CS 223 Computer Architecture and Organization

CPU Registers

J. K. Deka

Professor

Department of Computer Science & Engineering

Indian Institute of Technology Guwahati, Assam.

Components of Computer

- The Control Unit and the Arithmetic and Logic Unit constitute the Central Processing Unit (CPU)
- CPU has temporary storage space - Registers
- Data and instructions need to get into the system and results out
  - Input/output
- Temporary storage of code and results is needed
  - Main memory

Connecting

- All the units must be connected
- Different type of connection for different type of unit
  - Memory
  - Input/Output
  - CPU

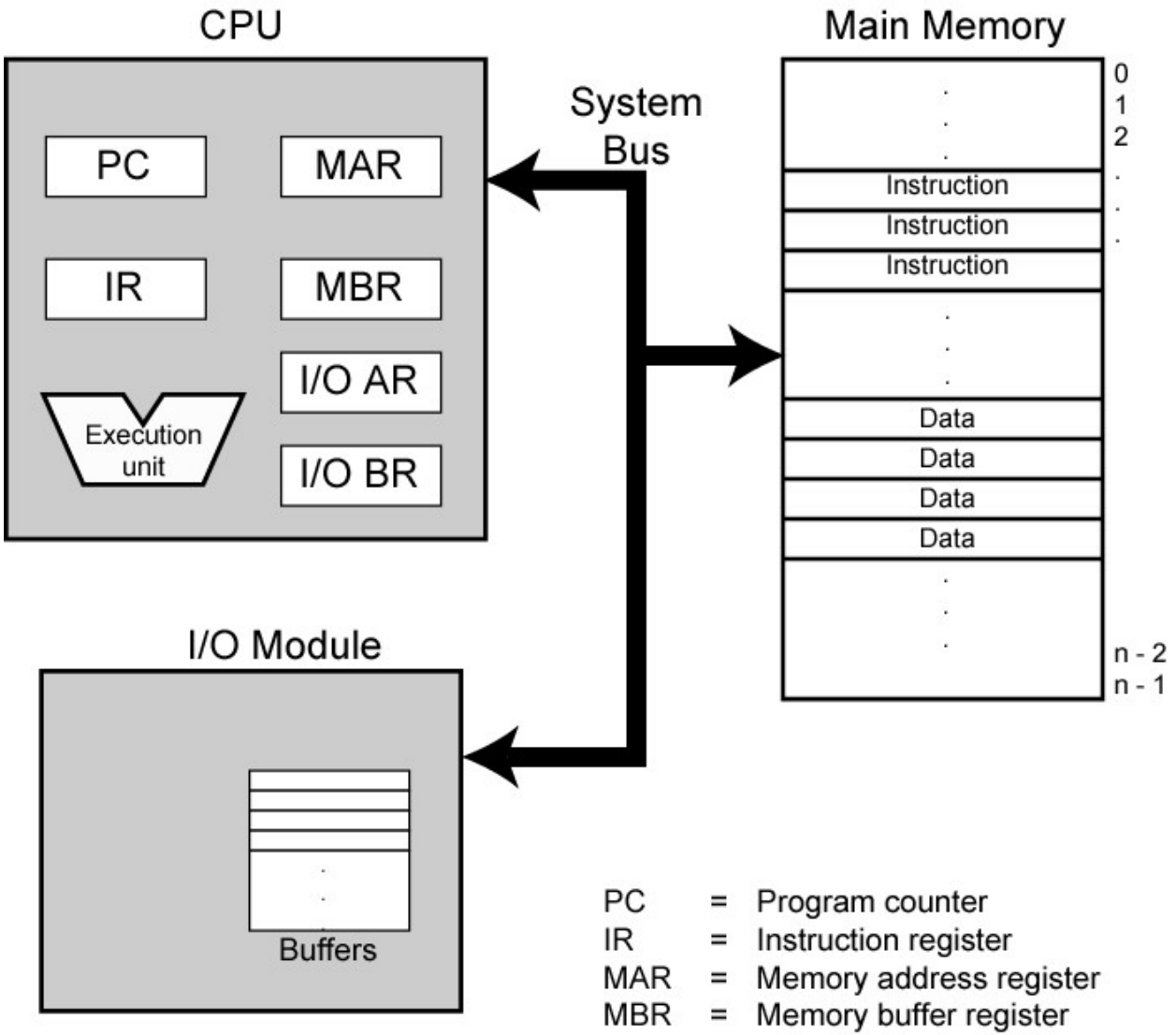
Memory Connection

- Receives and sends data
- Receives addresses (of locations)
- Receives control signals
  - Read
  - Write
  - Timing

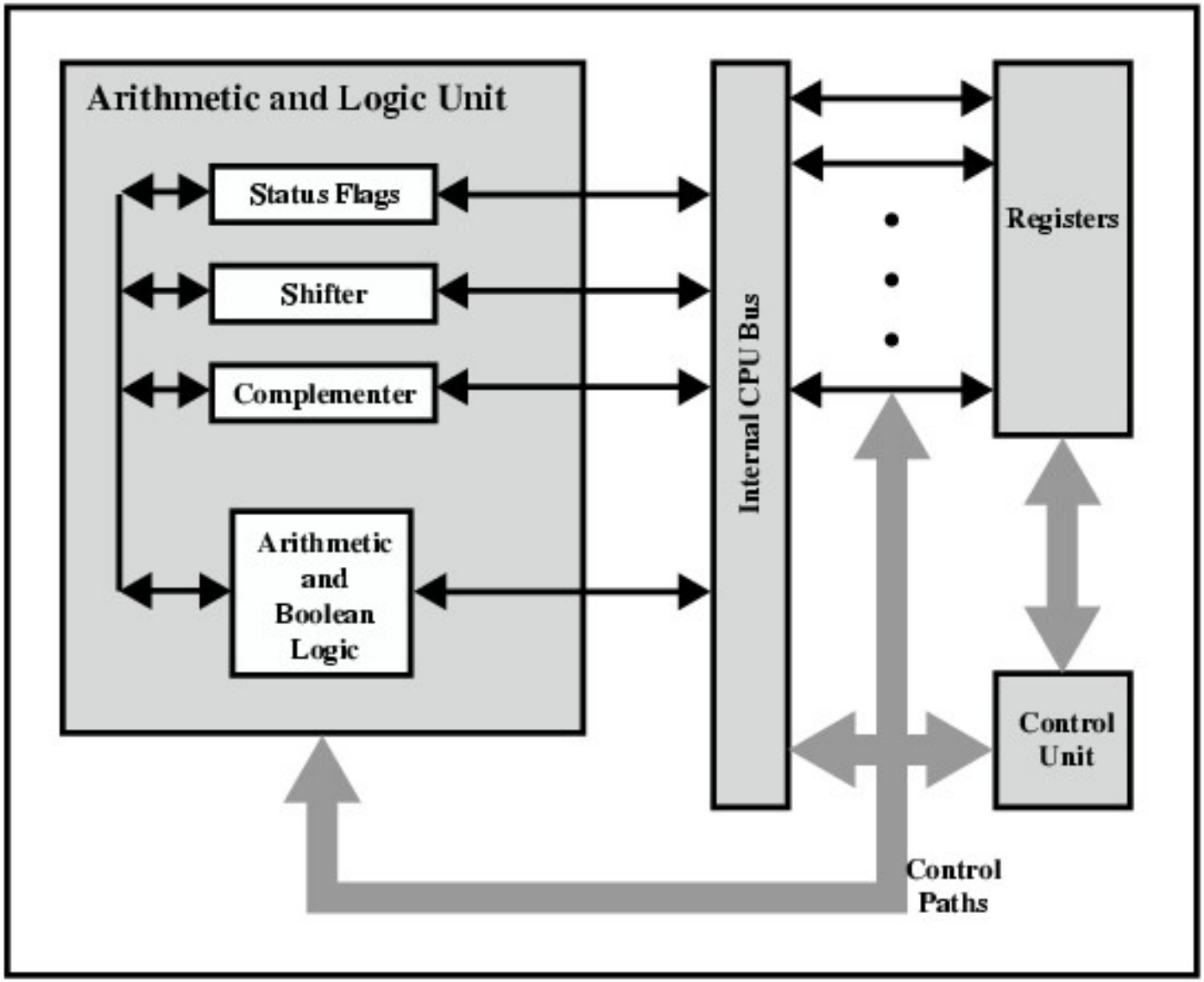
Input/Output Connection

- Similar to memory from computer's viewpoint
- Output
  - Receive data from computer
  - Send data to peripheral
- Input
  - Receive data from peripheral
  - Send data to computer

Computer Components: Top Level View

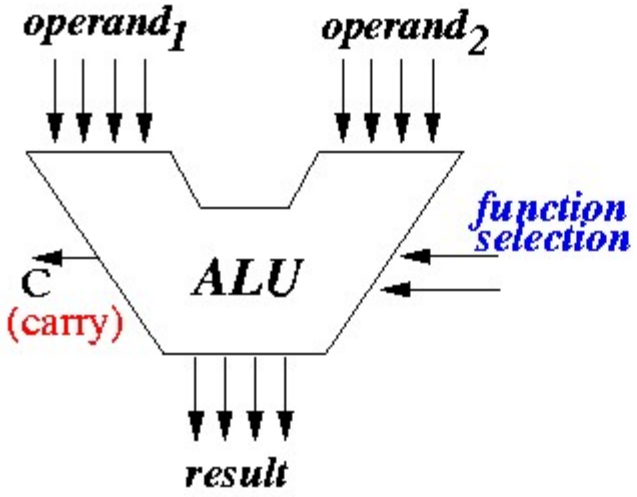


CPU Internal Structure

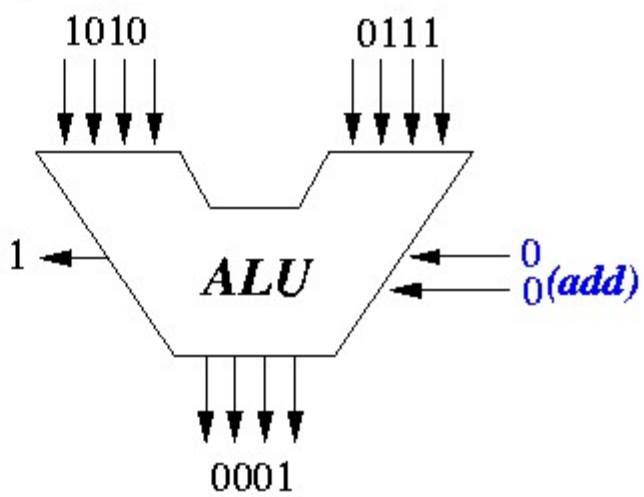


ALU

- ALU: Arithmetic and Logic Unit



Example operation:



The ALU is performing this addition:

$$\begin{array}{r} 1010 \\ +\ 0111 \\ \hline 10001 \end{array}$$

Registers

- CPU must have some working space (temporary storage)
- Called registers
- Number and function vary between processor designs
- One of the major design decisions
- Top level of memory hierarchy

User Visible Registers

- General Purpose
- Data
- Address
- Condition Codes

Universal Shift Register

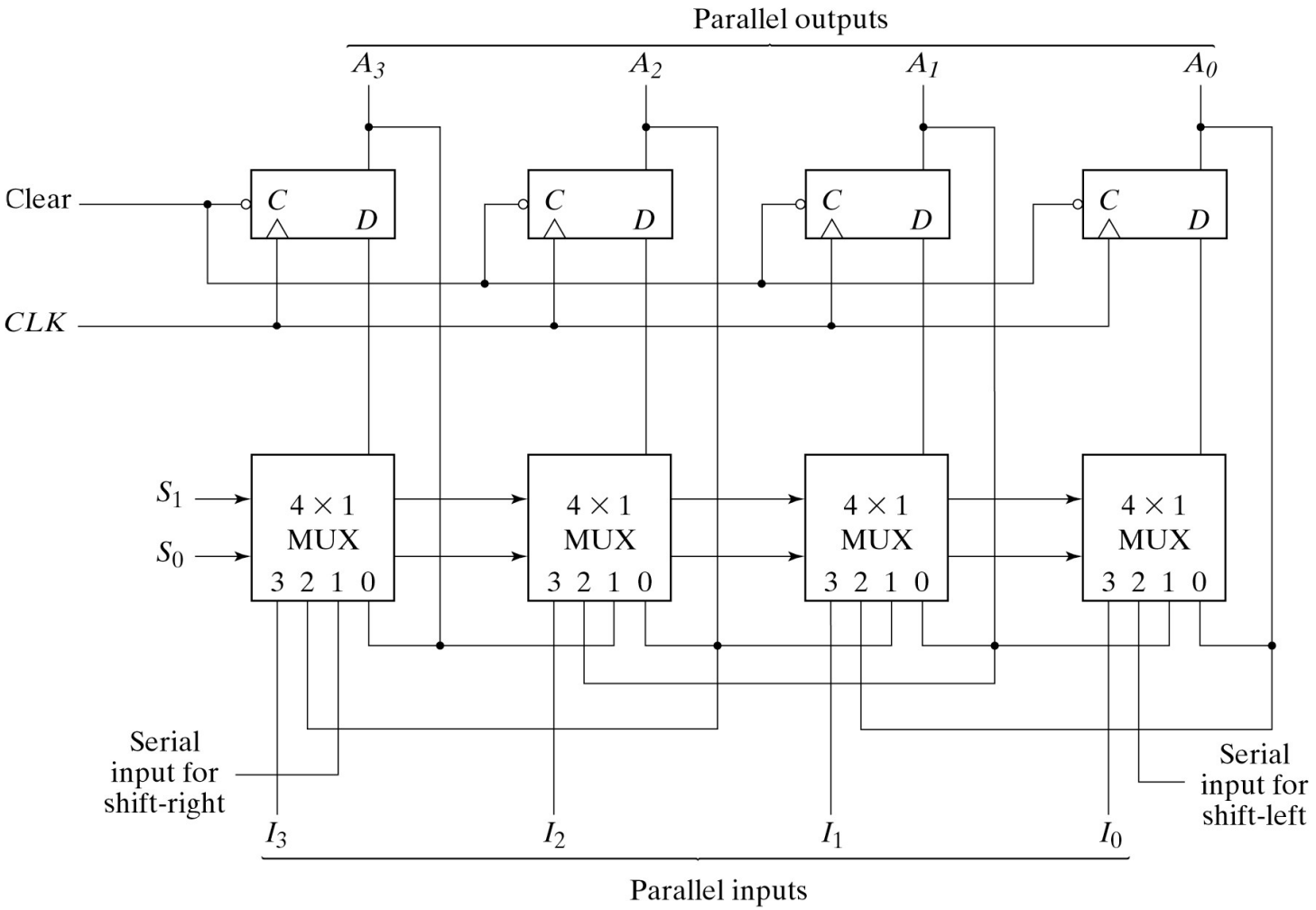


Fig. 6-7 4-Bit Universal Shift Register

How Many GP Registers?

- Between 8 - 32
- Fewer = more memory references
- More does not reduce memory references and takes up processor space
- Large enough to hold full address
- Large enough to hold full word
- Often possible to combine two data registers
  - C programming
  - double int a;
  - long int a;

Control & Status Registers

- Program Counter
- Instruction Decoding Register
- Memory Address Register
- Memory Buffer Register

Condition Code Registers

- Sets of individual bits
  - e.g. result of last operation was zero
- Can be read (implicitly) by programs
  - e.g. Jump if zero
- Can not (usually) be set by programs
- Needs for conditional instructions

Condition Code Registers

- Sets of individual bits
  - e.g. result of last operation was zero

For example:

```
for (i=10; i > 0; i--)
        a[i] = a[i]+10;
 next instruction
```

Program Status Word

- A set of bits (Flag bits)
- Includes Condition Codes
- Sign of last result
- Zero
- Carry
- Equal
- Overflow
- Interrupt enable/disable
- Supervisor

Program Status Word

- Condition Flag Bits (Depends on ALU Operation)
  - Sign, Zero, Carry, Equal, Overflow
- Flag bits set by programmer
  - Interrupt enable/disable
  - Supervisor

Reference

Computer Organization and Architecture –
Designing for Performance
William Stallings

Chapter 12: Page no. 418 – 423 (Seventh Edition)
Page No.: 435 – 440 (Eighth Edition)