Course: Introduction to Virtualization and Cloud computing

Credits: 03

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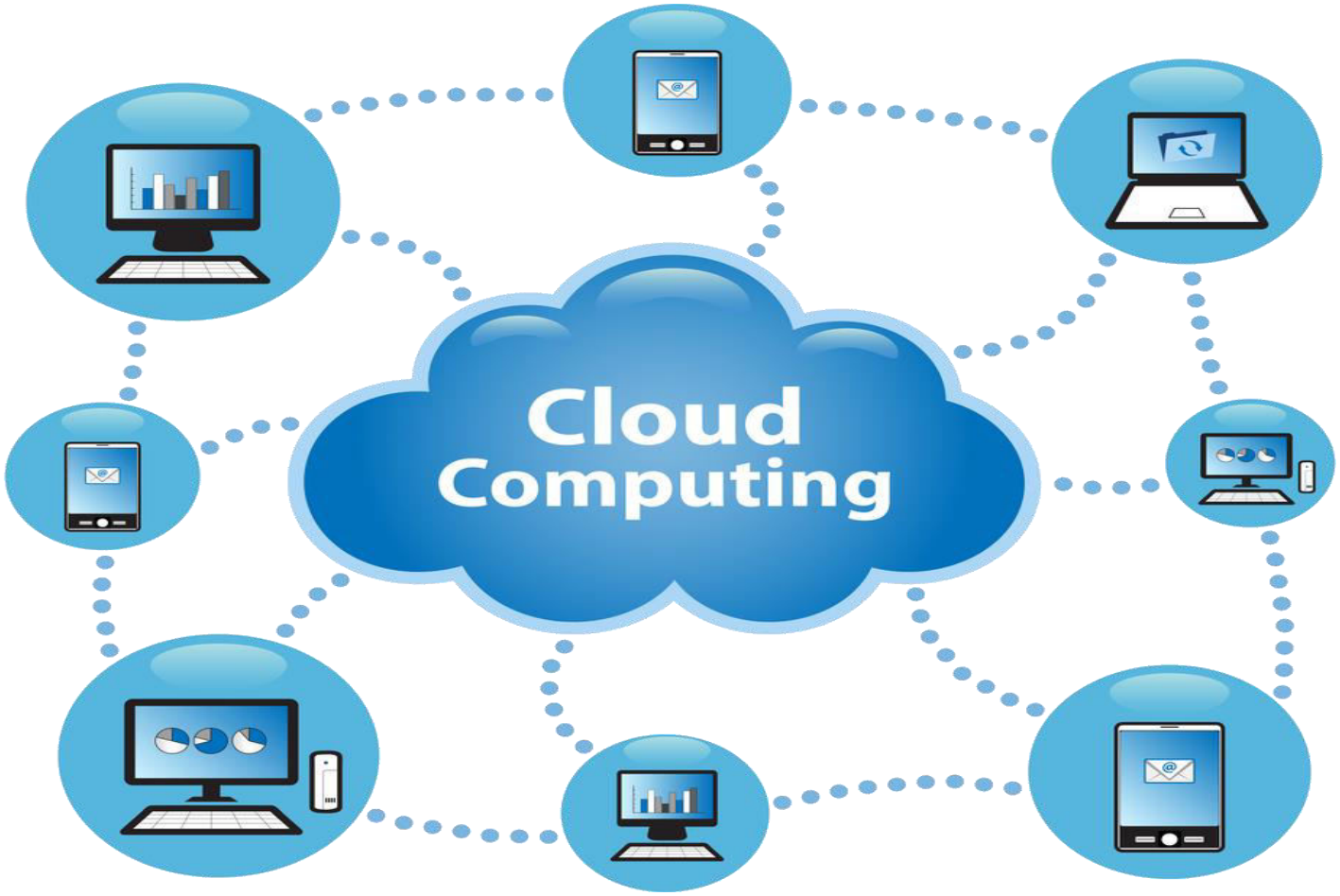
PROFESSOR- SOCS



What should you expect from this course?

Understanding on Cloud Computing

Technology and to help them build their skills to develop large-scale industry standard applications using cloud platforms and tools

Covers concepts of cloud storage as well as how to ensure security in cloud.

Course Outcomes

- CO 1 Understanding of Cloud Computing, its benefits, trends, and issues.
- CO 2 Infrastructure of Cloud computing.
- CO 3 Understanding Services and Applications by its type.
- CO 4 Cloud Capacity Planning and security in cloud computing.
- CO 5 Moving Applications to the Cloud.
- CO 6 Going through Cloud storage working and its creation
- CO 7 How does communication happens with the cloud
- CO 8 Concept of Mobile Cloud and using smartphones with cloud
- CO 9 Workloads and services management in cloud
- CO 10 Cloud migration and mobile web services working

Cloud computing jobs in high demand

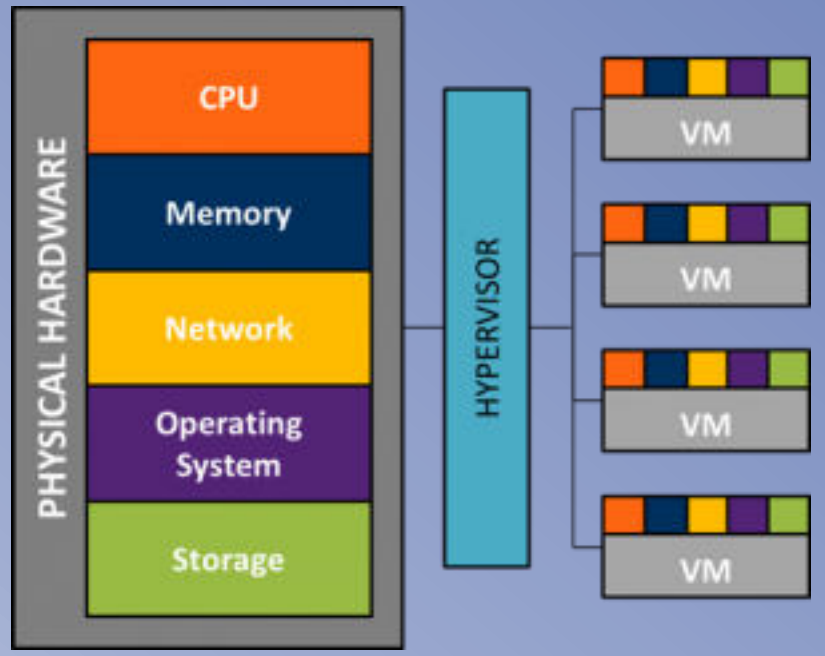
1. **Cloud Architect.**: development and implementation of cloud based initiative.
2. **Cloud Software Engineer:** Design and development of distributed software module.
3. **Cloud sales manager:** Cloud Business
4. **Cloud Engineer:** for Technical Task in virtualized infrastructure
5. **Cloud Services Developer:** Build multiplatform customer.
6. **Cloud System administrator**: Maintain the system in cloud platform
7. **Cloud system Engineer**: Build the virtual system.
8. **Cloud Network engineer**: Maintenance and optimization of network.
9. **Cloud Product Manager**: Planning for cloud based offering.
10. **Cloud Consultant**: Conduct technical studies and evaluations.

How do I create and activate a new AWS account?

1. Open the Amazon Web Services home page.
2. Choose Create an AWS Account.
3. choose Sign in to the Console
4. Enter your account information, and then choose Continue. Be sure that you enter your account information correctly, especially your email address. If you enter your email address incorrectly, you can't access your account
5. Choose Personal or Professional.
6. Enter your company or personal information.
7. Read and accept the AWS Customer Agreement.
8. Choose Create Account and Continue.
9. Add a payment method
10. Verify your phone number
11. Choose your country or region code from the list.
12. Enter a phone number where you can be reached in the next few minutes.
13. Enter the code displayed in the captcha and then submit.
14. In a few moments, an automated system contacts you.
15. Enter the PIN you receive, and then choose Continue.

Concept of virtualization

- **Virtualization** is the "creation of a virtual (rather than actual) version of something, such as a server, a desktop, a storage device, an operating system or network resources".
- In other words, Virtualization is a technique, which allows to share a single physical instance of a resource or an application among multiple customers and organizations. It does by assigning a logical name to a physical storage and providing a pointer to that physical resource when demanded.



Learning Outcomes

- **At the end of the session you will be able to:**
- Comprehend virtualization
- Explain need of compute virtualization
- Understand virtual clusters
- Apply various techniques used for computing virtualization
- Describe various resource management tools
- Describe application of virtual machine
- Describe hypervisor taxonomy
- Appreciate the concept of virtual machine
- Explain data center virtualization

Concept of virtualization

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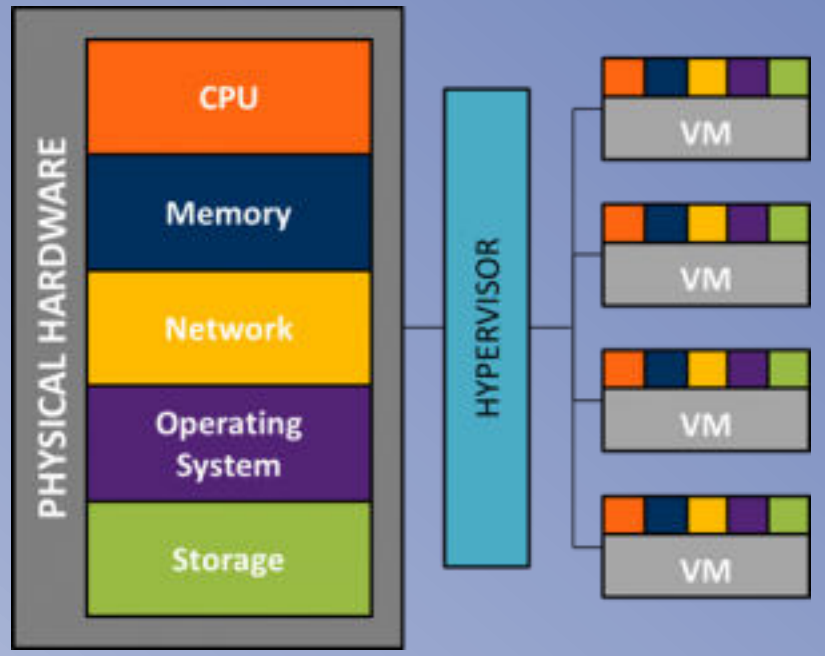


Overview

Virtualization

- Virtualization as the term indicates, refers to the technique of building an abstraction layer over the hardware that closely resembles the underlying hardware, OS or other system components, thereby, cloning the functionality of the original components into software.

Need for Virtualization

- Virtualization eliminates most of the inflexibilities inherent in the hardware systems and allows for better manageability leading to a better utilization of the system. The basic principle of hardware-software interchangeability, help us better understand the tradeoffs between performance and flexibility.

Introduction

- Virtualization refers to a technology that is used to make physical resources available as virtual resources.
- Cloud computing technologies use a set of techniques to create virtual servers, virtual storage, virtual networks, and perhaps virtual applications as well.
- Virtualization software is used to make a physical server like a virtual server.
- Operating system-level virtualization can be achieved by installing virtualization software on already installed operating systems.

Virtualization Reference Model

- The virtualization model consists of a host or physical resources in the first layer, virtualization tool in the second layer, and a guest in the third layer (application as well as virtual image) as shown in Fig. 6.1.

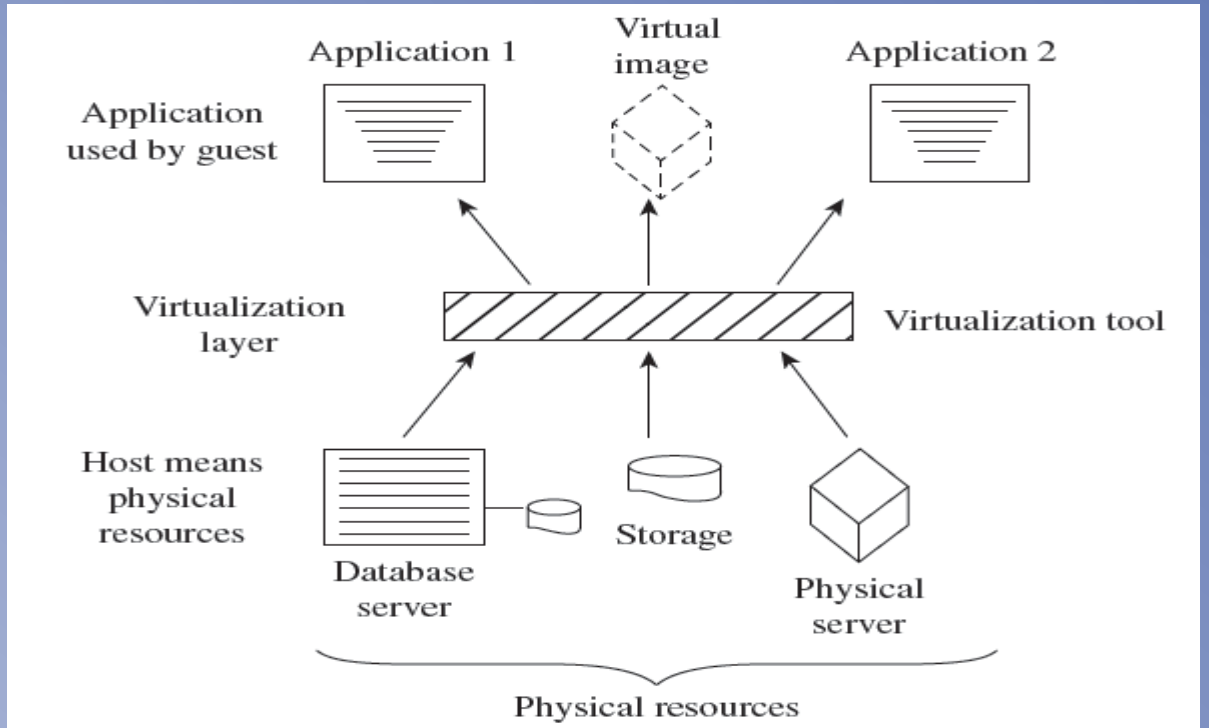
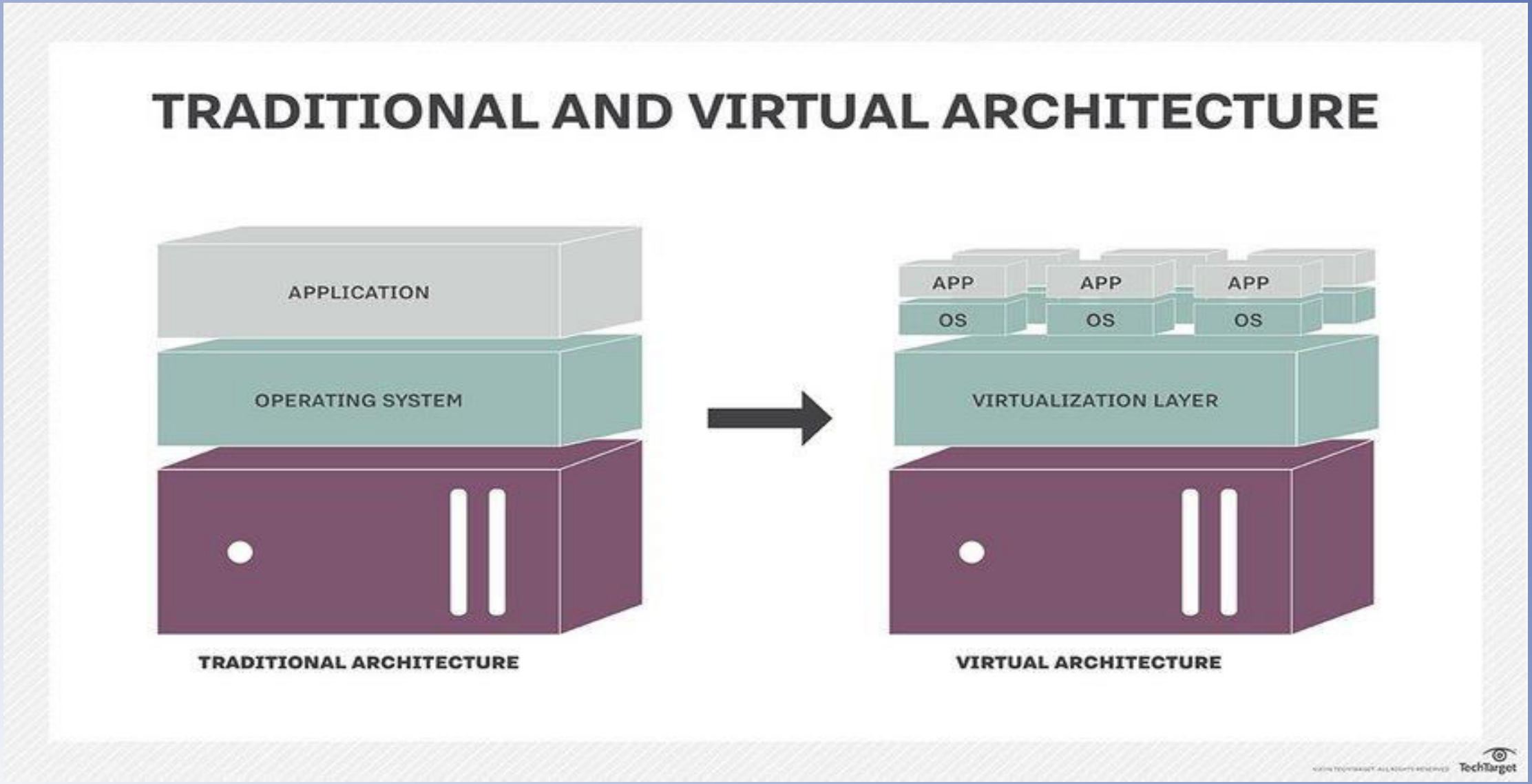


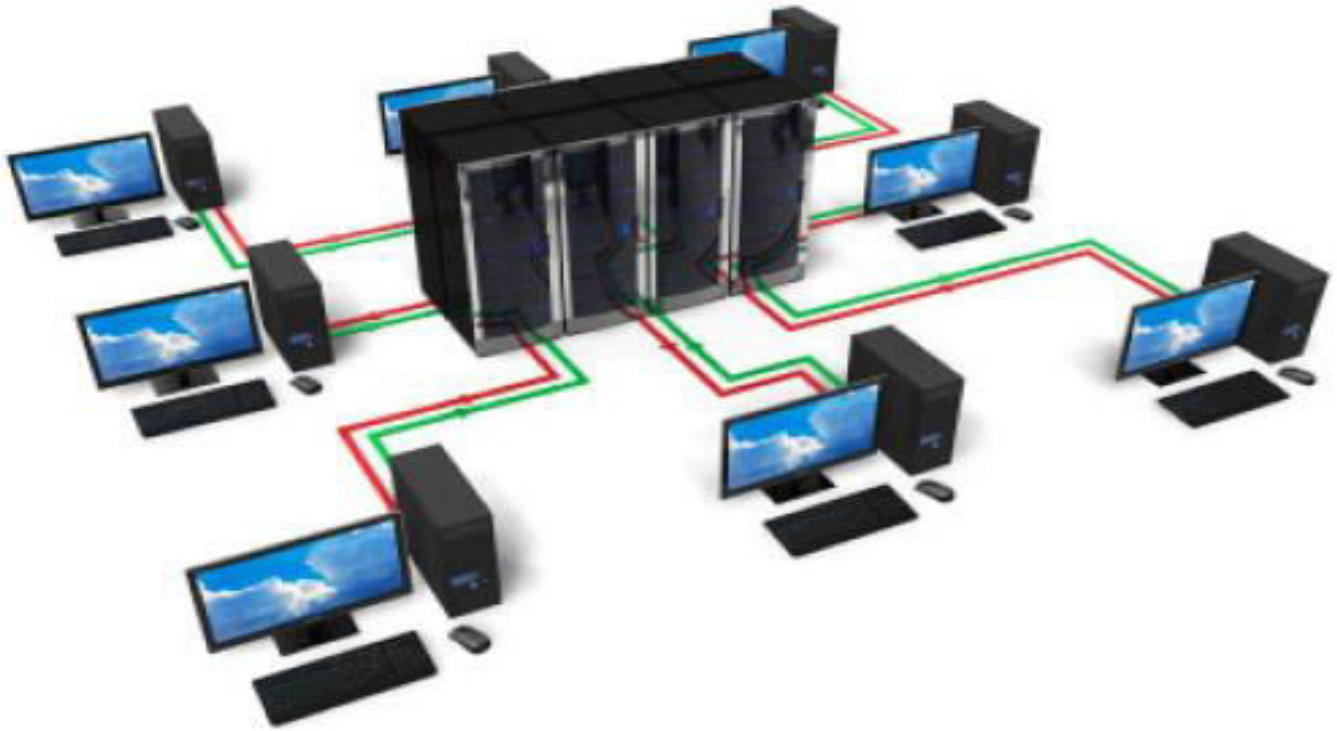
Fig. 6.1 Virtualization reference model

Traditional IT Infrastructure - Virtualization



Traditional IT Infrastructures

IBM ICE (Innovation Centre for Education)



- Traditionally, organizations have relied on physical infrastructures to manage data and information. With the explosion of information and related data, the physical footprint required to manage the information base has grown tremendously.

Shortcomings of physical infrastructures

- Asset Management
- Tracking Utilization
- Security and Compliance
- Provisioning
- Staff for Administration
- Sizing
- Optimization

Benefits of Virtualization

Advantages of Virtualization

The advantages of virtualization include the following:

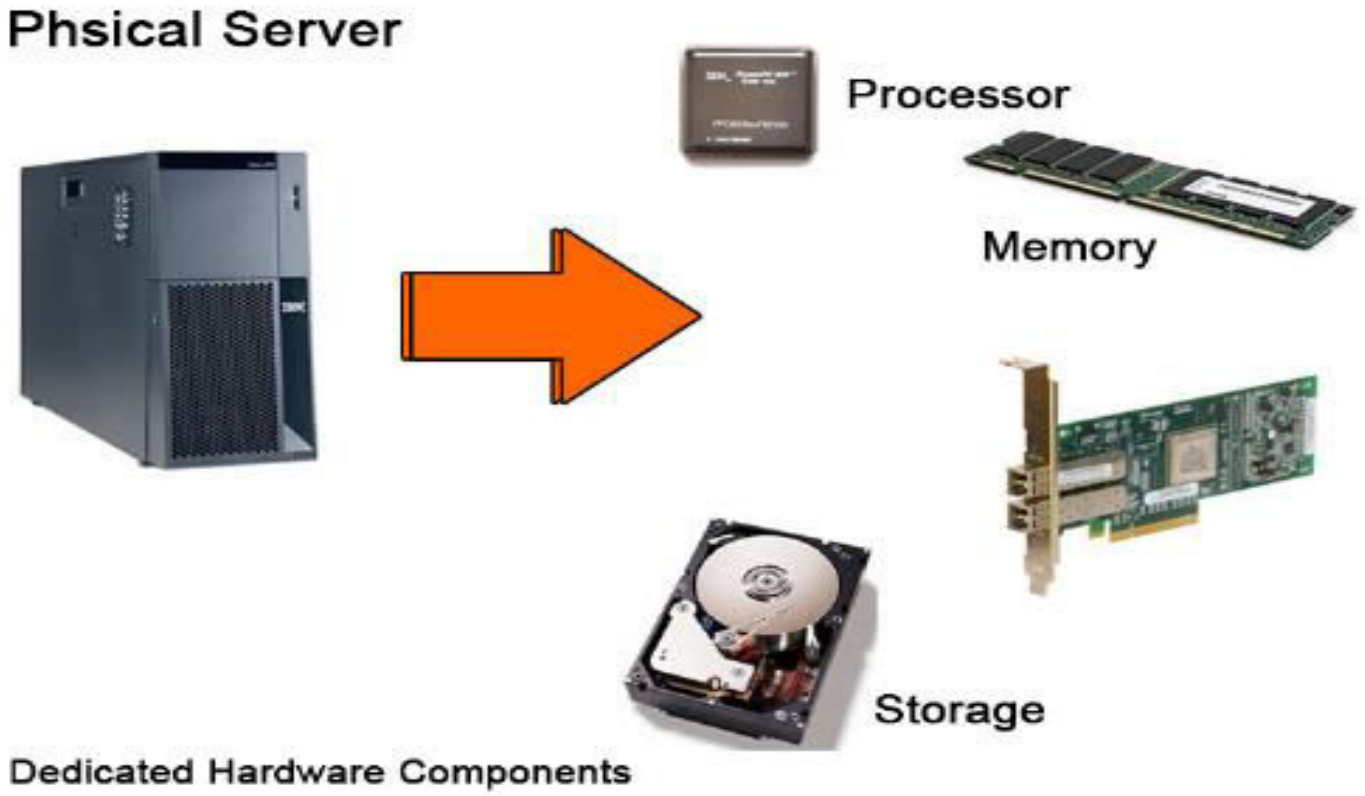
- It allows any network-enabled device to access any network application over any network.
- It maintains isolation of one workload from another application to enhance security in the environment.
- Virtualization of an application allows users to be comfortable with different versions of the operating system.
- It can support and allow application with multiple instances to run on various machines concurrently.
- It optimizes the use of a single system.
- It enhances the reliability or availability of an application through redundancy.

Comparison of traditional IT infrastructures with virtualized infrastructures

Parameter	Traditional IT	Virtualization
Utilization	0-20%	Typically 60-70%
Provisioning	Typically takes 6-8 weeks	1 day
Monitoring	Usage of monitoring tools. However, need manual intervention to take care of any hardware failures	Comparative ease in monitoring using automated tools. However, need manual intervention to take care of any failures
Sizing	Sizing needs to be completed before deployment. Re-sizing involves procuring new hardware and planned downtimes	Easier to resize. However, manual intervention required to resize
Staff for Administration	Require larger number of Full Time employees to manage the infrastructure	Reduced number of Full Time employees
Cost	Upfront costs involved in outright purchase of hardware	Initial hardware cost reduced due to sharing of hardware assets and increased utilization. There is a typical reduction of 40% in hardware
Optimization	Difficult to do as there is no easy way to monitor and load balance across machines	Easy to share resources and re-balance loads on the virtual machines on the same host. However, re-balancing across physical hosts require advanced features and planned downtime

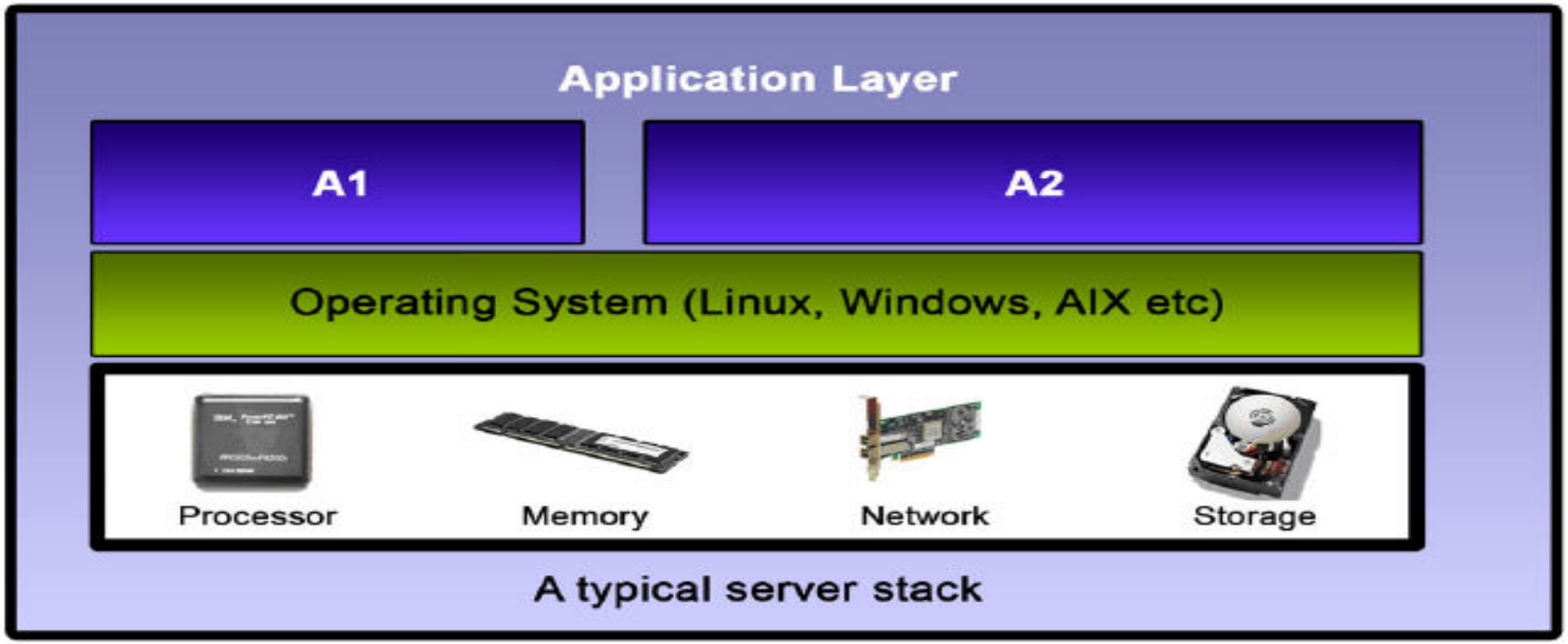
Implementing Virtualization

- A physical server is typically composed of four major physical components – Processor, memory, network and storage (adapters and disk drives).



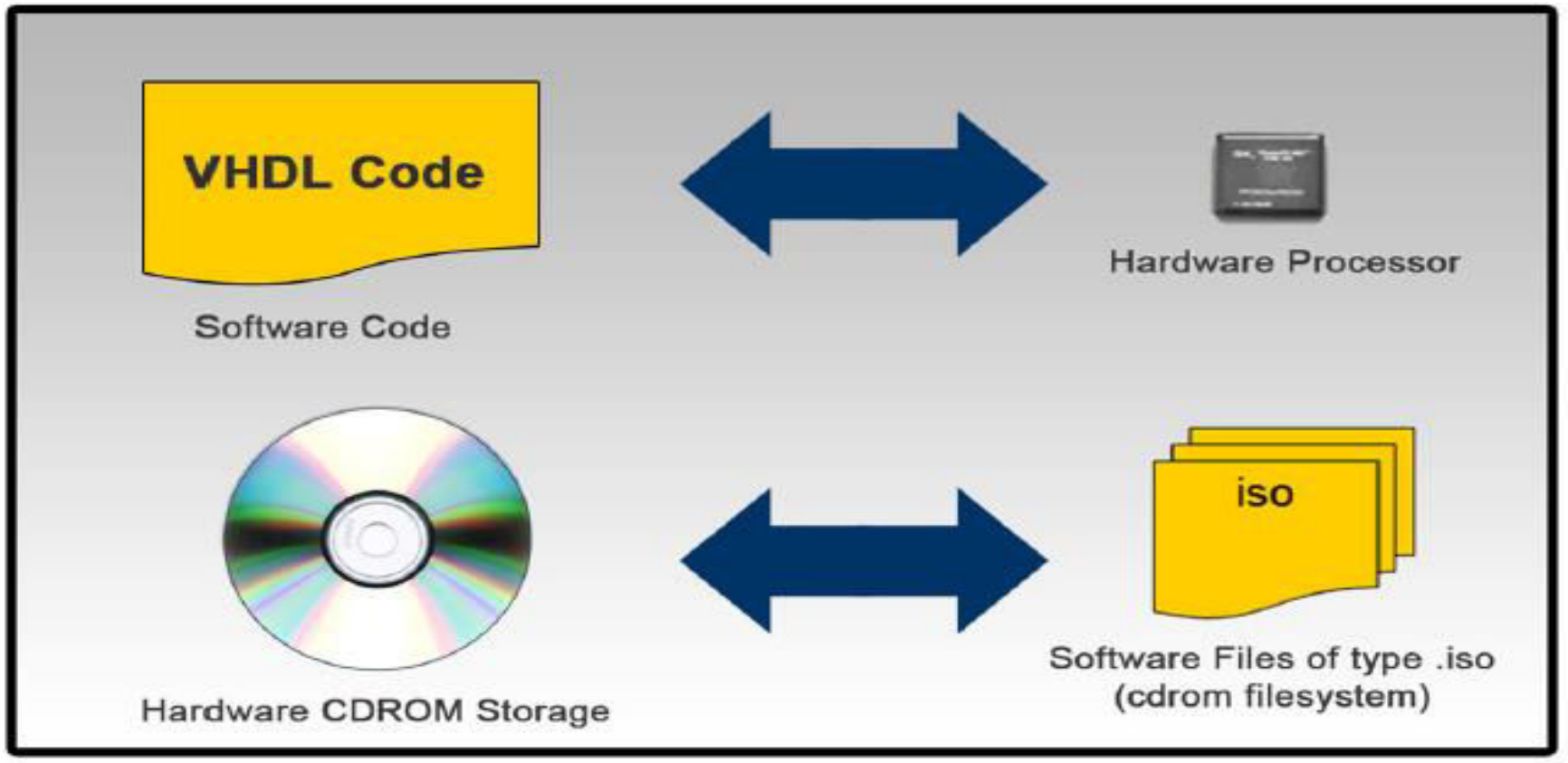
A typical hardware/software server stack

- The components marked in the white box are the hardware components. The Operating System resides over the hardware. The applications are stacked over the operating system and use services provided by the OS.

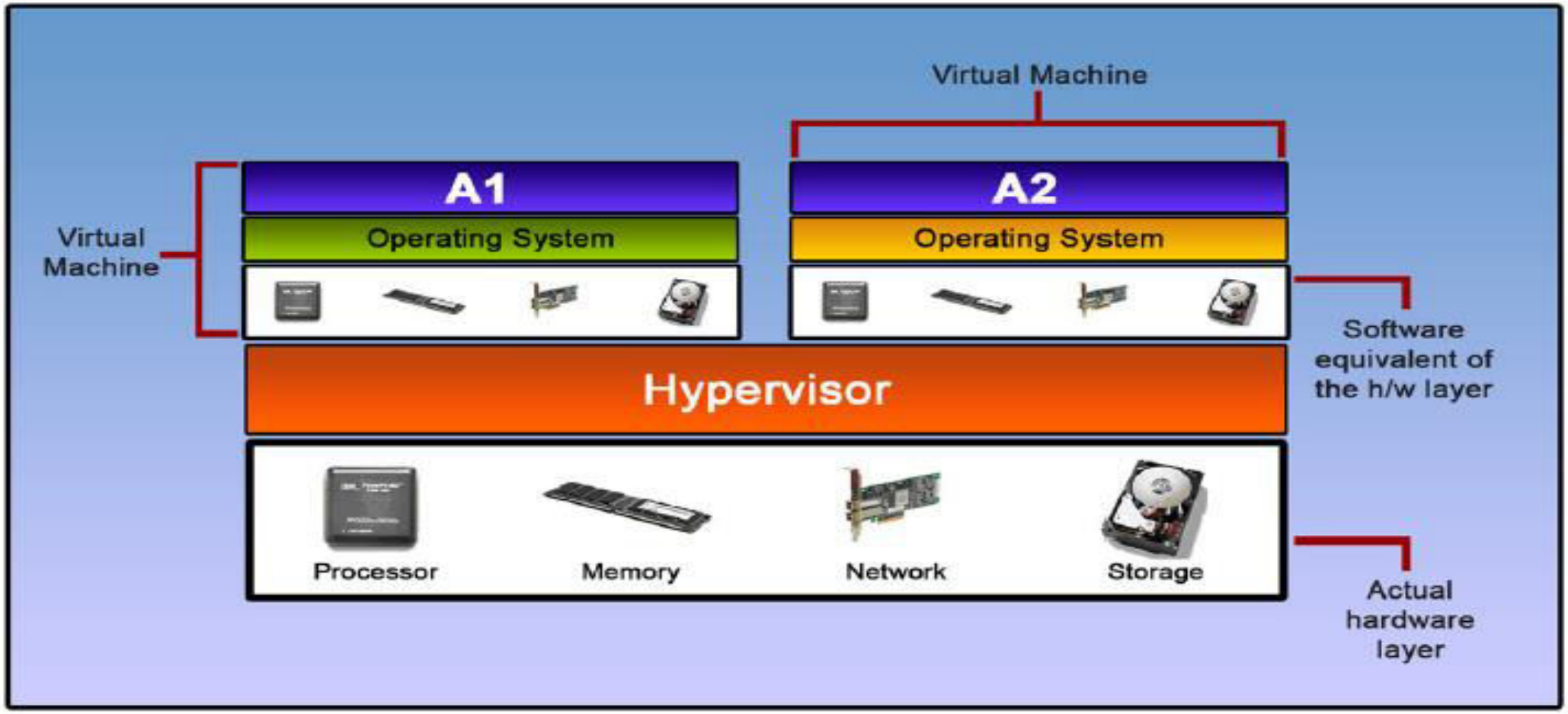


Logical Equivalence (1 of 2)

- Any logic written in software can be easily converted to a hardware equivalent.
  Any existing hardware can be easily converted to software.

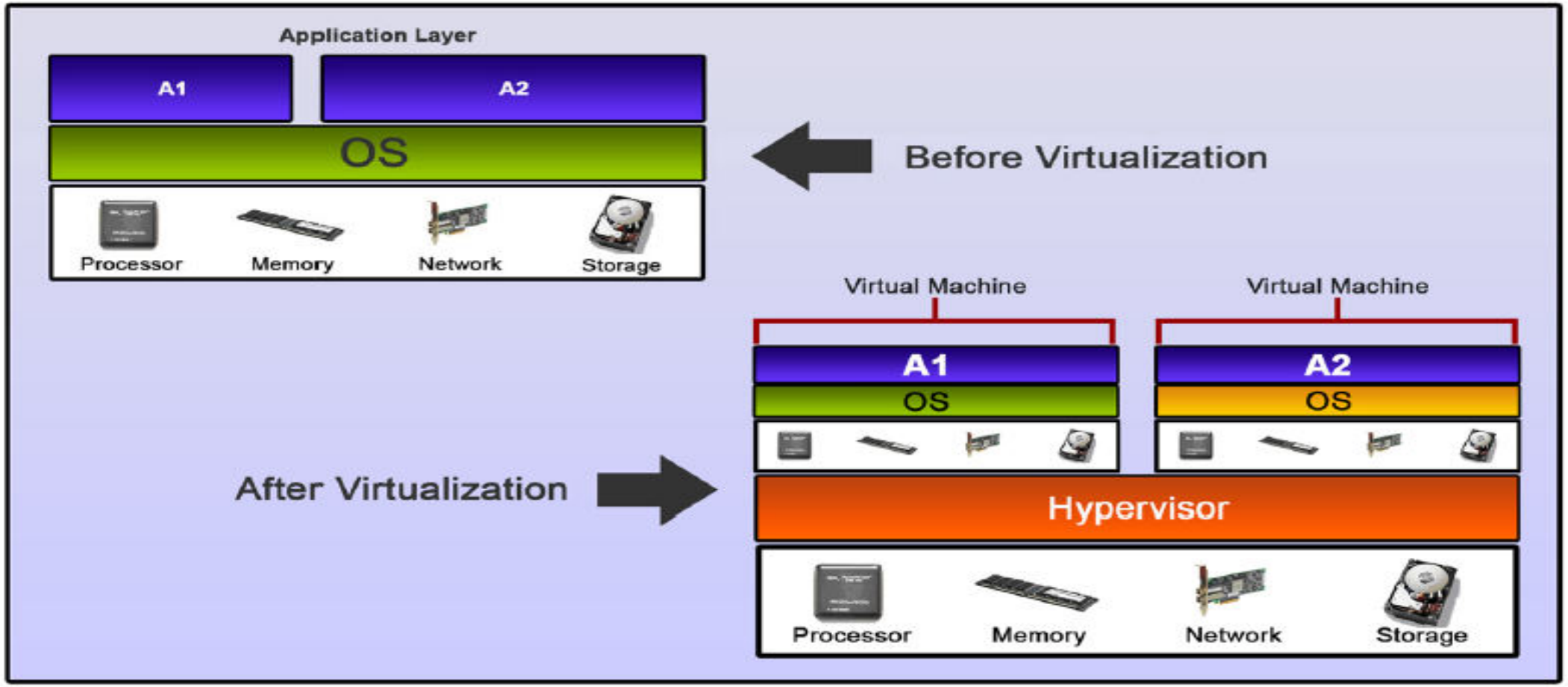


Logical Equivalence (2 of 2)



Pre and Post Virtualization Server Stacks

IBM ICE (Innovation Centre for Education)



Server/Compute Virtualization

- Server/Compute virtualization in cloud computing refers to making a virtual edition of a device or resource, such as a server, storage device, network, or an operating system where the structure splits the resources as one or more environments for execution.
- The following are the advantages of server/compute virtualization:

1. Consistency
2. Energy efficiency
3. Enhanced disaster recovery
4. Cost savings

- A virtual machine is a reasonable computing system like a physical machine which governs an application and operating system (OS). Some of the virtual components used in a virtual machine are as follows:

Server/Compute Virtualization

A virtual machine (VM) can be configured with the following virtual components:

- Virtual central processing unit (vCPU)
- Virtual random access memory (vRAM)
- Virtual disk
- Virtual network adaptor (vNIC)
- Virtual DVD/CD-ROM and floppy drives
- Virtual SCSI (Small Computer System Interface) controller
- Virtual USB controllers
- Virtual machine console

Server/Compute Virtualization

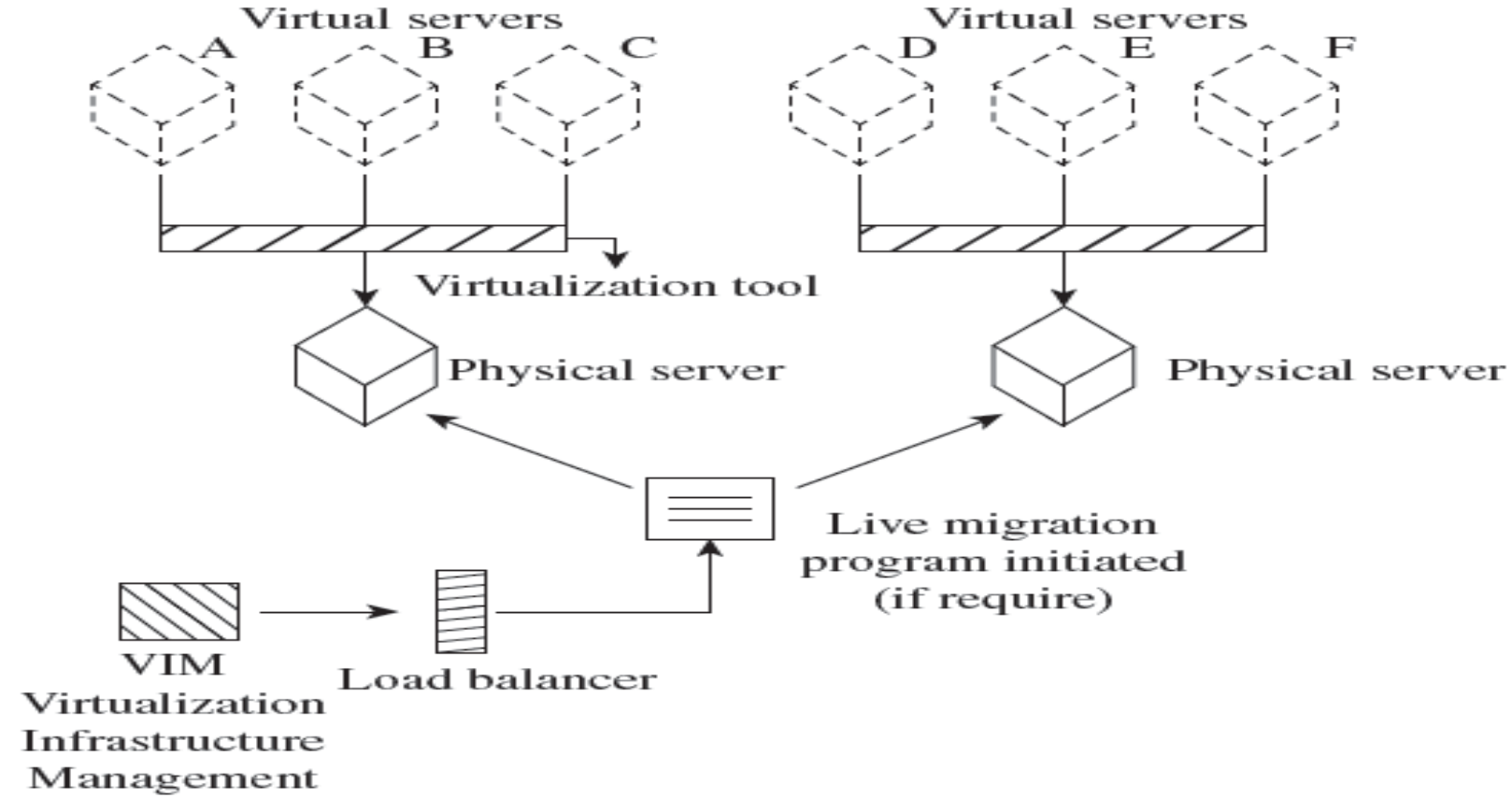


Fig. 6.2 Compute virtualization

Area and technology based classification

Virtualization can be also be classified based on the technology or the area that is being virtualized

- Server Virtualization
- Network Virtualization
- Storage Virtualization
- Desktop Virtualization
- Application Virtualization
- Management Virtualization

Types of Virtualization

- Virtualization is classified based on the extent of hardware emulation.
- Full Emulation
- Full/Native Virtualization
- Para-Virtualization
- OS Virtualization
- Application Virtualization

Server/Compute Components

The logical components of a server/compute system comprise the following:

- File system
- Operating system
- Volume manager
- Device drivers

Need of Server/Compute Virtualization

- Compute virtualization facilitates and permits various applications and operating systems to function on a physical machine.
- This method considerably minimizes charge and enhanced consumption. Resource management is the allotment of a physical machine or clustered physical machines to VMs.
- Every physical machine and group has a parent resource pool which provides the resources of that physical machine or group.
- Each child resource pool possesses a few of the resources of their parents. A parent resource pool may include virtual machines, child resource pools, or both.

Need of Server/Compute Virtualization

- Present CPUs are prepared with hyper-threading characteristics and multiple cores per CPU. A multicore CPU is an incorporated circuit with which two or more processing units have been connected for improved functioning and more effective, synchronized processing of multiple resources.
- A hypervisor augments and supports the CPU resources by use of modern CPU aspects such as hyper-threading and multicore. It also helps in the following ways:

1. Server consolidation
2. Improved security
3. Increased hardware consumption
4. Hardware independence and support portability
5. Decreased provisioning timing

Virtual Clusters

- There are common agreements for most applications or users, such as user-level or OS programming libraries.
- The VMs (guest systems) and physical machines (host systems) may operate with different OSes.
- The virtual environment design should be able to function quickly. In this case, deployment should be to build and allocate software stacks (i.e., applications, OS, and libraries) to a physical node within clusters as quick as possible and to instantly switch run time environments from one virtual cluster of user to another.
- Live moving VMs permit one to deliver workloads from one node to other one.
- One more advantage for clustering carried by virtualization is load-balancing applications in a virtual cluster.

Advantages of Server/Compute Virtualization

Compute virtualization offers the following advantages:

- Server consolidation
- Segregation
- Encapsulation
- Non-dependence on hardware
- Reduction in cost

Techniques of Server/Compute Virtualization

The three methods which manage confidential commands to virtualize the CPU are:

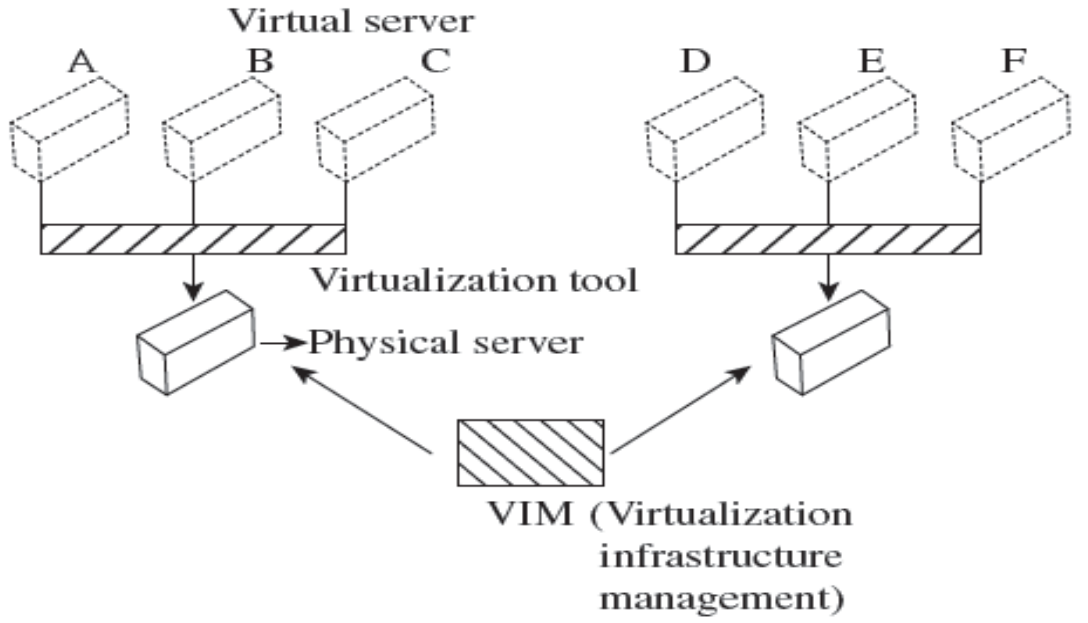
- Full Virtualization
- Para Virtualization
- Hardware Assisted Virtualization

Virtual Machine and Hardware Components

- A VM is a rational compute system similar to a physical machine which operates an application and an OS.
- An operating system which works within a virtual machine is known as a guest operating system.
- Network file system (NFS) and virtual machine file system (VMFS) are the file systems sustained by the hypervisor.
- The VMFS is a group of file systems augmented to preserve files of a virtual machine.
- In a virtualization environment, if any of the physical servers does not work properly, virtual infrastructure management (VIM) is initiated to divert traffic to a new selected physical server.

Virtual Machine and Hardware Components

- In Fig. Virtual machine management systems, if E, F, and G virtual instances are not working, then live migration of these E, F, and G into a new destination will be carried out.



VIM selects and diverts traffic to a new selected physical server after accessing capacity of other available hypervisor. E, F, and G virtual servers are live migrated to a new destination.

Fig. 6.5 Virtual machine management systems

Hypervisor Taxonomy

- A hypervisor, also known as a virtual machine manager, is a program that permits multiple operating systems to share one hardware host.
- Hypervisor is compute virtualization software which facilitates manifold operating systems to operate on physical machines simultaneously.
- The hypervisor is the main constituent of the data center consolidation.
- Hypervisor has two main constituents—virtual machine monitor (VMM) and kernel.

Hypervisor Taxonomy

- Hypervisors are categorized into two types:
- Type 1 (Bare-metal hypervisor)
- Type 2 (Hosted hypervisor)

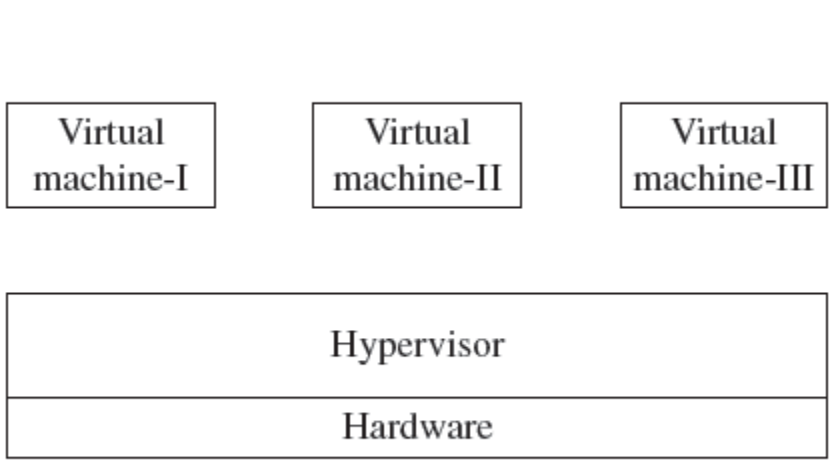


Fig. 6.6 Hypervisor Type 1

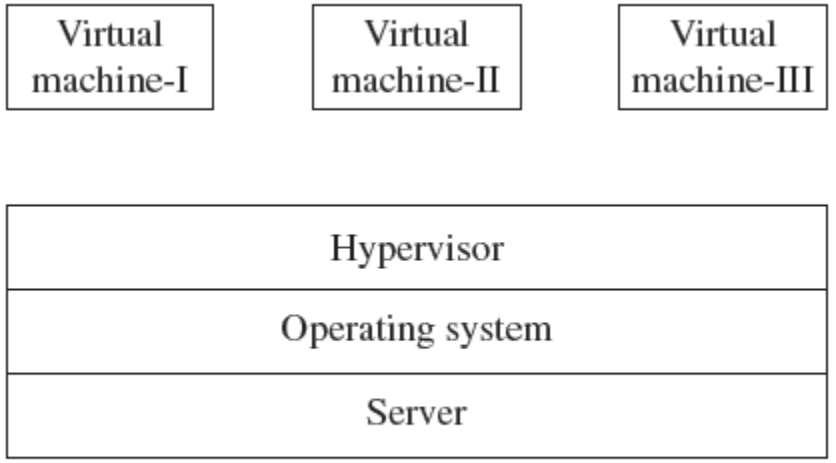


Fig. 6.7 Hypervisor Type 2

Resource Management and Tools

- Cloud resource management needs versatile judgments and policies for multi-objective optimization.
- The policies for cloud resource management associated with the three cloud delivery models, Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS) vary from each other.
- In cloud computing, where alterations are common and spontaneous, centralized control is not believable to offer a persistent service and performance assurances.
- Resource management policies frequently mutually target power utilization and performance.

Resource Management and Tools

- Resource management is the allotment of a physical machine or clustered physical machines to virtual machines.
- Unused memory allocated by a virtual machine to CPU can be accessed and used by other virtual machines without disturbing other resources.
- Some virtual machines can enclose the same user data, administer the same guest operating system, or have the same applications.
- A hypervisor recognizes surplus pages copied by their contents.
- Virtual machines may securely alter the shared pages without disturbing other virtual machines which are sharing that memory.

Physical Machine to Virtual Machine (P2v) Conversion

- A VM maintains a relationship between various virtual machines, and between a hypervisor and a VM in a grouped server environment.
- Physical to VM exchange is a procedure via which a physical machine is transformed into a virtual machine. When transforming a physical machine, the 'converter application' (Converter) copies data on the hard disk of the source machine and shifts that data to the target virtual disk.
- Advantages of P2V converters are:

1. Runs migration among heterogeneous hardware
2. Minimizes time required to set up a new virtual machine
3. Permits migration of machines to a new hardware without re-launching the application or operating system

Physical Machine to Virtual Machine (P2v) Conversion

- The P2V 'converter application' comprises three constituents—converter server, converter agent, and converter boot CD.
- There are two means to shift from physical machine to virtual machine (VM). These are cold migration and hot migration.

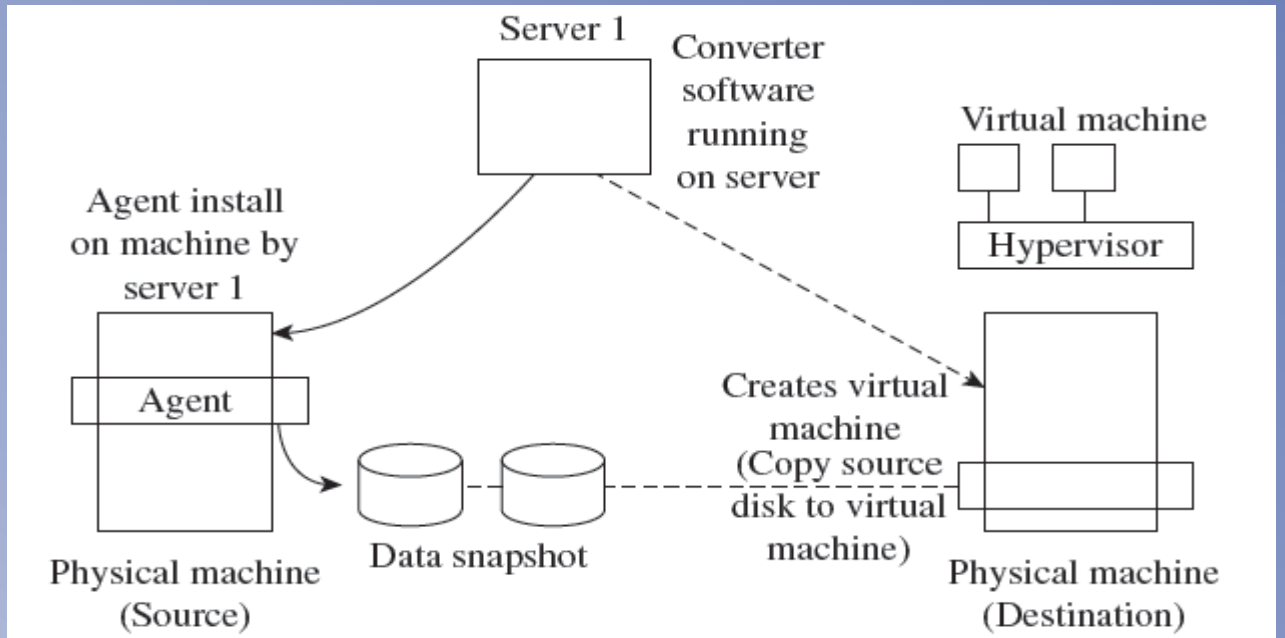


Fig. 6.8 Physical machines to virtual machine (P2V) conversion

Types of Virtualization

- Different types of virtualization are :
- Data Center Virtualization
- Server Virtualization
- Storage Virtualization
- Sensor Virtualization

Storage Area Network

- Storage area network (SAN) refers to the LAN design for managing huge amounts of data transfer.
- It uses interconnection technology for supporting data storage, retrieval, and replication. NAS works on TCP/IP, whereas SAN for disk blocks transformation works on low-level network protocols.
- Storage area networks are actually designed for data management. It is a rapid storage device network and can be connected with servers.
- SAN is helpful for transferring data from one storage device to another without disturbing other devices.
- SAN also supports fast backup as CPU cycles of server are not involved in the backup process. At the time of recovery, SAN plays an important role.

Storage Area Network

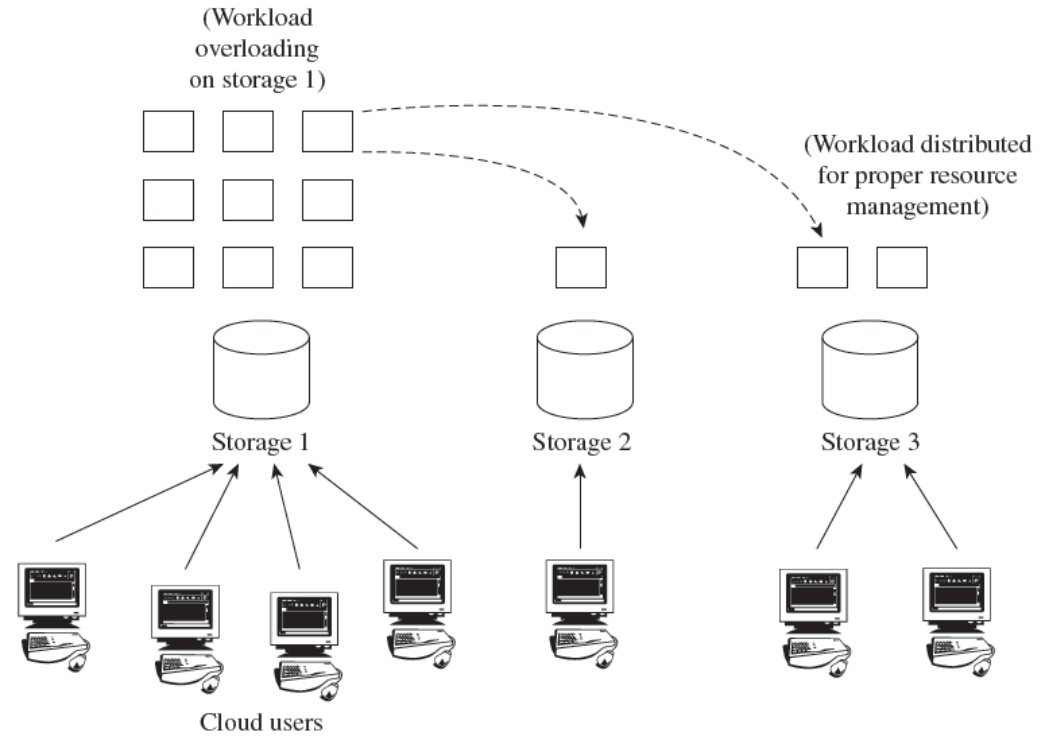


Fig. 6.10 Storage area network—SAN

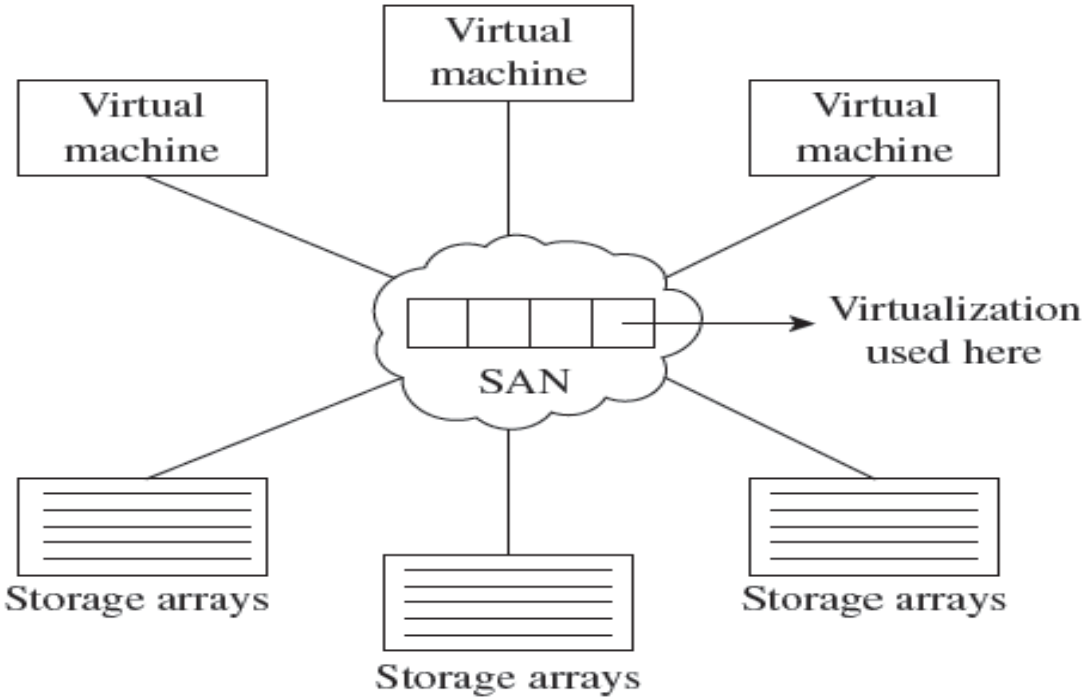


Fig. 6.11 Block-level storage virtualization

Network Attached Storage

- Network-attached storage (NAS) is actually a dedicated file storage device for providing local area network nodes with file-based shared storage using a standard ethernet connection.
- NAS has its own IP address and each NAS exists on the LAN as an independent network node.
- Some examples of NAS devices include Seagate Central, Seagate Business Storage NAS, and 8-Bay Rackmounts. All NAS products provide a secure and centralized location for the files.
- Accessing of NAS system storage data is easy—it can be accessed from anywhere, whether one is in own house, on another computer, or through mobile, Wi-fi technology, etc.

Network Attached Storage

➢NAS has the following benefits:

- Broad access to information
- Better efficiency
- Better flexibility
- Centralized storage
- Simplified management
- Scalability
- High availability
- Security

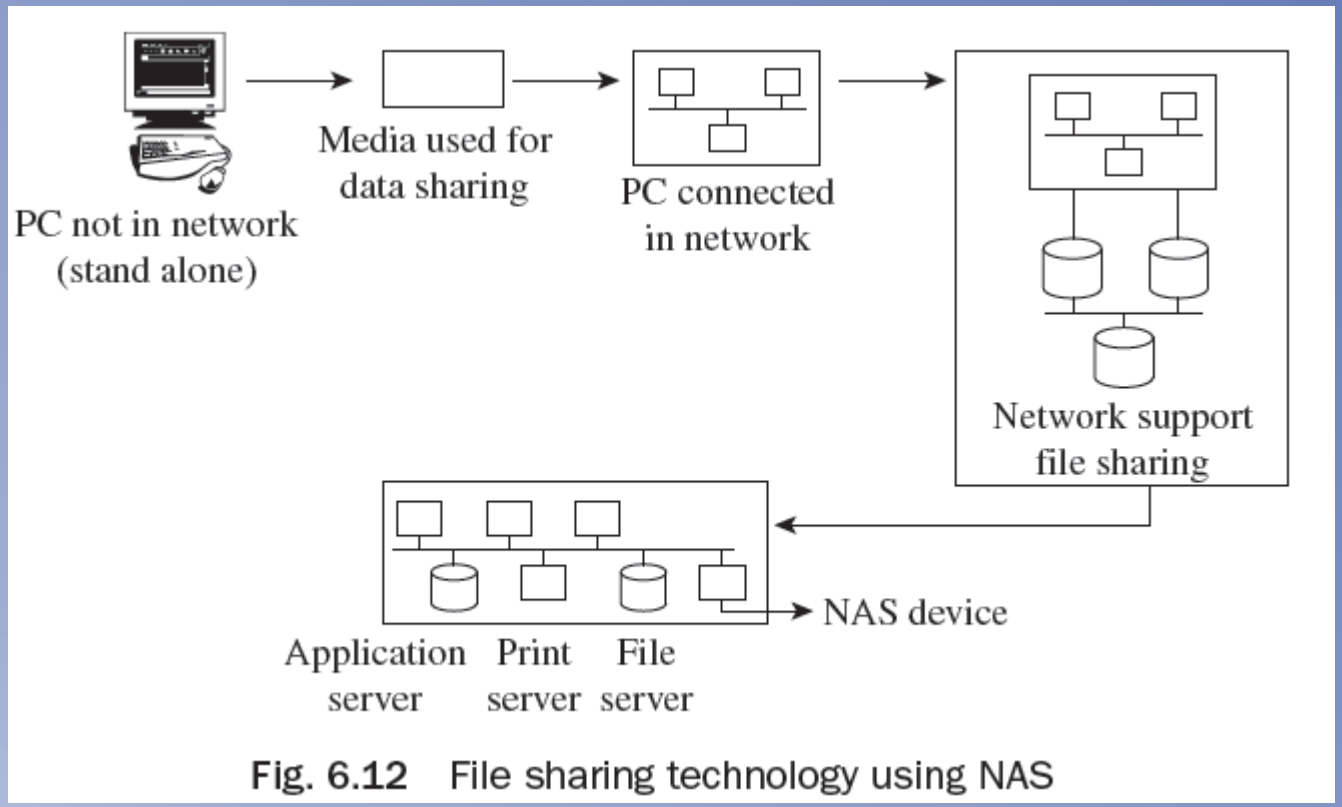


Fig. 6.12 File sharing technology using NAS

Network Attached Storage

➢NAS has the following components:

- NAS head (CPU and memory)
- Network interface cards (NICs) for providing connectivity
- Operating system for handling NAS functionality
- Network file system (NFS) and common Internet file system (CIFS) protocols for file sharing. NFS mainly supports UNIX-based operating environments, whereas CIFS is supported by Microsoft Windows-based operating environments. Supported file sharing protocols facilitate users to share files with different operating platforms.
- Storage protocols to connect and manage physical disk resources
- Storage array

Network Attached Storage

➢ **Comparison between SAN and NAS:**

- Storage area network (SAN) supports networking, whereas network-attached storage (NAS) is a storage device, in a network.
- Operating systems consider SAN as a disk, whereas a NAS device is a file server.
- SAN supports block-level storage for servers, whereas NAS devices support file-level storage. For saving files such as word documents or MS Excel spreadsheets, NAS is generally used.

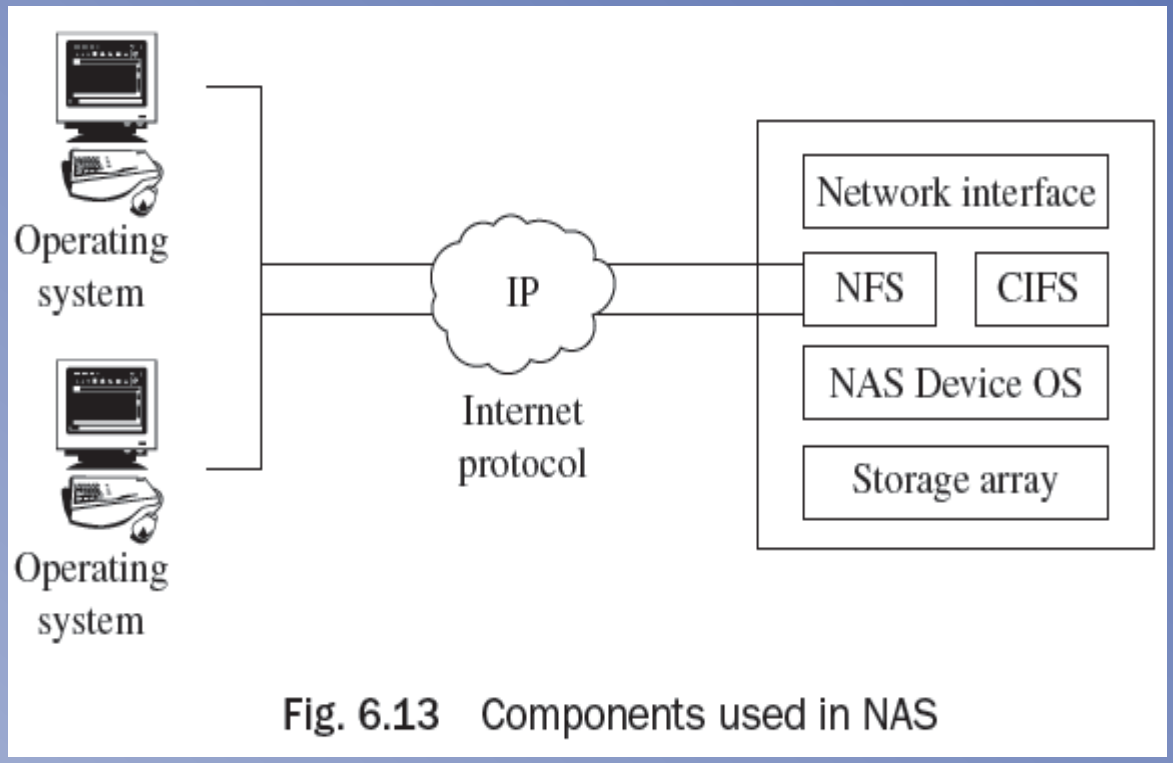
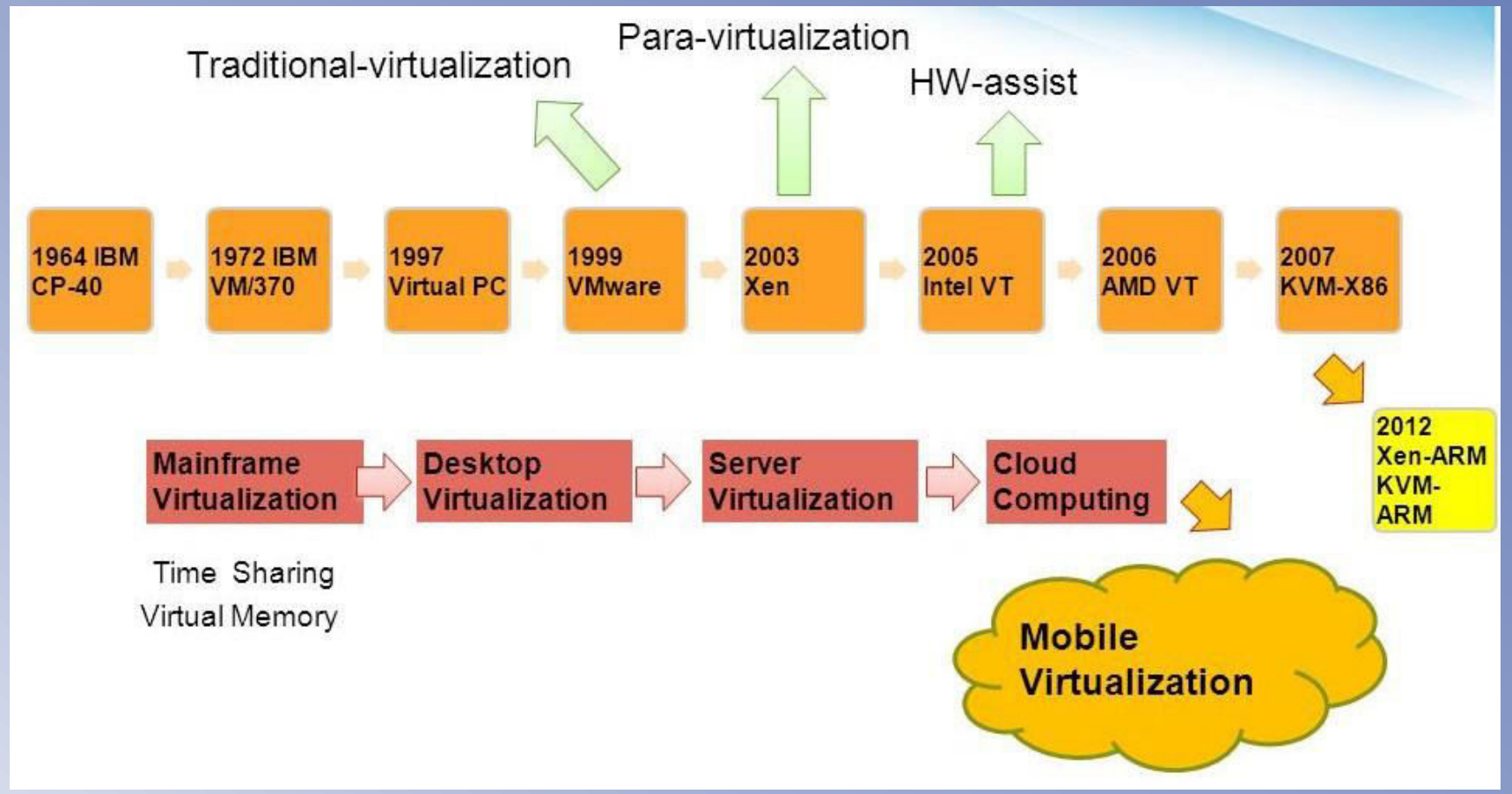
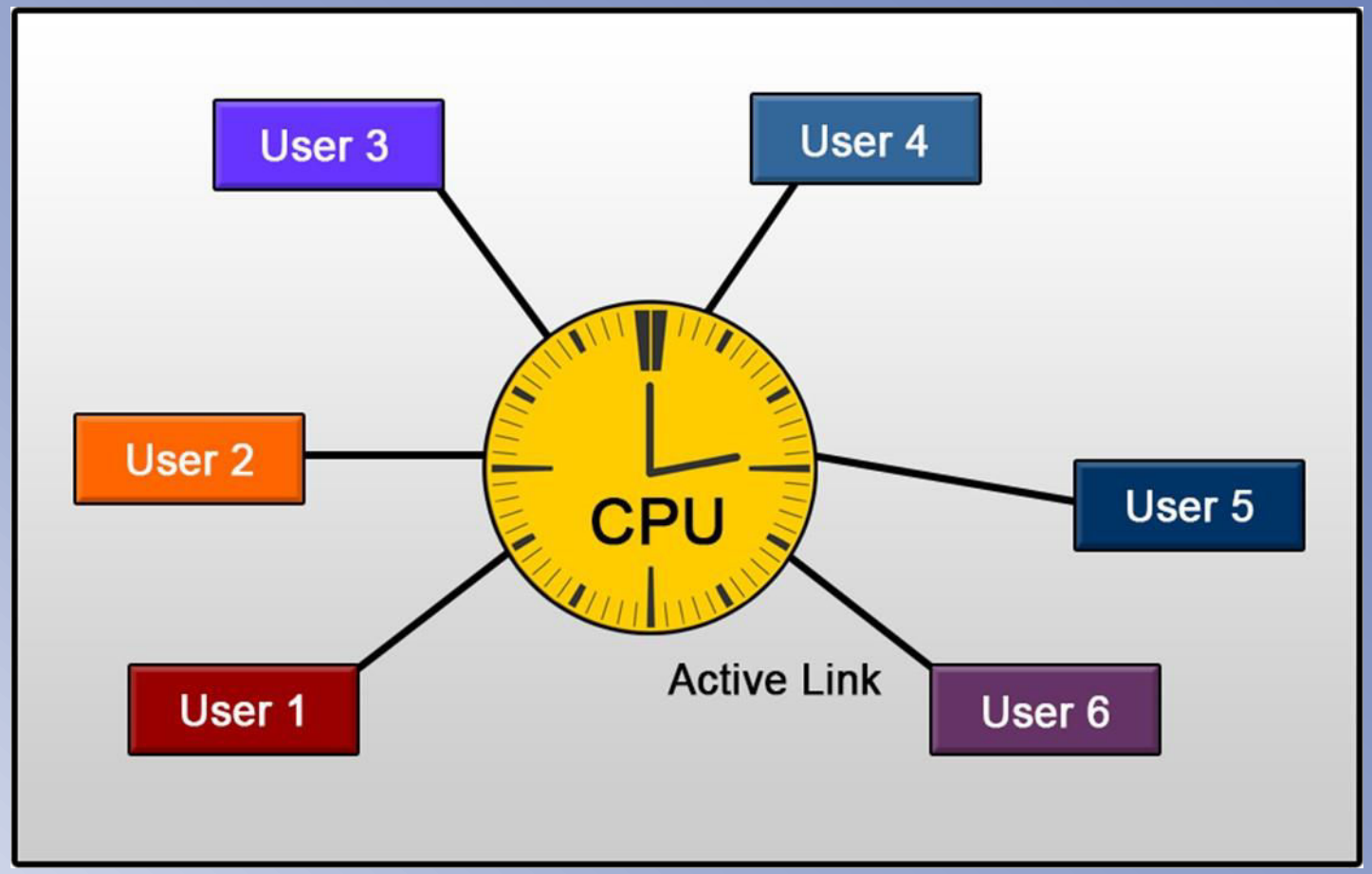


Fig. 6.13 Components used in NAS

History of Virtualization



Time-sharing systems

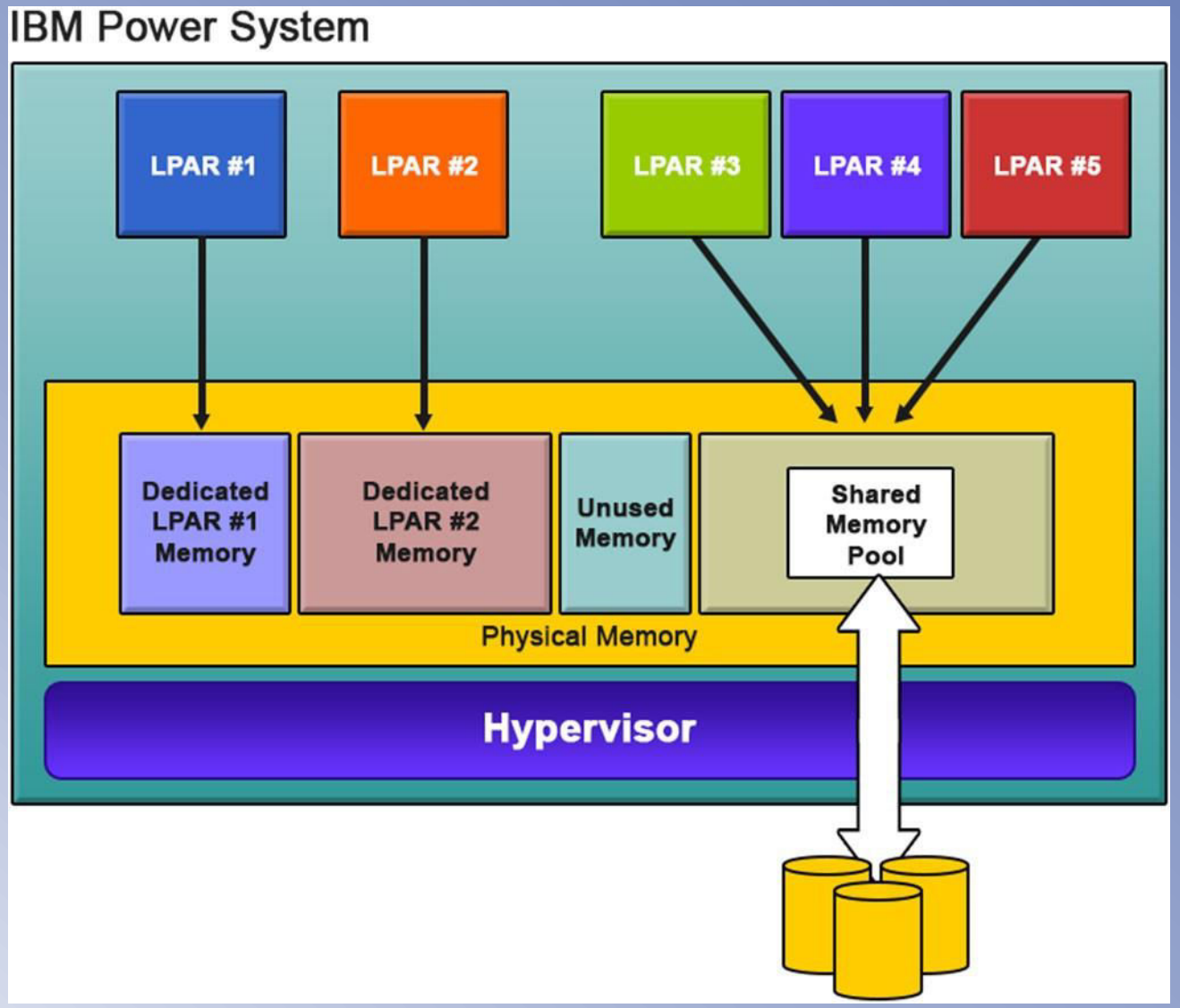


IBM Mainframe Virtualization

- The earliest pioneer of modern virtualization technology was IBM. IBM invented virtualization nearly 50 years ago.

- In the late 1960s, IBM introduced the first successful virtual machine operating system, the CP-40 which was geared for the System/360 Mainframe. A revision of CP-40 was introduced by the name of CP-67 and was later implemented as S/360-67 and finally as S/370.

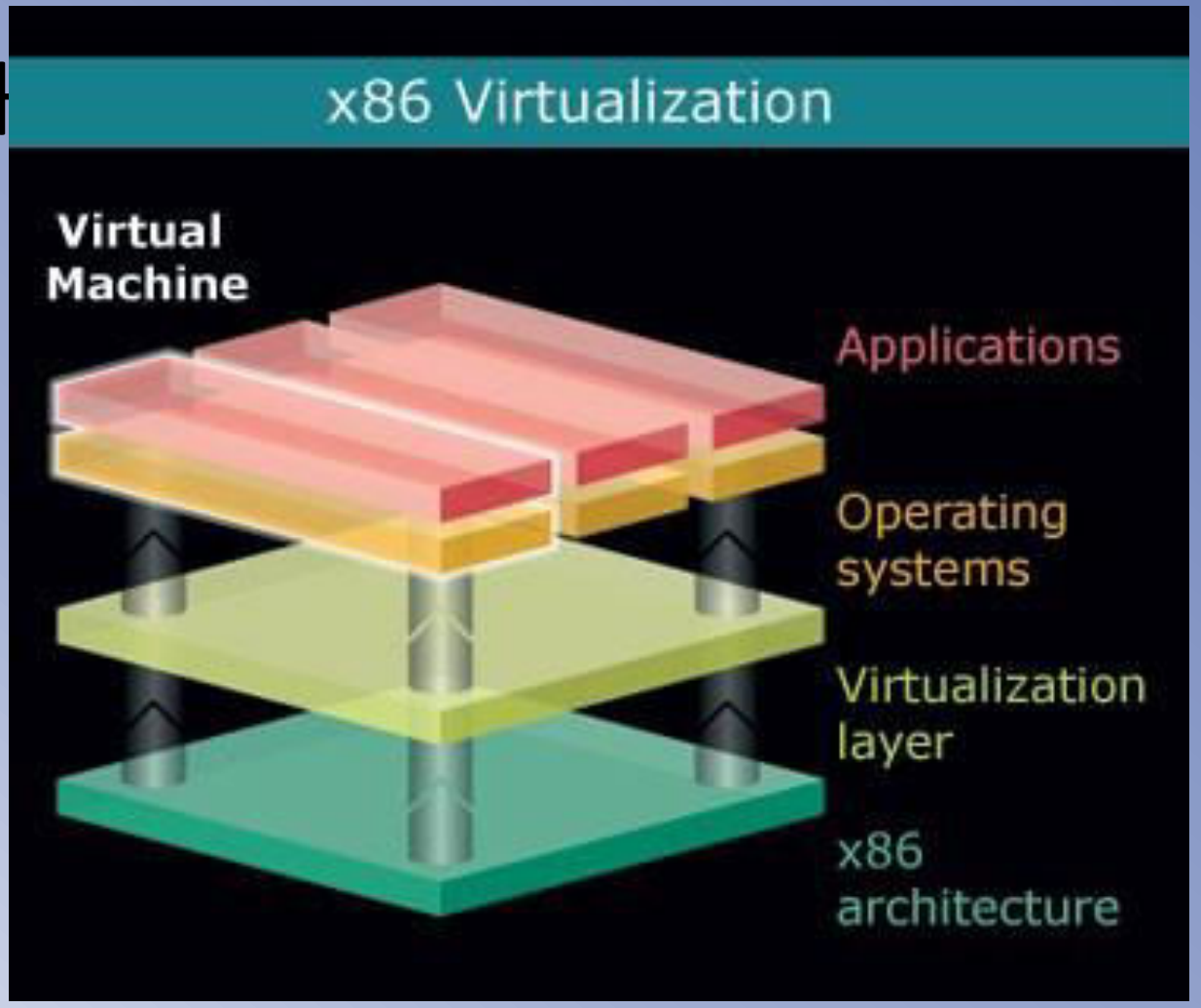
IBM PowerVM Virtualization



Extending Virtualization to x86

- The virtualization on x86 Architecture was introduced in the year 1985.
- In 1997, Connectix released the first version of “Virtual PC” for MAC platforms.
- In 1998, VMware filed an US Patent 6,397,242 for virtualization techniques for x86 architecture and subsequently, a VMware Virtual Platform was introduced for IA32 architecture.
- In 2000, FreeBSD introduced FreeBSD Jails for OS Virtualization.
- In 2001, Connectix building on it initial success on Virtual PC launches the first version for Microsoft Windows.
- Year 2003, marked the release of the first open source hypervisor for x86 machines called Xen Hypervisor. The company XenSource that developed the hypervisor was later acquired by Citrix. Citrix is currently one of the major virtualization solution provider in the x86 market.
- In 2006/2007, Virtual Iron released Virtual-Iron, an x86 bare-metal hypervisor for enterprise customers. VirtualBox was also introduced as an open source alternative under the GPL license.

H Virtualization



Source: https://www.desktop-virtualization.com

Impact of Virtualization

The impact of virtualization can be classified under two major headings:

1. Cost
2. Manageability.

Cost Impact

- Security/Segregation of critical applications
- Limited or No Monitoring
- Ineffective Asset Management
- Provisioning Turnaround

Thank You!

Lecture-6-11 Unit-2

Virtualization Technology

Welcome to:

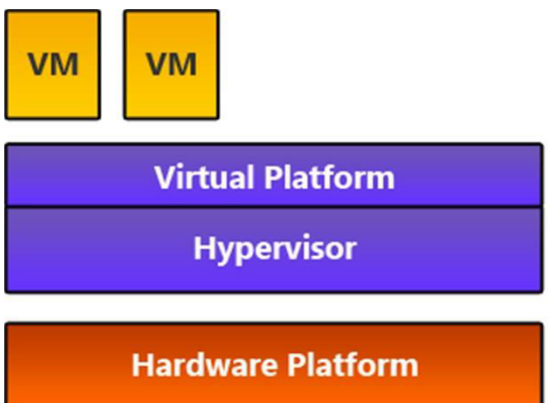
Server and Storage Virtualization

Unit objectives

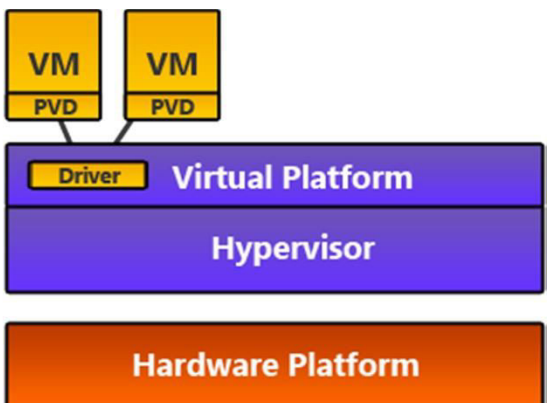
After completing this unit, you should be able to:

- Identify the types of server virtualization
- Explain hardware assisted virtualization
- Define and describe hypervisors
- Explain Desktop virtualization
- Differentiate between the types of desktop virtualization
- Understand Storage virtualization
- Identify the types of Storage virtualization

Types of Server Virtualization (1 of 3)



Full Virtualization

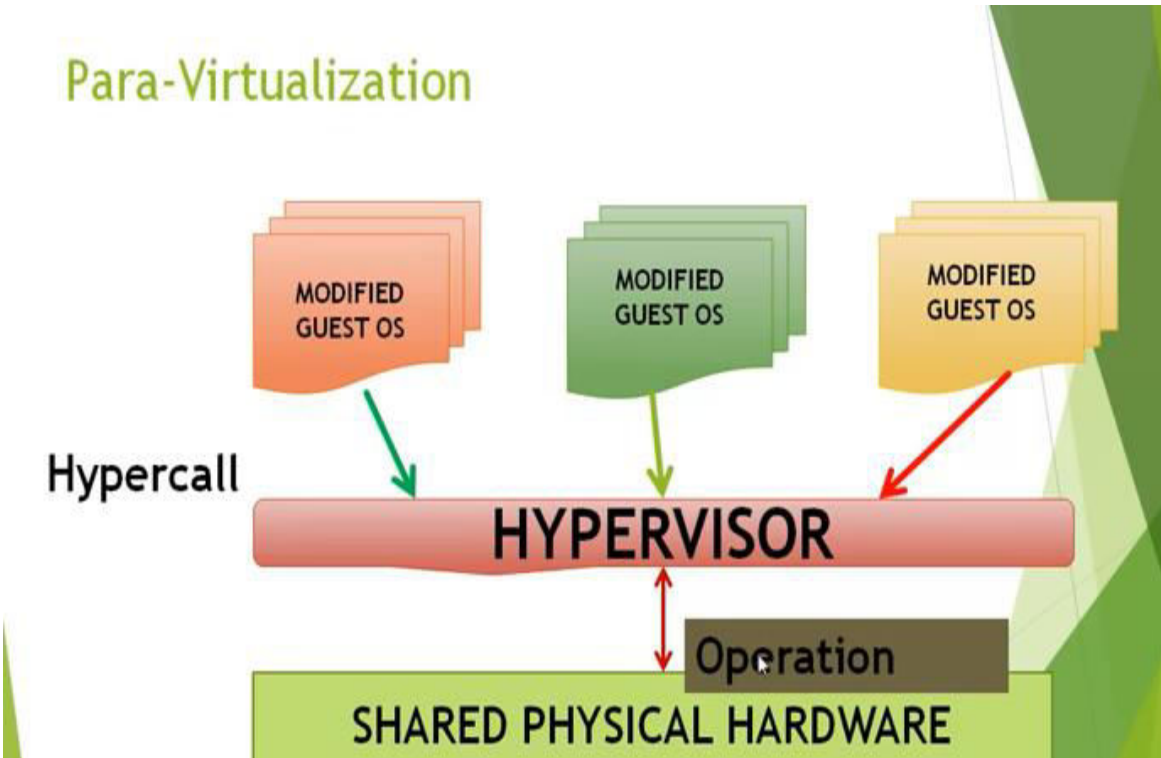


Para-Virtualization

PARAVIRTUALIZATION

- Paravirtualization is virtualization in which the guest operating system (the one being virtualized) is aware that it is a guest .
- Accordingly has drivers that, instead of issuing hardware commands, simply issue commands directly to the host operating system.
- This also includes memory and thread management as well, which usually require unavailable privileged instructions in the processor.

Para-Virtualization

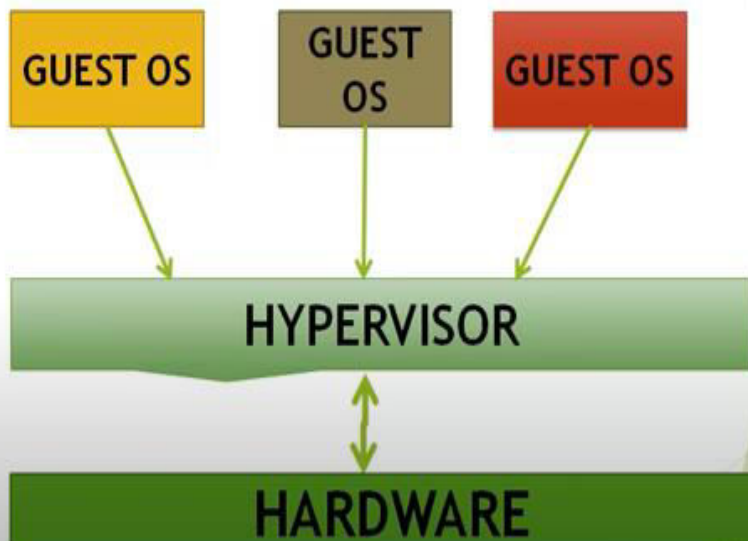


- In paravirtualization, OS hypercalls instructions are handled at compile time when the non-virtualizable OS instructions are replaced with hypercalls.
- The advantage of paravirtualization is lower virtualization overhead,.
- The performance advantage of paravirtualization over full virtualization can vary greatly depending on the workload.
- As paravirtualization cannot support unmodified operating systems (e.g. Windows 2000/XP), its compatibility and portability is poor

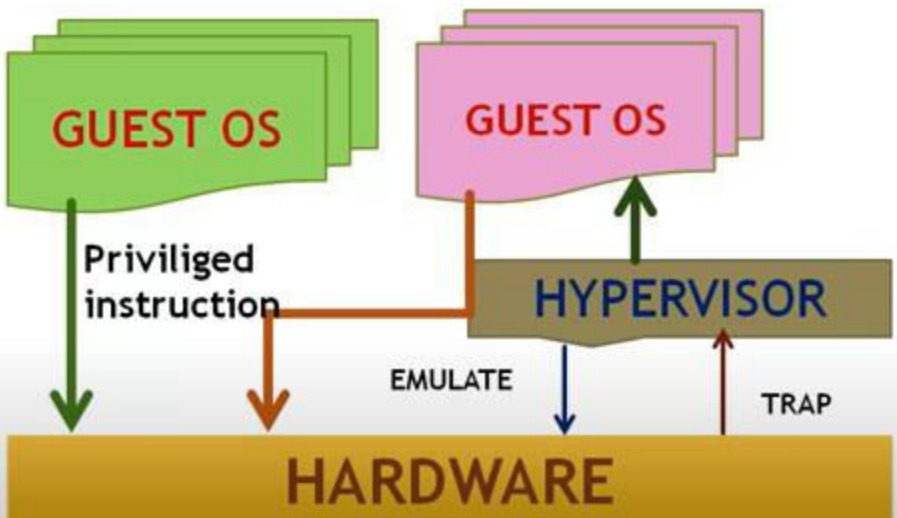
FULL VIRTUALIZATION

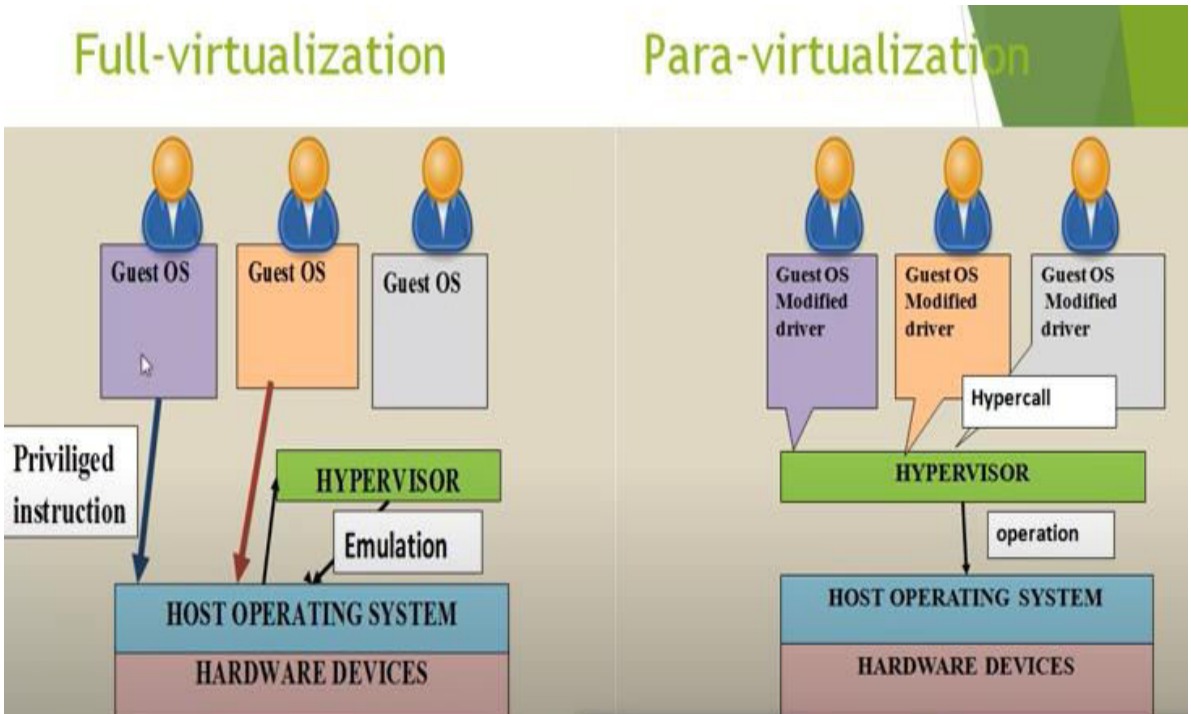
- Full Virtualization is virtualization in which the guest operating system is unaware that it is in a virtualized environment, and therefore hardware is virtualized by the host operating system.
- The guest OS can issue commands to what it thinks is actual hardware, but really are just simulated hardware devices created by the host.

FULL-VIRTUALIZATION



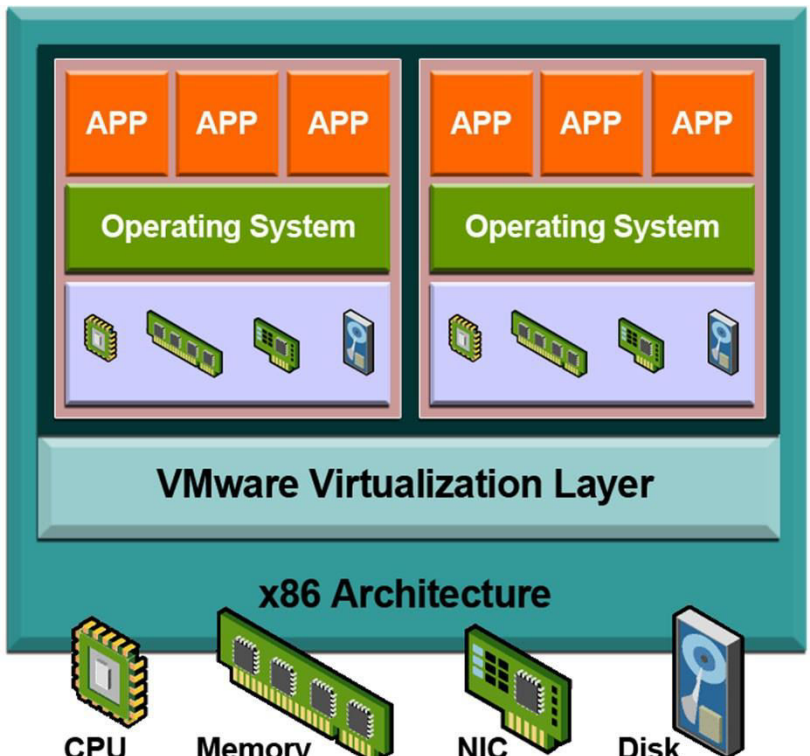
FULL-VIRTUALIZATION



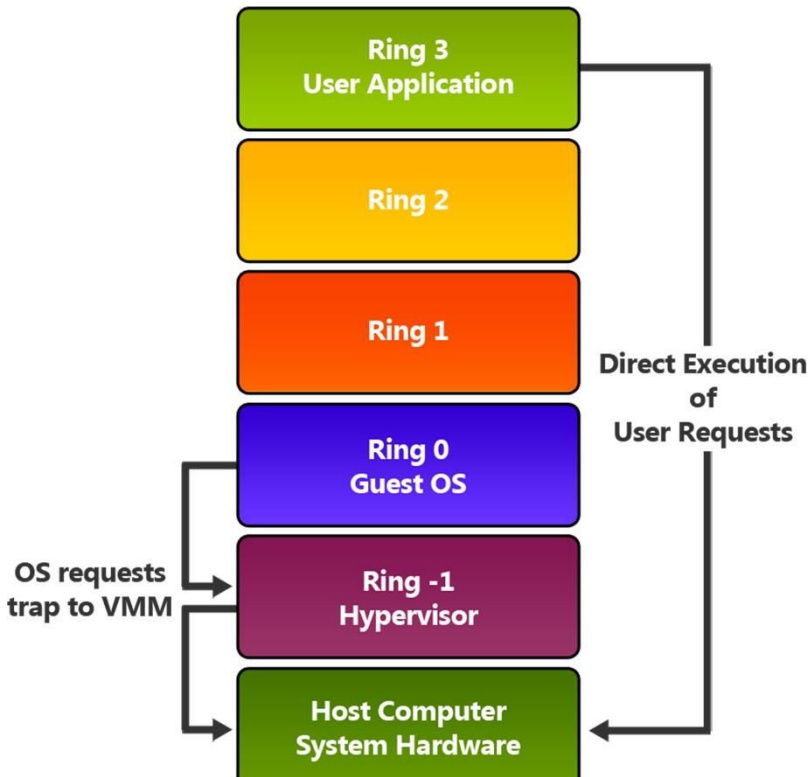

Full-virtualization
Guest OS
Guest OS
Guest OS
Priviliged instruction
HYPERVISOR
Emulation
HOST OPERATING SYSTEM
HARDWARE DEVICES
Para-virtualization
Guest OS Modified driver
Guest OS Modified driver
Guest OS Modified driver
Hypercall
HYPERVISOR
operation
HOST OPERATING SYSTEM
HARDWARE DEVICES

Simulation

.


APP
APP
APP
Operating System
APP
APP
APP
Operating System
VMware Virtualization Layer
x86 Architecture
CPU
Memory
NIC
Disk

Hardware Assisted Virtualization (1 of 2)

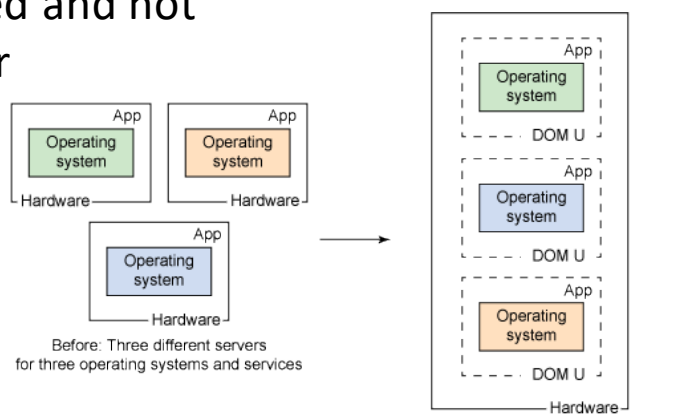


Hypervisor

A **hypervisor** or **virtual machine monitor** (**VMM**) is computer software, firmware or hardware that creates and runs virtual machines. A computer on which a hypervisor runs one or more virtual machines is called a *host machine*, and each virtual machine is called a *guest machine*.

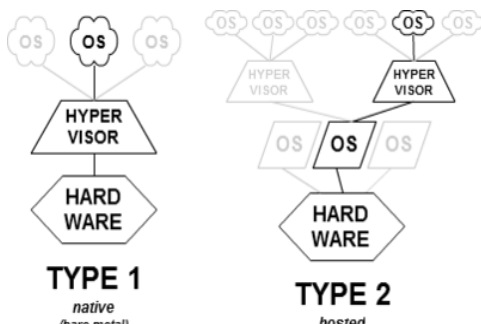
It is the part of the private cloud that manages the virtual machines, i.e. it is the part (program) that enables multiple operating systems to share the same hardware. Each operating system could use all the hardware (processor, memory) if no other operating system is on. That is the maximum hardware available to one operating system in the cloud.

the hypervisor is what controls and allocates what portion of hardware resources each operating system should get, in order every one o them to get what they need and not to disrupt each other

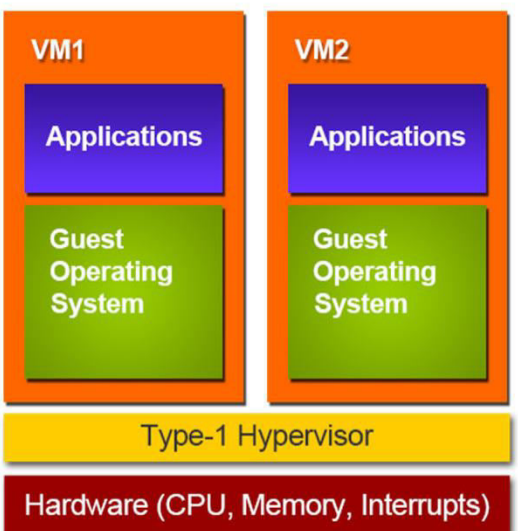


Type-1, native or bare-metal hypervisors: These hypervisors run directly on the host's hardware to control the hardware and to manage guest operating systems

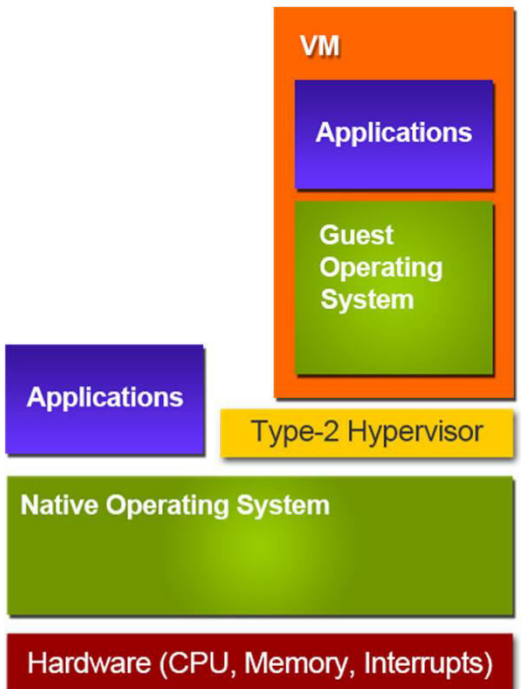
Type-2 or hosted hypervisors: These hypervisors run on a conventional operating system (OS) just as other computer programs do. A guest operating system runs as a process on the host.



Types of Hypervisors

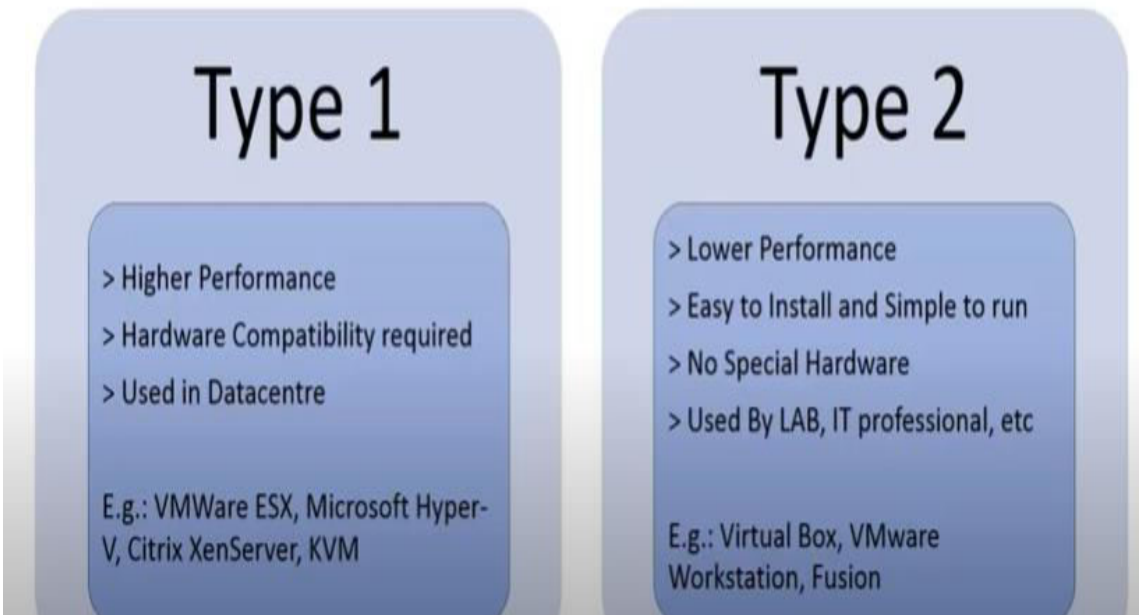


Type 1 Hypervisors

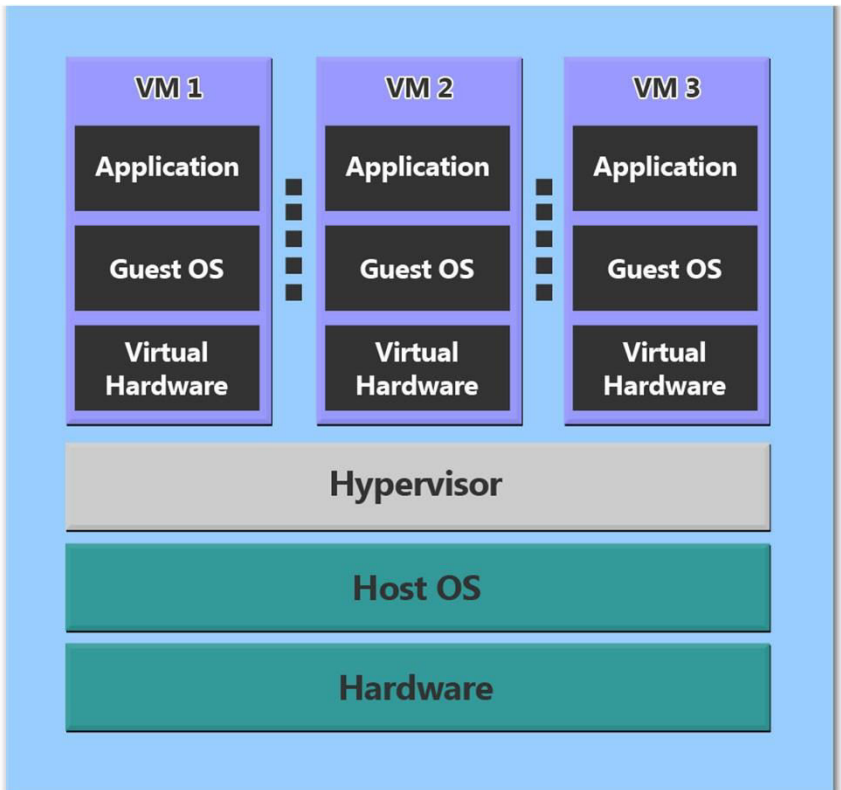


Type 2 Hypervisors

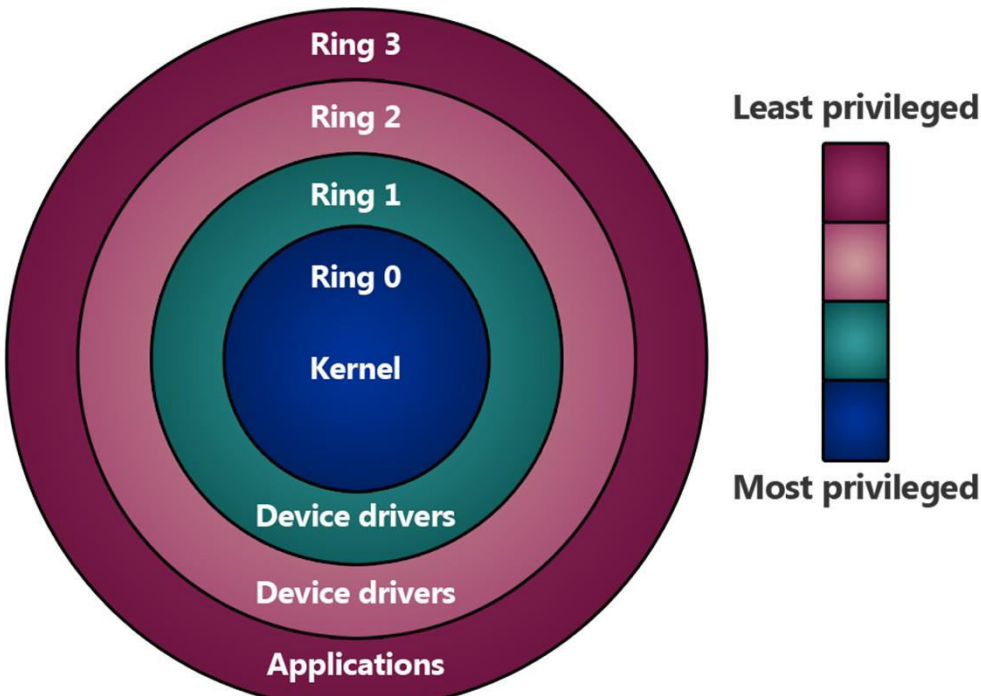
Comparison


Type 1
> Higher Performance
> Hardware Compatibility required
> Used in Datacentre
E.g.: VMWare ESX, Microsoft Hyper-V, Citrix XenServer, KVM
Type 2
> Lower Performance
> Easy to Install and Simple to run
> No Special Hardware
> Used By LAB, IT professional, etc
E.g.: Virtual Box, VMware Workstation, Fusion

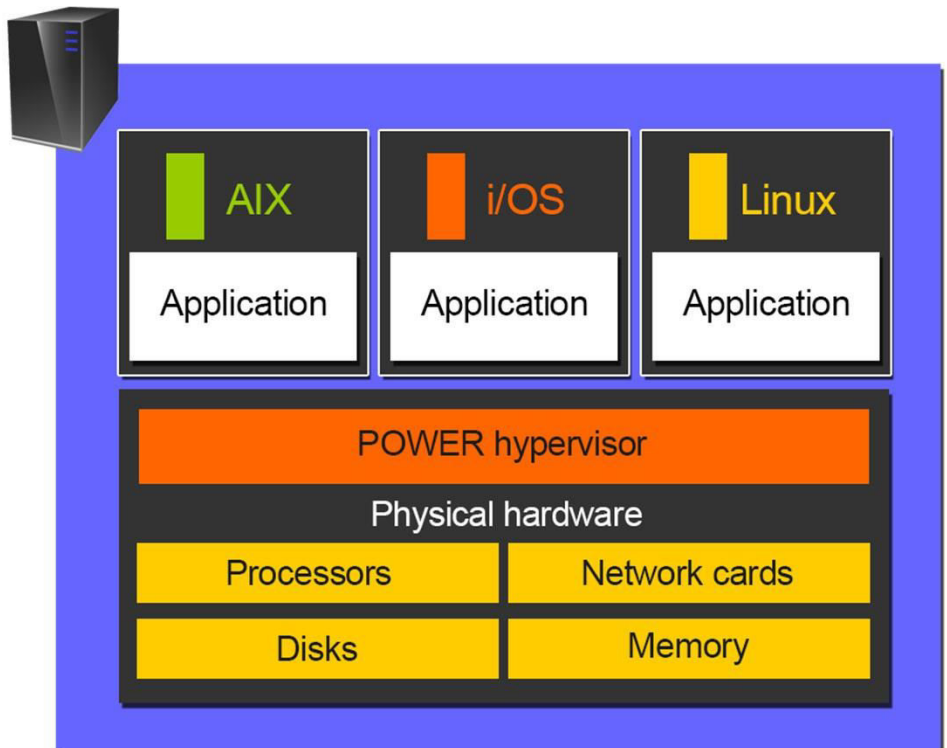
Hypervisors



Ring levels on x86 processors



IBM PowerVM Hypervisors



Common considerations in server virtualization

- **SPOF in Server Virtualization**: When companies replace multiple physical servers with virtual machines (VMs) that run on a single physical server, the hypervisor and the physical server on which it runs become a single point of failure (SPOF). Worse yet, the SPOF is not limited to only one server; it extends to all of the VMs hosted on that server

- **Patch Management**: Patch management is the process of distributing and applying updates to software. These patches are often necessary to correct errors (also referred to as "vulnerabilities" or "bugs") in the software.

- Migration of existing IT infrastructure

- Licensing

- Legacy/Proprietary Applications

Single Point of Failure (SPOF)

A single point of failure (SPOF) is a critical system component with the ability to cease system operations during failover. SPOFs are undesirable to systems requiring reliability and availability, such as software applications, networks or supply chains.

In computing, SPOFs are identified and resolved through redundant and high-availability clusters.

For example, upon machine failure, another machine immediately assumes lost functions and responsibilities. Similar redundancy designs are often employed at internal component levels.

At system levels, multiple machines or systems provide required redundancy. Replication is used at the site level, where another site or location is prepared to take over in the event of sudden site access failure.

Highly reliable systems are designed without SPOFs. This means that failure of a component, system or site does not halt system or operational functions.

Patch Management

Common areas that will need patches include operating systems, applications, and embedded systems (like network equipment). When a vulnerability is found after the release of a piece of software, a patch can be used to fix it. Doing so helps ensure that assets in your environment are not susceptible to exploitation.

Why do we need patch management?

Security: Patch management fixes vulnerabilities on your software and applications that are susceptible to cyber-attacks, helping your organization reduce its security risk.

System uptime: Patch management ensures your software and applications are kept up-to-date and run smoothly, supporting system uptime.

Patch Management

Compliance: With the continued rise in cyber-attacks, organizations are often required by regulatory bodies to maintain a certain level of compliance. Patch management is a necessary piece of adhering to compliance standards.

Feature improvements: Patch management can go beyond software bug fixes to also include feature/functionality updates. Patches can be critical to ensuring that you have the latest and greatest that a product has to offer.

Physical Machine to Virtual Machine (P2v) Conversion

- A VM maintains a relationship between various virtual machines, and between a hypervisor and a VM in a grouped server environment.
- Physical to VM exchange is a procedure via which a physical machine is transformed into a virtual machine. When transforming a physical machine, the 'converter application' (Converter) copies data on the hard disk of the source machine and shifts that data to the target virtual disk.
- Advantages of P2V converters are:

1. Runs migration among heterogeneous hardware
2. Minimizes time required to set up a new virtual machine
3. Permits migration of machines to a new hardware without re-launching the application or operating system

Physical Machine to Virtual Machine (P2v) Conversion

- The P2V 'converter application' comprises three constituents—converter server, converter agent, and converter boot CD.
- There are two means to shift from physical machine to virtual machine (VM). These are cold migration and hot migration.

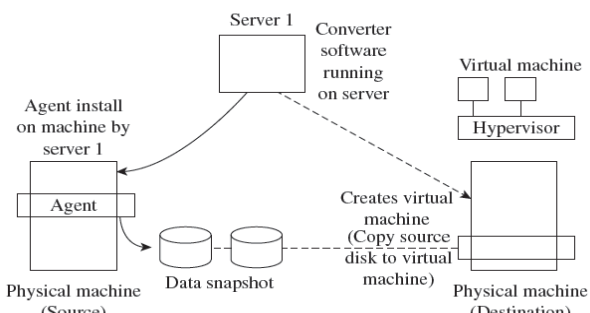
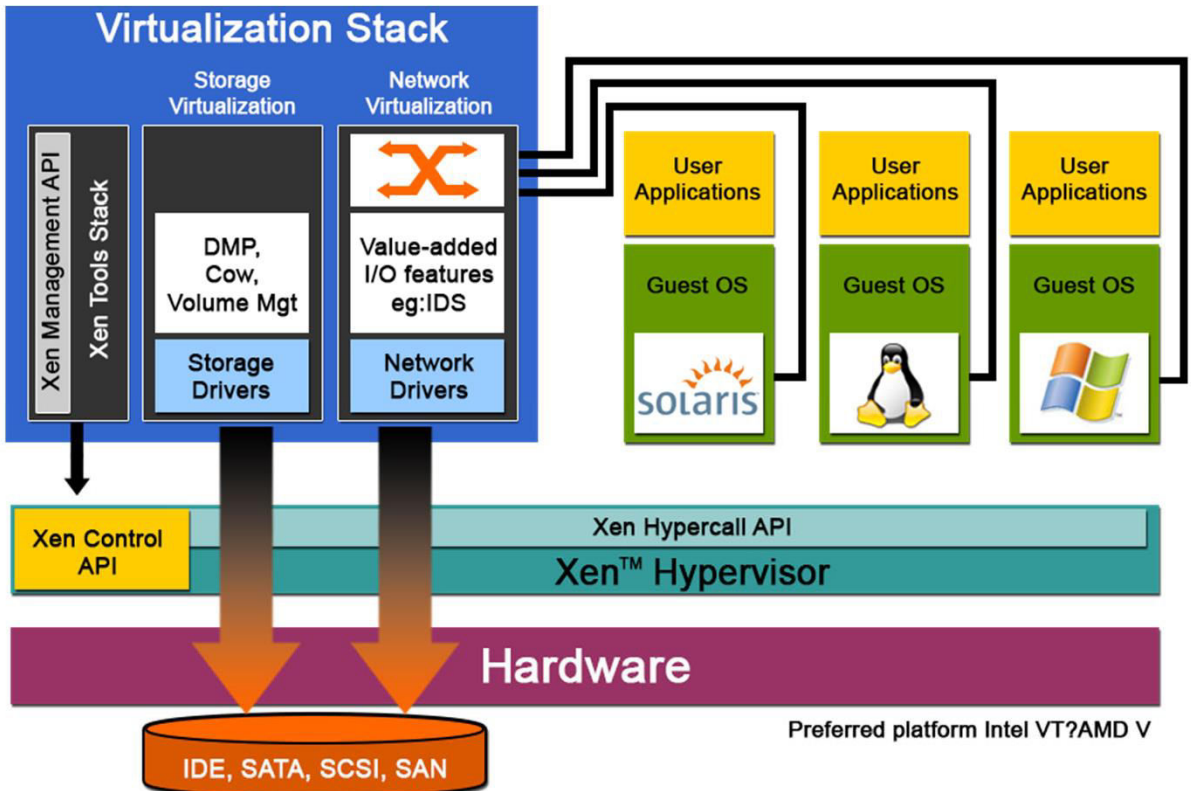


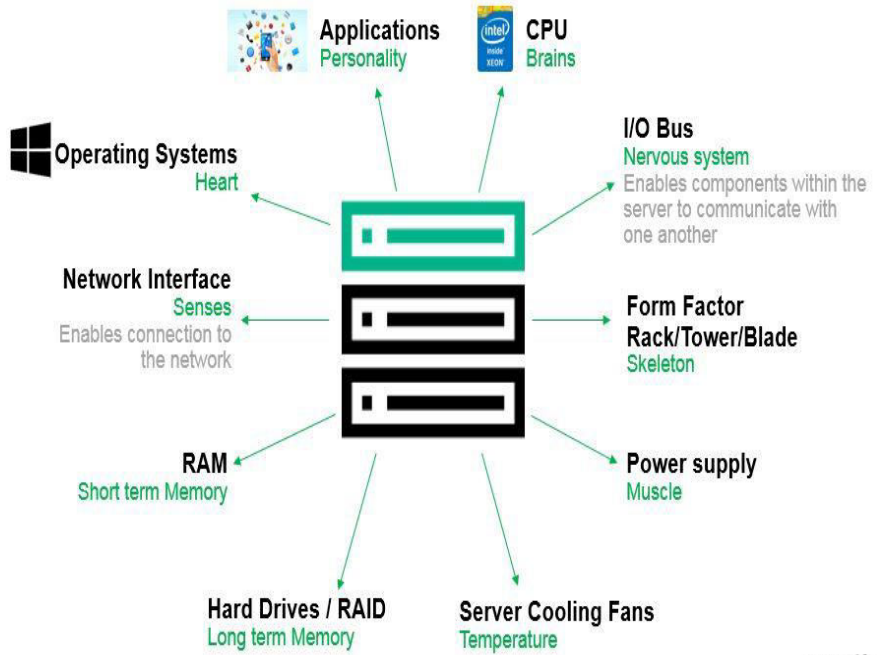
Fig. 6.8 Physical machines to virtual machine (P2V) conversion

Anatomy of server virtualization



Server Anatomy

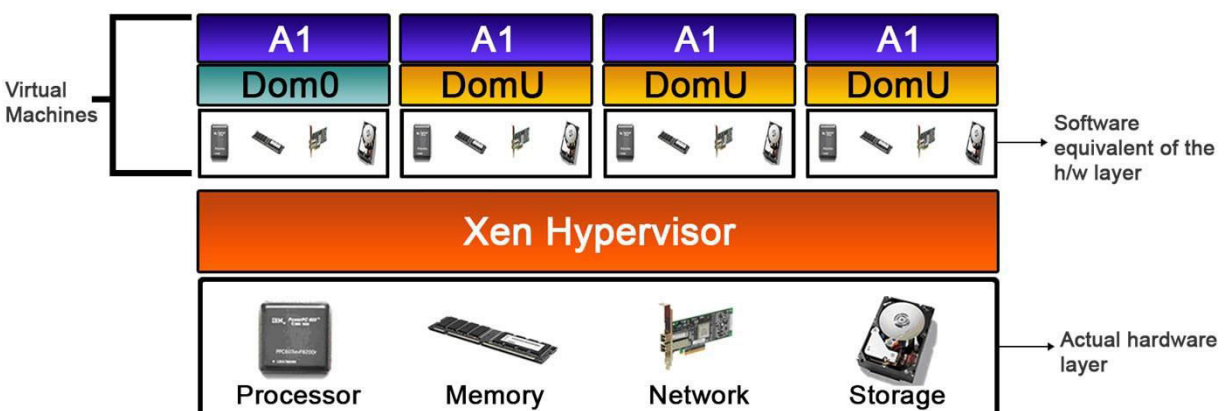
Core components of the server



#CoffeeCoaching

Three major layers in Xen Server

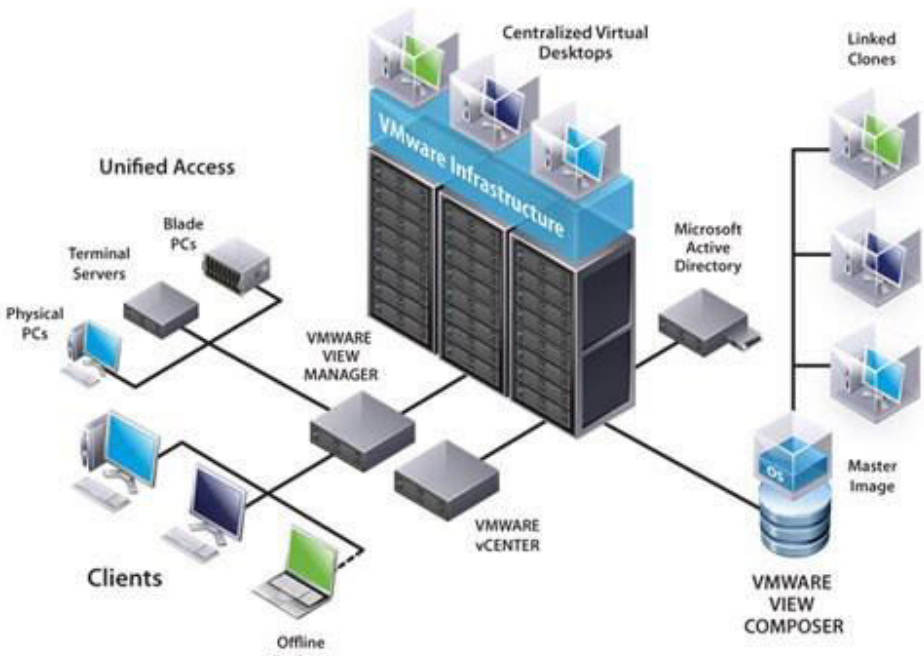
1. Hardware Layer
2. Hypervisor
3. Domains Layer



Desktop Virtualization

- Desktop virtualization refers to the technique of creating an abstraction of desktop clients or end-user computing equipment.
- This is not very different from virtualizing a physical server.
- The process involves creating a logical abstraction or a virtual image of the desktop and placing it on a centralized physical server.

How desktop virtualization works?



Source: http://www.ipexpert.gr

Benefits of Desktop Virtualization

Cloud Computing Case Study: Desktop Virtualization with Cloud Computing

Goal

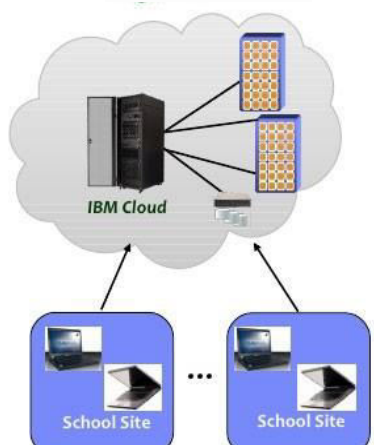
- Transform from traditional student computing model to a more efficient deployment of learning services
- Avoid costly upgrades to PC's at school sites

Challenges

- Increasing costs of managing and maintaining aging PC's at schools sites
- Need for enhanced services by teaching staff and students without available budget to deliver

Benefits

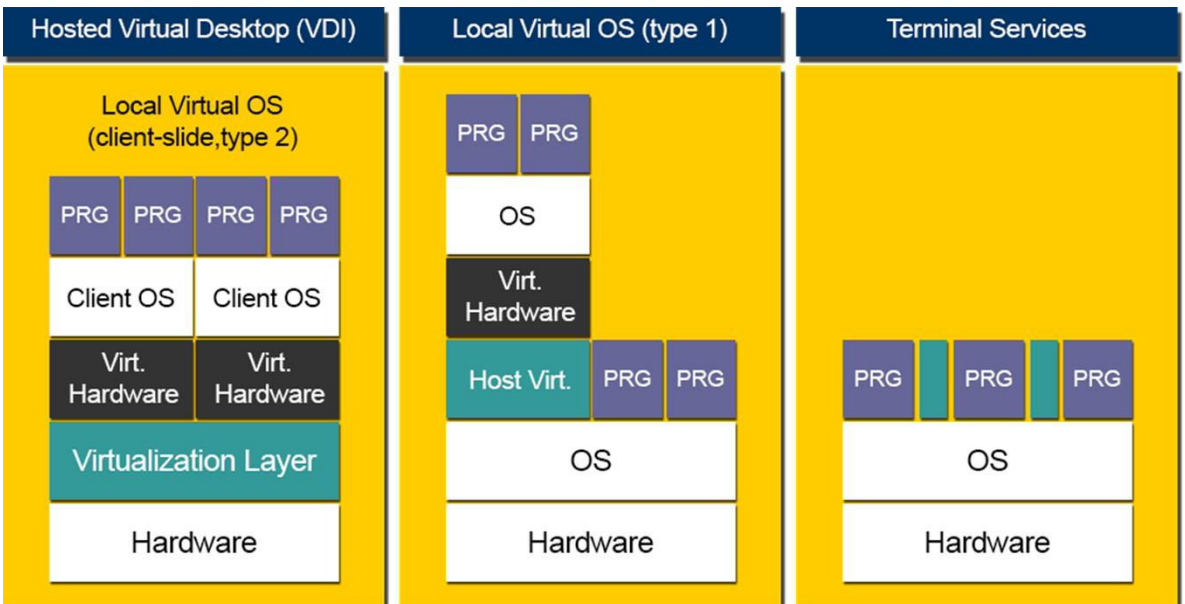
- Lower costs – 62% savings documented by Forrester study
- Enhanced services – greater services provided by virtual desktops than older software on standalone PC's



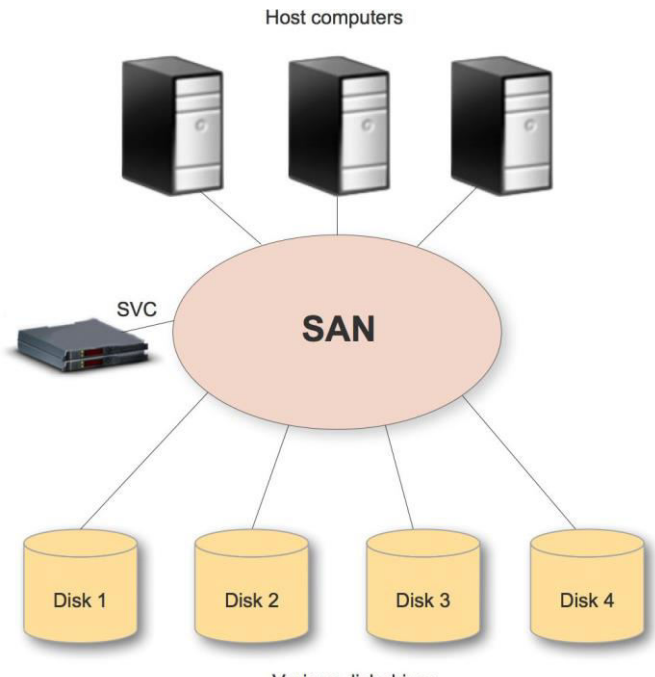
Constraints in Desktop Virtualization

- Network bandwidth
- Security of the network
- Graphic Intensive Applications
- Application requires direct access to peripherals debuggers /programmers used in the hardware design sector that in turn require direct access to host connected serial, USB ports are not well tested on VDI.

Types of Desktop Virtualization



Storage Virtualization Overview



Benefits of storage virtualization

Major shortcomings of the conventional storage systems

- Interoperability
- Manageability
- Scalability

Features in the logical layer

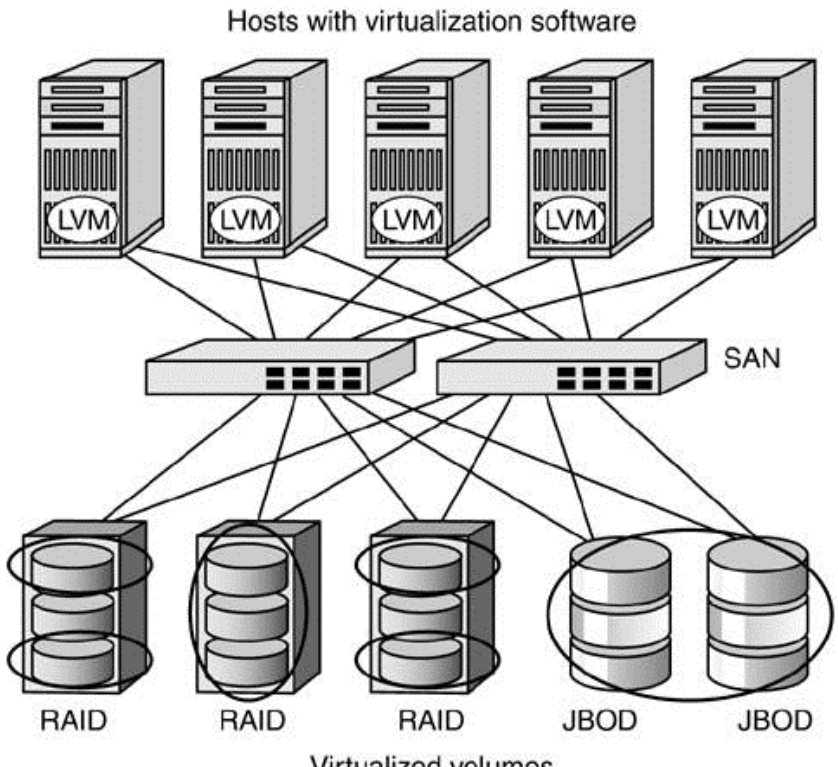
- Features built into the logical layer may vary from vendor to vendor, but almost all of them ensure the following:
- Interoperability
- Manageability
- Scalability

Types of Storage Virtualization

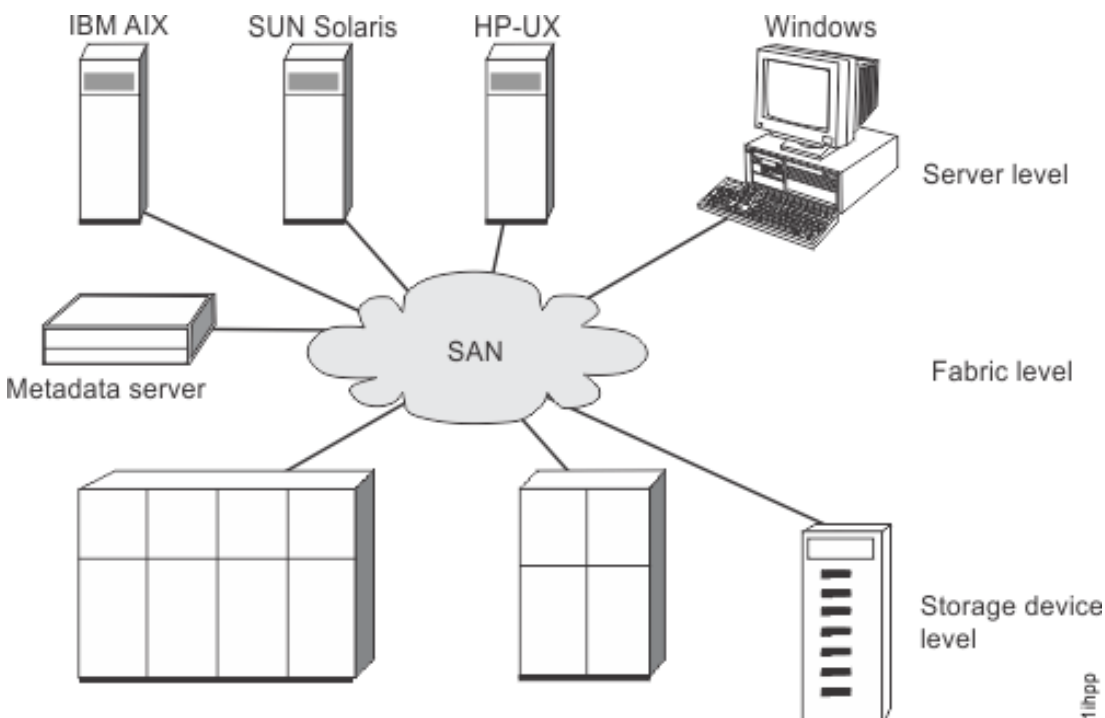
Commonly used protocols for storage in the industry are classified broadly in three categories:

- Host based storage virtualization
- Storage based virtualization
- Network based
- Hybrid model

Host based mirroring



Storage level virtualization



Storage Area Network

- Storage area network (SAN) refers to the LAN design for managing huge amounts of data transfer.
- It uses interconnection technology for supporting data storage, retrieval, and replication. NAS works on TCP/IP, whereas SAN for disk blocks transformation works on low-level network protocols.
- Storage area networks are actually designed for data management. It is a rapid storage device network and can be connected with servers.
- SAN is helpful for transferring data from one storage device to another without disturbing other devices.
- SAN also supports fast backup as CPU cycles of server are not involved in the backup process. At the time of recovery, SAN plays an important role.

Storage Area Network

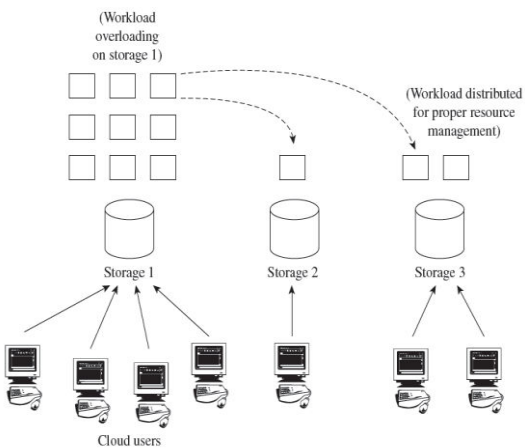


Fig. 6.10 Storage area network—SAN

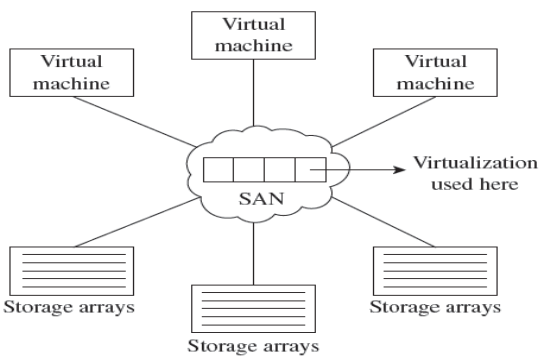
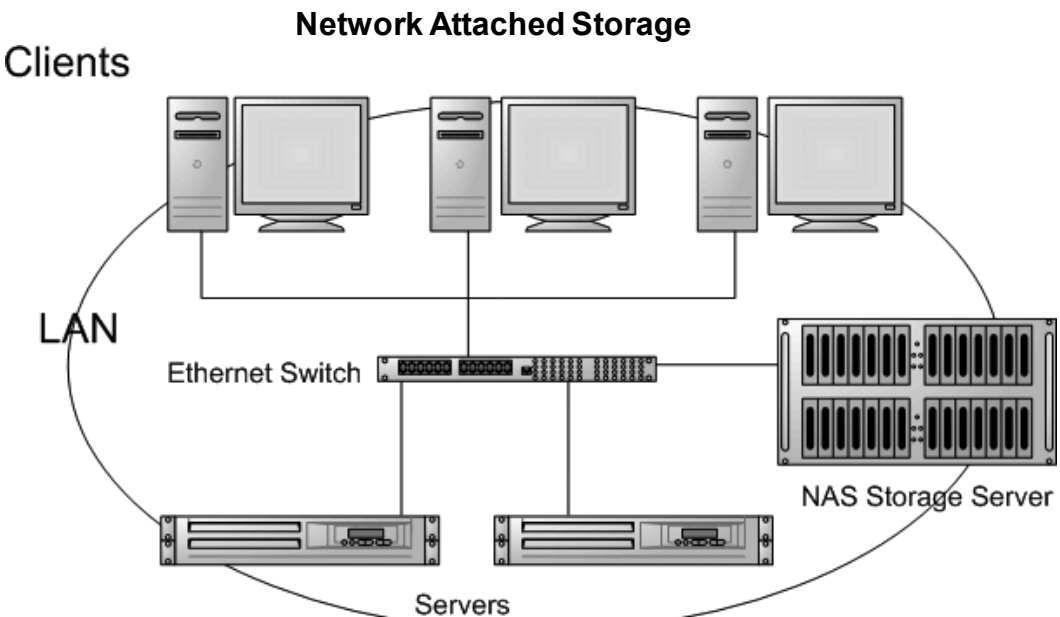
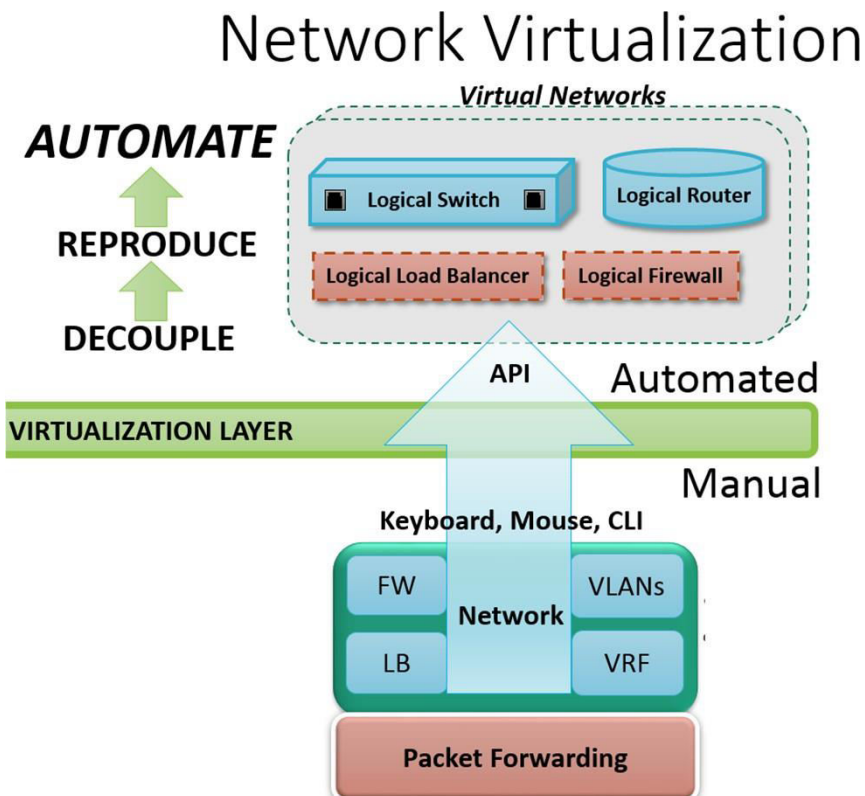


Fig. 6.11 Block-level storage virtualization

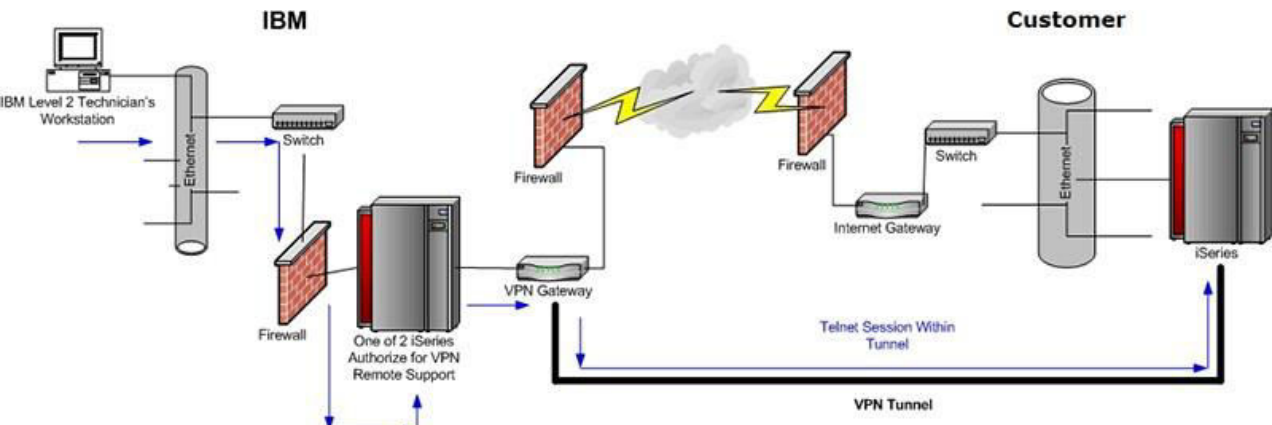
Network based storage virtualization



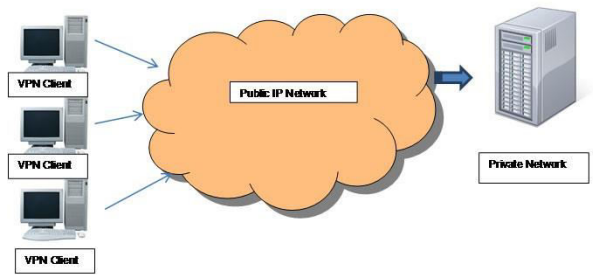
Network virtualization overview



Virtual Private Network (VPN)

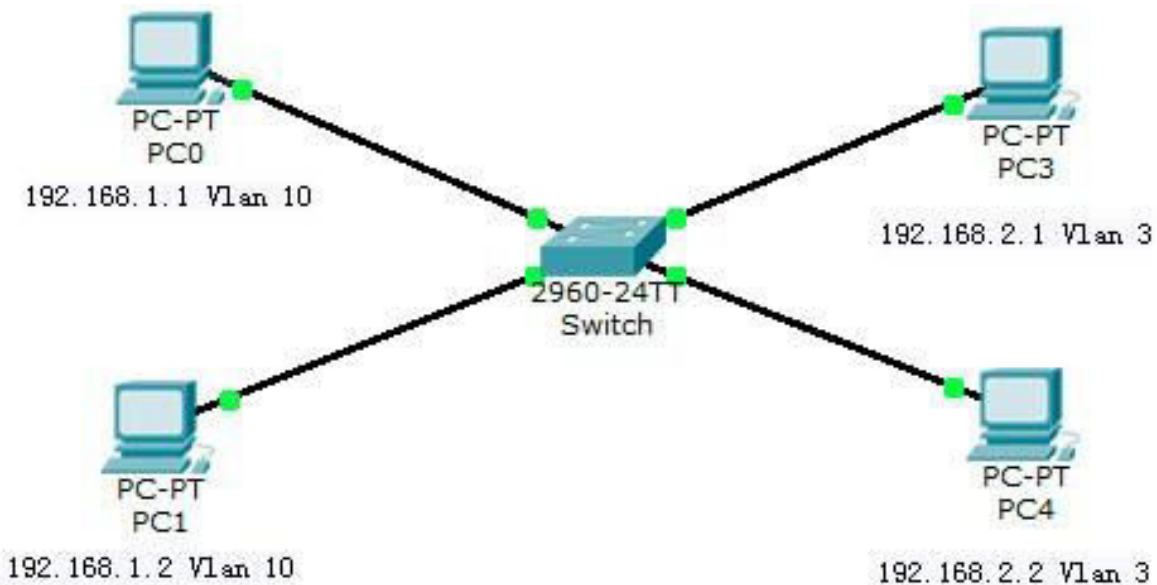


How VPN works



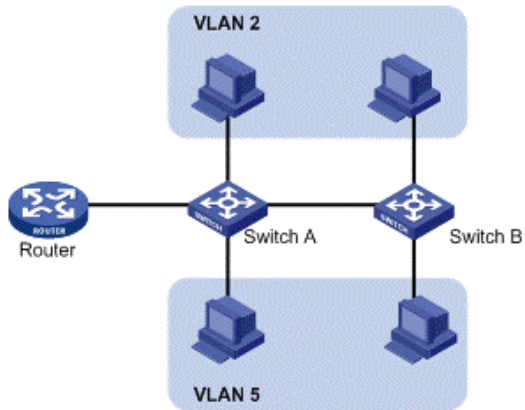
- VPN connect remote users with their central company servers over the public network while maintaining security and confidentiality of data that is being transmitted. This gives the effect of being connected directly to the company LAN.
- All operations that can be performed on the company LAN can be performed on the VPN as well.
- VPN does not require any dedicated leased lines to maintain confidentiality. VPN creates a logical network over and above the physical public network that is already in place.
- This is achieved through a range of technologies that are available from Layer-1 to the application layer of the network protocol stack.

Virtual LAN (VLAN)

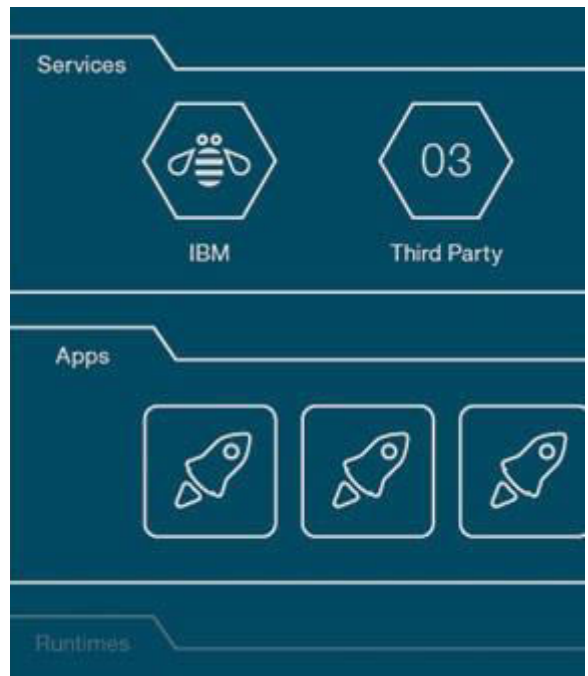


Advantages of VLAN

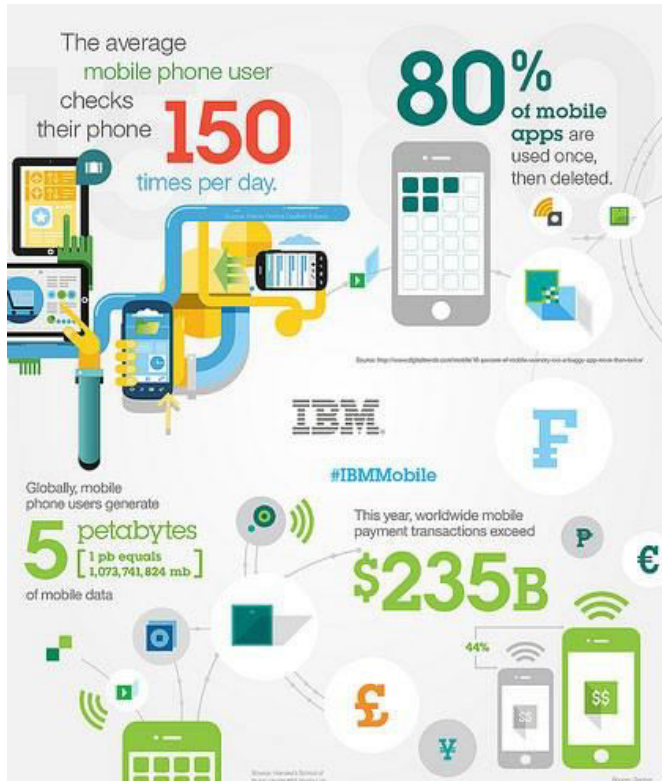
- Manageability
- Data Sharing
- Tracking Usage
- Reduction of broadcast traffic on switch
- VLANs are also used to share a high network bandwidth channel among several different VLANs
- Server Virtualization and VLAN



Challenges in using applications in traditional install, use and update model



Solution for challenges



Architecture

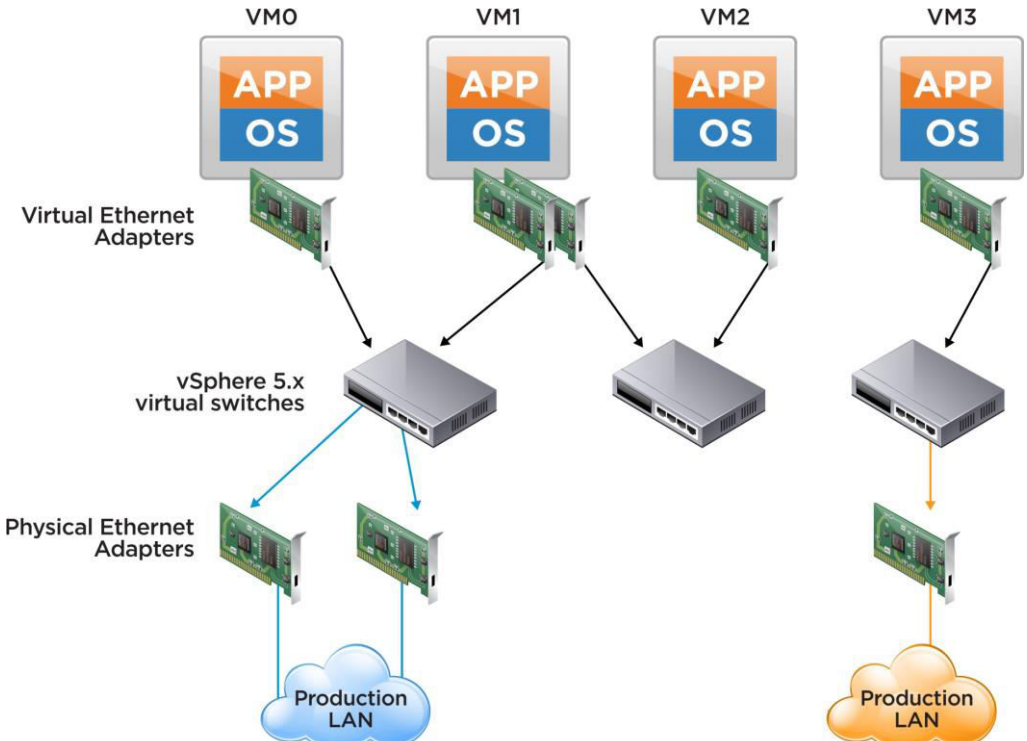
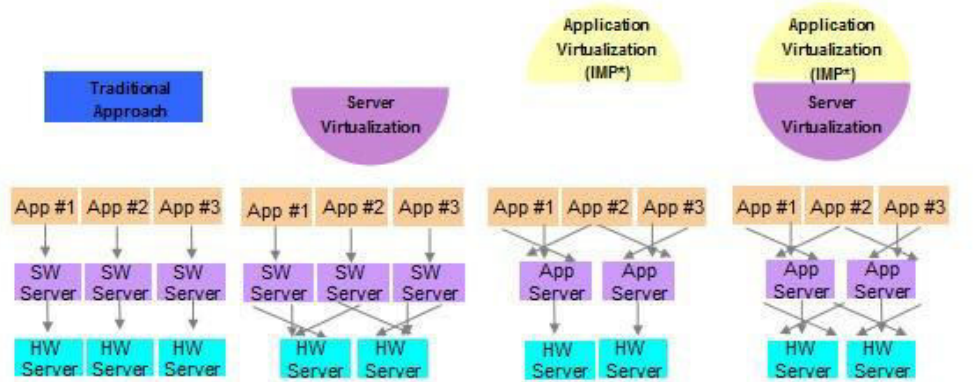


Image source: labs.vmware

Benefits of application virtualization

An effective combination of virtualization



Reduced hardware	✓	✓	✓ ✓
Improved H/W mgt	✓		✓
Dynamic adjustment	✓	✓	✓ ✓
HW high-availability	✓		✓
App. high-availability		✓	✓
Service level mgmt		✓	✓
Improved app mgmt		✓	✓
Lower operational costs		✓	✓

*IMP = Intelligent Management Pack

Checkpoint (1)

1.These are common shortcomings of physical infrastructures : Asset Management, Tracking Utilization, Security and Compliance, Provisioning, Staff for Administration, Sizing, Optimization.

a. True
b. False
c. Partial True and Partial False.

2. The_____code (software) is logically equivalent to a hardware processor.

3. A_____storage that can be converted into an iso9660 software image.

4. Native Virtualization, Para-Virtualization, OS Virtualization, Application Virtualization are classification of Virtualization

a. based on the extent of hardware emulation
b. based on the technology or the area that is being virtualized – Server, Storage, Network
c. a and b
d. none of above.

Checkpoint (2)

5. The earliest pioneer company of modern virtualization technology was _____ and it invented virtualization more than 40 years ago.

6. Intel introduced Intel VT-x and AMD introduced AMD-V to support _____ in hardware.

7._ eliminates most of the inflexibilities inherent in the hardware systems and allows for better manageability leading to a better utilization of the system.

8. The_____ is responsible for allocating memory, CPU resources, network and storage to each virtual machine.

Checkpoint (3)

1._,_____, and_____are the three major layers in a Xen Server.

2._ creates an abstraction over the disks in the form of logical volumes and volume group.

3._ provides a file system level abstraction of the storage, i.e. the remote storage file system can be locally mounted by a host as any other file system.

a. NAS

b. SAN

c. Both NAS and SAN

4._ refers to the components built into the host server operating system and the host hardware to enable storage virtualization.

Checkpoint (4)

5. Storage based virtualization refers to the use of exclusive_____storage protocols to access storage systems.
   a. host-dependent
   b. guest-dependent
   c. host-independent
   d. guest-independent

6. Major shortcomings of the conventional storage systems are :
   a. Interoperability, Reliability and Scalability
   b. Interoperability, Manageability and Scalability
   c. Security, Reliability and Reusability
   d. None

7.In a_____, the desktop virtual machines are kept on a central server. The end-user equipment could be a thin-client capable of presenting a remote display to the end-user, very similar to a RDP protocol client. The hosted virtual desktops may be provisioned on-demand, be maintained in current configuration for longer runs, or be saved and archived in a desktop-repository on the server.

8.KVM is enabled only in the presence of Intel VT-x hardware on Intel platforms or AMD-V feature on AMD platforms.
   a. True
   b. False
   c. Can be true or false, depends on type of OS.

Unit-3- Introduction to Cloud Computing

Unit-3 Lecture-1-2

Introduction to Cloud Computing

Learning Outcomes

At the end of the session you will be able to:

- Define cloud computing
- Describe need of cloud computing
- Describe history of cloud computing
- Explain historical evolution of cloud computing
- Describe benefits of cloud computing
- Understand limitations of cloud computing
- Explain elastic computing
- Differentiate various vendors of cloud computing
- Distinguish traditional data center and cloud data center

What is Cloud Computing?

Cloud Computing View Points

Executive	*"A buyer centric view of technology where applications are available, through purchase, rental or even development, wherever and whenever."*
CFO	*"An approach to consume technology in a pay-as-you-go model where consumers only pay for what they use."*
CIO	*"A comprehensive virtualization model for technology from infrastructure through application delivery ."*

Cloud Computing is all of these things!

Introduction

- Cloud computing is a technology which utilizes the Internet and central isolated servers in order to sustain applications and data.
- This technology permits much more proficient computing by consolidating bandwidth, processing, and storage memory.
- Cloud offers robust memory administration, thus there is no necessity to sustain memory on a personal system.

Examples:

- **<u>Cloud computing with an example -</u>**
- *Whenever you travel through a bus or train, you take a ticket for your destination and hold back to your seat till you reach your destination. Likewise other passengers also takes ticket and travel in the same bus with you and it hardly bothers you where they go. When your stop comes you get off the bus. Cloud computing is just like that bus, carrying data and information for different users and allows to use its service with minimal cost.*
- *Landline Phone Vs. Smart Phone*
- *Making of Websites*

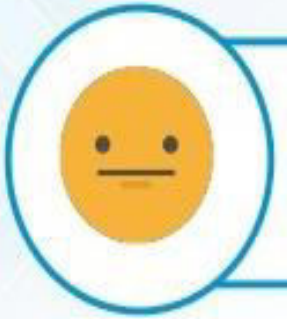
- **What is Cloud Computing?**
- **It enable us to utilize high end resources so that we build great applications without worrying about infrastructure.**
- **i.e you can create a application without worrying of hardware, software, security, backup.**

-

Before Cloud Computing: Disadvantage

This setup is expensive.

Troubleshooting problems can be tedious and may conflict with your business goals.



Since the traffic is varying, your servers will be idle most of the time.

How did we fix this?

Solution

Put your data on Cloud Servers and voila! No more buying expensive servers!

Scalability! Your server capacity will vary according to traffic, how cool is that?

Your cloud provider will manage your servers, hence no worries about the underlying infrastructure.

Definition's: Cloud Computing

- **What is Cloud?**
- The term **Cloud** refers to a **Network** or **Internet.**
- In other words, we can say that Cloud is something, which is present at remote location. Cloud can provide services over public and private networks, i.e., WAN, LAN or VPN.
- Applications such as Gmail, Yahoo Mail, web conferencing, customer relationship management (CRM) execute on cloud.

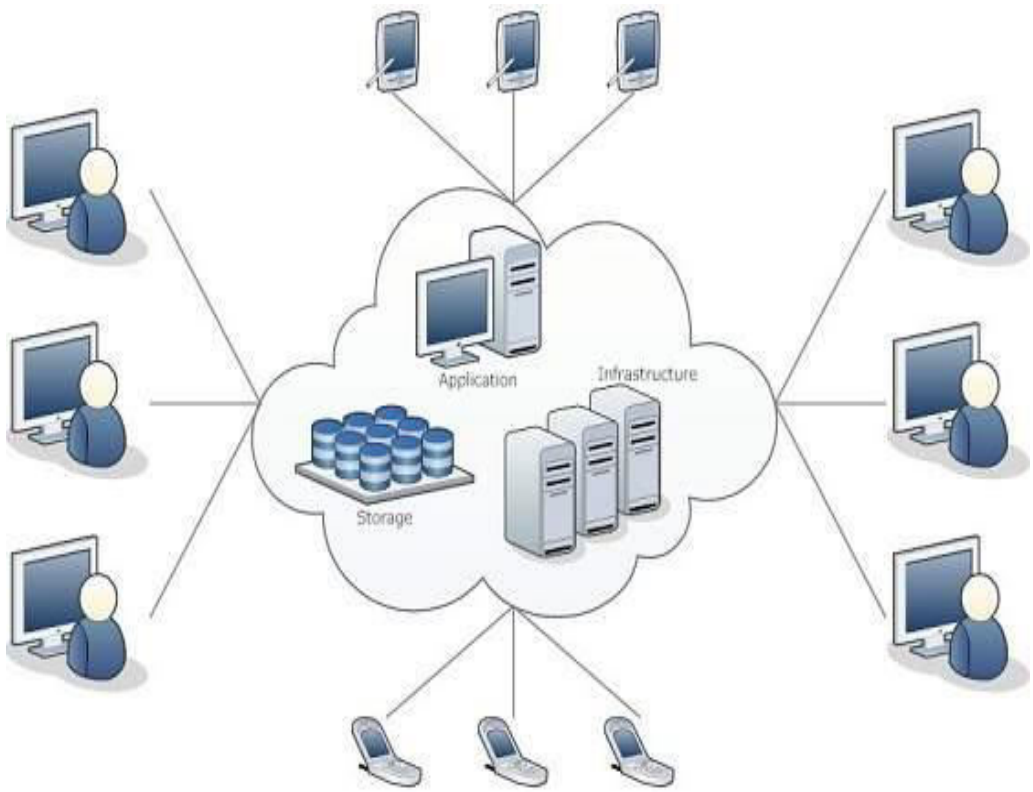
- *Cloud Computing provides us means by which we can access the applications as utilities over the internet. It allows us to create, configure, and customize the business applications online.*

- **Definition:**
- **Cloud Computing refers to manipulating, configuring, and accessing the hardware and software resources remotely. It offers online data storage, infrastructure, and application**

Cloud Introduction

→ According to Forrester, Cloud Computing is:

"A form of standardized IT-based capability — such as Internet- based services, software, or IT infrastructure — offered by a service provider that is accessible via Internet protocols from any computer, is always available and scales automatically to adjust to demand, is either pay-per-use or advertising-based, has Web- or programmatic-based control interfaces, and enables full customer self-service."



*Cloud computing offers **platform independency,** as the software is not required to be installed locally on the PC. Hence, the Cloud Computing is making our business applications **mobile** and **collaborative.***

Cloud computing is a technology that uses the internet and central remote servers to maintain data and applications.

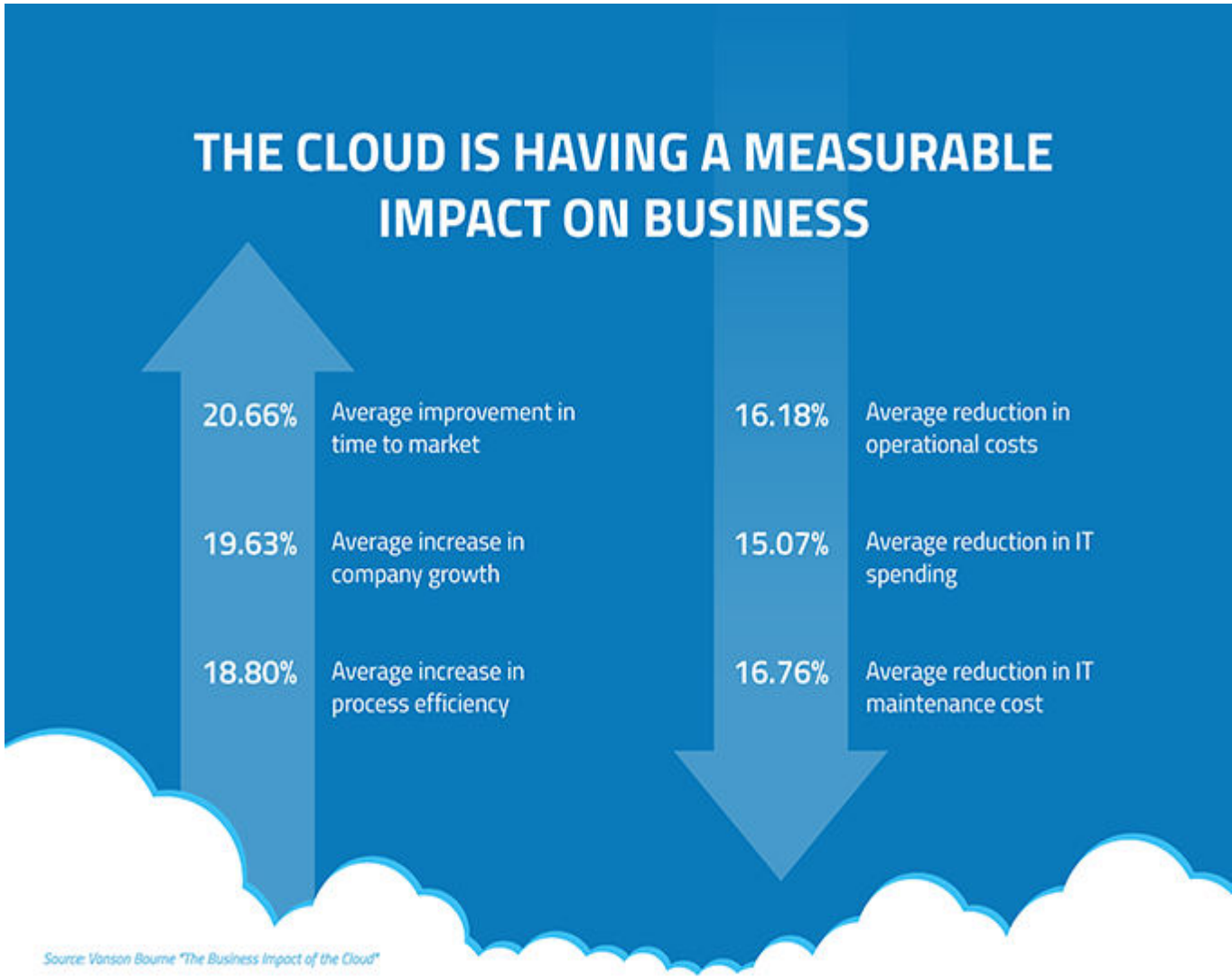
Definition of Cloud Computing

The term ‘cloud’ is defined by NIST as follows:

- *“Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This cloud model is composed of five essential characteristics, three service models, and four deployment models.”*
- *Cloud Computing can be defined as delivering computing power(CPU, RAM, Network Speeds, Storage OS software) a service over a network (usually on the internet) rather than physically having the computing resources at the customer location.*
- ***Example:** AWS, Azure, Google Cloud*

Why do we need cloud computing?

- According to a study by the Cloud Security Alliance, 33% of organizations have a "full steam ahead" attitude toward cloud services and 86% of companies spend at least part of their IT budget on cloud services.
- IT leaders at 79% of companies receive regular requests from end users each month to buy more cloud applications with file sharing and collaboration, communication, social media, and content sharing topping the list of the most-requested cloud services.



Why do we need cloud computing?

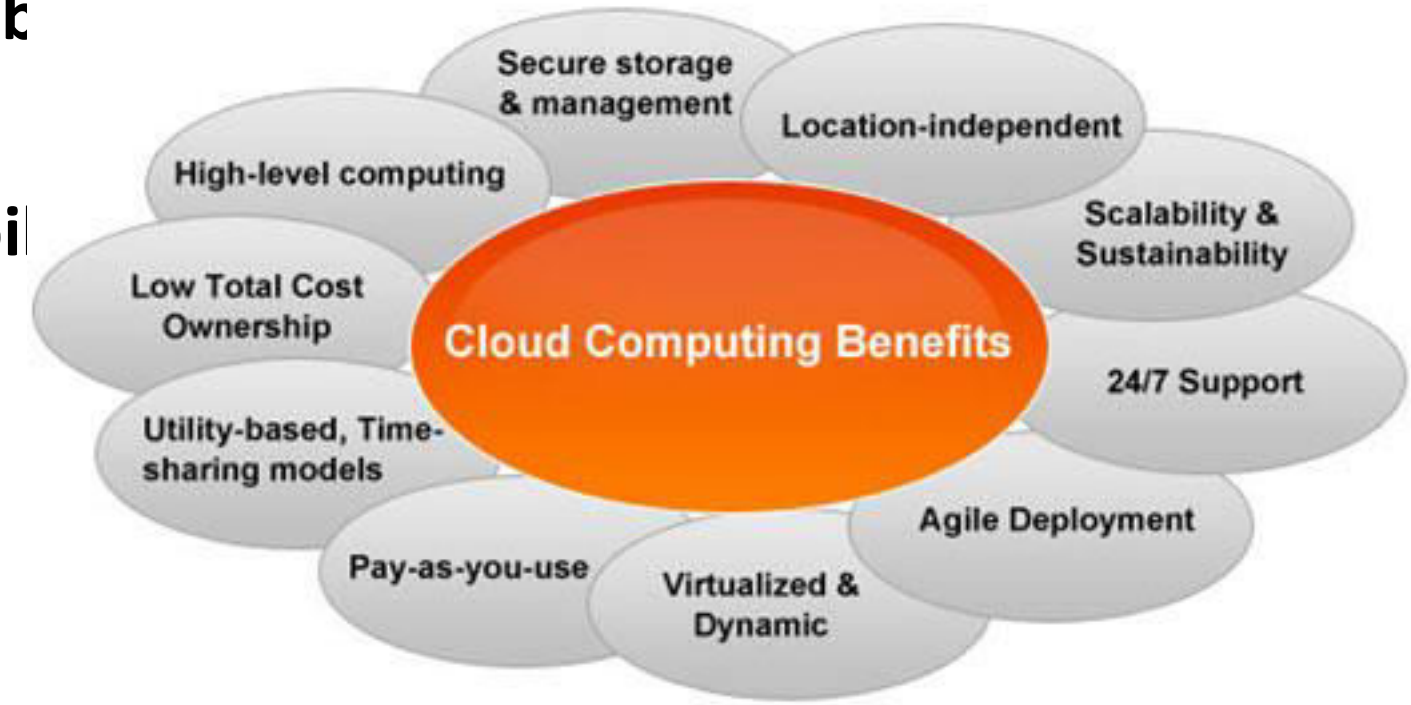
1. **Fresh Software:** Availability of software
2. **Do more with less: cost saving**. Yes, Cloud computing has made drastic change in the reduction of hardware and software cost and other server resources as well.
3. **Always-on availability:** Most cloud providers are extremely reliable in providing their services, with many maintaining 99.99% uptime.
4. **Improved mobility:** Data and applications are available to employees no matter where they are in the world. E.g. Facebook.
5. **Huge amount of processing power:** We can run all our workload data of applications and processes online over the internet remotely instead of using physical hardware and software.
6. **Day to day issues related to server maintenance or installation of software/hardware:** renewal of license, all those factors are undertaken via cloud computing service providers
7. **Protects and recovers all crashed or loss data**: so we don't have to worry about crashed or loss of data, it gives you high security

Advantages of Cloud Computing

1. **Lower cost computer for users:** In cloud, you don't require a high-powered (and accordingly high-priced) computer to run cloud computing's web based applications because applications run on cloud not on desktop PC or laptop.
2. **Lower IT infrastructure cost**: By using cloud computing, you need not to invest in larger numbers of more powerful servers, you also need not to require the IT staff for handling such powerful servers.
3. **Fewer maintenance cost:** The maintenance cost in cloud computing greatly reduces both hardware and software maintenance for organizations of all sizes.
4. **Lower Software Cost**: It reduces the software cost because you don't need to purchase separate software packages for each computer in the organization.
5. **Instant software updates:** Another software-related advantage in cloud computing is that users don't need to face with the choice between obsolete software and high upgrade costs. If the app is web-based, updates happen automatically and are available next time when the user logs in to the cloud.

Advantages of Cloud Computing

- **Increased computing Power:** The execution capacity of cloud servers are very high. It processes the application very fast.
- **Unlimited storage capacity:** Cloud offers you a huge amount of storage capacity like 2000 GB or more than that if required.
- **Improved compatibility b**
- **Backup and recovery**
- **Performance and Scalabi**
- **Increase data safety**



Disadvantages of Cloud Computing

1. **Require a constant Internet Connection**: Cloud computing is impossible without Internet connection. To access any applications and documents you need a constant Internet connection.

2. **Require High Speed Internet connection**: Similarly, a low-speed Internet connection makes cloud computing painful at best and often impossible. Web based apps often require a lot of bandwidth to download, as need to download large documents.

3. **Stored Data Might Not Be Secure**: With cloud computing, all your data is stored in the cloud. That's all well and good, but how secure is the cloud? Can't unauthorized users gain access to your confidential data?

Defining cloud computing

Defining Cloud Computing

Cloud computing takes the technology, services, and applications that are similar to those on the Internet and turns them into a self-service utility. The use of the word "cloud" makes reference to the two essential concepts:

- **Abstraction:** Cloud computing abstracts the details of system implementation from users and developers. Applications run on physical systems that aren't specified, data is stored in locations that are unknown, administration of systems is outsourced to others, and access by users is ubiquitous.
- **Virtualization:** Cloud computing virtualizes systems by pooling and sharing resources. Systems and storage can be provisioned as needed from a centralized infrastructure, costs are assessed on a metered basis, multi-tenancy is enabled, and resources are scalable with agility.

Virtualization

- Virtualization is a term that refers to the abstraction of computer resources
- Virtual machine (VM), a software implementation of a machine (computer) that executes programs like a real machine

How does cloud computing work

- Assume that you are an executive at a very big corporation. Your particular responsibilities include to make sure that all of your employees have the right hardware and software they need to do their jobs. To buy computers for everyone is not enough. You also have to purchase software as well as software licenses and then provide these software's to your employees as they require. Whenever you hire a new employee, you need to buy more software or make sure your current software license allows another user. It is so stressful that you have to spend lots of money.

- But, there may be an alternative for executive. So, instead of installing a suite of software for each computer, you just need to load one application. That application will allow the employees to log-in into a Web-based service which hosts all the programs for the user that is required for his/her job. Remote servers owned by another company and that will run everything from e-mail to word processing to complex data analysis programs. It is called cloud computing, and it could change the entire computer industry.

History of Cloud Computing

- Before emerging the cloud computing, there was **Client/Server computing** which is basically a centralized storage in which all the software applications, all the data and all the controls are resided on the server side.
- *If a single user wants to access specific data or run a program, he/she need to connect to the server and then gain appropriate access, and then he/she can do his/her business.*
- Then after, **distributed computing** came into picture, where all the computers are networked together and share their resources when needed.

- ***On the basis of above computing, there was emerged of cloud computing concepts that later implemented***.

Overlapping of virtualization and cloud

- Virtualization is only an enabler for Cloud. Virtualization provides the required infrastructure flexibility to cloud by virtualizing the resources which allows for easy provisioning and management of these resources across hardware pools

- Virtualization is only one of the eight major building blocks of Cloud.

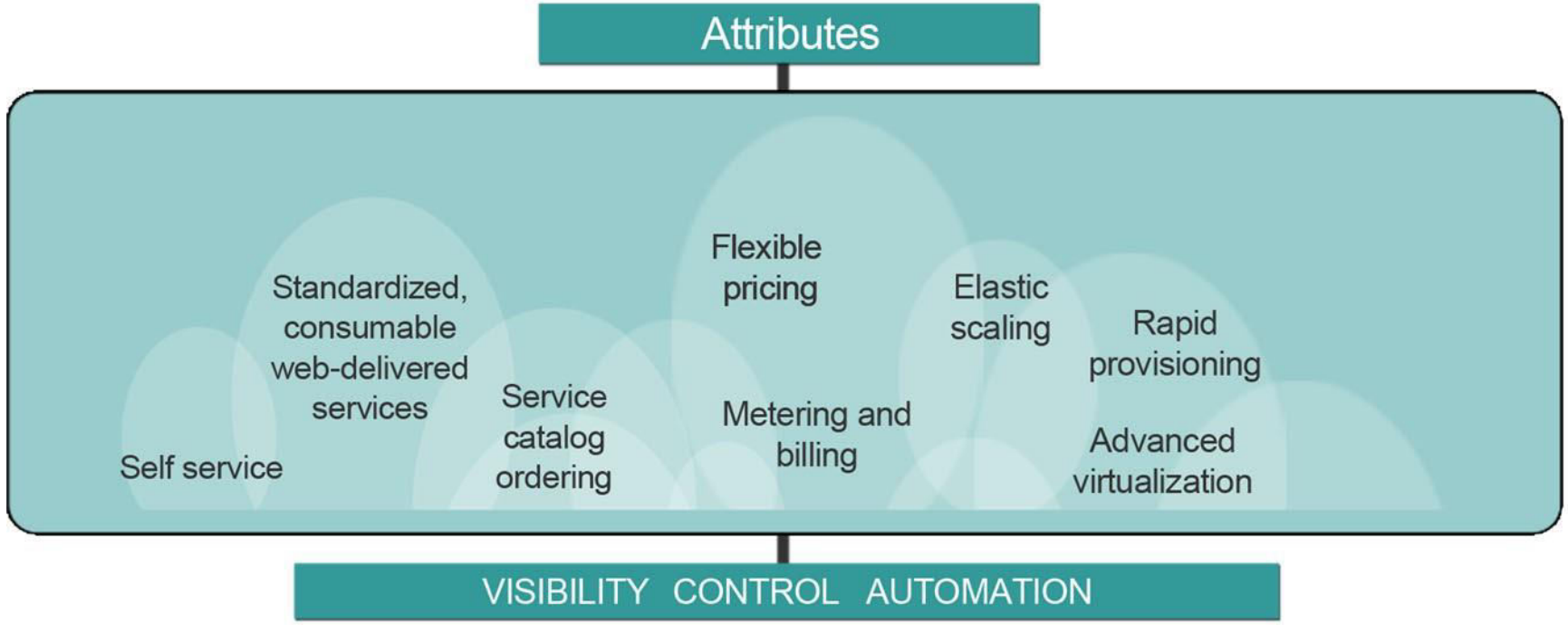
- Virtualization is most relevant to IaaS (Infrastructure as a Service). However, PaaS (Platform as a Service) and SaaS (Software as a Service) could largely be achieved without virtualization. Increasingly, PaaS and SaaS units are being packaged as VMs for easy deployment.

- The real difference between Cloud and Virtualization comes from the business aspects of Cloud and the Service management framework built into Cloud.

Areas and relative savings

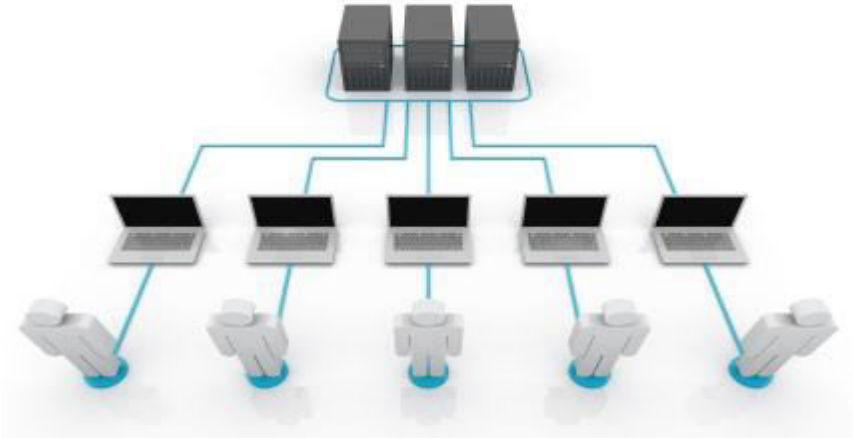
Parameter	Virtualization	Cloud
Utilization	Typically 60-70%	Typically 60-70%. However, it is possible to share resources across pools (physical hosts) and maintain the utilization levels. Spare capacity available on demand
Provisioning	Manual, 1 day	Automatic, On-demand within minutes or few hours
Monitoring	Comparative ease in monitoring using automated tools. However, need manual intervention to take care of any failures	Typically automated. No manual intervention required due to advanced orchestration capabilities built into the cloud
Sizing	Easier to resize. However, manual intervention required to resize for new requirements	On-demand automatic rescaling of the resources
Staff for Administration	Reduced number of Full Time employees	Typical reduction in number of employees required to manage the infrastructure. On an average, FTE reduction is generally in the range of 1 administrator for 400 cloud instances
Cost	Initial hardware cost reduced due to sharing of hardware assets and due to increased utilization	In most cases, the initial hardware cost is almost negligible. There'll be running cost on a monthly basis.
Optimization	Easy to share resources and re-balance loads on the virtual machines on the same host. However, re-balancing across physical hosts require advanced features and planned downtime	Easy to share resources and re-balance loads across resource pools. No manual intervention required to move resources or resize resources for an application.

What is cloud computing?



Cloud computing improves service management

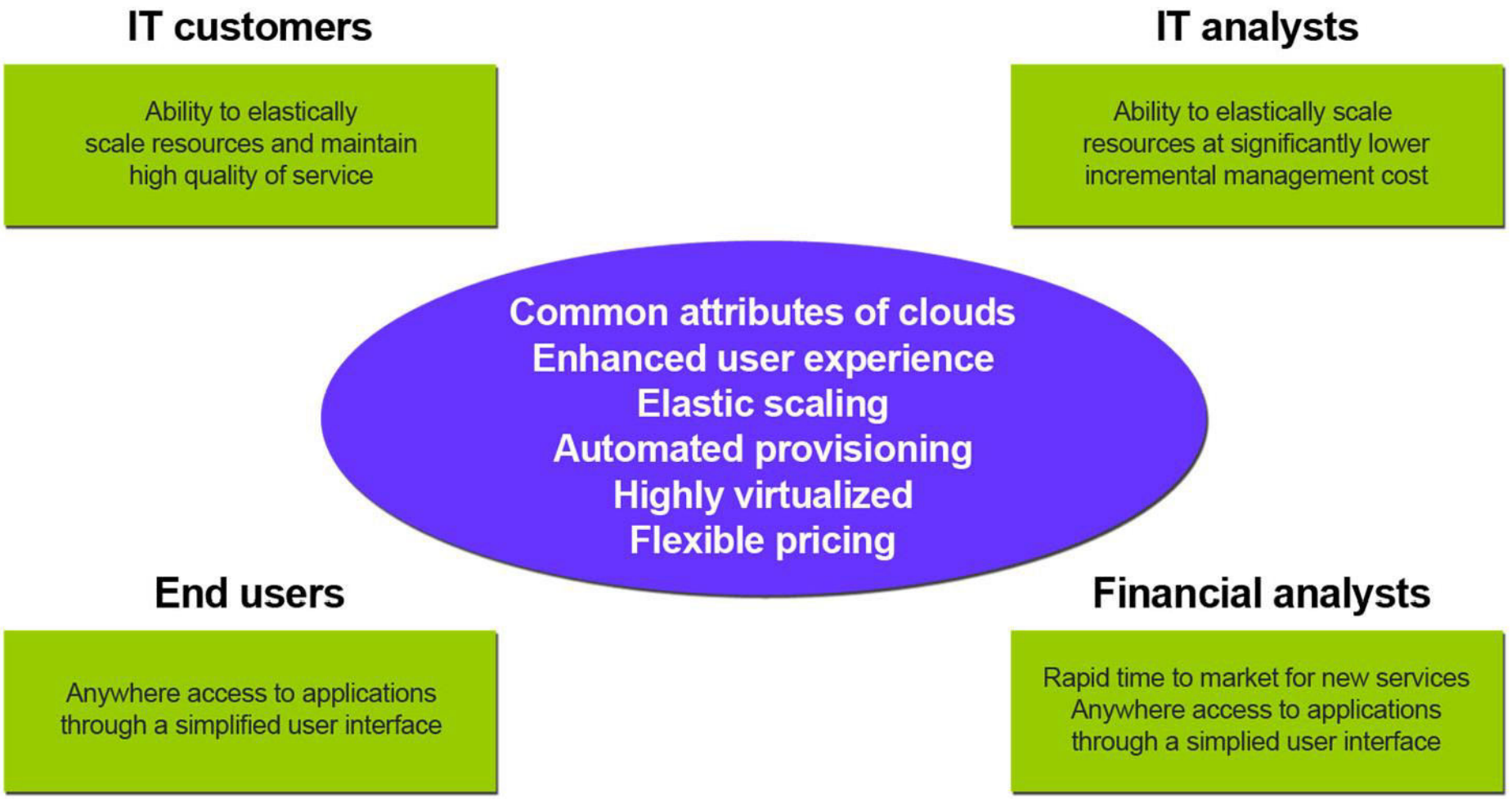
A service driven model



- Cloud computing provides service delivery for consumer and business needs in a simplified way.

- Hardware and platform-level resources are provided as services on an on-demand basis.

Advantages of cloud



Basic Structure of Cloud Computing

The basic structure of cloud computing is shown in Fig. 1.1. As given in the figure, facilities and services are offered by cloud providers in a cloud computing environment and different users from various locations and devices can request for specific services that are offered.

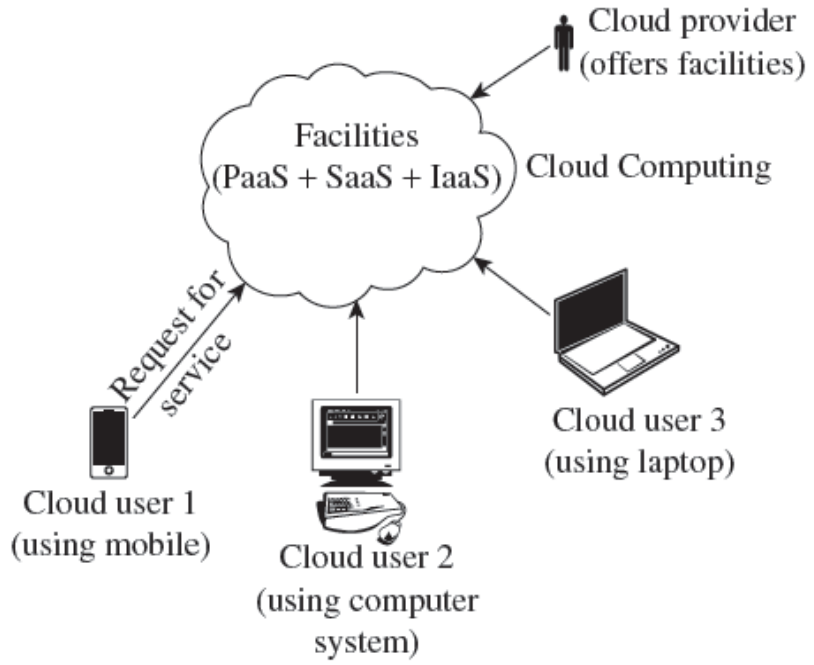


Fig. 1.1 Basic structure of cloud computing

Basic Structure of Cloud Computing

Some of the benefits of cloud computing are given here:

- It improves parallelism and allocation of resources for fast accessing.
- One may acquire software services, networked storage space, computer resources, and various other services at a single place.
- An additional company hosts a set of applications, get software renewals (with no charge), and so on.
- It improves monetary burden such as operational expenses, renewing charge, and capital expenses.

Cloud Resource Management

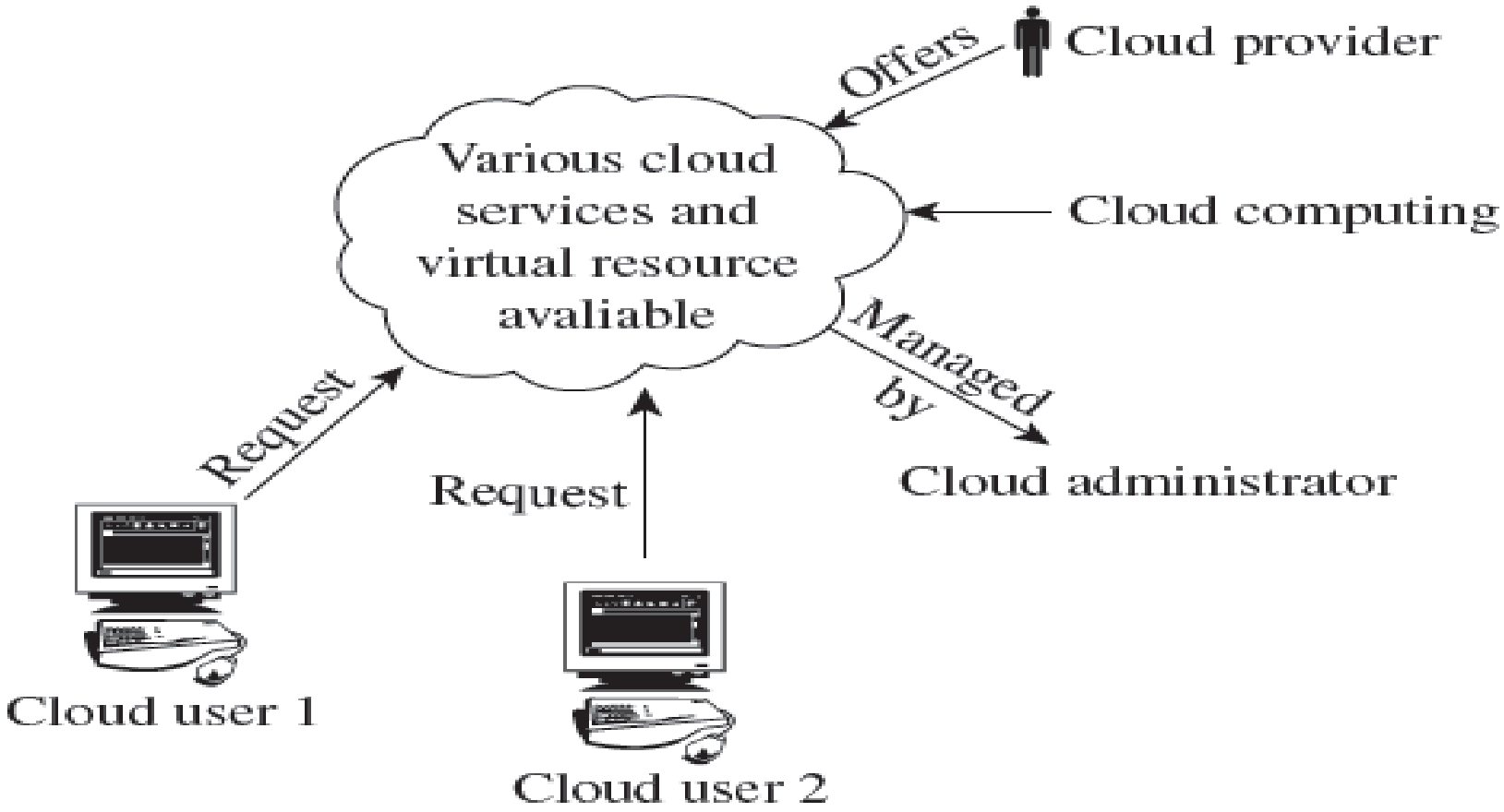


Fig. 1.2 Cloud resource management

Terminology used in Cloud Computing

Cloud consumer	An individual person or organization that sustains a business relationship with cloud providers and avails the services offered by the provider
Cloud provider	An individual person or organization who offers a service and is liable for the services of cloud computing to the parties that demand it
Cloud auditor	A party that conducts evaluation of cloud services, such as performance, operation on various systems, and security, among others
Cloud broker	The management between cloud providers and cloud consumers, like presentation and delivery of various services
Cloud carrier	The mediator responsible for connectivity and transport of cloud services from service providers to cloud consumers

Need of Cloud Computing

Cloud computing is a new trend in computing due to its many benefits:

- Reduced Costs
- Scalability
- Remote Access
- Disaster Relief
- Ease of Implementation
- Skilled Vendors
- Response Time
- Easy to Customize
- Virtual Provisioning
- Fully Automated Storage Tiering—FAST

History of Cloud Computing

The historical evolution of Cloud Computing is as follows:

- Client-Server Technology
- Peer-to-Peer Approach
- Distributed Computing
- Evolution of Cloud Computing from Grid Computing
- Autonomic Computing
- Platform Virtualization
- Service Oriented Architecture—SOA
- Utility Computing
- Web 2.0
- Parallel Computing

Client-Server Technology

- Client-Server is the technology behind cloud computing. It is shown in Fig. 1.4. In this, multiple computers perform collectively to augment computing power.
- The server is the prime regulator wherein software kept for access.
- The client is simply a tool which is associated with the user for facilitation.
- Due to inadequate processing power, IT employees neither acquire instant access nor can two users access similar data concurrently in client–server technology.

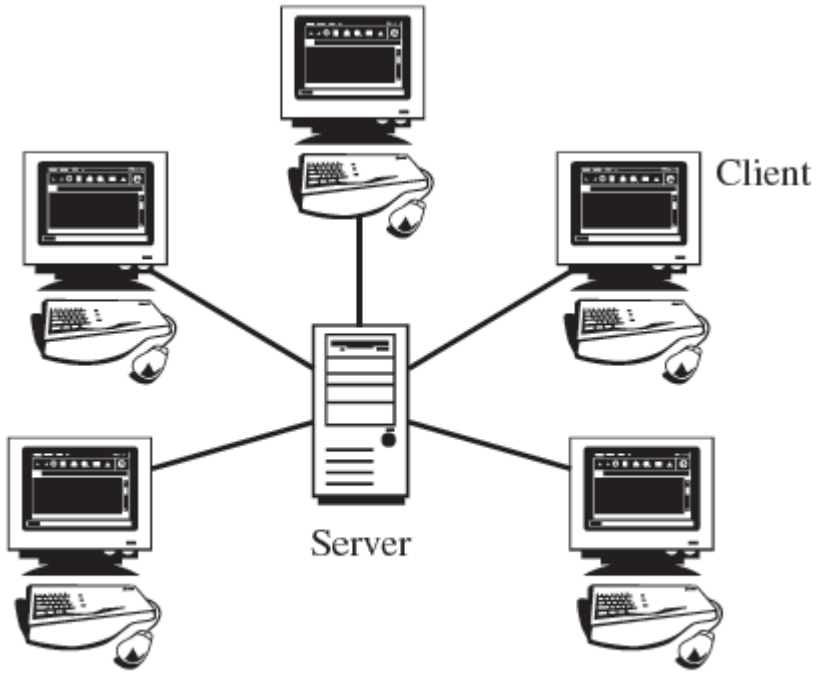


Fig. 1.4 Client-Server technology

Peer to Peer Approach

- Peer-to-Peer (P2P) is a decentralized approach and it encompasses no principal server. It is a design in which every computer has equal responsibilities and facilities.
- P2P facilitates straight swap of services and resources.
- This kind of network is not simple to manage.

Distributed Computing

- Distributed computing utilizes those idle resources that are not utilized for some reason or the other. Figure 1.5 shows distributed computing.

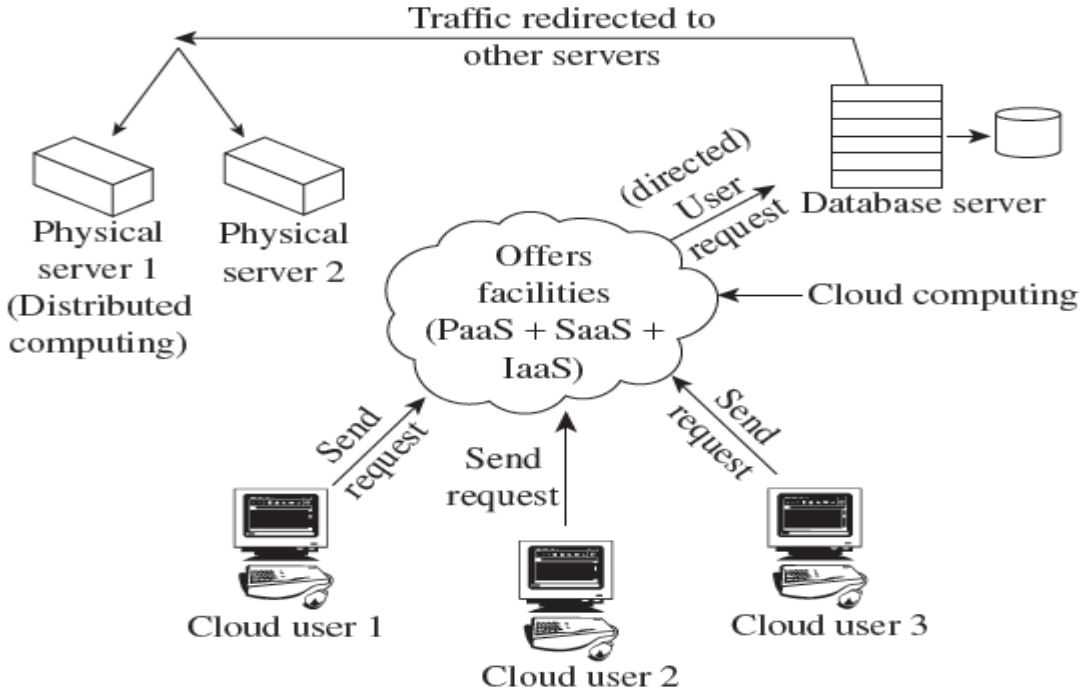
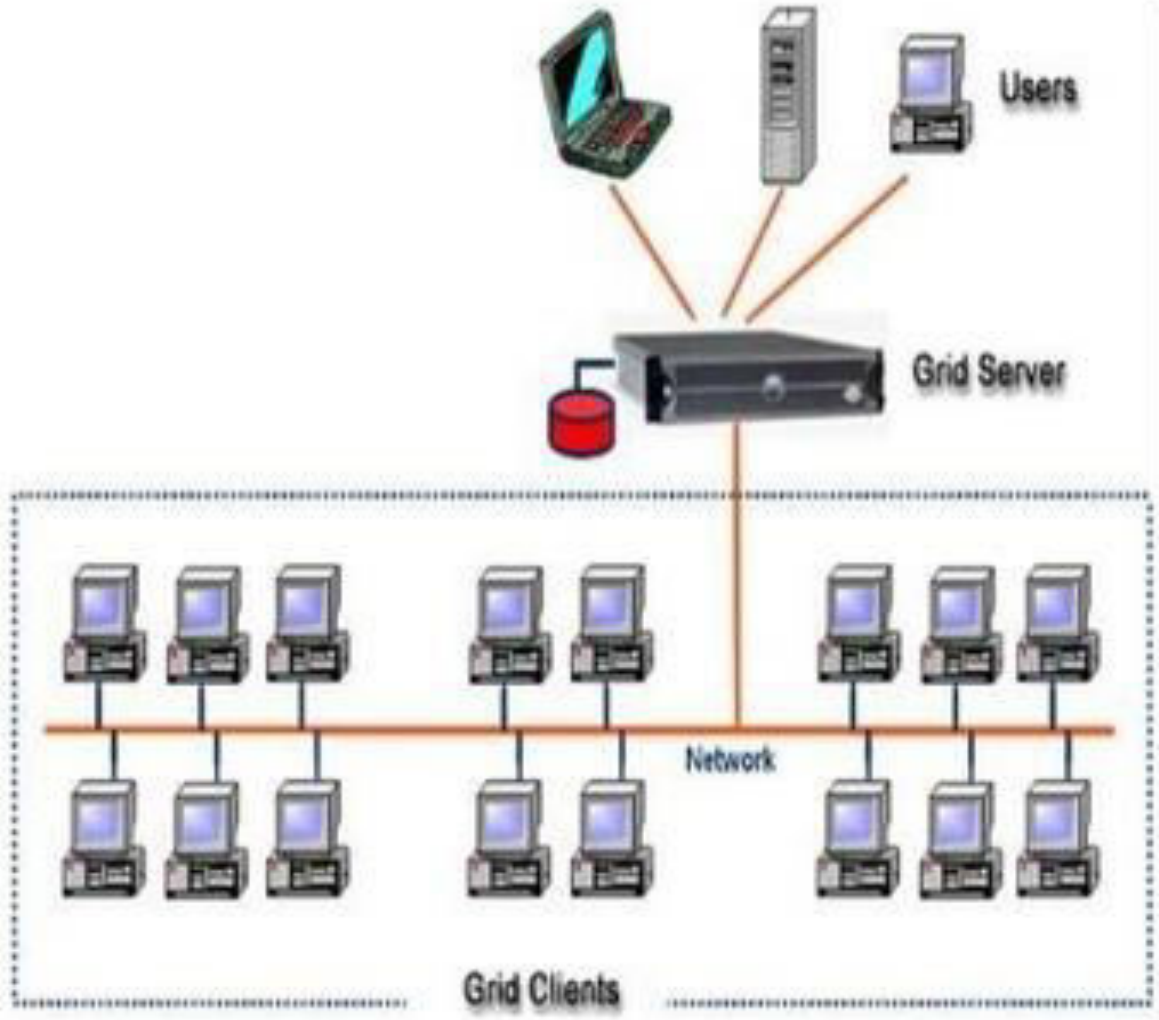


Fig. 1.5 Distributed computing

How Grid computing works ?

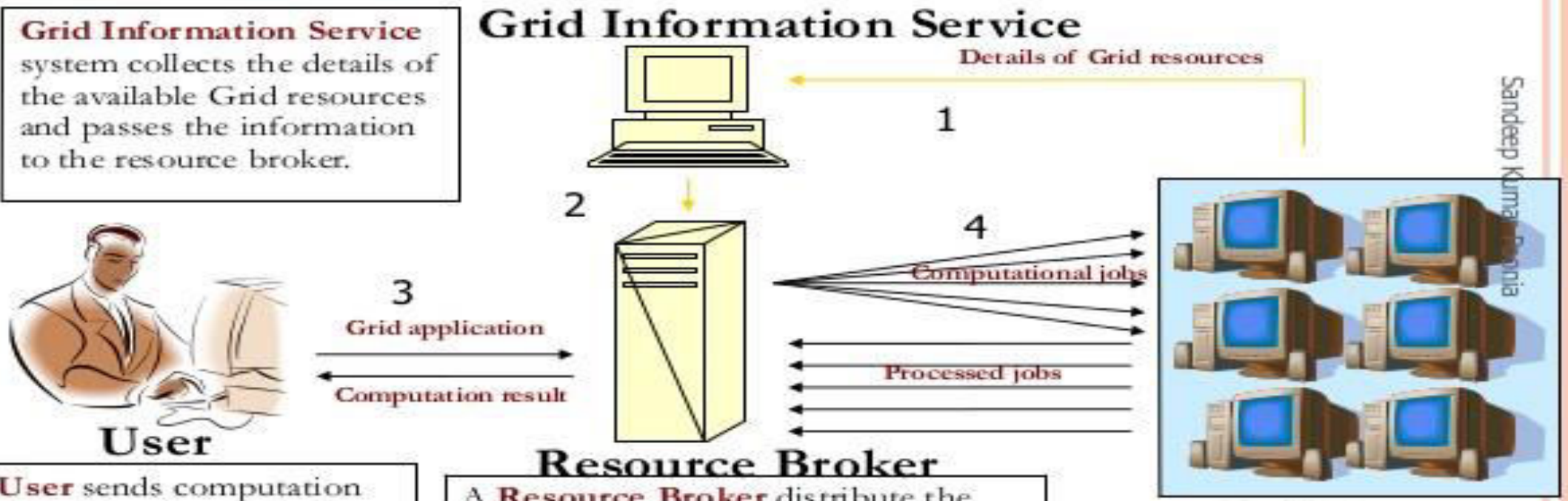


In general, a grid computing system requires:

- **At least one computer, usually a server, which handles all the administrative duties for the System**
- **A network of computers running special grid computing network software.**
- **A collection of computer software called middleware**

A TYPICAL VIEW OF GRID ENVIRONMENT

Grid Information Service system collects the details of the available Grid resources and passes the information to the resource broker.



A **User** sends computation or data intensive application to Global Grids in order to speed up the execution of the application.

A **Resource Broker** distribute the jobs in an application to the Grid resources based on user's QoS requirements and details of available Grid resources for further executions.

Grid Resources (Cluster, PC, Supercomputer, database, instruments, etc.) in the Global Grid execute the user jobs.

Grid Framework

- Grids are a type of dispersed computing system, whereas a virtualized super computer is made from various networked.
- Grids focus on two different but associated objectives—supplying isolated access to IT resources and building up processing control.
- The grid is a technology which controls two factors—allocation and trust.
- Grid computing is a versatile technology which has its base in e-science and has progressed from previous expansions in parallel and high-performance computing (HPC).

Grid Framework

The main resources that can be shared in a grid are:

1. Processing and computing power
2. Networked file and data storage systems
3. Bandwidth and communications
4. Application software
5. Tools used for scientific purpose

Grid Framework

The distinct definitions for grid and grid computing are:

- **Grid middleware** is exclusive software that offers the essential functionality needed to facilitate sharing of various resources and setting up of virtual businesses. Grid middleware is exclusive software that is incorporated into the infrastructure of the concerned corporation. Grid middleware offers a unique virtualization and sharing layer which is positioned among the various infrastructures and the particular user applications using it.
- **Grid computing** is fundamentally the installed Grid middleware or the computing permitted by grid middleware based on synchronized, safe, flexible resource sharing among a collection of resources, people, and organizations.

Grid Framework

- **Grid infrastructure** refers to the union of grid middleware and hardware which converts single portions of data resources and hardware into an incorporated virtualized infrastructure that is displayed to the user as the only computer in spite of heterogeneity of the fundamental infrastructure.
- **Utility computing** is a type of computing that provides customized applications of grid and computing as a service. It is based on pay-as-per-utilization business modules.

Grid Architecture

- The grid design offers an outline of the grid constituents, describes the objective and operations of its constituents, and shows how the constituents interrelate with each other. Various layers of the grid architecture are:

- Fabric layer
- Connectivity layer
- Resource layer
- Collective layer
- Application layer

Grid Architecture

The key functionalities of a grid middleware are as follows:

1. Integration and virtualization of various independent resources
2. Requirement of information concerning resources and their accessibility
3. Lively and flexible resource administration and allotment
4. Brokerage of resources based on open markets or corporation strategies
5. Safety comprising agreement and confirmation of users and accountability
6. Licenses administration
7. Expense and invoicing
8. Transport of non-insignificant ‘Quality of Service’

Challenges of Grid Computing

- It is not enough to just change the prevailing spread IT infrastructure into a grid. In majority of instances, investments are required for making the existing applications to work on a grid infrastructure.
- Lack of values for grid computing make resources' findings for grid technology difficult and risky.
- Grid computing is a versatile technology and the launching of grid computing in a corporation is characteristically a long-standing plan that needs time until the visibility of first results. The beginning of grid computing could need consistency of physical resources. Even if grids would essentially be capable to handle heterogeneity of resources that are accessible, advanced heterogeneity of resources might need advanced savings in terms of money and time and hence increase the downfall risk.

Cloud Computing Architecture

- In cloud computing environment, physical resources are made available to cloud users with the help of virtualization software in the form of virtual resources.
- Cloud computing architecture is not fixed as other computing architectures, but it is different on the basis of different jobs, resource distribution.

Cloud Computing Architecture

Basic cloud computing environment is shown in the Fig. 3.1 in which various services such as available servers, virtual desktop, system software, application software, database, etc. are available for cloud users. Users can avail the services using any device such as desktop system, laptop, mobile, tablet, etc.,

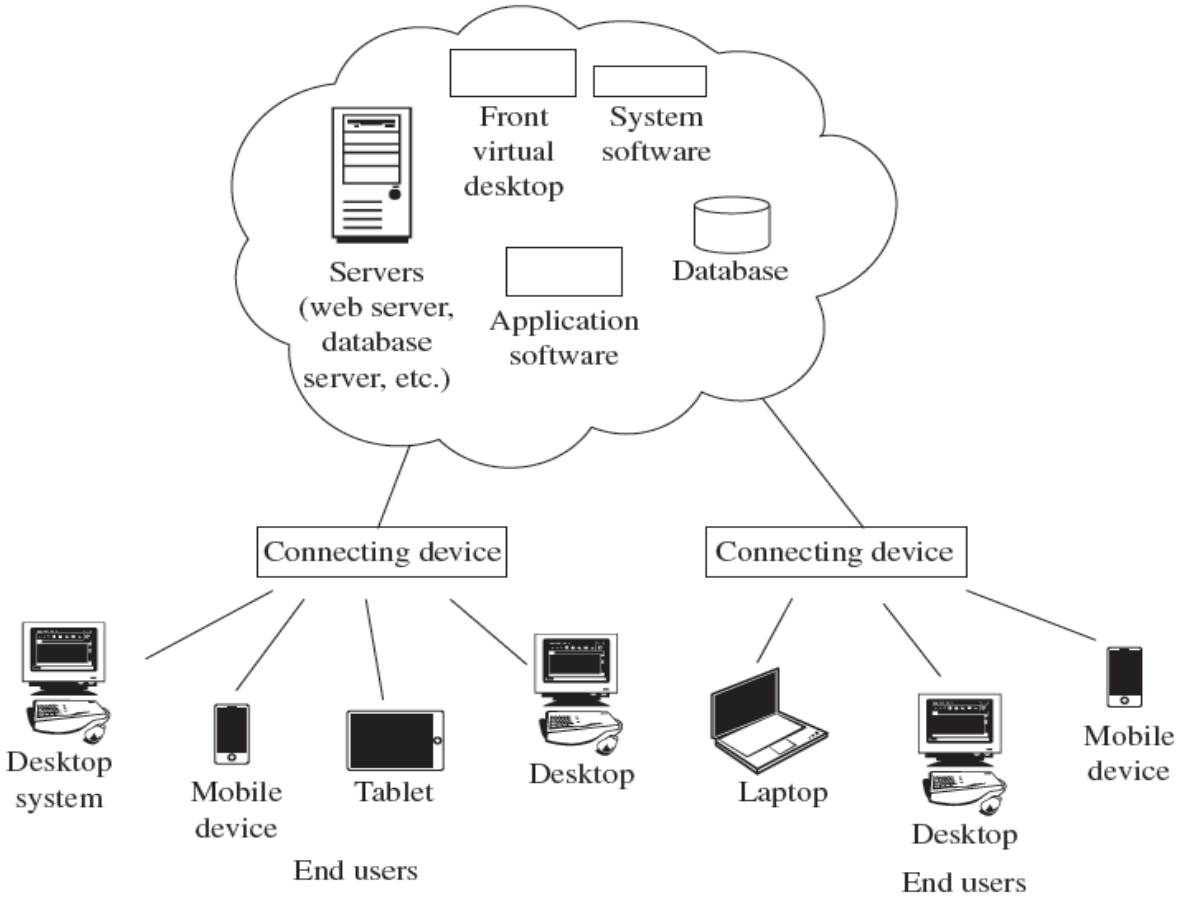


Fig. 3.1 Cloud architecture

Cloud Computing Architecture

The Cloud Computing architecture is discussed based on different criteria:

- On the Basis of Load Balancing
- On the Basis of Disk Provisioning
- On the Basis of Storage Management
- On the Basis of Hypervisor Installed
- On the Basis of Migration
- On the Basis of Service Relocation
- On the Basis of Cloud Balancing
- On the Basis of Virtual Switches Load Balancing
- On the Basis of Failure Detection and Recovery

Key Design Aspects of Cloud Architecture, Cloud Services and Cloud Applications

- Cloud computing has various issues related to its architecture:
- **Issues at Design Level**

  Issues of Architectural of Cloud Computing

  Platform Related Issues
- **Issues Related to the Implementation**

  Issues related to Business

  Technical Issues

Similarities and Differences between Grid and Cloud Computing

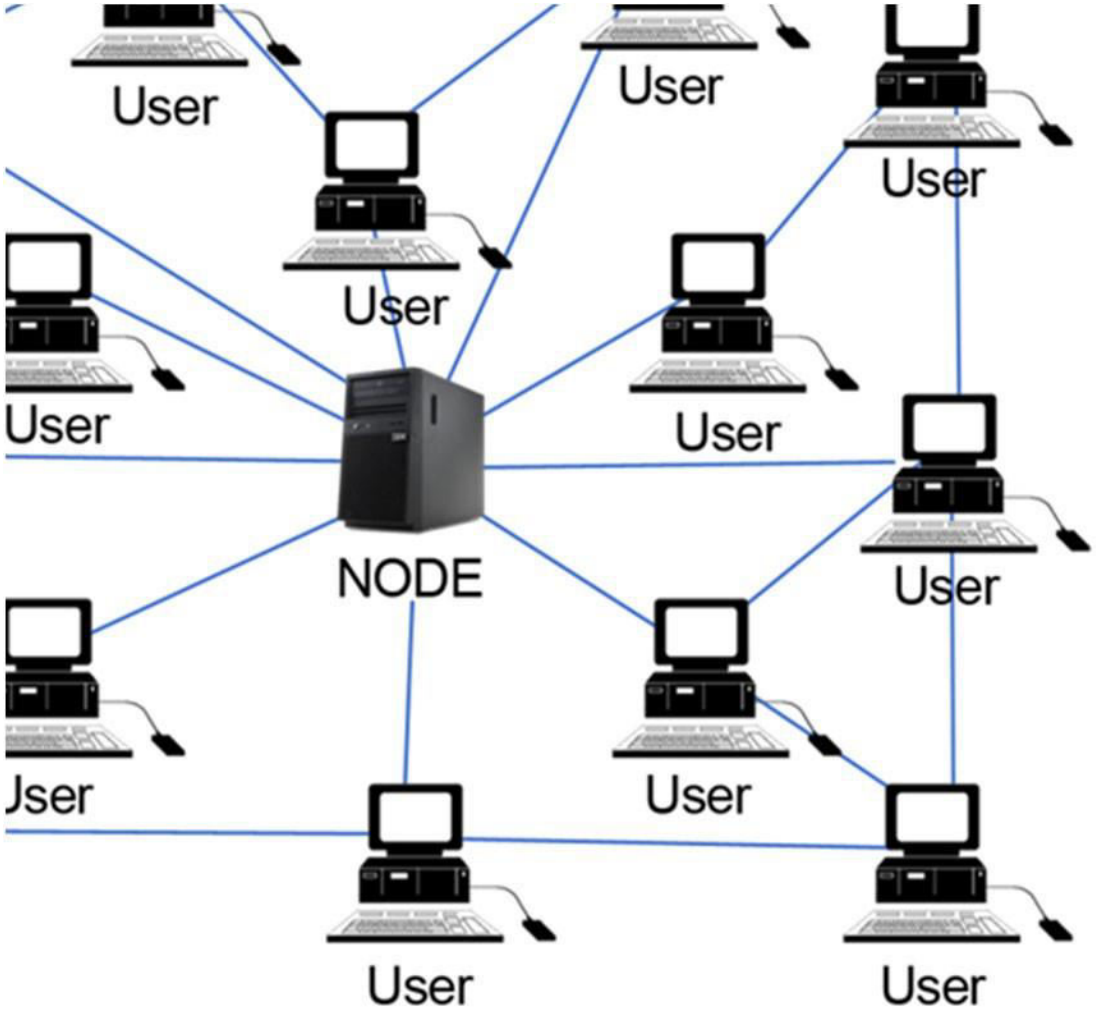
Similarities:

- Grid computing and cloud computing are scalable.
- Grid and cloud computing offer service-level agreements (SLAs) for uptime accessibility of around 99 per cent. If the service slides below the definite uptime service level, the service credit for receiving data to the customer gets delayed.

Differences:

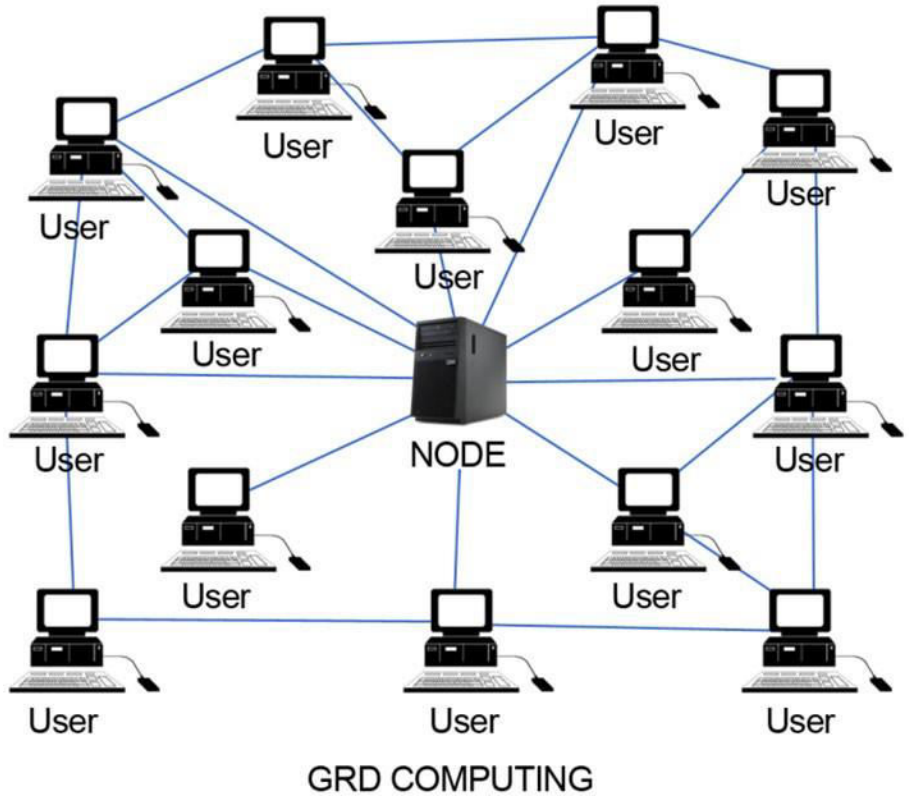
- Cloud computing offers SaaS applications, whereas grid computing is used when the processing authority of service or an application is distributed across multiple systems.
- With cloud computing, the corporation acquires feasibility and expense savings, whereas with grid computing the corporation acquires suppleness and authority.

Grid computing

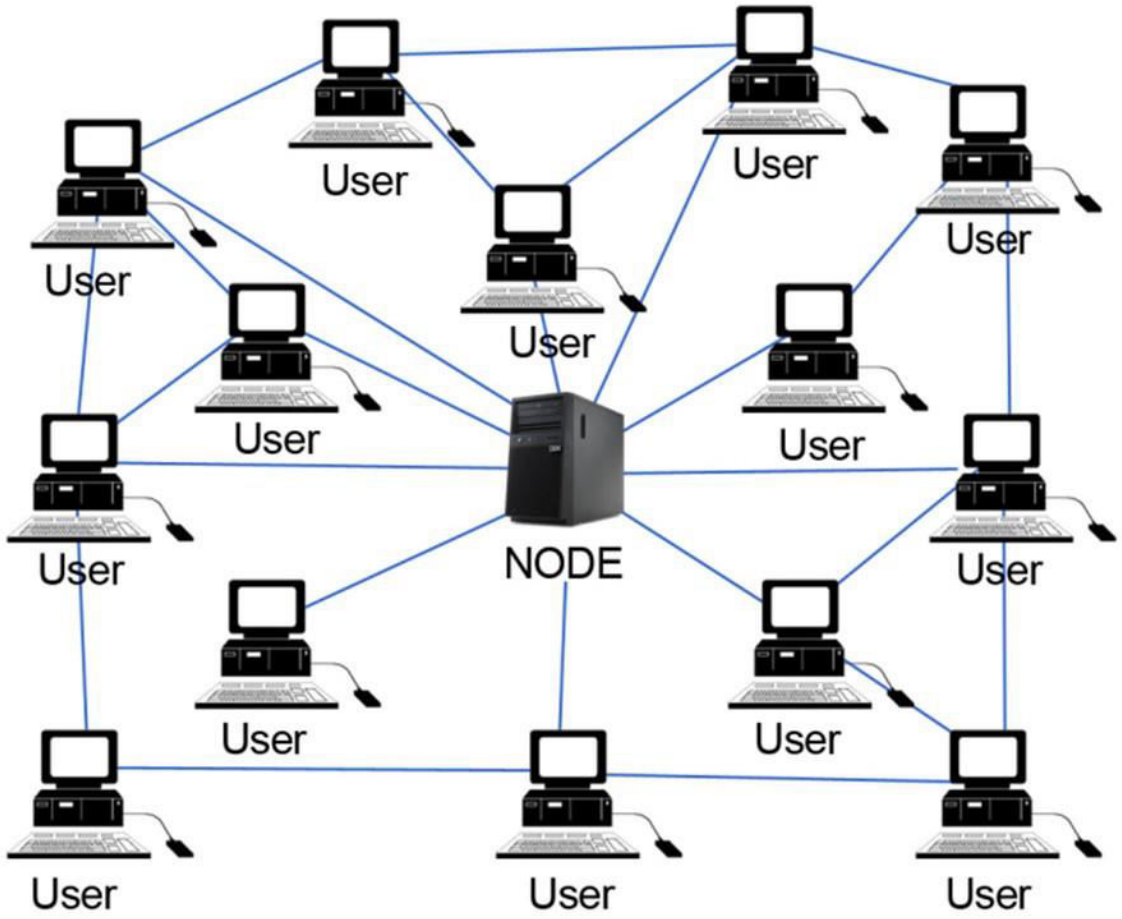


GRD COMPUTING

Cloud Vs Grid Computing



Relationship between grid and cloud computing



GRD COMPUTING

Grid vs. Cloud

	Grid	Cloud
Underlying concept	Utility Computing	Utility Computing
Main benefit	Solve computationally complex problems	Provide a scalable standard environment for network-centric application development, testing and deployment
Resource distribution / allocation	Negotiate and manage resource sharing; schedulers	Simple user <-> provider model; pay-per-use
Domains	Multiple domains	Single domain
Character / history	Non-commercial, publicly funded	Commercial

Evolution of Cloud Computing from Grid Computing

Table 1.2 Evolution of cloud computing from grid computing

Grid computing	Utility computing	Software as a Service	Cloud computing
Big crisis could be resolved with equivalent computing	Provided computing resources as metered services (disburses as per usage)	Beneficial in usage based payments to applications.	An Internet based computing offering services such as IaaS, PaaS, and SaaS.

Grid vs. Cloud

	Grid	Cloud
Underlying concept	Utility Computing	Utility Computing
Main benefit	Solve computationally complex problems	Provide a scalable standard environment for network-centric application development, testing and deployment
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Domains	Multiple domains	Single domain
Character / history	Non-commercial, publicly funded	Commercial

Web 2.0

- Web 2.0 represents a change in technology in the world of the World Wide Web. It is usually designed to increase data security and customization of application as per the requirement with improved functionality.

The important features of Web 2.0 are as follows:

- Easy to access
- User interaction and participation
- Rich customization features
- Easy communication through video chatting, instant messaging facilities, etc.
- User-friendly writing tools and applications
- Data management and analysis
- Multimedia supporting tools
- Web application and hosting

Parallel Computing

- Parallel computing simultaneously uses various computing resources for solving a computational problem.
- It is based on the principle that a single large problem is divided into small parts and parallely runs different parts on different machines.
- Parallel computing supports applications that require processing of a large problem in a sophisticated way. Some of the examples are Big data problem, Data mining, Search engines, Medical diagnosis, Virtual reality, Multimedia.

Services Provided by Cloud Computing

- Electronic Faxing
- Voice on Clouds
- Commerce on Clouds
- Distributed Hosting on Clouds
- Accounting and Online Banking

News on Cloud Computing

- A mobile phone can be used to access services related to news.
- Google Apps or Gmail is capable of seeking information via e-mail, rapidly from any tool. We can talk and work with partners or consumers without any language barrier.
- Distribution and editing of data with trouble-free collaboration using Google items Docs and Sites. TripIt is a private travel that assists in arranging tours. Data is gathered from consumers and colleagues by using Google types. There is joint work on a general venture.
- Through Force.com, you may construct a scalable business application on the cloud platform. Both Google's cloud and salesforce.com computing platforms are employed to generate business and web applications.
- Using online patterns for presentations, spreadsheets, and records.
- Functioning steady, safe, and quick Web apps.
- Easily and firmly distributing video in apps through Youtube for Google apps.

Benefits of Cloud Computing

Cloud computing offers the following benefits:

- Pay as per use
- Reduced investment and proportional costs
- Accessibility from anywhere
- Increased scalability
- Increased availability and reliability
- Dynamic provisioning

Limitations of Cloud Computing

Some of the limitations of Cloud computing are:

- Availability of Services
- Data Lock-in
- Data Segregation
- Privilege Neglect
- Scaling Resources
- Data Location
- Deletion of Data
- Recovery and Backup
- Offline Clouds
- Unpredictable Performance

How to develop Cloud Computing

For the development of cloud infrastructure, the following are needed:

- Understanding the prevailing conventional data center
- Computing resources that will be virtualized
- Installing service administration devices

Core Components of Traditional Data Centers

- **Application** Program employed to carry out numerous computing functions. It may be an operating system, DBMS, and many more.
- **DBMS** It is an administration system which offers the ability to save or get data from rationally prepared tables.
- **Compute** Resources which work numerous applications using various elements.
- **Storage** This is used to save data for often use.
- **Network** It is the ability to communicate among systems. It assists us to share data and resources.

Vendors of Cloud Computing

- Amazon Web Services—IaaS
- Google—SaaS, PaaS
- Microsoft Azure Service Platform—PaaS
- Rackspace—Cloud Hosting
- Salesforce.com—SaaS, PaaS

Elastic Computing

- Elastic computing is the capability of a cloud service supplier to provision flexible computing strength when and where required.
- In cloud computing, elasticity is described as the level to which a system is capable of adapting to workload variation by offering and taking back resources the autonomic way; at every point in time the accessible resources meet the present need.

Social Networking

- Social networking may be done for business purposes, social purposes, or both.
- Examples of social networking include LinkedIn, Facebook, etc..
- A social networking website is an online podium which permits customers to build a public profile and interact with other users on the website.
- Some social networking websites like LinkedIn are used for creating professional links, whereas sites such as Facebook are on both sides of the line (i.e., professional and private).

Enterprise Cloud Computing

Enterprise cloud computing is the process of using cloud computing for saving cost and for business innovation by getting extraordinary speed and agility, and improved collaboration among customers and business partners. Enterprise cloud computing is important because:

- Cost of accessing data can be reduced to a great extent by linking it directly with the usage. Customers are charged on a pay-per-use basis.
- Start-ups can test out new business ideas risk-free and at low cost, due to enormous scalability. Since there is no upfront capital expense involved, in case a new project takes off, it can be scaled up instantly, and vice versa.

Enterprise Cloud Computing

- Enterprise cloud computing allows a company to create a shared workspace in order to collaborate with its trading partners and work together as a 'virtual enterprise network'. In this way, they can share the information and communication resources, without actually owning it all. This also helps in lowering costs. As shown in Fig. 1.9, an enterprise with *n* numbers of hosts can connect through cloud services and different types of services supported by cloud network such as database, servers, and various applications.

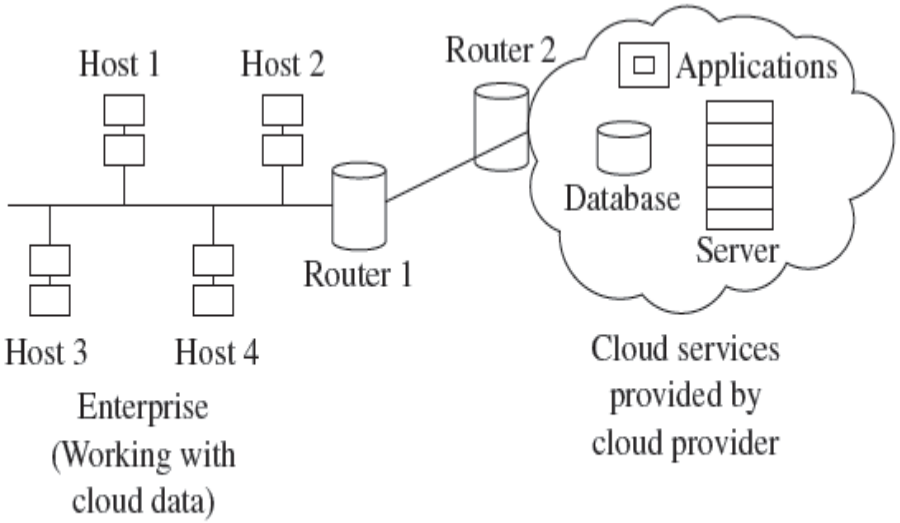


Fig. 1.9 Enterprise cloud computing

Cloud computing business value

- Provides creative ways for companies to address how they utilize IT
- Reduces capital expenses and operational costs
- Makes IT applications and infrastructure dynamically available
- Provides rapid service delivery
- Provides ability to test new plans with little delay

Business impact when using a cloud

- Companies are improving their overall IT quality

- Substantial savings

✓ Power, operations, hardware purchase

✓ Avoids the cost impact associated with over-provisioning and under-provisioning

- New opportunities

✓ Investment to support a new product is noticeably reduced

- Faster start-up

✓ Time between approval of a project and the start of work is shorter

Cloud computing technological value

Technological capabilities

- Heritage of Grid Computing
- Resource capacity
- Virtualized pool of resources
- Automation
- Self service provisioning
- Scalability, agility
- Multi-tenancy

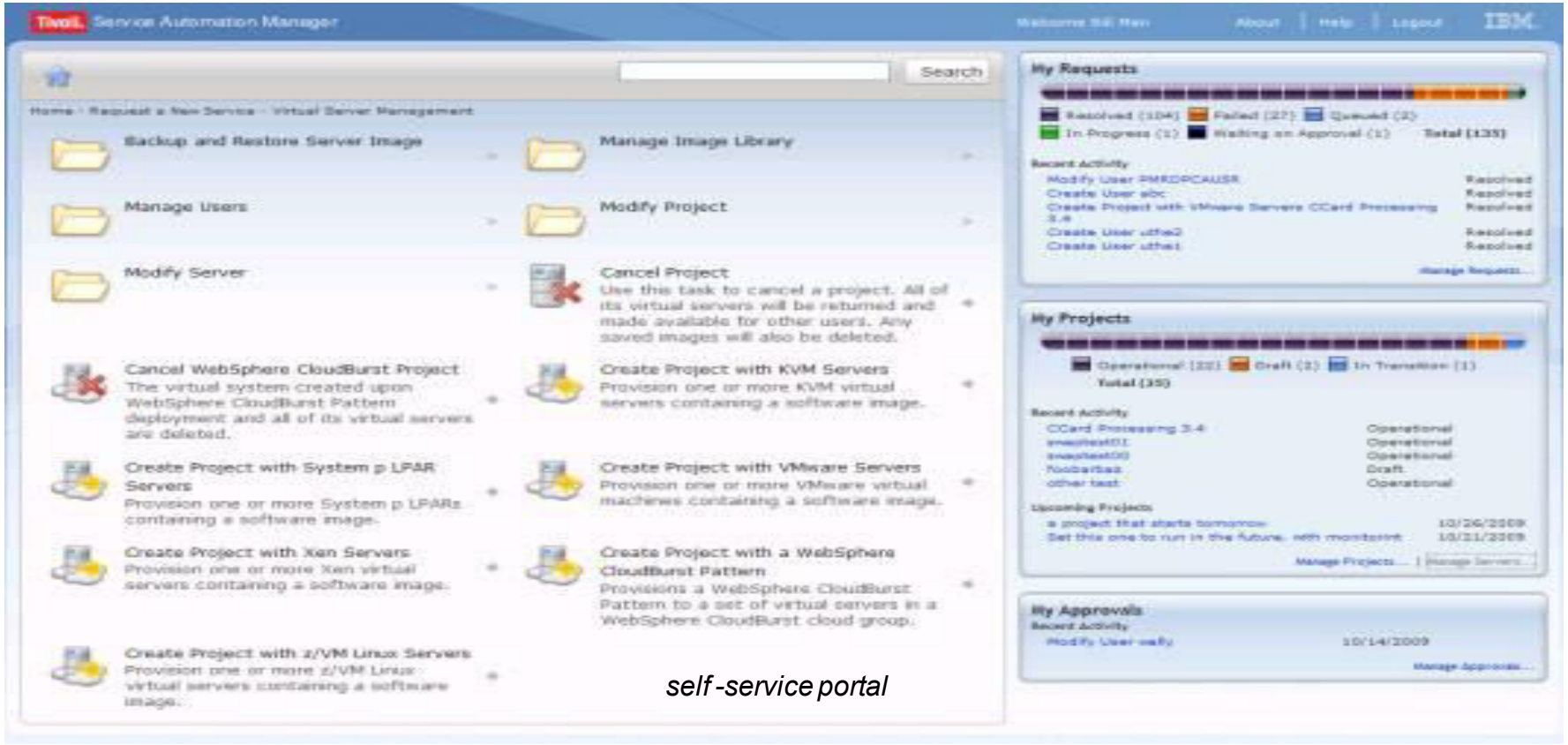
Value

- Accelerate the deployment of new applications by serving computing resources for the enterprise's core business
- Gain flexibility to meet changes in computing resource demands

Potential inhibitors…

Strong network management and high bandwidth needed Performance of applications Compliance with regulations for data stored in the cloud

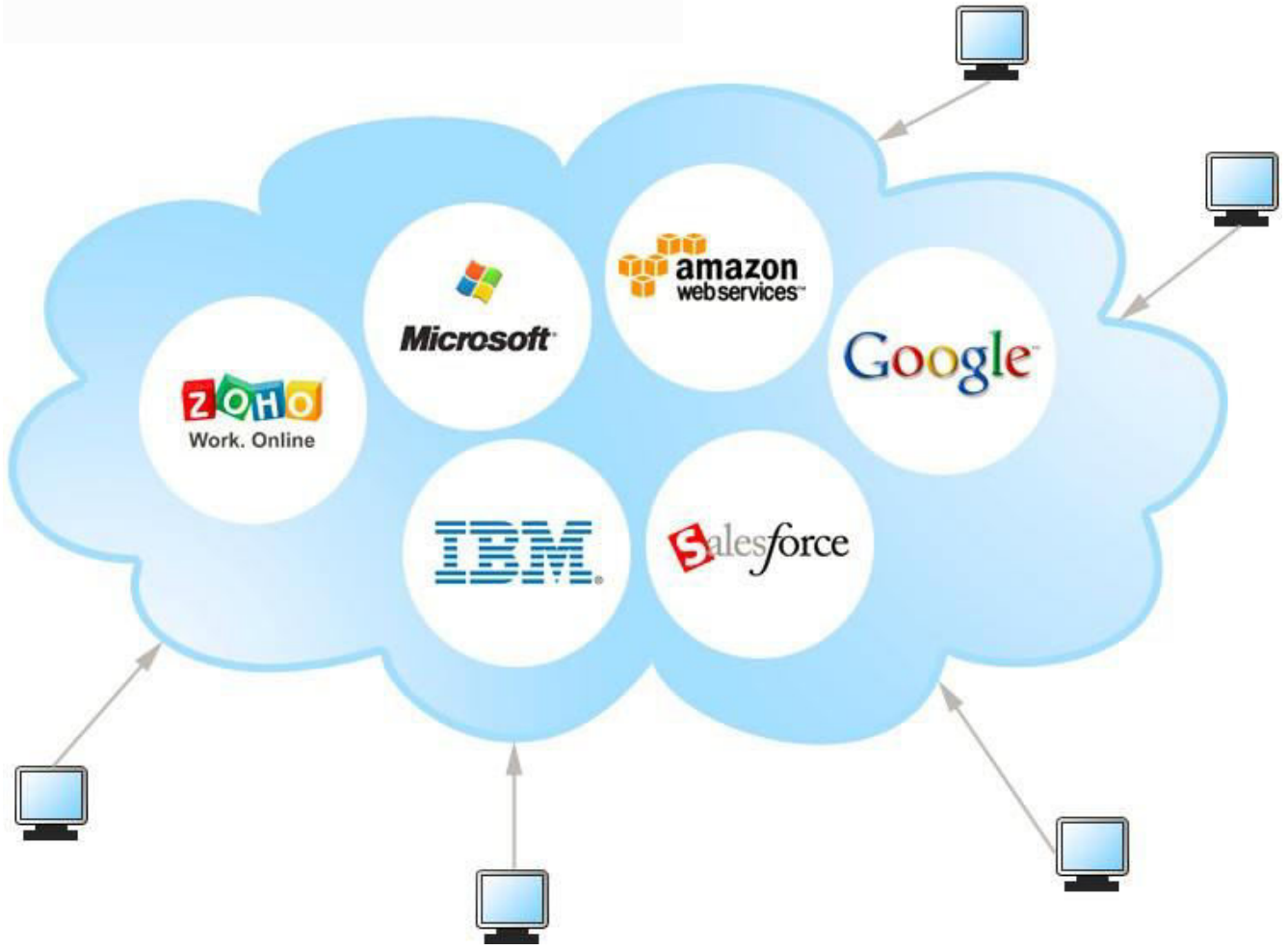
Cloud computing and end user



self-service portal

Similar to banking ATMs and retail point of sale, cloud is driven by self service technology advancement.

What does cloud computing change for the provider?



Pros and cons of a cloud model

- Pros:

✓ Scalability
✓ Cost
✓ Flexibility
✓ Agility
✓ Elasticity

Cons:

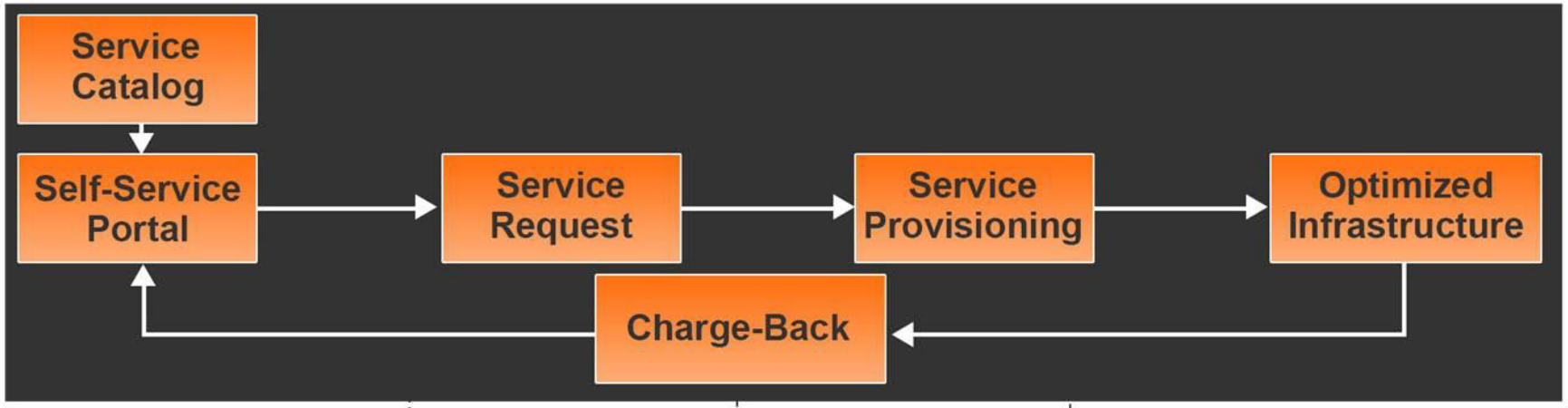
✓ Security
✓ Lack of control
✓ Standardization

Anatomy of a cloud

A cloud is composed of eight major components.

1. Provisioning and Configuration Module
2. Monitoring and Optimization
3. Metering and Chargeback
4. IT Service Management
5. Orchestration
6. CMDB (Configuration Management Database)
7. Cloud Lifecycle Management Layer
8. Service Catalog

Cloud computing solution components



User/IT self service
Improving customer satisfaction and responsiveness

Standardized delivery models
Utilize service catalog of standard components.

Capacity management
Reservation with connection to platform configuration

Controlled anticipation
Validated change requests with automated approval workflow process

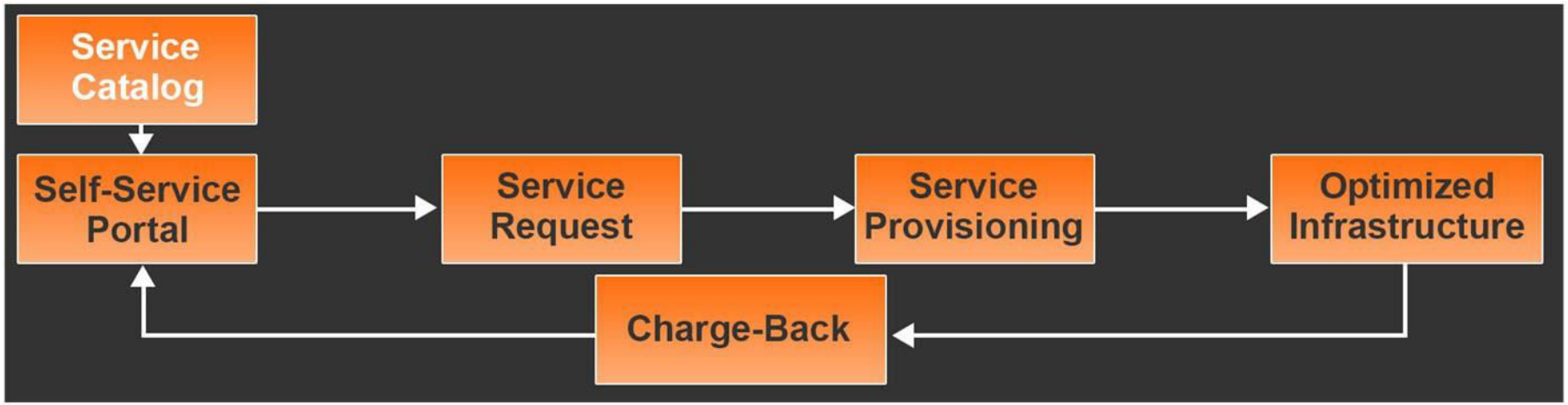
Low or no touch deployment
Drive down operational costs and manage thru full life-cycle

Deploy new systems faster
Shorter leads times, quicker to market, agility, competitive advantage

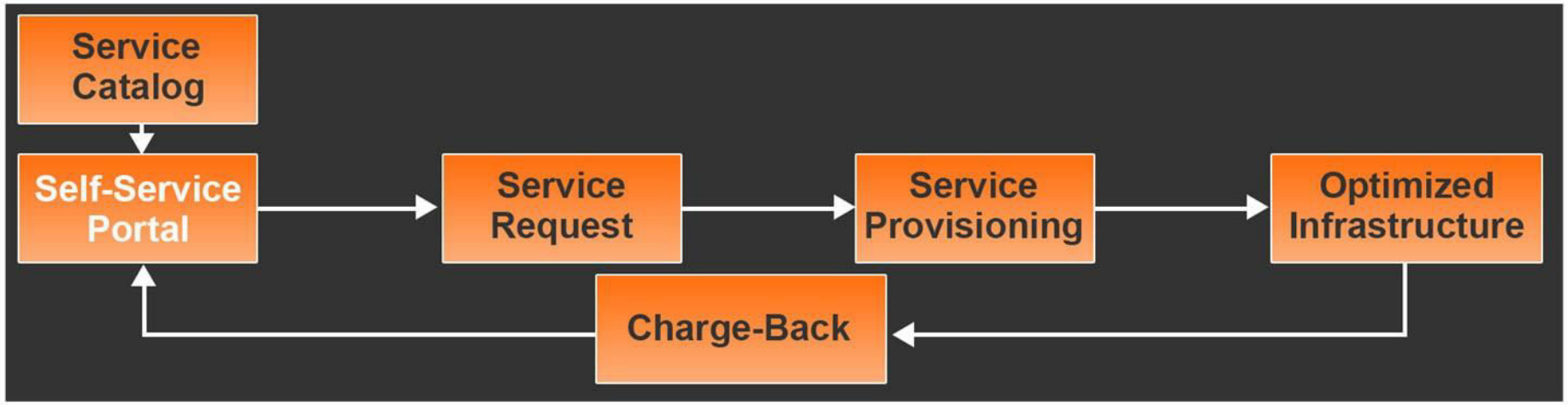
Improve server and power utilization
Cost avoidance on new hardware, energy and cooling costs

Consistency of configuration
Driving compliance, easier support and auditing, consistent security.

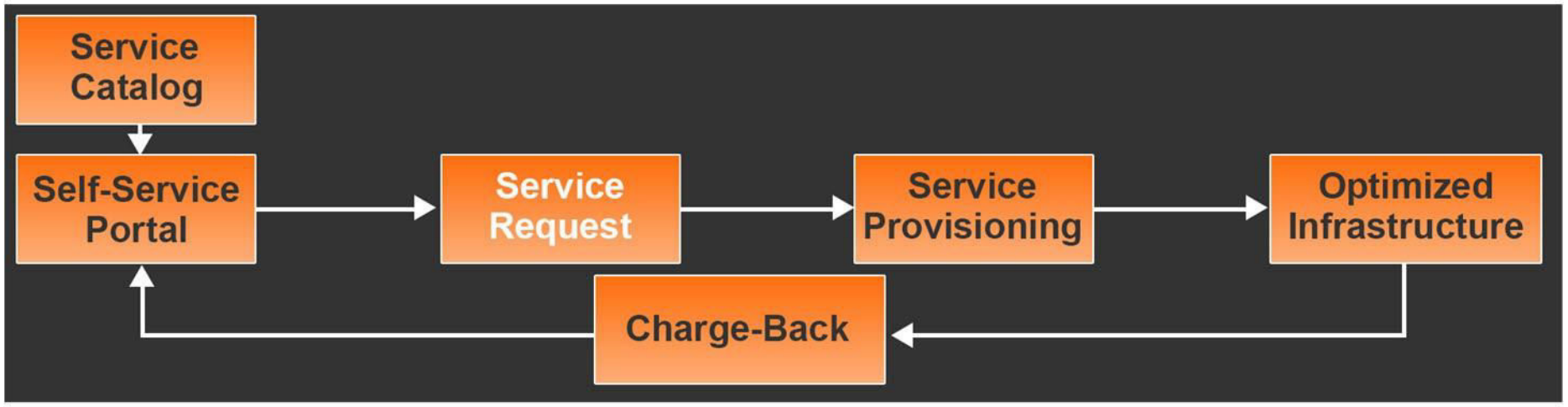
Service Catalog



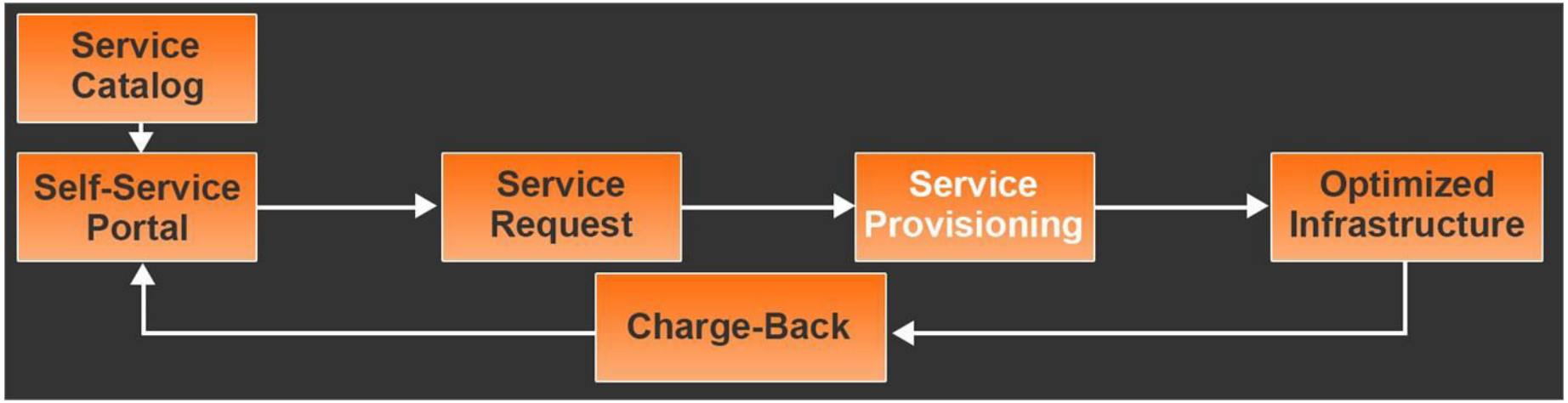
User self-service portal



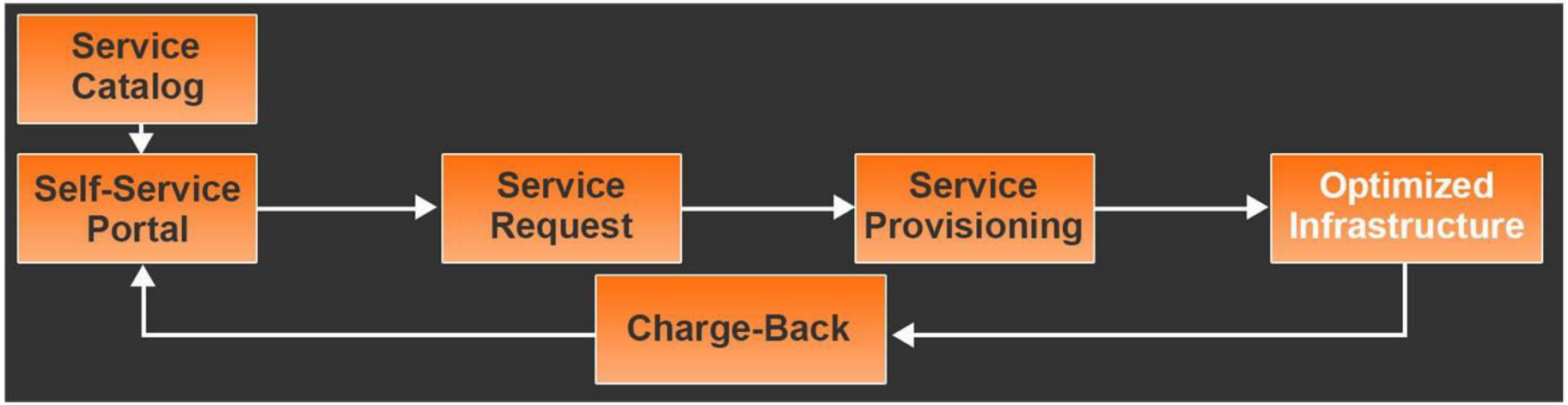
Service request management



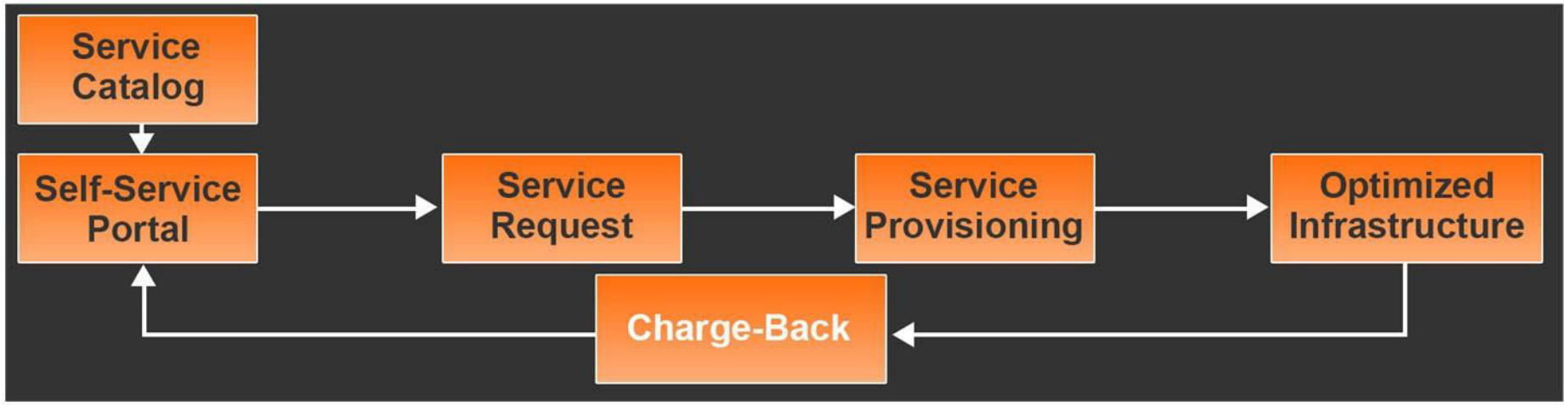
Provisioning



Optimized infrastructure



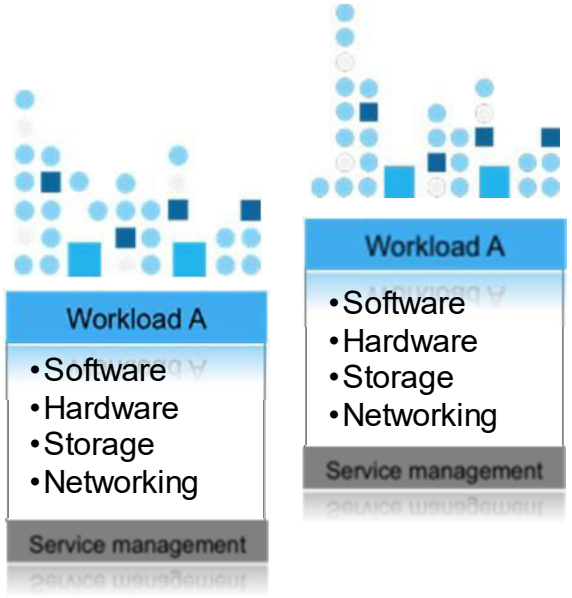
Chargeback



Chargeback model agreement between cloud provider and cloud consumer

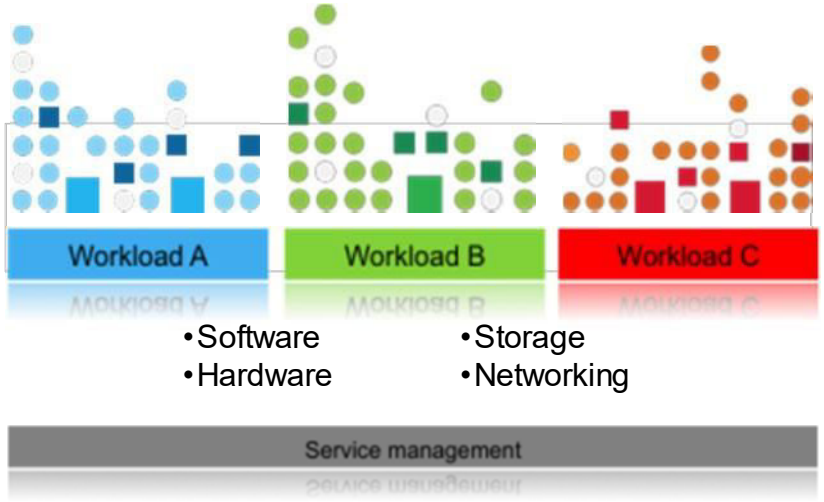
What is different about cloud computing?

Without cloud computing



With cloud computing

- Virtualized resources
- Automated service management
- Standardized services
- Location independent
- Rapid scalability
- Self-service



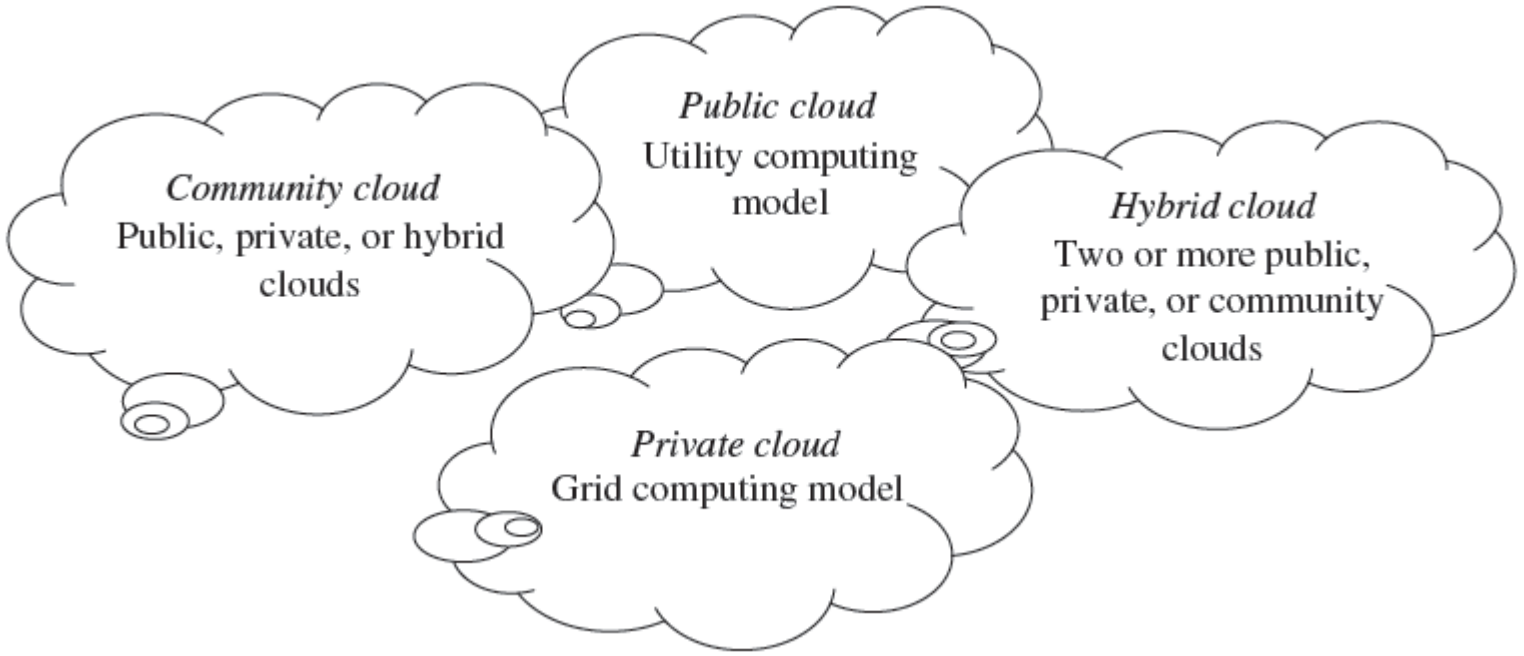
Benefits of cloud

Capability	From	To
Server/Storage Utilization	10-20%	70-90%
Self service	None	Unlimited
Test Provisioning	Weeks	Minutes
Change Management	Months	Days/Hours
Release Management	Weeks	Minutes
Metering/Billing	Fixed cost model	Granular
Standardization	Complex	Self-Service
Payback period for new services	Years	Months

Cloud Deployment Models

Cloud Deployment Models

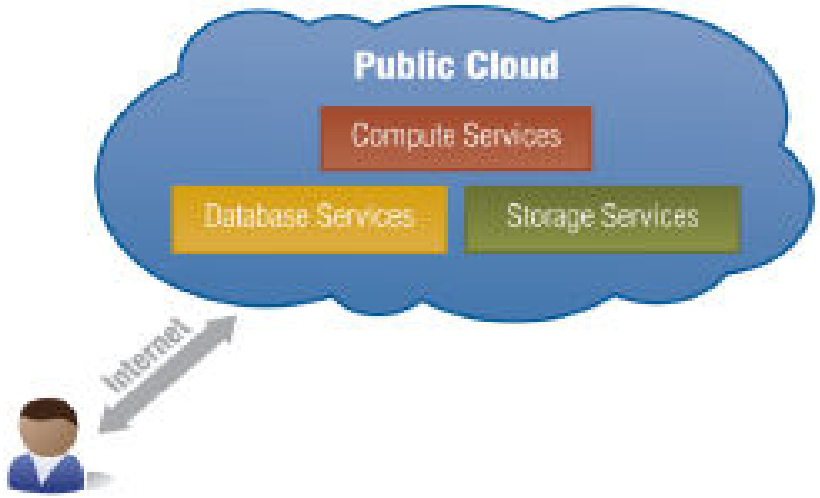
- **Deployment models define the type of access to the cloud, i.e., how the cloud is located?**
- The cloud model is invented with four deployment models—public cloud, private cloud, hybrid cloud, and community cloud.)

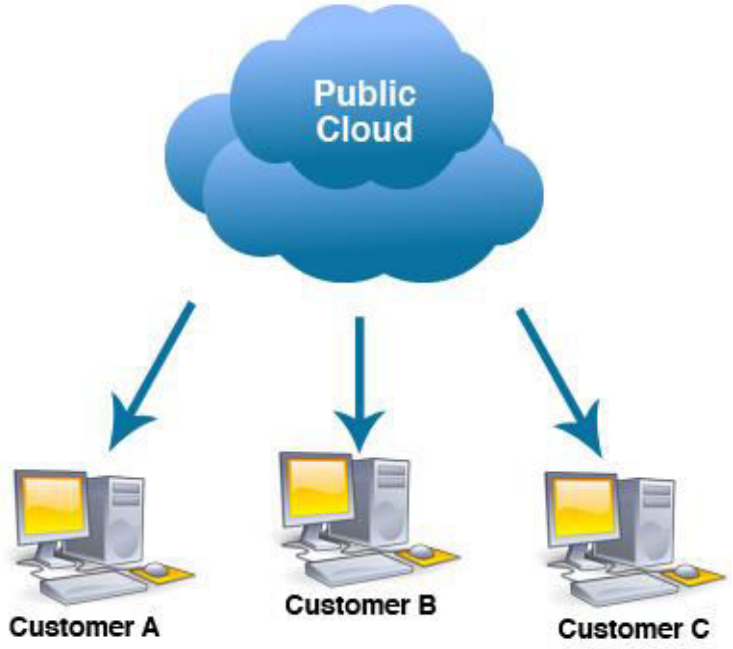


Public cloud

- **A Public cloud is basically the internet**. Service providers use the internet to make resources, such as applications and storage, available to the general public, or on a 'public cloud.
- The public cloud is the first deployment model. In this model, users have many options to opt for and decide on any service provider as per requirement.
- Some of the examples of those companies which provide public cloud facilities are: IBM, Google, Amazon, Microsoft etc. This cloud service is open for use.

- **Public Cloud**: the services are delivered to the client via the Internet from a third party service provider.





Public Cloud

- The advantages of Public cloud are:

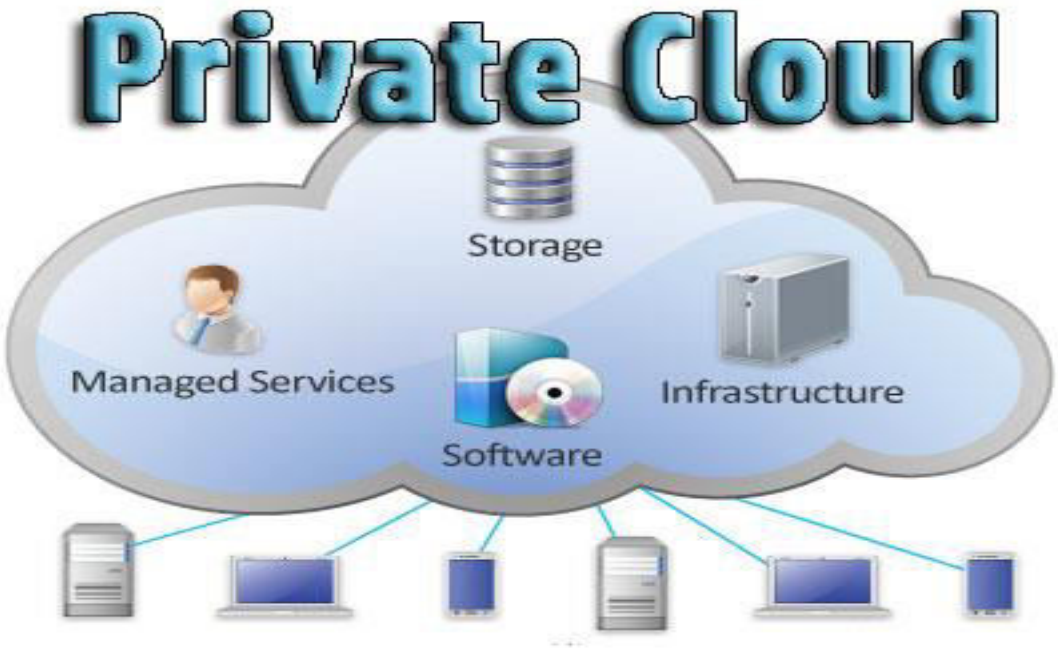
1. Flexible
2. Reliable
3. High Scalable
4. Low cost
5. Place independence

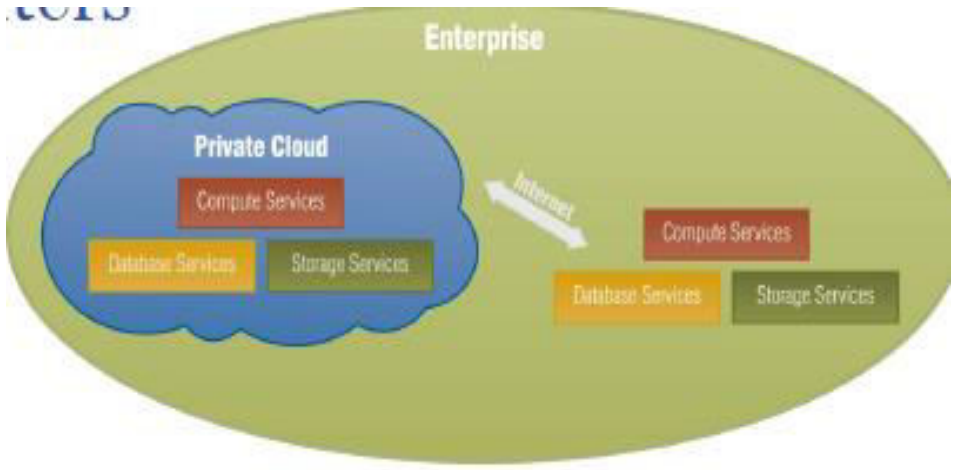
- Disadvantages are:

1. Less Secured
2. Poor Customizable: Not able to be modified

Private Cloud

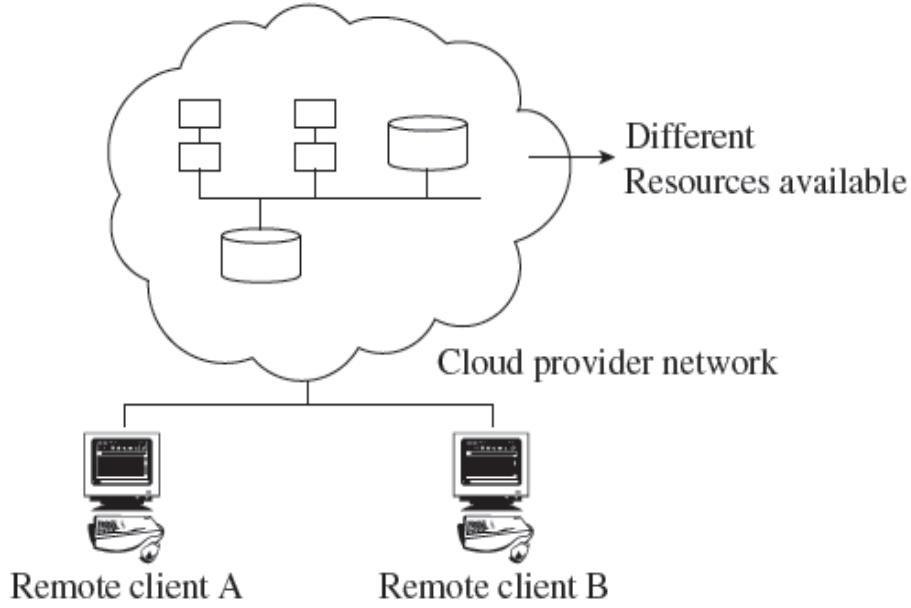
- **Private Cloud also termed as 'Internal Cloud';** which allows the accessibility of systems and services within a specific boundary or organization.
- The cloud platform is implemented on a cloud-based secure environment that is guarded by advanced firewalls under the surveillance of IT department that belongs to a particular organization.
- **Private clouds permit only authorized users, providing the organizations a greater control over data and its security**.
- ***Private Cloud are data centre architectures owned by a single company that provides flexibility, scalability, provisioning, automation and monitoring.***





Private Clouds

- The private cloud offers several advantages of an open cloud computing setting that comprises its service support and flexibility.
- Private clouds allow infrastructure to be accessed only by the members of the organization and granted by third parties.
- Examples of private cloud include Eucalyptus cloud computing infrastructure with Ubuntu Server, Elastra private-cloud, Vmware, Microsoft, etc.



Private Cloud

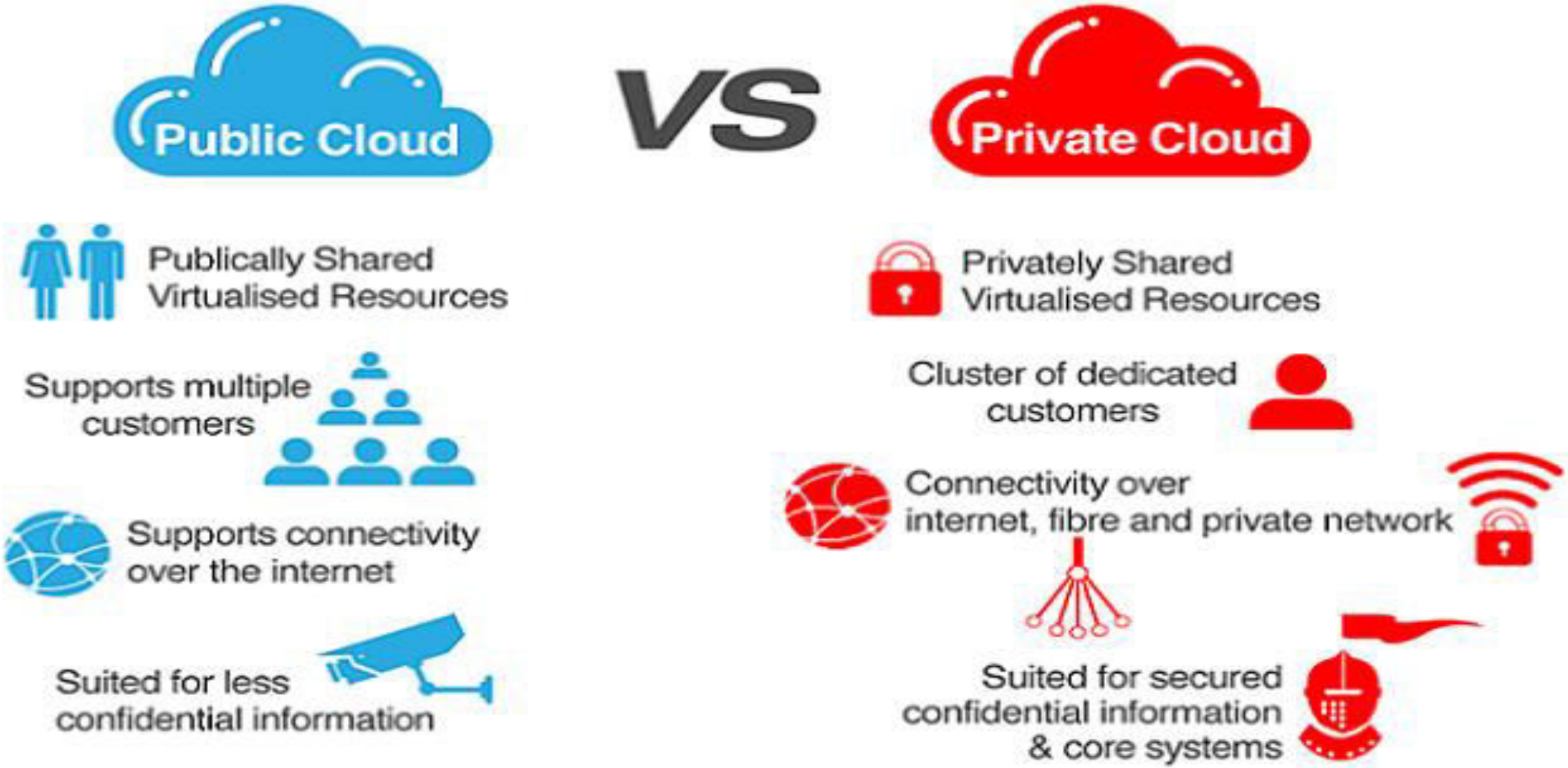
- The advantages of using private cloud are:

1. Highly private and secured: Private cloud resource sharing is highly secured.
2. Control Oriented: Private clouds provide more control over its resources than public cloud as it can be accessed within the organization's boundary.

- The Private cloud has the following disadvantages:

1. Poor scalability: Private type of clouds is scaled within internal limited hosted resources.
2. Costly: As it provides secured and more features, so it's costlier than public cloud.
3. Pricing: is inflexible; i.e. purchasing a new hardware for up-gradation is more costly.
4. Restriction: It can be access locally within an organization and is difficult to expose globally.

-


Public Cloud
VS
Private Cloud
Publically Shared
Virtualised Resources
Supports multiple
customers
Supports connectivity
over the internet
Suited for less
confidential information
Privately Shared
Virtualised Resources
Cluster of dedicated
customers
Connectivity over
internet, fibre and private network
Suited for secured
confidential information
& core systems

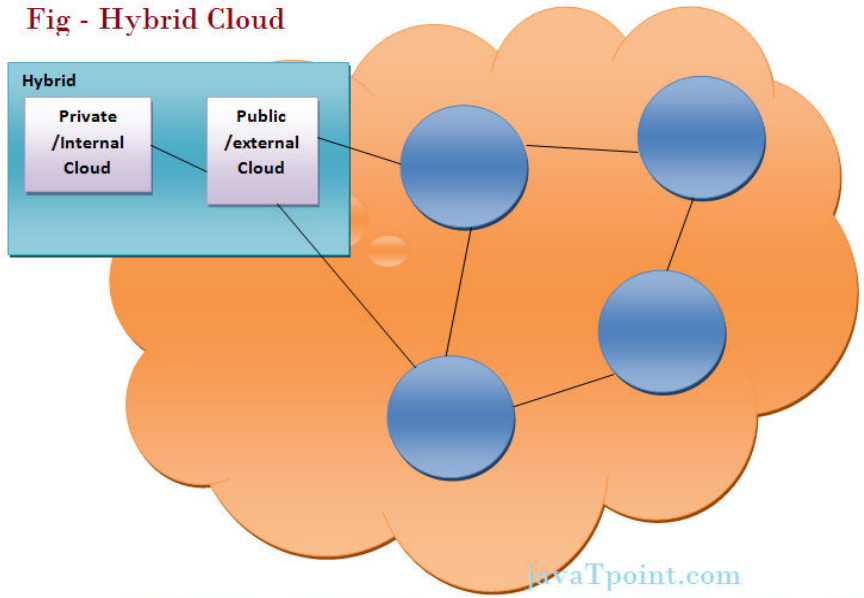
Hybrid Cloud

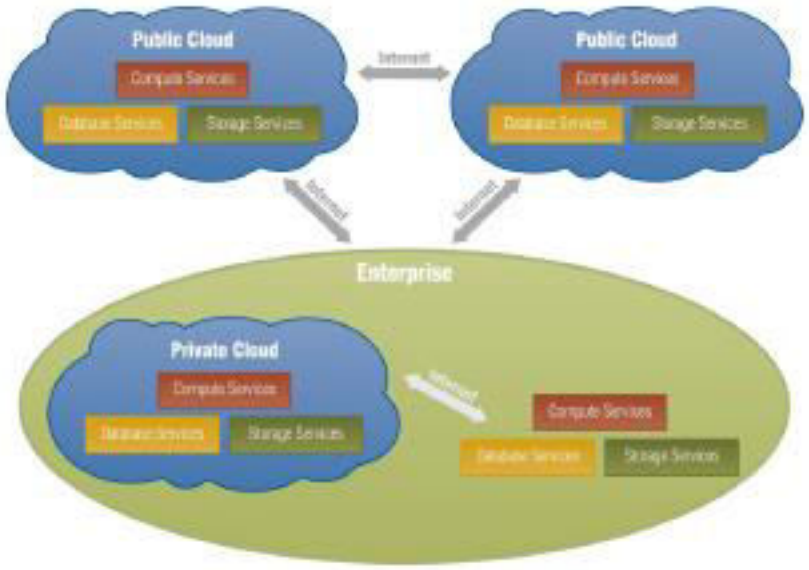
- The Hybrid cloud is the mixture of public and private cloud. Non-critical activities are performed by public cloud while critical activities are performed by private cloud.

- i.e. it can be a combination of two or more cloud servers, i.e. private, public or community combined as one architecture, but remain individual entities. *Non-critical tasks such as development and test work-loads can be done using public cloud* whereas *critical tasks that are sensitive such as organization data handling* are done using private cloud

Example:

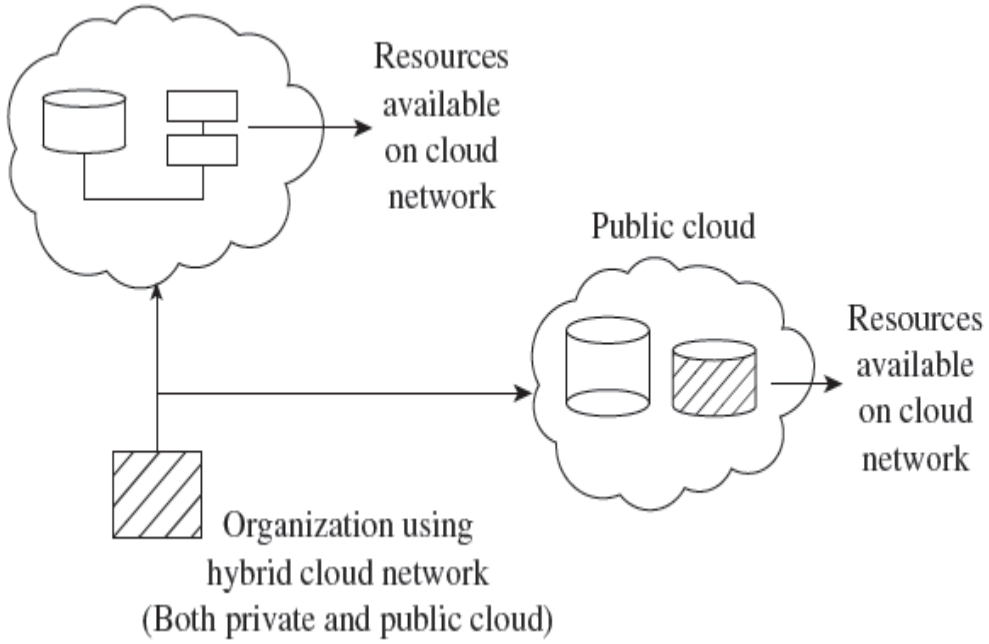
- ERP in Private cloud
- Sales & Email on public





Hybrid Clouds

- The hybrid cloud is a combination of a private and public cloud which is mutually dependent on one another.
- In this model, cloud users are supplied with information on the public cloud, in spite of the reality that the cloud supplier has to maintain the company-significant services and information in a few instructions.



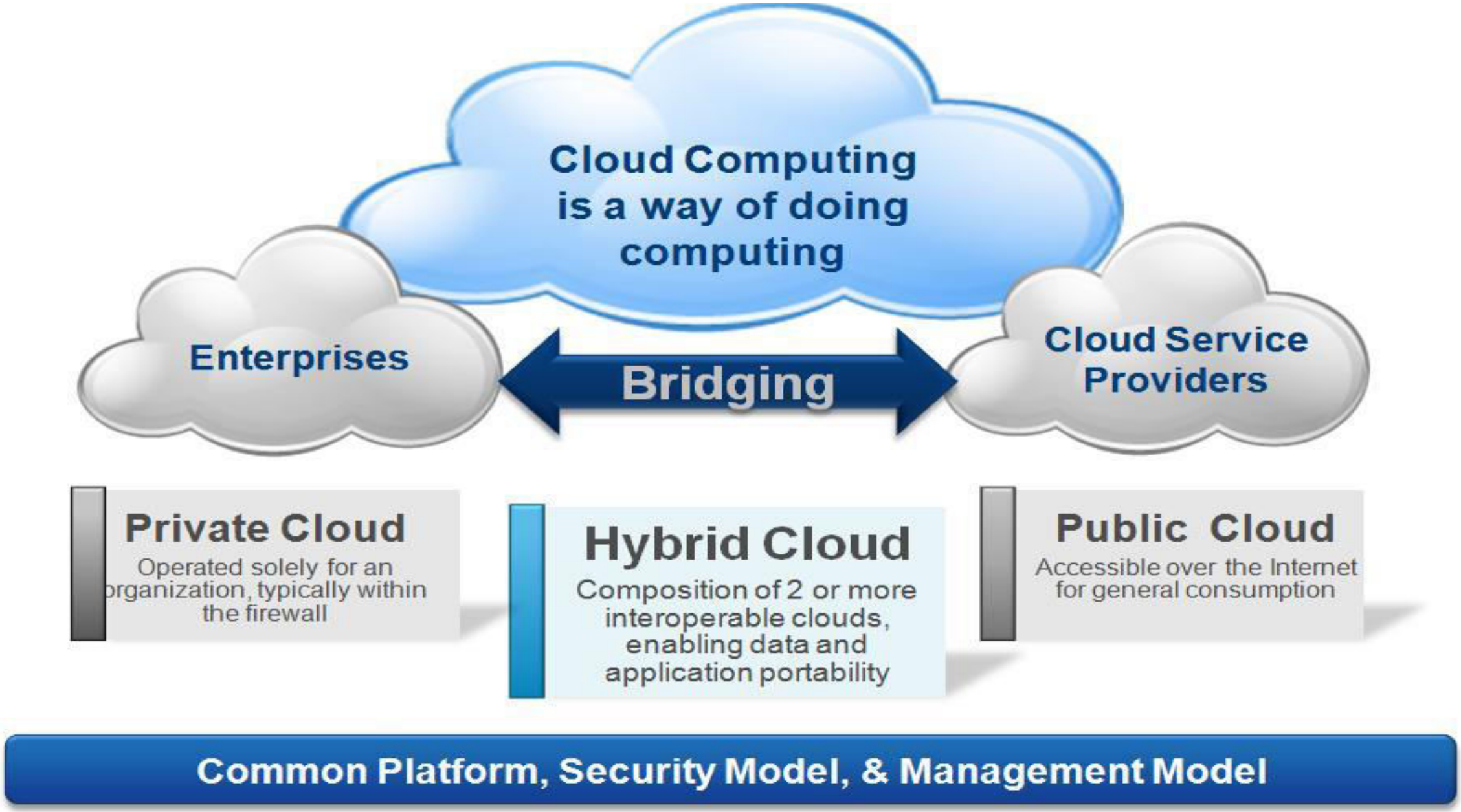
Hybrid Cloud

- Advantages of Hybrid Cloud Computing are:

1. Flexible
2. Secure
3. Cost Effective
4. Rich Scalable

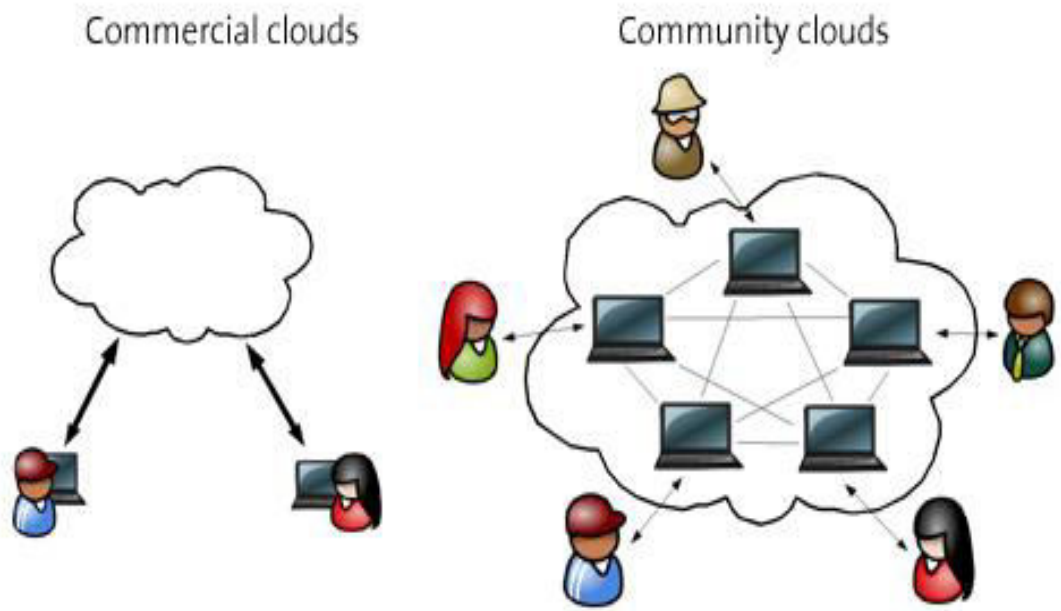
- Disadvantages of Hybrid Cloud are:

1. Complex networking problem
2. Organization’s security Compliance


Cloud Computing is a way of doing computing
Enterprises
Bridging
Cloud Service Providers
Private Cloud
Operated solely for an organization, typically within the firewall
Hybrid Cloud
Composition of 2 or more interoperable clouds, enabling data and application portability
Public Cloud
Accessible over the Internet for general consumption
Common Platform, Security Model, & Management Model

Community Cloud

- Community Cloud is type of cloud computing in which setup of cloud is shared manually among different organizations that belong to the same community or area.
- Example of such community is where organizations/firms are there along with the financial institutions/banks.
- A multi-tenant setup developed using cloud among different organizations that belong to a particular community or group having similar computing concern.
- For joint business organizations, ventures, research organizations and tenders community cloud is the appropriate solution.

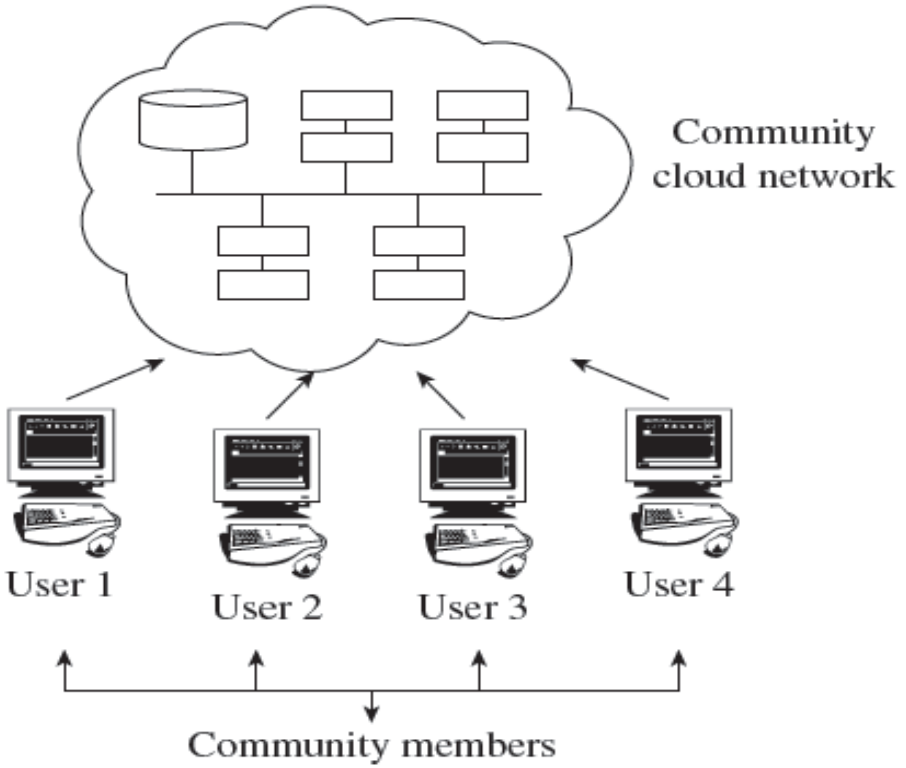


Community Clouds

- A community cloud falls between public and private clouds category.
- The drawback related to a community cloud is that of having costs higher than a public cloud.
- Examples of community cloud include

  Google's 'Gov Cloud', NASA Nebula cloud,

  etc.



Pros and cons of each architecture

- **Benefits**

- **Private cloud:**
  - ✓ Fewer security concerns
  - ✓ IT organization retains control over data center

- **Public cloud:**
  - ✓ Low investment
  - ✓ Good test/development environment for applications

- **Hybrid cloud:**
  - ✓ Operational flexibility
  - ✓ Scalability

- **Risks**

- **Private cloud:**
  - ✓ High investment hurdle in private cloud implementation
  - ✓ New operational processes are required

- **Public cloud:**
  - ✓ Security concerns
  - ✓ IT organization may react negatively to loss of control over data-center function

- **Hybrid cloud:**
  - ✓ Hybrid clouds are still being developed
  - ✓ Control of security between private and public clouds

Deployment Models

- **PUBLIC CLOUD**

The **public cloud** allows systems and services to be easily accessible to the general public. Public cloud may be less secure because of its openness.

- **PRIVATE CLOUD**

The **private cloud** allows systems and services to be accessible within an organization. It is more secured because of its private nature.

- **COMMUNITY CLOUD**

The **community cloud** allows systems and services to be accessible by a group of organizations.

- **HYBRID CLOUD**

The **hybrid cloud** is a mixture of public and private cloud, in which the critical activities are performed using private cloud while the non-critical activities are performed using public cloud.

NIST Cloud Deployment Models

Public Cloud	Cloud infrastructure made available to the general public.
Private Cloud	Cloud infrastructure operated solely for an organization.
Hybrid Cloud	Cloud infrastructure composed of two or more clouds that interoperate or federate through technology
Community Cloud	Cloud infrastructure shared by several organizations and supporting a specific community

… and one other

Virtual Private Cloud	Cloud services that simulate the private cloud experience in public cloud infrastructure

Alternative Deployment Models

➢Linthicum Model

- Storage as a Service
- Database as a Service
- Information as a Service
- Process as a Service
- Application as a Service
- Platform as a Service
- Integration as a Service
- Security as a Service
- Management as a Service
- Testing as a Service

➢Jericho Cloud Cube Model

- Internal or external
- Proprietary or open
- Perimeterized or de-perimeterized architectures
- Outsourced or insourced

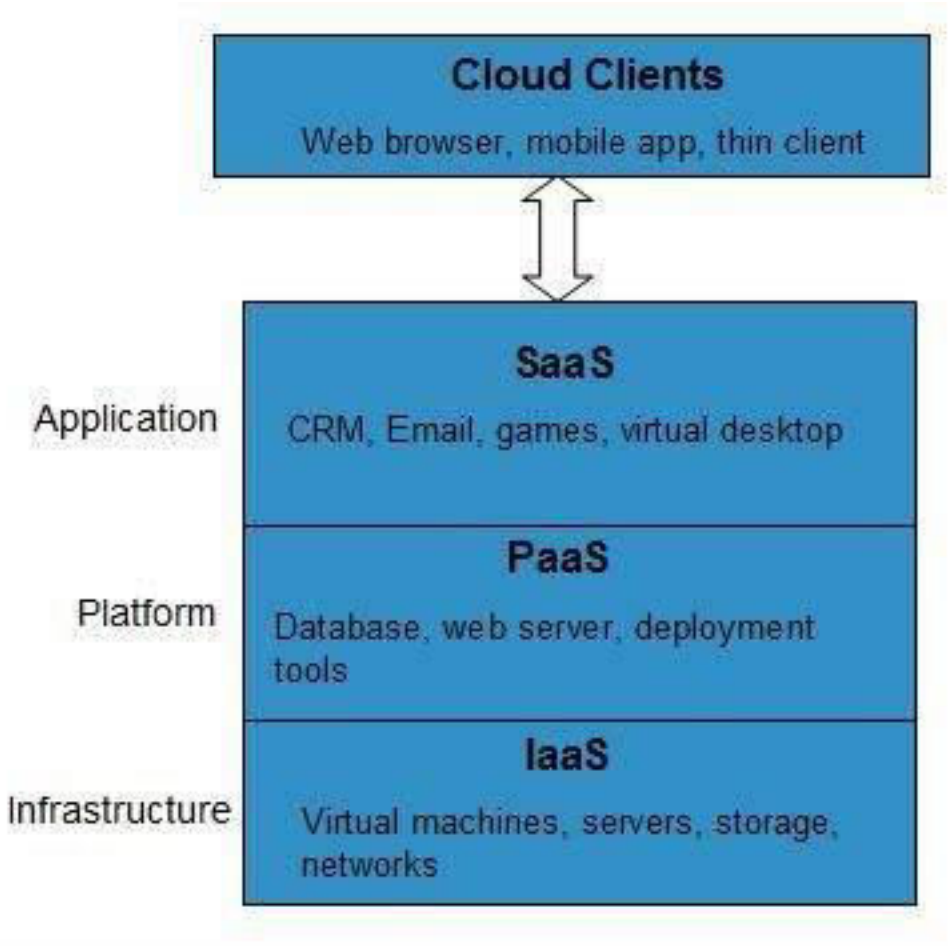
Service Models

- Cloud computing is based on service models.
- These are categorized into following service models which are -

1. **Infrastructure-as–a-Service (IaaS)**
2. **Platform-as-a-Service (PaaS)**
3. **Software-as-a-Service (SaaS)**
4. **Anything-as-a-Service (XaaS)** is also a service model, which includes
    - *Network-as-a-Service*
    - *Business-as-a-Service*
    - *Identity-as-a-Service*
    - *Database-as-a-Service*
    - *Strategy-as-a-Service*

Service model

- **IaaS** provides access to fundamental resources such as physical machines, virtual machines, virtual storage, etc.
- Interrelated e.g.: particular store in a mall., server.
- **PaaS** provides the runtime environment for applications, development and deployment tools, etc.
- Interrelated e.g.: Laundry Machine services, java platform.
- **SaaS** model allows to use software applications as a service to end-users.
- Interrelated e.g.: Services in restaurant., Google sheet, Google doc, Google slide.



1) **IaaS** (Infrastructure as a Service):

   a. Delivers computer infrastructure, typically a platform virtualization environment as a service.

   b. Cloud providers build datacenters, managing power, scale, hardware, networking, storage, distributed systems, etc...

   c. Rather than purchasing servers, software, data center space or network equipment, clients instead buy those resources as a fully outsourced service.

   d. Eg: Amazon Web Services(AWS), Rackspace Hosting, VMWare, Citrix, Azure

2) **PaaS** (Platform as a Service):

   a. Provides **developer's** necessary tools to create, test, host and maintain created applications.

   b. Cloud providers offer an Internet-based platform to developers who create services but don't want to build their own cloud.

   c. Ex: Microsoft Azure, Google App, AWS

3) **SaaS** (Software as a Service):

   a. SaaS is a software delivery methodology that provides licensed multi-tenant access to software and its functions remotely as a Web-based service.

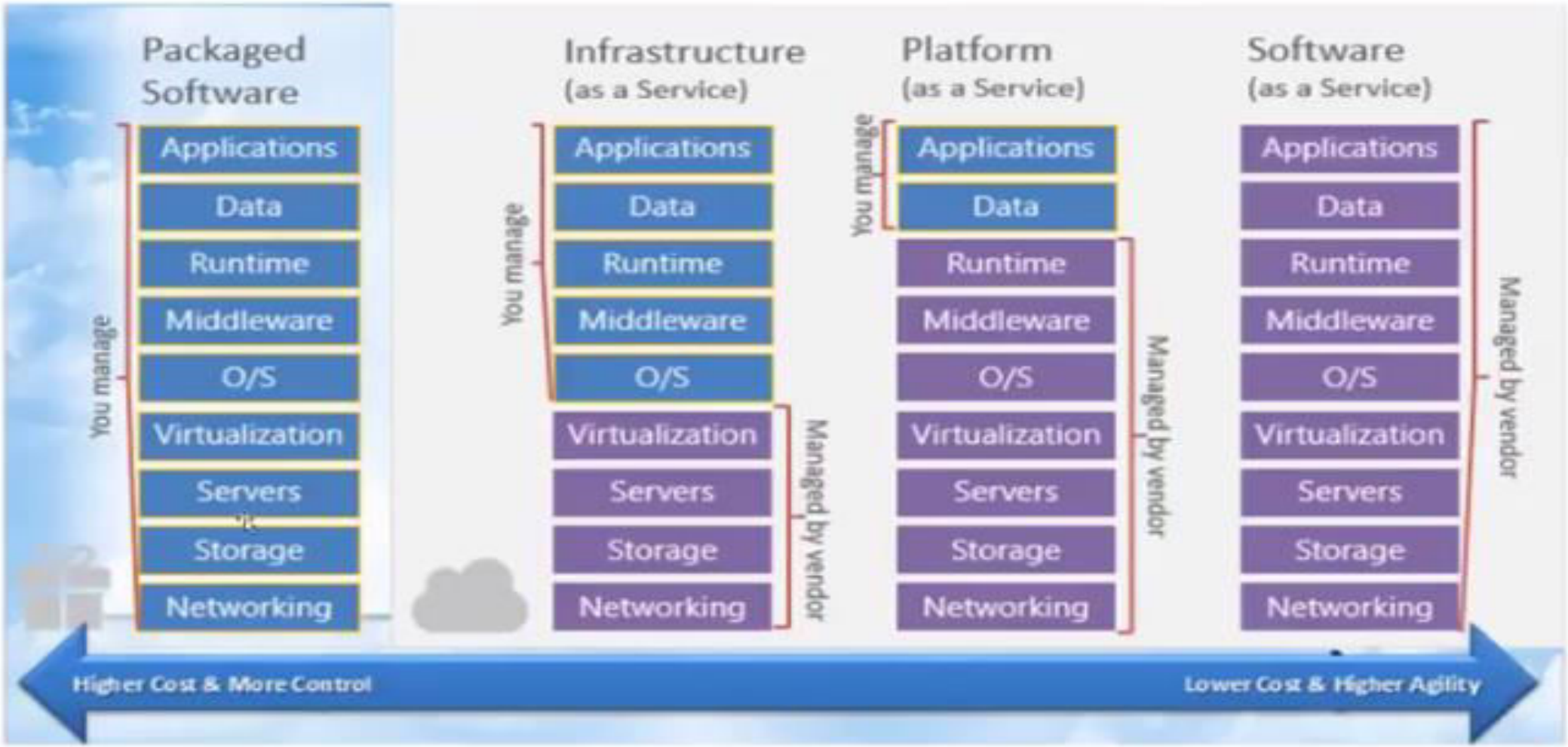
   b. From **end user's** point of view apps are located in the cloud and it is almost always accessible through a web browser.

   c. Any application hosted on a remote server that can be accessed over the Internet is considered as SaaS.

   d. Usually billed based on usage and a multi-tenant environment.

   e. Ex: Microsoft Azure, Gmail, Google Apps (Office like features), Sales Force CRM

The following picture neatly summarizes the functionality of the three service models of the cloud.

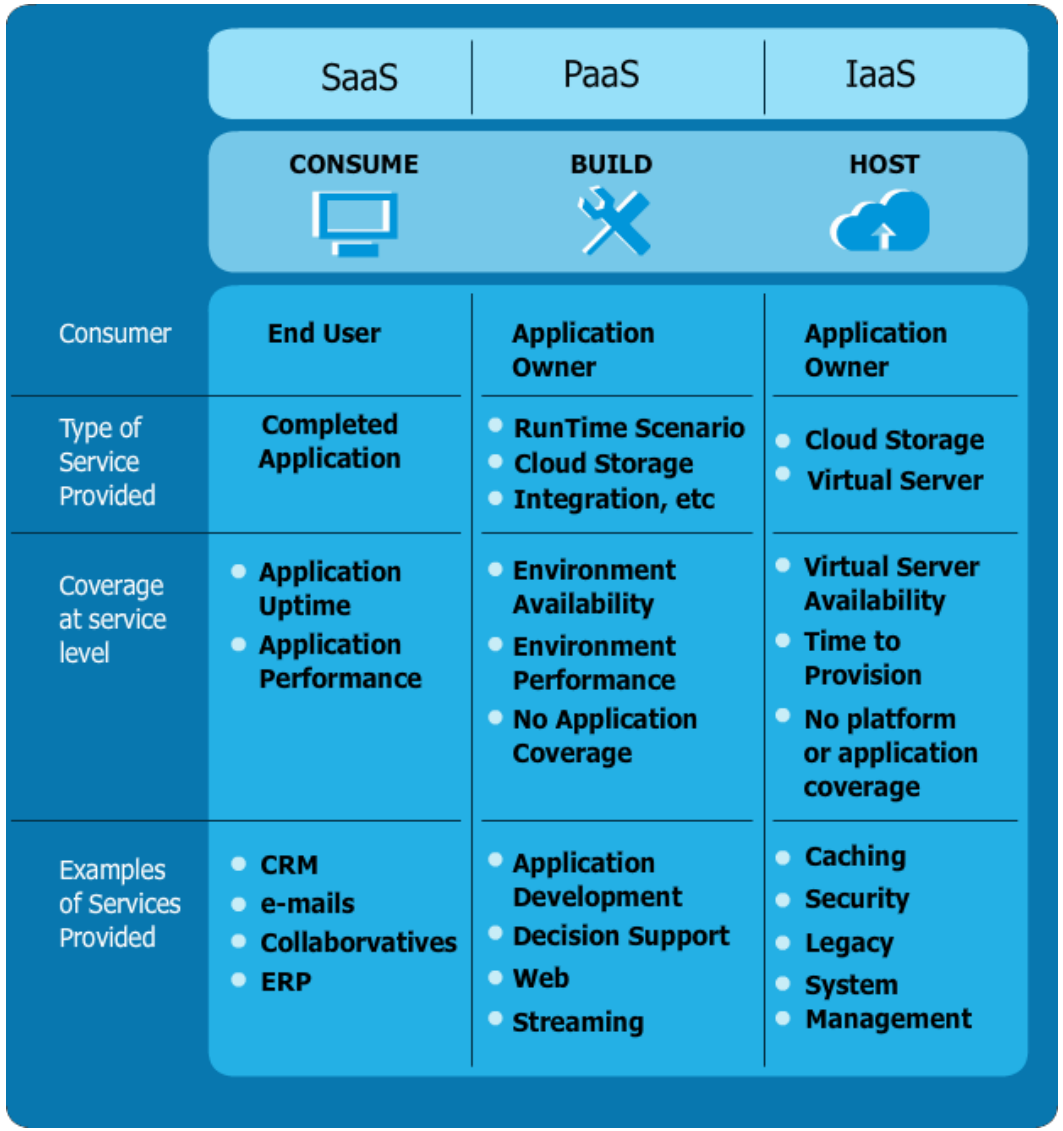


Cloud Delivery Models

→ Software as a Service (SaaS):
- » The application is hosted centrally
- » Software testing takes place at a faster rate
- » Reduction in IT operational costs
- » No need to install new software to release updates

→ Platform as a Service (PaaS):
- » Facilitation of hosting capabilities
- » Designing and developing the application
- » Integrating web services and databases
- » Providing security, scalability and storage

→ Infrastructure as a Service (IaaS):
- » Virtualization of Desktop
- » Internet availability
- » Use of billing model
- » Computerized administrative tasks



What does Pay-as-you-go Mean?

Service Model	Typical Unit of Measure	Typical values
SaaS	Per user per month, Per location per month, etc.	No norm. The vendor is free to set his pricing and the unit of measure!
PaaS	Per GB per month for DBs, Per connection per month for integration layer, Data Transfer In/Out	10 USD/GB-month
IaaS	Instance-hours per month, Data Transfer in/Out, GB per month for storage	10 cents/hour 10 cents/GB – in, 15 cents/GB-out 10 cents/GB-month

SaaS

Software
as a Service

Email

CRM

Collaborative

ERP

CONSUME

PaaS

Platform
as a Service

Application Development

Decision Support

Web

Streaming

BUILD ON IT

IaaS

Infrastructure
as a Service

Caching

Legacy

File

Networking

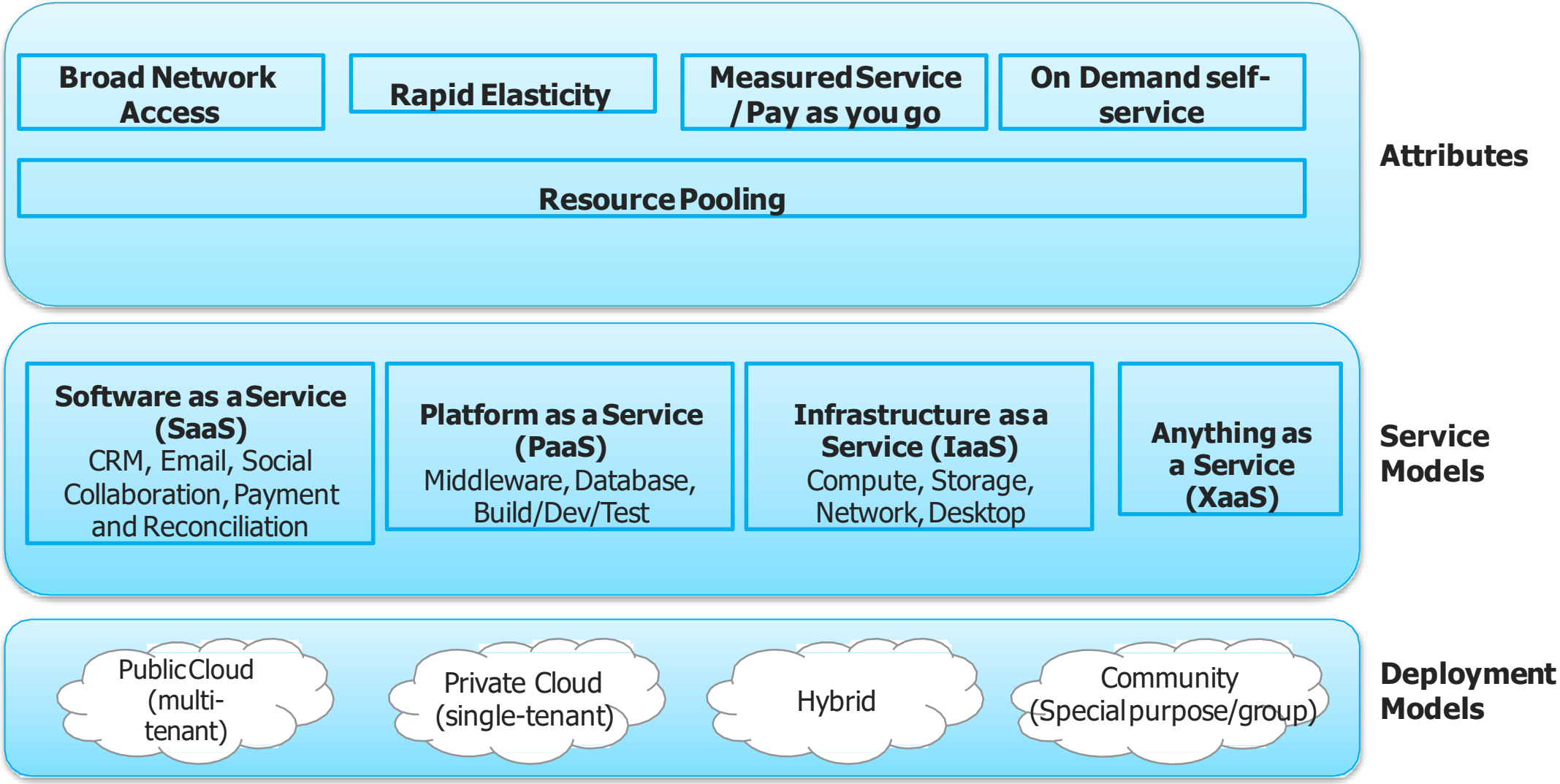
Technical

Security

System Mgmt

MIGRATE TO IT

Cloud Introduction: The NIST Model

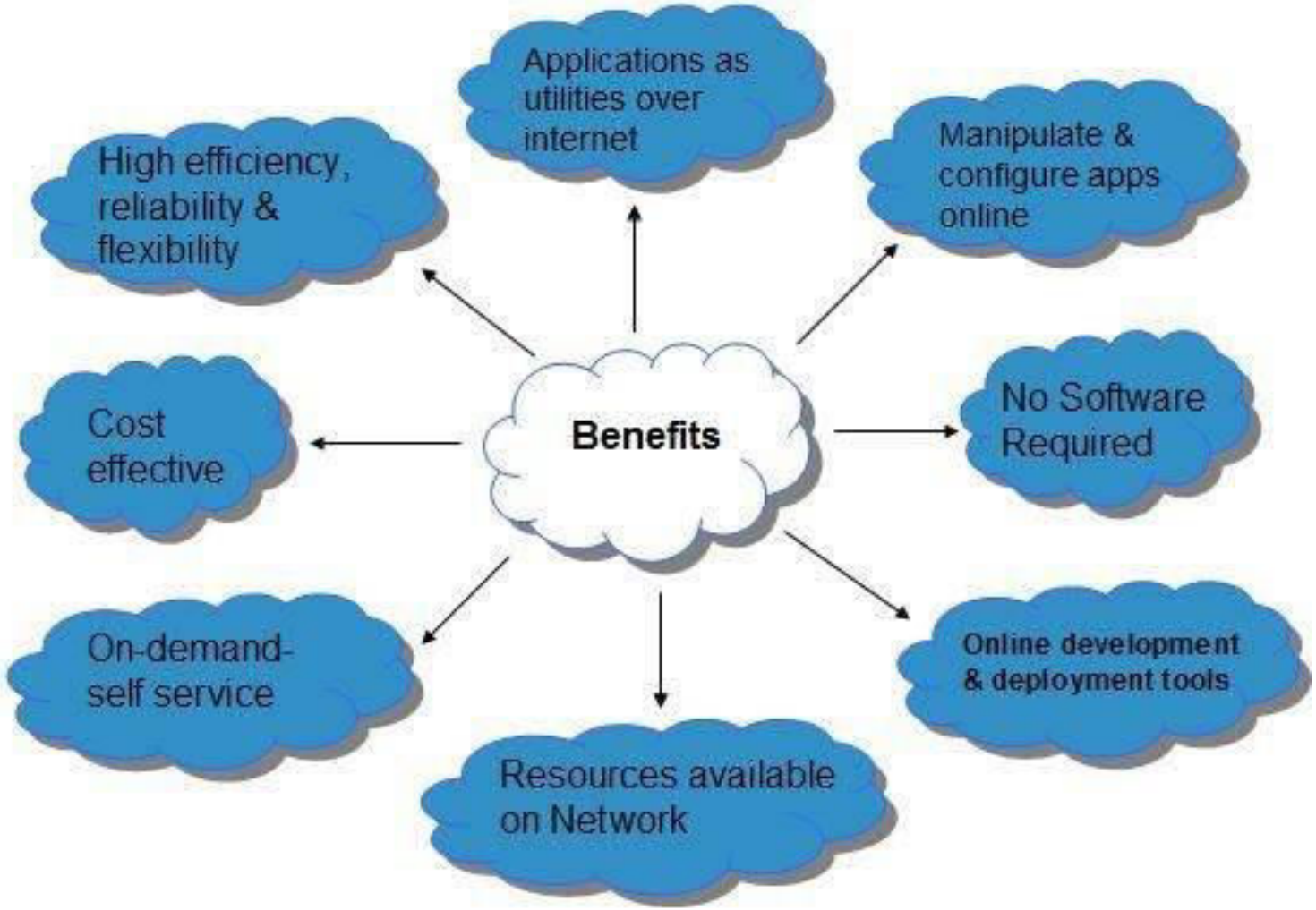


http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf

NIST Model

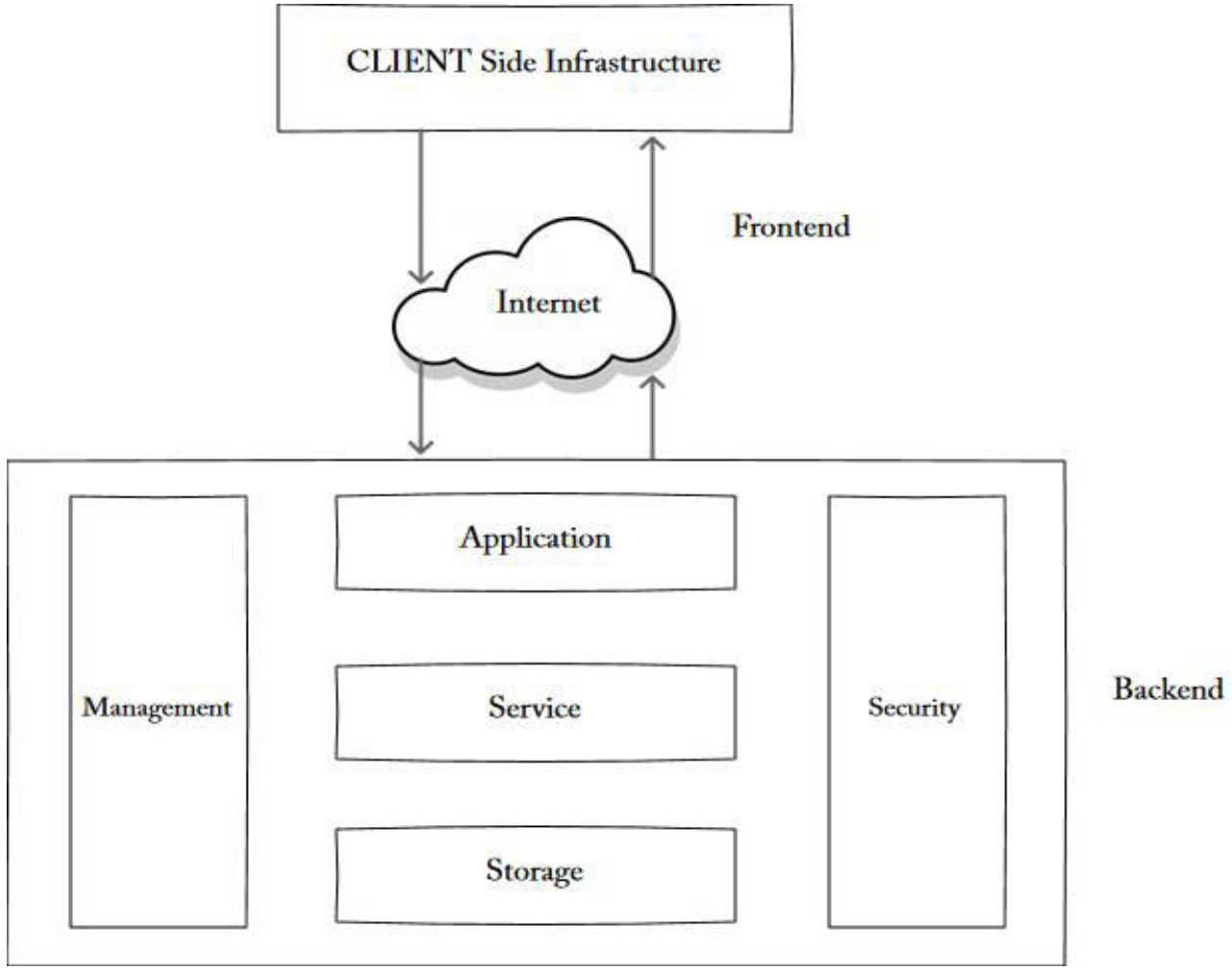
- **On Demand Self Service:** Cloud Computing allows the users to use web services and resources on demand. One can logon to a website at any time and use them.
- **Broad Network Access:** Since cloud computing is completely web based, it can be accessed from anywhere and at any time.
- **Resource Pooling:** Cloud computing allows multiple tenants to share a pool of resources. One can share single physical instance of hardware, database and basic infrastructure.
- **Rapid Elasticity:** It is very easy to scale the resources vertically or horizontally at any time. Scaling of resources means the ability of resources to deal with increasing or decreasing demand.
- The resources being used by customers at any given point of time are automatically monitored.
- **Measured Service:** In this service cloud provider controls and monitors all the aspects of cloud service. Resource optimization, billing, and capacity planning etc. depend on it.

Benefits of Cloud Computing



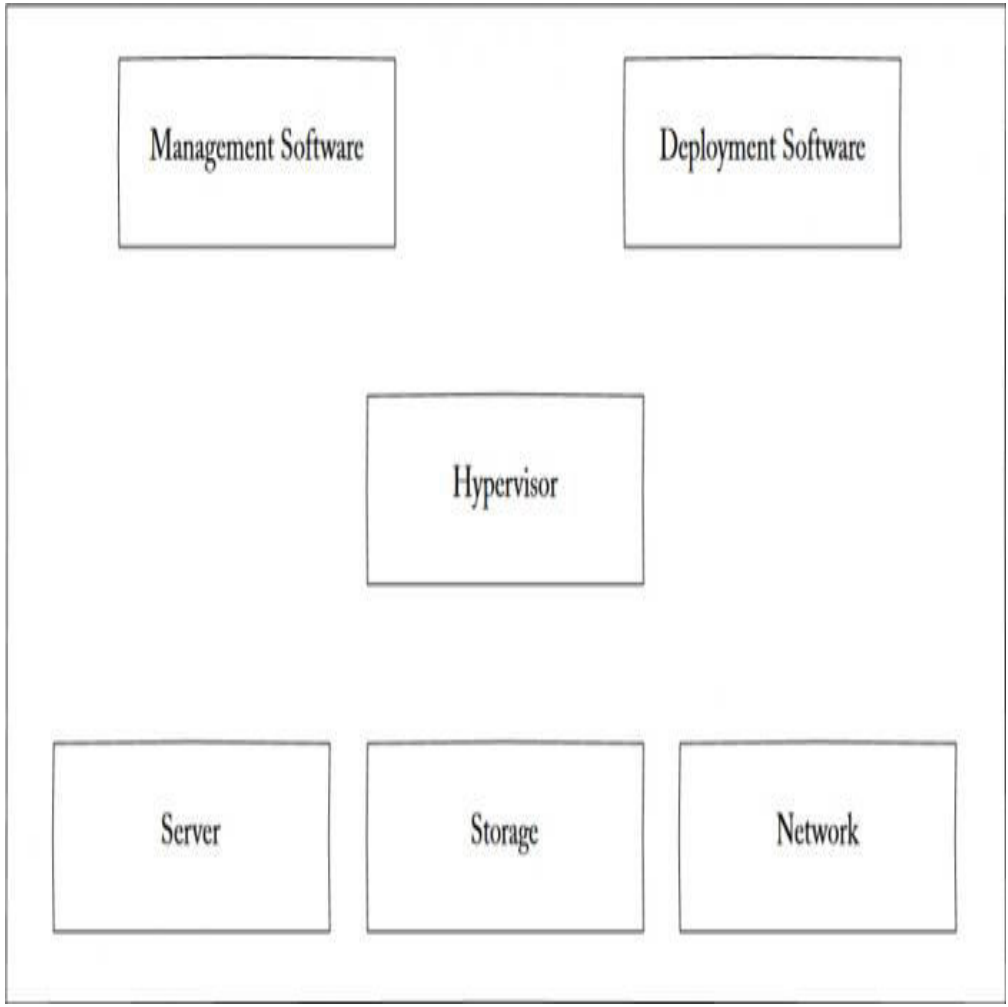
Cloud Architecture layers- Exploring Cloud stack

- The broad divisions of cloud architecture are:
- Front-end
- Back-end
- Each of the ends is connected through a network, usually Internet.
- The **front end** refers to the client part of cloud computing system. It consists of interfaces and applications that are required to access the cloud computing platforms, Example - Web Browser.
- The **back End** refers to the cloud itself. It consists of all the resources required to provide cloud computing services. It comprises of huge data storage, virtual machines, security mechanism, services, deployment models, servers, etc.



Cloud infrastructure: components

- **Cloud infrastructure** consists of servers, storage devices, network, cloud management software, deployment software, and platform virtualization
- Management Software: It helps to maintain and configure the infrastructure.
- Deployment Software: It helps to deploy and integrate the application on the cloud.
- Network: It allows to connect cloud services over the Internet Server
- The **server** helps to compute the resource sharing and offers other services
- Storage: Cloud keeps multiple replicas of storage. If one of the storage resources fails, then it can be extracted from another one, which makes cloud computing more reliable.



Composability

- cloud computing describes some new capabilities that are architected into an application stack and are responsible for the programmability, scalability, and virtualization of resources. One property that differentiates cloud computing is referred to as composability.
- Applications built in the cloud often have the property of being built from a collection of components, a feature referred to as composability.

- Benefits from a composable system that a user does—these things, among others:
- Easier to assemble systems
- Cheaper system development
- More reliable operation
- A larger pool of qualified developers
- A logical design methodology

Platform-as-a-Service

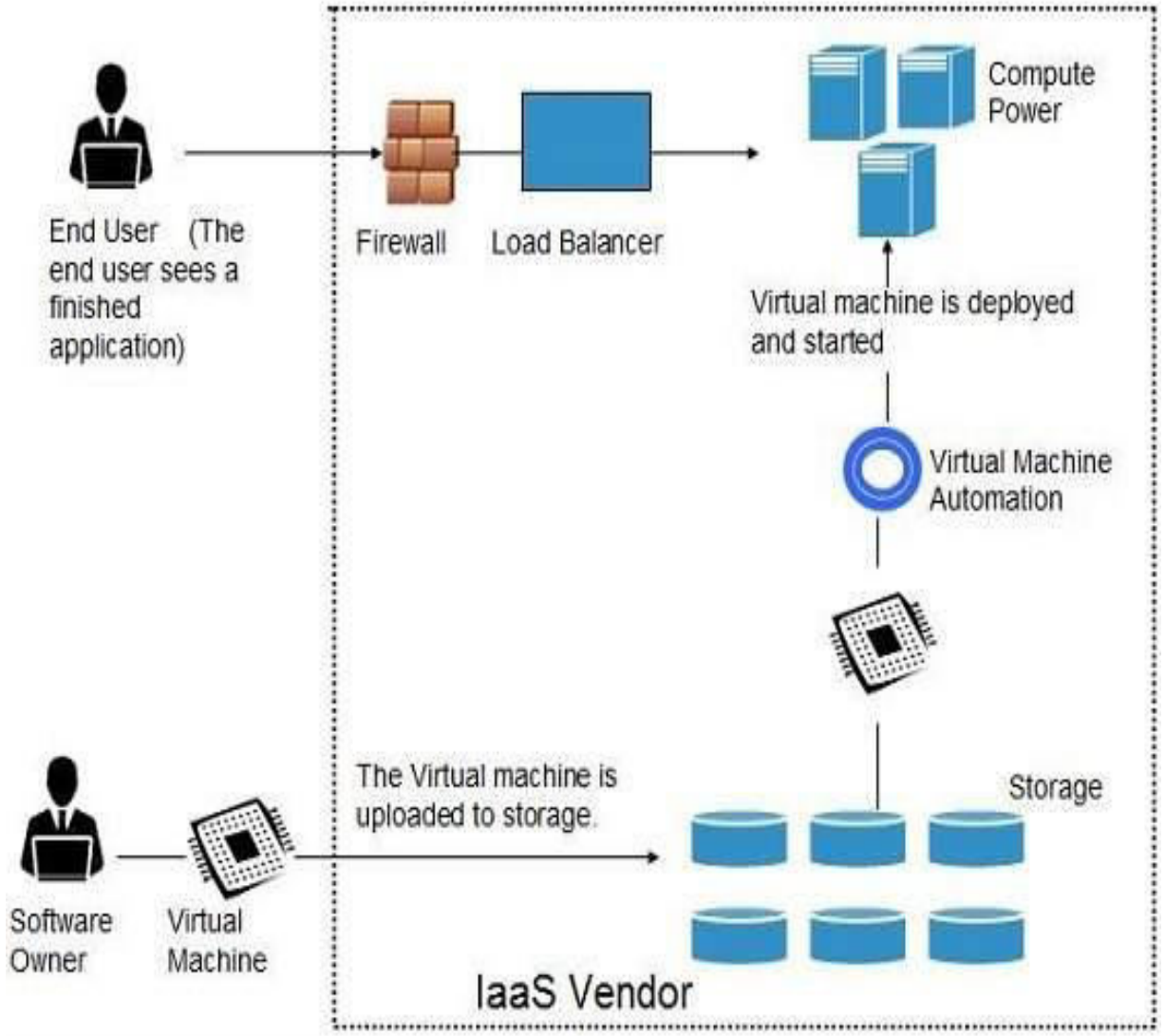
- It offers the runtime environment for applications. It also offers development and deployment tools required to develop applications. PaaS has a feature of **point-and-click** tools that enables non-developers to create web applications.
- **App Engine of Google** and **Force.com** are examples of PaaS offering vendors. Developer may log on to these websites and use the **built-in API** to create web-based applications.
- But the disadvantage of using PaaS is that, the developer **locks-in** with a particular vendor. For example, an application written in Python against API of Google, and using App Engine of Google is likely to work only in that environment.
- Benefits
- Lower administrative overhead: Customer need not bother about the administration because it is the responsibility of cloud provider.
- Lower total cost of ownership: Customer need not purchase expensive hardware, servers, power, and data storage.
- Scalable solutions: It is very easy to scale the resources up or down automatically, based on their demand.
- More current system software: It is the responsibility of the cloud provider to maintain software versions and patch installations.

Disadvantages of PaaS

- Vendor Migration: Migration from one PaaS vendors' application to another PaaS vendor will create some problem.
- Data-Privacy: Privacy of data can get hamper if it is not hold within the boundary of the company or organization.
- Mix-up Complexity: It may happen that some of the applications developed are local while others are from cloud; which may increase the complexity.

Infrastructure-as-a-Service

- **Infrastructure-as-a-Service** provides access to fundamental resources such as physical machines, virtual machines, virtual storage, etc. Apart from these resources, the IaaS also offers:
- Virtual machine disk storage
- Virtual local area network (VLANs)
- Load balancers
- IP addresses
- Software bundles
- All of the above resources are made available to end user via **server virtualization.**



- Advantages of IaaS are:
- Dynamic: Users can dynamically opt & configure devices such as: CPU, storage drive etc.
- Easy Access: Users can easily access the vast cloud computing power.
- Renting: Flexible and efficient while renting IT infrastructures.
- Full control of computer resources along with portability.
- Disadvantages of IaaS are as follows:
- Internet connection is must.
- IaaS depends on virtualization services.
- This service restricts the user-privacy & customization.

IDaaS (Identity as a Service)

- IDaaS (Identity as a Service) This provides management of employee or user's identity information as digital entity. It minimizes the problem of remembering every different username & password combination or disabling of account when an employee leaves the company.
- Employees in a company require to login to system to perform various tasks. These systems may be based on local server or cloud based. the problems that an employee might face:
- *Remembering different username and password combinations for accessing multiple servers.*
- If an employee leaves the company, it is required to ensure that each account of that user is disabled. **This increases workload on IT staff**.
- To solve above problems, a new technique emerged which is known as **Identity-as–a-Service (IDaaS).**

- **Identity** refers to set of attributes associated with something to make it recognizable. All objects may have same attributes, but their identities cannot be the same. A unique identity is assigned through unique identification attribute.
- There are several **identity services** that are deployed to validate services such as validating web sites, transactions, transaction participants, client, etc. Identity-as-a-Service may include the following
- Single sign-on (SSO) is a session and user authentication service that permits a user to use one set of login credentials (e.g., name and password) to access multiple applications.
- IDaaS may include:
- Directory services
- Registration information
- Authentication services
- Risk & event monitoring
- Profile management
- Sign-on services

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IBM Innovation Centre for Education

Welcome to:

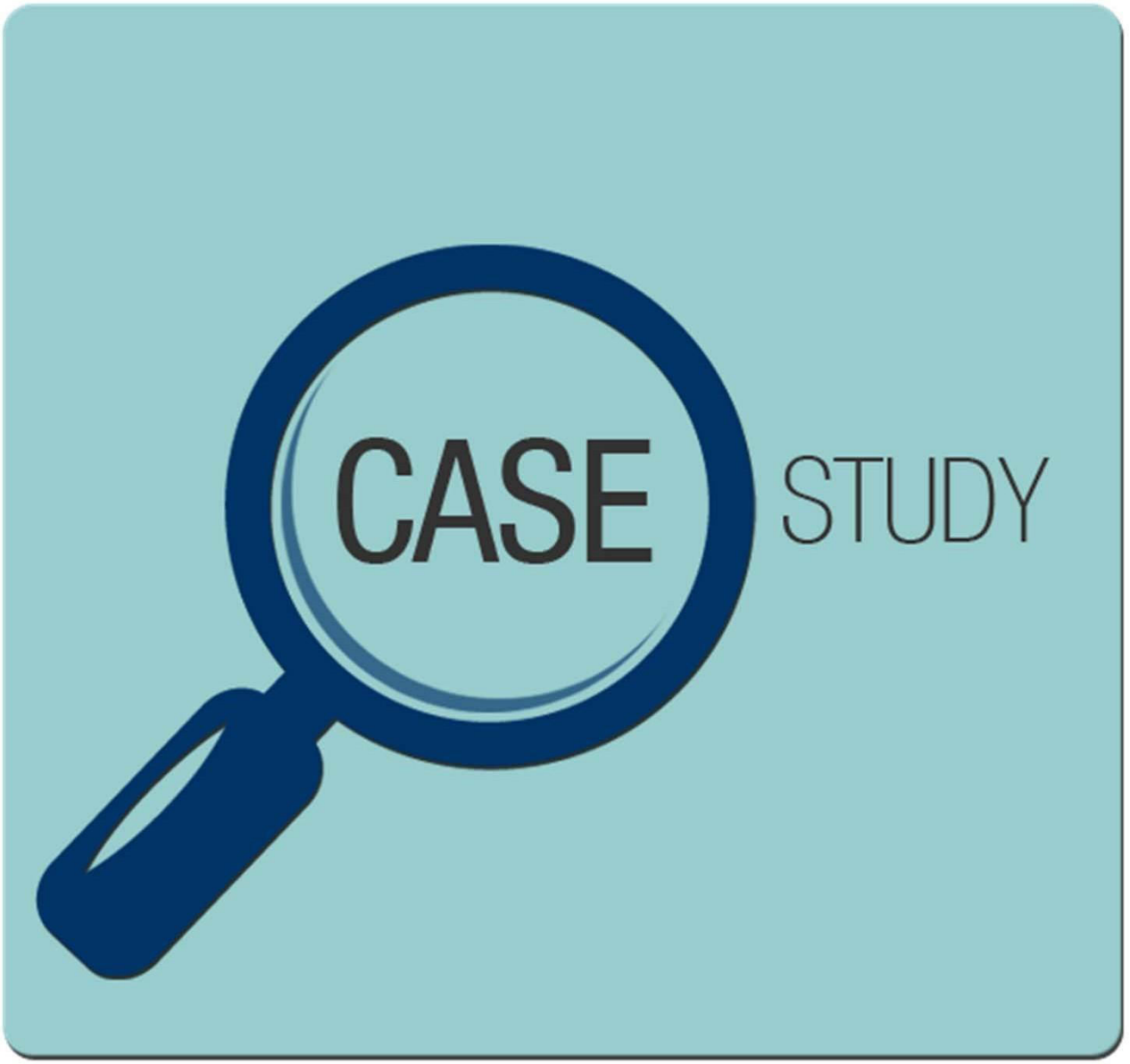
Case study on virtualization and cloud workloads

Unit Objectives

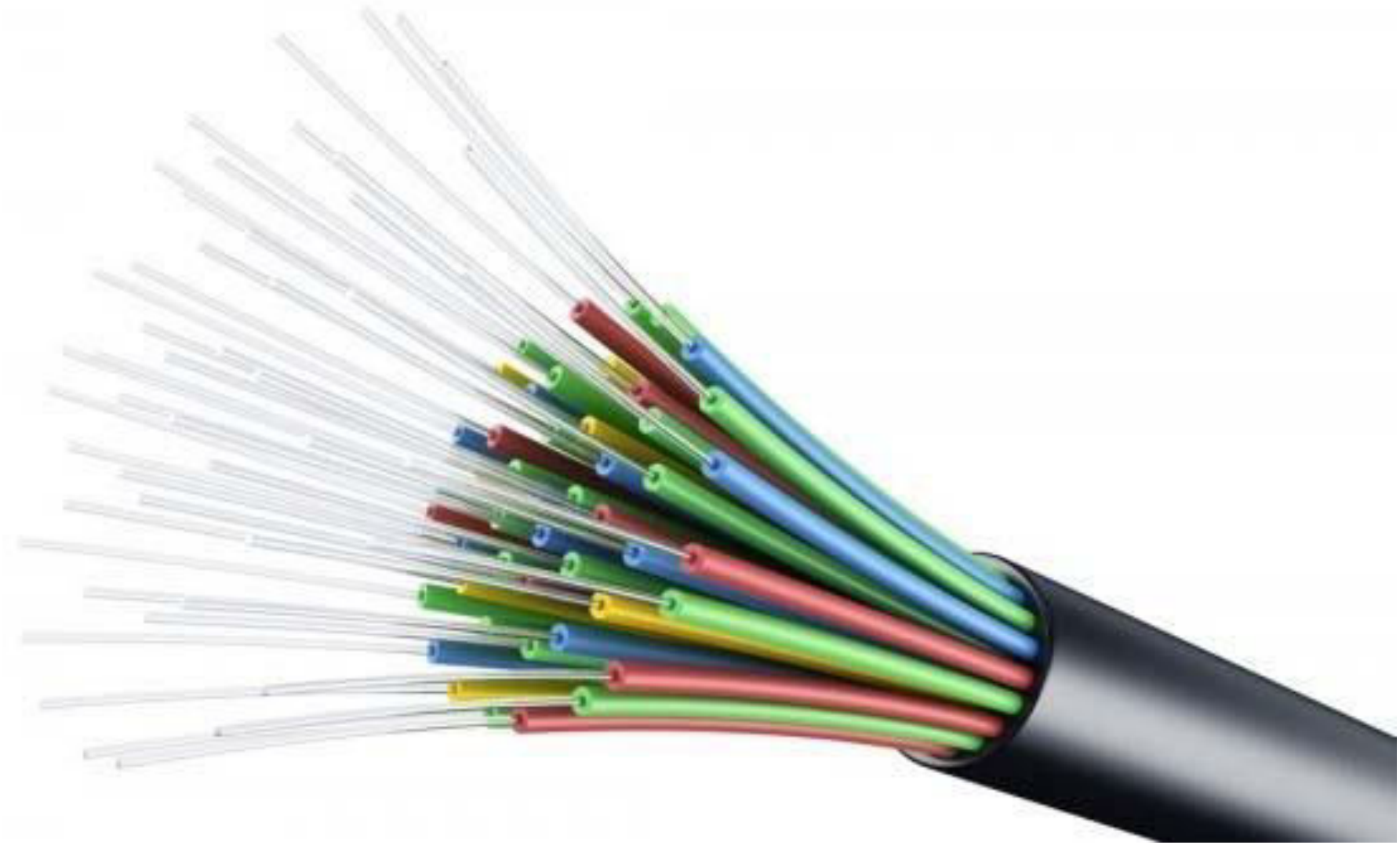
After completing this unit, you should be able to:

- Identify the practical considerations for virtualization
- Understand the need to prepare for virtualization
- Describe the various steps in preparation
- Explain the different transition tools for virtualization
- Define cloud workloads

Case study overview



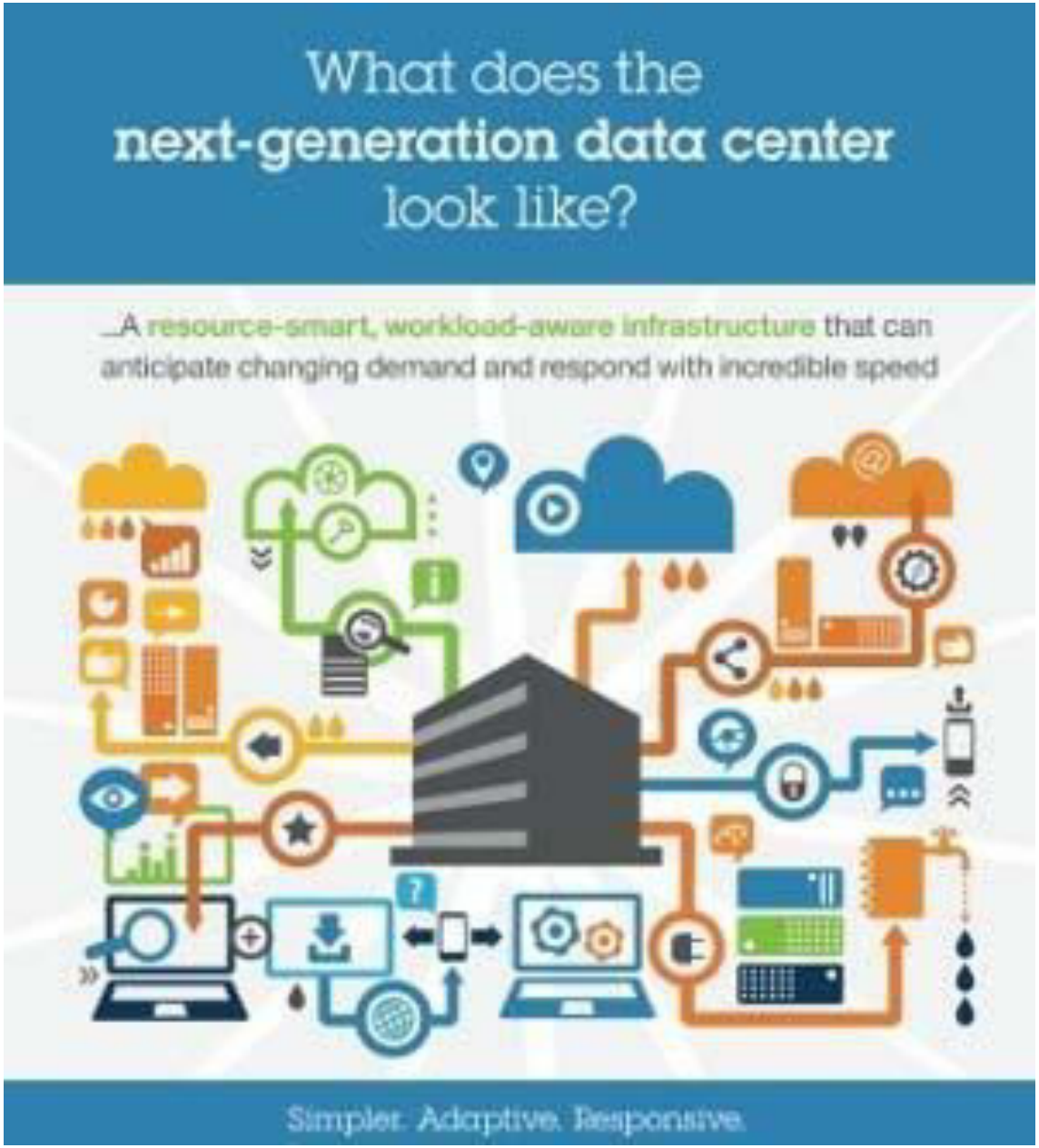
Customer IT landscape



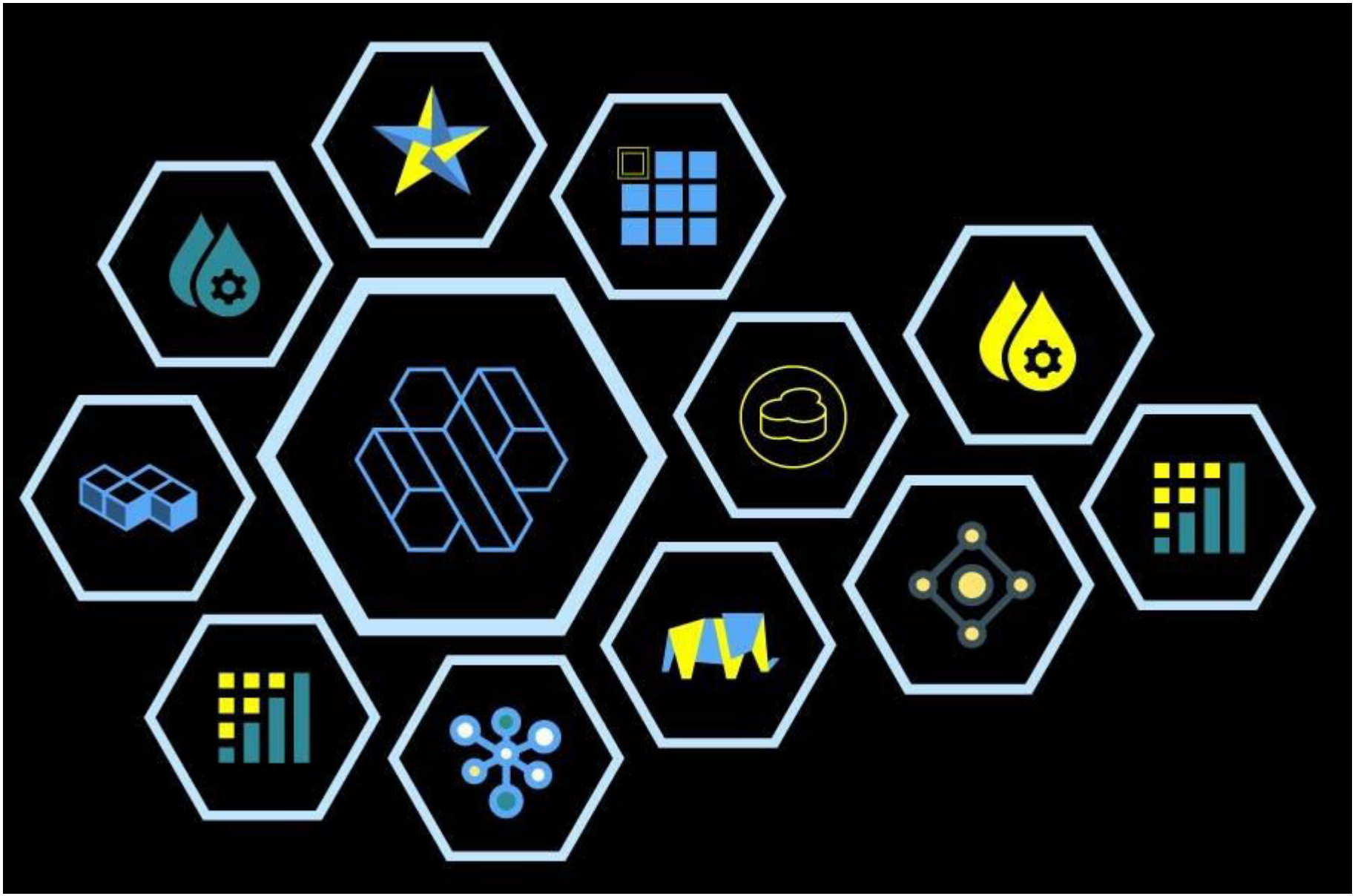
Functions of the data center

Triggers for virtualization (1 of 2)

Triggers for virtualization (2 of 2)



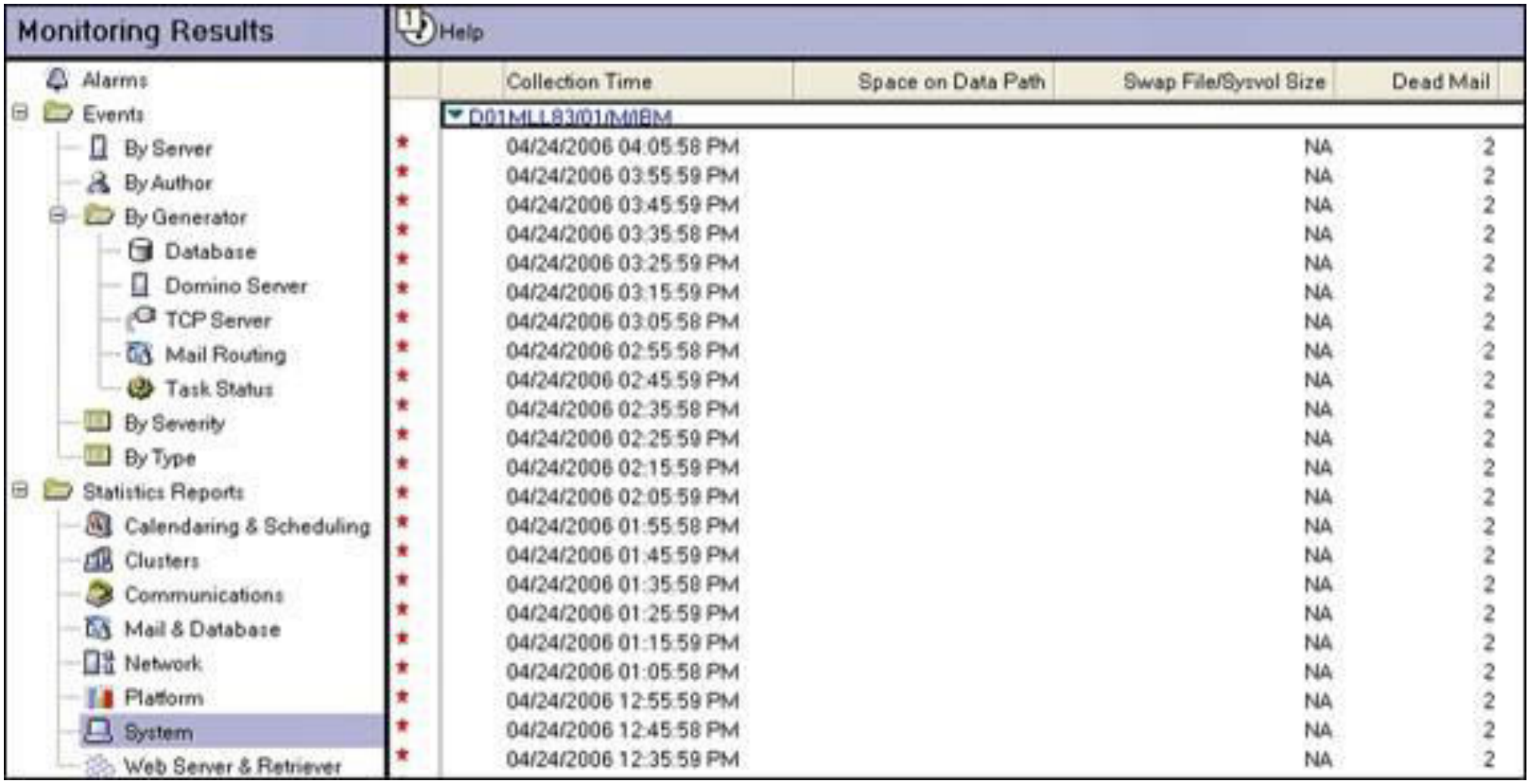
Preparation for virtualization



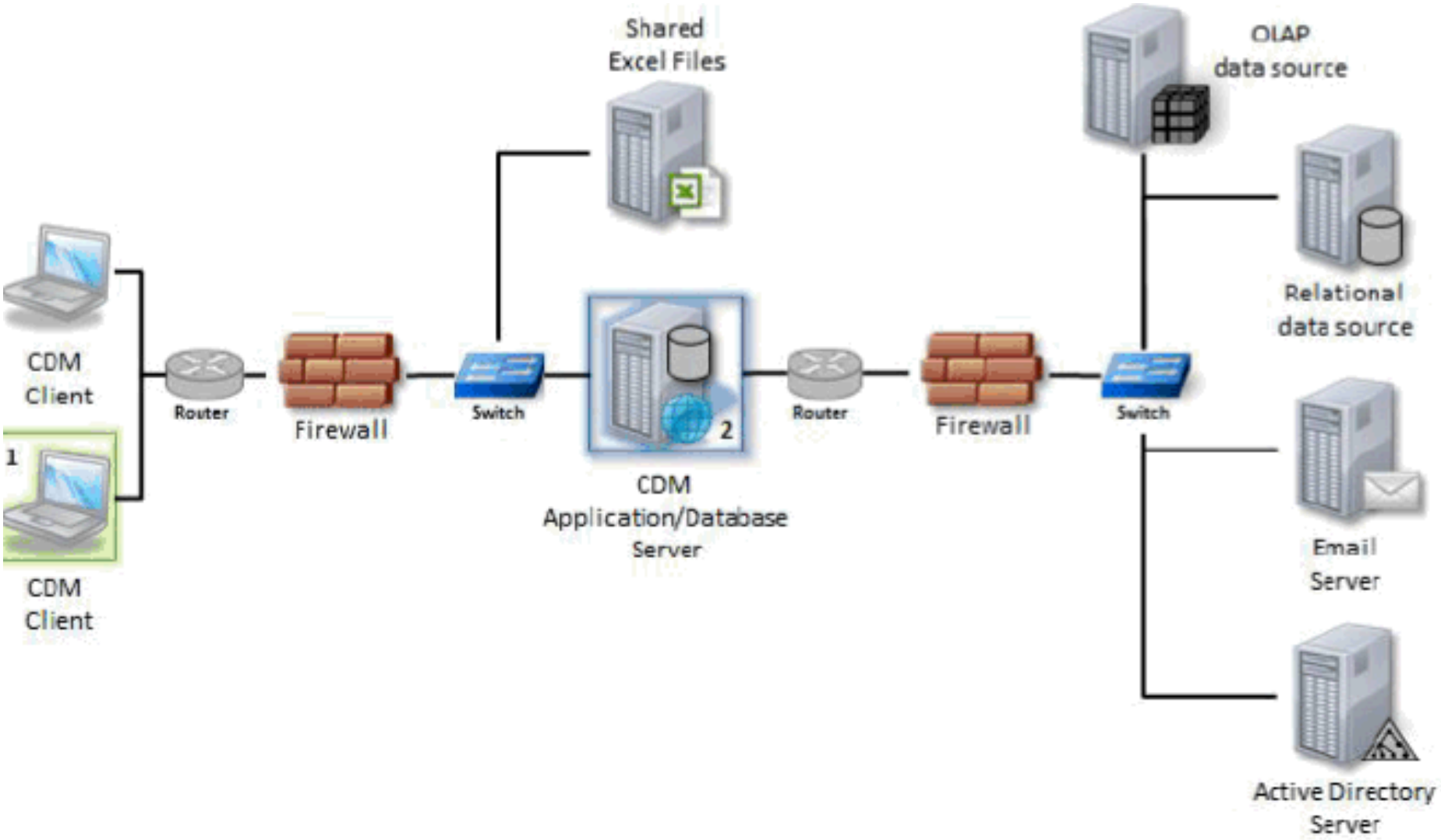
Server selection (1 of 2)

Server selection (2 of 2)

Server sizing (1 of 2)



Server sizing (2 of 2)

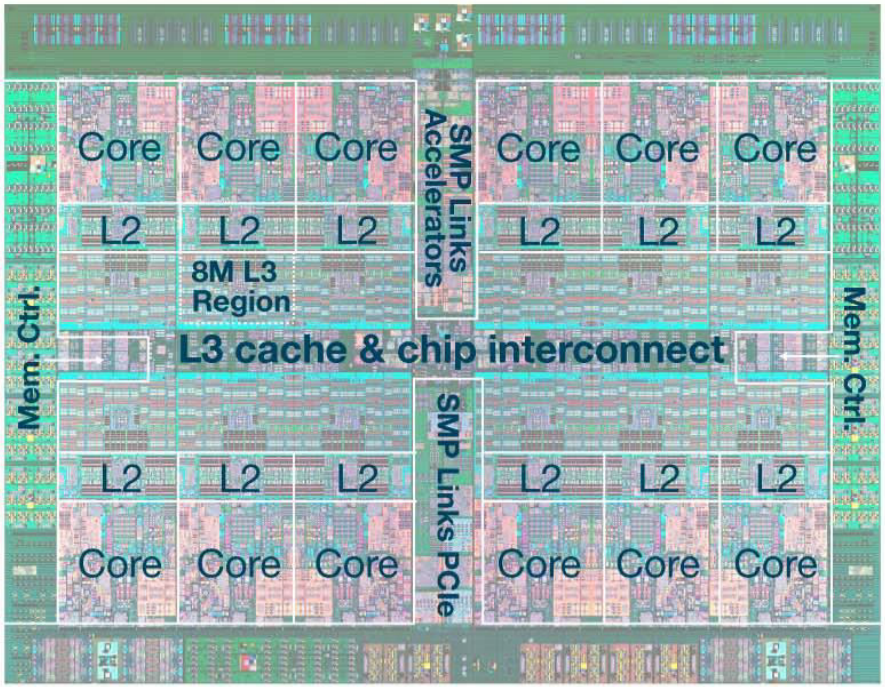


Server criticality

Cores
- 8-12 cores (SMT8)
- Enhanced prefetching

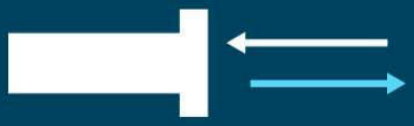
Caches
- 64K data cache (L1)
- 512 KB SRAM L2 / core
- 96 MB eDRAM shared L3
- Up to 128 MB eDram L4 (off-chip)

Memory
- Dual memory controllers
- Up to 230 GB/sec sustained bandwidth



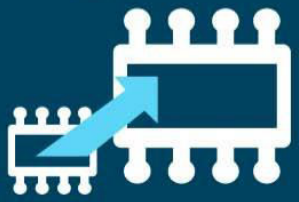
Continuous data load

Massive IO bandwidth

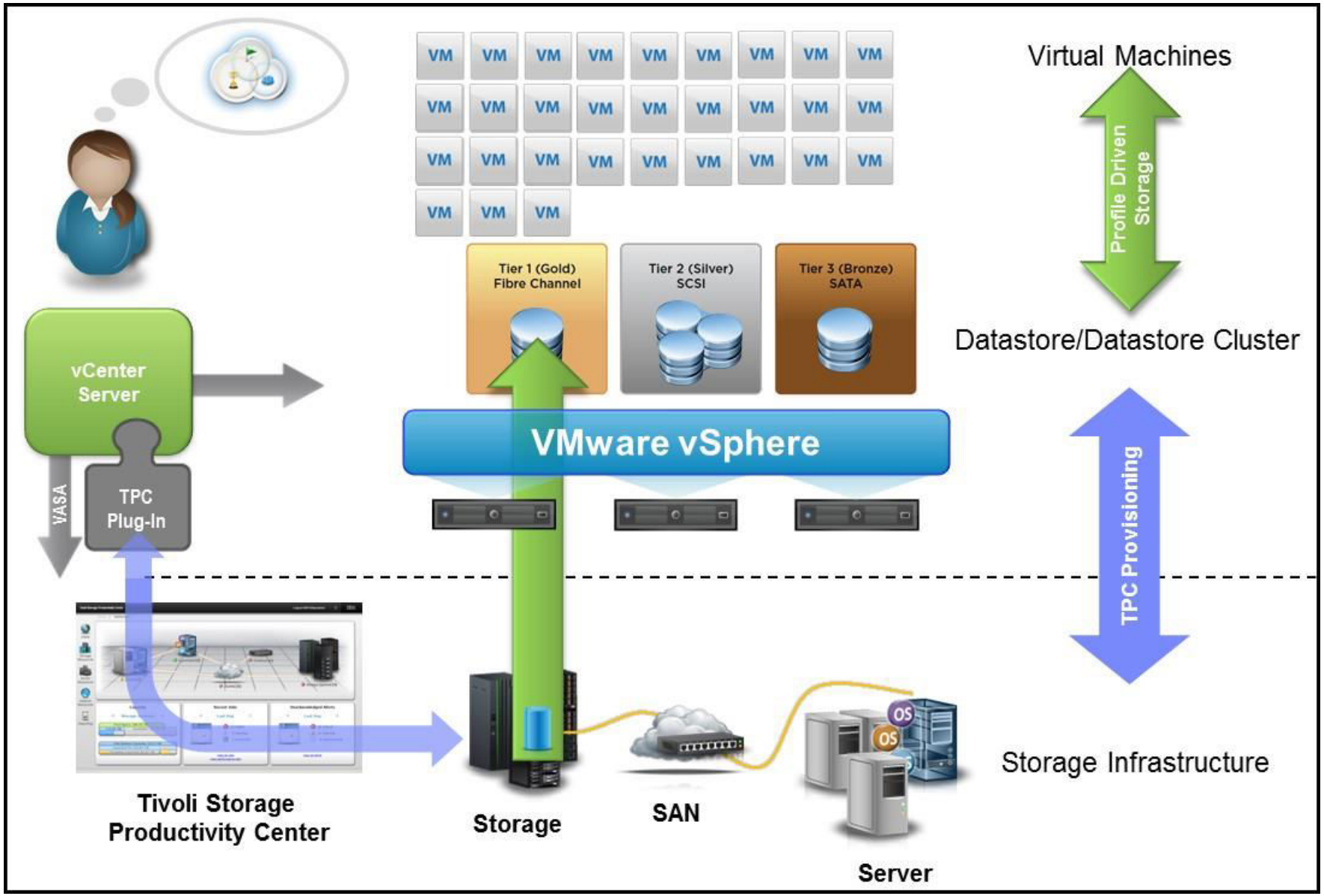


Superior parallel processing

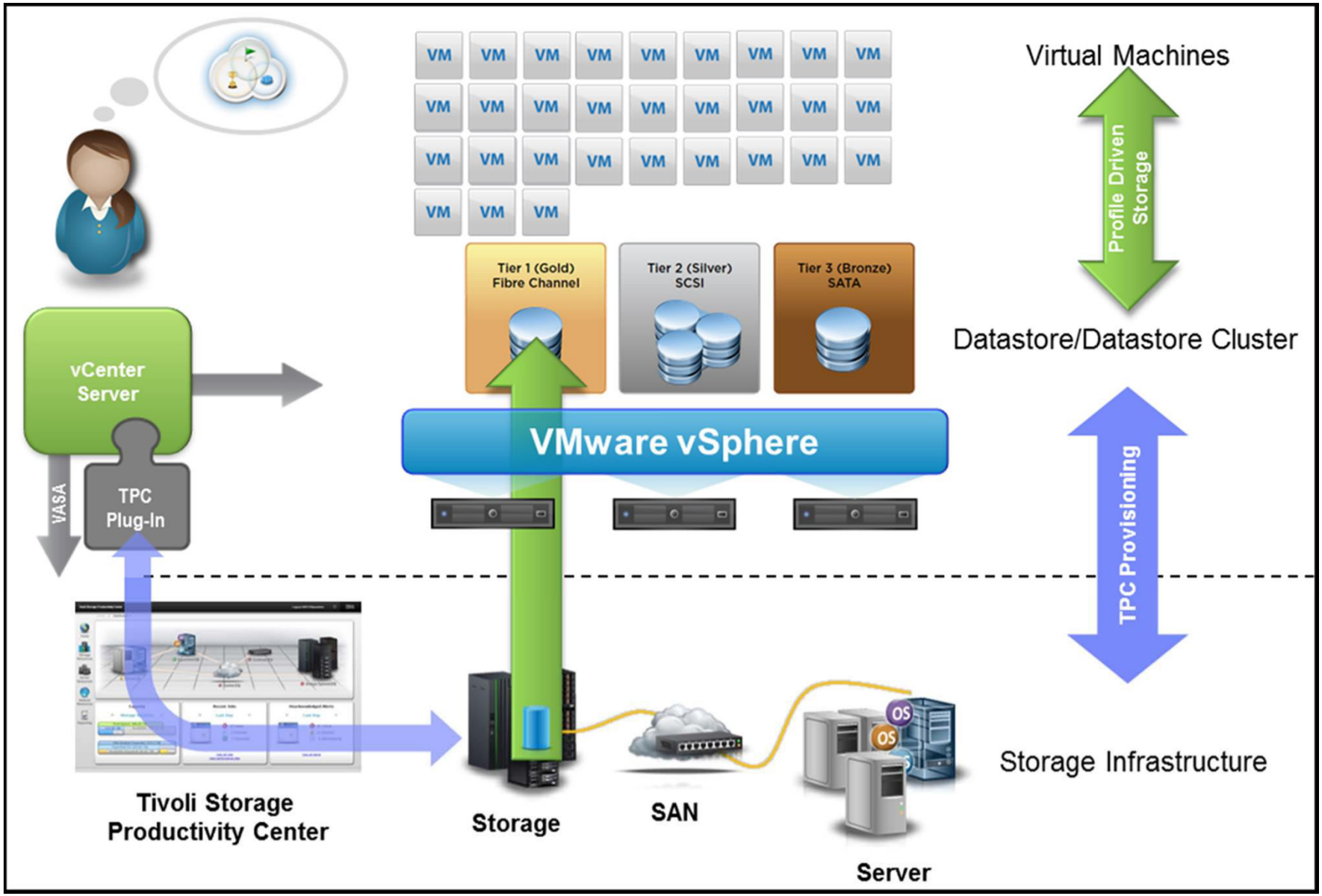
Large-scale memory processing



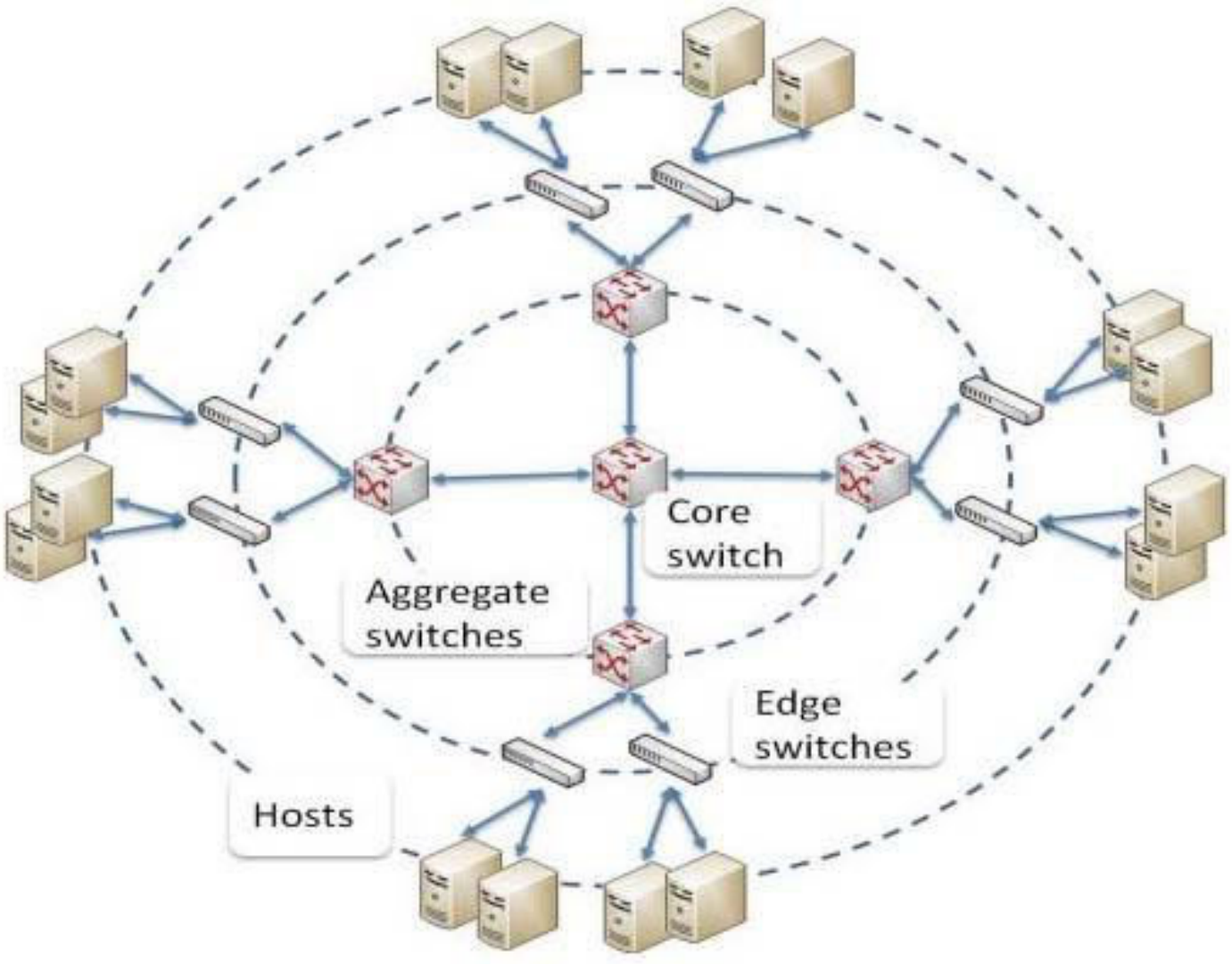
Provisioning (1 of 2)



Provisioning (2 of 2)



Proximity and Locality

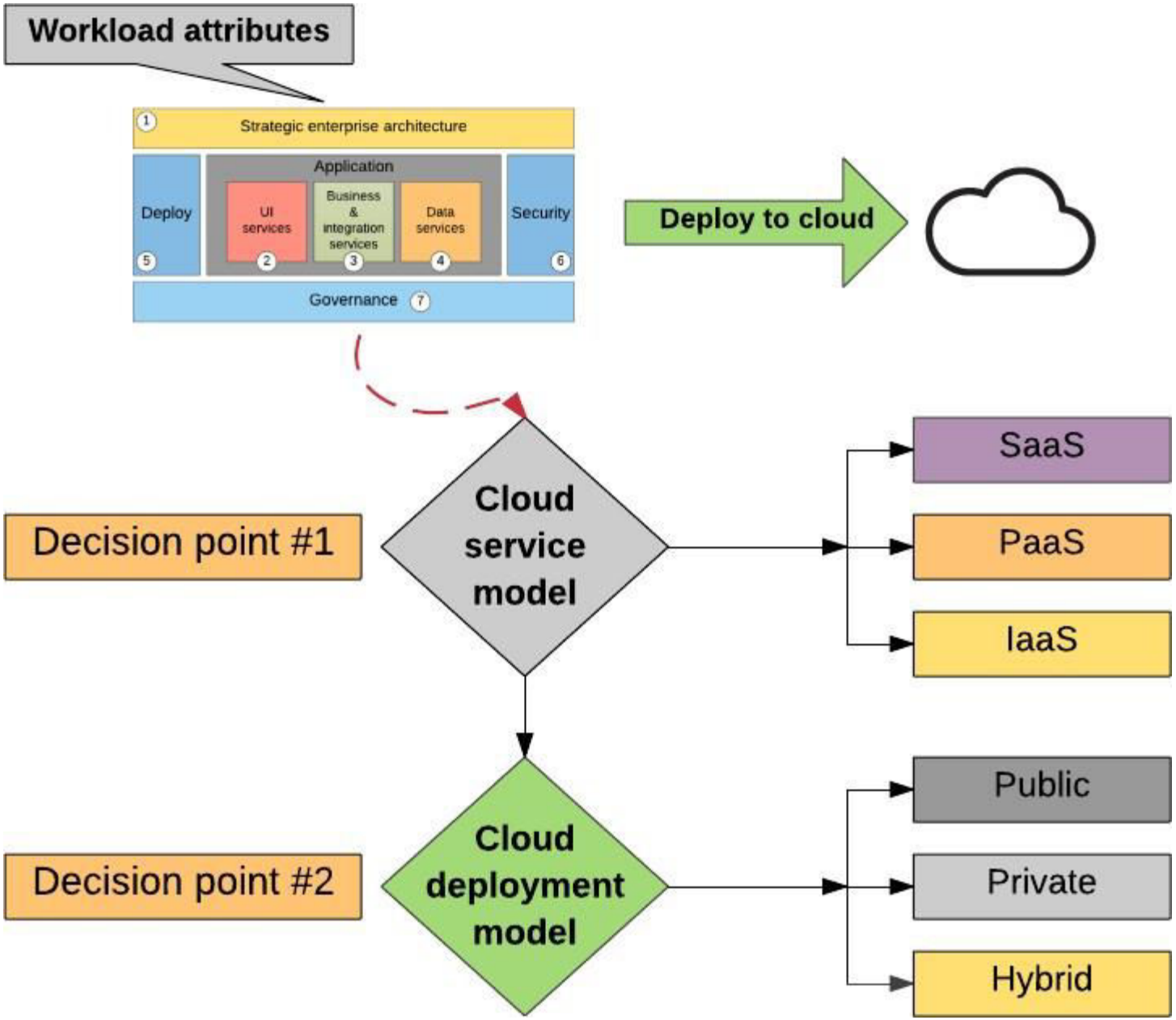


Transition tools for virtualization

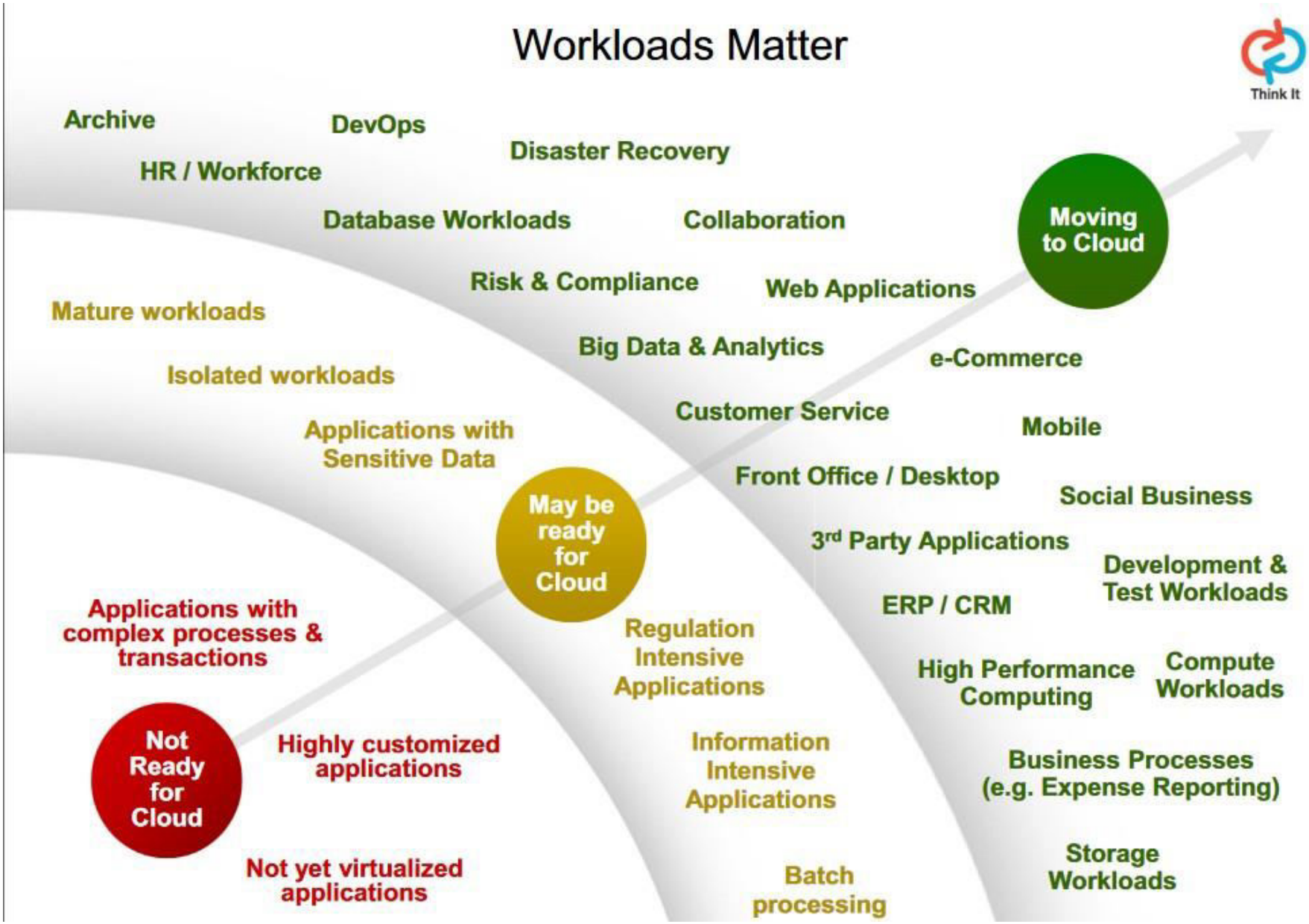
Cost Savings

- Typical cost saving experienced by FiberCoils after moving to virtualization is in the range of 40%. This includes saving on the datacenter space, physical servers, operational costs and easy manageability of the IT infrastructure.

Cloud Workloads Overview



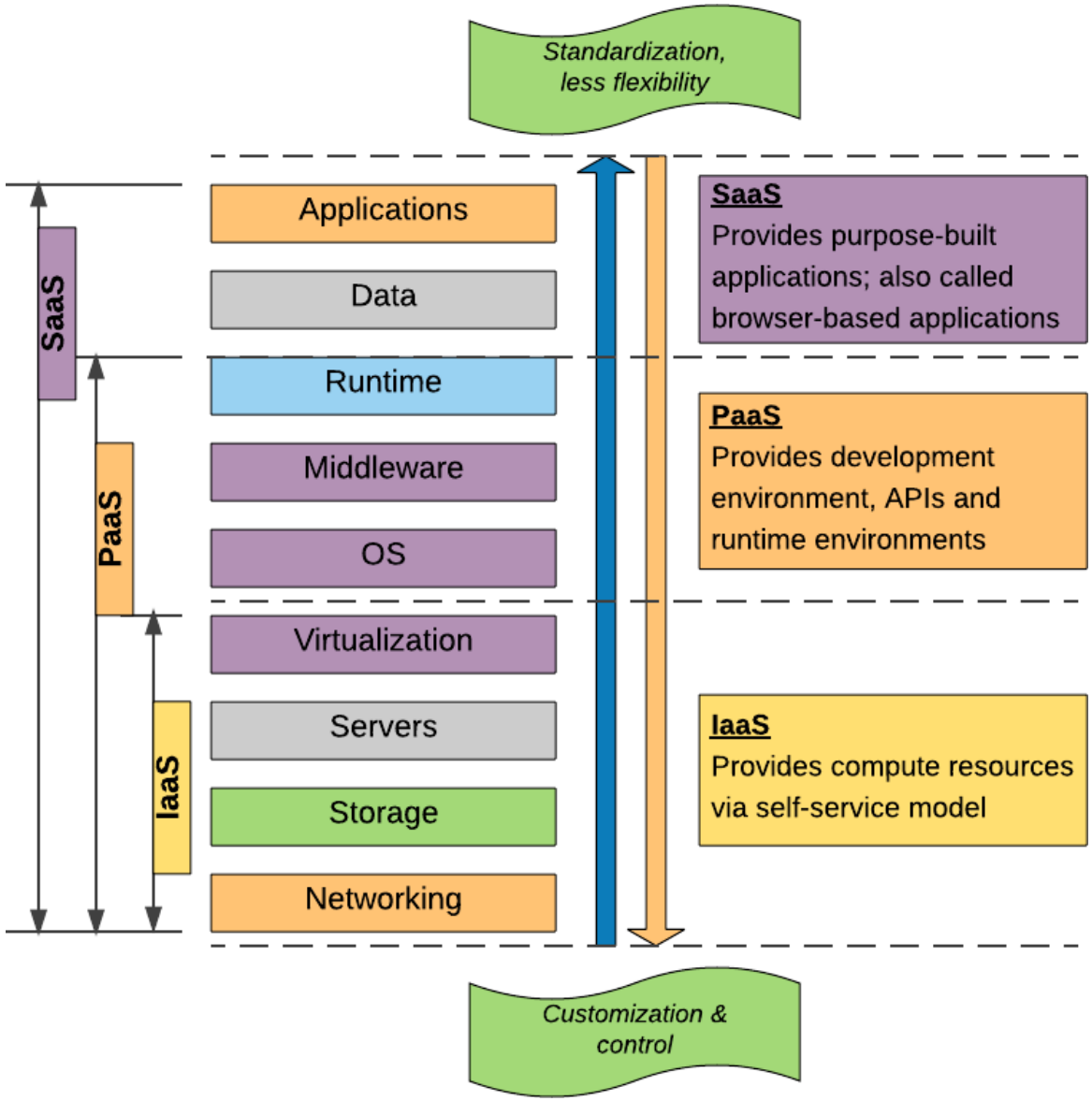
What is workload?



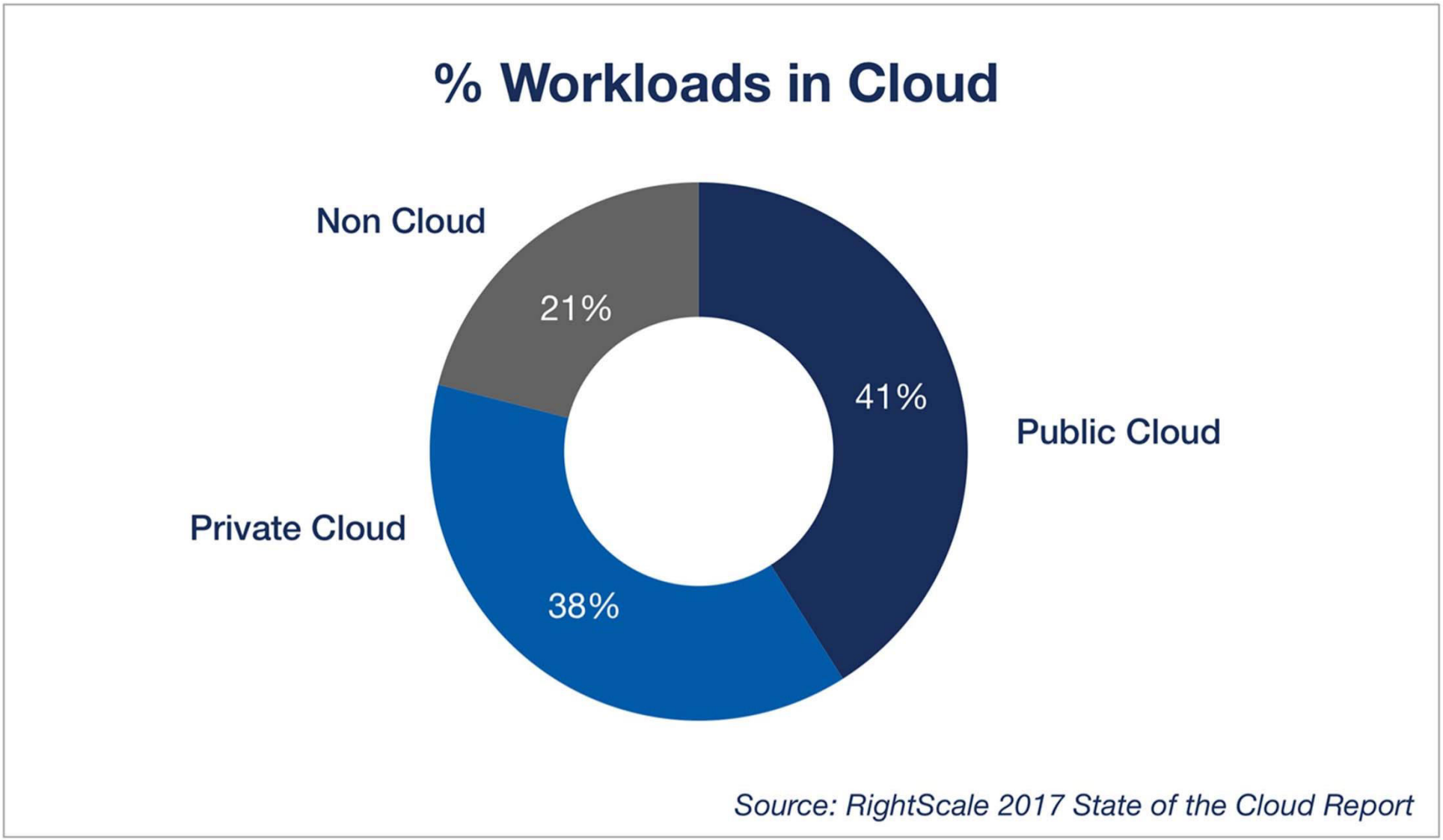
Workload characterization

Factors that influence cloud workload

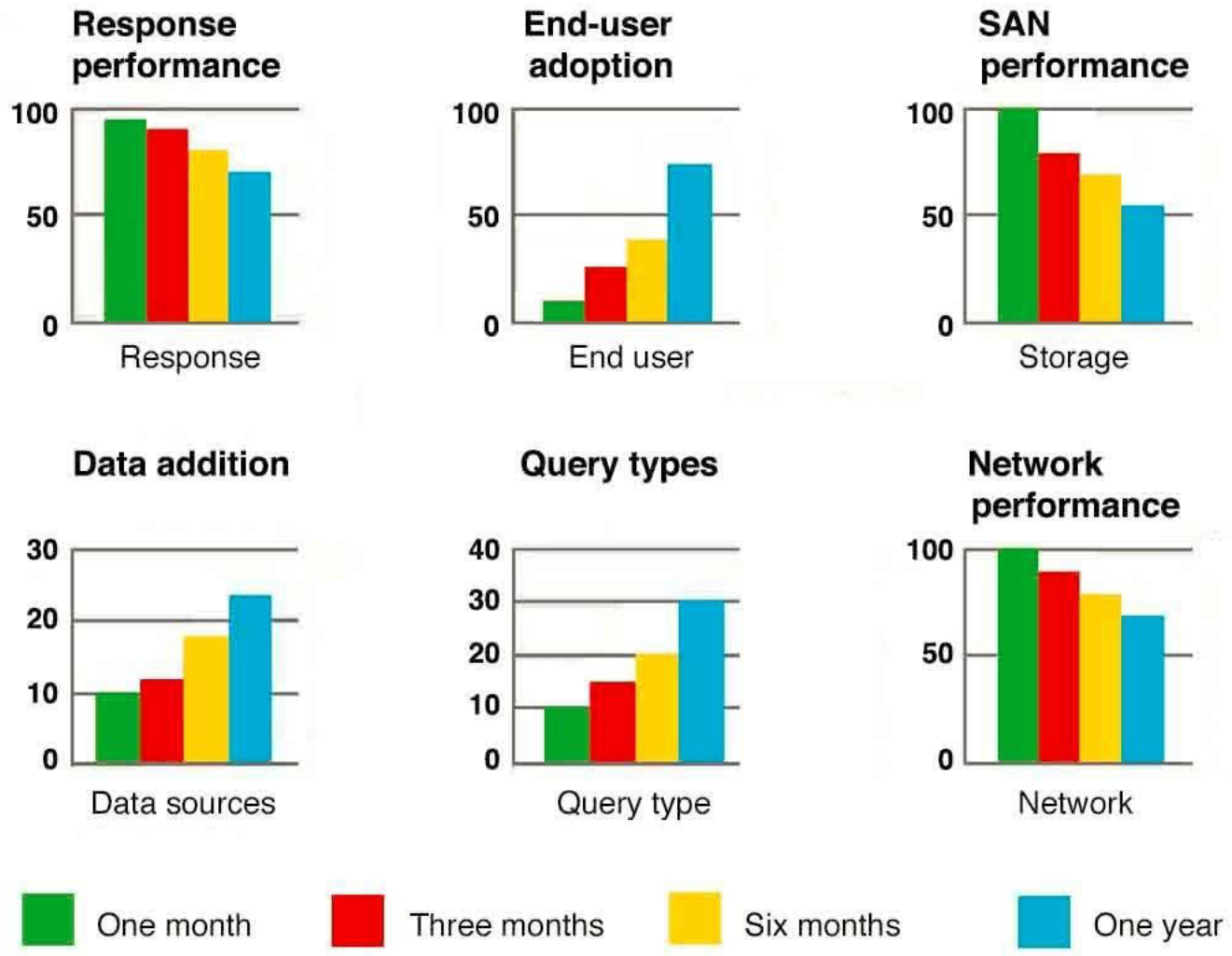
Workloads most suitable for cloud



Private cloud solution



Types of workload



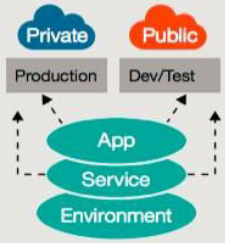
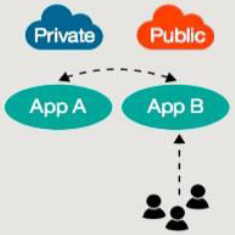
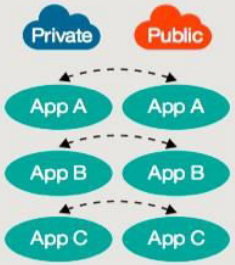
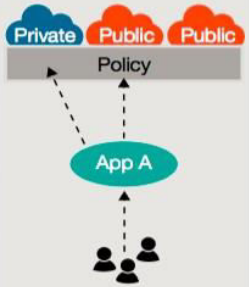
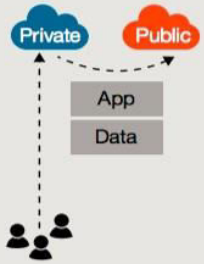
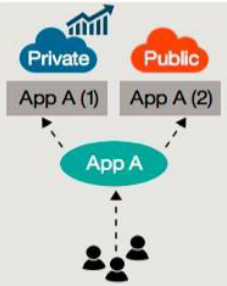
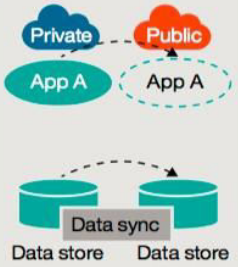
Temporary non-production workloads

Temporary non-production workloads are preferably placed on a public cloud.

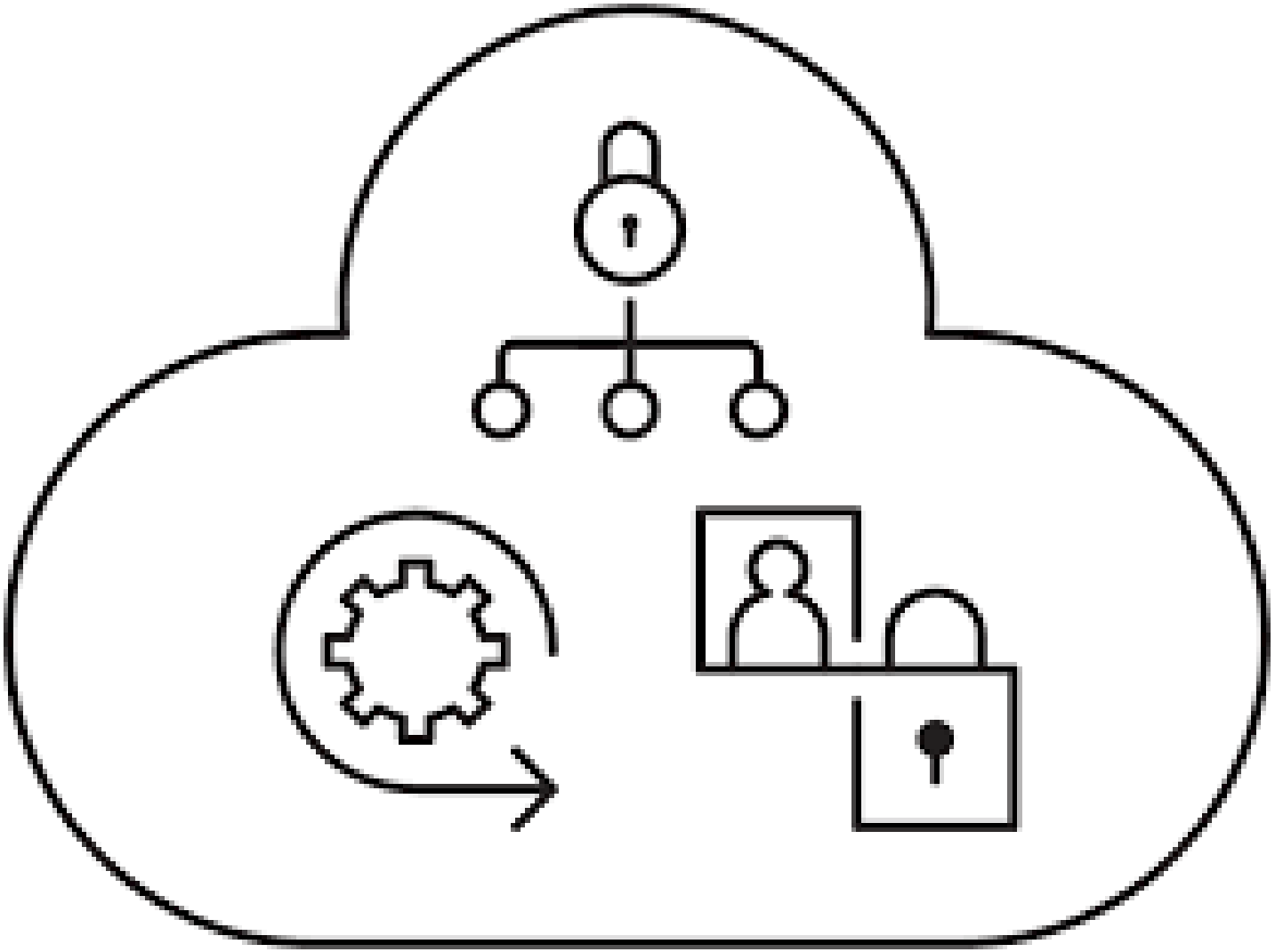
Examples of temporary workload are:

1. **Workload I**
2. **Workload II**

Mission critical production workloads

Next gen hybrid workloads			Hybrid cloud brokerage and management	Hybrid infrastructure scale out		
Independent workloads	SOR-SOE integration	Portability and optimization		Backup and archive	Capacity access	Disaster recovery
						
Choose private, public or hybrid cloud based on independent workload requirements	Systems of Record (SOR) on private and Systems of Engagement (SOE) on public	Application and/or data are portable and can go to and from public and private for improved optimization	Planned or policy-based management and sourcing across multiple environments (infrastructure, platform and applications)	Utilize off-premise resources for backup and archiving of on-premises resources	Opportunistic use of public cloud as additional resource for large jobs (e.g., high-performance computing, Big Data Batch)	Set up and make available as parallel environment off-premises

Advantages



Mission critical workloads

Examples of mission critical workloads:

1. **Workload I**
2. **Workload II**

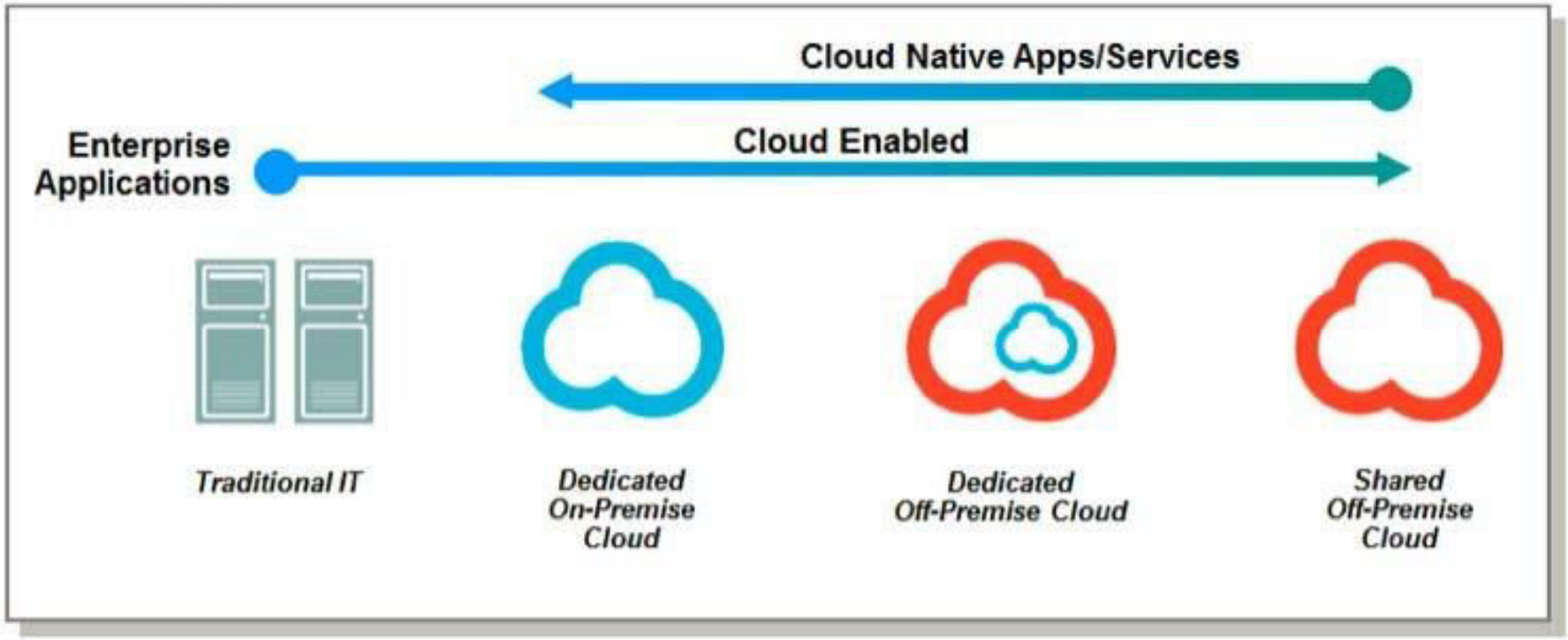
Mixed workloads

Qualities needed for mixed workloads:

- Capacity scaling
- Performance scaling
- Automatic tiering
- Quality of service
- Strong mixed R/W performance

Production only workload most suitable for a hybrid cloud

IBM defines hybrid cloud as the secure consumption of services from two or more sources, including private cloud, public cloud, or traditional IT



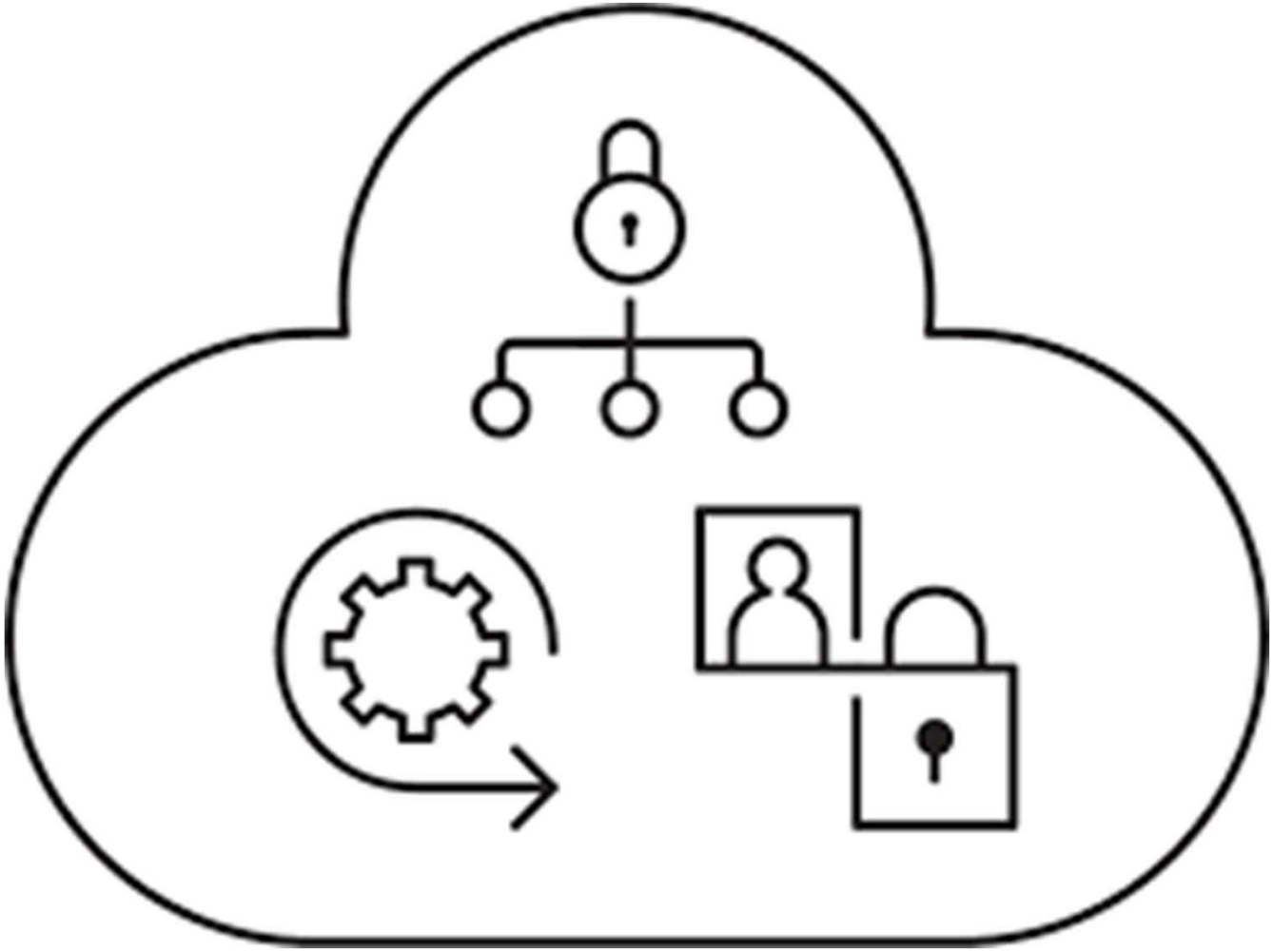
Industry specific cloud workloads

Examples:

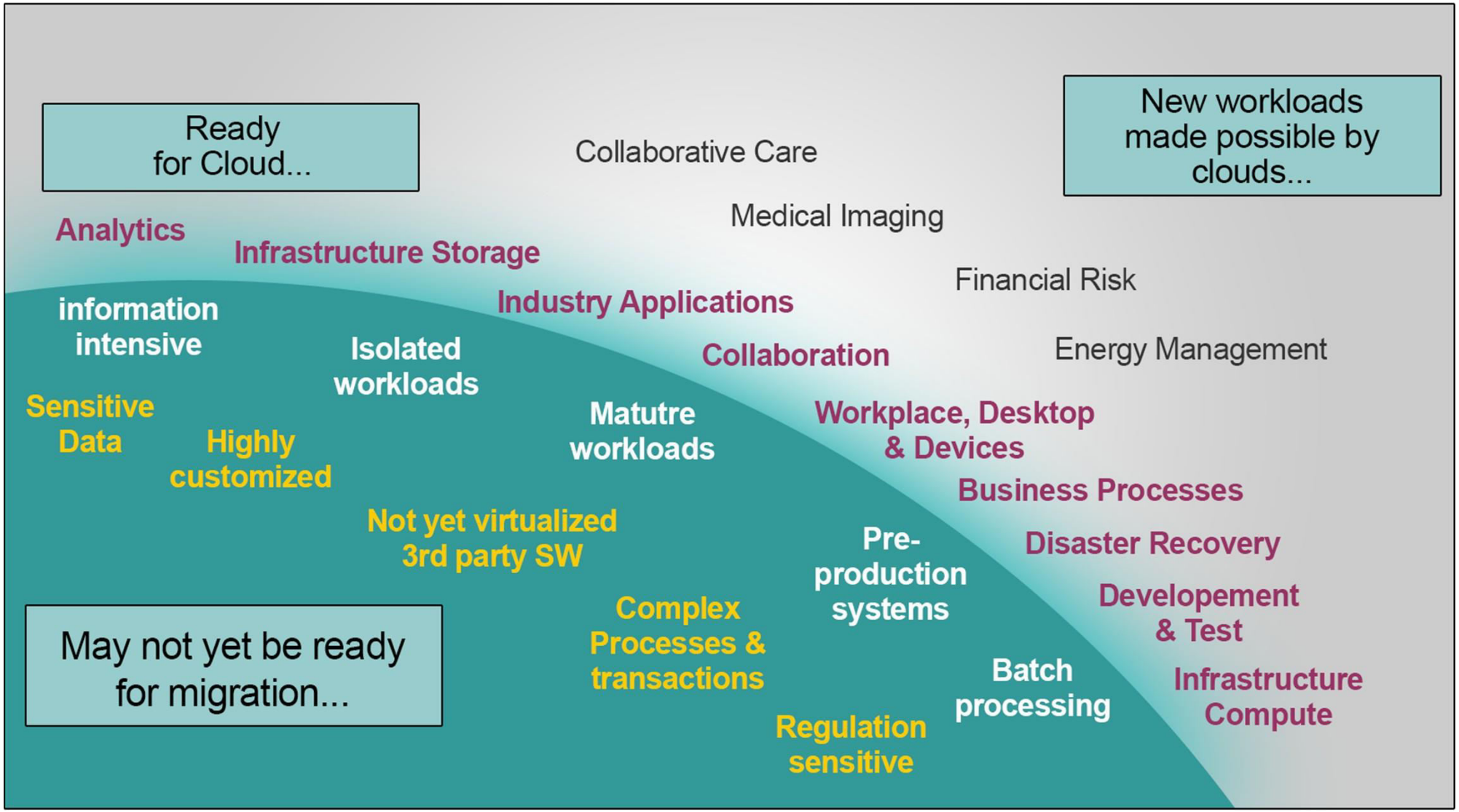
- **Ecommerce**
- **Healthcare**
- **Education Sector**

Workloads not suitable for public cloud

Workloads not suitable for private cloud



Workloads made possible by cloud



Checkpoint (1 of 2)

1. The customer must run ..... tools to determine the effective utilization of each server.

2. All qualified servers for virtualization will be classified under two major categories –
   a. VMs and Computer Systems
   b. VMs and VDIs
   c. VMs and Hypervisors
   d. Hypervisors and Computer Systems

3.A set of servers that serve critical functions in the organization and Servers that constantly run at a higher utilization about 95% of the time can be retained as physical servers
   a. True
   b. False

4..... enables dependent servers to be placed together on the same physical server and colocated locally to enable better communication and reduction in communication and IO latency.

5.A virtualization vendor provides its own custom tools for consolidating a physical infrastructure. Among many tools one major category of tools is ..... (which provide mechanisms for creating, managing, storing and deleting virtual machines in the datacenter. In addition to the basic functionality, the tools provide mechanisms for monitoring and ongoing optimization of the current IT infrastructure.)

Checkpoint Solution (1 of 2)

1. The customer must run **performance** tools to determine the effective utilization of each server.

2. All qualified servers for virtualization will be classified under two major categories –
   a. VMs and Computer Systems
   b. VMs and VDIs
   c. VMs and Hypervisors
   d. Hypervisors and Compuer Systems

3.A set of servers that serve critical functions in the organization and Servers that constantly run at a higher utilization about 95% of the time can be retained as physical servers
   a. True
   b. False

4.Virtualization enables dependent servers to be placed together on the same physical server and co-located locally to enable better communication and reduction in communication and IO latency.

5.A virtualization vendor provides its own custom tools for consolidating a physical infrastructure. Among many tools one major category of tools is **Manageability Tools** (which provide mechanisms for creating, managing, storing and deleting virtual machines in the datacenter. In addition to the basic functionality, the tools provide mechanisms for monitoring and ongoing optimization of the current IT infrastructure.)

Checkpoint (2 of 2)

6.The workload consists of some amount of application program running in the computer and usually some number of users connected to and interacting with the computer's applications. The notion of a workload is central to Cloud Computing. Mainly, a workload is a discrete capability or amount of work you'd like to run on a Cloud instance. For example, serving up a Web site or running a Hadoop node are classic examples of workloads.

a. True

b. False

7.The best way to profile a workload for a cloud type is to classify the application in tiers: Tier-1 to Tier-4. An SLA can be associated with each Tier. If the SLA provided by a cloud service vendor does not meet the SLA required for a Tier, the application has to be hosted on Cloud implementation that_____the SLA requirement.

a. deceeds or meets

b. meets or exceeds

c. meets only

d. none

8. Regulated Industry workloads adhering to PCI, HIPPA compliance regulations are not suitable for _____Clouds. These are best suited for_____Clouds.

a. private, public

b. hybrid, public

c. public, private

d. note

Checkpoint Solution (2 of 2)

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c. public, private

d. note

Unit summary

Having completed this unit, you should be able to:

- Identify the practical considerations for virtualization
- Understand the need to prepare for virtualization
- Describe the various steps in preparation
- Explain the different transition tools for virtualization
- Define cloud workloads