Policy Based Preservation Environments (iRODS)

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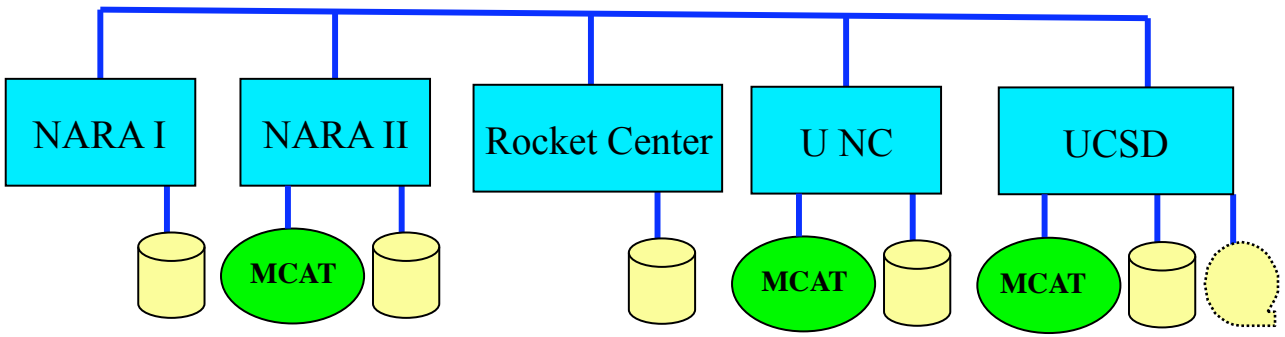
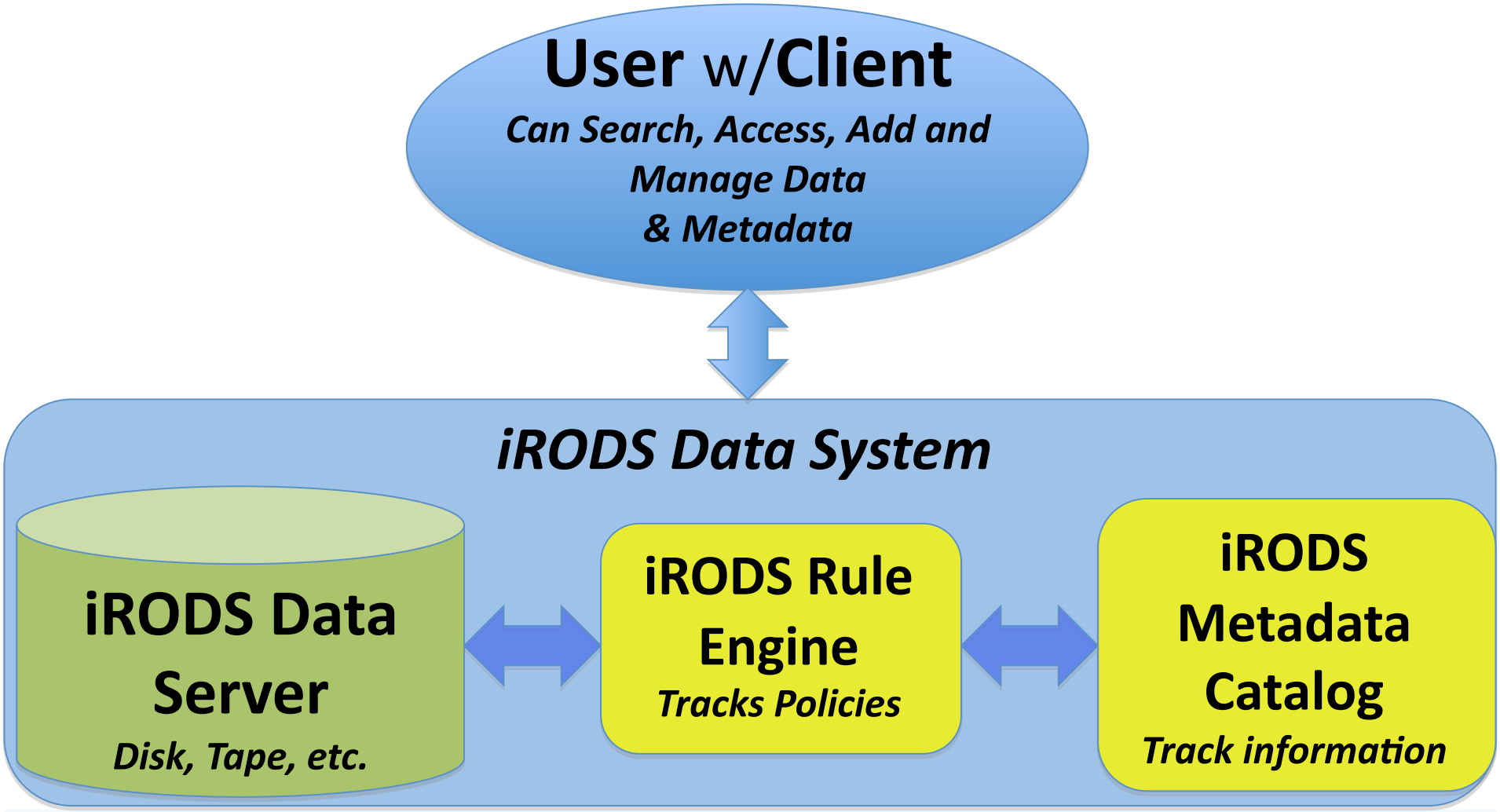
National Archives and Records Administration Transcontinental Persistent Archive Prototype

Preservation Environment with
Storage Resources at five sites



Extensible Environment that can be federated with additional research and education sites. Each site uses different vendor storage products. Each site manages selected NARA digital holdings (26 TBs, 20 million files).

Overview of iRODS Architecture



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

Preservation Challenges

- Infrastructure independence
  - Manage properties of the archives independently of the choice of technology
- Communication with the future
  - Provide representation information for each record (provenance, descriptive metadata, data structure, parsing)
  - Provide representation information for the preservation environment (policies, procedures, state information)
  - Maintain ability to apply preservation procedures by migrating procedures onto new technology
- Assessment of communication from the past
  - Track application of all versions of preservation policies
  - Validate assertions about preservation properties

Policy-based Data Preservation
integrated Rule Oriented Data System

- *Purpose* - reason a preservation environment is assembled
- *Properties* - attributes needed to ensure the **purpose**
- *Policies* - controls for enforcing desired **properties**
- *Procedures* - functions that implement the **policies**
- *State information* - results of applying the **procedures**
- *Assessment criteria* - validation that **state information** conforms to the desired **purpose**
- *Federation* - controlled sharing of **logical name spaces**

These are the essential elements for policy-based data preservation.

TPAP Implementation

- Properties - expressed as required metadata attribute
  - standard preservation metadata
- Policies - expressed as computer actionable rules
  - standard set of preservation policies
- Procedures - expressed as workflows composed by chaining basic operations
  - standard set of micro-services
- Assessment Criteria - expressed as periodically executed rules
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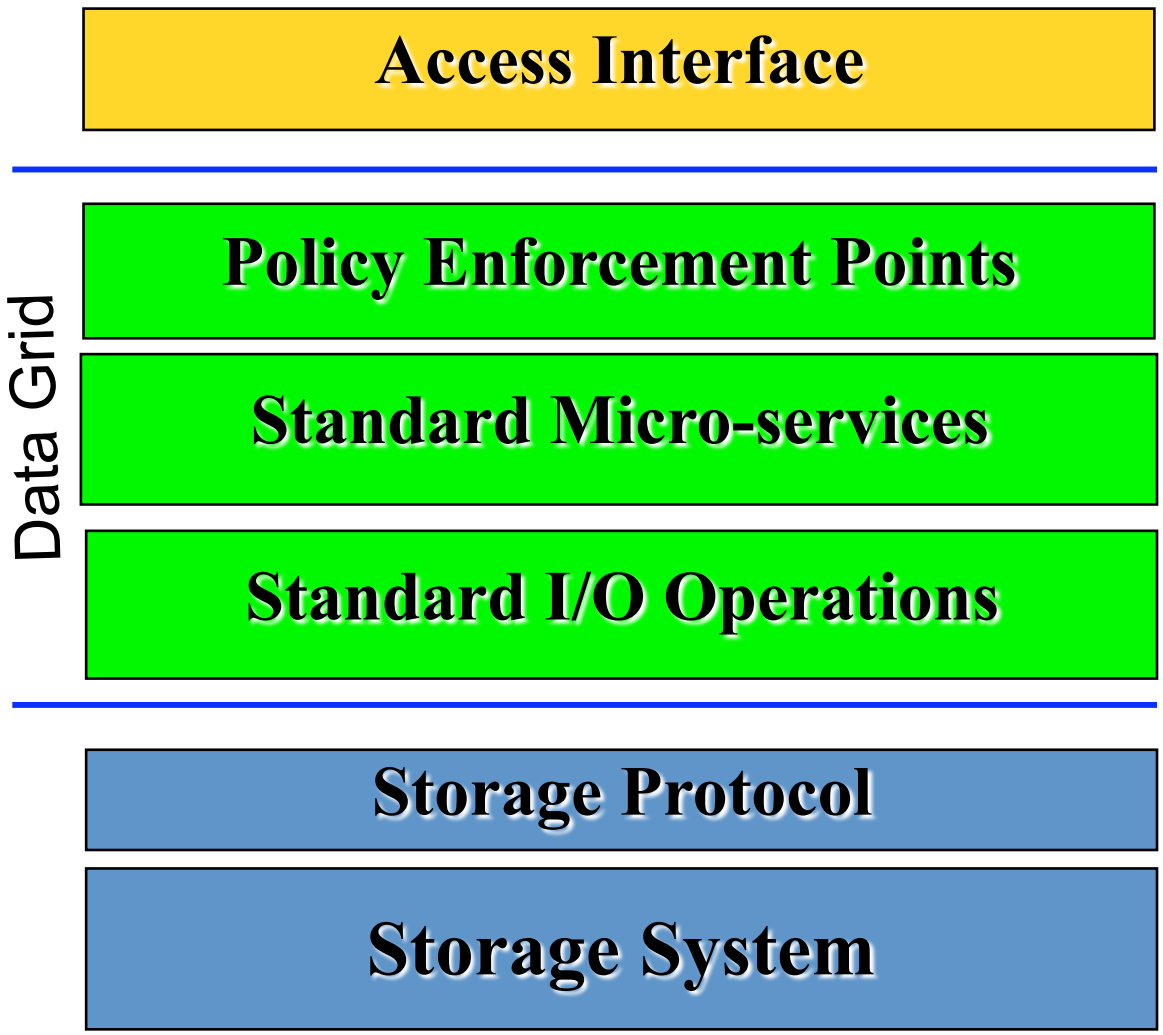

Map from the actions requested by the client to multiple policy enforcement points.

Map from policy to standard micro-services.

Map from micro-services to standard Posix I/O operations.

Map from standard Posix I/O operations to the protocol supported by the storage system

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Lessons Learned

- Scalability / Reliability / Robustness
  - Maintain interactivity through appropriate catalog indexing
  - Manage network outages at the client level
  - Minimize memory used
- Assessment / Audit trails
  - Query preservation metadata to validate properties
  - Map audit trails to standard events
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- Federation / Extensibility / Ease of Use
  - Replicate metadata and records to a deep archive
  - Extensible architecture that enables software evolution
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Level of Sophistication

- How many different access mechanisms are needed?
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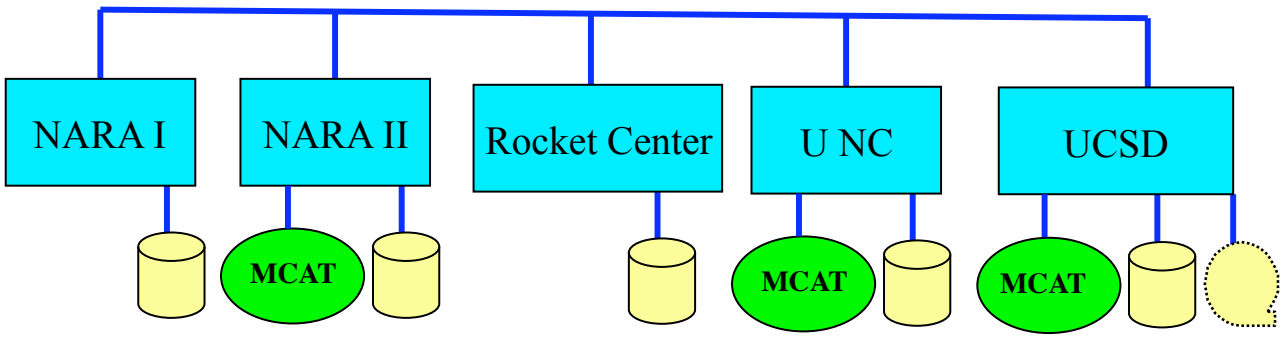

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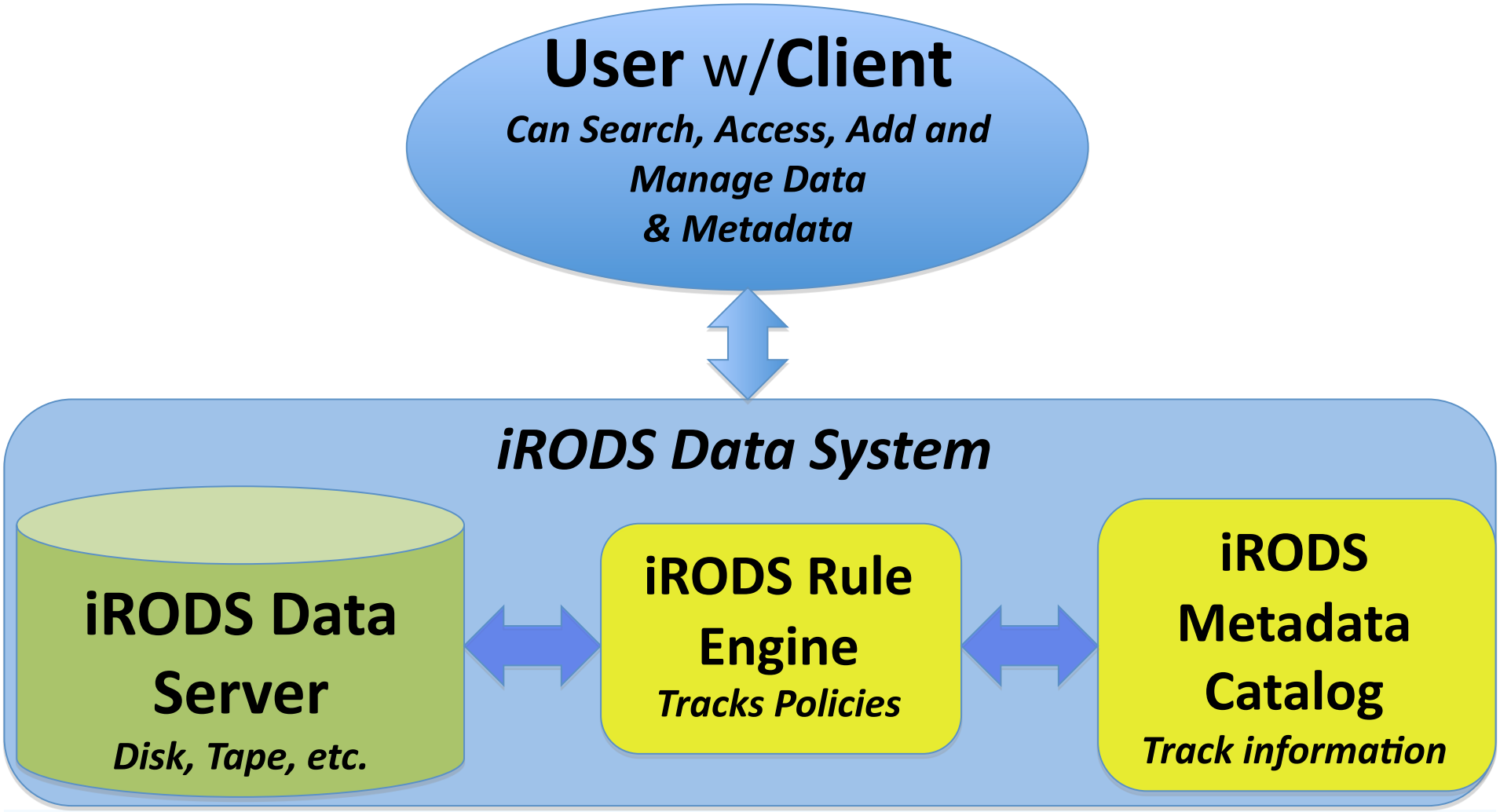

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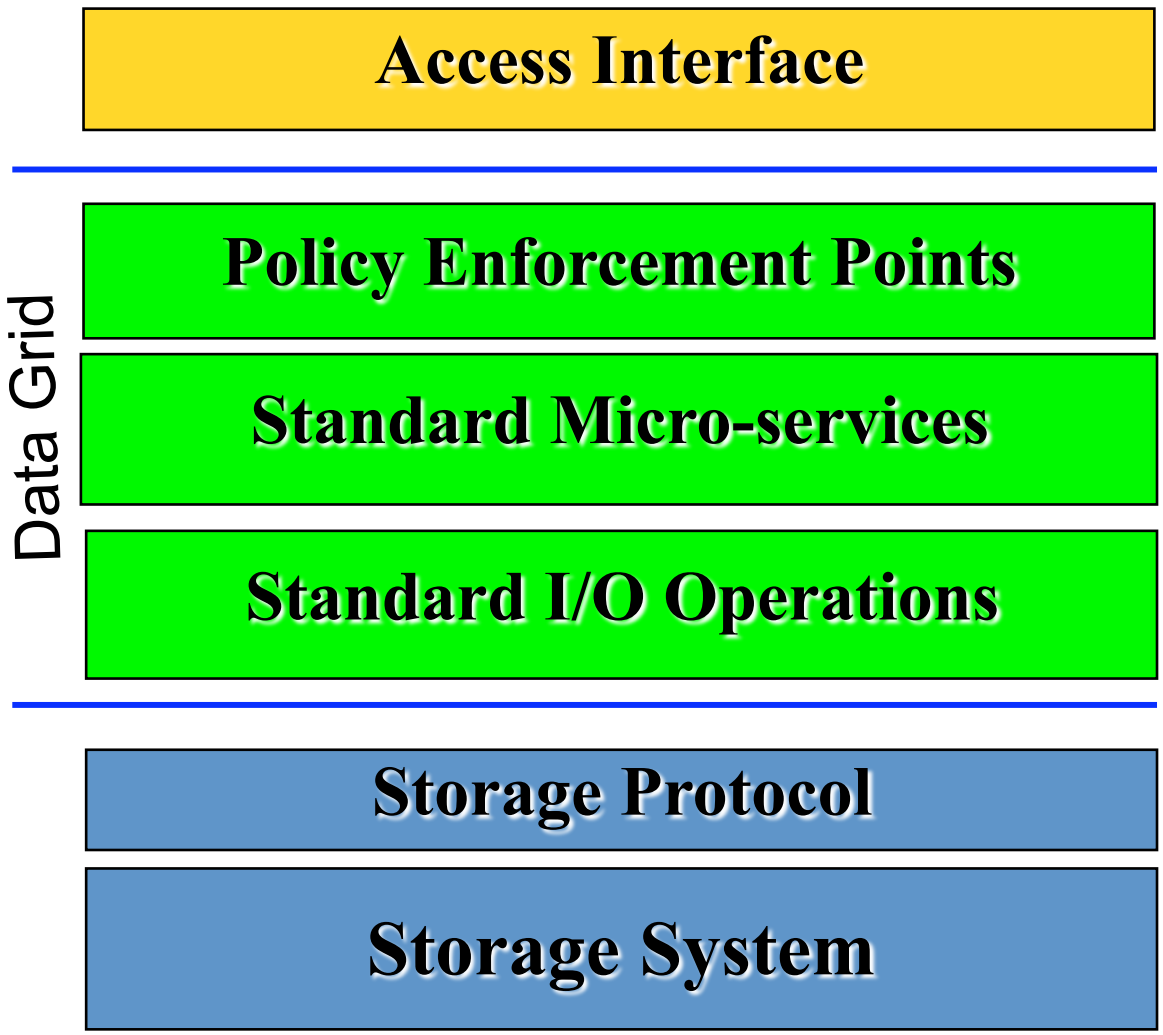

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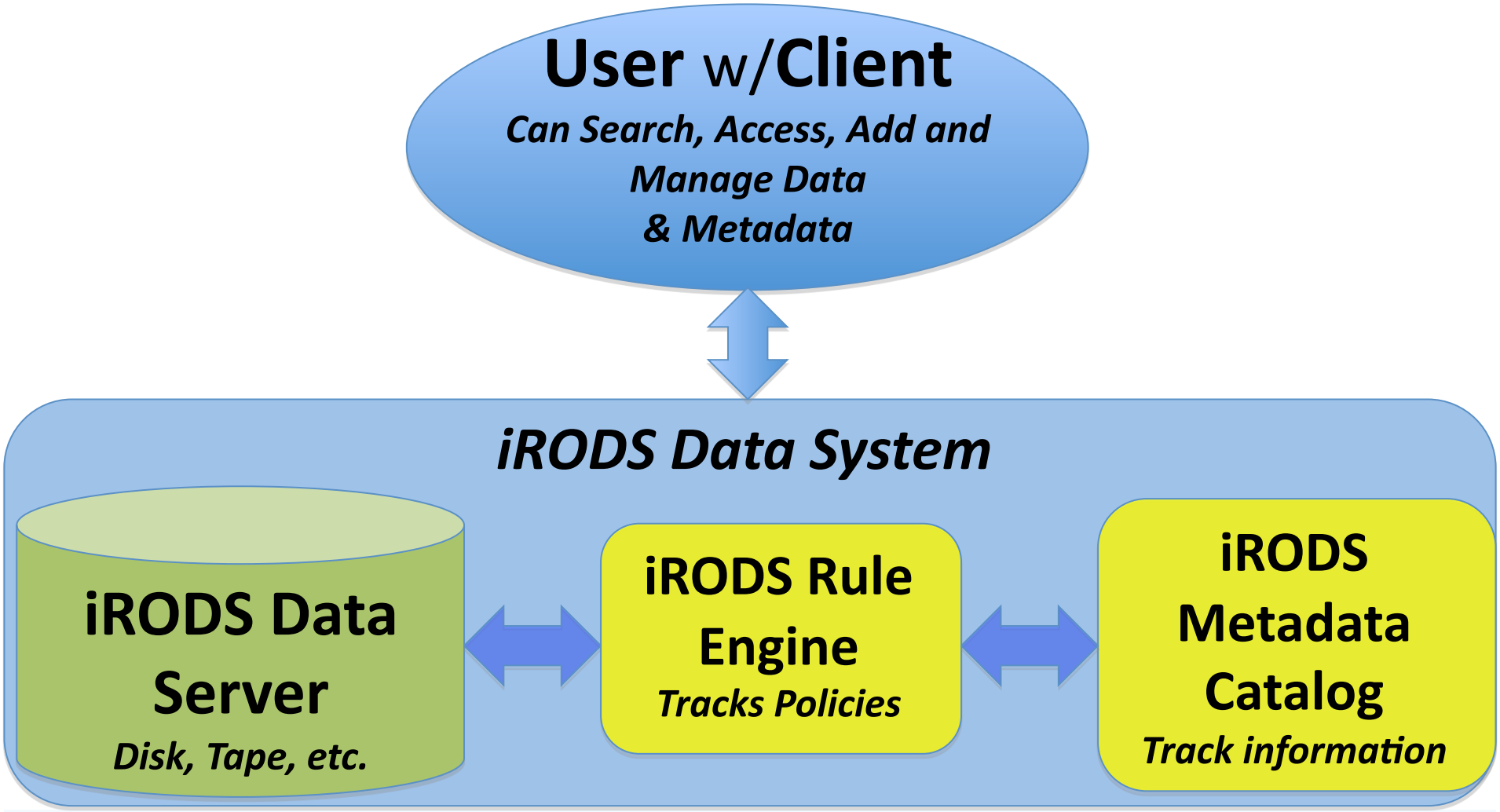

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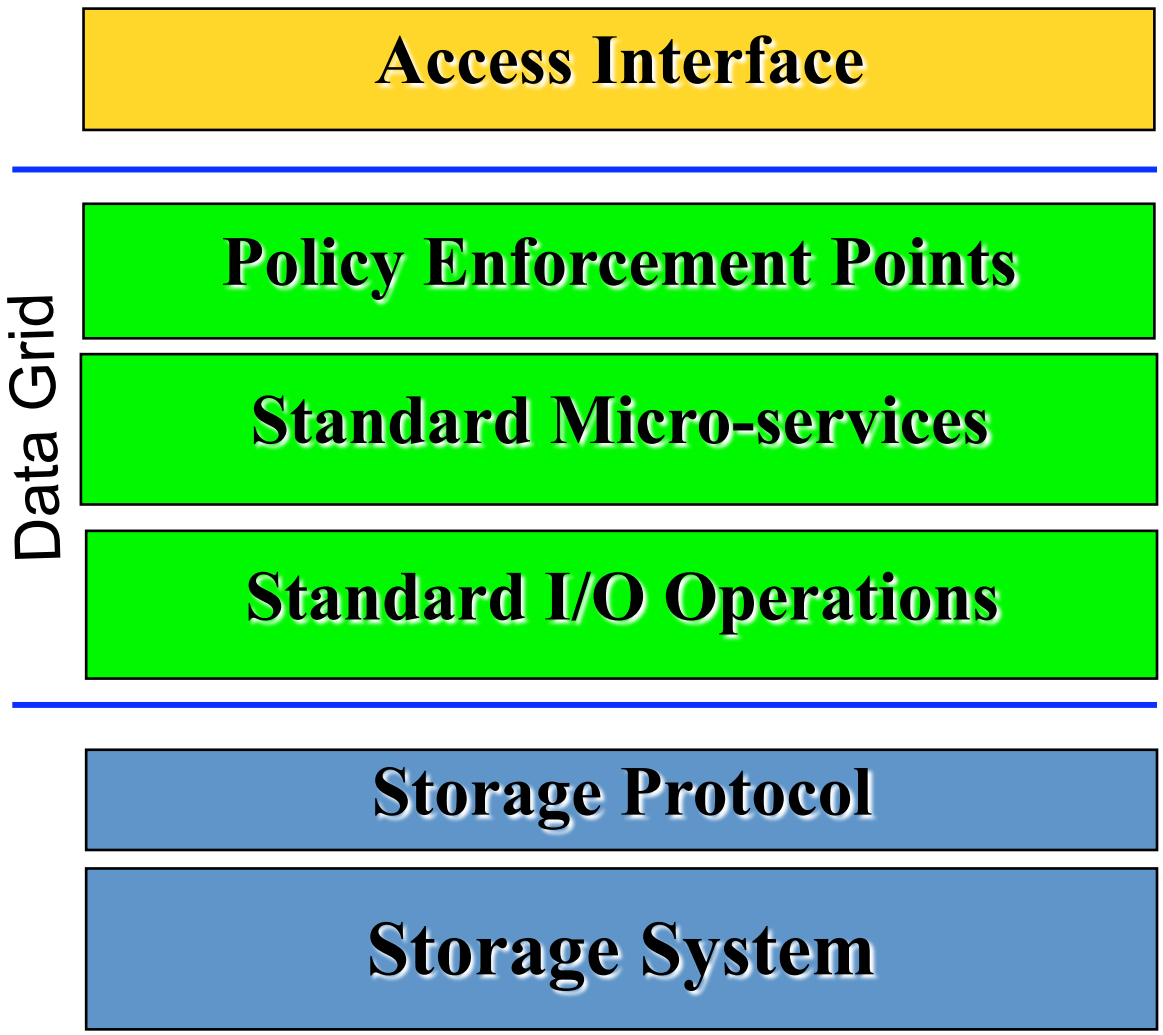

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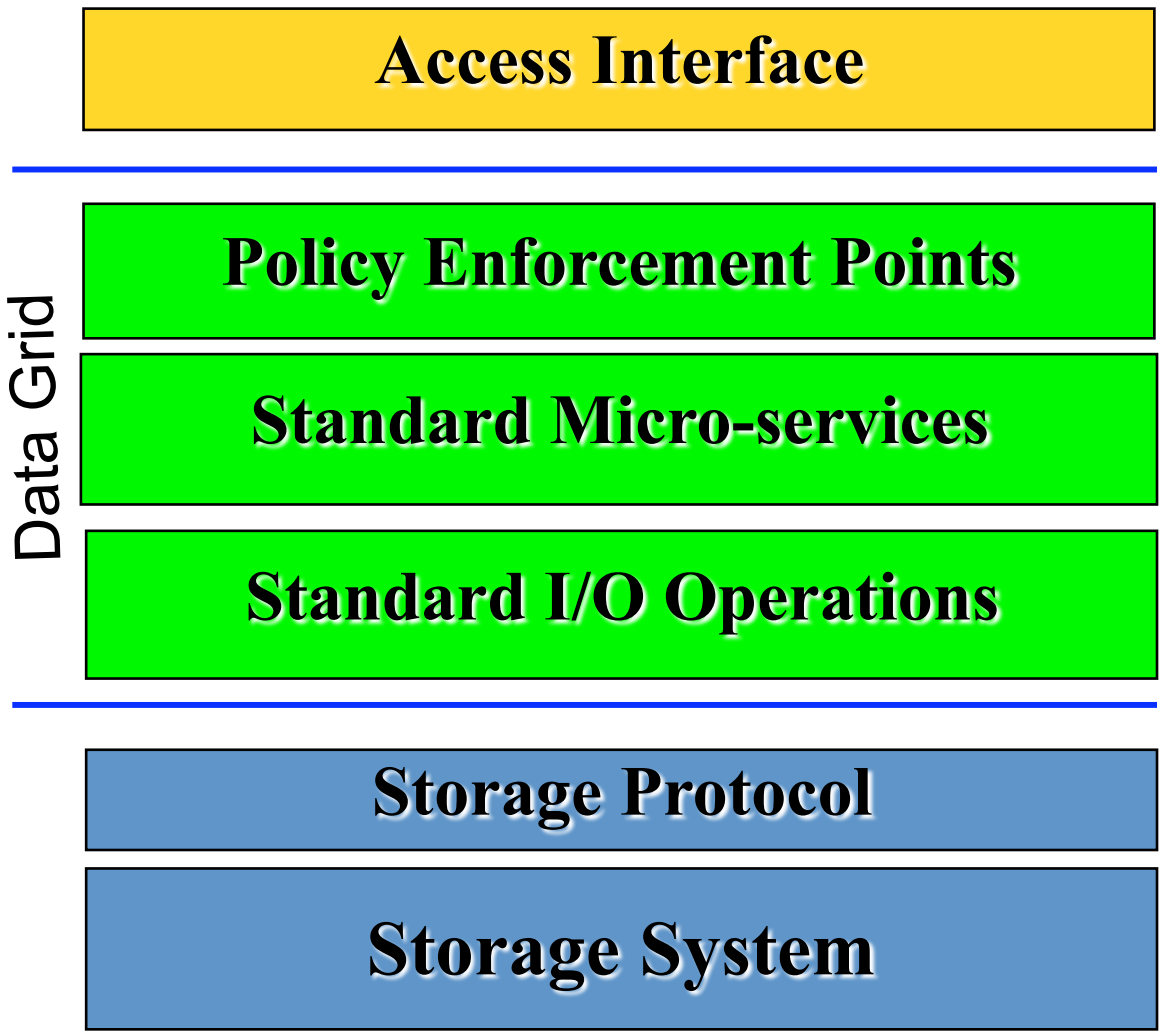

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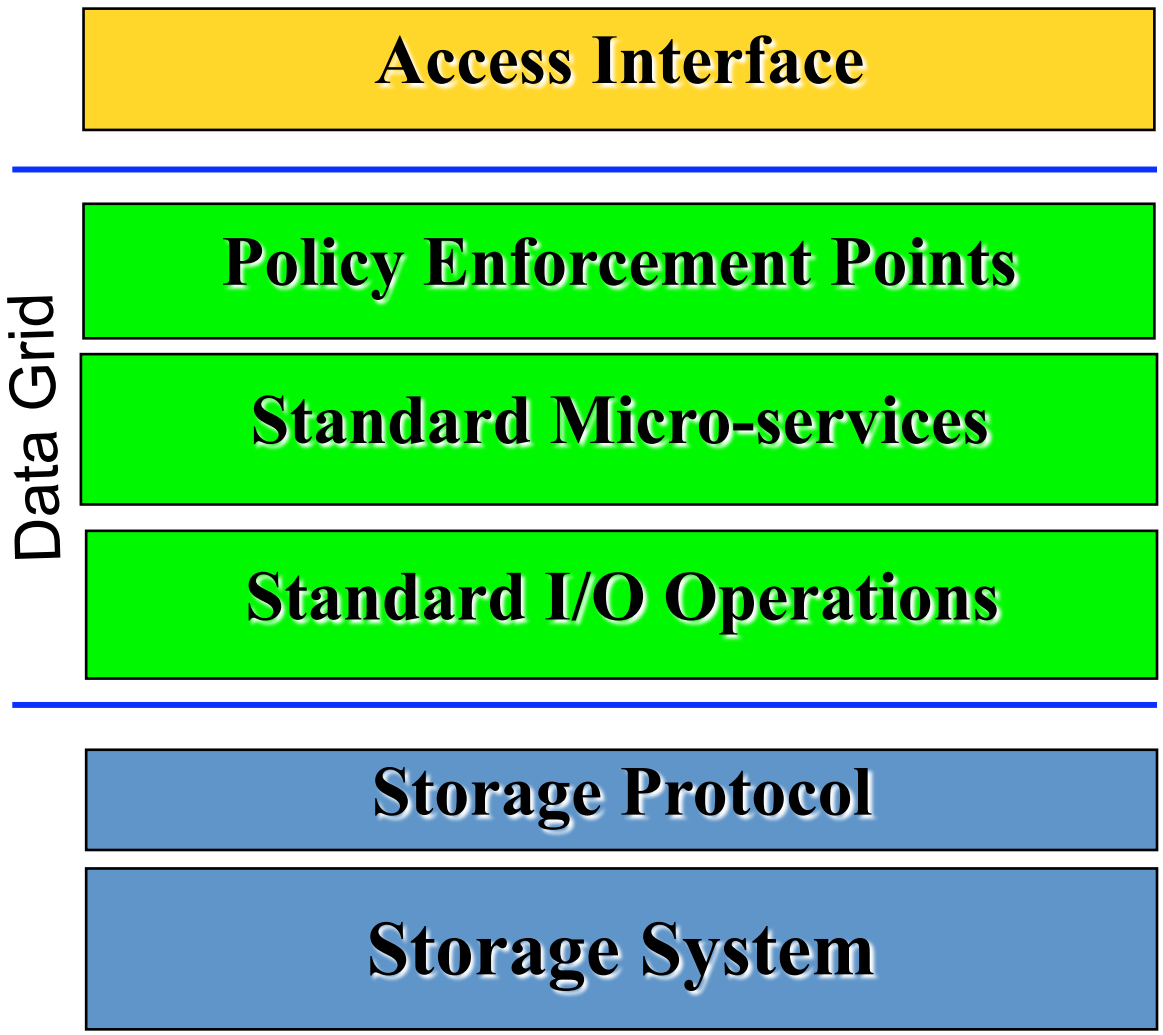

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Data Grid Clients (35)

API	Client	Developer
Browser		
	DCAPE	UNC
	iExplore	DICE-Bing Zhu
	JUX	IN2P3
	Peta Web browser	PetaShare
Digital Library		
	Akubra/iRODS	DICE
	Dspace	MIT
	Fedora on Fuse	IN2P3
	Fedora/iRODS module	DICE
	Islandora	DICE
File System		
	Davis - Webdav	ARCS
	Dropbox / **iDrop**	DICE-Mike Conway
	FUSE	IN2P3, DICE,
	FUSE optimization	PetaShare
	OpenDAP	ARCS
	PetaFS (Fuse)	Petashare - LSU
	Petashell (Parrot)	PetaShare
Grid		
	GridFTP - Griffin	ARCS
	Jsaga	IN2P3
	Parrot	Notre Dame-Doug Thain
	Saga	KEK

API	Client	Developer
I/O Libraries		
	PHP - DICE	DICE-Bing Zhu
	C API	DICE-Mike Wan
	C I/O library	DICE-Wayne Schroeder
	Jargon	DICE-Mike Conway
	Pyrods - Python	SHAMAN-Jerome Fusillier
Portal	EnginFrame	NICE / RENCI
Preservation		
	Arch	DICE-Mike Conway
Tools		
	Archive tools-NOAO	NOAO
	Big Board visualization	RENCI
	File-format-identifier	GA Tech
	icommands	DICE
	Pcommands	PetaShare
	Resource Monitoring	IN2P3
	Sync-package	Academica Sinica
	URSpace	Academica Sinica
Web Service		
	VOSpace	NVOA
	Shibboleth	King's College
Workflows	Kepler	DICE
	Stork	LSU
	Taverna	RENCI

Policy Enforcement Points (71)

ACTION
acCreateUser
acDeleteUser
acGetUserbyDN
acTrashPolicy
acAclPolicy
acSetCreateConditions
acDataDeletePolicy
acRenameLocalZone
acSetRescSchemeForCreate
acRescQuotaPolicy
acSetMultiReplPerResc
acSetNumThreads
acVacuum
acSetResourceList
acSetCopyNumber
acVerifyChecksum
acCreateUserZoneCollections
acDeleteUserZoneCollections
acPurgeFiles
acRegisterData
acGetIcatResults
acSetPublicUserPolicy
acCreateDefaultCollections
acDeleteDefaultCollections

PRE-ACTION POLICY
acPreProcForCreateUser
acPreProcForDeleteUser
acPreProcForModifyUser
acPreProcForModifyUserGroup
acChkHostAccessControl
acPreProcForCollCreate
acPreProcForRmColl
acPreProcForModifyAVUMetadata
acPreProcForModifyCollMeta
acPreProcForModifyDataObjMeta
acPreProcForModifyAccessControl
acPreprocForDataObjOpen
acPreProcForObjRename
acPreProcForCreateResource
acPreProcForDeleteResource
acPreProcForModifyResource
acPreProcForModifyResourceGroup
acPreProcForCreateToken
acPreProcForDeleteToken
acNoChkFilePathPerm
acPreProcForGenQuery
acSetReServerNumProc
acSetVaultPathPolicy

POST-ACTION POLICY
acPostProcForCreateUser
acPostProcForDeleteUser
acPostProcForModifyUser
acPostProcForModifyUserGroup
acPostProcForDelete
acPostProcForCollCreate
acPostProcForRmColl
acPostProcForModifyAVUMetadata
acPostProcForModifyCollMeta
acPostProcForModifyDataObjMeta
acPostProcForModifyAccessControl
acPostProcForOpen
acPostProcForObjRename
acPostProcForCreateResource
acPostProcForDeleteResource
acPostProcForModifyResource
acPostProcForModifyResourceGroup
acPostProcForCreateToken
acPostProcForDeleteToken
acPostProcForFilePathReg
acPostProcForGenQuery
acPostProcForPut
acPostProcForCopy
acPostProcForCreate

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Micro-services - How many are needed?

print_hello
print_hello_arg
msiVacuum
msiQuota
msiDeleteUnusedAVUs
msiGoodFailure
msiSetResource
msiCheckPermission
msiCheckOwner
msiCreateUser
msiCreateCollByAdmin
msiSendMail
recover_print_hello
msiCommit
msiRollback
msiDeleteCollByAdmin
msiDeleteUser
msiAddUserToGroup
msiSetDefaultResc
msiSetRescSortScheme
msiSysReplDataObj
msiStageDataObj
msiSetDataObjPreferredResc
msiSetDataObjAvoidResc
msiSortDataObj
msiSysChksumDataObj
msiSetDataTypeFromExt
msiSetNoDirectRescInp
msiSetNumThreads
msiDeleteDisallowed

msiOprDisallowed
msiDataObjCreate
msiDataObjOpen
msiDataObjClose
msiDataObjLseek
msiDataObjRead
msiDataObjWrite
msiDataObjUnlink
msiDataObjRepl
msiDataObjCopy
msiExtractNaraMetadata
msiSetMultiReplPerResc
msiAdmChangeCoreIRB
msiAdmShowIRB
msiAdmShowDVM
msiAdmShowFNM
msiAdmAppendToTopOfCoreIRB
msiAdmClearAppRuleStruct
msiAdmAddAppRuleStruct
msiGetObjType
msiAssociateKeyValuePairsToObj
msiExtractTemplateMDFromBuf
msiReadMDTemplateIntoTagStruct
msiDataObjPut
msiDataObjGet
msiDataObjChksum
msiDataObjPhymv
msiDataObjRename
msiDataObjTrim
msiCollCreate

msiRmColl
msiReplColl
msiCollRepl
msiPhyPathReg
msiObjStat
msiDataObjRsync
msiCollRsync
msiFreeBuffer
msiNoChkFilePathPerm
msiNoTrashCan
msiSetPublicUserOpr
whileExec
forExec
delayExec
remoteExec
forEachExec
msiSleep
writeString
writeLine
writeBytesBuf
writePosInt
writeKeyValPairs
msiGetDiffTime
msiGetSystemTime
msiHumanToSystemTime
msiStrToBytesBuf
msiApplyDCMetadataTemplate
msiListEnabledMS
msiSendStdoutAsEmail
msiPrintKeyValPair

msiGetValByKey
msiAddKeyVal
assign
ifExec
break
applyAllRules
msiExecStrCondQuery
msiExecStrCondQueryWithOptions
msiExecGenQuery
msiMakeQuery
msiMakeGenQuery
msiGetMoreRows
msiAddSelectFieldToGenQuery
msiAddConditionToGenQuery
msiPrintGenQueryOutToBuffer
msiExecCmd
msiSetGraftPathScheme
msiSetRandomScheme
msiCheckHostAccessControl
msiGetIcatTime
msiGetTaggedValueFromString
msiXmsgServerConnect
msiXmsgCreateStream
msiCreateXmsgInp
msiSendXmsg
msiRcvXmsg
msiXmsgServerDisConnect
msiString2KeyValPair
msiStrArray2String
msiRdaToStdout

Micro-services (229)

msiRdaToDataObj
msiRdaNoResults
msiRdaCommit
msiAW1
msiRdaRollback
msiRenameLocalZone
msiRenameCollection
msiAclPolicy
msiRemoveKeyValuePairsFromObj
msiDataObjPutWithOptions
msiDataObjReplWithOptions
msiDataObjChksumWithOptions
msiDataObjGetWithOptions
msiSetReServerNumProc
msiGetStdoutInExecCmdOut
msiGetStderrInExecCmdOut
msiAddKeyValToMspStr
msiPrintGenQueryInp
msiTarFileExtract
msiTarFileCreate
msiPhyBundleColl
msiWriteRodsLog
msiServerMonPerf
msiFlushMonStat
msiDigestMonStat
msiSplitPath
msiGetSessionVarValue
msiAutoReplicateService
msiDataObjAutoMove
msiGetContInxFromGenQueryOut

msiSetACL
msiSetRescQuotaPolicy
msiAdmReadRulesFromFileIntoStruct
msiAdmInsertRulesFromStructIntoDB
msiGetRulesFromDBIntoStruct
msiAdmWriteRulesFromStructIntoFile
writeXMsg
readXMsg
msiSetReplComment
msiSetBulkPutPostProcPolicy
msiVerifyOwner
msiVerifyAVU
msiVerifyACL
msiVerifyExpiry
msiVerifyDataType
msiVerifyFileSizeRange
msiVerifySubCollOwner
msiVerifySubCollACL
msiVerifySubCollAVU
msiListFields
msiHiThere
msiTestWritePosInt
msiListColl
msiTestForEachExec
msiGetFormattedSystemTime
msiPropertiesNew
msiPropertiesClear
msiPropertiesClone
msiPropertiesAdd
msiPropertiesRemove

msiPropertiesGet
msiPropertiesSet
msiPropertiesExists
msiPropertiesToString
msiPropertiesFromString
msiRecursiveCollCopy
msiGetDataObjACL
msiGetCollectionACL
msiGetDataObjAVUs
msiGetDataObjPSmeta
msiGetCollectionPSmeta
msiGetDataObjAIP
msiLoadMetadataFromDataObj
msiExportRecursiveCollMeta
msiCopyAVUMetadata
msiGetUserInfo
msiGetUserACL
msiCreateUserAccountsFromDataObj
msiLoadUserModsFromDataObj
msiDeleteUsersFromDataObj
msiLoadACLFromDataObj
msiGetAuditTrailInfoByUserID
msiGetAuditTrailInfoByObjectID
msiGetAuditTrailInfoByActionID
msiGetAuditTrailInfoByKeywords
msiGetAuditTrailInfoByTimeStamp
msiSetDataType
msiGuessDataType
msiMergeDataCopies
msiIsColl

msiIsData
msiGetCollectionContentsReport
msiGetCollectionSize
msiStructFileBundle
msiCollectionSpider
msiFlagDataObjwithAVU
msiFlagInfectedObjs

Preservation Attributes - How Many?

ZONE_ID
ZONE_NAME
ZONE_TYPE
ZONE_CONNECTION
ZONE_COMMENT
ZONE_CREATE_TIME
ZONE_MODIFY_TIME
USER_ID
USER_NAME
USER_TYPE
USER_ZONE
USER_DN
USER_INFO
USER_COMMENT
USER_CREATE_TIME
USER_MODIFY_TIME
RESC_ID
RESC_NAME
RESC_ZONE_NAME
RESC_TYPE_NAME
RESC_CLASS_NAME
RESC_LOC
RESC_VAULT_PATH
RESC_FREE_SPACE
RESC_FREE_SPACE_TIME
RESC_INFO
RESC_COMMENT
RESC_CREATE_TIME
RESC_MODIFY_TIME
RESC_STATUS

DATA_ID
DATA_COLL_ID
DATA_NAME
DATA_REPL_NUM
DATA_VERSION
DATA_TYPE_NAME
DATA_SIZE
DATA_RESC_GROUP_NAME
DATA_RESC_NAME
DATA_PATH
DATA_OWNER_NAME
DATA_OWNER_ZONE
DATA_REPL_STATUS
DATA_STATUS
DATA_CHECKSUM
DATA_EXPIRY
DATA_MAP_ID
DATA_COMMENTS
DATA_CREATE_TIME
DATA_MODIFY_TIME
DATA_ACCESS_TYPE
DATA_ACCESS_NAME
DATA_TOKEN_NAMESPACE
DATA_ACCESS_USER_ID
DATA_ACCESS_DATA_ID
COLL_ID
COLL_NAME
COLL_PARENT_NAME
COLL_OWNER_NAME
COLL_OWNER_ZONE

COLL_MAP_ID
COLL_INHERITANCE
COLL_COMMENTS
COLL_CREATE_TIME
COLL_MODIFY_TIME
COLL_ACCESS_TYPE
COLL_ACCESS_NAME
COLL_TOKEN_NAMESPACE
COLL_ACCESS_USER_ID
COLL_ACCESS_COLL_ID
META_DATA_ATTR_NAME
META_DATA_ATTR_VALUE
META_DATA_ATTR_UNITS
META_DATA_ATTR_ID
META_DATA_CREATE_TIME
META_DATA_MODIFY_TIME
META_COLL_ATTR_NAME
META_COLL_ATTR_VALUE
META_COLL_ATTR_UNITS
META_COLL_ATTR_ID
META_NAMESPACE_COLL
META_NAMESPACE_DATA
META_NAMESPACE_RESC
META_NAMESPACE_USER
META_NAMESPACE_RESC_GROUP
META_RESC_ATTR_NAME
META_RESC_ATTR_VALUE
META_RESC_ATTR_UNITS
META_RESC_ATTR_ID
META_RESC_GROUP_ATTR_NAME

META_RESC_GROUP_ATTR_VALUE
META_RESC_GROUP_ATTR_UNITS
META_RESC_GROUP_ATTR_ID
META_USER_ATTR_NAME
META_USER_ATTR_VALUE
META_USER_ATTR_UNITS
META_USER_ATTR_ID
RESC_GROUP_RESC_ID
RESC_GROUP_NAME
RESC_GROUP_ID
USER_GROUP_ID
USER_GROUP_NAME
RULE_EXEC_ID
RULE_EXEC_NAME
RULE_EXEC_REI_FILE_PATH
RULE_EXEC_USER_NAME
RULE_EXEC_ADDRESS
RULE_EXEC_TIME
RULE_EXEC_FREQUENCY
RULE_EXEC_PRIORITY
RULE_EXEC_ESTIMATED_EXE_TIME
RULE_EXEC_NOTIFICATION_ADDR
RULE_EXEC_LAST_EXE_TIME
RULE_EXEC_STATUS
TOKEN_NAMESPACE
TOKEN_ID
TOKEN_NAME
TOKEN_VALUE
TOKEN_VALUE2
TOKEN_VALUE3

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Preservation Attributes (205)

TOKEN_COMMENT
AUDIT_OBJ_ID
AUDIT_USER_ID
AUDIT_ACTION_ID
AUDIT_COMMENT
AUDIT_CREATE_TIME
AUDIT_MODIFY_TIME
SL_HOST_NAME
SL_RESC_NAME
SL_CPU_USED
SL_MEM_USED
SL_SWAP_USED
SL_RUNQ_LOAD
SL_DISK_SPACE
SL_NET_INPUT
SL_NET_OUTPUT
SL_CREATE_TIME
SLD_RESC_NAME
SLD_LOAD_FACTOR
SLD_CREATE_TIME
RULE_BASE_MAP_VERSION
RULE_BASE_MAP_PRIORITY
RULE_BASE_MAP_BASE_NAME
RULE_BASE_MAP_OWNER_NAME
RULE_BASE_MAP_OWNER_ZONE
RULE_BASE_MAP_COMMENT
RULE_BASE_MAP_CREATE_TIME
RULE_BASE_MAP_MODIFY_TIME
RULE_ID
RULE_VERSION
RULE_BASE_NAME
RULE_NAME
RULE_EVENT
RULE_CONDITION
RULE_BODY
RULE_RECOVERY
RULE_STATUS
RULE_OWNER_NAME
RULE_OWNER_ZONE
RULE_DESCR_1
RULE_DESCR_2
RULE_INPUT_PARAMS
RULE_OUTPUT_PARAMS
RULE_DOLLAR_VARS
RULE_ICAT_ELEMENTS
RULE_SIDEEFFECTS
RULE_COMMENT
RULE_CREATE_TIME
RULE_MODIFY_TIME
DVM_ID
DVM_VERSION
DVM_BASE_NAME
DVM_EXT_VAR_NAME
DVM_CONDITION
DVM_INT_MAP_PATH
DVM_STATUS
DVM_OWNER_NAME
DVM_OWNER_ZONE
DVM_COMMENT
DVM_CREATE_TIME
DVM_MODIFY_TIME
FNM_ID
FNM_VERSION
FNM_BASE_NAME
FNM_EXT_FUNC_NAME
FNM_INT_FUNC_NAME
FNM_STATUS
FNM_OWNER_NAME
FNM_OWNER_ZONE
FNM_COMMENT
FNM_CREATE_TIME
FNM_MODIFY_TIME
QUOTA_USER_ID
QUOTA_RESC_ID
QUOTA_LIMIT
QUOTA_OVER
QUOTA_MODIFY_TIME
QUOTA_USAGE_USER_ID
QUOTA_USAGE_RESC_ID
QUOTA_USAGE
QUOTA_USAGE_MODIFY_TIME
QUOTA_USER_NAME
QUOTA_USER_ZONE
QUOTA_USER_TYPE
QUOTA_RESC_NAME

Preservation Policies

- Arrangement
  - Organize records in series, and manage policies on each series
- Authenticity
  - For every record, record provenance metadata
- Chain of custody
  - For every record, manage an audit trail
- Integrity
  - For every record, manage two replicas and verify checksums
  - For every record, enforce retention and disposition
- Trustworthiness
  - Fore each series, validate ISO MOIMS-rac assessment criteria

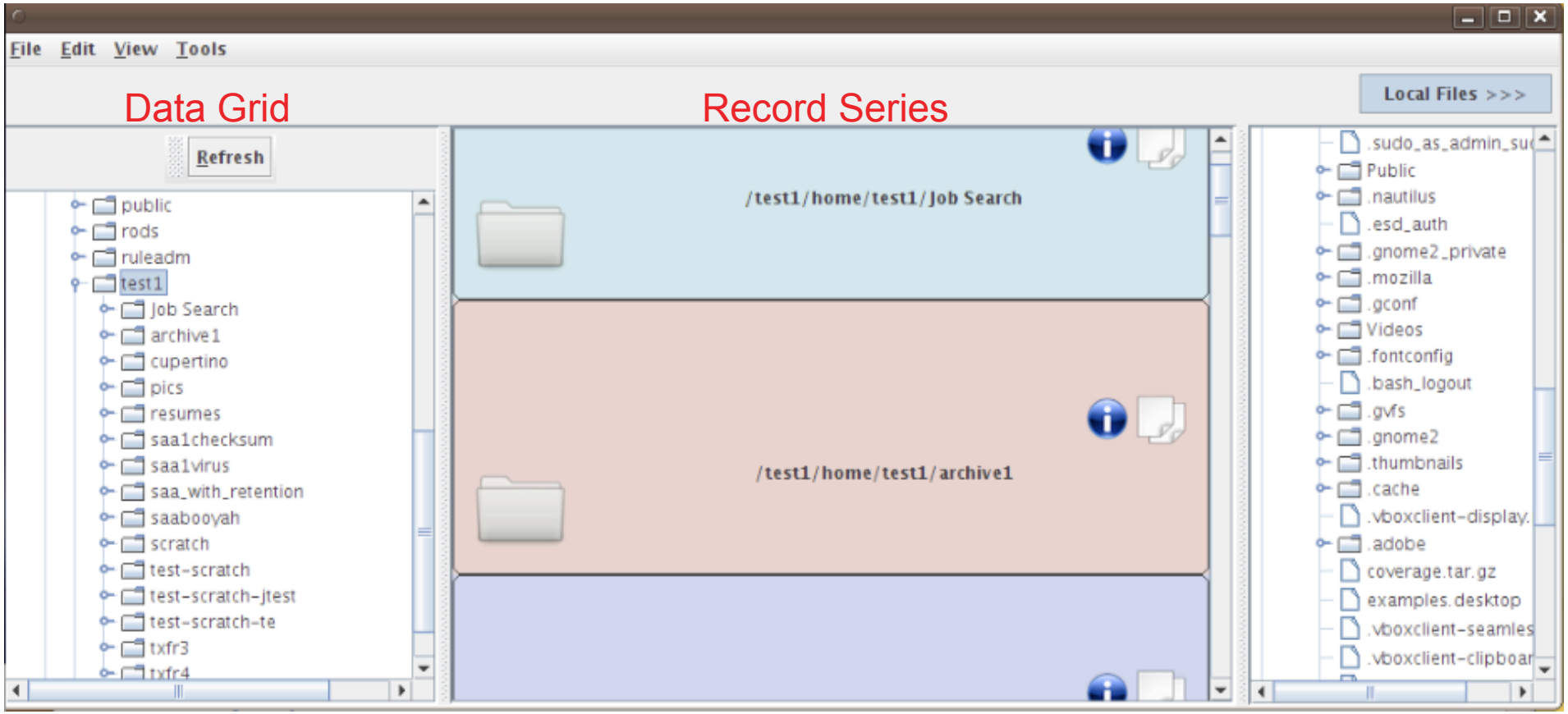
Example Disposition Procedure

```
acPurgeFiles()
{   msiGetIcatTime(*Time,unix);
    acGetIcatResults(remove,DATA_EXPIRY < '*Time',*List);
    forEachExec(*List)
    {  msiDataObjUnlink(*List,*Status);
       msiGetValByKey(*List,DATA_NAME,*D);
       msiGetValByKey(*List,COLL_NAME,*E);
       writeLine(stdout,Purged File *E/*D at *Time );
    }
}
```

Create and Apply Preservation Policies

- Maintain a repository of rules in iRODS
  - Rules characterized as XML files with input parameters explicitly characterized as rule parameters
- Build policy template and save in policy repository
  - Select which rule sets will be applied
- Map policy template to a record series (collection)
  - Add policy parameters as metadata on the record series
- On ingestion of a file into the record series:
  - Retrieve policies and parameters from the record series metadata
  - Invoke associated rules and apply preservation procedures
- This decouples the choice of access interface from the execution of your preservation policies

iDrop Client - Ingesting a Record



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Arch - Defining a Policy

Jargon
Arch

IRODS

- Main
- Policy-Driven Service Administration
- Policy Administration
  - View/Update Policy Repositories
  - Add a Policy Repository
  - Add a Policy
  - View/Update Policies in Repository
- Staging Area Administration
- Rule Developer
- Series Administration
- Arch Confi

Add a Policy

Policy Name
demo policy with checksum

Select a Policy Repository: saa demo policy repo 1

Description
This is a simple policy that does checksum and replication

Do objects need to go to a staging area first? ☐

Is virus scanning required? ☑

Is a checksum required? ☑

How many replicas should be made? 3

How many days should items be retained?

Reset Update

List Policy Sets in Policy Repository

Jargon Arch

IRODS

- Main
- Policy-Driven Service Administration
- Policy Administration
  - View/Update Policy Repositories
  - Add a Policy Repository
  - Add a Policy
  - View/Update Policies in Repository
- Staging Area Administration
- Rule Developer
- Series Administration
- Arch Confi

List Policies in Repository

Select a Policy Repository saa demo policy repo 1

Refresh

Show 10 entries Search:

	Policy Name	Description	Location
	bob the policy	this is a test	/renci/home/saademo/policy_repo_1 /bob+the+policy.xml
	saa checksum and retention policy	Policy that requires a checksum and specifies a retention policy	/renci/home/saademo/policy_repo_1 /saa+checksum+and+retention+policy.xml
	saa checksum policy	Policy that requires a checksum	/renci/home/saademo/policy_repo_1 /saa+checksum+policy.xml
	saa virus scan policy	policy that requires a virus scan	/renci/home/saademo/policy_repo_1 /saa+virus+scan+policy.xml

Showing 1 to 4 of 4 entries

Adding Policies to a Record Series

Jargon Arch

IRODS

- Main
- Policy-Driven Service Administration
- Policy Administration
- Staging Area Administration
- Rule Developer
- Series Administration
  - Add Series
  - View/Update Series
  - Series Exceptions
  - Series Policy Admin
- Arch Confi

Add a Series

Add a Series

saa_virus_scan_series

Select a Policy Repository

saa demo

Series Collection Absolute Path

/renci/home/saademo/archive

Description

A series with virus scan, checksum, and replication

Policy Name

demo policy with checksum

Reset Update

iDrop Interface

Policies on a Record Series

File Edit View Tools

Local Files >>>

Refresh

ondrej
pdreher
probinson
psheldon
public

/renci/home/saademo/archive_root/another_another_checksum_series

/renci/home/saademo/archive_root/another_another_checksum_series

Absolute Path	ID	Attribute	Value	Units
/renci/home/s...	570341	PolicyDrivenService:SeriesAttributeMarkerAttribute	requireChecksum	true
/renci/home/s...	570341	PolicyDrivenService:SeriesToAppMapping	saa demo	
/renci/home/s...	570341	PolicyDrivenService:SeriesToPolicyMapping	saa checksum policy	

Cancel OK

sheauc
sram
sreekanth
terrell
test1
testhou
testuser#ncdc
tip
tooby
tpalmeri
usertutor
usertutor1
usertutor10
usertutor11
usertutor12
usertutor13

/renci/home/saademo/archive_root/bulk_vscan

/renci/home/saademo/archive_root/ed_the_series

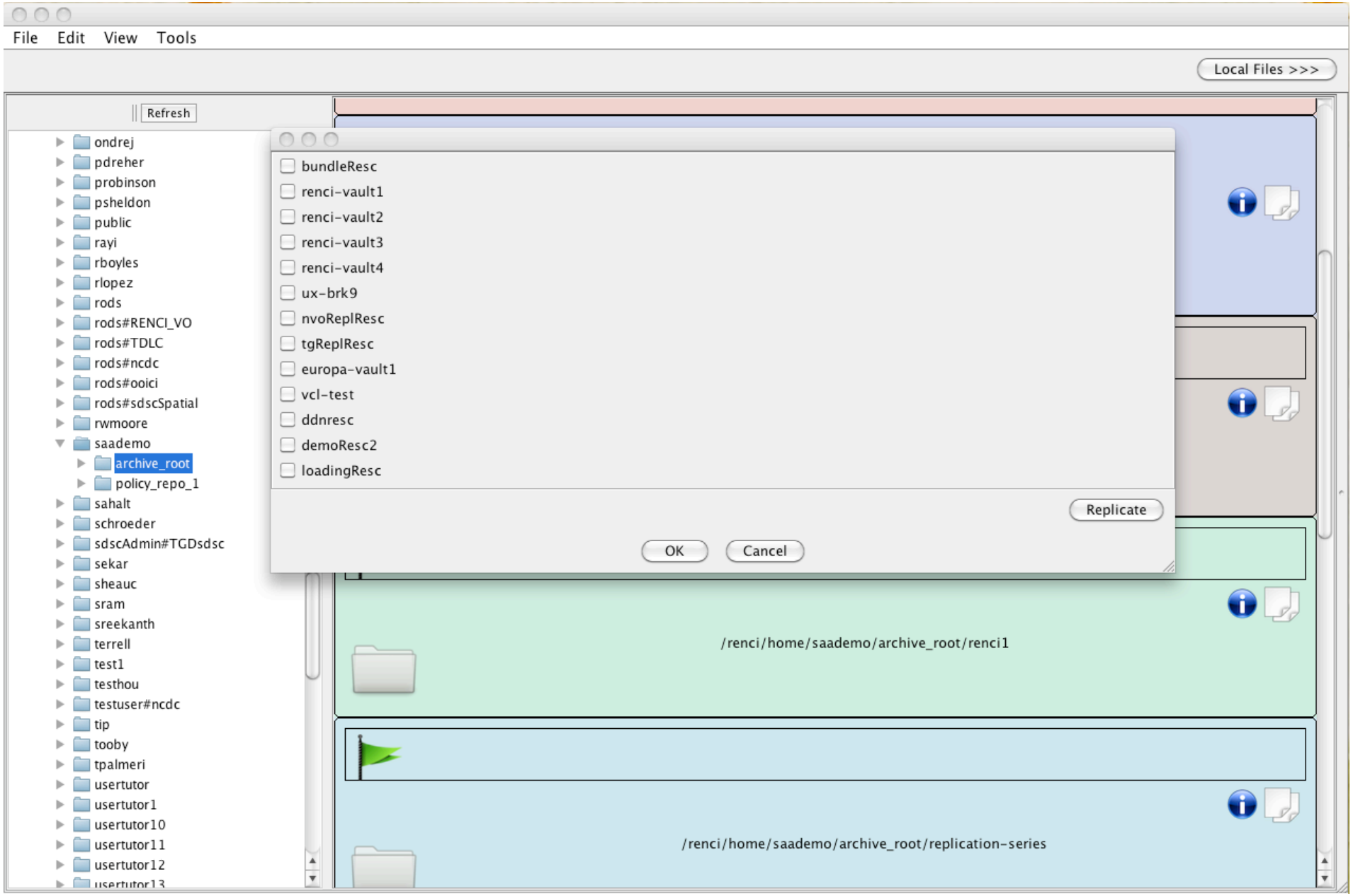
Record Series Attributes

/renci/home/saademo/archive_root/saa_checksum_series

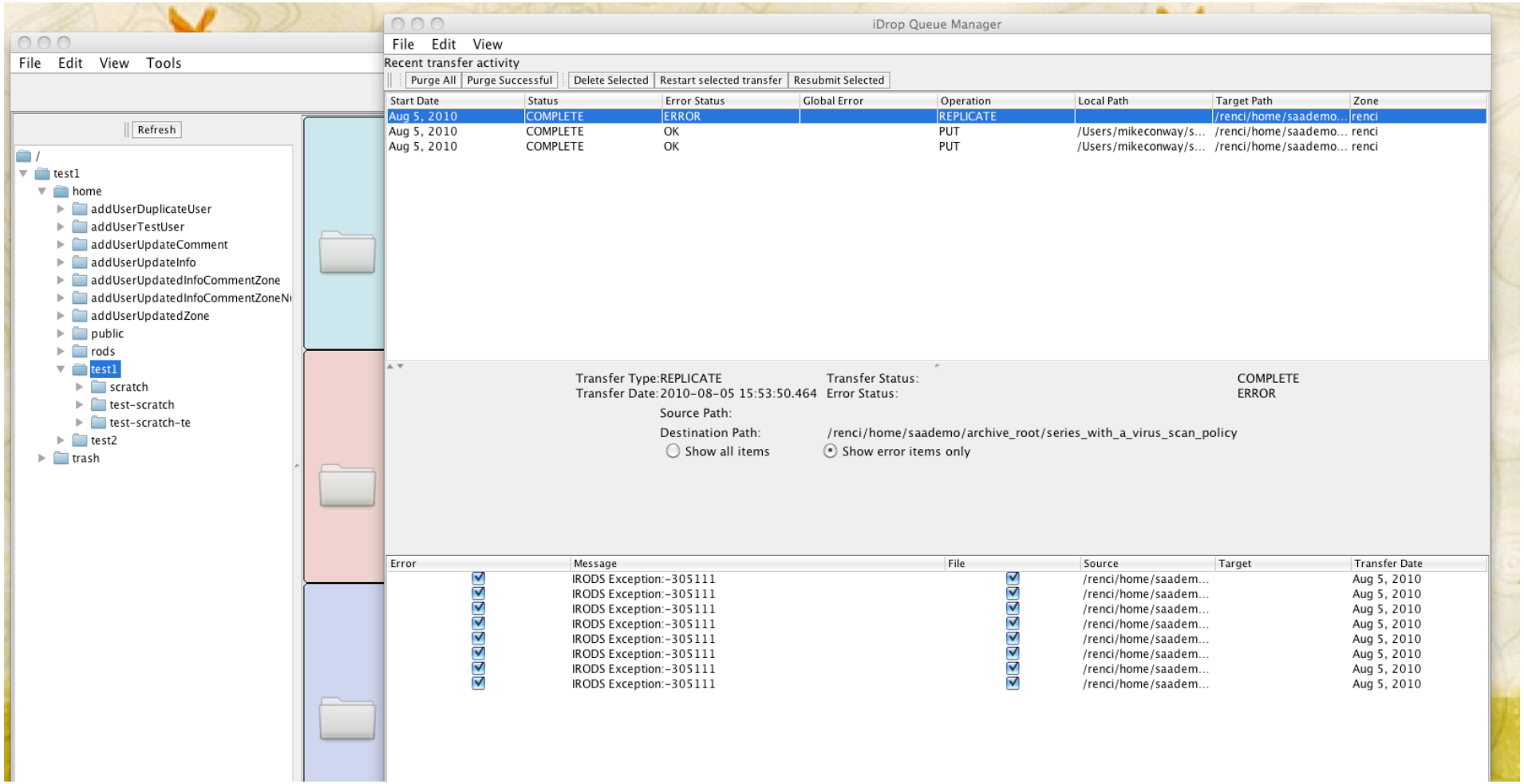
..	...	Attribute	Value	Units
..	...	PolicyDrivenService:SeriesAttributeMarkerAttribute	requireChecksum	true
..	...	PolicyDrivenService:SeriesToAppMapping	saa demo	A series with a checksum policy
..	...	PolicyDrivenService:SeriesToPolicyMapping	saa checksum policy	A series with a checksum policy

Cancel OK

Selecting Resource for Replication



Record Transfer Status



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Tracking Virus Policy

Tracking Preservation Policies on Record Series

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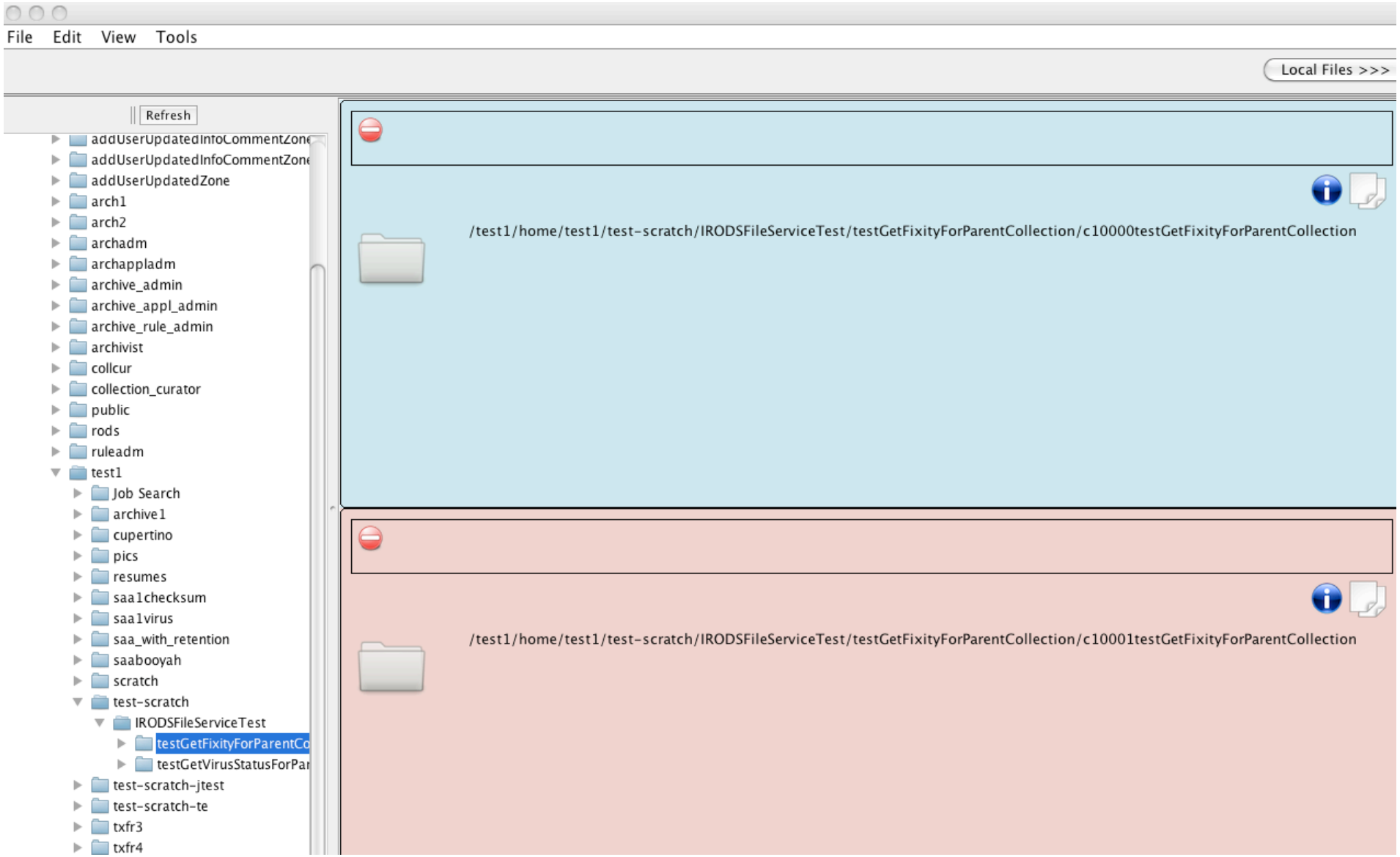
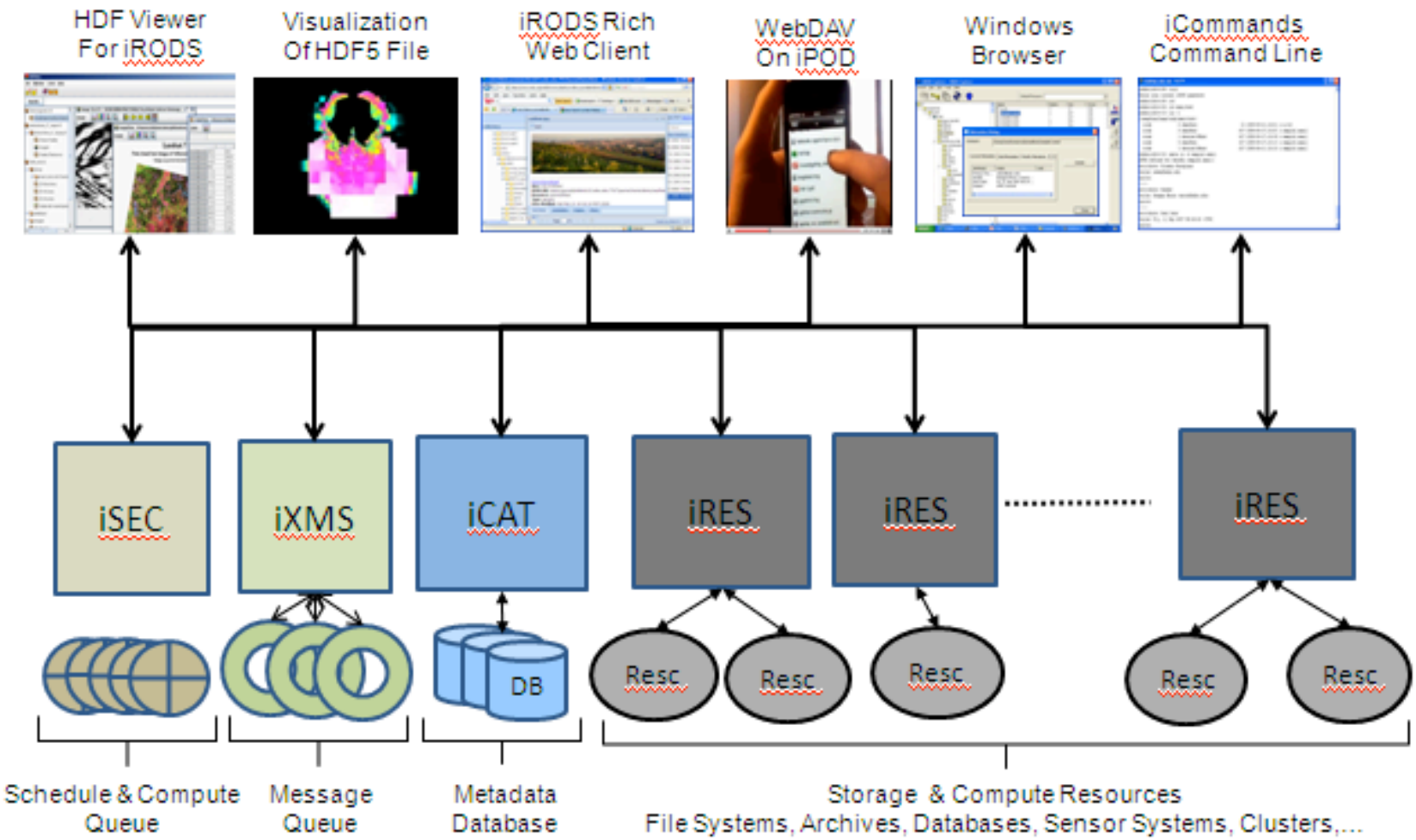
Tracking Integrity



iRODS Distributed Data Management



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Supported Storage Systems

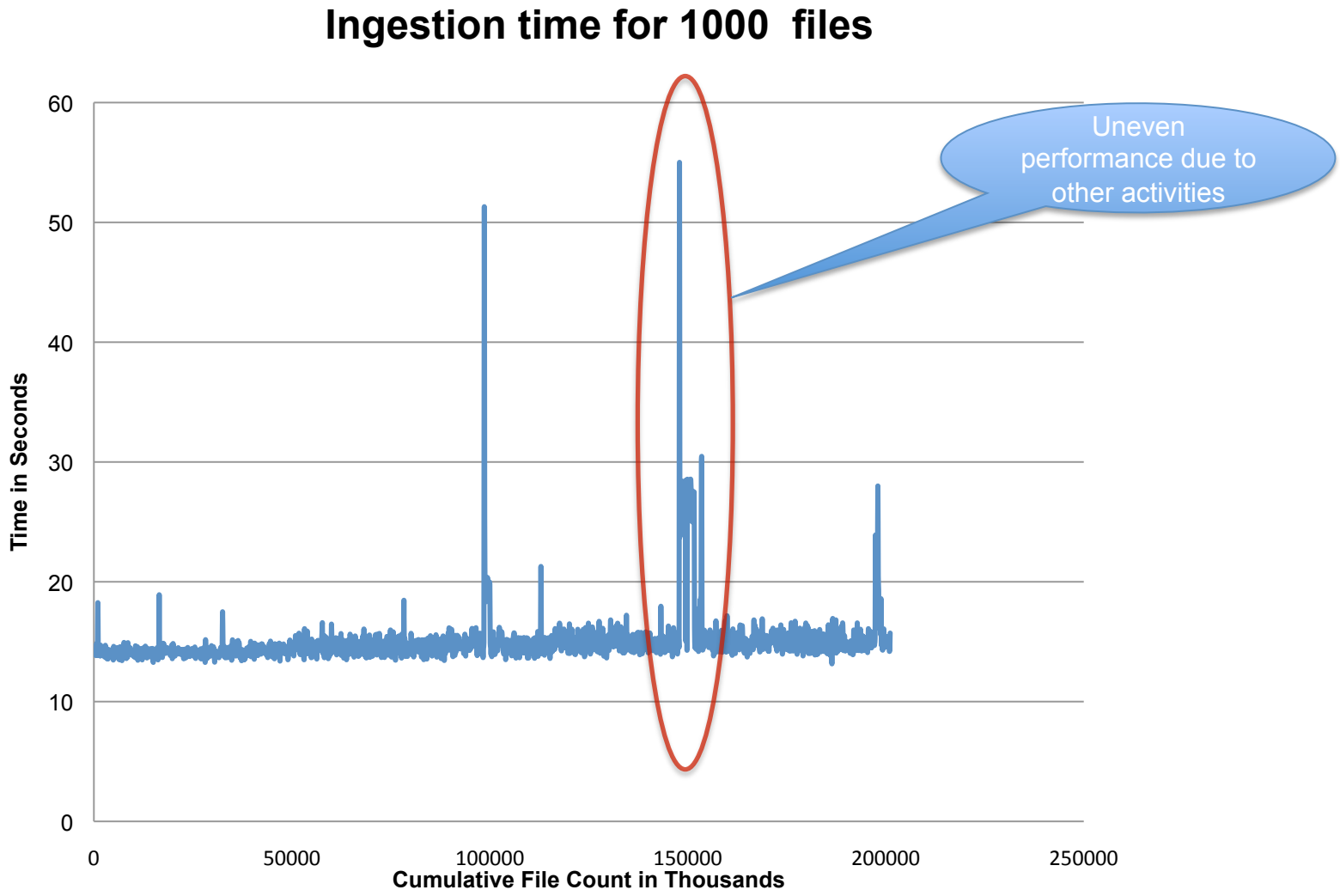
- File systems - Windows, Linux, Mac
- Tape archives - HPSS, Sam-QFS
- Repositories - Flickr, Web sites
- Cloud storage- Amazon S3, EC2
- Relational database - PostgreSQL, Oracle, mySQL

- Under development
  - Table driven resources

Modular Architecture

- Authentication
  - GSI (PKI), Kerberos, Shibboleth, Challenge-response
- Authorization
  - Roles, user groups, resource groups, policy constraints, ACLs
- Transport
  - TCP/IP (parallel I/O streams), Reliable Blast UDP
- Metadata catalog
  - PostgreSQL, mySQL, Oracle
- Distributed rule engine
  - Scheduler, messaging system, execution engine, rule base

Performance to Scale: 200 Million Files



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Tuning of TPAP Performance

- Multiple Data Transfer Modes
  - Registration and Move
  - Bulk Upload/Download
  - Bulk Metadata Ingestion Operations
  - Parallel TCP/IP Streams of Data Transfers
  - Blast UDP for Large Data Transfers
  - Aggregation-based Data Transfers (tar/bundle)
- Tuning of iCAT Database to Maximize Performance
  - Judicious use of Indices & Hints
  - System Layout Architecture of iCAT Host
  - Use of Flash-based Hard Drives (TACC)
  - Master-Slave and Replicated iCAT
- Policy-based Operation Scheduling
  - Take advantage of locality and/or 'lean' times

BagIt v.96 Export Interoperability

- BagIt – The preferred format for transfer of digital content to the Library of Congress.
  - Implemented as a micro-service that packages an existing iRODS collection as a BagIt bag.
  - Can be invoked through an interactive rule
  - Can be invoked from a preservation policy
- First step "Towards Interoperable Preservation Repository" (TIPR) Repository Exchange Package (RXP)

SHAMAN Year 2 - Interoperability

- Managing engineering data throughout the extended supply chain
  - Apply policies across different asset management systems using integrated iRODS and Multivalent
  - A critical R&D question is how to assure authenticity of digital objects across the supply chain - increased evidence of forgery
  - Audit trail of social networking tools (Multivalent) to track and maintain "decision points" in design and execution
    - Use of Cheshire IR system to mine audit trails
  - Ability to parse engineering formats natively, *without data loss*, rather than migration to STEP
    - Multivalent support implemented for JT (Siemens) format for CAD
  - Integration of Defuddle (UIUC) and Multivalent systems to characterize and render scientific data

University of Liverpool Industrious Media

- Assembling policy library to support product lifecycle management
  - PLM reflects agenda of industry, not just government
    - Engineering, health care, media sectors
    - ISO MOIMS-rac assessment criteria is “not enough”
- Developing new architecture for Multivalent
  - Now Media services can be called by iRODS rules
    - Identify, validate, parse, render, view, annotation, etc.
    - More advanced than current approaches, which do not support full parsing of the data
    - Key Lesson: Independent parsing of data is a core requirement of digital preservation

Preservation Environments

- Multiple federal agencies are exploring implementation of preservation environments
  - NARA, Transcontinental Persistent Archive Prototoype
  - NOAA / NCDC, climate data archives & data processing services
  - NASA, computer simulation archives & trustworthy assessment criteria
  - NOAO, Astronomy image archives & data sharing
  - NIST, preservation interoperability standards
  - NSF, simulation and sensor data archives

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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http://irods.diceresearch.org

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