Modern Computer Systems

Dr. Sapumal Ahangama

Department of Computer Science and Engineering
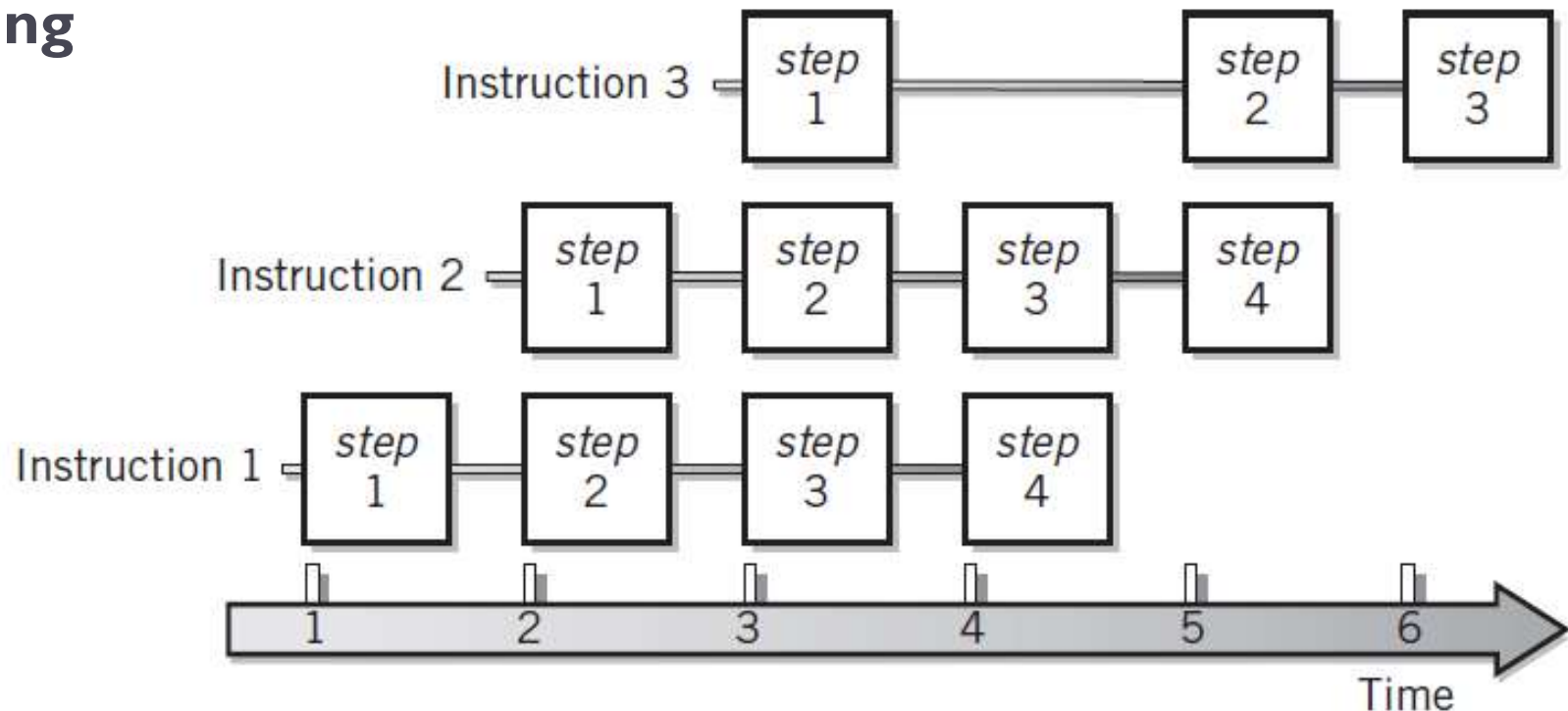
1

OUTLINE

- CPU Enhancements
- Multiprocessing
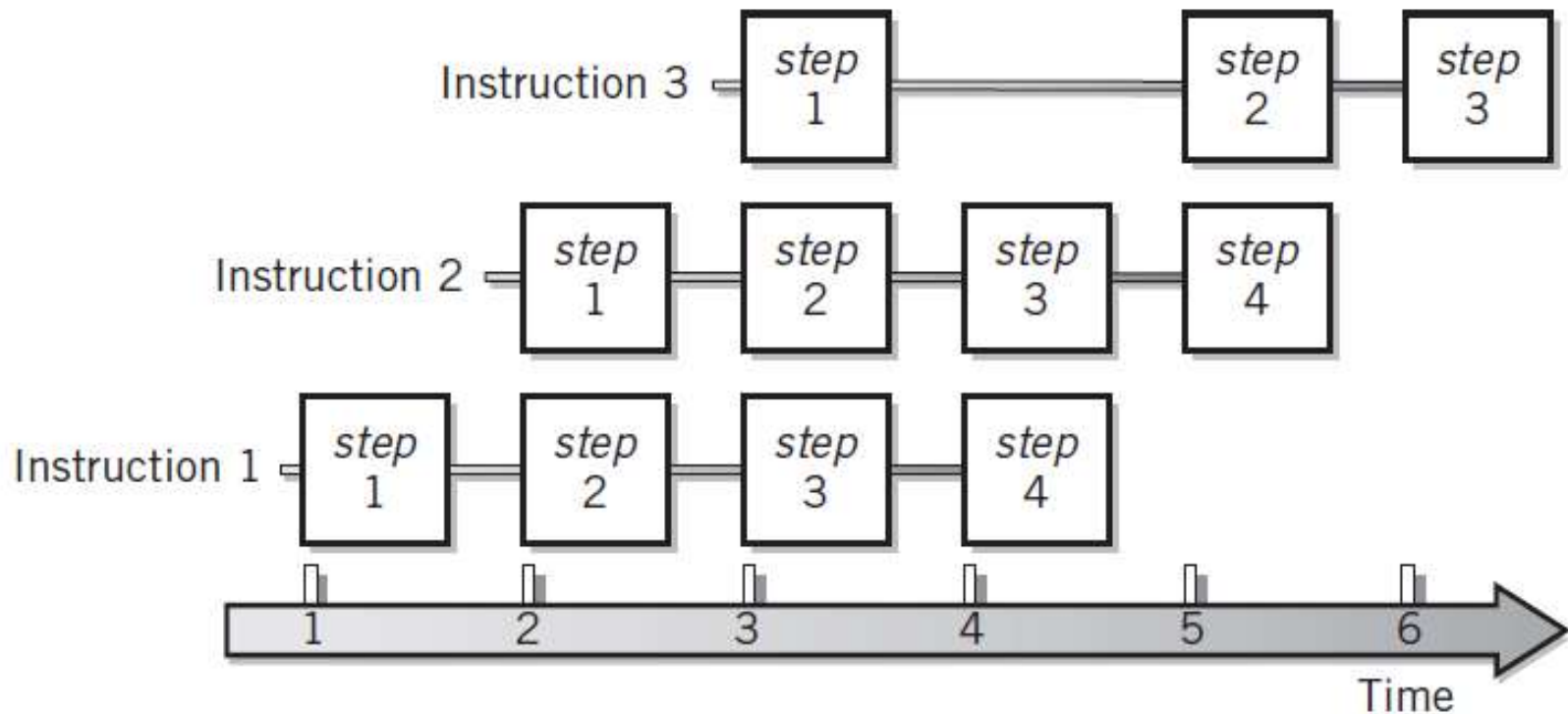- Clusters
- Virtualization

PIPELINING

- ▸ If there are 2 stages of the execution cycle and implemented separately,
  - ▸ Only one stage is in use at a given time
- ▸ Overlap of instructions
  - ▸ More than one instruction is worked at a time
  - ▸ **Pipelining**

PIPELINING
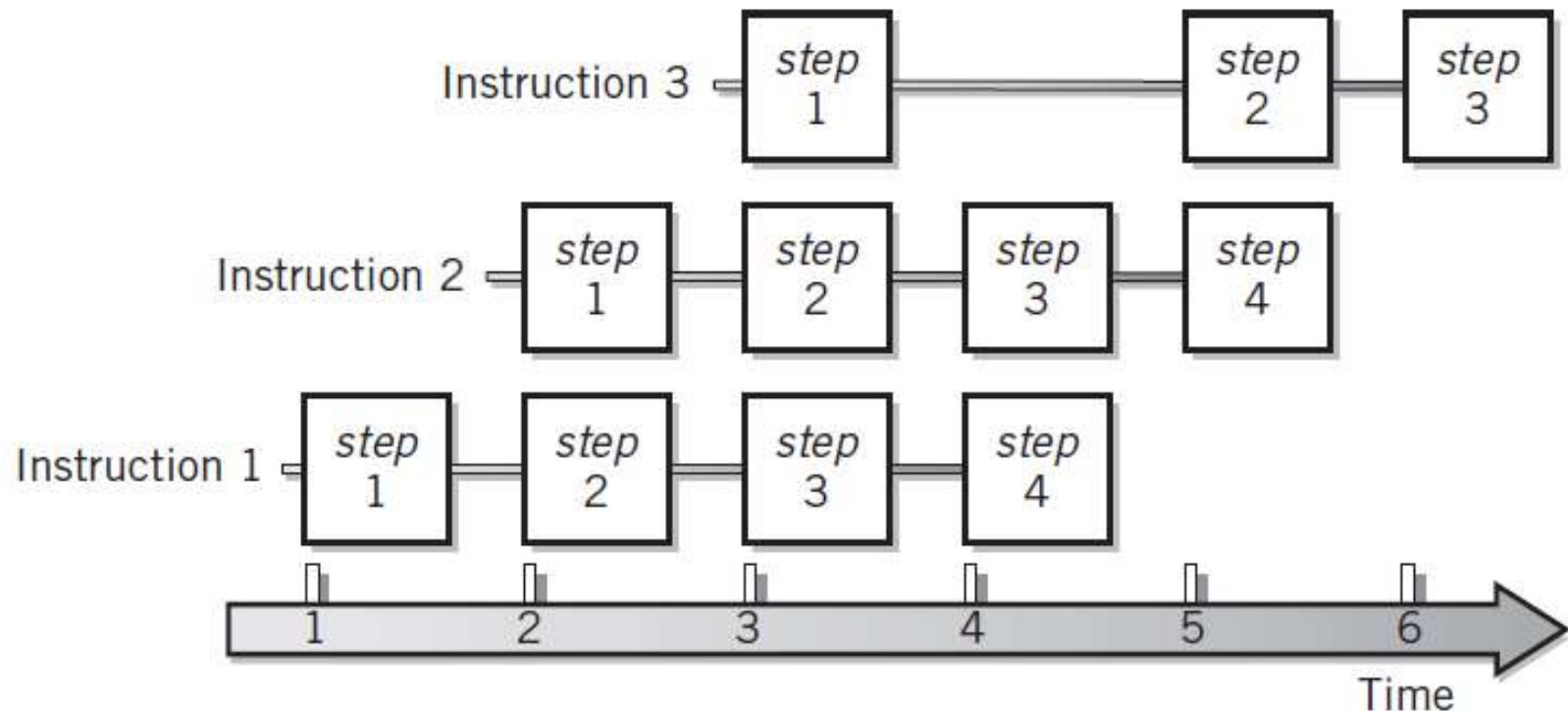
- Branching?
  - May invalidate all the instructions in the timeline
- Solutions?
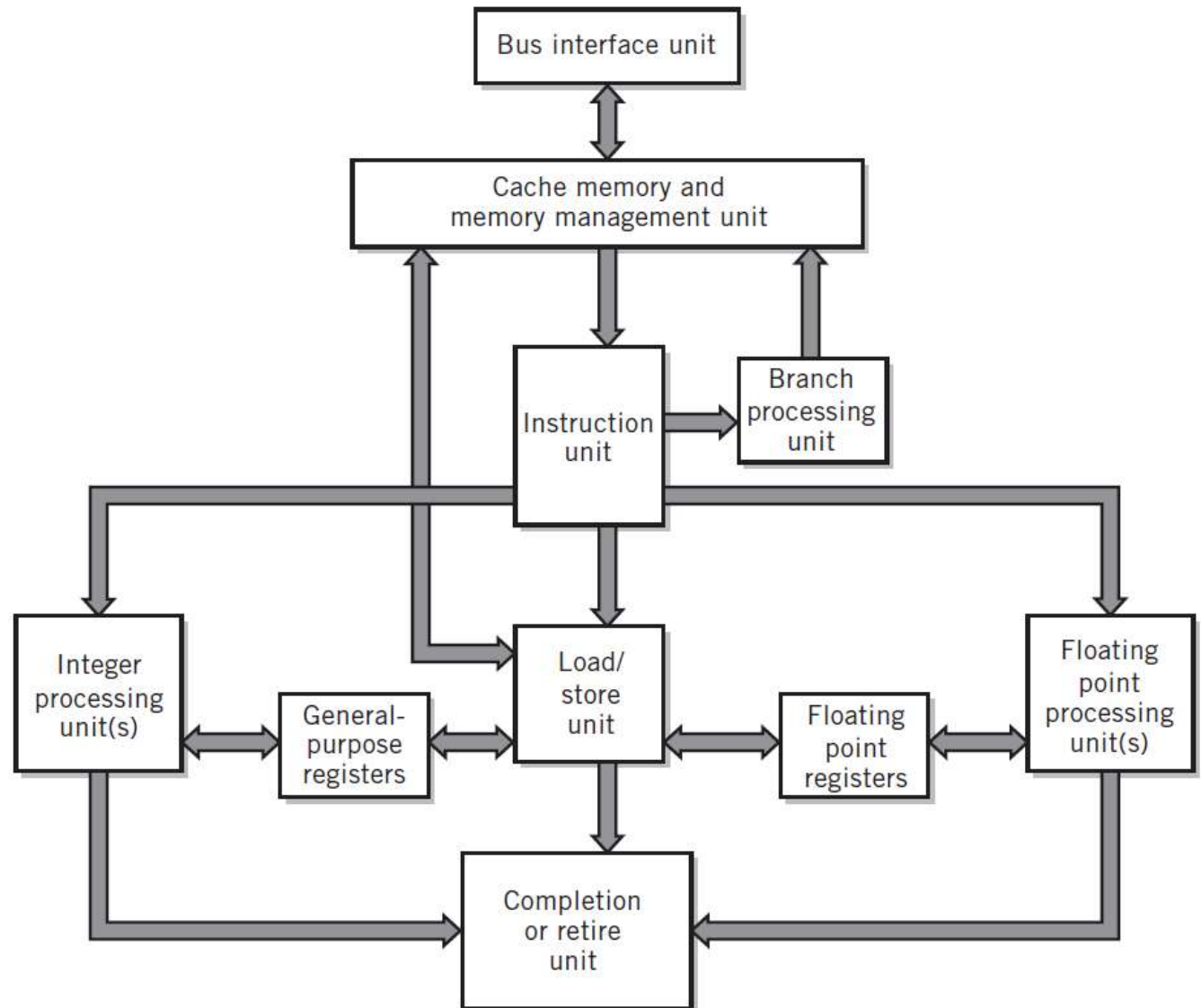 - Multiple pipelines
  - Branch prediction

PIPELINING

- Instruction reordering
  - Problem of waiting for data results from previous instructions
  - Computer designs contain logic that can reorder instructions

MODERN CPU DESIGN

- ▶ Familiar components of the CPU
  - ▶ ALU
  - ▶ PC
  - ▶ CU

Bus interface unit

Cache memory and memory management unit

Instruction unit

Branch processing unit

Integer processing unit(s)

General-purpose registers

Load/store unit

Floating point registers

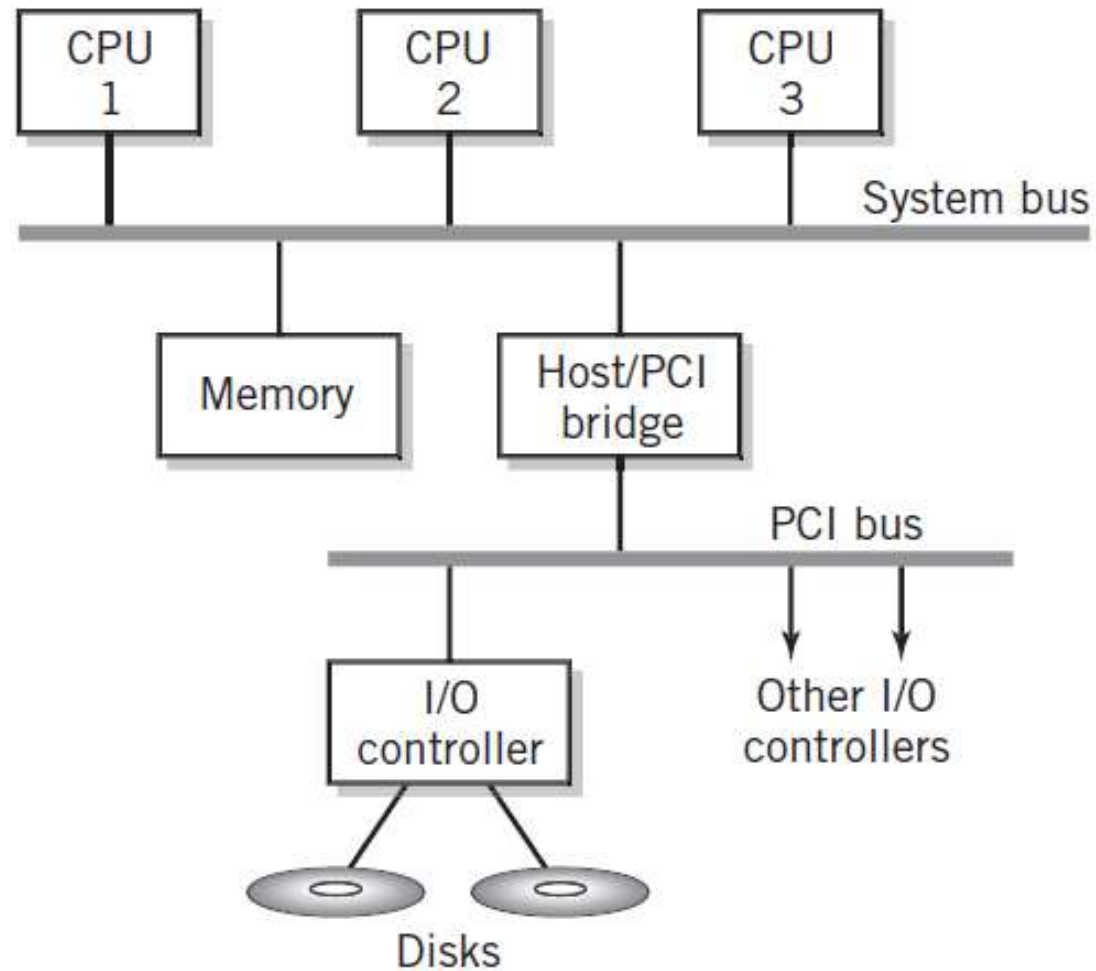Floating point processing unit(s)

Completion or retire unit

MULTIPROCESSING

▶ Increase performance in a computer system is to increase the number of CPUs

    ▶ Sharing some or all of the system's memory and I/O facilities

    ▶ Multiprocessor systems

▶ Multicore processors - multiple CPU processors are supplied within a single integrated circuit

MULTIPROCESSING

MULTIPROCESSING

- Each CPU processes its own assigned sequence of program instructions **independently**
  - Dual-core processor effectively doubles the number of instructions?
  - Quad-core processor would quadruple the rate, and so forth?

- Increasing the number of CPUs might lead to an increase in overheads
- The program segments will be dependent

MULTIPROCESSING

▶ Benefits of multiprocessing capabilities

  ▶ Increased computation power at a lower cost

  ▶ Equivalent processing power can be reached at lower clock speed

  ▶ Programs can be subdivided to independent pieces

  ▶ Higher throughput

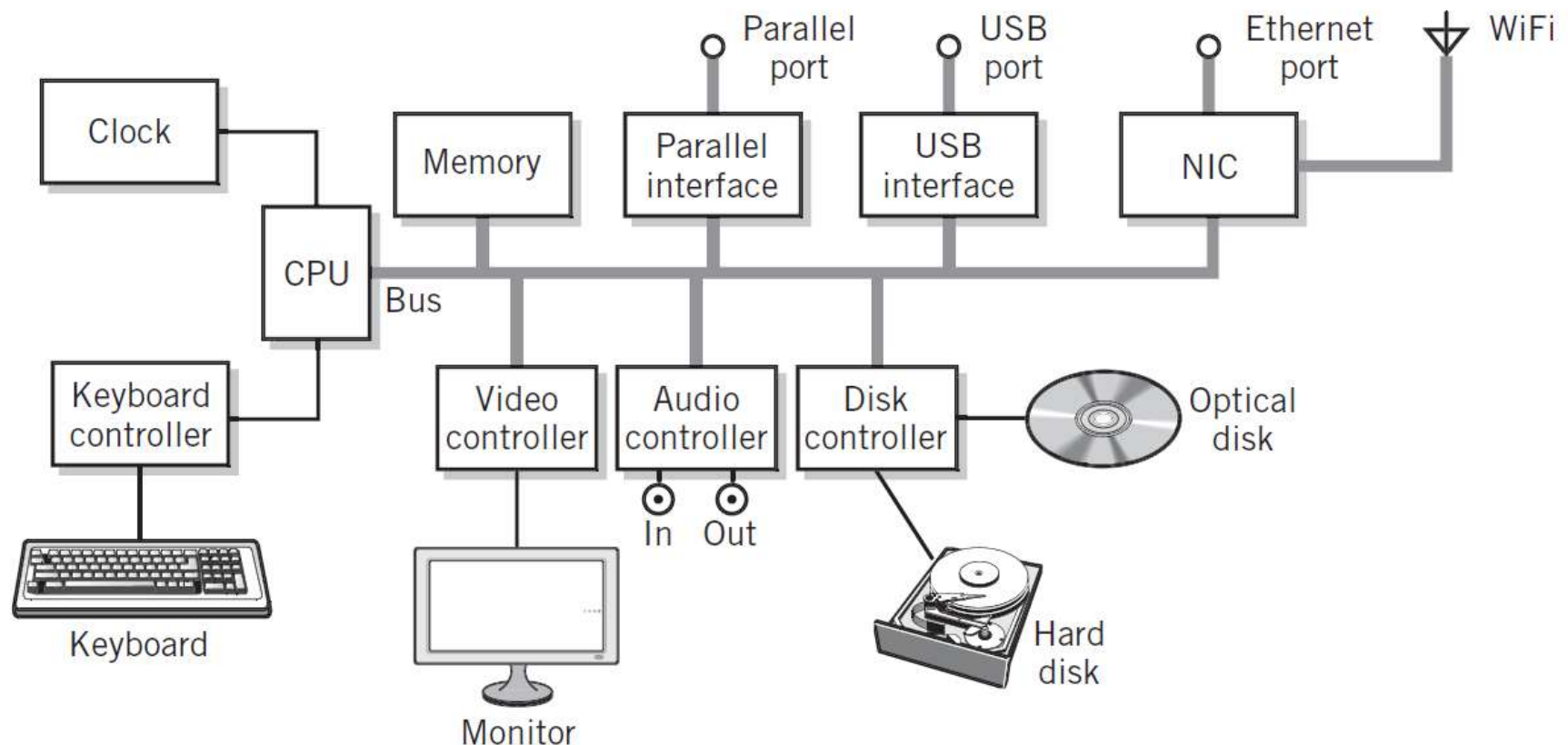▶ Assignment of work to the various processors is the responsibility of the operating system

  ▶ Threads

MULTIPROCESSING

▶ Configuring a multiprocessing systems

- ▶ **Master-slave multiprocessing:** master CPU manages the system, controls all resources and scheduling and execute the operating system.

- ▶ **Symmetrical multiprocessing:** each CPU has identical access to the operating system and system resources
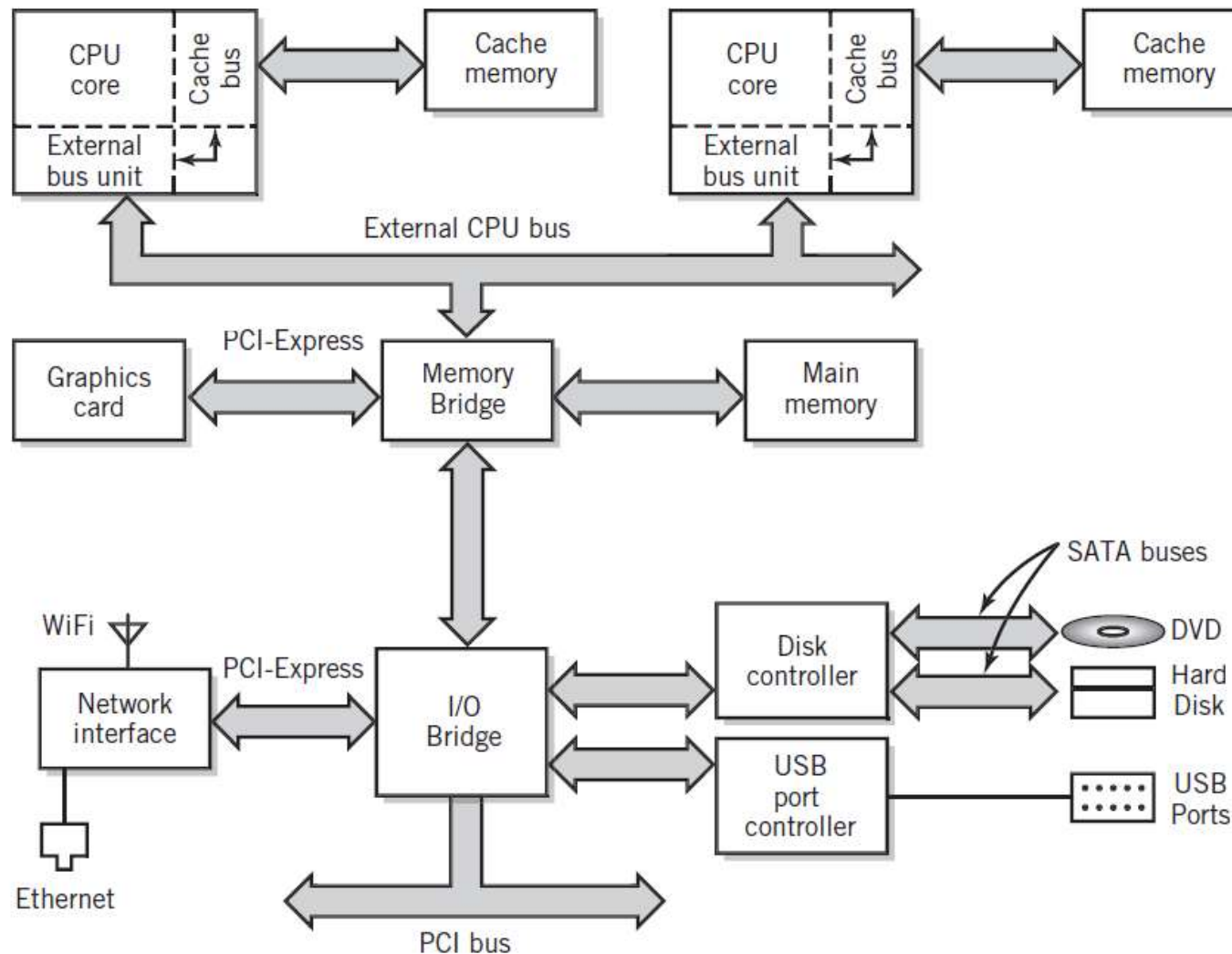
SYNERGY

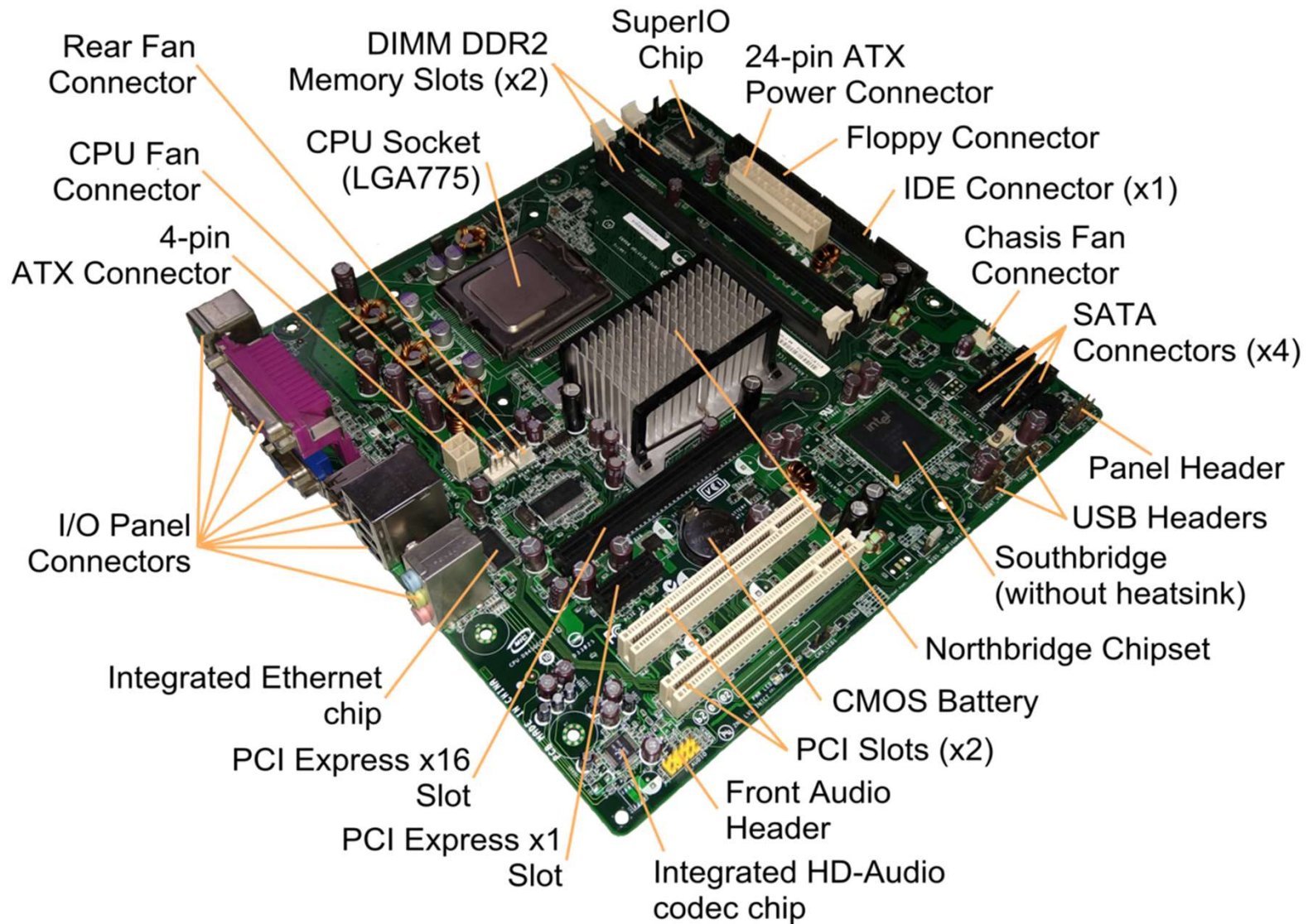▶ CPU, memory, I/O modules and the connections are optimized to maximize computer system performance

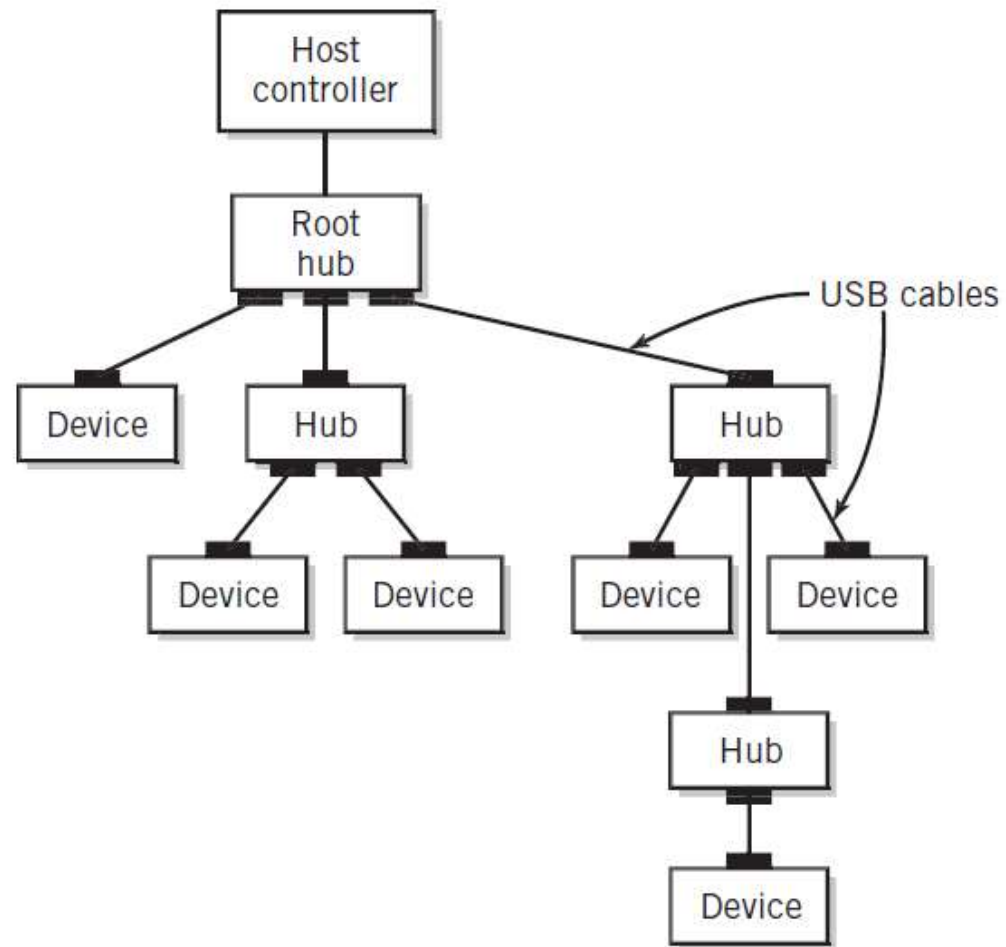# COMPUTER SYSTEMS

▸ A more realistic modern computer system layout

COMPUTER SYSTEMS

Rear Fan Connector

DIMM DDR2 Memory Slots (x2)

SuperIO Chip

24-pin ATX Power Connector

CPU Fan Connector

CPU Socket (LGA775)

Floppy Connector

IDE Connector (x1)

4-pin ATX Connector

Chasis Fan Connector

SATA Connectors (x4)

I/O Panel Connectors

Panel Header

USB Headers

Southbridge (without heatsink)

Northbridge Chipset

Integrated Ethernet chip

CMOS Battery

PCI Express x16 Slot

PCI Slots (x2)

PCI Express x1 Slot

Front Audio Header

Integrated HD-Audio codec chip

UNIVERSAL SERIAL BUS

CLUSTERS

▶ A group of loosely coupled computers configured to work together as a unit

▶ Multiprocessor vs. Cluster?

▶ Reasons for using clusters

▶ Increasing available computing power

▶ Create fault tolerant systems

▶ To create high availability systems

▶ Load balancing

CLUSTERS

(a) Shared-nothing model

(b) Shared-disk model
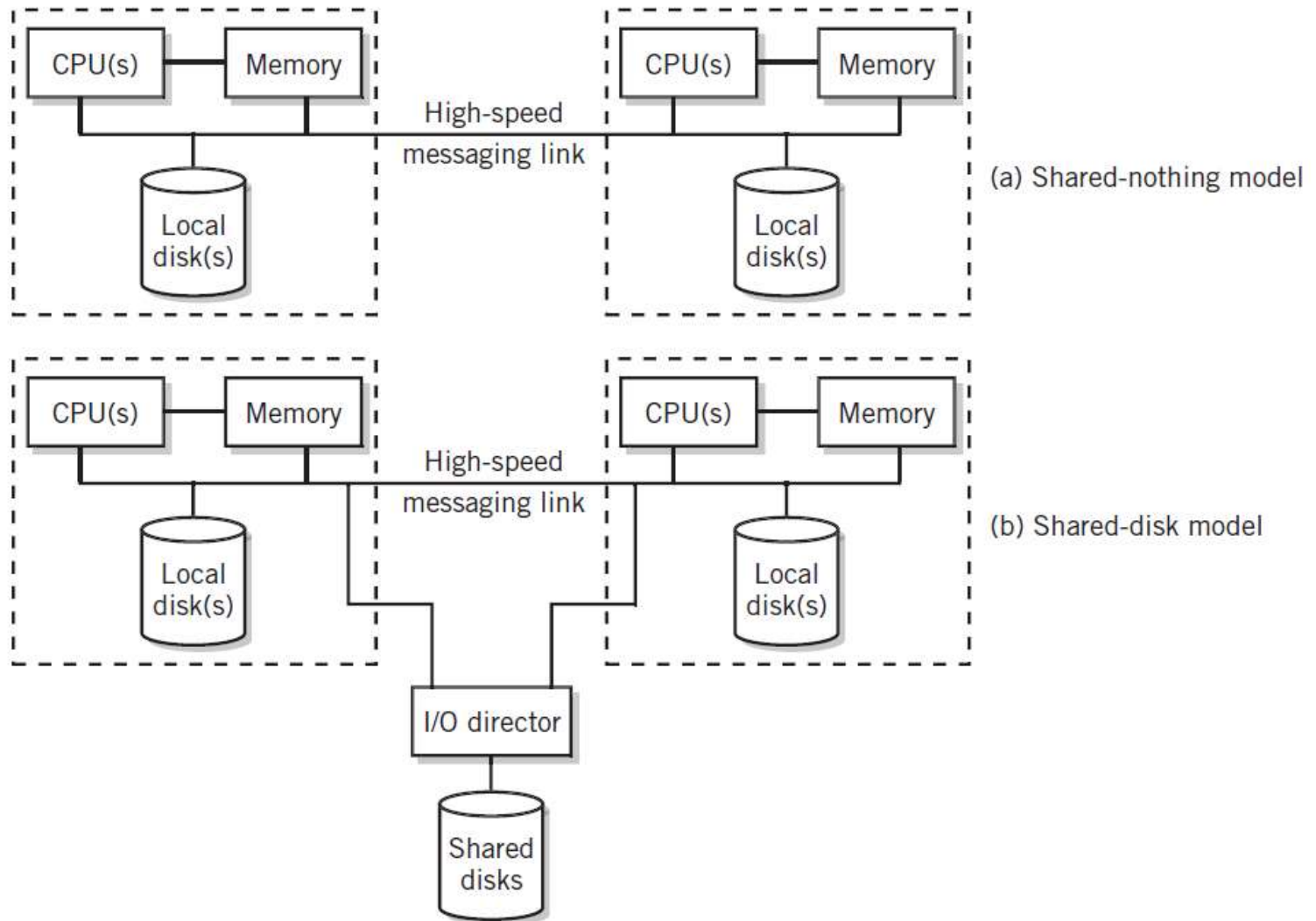
HIGH PERFORMANCE COMPUTING

▶ For tasks that need a large amounts of computing power

  ▶ Supercomputers

  ▶ Used for complex scientific computations such as quantum mechanics, weather forecasting, molecular modeling etc.

THANK YOU

REFERNCES

- Chapter 8 and 11: The Architecture of Computer Hardware, Systems Software & Networking: An Information Technology Approach -4th Edition, Irv Englander -John Wiley and Sons