

# 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**



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- **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”***



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# European Datagrid



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



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# 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 ...



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# 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



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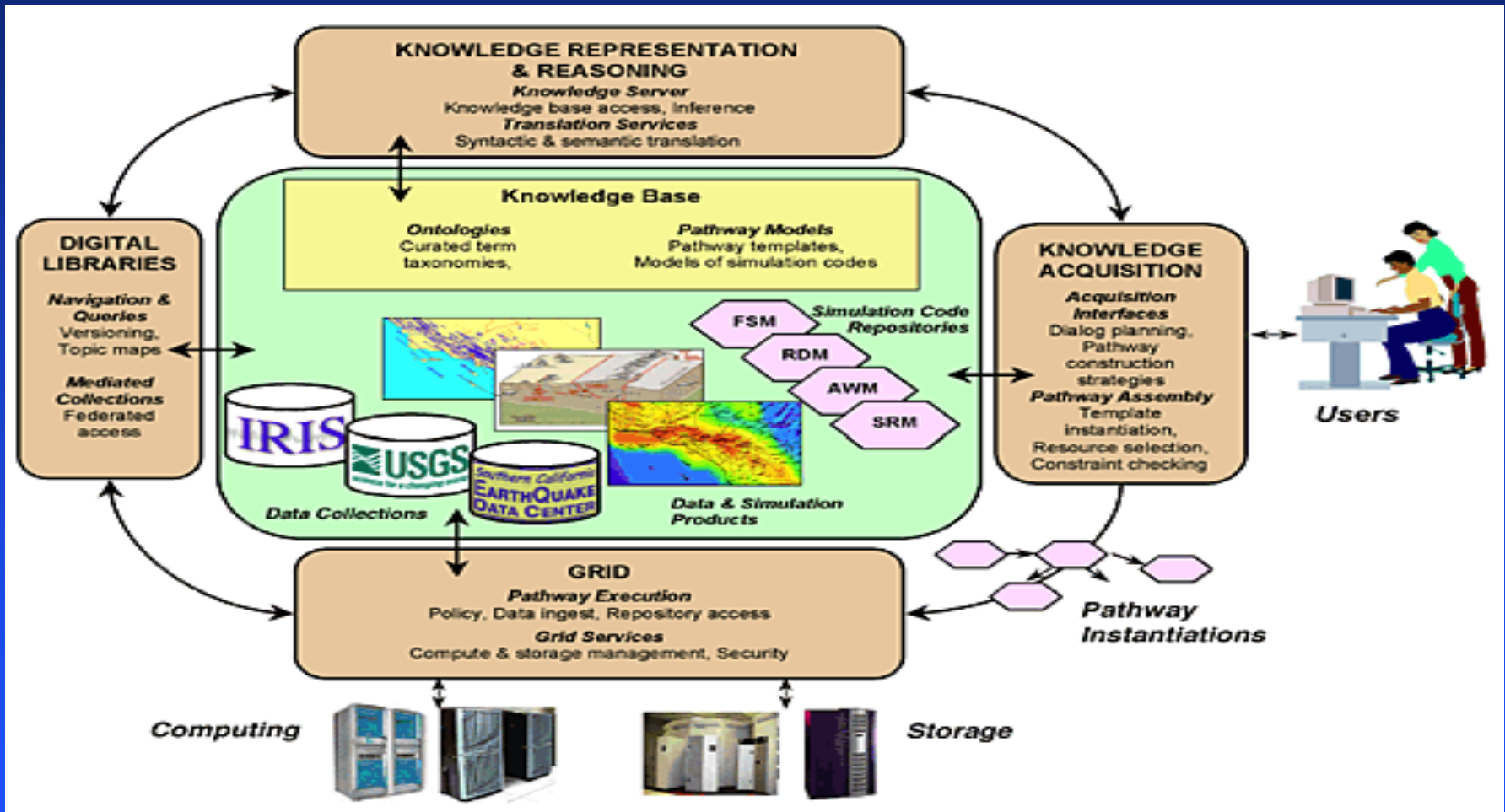
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# NSF SCEC

•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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## **Concepts**

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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.*



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# Logical Layers (bits,data,information,..)

Semantic data Organization (with behavior)  
myActiveNeuroCollection      patientRecordsCollection

Inter-organizational Information Storage Management

Virtual Data Transparency

image.cgi    image.wsdl    image.sql

Data Replica Transparency

image\_0.jpg...image\_100.jpg

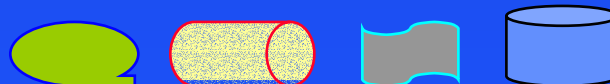
Data Identifier Transparency

E:\srbVault\image.jpg /users/srbVault/image.jpg    Select ... from srb.mdas.td where...

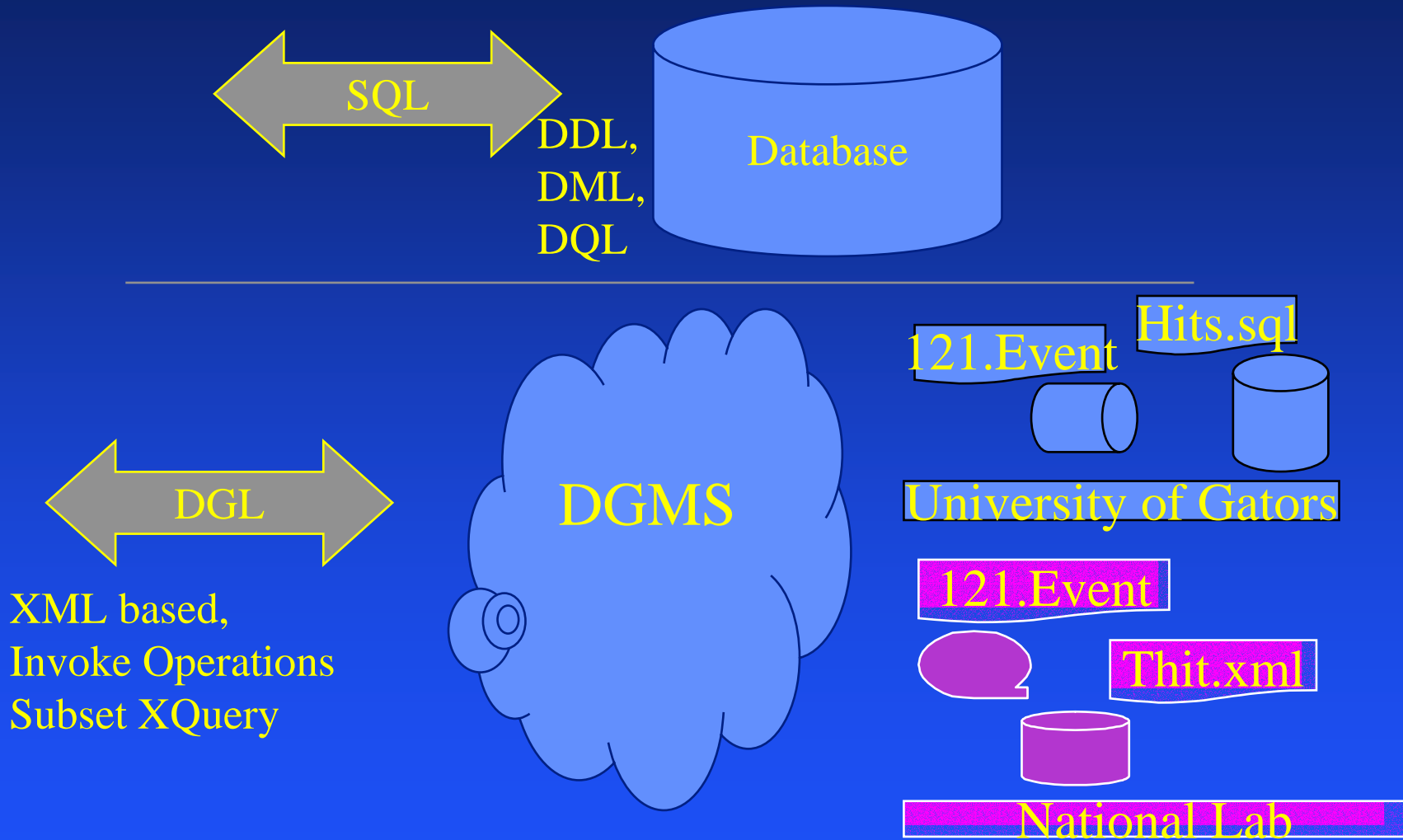
Storage Location Transparency



Storage Resource Transparency



# Need for Standard DGL



# 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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## Practice

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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



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# 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'?



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# Storage Resource Broker at SDSC

## Storage Resource Broker (SRB)

Data brokered by SDSC instances of SRB\*\*

Project Instance	As of 1/9/2002		As of 5/17/2002		As of 9/10/2002		As of 5/02/2003		As of 7/24/2003		Users	Comments	Funding Agency
	Data_size (in GB)	Count (files)	Data_size (in GB)	Count (files)	Data_size (in GB)	Count (files)	Data_size (in GB)	Count (files)	Data_size (in GB)	Count (files)			
NPACI	2,829.18	807,737	1,972.00	1,083,230	2,214.00	1,131,017	4,480.00	1,818,530	6,050.00	2,317,368	367	NPACI Users	NSF/NPACI
Digsky	10,565.00	5,079,683	17,800.00	5,139,240	29,000.00	5,225,347	33,930.00	5,292,161	48,100.00	5,719,025	68	2Mass,DPOSS,NVO	NSF/ITR
DigEmbryo	227.77	16,629	433.00	31,630	604.00	43,071	658.00	43,326	720.00	45,365	23	Visible Embryo	NLM
HyperLter	147.50	1,694	150.00	3,596	150.50	3,602	207.00	4,473	215.00	5,097	27	HyperSpectral Images	NSF/NPACI (ESS)
Hayden	3,917.00	18,112	6,900.00	41,391	6,627.00	42,227	7,078.00	59,399	7,078.00	59,399	142	FlyThrough for Planetarium	AMNH/Hayden
Portal	7.40	443	38.00	5,495	63.88	10,278	880.00	24,521	968.00	27,250	316	Grid Portal	NSF/NPACI
SLAC	434.80	9,005	514.00	77,188	605.60	83,839	1,663.00	236,688	1,700.00	254,974	43	Protein Crystallography	NSF/NPACI (Alpha)
NARA/Collection	0.02	381	7.00	2,455	7.80	30,890	47.00	34,077	52.80	79,195	51	Archival Documents	NARA
NSDU/SIO Exp			19.20	383	28.32	1,031	65.12	7,614	232.00	15,809	23	SIO Explorer Documents	NSF/NSDL
TRA			5.80	92	58.50	2,298	91.07	2,371	90.60	2,385	25	Classroom Videos	NSF/NPACI (EOT)
LDAS			239.00	1,766	424.41	3,157	477.86	9,368	496.00	9,858	60	LDAS	
BIRN					90.40	6,600	87.42	177,612	121.00	237,283	138	Biomedical Informatics	NIH (NCRR)
AICS			27.00	4,007	40.36	6,985	65.80	11,654	95.30	18,762	20	Cell Signaling Images/Docs	NIH
UCSDlib							1,084.00	138,413	1,084.00	138,415	29	Archival Image Files	UCSD
NSDU/CI							177.20	775,959	278.00	993,886	113	K-12 Curriculum Web-sites	NSF/NSDL
SCEC									12.60	18,660	38	South Cal. Earthquake Ctr	NSF/ITR
TeraGrid									623.00	38,508	1,976	TeraGrid	NSF
<b>TOTAL</b>	<b>18,126.47</b>	<b>9,934,704</b>	<b>28,006.00</b>	<b>6,399,451</b>	<b>40,103.72</b>	<b>6,590,342</b>	<b>50,991.47</b>	<b>8,636,166</b>	<b>66,008.30</b>	<b>9,979,239</b>	<b>3,461</b>		
	<b>18 TB</b>	<b>10 million</b>	<b>28 TB</b>	<b>6.4 million</b>	<b>40.1 TB</b>	<b>6.59 million</b>	<b>51 TB</b>	<b>8.64 million</b>	<b>66 TB</b>	<b>9.97 million</b>	<b>3 thousand</b>		

\*\* Does not cover data brokered by SRB spaces administered outside SDSC.

Does not cover databases, covers only files stored in file systems and archival storage systems

## More features, 80 Terabytes and counting

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# 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  $\gg$  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



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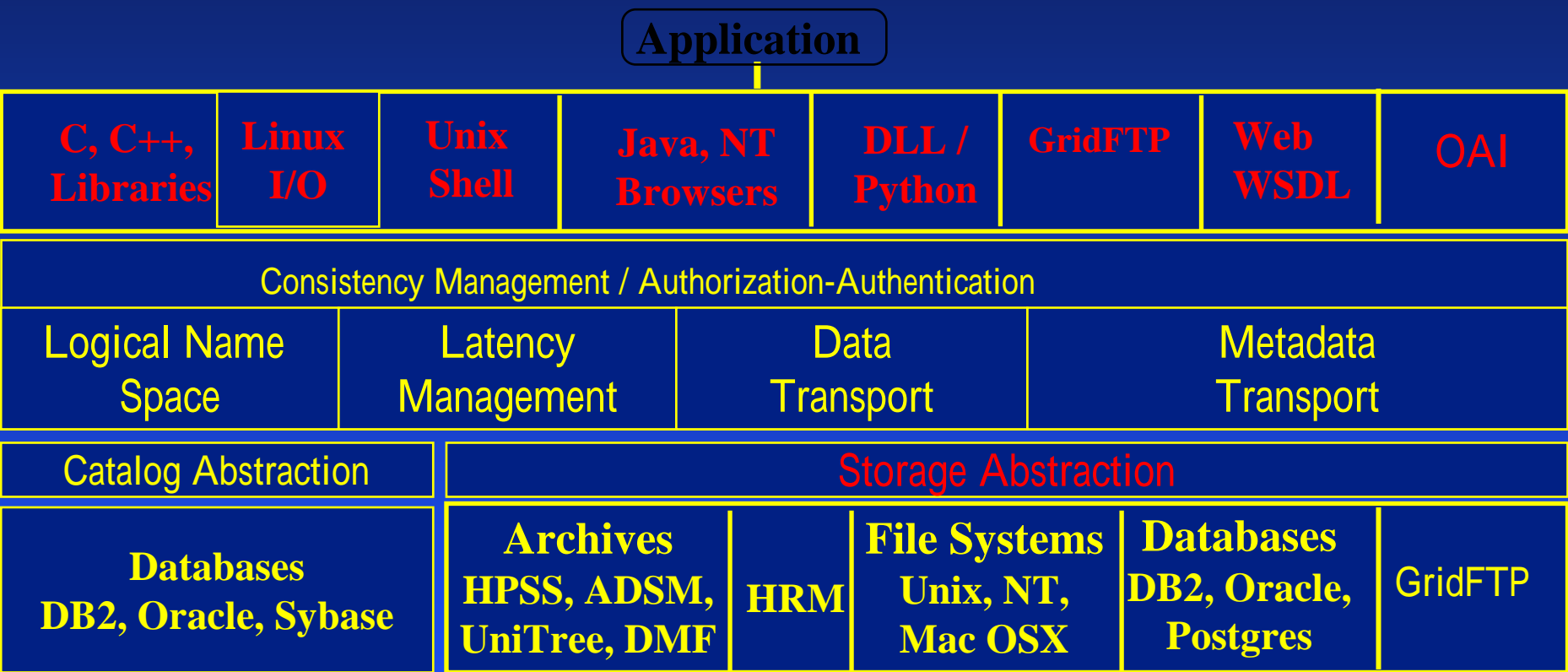
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# SDSC Storage Resource Broker & Meta-data Catalog



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# SDSC Matrix Architecture

