Operating Systems (A) (Honor Track)

Lecture 23: Course Review

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Course Review

- OS Concepts and History
- Hardware Support for OS
- Processes and Threads
- Virtual Memory
- Scheduling
- Synchronization
- File Systems
- I/O
- Distributed Systems

Hardware Support for OS

- Von Neumann Architecture
- Protection
  - Kernel mode vs. user mode
- Events
  - Interrupt
  - Fault
  - System call
  - Software Interrupt

Processes and Threads

- Processes
  - Address space
  - Process control block (PCB)
  - Context switch
- Threads
  - Lightweight processes (LWPs)
  - Kernel vs. user-level threads
  - Thread scheduling
  - Preemptive vs. non-preemptive scheduling

Virtual Memory

- Paging
- Segmentation
- Paging mechanisms
  - TLB
- Page replacement algorithms
  - Optimal (Belady's)
  - FIFO, SCR, NRU, LRU, Clock, WS, WSClock
  - Belady's anomaly
- Virtual memory for Windows/Linux

Scheduling

- Single processor scheduling
  - Batch systems
    - First come first serve
    - Shorted job first
  - Interactive scheduling
    - Round-robin
    - Priority scheduling
      - Priority inversion
      - Priority inheritance
    - Multiple-level feedback queues (MLFQ)

Scheduling (cont.)

- Multiprocessor scheduling
  - Load sharing
  - Gang scheduling
- Real-time scheduling
  - Static vs. Dynamic
  - Preemptive vs. Non-preemptive
  - Periodic vs Aperiodic

  - Deadline scheduling
  - Rate Monotonic Scheduling (RMS/RMA)

Synchronization

- Critical sections
- Synchronization mechanisms
  - Atomic read/write
  - Locks
  - Semaphores
  - Monitors
  - Messages
- Classic problems
  - Dining philosopher
  - Producer-consumer
  - Reader-writer

Deadlocks

- Deadlock conditions
  - mutual exclusion
  - hold-and-wait
  - no resource preemption
  - circular wait
- Dealing with deadlocks
  - Ignore it – Living life on the edge
  - Prevention – Make one of the four conditions impossible
  - Avoidance – Banker's algorithm (control allocation to find a safe way)
  - Detection and recovery – Look for a cycle, preempt or abort
- Livelocks

File Systems

- Physical disks
- Files & directories
- File system implementation
  - File system organization
  - Unix inodes
    - How to draw a file structure
  - Windows FAT
- New file systems
  - Journaling File Systems
  - Log-structure File Systems

Input/Output

- I/O Devices
  - Character devices
  - Block devices
  - DMA
- I/O Software Design
  - Hierachical design
  - Buffering
  - Scheduling: the elevator algorithm
- RAID
  - RAID 0,1,2,3,4,5,6
  - Multi-level RAID

Distributed Systems

- Concepts
  - Different distributed systems
- Remote procedure call (RPC)
  - RPC model
  - Stub compiler
- Network file system (NFS)
  - Statelessness
- Virtualization and Cloud
  - ~~VMM/Hypervisor~~
  - ~~Virtualization types~~

Final Exam

- **Time: 2025/1/6 14:00-16:00**
- **Location: 二教/404**
- Final Exam
  - Covers everything we have learned so far
    - Including those before midterm
  - Don’t forget the papers (Exokernel, LFS, SeL4)
    - Expect some simple questions on them