Announcements

- Project #6 is due Tuesday at 6:00 PM
- Office Hours Next Week
  - Jeff
    - Tu 11-12
    - Th 11-12
  - Tas
    - Johnny: Wed
    - Austin: Normal
  - Review session:
    - W 10-12 (1121 CSIC)
- Course Evaluations
  - Please fill them out!

Distributed Systems

- A unified view of local and remote access
- Typical Services
  - data migration
    - provide only the data required, not the whole file
    - manage multiple copies as versions of the same object
  - process migration
    - a process can move from one machine to another
    - reasons for migration:
      - load balancing
      - data affinity
      - hardware/software preference (better configuration)

Distributed OS Design Issues

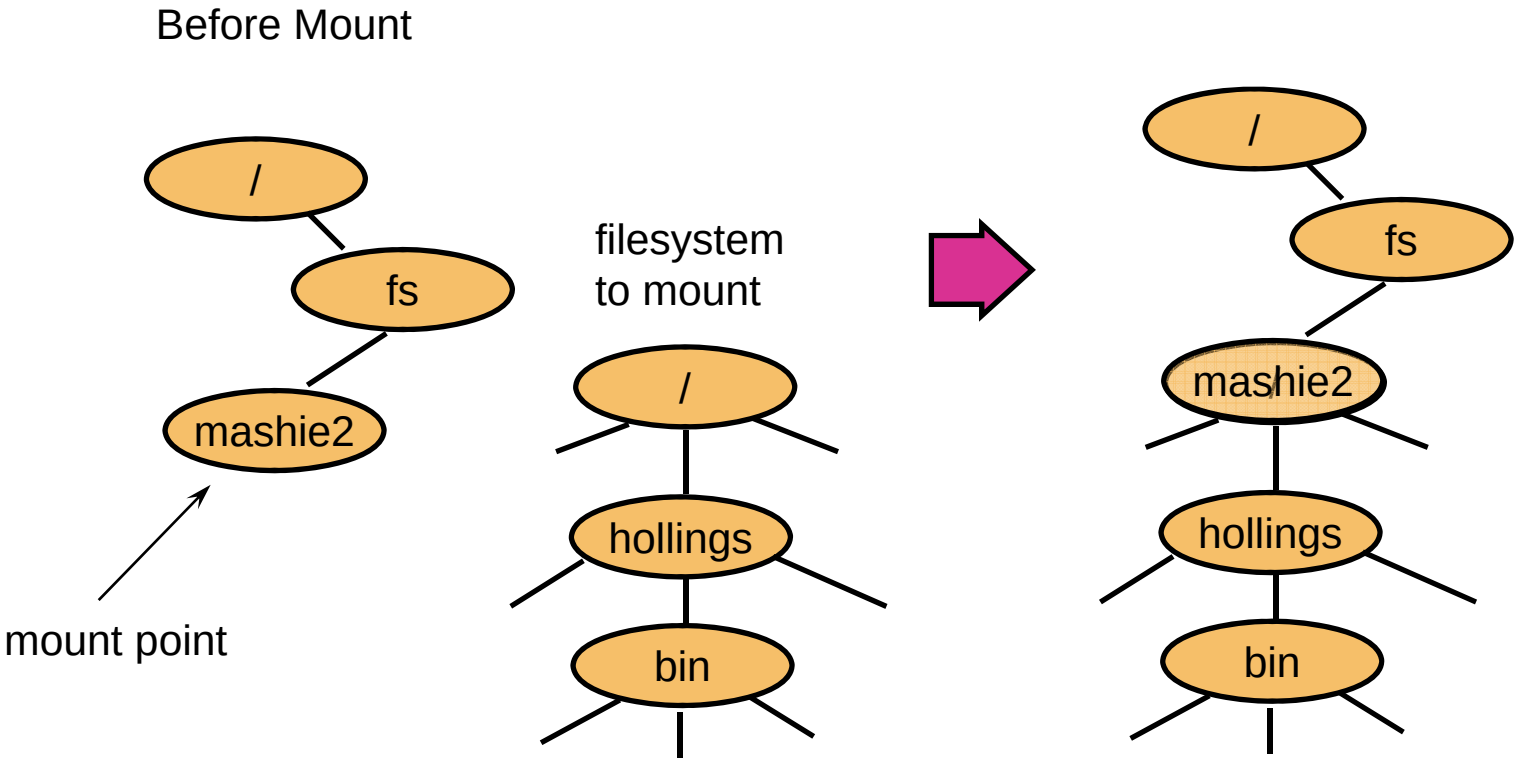
- Should provide same model as a central system
  - easy to understand for users
- Needs to be scaleable
  - will it work with 100, 1,000, or 10,000 nodes?
- Failure Modes
  - avoid a single central failure point
  - can loss performance or functionality with failure
    - but loss should be proportional to size of failure
- Security
  - should provide same guarantees on data integrity as a local system

File Server State

- Does the fileserver maintain information between requests?
- Stateless
  - example: NFS
  - each request contains a request to read/write a specific part of a file
  - requests must be *itempotent*
    - the same request can be applied several times
  - makes recovery of failed clients/servers easier
- Stateful
  - example: AFS
  - servers maintain connections for clients
  - improves performance
  - required for server based cache management

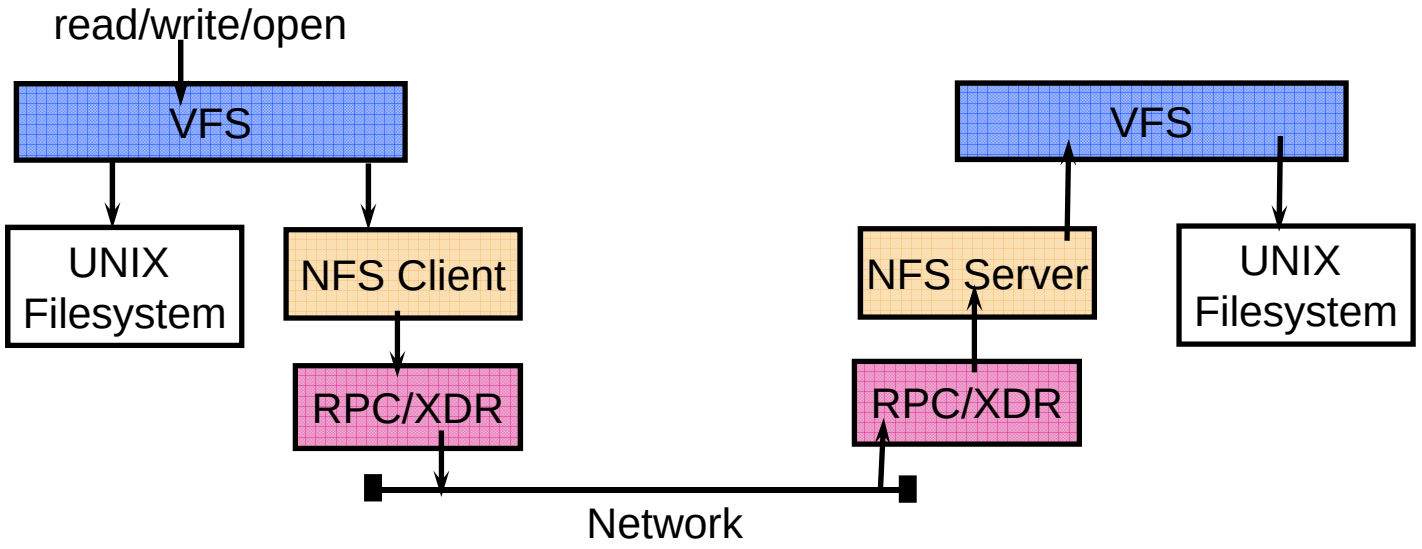
Mounting a filesystem

- Mount attaches a filesystem to a directory
  - can be used for local or remote (NFS) filesystems



NFS

- Provides a way to mount remote filesystems
  - can be done explicitly
  - can be done automatically (called an automounter)
  - clients are provided “file handle” by the server for future use
- Uses VFS: extended UNIX filesystem
  - inodes are replaced by vnodes
    - network wide unique inodes
    - can refer to local or remote files



NFS (cont.)

- Requests
  - are sent via RPC to the server
  - include read/write
  - query: lookup this directory info
    - must be done one step (directory) at a time
  - change meta data: file permissions, etc.
- Popular due to free implementations
- Provides no coherency

AFS

- Designed to scale to 5,000 or more workstations
- Location independent naming
  - within a single cell
- volumes
  - basic unit of management
  - can vary in size
  - can be migrated among servers
- names are mapped to “fids”
  - 96 bit unique id’s for a file
  - three parts: volume, vnode, and uniqidentifier
  - location information is stored in a volume to location DB
    - replicated on every server

AFS (cont.)

- File Access
  - open: file is transferred from server to client
    - very large files may only be partially transferred
  - read/write: performed on the client
  - close: file (if dirty) is written back to server
    - can fail if the disk is full
- Consistency
  - clients have callbacks
  - sever informs client when another client writes data
  - only applies to open operation
  - only requires communication when:
    - more than one client wants to write
    - one client wants to write and others to read

Display and Window Management

- The screen is a resource in a workstation system
  - multiple processes desire to access the device and control it
  - OS needs to provide abstractions to permit the interaction
- Services
  - protection
  - windows
  - multiplex keyboard and mouse
  - configuration and placement
- Issues
  - how to get good performance and remain device independent
  - how much policy to dictate to users

My Research Interests

- Parallel Computing
  - There are limits to how fast one processor can run
  - solution: use more than one processor
- Issues in parallel computing design
  - do the processors share memory?
    - is the memory “uniform”?
    - how do processors cache memory?
  - if not how do they communicate?
    - message passing
    - what is the latency of message passing

Parallel Processing

- What happens in parallel?
- Several different processing steps
  - pipeline
  - simple example: grep foo | sort > out
  - called: *multiple instruction multiple data* (MIMD)
- The same operation
  - every processor runs the same instruction (or no-instruction)
  - called: *single instruction multiple data* (SIMD)
  - good for image processing
- The same program
  - every processor runs the same program, but not “lock step”
  - called: *single program multiple data* (SPMD)
  - most common model

Issues in effective Parallel Computation

- Getting enough parallelism
  - Limited by what is left serial
  - Even 10% serial limited to a speedup of 10x even with infinite numbers of processors
- Load balancing
  - every processor should to have some work to do.
- Latency hiding/avoidance
  - getting data from other processors (or other disks) is slow
  - need to either:
    - hide the latency
      - processes can “pre-fetch” data before they need it
      - block and do something else while waiting
    - avoid the latency
      - use local memory (or cache)
      - use local disk (of file buffer cache)
- Limit communication bandwidth
  - use local data
  - use “near” data (i.e. neighbors)

My Research:

- Given a parallel program and a machine
- Try to answer performance related questions
  - Why is the programming running so slowly?
  - How do I fix it?
- Issues:
  - how to measure a program without changing it?
  - how do you find (and then present) the performance problem, not tons of statistics?
- Techniques:
  - dynamic data collection
  - automated search
  - analysis of process interactions

Introduction

- Software today
  - makes extensive use of libraries and re-usable components
  - Libraries used by an application may not be tuned to the application's need
- Fast software development/distribution with built-in (default) configurations
  - Applications may not run well in all environments
  - There may be no single configuration good for all environments

Large Scale Computing

- Today (12/2011)
  - 12 systems with more than 128k processors
  - More than 50 systems >= 16k processors
  - World's fastest computer (K in Japan)
    - 705,024 SPARC cores
    - 1.4 petabytes of RAM (1,410,048 GB)
    - Uses 12.659 MW of electricity