Operating Systems Fundamentals

The History of Operating Systems

4 Generations

Summary: OS Generations

- First Generation (1945 – 55)
  Vacuum tubes and plugboards
- Generation 2 (1955 – 65)
  Transistors and batch systems
- Generation 3 (1965 – 80)
  Integrated Circuits and multiprogramming
- Generation 4 (1980 – Present)
  Personal computers

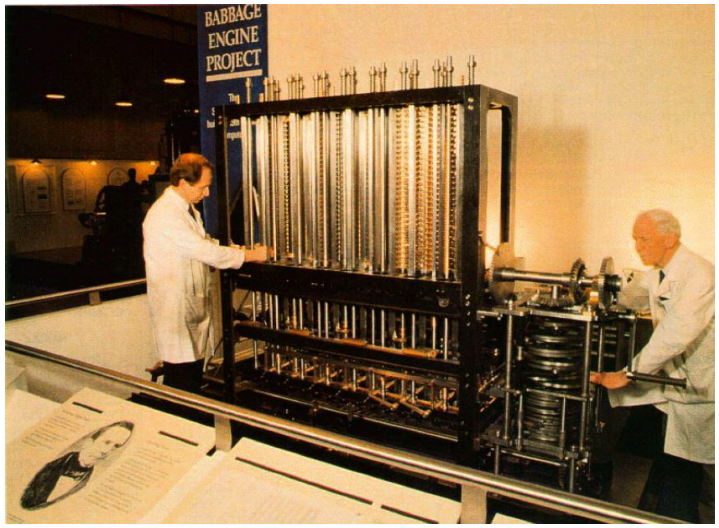
Prediction from 1960's

In your own time, watch

https://www.youtube.com/watch?v=EC5sbdvnvQM

Early Computers

- Charles Babbage (1791-1871) designed the first true digital computer called the analytical engine.
- That was purely mechanical and intended to do mathematical operations
- The engine was supposed to be made of brass, and to be steam powered
- He did not actually build the machine but inspired others in the field.
  - Difference engine
  - Finite differences



Early Computers

- Babbage also thought of the concept of software
- He hired the first programmer (Lady Ada, Countess of Lovelace) [1815 – 1852]

"Enchantress of Numbers"

1ST GENERATION

The Early Computers/Operating Systems

First Generation: 1945 to 1955

- No operating system
  vacuum tubes, plug boards
- Human operators - Programs were entered by setting some switches
- Very slow and primarily used for scientific calculations

Who would have guessed!

"I think there is a world market for maybe five computers."

– Thomas Watson, chairman of IBM - 1943

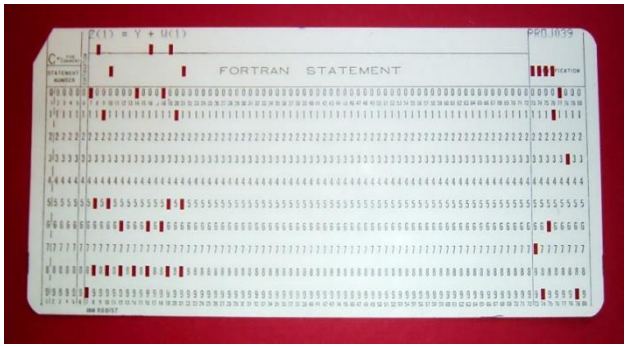
2ND GENERATION

Second generation 1955 – 1965

- Transistors, batch systems
- Universities started to buy computers (spending millions)
- Punched cards were used
- To run a job (a program or a set of related programs) first punch it and give the deck to the operators and wait for the output (batch operation)
- Computers were single user

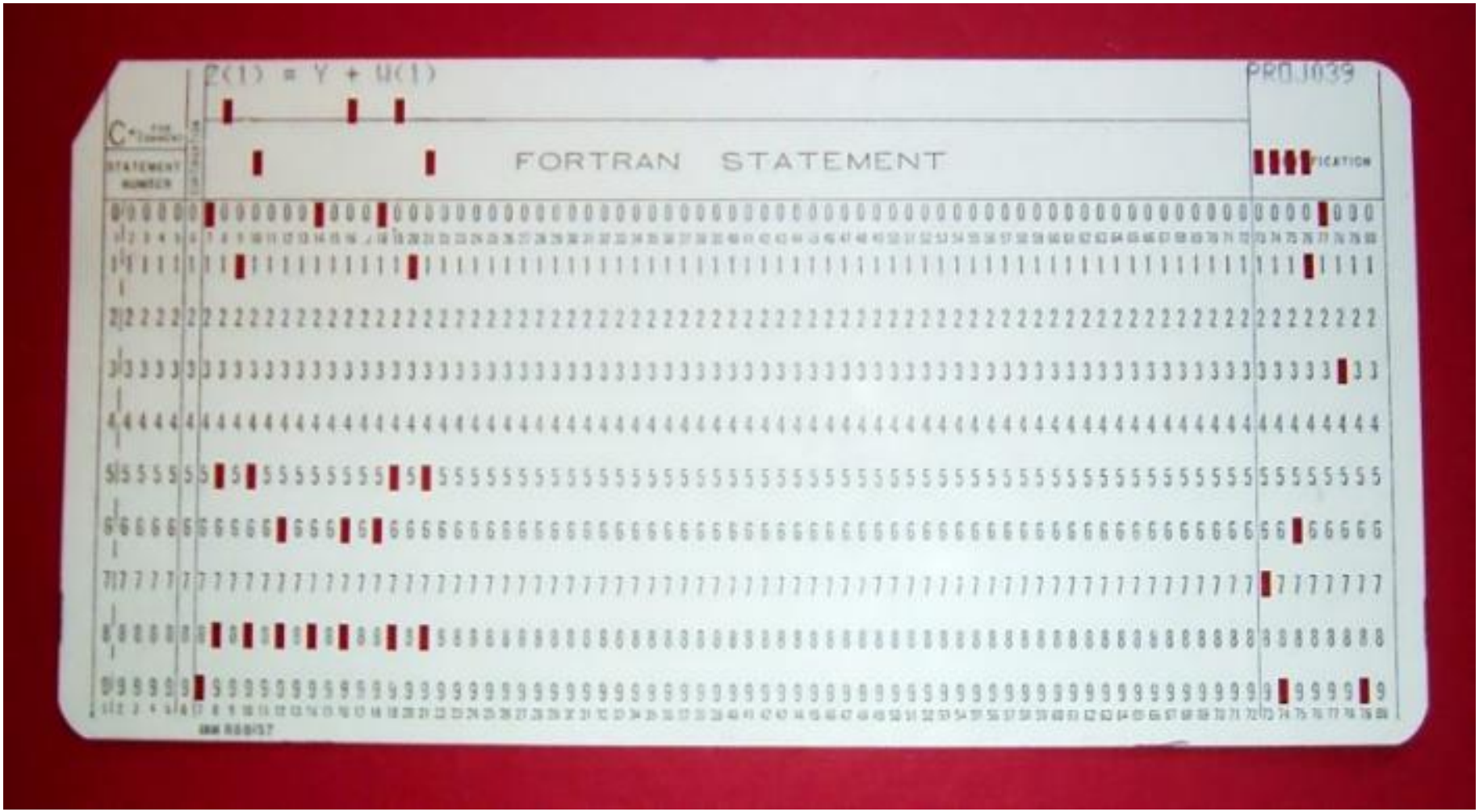
IBM STRETCH

DEC
PDP-1

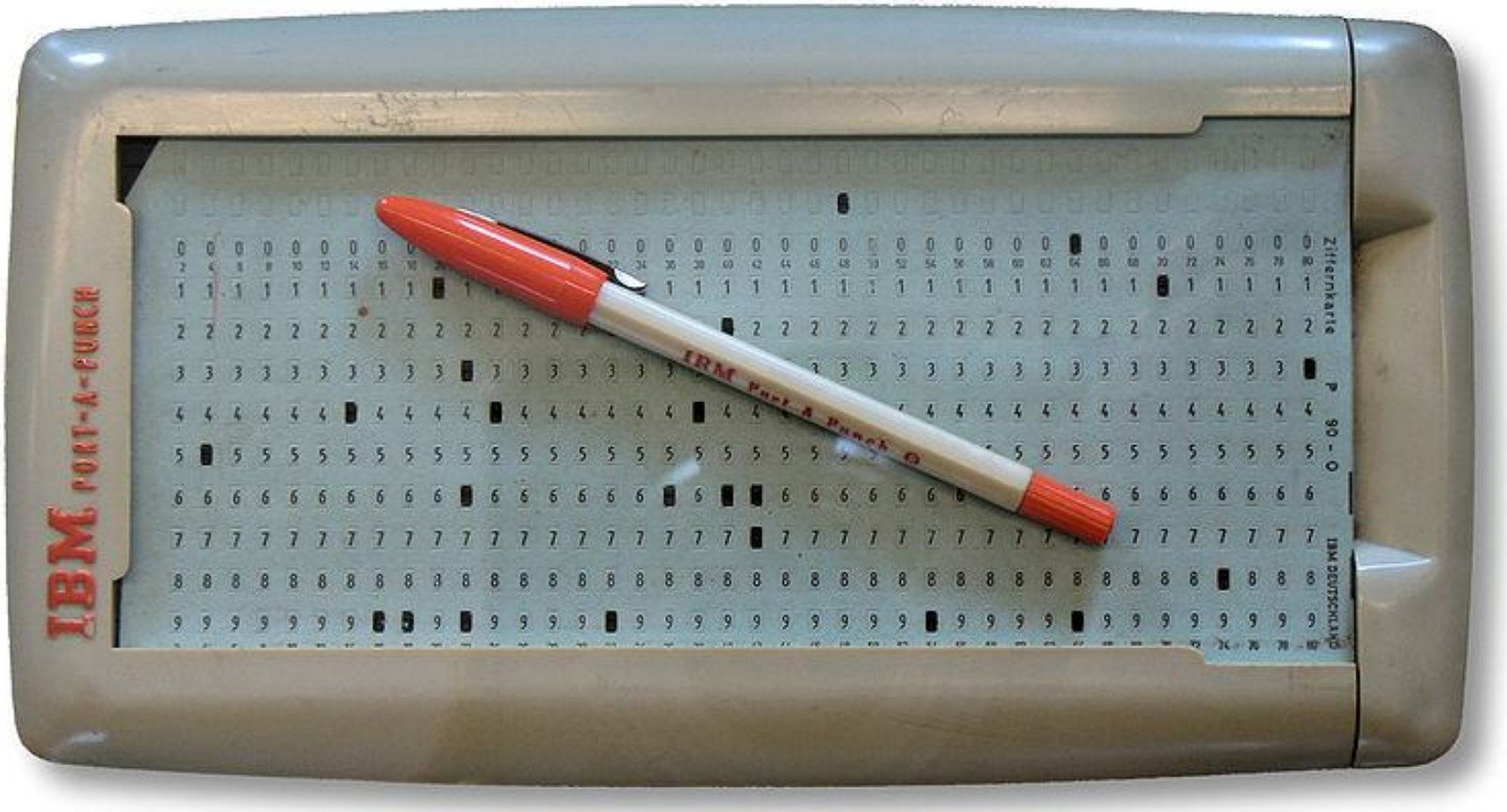


Punch Card

Second generation 1955 – 1965



Second generation 1955 – 1965



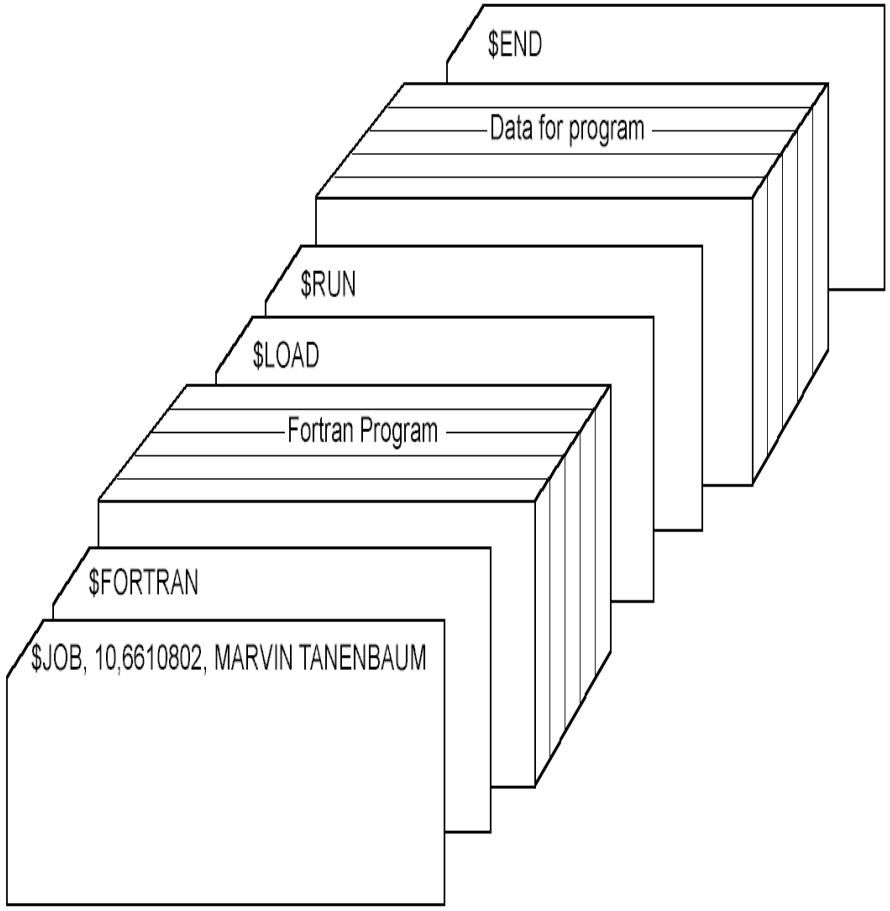
Structure of a typical Fortran Monitoring System job – a 2nd generation operating system

$JOB card specifies:
- The max runtime in minutes
- The account number to be charged
- The programmer's name

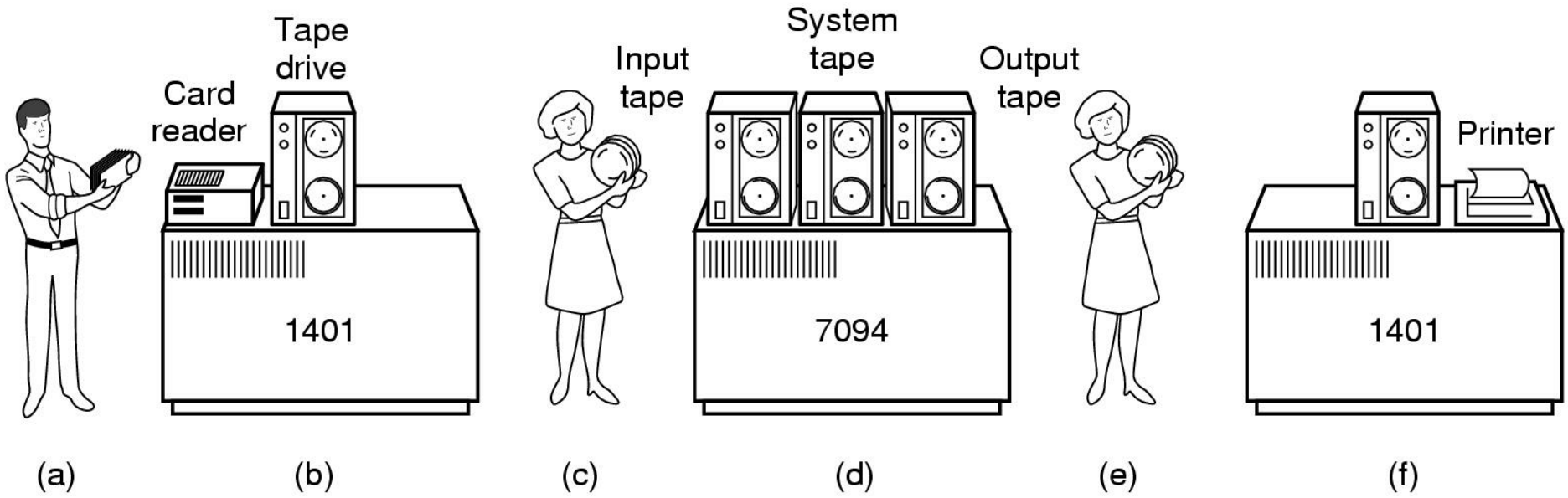
$FORTRAN card:
- tells the operating system to load the Fortran compiler

$RUN means
- run the program with the following data

$END end of job .



Early Batch Systems



(a) bring cards to IBM 1401 machine (machine for card reading)
(b) read cards to tape
(c) put tape on IBM 7094 which does computing
(d) write output to tape
(e) put tape on IBM 1401 which prints output offline

A Famous Remark

"I have travelled the length and breadth of this country and talked with the best people, and I can assure you that data processing is a fad that won't last out the year."

- The editor in charge of business books for Prentice Hall - 1957

3RD GENERATION

Third generation 1965 – 1980

- Integrated Circuits and Multiprogramming
- System 360 and S/370 family of computers
- Spooling (simultaneous peripheral operation on-line)
- Time sharing, On-line storage for System programs
- User programs and data, Program libraries
- Virtual memory

Third generation 1965 – 1980 continued..

Integrated Circuits and Multiprogramming

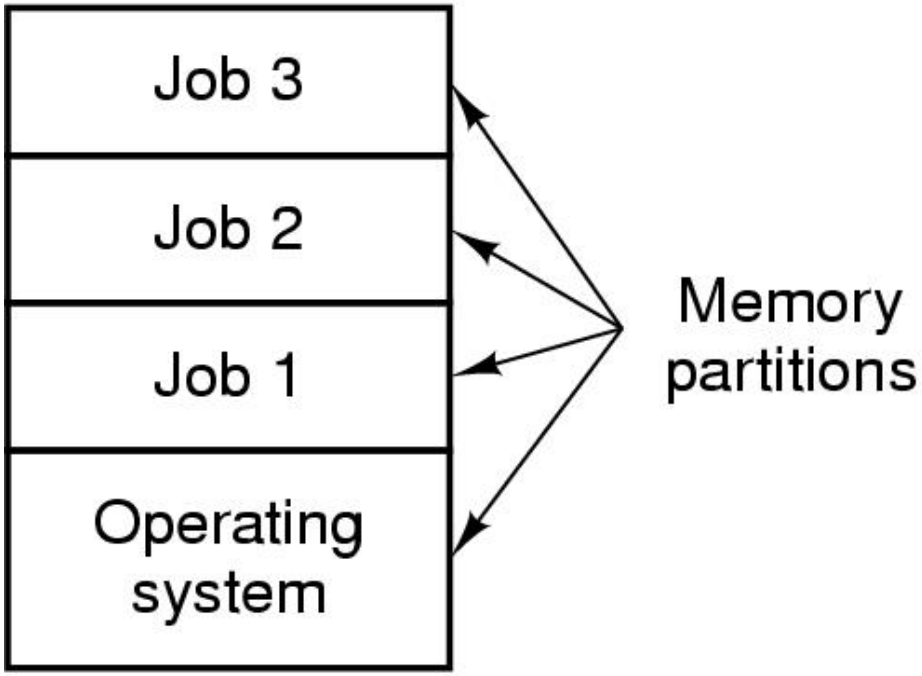
- IBM's System/360 mainframe computer with a standard architecture designed to handle both **scientific** and **commercial** computing

Third generation 1965 – 1980 continued..

- OS/360 was the operating system of System/360
  - First the single task "Primary Control Program" was introduced
  - Then "Multiprogramming with a Fixed number of Tasks"
  - Finally "Multiprogramming with a Variable number of Tasks"

- In multiprogramming, multiple jobs are in the memory and when a job finishes another can start immediately while the free memory partition is being reloaded.

Third generation 1965 – 1980 continued..



- **Multiprogramming system**
  - three jobs in memory – 3rd generation

Third generation 1965 – 1980 continued..

The concept of **spooling** was introduced by 3rd generation operating systems:

- A program is loaded from cards to disk. Whenever a job finished and a memory partition became available, it was loaded directly to memory.

But were still not interactive,

- programmers may not be aware of errors until some hours later!

This problem lead to the development of time-sharing systems where the user has an online terminal .

Third generation 1965 – 1980 continued..

MULTICS, (MULTICS = Multiplexed Information and Computing Service)
A third generation OS introduced the concept of
Time-Sharing computing

Labelled as father of all modern Oss,
led to the development of UNIX
(The name *Unix* (originally Unics) is itself a pun on *Multics)*

UNIX (1970s, AT&T, American Telephone and Telegraph Company)
became popular with companies and government agencies,
and people started to develop their own UNIX OS.
(does 1/1/1970 appear familiar?)

IEEE (Institute of Electrical and Electronics Engineers)
developed a standard for UNIX-like OSs, called **POSIX** to prevent chaos.

Note re POSIX

- POSIX is a family of standards, specified by the IEEE, to clarify and make uniform the application programming interfaces (and ancillary issues, such as command line shell utilities) provided by Unix operating systems. When you write your programs to rely on POSIX standards, you can be pretty sure to be able to port them easily among a large family of Unix derivatives (including Linux, but not limited to it!);

- if and when you use some Linux API that's not standardized as part of Posix, you will have a harder time if and when you want to port that program or library to other Unix systems (e.g., Mac OS) in the future.

Famous Remark

"There is no reason anyone would want a computer in their home.“

- Ken Olson, president, chairman and founder of Digital Equipment Corp. - 1977

4TH GENERATION

UNIX, MINIX, LINUX, XINU, GNU

Andrew S. Tanenbaum wrote a version of UNIX called
MINIX (mini-UNIX, released in 1987) with POSIX support, for educational use.

A Finnish student Linus Torvalds wrote a free production of MINIX called ……?

- Linux has a slightly different **kernel** design to that of MINIX
  (but that's for another day…. Think Android !!)

XINU, a UNIX-like OS was originally developed by Dr. Douglas Comer in 1984 at Purdue University as an educational and research tool for computer systems. Xinu Is Not Unix! (note the spelling !)

GNU, a UNIX-like OS started in 1984 by Richard Stallman (MIT). The aim was to create a completely "free" OS for all. Still not yet fully realised but led to the Free Software Foundation and the GNU General Public Licence (the most widely used free software licence).

Fourth generation 1980 - present

Personal computers were developed after LSI (Large Scale Integration) circuits were invented.

First Microcomputer:

- Intel 8080 CPU + attached 8-inch floppy disk
- First disk based OS CP/M (Control Program for Microcomputers)

In the 1980s IBM designed the IBM PC and contacted **Bill Gates** for an operating System.

Fourth generation 1980 - present

Atari 800 - 1979

Commodore VIC 20 - 1980

Commodore 64 - 1982

Sinclair QL - 1984

IBM - 1981

Apple II - 1977

Amstrad - 1986

Fourth generation continued..

- In the 1980s IBM designed the IBM PC and contacted Bill Gates for an operating System.
- Bill Gates suggested to IBM that they should look at CP/M (Control Program for Microcomputers, one of the most successful OS for microcomputers at that time, created by Gary Kildall)

Unfortunately

- Kildall did not sign a non-disclosure agreement, and did not make an agreement with IBM
- IBM went back to Bill Gates and signed a contract with him to write an OS for their new home computer (MS-DOS)
- MS-DOS was based on QDOS, the "Quick and Dirty Operating System" written by Tim Paterson of Seattle Computer Products (later renamed to 86-DOS)
- QDOS was based on Gary Kildall's CP/M
- Microsoft bought the rights to QDOS for $50,000

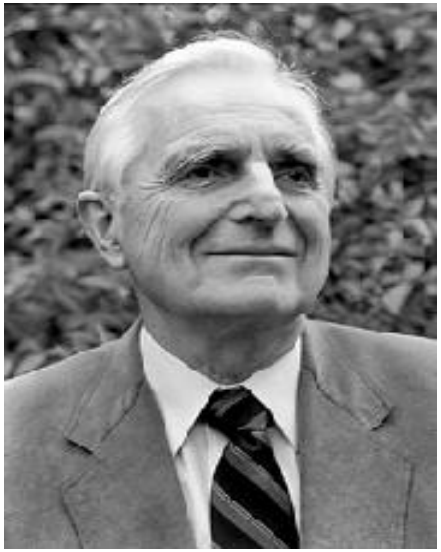
Fourth generation continued..

Personal computers and workstations

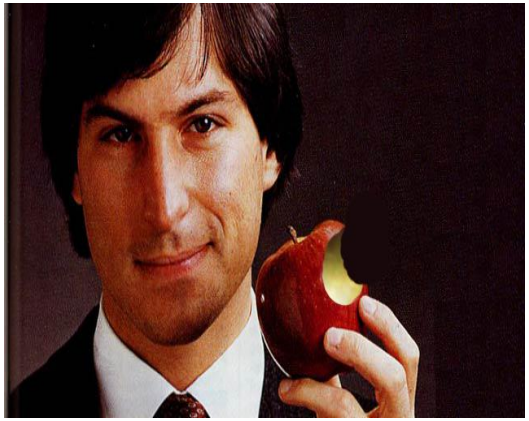
- MS-DOS and Unix
- Massively parallel systems
- Pipelining
- Computer networks
- Distributed computing – Using multiple independent computers to perform a common task.

Fourth generation continued..

- Early MS-DOS was very primitive but later versions included advanced features taken from UNIX
- The early OS for microcomputers were based on users typing in commands from the keyboard
- Doug EngelBart (Stanford Research Institute) invented the Graphical User Interface (GUI) with windows, icons, menus and mouse



Fourth generation continued..



- Steve Jobs saw the value of the GUI in a PC and developed the apple computer with GUI (Apple Macintosh) in his garage.

- He was also the co-founder of Pixar which has created many successful animated movies:
  - Toy Story; A Bug's Life, Finding Nemo, Monsters Inc, ..

MS-DOS and Windows

Microsoft developed a GUI-based system called Windows which originally ran on top of MS-DOS (just as a GUI to DOS)

```
GRAFTABL COM      11237 03.02.90    13:00
GRAPHICS COM      19758 03.02.90    13:00
GRAPHICS PRO      21232 03.02.90    13:00
EXE2BIN  EXE       8584 03.02.90    13:00
EXPAND   EXE      14035 03.02.90    13:00
JOIN     EXE      17934 03.02.90    13:00
LCD      CPI      10771 03.02.90    13:00
LOADFIX  COM       1273 03.02.90    13:00
INFO     TXT      15690 03.02.90    13:00
ANWINFO  TXT      10313 03.02.90    13:00
PRINTER  SYS      18852 03.02.90    13:00
REPLACE  EXE      20194 03.02.90    13:00
SUBST    EXE      18574 03.02.90    13:00
TREE     COM       6974 03.02.90    13:00
COMMAND  COM      50031 03.02.90    13:00
DOSSHELL INI      17830 28.05.06    21:18
       83 Datei(en)     2147161 Byte
                       26421248 Byte frei

C:\DOS>ver

MS-DOS Version 5.00


C:\DOS>_
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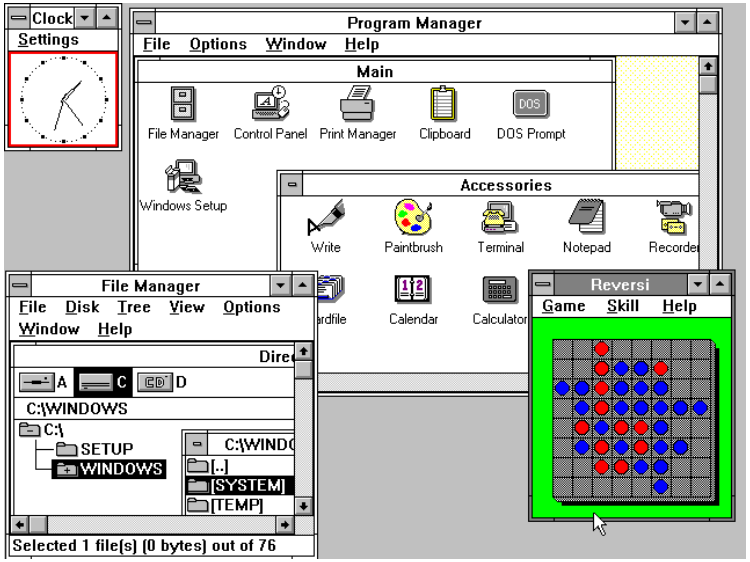


Famous Remark

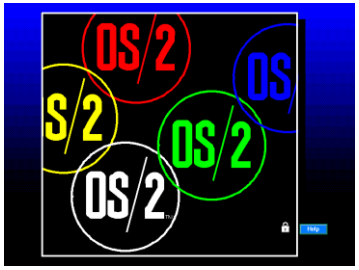
"We don't see Windows as a long-term graphical interface for the masses.“

- A Lotus Software Development official, while demonstrating a new DOS version - 1989

Fourth generation continued..

- Windows 3.0 (an MS-DOS application)
- Windows 95 and 98 were real GUI based operating systems based on 16 bit Intel assembly language
- Windows NT was a 32-bit rewrite from scratch version of Windows 98.
- Windows 2000 (Windows NT version 5.0)
- Windows ME (Millennium Edition)
- Windows XP (eXPerience)
- Windows Vista
- Windows 7
- Windows 8
- Windows 10
- Windows 11

Fourth generation continued..



- **IBM OS/2**
  - Initially a Microsoft/IBM collaboration
  - IBM only from 1990 (Microsoft concentrates on Windows)
  - 1992 OS/2 2.0
    - "a better DOS than DOS and a better Windows than Windows“
    - Could actually run Windows as a DOS program within OS/2
  - 1994 OS/2 Warp
  - Internal IBM management problems lead to its demise

Fourth generation 1980 - present

Compaq

DeskPro386 - 1986

SunOS SPARCstation 1990s

Apple Mac – 1990s

Apple iMac

– 2000 ish

SUPER COMPUTERS

Power Indices reminder

Prefix	Symbol(s)	Power of 10	Power of 2
yocto-	y	10^{-24} *	--
zepto-	z	10^{-21} *	--
atto-	a	10^{-18} *	--
femto-	f	10^{-15} *	--
pico-	p	10^{-12} *	--
nano-	n	10^{-9} *	--
micro-	µ	10^{-6} *	--
milli-	m	10^{-3} *	--
centi-	c	10^{-2} *	--
deci-	d	10^{-1} *	--
(none)	--	10^{0}	2^{0}
deka-	D	10^{1} *	--
hecto-	h	10^{2} *	--
kilo-	k or K **	10^{3}	2^{10}
mega-	M	10^{6}	2^{20}
giga-	G	10^{9}	2^{30}
tera-	T	10^{12}	2^{40}
peta-	P	10^{15}	2^{50}
exa-	E	10^{18} *	2^{60}
zetta-	Z	10^{21} *	2^{70}
yotta-	Y	10^{24} *	2^{80}

* Not generally used to express data speed

** k = 10^{3} and K = 2^{10}

Current #1 – January 2023

The **HPE Frontier (USA)**

as of January 2024, is ranked number one in the TOP500 list as the fastest supercomputer in the world, with 1.194 exaFLOPS, which is 1.192 quintillion operations per second

It has 8,699,904 Cores.

HPE Cray OS. HPE Cray OS is based on SUSE® Linux Enterprise Server (SLES) with enhancements for high performance computing

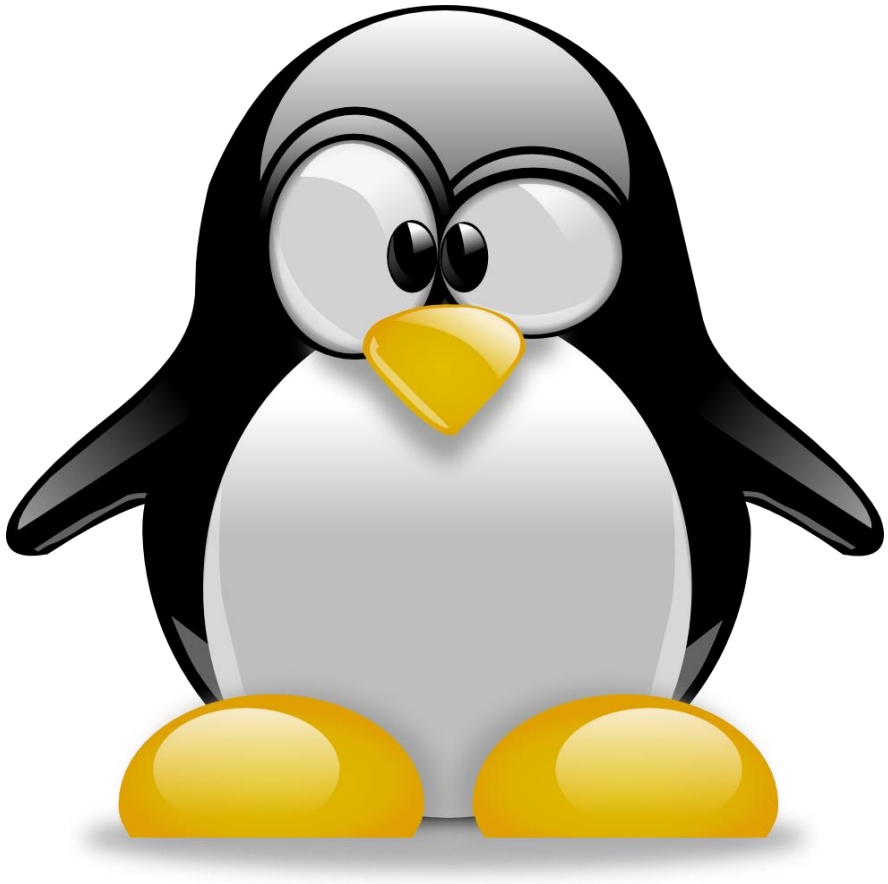
The “flop” in exaflop is an abbreviation for floating point operations.

To match what an exaflop computer can do in just one second, a human would have to perform one calculation (operation) every second for 31.6 billion years.

All …. using what OS ?

All top 10 use …..

LINUX



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Final Famous Remark

- Popular Mechanics, forecasting the relentless march of science, 1949

"Computers in the future may weigh no more than 1.5 tons.“