

## Execution of the Complete Instruction

### 3.1 Introduction

An instruction cycle consists of an instruction fetch, followed by zero or more operand fetches, followed by zero or more operand stores, followed by an interrupt check (if interrupts are enabled) The major computer system components (processor, main memory, I/O modules) need to be interconnected in order to exchange data and control signals. The most popular means on interconnection is the use of a shared system bus consisting on multiple lines.

### 3.2 Control unit

A computer can be programmed by using a small set of basic logic components that store binary data and perform arithmetic and logical operations on data. If a particular computation is to be performed, a configuration of logic components designed specifically for that computation could be constructed. Programming in hardware is termed a **hardwired program**. This customized hardware system accepts data and produces results. This customized hardware system is not very flexible because for each new program, this customized hardware must be rewired.

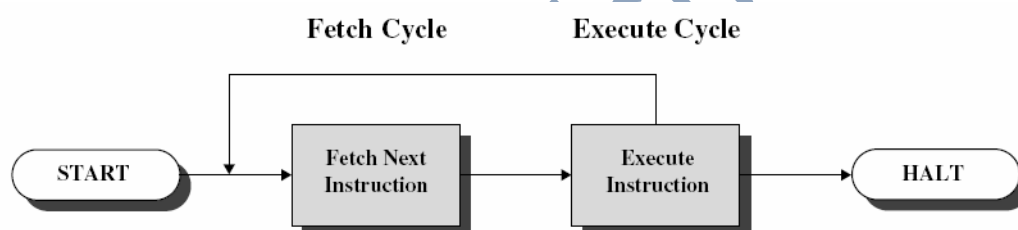
As an alternative, construct a general-purpose configuration of arithmetic and logic functions. This set of hardware will perform various functions on data depending on control signals applied to the hardware. This general-purpose hardware system accepts data and control signals and produces results. For each new program, the programmer merely needs to supply a new set of control signals. How shall control signals be supplied? The entire program is actually a sequence of steps. At each step, some arithmetic or logic operation is performed on some data. For each step, a new set of control signals is needed. Simply provide a unique code for each possible set of control signals, and add to the general-purpose hardware a segment that can accept a code and generate control signals.

Programming is now much easier. Instead of rewiring the hardware for each new program, simply provide a new sequence of codes. Each code is, in effect, an instruction, and part of the hardware interprets each instruction and generates control signals. To distinguish this new method of programming, a sequence of codes or instructions is called **software(microprogram)**.

The CPU exchanges data with memory. The CPU typically makes use of two internal registers: a memory address register (MAR), which specifies the address in memory for the next read or write, and a memory data register (MDR), which contains the data to be written into memory or receives the data read from memory.

### **3.3 Instruction cycle**

The basic function performed by a computer is execution of a program, which consists of a set of instructions stored in memory. The processor does the actual work by executing instructions specified in the program. In the simplest form, instruction processing consists of two steps: the processor reads (fetches) instructions from memory one at a time and executes each instruction. The processing required for a single instruction is called an **instruction cycle**. An instruction cycle is shown below:



Program execution halts only if the machine is turned off, some sort of unrecoverable error occurs, or a program instruction that halts the computer is encountered.

Instruction Fetch and Execute

- The processor fetches an instruction from memory – program counter (PC) register holds the address of the instruction to be fetched next
- The processor increments the PC after each instruction fetch so that it will fetch the next instruction in the sequence – unless told otherwise
- The fetched instruction is loaded into the instruction register (IR) in the processor – the instruction contains bits that specify the action the processor will take
- The processor interprets the instruction and performs the required action

In general, these actions fall into four categories:

- **Processor-memory** – data transferred to or from the processor to memory
- **Processor-I/O** – data transferred to or from a peripheral device by transferring between the processor and an I/O module

- **Data processing** – the processor performs some arithmetic or logic operation on data
- **Control** – an instruction may specify that the sequence of execution be altered An instruction execution may involve a combination of these actions.

### 3.4 Execution of a Complete Instruction

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**3.4.1. Control Sequence of Fetch Cycle**

<u>Step</u>	<u>Action</u>
1	PCout,ARin,Read,Set carry in of ALU,clear y,Add,Zin
2	Zout,PCin,WMFC
3	DRout,IRin

**3.4.2. Control Sequence of Execution Cycle**

**Ex// Add R1,X**

<u>Step</u>	<u>Action</u>
4	Address of IRout,ARin,Read
5	R1out,yin,WMFC
6	DRout,Add,Zin
7	Zout,R1in
8	End