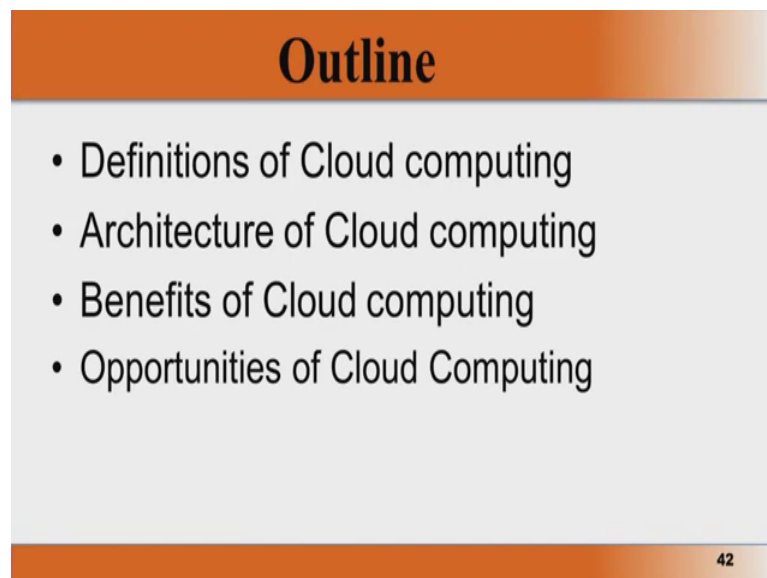**Introduction to Information Security**
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Lecture - 21

You use your system today, everywhere we are taking about I Cloud Microsoft has something called one drive, Google has something called Google drive. What is this cloud computing? If you look at business enterprises, there are lots of initiatives to put everything on a cloud. So, what you mean by this cloud computing? So, in the first part of this session we will understand some basic definitions of cloud computing. We will understand what cloud can offer, why we need a cloud and what are the challenges from a security point of you? It actually turns out that one of the major challenges today in providing a cloud computing infrastructure whatever it means is the security.

And we will also see some notions of where security brings a big issue, where security becomes a big issue when you look at cloud. So, this session we will talk about cloud computing in more detail.
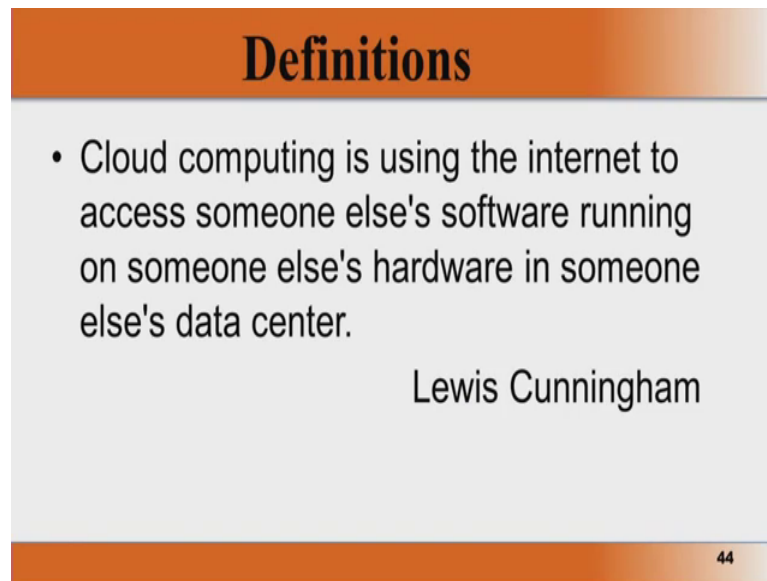
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So, we go with this. What is the definition of cloud computing, what is the architecture of a cloud, what are the benefits of having a cloud computing infrastructure and what are the opportunities you get by moving on to a cloud computing? In the next session, we will talk about what are the challenges in implementing a cloud infrastructure.

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Definitions

Source	Definition
Gartner	"a style of computing in which massively scalable IT-related capabilities are provided "as a service" using Internet technologies to multiple external customers" (Gartner 2008b)
IDC	"an emerging IT development, deployment and delivery model, enabling real-time delivery of products, services and solutions over the Internet (i.e., enabling cloud services)" (Gens 2008)
The 451 Group	"a service model that combines a general organizing principle for IT delivery, infrastructure components, an architectural approach and an economic model – basically, a confluence of grid computing, virtualization, utility computing, hosting and software as a service (SaaS)" (Fellows 2008)
Merrill Lynch	"the idea of delivering personal (e.g., email, word processing, presentations.) and business productivity applications (e.g., sales force automation, customer service, accounting) from centralized servers" (Merrill Lynch 2008)

So, these are all definitions of a cloud. Many people come out with cloud for example, Gartner says a style of computing in which massively scalable IT related capabilities are provided as a service using internet technologies to multiple external customer. There are many other definitions which are almost equivalent to this, but with some different nuances and colors. So, basically a cloud is one infrastructure is which can cater to the need of many people and do different varieties of services. So, it has different functionalities and it can have different types of service in the sense, it can store for you, it can compute for you and importantly, it can scale to a need. So, today your business is say x, tomorrow it becomes to x, then this cloud can scale. So, this is what we mean by the basic definition of a cloud, essentially means a provision of an infrastructure which is scalable and we can do varieties of services for you.

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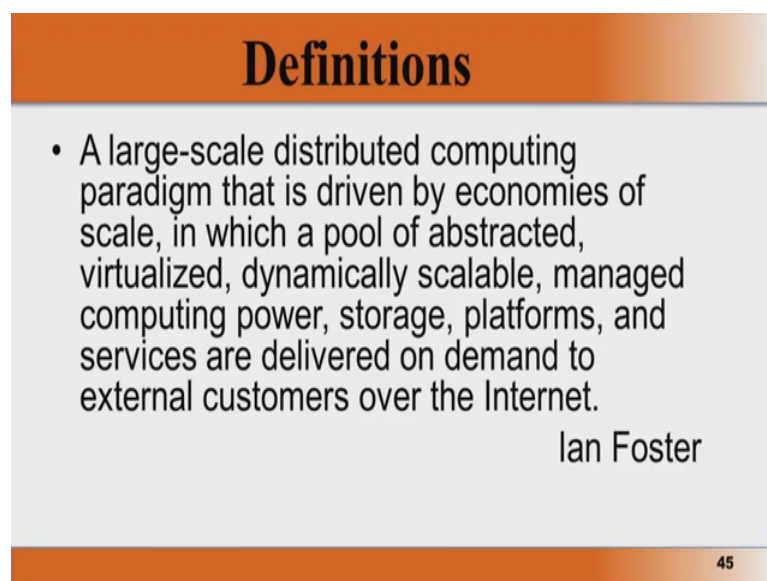

The other interesting definitions of cloud for example, cloud computing is using the internet to access someone else's software running on someone else's hardware in someone else's data center. So, this is a very nice, very interesting definition. Essentially it says you need not care all that you want is provider and you really need not bother who is running the software and which hardware or software is running, and where this hardware and software combination is located. So, it becomes completely independent of everything. You get a service and what you need is a basic internet connection. This is a very nice definition of a cloud computing.

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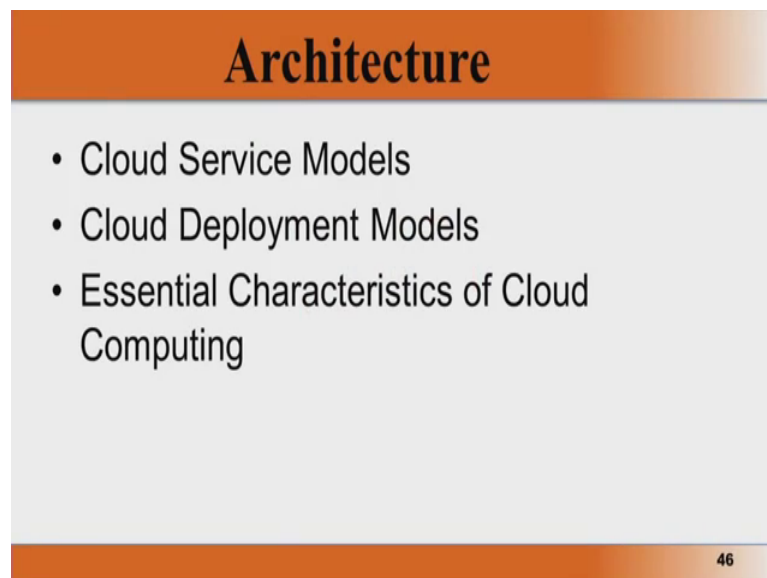
There are other definitions called which becomes a little more technical where in people talk about a cloud as a large scale distributed computing paradigm and important work again it talks about scalable management etc. Another important thing is what you call as a virtualization.

What you mean by virtualization? What is virtual mean? What does virtual, the word virtual mean? As far as you are concerned you look at one very big system and think that it is serving you. Actually it may be serving many people. You only look at your part and for you that server says that I am giving you a service whatever service you want. You really do not know what is internal to that server. You just see a machine, a black box which does all the functionality you want. So, all the implementation, everything is hidden from you and that is why this word virtualization comes there. So, as far as you are concerned you see one holistic server which is entire and you feel that it is entirely dedicated to serve you, but in reality it may be serving many people, but as far as you are concerned, it is a dedicated server for you. And, this is what the term virtualization mean .
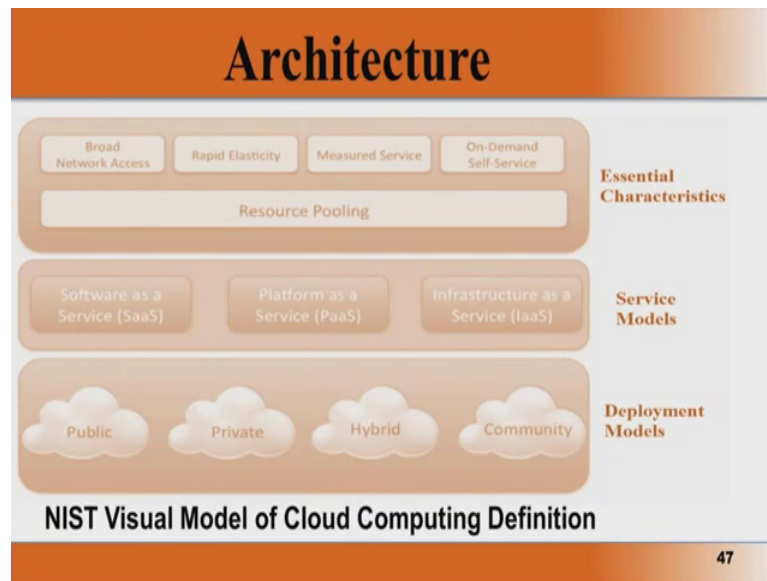
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So, we had some basic introduction to the definition of what a cloud is. Now, we will see the architecture of a cloud, how is a cloud, what are the important components of a cloud? When we look at cloud architecture, you actually need to see three important things. How do you think the cloud is going to service you? So, what is called as a cloud service model and how is this cloud being deployed? The cloud deployment model and what are all the characteristics of you want from this? So, when I want to arrive at

architecture for a cloud, I should basically have an understanding of what are the services it is going to provide, what type of services it is going to provide and how do you go and deploy this infrastructure that can provide you this service, and what do you expect from them as characteristics. So, all these three parameters essentially give out an architecture, define an architecture.
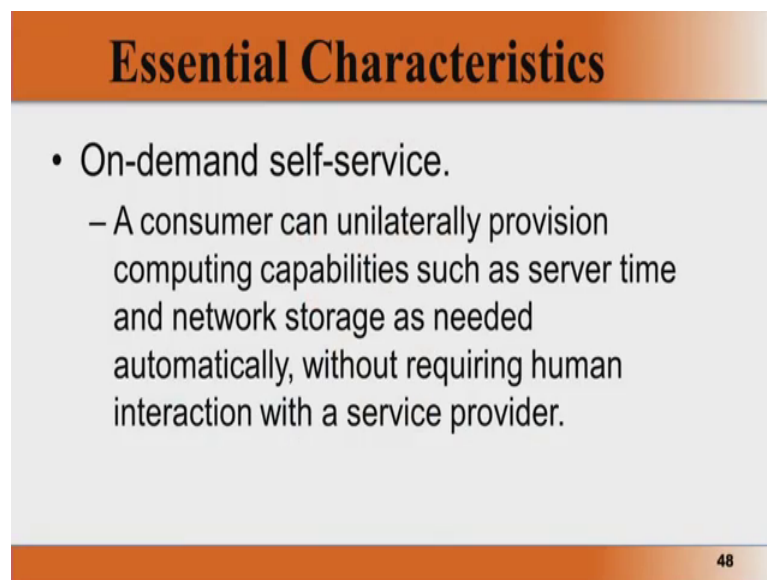
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Now, just based on these three parameters, namely characteristics, service and deployment, the entire cloud architecture can be viewed as shown in the slide. This is the NIST visual model of cloud computing definition. So, there are certain essential characteristics like what we call as broad network access, rapid elasticity measured services, on demand self services and resource pooling. These are all some essential characteristics that we expected from the cloud. We will go and discuss about each of these characteristics in great details, in this session.

We are also looking at several service models for this cloud. What I expect from a cloud? I want the entire software environment on the cloud that is what you call as SaaS software, as a service. The next model would be I do not need the software, but I need platforms in which I could build the software. For example, I may need JBoss, I may need a Linux, I may need the operating system, I may need development tools like compilers etcetera. So, this type I will develop software on that. This model is called PaaS which is platform as a service. I do not need anything. I just need the hardware. Then, this basically becomes an IAAS infrastructure as a service. I need the computer

hardware; I need the networking hardware and possibly some firmware on top of it, which you will put, right.

So, these are all the three service models and these service models I would like to have realized those characteristics that we have mentioned about and then, there are several deployment models, at least four deployment models a. public model, a public deployment model, a private deployment model, a community deployment model and probably a combination of these three which is called hybrid deployment model. So, to sum up this slide, an architecture of a cloud can be well defined based on three important parameters; the deployment models, the service models and then the essential characteristics. Now, we will go and define every label that we have put in every box here in detail as a part of this session.

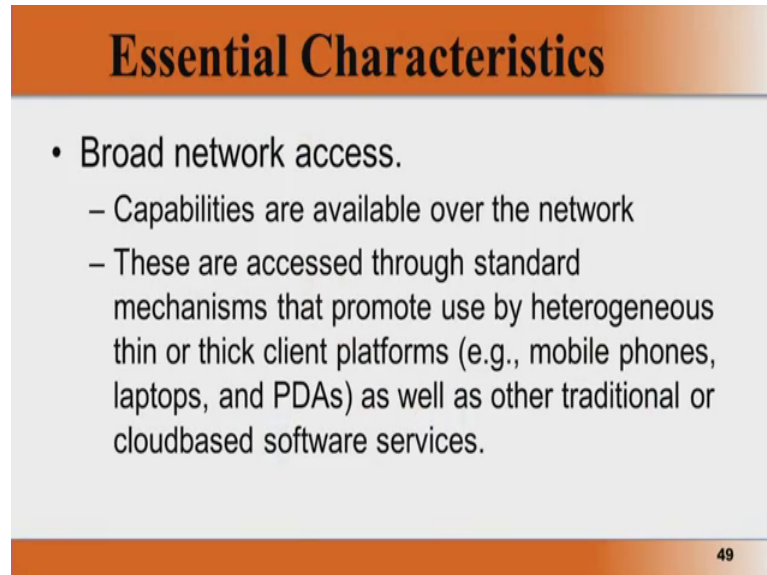(Refer Slide Time: 09:20)

Essential characteristics: We have talked of several essential characteristics in which one is on-demand self-service. Cloud is an infrastructure which is massively scalable. The moment I am talking scalability, one of the important thing that comes in mind that should be insured is lack of human intervention. I need to do some activity. It should be automatically done by the system. So, one of the thing that cloud should offer if at all it becomes scalable, it needs to become scalable is to give this on-demand self-service, where in a consumer if you want some service, he should be able to invoke that service whenever he needs it. That is why the adjective on demand and he needs to invoke it by himself without relying on some other human interaction. That is why we call it as self-service. So, this is one very important essential characteristic of a cloud environment

which essentially makes it scalable. From a scalability point of view, this is very important.
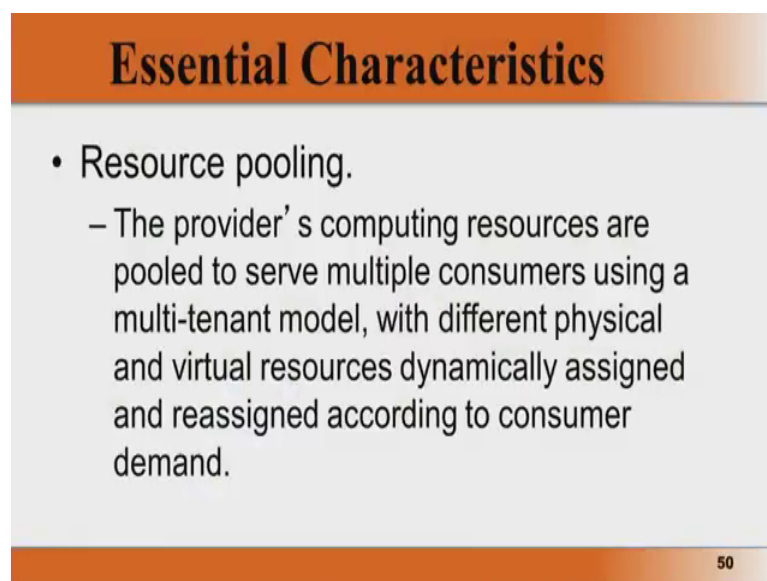
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The next one is broad network access. What you mean by a broad network access? Essentially it means that my access is not limited by the end device. For example, I need to have a cloud that I can access from a laptop, I can access from a mobile phone, I can access from a tablet, a Fablet or any PDAs and it should also be accessible from a desktop or a server etcetera. So, some sense of universality in terms of access to the infrastructure is necessary. So, that is what we mean by a broad network access.

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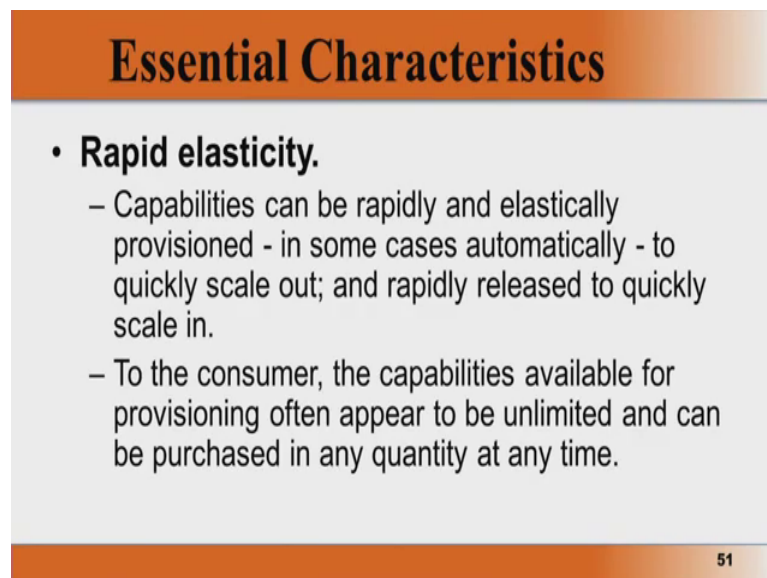The next one is of course resource pooling. We will talk about resource pooling in much great detail when we proceed in the session and one such model for resource pooling is called the multi-tenant model, but today the most important thing is that multiple consumers are using the cloud. If you say suppose a million consumers want to use your cloud for example, let us talk about Gmail. A millions of users could view this Gmail as a cloud because it provides a service for millions of users. Can I have million servers one for each for every user? Can I have millions of hard-disks? No. So, we essentially need to go and share the resources, pool the resources.

So, gmail is just one very small application, but when you look at cloud, we would give some user applications where, for example, we could have VLSI cloud for making chips. So, there will several companies you can come into this cloud and run processes, run programs that will go on for day's together. So, we are looking at having one set of resources and dynamically assign and release it from different programs or process is which want to use these resources. This is what we mean by resource pooling. Another most important thing is this rapid elasticity.

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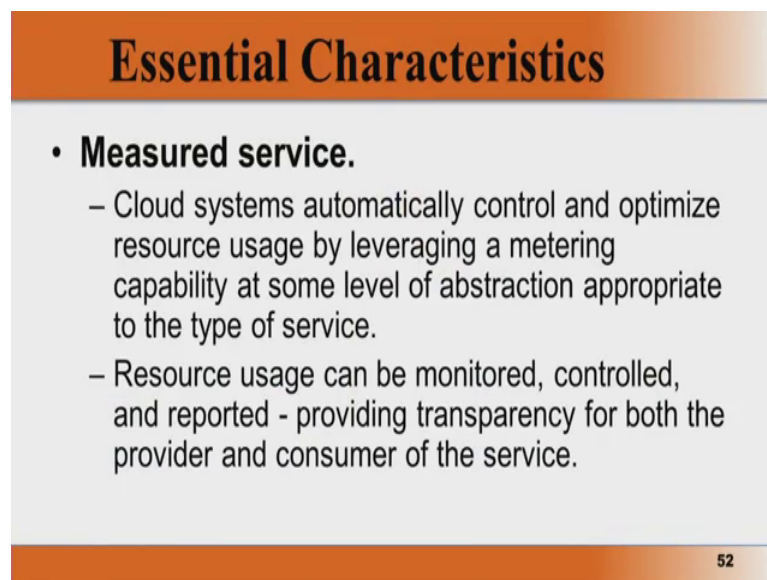So, what is elastic? When I stretch it and when I release it, basically it comes back to a shrink and size. It shrinks and expands as desired and we need this rapid elasticity. Essentially it means that when a customer wants lot of resources, it should be rapidly able to give those resources and the moment it does not need, you should be in a position to immediately withdraw and reassign to someone. So, this sort of an elasticity need to be built inside a cloud, so that on demand the user actually gets as much resources that

he wants and the moment he does not want, it can be shrunk and it can be given to others. It can be released and given to others. So, elasticity is another important characteristic of cloud and we use this word rapid because the user should never feel lack of resources. It is from here suppose you are a cloud service provider, it is very important that you keep your customer satisfied. The customer should never feel that there is a lack of resources and that means the moment he ask for a resource, the program that he runs ask for a resource, it should be provided and from your point of you, you need not be willing to keep a resource with a process when it does not need. So, you should quickly pull it out. So, this quick response is captured by that objective rapid.

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So, this is another characteristic of the cloud. The other thing is cloud cannot be given free. You have to run the cloud. As a cloud service provider, I need revenue. So, there should be a very nice and transparent way of you know controlling this cloud, controlling and optimizing the resource usage, and you should also have a clear metering capability at some level of abstraction for your service. How much amount of CPU I am using? How much amount of disk I should use? How much amount of memory I am using? How much amount of network I am using? So, all these resource usage should be monitored, controlled and reported and importantly that it should be very transparent, right.

So, when you make a call, then immediately SMS comes saying this is the up duration that you are spoken and this is the amount you have used from your balance. So, this is a measured example of a measured service, but measured service should not be that it

should be one important point that you should note in this particular slide is the measured service should not be a nuisance, right. So, for every half a minute, I do not want a message say you have done this. That will clog your network, right. So, I need to have sort of a summary of my usage. I am just talking about a mobile phone usage in this. So, there should be some abstraction in which you go and measure your service of you have provided. What should I measure itself is a very important debate. The moment I go and measure everything, then again your entire cloud service should be more on the measuring end rather than servicing end. So, these are some very important characteristics that we need to keep in mind.

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Now, we will look at cloud service models. There are three service models as I told you. One is the software as a service, another is platform as a service, and another is cloud infrastructure as a service.

We will talk about this SPI model in some detail here. I have actually explained this. As an infrastructure, as a service essentially means that we will provide the processing capabilities like CPUs, the storage, networks and other fundamental computing resources. So, the consumer will be in a position to run arbitrary software which also includes his own operating system, application etcetera, and the consumer will not manage or control the infrastructure. It will be completely controlled by the cloud service provider, but the consumer will have the control on the operating systems, the storage, deployed applications etcetera and he will also have limited control over the networking components like how I configure the firewall for example. If I look at platform as a service, the capability provides to the consumer is to one is to deploy the cloud infrastructure plus some things like operating systems etcetera, and any development tools like I mentioned JBoss etcetera.

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Platform as a Service (PaaS)

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

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Now, the platform can be essentially used for developing your own applications. So, this is platform as a service. Gor example, you open your website. So, there are several people who can host your website, that can be termed as a platform as a service. The other thing is entire software itself as a service, right. So, we have the entire software. You just have some generic workflows. This workflow itself can become a service. So, here the consumer just gives the functionality and it is completely tailor made for the customer, for the consumer and he does not do anything. Everything is managed and controlled by the cloud provider.

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Software as a Service (SaaS)

- The capability provided to the consumer is to use the provider's applications running on a cloud infrastructure.
- The applications are accessible from various client devices through a thin client interface such as a web browser (e.g., web-based email).
- The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.

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So, in the next session we will go and talk about the deployment models for cloud.

Thank you.