

1. Last time
  2. Midterm logistics
  3. Class overview
  4. Your questions
- 

## 2. Logistics

- 75-minute exam
  - closed book
  - turn in your exam at minute  $x$ ,  $x < 65 \vee 75 \leq x < 78$
- One two-sided sheet of notes, with the specifications on the class web page

3. Class overview (not comprehensive, not guaranteed to be necessary or sufficient for exam)

## Material

- readings

- labs

- HWs

- lectures/classes

## Lectures/classes:

- OSes: what are they?
  - goals, purpose
- Processes:
  - process's view of memory, registers
  - stack frames
  - OS's view of processes
- System calls
- Process/OS control transfers
- Process birth: `fork()` / `exec()`
- Shell
- File descriptors
- Redirection, pipelines
- threads
- concurrency
  - hard to deal with! abstractions help (but not fully)

- critical sections
- mutexes
- spinlocks
- condition variables
- monitors

- lots of things can go wrong: safety problems, liveness problems, etc.

- lack of sequential consistency makes the problem worse

- safety: build primitives that get help from H/W

- liveness: various problems, including deadlock

- tradeoffs

- for example, performance vs. complexity

- "advice"

~ software safety (Therac-25)

- scheduling

- when scheduling happens, which metrics, what costs

- specific disciplines
- lessons + conclusions

- virtual memory

- intro

- paging

- page tables

- virtual memory on x86-64

virtual address: [0000 36 bits 12 bits]

entry in L1...L4 page tables

[40 bits more bits bottom 3 bits]

protection (u/s | w/R | P/NP)

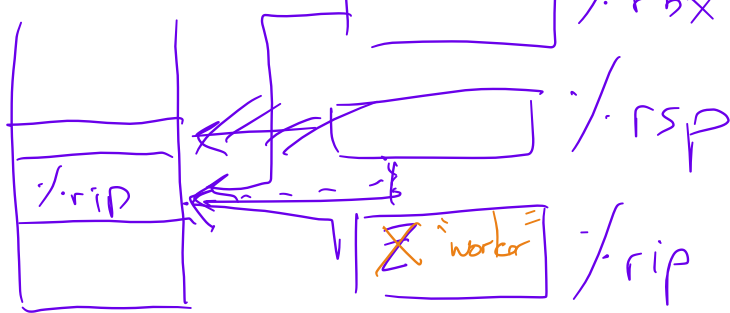
what's a TLB?

page faults  
mechanics

uses

costs

lib



call worker

~~movq %rip, %rbx~~

worker:

movq (%rsp), %rbx  
ret

rbx = \*rsp      rbx ← \*rsp  
vs.  
rbx = rsp      rbx ← rsp

spinlock: (Fall 2019)

- mutex

- atomic processor

- queue of quiescent waiters

- implicit mem. barrier

- deadlock detection

- ticketing algorithm

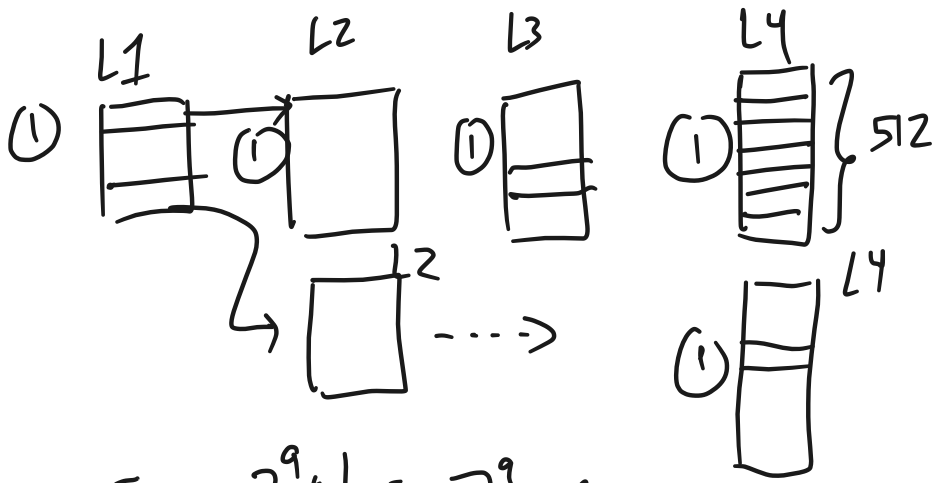
- busy waiting

- monitor

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FCFS

min phys. pages used by a process that make.  
 $2^9 + 1$  allocations of 4kB each.



$$5 + 2^9 + 1 = 2^9 + 6$$

