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Cloud Computing: Implementation, Management, and Security

Valdeta Demiri

Abstract

Cloud computing, a cutting-edge advancement in information and communication technology, offers significant advantages. Includes the flexibility of computing capabilities, unlimited processing power, and economic benefits for individuals and enterprises, as services are paid according to their use. Cloud services, while offering numerous benefits from information technology, must primarily be secure to be reliable.

Encryption methods can protect data; this approach highlights the limitations of cloud services, rendering them unreliable and inefficient in their offerings. All this makes data owners, especially enterprises, have doubts when their data storage is not under their control, which often occurs in the cloud.

This research paper aims to address challenges and dilemmas of cloud computing, providing information on its organisation, models, and standard services. It particularly focuses on the security aspects of storing enterprise data and the approach to service provider reliability.

The topic brings in key points for implementation, management, and security that enterprises should consider when selecting a cloud technology provider. Through field studies, this research paper demonstrates how the provider of these services fulfils these key points.

Keywords: Cloud Computing, Scalability, Multi-Tenancy, Privacy, SaaS

INTRODUCTION

Technologies such as clusters, networks, and, more recently, cloud computing have now become a reality. The purpose of their creation is to exploit these powerful and virtualized resources, apparently. As a whole, for various purposes of individuals, companies, and beyond. These information services offered are a good business model that utilises information power in public services, as gas, electricity, and telephone. Therefore, the consumer pays for what they consume.

Large computer companies use cloud computing. It describes the cloud-based services these companies provide. The primary purpose is to provide data storage, providing programs, for businesses from any place where they are located.

Cloud computing is the illusion of infinite resources, or the ability to pay "as much as you need" no more, no less; it is defined as: pay as you use, use whenever you need these computing resources (networks, servers, data, applications or services), get as much as you need, use when you want these resources.

- Pay per usage
- Management of the system as desired
- Virtualised services

Cloud computing also includes APIs, which are development programs that allow programmers to use or further develop the applications they create.

CLOUD COMPUTING

Cloud Computing is an essential term in the world of information technology. It is rapidly developing and attracting an increasing number of service providers as well as clients. The rapid growth has been made possible by the emergence of new computing technologies that allow the use of computer infrastructure and data storage at an affordable cost.

Cloud Computing is a computing model that incorporates the concept of "outsourcing" computing resources, which are scalable and provisioned on demand without requiring significant initial investments in IT infrastructure.

Several definitions attempt to define the term cloud computing. According to the American National Institute of Standards and Technology, it is a model that supports convenient services, such as networks, applications, and other services, that can be rapidly assigned or retrieved (Mather et al., 2009).

Although Cloud Computing has become familiar, experts believe that earlier forms of the Cloud have existed for decades.

- **Cloud 1.0** – The Cloud 1.0 network represents an abstract model of TCP/IP, where network communication tiers communicate with each other without knowing exactly who or where the other side is.
- **Cloud 2.0 –** represents data on the "World Wide Web", where various documents can be published or downloaded without knowing their exact path.
- **Cloud 3.0** – model is an abstraction of the complex infrastructure of servers etc. Simply put, Cloud 3.0 is considered an extension and generalisation of the Cloud 1.0 and 2.0 models

Concept cloud computing is becoming an integral part of today's companies, regardless of their industry or size. In recent years, a growing wave of companies has adopted the cloud to reduce costs, better manage their products and services, and scale their business more easily. The challenge that any company faces when considering incorporating cloud into its system is determining the skills needed to hire the person who will be responsible for it.

Since the concept of "cloud" is relatively new in the computing world, it is challenging to provide a definitive list of skills that a cloud analyst should possess. In recent years, cloud positions have included engineers, analysts, architects, as well as developers and administrators.

Many companies that utilised the web did not understand the role of developers. Additionally, they were unsure of the appropriate compensation for employees working in this sector. We are currently in a period of rapid evolution.

Many things still need to find their place. Since the cloud market is in transition, the list of necessary skills related to it cannot be clearly defined. Analysts predict that the position of cloud architect will be the first to be evaluated, due to the need to create a long-term architectural plan.

Cloud Computing means using many computers together to do tasks. Although cloud computing has existed for a while, IT teams now see it differently, because its flexibility lets them execute more services and applications in the back office. As shown in *Figure 1*, cloud computing offers flexible resources through virtualization.

Figure 1.

Cloud Computing

A Brief History of Cloud Computing

The term cloud computing is not a new one; it is used for many things nowadays. It has changed how we see the possibilities of using it today. The power and scale of the cloud have evolved significantly since its inception.

Over time, as technology and business environments have advanced, the status quo of cloud computing has changed. What was previously known as cloud computing was the same in principle, but the use of information today has undergone a significant scale of change.

Main Goals

Companies strive in order to reduce their operating expenses. Utilising technology can help address this by eliminating the need for significant capital investments. In the face of technological changes, it is beneficial to allow a cluster of servers to handle the processing needs of small companies.

A large number of companies have service-level agreements in place. For those unfamiliar with service level agreements, they are commonly referred to as SLAs (Service Level Agreements).

Service-Level Agreement

IaaS offers a certain quality of service. An SLA typically includes availability guarantees, ensuring uninterrupted service. Most IaaS providers focus their SLA on guaranteeing uptime and defining the guaranteed uptime during which the service will be available for a given period.

Most servers are in safe places, but it is important to be careful still. Considering that something with the cloud can go wrong. The possibility is always out of the question.

SLAs aim for a 99.99% uptime level but cannot guarantee that the data will consistently meet this level. This is something that many administrators need to keep in mind. SLAs play an important role in cloud computing and set the standard for uptime. While the cloud may always be online, the data it stores may not be accessible if an issue occurs. Although the chances of this happening are low, it can happen.

Therefore, it can be a key objective of cloud computing to provide SLAs with a certain level of uptime. The technical team should advise the CIO that this problem can create problems for supervisors. IT can be chosen easily, including data integrity of SLA, a thing which will help to prevent confusion or problems that arise from losing non-productive data.

Another advantage that cloud technology offers its users is shared processing power. Rather than constantly worrying about updating their hardware, the users can pay one provider to do that job for them. In most cases, the average user is not interested in or does not worry about the technical details of their computers. Most users work on finishing their job without having technical problems. Using this technology makes the job easier, especially for people who often deal with small problems, but technical problems slow down the work.

WHAT IS CLOUD COMPUTING?

In simple terms, it can be broken down into browser-based applications hosted on a remote server. For a normal user, that is all they need to know about cloud computing.

It is a way for small organisations to compete with large organisations, which means saving a significant amount of money, and a way to leverage energy efficiency in operations. Cloud computing is tied to the Internet technology that surrounds us.

Providers connect to the network as an extension of their machine. As long as a user is connected to the internet, the power of cloud computing comes into play, offering numerous benefits. One example would be processing power.

Notable feature, as the growing popularity of free storage space on servers will greatly benefit users in the future. A significant benefit of this is the prevention of data loss. With data management on a large number of computers on a network, the likelihood of data loss is significantly reduced.

BENEFITS OF CLOUD COMPUTING

Because the clients do not own the infrastructure in cloud computing, they can remove the previous costs and instead pay for what they use. So many services pay only for what they use. So many use the option "pay after use" similar to utility billing.

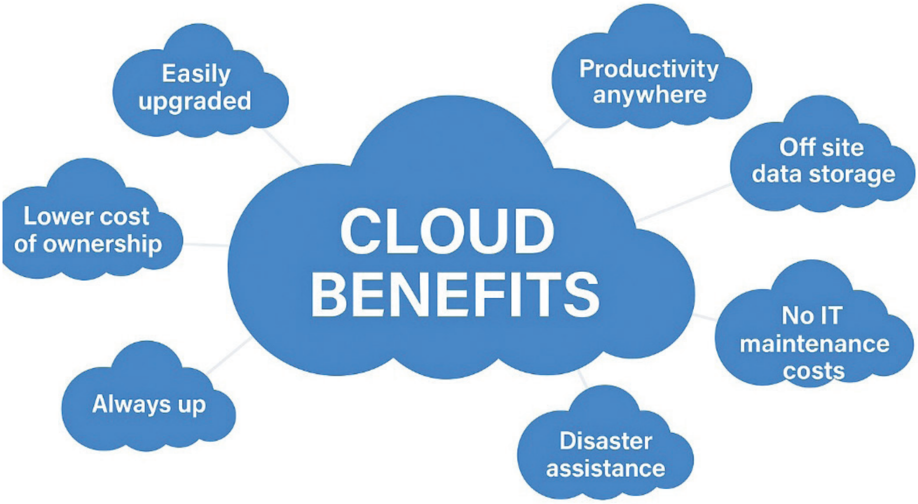
By sharing computing power between the users, they are used in an effective way, and servers pass less time sitting idle. It helps to lower the costs and speed up application development. Also, it gives access to the customers to more computing power when they need it, without having to build or maintain their systems for maximum requirements.

Increased availability of higher bandwidth speeds has also facilitated the model. Greater capacity, however, there are also issues to consider, due to the greater availability of increased bandwidth speeds.

There are significant benefits to using this technology. With new technology always there are new possible risks. Still, companies that need to offer cloud computing resources will gather several features, enabling organisations using cloud technology to be more efficient. As shown in *Figure 2,* it offers several key benefits.

Figure 2.

Benefits of Cloud Computing



FLEXIBILITY

With the model "server for rent", businesses have more flexibility in how they use the technology. Instead of buying and maintaining their servers, they adjust their resources, choosing the space or power they need at any time. By updating applications, the process can be significantly accelerated and made more efficient.

SCALABILITY

With cloud computing, one person can quickly transition from a small to a large scale. Organisations can be a good example if they can process large amounts of data at a given time and then return to normal without requiring significant resources from those servers. Often, it is more cost-effective for many organisations to rent mighty computing power than to purchase the equipment.

Cyclical and seasonal businesses can be a good fit for a "server rental" facility that serves cloud computing. A cyclical business, such as tax preparation, can utilise its resources during the first six months of the year when demand is high and then scale back its use when demand is low.

CAPITAL INVESTMENTS

Companies expecting a significant increase in the use of the coming years are expected to invest a large amount of money in the infrastructure for cloud computing. Most of them do not even know specifically how it will be used, but they are confident that the demand will exist in the coming years.

IT expenses consume a significant portion of the budget from money that companies can waste in different fields, like marketing, development, and human resources. Most basic IT purchases, such as hardware, will not be a problem as long as the tasks, assets, and functions are carried out.

PORTABILITY

In the global economy, organisations need to have people in the field, away from headquarters, to manage things. With cloud computing technology, they can utilise their computing power wherever their people are, as long as the users have access to it. Access to it is available wherever companies do business today, so this should not be an issue.

DISADVANTAGES OF CLOUD COMPUTING

Just like with any new and changing technology, cloud computing has potential downsides. Such problems should be taken seriously by organisations that rely on outside help for complex tasks. IT experts should always keep in mind potential downsides that could develop in the future.

RELABILITY

Companies that offer cloud services should inform the users that they are trustworthy, just like electricity. Power is always trustworthy and available; cloud providers should think about doing the same thing. It is important for businesses to rely on the cloud to finish the main parts of their work. To improve reliability, one could plan around hosting the most crucial functions in-house, while delegating most non-critical processing to a vendor's cloud.

There are some worries about data. It would be helpful to know where to save the data, as many providers of cloud prefer not to share this information. You can make this location information an important part of your deal with a provider. If you are ready to work with different terms, most vendors would agree to share this. If they do not share where the data is being stored, this is a sign that they do not know themselves, but it is not a good sign.

SECURITY

Keeping essential data safe is always an important topic, but with the increase in technology, the information is being spread faster. Using rare clients could potentially be compromised. SLAs should state how cloud providers will protect the data.

If companies are not cautious, this can be turned into a dangerous risk. With frequent reports of lost data or stolen data, and mishandled data, they could seriously undermine efforts to adopt cloud technology (Velte et al., 2010).

The concept of cloud is a term coined to make people more comfortable. However, while providers can quickly understand what that means, technologies can still pose concerns about the ability to secure private data that shouldn't be exposed. *Figure 3* shows how cloud security protects online data.

Figure 3.

Security in the Cloud

FEW OR NO REFERENCES

Due to privacy concerns, cloud vendors are largely incapable of providing use cases of companies using their services. Only a small number of big companies can report their cloud computing practices.

As a result, many organizations are uneasy about using cloud computing resources, despite it being the most popular term in the tech world.

Drawbacks of this technology are made worse by the fact that fewer companies are known to be using the technology due to some internal problems with the cloud. This means that small start-up companies will likely need to leverage some of the big ones before they begin adopting the cloud.

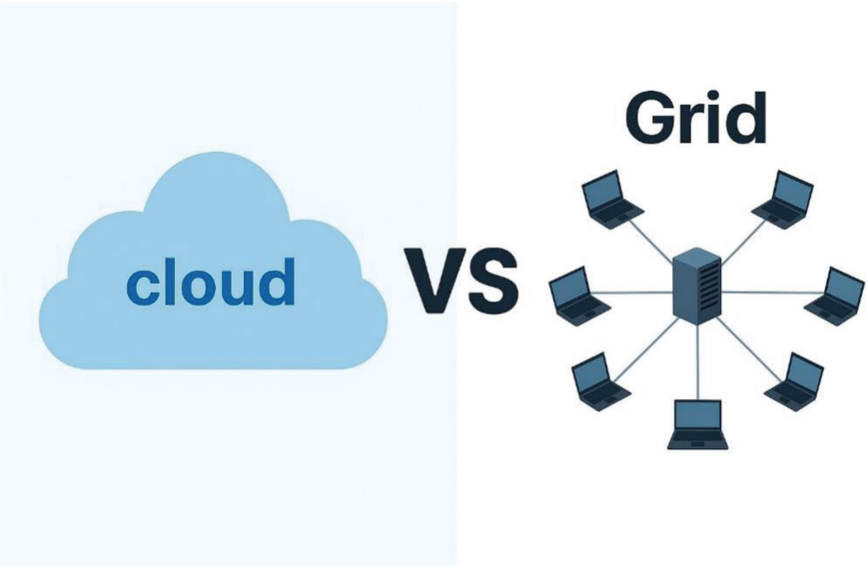
GRID COMPUTING VS CLOUD COMPUTING

Grid Computing is often misunderstood with cloud computing, but they are not the same thing. Grid computing is the same as cloud computing; they work together like one big virtual supercomputer to handle large tasks. Today, so many cloud platforms use cloud computing network behind the scenes to offer "pay per use. However, it is essential to recognise that cloud computing is not merely a continuation of grid computing, but a next-generation evolution of the network services model, leading to significant advancements in the field (Hugos & Hulitzky, 2011).

Commercial service platforms are another type of Sass. They give users an important online role to have access to different services. These platforms are often used in financial systems or for reservations. For example, the users can reserve flights or other services, and the system decides automatically the price and arranges everything based on what the user needs. In Figure 4, the differences between grid and cloud computing are highlighted.

Figure 4.

Grid computing or Cloud computing



CLOUD WEB SERVICES

How Cloud Computıng Works and What It Offers

Key concepts in cloud computing are "virtual" or "virtualisation". These infrastructures do not provide physical access to the devices that are being used. Instead, the entire infrastructure is built on a software system controller for the hardware of the computer as a whole (such as those from manufacturers VMware, Microsoft Hyper-V, or Citrix).

These platforms create several virtual units from a physical unit, offering them as services, platforms, or even virtualised infrastructures. These virtual units are utilised by businesses offering services, with a payment typically calculated based on the time used, whether in the form of virtual devices or services. For this reason, cloud computing is often defined as a service that "pays as you use" (pay-as-you-go).

Other types of series are web services, which originated from the development of technology based on cloud infrastructure, but whose development and ownership costs have always been and remain high.

Communication as a Service (CaaS)

Technology that allows one or more users to use it. Creating this model follows progression, considering that in this model, we also have software for communication provided as a service. However, a vital part of this model is also the hardware for communication and the guarantee of service quality. This model has initiated the process of evolution within the telecommunications industry, unlike the SaaS model, which originated from the software-as-a-service sector.

The providers of these types of solutions take care of managing the hardware; therefore, this model is based on a specific focus on developing the conditions for efficient communication. Communication in this model can be created based on IP, sending messages in the moment (instant messaging), applications for interaction, and video-audio conferencing, and others.

CaaS lets small businesses stay flexible without the high costs of doing it alone. Service providers are typically prepared to optimise the load points for their customers by offering services that enable increased capacity, device support, modes, or area coverage, as required by their customers.

Group function can change dynamically, ensuring the feature keeps peace with customers that resource providers will not have the service stop working.

CaaS almost manages itself and is managed by the customer. This eliminates the need for the business customer to make any capital investment in infrastructure. With CaaS, customers can upgrade their communications services without having to build facilities tailored to their specific needs. This allows these customers to allocate their budget and personal resources where their business can utilise them most effectively.

Infrastructure as a Service (IaaS)

IaaS is a model based on the cloud that offers users access to computing resources online, offering a cost-effective solution for businesses. This model incorporates the physical technology essential for building all models, including this one. Even companies responsible for providing service models have this type of service as the basis for developing their business, making it a financially wise choice for many.

According to Wikipedia, IaaS is a cloud model where computing resources like platforms and virtual machines are offered to users as a service. IaaS allows organizations to go into the infrastructure of IT on demand, supported by large investments in technology, services, and data centre systems.

Compared to traditional outsourcing, which demands comprehensive due diligence and tools during the contract, IaaS centres on a service delivery model that provides unspecified, standardised infrastructure specifically for customer applications.

Modern On-Demand Computing

On-demand computing (ODC) is a system where companies take resources only when they need them. These resources can include saving, the processing power, and the software. ODC is useful mostly for projects that are short and for everyday tasks. It was developed to help organizations handle changing computing demands efficiently, since resource requirements often rise and fall over time.

MAIN CHARACTERISTICS OF PAAS

The main features of PaaS include services to develop, test, distribute, run and control applications, supporting their entire development lifecycle.

Support for shared user architecture helps solve developer concerns about the application's use by multiple users. Paas providers often include tools for managing and securing applications, as well as connecting with web services and databases.

The capacity to build deploy, undefined, or distributed teams greatly increases the productivity of PaaS offerings. PaaS helps to understand how applications function and how users behave using these control panels, which tell metrics how the performance and activity of the user is. Some PaaS offerings utilise a pay-per-use billing model.

SOFTWARE AS A SERVICE (SAAS)

Application sits in the top layer of the cloud. Users can reach these services from portals on the internet provided by this layer. Instead of using installed programs on their computers, users now have access to the same functions on the internet. For example, traditional applications such as Word, Excel, and PowerPoint are available as web services.

This model is called "Software as a Service"; it lets users avoid dealing with installation updates and testing. Salesforce.com represents a SaaS model, providing the possibility of using business applications that are deployed, allowing users to adapt the application at any time and from any location.

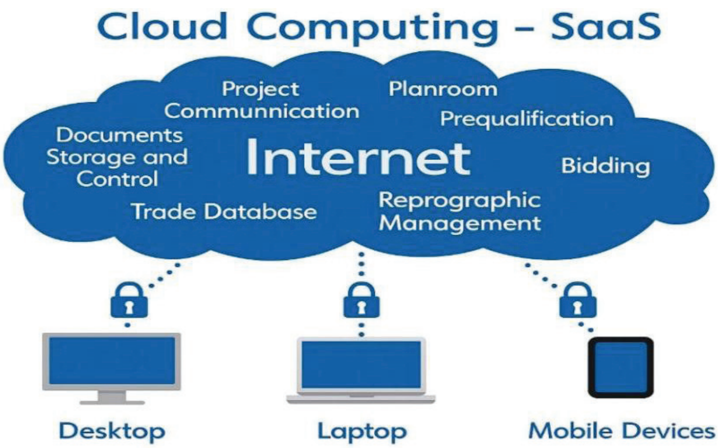
Different from traditional software, SaaS is hosted online and accessed via the internet. SaaS is hosted online and has access from the internet. As new web technologies, SaaS continues to grow in popularity, and often it offers subscription plans. Cable service has become easier to access, allowing users to access it from numerous locations worldwide. The significant ISP to increase bandwidth, combined with the continued introduction of increasingly powerful microprocessors and inexpensive storage devices, is providing a robust platform for the design, distribution, and use of software in all areas of business and personal computing. SaaS is mostly used to offer software to business clients at a low cost. It gives them the same benefits as traditional software without installation, management, or a high upfront cost. Most of the customers do not care about the details of software deployment; they just need to use it in their work. Many types of software can be offered through SaaS, including accounting, email, human resources, security in IT, and web content management.

The primary difference between SaaS and previous Internet-delivered solutions is that SaaS solutions are designed to run specifically within a browser. SaaS applications function directly in a browser. Their architecture is designed to support many users at the same time.

This shows significant differences from traditional clients with server services or service provider solutions, which are typically based on catering to a captive audience. How SaaS delivers software through the cloud is shown in Figure 5.

Figure 5.

Software as a Service



IMPLEMENTATION ISSUES

A variety of software components and application frameworks can be utilised in the development of SaaS applications. Using components and application frameworks can lower the time and the cost of a traditional product into a SaaS solution. According to Microsoft, Saas can be grouped into four maturity levels. Main characteristics are ease of configuration and scalability. Each level is built on the previous one by adding one of these characteristics.

SaaS Architectural Maturity Level 1 - Ad-Hoc/Custom

The first maturity level does not have real maturity. Every client gets a version to personalize the application, which functions in its instance on the hosting servers. Moving traditional non-network applications to this level usually requires less development, and it can lower the operational costs by combining the management of hardware and software.

SaaS Architectural Maturity Level 2 – Configurability

The second level allows the clients to use separate instances in the same application with configurable settings. This enables vendors to cater to the diverse needs of each customer using detailed settings. It also allows vendors to ease the maintenance burden by updating the shared code base.

SaaS Architectural Maturity Level 3 - Multi-Tenancy Efficiency

At the third level, multi-tendency allows one application to be used by all clients in an effective way, with a noticeable impact on end users; however, it ultimately has a limited ability to scale.

SaaS Architectural Maturity Level 4 – Scalability

The fourth level of maturity, scalable, improves from a shared user architecture. It can run so many copies of the application in hundreds or thousands of servers. Servers can be added or removed based on the requirements, without requiring further changes to the application software architecture.

Privacy

So many people believe that privacy is just part of the information. Even though they are strongly connected, privacy has its own unique issues and challenges. In this chapter, these aspects in contact with traditional informatics will be discussed (Rittinghouse & Ransome, 2010).

Especially in the industry where there are fewer regulations outside of healthcare and financial services, the responsibility of saving privacy is wrongly placed on the service provider instead of the business unit that owns the data. Often, privacy is treated as an optional requirement, one box to check among many other important obligations.

What is privacy?

In this chapter, these aspects will be examined more concretely in the context of cloud computing, and we will compare those models with the traditional computing models. Especially, in industries that are less strictly regulated outside healthcare and financial services, to save privacy, which is often wrongly placed by the cloud service provider instead of the business unit that owns the real data. Often, privacy is treated as an optional requirement, in a box among many other important regulations.

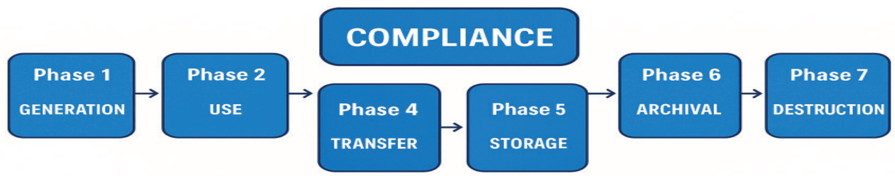
What is the data lifecycle?

Data lifecycle refers to the phases through which personal data and organizations pass, from the moment they are created till the moment they reach their form or it is no longer needed.

Personal data should be managed carefully this entire cycle. In cloud environments, it is important to consider how each stage of the lifecycle may be affected, so that the protection of personal information is maintained at every possible point, as illustrated in *Figure 6* below.

Figure 6.

Cycle of data KPMG



What are the main privacy concerns in the cloud?

Privacy advocates have pointed out so many concerns about cloud computing. These often include the security and the privacy. Except that, some other important issues to keep in mind are: People, personal information which are collected have the right to know exactly the information that an organization holds about them. This right is important, especially when it comes to marketing activities. In some places, marketing is being regulated differently from using data, and marketing efforts usually aim at individual end users in accordance with the organization's privacy policies.

When the data is saved or processed in the cloud, a key concern is whether the organization can fully meet the rights. Specifically, the organization must be able to fulfill these rights. Specifically, the organization should be able to give the subject access to the data in which all the information is saved when they request it. If a person decides to exercise this right, the organization must have processes in place to respond properly to the person's data handled according to the law and policies. Is it possible for a cloud provider to fully erase all the data when an organization requests it?

Compliance: Which rules are applied in the cloud? Which laws, standards, and contracts cover these data, and who is responsible for following them? How has the shift to the cloud impacted existing privacy compliance requirements? The cloud may traverse multiple jurisdictions; for example, data may be stored in various locations across multiple states within the United States.

Storage: Where is data saved in the cloud? Has it been moved to the centre of data or to another place? Are they saved together with the other organizations that use the cloud? Privacy laws change based on the location, and they can limit an organisation's ability to transfer specific types of personal information to other places. When data is saved in the cloud, transfers can sometimes happen without the organization realizing it, which can lead to violations of local privacy laws.

Is the Cloud Model Trustworthy?

Most of modern cloud computing is built on this trusted high-level platform that functions in servers using different types of virtualized technology. These services are provided through large data centres that operate under service level agreements to secure consistent performance. Cloud providers design their offers to meet the customer requirements of the clients, including specific levels of service that users expect. From the user perspective, the cloud is like a single point of access for all computing tasks. These services can be used anywhere in the world as long as there is an internet connection. Cloud growth has also been supported by open standards and open-source software, which can make it easier for services to work together.

CONCLUSION

Cloud computing is currently the most widely used concept in the IT world, encompassing both the education and professional sectors. It is one of the most important transformations the IT field has ever undergone. As organizations embrace cloud adoption, they enter a new environment that relies on the trust of the provided services.

Cloud has already helped companies increase their competitiveness today and will continue to play a crucial role in sustaining it in the future. Those who continue to reject cloud solutions, viewing them as inflexible, are likely to fail due to their lack of skills and the associated cost burdens.

While cloud computing is truly very important and you might already be using it, whether for personal tools or in your business, here is an overview of the benefits and drawbacks we have learned from this research. Cloud computing is a truly affordable way to access all the resources they need in one place. It is a more efficient way to spread out your resources, making it easier to access things from a distance.

However, is cloud computing truly secure in every way? For example, even though cloud computing includes backups, if something goes wrong, will you have your backup? Is it as private as you think it is? Are your data truly secure, or could someone else gain access?

The primary concern with cloud computing stems from the feeling of losing control over protected information. Actual measures do not fully address the challenges of storing and processing data with cloud providers from third parties. Best practices recommend extending enterprise control measures to the cloud environment by using trusted methods. Implementing these techniques can help in reducing the concerns associated with cloud computing today, because they have the potential to improve data security and privacy in the cloud to ensure proven advantages in business innovation through cloud participation.

These approaches also address potential issues and abuses that may arise from increased reliance on cloud computing, as well as strategies for maintaining security against such attacks.

Specifically, new threats require new measures to preserve and enhance security. Among these are tools to monitor and understand privacy leaks, perform authentication, and ensure service availability against cloud-based attacks.

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