Practical Experiences on SRM

GSM-WG

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OGF-21, Oct. 16, 2007
Seattle, WA, USA

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History

- 7 year of Storage Resource Management (SRM) activity
- Experience with system implementations v.1.1 (basic SRM) – 2001
  - MSS: Castor (CERN), dCache (FNAL, DESY), HPSS (LBNL, ORNL, BNL), JasMINE (Jlab), MSS (NCAR)
  - Disk systems: dCache (FNAL), DPM (CERN), DRM (LBNL)
- SRM v2.0 spec – 2003
- SRM V2.2 – enhancements introduced after WLCG (the World-wide LHC Computing Grid) adopted SRM standard
  - Several implementations of v2.2
  - Extensive compatibility and interoperability testing
  - MSS: Castor (CERN, RAL), dCache/{Enstore,TSM,OSM,HPSS} (FNAL, DESY), HPSS (LBNL), JasMINE (Jlab)
  - Disk systems: BeStMan (LBNL), dCache (FNAL, DESY), DPM (CERN), StoRM (INFN/CNAF, ICTP/EGRID)
- Open Grid Forum (OGF)
  - Grid Storage Management (GSM-WG) at GGF8, June 2003
  - SRM collaboration F2F meeting – Sept. 2006
  - SRM v2.2 spec submitted for OGF recommendation – Sep. 2007

Who's involved…

- CERN, European Organization for Nuclear Research, Switzerland
  - Lana Abadie, Paolo Badino, Olof Barring, Jean-Philippe Baud, Tony Cass, Flavia Donno, Akos Frohner, Birger Koblitz, Sophie Lemaitre, Maarten Litmaath, Remi Mollon, Giuseppe Lo Presti, David Smith, Paolo Tedesco
- Deutsches Elektronen-Synchrotron, DESY, Hamburg, Germany
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- Fermi National Accelerator Laboratory, Illinois, USA
  - Matt Crawford, Dmitry Litvinsev, Alexander Moibenko, Gene Oleynik, Timur Perelmutov, Don Petravick
- ICTP/EGRID, Italy
  - Ezio Corso, Massimo Sponza
- INFN/CNAF, Italy
  - Alberto Forti, Luca Magnoni, Riccardo Zappi
- LAL/IN2P3/CNRS, Faculté des Sciences, Orsay Cedex, France
  - Gilbert Grosdidier
- Lawrence Berkeley National Laboratory, California, USA
  - Junmin Gu, Vijaya Natarajan, Arie Shoshani, Alex Sim
- Rutherford Appleton Laboratory, Oxfordshire, England
  - Shaun De Witt, Jens Jensen, Jiri Menjak
- Thomas Jefferson National Accelerator Facility (TJNAF), Virginia, USA
  - Michael Haddox-Schatz, Bryan Hess, Andy Kowalski, Chip Watson

What is SRM?

- **Storage Resource Managers (SRMs) are middleware components**
  - whose function is to provide dynamic space allocation and file management on shared storage components on the Grid
  - Different implementations for underlying storage systems based on the SRM specification
- **SRMs in the data grid**
  - Shared storage space allocation & reservation
    - important for data intensive applications
  - Get/put files from/into spaces
    - archived files on mass storage systems
  - File transfers from/to remote sites, file replication
  - Negotiate transfer protocols
  - File and space management with lifetime
  - support non-blocking (asynchronous) requests
  - Directory management
  - Interoperate with other SRMs

Motivation & Requirements (1)

- Grid architecture needs to include reservation & scheduling of:
  - Compute resources
  - Storage resources
  - Network resources
- Storage Resource Managers (SRMs) role in the data grid architecture
  - Shared storage resource allocation & scheduling
  - Specially important for data intensive applications
  - Often files are archived on a mass storage system (MSS)
  - Wide area networks – need to minimize transfers by file sharing
  - Scaling: large collaborations (100's of nodes, 1000's of clients) – opportunities for file sharing
  - File replication and caching may be used
  - Need to support non-blocking (asynchronous) requests

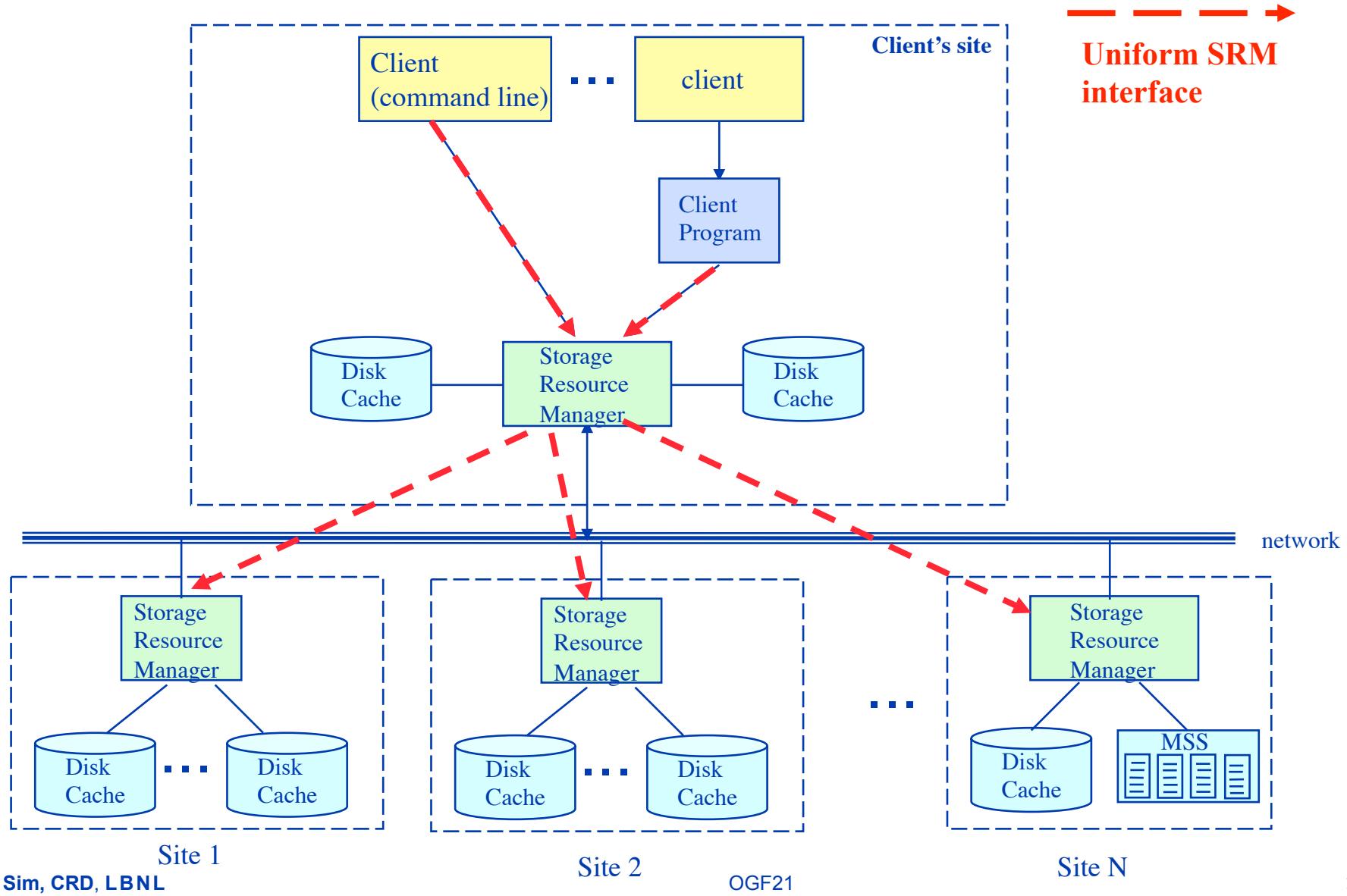
Motivation & Requirements (2)

- Suppose you want to run a job on your local machine
  - Need to allocate space
  - Need to bring all input files
  - Need to ensure correctness of files transferred
  - Need to monitor and recover from errors
  - What if files don't fit space? Need to manage file streaming
  - Need to remove files to make space for more files
- Now, suppose that the machine and storage space is a shared resource
  - Need to do the above for many users
  - Need to enforce quotas
  - Need to ensure fairness of space allocation and scheduling

Motivation & Requirements (3)

- Now, suppose you want to do that on a Grid
  - Need to access a variety of storage systems
  - mostly remote systems, need to have access permission
  - Need to have special software to access mass storage systems
- Now, suppose you want to run distributed jobs on the Grid
  - Need to allocate remote spaces
  - Need to move (stream) files to remote sites
  - Need to manage file outputs and their movement to destination site(s)

Client and Peer-to-Peer Uniform Interface



Storage Resource Managers: Main concepts

- Non-interference with local policies
- Advance space reservations
- Dynamic space management
- Pinning file in spaces
- Support abstract concept of a file name: Site URL
- Temporary assignment of file names for transfer: Transfer URL
- Directory Management and ACLs
- Transfer protocol negotiation
- Peer to peer request support
- Support for asynchronous multi-file requests
- Support abort, suspend, and resume operations

Site URL and Transfer URL

- **Provide: Site URL (SURL)**
  - URL known externally – e.g. in Replica Catalogs
  - e.g. srm://ibm.cnaf.infn.it:8444/dteam/test.10193
- **Get back: Transfer URL (TURL)**
  - Path can be different than SURL – SRM internal mapping
  - Protocol chosen by SRM based on request protocol preference
  - e.g. gsiftp://ibm139.cnaf.infn.it:2811//gpfs/sto1/dteam/test.10193
- **One SURL can have many TURL**
  - Files can be replicated in multiple storage components
  - Files may be in near-line and/or on-line storage
  - In a light-weight SRM (a single file system on disk)
    - SURL may be the same as TURL except protocol
- **File sharing is possible**
  - Same physical file, but many requests
  - Needs to be managed by SRM implementation

Types of storage and spaces

- **Access latency**
  - On-line
    - Storage where files are moved to before their use
  - Near-line
    - Requires latency before files can be accessed
- **Retention quality**
  - Custodial (High quality)
  - Output (Middle quality)
  - Replica (Low Quality)
- **Spaces can be reserved in these storage components**
  - Spaces can be reserved for a lifetime
  - No limit on number of spaces
  - Space reference handle is returned to client
  - Total space of each type are subject to SRM and/or VO policies
- **Assignment of files to spaces**
  - Files can be assigned to any space, provided that their lifetime expiration is shorter than the lifetime expiration of the space

Managing spaces

- **Default spaces**
  - Files can be put into an SRM without explicit reservation
  - Defaults are not visible to client
- **Files already in the SRM can be moved to other spaces**
  - By srmChangeSpaceForFiles
- **Files already in the SRM can be pinned in spaces**
  - By requesting specific files (srmPrepareToGet)
  - By pre-loading them into online space (srmBringOnline)
- **Updating space**
  - Resize to request more space or to release all unused space
  - Extend or shorten the lifetime of a space
- **Releasing files from space by a user**
  - Release all files that user brought into the space whose lifetime has not expired
  - Move permanent and durable files to near-line storage
  - Release space that was used by user

Directory management

- Usual unix semantics
  - srmLs, srmMkdir, srmMv, srmRm, srmRmdir
- A single directory for all spaces
  - No directories for each file type
  - File assignment to spaces is virtual
- Access control services
  - Support owner/group/world permission
    - ACLs supported – can have one owner, but multiple user and group access permissions
    - Can only be assigned by owner
    - When file is requested from a remote site, SRM should check permission with source site

Space reservation

- **Negotiation**
  - Client asks for space: C-guaranteed, MaxDesired
  - SRM return: S-guaranteed <= C-guaranteed,
    best effort <= MaxDesired
- **Types of spaces**
  - Specified during srmReserveSpace
  - Access Latency (Online, Nearline)
  - Retention Policy (Replica, Output, Custodial)
  - Subject to limits per client (SRM or VO policies)
  - Default: implementation and configuration specific
- **Lifetime**
  - Negotiated: C-lifetime requested
  - SRM return: S-lifetime <= C-lifetime
- **Reference handle**
  - SRM returns space reference handle
  - Client can assign Description
  - User can use srmGetSpaceTokens to recover handles on basis of ownership

Transfer protocol negotiation

- **Negotiation**
  - Client provides an ordered list of desired transfer protocols
  - SRM returns first protocol from the list it supports
  - Example
    - Client provided protocols list: bbftp, gridftp, ftp
    - SRM returns: gridftp
- **Advantages**
  - Easy to introduce new protocols
  - User controls which transfer protocol to use
- **How it is returned?**
  - The protocol of the Transfer URL (TURL)
  - Example: bbftp://dm.slac.edu/temp/run11/File678.txt

New concepts in v2.2

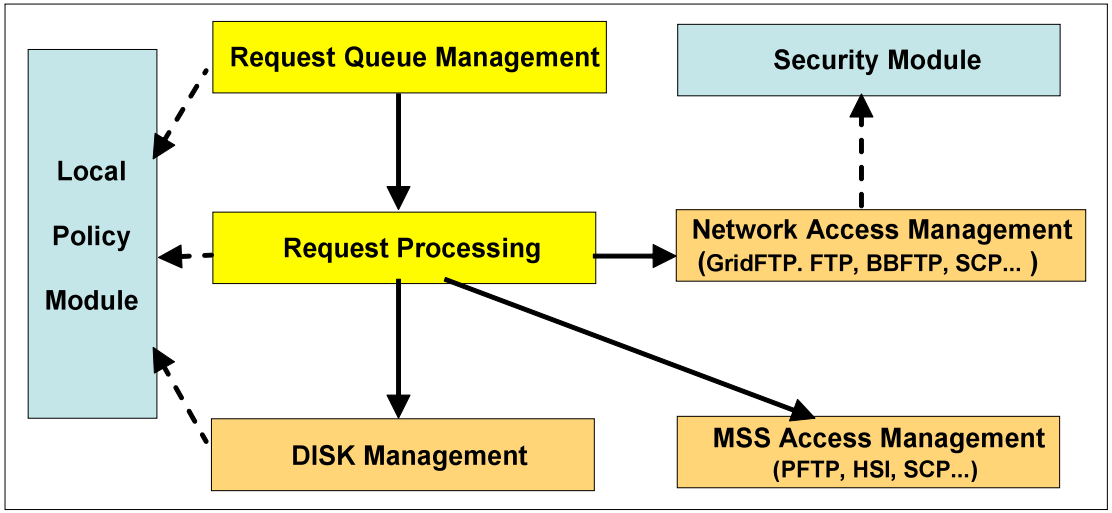
- **Composite Storage Element**
  - Made of multiple Storage Components
    - e.g. component 1: online-replica
      component 2: nearline-custodial (with online disk cache)
    - e.g. component1: online-custodial
      component 2: nearline-custodial (with online disk cache)
  - srmBringOnline can be used to temporarily bring data to the online component for fast access
  - When a file is put into a composite space, SRM may have (temporary) copies on any of the components.
- **Primary Replica**
  - When a file is first put into an SRM, that copy is considered as the primary replica
  - A primary replica can be assigned a lifetime
  - The SURL lifetime is the lifetime of the primary replica
  - When other replicas are made, their lifetime cannot exceed the primary replica lifetime
  - Lifetime of a primary replica can only be extended by an SURL owner.

SRM v2.2 Interface

- *Data transfer functions* to get files into SRM spaces from the client's local system or from other remote storage systems, and to retrieve them
  - srmPrepareToGet, srmPrepareToPut, srmBringOnline, srmCopy
- *Space management functions* to reserve, release, and manage spaces, their types and lifetimes.
  - srmReserveSpace, srmReleaseSpace, srmUpdateSpace, srmGetSpaceTokens
- *Lifetime management functions* to manage lifetimes of space and files.
  - srmReleaseFiles, srmPutDone, srmExtendFileLifeTime
- *Directory management functions* to create/remove directories, rename files, remove files and retrieve file information.
  - srmMkdir, srmRmdir, srmMv, srmRm, srmLs
- *Request management functions* to query status of requests and manage requests
  - srmStatusOf{Get,Put,Copy,BringOnline}Request, srmGetRequestSummary, srmGetRequestTokens, srmAbortRequest, srmAbortFiles, srmSuspendRequest, srmResumeRequest
- Other functions include Discovery and Permission functions
  - srmPing, srmGetTransferProtocols, srmCheckPermission, srmSetPermission, etc.

Berkeley Storage Manager (BeStMan) LBNL

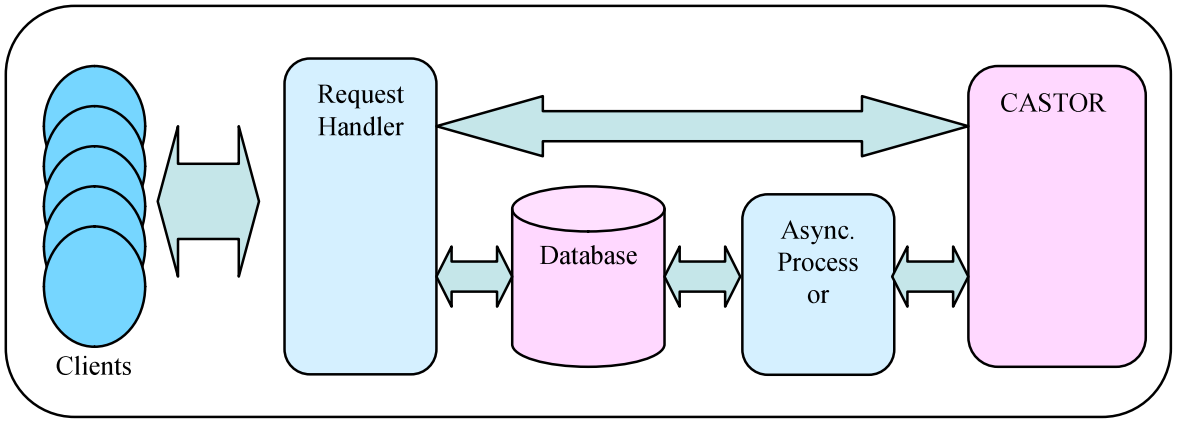
- Java implementation
- Designed to work with unix -based disk systems
- As well as MSS to stage /archive from/to its own disk (currently HPSS)
- Adaptable to other file systems and storages (e.g. NCAR MSS, VU L-Store, TTU Lustre)
- Uses in-memory database (BerkeleyDB)



- Multiple transfer protocols
- Space reservation
- Directory management (no ACLs)
- Can copy files from/to remote SRMs
- Can copy entire directory robustly
  - Large scale data movement of thousands of files
  - Recovers from transient failures (e.g. MSS maintenance, network down)

- Local Policy
  - Fair request processing
  - File replacement in disk
  - Garbage collection

Castor-SRM
CERN and Rutherford Appleton Laboratory

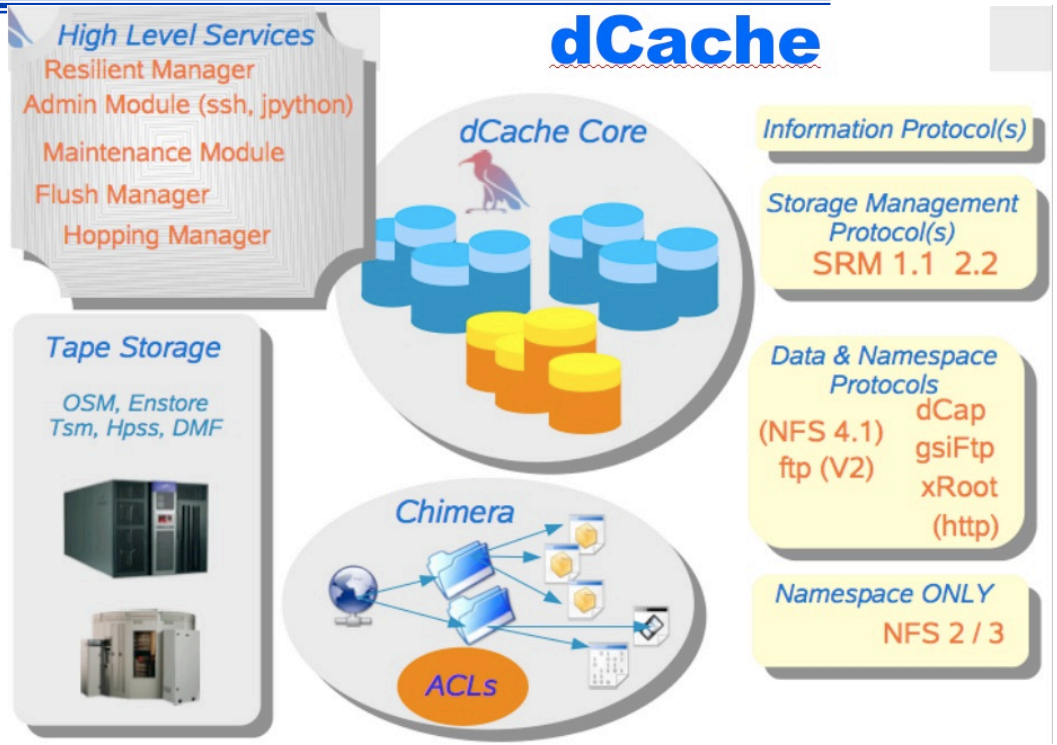


- **CASTOR is the HSM in production at CERN**
- **Support for multiple tape robots**
  - Support for Disk-only storage recently added
- **Designed to meet Large Hadron Collider Computing requirements**
  - Maximize throughput from clients to tape (e.g. LHC experiments data taking)

- **C++ Implementation**
- **Reuse of CASTOR software infrastructure**
  - Derived SRM specific classes
- **Configurable number of thread pools for both front- and back -ends**
- **ORACLE centric**
- **Front and back ends can be distributed on multiple hosts**

dCache-SRM
FNAL and DESY

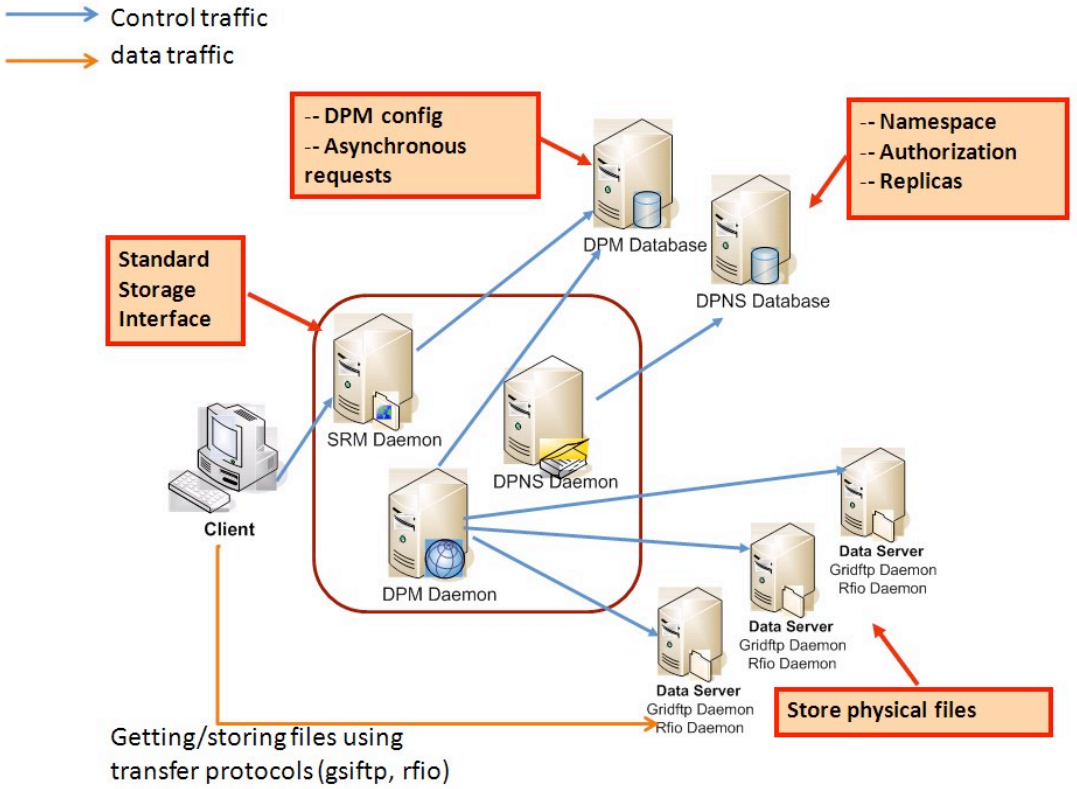
- Strict name space and data storage separation
- Automatic file replication on based on access patterns
- HSM Connectivity (Enstore, OSM, TSM, HPSS, DMF)
- Automated HSM migration and restore
- Scales to Peta-byte range on 1000's of disks
- Supported protocols:
- (gsi/krb)FTP, (gsi/krb)dCap, xRoot, NFS 2/3
- Separate IO queues per protocol
- Resilient dataset management
- Command line and graphical admin interface
- Variety of Authorization mechanisms including VOMS
- Deployed in a large number of institutions worldwide



- SRM 1.1 and SRM 2.2
- Dynamic Space Management
- Request queuing and scheduling
- Load balancing
- Robust replication using SrmCopy functionality via SRM, (gsi)FTP and http protocols

Disk Pool Manager (DPM) CERN

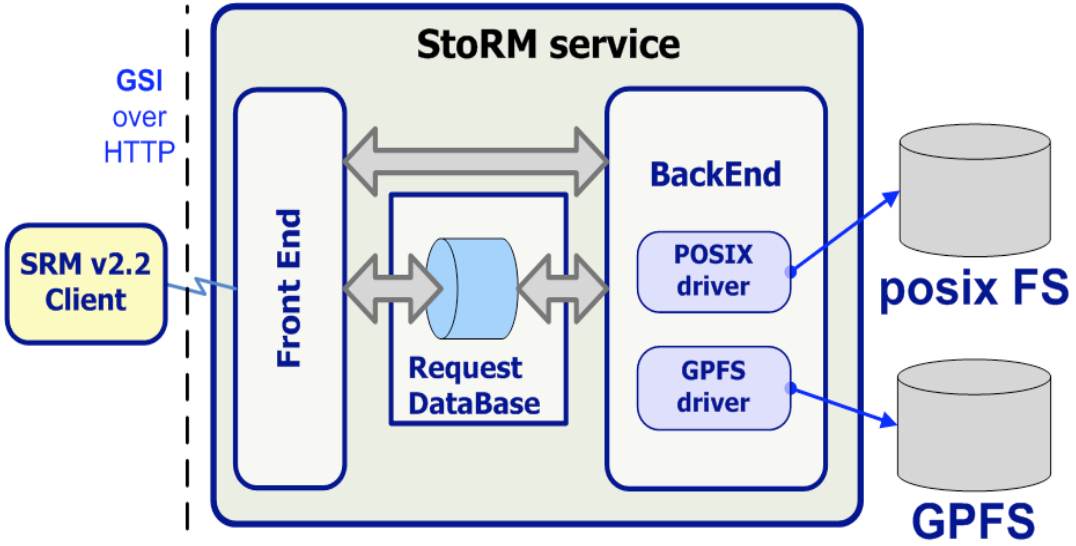
- **Manages storage on disks only**
- **Security**
  - GSI for authentication
  - VOMS for authorization
  - Standard POSIX permissions + ACLs based on user's DN and VOMS roles
- **Virtual ids**
  - Accounts created on the fly
- **Full SRMv2.2 implementation (srmCopy being done)**
- **Standard disk pool manager capabilities**
  - Garbage collector
  - Replication of hot files
- **Transfer protocols**
  - GridFTP
  - Secure RFIO
- **Easy to install and administer**



- **Supported database backends**
  - MySQL
  - Oracle
- **High availability**
  - All servers can be load balanced (except the DPM one)
  - Resilient: all states are kept in the DB at all times

Storage Resource Manager (StoRM)
INFN/CNAF - ICTP/EGRID

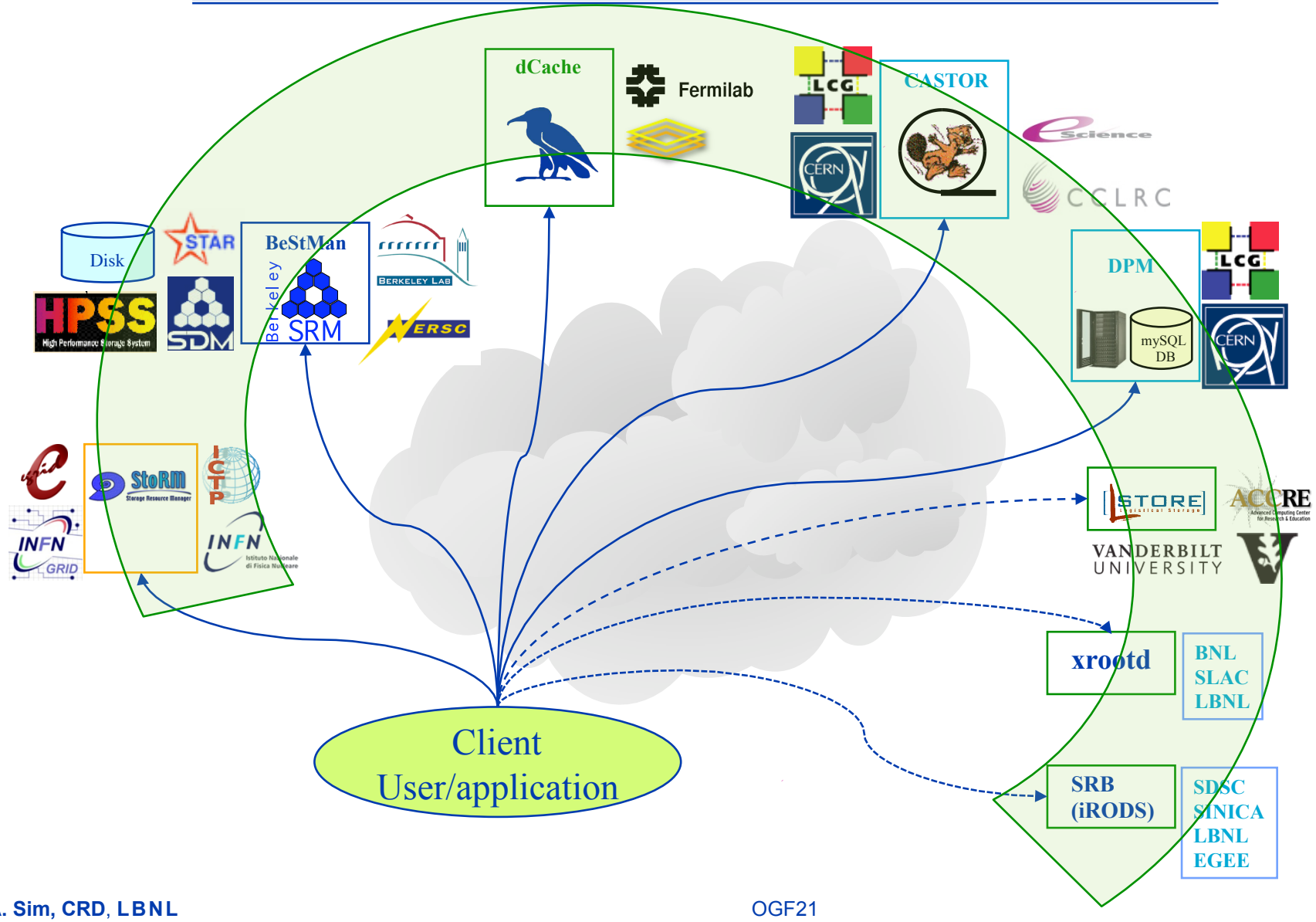
- It's designed to leverage the advantages of high performing parallel file systems in Grid.
- Different file systems supported through a driver mechanism:
  - generic POSIX FS
  - GPFS
  - Lustre
  - XFS
- It provides the capability to perform local and secure access to storage resources (*file://* access protocol + ACLs on data).



StoRM architecture:

- Frontends: C/C++ based, expose the SRM interface
- Backends: Java based, execute SRM requests.
- DB: based on MySQL DBMS, stores requests data and StoRM metadata.
- Each component can be replicated and instantiated on a dedicated machine.

Interoperability in SRM v2.2



SRMs at work

- Europe : LCG/EGEE
  - 177+ deployments, managing more than 10PB
    - 116 DPM/SRM
    - 54 dCache/SRM
    - 7 CASTOR/SRM at CERN, CNAF, PIC, RAL, Sinica
    - StoRM at ICTP/EGRID, INFN/CNAF
- US
  - Estimated at about 30 deployments
  - OSG
    - dCache/SRM from FNAL
    - BeStMan/SRM from LBNL
  - ESG
    - DRM/SRM, HRM/SRM at LANL, LBNL, LLNL, NCAR, ORNL
  - Others
    - JasMINE/SRM from TJNAF
    - L-Store/SRM from Vanderbilt Univ.
    - BeStMan/SRM adaptation on Lustre file system at Texas Tech

Example of usage of SRMs in a couple of projects

BeStMan Features

- Multiple disk partition support
- Default space management for files with lifetime
  - Allocation of space, garbage collection
- Space reservation management
- Support for multiple file transfer servers
  - E.g. configure for 5 GridFTP servers
- Per-user (not per-request) request management
- Multi-file/directory per request
- Incoming and outgoing file transfer queue management and transfer monitoring
- Support file sharing and file streaming
- Easy adaptability to Unix-based file systems
- API for customization for local mass storage systems
- Simple installation and easy maintenance

BeStMan adaptations

- SRM v1.1
  - DRM for UNIX-like disk based file system
  - HRM for HPSS and NCAR-MSS
- SRM v2.2
  - BeStMan
    - For UNIX-like disk based file system
    - For HPSS and NCAR-MSS
  - BeStMan-Gateway
    - Skeleton SRM for local implementation
  - SRM-Xrootd: using BeStMan-Gateway for Xrootd – in progress
  - Xrootd-SRM: using BeStMan in Xrootd nodes – in progress
  - SRM-Client-2
  - SRM-Tester-2

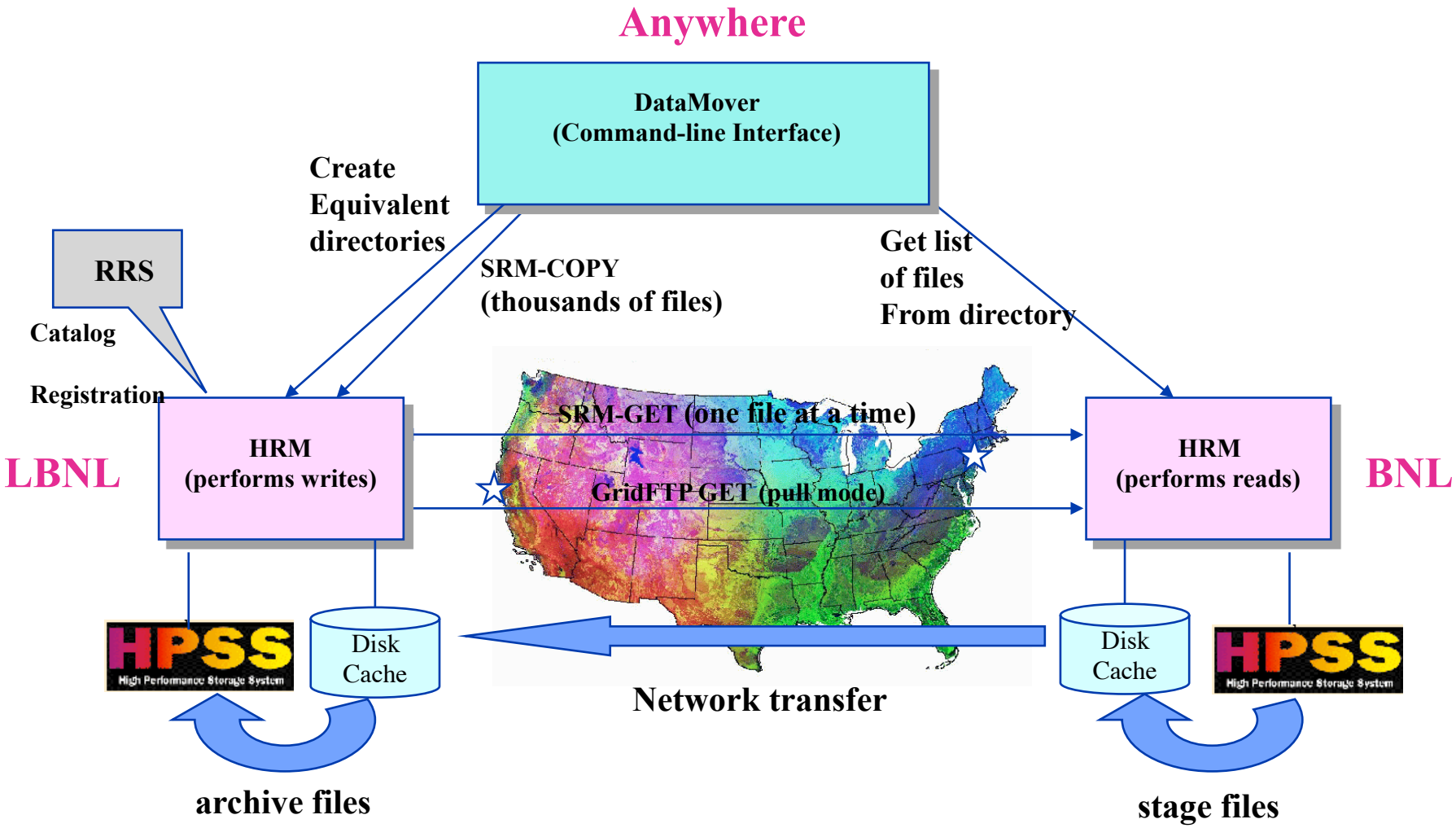
Some Production Use Cases

- **STAR experiment**
  - Uses DRM for analysis
  - Uses HRMs for production-level file replications
    - HPSS access at BNL and NERSC/LBNL
  - Currently, extensive testing with BeStMan
- **Earth System Grid**
  - Uses DRMs and HRMs at multiple sites
  - Uses an adapted HRM for NCAR's MSS
  - Plans to update to BeStMan, SRM v2.2

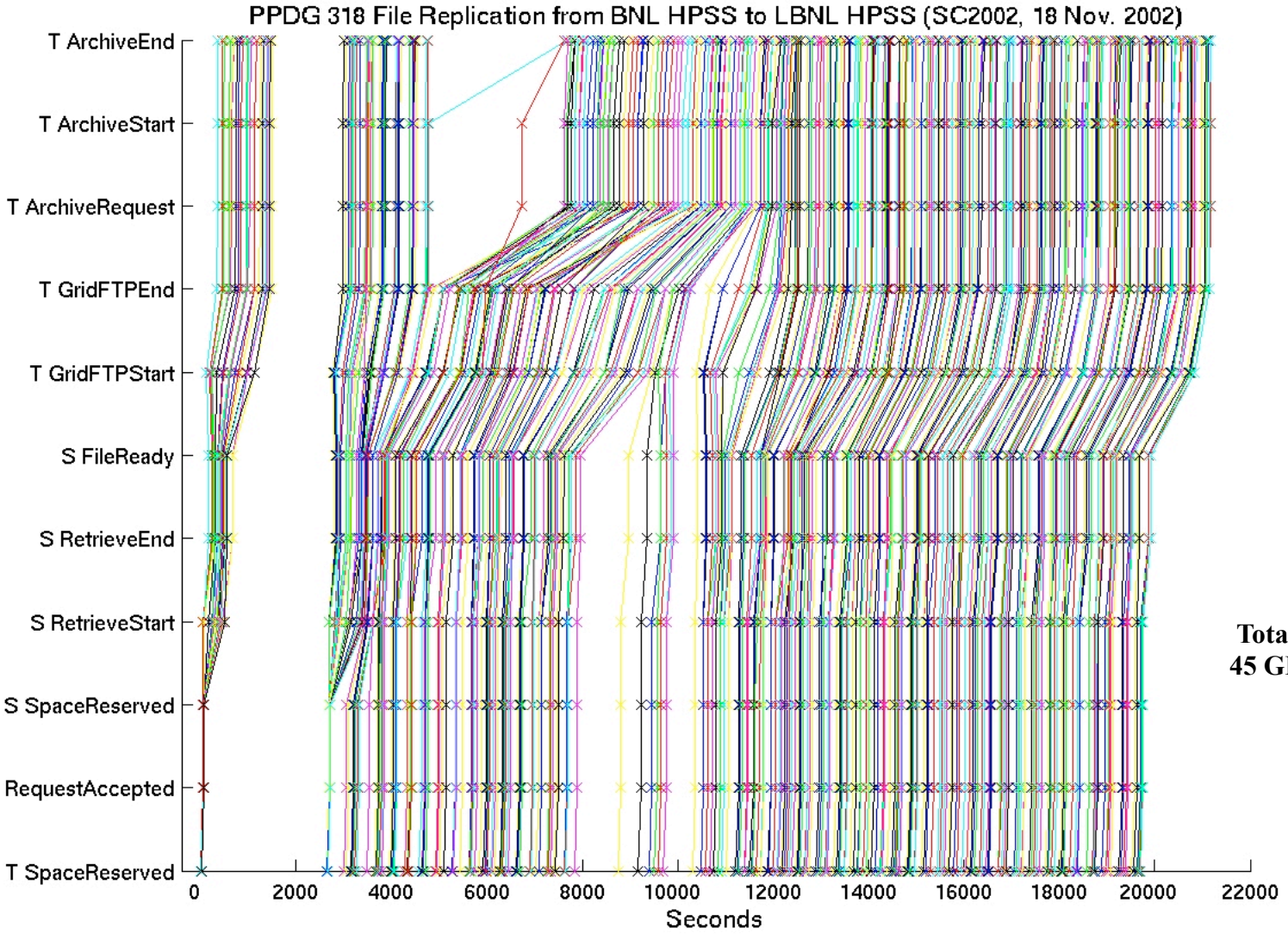
STAR experiment

- **Data Replication from BNL to LBNL**
  - 1TB/10K files per week on average
  - In production for over 4 years
- **Event processing in Grid Collector**
  - Prototype uses SRMs and FastBit indexing embedded in STAR framework
- **STAR analysis framework**
  - Job driven data movement
    1. Use BeStMan to bring files into local disk from a remote file repository
    2. Execute jobs that access “staged in” files in local disk
    3. Job creates an output file on local disk
    4. Job uses BeStMan to moves the output file from local storage to remote archival location
    5. SRM cleans up local disk when transfer complete
    6. Can use any other SRMs implementing v2.2

DataMover/HRMs in HENP-STAR experiment for Robust Multi-file replication over WAN

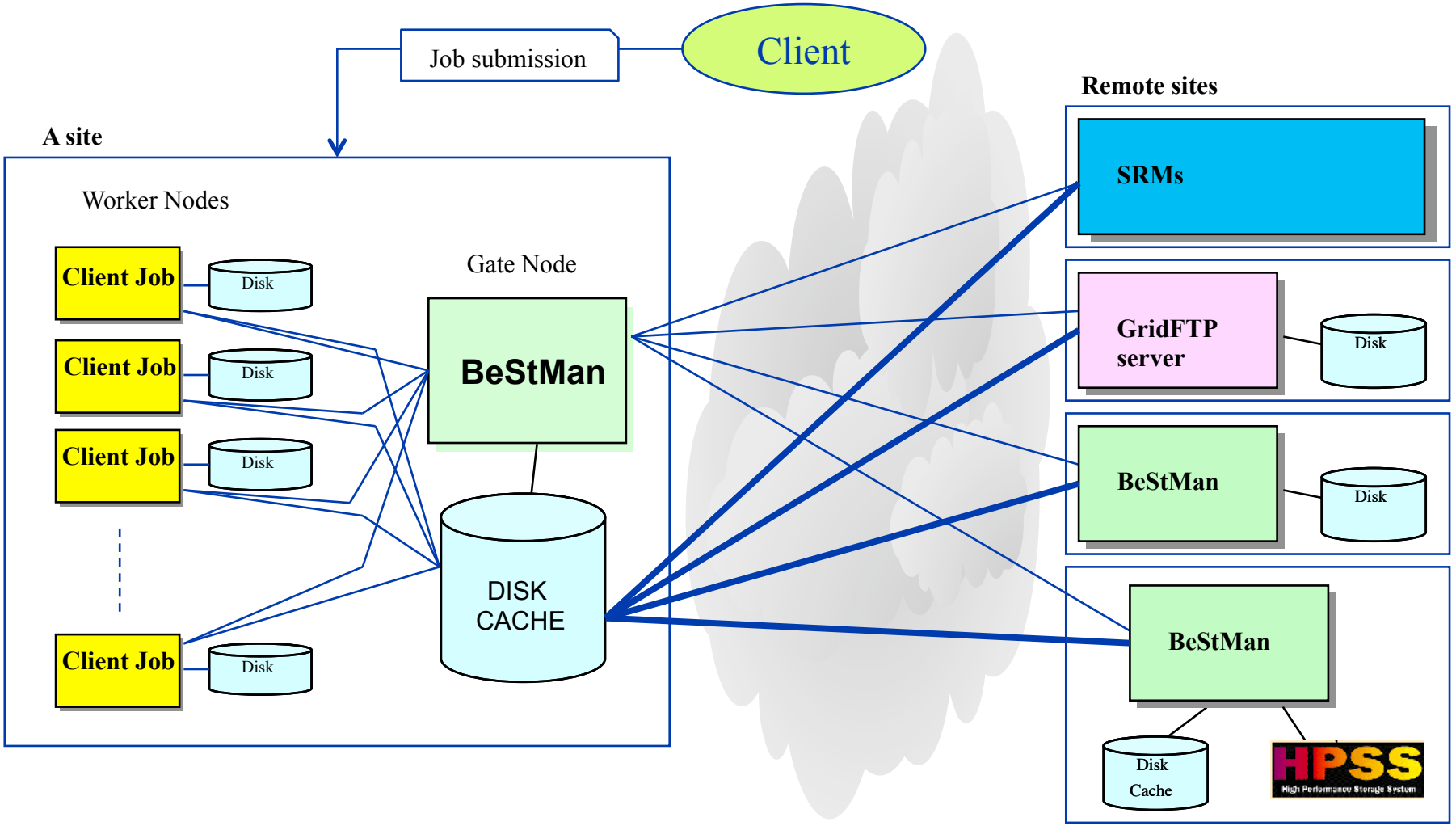


File Tracking Shows Recovery From Transient Failures

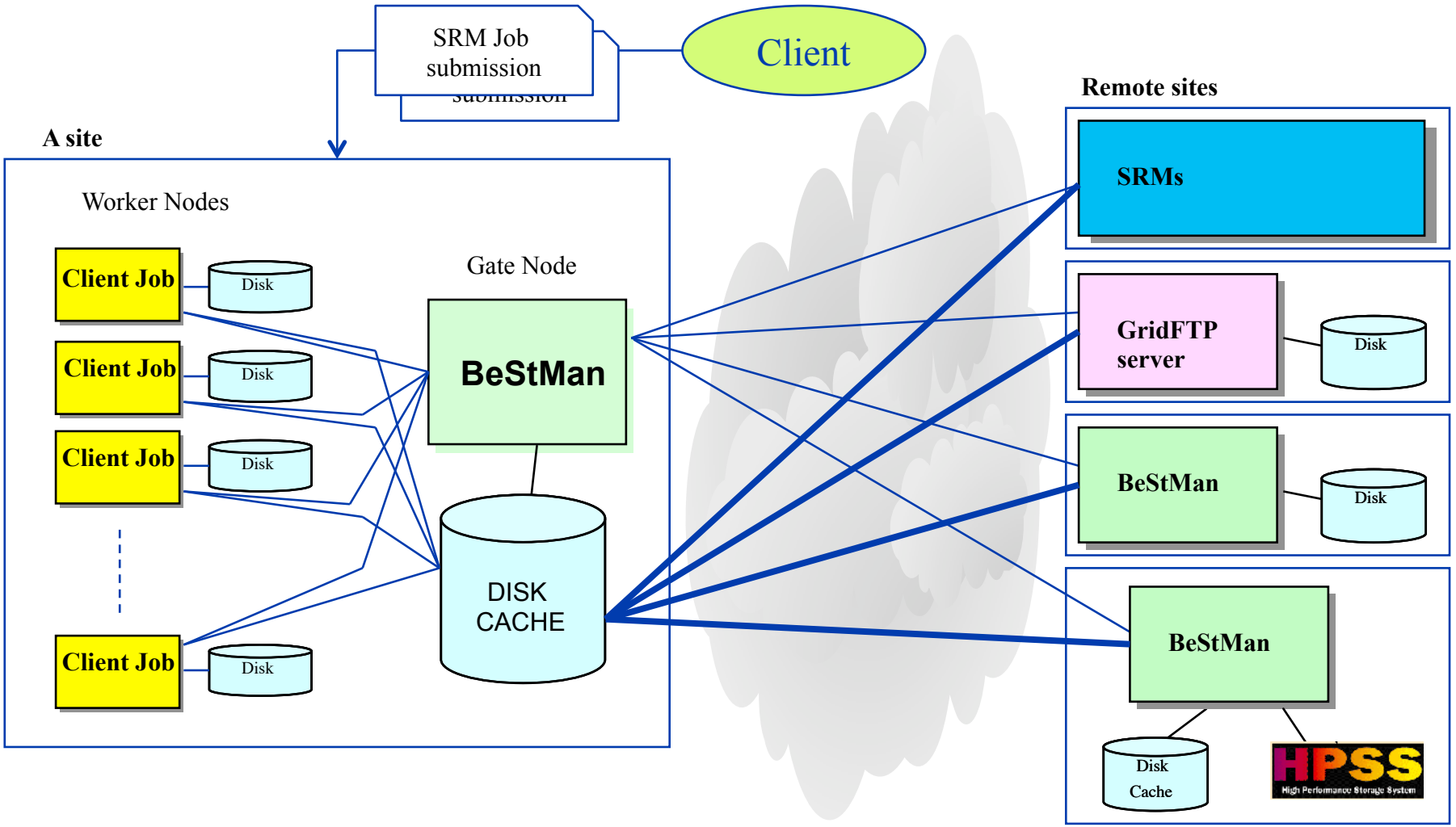


Total: 45 GBs

STAR Analysis scenario (1)



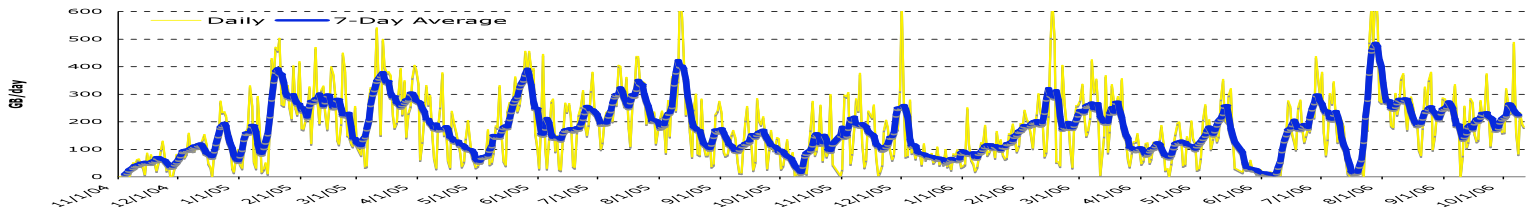
STAR Analysis scenario (2)



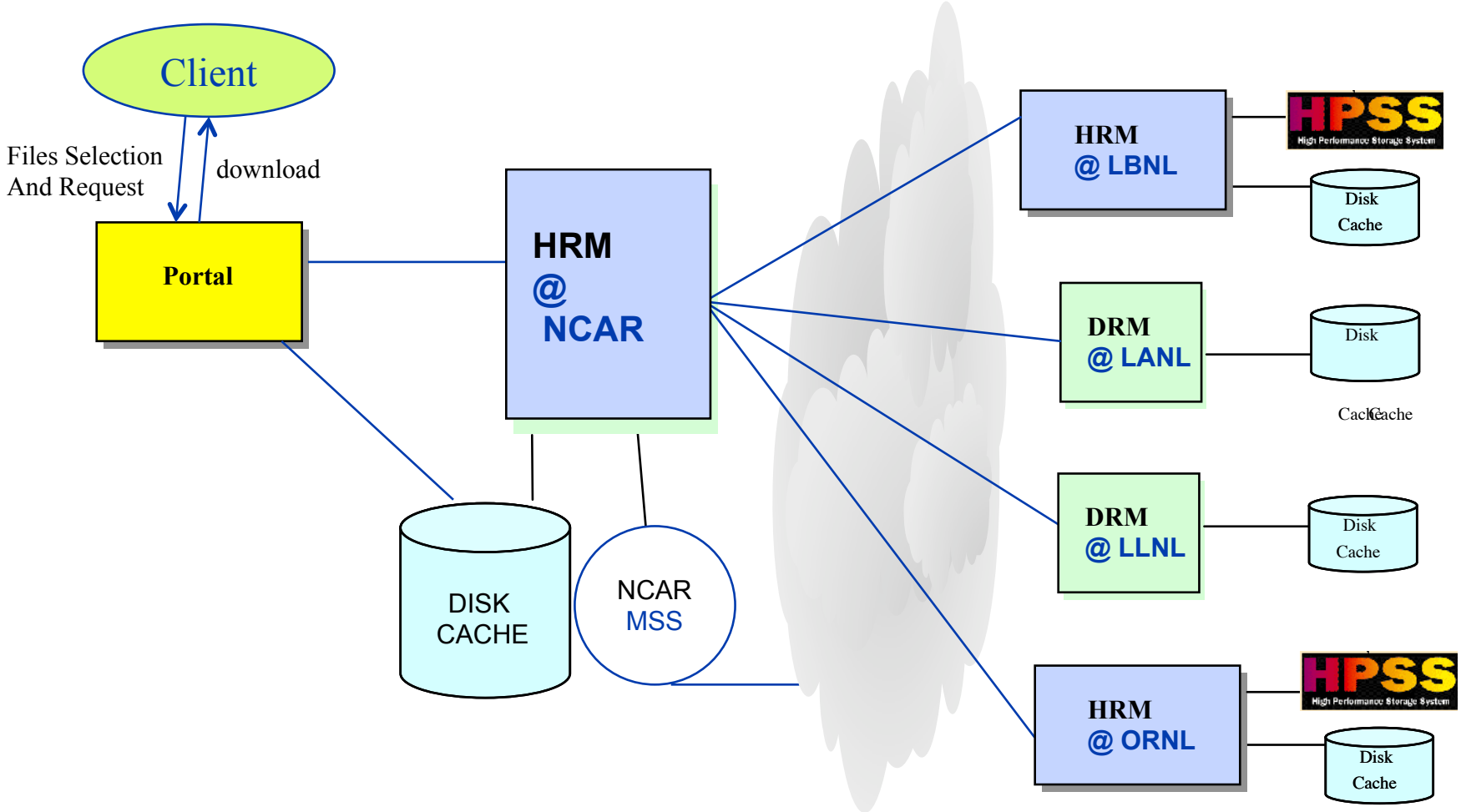
Earth System Grid

- **Main ESG portal**
  - 148.53 TB of data at four locations (NCAR, LBNL, ORNL, LANL)
    - 965,551 files
    - Includes the past 7 years of joint DOE/NSF climate modeling experiments
  - 4713 registered users from 28 countries
    - Downloads to date: 31TB/99,938 files
- **IPCC AR4 ESG portal**
  - 28 TB of data at one location
    - 68,400 files
    - Model data from 11 countries
    - Generated by a modeling campaign coordinated by the Intergovernmental Panel on Climate Change (IPCC)
  - 818 registered analysis projects from 58 countries
    - Downloads to date: 123TB/543,500 files, 300 GB/day on average

Courtesy: http://www.earthsystemgrid.org



SRMs in ESG


Client
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download
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@ LBNL
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High Performance Storage System
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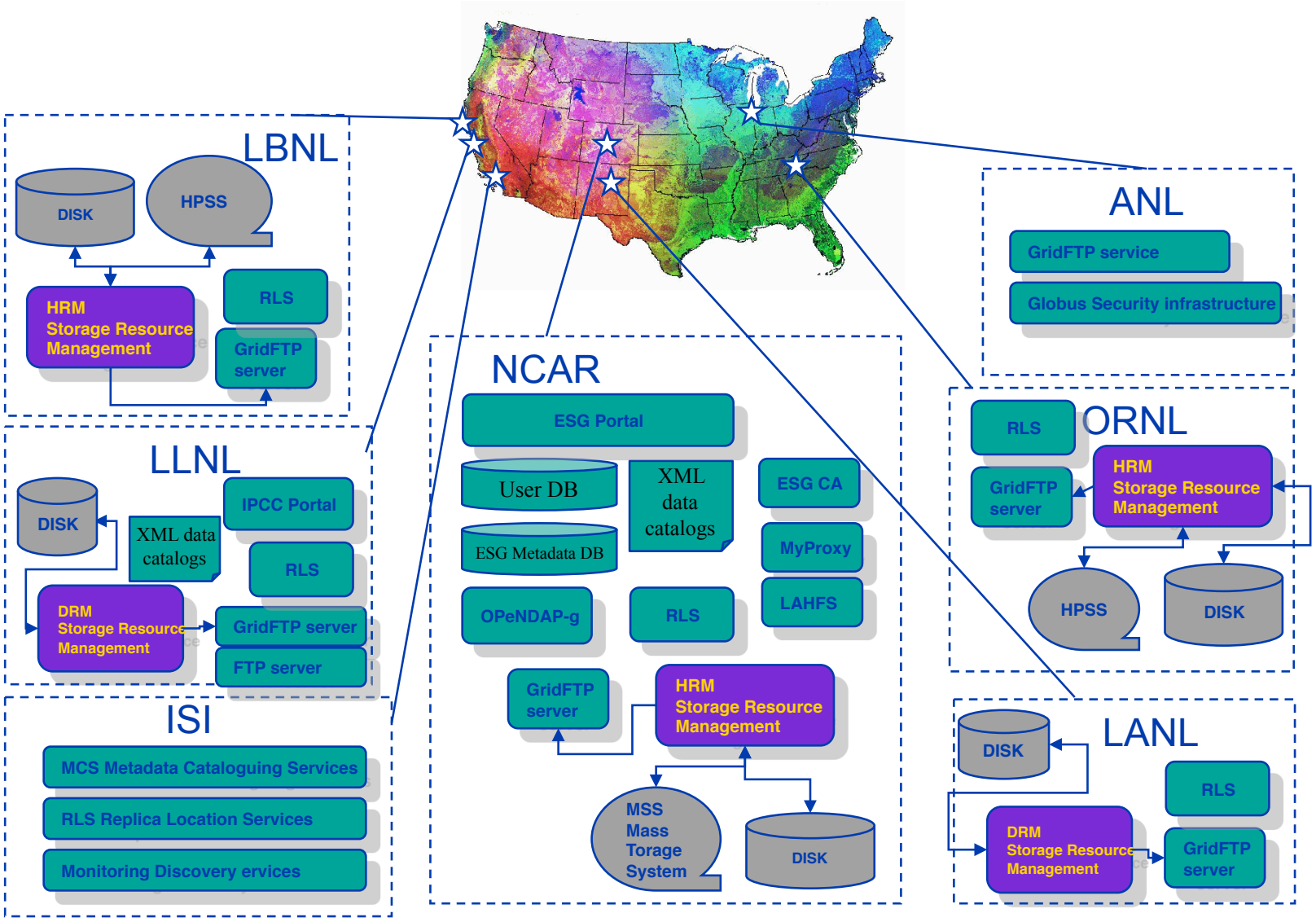
SRM works in concert with other Grid components in ESG



How is testing done? (1)

- Storage Resource Managers (SRMs) are based on a common interface specification.
  - SRMs can have different implementations for the underlying storage systems.
  - Compatibility and interoperability need to be tested according to the specification.
- Availability test
- Basic test
- Use case test
- Interoperability test
- Stress test

How is testing done? (2)

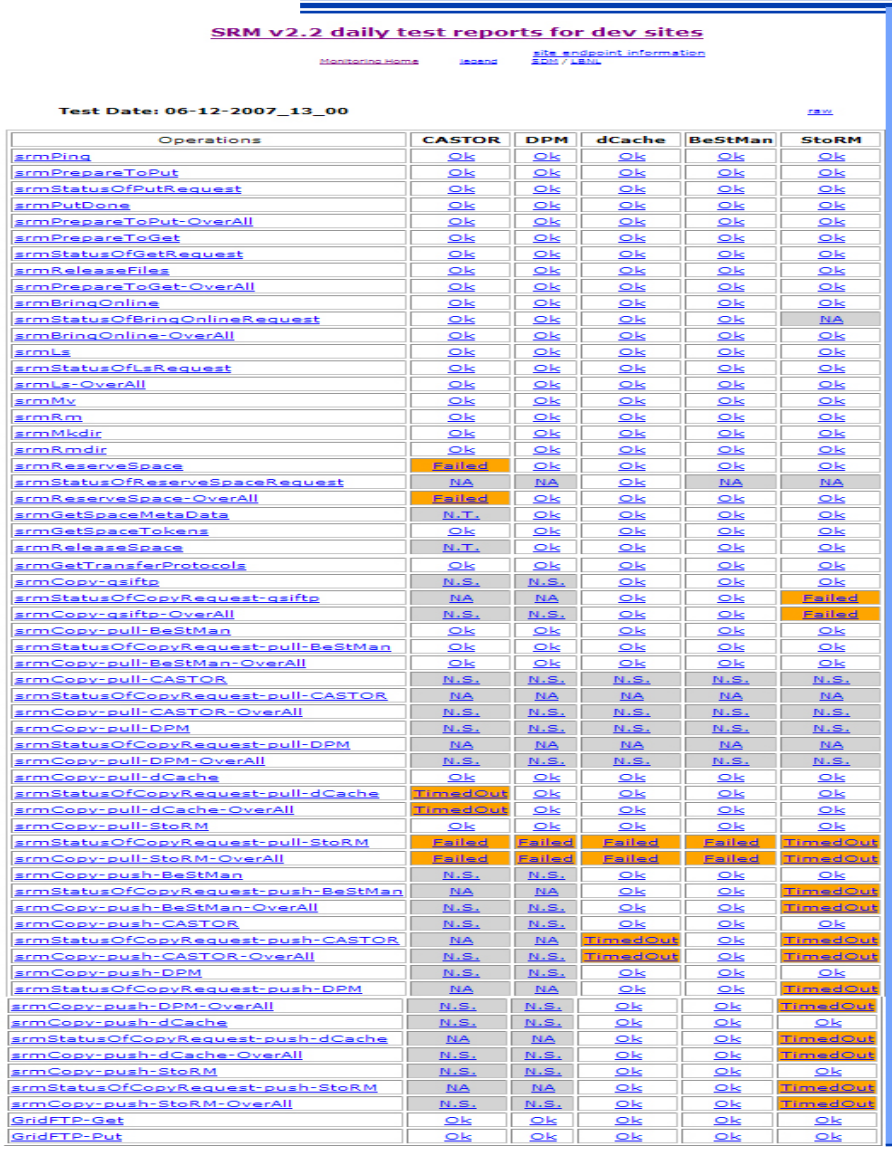
- **S2 test suite for SRM v2.2 from CERN**
  - Basic functionality, tests based on use cases, and cross-copy tests, as part of the certification process
  - Supported file access/transfer protocols: rfio, dcap, gsidcap, gsiftp
  - S2 test cron jobs running 7 times a day.
    - Results published on a web page
    - https://twiki.cern.ch/twiki/bin/view/SRMDev
  - Stress tests simulating many requests and many clients
    - Available on specific endpoints, running clients on 11 machines

How is testing done? (3)

- **SRM-Tester from LBNL**
  - Tests conformity of the SRM server interface according to the SRM spec v1.1, and v2.2
    - Compatibility and interoperability of the SRM servers according to the spec
  - Supported file transfer protocols: gsiftp, ftp, http and https
  - Test cron jobs running twice a day.
    - Results published on a web site
    - http://datagrid.lbl.gov
  - Reliability and stress tests simulating many files, many requests and many clients
    - Available with options, running clients on 8 node cluster
    - Planning to use OSG grid resources

- **Java-based SRM-Tester and C-based S2 test suite complement each other in SRM v2.2 testing**

SRM-Tester results
SRM v2.2 functional view



SRM v2.2 daily test reports for dev sites

Monitoring Home legend site endpoint information SDM / LBNL

Test Date: 06-12-2007_13_00 raw

Operations	CASTOR	DPM	dCache	BeStMan	StoRM
srmPing	Ok	Ok	Ok	Ok	Ok
srmPrepareToPut	Ok	Ok	Ok	Ok	Ok
srmStatusOfPutRequest	Ok	Ok	Ok	Ok	Ok
srmPutDone	Ok	Ok	Ok	Ok	Ok
srmPrepareToPut-OverAll	Ok	Ok	Ok	Ok	Ok
srmPrepareToGet	Ok	Ok	Ok	Ok	Ok
srmStatusOfGetRequest	Ok	Ok	Ok	Ok	Ok
srmReleaseFiles	Ok	Ok	Ok	Ok	Ok
srmPrepareToGet-OverAll	Ok	Ok	Ok	Ok	Ok
srmBringOnline	Ok	Ok	Ok	Ok	Ok
srmStatusOfBringOnlineRequest	Ok	Ok	Ok	Ok	NA
srmBringOnline-OverAll	Ok	Ok	Ok	Ok	Ok
srmLs	Ok	Ok	Ok	Ok	Ok
srmStatusOfLsRequest	Ok	Ok	Ok	Ok	Ok
srmLs-OverAll	Ok	Ok	Ok	Ok	Ok
srmMv	Ok	Ok	Ok	Ok	Ok
srmRm	Ok	Ok	Ok	Ok	Ok
srmMkdir	Ok	Ok	Ok	Ok	Ok
srmRmdir	Ok	Ok	Ok	Ok	Ok
srmReserveSpace	Failed	Ok	Ok	Ok	Ok
srmStatusOfReserveSpaceRequest	NA	NA	Ok	NA	NA
srmReserveSpace-OverAll	Failed	Ok	Ok	Ok	Ok
srmGetSpaceMetaData	N.T.	Ok	Ok	Ok	Ok
srmGetSpaceTokens	Ok	Ok	Ok	Ok	Ok
srmReleaseSpace	N.T.	Ok	Ok	Ok	Ok
srmGetTransferProtocols	Ok	Ok	Ok	Ok	Ok
srmCopy-gsiftp	N.S.	N.S.	Ok	Ok	Ok
srmStatusOfCopyRequest-gsiftp	NA	NA	Ok	Ok	Failed
srmCopy-gsiftp-OverAll	N.S.	N.S.	Ok	Ok	Failed
srmCopy-pull-BeStMan	Ok	Ok	Ok	Ok	Ok
srmStatusOfCopyRequest-pull-BeStMan	Ok	Ok	Ok	Ok	Ok
srmCopy-pull-BeStMan-OverAll	Ok	Ok	Ok	Ok	Ok
srmCopy-pull-CASTOR	N.S.	N.S.	N.S.	N.S.	N.S.
srmStatusOfCopyRequest-pull-CASTOR	NA	NA	NA	NA	NA
srmCopy-pull-CASTOR-OverAll	N.S.	N.S.	N.S.	N.S.	N.S.
srmCopy-pull-DPM	N.S.	N.S.	N.S.	N.S.	N.S.
srmStatusOfCopyRequest-pull-DPM	NA	NA	NA	NA	NA
srmCopy-pull-DPM-OverAll	N.S.	N.S.	N.S.	N.S.	N.S.
srmCopy-pull-dCache	Ok	Ok	Ok	Ok	Ok
srmStatusOfCopyRequest-pull-dCache	TimedOut	Ok	Ok	Ok	Ok
srmCopy-pull-dCache-OverAll	TimedOut	Ok	Ok	Ok	Ok
srmCopy-pull-StoRM	Ok	Ok	Ok	Ok	Ok
srmStatusOfCopyRequest-pull-StoRM	Failed	Failed	Failed	Failed	TimedOut
srmCopy-pull-StoRM-OverAll	Failed	Failed	Failed	Failed	TimedOut
srmCopy-push-BeStMan	N.S.	N.S.	Ok	Ok	Ok
srmStatusOfCopyRequest-push-BeStMan	NA	NA	Ok	Ok	TimedOut
srmCopy-push-BeStMan-OverAll	N.S.	N.S.	Ok	Ok	TimedOut
srmCopy-push-CASTOR	N.S.	N.S.	Ok	Ok	Ok
srmStatusOfCopyRequest-push-CASTOR	NA	NA	TimedOut	Ok	TimedOut
srmCopy-push-CASTOR-OverAll	N.S.	N.S.	TimedOut	Ok	TimedOut
srmCopy-push-DPM	N.S.	N.S.	Ok	Ok	Ok
srmStatusOfCopyRequest-push-DPM	NA	NA	Ok	Ok	TimedOut
srmCopy-push-DPM-OverAll	N.S.	N.S.	Ok	Ok	TimedOut
srmCopy-push-dCache	N.S.	N.S.	Ok	Ok	Ok
srmStatusOfCopyRequest-push-dCache	NA	NA	Ok	Ok	TimedOut
srmCopy-push-dCache-OverAll	N.S.	N.S.	Ok	Ok	TimedOut
srmCopy-push-StoRM	N.S.	N.S.	Ok	Ok	Ok
srmStatusOfCopyRequest-push-StoRM	NA	NA	Ok	Ok	TimedOut
srmCopy-push-StoRM-OverAll	N.S.	N.S.	Ok	Ok	TimedOut
GridFTP-Get	Ok	Ok	Ok	Ok	Ok
GridFTP-Put	Ok	Ok	Ok	Ok	Ok

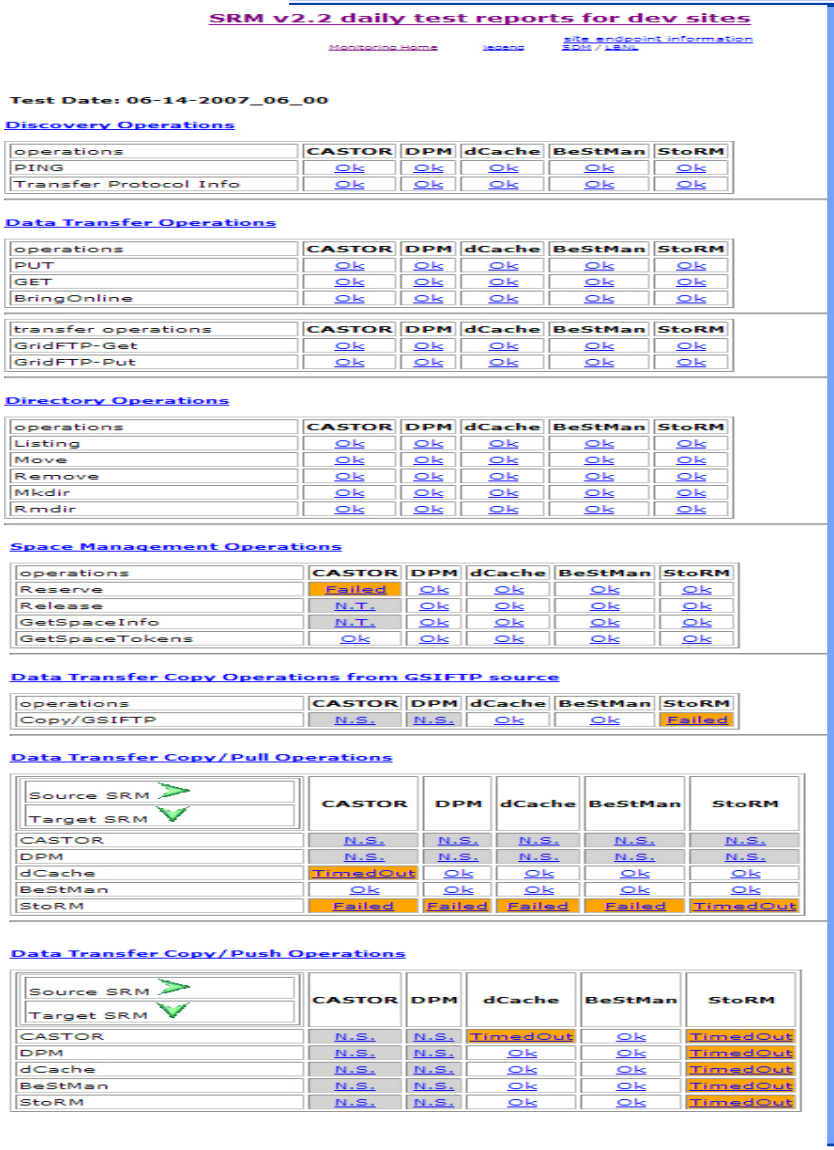
SRM v2.2 daily test reports for dev sites

Monitoring Home legend site endpoint information SDM / LBNL

Test Date: 06-14-2007_06_00 raw

Operations	CASTOR	DPM	dCache	BeStMan	StoRM
srmPing	Ok	Ok	Ok	Ok	Ok
srmPrepareToPut	Ok	Ok	Ok	Ok	Ok
srmStatusOfPutRequest	Ok	Ok	Ok	Ok	Ok
srmPutDone	Ok	Ok	Ok	Ok	Ok
srmPrepareToPut-OverAll	Ok	Ok	Ok	Ok	Ok
srmPrepareToGet	Ok	Ok	Ok	Ok	Ok
srmStatusOfGetRequest	Ok	Ok	Ok	Ok	Ok
srmReleaseFiles	Ok	Ok	Ok	Ok	Ok
srmPrepareToGet-OverAll	Ok	Ok	Ok	Ok	Ok
srmBringOnline	Ok	Ok	Ok	Ok	Ok
srmStatusOfBringOnlineRequest	Ok	Ok	Ok	Ok	NA
srmBringOnline-OverAll	Ok	Ok	Ok	Ok	Ok
srmLs	Ok	Ok	Ok	Ok	Ok
srmStatusOfLsRequest	Ok	Ok	Ok	Ok	Ok
srmLs-OverAll	Ok	Ok	Ok	Ok	Ok
srmMv	Ok	Ok	Ok	Ok	Ok
srmRm	Ok	Ok	Ok	Ok	Ok
srmMkdir	Ok	Ok	Ok	Ok	Ok
srmRmdir	Ok	Ok	Ok	Ok	Ok

SRM-Tester results
SRM v2.2 collective view



SRM v2.2 daily test reports for dev sites

Monitoring Home legend site endpoint information SDM / LBNL

Test Date: 06-14-2007_06_00

Discovery Operations

operations	CASTOR	DPM	dCache	BeStMan	StoRM
PING	Ok	Ok	Ok	Ok	Ok
Transfer Protocol Info	Ok	Ok	Ok	Ok	Ok

Data Transfer Operations

operations	CASTOR	DPM	dCache	BeStMan	StoRM
PUT	Ok	Ok	Ok	Ok	Ok
GET	Ok	Ok	Ok	Ok	Ok
BringOnline	Ok	Ok	Ok	Ok	Ok

transfer operations	CASTOR	DPM	dCache	BeStMan	StoRM
GridFTP-Get	Ok	Ok	Ok	Ok	Ok
GridFTP-Put	Ok	Ok	Ok	Ok	Ok

Directory Operations

operations	CASTOR	DPM	dCache	BeStMan	StoRM
Listing	Ok	Ok	Ok	Ok	Ok
Move	Ok	Ok	Ok	Ok	Ok
Remove	Ok	Ok	Ok	Ok	Ok
Mkdir	Ok	Ok	Ok	Ok	Ok
Rmdir	Ok	Ok	Ok	Ok	Ok

Space Management Operations

operations	CASTOR	DPM	dCache	BeStMan	StoRM
Reserve	Failed	Ok	Ok	Ok	Ok
Release	N.T.	Ok	Ok	Ok	Ok
GetSpaceInfo	N.T.	Ok	Ok	Ok	Ok
GetSpaceTokens	Ok	Ok	Ok	Ok	Ok

Data Transfer Copy Operations from GSIFTP source

operations	CASTOR	DPM	dCache	BeStMan	StoRM
Copy/GSIFTP	N.S.	N.S.	Ok	Ok	Failed

Data Transfer Copy/Pull Operations

Source SRM / Target SRM	CASTOR	DPM	dCache	BeStMan	StoRM
CASTOR	N.S.	N.S.	N.S.	N.S.	N.S.
DPM	N.S.	N.S.	N.S.	N.S.	N.S.
dCache	TimedOut	Ok	Ok	Ok	Ok
BeStMan	Ok	Ok	Ok	Ok	Ok
StoRM	Failed	Failed	Failed	Failed	TimedOut

Data Transfer Copy/Push Operations

Source SRM / Target SRM	CASTOR	DPM	dCache	BeStMan	StoRM
CASTOR	N.S.	N.S.	TimedOut	Ok	TimedOut
DPM	N.S.	N.S.	Ok	Ok	TimedOut
dCache	N.S.	N.S.	Ok	Ok	TimedOut
BeStMan	N.S.	N.S.	Ok	Ok	TimedOut
StoRM	N.S.	N.S.	Ok	Ok	TimedOut

S2 basic tests results

SRM function	CERN C2	CNAF C2	BNL dCache	DESY dCache	UKED dCache	FZK dCache	FNAL dCache	CERN DPM	UKED DPM	UKGL DPM	LAL DPM	LBNL BeStMan	CNAF StoRM	CNAF StoRM2	UKBR StoRM
WLCG MoU SRM v2.2 methods															
Ping	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
PtP	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
StOfPut	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
PutDone	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
PtG	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
StOfGet	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
BoL	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
StOfBoL	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
AbortR	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
AbortF	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
RelFiles	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
GetReqSum	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
GetReqToks	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
GetTrProts	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
Ls	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
Mkdir	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
Rmdir	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
Rm	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
Mv	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
ResSpace	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
StOfResSp	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
RelSpace	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
GetSpToks	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
GetSpMD	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
ExFileLT	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log

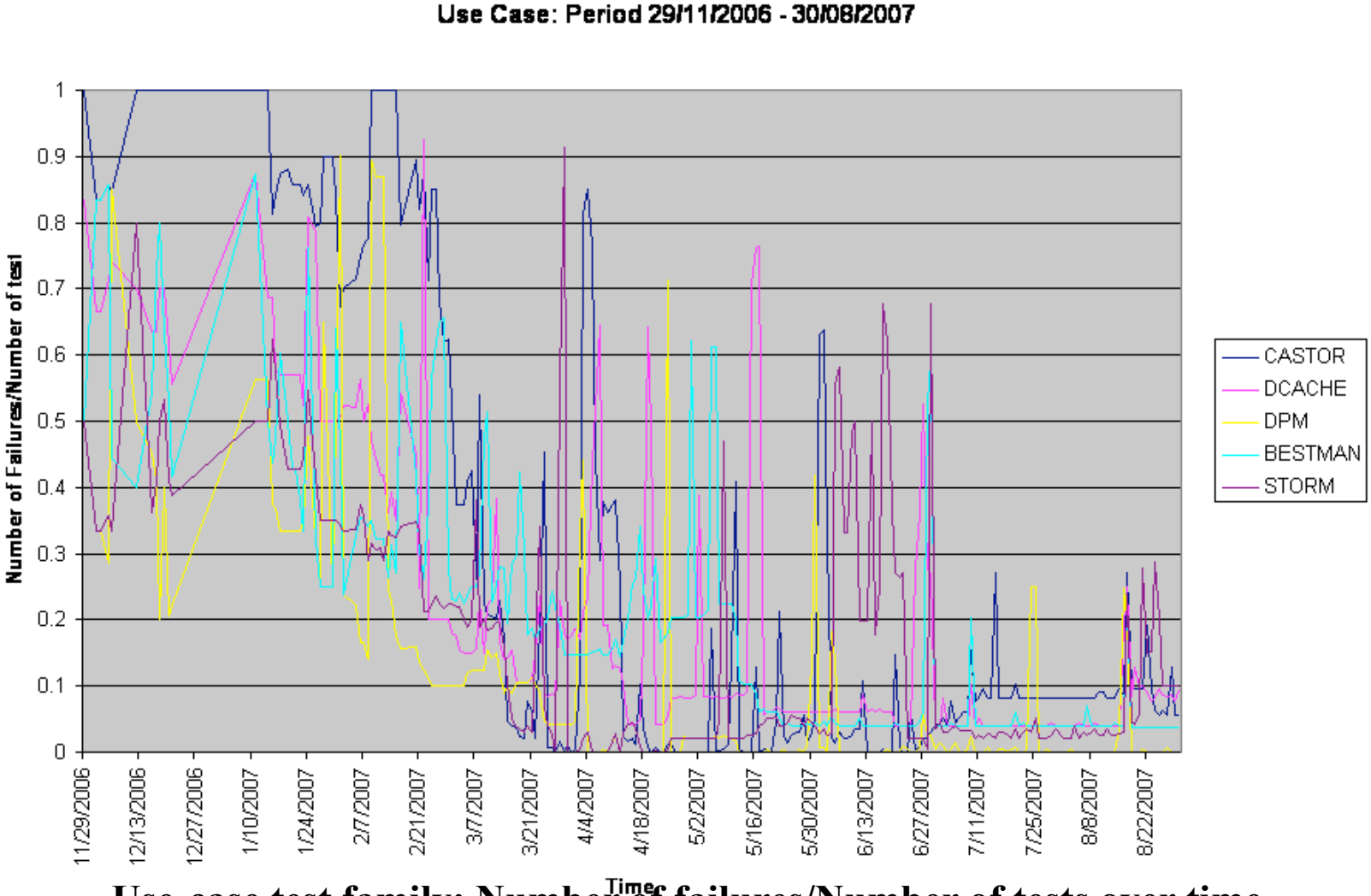
Courtesy: https://twiki.cern.ch/twiki/bin/view/SRMDev

S2 use-case tests results

SRM test	CERN C2	CNAF C2	CERN C2-1	BNL dCache	DESY dCache	FZK dCache	NDGF dCache	FNAL dCache	CERN DPM	UKED DPM	UKGL DPM	LAL DPM	LBNL BeStMan	CNAF StoRM	CNAF StoRM2	UKBR StoRM
CheckGarbageSpaceCollector	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
CheckSize	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
ExtendFileLifeTime	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
FileNames00	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
FileNames01	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
GetRemoved01	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
GetStatusPartialEx	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
GetStatusPartialNe	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
LsDirCountOffset	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
LsDirDetail	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
LsDirFull	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
LsFullDetail	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
LsNonExistent	Out Log	Out	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
LsTopDir	Out Log	Out	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
Mkdir00	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
MvBeingPut	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
MvDirBeingPutInto1	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log
MvDirBeingPutInto	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log	Out Log

Courtesy: https://twiki.cern.ch/twiki/bin/view/SRMDev

Testing Brought Improvements over time (2)



Use-case test family: Number of failures/Number of tests over time

Summary and Current Status

- Storage Resource Management – essential for Grid
- Multiple implementations interoperate
  - Permit special purpose implementations for unique products
  - Permits interchanging one SRM product by another
- Multiple SRM implementations exist and are in production use
  - Particle Physics Data Grids
    - EGEE, OSG, …
  - Earth System Grid
  - More coming …
    - Combustion, Fusion applications
    - Medicine
- Cumulative experience in OGF GSM-WG
  - SRM v2.2 spec submitted – Sep. 2007
    - Entered 60-day public comment – Oct. 15, 2007

Documents and Support

- **SRM Collaboration and SRM Specifications**
  - http://sdm.lbl.gov/srm-wg
  - OGF mailing list : gsm-wg@ogf.org
  - Developer's mailing list: srm-devel@fnal.gov

- **BeStMan (Berkeley Storage Manager)**
  - http://datagrid.lbl.gov/bestman
- **CASTOR (CERN Advanced STORage manager)**
  - http://www.cern.ch/castor
- **DPM (Disk Pool Manager)**
  - https://twiki.cern.ch/twiki/bin/view/LCG/DpmInformation
- **dCache**
  - http://www.dcache.org
- **StoRM (Storage Resource Manager)**
  - http://storm.forge.cnaf.infn.it

- **Other info : srm@lbl.gov**