The Grid: Five Computing Models

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


The Vision of the Grid

Flexible, high-performance access to all significant resources

On-demand creation of powerful virtual computing systems and organizations
The GRID Vision

**European Grid projects**

Goals and functions of UNICORE

UNICORE Status

Experience and Challenges

Summary

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UNICORE is funded in part by BMBF, the German Ministry of Education and Research under project grant:

**UNICORE Plus: 01-IR-001**

January 1, 2000 - December 31, 2002

http://www.unicore.de

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**UNICORE Project Partners**

- Forschungszentrum Jülich (FZJ, Project coordination)
- Deutscher Wetterdienst Offenbach (DWD)
- Pallas GmbH Brühl (Pallas)
- Rechenzentrum Universität Stuttgart (RUS)
- Konrad-Zuse-Zentrum Berlin (ZIB)
- Leibniz-Rechenzentrum München (LRZ)
- Paderborn Center for Parallel Computing (PC²)
- Rechenzentrum Universität Karlsruhe (RUKA)
- Technische Universität Dresden (TUD)
- fecit*
  * Subcontractor to Pallas

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LRZ: SR 8000, VPP
RUS: Hitachi, SX-5
FZJ: 2xT3E, T90, SV1
ZIB: T3E, SGI
DWD: T3E, IBM SP
RUKA: IBM SP
PC²: hpcLine
TUD: SGI
Pallas: Sun
fecit: VPP, Sun
Research groups using Jülich’s John von Neumann Institute for Computing (NIC)

EUROGRID Partner

- Partner:
  - Forschungszentrum Jülich, D
  - Pallas GmbH, D (Project Coordinator)
  - Parallab - University of Bergen, N
  - CNRS - IDRIS, F
  - Warsaw University - ICM, PL
  - Victoria University of Manchester, UK
  - Deutscher Wetterdienst, D
  - GIE EADS CCR, F
  - ETH Zürich (CSCS Manno), CH
  - Fecit, UK (Assistant Contractor)
  - Debis Systemhaus, D (Assistant Contractor)

GRIP Partners

- Partner:
  - Forschungszentrum Jülich, D (Project Coordinator)
  - Pallas GmbH, D
  - Deutscher Wetterdienst, D
  - Victoria University of Manchester, UK
  - Fecit, UK
  - University of Southampton, UK
  - Warsaw University – ICM, PL
EU-geförderte „Take-up Action“ zur Koordination und zum Informationsaustausch aller EU-geförderten Grid Projekte

Laufzeit 1.4.2002 – 31.3.2004

Partners: all EU funded projects

Open Computing Grid for Molecular Science and Engineering


Partner:
- University of Tartu, EE (Project Coordination)
- University of Ulster, UK (Northern Ireland)
- Mario Negri Institute, IT
- Forschungszentrum Jülich, D
- ComGenex Inc., HU

GRIP Interoperability Project
Funded in Part by EC: IST-2000-32257
Duration: January 2002- December 2003

Partners:
- Forschungszentrum Jülich, D (CO)
- Pallas GmbH, D
- University of Manchester, UK
- University of Warsaw, PL
- Deutscher Wetterdienst, D
- University Southampton, UK (AC)
- Argonne National Laboratory, US (SC)
- fecit, UK (SC)

The GRID Vision
European Grid projects

Goals and functions of UNICORE
UNICORE Status
Experience and Challenges
UNICORE: UNiform Interface to COmputing Resources

• conceived prior to the ‘invention’ of the GRID
• UNICORE has both a modest and an ambitious goal:
  - Seamless
  - Secure
  - Intuitive
  access to distributed German HPC resources
• Create a system that can be used in production at the German HPC centers

UNICORE Goals

UNICORE Functions

• Creation of system-independent jobs
• Execution at different sites
• Creation of complex interdependent multi-system and multi-site jobs
• Monitoring and control of jobs
• Dependencies
• Workflow

UNICORE Functions

• Transfer of data to and from the workstation
• Automatic data transfer between systems and sites
• Access to data in Unix file systems and archives
• Application support
• No changes to third party applications
• Support for legacy job scripts
• Support for Metacomputing
• Performance analysis using VAMPIR

UNICORE Functions

• Single sign-on
• No changes to local user management and naming conventions
• Secure communication over the Internet
• Support for all platforms, operating systems, and batch systems at partner sites
• Retaining of administrative autonomy and security policies of participating sites
UNICORE Functions

- Continued development and support after the end of the project
- Basis for additional national and international projects
- Production quality prototype

UNICORE Status

- UNICORE achieves seamlessness through abstraction
  - Abstract Job Objects (AJO) model most user actions
  - Represented as Java classes and XML
- Abstract jobs are translated to system and site specific jobs and actions at the target system
- Changes at the destination don’t affect the user
**UNICORE Status**

- UNICORE implements a very strong security based on X.509 certificates
  - Single sign-on
  - Mutual authentication of clients and servers
  - Signing of code by developers
  - Signing of jobs
  - Encryption of communication

**UNICORE Architecture**

- The functions to meet the project objectives have been implemented (final version end 2002)
- Pallas GmbH in Brühl will continue to support UNICORE commercially
- UNICORE sources are available to research free of charge under community licence (download from www.unicore.org in May)
- UNICORE is used in other projects:
  - EUROGRID, GRIP, OpenMolGRID, ...
- UNICORE is available in IBM's new GRID Innovation Centre
UNICORE Status

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GRIP Objectives

- Develop software to facilitate interoperation between UNICORE and Globus combining the unique strength of each system
- Build and demonstrate biomolecular and meteorological inter-grid applications
- Contribute to and influence international Grid standards through the Global Grid Forum
  + UNICORE's Object model is well suited to be translated into Web Services
Grid Architecture

- Application Layer: Applications, Portals, Environments
- Collective Layer: Higher Services, APIs, Protocols
- Resource Layer: APIs, Protocols, SDKs
- Fabric Layer: Computers, Networks, Devices

Grid Architecture

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Globus

Legion

UNICORE
Grid Architecture

UNICORE

Application Layer
Collective Layer
Resource Layer
Fabric Layer

Applications, Portals, Environments
Services, APIs, Protocols
APIs, Protocols, SDKs
Computers, Networks, Devices

UNICORE Agents

Key UNICORE Technologies

- Seamless Computing Model
  - Job abstraction
  - Incarnation
  - File staging and transfer support
- Security Model
  - X509 certificate based security model
  - Consigner plus endorser model
  - Several CA policies
  - Fully flexible firewall support
- Generic Client
  - No changes to application needed
  - Handy GUI environment
- Portable Server
  - Java + Perl

Parallels and Contrasts

- Resource Description
  - Unicore: Same model for discovery and request
  - Globus: Different models for discovery and request
- Jobs vs Applications
  - Unicore: Workflow environment
  - Globus: Application APIs and toolkit
- Security
  - Unicore: End-to-End security model
  - Globus: Requires transitive trust
- Incarnation and Grounding
  - Unicore: Incarnation of abstractions at server
  - Globus: Client side grounding (substitution to 'normal form')?
- Protocol Complexities
  - Unicore: Polling (request/response)
  - Globus: Callback
UNICORE Missing Technologies

- Missing Models
  - Distributed directory services
  - Multi-language Implementations
  - Application level message passing
  - Event management
  - Synchronized job start
- Missing Implementations (Expected Soon)
  - Resource reservation (UNICORE Plus)
  - Interactive processing (Eurogrid)
  - File streaming (Eurogrid)
  - Dynamic rerouting of (brokered) Jobs (Eurogrid)
  - Meta-data support
  - Dynamic support for new Vsites on the fly.

Proposed Solution

Experience

- UNICORE software works extremely well
- Users demand application support
- Users need reliable solutions
- Retaining site autonomy enables integration
- Strong security is essential
Challenges

• **Support**
  – Long term commitment by developers
  – Support by the computing centers

  This is requires funding beyond projects terms

• **Staying current with other developments**
  – Globus (GRIP)
  – OGSA (GRIP and/or follow-on)

  The development must continue for many years

Challenges

• **Security**
  – Certificate management is a major hurdle for users
  – Mutual acceptance of certificates of different CA s must be solved (equivalence of policies)
  – Firewalls and firewall policies can hinder communication

  This is both a technical and an administrative challenge

Challenges

• **Administrative Autonomy**
  – Sharing of resources between centres is a major obstacle
  – different funding agencies
  – different local governments
  – different nations

  prevent effective Grid computing

  This is *only* an administrative challenge

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Web addresses:

• [http://www.unicore.de](http://www.unicore.de)
  Informationen zum Projekt

• [http://www.fz-juelich.de/unicore-test](http://www.fz-juelich.de/unicore-test)
  Freie UNICORE Client Software

• [http://www.unicore.org](http://www.unicore.org)
  Download für Software + Source

• [http://www.eurogrid.org](http://www.eurogrid.org)
  Informationen zu EUROGRID

• [http://www.grid-interoperability.org](http://www.grid-interoperability.org)
  Informationen zu GRIP