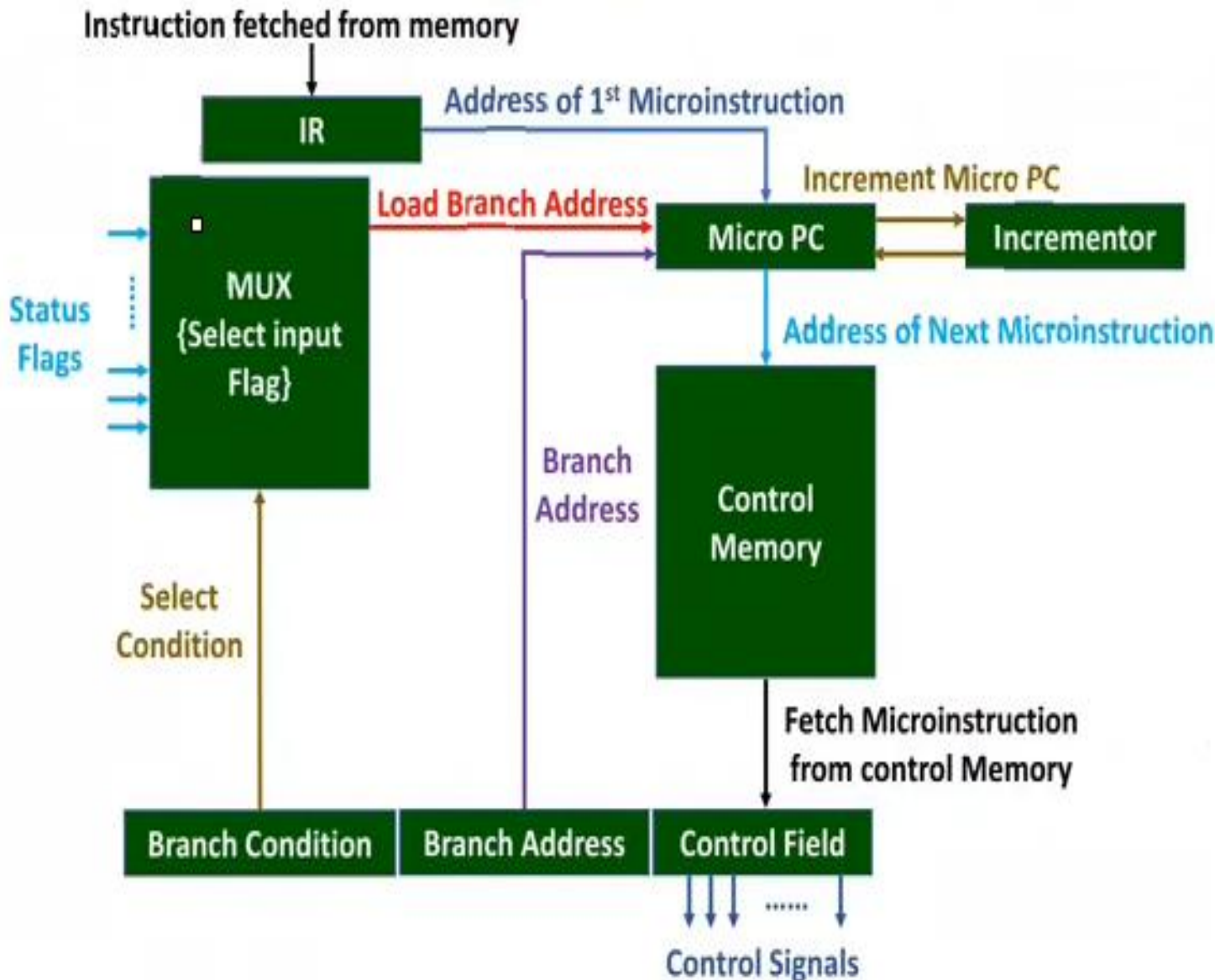# ECE-2002 Computer Organization and Architecture

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Actual Microprogrammed control unit

- Instruction fetched from the main memory into IR.
- The processor uses opcode to identify the address of the first micro-instruction.
- That address is loaded into Micro PC.
- Corresponding microinstruction is fetched from control memory.
- Micro PC- holds address of next microinstruction
- Incrementor- Increment PC after every microinstruction

Actual Microprogrammed control unit
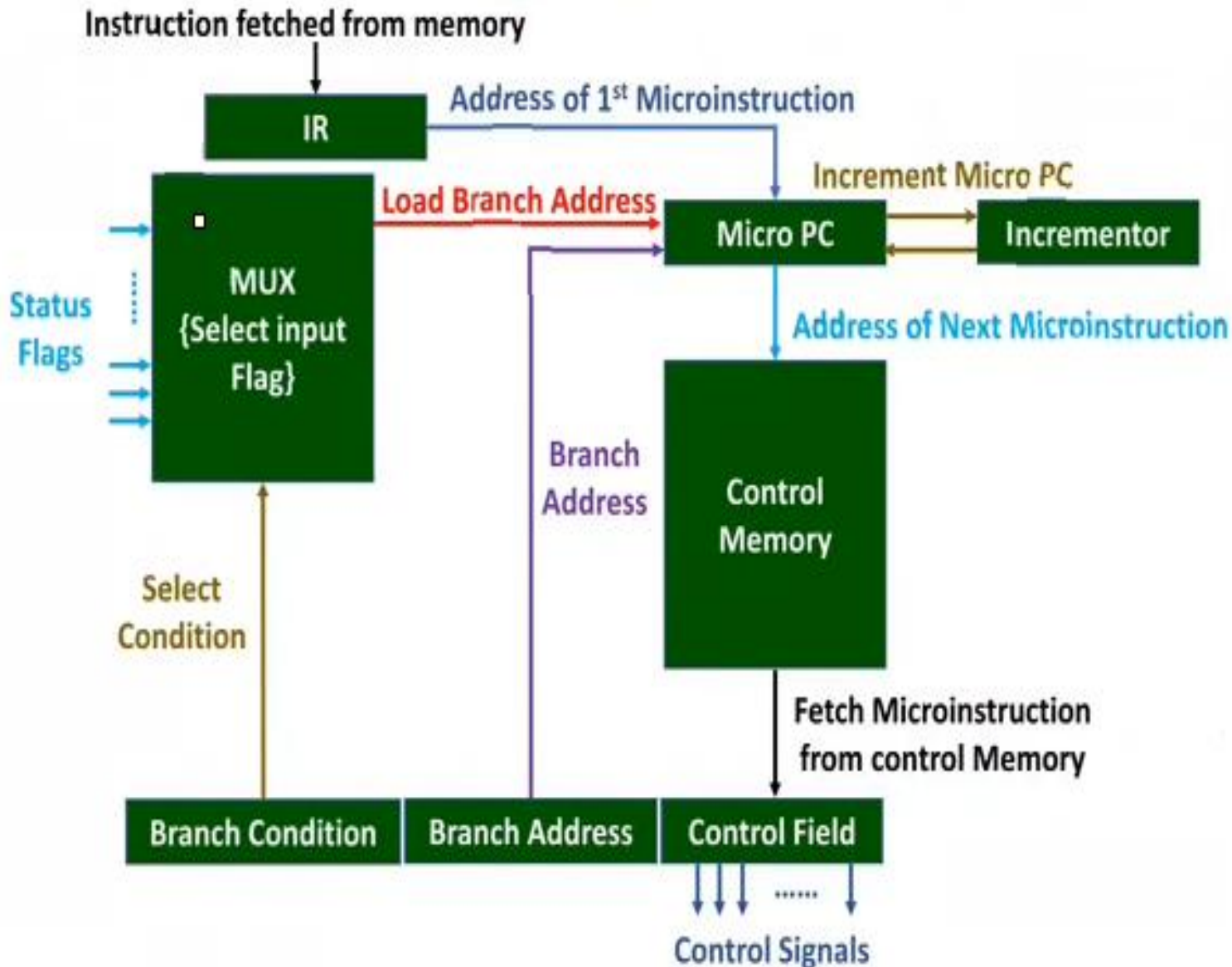
- ➢ Once microinstruction is fetched from the control memory, it generates control signals.
- ➢ Branch Address- in case of jump microinstructions
- ➢ Branch Condition- in case of jump with conditions microinstructions
- ➢ Conditions are selected based on status flags through Mux.
- ➢ If condition is true, load branch address to Micro PC.

Micro-Instruction Format

The main part of the micro-instruction is its control field.
It determines the control signals to be produced.
It can be of two different formats: Horizontal or Vertical.

1) **HORIZONTAL MICRO-INSTRUCTION**

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.
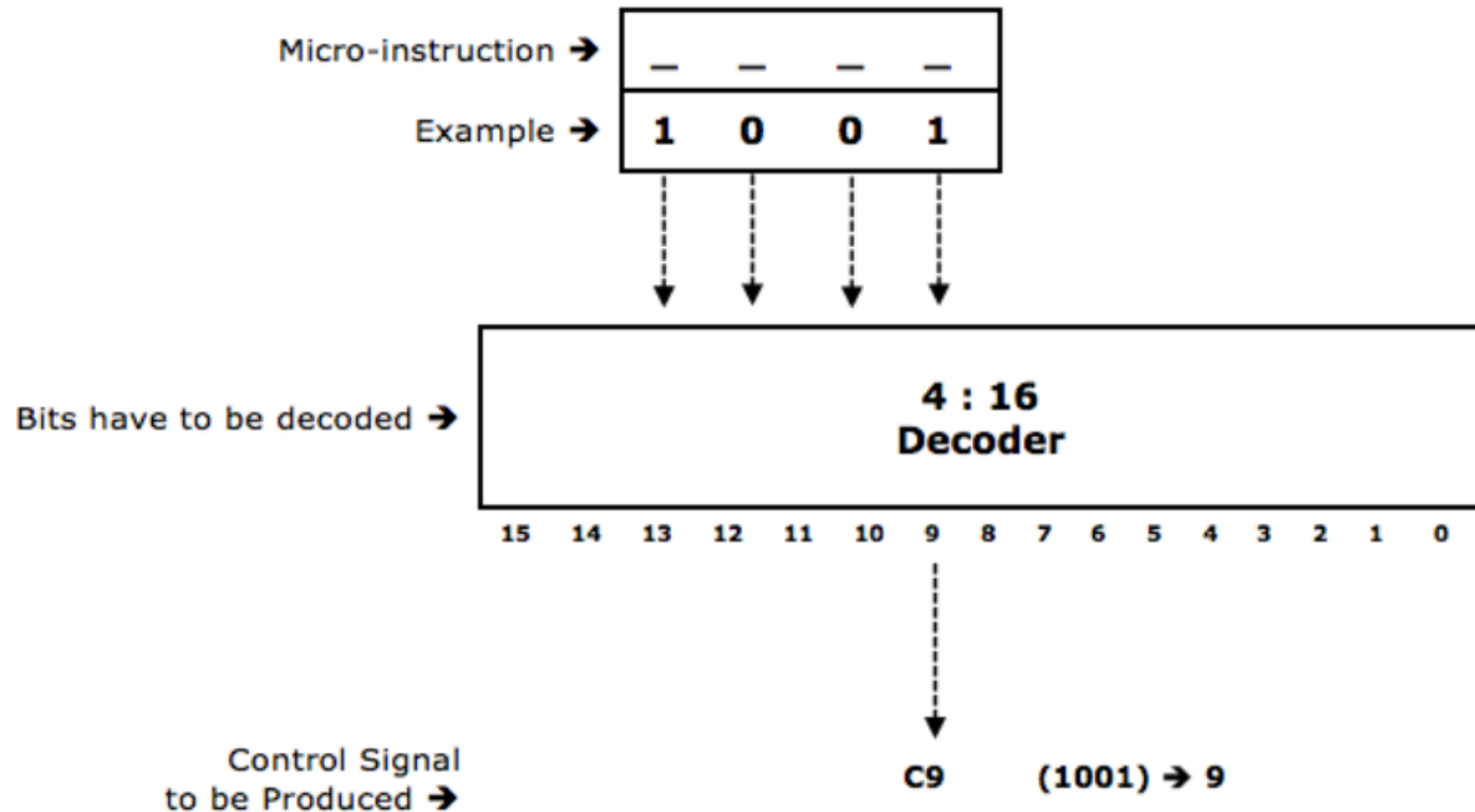
	C_3	C_2	C_1	C_0
Micro-instruction →				
Example →	1	0	0	1
Control Signals to be Produced →	C_3			C_0
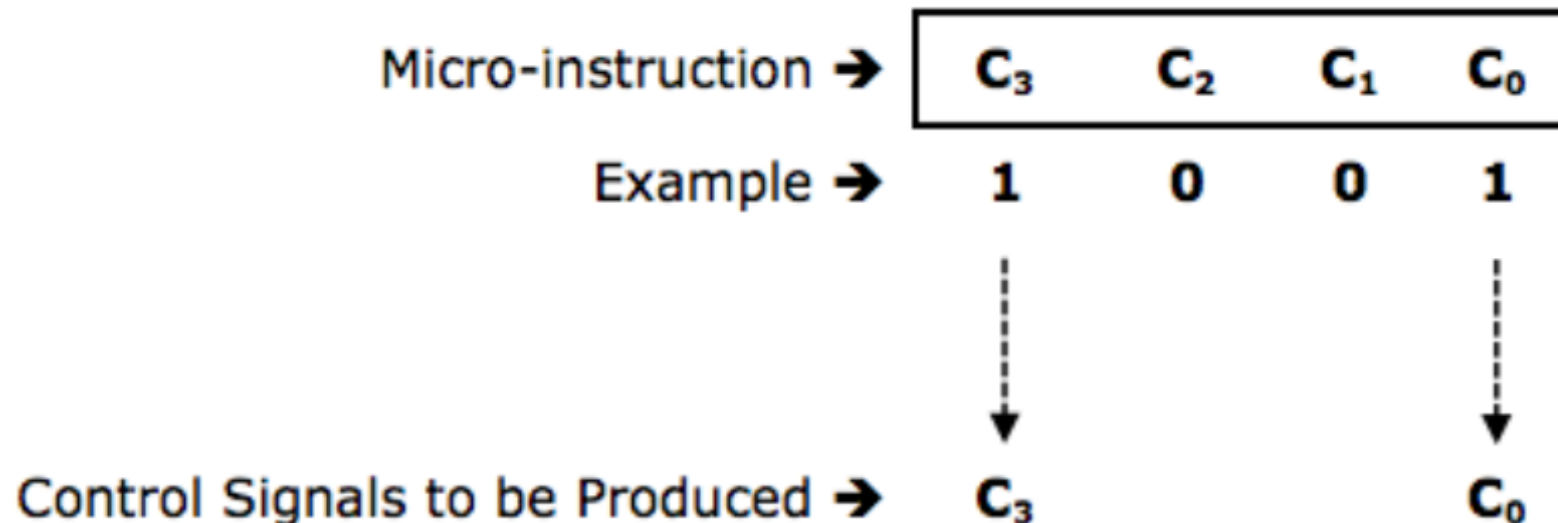
Micro-Instruction Format

2) **VERTICAL MICRO-INSTRUCTION**

Here bits of the micro-instruction have to be decoded.

The decoded output decides the control signal to be produced.
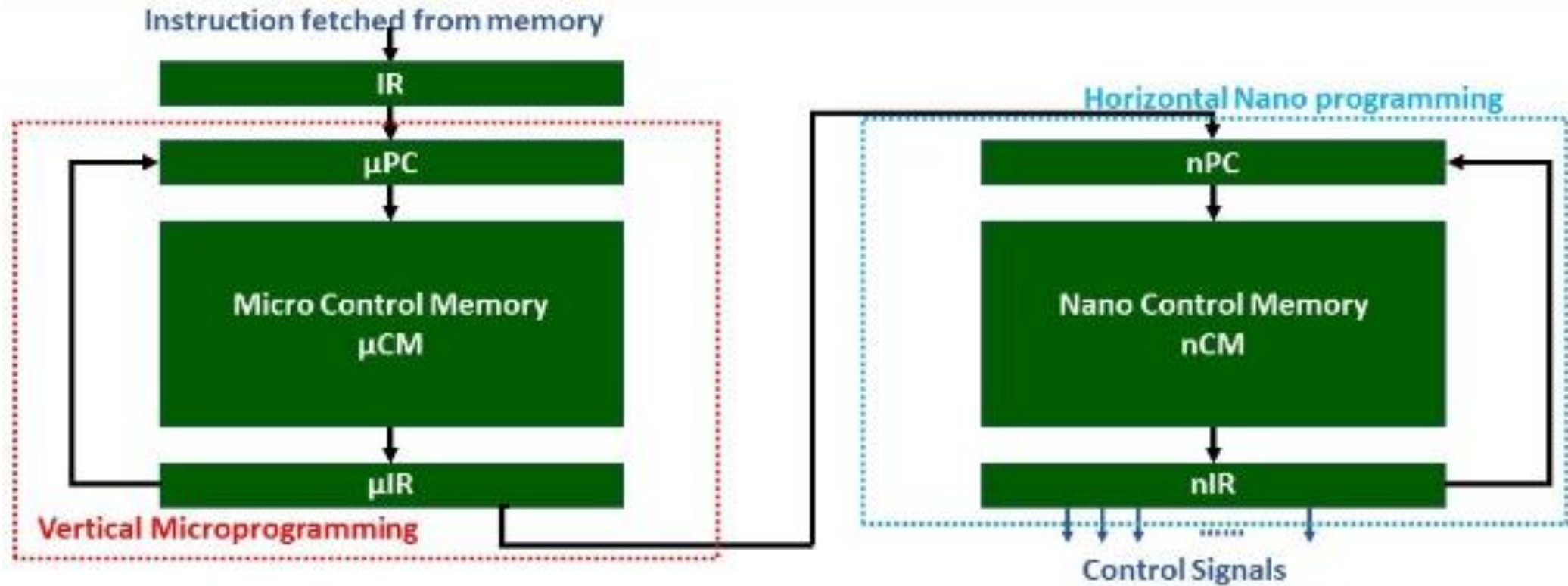
Micro-instruction ➜ | _ | _ | _ | _ |

Example ➜ | 1 | 0 | 0 | 1 |

Bits have to be decoded ➜ **4 : 16 Decoder**

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

Control Signal to be Produced ➜

C9   **(1001) ➜ 9**

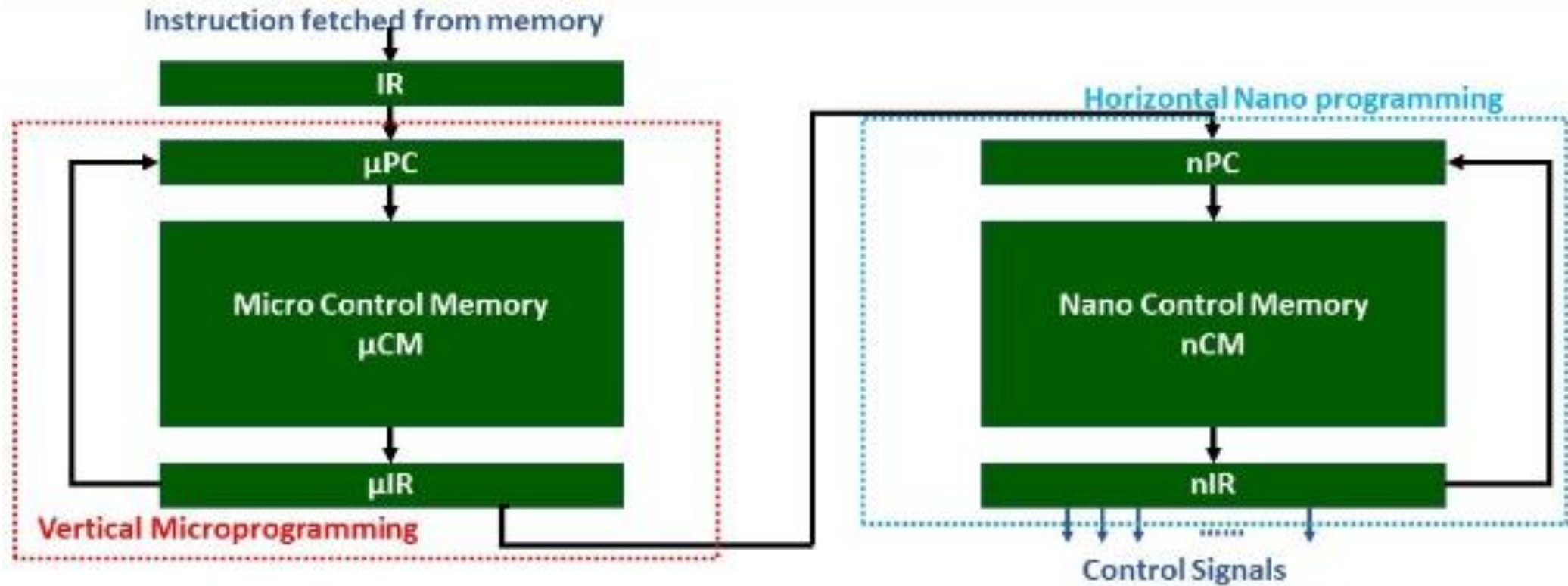|	HORIZONTAL MICRO-INSTRUCTION	VERTICAL MICRO-INSTRUCTION
1	Every bit of the micro-instruction corresponds to a control signal.	Bits of the micro-instruction have to be decoded to produce control signals.
2	Does not require a decoder.	Needs a decoder.
3	N bits in the micro-instruction will totally produce N control signals.	N bits in the micro-instruction will totally produce 2^N control signals.
4	Multiple control signals can be produced by one micro-instruction.	Only one control signal can be produced by one micro-instruction.
5	As the control signals increase, the micro-instruction grows wider. Hence the Control Memory grows Horizontally.	To produce more control signals, more number of micro-instructions are needed. Hence the Control Memory grows Vertically.
6	Executes faster as no decoding needed.	Executes slower as decoding is needed.

Nano-Programming

➤ Horizontal micro-instructions can produce multiple control signals simultaneously but are very wide. This makes the control memory very large.

➤ Vertical micro-instructions are narrow, but after decoding, only produce one control signal. This makes the control memory small, but the execution is slow since decoding is needed.

➤ Hence, a combination of both techniques is needed to be called nano programming.

Nano-Programming

> Instruction fetched from the main memory into IR.
> The processor uses opcode to identify the address of the micro-instruction.
> That address is loaded into Micro PC.
> Corresponding microinstruction is fetched from control memory and given to micro IR.

Nano-Programming

- ➢ Since the microinstruction is in vertical form it has to be decoded.
- ➢ The decoded output loads a new address in nPC (nano PC).
- ➢ Using this address, nano-instruction is fetched from the nCM into nIR.
- ➢ Since the instruction is in horizontal form, it can directly generate control signals.