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 RENCI Data Grid

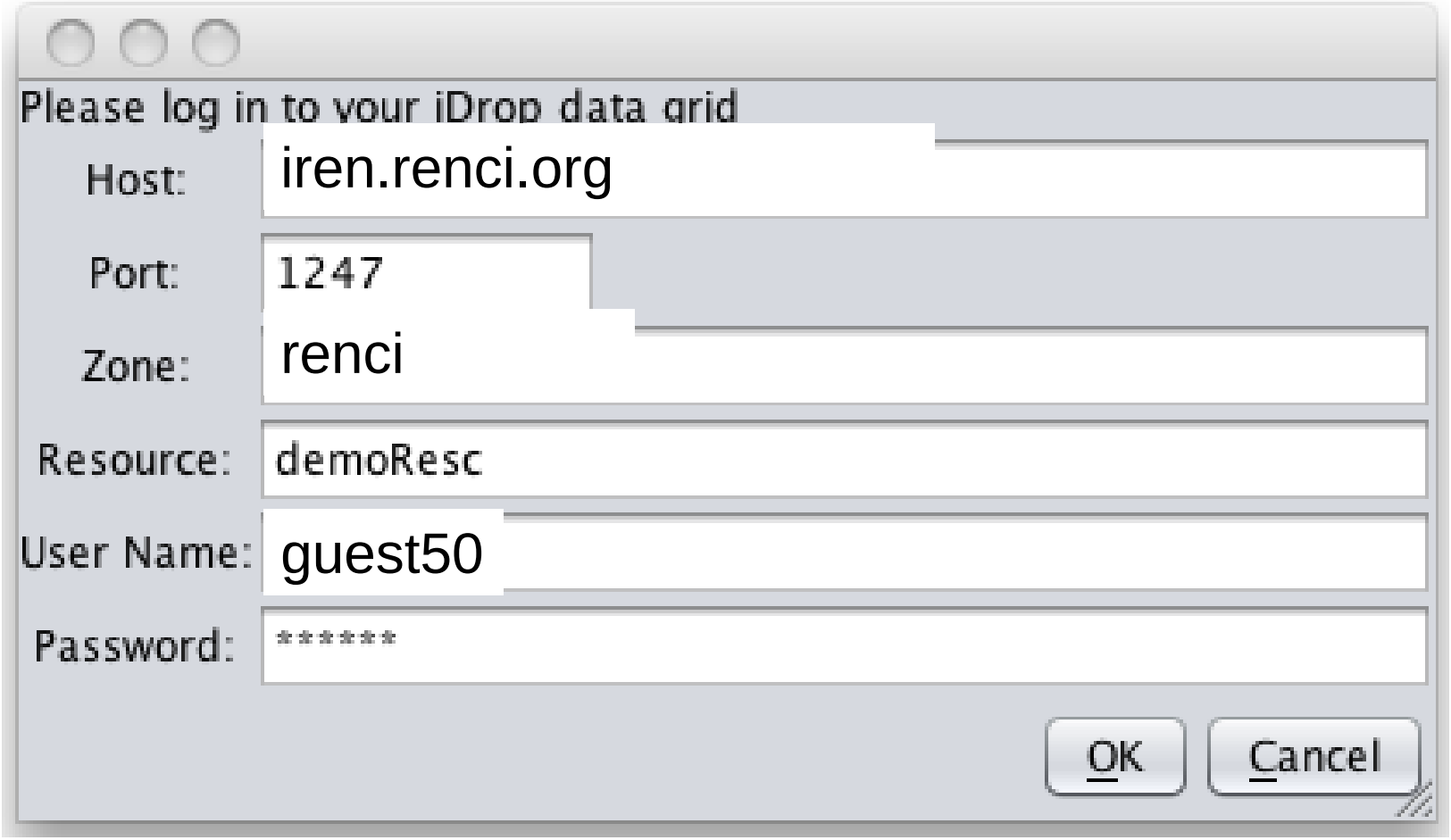
- Your user name will be

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

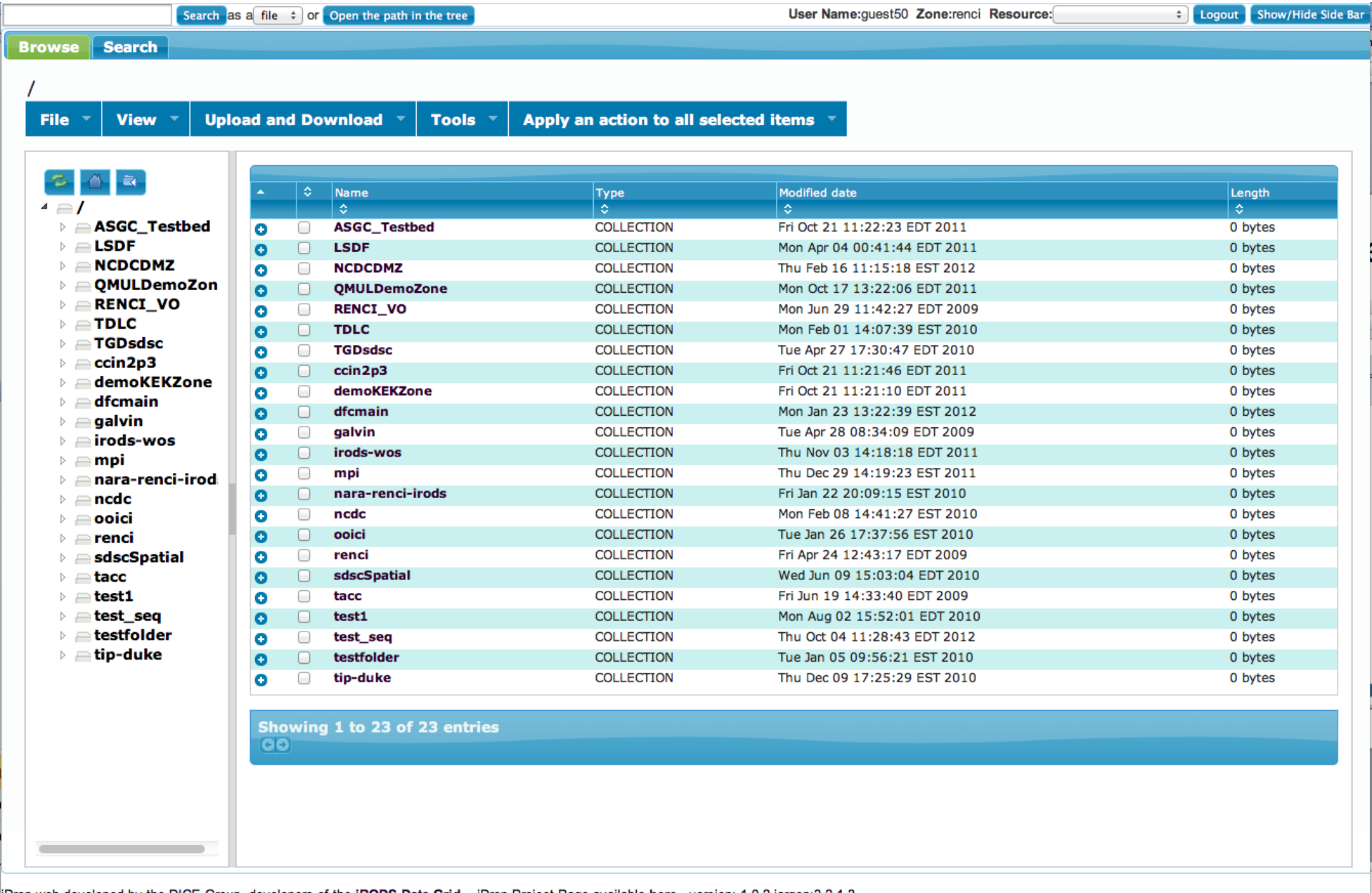
  passXX where XX is a number from 01 to 50

iDrop-web Interface

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



iDrop-web Interface



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

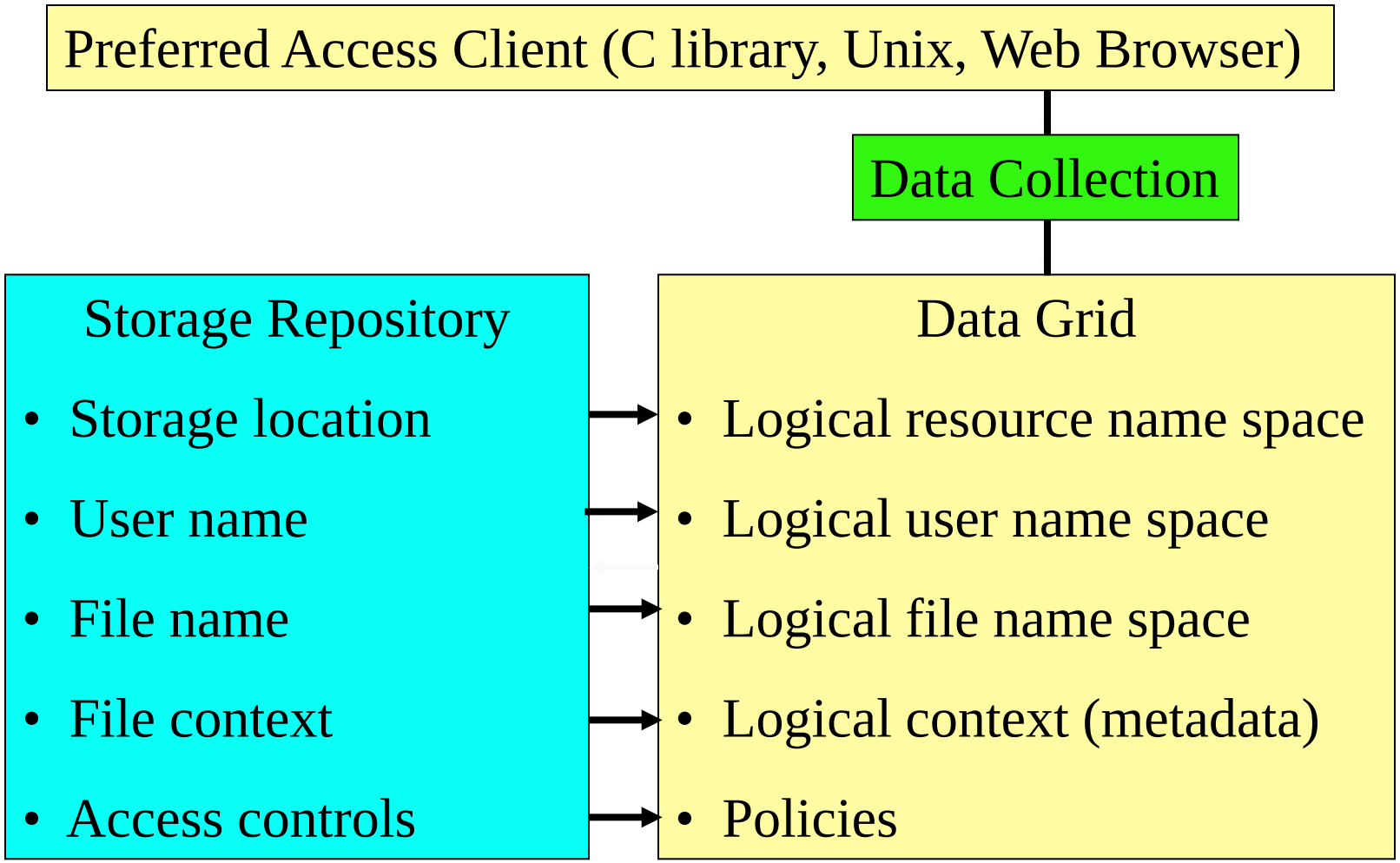
Data Grid Clients (~50)

API	Client	Developer	Language
Browser			
	DCAPE	UNC	
	iExplore	RENCI-Oleg	C++
	JUX	IN2P3	Jargon
	Peta Web browser	PetaShare	
	iDrop web browser	Mike Conway	Java
	Davis web interface	ARCS	
	Rich web client	Lisa Stillwell - RENCI	
Digital Library			
	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
File System			
	Davis - Webdav	ARCS	Jargon
	iDrop	DICE-Mike Conway	Jargon
	FUSE	IN2P3, DICE,	FUSE
	FUSE optimization	PetaShare	FUSE
	OpenDAP	ARCS	
	PetaFS (Fuse)	Petashare - LSU	
	Petashell (Parrot)	PetaShare	

iRODS Clients (Cont.)

Grid			
	GridFTP - Griffin	ARCS	
	Jsaga	IN2P3	Jargon
	Parrot	UND - Doug Thain	
	SRM	Academia Sinica	
	Saga	KEK	
I/O Libraries			
	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
Portal			
	EnginFrame	NICE / RENCI	Jargon
	Petashare Portal	LSU	Jargon
Tools			
	Archive tools-NOAO	NOAO	
	Big Board visualization	RENCI	
	iFile	GA Tech	
	i-commands	DICE	
	Pcommands	PetaShare	
	Resource Monitoring	IN2P3	
	Sync-package	Academica Sinica	
	URSpace	Teldap - Academica Sinica	
Web Service			
	VOSpace	IVOA	
	Shibboleth	King's College	
Workflows			
	Kepler - actor	DICE	Jargon
	Stork - interoperability	LSU	
	Workflow Virtualization	LSU	
	Taverna - actor	RENCI	

Data Virtualization



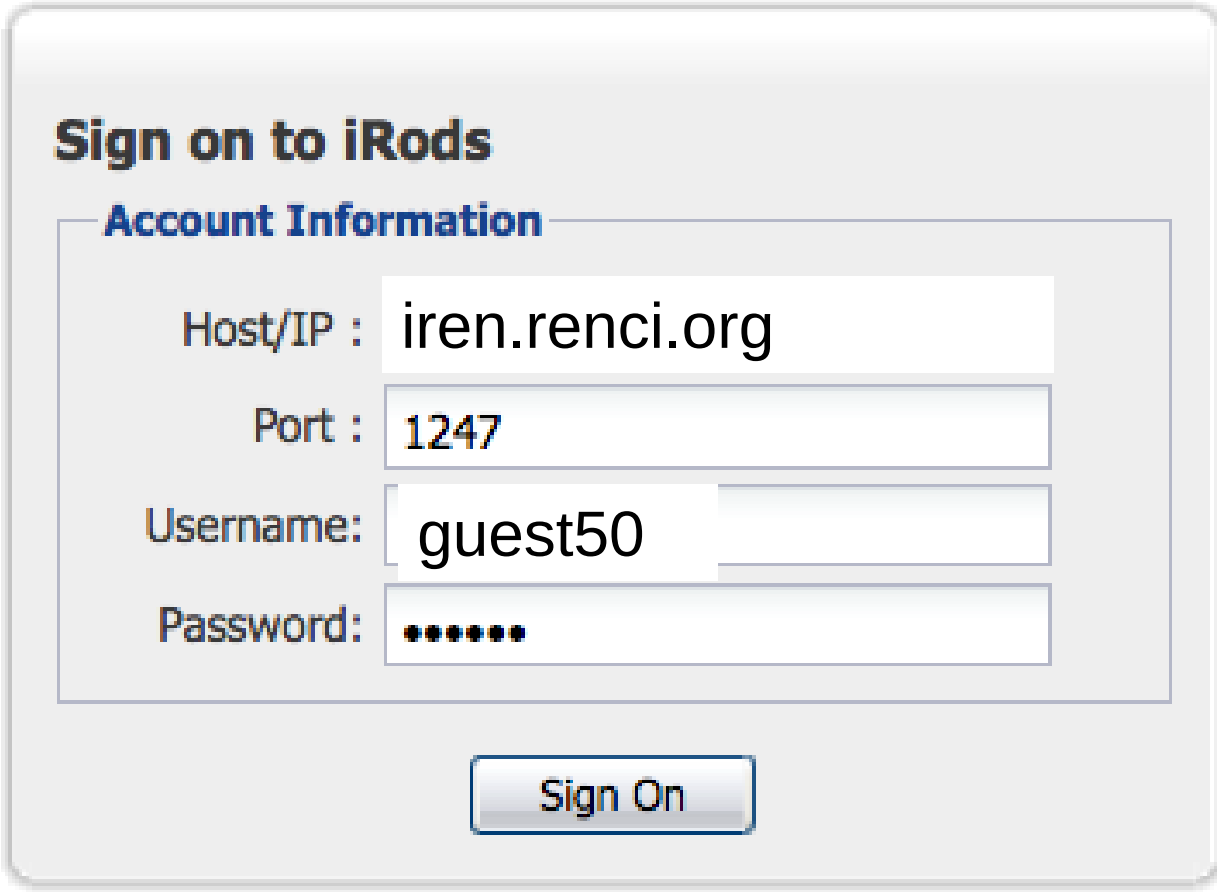
Data is organized as a shared collection

iDrop

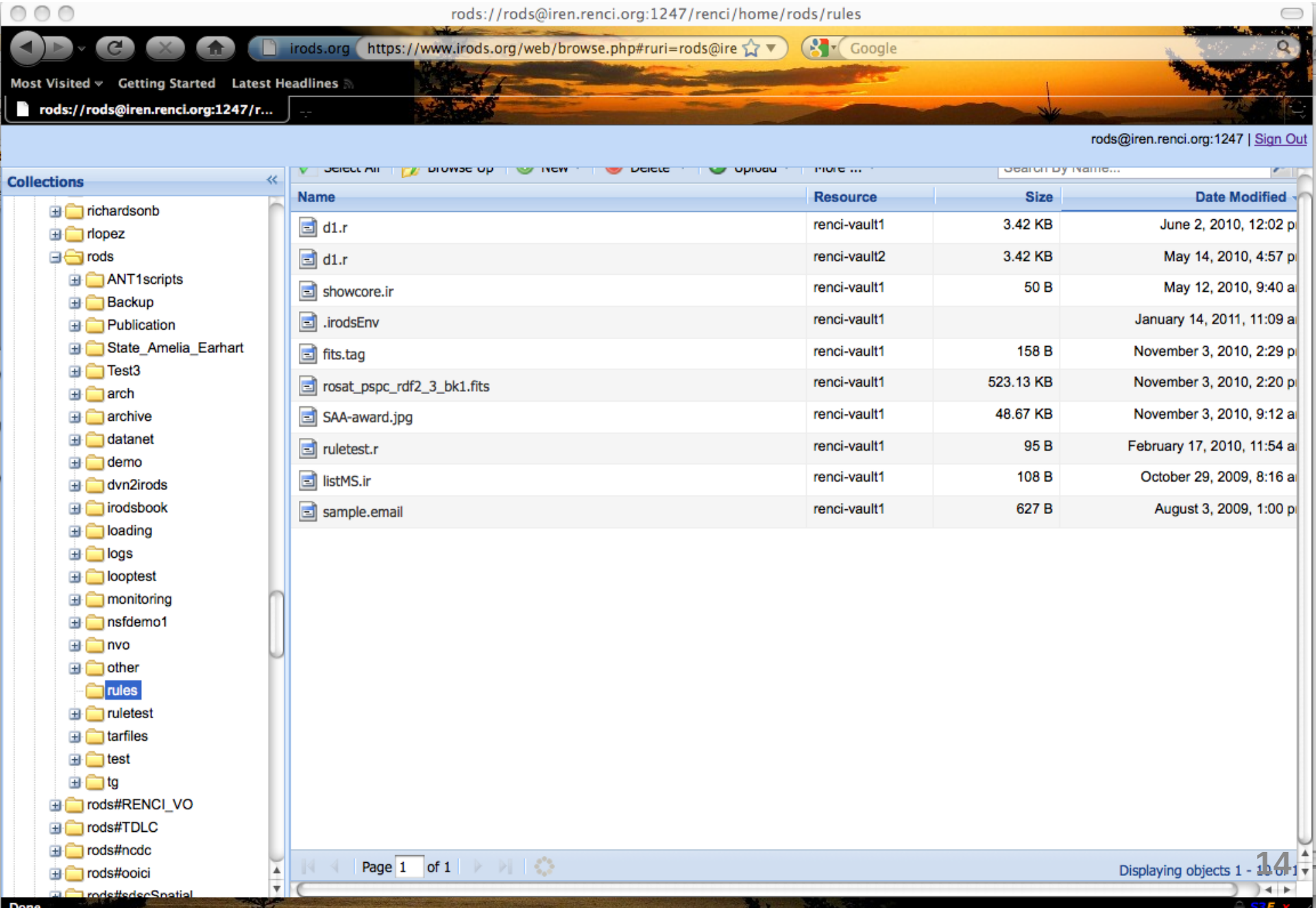
- Synchronization interface to LifeTime Library
  - http://iren-web.renci.org/idrop-release/idrop.jnlp
  - Installs in system tray
- Manages data transfers over unreliable networks
  - Can synchronize a local laptop directory with a directory in the data grid
  - Periodically transfer files
  - Track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

Rich Web Client – Web Browser

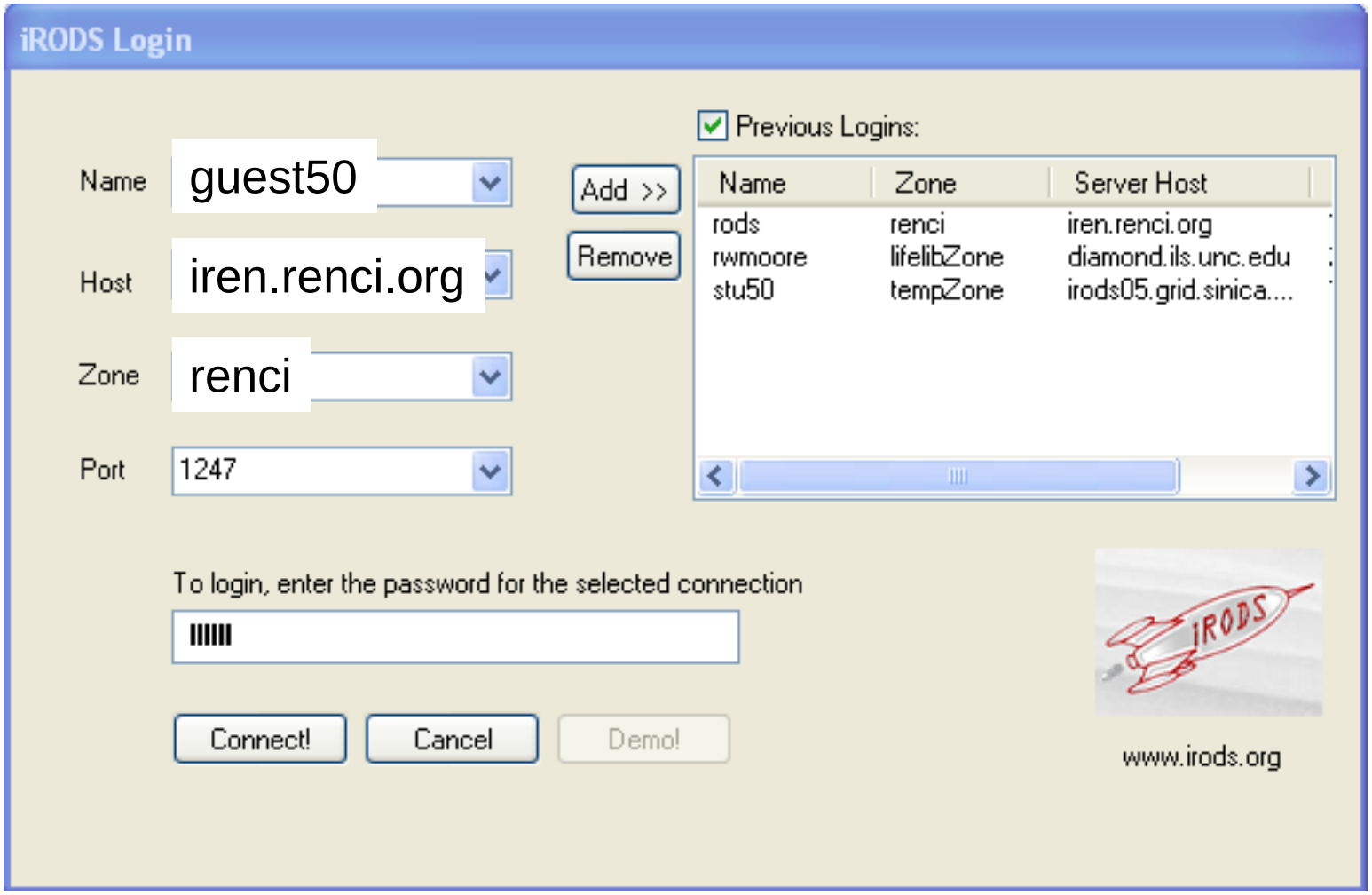
- https://www.irods.org/web/index.php



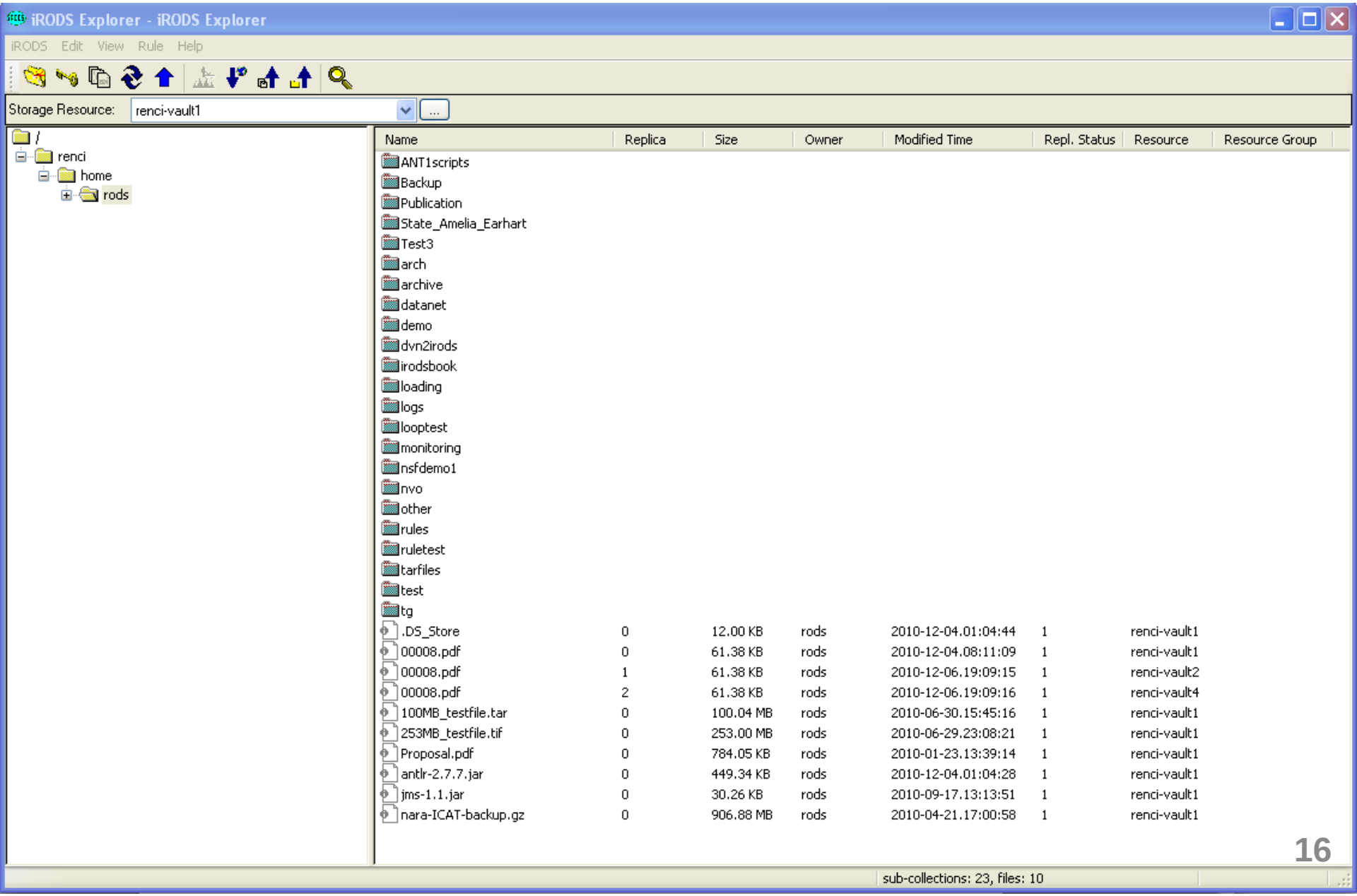
Rich Web Client Browser



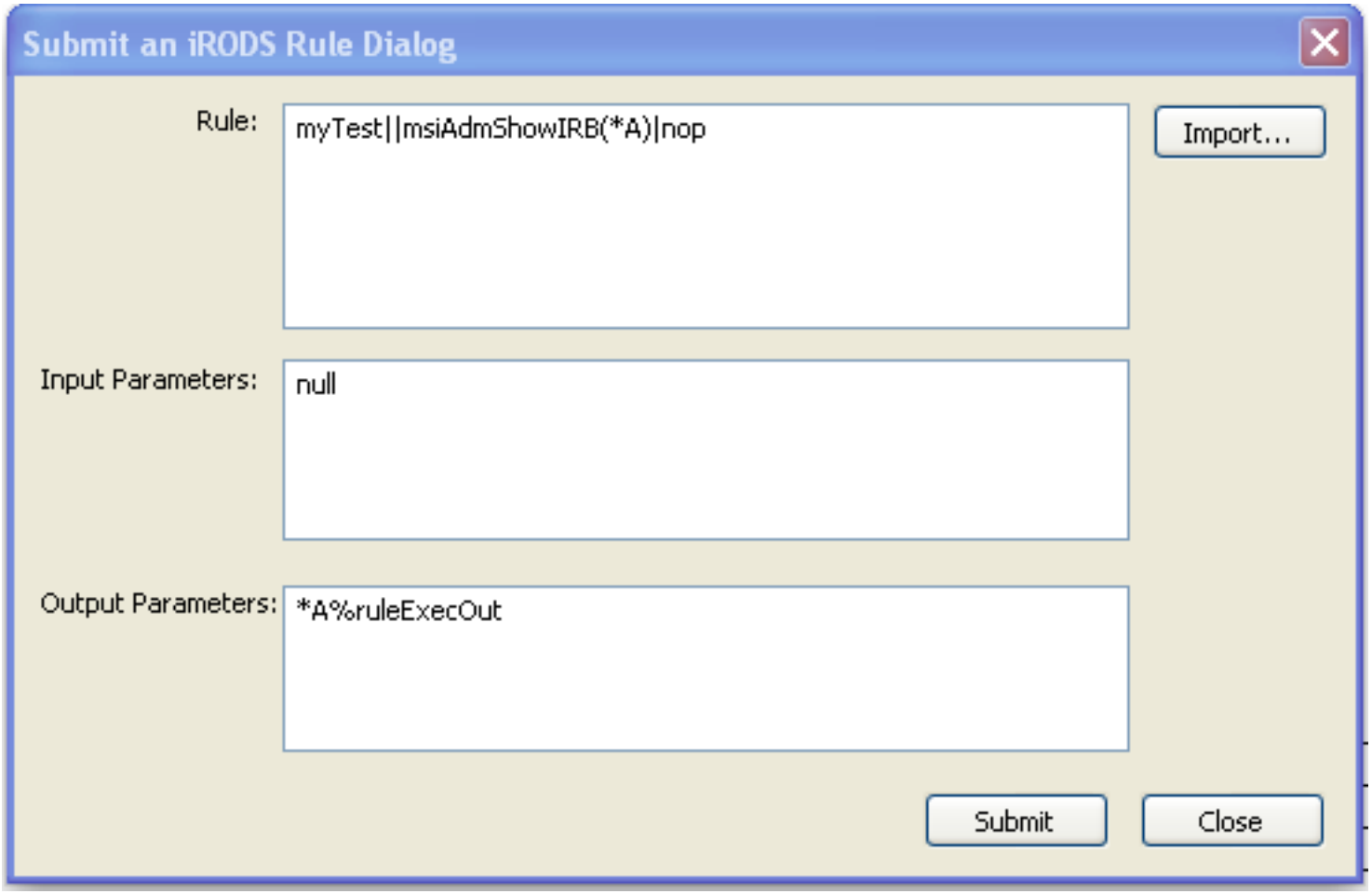
Windows iExplorer
https://www.irods.org/index.php/windows



Windows iExplorer



Executing a Rule



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
- 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

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_1, ..., MS_n | RMS_1, ..., RMS_n
- 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

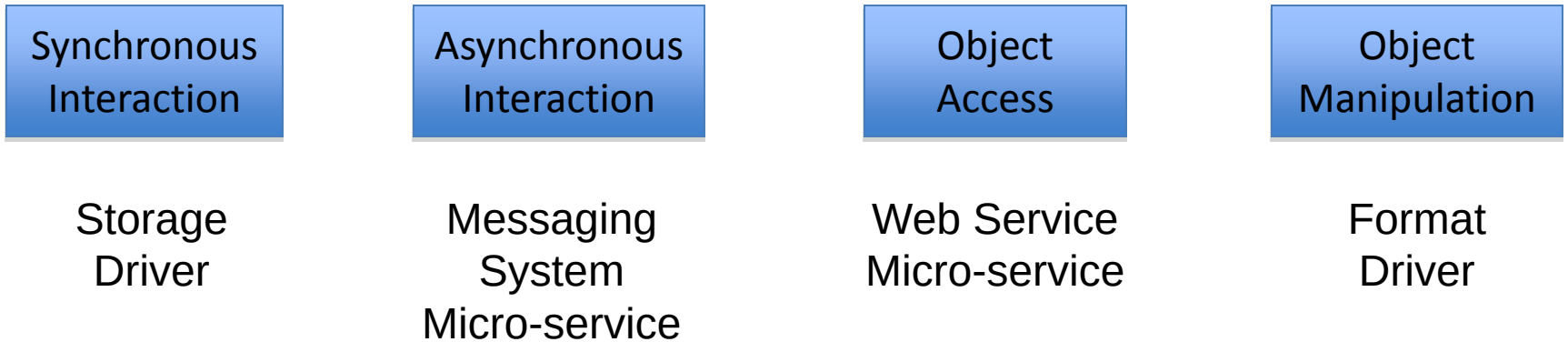
```
myTestRule {
#Input parameters are:
#  String with conditional query
#Output parameter is:
#  Result string
  msiExecStrCondQuery(*Select,*QOut);
  foreach(*QOut) {
    msiPrintKeyValPair("stdout",*QOut)
  }
}
INPUT *Select=$"SELECT count(META_DATA_ATTR_VALUE),
order(META_DATA_ATTR_NAME), META_DATA_ATTR_NAME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

Applications

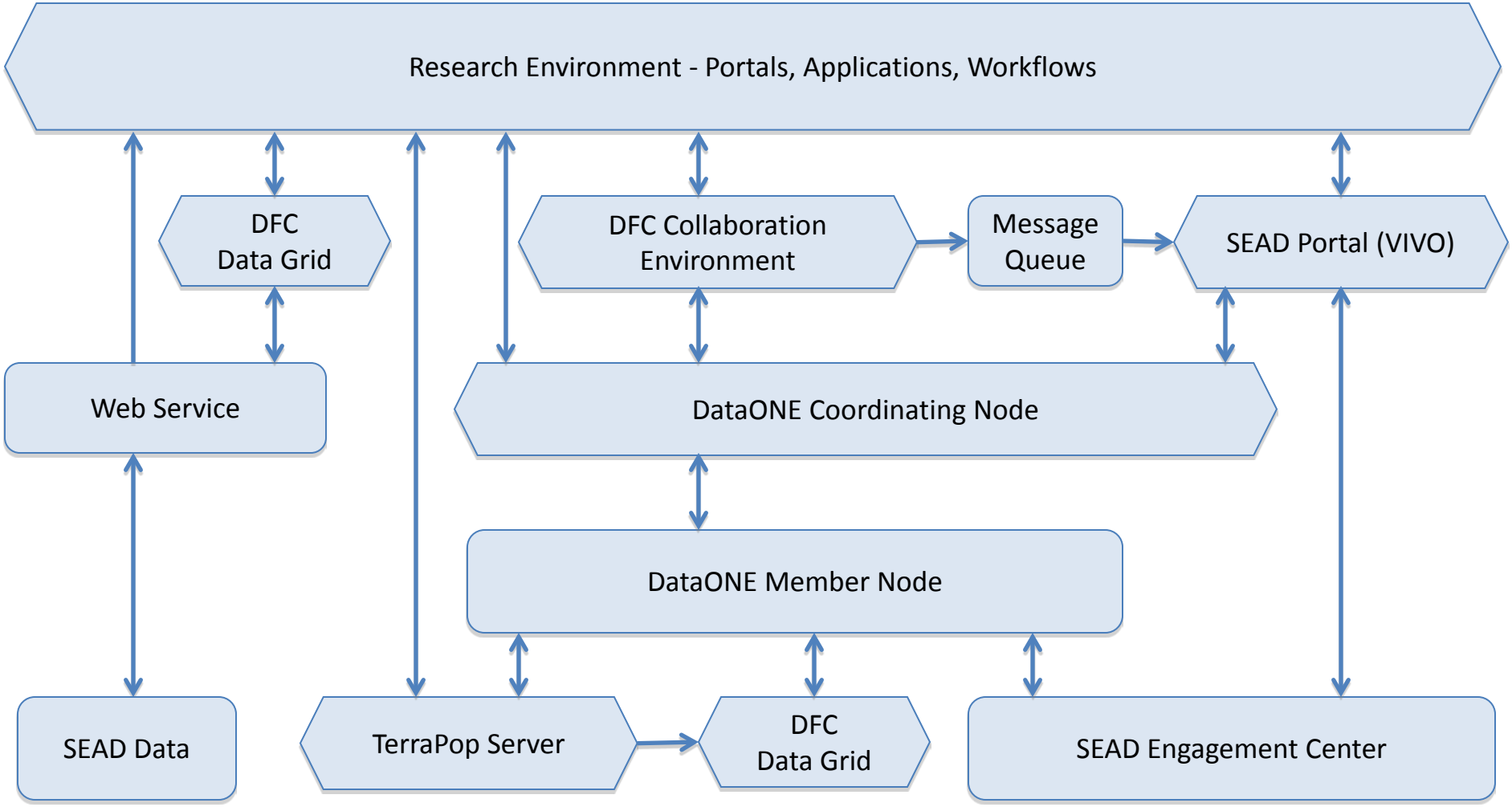
- Interoperability mechanisms
- Knowledge management
- Collection life cycle
- Data grids

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

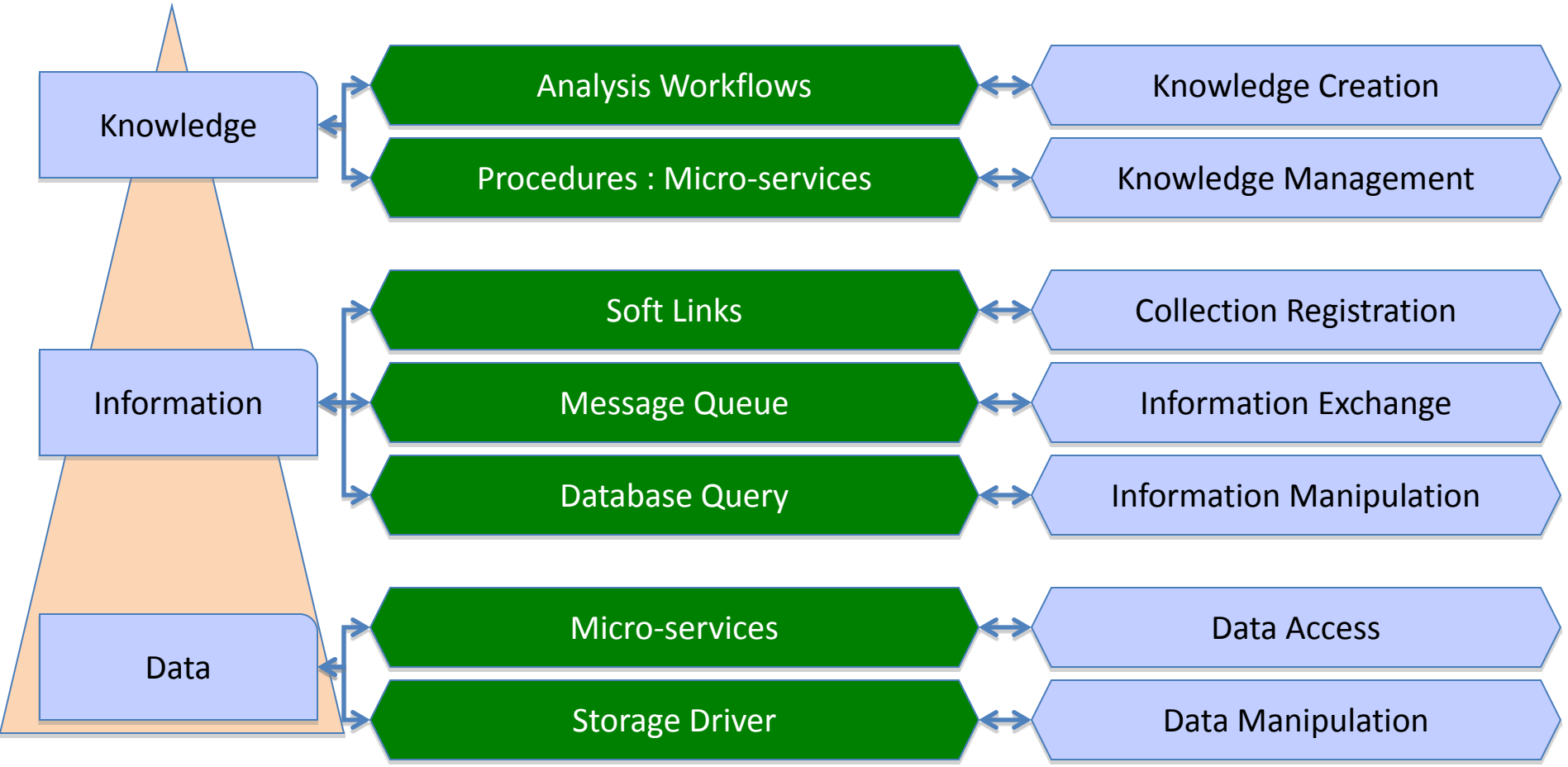


DataNet Interoperability

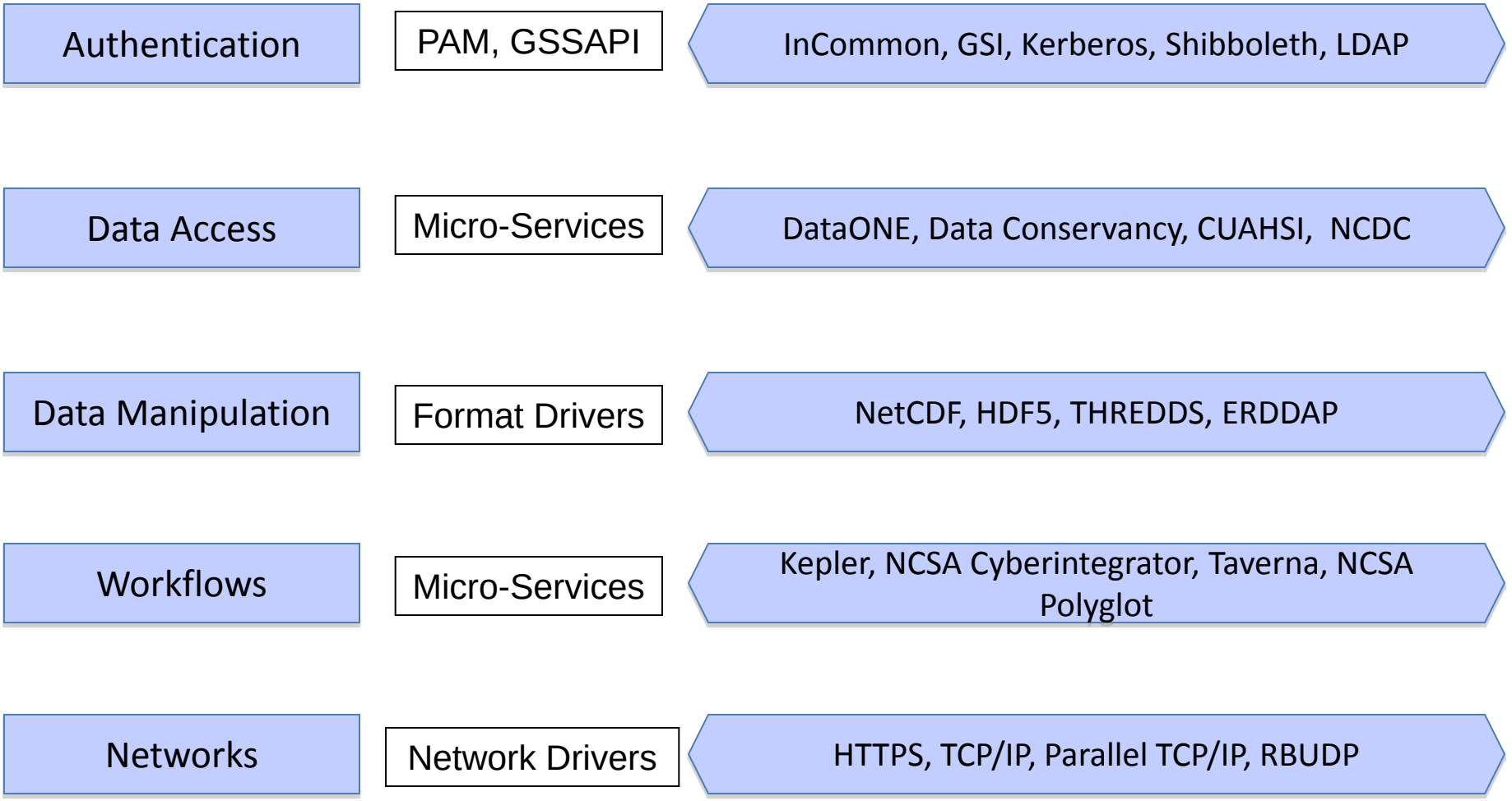


Interoperability Mechanisms

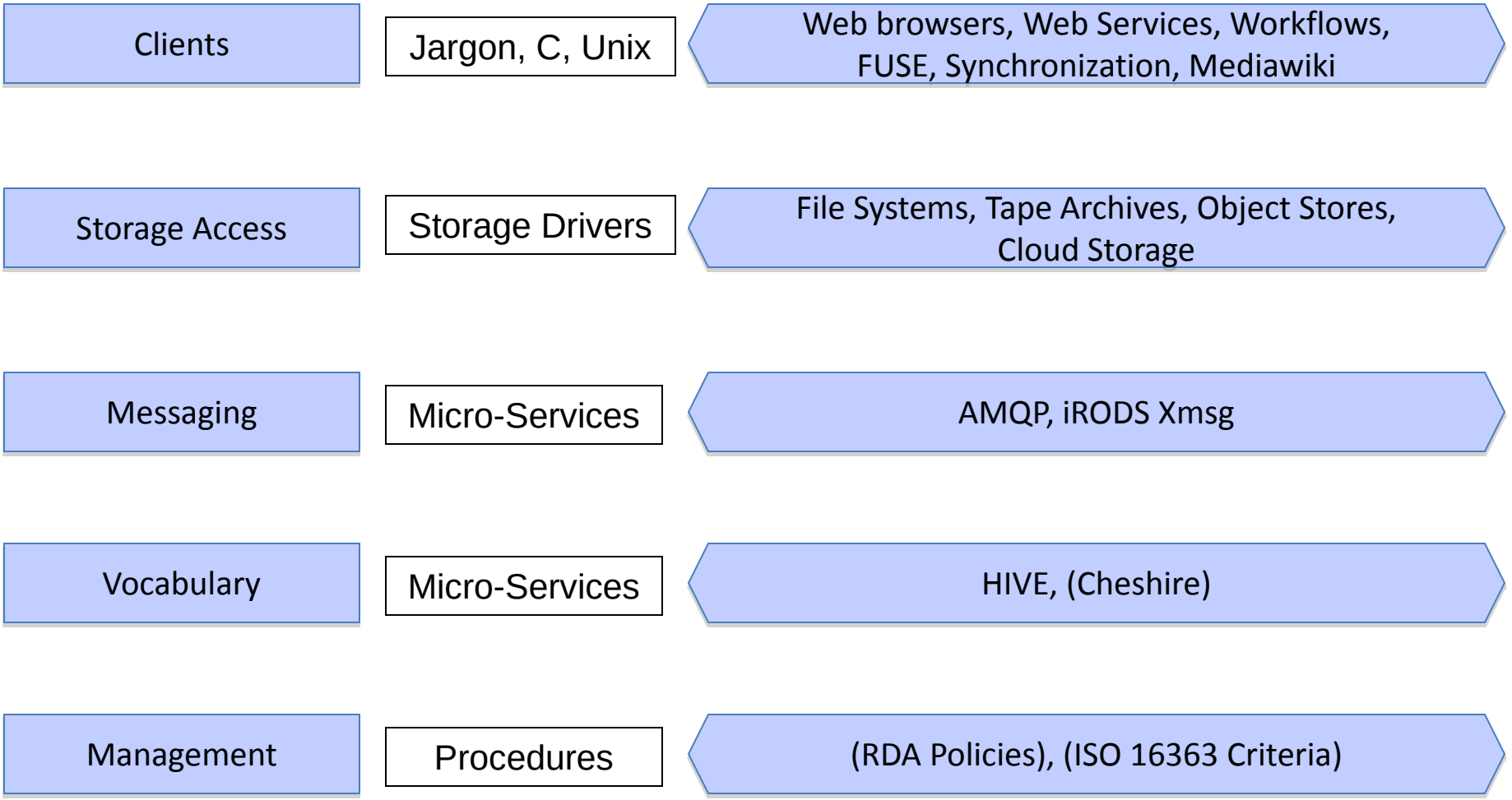
Policies control execution of each interoperability mechanism



DFC Interoperability Layers

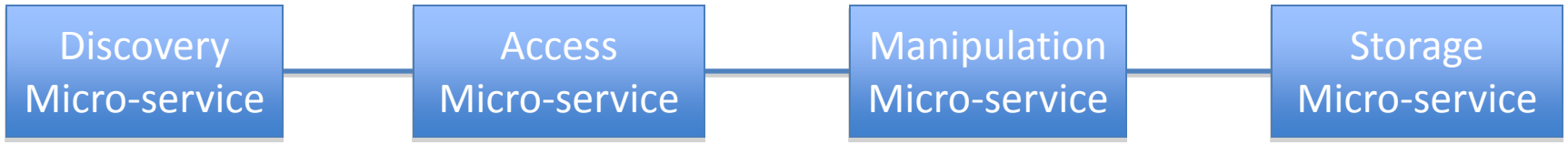


DFC Interoperability (2)

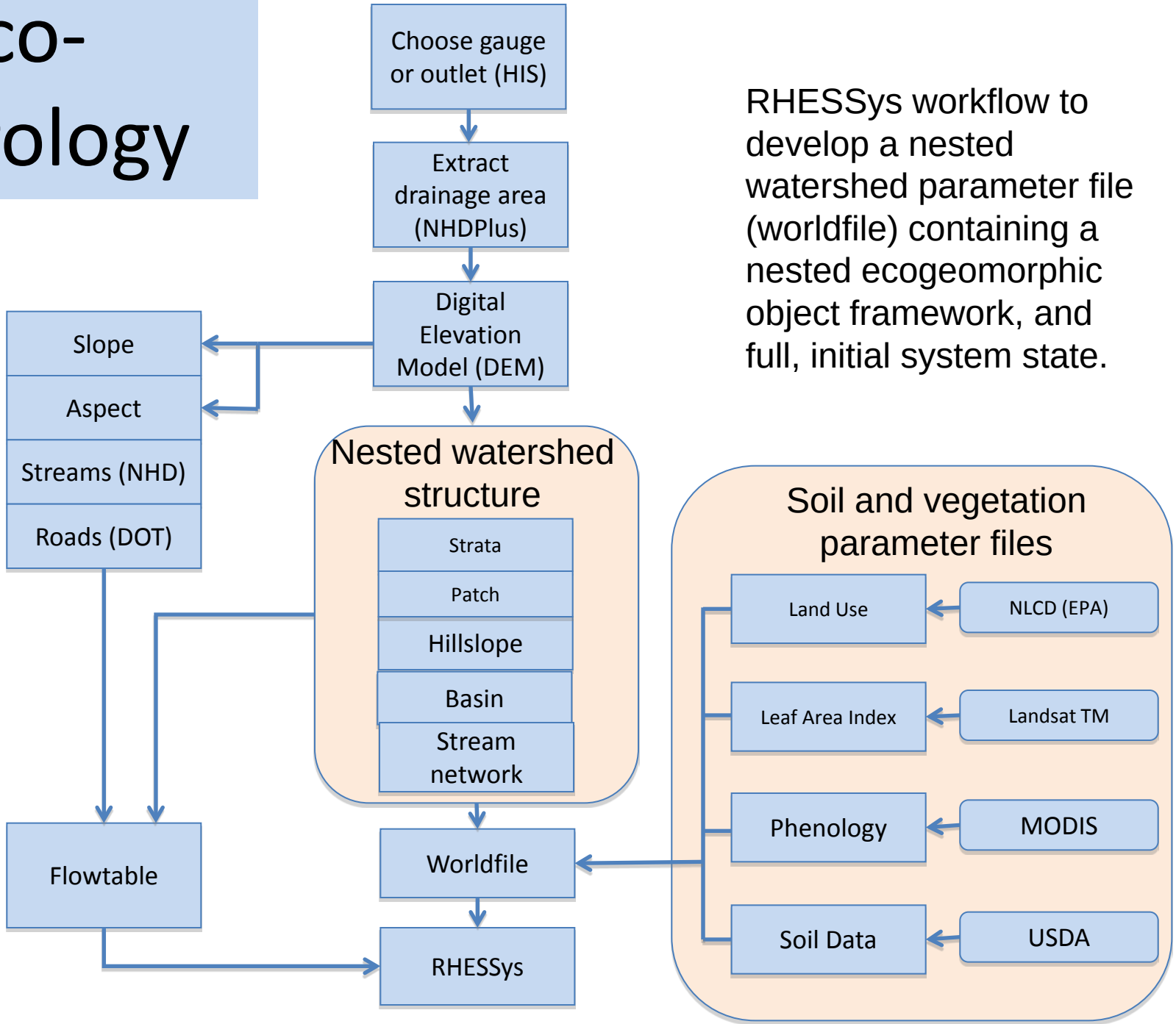


Knowledge Management

- 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

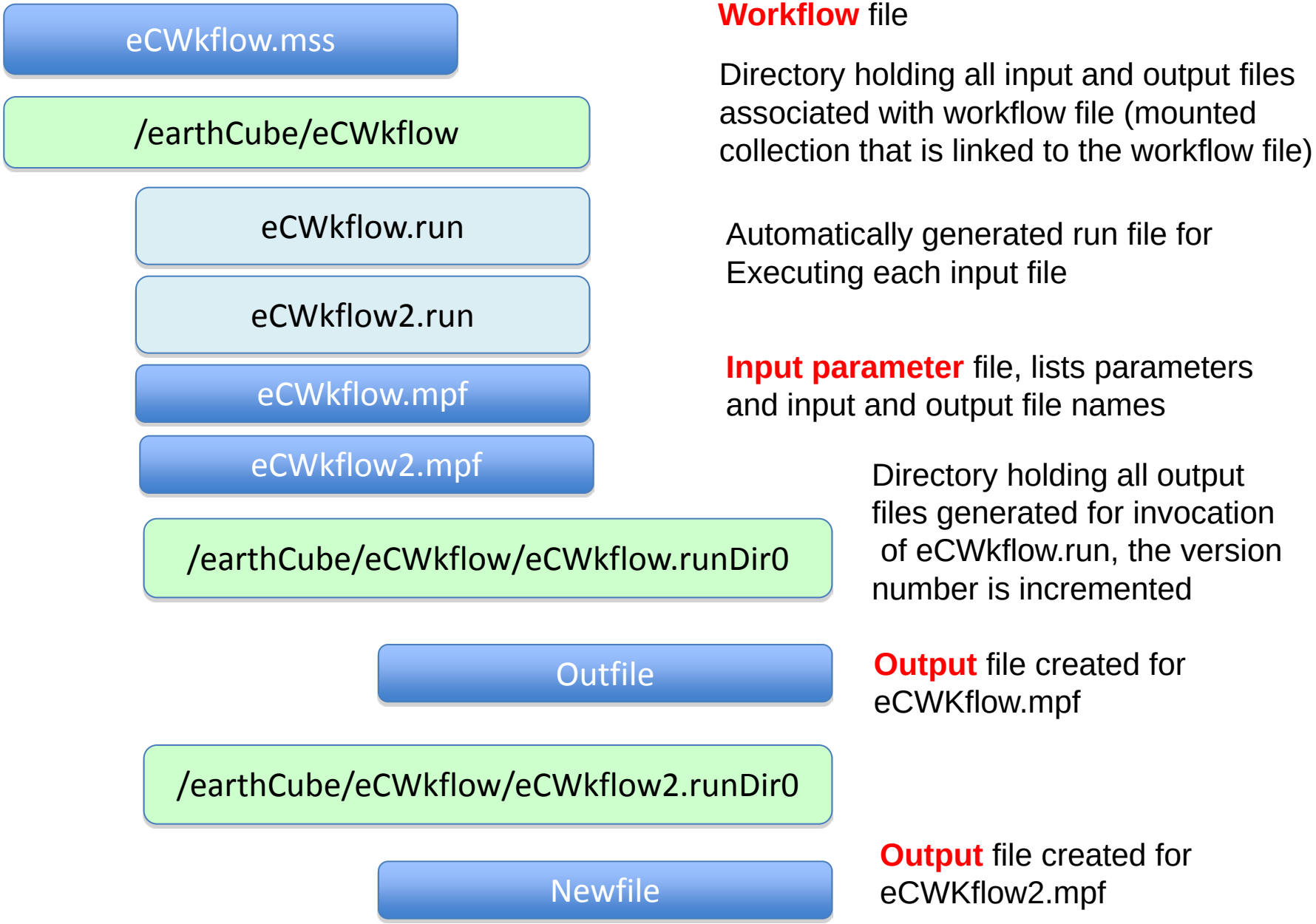


Eco-Hydrology



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

Workflow Management



iRODS Rule for RHESSys

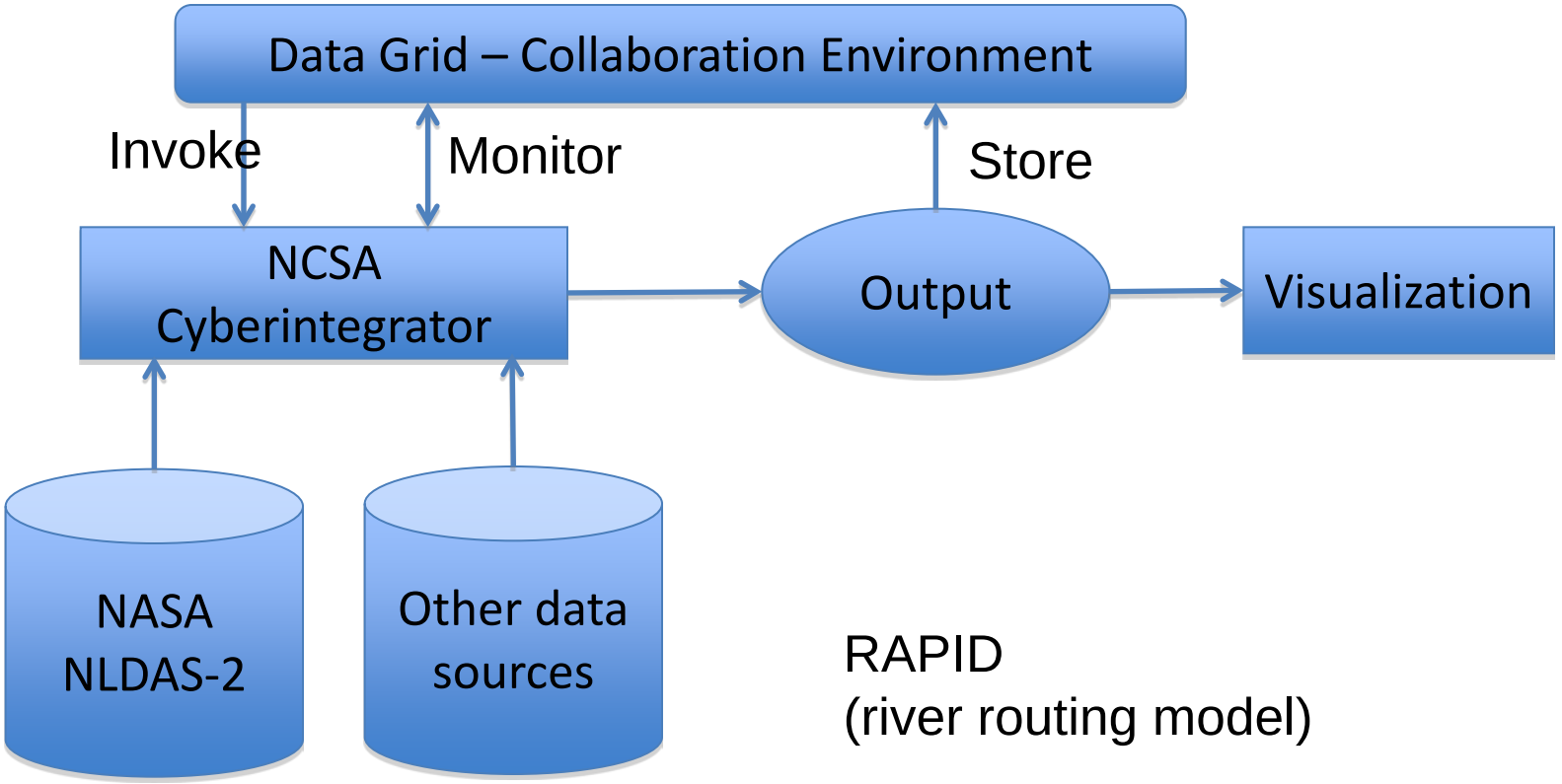
Modular workflow composed by chaining basic transformation

- 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

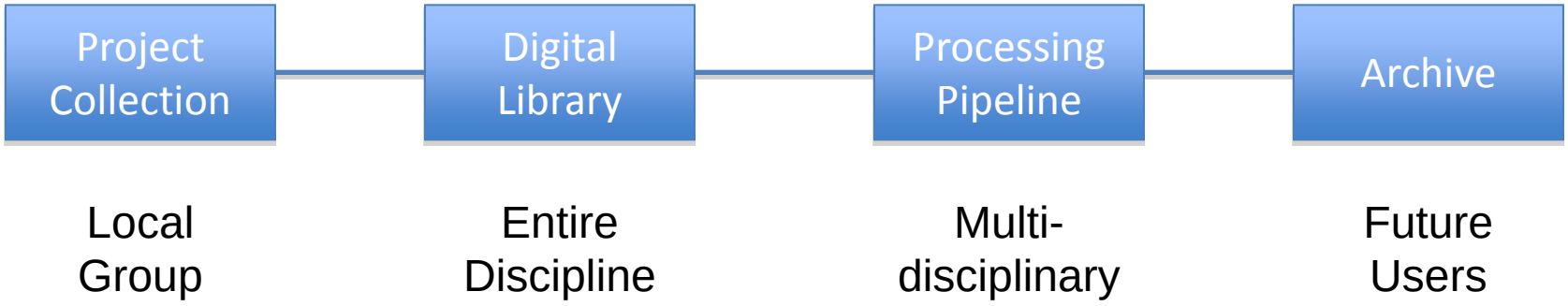


RAPID
(river routing model)

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
  - Responses from international community
- E-mail
  - irods@irods.org

Data Grid Registration

- 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 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"