iRODS
Policy-Driven Data Preservation

Integrating Cloud Storage and Institutional Repositories

Reagan W. Moore

Arcot Rajasekar

Mike Wan

{moore,sekar,mwan}@diceresearch.org

http://irods.diceresearch.org


THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL


Abstract

- The integrated Rule-Oriented Data System (iRODS) organizes distributed data into a sharable collection. The data may reside in cloud storage, in institutional repositories, in tape archives, in laptop file systems. We will demonstrate the enforcement of management policies across the multiple storage locations, access mechanisms ranging from web browsers to Fedora to Web-DAV to EnginFrame interfaces, and types of assertions that can be made on data in cloud storage.

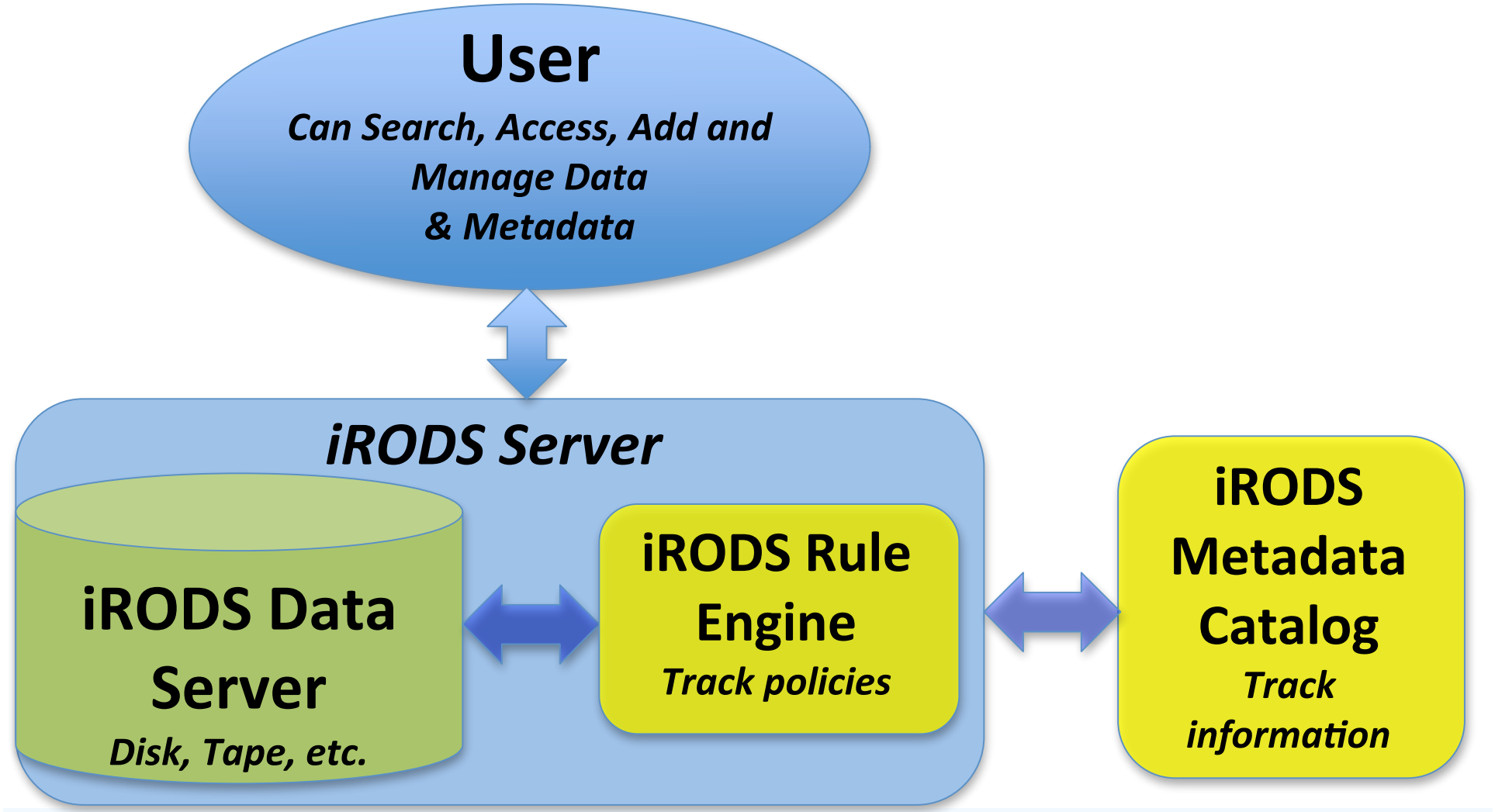

THE UNIVERSITY *of* NORTH CAROLINA *at* CHAPEL HILL


Projects

- TPAP - Transcontinental Persistent Archive Prototype
  - Preservation research in collaboration with NARA
- DCAPE - Distributed Custodial Archival Preservation Environment
  - Collaboration with State Archives to build preservation policies
- PoDRI - Policy Driven Repository Interoperability
  - IMLS collaboration with Duraspace to integrate Fedora / iRODS
- OOI - Ocean Observatories Initiative
  - NSF collaboration to archive sensor data
- CDR - Carolina Digital Repository
  - UNC-CH collaboration to build an institutional repository
- TUCASI - Triangle Universities Center for Advanced Studies, Inc.
  - Collaboration to build cyberinfrastructure between UNC, Duke, NCSU, RENCI


THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL


Overview of iRODS Data System



*Access data with Web-based Browser or iRODS GUI or Command Line clients.

Integrated Rule Oriented Data System

- Software to organize distributed data into a sharable collection, while enforcing management policies
  - Manage properties of the shared collection
- Developed by DICE Center
  - University of North Carolina at Chapel Hill
    - 6 staff, 4 students
  - University of California, San Diego
    - 5 staff
- Funded by

NSF OCI-0848296 "NARA Transcontinental Persistent Archives Prototype"
NSF SDCI-0721400 "Data Grids for Community Driven Applications"

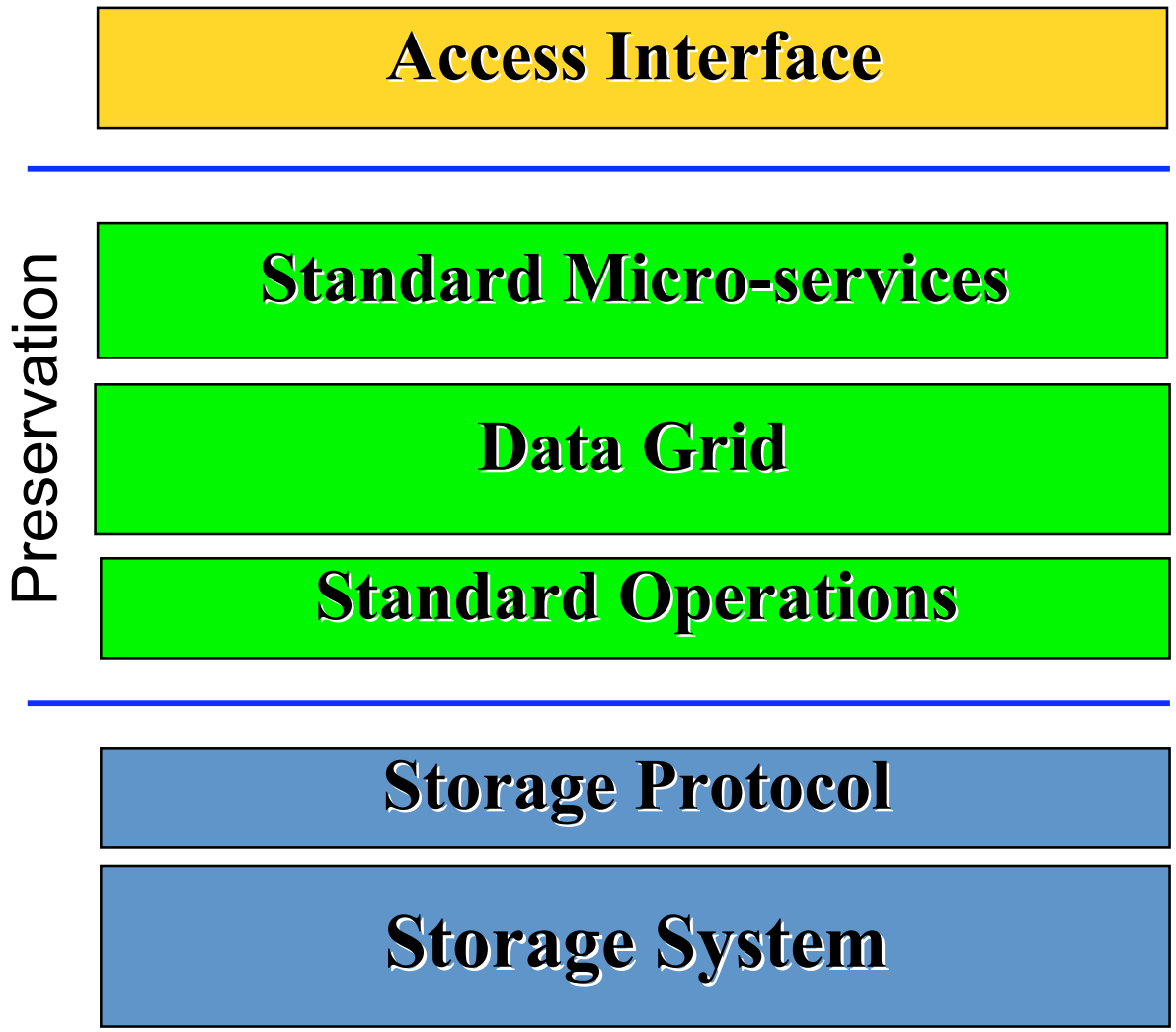

THE UNIVERSITY *of* NORTH CAROLINA *at* CHAPEL HILL
UCSD


Preservation Concept

- Maintain properties of records while utilizing new storage systems
  - Records are permanent
  - Federate storage across cloud, archives, file systems
- Implications - infrastructure independence
  - Active management of records
  - Multiple indirection mechanisms to protect records from dependencies upon technology
  - Validation of state information and parsing of audit trails to verify assertions about records


THE UNIVERSITY *of* NORTH CAROLINA *at* CHAPEL HILL


Data Virtualization



Map from tasks requested by the access method to a standard set of micro-services

The standard micro-services are mapped to standard operations.

Operations are mapped to the protocol of the storage system

View clients and storage as ephemeral

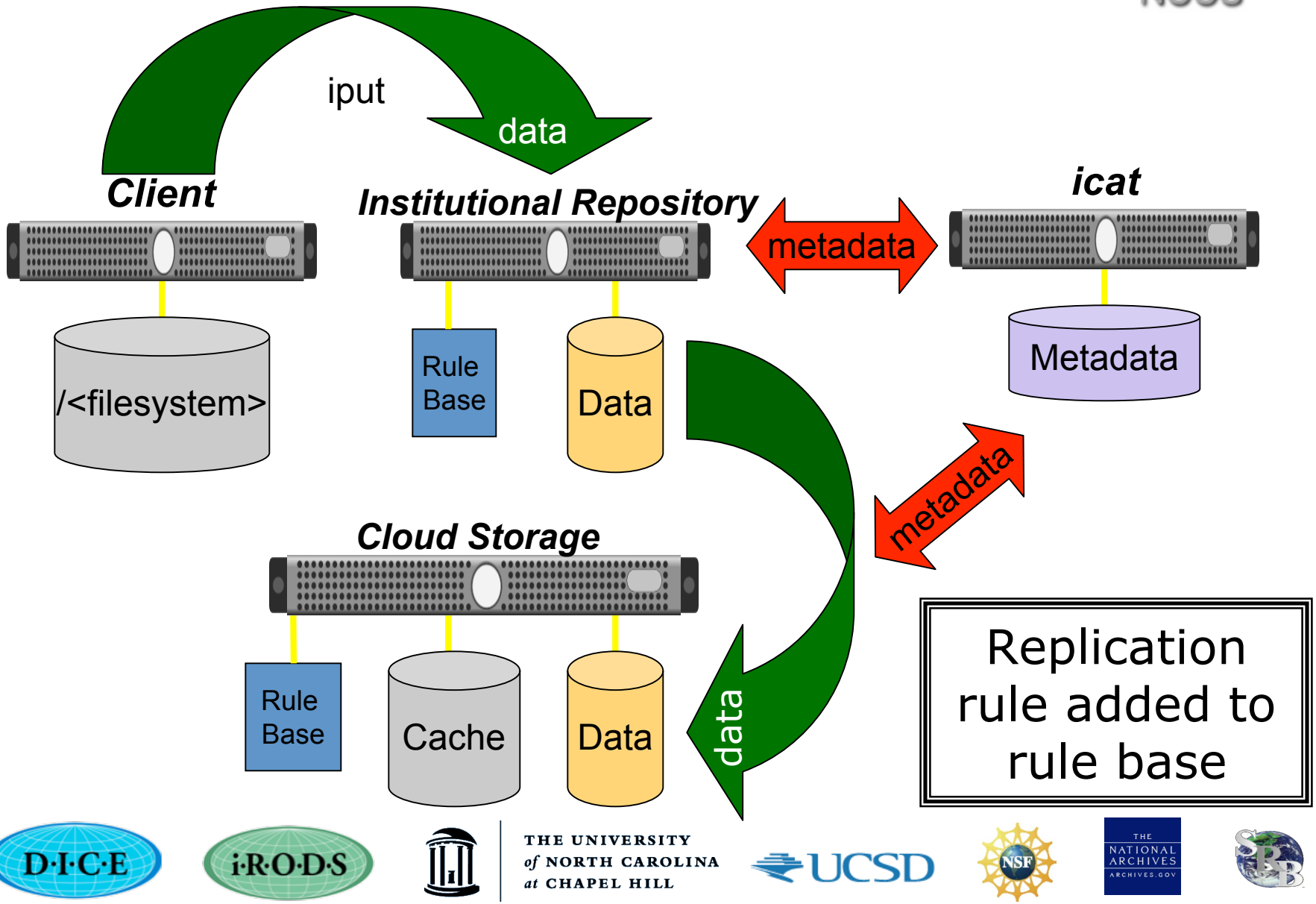
D·I·C·E iRODS THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL UCSD NSF THE NATIONAL ARCHIVES ARCHIVES.GOV

Policy-based Record Management

- Express policies as computer actionable rules
  - Define explicit locations in data management framework where policies will be enforced
- Express procedures as remotely executable micro-services
  - Create new preservation services by linking micro-services into a workflow
- Manage state information to track the application of preservation procedures
  - Maintain audit trails to track evolution of policies and procedures


THE UNIVERSITY *of* NORTH CAROLINA *at* CHAPEL HILL


iput With Replication



Policies Implemented Outside of the (Cloud) Storage

- Automation of preservation procedures
  - Descriptive metadata extraction
  - Creation of archival form (AIP)
  - Transformative migration
- Automation of administrative functions
  - Distribution, replication, retention, disposition
  - Report generation - usage, performance, error tracking
- Periodic validation of assessment criteria
  - Trustworthiness, integrity, authenticity, chain of custody
  - Parsing of audit trails for policy compliance over time

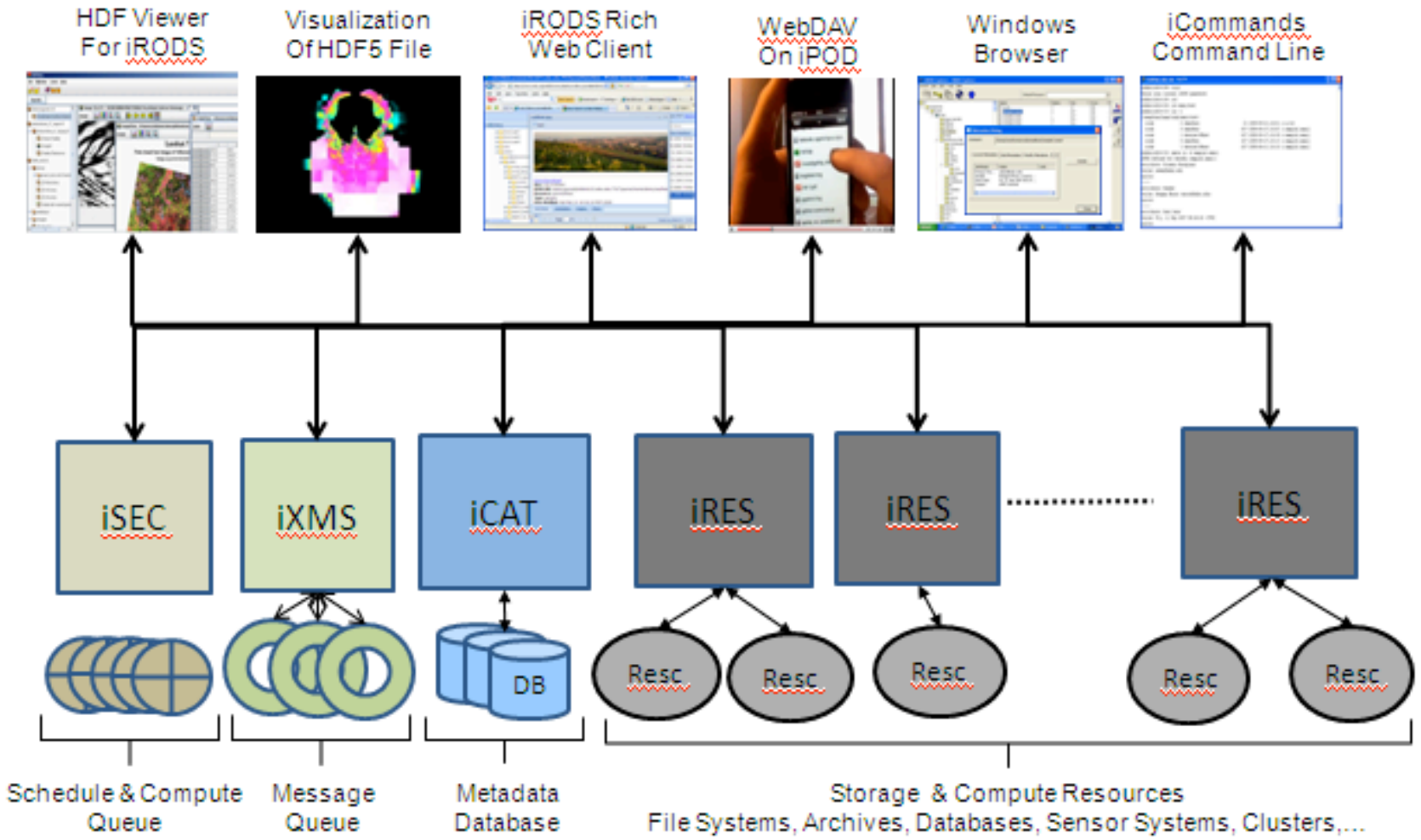

THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL


Management Framework

- Instrument data management infrastructure at all locations where policy should be enforced (65 hooks)
  - File create, open, read, write, delete
  - Collection create, delete
  - User create, modify, delete, group
  - Resource create, modify, delete, group
  - Metadata file modify, collection modify, descriptive
  - ACL modify
- Support pre-processing policy
  - Authorization, selection, redirection
- Support post-processing policy
  - Audit trails, redaction, derived product generation


THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL


iRODS Distributed Data Management



D·I·C·E i·R·O·D·S THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL UCSD NSF THE NATIONAL ARCHIVES ARCHIVES.GOV

Types of Rules

- Synchronous rules applied by framework at management hook locations
  - Stored in rule base; core.irb file
- Asynchronous rule that are queued for deferred or periodic execution
  - Batch system to manage queue
- Interactively executed rules defined by a user
  - Executed through irule command


THE UNIVERSITY *of* NORTH CAROLINA *at* CHAPEL HILL


iRODS Rules

- Server-side workflows

  Action | condition | workflow chain | recovery chain
- Condition - test on any attribute:
  - Collection, file name, storage system, file type, user group, elapsed time, IRB approval flag, descriptive metadata
- Workflow chain:
  - Micro-services / rules that are executed at the storage system
- Recovery chain:
  - Micro-services / rules that are used to recover from errors


THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL


Checksum Validation Rule

```
myChecksumRule{
    msiMakeQuery("DATA_NAME, COLL_NAME, DATA_CHECKSUM",*Condition,*Query);
    msiExecStrCondQuery(*Query,*B);
    assign(*A,0);
    forEachExec (*B)  {
            msiGetValByKey(*B,COLL_NAME,*C);
            msiGetValByKey(*B,DATA_NAME,*D);
            msiGetValByKey(*B,DATA_CHECKSUM,*E);
            msiDataObjChksum(*B,*Operation,*F);
            ifExec  (*E != *F)  {
                 writeLine(stdout,file *C/*D has registered checksum *E and computed checksum *F);
            }
            else {
                 assign(*A,*A + 1);
            }
    }
    ifExec(*A > 0)  {
          writeLine(stdout, have *A good files);
    }
}
```

*Condition can be COLL_NAME like '/ils161/home/moore/genealogy/%'


THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL


Highly Extensible

- To integrate cloud storage
  - Wrote an S3 driver to execute the cloud storage protocol
  - Implemented cloud storage as a compound resource
    - Added disk cache in front of the cloud storage to enable enforcement of policies across all cloud accesses
  - All iRODS clients can then be used to access data stored in the cloud
    - Web browser, WebDav, FUSE, Kepler & Taverna workflows, Unix shell commands, C libraries, EnginFrame portal
  - Can write policies to distribute data between cloud, file systems, archives, laptops.
  - Can federate other data grids with the data grid that uses the cloud storage

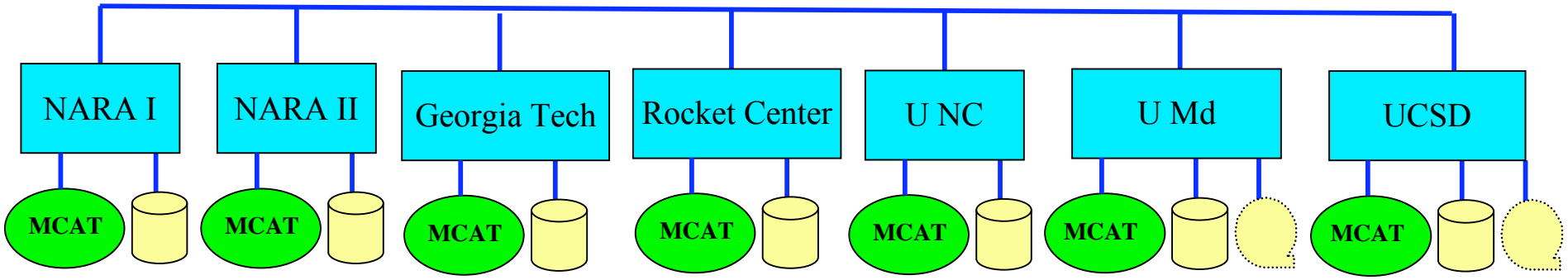
NARA Transcontinental Persistent Archive Prototype

- Use data grid technology to build a preservation environment
- Conduct research on preservation concepts
  - Infrastructure independence
  - Enforcement of preservation properties
  - Automation of administrative preservation processes
  - Validation of preservation assessment criteria
- Demonstrate preservation on selected NARA digital holdings
  - Integration of generic infrastructure with preservation technologies (Cheshire, MVD, JHOVE, Pronom, Fedora, Dspace)


THE UNIVERSITY *of* NORTH CAROLINA *at* CHAPEL HILL


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.

D·I·C·E i·R·O·D·S THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL UCSD NSF THE NATIONAL ARCHIVES ARCHIVES.GOV

iRODS is a "coordinated NSF/OCI-Nat'l Archives research activity" under the auspices of the President's NITRD Program

Reagan W. Moore

rwmoore@renci.org

http://irods.diceresearch.org

NSF OCI-0848296 "NARA Transcontinental Persistent Archives Prototype"
NSF SDCI-0721400 "Data Grids for Community Driven Applications"


THE UNIVERSITY *of* NORTH CAROLINA *at* CHAPEL HILL
UCSD