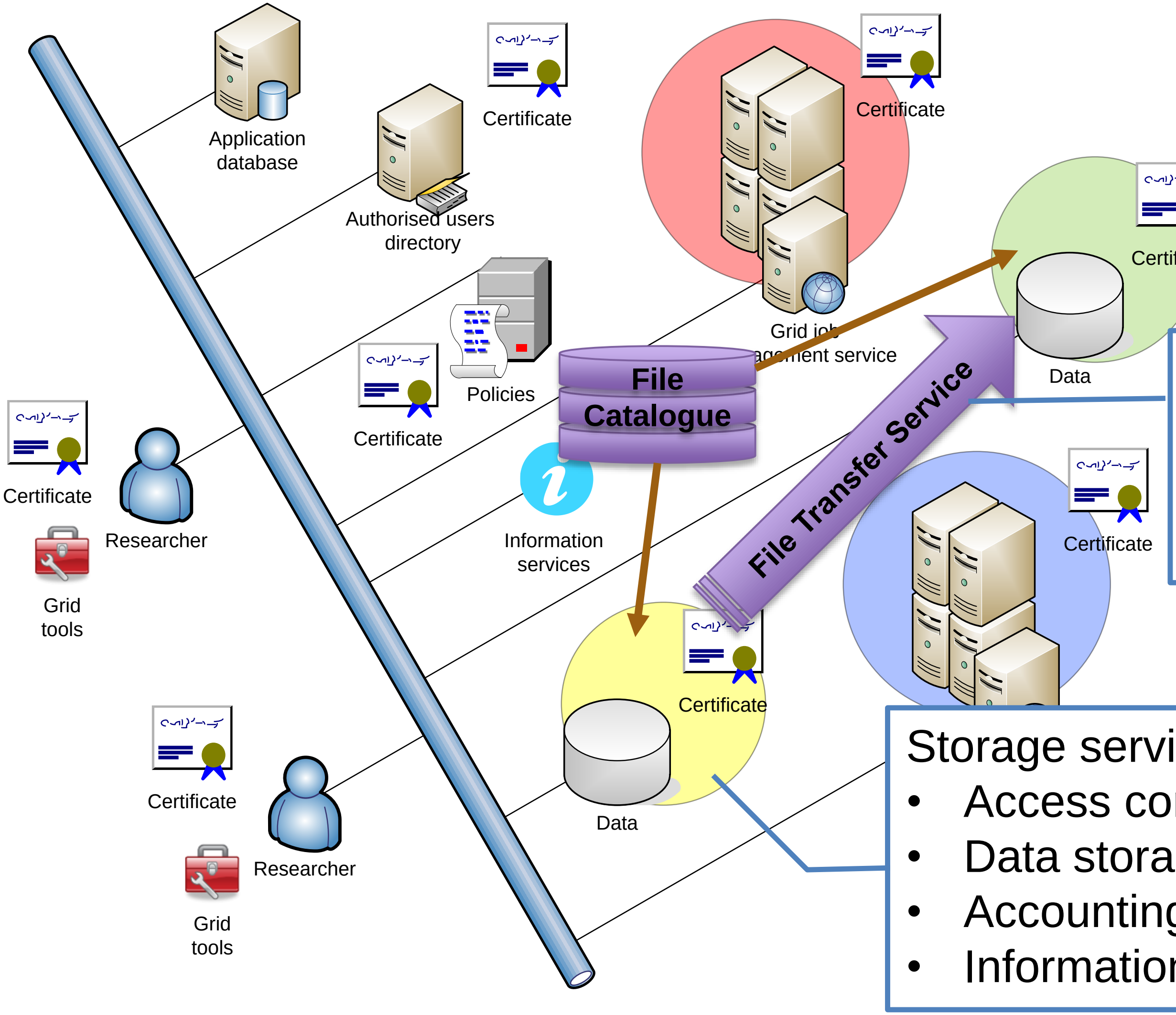
Scientific data management

Storage and data management components



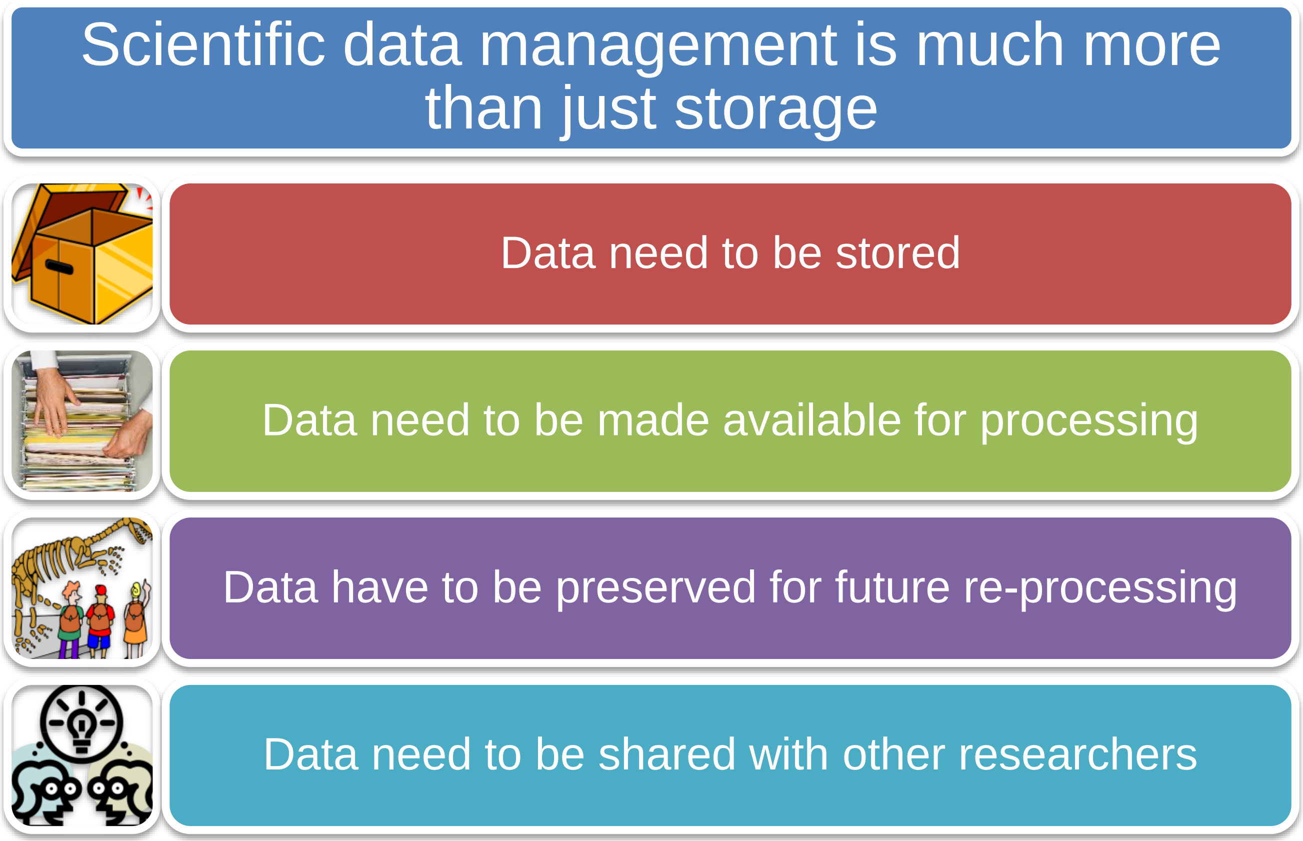
Special data management components:

- File catalogue
- File transfer service

Storage services deal with:

- Access control
- Data storage
- Accounting
- Information

More than just storage



Scientific data management is much more than just storage

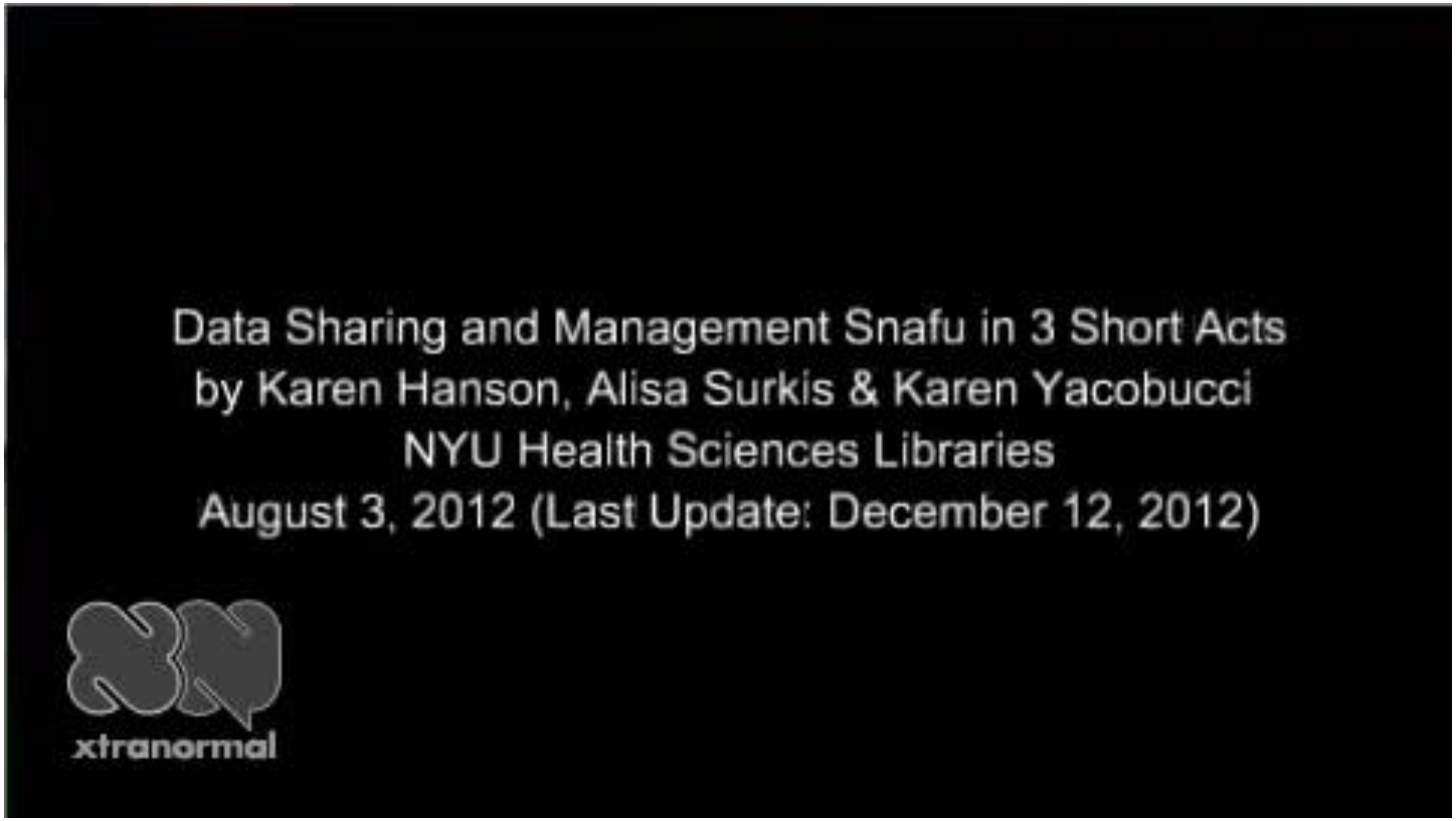
Data need to be stored

Data need to be made available for processing

Data have to be preserved for future re-processing

Data need to be shared with other researchers

Data management on YouTube (by NYU)



Data Sharing and Management Snafu in 3 Short Acts
by Karen Hanson, Alisa Surkis & Karen Yacobucci
NYU Health Sciences Libraries
August 3, 2012 (Last Update: December 12, 2012)

Storage requirements

- Large enough storage is needed
  - From Gigabytes for some to Petabytes for some others
- Large enough bandwidth between the apparatus, storage, data processing facility and the user
  - Terabits per second these days
- Controlled write, read and list access
  - From password to certificates and VOs to federated identities
- Encryption: for data, or transfer, or both, or none
- Adequate space management
  - quotas, space recovery utilities
- Transfer, replication and migration tools
  - Per file, per logical group, per database

Storage requirements (continued)

- Backup
  - a large range of requirements: from basic RAID to multiple replicas, local and remote, tapes or other media, with recovery of older versions in case of accidental modifications etc
- Indexing of what is stored
  - From basic POSIX information listing to metadata catalogs, adequately protected from unauthorised access
- Logical organization in terms of metadata-based grouping
  - possibly reflected in physical grouping for optimization
- Monitoring and statistics collection (accounting)
  - Various usage parameters as a function of time, access monitoring and such - all protected from unauthorised access

Data processing requirements

- Accessibility of data from a computing resource
  - streaming and/or caching
  - copying for a direct access: single files, logical groups, per job or per site
  - querying in case of databases
- Persistent and unique identifiers
  - per file, per logical group, per database and such
- Mechanisms to match/resolve identifiers to physical addresses
  - For streaming, copying, querying and such
- Well-defined (formalized) data formats/structures and tools for conversion between (at least some of) them

Preservation requirements

- Continuous storage upgrade and media migration
- Identifiable authorship of the data
    - per file, logical group, database etc
- Provenance information
    - original data taking conditions, possible modifications, changes of ownership, changes of access rights etc
- Preservation of data format description
    - possibly encapsulated in data

Preservation requirements (continued)

- Preservation of processing algorithms and/or workflows
- Preservation of computing environments used to produce or process the data
- Preservation of metadata
- Preservation of accessibility:
  - if possible, preservation of protocols
  - when protocols change, consistent re-mapping of data identifiers to new protocols
  - long-term access rights management: granting write access to curators, migration to new AAI technologies, revoking access rights of non-authorized individuals, opening up for public read and list access

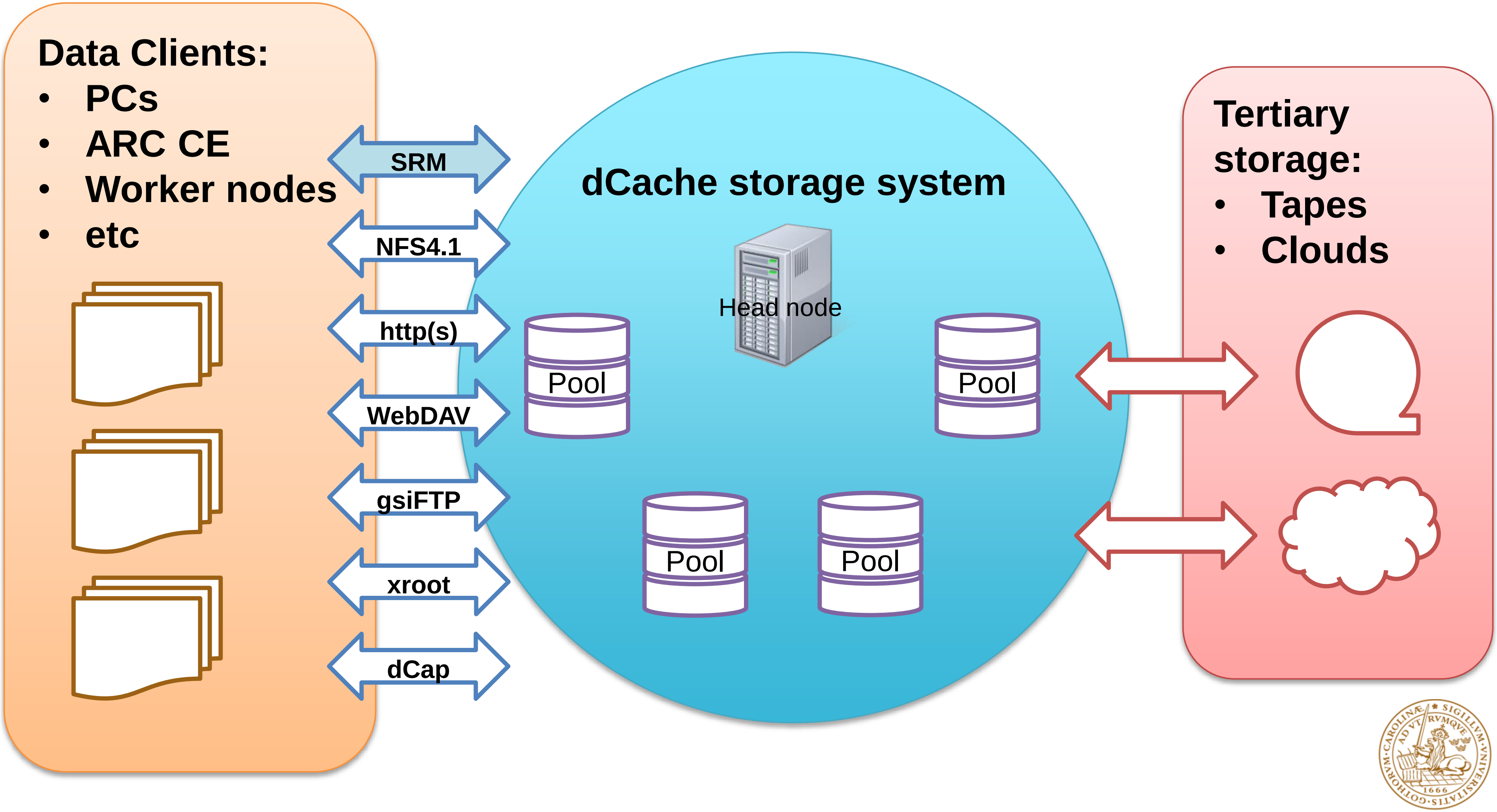
Sharing requirements

- Access control managed by authorized users
  - From dedicated managers for large research groups, to individual researchers who produce the data
- Networked access via industry-standard protocols and means
  - like http/webdav today, remotely mounted or synched file systems, etc
- Discovery tools relying on metadata
  - Including authorship, provenance and other info
- Upload tools
  - From simple copy or file-by-file transfer, to portals and other utilities dealing with logical groups, databases etc

What does Grid offer today for data management

- **Storage Elements (SE)**
  - Disk/tape storage pools managed by storage middleware (e.g. **dCache**)
    - » Internal space management, shares, some backup etc
    - » Grid access control
    - » Storage federation (common name space across different SEs)
    - » Accounting and information
- File transfer service (**FTS** by EMI)
- Data and metadata indexing services
  - Simple file catalogue (**LFC** by EMI)
  - Application-specific metadata catalogues
    - » Attempts to create generic catalogues failed
- Client tools for the above

dCache storage solution



Data Clients:

- PCs
- ARC CE
- Worker nodes
- etc

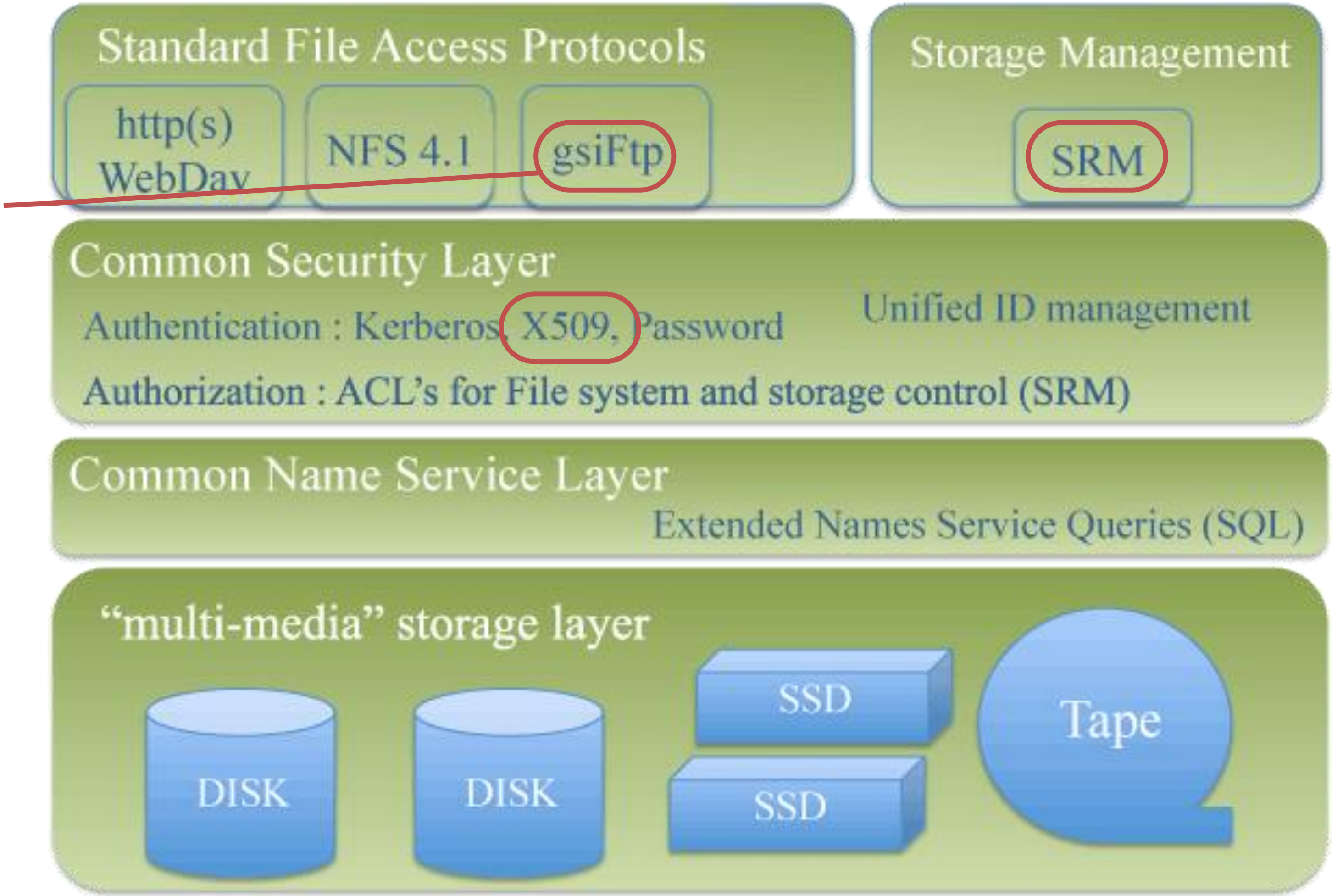
dCache storage system

Tertiary storage:

- Tapes
- Clouds

Graphics adapted from Patrick Fuhrmann

dCache details



a.k.a GridFTP

Standard File Access Protocols

http(s) WebDav

NFS 4.1

gsiFtp

Storage Management

SRM

Common Security Layer

Authentication : Kerberos, X509, Password

Unified ID management

Authorization : ACL's for File system and storage control (SRM)

Common Name Service Layer

Extended Names Service Queries (SQL)

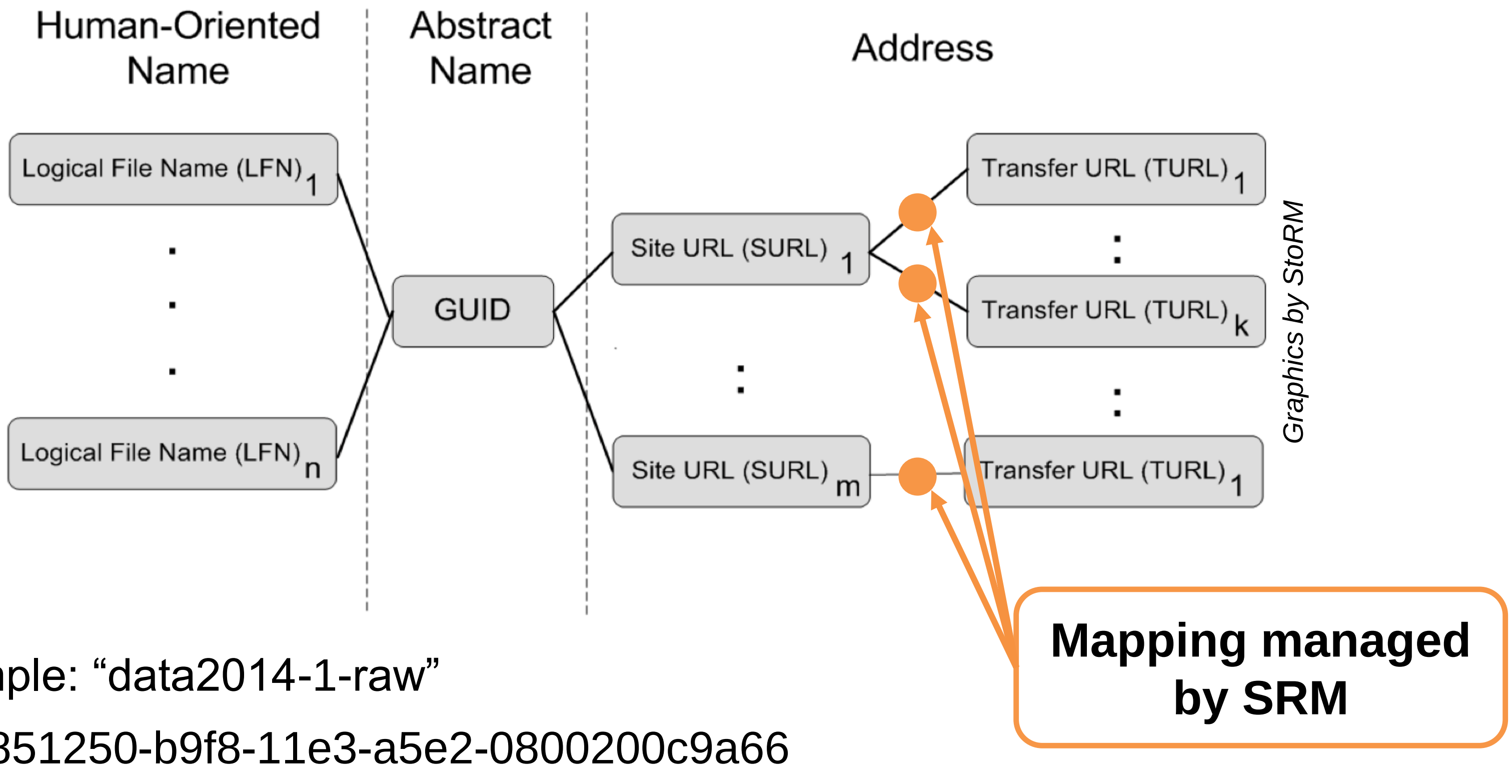
"multi-media" storage layer

Graphics by Patrick Fuhrmann

Story of Storage Resource Manager (SRM)

- The first Grid standard
  - Introduced as an abstraction on top of the multitude of transfer protocols (gsiFTP, https etc)
- SRM-enabled service is meant to provide:
  - Transfer protocol negotiation
  - Dynamic Transfer URL allocation
  - Uniform access to heterogeneous storage, access permissions
  - Access to permanent and temporary types of storage
  - Space reservation
  - Reliable transfer services
- The specification was never implemented to a full extent
  - Gradually losing importance, as https starts to dominate

Grid file names



Mapping managed by SRM

- LFN example: “data2014-1-raw”
- GUID: 26851250-b9f8-11e3-a5e2-0800200c9a66
  - Globally Unique Identifier; can denote a dataset or a single file
- SURL: **srm**://dcache.swegrid.se/lund/astro/data2014-1-raw.xls
- TURL: https://server5.liu.se/pool3/12nsd3/data2014-1-raw.xls

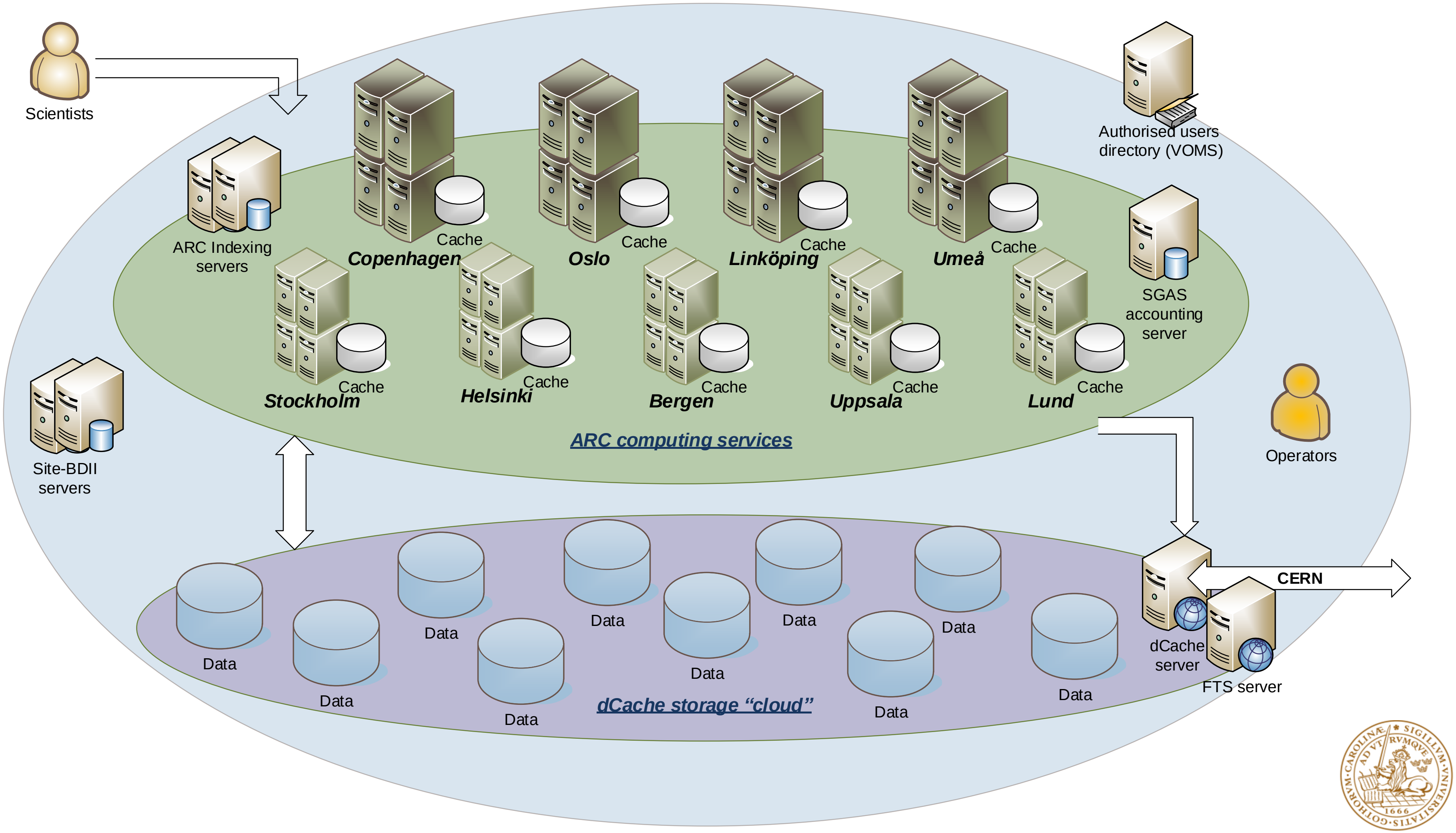
Some other data management services

- LHC File Catalogue (LFC)
  - – maps LFNs to GUIDs to SURLs
  - – Can store some file metadata (size, checksum etc)
    - » *metadata*: data about data
- File Transfer Service (FTS)
  - – Performs massive file transfers between Storage Elements on behalf of Grid users
  - – Makes use of X509, SRM, GridFTP, https
- Both LHC and FTS are rarely used outside CERN
  - – Are designed for handling very large amounts of files

ARC data management tools

- ARC comes with a set of basic file management tools
  - Use X509 Grid security
  - Support most known protocols, including SRM
    - » Can also interact with LFC and some area-specific data catalogues
  - Can not interact with FTS, neither can be used for storage management
- Commands:
  - **`arcls, arccp, arcrm, arcmkdir`**

Nordic Grid infrastructure: distributed storage



SweStore uses Grid technologies

- **SweStore** is a Swedish national long-term storage for various researchers
  - http://snicdocs.nsc.liu.se/wiki/SweStore
- Has storage pools distributed over several centers
  - Part of it in LUNARC; central services – in Linköping
- Uses dCache, and recently – iRODS
  - iRODS stands for Integrated Rule-Oriented Data System
    - Provides higher-level functionality than dCache (can use dCache as storage)
    - Makes no use of Grid Security Infrastructure
- Practically any research group in Sweden can apply for a storage space at SweStore
  - Some groups have dedicated storages within SweStore

Exercises

- Goals: use **`arc*`** command line tools to upload/download files
  - Start: browse SweStore using a regular browser (**requires certificate in the browser**) https://webdav.swestore.se/nordugrid

  -
    ```
    arcproxy –S nordugrid.org:/nordugrid.org/tutorial/Role=student
    ```

  -
    ```
    arcls gsiftp://gsiftp.swestore.se/nordugrid/tutorial
    ```

  -
    ```
    arcls –l gsiftp://gsiftp.swestore.se/nordugrid/tutorial
    ```

  -
    ```
    arcls --metadata
    gsiftp://gsiftp.swestore.se/nordugrid/tutorial/ARC-logo.png
    ```

  -
    ```
    arccp --recursive=999
    gsiftp://gsiftp.swestore.se/nordugrid/tutorial/xrsl/ xrsl/
    ```
  - **The following should fail:**
    - » ```
      arcmkdir gsiftp://gsiftp.swestore.se/nordugrid/tutorial/newdir
      ```
    - » ```
      arcrm gsiftp://gsiftp.swestore.se/nordugrid/tutorial/ARC-logo.png
      ```

Exercises

- For advanced students: try to install ARC Graphical Clients from http://sourceforge.net/projects/arc-gui-clients/
  - Needs **`cmake`**, **`libqt4-dev`** and **`nordugrid-arc-dev`**
- For those who did not manage to submit jobs last time, use the downloaded **`.xrsl`** files to do so:
  - **`arcsub -c arc-iridium.lunarc.lu.se hello_grid.xrsl`**
  - **`arcls <jobID>`**
  - **`arcstat <jobid>`**