CS 537
Section 7
Programming Assignment 4

Michael Swift

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Quiz 5 answers

- Making threads be created one at a time
  - Call pthread-join(&threads[i]);
  - Call sem_wait() in main(), sem_signal() in print_hello
- Fixing locks:
  - No need to spin;
  - Initialize mutex to FALSE
  - Release mutex before returning
- More locking
  - Causes deadlock

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P4: File System Measurement

- Due date: Tuesday 12/15
- Goal: measure FS characteristics

- This is a group project
  - Email me by Wednesday, 12/2, if you want to change groups

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Measuring FS characteristics

- Block size
  - What is the smallest unit of data the file system will transfer to and from disk?
- Prefetch size
  - How much data does the FS read in advance when you read sequentially?
  - When you read sequential data, the FS may fetch more data than you want
    - Usually it gets your data, then keeps fetching more in the background
  - How much it fetches depends on:
    - How far into the file you are
    - Whether the block number is a multiple of 2,4,8,16,32, etc

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Multi-Level Indexed Files

- Variation of Indexed Allocation
  - Dynamically allocate hierarchy of pointers to blocks as needed
  - Meta-data: Small number of pointers allocated statically
    - Additional pointers to blocks of pointers
  - Examples: UNIX FFS-based file systems

double
indirect
indirect
indirect
triple
indirect
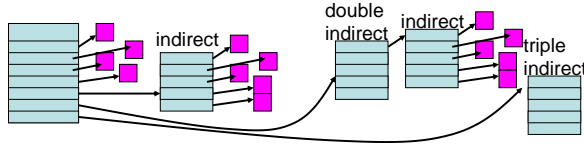
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Measuring FS characteristics

- Number of direct block pointers
  - File system stores indexes of some blocks directly with file, others are stored with indirect pointers
  - How many blocks can be directly referenced from the file?

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How to do this

- Disk access takes longer than memory access
  - ~1 ms for disk
  - ~1-10 microseconds for memory
- Figure out when the file system has to access the disk
  - Write code to force this to happen
  - Use time measurements to figure out when it does happen

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Timers

- You need precise timers to measure the difference between.
  - Use rdtsc() instruction on x86.

```
extern __inline__ unsigned long long int
  rdtsc() {
    unsigned long long int x;
    __asm__ volatile (".byte 0x0f, 0x31" : "=A"
     (x));
    return x;
}
```

  - This returns # of processor cycles since boot
    - Divide by MHz from /proc/cpu_info to convert

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Timers

- Other timers
  - Gettimeofday() returns data with microsecond precision but may not be accurate (microsecond value may not change)
  - Clock_gettime() can also be used
    - Use CLOCK_MONOTONIC _HR

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Test platforms

- Run tests on instructional linux machines
  - Measure files in /tmp
  - This uses ext3 file system
- You can develop/test code on any machine, but results must be from these machines
  - Don't try this on a Mac

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Hints

- The file system reads in extra block when you read sequentially
  - To bypass this, read backwards
- You need to control what is in the cache
  - Use O_DIRECT flag to open()
  - Use fadvice perl script
  - You may need some experimentation to get this right

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Working in groups

- Meet early to divide work
  - Schedule meetings and don't blow them off; that will hurt you grade
- Use source code control
  - Subversion, CVS, git, mercurial, etc.
- Make sure code compiles before you check it in
  - Don't make others do your dirty work
- Commit to when you will have things ready for others to use/test
  - And tell them in advance if you will not make the deadline
- Others?

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