Module 3: Operating-System Structures

- System Components
- Operating System Services
- System Calls
- System Programs
- System Structure
- Virtual Machines
- System Design and Implementation
- System Generation

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Common System Components

- Process Management
- Main Memory Management
- Secondary-Storage Management
- I/O System Management
- File Management
- Protection System
- Networking
- Command-Interpreter System

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Process Management

- A process is a program in execution. A process needs certain resources, including CPU time, memory, files, and I/O devices, to accomplish its
- The operating system is responsible for the following activities in connection with process management.
 - Process creation and deletion.
 - process suspension and resumption.
 - Provision of mechanisms for:*process synchronization
 - *process communication

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Main-Memory Management

- The operating system is responsible for the following activities in connections with memory management:
 - Keep track of which parts of memory are currently being used and by whom.
 - Decide which processes to load when memory space becomes available.
 - Allocate and deallocate memory space as needed.

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Secondary-Storage Management

 Since main memory (primary storage) is volatile and too small to accommodate all data and programs permanently, the computer system must provide secondary storage to back up main memory.

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Secondary-Storage Management

- Most modern computer systems use disks as the principle on-line storage medium, for both programs and data.
- The operating system is responsible for the following activities in connection with disk management:
 - Free space management
 - Storage allocation
 - Disk scheduling

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I/O System Management

- The I/O system consists of:
 - A buffer-caching system
 - A general device-driver interface
 - Drivers for specific hardware devices

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File Management

- A file is a collection of related information defined by its creator. Commonly, files represent programs (both source and object forms) and data.
- The operating system is responsible for the following activities in connections with file management:
 - File creation and deletion.
 - Directory creation and deletion.
 - Support of primitives for manipulating files and directories.
 - Mapping files onto secondary storage.
 - File backup on stable (nonvolatile) storage media.

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Protection System

- Protection refers to a mechanism for controlling access by programs, processes, or users to both system and user resources.
- The protection mechanism must:
 - distinguish between authorized and unauthorized usage.
 - specify the controls to be imposed.
 - provide a means of enforcement.

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Networking (Distributed Systems)

- A distributed system is a collection processors that do not share memory or a clock. Each processor has its own local memory.
- The processors in the system are connected through a communication network.
- A distributed system provides user access to various system resources.
- Access to a shared resource allows:
 - Computation speed-up
 - Increased data availability
 - Enhanced reliability

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Command-Interpreter System

- Many commands are given to the operating system by control statements which deal with:
 - process creation and management
 - I/O handling
 - secondary-storage management
 - main-memory management
 - file-system access
 - protection
 - networking

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Command-Interpreter System (Cont.)

- The program that reads and interprets control statements is called variously:
 - control-card interpreter
 - command-line interpreter
 - shell (in UNIX)

Its function is to get and execute the next command statement.

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Operating System Services

- Program execution system capability to load a program into memory and to run it.
- I/O operations since user programs cannot execute I/O operations directly, the operating system must provide some means to perform I/O.
- File-system manipulation program capability to read, write, create, and delete files.

Operating System Concepts

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Operating System Services

- Communications exchange of information between processes executing either on the same computer or on different systems tied together by a network. Implemented via shared memory or message passing.
- Error detection ensure correct computing by detecting errors in the CPU and memory hardware, in I/O devices, or in user programs.

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Additional Operating System Functions

Additional functions exist not for helping the user, but rather for ensuring efficient system operations.

- Resource allocation allocating resources to multiple users or multiple jobs running at the same time.
- Accounting keep track of and record which users use how much and what kinds of computer resources for account billing or for accumulating usage statistics.
- Protection ensuring that all access to system resources is controlled.

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System Calls

- System calls provide the interface between a running program and the operating system.
 - Generally available as assembly-language instructions.
 - Languages defined to replace assembly language for systems programming allow system calls to be made directly (e.g., C. Bliss, PL/360)

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System Calls

- Three general methods are used to pass parameters between a running program and the operating system.
 - Pass parameters in registers.
 - Store the parameters in a table in memory, and the table address is passed as a parameter in a register.
 - Push (store) the parameters onto the stack by the program, and pop off the stack by operating system.

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System Programs

- System programs provide a convenient environment for program development and execution. They can be divided into:
 - File manipulation
 - Status information
 - File modification
 - Programming language support
 - Program loading and execution
 - Communications
 - Application programs
- Most users' view of the operation system is defined by system programs, not the actual system calls.

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System Structure - Simple Approach

- MS-DOS written to provide the most functionality in the least space
 - not divided into modules
 - Although MS-DOS has some structure, its interfaces and levels of functionality are not well separated

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MS-DOS Layer Structure Application program Resident system program MS-DOS device drivers ROM BIOS device drivers Departing System Concepts 3.20 Lattice 2012 - Siberschatz and Clahin 6-1999

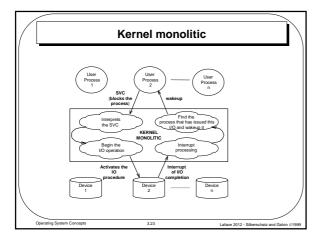
System Structure – Simple Approach (Cont.)

- The original UNIX operating system had limited structuring.
- The UNIX OS consists of two separable parts.
 - Systems programs
 - The kernel
 - *Consists of everything below the system-call interface and above the physical hardware
 - Provides the file system, CPU scheduling, memory management, and other operatingsystem functions; a large number of functions for one level.

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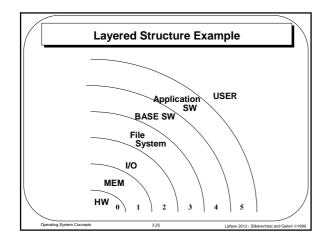
UNIX System Structure USERS SHELL AND COMMANDS COMPILERS AND INTERPRETERS SYSTEM LIBRARIES KERNEL INTERFACE (SYSTEM CALL) SIGNAL - TERMINAL, DISKS, TAPE, ... DRIVERDEVICE MNG (RAW AND BLOCKS) - FILE SYSTEM CPU SCHEDULING - MEMORY PAGING HW KERNEL INTERFACE TERMINAL DISK MEMORY CONTROLLER ... DISK MEMORY CONTROLLER ... CONTROLLER ...



System Structure - Layered Approach

- The operating system is divided into a number of layers (levels), each built on top of lower layers.
 The bottom layer (layer 0), is the hardware; the highest (layer N) is the user interface.
- With modularity, layers are selected such that each uses functions (operations) and services of only lower-level layers.

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Layered Structure of the THE OS

- A layered design was first used in THE operating system.
 Its six layers are as follows:
 - layer 5: user programs
 - layer 4: buffering for input and output
 - layer 3: operator-console device driver
 - layer 2: memory management
 - layer 1: CPU scheduling
 - layer 0: hardware

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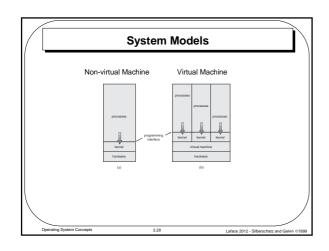
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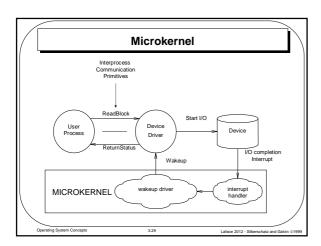
Virtual Machines

- A virtual machine takes the layered approach to its logical conclusion. It treats hardware and the operating system kernel as though they were all hardware.
- A virtual machine provides an interface *identical* to the underlying bare hardware.
- The operating system creates the illusion of multiple processes, each executing on its own processor with its own (virtual) memory.

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System Design Goals

- User goals operating system should be convenient to use, easy to learn, reliable, safe, and fast.
- System goals operating system should be easy to design, implement, and maintain, as well as flexible, reliable, error-free, and efficient.

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Mechanisms and Policies

 Mechanisms determine how to do something, policies decide what will be done.

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The separation of policy from mechanism is a very important principle, it allows maximum flexibility if policy decisions are to be changed later.	
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