The Grid

- An introduction from a personal perspective -

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Introduction …

• First Grid-related talk of this year’s GridKa school …

• A *general* introduction, no explanation of technical details

• I assume you haven’t heard much (but a little)

• Details during the week from the *real* experts

• After a short introduction, I will discuss a handful of *crucial* aspects, which you might keep in mind during the week in order to develop your *own* opinion and perspectives on things …

• Disclaimer: Lots of what I say today is a *personal* view, based on experiences though …
... Introduction

Wow, is that the new IBM notebook pc with internal modem???

No, it's two pieces of rye bread with roast beef...
• Trivially, computing requirements must always be related to the technical abilities at a certain time …

• Until not long ago: (at least in HEP …)
  • Computing was a pure offline task:
    “Let’s first take data and then see how we handle them.”
  • Necessary resources could be provided locally
  • In HEP, people have always been used to global approaches

• Nowadays: (LHC, ILC, …)
  • Computing is treated like a detector component
  • Necessary resources can not be provided locally anymore
  • Larger amounts of resource are not provided locally

• Paradigm changed from local to global
The Major Trends in Computing

- Mainframe (one computer, many people)
- PC (one person, one computer)
- Ubiquitous Computing (one person, many computers)

Image © Mark Weiser/PARC
... Legacy ...
... Legacy ...
“We will probably see the spread of ‘computer utilities’, which, like present electric and telephone utilities, will service individual homes and offices across the country.“ Len Kleinrock (1969)

“A computational grid is a hardware and software infrastructure that provides dependable, consistent, pervasive, and inexpensive access to high-end computational capabilities.“ I. Foster, C. Kesselmann (1998)

“The sharing that we are concerned with is not primarily file exchange but rather direct access to computers, software, data, and other resources, as is required by a range of collaborative problem-solving and resource brokering strategies emerging in industry, science, and engineering. The sharing is, necessarily, highly controlled, with resources providers and consumers defining clearly and carefully just what is shared, who is allowed to share, and the conditions under which sharing occurs. A set of individuals and/or institutions defined by such sharing rules what we call a virtual organization.“ I. Foster, C. Kesselmann, S. Tuecke (2000)
The Grid

“Sharing resources within Virtual Organizations in a global world.”
Grid Dream

Mobile Access

Desktop

Visualizing

Supercomputer, PC-Cluster

Data Storage, Sensors, Experiments

Internet, Networks
Grid Computing

Grid Computing is about *virtualization* of *global* resources.

- It is about *transparent* access to globally distributed resources such as data and compute cycles.

- A Grid infrastructure consists of *services* to access resources and (of course) of the *resources* itself.
  - Opposite to *distributed computing*, Grid resources are *not centrally controlled*.
  - Hence it is mandatory to use *standard, open, general-purpose protocols and interfaces*.
  - A Grid must *deliver nontrivial qualities of services*.

- In general Grid infrastructures are *generic*; without any dependencies of the applications / experiments.
A Virtual Organization (VO) is a dynamic collection of individuals, institutions, and resources which is defined by certain sharing rules.

- A VO represents a collaboration
- Users authenticate with personal certificates (Authentication)
- Users are members of a certain VO (Authorization)
- Certificates are issued by a Certification Authority (CA)

- Grid Infrastructure
  - Core Services (mandatory per VO)
    - VO Membership Services
    - Grid Information Services
    - Workload Management System
  - Resources (brought in by partners (Grid sites))
... Building Blocks ...
... Building Blocks
Grid Types

• Data Grids:
  • Provisioning of transparent access to data which can be physically distributed within *Virtual Organizations* (VO)

• Computational Grids:
  • allow for large-scale compute resource sharing within Virtual Organizations (VO)

• (Information Grids):
  • Provisioning of information and data exchange, using well defined standards and web services

*Note!*

Jobs are *transient*; data is *persistent*.
Grid Projects
Objectives

The EGEE project brings together experts from more than 50 countries with the common aim of building on recent advances in Grid technology and developing a service Grid infrastructure which is available to scientists 24 hours-a-day.

The project provides researchers in academia and business with access to a production level Grid infrastructure, independent of their geographic location. The EGEE project also focuses on attracting a wide range of new users to the Grid.
... EGEE
Highlights from EGEE 2

- >200 VOs from several scientific domains
  - Astronomy & Astrophysics
  - Civil Protection
  - Computational Chemistry
  - Comp. Fluid Dynamics
  - Computer Science/Tools
  - Condensed Matter Physics
  - Earth Sciences
  - Fusion
  - High Energy Physics
  - Life Sciences
- Further applications under evaluation

Applications have moved from testing to routine and daily usage
~80-90% efficiency

98k jobs/day
The (Grid) Reality
Global vs. Local

• A dilemma

• The Grid idea was deployed to meet vast resource requirements (not only of LHC) *globally*

• It allowed to couple local resources at many places w/o giving up their *political* independencies

• All resources went into the Grid

• Utilization of Grid resources is *batch-like*

• Especially in HEP (LHC) physics requires at its far end *interactive* analysis

• Cycles must be directly accessible; data must be *local*

• M.Hardt: *Interactivity on the Grid* [Thursday]

• Y.Kemp: *The Global Grid and the Local Analysis* [Thursday]
Data Management …

- Online System
  - ~1 TIPS
  - ~100 MBytes/sec

- Offline Farm
  - ~20 TIPS
  - ~100 MBytes/sec

- CERN Computer Centre
  - >20 TIPS
  - ~Gbits/sec

- Tier 0
  - 1 TIPS = 25,000 SpecInt95
  - PC (1999) = ~15 SpecInt95

- Tier 1
  - US Regional Centre
  - Italian Regional Centre
  - French Regional Centre
  - GridKa Regional Centre
  - ~0.25TIPS
  - ~Gbits/sec or Air Freight

- Tier 2
  - DESY ~1 TIPS
  - Tier2 Centre ~1 TIPS
  - Centre TIPS

- Tier 3
  - Institute ~0.25TIPS
  - Institute
  - Institute
  - Physics data cache
  - Workstations
  - ~Gbits/sec
  - 100 - 1000 Mbits/sec

- Physics data cache
- Workstations

- Physicists work on analysis “channels”
- Each institute has ~10 physicists working on one or more channels
- Data for these channels should be cached by the institute server

- • One bunch crossing per 25 ns
  - • 100 triggers per second
  - • Each event is ~1 Mbyte
• Data is persistent whereas jobs are transient
• As soon as data is stored homogeneity is broken

• Original idea: VO is based on common sharing rules
• All users w/i VO are equal
• Storage: VO vs. single user

• Data consistency

• SE implementations
• SRM, gridFTP
• dCache, castor, DPM, StoRM

• G.Cowan: Importance of Data Storage [today]
Security ...
... Security

- Personal **authentication** via personal certificates issued by a Certification Authority (CA)
- **Authorization** w/i Virtual Organizations (VO)

- A user has access to *all* resources of the VO

- `ps -auwx`
- User may see what is happening on the node the jobs runs
- Admins can certainly check jobs

- Banking, car industry, health system
- ...

- D.Jackson: *Grid Security* [Friday]
Brokerage / Scheduling

• Resource Brokerage on Grid level
• Scheduling on local level

• How to protect against misuse:
  • limits/quotas per user
  • limits/quotas per VO

• Central scheduling – individual scheduling -- pilot jobs

• Shares rather then dedicated resources

• U.Schwickerath: Scheduling [Tuesday]
Software ...
... Software

- The middleware implements the Grid services and client software
- It must run on *right OS’*
- It must be
  - Developed and tested
  - Distributed and deployed
  - Operated and maintained

- VO–specific software is special
- It must be handled separately
- It must not interfere with the middleware
- It must be maintained
Operations …
• The local installation is operated in a global environment

• Queue lengths: very long queues are nightmare for admins

• Multiple VO support: Different groups want different things

• OSG (US): 1 main VO per site
  • BNL: ATLAS
  • Fermilab: CMS

• U.Lang: \textit{Achieving Sustainability for Grids} [today]
• G.Mathieu: \textit{Information Systems and Monitoring} [Friday]
Users View …
... Users View

- The Grid provides almost infinite resources to a single user on the price of a certain overhead

- Grid computing requires a new view to computing

- even the local resources appear as remote for the user (jobs are attracted by the data)

- The scheduler might always send your job to a remote site

- U. Schwiegelshohn: *Grid Business Models in Academic Environments* [Tuesday]
Support …

WARNING!

IF THE HELP DESK THINKS YOUR QUESTION IS STUPID, WE WILL SET YOU ON FIRE
... Support

• Support is one of the most underestimated issues
• It never scales
• It involves political and sociological aspects

• It can create frustration on both sides: admins and users

• It can be a nightmare
Summary …

Where are we now?

1 - Tangosol Coherence
2 - GigaSpaces
3 - Terracotta
4 - GridGain
… Summary

- Grid computing has already become a key technology
- Resources are hardly available outside the Grid in many fields
- LHC relies on the Grid!
- Admins need to operate their system in a global context
- Users must think globally when utilizing the Grid
- Globalization does not mean full freedom but requires strict standards and some disciplines

Bingo!
Grid Literature

Books:

• Foster, C. Kesselmann: *The Grid: Blueprint for a New Computing Infrastructure*, Morgan Kaufmann Publisher Inc. (1999)


Articles:


• I. Foster: *What is the Grid? A Three Point Checklist* (2002)