2. Computer Evolution

ENIAC (Electronic Numerical Integrator And Computer)

- Ecket and Mauchly at University of Pennsylvania
- Trajectory tables for weapons
- Started 1943, finished 1946 – too late for war effort
- Used until 1955

- Decimal (not binary)
- 20 accumulators of 10 digits
- Programmed manually by switches
- 18,000 vacuum tubes, 30 tons, 15,000 square feet
- 5,000 additions per second

von Neumann machine

- Stored program concept
- Main memory storing program and data
- ALU operating on binary data
- Control unit interpreting instructions from memory and executing
- I/O equipment operated by control unit

IAS (Princeton Institute for Advanced Studies)

- o Completed 1952
- o 1000 x 40 bit words
  - Binary number
  - two 20 bit instructions per word
- o Set of registers (storage in CPU)
  - MBR
  - MAR
  - IR
  - IBR (Instruction Buffer Register)
  - PC
  - AC
  - MQ (Multiplier Quotient)

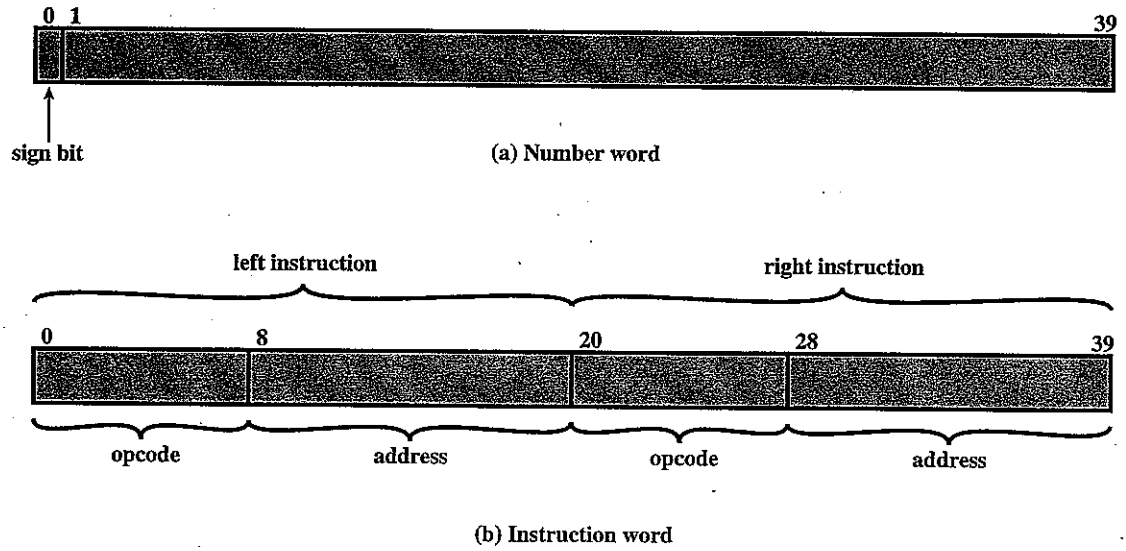


Figure 2.2 IAS Memory Formats

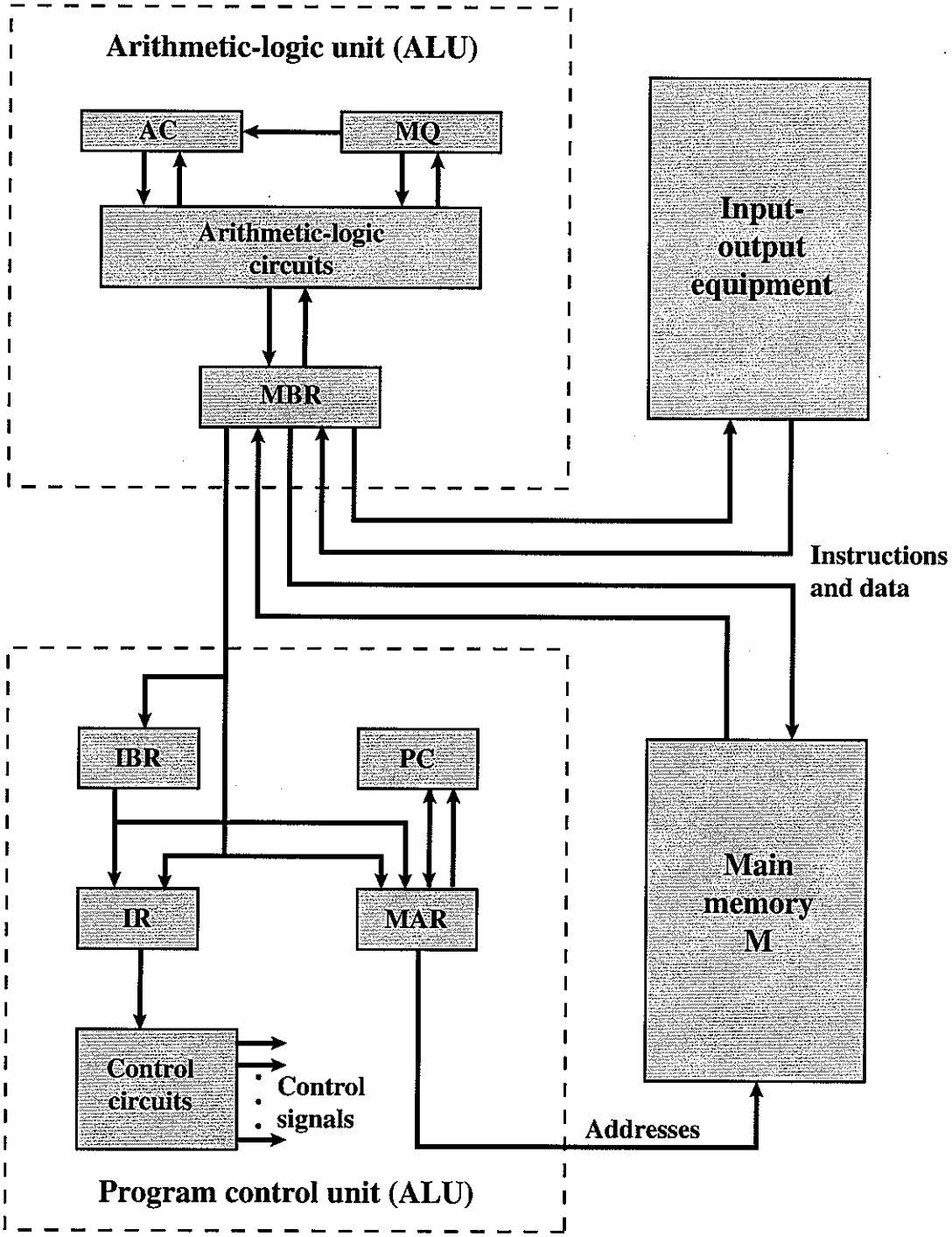
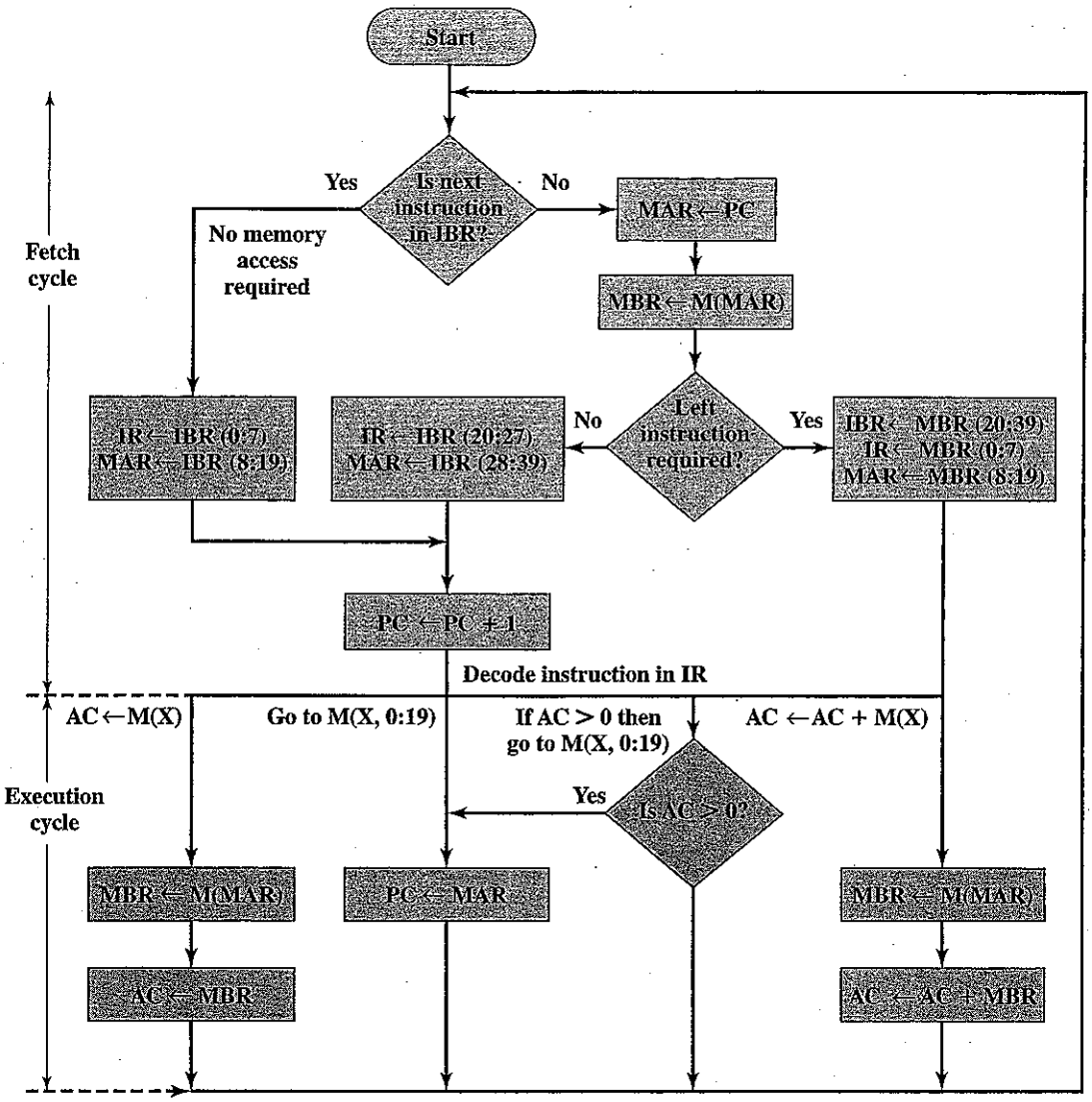


Figure 2.3 Expanded Structure of IAS Computer



M(X) = contents of memory location whose address is X
(i:j) = bits i through j

Figure 2.4 Partial Flowchart of IAS Operation

Table 2.1 The IAS Instruction Set

Instruction Type	Opcode	Symbolic Representation	Description
Data transfer	00001010	LOAD MQ	Transfer contents of register MQ to the accumulator AC
	00001001	LOAD MQ,M(X)	Transfer contents of memory location X to MQ
	00100001	STOR M(X)	Transfer contents of accumulator to memory location X
	00000001	LOAD M(X)	Transfer M(X) to the accumulator
	00000010	LOAD −M(X)	Transfer −M(X) to the accumulator
	00000011	LOAD |M(X)|	Transfer absolute value of M(X) to the accumulator
	00000100	LOAD −|M(X)|	Transfer −|M(X)| to the accumulator
Unconditional branch	00001101	JUMP M(X,0:19)	Take next instruction from left half of M(X)
	00001110	JUMP M(X,20:39)	Take next instruction from right half of M(X)
Conditional branch	00001111	JUMP + M(X,0:19)	If number in the accumulator is nonnegative, take next instruction from left half of M(X)
	00010000	JUMP + M(X,20:39)	If number in the accumulator is nonnegative, take next instruction from right half of M(X)
Arithmetic	00000101	ADD M(X)	Add M(X) to AC; put the result in AC
	00000111	ADD |M(X)|	Add |M(X)| to AC; put the result in AC
	00000110	SUB M(X)	Subtract M(X) from AC; put the result in AC
	00001000	SUB |M(X)|	Subtract |M(X)| from AC; put the remainder in AC
	00001011	MUL M(X)	Multiply M(X) by MQ; put most significant bits of result in AC, put least significant bits in MQ
	00001100	DIV M(X)	Divide AC by M(X); put the quotient in MQ and the remainder in AC
	00010100	LSH	Multiply accumulator by 2; i.e., shift left one bit position
	00010101	RSH	Divide accumulator by 2; i.e., shift right one position
Address modify	00010010	STOR M(X,8:19)	Replace left address field at M(X) by 12 rightmost bits of AC
	00010011	STOR M(X,28:39)	Replace right address field at M(X) by 12 rightmost bits of AC

Commercial Computers

- 1947 Eckert-Mauchly Computer Corporation
- UNIVAC I (Universal Automatic Computer)
- US Bureau of Census 1950
- Became part of Spreey-Rand Corpotation
- UNIVAC II late 1950s

- IBM
- Punched-card processing equipment
- 1953 the 701
  - IBM's first computer
  - Scientific calculation
- 1955 the 702
  - Business application
- Lead to 700/7000 series

Second Generation Machines

Transistor

- William Shockley et al at Bell Labs in 1947
- Made from silicon (Sand) – solid state device
- Smaller
- Cheaper
- Less heat dissipation

Transistor-based computers

- NCR and RCA produced small transistor machines
- IBM: 7000
- DEC: PDP-1 (1957)

Generations of Computer

- Vacuum tube - 1946-1957
- Transistor - 1958-1964
- Small scale integration - 1965 on
  —Up to 100 devices on a chip
- Medium scale integration - to 1971
  —100-3,000 devices on a chip
- Large scale integration - 1971-1977
  —3,000 - 100,000 devices on a chip
- Very large scale integration - 1978 to date
  —100,000 - 100,000,000 devices on a chip
- Ultra large scale integration
  —Over 100,000,000 devices on a chip

Third Generation

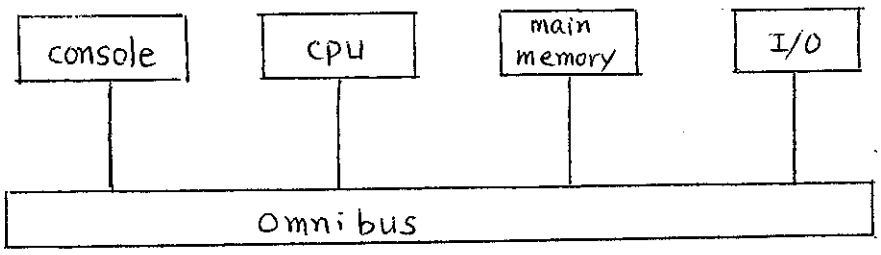
IBM S/360

- o 1964
- o Replaced 7000 series
- o Universal (Business + Scientific)
- o Family concept
  - Same instruction sets
  - Similar O.S. – DOS or OS/360
  - Increasing speed
  - Increasing memory size
  - Backward compatible

- o S/370 (1970)
  - Amdahl 470 (1975) – clone
- o S/390 (1990)
  - ES/9000 model, fiber-optical I/O channels

DEC

- o 1964
- o First minicomputer
- o Lower cost (than main frame): Lab
- o Bus structure



Intel

- 4004 (1971)
  - First microcomputer
  - All CPU components on a single chip
  - 4 bit

- 8008 (1972)
  - 8 bit

- 8080 (1974)
  - Intel's first general purpose microprocessor
  - 8 bit data path

- 8086
  - 16 bit
  - Instruction cache
  - Used in first IBM PC

- 80286
  - 16 Mbyte memory addressable

- 80386
  - 32 bit
  - Support for multitasking

- 80486
  - Powerful cache and instruction pipelining
  - Built-in co-processor

- Pentium
  - Superscalar
  - Multiple instructions executed in parallel

- Pentium Pro
  - Increase superscalar organization
  - Aggressive register renaming
  - Branch prediction
  - Data flow analysis
  - Speculative execution

- Pentium II
  - MMX technology
  - Graphics, video, and audio processing

- Pentium III
  - Additional floating point instructions for 3D graphics

- Pentium 4
  - Further floating point and multimedia enhancements

- Itanium
  - 64 bit

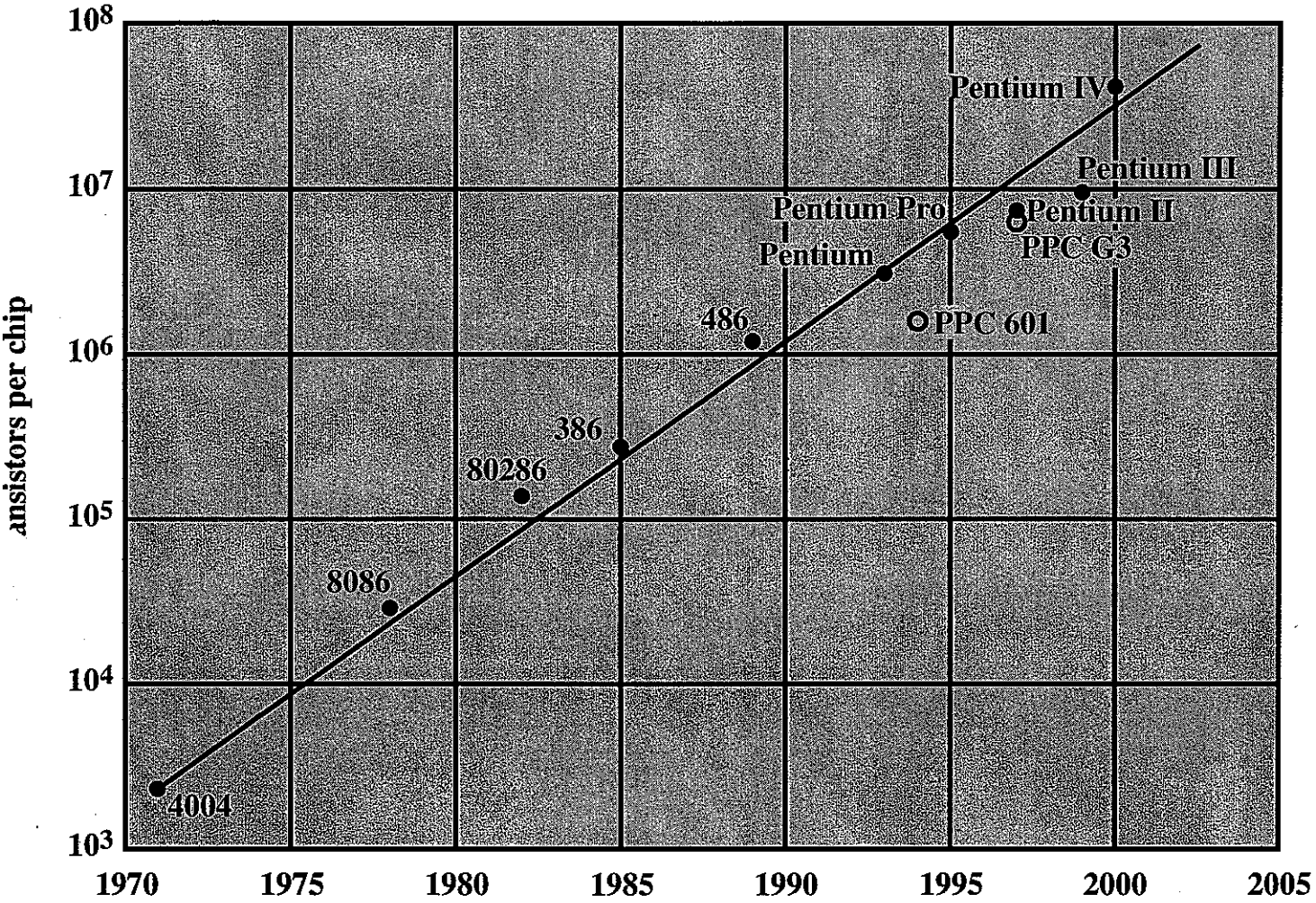


Figure 2.8 Growth in CPU Transistor Count