

# Policy Based Data Management

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# Topics

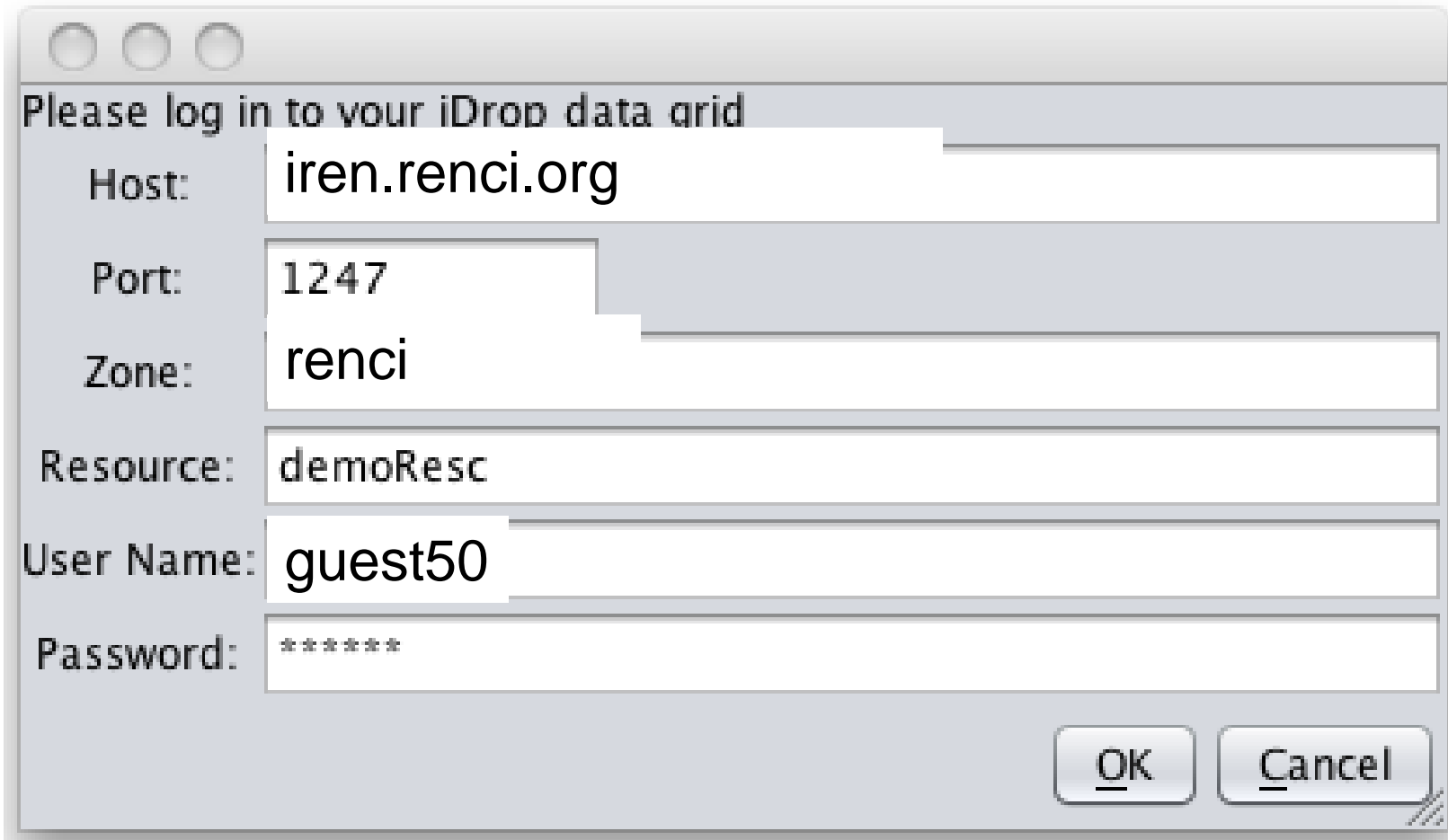
- Explore web browser interfaces to a data grid
  - List files
  - Upload files
  - Download files
  - Share files
  - Replicate files
  - Add metadata
- Explore data grid policies

# Default Accounts on RENCIG Data Grid

- Your user name will be  
    guestXX     where XX is a number from 01 to 50
- Your password will be  
    passXX     where XX is a number from 01 to 50

# iDrop-web Interface

- <http://iren-web.renci.org:8080/idrop-web>
- <http://iren-web.renci.org:8080/idrop-web2/login/login/loginButton>



Please log in to your iDrop data grid

Host: iren.renci.org

Port: 1247

Zone: renci

Resource: demoResc

User Name: guest50

Password: \*\*\*\*\*

# iDrop-web Interface

Search as a  or

User Name: guest50 Zone: renci Resource:  Logout Show/Hide Side Bar

Browse Search

/

File View Upload and Download Tools Apply an action to all selected items

- ASGC\_Testbed
- LSDF
- NCDCDMZ
- Q MULDemoZon
- RENCI\_VO
- TDLC
- TGDsdsc
- ccin2p3
- demoKEKZone
- dfcmain
- galvin
- irods-wos
- mpi
- nara-renci-irod
- ncdc
- ooci
- renci
- sdscSpatial
- tacc
- test1
- test\_seq
- testfolder
- tip-duke

Name	Type	Modified date	Length
ASGC_Testbed	COLLECTION	Fri Oct 21 11:22:23 EDT 2011	0 bytes
LSDF	COLLECTION	Mon Apr 04 00:41:44 EDT 2011	0 bytes
NCDCDMZ	COLLECTION	Thu Feb 16 11:15:18 EST 2012	0 bytes
Q MULDemoZone	COLLECTION	Mon Oct 17 13:22:06 EDT 2011	0 bytes
RENCI_VO	COLLECTION	Mon Jun 29 11:42:27 EDT 2009	0 bytes
TDLC	COLLECTION	Mon Feb 01 14:07:39 EST 2010	0 bytes
TGDsdsc	COLLECTION	Tue Apr 27 17:30:47 EDT 2010	0 bytes
ccin2p3	COLLECTION	Fri Oct 21 11:21:46 EDT 2011	0 bytes
demoKEKZone	COLLECTION	Fri Oct 21 11:21:10 EDT 2011	0 bytes
dfcmain	COLLECTION	Mon Jan 23 13:22:39 EST 2012	0 bytes
galvin	COLLECTION	Tue Apr 28 08:34:09 EDT 2009	0 bytes
irods-wos	COLLECTION	Thu Nov 03 14:18:18 EDT 2011	0 bytes
mpi	COLLECTION	Thu Dec 29 14:19:23 EST 2011	0 bytes
nara-renci-irods	COLLECTION	Fri Jan 22 20:09:15 EST 2010	0 bytes
ncdc	COLLECTION	Mon Feb 08 14:41:27 EST 2010	0 bytes
ooci	COLLECTION	Tue Jan 26 17:37:56 EST 2010	0 bytes
renci	COLLECTION	Fri Apr 24 12:43:17 EDT 2009	0 bytes
sdscSpatial	COLLECTION	Wed Jun 09 15:03:04 EDT 2010	0 bytes
tacc	COLLECTION	Fri Jun 19 14:33:40 EDT 2009	0 bytes
test1	COLLECTION	Mon Aug 02 15:52:01 EDT 2010	0 bytes
test_seq	COLLECTION	Thu Oct 04 11:28:43 EDT 2012	0 bytes
testfolder	COLLECTION	Tue Jan 05 09:56:21 EST 2010	0 bytes
tip-duke	COLLECTION	Thu Dec 09 17:25:29 EST 2010	0 bytes

Showing 1 to 23 of 23 entries

# iRODS Distributed Data Management

# Three Perspectives on Use of Data Grids

- User
  - Store and manipulate data and workflows
- Data grid administrator
  - Enforce community consensus for data management through policies and procedures
- Data grid developer
  - Encapsulate domain knowledge in micro-services and storage drivers

# Three Interaction Levels

- Execute commands from a client
  - Scripts, workflows, shell commands
- Execute operations through a rule
  - Interactive rule or system level rule
- Encapsulate operations within a micro-service
  - Parsing of data formats, applying transformations



# Data Grid Clients (~50)

API	Client	Developer	Language
Browser			
	DCAPE	UNC	
	iExplore	RENCI-Oleg	C++
	JUX	IN2P3	Jargon
	Peta Web browser	PetaShare	
	<b>iDrop web browser</b>	Mike Conway	Java
	Davis web interface	ARCS	
	<b>Rich web client</b>	Lisa Stillwell - RENC	
<b>Digital Library</b>			
	Akubra/iRODS	DICE	Jargon
	Dspace	MIT	
	Fedora on Fuse	IN2P3	FUSE
	Fedora/iRODS module	DICE	Jargon
	Islandora	DICE	Jargon
	Curators Workbench	CDR-UNC-CH	Jargon
<b>File System</b>			
	Davis - Webdav	ARCS	Jargon
	<b>iDrop</b>	DICE-Mike Conway	Jargon
	FUSE	IN2P3, DICE,	FUSE
	FUSE optimization	PetaShare	FUSE
	OpenDAP	ARCS	
	PetaFS (Fuse)	Petashare - LSU	
	Petashell (Parrot)	PetaShare	



# iRODS Clients (Cont.)

<b>Grid</b>	GridFTP - Griffin	ARCS	
	Jsaga	IN2P3	Jargon
	Parrot	UND - Doug Thain	
	SRM	Academia Sinica	
	Saga	KEK	
<b>I/O Libraries</b>	PRODS - PHP	Renci - Lisa Stillwell	
	C API	DICE-Mike Wan	C
	C I/O library	DICE-Wayne Schroeder	C
	Fortran	Schroeder	C
	Eclipse file system	CDR - UNC-CH	Jargon
	Jargon	DICE-Mike Conway	Jargon
	Pyrods - Python	SHAMAN-Jerome Fusillier	Python
<b>Portal</b>	EnginFrame	NICE / RENC I	Jargon
	Petashare Portal	LSU	Jargon
<b>Tools</b>	Archive tools-NOAO	NOAO	
	Big Board visualization	RENC I	
	iFile	GA Tech	
	i-commands	DICE	
	Pcommands	PetaShare	
	Resource Monitoring	IN2P3	
	Sync-package	Academica Sinica	
	URSpace	Teldap - Academica Sinica	
<b>Web Service</b>	VOSpace	IVOA	
	Shibboleth	King's College	
<b>Workflows</b>	Kepler - actor	DICE	Jargon
	Stork - interoperability	LSU	
	Workflow Virtualization	LSU	
	Taverna - actor	RENC I	

# Data Virtualization

Preferred Access Client (C library, Unix, Web Browser)

Data Collection

## Storage Repository

- Storage location
- User name
- File name
- File context
- Access controls

## Data Grid

- Logical resource name space
- Logical user name space
- Logical file name space
- Logical context (metadata)
- Policies

Data is organized as a shared collection

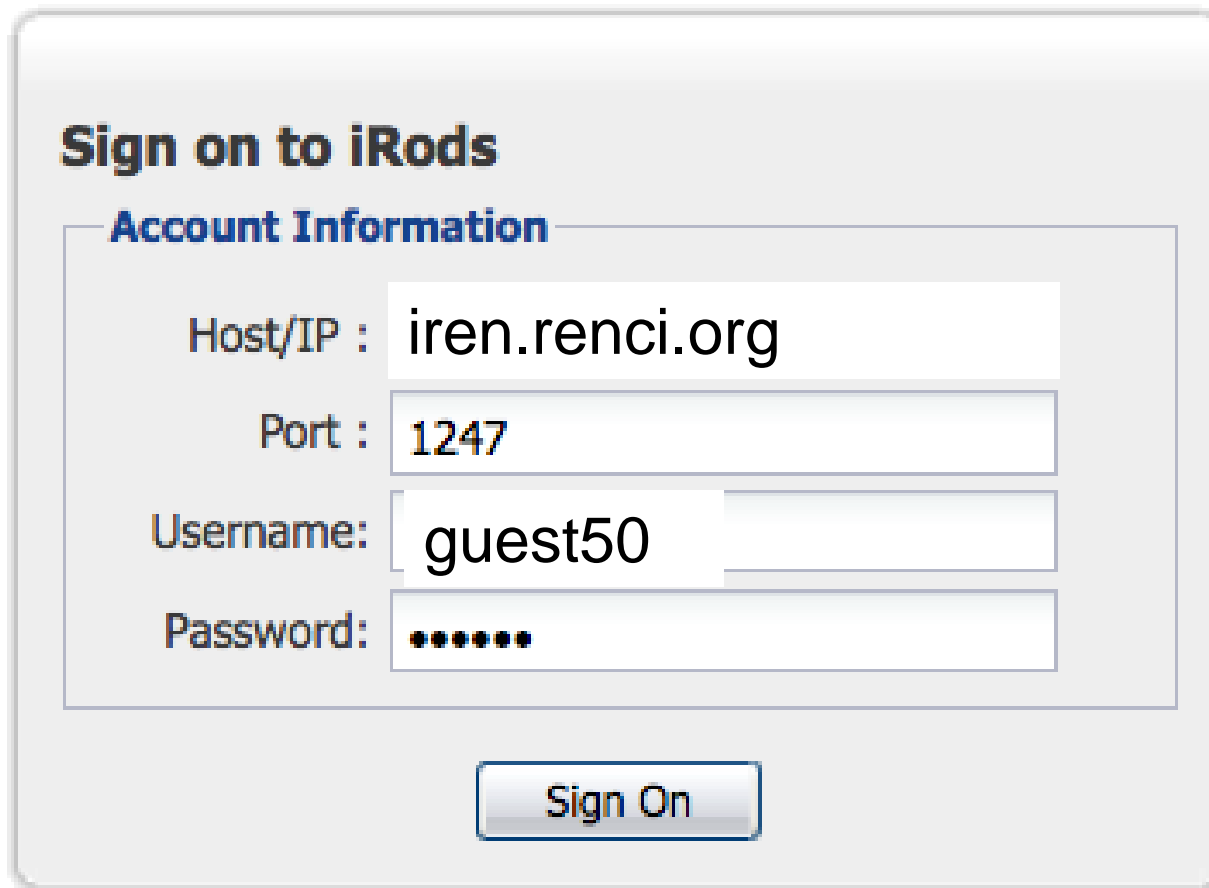


# iDrop

- Synchronization interface to LifeTime Library
  - <http://iren-web.renci.org/idrop-release/idrop.jnlp>
  - Installs in system tray
- Manages data transfers over unreliable networks
  - Can synchronize a local laptop directory with a directory in the data grid
  - Periodically transfer files
  - Track status of each file transfer
  - Have sent 700,000 files per synchronization

# Rich Web Client – Web Browser

- <https://www.irods.org/web/index.php>



**Sign on to iRods**

**Account Information**

Host/IP :

Port :

Username:

Password:

# Rich Web Client Browser

Address bar: rods://rods@iren.renci.org:1247/renCI/home/rods/rules

Browser tabs: irods.org | https://www.irods.org/web/browse.php#ruri=rods@ire

Navigation: Most Visited | Getting Started | Latest Headlines

Current path: rods://rods@iren.renci.org:1247/r...

User: rods@iren.renci.org:1247 | [Sign Out](#)

Search by Name...

Name	Resource	Size	Date Modified
d1.r	renCI-vault1	3.42 KB	June 2, 2010, 12:02 p
d1.r	renCI-vault2	3.42 KB	May 14, 2010, 4:57 p
showcore.ir	renCI-vault1	50 B	May 12, 2010, 9:40 a
.irodsEnv	renCI-vault1		January 14, 2011, 11:09 a
fits.tag	renCI-vault1	158 B	November 3, 2010, 2:29 p
rosat_pspc_rdf2_3_bk1.fits	renCI-vault1	523.13 KB	November 3, 2010, 2:20 p
SAA-award.jpg	renCI-vault1	48.67 KB	November 3, 2010, 9:12 a
ruletest.r	renCI-vault1	95 B	February 17, 2010, 11:54 a
listMS.ir	renCI-vault1	108 B	October 29, 2009, 8:16 a
sample.email	renCI-vault1	627 B	August 3, 2009, 1:00 p

Page 1 of 1 | Displaying objects 1 - 10 of 1

14

# Windows iExplorer

<https://www.irods.org/index.php/windows>

iRODS Login

Name

Host


Zone

Port

Previous Logins:

Name	Zone	Server Host
rods	renci	iren.renci.org
rwmoore	lifelibZone	diamond.ils.unc.edu
stu50	tempZone	irods05.grid.sinica...

To login, enter the password for the selected connection



[www.irods.org](http://www.irods.org)

# Windows iExplorer

The screenshot shows the iRODS Explorer application window. The title bar reads "iRODS Explorer - iRODS Explorer". The menu bar includes "iRODS", "Edit", "View", "Rule", and "Help". The toolbar contains various icons for file operations. The "Storage Resource" is set to "renci-vault1". The left sidebar shows a tree view with folders: "/", "renci", "home", and "rods". The main pane displays a table of files and folders.

Name	Replica	Size	Owner	Modified Time	Repl. Status	Resource	Resource Group
ANT1scripts							
Backup							
Publication							
State_Amelia_Earhart							
Test3							
arch							
archive							
datanet							
demo							
dvn2irods							
irodsbook							
loading							
logs							
looptest							
monitoring							
nsfdemo1							
nvo							
other							
rules							
ruletest							
tarfiles							
test							
tg							
.DS_Store	0	12.00 KB	rods	2010-12-04.01:04:44	1	renci-vault1	
00008.pdf	0	61.38 KB	rods	2010-12-04.08:11:09	1	renci-vault1	
00008.pdf	1	61.38 KB	rods	2010-12-06.19:09:15	1	renci-vault2	
00008.pdf	2	61.38 KB	rods	2010-12-06.19:09:16	1	renci-vault4	
100MB_testfile.tar	0	100.04 MB	rods	2010-06-30.15:45:16	1	renci-vault1	
253MB_testfile.tif	0	253.00 MB	rods	2010-06-29.23:08:21	1	renci-vault1	
Proposal.pdf	0	784.05 KB	rods	2010-01-23.13:39:14	1	renci-vault1	
antlr-2.7.7.jar	0	449.34 KB	rods	2010-12-04.01:04:28	1	renci-vault1	
jms-1.1.jar	0	30.26 KB	rods	2010-09-17.13:13:51	1	renci-vault1	
nara-ICAT-backup.gz	0	906.88 MB	rods	2010-04-21.17:00:58	1	renci-vault1	

sub-collections: 23, files: 10



# Executing a Rule



The image shows a dialog box titled "Submit an iRODS Rule Dialog". It contains three text input fields and three buttons. The "Rule:" field contains the text "myTest||msiAdmShowIRB(\*A)|nop". The "Input Parameters:" field contains the text "null". The "Output Parameters:" field contains the text "\*A%ruleExecOut". There is an "Import..." button to the right of the Rule field. At the bottom right, there are "Submit" and "Close" buttons.

Submit an iRODS Rule Dialog

Rule: myTest||msiAdmShowIRB(\*A)|nop Import...

Input Parameters: null

Output Parameters: \*A%ruleExecOut

Submit Close

# FUSE File System Interface

- Based on FUSE environment
  - Mac, Solaris, Unix
- Instructions for installing iRODS-FUSE driver
  - [https://www.irods.org/index.php/iRODS\\_FUSE](https://www.irods.org/index.php/iRODS_FUSE)
- Mount iRODS directory as local directory
  - `mkdir ~/fmount`
  - `irodsFs ~/fmount`
- Can then apply local unix shell commands on remote iRODS directory

# iRODS i-Commands

Unix Shell

# .irodsEnv file

```
irodsHost 'iren.renci.org'  
irodsPort 1247  
irodsHome '/renci/home/guestXX'  
irodsUserName 'guestXX'  
irodsZone 'renci'
```

Your password is passXX

Replace XX with a number from 01 to 50  
in both guestXX and passXX



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# i-Commands

- iRODS shell commands similar to Unix
  - Change the working directory                      icd
  - Set access permissions                              ichmod
  - Copy between directories                            icp
  - List files    ils
  - Move a file between directories                    imv
  - Change your password                                ipasswd
  - Display active connections                        ips
  - Remove a file                                         irm
  - Make a directory                                     imkdir
  - Print current working directory                    ipwd

# Unique iRODS i-Commands

- List all i-Commands `ihelp`
- Initialize access (authenticate) `iinit`
- Exit from data grid `iexit`
- Put a file into the data grid `iput`
- Get a file from the data grid `iget`
- Physically move a file `iphymv`
- Upload tar files `ibun`
- Replicate a file `irepl`
- Trim replicas `itrim`
- Remove files from trash `irmtrash`
- Register a file `ireg`
- Check whether local file is registered `iscan`
- List resources `ilsresc`

# iRODS i-Commands

- Rules

- Execute a rule `irule`
- List status of delayed rules `iqstat`
- Delete a delayed rule `iqdel`

- Metadata

- Add metadata `imeta`
- Query the metadata catalog `iquest`
- Show system metadata `isysmeta`
- List user information `iuserinfo`
- List server information `imiscsvrinfo`

- Messaging

- Send/receive messages `ixmsg`

# Data Grid Administrator



# Administrative Policies

- Automated replication
- Automated checksum generation
- Automated metadata extraction
- Automated distribution
- Quotas / audit trails
- Retention / disposition
- Cache management / aggregation
- Data sharing

# Policy Enforcement Points

Actions  iCommands	none	acChkHostAccessControl	acSetPublicUserPolicy	acAclPolicy	acSetRescSchemeForCreate	acRescQuotaPolicy	acSetVaultPathPolicy	acPreProcForModifyDataObjMeta	acPostProcForModifyDataObjMeta	acPreProcForDataObjOpen	acPostProcForOpen	acSetMultiReplPerResc	acPostProcForCreate	acPostProcForPut	acPostProcForCopy	acPostProcForRepl	acPostProcForPhymv	acPreProcForObjRename	acPostProcForObjRename	acPreProcForRmColl	acTrashPolicy	acDataDeletePolicy
	icp		X	X	X	X	X	X	X	X	X	X		X		X						
icp -N 2		X	X	X	X	X	X	X	X	X	X		X		X							
iphybun		X	X	X	X	X	X	X	X	X		X										
irepl		X	X	X	X	X	X			X		X				X						
ibun -cD		X	X	X	X	X	X	X	X				X	X								
iput		X	X	X	X	X	X	X	X				X	X								
iphymv		X	X	X	X	X	X	X	X			X					X					
imv		X	X	X			X	X	X			X						X	X			
irm		X	X	X			X	X	X			X						X	X		X	X
irm -r collection		X	X	X			X	X	X			X						X	X	X	X	X
ichksum		X	X	X				X	X													
iput -f		X	X	X				X	X	X	X			X								
irsync		X	X	X				X	X	X	X			X								
irule - msiDataObjWrite		X	X	X				X	X	X	X			X								
irule - msiDataObjRead		X	X	X						X	X											
idbo exec		X	X	X						X	X											
iget		X	X	X						X	X											
igetwild.sh		X	X	X						X	X											

# iRODS Distributed Data Management

# Rules

Distributed Rule Engine

Distributed Rule Base – core.irb

# Computer Actionable Policies

- Retention, disposition, distribution, arrangement
- Authenticity, provenance, description
- Integrity, replication, synchronization
- Deletion, trash cans, versioning
- Archiving, staging, caching
- Authentication, authorization, redaction
- Access, approval, IRB, audit trails, report generation
- Assessment criteria, validation
- Derived data product generation, format parsing
- Federation



# Format of a Rule

- Action | Condition | MS<sub>1</sub>, ..., MS<sub>n</sub> | RMS<sub>1</sub>, ..., RMS<sub>n</sub>
- Action
  - Name of action to be performed
  - Name known to the server and invoked by server
- Condition – condition under which the rule apply
- Micro-services - If applicable micro services will be executed
- Recovery micro-service - If any micro service fails, recovery micro service(s) executed to maintain transactional consistency
- Example of micro-service / recovery micro-service
  - createFile(\*F)                      removeFile(\*F)
  - ingestMetadata(\*F,\*M)              rollback

# Rule to Count Metadata

```
myTestRule {
#Input parameters are:
# String with conditional query
#Output parameter is:
# Result string
  msiExecStrCondQuery(*Select,*QOut);
  foreach(*QOut) {
    msiPrintKeyValPair("stdout",*QOut)
  }
}
INPUT *Select=$"SELECT count(META_DATA_ATTR_VALUE),
order(META_DATA_ATTR_NAME), META_DATA_ATTR_NAME
where COLL_NAME like '/renci/home/guest50%%'"
OUTPUT ruleExecOut
```

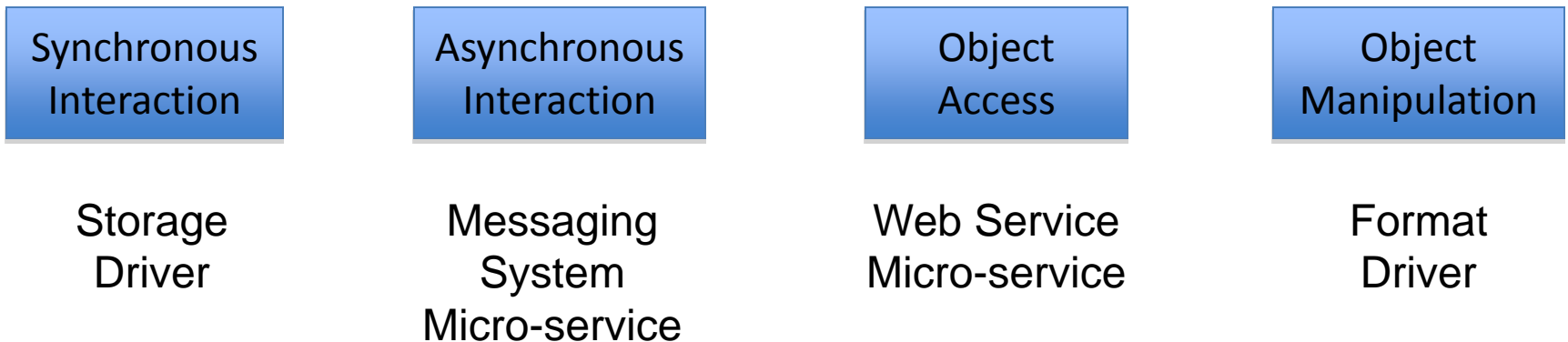
# Applications

- Interoperability mechanisms
- Knowledge management
- Collection life cycle
- Data grids

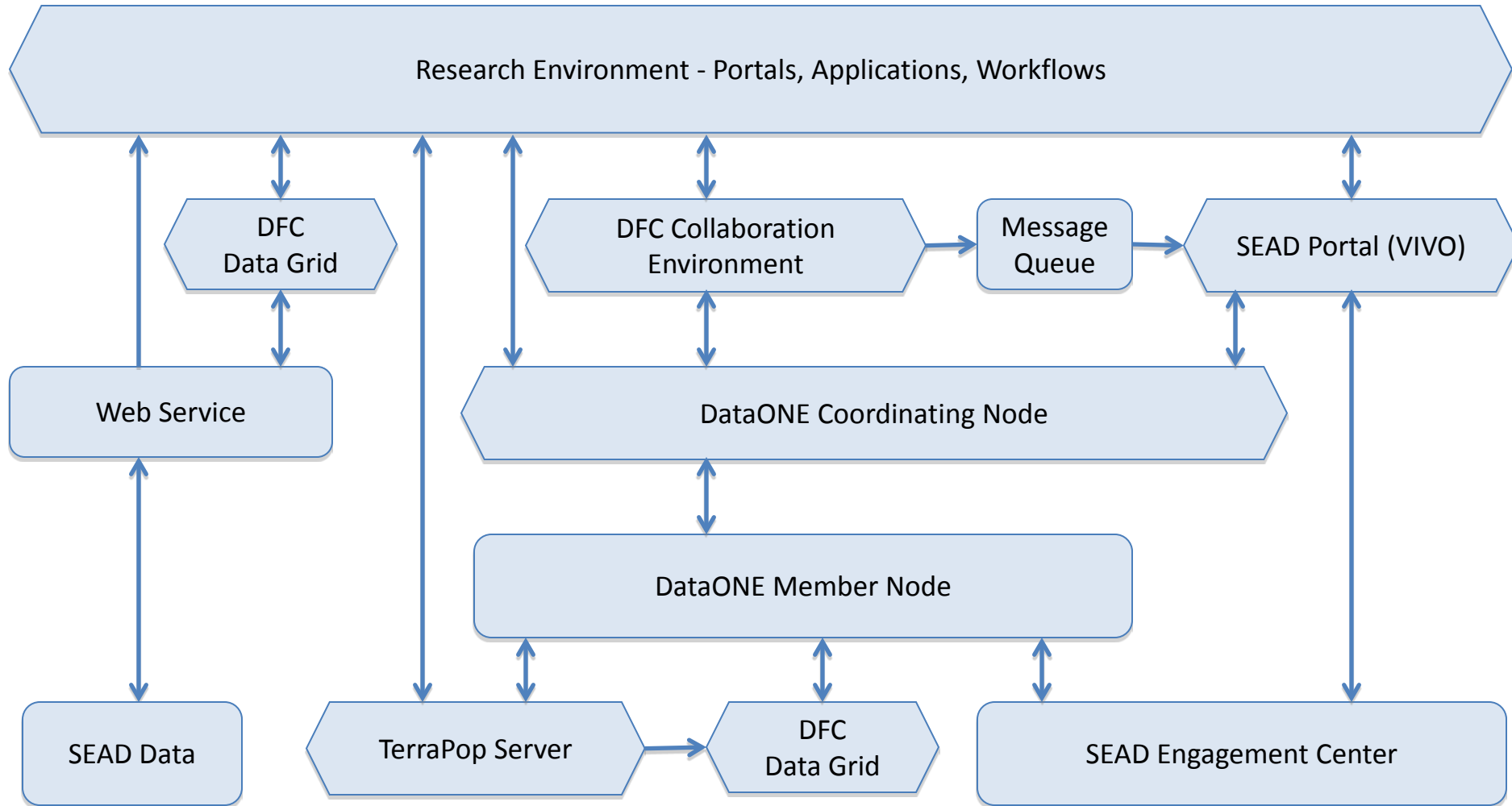


# Interoperability Mechanisms

- Challenge
  - Identify classes of interoperability mechanisms needed to support access to existing infrastructure
- Each class defines the knowledge that must be captured to enable interaction
  - Capture knowledge in micro-services, drivers, and rules

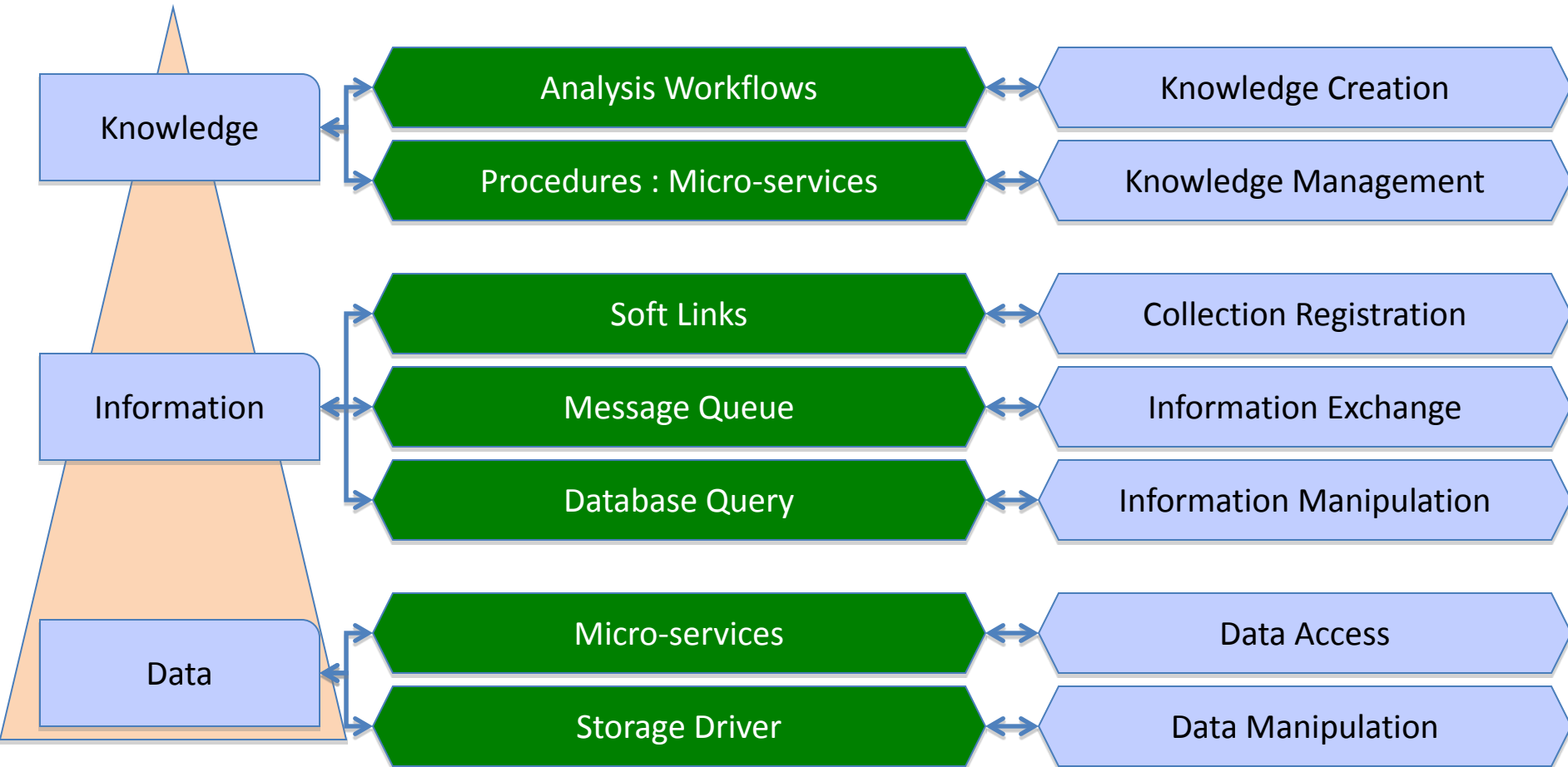


# DataNet Interoperability



# Interoperability Mechanisms

Policies control execution of each interoperability mechanism



# DFC Interoperability Layers

Authentication

PAM, GSSAPI

InCommon, GSI, Kerberos, Shibboleth, LDAP

Data Access

Micro-Services

DataONE, Data Conservancy, CUAHSI, NCDC

Data Manipulation

Format Drivers

NetCDF, HDF5, THREDDS, ERDDAP

Workflows

Micro-Services

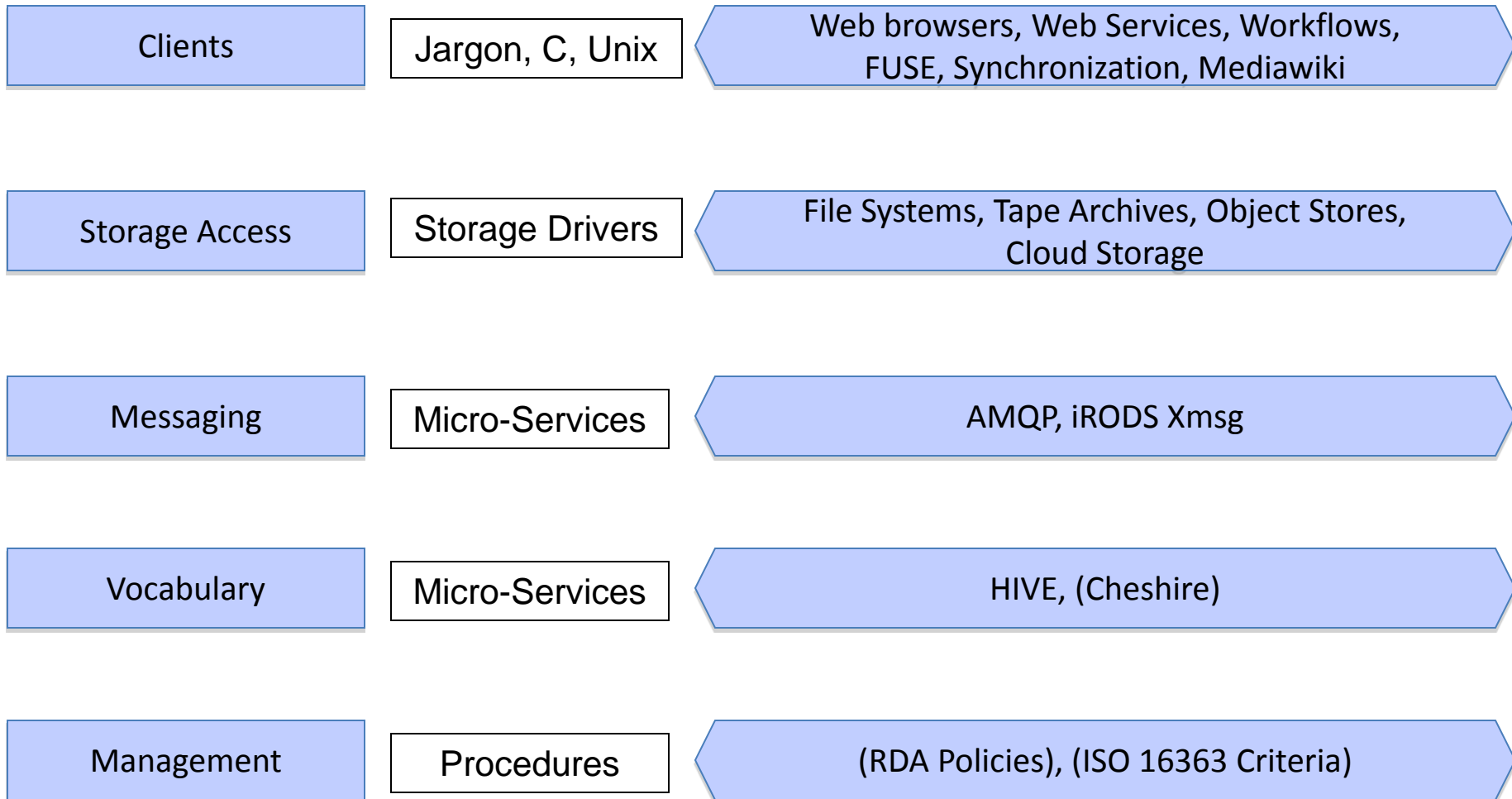
Kepler, NCSA Cyberintegrator, Taverna, NCSA  
Polyglot

Networks

Network Drivers

HTTPS, TCP/IP, Parallel TCP/IP, RBUDP

# DFC Interoperability (2)

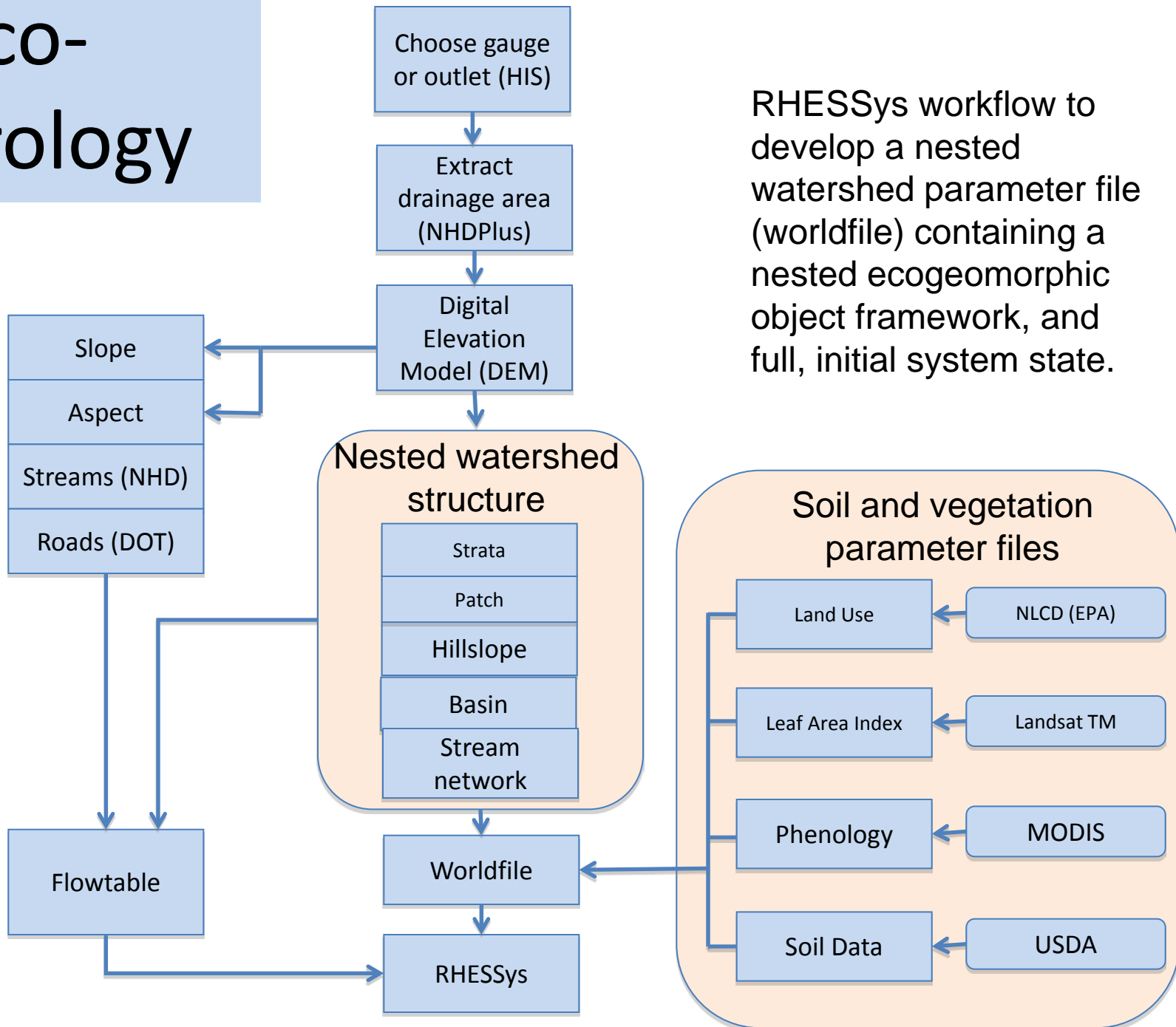


# Knowledge Management

- Challenge
  - Capture domain knowledge needed to discover, access, and manipulate domain objects
  - Capture domain knowledge that represents the application of a workflow (workflow registration)
  - Capture knowledge needed to manage a collection life cycle (policies and procedures)
- Support extensible knowledge encapsulation mechanisms



# Eco-Hydrology



RHESSys workflow to develop a nested watershed parameter file (worldfile) containing a nested ecogeomorphic object framework, and full, initial system state.

# Workflow Management

eCWkflow.mss

/earthCube/eCWkflow

eCWkflow.run

eCWkflow2.run

eCWkflow.mpf

eCWkflow2.mpf

/earthCube/eCWkflow/eCWkflow.runDir0

Outfile

/earthCube/eCWkflow/eCWkflow2.runDir0

Newfile

## **Workflow** file

Directory holding all input and output files associated with workflow file (mounted collection that is linked to the workflow file)

Automatically generated run file for Executing each input file

**Input parameter** file, lists parameters and input and output file names

Directory holding all output files generated for invocation of eCWkflow.run, the version number is incremented

**Output** file created for eCWkflow.mpf

**Output** file created for eCWkflow2.mpf



# iRODS Rule for RHESys

Modular workflow composed by chaining basic transformation

Define input variables

Call functions to apply each transformation step

Store results in shared collection

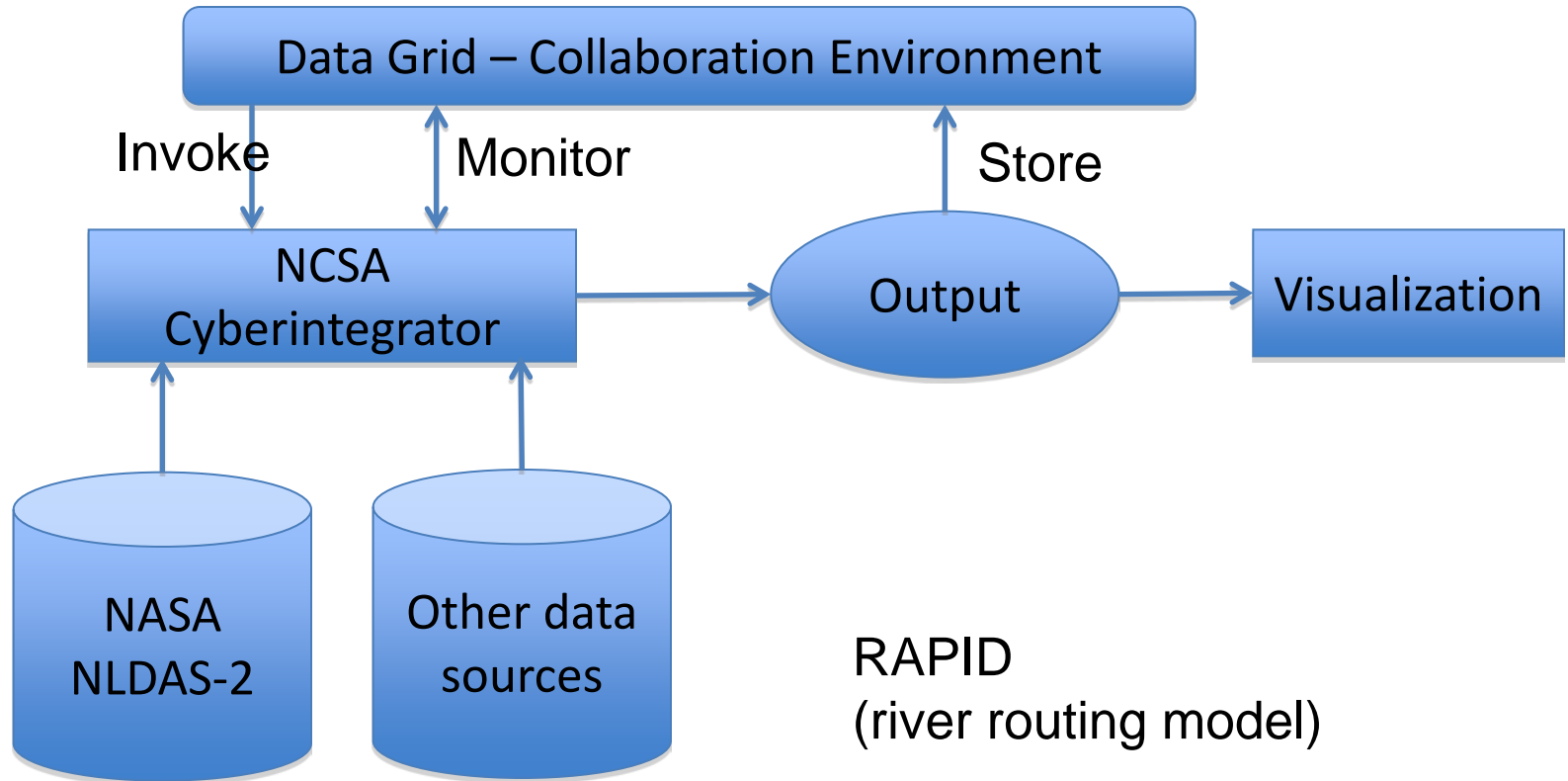
```
main {  
    getExtentForGageReachcode(*gageReachcode, *extentInNHD_Vect_Coords);  
  
    convertExtentToNHD_DEM(*extentInNHD_Vect_Coords,  
*extentInNHD_DEM_Coords);  
  
    extractTileFromNHD_DEM(trimr(*extentInNHD_DEM_Coords, "\n"));  
  
    importDEMTileIntoNewGRASSLocationAsUTM(*extentInNHD_Vect_Coords,  
*newLocPhysPath, *newLocObjPath);  
  
    delineateWatershedForNHDGage(*nhdStreamGageID, *newLocPhysPath,  
*newLocObjPath);  
}
```

```

extractTileFromNHD_DEM(*extentCoords) {
# Split path to object into collection and name
  msiSplitPath(*nhdDEMObjPath, *nhdDEMObjColl, *nhdDEMObjName);
  writeLine("serverLog", *nhdDEMObjColl);
  writeLine("serverLog", *nhdDEMObjName);
# Build query to discover physical path
  msiAddSelectFieldToGenQuery("DATA_PATH", "null", *genQInp);
  msiAddConditionToGenQuery("DATA_NAME", "=", *nhdDEMObjName, *genQInp);
  msiAddConditionToGenQuery("COLL_NAME", "=", *nhdDEMObjColl, *genQInp);
  msiAddConditionToGenQuery("DATA_RESC_NAME", "=", *rescName, *genQInp);
# Run query
  msiExecGenQuery(*genQInp, *genQOut);
# Extract path from query result
  foreach (*genQOut) {msiGetValByKey(*genQOut, "DATA_PATH", *filePath); }
  writeLine("serverLog", *filePath);
# Determine physical path of input directory
  msiSplitPath(*filePath, *inFileDir, *headerFileIgnore);
# Generate physical path of output file
  msiSplitPath(*inFileDir, *inFileParentDir, *rasterDatasetName)
  *tileFileName = "SUBSET-++*rasterDatasetName++.img"
  *tileFilePath = *inFileParentDir++/"++*tileFileName;
# Generate iRODS path of output
  msiSplitPath(*nhdDEMObjColl, *nhdDEMObjCollParent, *junk)
  *tileObjPath = *nhdDEMObjCollParent++/"++*tileFileName
  *args = "-of HFA -projwin "++*extentCoords++" "++"*inFileDir"++" "++"*tileFilePath";
  writeLine("serverLog", *args);
  msiExecCmd("gdal_translate", *args, "iren.renci.org", "null", "null", *cmd_out);
  writeLine("serverLog", *cmd_out);
# Register tile file with iRODS
  msiPhyPathReg(*tileObjPath, *rescName, *tileFilePath, "null", *status);
}

```

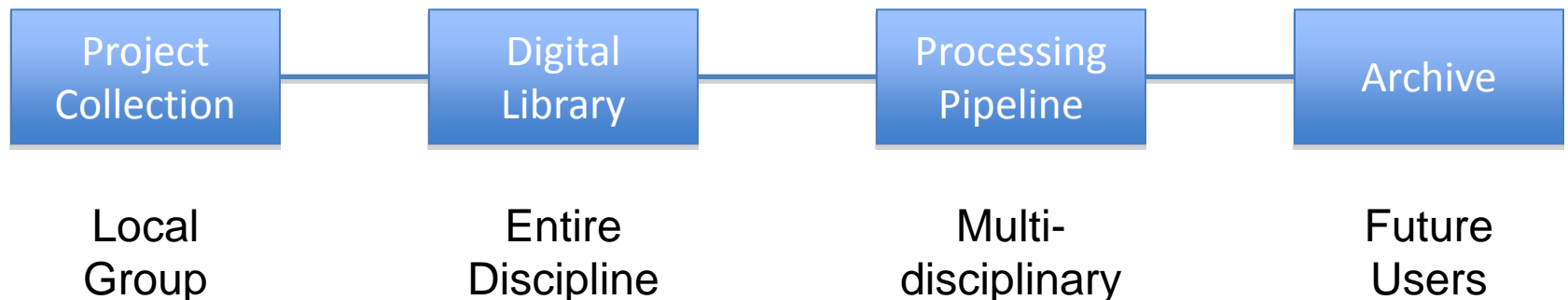
# Event-Driven Real-Time Drought Analysis/Prediction Workflow



<http://rapid.ncsa.illinois.edu:8080/rapid/>

# Collection Life Cycle

- Challenge
  - Support all phases of a collection life cycle
- As the user community changes, expect a collection to migrate to next stage of the life cycle
  - Requires evolution of the management policies to track the transitions
- **Manage evolution of policies between life cycle stages**



# Disciplines Using Data Grids

- Astronomy
  - National Optical Astronomy Observatory
  - CyberSKA Square Kilometer Array
  - Large Synoptic Survey Telescope
- High energy physics
  - BaBar (2 Petabytes of data)
- Particle physics
  - T2K Queen Mary University London
- Genomics
  - Broad Institute, Wellcome Trust Sanger Institute
- Seismology
  - Southern California Earthquake Center
- Astrophysics
  - AMS: cosmic ray experiment on the International Space Station (1 PB).
- Neuroscience
  - International Neuroinformatics Coordinating Facility
- Medicine
  - Sick Kids Hospital, Toronto

# International Use

- Countries developing national-scale data grids based on DFC technology:
  - Australia
  - France
  - Germany
  - Italy
  - New Zealand
  - Sweden
  - Norway
  - UK
- Federal agencies investigating data grids based on DFC technology:
  - NOAO (production)
  - NOAA (production)
  - NASA (production)
  - NSF XSEDE (production)
  - NIH (proposal)
  - JPL (testing)
  - OSTP (discussion)

# iRODS Support

- Wiki – <http://irods.diceresearch.org>
  - Documentations
  - Architecture overview
  - Releases
  - iRODS Roadmap
- iROD-chat discussion list
  - [irods-subscribe@irods.org](mailto:irods-subscribe@irods.org)
  - Responses from international community
- E-mail
  - [irods@irods.org](mailto:irods@irods.org)

# Data Grid Registration

- [https://www.irods.org/index.php/Register\\_iRODS](https://www.irods.org/index.php/Register_iRODS)
  - Each data grid needs a unique name to enable federation
- Policy sets
  - Share core.re file
  - Research Data Alliance Practical Policy Working Group is sharing policies
  - Jewel Ward [jewel\\_ward@unc.edu](mailto:jewel_ward@unc.edu) is assembling generic policy sets



iRODS is a "coordinated NSF/OCI-Nat'l Archives research activity" under the auspices of the President's NITRD Program and is identified as among the priorities underlying the President's 2011 Budget Supplement in the area of Human and Computer Interaction Information Management technology research.

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***NSF OCI-0848296 "NARA Transcontinental Persistent Archives Prototype"***  
***NSF SDCI-0721400 "Data Grids for Community Driven Applications"***  
***NSF OCI-0940842 "DataNet Federation Consortium"***



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