Introduction

Chapter 1

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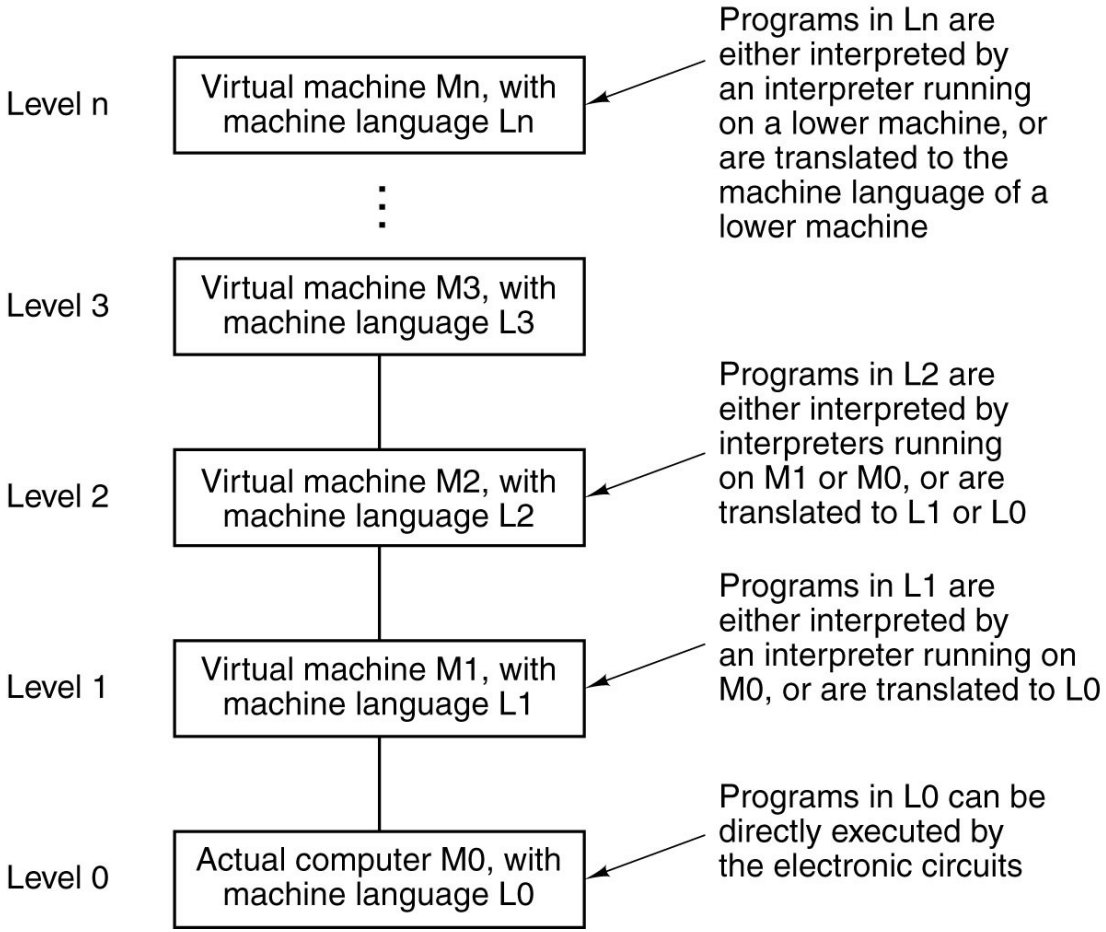
Languages, Levels, Virtual Machines



A multilevel machine

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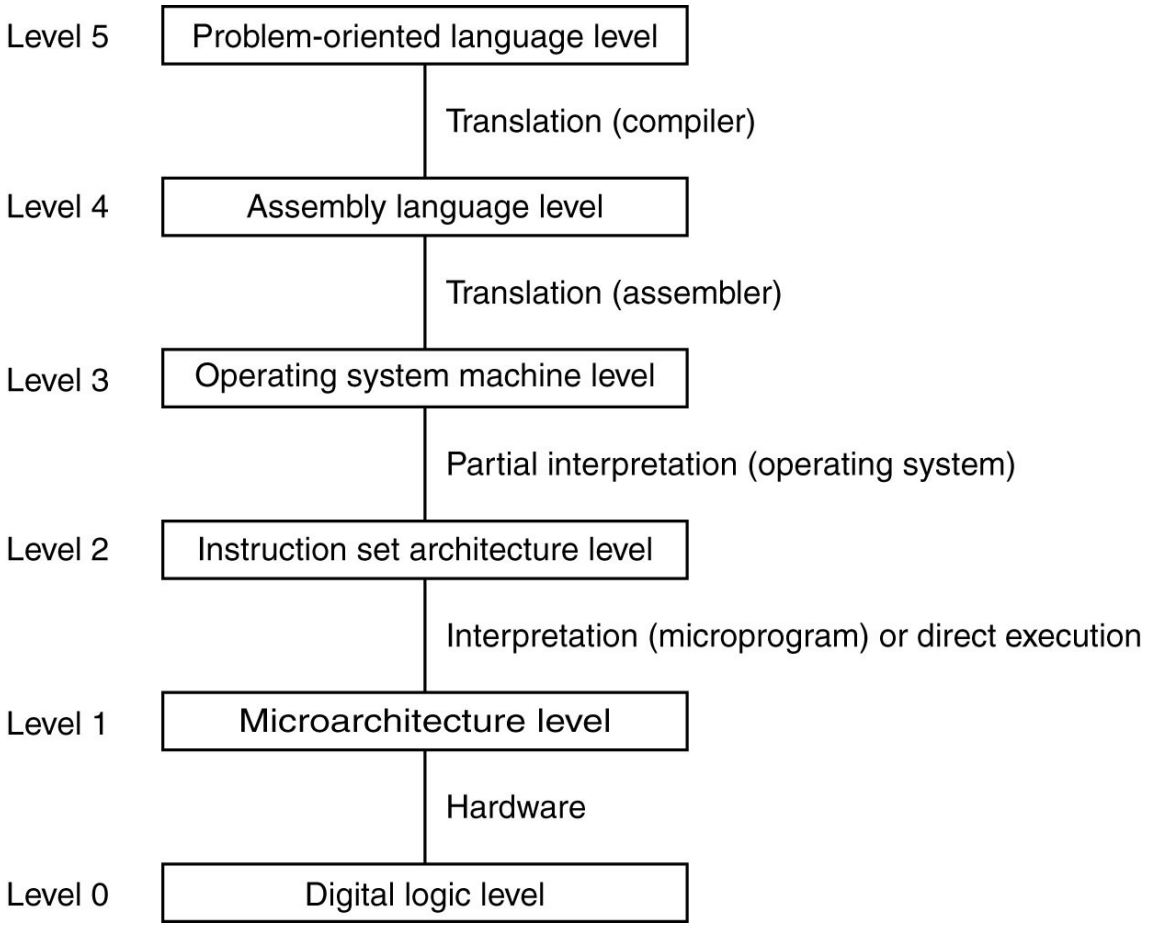
Contemporary Multilevel Machines



A six-level computer.

The support method for each level is indicated below it .

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Evolution of Multilevel Machines

a) Invention of microprogramming
b) Invention of operating system
c) Migration of functionality to microcode
d) Elimination of microprogramming

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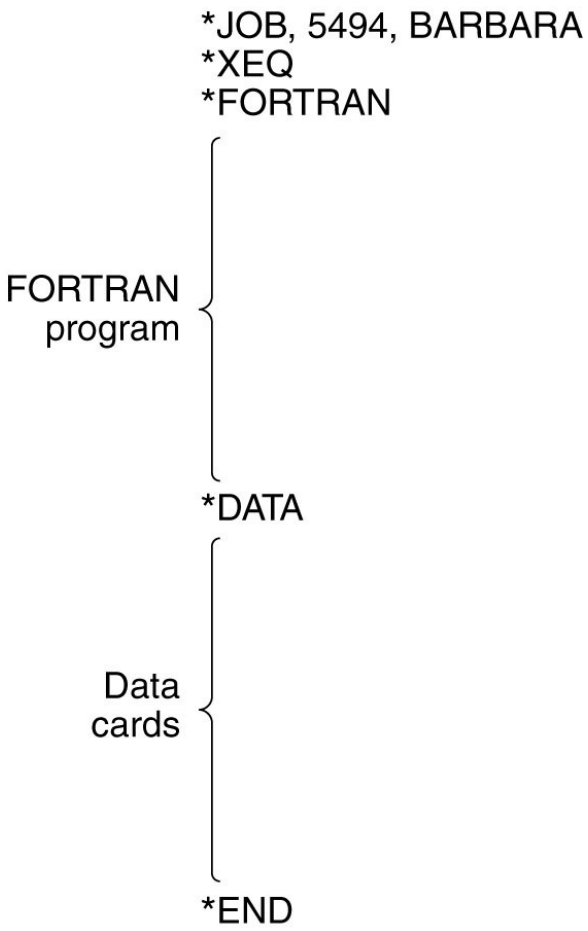
Operating System Tasks



A sample job for the FMS operating system

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Milestones in Computer Architecture (1)

Year	Name	Made by	Comments
1834	Analytical Engine	Babbage	First attempt to build a digital computer
1936	Z1	Zuse	First working relay calculating machine
1943	COLOSSUS	British gov't	First electronic computer
1944	Mark I	Aiken	First American general-purpose computer
1946	ENIAC I	Eckert/Mauchley	Modern computer history starts here
1949	EDSAC	Wilkes	First stored-program computer
1951	Whirlwind I	M.I.T.	First real-time computer
1952	IAS	Von Neumann	Most current machines use this design
1960	PDP-1	DEC	First minicomputer (50 sold)
1961	1401	IBM	Enormously popular small business machine
1962	7094	IBM	Dominated scientific computing in the early 1960s
1963	B5000	Burroughs	First machine designed for a high-level language
1964	360	IBM	First product line designed as a family

Some milestones in the development of the modern digital computer.

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Milestones in Computer Architecture (2)

Year	Name	Made by	Comments
1965	PDP-8	DEC	First mass-market minicomputer (50,000 sold)
1970	PDP-11	DEC	Dominated minicomputers in the 1970s
1974	8080	Intel	First general-purpose 8-bit computer on a chip
1974	CRAY-1	Cray	First vector supercomputer
1978	VAX	DEC	First 32-bit superminicomputer
1981	IBM PC	IBM	Started the modern personal computer era
1981	Osborne-1	Osborne	First portable computer
1983	Lisa	Apple	First personal computer with a GUI
1985	386	Intel	First 32-bit ancestor of the Pentium line
1985	MIPS	MIPS	First commercial RISC machine
1987	SPARC	Sun	First SPARC-based RISC workstation
1990	RS6000	IBM	First superscalar machine
1992	Alpha	DEC	First 64-bit personal computer
1993	Newton	Apple	First palmtop computer

Some milestones in the development of the modern digital computer.

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Computer Generations

a) Zeroth Generation
Mechanical Computers (1642 – 1945)

c) First Generation
Vacuum Tubes (1945 – 1955)

e) Second Generation
Transistors (1955 – 1965)

g) Third Generation
Integrated Circuits (1965 – 1980)

i) Fourth Generation
Very Large Scale Integration (1980 – ?)

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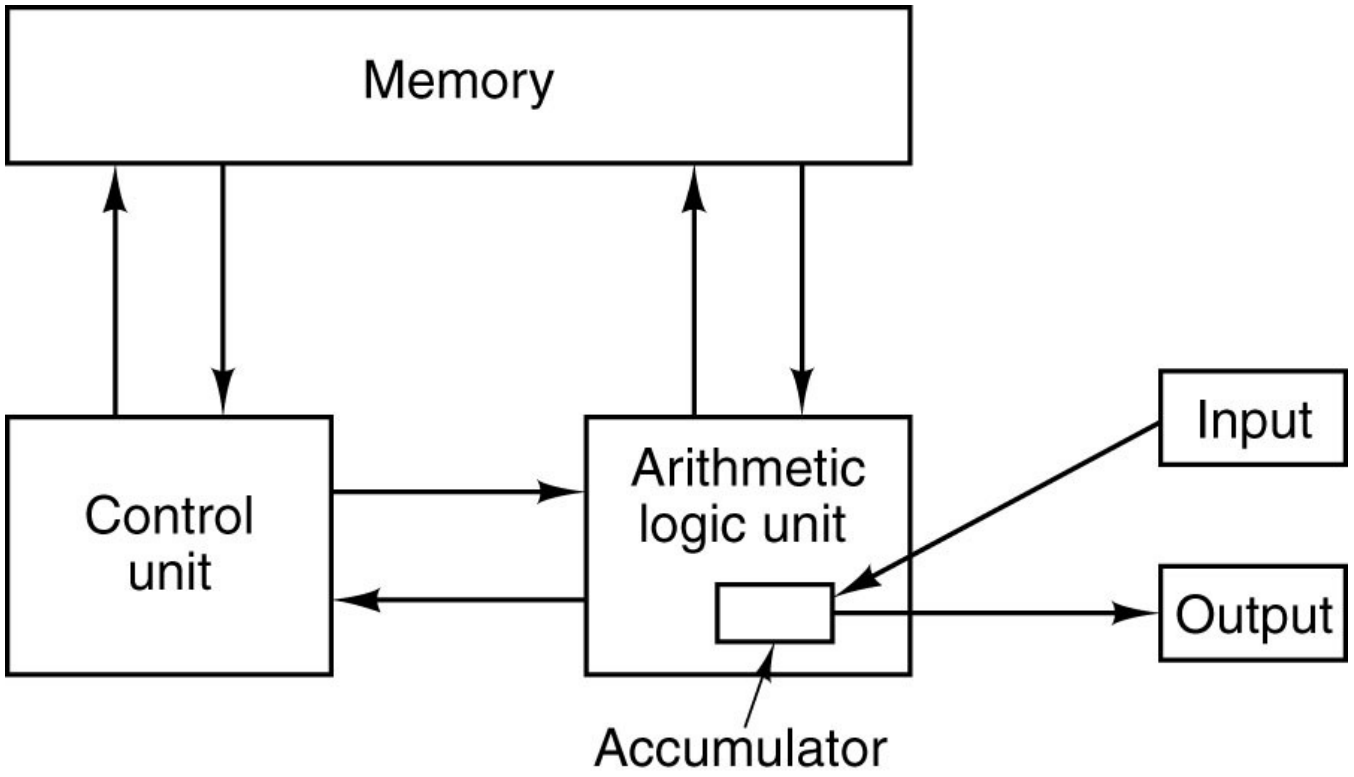
Von Neumann Machine



The original Von Neumann machine.

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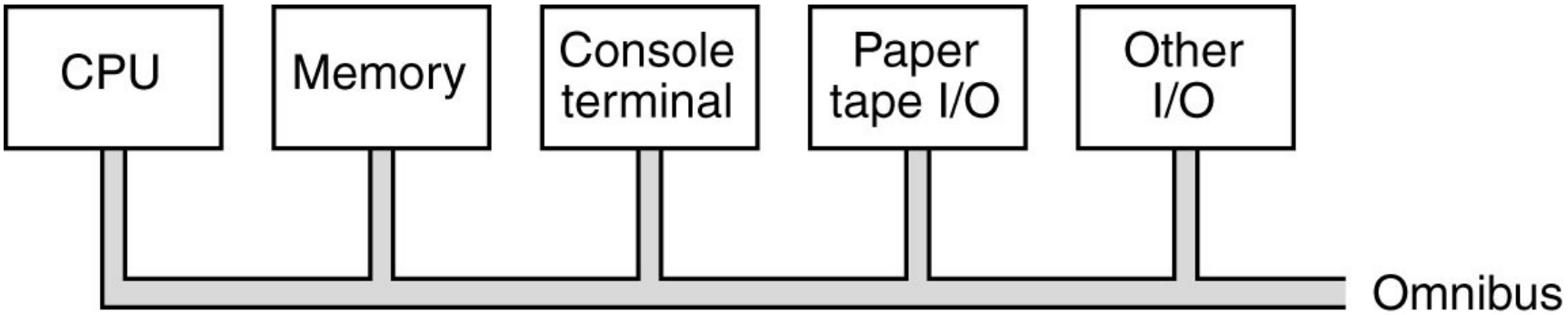
PDP-8 Innovation – Single Bus



The PDP-8 omnibus

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IBM 360

Property	Model 30	Model 40	Model 50	Model 65
Relative performance	1	3.5	10	21
Cycle time (in billionths of a sec)	1000	625	500	250
Maximum memory (bytes)	65,536	262,144	262,144	524,288
Bytes fetched per cycle	1	2	4	16
Maximum number of data channels	3	3	4	6

The initial offering of the IBM product line.

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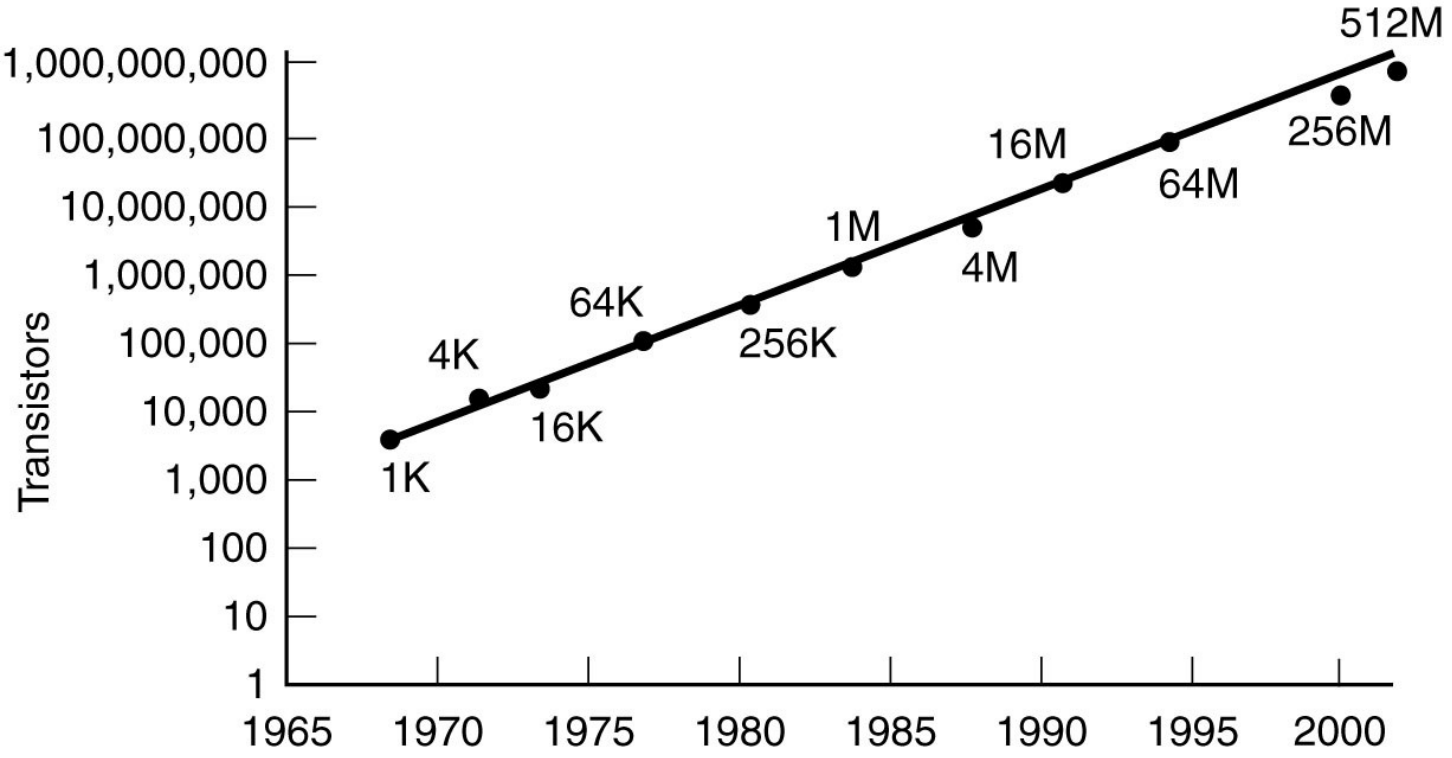
Technological and Economic Forces



Moore's law predicts a 60-percent annual increase in the number of transistors that can be put on a chip.

The data points given in this figure are memory sizes, in bits.

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The Computer Spectrum

Type	Price ($)	Example application
Disposable computer	0.5	Greeting cards
Microcontroller	5	Watches, cars, appliances
Game computer	50	Home video games
Personal computer	500	Desktop or notebook computer
Server	5K	Network server
Collection of Workstations	50–500K	Departmental minisupercomputer
Mainframe	5M	Batch data processing in a bank

The current spectrum of computers available. The prices should be taken with a grain (or better yet, a metric ton) of salt.

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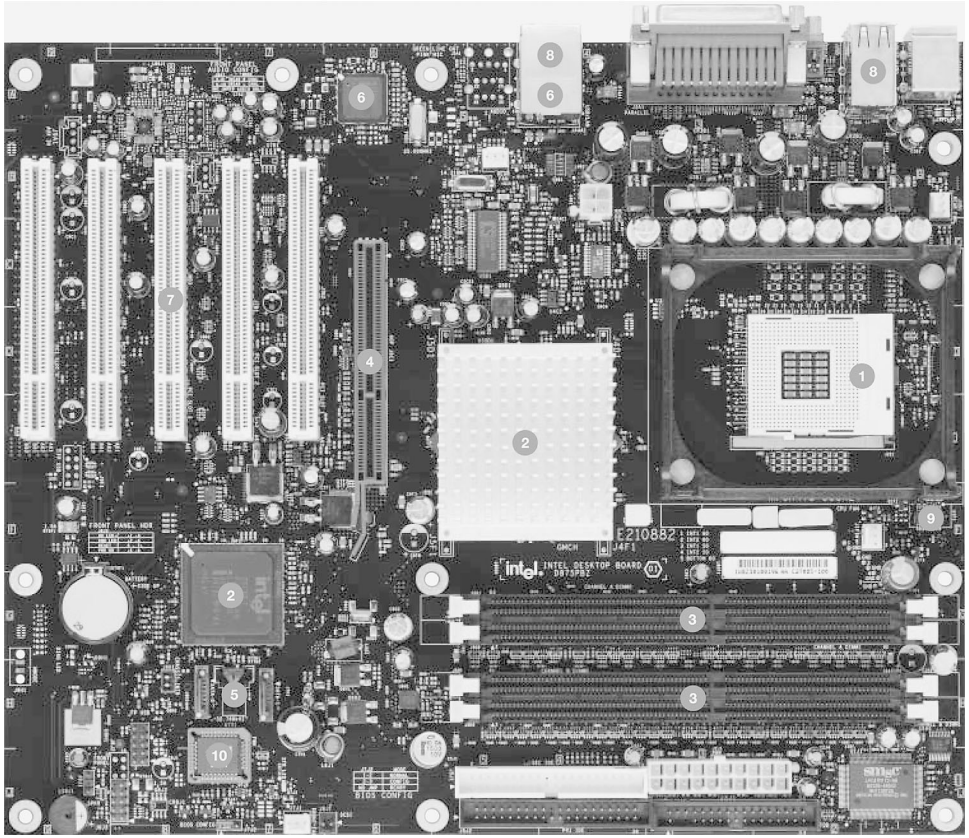
Personal Computer



1. Pentium 4 socket
2. 875P Support chip
3. Memory sockets
4. AGP connector
5. Disk interface
6. Gigabit Ethernet
7. Five PCI slots
8. USB 2.0 ports
9. Cooling technology
10. BIOS

A printed circuit board is at the heart of every personal computer. This figure is a photograph of the Intel D875PBZ board. The photograph is copyrighted by the Intel Corporation, 2003 and is used by permission.

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Example Computer Families

a) Pentium 4 by Intel
b) UltraSPARC III by Sun Microsystems
c) The 8051 chip by Intel, used for embedded systems

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Intel Computer Family (1)

Chip	Date	MHz	Transistors	Memory	Notes
4004	4/1971	0.108	2300	640	First microprocessor on a chip
8008	4/1972	0.108	3500	16 KB	First 8-bit microprocessor
8080	4/1974	2	6000	64 KB	First general-purpose CPU on a chip
8086	6/1978	5–10	29,000	1 MB	First 16-bit CPU on a chip
8088	6/1979	5–8	29,000	1 MB	Used in IBM PC
80286	2/1982	8–12	134,000	16 MB	Memory protection present
80386	10/1985	16–33	275,000	4 GB	First 32-bit CPU
80486	4/1989	25–100	1.2M	4 GB	Built-in 8-KB cache memory
Pentium	3/1993	60–233	3.1M	4 GB	Two pipelines; later models had MMX
Pentium Pro	3/1995	150–200	5.5M	4 GB	Two levels of cache built in
Pentium II	5/1997	233–450	7.5M	4 GB	Pentium Pro plus MMX instructions
Pentium III	2/1999	650–1400	9.5M	4 GB	SSE Instructions for 3D graphics
Pentium 4	11/2000	1300–3800	42M	4 GB	Hyperthreading; more SSE instructions

The Intel CPU family. Clock speeds are measured in MHz (megahertz) where 1 MHZ is 1 million cycles/sec.

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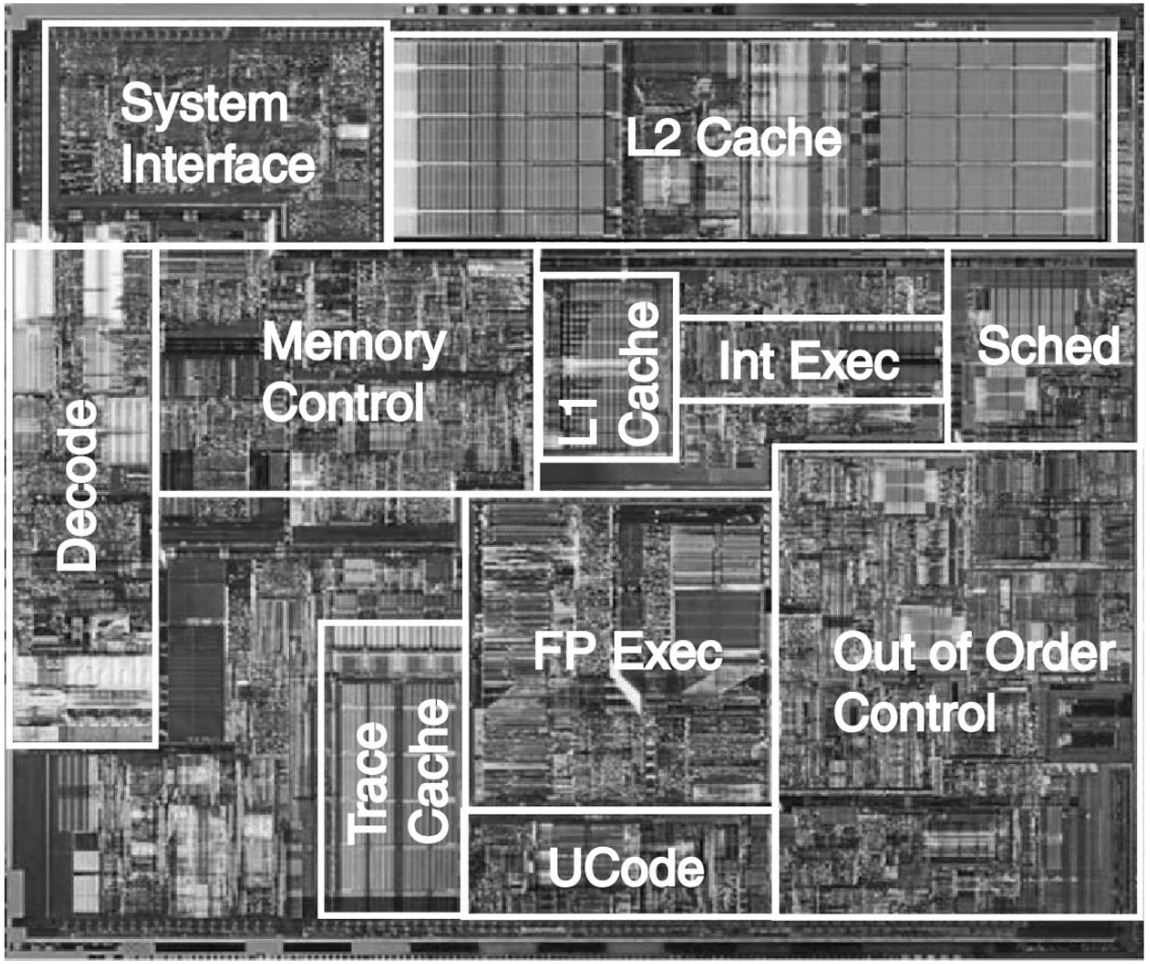
Intel Computer Family (2)



The Pentium 4 chip. The photograph is copyrighted by the Intel Corporation, 2003 and is used by permission.

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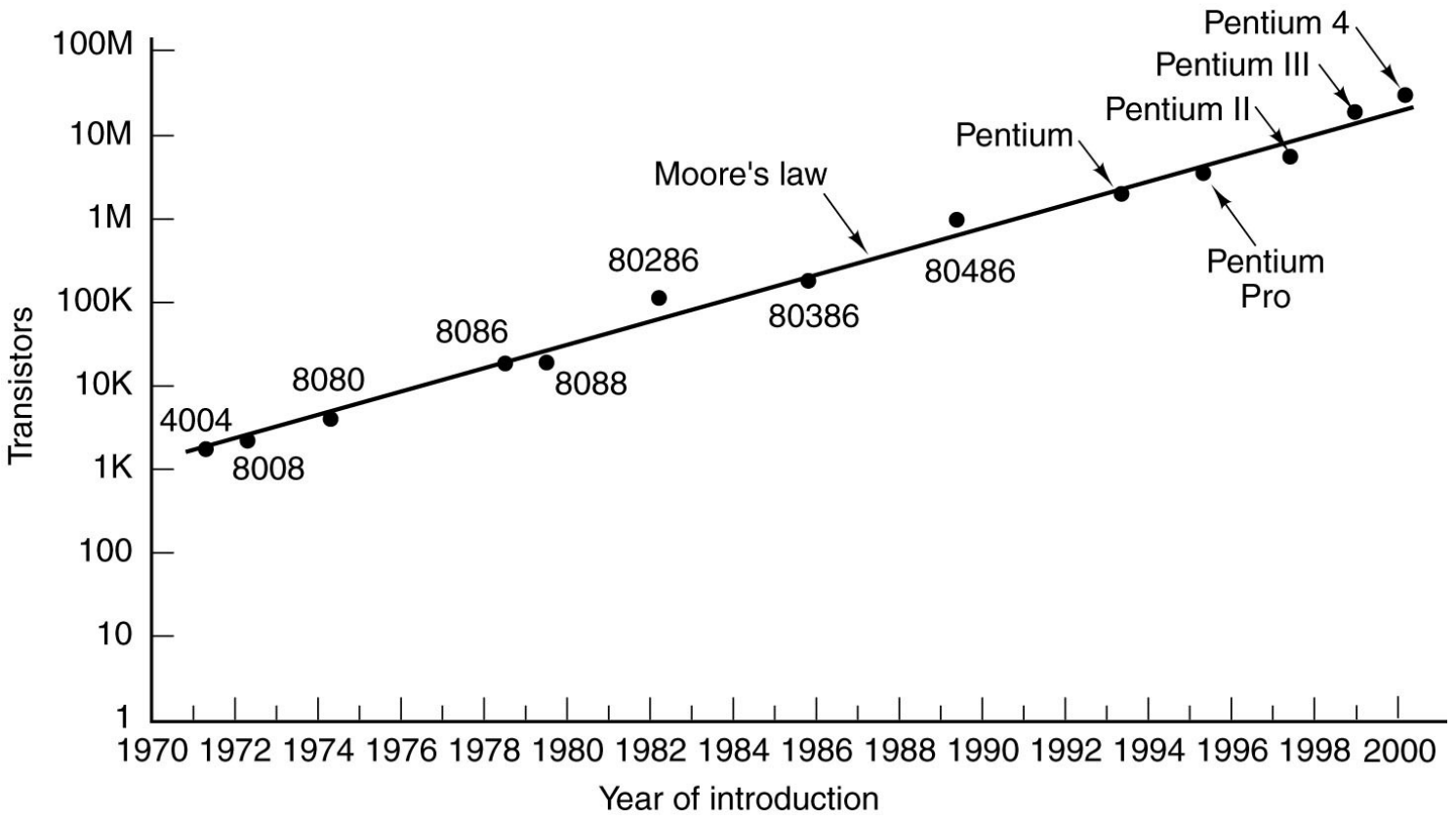
Intel Computer Family (3)



Moore’s law for (Intel) CPU chips.

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MCS-51 Family

Chip	Program memory	Mem. type	RAM	Timers	Interrupts
8031	0 KB		128	2	5
8051	4 KB	ROM	128	2	5
8751	8 KB	EPROM	128	2	5
8032	0 KB		256	3	6
8052	8 KB	ROM	256	3	6
8752	8 KB	EPROM	256	3	6

Members of the MCS-51 family.

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Metric Units

Exp.	Explicit	Prefix	Exp.	Explicit	Prefix
10^{-3}	0.001	milli	10^{3}	1,000	Kilo
10^{-6}	0.000001	micro	10^{6}	1,000,000	Mega
10^{-9}	0.000000001	nano	10^{9}	1,000,000,000	Giga
10^{-12}	0.000000000001	pico	10^{12}	1,000,000,000,000	Tera
10^{-15}	0.000000000000001	femto	10^{15}	1,000,000,000,000,000	Peta
10^{-18}	0.000000000000000001	atto	10^{18}	1,000,000,000,000,000,000	Exa
10^{-21}	0.000000000000000000001	zepto	10^{21}	1,000,000,000,000,000,000,000	Zetta
10^{-24}	0.000000000000000000000001	yocto	10^{24}	1,000,000,000,000,000,000,000,000	Yotta

The principal metric prefixes.

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