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SERVICE BASED FAIR RESOURCE ALLOCATION MODEL (SbFRAM) IN WiMAX

[1]KHALID MAHMOOD AWAN, [2]ABDUL HANAN ABDULLAH, [3]KHALID HUSSAIN
[1,2,3]Department of Computer Science, Faculty of Computing, Universiti Teknologi Malaysia, 81310, Skudai Johor Malaysia
E-mail: {[1]makhalid2, [3]hkhalid2}@live.utm.my, [2]hanan@utm.my

ABSTRACT

Two broader categories of the services are introduced in the paradigm of WiMAX. In IEEE 802.16 standard has added these services and called them as Constant Bit Rate (CBR) and Variable Bit Rate (VBR). Both of these services designed for real time and non real time traffic. As per literature available there is a gap to provide additional resources to fulfill the required service class from the user. In this paper we propose a Service Based Fair Resource Allocation Model (SbFRAM), for evaluating the required service from Subscriber (SS) along with the channel condition. Our proposed model evaluates, for providing the required service to SS how much additional resource will be required. In this model we introduced Priority Queue Scheduling Methodology for providing additional resources as per channel condition. In this paper we made comparison with and without proposed model on both traffic, CBR and VBR. We experiment that our proposed model manages the user request by providing them extra resources as required for satisfaction. Their request handled in Priority Queue Scheduling based mechanism. Results shows, that we achieve improvement by providing the additional resource on fair scheduling basis. To achieve the required performance for fairness we have to compromise on delay.

Keywords: *Resource Allocation, SNR, CBR, VBR, Priority Queue*

1. INTRODUCTION

WiMAX is a 4G wireless network technology. This system is designed for the metropolitan area network. Wireless network are generally less efficient and unpredictable as compared to wired network. This is because resources in the wireless networks are always limited. Management of available resources is a critical issue [1]. To provide the quality of service in a wireless environment is major focus area in current research. To handle this challenge WiMAX provides strong contender for broadband wireless technology.In WiMAX when a new subscriber requests for the service a call admission control process is initiated. According to the procedure Base Station (BS) monitors existing resources for the provision of service for new users. Which ensures that the system have the enough resources to accommodate the services required to newly requesting user. Performance of the scheduling algorithms can satisfy the minimum level of QoS [2, 3].

Scheduling is a critical process for allocating shared resources [4]. The process involves allocating bandwidth among the contended users. Scheduling algorithms for a particular network need to be selected based on the type of service required by users in the network and its QoS requirements. For real time application such as video conferencing, voice and streaming delay or jitter play a most important role in QoS requirement. A task of scheduling algorithm in a multi-class traffic is to categorize the users in one of the pre-defined classes. Each user is assigned a priority of class, as well as ensuring that fairness between the users is maintained [5].

Scheduling algorithm is implemented both side for uplink and downlink in WiMAX network. The focus of the scheduling is allocation of bandwidth to the subscriber. A subscriber may get separate resource for each application, if the scheduling algorithm is not implemented at the SS side. If grant per Subscriber Station (SS) is applied then scheduling algorithm at SS needs to decide the allocation for each connection [6].To control the scheduling mechanism in WiMAX network it is necessary to maintain efficient mechanism on the Base Station. Number of issues arises at the time of uplink. To manage the resource optimally and efficiently the scheduling algorithm at BS

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coordinates with the scheduler on the Subscriber side [7].

In different scheduling mechanism multiple approaches are used for resource management. Most common schedulers are FIFO, WFQ, EDF and EDF which are used at SSs for rtPS class. To handle the scheduling of non-real time Polling Service Weighted Fair Queue is adopted. Whereas for providing the resource to Best Effort services FIFO method is adopted [8]. Considering proper quality of service framework, a low class priority service will provide additional required resources in priority scheduling paradigm.

WiMAX is not based on a static modulation scheme, multiple adaptive modulation and codding methodologies are used. In wireless environment modulations schemes synchronization play an important role for additional resources with respect to the service and modulation scheme [9]. J. Lin et al, proposed the uplink fair scheduling structure in WiMAX network [10]. This structure describes the factor of throughput and the delay handling in multi class's traffic. This structure introduced the Modified Weighted Round Robin mechanism in BS. The approach is to handle the scheduling issue at the subscriber side and allocation is made on the bases of number of users. SS is handling UGS and real time polling service with MWFQ. To handle non real time Polling Service MWFQ is used and for BE traffic FIFO is used.

To allocate bandwidth on priority bases to all the subscribers in the system a hybrid scheduling mechanism is introduced by M. Settember at al [11]. WRR based scheduling technique is used for bandwidth allocation to SSs, for rtPS and nrtPS classes on priority bases. Rest of resources allocated to BE classes by using (RR) round robin mechanism. Drawback of this approach is, if there is a low priority classes required additional resources then it have to will wait for long period of time [12].

In [13] WFQ approach is used for SS of both nrtPS and BE classes. The standard is not requiring any specific quality of service requirement for the Best Effort traffic [14]. To apply a complex architecture for the management of resources for the BE traffic is not feasible for practical implementation due to resource hungry architecture. The overhead of the system will be more than the actual efficiency of the system. The main comparison in this paper is made based on the grant per subscriber and grant per connection analyzed and recommended that GPCC is better then GPC in terms of delay in the network traffic.

After consultation the available literature on resource allocation using different scheduling mechanism for different type of classes. We observed that there is deficiency of an algorithm which can handle wireless traffic based on the fairness factor and allocates the resources considering the requirement of the users. WiMAX have multiple classes, with respect to those classes multiple scheduling mechanism are required. To handle this situation an efficient algorithm is required to compute and allocate the existing resources on the bases of the requirement. That algorithm should be able to handle the mobile as well as the user in hard location.

In WiMAX minimum resource allocation can be made by slot permutation allocation methodology [16]. Four Types of permutation are used in WiMAX, partial usage sub channelization (PUSC), full usage sub channelization (FUSC), adaptive modulation and coding AMC and tile usage sub channelization TUSC. In [13] a new algorithm is proposed which is based on the channel condition and the buffer capacity. This cross layer approach in WiMAX shows that wireless link effects the performance of system. To implement scheduling mechanism at the base station can produce better results. Main focus of this work is to get maximum throughput and fair scheduling among the service flows, but is not considering the channel status for scheduling.

2. PROPOSED FAIRENESS MODEL

Figure 1. shows the proposed Service Based Fairness Resource Allocation Model (SbFRAM), we developed an adaptive resource allocation model by evaluating the service. When user submits a request for a particular service, the proposed SbFRAM model checks the required service along with the channel condition. In this model we have introduced two sub model; Service Evaluator and Resource Manager. In our proposed model we consider both services Constant bit Rate (CBR) and variable Bit Rate (VBR).

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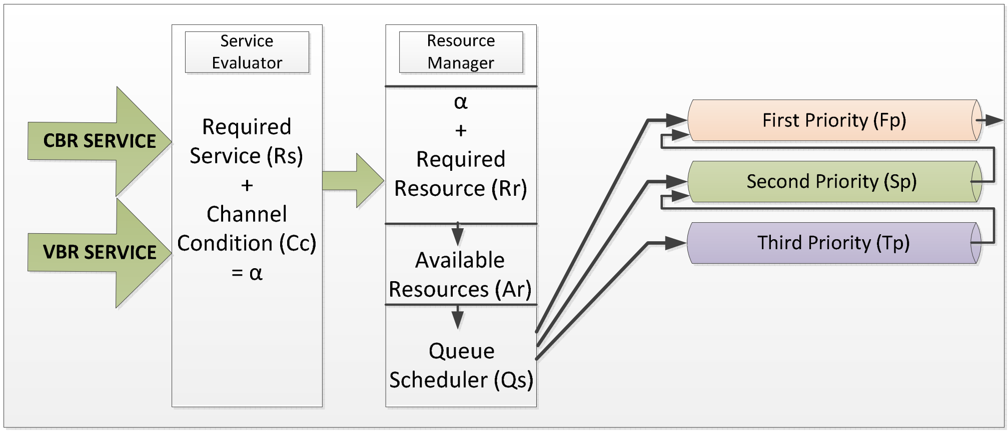

Figure 1. Service Based Fairness Resource Allocation Model (SbFRAM)

2.1 Constant Bit Rate Service

CBR is data traffic that keeps the bit rate same throughout the process, in real time data streaming with fixed size data packets. The quality of service class required by the user helps to determine fixed bandwidth requirement at the time of connection setup. The data can be sent in a steady stream. CBR service is often used when foxed rate uncompressed video is transmitted. Quality of service parameter includes call delay variation and call transfer delay in order to to transfer uncompressed voice and video using CBR. CBR is designed to for ATM virtual circuit where statistically constant amount of bandwidth is required for the duration of active connection. CBR service class is designed for real time application [18].

2.2 Variable Bit Rate Service

VBR is the term used in telecommunication and computing that relates to the bit rate used in the sound and video encoding. VBR files vary from amount of output data per time segment. VBR allows a higher bit rate and therefore requires more storage to be allocated to complex segment of media files. The disadvantage of VBR is, that it may take more time to encode as the process is more complex. VBR may also pose problem during streaming when the instantaneous bit rate exceeds the data rate of the communication path. Bits available can used more flexibility to encode sound or video data [18].

2.3 Service Evaluator

In WiMAX Services are generally categorize in five main classes. In our proposed model Service Evaluator is responsible for receiving user request form any of the five required service. Service Evaluator is consisting of two main features. 1. Required Service Rs and Channel Condition Cc When a user request for a service Rs identify the required Service whereas Cc will evaluate the channel condition from where the service is required. After evaluating these parameters we got the final value α.

2.4 Resource Manager

Resource Manger receive the value of α and estimate the further resource required for providing the required service to the user. After finalizing the Rr the Resource Manager evaluate how much reserve resource it have and how much it can allocate the user for the Rs. Then Resource Manager forwards the result to Queue Scheduler Qs which will place that request in the three available queues, First Priority Fp, Second Priority Sp, and Third Priority Tp.

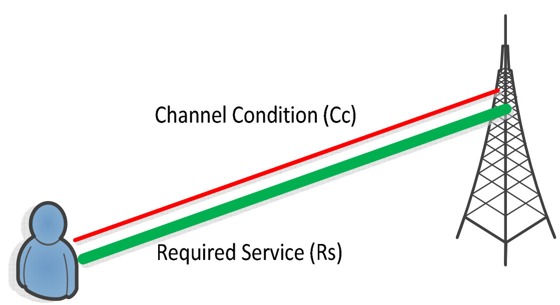

Figure 2. Service Evaluation

Let Cc and Rs be the random variables representing the input and output of the channel, respectively. Let $P_{R_s|C_c}(R_s|C_c)$ be the conditional distribution function of Rs given Cc, which is an inherent fixed property of the communications channel. Then the choice of the marginal distribution $P_{C_c}(C_c)$ completely determines the joint distribution $P_{C_c,R_s}(C_c,R_s)$ due to the identity.

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$$P\, C_c, R_s(C_c, R_s) = PR_s|C_c(R_s|C_c)PR_s(R_s)$$

Which in turn induces mutual information $I(R_s; C_s)$. The Overall Channel Condition along with SNR is described as

$$O_{Channel} = {}_{P\,R_s(R_s)}^{SUP} I\,(R_s;\, C_c)$$

As per Shannon theorem for every required service there is a channel capacity. That is maximum requirement for providing required service. On the bases of this theorem our proposed model calculates the channel capacity.

$$O_{Channel} = {}_{P\,(R_s)}^{SUP} I\,(R_s;\, C_c)$$

Secondly every channel has some noise ratio which is called Signal to Noise Ratio (SNR). In this equation we denote it as with α, and α > 0 and Rc < Cc for the required service Rs, as per the existing code for Rs should be > Rs as per coding algorithm and for the Rs the maximal probability of the SNR should be < α.

2.5 Queue Scheduler

In our proposed model we usedPriority Queue Scheduling Methodology (PQSM) for providing resource as per the requirement of the user service. According to the channel status Queue Scheduler places the desired request in the first, second and third queue according to the required service and channel condition.

First Priority (Fp): Queue Scheduler evaluates and places all those requests which required 10 to 15% additional resources for fulfill the required request. All those request place in the Fp.

Second Priority (Sp): Our proposed model based queue scheduler place all those request in Sp which are required 15 to 25% additional resources for fulfillment to required service.

Third Priority (Tp): In the last queue all those users which requires more then 25% to 50% additional resource has been placed. The users which required more than 50% additional resources are not selected because that decreases throughput of the network.Our queue scheduler is based on priority queue scheduling, so after certain period of time every required user got place in the next Sp and Fp.

3. SIMULATION AND RESULTS

To evaluate our proposed model we developed a five node based WiMAX scenario in NCTUns version 6.0 simulator. Simulation is executed for multiple times with respect to the services. For the both services we used the following parameters.

Table 1. Subscriber Station sustain rate detail

Service	Sustain Rate SS3	Sustain Rate SS4	Sustain Rate SS5	Sustain Rate SS6	Sustain Rate SS7
CBR	500	500	500	500	500
VBR	1000	1000	1000	1000	1000

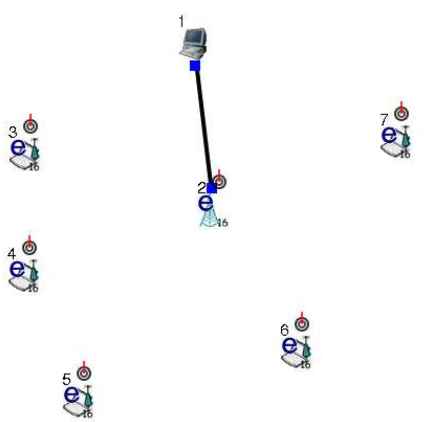

Figure 3. Five SS based scenario of WiMAX

The Figure 3 shows the real simulation screen shot of five nodes based SS scenario with one Base Station and one Host. In the first assumption every node demands the CBR service from Base Station and Base Station which is equipped with SbFRAM evaluate the demand service and its channel. Then the proposed SbFRAM initiate and received the request from user and provide the required service accordingly.

We run the simulation for 100Sec and our proposed model place on Base Station; received the real time request from user form different services. Figure 4 shows the user demanding the CBR service from the base station.

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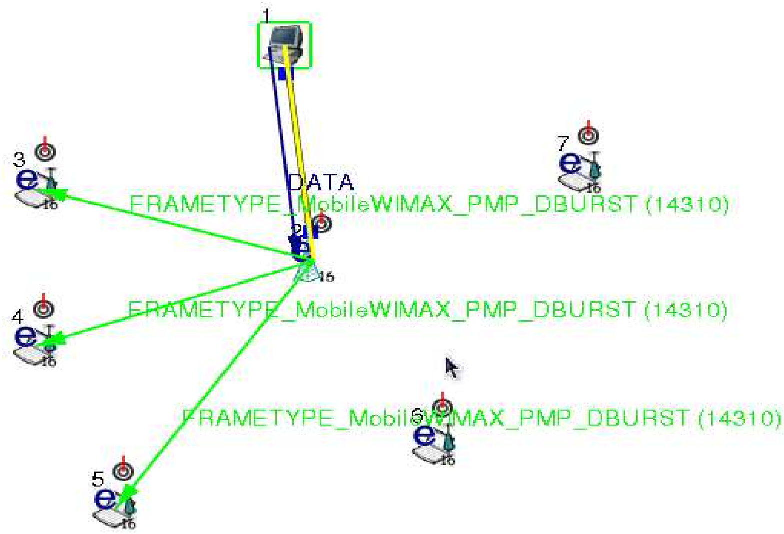

Figure 4. SS communication with Base Station for Required Service

3.1 Simulation Scenario 1

In simulation scenario we experiment our proposed model from only five nodes based WiMAX network. In which the assumption was that every user is demanding CBR service with variable channel condition. We experiment that how proposed model place the user request in the specified queue and how it mange the required resource for satisfying required service. The screen shot of the simulation has been presented in Figure 3 and 4.

In this simulation every SS is using the 802.16e protocol along with some additional predefined parameters. In the first run has the capability to submit required for all of traffic i.e. UGS, rtPS nrtPS and BE. In this study we evaluate the resource allocation to user with and without SbFRAM and monitor the performance of SbFRAM.

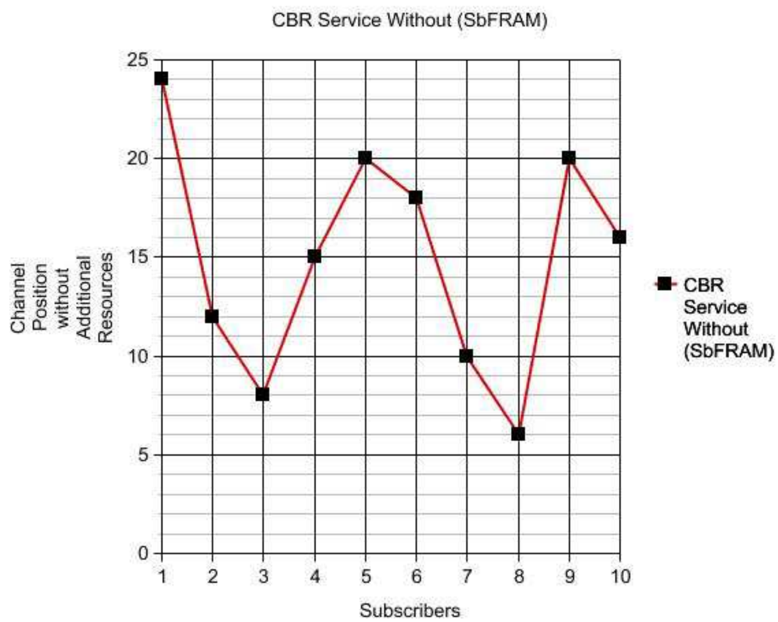

Figure 5. CBR Service without Additional Recourse

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Figure 5 shows the real picture of the 10 SS along with their channel condition, below explain on line user required extra resource for fulfill the required service whereas above explain on line user has required the minimum resources. By evaluating the required resource the proposed model SbFRAM place the user request according to the prescribed Queue Scheduler.

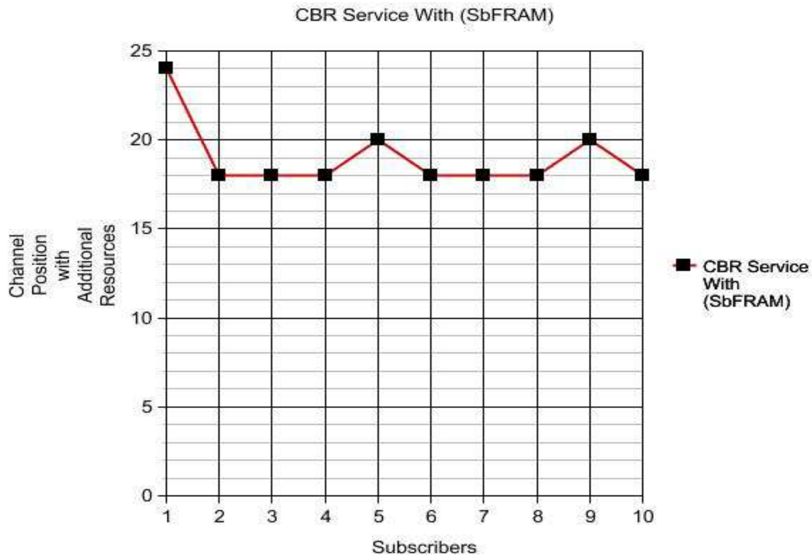

Figure 6. CBR Traffic with SbFRAM

Figure 6 presents the proposed model fairness resource methodology and according to the requirement SbFRAM provides the required resource and all users got the service with additional resource but with some delay. In this study our prime focus is to provide the user required services but we are compromising on delay.

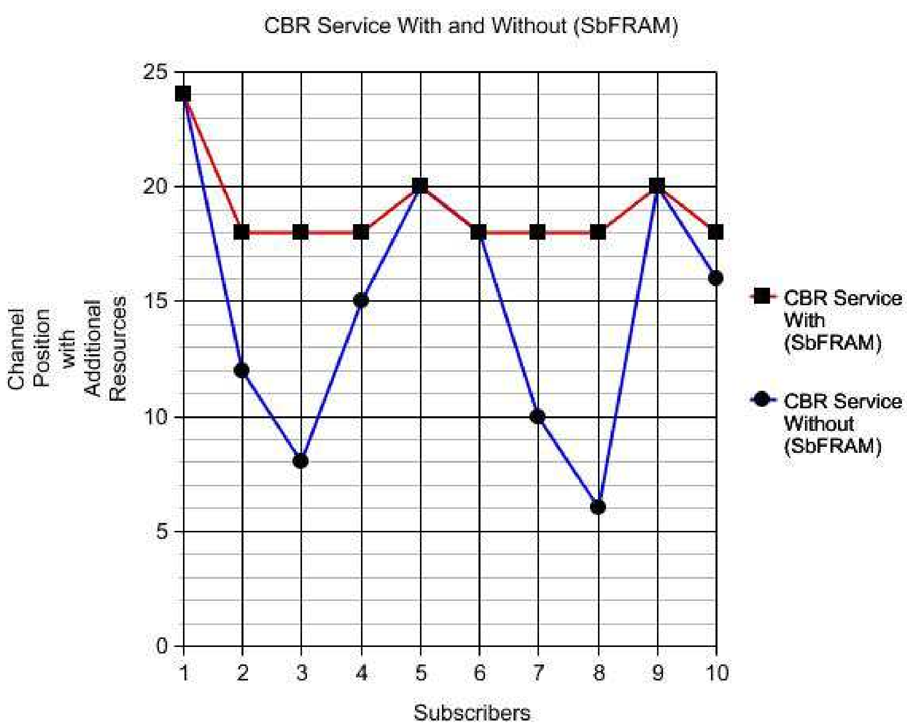

Figure 7. Performance Analysis of SbFRAM

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Figure 7 presents the overall performance of the SbFRAM, in which user 2,3,4,7,8 and 10 required more additional resource whereas only 1, 5 and 9 channel condition is according to the required service, so without additional resource their required service has been provide immediately. Whereas rest of the user place in the Fp, Sp and Tp according to their channel condition. But after a certain period of time every user got its required service.

3.2 Simulation Scenario 2

To evaluate and getting more confidence we evaluate our proposed model on VBR traffic, in this scenario the assumption is based on 10 users with requiring multiple service with multiple channel condition. In this assumption any user can demand any service like rtPS, nrtPS, ertPS and BE. In our previous work CbRAM [17], we presented the services along with the channel condition. So in this model the parameters are same as previous but Resource Manager will place the service in Queue Scheduler as per the requirement.

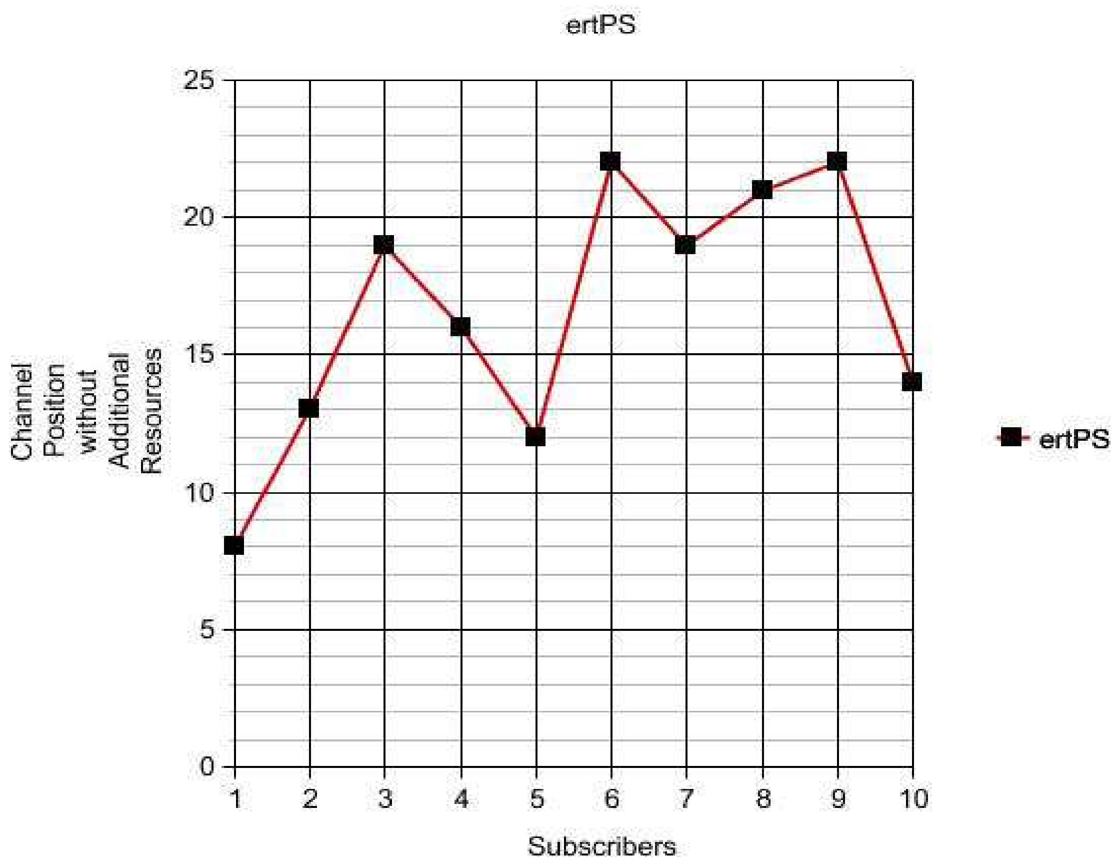

Figure 8. Additional Required resource for ertPS service

Figure 8 shows that all 10 subscribers required the ertPS service but 1,5 and 10 channel condition is not as per the equired parameter, so they palce in their respective queues for additional resource and when their required has been provided by the Resource Manger then Base Station provide them the required service.

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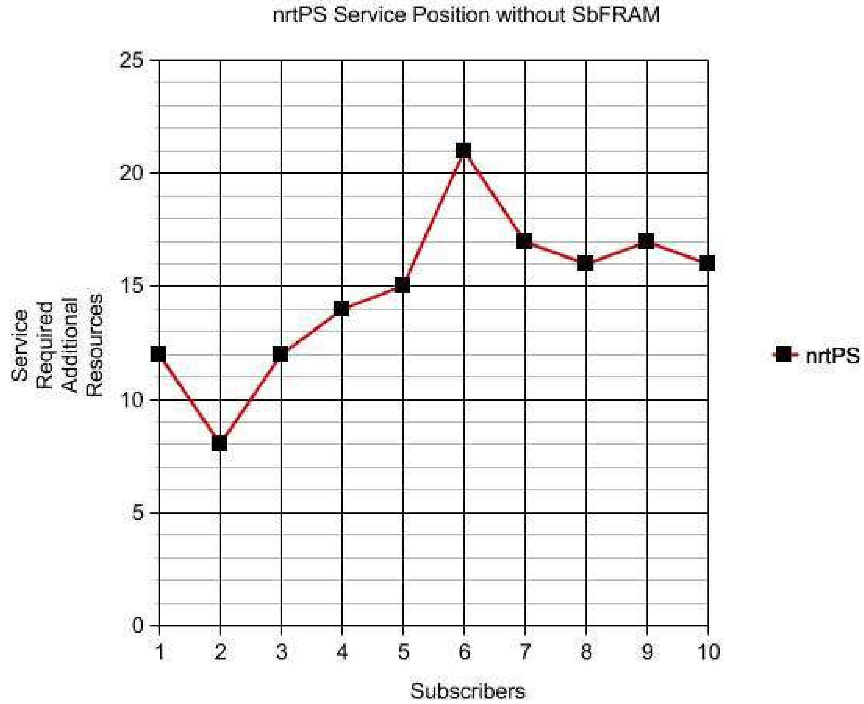

Figure 9. Channel Condition for nrtPS Service

With the same channel condition we experiment by changing the other service nrtPS. Figure 9 presents that in proposed model user 2, 3, 8, 9 and 10 required additional resources for providing the required service. We experiment our proposed model on every service and we found that for different user required additional resources. In Figure 10 we evaluate on rtPS service and marked 2, 3, 5, 7 and 8 for requiring additional resources. Whereas in Figure 11 only 1, 8 and 9 required more resource for BE service.

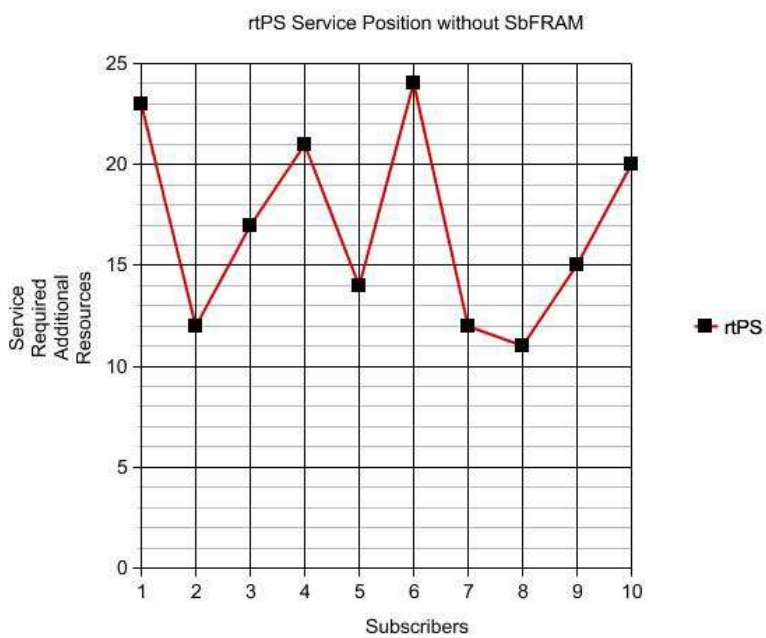

Figure 10. Channel Condition for rtPS Service

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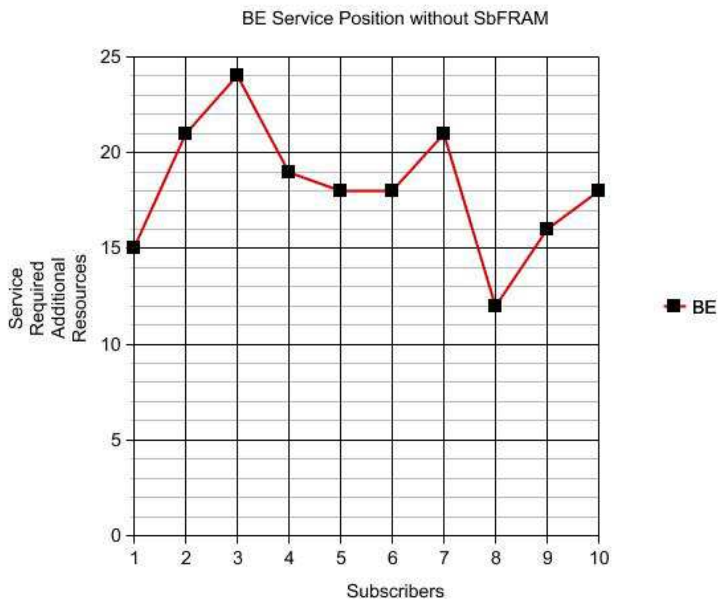

Figure 11. Channel Condition for BE Service

Figure 12 presents the summariesed picture at BS level where multiple services are demanded by the SS and SbFRAM has been queued all those services which required additional resources. After providing the required resource every SS entertain with that service. In this process those user which required more than 25% additional resource has been compromised on bit delay for providing the said service. The solid trend line presents that every service how much additional resources required and our proposed model provide the required resource as per the pre-set periority on the bases of the assumed service priority scheduling mechanism.

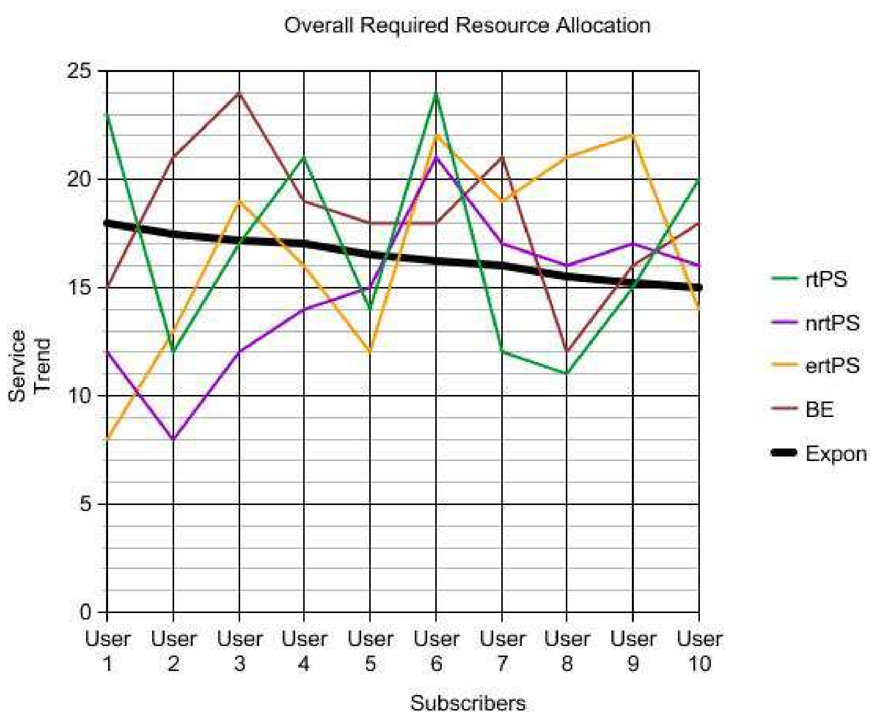

Figure 12. Overall Peroformance of SbFRAM for VBR Traffic

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4. CONCLUSION

In this paper we propose a SbFRAM using channel status. After studying the problem of fair resource management our proposed mechansim allocates based on the status of channel fairly and user satisfication level is achieved. Simulation shows the improvemnt in allocation of resouces in terms of fairness. Which shows that the user with low SNR value have been allocated with additional resource to achieve minimum satisfication. Our experiments shows that both constant bit rate and variable bit rate traffic gets improvemnte in fairness and level of user acceptance. This mechanism also improves wait time for low prioity classes. To provide fair and desired servcie to all the user without affecting the quality of servcie up to the maximum availbility of resources. This mechanism will not perform effieciently if the no of users with low SNR will be more.

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