Integration of Object-based Storage into Preservation Environments

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Preservation

- Archival processes through which a digital entity is extracted from its creation environment, and then supported in a preservation environment, while maintaining authenticity and integrity information.
- Extraction process requires insertion of support infrastructure underneath the digital material
- Goal is infrastructure independence, the ability to use any commercial storage system, database, or access mechanism
- Can Object-based Storage Devices support preservation functions?

Preservation Communities

- InterPARES - diplomatics
  - Preservation of records
- NARA - life cycle management model
  - Preservation of records from federal agencies
- State archives
  - Preservation of submitted “collections”
- Australia - continuum model
  - Preservation of active data with records

InterPARES - Diplomatics

- Authenticity - maintain links to metadata for:
  - Date record is made
  - Date record is transmitted
  - Date record is received
  - Date record is set aside [i.e. filed]
  - Name of author (person or organization issuing the record)
  - Name of addressee (person or organization for whom the record is intended)
  - Name of writer (entity responsible for the articulation of the record's content)
  - Name of originator (electronic address from which record is sent)
  - Name of recipient(s) (person or organization to whom the record is sent)
  - Name of creator (entity in whose archival fonds the record exists)
  - Name of action or matter (the activity for which the record is created)
  - Name of documentary form (e.g. E-mail, report, memo)
  - Identification of digital components
  - Identification of attachments (e.g. digital signature)
  - Archival bond (e.g. classification code)

InterPARES - Diplomatics

- Integrity - maintain links to metadata for
  - Name(s) of the handling office / officer
  - Name of office of primary responsibility for keeping the record
  - Annotations or comments
  - Actions carried out on the record
  - Technical modifications due to transformative migration
  - Validation

Support Infrastructure

- Manages the electronic records
- Manages the provenance metadata (authenticity)
- Manages the integrity metadata
- Manages the name spaces used to control the electronic records

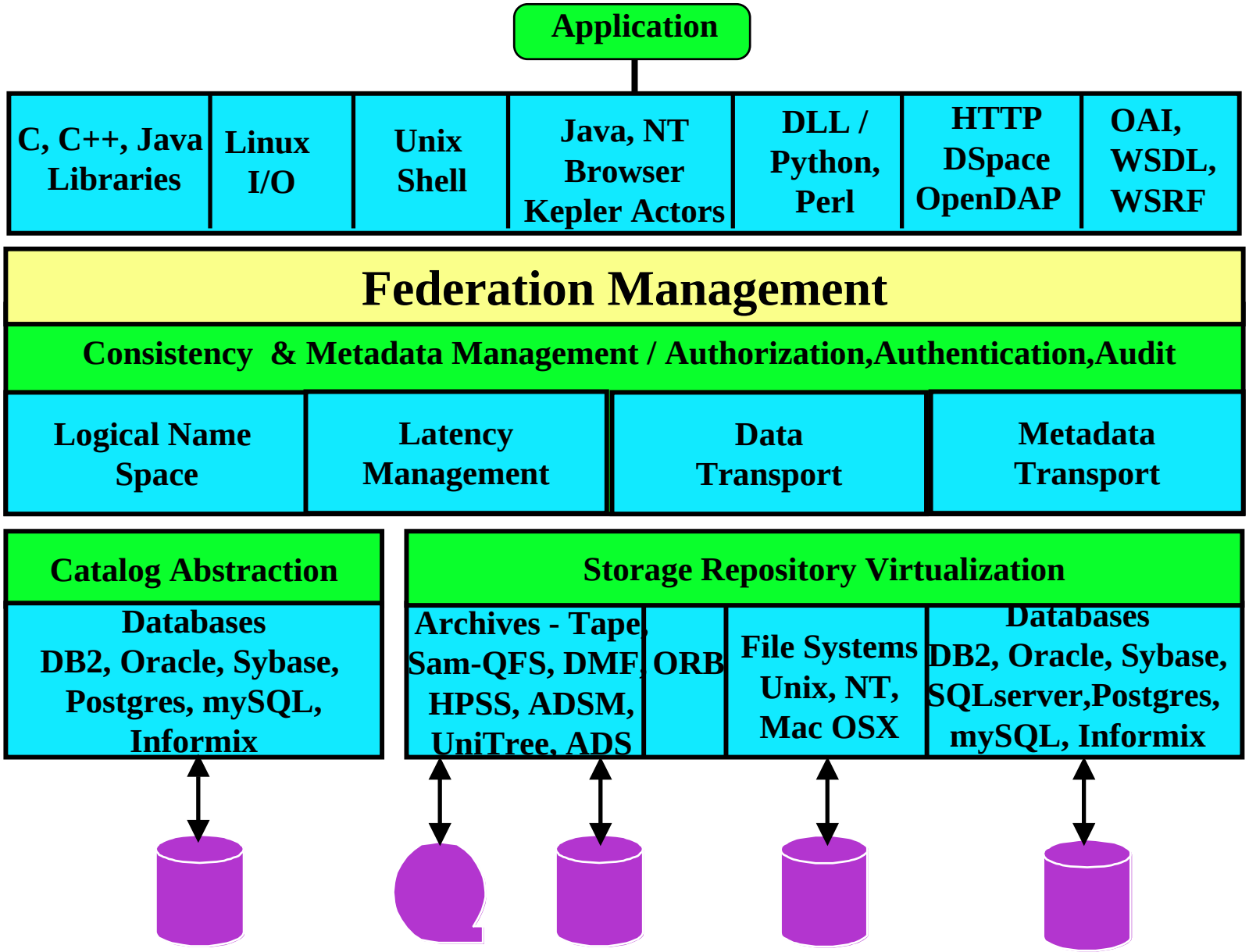
Data Grid Support for Preservation

- Authenticity - the assurance that provenance metadata remains linked to the electronic records
  - Link authenticity metadata (descriptive metadata) to files
  - Location independent naming convention for files
- Integrity - the assurance that the electronic records are not corrupted
  - Link integrity metadata (audit trails, access controls, checksums)
  - Support for distributed environments (replication, federation)
- Infrastructure Independence
  - Standard operations across databases
  - Standard operations across storage repositories

Data Grids

- Manage shared collections that are distributed in space
  - Location of item, access controls, checksums
- Implement infrastructure independence
  - Standard operations for interacting with storage repositories
- Implement presentation independence
  - Standard APIs to support porting of user interfaces

Storage Resource Broker - Data Grid



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Managing Distributed Data Name Spaces

Data Access Methods (Web Browser, Java, Perl, “C”)

Storage Repository

- Storage location
- User name
- File name
- File context (creation date,…)
- Access constraints

Naming conventions provided by storage systems

Data Grids Provide a Level of Indirection for Each Naming Convention

Data Access Methods (C library, Unix, Web Browser)

Data is organized as a shared collection

Data Collection

Storage Repository

- Storage location
- User name
- File name
- File context (creation date,…)
- Access constraints

Data Grid

- Logical resource name space
- Logical user name space
- Logical file name space
- Logical context (metadata)
- Control/consistency constraints

Authenticity

- Package authenticity metadata with the electronic record in an Archival Information Package (AIP)
  - Reference Model for an Open Archival Information System (OAIS).
  - Metadata Encoding and Transmission Standard (METS)
- Validate AIPs for conformance with preservation metadata standard METS profile
  - Standard evolves over time

Integrity

- Package integrity metadata with electronic records in an AIP
- Update AIP on every operation on the electronic record
  - Audit trail
  - Date of checksum validation
  - Transformative migrations of encoding format

Data Grid Operations

- Remote operations
  - Unix file system (open, close, seek, read, write, stat,..)
  - Bulk operations for latency management
  - Remote procedures for data filtering
  - Data transformations
  - Third party transfer
- Collective operations
  - Load leveling
  - Fault tolerance
  - Replication

Latency Management -Bulk Operations

- Bulk register
  - Create a logical name for a file
- Bulk load
  - Create a copy of the file on a data grid storage repository
- Bulk unload
  - Provide containers to hold small files and pointers to each file location
- Bulk delete
  - Mark as deleted in metadata catalog
  - After specified interval, delete file
- Bulk metadata load
  - Support parsing of metadata from a remote file at remote storage
- Requests for bulk operations for access control setting, …

Operations Performed by Object-based Storage Device

- Manipulation
  - Bulk operations for metadata extraction, registration of digital entities, load and unload of data
- Integrity
  - Validation of checksums
  - Validation of AIPs
  - Updates of Archival Information Packages
- Presentation
  - Transformative migration
    - Conversion of encoding format for display

Implications

- Global properties are managed by the data grid
  - Name spaces
  - Collective operations
- OSD can support local operations
  - Metadata extraction from files
  - AIP manipulation
- Security will be distributed between the data grid and the OSD
  - Data grids manage data distributed across administrative domains

Security Management

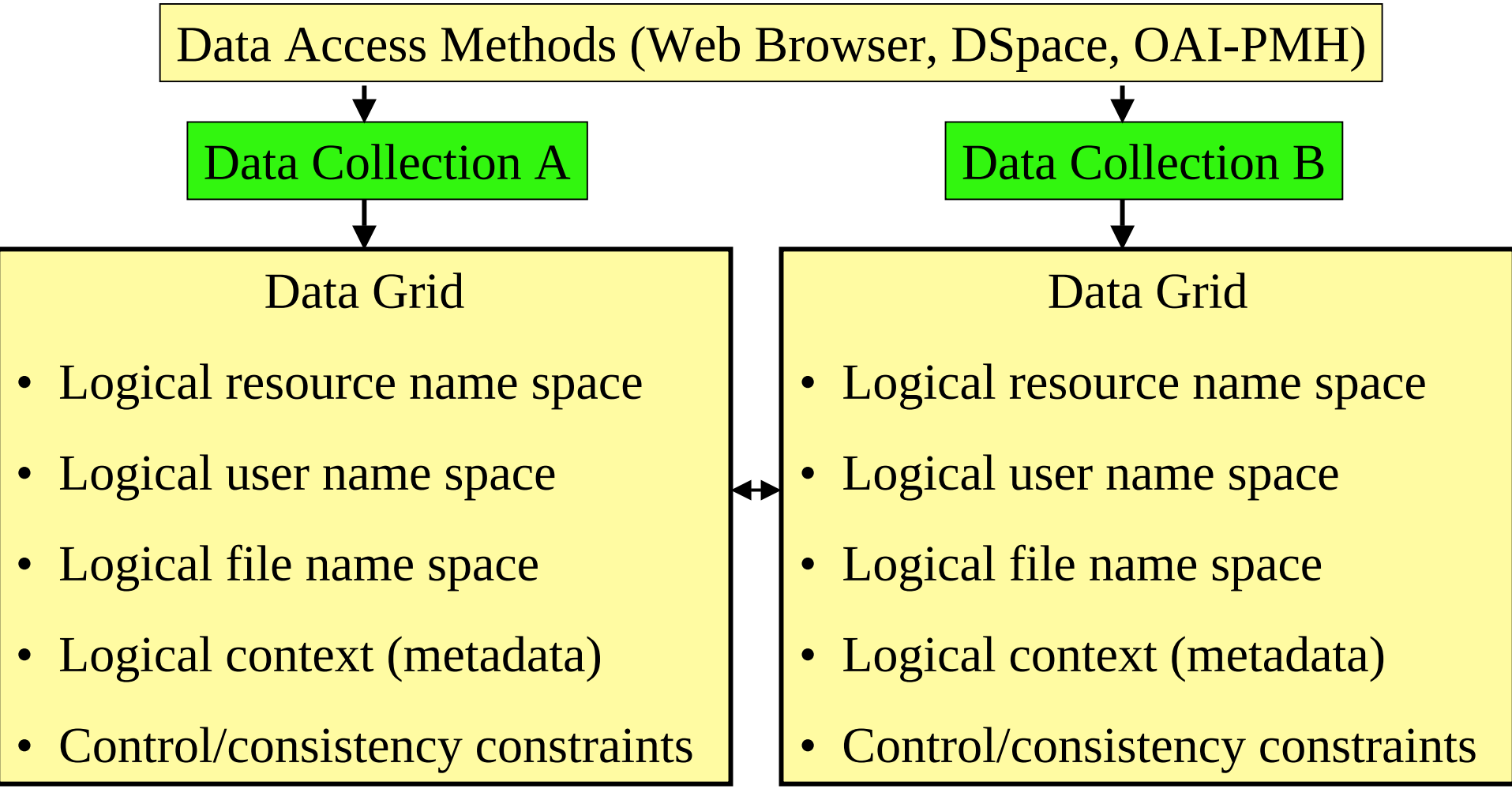
- Within the shared collection, the digital entities are owned and managed by the data grid
  - Files, URLs, SQL commands, database binary large objects can be registered into the shared collection
  - Files are stored under an account ID representing the data grid
- Access controls are managed by the data grid
  - Files / metadata / storage systems
- Access controls are defined for multiple roles
  - Schema extension, create new metadata
  - Modify metadata
  - Add annotations
  - Turn on audit trails
  - Write data
  - Read data

Federation of Data Grids

- A data grid provides a single sign-on environment
  - The data grid manages the name space for the user
- To authenticate persons between data grids
  - Define user name to be

    Home data grid / Group / User
  - Access Home data grid for authentication

Federation Between Enterprises



Access controls and consistency constraints
on cross registration of digital entities

Preservation Environments (Based on Storage Resource Broker)

- NARA research prototype persistent archive
- NHPRC Persistent Archive Testbed
- NSF National Science Digital Library persistent archive
- University of California - Digital Preservation Repository
- UCSD image archive
- MIT DSpace/SRB preservation environment

Storage Resource Broker Collections at SDSC (4/18/2005)	GBs of data stored	Number of files	Number of Users
Data Grid	Ê	Ê	Ê
NSF/ITR - National Virtual Observatory	53,862	9,536,751	100
NSF - National Partnership for Advanced Computational Infrastructure	33,196	6,878,235	380
Static collections ĞHayden planetarium	8,013	161,352	227
Pzone Ğ public collections	7,511	3,918644	67
NSF/NPACI - Biology and Environmental collections	22,179	54,695	67
NSF/NPACI ĞJoint Center for Structural Genomics	6,785	913,430	50
NSF - TeraGrid, ENZO Cosmology simulations	165,470	1,360,795	3,267
NIH - Biomedical Informatics Research Network	10,674	7,168,846	268
Digital Library	Ê	Ê	Ê
NSF/NPACI - Long Term Ecological Reserve	256	9,033	36
NSF/NPACI - Grid Portal	2,620	53,048	460
NIH - Alliance for Cell Signaling microarray data	559	71,318	21
NSF - National Science Digital Library SIO Explorer collection	2,655	1,052,550	27
NSF/ITR - Southern California Earthquake Center	107,470	2,304,282	64
Persistent Archive	Ê	Ê	Ê
NHPRC Persistent Archive Testbed (Kentucky, Ohio, Michigan, Minnesota)	96	378,806	28
UCSD Libraries archive	4,147	408,050	29
NARA- Research Prototype Persistent Archive	1,449	883,982	58
NSF - National Science Digital Library persistent archive	3,572	26,931,909	136
TOTAL	430 TB	62 million	5,285

Scalability

- Major challenge is the large number of files
  - Databases scale to a billion records
  - File systems scale to 20-50 million files
- Use containers to aggregate data before storage
  - Minimizes the number of files seen by the storage system
- Distribute files across storage systems
  - Load leveling
- Distribute files across data grids

Conclusion

- Object-based storage devices can support operations essential to preservation environments
  - Association of authenticity and integrity metadata with each file
  - Operations on the metadata (update, validation)
  - Integrity checking of files
  - Operations on the files (metadata extraction, transformative migration)

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