TurbGrid
Post-Processing Turbulence Simulation Data with Grid Computing

Luis Martins, Ricardo Reis, Carlos B. da Silva, Nelson Marques and José C.F. Pereira

LASEF/DEM/IST
AFA/FAP

Outline

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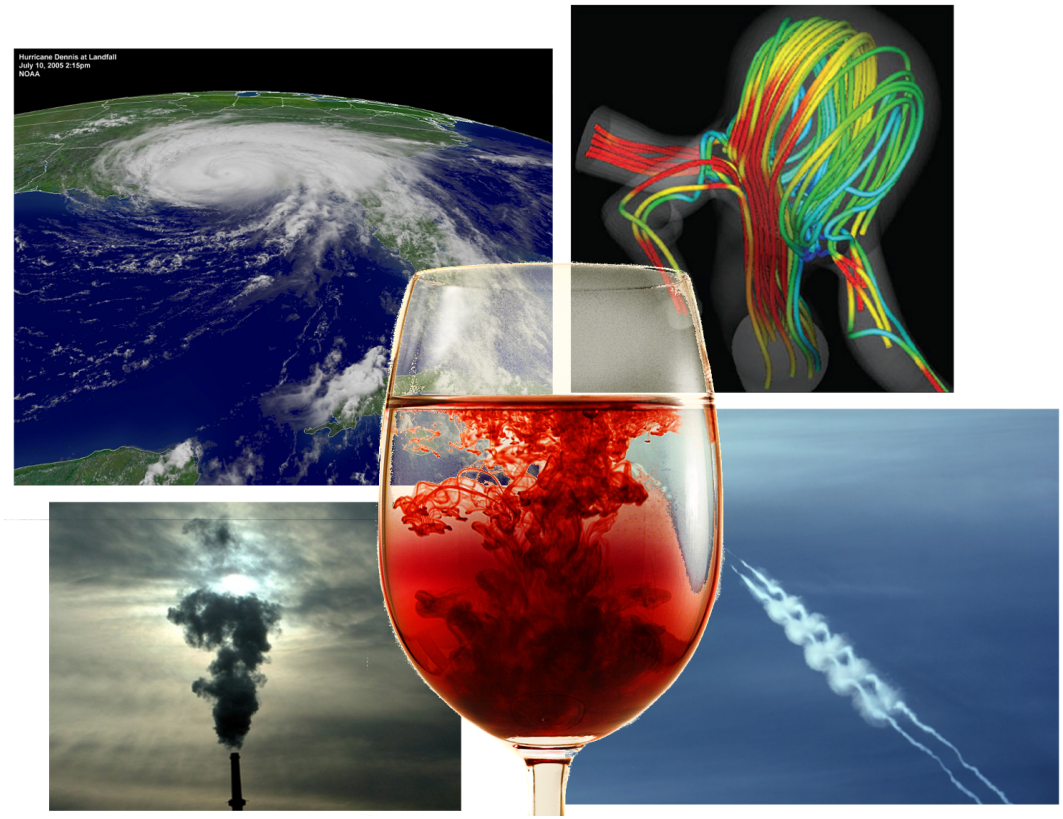
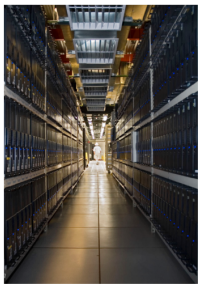
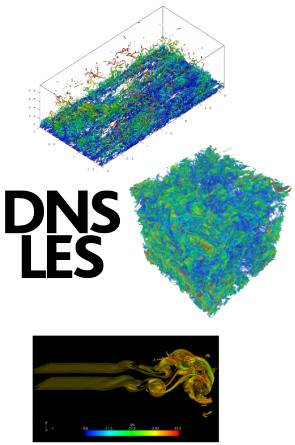
Turbulence

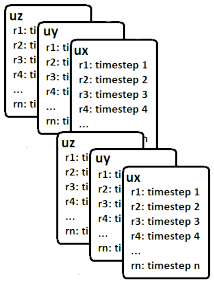
One of the big scientific challenges.
Global implications, turbulence is everywhere:

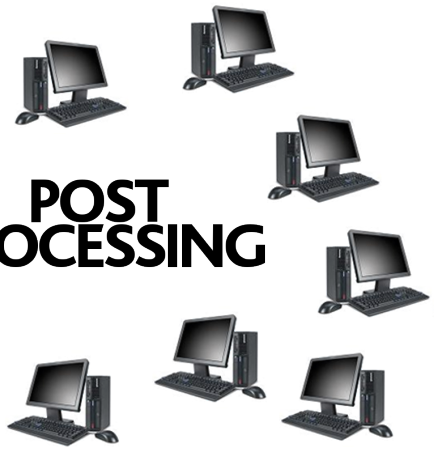


Workflow

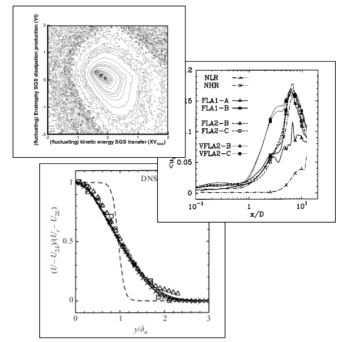




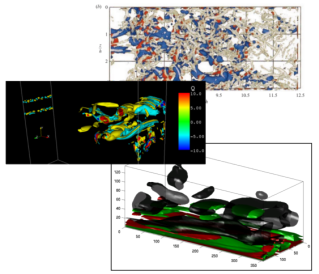




Statistical



Visual

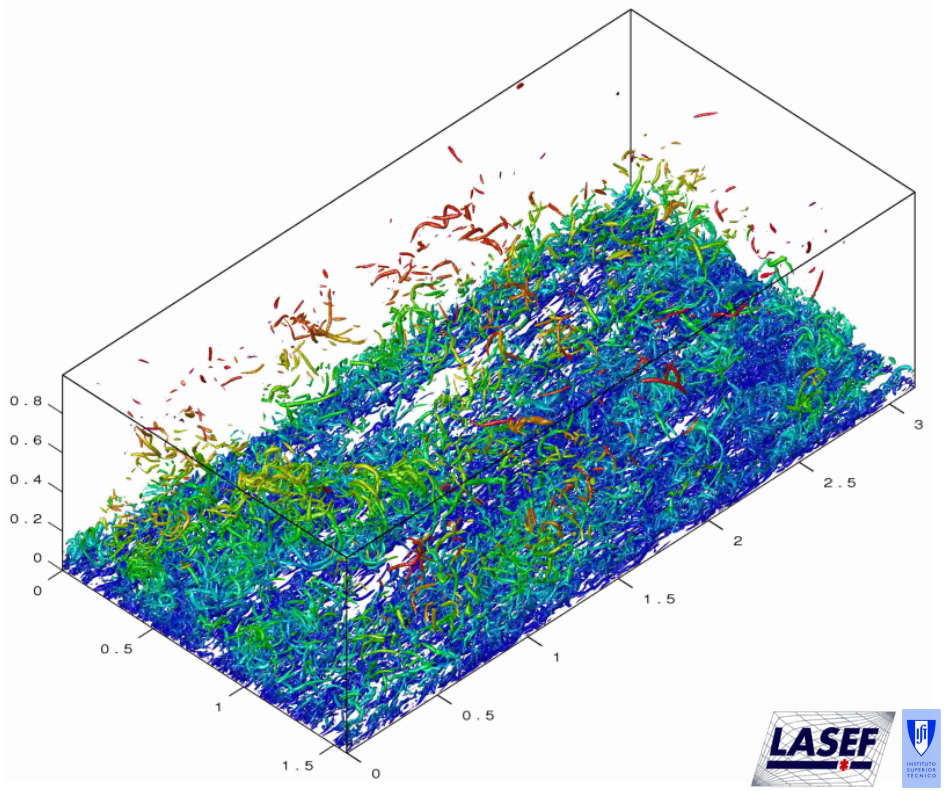


Simulation: Computational needs

High Performance Computing (HPC)

- DNS, LES simulations: CPU, RAM and storage demanding simulations.

for instance . . .
Jimenez and Hoyas (2005)
Channel flow
$18x10^9$ pts;
6e6 CPU/hours;
25TB data.



Simulation: Computational needs

High Performance Computing (HPC)

- DNS, LES simulations: CPU, RAM and storage demanding simulations.

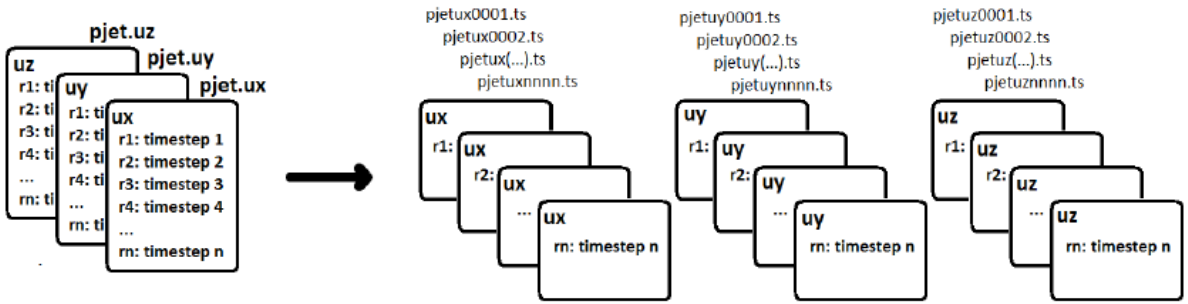
Grid for *HPC* is out of our interest:

- Access to simulation *HPC* resources becoming wide spread;
- Simulation codes have strong communication demands.

Post-processing: Computational needs

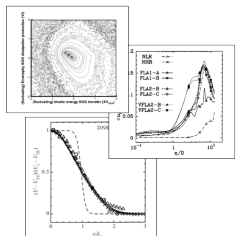
High Throughput Computing (HTC)

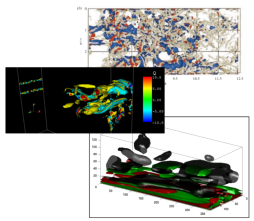
- Post-processing demands: storage resources, computing availability, visualization hardware.



terabytes of raw data: ***velocity, pressure, vorticy, . . .***

Statistics **Visualization**





Turbgrid - a Grid for turbulence post-processing

Interest in post-processing because:

- Raw data is useful for
  - Diferent applications (*is not the data, is how you use it*);
  - Scientific verification, peer review (*is that graph correct? is my implementation correct?*);
  - Benefits from increasing inter-par dialogue: more dynamic enviroment vs. periodic publications and conferences.
- Most post-processing is statistical and visualization: *embarassingly parallel batch processing per* Δt

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Main (tech.) problems:

Data transfer / Ease of use.

Current status: 2 Raw Databases

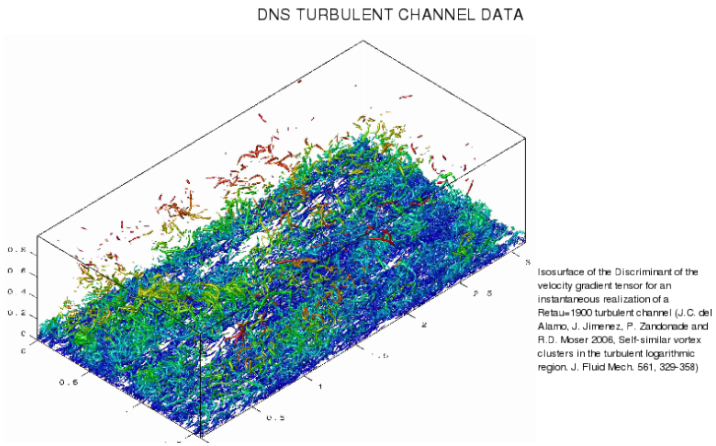
iCFDdatabase:

- 3.5 TB raw data (2007);
- Access: ftp;

http://cfd.cineca.it/cfd/icfddatabase

J. Jimenez:

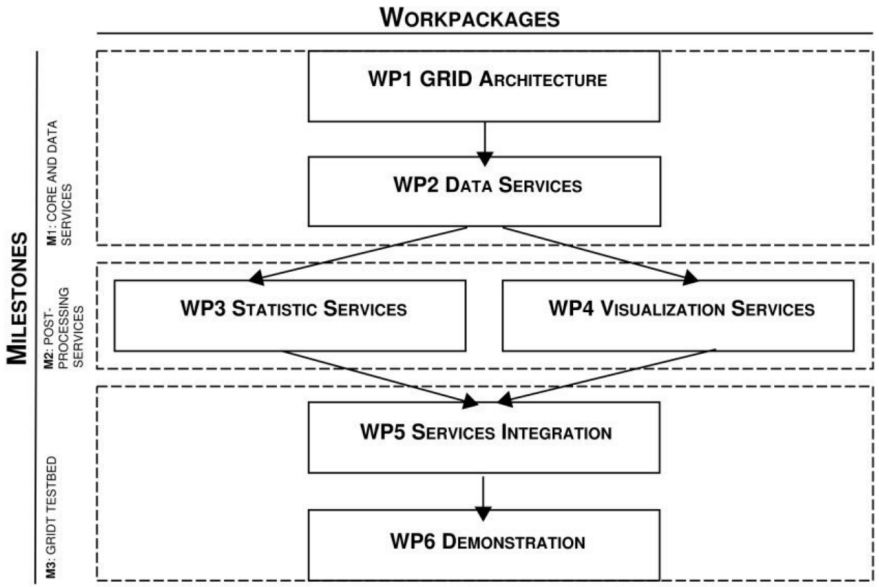
- 25 TB of data;
- Access: ftp;



Isosurface of the Discriminant of the velocity gradient tensor for an instantaneous realization of a Retau=1900 turbulent channel (J.C. del Alamo, J. Jimenez, P. Zandonade and R.D. Moser 2006, Self-similar vortex clusters in the turbulent logarithmic region. J. Fluid Mech. 561, 329-358)

http://torroja.dmt.upm.es/ftp

International interest



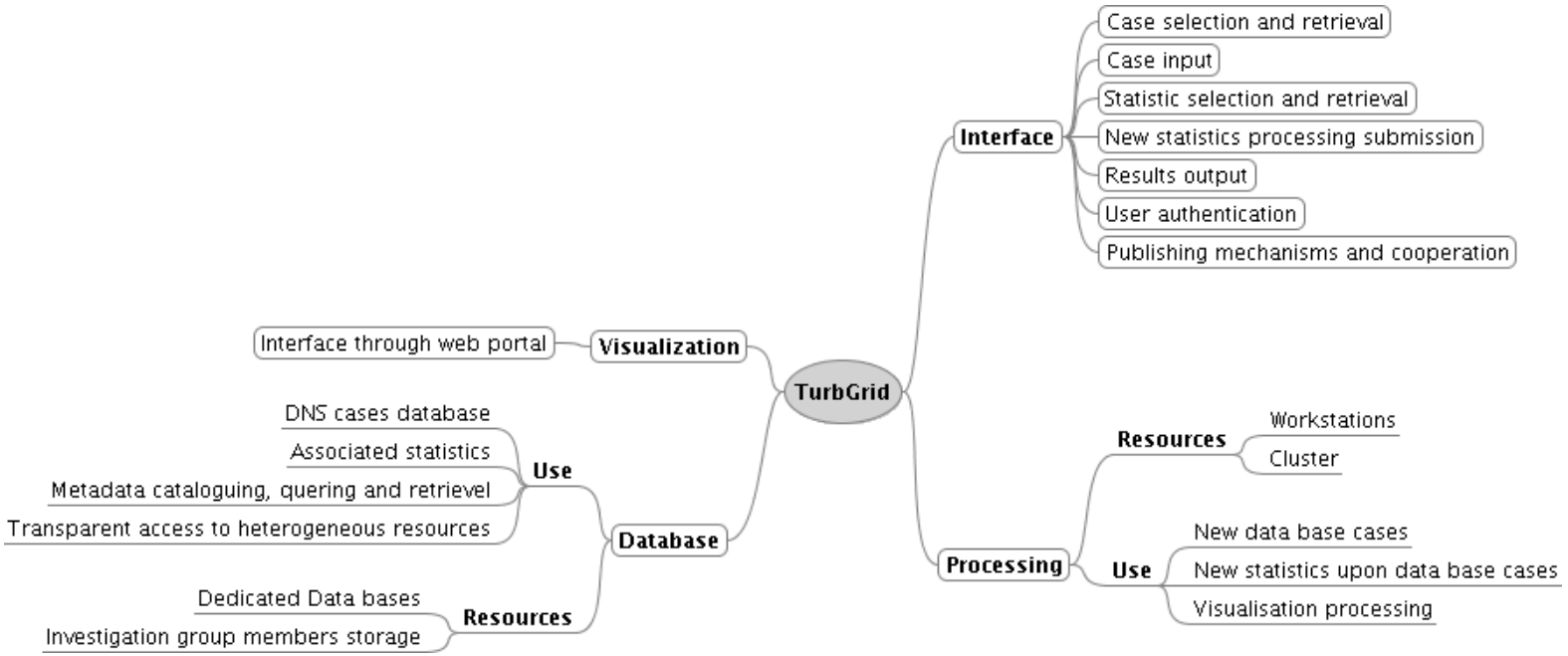
- Thrassos Panidis, GR
- Julian Andzrej Domaradzki, US
- Federico Toshi, IT
- Bernard Geurts, HL
- Aristeu Silveira Neto, BR
- Jorge Hugo Silvestrini, BR
- Kiyoshi Horiuti, JP

Objectives

Develop a testbed for post-processing and sharing of turbulence data sharing;

Outline

Global idea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Statistic selection and retrieval
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Results output
User authentication
Publishing mechanisms and cooperation
Visualization
Interface through web portal
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Metadata cataloguing, quering and retrievel
Transparent access to heterogeneous resources
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Investigation group members storage
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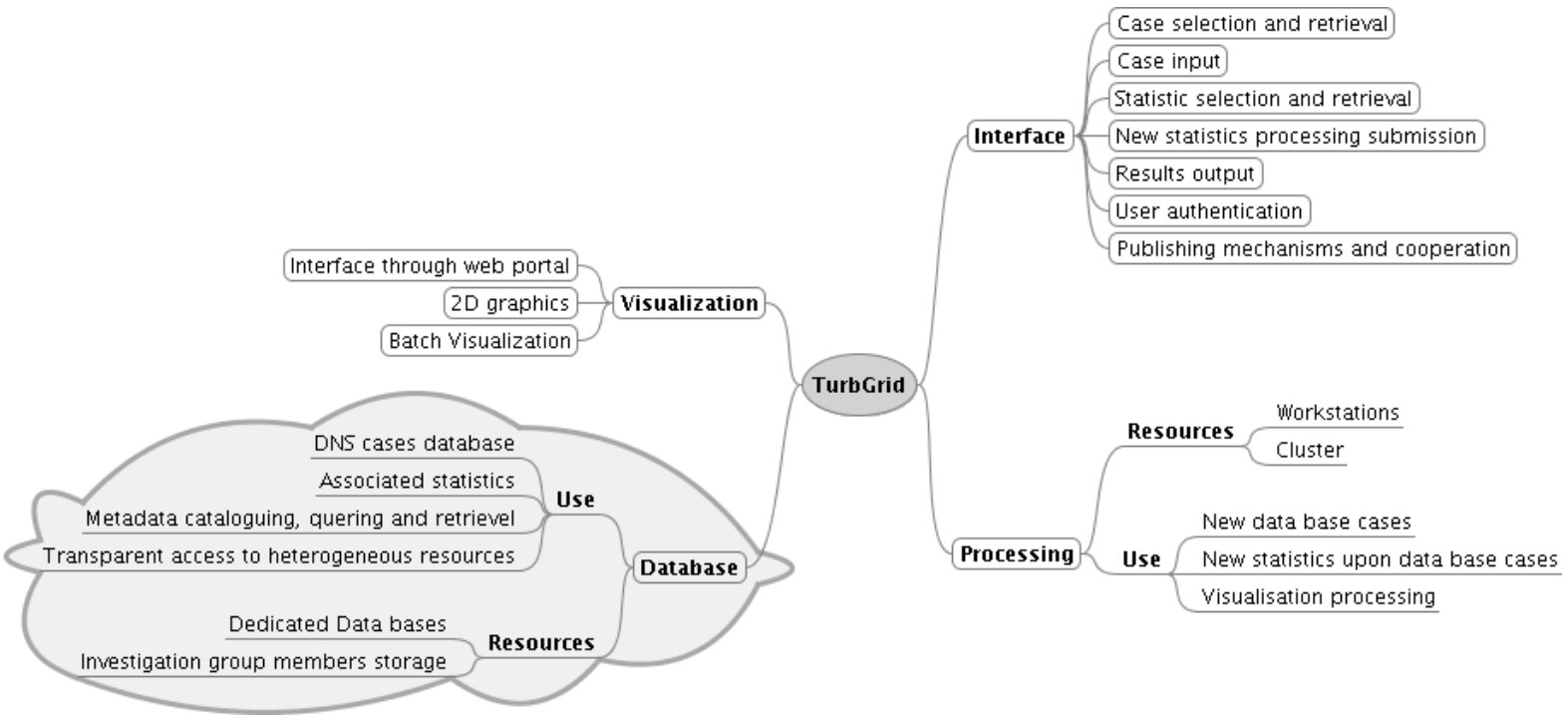
Workstations
Cluster
Use
New data base cases
New statistics upon data base cases
Visualisation processing

Global idea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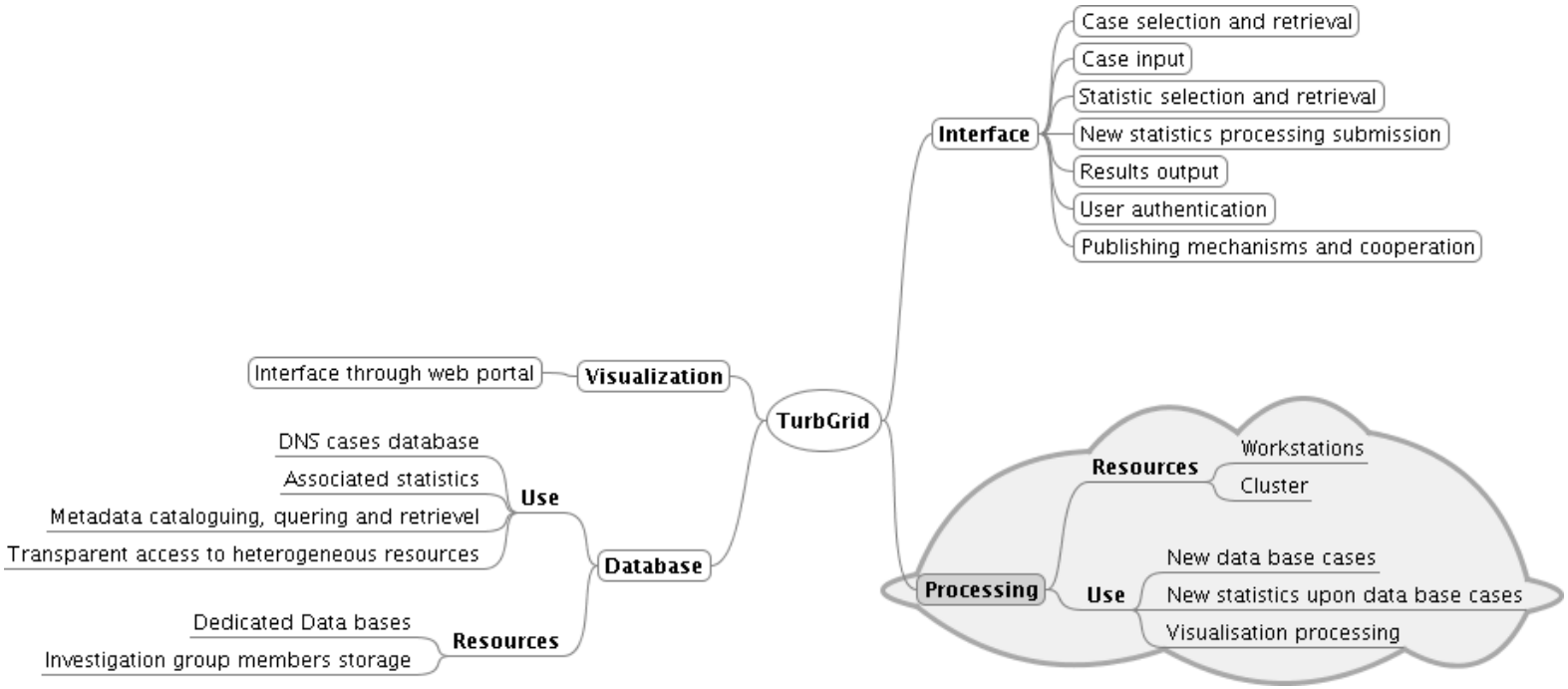
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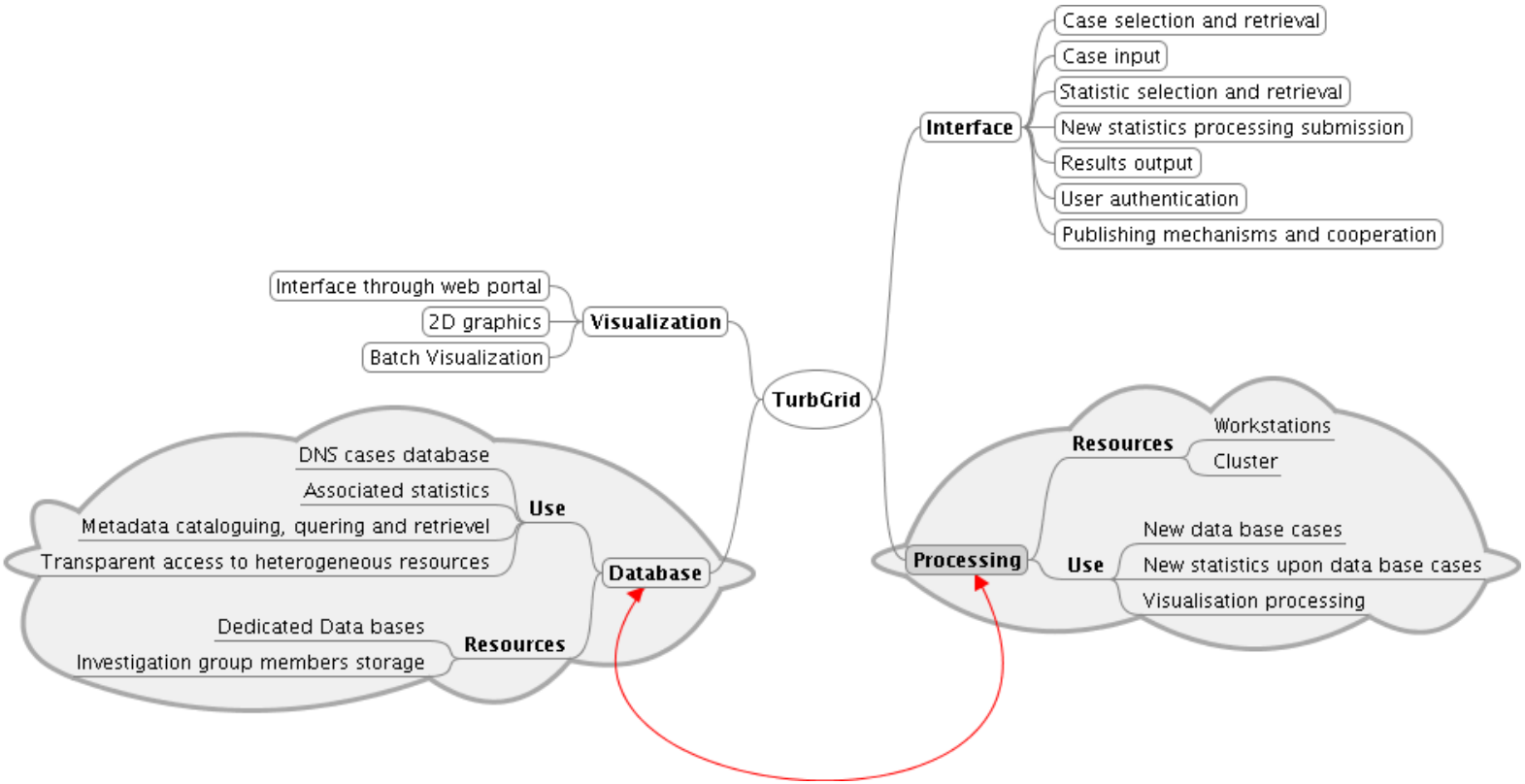
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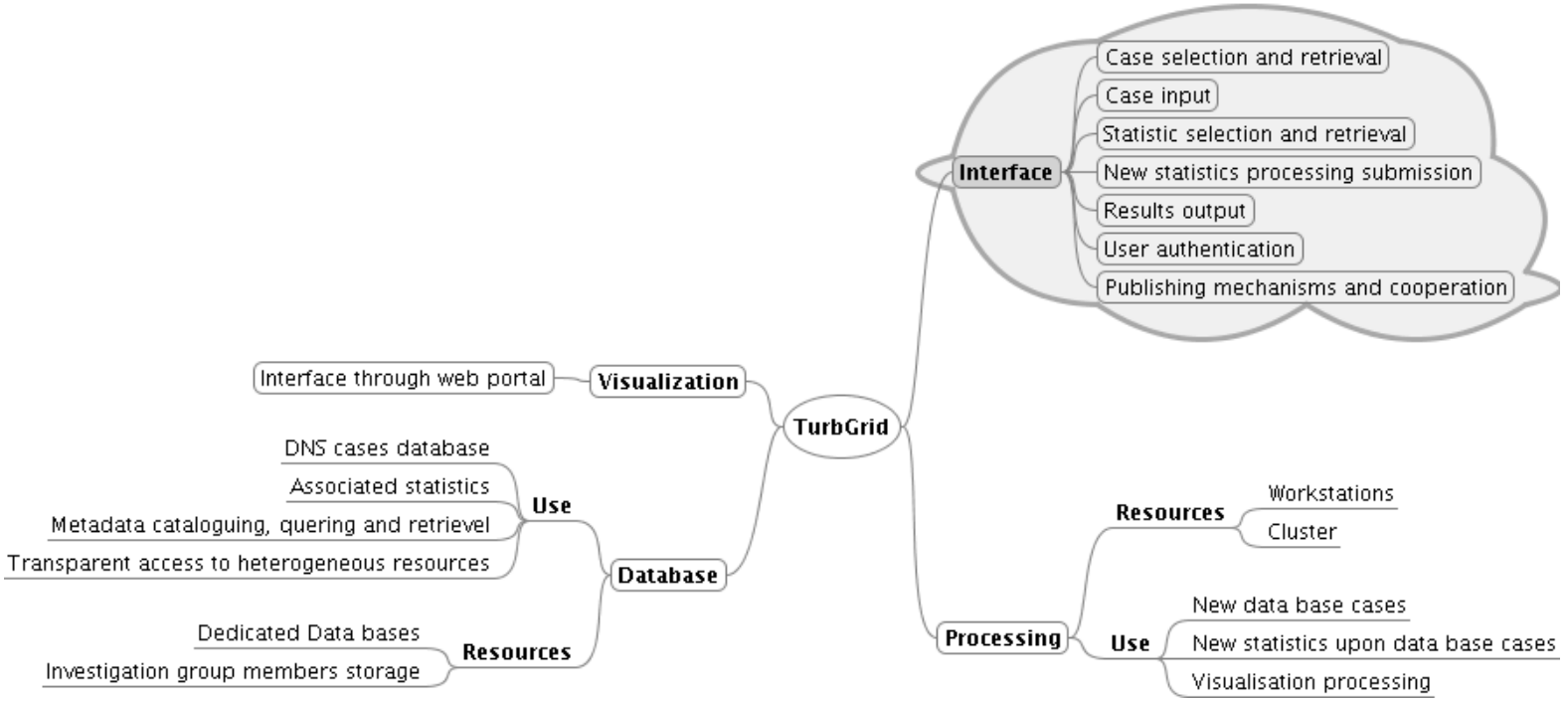
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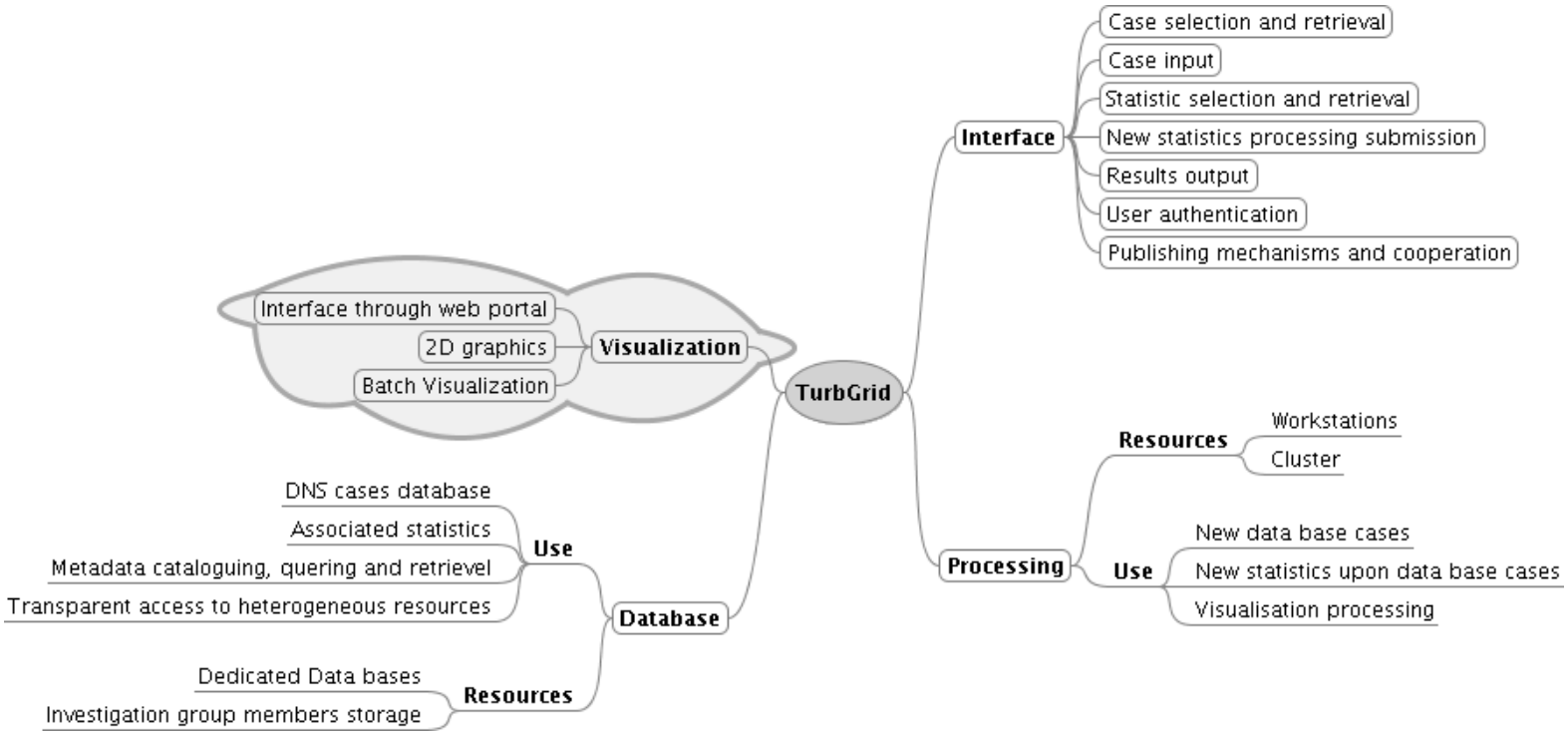
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Outline

Description - infrastructure LASEF

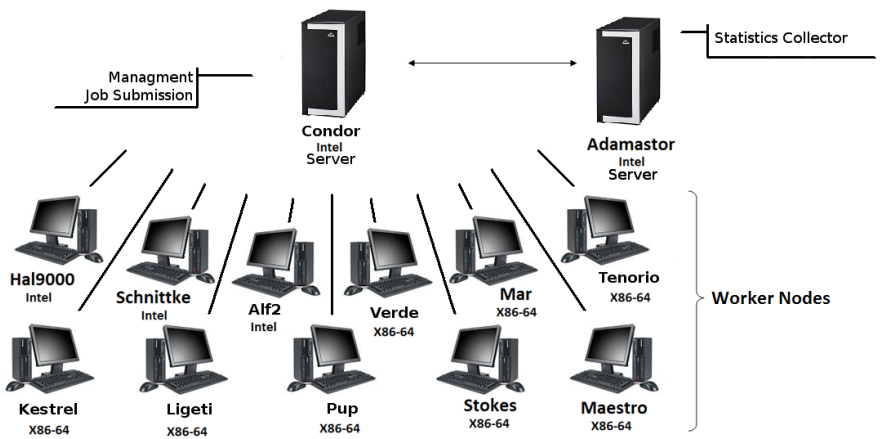
- Condor (High Throughput (*Wisconsin, USA*));
- Ganglia (resource monitoring);
- Post-processing tools: house codes (FORTRAN);
- Visualization: PARAVIEW;
- *Storage, 5TB NFS, 2xGbE*;
- Two generation of clusters:
  - 24xPIV@2.4GHz, 1GB RAM/node, 1x100Mbps ethernet;
  - 16xOpteron 252@2.6GHz, GB RAM/node, 2xGbE ethernet.

+

ISTcluster@IST (inter-department cluster):
28xXPPC970@2.3GHz, 8Gb RAM/node, GbE

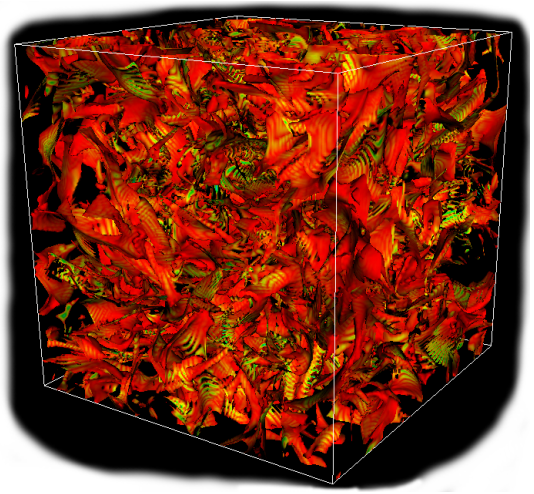
Condor pool

- campus ethernet (100Mpbs/1GbE)
- all Linux
- mixed x86, x86_64
- manager server
- statistics server

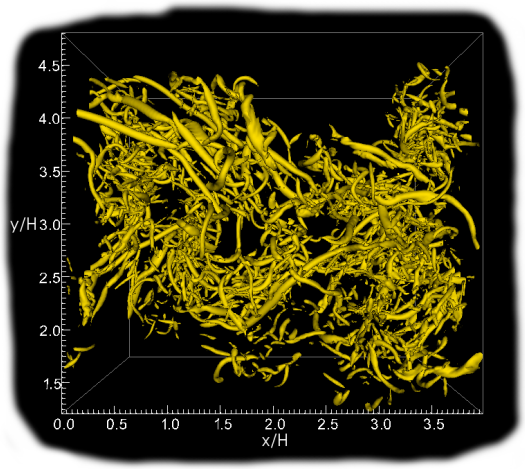


Condor pool

Data: Using 2 turbulence databases



Isotropic ($7x10^6$ pts)
total 8GB data



Planar jet ($25x10^6$ pts)
total 6GB (600MB/Δt)

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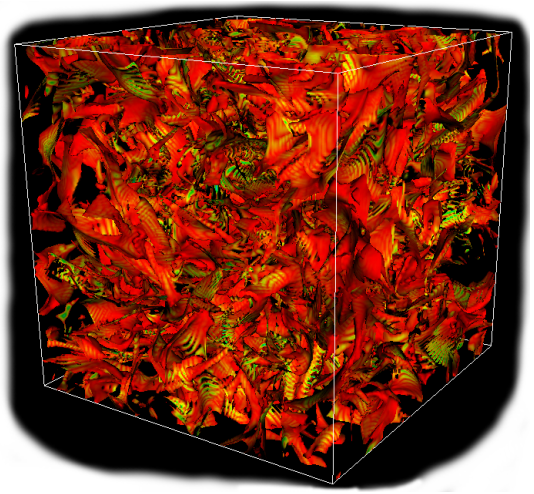

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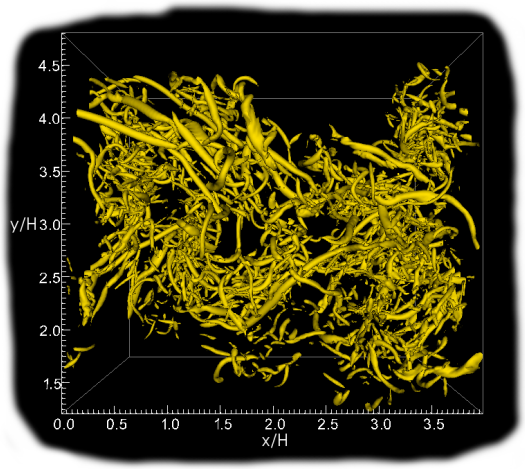


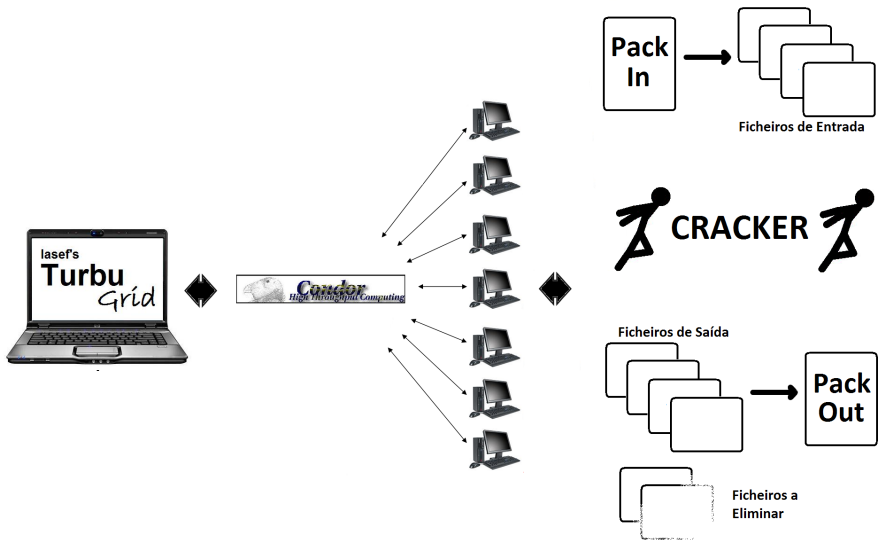
Planar jet ($25x10^6$ pts)
total 6GB (600MB/Δt)

currently running a planar jet $35x10^6$ *pts (800MB/*Δt*),*
preparing $80x10^6$ *(1.8GB/*Δt*) simulation.*

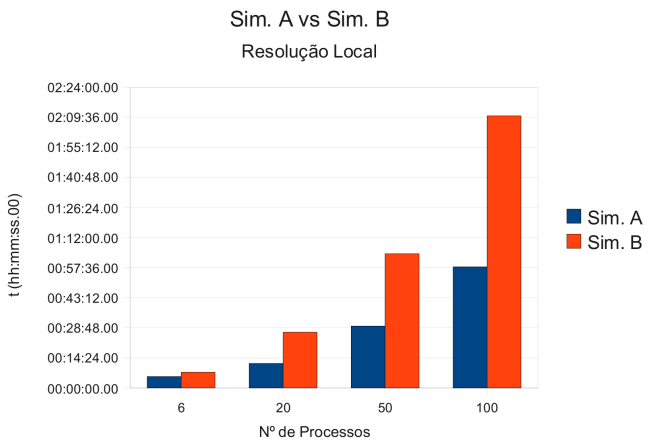
Tests

Task

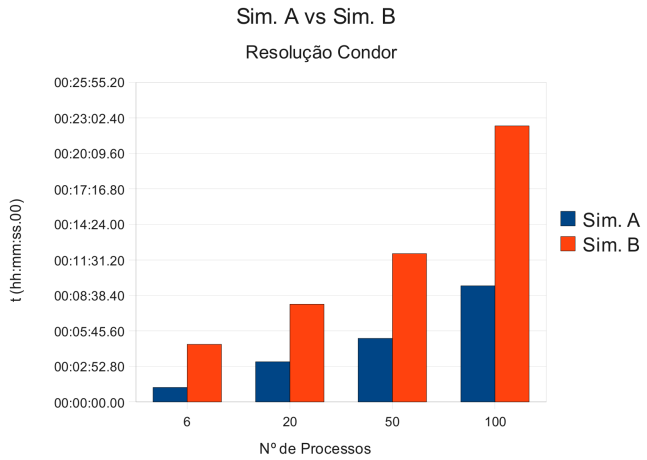
- Process 6 time steps;
- Process 20, 50 and 100 fields.



Performance



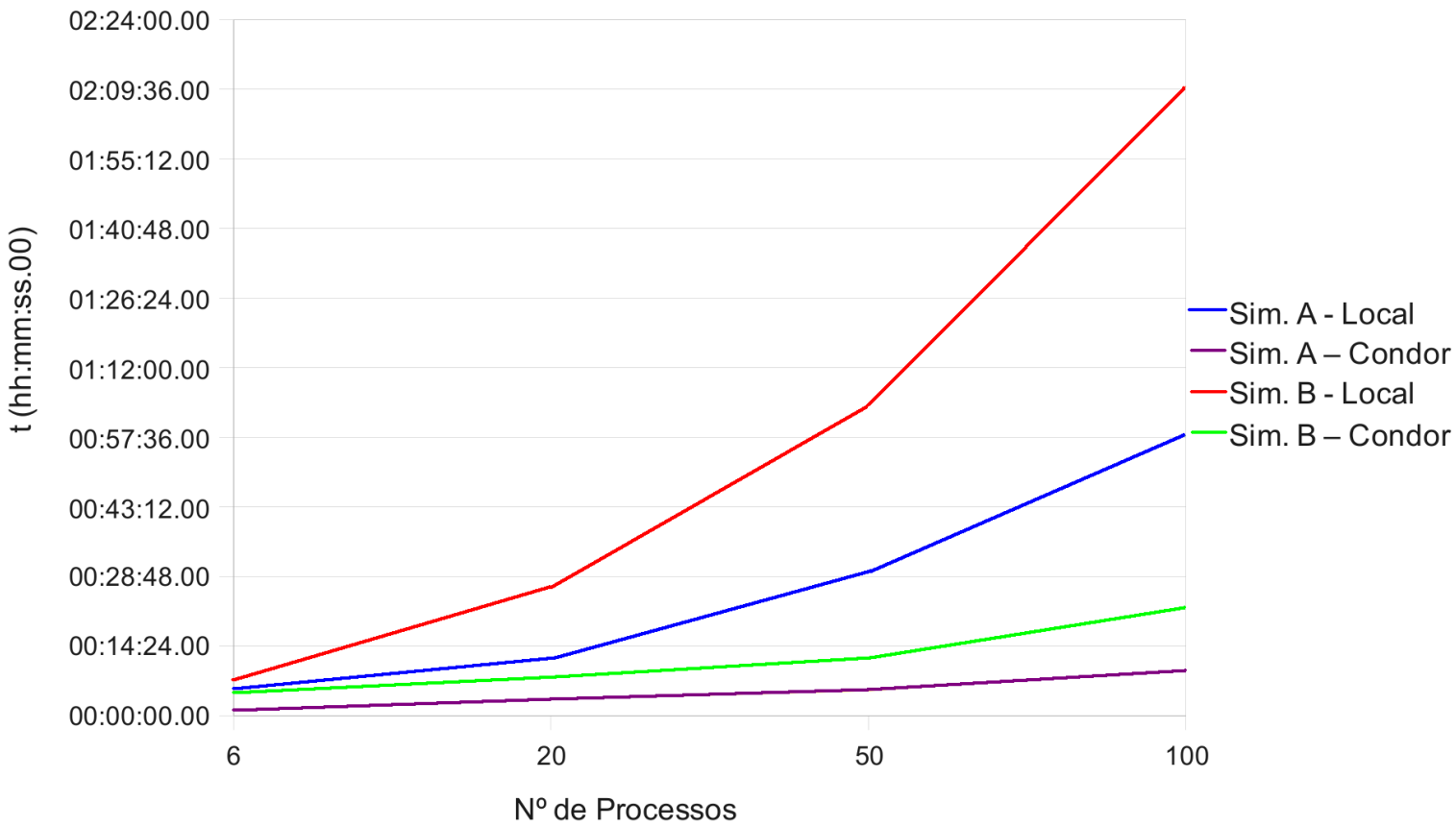
Performance comparison Local



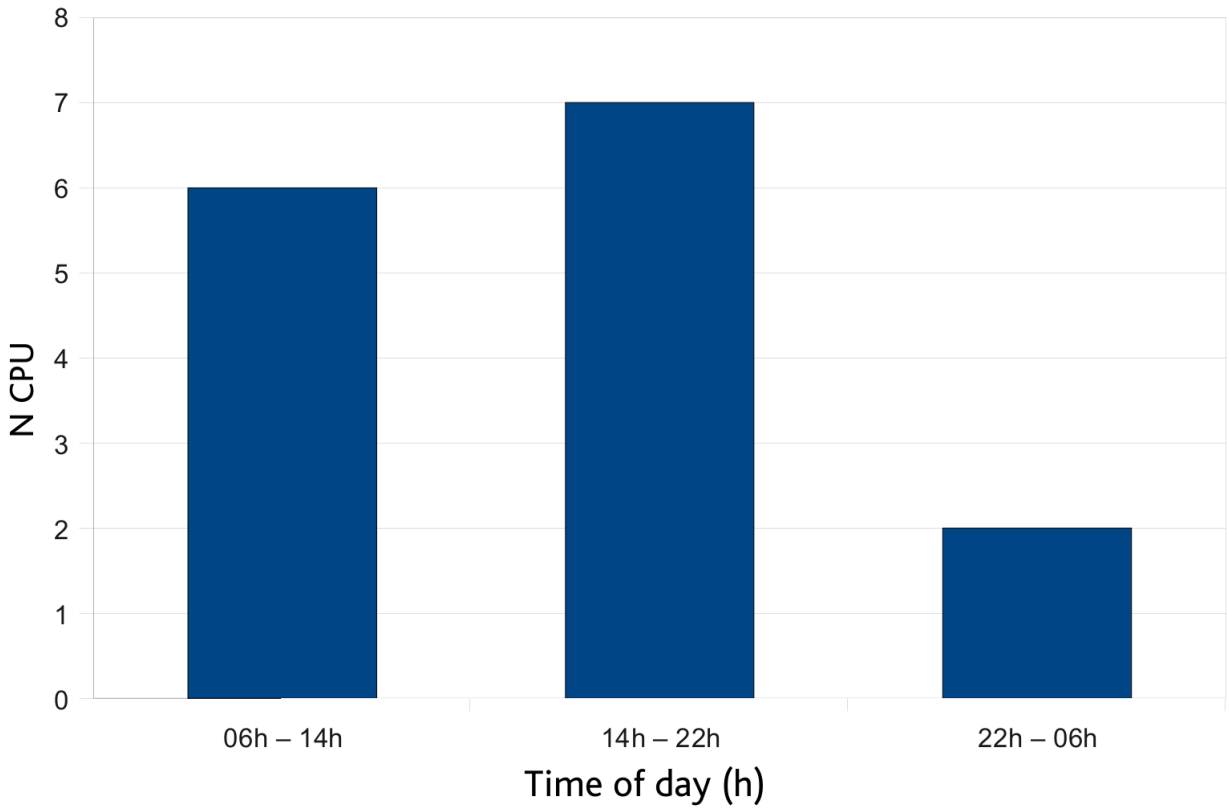
Performance comparison Condor

Proc N	Time t (hh:mm:ss.00)			
	Local		Condor	
	Sim A	Sim B	Sim A	Sim B
6	00:5:28.697	00:07:32.08	00:1:10.052	00:04:40.27
20	00:11:47.581	00:26:39.08	00:3:15.175	00:07:55.33
50	00:29:36.330	01:04:13.30	00:06:18.472	00:12:01.75
100	00:57:58.277	02:10:13.83	00:09:25.115	00:22:23.83

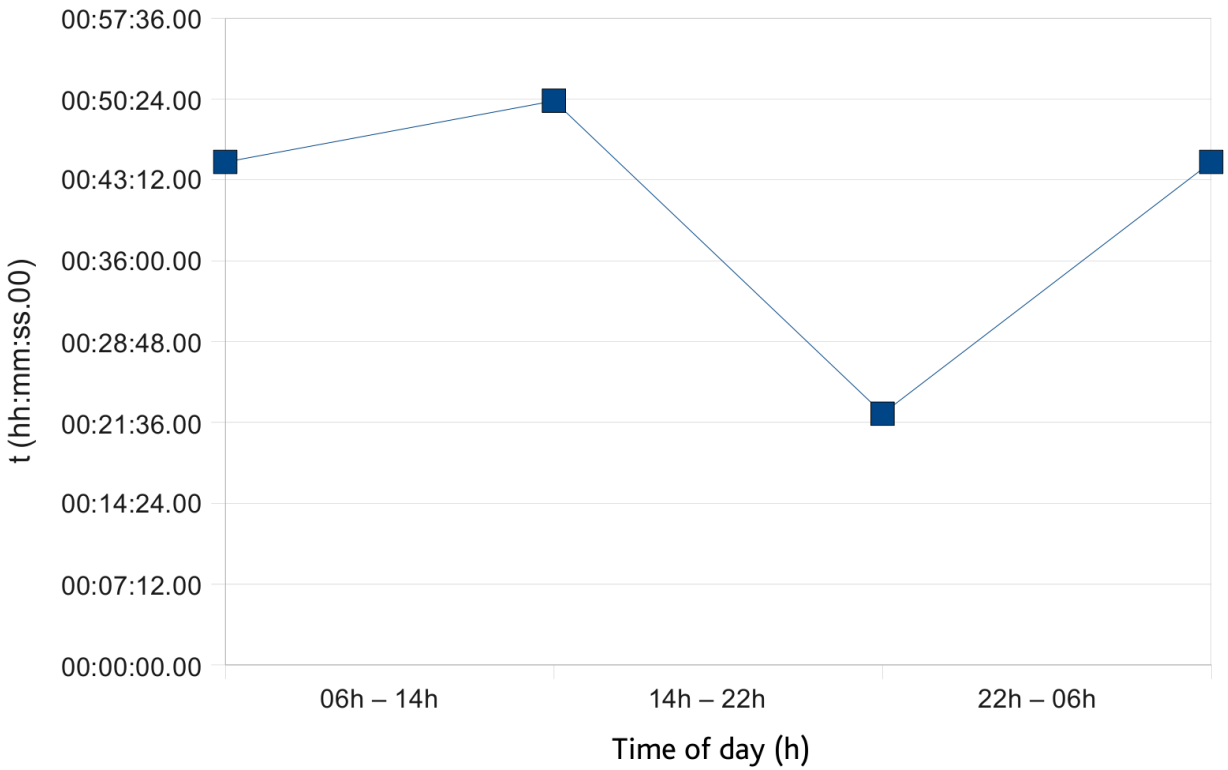
Overall


02:24:00.00
02:09:36.00
01:55:12.00
01:40:48.00
01:26:24.00
01:12:00.00
00:57:36.00
00:43:12.00
00:28:48.00
00:14:24.00
00:00:00.00
t (hh:mm:ss.00)
6
20
50
100
Nº de Processos
Sim. A - Local
Sim. A – Condor
Sim. B - Local
Sim. B – Condor

Availability



Variation with time of day



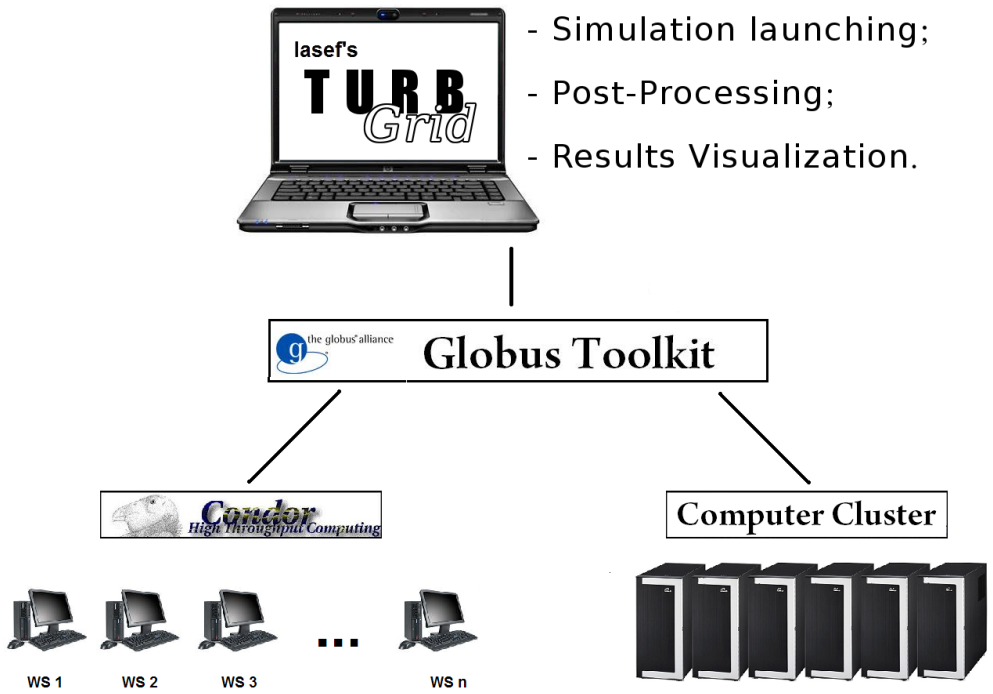
Outline

Conclusions

The testbed was successfully implemented, creating a grid environment for turbulence post-processing with the available workstations in LASEF.

Future work

- Expand local resources;
- Install GLOBUS, install/develop web interface;
- Envolve other turbulence investigation groups;
- Research coupling between local data acces and processing through webinterfaces and soap services.



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http://www.lasef.ist.utl.pt

FCT Project GRIDS ref POCI/EME/61961/2004

Author **Ricardo Reis, FCT PhD grant**, ref BD-24960/2005