

# **Computers Programming**

## **Course 3**

### **Operating Systems**

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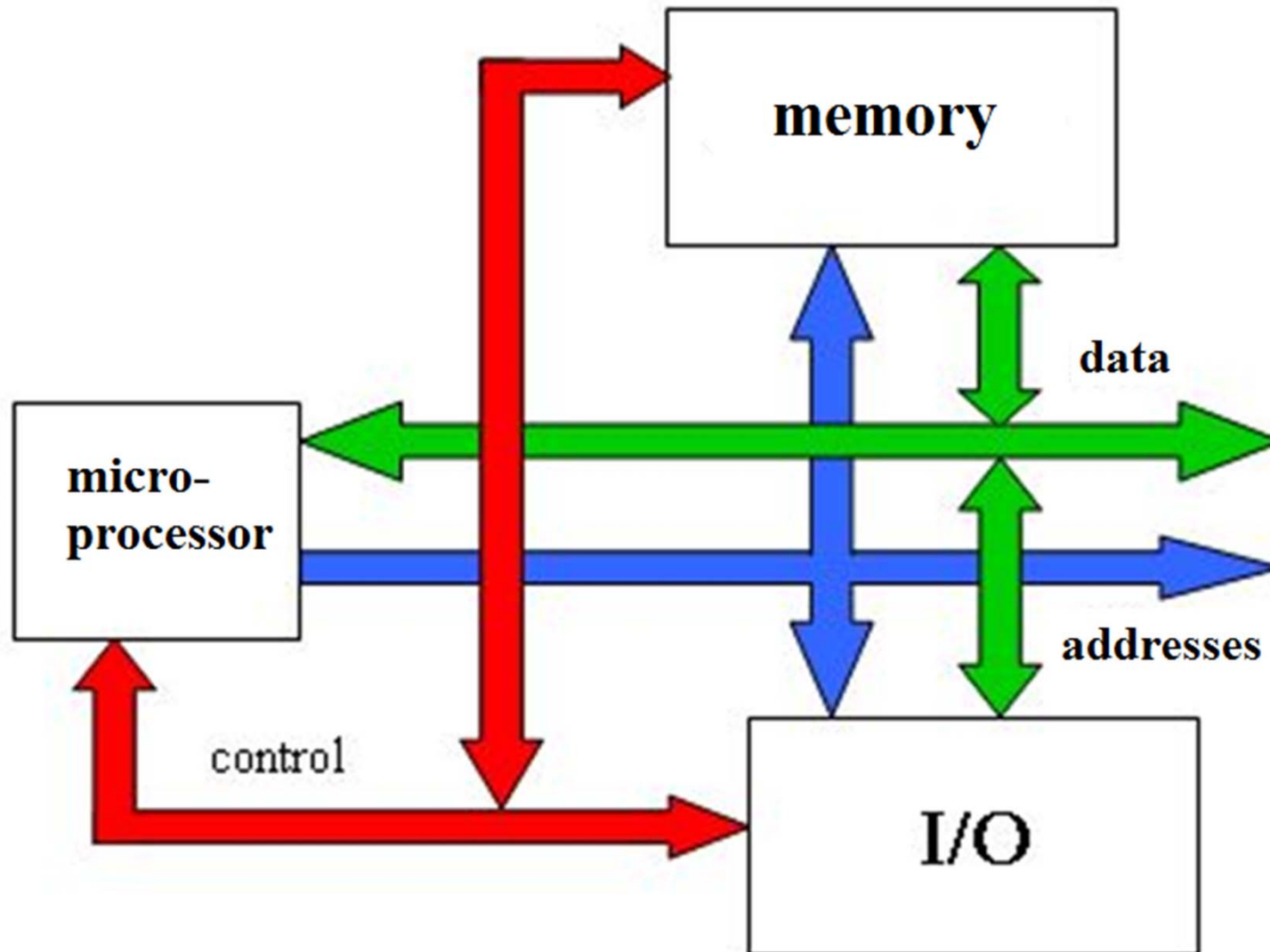
# Recap from previous course

## Basic PC Components

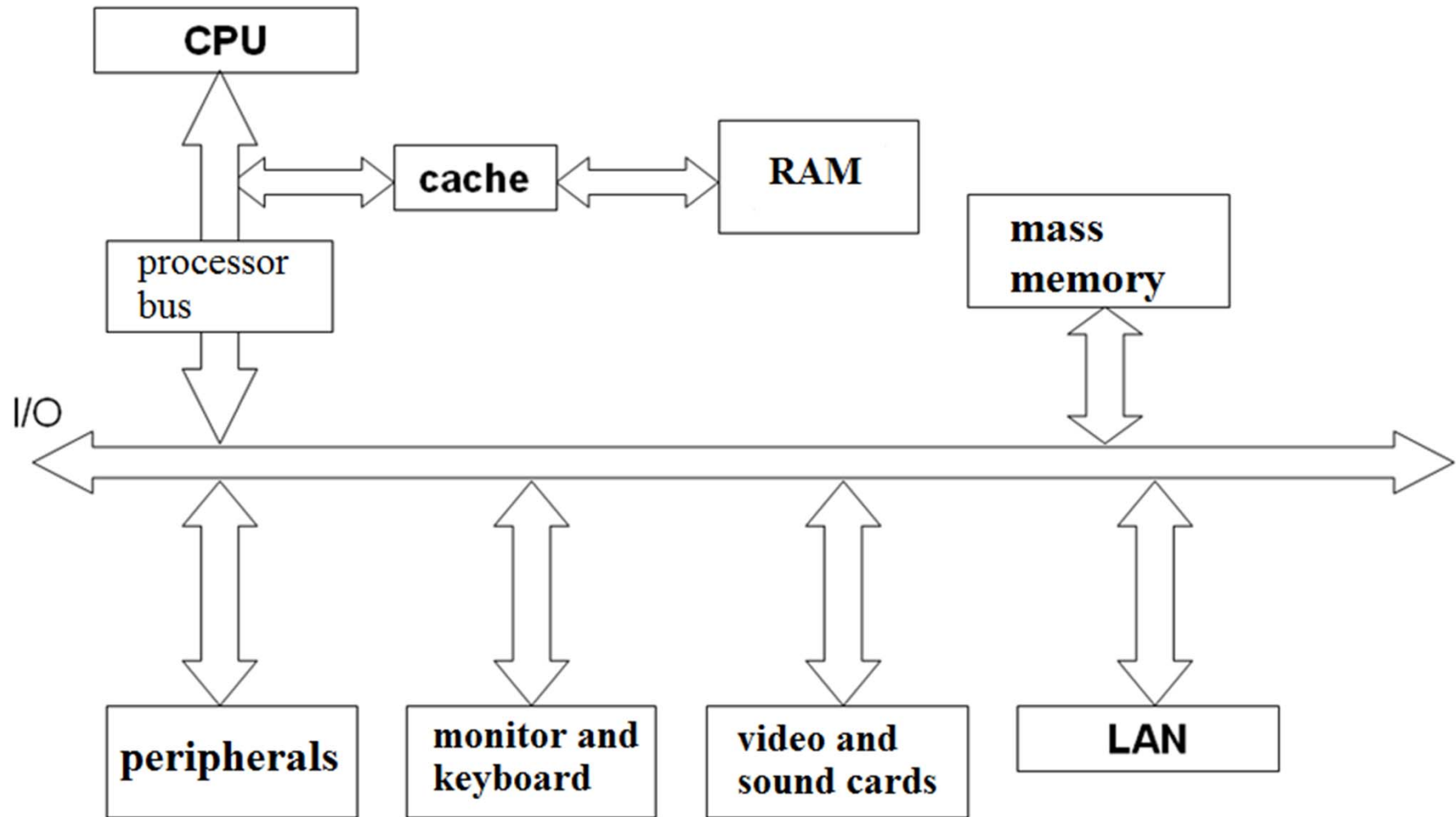
- **Motherboard:**
  - microprocessor
  - RAM memory, BIOS component
  - motherboard chipset
  - a wide variety of connectors
- **Power unit + PC box**
- **Input – Output Devices:**
  - keyboard ,
  - monitor,
  - video card,
  - HDD, etc.

# Recap from previous course

## The general structure of a computer system



## Recap from previous course



# Recap

## Example

- We were briefly presented a series of instruction categories for a generic 16-bit processor, which has 8 registers. Instructions are encoded on 16 bits (which means 6 octal numbers).

# Recap

- A series of 16 bits:

0 1 1 1 0 1 0 0 0 1 1 0 0 0 0 0

- Split in 6 octal numbers

0 / 111 / 010 / 001 / 100 / 000

- Equivalent with:

0 / 7 / 2 / 1 / 4 / 0

# Recap

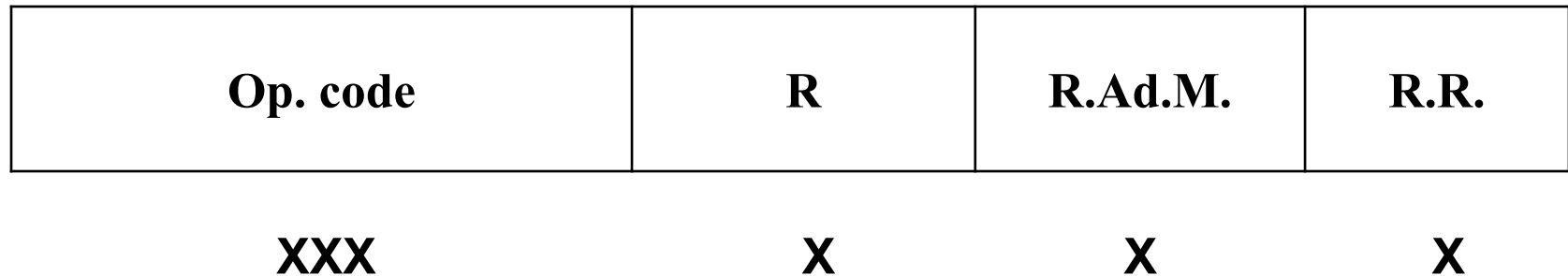
## Kinds of instructions

1) *Instructions with two operands in memory or registers*

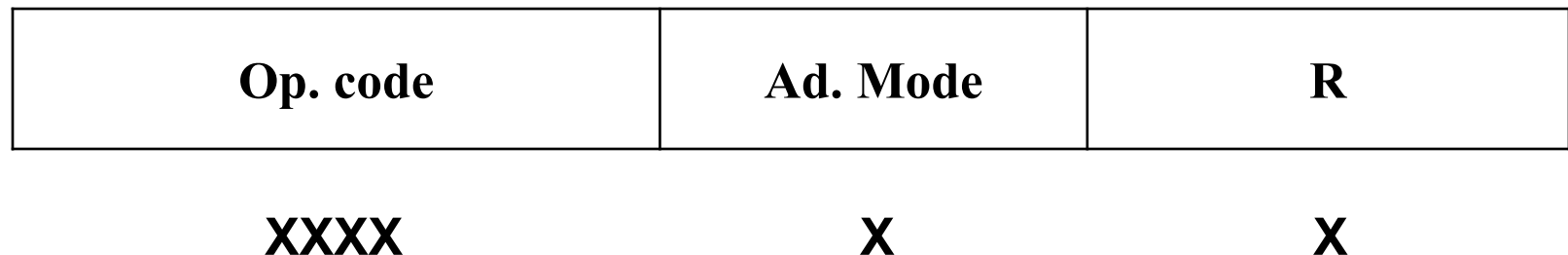
Op. Code	L.Ad.M.	L.R.	R.Ad.M.	R.R.
XX	X	X	X	X

$\langle \text{dest.} \rangle \leftarrow \langle \text{src.} \rangle \alpha \langle \text{dest.} \rangle$

2) *Instructions with an operand in registers and another operand in memory or registers*



3) *Instructions with only one operand in memory or registers*



**Etc.**

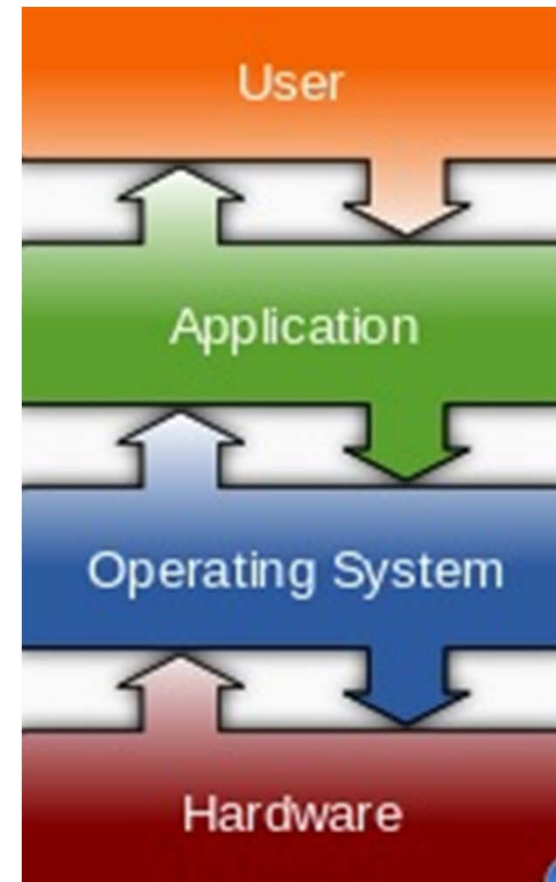


# Recap

direct addressing	Mode 0
indirect addressing through register	Mode 1
direct addressing with self-increment	Mode 2
indirect addressing with self-increment	Mode 3
direct addressing with self-decrement	Mode 4
indirect addressing with self-decrement	Mode 5
direct addressing with index	Mode 6
indirect addressing with index	Mode 7

# Operating Systems

- The operating system is an essential component in a computer.



# Definition:

**An operating system consist of a set of procedures that allow a user (or a group of users) to efficiently use (and eventually simultaneously use) the computing machine, which is available.**

# Main tasks of an OS:

1. Preparing and launching the programs;
2. Control the evolution of a running program;
3. Notification of exceptional events that may occur during execution;
4. Hardware resource allocation between different processes;
5. User/ programs' access to software resources;
6. Providing protection among programs, and between different software and the operating system;
7. Access control and security for information;
8. Providing techniques for communication between processes, and synchronization of these communications.

# OS Classification

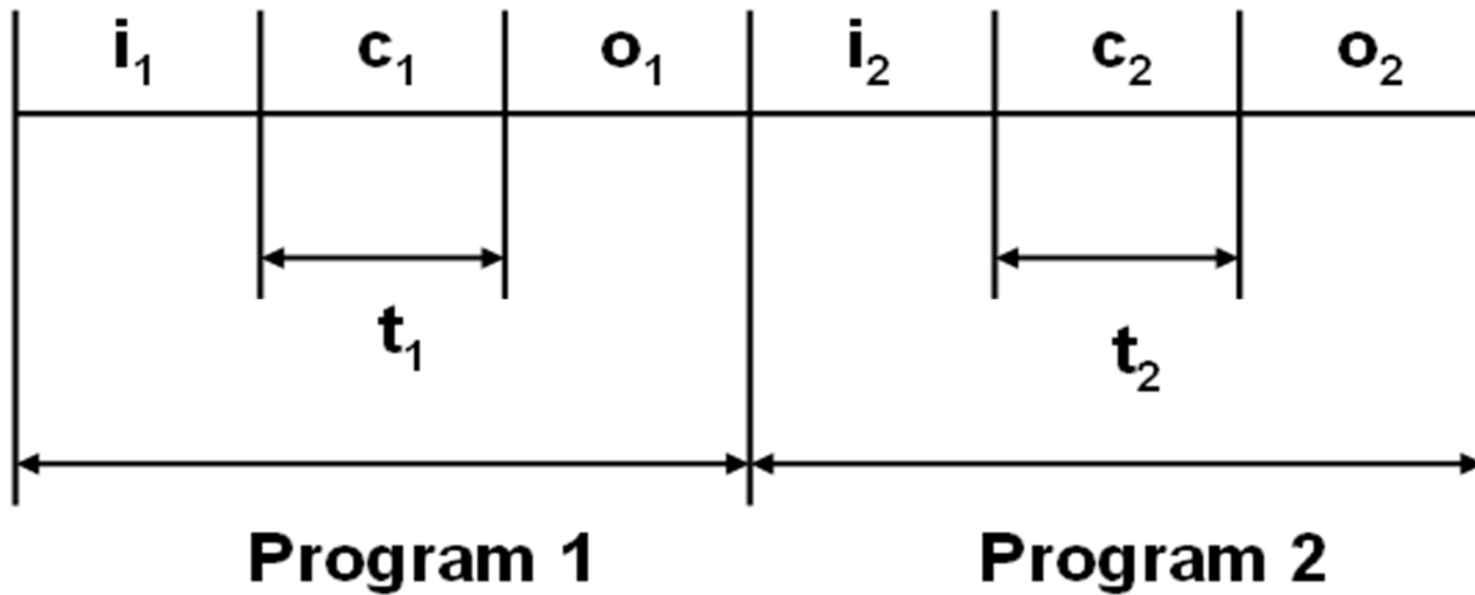
- **batch processing;**
- **multiprogramming;**
- **time sharing;**
- **multiprocessing.**

# **A. Batch Processing**

In this case, a program execution starts when the previous program is complete.

Phases of a program:

- i = input;
- c = computing;
- o = output.



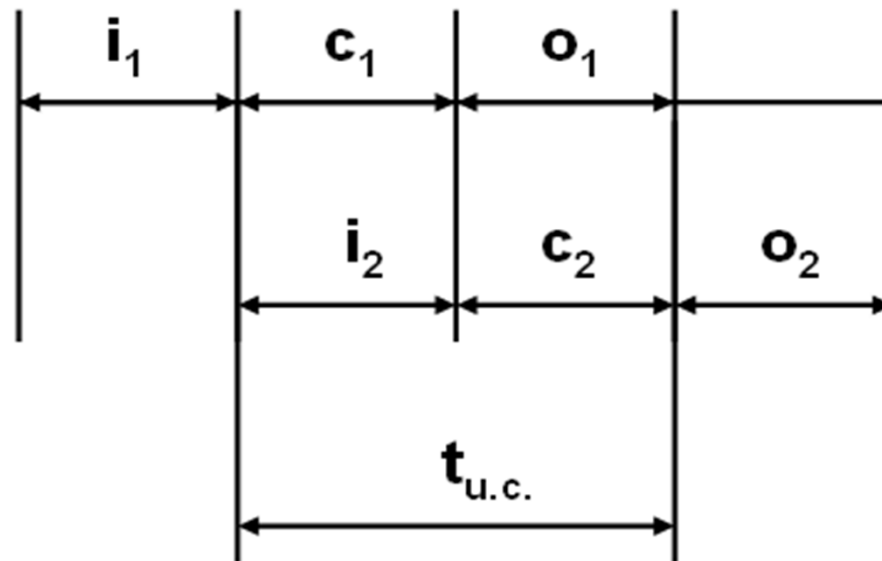
-  $t_1$  and  $t_2$  are times effectively used by computing unit.

Note:

The main disadvantage is that the computing unit is sporadically used.

## B. Multiprogramming

- In this case, the computer's RAM contains several executable programs. The activity of the computer is maintained especially with input-output operations.





## **C. Time Sharing**

- The time of computing unit is divided into slices (very tiny units of time) successively allocated to all users. This way, a relatively bigger program doesn't fully involve the computing unit for an interval of time.

## **D. Multiprocessing**

- Processing tasks are distributed to multiple processors /units that are working in parallel.

# Other classification considers the following operating systems:

- Real-time
- Multi-user
- Multi-tasking / single-tasking
- Distributed
- Embedded

# Real-time OS

- The main objective of real-time operating systems is their quick and predictable response to events.
- Usually, an real-time OS has an event-driven or time-sharing design and often aspects of both.
- An event-driven system switches between tasks based on their priorities or external events while time-sharing operating systems switch tasks based on clock interrupts.

In typical designs, a **task** has three states:

1. ***Running*** (executing on the CPU);
2. ***Ready*** (ready to be executed);
3. ***Blocked*** (waiting for an event, I/O for example).

Most tasks are blocked or ready most of the time because generally only one task can run at a time per CPU.

# Multi-user OS

- allows multiple users to access a computer system at the same time.
- time-sharing systems and Internet servers can be classified as multi-user systems as they enable multiple-user access to a computer through the sharing of time.
- single-user operating systems have only one user but may allow multiple programs to run at the same time.

# Multi-tasking OS

- allows more than one program to be running at the same time, from the point of view of human time scales.
- Multi-tasking can be of two types:
  - preemptive
  - cooperative

# Multi-tasking

- **preemptive multitasking** - the operating system slices the CPU time and dedicates one slot to each of the programs (UNIX, 32-bit versions of Windows, Mac OS X).
- **cooperative multitasking** is achieved by relying on each process to give time to the other processes in a defined manner (16-bit versions of Microsoft Windows, Mac OS prior to OS X).



# Distributed OS

- manages a group of independent computers and makes them appear to be a single computer.
- the development of networked computers that could be linked and communicate with each other gave rise to distributed computing.

# Embedded OS

- are designed to be used in embedded computer systems.
- are able to operate with a limited number of resources, being very compact and extremely efficient by design.
- Windows CE (*Windows Embedded Compact*) is an example of embedded operating systems

# Examples of most popular OS

- can be further classified as:
  - 8-bit operating systems (till '80)
  - 16-bit operating systems (till '90)
  - 32-bit operating systems (still in use)
  - 64-bit operating systems (becomes popular during last decade)

# CP/M

- CP/M ("**Control Program/Monitor**" becomes later **Control Program for Microcomputers**) was a popular operating system created for Intel 8080/85 based microcomputers by Gary Kildall of Digital Research, Inc.

# A minimal 8-bit CP/M system contains:

- A computer terminal using the ASCII character set
- An Intel 8080 (and later the 8085) or Zilog Z80 microprocessor
- At least 16 kilobytes of RAM
- A means to bootstrap the first sector of the diskette
- At least one floppy disk drive

# **Main components of CP/M**

- Basic Input/Output System (BIOS)
- Basic Disk Operating System (BDOS)
- Console Command Processor (CCP)
- Transient Program Area (TPA)

# BIOS

- directly controlled hardware components other than the CPU and main memory.
- provided the lowest level functions required by the operating system.
- BIOS is directly linked to the hardware platform.

# BDOS

- implemented the CP/M file system and some input/output functions
- the majority of the complexity in CP/M was isolated in the BDOS



# Console Command Processor (CCP)

- CCP accepted input from the keyboard and conveyed results to the terminal.
- The console would most often display the **A>** prompt, to indicate the current default disk drive.

# Transient Program Area (TPA)

- The read/write memory between address 0100 hexadecimal and the lowest address of the BDOS was the Transient Program Area (TPA) available for CP/M application programs.
- Although all Z80 and 8080 processors could address 64 kilobytes of memory, the amount available for application programs could vary, depending on the design of the particular computer.
- Some systems had more TPA memory available than others.



**MS-DOS gives you the only complete  
set of software tools for 16-bit systems.  
Now. From Microsoft.**

1981

# Microsoft

- April 1975 - the Microsoft company was founded by Bill Gates and Paul Allen
- Now is one of the world's largest software maker measured by revenues
- May 2011 Microsoft acquired Skype Technologies
- September 2013 - Microsoft acquired Nokia phone business

# MS-DOS

- Microsoft Disk Operating System is an operating system for x86-based personal computers.
- First version was based on **86-DOS** (Quick-and-Dirty Operating System or Q-DOS, a clone of CP/M) written by **Tim Paterson**.
- 1981 IBM PC
- 2000 – the last version (MS-DOS 8.0)

# What are the new features introduced by MS-DOS:

- Simple and clear interface
- Includes new techniques for error detection
- A complex program can be divided in small parts
- Efficient interface through COMMAND.COM (a command interpreter)
- The files and directories are organized in a tree structure
- The I/O devices can be easy connected to the system

# End of MS-DOS?

- embedded in Windows 95 up until Windows NT
- Windows XP contains a copy of the Windows Me boot disk, stripped down to bootstrap only. This is accessible only by formatting a floppy as an "MS-DOS startup disk".

# Basic components of MS-DOS

- BIOS
- BIO.COM & DOS.COM
- CONFIG.SYS
- COMMAND.COM
- AUTOEXEC.BAT



# UNIX

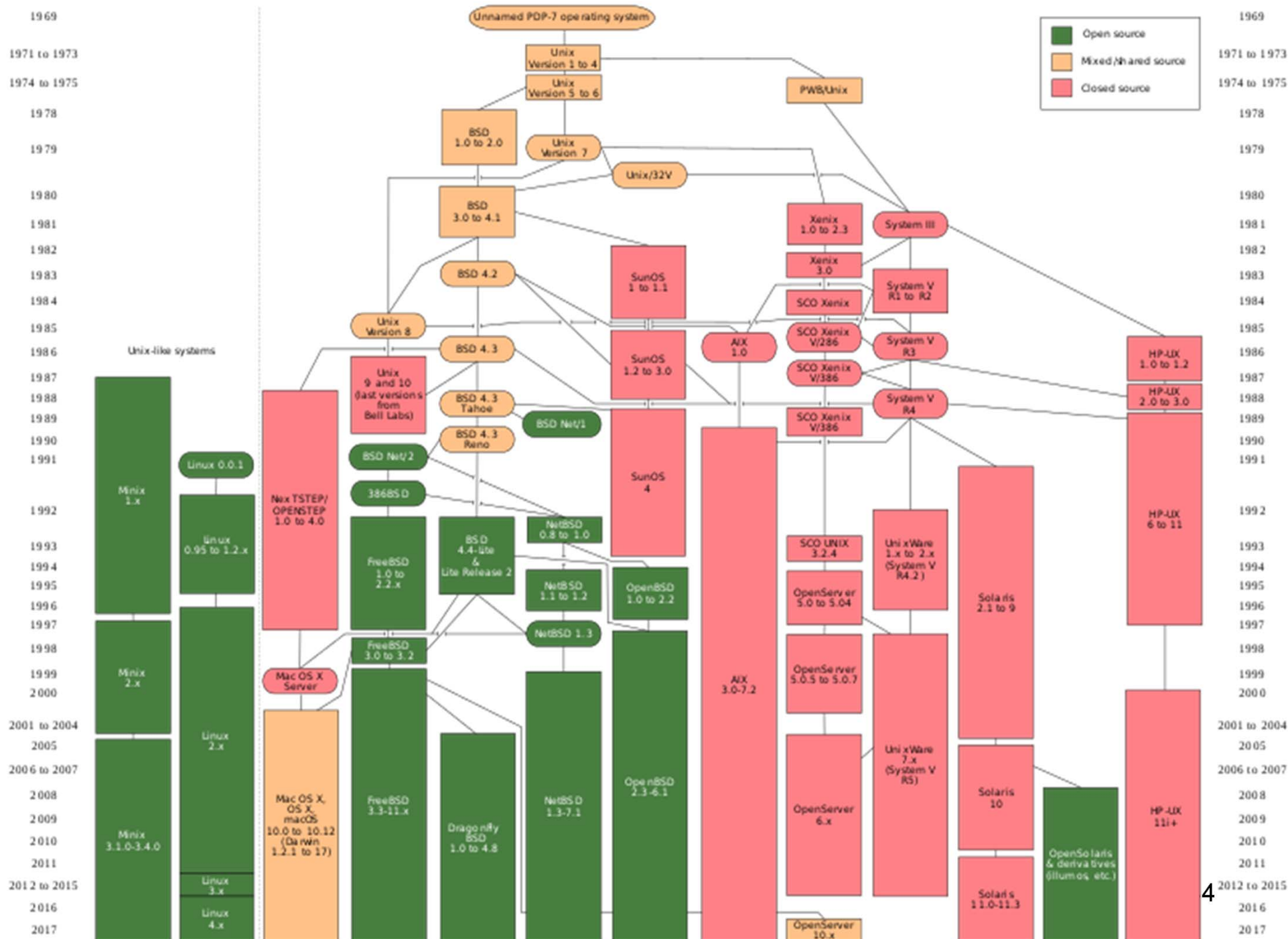
- a multitasking, multi-user computer operating system that exists in many variants.
- the original Unix was developed at AT&T's Bell Labs research center by Ken Thompson, Dennis Ritchie, and others on '70s.

# Predecessor

- mid-1960s MIT, AT&T Bell Labs, and General Electric were developing an experimental time sharing operating system called **Multics** (the project failed)
- 1970 Peter Neumann started a new project, named **Unics** (UNiplexed Information and Computing Service). Ken Thompson, Dennis Ritchie, M. D. McIlroy, and J. F. Ossanna were decided to redo the work at Multics but at a smaller scale.

# UNIX development

- 1969 – 1973 the C programming language was designed by Dennis Ritchie as a systems programming language for Unix.
- 1970 - 1980 UNIX developed into a standard operating system for academia
- Then the development explodes to so called “UNIX wars”

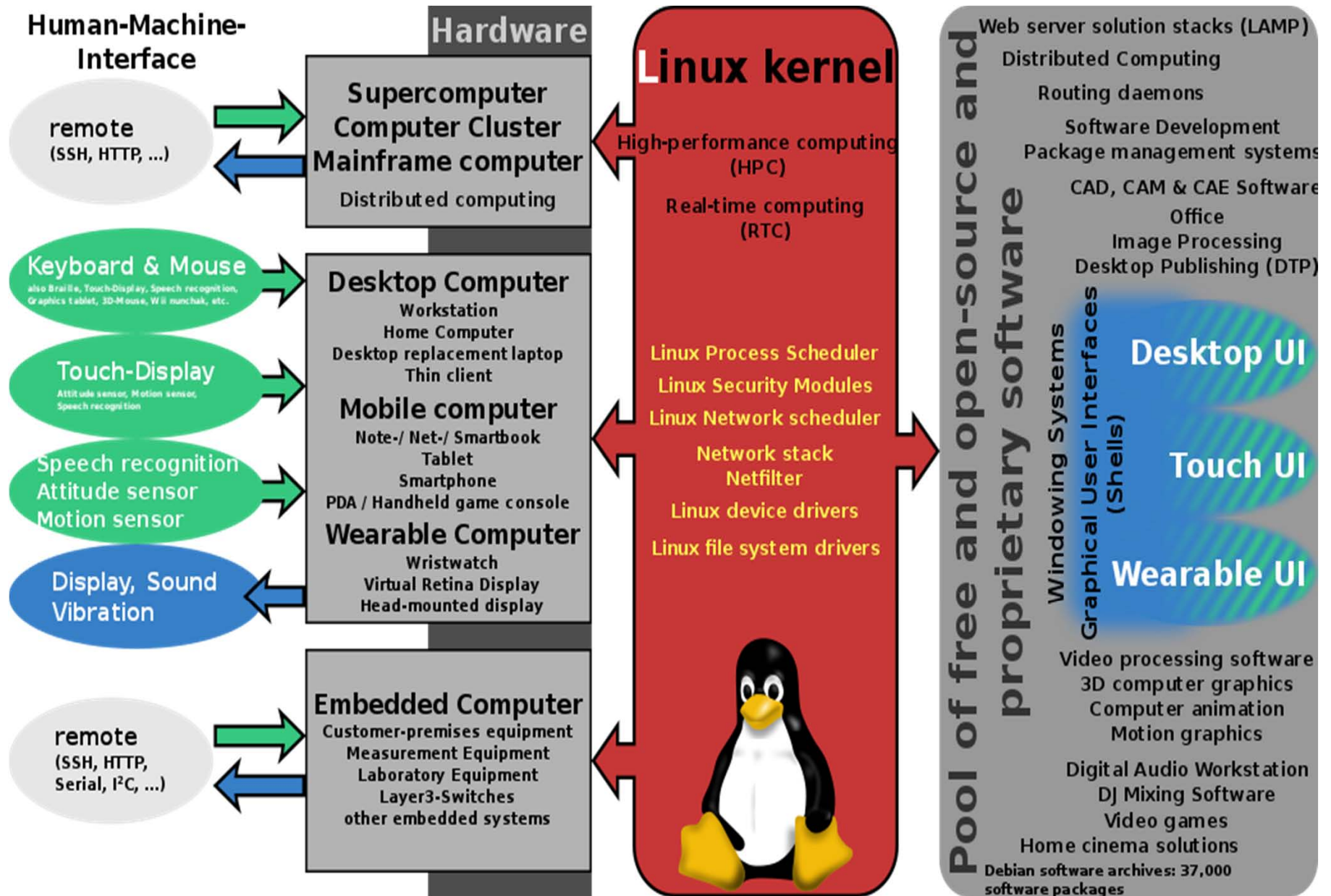


# Innovations introduced by UNIX

- Pipe concept (a direct data link between two processes)
- Text oriented
- Can connect a large network
- Electronic mail

# LINUX

- 1983 Richard Stallman initiated GNU Project in order to develop an Unix-like computer operating system
- 1991 Linus Torvalds developed the Linux kernel - an operating system that is a variant of the GNU operating system
- **more than 90% of today's 500 fastest supercomputers run some variant of Linux**



# Ubuntu

- Ubuntu is an operating system based on the Linux kernel.
- According to 2012 online surveys, Ubuntu is the most popular Linux distribution on desktop and laptop personal computers.
- Latest version: Ubuntu 19.10 Beta / 26 September 2019



# Many operating systems were resulted from UNIX

- in '80 AT&T tried to commercialize UNIX by licensing the OS to third-party vendors.
- After the "Unix wars" between groups of vendors, AT&T finally sold its rights in Unix to Novell in the early 1990s.

# NetWare OS

## by Novell

- 1985 Novell Inc. introduced a new network protocol and developed NetWare 286 OS
- After mid-1990 the popularity of NetWare OS was in decline
- Modern (2009) NetWare OS installations are still used by large organizations

# OSI model

- The Open Systems Interconnection (OSI) model (ISO/IEC 7498-1) is a conceptual model that characterizes and standardizes the internal functions of a communication system by partitioning it into abstraction layers.

# Description of OSI layers

7. Application	Network process to application
6. Presentation	Data representation, encryption and decryption
5. Session	Managing sessions between applications
4. Transport	Reliable delivery of info packets
3. Network	Addressing, routing and delivery between points on a network
2. Data link	A reliable direct point-to-point data connection
1. Physical	A direct point-to-point data connection

# Windows OS

- November 20, 1985 - Microsoft introduced **Windows 1** as a graphical operating system shell for MS-DOS
- **Windows Server 2016** - released in early 2016
- Today, the most recent versions include **Windows 10** and other active families (Windows Embedded, Windows Phone, etc.)

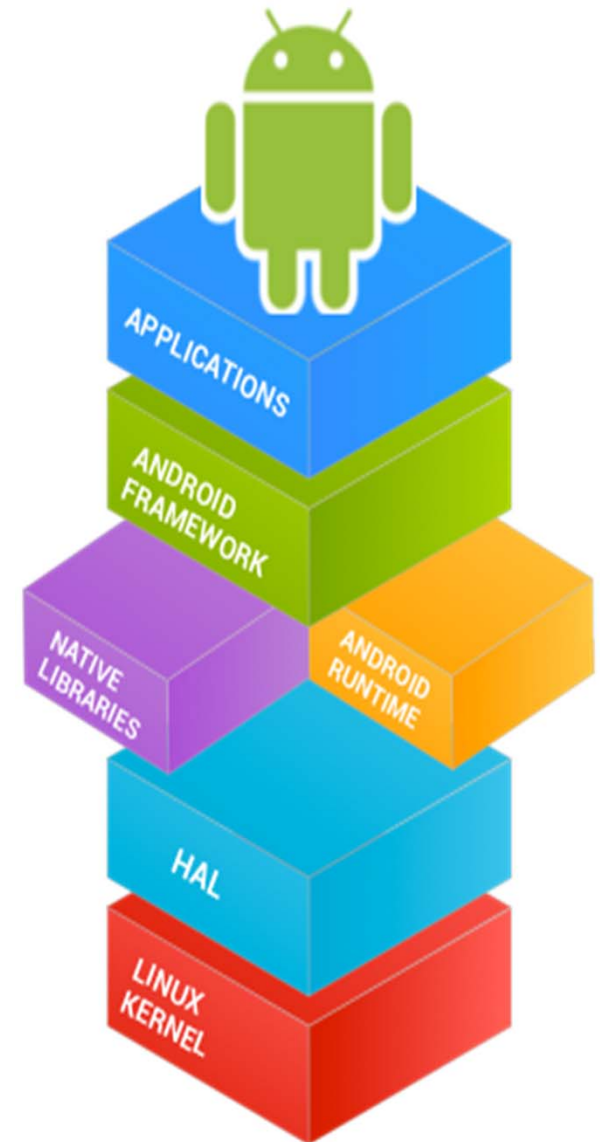
# Defunct Windows families

- **Windows 9x** – An operating systems produced from 1995 to 2000, which were based on the Windows 95 kernel (all versions of Windows 95, Windows 98, and Windows ME).
- **Windows Mobile** – By 2007, it was a very used smartphone software, but this popularity faded in the following years. In February 2010, facing competition from rival OSs including iOS and Android, Microsoft announced **Windows Phone** to supersede Windows Mobile.

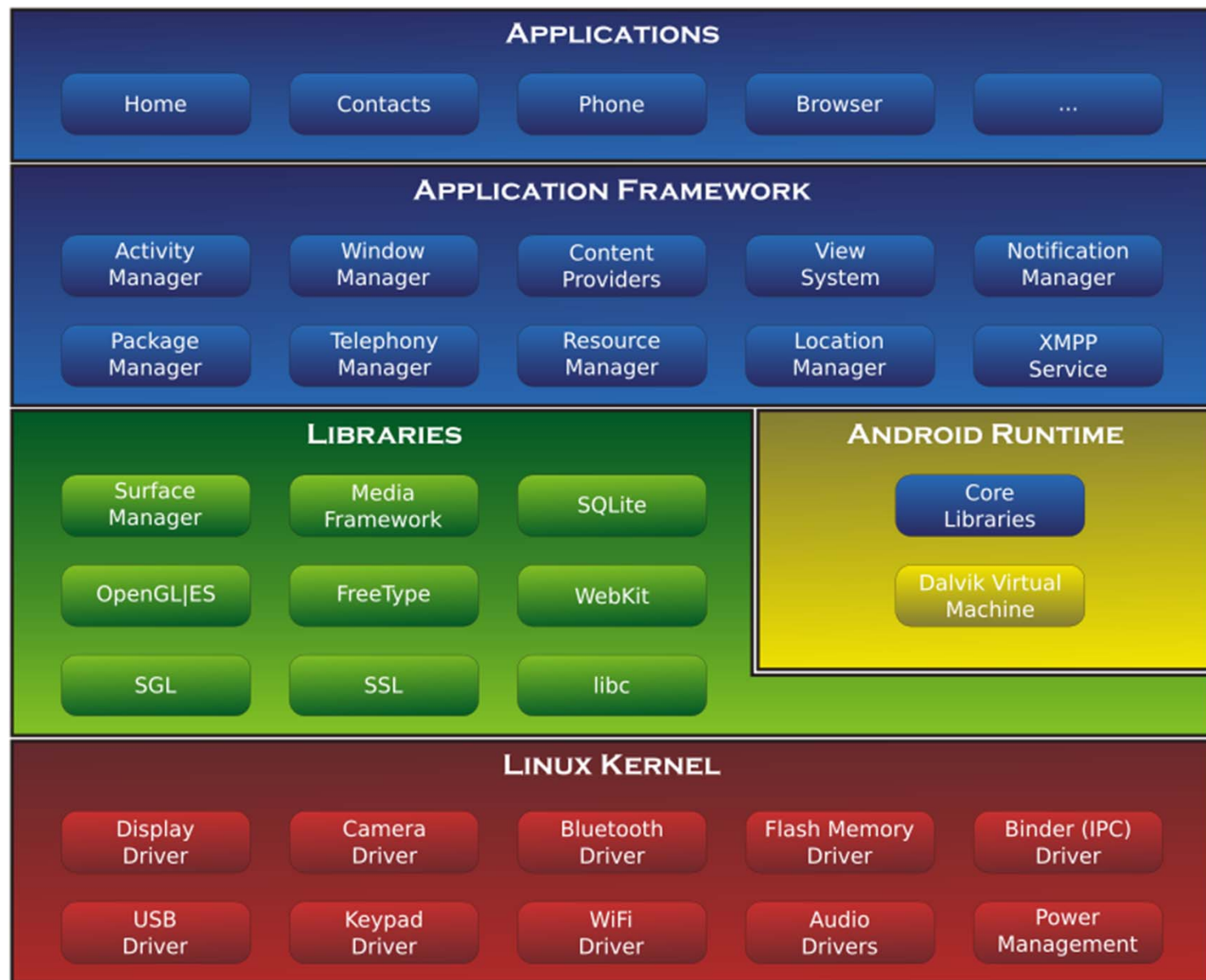
# Android

- a Linux-based operating system (initially developed by Android, Inc.)
- 2007-2008 Google developed first version of Android for mobile phones
- now is intended to become one of the most popular operating systems, not only for mobile devices

- Android is designed to manage processes to keep power consumption at a minimum.
- When an application is not in use the system suspends its operation so that, while available for immediate use rather than closed, it does not use battery power or CPU resources.
- The current stable version is Android 10, released on **September 3, 2019**. The core Android source code is known as Android Open Source Project (AOSP), which is primarily licensed under the Apache License.







# iOS

- a mobile operating system developed and distributed by Apple Inc.
- iOS is derived from OS X, the operating system used on Apple computers.
- is the first mobile OS that is build on 64-bit technology

# Writing information on mass memory (HDD)

- A hard disk drive (HDD) can be divided into multiple logical storage units (partitions)
- A separate file systems can be used on each partition
- Most used file system architectures:
  - File Allocation Table (FAT)
  - High Performance File System (HPFS)
  - New Technology File System (NTFS)

# File Allocation Table (FAT)

- FAT file system offers reasonable good performance and robustness
- While FAT12 is omnipresent on floppy disks, FAT16 and FAT32 are typically found on the larger media.
- The maximum possible size for a file on a FAT32 volume is 4 GB
- The open FAT+ specification proposes how to store larger files up to 256 GB

# Fragmentation

- The FAT file system does not contain built-in mechanisms which prevent newly written files from becoming scattered across the partition.
- On volumes where files are created and deleted frequently or their lengths often changed, the medium will become increasingly fragmented over time.

# High Performance File System (HPFS)

- a file system created initially for OS/2 to improve upon the limitations of the FAT file system.
- it was written by Gordon Letwin and others at Microsoft

# HPFS improvements

- support for long file names (255 characters as opposed to FAT's 8+3 characters)
- more efficient use of disk space (files are not stored using multiple-sector clusters but on a per-sector basis)
- an internal architecture that keeps related items close to each other on the disk volume
- less fragmentation of data
- extent-based space allocation

# **New Technology File System (NTFS)**

- developed by Microsoft Corporation for its Windows NT line of operating systems
- NTFS has several technical improvements over FAT and HPFS
- NTFS can compress files using specific algorithms