

Technology

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1.0 Technology is Everywhere

"Look around you... Technology dominates our lives and the world. More than 4.1 billion people now use the Internet..." The above quote is from the video "Did you know? 2019", which you can find on YouTube. The video shows current figures on how many people use the Internet, how many search queries we make, how many messages we send, etc.



"Did you know? 2019" <https://www.youtube.com/watch?v=bTM06NZOyDQ>

Technology is Everywhere		
He/she understands and knows the most important technological components, their capabilities and possible applications.		
Knowledge	Skills	Competences
He/she can <ul style="list-style-type: none"> describe the most important technological components and name their application purposes and potentials. recognise the basic technological components and know where to find further information on them. understand the possibilities of the available technology and how to use them. 	He/she can <ul style="list-style-type: none"> understand how machines and networks enable us to communicate. use technology in a good and safe way. 	He/she is able to <ul style="list-style-type: none"> relate the main technologies available to the challenges, risks and benefits. to relate the available technologies to one's own needs and to decide whether one wants to learn to use them or not.

Of course, technology does not completely determine our lives, but it does influence important aspects of our daily lives: new ways of communicating, sharing things, digital identity, seeking and offering help, feeling safe, etc. Technology enables us to build relationships with our friends, family and friends and other communities in new ways. We become citizens of the digital world. The basis for this is knowledge of technologies and basic technological skills. In this chapter, we would like to introduce you to these skills, show you how they came into being and explain what purpose they serve and where their limitations lie.



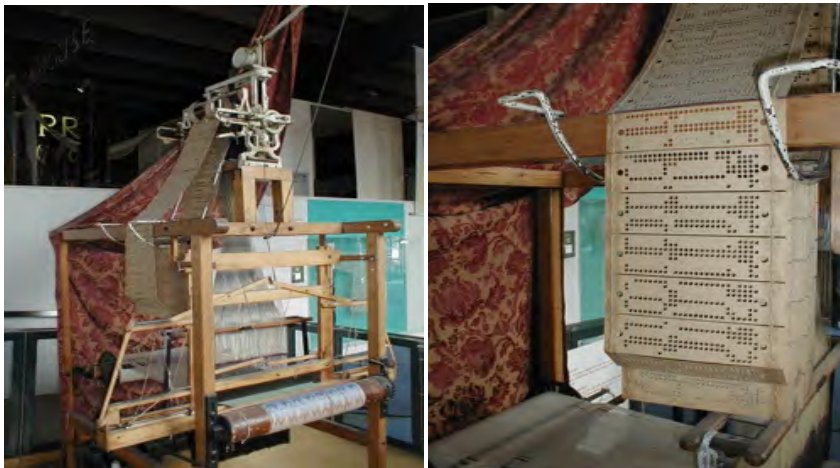
1.1 Tools and Machines

Tools have been used by humans and even animals to help with tasks. A stone is used to crush seeds, a lever to lift heavy things, an axe to cut down trees. Apparatus and machines, such as pulleys, bicycles or steam locomotives, have advanced humanity by helping to erect larger buildings, travel further afield and trade around the world. With the development of science and technology, more complex and powerful infrastructures and more versatile machines could be built.

In the course of history, there have been many inventions. Some are still influential today, such as the printing press, the car or television. However, none of these innovations can compete with the computer, the most revolutionary of all inventions.

The reason is simple: the computer is a programmable, versatile machine. Before, there were programmable machines like looms that could store on a card the position with the yarn colour and the needle to be woven. There were also other multifunctional machines, such as the internal combustion engine that could be attached to motorbikes, trucks or a lawnmower. But the computer can be used for many more purposes, as it can store any action and execute it in a certain order.

Throughout history, there have been machines and tools, but no invention has been as groundbreaking as the computer. There are two reasons for this: The computer is multifunctional, meaning it can be adapted to our needs, and it gives us countless ways to communicate, create networks and share information.



Jacquard-Maschine (1804) Quelle: Wikipedia (gemeinfreie Fotos)

The components that allow a computer to be programmable and multifunctional are its memory (like the pattern cards in looms) and the processor (like gears, belts, etc.). We will learn more about this in the following sections. Computers are very useful in business, government and private life thanks to this fact. We use them all the time for different purposes: accounting, video conferencing, video games, etc. Unfortunately, the biggest advantage is also the biggest challenge: their structure, use and functions are complex. This can be easily illustrated with the example of a mobile phone.

When mobile phones could only be used to make phone calls, they were easier to use than they are today. Today, we can still use a smartphone to make a call but even the simplest devices are still difficult to use for those who are not tech-savvy (like many older people). Even taking a photo and then sharing it is a complicated process. For example, you have to choose which app and which recipient you want to share the

photo with. And these are exactly the most interesting functions of these devices. Before, you could only perform simple actions: make a phone call, take a photo or send a message. Now, suddenly, everything is connected. Smartphones are therefore devices that not only have one purpose but offer a multitude of interconnected applications.

1.1.1 Computer

Personal computers (abbreviated PC) are universally applicable devices for data processing for private use. Companies like IBM, Fujitsu or DELL and many others sold these computers. Another example is Macs, which were developed by Apple. Personal computers allowed people to connect to the Internet or work from home. Parents bought them to help their children learn (e.g. as an electronic encyclopaedia), write texts, produce videos, edit photos, solve maths problems or connect to the Internet. Later, laptop computers became popular because they took up less space and were easy to transport. Today, computers and laptops are still used in private households, but there are many other ways to connect to the Internet. The reason they are still popular is for two reasons: They are relatively cheap and you can often work better with them than with a tablet.

Computers have become easier to use as operating systems have evolved, for example by adding colours, icons, windows and simpler input options, such as the mouse. The most natural interface developed so far is the touch screen, which allows us to operate the computer with our hands, or fingers.

Computers today have become cheaper and smaller. Laptops were originally only used for business purposes, especially if you travelled a lot. Thanks to their price and performance, they are now a good substitute for personal computers. Even if mobility is not necessary, they are a good choice for everyday tasks.



Personal Computer from the 80s, Mac from the 90s and iMac from the 2000s

Tip
For occasional use of the web, tablets are among the best devices. They are easy to set up and use, easy to carry and cheap. However, if you want to work or spend more time on the Internet, the computer is the best option.

1.1.2. Smartphones and Tablets

Smartphones and tablets as well as computers can access and use services on the Internet. If you plan to occasionally watch news programmes, read your e-mails or access Internet services, then the tablet is the best choice. If you want to write texts or use the Internet for work, then you need a computer. Apart from that, there is little difference, except for the size of the screen, which makes reading or surfing more comfortable, or the use of a keyboard, which makes it easier to type. As you can see, the differences between smartphones, tablets and computers depend on what you want to use the device for, not on your skills. If you intend to do more than just surf the Internet, e.g. edit texts and pictures or edit videos, then a computer is the best choice.

The main advantage of the tablet over a computer is: you can take it everywhere and always have the best input device in the world with you: your fingers.

There are many apps that you can install on your tablet. Depending on whether it is Android or OSX (i.e. MAC), you can buy and download them from the corresponding app shop (a kind of online shop for apps). However, there are some differences:

- All tablets have Wifi, some of them can also connect via mobile data plans, but only if they have a slot for a SIM card (i.e. for 4G or 5G). This also requires a contract with a telecommunications company.
- Like computers, tablets also have a working memory and storage for the permanent storage of data. This is not as important in a computer if you mainly surf the Internet with your tablet and smartphone. However, if you want to store a lot of videos and pictures, you should think about more memory.
- Devices that are regularly connected to the Internet can be connected to the cloud. This is your private space on the Internet where you can store personal information (e.g. addresses, photos, documents...). This makes it easier to recover your data if you lose your mobile phone, it breaks down or is stolen. You can also share data more easily with your computer via the cloud without having to connect. The most common cloud services are Google Drive, iCloud for Android and Mac respectively, but there are also other options such as Dropbox.

In summary, smartphones are becoming more and more widespread among young and old. They provide a good way for easy and direct access to the Internet (for surfing, checking e-mails and chatting). As with tablets, these types of touch devices facilitate access to Internet services with a simple interface (the use of hands). However, there are also ethical and privacy issues. Our smartphone always knows where we are and apps can access all our data. Apps ask us for consent to use data and often we give it without being aware of what is involved. While privacy risks worry people, such as what Google learns about us when we search for something or enter a restaurant, the most important and extensive information we give away is when we consciously share information with others, even if we are not fully aware of the implications.

1.2 Units of Measurement

In a world where everything is measurable, the first thing we need to know is how to deal with these units. We are talking about memory, speed, bandwidth, frequency, etc. First of all, the unit depends on what we want to measure.

Here are some examples:

- **Bit:** This is the smallest unit of information in a computer. It represents a logical state, such as true or false, one or zero, ...
- **Byte:** eight bits are one byte. A byte can contain information, such as a letter or a colour.
- **Hertz:** This is used for measuring frequencies. The repetitions per second are counted. A household microwave, for example, can heat food by using the transmitted energy with a wave frequency of 2 450 000 000 Hz.

Larger values can be summarised as follows:

- 1000 = 1 Kilo (K)
- 1000 Kilo = 1 Mega (M)
- 1000 Mega = 1 Giga (G)
- 1000 Giga = 1 Tera (T)

Therefore, we can say that the frequency of a microwave is 2 450 000 000 Hz or 2.45 GHz. More precisely, the jumps are not steps of 1000, but 1024, but for the sake of simplicity we calculate with 1000.



1.3 Hardware

The hardware is the part of the computer that you can touch: the casing, the cables but also devices such as a mouse, the monitor or the printer. If you want to buy a computer, you should read this chapter in detail. If you have problems with your computer (the computer is too slow, not enough memory, etc.), it is also useful to know the following components to solve your problems. A computer usually consists of the following components:

Processor


The processor is the heart of the computer. Two parameters are given for the computing power of a processor: **Frequency** and **power**. The frequency shows us how many calculations per second the processor can perform. Normally, this number is between 2 and 3 GHz. 1 Hertz corresponds to the number of operations per second. 1 GHz means one million operations per second (G = Giga). The performance of a processor depends on the model. For example, the manufacturer Intel offers the i3, i5, i7 and i9 models. If you need a computer for surfing the Internet or writing texts, an i3 or i5 processor would be sufficient. If you want to do design or photography and edit video, an i7 would be better. Processors are available from the companies Intel and AMD. Both options are good.

Working memory (RAM)

The processor needs a place to store data in order to work. The main memory (also called RAM) is a fast memory. RAM stands for Random-Access Memory and got its name because you can very quickly store and retrieve data in this memory at random locations. Computers usually need a minimum of 8 GB of RAM. The larger the RAM, the more programmes you can open at the same time and work with larger pictures and videos. If you only surf the Internet and open a few pages at a time, 8 GB is quite enough, but 16 GB would be better. The biggest disadvantage of this memory is that it is not permanent, i.e. if you do not save a document and the computer is switched off, you lose all your work. That is why you need an additional so-called "mass storage" to be able to save data permanently.

Mass storage, HD or SSD

All data is usually stored on your computer, be it photos, videos, documents, etc. Even large parts of the programmes you work with, such as a photo editing programme, are stored on your computer on HDD or SSD memory (hard disk or solid-state drive). The former is cheaper, the latter faster. How much faster is an SSD drive compared to a conventional HD hard drive? Probably the most noticeable difference is when the computer is switched on and the operating system with all programmes are loaded from permanent memory into RAM. On a computer with an HD, this would take a minute, on a computer with SSD a few seconds. An SSD can also reduce the time it takes to open a document or a large photo. SSDs are more expensive, so it is common to have a 256GB or 512GB SSD, while HDs usually have a minimum of 1024GB (or



Did you know that the processor you have in your smartphone is 1000 times more powerful than the processor in the rocket that took the first man to the moon?

1TB). If you can wait a few seconds longer for your computer to boot up and want to save some money, remember that the computer is continuously using memory and that a small change of milliseconds does make a difference in hundreds of operations in a second. In any case, your hard disk is too slow if your computer seems to freeze when you are editing a document or a photo.

The hard disk (or HD) is a magnetic disk that spins at an average of 7,500 revolutions per minute. The head can read data from or write data to the HD using electromagnetic pulses. This process is comparatively slow because the head has to be positioned exactly on the track and then wait until the rotation of the chuck matches the information it is looking for. This takes a relatively long time compared to other storage media.



An SSD hard disk (or solid-state drive) works similarly to the RAM we talked about before, but the information does not disappear when the computer is switched off. Chips similar to those in SSD disks are also used in other storage media, for example, USB memory sticks or memory cards for your camera.



Did you know that apart from the fan, the hard disk is the only mechanical device in a computer? All the other parts serve to make the computer faster, more durable and safer.

Screen

For computer screens, the most visible feature is the size. The screen diagonal is measured in inches. If we say that the screen is 21", it means that it measures 53.3 cm from one corner to the other. Another feature of screens is the aspect ratio. TV sets have a 16:9 format, which means that the screen is almost twice as wide as it is high (also known as widescreen). The advantage of such an aspect ratio is that you can watch films well or open several windows side by side, e.g. if you are reading a web page while writing a document at the same time.

Mouse, Keyboard etc.

To work with a computer, you need other devices such as a keyboard, mouse, speakers, webcam and a microphone if you want to participate in a video conference. We have chosen not to detail these functions because the solutions on the general market are very good and do not pose a risk; you can easily replace some of these functions if they are not good to use.



1.4 How Your Computer Works

Software is the part of the computer that does the calculations inside your computer, as opposed to hardware, which is the physical part. Software must be installed and started for it to work. You can download programs from the Internet, load them from a CD or use a USB stick. The most important software on a computer is the operating system (OS). It must be already installed when you buy a computer or a mobile phone. Other examples of software would be a word processor, a programme to edit pictures or videos, or a browser that you use to read the news. These are all computer programmes (also called applications or software).

1.4.1 Operating system (OS)

The operating system is the first programme that starts as soon as you switch on your computer. It controls all other programmes, helps manage data, devices (such as printer, mouse, keyboard, webcam ect.), connects you to the Internet and installs applications such as text and image editing programmes, browsers, etc.

As stated earlier, the operating system is the programme that controls all other programmes. Some operating systems are listed below:

- **Microsoft Windows:** is the world's most widely used operating system, now in its 10th version.
- **Linux:** is an open-source and free of charge operating system. Ubuntu is the most widely used Linux distribution.
- **Apple OS X:** is better known as the Mac (or Macintosh) operating system.

Take good note of which operating system is installed on your computer. It will help you find solutions to problems or errors on your computer. An operating system can never be uninstalled (unless you replace it with another one), It opens automatically as soon as you turn on the computer and it is the last programme to close and give the command to turn off the computer. The operating system can install, open and delete other programmes. The other programmes provide us with functions such as writing a letter, watching a movie or surfing the Internet. You can use one or more programmes at the same time, the operating system can only run once. You can work with one programme and do a lot of things: with a word processor, you can edit and open several documents at the same time or edit several pictures, etc.

As an example, the programme for surfing the Internet could be one of the following: Chrome, Firefox, Edge. In these programmes, you can go online and among many other things read the news, check your social media or search statements. Online services used for searching the Internet are, for example, Google, Bing or DuckDuckGo. The difference is that the former are programmes that are installed on the computer and started via a desktop or start menu icon, the latter are services on the Internet. For example, if you are working on a friend's computer and Firefox is not installed there, you cannot use the programme. You can install programmes, download them or someone else can provide them to you on a CD-ROM or USB stick.

Information

The operating system is the programme that controls all other programmes. But not only that. It protects you, warns you and helps you when you add a new device. Make a note of which version of the operating system you have installed. You will need it when you install programmes or need help with your computer. .

Search engines (such as Google, Bing or DuckDuckGo) are services on the web that you can reach via Internet addresses: www.google.com, www.bing.com and www.duckduckgo.com. You can open these addresses in any Internet browser. This is the essential difference between an operating system, an app or application and a website or service on the Internet. You only need one operating system, but you can use several applications that serve different purposes. A web page can be opened no matter which operating system or application you use.

The final question is: Which operating system should you choose? Windows, Linux or Mac? Which is the best? That's not easy to answer. So here are some tips:

- **Windows:** is the most widely used operating system. When you buy a computer, it will probably have Windows installed. This makes it easy in a private environment to get help from family, friends or courses. There are many applications for Windows but also many viruses.
- **Linux:** is free of charge and open-source (this means that the source code can be viewed openly). It is a little more difficult to use and is widely used, especially among computer specialists. It allows you to make many adjustments and personalise it to your needs. There are a small number of viruses for this operating system. Linux is adopted by various organisations and made available in so-called "distributions". In recent years, the operation of, for example, the Ubuntu distribution has become easier and clearer. You can therefore definitely give it a try.
- **Mac:** mixes the best of both worlds. The disadvantage is that the price is relatively high. The Mac system is similar to Windows, but there are fewer programmes than for Windows. The biggest advantage is that it is more stable and less susceptible to viruses.

What does the word "stable" mean in relation to an operating system? Can there be an unstable operating system? The answer is: it is the operating system's job to be stable, that is, not to crash or become slow after a few months of use. The operating system should also be able to clean up unused memory. It can happen that after a few months our operating system is slower than it was at the beginning and that it crashes so that we have to constantly switch the computer off and on again. When we talk about "crashes", we mean that the computer does not respond to any of our actions with the mouse or keyboard. If this happens frequently, the best solution is to reinstall the operating system. Other solutions would be to install software to clean it up and increase the speed of our operating system. But be careful, because these programmes could also damage the system.

Are there other operating systems? Yes, each type of device can have a different operating system:

- **Android:** on mobile phones, also tablets and increasingly on smart TVs, watches and other devices.
- **iOS:** on tablets and Apple mobile phones.

1.4.2 Apps and Programmes

Let's start with something that often confuses people: apps and programmes are not websites. Apps are installed on computers, mobile phones or tablets . You can give apps permission to access your camera, photos, contacts and data. Installing an app is one of the riskiest things you can do because the app can access your data. You can learn more about security in the following chapters. For a long time, a website was just a page with interesting content (pictures and videos) that you could look at. We say "was" because nowadays websites can also contain maps, videos, documents and even games. In any case, they are still pages that are good to "surf" through.

With an e-mail app for your smartphone, you can read and write e-mails. The app is useful for sending e-mails to your friends and receiving e-mails on the go. With a photo app, you can take and save photos, view the photos and share them with others. A smartphone with a GPS function can navigate you to a destination. In these three examples, the first app needed to access your contact list, the second your photos and the third your location. For these activities, you need to give the apps permission to send messages, take photos or use the maps. Giving apps access to functions and information on your smartphone always carries a security risk.

In general, be careful with the applications you install on your computer, mobile phone or tablet. You can find out how to install applications and apps safely in the chapter on safety. It is better to trust someone with experience who knows which apps are safe or read the comments in the app stores. Be prepared for possible security problems, because they can always occur. The safest computer on the Internet is the one that is switched off. Once you start installing things and connecting to the Internet, you can use a lot of services and information, but of course, you have to expect risks. The most important thing is to be aware of them and take the right preventive measures.

Avoid installing programmes that you have found on the Internet, trust only safe sources and, if in doubt, rather not install programmes and apps.



Häufigste Apps für den Internetzugang: Chrome, Firefox und Microsoft Edge

1.5 Other Devices and Applications

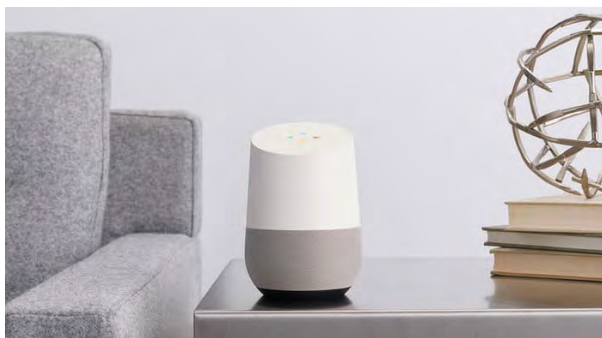
1.5.1 Home Automation

Home automation refers to systems that equip a house or building with digital services, such as energy management, security and comfort functions, and communication. The services can be connected via internal or external networks, wirelessly or by cable. Home automation is the combination of intelligent technology and functions of a building.

You can see some devices designed for temperature control in the next picture. The air conditioning and heating can be controlled from anywhere in the house, using a smartphone or tablet, for example. The devices such as lamps, music players, blinds, doors, cameras, security systems, oven, etc. can even be controlled from outside the house.



One of the most common devices in home automation are digital assistants. Three brands currently dominate: Amazon Echo & Alexa, Google Home Assistant and Apple Homepod.



Digital assistants always have an open ear for you and can take your wishes, give simple answers or carry out predefined actions. For example, you can ask an assistant for the weather forecast, get the most important news of the day or set the alarm clock for 5 o'clock. Some digital assistants can connect to other services, such as music from Spotify, the lighting control or the heating system. In this case, you could give the digital assistant the command to play music or turn on the lights in the house. You can give these commands in natural language.

The "smart home" thrives on the idea of living in a comfortable and safe house. Advantages can be that we save energy or that digital assistants help us. For people with physical limitations, these systems can be a way to live autonomously.

1.5.2 Wearables

Wearables are intelligent electronic devices that are incorporated into clothing or worn on the body as implants or accessories. They perform functions that can enhance the user's physical and mental abilities. The most common wearable is the smartwatch. In addition, there are also these devices incorporated into clothing, glasses, shoes or even attached to or under the skin. Currently, the devices are mainly used for health monitoring (e.g. measuring how many steps one has walked during the day).



1.5.3 The Internet of Things

The Internet of Things (or IoT) refers to the digital networking of everyday objects via local networks or the Internet. These objects or things can be the same as those presented in the section "Home automation" or "Wearables". They can also be other things that have corresponding interfaces, such as cars, public transport, a medicine dispenser, a suitcase, a pencil or a key.

Imagine a world where everything is connected and where you know everything about these objects (location, condition, ...). Much of this is already a reality. Here are some examples::

- Cars can network with each other and even if you don't yet see what's happening a kilometre ahead, your car can receive signals from other vehicles and warn you of dangerous situations.
- Your luggage can inform you that it has been lost and tell you where to find it. This technology can also help you find your pets or keys, or even yourself if you get lost somewhere. On a farm, you can put sensors on a cow to get information about where it has been or how much milk it has given.
- In a restaurant, your table may have a device that takes your order.
- All items in a shopping cart can be entered and the price calculated without scanning.

The technology of the "Internet of Things" is still in its infancy. However, it is constantly evolving and is already in use in more and more places. When networked devices monitor our movements and preferences, privacy issues and ethical concerns can arise. Legislation needs to address such issues and people need to be educated about the risks.

2.0 Connecting People via the Internet

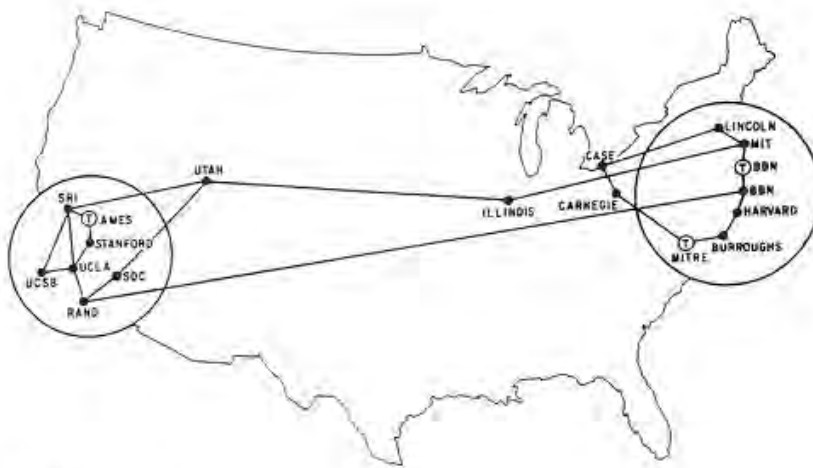
The Internet is the connection of network nodes. The purpose of the Internet was originally to allow the exchange of information between computers from different universities. In computer terminology, these are called nodes, which can be either computers or other devices that can be connected to the Internet, such as satellites or other networked devices. The Internet connects people for a variety of purposes: sharing information, creating or collaborating. But first, we should be able to connect our devices to the Internet. So let's start at the beginning.



Connecting People via the Internet		
He/she understands the technologies we use to connect to the Internet, how they have evolved, their differences and how they work in order to choose the most appropriate technology and be able to solve problems themselves or seek help if necessary.		
Knowledge	Skills	Competences
He/She knows <ul style="list-style-type: none"> the characteristics and differences of the connection options. the risks and how to minimise them. the historical development of the Internet. 	He/she is able to <ul style="list-style-type: none"> understand how machines and networks enable us to communicate. set up connection between devices safely. connect to other devices or networks. 	He/she is able to <ul style="list-style-type: none"> select the most appropriate technology for a connection, based on personal needs and capabilities. solve connection problems or seek help.

2.1 How it all Began

The Internet is an infrastructure that was developed in the USA in 1962 as part of the DARPA project. With the help of protocols and transmission rules, data could be exchanged between organisations. The project also had military origins, with the aim of building a distributed network without a control centre that could withstand attacks (remember the Cold War era). The DARPA project was later abandoned by the military and no longer funded. Years later, in the 1970s, universities took over the project and started connecting their computers. By 1971, 23 computers were connected worldwide. In 1991, the first website was published. In 1992 there were 10 functioning websites, in 1993 there were already 130. Today there are almost 1.5 billion. The whole world still benefits from the basic principle that was developed in 1962.



MAP 4 September 1971

Internet in 1971

The Internet is a network of networks, i.e. you log on to the network of an Internet provider (cable, mobile, fibre optic company) and they connect you to the networks of other providers.

The Internet spans the entire world without a control centre monitoring the connections. Information can still be distributed even if parts of the network only function in a restricted way (as is the case in some countries). Because information is transmitted without major restrictions, the Internet supports freedom of expression, but at the same time, also supports the distribution of illegal content.

We should thank the US military for planting the seed of the Internet and also for abandoning it and allowing other institutions to develop it further. The freedom of early engineers and researchers to experiment, learn and share their knowledge is the foundation of what the Internet is today.

2.2 How the Internet Works at Home

Each telecommunications company has its own network. The provider takes care of the infrastructure, the cables and the interfaces that connect to other networks in other countries. They use their customers' money to finance the maintenance of this infrastructure. You probably know many companies in your country that offer Internet services. To be able to connect to the Internet, you have to sign a contract with the provider. The local network belongs to the provider but the global network belongs to no one. It is rather a linkage of all connected networks.

In the 1990s, people used modems to connect to the Internet at home. For the transmission of signals that were converted into sounds, one simply used the telephone lines. At that time, when someone was connected to the Internet, the phone line was busy (just as if someone was on the phone). The maximum speed was 32-56 kB. In the following picture, you can see an acoustic coupler like the one used for data transmission in the 1980s. You may have seen something like this in the film War Games (1983).



Acoustic coupler. Source: secretlondon123 Wikipedia

In the next picture, you can see different modems and routers. The word "modem" is composed of the first letters of "modulator/demodulator". A modem converts data into sound signals, or digital data into analogue and then back into digital again. Over time, modems have become more powerful, cheaper and more reliable.



Multiple modems and routers. Source: Pratyeka Wikipedia

Today, modems are no longer necessary because the data does not need to be converted. If you have an Internet connection at home, your telephone provider has laid a line that leads to a small box in your house: the router. The name router describes the task of the device: to distribute data from your network at home to the Internet.

In 2000, ADSL connections came onto the market. At first very slow with 128 kB, then with 1-2 Mb. The advantage of an ADSL connection was that you could transmit on several channels at the same time, which meant you could make phone calls and surf at the same time. In the first decade of the 2000s, cable connections (630 Mb) and later fibre (300-600 Mb) came into our homes. This meant that in the following decade, private households reached the same connection capacity as the whole country in the 1990s.

In offices, computers used to have a connector called RJ-45. This network connector offers maximum speeds. Today, you can still find these connections on the back of your router, on some televisions or other devices that require high speed. This is the most common type of connection for a wired connection.



Source: David Monniaux Wikipedia

Information

A decade earlier, fibre optic lines were so expensive that only large companies could afford them. In the big cities, it is now common for fibre optic cables to be laid right into private homes.

2.3 The Internet Goes Wireless

We still rely on wired Internet, but increasingly we can use a wireless Wifi connection.

Routers enable both wired and wireless connections:



Router, rear side, view of the RJ connections and some buttons

2.3.1 Wifi

To access the Internet, we mostly use a Wifi (or WLAN) connection. For example, at home, in the library, at work, in restaurants, hotels, etc. The Wifi signal is provided by a router that connects you to the Internet. You can have a very good Wifi signal but still not have access to the Internet. In hotels, for example, you often have to book a ticket to use the Internet. At home, you can connect with a router, fibre optic or cable modem.

The Wifi icon shows waves propagating and indicates that a wireless network is available somewhere. There are different authentication methods to gain access to these networks. Some networks require a username and password, sometimes you also need a receipt or code to unlock yourself.



This is the Wifi icon that appears on your phone or computer when it connects to the Internet.



The router enables access to the Internet



Available networks. A lock indicates that the connection is password protected.

When you see the list of available networks on your device, some are marked with a closed lock. This means that you need a password and user name to access them. It also means that the data is transferred securely (strongly recommended if accessing from a public place). If you don't see a lock, you can connect to that WLAN, but it doesn't necessarily mean you can access the Internet. You may still need to enter a code, password or something similar.

There are different ways to connect to a Wifi network: WEP(least secure), WPA, WPA2(most secure). The frequency can be 2 GHz(greater range) or 5 GHz(faster)..

2.3.2 4G und 5G

The first mobile phones were only able to make and receive calls. This was the first generation of mobile phones, also called 1G . In the 2nd generation 2G it was possible to transmit small messages (SMS: short message service or MMS for multimedia). 3G made it possible to send and receive digital information, such as e-mails or simple Internet pages. Only with 4G could we connect to the Internet as if we were using a computer. Via 4G, even sound and voice is transmitted as data.

2G = digital, voice (GSM)

2,5G aggregated data (GPRS)

2,75G faster data (EDGE)

3,5, HSPA

4 für LTE

Not long ago, the new 5G standard for our smartphones was announced. Expectations are high, as we are promised by the media that 5G will revolutionise everything: Health, security, home automation, etc. Here are some of the main benefits::

- Reduction of delays in the transmission of data, which is very important in real-time applications, such as data exchange of cars, sending and receiving images of an operation.
- Increased bandwidth, which is important when it comes to sending high-resolution images or large amounts of data such as 3D displays or artificial intelligence applications (e.g. image recognition, data processing and sound).

Tip

If you lose the password of your router, you can reset it. Search for your router model using a search engine to find out more details. You will usually need a pen or pin to press a small button that is in a recess. This is to ensure that no one presses this button accidentally. .

5G is not yet available everywhere and 6G is already in development. What will this new generation bring us? More speed, more capacity, less power consumption... whatever it is, it will connect us more than before.

- A higher density of units is possible. Less interference occurs when there are many units in the same room, such as at large events, in large cities or when there are many units on all floors of a building

2.3.3 Share Internet Connections

Nowadays, more and more places (hotels, airports, trains, libraries, etc.) have Wifi connections. If your laptop or tablet cannot connect to a Wifi network and you have a 4G or 5G smartphone, you can share the connection from your smartphone to your other device. You can create a Wifi hotspot (access point), also called your private Wifi. After activation, you need to enter your name and password. Save it and enter it into your tablet or laptop. You can also share it with your friends.

Note: When you create a WLAN hotspot, you consume the data of your smartphone contract.

2.3.4 Bluetooth

Bluetooth is a technology to easily connect devices. Unlike the Internet, whose purpose is to connect millions of devices simultaneously, Bluetooth's networked functions are limited. Bluetooth can be very useful to connect your laptop to a hands-free car kit, your smartphone to your car or your keyboard to your smart TV. Bluetooth is a substitute for a wired connection.

The main advantage of Bluetooth compared to Wifi connections is that Bluetooth has been optimised to connect small devices. Therefore, the antenna is small and the power consumption is very low. Think of a smartwatch, for example. Bluetooth is perfect because you only need to connect it once to establish a secure connection between the two devices. From then on, the connection is automatic.



The Bluetooth logo means that this unit can communicate with other devices via Bluetooth.

3.0 Digital Technologies

We do not need to speculate about the technological possibilities of the future, because the future is already here. Already today, innovative technologies are creating new possibilities for the distribution of information and creating new global structures that influence the economy, personal relationships, privacy and knowledge. We will present these new technologies to you in the following.



Digital Technologies		
He/she knows what the world of digital technologies is all about: construction, developments, innovations and future challenges.		
Knowledge	Skills	Competences
He/she <ul style="list-style-type: none"> understands the workings and logic of the Internet, connectivity and other technologies we use in daily life or that appear in the news. knows some technological innovations, developments and designs that could influence our lives. 	He/she is able to <ul style="list-style-type: none"> form a critical opinion and give feedback. answer others' questions, give explanations and participate in discussions. 	He/she is able to <ul style="list-style-type: none"> understand the latest technologies and knows their future opportunities and risks.

3.1 Network Architectures

3.1.1 Client-Server

The most common structure of networks (the so-called "architecture") on the Internet is the client-server architecture. For example, you call up a website with its texts and pictures when you enter a web address (e.g. www.europa.eu) in an Internet browser (e.g. Google Chrome, Microsoft Edge, Mozilla Firefox, Safari). The same happens when you write an e-mail, for example to info@cumila.eu. "info" is the user name of the so-called "**domain**" (Internet address) "cumila.eu". "cumila.eu" and "europa.eu" are domains and represent a server. A server is a computer in a network with which you can exchange data. Some servers can only display web pages, others can send or receive e-mails (called "mail servers"). Computers communicate with a server using a protocol. The most common protocol for surfing the Internet is the "**Hypertext Transfer Protocol**" (abbreviated to "**http**"), which is why some web pages contain http or https at the beginning of the address. In the case of "https://europa.eu", the "s" at the beginning means that it is a secure connection because the data is exchanged between the client and the server in encrypted form. In the Internet browser, a secure connection is indicated by the lock symbol. In the following picture, you can see the entire Internet address of the website: https://europa.eu/european-union/about-eu_en

The domain is "europa.eu", the part that comes after "/european-union/about-eu_en" is a path that points to an exact page of the domain. The address of a website is also called a **URL** (Uniform Resource Locator). You can copy a web address to send an interesting article on a website or a Youtube video to a friend.

If you use a website where you enter confidential data (e.g. your account number, your e-mail address or your credit card details), make sure that a lock indicating secure transmission via https is displayed in the address bar.



When you access a website via an Internet browser, this is usually done via a client-server connection.

The Internet is a network through which millions of servers are accessible. If you enter an address incorrectly or there is a problem with the server (sometimes networks and servers fail), you will get a message alerting you to the error. Try typing in "europ.eu" and see what happens. If another site is using the name, that site will be displayed. If the address is not used by any website, you will get an error message.

Fraudulent websites exploit such false entries to direct users to a false page. Imagine your bank account is: "www.truemoney.eu", but you accidentally write: "www.tuemooney.eu", then you might get another website that looks like the one of your bank. You might then enter your access data and think that you are on the real website. The

credentials could then be intercepted by the fraudsters and used on the real site to access your bank account. These scams are called phishing (theft of credentials). Fraudsters also often forge e-mails that look like they come from your bank. In them, you are asked to urgently click on a link and enter your user name and password. Be vigilant and always check the Internet address in the address line of the browser carefully and, if in doubt, do not enter your login data.

Did you know that it is no longer mandatory to enter "www" at the beginning of a web address? "http" and "www" used to have to be prefixed to web addresses to refer to a web server capable of opening web pages. Today, your web browser automatically adds these parts if you do not specify them.

When you type https://europa.eu:443 into the address bar of your web browser, you are still opening the European Union website. The addition ":443" directs the request of the web browser to a so-called "port ". In rare cases, it may be necessary to specify this port.

3.1.2 Peer-to-Peer

Peer-to-peer networks or abbreviated "P2P" was a widespread technology around the turn of the millennium. You may remember Napster, Emule, Torrent, etc., which were often used to illegally download music or movies. In a P2P network, you could make direct connections between computers that acted as both client and server (instead of a server-client architecture where one computer is always a server and another is always a client). With P2P networks, it is still possible today to exchange data between computers without needing a central server. Thanks to this architecture, people all over the world can exchange music, films or programmes without a central computer..

3.1.3 Virtual Private Network (VPN)

A Virtual Private Network or VPN is a network that establishes a secure connection between computers. VPN solutions are usually used in a professional environment, whether at university, school or in a company and are also provided by commercial providers. For example, let's say you are studying at a university and you are offered the opportunity to connect to the university's server via a VPN. You need the address of the server, an access name and a password. If you are now in a hotel in London, for example, and surf via the hotel's WLAN, someone may be able to track what you are doing on the Internet. If you use the Internet via your university's VPN access, then you establish a secure (encrypted) connection via the university's server. This protects you from others being able to eavesdrop on your Internet activities.

Typically, organisations and companies use VPNs so that employees from outside can connect securely to the company network. For the same reason, VPNs are also increasingly used by private individuals, especially if you are in an Internet café and don't want anyone to track your Internet activities.

Information

Peer to Peer is a controversial protocol because it is also used to exchange copyright-protected files. However, the illegal action here is not in the protocol itself, but in its use.

3.2 The Building Blocks of the Internet

3.2.1 Domains

Every server on the Internet has an address by which it can be reached, also called an IP address (from "Internet Protocol"). You may have seen addresses like this before. They are 4 blocks of numbers separated by dots, such as 192.168.1.0. This address is an IPv4 address. The IPv4 system can only allocate around 4 billion addresses to devices. However, as there are more and more devices connected to the Internet, there were not enough free addresses. Today, the new IPv6 system is used, which can assign 340 sextillion addresses.

People find it difficult to memorise these long columns of numbers. That is why so-called "domain names" were introduced, with which one can call up a server e.g. via the web browser. After the domain name, an extension is added that indicates what the service is used for. The first domain endings were: .com (commercial providers), .net (technology), .org (organisations), .gov (government) and .edu (education). Later, country code domains such as .fr (France), .it (Italy), .eu (European Union), .de (Germany), .es (Spain), .au (Austria), etc. were added. New domain extensions are added all the time, such as .hotel, .team, .shop, etc. You can also buy your own domain, with your name, your company name or your association and set up a website under it. A domain costs around \$10 per year. It is not always easy to find a free domain name.

Why don't you try it? Search the net for a provider where you can book domain names. There is always a search function on their site that you can use to check whether a domain is still available.

If you have bought a domain (e.g. yourname.org), you also need a server to which the domain is linked. If you want to set up a website (such as www.nombretuasociacion.org) or use an e-mail (e.g. peter@nombretuasociacion.org), you also need to book a so-called "web hosting" offer on which you can store your website or your e-mails. There are some free options for this, but they often display advertising or packages that you pay for monthly or annually.

You have to do a bit of research if you want to set up your own domain and website. That's why many private individuals use free blogs, social media sites, video platforms and e-mail providers under the address of large companies. With these free options, you can gain your first experience on the net.

3.2.2 The World Wide Web

One of the most frequently used services of the Internet are websites, for example: <https://cumila.eu> or <https://europa.eu>. Web pages can be reached via their domain name. Normally, the abbreviation "https://" or "http://" appears at the beginning of a web address. After a domain name, we indicate in a path which page of the website we want to open, e.g.: https://europa.eu/european-union/about-eu/countries_en#-28members

The Internet was designed in the 1960s and became operational in 1969. The World Wide Web (or "the Web" for short) is a service that uses the infrastructure of the Internet and was invented by Sir Tim Berners-Lee in 1989. The web is constantly growing and changing. One of the biggest innovations was the HTML5 standard, which allows dynamic content such as maps, videos, or 3D simulations to be published on web pages, etc.

Domains and web addresses are a convenient way to access content on the web. We can link to images located on a server in Japan or access a website in Argentina. But the Internet includes even more services than the web and e-mails. There are many other services, such as video or music streaming, cloud services and many more. For the different services, you often need your own tools, such as a web browser or an e-mail programme.

The Internet became known to the general public mainly through the web and e-mail. The first websites were simple and contained few media and functions. Today, websites can be dynamic and contain useful functions. Today, websites are often indistinguishable from software programmes, as they can contain similarly complex functions.

3.2.3 E-mail

E-mails existed before there were websites. E-mail addresses also use the domain name system to make it easier for people to use. For example, an e-mail address is: info@cumila.eu. The domain, in this case, is "cumila.eu". The name of the user "info" is separated by an "@" sign (pronounced "at"). Many companies offer free e-mail addresses, such as Gmail or Yahoo. However, you can also create an e-mail address with your own domain, such as myname@mycompany.com. However, you usually need a paid contract for this.

This is how e-mail addresses are constructed: E-mail addresses never contain spaces, but only dots or separators. Before 2007, only Latin letters from a-z and numbers from 1-9 were allowed for domain names, as well as other special characters such as "_" and "-"). Today, you can also use local special characters in domain names, such as "ä", "á" or "ç".

The following rules apply to the allocation and use of e-mail addresses:

- The user name before the "@" sign must be unique in combination with the domain name. If, for example, pablo.sanchez@gmail.com has already been set up and another Pablo Sanchez also wants to set up a Gmail address, his only option is to use a different name or an addition, such as pablo.sanchez002@gmail.com.
- If you mistype an e-mail address, two things can happen: If the address does not exist, you will receive a message indicating the mistake. If the address exists, the message is sent to the wrong person.
- When you register an e-mail address, you often need to provide a password recovery method in case you lose it. This can be another e-mail address or your phone number.

In a nutshell:

- Domain names are unique throughout the Internet. User names of an e-mail address only have to be unique within a domain.
- Make sure you do not mistype the e-mail address.
- Be sure to include a way to recover your e-mail password.



3.3 New Digital Technologies

New digital technologies are emerging every day, but existing technologies are also finding new applications and thus new potentials and risks.


3.3.1 Cloud-Technology

Cloud technology has quickly become a widespread technology that has been adopted by many people. But it has also created fears. In many cases, our data, such as photos, documents, stories, places, is stored in the cloud, no matter what our sensitivities are against it or how much we resist it. A certain amount of scepticism is appropriate and anyone using the cloud should be aware of the following questions: Where is my data being stored? Who owns it? Who can access it? Many people fear that their data could be stolen. Some feel they are losing control. However, if you know the basic workings of the cloud, you can use it as a good way to keep your data safe and, if you want to, share it easily with other people.

The development of cloud technology began in 2007 for private use. Today, almost everyone has a storage space in the cloud. You, for example, probably also already store data in the cloud if you have a Google, Microsoft or Apple account. If you use an Android smartphone or tablet, have a Windows/Office computer or Apple, your data may also already be in the cloud.

Software and data can basically be used in two different ways::

- **Local (“on premises”):** Software is installed on your computer or in your network and data is also stored there. You can compare this with music that you buy on a CD-ROM or films on DVD.
- **In the cloud:** documents, photos, music, films and other data is stored in a storage space on the Internet. You can also use software made available on these cloud servers, such as office software, photo editing, music or video streaming (in contrast to the CD-Roms or DVDs mentioned in the previous point), without having to install a programme for it. The only requirement is an Internet connection and a browser.



Many people worry when they talk about the cloud: Where is this cloud? Who does it belong to? What if I lose it? In any case, one should also consider that the cloud is more than just a data storage device. It is a way to share data, store it securely and even enable new ways of working without depending on programmes installed on the computer at home.

A cloud consists of 3 layers:

- **Infrastructure:** the level of hardware and basic management functions.
- **Platform:** provides interfaces and thus connects the infrastructure level with the software level.
- **Software:** These are the programmes through which one can use the cloud as a user.

Why does one use the image of a cloud for the cloud? The image is of no help in clarifying the question of what or where this cloud is in the first place. The cloud is in fact nothing more than a multitude of networked servers (which in turn are nothing more than computers) located in huge data centres. The first picture shows a section of Facebook's data centre, the second a data centre in Catalonia.



Facebook server (shared by Mark Zuckerberg), Mare Nostrum (from <https://www.bsc.es/>)

The second question is: Who owns the cloud? The companies own the infrastructure (like Google, Microsoft, Amazon), but you own the data. If companies outside the EU want to offer cloud services to EU citizens, it is imperative that they comply with the legal conditions of the European Union. This is ensured by various agreements, e.g. for Switzerland, Canada, Japan and Israel (https://ec.europa.eu/info/law/law-topic/data-protection/international-dimension-data-protection/adequacy-decisions_en). If you use a cloud offering, make sure that the company has its registered office either in the EU or in one of these countries. The registered office is indicated on the company's website or in the general terms and conditions. Many people do not read these terms and conditions before signing a contract, but you should at least pay attention to them.

Here are some of the benefits of cloud services for your data (e.g. shared folders), documents or albums.

With Smartphones and Tablets Into the Cloud

Devices like smartphones and tablets work very well with the cloud. If you have an Android device, your data is stored in your Google account, if you have an iOS device (Apple), your data is stored in your "icloud" account (this is the name of the Apple Cloud). You can sign in with the following addresses: account.google.com and www.icloud.com to access your data on Google and Apple. You can also access data in the cloud using your computer. Either use a browser for this or install additional software such as Google Drive, Dropbox or iCloud to access the data in your file manager. Wha-

tever you decide, as soon as you create a folder in the cloud, you can access it with all the devices on which you have set up the access data.

Working in the Cloud

If you are connected to the Internet, you can edit documents directly in the cloud, e.g. with Office 365 or Google Docs without saving them on your smartphone, tablet or computer. Only if you do not have access to the Internet, this data is temporarily stored on your computer. As soon as you connect to the Internet, they are synchronised with the data in the cloud.

Select What is Stored in the Cloud

The use of the cloud is always optional. On your smartphone, for example, you can choose whether your photos, contacts and the like should be uploaded to the cloud and synchronised or whether you only want to save the data on your device. You decide whether you write a document with Microsoft Office installed on your computer or write a document in the cloud. You can also work with documents online and save local copies on your computer if you feel more secure doing so.

No Fear of Data Loss

The cloud is a good backup solution. You don't have to worry about your data when you update your smartphone or computer, or if your mobile phone is stolen or broken. Your data will still be stored in the cloud. After you have bought a new smartphone and entered your cloud account, all data and settings will be restored. Therefore, remember your user name and password, as these are the access data to your data in the cloud.

Working Together

Before the Internet era, it was common for data to be stored on one's computer. You usually only had one device and mobility was very low. Today, we are constantly accessing new information via our smartphone. We have multiple devices and want our data to be accessible from any of them. We also want our family, friends and colleagues to be able to access the data without sending an e-mail or passing a USB stick. When working with other people (so-called "collaborative environments"), data should not be stored locally because of inconsistencies between different versions or changes to data by different contributors. Working together on a centrally stored file in the cloud is much more beneficial in this respect.



3.4 Digital Risks and Dangers

3.4.1 Viruses and More

A virus is a programme that is installed without consent and has the ability to cause damage to a computer and spread. The first viruses appeared in the 1970s, in the networks of universities, organisations and governments. But it wasn't until the 1990s that viruses began to spread on a large scale: Michelangelo, Melissa, iLoveYou or Jerusalem (Friday the 13th) are some examples. The purpose of the first viruses was to spread panic among users, delete data or do funny things like flip the letters on the screen. However, as the damage caused by viruses grew and more variants of malware and scams came about, protecting against and combating computer viruses became an important task. These are examples of malware and scams:

- **Computer worms:** a programme designed to multiply and flood the network.
- **Trojans** are disguised malicious programmes that are smuggled into the system to spy on the user or gain access to the computer.
- **Ransomware:** a programme that renders data unusable by encrypting it. Usually, a demand for a ransom is made in order to decrypt the data again.
- **Fraud:** methods to fraudulently gain access to a computer. One common method, for example, fake Microsoft employees calling you and demanding access to the computer in order to perform alleged maintenance.

What do people want to achieve by putting viruses into circulation? The development of the first viruses was still seen by programmers as a challenge, a kind of competition to test their own abilities. Over the years, viruses were developed more and more specifically for certain purposes: to destroy other computers (e.g. those of a competitor), to steal data or to capture money.

In addition, you should think about how to protect yourself from viruses. The safest way is not to turn on the computer in the first place. However, this only helps us to a limited extent but should show you that there is no 100% protection against these computer threats, but only some recommendations:

- A good and up-to-date antivirus programme.
- Do not install software from dubious websites or those you receive by e-mail.
- a backup with the most important data and a system restore because sooner or later everyone gets a virus.

Finally, we will show you an example that will show you that you do not need any special technical knowledge to create a virus. A real-life example that has caused problems for many people. You received an e-mail from a friend saying, "I am forwarding this important message to you from a security company where a friend works: There is a virus being sent all over the Internet, please go to your system folder and if you find an icon that looks like a bear, remove it. Tell as many friends as you can about this." People who received this message did indeed find a file with a bear symbol in the specified location as described, deleted it and forwarded the message to their friends. However, the file was not a virus, but a file belonging to Microsoft Internet Explorer.

Information

The fear of a virus attack is justified. There is hardly anyone who works with computers who has not caught such a malicious programme. In case of an emergency, it is important that you are prepared and have an up-to-date backup of your data and your system.

Be careful with e-mails, even if they come from your circle of friends. Just like fake news, they can also send viruses directly.



"Virus" known as the *Teddy Bear Menace* 2002

3.4.2 Spam or Junk-Mail

Spam is the term for unsolicited e-mails. Our inbox is always full to the brim and often the amount of messages exceeds our capacity to process all the e-mails. In addition to spam, we receive countless e-mails from online shops, companies, but also from our friends, family and colleagues. Sometimes the important messages get lost in the flood of messages. There are a few tips to keep track of your inbox:

- Use two different e-mail addresses: One you use for actual communication with other people, the other to register on websites or in online shops.
- Mark spam: Although your e-mail server recognises many spam mails automatically and sorts them into the "Spam" folder, sometimes an unwanted mail makes it into your inbox. To ensure that such e-mails are recognised as spam in future, you can mark them as unwanted mail (usually via the menu of the right mouse button and the function "mark as spam").
- Check your spam folder from time to time in case messages have been sorted there by mistake.

Announcements, promotions, etc. are usually sent as newsletters, i.e. not directly to individuals like e-mails, but to groups of people. Newsletters sent by companies or organisations based in the European Union must offer a way to unsubscribe. The link to do so is usually at the end of the mail. If you click on the link, you will be unsubscribed from the newsletter.

3.4.3 We are Under Attack!

More and more companies are exposed to attacks in the network. So-called DoS attacks (abbreviation for Denial of Service) are widespread. In this case, a large number of requests are automatically sent to a company's server by other computers, so that the server is overloaded. Such an overload can also occur if, for example, many people try to order tickets for a large event on the Internet at the same time. However, this is not a DoS attack because it is not automated.

If you cannot reach a server, first check whether your Internet connection is working by calling up another website. Then check whether you have entered the address correctly. If everything is correct, then you can only wait until the service is restored. If necessary, try to reach the provider via other channels (e.g. by telephone).

The DoS example shows how vulnerable services on the Internet are. Companies put a lot of resources into the security of their systems but there are always vulnerabilities - technical and human. There are no 100% secure systems and we as consumers should be aware of this and not be surprised when services such as WhatsApp fail or the computer no longer starts after a Windows update.

Why are servers attacked in the first place? One possible reason is that competitors want to cripple a competitor's system or simply because someone can. Sometimes it is enough for a company to say that its system is unbreakable to get the experts interested and put this to the test.

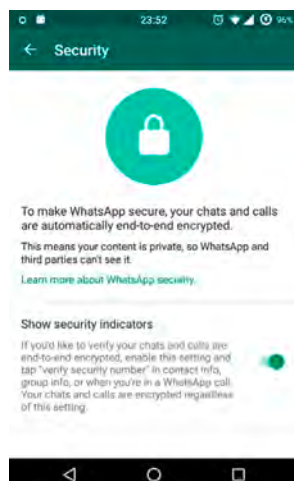
3.4.3 Encryption and Internet Security

For all the risks and dangers in the digital world, we are also protected from many things. Encryption (cryptography) and security mechanisms protect us in many areas on the Internet::

- **Securing communication and data transmission:** Only authenticated users can communicate with you (through signed e-mails) and communication is encrypted. This prevents interference in communication and eavesdropping by third parties (so-called "man in the middle" attacks).
- **Guarantee privacy:** e.g. by encrypting accessed websites.
- **Store information securely:** Unauthorised persons cannot access encrypted data, e.g. on a hard disk or USB stick.

There are many methods for encrypting and decrypting data. For example, WPA2 (Wifi Protected Access) is used to protect our Wifi connections. SSL (Secure Socket Layer) is used to make secure connections to websites (when a closed padlock appears in the search direction and the address starts with https://). Some of the methods have been further improved because they were found to be too weak. This is the case with WEP (Wired Equivalent Privacy), which was introduced a few years ago to better protect Wifi networks.

Apps like WhatsApp also use cryptography to shield the communication between sender and receiver (what we call end-to-end). Governments often view improved encryption critically, as it makes access to data more difficult for investigating authorities, for example. On the other hand, however, it grants freedoms and civil rights.



A warning from WhatsApp stating that data transmitted in encrypted form is used.

These methods provide a good level of security, but it is also not impossible to circumvent them if you have enough time and computing power. For example, the RSA algorithm (the initials of the creators Rivest, Shamir and Adleman) is used for encrypting data. The algorithm is based on the idea of public and private keys. With the public key, people can encrypt messages they want to send to you confidentially. Decrypting this message again, however, only works with your private key.

Think of it as sending someone an open padlock for which only you have the key. When someone wants to send you a confidential message, they put it in a sturdy box and lock it with the padlock. While the box is being transported to you, no one can open the box and read the message. Only you can open the box with your key and attain the message.

Just as someone can try to force open this box, someone can also try to find out your private key. That's why it's important to use what's called "strong encryption", which protects your data sufficiently.

When you register on a website and give a username and password, you usually have to use a combination of letters, numbers and symbols. If you use simple words, an attacker could easily gain access to your user account. A computer can automatically try up to several million words or combinations per second. If a password contains letters, numbers, capital letters and symbols, the number of possible combinations increases exponentially and the ability to determine your password becomes much more difficult. Good systems prevent such attacks by, for example, building in delays between login attempts to prevent automated testing.

The development of effective encryption methods is an ongoing process because, with increasingly powerful hardware, encryption must also be improved. The RSA-250 encryption was cracked on 28 February 2020. The decryption took tens of thousands of computers worldwide several months. With a single computer, it would have taken 2,700 years to decrypt a message encrypted with RSA-250. Prizes are often offered for the decryption of such technologies to encourage experts to check them. A prize of \$200,000 was offered for the decryption of RSA-2048.

Some cryptographic methods are so powerful that they are considered weapons in some countries and it is illegal to export them. Governments fear that terrorists or other illegal groups will use these methods to communicate in secret. Often, providers are required to provide a backdoor for access by authorities, a kind of master key to access the system.

3.5 Algorithms

An algorithm is a sequence of steps that can include operations, actions and conditions. You can compare an algorithm to a cooking recipe: you get a sequence of instructions for preparing a cake. Applying for a real estate loan at the bank also follows a precise sequence: documents are collected, the property is appraised, entries at the land registry are checked, etc. The algorithm ends in this case when the loan is either granted or rejected by the bank.

Algorithms are an important basis for how computers work. Softwares use these sequences to make decisions and display results. As we use computers more and more in everyday life, one could say that algorithms also determine our lives to a certain extent.

Algorithms are made by people. When they develop them, they follow the interests of the company, government or organisation that wants to use the algorithm. The impact of even small changes in an algorithm can have far-reaching consequences. Many algorithms are also not transparent for users.

This is an example of an algorithm for making tea:

1. Put 300 ml of water in a kettle.
2. Switch on the kettle.
3. Has it reached a temperature of 100°C?
4. If no: wait, go to step 3.
5. Switch off the kettle.
6. Put the water in a cup.
7. Place a teabag in the cup.
8. Wait 4 minutes.
9. Remove the teabag.
10. Is the water too hot for drinking?
11. If yes: wait, go to step 10.
12. Enjoy your tea.

As already mentioned, algorithm-based systems play a role in credit applications. Often, for example, insurance applications are already checked by computer programmes and only passed on to a human clerk for final evaluation. Computers thus have an increasingly far-reaching influence on which companies are founded or which people can spend more money on cars, travel, etc.

Another example: Every time you search for something on Google, an algorithm decides which items are displayed and in which order they appear. So an algorithm decides what information you get and also what products you are offered to buy.

3.6 Artificial Intelligence

Another area where algorithms play an important role in artificial intelligence. Imagine the following example: You are driving a car in a city. A motorcyclist is driving on the same road as you without keeping a safe distance. Suddenly, a person appears who is going through the traffic lights on red. Your reaction will certainly be to brake as quickly as possible and the motorcyclist will probably crash into the rear of your car. This is a knee-jerk reaction. No one can sue you for this because you did everything possible to minimise the damage to the weakest road user. Now imagine you are in an autonomous car. The car is equipped with cameras all around and knows the road conditions, the speed, the distance to the motorbike and the pedestrian. The autonomous car could calculate that the braking process is not sufficient to stop before a collision with the pedestrian. How it reacts in this situation is still unclear. Does it run over the pedestrian without braking in order to protect the motorcyclist? Will it find a way to avoid the collision, which could result in your own injury, but the pedestrian's survival?

When designing algorithms, therefore, not only technical aspects come into play, but ethical questions must also be answered. Who bears responsibility and liability in such a case is also not easy to answer.

Algorithms are one aspect of so-called artificial intelligence (AI). The first question is what intelligence is. Instead of defining the word "intelligent", Alan Turing (1912-1954) provided a method for finding out whether something is intelligent or not with the Turing Test. If you want to check whether a system (e.g. a computer) is comparable to human intelligence, you compare a task performed by a human with a task performed by the system. If an observer cannot distinguish between what a human did and what a computer did, then you are dealing with artificial intelligence. Here is an example: If you ask a personal assistant something and you cannot distinguish which answers come from a human and which from a computer, the computer system comes pretty close to human intelligence.

AI is associated with many human-related tasks, such as vision (face and object recognition), speech, communication (natural translation, text construction, etc.), decision-making, assistance and more. There are also tasks that are purely technical: Data processors (Big Data), games and simulations, etc.

Algorithmic applications such as deep learning, natural language processing, expert systems, learning machines, cognitive computing are some of the areas of AI that are growing very fast. From these, applications are being developed to help people in the areas of health, environment, entertainment, data cleansing, education and robotics.

Information

It is said that artificial intelligence will be one of the fields that will grow the most in this century and radically influence our lives. It is important that this technology is used transparently for humans and that we keep an eye on the consequences of the technology.

3.7 Big Data

Before the 1990s, all data produced by families was analogue. Photos, videos and sound recordings were stored on analogue media, such as a photo film, VHS tapes or audio cassettes. This data could also be sent and copied in analogue form (e.g. by fax or with a photocopier). The amount of information we generated was small and difficult to process. In the digital age, people have become big information providers.

This sometimes happens intentionally, for example when we participate in a survey or fill in a questionnaire. We consent to the collection of our data because we consider the purpose of the processing to be legitimate.

But there is also data that we unknowingly generate: when you send a photo with GPS information attached, share your location while surfing or reading, or Google about politics, sex or other sensitive topics. All this information can be collected and used by the providers. We are made aware of this use in the terms of use. However, most people do not read the terms of use and simply hope that no one will misuse their data.

Big Data actually collects such a large amount of data that the data about the individual disappears in it. The real risks of Big Data lie in the fact that the analysis of the data yields results that can have an impact on society. Health insurance companies, for example, could determine from the data of their insured that people with a chronic illness cause much higher costs and set a more expensive tariff for them. Here, too, it becomes clear that such systems do not have to be designed on the technical level alone, but that social and ethical issues also have to be taken into account.

Some online shops are, for example, interested in whether more shoes are bought online on Fridays or whether more wine is bought before the holidays. The offers in online shops are optimised according to these findings and the respective products are advertised more prominently on certain days, e.g. on the website itself, in social media or newsletters. Data from customers is thus transformed into knowledge that is used to achieve the company's goals.

Companies like Google collect a lot of information about us, e.g. the things we search for or which websites we have visited. This information is used to show us suitable advertising. On YouTube, videos that might interest us are suggested to us. These suggestions are largely determined by the computer system assigning me to a user group and suggesting the things that people in the same group consume. So collecting and processing large amounts of data can also be beneficial if really good and appropriate things are suggested to me.

Risks exist when these processes are not transparent and influence us unconsciously. For example, if we are politically influenced via social media (as will be explained in more detail in the chapter on social media). Other topics such as the protection of privacy or the use of personal data for other purposes (e.g. medical or private matters) are dealt with in the chapter "Law and Data Protection".

3.8 Blockchain

Blockchain is a technology for ensuring security without the need for a central office. It, for example, is used to manage the virtual currency Bitcoin. People can send and receive money without having to go via a bank (whether digital currencies are trustworthy is not something we want to go into here) .

Blockchain technology is also used for other purposes to ensure the security of transactions. Here are some examples:

- Universities issued certificates: ensuring printed (or digital) certificates are genuine.
- Cross-border transactions: adds security if more than one central bank is involved.
- At elections: preventing vote manipulation.
- Private contracts: ensuring validity (e.g. a tenancy agreement).

Blockchain technology will bring about major changes in transactions that previously required a third party to ensure security. The best-known example, as already mentioned, is the Bitcoin project. Besides new challenges and threats, however, this technology also brings new opportunities.



Information

■ If you spend €1 on Bitcoins
● in 2016, you could sell them for €100 at the end of 2020. However, this currency is not backed by any central bank. Inform yourself well before investing in such currencies.

3.9 Robotics

Robots are machines that can perform tasks automatically. They have sensors (heat, pressure, vision) to perceive your environment and actuators (wheels, clamps...) to interact with your environment. Robots do not have intelligence, otherwise, they would fall into the realm of artificial intelligence. Examples of robots can be found in car factories or in a very simple case in your home to clean the floor.

Robots that look like humans are called humanoid robots. They are often seen in science fiction films. Building a human robot is difficult because machines often already have problems keeping their balance. For example, transporting a glass of water without spilling anything is one of the biggest challenges for a robot. The Asimo Honda robot was an attempt to build a human-like robot.

The future of robots lies more in developing them for a specific purpose. These robots are usually not human-like, but better serve their purpose, such as:

- Risky operations during rescue operations or in places with toxic conditions.
- Helping older people or people with physical limitations to get out of bed.
- Lifting very heavy weights or doing other tedious tasks.

In many places, robotics is combined with artificial intelligence technologies. .



Asimo Honda Roboter (2018)