CHAPTER 5

FUNDAMENTAL OF STORAGE CLOUD NETWORKS

# 5.1 Introduction

A storage device is a hardware that is used in computing either in PC or Server or in Data Center which is used for storing, and extracting information or objects.

This device can hold and store information both temporarily and permanently, and can be internal or external to any computing device (Now a days mobile phones are also a computing devices), called as storage medium or storage media.

# 5.2 Cloud Computing Definitions

## 5.2.1 Software as a Service (SaaS)

The capability provided to the consumer is to use the provider’s applications running on a cloud infrastructure. Applications can be accessed from various client devices through a thin client interface such as a web browser. The consumer/customer does not manage or control the underlying cloud. The Infrastructure includes network, servers, storage, or applications, with the possible exception of limited user-specific application configuration settings.

## 5.2.2 Platform as a Service (PaaS)

The capability provided to the consumer/customer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages and tools supported by the provider.

The consumer/customer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations.

## 5.2.3 Infrastructure as a Service (IaaS)

The capability provided to the consumer/customer is to provision processing, storage, networks, and other fundamental computing resources where the consumer/customer is able to deploy and run arbitrary software, which can include operating systems and applications.

# 5.3 Types of Storage Devices

Storage devices are core components of any computing system. They store all the data and applications on a computer, excluding firmware which is directly burnt on the chip. They are available in different form as following.

RAM, cache, and hard disk, as well as optical disk drives (CD/DVD) and externally connected USB drives.

Hence two different types of storage devices are as following:

* *Primary storage:* smaller in size, designed to hold data temporarily, internal to the computer. Data access speed is fastest, and include RAM and cache memory.
* *Secondary storage:* have large storage capacity as compared to primary storage, as well as stores data permanently. They are either internal or external and include the hard disk, optical disk and USB storage.

## 5.3.1 Magnetic Storage Devices

Today, [magnetic storage](https://www.computerhope.com/jargon/m/magnmedi.htm) is one of the most common types of storage, these may include as following.

* Floppy diskette
* Hard drive
* Magnetic strip
* Super Disk
* Tape cassette
* Zip diskette

## 5.3.2 Optical Storage Devices

Optical storage uses lasers/lights for reading and writing data. Examples are as following.

* Blu-ray disc
* CD-ROM disc
* CD-R and CD-RW disc
* DVD-R, DVD+R, DVD-RW, and DVD+RW disc

## 5.3.3 Flash Memory Devices

Flash memory devices replacing magnetic media, comparably cheaper, more efficient and reliable technology.

* USB flash drive(Jump/Thumb)
* Memory card
* Memory stick
* SSD

## 5.3.4 Online and Cloud

Storing data online and in cloud storage is becoming popular as data can be accessed from anywhere dynamically as and when required.

* Cloud storage
* Network media

## 5.3.5 Paper Storage

Early days computers had no method of using any of the above technologies for storing information. Today paper storage are rarely used.

* [OMR](https://www.computerhope.com/jargon/o/omr.htm)
* [Punch card](https://www.computerhope.com/jargon/p/punccard.htm)

**5.3.6 Need of storage in computer**

A Storage for computers is like a mind or memory to human hence without a storage device, a computer would be considered a dumb device. But in a grid computing number of computers can share common storage, hence no need to separate storage. But to run application on individual machine like browsing, it needs local storage to function properly as cache and temporary file are used and they need to be stored somewhere.

**5.3.7 Requirements of so many different storage devices**

As the new applications are being developed, due to advancement of technology and processing power, different version of storage devices with Speed and Space, came into picture. When new storage devices are manufactured, older are replaced with newer ones.

First punch cards were used in early computers the magnetic media used for floppy disks was not available. Then floppy diskettes had been released, further they were replaced by CD-ROM drives, which were again replaced by DVD drives, and DVD been replaced by flash drives. Today, smartphones are available that have hundreds of times the capacity at a much smaller price and much portable to carry. Each advancement of storage technology gives computing device the ability to store data, save data faster, and access the saved data faster.

**5.3.8 Definition of storage location**

**Storage location** may be fixed or removable or may be over the network, its choice of the user to move the data to any of secondary storage, i.e. removable storage device such as a flash drive but default is Hard Drive.

## 5.3.9 Uses of Storage Devices in Present Scenarios

Most of the storage devices are no longer used. In present primarily hard disk drive or SSD are used to store data in computing devices. Desktop computers are equipped with disc drives, capable of reading CDs/DVD's those can write CD-R and other recordable discs. Now the days Information have the storage options on USB flash drives and to access to cloud storage.

## 5.3.10 Storage Device with Larger Capacity

Storage devices are available in different capacities from Mega Bytes to Tera Bytes. Networked computers may also have access to even larger storage with large tape drives, Bunch of Disks using cloud computing, or NAS devices.

Below is a list of storage devices, arranging from smallest capacity to the largest capacity:

1. Punch card
2. Floppy diskette
3. Zip disk
4. CD
5. [DVD](https://www.computerhope.com/jargon/d/dvd.htm)
6. Blu-ray disc
7. Flash jump drive
8. Hard drive / [SSD](https://www.computerhope.com/jargon/s/ssd.htm)
9. Tape drive
10. [NAS](https://www.computerhope.com/jargon/n/nas.htm) / Cloud Storage

## 5.3.11 Files Access On Storage Devices

Storage device management depends on the operating system feature called as files system. Microsoft Windows, uses a file manager to access the files stored on storage device/s. called as Explorer. Apple computers uses, Finder as default file manager.

## 5.3.12 Common Problems Encountered With Storage Devices

1. **Hardware failure.** Most of the users are being affected by hardware failures. Hence regular maintenance and appropriate handling is required to prolong the durability of storage devices.
2. **Data Loss.** File deletion makes to lose precious data. To handle the data loss, recovery programs are designed to provide a solution for lost files, deleted data, corrupt documents and hidden files. If data loss is accidental then data recovery software may retrieve back 80% of the lost data.

# 5.4 Fundamentals of Storage Networks

Storage Networks is a collection of servers, networked together with other storage devices using storage networking protocols.

Mainly following manufactures are proving Storage and Networking Solutions, Brocade, Qlogic, Emulex, Cisco, Dell, EMC, Hewlett Packard, IBM, Lenovo, Microsoft, NetApp, Oracle and VMware.

**Organization of storage devices**

## 5.4.1 Direct Attached Storage

A direct-attached storage device is not networked. Direct-attached storage (DAS) is connected to single computing system and not accessible to other computers. HDD and SSD is the usual form of direct-attached storage. Optical devices and tape are also example of DAS. In the enterprise, individual disk drives (bunch of disks) in a server are called direct-attached storage, or groups of drives (disk enclosures) that are external to the server directly connected to an Interface(PCI) card plugged into the internal bus of a server but are directly attached through technologies as

1. Small Computer System Interface (SCSI),
2. Serial Advanced Technology Attachment (SATA),
3. Serial-Attached SCSI (SAS),
4. Fibre Channel (FC) or iSCSI.

Are also called as Direct Attached Storage.

### 5.4.1.1 Direct-Attached Storage Pros and Cons

DAS gives better performance than networked storage because the server does not have to traverse a network (Connected Switches). Hence to get high performance DAS is used for some Data Intensive applications i.e. Microsoft Exchange.

Direct-attached storage can’t be easily shared and it does not facilitate failover in the case of server crash hence being criticized. But with virtualization DAS overcome above mentioned shortcomings and gained in popularity. In centralized and networked shared storage, such as NAS or SAN storage capacity is shared among servers over a dedicated network connection. But DAS is dedicated to a single server. Hence connectivity and expandability are constrained by the number of expansion slots.

The size of the DAS enclosure restricts storage capacity. Sharing with DAS is typically limited to a small number of ports or host connections. DAS is less expensive than SAN or NAS, DAS is easier to deploy when directly plugged into a server. This made DAS a practical storage choice for many small and medium-sized businesses (SMBs), where storage costs are a major factor.

Physical servers continue to boot from DAS storage. SSDs, makes booting locally more effective than a SAN. i.e., through local SSDs, physical server can be booted in few seconds. Direct-attached storage does not offer remote replication and snapshots.

### 5.4.1.2 Discover and Fix Security Issues in Das Systems

Security may be a concern where storage systems that host an organization's critical data and applications.

Below mentioned steps should be taken to protect data:

* Perform thorough security assessment to discover problems. Following security vulnerabilities may be discovered, such as user permissions, missing patches or mis-configured systems.
* Do audit of user access permissions, and scan the DAS for any information accessible to every person on the network then restrict unauthorized permissions, segment network to protect critical DAS systems.
* Operating system and application software patches should be continuously updated otherwise it can leave DAS vulnerable hence an intruder can gains unwanted access to the server connected to the DAS can access all the data on the system, breached.
* Fault tolerance testing should be done to check the resiliency of the DAS system.

### 5.4.1.3 Future Outlook and Trends of Direct Attached Storage

The SATA Express (SATAe) interface arrived in 2014, as a connecting technology for DAS. It enables DAS to benefit from the reduced latency overhead of more than 50 % of the nonvolatile memory express (NVMe) specification. NVMe, serve as the logical device interface for direct-attached Peripheral Component Interconnect Express (PCIe) storage devices, is architected for higher-performance SSDs.

## 5.4.2 Network Attached Storage

Network Attached Storage (NAS) is empowers heterogeneous customer gadgets to recover information from unified capacity. Standard Ethernet association can be utilized to get to shared record stockpiling in LAN. NAS gadgets are made do with a utility dependent on program. Every NAS lives on the LAN as a free system hub, characterized by one of a kind Internet Protocol (IP) address.

NAS Characterize is simple entry, high limit and genuinely minimal effort. NAS gadgets give framework to merge capacity in one place to help undertakings, for example, chronicling and reinforcement, and cloud get to.

### 5.4.2.1 Uses of Network-Attached Storage

NAS empowers clients to work together and share information all the more adequately, especially groups that are remotely found or in various time zones.

By utilizing remote switch association with NAS, it is simple for dispersed workplaces to get to documents from any gadget associated with the system. A NAS domain is sent as the establishment for an individual or private cloud.

NAS items are intended for use in undertakings, for home workplaces or private ventures. Gadgets as a rule contain something like two drive straights. Venture NAS is structured with all the more top of the line information highlights to help stockpiling and generally accompanies numerous drive sounds.

Endeavours needed to arrange and oversee hundreds or even a large number of discrete record servers before NAS. From that point to grow capacity limit, NAS apparatuses are fitted with more or bigger circles known as scale-up NAS.

Additionally NAS merchants utilizing administrations of distributed storage suppliers to get adaptability of repetitive reinforcement.

System connected capacity are utilizing hard circle drives (HDDs) to store information. In the event that numerous clients at the same time utilizes Input/yield (I/O) mistake may jump out at beat this NAS frameworks utilize quicker glimmer stockpiling.

### 5.4.2.2 NAS Use Cases

The necessities and design of HDD chose for a NAS is determined by the applications to be taken care of. Any standard assignment shared among collaborators and performing occasional information reinforcement is another utilization case.

Utilizing a NAS to deal with vast volumes of gushing media records requires bigger size circles, additional size of memory and incredible system handling frameworks.

NAS framework is utilized in home office condition to process interactive media records or to robotize reinforcements. NAS is likewise used to oversee capacity for shrewd TVs, home security frameworks and other customer based web of things (IoT) gadgets (Freezer, Washing Machine and so forth.).

NAS cluster is utilized in Enterprises to reinforcement focus for documenting and calamity recuperation. By running NAS gadget in server mode server mode, it likewise serve email, sight and sound documents, database demands or printing occupations as and when required or computerized.

NAS items additionally gives enough circles to help RAID (excess cluster of free plates), it transforms numerous hard circles into one coherent unit to speedup execution, high accessibility (HA) and repetition.

### 5.4.2.3 NAS Product Categories

NAS gadgets are arranged in three general classes dependent on limit and adaptability.

Top of the line: This is driven by undertakings that need to store substantial amounts of document information, including virtual machine pictures. This likewise furnishes fast access with bunching capacities. The bunching idea is developed to address disadvantages related with customary NAS. This uses Distributed File System. A DFS runs simultaneously on different NAS gadgets associated together to give access to all records in the bunch, independent of the physical hub.

Mid-end: The NAS midmarket needs a few hundred terabytes (TB) of information. They can't be grouped, nonetheless, which numerous NAS gadgets can prompt document framework siloes as and when required.

Low-end: The low end of the market is gone for little endeavours and home clients that require nearby shared capacity. Yet, presently this market is moving toward a cloud NAS demonstrate, side-effects, for example, Soft NAS Cloud, Virtual NAS and programming characterized capacity (SDS) from heritage stockpiling suppliers.

### 5.4.2.4 Future of Network-Attached Storage

The usefulness of NAS gadgets reached out to help virtualization. Top of the line NAS items additionally bolster streak stockpiling, multiprotocol access and replication. NAS gadgets run a standard OS, for example, Microsoft Windows, while others may likewise utilize exclusive OS.

IP is the information transport convention, Mid-end NAS items may bolster Network File System (NFS), Internetwork Packet Exchange (IPX), NetBIOS Extended User Interface (NetBEUI), and Server Message Block (SMB) or Common Internet File System (CIFS) .High-end NAS items bolster Gigabit Ethernet (GigE) for quicker information exchange.

In a system appended capacity organization, the NAS head plays out the NAS control capacities, gives access to back-end stockpiling through a web availability. This design is known as scale-up NAS engineering. With scale-out NAS, the director introduces bigger heads and additional hard circles to build stockpiling limit. Scaling out gives the degree an association's business needs. Undertaking NAS frameworks can store and process billions of documents without the execution exchange off of doing metadata seeks.

### 5.4.2.5 Scale-Out NAS and Object Storage

Item stockpiling is planned as an option for taking care of unstructured/scattered information. Both capacity philosophies manage scale, just in various style/execution.

In NAS, documents are halfway overseen by means of the Portable Operating System Interface (POSIX), which guarantees that various applications can share a scale-out gadget without dread synchronous access of records and give information security.

Article stockpiling utilized another approach to work with adaptable capacity in online run time dynamic web-scale conditions. It frequently works with unstructured information that isn't actually compressible, for example expansive video records and Streamed Data. Article stockpiling does not utilize any document framework. Items are put away in a level location space. Metadata are added to depict each item, and empowers brisk recognizable proof inside a level location namespace.

### 5.4.2.6 NAS and SAN Comparison

The similitudes and distinction among SAN and NAS is as following:

NAS handles unstructured information, SAN handle square stockpiling as organized information and arranges stockpiling assets on a free, elite system.

NAS handles I/O asks for individual records, though a SAN oversees I/O asks for coterminous squares of information. While NAS traffic moves crosswise over TCP/IP, for example, Ethernet,

SAN arrange traffic course over the FC/iSCSI convention planned explicitly for capacity systems. A NAS can be a solitary gadget, however SAN gives full square dimension access to a server's plate volumes.

### 5.4.2.7 SAN/NAS Convergence

Innovative obstructions kept the document and square stockpiling universes isolated, each in its own administration area and each with their qualities and shortcomings.

With the development of brought together capacity, there was a need to enhance substantial scale document stockpiling with SAN/NAS intermingling. This keeps square and record put together information with respect to one stockpiling exhibit.

Union backings (SAN) square I/O and (NAS) record I/O with same extent of switches. The idea of hyper-combination is spearheaded by Nutanix and SimpliVity Corp. (presently part of HPE). Hyper-merged framework (HCI) unites the figuring, system, and virtualization assets on a solitary apparatus. HCI frameworks pool levels of various stockpiling media and interfaces it to a hypervisor as a NAS mount point, despite the fact that the basic shared asset is square based capacity. Since HCI gives just the most essential document administrations, subsequently a server farm may at present need to actualize a different system with appended record stockpiling.

Combined foundation (CI) incorporates servers, systems administration, and capacity and virtualization assets on sets of equipment pre-approved by the seller.

Hyper Converged Infrastructure, solidifies gadgets in a single skeleton, yet CI comprises of discrete gadgets. This gives great adaptability in building stockpiling design. Associations stockpiling the executives currently deciding on CI and HCI frameworks to supplant a NAS or SAN condition.

### 5.4.2.8 Cloud-Based File Storage

Notwithstanding NAS gadgets, a few server farms supplant physical NAS with cloud-based record stockpiling. Amazon Elastic File System is the adaptable stockpiling in Amazon Elastic Compute Cloud (EC2). What's more, Microsoft Azure File oversees document shares dependent on SMB and CIFS for access by nearby and cloud-based foundation.

NAS passages some time ago empowered records to get to remotely appended capacity specifically, associating with a superior territory arrange over FC or JBOD (only a cluster of circle) in joined servers. NAS doors are still being used however less as often as possible contrasted with a distributed storage portal, object stockpiling or scale-out NAS.

A cloud passage lives in organization's server farm arrange, interfacing applications between neighbourhood stockpiling and general society cloud. For instance Nasuni Corp. made the cloud-local UniFS record framework programming, which is packaged on Dell PowerEdge servers or accessible as a virtual stockpiling machine (VSA) for use.

# 5.5 Fundamentals of Storage Protocols

For cloud initiatives, Storage is a major consideration; in terms of cost, performance, throughput, disk, vendor, and most importantly protocol.

## 5.5.1 Small Computer System Interface (SCSI)

SCSI is the square dimension get to technique from capacity plate. Squares are littlest unit that can be perused or written to on a capacity plate, they exist in various sizes relying upon circle type and use. Square dimension get to imply that the server can straightforwardly get to the plate hinders without the requirement for a document framework, this is inverse of record based capacity talked about later.

SCSI has been utilized to move information inside a solitary registering framework. Here working framework handles information perusing/composing utilizing the SCSI convention to a SCSI drive controller, overseen by at least one gadgets on a SCSI link inside a framework case. SCSI controller guaranteed that just a single gadget would be dynamic on the link whenever which counteracts information crash and defilement on the SCSI transport.

As SCSI was overseen by a solitary controller and contained inside a framework, chance for information misfortune, are negligible, this implied SCSI did not require control systems to deal with information misfortune or dispute. SCSI is utilized in its local organization however it has additionally been epitomized into different conventions for use inside capacity systems for merged capacity.

## 5.5.2 Fiber Channel (FC)

Fiber Channel developed to broaden the usefulness of SCSI with point-to-point, circle, and exchanged topologies. FC permits longer separations transmission contrasted with SCSI and capacity union. This exemplifies SCSI information and Command Descriptor Blocks (CDB) into the payload of FC outlines. FC systems gave the tending to, steering, and stream control required to help SCSI information.

Also Fiber Channel systems are giving 'lossless' arranged by conveyance with SCSI. This guarantees in a steady system FC casings won't be dropped, and conveyed effectively guaranteeing that the Upper Layer Protocols (ULP) won't require to reorder/resend outlines.

Fiber Channel systems are extended fiber-optic connections on devoted foundations/switches. These foundations are customarily worked in sets as correct reflections of one another. This gives finish physical excess and high transfer speed and low-dormancy. Fiber Channel N/W gadgets come in 1/2/4/8 Gbps speeds with 15/32 Gbps in progress. Additionally 10Gbps FC joins are commonly accessible on an exclusive cards for connections between switches.

## 5.5.3 Common Internet File System (CIFS)

CIFS is a common stockpiling convention ordinarily utilized in Microsoft conditions for record sharing. This is a document put together capacity framework based with respect to Small Message square (SMB). Windows-based document shares utilizes CIFS as the exchange convention of the record level information. Record put together capacity depends with respect to a hidden documents framework, for example, FAT32, XFS, and NTFS. Record level stockpiling is a brilliant mode for a few applications yet may not be compelling with some different applications.

Consequently an application needs guide square access to circle record based capacity isn't proper. This incorporates classification incorporate databases and most Operating Systems.

## 5.5.4 Network File System (NFS)

NFS is document based capacity convention utilized in Linux and UNIX conditions. This is additionally utilized in VMware conditions and can offer a few advantages for virtual machine stockpiling. As a record based capacity convention NFS confronting same confinements referenced for CIFS.

## 5.5.5 Hyper Text Transfer Protocol (HTTP) and Others

At the point when the information bundles leaves the server farm (private/interior cloud) and climbs to the specialist organization level, for example, Google, Amazon, should be navigated over HTTP . At the point when a huge number of hubs should be bolstered with various Terabytes each, conventional capacity conventions may not get the job done, it needs to deal with versatility of the frameworks and the organization of the circle. iSCSI and FC both require the board for the RAID, volumes, and LUNs.

Record Based Storage Protocols (CIFS, NFS) require a decent measure for the security and volumes. HTTP conventions based capacity are being utilized to improve capacity design and increment its versatility. Every convention has its uses, advantages and downsides. Most conditions can profit different or any required conventions. Distributed storage will require each convention as a key.

# 5.6 Fundamentals of Storage Networking Protocols

## 5.6.1 Internet/IP Small Computer System Interface (ISCSI)

Web SCSI (iSCSI) typify SCSI information and CDBs into payload of IP parcels in this manner SCSI convention to can be reached out crosswise over existing IP frameworks.

As IP is routable inside the server farm and over the WAN, iSCSI isn't generally utilized/upheld over steered limits. Consequently with iSCSI, stockpiling information can be reached out over the current framework with some extra expense.

In view of defects in the convention and restrictions of the customary Ethernet based server farm systems, iSCSI has not picked up the piece of the pie, as anticipated.

1GE connections are as of now soaked subsequently 10 Gigabit Ethernet been made standard. Subsequently executing iSCSI required extra exchanging foundation. 10GE has expanded data transmission restrains yet iSCSI isn't been slung the standard.

There are a few purposes behind this,

1) There is substantial existing interest in Fiber Channel, and

2) Limitation with iSCSI conventions.

a. SCSI convention anticipates lossless, all together conveyance, and spots it in TCP/IP parcels intended to help heterogeneous systems and

b. ISCSI encounter parcel misfortune and out-of-arrange conveyance much of the time. There is no extra devices to either SCSI or TCP/IP for taking care of the SCSI payloads.

c. iSCSI is unusable or ought to be discounted it just implies that extra contemplations must be made when structuring iSCSI, particularly in the Enterprise or bigger condition.

So as to give appropriate execution to iSCSI on shared systems following should be considered

1) Quality of Service (QoS),

2) Physical engineering, and

3) Jumbo edge bolster must be considered.

Subsequently numerous iSCSI systems been set on independent system equipment from the server farm LAN (segregated iSCSI systems.) This has limited a portion of the advantages of solidifying on a solitary convention. With 10 Gigabit Ethernet and the institutionalization of Data Center Bridging (DCB) iSCSI will extend in future.

## 5.6.2 Fiber Channel over Ethernet (FCOE)

Fiber Channel over Ethernet (FCoE) convention suite standard endorsed in 2009. It gives the usefulness to moving local Fiber Channel crosswise over merged Ethernet systems. What's more, depends on the DCB gauges. FCoE embodies Fiber Channel outlines inside Ethernet Jumbo Frame payloads subsequently using gigantic edges guarantee that the FC outline isn't divided or changed using any and all means.

The FCoE (With DCB) norms give a device set to merging existing Fiber Channel outstanding burdens on shared 10GE systems and all the while gives lossless, all together conveyance SCSI parcels. FCoE does not adjust the Fiber Channel convention suite and takes into account the current administration demonstrate including zoning, LUN covering, and so on.

FCoE has begun making strides once again the previous quite a long while pushed by huge equipment merchants in the capacity, system, and server markets. FCoE gives apparatuses to embodiment of FC in 10 Gigabit Ethernet outlines.

The motivation behind FCoE is to permit

1) Consolidation of low-inactivity,

2) High execution FC systems onto 10GE frameworks.

3) This takes into consideration a solitary system/link foundation which incredibly diminishes switch and link check, bringing down the power, cooling, and managerial prerequisites for server I/O.

FCoE is intended to be completely interoperable with current FC organizes and require small preparing for capacity and IP heads. FCoE works by embodying local FC into Ethernet outlines.

Local FC is a 'lossless' convention, so outlines doesn't drops amid times of blockage/crash. Thus by configuration so as to guarantee the conduct expected by the SCSI payloads.

Conventional Ethernet does not give the instruments to lossless conveyance on shared systems so improvements were characterized by the IEEE to give proper transport of epitomized Fiber Channel on Ethernet systems.

Ethernet improvements are in reverse perfect with customary Ethernet gadgets, which means DCB able gadgets can trade standard Ethernet outlines flawlessly with heritage gadgets.

The full FC outline is epitomized in an Ethernet enormous casing and maintains a strategic distance from any change/fracture of the FC outline.

This mapping among Ethernet and FC is done through a Logical End-Point (LEP) which is an interpreter between the two conventions and is in charge of giving the fitting encoding and physical access for casings cross from FC hubs to Ethernet hubs or potentially the other way around.

Following gadgets that go about as FCoE LEPs:

1) Fibre Channel Forwarders (FCF) are switches fit for both Ethernet and Fiber Channel, and

2) Converged Network Adapters (CNA) give the server-side association with FCoE organize.

Also the LEP activity should be possible utilizing a product initiator and conventional 10GE NICs however this spots additional remaining burden on the server processor instead of offloading it to connector equipment.

Preferred standpoint:

1) One of the significant favorable circumstances of supplanting FC layers when mapping onto 10GE is the encoding overhead. This significantly decreasing the convention overhead and expanding throughput.

2) The second significant favorable position is that FCoE keeps up FC layers which permits consistent incorporation with existing FC gadgets and keeps up the Fiber Channel instrument set, for example, zoning, LUN veiling and so on.

FCoE depends on another standard set known as Fiber Channel instatement Protocol (FIP) so as to give FC login capacities, multi-bounce FCoE systems, and FC zoning implementation on 10GE systems. Consequently FCoE is a convention to look over when planning joined systems, or exchanged structures.

# 5.7 Storage Virtualization

Storage virtualization is the method for pooling physical capacity from different capacity gadgets into what has all the earmarks of being a solitary stockpiling gadget. It's a pool of accessible stockpiling limit oversaw from a focal support. Here the administration programming distinguishes accessible capacity limit from physical gadgets and to then total that limit as a pool of capacity that can be utilized in a virtual domain by virtual machines (VMs) or hidden working frameworks. The virtual stockpiling programming blocks I/O asks for from physical or virtual machines and sends those solicitations to the fitting physical area of the capacity gadgets that is a piece of the pool of capacity in the virtualized condition. Here Virtual capacity seems like a standard read or keep in touch with a physical drive. A RAID exhibit can likewise be viewed as a kind of capacity virtualization. Various circles exhibit are introduced to the client as a solitary stockpiling gadget and out of sight, and it duplicates information to numerous plates if there should arise an occurrence of a solitary circle disappointment.

## 5.7.1 Types of Storage Virtualization

There are two fundamental strategies for virtualizing stockpiling:

1. File-based: File-based capacity virtualization is an explicit use case, connected to organize joined capacity (NAS) frameworks. Utilizing the SMB or NFS conventions, document based capacity virtualization breaks the reliance between the information being gotten to and the area of physical memory. This empowers the NAS framework to deal with document relocation out of sight to enhance execution.
2. Block-based or square access virtual capacity is generally connected in virtual capacity frameworks than document based capacity virtualization. Square based frameworks isolates the intelligent stockpiling (for example drive parcel), from the genuine physical memory obstructs in a capacity gadget, (HDD or SSD). Virtualization the executives programming gather the limit of the accessible squares of memory space and pool them into a mutual asset to be doled out to any number of VMs, exposed metal servers or holders.

Note: To get to that information in the physical stockpiling gadgets, the virtualization programming needs either to make a guide utilizing metadata or, at some point utilize a calculation to progressively find the information at run time.

## 5.7.2 Example of Storage Virtualization

1. Block-based virtualization was IBM's SAN Volume Controller (SVC), called IBM Spectrum Virtualize. The product keeps running on capacity exhibit and makes a solitary pool of capacity by virtualizing intelligent unit numbers (LUNs) those are appended to servers and associated with capacity controllers. This likewise empowers clients to level square information to open distributed storage.
2. Another capacity virtualization item is Hitachi Data Systems' otherwise called Hitachi Virtual Storage Platform (VSP). Hitachi's cluster based capacity virtualization which empowered clients to make a solitary pool of capacity crosswise over isolated exhibits, even those from other driving stockpiling merchants.

## 5.7.3 Virtualization Methods

Capacity virtualization is an approach to assemble and oversee capacity limit that is aggregated/gathered from numerous physical stockpiling gadgets and afterward made accessible and reallocated in a virtualized domain. Present day data advances, for example, hyper-combined framework (HCI), exploits virtual capacity, with virtual figure control and virtual system limit. Following are the manners in which where capacity can be designed to a virtualized domain:

**Host-Based Storage Virtualization**

For this situation, the host, or a hyper-met framework made up of various hosts, presents virtual drives of a settled ability to the visitor machines, regardless of whether they are VMs in a venture domain interfacing with distributed storage. Virtualization and the executives done at the host level by means of the board programming, and the physical stockpiling can be any gadget or plate cluster. It's for the most part observed in HCI frameworks and distributed storage

**Cluster Based Storage Virtualization**

Alludes to the strategy in which a capacity exhibit presents diverse sorts of physical stockpiling for use as capacity levels. The amount of a capacity level is comprised of strong state drives (SSDs) or HDDs is dealt with by the executives programming in the cluster and is covered up at the visitor machine or client level.

**System Based Storage Virtualization**

Normally utilized in ventures today. A system gadget, for example, a keen change, interfaces with all stockpiling gadgets in a Fiber Channel (FC) stockpiling territory arrange (SAN) and presents the capacity as a virtual pool wherever required for simple administration.

Storage virtualization isolates the genuine multifaceted nature of a capacity framework, for example, a SAN, which enables a capacity manager to play out the errands of reinforcement, filing and recuperation viably in less time.

## 5.7.4 In House Cloud Network (Development Cloud) Applications and Limitations

* Misconceptions About Development Cloud
* Cloud Stuff
* Cloud 101
* On-premise/internal vs Off-premise/external
* vCloud Director
* Workloads
* Environments and Networks
* Development Cloud is a New Bubble
* [Relationship to Other Environments](https://fusion.mastercard.int/confluence/display/CLOUD/FAQs#FAQs-RelationshiptoOtherEnvironments)
* Stage and Production Clouds
* Promotion to Higher Environments
* Experience Gained via Development Cloud
* Self-service and SLAs
* Security and Access
* Support and Role of Administrative Groups
* No Special Snowflakes
* Hosting Shared Services in Development Cloud
* Model-driven Automation

# 5.8 Fundamental of Cloud Computing

Cloud Storage includes the concepts of data center are the houses which facilitates cloud storage systems and related servers, systems and services by means of underlying hardware, Storage Protocols and Storage networking.

## 5.8.1 Definition of Cloud Computing

## Cloud Computing is a new computing model that distributes the computing missions on a resource pool that includes a large amount of computing resources. It is the result of development of infrastructure as a service (iaas), platform as a service (paas), and software as a service (saas). With broadband internet access, internet users are able to acquire computing resource, storage space and other kinds of software services according to their needs. In cloud computing, with a large amount of various computing resources provided by the cloud, users can easily solve their problems. This brings great flexibility for the users. using cloud computing service, users can store their critical data in servers and can access their data anywhere they can with the internet and do not need to worry about system breakdown or disk faults, etc. also, different users in one system can share their information and work, as well as play games together. Microsoft, IBM, Amazon, Google, and Yahoo are some of the important companies which provides cloud computing services. Recently more and more companies such as Sales Force, Face Book, YouTube, Myspace etc. also begin to provide all kinds of cloud computing services for internet users.

## 5.8.2 Characteristics of Cloud Storage:

Important characteristics of cloud storage is to dynamically interface with other cloud services, which includes

* SaaS (Software as a Service),
* PaaS (Platform as a Service),
* IaaS (Infrastructure as a Service),
* IaaC (Infrastructure as a Code) and
* BPaaS (Business Process as a Service).

### 5.8.2.1 Difference between a Public Cloud, a Private Cloud and a Hybrid Cloud?

A private cloud infrastructure is provisioned for exclusive use of Organization. It is owned, managed, and operated by Organization, a third party, or combination of them, and it may exist on or off premises. Public cloud infrastructure is deployed for open use by the public Infrastructure which exists on the premises of the cloud provider. A Hybrid cloud is the composition of two or more distinct cloud infrastructures (private or public) bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds).

### 5.8.2.2 Definition of SaaS

Software as a Service. SaaS are applications that are developed and hosted by the SaaS vendor which the end user accesses over the Internet. Unlike traditional packaged applications the SaaS vendor owns the software and runs it on computers in its data center.

### 5.8.2.3 Definition of PaaS

Platform as a Service. Although less established and not as widely available as compared to SaaS and IaaS offerings, ready-to-use application platforms offer great promise for organizations that aren’t compelled to own and manage the underlying infrastructure

### 5.8.2.4 Definition of IaaS

Infrastructure as a Service. The virtualized processing, storage, and networking services along with automation and management capabilities in this area offer the most flexible level of services in the cloud computing model.

### 5.8.2.5 Definition of DaaS

Database as a Service. A Physical Data Management strategy for managing an on-site private cloud made up of several different database architectures. These architectures are capable of providing varying degrees of database service to an application based on business requirement’s related to availability, scalability and performance. The main objective of the DaaS strategy is to provide a high quality database service while maximizing ROI on database software/hardware and supporting agile development efforts through faster service delivery.

### 5.8.2.6 Major Public Cloud Providers

There are a number of established cloud providers (Amazon/AWS, Microsoft/Azure, and Rackspace) and new entries every day. Many traditional hosting companies (Savvis, Affiliated Computer Services) are rebranding there services or delivering new cloud computing offerings.

### 5.8.2.7 "Service" With Respect To Cloud

A service is something that provides “value” to the Organization lines of business. Infrastructure and Platform services are not used directly by the business, however they are required to provide a business service (i.e. email, HR application to track benefits, etc.). Infrastructure services include storage, compute, network, backup & recovery, etc.

## 5.8.3 Working of Cloud Storage

Cloud storage works with the help of cloud Storage Access Protocols

### **5.8.3.1 Cloud storage access methods**

1. **Web services application programming interfaces (APIs):** are RESTful APIs (according to the principals of Representational State Transfer) to integrate with other related applications.
2. **File-based protocols:** are used to transfer files and provide integration independent of the application being connected. They also provide a faster integration than web service APIs. Those includes
   1. Network File System (NFS),
   2. Common Internet File System (CIFS)
   3. File Transfer Protocol (FTP)
3. **Block-based APIs:** use iSCSI to connect a front end to storage middleware that supports services like data replication and data reduction.
4. **Web-based Distribution Authoring and Versioning (WebDAV):**  based on Hypertext Transfer Protocol (HTTP).

## 5.8.4 Advantage of Cloud Storage:

1. Accessibility: Data/Files/Applications can be retrieved/accessed/managed from anywhere without any constraints as just needs Internet/Network Connectivity.
2. Have choice of not carrying Physical Storage Devices or Processing Devices/computers and applications as all can be available over cloud to use dynamically.
3. Cloud storage grows as per demand, hence storage allocation may be chosen as and when required.
4. Users are allowed to access data and cloud environment includes platforms and application to work on a project as a collaborative effort.
5. Data and Business Process, Infrastructure, Platform and Software services can be shared.
6. Usability: Data can be moved between Cloud storage and Local Storage.
7. Bandwidth Sharing: Web Link of Data stored at cloud may be shared to recipients.
8. Data Recovery: In case of emergency cloud storage may be used as backup plan as files can be accessed through network as and when required.
9. Reduction in Operational Cost as no need of internal data management, power and resources.
10. Synchronization: Cloud service effect the any committed changes to affiliated devices.
11. Metered Services: It’s an example of elasticity and adaptability where cloud model works on the principal of Pay as per use i.e. Storage and bandwidth, it’s a case of as users never pay for more resources than they need and used.
12. Availability: It’s always on and available for use.
13. Data Security: As soon as data is being transferred and stored at cloud, extra layer of security protocols and encryption (RSA, 3DES etc.) is added.
14. Customization: ability to customize cloud with other applications. For this API Integration capability with cloud can give lot of benefit including verification etc.
15. Automation Infrastructure development can be done with closed as per need basis, work can be accomplished from anywhere and anytime.

## 5.8.5 Misconceptions about Development Cloud (In House)

Much of it is great feedback and spot on, but given that the service is so new and provides capabilities that organization has not traditionally provided, it's worth highlighting the top misconceptions about the service.

### 5.8.5.1 It's Free

Development Cloud is never free, although there is a free tier of usage, more than modest consumption may require project to contribute funds to expanding the shared resource pools.  It’s chargeback model where you pay for only what you use.

### 5.8.5.2 Cloud Stuff

How is Development Cloud an example of a true "cloud"? Isn't "cloud" just a buzzword?

Following services are provided by DEVELOPMENT Cloud.

**Infrastructure as a Service (IaaS)** a key element of the Development Cloud implementation is the integration of an IaaS or cloud platform.  Although it is still early days in this market, there are some off-the-shelf products that are stable and feature rich enough to support the Development Cloud service. Every large systems company, systems management vendor and virtualization vendor has offerings in this area.  Some offerings are evolutions of and extensions to traditional systems management tools while others are green field cloud oriented products.

Some of the important capabilities provided by an IaaS and cloud platform solution:

* Catalogue of services
* Users can easily browse and select deployable stacks or images of interest.
* Self-service web interface for selecting and managing standard services
* API for automation
* Transparency of resource consumption
* Initially, some degree of "show back" or the ability to inform users of the costs of the services they are consuming
* Multi-tenant, heavily virtualized compute, storage and network
* Decoupled capacity management

**Platform as a Services (PaaS)** Although the market for on premise PaaS solutions is less mature than on premise IaaS solutions, But it’s been intend to strive to deliver a PaaS-like experience for the web container and DB services.

It won't achieve the level of product management and packaging expecting from vendor and provider PaaS offerings, but will begin to offer PaaS-like offerings of our standard application and database platforms in the spirit of Google App Engine, AWS Elastic BeanStalk, AWS RDS, etc.  One of the attractive aspects of off-premise cloud offerings is the ready availability of such PaaS services.

**Immature market and risk management** to apply much of these capabilities in off-premise cloud environments and that the market is relatively immature with an absence of standard interfaces apart from de-facto standards such as the AWS APIs, to bias our technology and tools selections toward those offerings that are more modular and adaptable. It’s also expected that to swap out tools over time and even support perhaps two IaaS deployment platforms over time.

### 5.8.5.3 on-Premise/Internal Vs Off-Premise/External

It is clear that garnering some of the benefits of a true cloud platform (see Experience gained section below) will be important to our higher level environments. Therefore, the experience gained with an on premise Development Cloud will help us prepare to realize higher level Cloud environments.

At the same time, the establishment of on premise Development Cloud as providing great experience on multiple fronts that will help us adopt off-premise cloud environments for certain use cases, workloads and data.  The costs associated with the on premise Development Cloud will help establish more of an apples-to-apples comparison

### 5.8.5.4 V Cloud Director

The initial form of the Development Cloud service uses VMware's vCloud Director Product as the Infrastructure as a Service (IaaS) layer. VCloud Director or "vCD" is similar to a variety of emerging IaaS products and platforms that are positioned to enable both enterprises and service providers to offer IaaS-based services. These products and tools are broadly characterized as "cloud platforms" with capabilities that overlap with an emerging set of "cloud management" tools.

Other examples in this space include Citrix's Cloud Stack, Eucalyptus and a variety of relatively nascent OpenStack-based offering such as Nebula. The most popular off-premise or public cloud form of IaaS is Amazon's EC2 service followed by Rackspace's offerings.

### 5.8.5.5 Workloads

**Workloads, app types:** Common web application and web service development, CI-based builds and automated regression tests, new/modified stack prototyping and development, infrastructure automation development are all within scope.

**X85/x64-based:** Along the lines of both general industry trends and practical vendor and provider investments in IaaS platforms and tools, focusing on support of x86/x64-based OS platforms and workloads that are compatible with those platforms.

Today, this implies support for Red Hat Enterprise Linux (RHEL) and Windows Server.  In the Prototyping with Modified Stacks and Platforms use case, on an exception basis, other x86-compatible OSs may be experimented with, but RHEL and Windows Server are the platforms on which the standard selectable services will be offered.

**Other Platforms**: Although Development Cloud will not be focusing on other platform architectures, but will continue to enhance ability to manage deployments targeting other platforms.

**Carrot**: The targeted platform mix aligns with our overall direction to move more of the web-based infrastructure to a RHEL / JBoss platform vs. a Win / AIX / WebSphere environments.  Utilization of the Development Cloud services can help projects accomplish these goals.

**Incompatible workloads**: Given that some workloads won't be compatible with the Development Cloud environment even over a longer period of time, and some capacity dedicated to supporting these workload deployments may be required for years. For example, packaged and custom applications that require a specific platform and/or stack that is not supported by in House Cloud may still require hosting in traditional DTL environment.  Hardware appliance based services are similar in that they would not be hosted on Development Cloud itself, but may be positioned on the periphery or, as an alternative, virtual forms of those appliances may be deployed on Development Cloud for development purposes.

## 5.8.6 Converting Existing Application Platform and Infrastructure in Cloud

### ****Not a Completely Distinct or Duplicate Environment****

Existing application platform and infrastructure services will be reused in support of Development Cloud.

### ***Setting the Stage***

By establishing a new environment, bubble, context, etc., and giving it a name, and set a clear message to all involved that this is not "Your father's Olds mobile". i.e. this is a clear, transformational effort to take a different, but informed tack to delivering development-oriented platform services.

### ***By Default, Not Weighed Down***

Along the lines of setting the "bit" as to this environment being different, it’s consciously avoiding the need to reuse and/or adapt newer implementation approaches to existing implementation methods.

Many existing policies will continue to apply, but many implementations will change over time to support our goals. For example, it’s intend to use best practices for positioning and allocation of hardware resources to best support a true elastic cloud environment.

### ***True Iaas Platform and Management Tools***

A true API-driven IaaS platform solution into the manner in which currently provided and support the VPN environment is not functionally feasible and is not a recommended best practice for organizations striving for cloud-like internal deployment platforms.

### ***Reuse of Existing Shared Services Will Be Prominent***

Apart from the newly established core compute and IaaS platform and some of the associated cloud management tools, there will be many examples of existing shared infrastructure services that will be reused as is by deployments in in house Cloud.

### ***It's Not All about a New Bubble***

In addition to rallying behind in house Cloud and higher Cloud environments, are already applying some of the common underlying capabilities to our existing deployment environments. Wherever it makes business sense, it will reuse across contexts.

For example, our ability to model and automatically provision Red Hat Enterprise Linux (RHEL)-based stacks in our VMware environments is being applied to both the existing deployment environments and will form part of the in House Cloud solution. Another good example is access to Internet resources from the development environment.

If it's feasible to achieve that access from both in house Cloud and VPN, this initiative will strive to help make that happen across both environments.

## 5.8.7 Relationship to Other Environments

House Cloud is different than existing environments

**Traditional Storage:** Not all workloads that use VPN are immediately compatible with the initial Development Cloud service. See the Use Cases documentation for more information about deciding whether your needs may be met by the Development Cloud service.

Over the next several years, it’s been expected in house Cloud to take on more of the workloads that have traditionally targeted the VPN environment. This migration and redirection of workloads won't happen overnight.

**Desktop Development:** Although there are similarities with respect to the degree of latitude offered to developers, clearly in house Cloud is intended to provide a more persistent, shareable and realistic deployment environment as compared to desktop-based development.  Although some current use cases supported by desktop-based development will be better served through the use of in House Cloud, there is clearly still a role for desktop-based development.

**Labs:** There are some clear parallels between the In House Cloud service and Labs' development environment, but there are also some key differences.  Apart from these differences, In House Cloud to leverage the practical experience gained by Labs and groups working Labs as they have already faced some similar challenges.  Examples of differences include:

**Generally accessible to developer community**: By design, Labs' development environments is focused on serving people participating in Labs' development and prototyping efforts.

**Accessible from Corp**: Given its general purpose orientation, In House Cloud resources must be accessible, through the appropriate firewalls and controls, from corporation based clients.

**Access to internal shared services**: There may be a greater degree of connectivity required between In House Cloud and existing shared services than currently enabled between Labs' Development environment and Organization internal shared services.

**Stratified roles and degrees of access**:  Along with the broader audience, there will likely be interest in stratifying the degrees of access allowed in In House Cloud. See Use Cases below.

**Existing Higher Environments**: In some cases, apps will progress from Development Cloud to traditional stage. In other cases, as mentioned above, apps will be developed in a pre-Development context before progressing to traditional VPN for initial formal deployment.

### 5.8.7.1 Stage and Production Clouds

**Staggered, overlapping with Development Cloud**: intent is to establish use of IaaS and cloud management solution in support of Development Cloud first while overlapping at least the planning for a companion Production Cloud. Don't want to commit to and pilot the solution in Production Cloud context prior to establishing at least some experience in the Development Cloud context.

**Stage Cloud**: After Production Cloud, It’s been expected that Stage Cloud goes hand-in-hand.

**Existing workloads needing cloud benefits**: For those workloads already deployed and in need of a more elastic, horizontally scale-able responses too hard to determine demand, some optimizations of the current deployment and management processes might be applicable. For example:

**Adjusting/adding capacity in place**: Through readjustment of existing CPU and RAM allocations, applying additional underlying compute capacity and other in-place approaches, some degree of enhancing the overall scalability of existing deployment may be feasible.

**Horizontal expansion**: Some of the existing stack deployment automation for RHEL-based deployments could be brought to bear to help improve some of the turnaround times to add capacity. However, that is only one piece of an overall puzzle in our current process.

## 5.8.8 Promotion to Higher Environments

This is great, will have a more flexible, self-service shared development environment.

***Existing policies and standards still apply****:* Although developers will gain a bit more freedom and speed to realize development services, existing policies and standards continue to apply.

***Experimenting with new components****:* When an individual becomes interested in a new component that is not yet on an approved list (e.g. Tools Portfolio Management list), the individual must follow the Software Business Case process even for evaluation use.

***Deployment designs (TADs) for new app systems****:* Prior to build out of new application systems to higher environments, the standard deployment design process will be applied where necessary according to existing conventions.

***Deployment in VPN will apply in some cases:***  Especially prior to the realization of higher Cloud environments, some applications will need a deployment design and build out in VPN even though some initial development was done in In House Cloud.

***Data modelling and reuse****:* Data Modelling continues to be a critical part of the overall analysis and design process.

***New tools and procedures****:* Over time, additional deployment modelling and packaging tools will enable development and infrastructure teams to better describe their deployment needs such that greater degrees of promoting deployment configurations across environments can be realized. For example:

***Java Web Deployment Packaging****:* In the Java web development context, developers will be able to declare dependencies on the web container environment such that a Meta package containing both the web container requirements and the application archive (WAR, EAR) can be provided for deployment and be applicable across environments.

***Stack Modelling****:* Application development and infrastructure teams responsible for experimenting with, evaluating and, in some cases, preparing new stack combinations for deployment to higher environments, will have the tools and standards to perform most of the preparation tasks on their own.  For example, a joint application development and infrastructure effort to standardize a Tomcat web container stack can, per available standards and tools, prepare a draft submission for the new stack without needing to depend on a variety of teams to carry out development and integration activities.

## 5.8.9 Experience Gained Via Development Cloud

Examples of the practical experiences will gain through the establishment of Development Cloud

***Self-service****:* At least for the use cases in scope, this degree of self-service will be a learning experience for all.  It will help further position us for additional self-service as it will apply to higher level environments albeit with greater levels of controls that required in those environments.

***Coarse grained lifecycle management****:* Practical experience will be gained in taking a completely different approach to life cycle management of our deployments.  Using a combination of modelled stacks and services, automation and an agile cloud platform will enable us to gain real world experience with these arguably simpler methods of maintaining deployed systems before attempt to apply those techniques, tools and platforms to higher level environments.

***Modelling and deployment automation:***  Developers and infrastructure service teams will be given the tools, guidance and standards to take on much of the modelling work required to prepare their deployments for automated deployment and redeployment to both tradition deployment and \*Cloud environments.

***Largely decouple capacity management from consumption:*** Unlike today's heavily virtualized deployment environments, Development Cloud will be a learning experience for us to manage a true IaaS cloud environment by anticipating overall capacity consumption trends and easily adding capacity in front of actual demand.

***Cost transparency****:* The manner in which Development Cloud is operated as a service and through the use of cloud management tools that can provide "show back" of usage will help all involved better understand the costs involved in providing and consuming the services.  This transparency of costs will also help us compare the benefits of establishing, maintaining and consuming on premise, internal cloud resources vs consumption of off-premise, external cloud resources.

***Minutes to deploy common, standard services****:* Once an overall role has been granted to a developer, it is expected that access to common and standardized services such as a personal web container instance and/or DB instance or schema for development will be a matter of tens of minutes - all handled without human intervention. Of course, the number of such on-demand services will be relatively small at the outset given the standardization and automation required.

***Day or so for custom, but supported services****:* In cases where important customizations are needed, say a custom FQDN for your app/service vs using the standard generic FQDNs drawn from an existing pool, you may need to wait a day or so.  Similarly, if you need certs for the customer FQDNs, the request and provisioning can be automated, but there will still be a manual approval that will take time to process.

## 5.8.10 Security and Access

***Role-based access****:* You request an Identity role to access Development Cloud services.

***Shared service access****:* Connectivity has been established between Development Cloud and many key shared services housed in VPN.  Rather than assuming wide open access to these other environments, our intent is to incrementally justify and request access such that the known dependencies become well documented and can help us understand the impact of extending Development Cloud with an off-premise cloud resources in the future.

***Outbound Internet access****:* There is real business value in enabling developers to have **outbound** access to Internet-based resources much like their capabilities from their desktops today.  Unsolicited inbound access is NOT going to be supported in Development Cloud.  That access may be best addressed in a distinct demo cloud (see Labs for an example).

## 5.8.11 Support and Role of Administrative Groups

The aggressive, self-service oriented nature and access to resources within minutes be a huge additional burden on various administrative teams.

***Development Cloud Admin support:*** Strategy is to leverage the admin teams to help design, implement and support the overall Development Cloud and higher Cloud environments, procedures and high degree of automated actions rather than putting the onus on admins to be involved in day-to-day user interactions with Development Cloud. For example, standing up a dedicated JBoss web container instance stack will not require any admin intervention.  However, admins will be involved in specifying how such stacks are built and provisioned.

***Admin per transaction support:*** NOT expecting manual intervention by various admin groups in support of most normal and standard interactions with Development Cloud.  That is the bar are setting.  Sys admins, web admins, etc. will be oriented toward designing how to deliver Development Cloud, implementing some of the key building blocks (e.g. standard stack/service definition) and providing some level of support for the service, i.e. rather than being the machine, people should design and support the machine.

***In-place updates and upgrades****:* Along the lines of above, it’s not been expected to put the burden on admin teams to perform in-place updates and upgrades to deployments in Development Cloud. Several approaches will be used to help developers effect updates and upgrades on their own:

* ***In-place Tools****:* In some cases, tools will be made available to update components in-place.  For example, to enable developers who have proper privileges the ability to simply execute "yum update" to update their OS instance and any other packages that were installed via the yum tool.  Later on, considering tools that can run within Development Cloud to automatically apply updates to systems. May even use Development Cloud as a proving ground for such automation before applying such capabilities to higher environments.
* ***Redeployment of newer stacks:*** Where in-place update and upgrade tools are not available, developers will always be able to deploy an updated form of the stack of interest.  Owners of stacks will be responsible for publishing updated stacks.  To make redeployment a streamlined process, developers will need to be able to export configuration and application data from older versions of the stack and import that data into the newly deployed form of the stack.

***Fleeting OS instances****:* Through tools, procedures and capabilities supported by Development Cloud, expected to move the broader organization to a point where OS instances aren't treated as much as special snowflakes that individually evolve through a long series of manual configuration changes.

Working in a true IaaS cloud environment implies that there is much less reliance on static set of host OS instances. Providing users of Development Cloud with the ability to easily redeploy their artefacts to newly provisioned stack instances should help us move in this direction.

***Modelling and automation:*** Developers and infrastructure admins will be provided with tools and guidance that will enable them to take on much of the onus of formalizing the packaging of experimental configurations that have been shown to bear fruit and to be worth formally deploying in upper level environments or as shared services hosted in Development Cloud; i.e. Developers should not have to wait on admin and other groups to at least package their experiments such that they can progress through a review and integration process to make them available in higher level environments.

## 5.8.12 Hosting Shared Services in Development Cloud

Shared services are hosted in Development Cloud s and when required.

***Production quality vs development instances of shared services:*** Although most production-capable shared services required by these use cases won't be hosted in Development Cloud, expected that development/test instances of some shared services will be migrated to and live within Development Cloud.

Eventually, as higher level \*Cloud environments come on line, some of the production shared services will be hosted in those Cloud environments and accessed by apps and services hosted in Development Cloud.

***Stubs of services****:* As Labs has done in some cases, where connectivity is not feasible, stubs or facsimiles of shared services may be hosted on Development Cloud.

### 5.8.12.1 Model-Driven Automation

Development Cloud relate to modelling and automated deployment of infrastructure software stacks that was being worked before.

***Provide content for some standard services****:*  The standard RHEL-based stacks including JBoss and Apache HTTP Server and the ability to automatically provision such stacks will be directly reused in support of Development Cloud.  Depending on the management requirements of Development Cloud deployments, may remove certain components from the Development Cloud-oriented stacks, but our use of Chef to model and assemble stacks using a set of modelled building blocks positions us to easily deliver a series of standard VM-based stacks for deployment within minutes.

***Further enhancements****:*

* Formalizing automation of web container instances as part of the stack deployment process.
* Potentially expanding scope of stacks to include DB oriented stacks depending on how self-service DB instance, schema, etc. will be realized.
* Providing better documentation such that developers and admins can build, test and qualify their own stack derivatives for review and potential standardization.

The key characteristics of the cloud are the ability to scale and provision computing power dynamically in a cost efficient way and the ability of the consumer (end user, organization or IT staff) to make the most of that power without managing the underlying complexity of the technology. Cloud architecture itself can be private (“on premise” or “off-premise”) or public (“off-premise”).

In addition to dynamic, cost efficient and ease of use in a private or public architecture, Organization adds to that definition “within the parameters of our Information Security and regulatory policies”.

For Organization these characteristics have specific benefit:

***Faster: faster*** time to market via standard services, dynamic platforms and automated provisioning. It supports rapid increases in demand for processing and storage capacity

***Better:***   Higher quality deployments through standardization and automation

***Cheaper:***  Greater systems utilization and less manual provisioning and rework Commodity and open-source processing platforms

### 5.8.12.2 Cloud Delivery Model

Cloud services deployment models and related topics are dominating the IT landscape.

Organizations are actively addressing these deployment models and has developed an approach to enable Organization to leverage them in a consistent manner to meet business needs.

Before delving into the cloud services deployment models and their security considerations a distinction must be made between cloud services offered by Organization and those offered by third parties.

Cloud services are typically delivered in two ways:

**On‐premise** where Organization provides all cloud infrastructure and/or services for consumption. Organization is responsible for cloud infrastructure and/or service security controls and is the custodian for data residing within the deployment.

**Off‐premise** where a cloud service provider manages the infrastructure and/or services and supplies them to Organization for consumption. Organization and/or the cloud service provider are responsible for security controls and data custodianship.

On-premise cloud solutions are currently being deployed within the Organization environment.

A cross functional team of subject matter experts have applied key learnings from various cloud offerings to deploy platforms that provide tangible benefits to business owners. Colloquially known as “Development Cloud and “Production Cloud” these offerings take full advantage of Cloud technology to drive time to market, operational efficiency and innovation; while ensuring that the same level of security controls implemented on the physical workloads of today are extended to the cloud workloads of tomorrow.

In many cases the trade-offs articulated throughout remainder of this document do not apply to Organization’s on premise cloud solutions.

On-premise cloud delivery greatly reduces the barriers to entry for cloud adoption as sensitive data (PII and PCI) remain under Organization’s control. The security controls that are deployed by organization meet and in many cases exceed PCI DSS recommendations providing high assurance for data protection.

However, offerings and capabilities will vary between on premise and off-premise cloud deliver solutions. Key capabilities that are offered with various off-premise cloud solutions may not be available with the Organization on premise solutions. Thoughtful and careful consideration must be done to ensure the right deployment model is selected. To learn more about Organization’s on premise cloud offerings

**The remainder of this document focuses exclusively on off-premise cloud services deployment models;**

There is a responsibility and liability shift between cloud computing models for both Organization and the cloud service providers that must be addressed through the legal/contract processes, as well as the technology processes.

From a security perspective, Organization is responsible for evaluating cloud based systems in the same manner as any other third party solution. Organization will leverage existing processes where possible, particularly in the areas of risk assessment, legal, and Security Due Diligence. It is important that all requests and contracts be reviewed by Information Security and Data Privacy which can be started by contacting for risk assessment.

The purpose of this document is to outline the cloud computing types, appropriate utilization, and overall direction that Organization will take to address cloud services. In general, data classified as Highly Confidential – Special Handling, Privacy Data must have known locations, not spread data across state or country borders. Data also classified as Highly Confidential, Special Handling, Card Data must meet the Privacy Data requirement and be certified PCI compliant annually.

## 5.8.13 Cloud Concepts and Models

From a strategy perspective, Organization is leveraging the existing NIST definitions for cloud standard characteristics, service models, and deployment models.

It is important to apply consistent definitions to any cloud service analysis or discussion in order to properly assess the security and operational controls that need to be applied as part of the risk management process.

It is also important to engage Organization Technologies and Information Security prior to engaging any cloud computing companies or resources.

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.

### 5.8.13.1 Cloud Service Models

There are three generally recognized cloud service models:

* + IaaS – Infrastructure as a Service
  + PaaS – Platform as a Service
  + SaaS – Software as a Service

Cloud security requirements may not differ by service model in essence, but how they are designed, applied, and enforced does differ. As more environmental control is relinquished moving from service model IaaS to PaaS to SaaS, the method and responsibility of incorporating security controls changes.

For Infrastructure as a Service (IaaS), the customer is responsible for building in the necessary security controls for the application, data, and systems. For Software as a Service (SaaS) models, the customer has to RFP security controls into the cloud provider assessment, legal, and contract processes. Organization has direct experience with the consumption of Software as a Service (SaaS) applications to deliver complete business solutions. Examples is business environment include Salesforce.com, and Workday. Organization has direct experience with the Infrastructure as a Service (IaaS) cloud model. Examples include Development Cloud, Production Cloud & Simplify Commerce.

The consumer/customer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, deployed applications, and possibly limited control of select networking components (e.g., host firewalls).

**NOTE:** The term virtualization is used heavily in the promotion of cloud computing offerings. Virtualization is a technology that allows multiple operating systems to run on a single server as if that server were actually several separate devices.

This allows for greater resource utilization and flexibility which can drive down cost and increase deployment speeds. It is often part of a myriad of processes and technologies which are combined to provide cloud computing, but does not provide cloud computing by itself.

### 5.8.13.2 Cloud Deployment

Cloud services are typically deployed to the following environments:

1. **Public** where the cloud infrastructure is made available to the general public or large industry group.
2. **Private** where the cloud infrastructure is operated solely for one organization.
3. **Community** where the cloud infrastructure is shared by several organizations and Supports a specific community that has shared concerns.
4. **Hybrid** where the cloud infrastructure is a composite of two or more clouds bound together by technology that enables data and application portability across both to allow for load balancing between the clouds.

## 5.8.14 Security Risks with Cloud

The following outlines several high level security risks when considering cloud computing services and models:

1. **Data protection and privacy** ‐ protecting customer and/or constituent information becomes increasingly difficult as layers of abstraction are added
2. **Information ownership and custodianship** ‐ those who own the data are not in a position to directly control or manage that data
3. **Regulatory and policy compliance** ‐ Ensuring compliance with diverse regulations and enterprise specific policies is challenging due, in part, to the inability to effectively audit and maintain situational awareness
4. **Law and jurisdiction** ‐ Clouds cross lines, borders, and oceans representing a highly diverse set of liabilities, ramifications, and risk
5. **Vulnerability and malware management** – Ensuring vulnerabilities to threats are mitigated in a meaningful timeframe and effectively, and obtaining assurance can be complex and time consuming
6. **Access and authorization management** ‐ Having the degree and granularity of control required for the company is not always possible or feasible in the cloud
7. **Identity management** – Governing identities becomes increasing complex and Authoritative control may not be possible
8. **Infrastructure sharing** – Impact to the enterprise due to vulnerabilities exposed on shared infrastructure increase brand and reputational risk

The risks of using cloud computing must be compared to the risks of staying with traditional solutions. It is sometime possible for the cloud customer to transfer risk to the cloud provider, but not all kinds of risks.

If a risk leads to the failure of a system, serious damage to reputation or legal implications, it is difficult to impossible for any other partner to compensate for this damage.

## 5.8.15 Evaluating Cloud Services

Normal channels will be leveraged to support the business through a complete evaluation of the proposed cloud based service or solution. This involves cross-functional coordination between the business, legal, and technical teams within Organization. Additional questions related to cloud computing models, types, and environments will be part of the Security Due Diligence risk assessment process.

As Organization develops solutions to secure and support cloud based services, goal would be to raise awareness across the enterprise on the overall Organizations strategy.

Although cloud models represent alternatives to provide solutions, the process of assessing risk and developing security and operational models can leverage the same assessment processes and procedures that are in place today at organizations.

**Cloud service assessment can leverage the following existing Organization processes**

1. **Data classification –** appropriate classification drives overall security control. Information Security helps assess the overall business solution early on in the concept/design phase.
2. **Security Due Diligence:** This program helps Organization meet the requirements Outlines in the Risk Assessment Standard. Detailed information is available internally on
3. **Legal and Contract:** Normal processes must be followed to establish any business relationship with a third party vendor or cloud service provider.
4. **Privacy and Data Usage Policy:**  It includes usage and distribution controls. Any Organization using cloud based solution will require contractual agreement between Organizations and the Cloud Service Provider. Cloud based solutions must adhere to the Legal, Risk Assessment, and Security due Diligence policies, Standards and procedures.

When assessing a cloud based service or solution, the following policies and standards represent the starting point for identifying proper security and operational requirements:

* Organizations Information Security Policy
* Global Privacy and Data Protection Policy
* Risk Assessment Standard
* Data Lifecycle Standard; Classification, Protection, Media and Disposition
* Virtualization Security Standard
* Security Logging and Monitoring Standard
* Unix Security Standard
* Network Security Standard
* Mobile Device and Personal Equipment Standard
* Windows Security Standard

# 5.9 Cloud Computing At Organization

## 5.9.1 Cloud Computing Part of It Transformation

Yes! Cloud Computing has the potential to address all three areas of focus (Technology, Operations and Cultural) and provide a platform that will be critical component of our transformation.

## 5.9.2 Organizations Currently Using Cloud Computing

Organizations currently use a number of SaaS offerings including human resources (Work Day), Organizations University (Cornerstone), sales/account management (SaleForce.com) and website acceleration (Akamai). They have invested heavily in technologies that are required for cloud computing such as virtualization and automation. Plan include limited deployments of applications in development on both a private cloud and a public cloud.

## 5.9.3 Getting Application into the Cloud

There is significant interest in exploring the deployment of Organizations applications in the cloud. Deployment of applications through a public or private cloud presents a number of challenges for Organizations including security, access, and management. Working closely with technical architects, security experts and legal, are creating a framework for evaluating application readiness or fit for cloud.

## 5.9.4 Background and Strategic Use of Cloud Computing.

It is the objective of Organization Operations & Technologies (O&T) to drive benefit to Organization, its customers, and cardholders through the use of Cloud Computing techniques, technologies, and third-party services. Cloud Computing is a buzz word of the information technology and business world. Cloud Computing has as many definitions as there are vendors and service providers selling its virtues.

The purpose of this document is two-fold:

1. To provide a consistent definition and view of the value of Cloud Computing.
2. To document our high level strategy and the current status of Cloud Computing at Organization.

## 5.9.5 It Transformation and Cloud Computing

Organization is on a journey to transform itself. Have an imperative to take advantage of current position of strength to prepare for the future. Transformation is organized into three areas of focus:

* *Technology Transformation* - more effective and efficient use of technology used, focusing on technologies that serve multiple business goals.
* *Operations Transformation* - maintaining a high level of service of our infrastructure and applications while responding efficiently and effectively to the changing needs of our business and customers.
* *Cultural Transformation* - looking at the way things are done within Organization, from career development, communications and international opportunities to increasing our business savvy while recognizing and rewarding behaviors that help us achieve our corporate goals.

Cloud Computing has the potential to play a key role in all three areas of focus and provide a platform that will become a critical component of Organization’s transformation.

## 5.9.6 Cloud Computing Does

* Addresses the goal of effective and efficient use of technology by standardizing and simplifying the platforms used.
* Supports our current high level of service and the speed can meet new and changing business objectives through automation.
* Provides us the versatility and scalability needed to meet the array of technology and capacity requirements are expected to satisfy now and in the future.
* Changes the way operate. It empowers teams to quickly define their needs and deploy the platforms they need to solve business problems and meet business needs.

## 5.9.7 Cloud Computing Benefits to Organization

The characteristics of the cloud computing as defined by the Open Cloud community[[1]](#footnote-1) are the ability to scale and provision computing power dynamically in a cost efficient way and the ability of the consumer (end user, organization or IT staff) to make the most of that power without managing the underlying complexity of the technology. Cloud architecture can be private (both “on premise” or “off-premise”) or public (only “off-premise”).

In addition to dynamic, cost efficient and ease of use in a private or public architecture, Organization adds to that definition “within the parameters of our Information Security and regulatory policies”.

For Organization these characteristics have specific benefit:

***Faster***

* Faster time to market via standard services, dynamic platforms and automated provisioning
* Supports rapid increases in demand for processing and storage capacity

***Better***

* Higher quality deployments through standardization and automation

***Cheaper***

* Greater systems utilization and less manual provisioning and rework
* Commodity and open-source processing platforms

## 5.9.8 Cloud Computing Evolution and Progress at Organization

While the impact of adopting Cloud Computing technology is revolutionary in terms of the change that it enables, it is really part of an evolutionary journey that began at Organization several years ago. That evolution can be viewed in the graphic below.

Dedicated

Virtualized &  
Consolidated

Internal Cloud

External Cloud

Integrated or   
Hybrid Cloud

Figure5.1: Evolution of Cloud Computing (Y-axis - Maturity)

Each stage can be defined in terms of five essential characteristics – service provisioning, network access, resource utilization, elasticity, and service measurement.

### 5.9.8.1 Dedicated

Dedicated processing environments are traditional information technology implementations where infrastructure (servers, network devices, storage devices, etc.) are dedicated or largely dedicated to a single application or service. Dedicated environments are typically higher cost environments than other environments in this continuum due to the lower utilization of the infrastructure.

***Current State:*** Today Organization still employs a declining number of dedicated environments for applications. Typically, dedicated environments are used for applications with unique infrastructure requirements or applications which must be segregated for security or regulatory purposes.

### 5.9.8.2 Virtualized

At their basic level, virtualized environments employ software technology which allows multiple operating systems to run on a single server as if that server were actually several separate devices. The value of the virtualized model is that a single piece of infrastructure can support many more applications. This model is more cost effective but requires applications to run in more standard configurations.

***Current State:*** Today Organization heavily utilizes virtualization technology in its UNIX/Linux and Windows server environments. Note: Outdated reference? -> Organization has over 71% of all server workloads and 7% of desktops virtualized. By comparison, the industry average for server workloads is estimated at around 50%.

It is important to understand that virtualization is a technology and that Cloud Computing is an operational model.

The next three stages in the evolution towards Cloud Computing leverage the foundation of virtualized server platforms and begin the transition to a fully integrated Cloud Computing environment. Moving from virtualization to achieve utilization economies to Cloud Computing requires additional capabilities, such as policy-driven automation, metering systems, self-service provisioning portals and development and processing platform standardization.

Figure 5.2 - Cloud Computing Model below shows the interrelationships between each of the Cloud Computing models described in the remainder of this section.

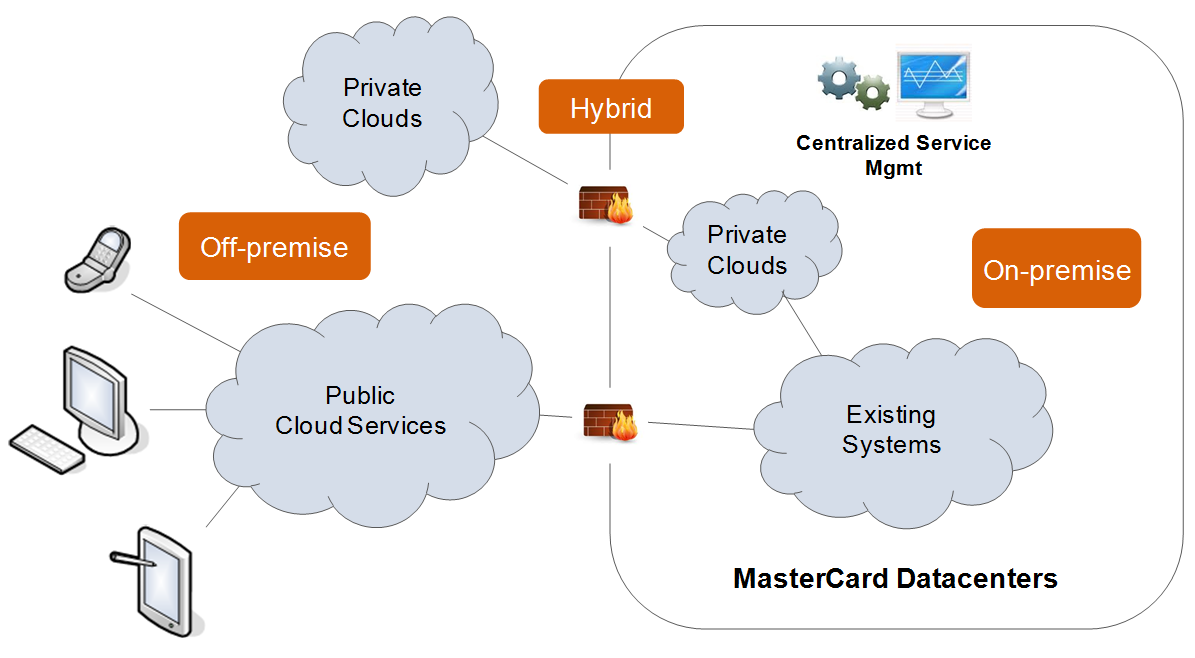


Figure 5.2 - Cloud Computing Model

### 5.8.9.3 Internal Cloud

An Internal Cloud Computing model implements the additional capabilities described above within a private data center to gain the efficiency, scalability, and speed benefits of Cloud Computing, but with the added benefits of easier and more secure integration with other on-premise infrastructure and application services.

In 2011, Organization O&T funded the project “Development Cloud On-Premise Infrastructure as a Service” to begin developing the capabilities needed for an Internal Cloud Computing environment. This project was the first step in enabling Application Development and Operations teams to accelerate the provisioning of computing environments. The resulting Development Cloud service has been a huge success, enabling development teams to spin up hundreds of environments in ‘self-serve’ fashion and greatly reducing the time to deliver and associated costs.

In 2013, Organization O&T funded the project “Production Cloud On-Premise Infrastructure as a Service” to allow for similar capabilities in higher-level stage and production environments. This effort continues into 2014.

### 5.8.9.4 External Cloud

An External Cloud Computing model utilizes third-party service provider’s infrastructure as a platform for developing and delivering new solutions. It has the same efficiency, self-service, and scalability characteristics as the Internal Cloud. The external cloud does offer additional benefit in that the operations, capacity management, hardware and software maintenance, and facilities management are the responsibility of the service provider. Use of the External Cloud can be limited by the architecture of an application, unique hardware requirements, and security and data privacy policies.

#### **5.8.9.4.1 Software as a Service (SaaS)**

In addition to an alternate method of providing infrastructure and platform related services External Cloud services include a service typically referred to as SaaS - Software as a Service. SaaS applications are developed and hosted by the SaaS vendor which the end user accesses over the Internet. Unlike traditional packaged applications, the SaaS vendor owns the software and runs it on computers in its data center. ***Current State:*** Organization today is already utilizing SaaS solutions from companies such as Salesforce.com, Workday, and Success Factors.

Looking forward, continue to support the further adoption of ready-to-use business applications whose development is not core to our business. As expanded use of such services for applications, will continue to refine existing policies and standards that will make such adoption a more conventional part of our “Build vs. Buy vs. Subscribe” decision-making process.

#### **5.8.9.4.2 Platform as a Service (PaaS)**

Although less established and not as widely available as compared to SaaS and IaaS offerings, ready-to-use application platforms offer great promise for organizations that aren’t compelled to own and manage the underlying infrastructure.

***Current State:*** Organization is not currently utilizing Platform-as-a-Service offerings in an External Cloud.

As progress with the development of our External Cloud services use, continue to evaluate and potentially adopt application services such as ready-to-use database or messaging services. The evaluation of more complete cloud-based application platforms will occur as this market matures.

#### **5.8.9.4.3 Infrastructure as a Service (IaaS)**

The virtualized processing, storage, and networking services - along with automation and management capabilities in this area - offer the most flexible level of services in the Cloud Computing model. Along with the flexibility of these generic services comes the cost of an organization managing all of the services on top of the IaaS platform.

***Current State:*** At this time, Organization O&T is actively engaged in initiatives that utilize external IaaS offerings – the most notable example is the Simplify Commerce product suite at the Internet ISP peering centres. Organization also uses Akamai’s Edge Caching solutions as both a solution to enhance web-site performance as well as a mitigation strategy against Distributed Denial of Service attacks (DDoS).

### 5.8.9.5 Hybrid Cloud

A Hybrid Cloud uses a combination of external and internal cloud services. This architecture attempts to combine the best of both worlds – offering the security, data privacy, compliance, and control of the internal private cloud as well as the flexibility and speed of the public cloud without having to provision peak capacity. For example: Using an external cloud service as a temporary platform for development and test environments and then migrating products onto the Internal Cloud as they “go live” and require the more rigorous access and security controls of the Internal Cloud. Or conversely, starting the initial offering of a product on a limited basis on the Internal Cloud and then migrating the product to the secured, External Cloud as usage and geographic expansion occurs.

While the promise of this model is significant, there are plenty of issues around actually implementing hybrid clouds. For example, moving seamlessly between the Internal and External Clouds requires strong standardization and cross-cloud cooperation. Today’s Cloud Computing standards continue to evolve and mature, and therefore make this requirement difficult to design for.

The implementation of a full Hybrid Cloud Computing model is a future consideration in Organization’s Cloud Computing strategy. At this time, focus on ensure driving towards the implementation of standards that will support the ease of movement between our Internal Cloud services and External Cloud services.

## 5.9.9 Cloud Computing Working Group

In order to manage the definition, direction, and value received from Cloud Computing, Organization O&T formed a Cloud Computing Working Group. The working group is made up of cross-functional representatives across Operations, Application Development, Enterprise Architecture, and Global Information Security. The working group is sponsored by Edgar Aguilar and Gary VonderHaar.

The primary purpose of the Cloud Computing Working Group is to ensure that initiatives inside and outside of Organization O&T utilizing cloud services or technology have direction and support that maximizes the investment and meets established objectives, all while adhering to Organization’s security and operational requirements. Through coordination with the working group, initiatives also gain further visibility as part of a holistic, corporate cloud story.

## 5.9.10 Implementation Strategy

The implementation strategy for Cloud Computing at Organization is three-fold:

1. To utilize Cloud Computing techniques and technologies to enhance our internal development and operational capabilities. Resulting in faster deployment of technology and more cost-effective utilization of our infrastructure.
2. To utilize external third-party Cloud Computing services to take advantage of their ability to
   1. Provide unique application functionality,
   2. Supplement our infrastructure and processing capacity, and
   3. Provide accelerated services to enhance time-to-market for our products and services.
3. To develop interoperability and portability between our Internal and External Cloud Computing capabilities.

It should be emphasized that this strategy will be implemented within the necessary parameters of our Information Security and regulatory policies.

## 5.9.11 Initiatives

There are many ongoing initiatives that fall within the visibility of the Cloud Computing Working Group. Intent is not to manage these but rather to provide assistance and direction to the initiatives.

### 5.9.11.1 Cloud Security

* Cloud computing at a Glance: Information Security policy reference material which is intended for key stakeholders such as business owners.

### 5.9.11.2 Development Cloud Expansion

* A new Development Cloud region is being established in Europe to better serve the needs of our European development centers by reducing latency between developer workstations and workloads deployed to Development Cloud
* Additional levels of connectivity to shared services in adjacent environments, new and refreshed turnkey deployment templates, enhanced documentation and automation are planned to enable more workloads to migrate from traditional development to the more efficient and dynamic Development Cloud hosting environment

### 5.9.11.3 Stage and Production Cloud

* The Production Cloud project is establishing an on-premise private cloud service oriented towards supporting elastic workloads.
* Building on capabilities from Development Cloud this initiative established a new elastic, on-premise private cloud hosting capability for Stage and Production workloads in Organization’s STL data center. This capability will help relieve pressure from projects to host on External Cloud platforms by providing an on-premise solution.

### 5.9.11.4 Public Cloud

* Complementing Labs-driven effort by exploring operational, security and life cycle management considerations for Production deployment on the cloud
* Involves running existing apps without architectural change in parallel to on-premise copies for a limited duration followed by decommissioning
* Continue to leverage and evaluate partners through multiple initiatives i.e. proof of concept for Big Data in the Cloud through Amazon Web Services (AWS)

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