EXTENDED APPLICATIONS OF DIGITAL LOGIC CIRCUITS

Dr. Suneth Pathirana
BSc(UWU-CST)(Hons), MSc(AI)(Moratuwa), MIEEE, PhD(MSU)

Senior Lecturer
Department of Computer Science & Informatics
Uva Wellassa University of Sri Lanka

suneth@uwu.ac.lk

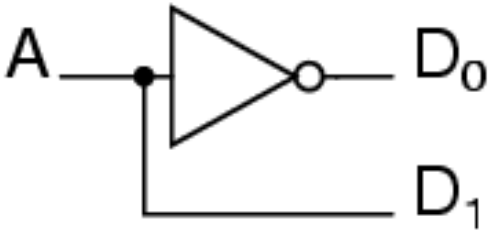
Decoders

- A decoder is a circuit that changes a code into a set of signals
- It is called a decoder because it does the reverse of encoding, but we will begin our study of encoders and decoders with decoders because they are simpler to design

Decoders

- A common type of decoder is the line decoder which takes an n-digit binary number and decodes it into 2^n data lines
- The simplest is the 1-to-2 line decoder
  - The truth table is

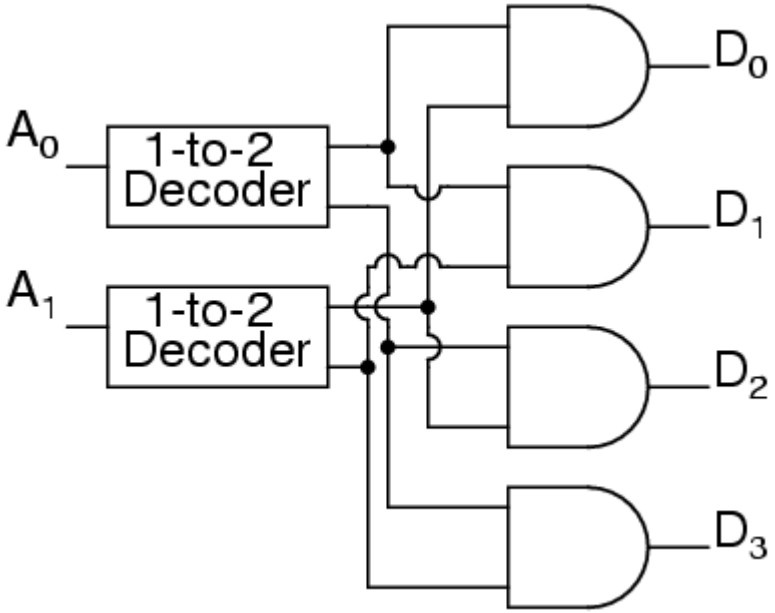
A	D_1	D_0
0	0	1
1	1	0

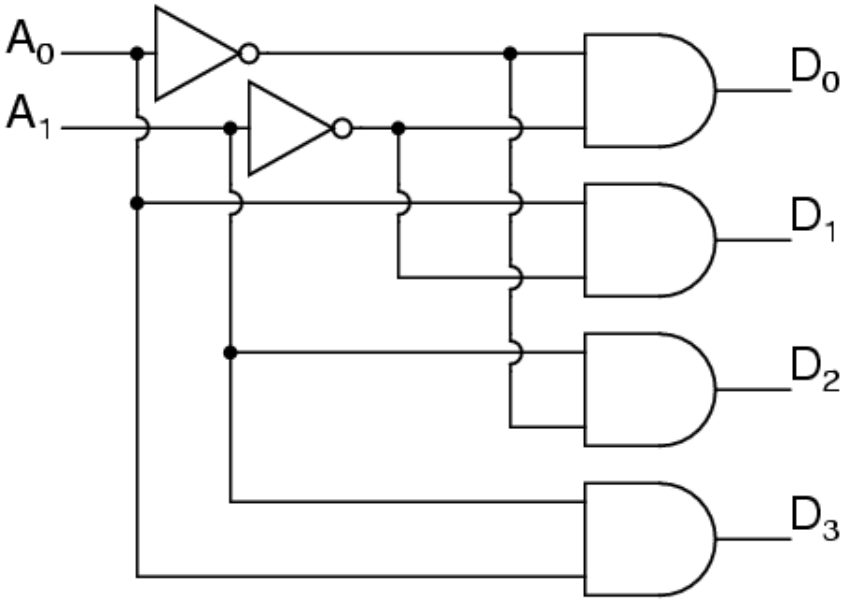


Decoders

- 2-to-4 line decoder

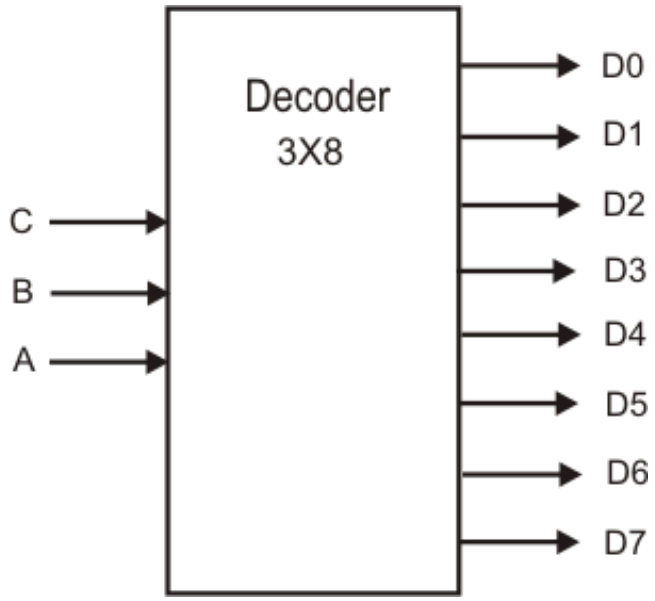
A_1	A_0	D_3	D_2	D_1	D_0
0	0	0	0	0	1
0	1	0	0	1	0
1	0	0	1	0	0
1	1	1	0	0	0

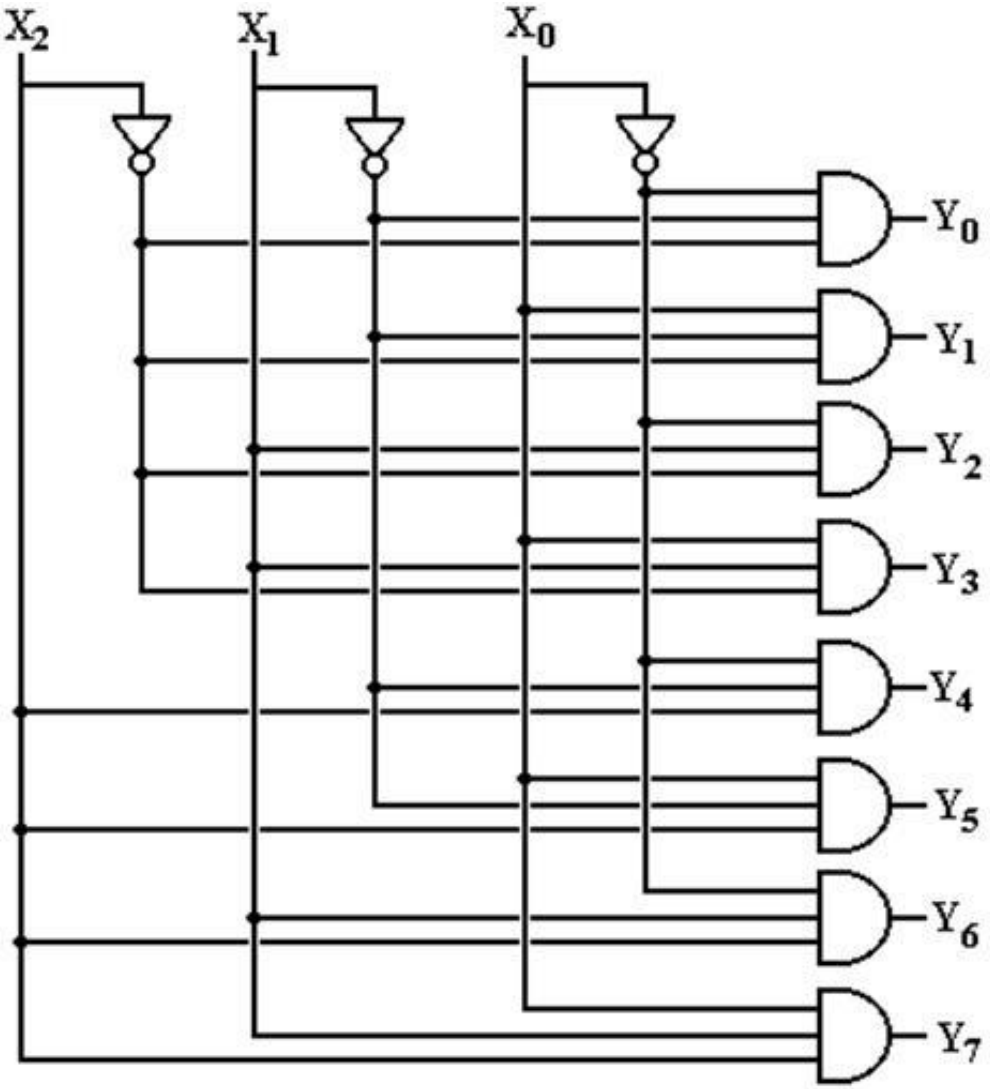




Decoders

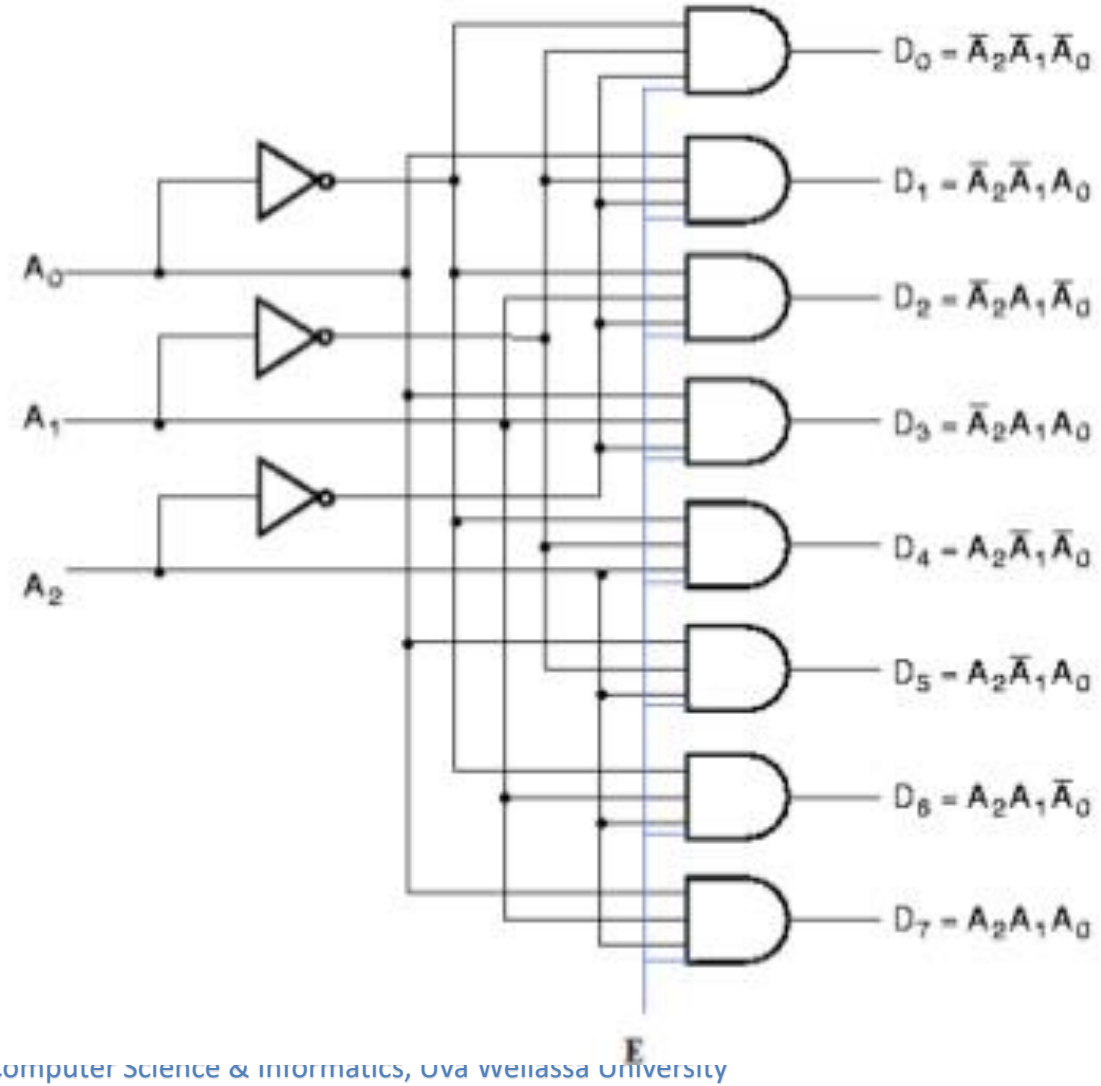
- 3 to 8 Decoder





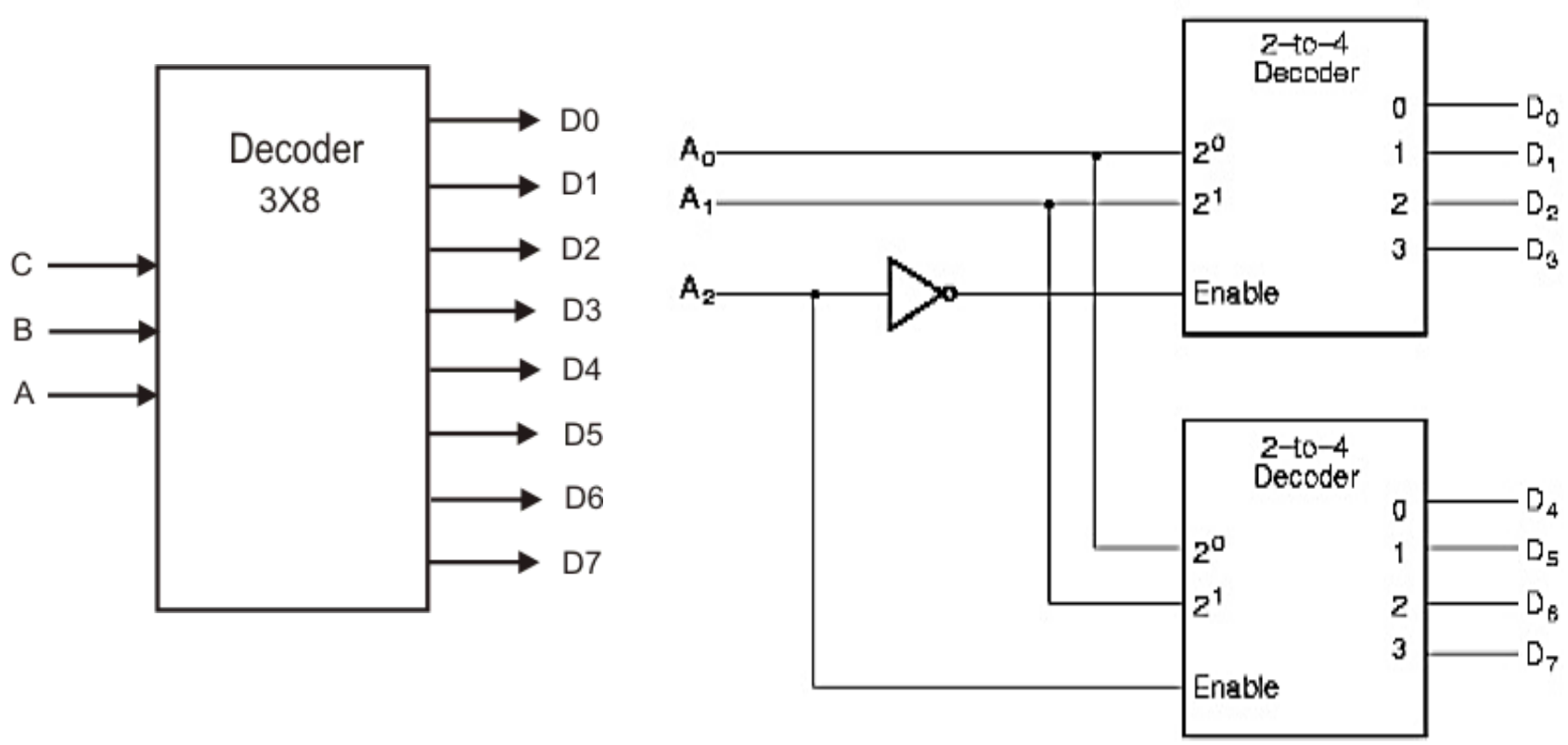
Decoders

- 3 to 8 Decoder
- With Enable



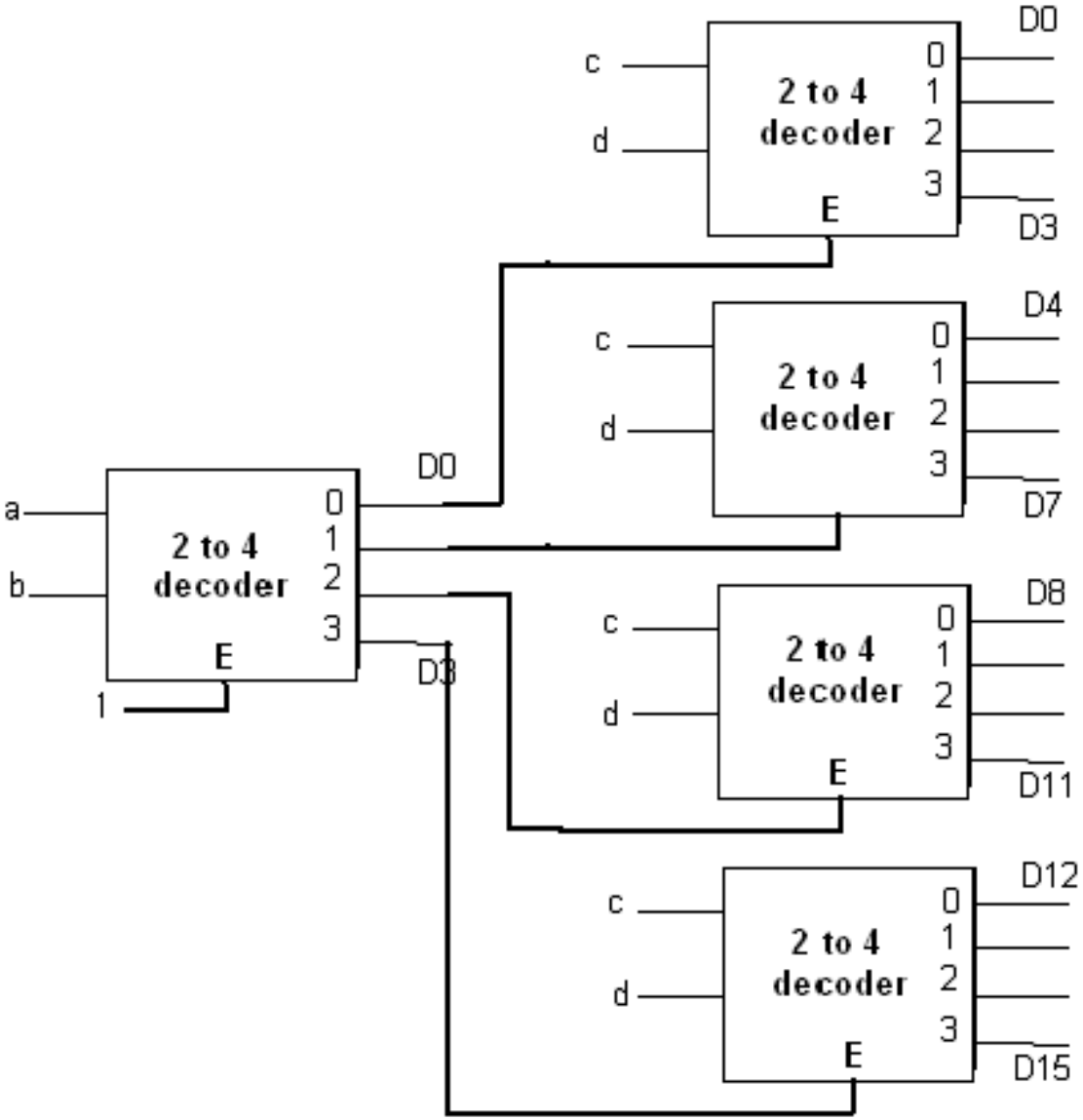
Decoders

- 3 to 8 Decoder using 2-to-4 decoders



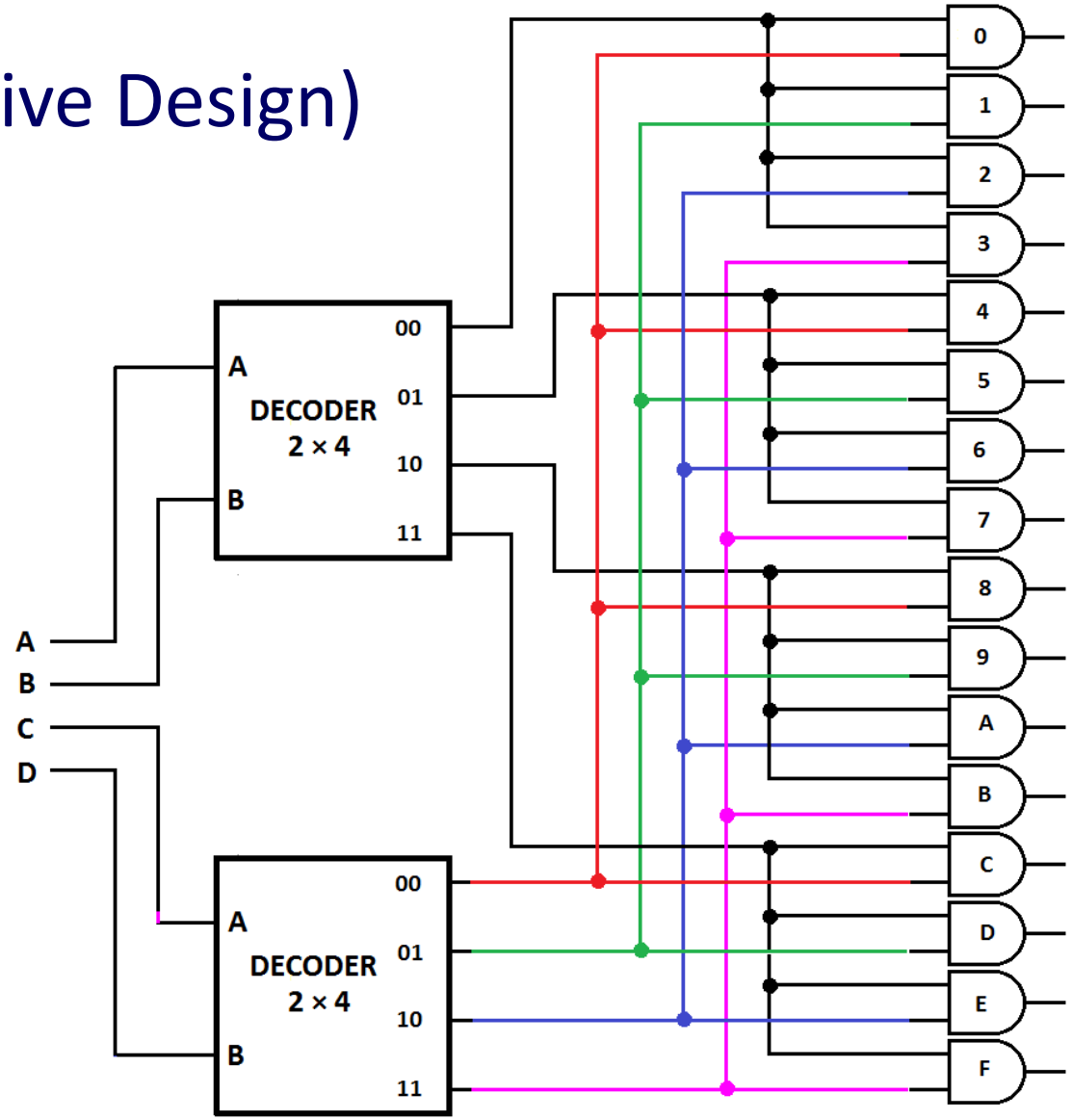
Decoders

- 4-to-16



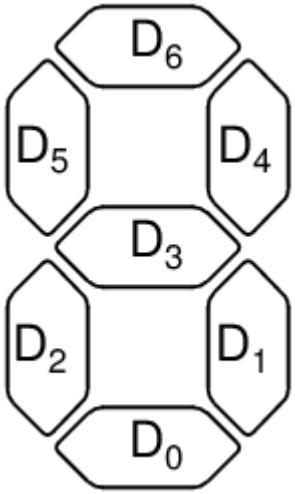
Decoders

- 4-to-16 (Alternative Design)



Decoders

- A more useful application of combinational encoder design is a binary to 7-segment decoder
- The seven segments are given according

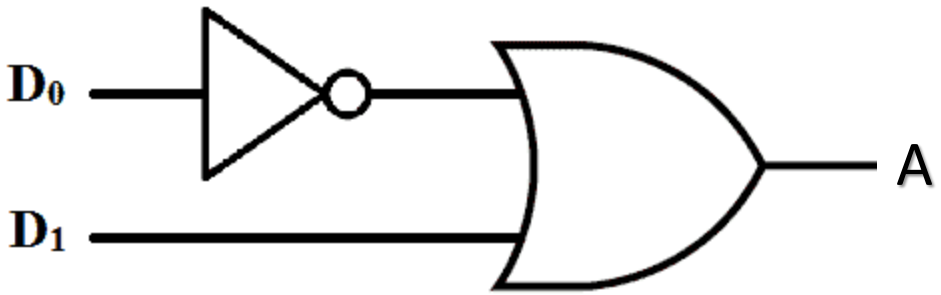


I_3	I_2	I_1	I_0	D_6	D_5	D_4	D_3	D_2	D_1	D_0
0	0	0	0	1	1	1	0	1	1	1
0	0	0	1	0	0	1	0	0	1	0
0	0	1	0	1	0	1	1	1	0	1
0	0	1	1	1	0	1	1	0	1	1
0	1	0	0	0	1	1	1	0	1	0
0	1	0	1	1	1	0	1	0	1	1
0	1	1	0	1	1	0	1	1	1	1
0	1	1	1	1	0	1	0	0	1	0
1	0	0	0	1	1	1	1	1	1	1
1	0	0	1	1	1	1	1	0	1	1

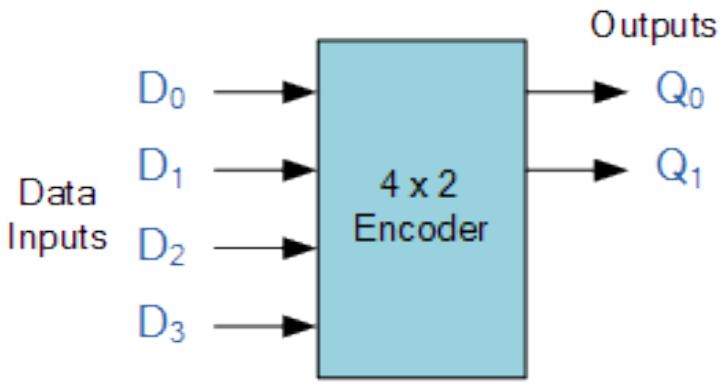
Encoders

- 2-to-1 line encoder is implemented by reversing the 1-to-2 decoder

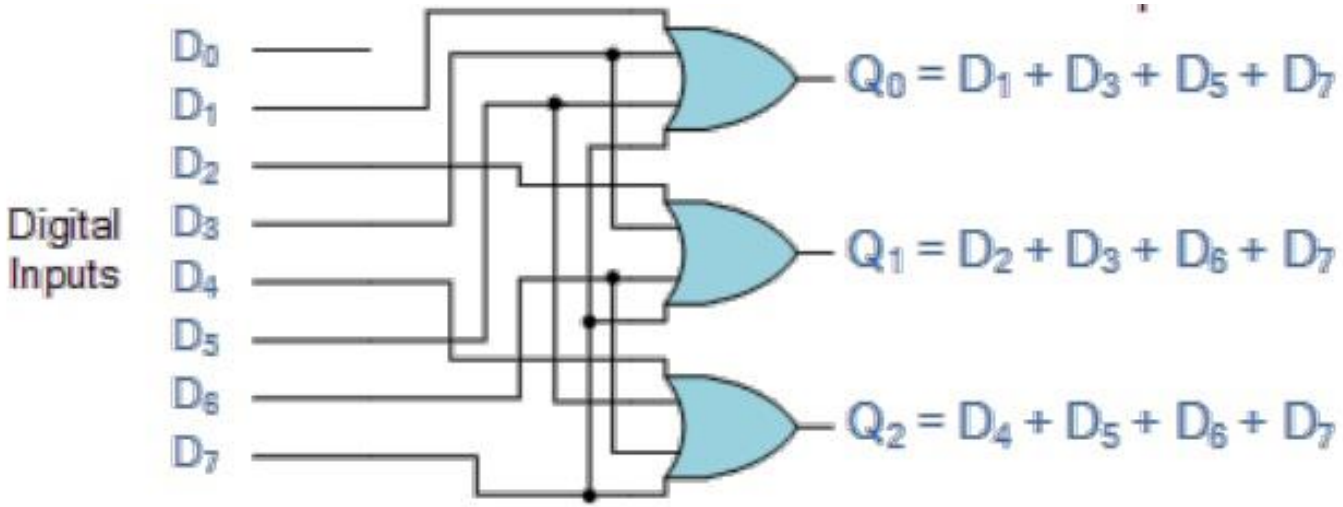
D_1	D_0	A
0	1	0
1	0	1



Encoders

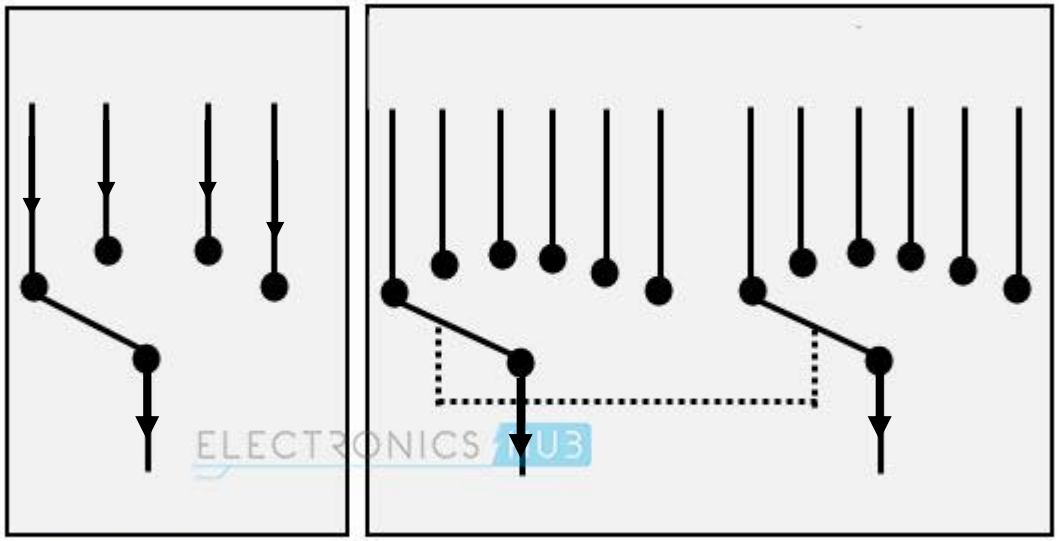


Inputs				Outputs	
D_3	D_2	D_1	D_0	Q_1	Q_0
0	0	0	1	0	0
0	0	1	0	0	1
0	1	0	0	1	0
1	0	0	0	1	1
0	0	0	0	x	x



Multiplexers

- Multiplexer means many into one
- A multiplexer is a circuit used to select and route any one of the several input signals to a signal output
- An simple example of an non electronic circuit of a multiplexer is a single pole multiposition switch

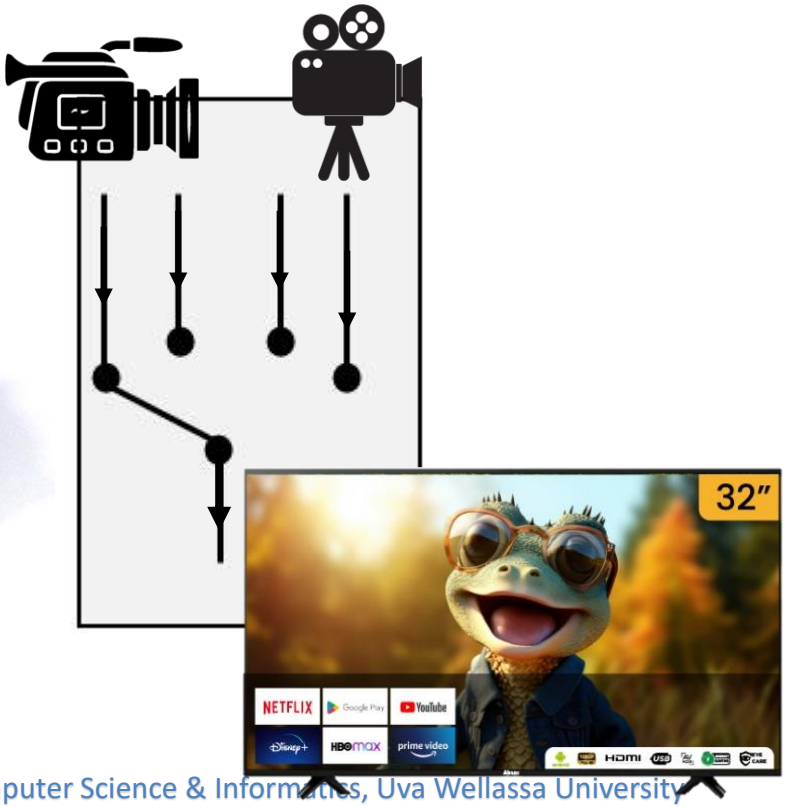


Single pole 4-way

2 pole 6 way

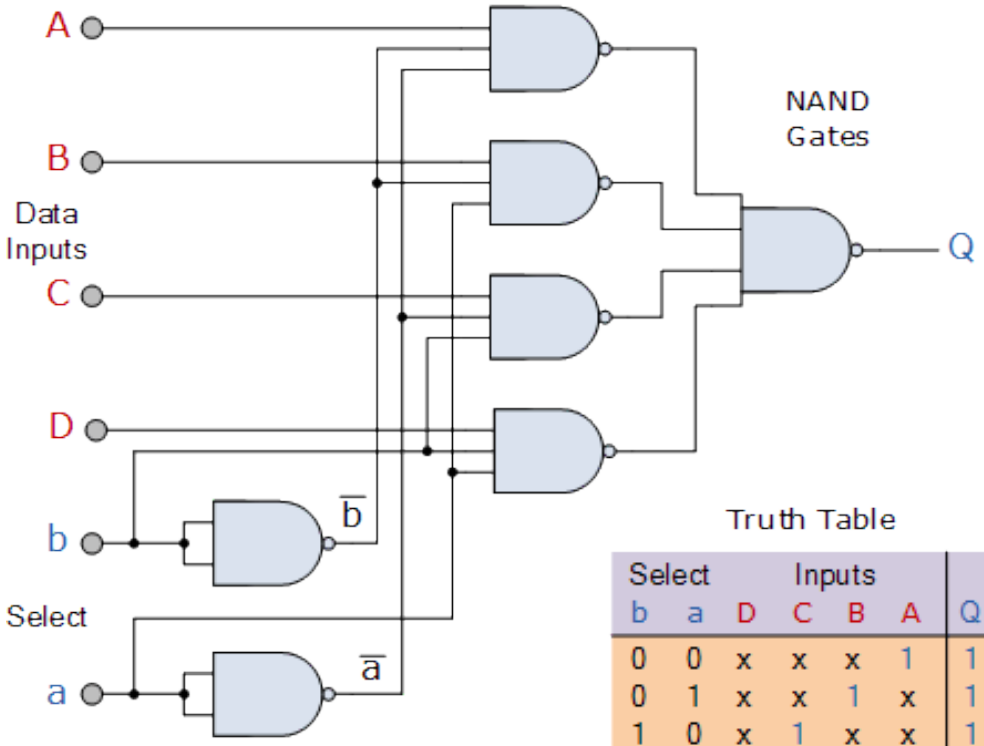
Multiplexers - Applications

- Multiple Microphones / Video Cameras / Musical Instruments but only one output (Digital Screen / Audio or Video Livestream / Speaker)



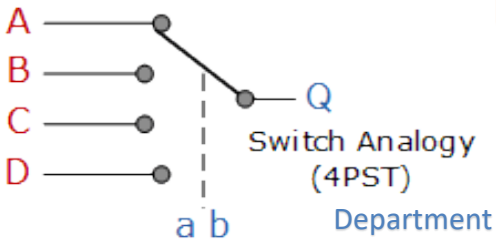
Multiplexers

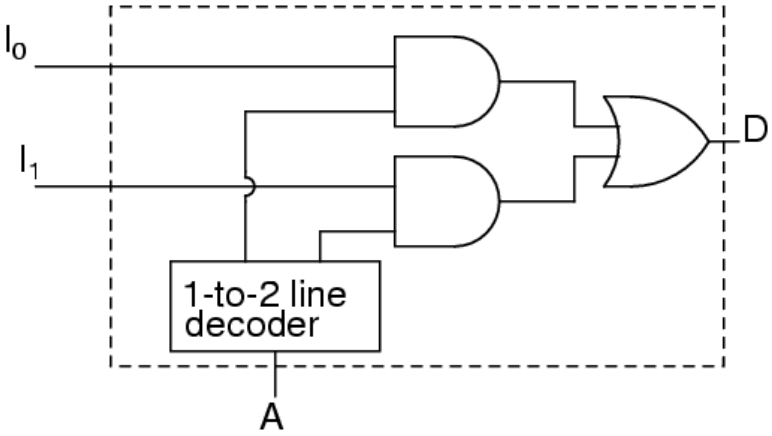
- Implementation

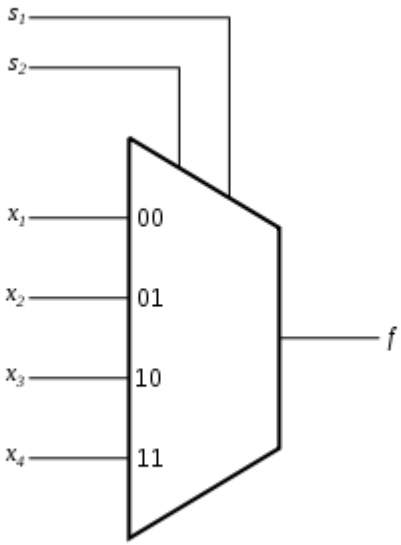


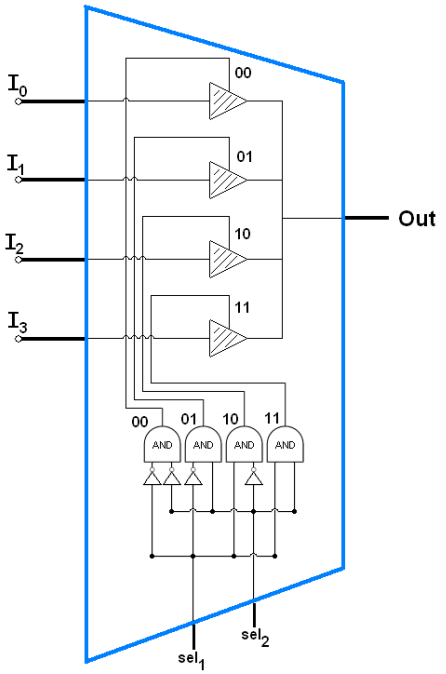
Truth Table

Select		Inputs				
b	a	D	C	B	A	Q
0	0	x	x	x	1	1
0	1	x	x	1	x	1
1	0	x	1	x	x	1
1	1	1	x	x	x	1



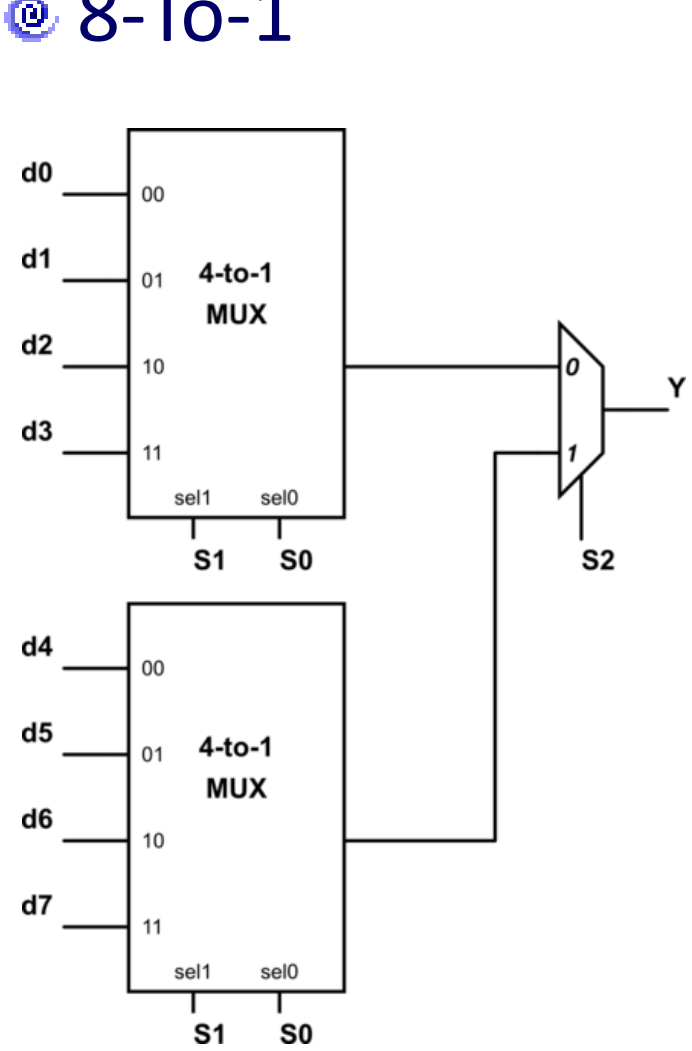


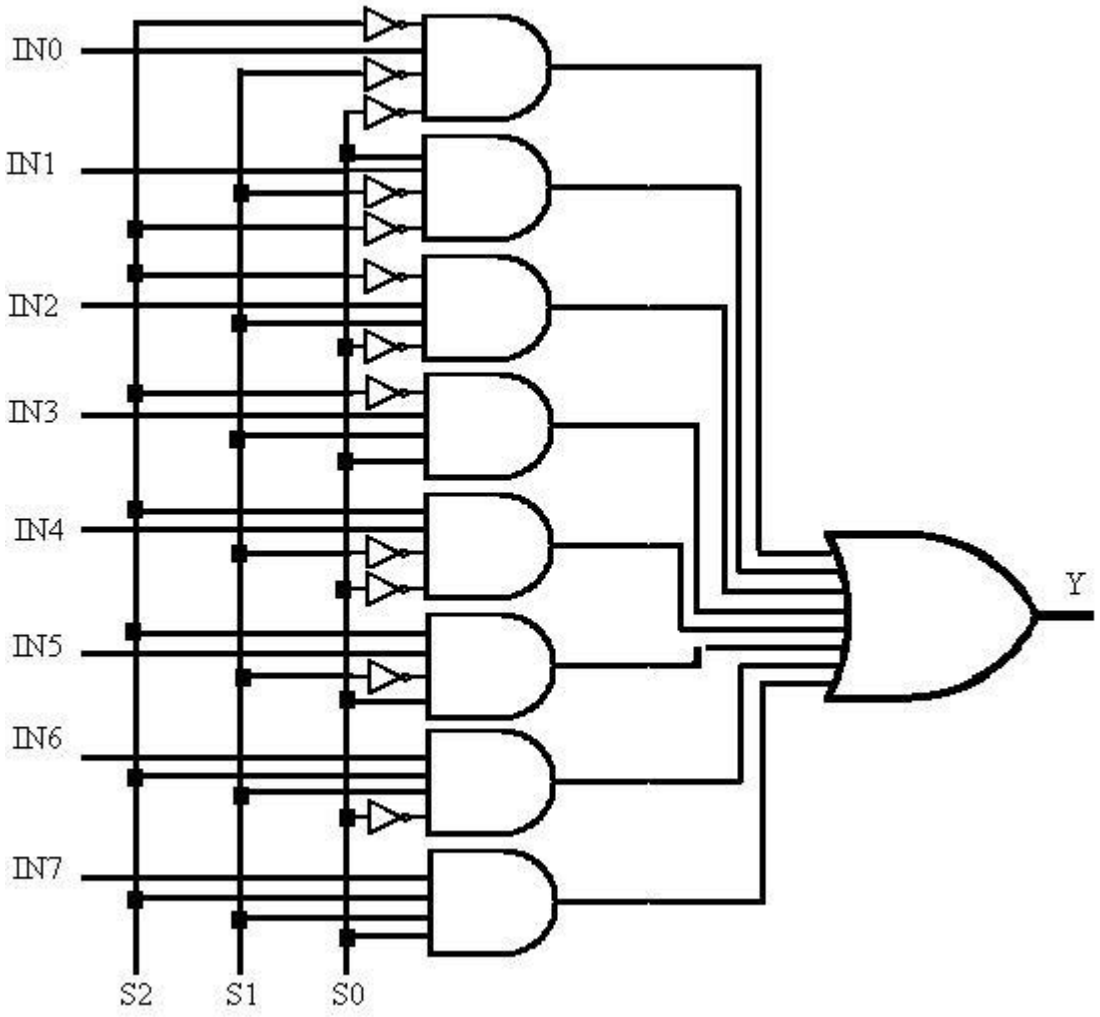




Multiplexers

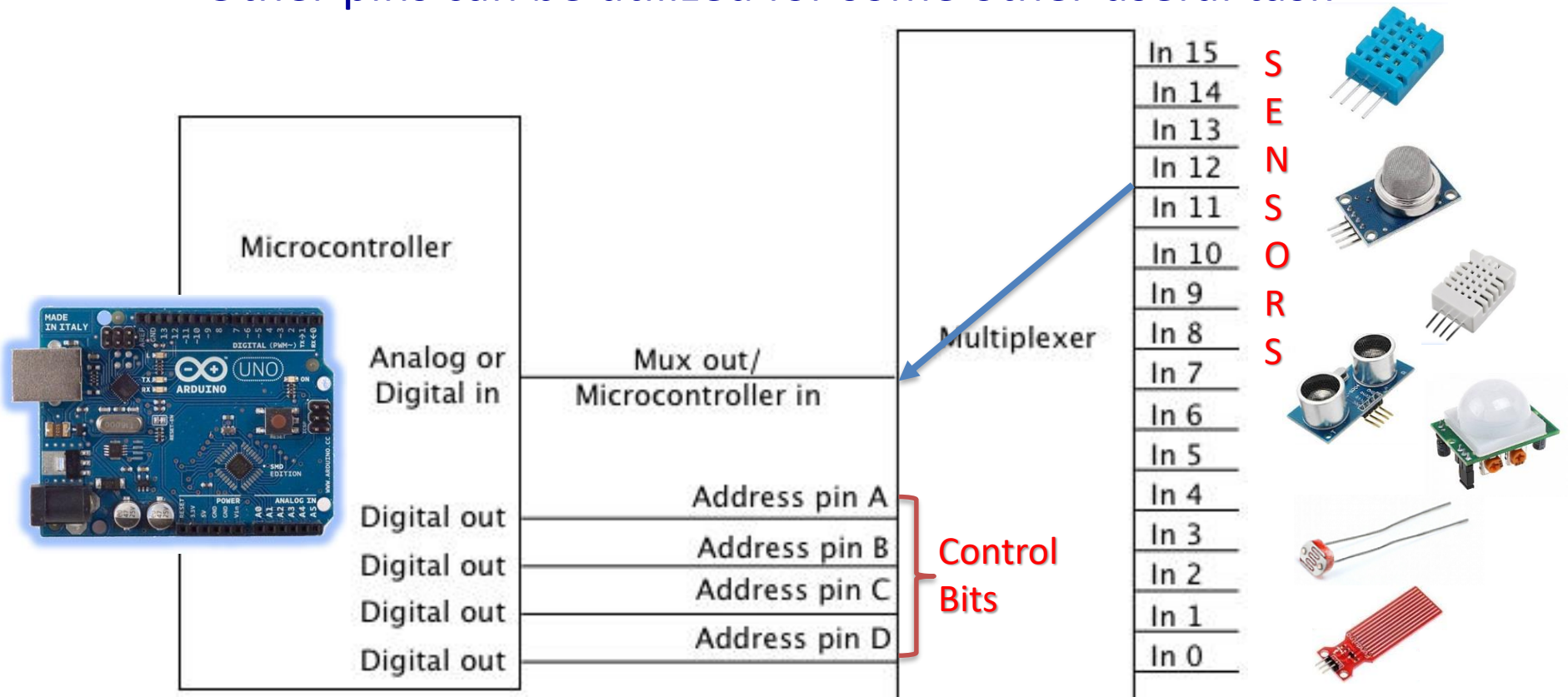
- 8-To-1





Multiplexers

- Applications
  - Many sensors connected to the microcontroller, but not all may active at a time
    - It is not a good idea to allocate a dedicated input pin for individual sensors then
    - Other pins can be utilized for some other useful task



Applications of Multiplexer

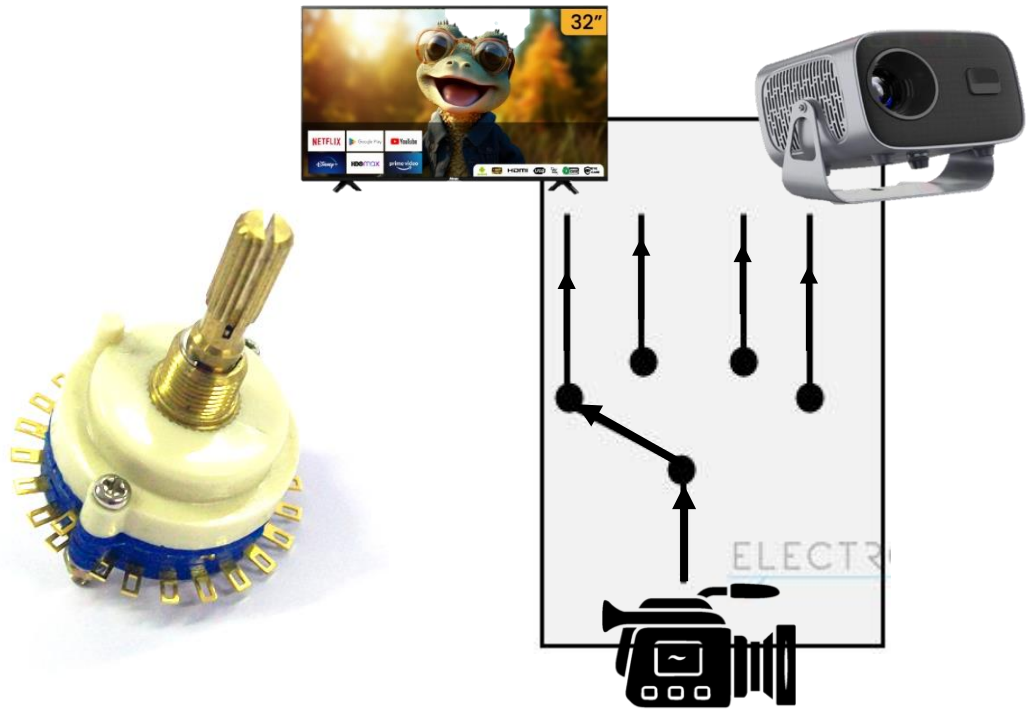
- Communication system
- Telephone network
- Computer memory
  - Multiplexers are used to implement huge amount of memory into the computer, at the same time reduces the number of copper lines required to connect the memory to other parts of the computer circuit
- Transmission from the computer system of a satellite

Demultiplexer

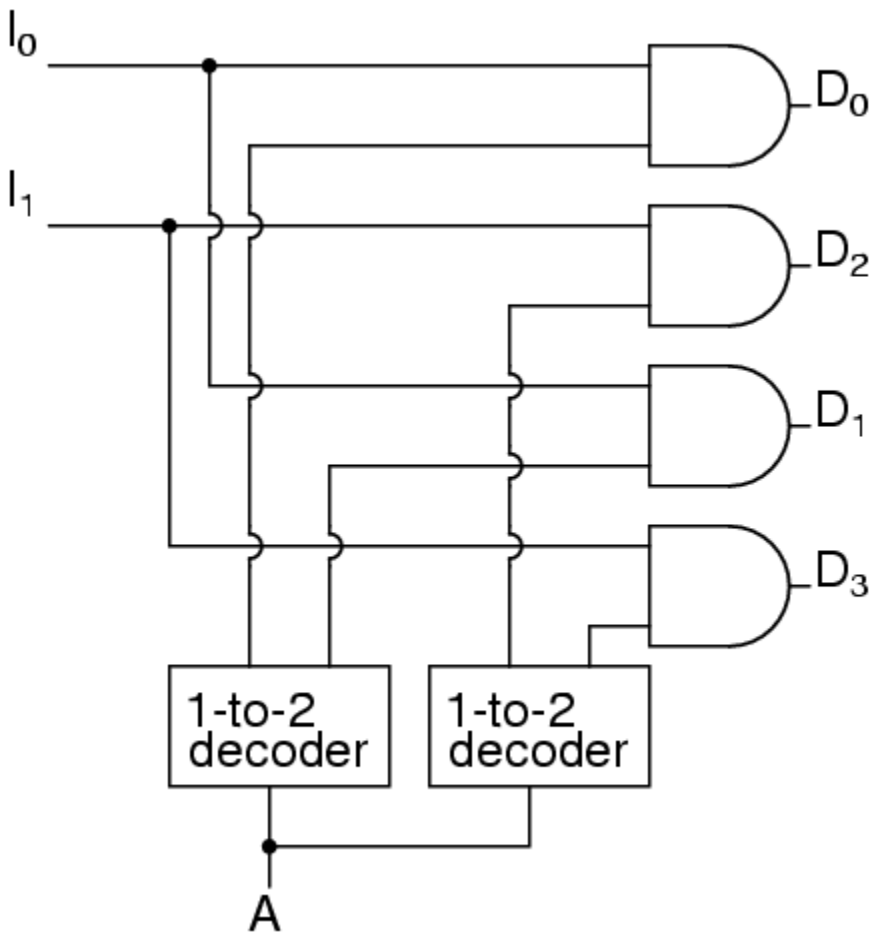
- Demultiplexer means one to many
- A demultiplexer is a circuit with one input and many output
- By applying control signal, we can steer any input to the output
- Few types of demultiplexer are 1-to 2, 1-to-4, 1-to-8 and 1-to 16 demultiplexer

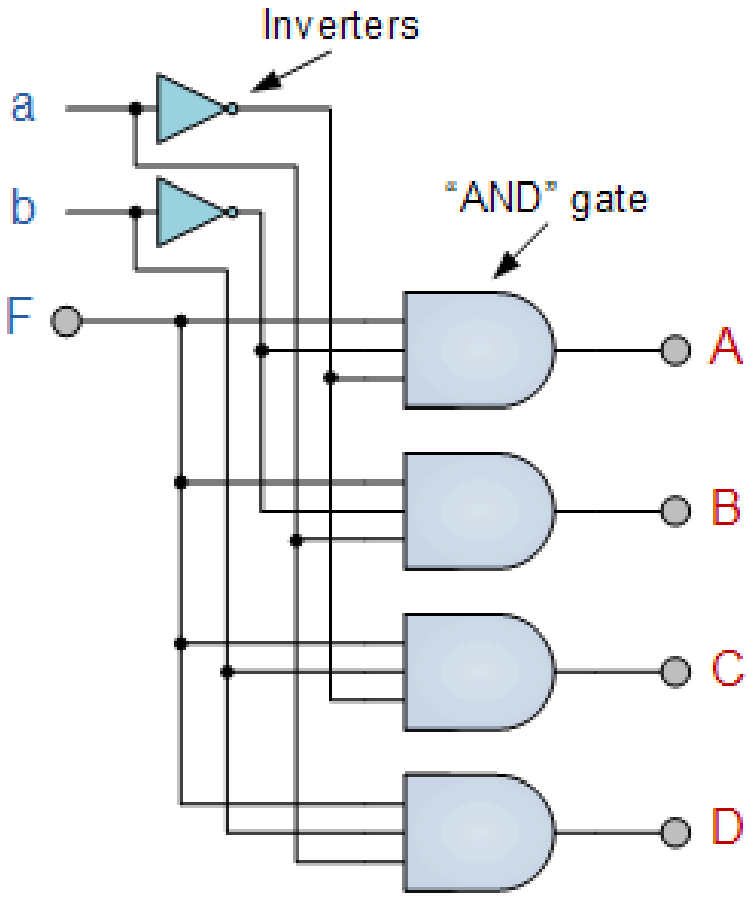
Demultiplexers - Applications

- Single input (device / signal) but many outputs



Demultiplexer





Applications of Demultiplexer

- To connect a **single source to multiple destinations**
- Communication System
- ALU (Arithmetic Logic Unit)
  - In an ALU circuit, the output of ALU can be stored in multiple registers or storage units with the help of demultiplexer
  - The output of ALU is fed as the data input to the demultiplexer
  - Each output of demultiplexer is connected to multiple register which can be stored in the registers.
- Serial to parallel converter

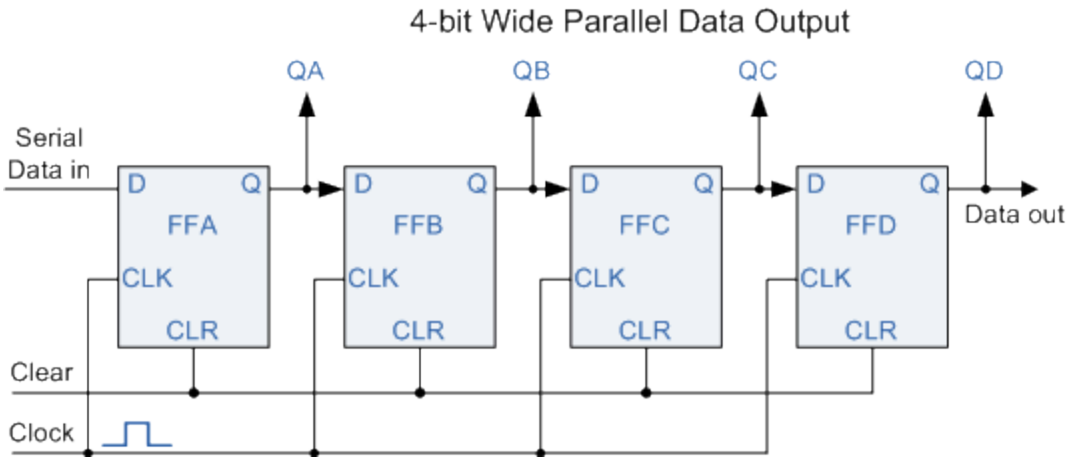
Shift Registers

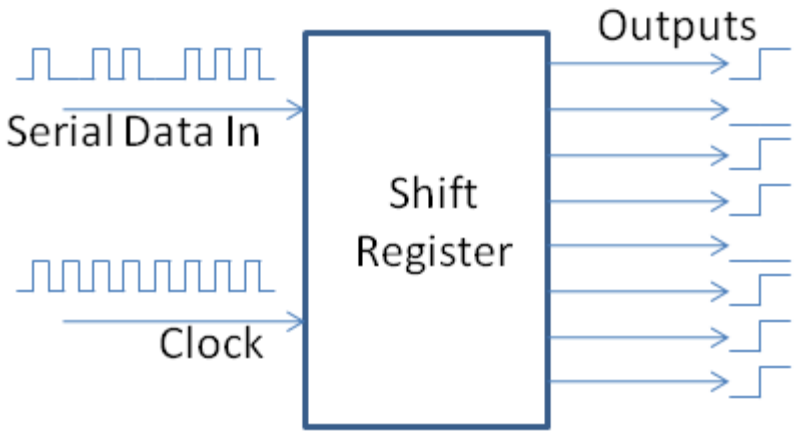
- Shift registers, like counters, are a form of **sequential logic**
  - Sequential logic, unlike combinational logic is not only affected by the present inputs, but also, by the prior history
  - In other words, sequential logic remembers past events
- Shift registers produce a **discrete delay** of a digital signal or waveform
- A waveform synchronized to a clock, a repeating square wave, is delayed by **"n"** discrete clock times, where **"n"** is the **number of shift register stages**

Shift Registers

- A waveform synchronized to a clock, a repeating square wave, is delayed by **“n”** discrete clock times, where **“n”** is the **number of shift register stages**
- For an example, a four stage shift register delays “data in” by four clocks to “data out”
- The stages in a shift register are **delay stages**, typically type **“D”** Flip-Flops or type **“JK”** Flip-flops
- Formerly, very long (several hundred stages) shift registers served as digital memory

Shift Registers

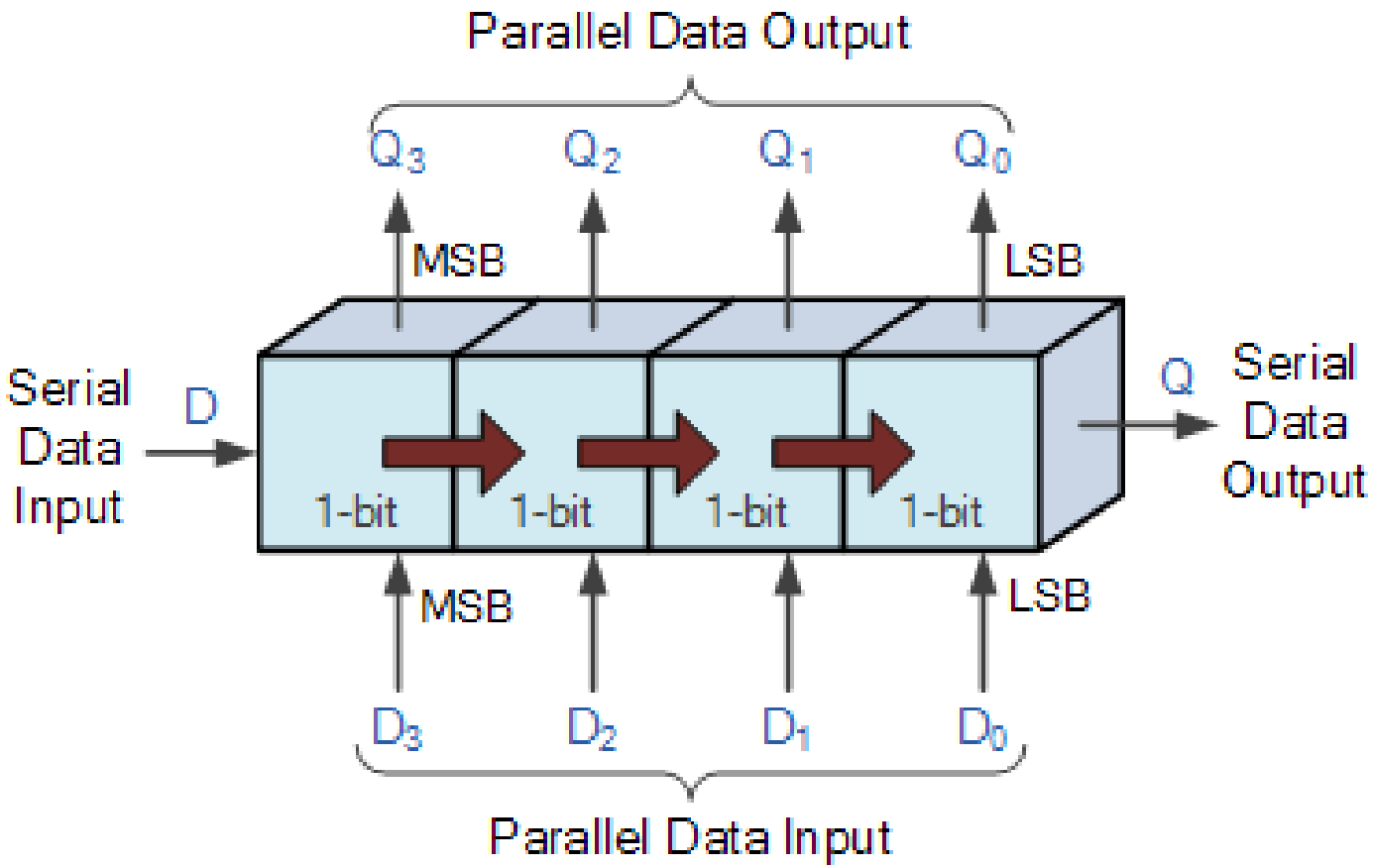




Shift Registers : Applications

- Serial data transmission, over a distance of meters to kilometers, uses shift registers to convert parallel data to serial form
  - Serial data communications replaces many slow parallel data wires with a single serial high speed circuit
- Some specialized counter circuits actually use shift registers to generate repeating waveforms
  - Longer shift registers, with the help of feedback generate patterns so long that they look like random noise, **pseudo-noise**

Shift Registers

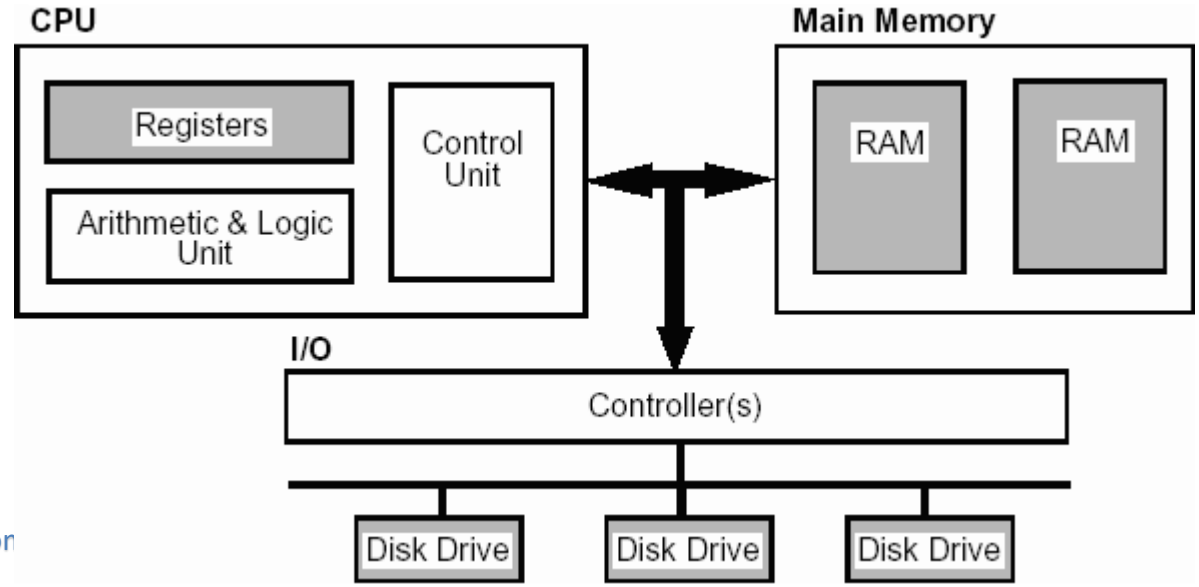


Welcome to Microcomputer Architecture

Department of Computer Science & Informatics, Uva Wellassa University

Memory Registers

- In computer architecture, a processor register is a small amount of storage available as part of a digital processor, such as a central processing unit (CPU)
- Such registers are typically addressed by mechanisms other than main memory and can be accessed faster

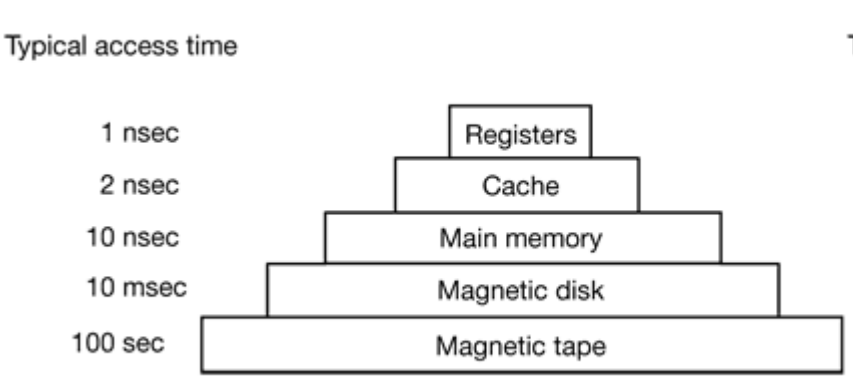


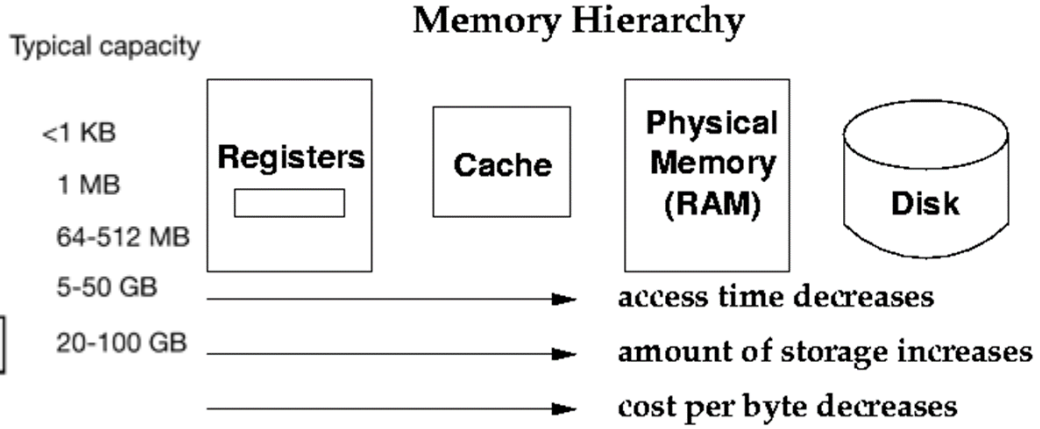
Memory Registers

- Memory Registers in CPU
  - Memory data register
  - Memory address register

The Memory Data Register (MDR)

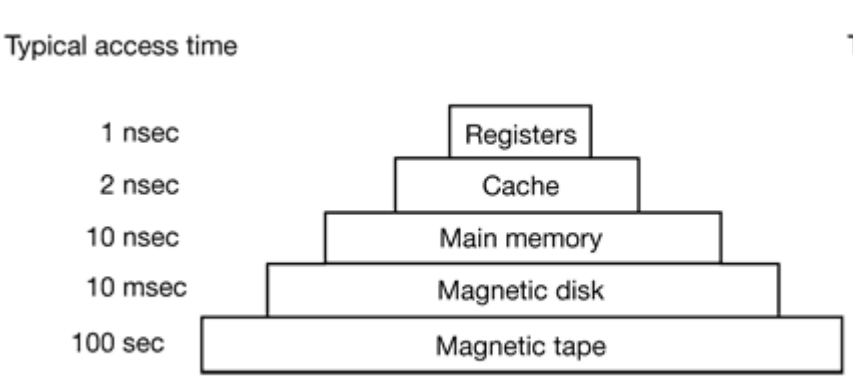
- The Memory Data Register (MDR) or Memory Buffer Register (MBR) is the register of a computer's control unit that contains the data to be stored in the computer storage (e.g. RAM), or the data after a fetch from the computer storage
- It acts like a buffer and holds anything that is copied from the memory ready for the processor to use it

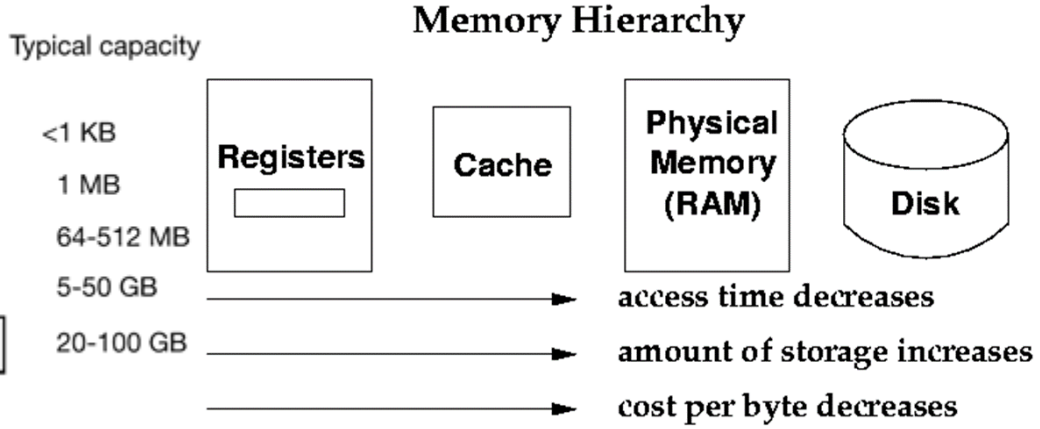




The Memory Data Register (MDR)

- The MDR is a two-way register
- When data is fetched from memory and placed into the MDR, it is written to go in one direction
- When there is a write instruction, the data to be written is placed into the MDR from another CPU register, which then puts the data into





Memory address register

- In a computer, the Memory Address Register (MAR) is a CPU register that either stores the memory address from which data will be fetched to the CPU or the address to which data will be sent and stored
- In other words, MAR holds the memory location of data that needs to be accessed
- When reading from memory, data addressed by MAR is fed into the MDR (memory data register) and then used by the CPU
- When writing to memory, the CPU writes data from MDR to the memory location whose address is stored in MAR