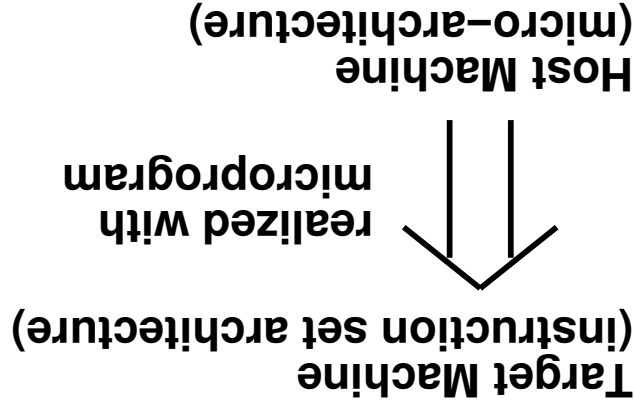


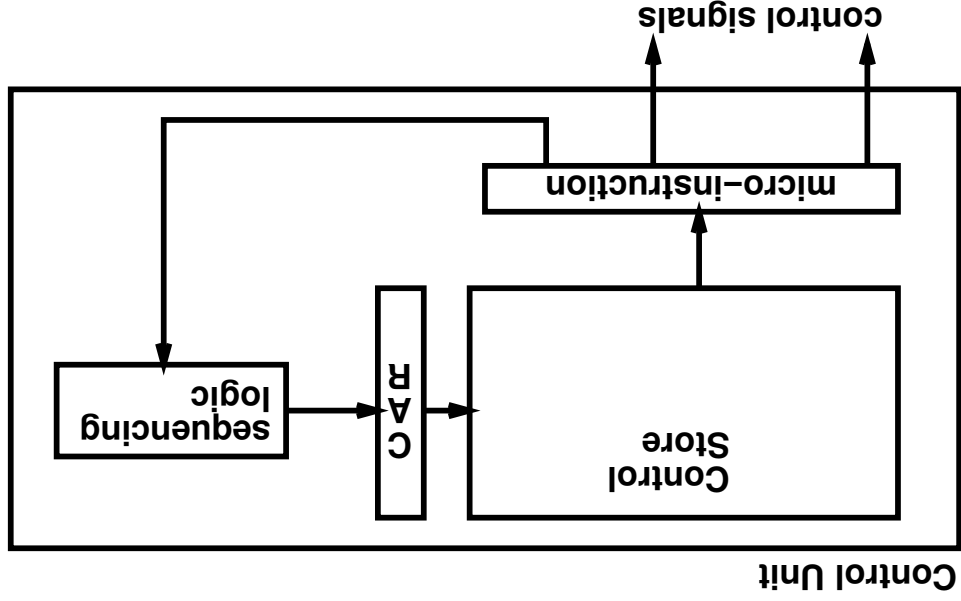
Micro-Programmed Control Units

Microprogrammed control unit: the selection of control signals from a *control store* to bring about the desired set of register transfer operations. One can think of a microprogrammed control unit as an inner computer that drives the outer computer.



The control signals that can occur in a micro-instruction are called *micro-operations*.

A Micro-Programmed Control Unit



Hardwired vs Microprogrammed Control Units

Hardwired:

advantages: very fast

disadvantages: (i) inflexible, (ii) random logic

Microprogrammed

advantages: (i) flexibility (easy to patch fixes), (ii) emulation of several machines on one hardware platform (see next page)

disadvantages: slower

Emulating multiple architectures on one hardware platform

Burroughs B1700: supporting multiple instruction set architectures for the languages (i) Basic, (ii) Fortran, and (iii) Cobol & RPG II.

Space implications	B1700	IBM S/260	savings
7 sample Fortran	280K	560K	50%
20 COBOL	450K	1490K	70%
31 RPG II	150K	310K	52%
Performance implications	B1700	IBM S/3, Model 10	speedup
RPG II compute bound	25 sec	208 sec	8.3

but B1700 cost 75% more to build.

Types of Control

immediate control: the bits of the micro-instruction are converted into control signals that directly control machine resources

residual control: control of the machine resource is achieved as a result of both bits in the micro-instruction and the value of some machine register

bit steering: encoded micro-operations in field A of the micro-instruction control different machine resources depending upon the value of field B in the microinstruction.

Specific Micro-instruction Encodings

Direct Control: (unencoded) each control signal is represented as a single bit in the microinstruction. Thus, for N control signals, we need at least an N -bit microinstruction.

Maximal encoding: all N control signals are encoded into a single field of $\lceil \log_2 N \rceil$ bits. Note: no parallelism is available and the decoder can be complex.

Minimally encoded: encode only those control signals that we have no desire to execute in parallel (e.g., ALU operations).

Types of Micro-Architectures

Vertical:

- a single micro-operation specified per microinstruction
- leads to small microinstruction word lengths (16-32 bits)

Horizontal:

- several micro-operations specified per microinstruction
- leads to large microinstruction word lengths (100s of bits)

Diagonal:

- varies between horizontal and vertical

Timing Considerations

- mono-phase timing
- poly-phase timing

- specialized branch micro-instruction (vert and/or diagonal)
- 2 branch destination addresses
- 1 branch target address modified w/ conditions from current machine state

Branching