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Cloud Computing : Economics Tutorial

Prof. Soumya K Ghosh

Department of Computer Science and Engineering

IIT KHARAGPUR

Cloud Properties: Economic Viewpoint

- **C**ommon Infrastructure
  - pooled, standardized resources, with benefits generated by statistical multiplexing.
- **L**ocation-independence
  - ubiquitous availability meeting performance requirements, with benefits deriving from latency reduction and user experience enhancement.
- **O**nline connectivity
  - an enabler of other attributes ensuring service access. Costs and performance impacts of network architectures can be quantified using traditional methods.

Cloud Properties: Economic Viewpoint *(contd…)*

- **U**tility pricing
  - usage-sensitive or pay-per-use pricing, with benefits applying in environments with variable demand levels.
- on-**D**emand Resource**s**
  - scalable, elastic resources provisioned and de-provisioned without delay or costs associated with change.

Utility Pricing in Detail

D(t)	demand for resources 0<t<T
P	max (D(t)) : Peak Demand
A	Avg (D(t)) : Average Demand
B	Baseline (owned) unit cost *[B_T : Total Baseline Cost]*
C	Cloud unit cost *[C_T : Total Cloud Cost]*
U (=C/B)	Utility Premium *[For rental car example, U=4.5]*

$C_T = \int_0^T U \times B \times D(t)dt = A \times U \times B \times T$

$B_T = P \times B \times T$

- Because the baseline should handle peak demand

When is cloud cheaper than owning?

$C_T < B_T \rightarrow A \times U \times B \times T < P \times B \times T$

$\rightarrow U < \frac{P}{A}$

- When utility premium is less than ratio of peak demand to Average demand

Utility Pricing in Real World

- In practice demands are often highly spiky
  - News stories, marketing promotions, product launches, Internet flash floods, Tax season, Christmas shopping, etc.
- Often a hybrid model is the best
  - You own a car for daily commute, and rent a car when traveling or when you need a van to move
  - Key factor is again the ratio of peak to average demand
  - But we should also consider other costs
    - Network cost (both fixed costs and usage costs)
    - Interoperability overhead
    - Consider Reliability, accessibility

Value of on-Demand Services

- Simple Problem: When owning your resources, you will pay a penalty whenever your resources do not match the instantaneous demand
    I. Either pay for unused resources, or suffer the penalty of missing service delivery

D(t) – Instantaneous Demand at time t

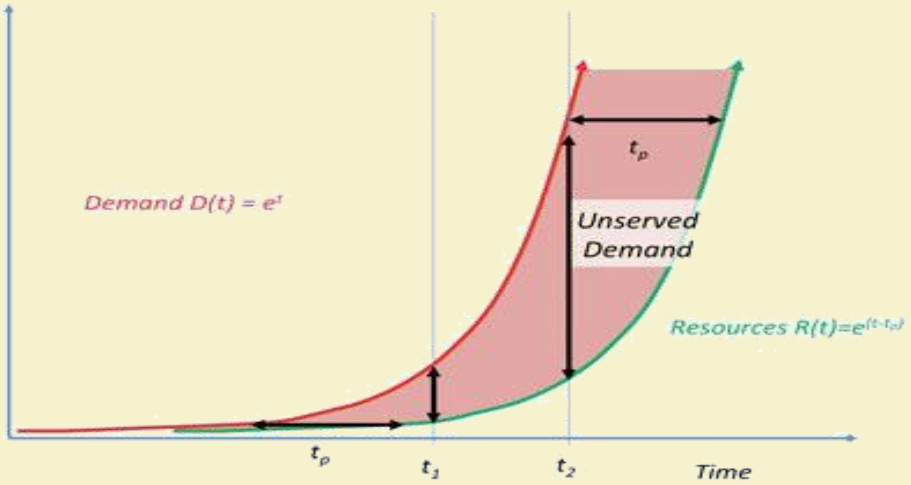
R(t) – Resources at time t

$$\text{Penalty Cost} \alpha \int |D(t) - R(t)| dt$$

- *If demand is flat, penalty = 0*
- *If demand is linear periodic provisioning is acceptable*

Penalty Costs for Exponential Demand

- Penalty cost $\propto \int |D(t) - R(t)|dt$
- If demand is exponential ($D(t)=e^t$), any fixed provisioning interval (t_p) according to the current demands will fall exponentially behind
- $R(t) = e^{t-t_p}$
- $D(t) - R(t) = e^t - e^{t-t_p} = e^t(1 - e^{t_p}) = k_1 e^t$
- Penalty cost $\propto c.k_1 e^t$



Exponential Growth with Continuous Monitoring And Non-Zero Provisioning Interval

Assignment 1

Consider the peak computing demand for an organization is 120 units. The demand as a function of time can be expressed as:

$$D(t) = \begin{cases} 50\sin(t), & 0 \le t < {}^{\pi}/_{2} \\ 20\sin(t), & {}^{\pi}/_{2} \le t < \pi \end{cases}$$

The resource provisioned by the cloud to satisfy current demand at time t is given as:

$$R(t) = D(t) + \delta.\left(\frac{dD(t)}{dt}\right)$$

where, δ is the delay in provisioning the extra computing recourse on demand

The cost to provision unit cloud resource for unit time is 0.9 units.

Calculate the penalty.

[Assume the delay in provisioning is ${}^{\pi}/_{12}$ time units and minimum demand is 0]

(Penalty: Either pay for unused resource or missing service delivery)

Assignment 2

Consider that the peak computing demand for an organization is ***100 units***.
The demand as a function of time can be expressed as

$$D(t) = 50(1 + e^{-t})$$

Baseline (owned) unit cost is ***120*** and cloud unit cost is ***200***.

In this situation is cloud cheaper than owning for a period of ***100*** time units?

Assignment 3

A company X needs to support a spike in demand when it becomes popular, followed potentially by a reduction once some of the visitors turn away. The company has two options to satisfy the requirements which are given in the following table:

Expenditures	In-house server (INR)	Cloud server
Purchase cost	6,00,000	-
Number of CPU cores	12	8
Cost/hour (over three year span)	-	42
Efficiency	40%	80%
Power and cooling (cost/hour)	22	-
Management cost (cost/hour)	6	1

- Calculate the price of a core-hour on in-house server and cloud server.
- Find the cost/effective-hour for both the options.
- Calculate the ratio of the total cost/effective-hour for in-house to cloud deployment.
- If the efficiency of in-house server is increased to 70%, which deployment will have now better total cost/effective-hour?

Thank You!