What do these terms mean?

• Operating Systems
• Virtual
• Concurrent
Topics covered in this lecture

- Course Overview
- Expectations
- Introduction
All course materials will be on:
- the course webpage
  - [http://www.cs.colostate.edu/~cs370](http://www.cs.colostate.edu/~cs370)
- canvas

Schedule

Lectures

Assignments

Announcements

Grades will be posted on Canvas

The course website and canvas are live now
Contacting us

• Instructor
  Yashwant Malaiya
  Computer Science (CSB 356)
  Office Hours: 2-3 PM Wed, 10:50-11:50 Th,

• GTAs, Office Hours in CSB 120
  Matt Dragan, Th 3-5, Fri 11-1PM
  Abhishek Yeluri, Tu 6-8PM, F 1-3PM

• UTAs: Prerana Ghotge, Sean Thunquest
  – Help Desk hours: On course web site

• All e-mail should be sent to cs370@cs.colostate.edu
  – The subject should start as CS370: ...
Topics we will cover in CS 370

- Processes
  - Processes and Threads
  - CPU Scheduling
  - Process Synchronization and Deadlocks

- Memory Management
  - Address translation
  - Virtual memory

- File System interface and management
  - Storage Management
  - File systems

- Virtualization
Textbook

• Operating Systems Concepts, 9th edition
  Avi Silberschatz, Peter Galvin, and Greg Gagne
  Publisher - John Wiley & Sons, Inc.
  (The Dinosaur Book)

• May also use materials from other sources including
  – Andrew S Tanenbaum, Modern Operating Systems
  – Thomas Anderson and Michael Dahlin, Operating Systems Principles & Practice
  – S. Pallikara, R. Wakefield
  – System Documentation, articles, news etc.
On the schedule page

• Topics that will be covered and the order in which they will be covered
• Readings - chapters that I will cover
• May also see chapters mentions of other resources besides the textbook
• Schedule for when the assignments will be posted and when they are due
  – Subject to dynamic adjustment
Grading breakdown

• Assignments: 28%
  – Programming & written
• Quizzes 12%
  – On-line and in-class (iClicker: some unannounced)
• Mid Term: 20%
• Project: 15%
• Final exam: 25%
Grading Policy I

• Letter grades will be based on the following standard breakpoints:
  
  >= 90 is an A, >= 88 is an A-
  >=86 is a B+, >=80 is a B, >=78 is a B-
  >=76 is a C+, >=70 is a C,
  >=60 is a D, and <60 is an F.

• I will not cut higher than this, but I may cut lower.

• There will be no make-up exams
  – Except for documented
    • required university event
    • acceptable family or medical emergency
Grading Policy II

• Plan: Every programming assignment will be posted 12-14 days before the due date. Written assignments will be posted 6-7 days before due date.
  – Every assignment will include specifications and will indicate it will be graded.

• Late submission penalty: 10%/day for the first 2 days and a ZERO thereafter.

• Detailed submission instructions posted on course website.

• Plan: Assignments will be graded within 2 weeks of submission
What will Quizzes and Tests include?

• I will only ask questions about what I teach, or ask you to study,
  – If I didn’t teach it, I won’t ask from that portion
  – Some on-line quiz questions about current state of technology may require you to search for an answer on the web

• If the concepts were covered in my lectures/slides/assignments
  – You should be able to answer the questions
  – You should be able to apply the concepts

• I will try to avoid questions about arcane aspects of some esoteric device controller
Exams

• One mid-term (20%)
• The final exam is comprehensive, but more emphasis on the later part (25%)
• There will be 12-13 quizzes (in class or online) (12%)
  – we may convert some homework into on-line quizzes
• Programming (5-6) / written (2-3) assignments
  – 28% of your course grade
• In class quizzes: iclicker. If you walk into class more than 20 minutes late or leave early, there is an automatic 75% deduction.
Term Project

• Group based
  – Logistics to be determined
• Options:
  – Research paper on current/developing technology
    • Paper, presentation, poster-session (dept)
  – Development
    • IoT/Embedded system
  – More details later
• Topics
  – Suggested topics will be announced.
Electronic devices in lecture room

• Use of Laptops and other electronic devices are not permitted.

• Exception: Permitted only in the last row, with the pledge that you will
  – not distract others
  – use it only for class related note taking
  – turn off wireless

• Laptop use lowers student grades, experiment shows, Screens also distract laptop-free classmates

• The Case for Banning Laptops in the Classroom

• Laptop multitasking hinders classroom learning for both users and nearby peers
Be kind to everyone

• You will be courteous to fellow students, instructor and teaching assistants
  – Classroom, outside, discussion board

• Do not distract your peers
  – No chatting
  – No eating
  – No cellphone use
Help me help you

• Surveys at the end of a class
• You will provide a list of
  – 2 concepts you followed clearly
  – 2 concepts you had problems keeping up
• Questions of interest for the majority of the class will be addressed in the next class
Help Sessions

• Thursdays 5-5:45 PM, CS 425
• TAs will discuss key techniques and skills
  – Participation strongly encouraged
  – Slides and videos will be on the web site
  – You must be familiar with Help Session materials

• This week
  – C pointers, dynamic memory allocation
  – Needed for upcoming programming assignment
ABOUT ME: Yashwant K. Malaiya

My Research

• Computer security
  – Vulnerability discovery
  – Risk evaluation
  – Assessing Impact of security breaches
  – Vulnerability markets

• Hardware and software
  – Testing & test effectiveness
  – Reliability and fault tolerance

• Results have been used by industry, researchers and educators
About me

• Teaching
  – Computer Organization (CS270)
  – Operating systems (CS370)
  – Computer Architecture (CS470)
  – Fault tolerant computing (CS530)

• Professional
  – Organized International Conferences on Microarchitecture, VLSI Design, Testing, Software Reliability
  – Computer Science Accreditation: national & international
  – Professional lectures
EXPECTATIONS

• You are expected to attend all classes
• You must be present during the complete class
• Assignments have to be done individually
• Expect to work at least 6-8 hours per week outside of class
  – Designing, coding and testing programs
  – Reviewing material from class
  – Do research for the project
• If you miss a lecture?
  – Add about 3 hours per missed lecture
Expert view on How to fail this class?

• Believing that you can learn via osmosis
• Missing lectures
  – “If you don’t have the discipline to show up, you will most likely not have the discipline to catch up”
  – Procrastinating
• Get started on the assignments late. Note that they incorporate new concepts.
Interactions

• You must sign up for Piazza in Canvas
• You can have discussions with me, the GTA, UTAs, and your peers
• But note
  – No code can be exchanged under any circumstances
  – No one takes over someone else’s keyboard
  – No code may be copied and pasted from anywhere, unless provided by us
• Bumps are to be expected along the way
  – But you should get over this yourself
  – It will help you with the next problem you encounter
From Operator to Operating System

Switchboard Operator

Computer Operators

©UCB
Gordon Moore (co-founder of Intel) predicted in 1965 that the transistor density of semiconductor chips would double roughly every 18 months.

Microprocessors have become smaller, denser, and more powerful.

2X transistors/Chip Every 1.5 years
Called “Moore’s Law”
## Computer Performance Over Time

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Uniprocessor speed (MIPS)</td>
<td>1</td>
<td>200</td>
<td>2500</td>
<td>2.5K</td>
</tr>
<tr>
<td>CPU per computer</td>
<td>1</td>
<td>1</td>
<td>10+</td>
<td>10+</td>
</tr>
<tr>
<td>Processor MIPS/$</td>
<td>$100K</td>
<td>$25</td>
<td>$0.20</td>
<td>500K</td>
</tr>
<tr>
<td>DRAM Capacity (MiB)/$</td>
<td>0.002</td>
<td>2</td>
<td>1K</td>
<td>500K</td>
</tr>
<tr>
<td>Disk Capacity (GiB)/$</td>
<td>0.003</td>
<td>7</td>
<td>25K</td>
<td>10M</td>
</tr>
<tr>
<td>Home Internet</td>
<td>300 bps</td>
<td>256 Kbps</td>
<td>20 Mbps</td>
<td>100K</td>
</tr>
<tr>
<td>Machine room network</td>
<td>10 Mbps (shared)</td>
<td>100 Mbps (switched)</td>
<td>10 Gbps (switched)</td>
<td>1000</td>
</tr>
<tr>
<td>Ratio of users to computers</td>
<td>100:1</td>
<td>1:1</td>
<td>1:several</td>
<td>100+</td>
</tr>
</tbody>
</table>

Anderson Dahlin 2014
People-to-Computer Ratio Over Time

- Today: Multiple CPUs/person!
  - Approaching 100s?

From David Culler

- Number Crunching
- Data Storage
- Productivity interactive
- Streaming information to/from physical world
• *Retail* hard disk capacity in GB
What is an Operating System?

Diagram illustrating the components of an Operating System, including User-mode and Kernel-mode, with various components such as APP, System Library, Kernel-user Interface, File System, Virtual Memory, TCP/IP Networking, Scheduling, Hardware Abstraction Layer, Hardware-Specific Software and Device Drivers, Processors, Address Translation, Graphics Processor, and Network.
What is an Operating System?

• Referee
  – Manage sharing of resources, Protection, Isolation
    • Resource allocation, isolation, communication

• Illusionist
  – Provide clean, easy to use abstractions of physical resources
    • Infinite memory, dedicated machine
    • Higher level objects: files, users, messages
    • Masking limitations, virtualization

• Glue
  – Common services
    • Storage, Window system, Networking
    • Sharing, Authorization
    • Look and feel
A Modern processor: SandyBridge

• Package: LGA 1155
  – 1155 pins
  – 95W design envelope

• Cache:
  – L1: 32K Inst, 32K Data (3 clock access)
  – L2: 256K (8 clock access)
  – Shared L3: 3MB – 20MB (not out yet)

• Transistor count:
  – 504 Million (2 cores, 3MB L3)
  – 2.27 Billion (8 cores, 20MB L3)

• Note that ring bus is on high metal layers – above the Shared L3 Cache
Functionality comes with great complexity!

**SandyBridge I/O Configuration**
Short History of Operating Systems

• One application at a time
  – Had complete control of hardware

• Batch systems
  – Keep CPU busy by having a queue of jobs
  – OS would load next job while current one runs

• Multiple users on computer at same time
  – Multiprogramming: run multiple programs at seemingly at the “same time”

• Multiple processors in the same computer

1960s
80286 (1984)

Dual core
2004
One Processor One program View

Early processors, LC-3 is an example

• Instructions and data fetched from Main Memory using a program counter (PC)

• Traps and Subroutines
  – Obtaining address to branch to, and coming back
  – Using Stack Frames for holding
    • Prior PC, FP
    • Arguments and local variables

• Dynamic memory allocation and heap

• Global data
One Processor One program View

- External devices: disk, network, screen, keyboard etc.
- Device interface: Status and data registers
- **User and Supervisor modes** for processor
- I/O
  - Device drivers can use polling or **interrupt**
  - Interrupts need **context switch**
  - I/O done in supervisor mode
  - **System calls** invoke devise drivers
What introductory texts don’t include

• No cache
• Direct memory access (DMA) between Main Memory and Disk (or network etc)
  – Transfer by blocks at a time
• Neglecting the fact that memory access slower than register access
• Letting program run *concurrently* (Multiprogramming) or with many threads
• Multiple processors in the system (like in Multicore)
Information transfer in a system

• CPU Registers – (Caches) - Memory
  – CPU addresses memory locations
  – Bytes/words at a time
  – We will see some details

• Memory – (Controllers hw/sw) - external devices
  – Chunks of data
  – External devices have their own timing
    • DMA with interrupts
  – Disk is external!
I/O Hardware (Cont.)

- I/O Devices usually have registers where device driver places commands, addresses, and data
  - Data-in register, data-out register, status register, control register
  - Typically 1-4 bytes, or FIFO buffer

- Devices have addresses, used by
  - Direct I/O instructions
  - Memory-mapped I/O
    - Device data and command registers mapped to processor address space