

CSE 120 Principles of Operating Systems

Fall 2004

Final Review

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Course Plugs

- If you like CSE 120 topics, you might find some other courses interesting
- CSE 121: OS Architecture and Implementation
 - ◆ [Wi05 \(Snoeren\)](#)
 - ◆ OS Implementation using Unix as a case study
 - ◆ System projects with experimentation
- CSE 123A/B: Computer Networking
 - ◆ 123A, [Wi05 \(Savage\)](#) – link layer up to internetworking (IP)
 - ◆ 123B, [Sp05 \(Vahdat\)](#) – internetworking up to session/application

Course Plugs (2)

- CSE 125: Software System Design and Implementation
 - ♦ [Sp05 \(Voelker\)](#)
 - ♦ One project the entire quarter
 - » Distributed, real-time, multiplayer 3D game
 - » It might not seem like it, but it is not really a games course
 - ♦ Groups of six, oriented towards graduating seniors
 - ♦ See CSE 125 class page on my home page for details

Overview

- Final mechanics
- Memory management
- Paging
- Page replacement
- Disk I/O
- File systems
- Advanced topics
- The End

Final Mechanics

- Bulk of the final covers material after midterm
 - ◆ Memory management, file systems, advanced topics
- Some material on concurrency, synchronization
 - ◆ Synch primitives, synch problems
- Based upon lecture material, homeworks, and project
 - ◆ I will use at least one question from this review on the exam
- **Closed book, one 8.5"x11" sheet of notes**
 - ◆ Yes, just one
 - ◆ Sample final on class web site
- Again, please, do not cheat
 - ◆ Have had some problems, I would hate to see it on the final

Memory Management

- Why is memory management useful?
 - ◆ Why do we have virtual memory if it is so complex?
- What are the mechanisms for implementing MM?
 - ◆ Physical and virtual addressing
 - ◆ Partitioning, paging, and segmentation
 - ◆ Page tables, TLB
- What are the policies related to MM?
 - ◆ Page replacement
- What are the overheads related to providing memory management?

Virtualizing Memory

- What is the difference between a physical and virtual address?
- What is the difference between fixed and variable partitioning?
 - ♦ How do base and limit registers work?
- What is internal fragmentation?
- What is external fragmentation?
- What is a protection fault?

Paging

- How is paging different from partitioning?
- What are the advantages/disadvantages of paging?
- What are page tables?
- What are page table entries (PTE)?
- Know these terms
 - ♦ Virtual page number (VPN), page frame number (PFN), offset
- Know how to break down virtual addresses into page numbers, offset
- How have you implemented paging in Nachos?

Page Table Entries

- What is a page table entry? In Nachos?
- What are all of the PTE bits used for?
 - ◆ Modify
 - ◆ Reference
 - ◆ Valid
 - ◆ Protection

Segmentation

- What is segmentation?
- How does it compare/contrast with paging?
- What are its advantages/disadvantages with respect to partitioning, paging?
- What is a segment table?
- How can paging and segmentation be combined?

Page Tables

- Page tables introduce overhead
 - ◆ Space for storing them
 - ◆ Time to use them for translation
- What techniques can be used to reduce their overhead?
- How do two-level (multi-level) page tables work?

TLBs

- What problem does the TLB solve?
- How do TLBs work?
- Why are TLBs effective?
- How are TLBs managed?
 - ◆ What happens on a TLB miss fault?
- What is the difference between a hardware and software managed TLB?

Page Faults

- What is a page fault?
- How is it used to implement demand paged virtual memory?
- What is the complete sequence of steps, from a TLB miss to paging in from disk, for translating a virtual address to a physical address?
 - ♦ What is done in hardware, what is done in software?

Advanced Mem Management

- What is shared memory?
- What is copy on write?
- What are memory mapped files?

Page Replacement

- What is the purpose of the page replacement algorithm?
- What application behavior does page replacement try to exploit?
- When is the page replacement algorithm used?
- Understand
 - ◆ Belady's (optimal), FIFO, LRU, Approximate LRU, LRU Clock, Working Set, Page Fault Frequency
- What is thrashing?

Disk

- Understand the memory hierarchy concept, locality
- Physical disk structure
 - ◆ Platters, surfaces, tracks, sectors, cylinders, arms, heads
- Disk interface
 - ◆ How does the OS make requests to the disk?
- Disk performance
 - ◆ What steps determine disk request performance?
 - ◆ What are seek, rotation, transfer?

Disk Scheduling

- How can disk scheduling improve performance?
- What are the issues in disk scheduling?
 - ◆ Response time, throughput, fairness
- Review
 - ◆ FCFS, SSTF, SCAN, C-SCAN

File Systems

- Topics
 - ◆ Files
 - ◆ Directories
 - ◆ Sharing
 - ◆ Protection
 - ◆ Layouts
 - ◆ Buffer Cache
- What is a file system?
- Why are file systems useful (why do we have them)?

Files and Directories

- What is a file?
 - ◆ What operations are supported?
 - ◆ What characteristics do they have?
 - ◆ What are file access methods?
- What is a directory?
 - ◆ What are they used for?
 - ◆ How are they implemented?
 - ◆ What is a directory entry?
- How are directories used to do path name translation?

Protection

- What is file protection used for?
- How is it implemented?
- What are access control lists (ACLs)?
- What are capabilities?
- What are the advantages/disadvantages of each?

File System Layouts

- What are file system layouts used for?
- What are the general strategies?
 - ◆ Contiguous, linked, indexed?
- What are the tradeoffs for those strategies?
- How do those strategies reflect file access methods?
- What is an inode?
 - ◆ How are inodes different from directories?
 - ◆ How are inodes and directories used to do path resolution, find files?

File Buffer Cache

- What is the file buffer cache, and why do operating systems use one?
- What is the difference between caching reads and caching writes?
- What are the tradeoffs of using memory for a file buffer cache vs. VM?

Summary

- Any remaining questions?