Cloud Computing
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Lecture - 22
Economics Tutorial

Hello. We will continue our discussion on Cloud Computing. Today, we will do some problem or some exercise on cloud economic, so that whether it is economical to use cloud or when it is economical to use cloud.

We have already discussed this particular topic in our previous lecture on cloud economic but we will see that we will look at some of the problems, some troy problem so that it makes our concept little more clear.

So, I just have couple of slide recap of over the earlier slide so that it will be easy for ask to get tune to the problem.

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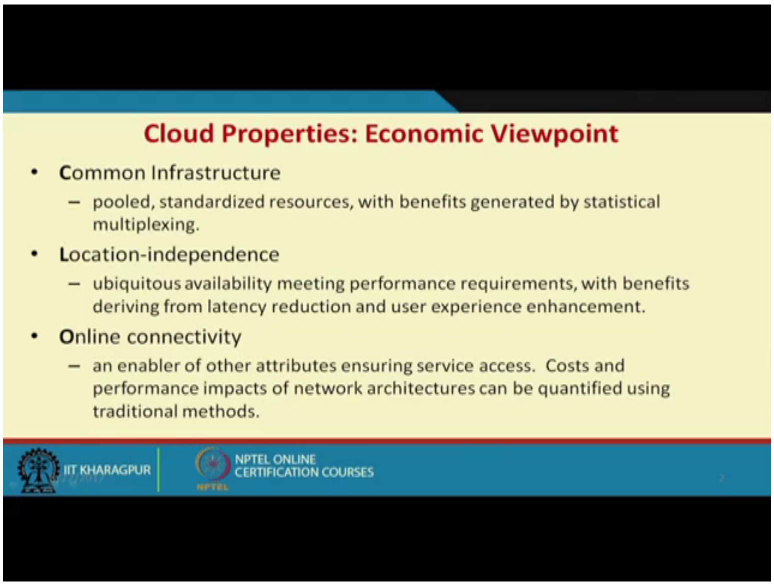

So, as you have discussed in cloud property if you from the economic point of view, it is a common infrastructure like pooled, standardized resource with benefits generated by statistical multiplexing. So, we are multiplexing the demands so that is from a pooled resources, we can do; location independent, online connectivity; that is broad network access.

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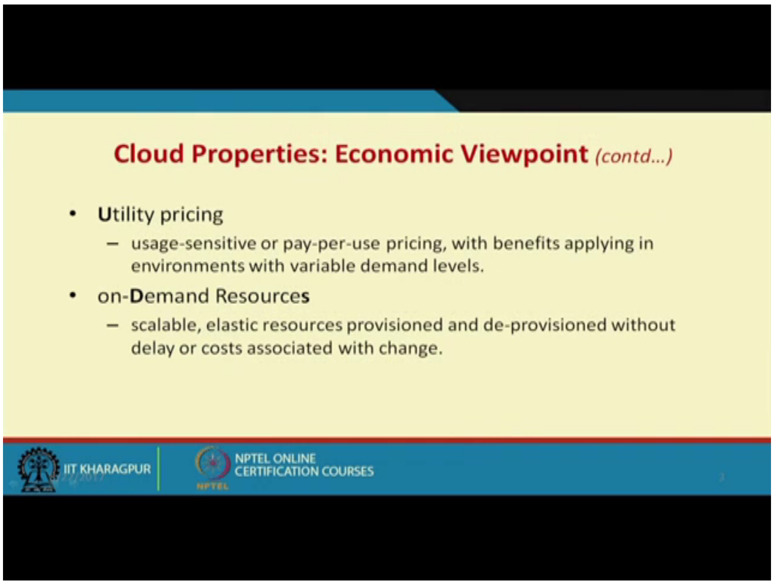

Utility pricing like you uses; sensitive or pay-per-use or pay as you go model; these benefits applying environments with variable demand levels session so on and so forth and on demand resources; so, it is a scalable, elastic resources provisioned de-provisioned without delay or cost in the associated with change.

So, overall it looks like that it is a win-win situation that whatever we do is all positive things, but whether it is a company or a organization needs to look into that whether it is a beneficial to deploy cloud depending on its type of things. As we discussed, suppose you require system a some high end system for a short period of time; then it may be beneficial to go for cloud.

Suppose the requirement of the system is longer period of time; daily you are using twelve hours or so; or may be more than that and then it may not be always economical to go for cloud type of things; so, in economic point of view that we will try to look at.

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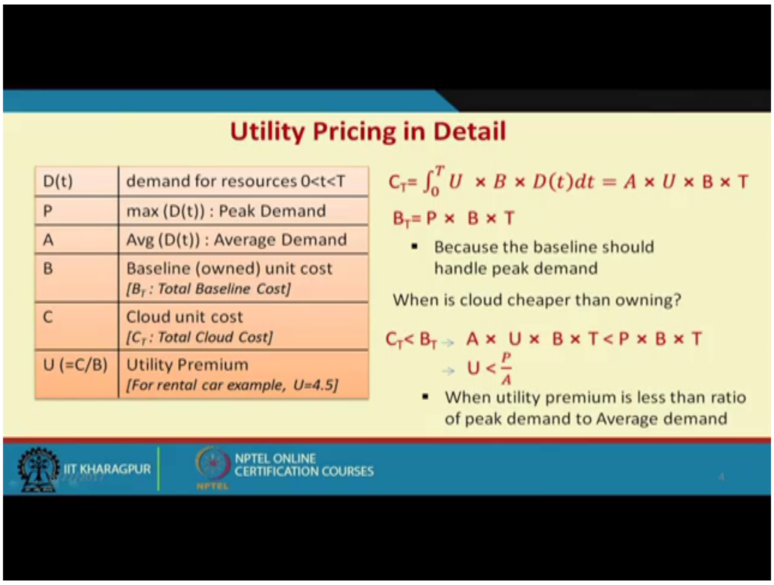

We have also seen these slides where we tried to look at that overall costing model where cloud cost is like; here the variables were that the D t demand D t is a demand is function of time; within a time period 0 to t; t is the max of D t, that is a peak demand, A is the average demand, B is the baseline that is the unit cost for owning the things, C is the cloud unit square; the total cost is the denoted by C t; total baseline B t.

So, U or C by B is the utility premium; like the example we have shown in our earlier slide is utility premium is 4.55, so; that means, it is all beneficial to use clouds so what is the utility. Similar, so we can calculate we have shown that we can calculate that 0 to t U B D t as a multiplication of these units. Similarly, B t that is the total baseline cost is P into B into t because the baseline should be handle peak time.

So, peak demand rather; so, baseline whenever we do a baseline costing of baseline design or what whenever you own or something; then we usually look for a peak demand. Like suppose I want to big make system for our say M Tech lab; so, what you have to say that if the number of students which can be admitted say in; so, number of system we think is; it should be at least 10; if not more to have some redundancy into the things, if there is a failure then recovery means; we can replace the systems.

But in actual things that the number of student's strength may not we; for a particular year of admission you may not attend that thing. Usually it may be less than that and so you have redundancy resources which are underutilized or not utilized.

So, when cloud is cheaper? If this cost of C t is less than B t or utility is P by A is less than P by A or here if you have the cost of cloud; by this what should be the utility premium. When utility premium is less than the ratio of the peak demand to the average demand then we can say it is cheaper.

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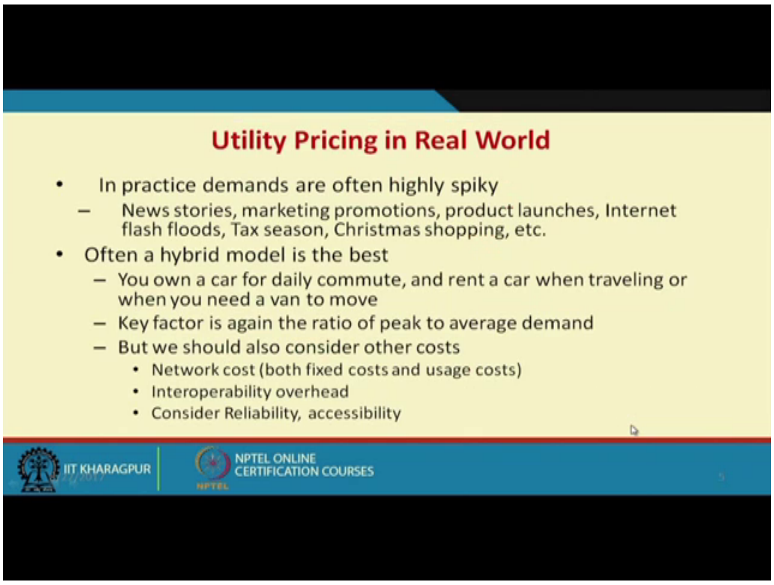

Now, utility pricing in the real world is not that simple; if they are lot of other things like in practice demands of in highly spikes are there. Like there are maybe news stories or marketing promotion and so on and so forth; of an hybrid model is based. You own a car for daily use; for whenever you are going out or traveling or for a longer distance, you use those rented things. Similarly, you have your own system but when you require some; when you are thinking there is some peak demand; you go for this type of things.

So, key factor is again the ratio to peak to average diamond, so that is the key factor. But we should also consider other cost which are not considered here; like network cost, interoperability over head; if to data are talking to each other then interoperability over head. Then consider reliability accessibility and so on and so forth.

So, those are other things which need to be accounted for when we calculate this cost.

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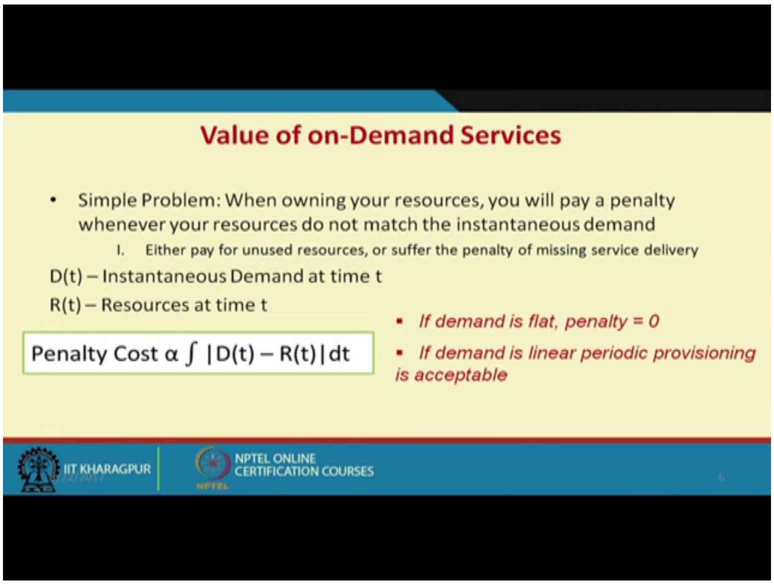

So, we also have seen this is a slide again; where there is on demand services, value of on demand services. When owning your own resource, you pay penalty whenever your resource do not match with the instantaneous demand. Either you penalty for unused resource or suffer for penalty for missing the service delivery; it can be there. So, if D t is the instantaneous demand and R t is the instantaneous resource; then the penalty cost is D t minus R t integral of that. Like D t minus R t mode integral of that over the time period 0 to capital T.

So, that is the thing if demand is flat; penalty is 0. If the demand is linear; periodic provisioning is acceptance. So, if the demand is linear periodic provisioning is accepted.

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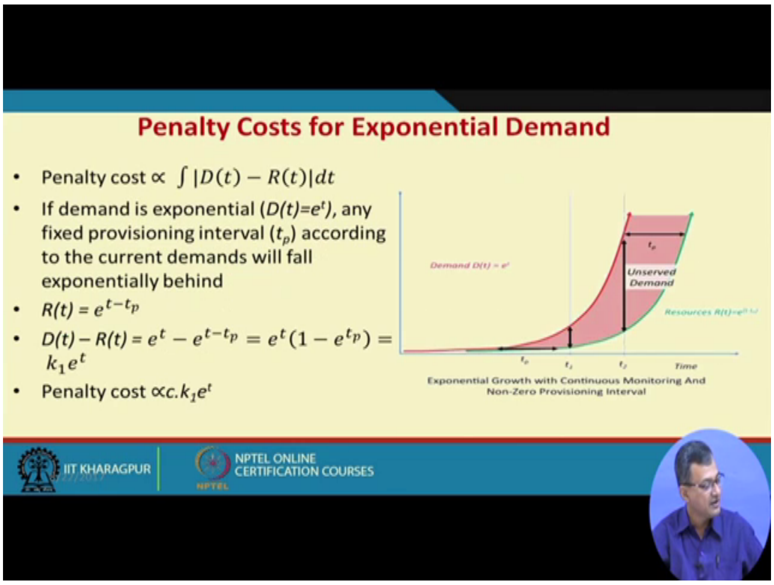

But most of the case; there is a lag between when the demand rises and the provisioning is done. And this sometimes creates a; it may create a big challenge because if the growth of demand is exponential, then chasing that demand with resource provisioning maybe extremely difficult. Like here we have seen that if the demand is exponential; D t is some form of e to the power t, any fixed provisioning interval t p; like it whenever you look for that extra provisioning, it will look for some provisioning interval t p.

So, around any according to the current demand will fall exponentially behind it; we have seen. So, R t equal to e of t minus t p; so, you have a lag between that. So, D t minus R t; if we calculate something constant into the e to the power t; so that means, the penalty is something C into k 1; e to the power t; that means, it also grows exponentially. Like, if you see the picture, so that due to this provisioning delay that it unserved demand goes on increasing. So, it is extremely difficult to chase this sort of situations.

So, these are all practical consideration; so, it is not that just doing a simple calculation, but there are different other consideration. For that, you need to have a predictive model that whether you can say that this time the demand will increase like; these are true for our other commercial things also, we do predict that during some seasonal things whether if the demand will increase on that time and have store accordingly. Here also you need to have some predictive model to do that if at all required.

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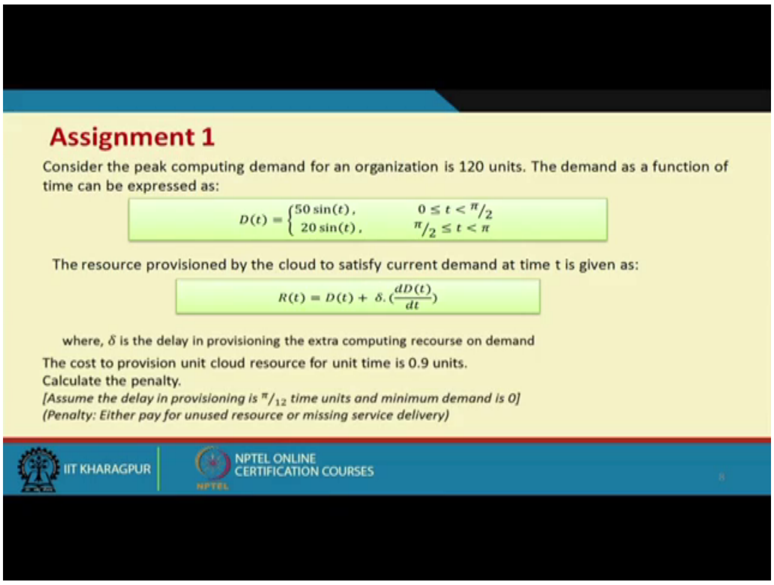

Now, we will try to look at one or two problems; which will allow us to have little more clarity on the whole thing. So, these are very troy problems; simple problem, but by doing so it will give us some sort of a clarity or confidence into the things.

So, what it says; consider a peak computing demand of an organization is 120 units, something, some 120 units. The demand is a function of time that can be expressed at this D t equal to 50 sin of t from t 0 to pi by 2. Whereas, 20 sin of t where pi by 2 to pi; this is the some functional model is given. The resource provisioning by cloud to satisfy current demand t is R t equal to D t; del of capital like del of D D t of by D t.

So, this is the resource provisioning; where del is a delay in provisioning the extra computing resource in time; this we consider. Now, the cost of provision unit cloud resource for unit time is 0.9 units; so, we need to calculate the penalty. So, our assumption is that the delay in provisioning is pi by 12 time units and minimum demand is 0; there is no demand is the minimum case. Penalty either pay for the unused resource or you miss some del service delivery. So, this is the consideration; so, we need to calculate the penalty.

So, let us just have a very straight forward working and see that how things work. So, if I have your R of 0 to pi integral 0 to pi from that given equation you can do.

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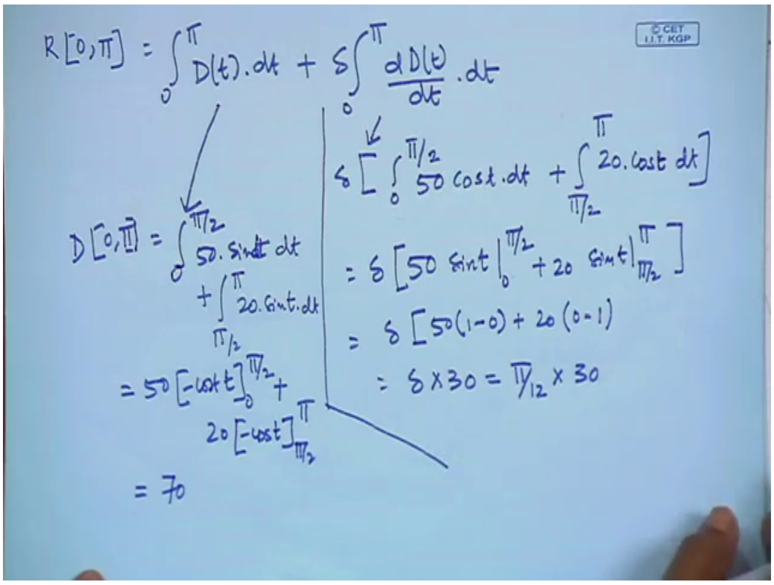

So, if we look at this portion; so, it is del of D t 30; so, on other sense this we can have; so if you go on calculating; so, it is 50 minus cos of t 0 to pi by 2; plus 20 minus cos of t pi by 2 by pi. So, if you go calculate; so, it will come as 70.

So, that what we have finally, if you look at.

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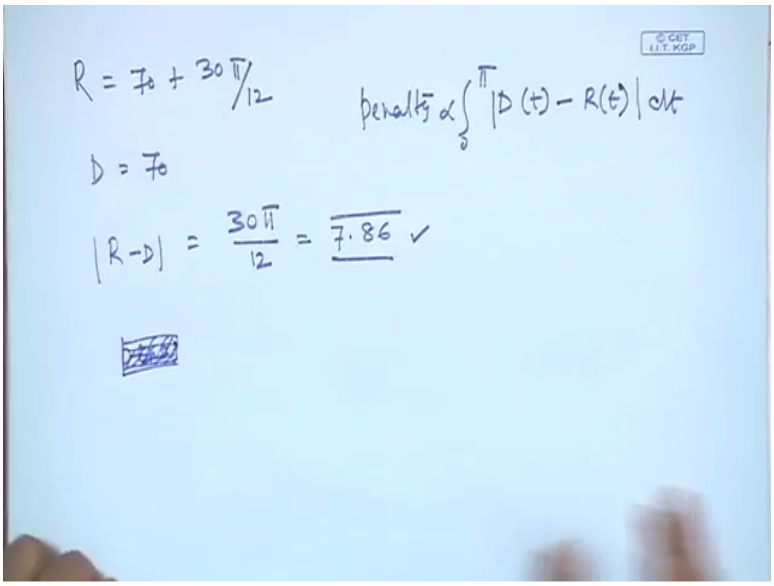

So, R equal to 70 plus 30 pi by 12 and your D value is 70; so, R minus D mode is 30 pi by 12; equal to 7.86. So, this is the value what we answer we will get; so, if you actually this corresponds; if you remember as we are talking about penalty; penalty equal to is proportional to 0; 2 pi demand minus mode of D t. So, we get these as the value of the penalty because in this case; what we say that is your resource availability that provisioned is greater than your; the demand; so, we get a positive value.

So, this is again from the equation we calculate; again I should say this all this calculation path, we have considered the other factors; like network provisioning or other type of maintenance cost and all those things, we considered; those we are not considered.

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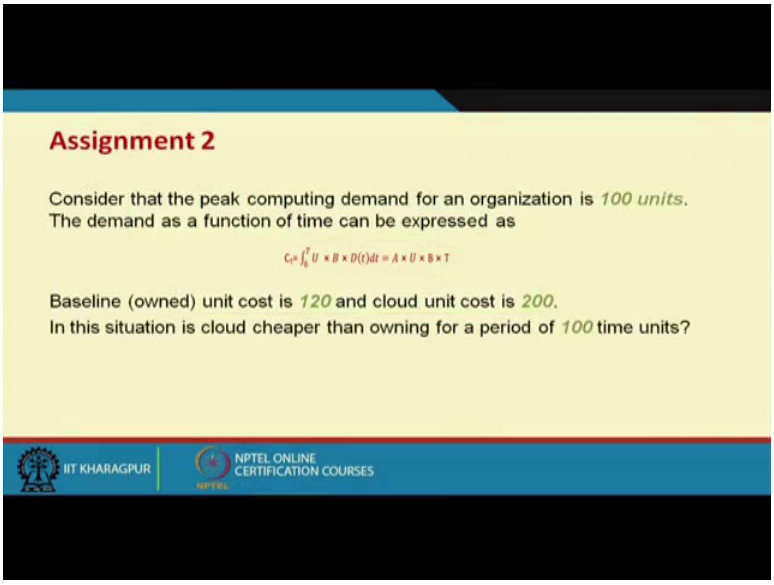

So, rather if we look at another problem like; consider the peak computing demand of an organization is 100 units. The demand is a function that can be expressed and that can be expressed as C t equal to 0 to t U into B into D t this and like this. So, this is the function what we have discussed.

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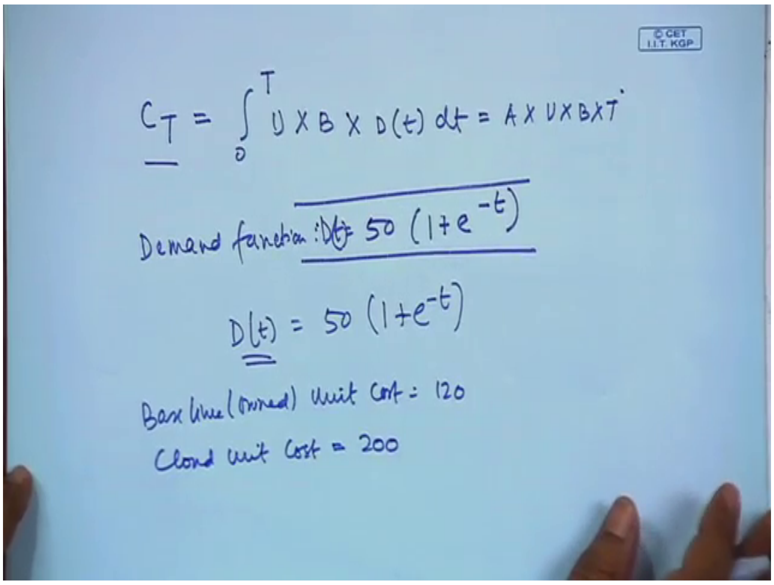

So, what we say; the cost of cloud C t equal to 0 to t; U cross B into; this we have the already seen. So, rather here the this is the total cloud cost; this we have already seen. Actually, if we; please note the demand function, which is there is it is not mentioned here; there is some typo. So, demand expressed as a time can be expressed as 50; into 1 plus e to the power minus t.

So, let me reframe the question again; consider a peak computing demand of an organization is 100 units. So, demand as a function of time can be expressed as this, so if I say the demand D t is expressed as this. So, this is not there in the question because there is a some missing terms. So, demand you considered 1 plus e to power minus t; so, this is a; demand is a function of time.

Now, what we additionally give baseline unit cost is 120; so, base line that you means in unit cost is 120 and cloud unit cost 200. So, what we need to do in this situation is cloud cheaper than owing for a period of 100 unit times. So, you want to calculate if the cloud is cheaper then owing it into 100 we are obtained. So, what you need to add here? This you need to calculate that whether if 100 unit time; if it is a utilizing is there; so, it is again straight forward.

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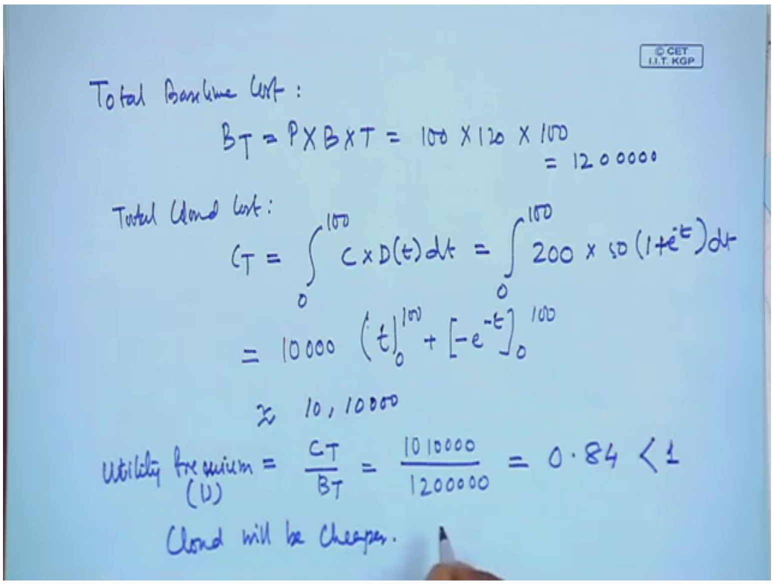

So, if I see total baseline cost B t equal to P into B into t equal to 100 into 120 into this much; total cloud cost C of t equal to 0 to 100; C D of t; D t equal to integral of 0 to 100; 200; 50, 1 minus 1 plus minus this into D t.

So, if you do a integration; so, if you do it, it approximately count as 1010 so much. If you just do that calculation, so here what we get 120; 1, 2, 3, 4, 5; 1, 2, 3, 4, 5 fine. So, what we do utility; so, utility premium as if from our this; so 0.84 or utility premium U, what we get is U is less than 0. So; that means, at least in this case cloud will be cheaper.

So, I can have simple calculation to find out that what are the different; for different scenarios, what are the different cases are there.

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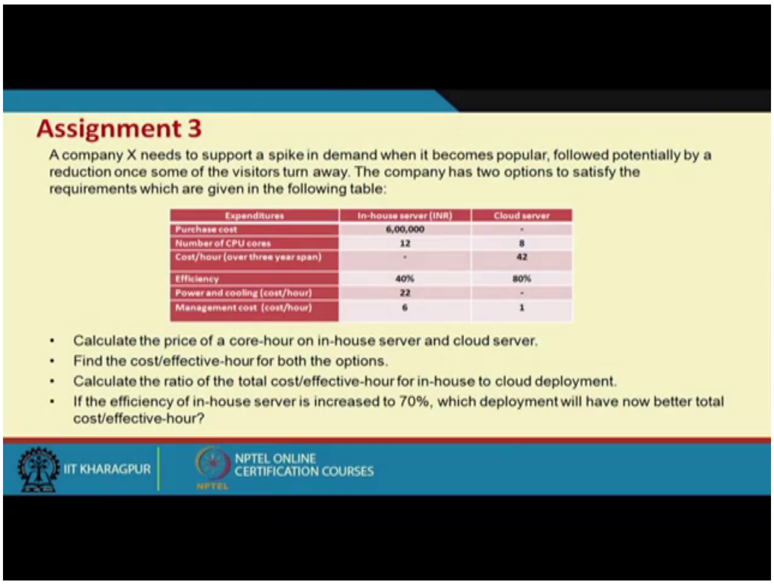

Let us look at another problem; here what says a company X needs to support a spike in demand when it come when it become demand when it becomes popular followed by potentially a reduction once some of the visitors turns away; that means, when there can be spike and fall in the demand; this sort of scenarios.

The company has two option to satisfy the requirement which are given in a table. So, what it says purchase cost of in house is something and cloud server in a way there is no purchase cost. Number of CPU cores for in house server is 12 whereas the cloud server is 8. Cost per hour over 3 year span for the cloud sever as you are renting; it is something 42 units per hour cost.

Efficiency of the in house server because it is underutilized, so it is 40 percent whereas, the cloud server is 80 percent; because you are using it when the demand is there. Power and cooling requirement in case of in house server is 22; whereas, for the cloud server is nil and management cost per hour is 6; in case of in house server and cloud server it is 1.

So, again let me just repeat purchase cost is 6 lakh for in house and nil for cloud. Number of CPU core in house is 12, cloud 8; cost per hour in a 3 year span that in or other; means for cloud is 42 units whereas, for in house there is no cost hour; you can after on purchase the thing. If you since is 40 percent because most of the things are there is 60 means not that utilized. And whereas cloud sever; it is 80 percent power and cooling is 22 and nil and management cost per hour in case of a cloud is much more that is 6 and it is 1.

So, what you need to calculate with this data; calculate the price of a core hour on in house and cloud sever so that is straight forward.

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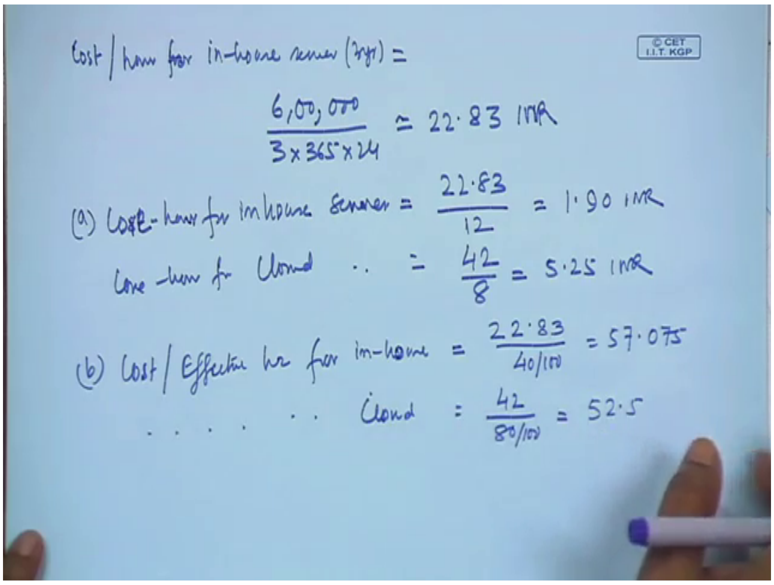

So, what we have cost per hour for in house sever considering 3 years is divided by 3 cross 365 cross 24. So, if you calculate it comes around 22.83 INR; if it is Indian currency or units of cost.

Now, if we have a cost hour for in house; server it is 22.83 by 12 because the first question was core hour; for in house server. So, core hour for in house server is this one is 1.90 unit or if we consider a new thing. So, core hour for cloud server is 42 by 8; it directly comes from the question 5.25 INR. Now an question B; find the cost per effective hour for the both the option.

So, cost per effective hour for house is 22.83 and as it is 40 percent efficient; so, 40 by 100, so it is 57.075; so, it is INR or something; whatever the unit. Effective hour for cloud equal to it is 80 percentage efficiency; so, 5; so, this is the effective.

And now calculate the ratio of total cost per effective hour for in house to cloud deployment.

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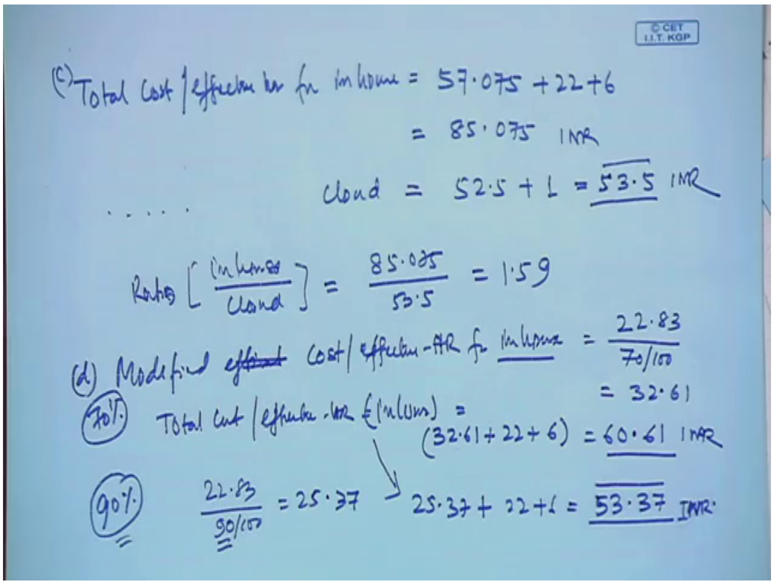

So now need to calculate the ratio of total cost per effective hour for in house and cloud deployment. So, total cost per effective hour in house is 57.075; if you have calculated earlier that is for the in house sever plus 22 because that is a power and cooling plus 6 for maintenance management cost and then we have 87.075. Same thing for cloud equal to 52.5 and it has only one management; so, it is 53.5 and if it is INR fine or whatever the unit.

So, ratio of effective hour of in house by cloud equal to 85.075 by 53.5; so 1.59 and finally, if the efficiency of in house sever units is to 70 percent; which deployment have will become better in the total cost effective hour. So, it has efficium efficiencies initially now 40; if you increase to 70 percent; so, which will be better. So, modified cost per plus effective hour for in house will be 22.83 by 70 percent now 100; so, we get 32.61.

So, total cost plus effective hour for in house; everything is for in house total cost per effective hour; still it is for in house, still it is 32.61 plus 22 plus 6; equal to 60.61. But if we see that the cloud it is still 53.25, now if it is instead of this is 70 percent increase. If it is a 90 percent in house; then if you do the same calculation, we will effectively what we will get instead of this value. So, 22.83 by 90 by 100; it is 25.37; so, with this total cost for 90 percent will become 25.37 plus 22 plus 6; 53.37 INR.

So, this is for if it is 90 percent; so, if you see 90 percent; then it is better than this cloud. So, it is if you look at the problem; so, if in your efficiency is less. So, as we discussed the overall utilization of the resource of the in house is highly underutilized, so you lose on those things. So, effectively we get a less it means we get a more benefit if we take from cloud.

However if your efficiency increases or in other sense that your infrastructure or your in house infrastructure; if it is heavily utilized like a we have seen up to 90 percent, then it may be better then it will be performance wise better than cloud. This is a very synthetic for example, to show that if the efficiency if you are more utilization are there then in this case is the in house will be better than cloud type or cloud purchasing a cloud.

So, it all depends on overall; what is your demand? What sort of demand is there? How long duration things are there? So, we need to take a call that whether you go for a cloud type of; economically beneficial to go to cloud service provider or have in house infrastructure.

So, this three is small problems on economic model of cloud shows that how by simple calculation we can find out and though in actual practice these are more complex with considering other for parameters as we have discussed.

So, hope this will help you in clearing or having a better understanding of this economy behind this cloud.

Thank you.