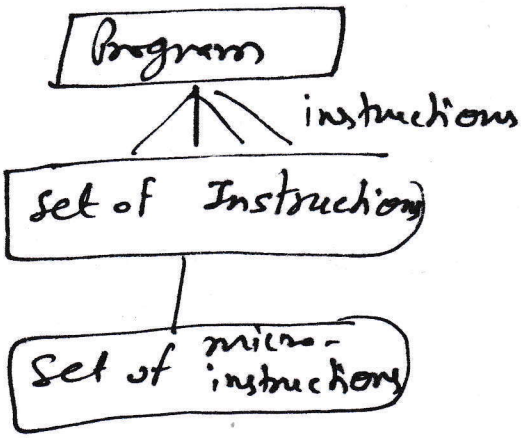
Microprogrammed Control Unit (MPCU) (Wilkes' design)

→ MPCU produces control signals by software, using micro-instructions.

→



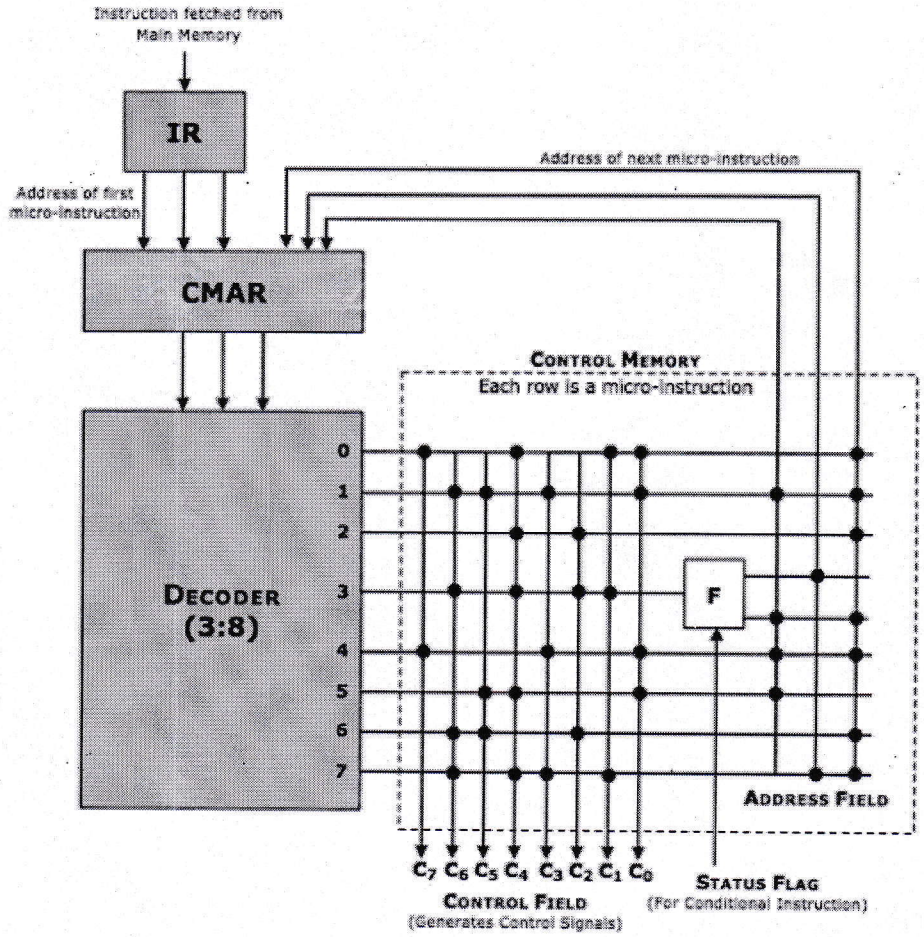
→ Every instruction requires a set of micro-instructions.

→ This is called its micro-program.

→ Microprograms for all instructions are stored in a small memory called "Control Memory"

⇒ Figure-1

Wilke's design



Typical Microprogrammed Control Unit

→ There is a big improvement over wilkes' design, to reduce the size of micro-instructions.

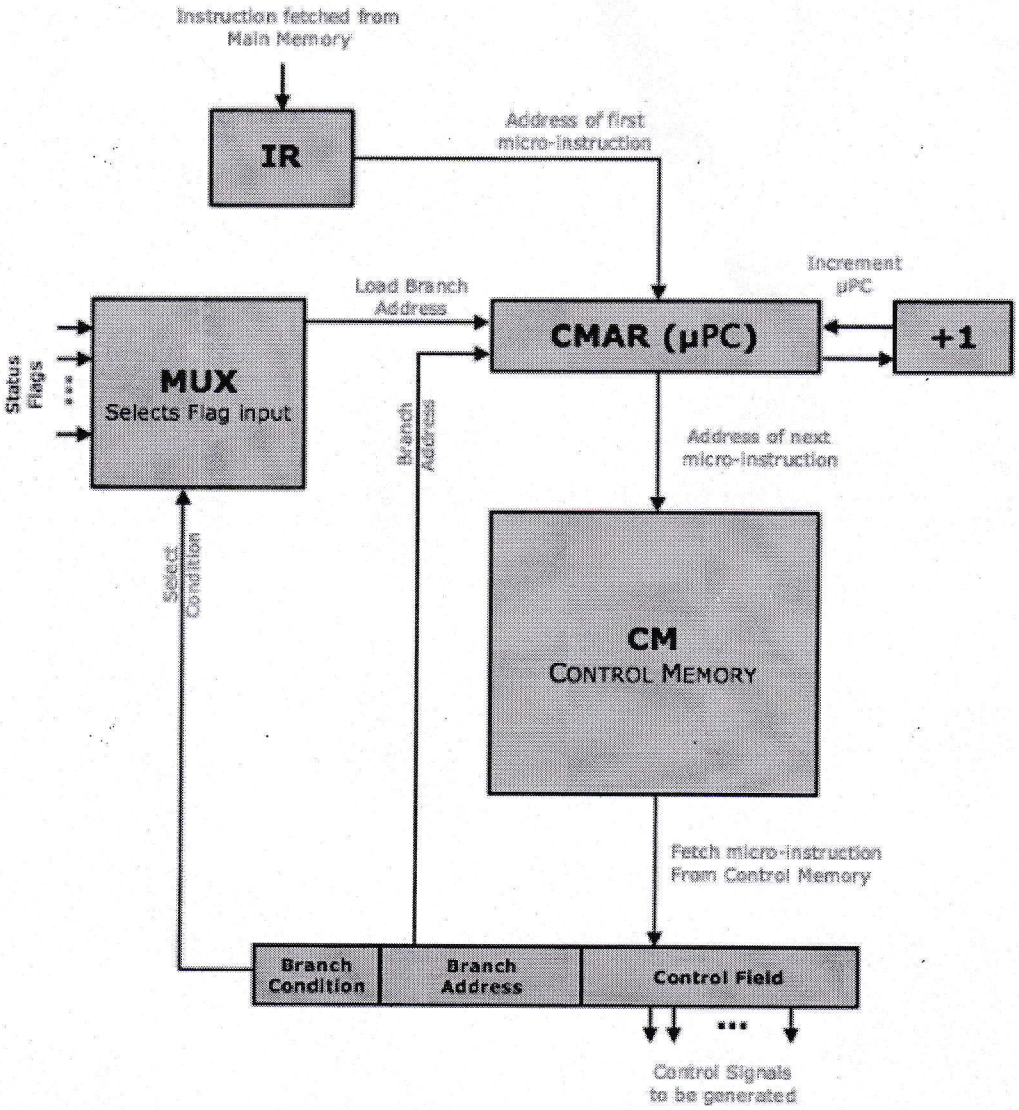
→ Most-micro-instructions will only have a control field.

→ The control field indicates the control signals to be generated.

→ Most of the micro-instructions will not have an address field.

→ If there is a branch-μ-instruction then there will be an address field.

Figure-2



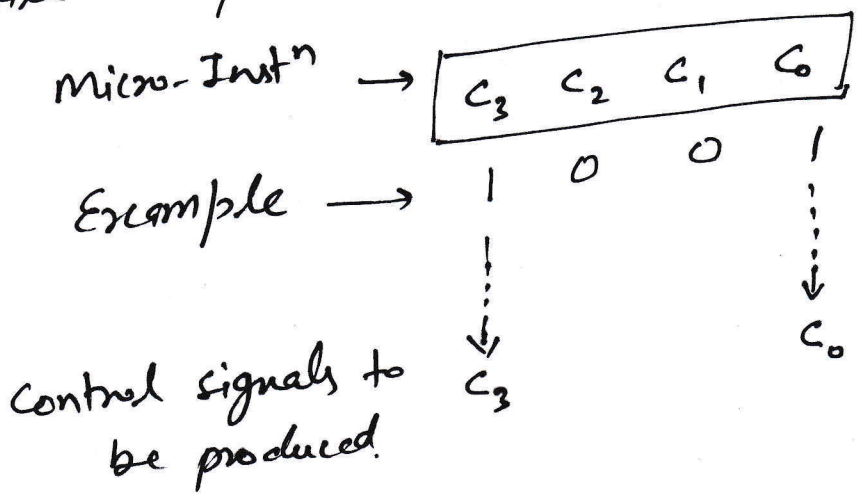
Typical MPCU

Micro-instruction Format

- Horizontal Micro-Instruction
- Vertical micro-Instruction

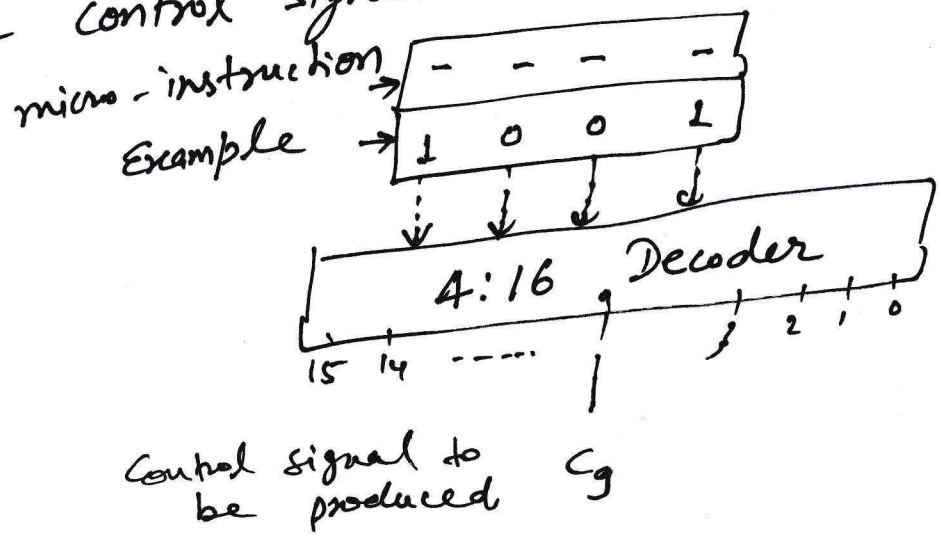
① Horizontal

Here, every bit of the micro-instruction corresponds to a control signal. whichever bit is "1", that particular control signal will be produced by the micro-instruction.



② Vertical

Here, bits of the micro-instruction have to be decoded. The decoded output decides the control signal to be produced.



	Horizontal Micro-instructions	Vertical Micro-instructions
1	Every bit of the micro-instruction corresponds to a control signal.	Bits of μ-instruction have to be decoded to produce control signals.
2.	Does not require a decoder.	2) Needs a decoder
3)	N bits in the micro-instruction will totally produce N control signals	3) N bits will produce 2^N control signals
4)	Multiple control signals can be produced by one micro-instruction	4) Only one control signal can be produced by one micro-instruction.
5)	Faster	5) Slower because of decoding
6)	Control memory is large as μ-instn are very wide	6) Micro-instruction are much narrower. Hence control memory is small.
7)	Simple circuit	8) Complex circuit.

→ Both the methods, horizontal & vertical have their pros & cons. Therefore a combination of both is used together called Nano-programming.

Nano-Programming :

→ H-u-instructions can produce multiple control signals, but are very wide, which makes the control memory very large in size.

→ Vertical-u-instructions are narrow, but on decoding can produce only one control signal. This makes the control memory small but the execution is slow.

→ Hence a combination of both techniques is needed called nano-programming.

→ Here, we have a two-level control memory.

→ The instruction is fetched from main memory into IR.

→ The address of first micro-instruction is loaded into uPC.

→ uCM to uIR.

→ The decoded output loads a new address in a nano-program counter (nPC).

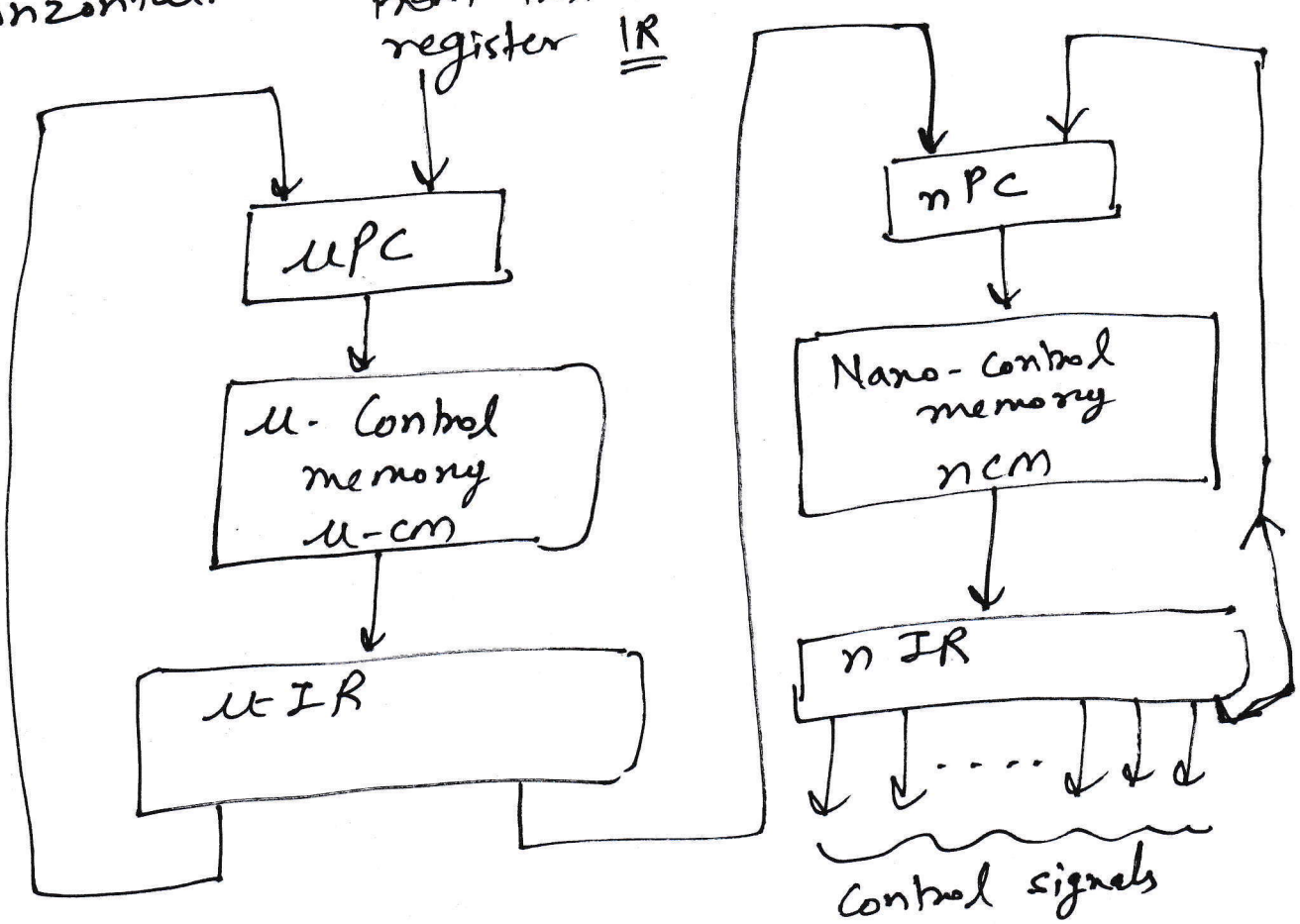
→ nCM to nIR.

→ Here, it is horizontal form and can directly generate control signals.

→ Such a combination gives advantages of both techniques.

→ The size of control memory is small as μ-instructions are vertical.

→ Multiple control signals can be produced simultaneously as Nano-instructions are Horizontal.



Micro-Instruction Sequencing: It is a method of determining the flow of the microprogram. There are two main techniques:

1) Dual Address field: