An Intelligent Handoff Algorithm for Cellular Networks

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ABSTRACT

In this study, an intelligent multi-criteria handoff algorithm that allowed for the selection of the optimal network segment based on a variety of parameters was designed and analyzed. The suburban area environment was taken into consideration in this study. The four input parameters that have been taken into account are the BTS traffic load, RSS, Path-Loss, and SNR. The general architecture of the suggested algorithm consists of the inputs, fuzzy inference engine, fuzzy rule base, de-fuzzifier, and fuzzifier. The handoff decision was used to determine whether or not handoff is the output of the fuzzy inference system. The handoff decision was the only output parameter of the FIS. The suggested algorithm takes a range of -50dBm to -100dBm for RSS, 50dB to 140dB for path-loss, and 50dB to 50dB for SNR, from lowest to highest. The traffic load on the BTS spans from 0% to 100%. The results showed that the probability of the required handoff was lowest when all the parameters are excellent. On the other hand, the probability of a handoff is maximum when all the parameters are at their worst. Also from the results, it was seen that the handoff index progressively rises as path loss increases, meaning that a MS with a higher path loss has a higher chance of being handed off than one with a lower path loss. In the event that the path-loss is becoming worse, a handoff must occur even if the remaining parameters are sufficient to continue a call. This will guarantee that calls won't be dropped as a result of the RSS degradation. It implies that in the event that the current serving BTS is failing, a mobile station would switch over to the target.

Keywords: Handoff, fuzzy, Path-Loss, intelligent, traffic load, de-fuzzifier

1.0 INTRODUCTION

The use of cellular systems is very common. The wireless revolution was sparked by these systems. Cellular systems offer nationwide and regional coverage for duplex voice and data communication. The frequency reuse pattern, which takes advantage of the fact that signal power decreases with distance to reuse the same frequency spectrum at spatially separated locations is the fundamental idea behind the design of cellular systems. The frequency band used by cellular systems is a very limited resource. Despite using aggressive frequency reuse and multiple access methods, mobile service providers still struggle with over-congestion as a result of increasing demand and scale. The level of traffic channel (TCH) congestion in the network causes a lot of TCH blocking, which has a negative impact on a mobile service provider's revenue and subscriber satisfaction (Hsin-Piao, *et al*., 2022).

The time and cost of implementation determine which congestion relief techniques, such as cell splitting, microcells, and expanding frequency bands, are available. A high degree of network performance is achieved by manually adjusting the network parameters. The solution to the cluster's unequal load distribution involves a lot of parameters. Among them are the following: timing advance (TA), handoff threshold, RXLEV-ACCESS-MIN, half-rate, transmitter power, and cell bar quality (CBQ) (Chandrasekhar and Behera, 2021).

A multi-criteria vertical handoff decision algorithm was presented by the authors in Chandralekha and Behera, (2019), and it chooses the best network with the optimal parameter value in a heterogeneous wireless environment. The multi-criteria vertical handoff decision metrics have been optimized through the application of neural network and genetic algorithm techniques. The optimal network segment was chosen by the authors in Faisal, *et al*., (2022) using fuzzy logic and the Multiple Objective Decision Making (MODM) technique. A handoff initiation scheme was implemented by research in Munuz *et al*., (2021) by combining several parameters from all available networks into a cost function. However, a Fuzzy Inference System (FIS) that only makes use of two input parameters, such as velocity and available bandwidth, was used to choose the target network. It is possible that the absence of other crucial parameters will lead to subpar outcomes. Fuzzy logic was used in a research paper in Majlesi, and Khalaj, (2020) to estimate the handoff requirement using only QoS and RSS. Fuzzy logic was used in the proposed algorithm in Honman and Benjapolakul, (2019) to handle erroneous traffic information, decide how to distribute loads, and maintain system stability. Regarding control, they looked at a novel strategy that details the means, timing, and BTS used to apply load balancing.

A module to determine whether vertical handoffs are necessary in a hybrid wireless environment was proposed by the authors in (Moshe and David, (2019). The investigated scheme measured the values of the network parameters obtained from the serving Point of Attachment (PoA) and other available wireless networks, and then used fuzzy logic to determine whether a Vertical Handoff (VHO) is necessary. Several parameters were used to calculate a VHO factor: the distance between the MS and the serving PoA; the predicted value of RSS; the degree of QoS provided; the speed of the MS, including its direction of travel (toward or away from the serving cell). This computed VHO factor is then compared to a threshold value that was predetermined based on the kind of serving cell in order to ascertain whether handoff is necessary. In order to minimize the call dropping probability of the MS caused by an abrupt drop in RSS, which was common in lognormal fading heterogeneous wireless networks, Grey Prediction Theory (GPT) was employed to predict future values of RSS. A dynamic load balancing algorithm based on sojourn time was presented by the authors in Chandrasekhar and Behera, (2021) for heterogeneous hierarchical wireless networks made up of macro- and micro-cell networks. The velocity, direction of motion, and local position of MS. Research were used to calculate the sojourn time in (Ali, *et al*., 2021). This research introduced a novel fuzzy logic-based load balancing algorithm for cloud computing, where load balancing is a fundamental and difficult problem. A fuzzy Q-was proposed by authors in (Akpado *et al*., 2020).

This study describes the design and execution of a fuzzy multi-criteria handoff algorithm that takes into account the signal to noise ratio (SNR), pathloss, traffic load on the BTS, and signal strength.

2.0 MATERIALS AND METHODS
2.1 Materials
a. Received Signal Strength (RSS)

The transmitted signal traveling through free space makes up the line-of-sight component of the received signal, and the transmitted signal reflected off the ground makes up the reflected component, (Ahmed and Saleh, 2021). Equation 1 shows that, independent of wavelength, the received power decreases to inversely the fourth power of d.

$$P_r dBm = p_t dBm + 20log_{10}(h_t h_r) - 40log_{10}d + G_r + G_t - losses \quad (1)$$

Where P_r is the received power in dBm, p_t is transmitted power in dBm, G_r is receiver antenna gain in dB, G_t is transmitter antenna gain in dB, h_t is transmitter height in meter, and h_r is receive antenna height in meter and d is the distance between transmitter and receiver in meter.

b. Signal to Noise Ratio (SNR)

It is important to note that co-channel interference, not the system's overall in-band noise, is what truly limits the efficiency and performance of cellular systems. This is due to the fact that the power of the unwanted signal is significantly greater than the total in-band noise (thermal, man-made) in the system; as a result, the noise can be disregarded, (Ibrahim, 2020).

Mathematically:

$$Signal\ to\ noise\ ratio, SNR = \frac{RSS}{I+N_s} \quad (2)$$

$$Signal\ to\ interference\ ratio, \frac{C}{I} = \frac{RSS}{I} \qquad for\ I >> N_s \quad (3)$$

Where RSS is the wanted signal power in dBm, I is the unwanted co-channel interfering signal power in dBm and N_s is the total in-band noise power in the system. The spectral efficiency of the modulation technique in the cellular system can be influenced by the signal to interference ratio, which is a useful indicator of its effectiveness.

c. Geographical Model with Second Tier

The relative geographic locations of the serving and interfering BTS in relation to the mobile station are taken into account when building this model (Fakhreddine and Clarence, 2019). The propagation loss over the flat earth and signal path loss resulting from free space are taken into account by the model. Six BTSs on the first tier, 12 BTSs on the second tier, 18 BTSs on the third tier, and so forth, can interfere with a mobile user in the center BTS.

At the MS user, which is being served by BTS on the center of the cluster, the RSS is given by equation 4.

$$RSS \propto \frac{1}{R^{a}} \tag{4}$$

Where R is distance between a MS and BTS in meters and α path-loss constant. The total interference from all the co-channel cells is given by equation 5, (Fakhreddine and Clarence, 2019).

$$I \propto \left[\frac{6}{D^{a}} + \frac{12}{(2D)^{a}} + \frac{18}{(3D)^{a}} + \frac{24}{(4D)^{a}} + \cdots\right] \tag{5}$$

$$I \propto \left[\frac{6x1}{D^{a}} + \frac{6x2}{(2D)^{a}} + \frac{6x3}{(3D)^{a}} + \frac{6x4}{(4D)^{a}} + \cdots\right] \tag{6}$$

Where D is the frequency re-use distance in meter and α = 4. Hence:

$$I \propto \sum_{M=1}^{T} \frac{6m}{(mD)^{a}} \tag{7}$$

Where T is the number of tier and α path-loss constant

$$\frac{RSS}{I} = \left(\frac{D}{R}\right)^{\alpha} \frac{1}{6\sum_{M=1}^{T}\frac{1}{m^{\alpha-1}}} \tag{8}$$

Where T is the number of tier and α is path-loss constant

For second tier co–channel cell, equation 8 will reduce and the third and higher tier can be ignored. Equation 9 is Taylor series.

$$SNR = \frac{RSS}{I} = \frac{\left(\frac{D}{R}\right)^{4}}{6.75} \tag{9}$$

In dB, equation 9 will be reduced to:

$$SNR = \frac{RSS}{I} = 40log_{10}(D) - 40log_{10}R - 10log_{10}6.75 \tag{10}$$

Where the $Re - use\ distance\ (D) = \sqrt{21}\ \ R\ for\ seven\ cluster\ cells.$

d. Justification of Geographical Model

The analytical results for propagation over a plane earth or two-ray models have been derived, (Fakhreddine and Clarence, 2019). For the BTS and mobile station elevated heights h_t and h_r respectively above the ground level and separated a distance d apart, the received power p_r is given in terms of the transmitted power pt as:

$$RSS = P_r = G_{ts}G_r\left[\frac{h_{ts}h_r}{R^2}\right]^2 p_{t(s)} \tag{11}$$

p_r is the desired signal power received at the MS from the serving BTS, $p_{t(s)}$ is the transmitted power from the serving BTS, h_{ts} height of the serving BTS antenna in meter, h_r height of the mobile station antenna in meter, G_{ts} is the serving BTS antenna gain and G_r the mobile station antenna gain. R is the distance between the MS and BTS in meter.

Similarly for the interfering signal power from the interfering BTS:

$$I \approx 6.75G_{ts}G_r\left[\frac{h_{ti}h_r}{D^2}\right]^2 p_{t(i)} \tag{12}$$

I is the unwanted signal power received at the mobile station from the interfering BTS, $p_{t(i)}$ is the transmitted power from the interfering BTS, h_{ti} height of the interfering BTS antenna in meter, h_r height of the mobile station antenna in

meter, G_{ts} is the interfering BTS antenna gain and G_r the mobile station antenna gain and D is the frequency re-use distance in meter.
Hence combining equations;

$$\frac{RSS}{I} = SNR = \frac{G_{ts}G_r\left[\frac{h_{ts}h_r}{R^2}\right]^2 p_{t(s)}}{6.75G_{ts}G_r\left[\frac{h_{ti}h_r}{D^2}\right]^2 p_{t(i)}} \tag{13}$$

From equation (13), it can be shown that SNR can be maximized by maximizing G_{ts}, h_{ts} and $p_{t(s)}$

$$SNR = \frac{RSS}{I} = \frac{\left(\frac{D}{R}\right)}{6.75}\ same\ as\ equation\ (9)$$

Which agrees with equation (9) based on the assumption there is equal radiated power on the entire cellular system and the same system with in cellular system

2.2 Method

It is thought of as an omnidirectional GSM cellular network. Every cell has 100 TCHs and is serviced by a central BTS. It is assumed that mobile users within a BTS's coverage area are dispersed normally. The suggested algorithm is to be located at the single BTS Controller (BSC), to which all BTSs are connected. An MS gathers data from all nearby BTS as well as a current serving BTS to calculate RSS, Path-loss, and SNR. Every 480 milliseconds, the mobile station completes this measurement report, which it sends to the BTS via a shared control channel, (Fakhreddine and Clarence, 2019).

The suburban area environment was taken into consideration in this study. When a BTS is close by and has a low or medium load, it is assumed that the coverage area of the cell sector can be virtually extended to include a portion of the BTS's serving area. This assists a close-by heavily loaded BTS. The suggested algorithm receives input from the four parameters. The general structure of the suggested multi-criteria handoff algorithm is depicted in Figure 1.

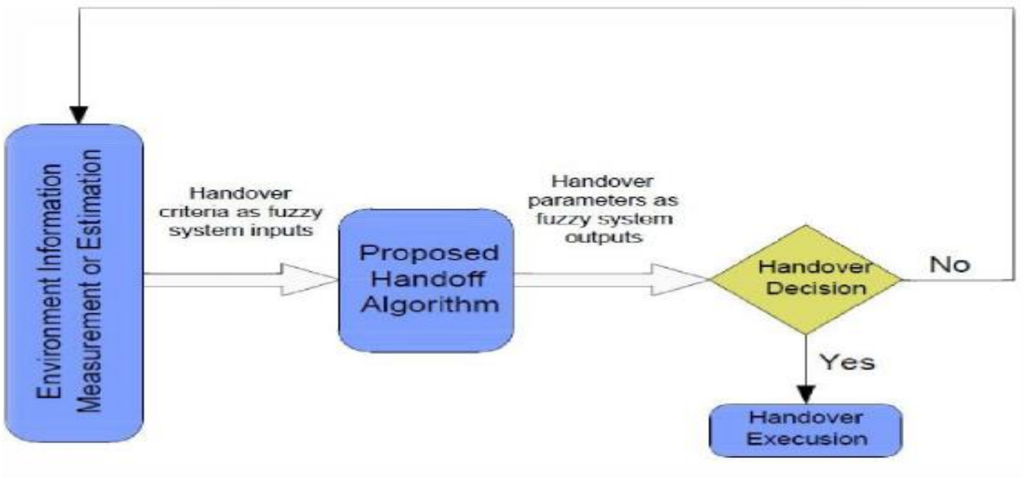

Figure 1: General Structure of the Proposed Multi-Criteria Handoff Algorithm

The FIS output ranges from 0 to 1, where 1 represents a precise handoff and 0 represents no handoff. When the FIS output is almost zero, an MS is ideally served by a better BTS, negating the need for a handoff. Conversely, if the FIS output is close to 1, the mobile station's performance has declined, necessitating a handoff to a better BTS.
The four input parameters that have been taken into account are the BTS traffic load, RSS, Path-Loss, and SNR. The general architecture of the suggested algorithm, complete with inputs, fuzzy inference engine, fuzzy rule base, de-fuzzifier, and fuzzifier, is depicted in Figure 2. The handoff decision, which is used subsequently to determine whether or not handoff is the output of the fuzzy inference system.

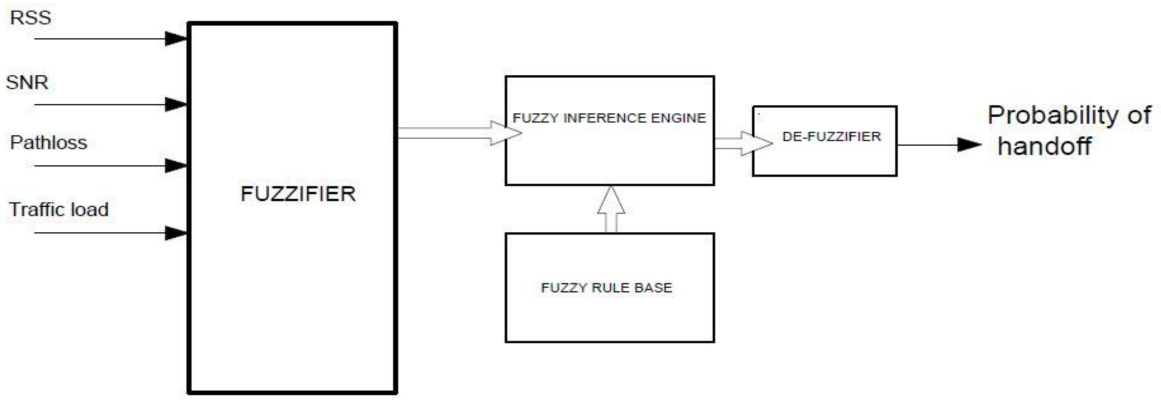

Figure 2: Structure of the Proposed Algorithm

The handoff decision is the only output parameter of the FIS. The suggested algorithm takes a range of -50dBm to -100dBm for RSS, 50dB to 140dB for path-loss, and 50dB to 50dB for SNR, from lowest to highest. The traffic load on the BTS spans from 0% to 100%.

a. Fuzzification of the Input Parameter RSS

Figure 3's fuzzy logic controller (FLC) is made to ensure that the MS hands off before the RSS drops below the minimal network values needed to maintain the quality of the service that is being used at the moment. The range of speech for RSS is -50dBm to -100dBm, as Figure 3 illustrates. As a result, three membership functions are used for RSS, and the same is true for traffic load, SNR, and path-loss. The range of weak RSS is -100dBm to -75dBm. Because of the deteriorating RSS, there is a higher chance of handoff for the MS in this region. The overall quality of the current application session declines if this parameter drops below a threshold, which eventually leads to a decrease in end-user satisfaction and a call drop.

The suggested algorithm has to carry out handoff before calling drop, even if the other parameter meets the necessary threshold for calls to continue. This cutoff is -100dBm for Airtel Nigeria's GSM 900MHz spectrum.

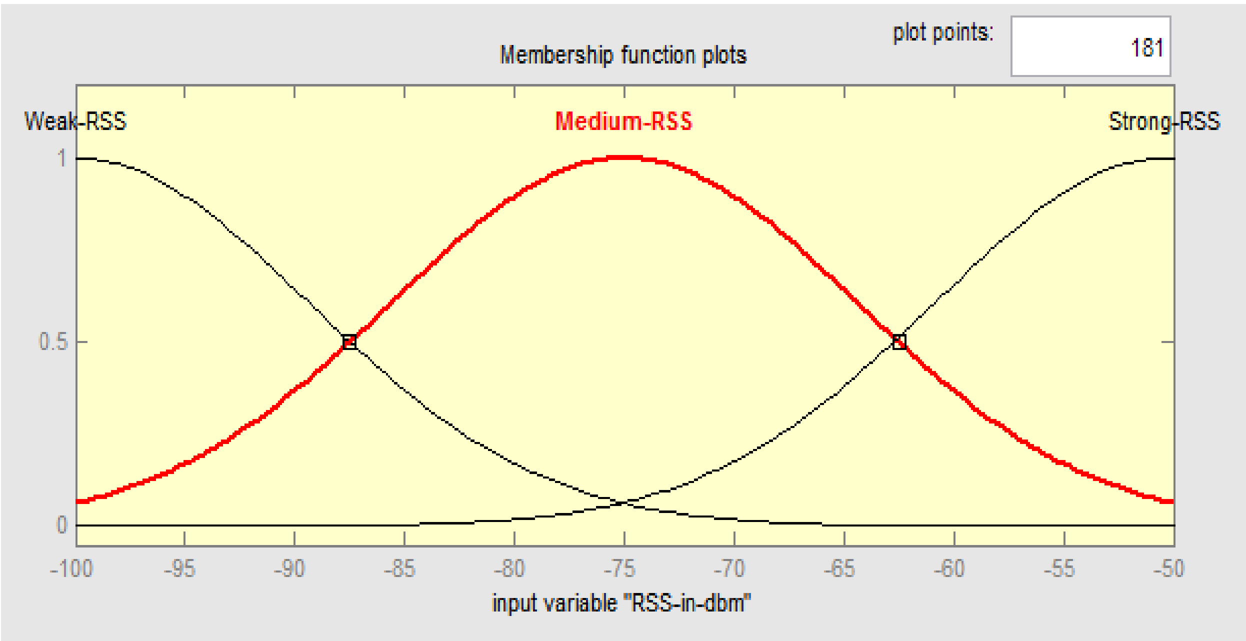

Figure 3: Membership Functions of RSS

b. Fuzzification of the Input Parameter SNR

A device's output noise level in relation to the signal level is measured using a metric called signal-to-noise ratio, or SNR. This factor typically dictates which service provider out of all of them to select. More subscribers have been served the better this parameter is maintained. Degraded quality of service results from the overall call value decreasing if SNR falls below the operator-set minimum threshold. Low SNR is between 0dB and 25dB, while the discourse range for SNR is between 0dB and 50dB. A MS in an area with low signal-to-noise ratio has a high likelihood of handing over to nearby BTSs. It is up to the rule base to decide this.

In Figure 4 FLC is intended to ensure that the MS executes handoff before the SNR drops below the minimal network requirements. This value in Airtel Nigeria is 9dB.

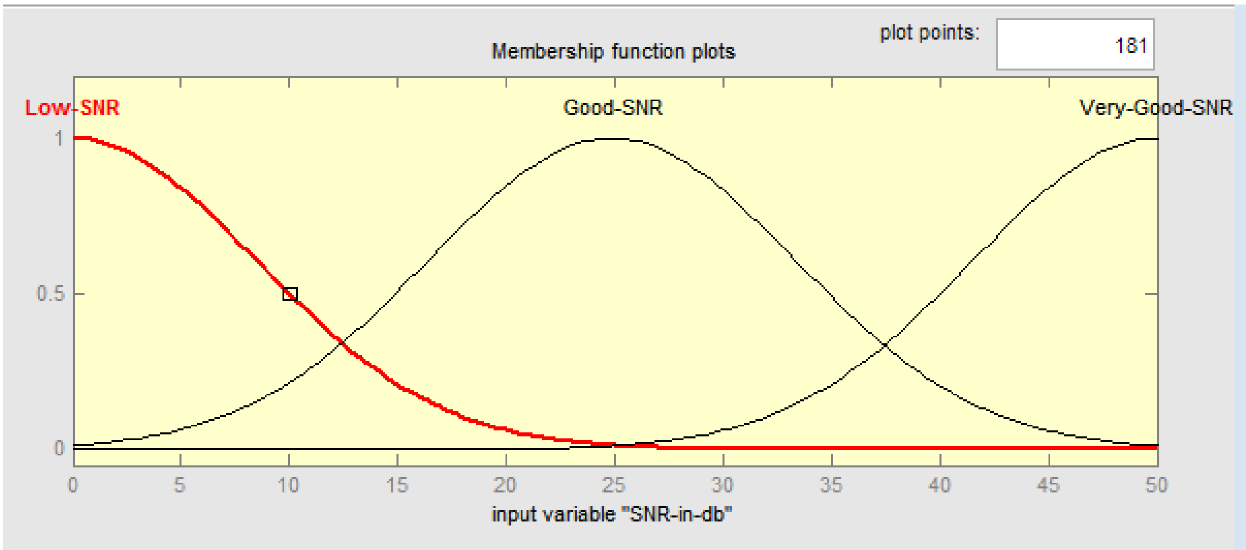

Figure 4: Membership Function of SNR

c. Fuzzification of the Input Parameter Path-loss

Figure 5 summarizes the discourse universe for Path-loss, which is between 50dB and 140dB. A high path-loss ranges from 95 to 140 dB. The purpose of the FLC in Figure 5 is to ensure that the MS executes handoff before the Path-Loss factor surpasses a maximum network value necessary to maintain the quality of the service that is currently being used. In Artel, a path-loss of more than 120 dB is regarded as a call-sustaining constraint.

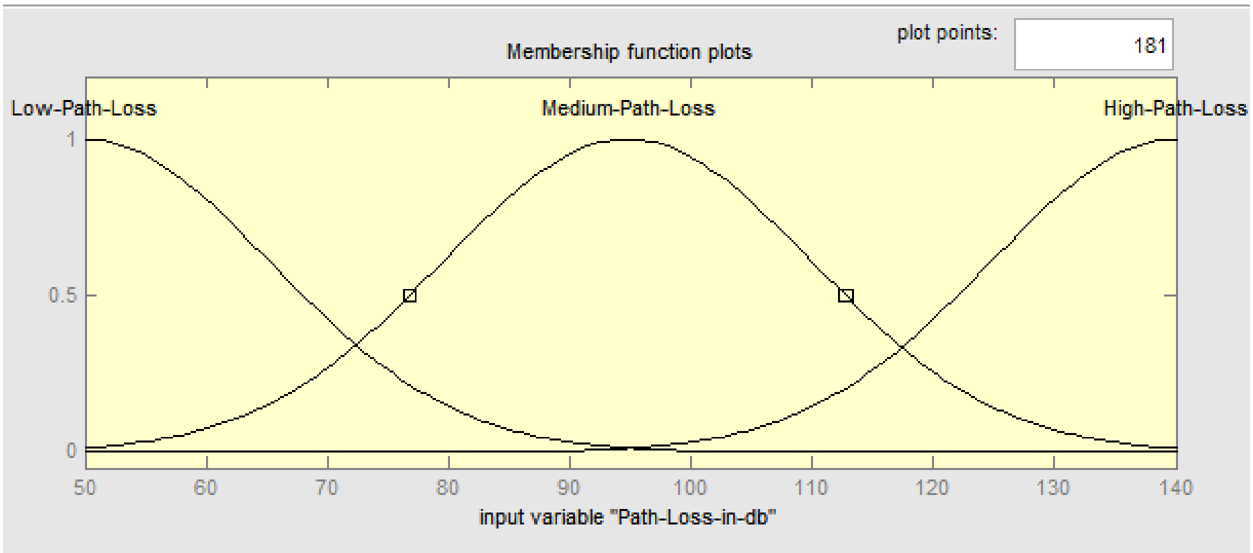

Figure 5: Membership Function of Path-loss

d. Fuzzification of the Input Parameter Traffic Load

Figure 6 illustrates the range of discourse for traffic load, which is 0 to 100%. A cell is deemed a high load BTS in Airtel when 90% of its traffic load has been utilized. The purpose of the FLC in Figure 6 is to ensure that the MS completes the handoff before the serving BTS becomes completely packed, leaving some channels available for incoming calls.

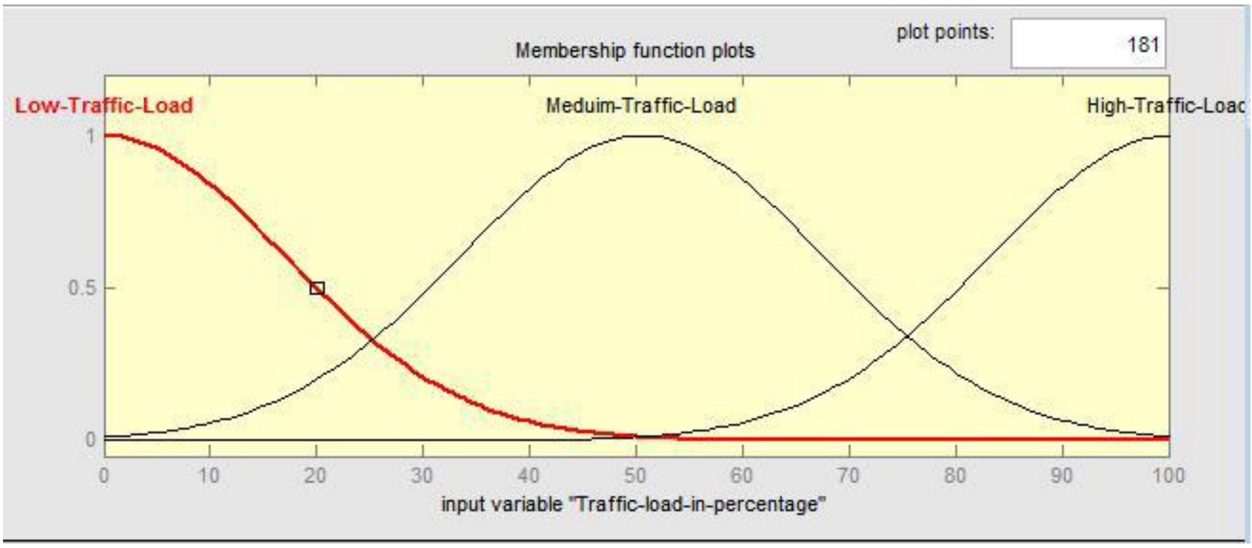

Figure 6: Membership Function of Traffic Load

e. Fuzzification of the Output Handoff Decision

The handoff decisions pertaining to the output decision variable have four fuzzy set values: No-handoff, Wait-Handoff, Becareful-Handoff and Handoff. For the variable handoff decision, the universe of discourse is defined as ranging from zero to one. This figure is crucial for comparing the BTSs' ranks.

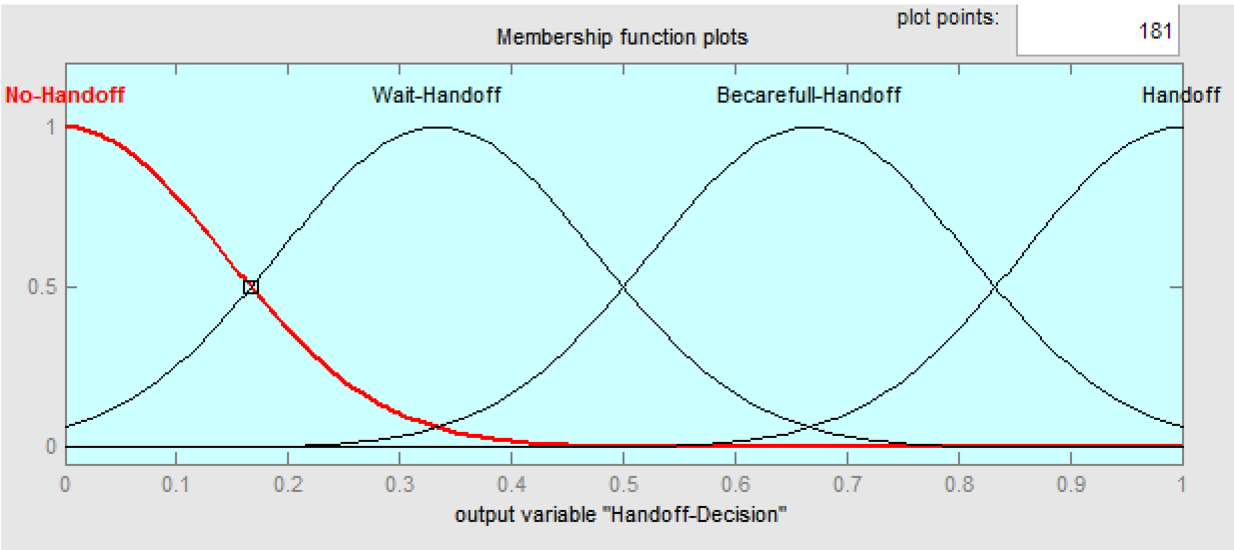

Figure7: Handoff Decision Membership Function

f. Fuzzy Inference System

The second step of the handoff process involves feeding the fuzzy sets into an inference engine, where a set of fuzzy IF-THEN rules is applied to obtain fuzzy decision sets. Figure 8 indicates the four inputs to FIS. The output of FIS is a decision if handoff process is to execute or not.

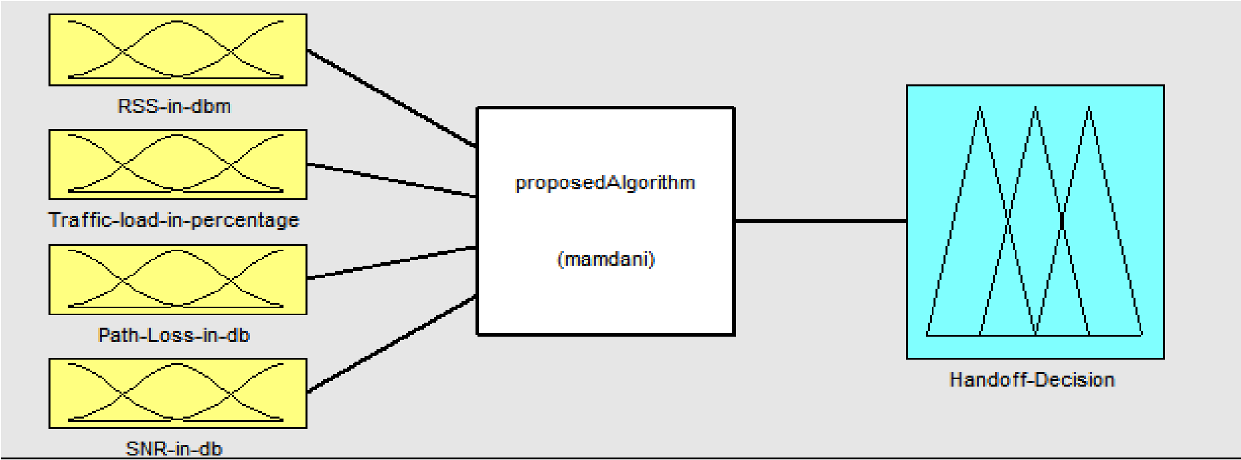

Figure 8: Input and Output Representation

Figure 9 shows the IF- Then Rules. For example, as shown in Figure 9: IF RSS in dBm is Strong RSS and Traffic Load in percentage is High traffic Load and Path-loss in dB is low-Path-loss and SNR in dB is Very Good SNR then the output is No Handoff.

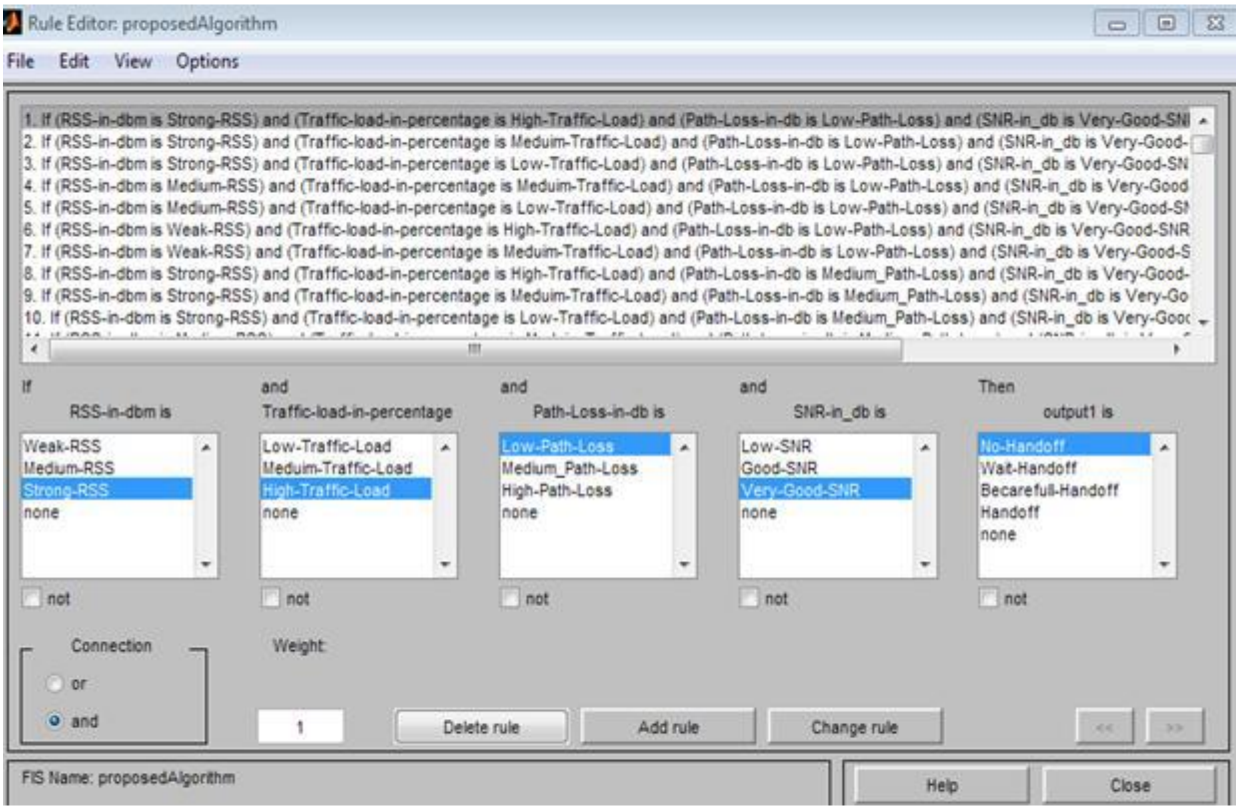

Figure 9: IF- Then Rules

g. Defuzzification

In the final phase of the handoff decision, the output fuzzy decision sets are combined into a single fuzzy set and sent to the defuzzifier to be transformed into an exact quantity.

3.0: RESULTS AND DISCUSSION

As MS moves from BTS I to BTS J, Figure 10 displays the RSS from two nearby BTS. When MS moves away from the BTS, the RSS of BTS I decreases, and as it approaches, the RSS of BTS j increases. According to a traditional algorithm, the ideal handoff area is 4500 meters, based on the RSS variation from either BTS. But as Figure 10 illustrates, if a minimum signal level is guaranteed, the traditional algorithm with hysteresis only permits a MS to decide to handoff if the RSS received from the neighboring BTS is sufficiently stronger than the current one by the designated hysteresis margin.

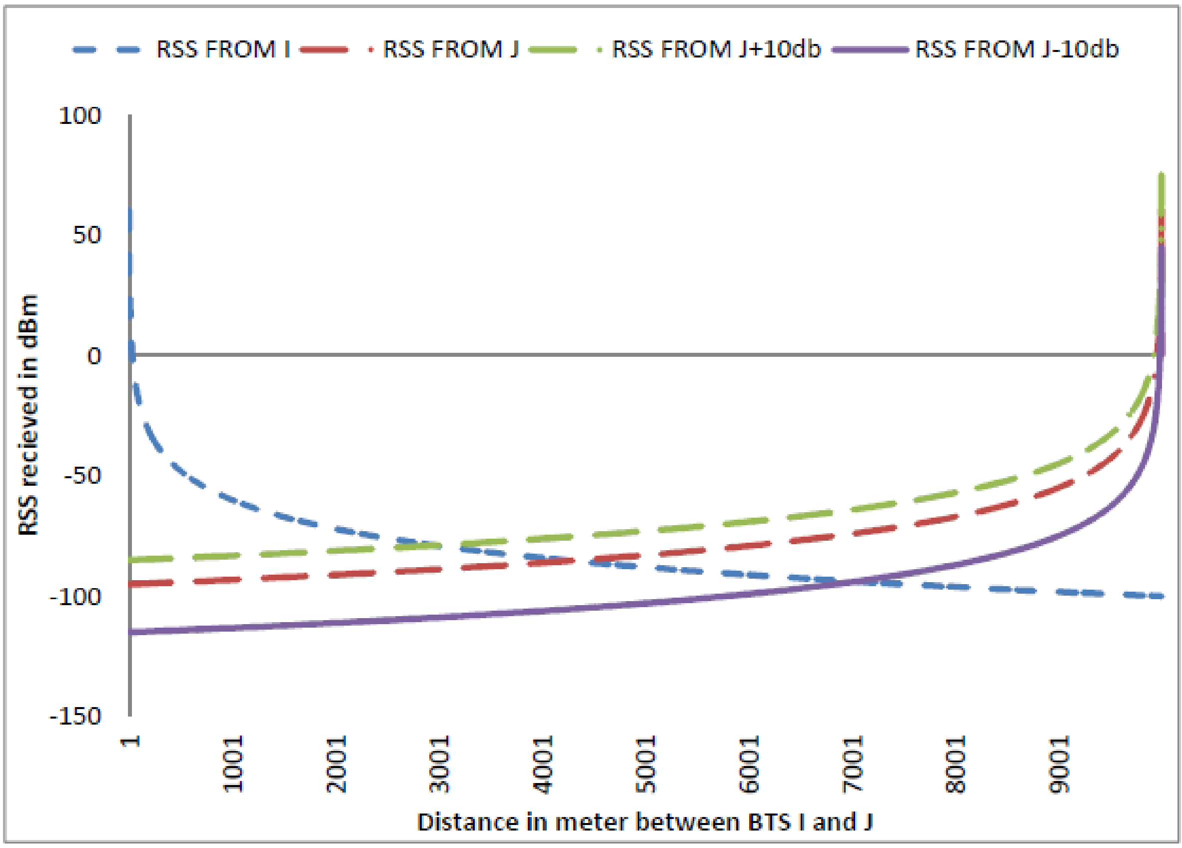

Figure 10: RSS from Base Station I and J in dBm

The path-loss from two nearby BTSs is displayed in Figure 11. The handoff procedure in cellular networks is in charge of making sure that any MS is always linked to the best BTS.
Power budget (PBGT) handoff ensures that in typical circumstances any MS is served by a BTS with the least possible path-loss.

But according to the traditional hysteresis algorithm, an MS can only decide to handoff if the neighboring BTS's path-loss is better than the current one by the designated hysteresis margin, given that a threshold path-loss is guaranteed.

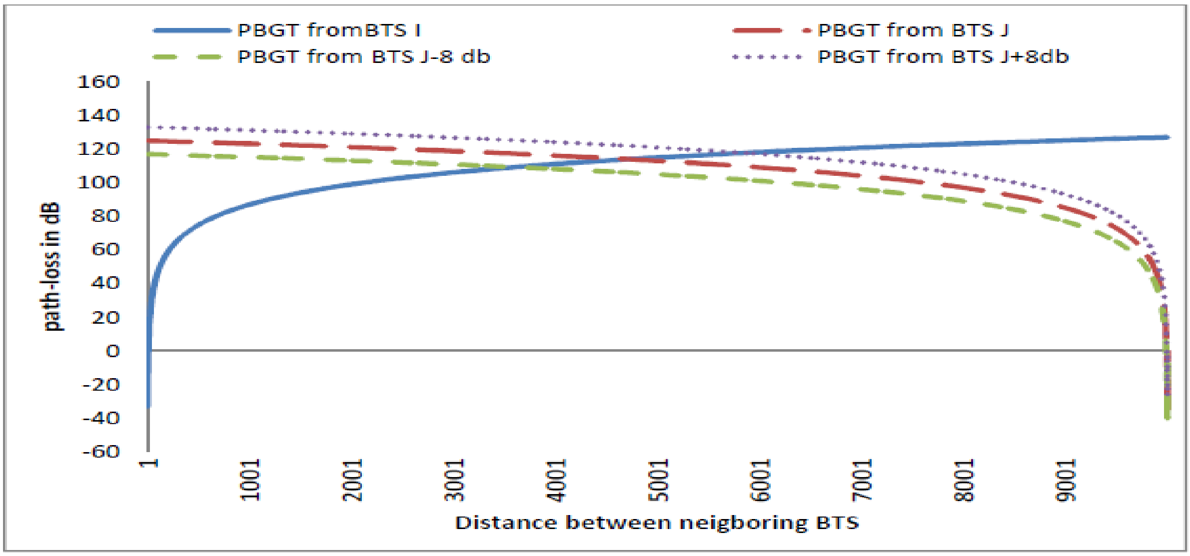

Figure 11: Path- Loss from Base Station I and J *in* dB

Figures 12–14 show three instances of the BTS rank for three distinct scenarios. Case 1: Excellent parameters all around, Case 2: Average parameters all around, and Case 3: Worst parameters all around: As one might expect, the probability of the required handoff is lowest when all the parameters are excellent. On the other hand, the probability of a handoff is maximum when all the parameters are at their worst.

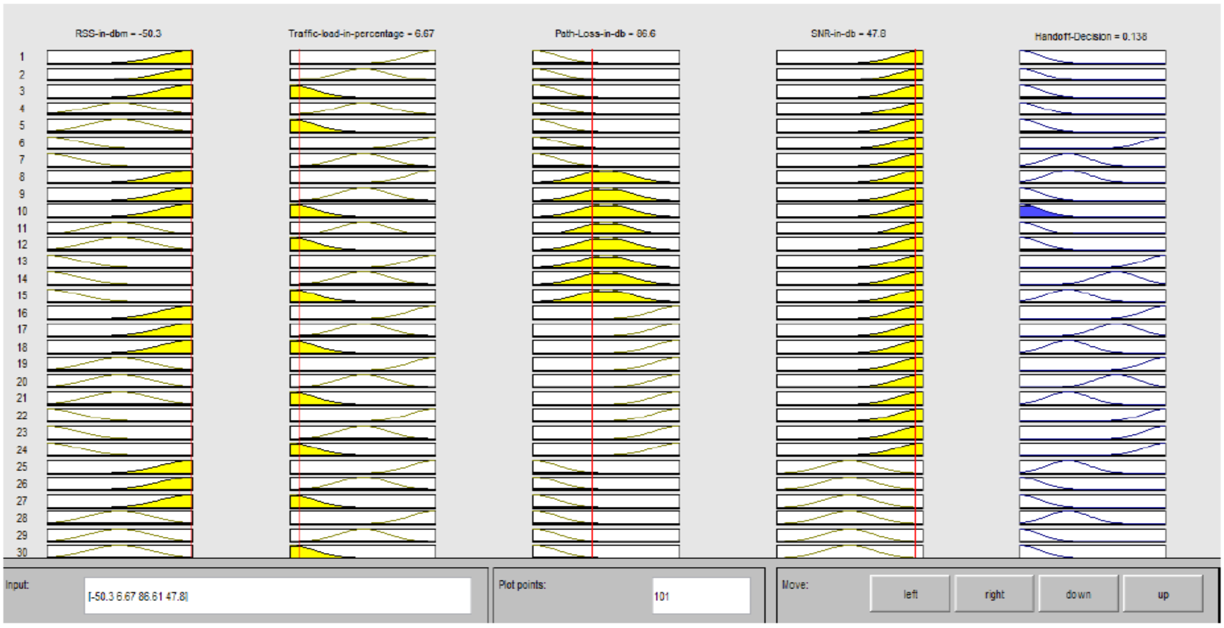

Figure 12: Rule Base Evaluations When All the Four Parameters Are Excellent

First case, as illustrated in Figure 12, involves a mobile station receiving RSS=-50.3dBm, 6.87 percent of all TCH being occupied, path-loss= 58.3dB, SNR=47.8dB, and a BTS rank of 0.138. This value shows that the current BTS is offering the maximum service, so the MS does not need to handoff.

Case number two is depicted in Figure 13 and involves a mobile station receiving RSS of -75dBm, 50% of all available TCH being occupied, a path-loss of 95dBm, and SNR of 25dBm. The suggested algorithm determines that the BTS rank is 0.362.

Once more, our FIS decided not to execute the handoff from this BTS because the current BTS is still offering good service. The BTS in Case One offers a better service than Case Two, but the FIS chooses not to handoff because doing so would result in an unnecessary handoff. A minimum threshold for an MS to handoff protects against this

pointless handoff. The lowest threshold for this work is determined to be 0.55. For an MS to require a handoff procedure, the rank of the BTS must be greater than this value.
However, the MS will be compelled to continue serving BTS even if this criterion is reached and a mobile station is unable to find a better ranked BTS.

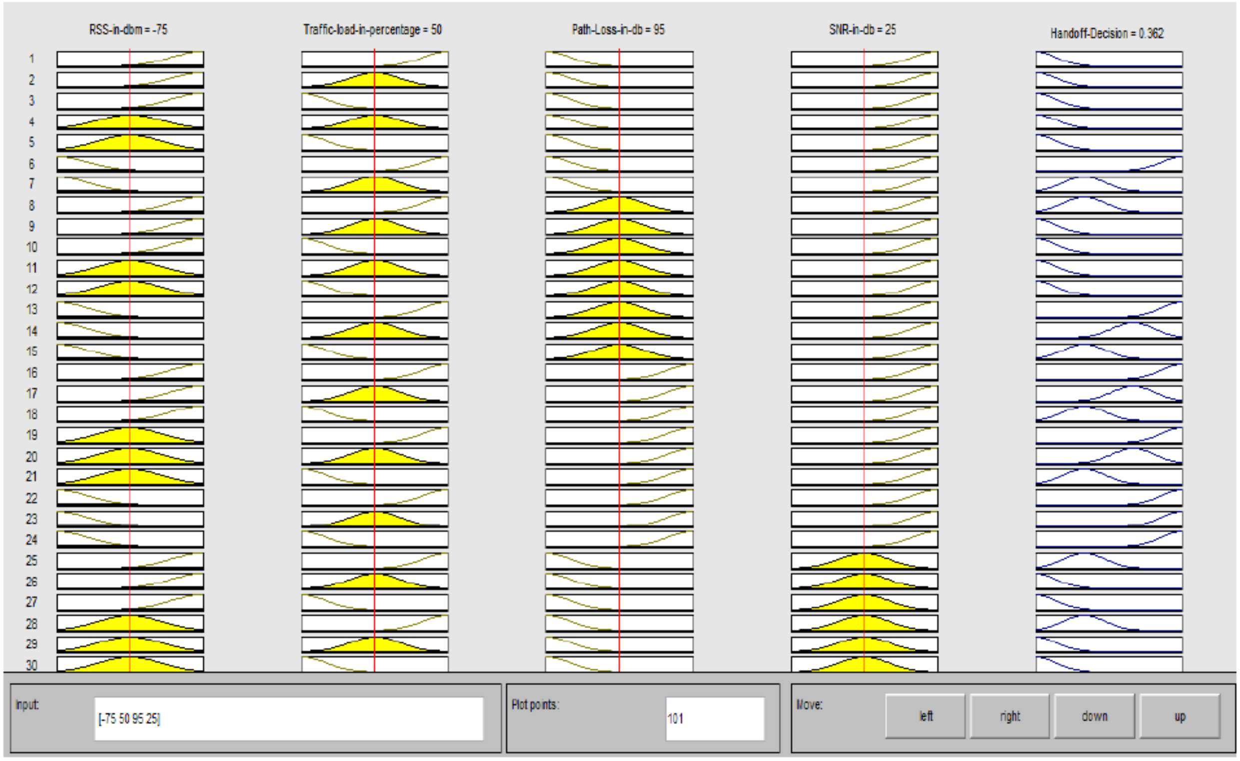

Figure 13: Rule Base Evaluations when all the Four Parameters are good

In the third case, depicted in Figure 14, a mobile station receiving RSS=-95.6dBm, 94.9 percent of all available TCH is busy (only 5 percent is free), path-loss = 132dB, and SNR = 6.94dB. This BTS's rank is 0.807, which is significantly higher than the required value for handoff to occur. This value indicates that a BTS should not maintain the connection because the RSS has started to deteriorate, it only has 5% of its free channel left, which is concerning because it could lead to incoming calls being blocked and MS interference. Therefore, a mobile station needs to transfer to a neighborhood that offers superior service. This is one approach to dealing with call drop. A BTS's rank becomes the worst of all when its RSS has declined, its RF is interfered with, its path loss is maximum, and it is overly crowded. This time, a handoff between MSs is required to avoid affecting KPI. To aid in this procedure, the algorithm provides a greater likelihood of handoff (i.e. 0.805).

Figure 14: Rule Base Evaluations when all the Four Parameters are worst

For the low load on the BTS, as illustrated in Figure 15, the handoff decision viewer increases as one moves from the very strong RSS to the weak RSS. The handoff decision viewer goes from a strong received signal to a weak signal for a medium load on the BTS. The handoff decision viewer shifts from the strong RSS toward the weak RSS when there is a high load on the BTS. With a high load percentage and weak RSS, the handoff decision viewer appears higher; with a strong RSS and low load on the BTS, it appears lower. As a result, BTS will begin sharing load from the edge of the coverage area when it becomes congested.

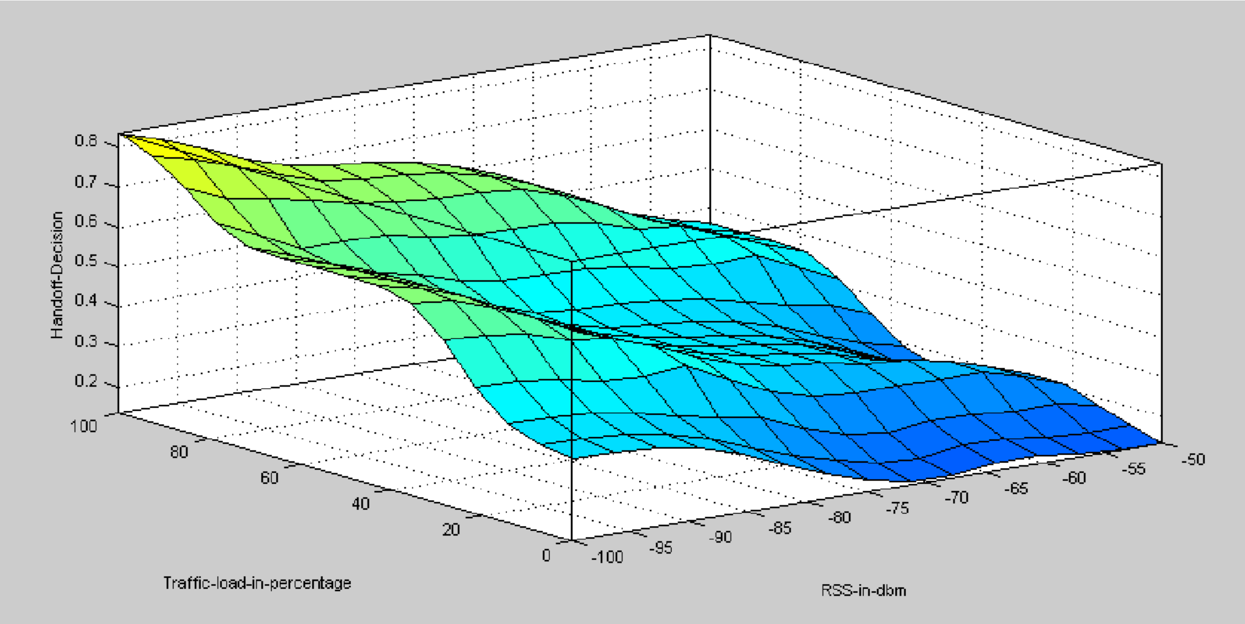

Figure 15: Surface Viewers between RSS and Traffic Load for Constant SNR and Path-Loss

Figure 16 shows the increase in the surface viewer from low path-loss toward high pathloss for each category of load (low load, medium load and high load).

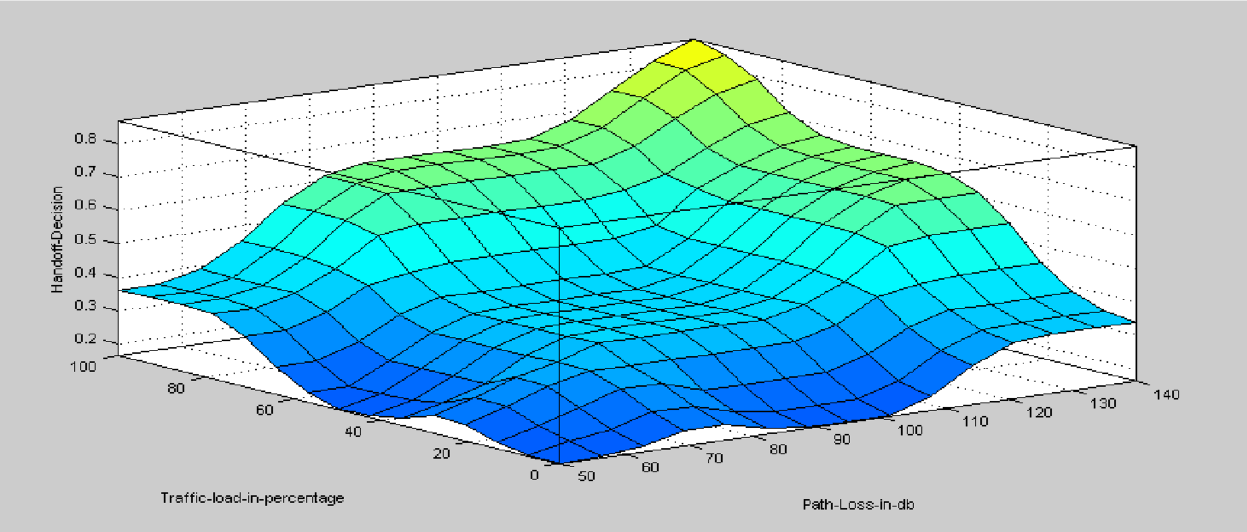

Figure 16: Surface Viewers between Path-Loss and Traffic Load for Constant SNR and RSS

For high path-loss and high load on the BTS, the surface reaches a high value. It implies that in cases of high path-loss would begin at the MS. Even though the current BTS is overly crowded, MS on a better BTS maintains the connection. Figure 17 shows the Surface Viewers between SNR and Traffic Load for Constant Path-Loss and RSS

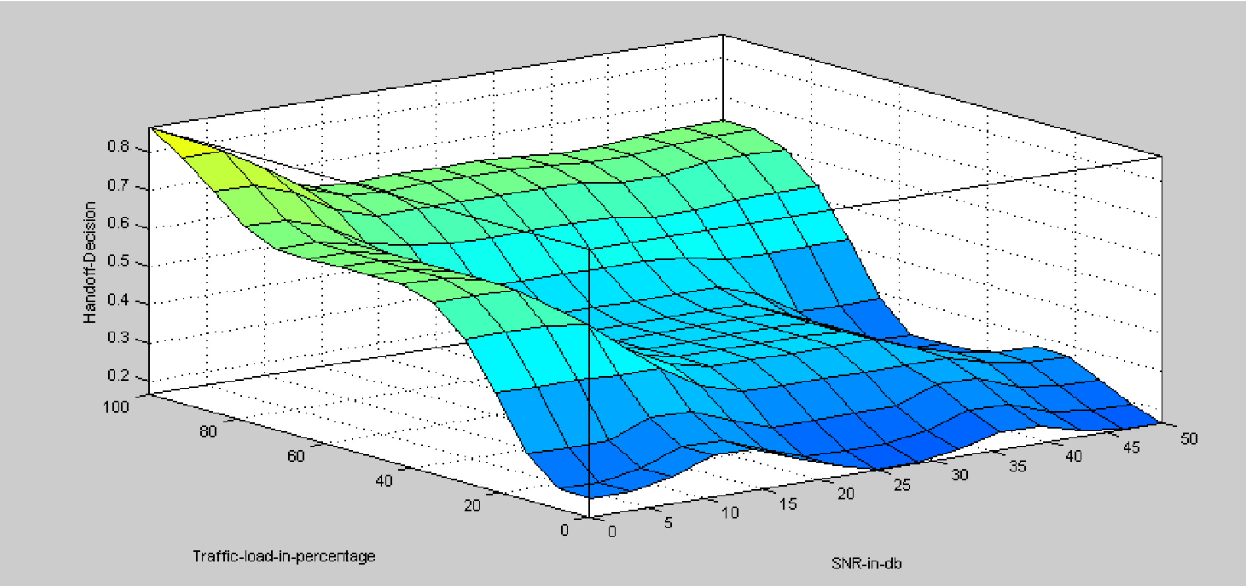

Figure 17: Surface Viewers between SNR and Traffic Load for Constant Path-Loss and RSS

Figure 17 illustrates how the likelihood of a handoff increases as the SNR drops and the BTS's load rises. When SNR is low and BTS load is extremely high, the maximum value is achieved.

The handoff index variation for RSS, Path-loss, SNR, and traffic load is displayed in Figures 18–21. In this analysis, we assume that the other three parameters stay unchanged. As each parameter deteriorates, the suggested algorithm provides a higher handoff index value. When the pre-established threshold values are met and a better adjacent BTS is located, handoff will eventually occur.

The handoff index variation with SNR is depicted in Figure 18 for constant values of BTS traffic load = 50%, path-loss = 100 dB, and RSS = -75 dBm. As SNR increases, the graph shows a non-linear decrease. The developed algorithm responds by increasing the handoff index when the MS is interfered with by the neighboring BTS, even though the remaining parameters are sufficient to maintain the connection. As a result, once the pre-set threshold is reached and a better BTS is identified from the neighboring cluster, the MS will be transferred to the better BTS (in terms of multiple criteria).

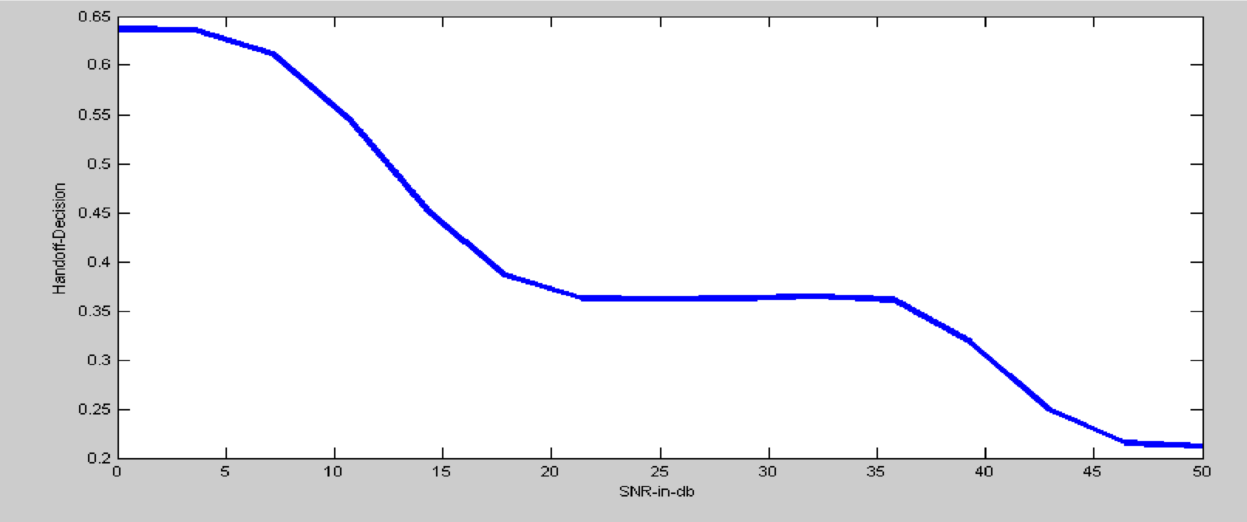

Figure 18: Variation of Handoff Index with SNR (dB) Values of Load of BTS=50%, Path- Loss=100 dB and RSS=-75dBm

Figure 19 illustrates how the handoff index varies with load; for constant values of other parameters, an increase in load would result in an increase in the handoff index. The suggested algorithm is real-time, in contrast to the conventional algorithm, and it increases the handoff index as the load increases and vice versa.

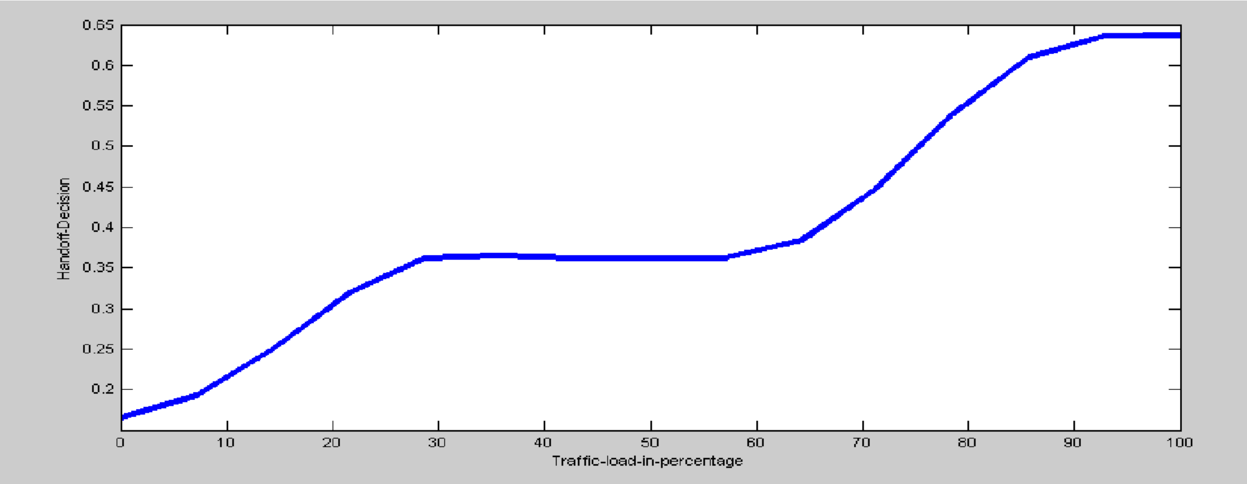

Figure 19: Variation of Handoff Index with Load (%) Values of SNR=25dB, Path- Loss=100dB and RSS=-75dBm

This ensures that the likelihood of a handoff increases with load whenever the BTS is overloaded. However, this value is different from those of MS with excellent SNR and interfered frequency, or from those with strong and weak RSS. Of course, the likelihood of a handoff increases for MS with weak RSS or interfered frequency.

Figure 20 show the Variation of Handoff Index with Path-Loss (dB) For SNR=25dB, Load of BTS=50% and RSS=-75dBm.

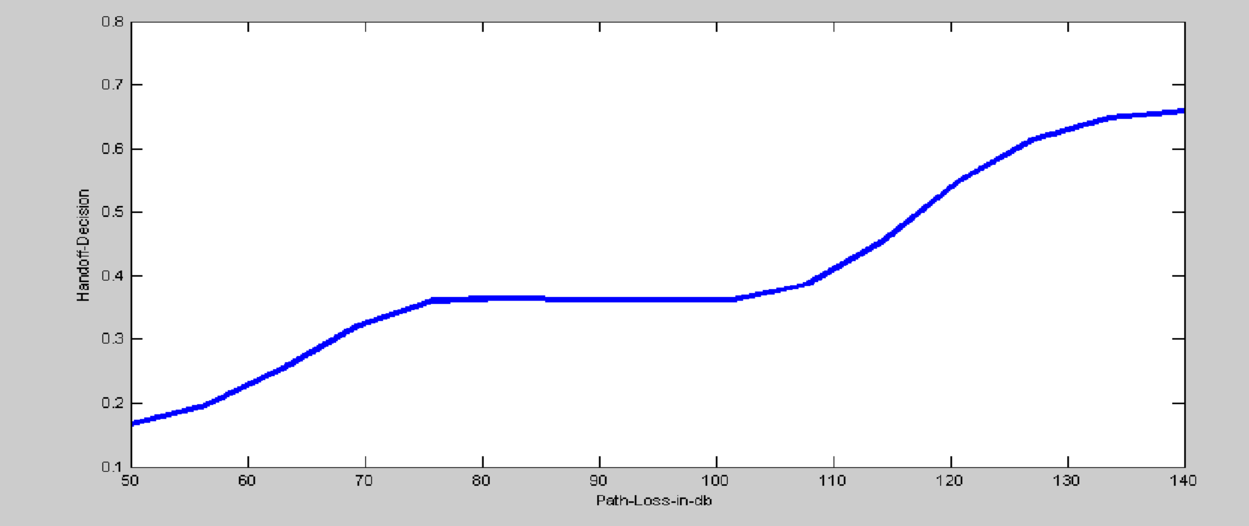

Figure 20: Variation of Handoff Index with Path-Loss (dB) For SNR=25dB, Load of BTS=50% and RSS=-75dBm

According to Figure 20, the handoff index progressively rises as path loss increases, meaning that a MS with a higher path loss has a higher chance of being handed off than one with a lower path loss. The algorithm would require handoff to be performed when a predetermined threshold value is reached or a better neighboring BTS is discovered. In the event that the path-loss is becoming worse, a handoff must occur even if the remaining parameters are sufficient to continue a call. This will guarantee that calls won't be dropped as a result of the RSS degradation. It implies that in the event that the current serving BTS is failing, a mobile station would switch over to the target.

Figure 21 shows the Variation of Handoff Index with RSS dBm for SNR=25dB, Path- Loss=100dB and Load of BTS=50%

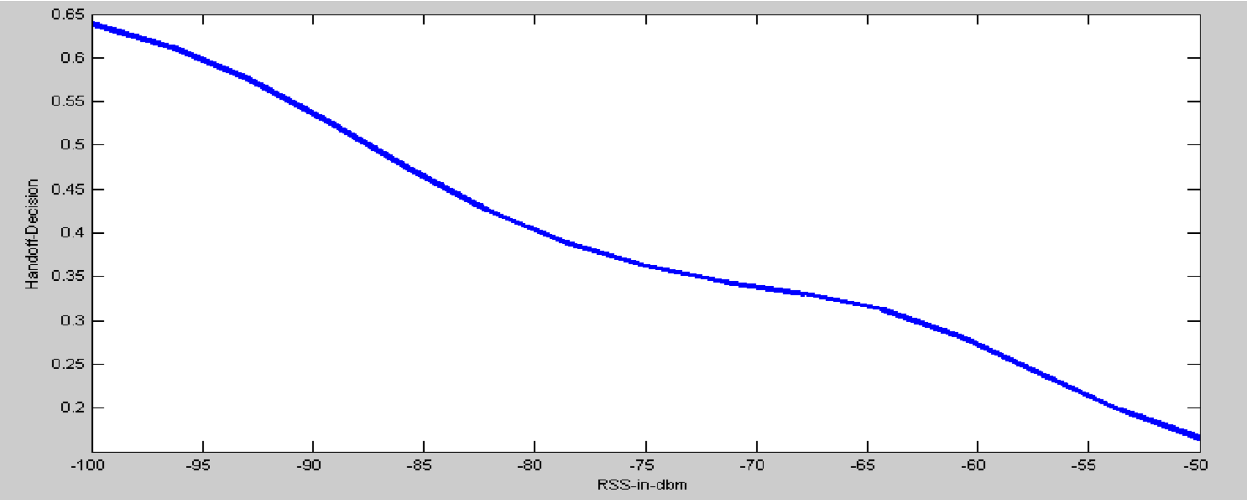

Figure 21: Variation of Handoff Index with RSS dBm For SNR=25dB, Path- Loss=100dB and Load of BTS=50%

Handoffs begin at the cell's edge if the base station is excessively crowded. According to Figure 21, a mobile station on -95dBm has a higher handoff index than one on -70dBm or -60dBm. In any case, a mobile station receiving RSS values of -90dBm will soon begin to be handoff if this BTS needs to relieve congestion through the handoff process. Once more, if the BTS is within the coverage of more than -90dBm, an MS between -85dBm and -90dBm will be handed off to relieve congestion, and so forth.

4.0 CONCLUSION

In this study, an intelligent multi-criteria handoff algorithm that allowed for the selection of the optimal network segment based on a variety of parameters was designed and analyzed. Typically, the handoff process is used to select a network segment. Single-criteria methods such as RSS, Power Budget, interference, distance, and others were used in traditional network selection.

The results of the simulation demonstrated how the suggested algorithm divided the load among the cluster members and made effective use of the limited resources. Depending on the load on the BTSs, the MS in the 2000–7000 m region dynamically swings between BTS I and J. In order for a BTS's coverage area to dynamically grow toward a nearby loaded cell or contract toward the cell center for a loaded sector. A BTS's coverage area is assumed to be virtually expanded in low load scenarios to include the partial serving area of a nearby BTS. The study focused on subjective membership functions, necessitating further research to identify various types that can enhance handoff performance. One potential approach is employing an Adaptive-network based Fuzzy Inference System (ANFIS) to develop input-output relationships based on human expertise.

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