SYST8111 – Server Virtualization

Title: Private Cloud Platforms

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Part A - Vendor Identification

1. Here are the profiles of five vendors specializing in cloud computing.

In my investigation, I have discovered multiple suppliers offering infrastructure services and private cloud platforms. Here are a few noteworthy examples:

1. **Amazon Web Services (AWS)**

AWS, plays a pivotal role in the field of cloud computing, its an online platform that provides cost-effective and scalable computing solutions to ISVs, application providers and vendors. Some of the on-demand operations provided by AWS includes content delivery, compute power, database storage and various other features which helps corporate to grow easily. It has the capability to work on different configurations based on users needs. AWS is known for its cost- effective service as it does not require a long-term commitment for anything which the consumer needs. It offers hybrid computing, management of centralized sectors and quick installation or removal of the application in any geographical locations.

2. **Google Cloud Platform (GCP)**

Google Cloud Platform (GCP) is a widely used cloud computing platform nowadays. GCP leverages cloud computing services offered by Google to assist customers in their digital transactions. Some of the services offered by GCP includes big data processing, compute, Machine learning and AI and Network. GCP's global infrastructure, allows businesses to quickly deploy scalable applications as it has with data centers in different regions. GCP provides freedom for the users to build, test, and deploy their applications on distributed and scalable infrastructure. It also provides its

users to utilize the service's capabilities in data management, security, analytics, and artificial intelligence (AI). The Google's API helps in speech detection and language translation which is one of the most preferred choices among customers.

3. Microsoft Azure

Microsoft Azure is identified as the second largest cloud service provider. Some of the services offered by Microsoft Azure includes Machine Learning +AI, Internet of things, Databases, Security, DevOps and many more. Microsoft's previous products and services offered by them in the cloud makes it the most intelligent and attractive cloud choice. Microsoft Azure offers advanced security solutions and services such as, Azure active directory, Security Center, Key vault, VPN gateway, Application gateway, and so on. Azure offers global availability by providing more data centers around the world. It utilizes virtualization to differentiate the coupling between CPU and the operating system, this is done with the help of an abstraction layer commonly known as hypervisor. This Hypervisor has the unique ability to emulate all the functionalities of the physical machine such as server and hardware into a virtual machine. There are multiple virtual machines available, and each one can be used to run numerous operating systems.

4. IBM Cloud Services

The services offered by IBM cloud are Software as a service (SaaS) platform as a service (PaaS) and infrastructure as a service (IaaS) via private, public and hybrid cloud models. With the help of internet, the IBM cloud organizations can access and deploy its resources such as compute power and storage networking. IBM cloud fulfils the requirements of the customers and ensures customer satisfaction with its amazing speed and agility of the cloud. IBM Cloud provides solution that enables higher level of security, compliance and management, with proven architecture methods and patterns. IBM Cloud

provides support for multicloud and hybrid cloud which makes it easy to work with different vendors. IBM Cloud computing services also helps home appliance manufacturer, medical supply businesses and retailers.

5. Alibaba Cloud

Alibaba Cloud is a leading cloud provider in China and in Asia Pacific, its part of Alibaba group. In Alibaba Cloud the cloud services are available on a pay-as-you go basis. It also includes services such as data storage, elastic compute, big data processing, relational database and content delivery network. Alibaba cloud was launched in 2009. Alibaba incorporates object storage service (OSS) which provides enterprises to store any type of unstructured data. Alibaba cloud provides cloud computing services such as IaaS, PaaS, DBaaS and SaaS. Along with other providers, Alibaba cloud also offers various cloud infrastructure and applications development services. Alibaba Cloud provides a wide range of AI-based services and products, including natural language processing, machine learning and computer vision, which enables customers to automate processes and build intelligent applications.

2. Here are the five infrastructure services corresponding to each vendor for building private cloud architecture.

1. **Amazon Web Services**
    a. **The Amazon Elastic Compute Cloud (Amazon EC2)** is a web service that provides secure, scalable computing capacity in cloud. It permits organizations to configure and access virtual compute capacity in the cloud.
    b. **AWS Lambda** is a serverless and event-driven compute service that allows to run code without managing servers. It enables to run code for any type of application with minimum or zero administration. It also enables the flexibility to pay for what is been used.
    c. **Amazon VPC** is the network environment in the cloud. Amazon VPC allows to create a private network within AWS cloud which uses most of the constructs and concepts of an on-premises network. Amazon VPC is an AWS foundational service which is integrated with numerous other AWS services.
    d. **Amazon S3 (Amazon Simple Storage Service)** is object storage which consist of simple web service interface to retrieve and store any amount of data from anywhere on the web. Amazon S3 is used as a primary storage for cloud-native application as a means for backup and disaster recovery.
    e. **Amazon Glacier** is a durable, secure and extremely low-cost storage service used for long-term backup and data archiving. It is an ideal

solution for data archiving as it take several hours to retrieve the data stored in them.

f. **Amazon Relational Database Service (Amazon RDS)** enables to setting up, operate and scale a relational database easily in cloud. It manages time consuming database administration task which in turn provides cost effective and resizable capacity.

2. **Google Cloud Platform**

   a. **The Google Compute Engine** is used as a provision for the virtual machines to deploy the applications with the help of required rom, ram and security groups.

   b. **Cloud Storage** enable to store large amounts of data , which is required to be highly available.

   c. **Cloud SQL** it offers services like PostgreSQL, MySQL and SQL Server. It also helps in managing relational database with automated backup and scaling.

   d. **Virtual Private Cloud (VPC)** it enables to create and manage isolated virtual networks for google cloud platform resources.

   e. **Cloud Load Balancing:** This is considered as an important service of google cloud which helps to distribute cloud among multiple replicas of the application.

3. **Microsoft Azure:**

   a. **Compute**. It includes cloud services for building apps and APIs. It includes Virtual machines and functions for serverless computing.

b. **Storage** includes Queue, blob, and Disk Storage as well as provides Backup and recovery.
c. **Azure CDN** This service is used to deliver content to users. The CDN service enables the users to access the data as soon as possible with the help of a network of servers placed strategically around the globe.
d. **Express Route** This service helps to connect on premise network to Microsoft cloud or any other services that is needed by the consumer with the help of a private connection.
e. **Virtual Network** This service allows to have any of the Azure services communicate with one another privately and securely.

4. **IBM Cloud Services:**
    a. **IBM Cloud Code Engine** enables serverless containers hosting platform as a service.
    b. **IBM Cloud Database** enables to store, query and analyze structured database.
    c. **IBM Security Advisor** ensure to secure the cloud resources and simplify regulatory compliances.
    d. **IBM Load balancer** ensures traffic flow management for cloud applications.
    e. **IBM Cloud Direct Link** helps to establish Physical or virtual private connections to IBM Cloud.

5. **Alibaba Cloud**
    a. **Apsara Stack:** Alibaba cloud offers a hybrid cloud solution which aims to encourage organizations to seamlessly integrate their on-premises IT infrastructure with its cloud platform.
    b. **Elastic Compute Service:** This cloud computing service provides scalable and on-demand computing resources. It enables users to launch virtual machines on demand and pay as they use.
    c. **Simple Application Server:** This is a completely managed, PaaS that enables easy deploy, run and scale web APIs, applications and microservices.
    d. **Apsara Stack:** Alibaba cloud offers a hybrid cloud solution which aims to encourage organizations to seamlessly integrate their on-premises IT infrastructure with its cloud platform.
    e. **Server Load Balancer (SLB):** This is a service that distributes the incoming network traffic across multiple servers. It also ensures to handles traffic effectively.
    f. **Auto Scaling:** This service of Alibaba Cloud automatically adjusts the number of virtual machines in an application based on the current demand.

3. Here are few identified purpose associated with each infrastructure service.

1. **Amazon Web Services**
    a. **Virtual Private cloud (Amazon VCP) Amazon** VPC is responsible for the network environment in the cloud.
    b. **Amazon E2C** enables to use ones or hundreds of server instance simultaneously. It provides complete, secure solutions for computing applications.
    c. **Amazon Lambda** The main purpose of this service is that it lets developers to run code for any type of application with no or zero administration. It also ensures auto scaling of the code with high availability. It lets developers the flexibility to pay for compute time they consumed.
    d. **Virtual Private cloud (Amazon VCP) Amazon** VPC is responsible for the network environment in the cloud. It lets to create a private network within the AWS cloud that uses most of the same constructs and concepts as an on-premises network.
    e. **Amazon S3** The main purpose is to provide infinite amount of storage and its delivery with 99.99999% durability. It facilitates the store and retrieval of any amount of data from the web with the help of a simple web service of object storage.

f. **Amazon Glacier The** main purpose of Amazon Glacier is that it provides faster access to the archive data. They take several hours to retrieve stored data. This is a low cost storage service which is ideal for data archiving and long-term backup.

g. **Amazon RDS** The main purpose of this service is that it makes it easy to setup, operate and scale an relational database in cloud. It manages time consuming administrative task while providing resizable and cost-effective capacity which helps the users to focus on their application and business .

2. **Google cloud platform**

a. **Google Compute Engine** The main purpose of this service is to provide the required computing resources such as RAM, ROM, and security groups, that allow the users to provision virtual machines to deploy and run the application.

b. **Cloud storage** The main purpose is to store huge amounts of data which is required to be highly available.

c. **Cloud SQL** The main purpose of this service is that it provides services like SQL Server, MySQL and PostgreSQL.

d. **Virtual Private Cloud** the main purpose is to deploy the application in the private network which can be achieved by google cloud.

e. **Cloud Load Balancing** the main purpose of this is to distribute the cloud across the multiple replicas of the applications.

3. **Microsoft AZURE**
    a. **Compute Service:** There are several uses of this service for instance it enables to create Virtual Machine in Windows, Linux or any other operating system within fraction of seconds. It is also possible to create scalable applications within the cloud. Once the application is deployed rest everything is taken care by Azure.
    b. **Blob Storage** The purpose of this service is to store massive amount of unstructured data. The data can be text and binary data.
    c. **Azure CDN The** primary objective of this service is to deliver data to the users as soon as possible and the users can access these data from any part of the glob.
    d. **Express Route** The main purpose of this service is that it enables to establish a private connection between on-premises network to the Microsoft cloud or any other services that is on need.
    e. **Virtual Network** The main purpose of this service is that it lets Azure service to communicate with other services in a private and secure manner.
4. **IBM Cloud Services**
    a. **IBM Cloud Code Engine** The purpose of this service is to enable its developers to run and deploy applications with zero management of the underling infrastructure.
    b. **IBM Cloud Database** The purpose of this service is to address data-intensive needs of data scientists and IT architects.

c. **IBM Security Advisor** The purpose of this service is to secure the cloud resources and simplify regulatory compliances.
d. **IBM Load balancer The** purpose is to provide traffic flow management for cloud applications.
e. **IBM Cloud Direct Link** The purpose is to establish Physical or virtual private connections to IBM Cloud.

5. **Alibaba Cloud**

a. **Elastic Compute Service:** The purpose of this cloud computing service is to provide scalable and on-demand computing resources. It enables users to launch virtual machines on demand and pay as they consume.
b. **Simple Application Server:** The purpose of this service is to manage, PaaS that enables easy deploy, run and scale web APIs, applications and microservices.
c. **Apsara Stack:** The purpose is to offer a hybrid cloud solution which aims to encourage organizations to seamlessly integrate their on-premises IT infrastructure with its cloud platform.
d. **Server Load Balancer (SLB):** The purpose is to distribute the incoming network traffic across multiple servers.
e. **Auto Scaling:** The purpose of this service of Alibaba Cloud is to automatically adjusts the number of virtual machines in an application based on the current demand.

3.Use-case for each vendor who have built their architecture.

1. **Amazon Web Services**

   Big companies in the field of Information Technology and services use Amazon Virtual Private cloud. Amazon VPC lets the provision of logically associated section of the AWS Cloud where it enables to launch AWS resources in a virtual network that they define. To enable access to critical resources companies, establish direct connection between on premise data center and AWS with the help of AWS Direct Cloud.

2. **Microsoft Azure**

   Multinational companies use Azures Virtual machine to configure different operating system in seconds and they can create applications in any programming language. Companies also use Express Route to establish a private and high bandwidth connect between headquarters and data centers.

3. **Google cloud Platform**

   Big companies like Ferrero uses Google Cloud Platform's Big Query for business analysts to store and analyse massive data sets in a very reliable, fast, and affordable manner. Ferrero with Google BigQuery could divide its database into real-time actionable consumer clusters to generate more accurate user profiles.

4. **IBM cloud**

   A leading home appliance company has been most aggressive in cloud migration. The company entrust the operations and management of business-critical SAP Business Warehouse and other enterprise applications to the IBM Cloud.

5. **Alibaba cloud**

   Banking industry use Alibaba cloud Object storage Secure to deploy a secure financial analytic platform. They also use the Express connect to establish an secure connection between on premise and Alibaba cloud.

Part B – Feature Comparison

1. Feature comparison chart with vendor name feature list and reference.

a. Compute Service

	Scalability	**Virtual Server**	**Container Instance**	**Serverless Computing**	**Job Orchestration**
Amazon Web Services (AWS)	AWS Auto Scaling	Elastic Compute Cloud (EC2) Instances, Amazon LightSail	EC2 Container Service (ECS), Elastic Container Registry (ECR)	Lambda	AWS Batch
Microsoft Azure	Azure Autoscaling, Virtual Machine Scale Sets	Azure Virtual Machines,	Azure Kubernetes Service (AKS)	Azure Functions, Azure Event Grid	Azure Batch
Google Cloud Platform (GCP)	Autoscaling	Compute Engine	Kubernetes Engine	Google Cloud Functions	Preemptible VMs
IBM Cloud	Auto Scaling	IBM Virtual Servers	IBM Cloud Kubernetes Service	IBM Cloud Functions	N/A
Alibaba Cloud	Autoscaling	Simple Application Server, Elastic	Container Registry	Function Computes	Batch Compute

		Compute Service			

b. Storage and database

	Object Storage	**Shared File Storage**	**Backup**	**Disaster Recovery**	**Relational Database**	**Non-Relational Database**
Amazon Web Services (AWS)	Simple Storage Services (S3)	Elastic File System	AWS Cloud Backup	CloudEndure Disaster Recovery	RDS for SQL Server, RDS for MySQL, RDS for Oracle DB, RDS for Postgre SQL	Dynamo DB
Microsoft Azure	Azure Blob Storage	Azure Files,	Azure Backup	Site Recovery	Azure Database for MySQL, Azure Database for PostgreSQL, SQL Database,	Azure Cosmos DB
Google Cloud Platform (GCP)	Google Cloud Storage	Google Cloud Storage FUSE	N/A	N.A	Google Cloud SQL, Cloud SQL support for Postgre SQL (Beta)	Cloud Firestore , Cloud BigTable
IBM Cloud	IBM Cloud Object Storage	File Storage	IBM Cloud Backup	Data Transfer Service	Compose for MySQL, IBM Cloud Databases	Databases for MongoDB, Databases for Elasticsearch

					for EnterpriseDB	
Alibaba Cloud	Object Storage Service	Network Attached Storage	Cloud Backup and Recovery Database Backup	Alibaba Disaster Recovery Hybrid Backup Recovery	ApsaraDB for MySQL, ApsaraDB RDS for SQL server	Time Series Database

2. Significant features that are most critical to any organization for the final selection of a platform.

1. Security

Security is the primary concern for most organizations and developers that build critical apps for instances banking, insurance companies and apps that deals with users' personal information. It is always important to rely on services that are reliable, takes security measures and provides certification seriously. There are variety of ways to build a private cloud environment with high security, providing a lot of great security methods and implementations to get access between private cloud and local development environment.

2. Scalability

Another most important factor to consider when choosing a cloud service provider is Scalability. It allows to quickly adjust the cloud computing resources as needed to meet the changing needs of the organization. Cloud service providers should be able to scale up and down effectively to meet the

requirements of the organization. Scalability can help organizations save a money by only paying for the services used.

Part C – Comparing Cloud Deployment Models

1. Comparison of Private, Public and Hybrid Cloud Models.

Cloud computing is a method of remote hosting of computer network, where massively computers are distributed and connected to the Internet and made available through Internet Protocol networks such as the Internet. Cloud computing involves computers as a service over the Internet, on-demand and distributed systems, utility computing, and processing of data for resource pooling, scalability, rapid recovery, and rapid elasticity from failure.

1. Public Cloud

In public cloud, Cloud service providers manage and operate computing resources. The CSP monitors the supporting infrastructure. They also ensure that resources are scalable and accessible to user. But its scary that anyone with an internet connection can access public cloud. Users can use the CSP's different services, run apps, and store their data. With the help of pay-per-usage strategy, customers can be assured that they will only be charged for the resources they consume.

Advantages

- **Cost Efficient**: In the public cloud, we have to pay for what we utilized. So it is more cost-efficient than sustaining the physical servers or their own infrastructure.

- **Automatic Software Updates**: In the public cloud, there is no need for updating the software manually. All are automatic software updates.
- **Accessibility**: Public clouds allow users to access their resources and applications through an internet connection from anywhere in the world. The only requirement is stable internet connection to access it.

Disadvantages

- **Security and Privacy Concerns:** Public clouds can be vulnerable to cyber attacks, data breaches, and other security risks. Since data is stored on servers owned and maintained by a third-party provider, there is always a risk or chance that sensitive or confidential data may be compromised or exposed.
- **Limited Control:** With public cloud services, users have limited control over the resources and infrastructure used to run their applications. This can make it difficult to convert the environment to meet specific necessities.
- **Reliance on Internet Connectivity:** Public cloud services require a stable and reliable internet connection to access the applications and resources hosted in the cloud. If the internet connection is unstable or slow, it can affect the availability and performance of the services.
- **Service Downtime:** Public cloud providers may generally experience service downtime due to maintenance activities, software issues, or hardware failures. This can result in temporary loss of access to data and applications.

- **Compliance and Regulatory Issues:** Public cloud services may not meet certain regulatory requirements or compliance, such as those related to data security or privacy. This can create legal or contractual obligations for businesses that are subject to these requirements.
- **Cost Overruns:** Public cloud services are normally billed on a pay-per-use basis, which can result in unpredicted cost overruns if usage exceeds projected levels. Furthermore, the cost of using public cloud services may upsurge over time, as providers regulate their pricing models or add new services and features.

2. **Private Cloud**

A Private Cloud is a cloud computing environment in which the services and infrastructure are operated and owned by a single organization, for example, a company or government, and it is accessed by only authorized persons within that organization. Private Cloud organizations have their individual data center. private cloud provides a upper level of security. Examples - Dell, HPE, VMware, etc.

Advantages

- **Security Status**: Private clouds deliver a higher level of security. Since the organization has full control over the cloud service, they can customize the servers to cope their security.

- **Customization of Service**: Private clouds give access to organizations for customizing the infrastructure and services to meet their specific requirements and can customize the security.
- **Privacy**: Private clouds provide improved privacy as the organization (company or government) has more control over who has the right to use their data and resources.

Disadvantages

- It comes with higher initial cost than other typers of cloud deployments.
- Here training for hardware, software and network is essential.

3. **Hybrid Cloud**

A hybrid cloud is a combination of both private and public cloud environments that allows organizations to utilize the advantage of the benefits of both types of clouds. It accomplishes traffic levels during peak usage periods It can deliver greater flexibility, scalability, and cost-effectiveness than using a single cloud environment. Examples – IBM, Rackspace, DataCore Software, Threat Stack, Infinidat, etc.

Advantages

- **Flexibility**: Hybrid cloud stores and maintains its data (also sensitive) in a private cloud server. While public server provides Scalability and Flexibility.
- **Scalability**: Hybrid cloud Permits organizations to move workloads back and forth between their private and public clouds depending on their needs.

- **Security**: Hybrid cloud controls over highly sensitive data. and it delivers high-level security. Also, it takes benefit of the public cloud's cost savings.

Disadvantages

- As scalable, flexible and secure as hybrid cloud models can be, they are the most advantageous for businesses that would benefit from splitting data into non-sensitive and sensitive categories.
- Implementation can be complicated and is usually best managed by a service partner with good experience in cloud deployments.

3. Case study for each model

a. Business Case 1: Digital Home Appliances Solution

- Cloud deployment model: Public cloud
- Vendor Name: Amazon Web Services
- Service Architecture Deployed

1. Compute: Uses Elastic Compute Cloud Instances for Virtual servers.
2. Storage: Utilizes Amazon simple storage service for storing details about products.
3. Database: Uses RDS for MySQL to store Critical User data.
4. Networking: To establish private, secure network it uses Amazon Virtual Private Cloud.

5. Security: To ensure security utilizes web application firewall.

b. Business Case 2: Secure Banking Service

- Cloud deployment model: Private Cloud
- Vendor Name: Dedicated infrastructure with Microsoft Azure
- Service Architecture Deployed

1. Compute: Inorder to handle banking applications deploy virtual machines on Azure.
2. Storage: Stores Client's Critical Personal information on Azure Blog Storage.
3. Database: Uses Azure Database for MySQL for managing client details.
4. Networking: To establish private, secure network it uses Azure Virtual Networks.
5. Security: Employs Multi factor Authentication and Azure Active Directory to ensure security and authentication of user's data.

c. Business Case 3: Global Travel Solutions LLC

- Cloud deployment model: Hybrid cloud
- Vendor Name: Combination of Google Cloud Platform and on-premises data centre.

- Service Architecture Deployed

    1. Google Compute Engine is utilized for Travel log operations and applications.

    2. On-premises mainly handles the storage and processing of critical sensitive data.

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