

Introduction to Operating Systems

Andre M. Maier, DHBW Ravensburg
dhbw@andre-maier.com

Lecture Information

- Lecture notes
 - All material is provided in the related Moodle course room
- Recommended literature
 - Andrew S. Tanenbaum: “Modern Operating Systems”, 4th ed, Pearson 2014
- Lab Requirements
 - PC or Laptop
- Final exam
 - Written exam, mostly multiple choice, 90 mins, non-programmable calculator allowed
- Contact
 - dhbw@andre-maier.com

Remote Lectures

- Mute your microphone when you're not speaking to avoid unnecessary background noise.
- Do not multitask.
- Recording of the lecture and any other class activity are strictly prohibited. This includes both video and audio, as well as screenshots.
- Use the chat in the related Moodle course room.
- Regular breaks will be taken during each lecture.

Survey

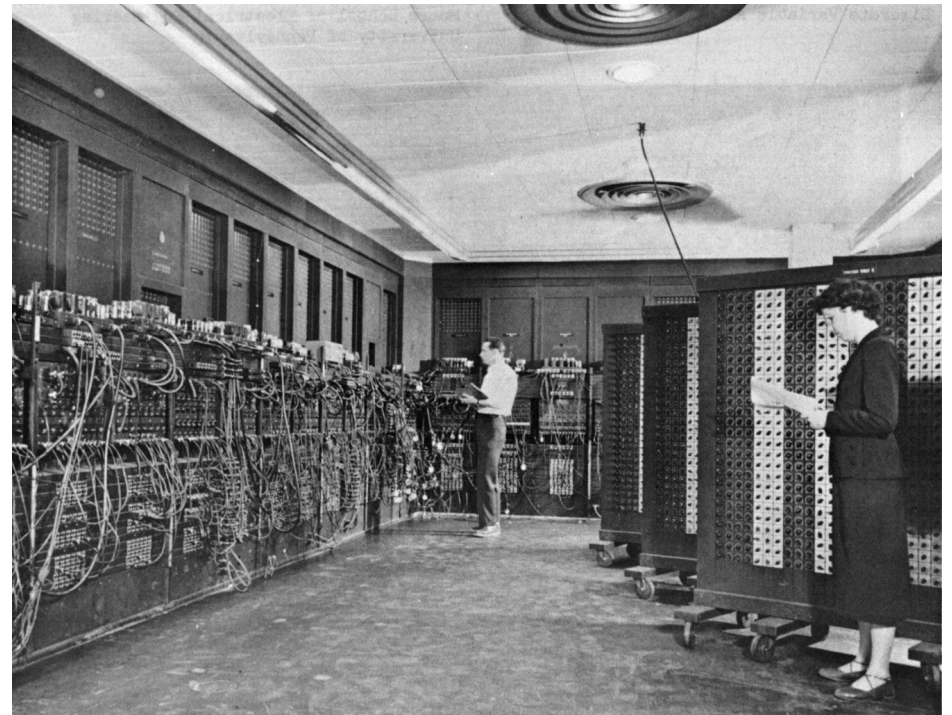
- Go to the related Moodle course room.
- Take the quick survey.

What is an Operating System?

- “An Operating System is a set of programs that enables multiple users to concurrently use a computer system in an efficient and convenient way.”
- Definition has changed over time in history
- ISO/IEC 2382:2015 (previously DIN 44300)
- Operating Systems provide two main functions: **abstraction** and **resource management**

History of Operating Systems (1)

- ENIAC
 - **E**lectronic **N**umerical **I**ntegrator **A**nd **C**omputer
 - Designed in 1945 by Eckert and Mauchly (University of Pennsylvania)
 - calculated a trajectory in 30 seconds that took a human 20 hours
 - 20,000 vacuum tubes
7,200 crystal diodes
1,500 relays
 - Weighed 30 tons
 - Consumed 150 kilowatts of power

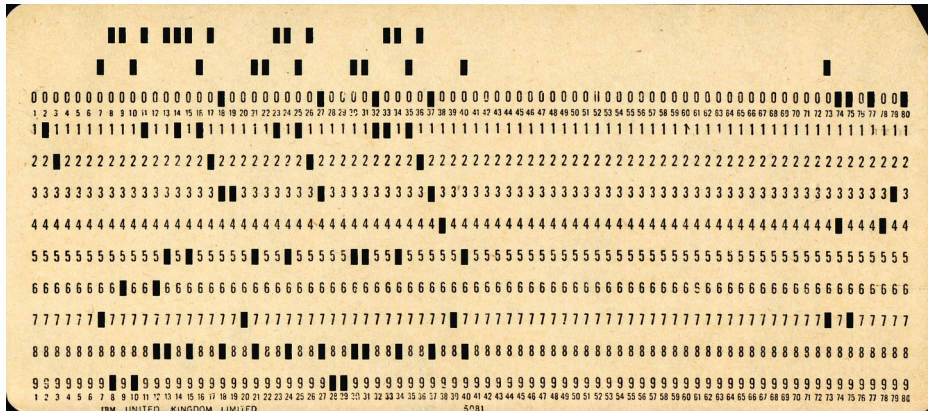


ENIAC, photograph by the U.S. government, public domain

History of Operating Systems (2)

- 1940 - 1955 (1st generation)
 - “The dawn of machine computing”
 - Programmers used plug boards or manually loaded their programs via card decks.
 - Programs were “written” in machine language
 - One single user, purely consecutive activities in the workflow
 - Irrelevant response time
 - *“I think there is a world market for maybe five computers”
(Thomas Watson, chairman of IBM, 1943)*

History of Operating Systems (3)



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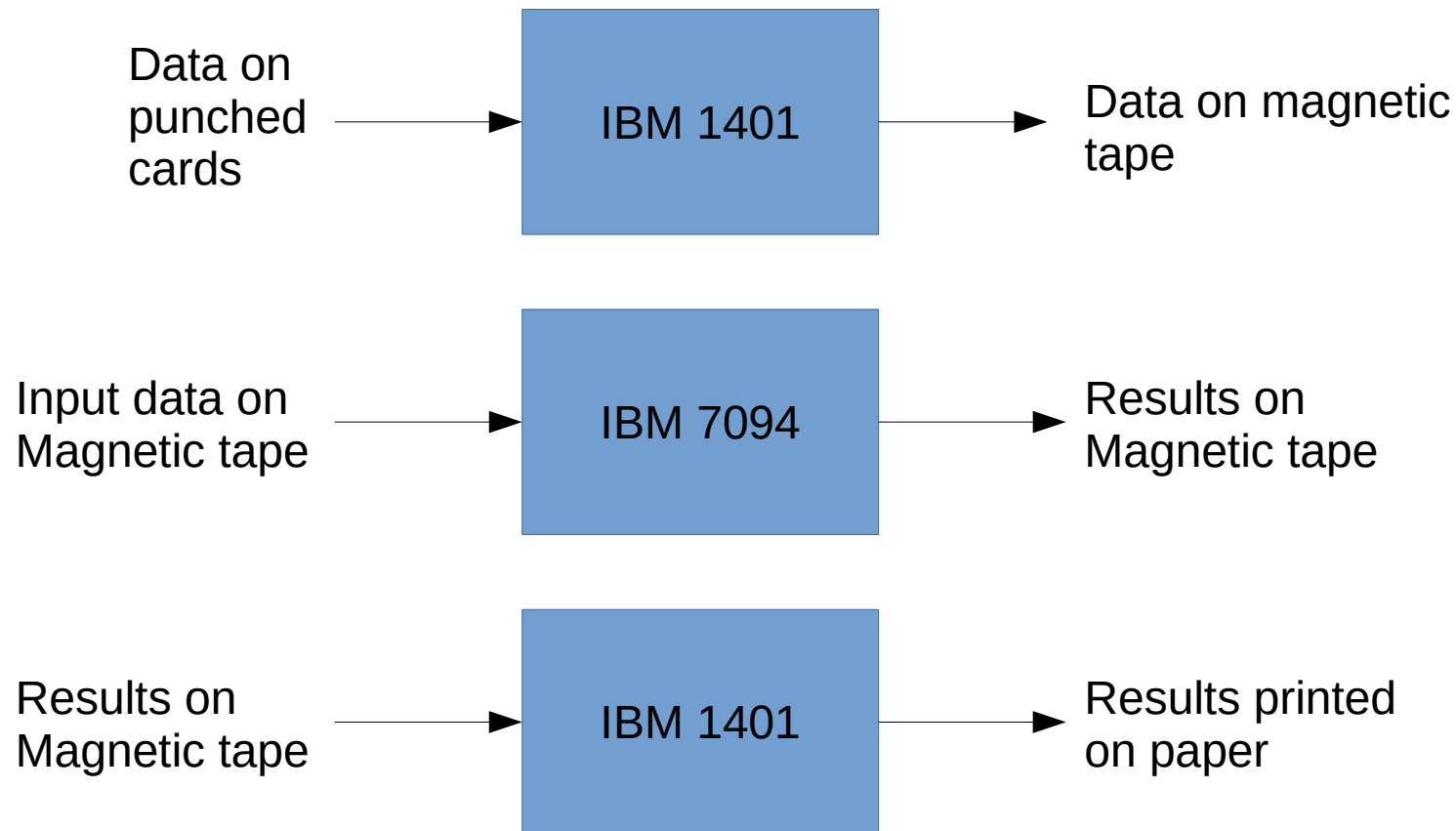
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History of Operating Systems (4)

- 1955 - 1965 (2nd generation)
 - The era of mainframes
 - Programming languages
 - Assembler
 - FORTRAN
 - Computers are expensive
 - Need for efficient use of the hardware
 - Solution: batch systems

History of Operating Systems (5)

- Example of an early batch system



History of Operating Systems (6)

- 1965-1980 (3rd generation)
 - IBM 360 product line, OS/360
 - First major computer line to use ICs
 - Improvement of I/O operations
 - Spooling (Simultaneous Peripheral Operation On Line)
 - Need for multiprogramming
 - Memory partitioning
 - Need for quicker response time
 - Timesharing (CTSS, MULTICS)
 - Growth of minicomputers
 - DEC PDP-1, PDP-7, PDP-11
 - UNIX

History of Operating Systems (7)

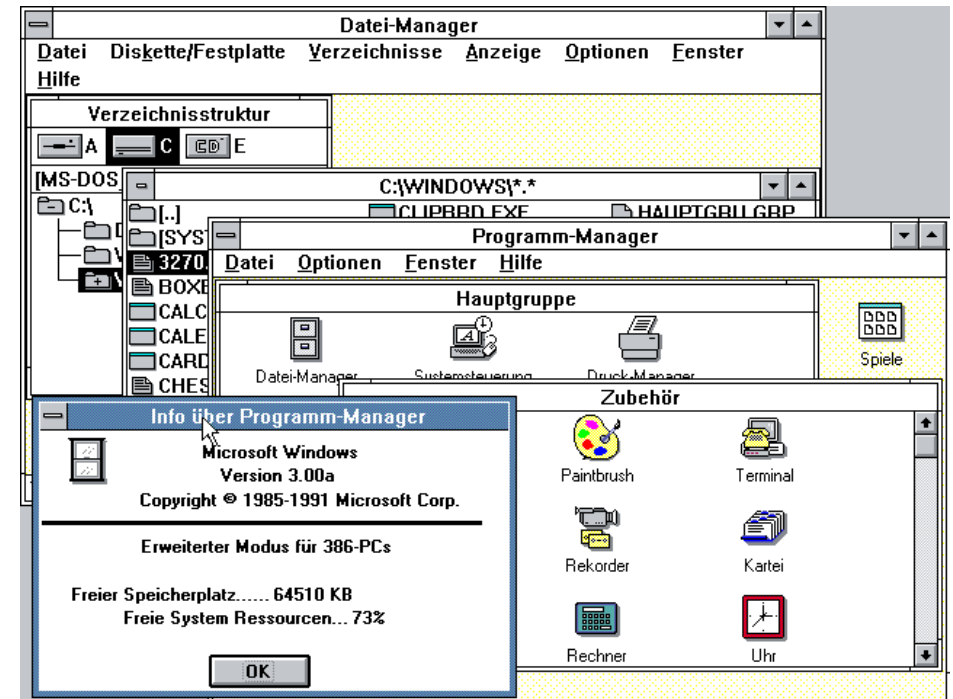


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History of Operating Systems (8)

- 1980-today (4th generation)
 - Development of Large Scale Integration circuits
 - Computers become smaller and cheaper
 - Personal Computers
 - CP/M in 1974
 - MS-DOS in 1981
 - Need for user-friendliness
 - Macintosh System 1 in 1984
 - Microsoft Windows in 1985
 - Increasing number of hardware manufacturers

History of Operating Systems (9)



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Windows 3.0 Screenshot, public domain

History of Operating Systems (10)

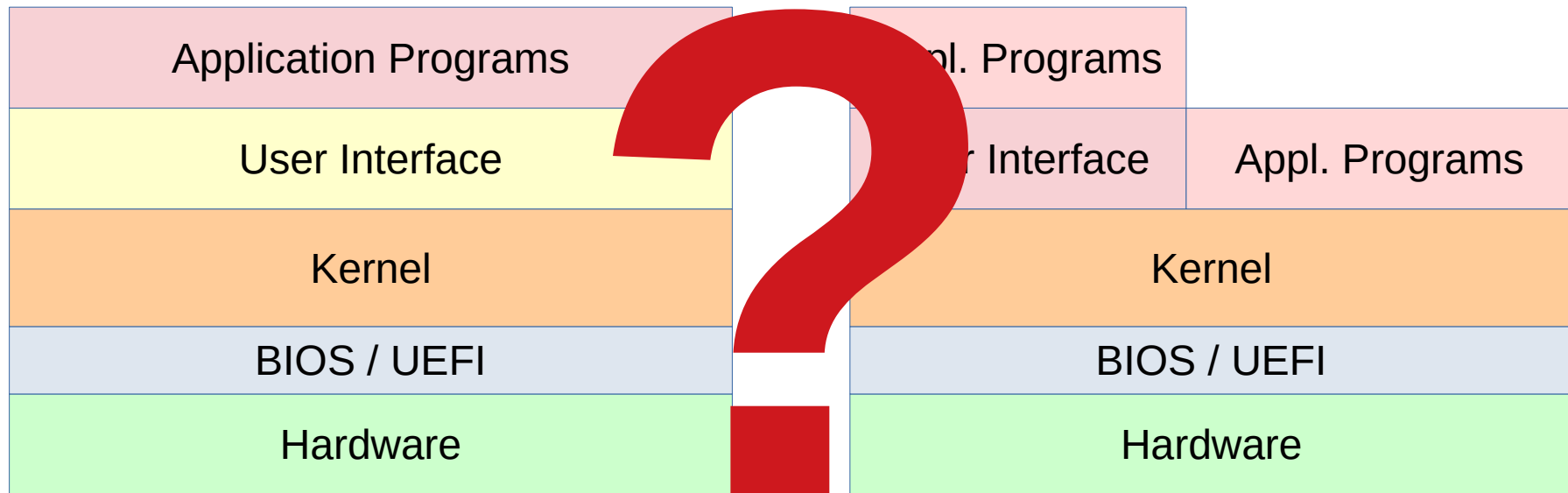
- 1990-today (5th generation)
 - Smaller and cheaper mobile phones
 - Nokia Communicator in mid-1990s
 - Phone + PDA
 - Integrated voice and data networks
 - Apple iPhone in 2007
 - Android in 2008

History of Operating Systems (11)



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Placement of Modern Operating Systems



BIOS = Basic Input Output System
UEFI = Unified Extensible Firmware Interface
GUI = Graphical User Interface
CLI = Command Line Interface

General Characteristics of an OS

- Purpose
 - Self-organization of computer systems.
- Approach
 - Abstraction from any specific hardware
 - Number of processors and cores
 - Size of main memory (RAM)
 - Connected devices (e.g. hard drives, keyboard, mouse)
- Objective
 - To utilize processing power and peripherals as efficiently as possible.
 - To run programs as independently from any underlying hardware as possible.

Components of an Operating System (1)

- Abstract processor architecture
- Process management
 - Concurrency
 - Threads
 - Scheduling
 - Interaction between processes
- Process synchronization
 - Non-blocking techniques
 - Semaphores
 - Monitors
 - Synchronization errors

Components of an Operating System (2)

- Memory Management
 - Static memory allocation
 - Dynamic memory allocation
- Address spaces
 - Page swapping
 - Virtual addressing

Components of an Operating System (3)

- Exception handling
 - Signals
- Input / Output
 - Abstract devices
- File management
- User management
 - Security mechanisms

Lab Exercise

- Download and install a hypervisor software, such as
 - Oracle VM VirtualBox (Windows + macOS)
 - VMware Workstation Player (Windows + macOS)
 - Linux QUEMU/KVM (Linux)
 - Parallels (macOS)
- Set up a virtual machine running a Ubuntu Linux
 - <https://ubuntu.com/>