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The Cloud Computing with respect to Provider and Consumer

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Abstract: This paper, demonstrate basic definition of cloud computing and cost estimation of cloud computing environment in compare to fixed dedicated resources. Intention of this paper is to provide clear idea to industry people when to move pure cloud, pure dedicated resources or hybrid of these. This would help industry people estimate the cost of resources in both ways: as a cloud provider point of view or cloud consumer point of view. From the cloud provider point of view, the construction of very large datacenters at low cost sites using commodity computing, data storage, networking and then the possibility of selling those resources on a pay-as-you-go model below the costs of many medium-sized datacenters, while making a profit by statistically multiplexing among a large group of customers. From the consumer point of view they can use any services like a software, they don't bother on in maintaining hardware's and for over provisioning or under provisioning problem. And from the cost perspective they need to pay only when they use resources. This paper describes the basic questions-answer which would help researchers who are new to cloud computing. Hopefully this will help in basic understanding of cloud computing environment and we will move on further with this new technology.

Keywords: Over provisioning, Under provisioning, Linear Demand of Resources, Varying Demand of Resources, Peak Demand.

I. INTRODUCTION

If someone look at present IT scenario, Cloud computing is the most emerging business methodology in IT world. This emerging business methodology gives us numerous research environments. A research worker, who is very new in this environment may have question in mind that, "when and why" we should move to cloud environment rather than using dedicated datacenters. Question may arises how cloud computing provides benefits both, those who proving that services and those who consuming that services.

The well known definition of cloud computing is that, this methodology provides numerous facility without upfront investment of datacenter. Resources utilization and its cost estimation is the key factor in this environment and widely acceptable. While providing cloud facility or consuming cloud facility we should have clear idea about our investments and its returns. Moreover one should know the feasible conditions for adapting cloud facility in his/her organization. As cloud defines itself as on demand service and it metered like other traditional utility computing, one must have to know how this services benefices the computing world when demand of resources are fixed or may be variable with time [5]. Not only that, if someone is talking about the benefits of cloud computing, he/she must consider the benefits of cloud for the both parties those who provide this facility and those who uses that facility. Considering all of these aspects, this research work analyzes some mathematics for which one can get better idea about best part of cloud computing and the circumstances for the organization to move into cloud environment rather than using traditional datacenters.

**Note: This isn't proof of the inevitability of cloud computing

II. PROVIDER PERSPECTIVE

Provider perspective mainly deals with the amount which is going to be invested and the expected return from it.

To better understand provider perspective we made comparison TCO of cloud and TCO of datacenter and made a graphical representation in figure 6. It argues that there are possibilities that infrastructure and platform provider can sell their capacity directly to the consumer. So, while comparing we take business model or TCO of PASS layer under consideration. The key difference of cloud infrastructure with datacenter is that cloud infrastructure is build in concept of distributing the workload over large number of low cost hardware components whereas datacenter is build in concept of consolidating workload onto high price scale up hardware's. If we want to establish new application on top of datacenter, we need to buy another high cost scaling hardware's. So, while comparing we take business model or TCO of PASS layer under consideration [3]. The key difference of cloud infrastructure with datacenter is that cloud infrastructure is build in concept of distributing the workload over large number of low cost hardware components whereas datacenter is build in concept of consolidating workload onto high price scale up hardware's. If we want to establish new application on top of datacenter, we need to buy another high cost scaling hardware's [4].

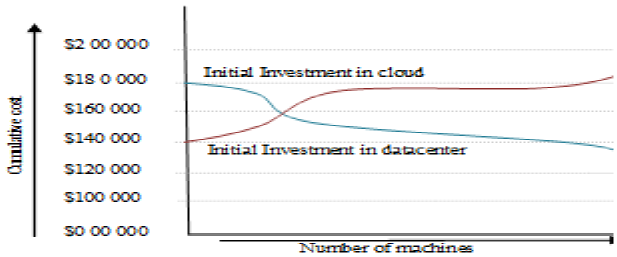


Figure 1: cost variation in cloud environment and datacenter

Figure 1 shows graphical representation of investment cost variation in cloud environment and datacenter. In X axis, the number machines are the number counts of VM or instance for cloud and direct computing hardware's for the datacenter. It is clear from the graph as number of machines increases cloud investment cost decrease, but for datacenter it gives an opposite result.

So, analysing figure 1 gives us a clear idea that moving to cloud is very cost effective to those who are going to invest money in building infrastructure. But when we decide to move on cloud infrastructure we should have proper knowledge of the number instances that we are providing and the cost of developing the cloud instance. It is observed that average cost of developing an instance of cloud infrastructure would be preferable only if:

Cost of cloud instances + P(cost of datacenter) < cost of datacenter

Where P(cost of datacenter) is the probability of utilization costt of datacenter and R.H.S must always lower than L.H.S.

III. CONSUMER PERSPECTIVE

While determining cloud benefits in respect of consumer we need to consider infrastructure based on consumed cloud resources Vs Dedicated datacenter. As cloud provide resources are like utility and charges are made as per use. So, our assumption is that cloud components or resources cost zero if components are not used and the costs are independent of time. Dedicated resources would always be charged the same even if they are used or not. We made elaborations of Jeo Weinman mathematics [2] with graphical representation and fourteen different scenarios as users generates. Findings of our research are the minimal condition (both pure and hybrid cloud) for moving towards cloud base infrastructure.

Problem with dedicated datacenter is that it suffers from over provisioning and under provisioning problem. With the help of elasticity, adding or removing of computing resources dynamically can be possible in cloud and this facility can sort out the over provisioning and under provisioning problem. Figure 2a) shows over provisioning problem whereas figure 7b) shows under provisioning problem [1].

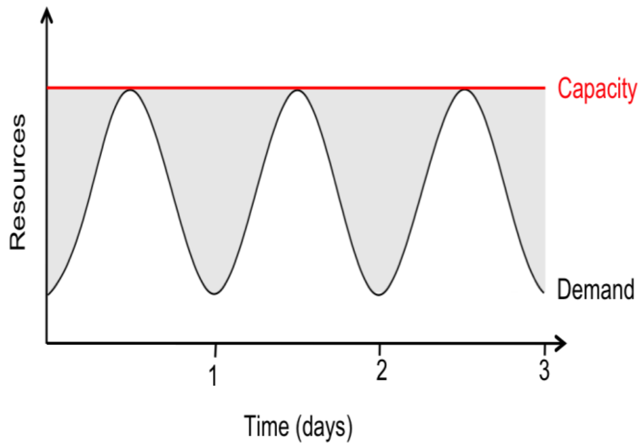


Figure 2a: Over Provisioning

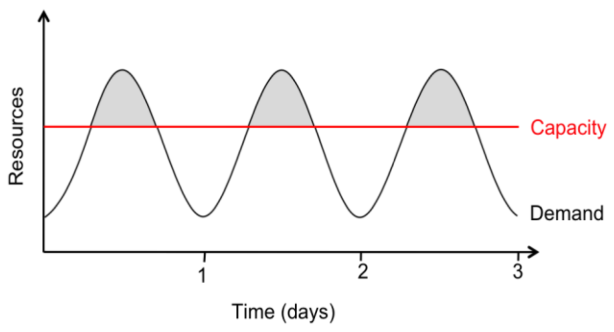


Figure 2a: Under Provisioning

In the given Resource-Time graph the red line denotes amount of fixed resources or highest amount of resources set in a datacenter to provide the facility to datacenter consumers. The shaded area of the graph in figure 2a) shows the unused portion of resources while in figure 2b) the shaded part represents the resources that the fixed capacity of a datacenter failed to serve.

We stated above that the cost of the services is independent of the time of request and elasticity in the resources which are available in cloud environment, then the graph plotting of demand-time can be observed to be monotonically increasing decreasing and is given in 2c).

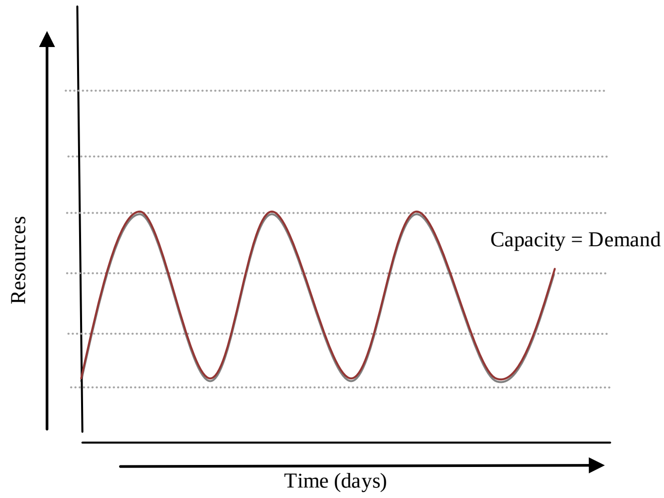


Figure 2a: Capacity of resources and Demand of resources are equal

Scaling facility of cloud component causes cloud base infrastructure capacity based on user demand. So capacity in cloud based infrastructure is also dynamic and equals to demand. As in figure 2c red line curve for capacity and black curve for demand are moving along the same path. This is done so as to able to solve the case scenarios presented below in an easier fashion. In derivation of scenarios first 6 cases (case 1 to case 2) are compared between pure cloud and datacenter. Case 7 is the minimal condition to move towards cloud and Case 8 is the comparison of datacenter and pure cloud using minimal condition. Case 9 describes hybrid cloud cost when demand is non linear and Case 10 finds the minimum resources which should be assigned in the hybrid cloud. Case 11 is the minimal condition of hybrid cloud with non linear demand. Case 12 describes hybrid cloud cost when demand is linear and Case 13 finds the minimum resources which should be assigned in the hybrid cloud. Case 14 is the minimal condition of hybrid cloud with linear demand.

Let the varying Demand Δ, be a function of time, i.e Δ(t) is the function determining the demand at any time t. And let μ be the average demand. By average demand, we mean, the ratio of total demand and the total time. Let the peak demand be represented by π.

Therefore, $\pi >= \mu$.

Let C be the cost of the dedicated service on hourly basis and ξ be a constant determined by the ratio between cloud services and dedicated services per hour. If the cloud services cost $3/ hr and dedicated resource cost $2/ hr, then ξ would be equal to 1.5.

Let us consider a time interval T, for which a hosting service is required.

This implies 0<=t<=T.

From our previous assumptions, we derive the following:

To serve the demand Δ(t) varying with time and with a peak value π and an average μ, the cost for hosting a dedicated service would be Π.C.T. And the cost for the cloud services is

$\sum^{T}_{i=0} \xi . C . \Delta(t) = \xi . C . \sum^{T}_{i=0} \Delta(t) = \xi . C.\mu.T$.

Case 1: If ξ <1

Consider,

Cloud Services cost = ξ.C.μ.T

Dedicated services cost= Π.C.T

Let us determine demand is non-linear

So,

$\mu \leq \Pi$ and $\xi < 1$ is given.

Therefore, $\xi.C.\mu.T \leq \Pi.C.T$

We can say that cloud services are always cheaper than dedicated services if ξ<1 and demand is variable.

Case 2: If ξ <1

Consider,

Cloud Services cost = ξ.C.μ.T

Dedicated services cost= Π.C.T

Let us determine demand is linear than μ= Π. In such condition demand of resources does not give us the inequality that we require but the given condition provides us required inequality condition and thus we can determine that cloud service cost is cheaper than dedicated services cost.

So,

$\mu = \Pi$ and $\xi < 1$ is given.

Therefore, $\xi.C.\mu.T < \Pi.C.T$

We can say that cloud services are always cheaper than dedicated services if ξ<1 and demand is variable.

Case 3: Now if **ξ =** 1 than:

Consider,

Cloud Services cost = ξ.C.μ.T

Dedicated services cost= Π.C.T

Let us determine demand is non-variable

So,

$\mu \leq \Pi$ and $\xi = 1$ is given.

Therefore, $\xi.C.\mu.T \leq \Pi.C.T$

So cloud services cost is cheaper than dedicated resources.

Case 4: Again if **ξ =** 1 than:

Consider,

Cloud Services cost = ξ.C.μ.T

Dedicated services cost= Π.C.T

Let us determine demand is linear

So,

$\mu = \Pi$ and $\xi = 1$ is given.

Therefore, $\xi.C.\mu.T = \Pi.C.T$

So cloud services cost is equal to dedicated resources cost.

Form the above Case 3 and Case 4 we can conclude ourselves that when ξ =1 then the cloud services cost is cheaper than dedicated services cost only when demand of resources is variable. If there is flat amount of demand than use of cloud services or dedicated services are the same thing.

Case 5: If ξ >1,

As we know

Cloud services cost = ξ. C.μ.T

Dedicated services cost = Π.C.T

Let us determine demand is non-linear. Because of savings resources when resources are not in use, even if **ξ > 1** cloud services cost produces less amount in compare to dedicated resources cost.

So,

$\mu \leq \Pi$ and $\xi > 1$ is given.

Therefore, $\xi.C.\mu.T \leq \Pi.C.T$

Therefore cloud service cost is cheaper than dedicated services cost

Case 6: Again if ξ >1,

As we know

Cloud services cost = ξ. C.μ.T

Dedicated services cost = Π.C.T

Let us determine demand is linear. Since there is no variation in demand and **ξ > 1** so cloud services cost produces greater amount in compare to dedicated resources cost.

So,

$\mu = \Pi$ and $\xi > 1$ is given.

Therefore, $\xi.C.\mu.T \geq \Pi.C.T$

Therefore cloud service cost is greater than dedicated services cost. But such scenario is very rare.

Case 7: After studying above six cases we can say that cloud cost is cheaper than dedicated service cost. But case 4 produces both the cost are equal and case 6 produces cloud cost greater than dedicated services cost. Case 5 is based on cloud definition only. These conditions somewhat fails to produce cloud cost to be cheaper so we need proper conditions so that cloud cost always produce less amount money.

Now if cloud service cost is cheaper than the dedicated service, than must be:

$$\xi.C.\mu.T \leq \Pi.C.T$$

$\xi . \mu \leq \Pi$

$\xi \leq \Pi / \mu$

Again condition 1: demand is linear than must be $\mu = \Pi$

Than $\xi \leq 1$

And condition 2: demand is non-linear than must be $\mu \leq \Pi$

Than $\xi \leq \Pi / \mu$

So, these are the conditions for that cloud services cost must be cheaper than dedicated services cost. So, if the scenario described in Case 4 occur than we may use any service (cloud or dedicated) and if the Case 6 occur than it is better to use dedicated services. And for Case 5, it must be recomputed with condition $1 < \xi \leq \Pi / \mu$

Case 8: If $\xi \leq \Pi / \mu$

As we know

Cloud services cost = ξ. C.μ.T

Dedicated services cost = Π.C.T

Demand is variable and is given $\xi \leq \Pi / \mu$

Now, multiply above inequality with C.μ.T we get

$\xi . C.\mu.T \leq \Pi.C.T$

It produces cloud service cost cheaper than dedicated service cost.

These eight scenarios give idea about cost estimation when we are using complete cloud base application. Next few cases we will see about cost estimation when hybrid cloud used in any industry.

Case 9: Consider **Δ(t)** is variable and non-linear demand, τ be the time during which the cloud services would be used over the dedicated services in a hybrid environment. Π is the peak demand and η is the demand handled by the cloud. Since, **Δ(t)** is variable demand, hence this demand is maintained by η amount of resources for the τ period of time. We assume that η amount of resources is divided by dη number of slots and time τ is divided by dτ number of slots. So **Δ(t)** must be

$$\mathbf{\Delta(t)} = (\Pi - \int^{\eta}_{0} d\eta) + \int^{\eta}_{0} \int^{\tau}_{0} d\eta.d\tau$$

Let us take two different views of variable and non-linear demands which are shown in figure 3a and figure 3b. These graphs may vary with different scenario of non-linear demand.

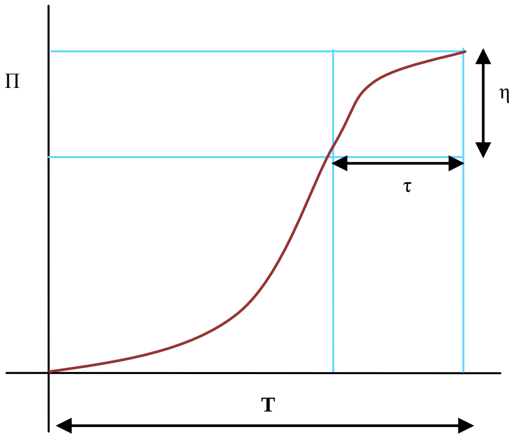


Figure 3a: example of non-linear demand

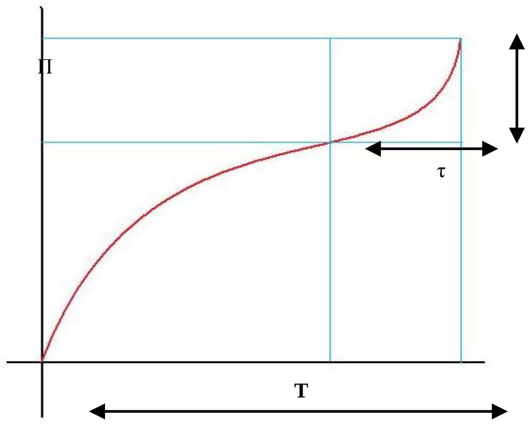


Figure 3a: example of non-linear demand

Then the cost of hybrid solution is:

$$(\Pi - \int^{\eta}_{0} d\eta).C.T + \xi.C \int^{\eta}_{0} \int^{\tau}_{0} d\eta.d\tau$$
$$= (\Pi - \eta).C.T + \xi.C \int^{\eta}_{0} \int^{\tau}_{0} d\eta.d\tau$$

$\int^{\eta}_{0} \int^{\tau}_{0} d\eta.d\tau$ represents the area of demand.

Case 10: If we are using hybrid solution, than the most important factor is to determine the amount of resources which should be put in the cloud. Let us determine the value of η with help of Case 9.

We know (from the case 9 above) that the total cost in a hybrid environment is equal to:

$$= (\Pi - \eta).C.T + \xi.C \int^{\eta}_{0} \int^{\tau}_{0} d\eta.d\tau$$

From the diagram using similarity of triangles,

$$\Pi / T = \eta / \tau$$

$\tau = (\eta.T)/ \Pi$

And **Δ(t)** = $\int^{\eta}_{0} \int^{\tau}_{0} d\eta.d\tau$ represents the area of demand

Substituting in the above equation $(\Pi - \eta).C.T + \xi.C \int^{\eta}_{0} \int^{\tau}_{0} d\eta.d\tau$

We get

$$(\Pi - \eta).C.T + \xi.C.\ \eta \int^{\tau}_{0} d\tau$$
$$(\Pi - \eta).C.T + \xi.C.\eta.\tau$$

putting value $\tau = (\eta.T)/ \Pi$,

$$(\Pi - \eta).C.T + \xi . C.\eta.(\eta.T)/ \Pi$$

Differentiating the above equation with respect to η,

we get

$$d/d\eta(\ (\Pi - \eta).C.T + \xi . C.\ \eta . (\eta.T)/ \Pi) = 0$$

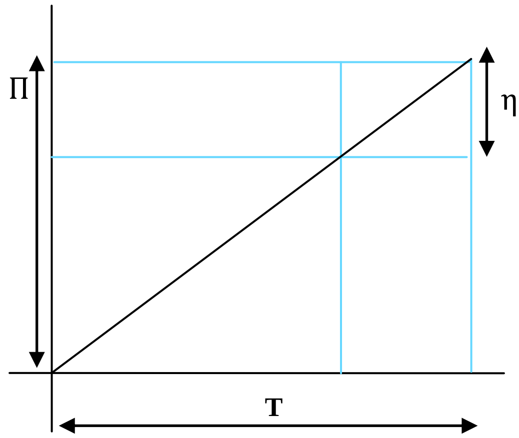
$\eta = ½ .(\Pi / \xi)$

Case 11) Now it's time to determine the value of ξ for which hybrid services will be cheaper. We know that hybrid services cost (case 9) is $(\Pi - \eta).C.T + \xi.C \int^{\eta}_{0} \int^{\tau}_{0} d\eta.d\tau$ so we need to proof, $\xi.C \int^{\eta}_{0} \int^{\tau}_{0} d\eta.d\tau$ amount of cost must be less than η.C.T (η portion is dedicated)

The condition for making hybrid services cheaper

$$\xi.C \int^{\eta}_{0} \int^{\tau}_{0} d\eta.d\tau < \eta.C.T$$
$$\xi.C.\eta.\tau < \eta.C.T$$
$$\text{i.e} \quad \xi < T/ \tau$$

Case 12)



Consider **Δ(t)** is variable and linear demand, τ be the time during which the cloud services would be used over the dedicated services in a hybrid environment. Π is the peak demand and η is the demand handled by the cloud. Since, **Δ(t)** is variable demand and this much of demand is maintain by η amount of resources for the τ period of time. We assume that η amount of resources is divided by dη number of slots and time τ is divided by dτ number of slots. So **Δ(t)** must be

$$\mathbf{\Delta(t)} = (\Pi - \int^{\eta}_{0} d\eta) + \int^{\eta}_{0} \int^{\tau}_{0} d\eta.d\tau$$

Then the cost of hybrid solution is:

$$(\Pi - \int^{\eta}_0 d\eta).C.T + \xi.C \int^{\eta}_0 \int^{\tau}_0 d\eta.d\tau$$
$$= (\Pi - \eta).C.T + \xi.C \int^{\eta}_0 \int^{\tau}_0 d\eta.d\tau$$

$\int^{\eta}_0 \int^{\tau}_0 d\eta.d\tau$ represents the area of demand.As demand is linear it represents the area of triangle. So $\mathbf{\Delta(t)} = ½\ \eta.\tau$

Case 13) Let us determine the value of η with help of Case 12.

We know (from the case 12 above) that the total cost in a hybrid environment is equal to:

$$= (\Pi - \eta).C.T + \xi.C\ ½\ \eta.\tau$$
$$= (\Pi - \eta).C.T + ½\ \xi.C\ .\ \eta.\tau$$

From the diagram using similarity of triangles,

$$\Pi / T = \eta / \tau$$

$$\tau = (\eta.T)/ \Pi$$

Substituting in the above equation $(\Pi - \eta).C.T + ½\ \xi.C\ .\ \eta.\tau$ and putting value $\tau = (\eta.T)/ \Pi$

We get

$$(\Pi - \eta).C.T + ½.\xi.C.\eta.(\eta.T)/ \Pi$$

Differentiating the above equation with respect to η,

We get

$$d/d\eta(\ (\Pi - \eta).C.T + ½.\xi\ .\ C.\ \eta\ .\ (\eta.T)/ \Pi) = 0$$

$$\eta = \Pi / \xi$$

Case 14) Now it's time to determine the value of ξ for which hybrid services will be cheaper. We know that hybrid services cost (case 12) is $(\Pi - \eta).C.T + ½\ \xi.C\ .\ \eta.\tau$ so we need to proof, $½\ \xi.C.\eta.\tau$ amount of cost must be less than $\eta.C.T$ (η portion is dedicated)

The condition for making hybrid services cheaper

$$½\ \xi.C.\eta.\tau < \eta.C.T$$

i.e $\xi < 2.T/ \tau$

After studying above scenarios we can determine when and which cloud computing is relevant for any IT industry. These analyses almost describe all the criteria for determining cloud environment (pure cloud, pure dedicated resources or hybrid resources) which may cost optimal.

IV. CONCLUSION

The basic definition of cost estimation of cloud computing environment is provided here to make industry people aware about investments in each phase of development and when to move to pure cloud, pure dedicated resources or hybrid of these. The description given above would help estimate the cost of resources in both ways: from a cloud provider point of view or cloud consumer point of view. From the cloud provider point of view, the construction of very large datacenters at low cost sites using commodity computing, data storage, networking and then the possibility of selling those resources on a pay-as-you-go model well below the costs of many medium-sized datacenters while making a profit by statistically multiplexing among a large group of customers. From the consumer point of view they can use any services like a software, they don't need to bother maintaining hardware's and for over provisioning or under provisioning problem. All these cost estimations made here are fully based on our proposed architecture; it may vary with different architecture and the topology of internal infrastructure. This basic questions-answer would help researchers who are new to cloud computing. Hopefully, this will help in basic understanding of cloud computing environment and we will move on further with this new technology.

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