Grid Computing: Easy Access to Distributed Resources

HLRS Parallel Programming Workshop

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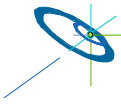
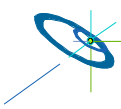


Outline

I. “The Grid” - What is it?
II. Goals & Problems
III. Projects, Tools & Applications
IV. Future
V. Summary



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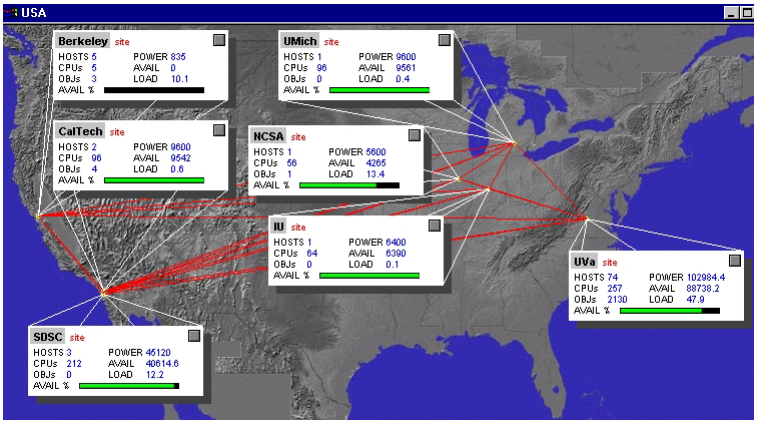
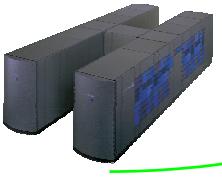
Computer, Networks, Experts



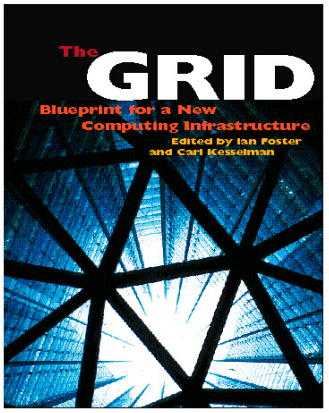
National Legion Net

Computational grid vs. electric power grid



The Grid

- Distributed Computing
  - synchronous processing
- High-Throughput Computing
  - asynchronous processing
- On-Demand Computing
  - dynamic resources
- Data-Intensive Computing
  - databases
- Collaborative Computing
  - science



Ian Foster and Carl Kesselman, editors, "The Grid: Blueprint for a New Computing Infrastructure," Morgan Kaufmann, 1999

Definitions

- *The **metacomputer** is a network of heterogeneous, computational resources linked by software in such a way that they can be used as easily as a personal computer.*
  (L. Smarr and C.E. Catlett, „Metacomputing", Communications of the ACM 35/6, 45-52, 1992.)
- *A **computational grid** is a hardware and software infrastructure that provides dependable, consistent, pervasive, and inexpensive access to high-end computational capabilities.*
  (Ian Foster & Carl Kesselman, „The Grid", MK, 1998.)
- *"**Grid Problem**", which we define as flexible, secure, coordinated resource sharing among dynamic collections of individuals, institutions, and resources.*
  (Ian Foster, Carl Kesselman and Steven Tuecke, "The Anatomy of the Grid",Int. Journal of Supercomputing Applications, 2001.)

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Goals

- "as easy to use as a PC"

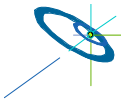
- reliable
- dynamic
- secure
- cheap
- multi-institutional

Technologies for the management of resources

- Definition of resource types:
  - Computing
  - Data
  - Network
  - Instruments
- High level services:
  - Resource discovery
  - Resource scheduling
  - Resource brokering
- Monitoring
- Security issues (authentication, authorization)

Networks

- Current bottleneck of Grids
- Gbit-Networks in place
  - USA: vBNS, Abilene, ESNet
  - Germany: G-WIN (2.5 GBits)
  - France, GB, Italy, Netherlends: similar activities
  - Interconnecting national networks:
    - STAR TAP
    - Géant
- Technology: moving away from ATM
  - Quality of Service ?



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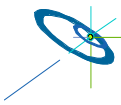
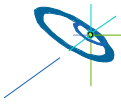


Projects

- Europe
  - DataGrid
  - EUROGRID
  - DAMIEN
  - GrASP
  - GridLab
  - FP6 (NextGrid, TrustCoM)
- USA
  - GLOBUS
  - Legion
  - IPG
  - GrADS
  - ....
- Germany
  - UNICORE+
- Italy
  - http://sara.unile.it/grb/
- France
  - Action Concertée Incitative GRID (ACI GRID)
- Great Britain
  - UK-HEP Grid
  - e-science
- Japan
  - Ninf
  - NaRegi



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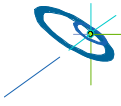
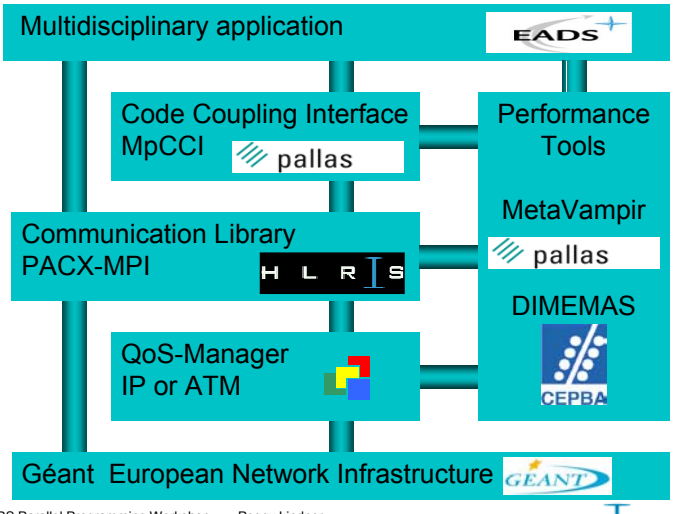


DAMIEN

- Problem
  - how to write applications for Computational-Grids ?
  - Users of Parallel Computers are used to
    - standards (e.g. MPI)
    - libraries
    - tools
  - These are not yet available for Grid-environments
- Goals:
  - provide a toolbox starting from existing and widely accepted tools to support Grid-environments
  - implement the necessary changes
  - test the toolbox with real applications from industry in a testbed

DAMIEN Structure



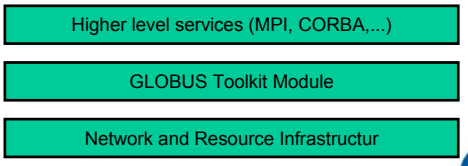
GLOBUS

- The Globus Alliance is developing fundamental technologies needed to build computational grids.
- Main partners:
  - Argonne National Lab (ANL, http://www.anl.gov/)
    Ian Foster, Steve Tuecke, Gregor von Laszewski and
  - Information Sciences Institut (ISI, http://www.isi.edu/)
    Carl Kesselmann, Karl Czajkowski, Ann L. Chervenak)
- Sponsored since 1996 mainly by:
  DARPA, DOE, NSF, and NASA IPG
- Its goal is to provide basic infrastructure that can be used to build high-level services and techniques that allow those services to observe and guide the operation of the low-level mechanisms

the globus project
www.globus.org

GLOBUS

- Resource management (GRAM)
- Communication (NEXUS, Globus-IO)
- Security (GSI)
- Remote data access (GASS)
- File Transfer (GridFtp)



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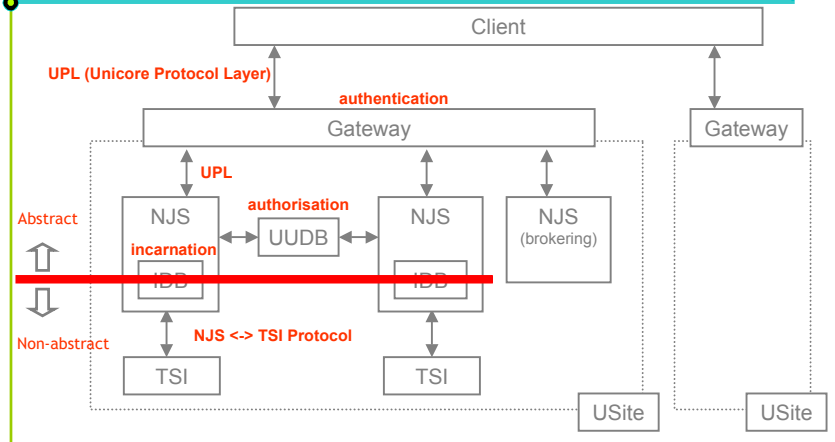
UNICORE+ ?

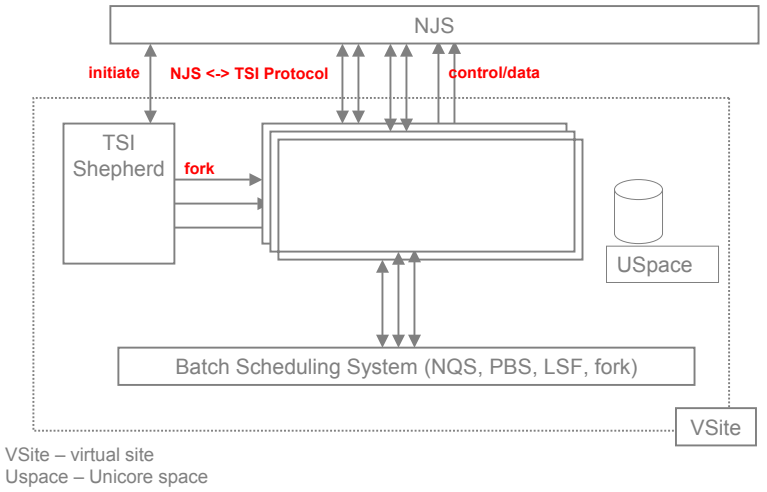
- **Uni**form **I**nterface to **CO**mputing **Re**sources
- Goals:
  - Seamless, secure and intuitive access to HPC resources
  - Consistent batch access to different remote systems
  - Support existing and emerging technologies
  - Minimal intrusion into the centers
  - Support multi-system and multi-site applications
- Partners
  - Forschungszentrum Jülich
  - Pallas GmbH
  - Deutscher Wetterdienst
  - University of Karlsruhe
  - Rechenzentrum der Universität Stuttgart
  - Leibniz-Rechenzentrum München
  - Universität-GH Paderborn
  - Konrad-Zuse-Zentrum Berlin
  - Technical University of Dresden

Architecture (I) Overview



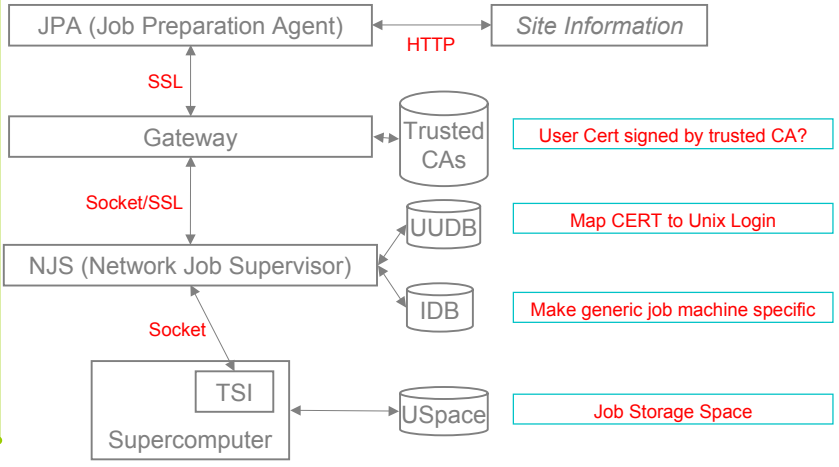
TSI – Target System Interface IDB – Incarnation Database Usite – UNICORE site
NJS – Network Job Supervisor UUDB – UNICORE User Database

Architecture (II) NJS and TSI

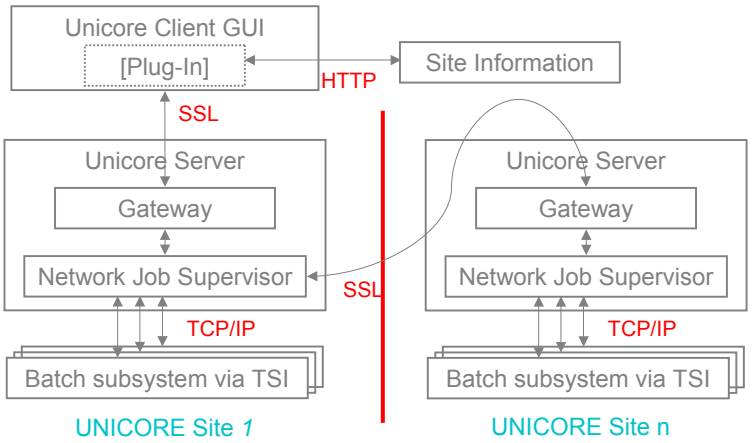


VSite – virtual site
Uspace – Unicore space

Job submission and execution



Multi-site Jobs



Extend the User Interface – The UNICORE Plug-In mechanism

- Use the plugin interface to add components to the client
  - new task types (with menu entries, dialog panels, icons)
  - new services (extension plugins)
- Plugins can
  - access site information and resources
  - construct UNICORE jobs in containers
  - containers encapsulate AJOs and UI information
  - use the remote file selector and editor
  - access and process the job outcome (results)

  ⇨ Application specific support

The UNICORE Plug-In concept

- Currently supported plug-in:
  - CPMD
  - Fluent
  - STAR-CD
  - Nastran
  - Gaussian
  - Metacomputing and Vampirtrace
  - And many more …

The UNICORE user interface

» …. Will be demonstrated now

» If you want to try go to
http://www.unicore.org/

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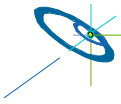
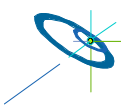


Open Grid Services - Infrastructure/ Architecture

Web Services
- Based on XML and XML Schema
- Web service model used for standardized interface description and communication
- Web services provide a kind of stateless RPC / messaging

OGSA
- OGSA also makes web services stateful – useful for the kind of services which make up a Grid
- OGSA also allows construction of service interfaces from other interfaces – interface inheritance
- OGSA provides service data – think of Remote Instance Variables (RIV) for web services



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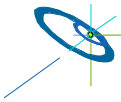

Summary

- The Grid will change the handling of users, data and jobs
- The Grid enables a higher complexity in the Simulations
- A lot of activities currently on all levels

- Lessons learnt from electric power grid
  - waste of resources
  - shortages of resources
  - international incompatibilities
  - monopolies
  - really not interested, where the resources come from ?