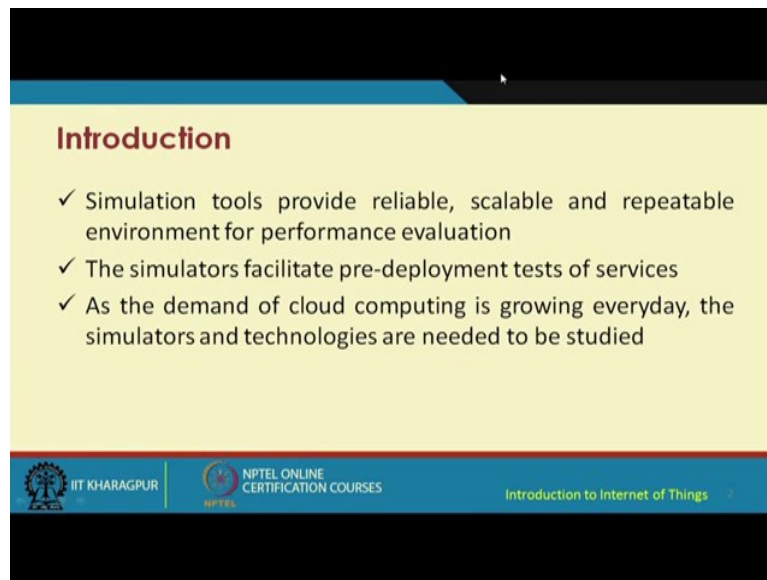**Introduction to Internet of Things**
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Lecture - 40
Cloud Computing- Case Studies

The current lecture on cloud is on some case studies and more specifically case studies related to the available cloud platforms and including the Cloud Simulation platforms. So, we are going to go through some of them. So, before I start I would like to mention that you know before even before the adoption of cloud whether it is for R and D purpose or whether it is for actual use in a business it is required to assess this particular technology the different solutions that are offered by this technology it is required to assess. So, how can we assess one of the ways is through simulations. So, there are different simulations platforms that have been that are made available by different community groups. So, we can use those in order to assess how cloud is going to perform what are the different modules what are their implications on the overall performance of the system and so on. So, that is a very important aspect of cloud computing.

So, I will go through some of these different Cloud Simulation platforms, but before that I would like to make you understand some of these issues of simulation. So, first of all the simulation tools would be required to ensure reliability, scalability and repeatability for of performance evaluation.
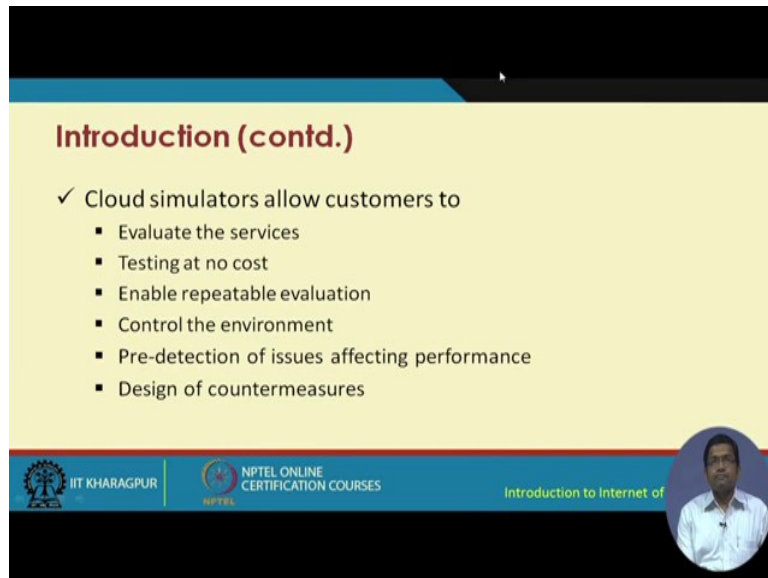
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So, you know we have to ensure that the system is reliable even before it is used it is scalable and the data that we are getting you know that is repeatable. So, we have a repeatable environment which will give you the same or similar kind of data even if you rerun the same simulation over time you know you run in you know at different instants of time you know you have a repeatable environment which will give you similar kinds of data. So, that is very much required for performance evaluation.

The simulators basically facilitated pre deployment tests of services then that is basically quite generic as well I mean not just specific to cloud any simulator even mean what a simulator does is even before you deploy the infrastructure the services is the platform as a whole you need to test how it is going to work. So, this is another purpose of the simulator and the third is as the demand of cloud computing is going every day the simulators and technologies are needed to study how things how different features which are going to be enabled which are going to be added additionally how they are going to perform in the cloud environment.
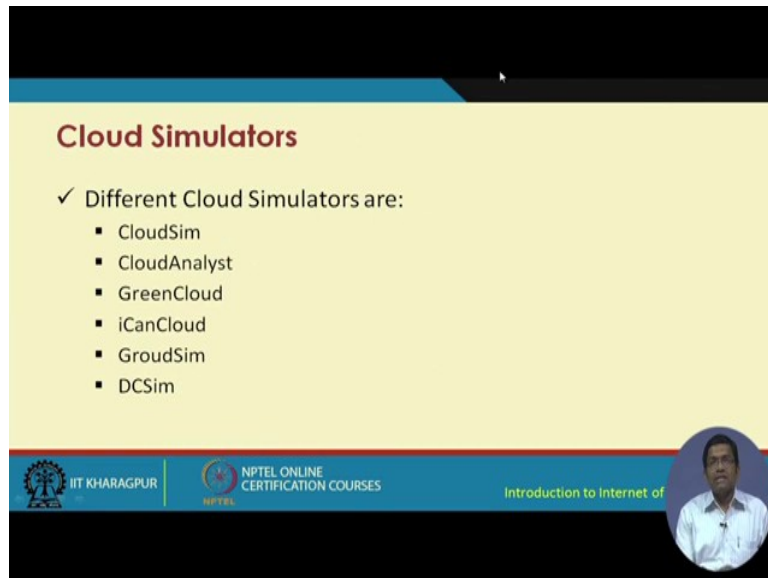
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So, Cloud Simulators allow the customers to evaluate the services to test the services and the platform at no additional cost because no additional infrastructure is going to be taken enabling a repeatable evaluation repeatability I have already mentioned to you controlling the environment pre detection of issues affecting performance pre detection means even before actually the cloud is deployed you want to pre detect what are the issues that are going to be there which would be affecting the performance of the cloud environment and that has to be done even before the deployment is going to take place. So, Cloud Simulator will help you do that and designing of the countermeasures in the case of you know the performance degradation due to some issues or you know certain things going wrong.

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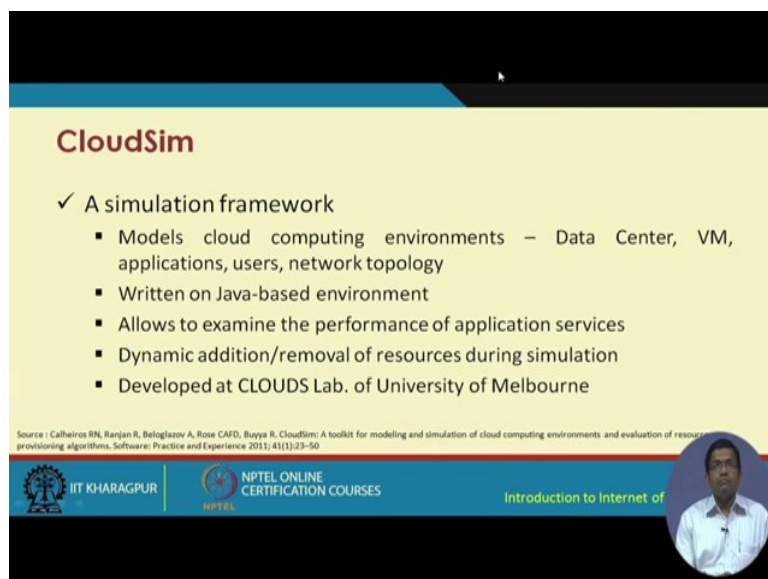
So, what are the counter measures that have to be taken and you know designing that and evaluating those aspects different Cloud Simulators that are available include CloudSim which is probably one of the most popular you know simulation platforms that is available in the community CloudAnalyst is another one third is green sorry, GreenCloud. Next is iCanCloud, the next one is GroudSim and the last one is DCSim in this particular list. So, these are some of the some of the CloudSimulators that are available for use if you want to simulate cloud before actually deploying cloud.

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So, CloudSim is a simulation platform as I said before which has different modules which has different classes for different cloud computing environments including modules for data center you know for modeling data centers modules for data center virtual machines applications users network topology. So, there are different types of modules and their corresponding models that are made available it is CloudSim is based on a java based environment it is written on a java based environment that allows to examine the performance of application services. It is also possible to dynamically add and remove resources in CloudSim and CloudSim was developed at the University of Melbourne by the team led by Professor Rajkumar Buyya, he is very much popular in cloud computing and in his lab the clouds lab of the University of Melbourne this CloudSim platform was developed.

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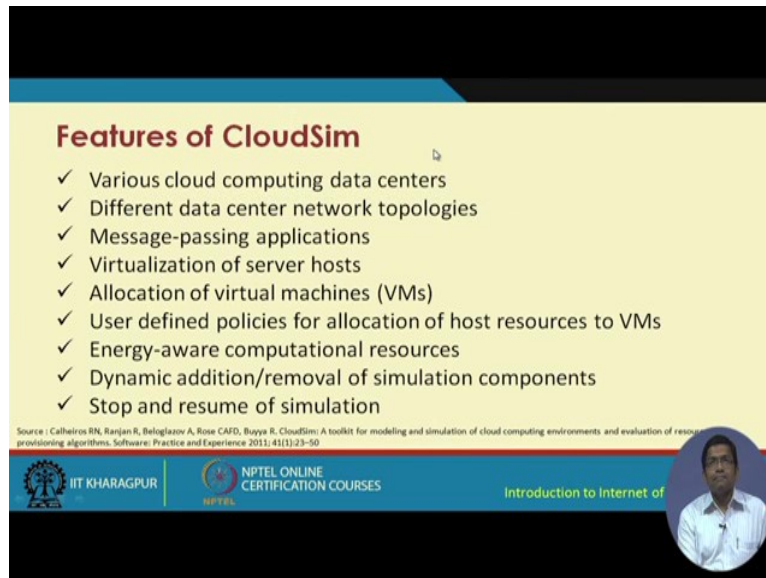

The advantages of CloudSim include taking care of time effectiveness. So, cloud based applications implementation has to be done in minimum time with minimum effort. So, time effectiveness is one second thing is dealing with fix flexibility and applicability supporting you know the use of diverse cloud environments enabling the modeling of application surfaces in any environment.

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These are the some of the advantages of CloudSim. Features of CloudSim include I will just read from this list and because these are quite self explanatory I would simply lead them without actually needing to expend them in further detail. So, features include various cloud computing data centers different data center network topologies message passing applications virtualization of server hosts allocation of virtual machines user defined policies for allocation of host resources to virtual machines energy aware computational resources dynamic addition or removal of simulation components and stop and resumption of simulation.
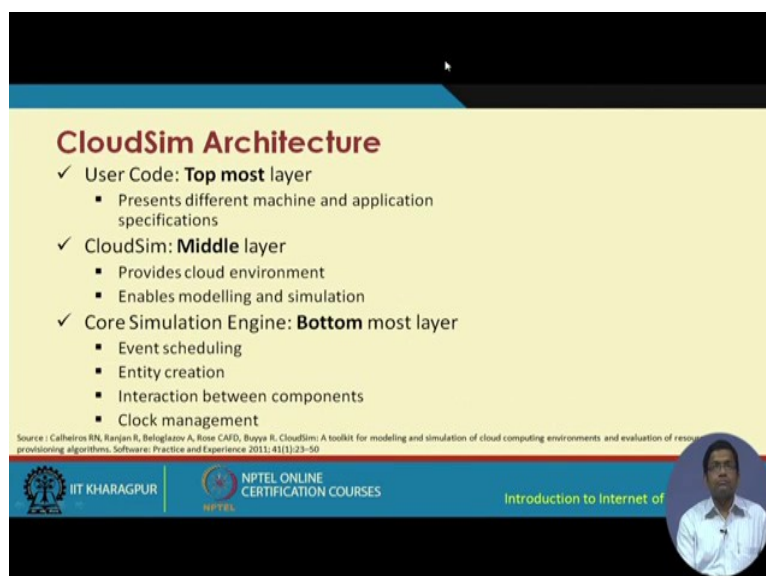
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So, these are some of the features that are supported by CloudSim. In the CloudSim architecture we have different layers the topmost layer is the user code layer which basically presents the different machine and application specifications the middle layer is actually the CloudSim layer which provides the actual cloud environment. And also enables modeling and simulation of cloud and the bottom most layer is known as the core engine core simulation engine layer and these basically takes care of event scheduling event scheduling means because we are dealing with discrete event simulation different events like the creation of the virtual machine, the porting of the virtual machine on the host and so on.

So, these are like discrete different events. So, scheduling of the events is taken care of at the bottommost layer the core engine layer creating these different entities these different virtual machines the data centers etcetera. Entity creation is also done at the core engine layer interaction between the different components the clock management because you know there is actually a clock class from which you know the whatever you know entities you borrow you inherit you know you have to take help of the clock; that means, the time you will be required to be inherited. So, that these different entities are time synchronized and overall we have a clock managed solution.
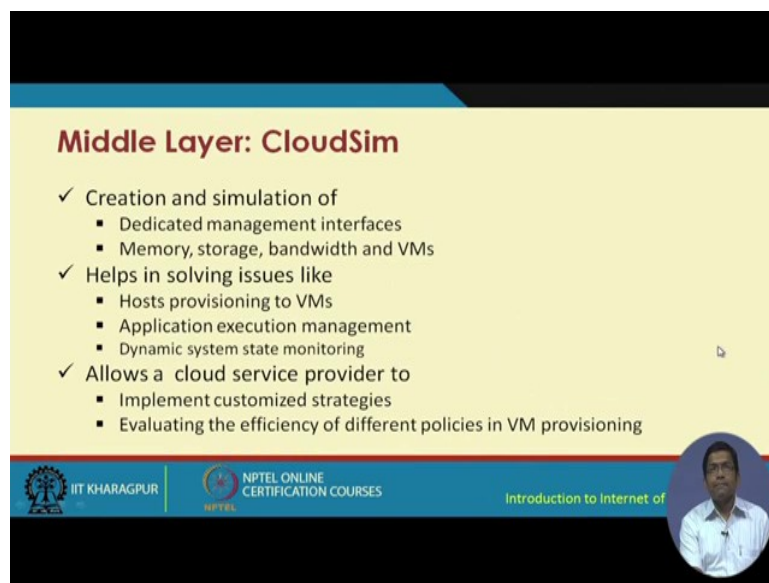
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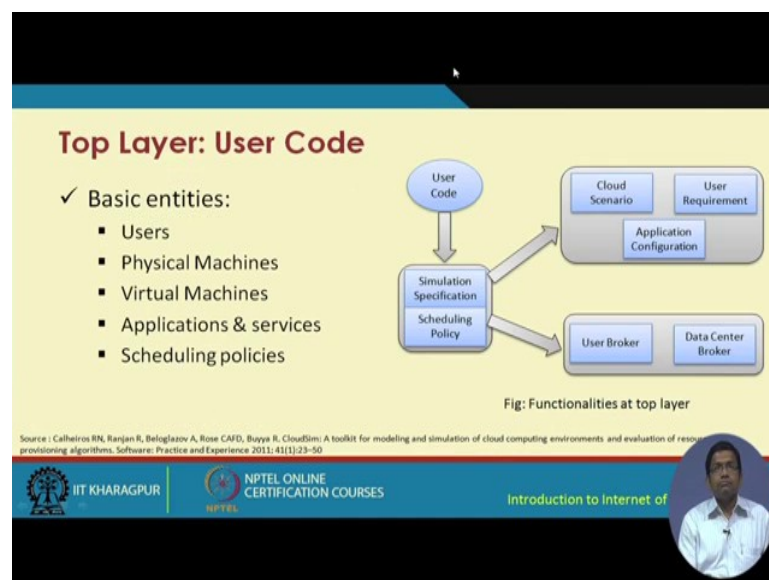
The top layer basically has different entities such as the users the physical machine the virtual machines the applications and surfaces and scheduling policies. So, basically I will show you with the help of this particular figure. So, what will happen is you have this user code and

then you have the simulation specification and the scheduling policies. So, simulation simulation specification and you know the scheduling policy again breaks into 2 parts one is the application configuration which has sorry as a application configuration the cloud scenario and the user requirement. So, this is basically that simulation specification. So, this is taking care of by these three different components the cloud scenario user requirement and application configuration the scheduling policy is taken care of by this subcomponents which is basically the user broker.

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And the data center broker the middle layer is basically the CloudSim layer which takes care of the creation and simulation of dedicated management interfaces issues such as memory management storage bandwidth and virtual machine creation and simulation are taken care of at this layer.

This particular layer helps in solving issues like host provisioning to virtual machines application execution management and dynamic system state monitoring it allows a cloud service provider to implement customized strategies evaluating the efficiency of different policies in virtual machine provisioning here is the overall CloudSim architecture.
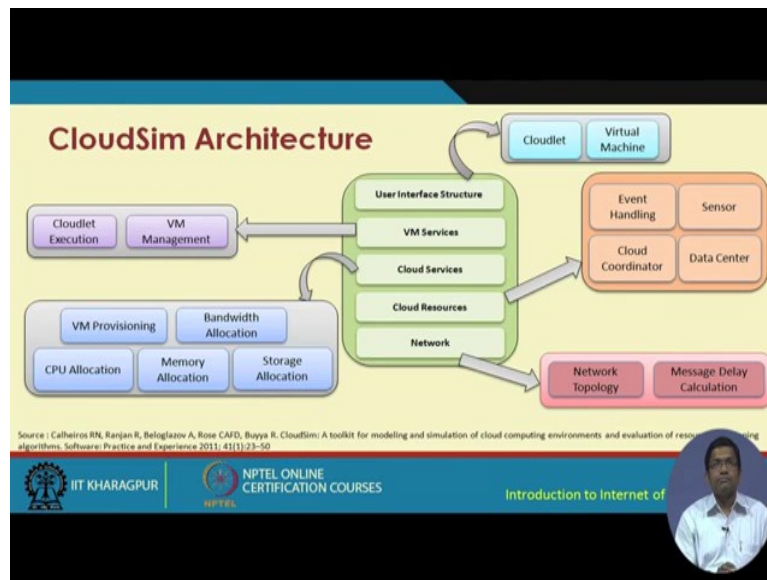
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So, we have different layers in CloudSim we have the user interface structure the virtual machine services cloud services cloud resources and network. So, these are the different components of the cloud same.

So, user interface structure has 2 different sub components the cloudlet and the virtual machine. So, cloudlet is sort of like a small physical server which will put the you know which will create these virtual machines then we have what the virtual machine services constituting the cloudlet execution of the cloudlet that is created and the virtual machine management. Then we have the cloud services comprising of virtual machine provisioning bandwidth allocation CPU allocation memory allocation and storage allocation then we have the fourth one which is the cloud resources component of the layer which includes event handling sensor management data center and the cloud coordinator and then we have the network layer which takes care of the network topology and message delay calculation.

So, that was the CloudSim another production another system which works on top of CloudSim is the cloud analyst which is a product that was again developed by the group led by Professor Rajkumar Buyya.

So, the crowd analyst is a simulation tool designed on top of cloud seemed to provide a graphical user interface that will support geographically distributed large scale cloud applications the overall purpose of cloud analyst is to study the behavior of such applications under different deployment configurations. So, basically this cloud analyst will have different metrics to trick take care of the performance of this cloud the different parts of the cloud and so on.

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The features of cloud analyst include it is easy to use due to the availability of GUI it has high level of configurability it has a feature of flexibility of adding different components repeatability of experiments graphical output provisioning with the help of charts and tables.
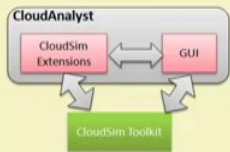
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And easy extend extensibility with the help of java swing and different other technologies the cloud analyst architecture is given in front of you in the figure. So, we have 2 main components one is the CloudSim extensions by offering different metrics different you know different extensions that will help you to analyze what is going on how the cloud is behaving

and so on and the graphical user interface. So, this interaction with the core CloudSim and the different components the 2 components of cloud analyst are shown in this particular figure.

So, the cloud analyst list basically comes with different components such as the GUI package for front end development the simulation, simulation component which basically creates executes and holds virtual machines then we have the user base for user traffic generation data center controller internet for internet working routing networking network provisioning. So, on internet characteristics component which basically takes care of properties of the internet with respect to delay bandwidth throughput etcetera the VM load balancer which takes care of issues of policies for load balancing and the cloud app service broker which takes care of entities for which has entities for routing between the user base and the data center.

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So, why do we need GreenCloud. So, sorry, so, that was the cloud analyst and now we have another Cloud simulation platform which is known as the GreenCloud. So, why do we need GreenCloud. So, in GreenCloud, by the way this GreenCloud was developed by a team of US and Europe. Pascal Bouvry group and Samee Ullah Khan you know from the University of North Dakota and Pascal Bouvry from University of Luxembourg in Europe. So, they together came up with discrete GreenCloud platform which is again a packet level simulator which is energy aware and that basically helps in reducing the overall you know energy expenses with the help of energy expenses in the adoption of cloud.

So, why do we need GreenCloud the computing capacity has increased the cost and operational expenses of data centers. So, energy consumption by data center is the major factor that drives the operational expenses. So, what is GreenCloud it offers operational cost. So, operational cost is the energy utilized by computing and combination communication units within a data center and how that is done GreenCloud basically monitors the energy consumption of the servers the switches etcetera and it is developed as an extension of NS2 packet level network level network simulator.

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The features of GreenCloud are listed over here I would just read read it out for your convenience. So, number one feature is that it is it offers a user friendly graphical interface, number 2 is it is open source. Next is the facility for monitoring energy consumption of network and devices, forth is that it supports simulation of cloud network components, fifth is it supports monitoring of energy consumption of individual components. Next is that enables improved power management schemes which is very much important in the context of this particular simulator energy consumption monitoring and reduction is an important feature that is offered by GreenCloud and the last one last feature is dynamic management and configuration of devices.

So, those were the simulators now let us talk about some real commercial and open source cloud platforms that are available for use. So, some examples of opens open source cloud include OpenStack; CloudStack eucalyptus and so on commercial cloud platforms include Amazon web services, Microsoft azure, Google app engine and so on. So, now, let us look at the open source cloud platforms these open source cloud platforms mostly offer infrastructure as a service whereas, the commercial ones offer in addition to infrastructure as a service platform is a service software is a service. So, on a subscription basis or; that means, on a payment basis in terms of security these security issues are implemented by the user; that means, by the customer at the user end and commercial clouds these are implemented the security aspects are implemented the security components are implemented by the service provider.

So, here the type of the cloud is private on premise; that means, in the facility of the user the cloud will be installed and so on premise and the commercial clouds are basically public off-premised. So, these are not available on the campus on the in the institutional premises and so on. So, these have to be available made a these are made available to the public and these have to be subscribed to over the internet.
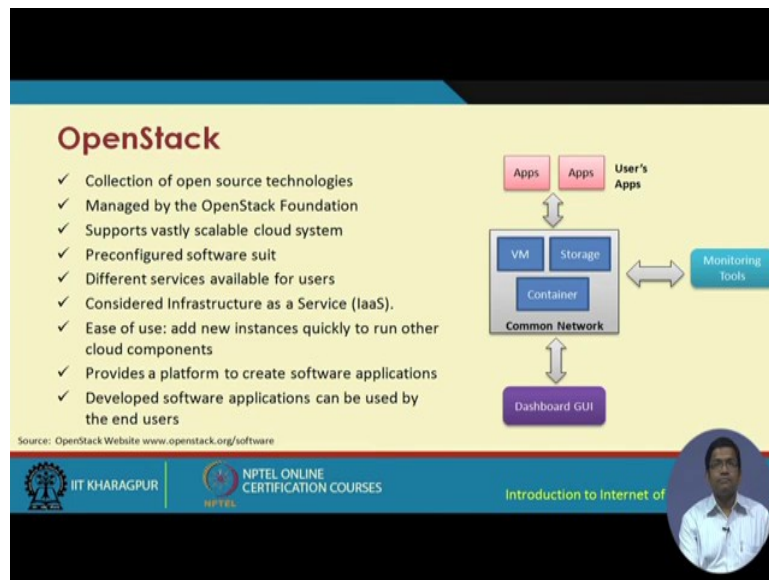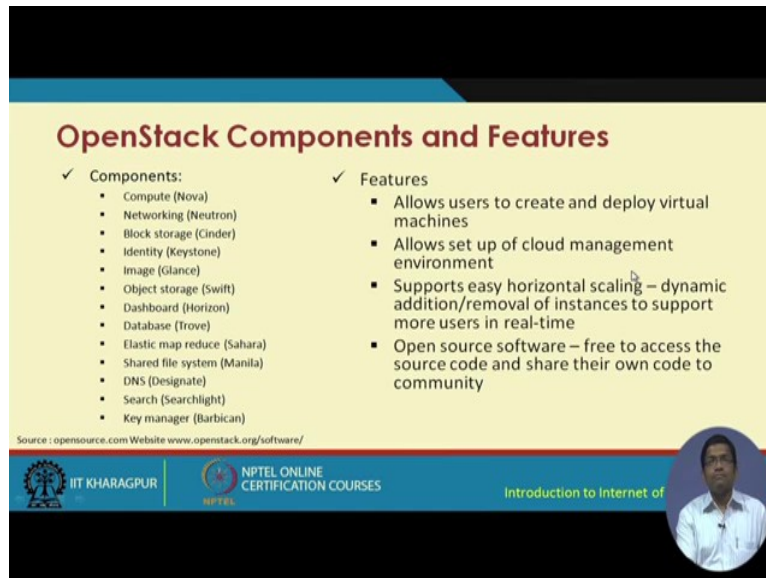
So, OpenStack is one very popular form of a cloud platform that can be used. So, OpenStack is a collection of open source technologies that is managed by the OpenStack foundation it supports vastly scalable cloud system it has preconfigured software units different services are available for the users it considers infrastructure as a service. So, OpenStack basically supports IaaS and not a SaaS or PaaS it is easy to use because you know one can easily add new instances and can quickly run different cloud components it provides a platform to create software applications and has been developed it has developed software applications which can be used by the end users.

So, this is basically the schematic of OpenStack. So, we have the common network component which includes a container storage and virtual machine. So, this is basically the common network component then you have these different apps at the user's apps layer and then it also connects with the dashboard geographical interface.

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And the different monitoring tools are also available through the OpenStack platform OpenStack has different components and features. I am not going to go through, but as you can see over here they have different components for computation networking storage you know and so on and so forth database etcetera, etcetera and they have different names for each of them nova neutron cinder glance keystone swift horizon trove etcetera, etcetera.

These different components have their own different names the features include allowing users to create and deploy virtual machines allowing the setting up of cloud management environment supporting easy horizontal scaling. That means, dynamic addition and removal of instances to support more users in real time and open source software this is open source software which is freely accessible to anyone we along with the source code which can be shared to shared in order to share with the community for the deployment and use of this platform.

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Microsoft azure is available on a payment basis it is not free it you know earlier it actually it used to be known as the windows azure it supports infrastructure as a service and as and also the platform as a service. So, infrastructure as a service was also offered by OpenStack, but not platform as a service. So, this paid software Microsoft azure basically comes with the platform as a service in addition to the infrastructure as a service it supports extensive set of surfaces to quickly create deploy and manage applications there are many many programming language support and frameworks that are available in this particular platform the azure platform and it is available across a worldwide Microsoft managed data centers.
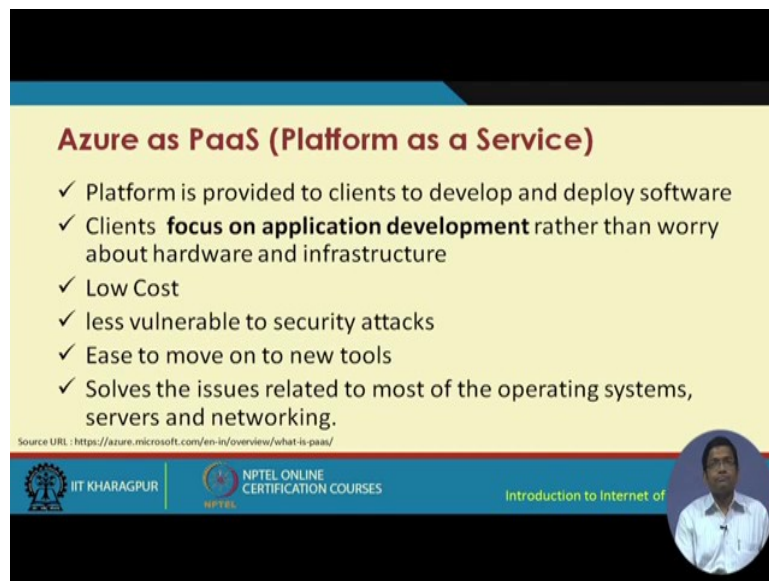
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So, these are the different advantages of Microsoft azure and here the list of different services that are supported by as your are given in front of you we have support for computing support for mobile services storage services data management messaging media services content delivery content delivery means that you know something like offering different types of media you know etcetera through platforms like YouTube and so on.

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So, content delivery network developer you know developer services management services and machine learning support. Azure as a platform as a surface PaaS platform is provided to clients to develop and deploy software. So, this is very important. So, when we talk about platform as a service we are talking about some platform that is offered for the development of the software to the clients you know clients get the development platform for use on a after makings the payments.

So, clients basically focus on application development rather than worrying about the hardware and the infrastructure Azure is low cost is less vulnerable to security attacks as claimed by them then it is easy to move on to new tools with the help of azure it also solves.

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The issues related to most of the operating system servers and networks. Azure as infrastructure as a service the previous one was platform as a service. And the next one is infrastructure as a service in this particular module it offers total control of the operating system and the application stack it has features to access manage and monitor the data centers and it is ideal for the application where complete control is required.

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The next one which is also quite popular is the EC2 Amazon platform EC2 elastic compute cloud the name says it actually the advantages of Amazon EC2 is evident from the name. So,

a web service for users to launch EC2 is a web service for users to launch and manage the server instances in Amazon's datacenter it provides various APIs tools and utilities it has the facility for dynamic computation scaling in the AWS cloud and it supports paper use billing rather than making large and expensive hardware purchases. So, Amazon has different is EC2 Amazon EC2 has different instances.

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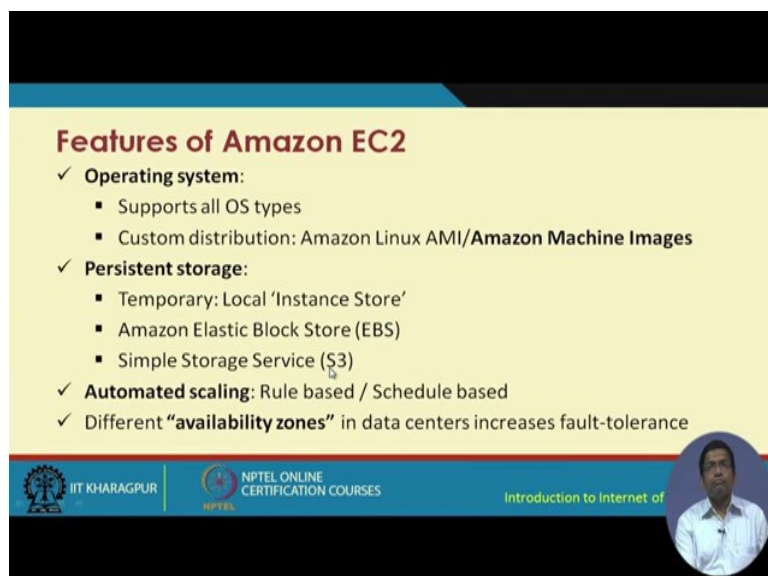
So, these instances are of different types for different serving different purposes and their specific names that are given by them in EC2 are also listed over here.

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So, in terms of the operating system EC2 basically supports all operating systems in terms of storage it has temporary storage for local instance store which is a local instance store and also the Amazon elastic block store the EBs and the third is the simple storage service(S3). So, these are the persistent storage mechanisms that are available to a in EC2 then the automated scaling, which is basically for horizontal scaling where there are rules and schedules that are given and the scaling is going to be on the basis of that there are different available zones in the data centers that basically increases fault tolerance.

So, EC2 basically comes with the concept of available zones availability zones. So, in the availability zone basically it is designed, the zones are designed in such a way that if there is some component that goes down there will be some other component that is going to automatically take over.

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So, the zone basically at the time of creation basically ensures that such availability is there. So, that basically improves the overall fault tolerance in data centers.

Features of Amazon EC2 also include firewall support for firewall rules and securities overall there is predefined protocol ports etcetera which has source IP ranges supporting different firewall rules and security mechanisms elastic IP address mapping which basically maps between the IP and the VM of users. So, what you have essentially is one pool which is basically the IP address pool the other one is the pool of virtual machines that can be created

for the user. So, basically this elastic IP addressing will map between the IP addresses and the virtual machine and the corresponding virtual machine.

Amazon CloudWatch CPU disk network resource utilization monitoring these are some of these functions of CloudWatch then you have the enhanced security mechanisms as features in EC2 and the last one that I would like to mention specifically is the formation you know is the availability of feature for creation of virtual private clouds. So, which will basically logically separate the private clouds not private cloud, but it is sort of like a virtual private cloud. So, I can install in my lab a virtual private cloud which will be logically separating from the rest of the Amazon web services cloud and this can be optionally connected to the users own network.

So, with this we come to the conclusion of this lecture we have gone through 2 different aspects of cloud. One is the different simulation platforms they are there CloudSim cloud analyst so on and so forth thereafter we spoke about the actual you know cloud platforms that are available for real deployment. So, in which again there are 2 classes of such kind of tools one is the open source once. So, OpenStack by open foundation is OpenStack foundation is an example of a open source cloud platform. The paid ones include Amazon EC2, Amazon web services, Microsoft; Microsoft azure and so on.

So, with this we you know stopped over here with the cloud and also in another lecture you will be given some hands on demos some demos with which you can perform some hands on you know experimentation with cloud if you have the facilities with you. You can you know when we go through these different you know steps in the next lecture you can also perform the experiments yourselves with adequate facilities at your end.

Thank you.