

Comparative Study of Different Cloud Computing Deployment Models

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Abstract: Cloud Computing, often seen as a technological revolution, makes it possible to dematerialize information systems by making services accessible via a communication network, more often via the Internet. Its growth can be explained by its major advantages such as cost reduction, greater flexibility and independence from traditional physical infrastructures.

We will compare the 4 cloud deployment models by showing how each model works. We will also detail the benefits and risks associated with each model.

➤ *The Study Focuses on these Four main Deployment models, Namely:*

- *Public Cloud,*
- *Private Cloud,*
- *Hybrid Cloud,*
- *Community Cloud.*

Although the benefits of cloud computing are countless, this study also raises significant challenges related to cloud, particularly in terms of data security, dependence on a stable Internet connection.

To help businesses navigate this complex landscape, we have provided some recommendations concerning specific needs, integration capabilities and potential risks.

Keywords: *Cloud Computing, Cloud Deployment, IaaS, PaaS, SaaS, Company.*

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I. INTRODUCTION

For several decades, information technologies have taken an important place in most areas of our society and especially in our communications. Over the last decade, with the standardization of the Internet, the development of high-speed networks, pay-per-use and the societal quest for mobility, the IT world has seen the popularization of a new paradigm, the Cloud.

Cloud computing can be defined as a dematerialization or deportation of information systems to remote servers, traditionally deployed and managed locally by a user or a private company. Cloud computing is an IT concept born in the 1970s which is part of the process of evolution of IT.

Cloud service is implemented by the cloud provider (CSP, Cloud Service Provider). The user accesses these services on demand via a wide network such as the Internet.

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Cloud computing is considered a fully virtualized system, enabling both computing, storage and utilization of software resources as well as servers as a single platform.

This new concept offers opportunities for companies to reduce their investment costs in infrastructure and software.

In this article, we will present the 4 cloud deployment models by showing the operation and typology of each model. We will also detail the benefits and risks associated with each model.

II. PRESENTATION OF SERVICE MODELS

Some companies choose to acquire their own infrastructure. In this case, the company ensures the management of the entire infrastructure, namely the maintenance of hardware, network, server storage, etc. This model is called “**ON-Premise**”, which means that the company maintains total control over its IT environment; She is therefore in charge of all the layers that we can represent in the table below:



Fig 1 Cloud Computing Layers

Conversely, and generally, Cloud computing is based on a model of structured services which allow companies and users to access IT resources. online without having to manage complex physical infrastructures [6]. We use the terminology “**as a Service**” (as a service), because businesses can use computing resources without having to physically own them.

➤ *There are Three main Service models in their Definition of Cloud Computing:*

- Infrastructure as a Service (IaaS) ;
- Platform as a Service (PaaS) ;
- Software as a Service (SaaS).

The following sections present each service model in detail and a summary table will subsequently be presented to illustrate each type of service.

➤ *Infrastructure as a Service (IaaS)*

In this model, the cloud provider controls the underlying infrastructure:

- Virtualization;
- Servers;
- Storage;
- Network.

The user maintains the upper layers and chooses the operating system, software, applications and data.

➤ *Two Examples are:*

- Amazon AWS EC2
- Google Compute Engine

➤ *Platform as a Service (PaaS)*

The cloud provider is also responsible for:

- Operating system
- Middleware
- Runtime.

The client retains the data and the application. This is ideal for developers who want to run their PHP, Python, or Java applications without worrying about the underlying layers.

➤ *Two Examples are:*

- Amazon AWS BeanStalk
- Google App Engine

➤ *Software as a Service (SaaS)*

In the SaaS model, the cloud provider manages and provides everything. This is the service model that most of us are familiar with.

• *Examples are:*

- ✓ Office 365;
- ✓ Gmail;
- ✓ Facebook;
- ✓ Twitter, etc.

➤ *Representative Diagram of the Different types of Services*

IaaS	PaaS	SaaS
Application	Application	Application
Data	Data	Data
Runtime	Runtime	Runtime
Middleware	Middleware	Middleware
Operating System	Operating System	Operating System
Virtualization	Virtualization	Virtualization
Servers	Servers	Servers
Storage	Storage	Storage
Networking	Networking	Networking

Fig 2 Diagram of 3 main Cloud Services

III. THE FOUR CLOUD DEPLOYMENT MODELS

Cloud deployment is a strategic approach that allows companies to host their data on remote infrastructures. The 3 service models above are delivered through these 4 main deployment models, namely:

- *Public Cloud;*
- *Private Cloud (Internal and External);*
- *Hybrid Cloud;*
- *Community Cloud.*

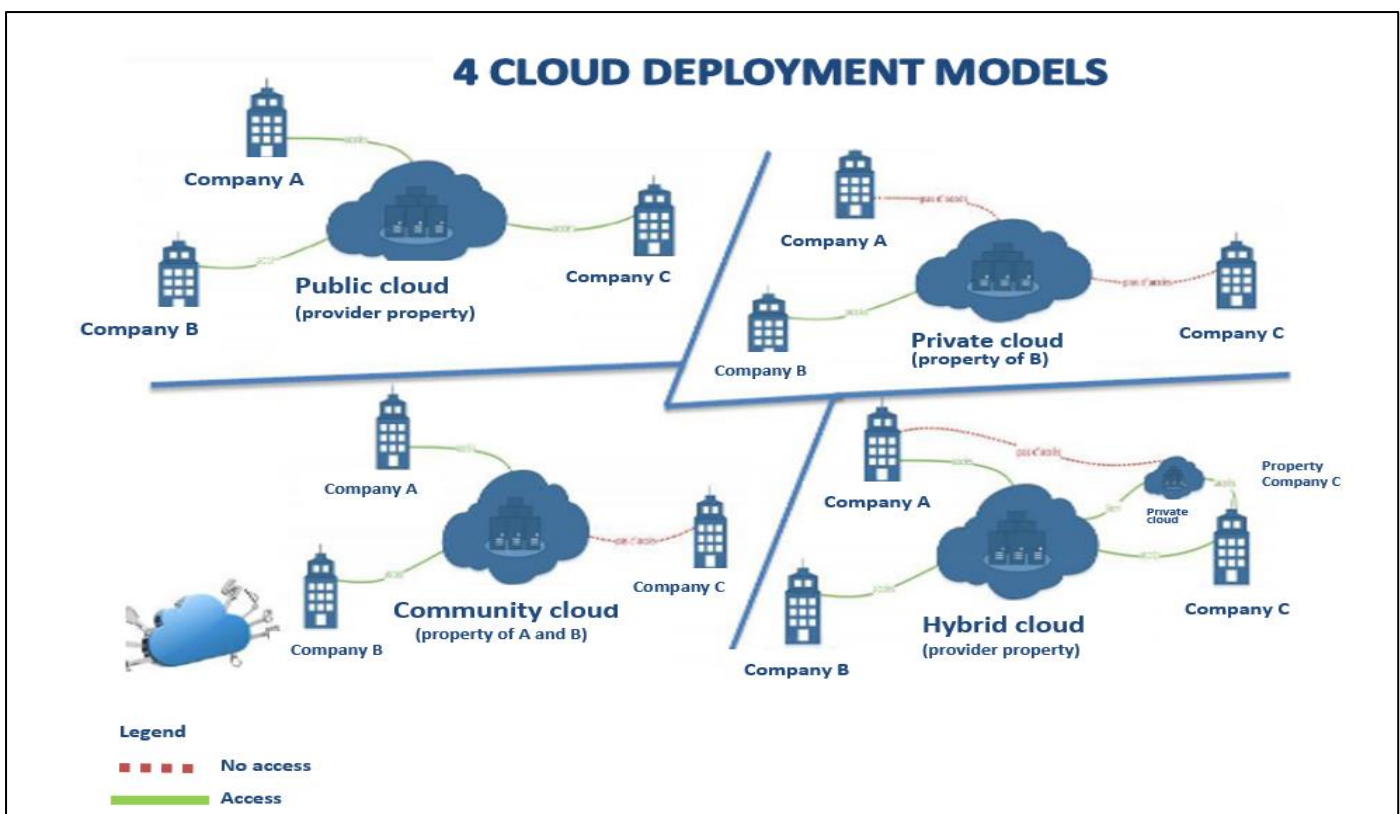


Fig 3 Illustration of 4 Cloud Deployment Models

➤ *Public Cloud*

Public clouds are open to the company or large industrial groups [7]. It's owned by a Cloud Service Provider and owns and manages cloud infrastructure.

In this deployment model, several companies use the infrastructure of the same provider, but the infrastructure

remains owned by the provider. Multi-tenant: coexistence of multiple consumers in the same cloud.

The most common case is that of the Amazon Web Services platform, therefore it is an external public cloud and owned by Amazon.

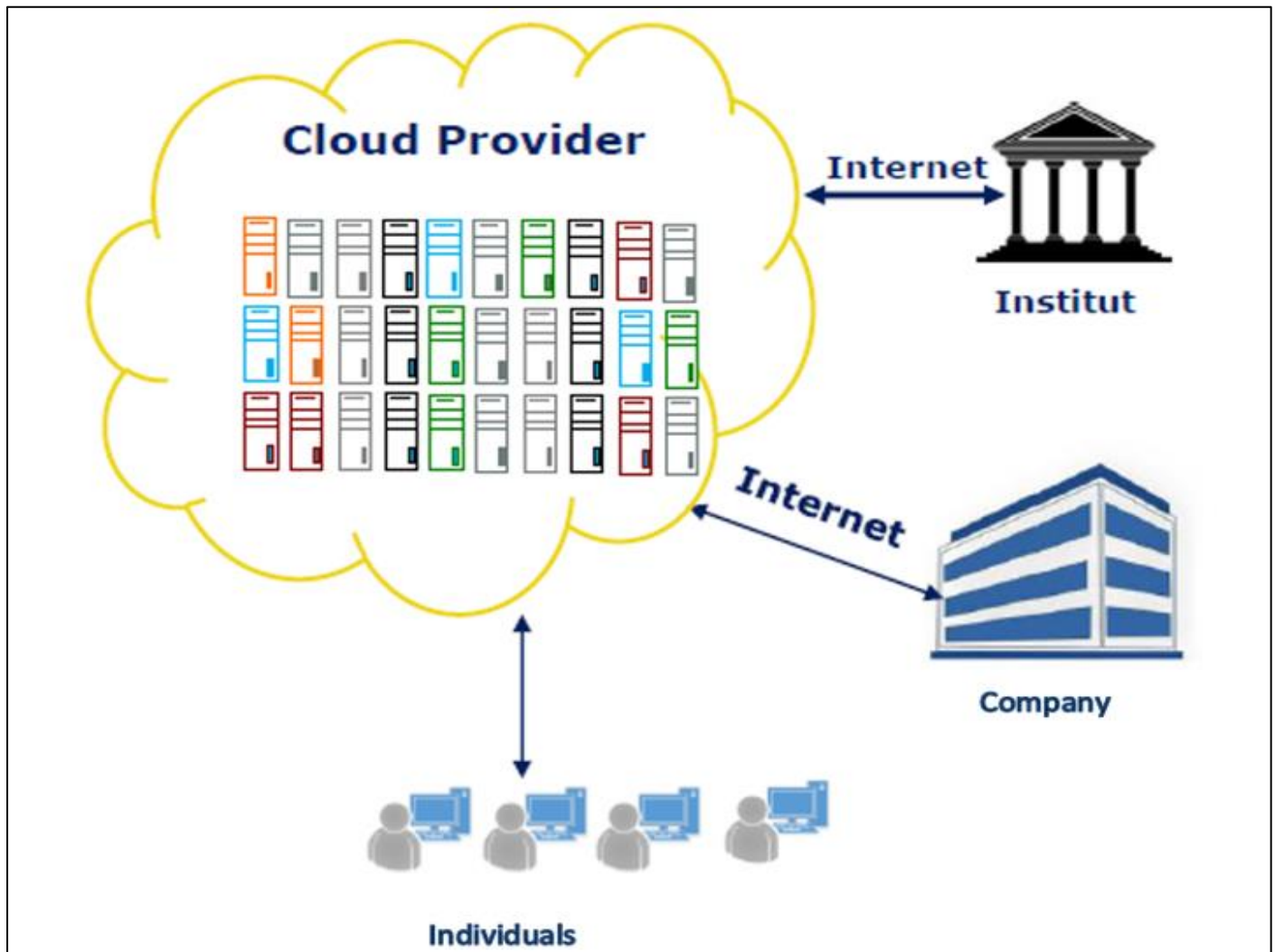


Fig 4 Illustration Cloud Public

➤ *Private Cloud*

Private Cloud is used by a single organization, it can be managed by the organization or by a third party. The infrastructure can be placed on the organization's premises or externally.

Unlike the public cloud that provides services to multiple companies, only one company operates a private cloud.

For this deployment model, company X can subscribe to a cloud service that will only be accessible internally.

➤ *We Distinguish Two Types of Private Clouds, Namely:*

- Internal private cloud

- External private cloud

An unauthorized outside person will not be able to access it, so it is an internal private cloud and is the property of this company.

- **Example:** A company X uses the S3 (Simple storage service) offer from Amazon web service to store its data in the cloud.
- **Internal private cloud:** This cloud model is used when an organization does not want to store its data in the public cloud to improve the use of resources and automate the management of these resources.

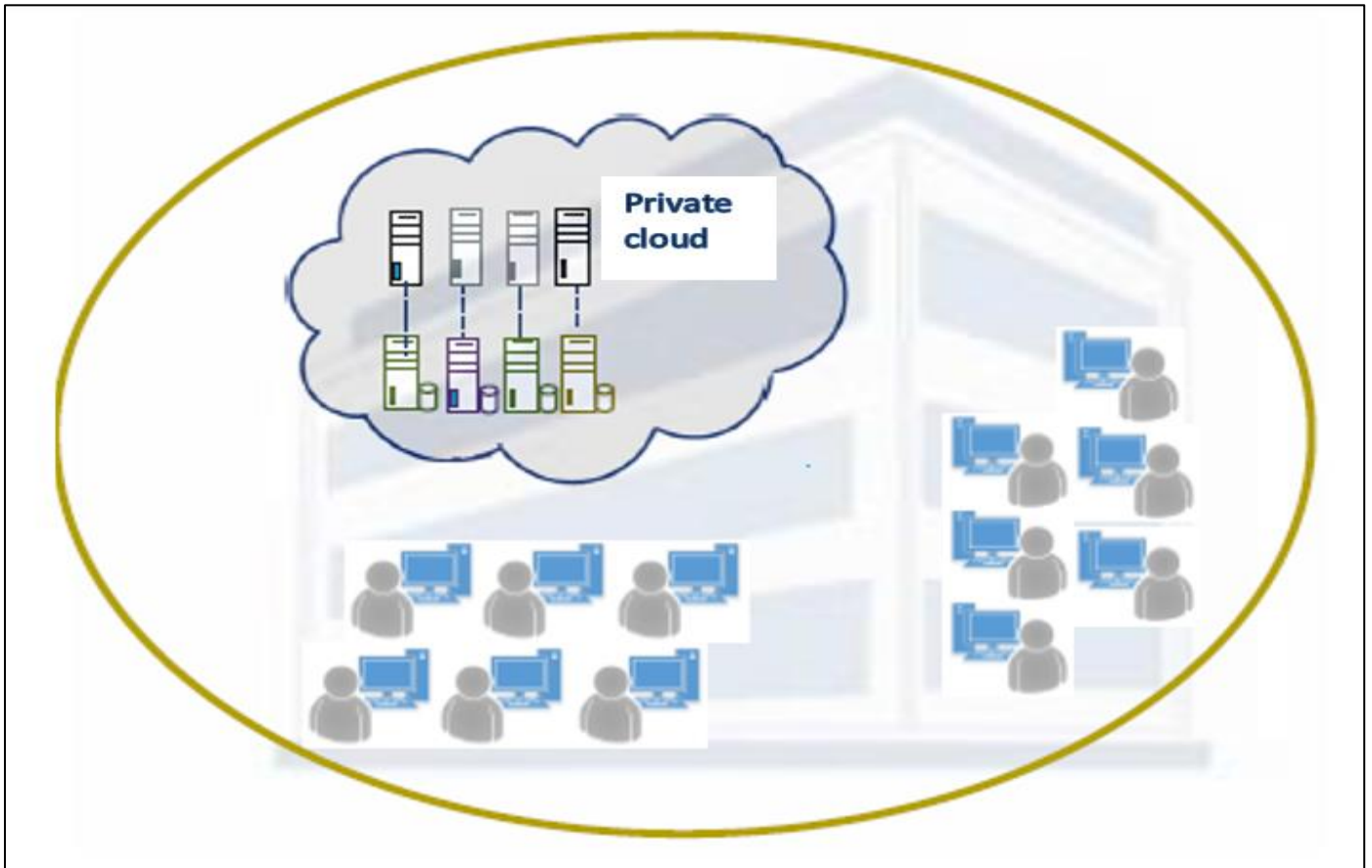


Fig 5 Private Cloud Illustration

- **External private cloud:** Unlike internal private cloud, this model are used when the organization aims to expand its capacity by using a proprietary private cloud that is remotely accessible and provisioned by another organization.

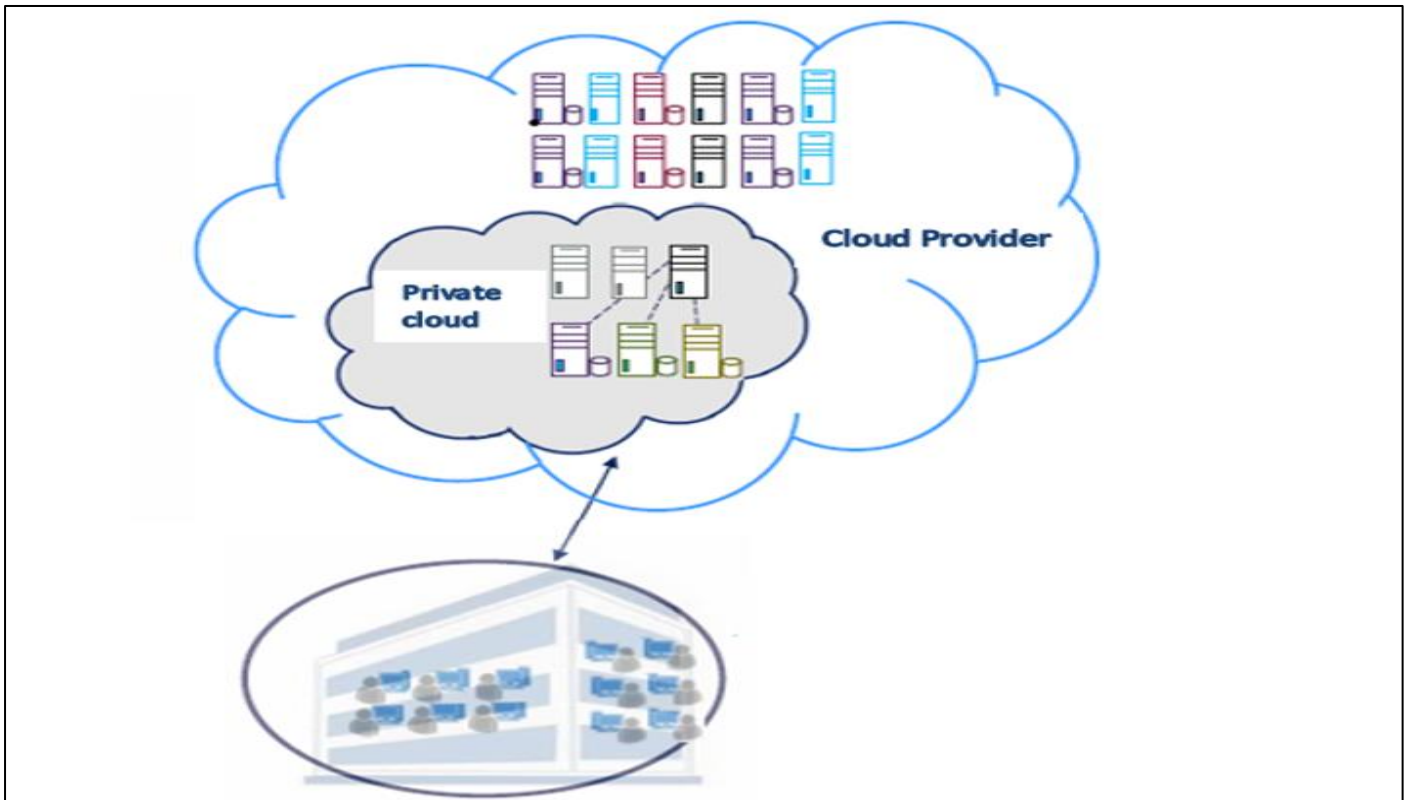


Fig 6 Illustration External Private Cloud

➤ *Hybrid Cloud*

Hybrid clouds are made up of one or more models that remain separate entities. These infrastructures are linked together by the same technology which allows the portability of applications and data (8).

This is an excellent solution for distributing resources according to the benefits sought.

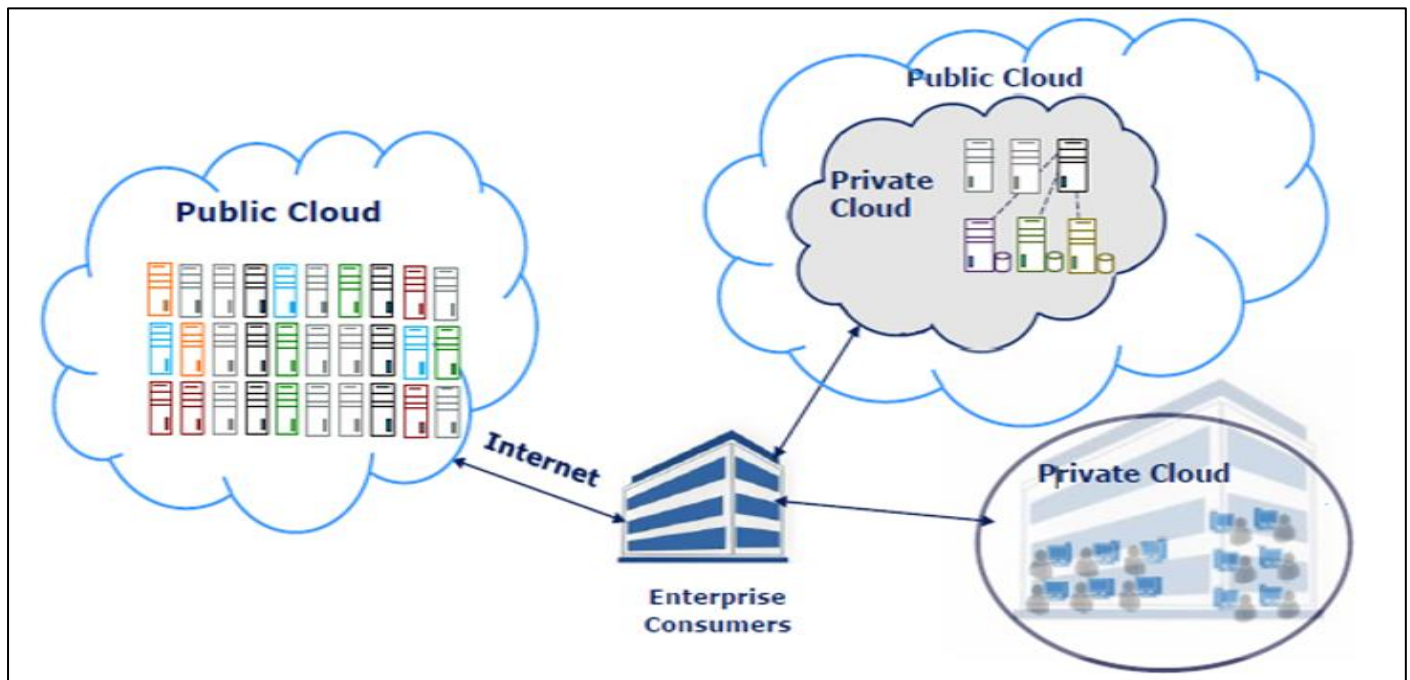


Fig 7 Hybrid Cloud Illustration

This model combines multiple clouds: private community or public that retain their identities but are linked together as a single unit (6).

➤ *Community Cloud*

Community clouds are shared by multiple organizations for the needs of a community that wishes to pool resources (security, compliance, etc.).

It can be managed by the organizations or by a third party and can be placed on premises or outside (5).

In this deployment model, several companies can exchange information using the Internet through a secure tunnel. **It's sort of an external private cloud.**

- Example: Several universities and schools have access to the National Telecommunications Network for technology, teaching and research



Fig 8 Community Cloud Illustration

IV. ADVANTAGES AND DISADVANTAGES OF THE CLOUD

➤ *Advantages*

Cloud computing also offers financial advantages because thanks to this technology a company no longer needs heavy investments in IT capital and no waste of time and expenses in maintaining complex infrastructures.

- Cost reduction
- Device independence (Shadow IT)
- Instant software updates
- Unlimited storage capacity
- Elasticity and resources can automatically adapt to an increase in load.

➤ *Disadvantages*

However, the tradeoff for these benefits is dependence on the internet and service providers, not to mention data security and privacy. Here are some downsides:

- Permanent internet connection: access to the internet then becomes a condition **Sine qua non** without which it becomes impossible to work.
- Bandwidth: no access to the cloud because of low-speed connections, subscribing to cloud service requires having a very good internet connection in order to significantly reduce the waiting time when executing an operation.

- Limited features (hosted application version compared to the locally installed version): synchronization and updates must be done regularly to ensure the uniqueness of the applications.
- Data stored in the cloud may be secure: in some countries, the government accesses company data which risks violating data confidentiality and security.
- Recorded data may be lost: In the event of a major failure in the provider's infrastructure, loss of data is possible.

V. COMPARISON OF DIFFERENT CLOUD DEPLOYMENT MODELS

In view of the above, to make its choice, each company must evaluate the advantages and challenges of the different options in order to opt for the Cloud solution best suited to its needs in terms of security, flexibility and costs.

The table below presents a comparison of the 4 main cloud deployment models to help businesses make an informed choice.

➤ *Comparison table of the four main Cloud Deployment Models*

Table 1 Comparison table of the four main Cloud Deployment Models

Criteria	Private Cloud	Cloud Public	Hybrid Cloud	Community Cloud
Preview	Private cloud refers to an infrastructure dedicated exclusively to an organization, hosted on-site or in a private data center.	The public cloud is based on an infrastructure shared between several users, managed and maintained by a provider.	Hybrid cloud combines private and public cloud to enable smooth interaction between two environments.	Community cloud is based on an infrastructure shared between several organizations with common needs, here management is done collectively or delegated.
Owner	The infrastructure belongs exclusively to the organization that uses it (Private infrastructure).	Infrastructure owned and administered by the cloud service provider, for example: AWS, Azure, Google Cloud).	Ownership is mixed: the organization manages the private part and the provider controls the public part.	Ownership is shared among member organizations or delegated to a third party designated by the community.
Accessibility	Accessible only by the organization via secure and dedicated networks.	Accessible to any user with an Internet connection and a valid account.	Accessibility determined by needs: sensitive data is managed privately and other data is managed publicly.	Accessible only to community members, in accordance with established rules.
Costs	High costs, including initial investments, maintenance and operation.	Variable costs depending on usage, with a low initial investment thanks to the "pay-as-you-go" model.	Combined costs: investment for the private sector and operating expenses for the public.	Costs are shared between members, which reduces individual costs.
Security	High security, suitable for sensitive data, critical	Security dependent on the guarantees offered	Adjustable security: critical private data and	Security defined collectively by

	applications and strict regulations.	by the supplier, although high standards are often respected.	less sensitive public data.	members, according to specific needs.
Performances	High performance thanks to resources reserved only for the organization.	The performances are variable depending on the use of resources shared with other users.	Balanced performance based on load distribution between the two environments.	Performance generally adapted to the specific needs of the community.
Flexibility	Limited flexibility: Expansion requires additional hardware investments.	Very flexible, with resources available on demand and without constraints material.	Offers optimal flexibility through the combination of both environments.	Offers moderate flexibility, it depends on agreements between members and allocated resources.
Maintenance	Managed internally requires dedicated expertise and budget.	Fully supported by the supplier.	Shared maintenance: internal for the private sector, supplier for the public.	Insured collectively or outsourced according to needs.
Use	Ideal for critical applications and sensitive data (banks, governments, medical).	Suitable for small businesses like startups, for testing, development environments, or for businesses looking to reduce costs.	Recommended for organizations that need to rapidly scale their IT resources while meeting certain hybrid compliance requirements.	Suitable for collaborative projects. Example: universities, research consortia, NGOs etc.
Benefits	Full control over infrastructure, high security, easy compliance with regulatory standards.	Reduced cost, rapid scalability, simplified access and centralized management by the supplier.	Optimization of resources, increased flexibility and ability to adapt loads according to needs.	Reduction of costs, pooling of resources and strengthening of collaboration between members.
Disadvantages	High cost, management complexity and limited capacity to absorb growing demand.	Vendor dependency, data privacy and security risks.	Complexity of integrating the two environments, combined management costs.	Complex governance, need to coordinate the interests of members and manage possible conflicts.

VI. CONCLUSION AND RECOMMENDATIONS

In conclusion, the cloud is a revolution in the IT field, attracting behind its new technologies as well as completely new ways of thinking and designing today's information systems.

The use of Cloud is increasingly remarkable given several factors, including its cost-effective architectures, supporting data transmission, storage and intensive computing.

However, these promising storage services raise the question of data protection and regulatory compliance, which implied the problem of loss of control and governance.

In parallel with the security issue, the viability of such a model, where the production of computing resources is concentrated in a limited number of ever-larger data centers, can be debated on certain aspects such as fault tolerance, particularly during natural disasters or human errors.

We provide some recommendations that can help businesses to choose a cloud model. For businesses that want to move to the cloud, choosing the right cloud model depends on the needs of each organization. If a business has a small budget or needs that change often, the public cloud is a good option; It's flexible and inexpensive, which works well for small businesses testing new markets.

For industries that deal with sensitive data or are subject to strict regulations, the private cloud is recommended, as it offers more security and control. For businesses looking for both flexibility and security, they can look to hybrid cloud, which combines the benefits of public clouds and private clouds.

For collaborative (community) projects such as university research, NGOs or certain government initiatives, the community cloud is a good option, because it allows resources to be shared between several organizations with similar needs.

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