



# Introduction to Cloud Computing

By  
Md Ruhul Islam

# Lecture Motivation...

## ■ General overview on cloud computing

- What is cloud computing
  - Services
  - Types
- Advantages and disadvantages
- Enabling technologies
- An example infrastructure

# Lecture Outline

- What is Cloud?
- What is Cloud Computing?
- Cloud Computing Services
- History of Cloud Computing
- Why Cloud Computing
- Drawbacks of Cloud Computing
- Types of Clouds

# A Cloud is ...

- **Datacenter hardware and software** that the vendors use to offer the computing resources and services



Datacenter

# What is a Data Center?

- As an organization's IT needs to grow, the total cost of ownership (TCO) of its IT resources grows
- Resource management, power, cooling scaling, fault-tolerance, space (real estate) becomes an issue
- Solution? Consolidate your IT resources into a **data center!**



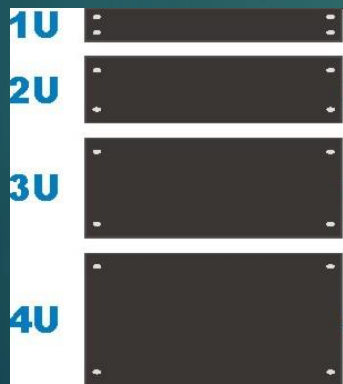
# Data Center Goals



- Minimize floor space, maximize resource density
- Keep the equipment in a safe and controlled environment
- Resources must be easy to access physically and manage, components must be individually replaceable without disrupting normal operations
- Optimize operational costs

# Physical Layout

- Equipment is placed in **racks**
- Equipment is designed in a modular fashion to fit into **rack units** (1U, 2U etc)
- Servers, blade enclosures, networking and power equipment etc can be loaded into these racks



1U Server



7U Blade center

# Data Center components

## ■ Air conditioning

- Keep all components in the manufacturer's recommended temperature range

## ■ Redundant Power

- UPS/Generators
- Multiple power feeds

## ■ Fire protection

## ■ Physical security

- CCTV/Access Control

## ■ Connectivity

- Multiple ISPs/Leased Lines

## ■ Monitoring Systems





# A Quick Introduction to Servers and Blades

# Servers

- Computers that provide “services” to “clients”.
- Typically more powerful and have more resources than desktop computers.
- Organizations requiring more and more physical servers to provide various services (Web, Email, Database, etc.)
- Server hardware is becoming more compact.



# Servers for Datacenters

- For large-scale installations, server hardware is getting more compact to help with manageability, scalability, and power and cooling
- Organizations would like to conserve the amount of floor space dedicated to their data centers.



# Blades and Blade Enclosures

- A blade server is a stripped down server computer with a modular design
- A blade enclosure holds multiple blade servers and provides power, interfaces and cooling for the individual blade servers.
- A single rack can hold up to 42 1U servers



# Cloud Computing

- Represents both the cloud & the provided services
- Why call it “cloud computing”?
  - Some say because the computing happens out there "*in the clouds*"

Wikipedia: "*the term derives from the fact that most technology diagrams depict the Internet or IP availability by using a drawing of a cloud.*"

# Cloud Computing

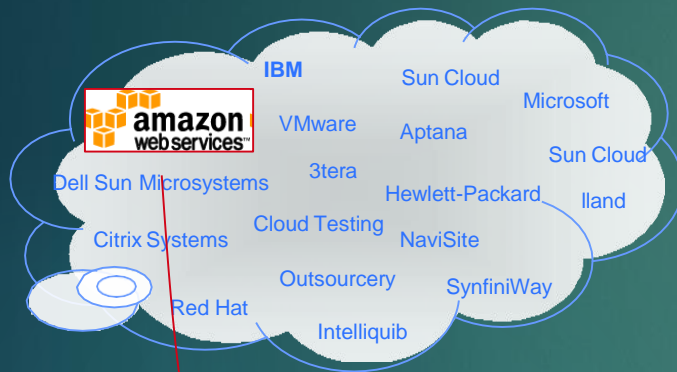
- ▶ Cloud computing is a model for enabling *convenient, on-demand network access* to a *shared pool of configurable computing resources* (e.g., networks, servers, storage, applications, and services) [Mell\_2009], [Berkely\_2009].
- ▶ It can be *rapidly provisioned* and *released* with minimal management effort.
- ▶ It provides *high level abstraction* of computation and storage model.
- ▶ It has some essential **characteristics, service models, and deployment models**.



# Cloud Computing

## ■ Who is Who...

Cloud providers



Cloud Users & Service Providers



Service Users



“With Amazon [AWS], on Day One of launch we could scale to the world.”

-Brad Jefferson, Co-Founder & CEO, Animoto

“Animoto has partnered with Amazon to leverage multiple offerings in their Web Services (AWS) platform which, in conjunction with Animoto's own render farm, constitutes the Animoto web infrastructure.”



Users use it to produce video pieces from their photos, video clips and music.

# Essential Characteristics

- ▶ **Heterogeneous Access:** A heterogeneous cloud, on the other hand, integrates public and private components from more than one vendor, either at:
  - Different levels, such as a management tool from one vendor driving a hypervisor from another
  - The same level, where a single management tool drives multiple hypervisors
- ▶ For example, you'd **choose** a public cloud provider, like Azure, GCP, or AWS, and then pair it with a private offering like those from VMware, CloudStack, or OpenStack.
- ▶ **On-Demand Self Service:**
  - ▶ A consumer can unilaterally provision computing capabilities, automatically **without requiring human interaction with each service's provider**.
  - ▶ Capabilities are available over the network and accessed through standard mechanisms that promote use by heterogeneous **thin** or **thick** client platforms.



# Essential Characteristics (cont.)

## ▶ **Resource Pooling:**

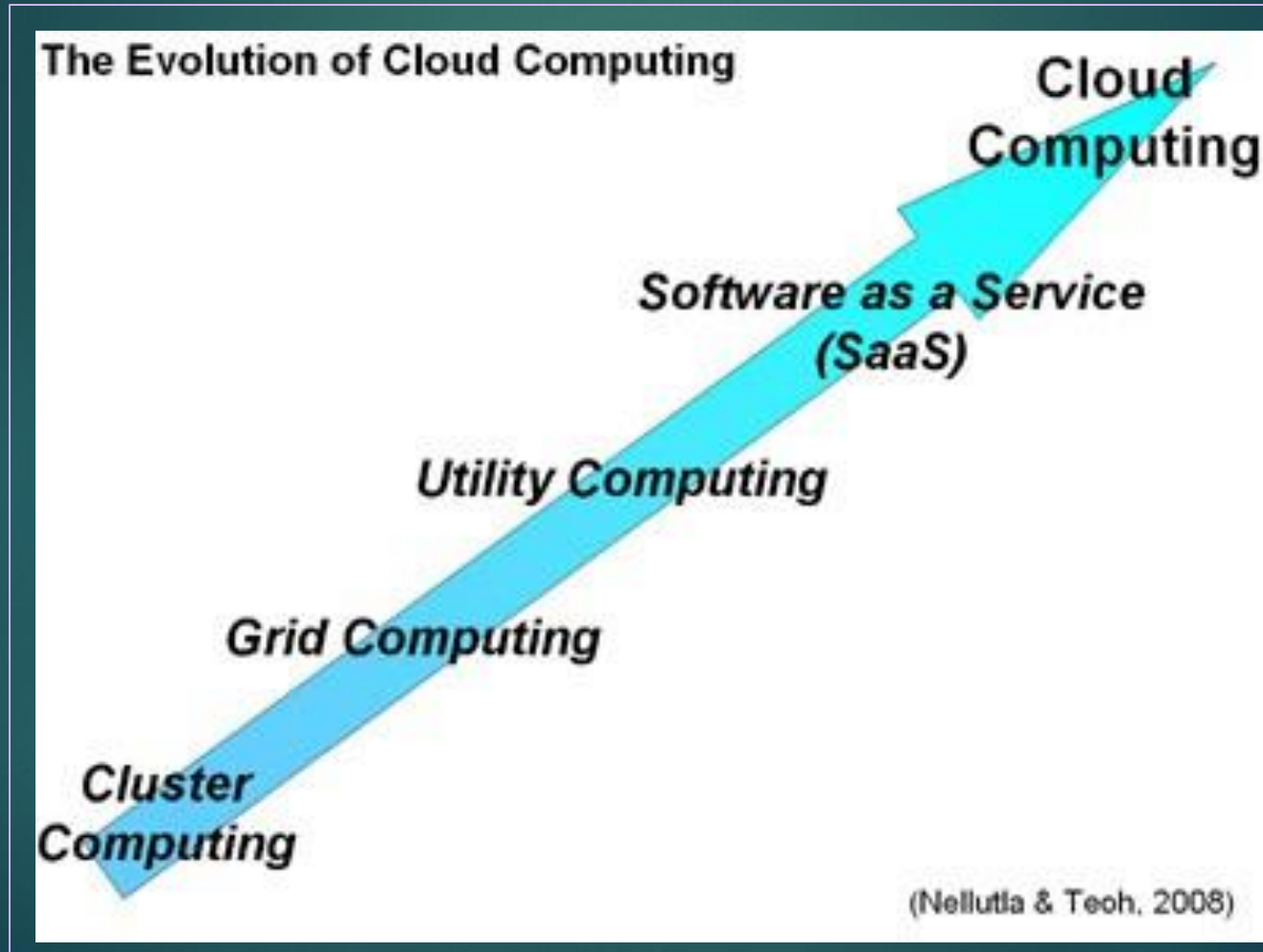
- ▶ The provider's computing resources are pooled to serve multiple consumers using a *multi-tenant model*.
- ▶ Different physical and virtual resources dynamically assigned and reassigned according to consumer demand.

## ▶ **Measured Service:**

- ▶ Cloud systems *automatically control and optimize* resources used by leveraging a metering capability at some level of abstraction appropriate to the type of service.
- ▶ ***It will provide analyzable and predictable computing platform.***

# Evolution

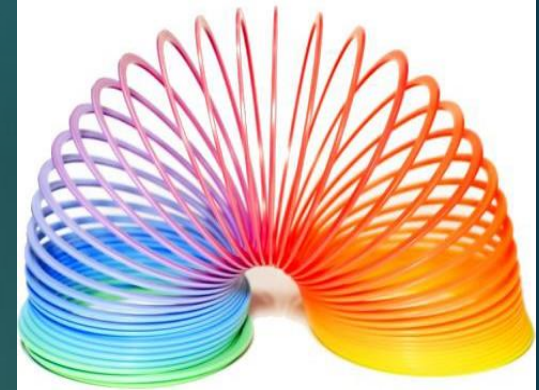
- Discussed in lecture1



# Why Cloud Computing?

- **Large-Scale Data-Intensive Applications**
- **Flexibility**
- **Scalability**
- **Customized to your current needs:**
  - Hardware
  - Software
- **Effect:**
  - Reduce Cost
  - Reduce Maintenance
  - High Utilization
  - High Availability
  - Reduced Carbon Footprint

# Why Cloud Computing?



## ■ Flexibility

- Software: Any software platform
- Access: access resources from any machine connected to the Internet
- Deploy infrastructure from anywhere at anytime
  - Software controls infrastructure

# Why Cloud Computing?

## ■ Scalability

- Instant
- Control via software
  - Add/cancel/rebuild resources instantly
- Start small, then scale your resources up/down as you need
- illusion of infinite resources available on demand



# Why Cloud Computing?

## ■ Customization

- Everything in your wish list
  - Software platforms
  - Storage
  - Network bandwidth
  - Speed

# Why Cloud Computing?



## ■ Cost

- Pay-as-you-go model
- Small/medium size companies can tap the infrastructure of corporate giants.
  - Time to service/market
  - No upfront cost



# Why Cloud Computing?

## ■ Maintenance

- Reduce the size of a client's IT department
- Is the responsibility of the cloud vendor
- This Includes:
  - Software updates
  - Security patches
  - Monitoring system's health
  - System backup
  - ...etc





# Why Cloud Computing?

## ■ Utilization

- Consolidation of a large number of resources
  - CPU cycles
  - Storage
  - Network Bandwidth

# Why Cloud Computing?

## ■ Availability

- Having access to software, platform, infrastructure from anywhere at any time
- All you need is a device connected to the internet



## ■ Reliability

The system's fault tolerance is managed by the cloud providers and users no longer need to worry about it.

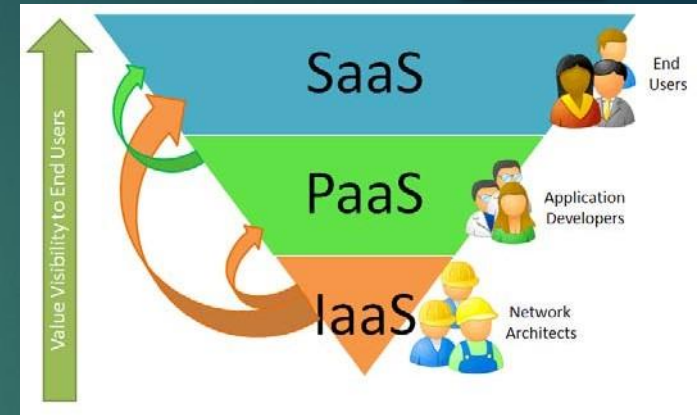
# Drawbacks

- Security
- Privacy
- Vendor lock-in
- Network-dependent
- Migration

# Cloud Computing Services

## Three basic services:

- **Software as a Service (SAAS) model**
  - Apps through browser
- **Platform as a Service (PAAS) model**
  - Delivery of a computing platform for custom software development as a service
- **Infrastructure as a Service (IAAS) model**
  - Deliver of computer infrastructure as a service



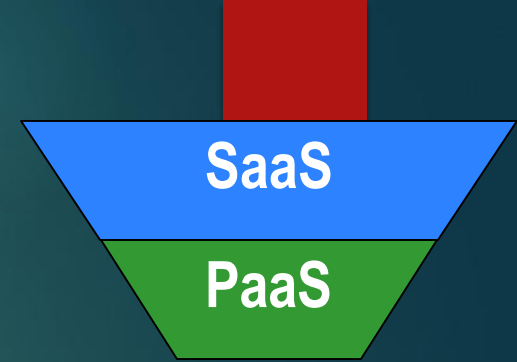
# SaaS



SaaS

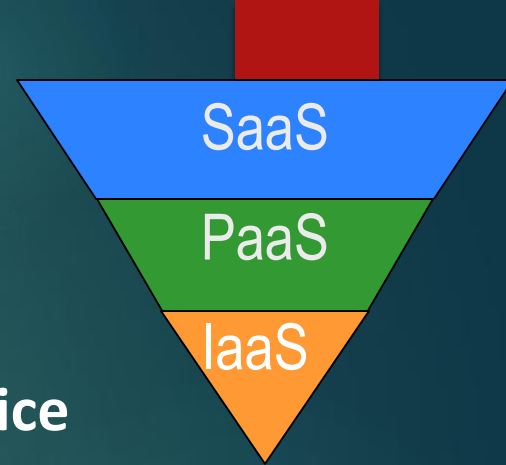
- Started around 1999
- Application is licensed to a customer as a service on demand
- **Software Delivery Model:**
  - Hosted on the vendor's web servers
  - Downloaded at the consumer's device and disabled when on-demand contract is over

# PaaS



- Delivery of an integrated computing platform (to build/test/deploy custom apps) & solution stack as a service.
- Deploy your applications & don't worry about buying & managing the underlying hardware and software layers

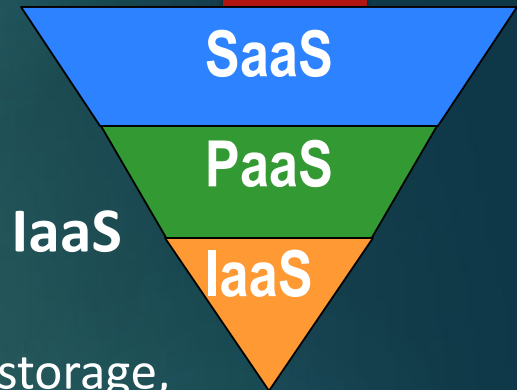
# IaaS



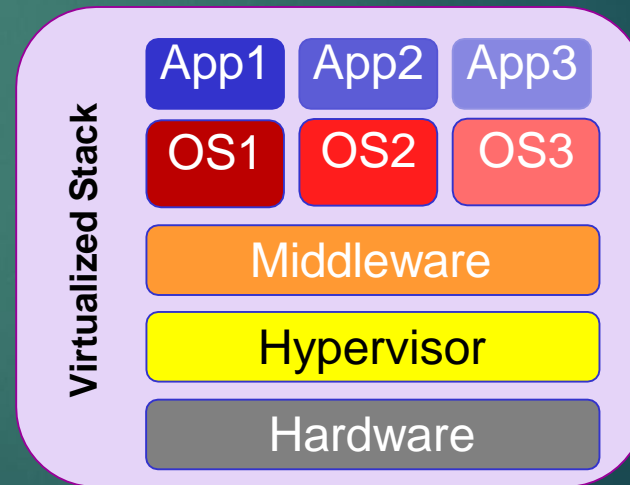
- Delivery of computer infrastructure (typically platform virtualization environment) as a service
- Buy resources
  - Servers
  - Software
  - Data center space
  - Network equipment as fully outsourced services
- Example:



# IaaS



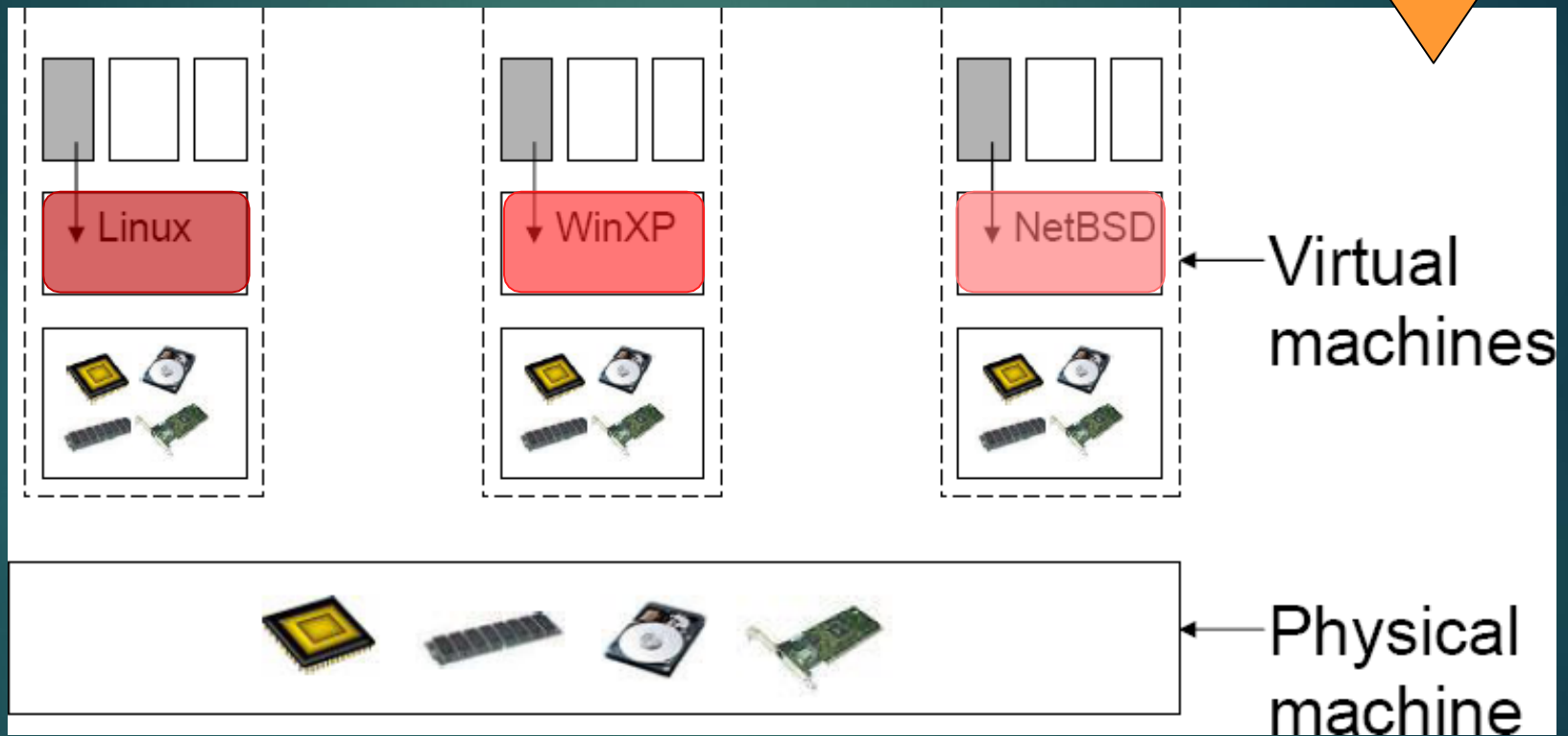
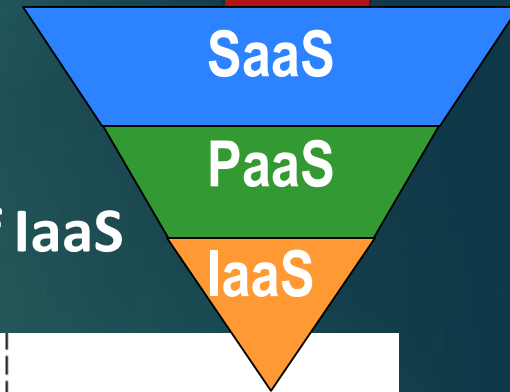
- **Virtualization Technology is a major enabler of IaaS**
  - It's a path to share IT resource pools: Web servers, storage, data, network, software and databases.
  - Higher utilization rates



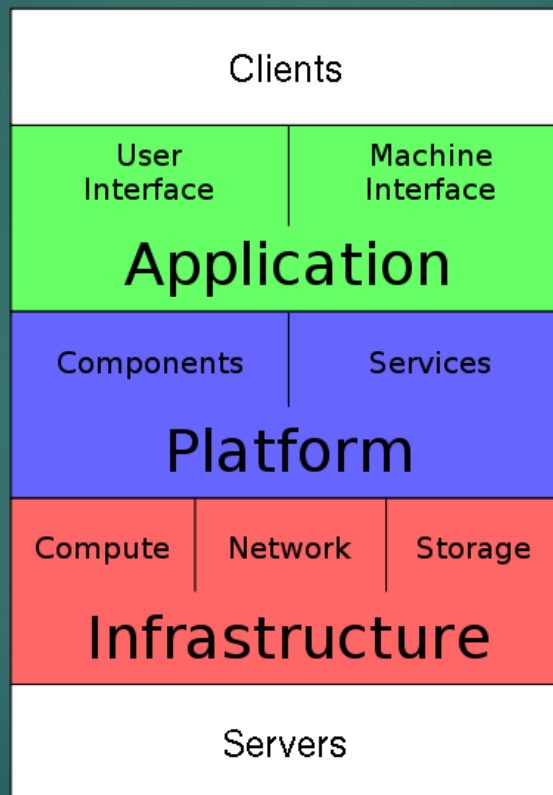


# IaaS

- Virtualization Technology is a major enabler of IaaS

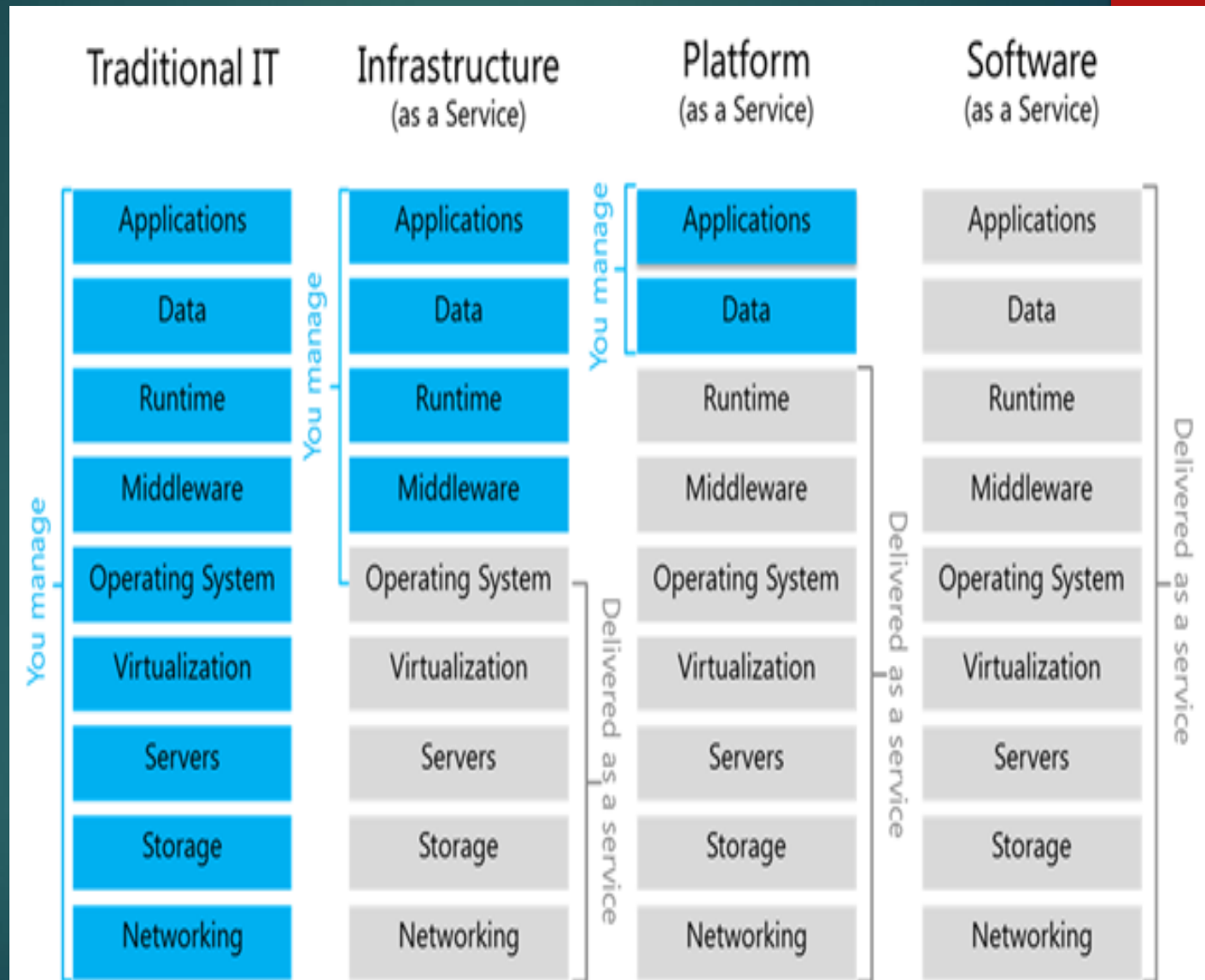


# Services



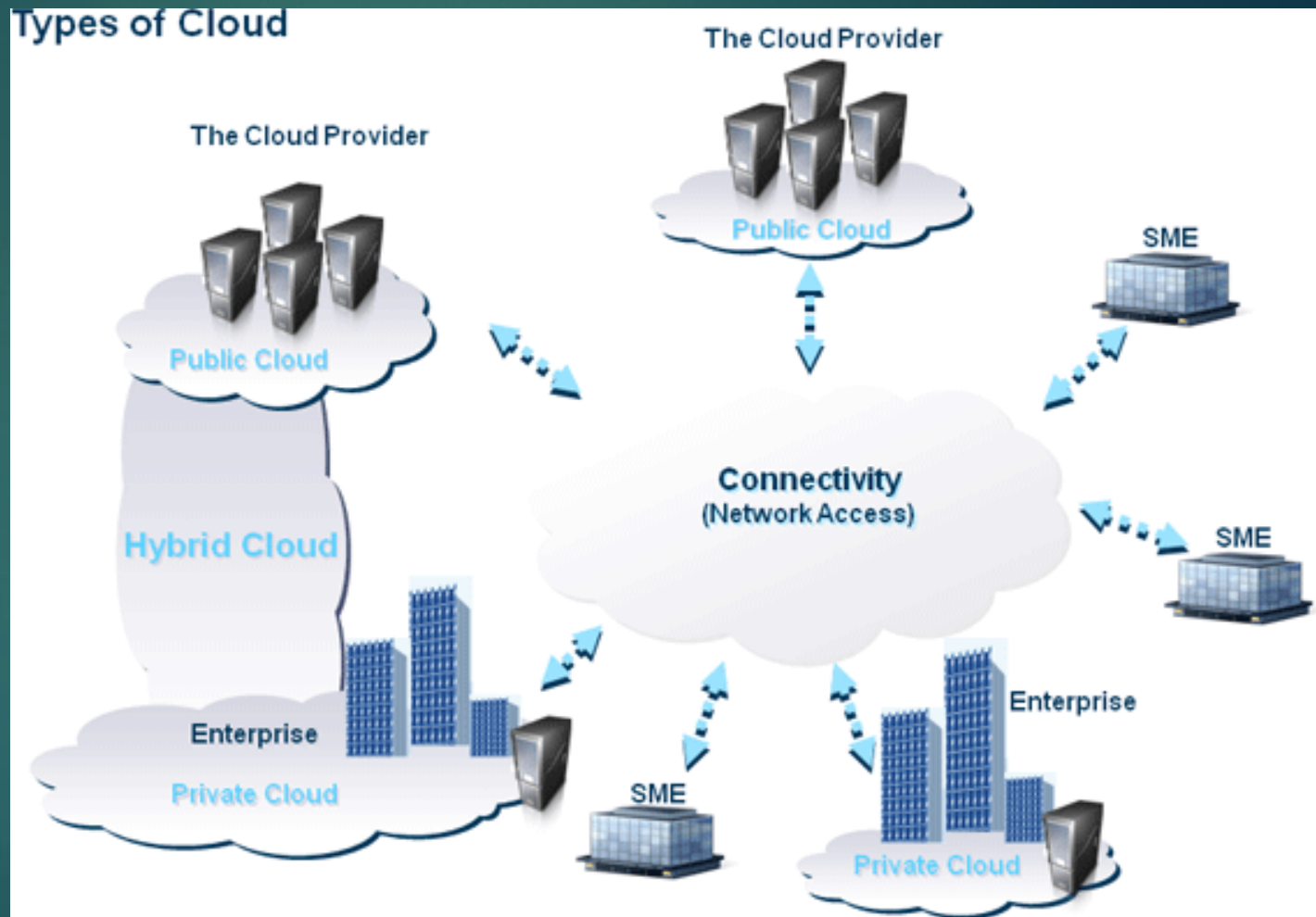
Cloud Computing Stack

# Traditional IT vs Cloud Services



# Types of Clouds

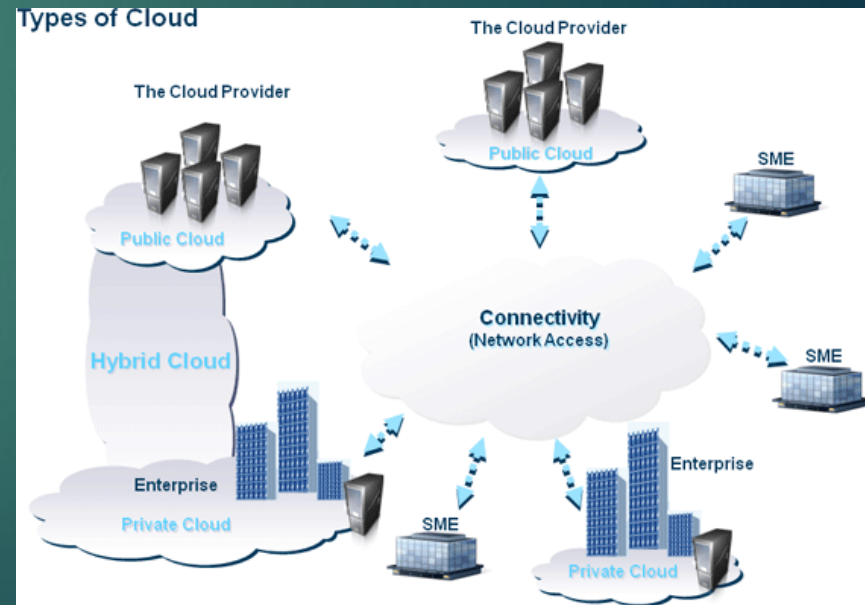
- Public
- Private
- Hybrid



# Types of Clouds

## ■ Public (external) cloud

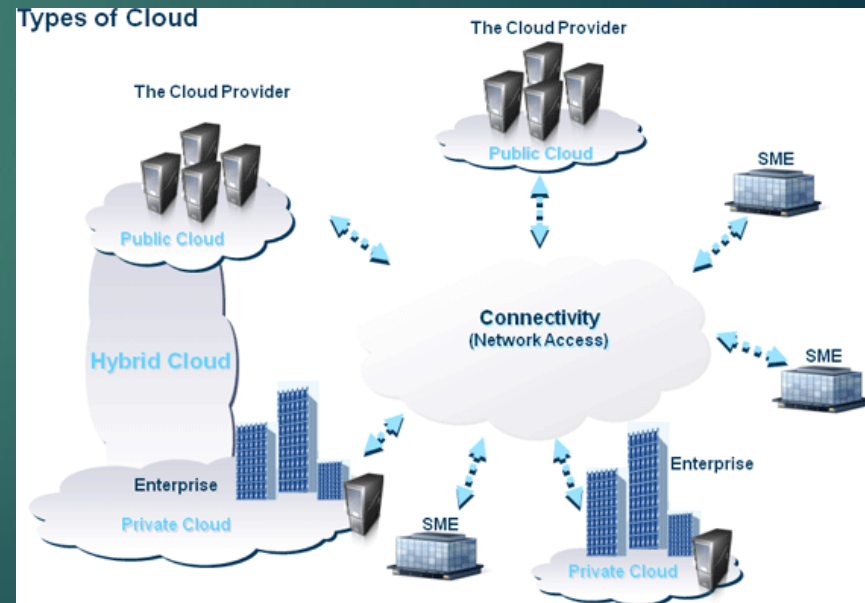
- Open Market for on demand computing and IT resources
- Concerns: Limited SLA, Reliability, Availability, Security, Trust and Confidence
- Examples: IBM, Google, Amazon, ...



# Types of Clouds

- **Private (Internal) cloud**

- For Enterprises/Corporations with large scale IT



# Types of Clouds

## ■ Hybrid cloud

- Extend the Private Cloud(s) by connecting it to other external cloud vendors to make use of available cloud services from external vendors

## ■ Cloud Burst

- Use the local cloud, when you need more resources, burst into the public cloud

