The Stanford Digital Repository
A Case Study in Building A Common Preservation Infrastructure

CNI Spring Task Force Meeting
Phoenix, AZ – April 17, 2007

Tom Cramer, tcramer@stanford.edu
Rachel Gollub, rgollub@stanford.edu
SDR is...

- a preservation system
- now in production with ~3 TB of content
- capable of ingesting ~200 GB/day
- a repository of a certain age

Timeline:
- 1997: need identified
- 2000-2001: “Dark Cave” concept
- 2002: prototype
- 2003: NDIIPP redesign
- 2004-2005: in prod
Three Major Areas of Preservation Needs

• **Digital Library**
  - SULAIR collections & resources
  - Digitization artifacts

• **Institutional Repository**
  - Research data,
  - Publications, dissertations,
  - Learning objects, university assets

• **External Depositors**
  - Online preservation and access
  - Dark archive
Design Objectives & Assumptions

• Preservation-focused archive
• Replicated content
  – (multiple copies, geographically distributed)
• Secure
• Auditable
• Modular
• Tiered storage environment
  – (online, nearline, offline)
• Version rather than delete
• Content-agnostic
Core Repository Functionality

- Preserving access to digital information over time ...through generations of technology obsolescence and change.

- Maintaining integrity of that information over time ...through generations of migration and reformatting.

Repository Services Functionality

- All (or almost all) user-facing services
- Enhanced access & delivery through applications
- Dry research, new indexing, e-science, etc.
- Federation
SDR’s Core Repository

Ingest
- SIP Validation
- Packaging
- AIP Validation
- Storage
- QA
- Geographic Distribution
- Reporting
- Cleanup

Preservation
- Risk Assessment
- Policy Management
- Triage
- Preservation Actions
- Media/Storage Migration
- Format Migration
- Technology Migration

Access
- Authorization
- Negotiation
- Retrieval
- Packaging
- Verification/Validation
- Transmission
- Logging
- Cleanup
SDR Serves As Common Preservation Infrastructure

while specialty archives and applications provide focused digital content collection, access and value-added services
E.g., Preservation of the Parker Manuscripts

- 530 Manuscripts
- 200,000 pages
- For each page:
  - 22 MB JPEG2000 delivery surrogate
  - 22 MB JPEG2000 delivery surrogate
  - 110 MB submaster TIFF
  - 220 MB master TIFF

Rich web application, tailored to Parker for general public, medievalists

SDR
SDR Workflow

- Digital Collections
- Geospatial Data
- External Collections

Conversion

Ingest

Virus Check

Ingest

Storage Layer

Access Layer

Luna

Book Reader

DEWI (?)
SDR High-Level Architecture
SDR Architecture
March 2006

Conversion Machine
- Creates the Transfer Manifest and the submission information package

Ingest Gatekeeper
- Ingest validation and virus scanning happens here

Ingest
- Ingest completes, and creates the archival information package

Storage System
- This software determines what goes online and what goes offline, according to the Transfer Manifest.
- All metadata is stored here separately from content, as well as with it.
- Content is stored, along with metadata, in an archival information package

Online Storage

Nearline and Offline Storage (Tape)
- All metadata and data goes on tape, and is stored in geographically distributed secure locations

Access Layer
- "Air Gap": All access to the repository is through the access layer, which is read-only.

Federation
- OAI
- Aquifer
- SRB
## SDR Physical Topology

**March 2006**

<table>
<thead>
<tr>
<th>Module(s)</th>
<th>Hardware</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversion, Gatekeeper</td>
<td>Sun Fire X4100 Server&lt;br&gt;4 TB Nexsan SATA Disk</td>
</tr>
<tr>
<td>Ingest, Storage code, Storage Request Processor</td>
<td>Sun Fire X4100 Server&lt;br&gt;4 TB Nexsan SATA Disk</td>
</tr>
<tr>
<td>Online storage</td>
<td>32 TB Sun Honeycomb Storage System</td>
</tr>
<tr>
<td>Tape Copies</td>
<td>Sun StorEdge L700 Tape Library, with LTO2 drives&lt;br&gt;IBM Tivoli Storage Manager&lt;br&gt;Iron Mountain data protection plan</td>
</tr>
<tr>
<td>Access Service, Access Cache</td>
<td>Sun Fire X4100 Server&lt;br&gt;8 TB of Nexsan SATA Disk</td>
</tr>
</tbody>
</table>
Metadata Strategy

• A “Transfer Manifest” is generated during conversion (pre-ingestion): includes descriptive, administrative, and structural metadata for the object

• METS wrapper; descriptive MD in MODS

• Parsed and error-checked automatically by Ingest

• Minimum required set is very small

• Ideal: a finite and manageable number of schemas. E.g., simple book, manuscript, image...
A Sample Transfer Manifest

<mets ID="library_stanford_edu_e33914b2-fa74-11da-83e8-db2a90744a3c"
OBJID="library_stanford_edu_e33914b2-fa74-11da-83e8-db2a90744a3b"
LABEL="Generic Bit Preservation Agreement for SULAIR DPG collections"
TYPE="SUL_SDR__transferManifest" ...>
  <metsHdr CREATEDATE="2006-06-13T13:41:17" RECORDSTATUS="TM">
    <agent ROLE="CREATOR" TYPE="OTHER" OTHERTYPE="SOFTWARE">
      <name>SDR_CSN_CONVERTER_V1.1</name>
    </agent>
    <altRecordID TYPE="SUL_CSN_objectID">90990250</altRecordID>
  </metsHdr>
  <dmdSec ID="DMD_CSNObjID">
    <mdWrap MDTYPE="MODS" LABEL="CSN_BookSimple, CSN_SUL_ProjectName">
      <xmlData>
        <mods:mods>
          <mods:titleInfo>
            <mods:title>
              SDR Preservation Agreement: Bit Preservation, Generic, v1.0
            </mods:title>
          </mods:titleInfo>
        </mods:mods>
      </xmlData>
    </mdWrap>
  </dmdSec>
</mets>
Using References Among Transfer Manifests for...

• Preservation Agreements
  • signed, approved agreement
  • specifies long term plan, details of preservation
  • access rights by depositor maintained group
  • ingested as a digital object, referenced by the TM

• Collection Level Metadata
  • collection schema
  • ingested as a digital object, referenced by other digital objects’ TMs

• Versioning
  • file by file
  • most current data referenced in most current TM
  • each TM refers to the TM immediately previous, so no version is lost

• File format information
  • format registry (GDFR)
  • links from TMs to ingested format information from the registry
What Do We Wonder About?

• MD extensibility, flexibility
• Duplication of content b/t access and preservation systems. Big storage overhead.
• Need for DOR (digital object registry) - metadata tracking, reconciliation outside of SDR
• Long term overhead of tape infrastructure
• Sustaining focus, progress once we:
  1.) go into full production
  2.) phase out NGDA-funded development
Mix of roles needed:

- Dedicated development manager, architect, project manager (Rachel)
- one ‘product manager’, digital preservationist (Keith)
- embedded, expert metadata design, support (Nancy)
- Five developers (plus one borrowed) swarming development through reassignment into one group
- discrete operational/production support group
- NGDA grant mgmt by someone outside the group (Julie)
- In house system administration & storage administration support
- organizational emphasis/top priority over 2+ years
What Has Worked?

• Dedicated team (albeit with other duties). Can’t develop a system of this scope and scale on the margins

• Core repository v. repository services distinction. Helped segment the problem into bite-sized chunks, and move forward. Helped tamp down expectations that SDR would be all things to all people.

• Modularity mindset. Developing tomorrow’s legacy code today. Commitment to making progress, even if we don’t have the perfect answer.

• Concrete use cases - NGDA, Google, Parker, etc. helped frame what we need. SDR development not predicated on hypothetical IR use cases.
What Has Worked? (continued…)

- Sys & storage admins & dedicated infrastructure.
- Surprised even ourselves by sheer volume of machines & storage
- Decision for tiered storage—tape gives us significant capacity, relieves (some of the) pressure on selection, management.
- Leveraging NGDA activity as a catalyst—to start production development—and tying SDR’s progress to NGDA milestones