Today: Coda, xFS

- Case study: NFS (continued)
- Case Study: Coda File System
- Brief overview of other recent file systems
  - xFS
  - Log structured file systems

File Attributes (1)

Attribute	Description
TYPE	The type of the file (regular, directory, symbolic link)
SIZE	The length of the file in bytes
CHANGE	Indicator for a client to see if and/or when the file has changed
FSID	Server-unique identifier of the file's file system

- Some general mandatory file attributes in NFS.
  - NFS modeled based on Unix-like file systems
    - Implementing NFS on other file systems (Windows) difficult
  - NFS v4 enhances compatibility by using mandatory and recommended attributes

File Attributes (2)

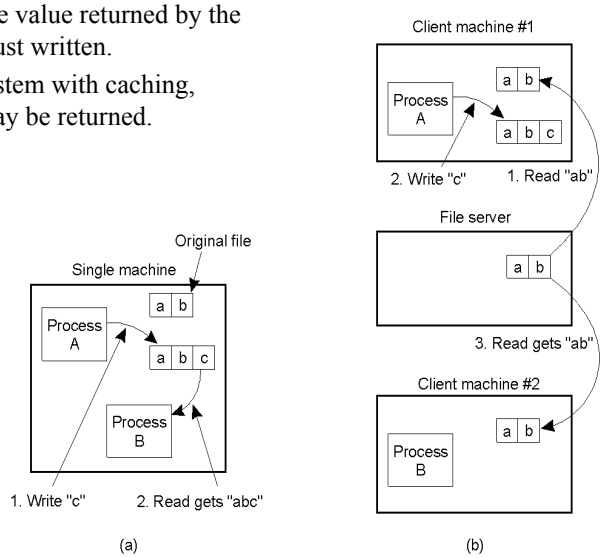
Attribute	Description
ACL	an access control list associated with the file
FILEHANDLE	The server-provided file handle of this file
FILEID	A file-system unique identifier for this file
FS_LOCATIONS	Locations in the network where this file system may be found
OWNER	The character-string name of the file's owner
TIME_ACCESS	Time when the file data were last accessed
TIME_MODIFY	Time when the file data were last modified
TIME_CREATE	Time when the file was created

- Some general recommended file attributes.

Semantics of File Sharing

a) On a single processor, when a *read* follows a *write*, the value returned by the *read* is the value just written.

b) In a distributed system with caching, obsolete values may be returned.



Semantics of File Sharing

Method	Comment
UNIX semantics	Every operation on a file is instantly visible to all processes
Session semantics	No changes are visible to other processes until the file is closed
Immutable files	No updates are possible; simplifies sharing and replication
Transaction	All changes occur atomically

- Four ways of dealing with the shared files in a distributed system.
  - NFS implements session semantics
    - Can use remote/access model for providing UNIX semantics (expensive)
    - Most implementations use local caches for performance and provide session semantics

File Locking in NFS

Operation	Description
Lock	Creates a lock for a range of bytes (non-blocking_
Lockt	Test whether a conflicting lock has been granted
Locku	Remove a lock from a range of bytes
Renew	Renew the lease on a specified lock

- NFS supports file locking
  - Applications can use locks to ensure consistency
  - Locking was not part of NFS until version 3
  - NFS v4 supports locking as part of the protocol (see above table)

File Locking: Share Reservations

Current file denial state

Request access	NONE	READ	WRITE	BOTH
READ	Succeed	Fail	Succeed	Fail
WRITE	Succeed	Succeed	Fail	Fail
BOTH	Succeed	Fail	Fail	Fail

(a)

Requested file denial state

Current access state	NONE	READ	WRITE	BOTH
READ	Succeed	Fail	Succeed	Fail
WRITE	Succeed	Succeed	Fail	Fail
BOTH	Succeed	Fail	Fail	Fail

(b)

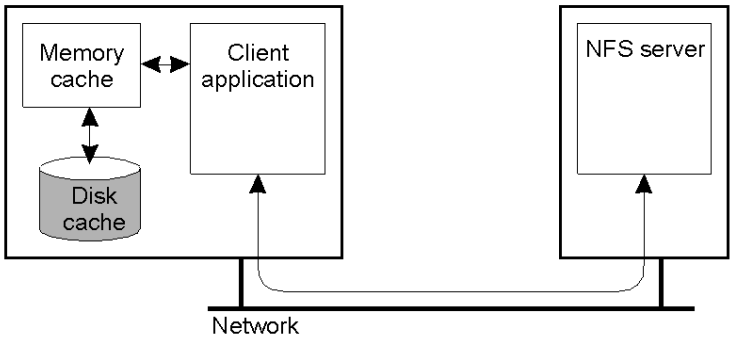
- The result of an *open* operation with share reservations in NFS.

a) When the client requests shared access given the current denial state.

b) When the client requests a denial state given the current file access state.

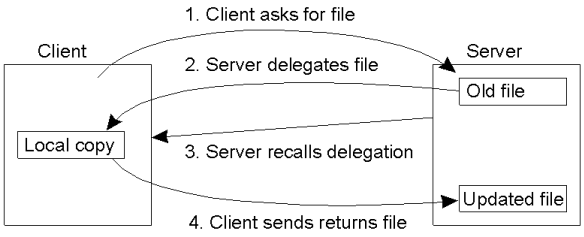
Client Caching

- Client-side caching is left to the implementation (NFS does not prohibit it)
  - Different implementation use different caching policies
    - Sun: allow cache data to be stale for up to 30 seconds

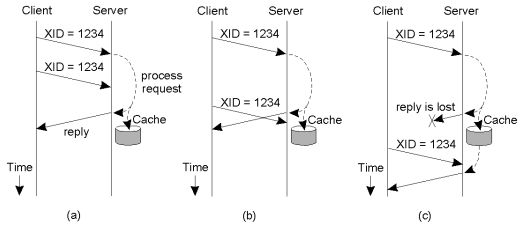


Client Caching: Delegation

- NFS V4 supports open delegation
  - Server delegates local open and close requests to the NFS client
  - Uses a callback mechanism to recall file delegation.



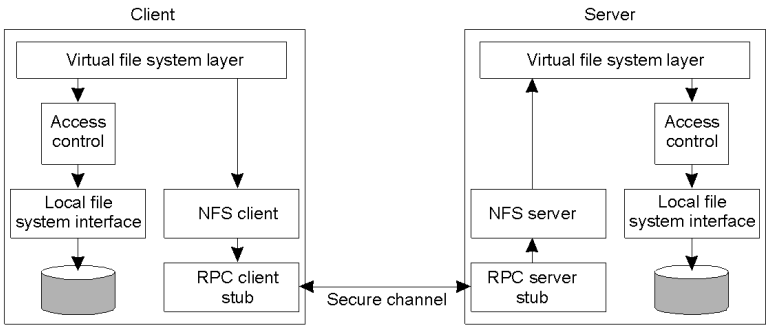
RPC Failures



- Three situations for handling retransmissions: use a duplicate request cache
- The request is still in progress
- The reply has just been returned
- The reply has been some time ago, but was lost.
- Use a duplicate-request cache: transaction Ids on RPCs, results cached

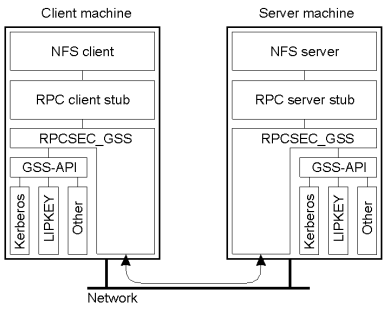
Security

- The NFS security architecture.
  - Simplest case: user ID, group ID authentication only



Secure RPCs

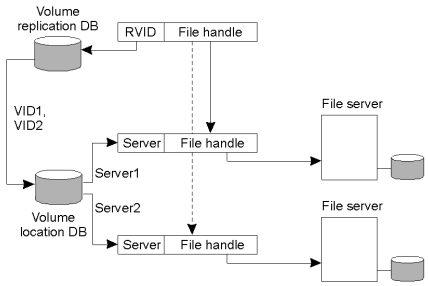
- Secure RPC in NFS version 4.



Replica Servers

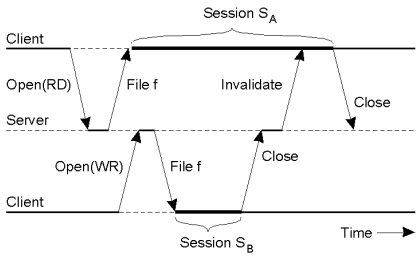
- NFS ver 4 supports replications
- Entire file systems must be replicated
- FS_LOCATION attribute for each file
- Replicated servers: implementation specific

File Identifiers



- Each file in Coda belongs to exactly one volume
  - Volume may be replicated across several servers
  - Multiple logical (replicated) volumes map to the same physical volume
  - 96 bit file identifier = 32 bit RVID + 64 bit file handle

Sharing Files in Coda



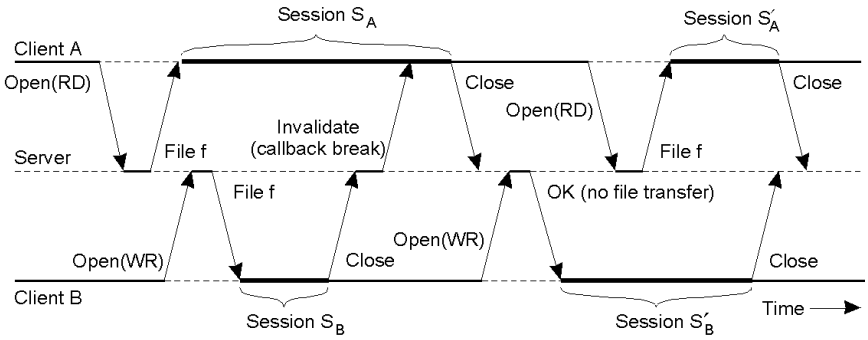
- Transactional behavior for sharing files: similar to share reservations in NFS
  - File open: transfer entire file to client machine [similar to delegation]
  - Uses session semantics: each session is like a transaction
    - Updates are sent back to the server only when the file is closed

Transactional Semantics

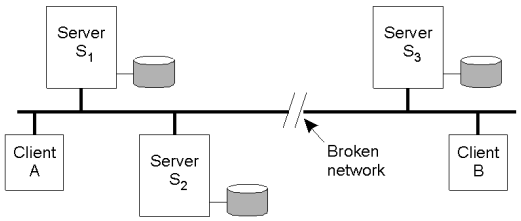
File-associated data	Read?	Modified?
File identifier	Yes	No
Access rights	Yes	No
Last modification time	Yes	Yes
File length	Yes	Yes
File contents	Yes	Yes

- Network partition: part of network isolated from rest
  - Allow conflicting operations on replicas across file partitions
  - Reconcile upon reconnection
  - Transactional semantics => operations must be serializable
    - Ensure that operations were serializable after thay have executed
  - Conflict => force manual reconciliation

Client Caching

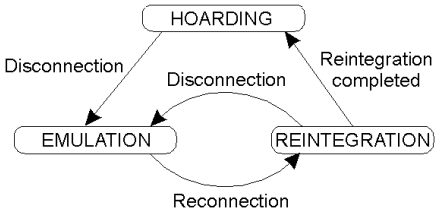


Server Replication



- Use replicated writes: read-once write-all
  - Writes are sent to all AVSG (all accessible replicas)
- How to handle network partitions?
  - Use optimistic strategy for replication
  - Detect conflicts using a Coda version vector
  - Example: [2,2,1] and [1,1,2] is a conflict => manual reconciliation

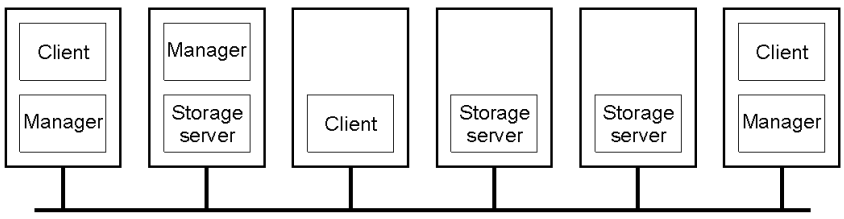
Disconnected Operation



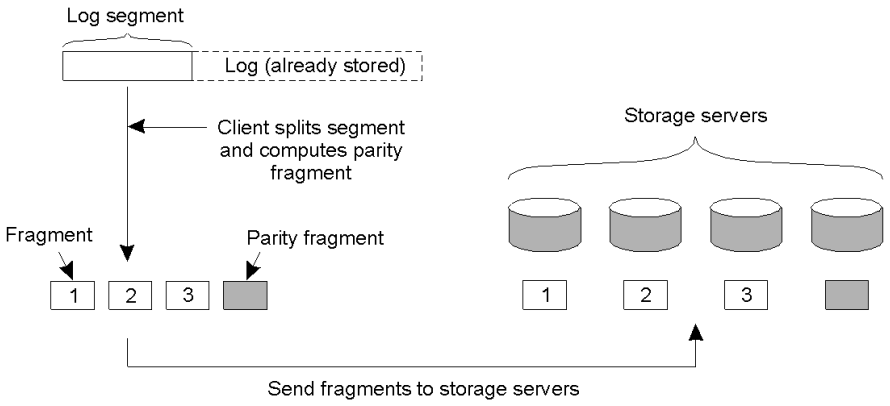
- The state-transition diagram of a Coda client with respect to a volume.
- Use hoarding to provide file access during disconnection
  - Prefetch all files that may be accessed and cache (hoard) locally
  - If AVSG=0, go to emulation mode and reintegrate upon reconnection

Overview of xFS.

- Key Idea: fully distributed file system [serverless file system]
- xFS: x in "xFS" => no server
- Designed for high-speed LAN environments

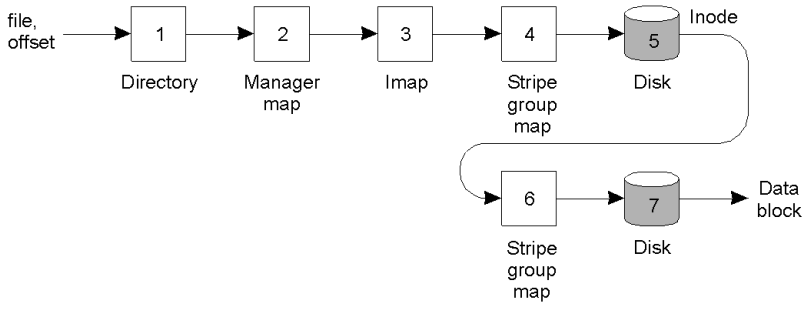


Processes in xFS



Reading a File Block

- Reading a block of data in xFS.



xFS Naming

- Main data structures used in xFS.

Data structure	Description
Manager map	Maps file ID to manager
Imap	Maps file ID to log address of file's inode
Inode	Maps block number (i.e., offset) to log address of block
File identifier	Reference used to index into manager map
File directory	Maps a file name to a file identifier
Log addresses	Triplet of stripe group, ID, segment ID, and segment offset
Stripe group map	Maps stripe group ID to list of storage servers