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Informatics for Economists

Strategic project of TBU in Zlín, reg. no. CZ.02.2.69/0.0/0.0/16_015/0002204

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1. Computer Science and Computing



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Try to think....
...and formulate the concept
of the subject
"Informatics for Economists"



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1.1 Information Age and Knowledge Society

The present human civilization is characterized by a growing flood of information. Recently, considerations have been increasing how to improve methods of information process management.

Nowadays, information is becoming increasingly common:

- social, technological and economic influences operate globally, and information, information and communication technologies affect and increasingly change our everyday lives
- main factor of success in modern society is reliable and fast access to information
- information and support processes, systems and networks are important assets of an organization
- Information needed to run a business is plentiful and growing.





The development of economy directly depend on knowledge of a generation and the proper usage of information which help with educating society and creating new products and technologies. Information age, information and knowledge society require computer and information literate citizens :

- **The key capabilities in the form of knowledge and skills appropriate to the context of the knowledge society are essential for everyone**
- **Knowledge is the current source of competitive advantage**
- **New skills for knowledge society are not only classical literacy (reading, writing, counting), but also digital literacy and good creative, logical and critical thinking**
- **Dynamic changes in society and labour market require modern, flexible, innovative and creative possibilities of education**





- Information age and information and knowledge society require computer and information literate citizens.
- Neither education did avoid the response to dynamic changes in society, including the increase in the amount of information, the globalization of research and education, the competitive environment, demographic changes.
- Mastering the fundamentals of computer science (not only usage but also correct access to information) must therefore become part of the general education of a modern person.
- It is natural that knowledge in the field of computer science has become part of any education > it is therefore essential to prepare the part of the human population that will use these technologies – its education.





1.2 Computer Science and Informatics

Computers exist in a wide range of forms, and thousands of computers are hidden in devices we use every day but don't think of as computers such as cars, phones, TVs, microwave ovens, and access cards.

In recent years, several advanced countries have declared the intention to transform their ICT school subject into a new Computer Science, Informatics, or Computing Education.

Informatics is a branch of information engineering. It involves the practice of information processing and the engineering of information systems, and as an academic field it is an applied form of information science.

According to Kernighan (2017) this has led to the study of informatics with mathematical, biological, cognitive and social aspects.





1.3 Subject Informatics for Economists

The field of informatics has great breadth and encompasses many subspecialties, including disciplines of computer science, information systems, IT and statistics.

The discipline *Informatics for Economists* provides an overview of selected areas of informatics from the point of view of the needs of the faculty of economic faculties.

Discipline provides scientific understanding of topics such as:

- information processing and data storage,
- computer networks and the Internet,
- programming languages and algorithms,
- software engineering,
- artificial intelligence, computer graphics, etc.





Main aim of the course Informatics for Economists is:

- to give an up-to-date view of current state and trends in the field of ICT,
- to provide an overview of selected areas of informatics from the point of view of the needs of the faculty of economic faculties.

Subject is oriented to:

- broad knowledge and basic skills in the informatics area (IT),
- learning outcomes of the course unit is to gain the complex orientation in modern ICT.





As stated in (Buřita et al., 2010), the field of informatics has great breadth and encompasses many subspecialties, including disciplines of computer science, information systems, IT and statistics.

Informatics for Economists is a discipline that seeks scientific understanding of topics such as:

- information processing and data storage,
- computer networks and the Internet,
- programming languages and algorithms,
- software engineering,
- artificial intelligence, computer graphics, etc.





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Try answering the following questions:

1. Characterize the Information Age and Knowledge Society
2. Characterize the term "informatics". What does it come out of?
3. What the subject "computer science " deals with?
4. Which problems are solved by this subject?
5. Specify the main aim of the course Informatics for Economists.
6. Specify the main topics of the subject Informatics for Economists.



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2. Data Storage and Encoding



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Try to think
..... formulate the definition
of the term "data" and
"information"





2.1 Data, information, knowledge

Data is designation for various symbols and numbers that perform the function of objective facts about events.

Term "data "is used to describe:

- a state, phenomenon, or property of the object being inspected
- data displays the status of the objects or the processes in progress in the reality around us.
- term data is understood in the sense of the technical record of reality.

The data can be structured and can be evaluated from a quantitative perspective in terms of costs, speeds capacity.





In addition to these quantitative indicators (aspects), qualitative aspects can also be applied:

- Availability- whether we have access to them, whether they are available on site and when and where we need them
- Correspondence- compliance with what demands we have, what we expect
- Readability- ease, accuracy and understanding of the data we have at our disposal.

However, no data can be considered as information, but data that is meaningful to the user, meaning, purpose.





The term "information" derives from the Latin word *informo-informatio-informare*, which means communication, transmission of the message. Information is:

- one of the basic concepts of cybernetics, science of management in organisms > what people are telling other people is called general information.
- processed data that the user understands and interprets to them importance and meaning (Denning & Martell, 2015)
- Information can include data, numbers, characters, commands, commands, messages, and so on.

In the concept of information (a signal with information content), cybernetic has revealed the essence of the management process. The basic characteristics of information can also include its price.





- Data are transformed into information and knowledge by data processing.
- Data constitute the basis (foundation) of the information pyramid (see Figure 1).
- Information is processed data that the user understands and interprets to them importance and meaning.
- According to Grabowski et al., (2014), knowledge is structured summary of interrelated findings and experience gained from a certain area or for some purpose.

Source: Grabowski et. al. (2014)

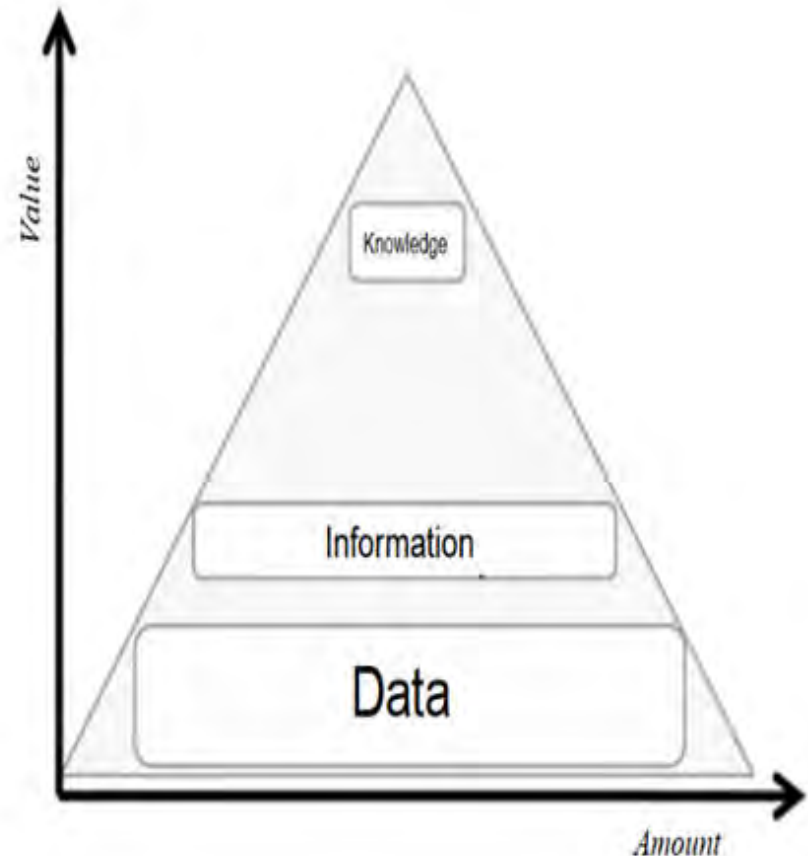


Figure 1: Information pyramid
source: Grabowski et. al. (2014)



In addition to concepts of data and information, "knowledge" appears as another term (Denning & Bell, 2012).

- *Knowledge* can be understood as an information enriched with our previous experiences, skills, relationships, values, principles, models that are fit for use.

Data and knowledge *cannot be replaced* as they are complementary components of the decision process:

DATA + INFORMATION + KNOWLEDGE (information and experience) => *Comprehensive Knowledge* (see Figure 2).

Knowledge is an important input of production and strategic processes because it enables us to use traditional resources efficiently - traditional production factors (labour, land, capital).



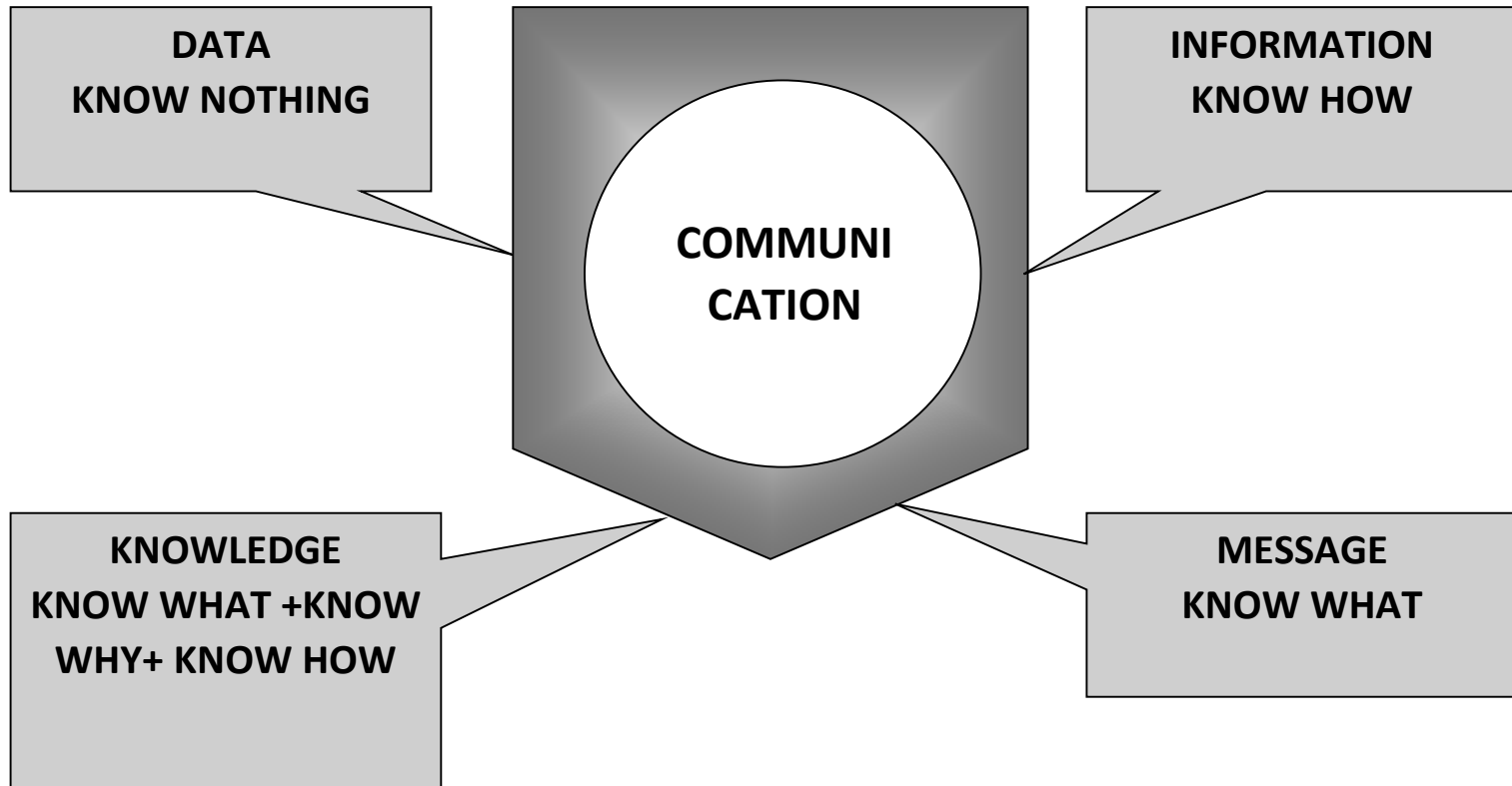


Figure 2 Architecture of information concepts
source: Porvazník (2003)



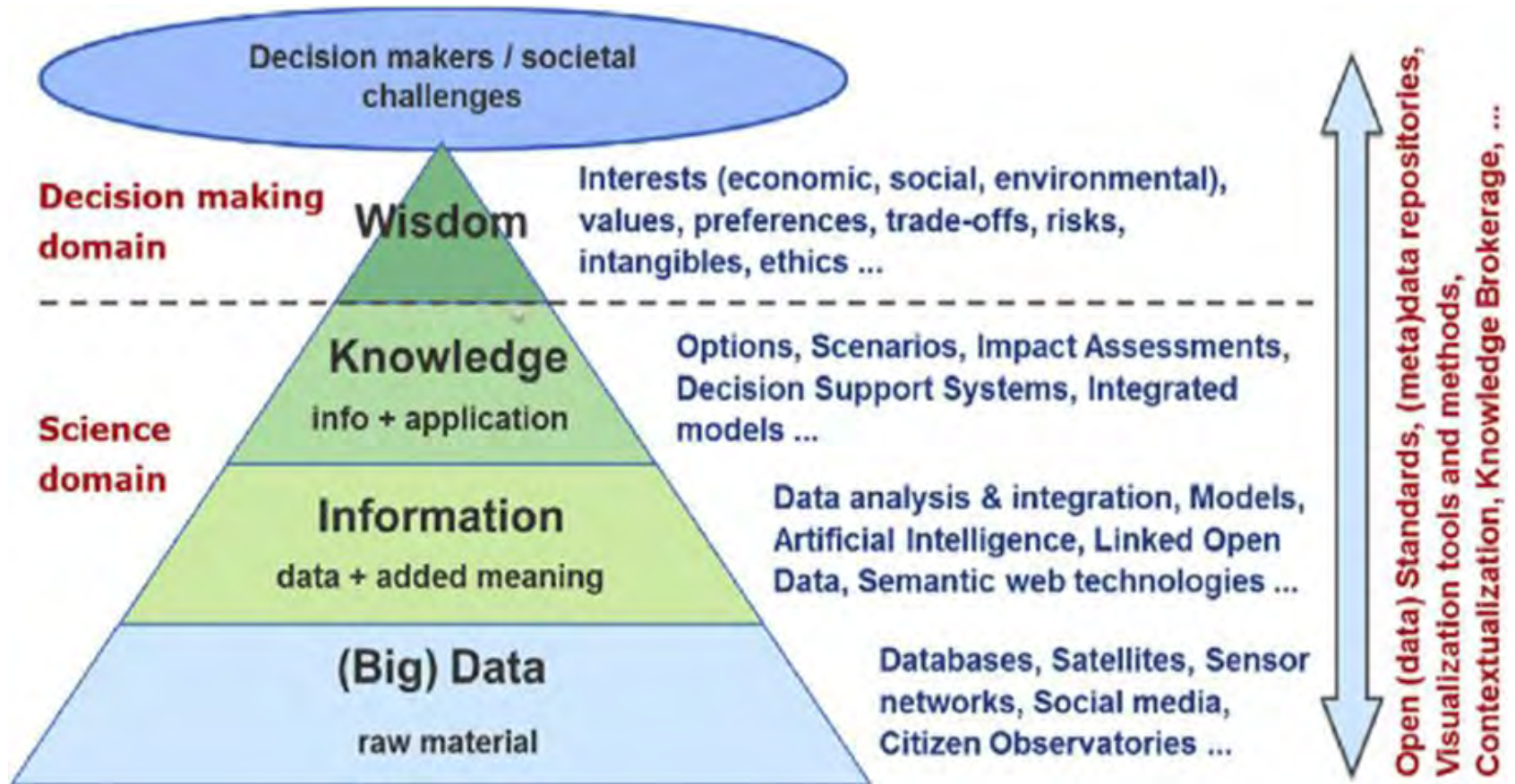


Figure 3: DIKW hierarchy from data to decision
source: R. Lokers et al. (2016, p. 84)





2.2 Data Storage, Information Units

- Information on computers is encoded as a sequence of zeros and ones
- As a basic numerical data representation system - a binary component is used, which is advantageous in computer science
- Two different states can be easily realized
- The basic (and smallest) unit of information is 1 bit (abbreviated "1 b")
- Bit is a digit that can be "0" or "1" that is the basis of the binary system
- One bit is an elementary amount of information
- It is the information that came from two options, whether a certain year is true (logical 1) or false (logical 0)
- If we have only one option, we do not have to make to decision.
Examples: circuit closed - open





- **Byte** is defined as **eight** bits - to represent a group of 8 bits, a single byte unit is used (abbreviated as "B")
- Information on computers is encoded as a sequence of **zeros and ones**
- It is the smallest unit of information that CPUs can handle on computers
- One byte of information corresponds to **eight binary digits**, and can distinguish among $2^8 > 256$ different values
- One byte expresses a unit into which one character can be saved - a letter, a digit, or another character symbol (for example, characters (: + *? @ % etc.)
- In this way, a total of **256 different symbols** of numbers 0 and 1 can be created in one B.





2.3 Numerical Systems

Numerical system is a way of representing numbers:

- One set is a set of numbers
- elements of the second set are words compiled from the characters of a particular alphabet
- These characters are called digits

In the world of computers, three basic systems are used:

- a) binary, $n = 2$
- b) decadic, $n = 10$
- c) hexadecimal ($n = 16$)

decimální	128	64	32	16	8	4	2	1	binární
71	0	1	0	0	0	1	1	1	0100 0111
16	0	0	0	1	0	0	0	0	0001 0000
111	0	1	1	0	1	1	1	1	0110 1111
133	1	0	0	0	0	1	0	1	1000 0101
17	0	0	0	1	0	0	0	1	0001 0001
48	0	0	1	1	0	0	0	0	0011 0000

n = number of elements of the numerical system.





Binary numerical system (see Fig. 4) uses only two symbols 0 and 1, which correspond to two states of the electrical circuit (off and on).

- The two-digit number can be easily converted to decimal.
- **Hexadecimal system** writing means the entry of a number in a hexadecimal numbering system that uses the digits 0-9 and the letters A-F.
- The number A thus represents the decimal value 10.
- Analogically, then B = 11, C = 12, D = 13, 14 = E, 15 = F.

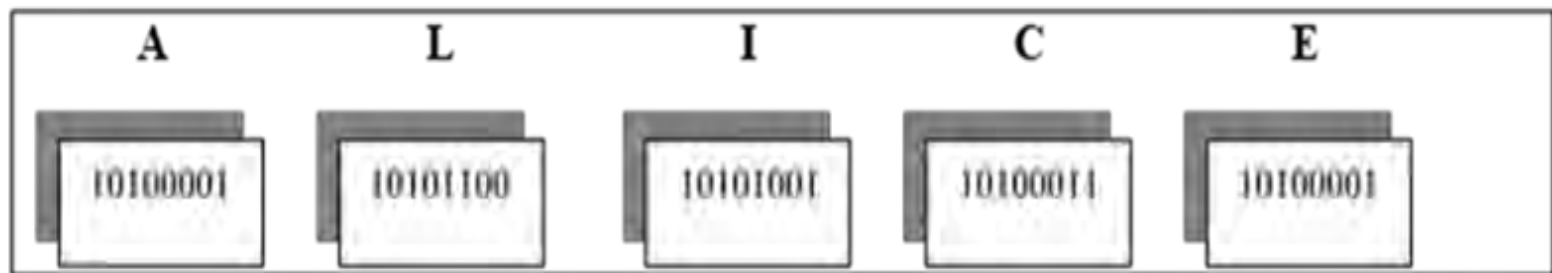


Figure 4 Binary expression of text ALICE
source: own processing





2.4 Codes, Encoding and Data Formats

Coding – data must be recorded and communicated to each other.

There are transfer rules to convert between external information (comprehensible data) and computer data.

Code is then a rule for uniquely assigning elements of two sets or lists. Such a description is called encoding of information (see Figure 5).

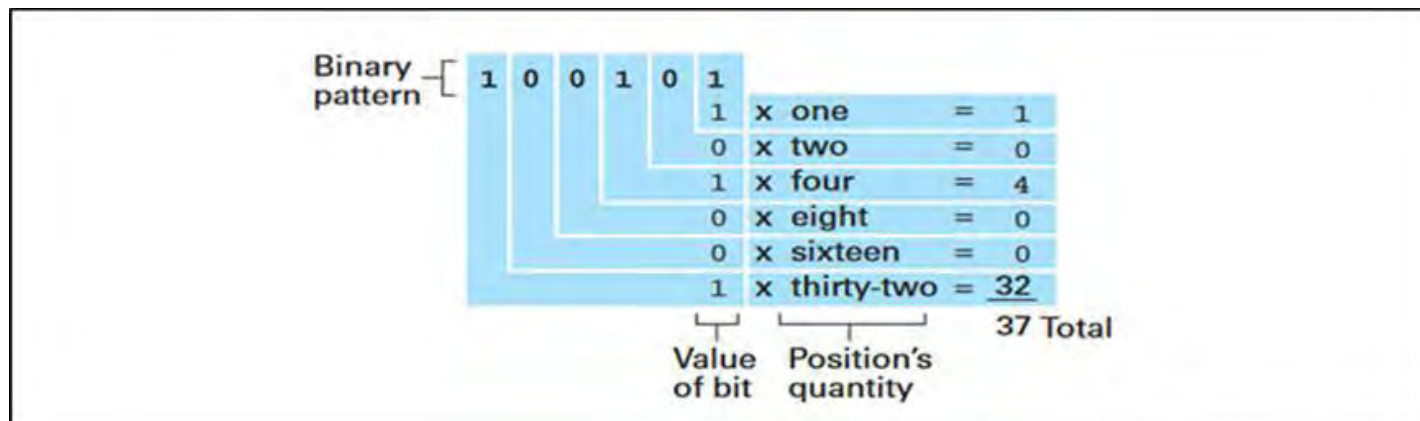


Figure 5 Encoding in the binary numerical system
source: Brookshear (2013, p.57)





2.5 Data Compression

When saving or transmitting data is often useful, and sometimes it is necessary to reduce the size of the data involved while retaining the underlying information. Technique for accomplishing this is called data compression:

The goal of compression is to reduce the size of data for more efficient storage or transmission

- The compressed file is for archiving, data distribution, portable, and does not take up much space in the computer's memory.
- Compression of data is widely used in practice to minimize the volume of data being transmitted.
- **Unicode** character encoding system with a capacity of 65,536 symbols was designed.





2.6 General Data Compression Methods

- Common user today commonly encounters compressed file shapes.
- There are a number of methods and compression algorithms for data volume reduction.
- The user should be able to use one of the compression programs (ZIP, RAR, 7z, ARJ, ACE, LHA, TAR, etc.) to transfer files to computer.

Data compression schemes can generally be divided into two categories:

1. Lossless compression - no loss of information occurs during compression - lossless schemes do not lose information - the result is not different from the original neither or a single bit.
2. Lossy compression - some information may be lost - that may lead to the loss of information. Applied mainly to audio, video, or video. The result after decompression is not the same as the original, but it is very similar.





2.7 Compressing Images, Audio and Video

Many compression formats have been created specifically for compression of graphics (images).

- GIF (Graphic Interchange Format - combinations of the red, blue, and green components of each of these colours are encoded into 3 bytes.
- JPEG (Joint Photographic Experts Group) within ISO. Today, it has become a standard in graphics compression
- TIFF (Tagged Image File Format) used by a standardized format for storing photographs .
- MPEG (Motion Picture Experts Group) - most commonly used standards for encoding and compressing audio and video
- The best-known system for compressing audio is MP3, which is short for MPEG layer 3.





Try answering the following questions:

1. Characterize the terms "information" and "data"
2. Explain the basic difference between them. Give examples.
3. Characterize the terms "bit" and "byte". What do they label?
4. What is coding for? Which codes do you know?
5. What is data compression? What is its meaning?
6. Specify the main methods of data compression, advantages and disadvantages.
7. Specify the three main representatives of the compression programs.
8. Specify some formats for storing audio and multimedia files (video).





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3 Computer Architecture and Data Processing



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3.1 Computing Hardware

Computer hardware (HW) includes the physical parts or components of a computer, such as the cabinet, central processing unit, monitor, keyboard, data storage, graphics card, sound card, and motherboard. By contrast, software is instructions that can be stored and run by HW. Intermediate between software and hardware is "firmware", which is software that is strongly coupled to the particular hardware of a computer system and thus the most difficult to change but also among the most stable with respect to consistency of interface.

- HW is now a huge complex of a variety of technical and software resources, tools and systems, and computers interfere with all areas of human activity





3.2 Computer Classification

The development of the 5th generation consists in the application of artificial intelligence and of communication in natural language.

The basic criteria used today by performance and area of use are:

- internal architecture, processor speed, internal memory range, external memory capacity, device output speed, user count, and cost.

Basic classification - the basic groups of computers are distinguished:

1. supercomputers
2. desktop computers - mainframes
3. middle class computers - servers and powerful workstations
4. personal computers (desktop, portable and network computers)
5. computers for non-personal use: control of technological processes, etc.





The organization of a computing machine is often called as architecture. There are two basic concepts of computer design:

1. von Neumann's diagram (see Figure 6) – uses one common electronic memory for program and data; concept has five main modules
2. Harvard architecture – uses separate memory for data and program.

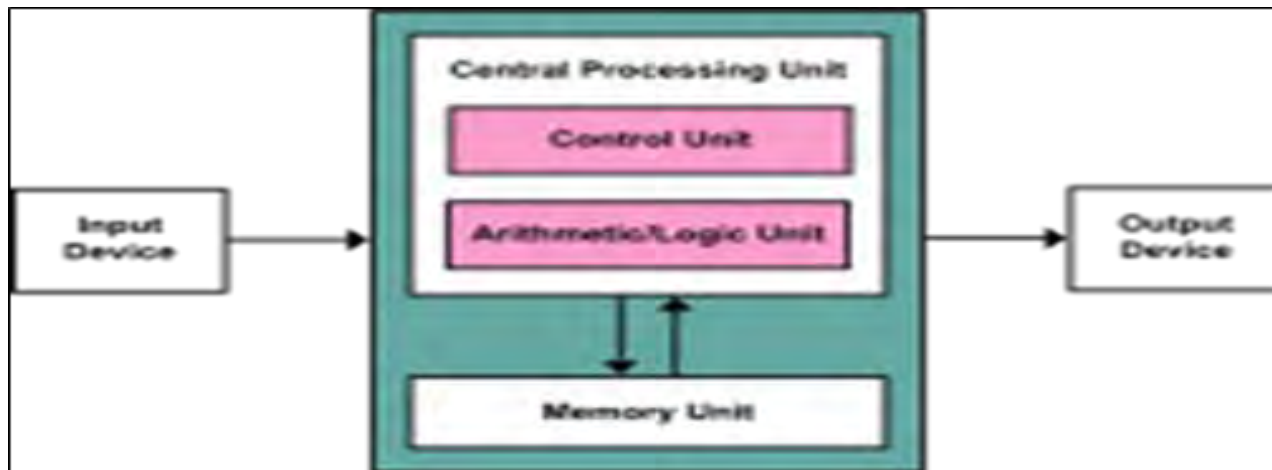


Figure 6 Von Neumann architecture
source: Brookshear (2013)





3.3 Computing System

Computing system – combination of program and machine although other systems exist with only hardware components.

Generally consists of three main parts:

1. Central processing unit (CPU) – executes instruction and processes data
2. Memory (RAM, ROM) that holds the programs and data to be processed
3. I/O devices as peripherals that communicate with the outside world.

Computing system needs:

- Precise specification of the set of instructions implemented by the HW.
- Precise method to represent a program as a series of instructions.
- Memory that stores the program and the data on which it operates.
- Control unit that reads and executes instructions of a program in the order prescribed by the program.





The general computer structure currently distinguishes 8 components - processor, motherboard, bus, internal and external memory, input /output devices, and communication devices:

- Located on the computer mainboard (motherboard) which integrates the processor, internal memory, bus and interface to connect additional components.
- Processor (CPU) is the "brain" of the computer, it processes the instructions of the programs that control its operation, and thus actually performs the specified task.

CPU is a complex electronic component and consists of a controller and an arithmetic-logic unit (ALU).

Computer speed is also influenced by the number of processors (called multiprocessing).





- The processor reads the instruction from the memory and then executes the program; memory is used to store data and programs.
- The memory circuits are fixed with the processor on the computer motherboard. It is divided into a read-only ROM and a read-write RAM.
- Computer components are connected by buses which are divided by analogy to data, address and control buses (see Figure 7).
- Memory "cache" balances different processor and main memory speeds.
- External memory (HDD, optical discs) is the memory used to permanently store information (programs and data).
- The input device converts the input data into electronic form .
- User provides input data for processing through input devices and presents the results using output devices.

Source: Brookshear & Brylow (2015)



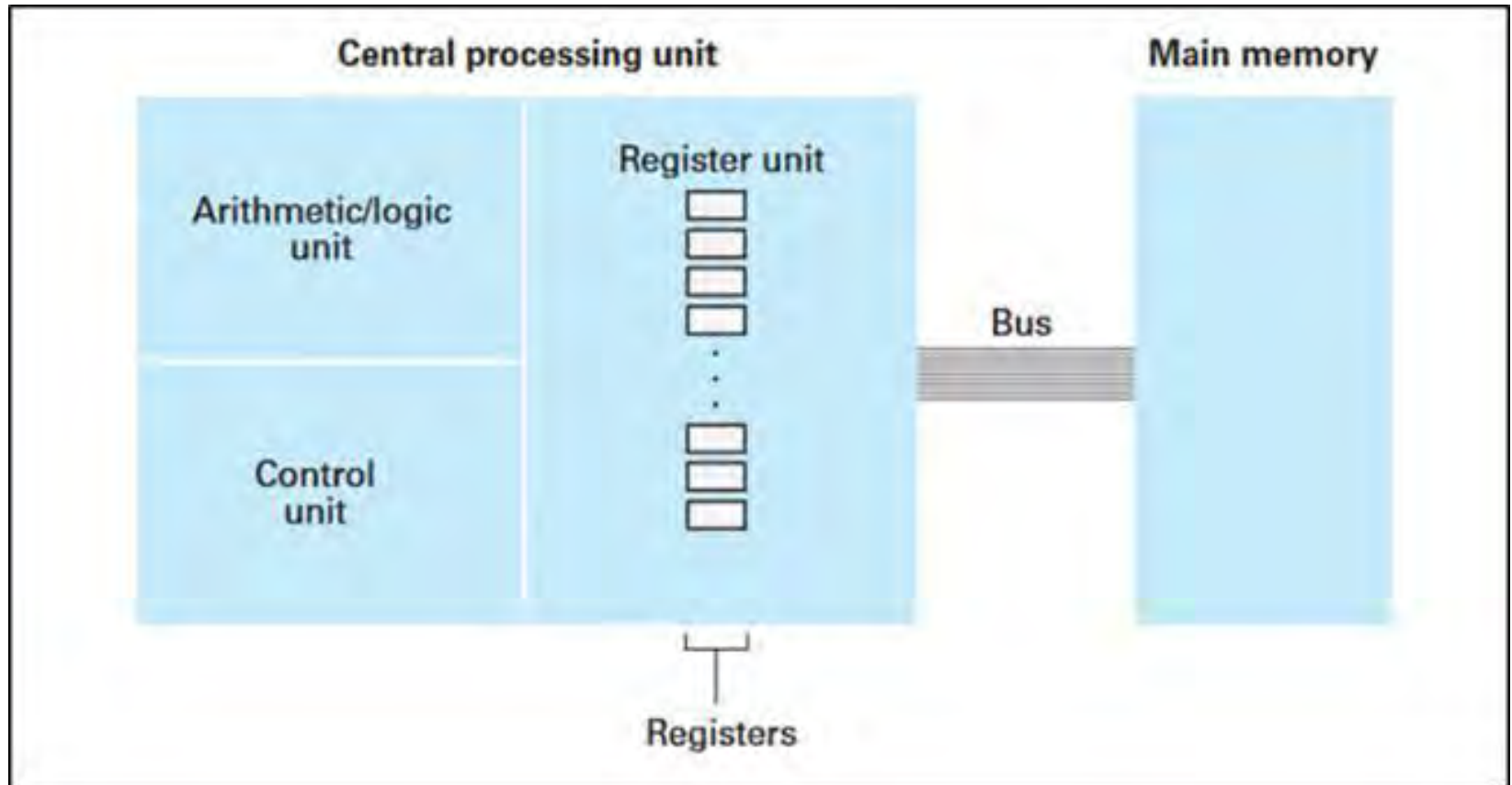


Figure 7 CPU and main memory connected via bus
source: Brookshear (2015, p.94)



3.4 Processor Properties

Processor performance has a significant impact on the speed of computer, given in MIPS (Million Instruction per Second) units.

Cady (2010) describes three fundamental factors affect CPU performance:

1. Word length - number of bits a processor can process at any given time
2. Clock frequency - number of cycles performed by the processor (GHz/sec)
3. Bitrate - the number of bits that are passed between processor and internal memory or other components at a given time.

Each processor is equipped with an instruction set of commands.

The internal architecture, processors are divided into:

- RISC with fewer instructions
- CISC with a large number of instructions.





3.5 Main Producers



- Intel Corporation (USA) is today one of the largest chip manufacturers
- IBM (International Business Machines Corporation) is one of the largest IT companies in the world.
- AMD (Advanced Micro Devices) has become the world's leading graphics chip manufacturer.
- Motorola, Inc. is another leading US manufacturer of mobile integrated electronic circuits, mobile phones, mobile terminals, wireless networks and other devices.

Computers are getting smaller, thinner, and more lightweight with every new generation of consumer technology.

Portable devices differ in size, shape and application; according to type and design we distinguish notebooks, netbooks, ultrabooks and tablets.





3.6 Data and Information Processing

The input data is converted to electronic form by input devices - so that it can be processed by a processor. The processed data are temporarily stored in the internal memory, eventually in the cache (see Figure 8).

After data transmission and processing, the output device then converts the data from the electronic form to a user-friendly form (print, monitor).

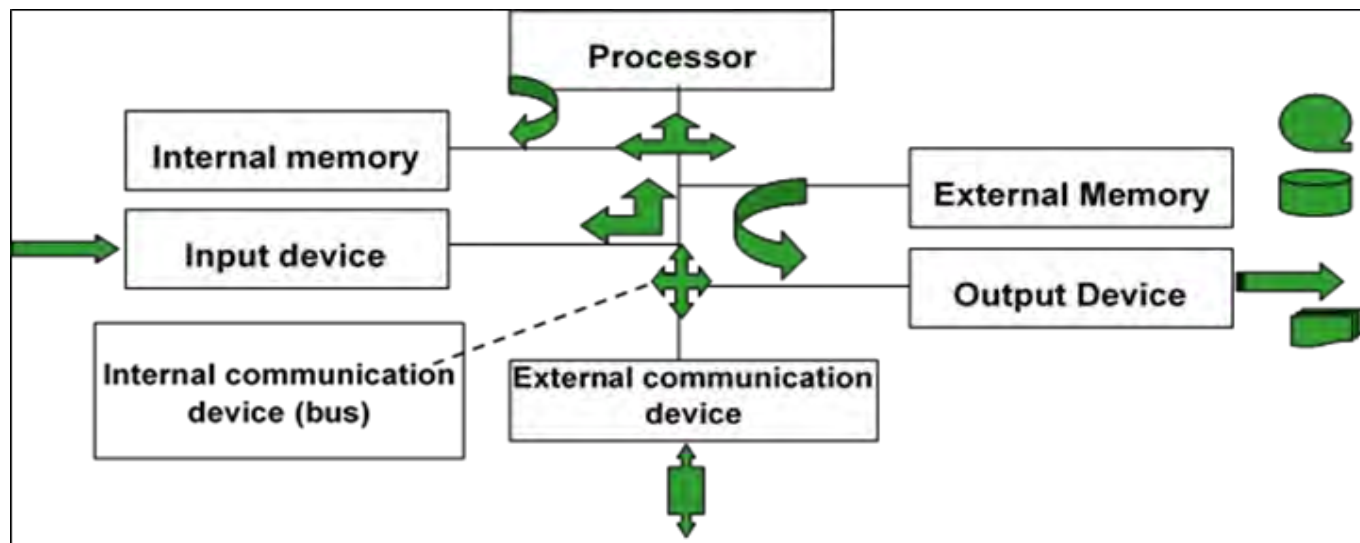


Figure 8 Computer data processing

source: own processing





3.7 Information Processing System

Information processing – it is a process that describes everything that happens in computer system, from loading of input data to printing of a text file.

Information processing system - is a system which takes information (a sequence of enumerated symbols or states) in one form and processes (transforms) it into another form, e.g. to statistics, by an algorithmic process.

An information processing system is made up of four basic parts, or subsystems (see Figure 9): input, processor, storage, output

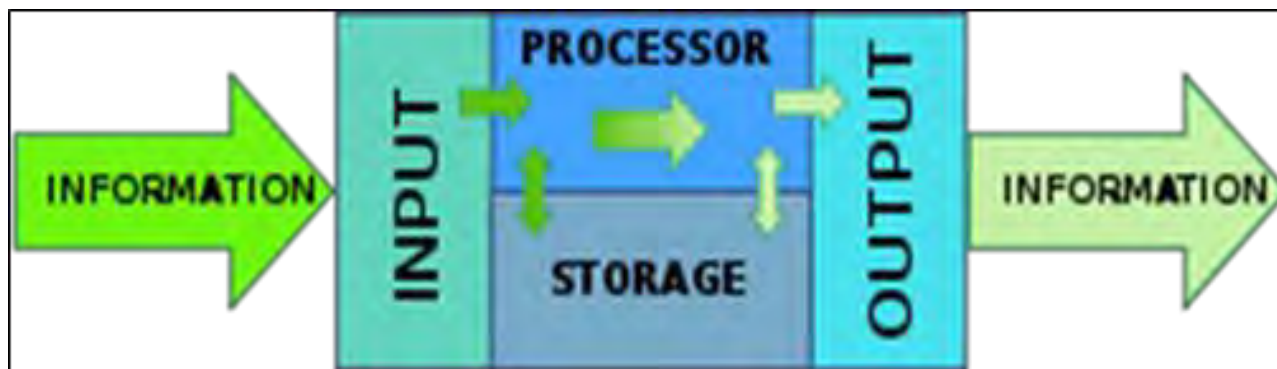


Figure 9 Information processing

source: Brookshear (2013)





3.8 Program Execution

A computer follows a program stored in its memory by copying the instructions from memory into the CPU as needed. The CPU performs its job by continually repeating an algorithm that guides it through a three-step process known as the machine cycle.

- The steps in the machine cycle are fetch, decode, and execute (see Fig. 10).
- CPU places the instruction received from memory in its instruction register.
- CPU executes instruction by activating the appropriate circuitry to perform the requested task.

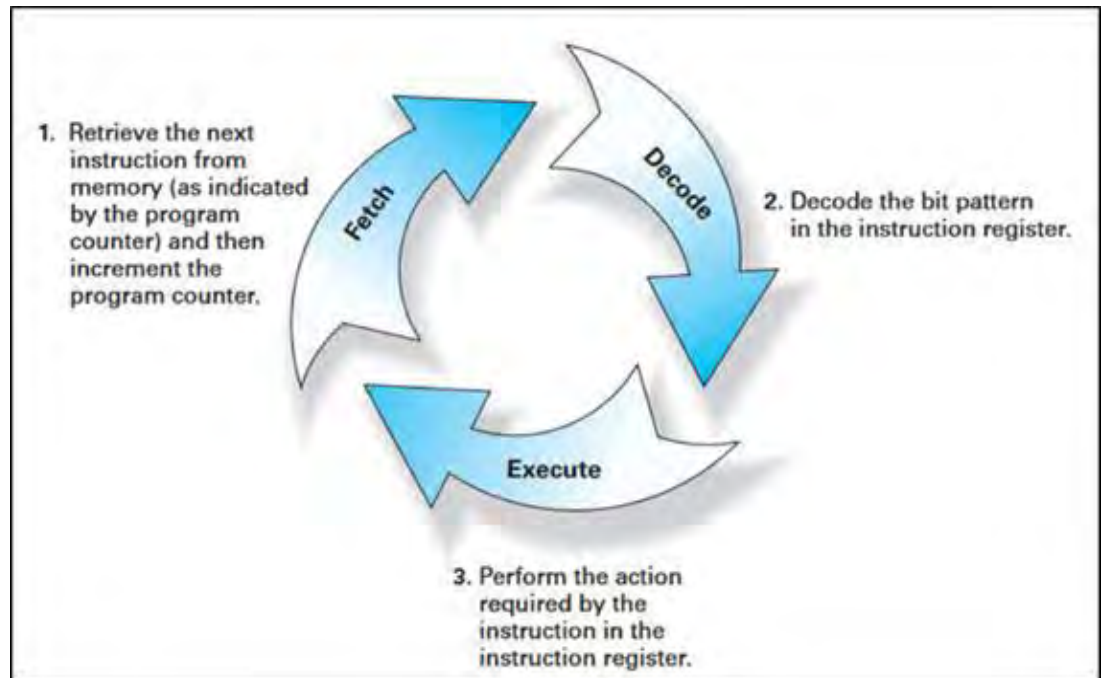


Figure 10 The machine cycles
source: Brookshear (2015, p.104)





Try answering the following questions:

1. Classify computers by generation, performance, and usage area.
2. Specify the main components of personal computer.
3. Which basic computer concepts do you know? How does it differ?
4. Specify the main parts of the computing system.
5. Processor – characteristics, functions, properties, manufacturers.
6. Describe the principle of data processing in the computer.
7. Specify the basic parts of the information processing system.
9. Explain the terms "compatibility" and "multiprocessing"





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4. Computer Software and Operating Systems



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Try to think

***.....and formulate the definition of
the task and role of Operating
Systems***





4.1 Basic Concepts

Computer software is a - set of computer programs located on computer:

- collection of data or instructions to tell the computer how to work
- all information processed by computer systems, programs and data, includes computer programs, libraries and related data.

The program :

- is a form of expressing the process of solving a task on a computer
- controls the operation of the computer and is a means of communication between user and computer
- determines what operations, and in which order the computer should perform, what data it should process, where it will be taken and where it will store the results.





The process - a running computer program loaded into the computer's memory. Another way to process a program is to interpret it (by command).

The algorithm - a general procedure for solving a given task
Its content is a clear procedure for solving the problem on the PC.

Algorithmisation - the ability to understand the problem solved, to analyse it, to decompose it into substeps and describe it so that the solution of the problem always leads to a clear result.

Therefore, **the program** is writing an algorithm in the selected programming language which contains instruction sequences that are executed by the processor.

Source: Brookshear & Brylow (2015)





Programming - an activity that involves creating an algorithm and a program - a number of programming languages have been created (Assembler, Cobol, Fortran, Pascal, Basic, PL1, C, Perl, Java, Delphi, etc.).

For **system programming**, C (C ++, C #) and Java for the J2EE (Java 2 Enterprise Edition) development environment, are currently being used.

The most common types of programs currently being created include web applications, run in an Internet environment, controlled from an Internet browser.

For easier and more efficient programming, the programming language is part of the development environment that helps the programmer create and verify the program.

In particular, **Active Server Pages (ASP)** or **Personal Home Pages (PHP)** are used to program web applications.





4.2 Software Classification

According to Brookshear & Brylow (2015), let us begin by dividing a machine's software into two broad categories (see Figure 11):

1. Basic (system) software (operating system, firmware, utility software, etc.)
2. Application software (ASW).

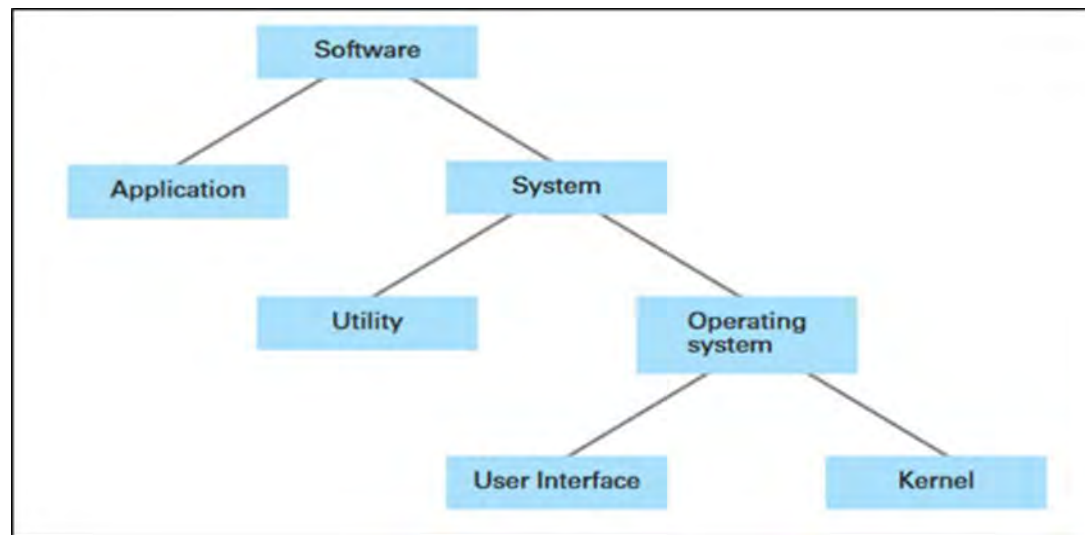


Figure 11 Software classification,
source: Brookshear & Brylow (2015)





Ad 1. Basic software or also system software is a computer software that allows the application software to run or process.

Within the class of basic (system) software are two categories:

- one is the operating system itself
- other consists of software units collectively known as utility software

Typical representative of system software is operating system, firmware and development environment for creating application SW.

Firmware is software that is firmly embedded in hardware.

Ad 2. Application software (ASW) is designed and created to handle a specific task type or to solve a particular problem.

Examples of ASW: spread sheets, database systems, desktop publishing systems, accounting systems, program development software, etc.

Source: Brookshear & Brylow (2015)





4.3 Operating System and Classification

An operating system (OS) of the computer is the software that controls the overall operation of a computer.

OS is then a set of programs for its operation, enabling efficient use of computer resources (hardware) and easy user work.

OS can generally be divided:

1. Based on the number of users per OS and multiuser OS.
Multiuser OS must ensure that multiple users access the system simultaneously.
2. According to the number of processed jobs (programs) per single and multiprogram which allow OSs to run multiple programs at the same time (multitasking).





3. Based on the collaboration of system resources of the server with client (user) architecture applications:

- a) Host-Terminal (all resources are run on the server and the user works with a terminal without any intelligence)
- b) File-Server (system resources work both on the server and on the client, and data must be moved from server to client for full-file processing)
- c) Client-Server (system resources work both on the server and on the client and the processed data is transferred to the client according to the requirement).

Source: Brookshear & Brylow (2015)





4. Depending on the type of processing:

- a) Multitasking, i.e. running multiple programs simultaneously
- b) Multiprocessing - simultaneous processing of programs on a multiprocessor
- c) Batch processing – the execution of jobs by collecting them in a single batch.
- d) Real-Time (interactive) processing – to ensure immediate PC response, such as patient life monitoring, power plant management, etc.

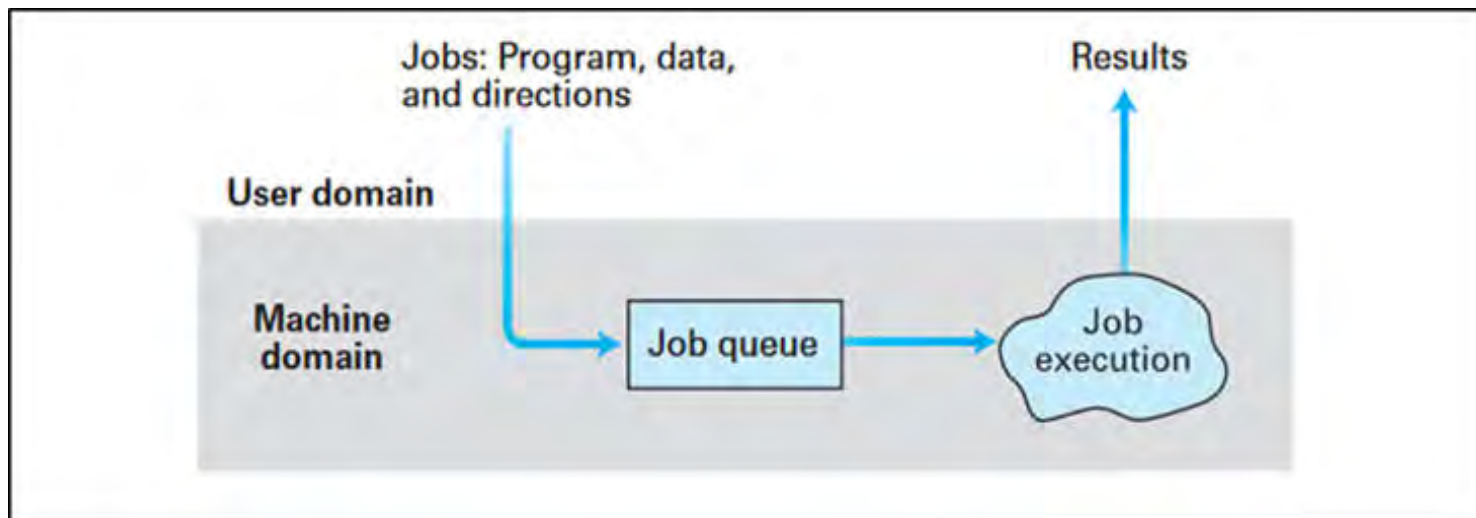


Figure 12 Batch processing,
source: Brookshear & Brylow (2015)





4.4 Booting Process

Operating system provides the SW required by other software units - this is accomplished through a procedure known as boot strapping (booting).

Computer's main memory is constructed from volatile technologies — meaning that the memory loses the data stored in it when the computer is turned off.

Thus –
the contents
of main
memory
must be
replenished
each time
the computer
is restarted.

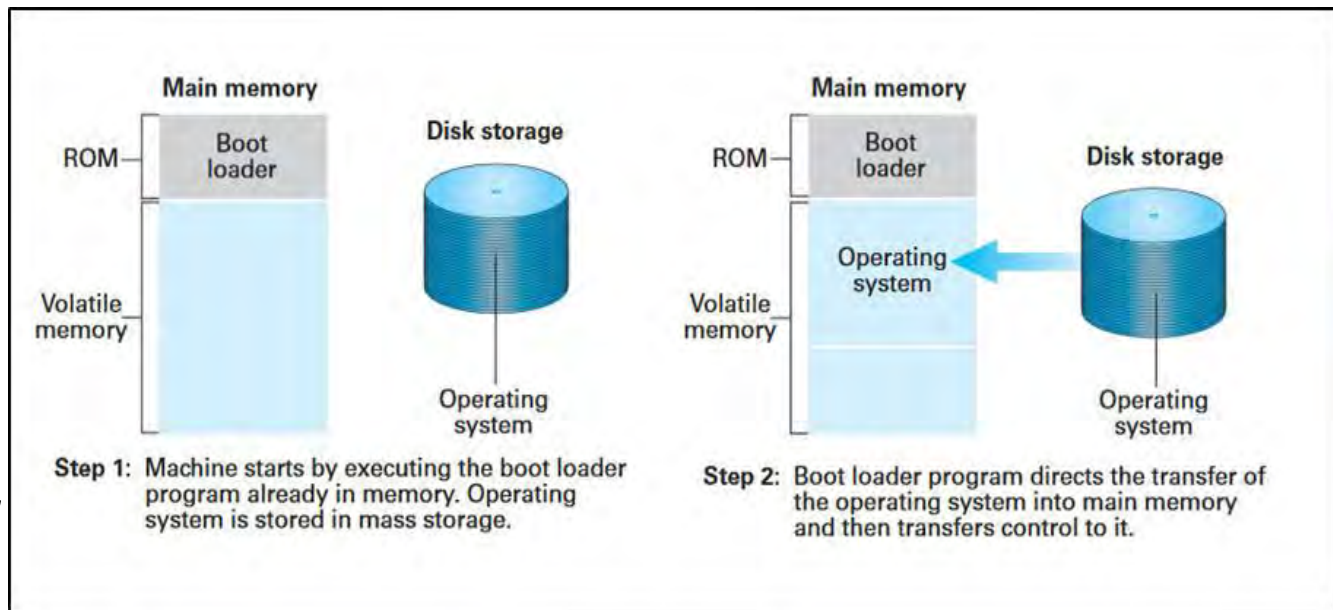


Figure 13 Booting process,
source: Brookshear & Brylow (2015)





4.5 Operating System Distribution

Windows OS is a Microsoft operating system designation.

In 2018, Microsoft launched a major update to the Windows 10 operating system, bringing a host of new features and enhancements .

Linux is recognized as one of the more reliable OS available today.

Currently, the three most widespread mobile operating systems that can be found in smartphones and tablets dominate the mobile market :

Google Android is currently one of the most popular mobile operating systems; it is a Linux-based mobile OS that is available as open source.

iOS - is a mobile operating system created by *Apple Inc.* (USA). Currently, iPhone, respectively iPad is one of the most powerful tools for work, fun and learning. Due to the constant development in this area, the content of this chapter cannot be exhaustive.

source: Brookshear & Brylow (2015)





Try answering the following questions:

1. What is the role of an operating system?
2. List the components and four activities of a typical operating system.
3. Summarize the difference between a "program" and a "process".
4. What is the difference between application SW and utility SW?
5. Characterize the program and programming activity?
6. What is an "algorithm"?
7. Describe the basic OS characteristics.
8. What operating systems (mobile OS) do you know?
9. Summarize the booting procedure.
10. Explain the terms "compatibility" and "multiprocessing".





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5. Networking and Internet

Network Fundamentals



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5.1 Network Fundamentals

The need to share information and resources among different computers has led to linked computer systems, called networks, in which computers are connected so that data can be transferred from machine to machine.

In these networks, computer users can exchange messages and share resources, such as printing capabilities, software packages, and data storage facilities, that are scattered throughout the system.

With the development of communications and, in particular, Internet infrastructure, initially closed corporate information systems were gradually opened up and interconnected with the information systems of other businesses, organizations and business partners.





5.2 The Internet Structure

The basic structure of the Internet is broken up between tier 1, tier 2 and tier 3 carriers (layers):

1. Bone is the highest layer of the Internet hierarchy; this layer holds together the entire Internet. Tier 1 networks are backbone Internet providers that connect directly to the Internet; provides data transfer and routing to the middle (transit) network layer.
2. Medium-sized networks - known as regional or transit networks - lie beneath the backbone network. This layer provides data transfer and routing to the lower (root) layers of the network.
3. Root networks - they are local (LAN, PAN) or urban (MAN) networks. This layer only transfers packets between guests, but not between networks. Most users communicate with this layer.





The arrangement of the connected computers creates a computer network (see Figure 14). Network nodes are either computers or special devices that represent active network elements. Network connectors, respectively transmission paths are made up of cables or wireless technologies. The providers generally supply Internet connectivity for homes and small businesses.

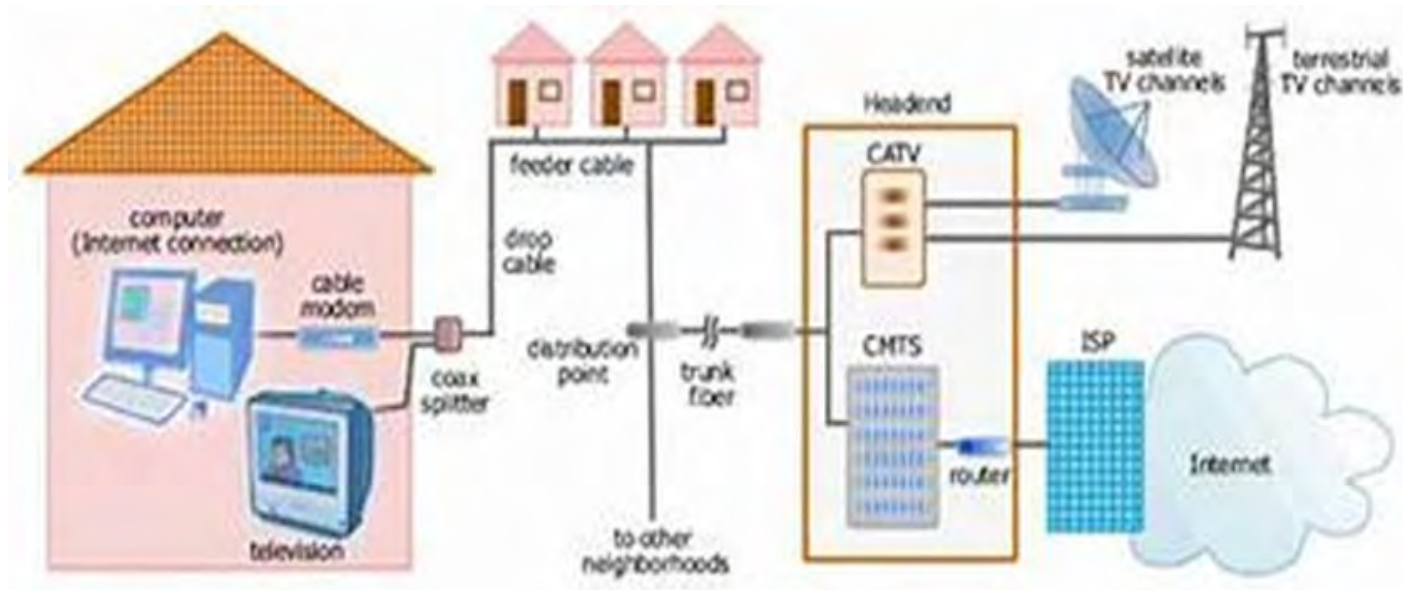


Figure 14 Internet structure

source: Burian (2014)





5.3 Computer Network Classifications

Computer network is classified as:

- a) Local Area Network (LAN),
- b) Metropolitan Area Network (MAN),
- c) Wide Area Network (WAN)

LAN normally consists of a collection of computers in a single building or building complex. For example, the computers on a university campus or those in a manufacturing plant.

MAN is a network of intermediate size, such as one spanning a local community.

WAN links machines over a greater distance – perhaps in neighbouring cities or on opposite sides of the world.





Another means of classifying networks is based on whether the network's internal operation is based on designs that are in the public domain or on innovations owned and controlled by a particular entity such as an individual or a corporation.

A network of the former type is called an open network; a network the latter type is called a closed, or sometimes a proprietary, network.

Computer networks can be classified by:

1. Switching – we divide networks into commutating networks, i.e. circuit switching (e.g. telephone network, ISDN) and packet switched packet (Ethernet) networks;
2. type of transmitted signals is divided into analog and digital;
3. the scope and purpose;
4. network ownership – networks are falling apart into public and private networks





In terms of the types of used computers, networks can be divided into :

1. Homogeneous - all connected computers are of the same kind (Fig. 15)
2. Heterogeneous - there are different kinds of computers in these networks without limitations
3. networks where large mainframes and PC ´s are interconnected.
Typical is the public data network.

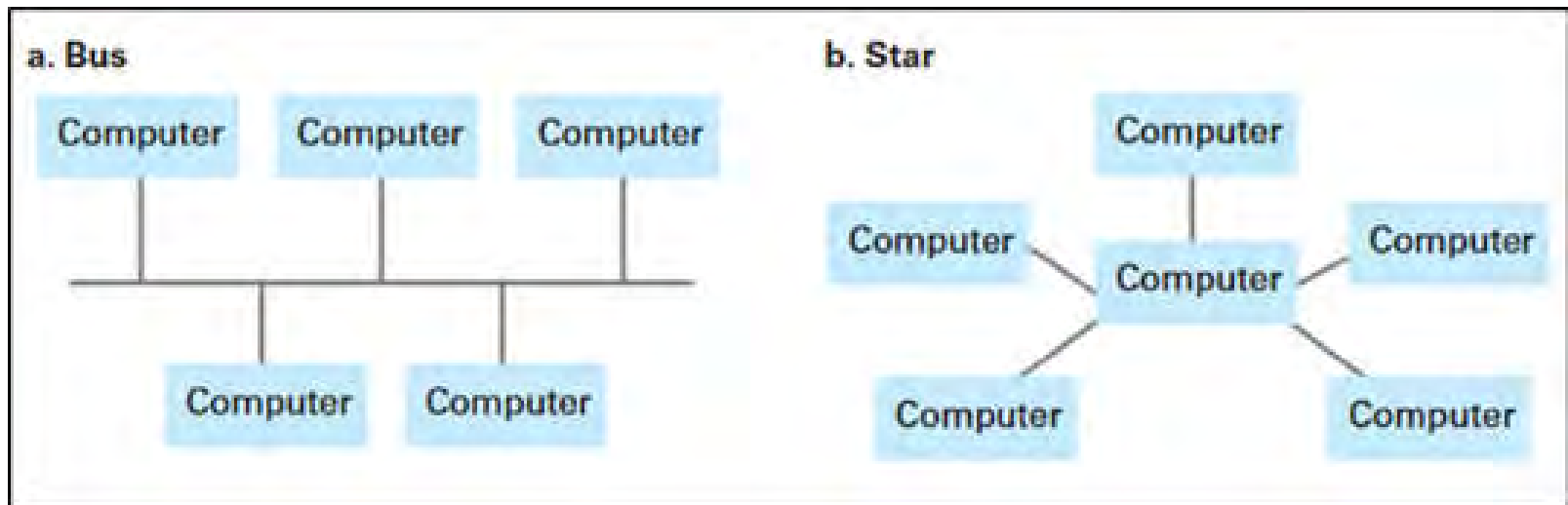


Figure 15 Two popular network topologies

source: Brookshear, 2015, p. 171





5.3 Internet Addressing

Internet needs an internet-wide addressing system that assigns a unique identifying address to each computer in the system > these addresses are known as IP addresses.

Machines throughout the Internet are assigned unique IP addresses.

The ISPs are then allowed to allocate the addresses within their awarded blocks to machines within their region of authority.

For this reason, the Internet has an alternative addressing system in which machines are identified by mnemonic names.

The names of computers on the Internet are made up of pieces called domains.





Internet domain - is a unique name (identifier) of a computer or computer network that is connected to the Internet.

Internet domain - is written as a sequence of domain names separated by dots, with domains arranged in a tree:

- examples of a domain name is *example.com*, *cs.wikipedia.org*.

Top Level Domain - is the top-level domain (TLD) of the domain tree: domains *cz.*, *.sk*, *.eu* are referred to as Top level 1 domains:

- analogically, *sony.com* is a level 2 domain.

Domain Naming System (DNS) is used to convert between names and IP addresses of computers and devices.

DNS is based on the client-server principle.

Each domain has its own administrator who sets the rules here and makes sure they follow them.





5.4 Internet Protocols

Internet is a collection of connected networks.

Coordination is ensured by *protocols* - the standards by which electronic communication and data transfer between two endpoints – most often done by a computer, takes place.

It is a framework for the specification of a network's physical components and their functional organization and configuration, its principles and procedures, as well as communication protocols used.

Protocols consist of a set of rules, formats, and procedures that determine the exchange of data between two or more communicating elements.





The TCP/IP protocol suite is - a practical implementation of a layered network architecture, the ISO reference model.

The main Internet protocols include the TCP/IP family of protocols, including:

- Internet Protocol (IP)
- Transmission Control Protocol (TCP)
- User Datagram Protocol (UDP) and others.

Internet Protocol (IP) is a basic network layer protocol for the whole entire Internet.

- Protocols can be implemented: HW, SW, or a combination of both.
- The most important task of IP is to find a way to the opposite computer.





The IP address is unique to each network adapter across the Internet. Each IP address has two parts (see Figure 16):

- network address and
- network adapter address.

Packet – a fixed block of bytes, consisting of a header, data, and an end portion. Packets can be sent over the network or telephone lines.

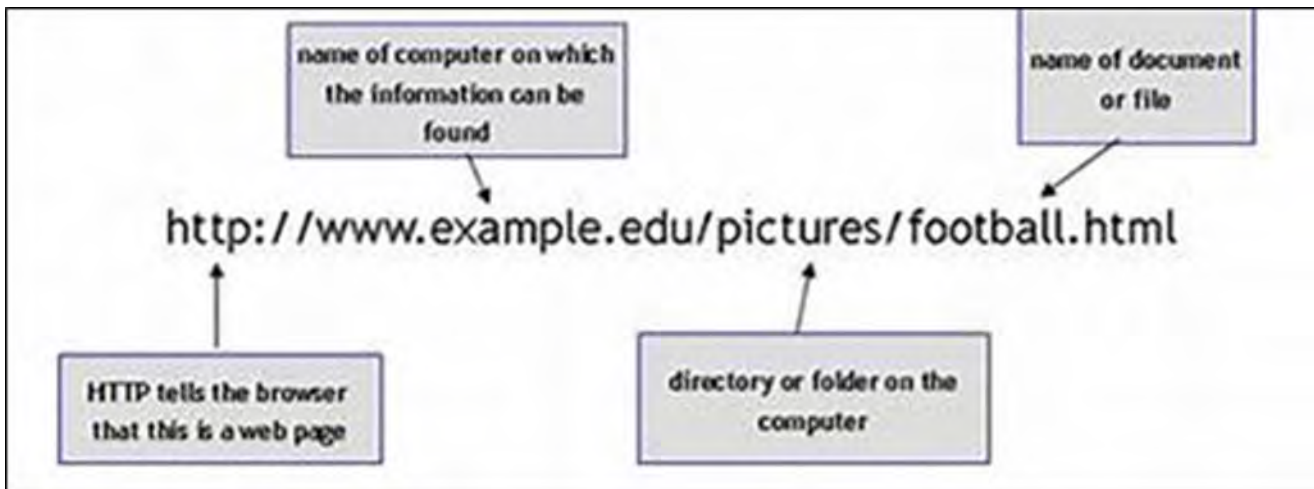


Figure 16 Main parts of the IP address
source: Burian (2012)





IP version 4 protocol (IPv4) - uses 32-bit addresses to address computers. Specifically, it is a four-byte number (four decimal numbers separated by dots) e.g. 195.178.90.249

The way of addressing computers using IPv4, given the increase in the number of computers, is no longer sufficient.

According to Burian (2012), that is why the version 6 (IPv6) protocol, which uses 128-bit addresses, has support for mobile devices, provides greater security functionality, has been developed.

Communication between the same layers is controlled by the communication protocol – a set of rules that determine syntax and meaning of each message in communication.





5.5 Layer Model

Communication and its management are a complex problem that is simplified by dividing it into layers (see Fig. 17). Standardized ISO/OSA model (Open Systems Architecture), is a seven-layer reference model.

TCP/IP Model was developed before OSI Model, and hence, the layers differ.

Concerning the diagram (Figure 17), it is clearly seen that TCP/IP model has four layers namely: Network Interface, Internet, Transport and Application Layer.

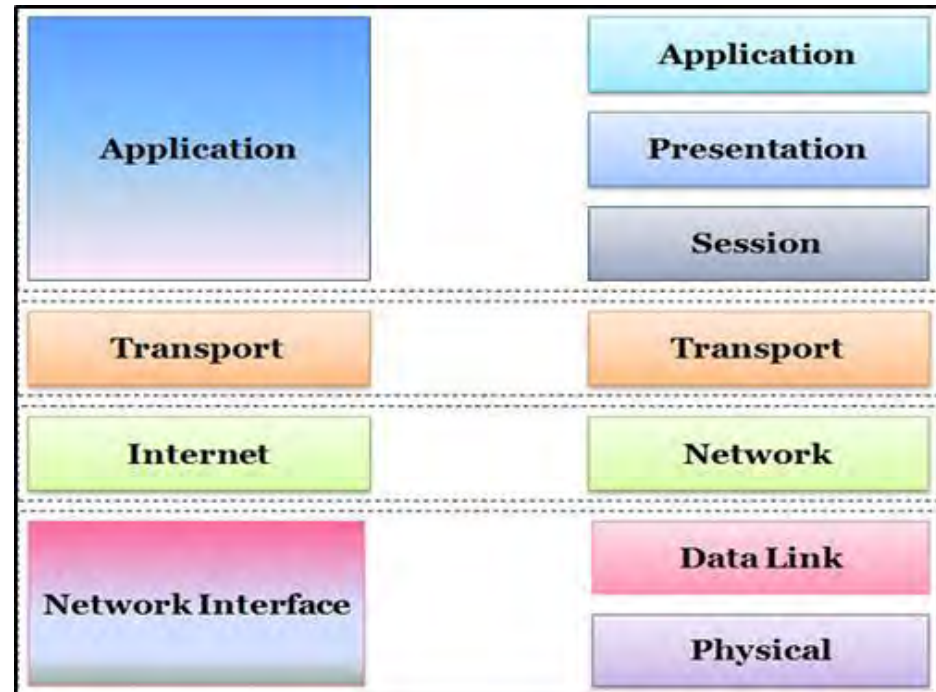


Figure 17 TCP/IP vs. OSI Model
source: Brookshear (2015)





Domain Naming System (DNS) is used - to convert between names and IP addresses of computers and devices:

- DNS is based on the client-server principle.
- The server maintains a database of names, addresses, and other information.

Each domain has its own administrator who sets the rules here and makes sure they follow them.

The client (resolver) queries its local server - it receives a response or a link to another server that is closer to the query solution > in this case, the client repeats the query.

Source: Pužmanová (2007)





5.6 Connect Technology

Technology by which end systems connect to access ISPs is varied:

- Bluetooth is a technology that addresses wireless connectivity between short-range devices.
- Wi-Fi is a standard for wireless local area networks (Wireless LAN, WLAN) and is based on IEEE 802.11 Specifications.
- The strategy is to connect the Access Point (AP) to an access ISP and thus provide Internet access through that ISP to end systems within the AP's broadcast range. The area within the AP's range is often called a hotspot.
- Other popular techniques for connecting to access ISP's use cable or satellite systems.





5.7 Web 2.0, 3.0

With the development of Internet services, there has been a demand for its ability to involve users in shaping information.

- Web 2.0 is a huge data concentration platform that is supported by simple, user-friendly means (wiki systems, blog...)
- It is very common to link different information with geographic systems e.g. (*Flightradar24.com, Weather-forecast.com, Panoramio.com, Windy.com, etc.*).

Web 3.0 (also called as the Semantic Web) - more important aspect is the view of user access to the web, where the original, passive approach, moves to a significantly cooperative way of using the web, where the user has the means to be able to easily create the content:

- it is a site where information is structured and stored according to standardized rules, making it easier to find and process.





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6. Security, ICT Trends and Strategic Technologies

Security Threats and Risks



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6.1 Security Threats and Risks

When a computer is connected to a network, it becomes subject to unauthorized access and vandalism:

- Many of these incorporate the use of malicious software > malware.

Malware has many forms: *computer viruses, Trojans, worms, backdoor, downloader, dropper, dialer, spyware, adware, spam, hoax, rootkit, tracking cookie, phishing etc.*

Annoying programs and messages are imposed on us by someone else to get some information or manipulate us into a certain action:

- These include spyware, hoaxes, and spam.
- Virus activity is very dangerous
- Sites with illegal SW (warez) are the perfect haven for vermin, which puts users at great risk!





Prevention is the most important protection for the fight against viruses > AV system should be an integral part of every PC!

Installing an AV program or getting a firewall is not enough!

The main task of AV programs is to identify the files infected with the virus, respectively - is to cure; the main activity is to fight against viruses.

In terms of searching, identifying viruses and healing infected files, the types of AV controls can be divided into three basic groups:

➤ **single-purpose antiviruses, scanners and antivirus systems.**

Main role is played by the user himself, security SW / HW elements are just a supplement.

Methods of AV Control: Antivirus Test, Heuristic Analysis, Comparative Analysis.





6.2 New ICT Trends and Concepts

Information technology has become an integral part of our daily life. New trends are emerging in the area of ICT and information systems. Gartner Inc. (2019, Feb 20) defines a strategic technology trend as one with substantial disruptive potential that is beginning to break out of an emerging state into broader impact and use, or which are rapidly growing trends with a high degree of volatility reaching tipping points over the next five years.

In this context, there are a number of new concepts: groupware, workflow, business intelligence, cloud computing, big data, the Internet of Things, etc.

Of all these trends, let us mention only those that we consider most important, respectively which we consider significant.





6.3 Top 10 Strategic Technologies

The top 10 strategic technology trends for 2019 are (Gartner, 2019):

1. Human communication technologies – technologies, which communicate with people and vice versa by much more human, more natural.
2. Artificial Intelligence (AI) – the ability to use AI for better decision making, reengineering business models and ecosystems, or for customer experience will remain the driving force behind digital initiatives until 2025.
3. The Internet of Things - key elements are miniature sensors, image recognition technology capable of recognizing people, buildings, and other objects or solutions for payments, typically implemented through mobile phones.





4. **Autonomous Things** - such as robots, drones and autonomous vehicles, use AI to automate functions previously performed by humans.
5. **Empowered Edge** - describes a computing topology in which information processing, and content collection and delivery, are placed closer to these endpoints.
6. **AI-Driven Development** - a model in which the professional developer can operate alone using predefined models delivered as a service.
7. **Augmented Analytics** - focuses on a specific area of augmented intelligence, using machine learning (ML). Augmented analytics capabilities, as a key feature of data preparation, data management, modern analytics, business process management, process mining and data science platforms





8. **Digital Twins** - refers to the digital representation of a real-world entity or system. Gartner (2019) estimates there will be more than 20 billion connected sensors and endpoints. They will collect and visualize the right data, apply the right analytics and rules, and respond effectively to business objectives.

9. **Blockchain** - a type of distributed ledger, promises to reshape industries by enabling trust, providing transparency potentially lowering costs, reducing transaction settlement times and improving cash flow.

10. **Smart Spaces** - is a physical or digital environment in which humans and technology-enabled systems interact in increasingly open, connected, coordinated and intelligent ecosystems.

Multiple elements — including people, processes, services and things — come together in a smart space to create a more immersive, interactive and automated experience for a target set of people.





6.4 Other Trends of Using ICT

According Dugall (February 11, 2019), , other trends in the field of using ICT, which can be found e.g. in the IFA Berlin, the world's most important technology marketplace (see <https://www.ifa-berlin.com>), presented key ICT strategies and technologies that will be of strategic importance to companies:

Other trends in the field of using ICT are (Dugall, 2019):

- Miniaturization of HW, new applications and interfaces for mobile devices – super thin TVs, super lightweight ultrabooks, touch screens and extremely cheap netbooks.
- Nowadays, a new category of high-performance tablets of the new generation is well-established on the market





Big Data: The data explosion has reached unreal dimensions today - the amount of data that needs to be processed often exceeds the current capabilities of commonly available technologies.

- **Future system of payment** – no cash, all transactions in electronic form, which helps companies to increase efficiency of payments and customers increase comfort and safety.

Cloud computing – can be defined as a technology that allows data and applications to be accessed from anywhere.

Smarter things – as mobile robots, the wireless device power, machine-to-machine communication services, mesh network sensors, home health monitoring.

Virtual reality (VR), augmented reality (AR) and mixed reality (MR) are changing the way in which people perceive the digital world.

Process modelling, analysis of social networks, etc.





Try answering the following questions:

1. Characterize computer network and describe what it is for?
2. Classify computer networks in terms of their types, area, purpose.
3. Characterize Internet communication protocols and TCP / IP layers.
4. Which networking technologies do you know?
5. Which wireless technologies do you know?
6. Define the terms "infiltration" and "malware".
7. Characterize the term "computer virus".
8. Which security threats and risks on the Internet do you know?
9. Which main methods of AV Control do you know?
10. What are the basic rules for protection against computer viruses?
11. Identify and characterize the main directions of strategic trends in IT.





6. DISCUSSION AND REFLECTION

*Try to think ... and formulate the
strategic trends in Computer Science*





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Informatics for Economists

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2019

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MINISTERSTVO ŠKOLSTVÍ
MLÁDEŽE A TĚLOVÝCHOVY

INTRODUCTION

This study material is intended for students of computer science as well as for students of the study program of the Faculty of Management and Economics of Tomas Bata University in Zlín. This paper presents an introductory survey of computer science, respects the requirements of today's knowledge society and at the same time reflects the needs of future managers and economists, while maintaining comprehensibility of the content. It gives students an overview of computer science a foundation from which they can appreciate the relevance and interrelationships of future courses in the field. As for computer science students, most begin their studies with the illusion that computer science is programming, web browsing, and Internet file sharing. Yet computer science is much more than this.

Computer science students need exposure to the breadth of the subject in which they are planning to major. Providing this exposure is the theme of this article and study text. Author don't expect any deeper knowledge of some specific areas of informatics, such as algorithmisation, knowledge of programming languages, computer graphics, artificial intelligence, etc.

Finally, I would like to emphasize that subject of informatics is a very dynamic, and some of the information that is mentioned in the text may not be up to date in a few years. At the same time, I recommend that you continue to develop your knowledge and exploring other sources of information.

Zlín, April 2019

Ing. Pavel Rosman, Ph.D.



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1 COMPUTER SCIENCE AND COMPUTING

This chapter covers the framework schema of computer science and contains overarching themes during students acquire new knowledge and competences.

1.1 Information age and knowledge society

Social, technological and economic influences operate globally, and information, information and communication technologies affect and increasingly change our everyday lives. Human potential is a major source of economic values, and education is becoming a lifelong effort for the majority of the population. The fact that information is the driving force of a society, probably no one no doubt. Neither did education avoid the response to dynamic changes in society, including the increase in the amount of information, the globalization of research and education, the competitive environment, demographic changes (Quinn, 2012).

According to Denning & Bell (2012), the present human civilization is characterized by a growing flood of information, and must face a very challenging search, deciding and selecting the right resources, which requires large amounts of energy and time for sorting out such an amount of data and select only those that are needed. People are being forced to change their specialization and have to study continuously to improve their qualifications. The main factor of success in modern society is reliable and fast access to information (European Reference Framework, 2007). It is important not only for individuals, but much more for organizations that need to manage this information (Novotný & Voříšek, 2011).

According to Araya & Peters (2010), information age and information and knowledge society require computer and information literate citizens. Mastering the fundamentals of computer science (not only usage but also correct access to information) must therefore become part of the general education of a modern person (Council of the EU, 2011). As stated in Denning & Bell (2012), neither education did avoid the response to dynamic changes in society, including the increase in the amount of information, the globalization of research and education, the competitive environment, demographic changes. It is therefore essential to prepare the part of the human population that will use these technologies – its education. As stated in Réveszová (2016), it is natural that knowledge in the field of computer science has become part of any education (European Union, 2014).



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1.2 A Brief History of Computing

Computers exist in a wide range of forms, and thousands of computers are hidden in devices we use every day but don't think of as computers such as cars, phones, TVs, microwave ovens, and access cards. Since the advent of computers, individuals and organizations process information digitally. According to Kernighan (2017) this has led to the study of informatics with mathematical, biological, cognitive and social aspects.

The history of *computing hardware* covers the developments from early simple devices to aid calculation to modern day computers that surf the Internet, play games and stream multimedia in addition to crunching numbers. Early mechanical tools to help humans with digital calculations, like the **abacus**, were called "*calculating machines*". The development of computers is a long way to begin with B. Pascal, who built a machine with a built-in mechanical addition algorithm in the 17th century, and G. W. Leibniz extended this solution to all arithmetic operations half a century later. Charles Babbage, in the 19th century, devised the basic principles of the machine for solving complicated calculations and designed the so-called "*analytical machine*", which was already programmable (Brookshear & Brylow, 2015).

The first real computers were made in the 1930s were characterized by large kilowatts, weight (tons) and many unreliable components (relays, tubes). A series of breakthroughs, such as miniaturized *transistor* computers, and the **integrated circuit**, caused digital computers to largely replace analog computers. The technology platform (tubes, semiconductors) broke in 1969 when Intel placed the integrated circuits in one case and created the first **microprocessor**. An important milestone was the commercialization of the IBM personal computer PC in 1982.

A major step toward popularizing computing was the development of **desktop computers**. This created access to computers for the broadest population (Naumann, 2009).

An overview of history of computing is detailed in Encyclopaedia Britannica *History of Computing*, see also at (<https://www.britannica.com>).

As we face the modern challenges of understanding nature's ways of computation, people are asking the same fundamental questions of computer science: What is computation? What is information? What's the difference between Computer Science and Informatics?



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1.3 Computer Science and Informatics

In recent years, several advanced countries have declared the intention to transform their ICT school subject into a new Computer Science, Informatics, or Computing education.

As stated in (Evans, 2011) **Computer science** provides the underpinnings for today's computer applications as well as the study of information processes, computer design, programming, information processing, algorithmic solutions of problems, and the algorithmic process itself (Brookshear & Brylow, 2015).

According to (Kaluža & Kalužová, 2015) **Informatics** is a branch of information engineering. It involves the practice of information processing and the engineering of information systems, and as an academic field it is an applied form of information science. The field considers the interaction between humans and information alongside the organisations, technologies and systems. As stated in (Buřita et al., 2010) as such, the field of informatics has great breadth and encompasses many subspecialties, including disciplines of computer science, information systems, information technology and statistics.

1.3.1 Subject Informatics for Economists

Informatics for Economists is a discipline that seeks scientific understanding of topics such as information processing, data storage, computer networks and the Internet, programming languages, algorithms, software engineering, artificial intelligence, computer graphics, etc. It provides also the underpinnings for today's computer applications as well as the foundations for tomorrow's infrastructure. The discipline provides an overview of selected areas of informatics from the point of view of the needs of the faculty of economic faculties.

As stated in (Buřita & Rosman, 2014) subject is oriented to broad knowledge and basic skills in the informatics area (IT). The main aim of the course is to give an up-to-date view of current state and trends in the field of information and communication technologies. Learning outcomes of the course unit is to gain the complex orientation in modern information and communication technology (ICT). The point is whether students coming from secondary schools are ready to use the offered eLearning tools and the potential to the full. It is natural that knowledge in the field of computer science has become part of any education. Especially for the development of students' key competencies (European Reference Framework, 2007)



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1.4 An Outline of the Overarching Themes

The theoretical part of the paper is divided into six chapters. The introductory chapter (Computer Science and Computing) deals the scope of computer science, develop a historical perspective, and establish a foundation from which to launch our study and closes with the history of computing. Secondary chapter (Data Storage and Encoding) deals with topics related to representing and storing data on computer. In this chapter we look at how information is encoded and stored within modern computers. Chapter covers the data storage of various types, including images, audio and video, including digital photography, sound and video recording and reproduction, and remote communication.

In Chapter 3 (Computer Architecture and Data Manipulation) we investigate computer architecture and the basic internal operations including the data manipulation in a computer. After studying you will be able to classify computers and their basic functions, describe the concept and structure of the current computer, the principle of computer operation and the process of data processing in the computer, identify and characterize major PC components.

Chapter 4 (Operating Systems) deals with the software that controls the overall operation of a computer. It is a computer's operating system that controls the interface between the machine and its outside world, protecting the machine and the data stored within from unauthorized access, allowing a computer user to request the execution of various programs, and coordinating the activities to fulfil the user's requests.

Chapter 5 (Networking and the Internet) is focused on the area networking. The purpose of this chapter is to define the basic principles, characteristics and properties of computer networks. At the end of this chapter you will be able to characterize the basic concepts of computer networks; to describe the components of a computer network, including the communication protocol layers, and technologies of wireless networks. Chapter 6 includes main strategic technology trends and other trends of using ICT for the year in 2019.

Questions and Tasks

1. Characterize the term "informatics". What does it come out of?
2. What he deals "computer science" with? Which problems are solved by this subject?
3. What does deal the subject Informatics for Economists with?



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2 DATA STORAGE AND ENCODING

In this chapter, we consider topics associated with data representation and the storage of data within a computer. We will consider data storage of various types, information encoding, know major types of image, audio and video formats including their standards, and know the main compression methods including their advantages and disadvantages.

"Information is the content of what we are exchanging with the outside world when adapting it and adapting it to it."

Norbert Wiener

2.1 Data, information, knowledge

The increasing dependence of humanity on ICT puts more and more emphasis on data and information. In this chapter we will deal with concepts that are related to the representation of data and their storage in a computer. In order to be well and fast in the world of computers, software and other resources, we must first define its space, basic concepts and their mutual relationships. We will come out of these basic concepts: **data, information, knowledge**.

2.1.1 Definition of basic terms

Data is an expression for data used to describe a state, phenomenon, or property of the object being inspected. Data is therefore a designation for various symbols and numbers that perform the function of objective facts about events. In order to benefit from the data, we need to process them. The data displays the status of the objects or the processes in progress in the reality around us. The term data is understood in the sense of the technical record of reality. Data is obtained by measurement or observation and can be divided into continuous and attributable data. The data can be structured and can be evaluated from a quantitative perspective in terms of costs, speeds capacity. In addition to these quantitative indicators (aspects), qualitative aspects can also be applied:

- **Availability** - whether we have access to them, whether they are available on site and when and where we need them
- **Correspondence** - compliance with what demands we have, what we expect
- **Readability** - ease, accuracy and understanding of the data we have at our disposal.



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Information is one of the basic concepts of cybernetics, science of management in organisms. What people are telling other people is called general information (Rosický, 2010). The term "*information*" derives from the Latin word *informo-informatio-informare*, which means communication, transmission of the message. Information is a general abstract concept that denotes the content or meaning of a message as something that reduces ignorance (entropy) – uncertainty. Thus, according to (Denning & Martell, 2015) the information is processed data that the user understands and interprets to them importance and meaning. Information can include *data, numbers, characters, commands, commands, messages*, and so on (Pavlíček & Galba, 2012). In the concept of information (a signal with information content), cybernetic has revealed the essence of the management process. However, no data can be considered as information, but data that is meaningful to the user, meaning, purpose. The basic characteristics of the information can also include its price. In addition to concepts of data and information, "knowledge" appears as another term (Denning & Bell, 2012).

Knowledge can be understood as an information enriched with our previous experiences, skills, relationships, values, principles, models that are fit for use (Černý, 2015). Informally, we use information to mean knowledge. Knowledge is an important input of production and strategic processes because it enables us to use traditional resources efficiently - traditional production factors (labour, land, capital).

Data and **knowledge** *cannot be replaced* as they are complementary components of the decision process: **data** + **information** (data and links between them) + **knowledge** (information and experience) => **comprehensive knowledge**.

2.2 Data Storage, Information Units

As stated in Vaníček (2007) information on computers is encoded as a *sequence of null and one*. As a basic numerical data representation system, a binary (binary) component is used, which is advantageous in computer science, because two different states can be easily realized. If we have two options and we learn that one of them is true, we get the least amount of information that can get two values - 0 (true, yes, logic 1) or 0 (false, no, logical 0). The basic (and smallest) unit of information is **1 bit** (abbreviated 1 b).



Bit is a digit that can be **0** or **1** that is the basis of the binary system. One bit is an elementary amount of information. The letter “b” is used to express a single bit. It is the information that came from two options, whether a certain year is **true** (logical 1) or **false** (logical 0). If we have only one option, we do not have to make to decision. Examples: circuit closed - open.

Byte is defined as **eight** bits. To represent a group of 8 bits, a single byte unit is used (abbreviated as “B”). It is the smallest unit of information that CPUs can handle on computers. Hence, one byte of information corresponds to eight binary digits, and can distinguish among 2^8 (256) different values. For larger amounts of information, we use metric prefixes, but instead of scaling by factors of 1000 they scale by factors of 2^{10} (1024). Hence, one kilobyte is 1024 bytes; 1 MB is 2^{20} (approximately one million) bytes; 1 GB is 2^{30} (approximately one billion) bytes; and 1 TB is 2^{40} bytes (Brookshear & Brylow, 2015).

According to Null & Lobur (2014), **one byte** expresses a unit into which one character can be saved - a letter, a digit, or another character symbol (for example, characters: + *? @ % etc.). In this way, a total of 256 different symbols of numbers 0 and 1 can be created in 1 B. A rule applies: a single character is stored in one byte. Bit sequences sometimes represent numerical values, but in other cases they represent alphabet characters, images, or sounds.

2.3 Numerical Systems

Numerical system is a way of representing numbers. One set is a set of numbers. Elements of the second set are words compiled from the characters of a particular alphabet. These characters are called digits. The numbers thus consist of an ordered set of symbols, called digits, and the relations between the numbers defined for each arithmetic operation. In the world of computers, three basic systems are used (Sklenák, 2001):

- **binary**, $n = 2$
- **decadic** (decimal), $n = 10$
- **hexadecimal** ($n = 16$),

decimální	128	64	32	16	8	4	2	1	binární
71	0	1	0	0	0	1	1	1	0100 0111
16	0	0	0	1	0	0	0	0	0001 0000
111	0	1	1	0	1	1	1	1	0110 1111
133	1	0	0	0	0	1	0	1	1000 0101
17	0	0	0	1	0	0	0	1	0001 0001
48	0	0	1	1	0	0	0	0	0011 0000

where **n** = *number of elements* of the numerical system.

Binary numerical system (see Fig. 1) uses *only two* symbols 0 and 1. which correspond to two states of the electrical circuit (off and on). The two-digit number can be easily converted to decimal. The maximum value of one byte $[11111111]_2$ is equal to **255**₁₀.



Hexadecimal writing means the entry of a number in a hexadecimal numbering system that uses the digits 0-9 and the letters A-F. The number A thus represents the decimal value 10. Analogically, then B = 11, C = 12, D = 13, 14 = E, 15 = F.

As stated in Vaníček (2007), documents in written or printed form are usually stored on a computer as a set of bytes according to a simplified rule: 1 character = 1 byte. The ALICE name has a 5-byte ASCII alphabet (see Fig. 1).

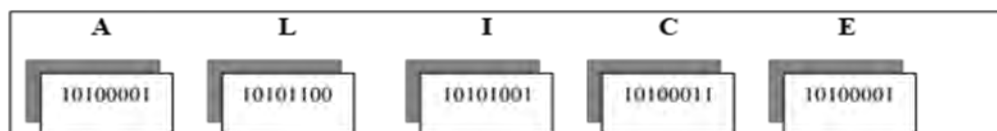


Figure 1 Binary expression of text ALICE source: own processing

2.4 Codes, encoding and data formats

Coding - data, resp. information must be recorded and communicated to each other. There are transfer rules to convert between external information (comprehensible data) and computer data. **Code** is then a rule for uniquely assigning elements of two sets or lists. Such a description is called **encoding** of information (see Fig. 2). Information in the form of text is usually expressed using a code that assigns a unique bit pattern to each of the different symbols (alphabetic, digit, character). The text is then represented as a *long string of bits* in which neighbouring bit strings represent the symbols that follow in the original text.

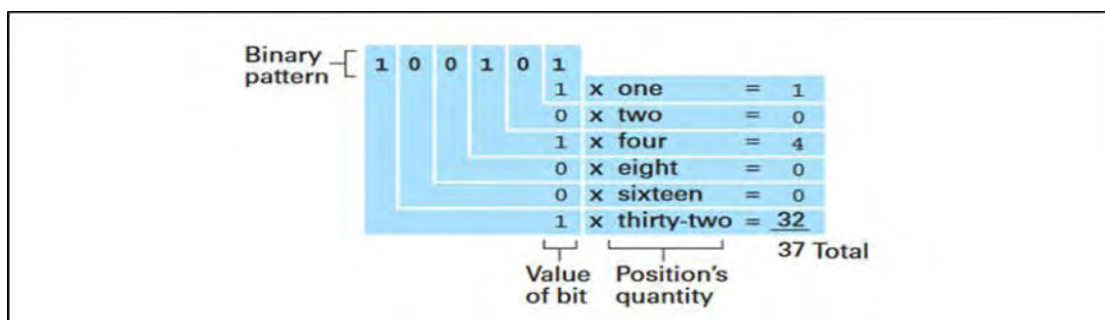


Figure 2 Encoding in the binary numerical system Source: Brookshear, 2013,

For this reason, a **Unicode** character encoding system with a capacity of 65,536 symbols was designed. Unicode is a sixteen-character table of all existing alphabets. Each character can be up to 31 bits long and encryption covers all known character sets (including Japanese and Chinese fonts). The double entry allows you to represent numeric values only with the digits 0 and 1 instead of the digits 0,1,2,3,4,5,6,7,8 and 9 as in the traditional decimal system.

2.5 Data Compression

When saving or transmitting data is often useful, and sometimes it is necessary to reduce the size of the data involved while retaining the underlying information. The technique for accomplishing this is called **data compression**. The goal of compression is to reduce the size of data for more efficient storage or transmission. The purpose of file compression is therefore to reduce the memory space required to store the file. The compressed file is for archiving, data distribution, portable, and does not take up much space in the computer's memory.

As stated in Vlček (2004) compression of data is widely used in practice *to minimize the volume of data* being transmitted. Compression and decompression are sometimes built directly into communication devices and the user cannot see it externally.

2.5.1 General Data Compression Methods

According to Brookshear & Brylow (2015), common user today commonly encounters compressed file shapes. There are a number of methods and compression algorithms for data volume reduction. The user should be able to use one of the compression programs (ZIP, RAR, 7z, ARJ, ACE, LHA, TAR, etc.) to transfer bulky files to their or another computer. Data compression schemes can generally be divided into two categories, recognizing:

1. **lossless compression** - no loss of information occurs during compression. Lossless schemes are those that do not lose information in the compression process. The data is assumed to be reconstructed to the original form (before compression) when reverse engineered. The *result is not different from the original* or even a single bit.
2. **lossy compression** - some information *may be lost*. Lossy schemes are those that may lead to the loss of information. Applied mainly to audio, video, or video. The result after decompression *is not the same* as the original, but it is very *similar*.

Ad a) In situations where data contains long sequences of the same values the compression technique called Run-Length Encoding (RLE), which is a lossless method is used. Another is based on dictionary coding methods. The strongest modern lossless compressors use an arithmetic coding is a more modern coding technique, which that uses the mathematical calculations of a finite-state machine to produce a string of encoded bits from a series of input data symbols (Brookshear & Brylow, 2015).



2.5.2 Compressing Images, Audio and Video

Images can be encoded using bit mapping methods that are quite large. Therefore, many compression formats have been created specifically for *compression of graphics* (images). One of them, called **GIF** (Graphic Interchange Format), is a dictionary coding system. Simplifies the compression problem by assigning one pixel to 256 colours. The combinations of the red, blue, and green components of each of these colours are encoded into three bytes, and those 256 combinations are stored in a table (dictionary) called a colour palette.

Another image compression system is referred to as **JPEG** (Joint Photographic Experts Group) within ISO. Today, it has become *a standard in graphics compression*. This format today uses most digital cameras as a proven format for compressing colour photos. Still another system is **TIFF** (Tagged Image File Format) used by a standardized format for storing photographs along with related information such as date, time, and camera settings.

The most commonly used standards for encoding and compressing **audio and video** were developed by the Motion Picture Experts Group (**MPEG**) encompasses a variety of standards for different applications. The techniques employed by MPEG in general, video compression techniques are based on video being constructed as a sequence of pictures. The best-known system for compressing audio is **MP3**, which was developed within the **MPEG** standards. In fact, the acronym MP3 is short for MPEG *layer 3*. Among other compression techniques, MP3 takes advantage of the properties of the human ear, removing those details that the human ear cannot perceive. As stated in (Brookshear & Brylow, 2015) MP3 can be used to obtain significant compression of audio while maintaining near CD quality sound.

Control questions and tasks

1. Explain the basic difference between "*information*" and "*data*". Give examples.
2. Characterize the terms "*bit*" and "*byte*". What do they label?
3. What is coding for? Which codes do you know?
4. What is data compression? What is its meaning?
5. Characterize the main methods of data compression, advantages and disadvantages.
6. List four generic compression techniques.
7. Specify the three main representatives of the compression programs.
8. Specify some formats for storing audio and multimedia files (video).



3 COMPUTER ARCHITECTURE AND DATA PROCESSING

In this chapter, we'll get to know how computer processes data and communicates with peripheral devices. The presentation is focused on the characteristics and usability of the main components of the computer.

3.1 Computing Hardware

Information and Communication Technologies (ICT) have enabled hundreds of millions of people worldwide to connect to the network and exchange information, news, knowledge, money, photos, music or movies in a way that is unprecedented. The same is true for entire businesses, organizations, their customers, suppliers, and the like all business partners (Meyer, 2005). As stated in (Dohnal & Pour, 2016) nowadays, ICT is now a huge complex of a variety of technical and software resources, tools and systems, and computers interfere with all areas of human activity. Due to developments in this area and to a limited extent, this chapter does not focus on a detailed description of specific components.



Computer hardware includes the physical, tangible parts or components of a computer, such as the cabinet, central processing unit, monitor, keyboard, computer data storage, graphics card, sound card, speakers and motherboard (Horák, 2007). By contrast, *software* is instructions that can be stored and run by hardware. Intermediate between software and hardware is "*firmware*", which is software that is strongly coupled to the particular hardware of a computer system and thus the most difficult to change but also among the most stable with respect to consistency of interface.

According to Dembowski (2009) not only computers, but their classification has been developing. From the point of view of this classification, computer systems with a very high degree of integration are currently being developed, emphasizing the openness to the surrounding systems and the distribution, i.e. the allocation of computing resources to multiple locations (Denning & Martell, 2015).



3.1.1 Computer Classification

The development of the 5th generation consists in the application of artificial intelligence and the development of communication with the computer in natural language. The basic criteria used today by performance and area of use are *internal architecture, processor speed, internal memory range, external memory capacity, device output speed, user count, and cost*. According to Dembowski (2009), this classification, the basic groups of computers are distinguished:

1. supercomputers;
2. desktop computers - mainframes;
3. middle class computers - servers and powerful work-stations;
4. personal computers (desktop, portable and network computers);
5. computers for non-personal use: (control of technological processes, etc.).



3.1.2 Computer Architecture

The organization of a computing machine is often called as **architecture**. There are **two** basic concepts of computer design (Horák, 2009):

1. **von Neumann's** diagram uses one common electronic memory for program and data;
2. **Harvard architecture** – uses separate memory for data and for program.

Von Neumann architecture (see Fig. 3) concept has **five** main modules - basic hardware components and a bus connecting these components; computer stores program data and instruction data in the same memory. Computer with a **Harvard architecture**, uses separate memories for storing program and data. The Harvard schematic is used on single-chip computers (tablets, mobile phones, etc.).

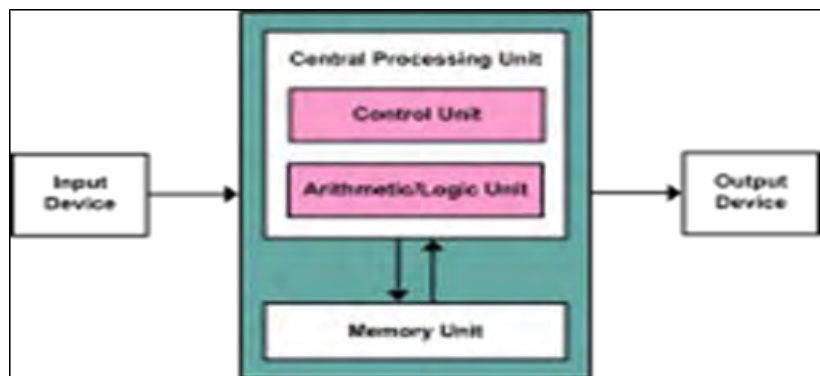


Figure 3 Von Neumann architecture Source: own processing

Through last decades the computers generally became both **smaller** and **faster**, which led to evolutions in their architecture. Current computers *are not designed* consistently according to one of the two basic schemes (see previous chapter). Universal personal computers contain **only one** internal (operating memory), where programs and processed data are placed.

3.2 Computing Systems

A combination of hardware and software forms a usable **computing system**. A computing system is a combination of program and machine although other systems exist with only hardware components. The program causes the machine to calculate a function. We can also say that the computing system calculates a function. To make all this work, computing system needs (Brookshear & Brylow, 2015):

- Precise specification of the set of instructions implemented by the hardware.
- A precise method to represent a program as a series of instructions.
- A memory that stores the program and the data on which it operates.
- A control unit that reads and executes instructions of a program in the order prescribed by the program.

Computing systems generally consist of **three main** parts (Minasi, 2005):

1. **central processing unit** (CPU) which executes instruction and processes data,
2. **memory** (RAM, ROM) that holds the programs and data to be processed,
3. **I/O (input/output) devices** as peripherals that communicate with the outside world.

The processor (CPU) is the "*brain*" of the computer, it processes the instructions of the programs that control its operation, and thus actually performs the specified task. CPU consists of a **controller** and an **arithmetic-logic unit** (ALU). The core of each processor is an integrated circuit that can handle a set of microinstructions - simple commands. The processor family that processes the same machine code is the processor architecture. As technology allows more and more electronic circuits to be mounted on a single silicon chip, physical barriers between computer components are also diminishing. For example, a single chip may contain both the processor and the memory. Current state-of-the-art technologies allow multiple complete processors to be placed on a single chip. On this architecture, multi-core processors are built that contain two or more processors along with a shared cache on one chip.



As stated in Cady (2010) CPU is a complex electronic component located on the **computer motherboard** (motherboard) which integrates the *processor, internal memory, bus* and *interface* to connect additional components. The general computer structure currently distinguishes **8** components - processor, motherboard, bus, internal and external memory, input and output devices, and communication devices (Meyer, 2005).

Memory is used to *store data* and *programs*. The memory circuits are fixed with the processor on the computer motherboard. It is divided into a read-only ROM and a read-write RAM. Memory “**cache**” balances different processor and main memory speeds. External memory (HDD, optical discs) is the memory used to permanently store information (programs and data). The input device converts the input data into electronic form (Horák, 2007).

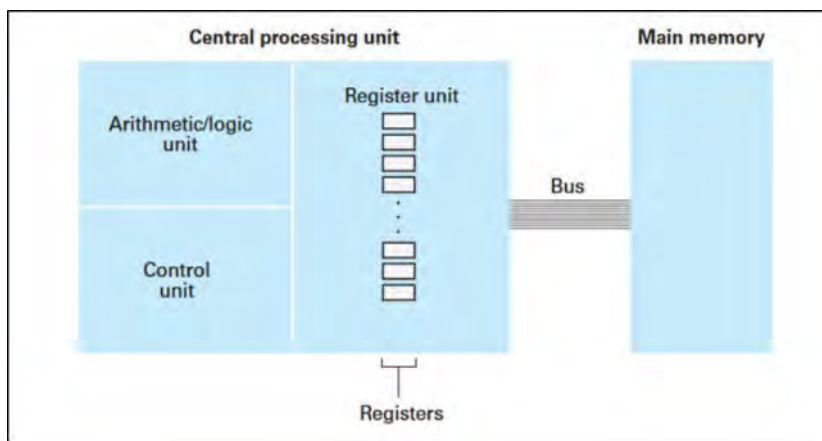


Figure 4 CPU and main memory connected via bus
source: Brookshear, 2015, p.94

Computer speed is also influenced by the number of processors (called **multiprocessing**). Each task is divided into smaller parts that are processed simultaneously.

The condition for using multiprocessing is its

support by the operating system. The output device converts electronic data into a user-friendly form. Computer components are connected by **buses**. Brookshear & Brylow (2015) divide them by analogy to *data, address* and *control* buses (see Fig. 4).

The computer is controlled by the user, which provides input data for processing through input devices and presents the results using output devices. Computers are getting smaller, thinner, and more lightweight with every new generation of consumer technology.

Portable devices differ in size, shape and application. According to type and design we distinguish *notebooks, netbooks, ultrabooks* and *tablet PCs*. As the name implies, a portable device simply means something that is small and lightweight enough to move around and carry with relative ease (Pavlíček & Galba, 2012).

3.3 Processor Properties

Processor architectures use a variety of technologies, resulting in significant features that we will now summarize. These are processor performance and instruction set, word length (internal bus width), production technology, interrupt system, memory management, protection, and more. Processor performance has a significant impact on the speed of your entire computer. It is expressed in the number of comparable operations per second (Meyer, 2005). It is given in **MIPS** (Million Instruction per Second) units.

Cady (2010) describes three fundamental factors affect CPU performance:

1. **word length** - the number of bits a processor can process at any given time;
2. **clock frequency** - number of cycles performed by the processor in 1 sec (in GHz);
3. **bitrate** - the number of bits that are passed between the processor and the internal memory or other components at a given time.

Each processor is equipped with an instruction set of commands. The processor reads the instruction from the memory and then executes the program. According to Minasi (2005), the internal architecture, processors are divided into:

- **RISC** with fewer instructions
- **CISC** with a large number of instructions.

The RISC-based processor is equipped with a basic set of frequently used instructions. If a more complex operation is needed, the processor will "build" it from the basic set instructions. RISC processors are used, for example, in mobile phones, because simpler architecture is reflected in lower power consumption. RISC processors are used in powerful workstations, servers and supercomputers (Sun, IBM, HP).



3.3.1 Main producers

One of the largest chip manufacturers is **Intel Corporation** (USA), which is today the world's largest manufacturer of semiconductor circuits. In addition to personal computer processors, it produces chipsets, flash memories and multimedia equipment (electronic microscopes and web cameras). The increase in power is no longer by increasing the frequency, but by the number of cores in the processor itself. The latest chip architecture is already focusing on hybrid technology that combines processor and graphics chip performance.



IBM (International Business Machines Corporation) is one of the largest IT companies in the world. Its core business today is the manufacture and sale of computer hardware and software. The company is based in New York, USA. **Advanced Micro Devices** (AMD) is a leading manufacturer of processors in the US that has become the world's leading graphics chip manufacturer. AMD focuses mainly on the development of processors, graphics cards and chipsets. **Motorola, Inc.** is another leading US manufacturer of mobile integrated electronic circuits, mobile phones, mobile terminals, wireless networks and other devices. In addition to processors for computers, Motorola manufactures chipsets, flash memories, telecommunications chipsets, as well as complete communications devices.

3.4 Data and Information Processing



Data processing (see Fig. 5.) on the computer is as follows: the program is first loaded into the internal memory. From there, instructions for data processing are gradually selected. The input data is converted to electronic form by input devices so that it can be processed by a processor that also controls the entire computer. The processed data are temporarily stored in the internal memory, eventually in the cache. Subsequently, they are transferred to/from the processor and stored in external memory (e.g. hard disk) after processing (Meyer, 2005).

After data transmission and processing, the output device then converts the data from the electronic form to a user-friendly form (print, monitor).

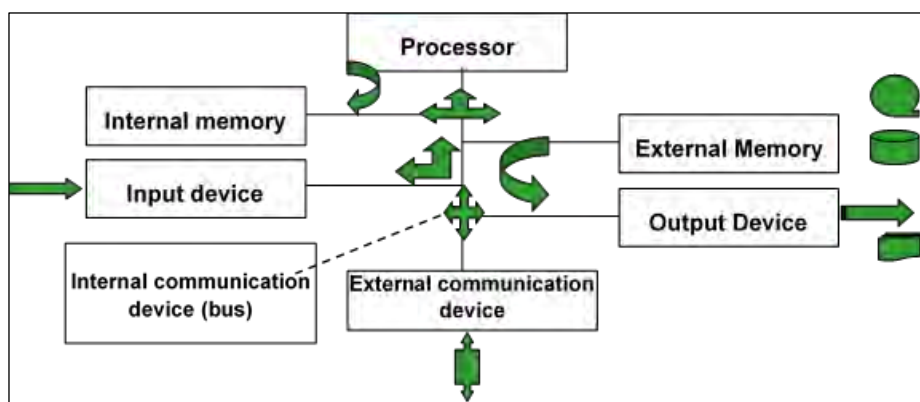


Figure 5 Computer data processing

Source: own processing

All computer components are interconnected by internal communication devices - buses. The external communication device then allows to connect several computers to each other.

3.4.1 Information processing

Information processing is the change (processing) of information in any manner detectable by an observer. As such, it is a process that describes everything that happens (changes) in the universe, from the falling of a rock (a change in position) to the printing of a text file from a digital computer system (Denning and Bell, 2012)

As stated in Brookshear & Brylow(2015), an **information processing system**, as its name suggests, is a system (be it electrical, mechanical or biological) which takes information (a sequence of enumerated symbols or states) in one form and processes (transforms) it into another form, e.g. to statistics, by an algorithmic process. An information processing system is made up of four basic parts, or subsystems (see Fig. 6): input, processor, storage, output. An object may be considered an information processor if it receives information from another object and in some manner changes the information before transmitting it.

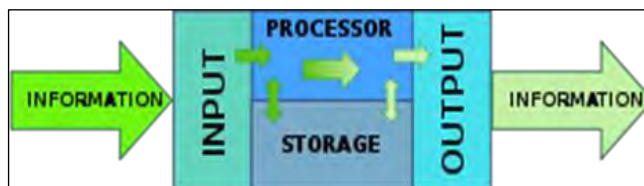


Figure 6 Information processing Source: own

3.5 Program Execution

A computer follows a program stored in its memory by copying the instructions from memory into the CPU as needed. Once in the CPU, each instruction is decoded and obeyed. The CPU performs its job by continually repeating an algorithm that guides it through a three-step process known as the machine cycle. The steps in the machine cycle are **fetch**, **decode**, and **execute** (Fig. 7). During the fetch

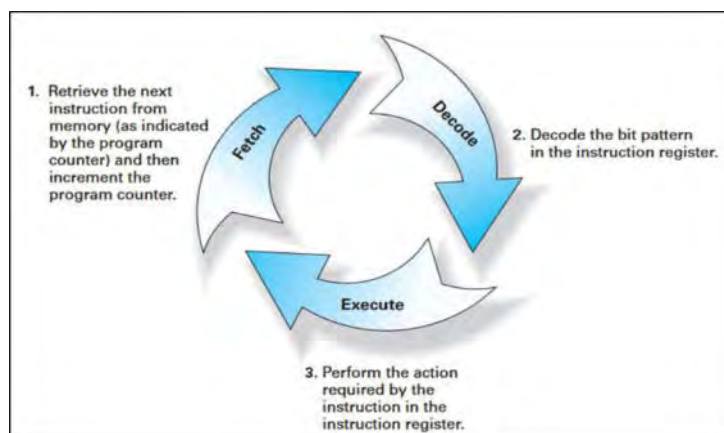


Figure 7 The machine cycles

Source: Brookshear, 2015, p.104

step, the CPU requests that main memory provide it with the instruction that is stored at the address indicated by the program counter. The CPU places the instruction received from memory in its **instruction register** (Brookshear & Brylow, 2015).

With the instruction now in the instruction register, the CPU decodes the instruction, which involves breaking the operand field into its proper components based on the instruction's opcode. The CPU then executes the instruction by activating the appropriate circuitry to perform the requested task. Once the instruction in the instruction register has been executed, the CPU again begins the machine cycle with the fetch step. Observe that since the program counter was incremented at the end of the previous fetch, it again provides the CPU with the correct address (Null & Lobur, 2014).

3.5.1 Communicating with Other Devices

Communication between a computer and other devices is normally handled through an intermediary apparatus known as a *controller* (Cady, 2010). A controller translates messages and data back and forth between forms compatible with the internal characteristics of the computer and those of the peripheral device to which it is attached. Originally, each controller was designed for a particular type of device; thus, purchasing a new peripheral device often required the purchase of a new controller as well. Recently, steps have been taken within the personal computer arena to develop standards, such as the universal serial bus (USB) and FireWire, by which a single controller is able to handle a variety of devices.

According to Brookshear & Brylow (2015), a single USB controller can be used as the interface between a computer and any collection of USB-compatible devices.

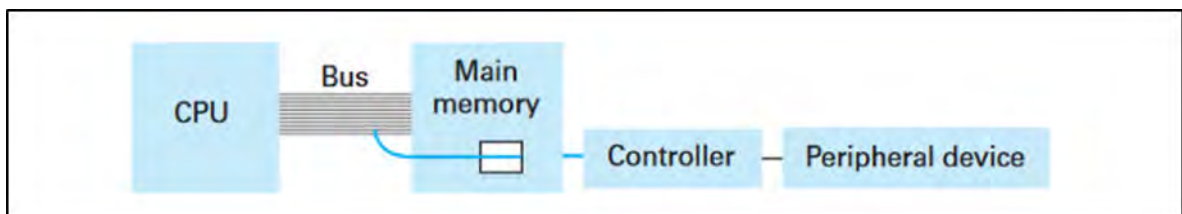


Figure 8 Conceptual representation of memory mapped I/O
source: Brookshear, 2015, p.116

Compatibility is understood to be the consistency of the processor instruction set and sometimes the compliance of the electronic terminals. If only the instruction set is the same, it is software compatibility, if the hardware / terminals is identical, hardware compatibility. Users and programmers are also generally interested in backward compatibility. This is the compatibility of newer hardware versions with older versions (Pavlíček & Galba, 2012).

3.6 Computer Speed, Multiprocessing, Pipelining

Computer speed is affected by the number of processors. Higher categories of computers are equipped with several processors, allowing for parallel processing, called **multiprocessing**. Multicore processors are built that contain two or more processors along with a shared cache on a single chip. The issue of processors is quite extensive. Each task is divided into smaller parts that are processed simultaneously. Manufacturers offer processors in different type ranges with different cache sizes and frequencies (Brookshear & Brylow, 2015).

According to Toman (2011), the condition for using multiprocessing is its *support by the operating system*. An example of how a computer's throughput can be increased without requiring an increase in execution speed involves **pipelining**, which is the technique of allowing the steps in the machine cycle to overlap. As stated in Pavlíček & Galba (2012), pipelining can be viewed as a first step toward parallel processing, which is the performance of several activities at the same time. However, true parallel processing requires *more than one processing unit*, resulting in computers known as **multiprocessor machines**.

The hardware issue is extensive and hardware development is constantly taking place. The issue of processors is quite extensive. You can also find up-to-date information on the issue of computer hardware on specialized servers with the given issue (www.svethardware.cz, www.mobilmania.cz, www.itbiz.cz, etc.) and in the resources at the end of this study material.

Control questions and tasks

1. Classify computers by generation, performance, and usage area.
2. Specify the main components of your personal computer.
3. Which basic computer concepts do you know? How does it differ?
4. Describe the principle of operation and processing of data in the computer.
5. Processors - characteristics, functions, main parts, types, division, manufacturers.
6. Motherboard - meaning, function, main parameters and components, manufacturers.
7. What function does the bus perform and how do we divide it?
8. Internal and external memories - basic distribution, main types.
9. Which I/O devices do you know. Which pointing devices?
10. Explain the terms "*compatibility*" and "*multiprocessing*"



4 SOFTWARE AND OPERATING SYSTEMS

This chapter is focused on topics related to computer software and the operating systems which are software packages that coordinate a computer's internal activities as well as oversee its communication with the outside world. It is a computer's operating system that transforms the computer hardware into a useful tool.

4.1 Operating System

According to Brookshear & Brylow (2015), *computer software* is a collection of data or computer instructions that tell the computer how to work. This is in contrast to physical hardware, from which the system is built and actually performs the work. In computer science and software engineering, computer software is all information processed by computer systems, programs and data. Software includes computer programs, libraries and related data. To understand the composition of a typical operating system, we first consider the complete spectrum of software found within a typical computer system. Then we will concentrate on the operating system itself.

4.2 A Software Survey

Computer software (SW) is a set of computer programs located on your computer. The software is created by *programming*. The **program** is a form of expressing the process of solving a task on a computer. The program controls the operation of the computer and is a means of communication between man and computer, respectively between computers. The program determines what operations, and in which order the computer should perform, what data it should process, where it will be taken and where it will store the results (Toman, 2011).

The **process** is a running computer program loaded into the computer's memory. Another way to process a program is to interpret it (by command). The **algorithm** is a general procedure for solving a given task. Its content is a clear procedure for solving the problem on the computer. Then *algorithmisation* is the ability to understand the problem solved, to analyse it, to decompose it into substeps and describe it so that the solution of the problem always leads to a clear result. Therefore, the **program** is writing an algorithm in the selected programming language which contains instruction sequences that are executed by the processor.



As stated in Pavlíček & Galba (2012), **programming** is an activity that involves creating an algorithm and a program. A number of programming languages have been created (Assembler, Cobol, Fortran, Pascal, Basic, PL1, C, Perl, Java, Delphi, etc.). For *system programming*, C (C ++, C #) and Java for the J2EE (Java 2 Enterprise Edition) development environment are currently being used. The most common types of programs currently being created include web applications, run in an Internet environment, controlled from an Internet browser. For easier and more efficient programming, the programming language is part of the development environment that helps the programmer *create and verify* the program. In particular, Active Server Pages (ASP) or Personal Home Pages (PHP) are used to program web applications (Kaluža & Kalužová, 2012).

4.3 Software Classification

To understand the composition of a typical operating system, we first consider the complete spectrum of software within a typical computer system. Then we will concentrate on the operating system itself. According to Brookshear & Brylow (2015), let us begin by dividing a machine's software into two broad categories (see Figure 9):

1. basic (system) software (e.g. operating system, firmware, utility software, etc.),
2. application software (ASW).

Basic software or also system software is a computer software that allows the application software to run or process. Typical representative of system software is operating system, firmware and development environment for creating application SW. Within the class of system software are two categories: one is the *operating system* itself and the other consists of software units collectively known as **utility** software (Kaluža & Kalužová, 2012).

Firmware is software that is firmly embedded in hardware. For example, the Basic Input/output System (BIOS) of the computer in Read Only Memory (ROM). Other instances of utility software include software to compress and decompress data, software for playing multimedia presentations, and software for handling network communication (Horák, 2007).

Application software (ASW) is designed and created to handle a specific task type or to solve a particular problem. ASW consists of the programs for performing tasks particular to



the machine's utilization. Examples of ASW include *spread sheets, database systems, desktop publishing systems, accounting systems, program development software, etc.*

4.4 Operating System and Classification

An operating system of the computer is *the software that controls the overall operation* of a computer. The operating system (OS) is generally a set of programs responsible for allocating computer resources, such as memory, processor, disk drives, and peripherals (printers, monitors, modems, mice, keyboards to applications being processed and used effectively.

The OS is then a set of programs for its operation, enabling efficient use of computer resources (hardware) and

easy user work. OSs used for different levels of computers and designed for different goals differ in their complexity, the scope of the functions they provide. Network OS coordinates the functions of a computers,

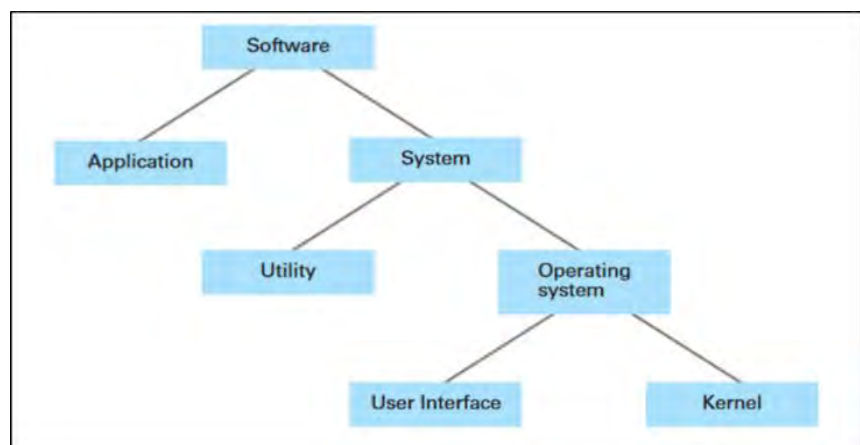


Figure 9 Software classification,
source: Brookshear, 2015, p. 145

monitors communication in a computer network, and is certainly more complex than an OS for PC users. According to Brookshear & Brylow (2015), OS can generally be divided:

1. Based on the number of **users** per OS and multiuser OS. Multi-user OS must ensure that multiple users access the system simultaneously.
2. According to the number of **processed jobs** (programs) per single and multi-program which allow OSs to run multiple programs at the same time (multitasking).
3. Based on the **collaboration** of system resources of the server with client (user) architecture applications:
 - a) **Host-Terminal** (all resources are run on the server and the user works with a terminal without any intelligence)

- b) **File-Server** (system resources work both on the server and on the client, and data must be moved from server to client for full-file processing)
 - c) **Client-Server** (system resources work both on the server and on the client and the processed data is transferred to the client according to the requirement).
4. Depending on the **type of processing**:
- a) **Multitasking**, i.e. running multiple programs simultaneously
 - b) **Multiprocessing** - simultaneous processing of programs on a multiprocessor PC
 - c) **Batch processing** – the execution of jobs by collecting them in a single batch, then executing them without further interaction with the user. In batch processing systems, the jobs residing in mass storage wait for execution in a job queue (see Figure 10). A queue is ordered as first-in, first-out (FIFO).

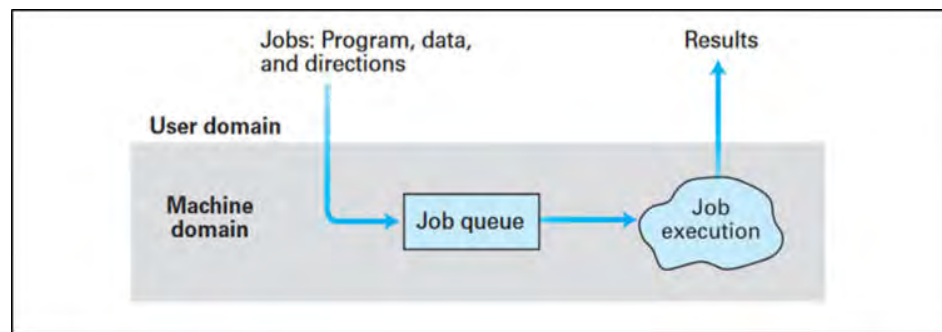


Figure 10 Batch processing

source: Brookshear, 2015, p.141

- d) **Real-Time (interactive) processing** – to ensure immediate PC response, such as patient life monitoring, power plant management, etc. To accommodate these needs, new operating systems were developed that allowed a program being executed to carry on a dialogue with the user remote terminals (see Fig. 11).

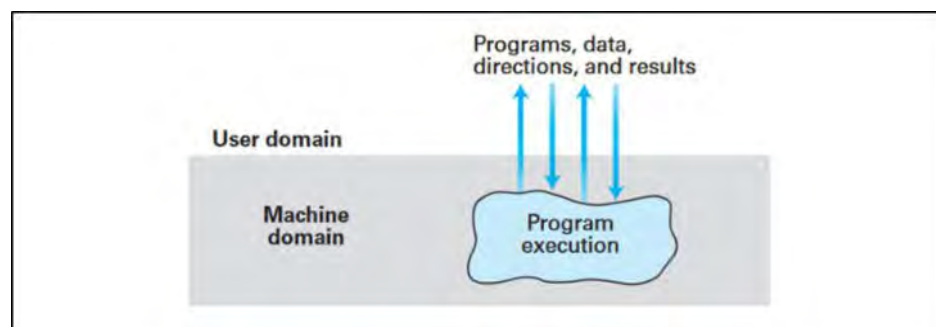


Figure 11 Interactive processing

source: Brookshear, 2015, p. 142

4.4.1 Booting Process

As stated in Brookshear & Brylow (2015), an operating system provides the software infrastructure required by other software units, but we have not considered how the operating system gets started. This is accomplished through a procedure known as *boot strapping* (often shortened to **booting**) that is performed by a computer each time it is turned on. It is this procedure that transfers the operating system from mass storage (where it is permanently stored) into main memory (which is essentially empty when the machine is first turned on).

A CPU is designed so that its program counter starts with a particular pre-determined address each time the CPU is turned on. It is at this location that the CPU expects to find the beginning of the program to be executed. Conceptually, then, all that is needed is to store the operating system at this location. According to Brookshear & Brylow (2015), for technical reasons, a computer's main memory is typically constructed from volatile technologies — meaning that the memory loses the data stored in it when the computer is turned off. Thus, the contents of main memory must be replenished each time the computer is restarted.

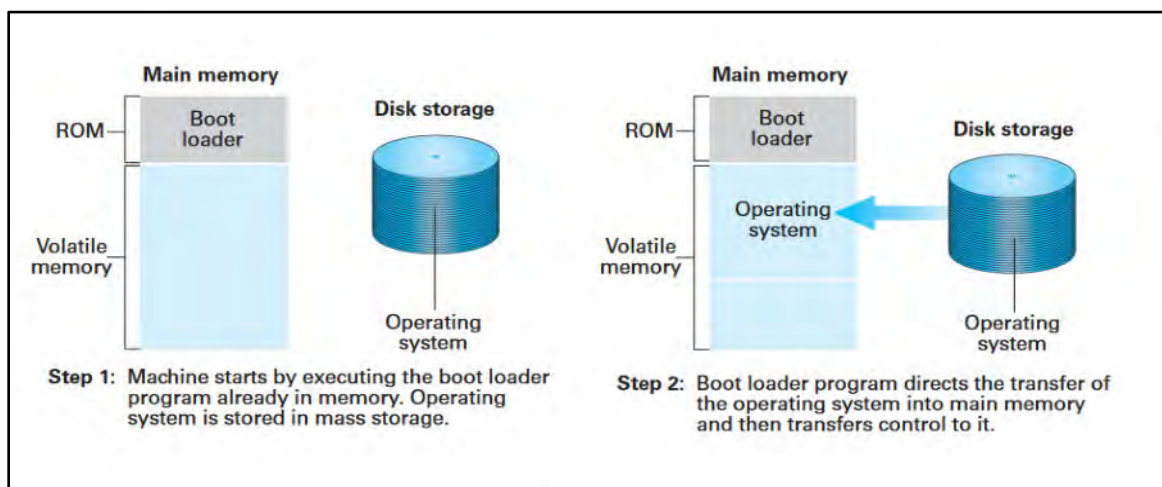


Figure 12 The booting process

source: Brookshear, 2015, p. 151

In a general-purpose computer, a program called the *bootloader* is permanently stored in the machine's ROM. This, then, is the program that is initially executed when the machine is turned on. The instructions in the boot loader direct the CPU to transfer the operating system from a predetermined location into the volatile area of main memory (see Figure 12). Modern boot loaders can copy an operating system into main memory from a variety of locations.

4.4.2 Main Components of an Operating System

Let us focus now on components that are within the domain of an operating system (OS). In order to perform the actions requested by the computer's users, an operating system must be able to communicate with those users. More modern operating systems perform this task by means of a graphical **user interface** (GUI) in which objects to be manipulated, such as files and programs, are represented pictorially on the display as icons. These systems allow users to issue commands by using one of several common input devices (Hužvár & Laco, 2014).

An important component within today's GUI shells is the **window manager**, which allocates blocks of space on the screen, called windows, and keeps track of which application is associated with each window. When an application wants to display something on the screen, it notifies the window manager, and the window manager places the desired image in the window assigned to the application. As stated in Brookshear & Brylow (2015), two additional components within the kernel of an operating system are the **scheduler** and **dispatcher**, which we will study in the next section. For now, we merely note that in a multiprogramming system the scheduler determines which activities are to be considered for execution, and the dispatcher controls the allocation of time to these activities.

4.4.3 Operating System Distribution Microsoft

Windows OS is a Microsoft operating system designation. They all have a graphical user interface, but they differ in the kernel used, the level of multitasking support (simultaneous multiple task execution) and the libraries used and the purpose of use. Microsoft Windows 10 is an operating system designed for use on desktops, laptops, tablets, smartphones, and other devices. The goal is to make the work easier for users. It also diagnoses network problems, implements network protocol stacks, and supports IPv6 (Burian, 2012).

In 2018, Microsoft launched a major update to the Windows 10 operating system, bringing a host of new features and enhancements (Microsoft CZ., 2018). Windows has touch controls, you can browse the web more easily, enlarge photos, and more. For more information you can visit the web site at <https://www.novinky.cz/internet-a-pc/testy/472451-windows-10-dostala-nova-vylepseni.html/> (Note from author).



4.4.4 Operating System Distribution Linux

For the computer enthusiast who wants to experiment with the internal components of an operating system, there is Linux. It is a non-proprietary product and available, along with its source code and documentation, without charge. Because it is freely available in source code form, it has become popular among computer hobbyists, students of operating systems, and programmers in general. Moreover, Linux is recognized as one of the more reliable operating systems available today. For this reason, several companies now package and market versions of Linux in an easily useable form, and these products are now challenging the long-established commercial operating systems on the market. You can learn more about Linux from the Web site at <http://www.linux.org>.

4.4.5 Mobile Operating Systems

Currently, the three most widespread mobile operating systems that can be found in smartphones and tablets dominate the mobile market (Brookshear & Brylow, 2015). It's **Android** from Google, **iOS** from Apple and the latest and member of Windows Phone. However, right now, Microsoft has announced that it will no longer be taking care of this system.

Google Android is currently one of the most popular mobile operating systems. It is a Linux-based mobile operating system that is available as open source. Android operating system is an extensive open source platform that was developed especially for mobile devices (smartphones, navigation, smart TVs, etc.).

iOS - is a mobile operating system created by Apple Inc. iOS (with iOS) raised the bar of the mobile operating system among the most advanced in the world. Currently, iPhone, respectively. iPad is one of the most powerful tools for work, fun and learning.

BlackBerry has been the largest smart phone manufacturer in the world. However, after Apple and its iPhone, it was no longer enough to keep up with its competitors. BlackBerry has been struggling with declining sales of its smartphones for the past few years.

Note from author: Due to the constant development in this area, the content of this chapter cannot be exhaustive. For obtaining up-to-date information, it is possible to draw from internet sources, respectively purchasing professional literature that is on the market and is tracking relatively fast OS changes. Source:



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4.4.6 Security, software engineering

An important task performed by operating systems is to protect the computer's resources from access by unauthorized personnel. Since the operating system oversees the activities in a computer, it is natural for it to play a vital role in maintaining security as well. Security includes protection from unauthorized access and file recovery when the computer system is compromised. In the broad sense, this responsibility manifests itself in multiple forms, one of which is reliability. Thus, the security of a computer system requires a well-designed, dependable operating system. It permeates the entire software development spectrum and constitutes the field of computer science known as **software engineering** (Kernighan, 2017).

Control questions and tasks

1. What is the role of an operating system?
2. List the components and four activities of a typical operating system.
3. Summarize the difference between a "*program*" and a "*process*".
4. What is a role of the multitasking operating system?
5. What is the difference between application software and utility software?
6. What program resources and languages do you know and how do they break down?
7. Characterize the program and programming activity?
8. What is an algorithm?
9. Describe the basic OS characteristics.
10. Summarize the booting procedure.
11. What operating systems do you know?
12. What mobile operating systems do you know?
13. Specify Windows and Linux OS options.
14. Explain the terms "*compatibility*" and "*multiprocessing*".
15. Describe the possibilities of acquiring software legally.
16. Talk about SW software engineering.



5 NETWORKING AND THE INTERNET

This chapter is focused on the area networking, which encompasses the study of how computers can be linked together to share information and resources. Our study will include the construction and operation of networks, applications of networks, and security issues. In this section we investigate how messages are transferred over the Internet.

5.1 Network Fundamentals

The need to share information and resources among different computers has led to linked computer systems, called networks, in which computers are connected so that data can be transferred from machine to machine. Most people now have a bank account that is accessible to them through the Internet. In these networks, computer users can exchange messages and share resources—such as printing capabilities, software packages, and data storage facilities—that are scattered throughout the system. With the development of communications and, in particular, Internet infrastructure, initially closed corporate information systems were gradually opened up and interconnected with the information systems of other businesses, organizations and business partners. In this chapter we will explore this expanding field of computer science. We begin our study of networks by introducing a variety of basic networking concepts.

5.2 The Internet

The most notable example of an internet is the Internet (Burian, 2014), which originated from research projects going back to the early 1960s. The goal was to develop the ability to link a variety of computer networks so that they could function as a connected system that would not be disrupted by local disasters. Much of this work was sponsored by the U.S. government through the Defence Advanced Research Projects Agency (DARPA).

5.2.1 Internet Structure

The basic structure of the Internet is broken up between tier 1, tier 2 and tier 3 carriers. Tier 1 networks are backbone Internet providers that connect directly to the Internet. Internationally, there are five Internet service providers (ISPs) that are considered tier (Burian, 2012):



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1. "**Bone**" is the highest layer of the Internet hierarchy; this layer holds together the entire Internet. Tier 1 networks are **backbone** Internet providers that connect directly to the Internet. It provides data transfer and routing to the middle (transit) network layer. Internationally, there are five Internet service providers (ISPs) that are considered tier 1. These are AT&T, British Telecom, Equant, InfoNet and MCI (now Verizon). These companies have agreements with one another to allow for the free passage of traffic between them. Because traffic in this layer may be high, the backbone has a very wide bandwidth.
2. **Medium-sized networks** - known as *regional or transit networks* - lie beneath the backbone network. This layer provides data transfer and routing to the lower (root) layers of the network. They are smaller, mostly regionally based, and they tend to provide ISP links between larger organizations. These networks must have paths to at least two other networks. Computers in medium-size networks are known as "*ribbed*" because they are connected to the backbone.
3. **Root networks** - they are local (LAN, PAN) or urban (MAN) networks. This layer only transfers packets between guests, but not between networks. Most users communicate with this layer. The providers generally supply Internet connectivity for homes and small businesses. They are regionally based and often peer with larger tier 2 and tier 1 providers to allow global Internet connectivity (Pužmanová. 2007).

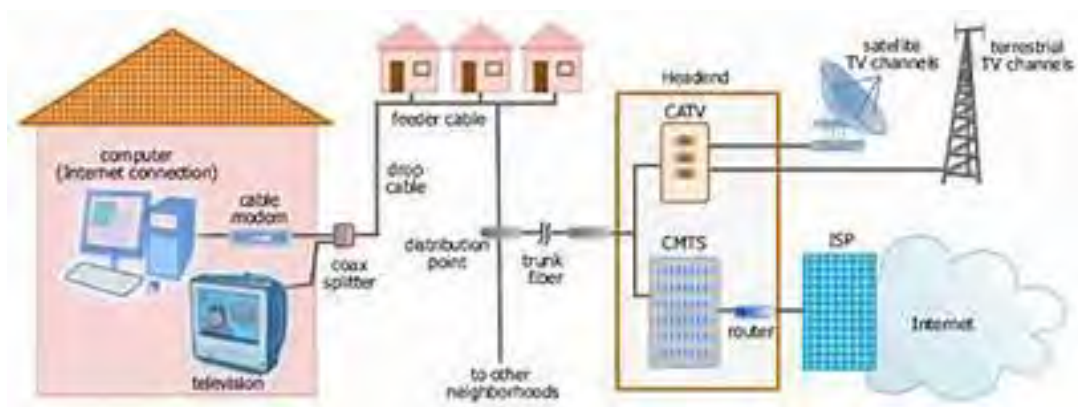


Figure 13 Internet Structure

Source: own processing

5.3 Computer Network, Classifications

The arrangement of the connected computers creates a *computer network*. As shown on Fig. 14) network nodes are either computers or special devices that represent active network elements. Network connectors, respectively transmission paths are made up of cables or wireless technologies. A computer network is often classified as being either a Local Area Network (LAN), a Metropolitan Area Network (MAN), or a Wide Area Network (WAN).

A LAN normally consists of a collection of computers in a single building or building complex. For example, the computers on a university campus or those in a manufacturing plant might be connected by a LAN. A MAN is a network of intermediate size, such as one spanning a local community. A WAN links machines over a greater distance – perhaps in neighbouring cities or on opposite sides of the world. Another means of classifying networks is based on whether the network's internal operation is based on designs that are in the public domain or on innovations owned and controlled by a particular entity such as an individual or a corporation.

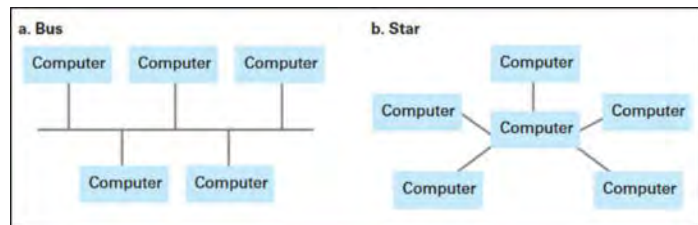


Figure 14 Two popular network topologies
source: Brookshear, 2015, p. 171

A network of the former type is called an *open* network; a network the latter type is called a *closed*, or sometimes a *proprietary*, network. Over the years, the development of the Internet shifted from a government-sponsored project to an academic research project, and today it is largely a commercial undertaking that links a worldwide combination of LANs, MANs, and WANs involving millions of computers (Jansa, Otevřel et al., 2016).

5.4 Computer Networks Classification

Computer networks can be classified by:

1. **switching** – we divide networks into commutating networks, i.e. circuit switching (e.g. telephone network, ISDN) and packet switched packet (Ethernet) networks;
2. the type of transmitted network signals is divided into **analog** and **digital**;
3. the **scope** and **purpose**;
4. **network ownership** – networks are falling apart into public and private networks.

We have already become familiar with the division of networks into local (LAN, Local Area Network) and WAN (Wide Area Network), that it is a division based on the network. However, most networking criteria are not entirely exact in nature. In terms of the types of computers used in the network, networks can be divided into (Brookshear & Brylow, 2015):

1. **homogeneous**: all connected computers are of the same kind (Fig. 14);
2. **heterogeneous**: there are different kinds of computers in these networks without limitations;
3. networks where large mainframes and PC's are interconnected. Typical is the **public data network**.

In general, these networks are constructed and maintained by organizations called Internet Service Providers (ISP's). It is also customary to use the term ISP in reference to the networks themselves. Thus, according to Burian (2014), we will speak of connecting to an ISP, when what we really mean is connecting to the network provided by an ISP.

5.5 Internet Addressing

An internet needs an internet-wide addressing system that assigns a unique identifying address to each computer in the system. In the Internet these addresses are known as **IP addresses**. Thus, machines throughout the Internet are assigned unique IP addresses. The ISPs are then allowed to allocate the addresses within their awarded blocks to machines within their region of authority. It is also customary to use the term ISP in reference to the networks themselves. As stated in Pužmanová (2007), for this reason, the Internet has an alternative addressing system in which machines are identified by mnemonic names.

The names of computers on the Internet are made up of pieces called **domains**. An Internet domain is a *unique name (identifier) of a computer* or computer network that is connected to the Internet. The Internet domain is written as a sequence of domain names separated by dots, with domains arranged in a tree. An example of a domain name is *www.example.com*, or *cs.wikipedia.org*. **Top Level Domain** (TLD) is the top-level domain of the domain tree. In a domain name, the top-level domain is listed at the end (e.g., *cs.wikipedia.org* is the top-level domain of org). Domains **.sk**, **.eu** are referred to as Top level 1 domains. Analogically, **sony.com** is a level 2 domain (Burian, 2012).

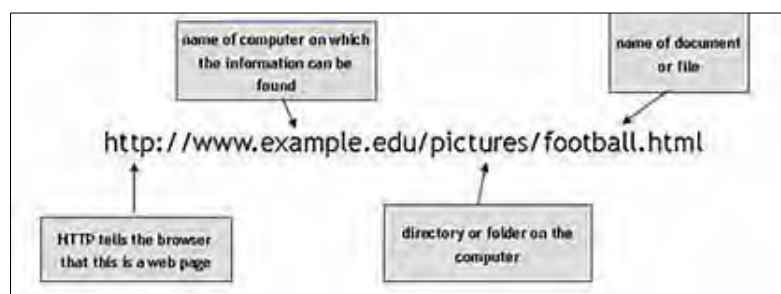


Domain Naming System (DNS) is used to convert between names and IP addresses of computers and devices. DNS is based on the client-server principle. The server maintains a database of names, addresses, and other information. The client (resolver) queries its local server - it receives a response or a link to another server that is closer to the query solution. In this case, the client repeats the query. Each domain has its own administrator who sets the rules here and makes sure they follow them.

5.1 Internet Protocols

As mentioned in Burian (2012), the Internet is a collection of connected networks. It is a framework for the specification of a network's physical components and their functional organization and configuration, its operational principles and procedures, as well as communication protocols used.

Communication management serves to collaborate communicating elements; this cooperation must be coordinated with manage-



ment data. Coordination is ensured by **protocols** (Dostálek & Kabelová, 2007).

The **protocol** is the standard by which electronic communication and data transfer between two endpoints (most often done by a computer) takes place. Protocols consist of a set of rules, formats, and procedures that determine the exchange of data between two or more communicating elements. Communication between the same layers is controlled by the *communication protocol* – a set of rules that determine the syntax and meaning of each message in communication. Protocols can be implemented HW, software, or a combination of both.

Packet – a fixed block of bytes, consisting of a header, data, and an end portion. Packets can be sent over the network or telephone lines. Network and several packet-switched communication protocols must be used to create information connections and routing (Burian, 2012).

Communication and its management are a complex problem that is simplified by dividing it into layers (see Fig. 15). The **TCP/IP protocol** suite is a practical implementation of a layered network architecture, although it does not exactly match the **ISO reference model**.



The main Internet protocols include the TCP/IP family of protocols, including: Internet Protocol (**IP**), Transmission Control Protocol (**TCP**), User Datagram Protocol (**UDP**) and others. Internet Protocol (IP) is a basic network layer protocol and the entire Internet. The most important task of IP is to find a way to the opposite computer. The whole concept of the IP protocol is based on the expectation that data transfers take place within a subset of networks that are interconnected at the network layer level, or through routers. In doing so, the IP protocol "fits" in these routers and decides where each particular data packet will be routed (sent) to reach its destination. According Dostálek & Kabelová (2007), this is called *routing*. IP version 4 protocol (IPv4) - uses 32-bit addresses to address computers. Specifically, it is a four-byte number (four decimal numbers separated by dots) e.g. **195.178.90.249**.

The IP address is unique to each network adapter across the Internet. Each IP address has two parts: network address and network adapter address. The Internet is constantly expanding and IPv4 addressing is no longer fully compliant. The way of addressing computers using IPv4, given the increase in the number of computers, is no longer sufficient). According to Burian (2014), that is why the version 6 (IPv6) protocol, which uses 128-bit addresses, has support for mobile devices, provides greater security and has the Quality of Service (QoS) functionality, has been developed.

5.1.1 Layer Model

The **TCP/IP** Model was developed before OSI Model, and hence, the layers differ. Concerning the diagram (Fig. 15), it is clearly seen that TCP/IP model has **four** layers namely, Network Interface, Internet, Transport and Application Layer. The standardized ISO/OSA model (Open Systems Architecture), is a **seven-layer reference model**. Application Layer of TCP/IP is a combination of Session, Presentation and Application Layer of the OSI Model.

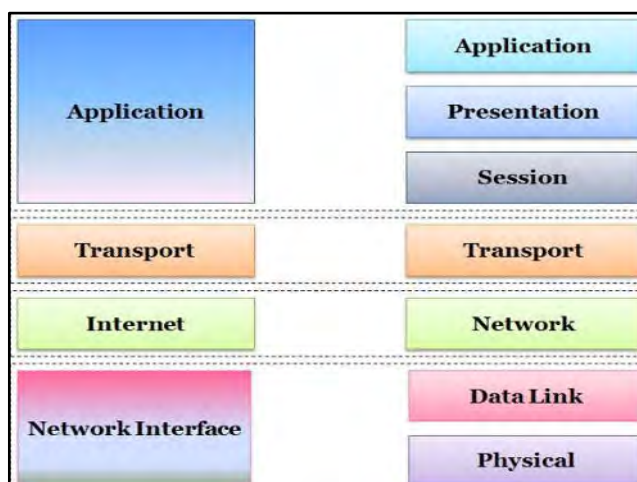


Figure 15 TCP/IP vs. OSI Mode source: own

As mentioned in (Dostálek & Kabelová (2007)), the TCP/IP family of protocols with which the entire Internet works today assumes **four** layers. For each layer to understand each other, it must use the same rules that are called **communication protocols**. Each network layer is defined by a service that is provided to the adjacent layer by the higher layer and by the functions it performs under the protocol. In a network environment, it is natural that layers of individual nodes work together to accomplish their tasks with layers of other nodes. However, this cooperation always takes place on the same level, respectively at the level of the same layers.

Domain Naming System (**DNS**) is used to convert between names and IP addresses of computers and devices. DNS is based on the client-server principle. The server maintains a database of names, addresses, and other information. The client (resolver) queries its local server - it receives a response or a link to another server that is closer to the query solution. In this case, the client repeats the query. Each domain has its own administrator who sets the rules here and makes sure they follow them (Pužmanová, 2007).

5.1.2 Connect technology

According to (Burian, 2014), the technology by which end systems connect to access ISPs is *varied*. **Bluetooth** is a technology that addresses wireless connectivity between short-range devices. Thus you can connect from PC via mobile to internet, respectively. on the contrary, and synchronize your mobile with data on your computer. Perhaps the fastest growing are wireless connections based on **Wi-Fi** technology. Wi-Fi is a standard for wireless local area networks (Wireless LAN, WLAN) and is based on IEEE 802.11 Specifications.

The strategy is to connect the AP to an access ISP and thus provide Internet access through that ISP to end systems within the AP's broadcast range. The area within the AP's range is often called a **hotspot**. Hotspots and groupings of hotspots are becoming quite prevalent, ranging from individual residences, hotel and office buildings, small businesses, parks, and in some cases entire cities. According Burian (2014), similar technology is used by the cellular telephone industry where hot spots are known as cells and the “*routers*” generating the cells are coordinated to provide continuous service as an end system moves from one cell to another. Other popular techniques for connecting to access ISP's use cable or satellite systems (Burian, 2014).



5.2 Web 2.0, 3.0

With the development of Internet services, there has been a demand for its ability to involve users in shaping information. This solution has become **Web 2.0**. The issue can be characterized both from a technological point of view and by a set of principles. Web 2.0 is a huge data concentration platform that is supported by simple, user-friendly means (wiki systems, blog...) that enable mashups. It is very common to link different information with geographic systems e.g. (*Flightradar24.com*, *Weather-forecast.com*, *Panoramio.com*, *Windy.com*, etc.). You can learn more about Internet2 at <http://www.internet2.org/>.

Web 3.0 (also called as the Semantic Web). A more important aspect is the view of user access to the web, where the original, passive approach, where the user was primarily a "reader", moves to a significantly cooperative way of using the web, where the user has the means to be able to easily create the content. According to Kernighan (2017), it is a site where information is structured and stored according to standardized rules, making it easier to find and process.

5.3 Internet and Social Networks in the Czech Republic

The Czech Statistical Office has published data on Internet usage and overall ICT in the Czech Republic for 2017 and 2018. Some information is really interesting – see article (Slouka, 2018) which presents the statistical data for those who are actively using the Internet. For a better idea, we will primarily use data that relates to people who actively use the Internet, not the entire population; among the total population of those over the age of 65 were included only 7,9 percent. As stated in Slouka (2018), when comparing the position of the Czech Republic with the 28 countries of the European Union, *two important pieces* of information will arise: firstly, the differences in the number of internet connected to households are in the range of approximately 30% between the states and unfortunately the Czech Republic is below the EU average. Economic activity is significantly more relevant.

After household statistics on internet access and status in the European Union, we will focus on social networks. Social Network or Community Network is a service on the Internet that allows registered members to create a personal (or corporate) public or semi-public profile, communicate with each other, share information, photos, videos, chat, and other activities.



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The name comes from the sociological concept of social network - a group of people who together maintain communication by various means. Czech Statistical Office collected data on their use in the Czech Republic. And some of the resulting information is interesting.

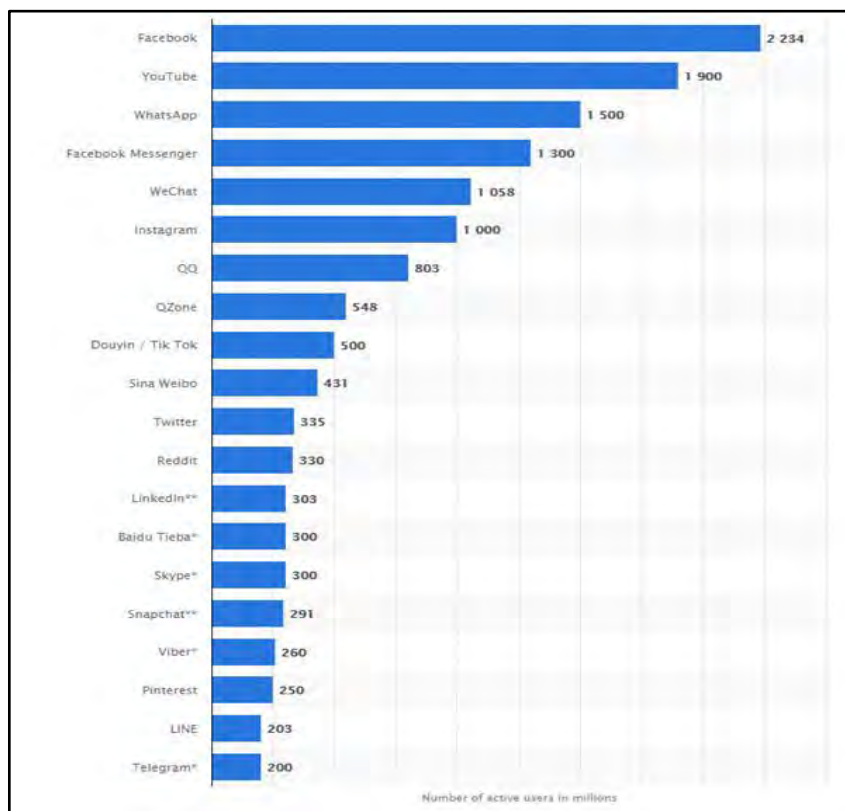


Figure 16 Most popular social networks in 2018. Source: www.statista.com/statistics/272014/global-social-networks-ranked-by-number-of-users

Most popular social media and networks by number of users shows Fig. 16 (valid as of October 2018).

5.4 Security Threats and Risks

When a computer is connected to a network, it becomes subject to unauthorized access and vandalism. There are numerous ways that a computer system and its contents can be attacked via network connections. Many of these incorporate the use of *malicious software* (so called **malware**).

As stated in Hák (2012), nowadays, there is a risk to everyone on the Internet. Public communication channels, such as computer networks and especially the Internet, provide fertile ground for



malicious programs. These are generally malicious software that has many forms: *computer viruses, Trojans, worms, backdoor, downloader, dropper, dialler, spyware, adware, spam, hoax, rootkit, tracking cookie, phishing* etc. (Hák, 2012).

According Koláček (2009), boot viruses use code execution in the boot sector of floppy disks and hard drives. They enter the operating memory when booting from the bootable media. File viruses attack program and data files. The macro viruses are undoubtedly the most common type of infection. Multiplex viruses attack files and system areas, combining the properties of boot viruses and file viruses. E-mail, Internet worms are a network equivalent of computer viruses. Trojans, in addition to the expected activity, do some other hidden way. Backdoor without user's knowledge opens the computer to attackers.

Annoying programs and messages are imposed on us by someone else to get some information or manipulate us into a certain action. These include *spyware, hoaxes, and spam*. Spyware takes care of sending confidential user and computer information to remote servers.

Virus activity is *very dangerous*. Viral signs may vary from innocuous inscriptions on the screen to manipulation of data in memory or on disk, or even physical destruction. Sites with illegal SW (warez), etc., are the perfect haven for vermin, which puts users at great risk! Note that simply installing an antivirus program or getting a firewall is not enough. The main role is played by the user himself, security SW / HW elements are just a supplement.

As stated in Hák (2012), there are several options to choose from, from the use of antivirus products or specialized software, to the use of hardware protection elements (firewall, proxy server, etc.). Prevention is the most important protection for the fight against viruses.

The AV system should be an integral part of every PC. The main task of AV programs is to identify the files infected with the virus, respectively - is to cure; the main activity is to fight against viruses. In terms of searching, identifying viruses and healing infected files, the types of AV controls can be divided into three basic groups: single-purpose antiviruses, scanners and antivirus systems. Methods of AV Control: Antivirus Test, Heuristic Analysis, Comparative Analysis. The basis of everything is the installation of a high-quality AV solution, correct settings and compliance with the basic rules of antivirus protection (Koláček, 2009).



**Control questions and tasks**

1. Characterize computer network and describe what it is for?
2. Classify computer networks in terms of their types, ownership, area, purpose.
3. Characterize each type of network; state the essential characteristics and representatives.
6. Characterize Internet communication protocols and architecture of TCP / IP layers.
7. What do you know about the ISO/OSI reference model?
8. Which networking technologies do you know?
9. Which wireless technologies do you know?
10. Define the terms "infiltration" and "malware".
11. Characterize the term "computer virus".
12. Indicate the most common causes of the origin, behaviour and effects of viruses.
13. Which security threats and risks on the Internet do you know?
14. Which special types of infiltrations do you know?
15. Which main methods of AV Control do you know?
16. What are the basic rules for protection against computer viruses?



6 NEW ICT TRENDS AND STRATEGIC TECHNOLOGIES

Information technology has become an integral part of our daily life. New trends are emerging in the area of ICT and information systems. Strategic technology trends have the potential to drive significant disruption and deliver significant opportunity.

6.1 The Top 10 Strategic Technology Trends

21st century has been defined by application of and advancement in information technology. Information technology has become an integral part of our daily life. Information technology is defined as “*the study, design, development, application, implementation, support or management of computer-based information systems.*”

Gartner Inc. (2019, Feb 20) defines a strategic technology trend as one with substantial disruptive potential that is beginning to break out of an emerging state into broader impact and use, or which are rapidly growing trends with a high degree of volatility reaching tipping points over the next five years. In this context, there are a number of new concepts: groupware, workflow, business intelligence, cloud computing, big data, the Internet of Things, etc. Of all these trends, let us mention only those that we consider most important, respectively which we consider significant. The top 10 strategic technology trends for 2019 are (Gartner):

1. Human communication technologies

Human communication technologies – technologies, which communicate with people and vice versa by much more human, more natural. *Global computing power at low prices* – the world presented by almost endless analytical understanding, computation power and continuously and effectively improving cost of it, businesses can better understand their customers and effectively prevent fraud.

2. Artificial Intelligence (AI)

Artificial Intelligence (AI) – the ability to use artificial intelligence for better decision making, reengineering business models and ecosystems, or for customer experience will remain the driving force behind digital initiatives until 2025.



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3. The Internet of Things

The Internet of Things (IoT) – more and more components will be involved in the Internet to provide information about their state or surroundings. Key elements are miniature sensors, image recognition technology capable of recognizing people, buildings, and other objects or solutions for payments, typically implemented through mobile phones.



4. Autonomous Things

Autonomous things, such as robots, drones and autonomous vehicles, use AI to automate functions previously performed by humans. Their automation goes beyond the automation provided by rigid programming models and they exploit AI to deliver advanced behaviours that interact more naturally with their surroundings and with people.

5. Empowered Edge

Edge computing describes a computing topology in which information processing, and content collection and delivery, are placed closer to these endpoints. It tries to keep the traffic and processing local, with the goal being to reduce traffic and latency. However, rather than create a new architecture, cloud computing and edge computing will evolve as complementary models with cloud services being managed as a centralized service executing, not only on centralized servers, but in distributed servers on-premises and on the edge devices themselves. Over the next five years, specialized AI chips, along with greater processing power, storage and other advanced capabilities, will be added to a wider array of edge devices.

6. AI-Driven Development

The market is rapidly shifting from an approach in which professional data scientists must partner with application developers to create most AI-enhanced solutions to a model in which the professional developer can operate alone using predefined models delivered as a service. This provides the developer with an ecosystem of AI algorithms and models, as well as development tools tailored to integrating AI capabilities and models into a solution. By 2022, at least 40 percent of new application development projects will have AI co-developers on their team.



7. Augmented Analytics

Augmented analytics focuses on a specific area of augmented intelligence, using machine learning (ML) to transform how analytics content is developed, consumed and shared. Augmented analytics capabilities will advance rapidly to mainstream adoption, as a key feature of data preparation, data management, modern analytics, business process management, process mining and data science platforms. Automated insights from augmented analytics will also be embedded in enterprise applications — for example, those of the HR, finance, sales, marketing, customer service, procurement and asset management departments — to optimize the decisions and actions of all employees within their context, not just those of analysts and data scientists.

8. Digital Twins

A digital twin refers to the digital representation of a real-world entity or system. By 2020, Gartner estimates there will be more than 20 billion connected sensors and endpoints and digital twins will exist for potentially billions of things. They will evolve them over time, improving their ability to collect and visualize the right data, apply the right analytics and rules, and respond effectively to business objectives.

9. Blockchain

Blockchain, a type of distributed ledger, promises to reshape industries by enabling trust, providing transparency potentially lowering costs, reducing transaction settlement times and improving cash flow. Today, trust is placed in banks, clearinghouses, governments and many other institutions as central authorities with the “single version of the truth” maintained securely in their databases. Blockchain provides an alternative trust mode and removes the need for central authorities in arbitrating transactions.

10. Smart Spaces

A smart space is a physical or digital environment in which humans and technology-enabled systems interact in increasingly open, connected, coordinated and intelligent ecosystems. Multiple elements — including people, processes, services and things — come together in a smart space to create a more immersive, interactive and automated experience for a target set of people and industry scenarios.



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6.2 Other Trends of Using ICT

According Dugall (February 11, 2019), other trends in the field of using ICT, which can be found e.g. in the IFA Berlin, the world's most important technology marketplace (see <https://www.ifa-berlin.com/>), which takes place every year in Berlin, presented key ICT strategies and technologies that will be of strategic importance to companies. Other trends in the field of using ICT are (Dugall, 2019):

Miniaturization of HW, new applications and interfaces for mobile devices – miniaturization has made tremendous progress, computers are steadily shrinking - super thin TVs, super lightweight ultrabooks, touch screens and extremely cheap netbooks. Nowadays, a new category of high-performance tablets of the new generation is well-established on the market.

Big Data: The data explosion has reached unreal dimensions today - the amount of data that needs to be processed often exceeds the current capabilities of commonly available technologies. Future system of payment – no cash, all transactions in electronic form, which helps companies to increase efficiency of payments and customers increase comfort and safety.

Cloud computing – can be defined as a technology that allows data and applications to be accessed from anywhere. Cloud is a powerful computing system that you can access through the web, request a service, and execute it. The user does not have to procure any HW, does not have to deal with system updates and does not need to buy SW. Typical examples are Google applications such as Gmail, Google Search, and Google Docs. Other trends are: **Smarter things** – as mobile robots, the wireless device power, machine-to-machine communication services, mesh network sensors, home health monitoring. Virtual reality (VR), augmented reality (AR) and mixed reality (MR) are changing the way in which people perceive the digital world. **process modelling, analysis of social networks**, etc.

Control questions and tasks

1. Identify and characterize the main directions of strategic technological trends in IT.
2. Identify and characterize other strategic technology trends in IT.



SUMMARY

We live in a society, in which ICT are becoming a moving force for its development. Informatics, ICT and computer network penetrated all aspects of activities where they enable us to work by brand new ways and create new values. ICT's are an important tool for managers, but it does not mean that they are a source of competitive advantage. Information technologies are part of every system and subsystem inside a company. Effective use of ICT is a prerequisite for proper orientation and success in the 21st century society. This infrastructure allows faster creation, processing, transfer and storage of huge amounts of information.

This study material was written for students of the study program of the Faculty of Management and Economics of Tomas Bata University in Zlín. This paper presents an introductory survey of computer science, respects the requirements of today's knowledge society and at the same time reflects the needs of future managers and economists, while maintaining comprehensibility of the content. The goal of this study material is to establish a functional understanding of computer science and related topics. Simultaneously presents a wide range of informatics topics most of those is typically included into a typical university curriculum but do not cover all topics.

The world belongs to new trends using ICT, to the artificial intelligence, Internet of Things, Industry 4.0, etc. The most promising technology of 2020 are becoming reality and these technologies is finally beginning to spread through the world. Using these innovations offers significant benefits. If we were to say a simplified, thanks to new technologies we will communicate more effectively. Mastering the fundamentals of computer science must therefore become part of the general education of a modern person.



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LIST OF ABBREVIATIONS

AI	Artificial Intelligence
ALU	Arithmetic Logic Unit
AR	Augmented Reality
AMD	Advanced Micro Devices
ASP	Active Server Page
ASW	Application Software
BIOS	Basic Input Output System
B2B	Business-to-Business
B2C	Business-to-Customer
B2E	Business-to-Employee
CPU	Central Processing Unit
CISC	Complex Instruction Set Computer
FIFO	First in First Out
DARPA	Defence Advanced Research Projects Agency
DNS	Domain Naming System
HDD	Hard Disc Drive
HW	Hardware
ICT	Information and Communications Technology
IoT	Internet of Things
IP	Internet Protocol
ISP	Internet service Provider
ISDN	Integrated Services Digital Network
IBM	International Business Machines Corporation
JPEG	Joint Picture Expert Group
LAN	Local area Network
MAN	Metropolitan Area Network
MIPS	Millions of Instructions per Second





ML	Machine Learning
PAN	Personal Area Network
PC	Personal Computer
PHP	Personal Home Page
RAM	Random Access Memory
RISC	Reduced Instruction Set Computer
ROM	Read Only Memory
SW	Software
TCP	Transport Control Protocol
TLD	Top Level Domain
UDP	User Datagram Protocol
USB	Universal Serial Bus++
VR	Virtual Reality
WAN	Wide Area Network





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