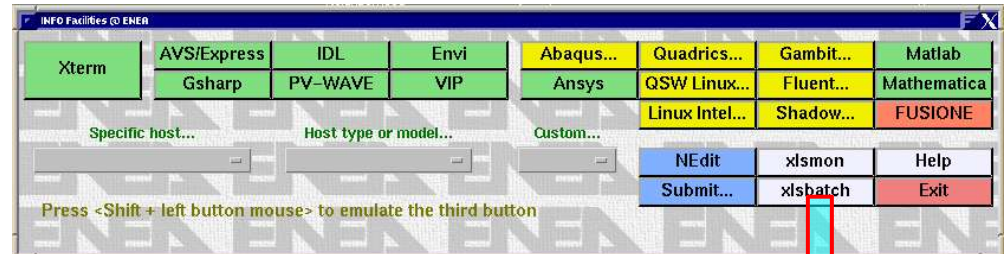
Submission time

Submission command

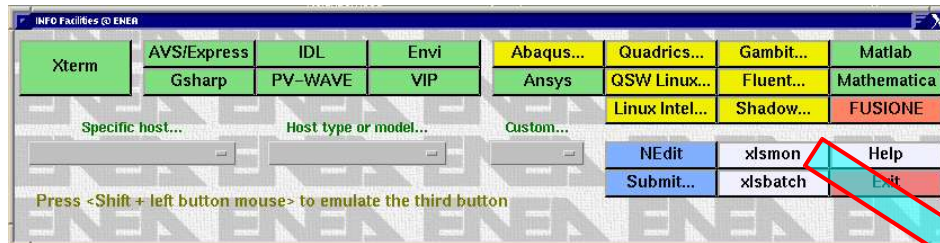
.....

Job status:

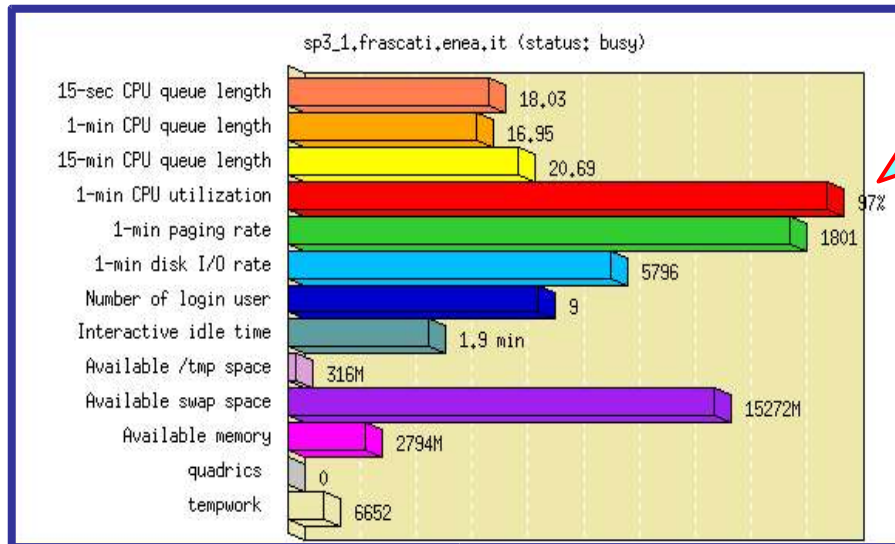
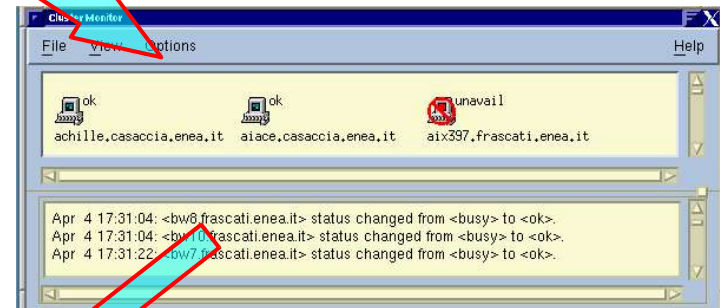
- ☒ running
- ☒ done
- ☒ exit
- ☒ zombi
- ☒ pending
- ☒ suspended
- ☒ unknown



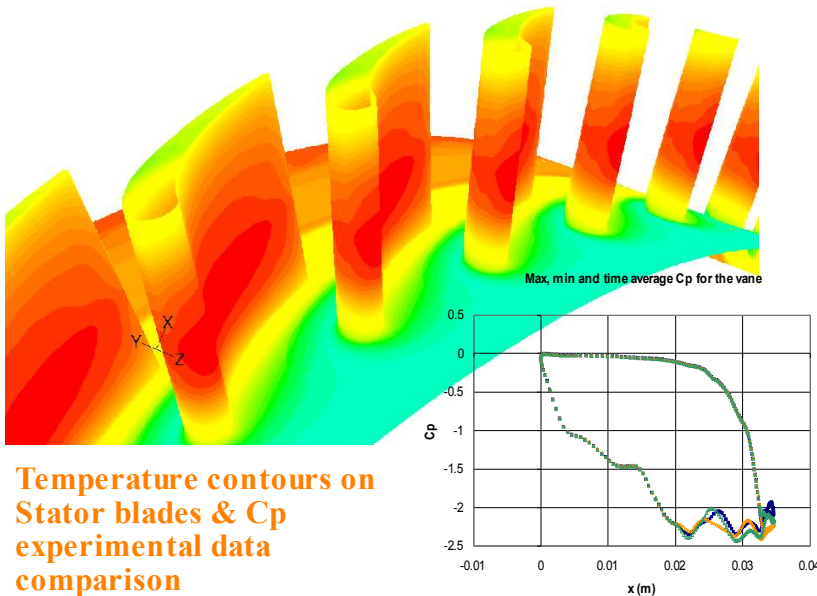
Monitoring host status by xlsmon (LSF)



Status of sp3-1 host using
xlsmon utility

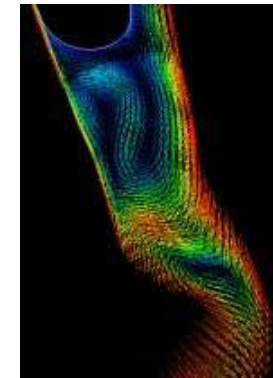
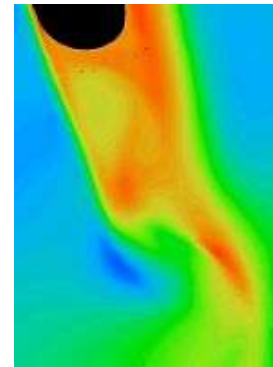
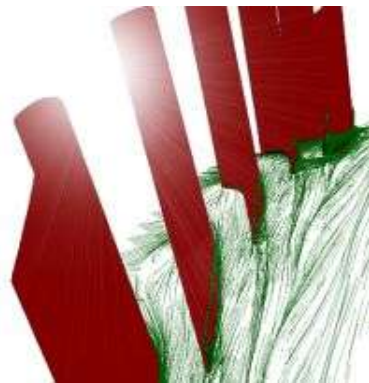


3D CFD Simulation on Aircraft Axial Turbin Stage with Wake & Vortex Shedding Analysis on Turbine Blades [FLUENT]

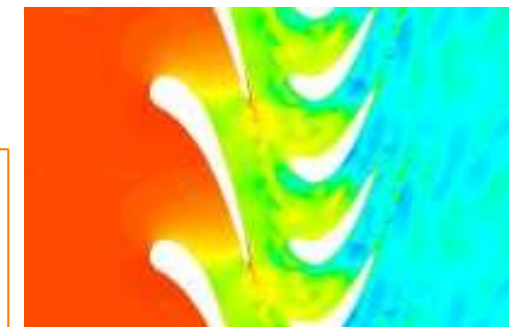
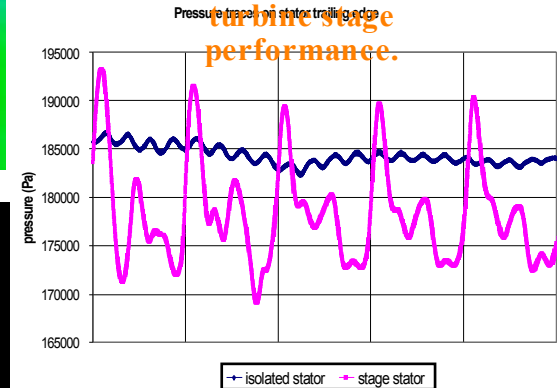


Temperature contours on Stator blades & C_p experimental data comparison

Secondary flow prevision and 3D Path Lines analysis



Large Eddy Simulation (LES) provides high resonable results on wake analysis and turbine stage performance.

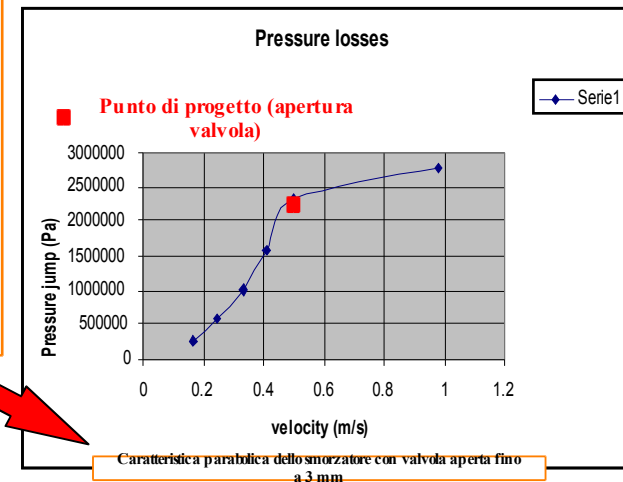
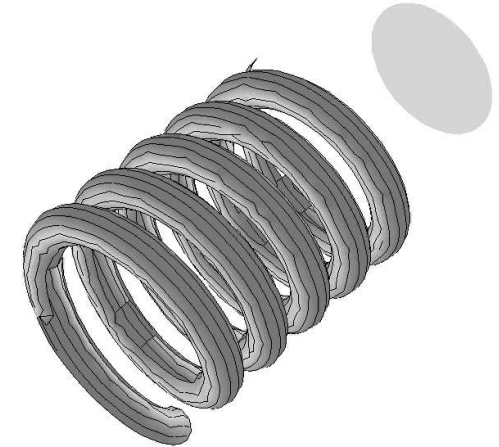
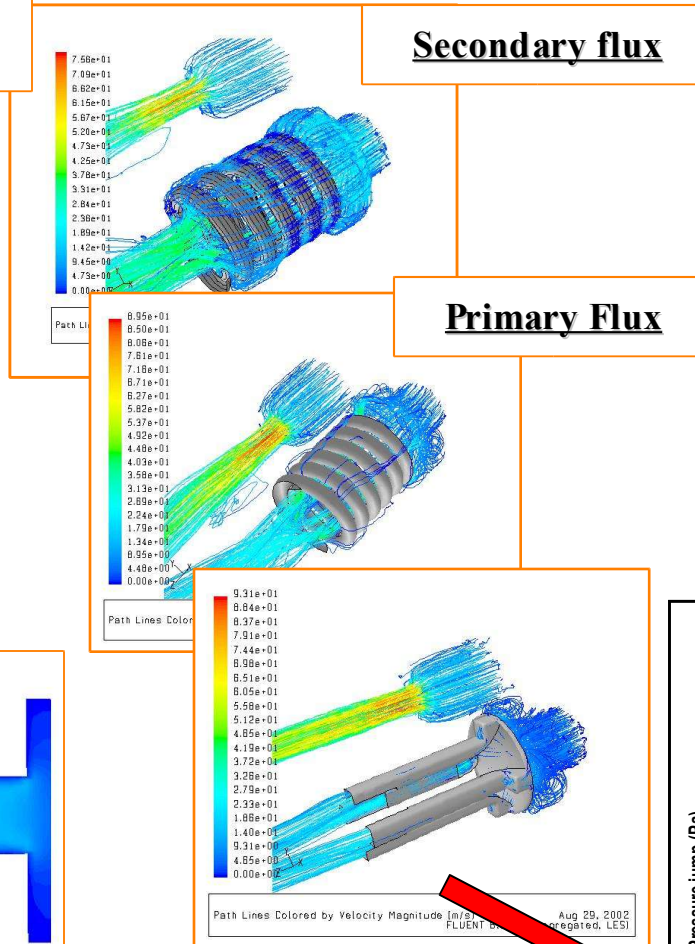
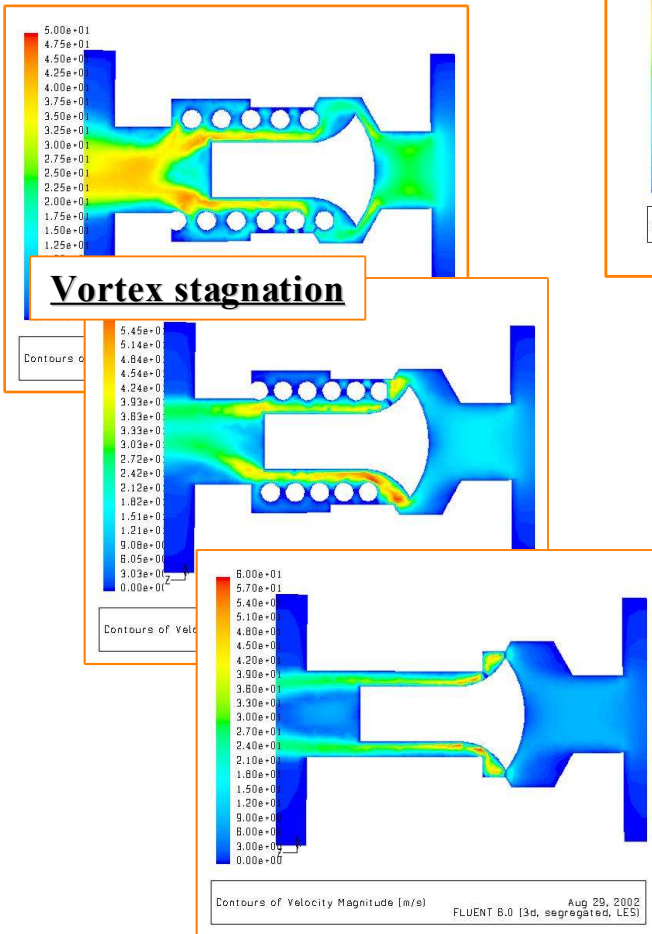


Temperature & wakes interactions

Mesh: 1 million cells
CPU Time: 6000 hours
Elapsed Time:
525 hours on
12 IBM SP3 platforms

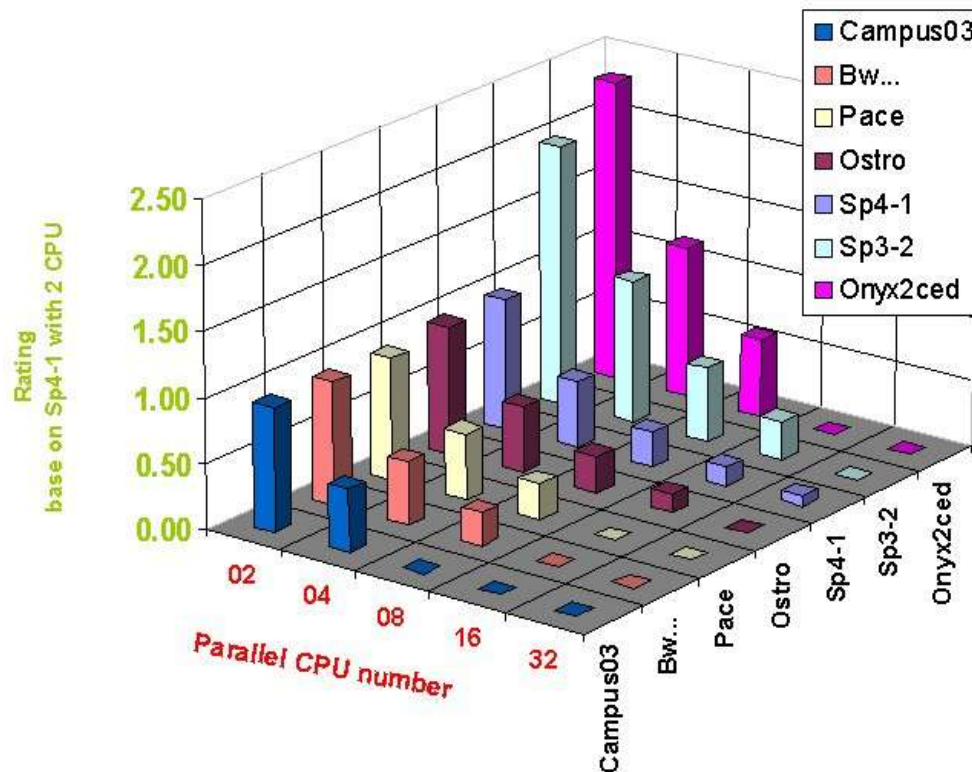
Mesh: 600,000 cells
CPU Time: 960 hours
Elapsed Time: 130 hours
on 8 Linux platforms

CFD Analysis of a fluid dumper [FLUENT]



FLUENT performance on different platforms in ENEA GRID

FLUENT Performance Rating on ENEA's Grid Computing

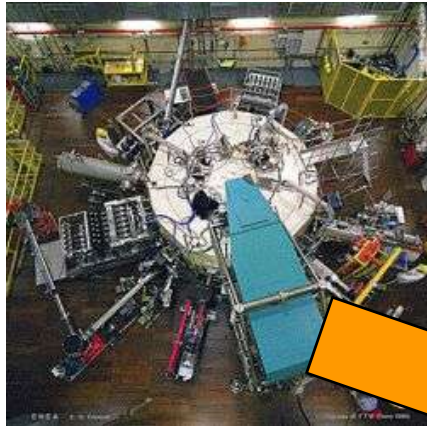


Scaling with #CPU & platform type

	#CPU	GHz
AIX		
Sp3-1	16	.375
Sp4-1	32	1.1
Ostro	16	1.3
Pace	8	1.3
Linux		
C..03	4	3
bw	8	1.8
IRIX		
Onyx.	8	0.4

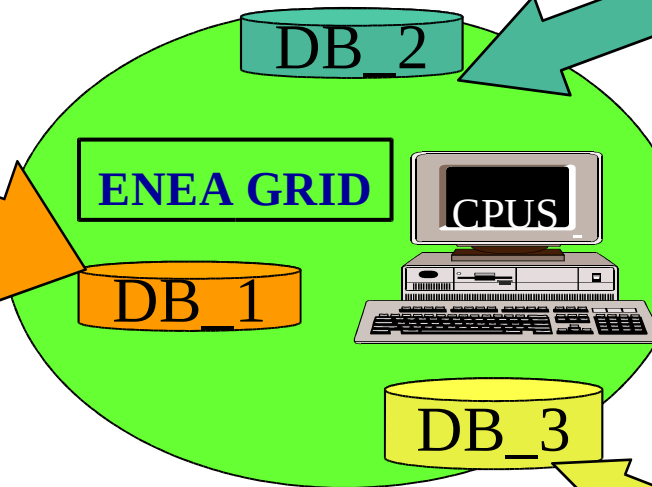
Cpu time normalized to the case: Sp4-1, 2 CPUs

ENEA GRID and experimental facilities



**Controlled Nuclear Fusion:
FTU
Frascati Tokamak Upgrade
Video Acquisition**

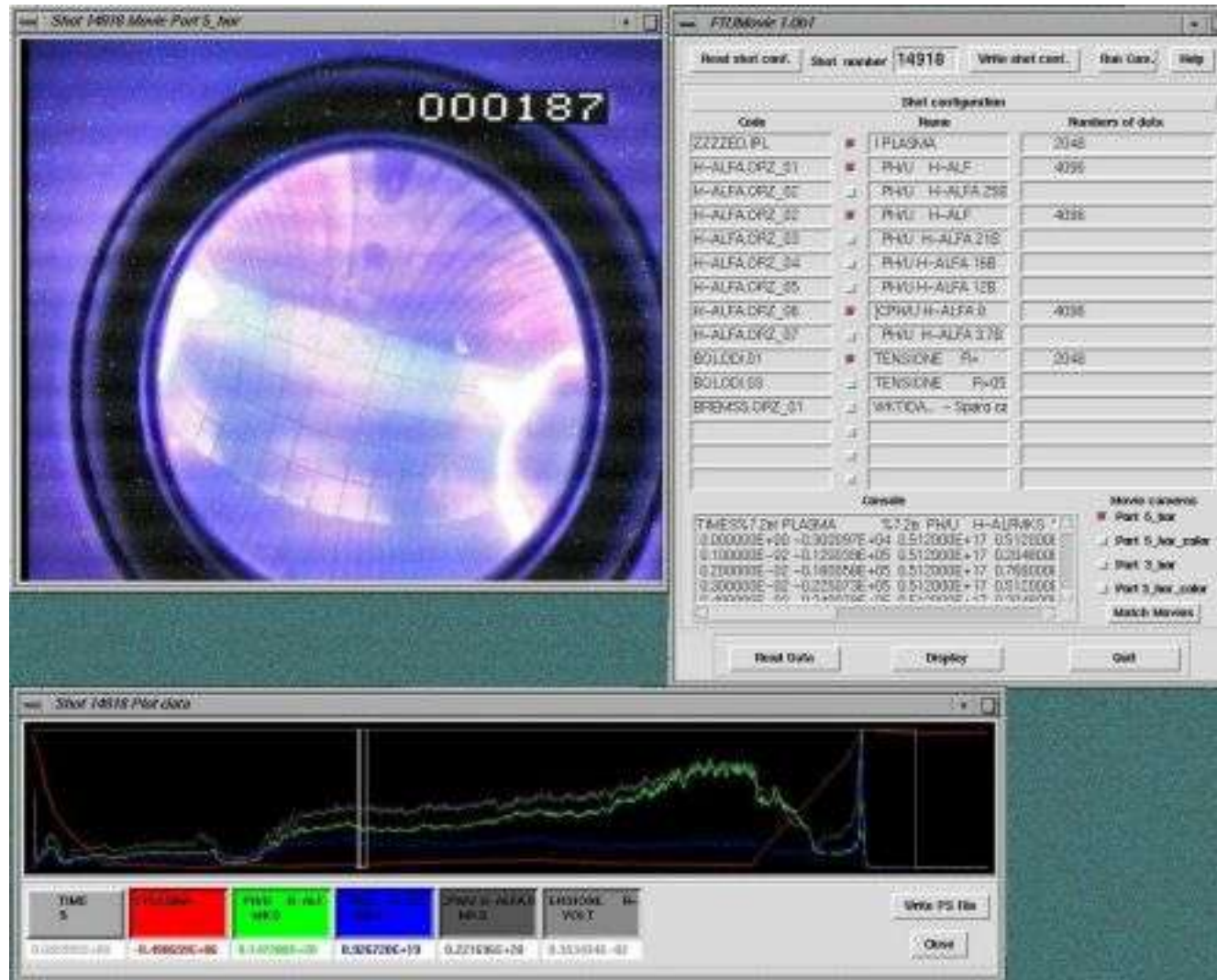
**DNA Sequence
system
(ABI Prism 3700)
Trisaia**



**Electronic Microscope
(Brindisi)
300 Kev (sept. 2004)**



ENEA GRID: FTU video acquisition data



ENEA GRID & GRID PARADIGM

“GRID concept: coordinated resource sharing and problem solving in dynamic, multi-institutional virtual organizations (VO)”

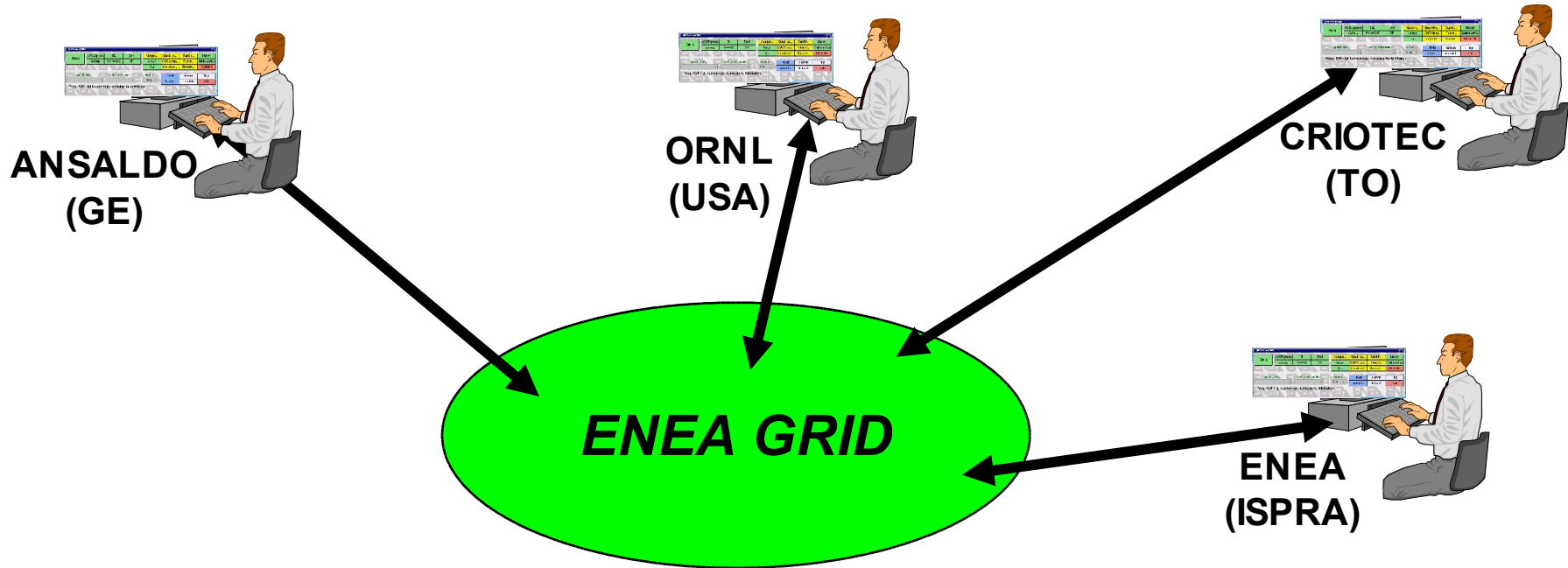
Foster & Kesselman, The Anatomy of the Grid, 2001

ENEA GRID infrastructure has been designed to provide a **multisite** resource sharing inside ENEA, both to **optimize the utilization of Central Computer Service (ENEA INFO) resources** and to **integrate the other resources** available inside the organization.

VO concept can not be fully developed inside an unique organization but similarities can be found with Project Groups sharing specific resources and ENEA GRID components can provide support to this (AFS groups, LSF resources).

There are cases where ENEA GRID infrastructure has been used to support the collaboration with other institutions (+ other GRID projects)

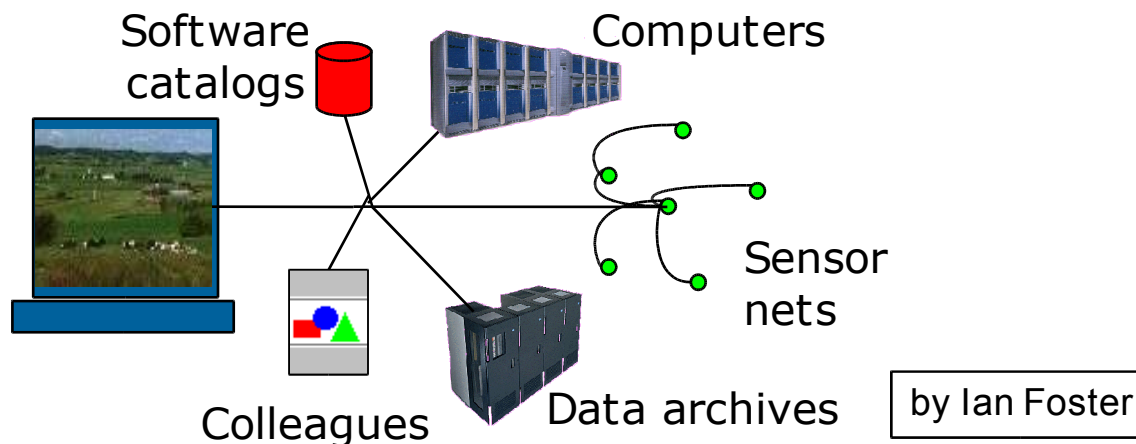
ENEA IGNITOR/Pellet Collaboration Activity



- **DATA sharing**
- **Applications in ENEA GRID**
- **Sharing Working Sessions (Citrix)**

ENEA GRID & GRID PARADIGM

ENEA GRID architecture answers to many of the challenges posed by the “GRID Problem” : “unique authentication, authorization, resource access and resource discovery”, Foster & Kesselman 2001



The choice of **mature components** (LSF & Citrix - proprietary, AFS - opensource project since 2000) reduce the generality of ENEA GRID as a GRID model but improves greatly the **reliability** and the **easiness of update & management**: **production quality infrastructure**.

ENEA GRID EXPERIENCE

Some remarks can be drawn from the analysis of the operation of ENEA GRID infrastructure in the last years.

User acceptance of GRID working mode requires a **new cultural approach** to the access to computational resources and depends strongly on the **service quality**:

- “Value” of the accessed resources
- Efficient networking and system faults monitoring
- Support of user customization for GRID environment

The administration of a distributed & integrated resource system is a technical, cultural and organizational challenge in a complex structure such as ENEA.

ENEA GRID improvements in progress

Increasing resources: AIX +32 SP nodes/Frascati, Cluster 16 AMD 64bit/Casaccia, Cluster 8 G5/Trisaia, 2 CPU AIX/Brindisi (**TELEGRID** Project).

Extending Windows services.

AFS optimization.

Studies in collaboration with CASPUR to manage the **replication of large amount of data over WAN** with better performances than AFS.

Participation in **CASPUR storage technology** tracking activity (SAN systems and file systems testing and evaluation, AFS implementation for parallel systems [IPP Garching]=> **DEISA Grid Project**)

Connection with other GRID Projects

Each GRID project is characterized by its own architectural design and middleware.

The focus of the participation of ENEA INFO in other GRID projects is **GRID interoperability**

Access to ENEA GRID through other GRID models should be compatible with ENEA GRID architecture: **gateway implementation.**

Current GRID projects:

- **EGEE** [Datagrid]
- FIRB/Grid.it : WP13, Computational Chemistry (CHEMGRID), Perugia Univ., ENEA Casaccia, et al.
ENEA activity starting July 2004 at Frascati

ENEA GRID and DATAGRID PROJECT

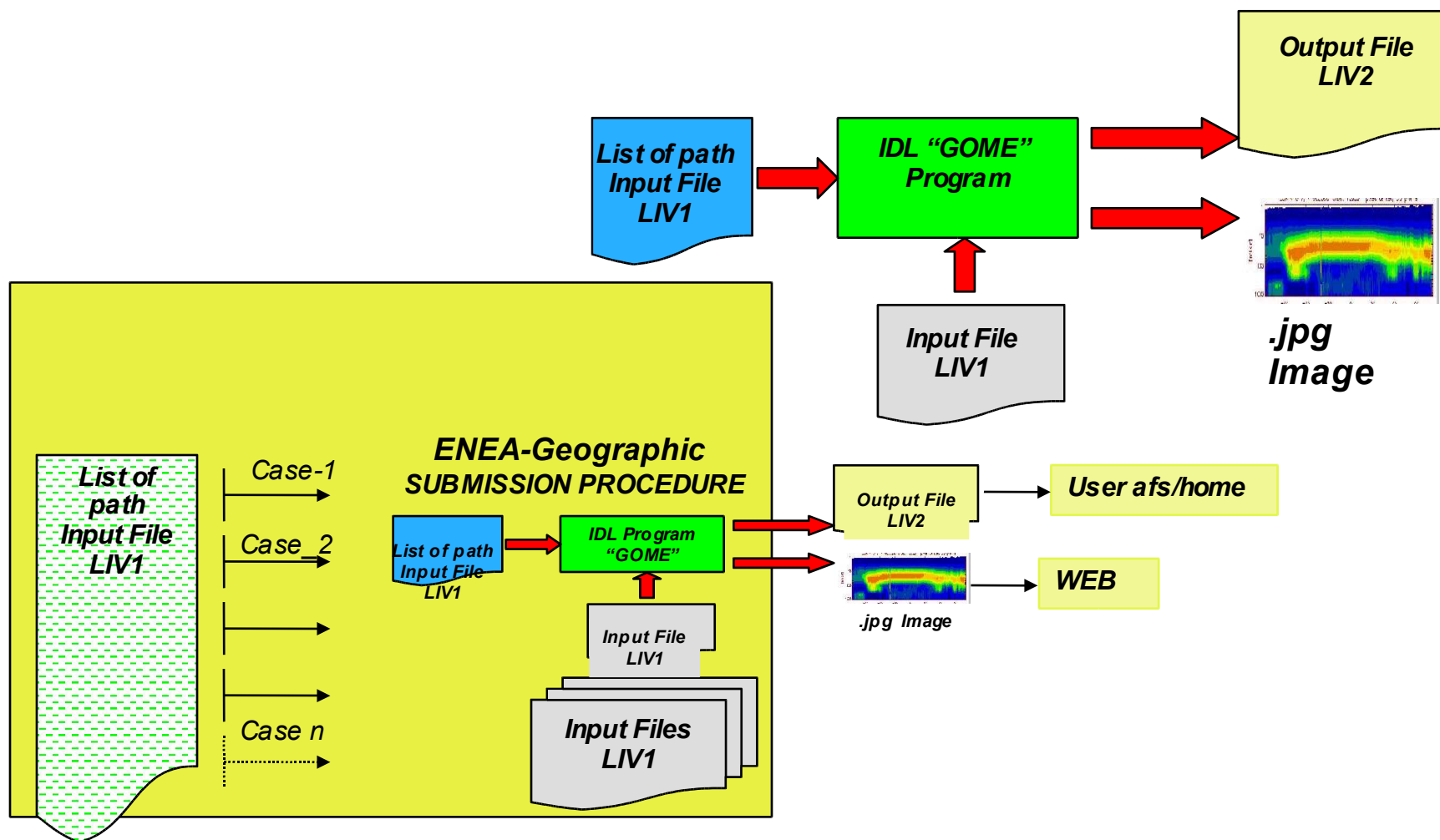
ENEA participated (unfunded) in DATAGRID project (ended 3/2004) through the collaboration with ESA, ESRIN Laboratory in Frascati.

A **gateway** between DATAGRID infrastructure and ENEA-GRID has been set-up at ESRIN enabling the submission of jobs from DATAGRID to ENEA-GRID

The gateway has been tested running the analysis of data from the GOME satellite (Ozone level) using IDL codes which can be easily run in a multiplatform environment.

The gateway provided a limited integration between the different GRID environment: **EGEE should attain a full integration**

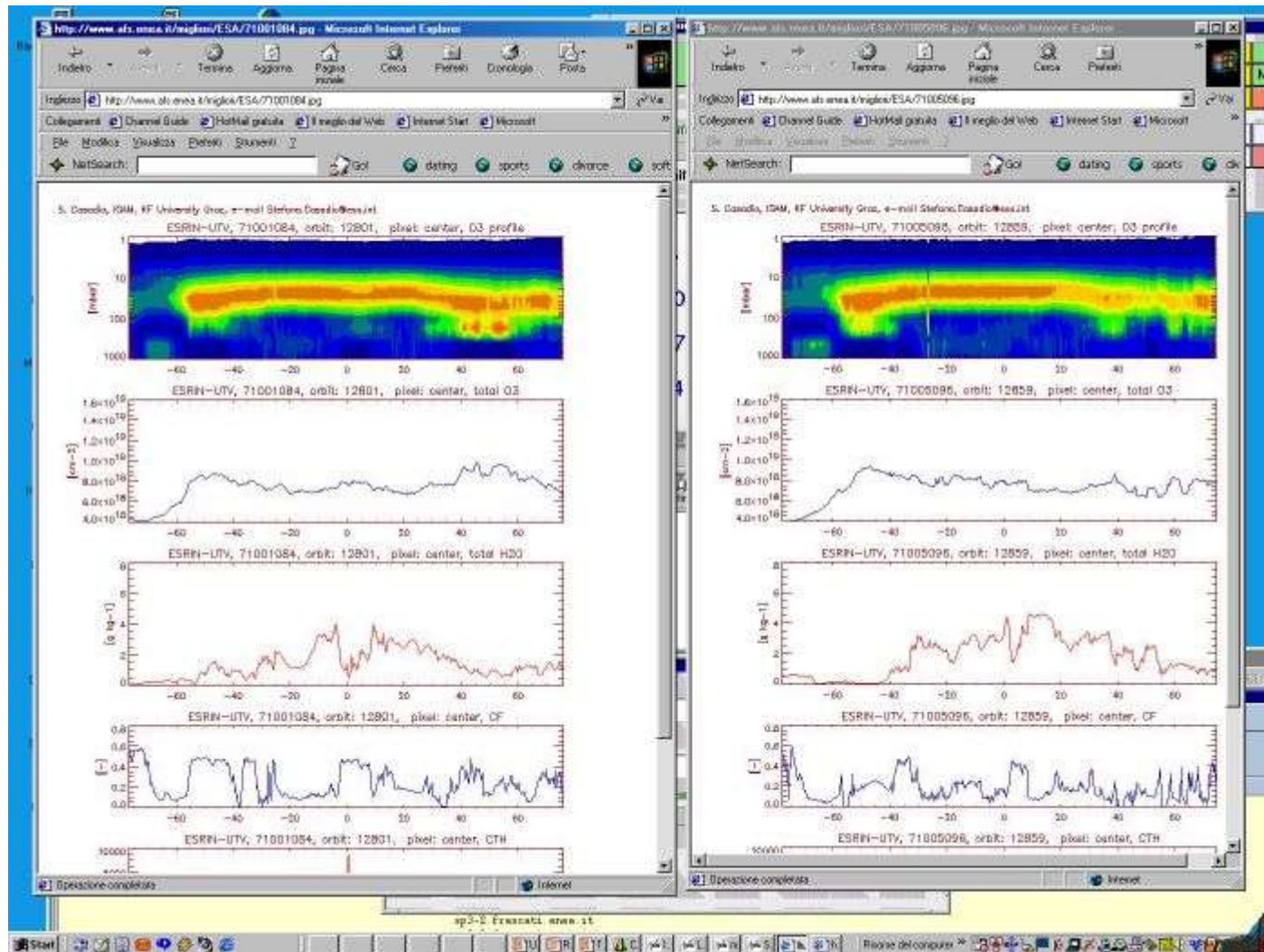
ENEA GRID/DATAGRID Test case: GOME data analysis



ENEA GRID/DATAGRID : GOME run cases in ENEA

LSF Batch - Console													
File Job Queue User Parameter Options													
													
119872	migliori	RUN	normal	grid0007.esrin.esa.it	sp3-2.frascati.enea.it	Jun	9	22:12:02	2002	/afs/enea.it/frascati/info/migliori/IDL/grid/NN0/lancio	[1]		
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119335	lucca	RUN	interactive	onyx2ced.frascati.enea.it	onyx2ced.frascati.enea.it	Jun	8	10:42:09	2002	fluent.lsf 3d			
119372	roccetti	RUN	interactive	onyx2ced.frascati.enea.it	onyx2ced.frascati.enea.it	Jun	6	15:03:05	2002	fluent.lsf 2ddp -pvmpi			
					onyx2ced.frascati.enea.it								
					onyx2ced.frascati.enea.it								
119452	roccetti	RUN	interactive	onyx2ced.frascati.enea.it	onyx2ced.frascati.enea.it	Jun	7	15:11:54	2002	/afs/enea.it/software/bin/gambit			
119872	migliori	RUN	normal	grid0007.esrin.esa.it	bw3.frascati.enea.it	Jun	9	22:12:02	2002	/afs/enea.it/frascati/info/migliori/IDL/grid/NN0/lancio	[6]		
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119872	migliori	RUN	normal	grid0007.esrin.esa.it	power3.frascati.enea.it	Jun	9	22:12:02	2002	/afs/enea.it/frascati/info/migliori/IDL/grid/NN0/lancio	[11]		
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119872	migliori	RUN	normal	grid0007.esrin.esa.it	sp28.frascati.enea.it	Jun	9	22:12:02	2002	/afs/enea.it/frascati/info/migliori/IDL/grid/NN0/lancio	[24]		
119872	migliori	RUN	normal	grid0007.esrin.esa.it	sp21.frascati.enea.it	Jun	9	22:12:02	2002	/afs/enea.it/frascati/info/migliori/IDL/grid/NN0/lancio	[25]		
119866	dangelo	PEND	small_10m	sp12.frascati.enea.it		Jun	8	23:59:14	2002	/afs/enea.it/software/bin/poe.lsf pig_sp -procs 24 -sharedmemory yes			
119872	migliori	PEND	normal	grid0007.esrin.esa.it		Jun	9	22:12:02	2002	/afs/enea.it/frascati/info/migliori/IDL/grid/NN0/lancio	[27]		
119872	migliori	PEND	normal	grid0007.esrin.esa.it		Jun	9	22:12:02	2002	/afs/enea.it/frascati/info/migliori/IDL/grid/NN0/lancio	[28]		
119872	migliori	PEND	normal	grid0007.esrin.esa.it		Jun	9	22:12:02	2002	/afs/enea.it/frascati/info/migliori/IDL/grid/NN0/lancio	[29]		

ENEA GRID/DATAGRID: GOME results on Web



ENEA-GRID and EGEE Project

EGEE (Enabling GRID for e-science in Europe) is a project in the 6th EU framework program, with the mission to deliver **production level GRID services** [www.eu-egee.org].

ENEA is one of the funded partners in the project, among the Italian participation which is coordinated by INFN.

EGEE project started recently (April 2004); a kick-off Meeting was held in Cork, April 2004.

The installation of a small testing environment (7 Linux boxes) with standard EGEE middleware is **currently in progress at ENEA Frascati**.

The development of a gateway to ENEA-GRID will follow.

Enea commitment: ~100 cpu (at 20%), second half 2005.



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