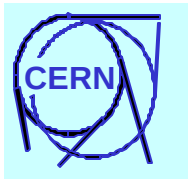

Middleware for the HEP DataGrid Project

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August, 2000

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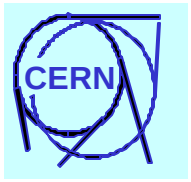
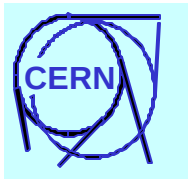


The GRID metaphor

- Unlimited ubiquitous distributed computing
- Easy to plug in
- Hidden complexity of the infrastructure
- Analogy with the electrical power GRID



The Grid from a Services View

Applications

Chemistry

Cosmology

Environment

Biology

High Energy Physics

Application Toolkits

Distributed Computing Toolkit

Data-Intensive Applications Toolkit

Collaborative Applications Toolkit

Remote Visualization Applications Toolkit

Problem Solving Applications Toolkit

Remote Instrumentation Applications Toolkit

Grid Services (Middleware)

Resource-independent and application-independent services

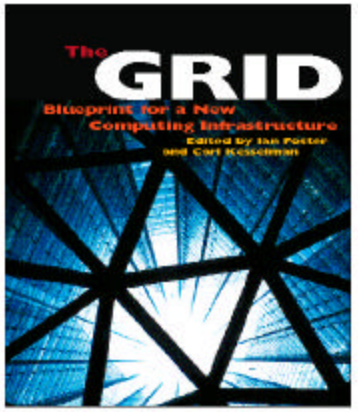
authentication, authorization, resource location, resource allocation, events, accounting, remote data access, information, policy, fault detection

Grid Fabric (Resources)

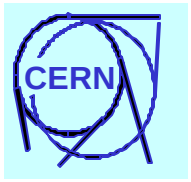
Resource-specific implementations of basic services

E.g., Transport protocols, name servers, differentiated services, CPU schedulers, public key infrastructure, site accounting, directory service, OS bypass

Are Grids a solution?



- **Change of orientation of US Meta-computing activity**
  - From inter-connected super-computers
    … .. towards a more general concept of a computational Grid (The Grid – Ian Foster, Carl Kesselman)
- **Has initiated a flurry of activity in HEP**
  - US – Particle Physics Data Grid (PPDG)
  - GriPhyN – data grid proposal submitted to NSF
  - Grid technology evaluation project in INFN
  - UK proposal for funding for a *prototype grid*
  - NASA Information Processing Grid



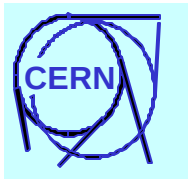
R&D required

Local fabric

- **Management of giant computing fabrics**
  - auto-installation, configuration management, resilience, self-healing
- **Mass storage management**
  - multi-PetaByte data storage, "real-time" data recording requirement, active tape layer – 1,000s of users

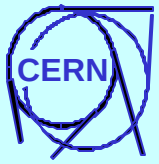
Wide-area - *building on an existing framework & RN (e.g.Globus, Geant and high performance network R&D)*

- **workload management**
  - no central status
  - local access policies
- **data management**
  - caching, replication, synchronisation
  - object database model
- **application monitoring**



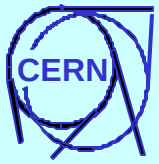
HEP Data Grid Initiative

- European level coordination of national initiatives & projects
- Principal goals:
  - Middleware for fabric & Grid management
  - Large scale testbed - major fraction of one LHC experiment
  - Production quality HEP demonstrations
    - "mock data", simulation analysis, current experiments
  - Other science demonstrations
- Three year phased developments & demos
- Complementary to other GRID projects
  - *EuroGrid:* Uniform access to parallel supercomputing resources
- Synergy to be developed (GRID Forum, Industry and Research Forum)



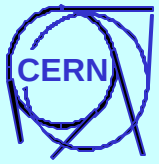
Preliminary programme of work

- WP 1 Grid Workload Management (C. Vistoli/INFN)
- WP 2 Grid Data Management (B. Segal/CERN)
- WP 3 Grid Monitoring services (R. Middleton/PPARC)
- WP 4 Fabric Management (T. Smith/CERN)
- WP 5 Mass Storage Management (J. Gordon/PPARC)
- WP 6 Integration Testbed (F. Etienne/CNRS)
- WP 7 Network Services (C. Michau/CNRS)
- WP 8 HEP Applications (F. Carminati/CERN)
- WP 9 EO Science Applications (L. Fusco/ESA)
- WP 10 Biology Applications (C. Michau/CNRS)
- WP 11 Dissemination (G. Mascari/CNR)
- WP 12 Project Management (F. Gagliardi/CERN)



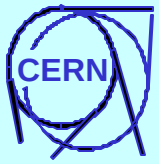
WP 1 GRID Workload Management

- **Goal: define and implement a suitable architecture for distributed scheduling and resource management in a GRID environment.**
- **Issues:**
  - Optimal co-allocation of data, CPU and network for specific "grid/network-aware" jobs
  - Distributed scheduling (data and/or code migration) of unscheduled/scheduled jobs
  - Uniform interface to various local resource managers
  - Priorities, policies on resource (CPU, Data, Network) usage



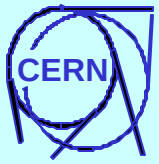
WP 2 GRID Data Management

- Goal: to specify, develop, integrate and test tools and middle-ware infrastructure to coherently manage and share PetaByte-scale information volumes in high-throughput production-quality grid environments.
- Issues:
- Universal Name Space
- WAN Data Access / Authentication / Authorization
- Efficient Data Transfer / Caching & Replication
- Interfacing to Mass Storage Systems
- Also:
- MetaData Publishing & Management



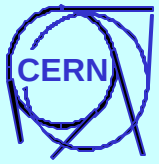
WP 3 GRID Monitoring Services

- **Goal: to specify, develop, integrate and test tools and infrastructure to enable end-user and administrator access to status and error information in a Grid environment.**
- **Goal: to permit both job performance optimisation as well as allowing for problem tracing, crucial to facilitating high performance Grid computing.**



WP 4 Fabric Management

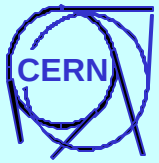
- Goal: to facilitate high performance grid computing through effective local site management.
- Goal: to permit job performance optimisation and problem tracing.
- Goal: using experience of the partners in managing clusters of several hundreds of nodes, this work package will deliver a computing fabric comprised of all the necessary tools to manage a centre providing grid services on clusters of thousands of nodes



WP 5 Mass Storage Management

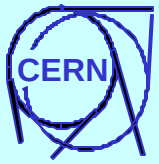
- **Goal: Recognising the use of different existing MSMS by the HEP community, provide extra functionality through common user and data export/import interfaces to all different *existing* local mass storage systems used by the project partners.**

- **Goal: Ease integration of local mass storage system with the GRID data management system by using these interfaces and through relevant information publication.**



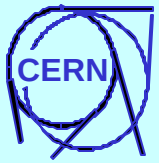
WP 6 Integration testbed

- **Goals:**
  - **plan, organise, and enable testbeds for the end-to-end application experiments, which will demonstrate the effectiveness of the Data Grid in production quality operation over high performance networks.**
  - **integrate successive releases of the software components from each of the development work packages.**
  - **demonstrate by the end of the project testbeds operating as production facilities for real end-to-end applications over large trans-European and potentially global high performance networks.**



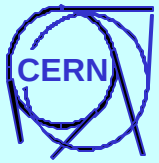
WP 7 Networking Services

- **Goals:**
  - **review the network service requirements of DataGrid and make detailed plans in collaboration with the European and national actors involved.**
  - **establish and manage the DataGrid VPN.**
  - **monitor the traffic and performance of the network, and develop models and provide tools and data for the planning of future networks, especially concentrating on the requirements of grids handling significant volumes of data.**
  - **deal with the distributed security aspects of DataGrid.**



WP 8 HEP Applications

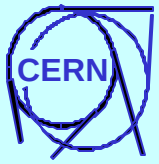
- **Goal: to exploit the developments of the project to offer transparent access to distributed data and high performance computing facilities to the geographically distributed HEP community**



WP 9 Earth Observation Science Applications

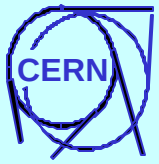
- **Goal: to define and develop EO specific components to integrate the GRID platform and bring GRID-aware application concept in the earth science environment.**

- **Goal: provide a good opportunity to exploit Earth Observation Science (EO) applications that require large computational power and access large data files distributed over geographical archive.**



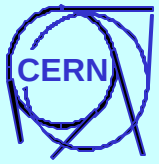
WP 10 Biology Science Applications

- **Goals:**
  - **Production, analysis and data mining of data produced within projects of sequencing of genomes or in projects with high throughput for the determination of three-dimensional macromolecular structures.**
  - **Production, storage, comparison and retrieval of measures of the genetic expression levels obtained through systems of gene profiling based on micro-arrays, or through techniques that involve the massive production of non-textual data as still images or video.**
  - **Retrieval and in-depth analysis of the biological literature (commercial and public) with the aim of the development of a search engine for relations between biological entities.**



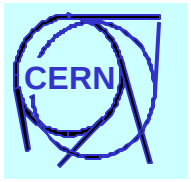
WP 11 Information Dissemination and Exploitation

- Goal: to create the critical mass of interest necessary for the deployment, on the target scale, of the results of the project. This allows the development of the skills, experience and software tools necessary to the growth of the world-wide DataGrid.
- Goal: promotion of the DataGrid middleware in industry projects and software tools
- Goal: coordination of the dissemination activities undertaken by the project partners in the European countries.
- Goal: Industry & Research Grid Forum initiated as the main exchange place of information dissemination and potential exploitation of the Data Grid results.



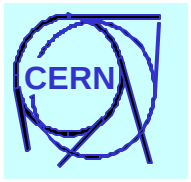
WP 12 Project Management

- **Goals:**
  - **Overall management and administration of the project.**
  - **Coordination of technical activity within the project.**
  - **Conflict and resource allocation resolution.**
  - **External relations.**



Participants

- Main partners: CERN, INFN(I), CNRS(F), PPARC(UK), NIKEF(NL), ESA-Earth Observation
- Other sciences: KNMI(NL), Biology, Medicine
- Industrial participation: CS SI/F, DataMat/I, IBM/UK
- Associated partners: Czech Republic, Finland, Germany, Hungary, Spain, Sweden (mostly computer scientists)
- Formal collaboration with USA
- Industry and Research Project Forum with representatives from:
  - Denmark, Greece, Israel, Japan, Norway, Poland, Portugal, Russia, Switzerland



Future Plans

- Test bed plans and networking to be reviewed in Lyon on June 30th
- Work Packages workshop in September
- Exchange of visits and training with Foster's and Kesselman's groups being arranged (UK and Italy soon)
- Participation to conferences and workshops (HPC in Cetraro, EU Grid workshop in Brussels, iGRID2000 in Japan, Middleware workshop in Amsterdam)