

Introduction to Information Security
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Lecture - 22

So, now we will discuss about the cloud deployment models. We have now talked about the essential characteristics. The next step is; and the platforms and the third in that architecture as I showed in the earlier slide is the deployment model. Now, there are four difference deployment models; a public, private, community, hybrid.

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Public Cloud

- The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.



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graph TD; PC((Public Cloud)) --> CA[Customer A]; PC --> CB[Customer B]; PC --> CC[Customer C];
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58

A public cloud is one infrastructure made available to the general public or a large industry group and is owned by an organization selling cloud services. So, everybody has to go to that public place and store data and do whatever you want.

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Private Cloud

- The cloud infrastructure is operated solely for a single organization. It may be managed by the organization or a third party, and may exist on-premises or off-premises.




59

A private cloud is setup for one organization and a group of organization. It may be on your premises or it can be off your premises, and it is done only exclusively for organization and nobody can share this, but it can be managed by a third party. A community cloud is only for one community and it is not for one organization, but for a community of organization. For example, it can be a mission driven problem or a policy or compliance considerations, there is a specific community that has some shared concerns. So, this will give that community a service, right.

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Community Cloud

- The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, or compliance considerations). It may be managed by the organizations or a third party and may exist on-premises or off-premises.



60

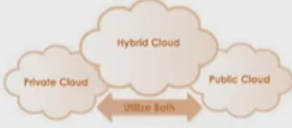
So, it is not for one organization, but it is for multiple, but organization which shares some similar concerns, similar policies. So, we have a cloud that can basically deal with

them and again this can be on the premises of some of one of these community organizations and can be off the premises. So, the next model is the hybrid model is the composition of two or more of these clouds that we have seen as the private, community or the public model.

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Hybrid Cloud

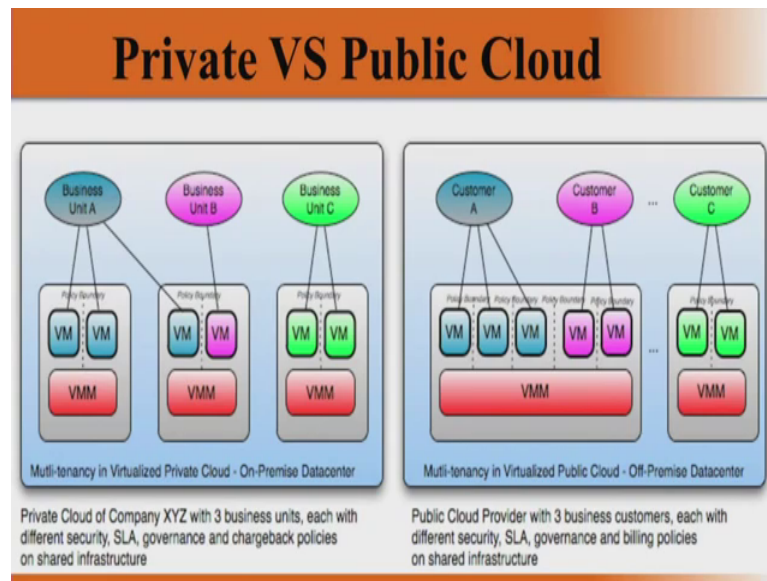
- The cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load-balancing between clouds).



61

What is so interesting about this hybrid cloud model is that they have some standardization that is based on the different organizations that take part here, but at the same time what is hybrid about this is how it is different from public. It gives separate isolations even at the hardware level, but in case of need, they can expand by doing what you call as cloud bursting for load balancing between the clouds. So, between two different sets of systems hardware, they have to ensure data and application portability and they are also bound by proprietary and standardized technologies of individual organizations, but they can basically extend it across clouds by using these cloud bursting techniques. So, this is a notion of a hybrid cloud.

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Now, this is what you see in private Vs public cloud, this is what we call as the multi tenant module. What is a multi tenant? In the same server more than one customer can exist, right. Now, let us look at the private which is on the left hand side. It is a private cloud. This is one organization which has three business units and essentially we have three servers, but you find that all three symmetric servers you will have and you find that the business A needs more than one server, it needs one and half servers for getting the required service for required performance, storage etc. While, business unit B needs only half server while business unit C needs one complete server. So, we have three servers now. Note that the business unit A and business unit B share one server, and there is one exclusive for business unit A and there is one exclusive for business unit C.

Within the server you have something called virtual machine monitor which actually hosts several virtual machines. Each virtual machine can be a software in isolation which is issued by organization, or some sort of these virtual machines can also be divided based on some policies, right. So, the policy boundaries can basically dictate the virtual machines. Normally in today's infrastructure, each virtual machine will be running one specific software. We look at banking. One will be right there you know running in the loan processing software for example, another can be running the email client, the third can be running some other fixed deposit software, and the fourth can be running your NEFT software etcetera. So, every virtual machine will be running software.

Why do we need a virtual machine? It is because when the software it gives a feel to the software that the entire server belongs to the software. So, when somebody develops software, he can assume that the entire server would belong to him. So, essentially he is not talking about attacks or interactions of this software with anybody else, with other software. So, this virtual machine will give the VM that you see on the slide, will give you a framework where the software, each software can run within that blue box that you see captioned or labeled VM, and it will be running that software alone, but more than many software's can run on a single server and each will have its own virtual machine.

When you look at the public clouds, so there is a notion of multi-tenancy in the private cloud also where it is more than one business unit can share the same server infrastructure. As you see business unit A and B sharing the middle server on your left hand side; on the right hand side you see a public cloud where many customers A, B many of them coming. Note that A and B share the same server, the physical hardware on which the softwares corresponding to customer A and the softwares corresponding to customer B run. They are the same server in the same single server your customer A and customer B runs their services. So, there are five different virtual machines as you see on the right hand side. Each virtual machine will give a notion of isolation; it gives a feel of isolation to the software that is installed in that virtual machine. So, this is the notion of a public cloud.

So, what we see now here is the most important thing is that for me to have effective usage of the resource, effective utilization of the resource we do the multi tenant model, where in more than one customer or software belonging to more than one customer are more than one software basically run concurrently on a single hardware platform, and each of this software will be isolated from all others who are running on the same hardware by the notion of by the technology termed virtualization. So, this is how the private and public clouds are built today.

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Outline

- Definitions of Cloud computing
- Architecture of Cloud computing
- **Benefits of Cloud computing**
- Opportunities of Cloud Computing


63

We have seen about the definition of clouds and we have now seen about architecture of clouds. Now, let us go and look at the benefits of cloud computing. What are the benefits of cloud computing?

(Refer Slide Time: 08:49)

Benefits of Cloud Computing

- Business Benefits of Cloud Computing
- Technical Benefits of Cloud Computing



64

We can classify these benefits as business benefits and technical benefits. You will now go and look at what are the business benefits and what are the technical benefits. The business benefits are five number. I need not invest any money. I can just go and hire a cloud and it gives me all that I want and I have to pay only monthly rent or monthly usage cost because the cloud is actually metered.

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Business Benefits

- Almost zero upfront infrastructure investment
- Just-in-time Infrastructure
- More efficient resource utilization
- Usage-based costing
- Reduced time to market

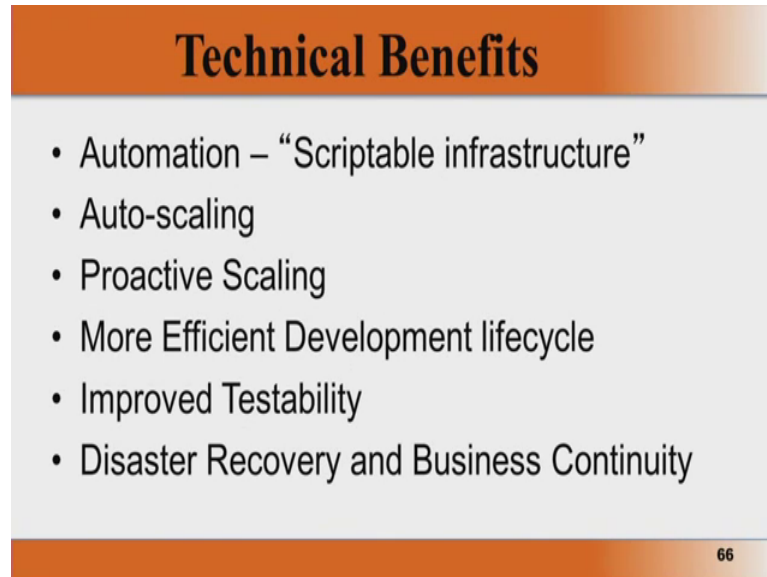
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So, almost zero upfront infrastructure investment. The second thing is I need not go rise a purchase order, hire a building, hire network clearances and get access to those networks by all the hardware. Nothing, all those are already provided by the cloud. So, it is just in time infrastructure whenever I want I can just start using the cloud. If I want to actually start my own data center of reasonably good capabilities, it requires at least two years of planning. So, if I want to start data center say two years from now, I should start planning now. I mean from this stage of you know hiring a building, setting up all the necessary infrastructure and I am looking also at tier 1 type of data sent is going to be a two year affair. So, the biggest benefit that business benefit that a cloud infrastructure gives you is just in time infrastructure and in more efficient resource utilization.

So, you are not paying for the actual resources. You are only paying for the meter. So, if the CPU is not assigned to me, I am not going to be paying that money if it is not a cloud and you have dedicated services for each software, then if CPU is not utilized, still you have already invested the money to buy that hardware and put in your data center. So, one important use of cloud is more efficient resource utilization, and you would have usage base costing. If I am not using, then I am not going to pay for it. The most important thing is that once you go for a cloud infrastructure, since many things are provider are there, you can actually go to launch your product or anything that counts out of this cloud computing in a very reduced time. So, I can go and market my organization. I am starting business today, I can make the business, I can bring the business to the

market with in very short time if I start using this cloud infrastructure because many things are maintained by them.

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Technical Benefits

- Automation – “Scriptable infrastructure”
- Auto-scaling
- Proactive Scaling
- More Efficient Development lifecycle
- Improved Testability
- Disaster Recovery and Business Continuity

66

Now, look at the technical benefits. One of the things here is this automation or what you call as a scriptable infrastructure. What is a scriptable infrastructure? I can go and pick and choose. What is a script? A script is one which can go and set several configuration parameters. It can pick parameters and choose, right. So, people have done script level programming. Understand what a script does, but for people who have not done scripting, it does essentially mean that we can go depending upon the scenario. You can quickly go and set what parameters I need to access.

Another important technical benefit of a cloud is auto scaling. You can just scale as and when it is needed. It can also go and predict a next month I have to this a server performance will go down because the data is increasing. So, let me go and scale it this month itself. So, I could have a pro-active scaling of servers and it is a very efficient development lifecycle. It can provide you more efficient development lifecycle because there are lot of things that gets monitored and reported very quickly, and it gives a very improved testability and because lot things are already tested if I look at a cloud, the platform, the infrastructure and the software whatever they are used by many customers. So, they would be tested. So, I need not go and test all these commonly available software and hardware, and entire testing would be restricted to the software that is executing on the cloud. So, this will improve or anything specific that is going on the cloud and this will certainly improve the testability.

The important thing is that this cloud is managed by a provider, cloud service provider. Please note that in many businesses, IT is a way of doing the business. IT by itself is not a business. If take bank, banking is a core business. IT is not a core business. If I am looking at market today, market is a core business. Developing software for that market is not a core business. So, when we look at business continuity and the issue like disaster recovery which are major technical benefits, where what is business continuous continuity mean, if I have continuous availability of the services, then my business continuity is very good. If it is going to stop, then the business continuity at even random terms, then the business continuity does not exist.

Similarly when there is a disaster, I quickly can recover and give the service. So, we are taking this availability in security term when we talk about the last point in the slide. Now, since the cloud is maintained and it is tested by many users and then, they essentially have a large infrastructure. Now, your disaster recovery and business continuity will be addressed automatically and that is one major technical benefit. If you are very small organization, you cannot afford to have your own cloud immediately. Rather than doing it, you can out source to an organization which can take care, which is a service provider and which can take care of your disaster recovery and business continuity type of issues. So, these are benefits of having a cloud.

Now, let us look at what are the basic opportunities that you get in cloud computing. So, there are what the opportunities are. So opportunities for whom? Opportunities for end consumers. What will the end consumer do? He gets the services done, for which you pay some monthly rent and for the business customers. So, business customers are those who sort of develop their entire business on the cloud.

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Opportunities of Cloud Computing

- End consumers.
- Business customers.
- Developers and Independent Software Vendors (ISVs).


68

So, for example if you are using Gmail, you are end consumer. If I am actually using a call center on cloud, then it is a business. I am a business customer and then there are developers and independent software vendors who will develop for the cloud. So, there are three different people who can use this cloud, right. So, it can be an end consumer like Gmail. Some fellow uses it. It can be a business customer who will write their software, there functionalities, either make you write in as a SaaS or they use the platform or they use hardware infrastructure and they build. Others are developers and independence software vendors the ISVs who will be giving who will be developing on the cloud and giving that as an infrastructure and selling it as software to others.

Now, for an end consumer, he basically looks at software as a service while a business consumer will look at both software, all the three, the software, the platform and infrastructure all as service while a developer are independent software vendor may use the pass and IAAS access through the platform.

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Opportunities of Cloud Computing

- End consumers.
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- Developers and Independent Software Vendors (ISVs).

68

So, it is for a developer who wants to develop some application or wants to put it on the cloud which several people can access on the cloud and execute, you will basically look at the PAAS and you will also try to access your infrastructure through this PAAS. So, PAAS through IAAS and IAAS through PAAS, the infrastructure will be accessed through the PAAS. So, there are lots of opportunities when you look at cloud. The opportunities are for end consumers who need not invest lot of money and get all the data and service done at the cloud. The business customers are those who will use the cloud to its brim. While, the developers and independent software vendors are those who will use the platform to develop applications for the cloud.

(Refer Slide Time: 18:53)

Security Issues in Cloud Computing



Now, in the next session we will go to security issues in cloud computing. Before I wind up this session, let me just sum up what we have done so far in terms of cloud computing. We have understood what are the characteristics of cloud computing, what are the deployment models of cloud computing, and what are the services that the cloud can give in terms of infrastructure, platform and software? Now, all these things are done for what? All these things are done because I do not want to take, I as an organization, I as an end consumer, I as a business partner, I do not want to business that we saw three that we saw in the previous slide. The business customers are I as a developer, leave the developer. At least the first two, I as an end consumer and I as a business customer I do not want to invest anything on the cloud; I do not want to know anything about it. I just want to use the service and I just assume that my service will be properly done.

Now, in some sense you go and trust the customer, trust the cloud service provider. You trust on what? You trust that it will give you the necessary service, he will give the necessary data and he will ensure the integrity of this data etc. So, when I start looking at the trust, then comes most important thing what you call as the security. So, now we have seen so far all about clouds, all about the infrastructure and all about its deployment. Now, we will go and address the major challenge in making people use the cloud and really making it trustworthy model for computation and storage and networking. The most important issue is going to be the security issue and we will talk about the security issues in cloud computing in the next session.