ASSIGNMENT 1 FRONT SHEET

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Student declaration I certify that the assignment submission is entirely my own work and I fully understand the consequences of plagiarism. I understand that making a false declaration is a form of malpractice.			
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Grading grid

P1	P2	P3	P4	M1	M2	D1

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I. Introduction

Today, to help reduce operational costs, operate infrastructure more efficiently, and expands a business market, large enterprises often use the cloud computing model. In this report, I will give the fundamental concepts of Cloud Computing and I also giving design appropriate architectural Cloud Computing framework for a given scenario.

1. What is Cloud Computing

According to (Thomas Erl, 2013), the definition of cloud computing that received from the National Institute of Standards and Technology (NIST): "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management ef ort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models."

2. Client/server

According to (Geeksforgeeks, 2019), the Client-server model is a distributed application structure that partitions task or workload between the providers of a resource or service, called servers, and service requesters called clients. In the client-server architecture, when the client computer sends a request for data to the server through the internet, the server accepts the requested process and deliver the data packets requested back to the client. Clients do not share any of their resources. Examples of Client-Server Model are Email, World Wide Web, etc.

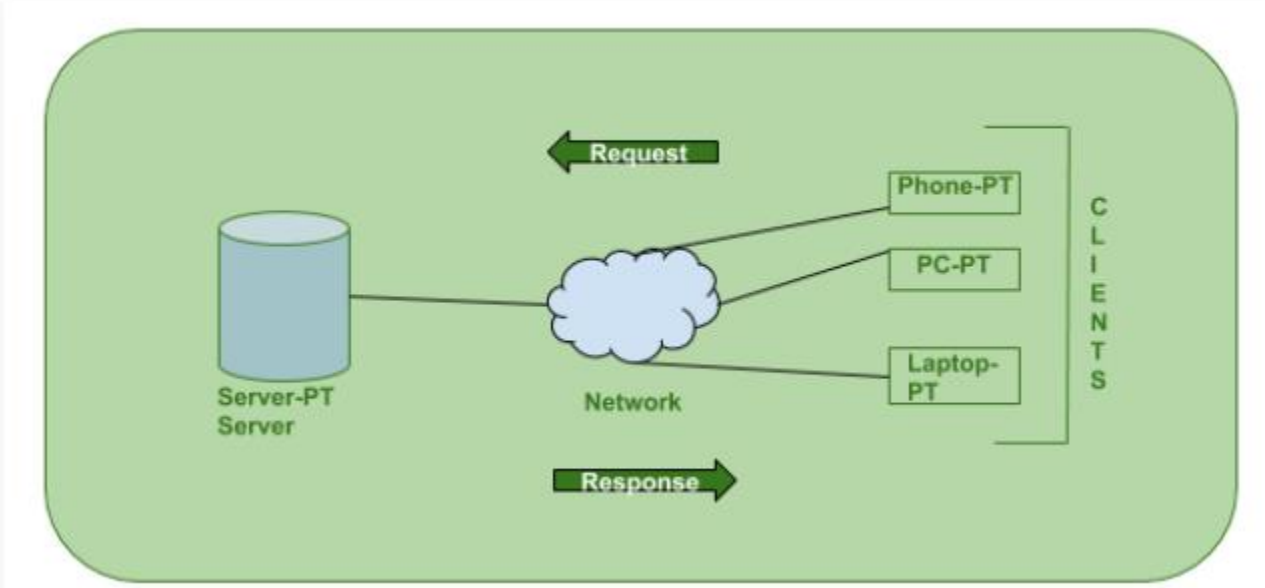

Figure 1: Client-Server

How the Client/server model work?

Client: Client is a device on the user side (such as computer, phone, tablet...), client device provides an interface to allow a device user to request services of the sever and to display the results the sever returns

Sever: Server is a computer (hardware and software) connected to the internet. Sever provides information or access to particular services.

So, it basically the Client sends a request and the Server will check in the database, if it is available then return that result to the client side.

3. Peer-to-Peer (P2P)

In a P2P network, computer systems and other devices are connected to each other via the internet. They can share files directly over the network to which these systems are connected. No central server is needed for this. Every computer on a P2P network becomes a server and a client at the same time.

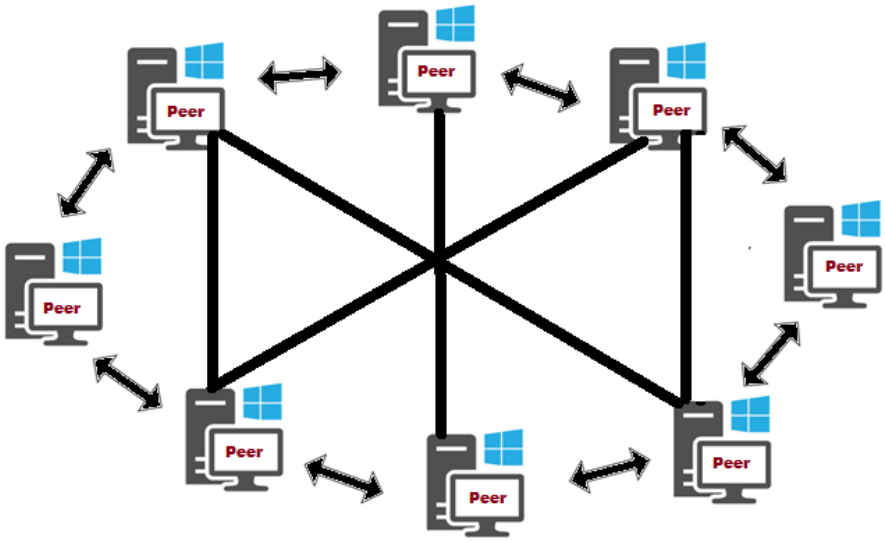

Figure 2: Peer to Peer (According https://tek4.vn/peer-to-peer-network-nen-tang-mang-ngang-hang-cua-blockchain/)

How Peer to Peer model work?

Unlike today's popular traditional client-server models, the P2P model does not have a central storage point, also known as a server. So, the data transmission will be interactive between the nodes. Each node can both act as a client and as a server, so it can both download data from another node as well as upload data to another node. On a peer-to-peer network, devices are connected to share files stored on their hard drives. Use software applications designed to mediate data sharing.

For example: Torrent is a simply example of a P2P network. In torrent, all the computers are connected to each on the internet. One computer can upload file in the network and other computer can download the files

4. High Performance Computing

High Performance Computing (HPC) is the ability to process data and perform complex calculations at high speed. High Performance Computing is often used in research fields that require fast and highly accurate computation. One of the best-known types of HPC solutions is the supercomputer. A supercomputer contains thousands of compute nodes that work together to complete one or more tasks.

A. Parallel

In the simplest sense, parallel computing is the simultaneous use of multiple computing resources to solve a computational problem. Parallel computing helps in performing large computations by dividing the workload between more than one processor, all of which work through the computation at the same time.

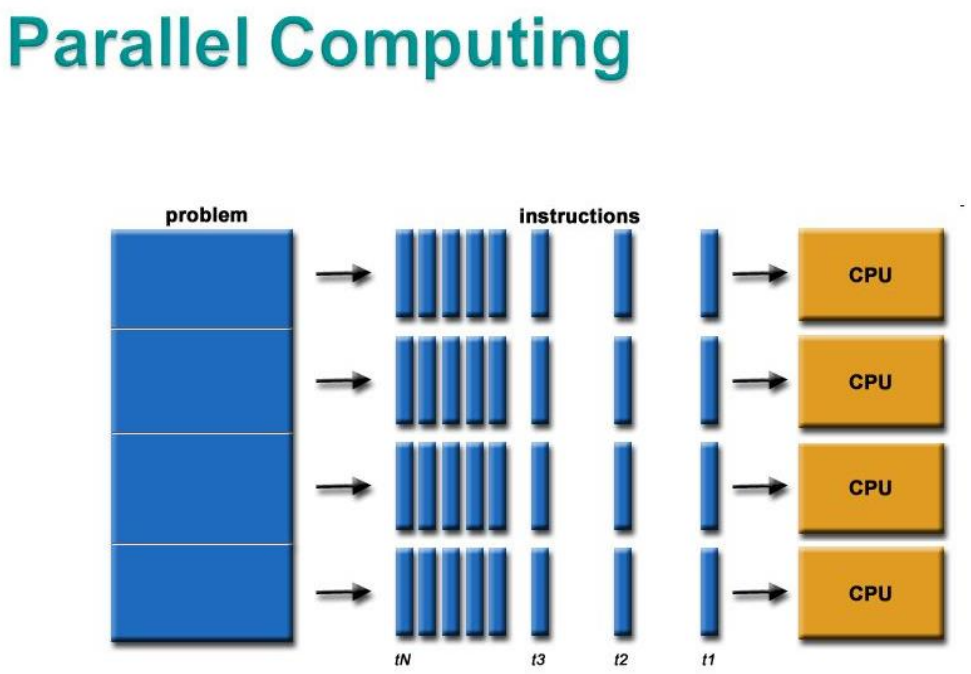

Figure 3: Parallel Computing (According https://slideplayer.fr/slide/16112811/)

There are typically four types of machines that can be used by proprietary and open-source parallel vendors – parallel bits, parallels in instructions, mission parallel or parallels in super words:

- Parallelism at a bit level raises the word size of the processor, which decreases the number of instructions the processor must perform to work on variables larger than word length.
- Parallels at the instruction level: hardware operates on a sequential dynamic, in which the processor chooses, during runtime, what to do in parallel. The program solution uses a parallel static, in which the programmer decides which instructions to execute in parallel.

- Work Parallel: a type of computer code parallels over multiple processors that execute multiple tasks simultaneously on the same data.
- Superword-level parallelism: a vectorization technique that can exploit parallelism of inline code

For example: The iPhone 5 has a 1.5 GHz dual-core processor. The iPhone 11 has 6 cores. The Samsung Galaxy Note 10 has 8 cores. These phones are all examples of parallel computing

B. Cluster Computing

Cluster computing is a high-performance computer cluster that can run as a single machine and is a computer type attached to a LAN. Networked computers essentially act as a single, much more powerful machine. A cluster of computers offers much faster processing speeds, greater storage capacity, better data integrity, high reliability, and broader availability of resources. Some features of cluster computing:

- All Computers of the same type (same processor, operating system)
- The computers are on the same network, so the machines communicate easier and more efficiently

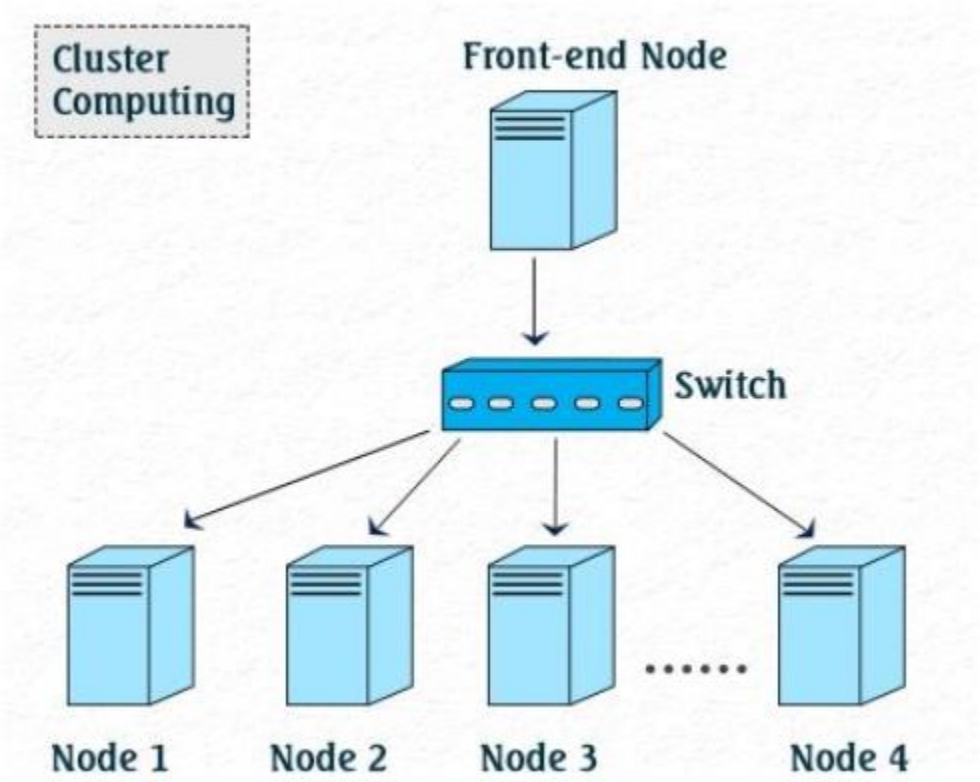

Figure 4: Cluster Computing (According to https://www.techyv.com/article/cluster-computing-more-powerful-and-better-than-many-single-computers/)

C. Distributed

Distributed computing is the collection of computers are connected by network. They divide a single task between multiple computers. All computers work together to achieve a common goal. Thus, they all work as a single entity. A computer in the distributed system is a node while a collection of nodes is a cluster.

Some benefits of distributed computing:

- Scalability: Since computing happens independently on each node, it is easy and generally inexpensive to add additional nodes and functionality as necessary.
- Performance: Distributed systems are extremely efficient because workloads can be broken up and sent to multiple machines.
- Redundancy: Most distributed systems are fault-tolerant as they can be made up of hundreds of nodes that work together. The system generally doesn't experience any disruptions if a single machine fails.

For Example: Uber is an interesting case study. Its infrastructure powers multiple solutions across literally hundreds of cities, dealing with trip planning, messaging, billing, passenger and driver notifications, and more. All of these tasks contributed to a colossal workload for its monolithic system.

Uber built an array of microservice applications, along with an API gateway linked to the app, to power its multi-layered service. It's this model that has allowed it to expand aggressively into new markets and scale accordingly without sacrificing usability and functionality.

5. Deployment Models

According to (Thomas Erl, 2013) , a cloud deployment model is defined according to where the infrastructure for the deployment resides and who has control over that infrastructure.

There are four common cloud deployment models:

- Public cloud
- Community cloud
- Private cloud
- Hybrid clout

A. Public cloud

According to (Thomas Erl, 2013), A public cloud is a publicly accessible cloud environment owned by a third-party cloud provider. The IT resources on public clouds are usually provisioned via the previously described cloud delivery models and are generally offered to cloud consumers at a cost or are commercialized via other avenues (such as advertisement). The cloud provider is responsible for the creation and on-going maintenance of the public cloud and its IT resources. Many of the scenarios and

architectures explored in upcoming chapters involve public clouds and the relationship between the providers and consumers of IT resources via public clouds.

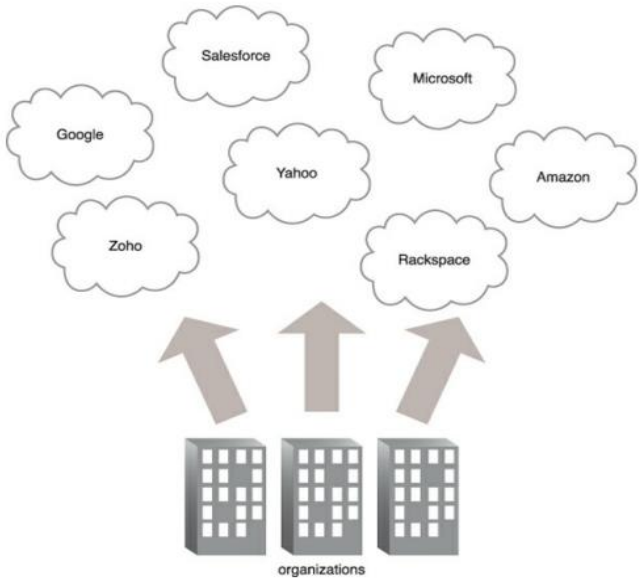

Figure 5: Public cloud (Thomas Erl, 2013)

The public cloud is ideal for use cases in which you must:

- Scale up quickly and accelerate time to market
- Run workloads over the short term
- Manage upfront costs
- Relieve demand on IT resources

Advantages	Disadvantages
▪ Less maintenance cost ▪ User demands can be easily met with scalability ▪ Less resource wastage ▪ Unlimited number of users	▪ Data privacy issues ▪ The controls for users are limited

For example: Viettel IDC's Cloud Sever virtual server service is a prominent public cloud model in Vietnam. This service is developed on a strong infrastructure platform with the world's leading virtualization software VMWare. Viettel IDC allows you to deploy virtual servers with just 1 click, convenient in increasing or decreasing capacity, resources... based on actual needs.

B. Community cloud

According to (Thomas Erl, 2013), A community cloud is similar to a public cloud except that its access is limited to a specific community of cloud consumers. The community cloud may be jointly owned by the community members or by a third-party cloud provider that provisions a public cloud with limited access. The member cloud consumers of the community typically share the responsibility for defining and evolving the community cloud.

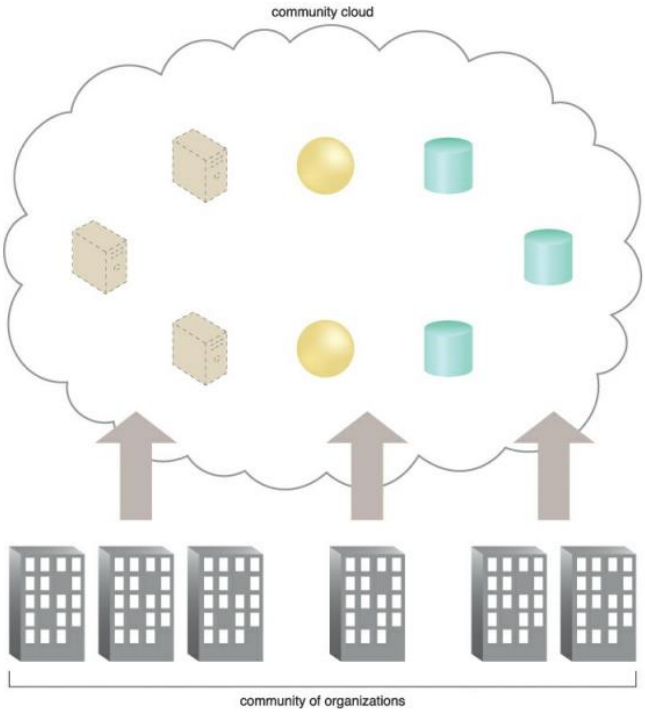

Figure 6: Community Cloud (Thomas Erl, 2013)

Community Cloud is suitable in case:

- Want privacy but financial ability is not good
- Do not want to take responsibility for the complete management of the cloud
- Want to interact with more than one company
- Want a more secure model than public cloud

Advantages	Disadvantages
▪ Allows cooperation and sharing with other partners ▪ Security level is more secure than public cloud ▪ Transition on the public (or private) cloud	▪ Limited storage ▪ Relatively high cost

For example: Google offers Google Apps service to government. The suite, with such applications as Gmail email and Google Calendar, offers U.S. government FISMA (Federal Information Security Management Act) moderate-level certification. Also, government user data is to be maintained on servers segregated from Google's commercial customers.

C. Private cloud

According to (Thomas Erl, 2013), A private cloud is owned by a single organization. Private clouds enable an organization to use cloud computing technology as a means of centralizing access to IT resources by different parts, locations, or departments of the organization.

A private cloud is ideal for use cases in which you must:

- Protect sensitive information, including intellectual property
- Meet data sovereignty or compliance requirements
- Ensure high availability

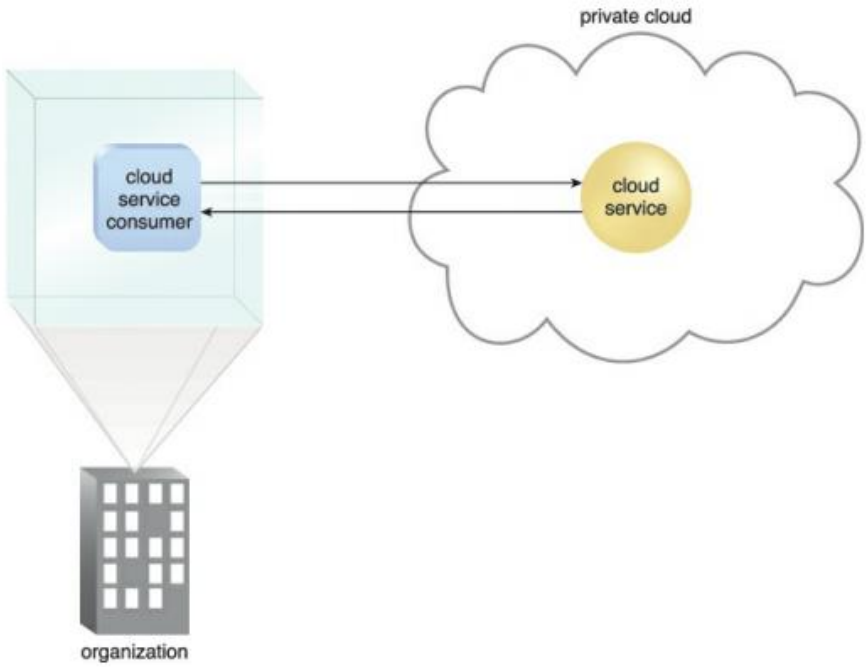

Figure 7: Private cloud (Thomas Erl, 2013)

Advantages	Disadvantages
▪ Easy to control and maintain ▪ Good security	▪ Higher initial cost ▪ Require highly skilled staff ▪ Service quality is not high

For example: Amazon provides Amazon Virtual Private Cloud (Amazon VPC) allows you to launch AWS resources in a logically isolated virtual network that you define. You have full control over your virtual network environment, including selecting IP address ranges, creating subnets, and configuring routing tables and gateways. You can use both IPv4 and IPv6 for most resources in a virtual private cloud, providing strict security and easy access to resources and applications. (aws.amazon.com, 2021)

Hybrid cloud

According to (Thomas Erl, 2013), A hybrid cloud is a cloud environment comprised of two or more different cloud deployment models. For example, a cloud consumer may choose to deploy cloud services processing sensitive data to a private cloud and other, less sensitive cloud services to a public cloud. The result of this combination is a hybrid deployment model.

Hybrid deployment architectures can be complex and challenging to create and maintain due to the potential disparity in cloud environments and the fact that management responsibilities are typically split between the private cloud provider organization and the public cloud provider.

Creating a hybrid cloud means that a company is using the public cloud but also owns on-premises systems, and there is a connection between the two. They work as one system. This is a very useful model that allows for a smooth transition into the public cloud over a longer period of time. Due to security requirements or data protection, some companies can’t operate only in the public cloud, so they may choose the hybrid cloud to combine the requirements with the benefits of a public cloud.

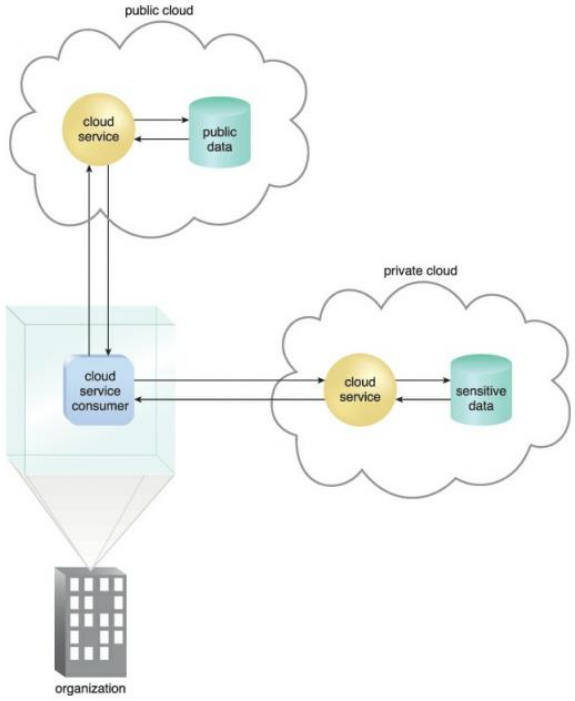

Figure 8: Hybrid Cloud (Thomas Erl, 2013)

Advantages	Disadvantages
▪ Stable, easy to scale as the number of users increases ▪ Superior flexibility and scalability ▪ Better security (Compared to public cloud)	▪ Difficult to manage ▪ Some security features are not good

For Example: Netflix is a fairly famous hybrid cloud model in recent years. Netflix rely heavily on hybrid cloud data storage due to its on-demand and pay-per-use features.

6. Service model

A. Infrastructure as A service (IAAS)

According to (Thomas Erl, 2013), The IaaS delivery model represents a self-contained IT environment comprised of infrastructure-centric IT resources that can be accessed and managed via cloud service-based interfaces and tools. This environment can include hardware, network, connectivity, operating systems, and other “raw” IT resources. In contrast to traditional hosting or outsourcing environments,

with IaaS, IT resources are typically virtualized and packaged into bundles that simplify up-front runtime scaling and customization of the infrastructure.

The general purpose of an IaaS environment is to provide cloud consumers with a high level of control and responsibility over its configuration and utilization. The IT resources provided by IaaS are generally not preconfigured, placing the administrative responsibility directly upon the cloud consumer. This model is therefore used by cloud consumers that require a high level of control over the cloud-based environment they intend to create. So IaaS model is suitable with IT administrators

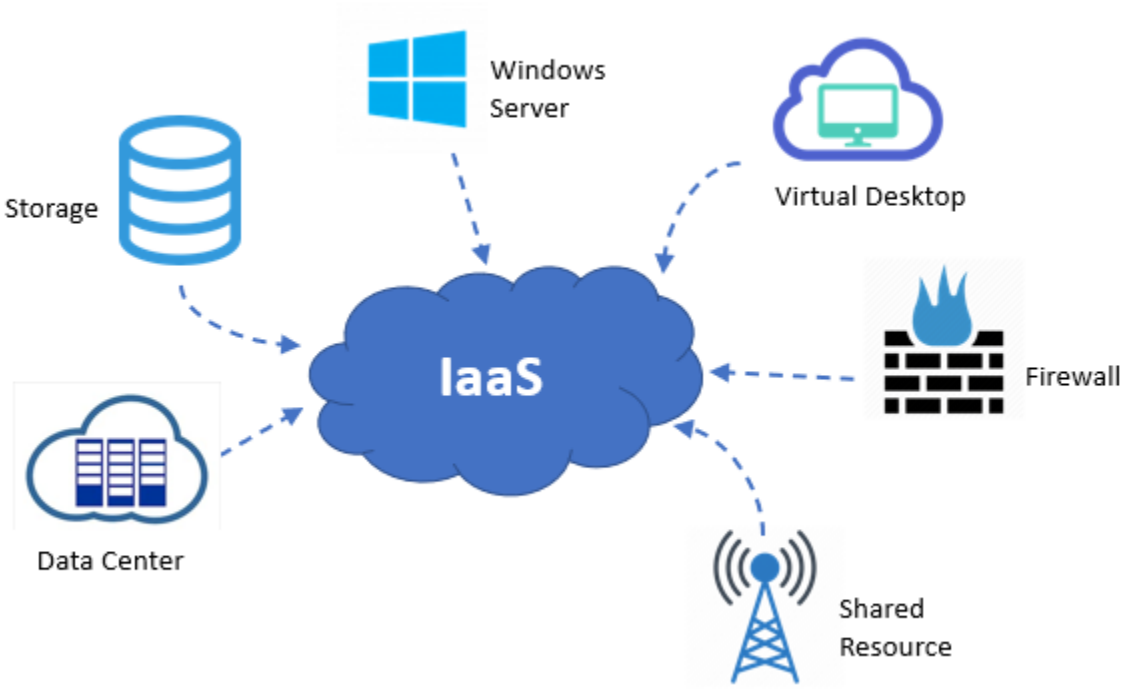

Figure 9: IaaS (According to: geekflare.com/cloud-service-models/)

For Example: In IaaS, customers use Azure to deploy different configurations of the managed infrastructure. Due to the highly flexible nature of these services, Azure IaaS is suitable for many business needs.

B. Software as a Service (SAAS)

A software program positioned as a shared cloud service and made available as a "product" or generic utility represents the typical profile of a SaaS offering. The SaaS delivery model is typically used to make a reusable cloud service widely available (often commercially) to a range of cloud consumers. An entire marketplace exists around SaaS products that can be leased and used for different purposes and via different terms (Thomas Erl, 2013).

That mean, SAAS would be suitable if you are end users

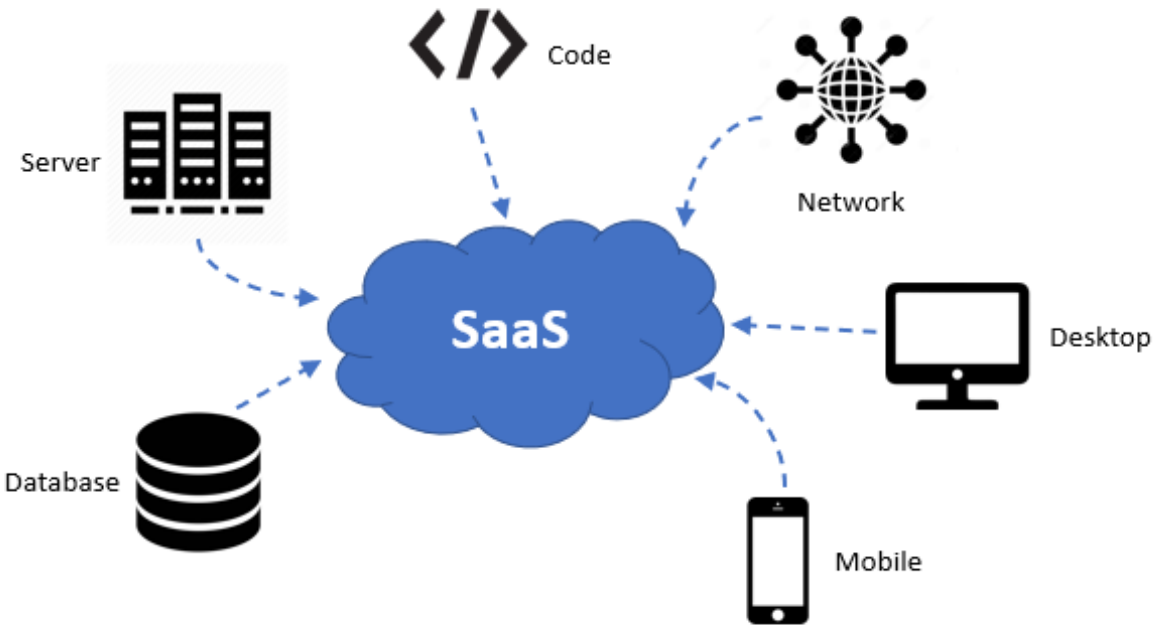

Figure 10: SaaS (According to: geekflare.com/cloud-service-models/)

For example: Google Apps, Dropbox, Slack…

C. Platform as a Service (PAAS)

According to (Thomas Erl, 2013), the PaaS delivery model represents a pre-defined "ready-to-use" environment typically comprised of already deployed and configured IT resources. Specifically, PaaS relies on (and is primarily defined by) the usage of a ready-made environment that establishes a set of pre-packaged products and tools used to support the entire delivery lifecycle of custom applications.

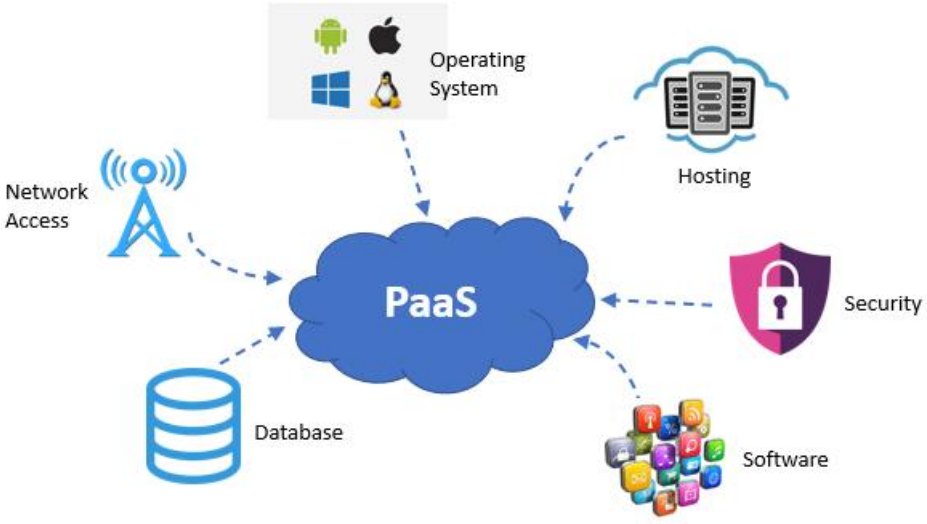

Figure 11: PaaS (According to: geekflare.com/cloud-service-models/)

Common reasons a cloud consumer would use and invest in a PaaS environment include:

- The cloud consumer wants to extend on-premise environments into the cloud for scalability and economic purposes.
- The cloud consumer uses the ready-made environment to entirely substitute an on-premise environment.
- The cloud consumer wants to become a cloud provider and deploys its own cloud services to be made available to other external cloud consumers.

With above reasons, It can be seem PaaS is suitable with software developers.

For example: Heroku is an Application-as-a-Service (PaaS) Cloud Platform. Developers use Heroku to deploy, manage, and scale modern apps. Heroku is fully managed by Heroku, giving developers the freedom to focus on their core product without the distraction of maintaining servers, hardware, or infrastructure.

7. Characteristics of cloud

A. On-demand self-service

Self-service means that the consumer performs all the actions needed to acquire the service himself, instead of going through an IT department. For example: Computer services such as Email, Application Network, or Server service can be provided without requiring interaction with each service provider.

B. Board network access

Cloud capabilities are available over the network and accessed through standard mechanism that promote use by heterogeneous client such as mobile phone, laptop…

C. Elastic resource pooling

The utilities providers' networks are pooled and are accessed by multiple customers on a "multi-local" basis. This model allows dynamically allocating hardware and virtualization resources depending on user needs as user requirements are decreased or expanded and resources are invoked for the application. The consumer is not concerned about controls or wants to know the precise location of the available services. Examples: Services for which storage, resources, memory, network bandwidth and virtual machinery are used. (Thomas Erl, 2013)

D. Rapid elasticity

According to (Thomas Erl, 2013), this capacity enables the device to be extended or decreased dynamically according to the user's needs. The framework automatically extends with rising demand by incorporating capital. As demand declines, the system cuts capital automatically. The intensity allows vendors to better utilize inventory, use redundant resources to their fullest capacity and support more clients. Scalability lets care consumers minimize their expenses by paying more for the services they need.

E. Measured service

The cloud system automatically controls and optimizes resource usage by leveraging metering at some level of abstraction appropriate to the type of service (e.g. storage, processing, bandwidth) and active user account). Resource usage can be monitored, controlled and reported, providing transparency to both providers and consumers of the service used. (Thomas Erl, 2013).

8. Virtualization and Multicore

A. Virtualization

Virtualization is a technology designed to create a middle layer between a computer hardware system and the software running on it. The idea of server virtualization technology is that a single physical machine can form many independent virtual machines. Each virtual machine has a separate system source setup, its own operating system, and its own applications. Virtualization is not just hardware, it can be the disk, CPU, I/O, network, OS, data and apps.

Advantage	Disadvantage
• Reduced costs • Reduce application installation, upgrades, and maintenance • Reduces the size of Data Center resources	• Lower performance • Require collection of skill • Security risks involved

• Easy to move hardware configurations or copy hardware configurations	

B. Multicore

Multi-core is a common term used to describe multiple CPUs working on a similar chip. Multicore helps the system to execute more tasks with better overall system performance, reducing resource consumption, reliability improvement and performing several tasks concurrently. Multicore-based processors are used in mobile devices, desktops, workstations and servers.

For example: The quad-core i5 will perform significantly faster than the dual-core i5, and that performance will be reflected in the price of the computer. In the case of the i5 model, all current laptop models in this article are dual-core, while all desktop models are quad-core. So i5 in laptop will have lower performance than i5 in desktop because laptop models only have dual core and not quad core. The dual-core model uses less power and is optimized for portable notebook devices that need longer battery life while desktops don't have to worry about battery life and can use processor consumes more power, like the quad-core model.

9. Propose solution

A. Scenario

ATN is a Vietnamese company which is selling toys to teenagers in many provinces all over Vietnam. The company has the revenue over 700.000 dollars/year. Currently each shop has its own database to store transactions for that shop only. Each shop has to send the sale data to the board director monthly and the board director need lots of time to summarize the data collected from all the shops. Besides the board can’t see the stock information update in real time.

Based on this scenario, the reason why ATN should use Cloud Computing following:

The fact that ATN has annual revenue of more than $700,000 and have so many stores in Viet Nam so this is a medium company with huge sale data monthly. With companies having to send data to the board director that means every month, the company has to pay high costs and take a quite of time for the document to arrive. With Cloud Computing ATN can reduce the cost and time of transport

The next, cloud storage data with advanced security features, the data stored on the cloud will be encrypted, data control leads to avoid leakage. With the simple infrastructure that the company has in place, it is very easy for an attack to affect the company and its customers.

With using Cloud Computing, data can be accessed from all devices such as PC or smartphone. The board director can access files and synchronize data easily with any device through an Internet connection, so the board director can access and view data anytime, anywhere so can reduce time to summarize the data from all the shops. Moreover, with cloud computing, the company can expand overseas market.

When businesses achieve sudden growth, with current infrastructure ATN have to buy more storage and associated licenses. After that, the operation of installing hardware. Equipment, installing software, configuring… is very time consuming and requires highly specialized skills. But with cloud computing it is different, scaling becomes extremely easy. ATN can increase or decrease storage capacity or add or remove features whenever there is a need to expand/ shrink. Besides, upgrading the service pack is also very simple, taking place within a few minutes.

B. Deployment Model

Public cloud is more fitting for the ATN because:

ATN company has the annual revenue of $700.000/ year. So public cloud is an ideal for cost savings with medium annual income. For a company that doesn't have as much infrastructure as ATN, using public cloud helps them minimize setup costs. With the public cloud, the company does not have to pay for hardware and software maintenance cost.

With a company that has as many transactions as ATN every month. Their data will increase year by year month by month. With public cloud, they can expand, exploit more resources whenever they need, or when they want to change, can easily switch.

ATN already has several stores in Vietnam, so using the public cloud will help employees use the service anywhere. Centralized operation and management of all underlying resources are shared on cloud services, making it easier for the company to operate. All you need to do is connect to the internet. Therefore, ATN can open more store in Vietnam as well as in other country without worrying about infrastructure and servers for the new store.

Public cloud is also quite easy to use without high technical requirements, so it is very suitable for companies that have never used cloud services like ATN.

C. Service Model

For ATN business, PAAS is the appropriate option. The main benefit of PaaS is simplicity and convenience for users – PaaS providers provide much of the infrastructure and other IT services, which users can access anywhere via Web browser. ATN can eliminate cost for local hardware and software.

Because PaaS deploys the service over the internet, it is easy for users to access the software from any device and browser with an internet connection. With PaaS, you don't have to go to the office and open a computer with pre-installed software to use it. When ATN registers to use the software, you are allowed to create additional accounts (with a limit on the number of packages purchased) for employees in the enterprise. ATN employees can sit anywhere, at any time, perform a simple login and use unlimited features. Very suitable for companies with many stores like ATN.

Since ATN had its own database, so the company had its own IT staff. PaaS provides a platform for developing applications that can be delivered over the Web. That makes it possible for PaaS to allow multiple developers to work on the source code at the same time. For example, if their team doesn't meet the requirements, they can hire a third-party to develop it at the same time. That will be much more economical when using SaaS and quite redundant in resources when using IaaS.

D. Programming

According to (Patel, 2018), Node.js is an open source, environment for network servers and applications. Node.js uses the Google V8 JavaScript engine to execute the code, and a large percentage of the underlying modules are written in JavaScript. Node.js applications are written in JavaScript. Node.js contains a built-in library that allows applications to act as a Webserver without the need for software like Nginx, Apache HTTP Server or IIS. Node.js provides event-driven architecture and non-blocking I/O API, optimizes application throughput, and is highly scalable.

Figure 12: Node.js

Advantages of Node.js

- Nodejs applications are mostly written in java script programming language - a common language, widely used and can run on many browsers, platforms, operating systems, ...
- Compatible with many devices. You can run applications developed by Nodejs on any device, be it Mac, Window, Linux...
- Node.js is extremely fast, handling the needs of 'huge' visitors in a very short time.
- Node.js owns the ecosystem of the npm bundle that is known as the world's biggest open-source library ecosystem.

With the above reasons, I think Nodejs will support ATN's system very well

E. Database

According to (Mongo DB, 2021), Mongo DB is an extensible, high-performance, open-source, free-template, and document-oriented database.

Figure 13: Mongo DB

The reason that why I choose MongoDB:

- The first can be mentioned is the flexibility to store data in different sizes, the data is in the form of a JSON document, so you can comfortably insert whatever information you want.
- MongoDB delivers all the features required for the most complex specifications of all scales, but for developers to understand and use the MongoDB documentation model is still quite basic.
- MongoDB is multilingual support. Several versions of MongoDB have been released and are in continuous development with driver support for popular programming languages, including Python, PHP, Ruby, Node.js, C++, JavaScript and more.
- MongoDB is a document-oriented database. You can easily access documents by indexing. Therefore, it provides fast query response. The speed of MongoDB can be 100 times faster than a relational database.
- MongoDB is a horizontally scalable database. When you have to process a large data, you can distribute it to many machines.
- Free to use

F. Cloud platform

Heroku is a cloud platform that enables developers to create, launch, maintain and expand applications (Heroku, 2021)

Figure 14: Heroku

Heroku has some benefits that suitable for project such as:

- Heroku is a cloud-based container as a service (PAAS). This allows businesses and developers to innovate in the fastest way possible and develop with modern architecture. The software also scales to meet the growing needs of an organization.
- Heroku offers developers a secure way of developing applications due to its set of security features. This PaaS platform reduces developers' requirement to push constant security patches, which can be a hassle, especially in more sophisticated web applications. Heroku ensures an optimal level of security for servers, application code and prevents any possible issues.
- Heroku will incorporate GitHub without any problems.
- Easy to scaling, management, and application monitoring.

10. Cloud Architecture

According (Thomas Erl, 2013), The dynamic scalability architecture is an architectural model based on a system of predefined scaling conditions that trigger the dynamic allocation of IT resources from resource pools. Dynamic allocation enables variable utilization as dictated by usage demand fluctuations, since unnecessary IT resources are efficiently reclaimed without requiring manual interaction.

The automated scaling listener is configured with workload thresholds that dictate when new IT resources need to be added to the workload processing. This mechanism can be provided with logic that

determines how many additional IT resources can be dynamically provided, based on the terms of a given cloud consumer's provisioning contract.

The following methods can also be used in this form of cloud infrastructure as well as resource duplication and the main author:

- Monitor using the cloud
- The supervisor
- Pay-Per-Use monitoring

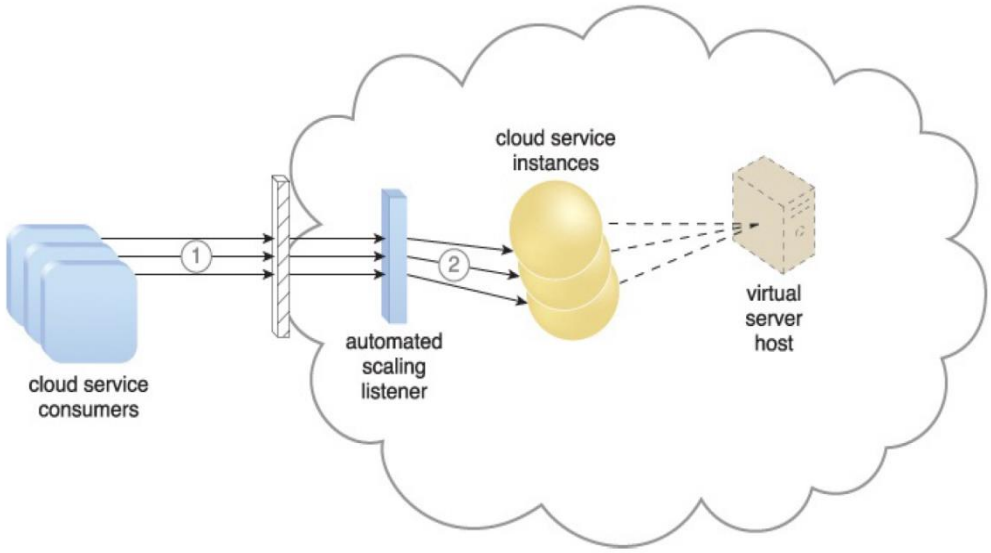

Figure 11.5 Cloud service consumers are sending requests to a cloud service (1). The automated scaling listener monitors the cloud service to determine if predefined capacity thresholds are being exceeded (2).

Figure 15: Cloud architecture

Firstly, the user of cloud service sends a request

Then the automated scaling listener tracks the cloud infrastructure dynamically to decide if demand exceeds a pre-determined level capacity limit. Two cases can happen as following:

Case 1: When the workload is good (is less than or equal to the capacity limit), the request is sent to the cloud provider to continue its process.

Case 2: When the workload is greater than the output threshold, the rate controller decides the next step on the basis of the predefined rate policy automatically.

The scaling listener would immediately begin the scaling process if eligible for cloud service rollout and further scaling.

Next, the signal is sent to the resource duplication system using the scaling listener and many variations of the cloud service are created to meet the number of requests from customer.

The automated listener continue watches, devalues and adds IT resources as needed. The order of customers is cancelled or returned if the cloud translation is not eligible for additional scaling.

For example: A customer sends a cloud service request. The workload of this proposal is 5 and actual threshold is only 3. With given rate strategy, the scale handler automatically decides to the next process. The RAM would immediately share the extensor if really want to scale. The signal sent to resource regeneration the scale handler's automated engine, which generates a series of service variations to match need. Customer requests are now redirected to the extended cloud infrastructure. However, the customer requires cloud provider will be canceled if not able to scale.

II. Conclusion

The above report, I have presented about fundamentals of Cloud Computing. Moreover, I have provided the sever platform, the deployment model and the cloud service. Thereby gaining more experience to use with given scenario, such as how to choose a deployment platform, service model, programming language.

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