presentation slides for

Java Software Solutions
Foundations of Program Design

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Focus of the course

- Program development
  - problem solving
  - program design and implementation
  - object-oriented concepts
  - steps in the development process
  - the Java programming language
- Specific programming concepts and techniques
  - data and operations
  - decisions and loops
  - objects and classes
  - arrays, vectors, strings
  - graphics
  - Graphical User Interfaces
  - sorting and searching

Computer Systems -- Introduction

- Before we can dive into programming, we need to understand the fundamentals of computers in general
- Chapter 1 focuses on:
  - components of a computer
  - how those components interact
  - how computers store and process information
  - computer networks
  - the Internet and the World Wide Web

Hardware and Software

- *Hardware*
  - the physical, tangible parts of a computer
  - keyboard, monitor, wires, chips, disks
- *Software*
  - programs and data
  - a *program* is a series of instructions
- A computer requires both hardware and software
- Each is essentially useless without the other

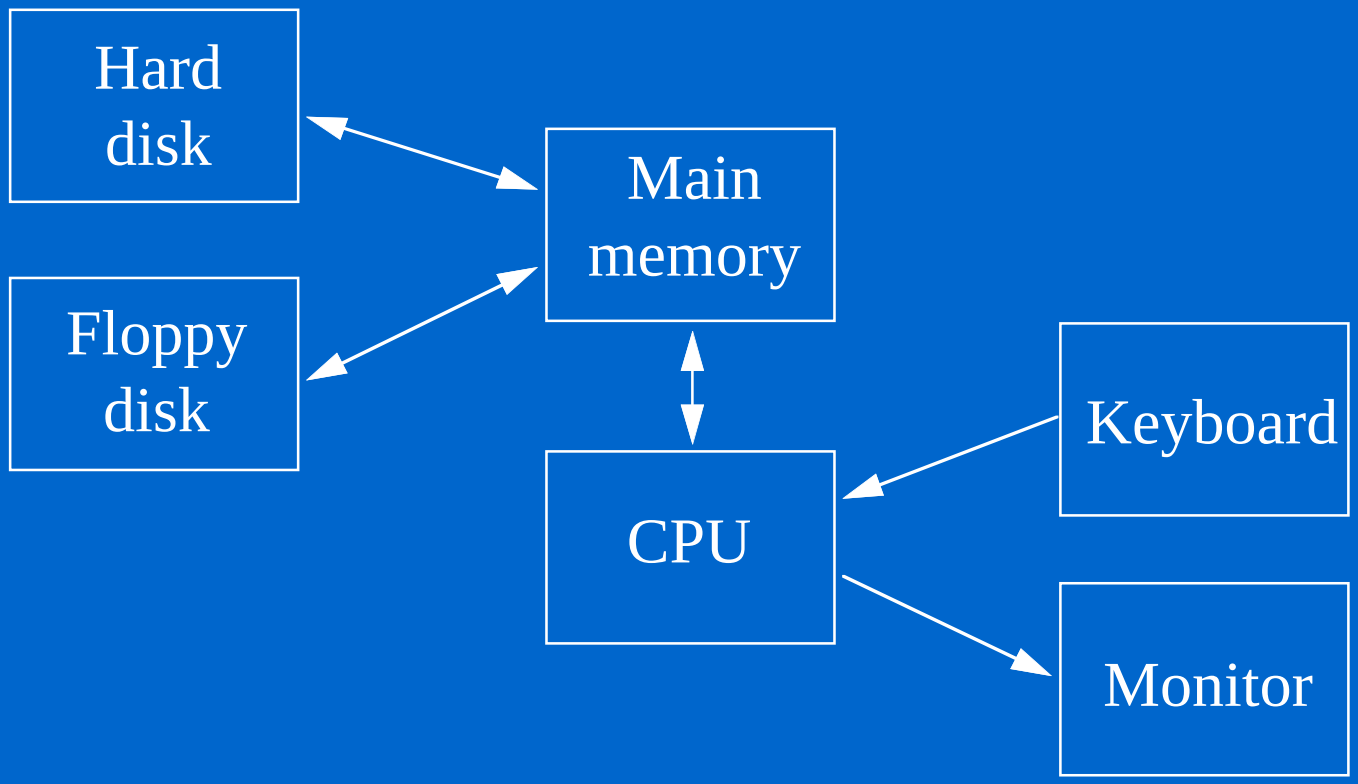
Hardware Components

- *Central Processing Unit* (CPU)
  - the chip that executes program commands
  - Intel Pentium processor, Sun Sparc processor
- *Input / Output* devices
  - allow interaction with the user
  - keyboard, monitor, mouse

Hardware Components

- *Main memory*
  - the primary storage area for programs and data in active use
- *Secondary memory* devices
  - long-term storage
  - floppy disks, hard disks, tapes

Hardware Interaction



Software Categories

- *Operating system*
  - controls all machine activities
  - provides the *user interface* to the computer
  - manages resources such as the CPU and memory
  - Windows 95, Solaris, Mac OS
- Application program
  - generic term for any other kind of software
  - word processors, missile control systems, games

Analog vs. Digital

- There are two basic ways to store and manage data
- *Analog*
  - continuous, in direct proportion to the data represented
  - example: a mercury thermometer - the mercury rises in direct proportion to the temperature
- *Digital*
  - the information is broken down into pieces, and each piece is represented separately
  - example: music on a CD

Digital Information

- Modern computers store all information digitally, including:
  - numbers
  - text
  - graphics and pictures
  - audio
  - video
  - program instructions
- In some way, all information is *digitized* - broken down into pieces and represented as numbers

Representing text digitally

- Each character, including spaces, digits, and punctuation, is stored as a number
- Corresponding upper and lower case letters are separate characters

Binary Numbers

- Once information is digitized, it is represented and stored in memory using the *binary number system*
- A single binary digit (0 or 1) is called a *bit*
- Devices that store and move information are cheaper and more reliable if they only have to represent two states
- A single bit can represent two possible states, like a light bulb that is either on (1) or off (0)
- Combinations of bits are used to store larger values

Bit Permutations

1 bit	2 bits	3 bits	4 bits
0	00	000	0000
1	01	001	0001
	10	010	0010
	11	011	0011
		100	0100
		101	0101
		110	0110
		111	0111
			1000
			1001
			etc.

Bit Permutations

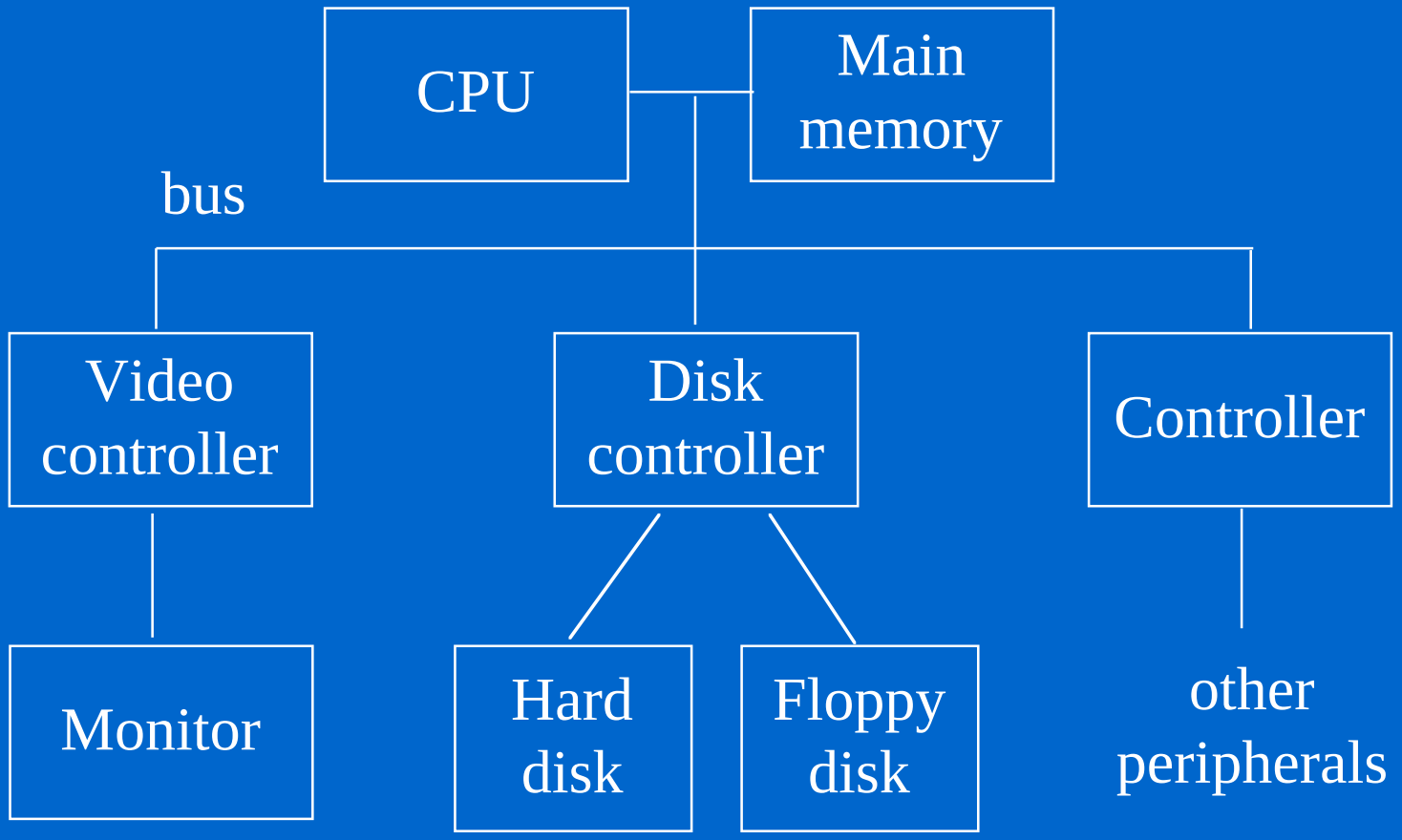
- Each bit that is added to the string doubles the number of states or items that can be represented
- N bits can represent 2^N unique items

1 bit	$2^1 = 2$ items
2 bits	$2^2 = 4$ items
3 bits	$2^3 = 8$ items
4 bits	$2^4 = 16$ items
5 bits	$2^5 = 32$ items

Computer Architecture

- Now we can examine the hardware components of a computer in more detail
- The CPU and main memory are the two key hardware components
- All other devices can be considered *peripherals*
- *Controllers* coordinate the activities of specific peripherals
- Binary information moves between devices across a group of wires called a *bus*

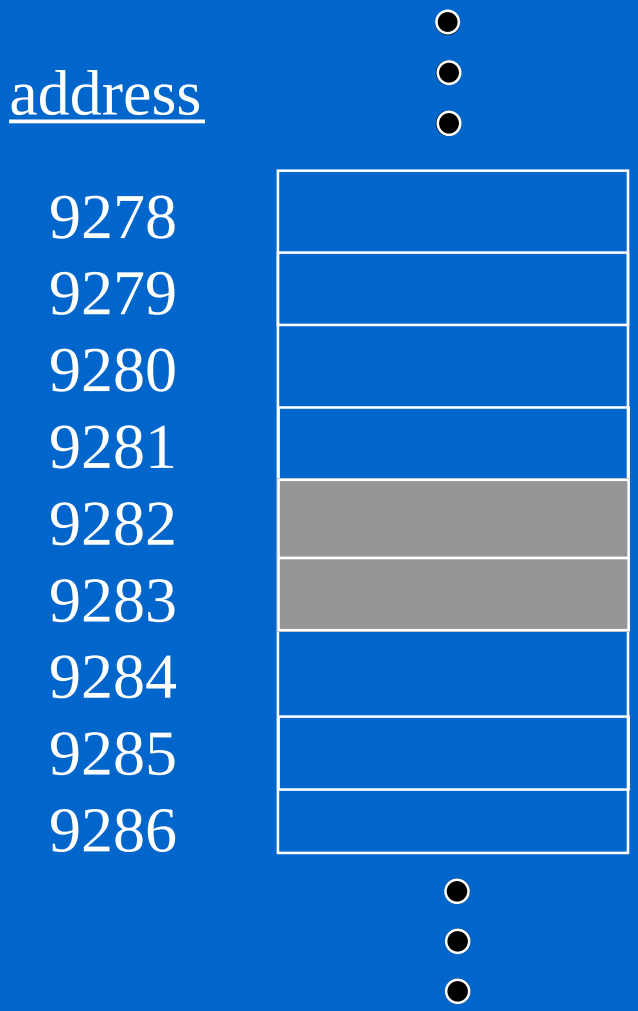
Computer Architecture



Memory

- Main memory is divided into many memory locations
- Each memory location has an address which uniquely identifies it
- Data is stored in one or more consecutive memory locations
- On most computers, each memory location holds 8 bits, or 1 *byte*

Memory



large values are stored in consecutive memory locations

Storage Capacity

- Each memory device has a storage capacity, indicating the number of bytes it can hold
- Capacities are expressed in various units of binary storage:

Unit	Symbol	Number of Bytes
kilobyte	KB	2^{10} = 1024
megabyte	MB	2^{20} (over 1 mill
gigabyte	GB	2^{30} (over 1 bill
terabyte	TB	2^{40} (over 1 tri

Memory

- Main memory is *volatile* - stored information is lost if the electric power is removed
- Secondary memory devices are *nonvolatile*
- Main memory and disks are *random access* devices, which mean that information can be reached directly
- A magnetic tape is a *sequential access* device since its data is arranged in a linear order - you must get by the intervening data in order to access other information

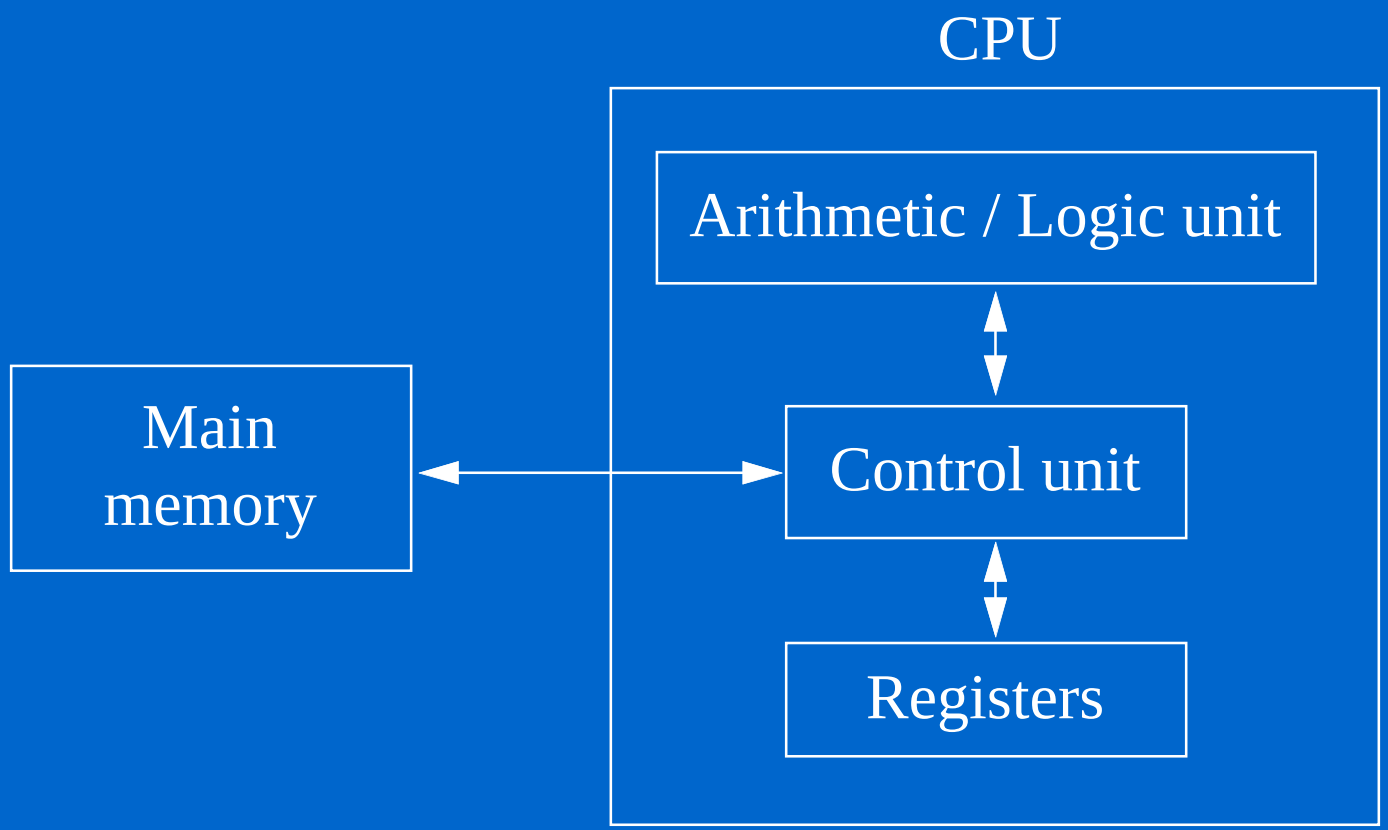
RAM vs. ROM

- *RAM* - Random Access Memory
- *ROM* - Read-Only Memory
- The terms RAM and main memory are basically interchangeable
- ROM could be a set of memory chips, or a separate device, such as a CD ROM
- Both RAM and ROM are random access devices!
- RAM should probably be called Read-Write Memory

The Central Processing Unit (CPU)

- A CPU is also called a *microprocessor*
- It retrieves, interprets, and executes instructions, one after another, continuously
- This process is called the *fetch-decode-execute cycle*
- The CPU contains:
  - *control unit* - coordinates processing steps
  - *registers* - small storage areas
  - *arithmetic / logic unit* - performs calculations and decisions

The Central Processing Unit



The Central Processing Unit

- The speed of a CPU is controlled by the *system clock*
- The system clock generates an electronic pulse at regular intervals
- The pulses coordinate the activities of the CPU
- The speed is measured in *megahertz* (MHz)

A Computer Specification

- Consider the following specification for a personal computer:
  - 200 MHz Pentium Processor
  - 32 MB RAM
  - 2.3 GB Hard Disk
  - 12x speed CD ROM Drive
  - 17” Multimedia Video Display with 1280 x 1024 resolution
  - 33,600 bps Data / Fax Modem

Monitor

- The primary output device listed in the specification is a 17” monitor
- The size is measured diagonally, like a television screen
- It has *multimedia* capabilities: text, graphics, video, etc.
- It has a *resolution* of 1280 by 1024 pixels
- High resolution (more pixels) produces sharper pictures

Modem

- *Data transfer devices* allow information to be sent and received between computers
- The computer specification includes a *modem*, which allows information to be moved across a telephone line
- It can send and receive fax documents as well as basic data
- It transfers information at a rate of 33,600 *bits per second* (bps)

Networks

- A *network* is two or more computers connected together so that information and resources can be shared
- Most computers are connected to some kind of network
- Each computer has its own *network address*, which uniquely identifies it among the others
- A *file server* is a network computer dedicated to storing programs and data that are shared among network users
- A file server often has a large amount of secondary memory

Network Connections

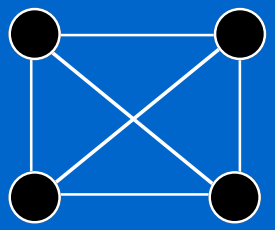
- There are many techniques for connecting computers into networks
- *Point-to-point connections* - each computer is directly connected to each other
- This technique is not feasible for more than a few close machines
- Adding a new computer requires a new communication line for each computer already in the network

Network Connections

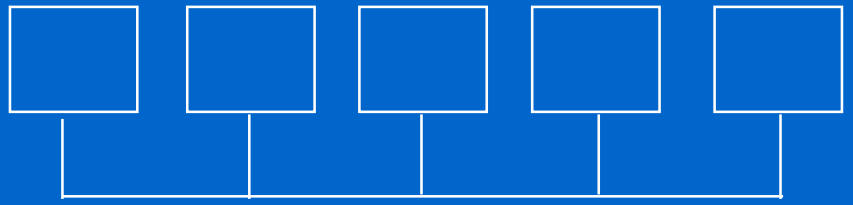
- Most modern networks share a single communication line
- Adding a new computer to the network is relatively easy
- The shared communication line must be managed carefully
- Network users must take turns using the line, which introduces delays
- Often information is broken down into parts, sent to the receiving machine, and reassembled

Network Connections

Point-to-Point



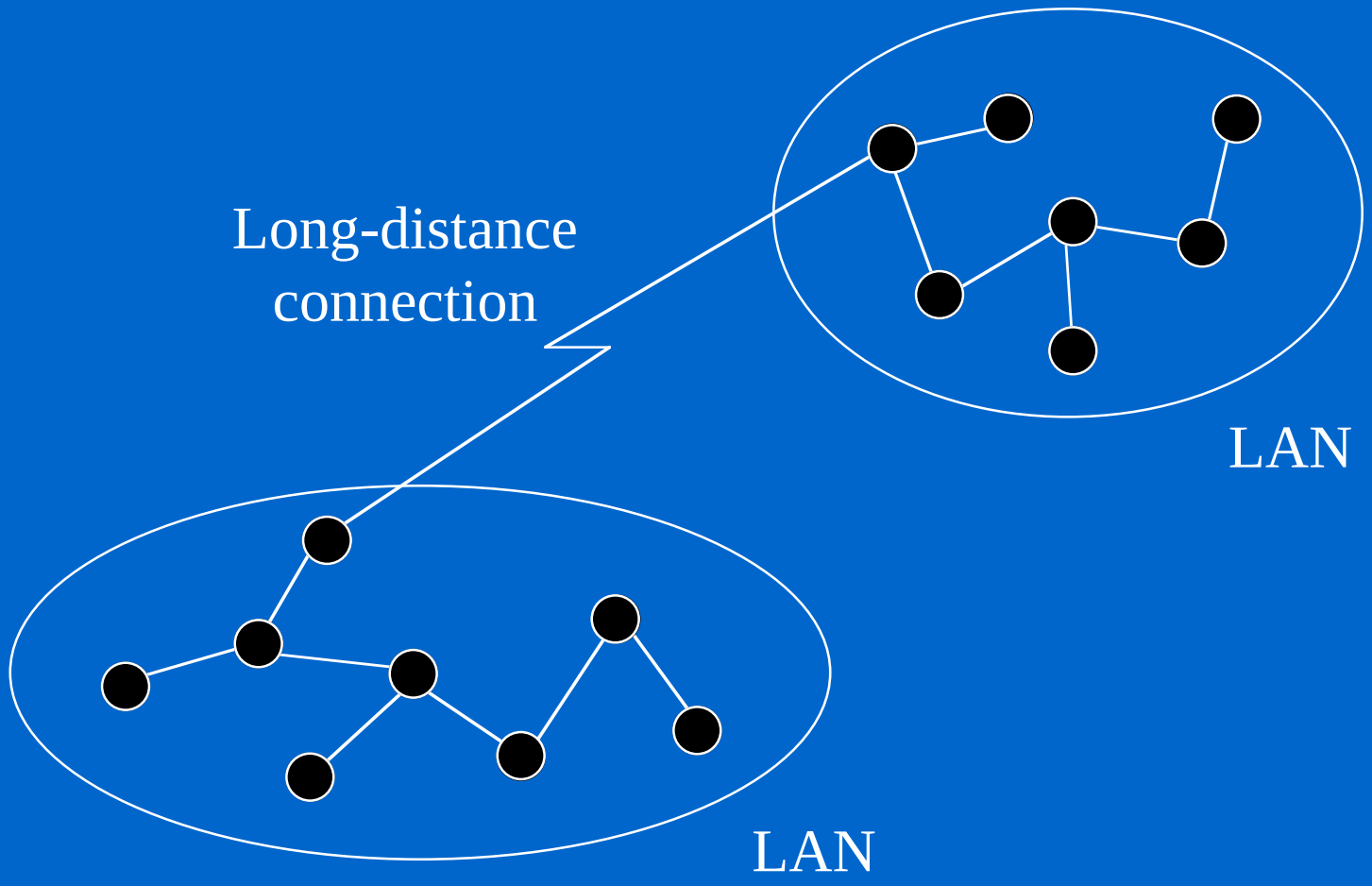
Shared Line



LANs and WANs

- A *local-area network* (LAN) is designed to cover small distances and a small number of computers
- A LAN often connects the machines in a single room or building
- A *wide-are network* (WAN) connects two or more LANs, often over long distances
- Individual LANs are usually owned by a single organization, but WANs often connect LANs from many different groups in many different countries

LANs and WANs



The Internet

- The *Internet* is a WAN which spans the entire planet
- The word Internet comes from the term *internetworking*, which implies a network of networks
- It started as a United States government project, sponsored by the Advanced Research Projects Agency (ARPA), and was originally called the ARPANET
- The Internet grew quickly throughout the 1980s and 90s
- Less than 600 computers were connected to the Internet in 1983; now there are over 10 million

The Internet

- The software which manages Internet communication is called *TCP/IP*
- The programs in the Internet Protocol (IP) formats the information for transfer
- The programs in the Transmission Control Protocol (TCP) reassembles messages and handles lost information
- Each computer on the Internet has a unique *IP address*, such as:

204.192.116.2

The Internet

- Most computers also have a unique Internet name, which is also referred to as an *Internet address*:

renoir.vill.edu

kant.wpllabs.com

- The first part indicates a particular computer (renoir)
- The rest is the domain name, indicating the organization (vill.edu)

The Internet

- The last section of each domain name usually indicates the type of organization:
  - edu - educational institution
  - com - commercial business
  - org - non-profit organization
- Sometimes the suffix indicates the country:
  - uk - United Kingdom
- New suffix categories are being considered

Internet

- A domain name can have several parts
- Unique domain names mean that multiple sites can have individual computers with the same local name
- When used, an Internet address is translated to an IP address by software called the *Domain Name System* (DNS)
- There is not a one-to-one correspondence between the sections of an IP address and the sections of an Internet address

The World-Wide Web

- The *World-Wide Web* allows many different types of information to be accessed using a common interface
- A *browser* is a program which accesses and presents information: text, graphics, sound, audio, and programs
- A Web document usually contains *links* to other Web documents, creating a *hypermedia* environment
- The term Web comes from the fact that information is not organized in a linear fashion

The World-Wide Web

- Web documents are defined by the *HyperText Markup Language* (HTML)
- Information on the Web is found using a *Uniform Resource Locator* (URL):

http://www.lycos.com

- A URL may indicate an HTML document, or some other kind of information