

# Cloud Computing

## Assignment 1

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### Question 1:

#### Computing Environment:

When many computers are connected through a network and communicate with each other to handle multiple issues a computing environment is created.

#### Types of Computing Environment:

- **Personal computing environment**
  - Only a single user can access the whole computing environment.
  - Identical to our personal computers, laptops, etc.
  - Only meant for a single user and designed for personal use.
  - Size is reduced compared to mainframe computers.
  - Every system has dedicated memory, computational power, and storage capacity.
  - Advantages:
    - Security - more secure, since only you can access.
  - Disadvantages:
    - Limited Storage.
    - Not utilizing the resources efficiently, not utilizing whole resources available.
- **Time-sharing computing environment**
  - To address the limitations of personal computing, in a time-sharing computing environment, sources are utilized to their fullest because multiple users share the environment on a periodic basis.
  - Advantages:
    - Effective resource utilization.
  - Disadvantages:
    - Waiting time is high

- For example, there are 3 processes p1,p2,p3 and they take 1sec,2secs,3secs to finish execution respectively.
  - If each process has a timeout of 0.5secs then p1 needs 2secs to complete in a time-sharing environment whereas the optimal time for it to be finished is 1sec.
  - The order of how the processes are executed is:
    - P1 - 0.5 secs
    - P2 - 0.5secs
    - P3 - 0.5 secs
    - P1 - 0.5secs (p1 finishes)
  - Response time is also high.
- Client-server computing environment
  - The client asks for a resource and the server responds with the resource.
  - Client and server communicate via the internet/network.
  - Client - which initiates the process, Server - which waits for the client to contact.
  - A server may have multiple clients at the same time while a client is in contact with only one server.
  - Advantages:
    - All the data is concentrated in a single place, the server, thus making it easier to protect.
    - The server is not located physically closer to the clients, yet they can access the server and request services.
    - Platform Independent - It does not matter which platform the client is using, yet they can periodically request data from the server.
  - Disadvantages:
    - Server Overloading/Congestion - If multiple clients request data simultaneously the server might overload and performance will be decreased.
    - Cost - Server maintenance and resetting the server in case it fails.
    - Server failure - If the server fails then none of the client's requests can be fulfilled and also resetting a failed server is costly.
- Distributed computing environment
  - Multiple Nodes are distributed geographically and are connected through a network and communicate with each other via the same.
  - Multiple nodes work together to perform a given task and communicate with each other in doing so while performing the given task.

- Different systems can have different tasks to execute and they share their resources in doing so.
- Advantages:
  - Nodes are distributed globally to reduce latency.
    - Latency - delay before a request can be served
  - Data is backed up - In case of some failure or an accident like a fire at one system, our data isn't lost because the nodes are geographically distributed and the data can be recovered.
  - Computation power - since so many systems share resources in executing a task, the computational power drastically increases.
- Disadvantages:
  - Security - our nodes and connections need to be secure and it is difficult to provide all of them with adequate security.
  - Also, there might be some information loss when messages/data are transferred from one node to other.
- Grid Computing
  - Inherits all the properties from distributed computing but all the nodes/grids in the grid computing act as one single entity and all nodes in the grid execute/perform a single task.
  - In distributed computing different nodes might have different tasks to execute but in grid computing, all the nodes in the grid come together to perform a single common task.
  - Often the task is split and distributed among the system nodes.
  - Requires middleware - special software that moderates which part of a task to assign to which node, like a manager, if one node is not working properly it needs to reassign its tasks to other nodes in the grid to get the job done.
  - Advantages:
    - Improved resource utilization.
    - Parallel processing - can run complex tasks and provide results faster.
    - Easier collaboration
    - Increased robustness. (robustness - in case one node fails and cannot run its subtask assigned by the middleware, then the subtask can be executed by some other node in the grid without any problems, data won't be lost)
  - Disadvantages:
    - Integrity - A solution returned by a grid is not trustworthy, i.e, we don't know if it is right or wrong.

- Dynamic nature of nodes - If nodes are added and removed dynamically from the grid system, it causes inconsistency and poor performance.
- Cloud computing environment
  - When the computing is made over a cloud, i.e, a group of systems managed by an organization or third party then we call such an environment a cloud computing environment.
  - The Cloud computing environment follows a structure similar to a client-server architecture.
  - The Cloud users only see the service being provided and not the internal details of how the service is provided.
  - Advantages:
    - On-demand self-service - Resources can be provisioned and released only when needed.
    - Scalability - ability to scale up or scale down the resources based on the usage.
    - Resource pooling - A large number of resources are pooled together.
    - Measured service - you only pay for what you have used unless it is not a private cloud.
    - Can be accessed anywhere and anytime using the internet.
  - Disadvantages:
    - Security - Security is the main concern since your data resides in a data center whose location is unknown to you and managed by a third party.
    - Cost - Even though cloud computing is a measured service, if you want a private cloud out of security concern, setting up and maintaining is costly.
    - When you don't have an internet connection you can't access the cloud.
- Cluster computing environment
  - Cluster computing refers that many computers are connected via a network and act as a single entity.
  - The clustered computing environment is similar to the parallel computing environment but with a major difference that in cluster computing we have multiple computer systems which give an impression of a single system while in parallel computing we have only a single system.
  - Advantages:
    - Faster computational speed
    - More computational power

- Data integrity - Cluster computing environment provided correct solutions to even complicated problems.
- Flexibility - Computational power can be increased just by adding a new system to our network.
- Disadvantages:
  - Cost - Since the quality of each cluster in the network is high, the cost required to set up a cluster computing environment is quite high.
  - Maintenance - since the infrastructure is quite high, the cost and effort required for maintenance are also high.

## Question 2:

Cloud Computing isn't always the best choice. This is because of various reasons listed below.

### Why cloud computing isn't always the best choice -

- It is inefficient and not good to rely on cloud computing when the computing can be done in the layers below the cloud layer more efficiently and quickly.
  - Consider the case of self-driving cars, if a car comes in front of a self-driving car it asks for further instruction which is to slow down, in this case, if we use cloud computing to instruct the car then it might be late and we might have an accident before our instruction reaches the computer.
  - This is because the necessary computation needs to be made faster. in this case, there is a delay associated with cloud computing as we need to report our current situation to the cloud and the cloud needs to process and provide instructions which are then received at the self-driving cars and then executed.
  - In this case, it is better to compute in the device itself, i.e, edge computing.
- Cloud computing is not the best choice when we need a solution for small immediate operations that have to be processed in milliseconds rates. Performing such operations locally is faster and cheaper.
- Security is one of the main concerns in cloud computing, but to have the advantages of cloud computing and also good security, having a private cloud is the best option, but it increases the cost of setting up the private cloud and maintaining it. So cloud computing is not the best choice when an organization needs high security and has a low budget.

- If you can't monitor your application's performance cloud is not a good choice, because you always want to monitor your application's performance to keep it running perfectly without any issues, if you can't monitor effectively or if the cloud service provider doesn't provide necessary tools then cloud computing is not the best choice.
- If the data/application needs to be migrated on a regular basis then cloud computing is not the choice, since different cloud service providers have different architectures and it is difficult to migrate your services.
- Also, cloud computing is not the best option if the internet connection is not available or the connectivity is poor or not stable since the cloud depends on the internet.

### Question 3:

#### Automated Museum tour guides:

Fog computing is better in this case, this is because of various reasons.

- fog computing provides a local view of the museum to the robots which enables them to compute information regarding the museum's environment.
- The computation needs to be faster as we cannot keep the guests waiting hence removing cloud computing as an option as there would be a delay.
- Since faster computation is required edge computing can be considered as an option but edge computing does not take the museum's situation into consideration, i.e, the robot has no idea of what is happening in the museum.
  - For example, some artifacts are removed from showcasing on a particular day, then to avoid the guide robot showcasing them to museum tourists, each robot needs to be re-programmed with the new set of instructions which is redundant and inconsistent.
  - Instead, we can provide the robots a local level of view of the museum and let them do all the work necessary.
  - We can achieve this using fog computing where the computing occurs at the gateway of the network.
  - We can make the necessary changes at the gateway and all the robots connected via the gateway understands the changes that occurred and proceeds with work without any issues.
- Hence fog computing paradigm is better in the case of a museum tour guide as it provides the robot a local level view and is computationally faster than cloud computing.