



Market Study Cloud services

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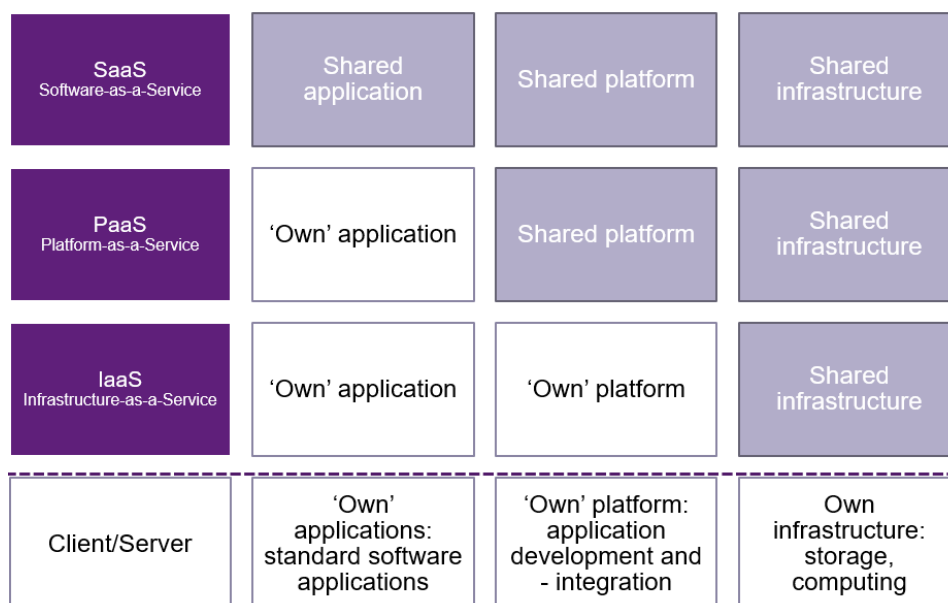
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Executive summary

More and more companies and organizations such as schools and health care providers use cloud services. As a result, this market is growing rapidly: in 2021, the global market, but also the European and the Dutch market, grew by 20 to 30 percent. The Netherlands is one of the frontrunners in Europe in terms of cloud services usage. As part of the focus area 'The Digital Economy' on its Agenda, ACM has conducted a study into whether the market for cloud services is functioning properly, and whether there are any risks to prices, quality, and innovation with regard to cloud services, possibly caused by market structures or by the practices of providers of such services. ACM has also studied in what ways risks can be addressed best.

Cloud services are IT services that are offered over the Internet, where users do not purchase any physical hardware and software, but rather pay for the actual use of one or more services that run on the infrastructure of a cloud provider. This allows users to scale up and down easily. Cloud services are often divided into three categories: IaaS, PaaS and SaaS, where the exact lines between each of these three layers are not always easily drawn.



Market participants

Cloud services are offered by some of the largest companies in the world, such as Amazon, Microsoft and Google. Other active market participants in the European and Dutch cloud services market include IBM, Oracle, VMware, OVHcloud, Scaleway and the Dutch company Leaseweb. The largest cloud providers are active on the IaaS, PaaS and SaaS layers, so they are vertically integrated. ACM has established that the cloud services of the two largest competitors, Microsoft Azure and Amazon Web Services (AWS), both in the Netherlands and in Europe, have very large market shares on the IaaS and PaaS layers (both of them have market shares of 35 to 40 percent). Google is the third competitor in the market, but a very strong one. There is a high degree of concentration in the market for cloud services.

In this study, which focuses on the business market, users consist of companies and organizations (public and private) that purchase cloud services. Their demand is expected to continue to grow with the increasing digitization and the growing importance of processing and analyzing data. Another important group of users are independent software vendors (ISVs): companies that develop IT services and offer them to end users as SaaS services, for example, via the marketplace of cloud providers and built on the IaaS and/or PaaS environment of cloud providers. Together they use many different services on the different cloud layers.

The importance of the initial moment of choice

A user's initial choice of a cloud infrastructure is of great importance. Therefore, at that first moment of choice, there is strong competition, for example with large amounts of *credits* with which cloud services can be tried out for free. The advantage of choosing one specific cloud provider with an integrated offer lies in quality (services can work together optimally) and price (volume discounts). The disadvantage is that it is then difficult for the user to switch wholly or partially to another provider: once the path has been taken, it is often difficult in this market to return (path dependence). Many companies do however purchase services from different cloud providers (multicloud), but this is usually limited to services that do not need to be linked to each other. ACM encourages users of cloud services to be aware of the path dependence when making new choices, and therefore to consciously make a trade-off between the added value of a specific cloud service and the degree of lock-in.

Switching barriers

After the first moment of choice, there may be *vendor lock-in*, meaning users are locked into the chosen provider for a long time. The switching barriers are technical, organizational/procedural and financial in nature. Technical and organizational barriers to transition are often present with IT services, but are larger with cloud services. Due to the strong interconnectedness between the various cloud services and business processes of an organization, it takes a lot of time and effort to unbundle any or all services and redesign them. In addition, there is no suitable alternative for every product due to different product offerings of different cloud providers. Finally, data cannot always be transferred (properly or at all) due to the use of different, closed APIs and standards; data portability is therefore not always possible.

In addition to technical/organizational barriers, there are also financial switching barriers. These are mainly caused by the tariff structure that many cloud providers use. This tariff structure is complex: for every action, stored GB or second of computing power, users have to pay. This structure creates unpredictability about the total costs of using cloud services and about any savings that can be realized as a result of a possible switch. In addition, moving data into the cloud is free (ingress fees), but fees are charged for moving data out the cloud, for example to another provider (egress fees). The *egress fees* of the major cloud providers are much higher than those of most smaller providers. As a result, the user has to make a large investment if he wants to move his data to another provider.

Poor interoperability

Where data portability facilitates the transfer (one-time or otherwise) of data, interoperability involves repeated communication between services of different providers. Poor interoperability reinforces lock-in because users will also have to use the same provider or a third-party service running on the same cloud infrastructure for new services that will have to work together with existing services. As a result, users have less freedom to combine services of different providers. This creates switching barriers and limits competition at the service level between different cloud providers.

Increasing consolidation

ACM expects the consolidation of the market for cloud services to continue as a result of, among other reasons, economies of scale and network effects. It is difficult for smaller players to compete effectively with large integrated providers. For example, other cloud providers cannot keep up with the growth and investment pace of the major cloud providers. In addition, providers that offer cloud services on the infrastructure of an integrated cloud provider, and also compete with services from the same cloud provider, may experience competitive impediments.

Risks

Increasing consolidation coupled with switching barriers and poor interoperability increase users' dependence on just a few vertically integrated cloud providers. This applies to both the end-users and companies that offer cloud services on the infrastructure of the major players (ISVs). This dependence limits competition after the initial moment of choice, which creates risks for price, quality and innovation. Given the strong growth of the market, it is likely that the large integrated cloud providers will continue to focus on developing new services and improving quality for the time being. However, ACM has indications that problems are now arising, for example due to rising tariffs of the use of cloud services.

Possible solutions

In an open digital ecosystem, users can switch to services of the highest quality or most competitively priced services seamlessly. This creates a sustainable form of competition that contributes to competitive prices, quality and innovation. To achieve this situation, improving interoperability and data portability is of great importance.

The Digital Markets Act, the proposed Data Act and the Dutch Competition Act are relevant legal instruments in this regard to address the risks outlined and promote open markets. The DMA states that cloud providers that are designated as gatekeepers should not restrict the switching of users. The Dutch Competition Act continues to be relevant for specific behavior, such as the use of anti-competitive contractual restrictions and pricing structures.

The proposed Data Act is also an important instrument for enabling cloud providers to contribute actively to data portability and interoperability and thus to improve in a durable manner the functioning of the market for cloud services. It is important that the Data Act addresses both the technical switching barriers (such as the use of open standards) and financial switching barriers (the switch must eventually become free of charge for the user). In addition, ACM still sees room for an important improvement in the Data Act, namely by also explicitly imposing interoperability obligations that facilitate the linking of services from different cloud providers. To this end, ACM makes a number of concrete text suggestions to the European Council, European Parliament and the European Commission.

In the coming months, ACM will further investigate switching barriers, including egress fees. ACM will investigate to what extent these switching barriers actually cause competition problems and whether they can be tackled best on the basis of competition rules or other instruments (DMA, Data Act).

1 Introduction

In this chapter, it is explained what the study entails. Section 1.1 explains the background and objectives of the market study. Section 1.2 explains the market study's scope, and section 1.3 the approach. Finally, section 1.4 explains the market study's structure.

1.1 Motivation

Background

Cloud services are playing an increasingly important role in the Dutch economy and in society as a whole. The percentage of Dutch businesses using cloud services in 2021 rose to 65%, a rise of 12 percentage points compared to the previous year.¹ Other organizations, including in the public sector, such as schools, care institutions and government bodies, are also increasingly using cloud services. The Netherlands is consequently among the top five countries with the highest expenditure on cloud services as a percentage of total IT costs.² The use of cloud services means that the ICT services used by organizations no longer run on their own servers, for example in a room in their offices, but in the cloud, i.e. on someone else's servers at an external location. In the cloud, organizations can remotely use storage capacity and computing power offered by cloud providers and can also use complementary services, including databases and innovative services such as artificial intelligence (AI) and machine learning tools. Since cloud services are increasingly being used by many organizations and consumers, they are an ever more essential part of our society and economy. Many things, including in the public domain, depend on the operation of cloud services. Hence there is very strong interest in cloud services.

The market for cloud services, like many other digital markets, has a number of major players. These are usually the same (foreign, non-European) businesses that also play a role in many other digital markets: Amazon, Microsoft and Google.³ The first two in particular have a strong position in the cloud services market in the Netherlands and Europe (but also worldwide).⁴ The market appears to be fairly concentrated. Cloud services are an increasingly important part of these operators' activity: Amazon Web Services (AWS), for example, has been described as the financial engine of the entire Amazon group.⁵

In addition to these three major US operators, there are also European cloud providers operating in this market. These are much smaller than the operators referred to above, however. Their joint market share has fallen to around 15%.⁶ Concerns are regularly voiced about the position and opportunities of the European players and the European Commission (EC) has been asked to take action.⁷

The EC has the digital future of Europe high on its agenda. The EC strives to create a thriving data economy and with its digital strategy aims to ensure that people and businesses can take full advantage

¹ Eurostat, [Cloud computing - statistics on the use by enterprises - Statistics Explained \(europa.eu\)](#), last visited on August 8, 2022.

² [The Netherlands in the global top 5 adoption of cloud services' - Techzine Europe](#), last visited on March 14, 2022.

³ [Chart: Amazon Leads \\$180-Billion Cloud Market | Statista](#), last visited on March 14, 2022.

⁴ [European cloud computing market size 2021 | Statista](#), last visited on March 14, 2022.

⁵ [What Is Amazon Web Services and Why Is It So Successful? \(investopedia.com\)](#), last visited on March 14, 2022.

⁶ [European cloud computing market size 2021 | Statista](#), last visited on March 14, 2022.

⁷ [Cloudbedrijf Leaseweb rekent op miljardensteun in strijd tegen techreuzen \(in Dutch\) \(fd.nl\)](#), last visited on March 14, 2022.

of the digital transformation.⁸ To this end, it has put forward a number of draft laws, such as the Digital Markets Act, the Data Governance Act, and the Data Act. This digital strategy also encompasses the market situation of cloud services. European Commissioner Margrethe Vestager, for example, has pointed to the need for more competition in the cloud services market so that users have more choice of where to place their data, among other things.⁹

In addition to concerns about concentration in this market, the cloud services market also entails risks relating to independence (including economic independence), vertical integration and vendor lock-in. This, combined with the growing economic and social importance of cloud services, is the reason why ACM is conducting a study into the market for cloud services. As the market regulator, ACM has the digital economy as a theme on its agenda¹⁰, and therefore invests in up-to-date and relevant knowledge. This is why ACM began this market study into cloud services in the spring of 2021.¹¹

Objective: knowledge accumulation and problem identification

With this market study into cloud services ACM has two goals: knowledge accumulation and problem identification. Cloud services are often complex and abstract. The structure of the market is also complex, partly because it is characterized by many different types of services and the relationship between them. ACM believes it is important to build up sufficient knowledge of this in order to form a detailed picture of the functioning of this market.

ACM's mission is to ensure that markets function well for both people and businesses, now and in the future. ACM sees risks to a healthy, effective, and sustainable competitive situation. With this market study ACM therefore investigates how the cloud services market functions in the Netherlands and Europe and whether there are problems caused by market structures or by the behavior of certain market participants. It also investigates how these problems can be addressed.

1.2 Delineation of the market study

As stated above, cloud services exist in almost all parts of our society. They are used by both consumers and organizations. Logically, there are many different types of cloud services: both in terms of the types of services they provide and in terms of their technical characteristics. The term cloud services is broad and can encompass many different types of services, from pure computing power to a complex application.

Cloud services are generally subdivided into three layers: Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). Which services belong to which layer may nevertheless differ depending on the provider. In all three layers, the end-user rents the hardware and software rather than having to purchase it: they pay for the actual use of one or more services, which may vary from month to month. This means it is easier to scale up and scale down and to use more or fewer different services.

⁸ [A Europe fit for the digital age | European Commission](#), last visited on March 14, 2022.

⁹ <https://news.bloomberglaw.com/antitrust/online-cloud-services-need-more-competition-eus-vestager>, last visited on March 14, 2022.

¹⁰ [Digital economy | ACM.nl](#), last visited on August 8, 2022.

¹¹ [ACM launches market study into cloud services | ACM.nl](#), last visited on August 8, 2022.

Services on the IaaS layer constitute the core of cloud services and can be seen as the foundation of cloud services. Servers, network equipment, and workstations are offered on this layer, providing computing power and storage capacity. On the IaaS layer it is possible to build PaaS and SaaS services which use this infrastructure. The PaaS layer is a platform or development environment in which tools are provided, the PaaS services (such as databases and machine learning tools), with which developers can develop and manage applications without having to manage the infrastructure. The PaaS layer is offered by cloud providers that offer their own services on it, but third parties can also use it to offer their services. Developers can use the building blocks on the platform and, for example, develop SaaS services. The SaaS layer consists of applications and software running on infrastructure of an IaaS and/or PaaS provider. SaaS services are turnkey services used by consumers and businesses; examples are accounting software and video streaming services. Services exist in all shapes and sizes and are very varied.

This market study focuses particularly on the IaaS and PaaS layers. It is these layers that have the highest degree of concentration. The SaaS layer is nevertheless taken into account with regard to the vertical integration of services and in the relationship between providers of SaaS services on the one hand and providers of IaaS and PaaS services on the other. Since ACM focuses particularly on these layers, the main focus of this market study is on the business side of cloud services. That means cloud services for businesses, organizations, public bodies, and institutions.

Problem identification and definition

As also stated above, ACM's problem identification focuses particularly on the question of whether market problems arise. The market for cloud services may also be affected by other types of problems, for example concerning security and privacy, geopolitical issues relating to sovereignty, or sustainability issues. ACM only takes these issues into account to the extent that they affect the competitive situation. Security and privacy can be relevant selection parameters that can influence the competitive process. The same can apply to geopolitical and sustainability issues. However, ACM does not consider these issues in isolation in this market study. Hence it does not investigate the extent to which cloud providers have a sustainable or secure product offering, or to what extent the geopolitical situation around cloud services is desirable. In this study, ACM confines itself to the competition situation.

This market study is not intended to be a competition investigation within the meaning of the Dutch Competition Act. In this market study, ACM does not define any relevant market for competition-law purposes and does not examine whether any operator has a dominant position. Therefore, where this market study refers to "the market", that does not mean a market within the meaning of the Dutch Competition Act.

Geographic delineation

On the basis of its jurisdiction, ACM logically focuses particularly on the Dutch market in this market study. However, the market for cloud services is international, not least due to the players that provide cloud services. ACM has also chosen to include the European market in this market study in view of the European internal market and the concerns of the EC described above. Where necessary, the situation in the Netherlands and Europe is compared to the situation worldwide, but this market study does not in principle include an analysis of the global market.

1.3 Approach

ACM has adopted the following approach in this market study. During the first phase of the market study the focus was primarily on gathering information on cloud services. To this end, ACM researched public sources and conducted discussions with independent experts in the field of IT and cloud services. It then held discussions with a large number of stakeholders in this market. Discussions were held with 11 providers of cloud services. ACM also held discussions with a number of CIOs of businesses that purchase cloud services, and with a number of Dutch industry associations. ACM also talked to other regulators in the Netherlands and Europe involved in this area. The list of interlocutors can be found in Annex 1 (partly confidential).

After this initial broad survey, ACM then conducted more in-depth study to obtain more facts about the state of the market. To this end, ACM conducted additional discussions with a number of stakeholders and sent a number of requests for information. An initial request for information was sent to chief information officers (CIOs) of Dutch businesses and organizations. This request was sent to them through the CIO Platform Nederland. The aim of this request was to gain more insight into the use of cloud services in the Netherlands and the experiences of CIOs with regard to subjects such as choice and switching. Fifteen CIOs answered this request. Since that is not a representative sample, ACM makes no statements based exclusively on the completed questionnaires. This information does nevertheless help in outlining the experiences of Dutch CIOs with regard to the choices they make and how they use cloud services in the Netherlands.

ACM also sent requests for information to some 10 providers of cloud services operating in the Dutch market. Nine cloud providers responded. They were asked to supply various figures (revenues, users) in the Dutch and European market. ACM also asked the cloud providers their opinion on themes such as switching problems and dependencies. A number of cloud providers were subsequently asked additional questions by ACM. In addition to the aforementioned information requested by ACM, a number of operators then provided ACM with information of their own volition.

Based on these discussions, requests for information, submitted information, and publicly available sources, ACM then conducted an analysis of the extent of any problems that might cause it concern as the market regulator.

Finally, ACM analyzed the extent to which various instruments were sufficient to address these problems. Both the current toolkit of ACM was taken into account as well as a number of laws that have been announced by the European Commission.

ACM has adjusted and discussed its findings with an advisory group made up in part of external representatives. This advisory group included people with extensive knowledge of cloud services and/or the digital economy and its providers. Its members were:

- Prof. José van Dijck. University Professor of Media and Digital Society at Utrecht University
- Prof. Martijn Warnier. Professor of Complex Systems Design at Delft University of Technology
- Senior enforcement officers from various disciplines within ACM, including the Chief Economist (or acting Chief Economist), Representatives of the Telecommunications, Transport and Postal Services Department, Competition Department and the Consumer Department.

1.4 Structure of this report

ACM uses the following structure for this report. First of all, in chapter 2, ACM gives a general explanation of what cloud services are, and how these have emerged. In that context, several common terms and technical aspects that are important for understanding the functioning of cloud services will also be discussed. In chapter 3, ACM describes the demand-side of the market, and looks into the use of cloud services in the Netherlands and in the rest of Europe. ACM subsequently describes the supply-side in chapter 4. ACM also explains what market participants are active in the cloud market, and what their market shares are.

In chapter 5, the most important market characteristics (economic or otherwise) are discussed, and it is explained in what way they have an impact on the cloud market. In chapter 6, ACM describes the identified market risks and barriers, and it analyzes the effects thereof on market dynamics. In chapter 7, it is subsequently explained what instruments the identified risks and impediments can be mitigated. Finally, ACM analyzes all findings in chapter 8.

Annex 1 contains a list of all discussion partners. Annex 2 contains a definition list used by ACM.

When people talk of the cloud, terms such as the cloud, cloud services, and cloud computing are often used interchangeably. In this report, ACM uses the following terms:

- The cloud: the collective term for the set of services including computing services
- Cloud services: the services offered on the cloud, for customers
- Cloud computing: calculations carried out on servers using of cloud services

2 What are cloud services?

In this chapter, ACM explains the main elements of the cloud. Many terms and definitions are used in the IT and cloud sector which are not fixed and can be interpreted in different ways. In section 2.1, it is explained what cloud services are, and what types of cloud exist. In section 2.2, it is subsequently explained what layers of cloud services can be distinguished. In chapter 2.3, the pricing structure is discussed, and in chapter 2.4, the role of standards and open source is explained. Finally, in chapter 2.5, it is explained how integration of different cloud services works. pricing structure

2.1 What is the cloud?

2.1.1 History of the cloud

Before the 1990s, operating systems and applications were linked directly to physical hardware: if a company had a mail server and an enterprise-specific application running on various operating systems, this required two separate servers. Around the turn of the century, VMware introduced virtualization software. By creating a simulated, i.e. virtual, computer environment, it was possible to run multiple virtual servers on a single physical server. By sharing physical hardware, organizations found it easier to scale up and scale down in terms of server capacity and these servers could be used more efficiently, leading to considerable savings. These advantages led to wide adoption of virtualization by the market. Businesses and organizations purchased or leased physical servers on which they could run their virtual servers. The US company Amazon, too, then mainly an e-commerce company, used virtualization and built services to standardize and automate its retail infrastructure as far as possible. In 2006, Amazon began renting out unused server capacity and tools under the name of Amazon Web Services (AWS). Not only were physical servers now used by multiple virtual servers, but multiple businesses could use a single server. Hence the first cloud service was born.¹²

2.1.2 The cloud & public cloud

There are various definitions of the cloud. The simplest and broadest definition is "a service that is provided over the internet". The most widely supported definition of the cloud, however, is that of the National Institute for Standards and Technologies (NIST). The NIST provides the following definition: A model for enabling on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.¹³ The NIST also states that the cloud has five essential characteristics: 1) Broadband access; 2) Payment per unit used; 3) On-demand self-service; 4) Scalability; 5) Pooled hardware

These five criteria are further explained below.

1. **Broadband access:** in cloud computing, the cloud services run on servers that are accessible via the internet. Hence it does not matter which device is being used: the storage capacity, computing power and functions are available everywhere, as long as a good internet connection is available. This provides possibilities for more flexible and better collaboration, all round the world, if required.

¹² Meeting with Hans Wanders, April 12, 2021; Notes of meeting VMware, July 7, 2021, DOX/IN/ACM/IN/699888; en <https://azure.microsoft.com/nl-nl/overview/what-is-virtualization/>, last visited on March 18 2022 and VMware discussion report.

¹³ [NIST Cloud Computing \(odc-noord.nl\)](https://nist.gov/CloudComputing(odc-noord.nl)), last visited on April 1, 2022.

2. Payment by unit used: with cloud computing organizations and businesses do not buy hardware themselves but pay for the actual use of services. Payment is therefore made, for example, per stored GB, calculation, or request.
3. On-demand self-service: users of cloud computing can adjust the required services themselves at any time by means of a dashboard. This means the user can be operational almost immediately, because no servers have to be purchased. Furthermore, a company is freed almost entirely of the need to consider the management and maintenance of servers, which is carried out by cloud providers. Depending on the provided service, cloud providers take care of security, updates, and the availability of the services.
4. Scalable: the capacity can be scaled up and down at any time. In this way, companies can easily grow or extra capacity can be available in busy periods at short notice. The capacity for an end-user is (almost) infinite. This allows a lot of flexibility.
5. Shared hardware: in cloud computing not everyone has his own server, but more users can use a single server. This means the servers can be deployed more efficiently, so criteria 2 and 4 become possible.

In addition to the above advantages, using cloud services has the advantage that a company or organization no longer has to make any (initial) investments in its own on-premises hardware, such as racks and servers. As well as the initial investment, which can be substantial, this also saves the associated management and maintenance costs. Using cloud services can therefore save a lot of costs (particularly for start-ups). This is particularly true due to scalability. In an on-premises setting a company must ensure that the infrastructure is suitable for the highest “peak” in the load of the servers. During the rest of the time, the infrastructure is not optimally used. At that time, there is reserve capacity. In the cloud, users pay only for the capacity used (pay-as-you-go/pay per use). This may mean the cloud is a better choice than having on-premises hardware, particularly when demand is changing or different capacity is required.

Cloud providers invest billions in improving their services on the different layers. By using the cloud, customers have easy access to the latest technologies and innovations from large companies. This can give companies an advantage compared to their competitors that do not use the cloud and can encourage innovation.

Within the cloud a distinction is often drawn between public and private cloud services. However, private cloud is not always seen as the cloud. This is because in private cloud the hardware is not pooled by different users, but an entire server is leased at an external site. The server is then only used by one company or organization. Hence it is not possible to scale capacity up or down in a few minutes and pay per use is not possible. Private cloud is therefore often considered rather to be the more classic forms, such as co-location and hosting.

In this study, ACM therefore does not consider private cloud, only public cloud. References to cloud thus mean public cloud. In addition to the above distinction, terms such as hybrid cloud and multicloud are often used. These are explained below.

2.1.3 Hybrid cloud

Hybrid cloud is a form of cloud that integrates on-premises infrastructure, private cloud, and public cloud with each other. On-premises infrastructure cannot always communicate well with a cloud service. In addition, a generic cloud service is often unable to run directly on on-premises infrastructure. In order to integrate on-premises infrastructure with a public cloud, a management layer is therefore required that enables the on-premises infrastructure to be connected to a public cloud.

A management layer connects the various APIs of the different infrastructures in a single dashboard. On this dashboard the whole system can be monitored and managed in a single environment. Workloads can also be moved between the various types of servers. This can be done most simply when the applications are built in containers. These are applications that are built in a “standard format” and supported by most IaaS platforms. An example of a widely supported standard for containers is Kubernetes.

Almost all operators offer hybrid cloud solutions and various providers have specialized in this, such as VMware with Cloud Foundation and IBM with Openshift.¹⁴

2.1.4 Multicloud

In addition to hybrid cloud there is also multicloud, where operators use cloud services of different providers.

If a company or organization uses multiple services, it may be desirable for these services to be integrated with each other, or to communicate with each other. This is not always necessary. For example, a company can choose to use the services of cloud provider A for its data analyses, but to use cloud provider B for its e-mail services. In this case, the public cloud of provider A does not have to be integrated with the public cloud of provider B. After all, the e-mail and data analysis services do not have to communicate with each other.

It may also be that a company uses, for example, infrastructure services (IaaS) of cloud provider A, but also a certain data analysis service (PaaS) of cloud provider B. In this case, it is desirable to integrate these services from different cloud providers with each other. Since companies increasingly use (different) cloud services, the desire to integrate services is increasingly common. This integration can take place in two ways: either by making the services interoperable on their individual (own) cloud, or by running the services of one cloud provider on the servers of the other cloud provider. These two forms are not possible in all cases, however. This depends on a number of technical elements. A management layer may also be required, as in the case of hybrid cloud. The European initiative Gaia-X also contributes to this. Gaia-X is a project initiated by a number of European parties, but which now also includes companies from outside Europe. The purpose of Gaia-X is to create a fully open, sovereign, standardized, and federated cloud toolbox. Hence Gaia-X is not a cloud provider but a means by which cloud providers can build a cloud to interconnect with each other.¹⁵

In section 2.4, ACM considers in greater depth the technical aspects such as standards (including open standards), and accordingly whether there is scope to integrate services, as well as the competition consequences (section 2.5).

2.2 The different cloud layers

The cloud contains different types of services: from pure computing power through to a ready-to-use application. These different services are often built, as it were, on each other: they use “underlying” services. In order to organize the different types of services, a distinction is often drawn between three different layers: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). The separation between these different layers is not strict, however: different market

¹⁴ Notes of meeting VMware, July 7, 2021, DOX/IN/ACM/IN/699888.

¹⁵ [GAIA-X - Home \(data-infrastructure.eu\)](https://gaia-x.eu/), consulted on June 9, 2022.

operators apply different classifications, so it is not always clear to which layer each individual service belongs.

The arrangement of the cloud layers is important for the rest of this market study. This is because every layer has its own characteristics and different market problems apply to the different layers. ACM believes that a precise distinction between the various layers is not necessary in order to conduct an analysis of each layer. The three layers and their main characteristics are described in the sections that follow and are shown below schematically in Figure 1.

In addition to these three primary layers, which are explained in the sections below, there are also a number of intermediate layers that can allow yet more differentiation, but can also increase the potential for multicloud by allowing interoperability. These intermediate layers are Function as a Service (FaaS), in which applications are developed with modular microservices, and Container as a Service (CaaS), in which applications or parts of applications run separately in a container but sections of the operating system and storage are shared. The intermediate layers are still being developed. These layers are not considered specifically below.

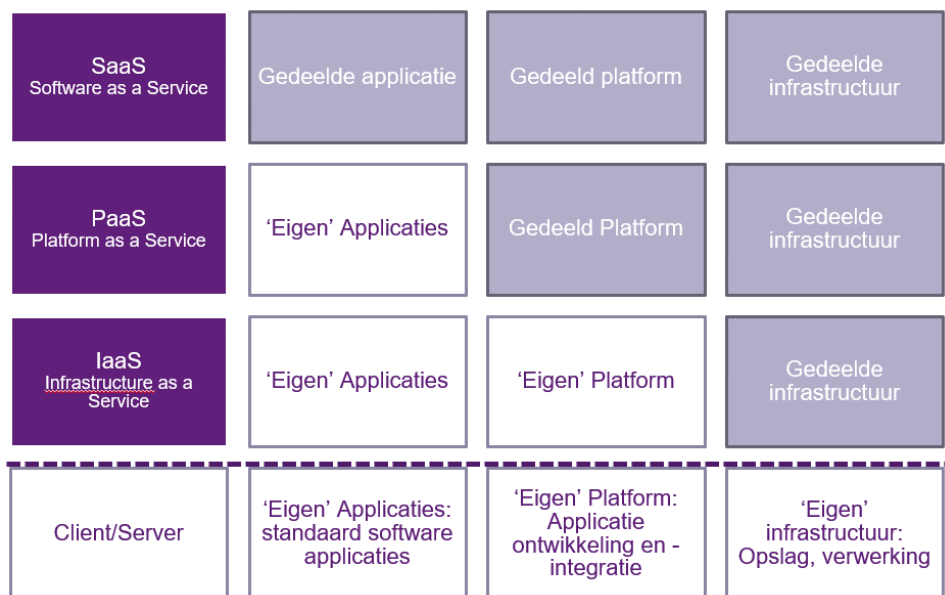


Figure 1: the different cloud layers

2.2.1 IaaS

Infrastructure as a Service (IaaS) is the fundamental layer of the cloud on which all other cloud services are built. The infrastructure, comprising hardware such as servers and network equipment, is provided virtually. On this layer, infrastructure services are offered such as storage and virtualization.

With IaaS services, the user can gain access via the internet to a computer on which the desired software can be installed. Users of IaaS therefore no longer have to invest in physical servers, but use the hardware of the cloud provider. This hardware is often in a data center. In some cases, the data center belongs to the cloud provider itself, but sometimes a cloud provider places the hardware in third-party data centers, where it leases space for servers. This is also referred to as Housing as a Service (HaaS). The cloud provider also provides updates, maintenance, and security for the hardware. The

user has access to and control of the servers via an API or a dashboard in order to manage capacity and other matters. Another advantage of the use of IaaS services is that the user often has access to servers around the world, because different IaaS providers have servers worldwide. This enables the user to achieve low latency for customers or branches around the world. In addition, users of IaaS services can enter into service license agreements (SLAs) for accessibility and speed in order to provide high-quality service at all times.

Users of IaaS services are still responsible themselves for the operating system used and the applications running on them. Since the IaaS services are essentially ordinary servers, the target group is enormous. Everyone who has or wants a remote server is a customer or potential customer.

An example of a widely used IaaS service is Amazon Simple Storage Service (S3) from AWS, which enables users to securely store almost unlimited data that is visible to the entire organization.¹⁶ Another example from LeaseWeb is its 2x AMD 24-Core EPIC 7402 server. This is a complete but empty server that can be equipped if desired with an operating system and management software.¹⁷

2.2.2 PaaS

Platform as a Service (PaaS) is a platform where building blocks are offered with which developers and programmers can build an application. These development support programs mean less time is required to write code because it is possible to use application components with ready-to-use code from the platform. This can handle everything such as search functions, security functions, workflow functions, databases and image recognition functions. Developers can use these building blocks to build an application without the need to program each component. Developers can execute and manage these applications without having to deal with the underlying infrastructure layer and the software layer on which the application is built, since this is managed entirely by the cloud provider.

All these different PaaS services can scale up and scale down independently of each other, but can also be managed and monitored from a single place. The helpdesk communication part and the settlement part of the application can, for example, scale up and down independently of each other, allowing efficient use of the infrastructure. In order to use the flexible upscaling and downscaling offered by the cloud, this PaaS layer must also run on the IaaS services.

The PaaS layer is mainly used directly by companies that develop software themselves. These can be developers, working in a company, or Independent Software Vendors (ISVs). The software can then be offered again as a SaaS service or internally in the organization as company-specific software.

An example of a PaaS service is Google Cloud Run, which enables developers to write their code in their favorite language without having to pay attention to the underlying infrastructure.¹⁸ Another example from Microsoft is the Azure SQL Database, which enables developers to use the database without having to worry about updates, capacity, and back-ups.¹⁹

2.2.3 SaaS

Software as a Service (SaaS) is software that is offered as a service via the internet. SaaS is the application layer of the cloud. SaaS consists of complete software that users can use after installation.

¹⁶ [Cloud Object Storage – Amazon S3 – Amazon Web Services](#), last visited, July 15, 2022.

¹⁷ [Get dependability and more with an AMD EPYC server- Leaseweb](#), last visited, July 15, 2022.

¹⁸ [Cloud Run: Container to production in seconds | Google Cloud](#), last visited, July 15, 2022.

¹⁹ [Azure SQL Database : Service voor beheerde clouddatabases | Microsoft Azure](#), last visited, July 15, 2022.

SaaS services come in all shapes and sizes, such as e-mail services, accounting software, video streaming services, or services that can operate IoT devices such as lighting and heating. SaaS services are thus used by both consumers and business users. A major category within SaaS is productivity software. These are services that are widely used in an office environment, such as the familiar Office products from Microsoft. The SaaS market is a very diverse market with many different providers.

Users of SaaS services no longer purchase a license, as in the case of traditional software, but for example take out a monthly subscription, possibly per user. The SaaS provider supplies the installation, management, and updates, after which the user can access the software via the internet.

The SaaS services are usually built on the IaaS and PaaS layers. Without these underlying layers, the application could not be flexibly scaled up and down. For end-users of SaaS services it is often unclear which underlying infrastructure is used and who owns it. For example, the cloud storage service of a SaaS provider may run on another cloud provider's IaaS service without this being visible to the end-user.

2.3 Pricing structure

Most cloud providers have a pricing structure based on a pay-as-you-go model²⁰, which is also referred to as pay per use. This pricing structure is generally different than the tariff model used in traditional ICT. This uses the relatively simple license-based pricing model, in which a fixed amount is paid for the license for an IT product.

In the case of pay-as-you-go, the user pays per unit used, for example per GB of storage or per second of computing power (see also section 2.1.1). At the end of each month, the user receives a summary invoice showing a breakdown of the use of the cloud services during the past month. Users therefore pay exactly for what they have used and are generally not tied to any particular volume requirements. However, various providers also offer a reserved-instance pricing scheme, a variant of the pay-as-you-go model with volume requirements. The user enters into a contract, usually for one to three years, setting out the minimum spend in the cloud or the minimum volume that will be used (usage commitment). On the basis of this contract, users then receive a discount for each unit of the services that they use.²¹

The price of the individual cloud services often depends on different factors. The prices of storage, for example, often depend on how often access to data has to be provided, the volume involved, and whether or not a premium option is used. There are also other (additional) tariffs if the data is then also processed. There is a charge for adding data, for example²², but also for making a copy of the data²³.

There are also prices for transportation of data in the cloud. Three kinds of data transport are possible in the cloud market. Data can be placed in the cloud, data can be moved in the cloud, and data can be removed from the cloud. Cloud providers charge different tariffs for these three categories. The tariffs that cloud providers have to pay to place data in the cloud are also referred to as ingress fees and the

²⁰ [Pricing \(amazon.com\)](#), [Prijsoverzicht - De prijzen voor Azure | Microsoft Azure \(in Dutch\) | Microsoft Azure](#), [Pricing Overview | Google Cloud](#), [IBM Cloud pricing | IBM](#), last visited, March 29, 2022.

²¹ [Reserveringen | Microsoft Azure \(in Dutch\)](#), [Pricing \(amazon.com\)](#), [Committed use discounts | Compute Engine Documentation | Google Cloud](#), [IBM Cloud Pay As You Go Committed Use | IBM](#), last visited, March 29, 2022.

²² [PutObject - Amazon Simple Storage Service](#), last visited on May 12, 2022.

²³ [CopyObject - Amazon Simple Storage Service](#), last visited on May 12, 2022.

tariffs that have to be paid when data is transported from the cloud are also known as egress fees. No explicit name is used for moving data within the cloud.

Cloud providers do not charge any fees when data is placed in the cloud²⁴, so the ingress fees are equal to 0. There are nevertheless costs associated with moving data within the cloud and transporting data from the cloud. The tariff for moving data within the cloud depends on whether the data is moved within a region, within a continent (intracontinental), or outside a continent (intercontinental). Moving data within the cloud is done, for example, by companies that have subsidiaries in different countries. The prices can also differ depending on the continent. A data transfer from North America to any other continent, for example, may have a different tariff than a data transfer from South America to any other continent. The tariff for transporting data from the cloud, the egress fees, often depends on the total volume of data that is moved. There are different prices for different sizes of data batches. In addition, the first 100GB is sometimes free. These egress fees are payable not only if the user wishes to move his data from the cloud, for example when switching, but, for example, also as a result of streaming a video service to a user. Section 6 provides more detail on the tariffs for data transport charged by the various cloud providers.

Overall, the pricing structure of cloud services means that a single cloud provider may charge many different tariffs even for just a storage service. All these different tariffs are included in various tariff grids that are publicly displayed on cloud providers' websites.

Cloud providers offer various services that provide information on costs. For example, users can set an alarm if a particular cost threshold is reached and dashboards provide a clear picture of costs. These additional services are often chargeable, however. There are also companies, such as C-facts, Intermax, and the CloudLab, that specialize in the pricing structure of cloud providers. They advise companies that wish to switch to the cloud, already use the cloud, or wish to switch cloud provider.

2.4 Role of open standards, open source

2.4.1 Standards

The term "standards" is widely used. There are all kinds of different standards, from IT security standards to food safety standards²⁵. Standards are sometimes set by the many different standardization organizations. One of the biggest is the International Organization for Standardization (ISO). Standards are set in a document consisting of requirements, specifications, guidelines, or characteristics that can be used consistently so that materials, products, processes, and services are fit for purpose.²⁶ Companies can demonstrate that they meet particular standards by means of certification.

Cloud services also use standards. Some cloud services have certification in which they meet specific security and compliance standards. Certification means that cloud users know how secure the service is that they are using and which requirements the service fulfils. The security and compliance standards most widely used among large providers are those drawn up by the ISO and the Cloud Security Alliance (CSA).²⁷²⁸

²⁴ This was not always the case. Up until 2010, AWS did charge ingress fees of 0.10 dollars per GB.

²⁵ [ISO - Standards](#), last visited on August 8, 2022.

²⁶ [What are open standards? | Opensource.com](#), last visited on April 11, 2022.

²⁷ [Compliance Programs - Amazon Web Services \(AWS\)](#); [Azure and other Microsoft cloud services compliance offerings - Azure Compliance | Microsoft Docs](#); [Security, Privacy, and Cloud Compliance | Google Cloud](#), last visited on April 11, 2022.

²⁸ The most widely used are ISO/IES 27001, ISO/IES 27017, ISO/IES 27018, and CSA star.

There are also standards in cloud services with which no certification is associated, as in the case of some software/technical standards. In principle, a software standard comes into existence when a service is developed. An example of a software standard is a standard that enables different cloud services to communicate with each other. If both cloud service A and cloud service B use standard X, for example the same Application Programming Interfaces (APIs) in order to communicate, it is no problem having cloud service A communicate with cloud service B. However, if cloud service B does not use standard X, but standard Y, it is difficult to have cloud service A communicate with cloud service B. There are then differences in the APIs used.

Even if cloud services use different standards, it is technically possible to have cloud services communicate with each other, but it is very complex. This becomes even more complex when the standards are closed, which means the structure of a particular standard is not publicly available. The user then does not know precisely how the standards of the services differ and hence does not know precisely what is necessary in order to connect the different services with each other. Creating such a connection requires the software to be reverse-engineered, which is very difficult.

As well as closed standards there are open standards. Open standards are standards that are publicly available and are maintained by a collaborative and consensus-driven process.²⁹ Since open standards are recorded and publicly available, they can be adopted by other developers. The fewer different standards there are, the greater the chance that different services can be connected to each other, which benefits interoperability.

Standards have a key role in achieving interoperability of cloud services. See, for example, section 2.5. with regard to multicloud and the integration of cloud services, and section 6.1.1 for the effect on the lock-in risks.

2.4.2 Open source

Developers of cloud services can choose between developing open source services and closed source services. Open source software is often published under the GNU General Public License (GPL). In short, this license enables users to do everything with the software, including adapting and selling it, provided that right is passed on and the software authors are cited. This means that all software written using GPL software immediately falls under the GPL and the source code must also be made public.³⁰ In addition to the GPL, there is also the GNU Lesser General Public License (LGPL). This is a watered-down version of the GPL that can be combined more easily with another license because not all the code used has to be open source.³¹ Another example of an open source license that can be combined with closed source code is the Apache license. Google often uses this license and has used it among other things for the Kubernetes container platform.³²

²⁹ In order to ensure that a standard can be implemented on a global basis, intellectual property rights according to the ITU are essential in order to license a standard. In addition, the standard must contain a level of detail making it possible to create different competing implementations of products or services. This means that there must be no concealed standardized interfaces and that standardized interfaces can only be supervised by the Standards Developing Organizations (SDOs) This facilitates interoperability and allows data exchanges between different products and services. See also [Definition of "Open Standards" \(itu.int\)](#).

³⁰ [De GNU General Public License v3.0 - GNU-project - Free Software Foundation](#), last visited on July 8, 2022.

³¹ [GNU Lesser General Public License v3.0 - GNU-project - Free Software Foundation](#), last visited on July 15, 2022.

³² [tests.system.providers.google.cloud.kubernetes_engine.example_kubernetes_engine — apache-airflow-providers-google Documentation](#), last visited on July 15, 2022.

Closed source, also known as proprietary software, is all software that is not covered by an open source license. A company or person then has copyright to the software and refuses to make the source code available.

The biggest advantage of developing open source services is the community. The community ensures that the software is improved and maintained. Since the source code is public, everyone can search for vulnerabilities and modify the code in order to innovate.

A disadvantage of developing open source software is that others can see the source code and then use it as a basis for developing a new product. This is also referred to as forking.

A fork can result in the community becoming divided. A large community is more efficient than several small communities. In order to prevent the community being split, developers of open source software are compelled to develop a service that works well for everyone. The possibility of forking provides this incentive and therefore has a positive effect. In the case of software that cannot be forked, there is less incentive to create a product that works for everyone. A large operator is not dependent on the community when developing services and may have an incentive for imposing specific standards, so the product will not work well for everyone.

2.5 Integration of services

As stated in section 2.1.3., there is sometimes a desire to integrate different services with each other. This can be done in two ways: either (1) by making the services each running on their own cloud infrastructure interoperable, allowing these services to connect and communicate, or (2) by running services of one cloud provider or the services of third parties on the servers of the other cloud provider. These two forms are not possible in all cases, however. In this context, it should be noted that interoperability is not binary. It is also possible that a service functions partially or that the service becomes interoperable after an update.

The first variant, making cloud services interoperable, is not always possible, because not all APIs and standards are disclosed. If the cloud provider of a specific service has not disclosed the APIs and standards, the service that wishes to connect will not know how this service works. The link cannot be made and interoperability is not possible. As a result, services of individual cloud providers cannot be integrated or communicate with each other.

If integration of services is possible, an intermediate management layer is required in order to integrate services from different providers, as in the case of hybrid cloud. This intermediate layer can enable the different cloud services to be integrated with each other. It is then possible to monitor and manage the different cloud services through a dashboard and thus also transfer workloads, for example.

The second method of integration is also not always possible: not all services can run in the cloud environment of another cloud provider. So-called native cloud services can only operate in their own cloud environment. A native cloud service of cloud provider A works only in the cloud environment of cloud provider A. This service cannot run in other cloud environments, because the necessary licenses have not been made available. Also, the APIs and standards are often unknown. As a result, the service is not offered in other cloud environments.

If there are native cloud services and these cannot be made interoperable with other services, these services can be said to be running in a “silo”: these native cloud services only work within their own cloud environment and cannot communicate with services from other cloud environments.

Since services cannot always be integrated, and hence run optimally in the cloud environment of a particular cloud provider, there is to a certain extent a closed ecosystem. It is not as closed as in the case of the Apple iPhone, for example, where Apple does not allow other operating systems or app stores to be installed and has made it almost technically impossible to do so.³³ The fact that the cloud environment is not as closed is because, for example, integration is possible sometimes. However, the ecosystem of different cloud providers is not as open as in the case of the Linux-based Ubuntu operating system, for example, in which users have the freedom to install unfiltered software and can even modify the operating system. The situation regarding the cloud will be somewhere in between, because on the one hand it is possible to integrate certain cloud services with each other and almost everything can be installed on the IaaS layer, but on the other hand closed standards are often used and licenses are often not granted.

³³ ACM app stores market study, p. 64

3 Users of the cloud

In this section, ACM discusses how users use the cloud. There are two distinct types of cloud service users: on the one hand, users who buy cloud services as the end-user, such as companies and public organizations, and, on the other hand, Independent Software Vendors (ISVs). These are companies that provide software products themselves (for example SaaS or PaaS services) but do not have the infrastructure. In section 3.1, ACM provides an overview of the extent of use, based on its own research and publicly available figures. In section 3.2, ACM considers the various options that users have and what points are included in the cloud strategies of companies. Finally, in section 3.3, the growth (expected) in use will be discussed.

3.1 Figures concerning use

3.1.1 Use of cloud services

An average of 41% of undertakings in the European Union use cloud services. There are wide differences within Europe. Figure 2 shows the use of cloud services in each Member State according to Eurostat. There are Member States with cloud adoption of slightly over 10% and Member States with adoption of more than 70%. The Netherlands is one of the Member States where undertakings make greatest use of cloud services: in 2020 the figure was 60% and in 2021 it was 65%.³⁴

Use of cloud computing services, 2020 and 2021

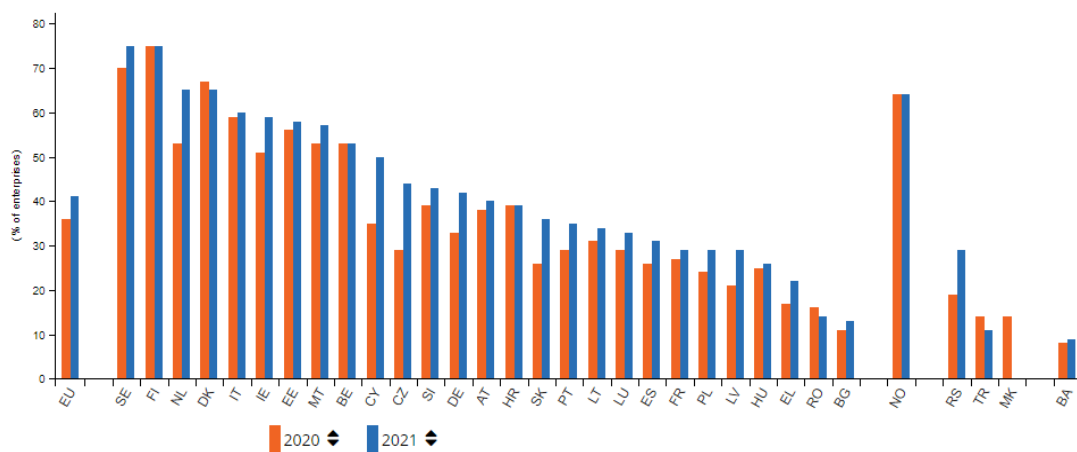


Figure 2: Use of cloud services in the European Union (Source: Eurostat)

The extent of use of cloud services differs depending on the type of undertaking. In Europe, an average of 72% of large companies³⁵ used cloud services. In the case of medium-sized companies³⁶ the figure was 53% and small companies³⁷ 38%.³⁸ The extent of use of cloud services also differs depending on the sector. Companies in the information and communication sector use cloud services much more than the retail sector, for example. An overview by sector is provided in Figure 3.

³⁴ [Cloud computing - statistics on the use by enterprises - Statistics Explained \(europa.eu\)](#), last visited on April 22, 2022.

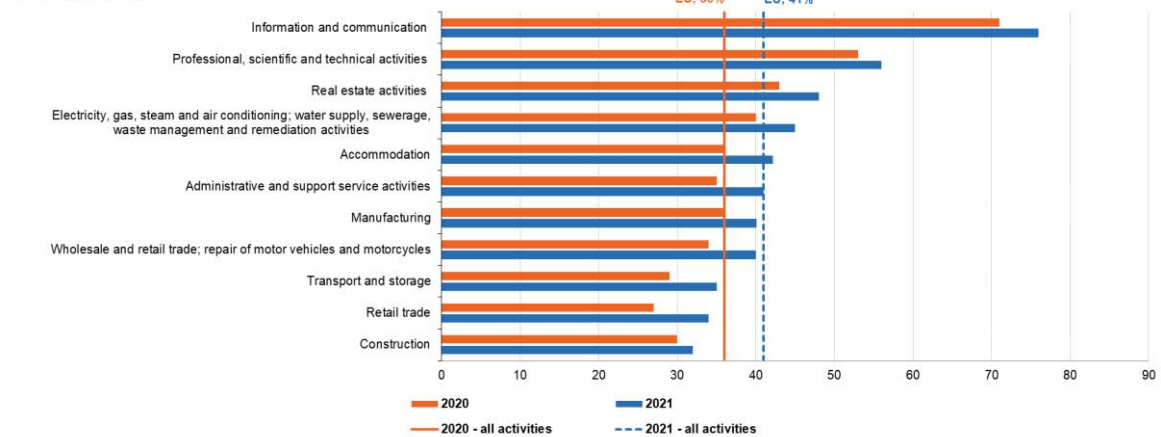
³⁵ Companies with more than 250 employees.

³⁶ Companies with between 50 and 249 employees.

³⁷ Companies with between 10 and 49 employees and self-employed people.

³⁸ [Cloud computing - statistics on the use by enterprises - Statistics Explained \(europa.eu\)](#), figure 3, last visited on April 22, 2022.

Use of cloud computing services, by economic activity, EU, 2020 and 2021
 (% of enterprises)



Source: Eurostat (online data code: isoc_cicce_use)

eurostat

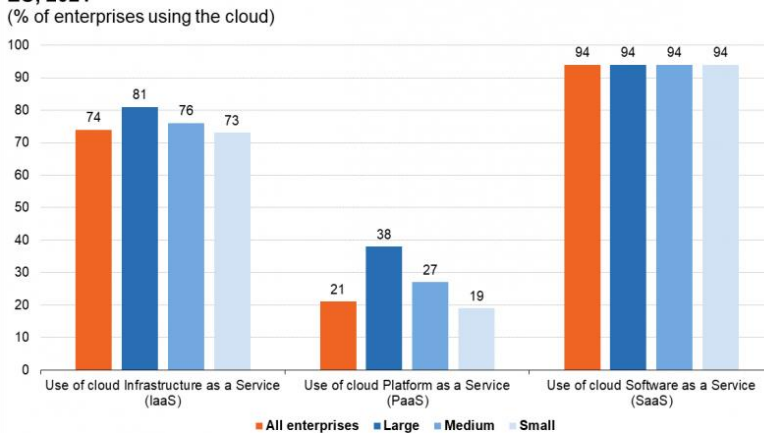
Figure 3: Use of cloud services by sector in the European Union (Source: Eurostat)

3.1.2 Use of the different cloud layers

Use of cloud layers in Europe

The use of cloud services varies per layer. Figure 4 shows cloud use per layer, drawing a distinction in terms of the size of undertakings.³⁹ By far, most companies using cloud services use SaaS services (94%). This does not differ depending on the size of the undertaking. The use of PaaS services is much lower and does differ depending on the size of the undertaking. On average, 21% of users of cloud services use PaaS services. Large operators in particular make relatively frequent use of them (38%). The use of IaaS services differs slightly depending on the size of the undertaking. On average, 74% of undertakings use IaaS services.

Types of cloud computing services used, by service model, EU, 2021
 (% of enterprises using the cloud)



Source: Eurostat (online data code: isoc_cicce_use)

eurostat

Figure 4: Use of the different cloud layers in the European Union (Source: Eurostat)

³⁹ [Cloud computing - statistics on the use by enterprises - Statistics Explained \(europa.eu\)](https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&plugin=1), figure 2, last visited on April 22, 2022.

Finally, Eurostat research also provides insight into the use of a number of specific types of cloud services. This shows that, among companies using cloud services, e-mail is the most frequently used service (79%), followed by storage services, productivity services, and security software.⁴⁰ See also Figure 5.

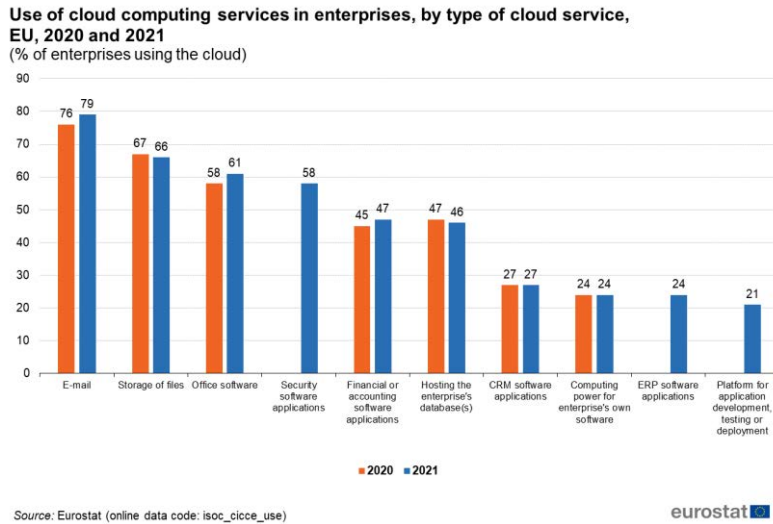


Figure 5: Use of different types of cloud services in the European Union (Source: Eurostat)

Use of cloud layers in the Netherlands

The research firms Dutch IT-channel and SmartProfile conducted research into digital mobility in 2021, specifically in the Netherlands. It shows that the use of IaaS and PaaS services by companies with more than 50 employees rose from 31% in 2019 to 76% in 2021. Education is the biggest user of these services: 92% of educational institutions use IaaS and PaaS services.⁴¹ The use of IaaS and PaaS services in the Netherlands per sector is shown in Figure 6.

The use of SaaS services has also risen sharply in recent years in the Netherlands. 92% of all Dutch companies with more than 50 employees used SaaS services in 2021, compared to 67% in 2019. In sectors such as education, government, and healthcare, the level of use was even nearly 100% in 2021.⁴² The use of SaaS services in the Netherlands per sector is shown in figure 7.

⁴⁰ [Cloud computing - statistics on the use by enterprises - Statistics Explained \(europa.eu\)](#), figure 4, last visited on April 22, 2022.

⁴¹ Mobiliteitsonderzoek 2021, available via [De Digitale Werkplek - Onderzoek Digitale Mobiliteit in Nederland 2021 \(in Dutch\) \(executive-people.nl\)](#), page 14

⁴² Mobiliteitsonderzoek 2021, available via [De Digitale Werkplek - Onderzoek Digitale Mobiliteit in Nederland 2021 \(in Dutch\) \(executive-people.nl\)](#), page 16.

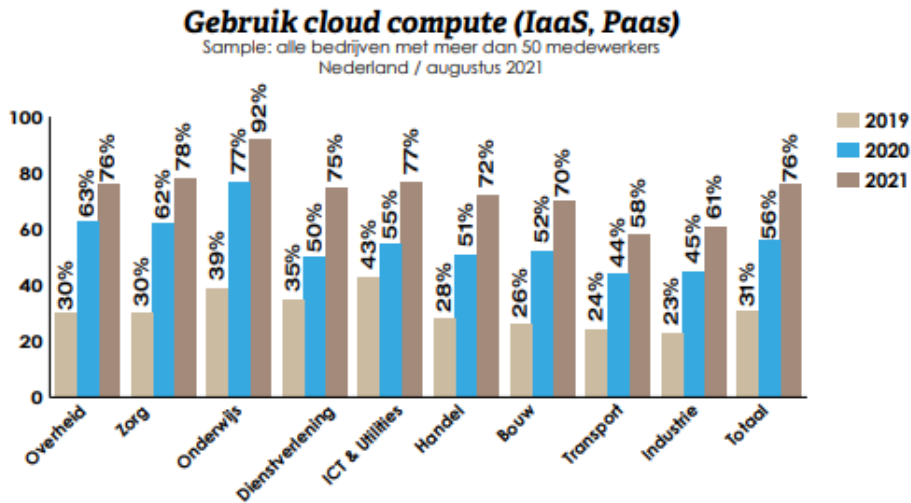


Figure 6: Use of IaaS and PaaS services per sector in the Netherlands (source: Mobility survey 2021)

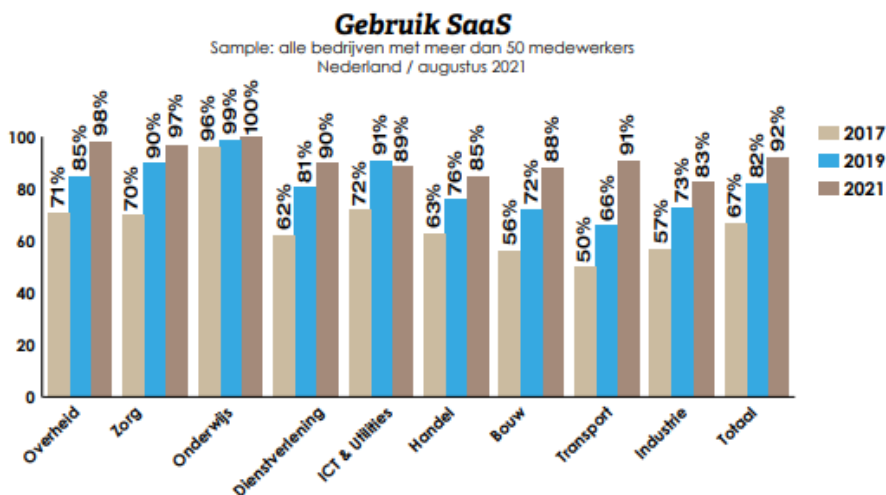


Figure 7: Use of SaaS services per sector in the Netherlands (source: Mobility survey 2021)

3.1.3 Use of multicloud

Companies can purchase cloud services from one or more cloud providers (multicloud). This happens on a large scale. According to survey data, 75-90% of all cloud users worldwide use multicloud.⁴³

This choice is not always made consciously. In some cases, companies are unaware that they are using multicloud⁴⁴, for example because end-users of a SaaS service do not know which provider owns the underlying infrastructure or because they are (unwittingly) purchasing SaaS services from different cloud providers. The responses to ACM's CIO questionnaire show the same picture. Although many companies use multicloud, many CIOs say that this is not a strategic choice. The situation often arises unconsciously or for historical reasons. Many CIOs say they focus first on a single cloud provider, gain

⁴³ See for example [85% of companies now operating in a multi-cloud environment | IT PRO](#), last visited April 25, 2022; [HashiCorp State of Cloud Strategy Survey](#), last visited April 25, 2022; and State of the Cloud report, Flexera, figuur 9.

⁴⁴ Notes of meeting IBM, november 4, 2021, ACM/IN/699966.

experience with it, and get it working properly. Some CIOs do say, however, that they deliberately consider multicloud to keep the switching possibilities open.⁴⁵ Multicloud is more difficult to organize. Various companies provide tools to manage this correctly and securely. Around 30% of companies use such tools.⁴⁶

3.2 Options when choosing a cloud provider

If a company or organization is going to use cloud services, it has to make many choices. An important aspect that affects the options is the existing IT infrastructure. There is a difference between the options for legacy firms, or companies that already have their own IT infrastructure (servers and hardware), and start-ups, which do not yet have existing IT infrastructure. For the latter type, the choice of the cloud is simpler. These companies can develop (or commission) their applications directly on the platform and infrastructure of a cloud provider, without having to take account of the way the existing IT infrastructure is organized. For legacy firms this is more complex. For example, they have own servers on premise or in a data center and use applications and software running on these servers. Migration to the cloud poses other challenges for them. After all, in order to exploit the advantages of cloud services, they have to find services to replace the existing services and then migrate all the data. The complexity of migration depends on the extent to which existing and new services have to work together and are required to communicate.

3.2.1 Option parameters

Product and service offering

Users can opt to purchase their cloud services from cloud providers that also have an (IaaS) layer, or they may opt to purchase services from third parties. These providers, such as ISVs, offer their third-party services directly to users, but sometimes also through the marketplace of a cloud provider or under a contractual relationship that they have with a cloud provider.

When companies use services on multiple layers of the cloud, it is often more attractive in the short term to purchase as many services as possible – in some cases even all services – from a single cloud provider. This makes a difference, for example, in terms of search costs and all these services will then work in the same cloud environment. Many of the services have been specifically developed for a particular cloud infrastructure, so that they work optimally and can also communicate well with each other. A disadvantage is that if services are all obtained from the same cloud provider, lock-in may occur (or may occur more rapidly) (see also section 6.1).

Additionally, cloud providers often grant discounts to companies that purchase various services from the same cloud provider. It is then often more attractive to purchase services A and B from the same cloud provider when an alternative for service B is also offered by another cloud provider.

Influence of historical choices

Legacy firms often choose their cloud provider on the basis of IT products they already use. The responses to questionnaires that ACM sent to Dutch CIOs showed that the majority of users chose a particular cloud provider because they had already been using products from that provider and hence

⁴⁵ Responses to CIO questionnaire, question 12, ACM/INT/453539.

⁴⁶ State of the Cloud report, Flexera, figuur 12.

already had a relationship with it.⁴⁷ A number of Dutch companies that already used the Office package from Microsoft, for example, state that they obtain it from a cloud provider, and are more likely to choose Microsoft Azure than another cloud provider. In legacy firms, previous IT choices thus have a major influence on subsequent choices, possibly giving rise to path dependence.

It is difficult to say to what extent the influence of historical choices differs for the various cloud layers. For example, since IaaS and PaaS services are usually located more in the core of a company, it is possible that familiarity with a certain provider is seen as more important. In the case of SaaS services, this may differ depending on the type of service.

Price

The costs of using cloud services are naturally very important. The tariff structure used by cloud providers (pay-as-you-go) means that the fixed costs that end-users have to pay for IT services may go down. However, this pricing structure can make costs difficult for users to predict. Companies almost always use multiple cloud services, so it is sometimes difficult to maintain a clear overview if every service consists of different prices and every request costs money (see also section 2.4). This also arises because the use of the cloud is variable and may grow rapidly. Initially there are often also discounts, which may be discontinued later. These aspects make it difficult for users to predict what the ultimate costs will be. The discussions with customers⁴⁸ also show that there is often great uncertainty about the ultimate cost of using cloud services. The Flexera report shows that companies on average exceed their original budget by 13%.⁴⁹ Another survey of senior IT professionals shows that one-third of the 750 questioned have budget overruns of 20-40%. 8% have even bigger budget overruns.⁵⁰

The questionnaires that ACM sent to cloud users also show that some companies find it difficult to make accurate estimates, particularly at the outset. As time elapses, the costs are easier to estimate, however, due to experience and reduced fluctuations⁵¹.

Free products or services

In order to gain customers, many cloud providers use credits. Credits are funds that users are able to spend in the cloud. Various cloud providers offer credits to start-ups and scale-ups. In some cases, these funds can be as much as 150,000 US dollars. By giving funds, cloud providers help start-ups and scale-ups grow their businesses.⁵² In addition, these funds allow those businesses to get to know various cloud services in a relatively simple manner.

In addition to credits for start-ups, large cloud providers in particular also provide free services. Free services can be used no matter what type of business is involved. They take various forms. Some services are free for a few months or can be used free for a certain number of hours.⁵³ Other services are provided free for the first 12 months. These often include storage or database services.⁵⁴ There are also services from a particular provider that are always free, although there are often limits attached to these. For example, database storage may be free up to a certain number of GB per month.⁵⁵

⁴⁷ Responses to CIO questionnaire, question 4, ACM/INT/453539.

⁴⁸ Notes of meeting CIO Platform Nederland, July 8, 2021, ACM/IN/699659.

⁴⁹ State of the Cloud report, Flexera, Figure 37.

⁵⁰ [New Cloud Survey | Pepperdata](#), last visited June 14, 2022.

⁵¹ Responses to CIO questionnaire, question 19, ACM/INT/453539.

⁵² [AWS Activate for Startups, Founders, & Entrepreneurs \(amazon.com\)](#), last visited June 14, 2022.

⁵³ [Free Cloud Computing Services - AWS Free Tier \(amazon.com\)](#), last visited on May 23, 2022.

⁵⁴ [Free Services | Microsoft Azure](#), last visited on May 23, 2022.

⁵⁵ [Free Cloud Computing Services - AWS Free Tier \(amazon.com\)](#), last visited on May 23, 2022. [Free Trial and Free Tier | Google Cloud](#), last visited on May 23, 2022.

Privacy and security

Privacy and security are also important choice parameters, for example because of the major impact if all data were to be exposed as a result of a hacking incident. Such an incident could involve sensitive and important information, such as personal data. Users must have confidence that their data will be kept securely and that the applicable privacy rules will be complied with. Cloud providers generally offer a high degree of privacy and security. The cloud is thus often much more secure than having data on premise.⁵⁶ On the other hand, for the owner of the data (the end-user) it is often not entirely clear on precisely which servers in the cloud the data is stored. This is important for some users. For various geopolitical reasons it may be important that the data is only stored in Europe.

Specific laws and regulations are also important for companies in certain sectors. High security requirements are set for the financial sector, for example. Not all cloud providers can meet these requirements.⁵⁷ Cloud providers can present certificates demonstrating that they comply with certain laws and regulations.

Choosing large operators

Users often choose known providers that already have a good reputation and a strong position in the market. As is evident from discussions with cloud providers, for example, companies and the government are often inclined only to consider the major providers when choosing a cloud provider.⁵⁸ There are various reasons why these operators are often chosen. On the one hand they innovate fast, so they can always offer the newest, high-quality products. That is attractive to users. On the other hand, using the services of large cloud providers offers the best chance of finding developers.⁵⁹ This is useful for end-users for support reasons and important for ISVs because of the ongoing development of their business. There is also path dependence here.

A reason for not choosing a particular (possibly large) cloud provider may be that it is also a competitor. Major operators such as AWS and Microsoft also operate in other markets. For example, the fact that AWS also has a banking license for financial institutions in the Netherlands may be a reason for not choosing AWS.⁶⁰

Migration possibilities

Users can choose to establish their cloud services in such a way that migration remains relatively easy, for example by using containers or open source services (also see section 2.5). There are also disadvantages associated with these choices, however. Implementing containers is complex, for example. In addition, not all services are based on open source or open standards, which is necessary for the effective use of containers, however. Moreover, a user must choose such flexible services “early” in his cloud implementation. It is almost impossible to do so later in the process.

Importance of different parameters

Research by IDC highlights the mutual importance of the different parameters for each type of user. 100 end-users and 30 ISVs were asked what selection criteria they used when choosing cloud services. Price was not a factor in this survey and no distinction was drawn between the different cloud layers.

⁵⁶ Notes of meeting Michiel Steltman, July 20, 2021, ACM/IN/707626; and [De toekomst van big data ligt in de cloud \(fd.nl\)](#) (in dutch)

⁵⁷ Notes of meeting [confidential: XXXXXXXX], June 28, 2021, ACM/IN/699665.

⁵⁸ [Cloudbedrijf Leaseweb rekent op miljardensteun in strijd tegen techreuzen \(fd.nl\)](#), last visited on March 14, 2022.

⁵⁹ Notes of meeting [confidential: XXXXXXXX], August 31, 2021, ACM/IN/701655.

⁶⁰ Notes of meeting [confidential: E- XXXXXXXX], May 25, 2022, ACM/UIT/582251.

Quality, reliability, the functionalities offered and the level of security are the main parameters for end-users. For ISVs, the situation is different: for them data security and compliance with regulations on data and storage are the most important.⁶¹

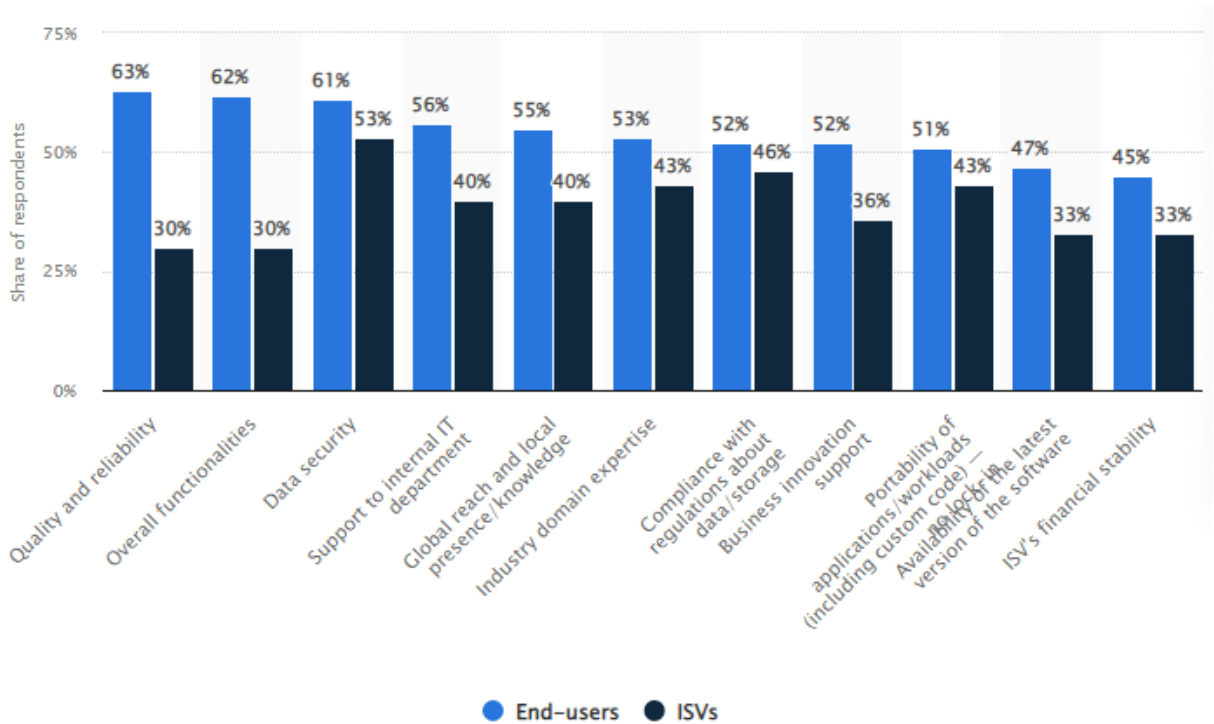


Figure 8: selection criteria for cloud services (source: statista)

3.2.2 Cloud strategy

The previous section showed that in the selection of a cloud provider there are many important parameters and that these choices differ for different users. Since initial choices have an impact over the longer term, some users choose to record what they consider to be the main factors in a cloud strategy. It may be that security is the main factor, for example, or that data always has to be stored in Europe, or that switching possibilities are important.

Of the 15 CIOs from whom ACM received responses concerning their cloud use, 13 said their business had developed a cloud strategy.⁶² Frequently occurring subjects in these cloud strategies include a cloud-first strategy, but also subjects such as security, the use of European data centers, and a strategy to allow easy migration.

Flexera has investigated the main challenges for businesses with regard to cloud services. Security, the lack of appropriate knowledge and expertise, and expenditure are deemed to be the main challenges.⁶³

⁶¹ • [Cloud business applications: selection criteria 2018 | Statista](#), last visited on April 29, 2022.

⁶² Responses to CIO questionnaire, question 3, ACM/INT/453539.

⁶³ State of the Cloud report, Flexera, Figure 33.

3.3 Growth in usage

The Covid pandemic is cited as one of the main reasons for the rapid growth in the use of cloud services.⁶⁴ Many companies have accelerated the digital transformation due to the Covid pandemic. According to an analyst at IDC, the cloud is seen as a “crucial factor for the resilience, agility, innovation, and efficiency of companies”.⁶⁵ The crucial nature of the cloud applies on the one hand to the digitization and more efficient organization of business processes, but on the other hand also to the growing importance of the processing and analysis of data. The volume of data generated, processed, and used has grown enormously worldwide, by an average of 20% per year. In 2020, the year when Covid-19 became a pandemic, it grew by as much as 57%.⁶⁶ The European Commission refers to data as a core component of the digital economy, and an essential source for the digital transition.⁶⁷ This is in line with the growth in internet traffic, which has grown by an average of 35% per year in recent years.⁶⁸

Growth in the use of cloud services is also expected in the years ahead. This growth will come on the one hand from companies using cloud services for the first time, and on the other hand from growing use of cloud services by each company. For example, a company may already use cloud services for part of its IT infrastructure, while another part still uses on-premises ICT (hybrid cloud). The growth in the use of cloud services can therefore also arise because companies expand their use of cloud services. The answers on the CIO questionnaire from ACM show that there are still significant differences between companies in terms of the percentage of their total ICT costs spent on cloud services.⁶⁹

This trend is also driven by a number of wider developments. These developments are described further below.

Increasing virtualization

Servers have been increasingly virtualized over the years. Whereas this initially involved operating systems with all overlying software, it is now taking place on an increasingly granular basis. This is achieved by using containers where parts of an application can be managed. This means that parts of an application can be updated and scaled separately. The virtualization means that the interconnectedness of the hardware and software is also steadily decreasing. Consequently, software no longer has to run on specific hardware, but can do so on generic hardware. An example of this is the Rakuten Mobile 5G network, which no longer uses specific hardware and the network runs in the cloud. This implementation means that in the event of a transition to a new-generation network, it is unnecessary to replace all the hardware; it can be done by means of a software update⁷⁰.

Increasingly fast networks

The arrival of 5G means ever faster networks. This applies not only to mobile networks but also to optical-fiber networks. These higher speeds mean greater capacity and lower response times. In

⁶⁴ [Canalys Newsroom - Global cloud services market Q1 2021](#), last visited on April 13, 2022 and State of the Cloud report, Flexera, Figure 72.

⁶⁵ [Public Cloud and the Related Supply Chain Contributed Almost \\$500 Billion to European GDP in 2020, Says IDC](#), last visited on April 13, 2022

⁶⁶ Volume of data/information created, captured, copied, and consumed worldwide from 2010 to 2025, Statista, available via [Total data volume worldwide 2010-2025 | Statista](#), last visited on July 28, 2022.

⁶⁷ Explanatory note by the Data Act, p1, available via [EUR-Lex - 52022PC0068 - EN - EUR-Lex \(europa.eu\)](#).

⁶⁸ Internet Value Chain Report, GSMA, Figure 2. Available via [Internet-Value-Chain-2022.pdf \(gsma.com\)](#).

⁶⁹ Responses to CIO questionnaire, question 5, ACM/INT/453539.

⁷⁰ [Solutions - Rakuten Mobile Builds the World's First Cloud-native, Software-defined 5G Network - Cisco](#), last visited on June 9, 2022

addition, more edge locations are created, so servers are located closer to the end-users. These two points mean that it is also possible to place more time-critical processes in the cloud.

Digitization of society

Society is already highly digitized and this will only increase in the years ahead. This is partly due to the emergence of IoT devices. Examples are smart devices in the home, smart infrastructure, smart factories, and self-driving cars. It is logical to connect these devices to a cloud service: on the one hand to orchestrate the overall system and on the other hand because it is possible to use less powerful hardware in the devices since calculations are carried out in the cloud.

Shortage of ICT personnel

The Dutch population is ageing and there is a shortage of technically trained personnel. This shortage also applies to ICT personnel that can manage the infrastructure. In order to mitigate this shortage (at least partly), part of the management can be automated and outsourced to a cloud supplier. This frees up the ICT personnel to do company-specific work.

As a result of these developments and the advantages of the cloud, ACM therefore expects accelerating growth in the use and importance of cloud services.

4 Description of market (providers)

In this chapter, ACM describes the different cloud providers as well as the market for cloud services. In section 4.1, the scale and distribution of the market is discussed. In section 4.2, the different Dutch and international cloud providers are described. Finally, in section 4.3, the marketplace is explained, and the thereto-related commission systems are described.

4.1 Size and distribution of the market

Size of market

In 2021 global revenues in the cloud market exceeded 275 billion euros⁷¹. The market has grown by 20-30% each year since 2017⁷². The bulk of revenues, around 50%, are generated through sales of SaaS services. Nonetheless, in recent years there has been strong growth in revenues from IaaS services. The research firm Canalys cites 30% to over 40% growth per year in spending on cloud infrastructure services since 2018.⁷³ The research firm Gartner also cites growth of 40% in 2020 based on revenue figures from the major IaaS providers.⁷⁴

Revenues in the cloud market in Europe amounted to around 65 billion euros in 2021 and have grown by 20-30% in recent years.⁷⁵ In Europe, too, the SaaS layer accounts for the bulk of revenues. The SaaS, PaaS and IaaS layers have generated on average 61%, 16%, and 22% of total cloud revenues, respectively, in recent years. Revenues from PaaS services have grown fastest in Europe in the past few years.

Revenues in the cloud market have also grown substantially in the Netherlands in recent years. Since 2016 the market has grown by an average of 30% per year.⁷⁶ In recent years this growth was due particularly to the SaaS and PaaS layers, which saw the biggest growth in percentage terms. The SaaS layer also generates the bulk of revenues in the Netherlands. The SaaS, PaaS, and IaaS layers on average generated 67%, 24% and 9% of total cloud revenues, respectively. Revenues from the cloud market in the Netherlands exceeded 3 billion euros in 2020.⁷⁷

Revenue growth is expected to slow down somewhat in the years ahead in the Netherlands, Europe, and worldwide, but the market is still expected to continue to grow by around 10-20% per year. Growth in the years ahead is expected to be generated particularly by growth of the PaaS and IaaS layers.⁷⁸ Figure 9 shows the growth in revenues and expected revenues in the Netherlands.

⁷¹ Revenue by segment, Statista, available via [Public Cloud - Worldwide | Statista Market Forecast](#), last visited on May 31, 2022.

⁷² Ibid

⁷³ [Canalys Newsroom - Global cloud services market Q1 2021](#), last visited on April 8, 2022.

⁷⁴ [Gartner Says Worldwide IaaS Public Cloud Services Market Grew 40.7% in 2020](#), last visited on April 8, 2022.

⁷⁵ Revenue by segment, Statista, available via [Public Cloud - Europe | Statista Market Forecast](#), last visited on May 31, 2022

⁷⁶ Revenue of the public cloud market in the Netherlands from 2016 to 2025, by segment, available via [Netherlands: public cloud revenue 2016-2025 | Statista](#), last visited on April 8, 2022 and calculations ACM.

⁷⁷ Revenue of the public cloud market in the Netherlands from 2016 to 2025, by segment, available via [Netherlands: public cloud revenue 2016-2025 | Statista](#), last visited on April 8, 2022

⁷⁸ [Public Cloud - Europe | Statista Market Forecast](#), [Public Cloud - Netherlands | Statista Market Forecast](#), [Public Cloud - Worldwide | Statista Market Forecast](#), last visited on April 28, 2022.

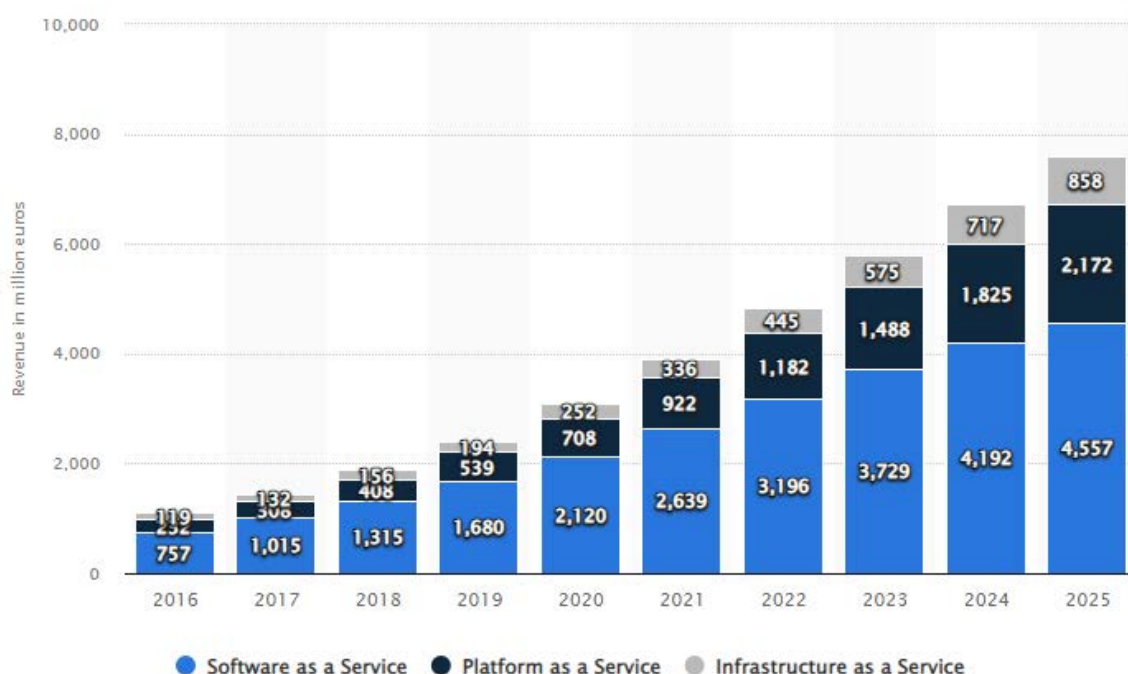


Figure 9: Revenues from cloud services in the Netherlands, in millions of euros (source: Statista)

Market shares

Cloud providers use different definitions for the various layers of the cloud. Hence it is difficult to obtain clear data on market shares in the cloud market. In order to gain a clear view of the market shares, ACM uses information obtained from both market operators and public sources. No reliable, public sources are available showing the market shares of the total cloud market. Therefore, only the market shares on the IaaS layer are described on the basis of the public sources. ACM has gathered data on the total cloud market and calculated market shares based on that data.

Market shares from public/external sources

Canalys has calculated global market shares based on global cloud expenditure on infrastructure services in the first half of 2021. Canalys states that AWS has the biggest market share, at 32%.⁷⁹ Microsoft comes next with a market share of 19% and Google with 7%. All three parties have strong growth of 32%, 50%, and 56%, respectively. This is in part because it is a growth market.⁸⁰

Gartner has calculated worldwide market shares based on revenue figures in 2020 and states that AWS has the biggest market share on the IaaS layer. AWS has a market share of over 40% and is followed by Microsoft with a market share of almost 20%. Alibaba and Google follow with 9% and 6%, respectively.⁸¹

A report prepared by CISPE states that AWS has retained its first-mover advantage on the IaaS layer and is by far the biggest player, with a global market share of between 40% and 50% in the years 2015-

⁷⁹ [Canalys Newsroom - Global cloud services market Q1 2021](#), last visited on April 8, 2022

⁸⁰ *Ibid.*

⁸¹ [Gartner Says Worldwide IaaS Public Cloud Services Market Grew 40.7% in 2020](#), last visited on April 8, 2022

2019. Microsoft has achieved strong growth in recent years and has seen its market share rise from around 6% in 2015 to 19% in 2019.⁸²

ACM market shares

ACM requested information from some nine operators in the Dutch market to understand the current distribution of the cloud market. Information was requested for the cloud market as a whole with the exception of productivity software, which means collaboration software (such as Google Workspace and Microsoft 365 (formerly Office 365)).⁸³ This information includes data on the level of revenues in both the Netherlands and Europe in 2019 and 2020. ACM has estimated the distribution of the cloud market on this basis.⁸⁴

Figures 10 and 11 show ACM's estimates of the market shares in the Netherlands and Europe in 2020.⁸⁵ Based on the revenue information⁸⁶ obtained, ACM concludes that Azure, with a market share of between 40% and 45%, has the biggest market share in the Netherlands. AWS follows Azure with a market share of between 30% and 35%. After AWS and Azure, GCP and Oracle have the biggest market share, at between 5% and 10%. The "others" category contains cloud providers that only have a market share of a few percent. This includes operators such as Leaseweb and ODC-Noord.

In Europe, AWS and Azure both have market shares of between 35% and 40%. GCP and Oracle follow AWS and Azure, as in the Netherlands, with a market share of between 5% and 10%. The "others" category contains operators that only have a market share of a few percent. This includes operators such as OVHcloud.

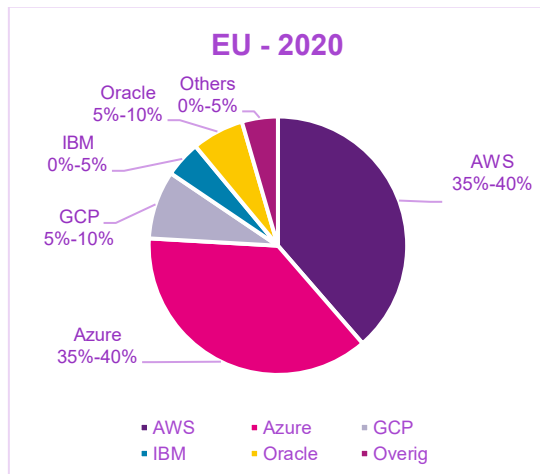


Figure 10: EU market shares (Source: data gathered by ACM)

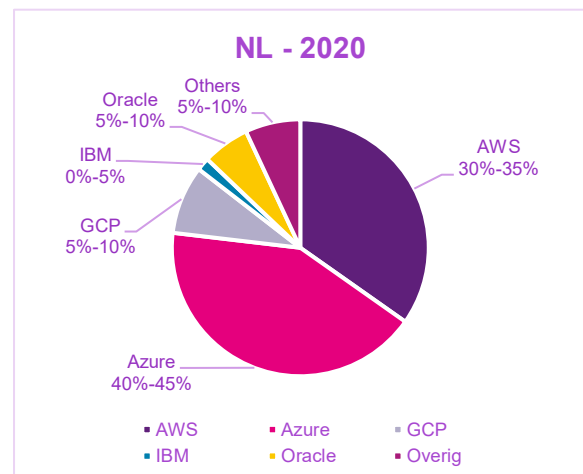


Figure 11: Netherlands market shares (Source: data gathered by ACM)

⁸² Frederic Jenny, 2021, Figure 8

⁸³ The market share of Azure may be underestimated, because part of Microsoft's SaaS services are probably not included in the revenue figures supplied to ACM.

⁸⁴ This entire cloud market contains all cloud layers combined, with the exception of the productivity software. Since not all parties break data down into different layers, ACM cannot calculate the market shares per layer.

⁸⁵ Calculations ACM, DOX/INT/453334.

⁸⁶ On the basis of these figures, ACM cannot at this stage calculate any precise market shares. This is because cloud providers record their data and have disclosed it to ACM in different ways. Furthermore, not all market operators draw a distinction in their services between the IaaS, PaaS, and SaaS layers, or they define them in different ways. As a result, the figures are uncertain.

Azure has a larger market share in the Netherlands than in Europe. This is partly because the Netherlands is a relatively Microsoft-oriented country. Microsoft is the only one of the three hyperscalers to have a Dutch webpage.⁸⁷ On the IaaS layer, Azure has a comparatively smaller market share worldwide according to public sources.

Conclusion

On the basis of the above data, ACM concludes that the two largest parties, Azure and AWS, have very high market shares on the IaaS and PaaS layers, in both the Netherlands and Europe. Google appears to be the strong third player in the market. ACM thus notes that there is a high degree of concentration in the market for cloud services. This concentration appears to be increasing rather than decreasing.

4.2 Description of market participants

4.2.1 Amazon, Microsoft & Google

There are three large operators that provide cloud services, namely Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP). These three operators are also known as the hyperscalers.

Amazon Web Services (AWS)

Amazon Web Services (AWS) was the first to enter the cloud services market in 2006. Before the formation of AWS, Amazon was only an e-commerce company that had to contend with peak loads in its sales and hence in the required IT capacity in certain periods. For that reason, Amazon invested in additional servers to cope with peak loads. Outside this peak season the extra server space was not used, however, and so capacity was underutilized. Amazon thus came up with the idea of offering IT resources to businesses, so that they could use part of its server capacity. In this way Amazon was able to make more efficient use of its IT capacity and other businesses were able to lease IT resources rather than having to acquire them themselves. This led to the creation of Amazon Web Services (AWS).

AWS provided the first cloud services in America in 2006. The first three services provided were Amazon EC2 (compute), Amazon S3 (storage), and Amazon SQS (app messaging). Over the years, AWS has developed a growing range of services. Currently AWS offers a total of over [confidential: XXX] of its own services, subdivided into 26 categories⁸⁸. Examples of these categories are computing, storage, databases, analytics, machine learning, and security. In addition to its own services, AWS has a marketplace in which third parties can also provide cloud services. The role of the marketplace is explained in section 4.3.

AWS is part of a company that first provided mainly infrastructure services and grew into a company operating on all layers of the cloud market. AWS thus offers a wide range of services meeting the IT needs of businesses. Today the services are used in 245 different countries. AWS has data centers around the world to serve the global services market. These data centers are directly or indirectly linked by means of optical-fiber cables. To create this network, AWS commissions infrastructure or uses existing third-party infrastructure.⁸⁹

⁸⁷ [Cloud Computing Services | Microsoft Azure](#), last visited on May 2, 2022.

⁸⁸ Response to request for information AWS, received on February 1, 2022, ACM/IN/701000.

⁸⁹ Ibid

Google started providing public cloud services under the name of Google Cloud Platform (GCP) in 2011. The first service that GCP provided was an App Engine that enabled businesses to develop new apps relatively easily. In 2013 GCP also began providing storage services and since then has constantly expanded its services¹⁰¹. In addition to IaaS and PaaS services, Google also created SaaS services for businesses based on Gmail, under the current name of Google Workspace¹⁰². Google Workspace provides various co-working applications, such as Meet, Docs, Drive, and Gmail¹⁰³.

Google currently operates on all three layers of the cloud, like Microsoft and Amazon. It offers more than 100 services subdivided into 18 different categories, such as AI and Machine Learning, Compute, Containers, IoT, and Serverless Computing¹⁰⁴. GCP also has a marketplace in which third parties can provide their services. GCP's services are available in more than 200 countries and territories¹⁰⁵. For this purpose Google has global data centers¹⁰⁶, which are connected principally by its own optical-fiber cables¹⁰⁷.

Financial

Revenues from Google Cloud, which consists of GCP and Google Workspace, rose by 47% in 2021.¹⁰⁸ This represents the highest percentage rise in revenues compared to other Google services, such as Google Search and YouTube ads. This rise in Google Cloud was largely due to the infrastructure and platform services of GCP. Nevertheless, as in the preceding years, Google again made no profit on its services in 2021. The operating loss has nevertheless fallen, both in absolute terms and as a percentage. In 2021 the loss was 3,099 dollars million and hence 45% lower than in 2020.¹⁰⁹

4.2.2 Medium-sized American and European operators

In addition to the hyperscalers, there are a number of non-Dutch, medium-sized operators in Europe and the Netherlands. These are particularly American and European players, such as IBM, Oracle, VMware, OVHcloud, and Scaleway.

American operators

IBM started providing public cloud services in 2011. Before that, IBM was already one of the biggest IT companies in the world, with products in computer hardware, software, and IT services. IBM provides services on all three layers of the cloud. IBM is most active on the IaaS and PaaS layers, where it offers hardware, virtualization, AI, and analytics services, among other things. In total it offers more than 150 services and focuses particularly on the hybrid cloud and multicloud solutions¹¹⁰. It also owns more than 60 data centers and operates on the SaaS layer to a large extent with other companies¹¹¹. The IBM Cloud was created on the basis of open standards and many of IBM's services are built on the basis of open source technology. By using open standards and open source technology, IBM ensures that its services are interoperable and flexible while limiting the risk of user lock-in, see Section 6¹¹².

¹⁰¹ [Google Cloud Platform - Wikipedia](#), last visited on April 1, 2022.

¹⁰² Notes of meeting Google, July 29, 2021, ACM/IN/699690.

¹⁰³ Google, "Annual report 2021", [GOOG 10-K Q4 2021 \(abc.xyz\)](#).

¹⁰⁴ [Products and Services | Google Cloud](#), last visited on April 26, 2022.

¹⁰⁵ [Global Locations - Regions & Zones | Google Cloud](#), last visited on April 1, 2022.

¹⁰⁶ [Discover our data center locations \(google.com\)](#), last visited on April 1, 2022.

¹⁰⁷ Response to request for information Google, received on January 31, 2022, ACM/IN/701003.

¹⁰⁸ Google, "Annual report 2021", [GOOG 10-K Q4 2021 \(abc.xyz\)](#).

¹⁰⁹ Ibid

¹¹⁰ [IBM Cloud | IBM](#), last visited on April 26, 2022.

¹¹¹ Notes of meeting IBM, november, 4 2021, ACM/IN/699966.

¹¹² [Open cloud | IBM](#), last visited on April 26, 2022.

Oracle Cloud Infrastructure (OCI) entered the cloud services market in 2016. Before Oracle started to provide cloud services, it was mainly known for its on-premises database systems. Oracle began providing computing power, storage, and network services in the cloud and since then has expanded its range of services. It provides services on all layers of the cloud and is relatively big in database and AI services¹¹³.

VMware was formed in 1998 and specialized in virtualization, which enables multiple virtual machines to run on a single physical machine. This makes it possible to run different operating systems on a single server. VMware initially provided this service on premise, but later also in the cloud. VMware's cloud operations are now focused particularly on multicloud solutions¹¹⁴. It provides IaaS, PaaS, and SaaS services, but is big particularly in the CaaS, Container as a Service, and FaaS, Function as a Service, layers¹¹⁵. In contrast to the providers described above, it has no hardware (such as servers) of its own. It uses AWS hardware for its services¹¹⁶.

European operators

OVHcloud entered the cloud services market in 2010. OVHcloud is a French provider with a cloud based on open standards and open source. Initially OVHcloud offered mainly IaaS services, but over the years it has increasingly begun to develop PaaS services. OVHcloud is a technological partner of both VMware and Google and currently has a wide range of services. OVHcloud does not offer any SaaS services, but does help SaaS operators with their infrastructure¹¹⁷. OVHcloud is available in more than 100 countries¹¹⁸.

Scaleway started providing cloud services in 2015. The first services that Scaleway provided were IaaS services. Scaleway currently provides more than 40 different types of service on all three layers of the cloud. Scaleway has six data centers and provides services in 160 different countries¹¹⁹.

There are also a number of other relatively young and small European operators in the market for cloud services. Deutsche Telekom has been providing IaaS services since 2016 in the form of Open Telekom Cloud and has nodes in Germany and the Netherlands¹²⁰. Schwarz Group – the parent company of Lidl, among others – became active in the cloud services market in 2018 with Stackit.¹²¹

4.2.3 Dutch operators

There are also a number of Dutch operators providing cloud services, such as Leaseweb, Uniserver, and ODC-Noord.

Leaseweb started providing hosting services in 1997¹²². Website creation required infrastructure and that infrastructure could be leased from Leaseweb. Leaseweb therefore owned servers and data centers before it entered the cloud market. The Leaseweb cloud is based on open source technology and

¹¹³ Notes of meeting Oracle, October 14, 2021, ACM/IN/700029.

¹¹⁴ [VMware History and Interactive Timeline](#)

¹¹⁵ Notes of meeting VMware, January 10, 2022, ACM/IN/699883.

¹¹⁶ Ibid

¹¹⁷ Notes of meeting OVHcloud, September 1, 2021, ACM/IN/700014.

¹¹⁸ [About OVH - History | OVHcloud](#), last visited on, March 31, 2022.

¹¹⁹ [About US | Scaleway](#), last visited on, March 31, 2022.

¹²⁰ [Open Telekom Cloud – jouw IaaS vanuit de Europese public cloud \(in Dutch\) \(open-telekom-cloud.com\)](#), last visited, March 31, 2022.

¹²¹ [STACKIT: Cloud & Colocation – EU secure, straightforward and custom-made](#), last visited on, april 1, 2022.

¹²² [Leaseweb 20 Years - A greater world](#), last visited on, april 26, 2022

Leaseweb only provides services relating to users' infrastructure.¹²³ Among other things, it provides storage services¹²⁴ and has around 26 data centers across Europe, Asia, Australia, and North America.¹²⁵

ODC-Noord is one of the four government data centers in the Netherlands and only provides services for government bodies.¹²⁶ At present, ODC-Noord only provides private cloud services and no public cloud. The services of ODC-Noord are predominantly based on open source. ODC-Noord began supplying Housing as a Service (HaaS) in 2013 and expanded this in 2014 to include hosting services. Today ODC-Noord also provides PaaS and SaaS services, but the bulk of the services it provides are IaaS services.¹²⁷

Uniserver introduced website hosting in 2000 and now also offers cloud services. It mainly provides IaaS services but also has a number of PaaS and SaaS services.¹²⁸ These are based on open source¹²⁹ and VMware technology.¹³⁰ Uniserver has a primary focus on hybrid cloud and has three data center sites in the Netherlands.¹³¹

4.3 Marketplace & commission

When operators without their own infrastructure, also referred to as Independent Software Vendors (ISVs), develop cloud services, they can offer it to users in two different ways. The third party can provide the service by means of a cloud provider's online platform, a marketplace, or can offer the service directly to users (or both).

Marketplace offering

Various cloud providers offer a marketplace with which they act as a bilateral platform. Cloud providers that have a marketplace include AWS, Azure, GCP, OVHcloud¹³², Oracle, and IBM. The bulk of the products offered in the marketplace are services of third parties, such as ISVs and data providers. Some cloud providers also offer their own services in their marketplace. In addition, some cloud providers with a marketplace offer their services in the marketplace of another provider. Providers with a marketplace that also offer their services in another provider's marketplace include IBM and Oracle. As far as ACM is aware, AWS, Azure, and GCP do not offer their services in another cloud provider's marketplace.

The applications offered via the marketplace range from security to image recognition software and from infrastructure software to business applications. The services of third parties that are offered in a marketplace of provider A have been developed on the infrastructure of provider A. This is because the service is then interoperable with other services of provider A and because third parties often do not have their own infrastructure (such as servers). Table 1 shows how many products are offered in the marketplaces of AWS, Azure, GCP, and OVHcloud. It also shows how many products are offered by third parties and by cloud providers themselves.

¹²³ Notes of meeting Leaseweb, June 24, 2021, ACM/IN/706516.

¹²⁴ [Onze IaaS-producten \(in Dutch\) | Leaseweb](#), last visited on April 26, 2022.

¹²⁵ [Onze Wereldwijde Datacenters \(in Dutch\) | Leaseweb](#), last visited on April 26, 2022.

¹²⁶ [History of ODC-Noord](#)

¹²⁷ Notes of meeting ODC-Noord, July 27, 2021, ACM/IN/699662.

¹²⁸ [About us - Uniserver](#), last visited on April 12, 2022.

¹²⁹ [CNCF groeit naar 800 leden, waaronder het Nederlandse Uniserver - Techzine.nl](#), last visited on April 12, 2022.

¹³⁰ [Infrastructure as a Service - Uniserver](#), last visited on August 8, 2022.

¹³¹ Ibid

¹³² OVHcloud has until now only had a marketplace for France.

Table 1: Number of products in own and third-party marketplaces¹³³

	Total number of products	Total number of own products	Total number of third-party products	Total number of third parties
AWS	12,591	408	12,183	1,360
Azure	18,046	304	17,742	N/A
GCP	6,276	92	6,184	N/A
OVHcloud	N/A*	N/A	N/A	290

*N/A = Not available

Advantages and disadvantages of using a marketplace

Providing or buying services in a marketplace brings a number of advantages for users. Cloud users sometimes enter into agreements with cloud providers on how much they plan to spend as a minimum in the cloud and record these agreements in order to take advantage of certain discounts, see also section 2.3. Expenditure in the marketplace can in some cases be added to the total expenditure with a cloud provider.¹³⁴ In that case, the user of the marketplace will purchase more from this cloud provider than if the third-party services are purchased outside the marketplace, so users can benefit more from discounts. A survey conducted by Tackle also shows that taking advantage of committed expenditure is the biggest reason for users to use the marketplace. That same survey also shows that 27% of the third parties using a marketplace started to use it at the special request of users. Other advantages of using a marketplace are the usually standardized contracts, rapid accessibility to applications, and simplified procurement procedures.¹³⁵

A disadvantage may be that the cost of the product may be higher if the service is sold through the marketplace than if it is purchased directly from the third party. This is because the third party often has to pay commission when the service is purchased through the marketplace and may pass it on in the tariffs it charges. ACM has not verified this, however, and for the user it may be negated by the volume discounts.

The use of a marketplace also brings advantages for third parties, the providers of services offered in the marketplace. According to a survey conducted by Tackle, the main reason why third parties offer services in a marketplace is to gain access to users and their “pre-committed” cloud expenditure. As stated earlier, users have sometimes entered into agreements with a cloud provider on the volume that they will purchase from a cloud provider. Since users can sometimes add the expenditure in a cloud provider’s marketplace to this provider’s total expenditure¹³⁶, a user may reach a commitment level earlier¹³⁷. Other advantages for third parties are that they can more easily conclude deals with users, intensify partnerships with cloud providers, and more easily reach new users¹³⁸. A disadvantage for third parties is that commission often has to be paid on the revenues from sales in a marketplace.

¹³³ The offering in the marketplace of cloud providers changes every day. The numbers were ascertained between April 1 and 15, 2022 on the basis of the various websites of the cloud providers. Information on the number of products in the IBM and Oracle marketplace cannot be obtained from public sources and are therefore not included in Tabel 1.

¹³⁴ Depending on the type of contract drawn up.

¹³⁵ [State of Cloud Marketplaces 2021 | Tackle](#), last visited on May 4, 2022; [What is AWS Marketplace? - AWS Marketplace \(amazon.com\)](#), last visited on April 8, 2022.

¹³⁶ Depending on the type of contract drawn up.

¹³⁷ [State of Cloud Marketplaces 2021 | Tackle](#), last visited on May 4, 2022.

¹³⁸ Ibid

these third parties are then approached directly. The discussions conducted by ACM revealed that third-party services are widely used, but that relatively few are purchased through the marketplace.¹⁴⁶ Tackle expects the marketplace to become increasingly important, but emphasizes that it will probably still account for only a fraction of total software sales¹⁴⁷.

¹⁴⁶ Notes of meeting [Confidential: XXXXXXXX], May 25, 2022, ACM/UIT/582251.

¹⁴⁷ [State of Cloud Marketplaces 2021 | Tackle](#), last visited on May 4, 2022.

5 Market characteristics

In this chapter, ACM describes the main economic characteristics that affect the market dynamics. It first examines a number of characteristics: economies of scale (section 5.1), network effects (section 5.2), and integration (section 5.3). Together these characteristics result in barriers to entry. ACM describes this in section 5.4.

5.1 Economies of scale

5.1.1 Data centers

The infrastructure required to provide IaaS services, such as servers and network equipment, is located in data centers. This infrastructure is not only essential for providing IaaS services, but is also for providing other cloud services, such as PaaS and SaaS services. A Machine Learning service (PaaS), for example, requires computing power, and a report drawn up by an employee in a CRM service (SaaS) must be stored somewhere. The user does not purchase infrastructure directly and does not have to manage it, but uses it indirectly when purchasing a PaaS or SaaS service. Data centers in which this infrastructure operates are therefore essential in the provision of cloud services.

The costs of these data centers are very high. There are costs for the building, costs for the physical infrastructure (such as servers, network equipment, and cooling equipment), operating costs (such as labor costs and support services), and energy costs¹⁴⁸. According to a study by Emerson Network Power and Ponemon Institute (hereafter: Emerson), operating costs and energy costs account for 80% of the total costs. In the study, they examined the costs of 41 data centers in North America. This shows that the average cost of the data center is more than 4.5 million euros per year. For large data centers, this can amount to more than 7.5 million euros per year¹⁴⁹. Large economies of scale can be achieved with data centers, however, both with regard to the size of one data center and with regard to having multiple data centers worldwide.

Economies of scale due to the size of a data center

According to the study by Emerson, the average costs per kilowatt and per server rack fall substantially as the size of a data center increases. Figure 12 shows the decline in average costs per kilowatt and per server rack. For data centers with an area of between 500 m² and 5,000 m², the average annual cost of the server rack is almost 100,000 dollars, and over 25,000 dollars per kilowatt. For data centers with an area exceeding 50,000 m², it is considerably lower. For these data centers, the average annual cost of a server rack is around 40,000 dollars, and around 5,000 dollars per kilowatt.

¹⁴⁸ Emerson & Ponemon Institute, "Cost to Support Compute Capacity", 2016

¹⁴⁹ The median is around 4 million euros (Emerson Report).

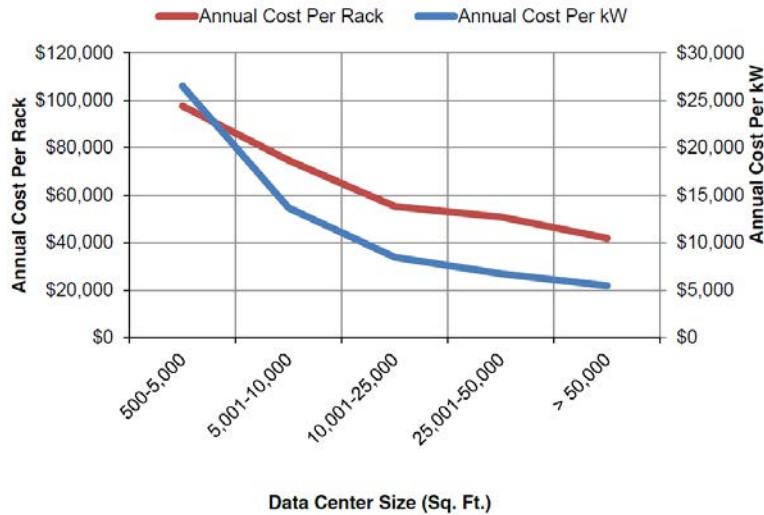


Figure 12: Average cost per kilowatt and server rack.¹⁵⁰

According to Emerson, economies of scale can be achieved with data centers in all cost categories: the physical building, the physical infrastructure, operating costs, and energy costs. Figure 13 shows for each data center size what the costs are per cost category. The economies of scale are greatest with regard to energy costs and operating costs. The difference in costs between a data center of a maximum of 5,000 m² and a data center exceeding 50,000 m² is more than 200% for both cost items.¹⁵¹ According to Emerson, these two cost items make up more than 80% of the total cost of a data center, regardless of its size. A Microsoft study also states that various economies of scale can be achieved with data centers. In addition to economies of scale in energy and labor costs, economies of scale can also be achieved in terms of security and reliability. Such investments are mainly fixed investments. Finally, according to Microsoft, large operators have greater purchasing power than small operators and can therefore obtain higher discounts on the purchase of infrastructure (hardware).¹⁵²

¹⁵⁰ Emerson & Ponemon Institute, "Cost to Support Compute Capacity", 2016.

¹⁵¹ Ibid

¹⁵² Microsoft, "The Economics of the Cloud", 2010, [The-Economics-of-the-Cloud.pdf \(microsoft.com\)](#), last visited on April 12, 2022.

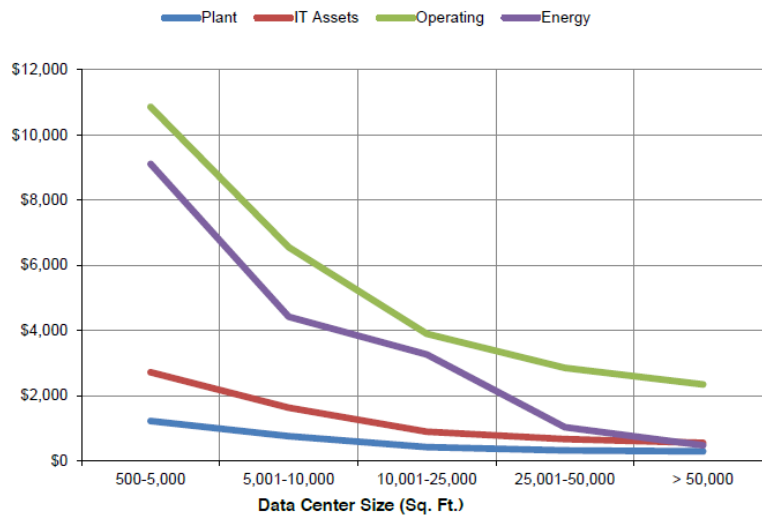


Figure 13: Cost per data center size for different cost categories

As well as the economies of scale related to the size of a data center, economies of scale can also be achieved by reducing variance. The higher the demand, the smaller is the relative variance in demand. By providing services for a variety of customers, it is possible to limit variance in the time of day, industry-specific variance, and variance in randomness, among other things. Industry-specific variance concerns seasonal products, for example. Companies operating in the Christmas parcel sector will have a different peak time than companies in the flower industry.¹⁵³ Having a large number of customers reduces the variance in demand, so servers can ultimately be used more efficiently.

Economies of scale due to having multiple data centers and customers worldwide

Some economies of scale that are connected to the size of the data center are reinforced by having multiple data centers and customers worldwide. This provides even greater purchasing power and further reduces the variance in demand. The variance in the time of day, industry-specific variance, and variance in randomness will be limited even more if the data centers are spread across multiple countries. Users generally peak during the day, for example. In the case of users in Japan, for example, that will be at a different time than users in the UK. By providing services for both users, variance in the time of day is reduced.¹⁵⁴

5.1.2 Credits

As described in section 3.2, many cloud providers offer credits to start-ups and scale-ups. The maximum credits given to start-ups and scale-ups by AWS, Azure, and GCP are 100,000 dollars¹⁵⁵, 150,000 dollars¹⁵⁶, and 100,000 dollars,¹⁵⁷ respectively. Oracle offers all start-ups 500 dollars and in the first two years 70% discount on cloud services.¹⁵⁸ IBM provides a maximum of 120,000 dollars¹⁵⁹ of credits.

¹⁵³ Microsoft, “The Economics of the Cloud”, 2010, [The-Economics-of-the-Cloud.pdf \(microsoft.com\)](#), last visited on April 12, 2022.

¹⁵⁴ Ibid

¹⁵⁵ [AWS Activate for Startups, Founders, & Entrepreneurs \(amazon.com\)](#), last visited on April 29, 2022.

¹⁵⁶ [Microsoft for Startups](#), last visited on April 29, 2022.

¹⁵⁷ [Google for Startups Cloud Program | Google Cloud](#), last visited on April 29, 2022.

¹⁵⁸ [Oracle for Startups - FAQ](#), last visited on April 29, 2022.

¹⁵⁹ [Startup with IBM - Build with free IBM Cloud credits and grow your business](#) last visited on April 29, 2022.

Finally, OVHcloud and Scaleway offer a maximum of 100,000 euros¹⁶⁰ and 36,000 euros¹⁶¹ of credits, respectively.

Giving credits to start-ups and scale-ups entails risks. A major risk of providing credits for start-ups and scale-ups is that a cloud provider does not know in advance whether the business that receives the credits will survive. It is possible that the business will go bankrupt and therefore the investment made, by means of credits, will not be recouped. A start-up or scale-up is at greater risk of going bankrupt than an established business. Forbes writes that nine out of ten start-ups do not survive.¹⁶² Providing credits for start-ups is therefore risky. This risk can be reduced by means of scale. The more users there are, the better the risk is spread. As a result thereof, cloud providers with many users can offer higher credits than operators with fewer users. There are also advantages for cloud providers in granting credits, however. If start-ups and scale-ups actually survive, they will probably be locked into the provider due to switching barriers (see chapter 6). This means that after taking advantage of the credits, the companies will most likely stay with the chosen cloud provider and the cloud provider can recoup the costs incurred in providing credits. There is also a chance that a start-up will develop into a unicorn. Unicorns are new businesses that have a market capitalization in excess of 1 billion dollars and are so named because they were once rare. The number of unicorns nevertheless continues to rise each year. In the first half of 2021, there were already as many unicorns as in the whole of the period from 2011 to 2015. The cloud is the biggest driver of this trend¹⁶³. A unicorn therefore generates high revenues for a cloud provider. The potential for a start-up to grow into a unicorn encourages cloud providers to grant generous credits.

5.1.3 Research & Development

In order to continue competing with other cloud providers, investments must be made in research & development (R&D). First, there are R&D costs in improving existing cloud services. For example, the technology that cloud providers use to scale up efficiently is becoming increasingly efficient and further automated. This requires continuous investments in research and new products¹⁶⁴. One such example is Google, which is involved in developing new energy-efficient (Tensor) chips to improve the operation of its machine learning applications¹⁶⁵. There are also R&D costs involved in developing new cloud services. The product offering of cloud providers is growing steadily. The product selection on the IaaS and PaaS layers has grown by over 40% between 2018 and 2020.¹⁶⁶

Both new cloud services and new techniques to improve existing services can be developed internally within the cloud provider, but also by third-party companies. If successful new services and/or techniques are developed by external companies, they can be brought in house by means of acquisitions if they are considered to be a success. Various cloud providers thus state that acquisitions are required to boost their selections¹⁶⁷, to differentiate sufficiently and fill any gaps in their own portfolio¹⁶⁸.

¹⁶⁰ [OVHcloud Startup Program: Startup Accelerator](#), last visited on April 29, 2022.

¹⁶¹ [Startup Program | Scaleway](#), last visited on April 29, 2022.

¹⁶² [90% Of Startups Fail: Here's What You Need To Know About The 10% \(forbes.com\)](#), last visited on April 29, 2022.

¹⁶³ [10 Reasons We Are Seeing More Unicorn Companies Than Ever Before \(minutes.co\)](#), last visited on June 2, 2022

¹⁶⁴ Microsoft, 'The Economics of the Cloud', 2010, [The-Economics-of-the-Cloud.pdf \(microsoft.com\)](#), last visited on April 14, 2022.

¹⁶⁵ [Cloud Tensor Processing Units \(TPUs\) | Google Cloud](#), last visited on May 2, 2022.

¹⁶⁶ Calculations ACM, DOX/INT/ACM/INT/453334.

¹⁶⁷ Response to request for information by Google, received on January 31, 2022, ACM/IN/701003; Response to request for information by Oracle, received on February 11, 2022, ACM/IN/700301.

¹⁶⁸ Response to requests for information by Microsoft Azure, received on January 31, 2022, ACM/IN/701030.

with the most users. The cloud provider with the most users generates more turnover due to the services of ISVs. When a service from an ISV is used, there is also underlying use of the infrastructure services of the cloud provider on which the ISV's service was developed. Usage and turnover of a cloud providers go up by every single use of services from an ISV. These are therefore network effects.

This network effect also applies in the marketplace. The provider with a large number of users will have more third-party services in its marketplace than a provider with relatively few or considerably fewer users. This is also evident from the figures in Table 1 (see chapter 4). AWS and Azure, which both have a much larger market share than GCP, both have twice as many third-party products in their marketplace. Offering a large variety of services attracts more users, which in turn attracts even more services from third parties and therefore more revenues.¹⁷⁷ As stated above, the provider of a marketplace receives commission from a third party when a service is purchased through the marketplace. In addition, the revenues from the infrastructure services of the marketplace provider also increase, because the third party's service was developed on this infrastructure. In the case of AWS, a user receives two invoices when he purchases a software service through the marketplace: one for the use of the software service and one for the use of the underlying infrastructure, such as storage or computing power¹⁷⁸.

There is another network effect. As cloud services of various providers operate in a different way, developers acquire specific knowledge of a cloud platform. In some cases, familiarity among employees plays a role in the choice for a specific cloud provider. If employees are already familiar with a certain cloud platform, chances are higher that that platform will be chosen.¹⁷⁹ Most developers will be familiar with the platforms of the biggest cloud providers. In addition, the larger cloud providers secure the loyalty of universities and students, among others, by means of targeted offers¹⁸⁰, and developers just entering the job market will prefer to learn about the most widely used cloud provider¹⁸¹. As most developers are familiar with the platform of the biggest cloud providers, the largest cloud provider will be chosen the most, and will thus be able to enjoy the most of this positive network effect.

5.3 Vertical integration of large operators

In section 2.5, ACM described that there are advantages in purchasing integrated services from a single cloud provider, because cloud services in some cases only work within that specific cloud environment and cannot always communicate with services from other cloud environments. In addition, users often obtain larger discounts if they buy everything from a single cloud provider. Not all cloud providers offer a large and widely integrated range of products. After all, a large, integrated offering requires major investments.

Having a large, integrated offering, but also being part of a conglomerate, also has various advantages. Economies of scale can be better exploited and in the case of conglomerates there are economies of scope, among other things. For entrants it may be difficult to compete effectively with large, integrated

¹⁷⁷ Investigation of competition in digital markets, Committee on the Judiciary, U.S. House of representatives, 2020, p. 117. https://judiciary.house.gov/uploadedfiles/competition_in_digital_markets.pdf.

¹⁷⁸ [Paying for products - AWS Marketplace \(amazon.com\)](https://aws.amazon.com/marketplace/), last visited on May 30, 2022.

¹⁷⁹ Notes of meeting [Confidential: XXXXXXXX] June 28, 2021, ACM/IN/699665.

¹⁸⁰ Notes of meeting with Scaleway, Juni 25, 2021, ACM/IN/699674.

¹⁸¹ Notes of Staff of the Subcommittee on Antitrust, Commercial, and Administrative Law, Committee on the Judiciary, U.S. House of Representatives, april 16, 2021, ACM/INT/453932.

operators. This section describes the advantages of vertical integration of major providers and the advantages of being part of a conglomerate.

Vertical integration

Several major players in the cloud services market are all vertically integrated: they operate on all of the aforementioned layers of the cloud. These cloud providers use a full stack design¹⁸², in which every layer of service makes optimum use of an underlying layer. This integration has the advantage that all services are well integrated in the specific architecture of a cloud provider, so they work optimally together. Each of the three major providers, Amazon (AWS), Microsoft (Azure), and Google (GCP), offer such an integrated package, as well as providers such as Oracle and IBM. Smaller cloud providers are often less active on different layers and have a less extensive product offering¹⁸³. Matching the services offered by the integrated operators requires huge, specialized development teams or major investments, as also described in the sections above. These operators focus primarily on providing their own services on a single layer. Examples of this type of operator are SurveyMonkey (SaaS) and OVHcloud (IaaS).

There are advantages for users in purchasing from cloud providers with an integrated offering. Users can turn to a single provider for all their ICT requirements. This has the advantage that all services can be included in a single contract and it is often possible to take advantage of volume discounts. In addition, the services work optimally together, because all services run within a single architecture. Cloud providers' standards sometimes differ, so services of different providers are not always interoperable (see also section 2.7). In addition, it is not necessary to use a management layer for the use of different services, because integrated operators already have this in place.

An integrated offering also has advantages for cloud providers. For the supply of a SaaS service, for example, it is not necessary to purchase IaaS services from other operators, which saves costs. Vertical integration also means that providers can gather more information on the market¹⁸⁴. Suppose that provider *k* provides IaaS, PaaS, and SaaS Services and a third party provides SaaS services developed on the infrastructure of provider *k*. On the basis of the metadata, provider *k* can see which of the third party's SaaS services are successful. As a result of this information, provider *k* knows which SaaS services are in demand and provider *k* can develop similar and more targeted services. Because integrated providers operate on all layers and are in principle more cost-efficient, it may be worthwhile for a provider to develop a similar service.

Amazon and Microsoft have taken opposite routes to arrive at a vertically integrated cloud offering. With AWS, Amazon mainly started from the IaaS layer, and expanded subsequently to the SaaS layer.¹⁸⁵ Microsoft has for many years had a strong position on the SaaS layer, including in the market for productivity software (Office packages), and has extended this to the PaaS and IaaS layers

Conglomerate effects

As well as being vertically integrated, Amazon, Microsoft, and Google are also part of major conglomerates. Together with Meta (Facebook) and Apple, they are often designated as the Big Five or GAFAM, the operators with the biggest market capitalization in the world.¹⁸⁶

¹⁸² Response to requests for information by Microsoft Azure, received on January 31, 2022, ACM/IN/701030

¹⁸³ Calculations of ACM, DOX/INT/ACM/INT/453334.

¹⁸⁴ Investigation of competition in digital markets, Committee on the Judiciary, U.S. House of representatives, 2020, p. 120.

¹⁸⁵ Notes of meeting [Confidential: XXXXXXXX] June 28, 2021, ACM/IN/699665.

¹⁸⁶ Cremer, J. & de Montjoye, Y & Schweitzer, H. "Competition policy for the digital era", European Commission, 2019, p-13.

Cloud providers that are part of a (tech) conglomerate can benefit of economies of scope. Many services in the digital economy use different layers of the cloud, such as (web) applications, video streaming services, search engines, storage services for consumers, or smart devices (IoT). There are advantages particularly in the management of the infrastructure, the 'engine' of these cloud services. Google, for example, uses the same infrastructure for GCP as for Google Search, Gmail and YouTube¹⁸⁷, and Amazon uses AWS infrastructure for Prime Video¹⁸⁸ and Amazon.com¹⁸⁹, among others. But this also applies to non-infrastructure services in the cloud. Amazon, for example, also uses PaaS services, such as databases, for Prime Video.¹⁹⁰ Ownership of cloud services entails cost savings. Since it does not have to be purchased from third parties, there is no mark-up payable.

Being part of a conglomerate also means that these cloud providers have deep pockets. This gives them the ability to make enormous investments in developing new services, expanding and improving the infrastructure, and attracting new customers. The importance of deep pockets is evident, for example, from the fact that Google has been able for 11 years to incur billions of dollars of annual losses on its cloud services due to the high investments made (see also section 4.1). The scale of the acquisitions made by [confidential: XXXXXXXXXXXXXXXX], among others (see also section 4.1), are also much harder for operators that are not part of a major group or conglomerate]. Operators that are part of a group or conglomerate consequently have an advantage and can develop new services and diversify their product offering faster and more easily.

The linkage of data flows from different markets also plays a major role. The more products and/or services a company offers, the more data is available for that company. This data can subsequently be used for targeted advertising or for improving the user experience.¹⁹¹ Google, for example, uses the data gathered with Google Search and Google Maps to identify various target groups for YouTube, among others¹⁹². The data from Google Search¹⁹³ and Google Maps¹⁹⁴ is also used by Google for various cloud services. This means that data generated by Google Search, for example, is also available to users. This is another way in which being part of a conglomerate has advantages in markets for cloud services.

In addition, cloud providers that are part of a conglomerate or a major holding sometimes already have relationships with companies for other products in other markets offered by those providers. For example, some companies already use an Oracle database on premise or Windows Server from Microsoft. These users already have contact with these operators in other markets (see also section 3.2), and these market participants often proactively point out new services (cloud-related or otherwise). The discounts that are given by market participants are sometimes cross-market discounts. In some cases, discounts are given, for example, if both Microsoft 365 or Windows Server and Azure are used¹⁹⁵. The questionnaire that ACM sent to users showed that the main reason why users chose a particular cloud provider was that they already used other products from that provider.¹⁹⁶ Finally, cloud providers that are part of a conglomerate or a major holding already enjoy a high degree of brand awareness.

¹⁸⁷ [Global Infrastructure | Google Cloud](#), last visited on May 2, 2022.

¹⁸⁸ [Amazon Prime Video Case Study - Amazon Web Services \(AWS\)](#), last visited on May 2, 2022.

¹⁸⁹ [Does Amazon.com use Amazon AWS? - Quora](#), last visited on May 2, 2022.

¹⁹⁰ [Does Amazon.com use Amazon AWS? - Quora](#), last visited on May 2, 2022.

¹⁹¹ Batura, O & van Gorp, N & Larouche, P. "Online Platforms and the EU Digital Single Market", 2015, [Online Platforms and the EU Digital Single Market \(europa.eu\)](#).

¹⁹² [YouTube will now show you more ads based on your search habits \(cnbc.com\)](#), last visited on May 2, 2022

¹⁹³ [Make informed decisions with Google Trends data | Google Cloud Blog](#), last visited on May 2, 2022

¹⁹⁴ [Google Maps Platform now integrated with the GCP Console | Google Cloud Blog](#), last visited on May 2, 2022

¹⁹⁵ CIO questionnaire, question 5, ACM/INT/453539.

¹⁹⁶ CIO questionnaire, question 5, ACM/INT/453539.

5.4 Barriers to entry

For many cloud providers, it is attractive to use a single cloud provider that offers services on different layers. Users predominantly wish to use services on multiple cloud layers and to link the various services that they use¹⁹⁷. This has an impact on barriers to entry. For new entrants it is unrealistic to start from scratch and compete on all layers with an extensive product offering. Below, ACM first analyzes the scope – and hence also the barriers – for the provision of services on a single specific layer. This is followed by an analysis of whether entrants in a single specific layer can exert sufficient competitive pressure on major integrated providers.

Challenges for new entrants

Generating sufficient sales as a new entrant can be difficult in the cloud services market. Third parties (ISVs) that develop SaaS or PaaS services will, as described in section 5.2, mainly opt to develop their services on the infrastructure of large cloud providers. In addition, business users that already use cloud services are often locked into other providers and have high switching costs (both of which are explained later in section 6.1). A new entrant's sales must therefore come primarily from new cloud users. These users, however, often choose providers which already have a degree of brand awareness or from which they already purchase other IT-related products (see also chapter 3)¹⁹⁸. In addition, existing major providers offer generous credit systems and free services¹⁹⁹, which are difficult for entrants to match. Finally, most users wish to use multiple layers of the cloud.²⁰⁰ As a result, users are more likely to choose services from an operator with a wide product offering, because the services in different layers then work well and efficiently. Services from different providers are not always readily interoperable at present, so a user cannot easily “click” services from different providers together²⁰¹. In addition, users are able to make the most use of volume discounts if they take out multiple services from a single provider. If multicloud is used, those economies of scale are lost.²⁰²

Barriers to entry for offering IaaS-services

Most users wish to use multiple layers of the cloud, but there are also users that only purchase IaaS services²⁰³. This latter group of users may only use storage or computing power, for example. As such, this is a relatively small part of the market, where, new entrants must be able to convince potential users that their services are trustworthy and meet the industry-specific requirements²⁰⁴. IaaS services are fairly homogenous, so competition is theoretically mainly on price. Due to the major economies of scale, large cloud providers might be expected to make entry difficult. However, by virtue of having an integrated offering and lock-in (this is explained in more detail in chapter 6), large, integrated cloud providers only compete to a limited extent on price, which provides space for other providers in this relatively small niche market.

¹⁹⁷ [File:Types of cloud computing services used, by service model, EU, 2021 \(% of enterprises using the cloud\).png - Statistics Explained \(europa.eu\)](#), last visited on June 9, 2022.

¹⁹⁸ Response to request for information from users .

¹⁹⁹ As described in section 5.1.

²⁰⁰ [File:Types of cloud computing services used, by service model, EU, 2021 \(% of enterprises using the cloud\).png - Statistics Explained \(europa.eu\)](#), last visited on June 9, 2022.

²⁰¹ Notes of meeting VMWare, January 10, 2022, ACM/IN/699883.

²⁰² Response to request for information from user [confidential: XXXXXXXX XXXXXXXX] November 25, 2022, ACM/IN/661092.

²⁰³ Response to request for information from providers Leaseweb, February 1, 2022, ACM/IN/699875.

²⁰⁴ Investigation of competition in digital markets, Committee on the Judiciary, U.S. House of representatives, 2020, p. 120. see https://judiciary.house.gov/uploadedfiles/competition_in_digital_markets.pdf

In theory, any provider can lease space in a data center and install servers on a small scale to provide IaaS services. The question, however, is whether it will generate sufficient sales and compete effectively with existing IaaS providers to recoup its costs. Due to the economies of scale that can be achieved (see section 5.1), an entrant needs a particular level of sales in order to be efficient as a provider.

There is also a number of operators that only provide IaaS services. These operators compete with each other particularly on price for the fairly homogenous IaaS services. IaaS providers that have already been in the market for some time have an advantage here since they have already incurred the entry costs. At the same time, entry into the market for offering IaaS services only seems far from impossible. After all, existing IaaS providers, too, must continue to make investments for expanding and improving the infrastructure, for example by expanding to other regions with internet hubs and by further reducing energy consumption (the most important cost item) of data centers.

Barriers to entry for offering SaaS-services

In 2021 there was a total of over 25,000 SaaS providers in the market worldwide²⁰⁵. Among the different layers in the cloud, SaaS services are currently used the most by business users (see also Figure 9 in Section 3). The barriers to entry for the provision of SaaS services are relatively low. As stated previously, SaaS services are turnkey applications that can be offered to both consumers and business users. Some SaaS services were already being provided on an on-premises basis and have been made suitable for the cloud²⁰⁶. Most SaaS services, however, have been developed for the cloud. The low barriers to entry and scalability of the cloud play an important role in this regard.

SaaS services are heterogeneous, so an entrant can easily differentiate itself. An entrant can opt to enter with a new kind of service in a niche or to enter with a service that is already being offered in a similar form. In principle there are few barriers to entry for a new SaaS provider. The SaaS provider can use the infrastructure of a different cloud provider to develop its service. This does not require any major upfront investments, because this infrastructure is paid for on the basis of use (see 2.3). This means costs are only charged when this infrastructure is actually used.

Entry may nevertheless be difficult if a SaaS provider wishes to enter with a service that is already being provided in the market. After all, users are already used to the existing SaaS service, there may be a lock-in situation (see chapter 6), and brand awareness may also play a role.²⁰⁷ The magnitude of the barrier to compete with existing SaaS providers depends on the strength of the position of the provider of the service that is already provided. In the case that the SaaS service is provided by an integrated cloud provider behavioral practices of these providers may further impede entry (see chapter 6).

The flexibility in scalability means that SaaS entrants can quickly and easily expand their services. Successful entrants can therefore grow fast. They benefit from the fact that costs for implementing updates, upgrades and patches to SaaS services can be spread out over all users, thereby making the costs per user very low. In the first half of 2021, SaaS providers accounted for more than one-third of all unicorns (start-ups valued at over 1 billion euros). As stated previously, the number of unicorns is rising each year. Successful SaaS providers are a major part of this²⁰⁸. In the case of new SaaS service in particular, there seem to be sufficient opportunities to enter (and enter successfully). Competing on popular existing service is more difficult, especially if these are offered by integrated cloud providers.

²⁰⁵ [Leading SaaS countries worldwide 2021 | Statista](#), last visited on June 2, 2022.

²⁰⁶ [Microsoft Launches Office 365 Globally - Stories](#), last visited on June 9, 2022.

²⁰⁷ Answers CIO questionnaire, ACM/INT/453539

²⁰⁸ [10 Reasons We Are Seeing More Unicorn Companies Than Ever Before \(minutes.co\)](#), last visited on June 2, 2022

Barriers to entry for offering PaaS-services

PaaS services are currently used least by users²⁰⁹ and there appear to be relatively few users that only purchase PaaS services²¹⁰. However, demand for PaaS services is expected to grow strongly in the future (see Figure 9 in Section 4). Nevertheless, the market for PaaS providers is currently relatively small and a large number of users of PaaS services use an integrated offering²¹¹.

PaaS services are much less diverse than SaaS services, so there is less scope for differentiation and fewer niches in which to enter than in the case of SaaS services. PaaS services are often focused on a specific form of development, such as web deployment, mobile deployment, and machine learning. Since there are only a limited number of development types, there are also only a limited number of platform types. The number of different types of PaaS services is therefore much smaller than the number of different types of SaaS services.

Large, integrated providers also offer PaaS services themselves that have been developed on their own infrastructure. For a provider that only provides PaaS services, it is difficult to gain clients who use multiple services and layers for the same reasons as for providers that only provide IaaS services. For a provider that only provides PaaS services, it is difficult to compete on price because large, integrated providers benefit more from economies of scale. Infrastructure is also required to develop and use a PaaS service. As in the case of SaaS services, the infrastructure can be purchased from other cloud providers, so the entry costs are relatively low. Non-integrated PaaS providers must nevertheless pay to use other parties' infrastructure. Large, integrated cloud providers do not have to do this, since they own the infrastructure and consequently have a cost advantage.

In addition, in the case of PaaS services, the integration with other services is often very important²¹². Whereas SaaS services are usually a user's end-product, PaaS services are generally used as part of a chain of different services. A machine learning platform is used, for example, to set dynamic prices for airline tickets. The prices are set on the basis of historical data that is updated with new data every hour. The prices must then be changed automatically on a website. In order to do this, the machine learning platform must be connected to the database where the data is stored and to the website to update the prices. Good interoperability between different services is essential for PaaS services. Integrated cloud providers have an advantage in providing PaaS services, because they can ensure that their services are effectively interoperable and can work together efficiently. Such interoperability is not always achievable for third parties, as a consequence of closed standards and lack of information on how other providers' infrastructure operate²¹³.

There are currently few (major) players that only provide PaaS services. ACM also expects that there will not be many new entrants in the future. It is difficult for PaaS providers to differentiate, and integrated providers have an advantage in terms of cost and efficiency in the provision of PaaS services. Most users of PaaS services also use multiple cloud services and layers and are more likely to choose a provider with an integrated offering.

²⁰⁹ [File:Types of cloud computing services used, by service model, EU, 2021 \(% of enterprises using the cloud\).png - Statistics Explained \(europa.eu\)](#), last visited on June 9, 2022.

²¹⁰ From ACM requests for information from providers. Operators that have distinguished between the various layers show that the majority of PaaS users use multiple layers. The requests for information from users revealed no user that only purchased PaaS services.

²¹¹ Response to request for information by OVHcloud, February 10, 2022, ACM/IN/700998.

²¹² [Practical guide to PaaS: Benefits and characteristics \(ibm.com\)](#), last visited on June 9, 2022.

²¹³ Notes of meeting IBM, November 4, 2021, ACM/IN/699966.

Conclusion

Most cloud providers wish to use multiple cloud layers and to link the various services that they use. A cloud provider that offers many different services is therefore generally more attractive to customers than a cloud provider with few services. This is reinforced by the fact that the services of different providers are not always interoperable at present. It is difficult for a new entrant to offer the same number of services as existing major cloud providers, since existing major cloud providers each offer more than a hundred of their own services and this number is growing. The existing market participants also have a lead due to the experience curve effect: the earlier a provider enters the market, the more knowledge their developers can acquire. These developers thus generally work more efficiently; they can improve existing services faster and develop new services faster. In this way, existing cloud providers can expand their product range faster than smaller cloud providers, so it is harder to catch up in the product offering of smaller cloud providers. In addition to the wide product offering, the current large cloud providers benefit from large economies of scale, positive network effects, and economies of scope. For new entrants it is therefore unrealistic to start from scratch and compete on all layers. The entry of Google in 2012 shows that many years of large investments are required in order to compete with existing integrated cloud providers. This requires a long breath and deep pockets.

The question remains whether there is sufficient competitive pressure on the current large, integrated providers. If it is possible to enter individual layers successfully, there will be some competitive pressure on large, integrated providers. The biggest competitive pressure is found on the SaaS layer, where entry is relatively easy, although there can be impediments when competing SaaS services of the large integrated cloud providers. These cloud providers, offer however relatively few SaaS services, with the exception of productivity software (by both Google and Microsoft). There is less competitive pressure on the IaaS and PaaS layers. On both layers there are a number of players that only provide services on that specific layer. Lock-in and the desire of most users to use services from multiple layers together mean that in the case of IaaS services the major cloud providers only have to compete on price to a limited extent. Consequently there is scope (albeit limited) for providers without an integrated offering to offer attractive prices for the fairly homogenous IaaS services. A PaaS service is often used in combination with other services, so large, integrated providers appear to have an advantage relative to providers that only offer PaaS services.

6 Market risks and barriers

ACM sees several market risks and barriers in the market for cloud services. In section 6.1, the technical and financial switching barriers that create lock-in situations for the user are described. In section 6.2, the risk of leveraging positions within different cloud services is discussed. Finally, section 6.3 goes into the consequences of the risks and impediments on market dynamics.

6.1 Lock-in

Users of cloud services in practice apparently seldom change their cloud provider.²¹⁴ Therefore, the initial choice of a particular provider has thus far in many cases – depending on the needs of the user – been a once-only decision. Once a choice has been made, it is more difficult and expensive to choose another provider at a later stage. This is also referred to as lock-in. ACM sees two types of causes of lock-in, namely i. the technical barriers that result from transferring data and continuing the business processes and poor interoperability, and ii. the costs of removing data from the cloud (egress fees).

6.1.1 Technical switching barriers

Interconnectedness

There is generally strong interconnectedness between ICT services and the business processes of an undertaking. For cloud services the interconnectedness with in-house business processes is even greater. This is because cloud services are often interconnected and because cloud services take over parts of business processes, and because businesses increasingly design their business processes on the basis of the IT systems of cloud providers.

Since different services are often interconnected, internal communication (the link) between the different services in the cloud is very important. APIs that take care of the internal communication between different services differ, however, depending on the cloud provider, as described in section 2.5. When a business wishes to switch to a different cloud provider, a lot of code therefore has to be rewritten to enable communication between the different (and possibly new) cloud services. Apart from the fact that this takes a lot of time, users also have to retrain in order to understand how the communication between the new services should be set up and managed. Moreover, the interconnectedness between different cloud services also means in practice that to switch to another cloud provider the services that are interconnected must be transferred at the same time, which increases the complexity of switching.

In general, the more services that are interconnected, the more complex it is to switch, regardless of the layer or layers involved. Since PaaS services are usually the most connected with other services, this is automatically even more a factor in the use of the PaaS layer.

Different product offering

There will always be differences in the product offerings of cloud providers, which means there is not always an alternative for a cloud service that is being used. This occurs the least with the relatively homogenous IaaS services, more with PaaS services, and the most with the heterogeneous SaaS services. The cloud services of large, integrated cloud providers often appear similar in general, but they

²¹⁴ Responses CIO questionnaire, question 19, ACM/INT/453539.

do not always fulfil exactly the same conditions and requirements. A service from cloud provider A can serve precisely the same purpose as cloud provider B but, for example, use different technical security or privacy standards. Users who wish to switch will again have to investigate all the services of the new cloud provider in detail.

Data portability

When switching, the data from the various services often must be transferred as well. Services of different providers are not always readily portable, however, so transferring data may be difficult. Data transfers require a connection between the service currently used and the service that will be used. The APIs or other interfaces that could make this possible, however, are not always available or cannot be developed because the service may be based on closed standards, as described in section 2.4.1. If no API is available or one cannot be developed, the data cannot be transferred. In addition, there are sometimes differences in format, so the format has to be modified before the data can be transferred to a cloud service of another cloud provider. Cloud providers state that cloud services on the IaaS layer (mainly storage space and computing power) are the most standardized. The PaaS and SaaS services are less so, with the result that data portability problems occur more on these layers.

In addition, IBM warns that it is important that open source environments stay open. Offering open source services should not become some sort of tactic for attracting a lot of customers fast, after which the service becomes closed, and users get locked in²¹⁵.

Latency (the time it takes for data to reach its destination in the network) also plays a role when transferring a service, if, as a result thereof, services of different cloud providers need to communicate with each other. For some services, it is important that they are always available and have a fast connection. Think of, for example, the use of a payment app. For these kinds of apps, it is not a workable situation if customers need to wait, for example, one minute before they are able to log in.²¹⁶ If data has to be transferred from cloud provider A to cloud provider B, the data leaves the cloud environment of cloud provider A and goes to the internet and then to the cloud environment of cloud provider B. This takes more time than when the data has to cover the same or often a smaller distance within a cloud environment. This delay in the data traffic can be a problem for some applications. These problems do not make a difference for each cloud layer, but they apply particularly to time-critical data services.

Multicloud

Many users of cloud services use different cloud providers (multicloud). However, as shown by section 3.1.4, this is usually an unconscious choice and mostly not aimed at reducing lock-in.²¹⁷

This is also confirmed by the Flexera report, which shows that 45% of multicloud users use apps within the respective cloud provider's own silos.²¹⁸ In such situations, the apps from different environments are not connected to each other.

The abovementioned technical impediments also occur when multicloud is used. At the moment, when using multicloud, one cloud provider is predominantly used, and services of other cloud providers are only used for specific services for which no interconnection is needed (often SaaS services)²¹⁹. Multiple

²¹⁵ Notes of meeting IBM, November 4, 2021, ACM/IN/699966.

²¹⁶ Notes of meeting [confidential: XXXXXXX], May 25, 2022, ACM/UIT/582251.

²¹⁷ Notes of meeting IBM, November 4, 2021, ACM/IN/699966.

²¹⁸ State of the Cloud report, Flexera, Figure 12.

²¹⁹ Responses CIO questionnaire, question 19, ACM/INT/453539.

providers argue that multicloud use shows that lock-in problems are limited. Users, however, indicate that, with regard to the cloud services that are used as well as to the thereto-related processes, it is still the case that switching is difficult²²⁰. As the interoperability between services of different cloud providers is insufficient, multicloud results in a de facto lock-in in multiple clouds. One of the causes of the lack of interoperability is a lack of available (fully or otherwise) APIs and high egress fees, which is further explained in section 6.2. Without this interoperability, it is not possible for users to combine services, or users are unable to make the optimal choice for the best service for a specific need.

6.1.2 Financial switching barriers

In its study ACM found no explicit indications of the presence of contractual switching problems: as far as it is aware, there are no clauses in contracts stating, for example, that other providers' services must not be used. Longer contracts are nevertheless entered into for periods of one to three years, in which discounts are granted based on volumes. Longer contracts also have advantages for users, however. With longer contracts, users can, for example, get more certainty regarding the quality and costs of services for a longer period of time.

In addition to technical switching barriers, there are also financial switching barriers in the market for cloud services. These arise first of all because the complex tariff structure leads to a lack of clarity on the costs of using cloud services (see also Sections 2.3 and 3.2.1)²²¹. This lack of clarity means that it is difficult to gauge another cloud provider's costs and what the switching costs will be. A company that helps organizations with their data migrations also indicates that, almost always, the migration is more expensive than is initially estimated by the parties involved.²²² With migrations, it is necessary to pay to move data, among other things. The current pricing structure, in which moving data from the cloud is expensive due to the egress fees charged, discourages switching.

Egress fees

As stated previously in section 2.3, placing data in the cloud is free (ingress fees), but there are costs for transferring data from the cloud (egress fees) and transferring data within the cloud. For transferring data from the cloud, cloud providers pay third parties (the network providers) for bandwidth. After all, the data is transferred from the cloud provider's network to a network outside that of the cloud provider. Various major cloud providers indicate that the costs for this bandwidth are low²²³. For their cloud services, some cloud providers use their own networks, while others lease these from third parties. As a result thereof, there may be cost differences among cloud providers.

Table 2 shows the tariffs charged by a number of cloud providers that users must pay for transporting data. The large differences between the providers' egress fees are striking. The egress fees in the case of the three major providers are between 0.05 dollars and 0.09 dollars per GB, depending on the volume transferred. In the case of Oracle and OVHcloud, transporting data from the cloud costs 0.0085 dollars per GB and 0.01 euros per GB, respectively, regardless of the volume. The egress fees of major providers are five to as much as 10 times as high as those of Oracle and OVHcloud. Compared to the other cloud providers, IBM has a slightly different pricing structure and is therefore not included in the table below. IBM offers monthly packages costing, for example, 999 dollars per month to move a

²²⁰ Responses CIO questionnaire, question 19, ACM/INT/453539.

²²¹ Notes of meeting CIO Platform Nederland, July 8, 2021, ACM/IN/699659.

²²² Notes of meeting [confidential: XXXXXXXX], May 25, 2022, ACM/UIT/582251.

²²³ Response to request for information [confidential: XXXXXXXX XXXXXXXX XXXXXXXX]; Response to request for information [confidential: XXXXXXXX XXXXXXXX XXXXXXXX].

maximum of 20 TB.²²⁴ It is notable that the tariffs of the three large providers are substantially higher than those of smaller cloud providers, since large providers can negotiate better data-transfer prices with telecom providers. It therefore appears that a substantial margin is being charged.

Table 2: Costs of data transfer per GB from Europe with various cloud providers in May 2022.

	Azure ²²⁵	AWS ²²⁶	GCP ²²⁷	OvHcloud ²²⁸	Oracle ²²⁹	[confidential: XXXXXXXX] ²³⁰
Ingress fees	Free	Free	Free	Free	Free	[XXXXXX]
Within cloud						
Within region	Free or 0.01 dollars	0.02 dollars	Free or 0.01 dollars	0.01 dollars	Free	[XXXXXX]
Within continent	0.02 dollars	0.02 dollars	0.02 dollars	0.01 dollars	Free	[XXXXXX]
Outside continent	0.05 dollars	0.02 dollars	0.08 dollars	0.01 dollars	Free	[XXXXXX]
Egress fees						
First 100GB	Free	Free	0.085 dollars	0.01 euros	Free	[XXXXXX]
Next 10TB	0.08 dollars	0.09 dollars	0.085 dollars	0.01 euros	Free ²³¹	[XXXXXX]
Next 40 TB	0.065 dollars	0.085 dollars	0.065 dollars	0.01 euros	0.0085 dollars	[XXXXXX]
Next 100 TB	0.06 dollars	0.07 dollars	0.065 dollars	0.01 euros	0.0085 dollars	[XXXXXX]

A pricing structure where storing data in the cloud is free, but retrieving data from the cloud is not has not always existed. In its first few years, AWS did charge ingress fees of 0.10 dollars/GB²³². Right before Microsoft made cloud services publicly available in 2010²³³, AWS announced that their ingress fees would be free²³⁴. Different cloud providers have said that this pricing structure is caused by the fact this is the standard in the market. As AWS as the first mover used such a pricing structure, the other

²²⁴ [Bandwidth Packaging & Pricing - Cloud - Netherlands | IBM](#), last visited on August 3, 2022.

²²⁵ Azure states that the prices are estimates and give an indication. Azure also offers a premium option using Microsoft's Premium Global Network. [Prijzen: bandbreedte | Microsoft Azure](#), last visited on May 13, 2022.

²²⁶ [EC2 On-Demand Instance Pricing – Amazon Web Services](#), last visited on August 3, 2022.

²²⁷ [All networking pricing | Virtual Private Cloud | Google Cloud](#), last visited on May 13, 2022.

²²⁸ [Cloud Tarief: de Public Cloud oplossingen naast elkaar \(in Dutch\) - OVH \(ovhcloud.com\)](#), last visited on May 13, 2022.

²²⁹ [Cloud Networking Pricing | Oracle Nederland](#), last visited on May 13, 2022.

²³⁰ Response to request for information [confidential: XXXXXXXX], received on February 22, 2022, ACM/IN/701033.

²³¹ The first 10 TB is free with Oracle.

²³² [AWS Price Reductions and Free Inbound Data Transfer | AWS News Blog \(amazon.com\)](#), last visited on May 17, 2022.

²³³ [Windows Azure General Availability - The Official Microsoft Blog](#), last visited on 17 May 17, 2022.

²³⁴ [AWS Price Reductions and Free Inbound Data Transfer | AWS News Blog \(amazon.com\)](#), last visited on May 17, 2022.

providers merely followed that structure²³⁵. In addition, a major cloud provider says that storing data in the cloud involves non-recurring costs as a result of which the costs can be settled with the storage costs. This is not the case with transferring data from the cloud. Some users will never transfer their data from the cloud, whereas other users do so a million times.²³⁶

Table 2 also shows that the tariffs for moving data within the cloud are substantially lower than those for moving data out of the cloud. AWS indicates that moving data within the cloud is generally less resource-intensive than when data is transferred from the cloud. AWS also indicates that within data transport, transporting data out of the cloud is used most frequently. As a result, AWS focused on making investments in the network to facilitate data transport from the cloud.²³⁷ Figures from another cloud provider supposedly show that the costs for moving data from the cloud are higher than the costs for moving data within the cloud²³⁸ The figures of another large cloud provider, by contrast, show that the costs of data transfers within the cloud are higher than data transfers out of the cloud.²³⁹

Because of the current pricing structure, the barrier to store data in the cloud is low, but it does sometimes require considerable investments to get data from the cloud when a user wishes to switch. Discussions held by ACM have revealed that, sometimes, in part because of the egress fees, multi-million investments are needed for switching. This investment sometimes equals the initial investment that was made for using cloud services.²⁴⁰

The level of the egress fees is not necessarily a problem for all customers, however. In many cases, a number of GBs can be moved for free. In addition, moving data outside the cloud can be part of so-called flat-sum agreements²⁴¹. Nevertheless, the egress fees mean that sometimes switching is no longer financially profitable. Since the volume of data created, analyzed and stored by companies is growing ever larger (this volume is expected to continue to increase by 20% per year²⁴² in the forthcoming period) and as the total egress fees that will have to be paid when switching will thus keep on growing, the egress fees can represent an increasingly large obstacle to switching. Especially when the tariffs remain unchanged. It is known that AWS has left its tariffs unchanged in the past year: the tariffs applying to data transfers from the cloud have already remained unchanged for seven years and those for volumes above 100 TB have even remained unchanged for 10 years²⁴³.

6.1.3 Lock-in as a result of (strategic) choices

Provider choices

Lock-in is to some extent inherent in IT services and the associated technical aspects, but it is also a consequence of the market dynamics and the strategic and other choices made by individual cloud providers and customers. For example, a provider can use open or common standards as far as possible. However, providers with a large, existing customer base in particular have an incentive to

²³⁵ Notes of meeting [confidential: XXXXXXXX XXXXXXXX XXXXXXXX] ; Notes of meeting [confidential: XXXXXXXX XXXXXXXX XXXXXXXX].

²³⁶ Response to request for information AWS, received on February 1, 2022, ACM/IN/701000.

²³⁷ Ibid

²³⁸ Response to request for information [confidential: XXXXXXXX XXXXXXXX XXXXXXXX].

²³⁹ Response to request for information by [confidential: XXXXXXXX XXXXXXXX XXXXXXXX].

²⁴⁰ Notes of meeting CIO Platform Nederland, July 8, 2021, ACM/IN/699659.

²⁴¹ Response to request for information [confidential: XXXXXXXX XXXXXXXX XXXXXXXX].

²⁴² • [Total data volume worldwide 2010-2025 | Statista](#), last visited on May 17, 2022.

²⁴³ [AWS Lowers its Pricing Again! – No Inbound Data Transfer Fees and Lower Outbound Data Transfer for All Services including Amazon CloudFront | AWS News Blog](#), last visited on May 17, 2022.

make choices that strengthen the lock-in. When a switch is more difficult, a provider has less to fear from a switch.

A provider would only have an incentive to focus on it when the degree of lock-in is an important factor in the choice made by a substantial proportion of the potential customers. A large cloud provider, namely Microsoft, states, however, that customers (particularly legacy firms) are currently engaged mainly in the initial transfer from on premise to the cloud and are focused to a limited extent on the ability to migrate between clouds.²⁴⁴ A number of relatively small providers are focused specifically on the use of open standards and hence limiting (technical) lock-in. They therefore offer tools to convert data to the right format.

Responding to lock-in

As soon as a user has chosen a particular provider, it appears difficult to switch. This could mean that competition for the market becomes fiercer. Cloud providers respond to the major importance of the initial choice in various ways. They do so among other things by offering credits and free tiers, enabling users to familiarize themselves with the services of a cloud provider easily and free of charge. Discussions with providers show that the major cloud providers offer large volumes of credits²⁴⁵. After a certain period of time, or quantity of use, the free services are no longer available, and the user starts to pay. For providers this is a way of bringing in customers with low initial costs, with revenues to follow over the longer term. Various providers indicate, however, that they are unable to match the discounts given by the large, integrated cloud providers.

Problematic

Lock-in is a problem that can cause damage in the market. Switching barriers make it possible for companies to charge existing customers higher prices or provide them with lower quality without losing customers immediately. Although in this study, ACM did not perform a structural analysis of the prices, ACM has heard from multiple users that the costs for cloud services for companies have risen considerably over the past few years²⁴⁶. Providers that anticipate lock-in are prepared to gain customers with a keenly priced offering 'front of house'.

The simpler the product, the more likely it is that competition for the market will provide sufficient discipline. The classic example of printers and cartridges is a case in point: when purchasing a printer, consumers will have to take into account both the purchasing and consumption costs.²⁴⁷ In the case of complex products, such as an IT system, that is less likely to be the case. The quality is difficult to determine at the time of purchase and the customer's need may change unpredictably over time. The same applies to cloud services. Cloud providers offer a vast range of cloud services, which increases each year by a large number of services. Users, too, use many different cloud services. In addition, the tariff structure is detailed, and therefore, in practice, difficult to comprehend by users. Moreover, users indicate that cloud providers present tariffs in such a way that it appears advantageous, but not necessarily is²⁴⁸. As a result, the costs for using the cloud (and also the costs for switching) can be difficult to predict. The unpredictability of the future expenses is one of the reasons that competition for

²⁴⁴ Response to request for information Microsoft Azure, January 28, 2022, ACM/IN/701030.

²⁴⁵ Notes of meeting Scaleway, Juni 25, 2021, ACM/IN/699674.

²⁴⁶ Notes of meeting VMWare, January 10, 2022, ACM/IN/699883 ; Notes of meeting CIO Platform, July 8, 2021, ACM/IN/699659 and Response to request for information [confidential: XXXXXXXX XXXXXXXX], December 6, 2021, ACM/IN/663440.

²⁴⁷ This does not mean, however, that consumers automatically do so in practice. After all, they do not meet the outdated image of the rational consumer.

²⁴⁸ Notes of meeting [confidential: XXXXXXXX], August 3, 2021, ACM/UIT/579664.

the market has a less disciplining effect. Next to cost unpredictability, it is also important that, in practice, buyers are not always aware of all of the information that is relevant for them. For example, a study into the impact of lock-in on cloud migration has shown that, when purchasing services, customers are not familiar with the proprietary standards that make the interoperability and portability of applications more difficult.²⁴⁹

6.2 Leveraging positions within the cloud through bundling of cloud services

Vertical integration

Users greatly value that they are able to purchase many different services from a single cloud provider that also work well together. At the same time, however, that high degree of vertical integration enables certain cloud providers to leverage a strong position in part of the services and transfer it to other services. ACM sees in particular the possibility that a strong position in the market for particular software products or with certain SaaS services may be transferred to the underlying cloud layers (PaaS and IaaS), or that a strong position in the IaaS layer may be transferred by bundling IaaS services with (multiple) PaaS and SaaS services.

The strategy of the biggest integrated cloud providers to acquire a strong position in all the different cloud layers, possibly by leveraging strong positions in certain layers to other layers, is a logical consequence of a market in which there are substantial barriers to switching, which become higher as more services are purchased that are integrated with each other.

A single integrated cloud service versus multicloud

Various market participants have indicated that a cloud service is a combination of software and the underlying infrastructure. Therefore, they argue that this is a single service (meaning this cannot be considered tying)²⁵⁰. These operators offer a number of technical, operational, and efficiency-related arguments as to why certain services 'by definition' only work within their own cloud environment.

At the same time, there may be strategic considerations for discouraging multicloud. Standards play a key role in the interoperability of cloud services, and, as such, can be used to put the competition at a greater disadvantage. Larger cloud providers may keep software standards of their services closed, and have them deliberately deviate from open standards in order to limit the interoperability with services of other providers. As a result thereof, users cannot have different services of different providers work with each other, which hinders the use of multicloud. Services of which the standards are closed, are also called cloud-specific or native services (see chapter 2). Connecting services with cloud-specific services of another provider is not always possible (or even not at all)²⁵¹.

The use of multicloud is discouraged, especially by the three larger providers, as relatively high egress fees need to be paid when data between two services of different cloud providers need to be exchanged. The data leaves the cloud environment of one cloud provider in order to enter the cloud environment of another cloud provider. The tariffs for moving data *within* the same cloud environment are substantially lower with these providers, see table 2 in section 6.1.

²⁴⁹ Opara-Martins *et al.* *Journal of Cloud Computing: Advances, Systems and Applications* (2016) 5:4.

²⁵⁰ Responses to requests for information to providers [Confidential: XXXXXXXX XXXXXXXX XXXXXXXX]; Response to request for information [confidential: XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX] and response to request for information [confidential: XXXXXXXX XXXXXXXX XXXXXXXX].

²⁵¹ Notes of meeting VMWare, January 10, 2022, ACM/IN/699883.

Tying and bundling

If the software, the underlying services and the infrastructure were seen as separate services, it could be argued that there is technical tying. After all, the end-user is not able to run certain PaaS and SaaS services on its own infrastructure or the infrastructure of an alternative cloud provider, perhaps because this is technically impossible due to specific technical characteristics of the service, or has been made impossible by strategic and other choices of the cloud provider. This limits end-users' ability to use best-of-breed technologies – the best service for a specific need from different service providers.

Discussions with market participants also show that due to the tariff structure it is often more attractive to purchase multiple services from a single cloud provider, because discounts also depend on the number of different services purchased from the cloud provider, so there are not only technical advantages but also financial advantages in purchasing as many services as possible from a single cloud provider.

Leveraging position of software products or SaaS services

The first possibility for leveraging a strong position is through the positions that certain operators occupy with their software products or SaaS services. Software products are designed to run on "generic" hardware. End-users purchase licenses, and run these programs or applications on their own hardware. SaaS services, by contrast, are often designed and developed for a specific infrastructure, with the service being a combination of the software product and the underlying infrastructure of a specific cloud provider.

Whereas a lot of software used to be sold, in recent years a lot of "SaaSification" has taken place.²⁵² A well-known example of this is Microsoft 365 (formerly Office 365), which in contrast to the 'traditional' Office packages are sold as a subscription, and it is possible to work in the cloud (as a SaaS service). Both software products and SaaS services are often protected by intellectual property rights, so alternative cloud providers cannot automatically provide these products or services on their own infrastructure if they do not own the product or service themselves. If cloud providers do wish to offer third-party software or services on their own infrastructure, they can purchase licenses in certain cases. A familiar example of this is the Software Provider License Agreement (SPLA) from Microsoft. By purchasing these licenses, cloud providers or hosting operators can offer Microsoft services (such as Microsoft 365) to their customers.

If a cloud provider offers a software product (or SaaS service) that is seen by many users as essential, that represents a potential source of power for a cloud provider. Such products weigh heavily in users' choice of a cloud provider. If a software service that could be run on premise is now only offered as a cloud service, for example because the old service is no longer supported by the provider, users may be pushed towards a certain cloud provider. This eliminates choice.²⁵³

When competing cloud providers purchase licenses from the cloud provider with the essential product, they are both competitors and customers of this cloud provider. That gives the owner of the essential product the possibility of increasing the costs payable by the competition or users of competing cloud providers with high license costs or even completely ceasing to make the product available. A study on behalf of CISPE²⁵⁴ alleges that Microsoft and Oracle in particular use their position in other adjacent markets to exclude other cloud providers from the market, particularly by raising license costs and bundling services.²⁵⁵ ACM has not investigated the extent to which this claim is justified. In early 2022,

²⁵² [How "SaaSification" is Taking The Tech World By Storm \(forbes.com\)](#), last visited on July 13, 2022.

²⁵³ Notes of meeting CIO Platform Nederland, July 8, 2022, ACM/IN/699659.

²⁵⁴ CISPE is an industry association of cloud providers in Europe, including AWS.

²⁵⁵ [159979_acbf93e9b2164250a0ca93e753616650.pdf \(filesusr.com\)](#), last visited on July 13, 2022.

competitors of Microsoft submitted a complaint to the European Commission arguing that the conditions that Microsoft attaches to the use of its Office services in the cloud raises the cost for users choosing to run Office services on the infrastructure of a competitor of Azure. According to the complainants, Microsoft is thus abusing its dominant position.²⁵⁶

In May 2022, Microsoft responded stating that it acknowledged part of the complaints, and announced that it would make changes to address the problem.²⁵⁷

In addition, one market participant **[Confidential: XXXXXXXX]** that ACM has spoken to in this market study states that a cloud provider **[Confidential: XXXXXXXX]** (the licensor) goes to great lengths to conduct audits of cloud providers that purchase licenses (the licensee), in which an unnecessarily large amount of information has to be provided and end-users of the licensee are sometimes approached directly by the licensor with a competing offer.²⁵⁸

There are organizations and associations that are committed to a fairer playing field with regard to licenses. CISPE and Cigref, for example, have jointly drawn up ten principles of fair software licensing, which are endorsed by various organizations, with the aim of combating unfair licensing conditions of certain software legacy firms.²⁵⁹

Leveraging a position on the IaaS

Conversely, a strong position in the IaaS layer also provides the possibility of using the strong position to guide customers primarily to its own PaaS and SaaS services and to bundle these with IaaS services. A cloud provider in principle has an incentive to offer as many products and services as possible, both its own and third-party services. At the same time, a cloud provider has the possibility of giving preference to its own services, for example by integrating third-party services less well, or by displaying and recommending its own services more prominently. Integrated cloud providers have the option of developing an alternative service for efficient third-party services that use the cloud provider's infrastructure, possibly based on open source services, with which the cloud provider's offering can be expanded. Integrated cloud providers use the data (including metadata) about the use of services by third parties (for example the growth in demand for storage capacity or computing power), so they can see which services are successful. A well-known example is that of Elastic's Elasticsearch and AWS Elasticsearch Service, which caused confusion among users of these service(s) due to the similarities between them, as the AWS service was introduced later and was based on the Elastic service, but had not been developed in cooperation with Elastic, so there was no partnership whatsoever between the two parties.²⁶⁰ Relatively small developers can thus be at a disadvantage. In addition, efficient third-party services can in practice be acquired by a major cloud provider, which can then fully integrate the service in its own offering and thereby expand its portfolio.

6.3 Consequences of market dynamics

Lock-in and the possibility of leveraging strong positions weaken the competition in the market for cloud services. In connection with the aforementioned economies of scale, network effects and barriers to entry, it is likely that the consolidation under way will increase further. The increasing consolidation will

²⁵⁶ [Microsoft faces EU antitrust complaint about its cloud computing business | Reuters](#), last visited on July 13, 2022.

²⁵⁷ [Microsoft responds to European Cloud Provider feedback with new programs and principles - EU Policy Blog](#), last visited on July 13, 2022.

²⁵⁸ Notes of meeting **[Confidential: XXXXXXXX XXXXXXXX XXXXXXXX]**.

²⁵⁹ [CIGREF and CISPE Launch Ten Principles to End Unfair Practices of Software Gatekeepers - CISPE - The Voice of Cloud Infrastructure Service Providers in Europe](#), last visited on August 17, 2022.

²⁶⁰ Notes of meeting **[Confidential: XXXXXXXX]**, May 25, 2022, ACM/UIT/582251.

lead to greater dependence of users on just a few vertically integrated cloud providers. This applies to both the end-user and parties seeking to offer services able to connect to these cloud providers' infrastructure and platform. Particularly in a more saturated market, this leads to risks to innovation, quality, and prices. The developments in the market for cloud services are also relevant for the competitive dynamics in the internet ecosystem as a whole, in which the cloud will play an increasingly important role.

6.3.1 Consequences of lock-in

Lock-in has a major influence on the competition dynamics in the market for cloud services. From the user's perspective it gives rise to path dependence. Once a path is embarked on, it is difficult to turn round. That means the initial choices are very important. From the perspective of the cloud provider, the user's initial choice is an important competition moment. That is clearly visible in the strategy that cloud providers adopt to bring in users with low initial costs and access to a wide range of services. Due to a lack of switching possibilities, the competition after the initial competition moment is much more limited. That reduces the pressure from the possibility that a dissatisfied customer or a customer who simply sees a better offer elsewhere will switch. Such a competition model could theoretically work well if cloud service users were able to estimate their future needs and usage and could enter into proper agreements on them beforehand. Both elements appear difficult, however. CIOs of Dutch companies indicate that a cloud provider is chosen in advance, even though the future is difficult to predict. These CIOs also state that the major cloud providers can apply conditions and tariffs unilaterally and that, in practice, there is hardly any scope for negotiation. The ability of cloud providers to make unilateral changes is a clear indication of the unequal bargaining position, and, by extension, that business users are insufficiently able to protect themselves contractually against the consequences of lock-in.²⁶¹

The risks of lock-in are greatest when there is saturation in the market in which cloud users have usually already made their selections and the share of "new cloud users" is limited. However, given the current strong growth in the market, the actual or potential profitability of cloud services and the importance of the cloud within these companies (see chapter 4), it is likely that cloud providers (including integrated cloud providers) will for the moment continue to rely on new services and improvements to the quality of the services.

However, the presence of barriers to switching makes it very difficult for new entrants or relatively small cloud providers to compete with large, integrated cloud providers. After all, users rarely switch. The presence of these barriers to switching intensifies the battle for new customers up front, with economies of scale, network effects and familiarity also favoring a few large operators. These operators can afford to attract new customers with large amounts of free services and credits, so they often win the battle up front. Relatively small and unknown cloud providers are consequently often not even considered.

The question is also whether the current and future competitive pressure will be sufficient for competitive tariffs within cloud markets. ACM has not investigated this for this study. It is clear, however, that at least two major cloud providers are generating high profit margins, so profits from cloud services make up a very considerable share (30% to 40%) of the total profits of these big tech undertakings.

²⁶¹ S. Borenstein, J.K. MacKie-Mason & J.S. Netz (1995), "Antitrust Policy in Aftermarkets", *Antitrust Law Journal* (63), p. 482

6.3.2 Consequences of leveraging

Major cloud providers often bundle the services on the different layers by offering certain services free of charge or at a discount if multiple services are purchased. As a result, it appears difficult for smaller operators that are less vertically integrated and have a smaller service offering to compete with major operators. The integrated cloud providers can be a one-stop shop for many users, and the advantages of bundling are important. ACM therefore considers it unlikely that there will be space over the longer term for a large number of cloud providers with a comprehensive, integrated offering. The strong integration of services on the different layers, whose standards are often closed and for which no, incomplete or expensive licenses are issued to other cloud providers, means that large operators will most likely retain their strong position, and that the market – which is still growing very fast at the moment – will, if nothing changes, most likely remain concentrated in the future. After all, it is very difficult for other operators to enter the market and provide the same wide service offering as the biggest cloud providers.

At the same time, there may also be consequences for the services of third parties (ISVs) offered on the infrastructure of large cloud providers, possibly through a marketplace. Providers of such services need the cloud provider to sell their own products, but that same cloud provider may also be or become a competitor for their own services, for example on the PaaS layer. This mechanism may ultimately undermine innovation in such services because it is less attractive to develop services that have to compete with the cloud provider's own services.

In addition, the integrated cloud providers can derive benefits from taking over promising services that are or could be offered on the cloud provider's infrastructure. With these new services the cloud provider immediately has a large reach due to the existing customer base. It is unclear, however, what these acquisitions will mean in the longer term for the cloud services market. Recent research has shown that acquisitions improve innovation in the short term, whereas they may have a negative impact in the longer term.²⁶²

6.3.3 Consequences for competition in other markets

The developments in the market for cloud services have consequences not only for the market itself, but also for the relationships throughout the internet ecosystem.

The cloud is unavoidable

The large cloud providers can become very important and almost unavoidable operators when it comes to reaching customers for certain businesses or software companies, as the use of advanced cloud services can confer a competitive advantage over competitors that do not use the cloud. More and more companies are also opting for a cloud-first strategy, in which cloud services are important input for a company and on-premises solutions are barely considered any longer. The cloud infrastructure (IaaS and PaaS) should therefore also be seen as a platform or ecosystem.²⁶³ According to predictions by analysts at Gartner, 95% of all new digital initiatives will use cloud-native platforms as the basis for their initiatives by 2025.²⁶⁴

Competitor and customer

²⁶² Denicolo, Polo (2021) Acquisitions, Innovation and the Entrenchment of Monopoly

²⁶³ Van Dijck (2021) Seeing the forest for the trees: Visualizing platformization and its governance

²⁶⁴ [Gartner Identifies the Top Strategic Technology Trends for 2022](#), last visited on July 13, 2022.

As explained in section 5.3, the cloud services of Amazon, Microsoft and Google are also part of conglomerates. A strong position within the cloud market gives cloud providers possibilities to use it in other markets in which they operate. That is because these services logically also often use their own infrastructure. Amazon, for example, has developed cameras that track every movement of customers in a supermarket, so they can leave the store without paying. Like many other Amazon services, this service uses AWS.²⁶⁵

It is notable that competitors in other markets often also use these cloud providers' infrastructure. Amazon has its own streaming service, for example, Amazon Prime Video, but also Netflix, too, uses the infrastructure of AWS for almost all computing power and storage services, databases, analytics, and recommendation tools, among other things.²⁶⁶ Spotify uses the services of GCP²⁶⁷, while Google also has its own music streaming service, YouTube Music. The competitor-and-user relationship may give the conglomerates a competitive advantage due to lower costs.

Data flows

The presence in several markets can also strengthen the position of these operators because it may lead to valuable data flows between different services. Cloud providers have user data, often metadata, from many different services and can use it to strengthen a position in other markets. In this way, competitors in many different sectors may be at a disadvantage. For example, the large amounts of data that these conglomerates hold can be valuable in making decisions and investment choices in other markets. Research shows that AWS can assess the potential success of start-ups early by looking at usage growth, giving it an edge over other operators²⁶⁸.

Expansion of portfolios through acquisitions and innovations in different sectors

In addition to the acquisitions and innovations in the cloud services market itself, new markets are also opened up by means of acquisitions and innovations, or positions in certain markets are strengthened by the cloud providers. The focus is on certain industries and sectors that are often data-intensive and can make optimal use of the company's cloud infrastructure, such as the financial sector, healthcare, the telecom sector (5G), the energy sector, and gaming and media. The acquisitions enable these services to be offered on the basis of vertical integration with the underlying infrastructure. For example, Microsoft acquired Nuance Communications for 19.7 billion dollars, with which it will provide a vertical cloud solution for medical service providers.²⁶⁹ Amazon also focuses on the health sector and in 2019 acquired Health Navigator, with which it sought to give a boost to Amazon Care. Microsoft also recently acquired Activision Blizzard, a developer and publisher of games, for 68.7 billion dollars. The CEO of Microsoft Gaming indicated that this acquisition would also accelerate the plans for (Xbox) Cloud Gaming²⁷⁰. In addition to acquisitions, the cloud providers themselves are developing more and more services for different sectors. For example, various cloud providers are also increasingly offering virtualized mobile telecom networks (5G). AWS, for example, offers Private 5G, which enables companies to connect machines and devices to a private network with hardware owned and managed by AWS.²⁷¹ These developments could also enable these companies to gain a growing position in markets that often use cloud infrastructures, and possibly lead to market concentrations in different sectors.

²⁶⁵ [In de Amazon-winkels registreren camera's elke beweging van de klant \(in Dutch\) \(fd.nl\)](#), last visited on July 13, 2022.

²⁶⁶ [Netflix on AWS: Case Studies, Videos, Innovator Stories \(amazon.com\)](#), last visited on July 13, 2022.

²⁶⁷ [Spotify Case Study | Google Cloud](#), last visited on July 13, 2022.

²⁶⁸ Khan (2017) Amazon's antitrust paradox, Yale Law Journal. An investigation of competition in digital markets, Committee on the Judiciary, U.S. House of representatives, 2020, p. 323.

²⁶⁹ [Microsoft accelerates industry cloud strategy for healthcare with the acquisition of Nuance - Stories](#), last visited on July 13, 2022.

²⁷⁰ [Welcoming the Incredible Teams and Legendary Franchises of Activision Blizzard to Microsoft Gaming - Xbox Wire](#), last visited on July 13, 2022.

²⁷¹ [Private 5G Mobile Networks – AWS Private 5G – Amazon Web Services](#), last visited on July 13, 2022.

7 Instruments

This chapter describes in what ways current and future legislation can help mitigate the identified problems and help promote competition in the market for cloud services. Section 7.1 contains an analysis of the current Dutch Competition Act, section 7.2 contains an analysis of the Digital Markets Act, and section 7.3 contains an analysis of the Data Act. In addition, this chapter also explains what cloud users themselves can do to limit risks. This is explained in section 7.4.

7.1 Dutch Competition Act

Merger control is aimed at preventing market power and hence the possibility of abuse. In view of the cross-border nature of the market for cloud services, it may be expected that mergers in cloud-related markets will reach the EC before the competition regulators of the national Member States. Because positions in cloud markets can be easily transferred to other services and layers, it is important to devote attention to vertical damage theories in cloud-related merger assessments. A key point here is that the acquisitions of undertakings with a small turnover – but possibly with a lot of potential in the market – are not subject to merger oversight. The DMA – which is discussed below – nevertheless requires gatekeepers to inform the EC about these mergers.

Whereas merger control is aimed at preventing market power due to takeovers and mergers, oversight of anticompetitive agreements (Article 101, TFEU²⁷²) and of abuse of a Dominant Position (Article 102) is *ex post*. If a violation is established, a fine or an order subject to periodic penalty payments can be imposed to force a change of behavior. ACM sees various practices in cloud markets that – if they had a dominant position – could constitute abuse of a dominant position or anticompetitive agreements. Examples are discount structures that make a partial switch to a competitor unattractive, denigration strategies in which users' attention is – unjustly – drawn, for example, to the security risks of combining services from different users, and the egress fees used in the market. Other strategies to reinforce lock-in, too, could be addressed through the Dutch Competition Act if it can be demonstrated convincingly that an undertaking is designing barriers to switching as a strategy. The ex-post instruments can contribute to competitive cloud markets in individual cases, but the possibilities for addressing the problems outlined in this report on a structural and market-wide basis are limited. Unlike the United Kingdom, for example, the Dutch Competition Act does not offer the power to impose remedies on the basis of identified market problems. The restrictions of the Dutch Competition Act and other existing instruments to address market problems in digital markets in general were important in the drafting of the Digital Markets Act.²⁷³

7.2 Data Act

The European Commission issued a proposal for the Data Act on February 23, 2022. With this regulation, the European Commission intends to promote the use of data²⁷⁴ and ensure that the value from data is shared evenly among the operators participating in the data economy. The proposal also

²⁷²Treaty on the Functioning of the European Union

²⁷³ See notes to Digital Markets Act p. 3, available at <https://eur-lex.europa.eu/legal-content/NL/TXT/PDF/?uri=CELEX:52020PC0842&from=nl>

²⁷⁴ This mainly concerns industrial data such as data generated by the use of IoT devices, and not personal data. The GDPR remains fully in force.

aims to contribute to the innovativeness and competitiveness of European companies. In addition to measures on access to data, for example, the proposal for the Data Act includes measures to allow customers to switch smoothly between different providers of cloud services and to provide guarantees against unlawful data transfers.²⁷⁵ The proposal for the Data Act contains various obligations on providers of data processing services, including providers of cloud services, to further promote competition in the sector.

First of all, a number of obligations have been included to promote switching. To this end, all providers of data processing services must ensure that users can switch to a comparable service from another provider and can transfer their data and applications to the other provider's IT environment. Contractual, technical, organizational, or commercial barriers that impede this must be eliminated.²⁷⁶ The rights of users and obligations of providers with regard to switching must be contractually recorded in accordance with the proposed Data Act, and the proposal also specifies requirements for these contracts. It is important here that the providers of data processing services ensure that users continue to have full continuity of services.²⁷⁷ In addition, according to the proposal, providers of data processing services must charge no more than the direct costs of switching. From three years after the entry into force of the Data Act, switching between providers must be free of charge for users.²⁷⁸ The proposal also sets requirements for the technical aspects of switching between data processing services. Providers must guarantee equivalent functionality after switching by using, dependent on the type of services, i. open specifications or ii. European interoperability standards or, if there are no European standards, a structured and complete submission of data in an accessible format.²⁷⁹ In this way, cloud-service users must be able to switch while keeping intact the functional quality.

There are also obligations intended to promote interoperability between different data services when switching. The proposal states that standards must be set to achieve interoperability and specifies the requirements these standards must meet. The European Commission can ask a standardization body to set the standards for certain services and can oblige providers of data processing services to use these by means of delegated acts in order to ensure interoperability in the case of a switch.²⁸⁰

The obligations under the Data Act apply to all cloud providers. ACM takes a positive view of the impact that the Data Act may have on a number of the switching problems outlined in Section 6. ACM is positive about the way in which the proposal for the Data Act specifies the obstacles that must be eliminated during a switch, such as a number of commercial, technical, contractual, and organizational obstacles. This also includes the phasing out of egress fees. It is also positive about the fact that the Data Act focuses on the transition period involved in a switch and states what arrangements a cloud provider must make during this transition period.

ACM nevertheless considers that the Data Act could still be improved in terms of solving interoperability problems. The Data Act does include provisions on the use of open standards for switching²⁸¹, but not for interoperability *per se*. ACM considers that the Data Act should also provide for this, for example by obliging cloud providers to make APIs public, so that other cloud providers can connect their services to

²⁷⁵ [Data Act: Commission proposes measures for a fair and innovative data economy \(europa.eu\) – most recent visit on August 8, 2022.](#)

²⁷⁶ Proposed Data Act, Section 23 – available at [EUR-Lex - 52022PC0068 - EN - EUR-Lex \(europa.eu\)](#).

²⁷⁷ Proposed Data Act, Section 24.

²⁷⁸ Proposed Data Act, Section 25.

²⁷⁹ Proposed Data Act, Section 26.

²⁸⁰ Proposed Data Act, Section 29.

²⁸¹ Section 29 in conjunction with Section 26(3).

them, thereby breaking open silos. In addition, ACM would like to see that the egress fees are lowered to cost-oriented tariffs so that these tariffs, too, do not form any barrier to data transfer between various cloud providers. In that situation, users are free to take out different services from different cloud providers, and to link these to each other. In that way, innovative specialist data processing services are given room, too. ACM has made several textual proposals in which it argues for changes to the Data Act. These can be found at www.acm.nl/en/publications/market-study-cloud-services.

Moreover, the proposed Data Act does not yet provide much substance with regard to oversight. The proposal states that Member States can do this themselves. There is no explicit role for the European Commission. ACM believes that effective oversight is essential for proper implementation of the Data Act. Effective oversight requires supervisory authorities from different Member States to be able to work together in a coordinated manner, particularly when it comes to an international market such as the market for cloud services, in which players are active in several Member States.

The Data Act is not yet final. A proposal by the European Commission is currently²⁸² being discussed in the European Council and the European Parliament. Once each of these actors have formed an opinion, the three of them (European Commission, European Council, and European Parliament) must reach an agreement in a so-called trilog. It is possible that an agreement will be reached between the various parties in 2022, or possibly 2023. Decisions will then be taken on the date of entry into force.

7.3 Digital Markets Act

In March 2022, the European Commission, the European Council and the European Parliament reached an agreement on a new regulation to help create a level (or more level) playing field in digital markets: the Digital Markets Act (DMA). The DMA introduces measures for very large online platforms with a so-called gatekeeper position. These are platforms which are largely unavoidable for both business users and end-users. The DMA imposes rules on providers of key platform services if they operate as gatekeepers. The EC has defined the number of key platform services to which these rules will apply. These are services and markets in which identified problems are clearest and most striking and in which the presence of a limited number of large online platforms operating as gatekeepers for business users and end-users has led, or probably will lead, to weak contestability of these services and the markets in which they operate.²⁸³ Cloud services are one of these key platform services.

In order to determine what providers are designated as gatekeepers and in connection with what core platform services the providers need to meet those obligations, the EC has set a number of criteria. The expectation is that at least the large cloud providers Amazon, Microsoft and Google (or their parent companies) will be designated as gatekeepers. It remains to be seen whether this will also apply to other cloud providers.

There are a number of obligations in the DMA that are important for the market problems identified in Section 6. These obligations are only imposed on gatekeepers. First of all, Article 14 of the DMA states that providers of key platform services must inform the EC of all intended concentrations, regardless of whether such concentrations are notifiable under competition rules. The EC then passes on this notification information to national competition authorities, which can then request the EC (under Article

²⁸² August 2022.

²⁸³ See notes to Digital Markets Act, available at <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020PC0842&from=nl>

22 EUMR) to assess the merger. This can include an investigation of any actual or anticipated competition problems.

There are also a number of prohibitions and obligations that are relevant to the identified problems²⁸⁴, for example:

- Article 6(6) states that a gatekeeper must not use any technical or other means to restrict the ability of end-users to switch.
- Article 6(9) states that gatekeepers must meet the wishes of end-users to achieve effective data portability at their request and at no charge. This concerns the end-user's data.

These obligations could have a positive impact on end-users' ability to switch. In that context, implementation is crucial for success. For example, it is currently not exactly clear what is and what is not allowed, for example, with regard to technical restrictions or egress fees. The stated obligations are all in Article 6. The obligations in this article could be specified in more detail. This could be done by means of implementing acts, but also by a further specification by the EC, either of its own accord or at the request of the gatekeeper.²⁸⁵

The European Commission enforces this legislation. National regulators, such as ACM, can assist the EC in that process. Both the EC and national regulators such as ACM can investigate non-compliance with the DMA. This can be done, for example, by means of an investigation on its own initiative or in response to a complaint from operators in the market. For example, if a CIO, ISV, or cloud provider suspects non-compliance with the DMA, they can report this to ACM. ACM can then investigate the practice and issue an opinion on it to the EC. The EC is ultimately authorized to take decisions on this and to enforce compliance.

The DMA is expected to come into force in early 2023. Gatekeepers then have six months to comply with the obligations under the DMA.

7.4 What can cloud users do themselves?

In addition to the existing and forthcoming regulations described above, to a certain extent cloud service users themselves can also make choices to prevent lock-in. It is not realistic to prevent lock-in in all cases, but it is important when choosing cloud services to carefully consider the long-term consequences for individual freedom of choice. The British government drew up guidance for companies operating in the cloud in 2019.²⁸⁶ The essence of its advice is that companies must strike a balance between the opportunities and risks of the cloud. The chart below from the Central Digital and Data Office (CDDO) clearly shows this balance.

²⁸⁴ The final version of the DMA is currently being prepared in Brussels. The most recent text is available via <https://www.consilium.europa.eu/media/56086/st08722-xx22.pdf>. There is a political agreement on this text, although it is still indicative. A number of further (possibly minor) adjustments may be made to it.

²⁸⁵ DMA, Article 8(2) and (3).

²⁸⁶ [Managing technical lock-in in the cloud - GOV.UK \(www.gov.uk\) – most recent visit on August 8, 2022.](https://www.gov.uk/government/publications/managing-technical-lock-in-in-the-cloud)

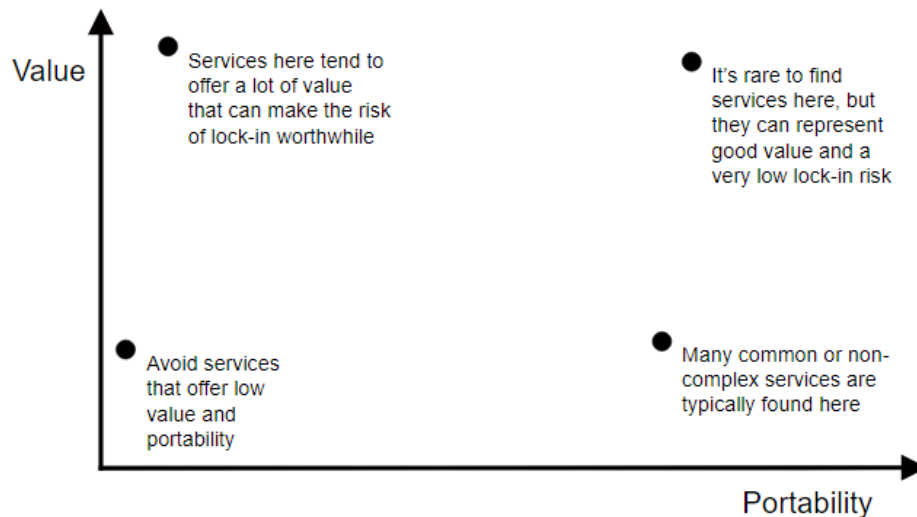


Figure 14: Assessment of value and portability of services (source: CDDO)

For SaaS services, it is recommended to use services based on open standards and formats as much as possible. For SaaS and IaaS services, it is recommended to use open source services where possible. It is only worthwhile to compromise on portability in the case of services that deliver clear added value. Finally, the CDDO points to the importance of broad skills and knowledge of different cloud solutions within a company. After all, switching to other cloud solutions is only possible if the teams within the company can also use multiple cloud solutions.

ACM agrees with the CDDO's advice. Because of the path dependence, it is important to consider early in the cloud journey which choices a company or organization wishes to make: which services offer choices that do not increase the dependence on a particular cloud provider? Companies can include this in their cloud strategy (see also section 3.2.2.)

8 Conclusions & recommendations

In this chapter, ACM analyzes all of the abovementioned findings in connection with each other, and draws conclusions with regard to the ways in which consolidation and the identified market risks affect market dynamics (section 8.1). ACM subsequently offers recommendations (section 8.2) for improving competition in the cloud market.

8.1 Analysis of the cloud market

Consolidation

The cloud services market²⁸⁷ has grown strongly in recent years and will continue to do so in the years ahead. Worldwide and also in the EU, revenues from cloud services are currently growing by 30% to 40% per year. This growth is due both to new users and to users that are increasingly migrating to the cloud. Particularly in the case of users of integrated cloud services on multiple layers, ACM notes that the first moment of choice is crucial. Once a user has chosen a specific cloud service provider, the barrier to switch to another cloud provider is very high in many cases. The discussions that ACM conducted for this study show that little switching takes place between cloud services of different cloud providers. Users of PaaS and SaaS services in particular may experience difficulties when switching. For users of IaaS services, that applies to a slightly lesser extent.

Entry into the cloud services market is therefore mainly possible by competing for new customers. ACM acknowledges that the competitive situation is not the same on every layer of the cloud market. There are providers that focus on a single specific layer. On the SaaS layer, for example, there are many different providers that also differ in terms of size. On the IaaS layer, where entry requires considerably larger investments, a smaller number of providers are active that focus on a specific part of the market, such as storage of back-ups and storage in the Netherlands.

At the same time, there is a clearly visible trend of consolidation among providers of integrated cloud services. Important features of the cloud market are the economies of scale already mentioned, the path dependence (the great importance of initial choices made by cloud users) and interconnectedness with many other services (services often have to communicate with each other for optimal operation). Economies of scale and economies of scope play a major role in the consolidation. In the current cloud market there is heavy investment in continuous improvement and expansion of the products and service offering. The three major cloud providers seem to be focusing on building their own ecosystem, where they can be a one-stop shop for the bulk of users. Other cloud providers seem unable to keep pace with the big three cloud providers. Developing the product and service offering generally entails high costs and marginal costs are very limited. Larger operators can logically recoup these investments from multiple clients. The same applies to the necessary investments, for example in cybersecurity. Finally, the major cloud providers also have the advantage that due to the large numbers the use of the infrastructure is more predictable and the variance is smaller.

²⁸⁷ This market study is not intended to be a competition investigation within the meaning of the Dutch Competition Act. In this market study, ACM does not define any relevant market for competition law purposes and does not examine whether any operator has a dominant position. Therefore, where this market study refers to "the market", that does not mean a market within the meaning of the Dutch Competition Act.

Risks in the cloud market

ACM sees two major risks in the cloud market. First, there is user lock-in, often reinforced by the practices used by cloud providers. The second risk lies in leveraging strong positions within different layers of the cloud.

The major risk of lock-in is that it reduces the incentives to provide high-quality services at competitive prices. After all, there is then a limited risk of losing users. The current growth in the market and the importance of winning new users still greatly reduces that risk at present. In this phase in particular, integrated cloud providers are strongly committed to further improvement and expansion of the product and service offering. This could change in the future when the cloud market becomes saturated. A negative effect of lock-in that can already be seen is the fact that users are unable to switch if the costs of using the cloud usually turn out to be higher than users estimate in advance, which is often the case.

The customer lock-in applies particularly when PaaS and SaaS services are purchased as part of an integrated service offer. Switching is complex with ICT products and services, which in practice are often closely interconnected with the processes within the organization. This is all the truer for integrated cloud services because in many cases new connections have to be made and it is necessary to switch to multiple services at the same time. Switching is further complicated by a lack of interoperability and the costs associated with migrating data from the cloud (egress fees).

Switching from non-integrated services, for example when a cloud user only purchases IaaS services, is easier, although, in that situation too, it requires quite a lot of work, time, and therefore money to convert the data so that it is suitable for use with another cloud provider. In addition, these users also have to pay egress fees to remove the data from the cloud. Although ACM has not investigated the reasonableness of these costs, some cloud providers' egress fees add to the lock-in of users.

In addition to lock-in, transfers of strong positions also reduce competition in the cloud services market. Leveraging strong positions within the various layers of the cloud operates in various directions. There are indications that cloud providers with popular proprietary software products or SaaS services put competitors at a disadvantage. They can do so, for example, by making little or no important software available to customers in another cloud or doing so only on the basis of higher costs or license fees. Leveraging a strong position also operates in the other direction. With strong positions in infrastructure, the large cloud providers steer users to own their own services.

8.2 Improving competition in the cloud market

Fair competition at service level

In the desired situation, users have the freedom to use the best-quality or most competitively priced services from different cloud providers. That does not happen sufficiently at present. The parallel use of services from different cloud providers still leads to many problems due to limited interoperability. This could be for technical or strategic reasons, but the fact is that the large cloud providers have an incentive to keep customers within their own ecosystem and therefore do not have an incentive to promote interoperability. In addition, third-party services can still too easily be placed at a disadvantage by the large cloud providers, for example by limiting functionality. This similarly does not benefit competition.

Switching and combining services

ACM expects that transfers of all of a user's cloud services to a different cloud provider will often continue to be a long and complex process in the future. The interconnectedness of the various ICT services is an important reason for this. Nevertheless, it is very important to lower these barriers as much as possible. Oversight based on the DMA and later also the Data Act will contribute to this. Users of cloud services can also contribute themselves by explicitly including flexibility in their cloud strategies. Given the complexity of a full switch, it is all the more important that users have the freedom to choose and combine the best or cheapest service from the different cloud providers and third parties. In that case, a cloud user could also opt for a gradual migration, even if links are needed between the different services.

Interoperability and data portability

Interoperability and data portability are very important for i. increased switching options, ii. freedom of choice for users and iii. fair competition in services that can be offered by both large cloud providers and third parties. The DMA, the proposed Data Act and the Dutch Competition Act have a role to play in all three. The DMA emphasizes the requirement that cloud providers with a gatekeeper function cannot restrict switching by end-users. The DMA additionally imposes restrictions on the use of data generated by the platform aimed at putting the competition at a disadvantage.²⁸⁸ What the DMA will mean for cloud markets in practice will largely be determined by the implementing acts and the regulatory dialogue with the European Commission.

The proposed Data Act is an important instrument to enable cloud providers to actively contribute to data portability and further improve interoperability in cloud markets. It is also important that the Data Act addresses both the technical (such as the publication of the used APIs) and financial switching barriers (the switch must ultimately be free of charge for the user, whereas high egress fees are still paid at present). ACM does still see room for one major improvement to the Data Act, namely the explicit imposition of interoperability obligations that facilitate the linking of services from different cloud providers.

The Dutch Competition Act is relevant for specific practices, such as the use of anti-competitive pricing structures and not making crucial technology and services available or only doing so on unfavorable terms.

Recommendation 1: ACM therefore recommends that the European Council and the European Parliament embrace the cloud-related proposals in the Data Act (Section 6 and Section 8) and include additional obligations that improve interoperability, for example by obliging cloud providers to make public the standards they use.

Recommendation 2: A well-conceived cloud strategy is important for users of cloud services now and in the future. Initial choices in particular can have major consequences. ACM recommends that users of cloud services consciously weigh up the added value of a specific cloud service and the degree of lock-in, and only accept lock-in if using the service has major advantages over alternatives.

²⁸⁸ DMA Article 5(2).

Regulators, including ACM, will have to actively investigate and address bottlenecks in the cloud market. ACM will conduct a further study into switching barriers (financial or otherwise), which are predominantly caused by egress fees. In that context, ACM will also take into account the context of high technical switching barriers. ACM will assess the extent to which these switching barriers actually cause real-world problems, and what the effects thereof are. In addition, ACM sees the proposed Data Act as an opportunity to promote interoperability between the various cloud services, and offers European legislatures concrete suggestions for improving this law in that area. This proposal can be found at www.acm.nl/en/publications/market-study-cloud-services.

Strong positions in the cloud services market also have consequences for competition in markets other than the cloud market. The large cloud providers also enter other markets such as healthcare and integrate their services with their own cloud infrastructure. In addition, these parties can use a large amount of data (including metadata). The DMA and the Data Act and the application of domestic and European competition law can help limit potential harmful effects of this. Alertness and further investigation by regulators, including ACM, into the effects thereof on other markets based on a strong position in and around the cloud is very important.

In this study, ACM has focused on market developments in the cloud. A range of different perspectives were nevertheless covered in the discussions conducted during the study, including security, privacy, and geopolitics. ACM has not further investigated these public interests, and nor has it formed a more detailed picture of how they should be weighed up and where they are already being addressed. ACM will engage in discussions with fellow regulators to put this topic on the agenda.

Annex 1: Interlocutors

Independent experts

- *Hans Wanders, formerly CIO, Government of the Netherlands*
- *Peter Vermeulen, ICT market analyst*
- *TNO*
- *Marlon Domingus*

Government of the Netherlands

- *Dutch Data Protection Authority*
- *Radiocommunications Agency Netherlands*
- *Ministry of Economic Affairs and Climate Policy*
- *National Cyber Security Centre*
- *De Nederlandsche Bank*

Industry associations and public private partnerships

- *Trusted Cloud*
- *Online Trust Coalition*
- *Michiel Steltman*
- *Dutch Cloud Community*
- *CISPE*
- **[Confidential: XXXXXXXX]**

Cloud providers

- *Scaleway*
- **[Confidential: XXXXXXXX]**
- *ODC-Noord*
- *Leaseweb*
- *VMware*
- *OVHcloud*
- *Google*
- *Amazon Web Services (AWS)*
- *Microsoft Azure*
- *Oracle*
- *IBM*

Users

- *CIO-Platform Nederland*
- *DataHub ACM*
- **[Confidential: XXXXXXXX]**
- **[Confidential: XXXXXXXX]**
- **[Confidential: XXXXXXXX]**

Overig

- *Staff of the Subcommittee on Antitrust, Commercial, and Administrative Law, Committee on the Judiciary, U.S. House of Representatives*

Annex 2: List of definitions

Term	Explanation
API	Application Programming Interface, way to interact with a piece of software
CaaS	Layer where applications or parts of applications run separately in a container but sections of the operating system and storage are shared
Certification	Demonstrating that a certain standard is met
Closed source	All software that is not covered by an open source license
Closed standards	Standards that are not publicly available
Cloud	the collective term for the set of services including computing services
Cloud computing	Calculations carried out on servers using cloudservices
Cloud services	The services offered on the cloud
Egress fees	Rates for extracting data from the Cloud
FaaS	Layer where applications are developed with modular microservices
Forking	Split off a group of developers who continue to develop the software themselves from the main community
Hybrid cloud	A form of cloud that integrates on-premises infrastructure, private cloud, and public cloud with each other
IaaS	The fundamental layer of the cloud on which all other cloud services are built. The infrastructure, comprising hardware such as servers and network equipment, is provided virtually. On this layer, infrastructure services are offered such as storage and virtualization.
Ingress fees	Rates for adding data in the Cloud
ISV	Independent Software Vendor
Kubernetes	Scalable and automatized container platform
Multicloud	Using cloud services of different providers
Native Cloud services	Cloud services that can only run in their own Cloud environment
On premise	Own hardware on location
Open source	Software with a public source offered under an open source license
Open standards	Standards that are publicly accessible and maintained through a collaborative and consensus-driven process
PaaS	Platform as a Service, a platform where building blocks are offered with which developers and programmers can build an application. These development support programs mean less time is required to write code because it is possible to use application components with ready-to-use code from the platform.

Pay-as-you-go	Model where the user pays per unit used
Private cloud	Renting of a server on an external location
Public cloud	A model for enabling on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction
Racks	Racks to house servers
Reserved-instance pricing scheme	Variant of the pay-as-you-go model with volume requirements
Reverse engineering	Reproduction of a product after detailed examination of its construction or composition
SaaS	Software that is offered as a service via the internet. SaaS is the application layer of the cloud. SaaS consists of complete software that users can use after installation. SaaS services come in all shapes and sizes, such as e-mail services, accounting software, video streaming services, or services that can operate IoT devices such as lighting and heating. SaaS services are thus used by both consumers and business users. A major category within SaaS is productivity software. These are services that are widely used in an office environment, such as the familiar Office products from Microsoft. The SaaS market is a very diverse market with many different providers.
Standard	Standards are set in a document consisting of requirements, specifications, guidelines, or characteristics that can be used consistently so that materials, products, processes, and services are fit for purpose
Unicorn	New businesses that have a market capitalization in excess of 1 billion USD before IPO