Data Grids: Opportunities and Technical Challenges Ahead

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Talk Outline

Introduction to Data Grids
  • Where and Why they need it

Concepts
  • Data Grid Transparencies
  • Gridflow, Data Grid Language

Practice
  • SDSC Storage Resource Broker, SDSC Matrix Project
  • Research Issues

Possibilities
  • Collaborate, Every one gets benefited

Reminder: Did I thank the PNC and acknowledge the SDSC Team
Grid as Utility Computing
NSF GriPhyN/iVDGL

- Petabyte scale Virtual Data Grids
- GriPhyN, iVDGL, PPDG – Trillium
  - Grid Physics Network
  - International Virtual Data Grid Laboratory
  - Particle Physics Data Grid
- Distributed worldwide
  - Harness Petascale processing, data resources
- DataTAG – Transatlantic with European Side
• Launched in August 2001
  • SDSC, NCSA, ANL, CACR, PSC

• 20 Tera flops of computing power
• One peta byte of storage
• 40 Gb/sec (academic network)
• “Building the Computational Infrastructure for Tomorrow's Scientific Discovery”
European Datagrid

- European Union
- Different Communities
  - High Energy Physics
  - Biology
  - Earth Science
- Collaborate and complement other European and US projects
PRAGMA

- Pacific Rim institutions collaborate to
  - Develop grid-enabled applications
  - Deploy the needed infrastructure
  - Allow data, computing, and other resource sharing
- Multiple collaborators
  - Australia, China, India, Japan, Korea, Malaysia, Singapore, Taiwan, US …
NIH BIRN

• Biomedical Informatics Research Network
  • Access and analyze biomedical image data
  • Data resources distributed throughout the country
  • Medical schools and research centers across the US
• Stable high performance grid based environment
  • Coordinate data sharing
  • Federate collections
  • Support data mining and analysis
NSF SCEC

• South California Earthquake Center
Distributed Data Management

- **Data collecting**
  - *Sensor systems*, object ring buffers and portals
- **Data organization**
  - *Collections*, manage data context
- **Data sharing**
  - *Data grids*, manage heterogeneity
- **Data publication**
  - *Digital libraries*, support discovery
- **Data preservation**
  - *Persistent archives*, manage technology evolution
- **Data analysis**
  - *Processing pipelines*, manage knowledge extraction
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Data Grids

A data grid provides a location independent logical name space consisting persistent identifiers for digital entities and storage resources formed by the coordination of multiple autonomous organizations.
Logical Layers (bits, data, information, ..)

Semantic data Organization (with behavior)
myActiveNeuroCollection  patientRecordsCollection

Virtual Data Transparency
image.cgi  image.wsdl  image.sql

Data Replica Transparency
image_0.jpg…image_100.jpg

Data Identifier Transparency
E:\srbVault\image.jpg  /users/srbVault/image.jpg  Select … from srb.mdas.td where...

Storage Location Transparency

Storage Resource Transparency

Inter-organizational Information Storage Management

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Need for Standard DGL

Database

SQL

DDL, DML, DQL

DGL

DGMS

XML based, Invoke Operations Subset XQuery

University of Gators

121.Event

Hits.sql

National Lab

121.Event

Thit.xml

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Data Grid Language

• Control & Context based flows
  - Declarative approach backed by relational concepts
  - Describe Workflow control structures (Sequence, Parallel Split, Cancel Step/Flow, IF loop, While loop, Milestone, …)
  - Describe Rules, Meta-data variables*

• Data Grid description
  - Data sets, collections, datagrid operations, …
  - Query on data resource (based on W3C XQuery subset)
  - Query on Process meta-data, state*

• Reference Implementation - SDSC Matrix Project

* Being Designed/developed as of the presentation date
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SDSC SRB – The History

• Started in 1995 funded by DARPA
  • Massive Data Analysis System (MDAS)
  • PI: Reagan Moore
  • “Support data-intensive applications that manipulate very large data sets by building upon object-relational database technology and archival storage technology”

• Multiple projects for many federal agencies
  • DoD, NSF, NARA, NIH, DoE, NLM, Library of Congress, NASA
  • In production or evaluation at multiple academic and research institutions round the world
SDSC SRB Team - Data “R” Us :-)

Camera-shy
- Wayne Schroeder
- Vicky Rowley (BIRN)
- Lucas Gilbert
- Marcio Faerman (SCEC)
- Antoine De Torcy (IN2P3)
- Students & emeritus
  - Erik Vandekieft
  - Reena Mathew
  - Xi (Cynthia) Sheng
  - Allen Ding
  - Grace Lin
  - Qiao Xin
  - Daniel Moore
  - Ethan Chen

World’s first ‘datagrid engineer’?
Storage Resource Broker at SDSC

More features, 80 Terabytes and counting
SDSC Matrix Project

- Gridflow Management System
- Implements the Data Grid Language using Web and Grid Standards
- Community based, open-source development
- Significant interest from grid projects, digital libraries and persistent archives for workflow
DGMS Research Issues

- Self-organization of datagrid communities
  - Inter-datagrid operations based on semantics of data in the communities (different ontologies)
- High speed data transfer
  - Terabyte to transfer - TCP/IP not final answer.
- Latency Management
  - Data source speed >> data sink speed
- Gridflow description and enactment
- Data placement and scheduling
  - How many replicas, where to place them…
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Where do we go from here?

• What can I do?
  • I am IT user: Take advantage of the new technologies
  • I am IT provider: Collaborate to find new horizons, GGF, OGSA, …, there are many things you contribute

• What possibilities
  • PRAGMA, iVDGL (develop or deploy software)
  • Open Source Software Development for Production Use

• United, we could accomplish more …
Appendix
### SDSC Storage Resource Broker & Meta-data Catalog

#### Application

<table>
<thead>
<tr>
<th>C, C++, Libraries</th>
<th>Linux I/O</th>
<th>Unix Shell</th>
<th>Java, NT Browsers</th>
<th>DLL / Python</th>
<th>GridFTP</th>
<th>Web WSDL</th>
</tr>
</thead>
</table>

#### Databases
- DB2, Oracle, Sybase

#### Archives
- HPSS, ADSM, UniTree, DMF

#### File Systems
- Unix, NT, Mac OSX

#### Databases
- DB2, Oracle, Postgres

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**Logical Name**

- Space

**Latency**

- Management

**Data Transport**

- Metadata Transport

**Consistency Management / Authorization-Authentication**

- Archives
- File Systems
- Databases

**Storage Abstraction**

- Catalog Abstraction

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**OAI**

- **Consortium**
- **Community**
- **GridFTP**

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**SDSC**

- **National Partnership for Advanced Computational Infrastructure**
- **University of Florida**
- **San Diego Supercomputer Center**

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**NPACI**
SDSC Matrix Architecture

- SOAP Service Wrapper Abstraction
  - JAXM Wrapper
  - OGSA
  - RPC-Style for SOAP
- Event Publish Subcribe, Notification
- JMS Messaging System
- Matrix Data Grid Request Processor
- Transaction Handler
- Status Query Handler
- Pipeline Query Processor
- Flow Handler and Execution Manager
- XQuery Processor
- Termination Handler
- Data flow pipeline Meta data Manager
- Matrix Agent Abstraction
  - SRB Agents
  - Other Data Services
  - OGSA Agent
  - WSDL Agent
- Persistence (Store) Abstraction
  - JDBC
  - In Memory Store

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