Engineering Robust Server Software

Final Exam Review
Final Exam Logistics

• Date/time: see course site
• Location: In our regular classroom
• 3 hour time limit once exam is started
• A two-sided cheat sheet (US Letter or A4), printed or handwritten
• Similar question style to the midterm
  • Focus on concepts and how to apply key takeaways
• Similar length to midterm (~7 questions)
• Covers topics since start of semester, but focus is on 2nd half topics
Final Exam Topics (1)

- Server software intro & differences from typical user applications
  - Run forever (resource mgmt), error handling, external users, performance

- Server API / protocol / design ideas
  - Asynchronous interfaces
    - Design for failure (FSMs + idempotent operations)

- Web protocols & technology
  - REST
  - HTTP
  - Data: XML, HTML, JSON
  - JavaScript
Final Exam Topics (2)

• Daemons
  • Becoming a daemon
  • Signals to interact with daemon
  • 4 approaches to request handling: process vs. thread, pool vs. per request
  • SUID bit (and setuid / seteuid system call)

• Containers
  • Namespaces via clone call (mount, user, process ID)

• Exceptions
  • Exception safety guarantees, temp-and-swap, RAII, smart pointers
  • Java finally clause
Final Exam Topics (3)

• Security intro
  • 4 dimensions: confidentiality, integrity, authentication, availability
  • Password security, rainbow tables, hashed passwords + salt

• Crypto
  • Cryptography principles, Caesar cipher, Vigenere cipher
  • One time pad, AES, Diffie-Hellman, RSA (encryption & signing), certificates
    • Concepts only — not detailed math

• Security vulnerabilities
  • Buffer overflow, sanitization of inputs, CSRF, privilege escalation, TOCTTOU

• Defense
  • Multiple layers of security
  • Intrusion detection and incident detection vs. response
Final Exam Topics (4)

• High Availability
  • Impacts of downtime and measuring info availability
  • Eliminate single points of failure
  • Redundancy (active/active vs. active/passive) at various layers
    • RAID levels, Universal HA topology, best practices

• Disaster Recovery
  • Recovery vs. restart
  • Building a backup solution (and Tyler’s immutable rules)
    • Backup granularity, architecture, consistency
Final Exam Topics (5)

• Scalability Intro
  • What is scalability (scale up vs. scale out, strong vs. weak scaling)
  • Amdahl’s Law
  • Shared HW impact to scalability
    • Functional units, caches, memory B/W, I/O B/W, …
  • Data movement impact to scalability
  • Blocking I/O impact to scalability
    • How to use non-blocking I/O
Final Exam Topics (6)

- Scalability & Synchronization
  - Locks, pthread synchronization primitives, sources of synchronization in code
  - Reader-writer locks, locking granularity, hand-over-hand locking
  - Memory consistency models and atomic operations
Final Exam Topics (7)

- **Scalability: Databases & Load Testing**
  - Databases & concurrency, isolation levels
  - Understanding query performance, indexes
  - Rules for load testing

- **IO Performance & Scalability**
  - Measuring IOPS vs. MB/s for performance
  - Direct-attached storage vs. storage servers (SAN, NAS)
  - Basics of IO performance measurement
  - How to size storage systems
Guest lecture themes

• Performance optimization
  • Always profile first
  • Identify bottlenecks, often via configuration as much as coding

• CI/CD and DevOps
  • Meaning of the terms
  • Benefit of automated build/lint/test

Conceptual questions on the key themes. Not fine details!