Increasing The Number of Channel of cell by reducing Bandwidth of Guard Band

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Abstract : Now a days Handoff failure is a very challenging issue. This happen for several reasons. One is the number of channels are limited in a cell. In this article, we proposed a technique to increased the number of channels in a cell. Here we reduce the band gap between two channel. Guard band is used to prevent interference between radio band. Reducing the bandwidth of guard band, same amount of bandwidth which we reduced from the guard band are added to the effective useful band.So, by doing this we can increase the bandwidth of effective useful band.Each channel has a fixed size bandwidth, so the increasing bandwidth may occurs some extra channels.Hence, by using this we can increase the number of channel in a cell, which decreases the Handoff failure Probability.If there are available free channel then handoff initiation rate is increased and in that way we may reduce Handoff failure and can improve the probability of Handoff rate.

IndexTerms - Handoff, Channel distribution, Guard Band, Resource Block(RB), Guard Band principle, Effictive useful Band.

I. INTRODUCTION

A. Channel distribution

IEEE802.11b and IEEE802.11g operates in the 2.4GHz ISM band and use 11 of the maximum 14 channels available and are hence compatible due to use of same frequency channels. The channels (numbered 1to14) are spaced by 5MHz with a bandwidth of 22MHz, 11MHz above and below the centre of the channel. In addition there is a guard band of 1MHz at the base to accommodate out-of-band emissions below 2.4GHz. Thus a transmitter set at channel one transmits signal from 2.401GHz to 2.423GHz and so on to give the standard channel frequency distribution as shown in[Figure.1]. It should be noted that due to overlapping of frequencies there can be significant interference between adjacent APs. Thus, in a well configured network, most of the APs will operate on the non-overlapping channels numbered 1, 6 and 11. The graph is shown in figure 1.

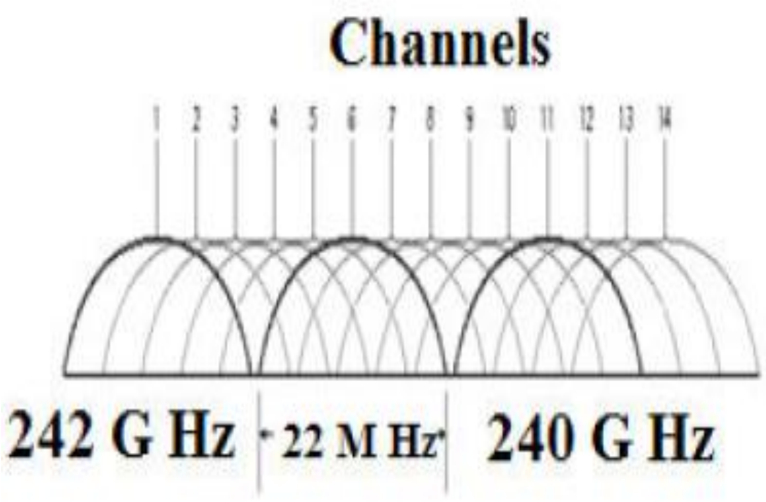

Figure 1 Channel Distribution

A guard band is a narrow frequency range that separates two ranges of wider frequency. A **guard band** is an unused part of the radio spectrum between radio bands, for the purpose of preventing interference.This ensures that simultaneously used communication channels do not experience interference, which would result in decreased quality for both transmissions. The Position of Guard band is shown in figure 2:

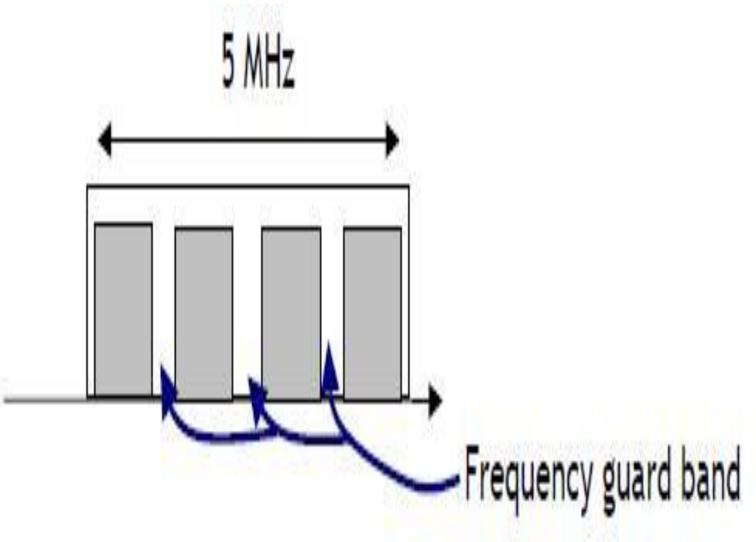

Figure 2 Frequency Guard Band

We can also say that about Guard Band as like, it is a spectrum's unused portion is intended to prevent crosstalk, or noise or interference from other modulated signals on the same transmission medium, such as AM or FM radio. The guard band concept applies to wired and wireless communications. It also simplifies the process of signal filtering for hardware, software or both.

The Guard Band in LTE has defined to be 10% of available bandwidth. As known, LTE technology offers several available channels bandwidth:

1. 1.4 MHz
2. 3 MHz
3. 5 MHz
4. 10 MHz
5. 15 MHz
6. 20 MHz

This means that different channels bandwidth will have different Guard Band, as shown in the following Table. Furthermore, it must to be clear in your mind that LTE protocol is defined to be an OFDMA System and channels are multiplexed in Resource Elements (RE) and Resource Block (RB).

B. **Guard Band and Useful bandwidth Calculation**

From Table. 1 it should be clear that only in the case of 1.4 MHz bandwidth the guard band does not correspond to 10%. In fact, it is equal to 320 KHz or 22.85%. Therefore, following it is possible to find an explanation about this difference between channel 1,4 MHz and the others. Guard Band calculation for 1.4 MHz bandwidth channel As we described before, for an LTE channel we will consider a Guard Band equal to 20% of the available bandwidth, distributed to 10% on the lower limit and 10% on the upper limit.

Therefore, the Useful Band available is:

$$B_u = 1.4\ \text{MHz} - (140\ \text{kHz} * 2)$$

$$= 1.4\ \text{MHz} - 280\ \text{kHz}$$

$$= 1120\ \text{kHz}$$

Since an RB has a spectral occupancy of 180 kHz (an RB is equal to 12 RE, each with 15 kHz) we can calculate the effective number of Resource Block assigned to this channel.

We have to remind the measure units in LTE are RE, RB and channel bandwidth. So, to calculate the right number of RB, we must to round down to the nearest number:

$$\textbf{RBs for 1.4 MHz} = \lfloor B_u / 1\ \text{RB} \rfloor$$

$$= \lfloor 1120\ \text{kHz} / 180\ \text{kHz} \rfloor$$

$$= \lfloor 6.22 \rfloor = 6$$

Now, we have an oddment of 0.22, that means:

$$180\ \text{kHz} * 0.22 = 39.6\ \text{KHz} \cong 40\ \text{kHz}.$$

Therefore, the guard band for to 1.4 MHz channel is equal to:

$$B_G = 280\ kHz + 40\ kHz = 320\ kHz \Leftrightarrow 160\ kHz + 160\ kHz$$

which is equal to 22,85% of 1,4 MHz.

Finally, the effective Useful Band is:

$$B'_u = 1.4\ \text{MHz} - 320\ \text{kHz} = 1080\ \text{kHz}$$

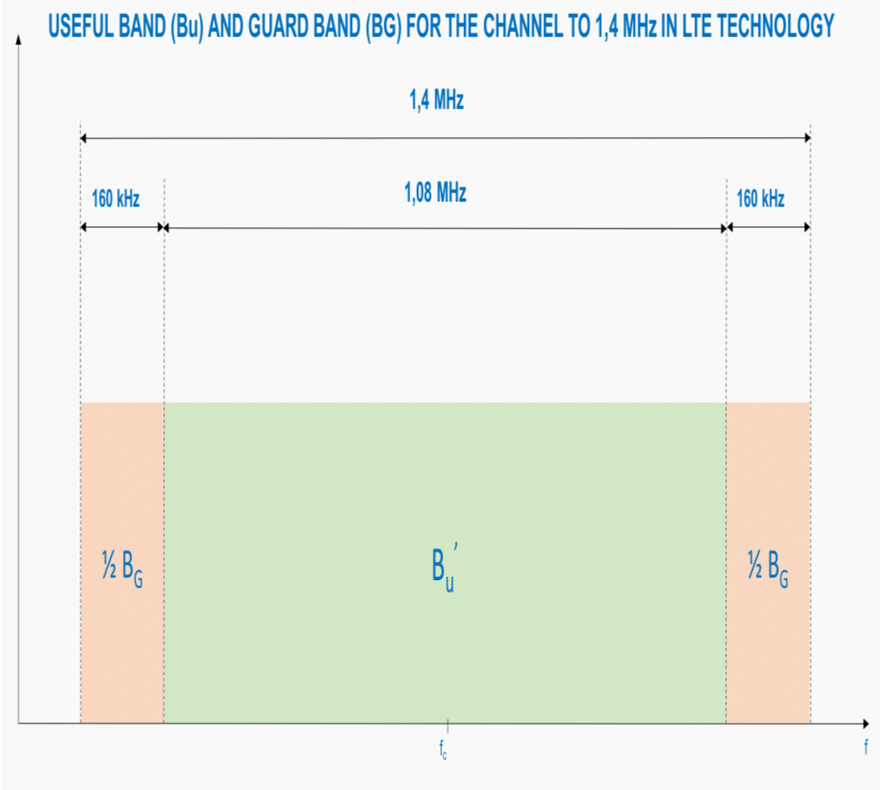

Figure 3: Useful Band and Guard Band for channel Bandwidth of 1.4 MHz

Guard Band calculation for all other bandwidth channel. Now it should be clear that using the above formula in all other bandwidth cases, the number of RB is an integer.

TABLE 1: CHANNEL BANDWIDTH, RESOURCE BLOCK(RB) NUMBER, USEFUL BAND AND GUARD BAND FOR LTE

Channel Bandwidth(MHz)	1.4	3.0	5.0	10.0	15.0	20.0
Number of RB in Frequency Domain	6	15	25	50	75	100
Useful Band(KHz)	1080	2700	4500	9000	13500	18000
Guard Band in each side(Kh=Hz)	160	150	250	500	750	1000

It means that the bandwidth is a multiple of RB plus the Guard Band (10%).

Guard band is the term for the unused part of the radio spectrum between adjacent radio bands. Originally created for the purpose of preventing interference, this narrow frequency range is used to separate two wider frequency ranges to ensure that both can transmit simultaneously without interfering with each other. In the UK, by utilizing the guard band spectrum licensed by Ofcom to TeleWare in May 2006 (PMN is a wholly owned subsidiary of the TeleWare Group), PMN enables companies to build a private network to carry GSM traffic between mobile phones used within the network and from mobile phones across intra-site IP networks and, therefore, without incurring mobile operator call charges.

II. GUARD BAND PRINCIPLE

The guard band principle for continuous data requires that the normal distribution is valid. Fortunately, there is ample evidence that this is a reasonable assumption (5). In this paper, the application of this principle is primarily to chemical-based testing and not process analytical technology or biological measurements.

It is necessary to evaluate a reportable value at or close to a regulatory or specification limit in terms of the inherent measurement uncertainty. The concept is summarized in **Figure 4**.

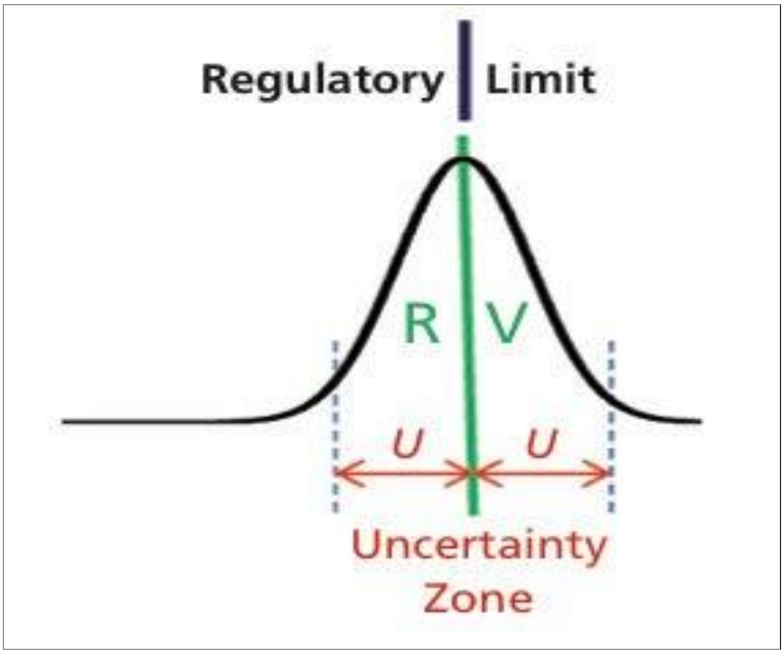

Figure 4 Concept of a guard band (±U) around a limit. RV is reportable value.

The difficulty comes in deciding how best to calculate the guard band (±U) for the reportable value derived from an analytical procedure. In principle, the total variance of an analytical procedure (s^2_{AP}) is estimated from the individual variance components using **Equation 1**:

$$s^2_{AP} = s^2_W + s^2_B + s^2_{SM} + s^2_{RS} \qquad \text{----------} \; (1)$$

where s^2_W is the within assay variance due to measurement process itself, is the between assay variance due to instrumental and operator effects, s^2_B is the assay variance due to the number of replicate samples, and s^2_{RS} is the variance introduced by the reference standard used.

Note that the contributions from the manufacturing process and the sampling process itself are explicitly excluded from the calculation of a guard band, which is entirely metrologically driven.

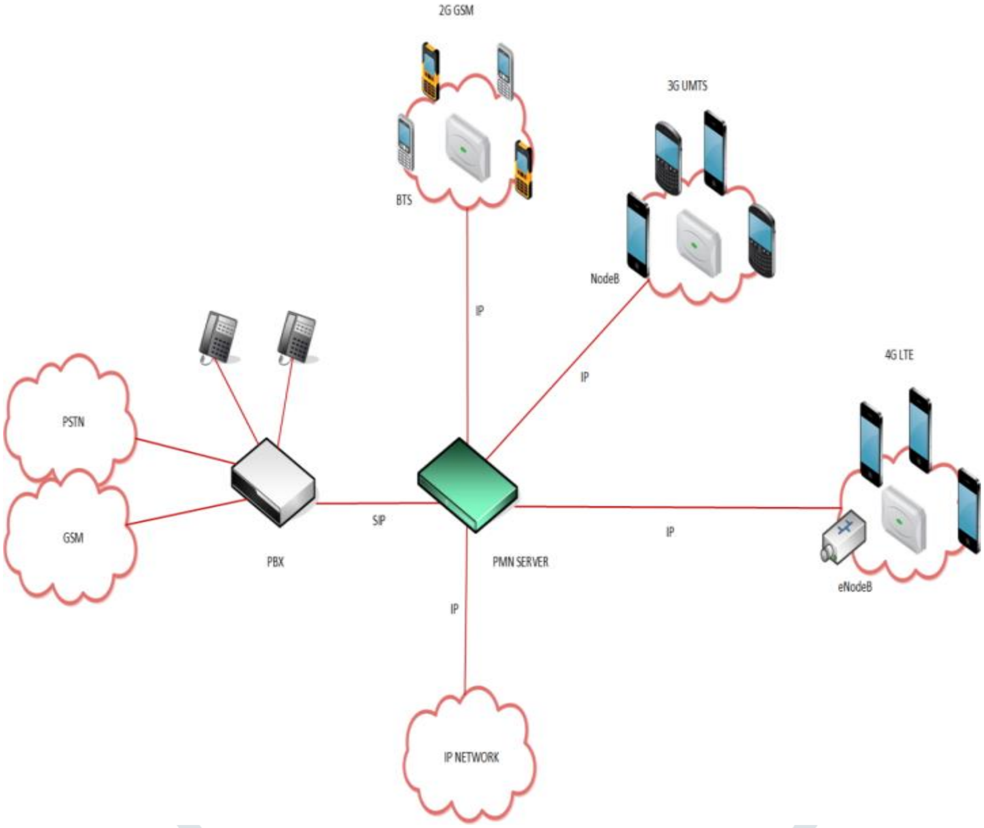

Figure 5: Structure of PMN server

The applications for Guard band spectrum extend beyond the immediate one of reducing call costs for a privet network mobile phone usage. Many enterprises have mobile users that are small office or remote location workers, and PMN also provides a solution for those who do not have sufficient signal for mobile use.

Guard band spectrum solutions operate at a lower frequency so are less power hungry, providing both a green alternative and less drain on the mobile phone battery. It also has less likelihood of experiencing interference with other electronic signals making it suitable for use in retail and industrial areas where other equipment may be in use. Outside of the UK, PMN(Private Mobile Network) will operate with third party operators of guard band spectrum.

III. RELATED WORKS

In recent times, a large amount of research is done in improving the handoff technologies of cellular as well as IEEE 802.11 based networks. In the past few years, many methods based on neighbor graph [1] and geo-location on APs [2] has been proposed, where the authors have proposed selective channel mechanisms. In [3] Li Jun Zhang et a. proposes a method to send probe requests to the APs one after the other and perform handoff immediately after any AP sends the response. This allows us to scan fewer channels. All these processes involve scanning of APs, it may be selective or all APs may be scanned. These methods are therefore time consuming as well as have a certain probability of handoff failure. In [4] and [5], authors use GPS based access point maps for handoff management. Handoff using received signal strength (RSS) of BS has been proposed previously. Using dynamic threshold value of RSS for handoff management for MSs of different velocities has been described in [6].

IV. PROPOSED WORK

In our Proposed work, we reducing the gap of Guard band,and use it as effective useful band.

We assume that,

There are total n number of channels.

So, it means there (n + 1) number of Guard band are available.

Suppose, total spectrum allocation of n channel is = L

Hence, bandwidth of a single channel is = L/n

Again assume that, bandwidth of each Guard band of a channel is = $B_{g.}$

From earlier discussion, we know that guard band takes 20 % of bandwidth from available bandwidth of channel, distributed to 10% on the lower limit and 10% on the upper limit.

So the expression of Bg is expressed as,

Bg = (L / n * (20 / 100)) or Bg = ((L / n)*2 *(10/100))

So, we can say that, the effective useful band of a channel (B_u) is = (L/n - B_g)

We know that a Guard **band** is an unused part of the radio spectrum between radio bands, for the purpose of preventing interference. It has a risk factor which is 1:6.

But in our Proposed work we make it half of 20 %, distributed to 5 % on the lower limit and 5 % on the upper limit.In other word we can say that, the risk factor is reduced from 1:6 to 1:3 i.e. half of the previous bandwidth of guard band. .So the bandwidth of each Guard band is reduce to became (Bg / 2). Shown in figure 7, And the effective useful band of a channel is increased,

which became = **(L / n -Bg + B_g / 2).**

So ,the effective useful band is increased = **(L / n - B_g + B_g / 2) - (L / n -B_g)**

=B_g/2

L/n is bandwidth of = 1 channel

So, Bg/2 is bandwidth of = 1* (B_g/2) channel

So now the total number of channel became = n + B_g/2 = N

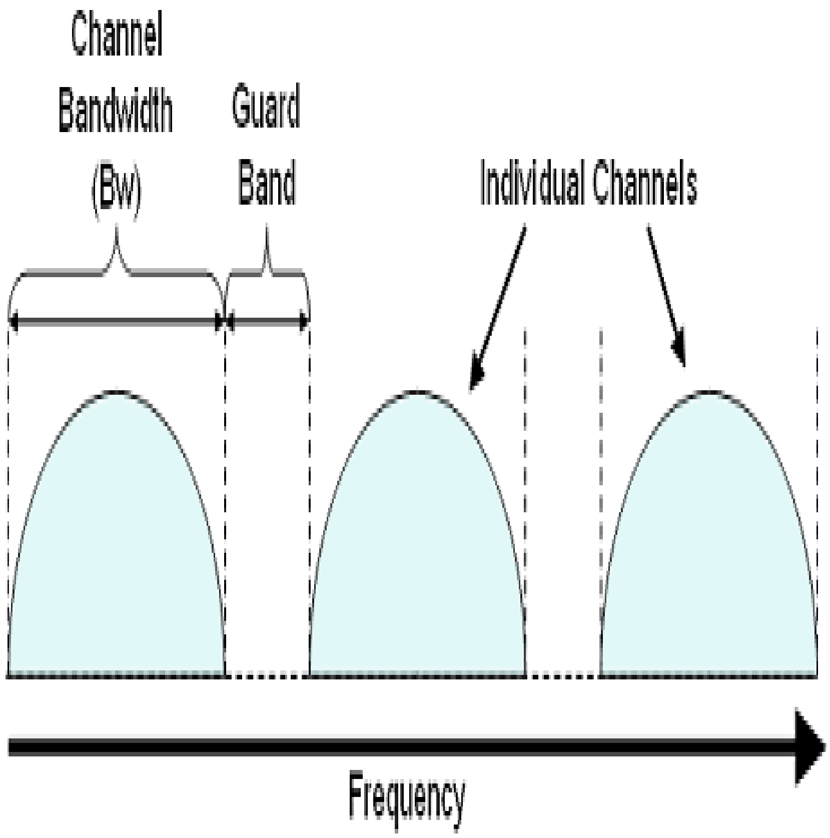

Figure 6 Guard Band and and useful Bandwidth of channel

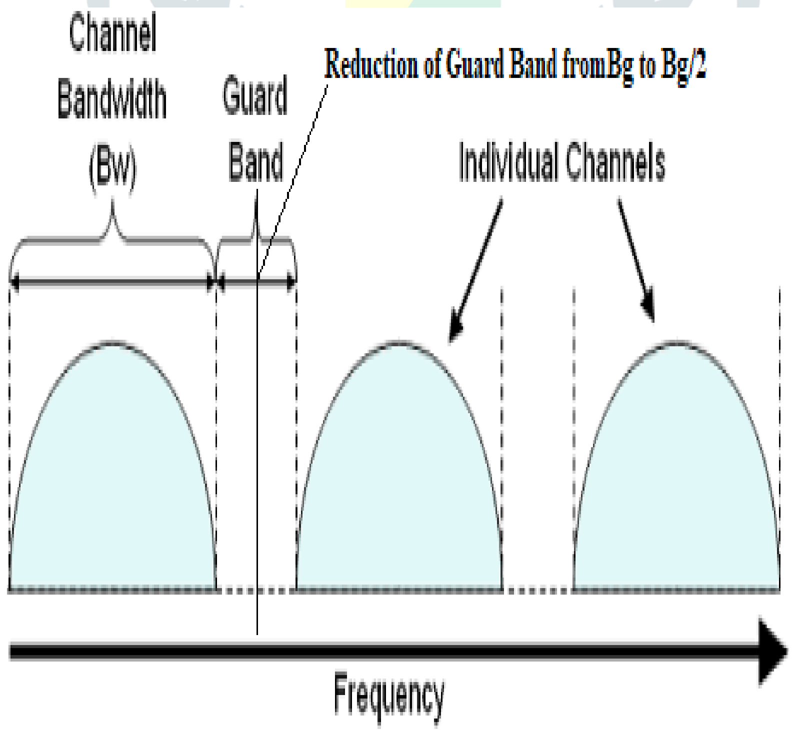

Figure 7 Reduction of Guard Band from Bg to Bg / 2

Here we summarize the technique in step by step:

1. Determine the total spectrum of n channel, say L.
2. Calculate the Bandwidth of a single channel, that means L / n.
3. Now calculate Bandwidth of Guard band depends on the bandwidth of channel.
4. Then subtract it from the bandwidth of a channel and calculate the effective useful band.

Now,In our Proposed work:

5. We reduce the bandwidth of Guard band upto 50 percent.
6. Add this reduced bandwidth of the Guard band to the effective useful band.
7. So, the effective useful bandwidth of the channel is increased.
8. After that, we calculate number of channel(s) from this increased bandwidth, which we get from by reducing of guard band bandwidth.

So, we can say that, using this technique the number of channels of a cell is increased and for this reason the drop of call is decrease, i.e.Handoff failure probability reduced.

V. SIMULATION RESULTS

By reducing the Bandwidth of Guard band we can increase the number of channels of a cell. So, by using this method we may avoid call drop, that means Handoff failure Probability reduced. Handoff Failure Probability reduction means enhancing the rate of Handoff, i.e. reducing Handoff initiation time.The graph is shown in figure 8:

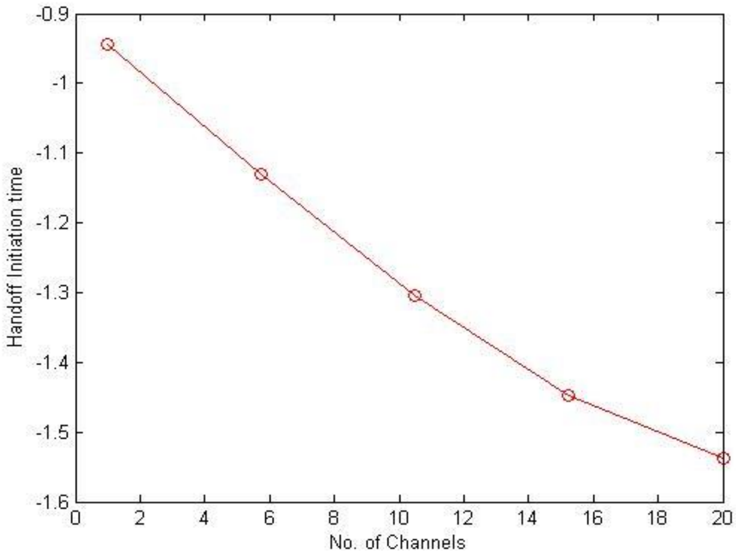

Figure 8 Number of Channel Vs. Handoff Initiation Time

VI. CONCLUSION

In this paper have introduced the distribution of channels. Here we also discuss about Guard band and the occurance of Guard band between channels, including their usages. In our proposed work we have introduced a novel technique by reducing the bandwidth of the Guard band and increasing the effective useful band with the same ratio. By doing this, we may reduce the failure probability of handoff by avoiding the call drop. The possibility of call drop is decreased because of the increasing the number of channel in a cell.

ACKNOWLEDGEMENT

We would like to convey our hearty respect and sincerest gratitude to our respected research advisor Dr. Debabrata Sarddar for sparing his valuable time and assimilating new flawless ideas at every stage of our work. Without his kind co-operation, motivation, and careful guidance, we would not have been able to carry out this research work successfully.We would also like to acknowledge DST-PURSE-II Programme for their kind co-operation.

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