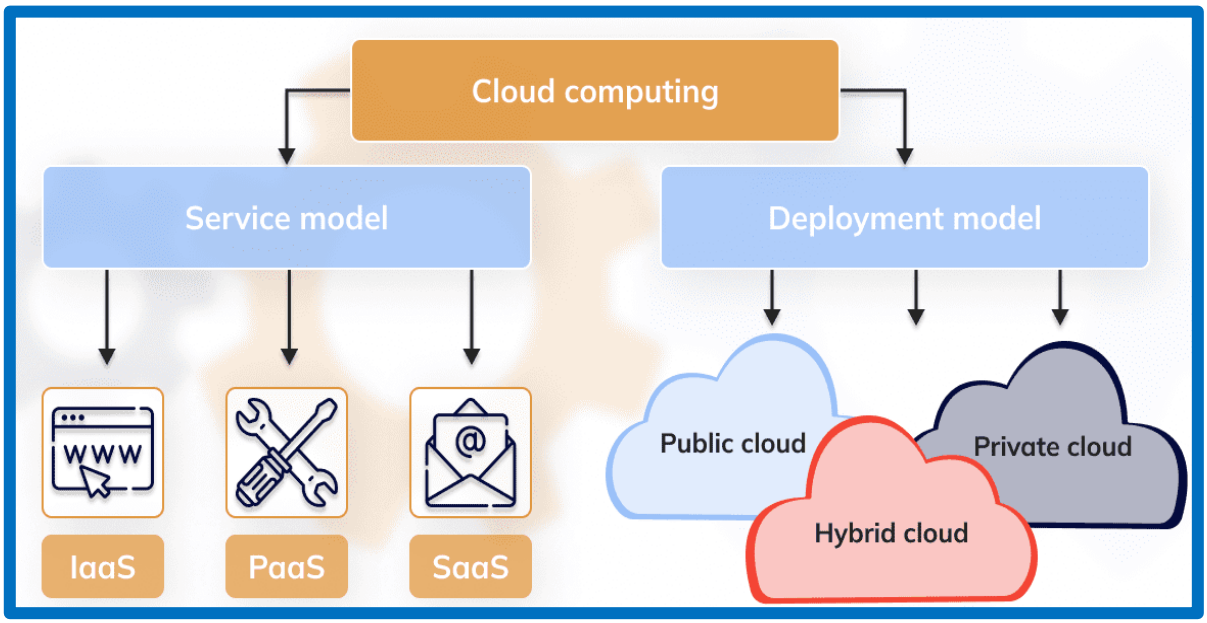
# THE NEW COLLEGE

An Autonomous Institution Affiliated to the University of Madras &
Accredited by NAAC with 'A++' Grade of 3.61/4 in the 4th Cycle)
Chennai – 600 014, Tamil Nadu, India.

## DEPARTMENT OF COMPUTER APPLICATIONS




# E-CONTENT: UNIT III NOTES

**Subject : CLOUD COMPUTING**

**Class : III BCA**

**BATCH : 2021-2024**


**Dr. J. Abdul Rasheedh M.C.A., M.Phil., Ph.D.**

**Assistant Professor,**

**P.G. Department of Computer Science,**

**The New College, Chennai-14.**

# CLOUD COMPUTING

## UNIT-3:

Platform and Software as a Service (PAAS/SAAS): Aneka-Integration of Private and Public Clouds-Comet Cloud: An Autonomic Cloud Engine-T-Systems' Cloud-Based solutions for Business Applications-Workflow Engine for Clouds-Understanding Scientific Applications for Cloud Environments.

- Platform as a Service - PaaS
    - The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages and tools supported by the provider.
    - The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations.
- Examples :
    - Microsoft Windows Azure
    - Google App Engine
    - Hadoop
    - … etc

## ANEKA IN CLOUD PLATFORM

Aneka is a software platform and a framework for developing parallel and distributed application on the cloud.

Aneka includes an extensible set of APIs associated with programming models like MapReduce.

These APIs support different cloud models like a private, public, hybrid Cloud.

It provides a middleware framework that abstracts the complexity of managing resources in a distributed environment, making it easier for developers to create and run applications across multiple nodes.

Role of an application platform as a service for multiple cloud computing:

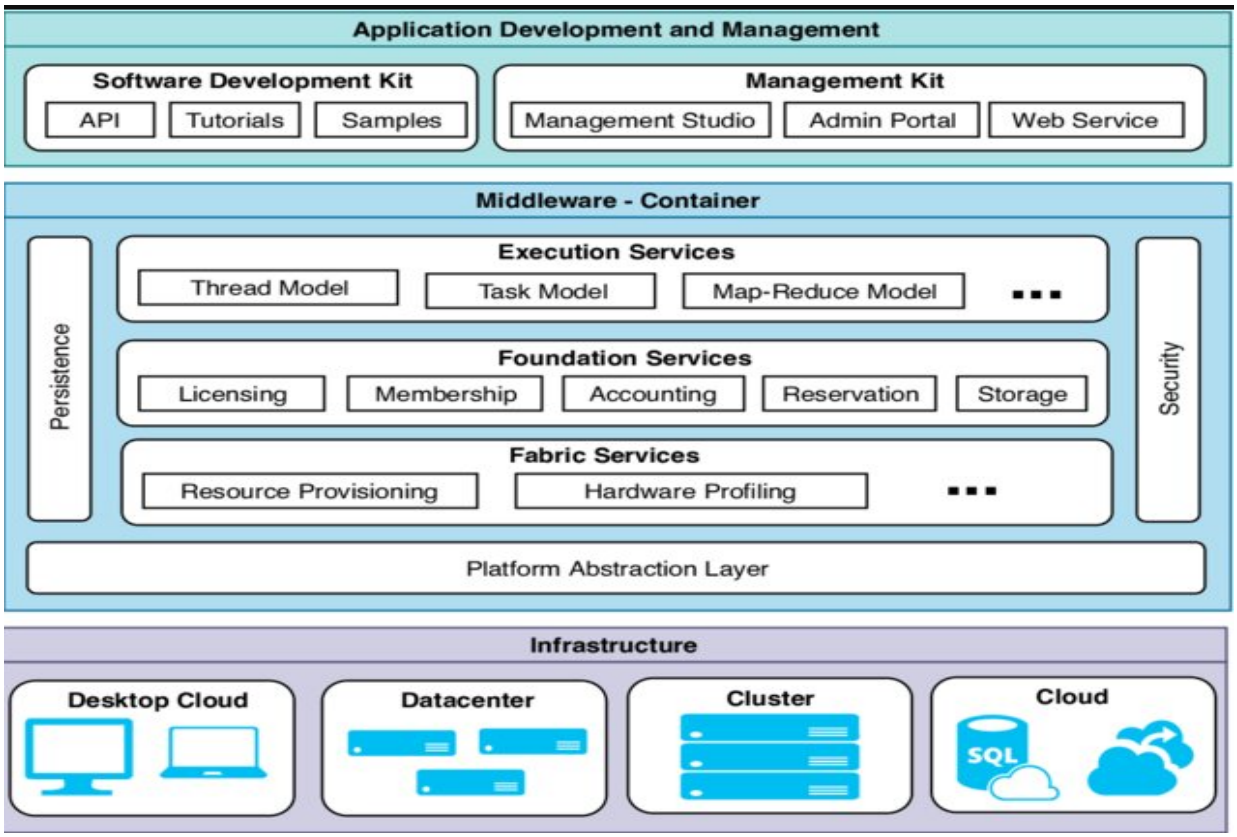
- Multiple Structures
- Aneka is a software platform for developing cloud computing applications.

- In Aneka, cloud applications are executed.
- Aneka is a pure PaaS solution for cloud computing.
- Aneka is a cloud middleware product.

What is container?

Containers are **packages of software that contain all of the necessary elements to run in any environment**. In this way, containers virtualize the operating system and run anywhere, from a private data center to the public cloud or even on a developer's personal laptop.

**Architecture of Aneka:**




In Aneka - Multiple containers can be classified into three major categories:

- Execution services
- Foundation services
- Fabric Services

**1. Execution Services:**

They are responsible for scheduling and executing application. Each of the programming models supported by Aneka defines specialized implementation of these services for managing the execution of a unit of work defined in the model

**2. Foundation Services:**

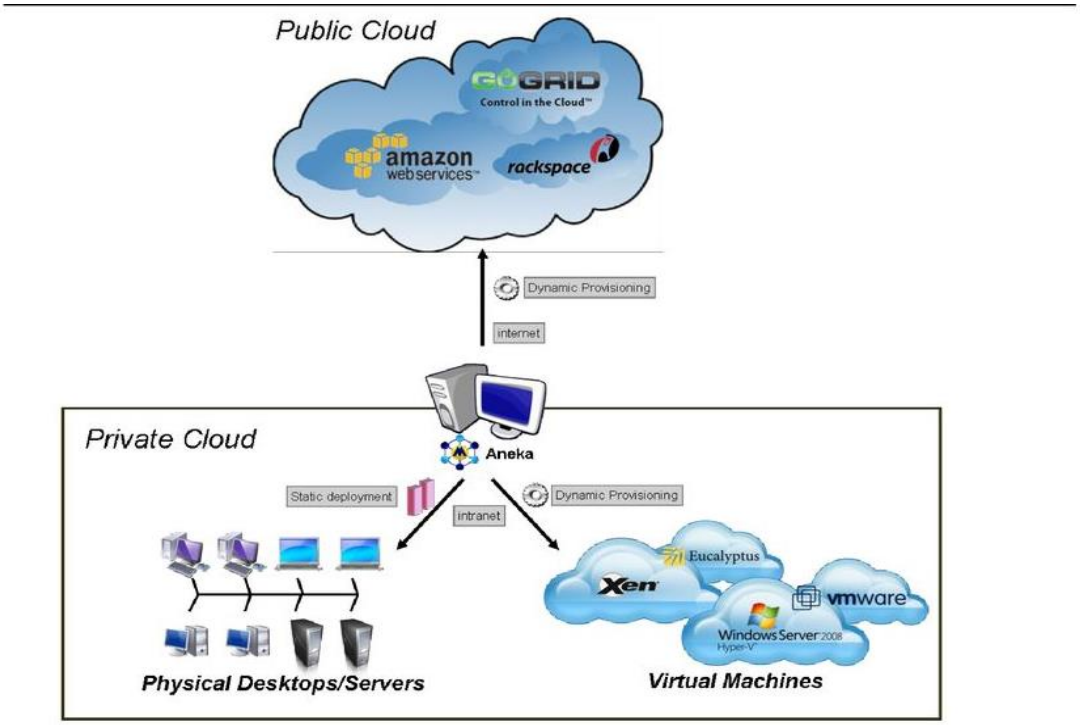
**These** are the core management services of the Aneka container . They are in charge of metering application, allocating resources for execution, managing the collection of available nodes, and keeping the services registry updated.

**3. Fabric Services:**

They constitute the lowest level of the services stack of Aneka and provide access to the resources managed by the cloud . An important service in this layer is the resource provisioning service, which enables horizontal scaling in the cloud. Resource provisioning makes Aneka elastic and allows it to grow or to shrink dynamically to meet the QoS requirement of application

## ANEKA RESOURCE PROVISIONING SERVICE

Aneka is one such platform that supports developers to program and deploy distributed applications in multi-cloud environments. It can be used to provision resources from different cloud providers and can be configured to request resources dynamically according to the needs of specific applications.



The most significant benefit of cloud computing is the **elasticity of resources, services, and applications**, which is the **ability to automatically scale** out based on demand and users' quality of service requests.

Aneka as a PaaS

**not only features multiple programming models** allowing developers to easily build their distributed applications,

**but also provides resource provisioning** facilities in a seamless and dynamic fashion.

Applications managed by the Aneka container can be **dynamically mapped** to **heterogeneous resources**, which can grow or shrink according to the application's needs.

+

This **elasticity is achieved by means of the resource provisioning framework**, which is composed primarily of services built into the Aneka fabric layer.

Aneka resource provisioning over **private and public clouds.**

This is a typical scenario that a medium or large enterprise may encounter.

It combines **privately owned resources** with **public rented resources** to dynamically increase the resource capacity to a larger scale.

Applications managed by the Aneka container can be **dynamically mapped** to **heterogeneous resources**, which can grow or shrink according to the application's needs.

+

This **elasticity is achieved by means of the resource provisioning framework**, which is composed primarily of services built into the Aneka fabric layer.

Aneka resource provisioning over **private and public clouds.**

This is a typical scenario that a medium or large enterprise may encounter.

It combines **privately owned resources** with **public rented resources** to dynamically increase the resource capacity to a larger scale.

- **On-demand resources**
- **Reserved resources**

**On-demand resources** are dynamically provisioned by resource pools for a fixed amount of time (for example, an hour) with no long-term commitments and on a pay-as-you-go basis.

**Reserved resources** are provisioned in advance by paying a low, one-time fee and mostly suited for long-term usage. These resources are actually the same as static resources, and no automation is needed in the resource provisioning service to manage them.

## COMET CLOUD:

Introduction:

CometCloud is an autonomic computing engine for Cloud and Grid environments. It is based on the Comet decentralized coordination substrate, and supports highly heterogeneous and dynamic cloud/Grid infrastructures, integration of public/private clouds and autonomic cloudbursts. CometCloud provides a shared coordination space over the Chord overlay network and various types of programming paradigms such as Master/Worker, Workflow, and MapReduce/Hadoop.

CometCloud supports autonomic cloudbursts and autonomic cloud-bridging on a virtual cloud which integrates local computational environments and public cloud services on-the-fly. Also it supports real-world scientific and engineering applications.

**What is CometCloud capable of?**

- Support core programming paradigms for real-world data and compute intensive applications
- Enables autonomic cloudbursts and cloud-bridging and on-demand scale-out and scale-in, driven by dynamic policies, economic model, QoS constraints, etc.
- Programming system support deployment of native (Java as well as non-Java) applications without any change.
- Current deployments include a virtual cloud integrating Incorporates mechanisms for fault-tolerance to handle node and communication failures and recovery.

What is a comet cloud?

COMET Cloud is **an Internet data storage designed for recording measured values from selected COMET measuring instruments**. The data is accessible after the user's connection to the Internet and is displayed in a web browser in the form of a table or graph.

CometCloud is being used to support a range of applications from varied domains including **business intelligence, financial analytics, oil reservoir simulations, medical informatics, document management**, etc.

What are the features of comet cloud?

CometCloud is an autonomic computing engine for Cloud and Grid environments. It is based on the Comet decentralized coordination substrate, and **supports highly heterogeneous and dynamic cloud/Grid infrastructures, integration of public/private clouds and autonomic cloudbursts**.

**What are CometCloud Features?**

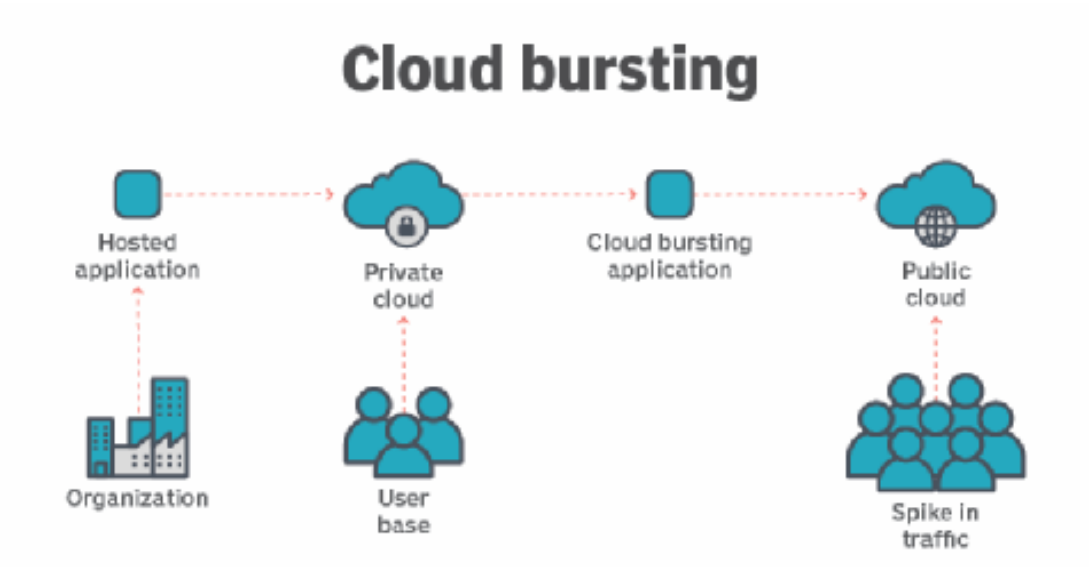
- Pull-based task consumption: workers pull tasks from the Comet space whenever they are available
- Policy-based autonomic cloudbursts: CometCloud supports on-demand scale-out and scale-in by policy and economic model.
- Cloud-bridging: CometCloud provides a cloud-bridging over a virtual cloud which integrates datacenter, clouds such as Amazon EC2 and Eucalyptus, and Grids such as Teragrid.
- Support for multi-core processors: users can run multiple workers on a node and utilized multiple cores.
- Support MapReduce with naïve disk writing: instead of using Hadoop file system, CometCloud uses the Comet space for storing data to support MapReduce and writes data into the disk if available memory amount goes below a threshold.
- Master throttling: CometCloud can control the rate of task generation of masters. If the rate is high, then more tasks keep in the space.
- Multiple masters: multiple masters can generate tasks and insert them into the same Comet space to collaborate.
- Task update: if a task with the same task id is inserted, the existing task is updated.
- Garbage collection: if tasks remain in the space for some time without being consumed, then they are cleared.

- Distributed task generation by workers: even workers can generate tasks and insert them into the space. Because every task should have a unique task id, CometCloud provides a way to provide a globally unique id to distributed workers.
- Fault-tolerance by replicating task space: each node replicates the preceding node's local space, and it merges the replicated space when its preceding node fails.

**Autonomic cloud bursting**

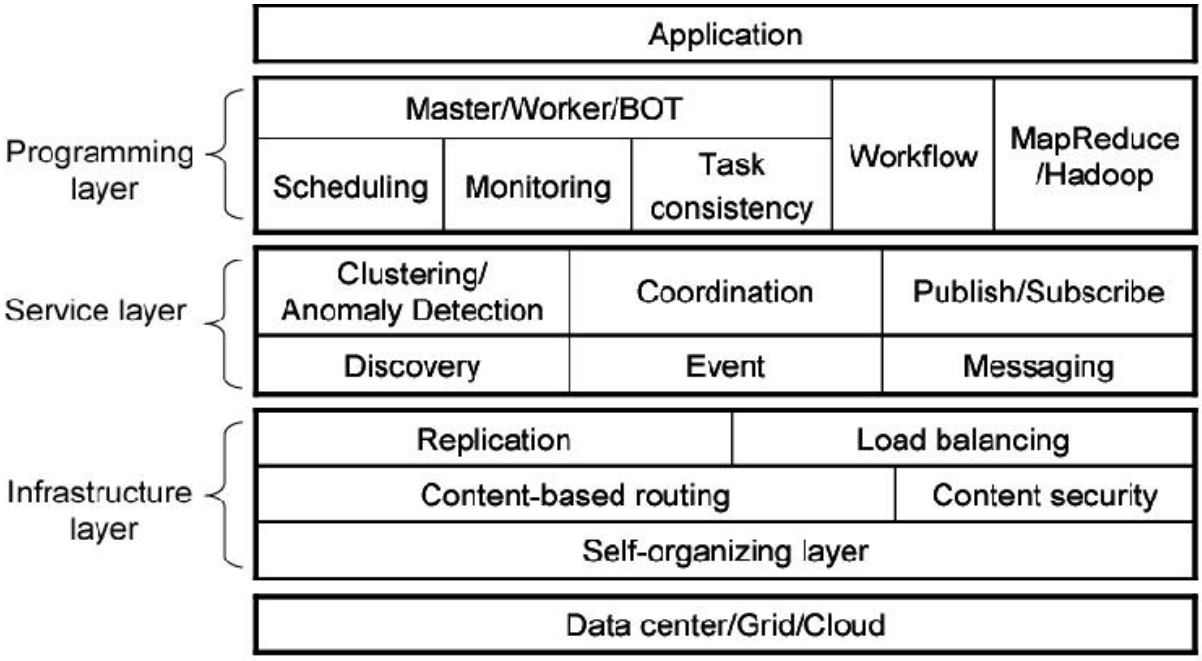
What is autonomic cloud bursting?

Cloud bursting is **an application deployment technique in which an application runs in a private cloud or data center and bursts into a public cloud when the demand for computing capacity spikes**. This deployment model gives an organization access to more computing resources when needed.




-

**The CometCloud architecture for autonomic cloudbursts :**




CometCloud is an autonomic computing engine for Cloud and Grid environments. It is **based on the Comet decentralized coordination substrate**, and supports highly heterogeneous and dynamic cloud/Grid infrastructures, integration of public/private clouds and autonomic cloudbursts.

## T- systems in cloud computing

What is T systems in cloud computing?

T-Systems is **a German-based cloud computing pioneer that helps companies and organizations of all sizes achieve digital transformation**.

- T-Systems
  - ICT service provider
  - Offers IT, telecommunications, integrated ICT services
  - 75 data center
  - 50,000 sever
  - Europa, Asia, America, Africa
- T-Systems uses Cloud Computing
  - leverage its services delivered from data centers
  - aligns cloud computing with the specific requirements
    - rejecting cloud principles where
      - conflict with statutory requirements
      - conflict with security imperatives

T-Systems is a major player in the realm of cloud computing, offering a range of services and solutions to businesses looking to leverage cloud technology. Here are some aspects of T-Systems' involvement in cloud computing:

1. **Cloud Infrastructure Services**: T-Systems provides infrastructure as a service (IaaS) offerings, including virtual servers, storage, and networking resources hosted in the cloud. These services allow businesses to scale their IT infrastructure without the need for significant upfront investment in hardware.
2. **Platform as a Service (PaaS)**: T-Systems offers platforms that enable developers to build, deploy, and manage applications without the complexity of maintaining the underlying infrastructure. This can include services like database management, application development frameworks, and middleware.
3. **Software as a Service (SaaS)**: T-Systems partners with software vendors to deliver their applications as a service over the cloud. This allows businesses to access software solutions on a subscription basis, reducing the need for upfront software licensing and ongoing maintenance costs.
4. **Hybrid and Multi-Cloud Solutions**: T-Systems helps businesses navigate the complexities of hybrid and multi-cloud environments, where they may use a combination of on-premises infrastructure, private cloud, and public cloud services from multiple providers. T-Systems can assist in integrating these different environments to ensure seamless operation and data interoperability.
5. **Managed Services**: T-Systems offers managed cloud services, where they take on the responsibility of monitoring, managing, and optimizing cloud infrastructure and applications on behalf of their clients. This allows businesses to focus on their core activities while T-Systems ensures the reliability and performance of their cloud environment.
6. **Security and Compliance**: T-Systems places a strong emphasis on security and compliance in their cloud offerings, providing robust measures to protect data and ensure regulatory compliance. This includes features such as data encryption, identity and access management, and compliance certifications.

Overall, T-Systems plays a significant role in enabling businesses to harness the power of cloud computing, offering a comprehensive suite of services to meet a variety of IT needs.

Which cloud providers are currently supported by T-systems?

Whether private, public, or hybrid cloud – T-Systems supports you in choosing the optimal cloud solution as well as the right provider, including **Microsoft Azure, AWS, Google, or Open Telekom Cloud**.


NOTE:

SYSTEM APPLICATION PRODUCTS

SAP stands for System Applications and Products in Data Processing.

SAP is the market leader in ERP software and helps companies of all sizes

What is 4HANA?

SAP S/4HANA is an abbreviation of **SAP Business Suite 4 SAP HANA, an enterprise resource planning (ERP) software package**. Organizations use SAP S/4HANA to integrate and manage business functions – such as finance, human resources, procurement, sales, manufacturing and service – in real time.

What are cloud-based business solutions?

Cloud solutions, also known as cloud computing or cloud services, **deliver IT resources on demand over the Internet**. Cloud service providers such Amazon Web Services, Microsoft Azure and Google Cloud Platform can deliver everything from applications to data centers on a pay-for-use basis to their subscribers.

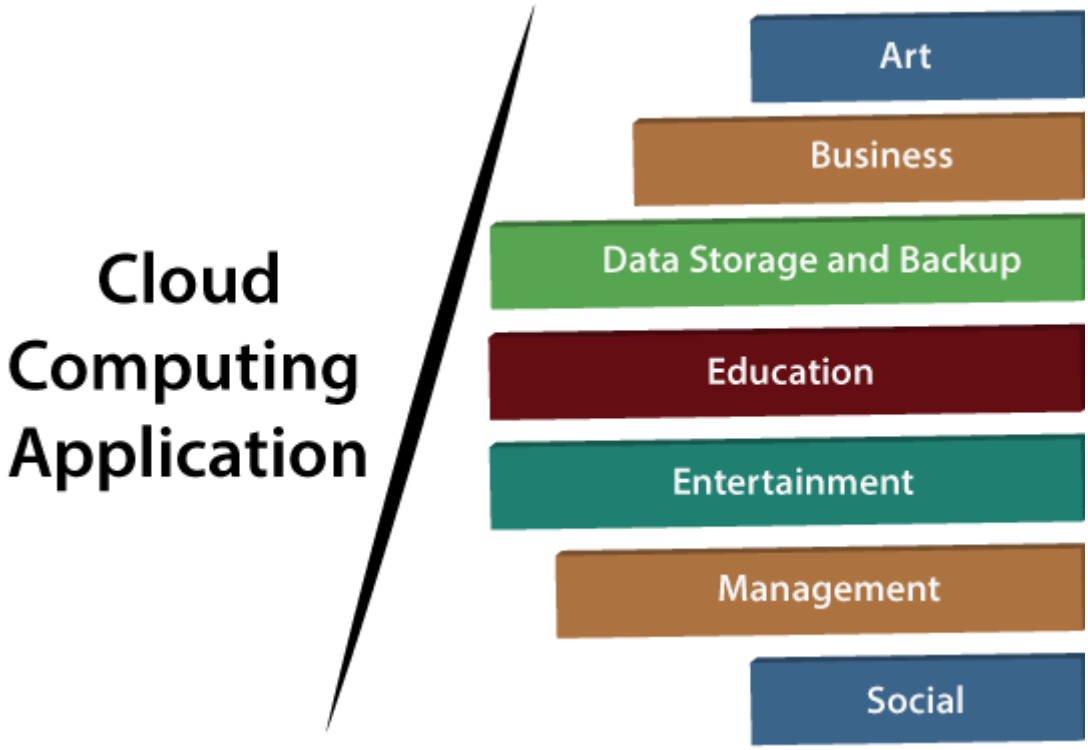
What is an example of a cloud-based application?

**Google Docs or Office 365** is a paradigmatic example of a cloud application. To access Google Docs or Office 365, you need nothing more than a machine capable of running a web browser and an internet connection. The interface and all the functionality, including data storage, are delivered from remote servers.0

**Cloud Computing Applications**

Cloud service providers provide various applications in the field of art, business, data storage and backup services, education, entertainment, management, social networking, etc.

The most widely used cloud computing applications are given below -




**Cloud – based solutions for Business Applications**

Business applications are based on cloud service providers. Today, every organization requires the cloud business application to grow their business. It also ensures that business applications are 24*7 available to users.

There are the following business applications of cloud computing -

**i. MailChimp**

MailChimp is an **email publishing platform** which provides various options to **design, send,** and **save** templates for emails.

**iii. Salesforce**

Salesforce platform provides tools for sales, service, marketing, e-commerce, and more. It also provides a cloud development platform.

**iv. Chatter**

Chatter helps us to **share important information** about the organization in real time.

**Bitrix24**

Bitrix24 is a **collaboration** platform which provides communication, management, and social collaboration tools.

**vi. Paypal**

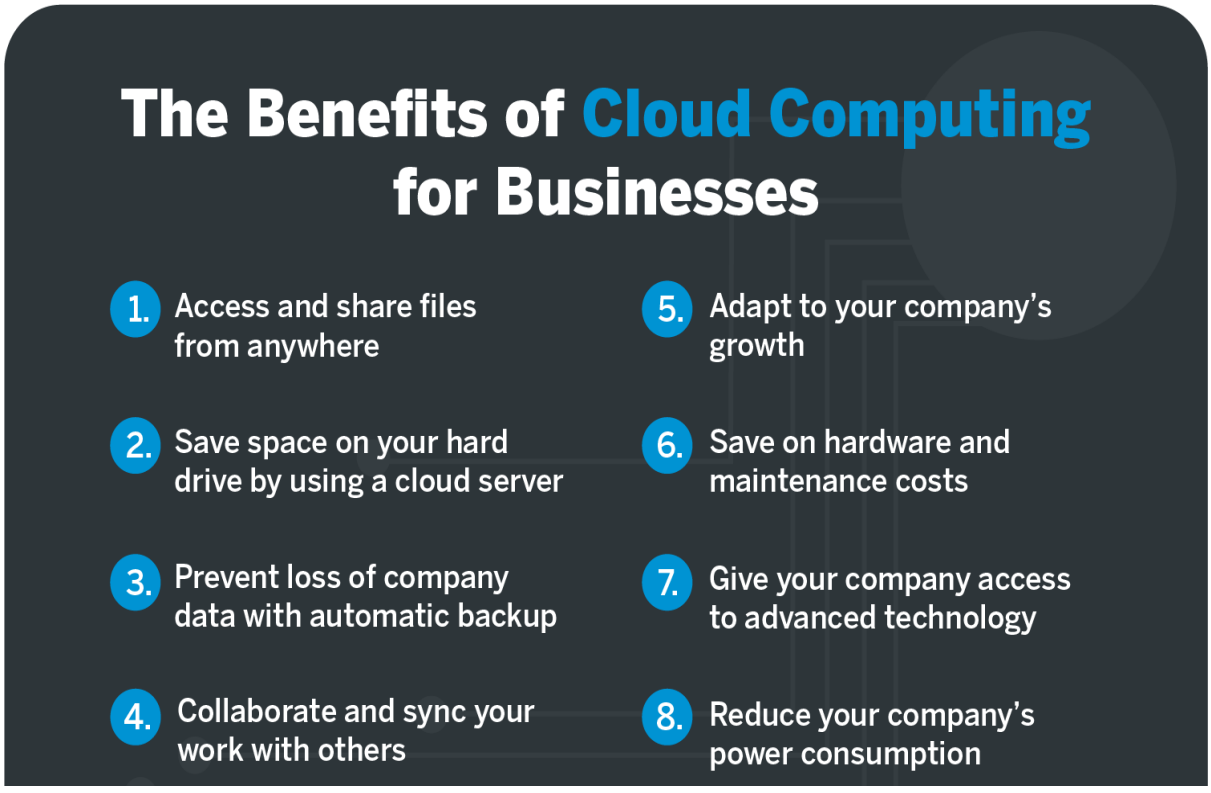
Paypal offers the simplest and easiest **online payment** mode using a secure internet account. Paypal accepts the payment through debit cards, credit cards, and also from Paypal account holders.

**vii. Slack**

Slack stands for **Searchable Log of all Conversation and Knowledge**. It provides a **user-friendly** interface that helps us to create public and private channels for communication.

**viii. Quickbooks**

Quickbooks works on the terminology "**Run Enterprise anytime, anywhere, on any device**." It provides online accounting solutions for the business. It allows more than 20 users to work simultaneously on the same system.

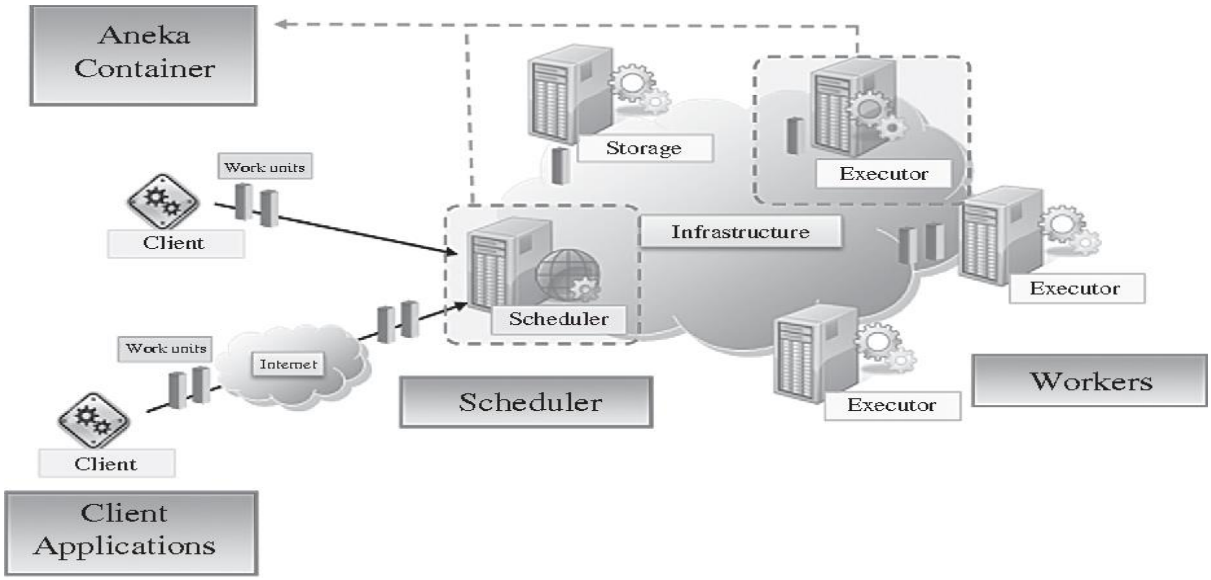


## Workflow Engine for Clouds:

What is workflow engine for clouds?

A workflow engine is designed as **a group of microservices so that multiple processes can occur at once**. There are two common types: Developer-friendly software. Low-code software.

## WORKFLOW ENGINE FOR CLOUDS




What is workflow engine for clouds?

A workflow engine is designed as **a group of microservices so that multiple processes can occur at once**. There are two common types: Developer-friendly software. Low-code software.

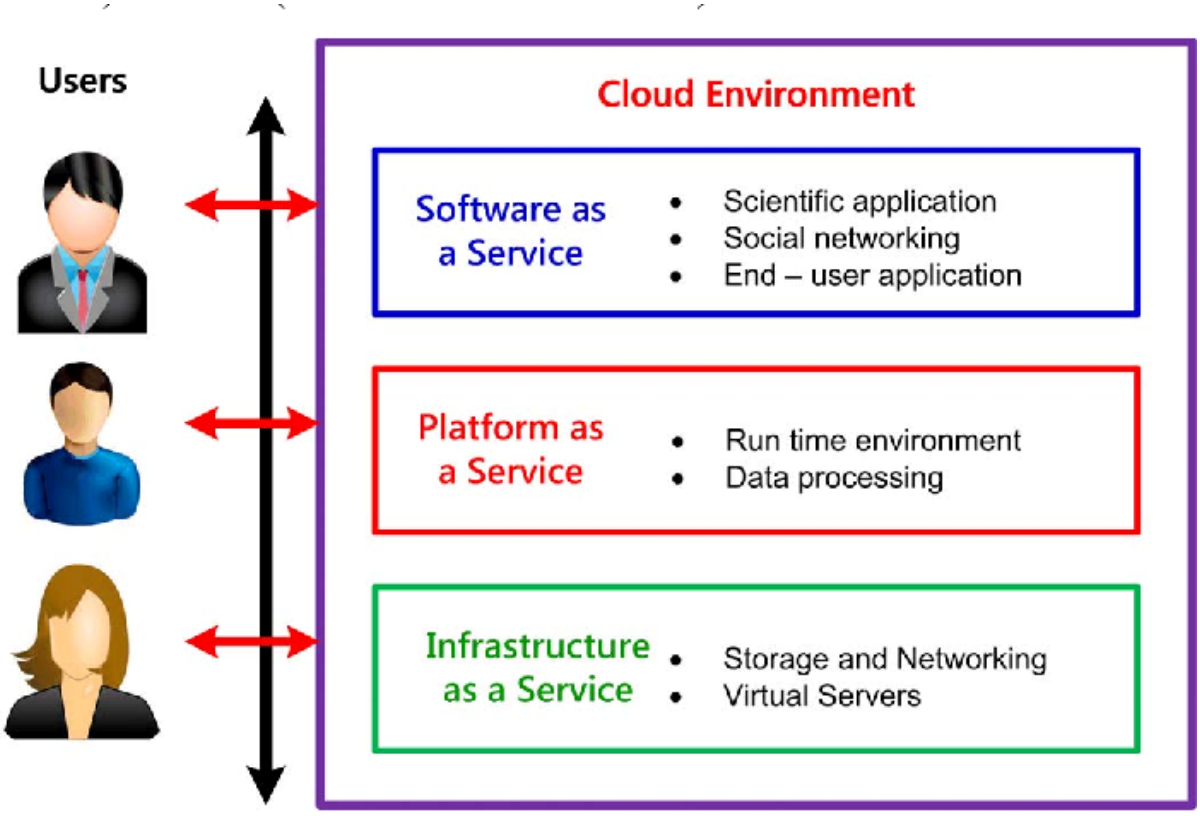
Scientific Applications of Cloud Computing:

Cloud computing can significantly benefit scientific research. Clouds can increase the amount of research you can complete in a given length of time. This is made possible by accessing more powerful resources that allow you to execute your analyses more quickly.

## Understanding Scientific Applications for Cloud Environments

- Scientific applications are a sector that is increasingly using Cloud computing systems and technologies.
- The immediate benefit seen by researchers and academics is the potentially infinite availability of computing resources and storage at sustainable prices if compared to a complete in-house deployment.
- Cloud computing systems meet the needs of different types of applications in the scientific domain: HPC (High Performance Computing) applications, HTC (High Throughput Computing) applications, and data-intensive applications.
- The opportunity for using Cloud resources is even more appealing since minimal changes need to be done to existing applications in order to leverage Cloud resources.

7



## Microsoft Azure for research

Microsoft Azure is a set of cloud services that draw from Microsoft's vast data centers, which are distributed across the globe. These services include storage, infrastructure, development, management, integration solutions, and many others. Azure for Research is not its own service, but rather a bundle of Microsoft Azure services marketed to researchers and scientists (Microsoft Corporation, 2013). These include:

**Websites/Web Applications:** Azure contains easily configurable templates, hosting, and other services for researchers to communicate their findings to others through their own webpage.

**Virtual Machines:** researchers can choose standard VM images to run or build applications on, or capture a VM image from their own operating environment. Azure allows researchers to run VMs in clusters, enabling them to perform multiple simulations/computations simultaneously

**Cloud Services:** if a researcher would prefer to perform computation without configuring a VM's operating system or any other aspect of the computing environment, they can choose to use Microsoft Azure's Cloud Services. Job submissions are entered into a web interface, computation occurs on virtual infrastructure completely obscured from the user, and associated data is managed through Azure's data services.

**Mobile Services:** Azure offers support for mobile devices – this could be relevant for researchers who wish to enter data remotely, or send push notifications to mobile devices once computation is complete.

**Storage/Data Services:** Azure offers NoSQL storage in the form of *Blobs* and *Tables*. Blobs are chunks of files, up to 200 GB in size (1TB for server backups) stored in Azure's infrastructure that can be shared with others or with cloud applications. Tables provides NoSQL data tables that can hold up to 200 TB of typed data – within a research/science context, Tables could be used to store raw data from instruments for later analysis. Azure

**Queues:** an asynchronous messaging tool that allows users to set up communication between applications hosted in Azure, or between tiers of an application hosted in Azure.

**HDInsight:** an Apache Hadoop-based storage system that allows users to securely store large-scale unstructured or structured data (that might be too large to fit into an SQL database).

**High-Performance Computing:** a service that works with HDInsight to analyze massive data sets through clustered computing nodes that work in parallel. This technique is discussed more in-depth below in the AzureBlast case study.

## Nimbus : Cloud Computing for Science

Nimbus: Cloud Computing for Science is an alternative solution for researchers and scientists seeking to leverage cloud computing in their work, developed by a team at the University of Chicago. It is a free and open source IaaS framework that enables users to dynamically allocate their own, private physical IT resources (or lease and access others' private IT resources) (Keahey & Freeman, 2008). The core mechanisms and services within Nimbus include:

**Workspace Service:** this service consists of a front-end workspace that connects the user to a back-end resource manager in order to deploy and manage virtual machines.

**Workspace Resource Manager/Workspace Pilot:** deploys and manages VMs through various sub-mechanisms.

**Workspace Control Tools:** used to start, stop, pause, connect, and manage VMs.

**IaaS Gateway:** allows a user to extend Nimbus with another IaaS infrastructure by mapping the user's KPI credentials from the second infrastructure back to their Nimbus credentials. Nimbus IaaS Gateway is configured to support Amazon EC2's REST API, working with the Nimbus Context Broker to allow users to easily extend their private cloud resources with public cloud resources if computing demand exceeds capacity.

**Context Broker:** creates a common configuration and security context across resources provisioned from one or many cloud infrastructures, enabling the user to operate in a multi-cloud environment (combining private and public cloud capabilities).

**Nimbus Storage Service:** allows the user to manage their cloud storage space and VM image repository, and works in conjunction with GridFTP to enable users to connect Nimbus to storage area networks, and a range of other distributed file systems.