William Stallings

Computer Organization and Architecture

9th Edition

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Chapter 3

A Top-Level View of Computer Function and Interconnection

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I/O Function

- I/O module can exchange data directly with the processor
- Processor can read data from or write data to an I/O module
  - Processor identifies a specific device that is controlled by a particular I/O module
  - I/O instructions rather than memory referencing instructions
- In some cases it is desirable to allow I/O exchanges to occur directly with memory
  - The processor grants to an I/O module the authority to read from or write to memory so that the I/O memory transfer can occur without tying up the processor
  - The I/O module issues read or write commands to memory relieving the processor of responsibility for the exchange
  - This operation is known as direct memory access (DMA)

Computer Modules

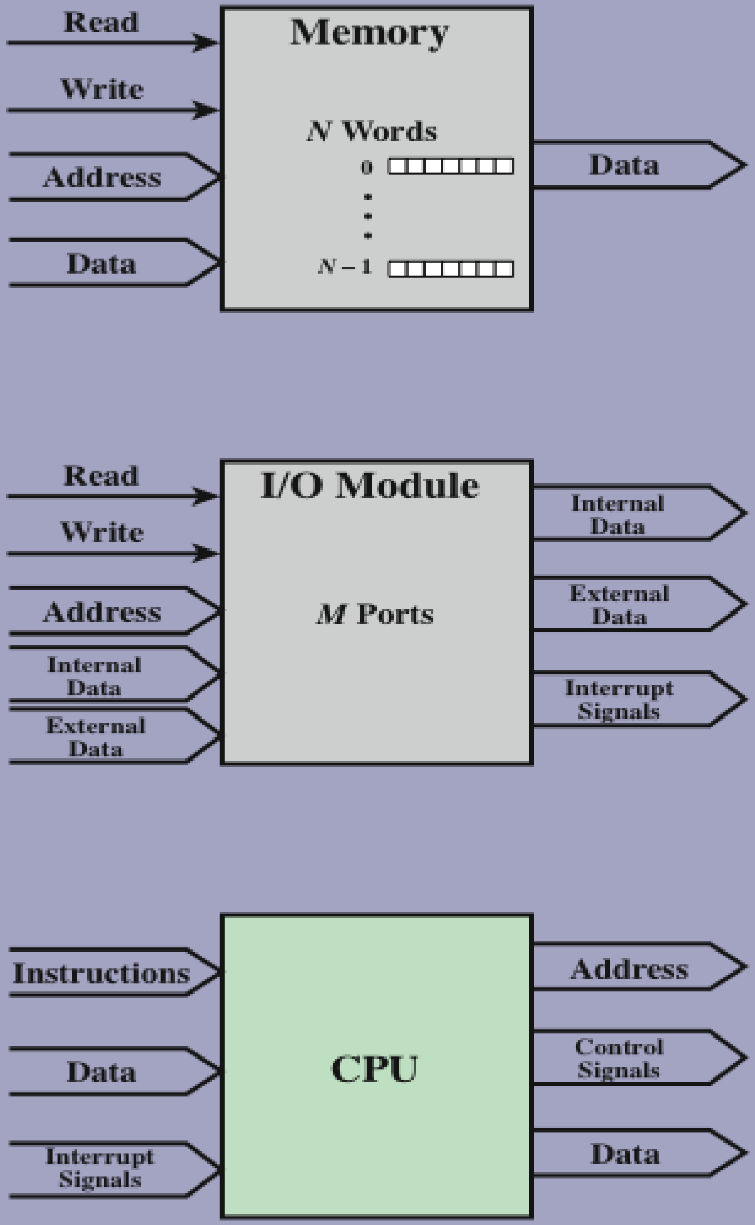


Figure 3.15 Computer Modules

The interconnection structure must support the following types of transfers:

Memory to processor

Processor reads an instruction or a unit of data from memory

Processor to memory

Processor writes a unit of data to memory

I/O to processor

Processor reads data from an I/O device via an I/O module

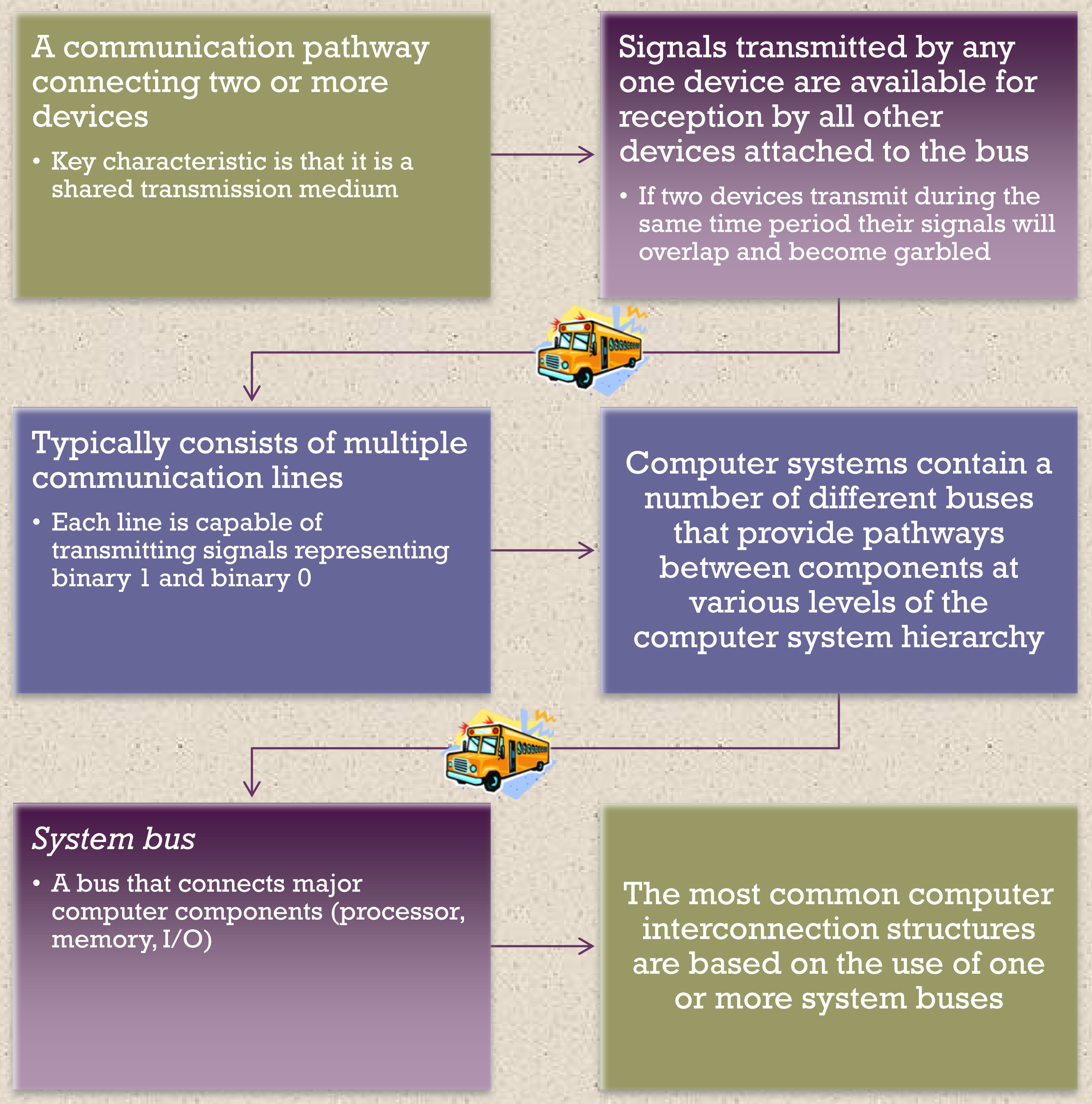
Processor to I/O

Processor sends data to the I/O device

I/O to or from memory

An I/O module is allowed to exchange data directly with memory without going through the processor using direct memory access

Bus Interconnection



A communication pathway connecting two or more devices

- Key characteristic is that it is a shared transmission medium

Signals transmitted by any one device are available for reception by all other devices attached to the bus

- If two devices transmit during the same time period their signals will overlap and become garbled

Typically consists of multiple communication lines

- Each line is capable of transmitting signals representing binary 1 and binary 0

Computer systems contain a number of different buses that provide pathways between components at various levels of the computer system hierarchy

System bus

- A bus that connects major computer components (processor, memory, I/O)

The most common computer interconnection structures are based on the use of one or more system buses

Data Bus

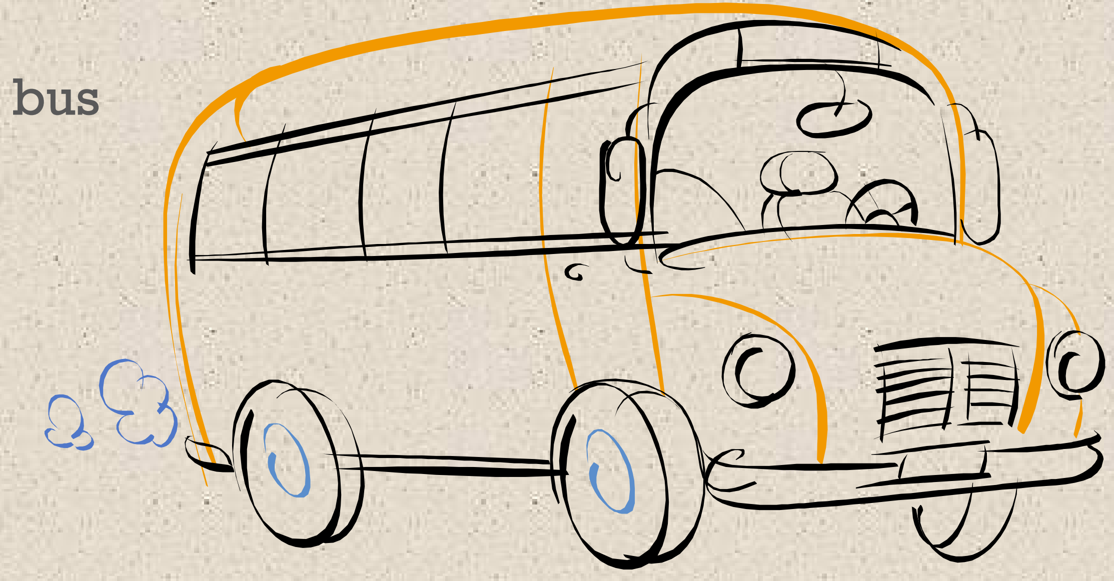
- Data lines that provide a path for moving data among system modules

- May consist of 32, 64, 128, or more separate lines

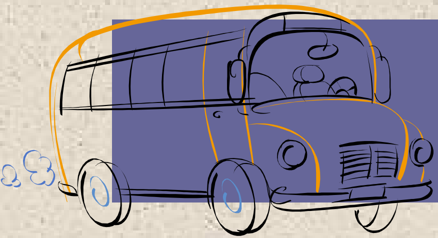
- The number of lines is referred to as the *width* of the data bus

- The number of lines determines how many bits can be transferred at a time

- The width of the data bus is a key factor in determining overall system performance

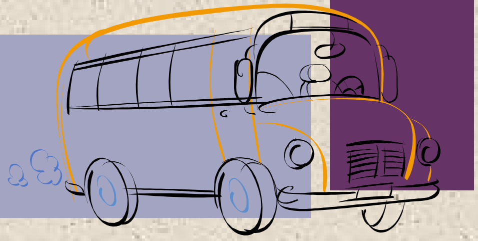


Address Bus



- Used to designate the source or destination of the data on the data bus
  - If the processor wishes to read a word of data from memory it puts the address of the desired word on the address lines
- Width determines the maximum possible memory capacity of the system
- Also used to address I/O ports
  - The higher order bits are used to select a particular module on the bus and the lower order bits select a memory location or I/O port within the module

Control Bus



- Used to control the access and the use of the data and address lines
- Because the data and address lines are shared by all components there must be a means of controlling their use
- Control signals transmit both command and timing information among system modules
- Timing signals indicate the validity of data and address information
- Command signals specify operations to be performed

Bus Interconnection Scheme

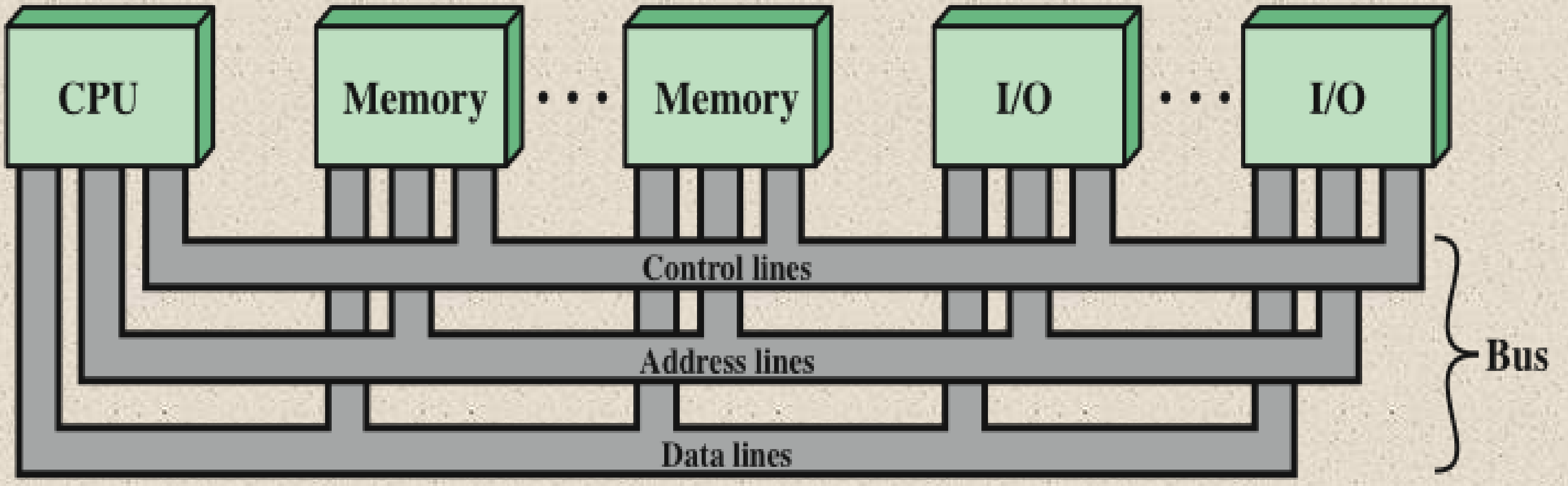
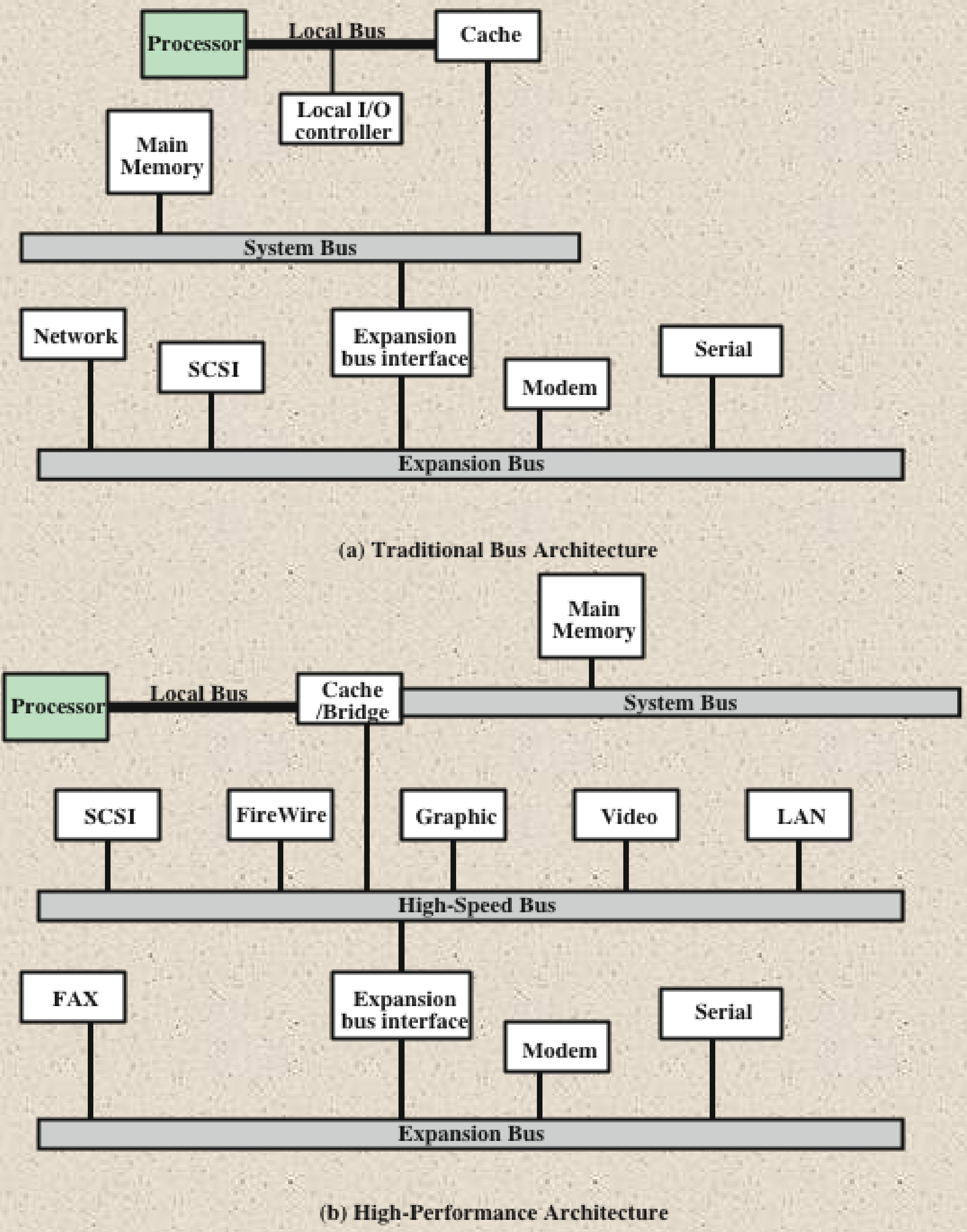


Figure 3.16 Bus Interconnection Scheme

Bus Configurations



(a) Traditional Bus Architecture

(b) High-Performance Architecture

Figure 3.17 Example Bus Configurations

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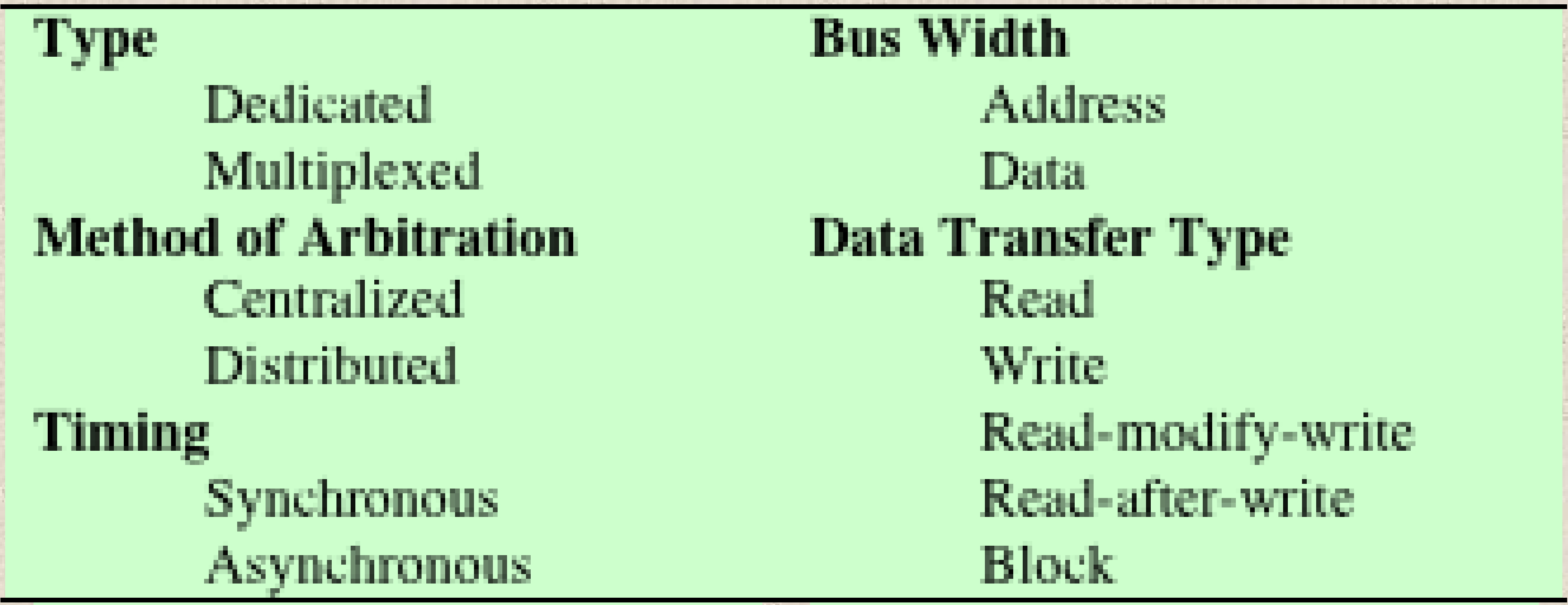
Elements of Bus Design



Type
- Dedicated
- Multiplexed

Method of Arbitration
- Centralized
- Distributed

Timing
- Synchronous
- Asynchronous

Bus Width
- Address
- Data

Data Transfer Type
- Read
- Write
- Read-modify-write
- Read-after-write
- Block