Grid computing: yesterday, today and tomorrow?

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Outline

• Yesterday and today:
  Achievements in the area of e-Infrastructures and Grid computing
  • Examples beyond e-Science
  • Issues: Complexity, Cost, Security, Standards

• The future:
  • Cloud Computing, Virtualisation, Data Centers, Software as a Service, Multi-core architectures, Green IT

Conclusions
The European Commission strategy for e-Science

e-Infrastructures: strategy

Connecting the finest minds
Sharing the best scientific resources
Building global virtual communities

Weather Forecast VO
Biomedics VO
Astrophysics VO

Sharing and federating scientific data
Sharing computers, instruments and applications
Linking at the speed of the light

Mario Campolargo, EC, DG INFSOM, Director of Directorate F: Emerging Technologies and Infrastructures

e-Infrastructure achievements: Research Networks

GEANT2: At the Heart of Global Research Networking

GEANT2 Global Connectivity November 2006

GEANT2 is operated by DANTE on behalf of Europe’s research and education networks

Connect ★ Communicate ★ Collaborate
e-Infrastructure HPC achievements: EGEE and DEISA

No. Cores

The DEISA supercomputing Grid
e-Infrastructure  HPC next steps: EGI and PRACE
In summary: Grid achievements for e-Science

- Grid for e-Science: mainly a success story!
  - Several maturing Grid Middleware stack
  - Many HPC applications using the Grid
    - Some (HEP, Bio) in production use
    - Some still in testing phase: more effort required to make the Grid their day-to-day workhorse
- e-Health applications also part of the Grid
- Some industrial applications:
  - Early deployment mainly in different EC projects
Grid achievements beyond e-Science

• Grid beyond e-Science?
  – Slower adoption: prefer different environments, tools and have different TCOs
    • Intra grids, internal dedicated clusters, cloud computing
  – e-Business applications
    • Finance, ERP, SMEs and Banking!
    • New economic and business models
  – Industrial applications
    • Energy, Automotive, Aerospace, Pharmaceutical industry, Telecom
  – e-Government applications
    • Earth Observation, Civil protection:
    • e.g. The Cyclops project
CitiGroup (Citigroup Inc., operating as Citi, is a major American financial services company based in New York City) adopted Grid computing.

http://www.americanbanker.com/usb_article.html?id=20080825IXTFW8BS

- Citi chose Platform Computing's Symphony grid product to consolidate its computing assets into a single resource pool with increased utilization.
- At Citi, since the grid was implemented, individual business units are charged for the processing power they use, creating a shared services environment.
- Citi is now using near 20,000 CPUs and there are periods of the day where the utilization rate is 100 percent.
- Citi is planning of using the cloud in cases their data centers do not suffice (overflow model or cooperative data centers).
Grid achievements in industry

• IT Industry demonstrated interest in becoming an Grid infrastructure provider and/or user (intra-grids):
  – On-demand infrastructures:
    • Cloud and Elastic computing, pay as you go…
    • Data centers: Data getting more and more attention
  – Service hosting: outsourced integrated services
    • Software as a Service (SaaS)
      (e.g. Salesfoce.com services)
  – Virtualisation being exploited in Cloud and Elastic computing (e.g. Amazon EC2 virtual instances)
• “Pre-commercial procurement”
  – Research-industry collaboration in Europe to achieve new leading-edge products
    • Example: PRACE building a PetaFlop Supercomputing Centre in Euro
The HPC view from ...the clouds!

Not All Clouds are Alike

• Flexible but complex: the Grid
  Grids imply dynamic arrival/departure
  Grids may include specialized nodes

• Cost-effective but confined: the Cluster
  Clusters are typically monocultures: just one type of node
  Applications may require tuning to a particular cluster size

• Responsive but repetitive: the Hypervisor
  Virtualized servers can be quickly provisioned
  Software stack within the virtual server retains issues of versioning and configuration
  Virtual appliances demand monitoring/management

• Enterprise cloud computing implies API leverage
  Immediate focus on function; immediate delivery of value
  Concerns arise around perception of platform lock-in

Courtesy Peter Coffee, Salesforce.com
Today and the future: Green IT, pay per CPU/GB virtualisation and/or HPC in every lab?

- Computer and data centers in energy and environmental favorable locations are becoming important.
- Elastic computing, Computing on the Cloud, Data Centers and Service Hosting - Software as a Service, are becoming the new emerging solutions for HPC applications.
- Many-multi-core and CPU accelerators are promising potential breakthroughs.
- Green IT initiatives:
  - IBM Project Big Green (a $1 billion investment to dramatically increase the efficiency of IBM products) and other IT industry initiatives try to address current HPC limits in energy and environmental impact requirements.
Today and the future: Cloud computing and storage on demand

- Amazon, IBM, Google, Microsoft, Sun, Yahoo, major ‘Cloud Platform’ potential providers
- Operating compute and storage facilities around the world
- Have developed middleware technologies for resource sharing and software services
- First services already operational
  - Examples:
    - Amazon Elastic Computing Cloud (EC2) - Simple Storage Service (S3)
    - Google Apps [www.google.com/a](http://www.google.com/a)
    - Sun Network.com [www.network.com](http://www.network.com) (1$/CPU hour, no contract cost)
    - GoGrid – a division of ServePath company ([www.gogrid.com](http://www.gogrid.com)) Beta released (pay-as-you-go and pre-paid plans, server manageability)
Capital Expenditures (CAPEX):

a. Hardware costs: 80,000 CPUs ~ in the order of 120M Euros (80-160M)
Depreciating the infrastructure in 4 years: 30M euros per year (20M to 40M)
b. Cooling and power installations (supposing existing housing facilities available)
25% of H/W costs: 30M, depreciated over 5 years: 6M Euros
Total: ~ 36M Euros / year (26M-46M)
Operational Expenditures (OPEX):

a. 20 MEuros per year for all EGEE costs (including site administration, operations, middleware etc.)

b. Electricity ~10% of h/w costs: 12M Euros per year (other calculations lead to similar results)

c. Internet connectivity: Supposing no connectivity costs (existing over-provisioned NREN connectivity)

*If other model is used (to construct the service from scratch), then network costs should be taken into account*

Total 32M / year

CAPEX + OPEX = 68M per year (58-78M)
EGEE if performed with Amazon EC2 and S3

In the order of ~50M Euros, probably more cost effective of EGEE actual cost, depending on the promotion of the EC2/S3 service

Data:
25Pb stored
11Pb transferred

Estimated cost if performed with Amazon’s EC2 and S3: € 47,486,548

Cloud mature enough for big sciences?

Probably not yet, as not designed for them; Does not support complex Scenarios: “S3 lacks in terms of flexible access control and support for delegation and auditing, and it makes implicit trust assumptions”

Are commercial computing clouds ready for high-energy physics?

May 23, 2008 14.54 am

Now that Web “cloud” computing and data storage are available through Amazon, Sun Microsystems, and IBM, is it time for high-energy physicists to ditch their traditional, custom-built computing networks in favor of commercial services?

A new study looks at this question in detail for perhaps the first time. The conclusion: Not yet. In a paper available here, the researchers outline a number of things that would need to change before Amazon’s S3 data storage and EC2 computing services could meet the sophisticated data-heavy needs of physicists.

The researchers traced 27 months’ worth of data usage by DZero, one of two experiments at Fermilab’s Tevatron accelerator, to see how physicists actually handle and crunch data. The study analyzed 113,062 DZero jobs executed between January 2003 and March 2005. These involved nearly a million hours of computation and processed more than 5.2 million gigabytes of data.

The study tested the reliability and accessibility of Amazon’s Simple Storage Service (S3) and Elastic Compute Cloud (EC2) from five public Internet nodes in the US and Europe.

The authors are Magur Palankar and Adriana Iamnitchi of the University of South Florida, Matei Ripeanu of the University of British Columbia, and Simon Cariboni of Harvard. The study will be presented at the Conference on High Energy Computing (CGW’08), to be held in Cracow, Poland, October 23, 2008.

http://www.symmetrymagazine.org/breaking/2008/05/23/are-commercial-computing-clouds-ready-for-high-energy-physics/
The future: 
“To Distribute or Not To Distribute”

- In the late 90s, petaflops were considered very hard and at least 20 years off …
- while grids were supposed to happen right way
- After 10 years (around now) petaflops are “real close” but there’s still no “global grid”
- What happened:
  → It was easier to put together massive clusters than to get people to agree about how to share their resources
  → For tightly coupled HPC applications, tightly coupled machines are still necessary
  → Grids are inherently suited for loosely coupled apps or enabling access to machines and/or data
- With Gilder's Law*, bandwidth to the compute resources will promote thin client approach
  * “Bandwidth grows at least three times faster than computer power.” This means that if computer power doubles every eighteen months (per Moore's Law), then communications power doubles every six months
- Example: Tsubame machine in Tokyo
Multi-core architectures

• Computer CPUs have adopted multi-core architectures with increasing number of cores
  – 2-4 cores in PCs and laptops
  – 8-32 cores in servers, 64-80 cores under development
  – Intel announced a 6 core Xeon

• The trend is driven by many factors:
  – Power consumption, heat dissipation, energy cost, availability of high bandwidth computing at lower cost, ecological impact

• The entire software ecosystem will need to adapt including related applications
Conclusion (1/2)

• We are at a flex point in the evolution of distributed computing
  • nothing new under the sun…!
  • Grid has delivered an affordable HPC infrastructure
  • to scientists all over the world to solve intense computing and storage problems within constrained research budget (and often for social/political reasons) Grid computing
  • leveraging international research networks to deliver an effective and irreplaceable channel for international collaboration
  • This has also been effectively used by industry
  • to increase the usage of their HPC infrastructure and reduce Total Cost of Ownership (TCO)

  – Major issues with wide adoption of Grids have to do with:
    • Cost of operations, complexity, not a solution for all problems (latency, fine grain parallelism are difficult), reliability, security..
Conclusion (2/2)

- **Cloud computing** and **hosted services** are emerging as the next incarnation of distributed computing with some obvious additional advantages but not really designed with scientific applications in mind.

- Many changes are happening in the basic underpinning technology (**parallel everywhere!**)

- New boundary constraints and very much **energy** are becoming the limiting factor to the otherwise still valid Moore’s Law...

- If we will be able to harness the potential enormous power of parallel computing (not so good story so far) then we might be able to provide better computing solutions for research in energy and eventually better energy solutions for our computing needs!
Thanks

Thanks to the organizers for the kind invitation and to all of you for your attention

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