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Cloud Computing & Servitization:

A Case Study and Future Trends

MASTER FINAL THESIS

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Abstract

Cloud computing (CC) is likely to prove commercial sustainability for many firms due to its flexibility and pay-as-you-go cost structure, particularly in the current situation of economic difficulties. This master thesis analyses the nature of CC and depicts how this technology allows firms to move data and applications to the Internet and access them through the services. The use of digital technologies is continuously increasing, which is an essential factor influencing the phenomenon of digital servitization. This master thesis also analyses how the cloud offers companies attractive opportunities to purchase and manage technologies. CC allows firms to become more efficient and productive, and it applies to different firms belonging to different industries in different geographic areas. The master thesis aims to analyze the influence of CC technologies on firms that decide to adopt them. The methodology adopted consists of a literature review, followed by market research, and ends with a case study that shows an example of the adoption of cloud technology. The result highlighted that CC is a technology that drives to meet clients' needs and improve their competitive positions; it also allows firms to outsource IT departments. However, CC also has some challenges represented by factors that raise barriers to the adoption of the technology and push IT managers to change their approach to managing access, control, and risk. CC also plays a vital role in contributing to Sustainable Development Goals.

Resumen

Es probable que la computación en nube (CC) demuestre la sostenibilidad comercial de muchas empresas debido a su flexibilidad y estructura de costos de pago por uso, particularmente en la situación actual de dificultades económicas. Esta tesis de maestría analiza la naturaleza de CC y describe cómo esta tecnología permite a las empresas mover datos y aplicaciones a Internet y acceder a ellos a través de los servicios. El uso de las tecnologías digitales está en constante aumento, lo que es un factor esencial que influye en el fenómeno de la servitización digital. Esta tesis también analiza cómo la nube ofrece a las empresas atractivas oportunidades para comprar y gestionar tecnologías. CC permite a las empresas ser más eficientes y productivas, y se aplica a diferentes empresas pertenecientes a diferentes industrias en diferentes áreas geográficas. La tesis de maestría tiene como objetivo analizar la influencia de las tecnologías de CC en las empresas que deciden adoptarlas. La metodología adoptada consiste en una revisión de la literatura, seguida de una investigación de mercado, y termina con un estudio de caso que muestra un ejemplo de la adopción de la tecnología de nube. El resultado destacó que CC es una tecnología que impulsa a satisfacer las necesidades de los clientes y mejorar sus posiciones competitivas; también permite a las empresas externalizar los departamentos de TI. Sin embargo, CC también tiene algunos desafíos representados por factores que levantan barreras a la adopción de la tecnología y empujan a los gerentes de TI a cambiar su enfoque para gestionar el acceso, el control y el riesgo. El CC también desempeña un papel vital en la contribución a los Objetivos de Desarrollo Sostenible.

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List of abbreviations / Glossary

BPR	Business Process Reengineering
CC	Cloud Computing
EC2	Elastic Compute Cloud
IAM	Identity and Access Management
IS	Information Systems
IaaS	Infrastructure as a Service
IoT	Internet of Things
PaaS	Platform as a Service
SLAs	Service Level Agreement
S3	Simple Storage Service
SME	Small and medium-sized
SaaS	Software as a Service
TAM	Technology Acceptance Model
TOE	Technology-Organization–Environment
TCT	Transaction Cost Theory
TMT	Media and Telecommunication
VMS	Video Management Software
VMS	Video Management Software
VPN	Virtual Private Network
VPC	Virtual Private Cloud

1. Introduction

Nowadays, companies are changing the focus of their business strategy from providing only products and services to designing value-added solutions. This transformation is referred to as servitization, providing the basis for gaining a competitive advantage. Company growth will enhance due to the transition to a service-oriented business strategy. Furthermore, companies are facing a growing urge to digitalize and connect with other stakeholders and markets due to the rise of data, accessibility, and digital coherence. These two concepts together create digital servitization, which involves “offering solutions through the use of digital technologies” (Elmacioglu, 2021).

Firms realize that engaging in servitization practice is becoming a crucial part of their business because it impacts the firm's profitability and sustainability. Product companies have shown accelerating interest in the shift towards serviced business models and practices, particularly when it comes to CC services (Elmacioglu, 2021). So, the dynamism of all business processes and a massive amount of information of different natures are the main characteristics of today's business environment. They require the use of information technologies as an integral and essential part of the management strategy of companies. One modern and alternative approach to business management is using services based on CC. The movement of the business to the cloud empowers companies to achieve significant economic benefits without investments in building their own IT infrastructure (G. Kiryakova, 2015). Cloud technologies are trendy and based on well-known technologies that upgrade and integrate them in a new way that improves the efficiency of their use. Cloud technologies are seen more as a new business model than a new technology. They offer attractive opportunities for the acquisition and management of computing resources and software platforms and capabilities for the prompt addition of new features according to changing needs (G. Kiryakova, 2015). Those technologies allow companies to carry out their main functions in a new environment that provides a reasonable basis for starting or expanding a business without significant investments. In this new scenario, there are opportunities for optimizing business processes and reducing the time to adapt and adjust to changing market conditions. Cloud technologies support the rapid growth of the business by ensuring access to virtually unlimited resources when needed. Based on cloud technologies, companies can create a flexible strategy for

development with maximal usage of resources, minimal efforts for their maintenance, and effective implementation of business activities (G. Kiryakova, 2015).

The phenomenon of CC is an enabler of servitization in different industries, including healthcare, manufacturing, and software. For instance, in the manufacturing industry, CC technologies rapidly evolve to play an important role in big data analytics for industry development, security systems, and smart homes. Notably, in manufacturing companies the management and deployment of software services can be facilitated by the introduction of CC because this type of technology serves as a scalable, cost-effective, and very flexible solution to complex information chains (Elmacioglu, 2021).

Furthermore, the integration of Cloud technologies into organizational services processes promise an extension of the value that services deliver to customers and owners of the firms (Elmacioglu, 2021).

1.1 Object

This thesis aims to analyze the influence of CC technologies on firms that decide to adopt them, evaluating a case study and proposing solutions for other SMEs.

1.2 Scope

This master thesis will focus on the adoption of CC toward business; while collecting information, the documents and journals taken into consideration come from academic sources. In addition, small and medium enterprises will be considered to identify if cloud technologies enhance their business activities correctly.

In this master thesis, the role of CC in digital servitization will be analyzed, showing how this new technology allows companies to perform their primary functions in a new environment that provides a reasonable basis for starting or expanding a business without a significant investment. The study will also present which type of cost the firms face when they adopt cloud technologies, aiming to emphasize that they are not paying only for the usage of the service on the cloud but also all the different costs associated with its adoption. This research approaches the world of CC and aims to define future trends on how this technology will help companies create a flexible strategy for development with maximal usage of resources and minimal efforts for the maintenance and effective implementation of business activities. Finally, a case study will be presented to show the actual implementation of this strategy in firms facing this transition. A firm in the Video Management Software sector is analyzed. An analysis of a specific solution is performed to depict the firm's main challenges or opportunities faced when adopting the cloud and to understand how the final customer is also gaining some advantage.

Moreover, the manufacturing, logistic, educational, and medical sector will be analyzed to properly understand how this new technology can be deployed in different ways based on the needs of the business activities. For the case study, a company will also be targeted to understand how companies present and deploy their solutions in the cloud framework, particularly a Danish company named Milestone Systems, which works in the Video Management Software sector. It will show how the company's approach changed before and after adopting cloud technologies. The scope of this thesis will not be to target specific companies. However, it will consist of collecting information from different firms belonging to different geographic areas and sectors and not only from a specific one, aiming to highlight common patterns for all the firms belonging to the same geographic areas and sectors. This work will not present requirements from a financial point of view, and no budget definition is needed.

1.3 Requirements

This master thesis does not present requirement.

1.4 Justification

Nowadays, the improvement in Information technology and related infrastructure allows the interconnections among products, processes, and services, which changes how businesses are conducted. Advances in IT have changed the way of working by automating existing processes. CC fulfils the company's needs by providing infrastructure, platform, and software readily available on-demand and pays like other utility services such as gas, electricity, water, and telephony. CC helps companies in becoming more efficient and productive. Many firms have started using CC services because of the unique benefits of flexibility, scalability of resources, reliability, broad network access, cost-effectiveness, and sustainability. CC allows resources to be rapidly provided, so it helps firms in responding to market change quickly. When adopting new technology, firms must assess the capabilities, features, and challenges to make a proper decision. This work aims to show which are the main characteristics that push firms towards adopting cloud technologies. The rapid growth of CC is obtaining considerable attention in the researcher's community. A literature review will be performed to understand better how the framework of this topic is nowadays, focusing more on showing how different economic sectors can gain an advantage by adopting it both from an efficiency and effectiveness point of view.

Furthermore, based on the information collected, a picture of companies' main advantages and disadvantages will be presented. Another point of interest that the work will cover is the solution's scalability and how this technology allows companies to perform their primary functions in a changing environment that provides a reasonable basis for starting or expanding a business without a significant investment. Finally, some future trends will be presented about the influence of CC in enhancing the concept of servitization.

2 Cloud Computing and Digital Servitization

2.1 Cloud Computing

CC is an example of digital technology, and it can be defined as internet-based computing that offers users on-demand usage and access to a range of shared resources, including data, applications, software, and storage and computing facilities (Elmacioglu, 2021).

The main characteristics of CC are the ones that follow:

- **On-demand self-service:** Users can request and obtain computing resources when needed. This characteristic creates a sensation of infinite computing resources available on demand, and it eliminates the need to perform preliminary plans for their long-term supply
- **Permanent network access**: Users can access the resources anytime and anywhere on the network through standard Web protocols. This mechanism allows and simplifies access to services through different devices (f.i. mobile phones, tablets, laptops, and workstations), and platforms.
- **Pooling and sharing of resources:** Computing resources are gathered and can serve multiple users, and they are distributed and assigned dynamically according to consumers' needs.
- **Elasticity (scalability):** Based on the current needs, users can decide to increase or decrease the hired resources. These characteristics allow consumers to respond promptly to dynamic changing needs.
- **Pay-per-use**: Payment of cloud services depends on consumption. The level of user activity will determine the service's cost.

2.2 Service models

CC provides three fundamental service models (G. Kiryakova, 2015):

- **Infrastructure as a service (IaaS)**: Infrastructure as a service is a model that allows users to rent computing resources servers, storage, and network equipment. The provider of IaaS owns and maintains the equipment. Users can install and use whatever software they need and are responsible for managing applications and data.
- **Platform as a service (PaaS)**. Platform as a Service is a model for providing a development environment for creating and launching web and mobile applications. The components of the environment are pre-configured and maintained by the service provider, which is a significant advantage that grants software developers flexibility during the development process of applications and releases them from obligations to manage the environment.
- **Software as a service (SaaS)**. Software as a service is a model that allows users to use different applications as hosted services rather than installing them on local computers. Software as a service offers a diverse range of software applications.

The three service models are interrelated. The choice of the model influences the processes and activities that serve. The SaaS model serves mainly end users (including businesses). PaaS interact with software developers (including software companies). The IaaS model facilitates IT specialists in maintaining hardware resources.

2.3 Deployment models

Different deployment models of CC can be implemented (G. Kiryakova, 2015):

- **Public cloud**: The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services. Any registered users can use resources available over the Internet, usually through web browsers.
- **Private cloud**: Infrastructure is intended for a private organization or group use. It is not shared with other users and is accessible only through the organization's private network. This type of infrastructure has a higher level of security, in fact most businesses prefer to use this deployment model because it guarantees more excellent reliability and security.

- **Hybrid cloud**: We have a combination of distinct cloud infrastructures within this infrastructure. The hybrid model allows the deployment of information and applications with significant importance in a private cloud. In contrast, applications with lower security requirements and more comprehensive access can be deployed on a public cloud.
- **Community cloud:** Is an infrastructure provisioned for exclusive use by a specific community of clients from organizations that have shared concerns (e.g., mission, security requirements, policy, and compliance considerations) that may be owned, managed, and operated by one or more of the organizations in the community or some combination of them (SebastiánBruque-Cámara, 2016)

3 Methodology

A literature review is an approach adopted to conceptualize research areas and synthesize old research, contributing to a cumulative research culture. A literature review can be performed in different ways.

- Narrative review
- Descriptive review
- Vote counting
- Meta analysis

The first two review methods are qualitative, while the last two are quantitative. In this work, the focus will be on the qualitative one.

The narrative review is the traditional way of performing a literature review, and it is based on a qualitative interpretation of the literature. It is performed orally, describing past studies, focusing on theories and frameworks, elementary factors, and their research outcomes. Although performing a narrative review mainly depends on the reviewer's preference, it may be subjective. As a result, two reviews with the same body of literature can end up with different conclusions (Yang, 2012).

A descriptive review tries to find an interpretable pattern from existing literature. It produces some quantification, often in frequency analysis, such as publication time, research methodology, and research outcomes. This review often presents a systematic procedure, including searching, filtering, and classifying processes. First, a reviewer performs a comprehensive literature search to collect many papers as possible in the investigated area. Then the reviewer treats an individual study as one data record and tries to identify common patterns in the paper considered (Yang, 2012).

The objective of this work is to depict the landscape of CC as an emerging technology and to provide a guide for future trends. Given the topic's nature, we will not examine variables, correlations, or theories. Instead, a mix of the two methods will be applied in this master thesis work.

However, online database searches nowadays have become the primary information source for a literature review. Therefore, for a literature review on CC, it is appropriate and practical to focus on online databases rather than library collections.

Some online database was taken into consideration:

- Engineeringvillage
- IEEE Electronic Library
- ScienceDirect (Elsevier)
- Scopus
- Emerald
- Google Scholar

A keyword search was done towards the four databases for the years between 2007 and 2022, to capture different perspective on the phenomenon (such as technological, organizational, and environmental) in different contexts (nations and sectors) combination of keywords such as technology, IaaS, PaaS, SaaS, CC Adoption, CC diffusion, economics of CC, CC services and CC review (Mahak Sharma, 2020). Filters were used to restrict the number of information obtained, like the filters document type “Journal”.

The first round of the filtering process consists of scanning titles to identify those articles that did not address the CC phenomenon in business and technology; the question asked was, “Does the research article discuss the adoption or usage of CC?”. This scanning also allows the identification of some duplicates provided in the result of the research.

The second round involved manually scanning abstracts and reading full text when needed. In this phase, those articles that did not have CC as a central theme of discussion were excluded; instead, they just mentioned CC along with other technologies. This phase was the most complete and time-consuming because reading the article was required to perform the filtering process.

Market research is provided, and two main geographical areas are analyzed. The first one considers the European Union; statistics about the use of the cloud by European firms are presented, mainly focused on understanding which type of cloud services are adopted by those firms. The analysis will provide insights about the usage at the country level. It will consider ten types of services identified in the literature review: use of CC for e-mail, storage of files, office software, security software applications, financial or accounting software applications, hosting the enterprises' databases, CRM software applications, etc. Then a further analysis is performed to understand the use of CC services by economic activity, to understand which economic activity presents the highest use of CC.

Furthermore, an analysis of the use of the technology is performed towards the size of the company by dividing them into three different categories, which are large, medium, and small. Then the enterprises' dimension will be compared to the type of service model

adopted, which can be IaaS, PaaS, and SaaS. At the EU level also, the enterprises' dependence on CC is shown by describing the level of sophistication of the cloud service they are using (the services are divided into three groups, namely essential services, intermediate services, and sophisticated services.

The second region is the Asian Pacific (APAC). The markets that belong to it are Australia, New Zealand, Japan, South Korea, China, Hong Kong SAR, Singapore, and India. The analysis will focus on six types of industry technology, media and telecommunications (TMT), financial services, energy and resource, healthcare and life sciences, and government and public services. This section presents information about the public cloud services growth across APAC in the last five years, showing how the level of growth or total spending in the public cloud changes based on the country. Moreover, statistics based on six types of benefits that firms gain due to the adoption of the cloud will be presented, and the main benefits are productivity, market share, revenue, profit, new customer segments, and operational efficiencies.

After the market research section, a case study is presented to properly show the benefit that firms can gain when deciding to deploy a solution on the cloud. The data obtained are collected from documents that the firm provided and questions made to the employee dealing with the technology. This was possible because the author did a 9-month internship in the firm, which allowed him to understand how the firm adopts and deploys the software correctly. The closeness to the firm also allows a better understanding of the digital transformation that Milestone System is facing.

The case study will be divided into different sections. An initial one will provide information about the firms and highlight the firm's core business. Once the solution is described, a more detailed section on the software and its principal system architecture is presented to better understand how the different components communicate. Finally, four different deployment scenarios are shown after presenting the components and how they interact.

Moreover, once the audience clearly understands how the XProtect software works on the cloud, a section about the operations costs for cloud services will be presented to properly show how the pricing change is based on the final user's needs.

Finally, the last section depicts the main reason for considering the cloud deployment of XProtect. This is performed by presenting the general cloud deployment advantages and the advantages related explicitly to XProtect.

This firm had also been included in the study because they operate in the two regions discussed before.

The requirement adopted will be mainly linked to the source of information. In fact, only databases with academic reconnaissance will be considered. During the literature review, both the theory and application of the CC framework will be considered, but the research will include mainly information on how it is applied in real contexts.

4 Review of the state of the art

CC has become a significant asset for firms seeking to meet their client's needs and enhance their competitive status. Their mastery of efficient and effective data storage has promoted a need for more significant storage space (Nasser Taleb, 2020). As a result, service providers must work to increase the capacity of online data centers. CC has become essential to sustaining superior performance to enhance competitive status (Baldini, 2017). As more storage space becomes available, firms are impacted positively, allowing them to store more significant amounts of data. These large data caches allow companies to house, analyze, and gain helpful information on customers' information, desires, and behaviours (Duan, 2015). CC also allows smaller firms to store and share data as fees for CC descend. Cloud-computing services require the ability to meet the increasing demand for speed and storage space globally (Dempsey, 2017).

Service providers are remunerated by organizations that use cloud-computing services. Large multinational firms are beginning to generate proprietary cloud networks that meet their specific needs (Nasser Taleb, 2020). These huge firms find it lucrative to provide private cloud networks rather than using those of general service providers (Varghese, 2018). For example, Coca-Cola has enormous amounts of data and can develop a private network with high security that aligns with its needs. One of the largest multinational computer companies, IBM is developing private cloud storage. Other multinational firms are likely to develop their cloud systems, as well.

The overwhelming numbers of large companies have an IT department. As cloud service providers increasingly develop more complex offerings, they will be able to customize the cloud to answer the needs of each corporation, thereby allowing companies to outsource their IT departments (Baldini, 2017). Companies will no longer need to invest funds in elaborate and expensive computers and IT departments. Further, IT employees will need to learn how to manage applications on the cloud. As CC becomes familiar and user-friendly, smaller firms and private individuals will join large companies in choosing to use the cloud.

Many companies analyze data several times each year. To perform analytics, firms need powerful computers. However, over time, CC will encompass that analysis so firms can access analytic information whenever needed. Thus, organizations will not need

expensive computers to answer that intermittent need (Baldini, 2017) . Furthermore, as these services become increasingly less expensive, businesses can contract for services only when needed. Thus, conducting analytics on the cloud will reduce costs and risks, thereby increasing firms' profits and reducing costs and risks (Baldini, 2017).

The company information system is crucial nowadays, providing the necessary information for decision-making. However, information systems are expensive software, a significant company investment, and require proper IT infrastructure. Therefore, more vendors offer a cloud-based version of business information systems. Cloud solutions allow for transforming the considerable investment cost into operating expenses, which is suitable for small and medium-sized companies and start-ups (G. Kiryakova, 2015).

Companies can benefit from all aspects of CC, although cost savings for individual firms are significant only when there is a massive scale use of the cloud; cost reduction or real elasticity in the scale of use requires large-scale facilities. For small and medium-sized enterprises (SMEs), CC offers significant opportunities. Using the cloud, SMEs can overcome some of the advantages that their bigger competitors have had in the past, such as the capital-intensive hardware investments needed to provide services (Mudge, 2010). Moreover, CC positively impacts business, and many companies have decided to use it for its profitability and scalability. In addition, its privacy and improved security are critical factors to business owners and scalability. Clouds help SMEs to decrease their cost in a significant way. The most beneficial economic goal for users is the "pay-as-you-go" policy, and the technology also comes with more elasticity in employing and reserving resources. The significant opportunities for CC are divided into three groups: adoption, growth, and policy. When companies decide to employ CC, one must evaluate the expected average and peak resource utilization, the potentials and delimitation of using physical equipment, and the operating expenses that come with them concerning the CC environment are considered (Zhou, 2016).

The main advantages of cloud business information systems over traditional ones are:

- **Flexibility and efficiency:** The cost of the service decrease according to consumption based on needs. Flexibility is in terms of functionality; at any time, companies can add or abandon new services.
- **Improved connectivity**: Companies can quickly provide access to the system or specific modules to their partners to work collaboratively to improve cooperation.

- **Easier administration**: Administration and renewal of the system is a liability of the service providers that facilitates IT departments in companies and enables their optimization.

4.1 Challenges of Cloud Computing

Adopting CC has many challenges and problems. This section discusses the main challenges and problems that might obstruct the adoption of CC that must be addressed to convince organizations to embrace this emerging technique (Nasser Taleb, 2020).

Past and the current decade have witnessed widespread adoption and use of CC. Due to the importance of CC in improving organizational performance, its governance plays an essential role for decision-makers. Cloud-computing governance can be considered part of the general umbrella of IT governance (Nasser Taleb, 2020). Researchers have offered several definitions for the term IT governance. Brandis, Dzombeta, Colomo-Palacios, and Stantchev (2019) defined IT governance as “IT governance is about the configuration of organizational resources to ensure effective management”. An essential aspect of IT governance is the alignment of IT objectives with corporate strategy. A compelling need exists for cloud-computing governance and how it can be implemented.

One issue that might obstruct the adoption and use of CC is compliance with general regulations and laws for customers and cloud providers. Kundu, Sura, and Sharma (2018) proposed a framework aimed at helping organizations cope with compliance aspects in their cloud-oriented environments. The results are encouraging and may lead adopter organizations to fewer reported compliance violations, higher contribution of CC to the overall quality of service, and organizational compliance management.

Another critical issue related to cloud-computing governance is the need for more expertise in handling cloud-computing-based IT control. S. N. Khan, Nicho, Takruri, Maamar, and Kamoun (2019) tried to link CC and IT governance to humane arrangements, validating and ranking role assigning and taking components through in-depth interviews with 12 IT decision-makers and 44 Information Systems Audit. The S. N. Khan et al. study indicates that skills and competencies are prioritized determinants of IT controls, whereas IT security, risk, and compliance emerge as capabilities crucial in evaluating and managing cloud-computing service providers. Such results should be subjected to further investigation to consider different regions.

Despite the vast benefits CC can deliver for organizations, many corporations still need to be convinced to adopt the technology. The main reason might be attributed to poorly understood factors that inhibit adopting and using the technology. To address this problem, Borgman, Bahli, Heier, and Schewski (2013) proposed a framework based on a technology-organization–environment (TOE) to discern the factors that influence companies' decisions to use CC. Borgman et al. study showed that technology and organization companies engage their ability to implement their goals.

The authors divide the challenges of CC governance into management and hardware compliance problems. The typical management issues faced are the following: ethical (security, availability, confidentiality, and privacy) issues, legal and jurisdictional issues, data lock-in, lack of standardized service level agreements (SLAs), technological bottlenecks, strategy issues, implementation issues, dependence on the internet, quality of service, change management, risk management, and performance measurement (Akinlolu Olumide Akande, 2013). While the issue of hardware compliance has received greater attention and viable solutions have been introduced, the management problem still needs further investigation and solutions. The authors suggest drafting international IT compliance regulations that CC service providers can adopt worldwide. These compliance regulations should apply to both customers and the service providers in case of any dispute that might surface in the future between the two parties. This approach is expected to expel the customers' fear of adopting CC technology (Nasser Taleb, 2020).

Using cloud business information systems is accompanied by some problems:

- Cloud systems are less comprehensive and functional than traditional solutions.
- There are difficulties in adapting cloud services to the specific business and its processes.
- Integrating already deployed applications (cloud, mobile and traditional), which have to operate in a dynamic environment, is complicated.

Despite these problems and shortcomings, cloud systems are a good solution for small and medium companies. This is because they are inexpensive for using modern business information systems (G. Kiryakova, 2015).

Computer security remains a critical and vital subject for scientists and practitioners. The introduction of CC aggravates the problem because customers lack full control of the resources provided by cloud-computing service providers. As a result, security in CC is more challenging for customers and cloud-computing providers (Nasser Taleb, 2020). IT

governance offers visibility and control; therefore, efforts toward corporate governance can reduce operation risks, establish compliance, and protect the invested value (Suicimeczov, 2014).

Barriers to adopting CC by the business include the cost of migration to a cloud model, fear of lock-in to one cloud service provider, data security, and the need for large-scale data centers. The most significant barriers to the adoption of CC are concerns about security and privacy. Of course, ICT security is always a significant concern, and cloud service providers must protect personal, scientific, commercial, and intellectual property information (Mudge, 2010).

Securing information in the cloud environment requires three levels of security:

- Network security
- Host security
- Application security

Security challenges exist at the three levels when companies move to the cloud.

Privacy and data protection laws and regulations, such as those of UE countries and US countries, require knowledge of where data are permanently stored. As a result, cloud service providers may be encouraged to locate their data centers in jurisdictions with minimal legal requirements (potentially outside UE and USA). However, users of cloud services may need the legal protection provided by strong data protection legislation (Mudge, 2010).

The uptake of cloud services depends upon providers and their clients trusting each other. Trusted behaviour includes security and privacy measures; trust in CC needs to use an integrated approach that builds on the ideas underlying Service Level Agreements (SLAs):

- Agreement upon policies for sharing information before any interaction between the client(s) and cloud service providers. This may be achieved using contracts or SLAs.
- Rigorous proofs of agreed good behaviour (as defined in the SLA) between the cloud service provider and their clients during all critical interactions and after the policy agreements have been reached
- Ensuring externally verifiable and auditable “good behaviour” records are kept over the life span of interactions, from commencement to the termination.

Only when all three components are linked together a truly trusted system can be achieved (Mudge, 2010).

4.2 Cloud Computing Costs

In all business interactions, at least two parties are involved; when an interaction between a vendor and a customer happens, a transaction is created. For example, when customers buy a good or service, the customer pays the price, but the cost of the purchased service is not only the price. The transaction itself of buying a service or good has costs. Transaction costs are the costs linked with managing, monitoring, and controlling trade (Nuseibeh, 2011). According to Williamson, customers try to monitor and control a transaction by choosing the best way for its governance. The best way of doing that is through contracts, but contracts are always incomplete. The main reason for that is linked to information asymmetry, information that only vendors know but not customers.

One of the most known transaction types in economic history is the make-or-buy decision, which includes many asymmetrical conditions, information, risks, legal expertise, and others. All these conditions make this type of transaction more complex. This type of transaction has been in information systems for a long time. IT managers often find themselves hesitant between building their systems in-house or buying ready systems, which represent an outsourcing of the information systems.

Researchers introduce four types of costs: the cost of transaction information processing services, set-up/contracting cost, the cost of monitoring and coordinating the activities of the vendor(s) and switching costs.

Two main motivations drive this phenomenon of outsourcing. The first motivation is efficiency based, which evolves around cost efficiency and concentration on core business processes. The second motivation is linked to the difficulties in managing IS activities due to deficiencies in IS departments (Makhlouf, 2020). The transaction cost theory (TCT) and IS (information systems) outsourcing raise some questions with regards to the cloud setup. For example, does all what we know about outsourcing decisions in the IS field translate to the emergent cloud context? Furthermore, what is the difference between cloud and outsourcing?

Researchers highlighted that the value chain of CC is more advanced than that of IS outsourcing (Böhm, 2011). They state that CC is an advanced form of IS outsourcing, what applies to IS outsourcing can extend to the cloud (Martens, 2011). For instance, the first motivation of outsourcing efficiency-based, applies to CC. Further motivation for CC includes economies of scale and demand pooling (Kashef MM, 2011) (Pal R, 2012).

Researchers define three dimensions of CC transactions, namely:

- Cloud asset specificity
- Cloud uncertainty
- Cloud transaction frequency

Williamson (1985) defined asset specificity as a *"durable investments that are undertaken in support of particular transactions, the opportunity cost of which investments is much lower in best alternative uses or by alternative users should the original transaction be prematurely terminated"*. This means that a company might have to make notable investments for specific transactions, which might not be utilized for anything other than those transactions, in a case like this the transaction is of high specificity. Researchers view cloud asset specificity with respect to the ability of a cloud user to move from a cloud vendor to another one in a smooth manner (Nuseibeh, 2011), and they also state that the amount of customization in a cloud service must also be considered in determining cloud asset specificity (Yigitbasioglu, 2014).

To determine the asset specificity of cloud services, the findings added some costs categories:

- Change management costs
- Meta Services costs
- Business process reengineering costs

So, cloud asset specificity is a function of change management costs, meta-service costs, and business process reengineering costs faced by the cloud customer.

Cloud vendors offer their customers free training until the customer is confident with the service in question, but the vendor also offers paid training to release certifications. For instance, Microsoft offers educational paid Azure certifications to their cloud customers and IT people upon request (Makhlouf, 2020).

From the customer's point of view, switching to the cloud is not only a matter of training. The companies that adopt it need to change their work style, and project management methods have to change; enterprises need to shift from a classical waterfall approach

towards an agile mindset. The CIOs (Chief information officer) play a vital role in changing the mindset and practices of the whole organization during the technological transition, and they need to be agile and flexible (M, 2017). Change management comes with many cost parameters such as paid intensive training, hiring cloud skills, building change strategies, and laying over outdated-skilled employees (Hentschel R, 2018).

CC is based on the “as-a-service" philosophy. Consultancy experts stated that companies have to buy services to track consumption, audit, migrate and ensure that they are getting optimal costs. So, firms had to buy many third-party services or sometimes build their solutions to manage the cloud portfolio better. From a security perspective, they also need to adopt additional services. Such services that emerge because of the move to the cloud can be termed Meta services, by which we mean cloud services that manage cloud services. For example, Azure-costs.com is a cloud service to manage Microsoft Azure cloud services, and it is a third-party, not offered by Microsoft; companies pay for it separately. Many other similar services and dedicated IT companies are emerging and building their business models only on selling these meta-services (Makhlouf, 2020).

Some companies have immature processes, which may disqualify them from moving to the cloud. Moving to the cloud in such situations would incur tremendous costs that may put the business at risk. In this situation, business process reengineering practices are needed to accompany cloud adoption, which is fundamental for a cloud project's success. There are many reasons linked to the rise of process engineering, and one is that responsibility and process ownership often need to be more specific. Such a grey area of process ownership leads to another point of BPR's importance for cloud scenarios. When an IT department is not adding value to the procurement of services, they create a “shadow IT” (Makhlouf, 2020). The term “Shadow IT” refers to a situation in most organizations where users deploy applications connected to the cloud or use services in the cloud within the business environment without the knowledge or consent of the IT department (proofpoint, 2022). As a result business units get themselves in trouble with cloud vendors, and IT is surprised with problems and unplanned projects to rescue the business units. To eliminate shadow IT problems, several IT processes had to change, and the IT department need to act as a broker for cloud services by providing and performing the following points:

- Gives end-users some level of flexibility and access services on demand, for instance, through an internal portal where end-users choose the applications they need from it.

- Let individual departments own their budgets, while IT is responsible for talking to multiple suppliers and negotiating contracts.
- Ensure that certain levels of security and data protection are met.

By following this point, the end-users get the flexibility they want. At the same time IT departments have visibility and control of budgets, governance, and security, controlling the emergence of shadow IT problems (Makhlouf, 2020).

There is usually a level of uncertainty in any transaction, and experts identified three areas of uncertainty that imply cost when adopting cloud technologies:

- Contract management
- Monitoring
- Legal compliance

The customer perceives CC as an easy choice with different advantages and a couple of hours of the adoption process. However, cases show that the adoption of the cloud is a complex economic setup that needs a more complex contract, based on this point contract management is inevitable for cloud scenarios. Cloud users must negotiate the contracts and build plans before engaging in a cloud initiative. Cloud customers do not have the needed negotiation skills; as a result, they should rely on the skills of the supply chain department in negotiating and managing contracts. Experts highlighted that contracts and service levels are very tricky, and vendors put most of the risk on the customer side when they issue contracts. Although, in this case, external legal expertise can be an option in contract management, an entity with experience in cloud contracts should navigate the information asymmetry of the contracts (Makhlouf, 2020).

Experts said that “Cloud end users act with cloud services like a teenager with a credit card”; they keep consuming the service while unaware of the costs they are incurring. Monitoring is crucial in the cloud setup, if not monitored cloud generates many unnecessary costs (Makhlouf, 2020). Although monitoring is vital to control costs, monitoring itself is a cost generator. Therefore, IT departments need monitoring tools, in such case three scenarios exist:

- The vendor might offer free-of-charge functionalities to help cloud customers monitor their consumption.
- The cloud customer might opt for adopting third-party cloud services to monitor the cloud service, (this is an example of Meta services mentioned before).
- Some cloud customers might prefer to build their monitoring tools.

Another monitoring cost is the cost of a monitoring resource because the best practice is to add a resource that is responsible for monitoring the vendor in terms of reviewing the SLA, this includes the cost of recruiting the resource or training an existing resource in the IT department (Makhlouf, 2020).

Legal compliance becomes more risk-prone with the usage of the cloud because data move towards different regions (van der Werff L, 2019), and cloud users need external legal consultancy to investigate compliance with laws. Unfortunately, this is not a one-time task, it needs to be updated frequently since the cloud and its legislation are changing.

Frequency means how often the transaction repeats, Williamson explained that the more a transaction repeat, the more it pays off to invest on its specific assets (Makhlouf, 2020). In CC, the transaction frequency consists in how often the services are adopted and how often a service is called.

4.3 Factors influencing Cloud Computing adoption

The first service of CC was launched by Amazon in 2007 an infrastructure as a service (IaaS). However, Google contributed the most significant development in 2010 by introducing software as a service (SaaS). Analysts predicted that the entire public cloud services market would grow 18 percent in 2017 to a total of $246.8bn, up from $209.2bn in 2016 (Gartner, 2017). With the increasing speed of technological change and competitive dynamics, it is difficult for firms to maintain capabilities in all technical and market areas (Mahak Sharma, 2020). Researchers have attempted to study the adoption of various information technologies by applying different theories, but among the many theoretical model TAM (Technology acceptance model) and TOE (technology organization environment framework) are widely accepted models for understanding IT adoption. The decision to adopt new technology is based on different parameters such as assessing capabilities, features, security risks, cost, relative advantage, complexity, compatibility, competitive pressure, top management support, and challenges of the technology, which in most case is not independent. It is also noticed that best practices can reduce uncertainty and fear in potential adopters, which explains why most companies are have a wait-and-see attitude toward cloud adoption (Mahak Sharma, 2020).

The literature has highlighted different motivators for potential adopters and existing users of CC services. Relative advantage, complexity, compatibility, and cost are crucial for

potential adopters (Gangwar, Understanding determinants of cloud computing adoption using an integrated TAM-TOE model, 2015). However, existing users considered compatibility, security, and service providers' technical support strategy for service usage (Retana, 2018). Other findings reveal information about the adoption of CC across countries and sectors. Relative advantage influences the adoption of CC in SMEs in northeast England (Alshamaila, 2013). It is also interesting to note that RA is found to be critical in developing countries (Gangwar, 2015) compared to developed countries. That information reveals that benefits such as scalability, virtualization, and other perceived benefits act as primary motivators towards adoption in developing nations (Mahak Sharma, 2020).

Moreover, compatibility has also shown inconsistent results for CC adoption across sectors. In their studies of Portuguese firms, Oliveira et al. (2014) found that compatibility also has a significant positive effect on the CCA in the service sector while insignificant in the manufacturing one (Oliveira, 2014). Hsu et al. (2014) found that compatibility is vital in the Taiwanese manufacturing and service sector (Hsu, 2014). The results imply that compatibility issues are barriers to adopting of CC in developed and developing countries (Mahak Sharma, 2020). Although complexity issues are more critical in developing countries, research highlights its significance, stating that the ease of use encourages developing countries to adopt new technology/innovation (Mahak Sharma, 2020).

Furthermore, competitive pressure positively impacts the speed of adoption, especially in the high-tech industry. Firms are not pushed to the adoption of cloud because of the changing needs but also because of high pressure from the competitors (Mahak Sharma, 2020).

4.4 Cloud Computing for Business Management

The concept of CC in business may sound ideal and easy to implement, but like all new technology, it has both positive and negative aspects. CC has been recognized for improving business, but not all businesses are the same. In this section, Amazon cloud services will be used as a model to describe CC services because they are one of the best available. Amazon provides its customers or sellers with web services that they can use to easily access documents, shared files, and applications, as well as store documents in the cloud (Dr.R. Sakthi Prasath, 2020). We will take a closer look at the services Amazon offers to understand better the business benefits of CC and who benefits more from these services.

Amazon offers its customer Elastic Compute Cloud services. This web service has several benefits for customers, including elasticity, flexibility, decreased costs, and reliability. Another service Amazon provides is S3, which is created to store a business information in the cloud securely. Companies like to store their information in the cloud to reduce expenses. When businesses do that, they can save money by avoiding purchasing a powerful server for storage, they will be charged just for the service they are using, and they can rely on Amazon storage. The main objective of any business is to increase profit and, at the same time, decrease cost. Amazon's CC can decrease costs in several ways. However, CC is not a tool that helps only in decreasing costs but also increases profit, builds better business relations, and remains current on technological advances (Dr.R. Sakthi Prasath, 2020).

Amazon's Elastic CC web services can reduce the costs of cooling and power, new servers, and server administration and management. With these reductions, companies can reduce the amount of space, equipment, and energy needed to run the same business only cheaper and more effectively. Moreover, it enables companies to provide standardized and lower-cost services. Businesses can approve operational budgets for new investments for direct business benefits when reducing costs. Furthermore, EC2 service does not help save money only towards the amount of hardware purchased, but it also influences the number of employees they must hire. Using CC will allow businesses to cut the cost of numerous employees for a task that a few employees can complete through adopting CC. By reducing the amount of hardware needed, the firm can decrease the number of operations personnel once needed to manage hardware. Amazon CC services can help teams, customers, and suppliers meet, share ideas, and do business more effectively and without delay, because team members, customers, and suppliers can be given access to the cloud (Dr.R. Sakthi Prasath, 2020).

Using CC in a company gives them the edge over its competition, which increases business value. This shared access also shortens the time it takes for a customer or supplier to access the market. When the market is virtual and constantly accessible, business profits and relationships can grow. Even though business growth is what businesses essentially look for, if a company outgrows its infrastructure, it may begin to split backward. Through the use of CC architecture, businesses have room to grow and scale back if needed. Pay-per-use services allow companies to pay only for what they need; this service will save system administrators from worrying about hardware procuring or making better use of excess and idle capacity (Dr.R. Sakthi Prasath, 2020).

Moreover, CC services can be seen as highly beneficial, and not all companies are ready to jump into them. Although large businesses have concerns over the use of CC, some of the problems entail start-up costs and data center constraints. The initial start-up costs for large businesses may be expensive, as switching between services is not only about raising, but it can also take much time, and as we know, in business, time is money. However, the long-term costs of switching services may be more profitable for large firms willing to make the shift. So, all business types can use CC services, but it may be ideal for smaller businesses or especially for starting businesses (Dr.R. Sakthi Prasath, 2020).

The primary types of cloud services used by enterprises are the following:

- Email

  When speaking about cloud email services, two scenarios can be faced. The first one is where we have an email client running on a cloud-based email infrastructure. For instance, when using Gmail or Yahoo, the user uses a cloud email while his/her emails are managed and stored on remote servers.

  The second scenario is more related to business workflow than personal use. In this case, cloud email stands for cloud email hosting, user management when the firm sets accounts and permissions for their employees, additional email features, and backend support. Upgrade maintenance and access to a pool of remote sending and receiving servers. Employees can access data via mail from clients from any place allowing for an improved work experience, collaboration, and enhanced flexibility (Ivanenko, 2022).
- Storage of files

  Cloud file storage is a service used for storing data in the cloud that provides servers and applications access to data through shared file systems. It allows team members to access, view, and edit the same files in near, real-time, and simultaneously from virtually any location. Edits are visible to users or groups as they are made, and changes are synchronized and saved so that the users or groups see the most recent version of the file (AWS, s.d.).

- Office Software

  Cloud office refers to software-as-a-Service (SaaS) collaboration and communication tools that combine email, file-sharing, instant messaging, conferencing, document management, search, and discovery. Examples of cloud

office suites include Microsoft Office 365 and Google's G Suite (Bhattacharjee, 2020).

- Security Software Applications

  Cloud security software protects data and applications in cloud infrastructure by providing features like malware identification, risk assessment, and threat management. As a result, it can monitor and protect an organization's data, applications, network devices, and endpoints from unauthorized access. In addition, the security system safeguards sensitive information in the event of malware or cyberattack, and it helps avoid server crashes during high traffic periods by controlling capacity (Trustradius, s.d.).

- Financial or accounting software applications

  Cloud accounting software is similar to traditional accounting; the only difference is that the software is hosted on remote servers. Like the SaaS business model, data is sent into the cloud, which is processed and returned to the use (Financialforce, s.d.).

- Hosting enterprises database

  A cloud database is built and accessed through a cloud platform; it fulfils many of the same functions as a traditional database with the added flexibility of CC. Users install software on a cloud infrastructure to implement the database. This enables enterprise users to use host databases without buying dedicated hardware, which is offered as a service and managed by the provider (IBM, s.d.).

- CRM Software applications

  A cloud-based CRM is software hosted on the customer relationship management provider's servers and can be accessed by customers over the internet. It differs from installed software, which has higher upfront costs and different staffing requirements. The provider owns and maintains all the software's infrastructure, and the user runs it on their PC through an internet connection (Zendesk, s.d.).

- ERP Software applications

  Cloud ERP software is an enterprise resource planning (ERP) software that runs on a secure server, providing easy accessibility via Internet. It gives companies an updated and real-time view of their synchronized data and extensive analytical capabilities, automated workflows, customizable dashboards, and reports. It also ensures scalability for continuous growth. Furthermore, users can connect to the cloud ERP software using a web-enabled device at any time and from anywhere (Acumatica The Cloud ERP, s.d.).

- Platform for application development, testing or deployment
  A cloud platform is a computing model in which cloud providers deliver hardware and software tools to users over the internet. Usually, these tools are needed for application development, testing, or deployment.

4.5 Conclusion

The State of the art allows concluding that CC is a technology that drives to meet the client's specific needs and improve their competitive positions. Therefore, it is suitable for all small and medium-large firms; it helps manage the increasing market demand.

In recent years, the number of multinational firms building their cloud networks has been increasing. As a result, they find it profitable to provide cloud networks rather than using general service providers.

Adopting this technology allows firms to outsource their IT departments, which may lead to actual money savings. This also represents one of the main drivers that lead smaller firms to embrace the world of CC, they will not need to invest money in expensive computers, but they could focus on their core business.

CC leads to cost savings only when there is a massive scale of use of the cloud, and it usually offers significant opportunities for small and medium-sized enterprises (SMEs), one of them consists of no need to perform capital-intensive hardware investments. Another one is linked to the privacy and security of the cloud.

Firms can also face issues when adopting it; a critical point relates to CC governance. First, an alignment between the IT department's objectives and the corporate strategy is needed then, there is also a need for compliance with general regulations and laws for customers and cloud providers.

The biggest barriers to the adoption of CC are concerns about security and privacy, the protection of personal, scientific, commercial, and intellectual property information must be assured by cloud service providers, and this must be done at three levels of security (Network security, Host security, Application security).

IT Managers often find themselves hesitant between building their systems on-premises or buying ready systems, which represent an outsourcing of the information systems. Usually, four types of costs are faced when shifting to the cloud: the cost of transaction information processing services, set-up/contracting cost, the cost of monitoring and coordinating the activities of the vendor(s) and switching cost.

In most cases, the decision to adopt cloud technologies is based on different parameters such as assessing capabilities, features, security risks, costs, relative advantage, and complexity; competitive pressure has a positive impact on the speed of adoption.

Amazon cloud services are one of the best available now on the market, and they offer Elastic Compute Cloud services, Amazon S3, IAM, and so on. Although those services will be explained in a case study proposed later in the work, they all adopt pay-per-use pricing.

Based on the literature review, the technology usage in Europe and Asia Pacific need to be further investigated to depict different patterns based on the firm country of origin, sector, size, and type of cloud services adopted. Moreover, a need to understand which service model is more deployed needs to be understood; this will be performed by analysing the use of CC by service models in Europe.

In most of the article reviewed, the factors that influence the adoption and the benefit or threat that firms obtain is studied. However, also enterprises' dependence on CC must be investigated. In the APAC region, an analysis of the public investment must be performed to show how all the countries considered are living growth but at a different pace.

In most of the reviewed articles, the authors identified benefits and limitations, which are:

BENEFIT	LIMITATIONS
Cost Savings	Lack of Control
Scalability/Flexibility	Dependency
Reliability	Privacy and Security Risk
Maintenance	Internet Based
Innovation	Migration Issue
Collaboration	Continuously Evolving
Competitivity	IT knowledge needed

Table 1. Cloud technology benefit and limitations
(Source: Own elaboration)

Those benefits and limitations are always linked to the technology itself, a need to identify them in a specific firm is needed. To fulfil this necessity, a case study needs to be presented to highlight the findings of Table 1 correctly. Milestone Systems will be presented, a firm facing digital transformation and operating in the European and Asia Pacific markets.

5 Market Research

This section contains market research about the usage and adoption of cloud technology in two geographical regions, the European Union and the Asian Pacific, the information presented are collected from two report, for Europe the information has been collected from Eurosta (Eurostat, 2022) t, and for Asian Pacific from Deloitte report done by Boy Kester, Joep Dijkhuis and Candy Chan (Boy Kester, 2021). It is performed for some reasons, the first reason is linked to the result of the state-of-the-art. Based on the findings, there is a necessity to collect information from market research about the usage of cloud technology to identify different patterns considering the country of origin, sector, size, and cloud services used. Another reason is linked to the need to understand the current technology trend and the different countries' approaches to adopting cloud technologies. Moreover, Milestone Systems has a strong presence in the EU and APAC markets, which explains why the two specific geographical areas are selected.

5.1 European Union

In the section that follows recent data are provided about firm usage of CC services in the European union are provided

- In 2021, 41% of EU businesses utilized CC services (Eurostat, 2022).
- 73% of those companies utilize cloud services related to security software applications, hosting enterprise's databases or computing platforms for application development, testing or deployment (Eurostat, 2022).
- Compared to 2020, the use of CC increased by 5% (Eurostat, 2022).

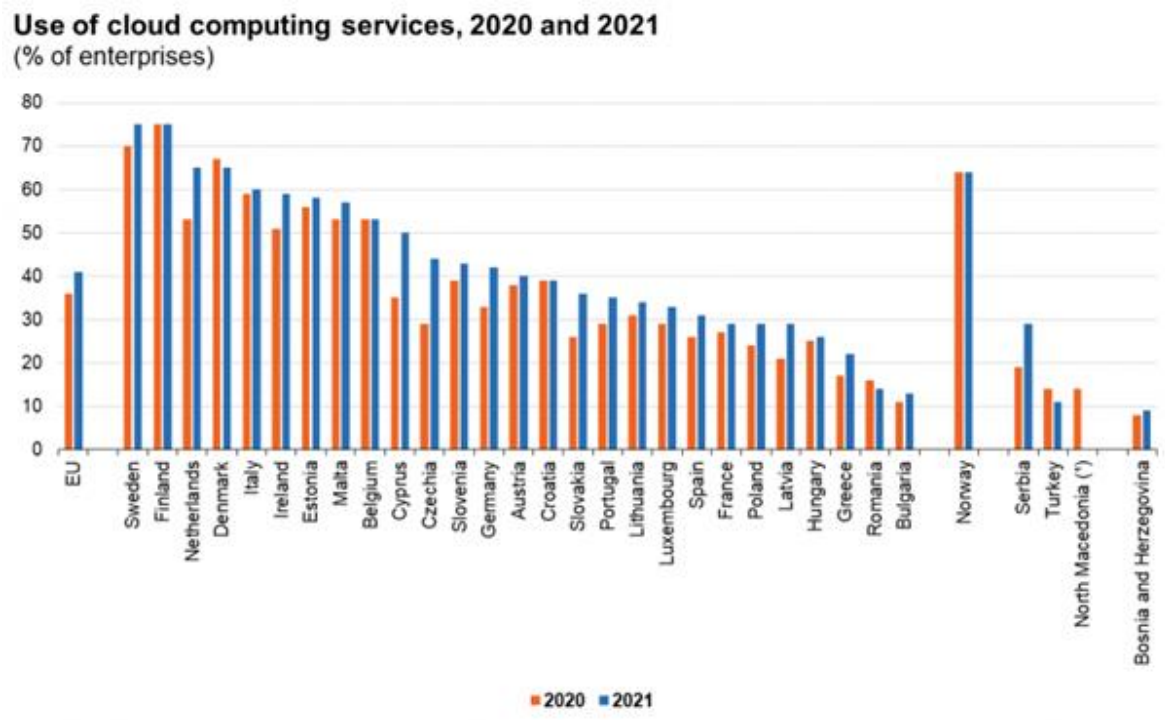

Figure 1. Use of CC services in enterprises, 2020 and 2021 (% of enterprises)
(Source: (Eurostat, 2022)*)*

Figure 1 shows that in 2021, at least 65% of the businesses in Sweden, Finland, Netherlands, and Denmark utilized CC, while less than 25% of firms used it in Greece, Romania, and Bulgaria (Eurostat, 2022).

In the firms that declare the usage of CC, 79% of them used a cloud service for their E-mail system (see Table 1) (Eurostat, 2022). Those firms choose to rely on a cloud service instead of building their own e-mail system.

	Use of cloud computing	E-mail	Storage of files	Office software	Hosting the enterprise's database(s)	CRM software applications	ERP Software applications	Platform for application development, testing or deployment
	% enterprises	% enterprises using the cloud						
EU	41	79	66	61	46	27	24	21
Belgium	53	82	81	68	58	46	36	27
Bulgaria	13	80	68	60	55	21	24	21
Czechia	44	81	62	85	32	17	19	17
Denmark	65	86	83	73	72	38	35	40
Germany	42	65	61	55	33	21	18	23
Estonia	58	77	65	68	33	21	18	23
Ireland	59	80	69	73	40	24	13	16
Greece	22	84	67	73	41	28	28	36
Spain	31	82	80	63	69	38	33	28
France	29	67	76	54	59	30	31	25
Croatia	39	88	72	61	54	20	18	22
Italy	60	96	58	58	39	19	20	10
Luxembourg	33	81	67	68	65	33	23	29
Netherlands	65	82	81	72	78	49	35	30
Austria	40	70	71	52	26	23	16	28
Poland	29	79	41	64	27	17	22	14
Portugal	35	89	71	61	46	26	34	25
Romania	14	80	58	58	50	27	30	22
Slovenia	43	73	66	66	43	21	25	23
Slovakia	36	88	60	65	39	28	16	18
Finland	75	85	76	75	49	41	37	17
Sweden	75	87	84	71	60	38	21	27
Norway	64	88	83	78	67	38	33	32

Table 2. Use of CC services in enterprises, 2021 (Source: (Eurostat, 2022)*)*

From Table 2 important information can be gathered, more than the 66% of firms use the cloud to store files, 61% use it for office tasks, and 46% use it to host databases. Hence, it can be seen that CC services meet a wide range of firm ICT needs (Eurostat, 2022).

Furthermore, organizations have access to more complex end-user software applications through the cloud; 47 % of businesses use it for finance and accounting, 27 % for managing customer data (CRM), and 24% for process and resource planning (ERP) (Eurostat, 2022).

The information and communication sector are the one that presents the majority of firms adopting CC services. On the other side, in the other sectors the percentage of firm using CC services range between 32% and 48% (Eurostat, 2022).

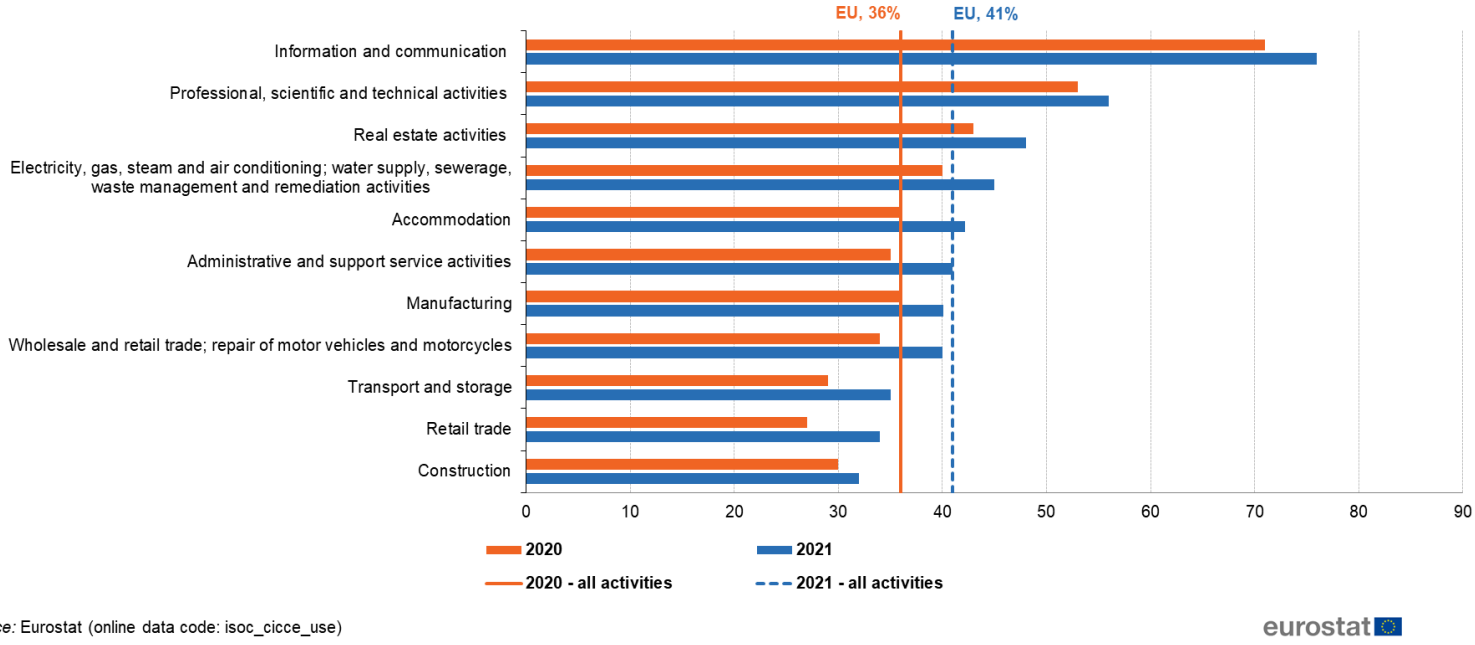

Figure 2. Use of CC services, by economic activity, EU, 2020 and 2021 (% of enterprises) (Source: (Eurostat, 2022))

Large established firms used CC at a high rate (72% in 2021 compared to 2020), which is an increase of 7 percentage points. Medium-sized businesses adopted CC at a rate of 53% in 2021 compared to 46% in 2020. The use of CC increased by 5% in small business, reaching the 38% (Eurostat, 2022), (see figure 3).

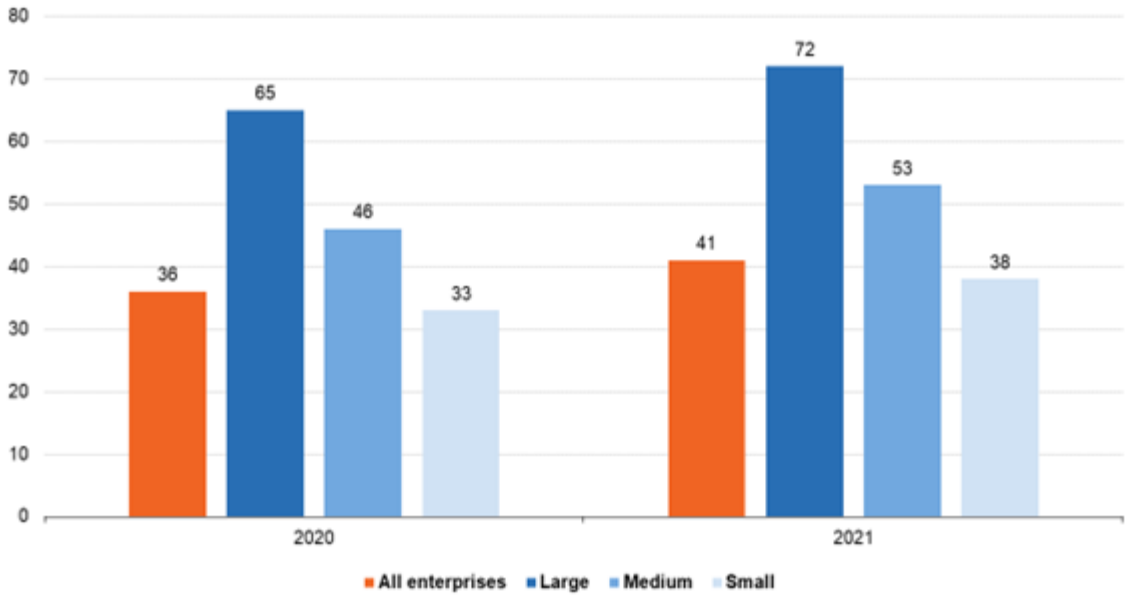

Figure 3. Use of CC services, by size, EU, 2020 and 2021 (% of enterprises)
(Source: (Eurostat, 2022)*)*

The usage of different cloud service types in 2020 and 2021 is compared in Figure 4. As mentioned before, 79% and 66% of firms declare to use CC services for email and storage of file respectively. However, compared with 2020, the usage of e-mail, office software services registrate a growth, specifically an increase of 3 % were registered for both (Eurostat, 2022).

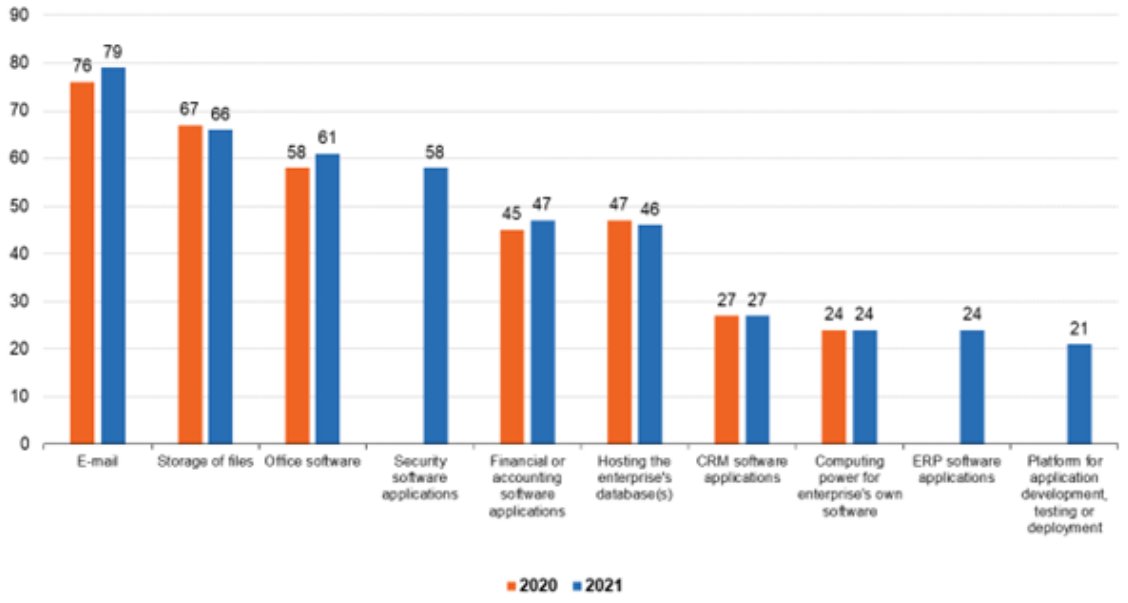

Figure 4. Use of CC services in enterprises, by type of cloud service, EU, 2020 and 2021 (% of enterprises)
(Source: (Eurostat, 2022)*)*

5.1.1 Use of Cloud Computing by service model

One or more cloud SaaS applications, such as email, office software, ERP, CRM software, were used by the majority of firms (94%) who indicate the usage of CC services (see Figure 5). Additionally, 74 % of firms used at least one IaaS and 21 % of firms declare the usage of at least one PaaS, which provide a hosted environment for application development, testing or deployment of applications (Eurostat, 2022).

Even though SaaS was used by firms of all sizes equally, it was found that the usage of IaaS an PaaS varied slightly depending on the size class. The percentage of large firm using IaaS is 81%, the percentage decrease by five points if medium enterprises are considered, and by 8 percentage point if small firm are considered. While for PaaS, in large firms the percentage is 38, for medium-sized firms is 27%, and small businesses reach 19% (Eurostat, 2022).

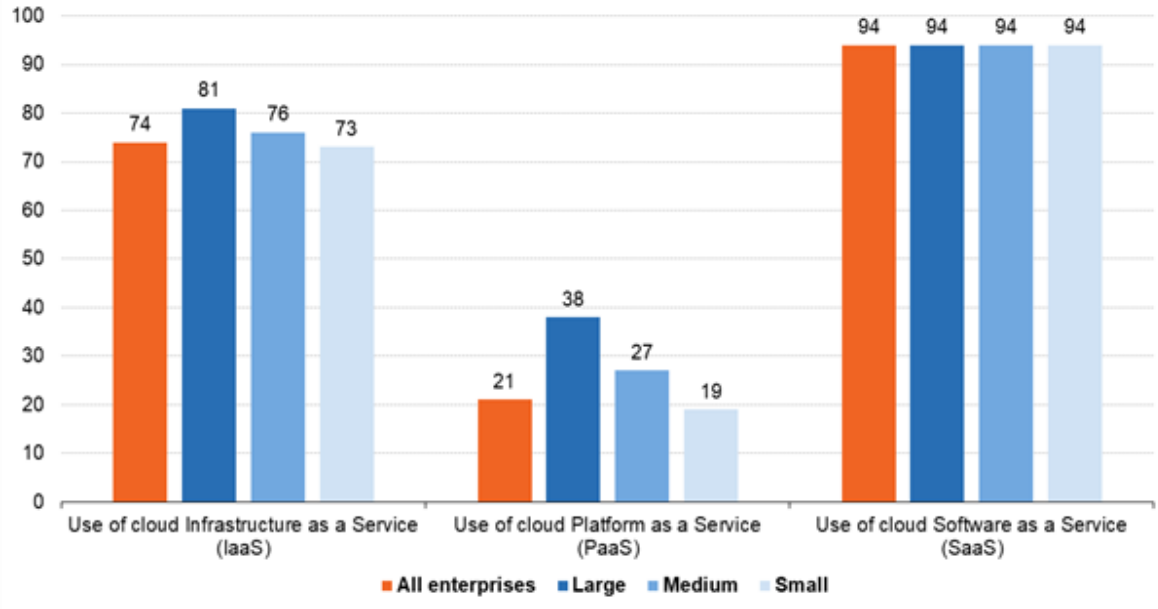

Figure 5. Types of CC services used, by service model, EU, 2021 (% of enterprises) (Source: (Eurostat, 2022)*)*

5.2 Asia Pacific's

In the literature review, it has been discussed which are the main challenges and barriers that companies face when adopting the cloud. In this section, the current situation in APAC region will be analysed. The markets covered are Australia, New Zealand, Japan, South Korea, China, Hong Kong SAR, Singapore, and India. The info presented are based on consultations with industry experts, publicly available information, and a bespoke survey of almost 600 organizations across the considered markets and industries (information provided by Ipsos to Deloitte see Appendix B of Boy Kester report (Boy Kester, 2021)).

In the Boy Kester report, a question has been made to organizations regarding their capability and ability to adapt to a shift in consumer preferences (Boy Kester, 2021). Almost one-third of the firms surveyed indicated that they do not have the capabilities to shift consumer preferences rapidly (Boy Kester, 2021), see Figure 8.

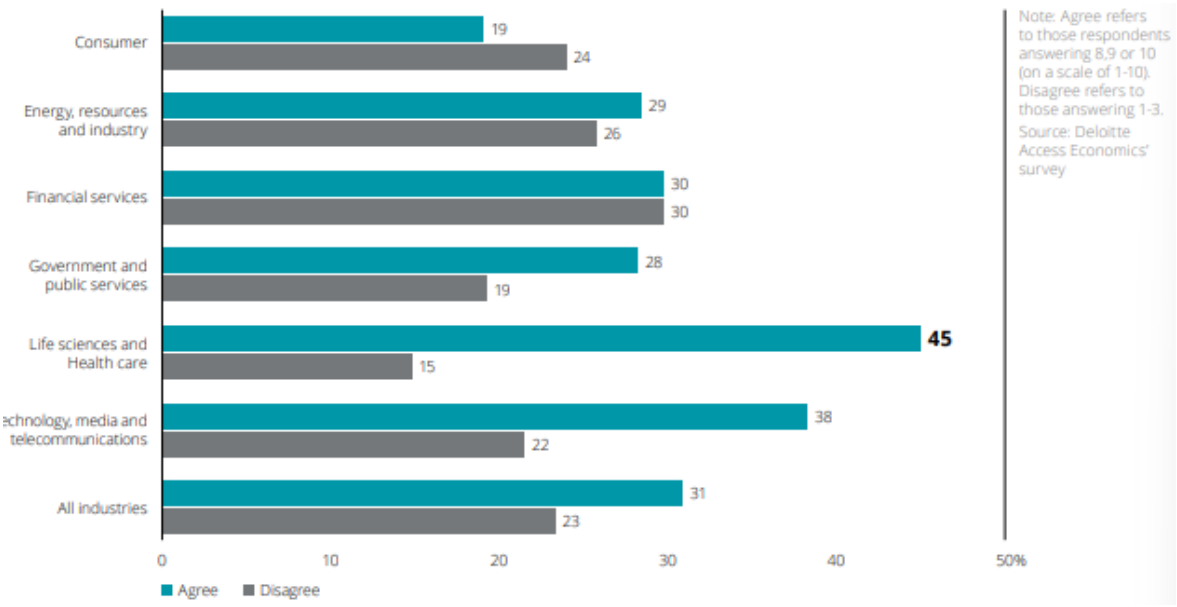

Figure 8. Response to the statement "My organisation has insufficient capability today to rapidly adapt to a shift in consumer preferences"
(Source: (Deloitte, 2022)*)*

Organizations increased their usage of digital technologies after the COVID-19 pandemic. In addition, 40% of firms in the media and telecommunication sector claimed to have significantly increased the usage of digital technologies (Boy Kester, 2021).

Cloud is one of those digital technologies, often digital technologies are seen as accelerating the pace of disruption, but they can also offer effective methods to avoid it

(Boy Kester, 2021). The adoption of cloud technology allows firms to be more agile and resilient, but only if companies manage the adoption process effectively.

As stated in the previous section, this technology includes a range of services, including SaaS, IaaS, and PaaS, which all support organizations in dealing with the complexity. Organization must be able to react rapidly to shifts in customer preferences and to the dynamism of today business environment, that is becoming always more complicated. Moreover, it is also important to understand the user experience and adapt it to meet changing needs (Boy Kester, 2021). In addition, it is easier for organizations to configure solutions using the cloud than on-premises, by adopting cloud infrastructure, companies can benefit from emerging technologies to meet new business requirements (Boy Kester, 2021).

Governments in APAC are at a different phase of their cloud journey, but they are all focused on the future and how the cloud can help the country in achieving efficiencies and improvements (Boy Kester, 2021).

The Australian Government's vision is to become a leading digital economy and society by 2030; in 2017, the Australian Digital Transformation Agency developed its Secure Cloud Strategy to guide government agencies in their transition to cloud adoption (Boy Kester, 2021). In June 2021, the Agency announced its investment in new cloud software to modernize its services because COVID-19 had changed way in which citizens interact with government services (Sharon, 2021).

China's appetite for cloud infrastructure services continues to surpass the rest of the world, with the government making it one of the main strategic priorities, driven by the continuous expansion of online services and digitization of processes and operations within enterprises and government organizations (Webster, 2021). Premier Li Keqiang, in March 2021, confirmed that the Chinese government seeks to support digital industries such as the cloud.

In 2020, Hong Kong launched the Government Cloud Infrastructure Services to sustain its position as Asia's leading digital city and to facilitate agile development and delivery of digital government services (Boy Kester, 2021). In June 2021, Victor Lam, CIO of the Hong Kong Government provided an update on the role of the cloud: *"Through the effective use of cloud and other technologies, we strive to support the Government to achieve policy outcomes in the years ahead, and our community's speedy recovery from the pan-*

demic aftermath… We will keep making use of cloud technology to help government departments to achieve lower costs, shorter time-to-market, and modernized IT system delivery" (CIO Tech Team, 2021).

In Japan, the government introduced a tax incentive for companies to improve productivity (Boy Kester, 2021), this incentive applies to companies that invest in and use a cloud-based system (Shimbun, 2021). In addition, the Government introduce a new Digital Agency in late 2021 (Rakuten Today, 2021).

In late 2020 the New Zealand Government began to build its Cloud Centre of Excellence, to accelerate the uptake of the cloud and implement a cloud migration across New Zealand's public sector (Boy Kester, 2021). This implementation is part of the Cloud-First policy announced in 2016 and its recently launched digital strategy in late 2019 (Andrew, 2020). The Strategy for a Digital Public Service provide guidance for creating public service that will meet the needs of people in a modern and changing world (Cavanagh, 2019).

The Singapore government continues to progress on its transition to the cloud by focusing on efficiency and the contribution to public service, the country has built one of the best digital government frameworks in the world (Boy Kester, 2021). The Digital Government Blueprint is designed to enlarge the local digital economy and to drive Singapore into an innovate, digital society (Boy Kester, 2021). The Government is also committed to developing a foundation for digital talent by introducing coding training from primary school, and technology internships from high school.

The South Korean government was one of the first to establish a national CC strategy, presenting its first blueprint to promote CC in 2015. In addition, in 2018 the government established guidelines for the public sector on how to use private cloud services, and then announced the goal to move all public information systems to the cloud by 2025. Furthermore, in January 2021, the Government announced it will invest $53.5 billion in the Digital New Deal by 2025, to prepare the country's economy for the future (Boy Kester, 2021).

Public cloud services expenditure growth across Asia Pacific in the last five years, with an average increase of 40% growth each year between 2015 and 2020, reaching $43 billion across APAC markets (Boy Kester, 2021).

Cloud is an essential and integral part of enterprises digital transformation process for firms, it provides them the tools and assets to promote innovation, agility. The amount of public cloud expenditure relative to the total amount of spending in each industry in the region indicates the importance of the cloud to each industry and highlights which ones are delaying cloud adoption (see Figure 9).

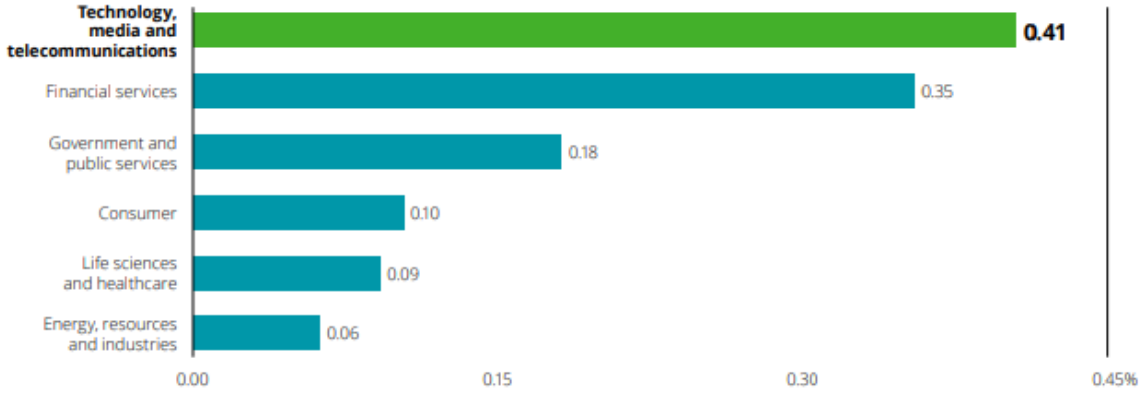

Figure 9. Public cloud spend as a share of sector output across Asia Pacific, 2018 (Source: (Deloitte, 2021)*)*

In Deloitte report (Boy Kester, 2021), only 7% of the surveyed firms said that their organizations had not adopted any cloud technology while most of the surveyed firms stated that they have made significant progress in investing and using cloud technology. Moreover, from the chart presented in figure 10, only 11% of the interviewed firms indicate an advanced level of cloud adoption, and most belong to the technology, media and telecommunication sectors (Boy Kester, 2021).

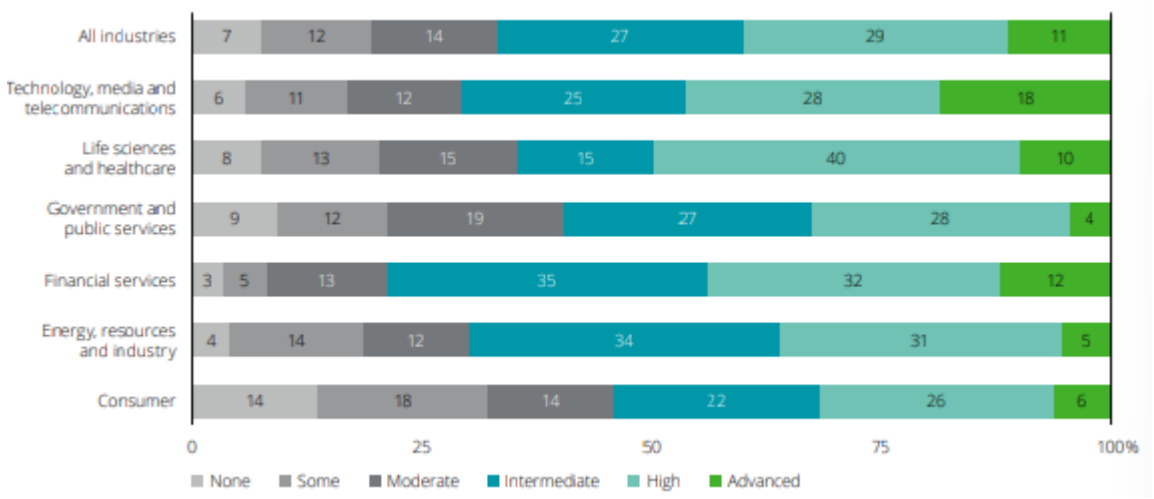

Figure 10. Current level of adoption of cloud technology
(Source: (Deloitte, 2021)*)*

Moreover, significant differences can be seen across industries, it can be seen that the technology, media and telecommunication sector have 18% of enterprises that are advanced adopters, which is more than the triple of the percentage of consumer, and government and public service sectors.

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Cloud has become an integral component of business strategy, more than 70% of surveyed firms indicated that cloud has enabled their teams to experiment and innovate quickly and frequently, and they feel more prepared to address future challenges and organization needs, in different situations cloud services allow firms to reinvent themselves (Boy Kester, 2021).

6 Case Study: Milestone Systems deploying XProtect on Cloud

The purpose of this section is to provide insights into the benefit and limitations of deploying a solution on the cloud, and Milestone XProtect will be analyzed as a video management software (VMS) that is deployed on Amazon Web Service (AWS) cloud infrastructure, and that operates in the European and Asia Pacific market. An overview of the different deployment architectures and relevant AWS services that are either a part of Milestone XProtect VMS product on AWS Marketplace or can be applied to extend and customize the standard offering will be presented. This section should let us understand the overall Milestone XProtect AWS Marketplace offering and how it can be deployed and adapted to meet specific customer needs.

Milestone Systems is a global supplier of open platform IP video management software headquartered in Copenhagen, Denmark, with 18 international offices in the US, the UK, Australia, Brazil, Bulgaria, UAE, France, Germany, Italy, Japan, Spain, and Singapore.

Founded in 1998 with the dream of building a software development company that could improve business through managing and distributing digital video data regardless of time or location. It is a company that set up its business with an international scope, and to efficiently reach customers in distant markets, the software was designed to be sold through regional and local partners. Today with more than 1000 employees, Milestone Systems is well established and respected as a world-leading provider of open platform IP video management software, with alliances and solution partners at the forefront of the industry.

Milestone XProtect is a Video Management Software (VMS) that brings a video surveillance installation together in a solution that keeps people, premises, and property safe. Built on an open platform architecture, it allows customizing surveillance systems and integrating other business applications for increased usability and performance.

6.1 Milestone VMS components

Milestone XProtect VMS is a scalable video management software that combines high-performance video processing and recording with advanced video management functions. The system architecture is divided into different components to allow continuous scaling and meet different customer needs. This allows the software to move from a single server installation serving ten camera devices to a fully distributed installation serving a thousand or more devices.

Figure 12 below provides an overview of the XProtect system architecture and its main system components when deployed in a distributed configuration, not all the components are necessary for an installation, but they can be installed if the functionality they offer is needed.

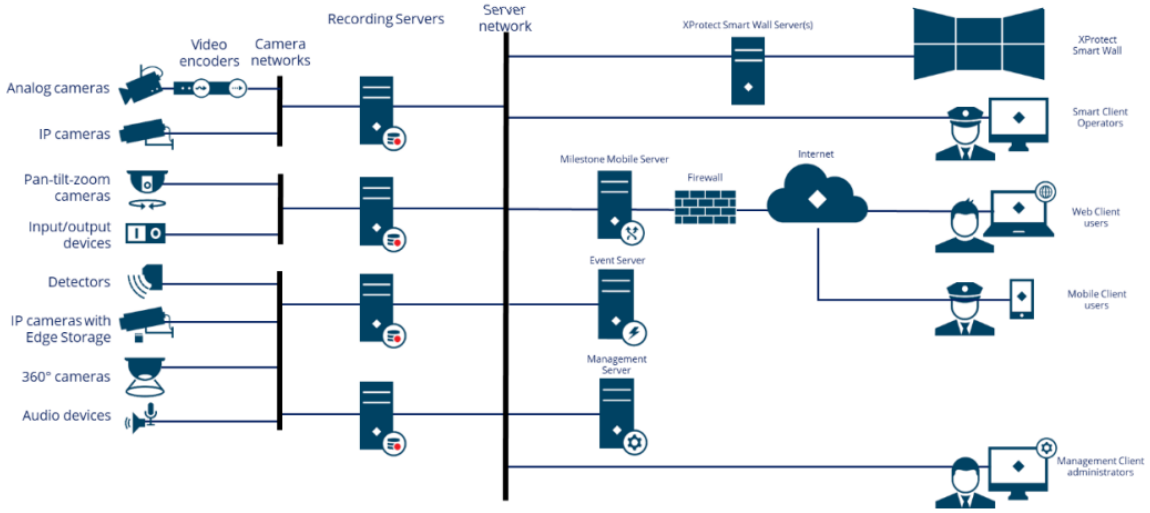

Figure 11. The principal XProtect VMS architecture with server components and client applications (Source: Milestone Systems,2020)

Now, a description of the key server components and client applications in the XProtect VMS system architecture it is provided.

The recording server is responsible for all communication with devices (cameras, video, audio encoders, IoT devices such as input/output (I/O) modules, metadata sources, etc.). This component receives media and metadata streams and makes both live and recorded streams available for viewing in the XProtect client application and other applications

integrated via the Milestone Integration Platform Software Development Kit (MIP SDK). In addition, the recording server is responsible for a comprehensive set of device and event-handling functions. For example, it can be configured to perform motion detection on received video streams.

The management server is the central component of the VMS, and it is responsible for handling the system configuration, distributing configuration to other system components, such as recording servers and facilitating user authentication. The configuration data are stored in a standard Microsoft SQL server installed on the management server or a separate dedicated server.

The event server handles various tasks related to events, alarms, maps, and third-party integrations via the MIP SDK (Milestone Integration Platform Software Development Kit).

The mobile server is responsible for hosting the XProtect Web Client and providing VMS access to the XProtect Web Client and Milestone Mobile client users.

XProtect Smart Client is the primary client for XProtect VMS, offering a complete set of advanced video surveillance and incident management features. The XProtect Smart Client is designed to be run remotely on the operator's computer and decodes video streams and renders these on the Smart Client workstation using hardware (GPU) accelerated decoding and/or software (CPU) decoding.

The XProtect Web Client is designed for the occasional or remote user who needs easy access to the VMS system, including live monitoring, playback, investigation, export, and light alarm management.

XProtect Mobile provides a flexible way of accessing an XProtect VMS for users using smartphones and tablets. The application provides all essential functions for live viewing, playback, and incident management.

The management client is a client administration interface for all parts of the VMS.

6.2 Cloud deployment scenario

The possibility of running XProtect VMS on AWS cloud infrastructure is an opportunity open to a broad set of enterprises and organizations of different sizes, active in different segments and industries, and with different IT maturity levels. It includes private businesses and enterprises, educational institutions, and public and governmental organizations.

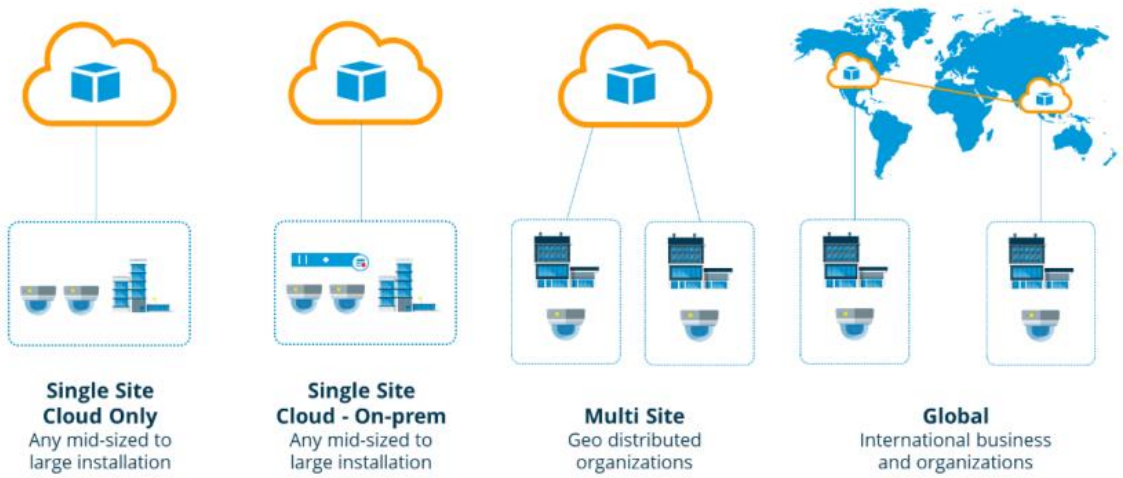

Figure 12. Typical deployment scenarios for XProtect VMS on AWS (Source: (Milestone, 2020)*)*

6.2.1 Single site – cloud only deployment

It represents the most straightforward deployment, and it consists in a situation where there is a customer with only one location, the video surveillance system cover cameras and other devices commissioned on one specific location. In this scenario, the servers of the VMS are deployed on the end customer's service infrastructure in AWS. When customers decide to deploy XProtect from AWS Marketplace, the cloud-only deployment is the default deployment scenario. Usually, the software is deployed in the AWS Region with the closest proximity to the customer's physical location, but network connectivity and data privacy matters may influence the selection of deployment regions.

6.2.2 Single site – cloud and on-premises deployment

As in the previous scenario, this deployment covers only one location, but instead of deploying all XProtect server functions on AWS, a hybrid deployment is selected, which means that some XProtect VMS services are in the cloud and some are physically on the customer's premises. In some cases, it makes sense to outplace one or more XProtect Recording Servers on-premises, for instance, when the size of the XProtect system measured in the number of connected cameras is very large or when it is difficult to get sufficient and reliable network connectivity to the AWS data center.

This type of deployment is suggested in regions with lower penetration and availability of reliable high-speed internet connectivity. Furthermore, this architecture is a natural stepping stone for migrating existing on-premises XProtect installations for an AWS cloud infrastructure.

6.2.3 Multi-site deployment

Nowadays, most companies operate across two or more geographically dispersed sites. Therefore, the advantages of cloud deployment VMS solutions become very evident for this type of c deployment, in this scenario, a cloud-hosted VMS application not only provides a centrally managed video surveillance platform covering all sites uniformly, but the cloud architecture also allows the on-premises deployment to be simplified and leaned. This optimizes the initial deployment time and cost, but it also reduces the maintenance costs because there is less on-premises hardware, which imply less maintenance and fewer on-site visits.

Customers with this type of deployment would usually deploy XProtect in an AWS Region located centrally to the customer's geographically dispersed sites, but if some sites are larger than others, it can be reasonable to deploy XProtect in the AWS Region in the closest proximity to the largest site.

Moreover, multi-site deployment can be performed with hybrid deployment on one or more sites, in which XProtect recording servers are placed on individual locations to provide local compute and storage capabilities or to mitigate capacity and reliability issues.

6.2.4 Global deployment

Some enterprises and organizations need to coordinate and align video security operations globally, connecting sites in multiple countries and continents. In this scenario, AWS is the perfect cloud provider with a reliable global presence and global network infrastructure, in which every data center, availability zone (AZ), and AWS Region are interconnected with high availability and low latency private global network infrastructure.

When designing a global XProtect deployment, there are several relevant principal design options:

- Single XProtect VMS system with regionally deployed XProtect recording servers

  In this design, the main components of XProtect are deployed in one principal AWS Region, while offices in remote countries would be served by XProtect recording servers deployed in an AWS Region nearby the customer's remote location. The remote recording servers would then be connected to the XProtect VMS system in the primary AWS Region.

- Federated XProtect VMS regional systems

  It consists of standalone XProtect VMS systems deployed in different AWS Regions that can be federated across AWS global infrastructure to form a centrally managed video surveillance system with no limits on the number of cameras that are connected to it. Additionally, a federated system hierarchy can naturally be hybrid, where on-premises deployed XProtect systems can be federated into a cloud base XProtect corporate deployment.

- Interconnected XProtect VMS regional systems

  Milestone Interconnect is a feature that allows Milestone's VMS to be interconnected with an XProtect Corporate headend system. It allows for the design of large-scale and geographically dispersed video surveillance installations. Moreover, each site can be designed with the required functionality and deployed as traditional on-premises systems, cloud-deployed, or any combination.

6.3 Operations Cost

Cloud deployment of XProtect VMS differs from on-premises deployment, especially concerning how the IT operation is managed and structured. The use of the cloud not only enables significant opportunities for outsourcing and optimization of IT operations, but it completely changes how compute and storage infrastructures is acquired, from the upfront purchase of static hardware to a flexible pay-per-use purchase of hardware as a service.

The list of parameters that contribute to the operational costs is long, and it depends on the nature of the business, industry, and geographical location, hence it is challenging to make an exact calculation of the operational costs. Therefore, only direct operational costs will be discussed in the following section, which are the cost of AWS services when used with XProtect VMS.

The AWS EC2 instances type required for a specific XProtect VMS deployment depends on a wide range of parameters, including the number of cameras in the system, stream properties such as resolution and framerate, and the use of server-side motion detection.

Milestone has done large-scale performance testing in different instance families and instance types, including t3, m5, m5a, c5, g3s, g4dn, and i3 families. Based on this testing, Milestone recommends the EC2 instance types presented in Table 4 below when operating with different degrees of recording (Degree of recordings refers to how much the VMS system is recording during a day, 10% recording corresponds to 2 hours, and 24 minutes recording per day). The measurements of the table are based on H.264 video streams with 1080p resolution and 30 FPS, with a constant throughput of 4.0 Mbps per camera.

INSTANCE TYPE	DEGREE OF RECORDING				RECOMMENDED MAX. AVG.. CPU LOAD
	100%	50%	25%	10%	
t3.large	7	7	8	8	35%
c5.large	16	17	17	18	50%
c5.xlarge	36	38	39	40	50%
c5.2xlarge	92	94	95	96	70%
g4dn.xlarge	97	106	110	113	50%
g4dn.2xlarge	133	242	268	275	70%
g4dn.4xlarge	427	468	480	480	70%

Table 3. Maximum cameras per XProtect recording server, for recommended EC2 instances. (Source: (Milestone, 2022)*)*

The Figure 14 below represents the price performance ratio for the recommended EC2 instance types listed in the Table 4, the dark blue line and the grey one represents respectively the annual cost per camera for US East (N. Virginia) and Europe (Ireland) with the maximum recommended utilisation.

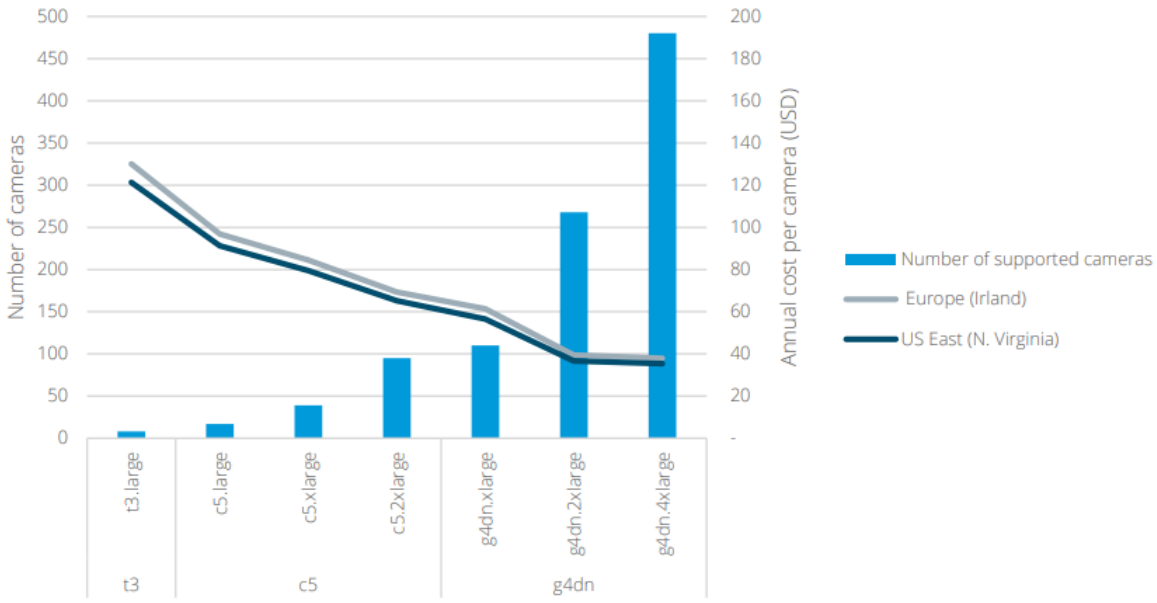

Figure 13. Price performance ratio of recommended EC2 instances (Source: (Milestone, 2022)*)*

The above graph shows that the annual cost per camera decreases for all the regions when increasing the number of cameras and selecting more powerful EC2 instances. Although this behavior was expected because the scaling up in the cloud always leads to

a decrease in the price, it can be seen that the cost is slightly higher in Europe (Ireland) with respect to US East (N. Virginia) this can be justified by taking in consideration the number of users that is using the cloud in that region, and it is known that the more user there are, the lower will be the cost faced.

The Amazon FSx for Windows File Server is used for long-term video storage, and the cost is determined based on how much data is retained and for how long, it is a flexible-priced storage service where the customer only pays for the resource they use. Furthermore, the native FSx service has several pricing parameters, but when using XProtect, a small set is relevant:

- Storage capacity

  It represents the average amount of storage provisioned in the file system per month, measured in gigabytes months (GB-Months).

- Throughput capacity

  Obviously, this parameter depends on the deployment type the final user implements. The cost is calculated considering the average throughput capacity provisioned for the file systems per month, measured in MBps-month. If the data are transferred from one availability zone to another, the data replication cost is included in the throughput capacity price.

The requirements for cloud connectivity depend on the organization, and AWS offers different networking services to meet different needs, but Milestone adopts only the essential AWS Site-to-Site VPN.

Moreover, AWS provides Virtual Private Cloud (VPC) without cost, the only cost that a customer's faces are the ones associated with the transfer of data out from the VPC, often called date egress. In the case of XProtect, data egress happen when users access the VMS systems through XProtect clients.

The quantity of data egress depends on the user behavior, the following parameters are the one that helps in quantify the amount of egress data:

- Number of users
- Which XProtect clients is used
- Frequency and duration of use

- Quantity of video streams viewed
- Use of XProtect network bandwidth optimization features

Figure 15 illustrates a graph showing the yearly cost for one user accessing the XProtect VMS system through different methods with different usage patterns in terms of average usage time per day and the number of camera streams that are viewed.

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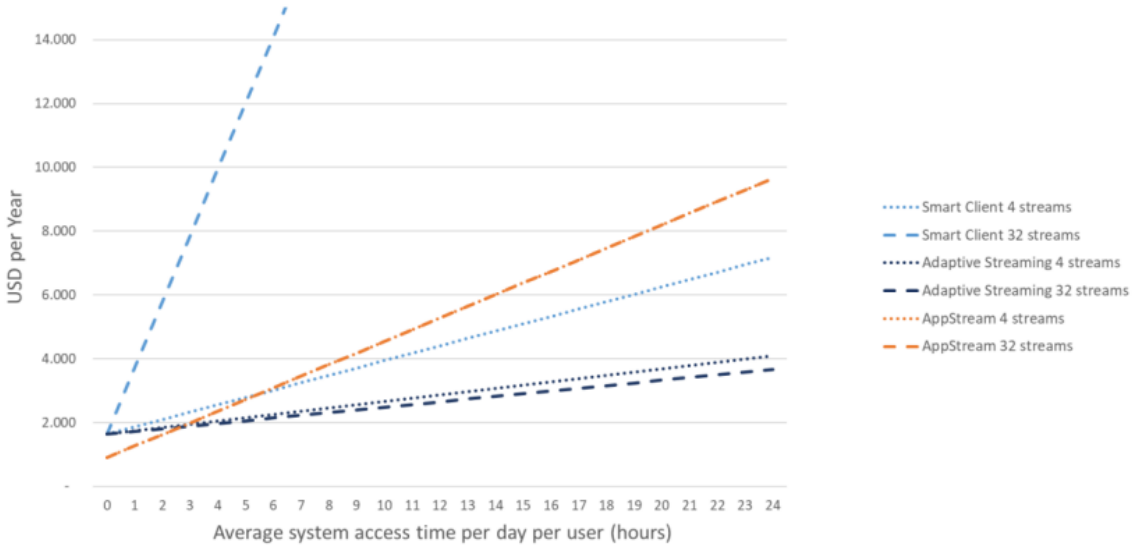

Figure 14. Accumulated yearly user access cost for different user access methods at different levels of average daily usage.
(Source: (Milestone, 2022)*)*

In the y-axis of Figure 15, we have the cost per year, including Virtual Private Cloud data egress and workstation hardware costs. Although the graph shows that the yearly cost is a linear function of how many hours a user accesses the system per day, it can be seen that the cost grows drastically when using non-adaptive stream access, the adaptive stream features keep the data egress cost at a reasonable level, even when the usage is stressed both in the number of access hour a day, and number of viewed cameras. Adaptive streaming is a method used to improve streaming over HTTP networks, with this feature, the video player learns what video quality a connection can support. If the connection struggles to play a video stream, the player will switch to lower quality for the next stream. Obviously, the quality of the stream will decrease, but the user will be able to see a continuous stream.

Amazon AppStream 2.0 is a viable and attractive solution to run client on the end customer premises, the service price is composed by three main parameters:

- Number of enabled unique users
- Duration of usage
- Type of EC2 instance used

While the use of AppStream raise additional AWS service cost, the user will not sustain cost for data egress, moreover this service can unlock additional savings on workstation hardware and reduced desktop IT administration effort.

Milestone has performed testing of the Smart Client in AppStream, using different user scenarios, different number of simultaneously displayed camera streams, different resolutions and at different frames rate. Figure 16 shows the result obtained, during the testing Milestone has compared the performance of decoding and rendering 480p, 720p and 1080p H.264 streams at 15 FPS and 25 FPS.

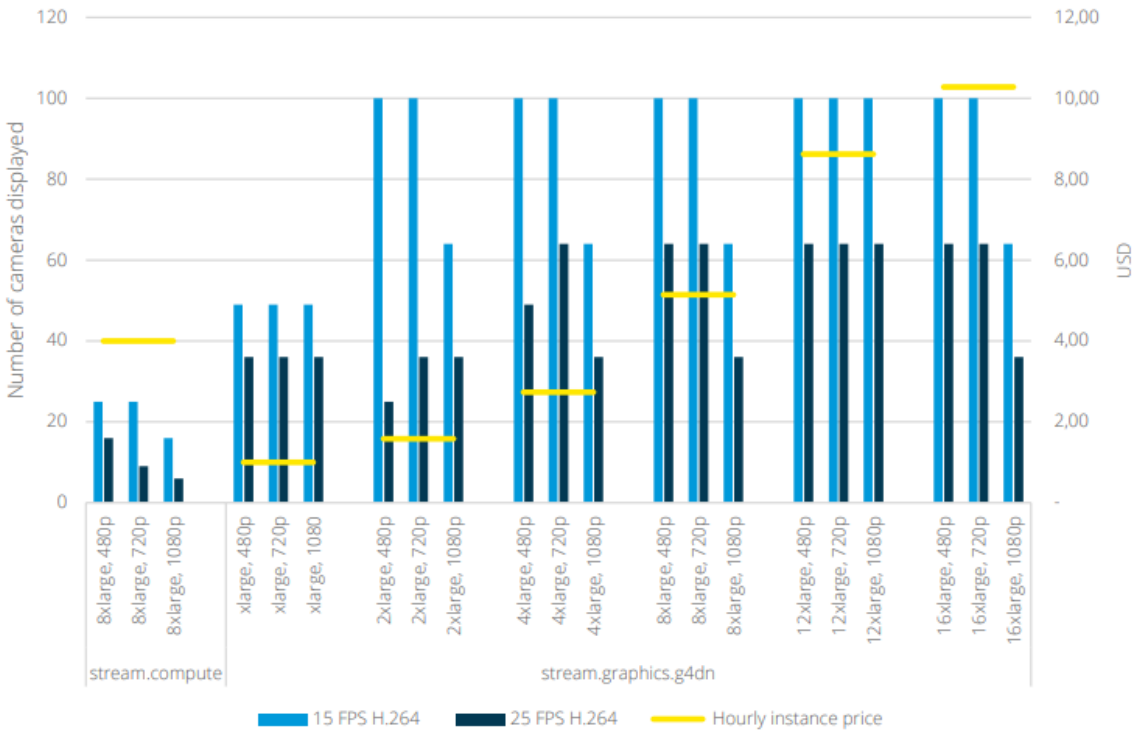

Figure 15. Amazon AppStream 2.0 – Smart Client performance at different user scenarios and different EC2 streaming instances
(Source: (Milestone, 2022)*)*

The smallest instance size in the stream.graphics.g4dn family delivers a good performance, and should suit all the different user usage scenarios. The stream.graphics.g4dn.xlarge instances supports decoding and rendering of approximately 49 camera streams at 15FPS, or 35 streams at 25 FPS. Furthermore, we can also extract other information about the maximum number of cameras that the client can display, and

the hourly instance price based on the type of EC2 instance and if there is the use or not of graphic card. When the user is using a normal computing (stream.compute) the hourly price of the instance is constant and it is 4 USD per hour, and for both stream at 15 FPS and 25 FPS the total number of cameras displayed decrease with the increase of the resolution. In the second case when there is the use of a graphic card to allow hardware accelerator the hourly price is constant within a family of EC2 instance, but it grows when adopting an EC2 instance family more powerful. For instance, in the xlarge family the hourly price is lower than 2 USD while in the 16xlarge family it is higher than 10 USD per hour. Moreover, for what concerns the number of cameras displayed in the first type of family we have different amount of cameras displayed for stream in 15 FPS and 25 FPS but within them the increase of resolution do not affect the number of displayed cameras. Generally, by looking at the graph when using a 15 FPS stream with a graphic card the number of displayed cameras is almost always the same when using a 480p or 720p resolution, it can be seen a decrease when shifting to a 1080p resolution. While when using the 25 FPS stream with a graphic card the scenario is different, in the first family the number is constant when increasing the resolution, in the second family it increases when increasing the resolution. While in the 5th family it's constant and in the last family it's constant for both 480p and 720p resolution but it decreases when shifting to 1080p.

When dimensioning server and storage infrastructure numerous assumptions are made, those may lead to an evident risk for errors resulting in the system overprovisioning. In a physical deployment the surplus of hardware is a sunk cost, but in a cloud deployment there are opportunities for post deployment optimization, so for cost reduction.

In addition to the AWS service charges final user should add the Internet access service provided by the regional Internet Service Provider, and the on-premises router equipment needed.

6.4 Cloud deployment advantages for XProtect

Milestone XProtect VMS is a compute and data-intensive workload, deployment of the software on AWS is particularly relevant for enterprises and organizations with a cloud-first strategy or a clear migration path to the cloud. Additionally, enterprises and organizations with high cloud readiness and AWS IT competencies are the best ones to fully explore the synergies between Milestone's VMS solution and the elastic scaling offered by AWS infrastructure and platform services.

There are many reasons why firms and organizations should consider deploying XProtect on AWS cloud infrastructure. These can be grouped into two categories:

- General cloud deployment advantages
- Advantages specifically related to XProtect

6.4.1 General cloud deployment advantages

When using the cloud, firms can rely on low-cost, pay-as-you-go pricing with no up-front expenses or long-term commitments, AWS can build and manage a global infrastructure at scale and pass the cost savings benefit to the firms in the form of low prices. Moreover, agility and instant elasticity is gained because AWS provides a massive global cloud infrastructure that allows you to innovate, experiment and iterate quickly. Instead of waiting weeks or months for hardware, enterprises can instantly deploy new applications, instantly scale up as their workload grows, and instantly scale down based on demand. Another advantage is to be open and flexible; companies can choose the development platform or programming model that makes the most sense for their business, and they can choose which services to use and how to use them, this flexibility allows a firm to focus on innovation instead of infrastructure. Finally, AWS is secure, its services and data centers have multiple layers of operational and physical security to ensure the integrity and safety of the firms data.

6.4.2 Advantages specifically related to XProtect

The first specific advantage is linked to the speed of deployment, and video surveillance systems are complex Internet of Things (IoT) systems because they are both compute and storage intensive. Therefore, commissioning these systems requires careful solution design, selection of server and storage hardware, and all the logistics with ordering, shipment, unpacking, and installation.

When firms adopt a cloud deployment of XProtect, many of these activities can be simplified or eliminated, allowing faster and cheaper deployment of XProtect VMS.

The cloud deployment of XProtect enables elastic scalability, as known the needs are continuously changing for the firm, and AWS cloud infrastructure allows customers to grow their XProtect deployment based on their needs. A deployment can scale from 10 to 500 cameras on a single EC2 instance, leveraging the ability to shift EC2 compute platform during operation makes scaling instant while maintaining an attractive balance between performance and cost. When a firm present higher needs, the deployments can be scaled out on additional EC2 instances to support thousands of cameras and IoT devices.

When designing the system, many assumptions need to be taken into consideration during the dimensioning of a video surveillance installation, hence there is an evident risk of errors, and those ones can result in suboptimal system performance. An example is the over-dimensioned systems that present expensive, underused hardware, and with time they will not provide a total return on the investments. In cloud deployment, excess system capacity can be removed as a part of post-deployment cost optimization, which reduces AWS service charges. For instance, if a firm has allocated a too powerful EC2 instance for their deployment, they can change it to a smaller, more price-effective instance type in a few minutes.

In the same way as the compute capacity being scaled elastically, additional video storage can be added when needed, Milestone suggests using Amazon FSx for Windows File server for long-term video storage.

XProtect deployment on the cloud allows flexible user access, as an alternative to on-premises deployment of the XProtect Smart Client, AWS gives the possibility to run client applications as hosted user sessions in the AWS cloud using the Amazon AppStream 2.0 service. This allows using the Smart Client virtually on any device, including browsers, Macs, and tablets. The service is also a good and secure way of providing access to the

Smart Client for remote users and law enforcement bodies without installing any XProtect software.

6.5 Case Study conclusion

Milestone Systems is an excellent example of a firm that decided to embrace the world of CC, by analyzing the solution, it can be seen how the firm did not wholly move everything on the cloud, but they are shifting to CC gradually, their solution can be both fully deployed on cloud or in a hybrid set up, where part of the VMS is on-premises, and the others are on the cloud. The strategy of Milestone is effective because cloud deployment reduces the cost faced by firms toward hardware and resources. Due to that, Milestone can meet the needs of enterprises and organizations of different sizes and is active in different segments and industries, characteristics that make Milestone flexible towards customer needs.

Milestone case studies help show the benefits and advantages that firms gain when adopting cloud technology, and they are always of two types, the specific ones related to the company sector and the generic ones related to the general benefit of the cloud.

The generic ones are linked to the benefit of CC, they face low cost due to the pay-as-you-go pricing with no upfront expenses, agility and elasticity are gained thanks to the massive global cloud infrastructure provided by the cloud provider that led to faster innovation, experiments, and iteration. Firms can instantly scale up when the workload grows and scale down when it decreases. Moreover, XProtect cloud deployment is open and flexible, firms can choose the development platform that makes the most sense for their business, this flexibility allows firms to focus on innovation instead of infrastructure. One specific advantage of XProtect on the cloud is linked to the speed of deployment because video surveillance systems are both compute and storage intensive. Milestone cloud solution enables elastic scalability because the cloud infrastructure allows customers to grow their XProtect deployment based on their needs, and it allows them to correct errors performed in the system design quickly. It also allows flexible user access, on the cloud is possible to run client applications as hosted user sessions.

7 Opportunities for other companies

With the increasing use of public cloud services, more sensitive data is at risk, a fact that explains the concern about risk issues for firms. The case study presented is a clear example of the right approach toward digital transformation in a cloud environment, shifting from the provision of a solution to a provision of a service that can be accessed at any time and from anywhere with the ability to scale up or down in a low amount of time.

Cloud adoption requires highly technical and specialized expertise, which many organizations might not have in-house, knowledge and skills in the cloud are in high demand. Also, the regulatory landscape of the CC has become increasingly complex, and policymakers and regulators seek to balance the benefits of increasing cloud adoption across organizations and the potential adverse effects, mainly around privacy and data violation.

To exploit cloud benefits, organizations need to start planning to spread capabilities, think about new innovative ways of operating to remain reliable for their customers, and use the cloud as a competitive enabler to manage business disruptions.

Six top actions are highlighted for organizations to get ready and promote the cloud across their business, and they are listed below:

- Leader-led cloud strategy

  It is vital to have a technical plan for migrating to the cloud, and organisations should look to integrate their cloud migration strategy within the overall organization strategy. To properly gain the management's commitment towards adopting the cloud, the design of relevant key performance indicators (KPIs) assigned to senior leaders needs to be performed. Those KPIs should be linked to value-enhancing business outcomes, such as enabling innovation, improving collaboration across business units, or driving employee satisfaction. Furthermore, leaders should share and communicate progress and successful use cases of cloud transformation (Boy Kester, 2021).
- Do not held back by legacy systems

  Legacy systems might have led business growth in the past. However, they can reach maturity point and become a financial weight to maintain, blocking organizations' ability to grow and innovate to meet the changing customer demand and business challenges. When firms modernize legacy systems and move them

to the cloud environment, an opportunity to retire obsolete systems arises (Boy Kester, 2021).

- Be courageous in experimenting

  The cloud is an accelerator for innovation and can transform a firm at a rapid pace. Although the pandemic has forced many firms to rethink their use of cloud technology, the disruption created by it pushes firms towards adopting the cloud and experimenting with new business ideas to drive growth (Boy Kester, 2021).
- Work with partners

  Organizations do not need to embrace the cloud journeys alone; cloud-proven consultants and providers have the knowledge and experience to guide an organization through their cloud migration journeys while anticipating and managing potential risks and uncertainties (Boy Kester, 2021).
- Develop a cloud-fluent workforce

  It is common to see many organizations focus resources on the technology front of the cloud instead of the workforce but operating in the cloud requires a talent pool with new skills. Therefore, enterprises must plan and define the workforce and skills needed to ensure practical work in a cloud environment (Boy Kester, 2021).
- Time to rethink risk

  When moving to the cloud, business leaders need to re-adapt their approaches to business risk, launching a new customer service could be a matter of days and weeks rather than months. These benefits bring new challenges and require looking at risks with a new lens. For instance, speed to market provides a competitive advantage, but it could also expose businesses quicker to other operational challenges in customer service and order fulfilment (Boy Kester, 2021).

The CC era is evolving fast, as organizations increasingly move into the cloud, business leaders need to shift approaches to managing access, control, and risk. These will have implications related to how a firm operates internally and its interactions with suppliers, partners, and customers.

The spreading of CC in EU and APAC enterprises is increasing, but there is still unexploited growth potential, especially in SMEs and in large European countries such as Germany, Spain, France, and Poland. Adopting the cloud creates several benefits for enterprises that lead to innovation and economic growth. The main factor influencing the adoption of the cloud is cost savings, firms do not need to buy and maintain expensive infrastructure, but they only pay for the services they use from the cloud provider.

Companies only pay for the infrastructure and services they need, depending on demand, the required services can be scaled up or down, and this leads to efficiencies. Moreover, efficiency advantages result from the fact that companies no longer have to worry about the investment, maintenance, and updating of servers or applications, the cloud provider can take care of this.

Using CC services leads to cost savings and efficiencies for businesses and promotes energy efficiency. Often, servers and storage capacities of classic IT infrastructure still need to be used by companies, through CC companies only use the required storage and computing capacity. In addition, firms no longer have their servers, but the cloud provider’s servers are shared, which also means that the enterprises' utility costs are reduced.

Moreover, adopting cloud services enables multi-dimensional network effects, as companies' cooperation is facilitated. For instance, several cooperating companies can work simultaneously on the development of products and services through a platform hosted in the cloud, this makes the development of products and services more flexible, faster, and efficient.

One of the most significant opportunities of CC is the encouragement of innovation, lower cost for computer capacities or software application allows companies to initiate and realize specific product or service developments. In addition, firms take less risk when projects can be developed more cost-effectively through CC, this applies to companies from all sectors of the European and Asia Pacific economy. Netflix represents an example; the firm needs great computing and storage requirements but does not have its infrastructure. For most of its computing and storage needs, Netflix relies on Amazon’s cloud offering, without CC, Netflix would probably never have been able to innovate the international television market. Hence, CC offers an entirely new way to do business and promotes innovation (Justus Haucap, 2022).

SMEs significantly benefit from the described advantages of CC due to cost-effective access to the latest technologies and applications, in the past, such applications or computing capacities were only available to large companies. CC not only reduces the costs of businesses but transforms fixed capital expenditure into operational costs, companies rent servers and computing capacity from the cloud provider, and no hardware needs to be purchased, this lower market entry barriers and promotes the emergence of new start-ups.

The benefits of CC are vast and apply to all businesses, but different aspects of CC apply to a specific types of companies:

- Start-Ups

  They do not have to make costly upfront investments in servers or computing power, and they can rent this service as needed, making it easier to enter the market.

- SMEs

  They benefit from the easy scalability, which creates efficiencies, and they get access to ample computing power and the latest applications, which make the development of new and innovative products possible.

- Large established firm

  They can outsource their entire IT department; this saves resources and allows the company to focus on its core business. It also enables flexibility for employees, and cooperation within a company as well as with other companies is facilitated.

8 Future Trends

CC is continuously growing in the tech world, as stated before, it enables simple on-demand access to shared computing resources through configurable services. Enterprises are progressing rapidly toward digital transformation, aiming to improve business continuity, agile processes, scalability, and profits. Cloud technology in the next year will remain at the core of the majority business strategy, providing the ability and flexibility to follow evolving standards.

The global spending on public cloud products is growing at an annual rate of 20.4%, and it will probably reach $600 billion in 2023 (Rimol, 2022). Gartner forecast, projects that end-user spending on IaaS is growing at 30.6% each year and for PaaS is growing at 26.1% each year. Moreover, a new type of service is spreading, namely Desktop as a Service (DaaS), with a growth rate of 26.6% per year. Enterprises that in the last years provided employees with traditional client solutions such as workstations and other office tools are now shifting to DaaS services.

The next generation of CC will enable businesses to take advantage of artificial intelligence, machine learning, and blockchain technology. With the increasing capabilities of AI, enterprises will be able to transfer more work to machines, which will release humans to do more creative work. This will apply mainly to industries like healthcare and education, many new AI-based services will emerge, like voice assistants and visual assistants that can help the final user with grocery shopping or booking a holiday. The user can communicate with a computer naturally and have it understand what they want to do.

In recent years, the cloud has been associated with AI, according to IBM, the union of cloud and AI *“insures to be a means to accelerate change and also be a source of innovation”*. In the last few years it has been noticed a big amount of investment on the capabilities of AI in the cloud platforms, tech giants like Google, Amazon, and Microsoft have started integrating AI abilities. AI carries unique features that can influence future generations of CC platforms, which will probably lead to the new AI-first cloud era. Furthermore, the combination of AI and the cloud is becoming disruptive across many industry verticals. The AI-cloud relation not only creates a new way of thinking about other technologies and methodologies, but it also brings a new degree of accessibility to AI

technology. CC and AI will be used to develop intelligent solutions for everyday business, this will enable firms to do things that they never imagined possible such as: streamline services and processes, develop and optimize operations, create new services and solutions, ensure the security of information and communications, empower users to work faster. According to Gartner, one in every three organizations will be using cloud-based AI by 2024, and it will become an integral component of an enterprise experience, firms will increasingly use AI systems to enhance their daily interactions with each other.

While the rise of blockchain technology means that data security will be at the forefront of CC, firms will be able to secure and store data on the cloud, while ensuring the privacy of that data.

The success and spreading of CC are leading to the evolution of two new computing technology:

- Quantum Computing
  In this new technology, quantum computers employ the principles of quantum physics to enable complex algorithm calculations and process large data sets in a short amount of time. In addition, a supercomputer provides powerful encryption capabilities for electronic communications and increases network security. Companies like Google, IBM, Microsoft, and AWS promote innovation by leveraging quantum physics principles to develop next-generation end-user products. Financial institutions can leverage quantum computing to accelerate their transaction processes, hence saving time and increasing process efficiency (Perry, 2022).

- Edge Computing
  Cloud providers are moving closer to the edge to respond to the growth of 5g, Internet of Things devices, and latency-sensitive applications. It is not a new technology in the tech world, but enterprises are increasingly adopting it. Even though data centers are built to store a large amount of information in one centralized location, half of the global population lives in rural areas. Edge computing allows systems to become increasingly distributed, bringing data and processing closer to users. This approach reduces latency, cuts bandwidth costs, and improves connection performance (Perry, 2022).

CC is likely to become even more continuous and invisible for firms, they will be able to access data from anywhere, and much data will be stored in the cloud, quickly becoming

the default option for data storage. The cloud will also become more intelligent, with AI-enabled systems helping businesses to manage their cloud data. CC services will become more specialized and supply different industries and business types. There will likely be different types of cloud providers with unique offerings (Joseph, 2022).

The flexibility, scalability, and cost-effectiveness of CC have made it a popular choice for companies of all sizes. However, CC is also beginning to enter the education industry. Schools and universities use cloud-based applications to improve communication and collaboration, manage workloads, and store data. For instance, Google Docs is a popular choice for students and professors who need to share documents and work on them in real time. Cloud-based learning management systems (LMS) are also becoming popular, allowing teachers to create and deliver course content online. Also, many schools use cloud-based storage solutions to store student records, grades, and other sensitive data. The benefit of CC is becoming increasingly apparent in the education sector, and its use will likely continue to grow in the years to come (Anand, 2022).

As the educational sector, the healthcare industry is embracing the cloud to store and manage data and deliver applications and services. There are many reasons behind this shift, but the principal among them is that cloud-based solutions can offer greater flexibility and scalability than on-premises solutions. Moreover, the cloud can help to improve patient care by providing doctors with better access to data and analytics. Lastly, by moving to the cloud, healthcare organizations can save money on hardware and IT costs (Anand, 2022).

9 Budget summary and/or economic feasibility study

The total amount of hours spent in the development of the thesis is 818 hrs, and the total cost is 33.340,00 €. Please see attached file Budget for more details.

10 Analysis and assessment of environmental and social implications

When enterprises move from on-premises infrastructure to the cloud, they gain some benefits, such as reduced general costs, trading capital expenditures for operational expenditures, and scalability without adding physical machines. These benefits change into less power usage and less environmental waste when cloud machines are retired.

There are three ways in which cloud migration can help enterprises to achieve their sustainability goals:

- Reduce power usage

  Cloud data centers, by design, operate more efficiently than smaller on-premises implementations, thanks to dynamic provisioning and multitenant architecture. When a data center is well designed, it can adapt hardware for efficiency to reduce power consumption and keep heat generation at a minimum. Moreover, data centers can be powered by wind, solar, or a mix of renewables and non-renewable sources that can further reduce their carbon footprint.
- Build a greener supply chain

  During the transition of the workloads to the cloud, most of the IT supply chain of the firms changes, and capital expenditures are traded for operational expenditures. Instead of procuring machines and racks and building their own data center, they pay for that as a service and benefit from an eco-optimized supply chain. Increasing the number of firms that adopt the cloud that will lead to a reduction of the carbon footprint across the globe.
- Join the circular economy

  Organizations benefit from economies of scale by migrating to the cloud, especially for carbon reduction, energy consumption, and equipment. The cloud enables them to take advantage of high-efficiency cloud infrastructure with centralized servers, optimized energy use, and intelligent cooling systems.

In this master thesis, it has been highlighted how the transition to CC is nowadays essential for firms. Moreover, the previous paragraph also highlights how this new

technology can help firms contribute to the Sustainable Development Goal. Mainly, the adoption of CC contributes to 3 points of the 17 SDGs, which are:

- Responsible use of resources
  CC ensures sustainable consumption of computing resources and production models.
- Fight against climate change
  As mentioned before, the adoption of cloud technology help in reduced the carbon footprint.
- Partnership for the goals
  When firms adopt the cloud, they can easily cooperate and interact with each other, allowing them to influence each other.

11 Discussion & Conclusions

CC allows firms that adopt it to adequately meet the specific need of their customer and enhance their competitive positions inside a specific market. Therefore, this technology is suitable for all start-ups, SMEs, and large established firms, and the findings prove that the number of enterprises adopting CC has continuously increased since 2008. Moreover, when firms decide to embrace this technology, it allows them to outsource their IT department, which may lead to actual savings of money, characteristics that justify why it is also suitable for start-ups and SMEs.

The spreading of cloud technology also raises issues for firms when they adopt it. The main issues are related to the governance of the technology and the need for compliance with general regulations and laws for customers and cloud providers.

This master thesis identifies a list of barriers companies face when shifting to the cloud, which are related to security and privacy, and the protection of personal, scientific, commercial, and intellectual property.

CC pricing is based on the concept of “pay as you go”, in which users pay only when they use services provided on the cloud. However, during the thesis development, other types of costs were identified within the utilization of the cloud. They are the cost of transaction information processing services, set-up/contracting costs, the cost of monitoring and coordinating the vendors' activities, and switching costs.

When firms decide to adopt the cloud, they are not just looking to cut their costs, but they also consider other parameters, which are: assessing capabilities, features, security risks, costs, relative advantage, and complexity.

In the market research, findings related to the EU and APAC were noticed.

In Europe, 41% of enterprises used CC in 2021, mainly for hosting their e-mail systems and storing files in electronic form. Moreover, 73% of those companies use cloud services related to security software applications, hosting enterprise databases, or computing platforms for application development, testing, or deployment. In EU firms, the use of CC increased by 5% compared to 2020, and most firms using CC belong to the information and communication sector. Taking into consideration the size of the firms, the use of CC was high in large established enterprises, where 72% of them declared to have used it in 2021, an increase of 7% compared to 2020.

Firms' dependence on CC can be described by the level of sophistication of the cloud service they use. The service can belong to essential, intermediate, and sophisticated services. The findings highlighted that the more sophisticated a cloud service, the more dependent a firm is on cloud technology.

In APAC, it was found that most firms declare that they cannot rapidly shift consumer preferences. Digital technologies can provide solutions to respond to the continuous change in customer needs appropriately. When firms adopt the cloud, they can be more agile and resilient. Cloud plays a vital role in preparing firms for the future and allows them to innovate faster and more frequently. Cloud infrastructure can be used to adapt the product to a new and broader consumer segment and business channels. Across APAC, governments are at different stages of their cloud journey, but they are all focused on the future and the cloud's role in leading the country to efficiencies and improvements. China is leading in that specific region, and the government made the cloud one of the main strategic priorities, driven by the continuous expansion of online services and digitization of processes. The growth in public cloud spending will happen at a different pace and scale across the market, and China will maintain its position in the APAC region as the market with the highest growth and demand for cloud services. The cloud has become an integral component of business strategy in the APAC region. Most firms indicated that the cloud enables their team to experiment and innovate quickly and frequently. They confirmed that cloud services allow firms to reinvent themselves in different situations.

The necessity to analyze a specific cloud solution is filled by providing a case study on Milestone Systems, a VMS company that deploys a solution on AWS cloud infrastructure. Milestone XProtect VMS is a scalable software video management that combines high-performance video processing and recording with advanced video management functions. When deploying XProtect on AWS cloud infrastructure, Milestone can meet the needs of enterprises and organizations of different sizes and be active in different segments and industries, not only large established firms or public and governmental organizations. In this case, the cloud allows the firm to gain new customers. When firms decide to deploy XProtect on the cloud instead of having an on-premises deployment, they face two advantages: the general advantages of cloud deployment and the specific advantages related to XProtect.

Cloud technology will remain at the core of the majority of business strategies. Global spending on public cloud products is growing at an annual rate of 20.4%. In addition, new types of services are spreading, like Desktop as a Service, enterprises that in the last year provided employee workstations and other office tools are now shifting to DaaS service.

The next generation of CC will enable businesses to take advantage of artificial intelligence, machine learning, and blockchain technology. The combination of AI and cloud will be used to develop solutions for everyday business, and this will allow firms to do things that they never imagined possible such as: streamline services and processes, develop and optimize operations, create new services and solutions, ensure the security of information and communications, empower users to work faster.

The success and spreading of CC are leading to the evolution of two new computing technology, quantum computing which employs the principles of quantum physics to enable complex algorithm calculations and process large data sets in a short amount of time, and edge computing which allow systems to become increasingly distributed, bringing data and processing closer to users.

CC is also beginning to make an entry in the education industry. Schools and universities are using cloud-based applications to improve communication and collaboration, as the educational sector and the healthcare industry are embracing the cloud to store and manage data and deliver applications and services.

Finally, CC has the potential to have a significant impact on the world, it has many benefits that it provides to its users, but there are challenges that the technology must address, people, are very skeptical about their data privacy and security.

Future works should address those issues, providing standards and regulations worldwide. Moreover, the adoption of the technology influences the market share of the firms and needs to be further investigated from the qualitative point of view there is information; what is needed is quantitative information about the influence of cloud adoption on firms.

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