CHITKARA UNIVERSITY

HIMACHAL PRADESH - NAAC Accredited

Control Memory & Address Sequencing

Lecture 16

Control Unit

- Initiate sequences of microoperations. The no. of micro operations in the systems are finite.
  - » The control function that specifies a microoperation is a binary variable. When it is in one state the corresponding microoperation is executed. The opposote state does not change the state of registers.
  - » Control signal *(that specify microoperations)* in a bus-organized system are
    - groups of bits that select the paths in multiplexers, decoders, and arithmetic logic units
- Two major types of Control Unit
  - » Hardwired Control :
    - The control logic is implemented with gates, F/Fs, decoders, and other digital circuits
    - + Fast operation, - Wiring change(if the design has to be modified)
  - » Microprogrammed Control :
    - The control information is stored in a control memory, and the control memory is programmed to initiate the required sequence of microoperations
    - + Any required change can be done by updating the microprogram in control memory, - Slow operation

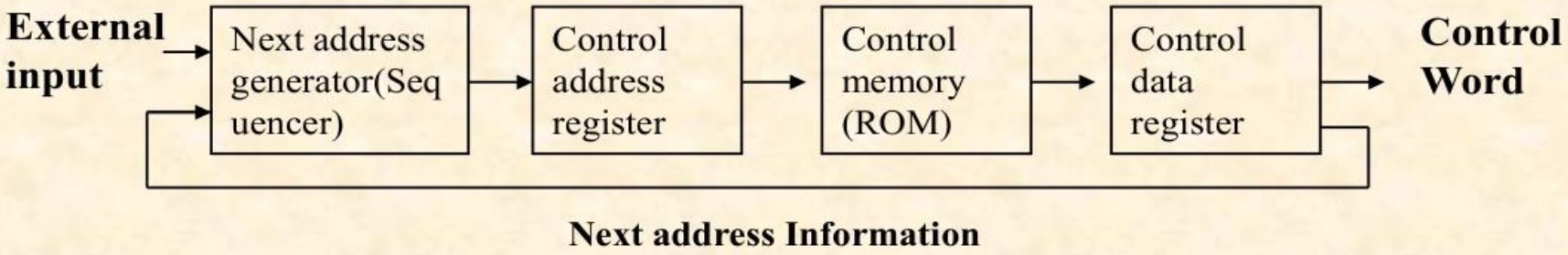
Control Word: control unit initiates a series of microoperations. during any time certain microoperations are initiated while others are idle.

- The control variables at any given time can be represented by a string of 1's and 0's is called control word.

Microprogrammed Control Unit

- A control unit whose binary control variables are stored in memory (*control memory*).

- **Microinstruction :** *Each Word in Control Memory contains within it a microinstruction.*
  - The microinstruction specifies one or more microoperations
- **Microprogram**
  - A sequence of microinstruction
    - » Dynamic microprogramming : *Control Memory* = RAM
      - RAM can be used for writing (*to change a writable control memory*)
      - Microprogram is loaded initially from an auxiliary memory such as a magnetic disk
    - » Static microprogramming : *Control Memory* = ROM
      - Control words in ROM are made permanent during the hardware production.
- **Microprogrammed control Organization :**



  - 1) Control Memory: A memory is part of a control unit.
    - » Computer Memory
      - Main Memory : for storing user program (*Machine instruction/data*)
      - Control Memory : for storing microprogram that can not be altered.
      - The microprogram consist of *Microinstruction*
  - 2) Control Address Register
    - » Specify the address of the microinstruction
  - 3) Sequencer (= *Next Address Generator*)
    - » Determine the address sequence that is read from control memory
    - » Next address of the next microinstruction can be specified several way depending on the sequencer input

- 4) Control Data Register (= *Pipeline Register*)
  - » Hold the present microinstruction while the next add. Is computed & read from control memory
  - » Allows the execution of the microoperations specified by the control word ***simultaneously*** with the generation of the next microinstruction. This requires two phase clock, with one clock applied to add. Register and other to data register.

Address Sequencing:

Microinstructions are stored in control memory in groups, with each group specifies a *routine*. The hardware that controls the address sequencing of the control memory must be able of sequencing the microinstruction with a routine and be able to branch from one routine to another.

An initial address is loaded into the control address register when power is turned on.this address is the address of the first microinstruction that activates the fetch routine. After the end of fetch routine, the instruction is in the instruction register of the computer.

The control memory next must goes through the routine that determines the effective address of the operand. After computing the effective address the address of the operand is available in the memory address register.

The next step is to generate the microoperations that execute the instruction fetched from memory. The microoperation steps to be generated in processor registers depend upon the operation code part of instruction.

Each instruction has its own microprogram routine stored in a given location of the control memory.

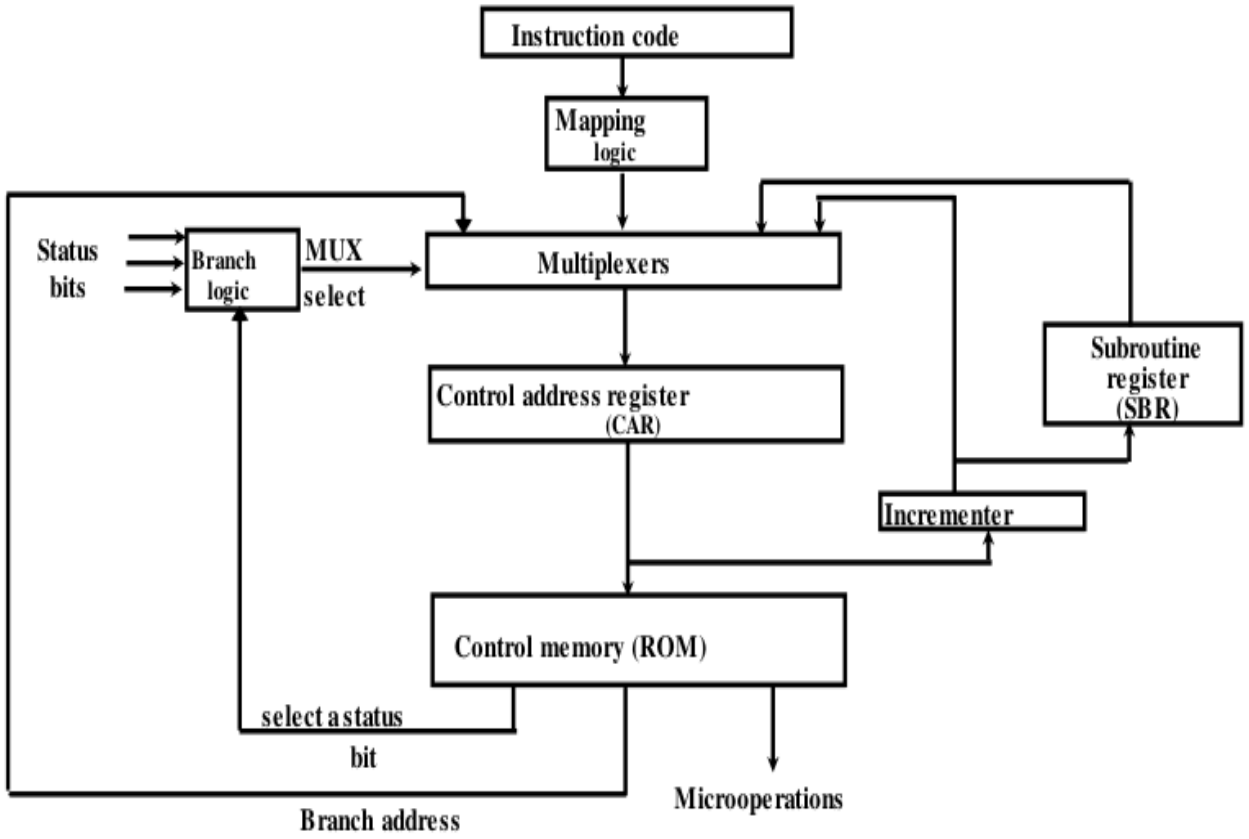
The transformation from the instruction code bits to an address in the control memory where the routine is located is called as ***Mapping.*** ? common sense

After the execution of the instruction control must return to the fetch routine.

Address Sequencing Capabilities :

- 1) Incrementing of the control address register
- 2) Unconditional branch or conditional branch, depending on status bit conditions
- 3) Mapping process (*bits of the instruction address for control memory*)
- 4) A facility for subroutine return

ADDRESS SEQUENCING



Sequencing Capabilities Required in a Control Storage

- Incrementing of the control address register
- Unconditional and conditional branches
- A mapping process from the bits of the machine instruction to an address for control memory
- A facility for subroutine call and return