**Lynda**  
  
**Components of Cloud Components**:

1. Clients:
   1. Mobile: Smartphones, Tablets
   2. Thin: Computers that do not have internal h/w, used to display info received from the cloud
   3. Thick: Typical computer use browsers to access the cloud
2. Datacenter:
   1. Servers which are located locally or externally
3. Distributed Servers:
   1. Network of multiple servers, so that the one can replace another if it goes down.

**Understand Cloud Infrastructure:**

* **Full virtualization:**
  + Unique applications
  + Different OS’s
  + One way to access services on the cloud
* Ideal For:
  + Sharing a computer system among multiple users
  + Isolating users from each other
  + Emulating hardware on another machine
* **Paravirtualization:**
  + Multiple operating systems on one device
  + Not all elements need to be emulated
  + Allows better scaling – requires less processor utilization
* Ideal For:
  + Disaster recovery
  + Migration
  + Capacity management

**Using the cloud to Enhance Resilience: (cases of downtime)**

**Cloud Computing:**

* Delivers capacity on demand
* Seamless mobility of applications
* Administrators can set up internal servers to fail over to cloud resources

Resilient Management Software:

* Can take a snap-shot of entire application environment
* Failure: The snapshot is recreated on cloud resources effortlessly

**Cloud Services:**

* Shared resources
* Large scalability
* Low barriers to entry
* Device independence

1. **Software as a Service (SaaS):**
2. Hosted applications
3. Accessed via the Internet using a browser
4. Pay for access

Benefits:

1. Cost savings – no softwares, or purchases
2. Lower learning curve – people are already familiar with browsers
3. Staff savings
4. Reliability
5. Security – browsers can be secured via SSL
6. Customization - easier

Obstacles:

1. Unique needs - all need not be there in cloud
2. Portability
3. Competition from open – source applications

Examples:

1. Salesforce – CRM(Customer relationship management)
2. Google Apps
3. Office 365
4. QuickBooks Online – accounting
5. Survey Monkey – online surveys
6. Halogen Software – HR talent and performance management
7. **Storage as a Service (SaaS):**

Similar to **software as a service**

1. Store specific data - flickr, photobucket
2. Store any data – dropbox
3. **Hardware as a Service (HaaS):**

**Also known as Infrastructure as a Service (IaaS)**

* Offers hardware instead of applications
* Can put whatever you want on it

Eg. Amazon S3, Amazon EC2

1. **Platform as a Service (PaaS):**

* Application delivery model like SaaS
* Supplies resources to build applications and services
* No need to install software
* Good for:
  + Application development, design and testing
  + Eg. Google App Engine, Windows Azure, OpenShift from Red Hat Cloud

**Storage and Database Services:**

**Advantages:**

* Improved availability – data is distributed, if something is affected the entire system won’t be affected
* Improved performance – data is balanced among various servers, thus improves the performance
* Lower cost – Build a network of computers
* Flexibility – systems can be modified

**Disadvantages:**

* Complexity
* Labor costs
* Security
* Integrity
* No standards

**Synchronization: Allowing data to be stored in cloud as well as in the local system. Data updates each time synchronization is performed.**

**VIRTUALIZATION:**

Hosting all of a physical machine’s hardware and software components independently on a single or shared hardware resource.

1. Virtual Machine:

* Set of virtual hardware devices(virtual CPU, virtual RAM. etc) + software that runs like a traditional OS

2. Virtual Server:

* VM running a server
* Usually runs one server based-app

3. Virtual Machine Monitor (VMM):

* Used to manage VM’s that exist on a single physical host machine
* Also known as the **hypervisor**

**(controls access to all of the physical resources on that computer)**

4. Virtual Infrastructure Management Component (VIM):

* Tool that communicates with multiple hosts and their VM’s
* Allows for centralized administration and efficient operation
* Eg. OpenNebula

5. Virtualization Platform:

* Software technology running on a server, used to create and host VMs
* Eg. VMware vSphere, Citrix XenServer, Microsoft Hyper-V
* These needs to be present before we can go on and create a VM on the server

**1. Hardware Virtualization:**

Process of emulating computing and memory resources on virtualization hosts using a VMM (aka HYPRE)

* Allows end users to run more than one OS on their computer
* Can be used in software development to enable parallel development or software testing across multiple OS’s – eg. Building an app – can be tested in windows, linux. Etc.
* Utilizes resources, reduces space, mobility benefits

**2. Hypervisors:**

**Key component of Virtualization.**

**Program that allows multiple operating systems to share the hardware of the host.**

* Each OS appears to have the host’s resources: processor, memory, network – all to itself
* Each OS have access only to the hardware allotted to it. The other OS is unaware of the other OS.
* The Host will have an OS.

Type 1: Bare Metal

* Installed directly on host hardware – there is no host OS
* Only hypervisor and other kernel components that support virtualization run on the hardware
* Small footprint, minimal overhead
* Direct access to hardware resources
* Eg. VMware ESXi

Type 2: Hosted

* Hypervisor is installed on a host system.
* Has a host OS. In this case host performs its own functions.
* Eg. Microsoft Hyper-V, VMware Workstation - this is installed over a Windows or linux ( which serves as the host OS)
* Server Core – is a very minimal system

**3. Desktop Virtualization: (Virtual Desktop Infrastructure)**

Allows end user’s OS to be stored remotely on a server in the data center.

Allows end user to access the virtual desktop, from any location.

(VM + Virtualization)

1. User virtualization: - Allows users the ability to maintain a fully personalized virtual desktop when not on the company network.
2. Application virtualization:
   1. - Allows user to access the application from remotely located server rather than from workstation.
   2. Server stores all personal info and characteristics of the application, but user can still run on a local workstation – i.e. streaming apps from an app server
   3. Application not installed but acts like it is

**4. Network Functions Virtualization:**

Building virtual network devices into server hardware. Eg. Switches, routers, IDS/IPS

These should be isolated from other VMs, else the performance of one will be affected by that of the other.

Benefits:

* Reduces need to purchase purpose-built hardware and supporting models
* Eliminates overprovisioning
* Reduces space, power, and cooling requirements
* Simplifies network services rollout and management requirements
* Reduces network services deployment time
* Scalability

**5. Storage Virtualization:**

Pools storage resources into a centrally managed storage solution. Pools it into a single management console.

Facilitates provisioning of storage of servers from a centralized location as required.

Backup benefits.

Includes data virtualization - data from multiples sources can be presented as from a single source to the user.

Storage methods:

1. DAS – Direct Attached Storage: Physically attached to a computer that is using it.
2. NAS – Network Attached Storage: Some kind of disk array. Not physically attached to server. Accessed through network.
3. SAN – Storage Area Network: Similar to NAS. Has a unit inbuilt with it for providing access to data. Most robust method.

**6. Virtualization and the Cloud:**

1. Enables on-demand self-service.
2. Increased elasticity in cloud computing.
3. Supports increased availability in the cloud.
4. Economies of scale
5. Reduces cooling and electricity costs
6. Ability to host multiple VMs on single server
7. Better resource utilization – resource pooling

**DIFFERENCE BETWEEN VIRTUALIZATION AND CLOUD COMPUTING:**

Virtualization is a part of cloud computing, but what makes cloud computing different?

* Virtualization needs a human being to interact with a hypervisor to create virtual machines. It needs an admin to manage everything.
* Whereas in Cloud Computing, there is an inbuilt API to handle all the processed. All the control activity has been outsourced to an API layer. Human factor of managing is automated.

**Basics of Data Storage**

**Cloud Data Storage:**

A repository for digital information on one or more servers, in one or more locations.

Eg. Aws, gcp. etc.

Benefits:

* Application Data
* Big Data (both file size and quantity)
* Archiving and backup
* Long-term storage
* Disaster recovery

Access from anywhere. Scalable – can grow with ones needs. Security – data protection. Cost – less cost for data handling.

Risks:

* Security
* Privacy
* Downtime

Cloud Data Storage Services:

* Online management
* API access
* Optimization

**Cloud Storage Types:**

DAS, SAN and, NAS – Page 6

DAS can be attached to the server. But unfortunately, this does not have the ability to scale. So a special adapter was plugged in called HBA (Host Bus Adapter). HBA connected to a network dedicated for storage called as SAN (Storage Area Network). Large storage solutions was added on to SAN. SAN gives the ability to centralize the management. This is very expensive. So the SAN was converted to a large LAN which is called as NAS (Network Attached Storage).

**Cloud Storage Solutions:**

**AWS:**

* full cloud platform with services in computing, databases, application and deployment
* primary storage is the Simple Storage Service (S3)
* S3 – no limited quantity and, individual objects can be as big as 5TB
* RDS, Dynamo DB

**Google Cloud Platform:**

* Cloud Storage
* Cloud SQL – relational my sql
* Cloud Datastore – schema less
* Cloud BigTable

**HP:**

* HP Cloud Storage

**Microsoft:**

* Azure Table Storage

**Rackspace**

**Data Storage Issues:**

* Security: people from anywhere can access your data
  + Vulnerability – anytime, anywhere access – ensure key authentication
  + Encryption – Prevent hacker data breach attack – access logs should be monitored
* Service Level Agreement (SLA): Tool to reduce downtime
  + Delivery – Accessibility and speed
  + Latency – response time, return speed
  + Global Network Recommendation – world-wide reach with storage host located closest to your own market
  + Scalability – Data load dependent
  + Server Availability – demand dependent

**Establishing and maintaining a secure storage:**

**Cloud Data Storage Security:**

* In transit: transferring to and from storage host
  + Data can be protected in a number of ways, none of which are mutually exclusive
  + HTTPS and SSL Protocols
  + Client-side encryption, prior to transfer
    - Requires key management strategy
* At rest: stored at remote facility
  + Server-side encryption
  + Set container policy to enforce encryption
  + Eg. AWS
  + Logging must be enabled; off by default
  + Tracks all requests for container and bucket data
  + Logs stored on storage host – Storage charges incurred

**Benefits and Risks**

Three main cloud computing scenarios:

1. Compute clouds:

* On-demand resources
* Useful to any size organization
* Eg. Amazon EC2

1. Compute storage:

* Maintain files off-site

1. Cloud applications:

* Applications are delivered over the internet
* Hosting and IT management is offloaded to the cloud

When to avoid cloud computing?

1. If the organization deals with HIPAA (Health Insurance Portability and Accountability Act ) data
2. Legislative issues
3. If application requires to set : Hardware dependencies
4. If application requires : Server control
5. Lack of need : there is no advantage of moving current system to cloud
6. Integration

**Business Case:**

Does it save money? Does it save time? Does it deliver more customers?

If not, a hybrid or on-premises model may be your best option

**Cloud Computing v/s Hosted Services**

Moreover the same, but cloud computing is more flexible, because it provides elasticity and scalability.

i.e.

- add new instances on demand

- “Upsize” existing services on demand

- “Downsize” existing services or remove instances when not needed

- Turn off instances, without deleting them

**Pay-per-use: (Cloud Computing)**

Charges based on use:

* Processing/Memory
* Network Communications
* Storage

Contract to “pre-buy” or gain lower rates

**On Demand: (Cloud Computing)**

* Very fast to turn on or off services
* Self-service
* Web Portals or Scripting
* Automation – API’s can be used to automate things

**Resiliency: (Cloud Computing)**

* Cloud providers offer varying levels of redundancy, fault-tolerance, and high availability
* You get what you pay for

**Workload Movement: (Cloud Computing)**

* Workloads (services, applications or VMs) can be moved as needed
  + Multiple servers
  + Multiple Data Centers
  + Multiple regions
* Meet your organization’s needs
  + High availability
  + Update Management
  + “Closer to the customer”

**Multi-tenancy:** (**Cloud Computing)**

* The cloud is generally a shared resource, your workload may run along-side someone else’s - even a competitor
* Private clouds are the main exception
* Security matters
* Exclusivity comes at a cost - and brings us back to more a “hosted services” model

**Operational Benefits:**

* Reduces Costs
* Increased storage
* Automation
* Flexibility
* Mobility

**Economic Benefits:**

* People : fewer staff
* Hardware : pay less for hardware in your firm
* Pay as you go
* Time to market : manage and run an instance instantly
* Software/maintenance : less
* Deployment time
* Availability : access from anywhere
* SLA adherence : vendor will be fixing the bug
* Upgrades : always improved
* IT relief
* More money!

**Cloud Storage Security:**

* Encryption: data coming to the system will be encrypted. You will need and encryption key to decode it.
* Authentication: Protect access to data by username and password.
* Authorization practices: One can list the users who can have access to data.

**CLOUD COMPUTING DEPLOYMENT MODELS**

There are different deployment models for cloud computing.

Each describes a way that cloud infrastructure is deployed either privately or to the public.

* Public Cloud Computing
* Private Cloud Computing
* Hybrid Cloud Computing
* Community Cloud Computing

**1. Public Cloud Computing**:

- Hosted Off site: things are put in the internet for the public

- Owned by as third-party company that sells cloud services to the public in a multi- tenant fashion

- Usually available to all the members of the public or large groups within an industry

- eg. Cloud service providers such as Google provides computing resources, some of which the public can use freely

**2. Private Cloud Computing:**

- Typically built to be used within an organization

- Most often developed and run by the organization’s IT Department – may also be held off site and run by a third party

- An international organization might develop a private cloud service

- eg. To provide computing resources to its employees in different geographic locations

**3. Hybrid Cloud Computing:**

- Combination of clouds of different types

- Clouds maintain their own characteristics but are bound to form a single unit

- Can offer standardized or proprietary access to data, and application portability

- eg. Organizations in the process of converting to cloud computing might use a hybrid cloud while they transition from a more traditional storage system to a cloud-based storage system.

**4. Community Cloud Computing:**

- Open and public inter-networks that enable clients to find resources on demand

- Separates an organization from cloud resource providers

- No contracts and agreements are needed before clients can access the content they require

**CHARACTERISTICS OF PUBLIC CLOUDS:**

* IT services available to any subscriber on the Internet
* IT services hosted on provider equipment – end user does not have to invest on hardwares
* Service is available 24/7
* Easy and inexpensive for consumers
* Re-use existing data/configurations
* Rapid scalability
* Data resides in a data center
* Data centers can replicate data
* Provider makes capital investment in infrastructure
* Consumers treat public cloud costs as operational expenses
* Reduced local space use, energy consumption
* Less local IT expertise required
* Responsibility for IT service maintenance falls on provider

**CHARACTERISTICS OF PRIVATE CLOUDS:**

* IT services hosted on equipment owned by private organization
* IT services delivered over a network
* IT services available only to users within the organization
* Private organization is responsible for:
  + Hardware
  + Software
  + Licenses
  + Installation, configuration, patching, troubleshooting
* Advantage : Private organization has full control over:
  + Data
  + Regulatory compliance
  + Fault tolerance – how highly available IT services are.

**CHARACTERISTICS OF COMMUNITY CLOUDS:**

* Pools computing resources to serve organizations with common needs
* Regulatory compliance – eg. Medical industry - all medical data
* Fast access to an application/data
* Similar security requirements
* When there are multiple customers with the same need.

**CHARACTERISTICS OF HYBRID CLOUDS:**

* Combines public and private cloud
* Consumer integrates on-premises IT services with cloud provider
* Could be used as interim solution before moving into a public cloud

Factors:

* Identity federation/SSO authentication
* Replicate user accounts to public cloud
* Replicate data to public cloud

**INTRODUCTION TO SERVICE MODELS**

Elasticity – refers the facility that we can add resources in the cloud as and when needed.

On-demand – refers to the fact that cloud services will be available from anywhere as long as we have network connection.

Provider pooled computing resources – cloud provider is responsible for acquiring and maintaining all hardware on which our cloud services run. All of that computing power is provided to tenants or customers when needed.

Metered service usage – pay only for what you use

Broad network access – access from any type of device

**WITHOUT CLOUD:**

Acquire computer hardware, software, licenses – expensive

Configure hardware/install software – need IT expertise

Configure and manage software

Monitor/Troubleshoot

**WITH CLOUD:**

Select a cloud provider

Ensure SLA aligns with business needs – performance and response time that we can expect from their service

Provision new IT services as needed

De-provision IT services as needed

Pay only for IT service usage

**COMMON CLOUD SERVICES**:

* End-user productivity apps
* Virtual Machines
* Hosting web sites
* Databases
* File storage/backup – second copy - in cloud and in local

**SERVICE MODELS IN CLOUD COMPUTING:**

1. IAAS – Infrastructure as a Service
2. PaaS – Platfrom as a Service
3. SaaS – Software as a Service

Available in combination or separately.

XaaS - anything as a Service

**IaaS:**

IaaS is offered as the bottom layer of the cloud computing model, focusing on the pure infrastructure

IaaS is the combination of:

* Physical Server hardware
* Physical Storage
* Networking components
* Power
* Racks and physical security
* Cooling

In the IaaS model, the hosting provider owns the physical infrastructure, and offers it to you a platform and the applications that run on it.

**Advantages of using IaaS:**

IaaS can be used in the following situations:

* To replace outdated in-house physical infrastructure
* “Warm” or “Cold” standby sites
* Temporary need for resource expansion or scaling
* Geographical scale of business and applications
* Unpredictable load to the server infrastructure
* Need for large computing power

**PaaS:**

PaaS is the layer on top of the physical infrastructure, mainly referring to the virtualization and Operating System layer.

In the PaaS model, the hosting provider is owner of the platform, and you as a customer can make use of it.

Similar to the IaaS model, except the hosting provider manages things like the installation of the operating system and the hypervisor.

PaaS could be used in the following business scenarios:

* Requiring temporary access to physical infrastructure and operating systems
* Lack of in-house platform management skills
* Short on platform maintenance experience
* Streamline application development and testing
* Easily having access to an infrastructure which allows you to run your own applications, including “warm” and “hot” standby sites

**SaaS:**

SaaS is the top layer of the overall cloud infrastructure, which offers complete applications to the cloud user

Examples of SaaS are:

* Hosted email infrastructure
* Web applications
* File sharing applications
* Music streaming solutions
* Line of Business applications

In the SaaS model, the hosting provider provides access and maintenance to the application, and you as a customer can make use of it

SaaS could be used in the following business cases:

* Avoid application and software maintenance and management tasks
* Having outdated software on the in-house platform
* Lack of skills to support or migrate the existing applications
* Focus on the business aspects without requiring IT interaction
* Cost vs. Investment in IT assets
* Trial/testing of certain hosted applications

**CLOUD COMPUTING  
HOW TO CHOOSE?**

A cloud provider or cloud services provider is an organization that offers a hosted computing infrastructure, a hosted computing platform, or hosted applications.

How to choose? Look at things like:

**1. Overall offering:**

* The best offering depends on your specific needs

**2. High Availability:**

- less downtime

- It comes with a cost

- Ask for a brief overview of the architecture to understand if and how it can provide high availability

- Platform uptime is expressed in “nine” (99.9% to 99.999%)

- Ask about their uptime and SLA

- Does the SLA offer compensation if levels are not met?

**3. Service Credibility:**

- do what they promise

- ask for customer references – check and validate them

- Large well cloud providers don’t always offer the best service

- Review official reports and industry analysis

**4. Flexibility:**

- Flexibility is not always doing what the customer asks

- Ask for different offerings upfront, so you know about future possibilities

- Flexibility includes “upsizing” and “downsizing”

**5. Test Drive:**

- Try before you buy

- Don’t put critical data in the trial environment

**6. Pricing:**

- Pricing should never be a the only point to consider

- Define the budget as early as possible

**CLOUD COMPUTING: MANAGING AND MONITORING**

* You will be the end-user and will be affected if the performance goes down
* Look at:
  + General resource consumption monitoring
  + Performance monitoring
  + Network bandwidth monitoring
  + Availability monitoring
  + Application monitoring

**How to monitor?**

* Native applications from the OS:
  + IaaS or PaaS
  + Many management tools are being designed to bridge between on-premises and cloud-hosted components
  + Principles remain the same or similar
* Tools from the Cloud Services Provider
  + Often the only option for SaaS
  + May be a differentiator between providers
  + Real-time portals vs. Time-delayed reports

**What to do?**

* Visualize Application performance in real-time
* Monitor business-transaction service levels
* Monitor cloud infrastructure health
* Isolate latency and bottlenecks
* Analyze existing dependencies
* Compare your existing resource consumption as a baseline

**INFRASTRUCTURE AS A SERVICE (IaaS):**

* For IT managers
* IT compute resources on which other cloud services run on
* IT compute resources available remotely over a network
* Eg. AWS – IaaS – allows consumers to envision storage, backup etc , Dropbox – SaaS + IaaS, Microsoft Azure
* Available to any device on the network
* Rapidly provision/deprovision new compute resources
* Computing infrastructure not required locally – advantage
* Less local square footage for IT resources
* Less local energy consumption

**PLATFORM AS A SERCVICE (PaaS):**

* Cloud services which provide services to IT developers and deployers
* Create/test applications
* Deploy applications in the cloud
* Performed using resources remotely
* Eg. Rackspace(PasS) - subscribers can create VMs, Cloud9 IDE, Microsoft Azure

**Common Benefits:**

- Available to any device on the network

- Ability to rapidly provision/deprovision applications and required resources

- Server infrastructure not required locally

- Faster time to market

**SOFTWARE AS A SERVICE:**

* Cloud service for end-users.
* Eg. Recording customer transaction data, send email
* Perform specific business tasks
* Service delivered remotely over a network
* Users can use any type of device
* Eg. MS Office 365, Gmail, Facebook – nothing is stored locally
* Benefits:
  + Available to any device on the network
  + Ability to rapidly provision/de-provision new users – adding new users/employees for example
  + Server infrastructure not required locally
  + Application licensing, monitoring, management done by the provider

**IDENTITY AS A SERVICE:**

Types of Identities:

* Internal Users
  + Internal users are those that form part of an organization, such as employees and maintenance personnel
* External Users
  + External users are those using a service or product offered by an organization .e.g. business partners and individuals in its customer base
* Consumers
  + Users who use authentication mechanisms while using social networking tools such as Facebook or services provided by providers such as Google

Identity and Access Management (IAM):

* Entity federation involves establishing and managing the identities and trust relationships of users, devices, and services in the cloud
* Organizations can outsource their identity management instead of handling it in-house
* Outsourcing IAM can be useful if a third party is better equipped at facilitating multiprotocol federation .e.g. between partners and clouds spanning multiple jurisdictions

Identity as a Service (IDaaS):

* A third party, such as a web-hosted service, manages access control and identity federation in a cloud
  + Process occurs separately from the applications that use the identities
* Hybrid:
  + Organizations and cloud service providers
    - Identities managed internally
    - Authentication processes outsourced

**DATA AS A SERVICE (DaaS):**

* Data is available on-demand
* Geographic location is irrelevant – data can be replicated anywhere
* User can use any type of device
* E.g. Google Drive, Microsoft Onedrive, Flickr
* User productivity regardless of device being used
* Access to data any time
* One version of a data file
* Data is encrypted in transit

**ADDITIONAL CLOUD SERVICES:**

**BUSINESS PROCESS AS A SERVICE (BPaaS):**

* Outsourced business process automation
* Relies on SaaS, PaaS, IaaS
* Business process is delivered over the network
* E.g. Credit card transaction processing – should ensure security in SLA, Human resources applications, Travel and expense management
* Benefits:
  + Complexity of business process automation runs elsewhere
  + Faster time to market
  + Regulatory compliance handles by provider (check SLA)

**COMMUNICATION AS A SERVICE:**

* Communications infrastructure hosted on provider equipment
* Remotely available over a network
* E.g VoIP, Instant messaging, Virtual call centre
* Complex equipment setup handled by provider
* Fault tolerance assured by provider
* Pay-as-you-go

**ANYTHING AS A SERVICE (XaaS):**

* Any IT service hosted on provider infrastructure
* Remotely available over a network

**CLOUD MIGRATION STRATEGY CONSIDERATIONS**

* Migrate existing virtual machines/applications to the cloud. These factors should be accounted for:
  + Performance, security, and reliability must be maintained
  + Increased resilience
  + Load balancing, auto scaling
* Building new VMs/applications in the cloud:
  + Employ APIs
  + EC2 instances
  + Database instances
  + S3 storage
* Identify which applications can run in the cloud:
  + Non-critical apps for pilot
* Moving an app to the cloud also means moving data
* Identify IT resources and tools for reuse
  + AWS programming models/languages
* Removal of existing hardware/software/service contracts
* Software licensing
  + BYOL vs cloud-supplied
* Incremental approach
  + Run components/systems in parallel (on premises and in the cloud)
* One-time costs
* Resistance to change
  + Staff
    - Cultural
    - Socio-political impedance
* Provide training
* Focus on long-term ROI (Return of Investments)
* Measure success of migration to cloud

**COSTING THE CLOUD**

1. **CAPEX –** Capital Expense
2. **OPEX –** Operational Expense

* Resource usage is metered – pay as you go
* Chargeback departmental billing (Private cloud)
* Internet consumer is billed (Public cloud)
* Consumer does not incur IT capital expenditures

Traditional internal IT infrastructure:

* All aspects of infrastructure are acquired, set up, and managed internally
* High CAPEX

Colocation facility:

* Owned by a third party that rents space equipped for housing and running IT infrastructure
* May also provide network connectivity, back-up power, and physical security services
* High CAPEX and moderate OPEX

Managed services:

* Full outsourcing of IT infrastructure
* Provider responsible for management of:
  + Hardware, basic software systems, software rental and database management
* Reduced CAPEX, increased OPEX

Public cloud:

* Fully outsourced infrastructure solution
* Hosted virtual computing environment
* Involves only OPEX, variable based on leveraged services

1. Cloud computing is generally cost-effective
2. Actual cost of implementation depends on business requirements
3. Cloud adoption considerations:
   * Ongoing operational costs
   * Reducing capital expenses
   * Ability to upsize or downsize on demand
   * Shifting risk
   * Re-use of services
   * Agility

**CLOUD COSTING MODELS**

* In weighing a cloud model adoption, in addition to initial outlay costs, important to consider:
  + Ongoing operational costs
    - Costs are more than monthly subscription fees
    - Bandwidth costs and compliance maintenance
  + Reducing capital expenses
    - Leveraging unowned cloud technology unaffordable to purchase outright
* Free payment model:
  + Registering and using the service costs nothing
  + Advertisements
  + Usage metrics might be tracked and sold
* Plan Payment model:
  + Consumer commits to anticipated usage
  + Billed, at a premium, for usage over your plan
  + Useful for a pattern of regular use of IT resources
* Pay as you go payment model:
  + Small monthly subscription fee
  + Usage is metered
  + A limit can be placed on usage to avoid large bills

**ASSESSING APPLICATIONS FOR THE CLOUD**

* Certain applications are more suited to cloud computing
* Such as applications that:
  + Are required only for a limited period
  + Need to be scaled often or have variable loads
  + Are non-critical
* The public cloud model may be a great solution for start-up companies
* Minimal initial capital outlay and scalability
* Agility enables a quicker time-to-market for new products

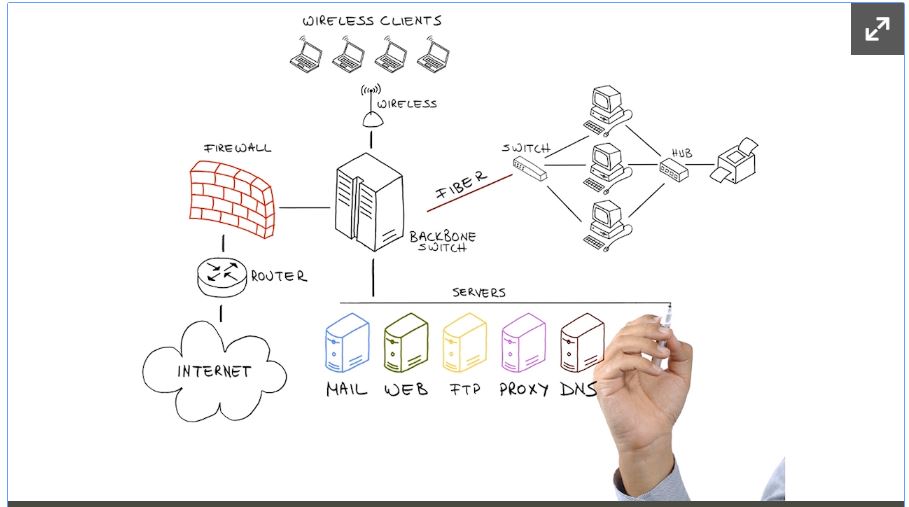
A cloud model may not be the ideal solution with:

* Legacy systems:
  + Increased cost in dealing with outdated technologies or proprietary hardware and software platforms that aren’t compatible with a cloud platform
* Mission-critical applications
  + May not be suitable for real-time mission-critical applications, for which even small breaks in connectivity could be disastrous
* Applications handling sensitive data
  + Increased risk with transferring or storing highly confidential or sensitive information

**NETWORKING FUNDAMENTALS – WIRELESS NETWORKS**

Two main types of networks are:

WAN and LAN



**CLOUD MANAGED NETWORKS**

* Cloud managed networks are enterprise networking application available from cloud service providers
* Allow companies to quickly implement network services without focusing on:
  + Server hardware
  + High availability
  + Scalability
* Allows you to build secure private networks in the cloud

**NETWORK VIRTUALIZATION**

* Allows you to connect virtual machines and devices to a network in the same way that you connect physical devices
  + With the capacity of VM’s to connect with or without using a physical adapter
* Makes it easy to build and rebuild complex network
* No need to invest in large amount of expensive, physical hardware
  + Supports a high number of virtual networks per physical network adapter
* Use of a Dynamic Host Configuration Protocol, or DHCP server
* Virtual machines connect to a network through a computer with a network adapter
  + It can connect to all computers connected to that network adapter
  + Without using a network adapter, it exists as part of an internal virtual machine network
  + Does require virtual components to function which act in a similar way to their physical counterparts in a physical network

**Virtual Switches:**

* Allows you to connect virtual servers to separate vlans
* Allows you to separate traffic for security and QoS reasons

**Virtual routers:**

**Virtual firewall: -** host based firewalls, monitor traffic

**Software Defined Networking (SDN):**

* Separates the networks control in fording planes to make it optimized

**Virtual vs Physical NICs (Network Interface Cards)**

CLOUD SECURITY

Security Risks:

* Accidental deletion
* Theft
* Privacy issues
* Compliance issue