Operating System

Lecture 21: Distributed File Systems

Manoj Kumar Jain

M.L. Sukhadia University Udaipur

Outline

- Background
- Naming and Transparency
- Remote File Access

Background

- Distributed file system (DFS) – a distributed implementation of the classical time-sharing model of a file system, where multiple users share files and storage resources.
- A DFS manages set of dispersed storage devices
- Overall storage space managed by a DFS is composed of different, remotely located, smaller storage spaces.
- There is usually a correspondence between constituent storage spaces and sets of files.

DFS Structure

- **Service** – software entity running on one or more machines and providing a particular type of function to a priori unknown clients.
- **Server** – service software running on a single machine.
- **Client** – process that can invoke a service using a set of operations that forms its *client interface.*
- A client interface for a file service is formed by a set of primitive *file operations* (create, delete, read, write).
- Client interface of a DFS should be transparent, i.e., not distinguish between local and remote files.

Naming and Transparency

- *Naming* – mapping between logical and physical objects.
- Multilevel mapping – abstraction of a file that hides the details of how and where on the disk the file is actually stored.
- A *transparent* DFS hides the location where in the network the file is stored.
- For a file being replicated in several sites, the mapping returns a set of the locations of this file's replicas; both the existence of multiple copies and their location are hidden.

Naming Structures

- **Location transparency** – file name does not reveal the file's physical storage location.
  - File name still denotes a specific, although hidden, set of physical disk blocks.
  - Convenient way to share data.
  - Can expose correspondence between component units and machines.
- **Location independence** – file name does not need to be changed when the file's physical storage location changes.
  - Better file abstraction.
  - Promotes sharing the storage space itself.
  - Separates the naming hierarchy form the storage-devices hierarchy.

Naming Schemes — Three Main Approaches

- Files named by combination of their host name and local name; guarantees a unique systemwide name.
- Attach remote directories to local directories, giving the appearance of a coherent directory tree; only previously mounted remote directories can be accessed transparently.
- Total integration of the component file systems.
  - A single global name structure spans all the files in the system.
  - If a server is unavailable, some arbitrary set of directories on different machines also becomes unavailable.

Remote File Access

- Reduce network traffic by retaining recently accessed disk blocks in a cache, so that repeated accesses to the same information can be handled locally.
  - If needed data not already cached, a copy of data is brought from the server to the user.
  - Accesses are performed on the cached copy.
  - Files identified with one master copy residing at the server machine, but copies of (parts of) the file are scattered in different caches.
  - *Cache-consistency* problem – keeping the cached copies consistent with the master file.

Cache Location – Disk vs. Main Memory

- Advantages of disk caches
  - More reliable.
  - Cached data kept on disk are still there during recovery and don't need to be fetched again.
- Advantages of main-memory caches:
  - Permit workstations to be diskless.
  - Data can be accessed more quickly.
  - Performance speedup in bigger memories.
  - Server caches (used to speed up disk I/O) are in main memory regardless of where user caches are located; using main-memory caches on the user machine permits a single caching mechanism for servers and users.

Cache Update Policy

- **Write-through** – write data through to disk as soon as they are placed on any cache. Reliable, but poor performance.
- **Delayed-write** – modifications written to the cache and then written through to the server later. Write accesses complete quickly; some data may be overwritten before they are written back, and so need never be written at all.
  - Poor reliability; unwritten data will be lost whenever a user machine crashes.
  - Variation – scan cache at regular intervals and flush blocks that have been modified since the last scan.
  - Variation – *write-on-close*, writes data back to the server when the file is closed. Best for files that are open for long periods and frequently modified.

Consistency

- Is locally cached copy of the data consistent with the master copy?
- Client-initiated approach
  - Client initiates a validity check.
  - Server checks whether the local data are consistent with the master copy.
- Server-initiated approach
  - Server records, for each client, the (parts of) files it caches.
  - When server detects a potential inconsistency, it must react.

Comparing Caching and Remote Service

- In caching, many remote accesses handled efficiently by the local cache; most remote accesses will be served as fast as local ones.
- Servers are contracted only occasionally in caching (rather than for each access).
  - Reduces server load and network traffic.
  - Enhances potential for scalability.
- Remote server method handles every remote access across the network; penalty in network traffic, server load, and performance.
- Total network overhead in transmitting big chunks of data (caching) is lower than a series of responses to specific requests (remote-service).

Caching and Remote Service (Cont.)

- Caching is superior in access patterns with infrequent writes. With frequent writes, substantial overhead incurred to overcome cache-consistency problem.
- Benefit from caching when execution carried out on machines with either local disks or large main memories.
- Remote access on diskless, small-memory-capacity machines should be done through remote-service method.
- In caching, the lower intermachine interface is different form the upper user interface.
- In remote-service, the intermachine interface mirrors the local user-file-system interface.

Thanks