Chapter 1 – Introduction to Computers The Internet and the World Wide Web

Outline

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Objectives

- In this chapter, you will learn:
  - To understand basic computer concepts.
  - To become familiar with different types of programming languages.
  - To become familiar with the history of the C programming language.
  - To become aware of the C standard library.
  - To understand the elements of a typical C program development environment.
  - To appreciate why it is important to learn C in a first programming course.
  - To appreciate why C provides a foundation for further study of programming languages in general and of C++ and Java in particular.

1.1 Introduction

- We will learn
  - The C programming language
  - Structured programming and proper programming techniques
- This book also covers (but not covered in this class)
  - C++
    - Chapter 15 – 23 introduce the C++ programming language
  - Java
    - Chapters 24 – 30 introduce the Java programming language
- This course is appropriate for
  - Technically oriented people with little or no programming experience
  - Experienced programmers who want a deep and rigorous treatment of the language

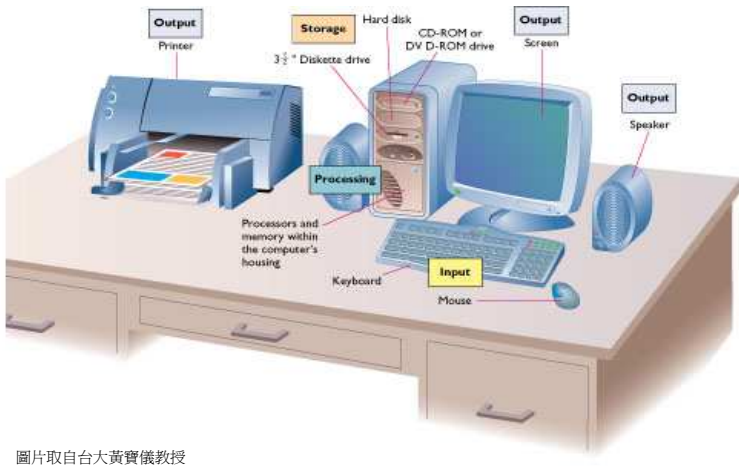
Computers, Information Technology, and You

- Computer System Capabilities
  - ✓ Data (資料) – input that goes into the computer (e.g., 指紋檔)
  - ✓ Information (資訊) – output that comes from the computer (e.g., 指認罪犯)
  - ✓ Data are just raw facts. Information is that data have been collected and processed into a meaningful form.
  - ✓ The procedure that transforms raw data into useful information is called processing.
  - ✓ Computers are very good at digesting data and producing information.
- Defining Information Technology Competency
  - ✓ Knowing the language of computers
  - ✓ Being able to use a computer
  - ✓ Being able to surf the Internet
  - ✓ Knowing the impact computers have and have had on society
  - ✓ Being an intelligent consumer of computers and computer-related products

Computers, Information Technology, and You

- The Computer's Strengths
  - ✓ Speed
  - ✓ Accuracy
  - ✓ Consistency
  - ✓ Reliability
  - ✓ Communications
  - ✓ Memory Capability
- Comparing Computers and Humans
  - ✓ Human output is slower than computer output
  - ✓ Humans recognize patterns quicker than computers
  - ✓ Computers are 100% accurate in recalling stored information
  - ✓ Humans think, computers don't

1.2 What is a Computer?



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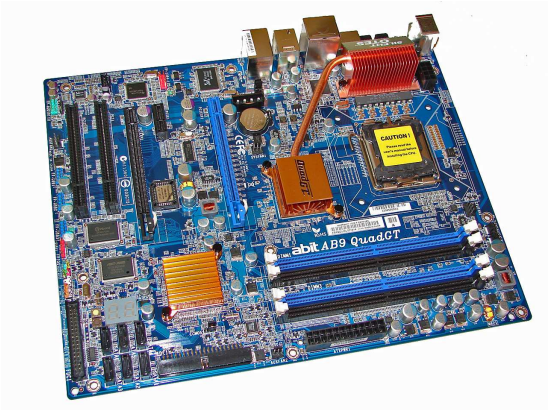
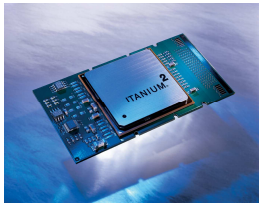
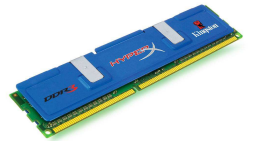
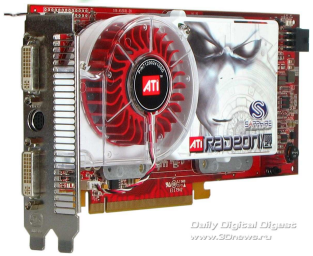
1.2 What is a Computer?









1.2 What is a Computer?

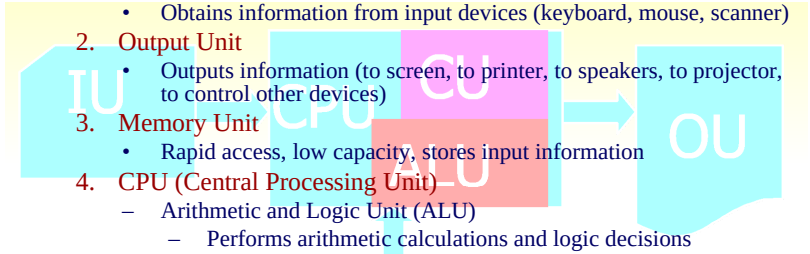
- Computer
  - Device capable of performing computations and making logical decisions
  - Computers process data under the control of sets of instructions called computer programs
- Hardware
  - Various devices comprising a computer
  - Keyboard, screen, mouse, disks, memory, CD-ROM, and processing units
- Software
  - Programs that run on a computer (operation systems, application programs)
  - Structured programming, top-down stepwise refinement, functionalization, and object-oriented programming

1.2 What is a Computer?

- **Bi**nary Digi**t**s (bit): 1 and 0
  - The computer can combine the two digital states to represent letters, numbers, colors, sounds, images, shapes, and even odors.
  - An “on” or “off” electronic state is represented by a bit, short for binary digit
- Encoding Systems: Bits (位元) and Bytes (位元組)
  - Bits are combined according to an encoding system to represent letters, numbers, and special characters, collectively referred to as alphanumeric characters
  - The combination of bits used to represent a character is called a byte (**Bi**nar**y** **Te**rm, 8 bits/byte)
  - 8 bits = byte
- Representation of a Character
  - ASCII (American Standard Code for Information Interchange) is the most popular encoding system for PCs and data communication
    - ASCII – 7 bits
    - ANSI – 8 bits/byte
    - UNICODE – 16 bits
    - Big5 – 16 bits
- Storage Capacities
  - KB (kilobyte) = 2^{10} Bytes = 1,024 Bytes ≈ 10^3 Bytes
  - MB (megabyte) = 2^{20} Bytes = 1,024 KB = 1,048,576 Bytes ≈ 10^6 Bytes
  - GB (gigabyte) = 2^{30} Bytes = 1,024 MB ≈ 10^9 Bytes
  - TB (terabyte) = 2^{40} Bytes = 1,024 GB ≈ 10^{12} Bytes

1.3 Computer Organization

- Five logical units in every computer:
  1. Input Unit
     - Obtains information from input devices (keyboard, mouse, scanner)
  2. Output Unit
     - Outputs information (to screen, to printer, to speakers, to projector, to control other devices)
  3. Memory Unit
     - Rapid access, low capacity, stores input information
  4. CPU (Central Processing Unit)
     - Arithmetic and Logic Unit (ALU)
       - Performs arithmetic calculations and logic decisions
     - Control Unit (CU)
       - Execute programs/instructions
       - Supervises and coordinates the other sections of the computer
       - Move data from one memory location to another
  5. Secondary Storage Unit
     - Cheap, long-term, high-capacity storage (e.g., Hard Disks, Memory Sticks)
     - Stores inactive programs



1.4 Evolution of Operating Systems

- Batch processing
  - Do only one job or task at a time
- Operating systems
  - Manage transitions between jobs
  - Increased throughput
    - Amount of work computers process
- Multiprogramming
  - Computer resources are shared by many jobs or tasks
- Timesharing
  - Computer runs a small portion of one user’s job then moves on to service the next user

Evolution of Computers

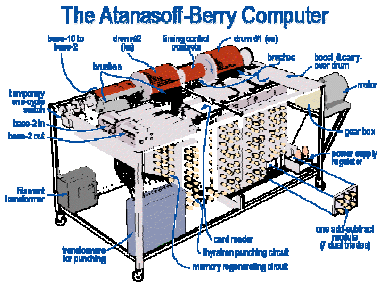
	第一代	第二代	第三代	第四代
	1951~	1959~	1964~	1971~
電腦元件	真空管	電晶體	積體電路 (IC)	大型積體電路 (LSI)
代表作	UNIVAC I	Honeywell 400	IBM 360	Microprocessor
速度	2,000 IPS	1 MIPS	10 MIPS	100 MIPS ~ 1 BIPS
內部作業速度	毫秒	微秒	10奈秒	奈秒以內

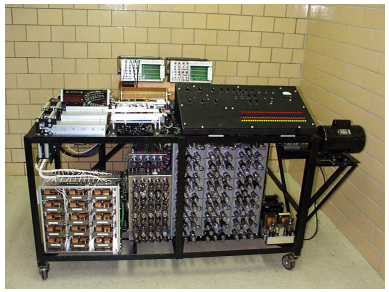
Classification of Computers

- Mainframe computers and supercomputers
  - ✓ Handle applications that require little I/O but lots of computing speed
    - ✓ Simulations
    - ✓ Weather forecasting
    - ✓ Study of how proteins are formed
    - ✓ Advanced graphics used in movies
    - ✓ Analysis of large amounts of data
- Servers, workstations, and PC
- Portable computers
  - ✓ notebook computers, handheld computers (e.g., PDA (Personal Digital Assistant))
- Special-purpose computers and embedded computers
  - ✓ Embedded Computers
    - ✓ Washing Machine, Refrigerators, etc.
  - ✓ Wearable Computers
    - ✓ Worn by the user
    - ✓ Customized for different professions

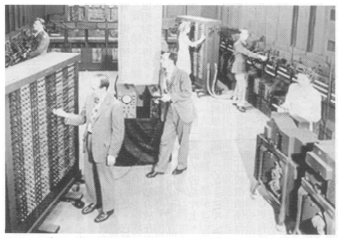
Atanasoff-Berry Computer

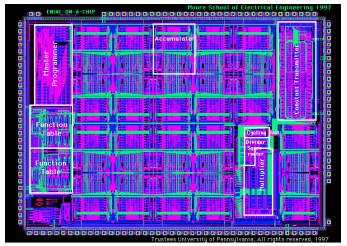
The Atanasoff-Berry Computer was the world's first electronic digital computer. It was built by John Vincent Atanasoff and Clifford Berry at Iowa State University during 1937-42. Atanasoff designed his computer to assist graduate students in nuclear physics with their mathematical computations.





ENIAC and Earth Simulator


ENIAC電腦一景



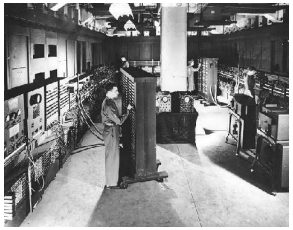
ENIAC (Electronic Numerical Integrator and Computer) 1946

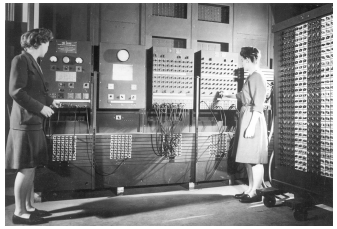
- Costs $400,000
- 30 tons, 30-by-50-foot space
- Can add 5000 numbers/sec or 14 10-digit multiplications/sec
- Contains 17468 Tubes.

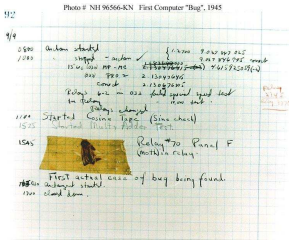
Earth Simulator (2002, Japan)

- 5,120 (640 8-way nodes) 500 MHz NEC CPUs
- 8 GFLOPS per CPU (41 TFLOPS total)
- 2 GB (4 512 MB FPLRAM modules) per CPU (10 TB total)

More on ENIAC

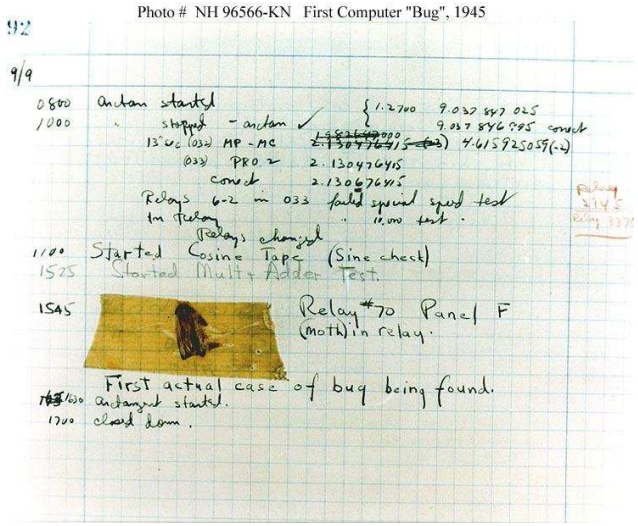






Computer (Full Precision)	Number of Procs	R_{max} GFlop/s	N_{max} Order	$N_{1/2}$ Order	R_{Peak} GFlop/s
Earth Simulator ****	5120	35860	1075200	266240	40960
Intel Itanium2 Tiger4 (4-way) 1.4GHz Itanium2 w/Quadrics Eliant (QsNetII)	4096	19940	975000	110000	23938
Intel Itanium2 Tiger4 (4-way) 1.4GHz Itanium2 w/Quadrics Eliant (QsNetII)	4032	19470	960000	110000	22579
ASCI Q AlphaServer EV-68(1.25 GHz w/Quadrics)	8160	13880	633000		20480
IBM BlueGene/L DD1 Prototype (0.5 GHz PowerPC 440 w/custom)	8192	11680	331775		16384
Apple G5 dual 2.0 GHz IBM Power PC 970s, w/Infiniband 4X primary fabric, Cisco Gigabit Ethernet secondary fabric	2200	10280	520000	152000	17600
Dell PowerEdge 1750, P4 Xeon 3.06 GHz, w/Myrinet	2500	9819	630000		15300
IBM eServer pSeries 690 (32 way 1.9 GHz POWER4+)	2112	8955	350000		16051
RIKEN Super Combined Cluster(dual Xeon 3.06GHz multiple clusters w/(1x512-1x128 InfiniBand/4X, 3x128 Myrinet)/GigE secondary)	2048	8728	474200	120000	12534
BlueGene/L DD2 Prototype (dual PowerPC 440 0.7 GHz)	4096	8655	294911		11469
HP RX2600 Itanium 2 1.5GHz w/Quadrics	1936	8633	839000	140000	11616
IBM eServer pSeries 690 (32 way 1.9 GHz POWER4+)	2048	8174	360000		15565
Dawning 4000A (quad Opteron 848 2.2Ghz w/Mirinet2000)	2560	8061	778480	180000	11264

More on ENIAC



NCKU HPC Environment

NCKU HPC Environment 詳細規格			
機關名稱	NCKU 計算機與網路中心	機器群名稱	NCKU HPC Environment
節點總數	128	每節點CPU數	4
CPU廠牌	AMD	型號	Opteron
時脈	2.8GHz		
主機板廠牌	SUN	型號	Fire X2200 M2
記憶體類型	DDR SDRAM	ECC功能	Yes
大小	大於4GB		
網路設備類型	InfiniBand		
作業系統	Linux-Suse		
Queuing System	DRM		
機器群網頁	http://www.cc.ncku.edu.tw/ch/services/hpc.htm		
建置日期	2007		
建置廠商	Stark/Sun		
已建置時間	3 年		
應用領域	平行計算環境研究		

Taiwan TOP 10 List (2007)

http://pccluster.nchc.org.tw/xoops/modules/tw_hpc/

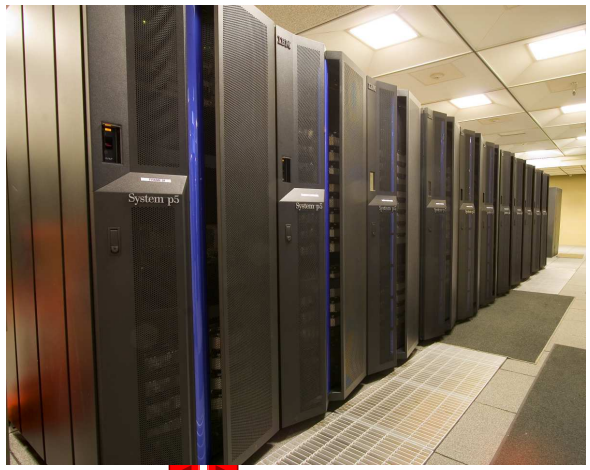
Rank	機關名稱	機器群名稱	應用領域	Processors	Rmax	建置日期	建置廠商
1	NCHC 國家實驗研究院高速網路與計算中心	IRIS	科學研究計算	2048	19910	2007/04/	IBM
2	NTU計算機及資訊網路中心	NTU HPC	科學研究計算	1024	8189	2007/10	勁智/Stark/IBM
3	國立中央大學地球科學院	Vger	科學研究計算	432	3577	2007/05/15	博盛/IBM
4	智冠科技	Blade Cluster BL-20P	Gaming	884	2767		HP
5	智冠科技	Blade Cluster BL-20P	Gaming	884	2767		HP
6	NCKU 計算機與網路中心	NCKU HPC Environment	平行計算環境研究	512	2100	2007	Stark/Sun
7	NCHC	Knowledge Management Cluster	科學研究計算	384	2000	2004	HP
8	NCHC	Formosa 2 HPC Cluster	科學研究計算	384	1228	2005/11	NCHC/Mirle/IBM
9	NCHC	Formosa PC Cluster	科學研究計算	300	1001	2003/11	NCHC/Mirle/IBM
10	中央研究院計算中心	Euler Computing System	平行計算環境研究	256	955	1998	IBM

TOP 1 in Taiwan

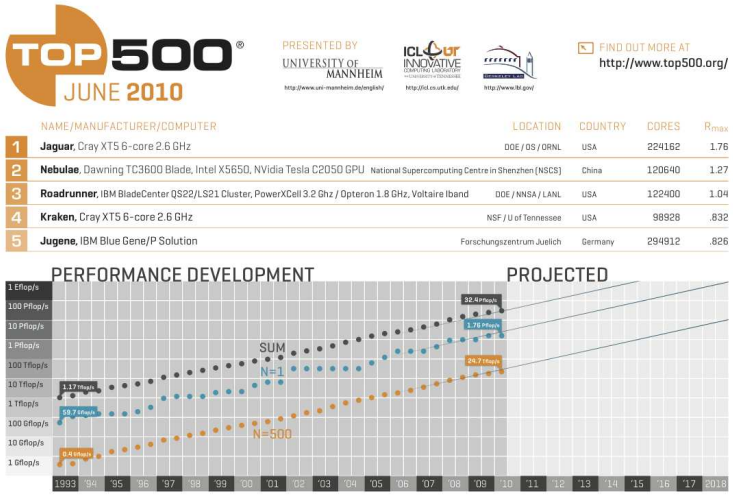
http://pccluster.nchc.org.tw/xoops/modules/tw_hpc/

The supercomputing platform IBM System Cluster 1350 has 2,048 processors with a combined throughput of 24.6 TFlops (10^{12}) /s Theoretically, it can perform 24.6 trillion floating point calculations per second (theoretical Rpeak at 24.6 Tflops/s; actual Rmax at 19.91 TFlops/s).

The cluster was assembled in the NCHC's southern business unit's branch office and will be operational in the third quarter of 2007.



TOP 500 List



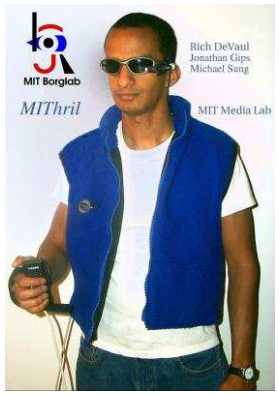
TOP 1 Worldwide

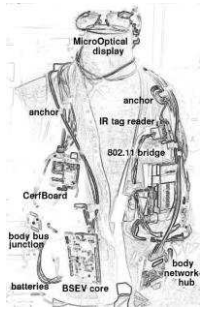
Cray and the Department of Energy's Oak Ridge, Tenn., lab upgraded an XT5 supercomputer nicknamed "Jaguar" to more than 224,000 processing cores.

That boosted the Jag to more than two petaflops (10^{15}) of computer power and Top 500 list, ranking it the world's fastest supercomputer.

Example of Wearable Computer

MIThril Hardware Design 2003





- From: http://www.media.mit.edu/wearables/
- See http://www.redwoodhouse.com/wearable/index.html for more information on wearable computers

Example of Wearable Computer

Image of the ZYPAD, rugged wrist wearable computer from Arcom Control Systems

1.5 Personal Computing, Distributed Computing, and Client/Server Computing

- Personal computers
  - Economical enough for individual
- Distributed computing
  - Computing distributed over networks
  - Grid Computing – users on the Internet share their unused computer power
- Client/server computing
  - Sharing of information across computer networks between file servers and clients (personal computers)

1.6 Machine Languages, Assembly Languages, and High-level Languages

1. Machine languages (機器語言)
   - Strings of numbers giving machine specific instructions
   - Example:

```
+1300042774
+1400593419
+1200274027
```

2. Assembly languages (組合語言)
   - English-like abbreviations representing elementary computer operations (translated via assemblers)
   - Example:

```
LOAD    BASEPAY
ADD     OVERPAY
STORE   GROSSPAY
```


1.6 Machine Languages, Assembly Languages, and High-level Languages

3 High-level languages (高階語言)
   - Codes similar to everyday English
   - Use mathematical notations (translated via compilers)
   - Example:

```
grossPay = basePay + overTimePay
```

1.7 History of C

- C
  - C was created by Dennis Ritchie at the Bell Telephone Laboratories in 1972
  - Evolved from two previous programming languages, BCPL (Basic Computer Programming language, 1967) and B (developed by Ken Thompson of Bell Labs)
  - Used to develop UNIX
  - Used to write modern operating systems
  - Hardware independent (portable)
  - By late 1970's C had evolved to "Traditional C"
- Standardization
  - Many slight variations of C existed, and were incompatible
  - Committee (ANSI, the American National Standards Institute) formed to create a "unambiguous, machine-independent" definition - ANSI Standard C
  - Standard created in 1989, updated in 1999

1.7 History of C

- Why Use C?
  - C is a powerful and flexible language
  - C is a popular language preferred by professional programmers
  - C is a portable language
  - C is a language of few words, containing only a handful of terms, called keywords, which serve as the base on which the language's functionality is built
  - C is modular. C code can (and should) be written in routines called functions.

1.8 The C Standard Library

- C programs consist of pieces/modules called functions
  - A programmer can create his own functions
    - Advantage: the programmer knows exactly how it works
    - Disadvantage: time consuming
  - Programmers will often use the C library functions
    - Use these as building blocks
  - Avoid re-inventing the wheel
    - If a premade function exists, generally best to use it rather than write your own
    - Library functions carefully written, efficient, and portable

1.9 The Key Software Trend: Object Technology

- Objects (物件)
  - Reusable software components that model items in the real world
  - Meaningful software units
    - Date objects, time objects, paycheck objects, invoice objects, audio objects, video objects, file objects, record objects, etc.
    - Any noun can be represented as an object
  - Very reusable
  - More understandable, better organized, and easier to maintain than procedural programming
  - Favor modularity

1.10 C++ and C++ How to Program

- C++
  - Superset of C developed by Bjarne Stroustrup at Bell Labs
  - "Spruces up" C, and provides object-oriented capabilities
  - Object-oriented design very powerful
    - 10 to 100 fold increase in productivity
  - Dominant language in industry and academia
- Learning C++
  - Because C++ includes C, some feel it is best to master C, then learn C++
  - Starting in Chapter 15, we begin our introduction to C++

1.11 Java and Java How to Program

- Java is used to
  - Create Web pages with dynamic and interactive content
  - Develop large-scale enterprise applications
  - Enhance the functionality of Web servers
  - Provide applications for consumer devices (such as cell phones, pagers and personal digital assistants)
- Java How to Program
  - Closely followed the development of Java by Sun
  - Teaches first-year programming students the essentials of graphics, images, animation, audio, video, database, networking, multithreading and collaborative computing

1.12 Other High-level Languages

- Other high-level languages
  - FORTRAN (FORmula TRANslator)
    - Used for scientific and engineering applications
    - Developed by IBM in 1950s
  - COBOL (COmmon Business Oriented Language)
    - Used to manipulate large amounts of data, e.g., for commercial applications
    - Developed in 1959
  - Pascal
    - Designed for teaching structured programming and rapidly became the preferred programming language in most colleges
    - Developed in 1971
  - Ada
    - Multitasking

1.13 Structured Programming

- Structured programming
  - Disciplined approach to writing programs
  - Clear, easy to test and debug and easy to modify
- Multitasking
  - Specifying that many activities run in parallel

1.14 Basics of a Typical C Program Development Environment

- Phases of C Programs:
  1. *Edit*
  2. *Preprocess*
  3. *Compile*
  4. *Link*
  5. *Load*
  6. *Execute*

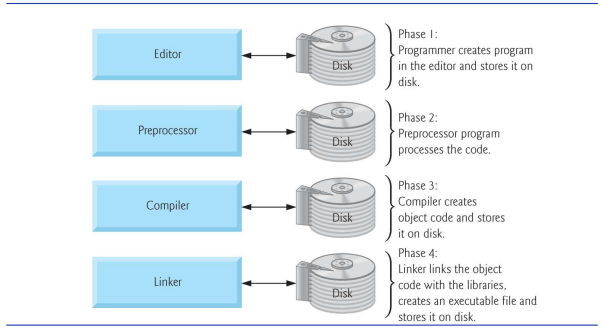


Fig. 1.1 | Typical C development environment. (Part 1 of 2.)

1.14 Basics of a Typical C Program Development Environment

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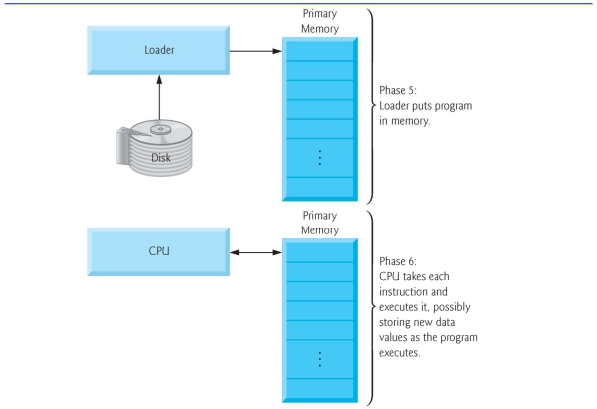


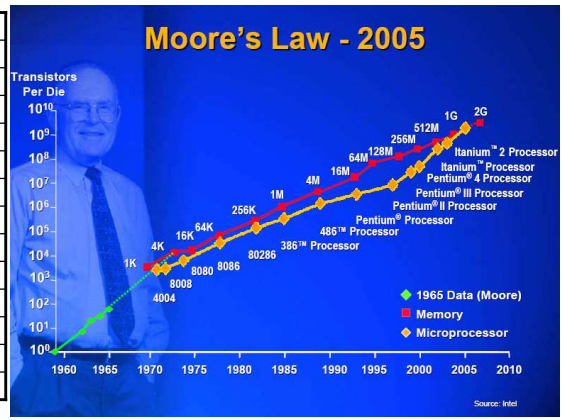
Fig. 1.1 | Typical C development environment. (Part 2 of 2.)

1.15 Hardware Trends

- Every year or two the following approximately double (Moore's Law):
  - Amount of memory in which to execute programs
  - Amount of secondary storage (such as disk storage)
    - Used to hold programs and data over the longer term
  - Processor speeds
    - The speeds at which computers execute their programs

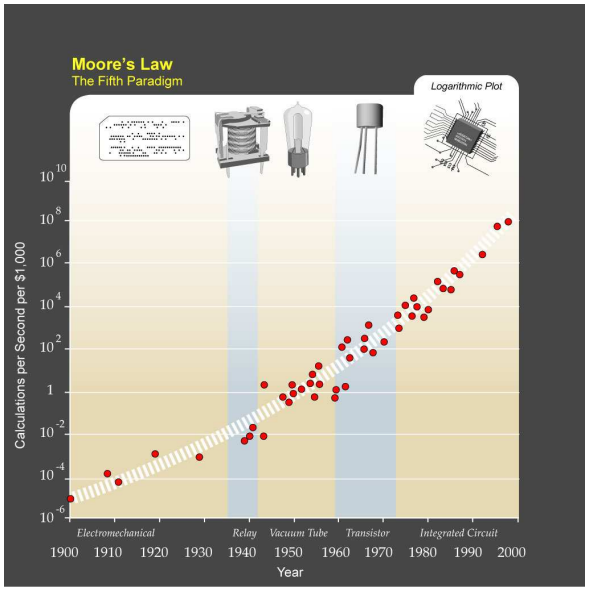
Moore's Law – Intel CPUs

	Year of Introduction	Transistors
4004	1971	2,250
8008	1972	2,500
8080	1974	5,000
8086	1978	29,000
286	1982	120,000
386	1985	275,000
486	1989	1,180,000
Pentium	1993	3,100,000
Pentium II	1997	7,500,000
Pentium III	1999	24,000,000
Pentium 4	2000	42,000,000
Itanium	2002	220,000,000
Itanium 2	2003	410,000,000

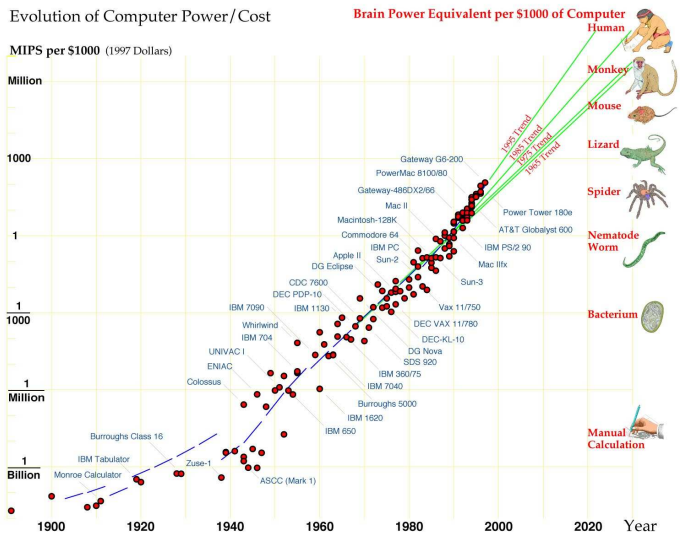


From: http://sscs.org/History/MooresLaw.htm

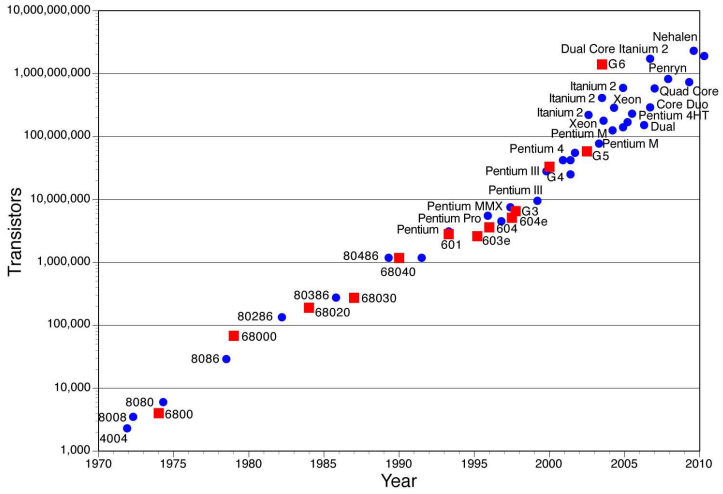
Moore's Law – Costs



Moore's Law – Speed/Cost



Moore's Law – Intel CPUs



1.16 History of the Internet

- Mother of the Internet
  - ARPAnet (Advanced Research Projects Agency) developed by Department of Defense
- The Internet enables
  - Quick and easy communication via e-mail
  - International networking of computers
- Packet switching
  - The transfer of digital data via small packets
  - Allows multiple users to send and receive data simultaneously
- No centralized control
  - If one part of the Internet fails, other parts can still operate
- TCP/IP
  - Transmission Control Protocol/Internetworking Protocol
- Bandwidth
  - Information carrying capacity of communications lines
- The Internet enables
  - Quick and easy communication via *e-mail*
  - Remote login via *telnet*, *bbs*
  - File transfer via *ftp*
  - International networking of computers

The Internet and Information Services

- Global Village
  - ✓ Computer Network
  - ✓ Upload – send a file to another computer (ftp)
  - ✓ Download – receive a file from another computer (ftp)
  - ✓ E-mails
  - ✓ Surfing the Net (telnet, bbs, news, p2p, phone, etc.)
  - ✓ World Wide Web (www, the Web)
- The Internet, also known simply as the Net, is a worldwide network of computers that has emerged as the enabling technology in our migration to a global village
- Most colleges and business are on the Net; that is, they have an Internet account
- Typically, individuals gain access to the Internet by subscribing to an Internet service provider (ISP) or to a commercial information service
- Three major networks in Taiwan: TANET, SEEDNet, HiNet

1.17 History of the World Wide Web

- World Wide Web (WWW)
  - Developed by CERN (the European Laboratory for Particle Physics)
  - Client-server model
  - Hyper text transfer protocol (HTTP) provides connectionless transfer through network
  - Locate and view multimedia-based documents on almost any subject via a browser
  - Makes information instantly and conveniently accessible worldwide
  - Possible for individuals and small businesses to get worldwide exposure
  - Changing the way business is done

PC 大 事 紀

- 1975 - The Altair 8800 (Computing was made available to individuals);
  - Microsoft and Bill Gates
- 1977 - The Apple II – Steve Jobs and Steve Wozniak
- 1981 - The IBM PC and MS-DOS
- 1984 - The Macintosh and Graphical User Interfaces (GUI)
- 1985 - Microsoft Windows
- 1993 - The Pentium Processor and Multimedia
  - The World Wide Web and the Internet Browser
- 1997 - IBM, Deep Blue (256 CPUs), Beats Garry Kasparov, the World Champion chess player, 3.5 to 2.5

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http://www.cc.ncku.edu.tw/download/

成大的電腦資源

http://www.cc.ncku.edu.tw/download/

1.18 General Notes About C and This Book

- Program clarity
  - Programs that are convoluted are difficult to read, understand, and modify
- C is a portable language
  - Programs can run on many different computers
  - However, portability is an elusive goal
- We will do a careful walkthrough of C
  - Some details and subtleties are not covered
  - If you need additional technical details
    - Read the C standard document
    - Read the book by Kernigan and Ritchie