Digital Libraries, Data Grids, and Persistent Archives

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Presented at the THIC Meeting at the Hilton San Diego/Del Mar
Del Mar CA 92014-1901
on January 22, 2002
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Accessing Data

• How do you access storage systems at remote sites in someone else’s administration domain?

• How do you organize distributed data into a cohesive collection with global, persistent identifiers?
Information Management Projects

• **Digital Libraries**
  – CDL - AMICO
  – DARPA/USPTO - patent digital library
  – NLM Visible Embryo digital library - GMU
  – NSF Digital Library Initiative, Phase II - UCSB, Stanford
  – NSF NPACI Digital Sky - Caltech 2MASS sky survey
  – NSF NSDL - UCAR / Columbia / Cornell / UCSB

• **Data Grid Environments**
  – DOE Data Visualization Corridor - LLNL
  – DOE Particle Physics Data Grid - Stanford, Caltech
  – NASA Information Power Grid - NASA Ames
  – NIH Biomedical Informatics Research Network
  – NSF Grid Physics Network - U Florida
  – NSF National Virtual Observatory - Johns Hopkins University / Caltech
  – NSF Southern California Earthquake Center - ISI

• **Persistent Archives**
  – NARA Persistent Archive
  – NHPRC - Archivist workbench
Specifying levels of Abstraction

• Technology management becomes simpler if the persistent archive infrastructure operates on abstractions, rather than an explicit physical implementation of a resource

• Can we abstract
  – Digital objects
  – Storage
Technology Management

- Application

  - Operating System

    - Storage System Abstraction
    - Storage System
    - Digital Object Abstraction
    - Digital Object

    - Display System Abstraction
    - Display System
Types of Digital Entity Abstractions

- **Logical representation**
  - What does the digital entity represent?
  - What is the associated meaning?
- **Physical representation**
  - What is the physical structure of the digital entity?
Levels of Abstraction for Bits

Abstraction for Digital Entity

Logical: I-nodes

Physical: Track / Sector

Digital Entity

Bit Stream

Abstraction for Repository

Logical: File Name

Physical: File System (NFS/AFS/NTFS)

Repository

Disk

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Managing Distributed Storage

• Separate the organization of digital objects from their physical storage
  – Logical Name Space to manage attributes about the digital objects
  – Data handling system to manage interactions with remote storage systems
• Create storage abstraction layer
• Storage Resource Broker (SRB) provides data management system
Levels of Abstraction for Data

**Abstraction for Digital Entity**
- Logical: Data Model (units, semantics)
- Physical: Encoding Format (syntax, structure)

**Abstraction for Repository**
- Logical: Name Space
- Physical: Data Handling System - SRB/MCAT

**Digital Entity**
- Files

**Repository**
- File System, Archive
Visible Embryo Project

Disk Cache

OHSU

GST

Eolas

Disk Cache

UIC Startup

ATD Net

BEN

ASX200

AFIP: Collab WS

NIC

MSWS

NT WS

MSWS

NT WS

Oakland

100 Gbit

Vegas

HSCC

WRL

DS3

JHU

OC-3

Disk Cache

OC-3

VBNS

OC-12

JHU

Abilene

OC-3

GMU

Disk Cache

DC POP

Abilene

OC-3

SDSC

Archive

NSP

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Disaster Response

- Support replicas - provide multiple copies of a data set stored at multiple sites, but accessed by the same logical file name.
- On access, map from logical file name to the physical file name. If the file is not accessible, automatically fail over to a replica.
SDSC Storage Resource Broker & Meta-data Catalog

<table>
<thead>
<tr>
<th>Application</th>
<th>Clients</th>
<th>Prime Server</th>
<th>Servers</th>
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Information Management - Logical Name Space

- Set of attributes to describe digital entities that are registered into the logical name space
  - SRB metadata - Unix file system semantics
  - Provenance metadata - Dublin Core
  - Resource metadata - User access control lists
  - Discipline metadata - User defined attributes
- Each digital entity may have unique attributes
Information Management

• Abstraction layer for interacting with information repositories
  – Manage the schema and physical table structures of a database
  – Extensible schema
  – User defined attributes

• Extensible Metadata CATalog (EMCAT) manages collections

• mySRB.html interface supports dynamic collection creation
Levels of Abstraction for Information

- Abstraction for Digital Entity
  - Logical: Collection Schema
  - Physical: XML Syntax

- Digital Entity

- Abstraction for Repository
  - Logical: Database Schema
  - Physical: EMCAT/CWM

- Repository

- Metadata Attributes

- Database
Knowledge Management - Discovery across Collections

- Characterization of relationships between attributes
  - Semantic / logical - cross-walks
  - Procedural / temporal - records management
  - Structural / spatial - GIS
- Abstraction layer for knowledge repositories
- Mapping from collection attributes to discipline concepts
- Model-based Mediation supports mapping from knowledge relationships to rule-based inference engines
Levels of Abstraction for Knowledge

### Abstraction for Digital Entity
- **Logical:** Relationship Schema
- **Physical:** ER/UML/XMI/RDF syntax

### Abstraction for Repository
- **Logical:** Knowledge Repository Schema
- **Physical:** Model-based Mediation System

### Digital Entity
- **Concept Space** (ontology instance)

### Repository
- **Knowledge Repository**
ERA Concept model

Mediation of Information using XML Storage Resource Broker/Extensible Meta-data CATalog

ERA: Archival Components Concept

Grid Security Infrastructure

Tapes

Disks

Internet

Records Schedule

Accessing Workbench
- Accession
- Verify
- Wrap & Containerize
- Describe

Archival Repository
- Collection
- Collection
- Metadata

Reference Workbench
- Query
- Rebuild
- Present

Collection

Collections

Archival Research Catalog

Older Fulfillment System
Further Information

• Academic
  http://www.npaci.edu/DICE

• Commercial - Storage Resource Broker
  constantin.scheder@gat.com