

.Energy efficiency in HPC :

A new trend ?

A software approach to save power but
still increase the number or the size of
scientific studies !



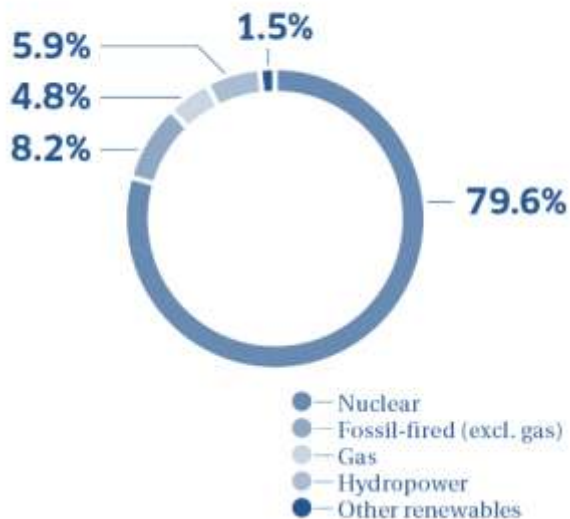
19 Novembre 2012

The EDF Group in brief

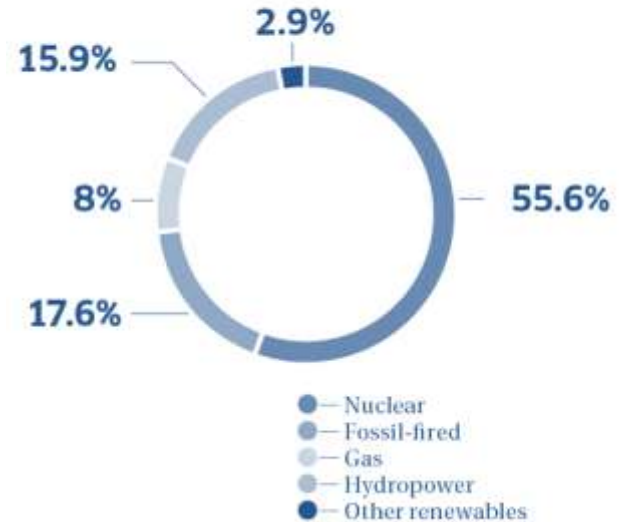
A GLOBAL LEADER IN ELECTRICITY

- **37.7 million** customers
- **156,168** employees worldwide

GENERATION 628.2 TWh

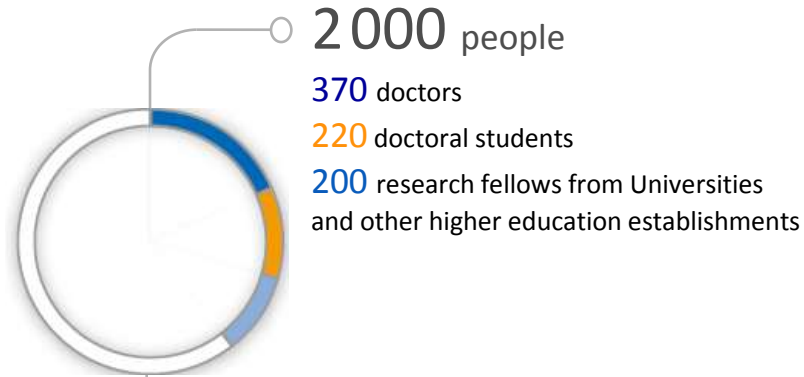


INSTALLED CAPACITY 134.6 GWe



- **€65.3 billion** in sales
- **87% carbon-free** generation

EDF R&D, key figures



€ 518 M
2011 budget

90 %

Success rate

For annual contacts signed with EDF Group entities and business units

15 departments

12 common laboratories

7 Research centers
of which

3 in France
1 in Germany
1 in the UK
1 in Poland
1 in China

500

Major research projects
per year



RESEARCH PROGRAMMES

A BIG USE OF COMPUTING RESSOURCES

Specific R&D for all Group activities

- ◆ Generation
- ◆ Energy management
- ◆ Sales
- ◆ Electrical grids
- ◆ Renewable energies

Covering all programmes:

- ◆ Information technology



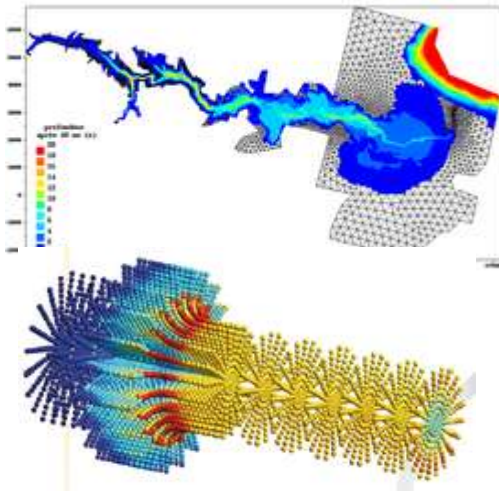
INFORMATION TECHNOLOGIES

▶ Improving the performance of operations through **advanced simulation technologies**

▶ Coming up with **new business opportunities** through innovative uses of new ICTs

Simulate

600 people working on numerical simulation



Compute

Ivanoé , a HPC cluster :
200,000 billion operations per second



Test

Augmented reality



Computing Power for EDF R&D

In 8 years, the
computing power at
EDF R&D
was multiplied by
2000



2002

Sinetics
100 Gflops



2011 : Ivanoé 200 Tflops

▶ 3 computers in the last TOP 500 (nov. 2012)

- Frontier2 (IBM Blue Gene P) : 328th with 100 teraflops
- Ivanoé, a conventional cluster : 149th with 200 teraflops
- Zumbrota (IBM BG Q) : 32nd with 690 teraflops

Performance ! What is that ?

- ▶ To reduce the computing time
- ▶ To obtain more precise results
- ▶ To increase the size of the field of study or to increase the number of simulations
- ▶ To allow the multi-physics coupling



The Project :

écoGrappe

Agence Nationale de la Recherche
ANR

- ▶ Founded by ANR

- ▶ It involves 3 partners :
 - Kerlabs
 - INRIA
 - EDF

- ▶ Aim of the project :
 - Design & implement a cluster management system
 - Take into account energy consumption

EDF's role



- ▶ Experimentally validate SNOOZE
 - Open source framework developed by Eugen Feller at INRIA
 - It manages virtual machines in private clouds
 - It is energy efficient

- ▶ Provide Hardware Infrastructure
 - HPSLab : High Performance Simulation Laboratory



HPSLAB ? What do you speak about ?

- ▶ An experimental platform...
...or a platform for experiments !

- ▶ various technologies

- ▶ processors
- ▶ Networks
- ▶ ...

- ▶ Easy administration

- ▶ most maintenance actions are made through web interfaces



- ▶ Fully equipped for electricity consumption measurements

Internship's Objective

- ▶ Implement a test protocol
 - Compare different use cases
 - Analyse diverse execution conditions

- ▶ How ?
 - Refining the data collected
 - Choising the right execution parameters
 - Monitoring the plateforme
 - Having a user-friendly interface

- ▶ Also
 - Analyse VM impact with SNOOZE
 - Compare to other monitoring projects

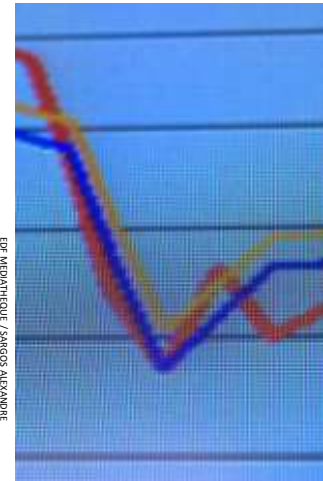


What has been done so far ?

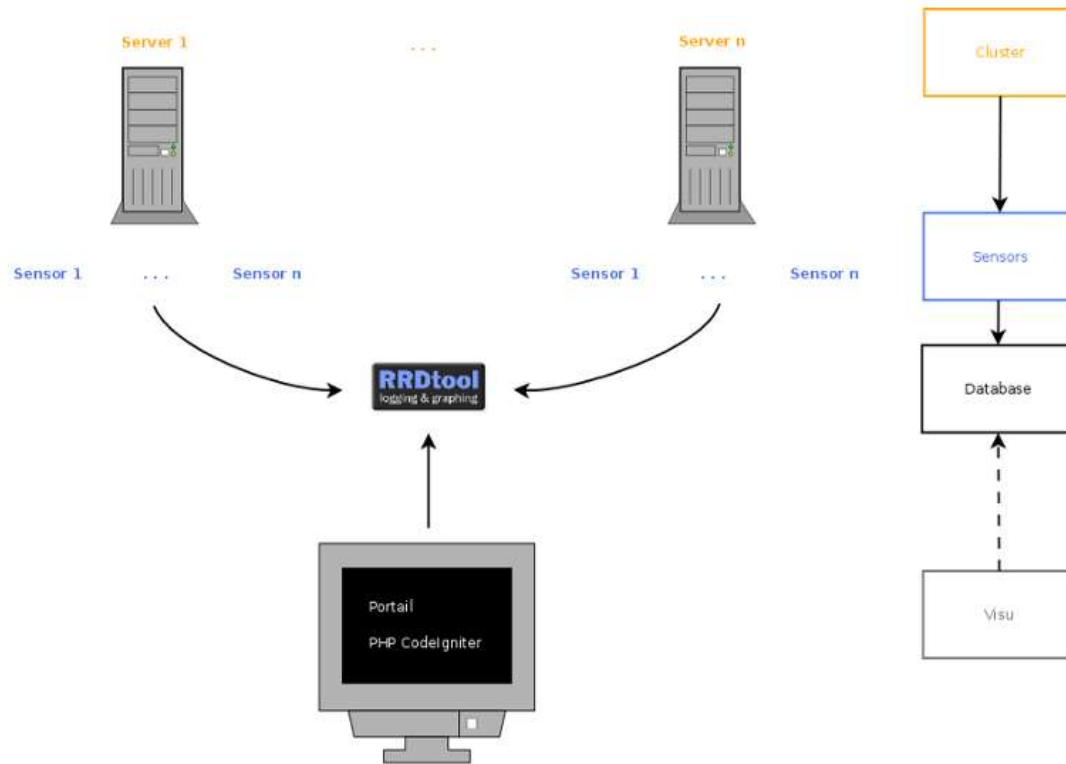
- ▶ State of the art in cluster
 - Type of servers
 - Type of sensors
 - Network interfaces

- ▶ Monitoring system
 - Scripts to get the data & plot it
 - Web interface
 - Comparaison to Ganglia

- ▶ First tests with Hadoop



Monitoring system architecture



Web Interface

The screenshot shows the EDF HPSLAB web interface in a browser window. The page title is "Welcome to HPSLAB !". There are navigation tabs: Accueil, Tests, Scénarios, Admin, Référence, and Docs. The EDF logo is in the top right. Below the navigation, there are two columns of checkboxes for selecting servers and graphs. The "datanode5" checkbox is checked. A "ganglia" button is visible. The page footer indicates "Page rendered in 0.0168 seconds".

Accueil Tests Scénarios Admin Référence Docs

Welcome to HPSLAB !

Veuillez choisir le(s) serveur(s)

- datanode1
- datanode2
- datanode5
- datanode6
- M460g1_r1
- M460g1_r3
- M460g1_r4
- M465g*_r2
- quad-intelG7-2
- ec2grappe

Veuillez choisir le(s) graphe(s)

- Puissance total
- Puissance serveur
- Puissance
- Temperature
- Usage CPU
- Usage total CPU
- Mémoire
- Usage de disque (bytes/s)
- Usage de disque (bytes)
- Charge réseau (bytes)

Veuillez comparer les résultats avec ceux de Ganglia

ganglia

Page rendered in 0.0168 seconds

The screenshot shows the EDF HPSLAB web interface displaying monitoring data. The page title is "Welcome to HPSLAB !". There are navigation tabs: Accueil, Tests, Scénarios, Admin, Référence, and Docs. The EDF logo is in the top right. Below the navigation, there are two line graphs. The top graph is titled "Temperature" and shows temperature in degrees Celsius over time. The bottom graph is titled "CPU USAGE" and shows CPU usage in percentage over time. The page footer indicates "Page rendered in 0.1367 seconds".

Accueil Tests Scénarios Admin Référence Docs

Welcome to HPSLAB !

Temperature

Usage (%)

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Hadoop



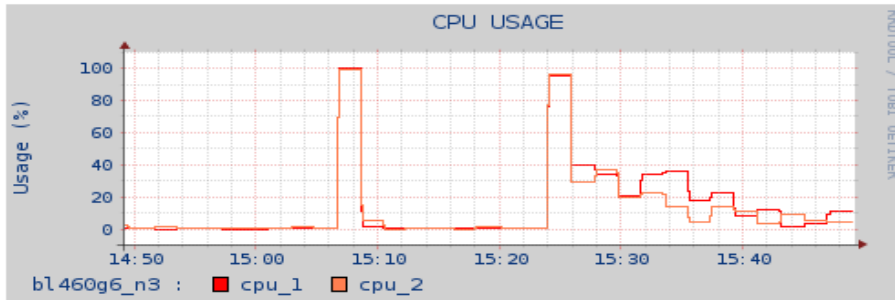
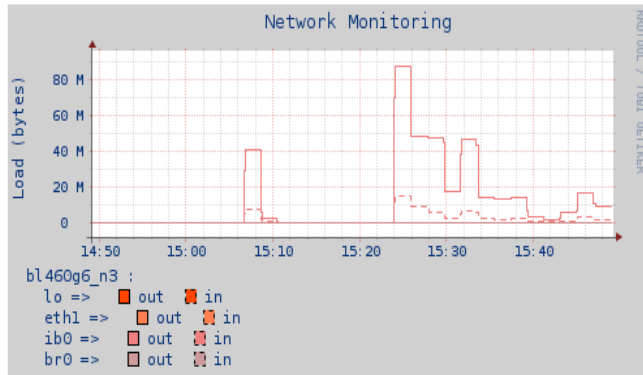
- ▶ What is it ?
 - Open source framework
 - Written in Java
 - Under Apache license

- ▶ Store & process large amounts of data

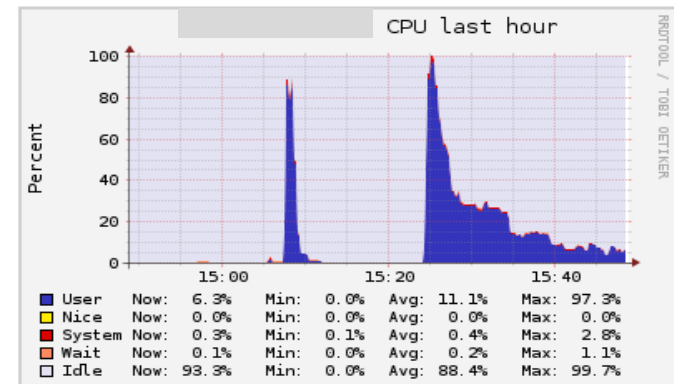
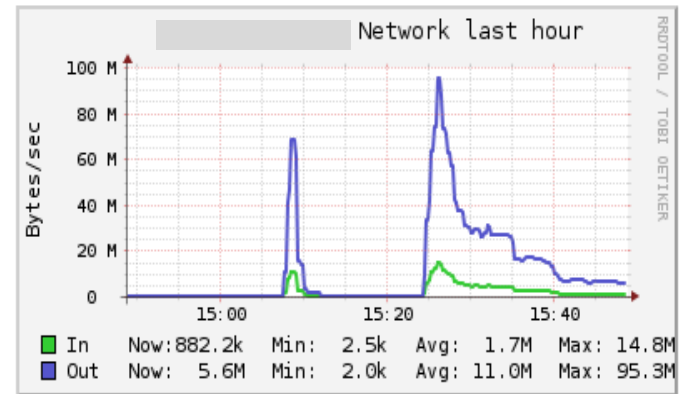
- ▶ How does it work ?
 - MapReduce : the programming model
 - HDFS : the distributed File System

Test with Hadoop

EDF's results

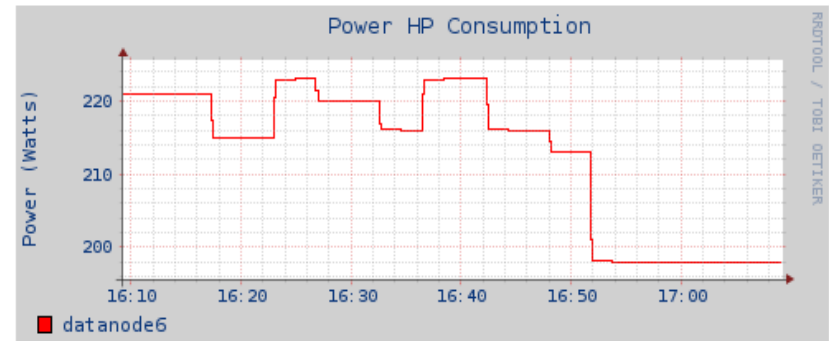
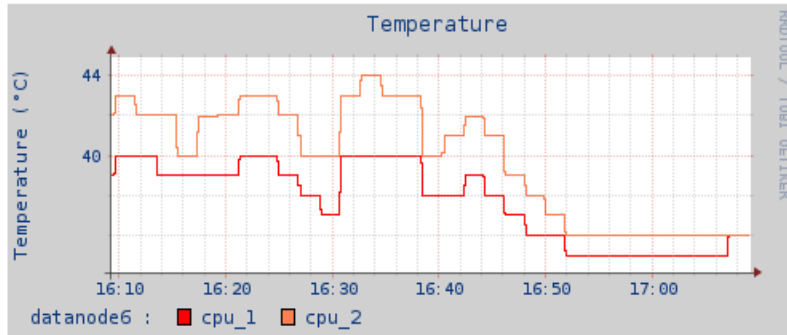


Ganglia's results

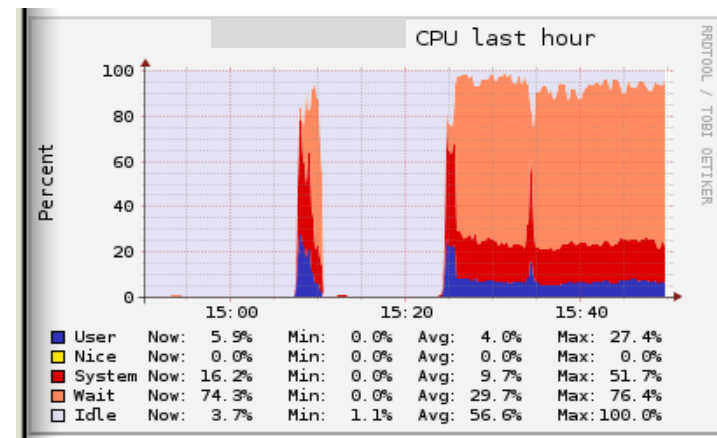
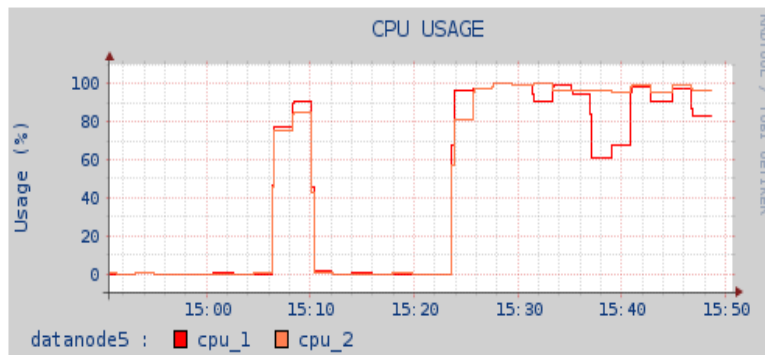


Test with Hadoop

EDF's results

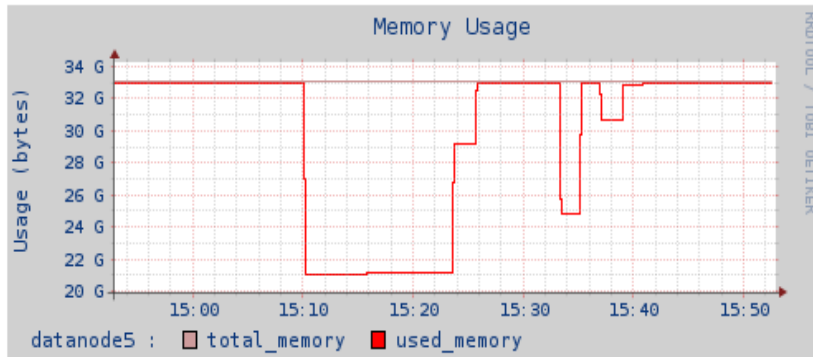
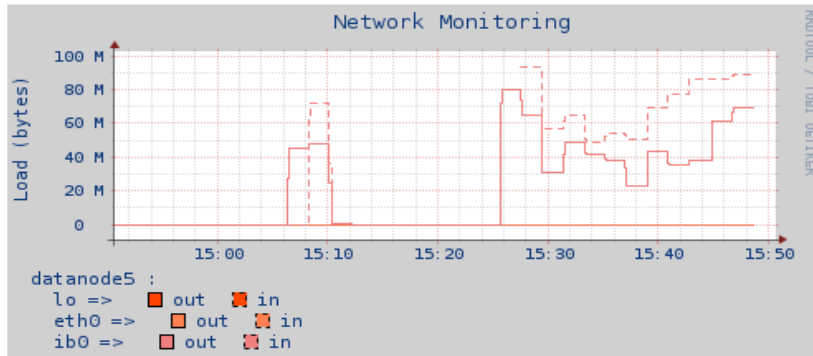


Ganglia's results

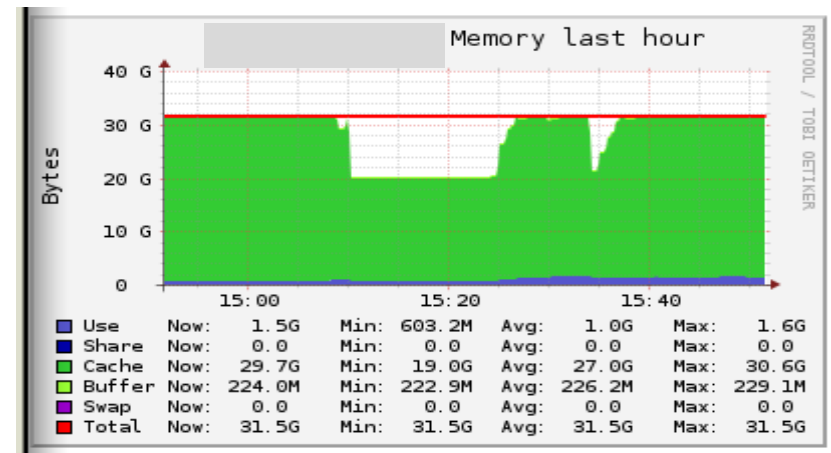
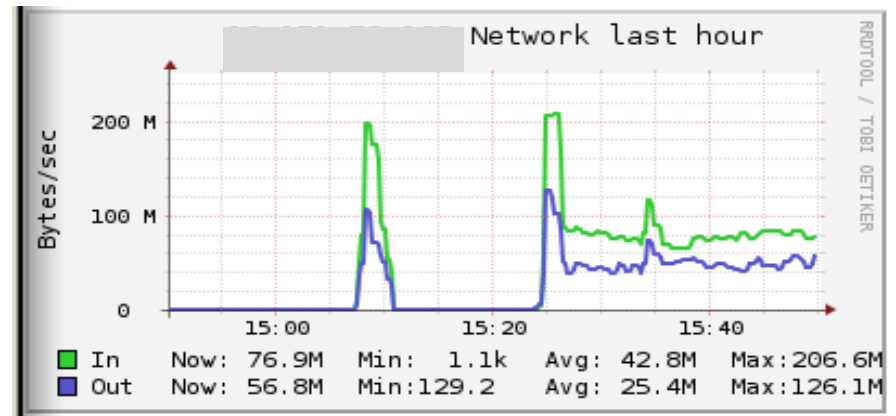


Test with Hadoop

EDF's results

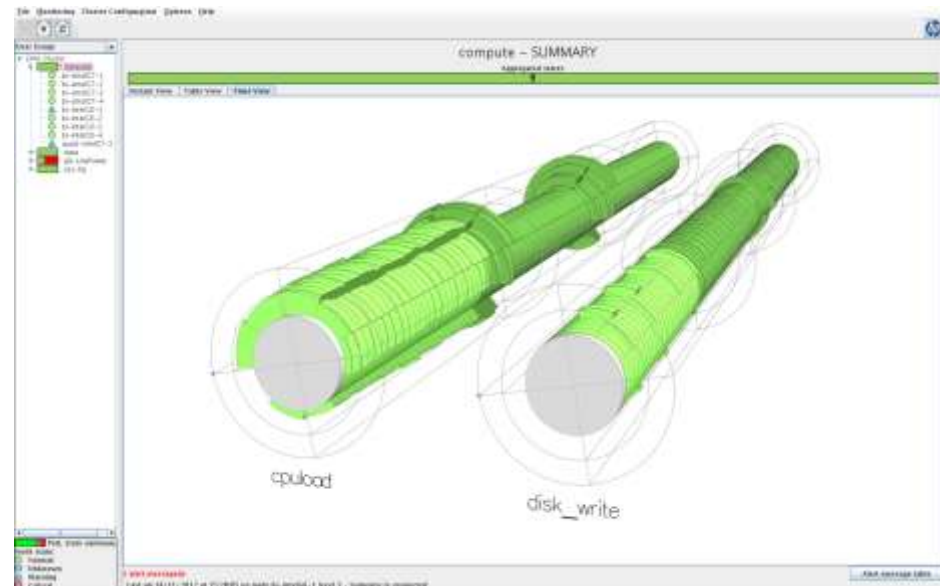


Ganglia's results



What is left to do ?

- ▶ Experimentally validate SNOOZE
 - Use the framework in the HPSLab cluster
 - Test it with multiple use cases
-
- ▶ Analyse the results



Aims for the future



- ▶ Become an EDF's researchers work tool



- ▶ Integrate this project to futur production clusters



.Links

- <http://www.edf.com>
- <http://ecograppe.inria.fr>
- <http://snooze.inria.fr>
- <http://hadoop.apache.org>
- <http://ganglia.sourceforge.net/>