From Grid to private Clouds, to inter-Clouds. An overview and some questions for future of cloud computing.

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I - Premise of Grid Computing…

Premise of Grid Computing…

CASA project (1990-1995)

Objective: distribution of large computations on several supercomputers across a (high speed) Gigabit WAN

Two research issues:

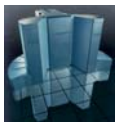
- Impact of high speed WAN on HPC applications?
- What algorithms and implementations to achieve **speedup** across a high speed WAN?

Premise of Grid Computing…

CASA project (1990-1995)

Chemical computation:

Vector computation



Calcul 1

Cray YMP

Network

Parallel scalar computation

Calcul 2

Intel DELTA

Hiding network time:

- 3 stage pipeline
- Overlaped computations and communications

Results:

- Cray Y-MP + Intel DELTA *vs* Cray Y-MP: **speedup 3.4**
- Pipeline: **overlapping at 98%**

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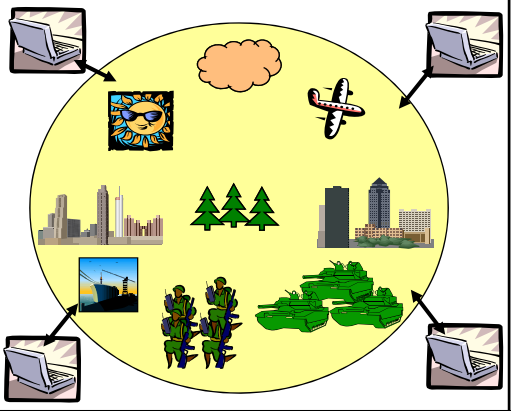
Premise of Grid Computing…

Synthetic Force project (1990-1998)

Objective: *Distributed Interactive Simulation of War*.
Distributed Multi-Agent system.

Military training:
- Fine simulation of military operations.
- Many simultaneous users
- Interactive simulation

Research issue: Size Up (× 100)
→ n × 100000 entities
→ n × 10000 vehicles



Premise of Grid Computing…

Synthetic Force project (1990-1998)

Multi-Agent simulation:

Application with many different computational parts
Interactive application with many simultaneous users

Interconnection of standard and specific hardware

March 1998: simulation of **100000** entities
→ **Size up achieved**

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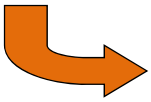
Premise of Grid Computing…

Results of the experiments

Distributed computing across a WAN:
- Possible: achieves speedup
- Allows to use specific (adapted) resources (not locally available)

Interactive and distributed computing on heterogeneous resources:
- Possible: achieves size up
- Allows more realistic simulations, with more users.

Main difficulties: complex to develop and to deploy



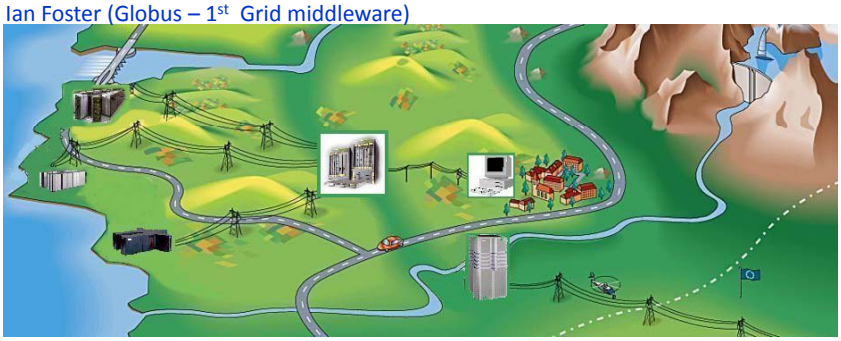
Need of a specific (and new) middleware
(grid middleware)

Grid Computing Emergence

Grid Computing Emergence

Ian Foster's view

Ian Foster (Globus – 1st Grid middleware)



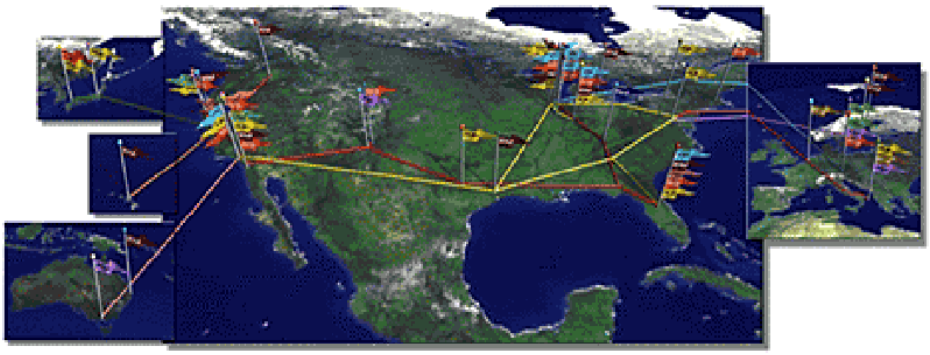
- An infrastructure to provide computing/storage/communication capabilities to users, when they need, where they need, and in a transparent way.
- To build « virtual organizations ».

Grid Computing Emergence

Proof of concept (1995-2000)

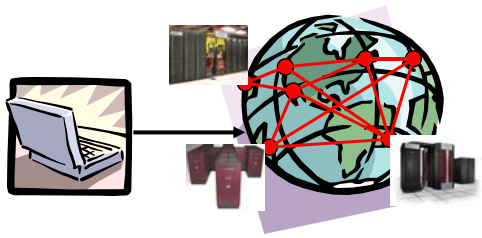
GUSTO: *Globus Ubiquitous Supercomputing Testbed Organization*

- 125 sites, 23 countries
- A testbed for the first Grid middleware



Grid Computing Emergence

Different kinds of Grids

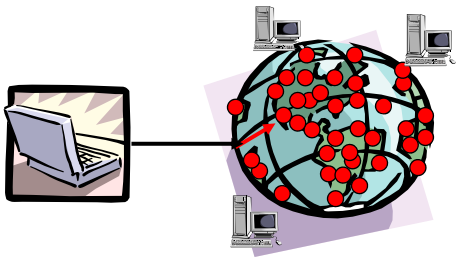


Grid of (reliable) supercomputers:

- for size up
- to access the right supercomputer (with the right architecture)

Grid Computing Emergence

Different kinds of Grids

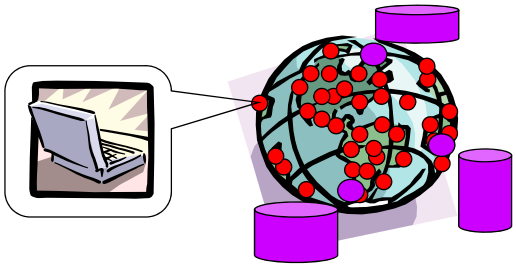


Grid of available (and volatile) desktop PCs everywhere on Internet:

- Ex: Seti@Home, LHC@Home, …
- Highly dynamic Grids (resources appear and disappear …)
- A generic middleware will be developed

Grid Computing Emergence

Different kinds of Grids



Management of CERN experiment results

Data storage + Computing rsrc

Grids of DATA:

- To share huge data.
- Repository can not be centralized… (too long access times)
  - file migration *vs* replication?
  - distributed *vs* centralized directory?
  - directory and repository coherence?

Grid Computing Emergence

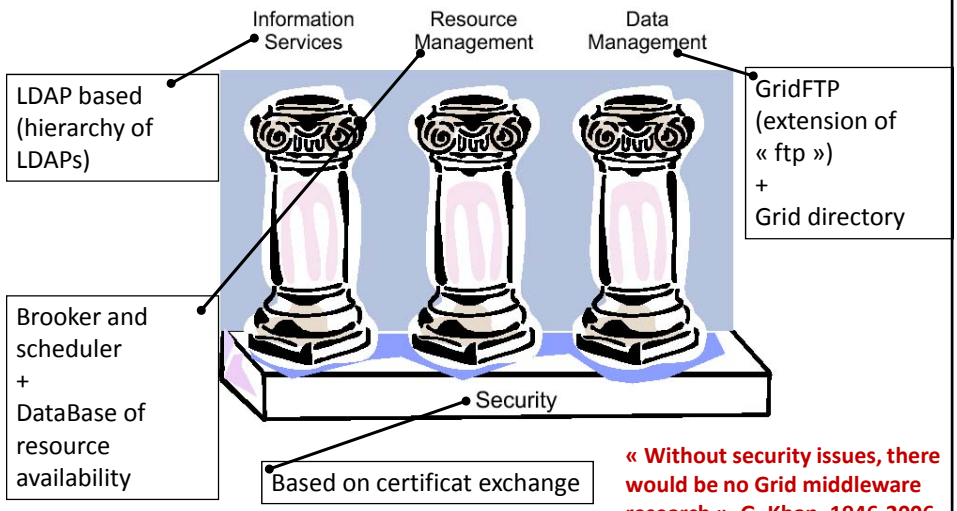
Different kinds of Grids

Collaborative Grid: distributed virtual and enhanced reality

- Real time issues, requires QoS …
- Concert across Internet in 2003, with expensive devices
  Collaborative work on virtual objects in 2009, medium cost devices

Grid Computing Emergence

Key issues of a Grid middleware

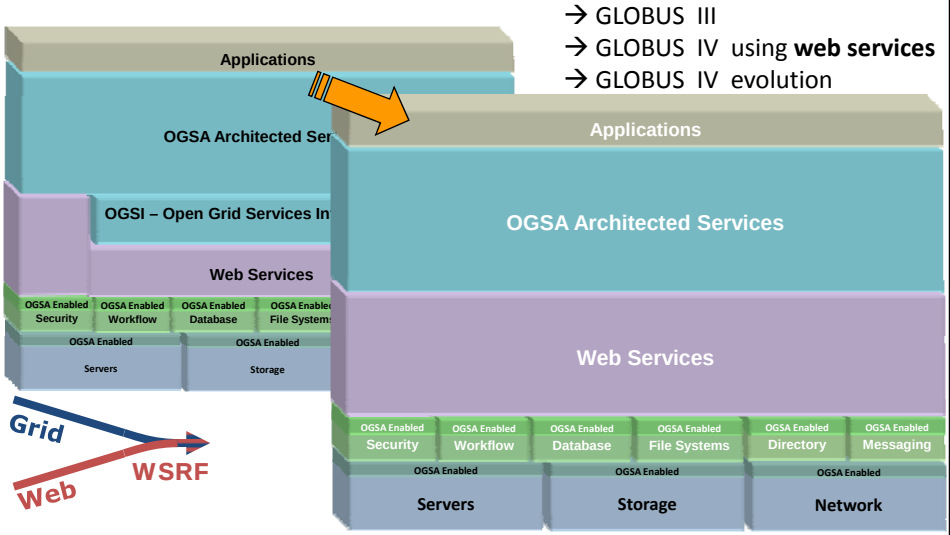


« Without security issues, there would be no Grid middleware research ». G. Khan, 1946-2006.

Grid Computing Emergence

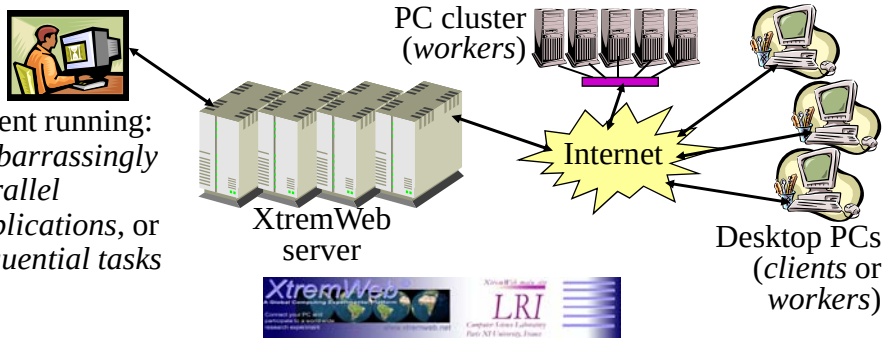
Becoming closer of Web services

*Open **Grid Service** Architecture*
→ GLOBUS III
→ GLOBUS IV using **web services**
→ GLOBUS IV evolution



Grid Computing Emergence

Grid middleware for independent tasks



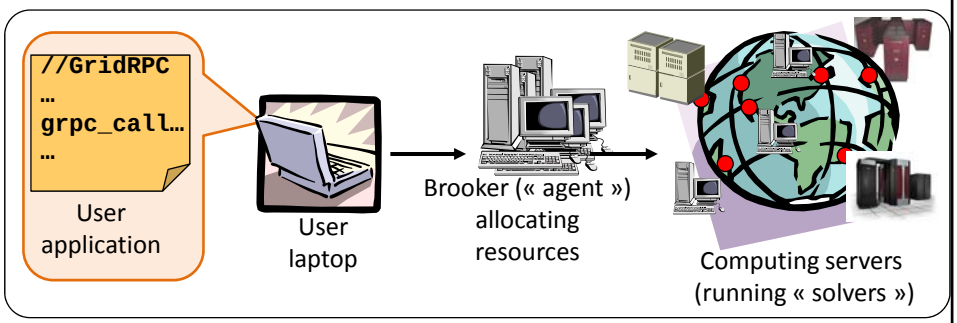
Client running:
embarrassingly parallel applications, or *sequential tasks*

Key issues:
- to deal with security of desktop workers
- support high volatility of desktop workers

Many similar industrial products

Grid Computing Emergence

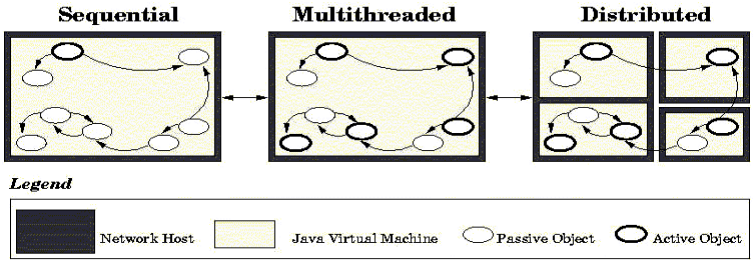
API and a Grid middleware for RPC



API: **GridRPC** + Specific Grid middleware (**NetSolve**, **Ninf**, **Diet**) + Distributed resources

Allows to implement more complex parallel applications:
- can call a parallel solver (run on one site)
- can overlap solver runs and/or communications (async. RPC)

API and Grid middleware for Active Objects



JAVA based

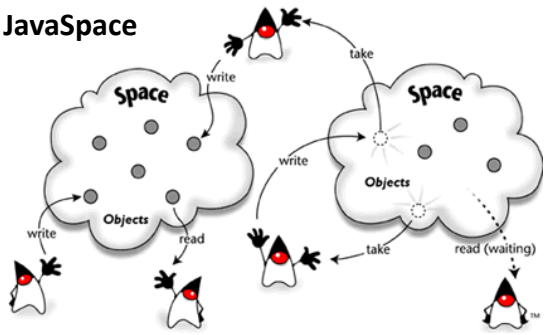
Support a large variety of parallel algorithms:

- Independent computations
- GRID RMI (object version of GRID RPC)
- Master-Workers
- Parallel algorithms with data circulation

ProActive

API and Grid middleware for a virtual shared memory

JavaSpace



A virtual shared memory *space* is located on one machine.

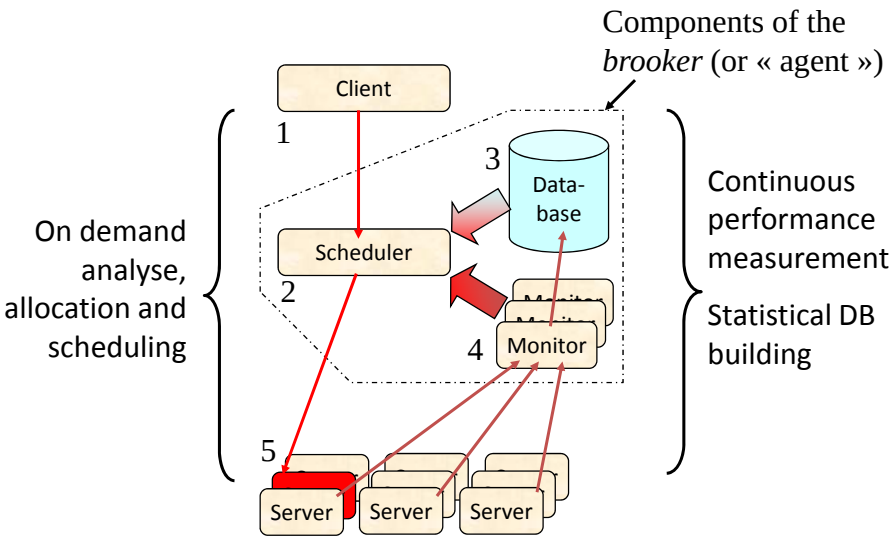
A space is R/W by any task from any machine.

Industrial products with distributed spaces (scalable spaces) exist :

GIGASPACES

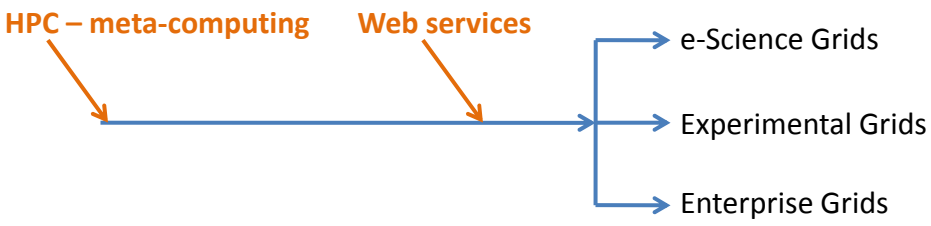
Grid Computing Emergence

Resource allocation in a Grid



Grid Computing Emergence

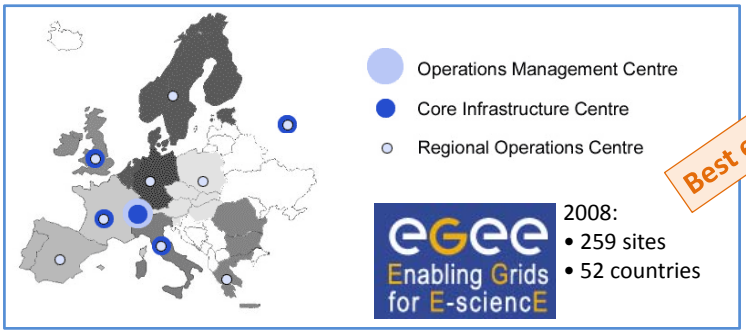
Evolution of Grids from 1998 to 2006



3 families of Grids

Grid Computing Emergence

e-Science Grids



EGEE: European production Grid for scientific research »

Middleware: Globus-II → Globus-II ++ → **gLITE**

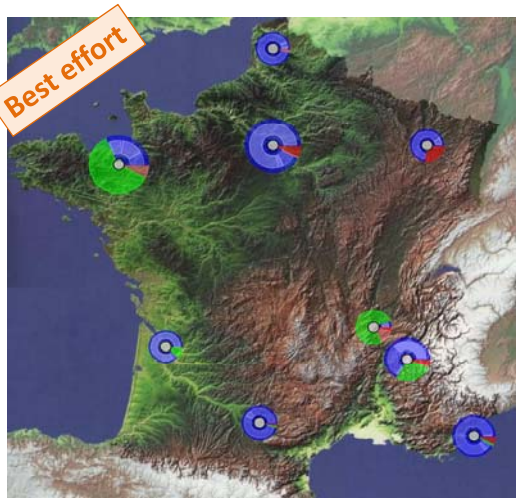
2008: 150/200 Virtual Organizations
7500/14000 users
150000 jobs/day

Each participant brings resources, and can access all resources.

Grid engineers make compatible security policies of all sites

Grid Computing Emergence

Experimental Grids



Grid'5000: French experimental Grid

Objective 1: 5000 processors
→ objective: 5000 cores
→ achieved, and surpassed

Objective 2: a real multi-site Grid
→ 15 clusters on 9 sites, +++
→ Private RENATER network, 10Gbit/s

Objective 3: a Grid for computer science research
→ NO production of applicative results

→ On demand OS deployment !!
« first cloud in the world » ☺

Grid Computing Emergence

Enterprise Grids

Definition:

One enterprise uses its PCs to run its independent & compute-intensive tasks.

The enterprise Grid is installed inside its secure network.

PCs of the Grid are not volatile:
- desktop PCs: PC of absent people,
- server farm: reliable and monitored.

Examples:
- September 2006: BNB-Paribas used a 3000 server-PC Grid (with QoS)
- June 2007: PSA observed great success of its 300-desktop-PC Grid (low QoS)

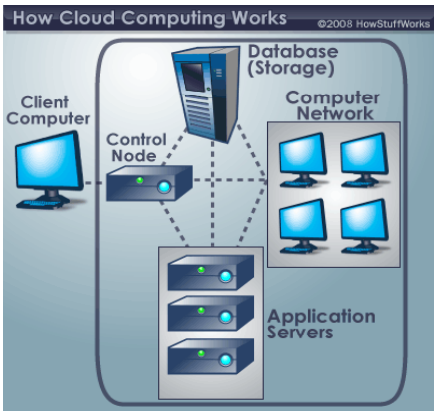
Cloud Computing Emergence

Cloud Computing Emergence

An industrial initiative (?)

Business model:

- A company provides computing resources
- Price is function of the consumed CPU time (parallelism is free)
- Data security inside the cloud
- Secure connection to join the cloud
- QoS is provided
- Virtualization on each node allows to support various applications from various customers



Personal point of view: the next step after Enterprise Grids.

Cloud Computing Emergence

An industrial initiative (?)

Large data centers:

- have global cooling and control of the machines
- allows to reduce management cost

Mutualisation:

- a customer requires machines only when he needs (on demand)
- allows to share resources between users (customers)

Ex : in March 2009, *Salesforce.com* managed data of 54 000 entreprises with only 1000 servers.

Virtualization:

- each application is run inside a virtual machine
- provides the environment required by the customer application
- allows to always use the most efficient available machines
- allows to use at 100% each machine (if machine are shared)

Data centers, Virtualization and Mutualisation reduce the cost

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Cloud Computing Emergence

A basic classification

Cloud of software (Software as a Service)

Ready to run some identified applications

Ex: Supelec experimented a private cloud of Matlab

Google ?
Google mail ?

Cloud of plateform (Platform as a Service)

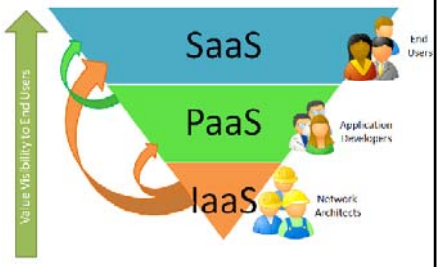
Ready to provide a development environment on an available hardware resource.

Grid'5000 ?

Cloud of hardware (Infrastructure as a Service)

Ready to provide hardware resources . The user/customer has to deploy an environment before to use these machines.

Amazone ?



Cloud Computing Emergence

First cloud assesment

« CLOUD » buzzword is a success!

Several major actors make money with « cloud technology »

Cloud was initially less ambitious than Grid, but aimed to be easier to deploy, to manage and to use

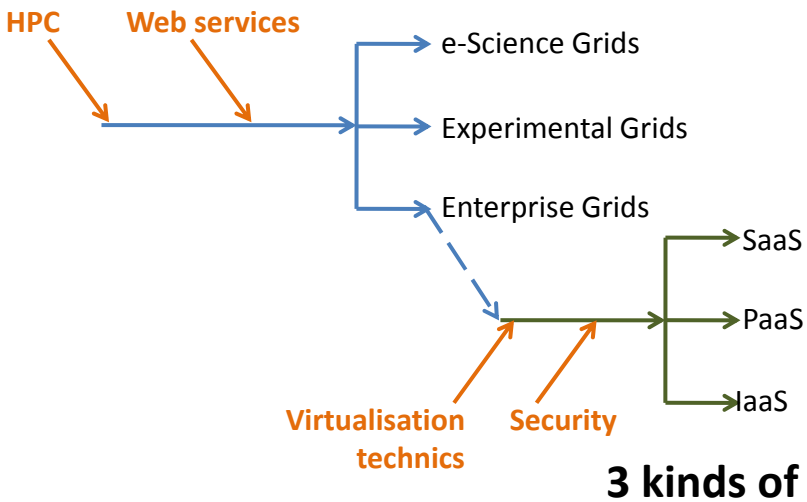
From a customer point of view :

- using extra resources on demand is a nice idea
- how can I be sure to get these extra resources when I need ?
  → limit of the « mutualisation » and QoS
- how can I be sure my data are in a secure system ?
  → limit of virtualization, remote security and transfer security

Private cloud can be an interesting compromise

Cloud Computing Emergence

From Grid to Cloud ?



3 kinds of Clouds

New Cloud Computing Approach

New approach in cloud computing

New cloud researches:

- Multi-site Clouds
- Inter-Clouds (interconnecting clouds of different institutions)

… looks like a Grid ?

Grid middleware technology is now introduced has the « Grid infrastructure for Cloud » (HPCS 2011)

50% news about « cloud » claim this new approach is promising

50% news about « cloud » say « WARNING »!

- it will (technically) fail!
- there is no business model!
- there is no need for these new clouds!

What do we need?

2008 – 2010: Europe has started some FP7 projects about « cloud »

- development of new Cloud middleware
- some of these projects are now calling for experiments

→ currently no real evaluation

September 2011: Europe opened a new call about « cloud »

- to not develop new middleware
- to develop « cloud applications » :
  - ✓ with a business model
  - ✓ at European scale

Missing real large cloud applications?

A European cloud infrastructure has a sense?

Multi-sites, multi-institution clouds have a sense?

Supélec

Future ?

I don't know! ☺

Supélec

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An overview and some
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Questions ?