CSE 421/521 - Operating Systems
Fall 2014

Lecture - I
Introduction

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University at Buffalo
August 26th, 2014

Contact Information

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Recitations

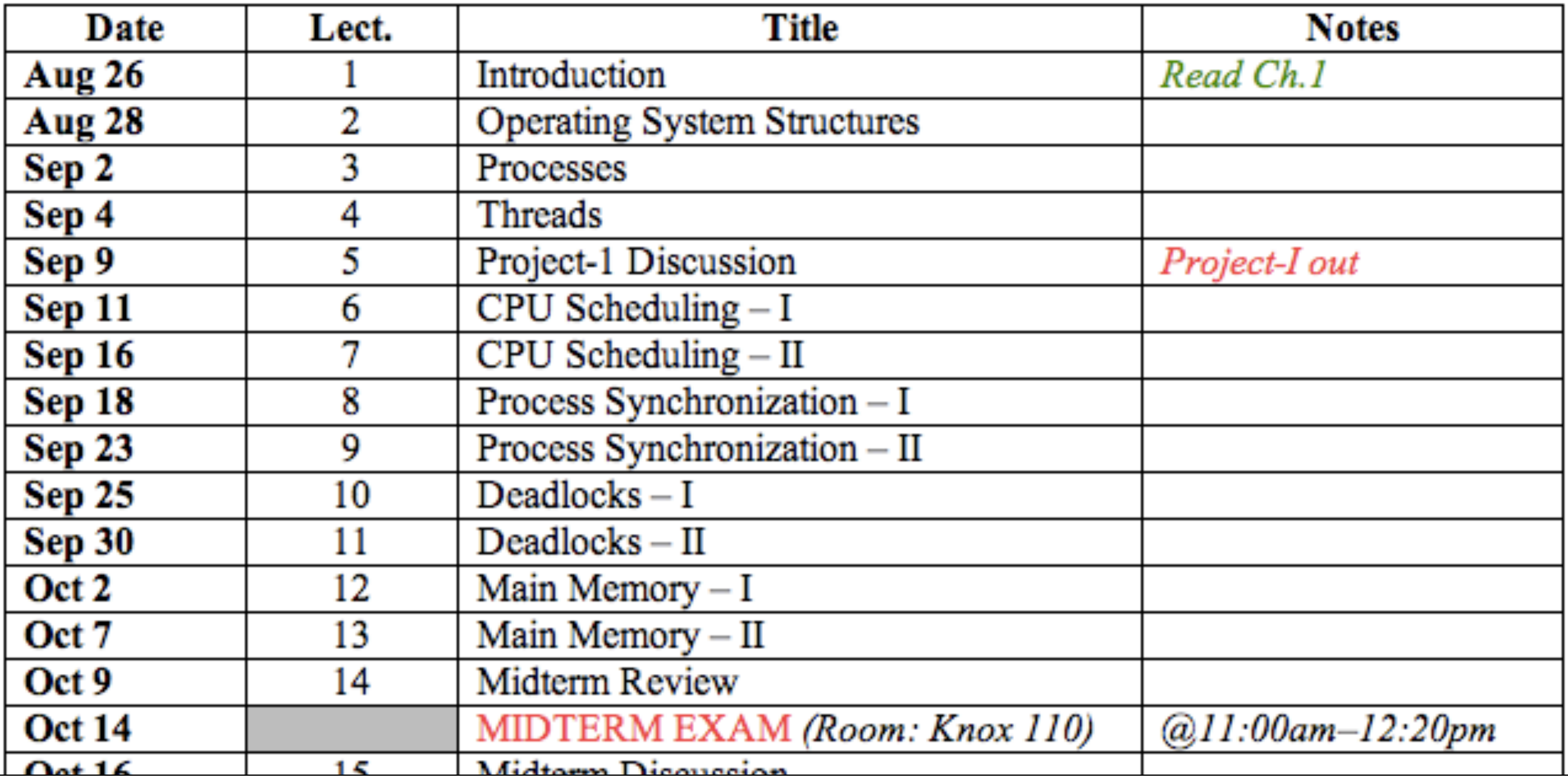
- The undergrads need to attend one of the following recitations:
  - Tue 3:00pm - 3:50pm
  - Wed 10:00am - 10:50am
  - * Recitations will start next week

- Recitations will include:
  - Clarification of some important course material
  - Solutions of quiz, HW, and other exercise questions
  - Project guidance
  - Programming tips

- PS: undergrads only, no grads allowed in recitations!

Course Web Page

- Course web page:
  - http://www.cse.buffalo.edu/faculty/tkosar/cse421-521_fall2014/
  - Important course related information will be available here, such as important dates, course schedule, and any changes to the schedule.



Date	Lect.	Title	Notes
Aug 26	1	Introduction	*Read Ch.1*
Aug 28	2	Operating System Structures	
Sep 2	3	Processes	
Sep 4	4	Threads	
Sep 9	5	Project-1 Discussion	*Project-I out*
Sep 11	6	CPU Scheduling – I	
Sep 16	7	CPU Scheduling – II	
Sep 18	8	Process Synchronization – I	
Sep 23	9	Process Synchronization – II	
Sep 25	10	Deadlocks – I	
Sep 30	11	Deadlocks – II	
Oct 2	12	Main Memory – I	
Oct 7	13	Main Memory – II	
Oct 9	14	Midterm Review	
Oct 14		MIDTERM EXAM *(Room: Knox 110)*	*@11:00am–12:20pm*
Oct 16	15	Midterm Discussion	

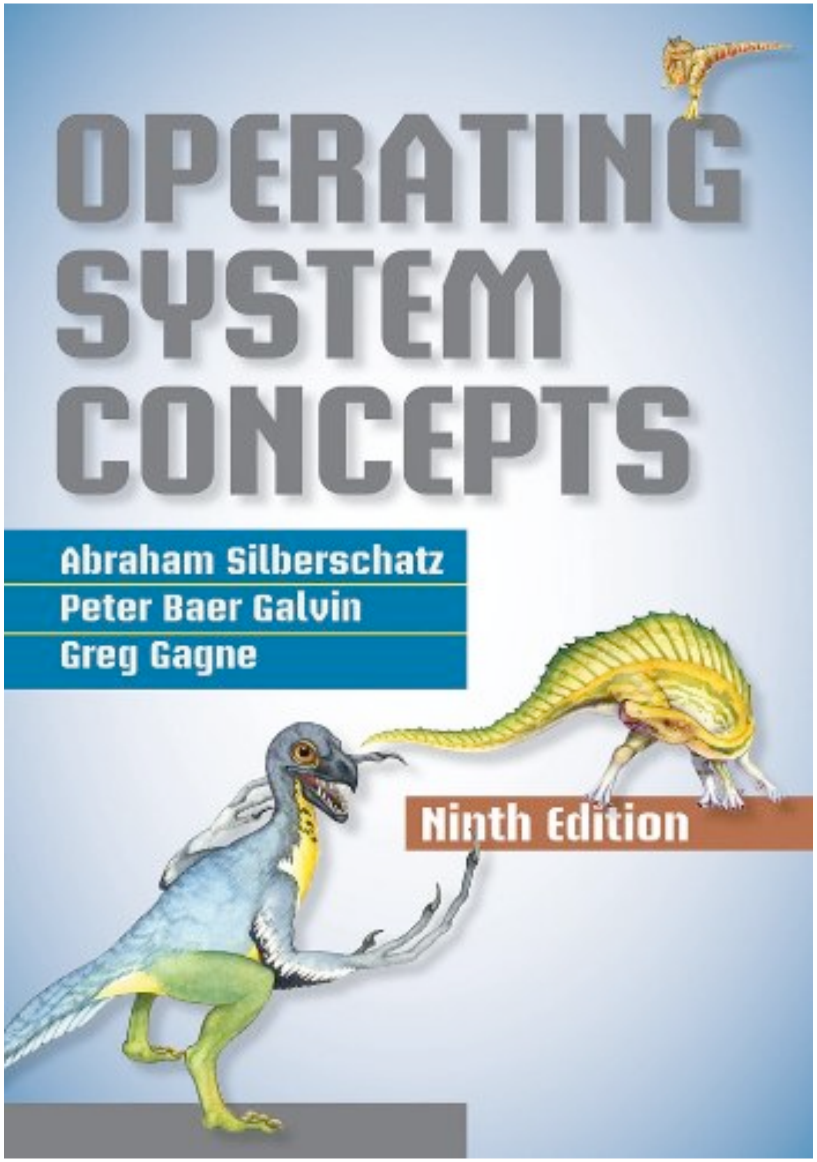
Piazza Discussion Forum

- We will be using Piazza for class discussion. The system is highly catered to getting you help fast and efficiently from classmates, the TA, and myself.
- Rather than emailing questions to the teaching staff, I encourage you to post your questions on Piazza.
- All lecture notes, important links and other documents will be posted to Piazza
- Find our class page at: https://piazza.com/buffalo/fall2014/cse421521/home

Course Syllabus

- Available online at:
- https://piazza.com/buffalo/fall2014/cse421521/resources

Textbook: Required

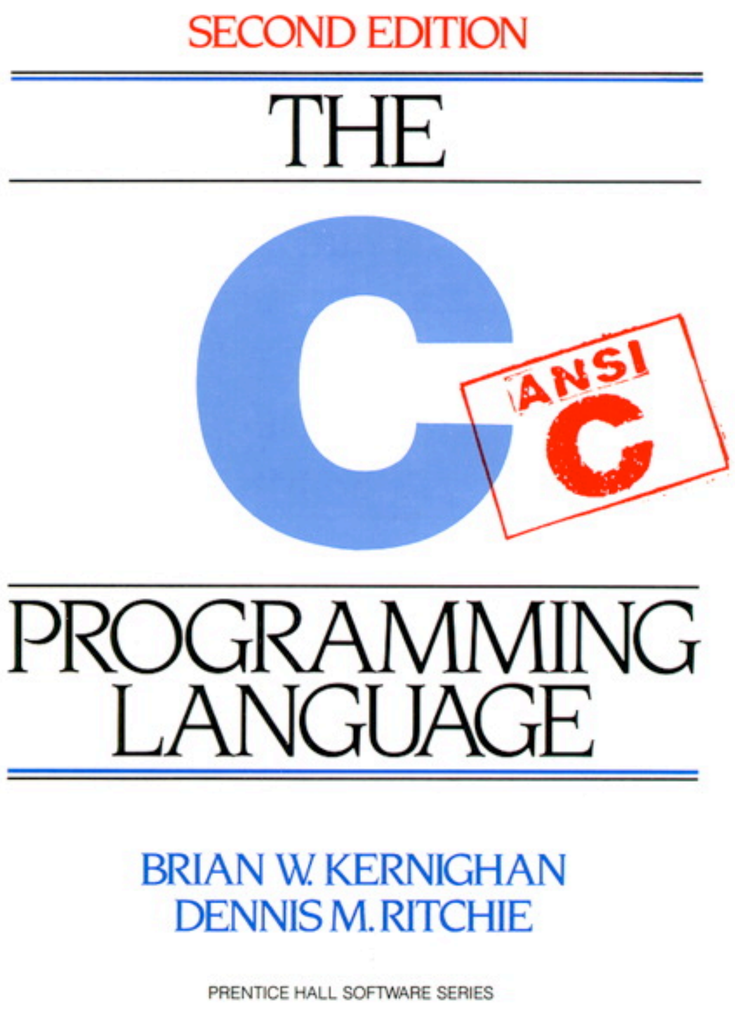


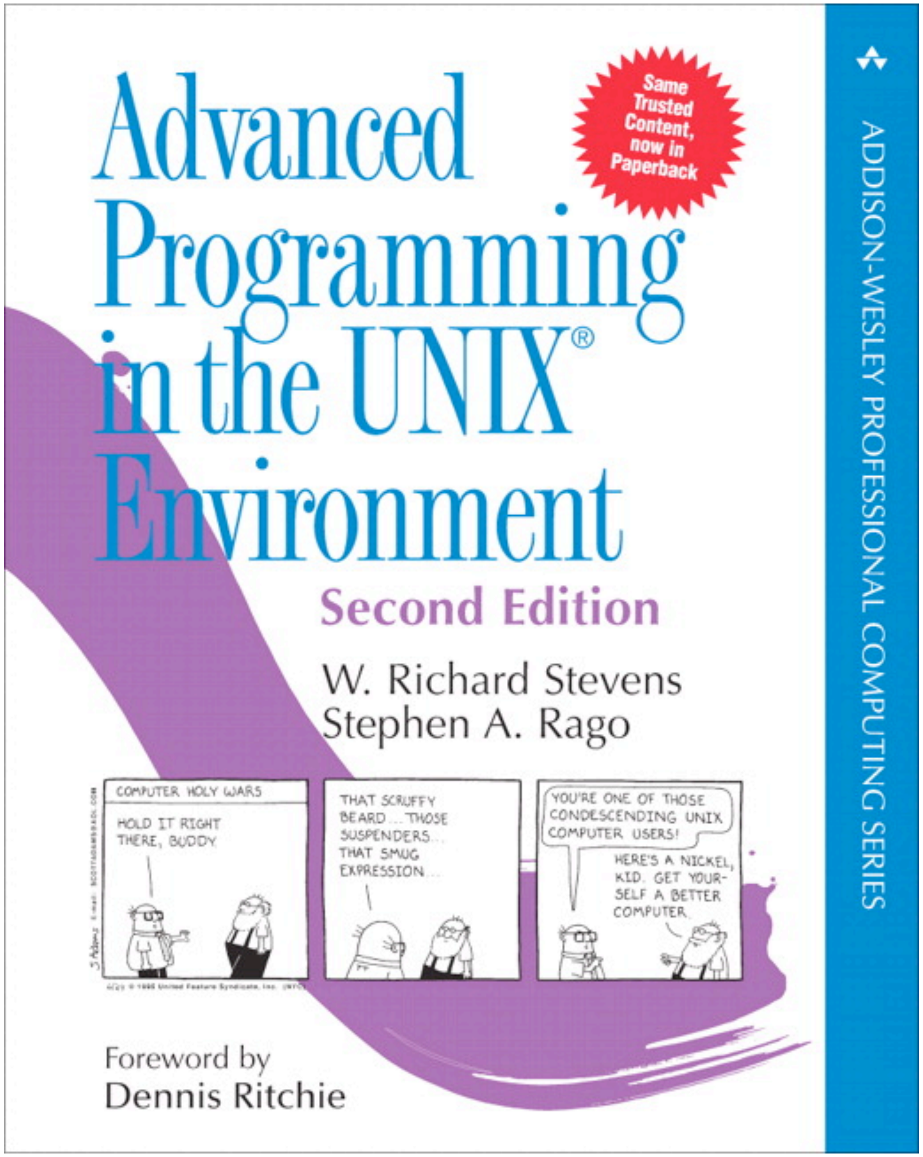
OPERATING SYSTEM CONCEPTS

Abraham Silberschatz
Peter Baer Galvin
Greg Gagne

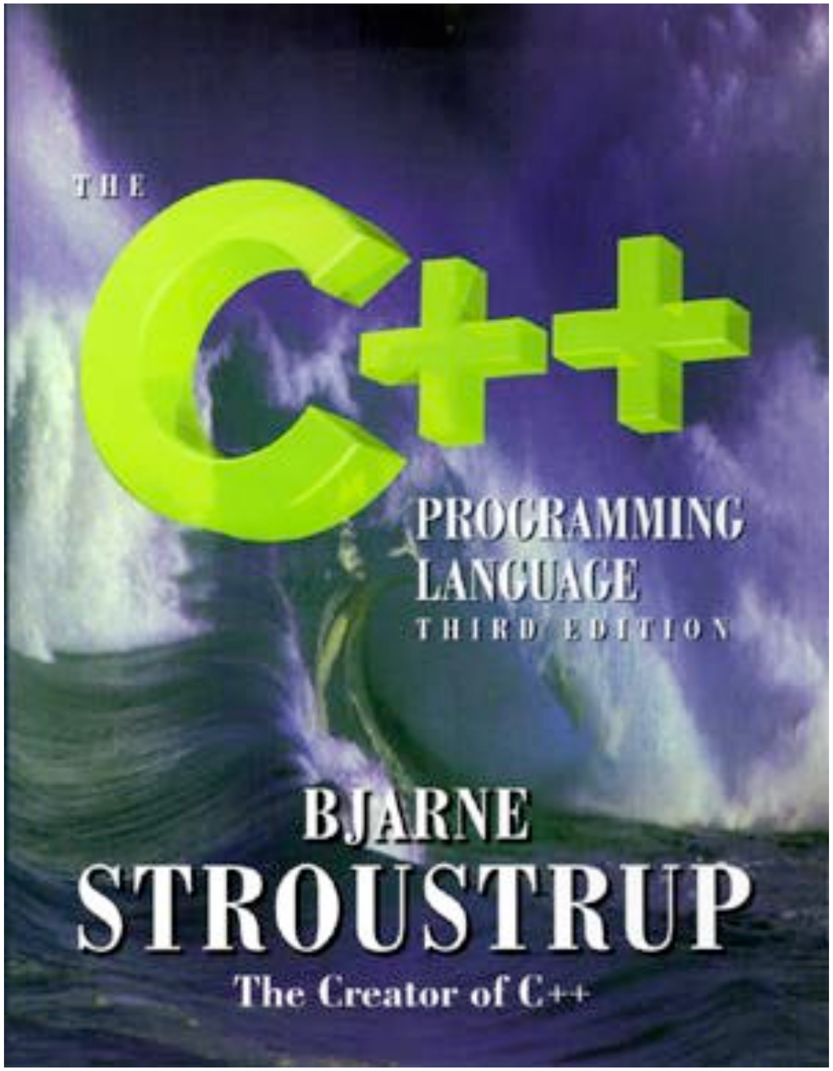
Ninth Edition

Recommended Supplementary Text




Advanced Programming in the UNIX® Environment
Same Trusted Content, now in Paperback
Second Edition
W. Richard Stevens
Stephen A. Rago
COMPUTER HOLY WARS
HOLD IT RIGHT THERE, BUDDY.
THAT SCRUFFY BEARD ... THOSE SUSPENDERS ... THAT SMUG EXPRESSION ...
YOU'RE ONE OF THOSE CONDESCENDING UNIX COMPUTER USERS!
HERE'S A NICKEL, KID. GET YOURSELF A BETTER COMPUTER.
Foreword by Dennis Ritchie
ADDISON-WESLEY PROFESSIONAL COMPUTING SERIES

Recommended Supplementary Text



Grade Components

- The end-of-semester grades will be composed of:

Pop Quizzes	: 5%	(5; 4 counted)
Projects	: 40%	(2)
Midterm	: 25%	(1)
Final	: 30%	(1)

* You are expected to attend the classes and actively contribute via asking and/or answering questions.

Pop Quizzes

- There may be pop quizzes at the beginning of some classes.
- The questions in the quizzes will come mostly from the material discussed in the previous lecture(s) or homework assignment(s).
- The quizzes will be very short (5-10 min) with one or two questions aiming to test whether you have understood the most recently discussed material in the curse.
- There will be 5 pop quizzes throughout the semester. One with the lowest grade will be discarded, and the rest four will count toward your final degree.

Homework

- There will be four homework assignments throughout the semester.

- The format of the homework questions will be similar to the exercises at the end of each chapter in the Silberschatz book.

- The homework assignments aim to ensure that you read the textbook and study regularly for the material covered in the class.

- The homework assignments will not be graded.

Projects

- There will be two hands-on programming projects throughout the course.

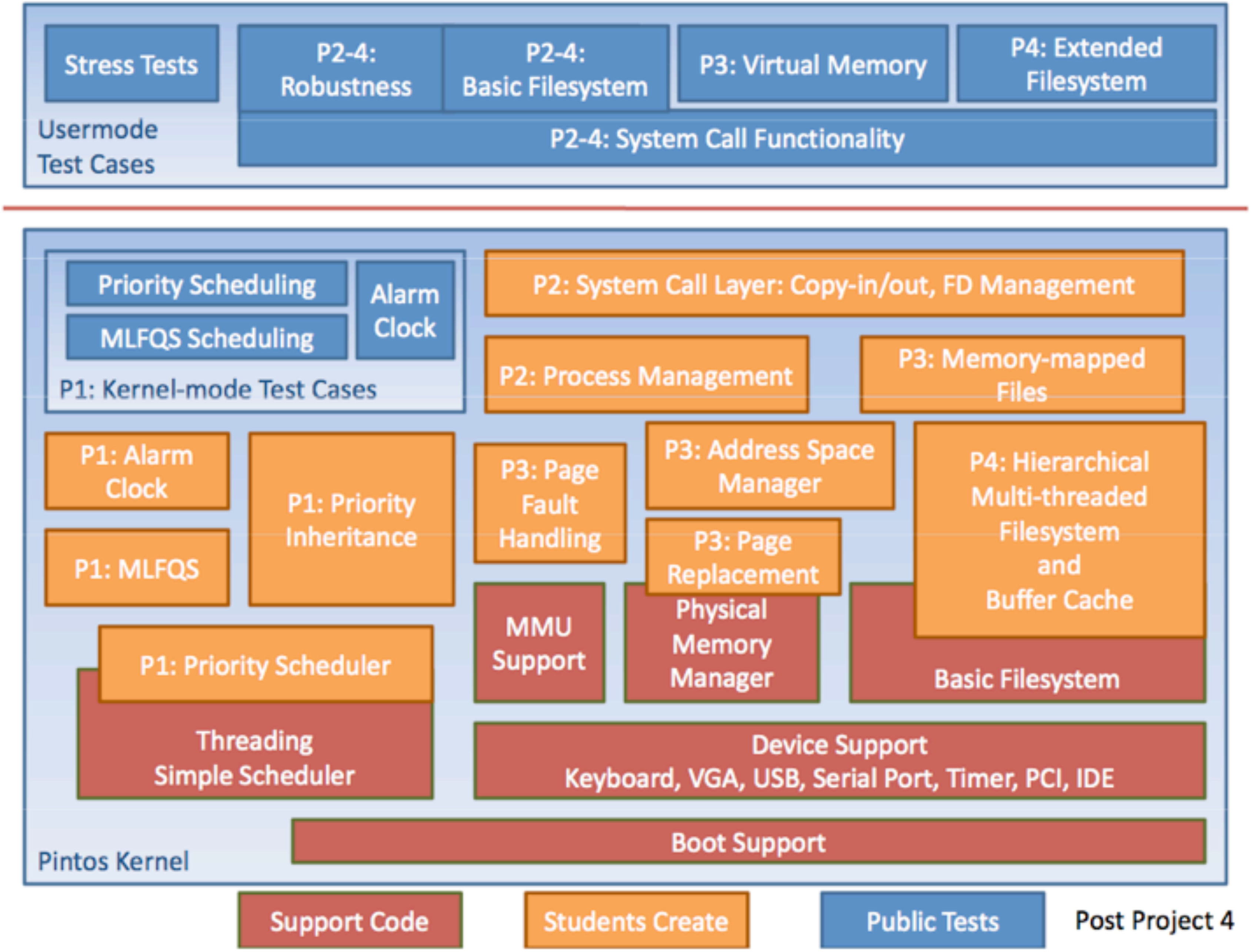
- These projects will aim to implement some core Operating System components at the kernel-level for better understanding of the concepts.

- These will be “individual” projects and they will require strong programming background (in C/C++) and UNIX programming experience.

Projects *(cont.)*

- Both projects will be based on Pintos operating system.
- Pintos is a simple operating system framework for the 80x86 architecture developed at Stanford University.
- http://www.cse.buffalo.edu/faculty/tkosar/cse421-521_fall2013/projects/project-2/WWW/pintos.pdf

Pintos Sample Projects



Grading Scale

- Final grades will be given according to this scale -->

* I will use “curve” to adjust grades (up) to this scale.

* There will be separate curves for graduate & undergraduate students!

90-100:	A
85-89.9:	A-
80-84.9:	B+
75-79.9:	B
70-74.9:	B-
65-69.9:	C+
60-64.9:	C
55-59.9:	C-
50-54.9:	D+
40-49.9:	D
0 - 39.9:	F

Rules

- No use of laptops/phones during the lectures!
- No late project submissions accepted!
- Exams will be closed book.
- You are only responsible from material covered in the class, homework, and projects.
- Academic dishonesty will be treated “very” seriously!

Academic Dishonesty

- There is a very fine line separating conversation pertaining to concepts and academic dishonesty. You are allowed to converse about general concepts, but in no way are you allowed to share code or have one person do the work for others. If you are caught violating the academic integrity policy, you will minimally receive an "F" in the course.
- We are using professional software which can easily detect any cheating attempts in programming projects. The results generated by this software is considered as official evidence for cheating from another student, or from internet or any other resource.

Academic Dishonesty *(cont.)*

- It is required as part of this course that you read and understand the departmental academic integrity policy located at the following URL:

- http://www.cse.buffalo.edu/undergrad/current_students/policy_academic.php

Passive vs Active Learning

Passive learning: learning through reading, hearing & seeing

Active learning: learning through saying and doing

After 2 weeks, we tend to remember:

Passive learning

- 10% of what we read
- 20% of what we hear
- 30% of what we see (i.e. pictures)
- 50% of what we hear and see

Active learning

- 70% of what we say
- 90% of what we say and do

How to Become an Active Learner

- Recall prior materials
- Answer a question
- Guess the solution first (even guessing wrong will help you to remember the right approach)
- Work out the next step before you have to read on
- Think of an application
- Imagine that you were the professor and think about how you would give a test on the subject material so that key concepts and results will be checked.
- Summarize a lecture, a set of homework or a lab in your own words concisely.

What Expect to Learn?

- Key Concepts of Operating Systems
  - Design, Implementation, and Optimization

- Topics will include:
  - Processes, Threads and Concurrency
  - CPU and I/O Scheduling
  - Memory and Storage Management
  - File System Structures
  - Synchronization and Deadlocks
  - Protection and Security
  - Distributed Computing & Related Issues

Introduction

What is an Operating System?

- It is a program
- It is a big hairy program
  - The Linux source code has more than 1.7 M lines of C code
- A program that manages the computer hardware
- An intermediary between the computer user and the computer hardware
- Manages hardware and software resources of a computer

Computer System Overview

- **A computer system consists of (bottom-up):**

1. hardware
2. firmware (BIOS)
3. operating system
4. system programs
5. application programs
6. users

Computer System Overview

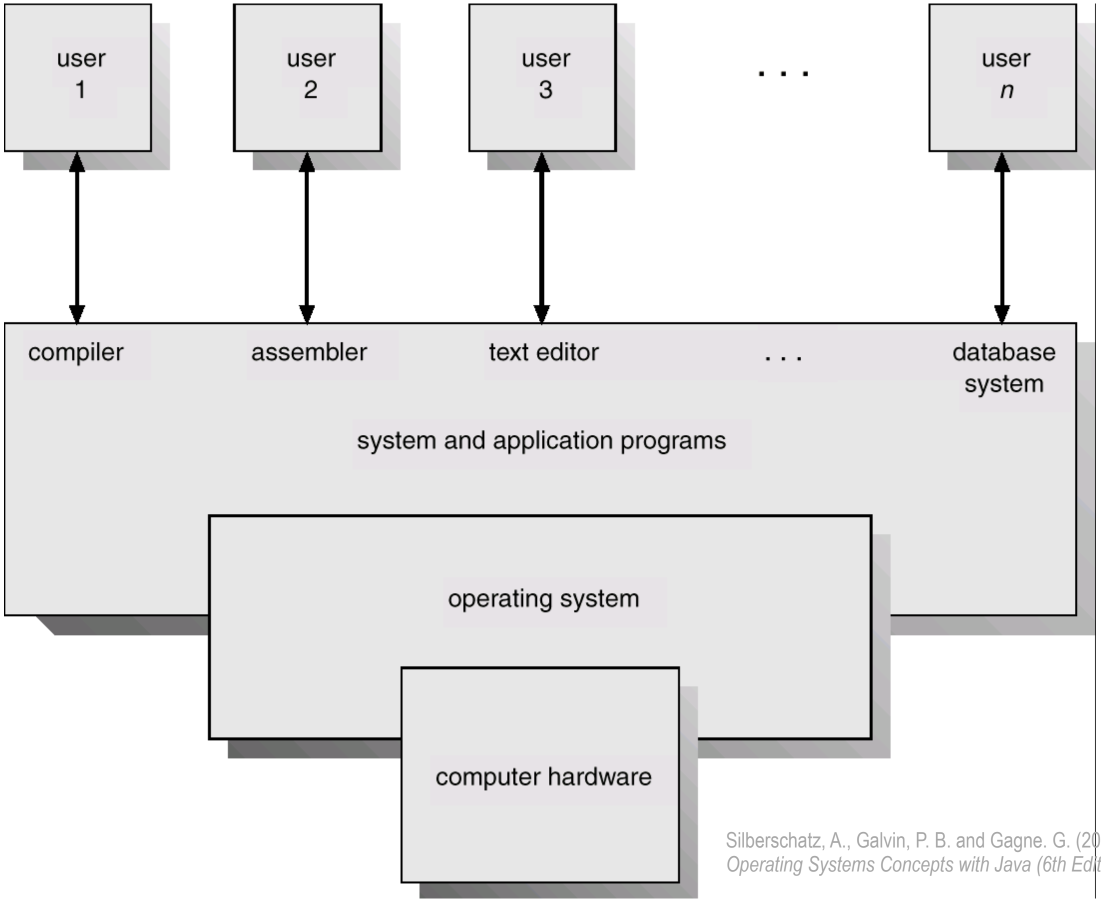
1. Hardware
   - ✓ provides basic computing resources
   - ✓ CPU, memory, disk, other I/O devices
2. Firmware (BIOS)
   - ✓ software permanently stored on chip (but upgradable)
   - ✓ loads the operating system during boot
3. Operating system
   - ✓ controls and coordinates the use of the hardware among the various application programs for the various users

Computer System Overview

4. System programs
   - ✓ basic development tools (shells, compilers, editors, etc.)
   - ✓ not strictly part of the core of the operating system
5. Application programs
   - ✓ define the logic in which the system resources are used to solve the computing problems of the users
   - ✓ database systems, video games, business programs, etc.
6. Users
   - ✓ people, other computers, machines, etc.

Role of an Operating System

- **The Silberschatz "pyramid" view**

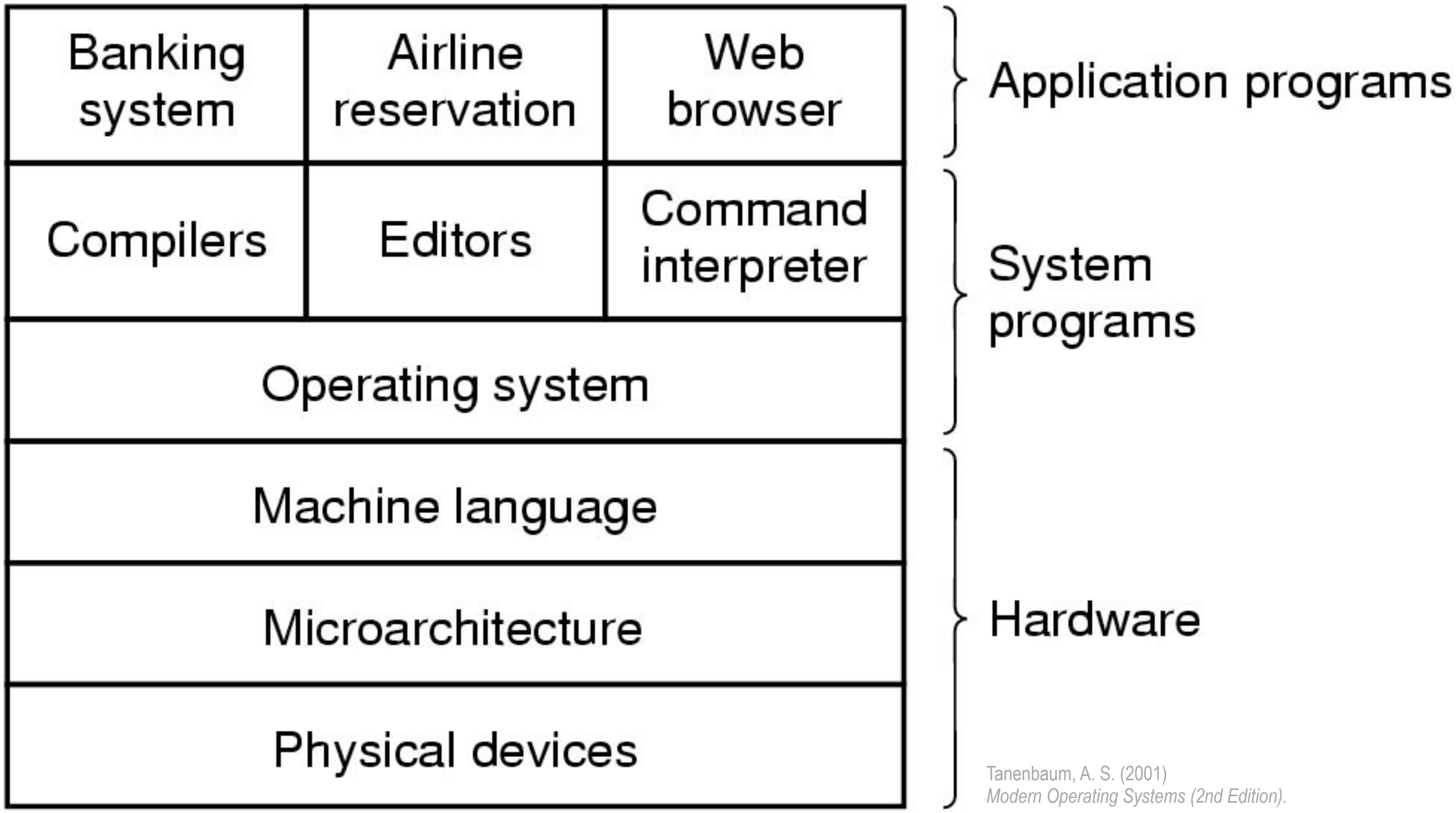


Silberschatz, A., Galvin, P. B. and Gagne. G. (2003) *Operating Systems Concepts with Java (6th Edition).*

Abstract view of the components of a computer system

Role of an Operating System

- **The Tanenbaum "layered" view**



Banking system | Airline reservation | Web browser — Application programs

Compilers | Editors | Command interpreter

Operating system — System programs

Machine language

Microarchitecture

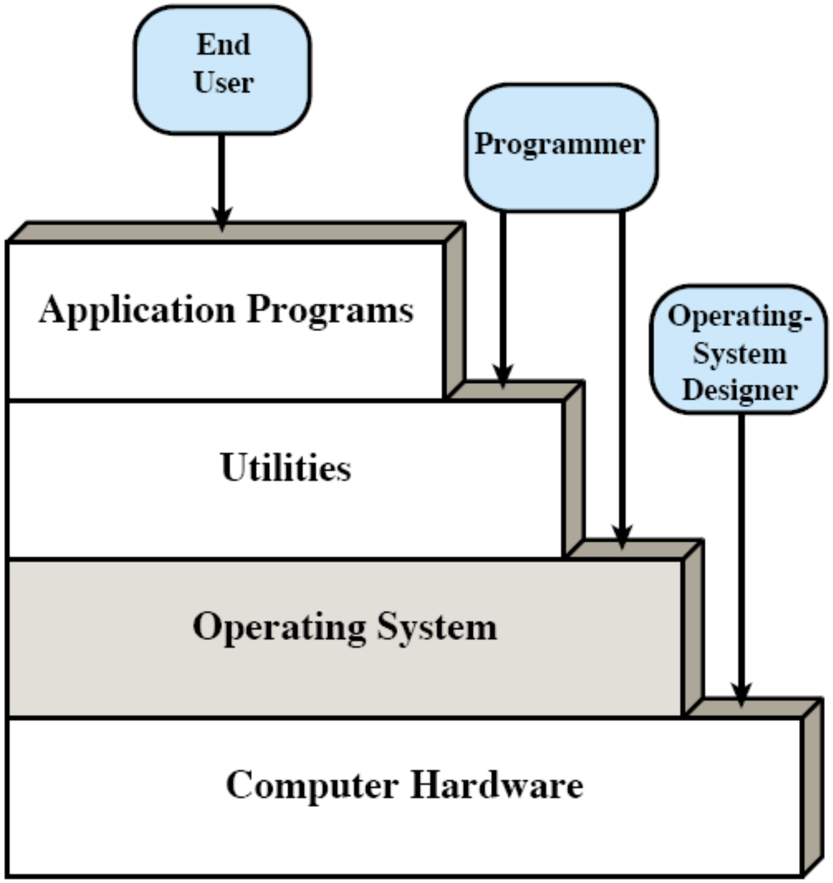
Physical devices — Hardware

Tanenbaum, A. S. (2001)
Modern Operating Systems (2nd Edition).

A computer system consists of hardware, system programs and application programs

Role of an Operating System

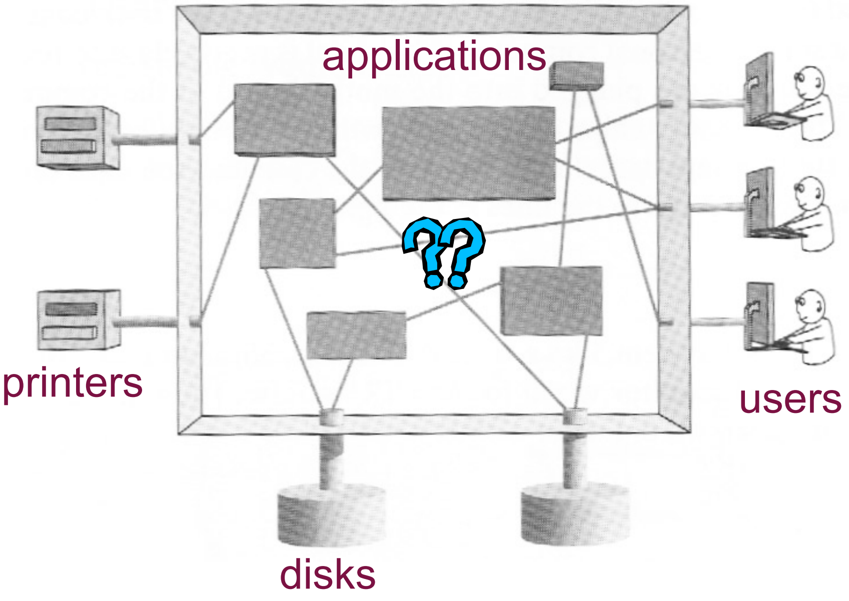
- **The Stallings "layered & stairs" view**



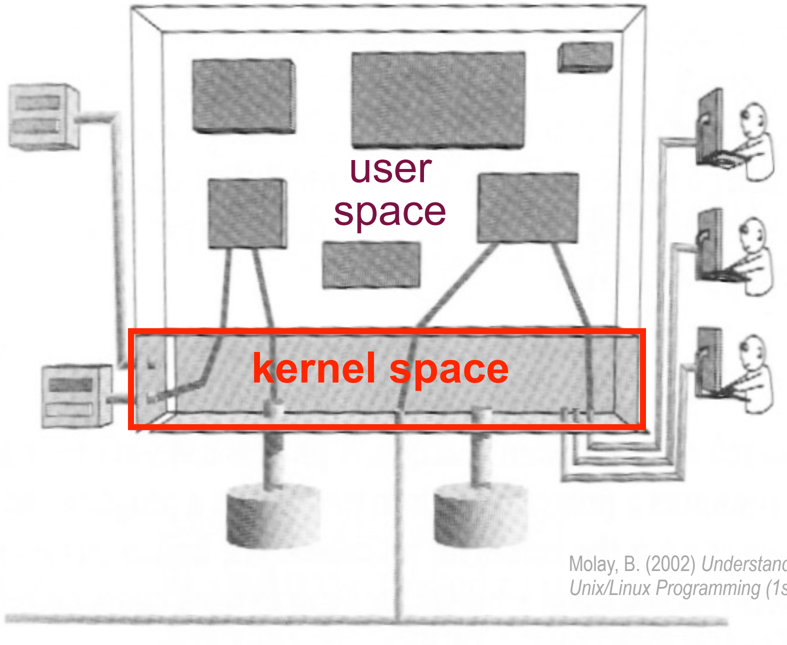
Layers and views of a computer system

Role of an Operating System

- **The Molay “aquarium” view**
  - the only not-layered view
  - everything must transit through the O/S or “kernel”



How are they all connected?



Molay, B. (2002) *Understanding Unix/Linux Programming (1st Edition).*

The kernel manages all connections

Key Point

- An operating system is a program that acts as an intermediary between users/applications and the computer hardware.

Operating System Goals

- From the user perspective:
  - Executes user programs and make solving user problems easier
  - Makes the computer system convenient to use
    - hides the messy details which must be performed
    - presents user with a virtual machine easier to use

- From the System/HW Perspective:
  - Manages the resources
  - Uses the computer hardware in an efficient manner
    - time sharing: each program gets some time to use a resource
    - resource sharing: each program gets a portion of a resource

OS Services for Users

- Program Execution
  - The OS loads programs and data into memory, initializes I/O devices and files, schedules the execution of programs

- Access to I/O Devices
  - The OS hides I/O device details from applications (direct I/O access is forbidden) and offers a simplified I/O interface

- Controlled Access to Files & Directories
  - The OS organizes data into files and directories, controls access to them (i.e. create, delete, read, write) and preserves their integrity

OS Services for Users

- Communications
  - The OS allows exchange of information between processes, which are possibly executing on different computers

- Error Detection and Response
  - The OS properly handles HW failures and SW errors with the least impact to running applications (i.e. terminating, retrying, or reporting)

OS Services for System/HW

- Resource Allocation
  - The OS allocates resources to multiple users and multiple jobs running at the same time
- Operation Control
  - The OS controls the execution of user programs and operations of I/O devices
- System Access
  - The OS ensures that all access to resources is protected, including authorization, conflict resolution etc.
- Accounting and Usage Statistics
  - The OS keeps performance monitoring data

The Major OS Issues

- **structure**: how is the OS organized?
- **sharing**: how are resources shared across users?
- **naming**: how are resources named (by users or programs)?
- **security**: how is the integrity of the OS and its resources ensured?
- **protection**: how is one user/program protected from another?
- **performance**: how do we make it all go fast?
- **reliability**: what happens if something goes wrong (either with hardware or with a program)?
- **extensibility**: can we add new features?
- **communication**: how do programs exchange information, including across a network?

More OS Issues..

- **concurrency**: how are parallel activities (computation and I/O) created and controlled?
- **scale**: what happens as demands or resources increase?
- **persistence**: how do you make data last longer than program executions?
- **distribution**: how do multiple computers interact with each other?
- **accounting**: how do we keep track of resource usage, and perhaps charge for it?

There are tradeoffs, not right and wrong!

Summary

- What is an OS?
- Role of an OS
- Operating System Goals
  - User View vs System View
- Operating System Services
  - For Users and HW

- Reading Assignment: Chapters 1 & 2 from Silberschatz.

Acknowledgements

- “Operating Systems Concepts” book and supplementary material by A. Silberschatz, P. Galvin and G. Gagne
- “Operating Systems: Internals and Design Principles” book and supplementary material by W. Stallings
- “Modern Operating Systems” book and supplementary material by A. Tanenbaum
- R. Doursat and M. Yuksel from UNR, Ed Lazowska from UWashington