Cloud Computing
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Lecture – 04
Cloud Computing Architecture

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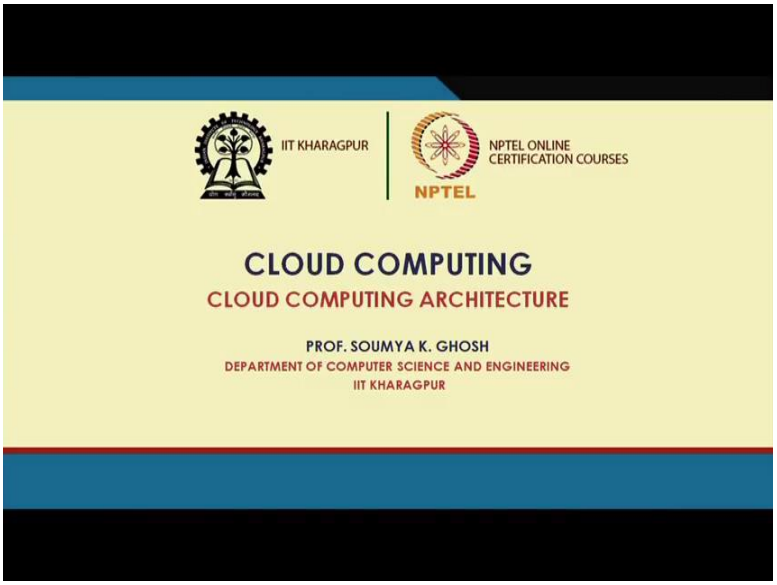

Welcome to the course on Cloud Computing. We will continue our discussion on different aspects of the cloud computing. Today, we will look at or we will start with Cloud Computing architecture, right. What are we will start with the basic introduction and we will go to more details in today's or subsequent lectures.

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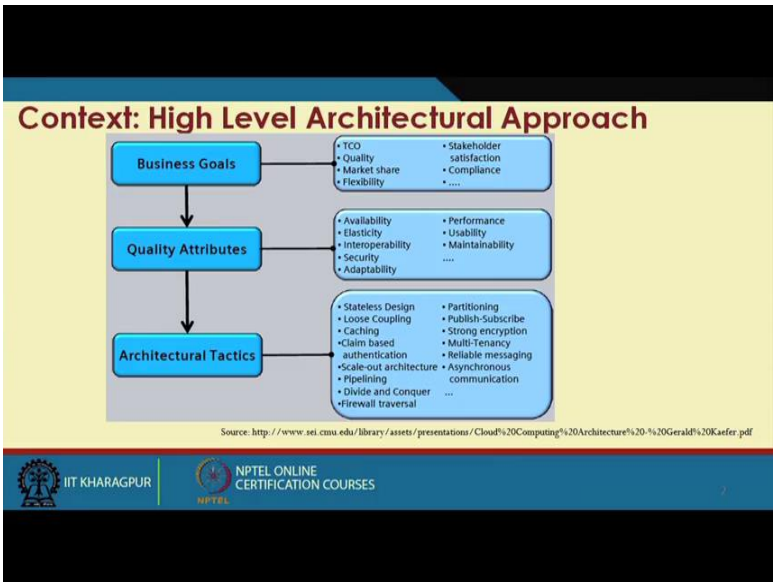

So, if we look at these high level architectural approach or high level view of this things, so what we have at the end of the things what we are looking for one is that from the user prospective or overall cloud computing, it is we want to achieve some business goal. It can be business goal with respect to consumers, it can be business goal with respect to the producer or it may be the overall framework of the cloud computing right. So, some of the business goals is the major thing. Next, we have the quality attributes and then the architectural tactics or the basic architectural framework.

So, if you look at that business goal at the top of the thing, what we looking for primarily, we are looking for some TCO like what is the total cost to the organization, who are the stake what about the stake holder satisfaction, compliance with different standards market shares, flexibility, etcetera. So, this is the overall business goal from the CSP point of view, and to achieve this business goal we have few more parameters we need to be looked into or which are which need to be monitored measured. And what we mean to say that need to be managed properly is that issue of availability, elasticity, interoperability, security, adoptability, performance, usability and maintainability.

Now, if you look at this if you just go back in one or two lectures, where we started with the basic definition of cloud computing. So, we were looking for these aspects of the things like that whether how much available, how it is elastic, how it is interoperability. So, these are major what we say major characteristics of the cloud. So, this

characteristics basically allows a service provider to define his business goal across these different cloud market.

And finally, in order to achieve; this different measured services or the business goals, we need to have basic architectural tactics or architectural view. So, like there were the considered essentials are whether it is a stateless design, whether we loosely coupled right what we are thinking that there are several devices which are geographical spread. So, they may be loosely coupled, heterogeneous, need to be what we want to bring into the thing is a some sort of a interconnect and homogeneity between the things over broad network access right. So, what is the caching mechanism. So, claim what should be the authentication, whether it is claim based authentication then there are several other aspects of the architectural techniques.

Now, if you look at this sort of things somewhere other are manifested at any type of service model, like if I say infrastructural service model, so some aspects will come into play, if I say PaaS some other aspects will come into play, and we have SaaS or any other type of model. So, this becomes important keep in mind while developing, proposing any architectural view. So, with this respect or with keeping this in view, we see that; what are the basic consideration to have in this cloud architecture.

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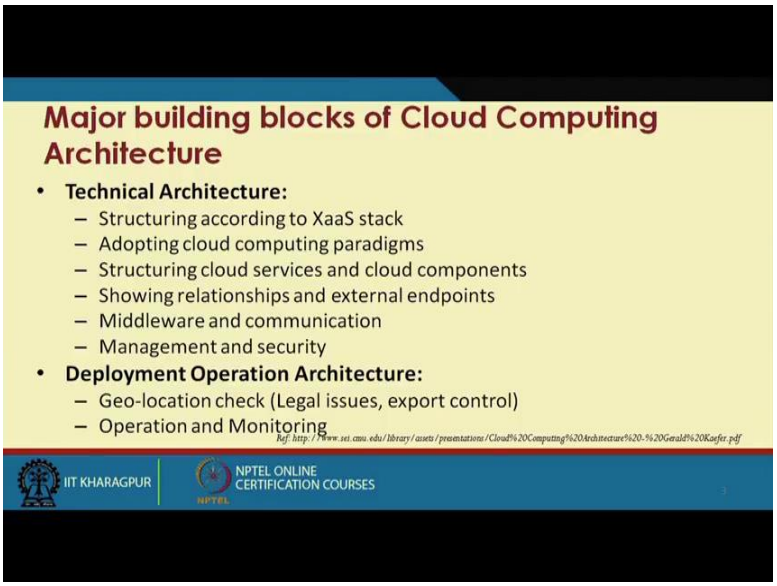

So, if you look at the major building block of cloud computing architecture, one is that technical architecture, structuring according to the XaaS stack. Adopting cloud

computing paradigms, structuring cloud services and components, middleware and communication and management and security. So, these are more technically architect technical feature of the architectural things.

There are some of the things, which are deployment operation architecture like geo-location check, right. I may want to say that due to my federal requirement all my data, all my applications for any type of government related activities should be within the territory of the country. I do not host or any application or any data outside the things. Like, if I am having a mail service, the mail data, mail server etcetera should reside within the geographically bounded area of our nation, so that might be a thing. There may be other legal issues etcetera. And there are deployments issues like operation and monitoring. So, what should be the operational view, how it will be monitored, how this XaaS stacks looked in to those are the other deployment operation architecture.

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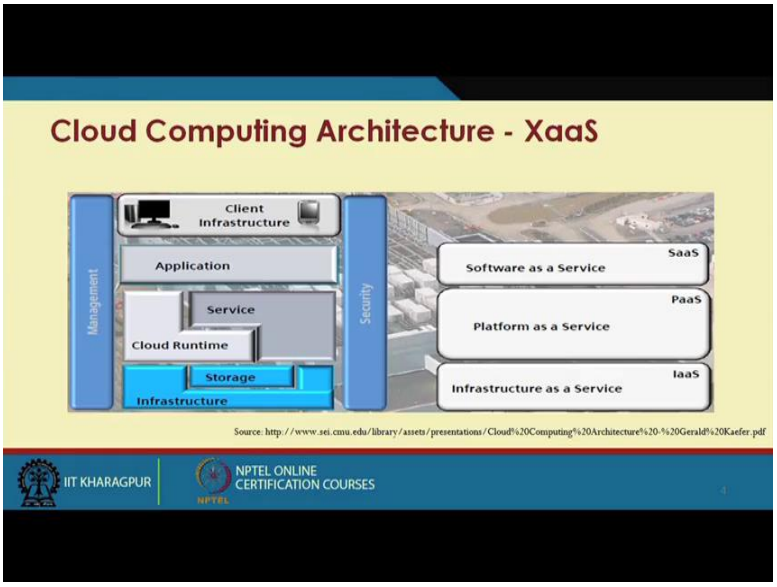

So, if you look at this typical XaaS thing, so what have at the down is this infrastructure as a service, then platform as a service, software as a service this is the typical stack of the or typical or most popular XaaS applications or services. Now, if you look at this architectural side of the things or the basic building block, so down the line is more of a storage and infrastructure. So, this is that is the colour in the blue; up in the thing is the application this right. And there are the client infrastructure which interacts with this application; in between is the middleware or what we say that the platform or the

platform as the service type of things where the services cloud runtime libraries and other things come out. So, any realization of any cloud computing infrastructure whether it is a public, private, open sourced, customized, we need to look in to some where other is broadly has to have these type realization.

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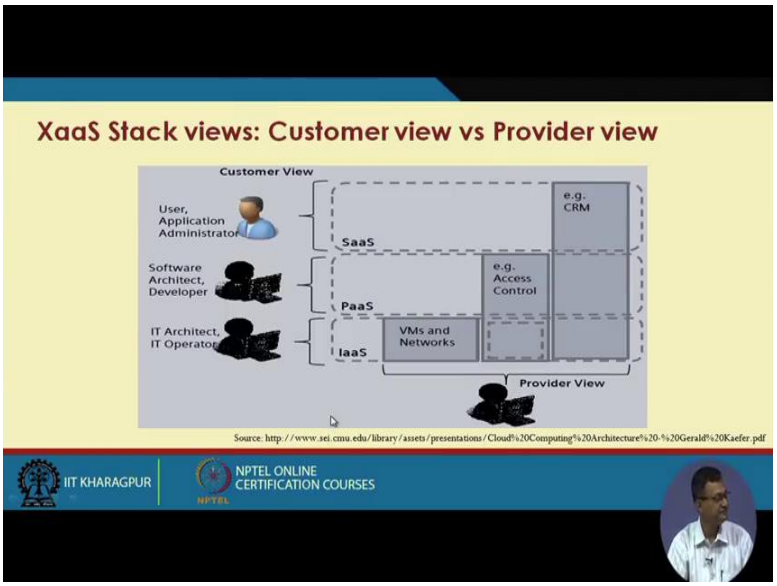

And if we look as view of consumer versus providers or the customer versus provider, so there are again for the IaaS this is primarily important for IT architect in the IT operation type of things. For the end user or the application user that is more important is the user application, administrator etcetera which overs around the top of the things like one of the popular application may be the CRM. And whereas for the software architect developer which comes in the middle which uses this hardware infrastructure or which is uses this infrastructure as a service, develop something and which are deployed or put support to these application above this. So, these are this categories like in the middle of the things. So, different people or different category of users are different view of this architecture.

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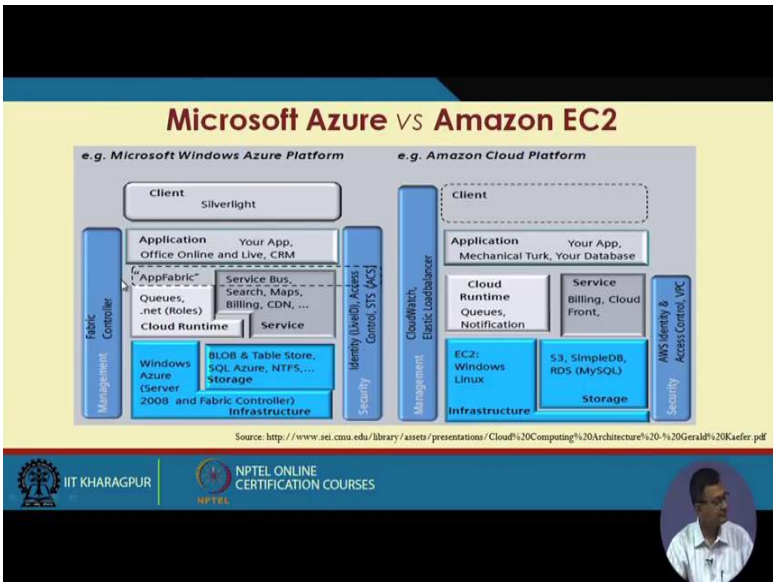

Now, we just try to map that with this our very two popular one of means two popular cloud services, there are several other popular services, but these are the things which are available which will put to get. So, one is the Microsoft windows azure platform, another is the Amazon cloud platform or Amazon EC2. Now, look at that also divided into more or less in that three stack. This is as more at the bottom of the things same as the incase of EC2; in case of Amazon it is windows servers and related stuff; where is in case of EC2 it is it can be windows Linux infrastructure along with Amazon S3 and simple DV and other type of storage.

And in between we are having this middleware which emulates the platform this is has a analog of stuff there. And at the top it has the applications. These are some of the windows azure applications and these are the Amazon applications. And here the client can connect through either in case of a client this is silver light in case of this or we can connect it through the browser.

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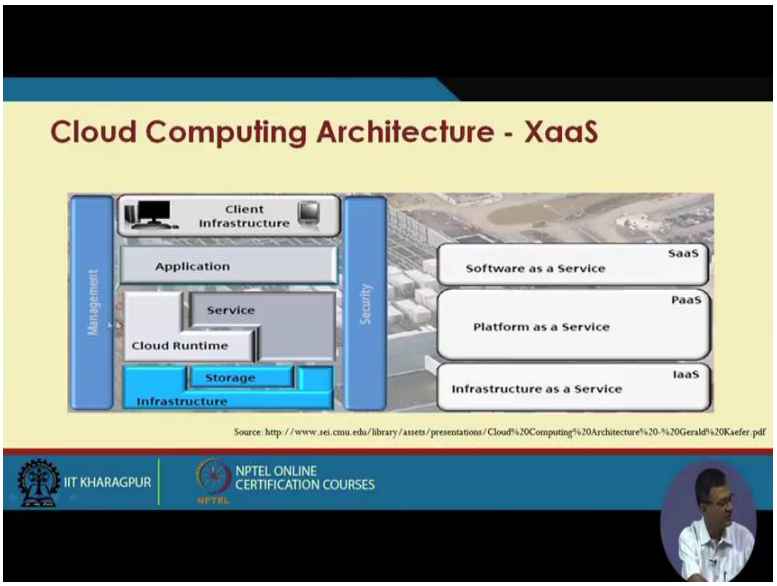

So, one thing I just look like to mention it was there in the previous slide also, there are two vertical stack right what we say management and security right. This is important because this management and security issues sometimes people who want to put the security is also a management aspect and sometimes we have other aspects like what we say quality of services. So, management quality of services and security in some of the references or material you will find that. So, all these are the scenarios where these are the stack which goes vertical that means, I cannot achieve security or management taking only one layer at a thing. So, it requires some sort of a cross layer considerations that is why these are vertical stacks.

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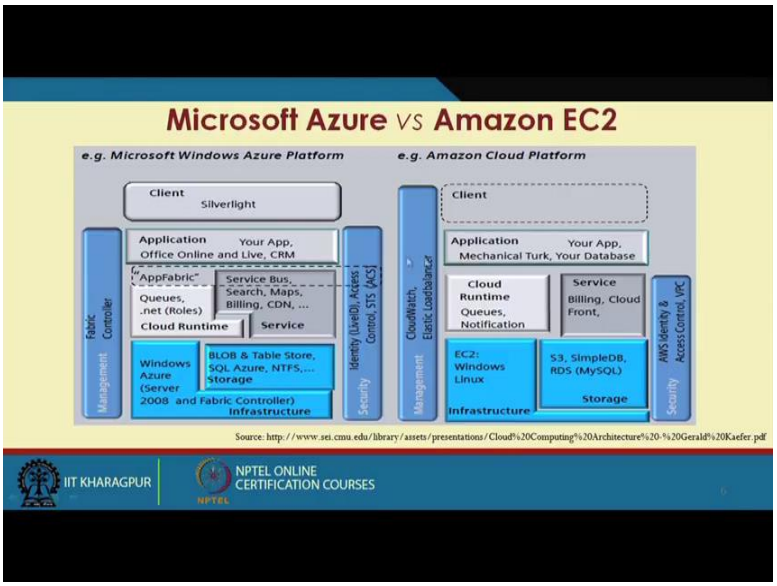

And if you see the same thing in case of a case of these azure or EC2, so these are also we have these vertical stacks. So, they have different component of security relevant component of management, but these goes on the vertical stack. Similarly, the security aspect is based on the we will see later on based on how much control we are having goes on to things. Like if I am having infrastructure as a service, so my security or management is more consideration on the as a infrastructure. So, once I rollout this infrastructure, one I provision this infrastructure vertual machine etcetera, so that is the responsibility of the user or the consumer to look into the thing.

If I having a up to a software as a service then all these issues are need to be provided up to that layer right. So, word processing service or CRM service which is a software service. So, all aspects up to that level of management and security it will provided, so that it depends that what sort of service provisioning or what sort of service deployment we are doing for this particular scenario.

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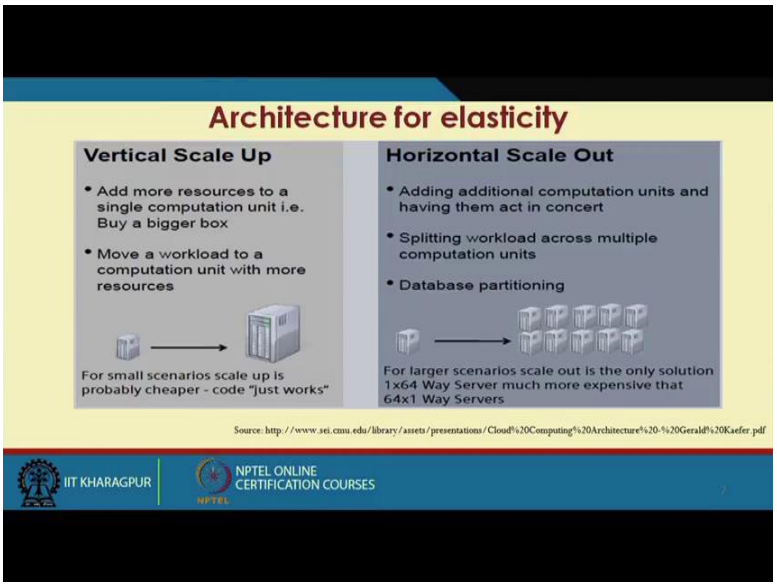

There are several aspects or issues as we are talking about; one is elasticity. As we are mentioned or as we are know that elasticity is one of the most important characteristics of cloud like if I scale up, scale down into this computing paradigm. Now, in order to achieve that. So, there can be two broad approaches right. So, this is this two broad approaches which is two when without cloud also it is more of a elastic computing when do. One is that you can do it vertical scale up; that means, at more resources to the box right, we have a particular infrastructure say for example, I have a particular rack with different servers.

So, we initially we are having say I am having some 24 servers, then I scale up putting more server into the things or my chases may be holding 16 blades and having initially 4 based on the requirement, the organization feels that the requirement go on another 4 or up to a 16 blade chases like fully loaded chases. Now this is vertically going up. So, this is has advantage where for in case of a small scenario, scale up is probably cheaper, so that it works just you be put on the things. So, add more resources to a single computational box, move the workload to the computation unit to more resources. So, I have more resources.

Whereas, when we have scenarios where for larger scenario scale out scale out is only solution 1 is to 64 way server is much more expensive than 64 into 1 way server, right.

So, having say 64 of 1 unit computational power and trying to achieve realize a 64 computational units is much cheaper than having a one unit of 64 computation.

So, what is happening that when I have a large scale scenario then expanding in that fashion may be pretty costly. So, in that cases not only expanding in terms of cost in terms of only financial aspects, it is maintainability rate of failure may be pretty high like a one if the single system, it is a single point of failure at time. Whereas if I have a multiple systems, so that if an if some systems fails, then I can have a way to work on in a little lower performance metric, but I can work on the things. So, this becomes whether it is a horizontal scale up or scale out or it is a vertical scale out, we need to consider based on our requirement.

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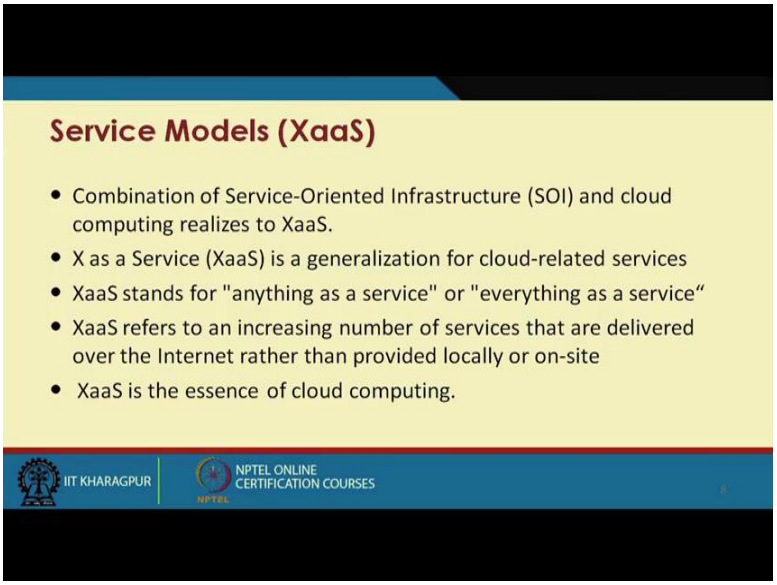

Now, if we again come back to our service model, so XaaS, what is happening is the combination of service-oriented infrastructure or a service-oriented architecture on for realization of infrastructure and cloud computing realize to a XaaS. So, what is the service oriented architecture, I believe most of you are acquire already knowing. So, what will do, we will have a; some sort of slides on service-oriented architecture in subsequent lectures. So, that those who are not accustomed or not very much familiar with this type of things, we will have immediately quick check up.

But nevertheless it is a service driven approach for infrastructure or PaaS or any type of things right. So, we are tried to combine SOI and cloud computing to realize this XaaS.

So, anything as a service is a generalization of cloud related services, refers to increasing number of services that are delivered over internet, rather than provided locally or on site. XaaS is the essence of cloud computing already we know. So anything as a service, so still we seen data is a service another popular we can have anything other type of services.

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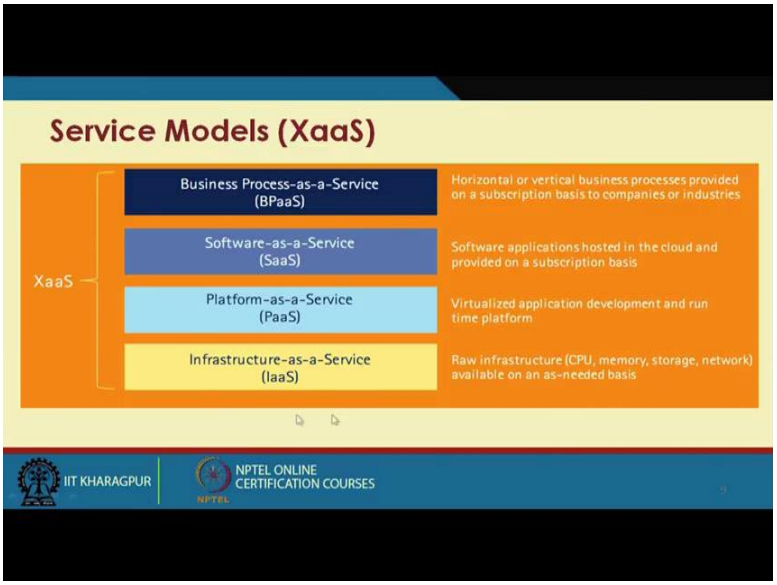

So, as some of these popular XaaS instance, one is infrastructure as a service, platform software service already known. There is another thing came up what is now becoming pretty popular what we say business process as a service. So, I have a business work flow which want to give as a service. So, horizontal or vertical business processes provided on a subscription basis to companies or industries. Like suppose for a particular operation, I have a business process. So, what are what does it mean, it may not be only one applications which is delivering the things.

So, I have different processes which has a orchestration between them, then allow me to realize a particular applications. It can be for something for the banking sector, it can be for some of the aspects of different development planning operations of the things. So, it is not only I run a application and get results. A application is dependent on other applications another etcetera.

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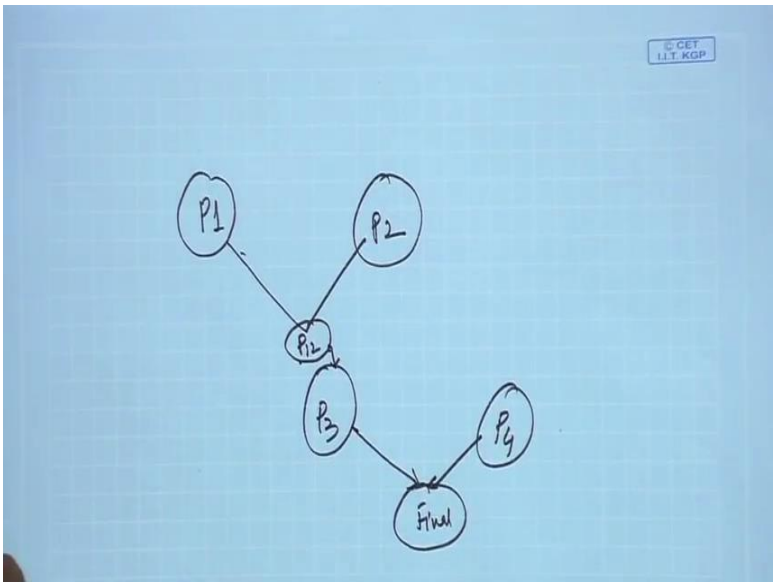

So, I have different processes or applications which allows me to realize the thing. So, it means as if P12 may lead to something called P3 which can is a input to the P3 and inturn P3 and P4 will come out with the final outcome of the things. Now, I have different may be different processes right. So, these are orchestration in the things. So, I can say I have business process which is basically division of the; or amalgamation or integration of different sub processes or sub applications. The interesting feature is that there is a timing relationship and what we say processes execution tree or process execution graph will be there, so that it follows a particular things.

Now, for this sort of things, if it is define, then whether I can say this I give a service with a business process as a thing. So, it is not now not only the application as a service or software as a service, so I basically have a something more than software as a service which talks with things; incidentally this different processes may come from different heterogeneous providers. So, I can basically now interact with or collaborate with different cloud service providers and then realize the thing. So, this business process is important because end of the day specially for the organization, this matters, rather many of you might have heard there is a very popular language what we say business process execution language where you can defined your business process of outflow into the thing and so it realize the thing. So, that is one of the major aspects.

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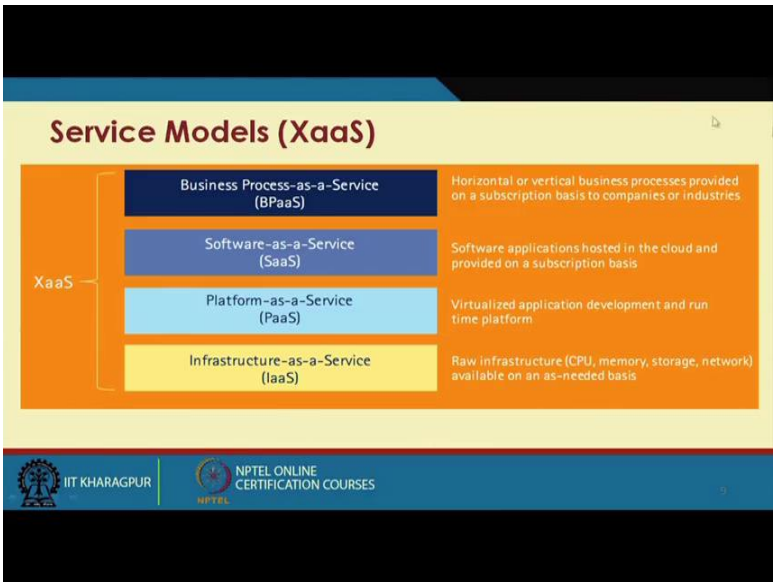

So, IaaS is the RAW infrastructure CPU etcetera. PaaS is the virtualized application development or run time platform. SaaS is the software application hosted in the cloud provided in a subscription basis. And this business process as a service is a horizontal or vertical business process involved in basis on a subscription basis to companies or industries.

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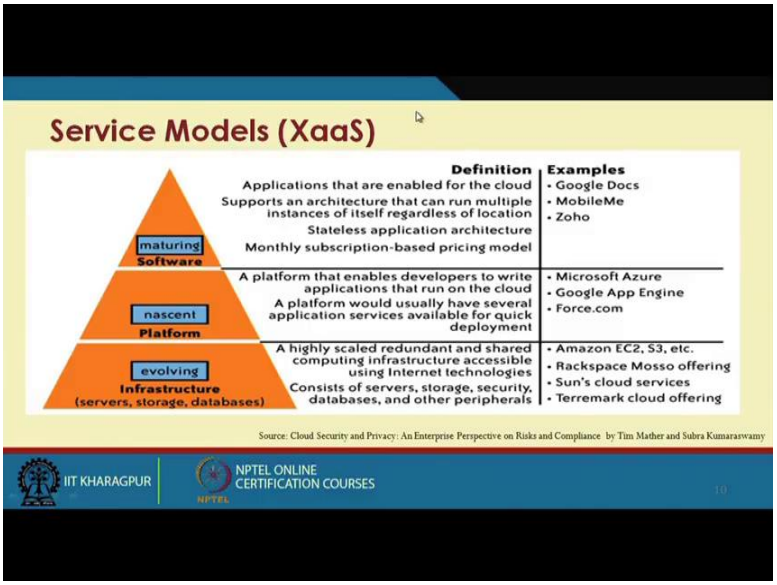

And if we again little relook, so it is something a tapering thing our popular IaaS, PaaS and thing, PaaS other infrastructure.

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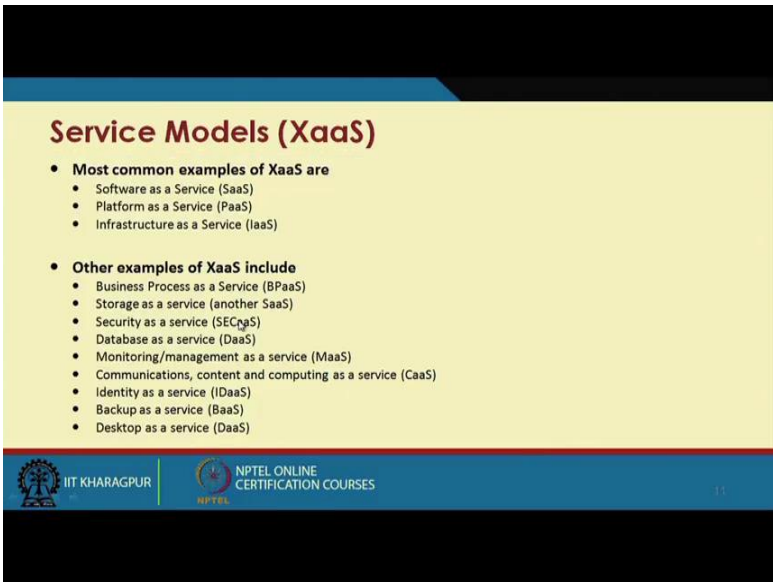

So, other than this three most popular examples, we have several other business process, several other XaaS instances, like we have already seen business process as a service, there is storage as a service, I can have security as a service like it provides different security future as a thing, I can have database as a service. So, I do not want to install etcetera, I want to leverage database into a service. Monitoring management as a service like I want to manage my IT infrastructure, like I want to I have a large say in our IIT infrastructure we have large labs which are used by different category different type of PG, UG courses and I want to basically manage the things, right.

Like manage the things up to a starting from software of the means what is the software going on, whether they are machine is basically having any problem from the hardware or type of things different things. So, whether I can have I have separate tools or somebody gives me a service which connects with this machines and do the things right or any large infrastructure in case of a organization. So, communication content computing as a service these are the some of the things, identity as a service, backup as a service, desktop as a service. So, I can have anything as a service and these are some of the things which are being used across the world.

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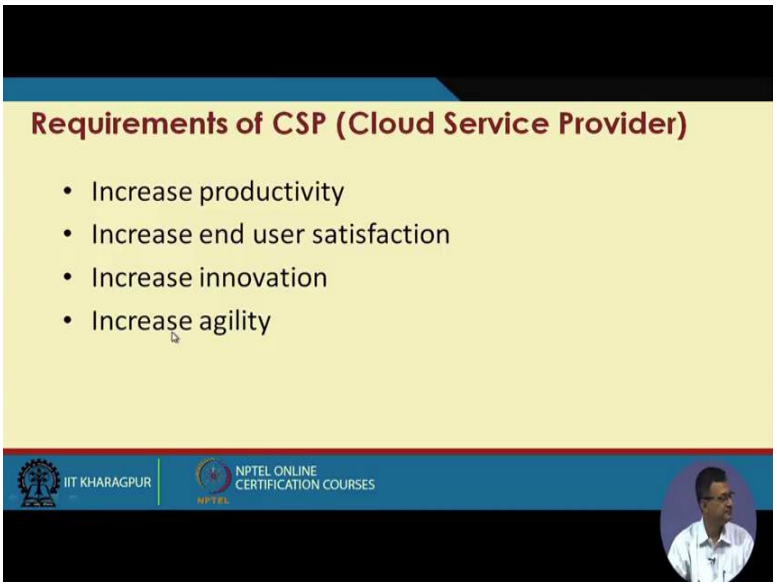

So, end of the day what does CSP or the cloud provider is looking for increase productivity, end user satisfaction, some innovative services, so that it has it can hold its market position. And have different entry its infrastructure as a aisle. So, it is as aisle and it can give, it cores it can what we say configure itself along with the need of article.

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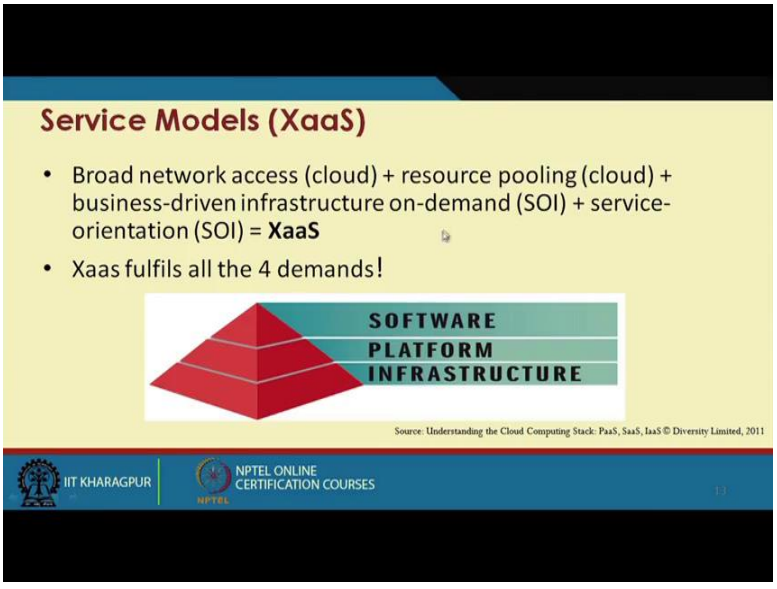

So, if we look at this again, if we come back to our basic definition and try to see, so one is the broad network access, resource pooling, business driven infrastructure on demand like what is there and service oriented orientation, service oriented architecture. So, all

this four feels us in realizing this XaaS type of services. So, XaaS fulfills all the four typical demands of service provider.

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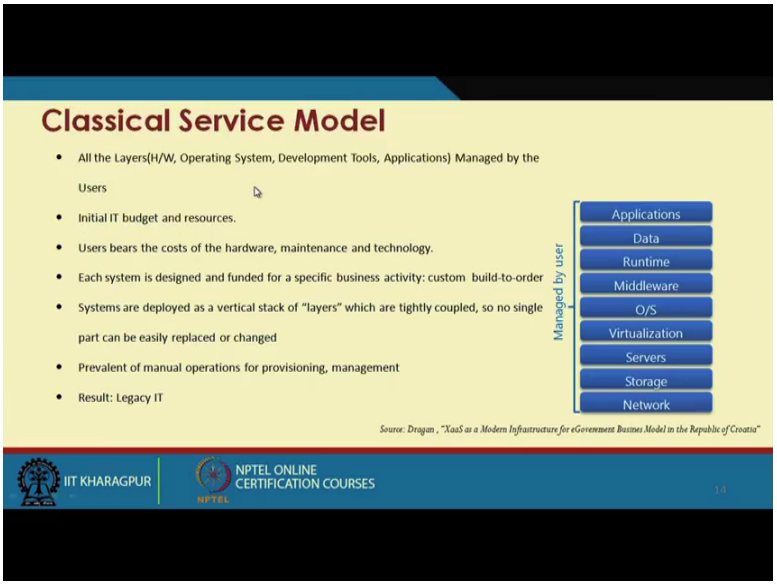

Now, like our network stack like our TCP/IP or OSI models, so if I want to have that what will be the typical classical stack of the things, stack of our service model or XaaS model. So, at the base of the things what so it is not like that, so it is a what we say, logical way of looking at the things, right, it is not like that something will done always over the other, but it is a logical representation of the things. Like at the core of the thing is the networking. So, you have a underlining broad network access which allows the things to talk each other right. Another core component is the storage it is also something omnipresent. Other aspect is the server.

So, if you look at this three stuff are primarily is the major building block, what we say the bear metal things over which it works. So, one is the communication, one is this different servers and other physical infrastructure, and other one is the storage. Storage always we try to keep it as a separate aspect other than keeping one of the infrastructure, in some of the cases storage are kept as a infrastructure, but storage plays a different type of role storage management is different thing, so that is that those are a important aspects of the storage is the input aspect.

Over that what in order to realize are the things is that is aspect of virtualization. So, I need to virtualize all the things. So, I can have a virtualization of the whole infrastructure

I can have the virtualization only of the particular behavior virtual machine, I can even virtualizes the network. So, I have a infrastructure virtualization, I want to realize a particular virtualize network infrastructure, and of course, storage. So, there is a virtualization basically try to have these so called virtual machines or virtual network, virtual storage type of stuff. Over that if it is a virtual machine I need to put the particular OS over which I should run the thing right.

So, this over that this middleware then I have runtime library, the data over for which more closely with the application and finally, end of the top of the stack is the applications. So, these are the different components which make this IaaS that the feasible, it may be noted that all the components are not equally important may not be equally important for all type of XaaS type of thing, but nevertheless they play a important role in realization of the thing.

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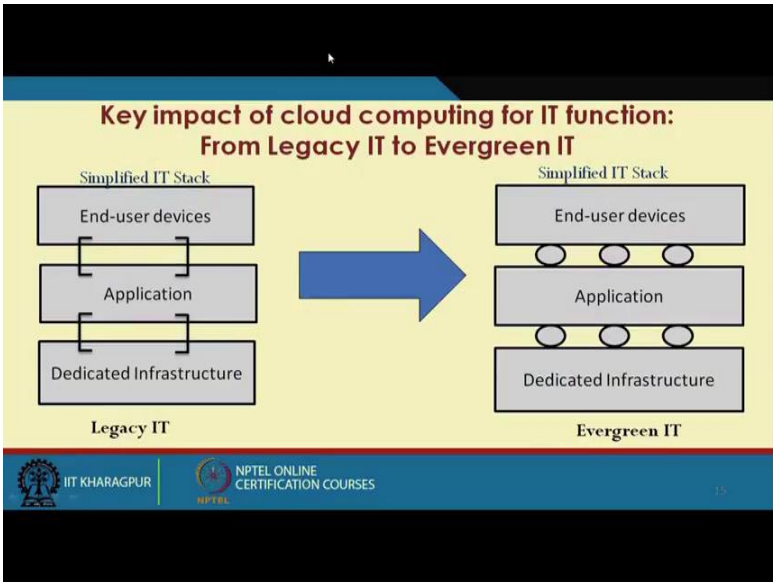

Now, if we try to because always it hover that all we are some somewhere other we are already getting this stuffs right, what is this big paradise shift right. So, as such we should we have already mentioned in our initial lectures that already we are having distributed systems and other things into place. We do realize lot of things etcetera. So, to make it more market viable and having a scalable computing infrastructure we as you go model measures services where real easily. So, if you look at that a simplified IT stack, so we have end user devices application and dedicated infrastructure.

So, this is in the legacy IT or still it is very much still it is very much present in or rather omnipresent in various organizations and other type of thing, so these are somewhat clipped together right or more strongly coupled right. So, that dedicated application runs over the applications dedicating infrastructure. So, application sizeing etcetera are made based on the infrastructure or other way around.

End user also have a some dedicated application to work with whereas, what we go for what we are trying to realize is more of a simplified IT infrastructure, these are little bit flexibilities are maintained. So, I have some dedicated infrastructure over application end user devices, but they are not very strongly bound. So, this is the thing what we are going to do and it can be shown also we can since see some of the subsequent lectures that this sort of things may allow us to have better utilization of the resources or better return on investment right. Or having a giving service different type of services on the same type of or a common resource based type of thing.

In some of the cases several organizations has several surplus resources, like if I talk again about our own UG or PG labs which may be having huge amount of computing resources, but then they may not be utilize across 24 hours right they are utilized may be 8 to 10 hours on a very loaded. But out of out of class hours or out of lab hours the those can be clubbed together to have to give the researchers the opportunity to run high simulation on the basic PC type of platform, so that may be one way of utilizing own resources in a better fashion.

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So, there are some of the other things like classical model plus XaaS model, there are different aspects like licensed software, hardware product and people based services these are the more popular aspects of our traditional cloud, traditional infrastructure models or classical infrastructure model. And we need to make the architecture in such a fashion that it maximizes this effort. Whereas, in is our imagine things we are going to a XaaS type of services like, so that is software IaaS, PaaS or any type of any type of XaaS type of services.

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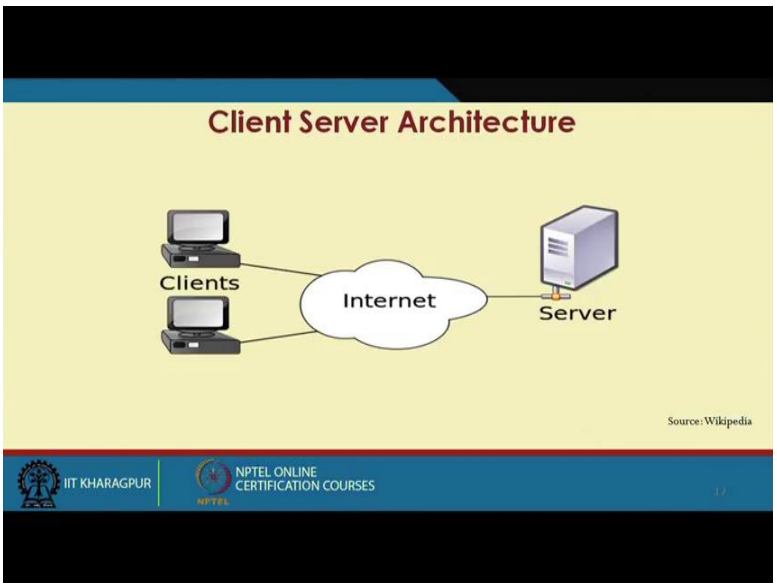

And rather if you look at our classical thing or still it is very much valid we have a client server architecture. So, there is a server which serves several clients; and based on the server programme is running on the server, and always waiting for the client to connect and we connect to the thing. And this is extremely popular and still very much in the use and will be in the use in several cases right. But from there we are migrated to a service oriented architecture, so instead of this very strongly coupled client server, we have service oriented to it, service talks to each other. And there are distinct advantages we can have heterogeneous things to talk to each other and we have lot of flexibilities. Very popular client server things are like FTP server, telnet, HTTP are a way particular demon of the server part which looks into this talks to this client.

So, we will carry on our discussion in our subsequent lectures on this particular architectural aspects of a cloud computing and we will also see that different things of virtualization another thing. So, for today we will for now for this lecture we will stop here.

Thank you.