



# **INDUSTRY 4.0** for **VET**

## **2. CLOUD COMPUTING**

## 2.1 The topic

### The first introduction

I'm sure you know the situation: The memory on your phone is full and the download of the current software update fails. But the problem is quickly solved! You simply move the folder with your latest holiday photos into the "cloud".



Now you have enough memory on your phone again and can perform the update. Later in the evening you can edit your holiday photos on your computer and share them with your family and friends using a cloud sharing service such as Dropbox or Google Drive. And as you're already just doing it, you save an important Word file in the cloud that you'll need at your office tomorrow.

But what does "**storing something in the cloud**" actually mean? What is a "**cloud**"? What are the areas of application and what is generally behind the term "**Cloud Computing**"?

### The practical relevance - for this you will need the knowledge and skills

No matter whether you run an established company, want to start a start-up with an innovative business idea or you use the Internet only as a private person. The term "Cloud Computing" is on everyone's lips and it is hard to imagine modern information technology without it. According to a survey by the European Union, by 2018 more than a quarter of all companies in the EU were already using Cloud Computing services. And the trend is rising!

To give you an idea of this future-oriented IT trend, this learning unit will introduce you to the basic ideas of Cloud Computing. You will learn in which areas the "cloud" is used and what the advantages and disadvantages of the services in are.

You will be able to assess whether and in what way Cloud Computing can be useful for you in your private or professional life.

### Learning objectives and competences at a glance

This learning unit gives you an overview of the basic ideas of Cloud Computing. You will learn what a cloud is and how Cloud Computing services are characterised. In addition, you will learn about the most important application areas of Cloud Computing and receive information about the different types of clouds.

You will also gain knowledge about the advantages and disadvantages of this IT trend.

Learning Objectives
Know and describe the term Cloud Computing.
List and define the five most important characteristics of Cloud Computing.
Know and explain the three basic application areas of Cloud Computing.
Know and explain the four cloud types.
Know and enumerate the advantages and disadvantages of Cloud Computing.

## 2.2 What does Cloud Computing mean?

Cloud Computing is generally understood as the **offering and use of information technology via a network** of several distributed computers. Normally, this network is the **Internet**.



With Cloud Computing, programs and data are no longer executed or stored locally on your own computer, but are distributed over many different external servers.

This also **provides access to computing power** and **platforms** for independent software development. You use the concentrated resources of a huge network and are no longer dependent on the performance of your own hardware.

This has the great advantage that you no longer have to invest in your own costly IT infrastructure. Generally, with Cloud Computing you only pay for the service that you actually use. **You "rent" IT services.**

The only thing you absolutely need to access IT services via Cloud Computing is a **browser** and an **Internet connection**. The Internet therefore plays a key role in Cloud Computing.

Indeed, the central importance of the Internet for this innovative form of IT use is already reflected in the name itself. You have probably been asking yourself for a long time why it is called "Cloud Computing", haven't you?

Well, the answer to this question is quite simple: The term "cloud" is just a **metaphor for the Internet**. So, in principle, Cloud Computing could also simply be described as **Internet-based computing**.

**Excursus****Why is the cloud a metaphor for the Internet?**

The metaphorical comparison with a cloud alludes to the fact that the Internet is an **abstract** and **formless** digital space that is **difficult to grasp** - just like a cloud.



The characteristics of **complexity** and **opacity** also come to mind through the image of the cloud.

In reality, there is nothing mystical about the Internet or the Cloud! In fact, behind the Internet is a network of **actually existing hardware**, i.e. of many different computers. However, these remain invisible to individuals when using the Internet.

The vagueness associated with the concept of the Internet also applies to Cloud Computing: If you use Cloud Computing, you have no knowledge of which external server your data is currently located on or from where exactly you are getting the computing power. But this knowledge is not necessary for you. Access to resources is done without your intervention - automatically, so to speak.

This means that for you, as a person using Cloud Computing, the metaphor of the cloud may well apply. For a better understanding, however, you should keep in mind that behind the term cloud there is of course a network of actually existing servers.

**Remember**

**The term cloud refers to the Internet.**

For example, if you store something in the cloud, your data is stored in a huge global network of physically real servers. But you don't know where exactly your data is stored. This is why the metaphor of the complex and non-transparent cloud or cloud is used.

So now you know what is behind the - literally - opaque term cloud.

You have also learned that Cloud Computing is basically simply the **Internet-based use of IT resources**.

So, we can make the following simple definition of Cloud Computing:

**Definition****Cloud Computing**

**... refers to the provision and use of IT services over a network, usually the Internet.**

With Cloud Computing, you can access a wide range of IT services **anywhere, anytime**, without being dependent on your own hardware. You have access to storage capacity, computing power, programs or other IT services of a huge network of servers. However, you usually only pay for the level of service you actually need.

## 2.3 Characteristics of Cloud Computing

Now that you have a general overview of the topic of Cloud Computing and know what a cloud is, the next step is to take a closer look at the **key features** of this IT trend.

The federal authority NIST (the abbreviation stands for National Institute of Standards and Technology) from USA has already published a report on Cloud Computing in 2011. According to this report, there are **five important characteristics** that make up Cloud Computing.

These characteristic features of are as follows:

- **On-demand Self Service**
- **Broad Network Access**
- **Resource Pooling**
- **Rapid Elasticity**
- **Measured Services**

Before we define each of these characteristics in more detail, here is a brief example:

Example
<p>Imagine that you have a <b>small business</b> but need to process and store <b>very large amounts of data</b>.</p> <p>You may be dealing with high-resolution image and video files that take up a lot of disk space. <b>Your old hard drive is already pretty full.</b></p> <p>In a few months, you may receive a very large order, which will involve much more data. But it is also possible that you will not get the order after all - your customers will want to decide at short notice.</p>



### What are you doing?

Now you are in a dilemma! Do you want to afford a new very expensive hard disk? And if so, how big should it be? And what if the job doesn't work out after all? Then you would have invested in new expensive hardware that you don't even need at the moment and that would gather dust in your equipment storage room.

Perhaps you already realise that in this case **Cloud Computing** is a good solution. Instead of buying a new hard drive, simply rent storage capacity from a cloud provider.

You can **decide** and **adjust** how much storage space you want to use. If you need more, you pay more. If you need less, you pay less.

The **full capacity of the cloud** is available to you at the touch of a button and you are completely **flexible**.

This example already illustrates some of the main features of Cloud Computing. Let's go through them together.

As mentioned above, an important feature of Cloud Computing is the so-called **on-demand self-service**. This simply means **self-service**.

With Cloud Computing, you can independently access IT services from the cloud - exactly when you need them. You don't have to make a phone call or write an email first to get more storage space, for example. Access is **automatic**. You don't need to communicate with the cloud provider.

**Definition**

**On-demand Self Service**

... means that cloud services are accessed automatically, i.e. without interaction with the cloud providers.

So, you help yourself. You simply take as many cloud resources (e.g. storage space, computing power) as you need at the moment and don't have to ask the cloud provider first.

Another important feature of Cloud Computing is the **Broad Network Access**. This means that Cloud Computing services are offered over a **network**, usually the Internet.

This means that you can use the cloud services via a wide variety of end devices (PC, laptop, smartphone, etc.) and are not tied to a specific location. You have access to the services and data **anytime** and **anywhere**. The only requirement is access to an Internet connection.

**Definition**

**Broad Network Access**

... means that cloud services are accessed over a network and you are not tied to a specific device.

So, you can access cloud resources anywhere and with any Internet-enabled device (laptop, tablet, smartphone, etc.).



Another very characteristic feature of Cloud Computing is **resource pooling**. This means that the IT resources (e.g. storage space, computing power) are virtually available in a large shared "pool". **From this pool of shared resources** many people can then help themselves.

It should be noted that users do not know from which specific servers the IT resources are currently obtained.

Imagine it this way: Suppose you share a swimming pool with your neighbours. When you fill it, everyone supplies water from their own garden hose. In the pool itself, however, you then no longer know which water drop comes from which garden hose.

**Definition**

**Resource Pooling**

... means that the IT resources are available in a common pool and many different people can use them.

In the process, the IT resources of different servers flow together. So, the person using Cloud Computing does not know from which server exactly the resources are obtained.

Another very essential feature of Cloud Computing is **Rapid Elasticity**. IT resources are made available **quickly** and **elastically**, i.e. flexibly and **adapted to requirements**.

Do you remember the example before? We asked ourselves the question whether you should buy a new hard disk for your company and if so, how big it should be. Because you didn't know how much storage capacity you actually needed, you would have probably bought a far too large hard disk. You would have spent more money than you actually needed. At the same time, you would have probably had to invest in a new hard drive again after a while if your business grew. On the other hand, if your business stagnates or shrinks, the brand-new hard drive would be around unused.

With Cloud Computing you don't have these problems. You can quickly and flexibly rent or cancel IT resources. Simply and precisely to the extent that you need the resources at the time.

This feature of Cloud Computing is sometimes referred to as **scalability**. This means that IT resources can grow with your needs or your business. At the touch of a button, you can extend or limit the use of cloud services - as needed.

**Definition**

**Rapid Elasticity**

... means that with Cloud Computing you can quickly and flexibly adapt IT usage to your actual needs

Cloud services are infinitely expandable. So, you can purchase services such as storage capacity and computing power at peak times in your company. When you no longer need the services, simply reduce your usage. This allows you to react quickly and flexibly to economic developments.

The last feature of Cloud Computing that you will learn about at this point is called **Measured Services**. This means that the cloud provider continuously measures and monitors the use of IT services by the individual. In this way the provider ensures that you always have as many resources available as you need. At the same time, only what you use is charged.

**Definition**

**Measured Services**

... means that the use of IT services is measured and controlled by the provider.

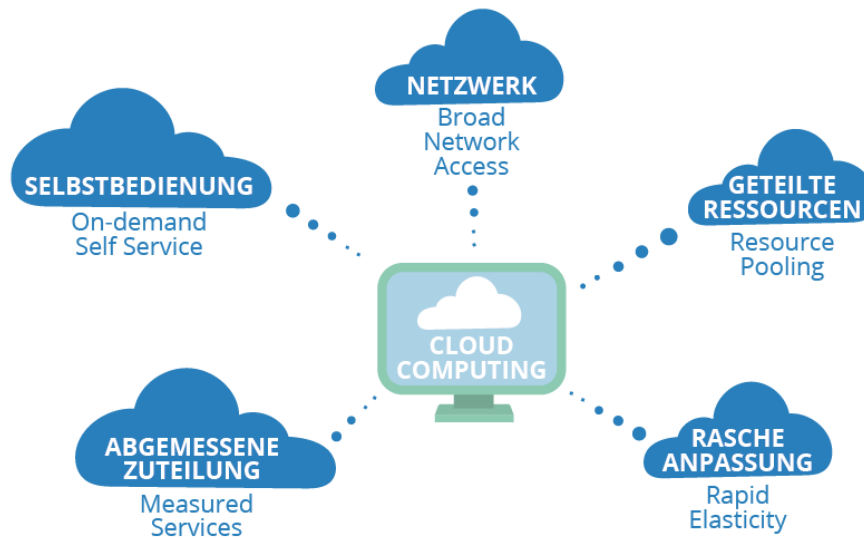
The cloud provider controls and optimises the allocation of IT resources. This means that with Cloud Computing, you usually pay no fixed fee, but according to consumption.

This would now explain the five most important features of Cloud Computing. Let us summarise them again:

**Remember**

Cloud Computing is characterized by: (1) **On-demand Self Service**, (2) **Broad Network Access**, (3) **Resource Pooling**, (4) **Rapid Elasticity** and (5) **Measured Services**.





## 2.4 Application areas of Cloud Computing

Now you have already learned a lot about Cloud Computing and its features. And you've probably already guessed it: there are almost no limits to the areas of application for this IT trend!

In principle, everything that used to be done only via the company's own IT infrastructure can now be done via the cloud. Cloud services cover all areas of modern information technology. However, this also means that the applications that are run in the cloud are not necessarily new. **The use of the cloud itself is the innovation!**

### Important

#### Cloud Computing as digital revolution

The special thing about Cloud Computing is not what is done in the cloud, but that it is done in the cloud!



Cloud Computing turns **information technology into a service** or **supply commodity** such as water, district heating or electricity.

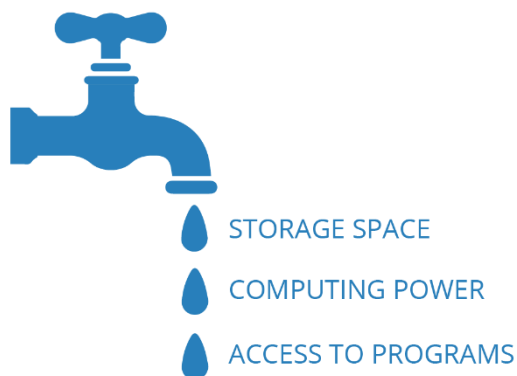
Just as today not everyone owns their own well, tiled stove or electricity generator, there is no longer any need to invest in the acquisition and maintenance of in-house IT infrastructure. Computing power, storage space and applications can be easily obtained via Cloud Computing over the Internet. Only what is actually consumed is charged.

This billing model is very similar to the operating costs for water or electricity. This is why Cloud Computing is sometimes referred to as **utility computing** (compare utility bill).

And just as with water and electricity, today's individuals no longer use their own infrastructure (imagine if everyone had to dig their own well!), but obtain the resources from an **external provider**.

For water supply, this means that you can simply turn on the tap and use as much or as little water as you need.

The situation is similar with Cloud Computing. Instead of investing in an expensive local IT infrastructure yourself, you use IT services via the cloud. In a sense, you turn on the "Internet tap" and only consume and pay for as many resources as you actually need at the time.



Central to Cloud Computing is the idea of **information technology as a service**. This means that not everyone takes care of their own IT infrastructure themselves, but rather rents resources from a cloud provider.

As mentioned above, the areas of application for Cloud Computing are diverse. Nevertheless, three major areas of application can be identified. The naming of the **three areas** follows the pattern of "X as a Service" (**XaaS**). So "X as a service".

We can distinguish:

- **Infrastructure as a Service (abbreviation: IaaS):** Use of infrastructure via the cloud. This is primarily about storage space, but also about computing power.
- **Platform as a Service (PaaS):** Use of a development environment and other resources for software programming via the cloud. This service is aimed at people who want to develop applications themselves, i.e. programmers are addressed here.

- **Software as a Service (abbreviation: SaaS):** Use of various software via the cloud. With this service, ready-made programs are accessed. They are no longer installed on the local computer, but run over the Internet.



**Infrastructure as a Service (IaaS)** is the **basis** for all other services. Storage space and raw computing power are obtained via the resource pool of the cloud. However, this is then used to run the company's own software. This service is primarily aimed at **IT departments of companies** or **public authorities**.

IaaS providers are usually **large companies** that make their enormous IT resources available to other user groups.

Examples of IaaS providers are:

- Amazon Web Services (AWS)
- Microsoft Azure
- Google Cloud Platform
- IBM cloud

**Platform as a Service (PaaS)** is already one level higher. It does not only provide the basic resources (storage and computing power), but also a development environment for creating software. This service is aimed at people who work in software development.

Examples of PaaS providers are:

- Google App Engine
- Apache Stratos
- Salesforce App Cloud

**Software as a Service (SaaS)** is finally the highest level of cloud services. Complete programs are accessed via the cloud. These are no longer "traditionally" installed on one's own computer, but used via the Internet. This form of cloud service is probably the one that **private individuals**, as well as companies, have most to do with.

Examples of SaaS services are:

- Microsoft Office 365
- Dropbox

- iCloud
- Google Drive

Since SaaS addresses the largest target group, the consumer, this area probably plays the most important role in your everyday life. That's why we'd like to take a closer look at one of the areas of activity of the above-mentioned SaaS services:

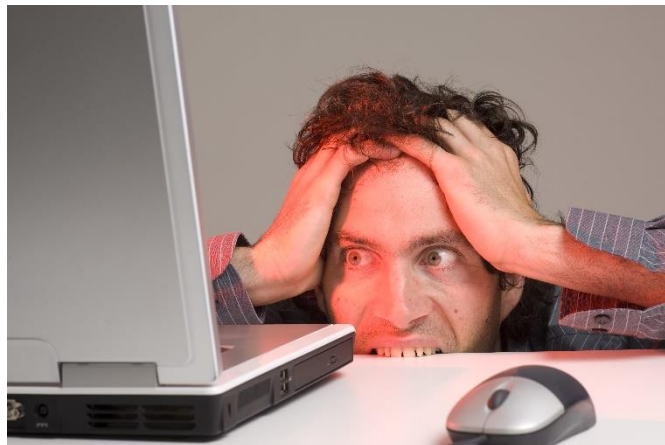
## Example

### Cloud storage provider: Store and share data in the cloud

Michael made it! He just finished his master thesis. Satisfied he leans back and is looking forward to celebrating his success with his friends later on.

He's already trying to shut down his laptop when he sees the newspaper. Michael's face turns pale. Because he remembers the report about Sabine Z., a student who forgot her computer on the train with the only version of her doctoral thesis. The thought alone makes Michael sick.

What if his laptop breaks down right now? Or if someone breaks into his apartment and takes his laptop? Better not take any risks! Save quickly! But unfortunately, Michael has left his USB stick in the office. "Shit", Michael thinks. "Okay, I'll just email my work to myself". But there's a problem here too, because Michael's master thesis is too big as an email attachment. Michael is close to desperation. The longer he thinks about it, the more certain he is that his laptop will break down exactly tonight.



Fortunately, Michael's roommate Alex comes home at that moment. He immediately recognises the problem and suggests that Michael save his work in a cloud storage like **Dropbox**, **Google Drive** or **Microsoft OneDrive**. So, the evening and Michael's nerves are saved!

### But what are cloud storage services?

With cloud storage services, files can be stored in the cloud and shared with others. All you need is an account and you'll get online storage. Some providers even offer a certain amount of storage for free.

In addition to simply **storing** your data, you can usually also share it with other people. This is especially useful when you want to work on a file together with others.

Cloud storage services are also suitable for **data transfer**: whether you want to send your data to friends or colleagues or simply transfer it from one end device to another.

Cloud storage services are also a great way to keep backup **copies of your data**. Just like Michael, with cloud storage you don't have to worry that the storage device will break or be forgotten on the train.

Note: For cloud storage services, the focus is on the use of storage capacity. However, they do not directly access the raw storage resources of the cloud. They use the resources via a **ready-made software, i.e. a program**. That's why a cloud storage service is therefore not an **Infrastructure as a Service (abbreviation: IaaS)**, but a **Software as a Service (abbreviation: SaaS)**!

## 2.5 Types of clouds

You now know that the application areas of Cloud Computing are almost unlimited. Now all that remains is to clarify what different types of clouds there are.

The US-based authority NIST (abbreviation stands for National Institute of Standards and Technology) distinguishes **four different basic types of clouds**:

- **Public Cloud**
- **Private Cloud**
- **Community Cloud**
- **Hybrid Cloud**

This categorisation is about how the Cloud Computing offering is delivered. Let's go through each type together.

**Public Cloud:** In the public cloud, the cloud resources are available to the general public. **In a sense, it is there for everyone**. But the individual users of the public cloud do not know who else is accessing the cloud resources. The cloud is shared with everyone who wants to use it.

In this "classic form" of the cloud, the **cloud infrastructure is operated and maintained by cloud providers**. **This happens off-site**. This means that the infrastructure is not located at the individual people using the cloud, but is distributed to external data centres and servers. The providers of public clouds are usually large companies.

We have already seen examples of public clouds above: Amazon, Google and Microsoft operate public clouds.

All cloud services that are **available to the general public** are referred to the term Public Cloud Computing.

### Excursus

#### **Amazon Web Services (AWS) as pioneer among public clouds and IaaS providers**

Amazon Web Services (AWS), a subsidiary of the shipping giant Amazon, was one of the pioneers in Cloud Computing.

Early on, Amazon had decided to rent out its huge server capacities to other companies at a profit. The economic figures show that this was a very good idea. Since its official founding in 2006, Amazon Web Services has developed into one of the company's top-selling divisions.

As of 2019, AWS is the world's leading cloud provider of **Infrastructure as a Service (IaaS)** and has many large companies as customers.

Did you know, for example, that in 2019 the streaming service Netflix, the booking platform Airbnb or even the US space agency NASA used storage capacities at Amazon Web Services?

**Private Cloud:** A private cloud is now an exclusive cloud. **The cloud infrastructure is only used by a single customer.** A network of servers is reserved or even built specifically for a company. No one else has access to this form of cloud.

Private clouds can either be located locally on company premises or can be rented from specific cloud providers. They can therefore be located **on-site or off-site.**

So if a cloud is **reserved for corporate use only**, it is a private cloud. This means that Amazon's server network was a private cloud before the founding of Amazon Web Services (AWS) - only Amazon itself used its IT resources.

**Important**

**Cloud Type = Deployment Type**

The different types of clouds are not about how the cloud is used, but by whom. In other words, it's about how the **IT offering is delivered** and how many companies or individuals have access to the cloud!

It follows that your privately used cloud storage, such as Dropbox, is not a private cloud. It is a public cloud.

That's because there is no exclusive cloud behind Dropbox, created for you alone and used only by you. On the contrary: the cloud structure behind Dropbox is open to any company or person who wants to use it.

**Community Cloud:** The Community Cloud is in a sense a private cloud with a somewhat expanded circle of users. In this model, a **specific community** shares the cloud resources.

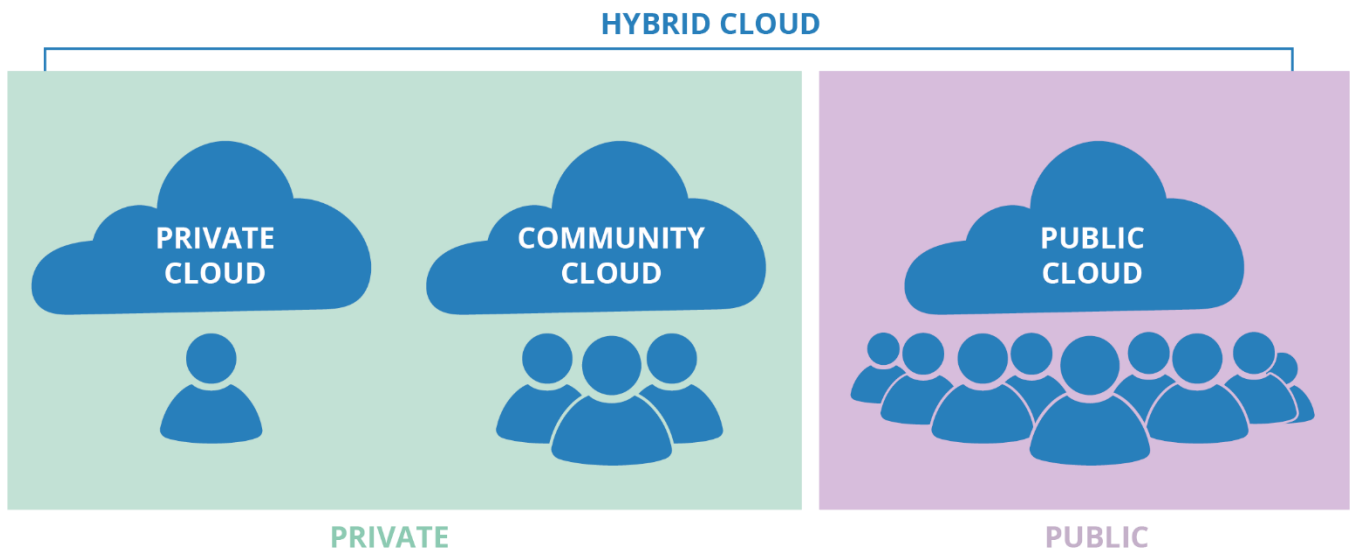
This community is typically made up of companies operating in the **same business sector** and having similar interests and needs.

The goal with the Community Cloud is to save costs compared to several individual private clouds.

**Hybrid Cloud:** Finally, there is the Hybrid Cloud model. **It is a hybrid between private and public cloud.**

With the hybrid cloud, companies decide to outsource **only certain areas of their IT needs to public clouds.** However, the company would prefer to leave certain data or processes in a private environment - so you use a private cloud for this. In most cases, considerations of data protection are in the foreground. For example, companies can store sensitive data in their private cloud and use a public cloud for other processes.

That would explain the **four types of clouds.** The following graphic summarises them again. You see: It's mainly about how many people have access to the cloud structure.



## 2.6 Advantages and also disadvantages of Cloud Computing

Finally, let's talk about the **advantages and a few disadvantages** of Cloud Computing.

Let's start with the **benefits**. is the trend of modern information technology. It would seem so, so "everything should go to the cloud". And there are actually many good reasons for Cloud Computing.

Cloud Computing is:

- **cost-effective:** investment in own IT resources is saved
- **practical:** access to IT resources and data anywhere and anytime
- **flexible:** Activating or deactivating resources depending on the current demand

With Cloud Computing, you no longer need to invest in your own expensive hardware. This applies to private individuals as well as companies.

If you run a business, you can also **reduce** the workload on your IT team by using the cloud. They no longer have to worry about the constant maintenance and servicing of hardware and software, but can concentrate on their core business. This **saves you money** and makes your company more **efficient**. And you only use and pay as much as you **need at any given time**.



Another major advantage of Cloud Computing is that you, as a private individual or small business, can "snatch" the IT advantages of the large companies. This applies both to **investment** in hardware and **innovations** in software.

"Big players" like Amazon, Microsoft and Google want to keep their finger on the pulse of the time and use the latest IT. And they also have the financial means to do so! You could never keep up on your own. Cloud Computing gives you the opportunity to **profit greatly from large companies**.

Some people even believe that Cloud Computing leads to more **equal opportunities**. This is because Cloud Computing means that, in principle, anyone with an Internet connection and certain financial resources has access to the latest information technology. And this is independent of where in the world that person is located.

Another central issue for Cloud Computing is **data protection**. For many of us, **external data storage**, for example of important documents or holiday photos, is the first point of contact with Cloud Computing.

No longer being dependent on the "state of health" and "lifespan" of one's own hard drive is an important point in favour of Cloud Computing for many people.

With the keyword security, however, we can also immediately move on to the disadvantages of Cloud Computing. But first a small comparison:

## Example

### Data storage in the cloud

You can think of storing your data in the cloud like storing your valuables in a bank.

Usually your valuables are much safer in the bank safe than at home under the pillow. However, if the bank is robbed, your valuables are naturally gone - and not only yours, but the valuables of many other people as well.



It is obvious that the bank does everything possible to avoid being robbed. Not only the financial aspects but also the loss of image would be devastating. This is why the bank is making major investments in its security system and also in fire protection.

It's the same with cloud providers. They are keen to keep their cyber security up to date. Even the hardware, i.e. the servers, are elaborately protected against theft or physical damage.



Nevertheless, there is of course no such thing as one hundred percent security in Cloud Computing. And if something happens to the cloud, then not only your data is gone, but also the data of many other people.

So, you see, Cloud Computing also has its risks and dark sides.

Some **disadvantages** that you should be aware of are

- **Dependence on the supplier:** Changing the provider can be difficult
- **Data protection and security:** problematic when working with sensitive data
- **Need for a stable Internet connection:** cannot be used without a well-functioning Internet
- **Climate protection:** Energy consumption of the huge data centres



Before accessing Cloud Computing, it is certainly advisable to think about the disadvantages and possible pitfalls. Despite the many advantages, Cloud Computing does not have to be the right choice in every situation!

For example, suppose you live in an area where **Internet access** is not yet well developed. In this case, you'll probably prefer to use installed software rather than software in the cloud. This way, you avoid having to constantly interrupt your work because your Internet connection is unstable.

Another negative aspect of Cloud Computing is, of course, that you become dependent on the cloud **provider**. If the cloud provider is broke, then you too have a big problem. That's why many companies prefer to rely on large and established cloud providers. But here, too, it can become problematic. What if you want to change the cloud provider? You may face some costs and hurdles. Have you ever tried to get out of your phone provider contract? It can be just as difficult when changing cloud providers.

The **climate issue** also provides ample food for thought. The huge data centres in the cloud consume vast amounts of electricity and other resources. So, when choosing a cloud provider, you could look at whether they are trying to be **climate-friendly**. For example, is there a strong focus on renewable energy?

Finally, a very important area is **data protection**. As you've already learned, with Cloud Computing, individuals don't know exactly where IT resources are coming from. This can be a problem if you want to store sensitive data, for example. Maybe the data is stored on a US server. This may not be compatible with the privacy policies of your home country or corporate headquarters.

You should also think about whether and how sensitive data is **encrypted**. This applies both to storage in the cloud itself and to the transmission of data over the Internet.

So, let's briefly review some of the aspects that need to be taken into account when talking about data protection and Cloud Computing:

- Where is the cloud infrastructure, i.e. the servers, located?
- Where is the cloud provider's headquarters? Does European law apply to it or, for example, US law?
- Is the data encrypted during transmission to and from the cloud?
- Is the data stored in encrypted form?
- Who is the source of the encryption key?

## Important

### Encryption and Cloud Computing

If you want to play it safe, you should rely on **strong encryption methods** in Cloud Computing.



This concerns both the **storage** and the **transmission** of the data!

Ideally, you don't rely on the cloud provider, but instead perform the encryption independently. If the cloud provider is hacked, not only your encrypted data, but also the code to decrypt may fall into the wrong hands.

## 2.7 Summary

Cloud Computing refers to the use of information technology over a network, usually the Internet. It is therefore **Internet-based computing**.

The idea behind this is that it is no longer every single company and private person who invests in their hardware and software, but that **IT resources** are **shared** within large networks.

Cloud Computing is an indispensable part of today's IT world and a **huge economic factor**. It covers all areas of **modern information technology** and the possibilities are practically endless. There is virtually nothing that cannot be done "in the cloud".



Despite the abundance of offers and the complexity of the topic, the basics of Cloud Computing can be broken down to the simple formula: **5-3-4**.

There are **five features** that are characteristic of Cloud Computing:

- **On-demand Self Service:** self-service
- **Broad Network Access:** Access to resources via a network, anytime and anywhere
- **Resource Pooling:** shared resources
- **Rapid Elasticity:** rapid adaptation of various resources to the actual need
- **Measured Services:** measured and monitored usage

There are **three areas of application**:

- **Infrastructure as a Service (abbreviation: IaaS):** Use of IT infrastructure via a cloud
- **Platform as a Service (abbreviation: PaaS):** Use of IT resources for software programming via a cloud
- **Software as a Service (abbreviation: SaaS):** Use of software via a cloud

And there are **four cloud types**:

- **Public Cloud:** for the general public
- **Private Cloud:** for individual companies
- **Community Cloud:** for a group of companies from the same industry
- **Hybrid Cloud:** Hybrid of Public Cloud and Private Cloud

The main **advantages** of Cloud Computing are **cost savings**, **flexibility** and **convenient access** to IT resources and data.

**Disadvantages** are the **dependence** on the cloud provider and the **need for a stable Internet connection**. There are also many problems and open questions in the areas of **data protection** and **IT security**. Furthermore, the issue of **climate protection** should not be neglected in Cloud Computing.