Traffic Driven & Received Signal Strength Adaptive Handoff Scheme

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ABSTRACT
In a cellular network, handoff is a transition for any given user from one base station to another geographically adjacent base station, as the user is free to move around. If handoff fails, it leads to forced termination of ongoing call. This is not user friendly at all. The major parameter in any network is defined by its Quality of Service (QOS) and handoff decision scheme plays a major role in QOS. In this paper, as the user is moving, handoff mechanism is analyzed on the basis of received signal strength from two different base stations and results are plotted using the Matlab code.

Keywords
Telecommunication, handoff, Received signal strength (RSS), Serving Station(SS), Target Station(TS), Mobile Terminal(MT)

1. INTRODUCTION
Mobile wireless communications is one of the most advanced form of human communications ever. The intense research has led to rapid development in the mobile communication sector. One of the important objectives in the development of the new generation is the quality improvement of cellular service, with handovers nearly invisible to the mobile station subscriber. Generally, a handoff takes place, when the link quality between the base station and the mobile terminal is degraded on movement. In next-generation wireless systems, it is important for Radio Resource Management (RRM) functionality to ensure that the system is not overloaded and guaranteeing the needed requirements. If the system is not properly planned, it leads to low capacity than required and the QOS degraded. The system became overloaded and unstable. Therefore, we need an algorithm which not only adapts itself according to the Received Signal Strength (RSS) but also on the load status of target station. Earlier scheme has few shortcomings like insufficient system resources and degraded service quality due to sudden increase in traffic. In addition, the previous works do not consider the load status of neighbouring cell. Proposed algorithms differently set the handoff threshold based on traffic of cells. In this paper, we propose a handover-based traffic management algorithm to adaptively controls the handover time according to the load status of cells. We considers traffic load as an important factor for initiating handover. The traffic load can seriously affect on QOS for users ,thus it requires efficient management in order to improve service quality.

The rest of this paper is organized as follows. First we develop a handover time algorithm, where in this proposed algorithm we set the threshold value based on traffic load of cells, speed of mobile terminal and distance parameters. We discuss the simulation results and finally the conclusion.

2. ADAPTIVE RSS ALGORITHM
Terms used in algorithm:-

Thres_serving: The threshold value of the RSS to initiate the handover process. Therefore, when the RSS of SS drops below thres_serving , the Mobile Switching Centre(MSC) registration procedures are initiated for MT's handover to TS

Thres_min:- The minimum value of RSS required for successful communication between an MT and TS.

Thres_target:-The threshold value of RSS from target station for handoff execution.

In this paper an adaptive algorithm is used for traffic distribution in the hotspot. The detailed algorithm is shown in figure.1.Traffic load is the rate of channel occupancy in the cell. To maintain the quality of service and to make the effective usage of resources, distribution of traffic is needed. The two Active modes are the HOLD and ON state between user and base station. The HOLD state has full downlink and thin uplink channel and ON state has both full downlink and uplink traffic channel. The load added by the handoff calls is defined as HANDOFF. The handoff call is assume to be in the ON state soon after the handoff process is over. The traffic load can be estimated by calculating the number of users in the three modes, HOLD, ON and HANDOFF which is described in Equation 1 [5].

$$N_T = N_{ON} + \beta\, N_{HOLD} + N_{HO} \quad (1)$$

here N_T is the amount of traffic loads, N_{ON} is the number of users in the ON state, N_{HOLD} is the number of users in the HOLD state and N_{HO} is the number of handoff calls. In Equation (1), β is an adaptive factor and the amount of traffic load varies from 0 to 1.

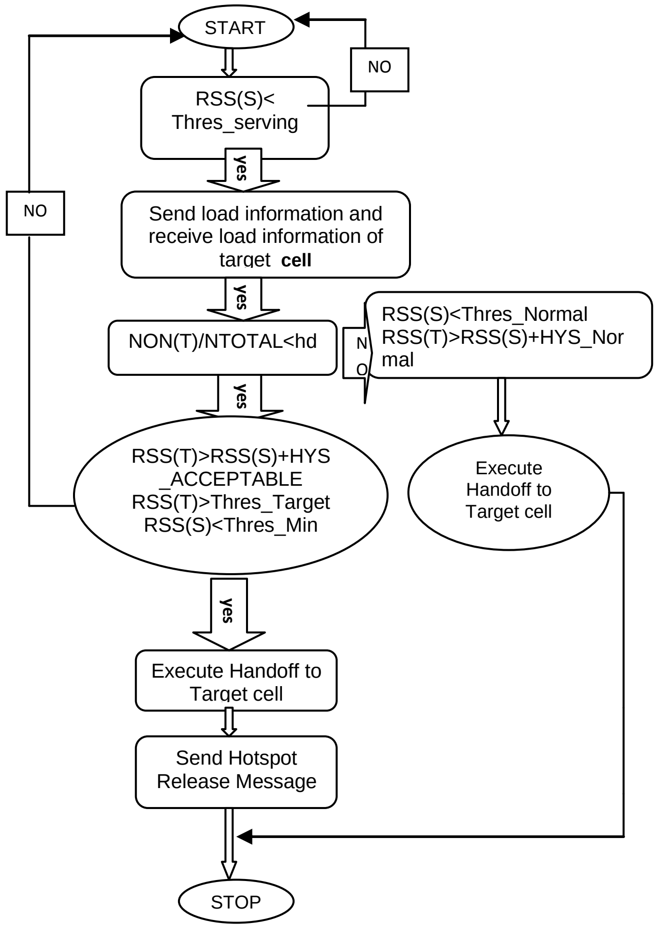

Figure1. Flowchart

The value of traffic load is approximated to 0 when the current cell is regarded as the lightly loaded cell and as the number of mobile nodes increase, the traffic load is taken as 1. The current cell becomes a hotspot. The hd value used in the algorithm is called hotspot threshold. If the ratio of number of available resources by number of total resources is less than hd, then that cell have hotspot status.Figure 1 shows the Adaptive RSS algorithm. As shown in Figure 1, when the RSS of the serving cell is less than threshold value, it sends the load information request message to the target cell and receive load information response message from the cell. The target cell calculates the amount of traffic load using Equation (1). If the amount of available resources of the target cell is less than the hotspot threshold, hd, the current serving cell sends hotspot alarm message to the target cell .Then, target cell completes all the pending handover request & send hotspot release message to serving station. Now, handover is executed to target station(TS). In this proposed algorithm, the proper threshold value should be carefully selected in order not to degrade the service quality of other users. The previous work used fixed RSS to initiate the handoff process. An adaptive RSS threshold is recommended to use so that the mobile has enough time to initiate the handoff process.. The algorithm has been modified by applying a mathematical formulation for controlling the handoff time and called as an adaptive RSS threshold (thres_min).

3. ADAPTIVE HANDOVER INITIATION TIME

The Adaptive RSS algorithm can recognize the load status of the neighbouring cells with the load information message in advance, before handover execution. After receiving the load information message, the proper threshold value should be carefully selected in order to initiate the handover process. In this algorithm, we use the mathematical equation to control the handover time& thres_min according to the load status of cells, mobile's speed and handover signalling delay.

$$Pf = a\cos(d/v\tau)/a\tan(a/2d) \quad (2)$$

$$Pa = 1-(1/\pi)*\theta 1 \quad (3)$$

This equation(2)[8] and equation(3)[8] is used to calculate probability of handoff failure(pf) & Probability of false handoff initiation(pa) respectively. First, we calculate d for a desired value of pf using (1),where d is MT's distance from the boundary of the serving BS, τ is the handoff signalling delay , a is cell size and$\theta 1$ =atan(a/2d) as shown in figure 2

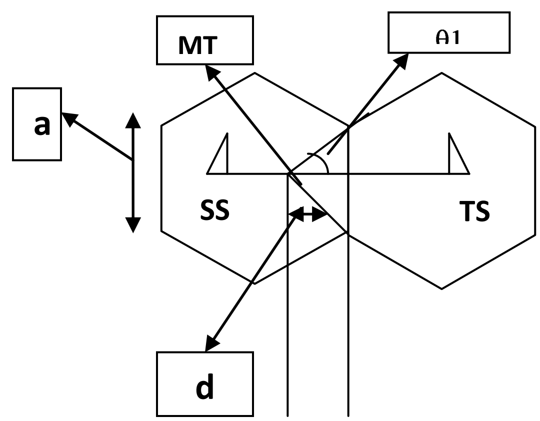

Figure.2 Analysis of probability of hand off failure & Initiation as MT moves from SS TO TS

Then the required value of thres_min is selected by equation 4

$$thres\_min = RSS(min) - 10\alpha\log(a-d)+\varepsilon[db] \quad (4)$$

Equation 4 is derived from path loss model, where $\alpha$is path loss coefficient.The thres_min value should be carefully selected in order not to degrade the service quality of other users. Adaptive threshold value avoids too early or too late initiation of the handoff process (registration). They are completed before the user moves out of the coverage area of the serving network.

4. RESULTS & DISCUSSIONS

The simulations are performed in Matlab. For simulations following scenarios and parameter are considered.

- Hexagonal cell radius(a)=1 km
- Max speed of mobile(v) = 100 km/h
- Standard deviation of shadow fading,
  $\varepsilon=8dB$

- Path-loss coefficient, α= 4
- Minimum value of RSS = -64 dBm
- thres_serving= -74 dB
- thres_target =-79 dB
- thres_normal= -79 dB
- hys_acceptable =3 dB
- hys_min =0 dB
- hys_normal=2 dB
- Cell Capacity=10

4.1 Variation of cell status on the basis of hotspot threshold

Hotspot identification is very important step in the given algorithm. If target station is a hotspot cell , the given algorithm delays the handover process to the target cell. In the mean time, the target cell completes all the pending handover We can see in figure.3 as number of available resources(channel) increases, the cell looses their hotspot status. It is therefore very much important to choose a proper value of hotspot threshold. If high threshold value(hd) is chosen ,it leads to unnecessary wastage of resources and time. For hd=0.6, we can see its looses its hot spot status ,when number of available resources are 6. In the figure.3 Sa=1 represent hotspot status and Sa=0 as non hotspot.

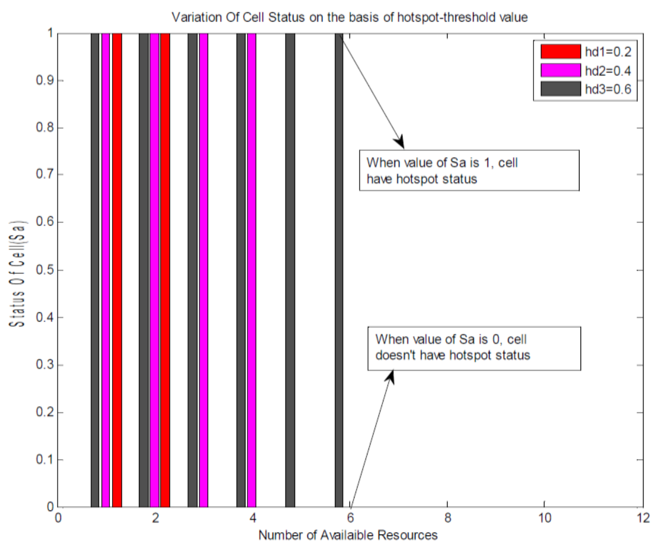

Figure.3 Variation of cell status on the basis of hd value

4.2 False Handoff Initiation Probability variation with cell size

It is clear from figure. 4, as value of d increases, probability of false handoff initiation(pa) increases. This leads to unnecessary wastage of wireless resources. This also increases load on network as false handoff initiation takes place. We can see, as the cell size is decreasing, the pa is increasing. As in next generation the smaller cell size is required to increase capacity, it is very much important to select a proper value of d, therefore thres_serving, to reduce probability of false handoff initiation.

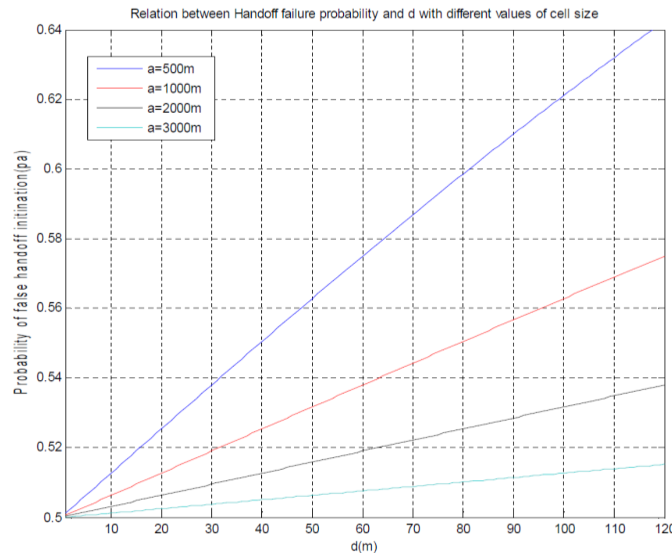

Figure. 4 Relation between handoff probability and d with different value of cell size

4.3 Relation between Probability of Handoff Failure (pf) and Handoff Signaling delay τ

In order to analyse this, the velocity of vehicle is kept constant 100 km./hr and result is analysed by varying the signal delay. It has been observed in figure.5 as handoff latency increases ,pf values increases for fixed value of thres_min .Higher the threshold value , lower will be the pf value. Therefore it is essential to predict the handoff delay in advance and then use an adaptive value of received signal to limit the handoff failure probability(pf) to a desired value. It is also observed that if proper signalling delay is used we can get desired pf value.

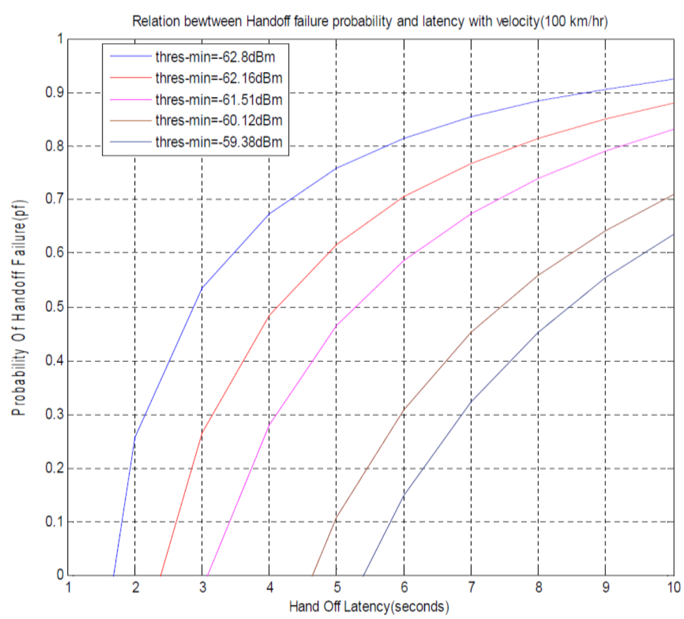

Figure. 5 Relation between probability of handoff failure and handoff latency

4.4 Relation Between Probability of Handoff Failure(pf) and Velocity

Equation 2 shows , if a fixed value of thres_min is used (hence, a fixed value of corresponding d) , the handoff failure probability depends on the speed of mobile terminal. The probability of handoff failure (pf) increases when MT's speed increases. The relationship between pf and MT's speed is shown in figure 6. As we can see in the figure 6a & 6b, the value of v increases, for particular value of d , pf increases for system handoff. This is because, as speed increases ,MT require less time to cover the region of serving station.The τ value of 3 represents intercellular handoff and τ=1 represents intracellular handoff.. It is observed for larger value of d ,pf value are smaller as compared to smaller values of d. This relation show that the value of d, therefore the value of thres_min, should be adaptive to the velocity of mobile terminal inorder to have required probability of handoff failure(pf).

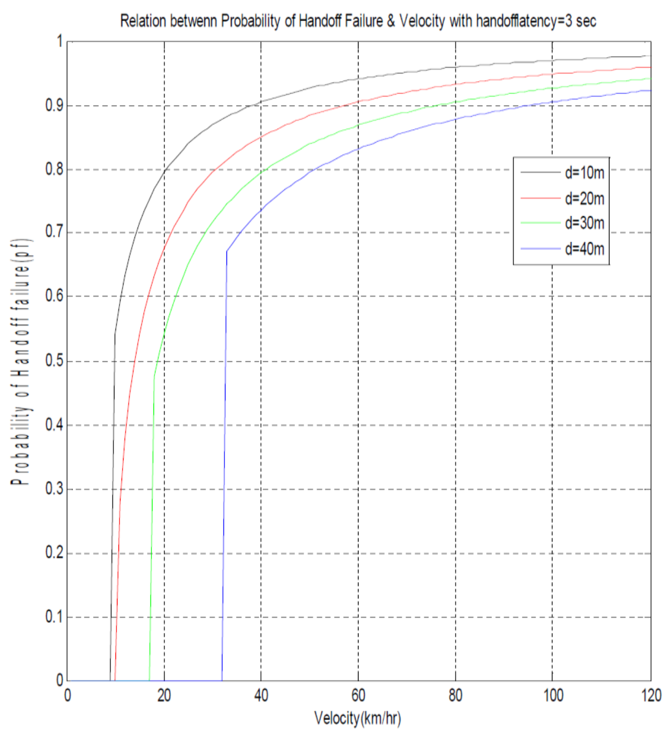

Figure.6.a. Relation between handoff failure probability and velocity

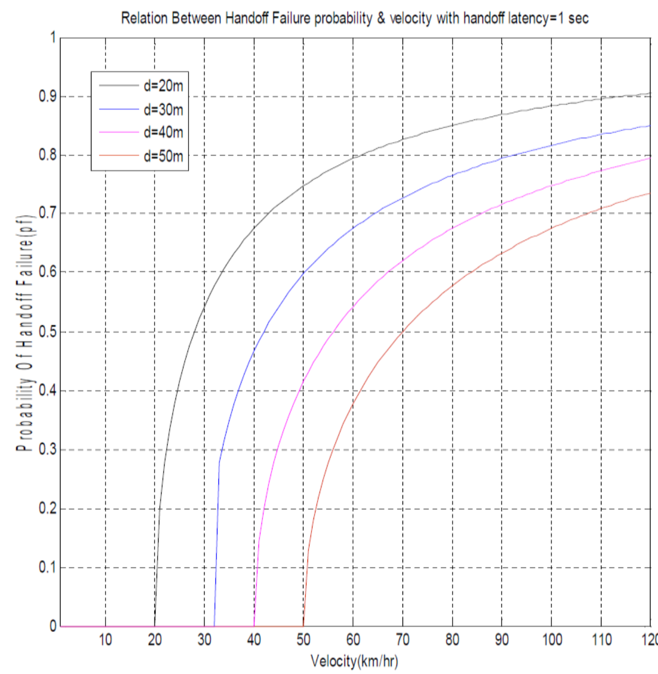

Figure 6.b. Relation between handoff failure probability and velocity

4.5 Relation Between Probability of Handoff Failure(pf) and Handoff Signalling Delay

Figure. 7, shows handoff failure probability increases as hand off latency time increases. Therefore it is very important to select handoff type before and than use adaptive value of thres_min to fix particular handoff probability. High latency refers to intercellular handoff whereas low refers to intracellular handoff.

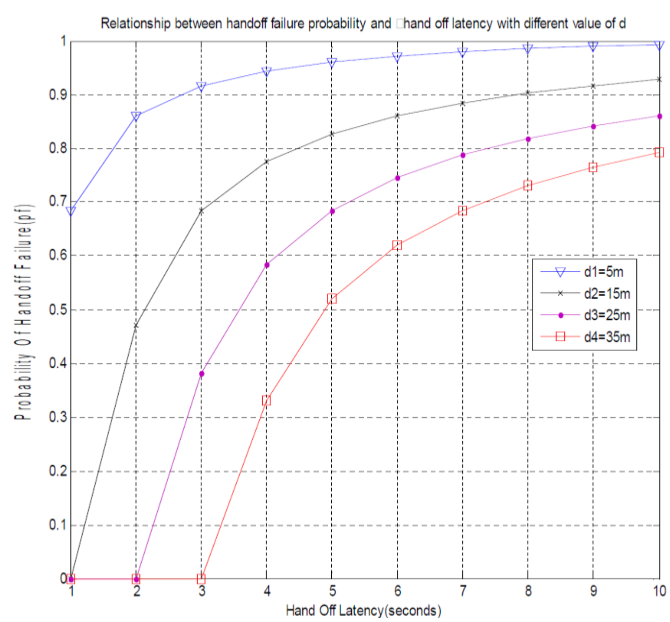

Figure.7 Relation between handoff failure probability and handoff latency

4.6 Relation Between Thres_min And Velocity

To determine the relation between thres_min and mobile terminal speed's(v),firstly the required value of d is determined. Here pf value is assumed to be 0.02. Then required value of thres_min is calculated. Figure. 8 shows , thres_min increases as mobile speed increases for particular value of τ. This is because for the MT with slow speed, the handoff initiation should start later compared to a high moving mobile terminal. The result also show that thres_min decreases as τ decreases. This implies for the MT's with high τ, the hand off initiation should start later., compared to mobile terminals having low τ

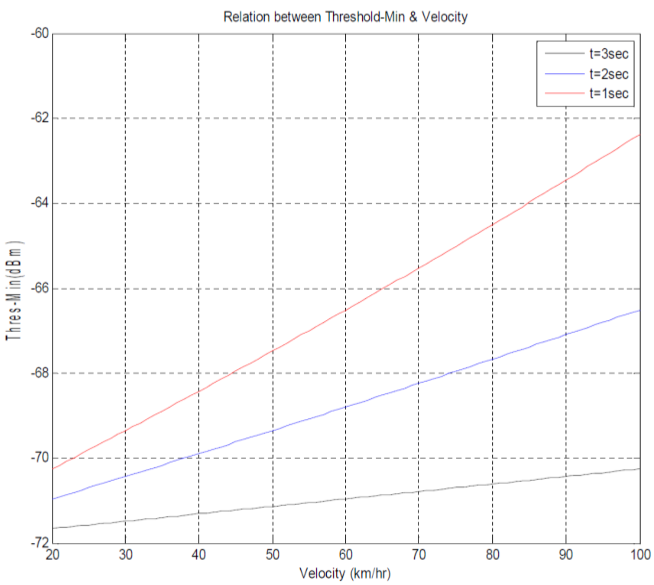

Figure.8 Relation between thres_min and velocity

4.7 Relation Between Probability of Handoff Failure(pf) and Velocity For Different Value Of Thres_min

In order to analyse this, the handoff latency is kept as 5 seconds and result is analysed by varying the velocity. It has been observed in figure.9 as velocity increases ,pf values increases for fixed value of thres_min .Higher the threshold value , lower will be the pf value. As we can see, for thres_min value of -59.38 ,even at the speed of 120 km./hr, the pf value lies between 0.1 to 0.2 Therefore it is essential to know the velocity of mobile terminal and then use an adaptive value of received signal to limit the handoff failure probability(pf) to a desired value.

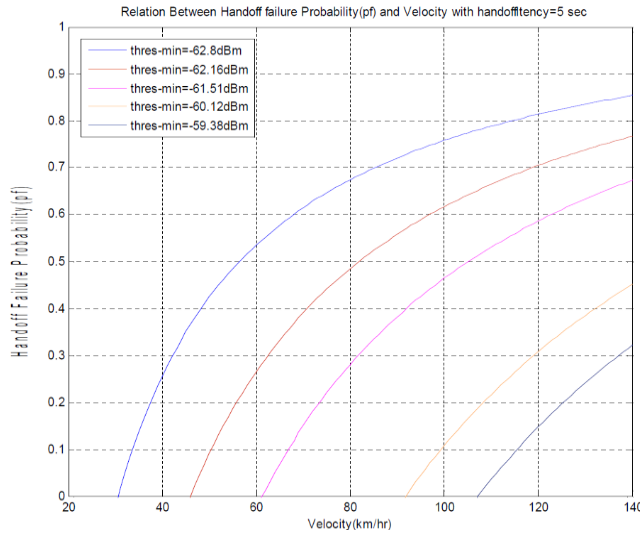

Figure. 9 Relation between probability of handoff failure and velocity

4.8 Comparison between Fixed and Adaptive RSS Algorithm

In fixed RSS algorithm, fixed value of thres_min is used. It is calculated such that a user with highest speed is guaranteed the desired value of handoff failure probability (pf). Here desired value of pf is taken as 0.2 and handoff latency is taken as 1 second. In case of Adaptive RSS algorithm ,according to the speed of mobile terminal , d is calculated for desired handoff probability . With that calculated value of d , thres_min is calculated for handoff to take place. As in fig. 10b ,it is Observed that with increase in velocity, pa for adaptive handoff algorithm increases whereas pa for fixed RSS algorithm remain constant,as it is calculated for maximum velocity of mobile terminal(100 km/hr).After 100 km/hr , pa of Adaptive RSS crosses fixed one as we assume maximum speed in fixed RSS as 100 km/hr. For velocity values lesser than 100 km/hr , the pa value of adaptive RSS is always less than fixed one. In Figure. 10a,we can see as in case of Adaptive algorithm thres_min is varying with velocity of mobile terminal. As velocity is increasing, thres_min value also increases ,whereas in case of fixed one ,the thres_ min is fixed. It shows that for high velocity MT , handoff initiation takes place earlier as compared to slow one. Thus thres_min is decided on the basis of velocity of mobile terminal and it leads to low hand drop call rate as compared to fixed RSS.

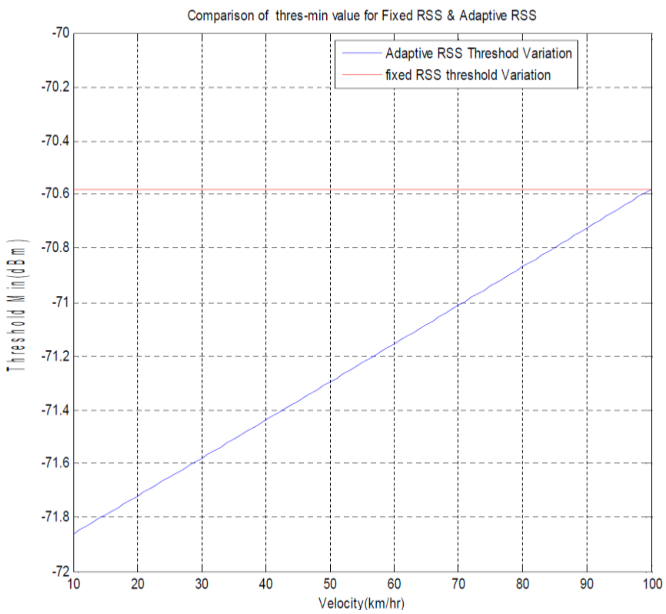

Figure.10a. Comparison between Fixed and Adaptive RSS

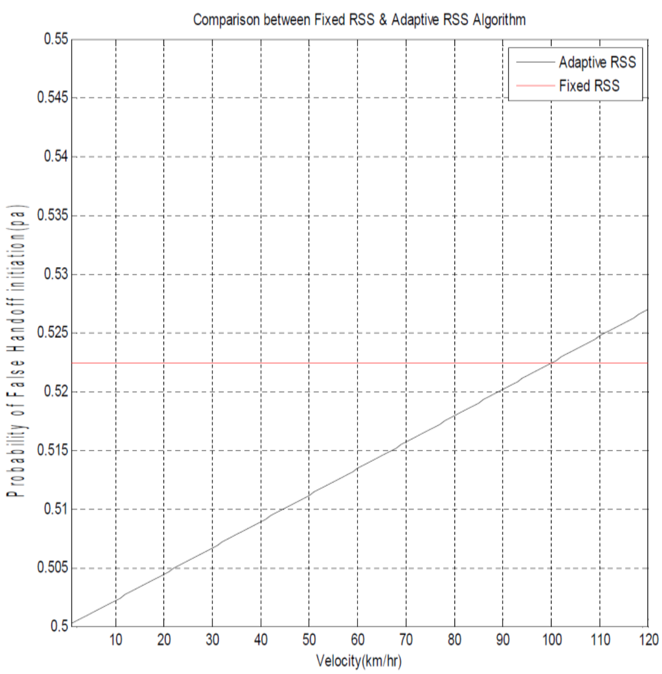

Figure.10b. Comparison between Fixed and Adaptive RSS

5. CONCLUSION

In the paper, we have presented a handover-based algorithm that adapts according to the load status of cells. A proper threshold value to control the handover initiation time according to the load status of cells, mobile's speed and handover types is used. This algorithm is developed to efficiently manage overloaded traffic in the cells and roll out the most precise or ideal time for handoff initiation. Also, a comparison of probability of handoff failure in case of fixed RSS and Adaptive RSS algortithm have been shown. Results prove that a better QOS is achieved in Adaptive RSS than fixed RSS scheme. This algorithm would help in removing the problems like call failures, interruptions in data transfer etc and also it provides the base for future work in the area that is adaptive techniques in wireless network management.

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