

15-410

*“...This is a **transformative** class...”*

Review
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Dave Eckhardt

Bruce Maggs

Synchronization

P3 grading guidance

- Weights are approximate

~50% shell works (w/o horrible hacks)

~30% tests

- 10% basic
- 15% stress, trickiness, argument verification
- 5% threads

~10% structure/style

~10% concurrency (preemption, locking, synch)

Synchronization

Exam will be closed-book

- *But you may bring a 1-sided 8.5x11 sheet of notes*
 - WRITTEN BY YOU IN YOUR OWN HAND
 - WRITTEN BY YOU IN YOUR OWN HAND
- *Weakly* non-cumulative
 - Emphasis on new material, design questions
 - You will need to use some “old” knowledge
 - We didn't really test on “P2 knowledge” (nor P3)
 - Recall: VM was off-limits on mid-term (and you've done it)
- Mixture of fact/concept testing and *design*

Synchronization

Faculty evaluation

- So did you get the reminder e-mails?

About today's "review"

- More "reminders" than "course outline"
 - Un-mentioned topic implies "text & lectures straightforward"
- Reading *some* of the textbook is advisable!

Read Your Code

Re-read your P2

Re-read your P3

Go over feedback

Talk about them with your partner

- **Schedule a time**

You should understand “the hard parts”

- **Focus on whichever part you know least well**
 - **(or fear the most)**

“Concept” Lectures

We could ask a question...

- ...we would give you guidance/refresh your memory

Examples

- Transactions
- Lock-free programming
- OS Structures
- Plan 9, PLATO

Core “Phase I” concepts

Machine model

- Registers
 - “regular”
 - “special”
- Interrupt (vs. exception – how they differ, why)

Process model

- You should be a memory-map *expert*
 - Kernel space, user space, virtual memory
- Process vs. thread
- *Exactly* what goes on a stack, where it comes from...

Core “Phase I” concepts

Mutual exclusion

- mutex, cvar, what's inside, why

Concurrency

- Race-condition expert!
- Be able to explain one to your nephew
 - (the one you'll visit over break)

Deadlock

- Ingredients
- Various approaches to coping

Virtual Memory

The Game

- Maintain multiple illusions (aka “address spaces”)

Players

- High-level info (what uses which regions, COW/ZFOD)
- Mapping data structure (maybe chosen by processor)
- TLB – cache of v-to-p translations from that data structure
 - “flush” - when, why, how?

Behavior of the Players

- Mappings are *sparse*
- This explains the ways they're implemented

Scheduling

Round-Robin

Things people do

- Multi-level feedback queues

Dubious

- Priority

“Priority Inheritance”

Disk scheduling

Spinning platter/waving arm model

Seek time vs. rotational latency

**FCFS, SSTF, SCAN, LOOK, C-SCAN, C-LOOK, SPTF,
WSPTF**

Fairness, mean response time, variance, starvation

Disk Array Overview

Historical practices

- Striping, mirroring

The reliability problem

- More disks \Rightarrow *frequent* array failures
- *Cannot* tolerate $1/N$ reliability

Parity, ECC, why parity is enough

- Erasure channels
 - Good terminology to display at parties

Disk Array Overview

RAID “levels” (really: flavors)

- Understand RAID 0, 1, 4 vs. 5
- What they're good for, why

File Systems

Data access model

- What it means for a file to be “open”

Cache issues

Naming

- Directory flavors, mounting

Core problem: block mapping

- Compare data structures to VM
- “Holes”

Architecture

- Layering to support multiple file system types, ...

IPC

Communicating process on one machine

Naming

- Name server?
- File system?

Message structure

- Sender id, priority, type
- Capabilities: memory region, IPC rights

Synchronization/queueing/blocking

IPC

Group receive

Copy/share/transfer

A Unix surprise

- **sendmsg()/recvmsg() pass file descriptors!**

RPC Overview

RPC = Remote Procedure Call

Extends IPC in two ways

- **IPC = Inter-Process Communication**
 - **OS-level: bytes, not objects**
- **IPC restricted to single machine**

Marshalling

Server location

RPC Overview

Call semantics

- Asynch? Batch? Net/server failure?

Client flow, server flow

- Client stub routines, server dispatch skeleton

Java RMI

- (have some sense—obviously, we didn't make you use it)

Marshalling

Values must cross the network

Machine formats differ

- **Serialize/de-serialize**
- **Format/packing**
- **Type mismatch issues**

“The pointer problem”

Distributed File Systems

Client-side redirection

- Which files are remote? How to operate remotely?

Communication

- RPC, XDR
- Flow of RPC operations to access a file
 - Mount, lookup, access
- Batching (what, why)
- Cache vs. consistency vs. locks

Protection Overview

Protection vs. Security

- Inside vs. outside “the box”

Objects, operations, domains

Access control (*least privilege*)

3 domain models

Domain switch (setuid example)

Multics ring architecture

Access Matrix

- Concept and real-world approaches

Security Overview

Goal / Threat / Response tuples

Malware

- Trojans, trapdoors
- Buffer overflow
- Viruses, worms

Password files, salt

- What is the threat, how does the technique help

Biometrics vs. cheating

Security Overview

“Understand cryptography”

- What *secure* hashing is good for
- One-time pad
- Symmetric (private-key) crypto
 - Small, “password-like” keys
- Asymmetric (public-key) crypto
 - Has private keys and public keys
 - And, in practice, session keys
- Kerberos
 - Symmetric crypto
 - Central server avoids the n^2 key problem

Preparation Suggestions

Sleep well (*two* nights)

Scan lecture notes

Read any skipped textbook sections

- Well, the most-important ones, anyway

Understand the code you turned in

- Even what your partner wrote
- What are the hard issues, why?

Preparation Suggestions

Prepare a sheet of notes

Read comp.risks & Effective Java

- Ok, after the exam will suffice

Don't panic!

- Budget time wisely during exam
 - (don't get bogged down on one question)

15-410 on One Slide

What a process/thread *really is*

- (the novel-length version, not the fairy tale)

Concurrency & synchronization

- Issues, mechanisms, *hazards*

How the pieces of hardware fit together

- ...to make a “system” which can run “programs”

A sense of “what's out there” beyond the kernel

Skills for non-small software artifacts

- Design, debugging, partnering
- Documenting, source control

Closing Thought

To understand a program you must become both the machine and the program.

–Alan Perlis