

CS 153
**Design of Operating
Systems**

Winter 2016

Final Review

Final

- 08:00A.M. - 11:00A.M., Thursday, Mar 17th
- Material for final
 - ◆ All topics covered after midterm
 - » Memory management, file systems, RPC, Android OS security
 - » One or two small problems from Android OS security
 - ◆ One problem from the pre-midterm materials
 - » Same as midterm
- Based upon lecture slides and corresponding material from textbook (mostly the slides, textbook helps further understanding)
- Read questions carefully!
- Closed book, no notes, no laptops, no cellphones
- Of course, no cheating

OS in a nutshell

- Reality:
 - ◆ Several concurrent programs that share hardware
 - ◆ Hardware can comprise any CPU, hard disk drive, RAM
- Abstraction offered by OS:
 - ◆ Every program runs as a separate process that
 - » Consists of several threads
 - » Has its own 2^{32} byte virtual address space
 - » Reads and writes files
 - ◆ Every program is completely agnostic to hardware and other programs

Overview of Topics

- Memory management
- Paging
- Page replacement
- Disk I/O
- File systems
- Advanced topics
 - ◆ LFS, RAID, RPC, NFS, Android OS security

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 and page 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)?
 - ◆ What are all of the PTE bits used for?
 - » Modify, Reference, Valid, Protection
- Know these terms
 - ◆ Virtual page number (VPN), page frame number (PFN), offset
- Know how to break down virtual addresses into page numbers, offset

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

- 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. virtual memory?

Advanced Topics

- What is FFS, and how is it an improvement over the original Unix file system?
- What is LFS, and how is it an improvement over FFS?
- What is RAID, and how does it help file system performance and reliability?
- What is RPC, and how is it implemented?
- What is NFS, how does it relate to file systems and RPC?
- How does Android provide isolation among apps?

Android OS and Security

- How does isolation help security?
- Why they can be broken sometimes?