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Content Distribution Scheme for Efficient and Interactive Video Streaming Using Cloud

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Abstract: **Now days, more number of users are using internet because of media streaming application. With the arrival of these applications, it is financially incapable to give promising bandwidth. Cloud computing gives an stretchable infrastructure so that it must reach the customers demand. Media content providers will assign some charges for reserved resource in the cloud. Some providers using a pricing scheme resources reserved in the cloud basis of non-linear time discount rate (Eg: Amazon EC2). Such a pricing model gives discount is on non-linear method for reserved resources in the cloud. In this case, an open challenge is to choose the right quantity to reserve the resource in the cloud and the time to reserve the resource in order to reduce the financial cost. We investigate a simple algorithm for reserving resource that increases the discounted rates in the price, while guaranteed that in cloud we are reserving enough resources. Based on the prediction, we are designing algorithms that decrease the risk of producing wrong decisions for reserving resource. Our algorithm minimizes the monetary cost for allocating resources in the cloud as compared to other ordinary schemes and we can see that in our simulations and numerical evaluations.**

Keywords: **Cloud Computing, Streaming, Non-linear Scheme, Network economics.**

1. INTRODUCTION

Now a days, more number of users are using internet because of media streaming application[1]. This large number of requirement cause a heavy load on data centers at media providers means in order to maintain a required bandwidth[2]. A difficulty is to supplying higher quality for more number of users. In this paper, we investigate a way that reduce the charge on media providers of streaming. If we store large number of resources in the cloud to reach the required demand, when users use only 40% of the capacity[3], then more number of volume will be useless most of the time, which is extremely incapable and wasteful[4][5]. Our main contribution is to Allocate the resource based on prediction that reduces the financial cost of reserving resource in the cloud, while promising that in cloud enough resources are reserved. We solving the problem based on future demand prediction. We design our algorithm to solve this issue. The proposed algorithm reduces the financial cost for allocating resource in cloud when compared other ordinary schemes and this will shown by our numerical results.

2. RELATED WORK

In literature, the demand of the user and the utilization of CPU is widely analyze [6]. Y. Lee et al. proposed a method called prediction called Radial Basis Function(RBF) networks to forecast the demand request by the user in web applications[7]. The demand activities of a user in P2P streaming using non-stationary time series model was predicted in [8]. Time series forecast by analyzing the wavelet method was studied in [9]. The scope of this paper is to forecast the transmitting bandwidth request. In this effort, we investigate the problem by including a given function of forecasting of demand for bandwidth streaming. To the best of our information none of the existing papers has formulate the minimizing the cost for media providers in terms of financial expenses.

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3. SYSTEM MODEL AND PROBLEM FORMULATION

The model that we explain in this paper for streaming media using cloud computing consists of the components (Fig.1)

- Prediction demand module, which forecast the request of streaming for each channel during the period of time in future.
- Broker, one who responsible for both distribute the right amount of resources in the cloud and the time reserve those resources in the cloud. In order to store the resources Broker implements our algorithm to make the judgment.
- Provider gives the resources and gives the traffic exactly or directly to viewers.

In this paper, the cloud provider assign some charges media providers resources reserved in the cloud to some period of time. In this case, in order to reserve the resources in the cloud, cloud provider gives more discounts for longer time.

We notice the following problem: How the media provider stores the enough resources in the cloud based on forecasting the future demand, so that no wastage should occur. Also the quality of the video should maintain with some level of confidence (η).

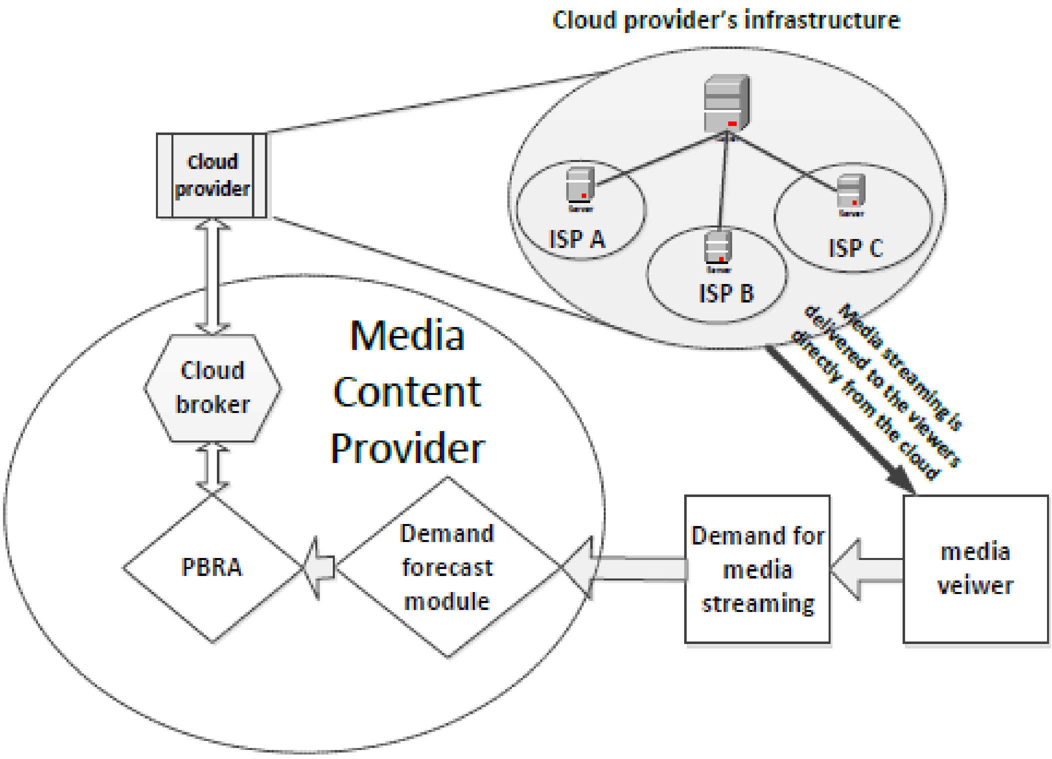

Fig 1: System model

Consider a video channel offered by a media provider. Let Z(t) be the actual demand for streaming capacity of the video channel at an instant of time t, It has been shown that Z(t) is a random process that follows a log-normal distribution with mean G[Z(t)] and variance (σ) characterized in [8] and [10], respectively.

$$\text{Probability } (Z(t) \leq \text{Alloc}(t)) \geq \eta; \qquad (1)$$

Because Z(t) is a random process, and the amount of bandwidth to be streaming which reserves in the cloud at any instant of time t by Alloc(t). Where η is a level of confidence means(pre determined threshold). Note that Lower the η means lower in confidence. However, decreasing η decreasing the wastage of reserved bandwidth. So appropriate selection of η is needed. In this part, our job is to find the right amount of resource reserved and the time to reserve the resource in the cloud, so that cost for streaming the required bandwidth should minimized and it is shown in eq (1).

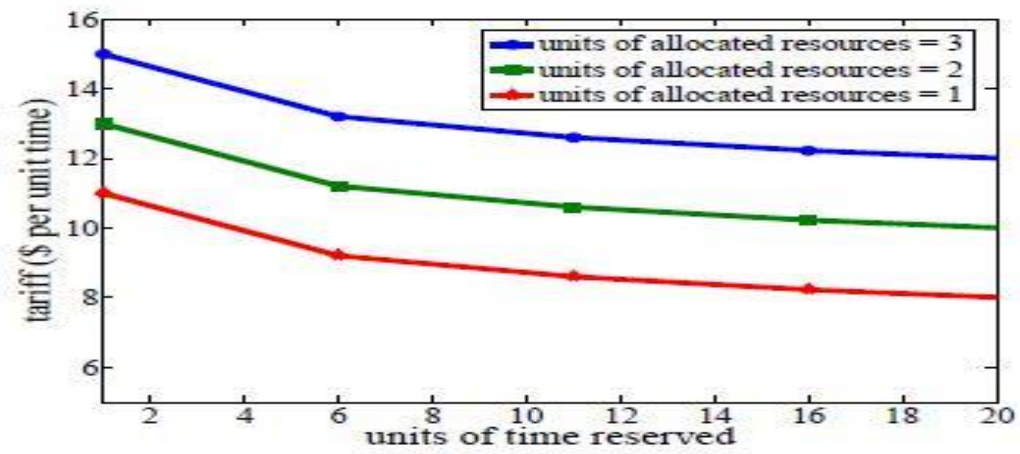

Fig 2: An example of rate for resource allocated and reservation time.

4. ALGORITHM DESIGN

In our analysis we are assuming some rules:

- Once we received a request from the media provider, without wasting any time we allocate a resource in the cloud, i.e immediately.
- In this we mainly concentrate on the bandwidth, and we must provide media to the viewers at that quality and the viewers located at different places and the way to maintain all these viewers are by having multiple data centers inside the network [5] [11] [12] placed at different locations.
- Once the viewer select the resource to reserve in the cloud, we cannot change or cancel that resource because that (prepaid) resource will be reserved.
- In cloud, rates are given in a table form, so we need minimum time to reserve the resource in the cloud.

We previously mentioned that we are concentrating on the algorithm which is easy to implement so that that should minimize the cost. Suppose if the media provider forecast the demand by the user for future time K using by the methods given in [11]-[14]. In each and every time slot the resources must reserved in the cloud by the media provider, and also the time and the resources over some period so that must reduce the cost(Fig 3).

We can call time slot as window , W-size of the window. Here, resource allocated in the cloud is constant but the real demand can change. The resources reserved in entire window j is storing enough resources that reach the forecast demand.

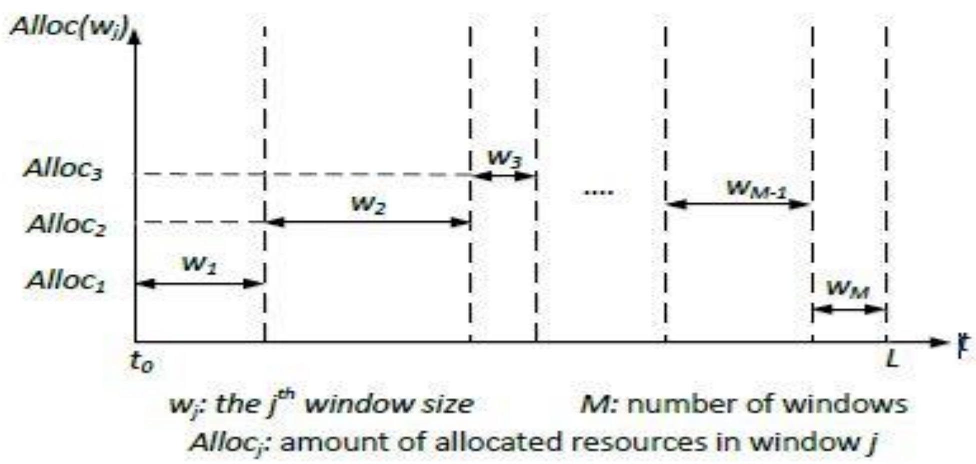

Fig 3: Forecast Based Resource Allocation Algorithm Design

We representing the resources reserved in the j^{th} window as $Alloc_j$. By doing this, there is a possibility of making wrong prediction so we are concentrating on reducing this wrong prediction by frequently updating the real forecast demand over period of time(Fig 1).

The cost for reserved resource while window j is calculated as

$Cost(w_j, Alloc_j) = tariff(w_j, Alloc_j) * w_j$ (2)

Where $tariff(w_j, Alloc_j)$ indicates the rate reserved for the resources for period of time charged by the cloud provider.

Hence, our algorithm is to reduce the $rate(w_j, Alloc_j)$ Vj,

Probability($Z(t) \leq Alloc(t)$) $\geq \eta$, V t ϵ Ҝ.

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we can calculate the minimum amount of resources required to reserved in any window j ($Alloc_j$) by answering the formula

$$\int_0^{Alloc_j} \frac{1}{x \cdot \sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{ln(x)-\mu_{max}}{\sigma}\right)^2} dx = \eta, \qquad (3)$$

where μ_{max} is the maximum value of the forecasting demand streaming while the window j.

Example: Finding the exact content of resources reserved in window j **and their time**

Consider the normalized forecasting streaming demand shown in Fig. 4 for a future period of time K = 12.

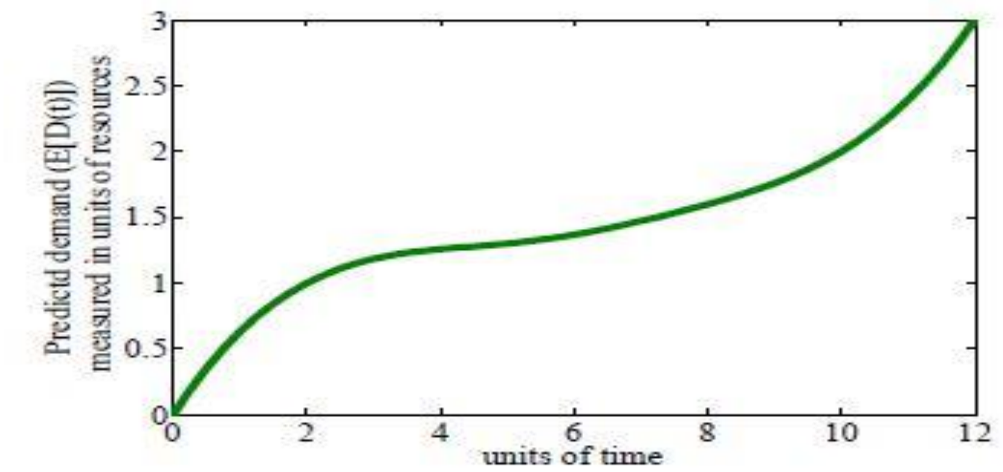

Fig: 4. An example of demand prediction over a future time K = 12.

Algorithms 1 Pseudo code for allocate size for a window and resource allocations in every window.

Given the predicted demand (G[Z(t)]) over a future time K,

Define:

w_h is a trial window size and w_{min} as the minimum reservation time.

To compute w **and** Alloc **for every window** j**, do**

$w_h \leftarrow 0$, {initial value}

$h \leftarrow 1$,{start iteration}

while $w_h \leq K$, **do**

$w_h = w_h + w_{min,}$ {trial window increments}

Compute $\mu_{maxh,}$

Compute $Alloc_h$ by solving eq (3),

X_h=tariff (w_h , $Alloc_h$) ,

h ← h+1,

end while

X_F = argmin(X_h V ħ),

Find h* corresponding to X_F

W_j^* ←w_{h*}

$Alloc_j^*$ ← $Alloc_{h*}$

j ← J+1.

From the table 1, we can see that the minimum value of cost rate X_h is when h* = 10 after evaluate our proposed algorithm.

TABLE 1
Example: Summary of results for iterations executed for window $j = 1$

iteration (h)	1	2	3	4	5	6	7	8	9	10	11	12
w_h	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0
μ_{max}	0.63	1.0	1.184	1.26	1.3	1.37	1.47	1.60	1.76	2.0	2.4	2.7
$Alloc_h$	1.0	1.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0
X_h = tariff($w_h, Alloc_h$)	11	10.85	12.25	12.0	11.75	11.50	11.28	11.06	10.84	10.62	12.65	12.43

5. HYBRID APPROACH FOR RESOURCE PROVISIONING

In this section, we have two types of plan according to the cloud provider: Reservation plan and on-demand plan. In the reservation plan media provider first reserve the resource in the cloud and once the user wants to use the media he must clear all the charges ie, prepaid. In on-demand plan, here media provider allocates the resource in the cloud upon needed it is like pay as you use.

In this section, an algorithm for this hybrid resource provisioning approach that gives more benefits for time discount offered in the reservation plan, since deleting any higher cost of resources reserved such that the total monetary cost of allocating resource in the cloud is reduced.

Algorithm 2 Pseudo code for allocating resource in the cloud using two resource provisioning plans

Define:

S is the set of all values of η gives best amount of resources allocated that reduces C_{hybrid},

For every window j**, do**

for every value η in the set S, **do**

h ← 1, {start iterations}

Run Algorithm 1 to calculate the correct size of window j (w_j^*) and the right amount of resource allocation ($Alloc_{RSVj}^*$) for this value of η using the reservation plan,

Compute $Alloc_{ODj} = \mu_{max} - Alloc_{RSVj}$, where μ_{max} is the maximum value of forecasting streaming demand

Compute X_h = tariff(RSV_j ; $Alloc_{RSVj}$) + tariff($Alloc_{ODj}$), h ← h+1,

end for

Y_F = argmin(X_h V ħ),

Find h* corresponding to Y_F ,

$\eta^* \leftarrow \eta_{h^*}$,

$Alloc^*_{RSVj} \leftarrow Alloc^{h^*}_{RSVj}$,

$Alloc^*_{ODj} \leftarrow Alloc^{h^*}_{ODj}$

6. PERFORMANCE EVALUATION

We calculate the performance of our algorithm proposed for the case when the cloud provider gives two streaming resource plans: the reservation and on-demand.

Evaluation of the algorithm (FBRA) proposed for reserving resources in the cloud

From figure 5 Performance vs. complexity, our proposed algorithm (FBRA) employs a trial window w_{try} with size taking values in multiplicative order of w_{min}, where w_{min} is the granularity for allocating resource in the cloud(means it must have minimum time to reserve the resource in the cloud).

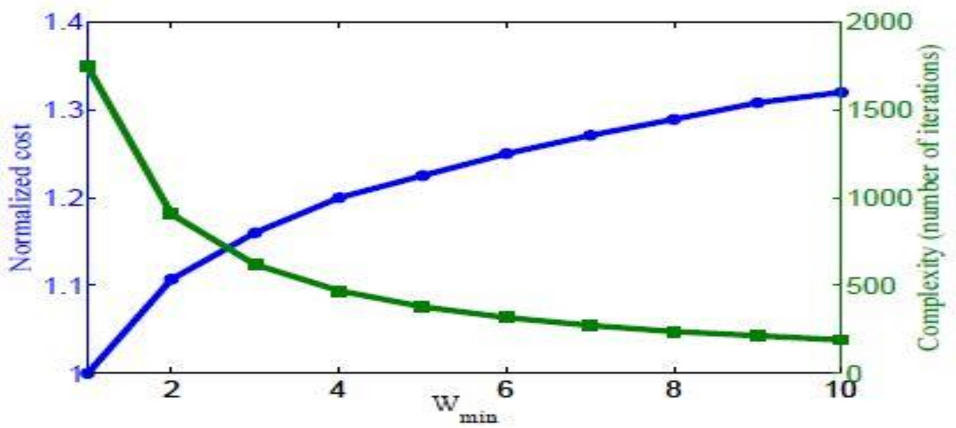

Fig 5: Performance vs Complexity of FBRA algorithm.

Comparison with other resource algorithms:

We calculate the performance of our FBRA algorithm vs two other resource schemes: Fixed-reserve-time, and Pay-as-you-go.

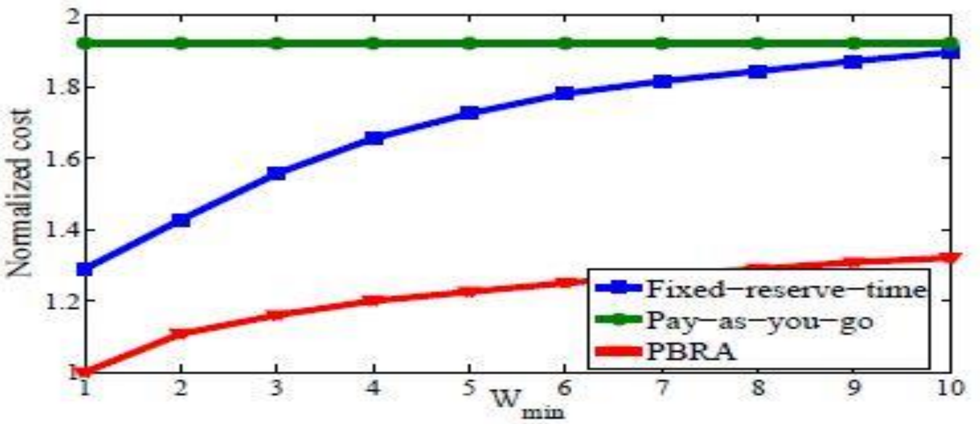

Fig 6: Comparing Performance

We calculated the total cost when using the above schemes for allocating resource in the cloud. To draw the comparison figure, we calculate the ratio of the complete cost for each value of w_{min} to the cost when using our FBRA algorithm with $w_{min} = 1$ in the Fig. 6.

7. CONCLUSION AND FUTURE WORK

This paper studies the problem for allocating resource in the cloud for media streaming applications. Here, we considered non-linear time-discount rate. We proposed the algorithm that sets both the amount of resources to be reserved in the cloud and the time to reserved that resource in the cloud. Our algorithm gives the discounted rates and promising that only enough resource is reserved in the cloud without any wastage. The results show that our algorithm adjust the trade-off between resources reserved on the cloud and resources allocated on-demand.

In future work, we are performing experimental measurements to characterize the streaming demand in the Internet and develop our own forecasting demand module. We shall also examine the case of multiple cloud providers and consider the market competition when allocating resources in the clouds.

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