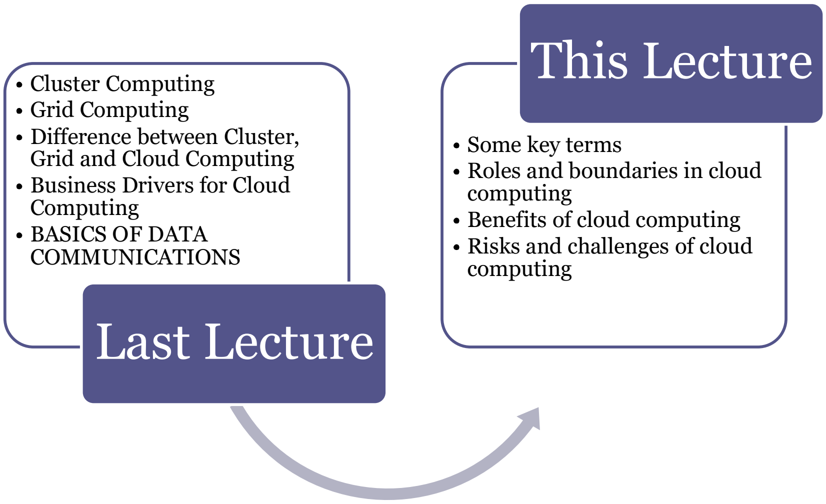
BSE-3502
Cloud Computing
Lecture 03

Department of Software Engineering
Mirpur University of Science and Technology (MUST)

Lecture 01
ROLES AND BOUNDARIES IN CLOUD COMPUTING



- Cluster Computing
- Grid Computing
- Difference between Cluster, Grid and Cloud Computing
- Business Drivers for Cloud Computing
- BASICS OF DATA COMMUNICATIONS

Last Lecture

This Lecture

- Some key terms
- Roles and boundaries in cloud computing
- Benefits of cloud computing
- Risks and challenges of cloud computing

Some key terms about Cloud Computing

- Some key terms and concepts essential for understanding Cloud Computing course:
  - IT Resources
  - On-premises
  - Cloud Service
  - Scaling
  - Multitenancy
  - Resiliency

Some key terms about Cloud Computing

- **IT Resources:** Can be physical or virtual resources (virtual resources are implemented in software):
  - Physical/Virtual machines/servers
  - Physical/virtual storage
- **On-premises:** An IT resource which is hosted/located at the enterprise's premises.
  - It is different from a Cloud resource since a Cloud resource is hosted on Cloud.
  - An on-premises IT resource can be connected to a Cloud resource and/or can be moved to a Cloud.
  - However the distinction is difficult for private clouds.

Some key terms about Cloud Computing

- **Cloud Service:** Any IT resource (software/VM) that is made remotely available by the cloud provider.
  - Remember that not all the IT resources deployed in a cloud environment are remotely accessible. Some resources are used within the Cloud for support and monitoring etc.
  - The human users interact with a leased VM.
  - Client programs interact with cloud software service/s through API calls.

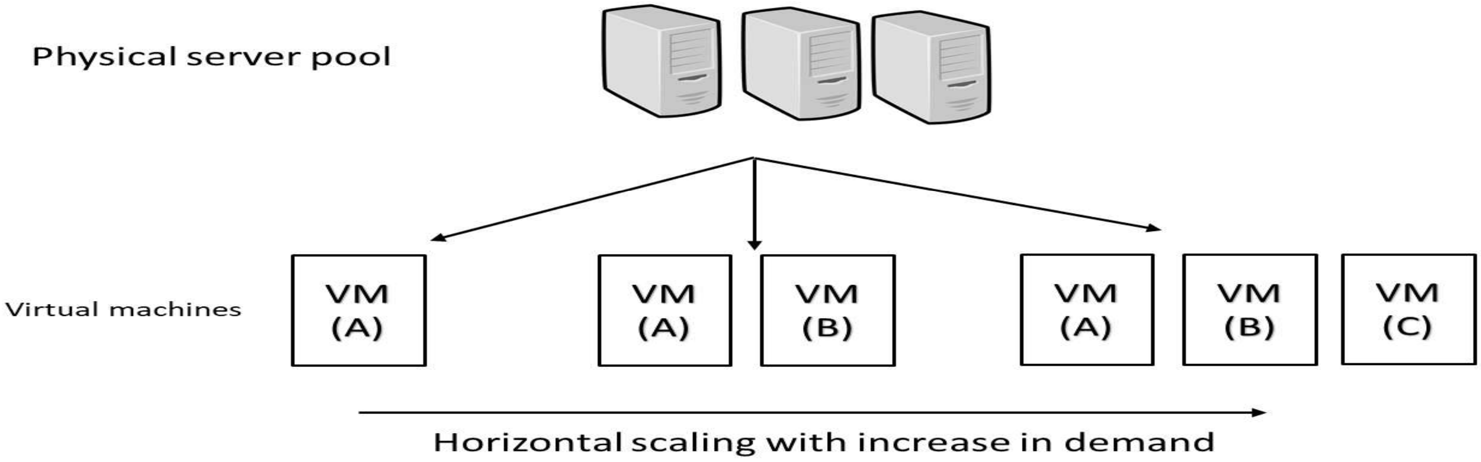
Scaling

Scaling: It refers to the ability of an IT resource to handle increased or decreased usage demands.

- Following are the types of scaling:
  - ○ Horizontal scaling
  - ○ Vertical scaling

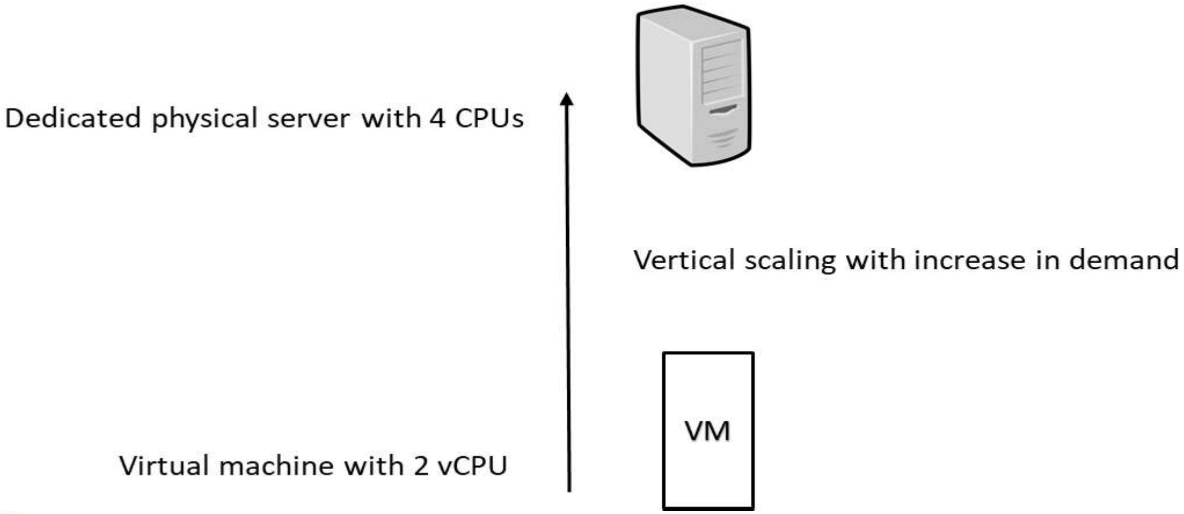
Horizontal scaling

It is the **scaling out** or **scaling in** of the IT resources of same type. The number of resources increases or decreases according to load.



Vertical scaling

- When an IT resource is replaced with a resource of higher capacity (**scaling up**) or when replaced with the resource of lower capacity (**scaling down**) according to workload.



Dedicated physical server with 4 CPUs

Vertical scaling with increase in demand

VM

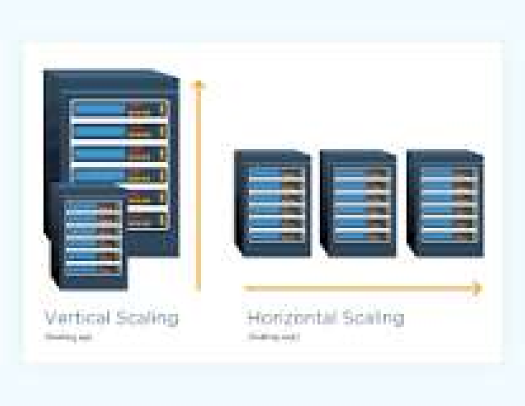
Virtual machine with 2 vCPU

Vertical scaling

- Specialized server are required,
- instantly available IT resources,
- additional setup is required (downtime required during replacement),
- limited by maximum hardware capacity,
- less common in Cloud.

Horizontal scaling

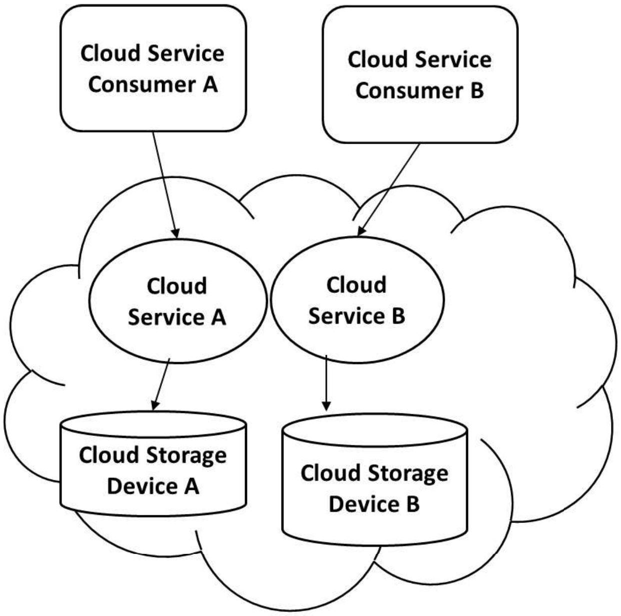
- Commodity hardware can do the work,
- instantly available IT resources,
- not limited by hardware capacity.



Multitenancy

- A software architecture consisting of software executing over a server and serves different users (tenants) whereby each tenant is isolated from the others.
- Cloud computing serves different cloud consumers by using virtualization software frequently.

Multitenancy

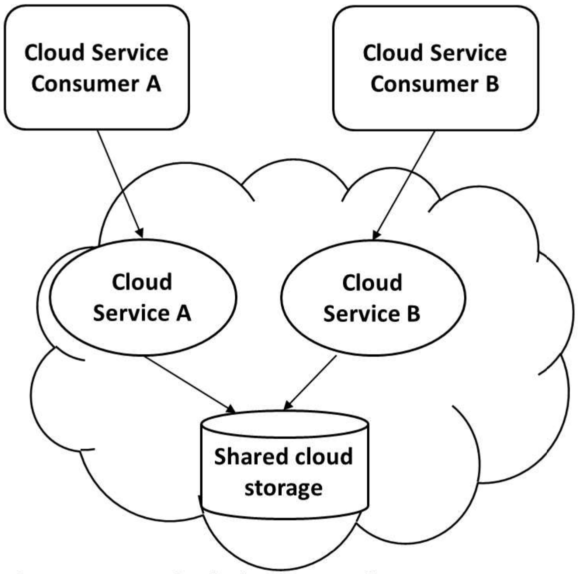


In single-tenant environment, there is a separate IT resource for each tenant.

Multitenancy

- The cloud provider pools the IT-resources by using multitenancy technology to dynamically assign and reassign these resources according to cloud consumers’ demands.
- The physical as well as virtual resources are multi-tenanted (or shared) by using statistical multiplexing.

Multitenancy

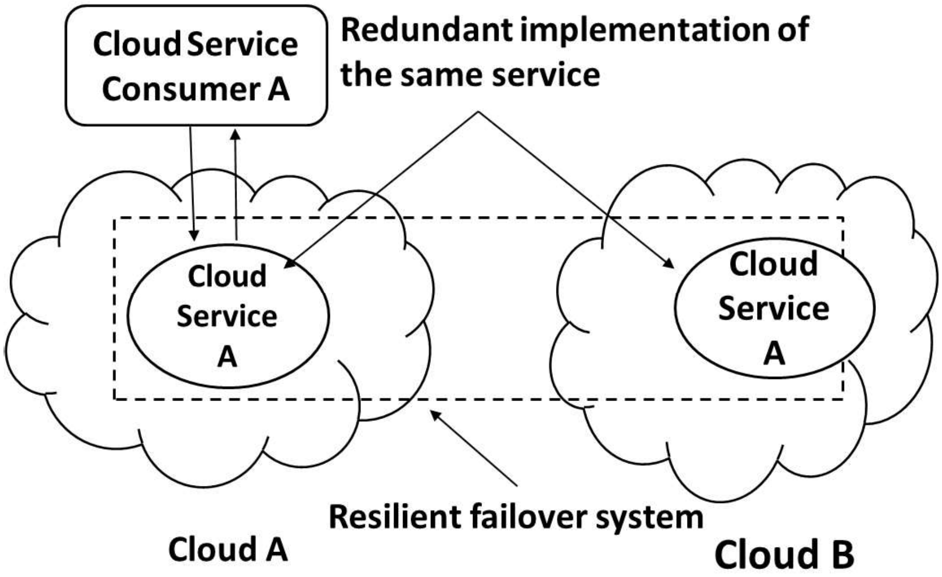


Multi-tenant environment, a single instance of an IT resource such as Cloud storage device serves multiple consumers.

Resiliency

- The ability of a computer system to recover from a failure is called resiliency.
  - The redundant implementation of IT-resources paves the way to a resilient system.
  - The whole system is pre-configured so that as soon as a resource fails, the processing is automatically handed over to the redundant resource.
  - Resiliency is one of the features of cloud computing whereby the redundancy of IT-resources is implemented at different physical locations and/or in different clouds.
  - For example the data can be kept at two different locations and replicated. If the primary hard disk fails, the secondary drive takes the data connectivity.
- A cloud service can be configured at two different VMs (A and B) and each VM is placed on a separate server or a different cloud. VM B is kept as failsafe resource. In case VM A fails, the VM B starts processing the user service user/s requests.

Resiliency


Cloud Service Consumer A
Redundant implementation of the same service
Cloud Service A
Cloud Service A
Resilient failover system
Cloud A
Cloud B

ROLES AND BOUNDARIES IN CLOUD COMPUTING

- **Cloud provider:** The organization that provides the IT resources.
  - Responsible for providing IT resources as per SLA.
  - Also performs the management and administrative tasks to assure flawless provisioning of cloud services.
  - A cloud provider usually owns the IT resources of the cloud.
  - It is also possible that the cloud provider resells the cloud services leased from another cloud providers.
- **Cloud consumer:** The organization or individual who has contracted with cloud provider to lease/rent the cloud IT-resources through user interface and/or through software API calls.
  - In the later case, a cloud consumer uses a *cloud service consumer* (a software program) to interact/use a cloud service.

ROLES AND BOUNDARIES IN CLOUD COMPUTING

- **Cloud Service Owner:** Is the one who owns the cloud service. Can be:
  - Cloud consumer: If the deployed service is on leased IT-resources.
  - Cloud provider: If the cloud provider has deployed the service on cloud IT-resources.
  - A cloud service owner may not be the owner of the cloud IT-resource.
- **Cloud Resource Administrator:** This role is responsible for administering the cloud resources (including cloud services).
  - Cloud resource administrator can be:
    - Cloud consumer (as cloud service owner)
    - Cloud provider (when the service resides inside the cloud)
    - Third party contracted to administer a cloud service

ROLES AND BOUNDARIES IN CLOUD COMPUTING

Additional roles:

- **Cloud Auditor**: Provides an unbiased assessment of trust building features of the cloud. These include the security, privacy impact and performance of the cloud. The cloud consumer may rely upon the cloud audit report for choosing a cloud.
- **Cloud Broker**: A party that provides mediation services to cloud providers (seller) and cloud consumers (buyer) for the purchasing of cloud services.
- **Cloud Carrier**: The party responsible for providing connectivity between cloud provider and cloud consumer. The ISPs can be assumed as cloud carriers.
- The cloud provider and cloud carrier are in legal agreement (SLA) to assure a certain level of connectivity and network security.

Class Activity

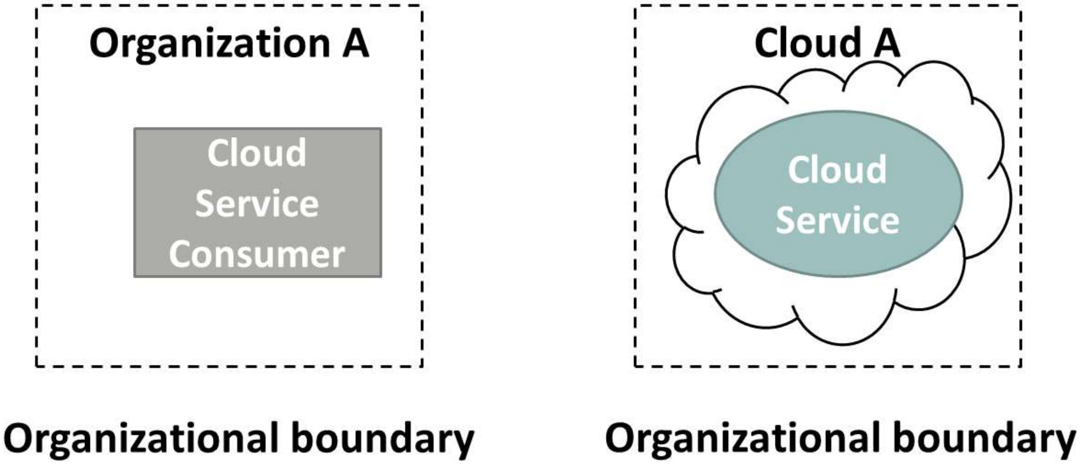
Write down examples for each of the following Cloud Computing Roles.

- Cloud Provider
- Cloud Consumer
- Cloud Service Owner
- Cloud Resource administrator
- Cloud Auditor
- Cloud Broker
- Cloud Carrier

ROLES AND BOUNDARIES IN CLOUD COMPUTING

- **Organizational boundary:** This is a boundary of ownership and governance of IT assets of an organization.
- Similarly, the cloud has its organizational boundary.

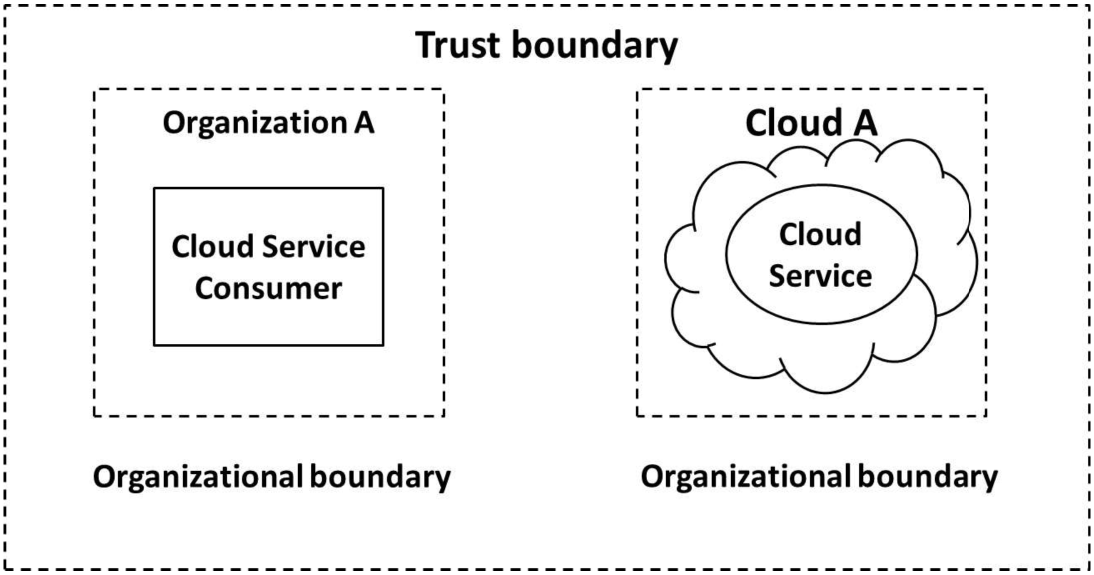
ROLES AND BOUNDARIES IN CLOUD COMPUTING



ROLES AND BOUNDARIES IN CLOUD COMPUTING

- **Trust boundary:** When an organization takes the role of cloud consumer, then it has to extend its trust boundary to include the cloud resources. A trust boundary represents a border around trusted IT-resources.

ROLES AND BOUNDARIES IN CLOUD COMPUTING



BENEFITS OF CLOUD COMPUTING

- The immediate benefit of using Cloud is the reduction in initial cost. The initial costs include:
  - Infrastructure costs:
    - IT equipment
    - Software
    - Networking
    - Construction costs
    - Installation costs
    - The infrastructure costs can be regarded as capital investments or ownership costs. The cloud saves the initial upfront ownership costs. The cloud offers affordable and attractive packages for services obtained in large volume. The cloud reduces investment and proportional costs.
  - Proportional cost or operational costs (as discussed before):
    - The cloud rental can replace this cost. The rental costs are highly competitive.

BENEFITS OF CLOUD COMPUTING

- The cloud provider can increase the profit by increasing the resource utilization, using proven practices and by optimizing the cloud architecture.
- Common measurable benefits for the cloud consumers are:
  - Pay-as-you-go rental for short term usage
  - The availability of virtually unlimited resources on demand with negligible wait time for provisioning.
  - The IT resources can be added or removed in a fine grained level e.g., 1 GB of storage increments
  - Applications and resources can be migrated across regions if required.

BENEFITS OF CLOUD COMPUTING

- **Increased scalability:** The cloud can dynamically and instantly provide the computing resources.
  - This provision can be on demand or as per user configuration.
  - Similarly these IT resources can be released automatically or manually with the decrease in processing demand.
  - This dynamic scalability avoids the over-provisioning and under-provisioning and the associated disadvantages.

BENEFITS OF CLOUD COMPUTING

- **Availability:** The availability of IT resources sometimes can be referred to profit and customer retention.
  - If an IT resource becomes unavailable (such as a database dealing with clients' orders) then this may result in customer dissatisfaction and loss of business.

BENEFITS OF CLOUD COMPUTING

- **Reliability:** The reliability of IT resources is very important for continual business data processing and response time.
  - The failure of any IT resource can be cause the collapse the IT system. For example failure of the Ethernet switch may crash a distributed application.

BENEFITS OF CLOUD COMPUTING

- The modular structure and resource redundancy in cloud increases the availability and reliability. Cloud, on the other hand provides a guaranteed level of availability and reliability through a legal agreement called service level agreement (SLA) between the cloud provider and cloud user.
- The recovery time after failure is the added penalty. It is the time when the system remains unavailable.
- The modular structure and resource redundancy in cloud increases the availability and reliability. It also improves the recovery time.

RISKS AND CHALLENGES OF CLOUD COMPUTING

- The term *vulnerability* refers to a state of being attacked.
  - Moving the business data to cloud can introduce vulnerabilities and security risks.
- The term *security framework* refers to the procedures and practices for securing the resource such as data, network and IT infrastructure.
- Unless the cloud provider and cloud user are covered under same security framework, the vulnerabilities are unavoidable.

RISKS AND CHALLENGES OF CLOUD COMPUTING

- The cloud provider and user have to be in a *trust* relationship. The factors affecting the trust may include the following facts:
  - The data is being accessed remotely.
  - There are multiple users sharing the cloud based IT resources such as virtual storage.
  - The cloud provider has a privileged access to the users' data.
  - The security of the data depends upon the security policies of the provider and the consumer.
- There can be malicious consumers (human and automated) who can benefit from the security vulnerabilities of the cloud environment by stealing and/or damaging the business data.

RISKS AND CHALLENGES OF CLOUD COMPUTING

- **Reduced operational governance control:** The cloud consumer gets a lesser privileged control over the resources leased from the cloud.
  - There can be risks arising as to how the cloud provider manages the cloud.
  - An unreliable cloud provider may not abide by the guarantees offered in SLA of the cloud services. This will directly affect the quality of cloud consumer solutions (enterprise software) which rely upon these services.
  - The cloud consumer should keep track of actual level of service being provided by the cloud provider.
    - The SLA violations can lead to penalties receivable from the cloud provider.

RISKS AND CHALLENGES OF CLOUD COMPUTING

- **Limited portability between cloud providers:** Due to lack of industry standards for cloud computing, the public clouds environments remain proprietary to their providers.
  - It is quite challenging to move a custom-built software from one cloud to another if it has dependencies upon the proprietary environment (such as security framework) of the former cloud.

RISKS AND CHALLENGES OF CLOUD COMPUTING

- **Multi-regional compliance and legal issues:** Cloud providers tend to set their data centers in regions favoring affordability and/or convenient. This may lead to legal issues for cloud provider as well as cloud consumers.
  - Some countries such as some UK laws require the personal data of UK citizens to be hosted inside UK.
  - Thus a cloud provider with multi-regional data centers including UK, can not migrate the UK citizen's personal data outside UK.
  - The UK citizens are legally bound to keep the personal data on clouds hosted in UK only.
  - Some countries such as USA allows government agencies' access to data hosted inside USA.
  - Despite that the owners of this data are neither residing inside nor the citizens of USA, but still their data is accessible by the USA government agencies if hosted inside USA.