

15-292

History of Computing

Mini-computers, workstations and advances in memory devices



The Minicomputer



- A class of multi-user computers
- In terms of size & computing power, in the middle range of the computing spectrum
 - in between mainframes (the largest) and the personal computers (the smallest)
- emerged in the 1970s (before the PC)
- the term evolved in the 1960s to describe the "small" 3rd generation computers that became possible with the use of the newly invented IC technology
- took up one or a few cabinets, compared with mainframes that would usually fill a room
- led to the microcomputer (the PC)
- Some consider Seymour Cray's CDC-160 the first minicomputer
- The PDP-8 was the definitive minicomputer
 - as important to computer architecture as the EDVAC report

Digital Equipment Corporation



- Founded in 1957 by Ken Olsen, a Massachusetts engineer who had been working at MIT Lincoln Lab on the TX-0 and TX-2 projects.
- Began operations in Maynard, MA in an old textile mill
- In 1961 DEC started construction of its first computer, the PDP-1.
 - PDP = Programmable Digital Processor



PDP Influence

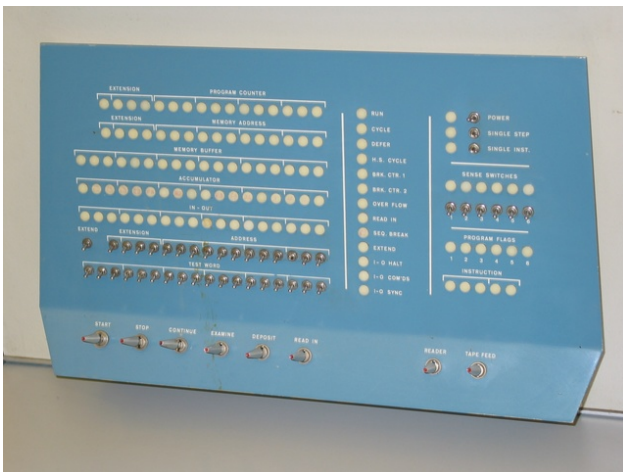


- Architecturally: allowed I/O to go directly from input device to core memory
 - Allowed fast I/O with minimal impact on processor
 - Called Direct Memory Access (DMA)
 - Defined the architecture of the minicomputer
 - Is built into the microprocessors used in PCs today
- Culturally: encouraged customer modification of its models
 - Provided catalogs with self-instruction
 - Done out of necessity, but appreciated by clients

PDP-1



PDP-1



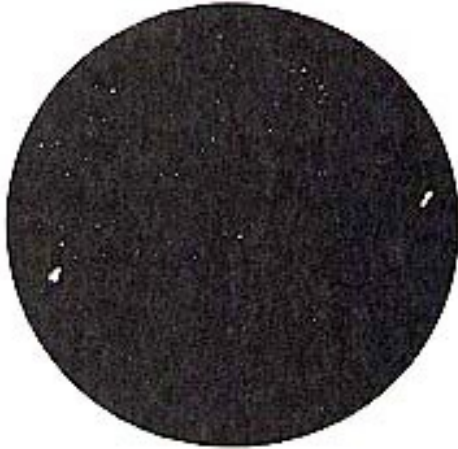
console and program tapes for PDP-1 (Computer History Museum)



Spacewar!

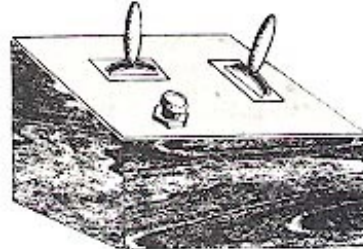
The first computer game, created on the PDP-1

<http://www.atarimagazines.com/cva/v1n1/spacewar.php>



The Starting Position.

The ships are in the centers of diagonally opposite quadrants. The vee of stars at top center is the horns of Taurus. You should be able to pick out the stars of Orion at the left (the bright star just above the wedge-ship is Rigel).



The original control boxes looked something like this. The controls are a) right-left rotation, b) acceleration (pulled back) and hyperspace (pushed forward), and c) torpedo button.

PDP-8



- True success for DEC followed with the introduction of the famous PDP-8 in 1965
 - under the leadership of C. Gordon Bell
 - the first to be called a minicomputer
 - taken from miniskirt?
 - 50,000 units would be sold
 - weighed 250 lbs.
 - Initially priced at \$18,000
- the first computer that was regularly purchased by a handful of end users as an alternative to using a larger system in a data center
- far simpler architecture than mainframes

PDP-8 and PDP-11



Digital Tidbits



- 1965 - \$15 million in revenues (876 employees)
- 1970 - \$135 million in revenues (5,800 employees)
- DEC was shipping as many PDP-8s as IBM was of 360s
- Digital would also produce the popular 32-bit VAX computer family
- The first versions of the C programming language and the UNIX system ran on Digital's PDP series of computers
- At its peak in the late 1980s, Digital was the second-largest computer company in the world, with over 100,000 employees.
- Later acquired by Compaq, which subsequently merged with Hewlett-Packard.

J.C.R. Licklider



- 1915-1990
- In 1950, Licklider moved from Harvard to MIT
 - Wrote his famous paper *Man-Computer Symbiosis* in 1960, which outlined the need for simpler interaction between computers and computer users.
 - <http://memex.org/licklider.pdf>
 - The earliest ideas of a global computer network were formulated by Licklider at MIT in August 1962
 - *The Computer as a Communications Device* (w/ R.W. Taylor)
- In October 1962 Licklider was appointed head of the DARPA information processing office
 - set up initial funding that led to the Internet years later
- In 1968, he became director of Project MAC at MIT

Project MAC



- A research laboratory, started at MIT in 1963 with initial funding from a two-million-dollar DARPA grant.
- Project MAC's major founders – Robert Fano, Fernando J. Corbató, John McCarthy, and Marvin Minsky The acronym "MAC" is glossed variously as
 - **M**ultiple **A**ccess **C**omputer
 - **M**achine **A**ided **C**ognition
 - **M**insky **A**gainst **C**orby (in later years)
- Project MAC envisioned the creation of a "computer utility"
 - computer utility - as reliable as source of computational power as the electric utility was a source of electrical power.

Multics



- Initial planning and development for Multics started in 1964.
- Corbató brought the first computer time-sharing system, CTSS, with him from the MIT Computation Center
- One of the early focuses of Project MAC would be the development of Multics, a successor to CTSS.
- Multics was to be the first high availability computer system
 - Developed as a part of an industry consortium including General Electric and Bell Laboratories.
 - In 1970 GE's computer business, including Multics, was taken over by Honeywell.

UNIX



- Bell Labs dropped out of Multics in 1969
- The UNIX operating system is produced in 1970 by Ken Thompson & Dennis Ritchie of Bell Labs who had worked on Multics
 - This project was called UNICS, short for Uniplexed Information and Computing System
 - The name has been attributed to Brian Kernighan, as a pun on Multics.
 - The name was later changed to UNIX.



UNIX (cont'd)

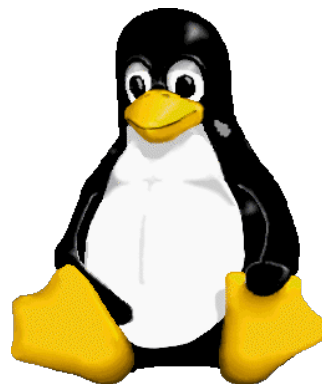
- Rewritten in C in 1973 to be more portable
- UNIX Variants:
 - BSD – University of California at Berkeley
 - SunOS – Sun Microsystems
 - Xenix – Microsoft Corporation
 - LINUX - written as a hobby by Finnish university student Linus Torvalds, who was attending the University of Helsinki in 1991
 - free software
 - open-source software
- UNIX was the one of the most popular operating systems of the 1970s and 1980s



Logos



The BSD Daemon



The LINUX Penguin

Computer Memory Revisited



- From the 1970s to the 2000s, many new devices were invented to increase the operating memory and archival storage of a computer.
- New inventions:
 - floppy disk
 - hard drive
 - removable disk
 - compact disc
 - flash drive

8" Floppy Disks

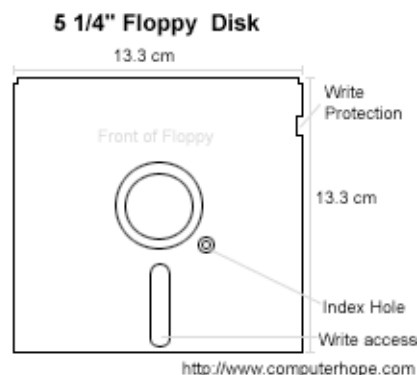


- 1971 – IBM uses 8" read-only floppy disk for the System 370 that holds 80KB
 - invented by Alan Shugart, an IBM engineer
- 1973 – IBM uses 8" read-write floppy disks for the IBM 3740 Data Entry System
 - Each disk holds 256KB
 - CP/M originally shipped on 8" floppy disks
 - 8" diskettes eventually were improved to 800KB



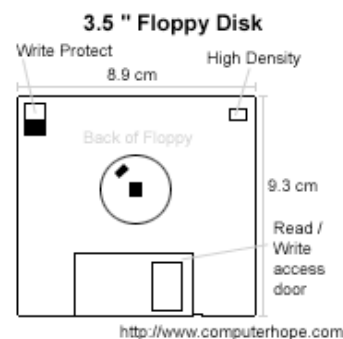
5 1/4" Floppy Disks

- 1976 – Reportedly, An Wang suggests that the floppy size is too big and feels a better size would be the size of a napkin (5 1/4")
 - Initially manufactured by Shugart Associates
 - Single-density (160KB)
 - Double-density (360KB)
 - Double-Sided High Density (1.2MB)



3 1/2" Floppy Disks

- A number of solutions were developed, with drives at 2", 2 1/2", 3" and 3 1/2" all being offered by various companies.
- In 1984, Apple Computer selected the Sony 3 1/2" format (90 mm) for their Macintosh computers
 - Double-Density (720KB)
 - High-Density (1.44MB)
- The end of the diskette?
 - 1998 – Apple I Mac
 - 2003 – Dell computers



Hard Disk Drive



- A **hard disk** uses rigid rotating magnetic platters.
- RAMAC (developed in the mid 1950s by IBM)
 - Occupied the space of two refrigerators and weighed a ton.
 - Stored those 5 million characters on 50 hefty aluminum disks coated on both sides with a magnetic iron oxide.
 - In February 1954, a team in San Jose successfully transferred data from cards to disks and back.
 - In September 1956, RAMAC was featured as the IBM 355,
- Most of the world's hard disks are now manufactured by just a handful of large firms: Seagate, Maxtor, Western Digital, Samsung, and the former drive manufacturing division of IBM, now sold to Hitachi.

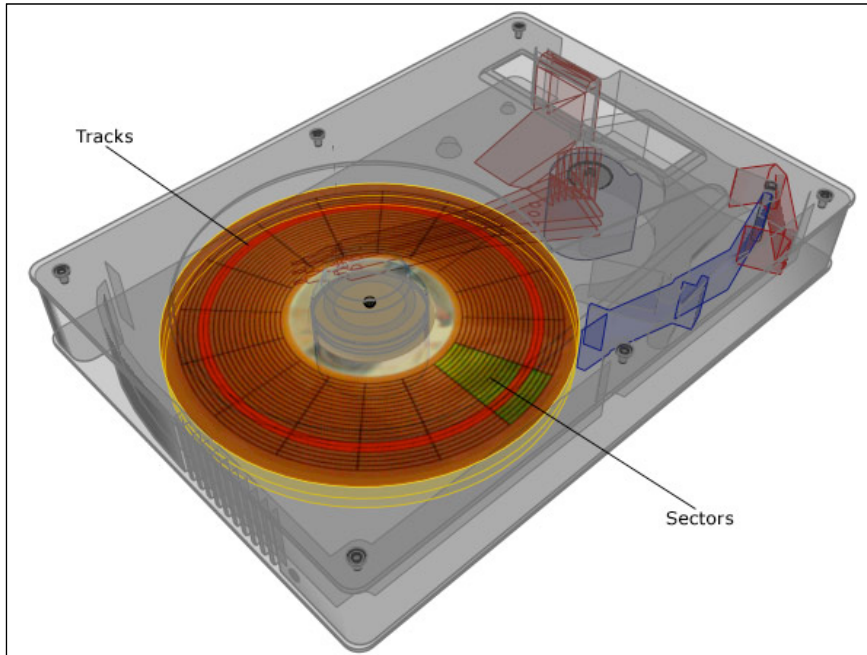
Hard Disk Drive



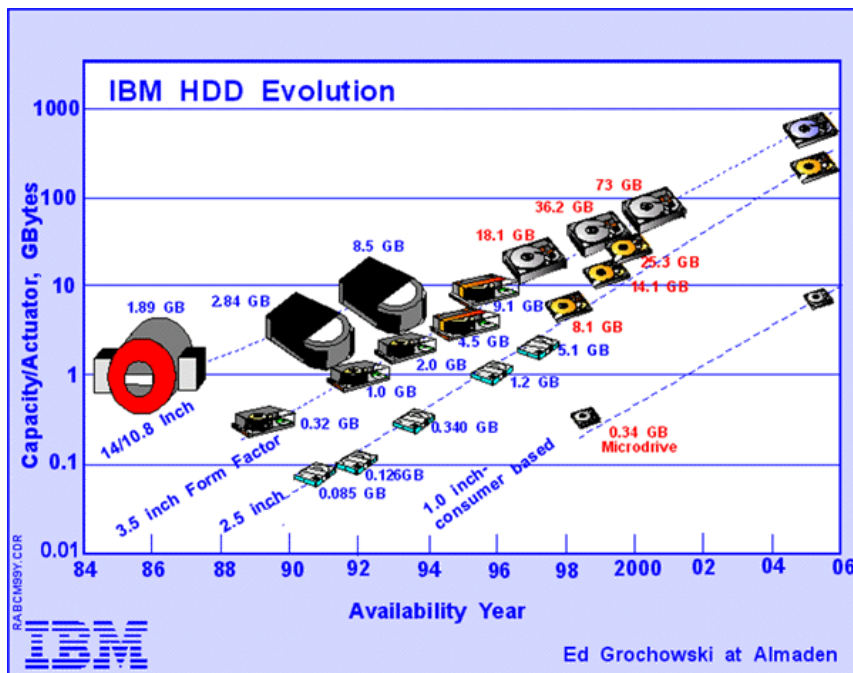
An air traffic controller is reflected in the cover of the IBM 355 Disk Storage unit, part of an IBM RAMAC 650 data processing system at the Indianapolis air route traffic control center in November 1959 to aid the U.S. Federal Aviation Agency in keeping tabs on an increasing volume of daily flights. The disks held a reservoir of data, including geographical locations of airways and beacons, reference tables and a complete record of flight plans. The information was constantly updated and instantly available for automatic computations and for reference by controllers. Capacity of the disk memory was six million digits. (IBM Archives)

Hard Disk Drive

from LinuxPlanet



Hard Disk Drive Evolution



Other Drives

- The Iomega Zip drive was a removable disk storage system in late 1994.
 - Capacity: 100MB, 250MB and later 750MB.
 - Popularity fades around the year 2000.
- A keydrive is a small removable data storage device that uses flash memory and a USB connector.
 - Invented in 1999-2000 by M-Systems & IBM
- The CD-ROM is a non-volatile optical data storage medium using the same physical format as audio compact discs.
 - Capacity: 700MB



DECTalk (1983)

- DECTalk was a new type of output device, it accepted ASCII text from an RS232C terminal port and spoke the text rather than printing it.
- It was the first such device offered by any major computer manufacturer.



Entertainer Stevie Wonder introduced DECTalk at Park Plaza Hotel in Boston.
(Digital Computing Timeline)



The VAX series

- VAX-11/780 introduced in 1977 by Digital
- VAX = Virtual Address eXtension
- Its architecture was designed to alleviate the PDP-11's most severe limitation: an address space that was too small for many applications.
 - The VAX increased the address from 16 to 32 bits.
 - The number of general registers also doubled from 8 to 16.
 - The instruction set had both two and three operand formats for many common operations with either a register or memory operand allowable.
 - VAX was an example of a CISC (Complex Instruction Set Computer)

The VAX series



VAX-11/780 (Digital Computing Timeline)



VAX-11/750 introduced in 1980 - the industry's first Large Scale Integration (LSI) 32-bit minicomputer. (Digital Computing Timeline)

The RISC Revolution



- RISC (Reduced Instruction Set Computer)
 - a technology that has revolutionized the computer architecture industry by increasing performance while reducing costs.
 - John Hennessy – Stanford University
 - In 1984, he cofounded MIPS Computer Systems, now MIPS Technologies, which produces microprocessors.
 - former President of Stanford University
 - David Patterson – UC Berkeley
 - Led the design and implementation of RISC I
 - This research became the foundation of the SPARC architecture



Sun and the SPARC



- Incorporated in 1982 with 4 employees
- 1985 – Sun begins work on its SPARC processor
 - SPARC = Scalable Processor ARChitecture
 - RISC (Reduced Instruction Set Computer)
- 1987 - introduces its first SPARC-based system, the Sun-4/260, with 10 MIPS performance.
- 1989 – first SPARC workstation introduced
 - rated at 12.5 MIPS 20-MHz, 1.4 MFLOPS, for a base price of US \$9000.
- 1991 – Sun becomes leader in RISC workstations with 63% of market
- Sun is bought by Oracle in 2010

Sun Workstations



Sun SPARCstation 2



Sun Ultra 5

Digital's Alpha



- Alpha was a totally new, open, 64-bit RISC architecture, engineered to support multiple operating systems and designed to increase performance by a factor of 1000 over its anticipated 25-year life.
- The first Alpha chip was the 21064, which provided a record-setting 200-MHz performance.
- Alpha was a commercial failure. Digital's reign at #2 was over.

