Karlsruhe Institute of Technology

dCache

dCache Beginners Course
Introducing dCache

An overview to dCache and how it is deployed in grid environments.

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Storage Management Systems

- dCache is a so called *storage management system*
- Storage management systems are characterised by the following main attributes:
  - Manage much higher amounts of data/files like “normal” filesystems (for example btrfs, ext4 or XFS) do, but usually on a much higher logical level.
  - Integrate many storage media that can be of different type into one system by utilising *Hierarchical Storage Management* (HSM), e.g. disks in front of a tape archival system.
  - Provide mechanisms to automatically balance the load (e.g. auto-replication), ensure resilience and high availability and means for advanced control systems to manage the data as well as the data flow.
  - Supports several access-protocols (e.g. POSIX or grid protocols like SRM)

Overview And History

- dCache is a highly sophisticated storage management system written in Java.
- It is being actively developed at Deutsches Elektronen-Synchrotron (DESY) since 2003. Major contributions come from Fermi National Accelerator Laboratory (FNAL) and Nordic Data Grid Facility (NDGF).
- It is one of the main storage management systems used within the European Middleware Initiative (EMI), the Worldwide LHC Computing Grid (WLCG) and in many other places.
- It uses standard open source technologies in several places.
- Support is provided by the developers and dedicated support groups. Communication is done mainly via mailing lists.

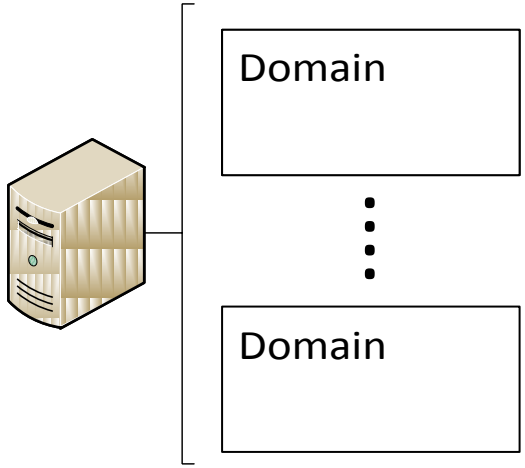
Functionalities And Features

- Detailed logging and debugging as well as accounting and statistics.
- XML information system with detailed live information about the cluster.
- Web-interface with live summaries of the most important information.
- Checksumming of data.
- Resilience and high availability can be automated in different ways.
- Powerful cost calculation is consulted in matters of data flow control (from and to pools, between pools and also between pools and tape) load balancing and performance tuning.
- Garbage collection of replicas, depending on their flags, age, et cetera.
- Space management and support for space tokens.

This course does not cover the HSM-capabilities ("writing to tape") of dCache.

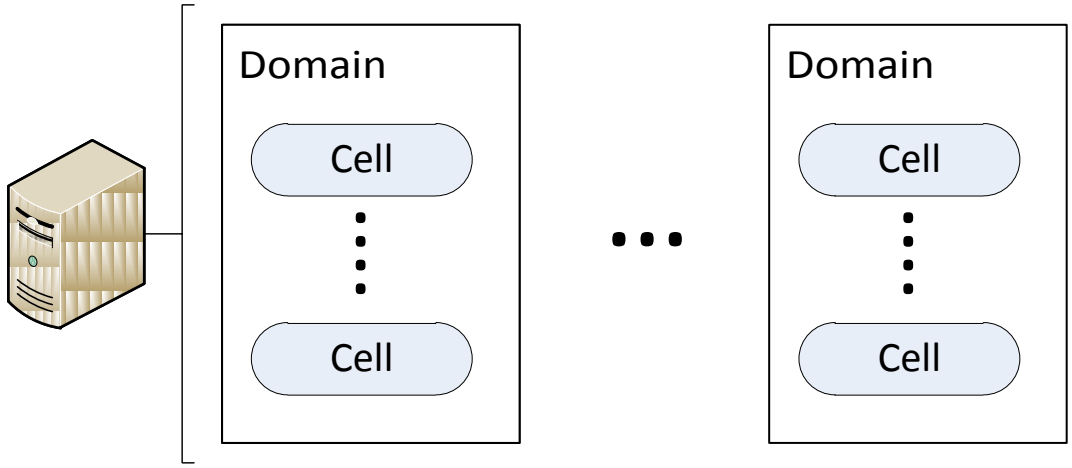
dCache's structure

- A dCache cluster is structured by the following three classes of objects:
  1. Domains
     - Each domain corresponds to exactly one Java VM and is thus bound to exactly one node of the cluster.
     - Nodes can generally run multiple domains.
     - A domain groups cells together.



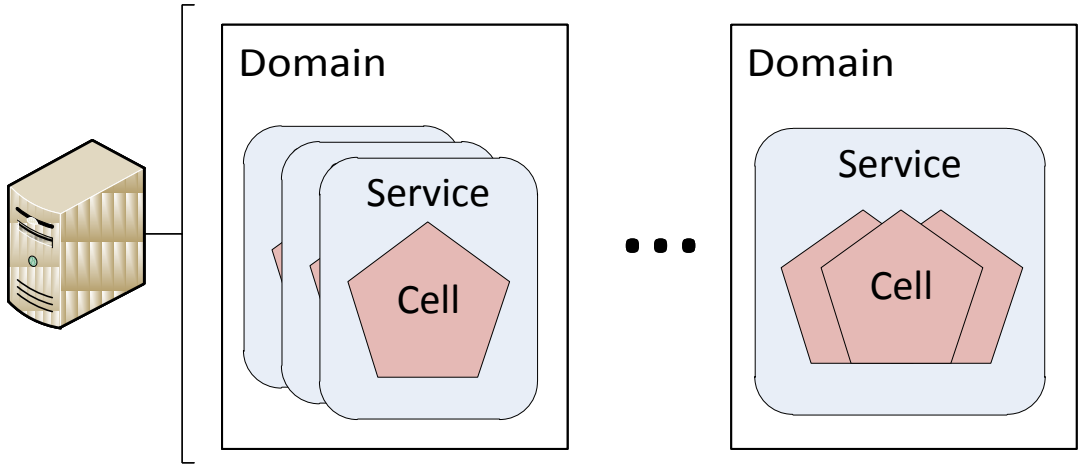
dCache's structure

2. Cells
   - A cell is the entity that provides services.
   - Every cell is always a member of exactly one domain.
   - Depending on the cell-type there may be multiple instances per cluster, possibly each running with different settings.



dCache's structure

3. Services
   - A service is provided by one or more cells (possibly from different domains).
   - Depending on the service-type there may be multiple instances per cluster, possibly each running with a different set of settings.
   - Some services require several cells to run properly.



About Cells And Services

- “Core”-services and –cells
  - Implement basic, common and central functionality.
  - Often these kind of cells/services are singular throughout a dCache setup.
- “Door”-services and -cells
  - Serve as gateways to the data stored in dCache.
  - Protocol specific.
  - Multiple doors allow for load balancing.
    - Setting up more than one SRM door should be done only by experts.
- “Pool”-services and -cells
  - Manage the actual data stored in dCache.
  - Of course, many pools are allowed in one dCache setup.
- There are a couple of additional cells/services, that are not vital to a functional dCache installation.

Supported Access Protocols

- NFS 3 – limited access to the file hierarchy and file meta data over network.
- NFS 4.1 (pNFS) – “full” network filesystem access.
- WebDAV – a superset of HTTP.
- gsi-/DCAP - *dCache Access Protocol* is dCache’s original and native access protocol, possibly GSI-secured.
- gsi-/FTP – the *File Transfer Protocol*, also in a GSI-secured fashion (a.k.a. GridFTP).
- xroot – the protocol from xrootd, the *eXtended ROOT Daemon*.
- SRM – *Storage Resource Manager* is a meta-protocol targeted at storage management systems, including many specific features like space tokens, lifetime and pinning. For the actual data transport another transfer-protocol (like GridFTP or gsiDCAP) is used.

File Hierarchy Provider

- dCache gathers all files in a traditional file hierarchy, which allows files being identified by (path-)name.
- For this a name space abstraction layer on top of a relational database called *Chimera* is used.
- Internal to dCache, files are identified by unique *PNFS-ID*s and Chimera keeps track of the mapping pathname ↔ PNFS-ID.
- Chimera also manages file's storage information and meta data, e.g. actual location in pools, replicas, creation time, POSIX file permission modes, etc.
- The cell offering the services to interact with Chimera in dCache is called the *PnfsManager*.
- The NFS 3 or NFS4.1 door services are there to allow NFS-mounts of the name space hierarchy.

dCache Setup On Clusters

- Thanks to the modular build of dCache, the cells can almost freely be grouped or separated in domains as desired.
- Everything is possible between the two extremes.
  - Having all cells running in a sole domain on one single machine, or
  - letting every cell run in its own domain on a dedicated machine.
- Typically, the first core services that are granted dedicated hardware are the SRM service and PnfsManager. All other services are somewhat lightweight and can be grouped on one host.
- Usually, the doors are next to be set up on dedicated machines.
- Pools are running on machines that are capable of managing heavy I/O to disk and via network.
- In order to ease the administration it is generally beneficial to run services/cells each in an own domain (as long as there is enough RAM to spend).
  - This way, every service can be restarted independently from the others

First Chapter Completed!

- Are there any questions?