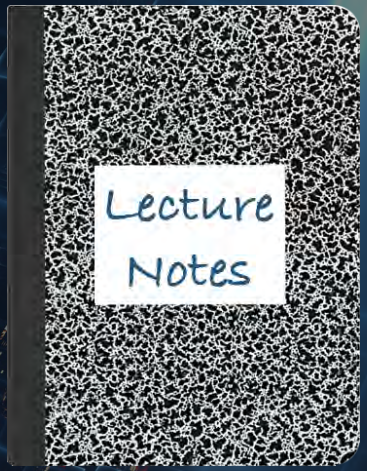
CS 417 – DISTRIBUTED SYSTEMS



Week 6: Network Attached Storage

Part 1: Network Attached Storage

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Accessing files

File sharing with socket-based programs

HTTP, FTP, telnet:

- Explicit access
- User-directed connection to access remote resources

We want more transparency

- Allow user to access remote resources just as local ones

NAS: Network Attached Storage

System Design Issues

- Transparency
  - Integrated into OS or access via APIs?
- Consistency
  - What happens if more than one user accesses the same file?
  - What if files are replicated across servers?
- Security
  - The local OS is no longer in charge
- Reliability
  - What happens when the server or client dies?
- State
  - Should the server keep track of clients between requests?

File service models

Download/Upload model

- *Read file:* copy file from server to client
- *Write file:* copy file from client to server

Advantage

- Simple
- Local access speeds

Problems

- ***Wasteful***: what if client needs small piece?
- ***Problematic***: what if client doesn't have enough space?
- ***Consistency***: what if others need to modify the same file?

Remote access model

File service provides functional interface:

- *create, delete, read bytes, write bytes, etc…*

Advantages

- Client gets only what's needed
- Server can manage coherent view of file system

Problem

- Possible server and network **congestion**
  - Servers are accessed for duration of file access
  - Same data may be requested repeatedly

Semantics of file sharing

Sequential Semantics

Read returns result of last write

Easily achieved *if*

- We use a remote access model
- Server data is not replicated
- Clients do not cache data

BUT

- Performance problems if no cache
  - Clients get obsolete data
- We can ***write-through***
  - Must notify all clients holding copies
  - Requires extra state, generates extra traffic

Session Semantics

Relax the rules

- Changes to an open file are initially visible only to the process (or machine) that modified it.
- Need to hide or lock file under modification from other clients
- Last process to close the file wins

Remote File Service

Server

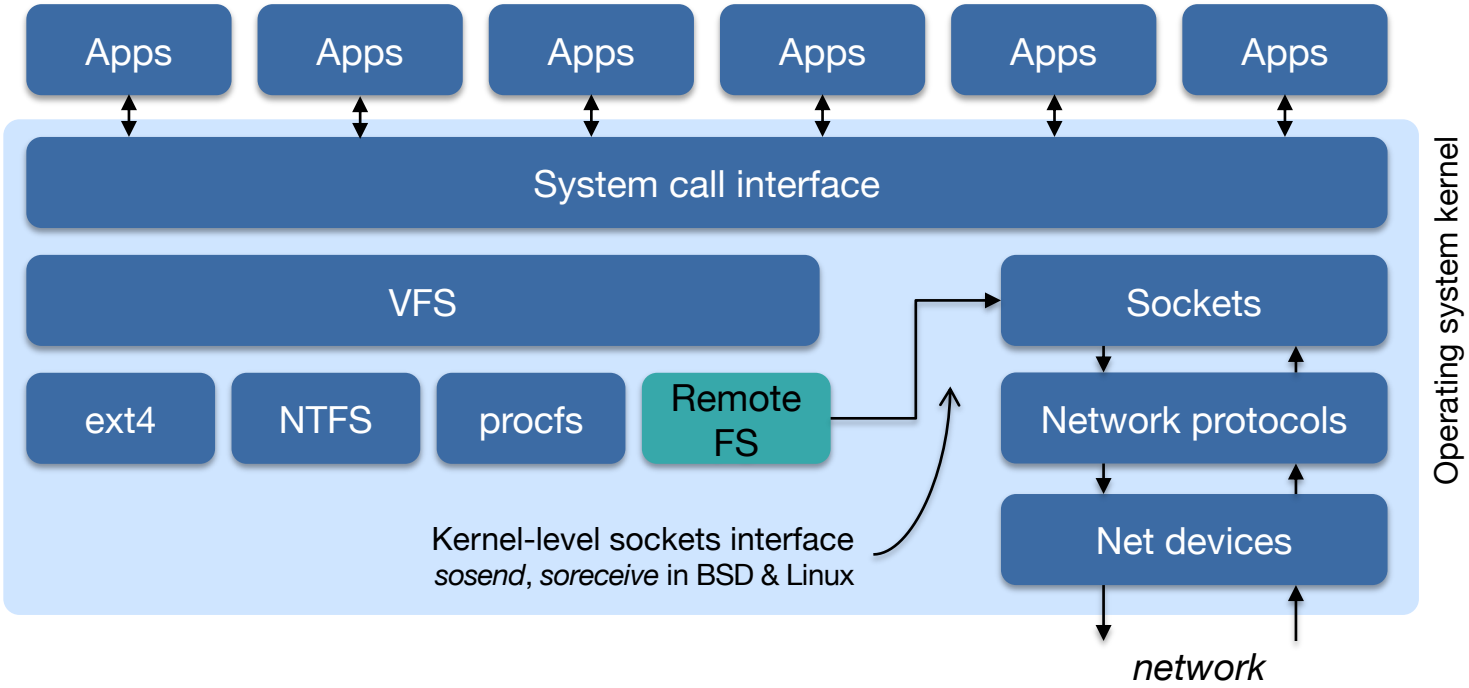
- **File Directory Service**
  - Maps textual names for file to internal locations that can be used by file service
- **File service**
  - Provides file access interface to clients

Client

- **Client module** (driver)
  - Client-side interface for the file and directory service
  - Can provide access transparency if implemented in the kernel

Accessing Remote Files

For maximum transparency, implement the client module as a file system type under VFS



Stateful or Stateless design?

Stateful

Server maintains client-specific state

- Shorter requests
- Better performance in processing requests
- Cache coherence is possible
  - Server can know who's accessing what
- File locking is possible

Stateless

Server stores no information on client accesses

- Each request must identify file and offsets
- Server can crash and recover – or fail over
  - No state to lose
- Client can crash and recover
- No open/close operations needed
  - They only establish state
- No server space used for state
  - Don't worry about the # of clients to support
- Client caching can affect consistency
- Problems if file is deleted on server
- File locking not possible

Caching

Hide latency to improve performance for repeated accesses

File data can reside in several places

- Server's disk ← *original version*
- Server's buffer cache
- Client's buffer cache
- Client's disk

WARNING:
risk of cache consistency
problems across multiple systems

Approaches to caching

Write-through

- What if another client reads its own (out-of-date) cached copy?
- All accesses will require checking with server
- Or … server maintains state and sends invalidations

Delayed writes (write-behind)

- Data can be buffered locally
  (watch out for consistency – others won't see updates!)
- Remote files updated periodically
- One bulk write is more efficient than lots of little writes
- Problem: semantics become ambiguous

Write on close

- Admit that we have session semantics

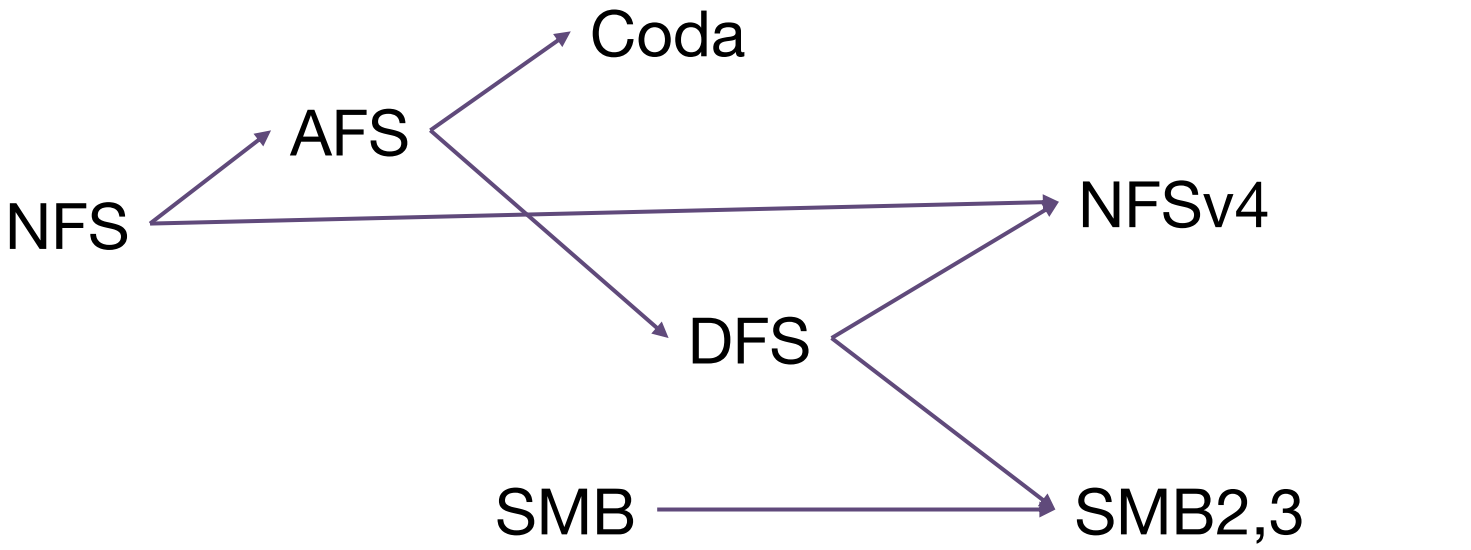
Read-ahead (prefetch)

- Request chunks of data before it is needed
- Minimize wait times if that data is later needed

Centralized control

- Keep track of who has what open and cached on each node
- More state to track on the server & more messages

Next…



The End