Rorabaugh, Tyler L.

Technical Analysis of Early PCs and DOS

Overview

- Analysis of early PCs:
  - Hardware
- Analysis of DOS:
  - Software
- Impacts on Modern Technology:
  - Operating Systems
  - Computer Hardware

Goals:

- Learn about early PCs and DOS:
  - Historical Interest
  - Appreciation of Modern PCs and APIs

The PC:

- IBM PC, Low Cost
  - PC [5150] – 1981
  - XT [5160] – 1983
  - AT [5170] – 1984
- Open Standards, Popularity:
  - Third Party Devices
  - Third Party Software
- Compatible Clones
  - Helped establish popularity

PC Hardware: Processors

- 8088
  - Same as 8086 but 8 bit data bus
  - Used in IBM PC and XT
  - 8087 optional FPU
- 80286
  - Used in IBM AT
  - Faster, memory management, access more memory
  - Features not used like expected

PC Hardware: Memory

- IBM PC
  - 16KB – 256KB, Expansion cards
  - BIOS used 8KB
- IBM XT
  - 64KB – 1MB, Expansion cards
  - BIOS used 384 KB
- IBM AT
  - Up to 16MB, 80286 address space

PC Hardware: Drives

- Low Budget
  - Tape drives
  - Floppy drive
- Floppy Drives Very Popular
- IBM PC
  - Up to 2 5.25″ single sided floppy drives
- IBM XT
  - Up to 2 5.25″ double sided floppy drives
  - 10MB hard drive
- IBM AT
  - Up to 2 5.25″ high density floppy drives
  - 20MB hard drive

PC Hardware: IO

- Keyboard
  - Very good keyboard -> popularity
- Monitor
  - Color Monitor
  - MDA – Text mode only
  - CGA – Text and graphics
  - EGA – Text and higher resolution graphics
- Serial and Printer Ports
  - Modems
  - Mice
  - Printers
- Expansion Cards:
  - Joysticks
  - Cash Drawers
  - Special Machinery

PC: Limitations

- Memory
  - Little available to programmer
    - Cost and address space
  - Fixed with expansion cards and 80286
- Storage Capacity
  - Hard drives quite expensive
  - Fixed with IBM XT
- Graphics:
  - Limited Resolutions and Colors
- Multi-Tasking & Memory Management
  - 8088 – No Support
  - 80286 – Added support, not backwards compatible -> not used

The Disk Operating System

- Root is CP/M
- Lightweight Single-Task Single-User Program Loader
- IBM asked Microsoft for OS
- Microsoft sourced 86-DOS from Tim Patterson
- Modified into MS-DOS
- Licensed PCDOS to IBM

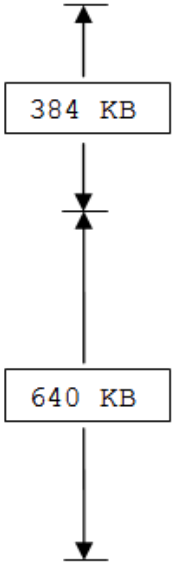
DOS: Boot Process

- POST [Started by PC BIOS]
- ↓
- ROM Boot Loader [PC BIOS]
- ↓
- Disk Boot Loader [First Sector of Disk]
- ↓
- Extra BIOS Code [IO.SYS]
- ↓
- SYSINIT Code [IO.SYS]
- ↓
- MSDOS.SYS [DOS kernel]
- ↓
- CONFIG.SYS [Settings and Drivers]
- ↓
- COMMAND.COM [Shell]

DOS: Memory Management

- Conventional Memory (640KB)
  - Kernel [MSDOS.SYS]
  - Applications
- Upper Memory Area (384KB)
  - Video Memory
  - BIOS Extensions
  - System ROM BIOS
- Loading High

DOS: Memory Management



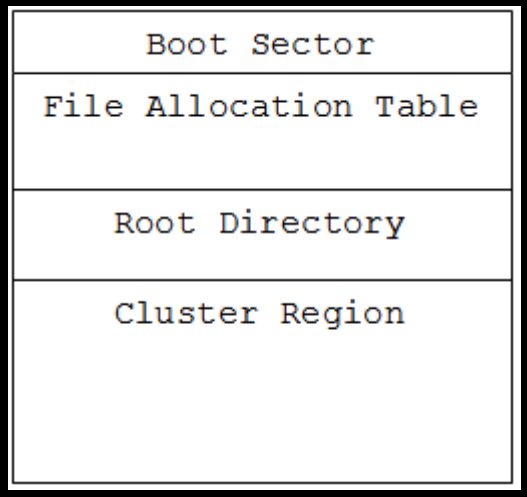
	Segment	Description
Upper Memory Area	0xF0000	System ROM BIOS
	0xE0000	BIOS Expansion, EMS Page Table 2
	0xD0000	BIOS Expansion, EMS Page Table 1
	0xC0000	BIOS Expansion
	0xB0000	Video Memory, CGA, MDA
	0xA0000	Video Memory, EGA
Conventional Memory	0x90000	Application Space, Shell (COMMAND.COM)
	0x80000	Application Space
	0x70000	Application Space
	0x60000	Application Space
	0x50000	Application Space
	0x40000	Application Space
	0x30000	Application Space
	0x20000	Application Space
	0x10000	Application Space
	0x00000	Kernel (MSDOS.SYS), Application Space

DOS: Memory Management

- Free Memory - Arena Entries
  - Headers chained together for searching
  - Essentially Dynamic Partitioning
- .COM
  - Raw binary
  - Max memory given at start
- .EXE
  - Has header telling DOS how much memory is needed
- Memory Requests
  - DOS functions

DOS: File Management

- FCB
  - Legacy for CP/M programs
  - No Directories
- FAT
  - Clusters
    - Basic block of data
  - File Allocation Table
    - Index table for clusters
    - Cluster Chaining
  - Directory Tables
    - Cluster #s
    - Name, Attributes



DOS: File Management

Cluster	Value	Description
0000	0001	File 1, Part 1
0001	0002	File 1, Part 2
0002	FFFF	File 1, End
0003	0005	File 2, Part 1
0004	FFFE	Bad Cluster
0005	0006	File 2, Part 2
0006	FFFF	File 2, End
0008	FFFD	Reserved Cluster
0009	FFFF	File 3, End

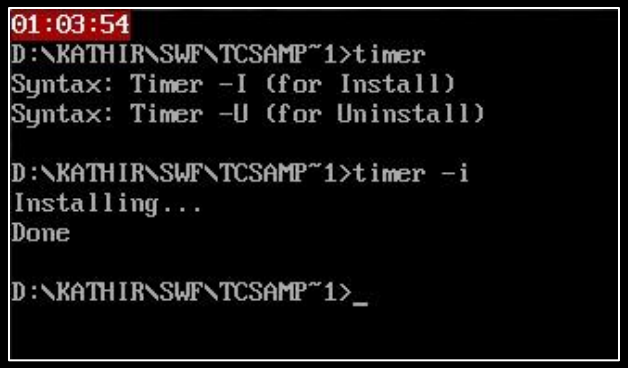
DOS: IO

- Basic Devices – BIOS
  - Keyboard, Screen, Drives
  - Software Interrupts
  - Available to DOS and programs
- Additional Devices – CONFIG.SYS
  - Loaded at startup

DOS: API

- Basic functions:
  - File access
  - Starting another program
  - Memory allocation
- Similar to BIOS function calls
  - Software interrupts
- Very primitive compared to today:
  - Limited libraries - programmers wrote their own for every program

DOS: Limitations



- No Multi-Tasking
  - TSRs were closest functionality
- One User
  - Original design was simple program loader
- No Security
  - Files only protected by attributes
    - System
    - Hidden
    - Read Only
- Limited API
  - No Common Libraries

Impacts: Windows

- PC
  - PC is only as good as its OS
  - PC grew out of DOS into Windows
  - PC popularity -> Windows popularity
- DOS
  - Early Windows built on MS-DOS
  - Early Windows were first graphic shells for DOS
  - Windows 3.x & 9x loaded with DOS

Impacts: FAT

- DOS and Windows made FAT very popular
- Floppy drives in PC
  - PCs made floppy disk popular
  - Removable drive implies inter-system data exchange
  - FAT was the answer to data sharing
- FAT now standard for camera storage
- FAT used in Flash Drives and SD cards
- Most OSs can read FAT drives

Impacts: x86 Architecture

- PC and DOS rose in popularity
  - More hardware and software targeted at PC
  - Intel created better processors with new features
- Backward compatibility is important
  - All x86 processors are backward compatible
  - Consumer can always run old software on new machine
  - Keeps consumers happy, thus reinforcing popularity

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