Storage Resource Management at Fermilab

Vanderbilt University
IBP/Grid Workshop (April 7-8, 2005)

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SRM Motivation (1)

Grid Architecture promises Reservation and Scheduling of the Following **Shared** Resources

- Computing Resources
- Network Resources
- Storage Resources (often neglected)

SRM provides Reservation and Scheduling of the Storage Resources

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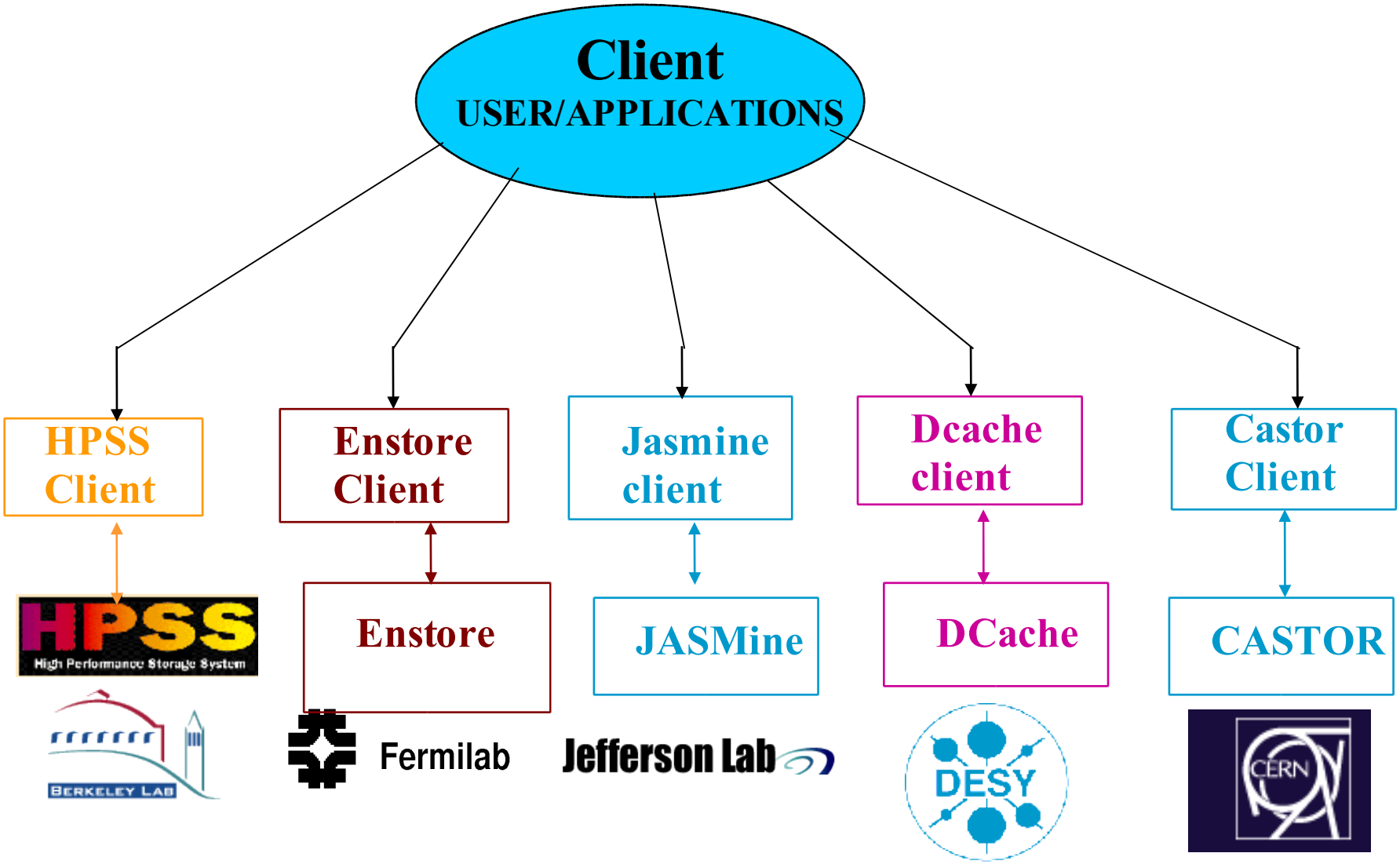
SRM Motivation (2)

High Energy Physics Collaborations span multiple institutions where

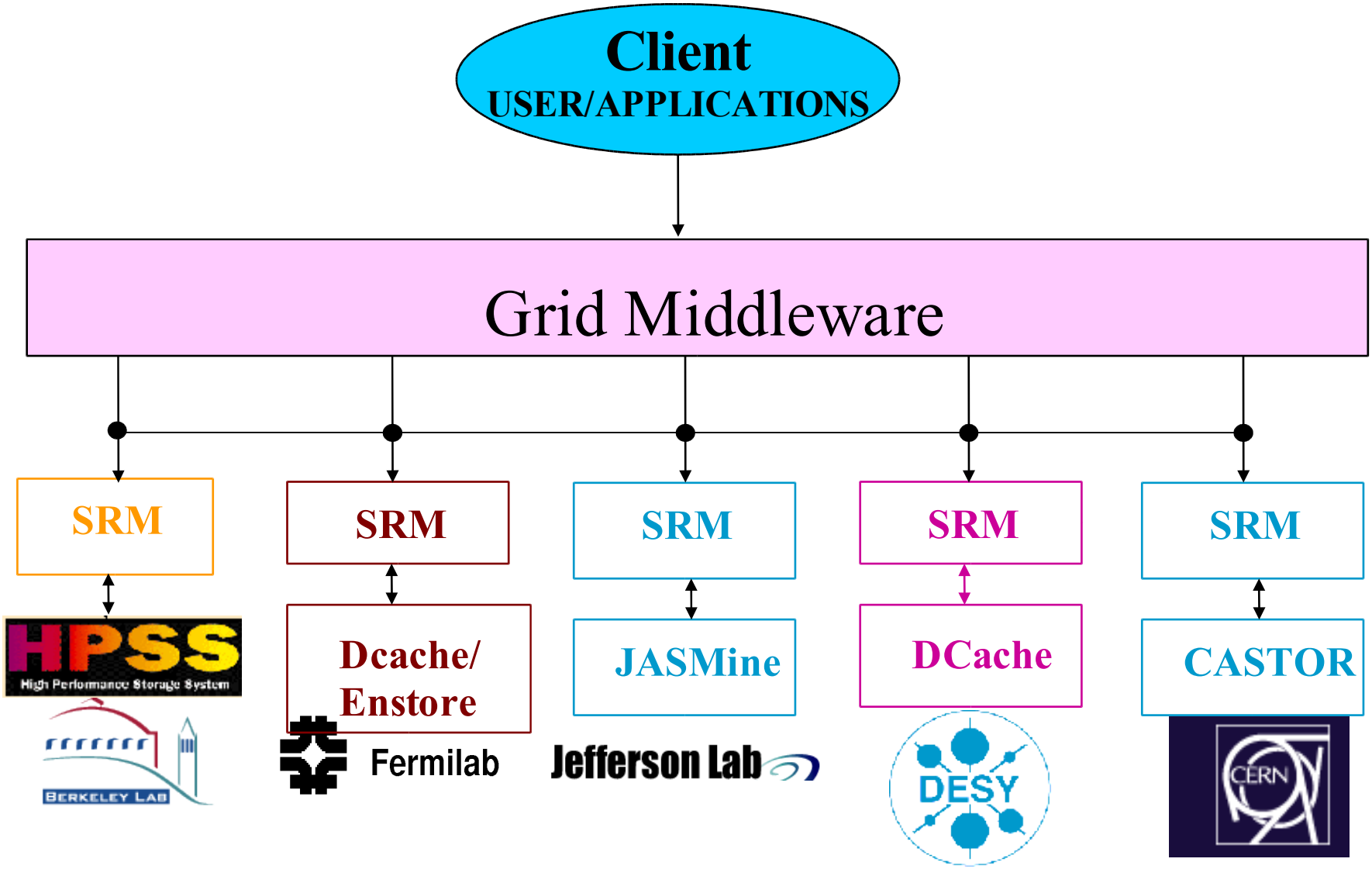
- A large variety of types of Storage Systems exist
  - Single Disk / Raid
  - Robotic Tape Storage System (Enstore, HPSS)
  - Distributed Disk Cache (dCache)
  - Hierarchical Storage System (dCache - Enstore)
- Heterogeneous environments and proliferation of custom Mass Storage Systems (MSSs) exist
- User applications often need to access data at multiple institutions on multiple MSSs

SRM provides Standardized Uniform Access to Heterogeneous Storage

Access to Multiple MSS



Uniform Access via SRM



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Storage Classification

Storage systems can be classified by:

- Persistence of data
  - Permanent
  - Temporary
- Data access availability
  - Data immediately available
  - Data needs advanced reservation before utilization (tapes need to be mounted, files need to migrate to disks, etc.)
- Supported transfer protocols
  - File transfer protocols
  - POSIX like access protocols

Need management interface that supports all of the above

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Storage Resource Managers

SRMs are middleware components that manage shared storage resources on the Grid and provide:

- Uniform access to heterogeneous storage
- File Transfer Protocol negotiation
- Dynamic Transfer URL allocation
- Access to permanent and temporary types of storage
- Advanced space and file reservation
- Reliable transfer services

Data life cycle on the grid overview

- Collection or generation
  - Data is collected from the CMS detector
  - Data generated by the analysis
- Storage
  - Data is stored on a shared storage system
- Registration
  - Data is registered in a Replica Catalog by via a Replica Registration Service (RRS)
- Replication
  - Data is replicated to a storage geographically close to the consumer
- Replica registration
  - RRS
- Delivery and consumption

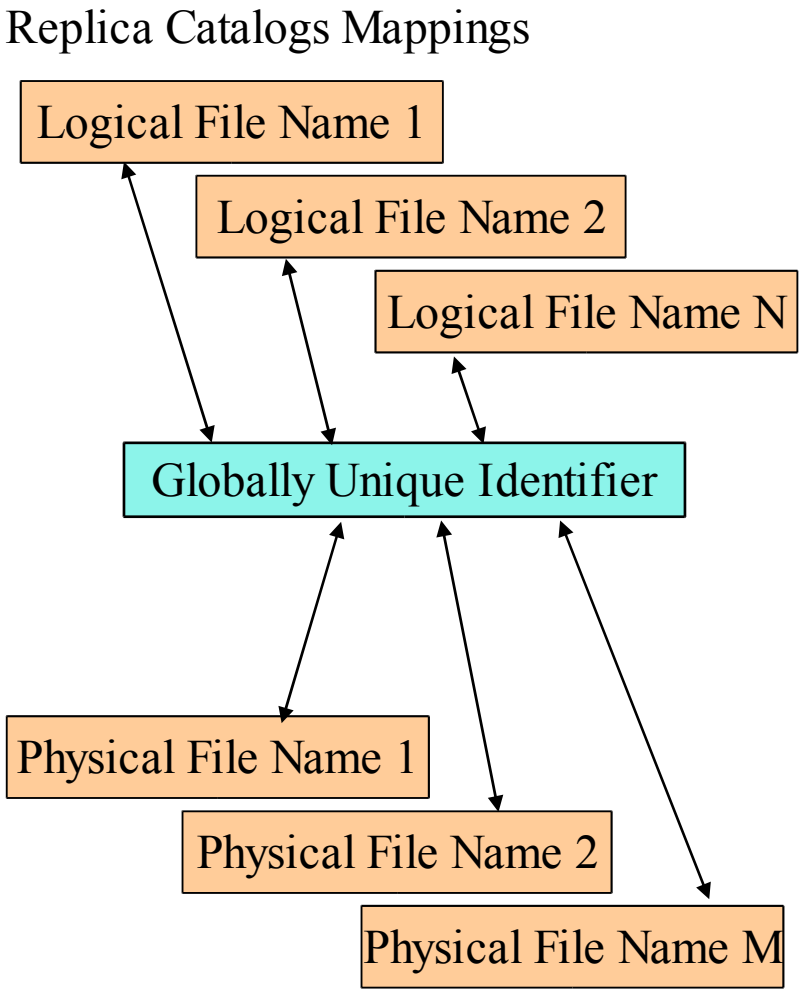
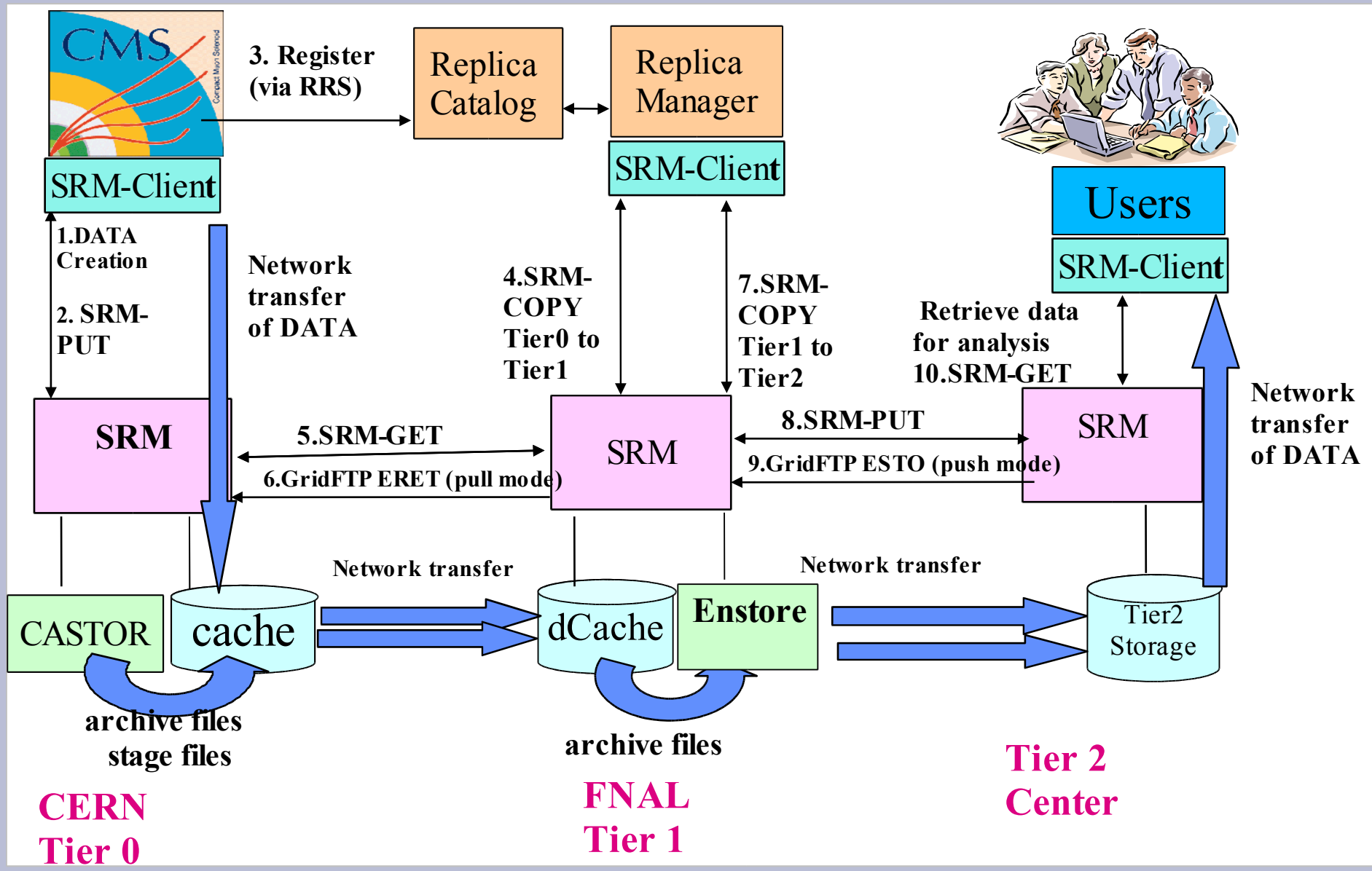


Illustration
US-CMS DATAGRID

- US-CMS is building a data grid to facilitate physics data analysis at academic institutions across the United States.
- Data grid 3 tier architecture.
  - Tier 0 CERN, Geneva, Switzerland.
  - Tier 1 consists of 5 regional centers, FERMILAB in Batavia, IL is a North American Center.
  - Tier 2 consists of 25 centres, 5 of these are in North America.
- SRM copy is used as a management protocol and reliable replication service for movement of data from tier 0 to tier 1 centers and from tier 1 to tier 2.

Data life cycle on the grid and a role of SRM on the GRID



Storage Resource Manager versions

- Two SRM Interface specifications
  - SRM v1.1provides
    - Data access/transfer
    - Implicit space reservation
  - SRM v2.1 adds
    - Explicit space reservation
    - Namespace discovery and manipulation
    - Access permissions manipulation
- Fermilab SRM implements SRM v1.1 specification
- SRM v2.1 by the end of 2004

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SRM Protocols and Groups of Functions

SRM interface consists of the following groups of functions:

- Space Management Functions – v2.1
- Data Transfer Functions – v1.1 and v2.1
- Directory Functions – v2.1
- Permission Functions – v2.1
- Status Functions – v1.1 and v2.1

SRM v2.1 in the rest of this talk

SRM Interface Details

Space Management Functions
- SrmReserveSpace
- SrmReleaseSpace
- srmUpdateSpace
- srmCompactSpace
- srmGetSpaceMetaData
- srmChangeFileStorageType
- srmGetSpaceToken

Directory
- SrmMkdir
- srmRmdir
- srmRm
- srmLs
- srmMv

Data transfer functions
- srmPrepareToGet
- SrmPrepareToPut
- srmCopy
- SrmRemoveFiles
- srmReleaseFiles
- srmPutDone
- srmAbortRequest
- srmAbortFiles
- srmSuspendRequest
- srmResumeRequest

Status Functions
- srmStatusOfGetRequest
- srmStatusOfPutRequest
- srmStatusOfCopyRequest
- srmGetRequestSummary
- srmExtendFileLifeTime
- SrmGetRequestID

Permission
- srmSetPermission
- srmReassignToUser
- srmCheckPermission

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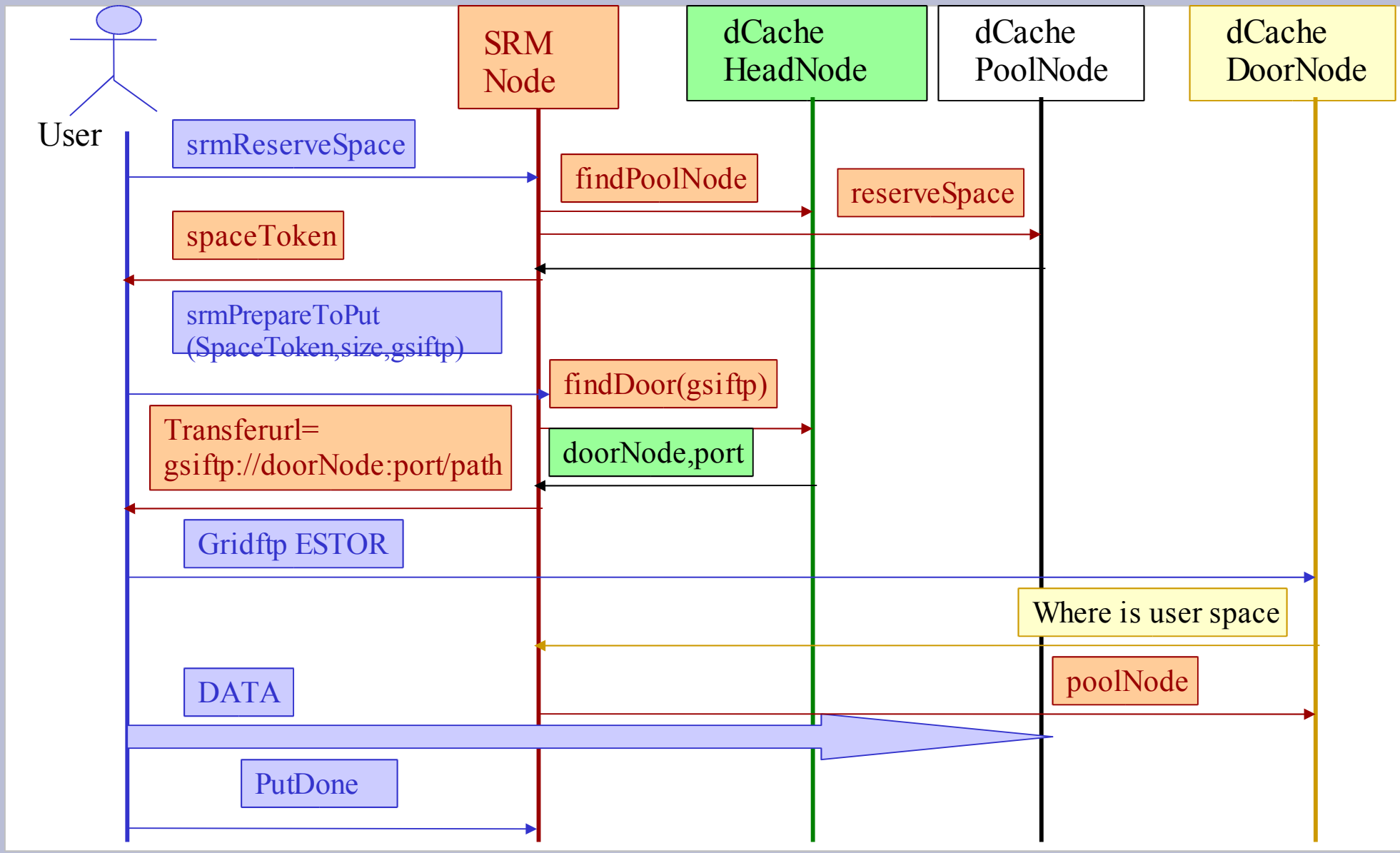
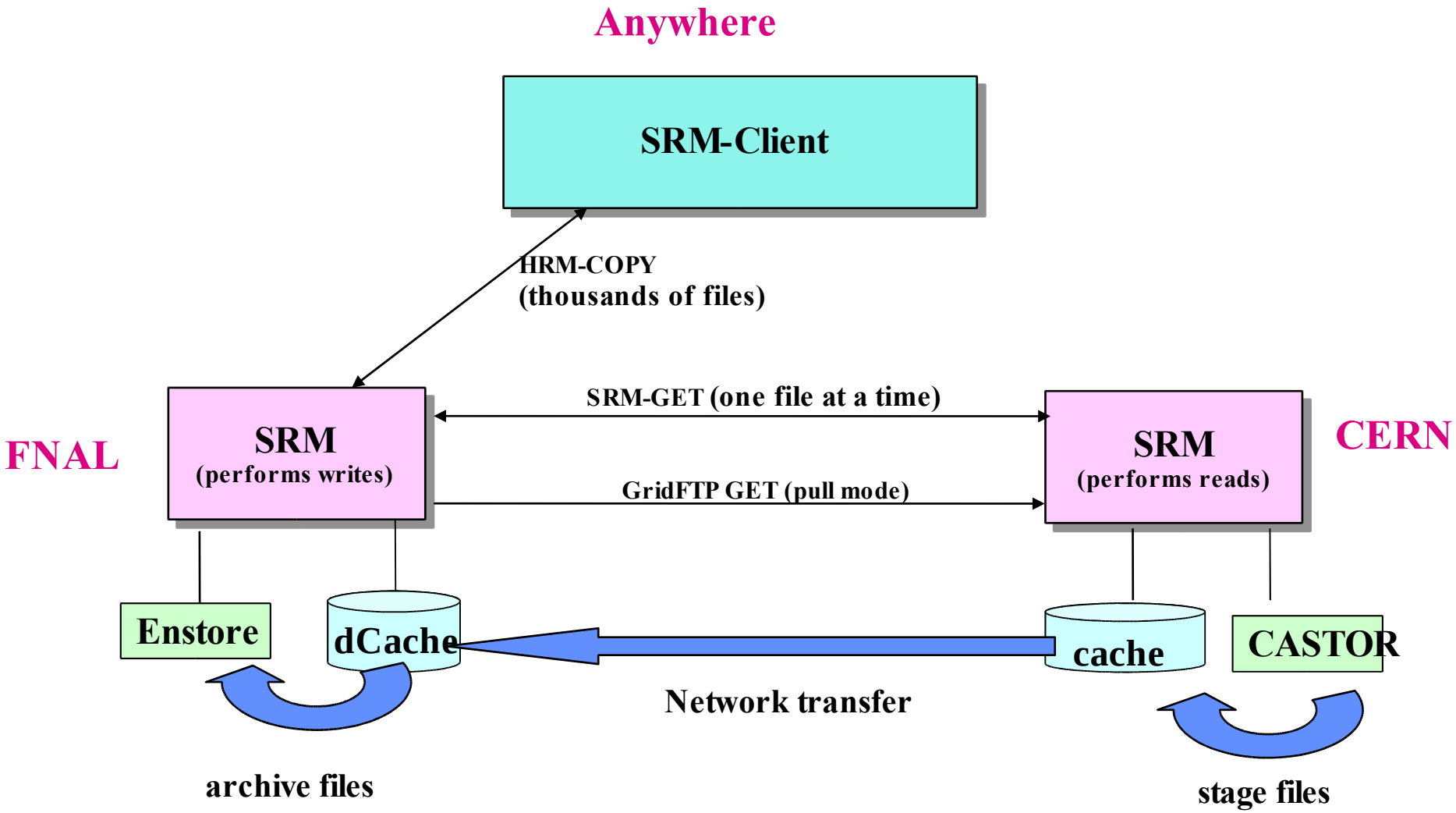
Srm Example 1 - srmPrepareToPut



Srm Example - Robust Replication



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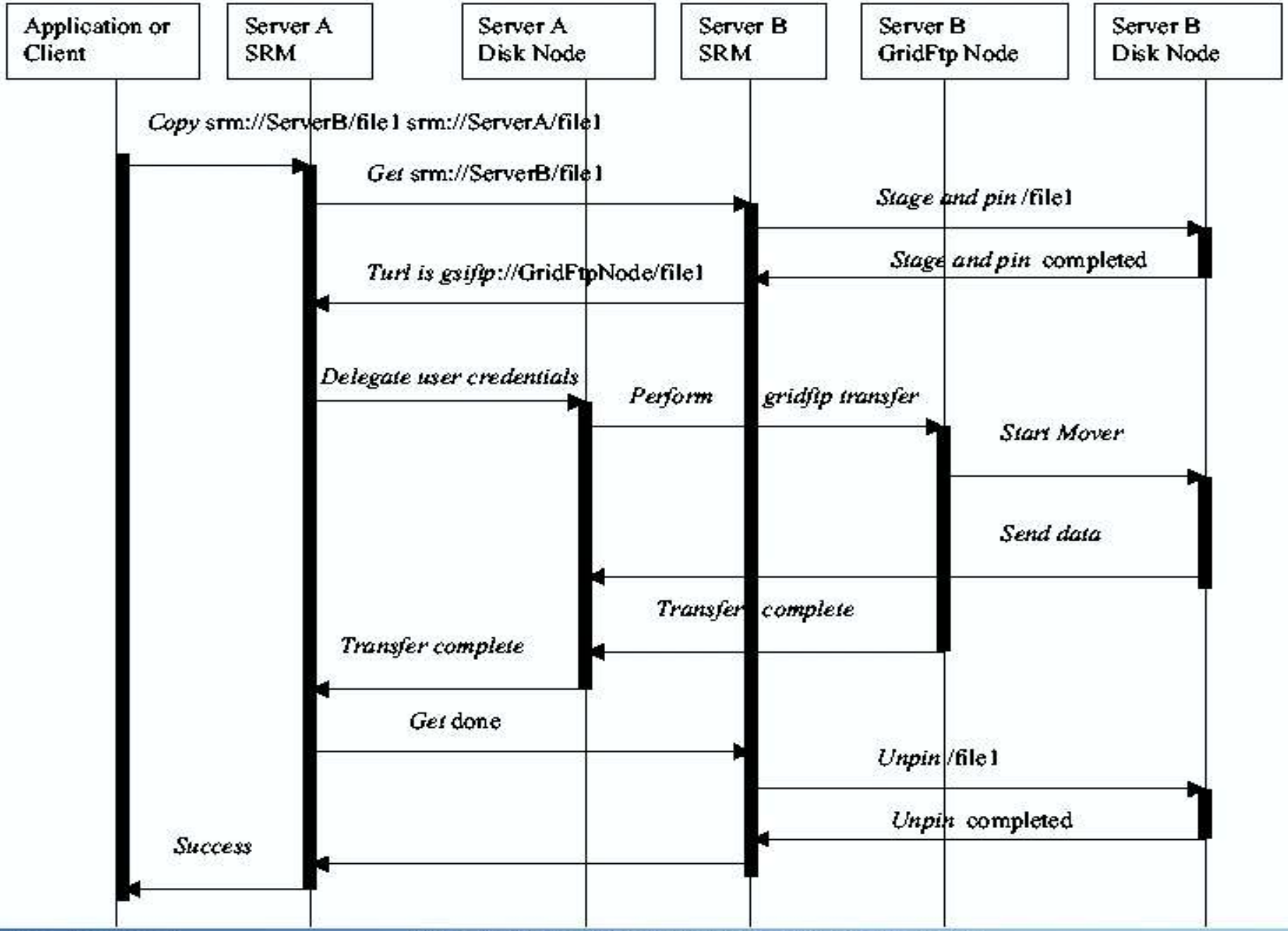
The sequence diagram of the SRM Copy Function performing "Copy srm://ServerB/file1 srm://ServerA/file1"



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Features and Plans

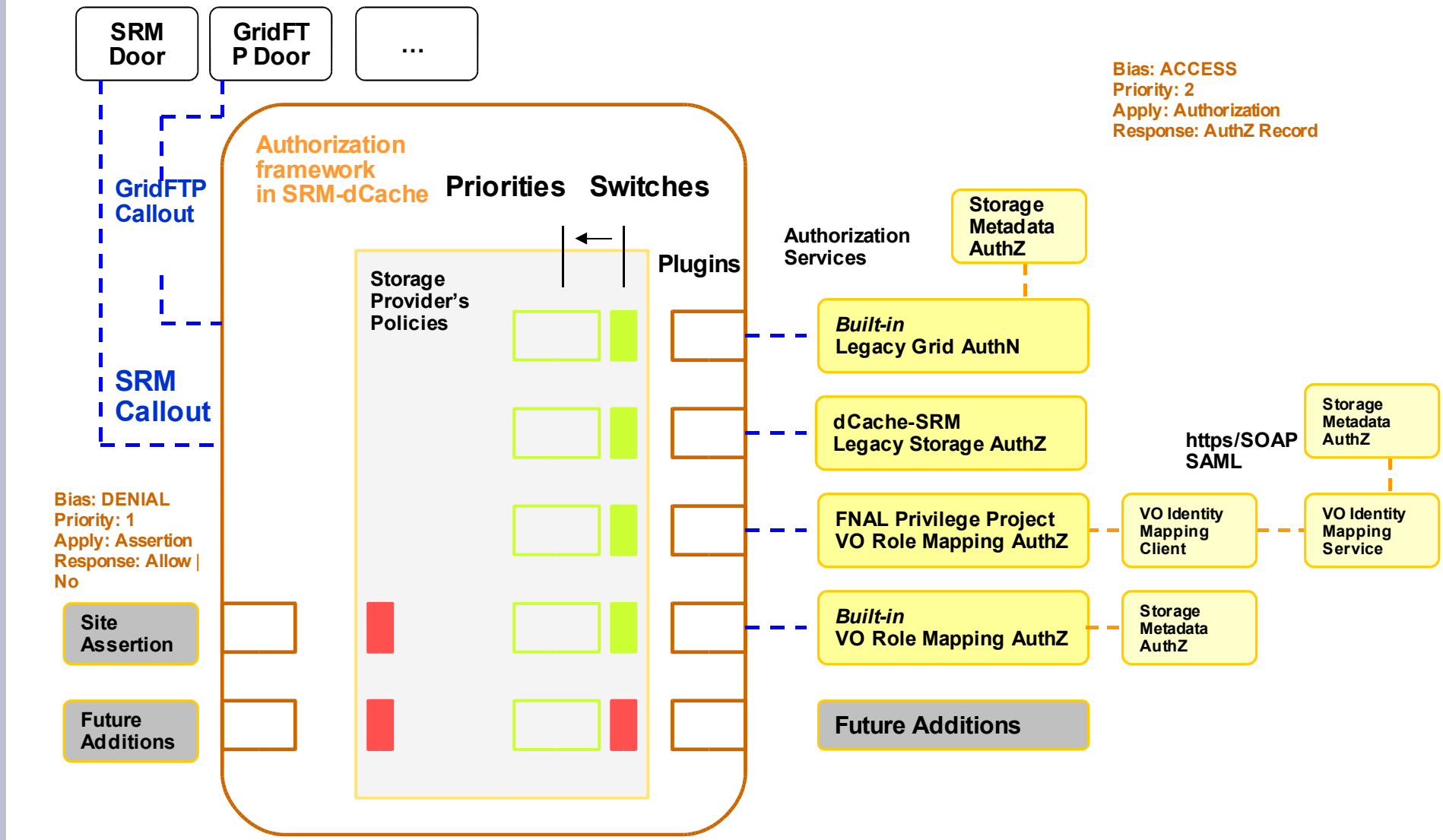
- Implicit Space Reservation: Initial version deployed. More to do.
  - Space reserved for a single file transfer, implicit in get/put/copy.
  - Reservation is not long-term, but just for time of transfer.
- SRM V2.1 API: Prototyped. Initial version being developed.
  - First feature we will deploy: srm-ls. High priority for our clients.
  - Expect this to be ready in 1-2 months, features released as available.
- Auditing, Accounting, Monitoring: SRM schema is "growing".
  - Already have GRIS-GIIS path working: total space and space used.
  - Will coordinate with parallel efforts to define initial schema.
  - Need SRM DB interface, query tools, path to MonAlisa for full A&A.
- Broader Client Shell Toolset: Depends on our V2.1 API work
  - V1.1 tools already in LCG dCache distribution (Michael Ernst)
  - Preparing for distribution of V1.1 tools in OSG channel as well.

Features and Plans 2

- VO Authorization Module Integration: Work done by Abhishek Singh Rana in context of SRM-dCache.
  - Pluggable Authorization Mechanism architecture
  - Priorities and switches allow fine-tuning of authorization policy
  - Integrated with Site-Wide VO Authorization Service
  - This is the long-term Grid solution, adapting to existing practice. US-CMS T1 uses scripts and VO tools now, until this is ready.
  - Discussions begun: mapping high-level storage authorization policies to performant low-level mechanisms (ACLs, ...)
- Storage Authorization is superset of existing VO Authorization
  - Some storage systems (dCache, ...) need to know "where" in the SE namespace that a username-role is authorized to work, for instance.
  - Critical in a multi-VO SE, but still important in a VO-specific SE. One physics group should not be able to affect another's data storage.

VO Authorization Module Architecture

(slide by Abhishek Singh Rana)



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Resources

- FNAL SRM implementation proven in field
  - SRM-dCache for US-CMS T1 was successful in SC2
- FNAL SRM at API V1.1, going to V2.1
  - More features, functionality in 1-2 months
- Planning for wider use: SRM service, SRM client shell tools
  - SRM-dCache use is expanding: LCG, US-CMS, OSG channels.
  - Can be used with other storage systems too.
  - Expanding staff, and "external" contributors welcome (open source).
- *"Storage is hard."*
  - Storage maintains state where compute worker nodes do not.
  - Access to storage meta-data must be performant, not just access to data.
- *"Agree to APIs and protocols, compete on implementations."*
  - Healthy variety of storage solutions here at workshop. Customers win! 8^)
- FNAL-SRM link: http://www-isd.fnal.gov/srm