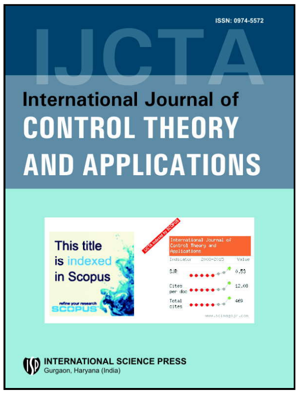

International Journal of Control Theory and Applications

ISSN : 0974-5572

Volume 10 • Number 13 • 2017

Design and Development of an Efficient Location Based Bandwidth Allocation Method for Wireless Mobile Networks

K. Suresh Kumar Reddy[1] and D. Rajaveerappa[2]

[1] Department of Computer Science & Engineering Sir Vishveshwaraiah institute of Science & Technology, Angallu, Madanapalle, Chittoor, A.P, India, Email: kambamsureshkumarredddy@gmail.com
[2] Department of Electronics and Communication Engineering Madanapalle Institute of Technology and Science, Madanapalle, Chittoor, A.P, India, Email: draja_2001@rediffmail.com

Abstract: At present days, a fast growing technology in mobile communications are 3G, 4G etc., Many users are enjoying a high experience of QoS especially in multimedia applications such as Skype calls, audio, etc. For network providers it's very difficult to provide such a QoS. It requires a efficient Bandwidth allocation techniques. The previous bandwidth allocation techniques are all having their own drawback such as high cost, bandwidth wastage, errors, high response time. We implemented a Novel approach for a development of an efficient location based Doppler shifted bandwidth allocation method for wireless mobile networks.

Keywords: AoA; Bandwidth Allocation; Bit Error Rate; Doppler Shift; QoS

1. INTRODUCTION

Allocating bandwidth and while maintaining a reasonable level of quality of service is an important part of managing a cellular network. As the use of multimedia applications increases, so are the demands for resources required to support them. Network resources such as bandwidth, buffer space, and processing time at each node, should be allocated in a cost-effective manner. Each application expects the network to provide a desired quality of service (QoS). QoS measurement includes bunds on the cell loss probability, cell delay, jitter, etc. The service provider is interested in providing the desired QoS, but as efficiently as possible. For these reasons allocation methods are needed to allocate resources while providing QoS guaranteed. Conventional approaches of resource allocation rely on predetermined traffic characteristics. The amount of resources required to provide the QoS is calculated using these values. These approaches experience the following fundamental problems [1]. First, the source characteristics may not be known a head of time. In case of interactive video, the user must guess at these characteristics. Second, the parameters may not adequately characterize the source. it has been shown for MPEG-compressed video that long-range dependencies occur, which implies that standard statistical models are probably inadequate. Third, the number of parameters required should be kept small, so to reduce the complexity of the allocation method [2].

Current allocation methods can be categorized as either off-line or on-line. Off-line methods predetermine allocation amounts before transmission begins. Such a method may allocate on resource level for the duration of the application, or may renegotiate the resource level at various times. This approach has several advantages including simplicity and predictability, but suffers from low resource utilization if the peak-to-mean ratio is high.

On-line methods periodically renegotiate resource allocation based upon predicted traffic behavior. Predictions are derived from measurement of the traffic and QoS observations. Such methods do not have the problems associated with off-line methods and may be implemented by filters, neural networks, dynamic algorithms or some other sampling procedure. These methods also have the advantage of adjusting the resource allocation with respect to a desired QoS. In addition, most methods suffer from a large number of renegotiations, and rely on a very complex measurement and allocation algorithm [3].

The wide area wireless networking technology, e.g. the 3G HSDPA it is now possible to experience high data transfer rates inside a moving vehicle. The capacity improvement in mobile bandwidth brings the vision of pervasive computing another step closer to reality. While the capacity improvement of wireless bandwidth is not in question, the stability or the consistency of the bandwidth is. Instead of being a deterministic entity, the interference and other scheduling issues make the wireless bandwidth behave more like a random variable that fluctuates over time and space. Sustaining the quality of service in wide area mobile computing environment therefore remains a challenging problem. In fact, even in wired networks, bandwidth is known to fluctuate, albeit at a lesser degree, due to load fluctuations [4]. Consequently, bandwidth predictability has sparked significant interest in many domains, including adaptive multimedia, admission control, congestion control, and network multi homing. However, studies on network traffic predictability have hitherto focused only on static environments where the users do not move. The issue of bandwidth predictability in mobile computing, especially in the context of high-speed (vehicular) mobility, remains largely unexplored [5]. There are many issues related to bandwidth allocation in wireless networks. These issues directly degrade the QOS. The issues are since the cell size is reducing and the user per cell is increasing, the probability of blocking the locally generated calls is increased and the probability of dropping the handoff is also increased. It is very difficult to maintain the QOS with the above problems. In order to overcome this problem, it has become necessary to develop certain mechanism where cell loss and necessary to develop certain mechanism where cell loss and delay can be reduced and bandwidth should be managed properly. In our cellular network every cell has base station and all are connected together and connected to the broad band network. Base stations maintain the tables regarding the bandwidth information about all the mobile nodes in their respective cells. Whenever new mobile node generated locally or migrated from neighboring cell the base station will follow the procedure given and allocate the bandwidth and update the bandwidth table [6].

The rest of this paper is organized as follows: in *section II* we discuss our proposed method, in *section III* we explain the simple example for positioning of a mobile vehicle, in *section IV* we discuss about the MATLAB simulation and the results of bandwidth usage efficiency in a network, bit-rate comparison and delay comparison, and in *section V*, we conclude the paper.

2. PROPOSED METHOD

Most of the present techniques are allocating bandwidth based on the signal strength that is three base station methods; this causes more bandwidth loss, bit rate error and also delay. In order to avoid such causes we implemented a bandwidth allocation based on the frequencies. This decreases the error rate, delay and bandwidth wastage.

Our work is implemented based on the Doppler shifted signal [7]. Basically, for allocation of bandwidth we need to know the location of a particular mobile, this can done by several ways, but we did with Doppler shift signals using two base stations, and also for allocating bandwidth, present technology using signal strength, but these make more calculation, complex and less QoS's. So, such scenario we are going to avoid in our method.

2.1. Two Base Station Method for Finding Location of Mobile Vehicles Based on Doppler Shifted Signals

Finding location from BS is Time consuming and risky process and so we are estimating location by using MS (Mobile Station) itself [8]. We are estimating location by using Two Base Stations for finding positioning of mobile and so we need to find the angles of arrival of signal direction from both Base Stations (BSs).

For AOA location method, the true arrival angles at BS 1 can be calculated by the equation

$$\theta_i = \tan^{-1}\left(\frac{y_i - y_s}{x_i - x_s}\right) \tag{1}$$

where it is assumed that each Angel of Arrival (AoA) is measured with respect to common baseline, for instance the x-axis. Since a line can be defined by point and an angle, the line of position for BS i is

$$y_s = x_s \tan\theta_i + \left(y_i - x_i \tan\theta_i\right) \tag{2}$$

Equating the line of position for the two BSs, i = 1, 2, and solving for x_s yields

$$x_s = \frac{y_2 - y_1 - x_2 \tan\theta_2 + x_1 \tan\theta_1}{\tan\theta_1 - \tan\theta_2} \tag{3}$$

which can be inserted back intoy_s for i = 1 or i = 2 to form the estimate of y_s.

2.1.1. Doppler Shift

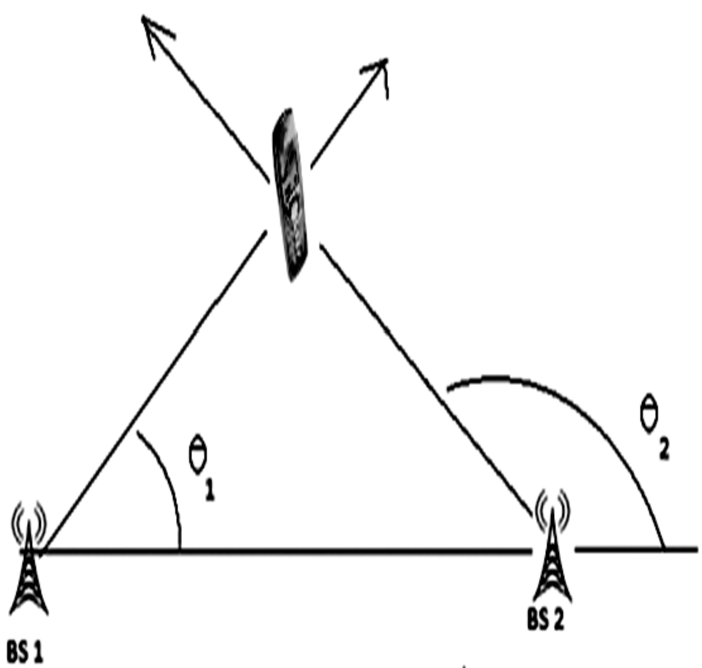

Figure 1: Illustration of Doppler Effect And hence the apparent

Consider a mobile moving at a constant velocity v, while it receives signals from a remote BS_i (i = 1, 2), as shown in fig 5. The angle θ_i is made between the line connecting BS_i and the mobile and the horizontal line connecting two BSs change in frequency, or Doppler shift, is given by f_{d_i} (for BS_i)

$$f_{d_i} = \frac{v}{\lambda_i} \cos\theta_i \tag{4}$$

f_{d_i} relates the Doppler shift to the mobile velocity and the spatial angle between the direction of motion of the mobile and the direction of arrival of the wave, it can be seen from equation 4 that if the mobile is moving towards the direction of arrival of the wave, the Doppler shift is positive, and if the mobile is moving away from the direction of arrival of the wave, the Doppler shift is negative [9]. The θ_i for BS_i can be found from the Doppler shift f_{d_i}.

The received frequency of the mobile can be given for BS_i as

$$f_{r_i} = f_{t_i} \pm f_{d_i} \tag{5}$$

where f_{r_i} is the received signal frequency of mobile due to BS_i and f_{t_i} is the transmitted signal frequency from BS_i [10].

2.2. Doppler Shifted Bandwidth Allocation Method

If the signal bandwidth is greater than Doppler Spread f_d then there will be burst error in data transmission as explained in Fig 2. This is called as Slow Multipath Fading.

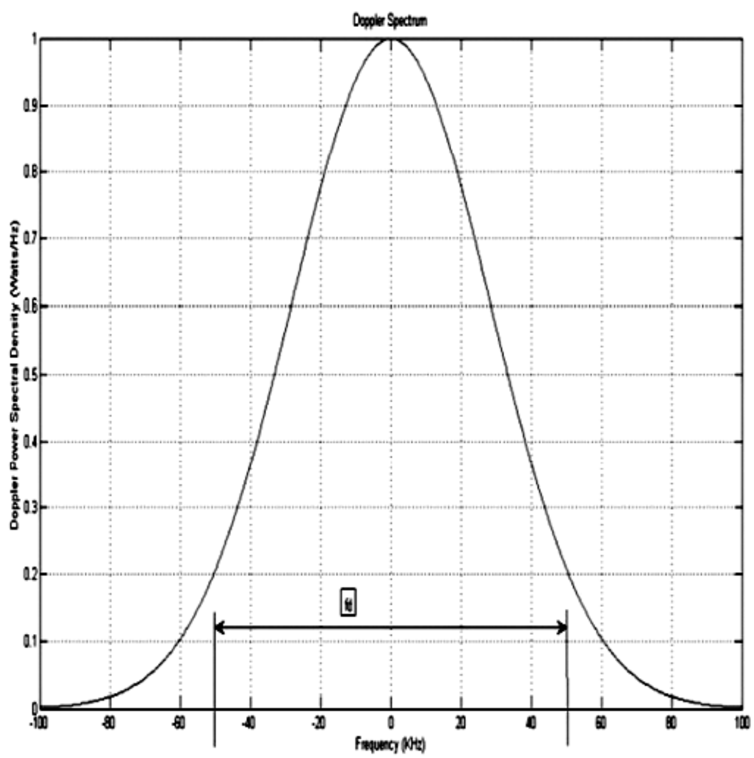

Figure 2: Illustrating the Doppler power spectral density

If the signal bandwidth is less than the Doppler Spread f_d then there will not be any burst error in data transmission as explained in Fig 2. This is called as Fast Multipath Fading [11].

Algorithm for Bandwidth Allocation

If there is handoff call then

Locally generated Available Bit Rate is dropped

Bandwidth allocated = NIL

Else

If there is no hand off call then

If negotiated bandwidth is available in free region then

Allocate the bandwidth

Else

If negotiated bandwidth is not sufficiently available in free region then

Allocate the bandwidth by adding up the available bandwidth in free region and unutilized bandwidth in semi active region

Else

If negotiated bandwidth is not still sufficient

Then

Either renegotiate the bandwidth or place the call in Available bit rate queue.

Comparison of two base station and three base station methods based on signal strength and frequency

Table 1
Comparison of Two Base Station and Three Base Station Methods based on signal strength and Doppler shift frequency.

Sl. No	*Location Finding & Bandwidth Allocation Method*	*Based on*	*BER*	*Delay*	*BW Wastage*
1	Three Base Station method	Signal strength	High	High	High
2	Two Base Station method	Doppler frequency	Low	Less delay	Less

BER: Bit Error Rate

BW: Bandwidth

3. A SIMPLE EXAMPLE FOR POSITIONING OF A MOBILE VEHICLE

Let us consider two base stations BS1 and BS2.

Transmitted frequency of BS1 f_{t_1} is 900 Hz

Transmitted frequency of BS2 f_{t_2} is 850 Hz

Wavelength of BS1 λ_1 is 0.3333 m i.e., $\lambda_1 = \frac{c}{f_{t_1}}$

Wavelength of BS2 λ_2 is 0.3529 m i.e., $\lambda_2 = \frac{c}{f_{t_2}}$ where, c = 3 × 10^8 m/sec

From the received signal frequency of BS1, the Doppler shift frequency is calculated as f_{d_1} = 53 Hz.

From the received signal frequency of BS2, the Doppler shift frequency is calculated as f_{d_2} = 50 Hz.

Let the velocity of vehicle v is120 Km/H i.e., 33.33 m/sec. The Angle of Arrival (AoA) of i^{th} BS with respect to the mobile unit is calculated using the formula [12].

$$\theta_i = \cos^{-1}\left(\frac{f_{d_i}\lambda_i}{v}\right)$$

And so, the AoA of BS1 is θ_1 = 57.9946° and the AoA of BS2 is θ_2 = 122.0054°.

Next, we need to find the position of mobile vehicle as a coordinate (x_s, y_s).

Let (x_1, y_1) be the position of BS1 as (-6, 0) and (x_2, y_2) be the position of BS2 as (4, 0).

From equations (2) & (3), we calculate x_s as -1.002 and y_s as 8.001

4. SIMULATION AND RESULTS

4.1. Two Base Station Method for Finding Location of Mobile Vehicles Based on Doppler Shifted Signals

We designed and implemented proposed work for improving QoS of wireless mobile networks based on Doppler shifted location based bandwidth allocation algorithm and simulation is carried out using MATLAB software

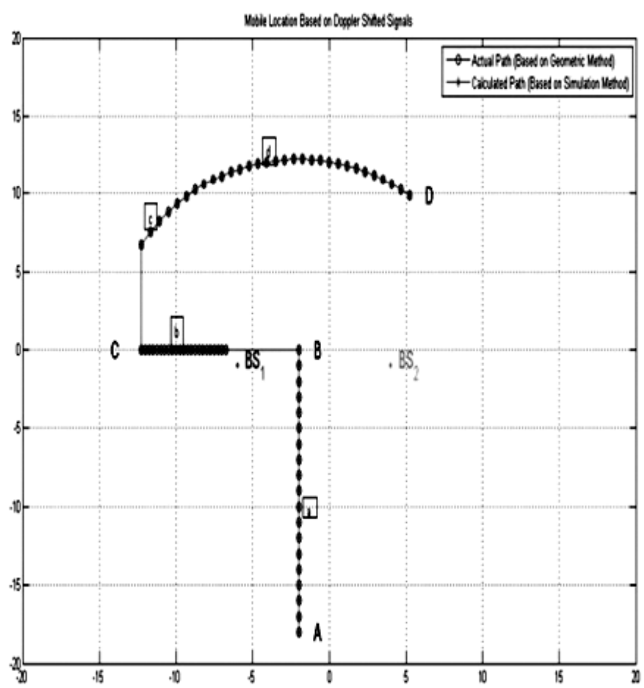

Figure 3: Results for mobile location over a combination of curved, straight and sharp corner paths.

Fig. 3 gives the results of mobile location over a path starting from point A (-2.001, -18.001) and ending at point D (5.249, 9.8744). The detailed results are listed in Table II. The BS1 is located at a position (-6,-1) and BS2 is located at a position (4,-1). The mobile vehicle is moving with a velocity of 35 Km/H over curved path and then moving with a velocity of 15 Km/H over bend regions. But the vehicle is moving with 120 Km/H over straight paths. For example, at point “c” the location of mobile over curved path is (-11.084, 8.2197) as per Table II.

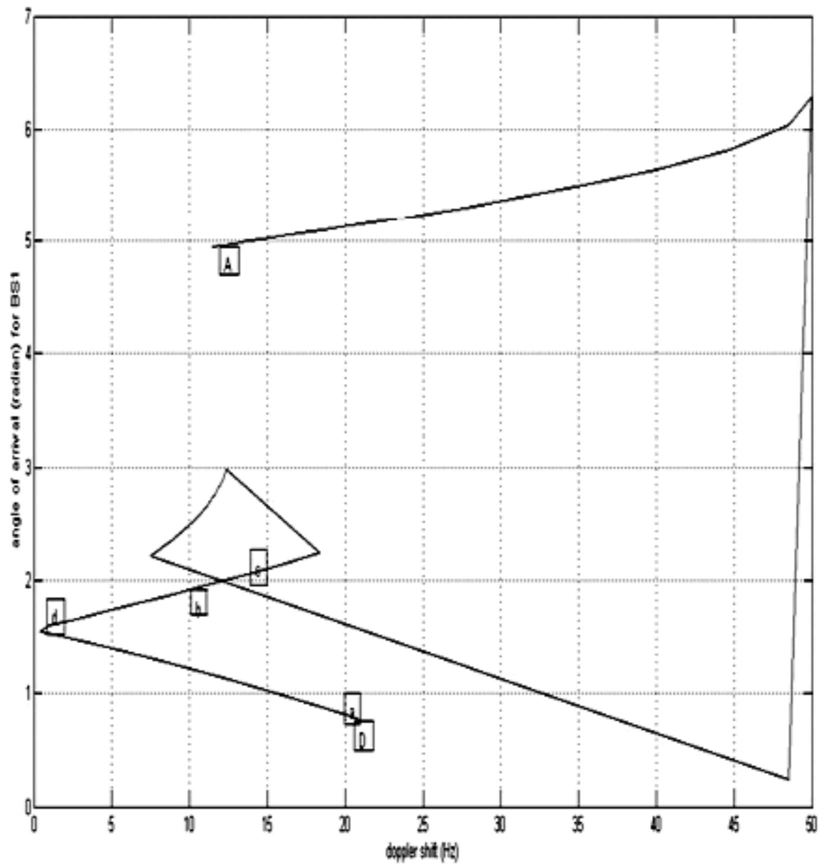

Figure 4: Results for AoA of BS1 over a combination of curved, straight and sharp corner paths.

Fig. 4 gives the results of AoA vs. Doppler shift frequency over a path starting from point A and ending at point D, The detailed results are listed in Table II. The AoA of BS1 with respect to mobile over a curved path at point “d” is radians 1.5577 for Doppler shift frequency 0.3824 Hz which gives a mobile location (-5.8343,11.635) as per Fig. 4. The AoA of BS1 with respect to mobile over a straight path at point “a” is 5.1305 radians for Doppler shift frequency 20.301 Hz which gives a mobile location (0.0010, -9.000) as per Fig. 4. Refer Table II.

Fig. 5 gives the results of AoA vs. Doppler shift frequency over a path starting from point A and ending at point D, The detailed results are listed in Table II. The AoA of BS2 with respect to mobile over a curved path at point “d” is 2.2322 radians for Doppler shift frequency 16.92 Hz which gives a mobile location (-5.8343,11.635) as per Fig. 5. The AoA of BS2 with respect to mobile over a corned bend path at point “b” is 3.0704 radians for Doppler shift frequency 11.776 Hz which gives a mobile location (-10.001, -0.001) as per Fig. 5. Refer Table II.

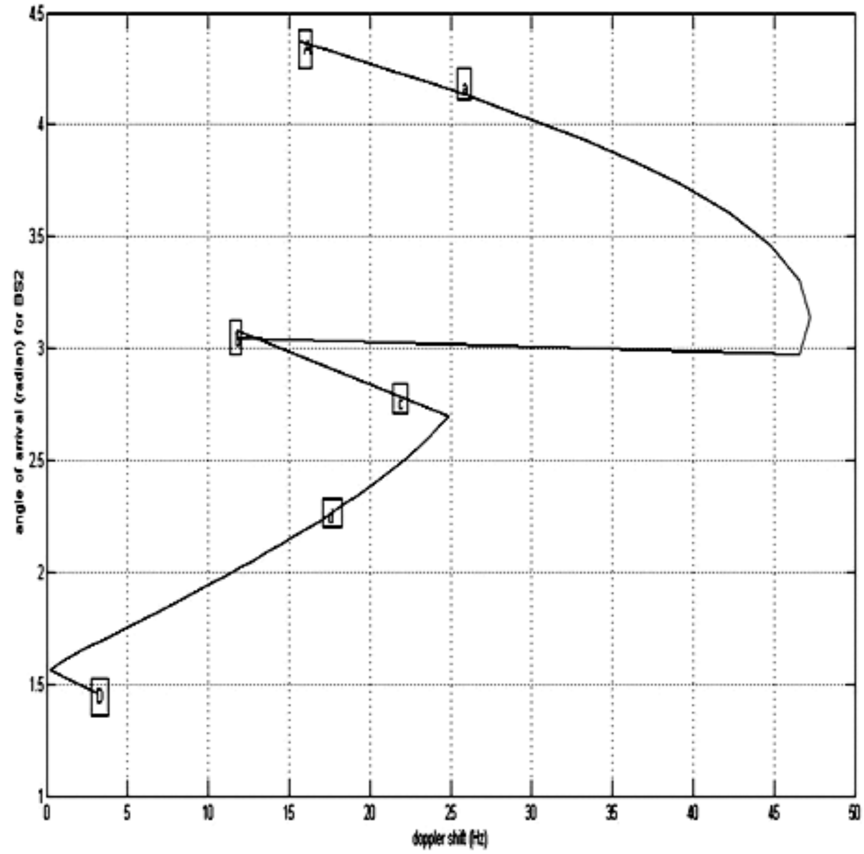

Figure 5: Results for AoA of BS2 over a combination of curved, straight and sharp corner paths.

Table 2
Simulation results for figures 3, 4, and 5.

Location Point Along the path	f_d *From BS1(Hz)*	f_d *From BS2(Hz)*	*AoA From BS1(rad)*	*AoA From BS2 (rad)*		y_3
A	11.119	15.718	4.9131	4.373	2.001	18.001
a	20.301	26.195	5.1305	4.124	-2.001	-10.001
b	12.128	11.776	2.8969	3.070	-10.001	-0.001
c	14.085	23.504	2.0748	2.593	-11.084	8.2147
d	0.3824	16.92	1.5577	2.232	-5.8343	11.635
D	20.97	3.1432	0.7684	1.456	5.249	9.8744

Doppler shifted frequency rad: radians

4.2. Bandwidth Allocation vs. without Bandwidth Allocation

Consider a maximum 30 numbers of receivers in a coverage area. If the bandwidth allocation is not done and as the number of receivers increases the bandwidth saving is reduced, and so it causes greater wastage of bandwidth.

When we consider our designed bandwidth allocation method based on Doppler shift it allocates bandwidth based on the necessity of a receiver and save bandwidth up to 15% for 30 users.

4.2.1. Bandwidth usage efficiency comparison

Our simulation results shows a graph between number of users and bandwidth efficiency as shown in figure 6, there is a sudden drop in bandwidth saving because of without bandwidth allocation. And of all 30 users efficiently allocated by our approach and also we saved up to 15% of overall bandwidth available, as shown in Fig. 6.

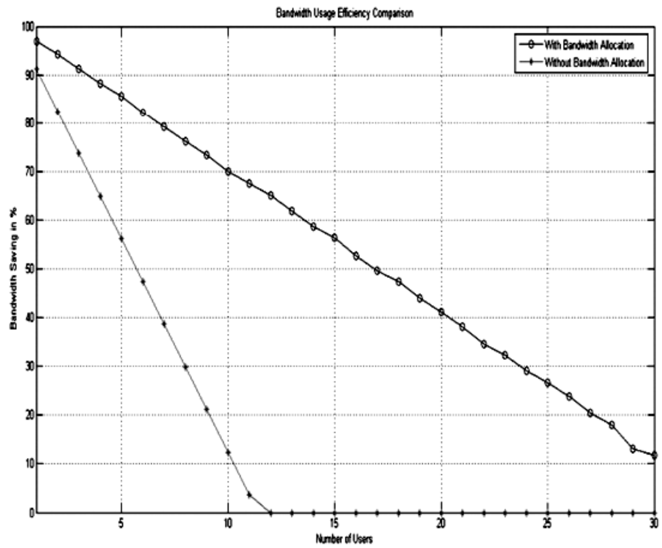

Figure 6: Bandwidth usage efficiency comparison

4.2.2. Bit rate comparison

Our simulation results show a graph between Mobile mobility time duration vs. bit error rate. The bit error rate is constant throw out the duration of vehicle motion when we consider without bandwidth allocation and with bandwidth allocation, the bit error rate is much less, as shown in Fig. 7.

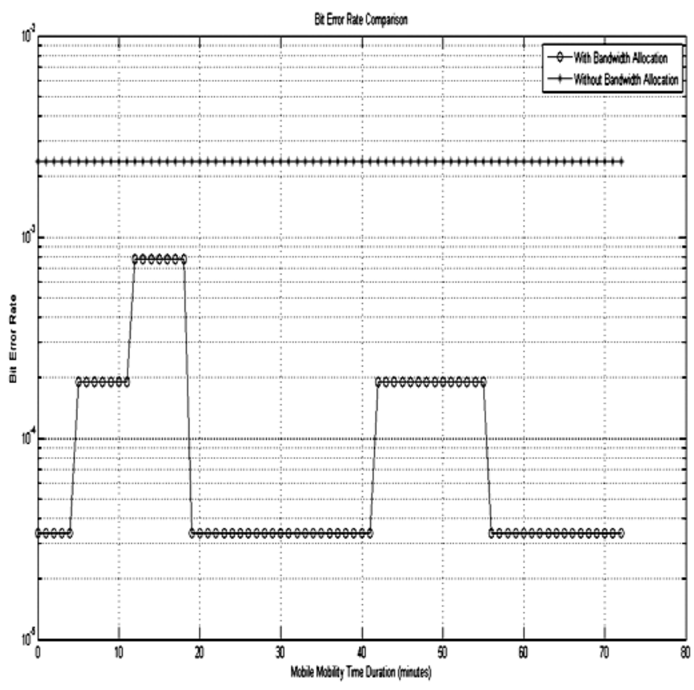

Figure 7: Bit error rate comparison

4.2.3. Delay comparison

Our simulation results show a graph between Mobile mobility time duration vs. delay. The delay is more throughout the duration of vehicle motion without bandwidth allocation and with Doppler shifted bandwidth allocation; the delay is much less as shown in Fig. 8.

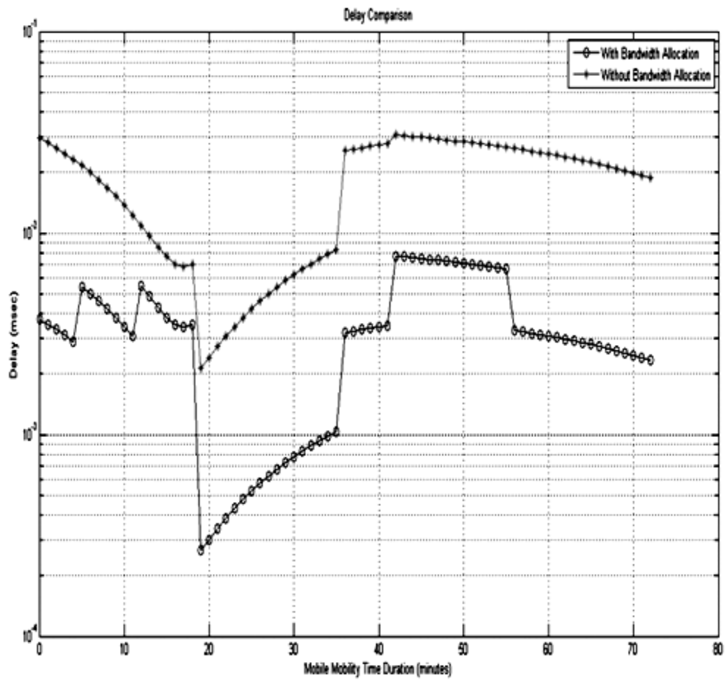

Figure 8: Delay comparison

5. CONCLUSION

We designed and implemented an efficient, less time consuming, robust, secured, and economical method of finding location of mobile vehicles using two base station method based on Doppler shifted signals and also bandwidth saving, less bit rate error, and less delay time using bandwidth allocation. The results show that our method gives more accurate values of location of mobile vehicles and efficient bandwidth usage for QoS compared to other existing methods. In future this work can be extended over a hybrid TDMA/FDMA/CDMA wireless mobile network.

REFERENCES

[1] Jun Yao, Salil S. Kanhere, Member, IEEE, and Mahbub Hassan, Senior Member, IEEE, "Improving QoS in High-Speed Mobility Using Bandwidth Maps", IEEE Transaction on mobile computing, vol 11, No.4 April 2012.

[2] L. Song, D. Kotz, R. jain, and x. He, "Evaluating Location Predictors with Extensive Wi-Fi Mobility Data," Proc.IEEE INFOCOM, Mar. 2004.

[3] Jie Xiong, Kyle Jamieson, Secure Angle: Improving Wireless Security Using Angle-of-Arrival Information, Hotnets '10, October 20–21, 2010, Monterey, CA, USA. Copyright 2010 ACM 978-1-4503-0409-2/10/10.

[4] P. Venkataram (Editor), "Wireless Communications for the Next Millennium", Tata McGraw-Hill, New Delhi, 1998.

[5] Andrea Goldsmith, "Wireless Communications", 2nd Edition, Cambridge University Press", 2011.

[6] Rajaveerappa D and Venkataram P, "A CDMA/TDMA MAC protocol for Multimedia Wireless Networks" , Intl. Conf. on Info., Commun., and Signal Proce. (ICICS'99), Singapore, Dec. 7-10, 1999.

[7] Theodore S. Rappaport, "Wireless Communications", 2nd Edition, Pearson Education Asia, 2002.

[8] Saleh Al-Jazza, "A Joint TOA/AOA Constrained Minimization Method for Locating Wireless Devices in Non-Line-of-Sight Environment", IEEE transactions on vehicular technology, vol. 58, no. 1, january 2009.

[9] Chien-Sheng Chen, Yi-Jen Chiu, and Jium-Ming Lin "Hybrid ToA/AoA schemes for mobile location in cellular communication systems", International Journal of Ad hoc, Sensor & Ubiquitous Computing(IJASUC) Vol.1, No.2, June 2010.

[10] Adaptive AOA-Aided TOA Self-Positioning for Mobile Wireless Sensor, http://www.mdpi.com/1424-8220/10/11/9742/htm Sept. 2008.

[11] D. Rajaveerappa and Fituri H. Belgassem, "A Two Ray Propagation Model For Finding Mobile Location Over Plain Microcellular Environment", 2010 IEEE International Conference on Computer and Communication Technology (ICCCT-2010), Sept. 2010, pp. 408-414.

[12] Brinda .P, "The Mobile Positioning in GSM networks", The PhD work, University of Zilina, Department of Telecommunication 2005.