Mitigating Latency by Setting the Priority in Network Bandwidth Allocation for Mobile Cloud Computing (MLNB)

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Abstract – Cloud computing is a new computing model which provides configurable computer resources to the users over internet based on user demand. Mobile computing is a technology through which multimedia data such as text, video, audio, animation and graphics can be transmitted via wireless enable devices without having fixed physical connection. Mobile cloud computing is a model by which users are able to build and deploy their applications using cloud resources. Cloudlet is a resource rich computer which is connected to the remote cloud always. Cloudlet is very close to the mobile users. When the cloudlet is not able to provide the resources to the user request, then the cloudlet redirects the user requests to the nearby cloudlet of a particular vicinity. In this proposed work, the available bandwidth is allocated to the user requests based on priority. The users are categorized into two types, namely, Business User and Residential User. The first priority goes to Business User rather than Residential User since Business User is paying more. Generally, Business Users are using more resources than Residential users. The Cloudlet Manager is introduced which acts as a resource manager. It allocates bandwidth to the user requests based on priority. A new algorithm called Mitigating Latency by Setting Priority in Network Bandwidth (MLNB) for Mobile Cloud Computing deals with allocation of bandwidth to the user requests in efficient manner by which latency is mitigated.

I INTRODUCTION

Cloud computing is not a new technology, but new computing model which provides configurable computer resources to the users based on their demand over internet. The benefits of cloud computing are self-service provisioning, elasticity, pay per use, cost savings, security, flexibility, increased collaboration, quality control, disaster recovery, loss prevention, automatic software updates, sustainability and so on. Mobile computing is a technology through which multimedia data such as text, video, audio, animation and graphics can be transmitted via wireless enable devices without having fixed physical connection. Mobile cloud computing is a model by which users are able to build and deploy their applications using cloud resources. Cloudlet is a resource rich computer which is connected to the remote cloud always. Cloudlet is very close to the mobile users. Mobile users are sending the requests to the cloudlet where requests are accessed and sends the response to the mobile users. If the cloudlet is not able to access the user requests due to insufficient of resources, then it forwards the requests to the other cloudlets of that vicinity where the user requests are accessed.

The users requests are categorized into two types, namely, business user requests and residential user requests. Priority mechanism is used in accessing user requests to mitigate the latency. The paper is organized as follows. The section I gives the introduction. The section II discusses the related work. The section III explains the proposed work. The section IV elaborates results and discussions and the section V elucidates the conclusion.

II RELATED WORKS

The related works are analyzed before proposing this MLNB algorithm. The following research works explain about allocation of bandwidth to the user requests in cloud computing.

Yiquan Kong [1] proposed that unfairness problem in allocating bandwidth is solved by using a method which uses the techniques which are fairness congestion control algorithm, Access Control List (ACL) and traffic policing and shaping. The method can rationally solve the problem after analyzing the reason of cloud computing bandwidth allocation unfairness. The inconsistency in allocating bandwidth of cloud computing is solved using non-adaptive UDP and TCP adaptive flow congestion methods. It facilitates end-to-end quality of service over the heterogeneous networks.
Akshay Badve et.al.[2] proposed that cloud computing provides configurable computing resources as a service over a network. Data center allocates cloud data to the users over a network based on predefined structure. Bandwidth allocation is one of the core areas of resource sharing in data centers. Performance of the cloud server is one of the core issues of the network. When number

of users are sending the requests to the same sever simultaneously, naturally the server performance is reduced significantly. So that new method has been proposed where rearranging the available bandwidth from inactive users to active users by using bandwidth latency technique in which latency allocation method is used.

Peda Gopi G.Krishna et.al.,[3] proposed that the residual bandwidth of passive users is used in allocating bandwidth to the users. User type is also considered. Bandwidth allocation algorithm is proposed for cloud computing.

Tushar T.[4] Hedaoo proposed that the cloud computing provides everything as a service to the users based on demand. Inconsistency in data sharing of cloud computing leads to network performance degradation of the data centers. Bandwidth allocation is very essential concept of resource sharing of data centers. Performance of the server is very significant in cloud computing. The number of user requests are hitting the server simultaneously for download which leads to decrease the system performance. So we present the solution for balance and improve the performance of the bandwidth, reallocating the bandwidth using the fair sharing and bandwidth mutual sharing techniques. Finally bandwidth is allocated dynamically to achieve better performance.

Abbas Bradai et.al.,[5] proposed that facilitates an effective layered video streaming method to the different types of users over various network conditions needs dynamic bandwidth allocation. The video stream is composed by hierarchical encoded sub-system which comprises base layer and enhancement layers. The video quality level to the terminal and network capabilities are adjusted where receivers use pull-based approach and various layers are subscribed. The bandwidth allocation method combined with an efficient scheduling mechanism is proposed to utilize the available bandwidth in well organized manner in enhancing Quality of Experience(QoE) of the end users. The main objective is to utilize the allocated bandwidth totally with respect to layers dependency of the stream and data blocks playback deadline. The proposed algorithm is compared with some extensive evaluations and other bandwidth allocation strategies for layered video streaming in using the allocation bandwidth fully.

III PROPOSED WORK

In this proposed work, the Cloudlet Manager is introduced. It is working as a resource manager of cloudlets of a particular vicinity. The Cloudlet Manager receives user requests and categorizes into Business User requests and Residential User requests. Since Business user requests are using more computing resources than Residential user requests. The Business users are paying more to the providers than Residential Users. So that, the Cloudlet Manager gives first priority to the Business User requests.

When the Cloudlet Manager receives more than one request from the Business User at a time, then the Cloudlet Manager allocates the bandwidth to the user requests based on operation type. The operations types are Read, Write and Other. The Cloudlet Manager gives first priority to the read operation, second priority to the write operation and third priority to the other operations in bandwidth allocation to the business user requests.

When the Cloudlet Manager receives more than one request from the Residential User simultaneously, then the Cloudlet Manager allocates the bandwidth to the user requests based on operation type. The operations types are Read, Write and Other. The Cloudlet Manager gives first priority to the read operation, second priority to the write operation and third priority to the other operations in bandwidth allocation to the residential user requests.

The Cloudlet Manager handles the user requests in an effective way by setting the priority. So that, the network latency is mitigated and cost is also minimized. Moreover, throughput is enhanced.

The proposed MLNB algorithm is given below:

1. *Compute B_{AV} as Total Available Bandwidth*
2. *Taking Number of Users ranging from U_1, U_2, ... U_n as Input*
3. *Allocate the B_{AV} to the requested users (U_i) based on the Priority order*
4. *Check the User Type and Operation Type when more than one request comes from the business user at a time*
    If (User==Business-User) && (Operation Type==Read)
        Priority '$P_1^{(U)}$' is assigned to Business User (BU)
    Else If (User==Business-User) && (Operation Type==Write)
        Priority '$P_2^{(U)}$' is assigned to Business User (BU)
    Else
        Priority '$P_3^{(U)}$' is assigned to Business User (BU)
    End If
5. *Check the User Type and Operation Type when more than one request comes from the residential user at a time*

    If (User==Residential-User) && (Operation Type==Read)

Priority '$P_1^{(U)}$' is assigned to Residential User (RU)
Else If (User==Residential-User) && (Operation Type==Write)
Priority '$P_2^{(U)}$' is assigned to Residential User (RU)
Else
Priority '$P_3^{(U)}$' is assigned to Residential User (RU)
End If

6. *Allocate the Bandwidth in Ascending Order $P_1^{(U)}$ $P_1^{(O)}$, $P_2^{(U)}$ $P_2^{(O)}$ ... $P_2^{(U)}$ $P_2^{(O)}$*
7. *Repeat the Steps 3 to 6 until the B_{AV} gets assigned to the users.*

IV. RESULTS AND DISCUSSIONS

The given network cases explain that how the user requests are being executed. Traditionally, the mobile requests are executed sequentially. The users are categorized into two types, namely, Business user and Residential user. The existing case and proposed case are given. By giving first priority to the Business user, the Cloudlet Manager is able to execute the user requests in efficient manner. Hence, latency in executing user requests is mitigated.

Network Case – I

In this case, 5 Residential Users and 5 Business User are taken. Network scenario is set up by having 10 users which includes both Business and Residential Users for 3 different time slots. The Residential Users are RU_1, RU_2, RU_3, RU_4, RU_5. The Business Users are BU_1, BU_2, BU_3, BU_4,BU_5. Each slot receives 15Kbps bandwidth in five consecutive locations. RU_2, RU_4 and RU_5 users are initiating two requests and remaining users RU_1 and RU_3 initiate only one request. Each slot takes one milli second (ms).

Existing Algorithm (Without Priority)

Table 1: Bandwidth Allocation to the Business User and Residential User without Priority

RU_1	RU_2	BU_1	BU_2	RU_3
RU_4	BU_3	RU_5	BU_4	BU_2
RU_4	RU_2	BU_3	RU_5	BU_5

RU_1 = 0ms, RU_2 = 1ms, RU_3 = 4ms, RU_4 = 5ms and RU_5 = 6ms. Totally, 0+1+4+5+6= **16ms**
BU_1 = 2ms, BU_2 = 3ms, BU_3 = 6ms, BU_4 = 8ms and BU_5 = 14ms. Totally, 2+3+6+8+14 **= 33ms**

Here, user requests are executed first come first serve basis since no priority is given to the users. Even though Business users are paying more and using more resources than Residential users, Business Users are waiting for their requests to be executed. It leads to lower profit and system performance. The Network latency is also increased. In order to avoid this situation, Business User based priority is developed which mitigates the latency and increases the subscribers count gradually.

MLNB Algorithm (Priority)

Table 2: Bandwidth Allocation to the Business User and Residential User with Priority

BU_1	BU_2	BU_4	BU_3	BU_5
BU_2	BU_3	RU_1	RU_4	RU_2
RU_2	RU_3	RU_5	RU_5	RU_4

RU_1 = 7ms, RU_2 = 9ms, RU_3 = 11ms, RU_4 = 13ms, RU_5 = 12ms. Totally, 7+9+11+13+12= **52ms**
BU_1 = 0ms, BU_2 = 4ms, BU_3 = 5ms, BU_4 = 2ms and BU_5 = 4ms. Totally 0+4+5+2+4 = **15ms**

In this proposed work, Business users are getting high priority than Residential users in network bandwidth allocation. From the above case, execution time of user requests is mitigated. Priority based proposed algorithm mitigates the latency from 33ms to 15ms which increases the speed and creates higher profit in terms of cost. So, it produces better results than existing algorithm.

Network Case – II

In this case, 10 Residential Users and 10 Business User are taken. Network scenario is set up by having 20 users which includes both Business and Residential Users for 5 different time slots. The Residential Users are RU_1, RU_2……RU_{10}. The Business Users are BU_1, BU_2…..BU_{10}. Each slot receives 15Kbps bandwidth in ten consecutive locations. RU_2, and RU_5 users are initiating two requests and remaining users RU_1, RU_3, RU_4, RU_6, RU_7, RU_8, RU_9 and RU_{10} initiate only one request. Each slot takes one milli second (ms).

Existing Algorithm (Without Priority)

Table 3: Bandwidth Allocation to the Business User and Residential User without Priority

BU_3	BU_1	BU_2	BU_6	BU_4
BU_5	BU_3	BU_6	BU_8	BU_7
BU_8	BU_{10}	BU_9	RU_2	RU_3
RU_2	RU_4	RU_6	RU_9	RU_5
RU_7	RU_8	RU_5	RU_{10}	RU_1

RU_1 = 1ms, RU_2 = 6ms, RU_3 = 2ms, RU_4 = 4ms, RU_5 = 9ms, RU_6 = 9ms, RU_7 = 14ms, RU_8 = 6ms, RU_9 = 12ms and RU_{10} = 11ms.

Totally, 1+6+2+4+9+9+14+6+12+11= **74ms**

BU_1 = 0ms, BU_2 = 20ms, BU_3 = 14ms, BU_4 = 18ms, BU_5 = 17ms, BU_6 = 23ms, BU_7 = 21ms, BU_8 = 22ms, BU_9 = 22ms and BU_{10} = 19ms. Totally, 0+20+14+18+17+23+21+22+22+19= **176ms**

MLNB Algorithm (Priority)

Table 4: Bandwidth Allocation to the Business User and Residential User with Priority

BU_1	RU_1	RU_3	RU_5	RU_4
RU_2	RU_8	RU_2	BU_3	RU_6
RU_5	RU_{10}	RU_9	BU_8	RU_7
BU_3	BU_6	BU_5	BU_4	BU_{10}
BU_2	BU_7	BU_9	BU_8	BU_6

RU_1 = 24ms, RU_2 = 14ms, RU_3 = 14ms, RU_4 = 16ms, RU_5 = 21ms, RU_6 = 17ms, RU_7 = 20ms, RU_8 = 21ms, RU_9 = 18ms and RU_{10} = 23ms.
Totally,
24+14+14+16+21+17+20+21+18+23= **188ms**

BU_1 = 1ms, BU_2 = 2ms, BU_3 = 5ms, BU_4 = 4ms, BU_5 = 5ms, BU_6 = 6ms, BU_7 = 9ms, BU_8 = 9ms, BU_9 = 12ms and BU_{10} = 11ms.

Totally, 1+2+5+4+5+6+9+9+12+11= **64ms**

In both Network cases (1&2) gives improved results in latency parameter and comparison graph is shown in Figure 1.

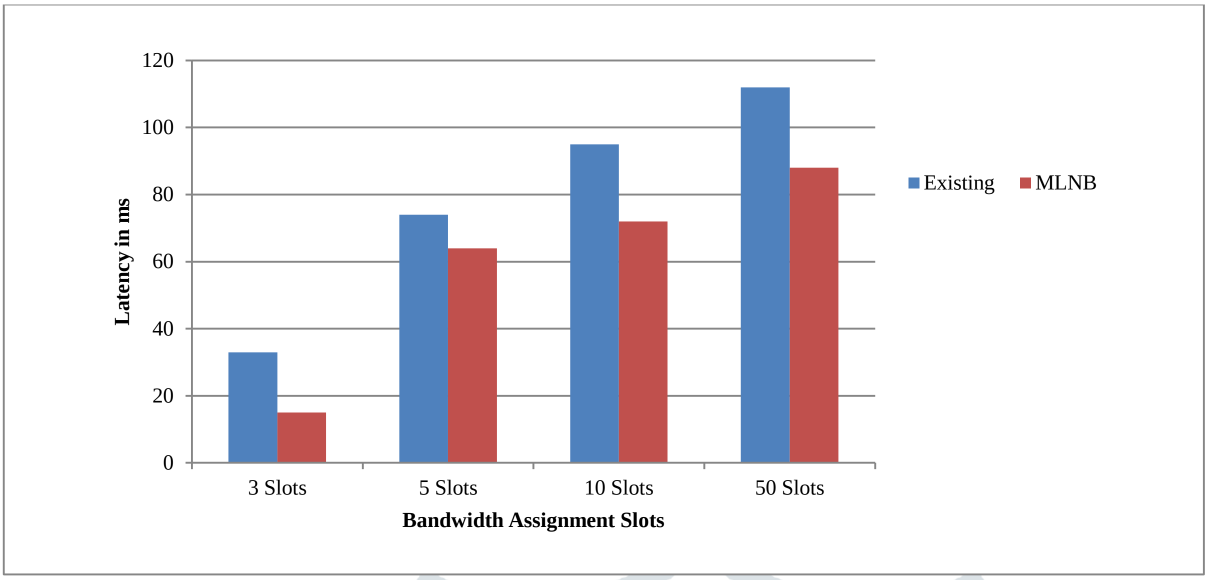

Figure 1. Bandwidth Allocation vs. Latency Comparison Graph

V. CONCLUSION

In this paper, a new algorithm called MLNB is proposed to mitigate latency in Cloudlet by setting the priority in allocating available bandwidth to the user requests using Cloudlet Manager. Cloudlets Manager is effectively used for resource allocation. The mobile users are categorized into two types, namely, Business user and Residential user. Since Business user is using more resource and paying more, the Cloudlet Manager give the first priority to Business User than Residential user. Priority based bandwidth allocation is done effectively by adding priority for each demand or request generated by the mobile user. Response Rate (%) during resource access is also increased by this approach. When the Cloudlet Manager receives more than one user request from either Business user or Residential user at a time, the operation types such as Read, Write and Others is taken into account in bandwidth allocation. Even though, the proposed MLNB algorithm mitigates latency, the other parameter apart from bandwidth allocation is not measured. Here, Application is not partitioned for the user. By partitioning the application using interoperability technique, latency can be reduced by using Cloudlets.

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