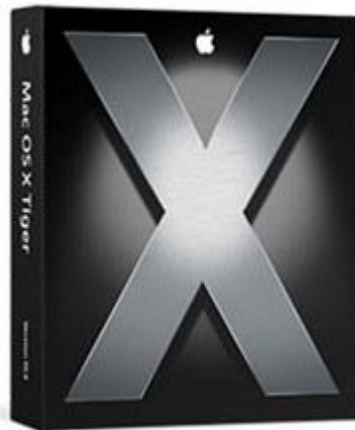


# Chapter 10

## Operating Systems



# Chapter Goals

- Describe the **two main responsibilities** of an operating system
- Define **memory** and **process management**
- Explain how **timesharing** creates the **virtual machine illusion**
- Explain the relationship between **logical** and **physical addresses**
- Compare and contrast **memory management techniques**

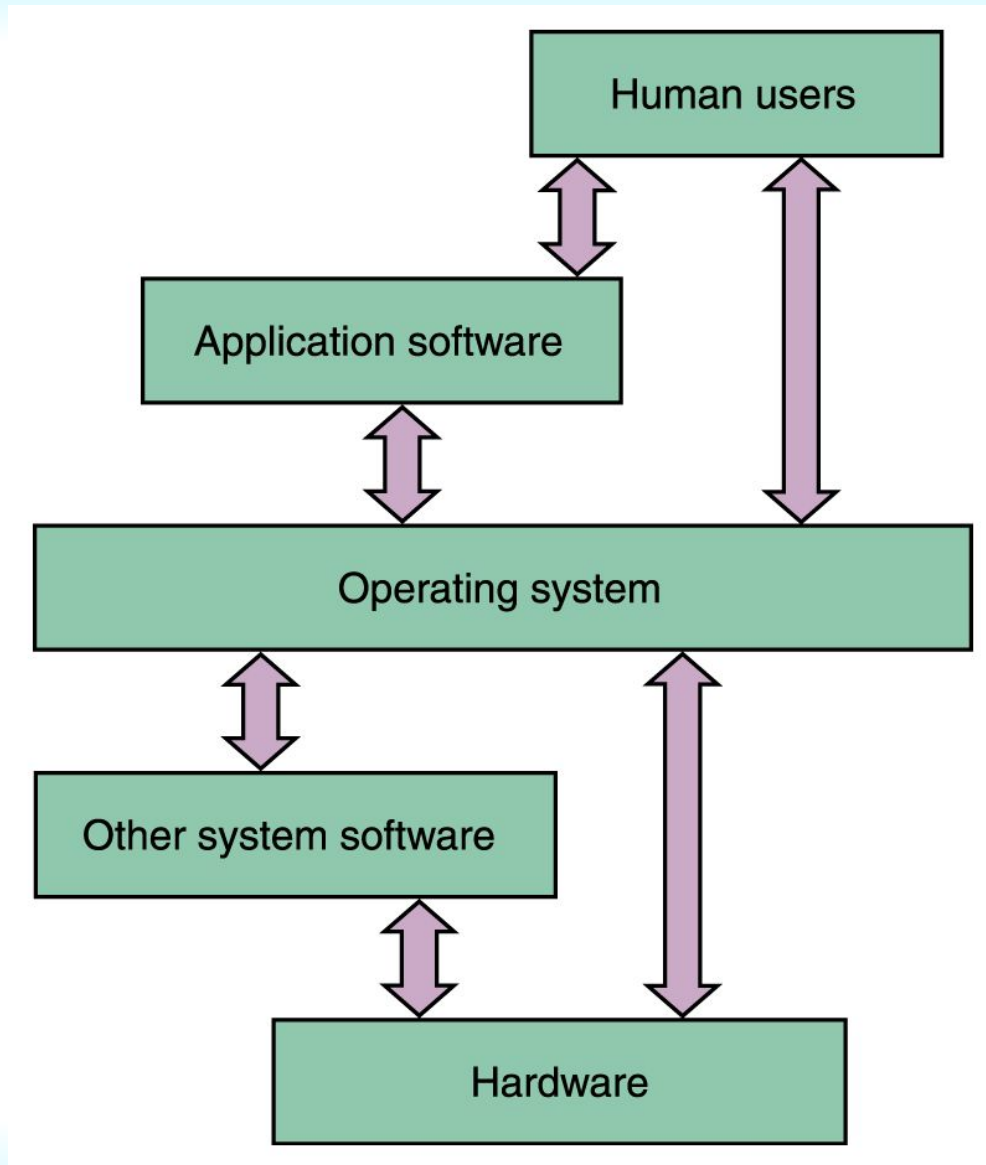
# Software Categories

- **Application software** Software written to address specific needs—to solve problems in the real world  
Word processing programs, games, inventory control systems, automobile diagnostic programs, and missile guidance programs are all application software
- **System software** Software that manages a computer system at a fundamental level  
It provides the tools and an environment in which application software can be created and run

# Operating System

- An **operating system**
  - manages computer resources, such as memory and input/output devices
  - provides an **interface** through which a human can interact with the computer
  - allows an application program to interact with these other system resources

# Operating System



**Figure 10.1**  
An operating system  
interacts with many  
aspects of a computer  
system.

# Operating System

- The various roles of an operating system generally revolve around the idea of “sharing nicely”
- An operating system manages resources, and these resources are often shared in one way or another among programs that want to use them

# Resource Management

- **Multiprogramming** The technique of keeping multiple programs in main memory at the same time that compete for access to the CPU so that they can execute
- **Memory management** The process of keeping track of what programs are in memory and where in memory they reside

# Resource Management

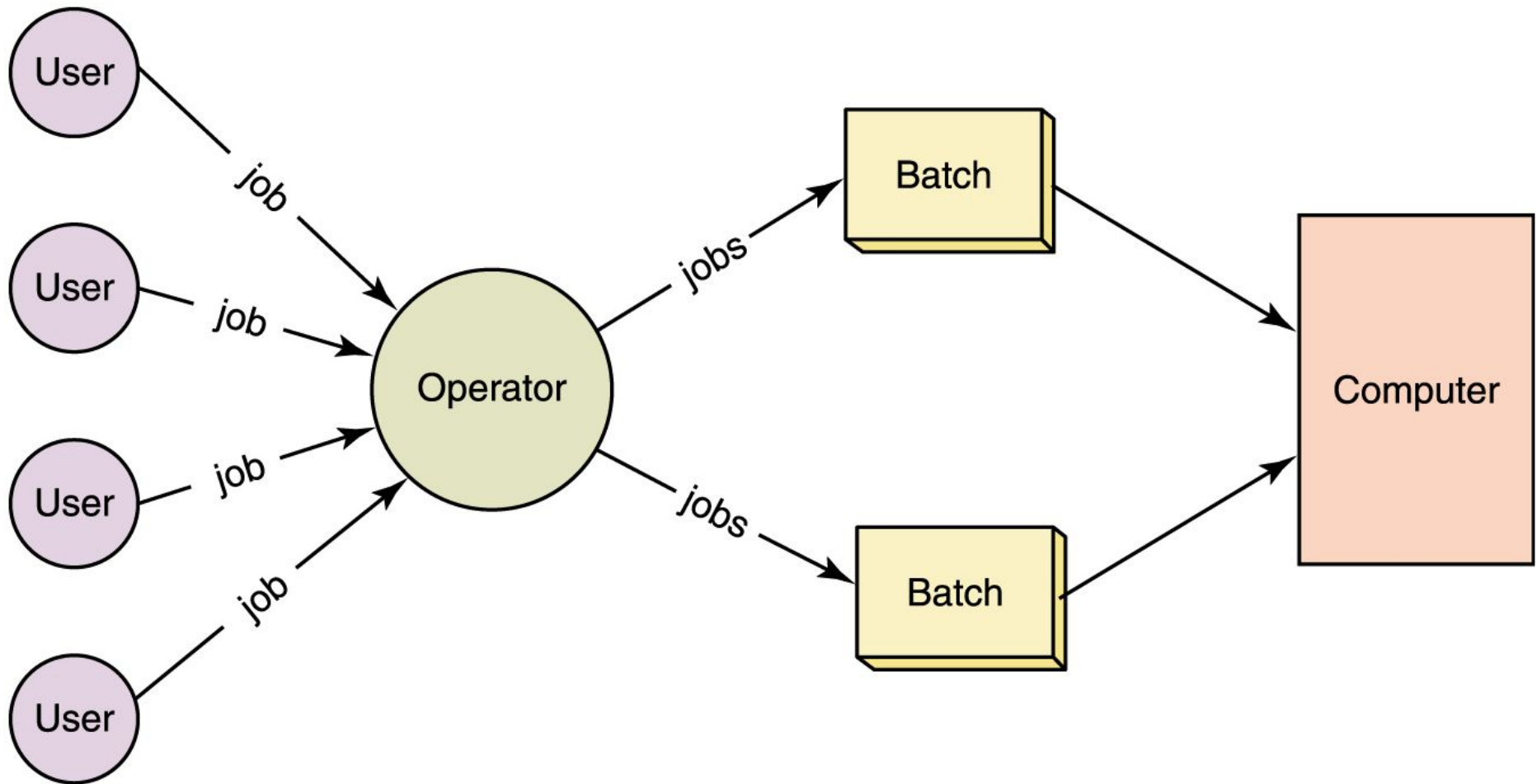
- **Process** A program in execution
- The operating system performs **process management** to carefully track the progress of a process and all of its intermediate states
- **CPU scheduling** determines which process in memory is executed by the CPU at any given point



# Batch Processing

- A typical computer in the 1960s and '70s was a large machine
- Its processing was managed by a human operator
- The operator would organize various jobs from multiple users into batches

# Batch Processing



**Figure 10.2** In early systems, human operators would organize jobs into batches

# Timesharing

- **Timesharing system** A system that allows multiple users to interact with a computer at the same time
- **Multiprogramming** A technique that allows multiple processes to be active at once, allowing programmers to interact with the computer system directly, while still sharing its resources
- In a timesharing system, each user has his or her own **virtual machine**, in which all system resources are (in effect) available for use

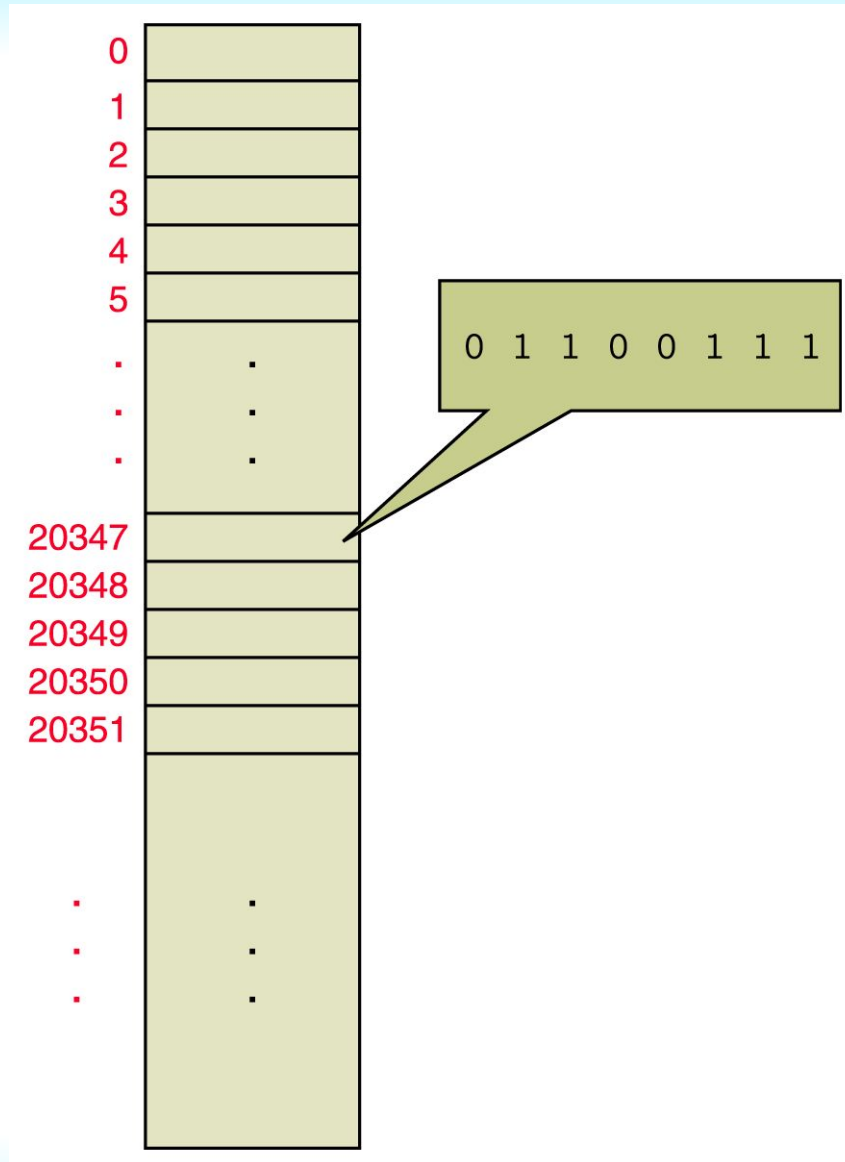
# Other Factors

- **Real-time System** A system in which response time is crucial given the nature of the application
- **Response time** The time delay between receiving a stimulus and producing a response
- **Device driver** A small program that “knows” the way a particular device expects to receive and deliver information.

# Memory Management

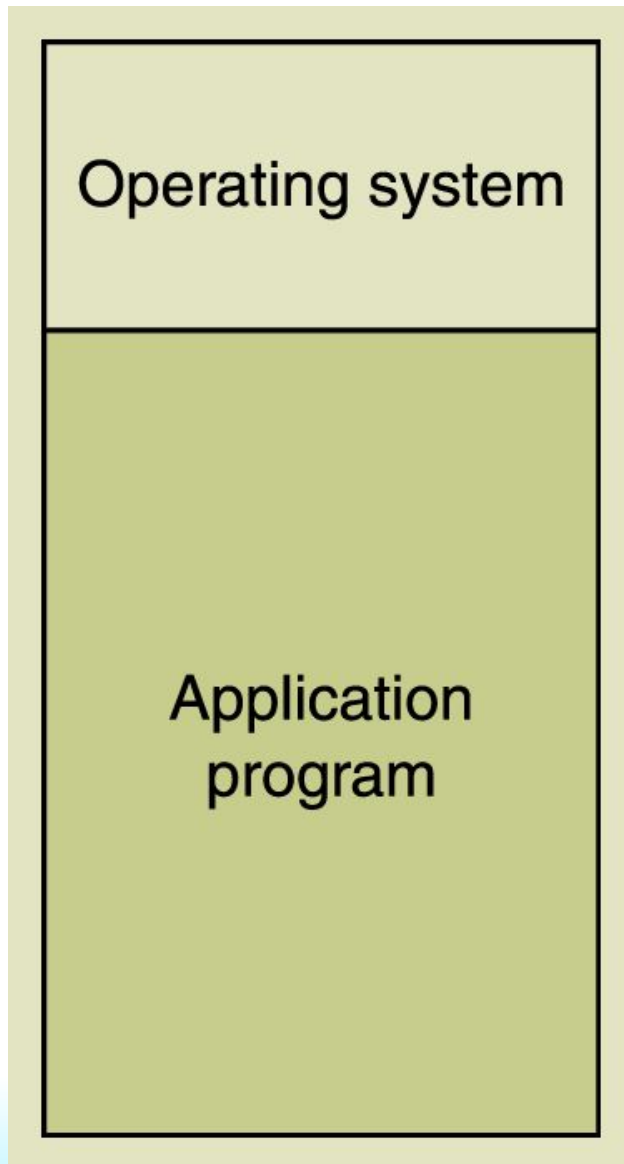
- Operating systems must employ techniques to
  - Track where and how a program resides in memory
  - Convert **logical addresses** into actual **addresses**
- **Logical address** (sometimes called a virtual or relative address) A value that specifies a generic location, relative to the program but not to the reality of main memory
- **Physical address** An actual address in the main memory device

# Memory Management



**Figure 10.3**  
Memory is a continuous set of bits referenced by specific addresses

# Single Contiguous Memory Management



**Figure 10.4**  
Main memory  
divided into two  
sections

- There are only two programs in memory
  - The operating system
  - The application program
- This approach is called **single contiguous memory management**

# Single Contiguous Memory Management

- A logical address is simply an integer value relative to the starting point of the program
- To produce a physical address, we add a logical address to the starting address of the program in physical main memory



# Single Contiguous Memory Management

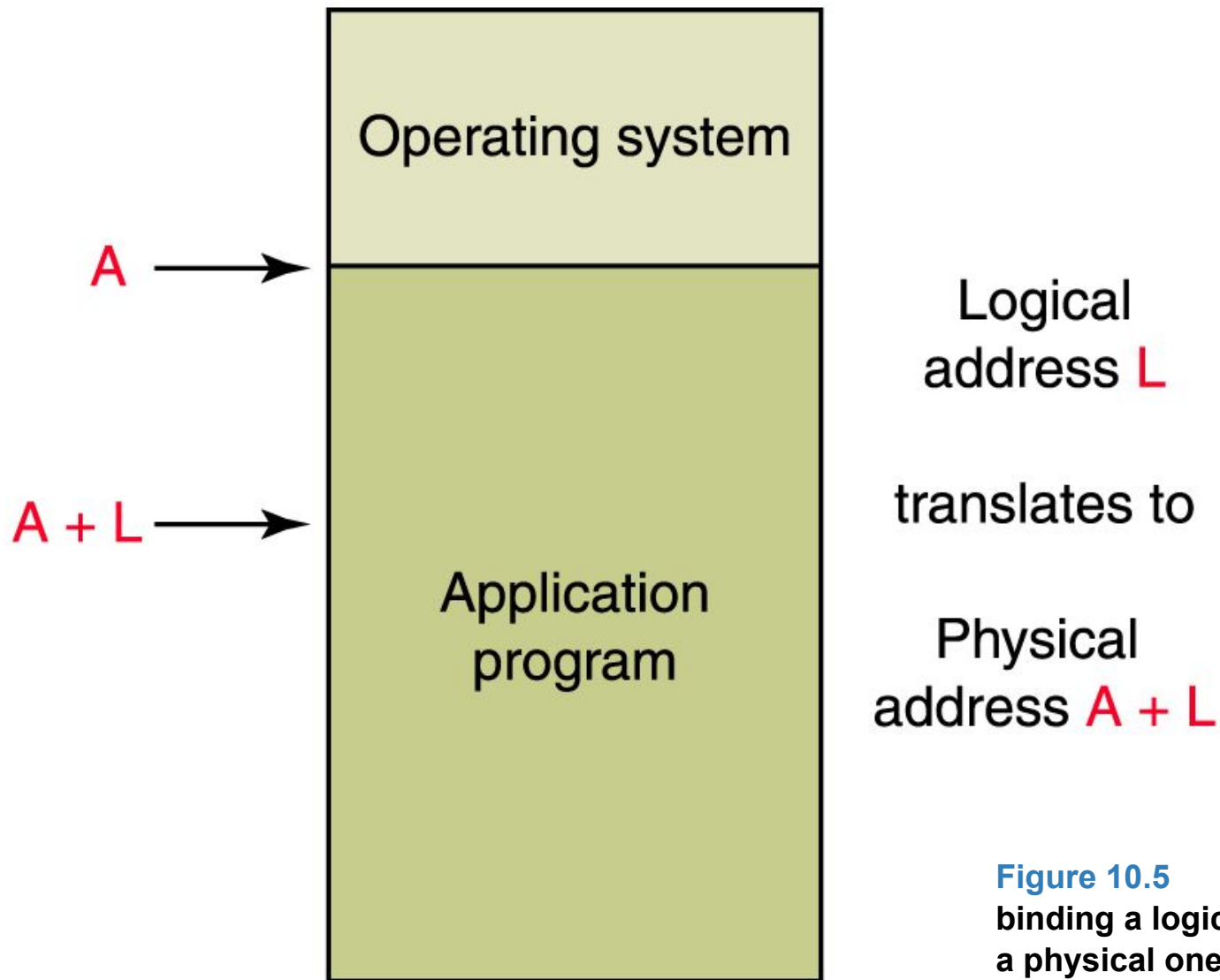
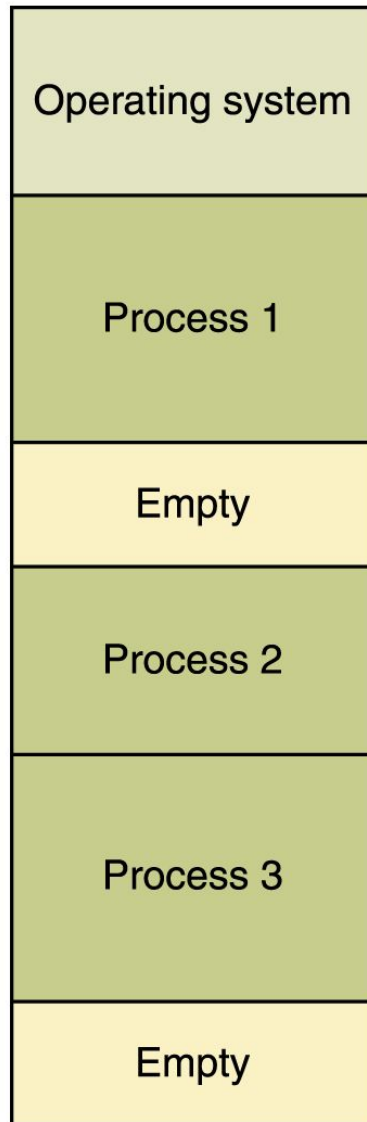


Figure 10.5  
binding a logical address to  
a physical one

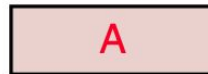
# Partition Memory Management

- **Fixed partitions** Main memory is divided into a particular number of partitions
- **Dynamic partitions** Partitions are created to fit the needs of the programs

# Partition Memory Management



Base register



Bounds register



Check:

$L < \text{length?}$

Yes

**Figure 10.6**  
Address resolution  
in partition memory  
management

- At any point in time memory is divided into a set of partitions, some empty and some allocated to programs
- **Base register** A register that holds the **beginning address** of the current partition
- **Bounds register** A register that holds the **length of the current partition**

# Partition Selection Algorithms

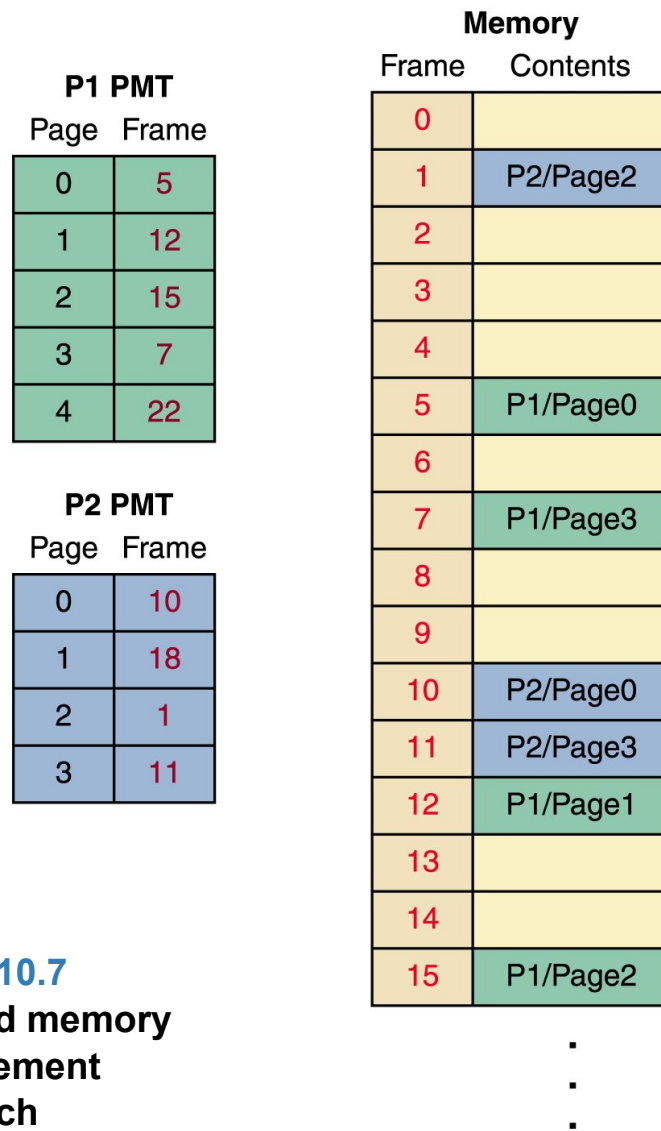
*Which partition should we allocate to a new program?*

- **First fit** Allocate program to the first partition big enough to hold it
- **Best fit** Allocated program to the smallest partition big enough to hold it
- **Worst fit** Allocate program to the largest partition big enough to hold it

# Paged Memory Management

- **Paged memory technique** A memory management technique in which processes are divided into **fixed-size pages** and stored in **memory frames** when loaded into memory
  - **Frame** A fixed-size portion of *main memory* that **holds a process page**
  - **Page** A fixed-size portion of a *process* that is **stored into a memory frame**
  - **Page-map table (PMT)** A table used by the operating system to keep track of **page/frame relationships**

# Paged Memory Management



**Figure 10.7**  
A paged memory management approach

- To produce a physical address, you first look up the page in the PMT to find the frame number in which it is stored
- Then multiply the frame number by the frame size and add the offset to get the physical address

# Paged Memory Management

- **Demand paging** An important extension of paged memory management
  - Not all parts of a program actually have to be in memory at the same time
  - In demand paging, the **pages are brought into memory on demand**
- **Page swap** The act of **bringing in a page from secondary memory**, which often causes another page to be written back to secondary memory

# Paged Memory Management

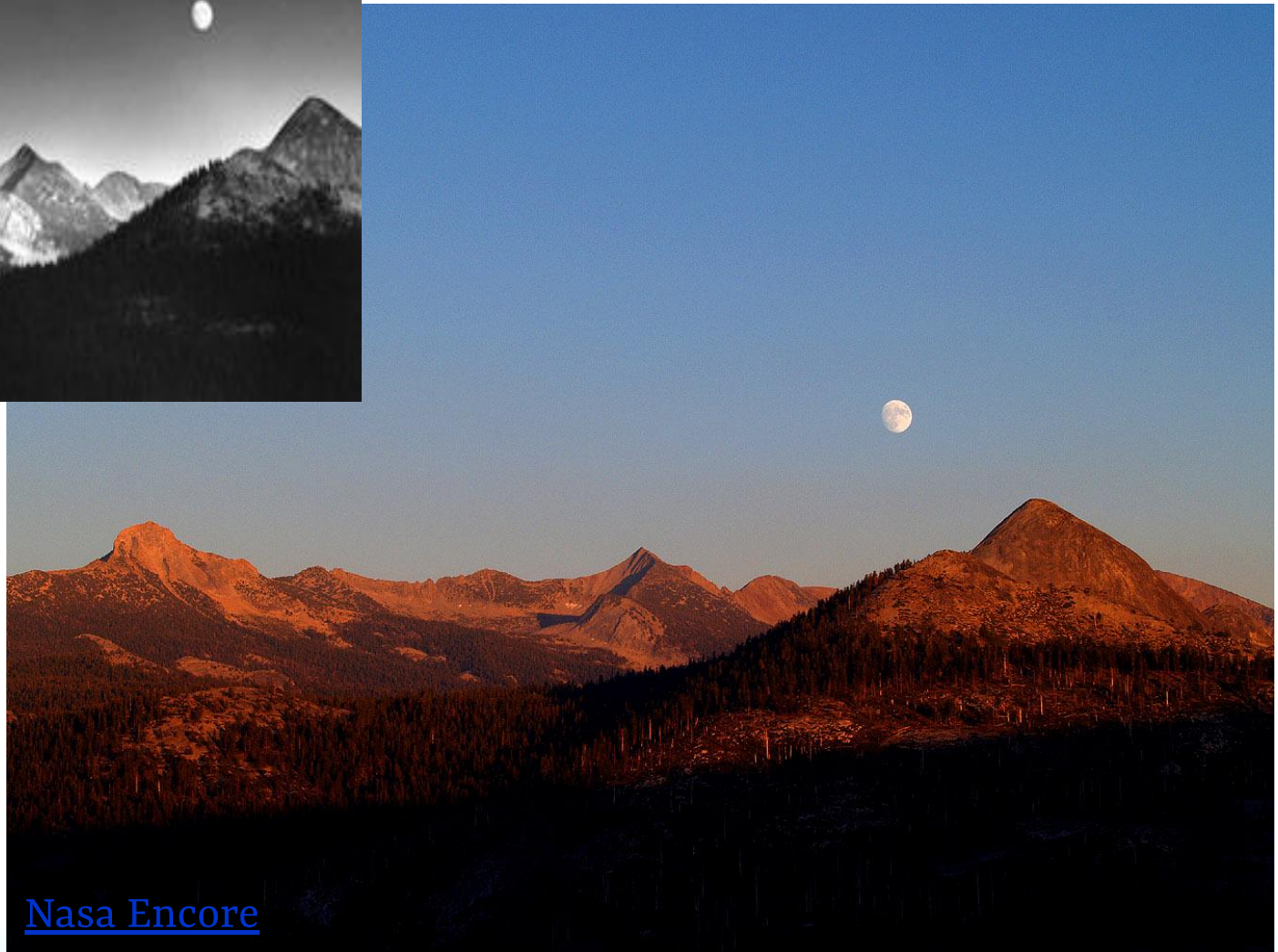
- The demand paging approach gives rise to the idea of **virtual memory**, the **illusion** that there are no restrictions on the size of a program
- **Too much page swapping**, however, is called **thrashing** and can seriously degrade system performance.



# Have A Good Night



Autumn Moon  
by Ansel Adams



[Nasa Encore](#)