Cloud Computing
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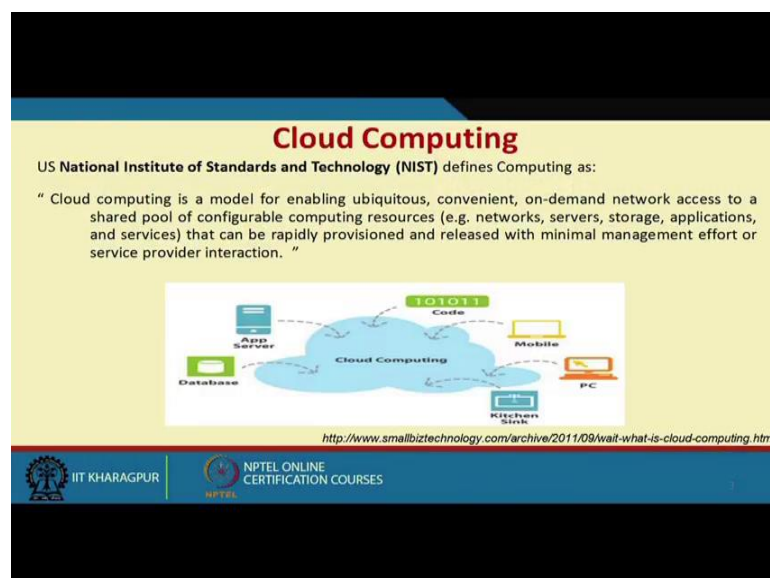**Indian Institute of Technology, Kharagpur**

Lecture – 03
Cloud Computing – Introduction

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Hi, welcome to our cloud computing course. We will continue our discussion on initially on basic or foundation of these cloud computing and then go into the more detail.

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So, as we were discussing yesterday or in the last class rather, that NIST defined cloud computing how NIST define the cloud computing model, as a enabling ubiquitous convenient on demand network access to a shared pool of configurable computing resources this is point to be noted.

So that means, there is a shared pool of resource which can be configured as per demand. So, that can be rapidly provision; that means it can be provisions to realize something and released or when I do not require it can be released with minimal management effort or service provider interaction. That means, whenever a customer or the user or the service consumer needs it can provision whenever it does the; it the no requirement is there, it can deprovisioned and that is exactly the pay as you go model.
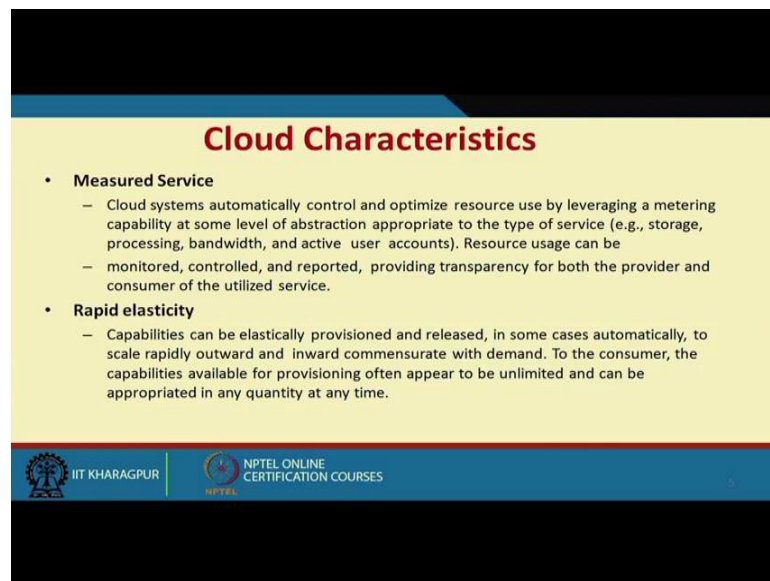
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If you look at the essential characteristics as we have already seen some of the things, they what we required; it is on-demand self-service that is a service which is on demand and it is a on-demand self-service. Broad network access, this is important thing; that means, I should have a appropriate network access because resources are distributed, they are at different geographical location, they are being pooled and provision to the user there is another thing is the resource pooling; that means, I can basically pooled resources into the for my needs and that gives us a multi tenant model with different physical and virtual resource dynamical assign like I from the same service provider, I

want to have a say, windows system windows subsystem with so many hardware specification and this are the different software specification.

From the same service providers somebody is having say a Linux say Ubuntu subsystem and one to realize those resources on the things. So, this sort of resource pooling and management of the resources is important aspects of the thing.

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There is another characteristics any type of services are measured services, right in a say; that means, I pay for what I use. So, whatever I am using is being measured. So, this is a measured services and another important aspects is rapid elasticity; that means, I can go up down as and when requirement is there, like a if I take a example like I am running a simulation, and I need a something a 4 GB sort of RAM, and when it is when we are when while running the things more data comes or more application load is there; I want to increase the RAM to 4GB to 8GB, right.

So, I need to for some portion of the time; I need to have bring more resources. So, that should I will be able to rapidly provisioning and not only that this type of elasticity is should be there; it should be I can go up come down when I requirement is there. So, that should be one of the important characteristics of property of cloud.

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There are several common characteristics which are what we say that typically a cloud computing platform or cloud service provider. So, provide one is as we have discussed massive scale up and down, resilient computing, homogeneity like I do not care that how weather at the back in that heterogeneous resources are there I want to have a homogeneous thing, typical one characteristics is that they are usually the resources many geographically, are geographically spread or geographically geographic distribution.

One major aspect is virtualization. So, I virtualize the think. So, I virtualize a windows over a Linux say there is a that sort of thing or I have a infrastructure over there virtualize several virtual machines and work on it, I can have different applications I work on it and type of things. So, that is one important aspect rather in subsequent lectures we will look little bit more on this virtualization aspect; there is a important aspect of service orientation. So, it is the services which are being communicating with each other rather than it is a data driven. So, it is not data orientation more of a service orientation, there can be different type of services. So, if we will see that in service oriented architecture.
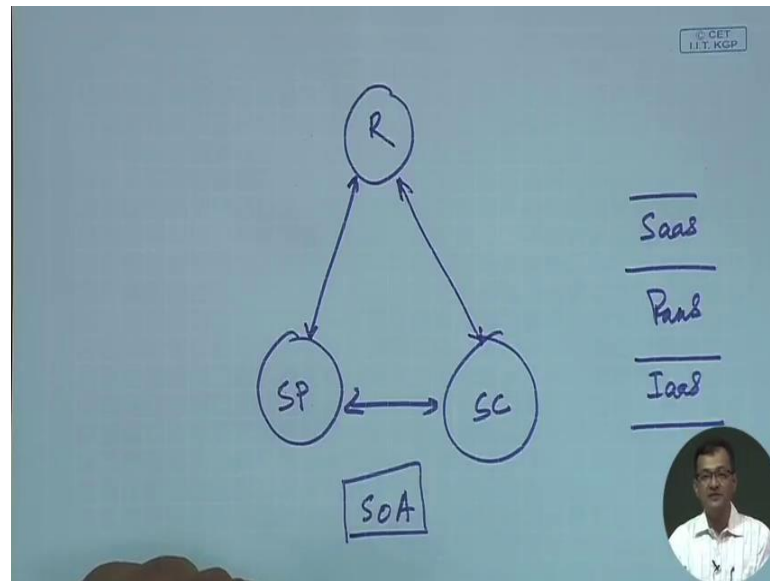
So, like we can have a service provider there can be a service consumer and there is a registry service or what we say somewhere some catalogue. So, the consumer talks to the or look at look up to the registry and find that what are the services are there, appropriately collect to the provider to access the service, right and service provider whenever it is having more or this is different service provider, it is a basically a bunch of represent a bunch of service provider jump bunch of consumer and it is a distributed, but some of logically centralized registry or catalogue and this service provider with basically upload update the registry in the things. It is as if I can have a analogy like this is the telephone directory type of thing, where I have different type of yellow pages and other thing and if whenever I required some to something to search starting from a particular person to particular type of activity, like I want to look for a say home delivery services.

So, I look at the things are over the home delivery services and then connect to that thing by a telephone call, right. So, this is somewhere a catalogue or registry service consumes or service provider and consumer, this over all it is a some sort of a service oriented architecture, right. So, that will again we will see little bit more that; what are the different type of service oriented architecture. So, one of the major aspects of this cloud computing is to realize service oriented architecture.

There is it may it usually have a low cost software, in the sense like at as this is being used and it is a multi tenant type of things the overall costing of the software comes down for the consumer end, right and expected to give a advance security. There are different concerned about security we will discuss some of the things, but expect to have a constant on the security. It is not only security in terms of whether somebody is bridging the security on things, some of the things like I say that the if the data is in cloud it is expected that the data is not lost right, but it is in my own system.

So, it is my responsibility to set the system keeps the system up and things. Similarly, some application I am; say a mail application on the cloud. So, it is expected that this is more stable and type of things whereas, if I am having my own mail server and mail relay etcetera then it is my maintenance and it goes on things. So, there are different aspects of the things. So, it is like it is supposed to provide a advance security features with respect to access control with respect to different resilient or blocking of different attacks, in a with respect to data preservation or no data lost type of situation and type of things, right.

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So, if you look at the typical cloud service model, we will go into more details subsequently. So, one as we immediately look at is the software as a service, right. So, what we see the capability to provide consumer to use provider's application running on cloud infrastructure.

Like we are nowadays using different type of things different type of aspects like say word processing, a spread sheet on the internet, right even there are different if you those who are use to scientific technical writing etcetera using tools likely I take etcetera we are having things called which are on the web; so that means, those applications are somewhere yields on the cloud and we want to hook into that application and then use those application and get my data either stored in my own the local machine or at times the data is stored in some other data service provider, right.

So that means, what you require is a basic minimal way of interfacing to the external cloud right and gets that the software as a service. Now the softwares must be running as some system or must be compiling or compiled on some platform, as a user I am not bothered about it right and what I say that for using the system what I require a basic interface may be a in sort of a web browser like say Mozilla, internet explorer, chrome and etcetera, etcetera.

So, and I have a basic and I have the knowledge to how the use the software, it can be word processer, it can be a scientific simulator, it can be a text processing, it can be some other type of applications right; a mathematical application or type of things. So, this is as a software as a service. So, what I am getting; the service I am getting as a software that. So, that makes lot of convenience at my end I do not have to purchase, that software neither I have to maintain the updates, neither I have to look at that how much my hardware requirement to run the software in some of the software there may be hardware requirement much higher, but my application is not that large. So, that scaling of the software becomes the responsibility.

So, this is the software as a service. Another thing is that infrastructure as a service so; that means, I want to realize some infrastructure at my end, right. So, that is the infrastructure as a service. Like, I want to realize a machine of particular specification, like I say it should be a it should have some 4GB RAM so much megahertz processor and so much hard disk, right. So, this is a infrastructure, as if I am realizing the whole system on my desk, right. So, that if I again if I what I have I can have different a simple and I can basically have this infrastructure as service. Today I require a 4GB RAM, tomorrow I require a 64GB RAM for some work next day, I require a 2 GB RAM, I do not know I want to only to some basic operation.

So, usually when I have this type of very variable requirements or type of things, I can basically provision that the infrastructure. So, there are provider who provides infrastructure as a service, right. In between this 2 IAS, infrastructure as a service and software as a service, we have another stuff call platform as a service, right. So, it provides a platform for some development work, some using some test cases and other thing. So, I require one is that software I am using another things is that I have the infrastructure, I load OS I or the OS can come with the infrastructure, I load other application then run and test and other things; otherwise I require that platform as a service, right.

So, there are service provider, who provide platform as a service type of models. So, this allows me to use as a platform. So, these are three very prominent what we say service model of cloud there are other various service model rather like data as a service which keep the data. Even people are talking about whether I can have something like science as a service like I give different scientific tools etcetera and then you work on a particular avenue on the type of things and looking other things or what we say it is a something anything as a service or XaaS type of things, it typical cloud philosophy wants to make this XaaS is a realization anything as a service type of model.

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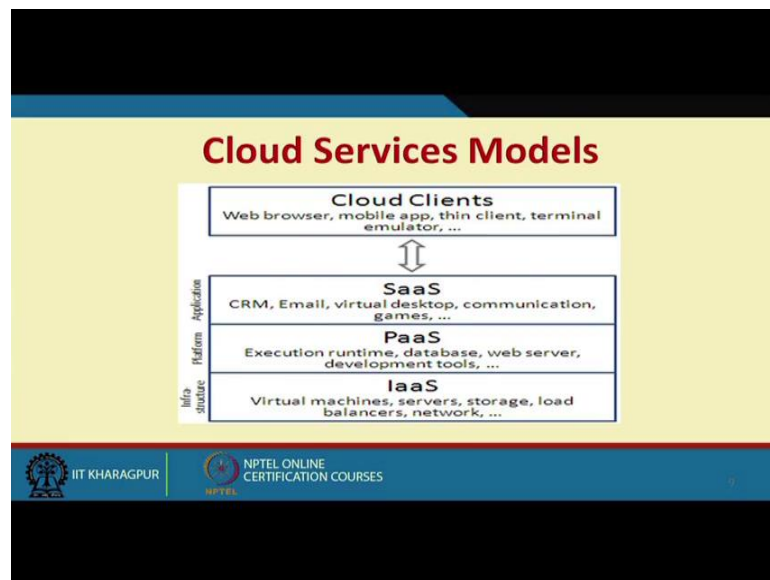
So, if we look at this over all stack. So, what we have at the below is the basic infrastructure, this is and over that this is platform as a service and over there are

software as a services, right. And there can be different type of infrastructure like we can say that virtual machine many be one infrastructure; servers, storage, load balancer, network these are the different type of infrastructures, right and there can be different other type of infrastructure as you can feel so. I can have external devices and other things have a infrastructure and type of things which can be pulled in. Over that when we look at the platform as a service there is more of a something execution platform on runtime, database, web server, development tool, development platform there can be some sort of a sand box type of environment and type of things.

So, these are a more as a platform as a service, and over that I have a SaaS or the software as a service which basically realize the this softwares likes there can be CRM, email, different virtual desktop, there are different games and so on things which runs over the over and above the this cloud infrastructure and PaaS. Now how where the? This part is more of the cloud provider end. So, some provider may provide SaaS, some may provide PaaS, some may provide SaaS, IaaS or what we say infrastructure as aservice; some may provide a mix of the things right, but if we look at the client perspective. So, how client access it? So, the best or the what we say the universal way is the web browser, right or what we say web client there are other things like an I can have mobile apps right which can access this type of a thing, even there are thin clients the terminal emulator and different type of other thing.

So, these are the interface by which the client interface to this cloud, right.

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 Now if we with this thing if we want to look at the different type of deployment models right. So, what are the different type of deployment model? How to realize those cloud or type of clouds right. One is the private cloud, I build a cloud and I use it like in our IIT Kharagpur with we indigenously with open source systems, we build a cloud called Meghamala. So, it is name of the cloud is Meghamala, it is a very not so large cloud, but is privately build on over source system primarily used by researchers, both faculty and research scholars, for mostly a infrastructure as a service over the things.

Over that we try to give other services like data services or other type of big data services and type of things, but primarily it is a infrastructure as a service. So, it is a private cloud it is accessible within the IIT, Kharagpur network itself and not accessible outside the network right and it has a different charging model like as it is a institute funded infrastructure. So, we do not charge anything on things. There can be others other end a what we say public cloud right. So that means, which is public. So, at different type of things, I can have public clouds as infrastructure, I can have public clouds as like amazon clouds are for infrastructure for a one of the popular example; there can be platform as a service type of cloud like what we look at some sort of a what we say that Microsoft azure or we can have things like software as a service type of cloud like Google doc tools spreadsheets type of things some of the examples.

So, these are the public clouds, right. There are another things what I can have a hybrid cloud right. So, it is a mix of things of public and private as such. There is a typical category of cloud which is a, what we say community cloud. So, it is something semi semi-public semi private type of things like I can have it is shared by several organization and support specific goals or what we say coat-un-coat it say some sort of a likeminded or like I means same type of goal achieving organization.

Like I say bank sector may have a banking cloud, right. So, that core banking things whatever they exchange with the things in our county like RBI, may be the nodal agency to handle or the things over that there is a cloud. I can have a institutional cloud like what we have say government funded institutional cloud, which can work on the things. I can have there are things like if I working with some other type of data like bank etcetera like one like what we work on in the spatial data we can have a Geospatial cloud which with the type of things.

So, this is addressed to a community, may not be a not in a one organization multiple organization, but it has some purpose to do right. So, this is a community cloud. Now I can have a hybrid or the things some private, some public, some community or public private only and type of things, right. So, these are the different type of what we say deployment models of the cloud.

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Now, though we will go little more differ into the things is subsequent lectures, but we can do see that the cloud and this virtualization somewhat come hand in hand right. So, if we look at this picture which we say there virtualized or virtualization stack. So, we have a bare metal of the hardware at the end, right, over that I require a something a middleware which allows me to create different virtual things.

So, what we are trying to see like what we are saying that we are having different Hardware, right.

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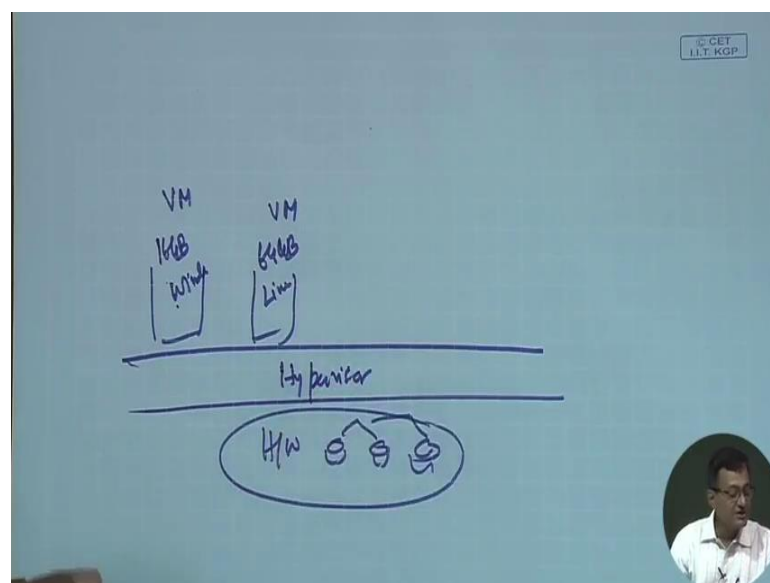
It can be different systems across different network etcetera and connected through different sort of network etcetera over that what I am end goal is to realize different virtual machine like I can say this is a 16GB machine of running windows. This is a maybe 64GB machine RAM with running something some orient of Linux etcetera right. Now, this collectively being realized to make this type of different virtual machines right I require something in between what we say VMM or virtual machine monitor or hyper visor.

So, this hypervisor basically allows me to emulate this different type of machines. So, if we look at the virtualization stack. So, one or virtualization how I want to what we want to virtualize one is that virtual works spaces I can have different virtual works spaces and abstraction of an execution environment that can be made dynamically available to the authorized clients by using well defined protocol. So, I suppose for my particular project

I require a environment for this may be development environment visualization environment, computing environment and then I generate dynamically or the organization generate dynamically to the for the team to work on it, right. And that may be a short term project of 14 days or something and it basically realized. Purchasing a whole stuff for that 14 days maybe a costly affair, but if I provision that from external world on a pay you or from public cloud and maybe a solution, right.

So, there is only another thing aspect is the virtual machine on to realize into the into different virtual machines; and then there are there can be different category of virtual machines which can be used by the user like as a talking about Meghamala, we realize different category of virtual machines with basically three category of virtual machines and whenever use a needs come we provision it based on the availability of the things. And it can provide infrastructure API, plugins to hardware support infrastructure etcetera. So, it can provide it provides API to connect to the different infrastructure. So, we will basically look at visualization there are different aspect of virtualization. So that we will look at in the subsequent lectures.
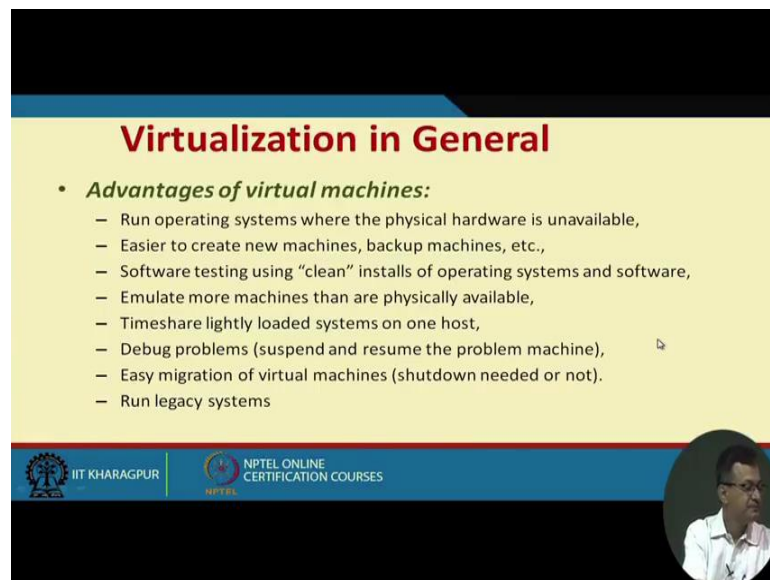
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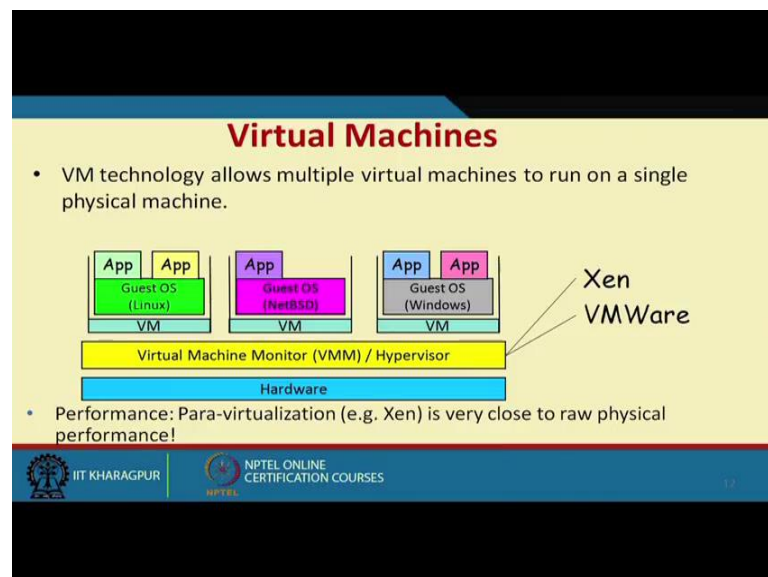
So, if we just look at this; whatever you are talking about. So, virtual machine technology allows multiple virtual machine to run a single physical machine.

So, this is my hardware. So, it is not that single physical machine means not only one machine there can be couple of machine clubbed together and realized, like I say that I

have ten 4GB systems or so that I can have some effectively 40GB things, and then I realize say three or two 16GB and one 8GB actually you cannot do all division there are some requirement to for this virtualization to happen. So, it 40GB can you break into two 16GB and so, I realize two 16 GB machine using underlining this hardware, right. So, what we require is one is the virtual machine monitor, which allows me to emulate this hardware and I can have different virtual machines over the things and there are a concept of guest OS which resize on the things, right.

So, there the guest OS here may be Linux, there can be other guest OS, there can be other guest OS and different type of things and this applications running on the things are different; and this virtual machine by may be used by somebody at some geographical location, this virtual machine somebody at the some other geographical location and so on and so for. So, everybody for individual consumer it is say machine for it is purpose. So, there are different category of virtualization, we will see the things like a performance for virtualization close to raw physical performance we will see that why and how and later on. So, some of the popular virtual machine monitor or hypervisor is one is Xen another is VM ware.

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So, virtualization in general there are advantages of the virtual machines, like run operating system where the physical hardware is unavailable, easier to create new

machine backup machine etcetera, software testing using clean install etcetera, there are of number of things which are which can be realized with this virtual machine.

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So, there are issues of cloud sourcing when we are, why it is becoming important? First of all high scale low cost providers. So, I can have lot of resources as a thing. So, economy party play a important role right when you get the much cheaper services on the things, etcetera, we will see in a separate lecture that whether this economy is always what this cloud economics of cloud says and whether always it is a beneficial or we need to think about there when the things are beneficial etcetera.

Anytime anyplace access via web browser. So, it is my whole computing my hold services whatever I am exercising is anytime anyplace type of services right. So, I do not bother about that where the services are leverage and type of things, and there are rapid scalability incremental cost and load sharing. So, there is scalability is pretty high right I can rapidly scalable. That is cannot forget need to focus on local ITs. So, that the whatever your infrastructure is there, that need to be looked into; there are some of the serious concerns also whenever you are leveraging or resources from a things, one major concern is performance reliability and service level agreements right what will be the performance what will be the reliability the service is always on and type of things and there are issues of service reliable agreements like I signs some agreement with the things whether these those are honored, not honored and type of things.

There are issues of concern of data and service parameters like I say concern of the data my data is in cloud, even I write a later the latter is in the cloud, I write a report there is in the cloud then I am concerned that whether this data is secured, should not be tampered and so far, and another issue is there service parameter this is also there like how do they say that the availability is 90 percent or 95 percent. How to look at those parameter; how to audit that that whatever I looked for is given by the things, right.

There are issues or application features and choices. So, it is sometimes we say that it is provides a application which is fixall, right, whether I do not have a customized choice of the thing whether there a issues there whether I can have or not there issues of interaction between cloud providers, right. So, there are one provider purchasing services from the thing, like it may be a infrastructure provider purchasing some of the infrastructure like hardware etcetera from a data provider and so on and so for.

No standard or like issue of standardization of the API is like whether it is a soap or rest type of services, when we look at the service oriented architecture and of course, issues of security privacy, security compliance, trust, competence, risk these are the major concern whenever we purchase this sort of a service. Especially it is critical when we purchase those things for our some of the misson critical or my day today operational requirement.

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Cloud storage why we keep it separate because it is place a pretty important role. We will if time permits we will look at that some of the storage aspects, but it say one of the important factor because data is extremely important for the consumer or for the service consumer or the users, right.

So, allow data stored remotely to be temporarily cached on the desktop computers, mobile phones or other internet linked device. So, you can have a sinking with the data also many of us are using this sort of services, for putting our data as a service. So, there are things like amazon EC2, S3 are well known examples where this data services are there.

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Some of the advantages just to re-iterate one is the lower computer cost, right one major aspects there is low I should say not computer cost lower computing cost.

Improved performance I expect that the overall performance will be improved, because I am purchasing something as a higher price; reduced software of course, like I do not have to purchase separate software etcetera. Instance software updates if there is a update this is getting updated; improve document format compatibility, if there are interoperability you should be a prop better you addressed.

Unlimited theoretically unlimited storage, I pay and I get the storage, increase data reliability, I it is stored in distributed things with proper redundancy, etcetera. So, it is

expected the data it will be high, universe and information access, I can access information at every point, latest version of the systems and software available; easier group collaboration when you are having one data different applications; device independent I can access from different type of devices.

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Required say there are; obviously, some these are all good points there are always some pit faults or some concerns or disadvantages, like requires a constant internet connection you are disconnected your gone.

Does not work well with low speed connection that is again network connectivity. Feature might be limited right. So, some of the things I may not get what I get on a customized personal thing at can be slow at time because this is provisioning etcetera finally, takes time. Stored data I am really we are nearly concerned about whether how secured it is; stored data can be lost, if there is a crash on the things or the provider goes out of the things that there may be chance of loss. Cloud is not truly a high performance computing systems. So, if we think that cloud will provide high performance with may not provide there HPC type of things, and there are several general concept or connectivity of a API's having particular database connectivity where the database will run, etcetera.

So, what will do we will stop here and for now and then we will look at the different architecture, and in my in our sub subsequent lectures.

Thank you.