Data Sharing with iRODS
(integrated Rule-oriented Data System)

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Sustainable Archives & Library Technologies
a laboratory on digital preservation since 2002
SALT: a metaphor for “Data Curation”??
GOAL: Building a Preservation Reference
Implementation (1/2)

• Go beyond preservation and access &
address the full lifecycle:
  • Appraisal & Disposition
  • Accessioning
  • Arrangement
  • Description
  • Preservation policy enforcement
  • Preservation trustworthiness assessments
GOAL: Building a Preservation Reference
Implementation (2/2)

• The reference implementation consists of:
  • the record management environment
  • the preservation management rules
  • the management processes that implement preservation services, and
  • the rules that verify compliance with assessment criteria.
DICE Data Sharing Collaboratives

• **For Long-Term Digital Preservation:**
  Collaborative activities with the National Archives, International, State and Professional archivist organizations, researching and developing prototypes for the long-term preservation of digital records. Innovative classes and workshop taught to archivists and IT professionals.

• **For the Humanities:**
  Collaborations include: T-RACES (a Testbed for the Redlining Archives of California’s Exclusionary Spaces) where a historical collection of urban and ethnic data and UC-wide data grid infrastructure are being developed. Teaching CI methods for the digital humanities over the last 2 years (summer workshops for IT staff and humanities researchers).

• **For the Social Sciences:**
  Involved in teaching research methodologies in the social sciences in the UCSD Urban Studies and Planning senior sequence series. Information Technology Award -- American Planning Association (APA) – April 17, 2006 for "Best Use of Technology for a University Urban and Regional Planning Program in the Information Technology Division”. Involved in a “Global Planning Grid” initiative.

• **For Community Informatics and Tribal Groups:**
  Collaborations with groups interested in community networking technologies: Tribal Regional Workbench (a Community Outreach Core of the UCSD Superfund Basic Research Program 2005-2010 – “Risk Assessment and Traditional Tribal Lifeways), and developing tools for preserving American Indian culture. “Koorie Archiving”: Monash University (Australian Research Council, pending).
## Current Research Projects: ~$10 million

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<td><strong>$260K</strong></td>
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iRODS Collaborations

- Notre Dame University - porting of the Parrot interface on top of iRODS, unifies access to GridFTP, iRODS, file systems
- University of Texas, Austin - creation of a Common Teragrid Software Stack kit for iRODS, simplifies installation of iRODS on Teragrid Sites
- Vanderbilt - integration of iRODS with LStore and Logistical Networking, integrates a distributed metadata catalog for the TDLC data grid
- MIT - integration of DSpace with iRODS, funded by NARA
- Fedora Commons - integration of Fedora with iRODS in support of NSDL
- Stanford - proposal to use LOCKSS reliability technology for guarantees on distributed iRODS rule base
iRODS Collaborations

- **SHAMAN** - integration of Cheshire and Multivalent browsing into iRODS micro-services for parsing data objects
- **CASPAR** - representation information for data and Trusted Repository Audit check list assessment of iRODS rules
- **James Cook University** - porting of Python, Perl, PHP load libraries on iRODS
- **UK ASPIS project** - integration of Shibboleth authentication with iRODS
- **ATOS** - use of iRODS in Bibliotheque Nationale de France
- **DEISA** - use of iRODS in European supercomputer centers
- **D-Grid** - iRODS beta test site
- **Archer** - creation of preservation rules (TRAC)
iRODS Interested Parties

- Royal British Columbia Museum - iRODS rules for fixity
- Globus - integration of iRODS and GridFTP
- Aerospace Corp - data interoperability
- Merrill Lynch - rule-based data management
- University of York - DAME distributed analysis systems
- IBM - integration with object based storage devices
- SNIA - integration with XAM technology
- Mitre - support for real-time data streams
- JPL - Planetary Data System
iRODS Tutorials - 2008

- January 31, SDSC
- April 8 - ISGC, Taipei
- May 13 - China, National Academy of Science
- May 27-30 - UK eScience, Edinburgh
- June 5 - OGF23, Barcelona
- July 7-11 - SAA, SDSC
- August 4-8 - SAA, SDSC
- August 25 - SAA, San Francisco
iRODS: the Latest Generation of Data Grids

Data Grids are middleware services

- Sitting between the applications and data providers
- Providing transparent and uniform access
- To diverse types of digital assets
  - Files, databases, streams, web, programs,…
  - Documents, images, data, sensor packets, tables,…
- From heterogeneous resources
  - File Systems, tape archives, sensor streams,…
- Distributed over a wide area network
  - Multiple administrative and security domains
- With users unaware of physical attributes of the data access
  - System addresses, paths, protocols,…
Data Grids are Trust Relationships

- **Data-level Trust**
  - Virtualization for integrity, authenticity, access provision, availability, data and metadata organization and management, community ownership and curation

- **User-level Trust**
  - Virtualization of authentication, authorization, auditing and accounting

- **Resource-level Trust**
  - Virtualization of administration and maintenance, appropriation (quota), availability and accessibility

**These are Data Grid 1.0 level trusts**
Data Grids are Trust Relationships

- **Policy-level Trust**
  - Virtualization of Management, Organizational and Community Rules

- **Service-level Trust**
  - Virtualization of Operations and Services

- **Execution-level Trust**
  - Virtualization of distributed, parallel, asynchronous, delayed and/or remote execution

- **These are Data Grid 2.0 level trusts**
User Base & Diversity of Applications

- Collections at SDSC:
  - 1+PetaBytes, 170+ Million files
  - Multi-disciplinary Scientific Data
    - Astronomy, Cosmology
    - Neuro Science, Cell-Signalling & other Bio-medical Informatics
  - Environmental & Ecological Data
  - Educational (web) & Research Data (Chem, Phys,…)
  - Archival & Library Collections
  - Earthquake Data, Seismic Simulations
  - Real-time Sensor Data
  - Growing at 1TB a day
  - Supporting large projects: TeraGrid, NVO, SCEC, SEEK/Kepler, GEON, ROADNet, JCSG, AfCS, SIO Explorer, SALK, PAT, UCSDLibrary, …
What is iRODS?

- It is a data grid system – data virtualization
  - A distributed file system, based on a client-server architecture.
  - Allows users to access files seamlessly across a distributed environment, based upon their attributes rather than just their names or physical locations.
  - It replicates, syncs and archives data, connecting heterogeneous resources in a logical and abstracted manner.

- It is a distributed workflow system – policy/service virtualization
  - Policy can be coded as functions (micro-services)
  - Remote micro-services can be chained
  - The chains (workflows) are interpreted at run-time
  - The chains can be triggered on an event and condition (rules)
  - They can also be recursive.
  - Micro-services communicate through parameters, shared contexts, and out-of-band message queues.

Similar to SRB
Policy Virtualization with iRODS

- Micro-Services
- Functions with well-defined semantics
- Transactional - recovery
- Context of application
- Message Queues
- Rules
- Triggered by events
- Conditional execution of
  - alternative rule declarations
- System constructs:
  - loops, recursion, branching
- Workflows
- Distributed Execution
- Immediate, Deferred, Periodic

User Application

Execution at SIO

Execution at MBARI

Execution at WoodsHole
Rule-based Data Management

- **Administrator-controlled rules to implement management policies**
  - Administrative - adding / deleting users, resources
  - Data ingestion - pre-processing, post-processing
  - Data transport / deletion - parallel I/O streams, disposition
  - Data retention policies – expiration, over-writes, versions
  - Data Reliability Policies – copies, formats, migration, checking,…
Distributed Management System

- Rule Engine
- Data Transport
- Metadata Catalog
- Execution Engine
- Execution Control
- Messaging System
- Virtualization
- Policy Management
- Server Side Workflow
- Scheduling
- Persistent State Information
Management Virtualization

• Examples of management policies
  • Integrity
    • Validation of checksums
    • Synchronization of replicas
    • Data distribution
    • Data retention
    • Access controls
  • Authenticity
    • Chain of custody - audit trails
    • Track required preservation metadata - templates
    • Generation of Archival Information Packages
Rule-based Data Management

- Associate rules with combinations of name spaces
  - Rule set for a particular collection
  - Rule set for a particular user group
  - Rule set for a particular user group when accessing a particular collection
  - Rule set for a particular storage system
  - Rule set for a particular micro-service
  - Generic rules based on SRB operations
Data Grid Collaboratives

- **BIRN**: “Biomedical Info. Research Network”  
  *SRB*

- **VidArch**: “Preserving Digital Video Context”  
  *SRB & iRODS*

- **TPAP**: “Transcontinental Persistent Archive Prototype”  
  *SRB & iRODS*

- **PAT**: “Persistent Archives Testbed”  
  *SRB*

- **HASS**: “UC-HRI: Humanities and Social Sciences grids”  
  *SRB*

- **DCP Center**: “Distributed Custodial Preservation” Center  
  *iRODS*

- **eLegacy**: California’s Geospatial Records: Archival Appraisal, Accessioning, and Preservation  
  *SRB*
BIRN: Biomedical Information Research Network
VidArch: Preserving Digital Video Context

- **UNC:** Gary Marchionini, Helen Tibbo, Cal Lee, Paul Jones: [http://www.ils.unc.edu/vidarch/](http://www.ils.unc.edu/vidarch/)
- **UCSD:** Richard Marciano, Chien-Yi Hou, Arcot Rajasekar, Reagan Moore

- Acquire samples of WWW video and appropriate context (YouTube 2008 presidential election)
- Develop a Preservation Model using iRODS for:
  - Creating persistent collections
  - Operationalizing the concept of “contextual information”
  - Defining sets of rules for the selection of resources to include within a collection, by:
    - defining policies and rules
    - implementing them within iRODS as sets of micro-services
    - defining validation criteria expressed as persistent state information resulting from the execution of micro-services
National Archives and Records Administration
Transcontinental Persistent Archive Prototype

Federation of Seven
Independent Data Grids

Extensible Environment, can federate with additional research and education sites. Each data grid uses different vendor products.
Distributed Data Management Concepts
- Data virtualization
  - Storage system independence
- Trust virtualization
  - Administration independence

Risk mitigation
- Federation of multiple independent data grids
  - Operation independence
PAT: Persistent Archives Testbed

Local Storage Resources

Kentucky Grid Brick
Michigan Grid Brick
Minnesota Grid Brick
Ohio Grid Brick
SLAC Storage

SDSC Archive

Metadata Catalog (Oracle)
Archival Storage (HPSS, Sam-QFS)

Shared Preservation Environment
PAT Project Participants

- Test a *community model* for electronic records management, with archival and technological functions in a distributed network (using the SRB: Storage Resource Broker – data grid technology)

- Initial Test sites:
  1. *Michigan* Department of History, Arts and Libraries,
  2. *Ohio* Historical Society,
  3. *Kentucky* Department for Libraries and Archives,
  4. *Minnesota* Historical Society,
  5. *SLAC* Stanford Linear Accelerator Archives and History Office.

Participants:
  (a) *California* State Archives
  (b) *Kansas* State Historical Society
  (c) University of Illinois Urbana Champaign
  (d) University of California Los Angeles (UCLA):
  (e) Yale Manuscripts and Archives
  (f) Georgia Tech

Observers:
  (a) Getty Research Institute
Persistent Archives Tesbed (PAT) project

- Participants were digital curators from:
  - Libraries / archives / historical societies / scientific data environments / museums
  - IT researchers and staff
- Main Goal:
  - Design a distributed repository for electronic records management
  - Demonstrate the management of various types of records with a common software infrastructure
- Approach: each site…
  - Chose an archival collection
  - Set up access control and update permissions for their preservation environment independently of the other participants
  - Implemented a different preferred interface for interacting with their archival collections
What Digital Curators Found Useful in the PAT Project

- Leverage common software and hardware
- Use commodity storage hardware
- Lower the cost of participation
- Reduce the level of expertise required at each site
- Focus on management of the archival collections and outsource the details of the archival repository
- Automate the manipulation of collections to minimize the level of effort
The Evolution of PAT: “archives on rules”

what the “DCP Center” project will try to do…

• Automate curation processes
  • e.g. design reusable curation workflows

• Enforce curation policies
  • e.g. enforce retention/disposition schedules

• Verify assertions about curation results
  • e.g. periodically verify checksums
  • e.g. parse audit trails to verify accesses
  • e.g. RLG/NARA Trusworthiness Assessment Criteria
Hybrid model (current capacity: 13.4 TB)
“Between 1932 and 1964, FHA and VA (through the GI Bill) financed over $120 billion of new housing, and less than 2% of this real estate was available to nonwhite families, mostly in segregated areas.”

“The Home Owners’ Loan Corp. (HOLC) created in June 1933, introduced the long-term mortgage in practice today. HOLC systematized appraisal methods across the nation and initiated the practice of redlining.”


Through their appraisal and redlining practices, HOLC and FHA institutionalized exclusion and contributed to the fragmentation of communities.
“This area is known as the servants' quarters of La Jolla, being populated with the serving class of whites, negroes and Mexicans. While populated with this lower social strata, the area is considered good security for conservative loans. The area comprises approximately six blocks and is located in the northwest portion of La Jolla, within easy walking distance of the business center of La Jolla. This area is located in Acquisition and Improvement District No. 1, City of San Diego, Causeway (Mattoon Bond District). The homes are predominantly one-story frame cottages, ranging in age from 8 to 30 years and the probable cost of construction is from $750 to $2,000. Homes show little pride of ownership.

The particular area is set aside by common consent for the colored population. The majority of the streets are paved, with sidewalks and curbs. Street lighting adequate. There is located in this area, in addition to the residential homes, two lumber yards and one iceplant. The area is 95% developed; 65% rented, 40% home-owned.”
1. POPULATION: a. Increasing     Slowly     Decreasing     Static
   b. Class and Occupation From business & professional men to WPA workers. Very mixed.
   Income from $700 to $1000 and up
   c. Foreign Families 20% Nationalities Mexicans, Russians & Polish Jews. A few Orientals
   d. Negro 10%
   e. Shifting to subversive racial elements and lower income groups.

2. BUILDINGS:
   a. Type and Size 5-7 rooms
   b. Construction Frame
   c. Average Age 30 years
   d. Repair Poor to fair
   e. Occupancy 95%
   f. Owner-occupied 35%
   g. 1935 Price Bracket $2500-4500
   h. 1937 Price Bracket $3000-5000
   i. 1939 Price Bracket $2750-4500
   j. Sales Demand Slow
   k. Predicted Price Trend Static
   l. Rental Demand Fair
   m. Predicted Rent Trend (next 6-12 months) Static to downward

3. NEW CONSTRUCTION (past yr) No. Type & Price: $3750-$4000, How selling Slow

4. OVERHANG OF HOME PROPERTIES:
   a. HOLC Few
   b. Institutions Many

5. SALE OF HOME PROPERTIES (3yr)
   a. HOLC 10-
   b. Institutions Many

6. MORTGAGE FUNDS: Very limited

7. Total Tax Rate per $1000 (1933) $52.00

8. DESCRIPTION AND CHARACTERISTICS OF AREA: Terrain: Level to heavily rolling in
   northwest portion with many steep grades which constitute construction hazards. Land
   improved 50% out of possible total of 85%. Roads & sidewalks have generally expired.
   Zoning is spotted and varies from single family to commercial use. Conveniences are
   all readily available. This area was subdivided some 40 years ago and has long since
   lost its desirability as a residential area, and is extremely heterogeneous both as
   to population and improvements. Architectural designs vary from 4-room frame boxes
   to frame, stucco and brick multi-family structures. In the northwest portion, which
   is protected by topography, will be found a small section along Kensington and Edgeware
   Roads which has better quality of both population and improvements. In the southwest
   part, west of Belmont Ave. and south of Bellevue Ave. There is a concentration of Negro
   families which is gradually expanding. For four blocks on each side of Temple St.
   throughout the district is a large population of Russian and Polish Jews. There is also
   a settlement of Mexicans north of Temple St. in the eastern part of the area.

9. LOCATION: Los Angeles. SECURITY GRADING: High D AREA NO: D-31 / DATE: 2-7-39
DCP: Distributed Custodial Preservation Center

Purpose:
Build a distributed production preservation environment that meets the needs of archival repositories for trusted archival preservation services.

Distributed partnership of 35 participants across 11 institutions:

* STATES:
  - California
  - Kansas
  - Michigan
  - Kentucky
  - North Carolina
  - New York

* UNIVERSITIES:
  - Tufts University
  - West Virginia University

* CULTURAL ENTITIES:
  - Getty Research Institute

* INTERNATIONAL PARTNERS:
  - Carleton University (Geomatics and Cartographic Research Centre)
**Goals:**
- Appraisal / accessioning tools
- Records retention schedules
- Transfer of geospatial records

**Approach:**
- Geospatial syndication
- Collaborative & Distributed Valuation
- Social tagging & datagrid automation

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**CSA**
California State Archives

**CaSIL**
California Spatial Information Library

**SDSC Archive**

**Metadata Catalog**
(Oracle)

**Archival Storage**
(HPSS, Sam-QFS)

**Local Storage Resources**

**Shared Preservation Environment**

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**UCSD**

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**SDSC**
Maintain Control of the Curation Environment

- Insert data management infrastructure between the records and the current technology
  - Distributed server architecture
- Protect the records from changes in the environment
  - Ensure that the curation properties are maintained
  - Ensure that the curation policies are enforced
  - Verify assessment criteria
Developing Skills for Preservation

• **SAA 2007 Summer Camp:** week-long hands-on training. *Topics included:*
  • Electronic Records
  • Components of an eRecords program
    – *Policies / Mandate*
    – *Technical Infrastructure*
    – *Social Infrastructure*
  • Infrastructure Independence
  • Appraisal & Disposition
  • Accessioning
  • Arrangement
  • Description
  • Preservation
  • Access
  • Scalability
• Archives: CA, WA, NC
• Libraries: AZ

• US Navy

• University of Illinois Urbana Champaign
• University of Madison-Wisconsin

• UC Irvine Spec. Coll.
• U. San Diego, Copley Library
• Harvard Business School, B. Lib.
• University of New Mexico, Pol. Arch.
• Occidental College, Periodicals Dept.

• National Fire Protection Association
• History Associates, Inc.

• Cigna
• Ford Motor Company
• Preservation Partners

• City of Richmond Archives, Canada
• Sacramento Archives & Museum Collection Center

• Marist Brothers of Canada

SAA e-Records
Summer Camp 2007
Building a Preservation Reference Implementation

- Go beyond preservation and access
- **SAA 2007 Summer Camp:** week-long hands-on training. *Topics included:*
  - Electronic Records
  - Components of an eRecords program
    - Policies / Mandate
    - Technical Infrastructure
    - Social Infrastructure
- **Address the full lifecycle:**
  - Appraisal & Disposition
  - Accessioning
  - Arrangement
  - Description
  - Preservation policy enforcement
  - Preservation trustworthiness assessments
• NARA ERA capabilities list, and the assessment criteria are based on the Trustworthy Repositories Audit & Certification (TRAC): Criteria and Checklist.

• For each identified capability, the required operations are encapsulated in micro-services that are executed at the storage location, under the control of rules that implement the management policies needed to enforce TRAC criteria.
Rules are also defined that periodically query the system to verify compliance, and automate recovery procedures when problems are found.

The reference implementation then consists of:

- the record management environment
- the preservation management rules
- the management processes that implement preservation services, and
- the rules that verify compliance with assessment criteria.
For More Information

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