Computing, Information Systems & Development Informatics Journal
Vol. 8 No. 4, December, 2017 - www.cisdijournal.org

Adaptive Congestion Control Scheme Using Dual Buffer.

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ABSTRACT

Wireless communication has become so important in the life of man and its use is not being limited to the rich alone but to all human beings be it rich, poor, old or young. The paper proposed scheme on the handoff management algorithm that would integrates an adaptive guard channel assignment scheme with the queuing of hand off calls and the new calls in order to reduce the dropping rate and the blocking rate respectively. The work will be implemented in two parts; firstly, we propose an adaptive guard channel assignment and shared channel allocation method that would be an improvement on the reviewed works. Secondly, the introduction of two-buffer systems and the analysis of the length of the queue and the time of allocating channel for a MT in a queue. The scheme will minimize both the dropping of ongoing call during the handoff and the blocking of newly originating calls, which is the important issue for the mobile communication. The design will be implemented using matlab, the result will be computed and compared with the best related work.

Keywords- Channel, Buffer, wireless, Handoff call and New call..

CISDI Journal Reference Format
Lawal, O.A., Ojesanmi, O.A. & Ibharalu, F.T. (2017): Adaptive Congestion Control Scheme Using Dual Buffer. Computing, Information Systems & Development Informatics Journal. Vol. 8 No. 4. Pp 53-64
Available online at www.cisdijournal.net

1. INTRODUCTION

Cellular networks have evolved into one of the most exciting areas in telecommunications industries and the diverse application demands could result to assured congestion from call droppings and call blockings. Thus, wireless networks should be designed with desired quality-of-service requirements to achieve a better performance in terms of improved Quality of Service (QoS). This is because the demand for wireless communications has grown exponentially over the last decade and it is expected to be even more in the near future. More and more multimedia traffic are being transmitted via wireless media and such applications require diverse QoS. As a result of the existence of the intrinsic scarcity of wireless channels, it is challenging to provide diverse QoS. (Geetanjali and Purohit, 2011). Mobile subscribers in a cellular telephone system are located within a geographical area called cell. This cell communicates with the mobile unit through the use of the sets of frequency channels assigned to it, which communicates with the Mobile Switching Center (MSC), and which also in turn connected to the Public Switched Telephone Networks in a well-structured network layout. The cell service unit handles two types of calls: the calls that originate in the cell, called the new calls and those that are transferred from another cells, called the handoff calls. When a mobile unit moves from one cell to the other, the call is handed over to the service unit of the new cell. The new service unit then allocates a frequency channel among its free channels. If the new service unit does not have a free frequency channel, then the call is terminated. It is desirable to avoid call termination of this nature, whenever it is possible. (Ahmed et al, 2015).

1.1. Motivation

Mobility of the users in a cellular wireless networks poses a challenge to the network engineers for achieving the desired QoS since the demand for wireless communications has been growing exponentially and more multimedia traffic are being transmitted via wireless media. Also, the main resource constraint in the wireless network is the channel availability for transmission, with the increased demand of bandwidth capacity due to scarcity of the inherent bandwidth. Thus, the work considered the need to give special consideration to handoff calls and providing an acceptable QoS for both the handoff calls and the new calls. The work employs the use of adaptive channel allocation technique with the integration of buffering technique and fuzzy logic model to address this problem.

2. LITERATURE REVIEW

Basically there are three types of channel assignment methods; this includes the Fixed Channel Assignment [FCA], the Dynamic Channel Assignment [DCA] and the Hybrid Channel Assignment [HCA]. (Nayak et al, 2015). In FCA, the set of channels are permanently allocated to each cell based on pre-estimated traffic intensity. In a cell, a channel can be assigned to a call using FCA, only if there are free channels available in the predetermined set for this cell. Otherwise, the call might be rejected even though there are many channels available in the network. (Sudarshan et al, 2010), Narendran, and Mala, (2011) and (Yong and Li, 2011). FCA schemes are often not able to maintain high quality Of service and capacity attainable with static traffic demands. The advantage of a FA scheme is its simplicity but the disadvantage is that, if the number of calls exceeds the number of channels assigned to cell, the excess calls are blocked. (Byung and Seong, 2013). In DCA, there is no permanent allocation of channels to cells. Rather, the entire set of available channels is accessible to all the cells, and the channels are assigned on a call-by-call basis. (Swati and Dhaval, 2015; Suad and Amin , 2015). DCA offers more efficient networks when the traffic load varies with time, especially under known distribution of the traffic. (Wu et al, 2010). One of the objectives in DCA is to develop a channel assignment strategy, which minimizes the total number of blocked calls. FCA scheme is simple but does not adapt to changing traffic conditions and user distribution. These deficiencies are overcome by DCA but FCA out performs most known schemes in DCA under heavy load conditions. Also, DCA technique has better performance than fixed channel assignment technique for light to medium traffic load. The HCA method combines aspects of both FCA and DCA methods, i.e. it assigns some fixed channels to every BS as FCA and the remaining channels are assigned to the BS when they are overloaded.

During communication, a mobile device always remains within the range of at least one base station (BS). Due to the limited spectrum, cellular systems distribute smaller cells in order to achieve high system capacity. Since each handover requires from the network management to reroute the call to the new BS, the number of the expected handovers increases. To meet the demands for higher capacity the smaller cells are deployed. MSC has a function to manage the handover decision, if a MT moves, the serving BSS may not be able to provide good signal strength as compared to others BSS. When a MS moves away from the BS, the received signal strength decreases, and when it gets lower than a threshold level, the handoff procedure is initiated. Handoff decision is based on received signal strengths (RSS) from current BS and neighbouring base stations (BSs). (Goswami and Spain, 2012).

When a mobile station (MS) moving from one BS (BSold) to another BS (BSnew), it is assumed that the signal is averaged over time, so that rapid fluctuations due to the multipath nature of the radio environment can be eliminated. The mean signal strength of BSold decreases as the MS moves away from it. Similarly, the mean signal strength of BSnew increases as the MS approaches it. MS measures the signal strengths from surrounding BSs and interference levels on all channels. A handoff can be initiated if the signal strength of the serving BS is lower than that of another BS by a certain threshold. (Goswami and Spain, 2012).

Based on received signal strength indication (RSSI) and bit error rate (BER) of local BS and other BS Hand over margin is decided. The MS breaks its old link and access the new BS which is called as break before make handover. This kind of network assigned handoff decision is known as mo-bile-assisted handoff (MAHO) (Schiller, 2010). The handoff time between handoff decision and execution is approximately one second. The MM+GG scheme accepts good quality signal with availability of channels exclusively for handoff calls in the adjacent cell (Goswami and Spain, 2012).

It is not possible to always maintain a good signal quality when handoff takes place in a wireless mobile system. Mobile Controlled Handoff (MCHO) extends the role of the MS by giving overall control to it. It provides the opportunity to the MS for choosing good signal BS out of all received signals from surrounding BSs. MS measures the signal strengths from surrounding BSs and interference levels on all channels. A handoff can be initiated if the signal strength of the serving BS is lower than that of another BS by a certain threshold. This type of handoff has a short reaction time. In MCHO technology, MS made decision of handoff based on signal quality received and reaction time is very low. Good quality signal calls are received and served successfully while poor signal quality calls are dropped or handed over to other BSs. (Goswami and Spain, 2012).

Chow and pin, 2011 developed a dynamic handoff priority adjustment scheme which applied a handoff queuing scheme to adjust handoff priority based on receiving signal strength, service class, and mobility of Mobile Hosts. There was lower call dropping probability (CDP) with acceptable call blocking probability (CBP). As far as the bandwidth utilization was concerned, the NP scheme was the best solution which utilized any avail-able bandwidth to satisfy new and handoff MHs. Jihoon and Hyun, 2013 presented a work on Adaptive Resource Allocation Scheme (AREAS) was compared to Non Priority (NPC) and Guard channel Scheme (GCS).The result show that the dropping probability was reduced compared to the NPC and the GCS. The effect of utilizing the available resources in AREAS led to high blocking probability compared to NPC where both new and handoff connections are not differentiated. Introduction of queuing system would have produced better result on both the dropping and the blocking probability.

Alagu and Meyyappan, 2012 introduced Adaptive Channel Allocation Scheme. The scheme utilize the available resources efficiently and also balance the load in the network traffic. It reduced the handoff rejection rate, at the expense of high new call rejection rate. Application of buffer system will provide better QoS. Kar and Nayak, 2014 developed Adaptive Channel Allocation Scheme (ACAS). There was an effective utilization of the available resources, It keeps the handoff call rejection rate below the given threshold and it also reduces the new call rejection rate by decrementing the number of guard channels when it is observed to be more than needed. The scheme considered only the handoff blocking rates, at the expense of blocking new calls. Also, the main problem faced in guard channel allocation is the number of guard channels chosen.

Malathy and et al, 2010 integrated Channel Allocation with the concept of buffering and dwell time of the call. The call dropping probability was greatly reduced and the call blocking probability was reduced. The reserved resources were not well utilized when the handoff arrival rate is low. Ahmed et al, 2015 discussed the problem of handoff calls management in cellular mobile communication and employed non-prioritized scheme to adjust blocking probability of handoff Calls. The work did not considered the required number of channels that would support the originating calls. Thus, there is no any guarantee that the call blocking probability will be reduced. Arun, 2015 considered two types of channel assignment: the guard channel assignment and the non guard channel assignment with mobile assisted handoff technique (MAHO). The work reserved some channels for handoff calls in the first case while the second case did not use guard channels. Thus, there was consideration for only the handoff call by minimizing the dropping rate but new calls were not considered. Also, the approach made use of static guard channels which may be idle when the new call arrival rate is high.

According to Qin et al, 2015, two schemes for channel allocation control in multiservice wireless cellular network have been considered. The first scheme runs with a fixed number of GCs for handoff calls, which mean that handoff calls have fixed priority than new calls. The second model adopts self-adaptive DGCA scheme, which according to current Probability of Dropping Handoff calls automatically adjusts the number of reserved GCs. The simulation results show that the adaptive DCAC scheme have better QoS and higher channel utilization but buffer system was not introduced to minimize call dropping and blocking. (Nayak and Kar, 2015) presented a dynamic guard channel allocation (DGCA) scheme, which can adaptively adjust the number of reserved channels for handoff calls When most guard channels are idle, they are allocated to new calls with high probability. When most guard channels are busy, they are allocated to new calls with low probability. Meaning channels may be reserved for handoff calls at the expense of blocking new calls even when such reservation is not necessary. This result in call blocking and call dropping during the course of adjusting the two categories of channel because no buffer was introduced.

3. METHODOLOGY

We propose an enhanced handover algorithm that is an improvement on existing works by (Arun, 2015) and (Nayak et al, 2015). . Our improvements on existing works are centered on the following:

(i) We propose an enhanced handoff algorithm that is an improvement on existing works especially those by (Arun, 2015) and (Nayak et al, 2015). Also, the proposed algorithm will give special consideration to the handover calls while ensuring as much as possible an acceptable QoS for both the handoff calls and the new calls by not reserving channels for none existing handoff calls at the expense of new calls blocking/ by reserving channels for the handover calls alone at the expense of new calls. (Kar and Nayak, 2014) and (Alagu and Meyyappau, 2012).

(ii) We propose an enhanced handoff algorithm that is an improvement on existing works especially those by (Arun, 2015) and (Nayak et al, 2015). Our improvements on the current work are centered on the introduction of two-buffer systems.

(iii) The new algorithm intends to consider the analysis of the multiple parameter of queue system and on analyzing the length of the queue (that is the size of the buffer), the time of allocating channel for a MT in a queue.

(iv) Also, we propose an enhanced handoff management that is an improvement over the present work by employing fuzzy logic model to effectively estimate the threshold, which indicates the number of channels that would be allocated for handoff calls.

3.1 Queuing Method of Channel Allocation

In addition to the adaptive guard channel allocation,
our approach also considered the analysis of the queuing systems to address the need to optimize channel assignment. The set of equation (i) to (vi) defines our approach to the formulation and representation of channel assignment scheme by incorporating the following constraints for the handoff call and the new calls: Size of the queue, the mean number of customers in the system, the mean number of customer in a waiting queue, the mean number of customer in service, total time spends in the system, mean time a customer spends in the queue and mean time a customer spends in the service. The same set of equation is also applicable to the new calls.

3.2 Fuzzy Logic Method for channel Allocation

The proposed solution to prioritize channels on the basis of the density of traffic use fuzzy logic concept and the utility of fuzzy sets lies in their ability to model uncertain or ambiguous data. The fuzzy logic is concerns with the principles of approximate reasoning. A fuzzy logic controller consists of:

(i) Fuzzifier: is the input stage that map the crisp/numeric signals of the total channels, handoff buffer length and new call buffer length, into fuzzy data/ membership functions by using the fuzzy rules defined in the rule base interface

(ii) Rule Base: is the stage that consists of set of fuzzy –if-then rule which define the control actions. That is, the fuzzy rule base contains a set of linguistic rules (conditions and output). These linguistic rules are expressed using linguistic values and linguistic variables. Different linguistic values can be assigned to a linguistic variable. These linguistic values are modeled as fuzzy sets.

(iii) Fuzzy Inference Engine: The fuzzy inference engine combines membership functions with control rules, which is related to human knowledge) to set the threshold as the fuzzy output. The associated control outputs are arranged in the fuzzy rule base table (table 1).

(iv) Defuzzifier: defuzzifier is the stage that converts fuzzy set output to a crisp value/output that the fuzzy logic controller use to determine the number of guard channel in the base station.

In order to obtain an enhanced QoS for handoff and originating calls by reorganizing guard channels with variations in traffic density, three parameters, total channels, buffer length for the handoff calls and buffer length for the new calls serve as input into the fuzzy system. These parameters are fed into fuzzifier, which transforms the real time measurements into fuzzy sets. The output variable is the number of guard channels. Fuzzy sets contain elements that have a varying degree of membership in a set. Therefore, it is different from an ordinary or crisp set, where element will only be considered members of a class if they have full membership in the class. The fuzzy sets have varying degrees o f membership functions which are low, medium and high.

3.3 Parameters used in the equation:

In this work, we assumed that both the handoff
calls and the new/originating calls arrive according to possion arrivals. Parameters were used under the assumption that all the channels in the base station have passed the constraint test. Also the dual buffer that is employed would have a tolerable delay. The parameters are as defined as follows:

h – Handoff calls
n – Originating or New calls
λ – Mean arrival rate
λh– Arrival rate for handoff calls.
λn – Arrival rate for new calls.
μ –Service rate i.e. the rate at which requests are serviced.
Ct – Total number of channels in a base station.

When both arrival rate, that is, λh and λn are greater than Ct, queuing method is employed:

Q1 – buffer size for handoff calls.
Q2 – buffer size for originating calls.
L – the mean number of customers in the system
Lq – the mean number of customer in a waiting queue
Ls – the mean number of customer in service
W – total time spends in the system
wq – mean time a customer spends in the buffer
ws – mean time a customer spends in the service

According to Osahenvem and Odiase, 2016, (equation (i) to (vi)), suppose arriving subscribers/customers in the system has a probability P, which is independent of the number of people in the system. The arriving customer is taken to be of either the handoff call or the new call with a finite length L.

For the call type handoff call with the arrival rate λ_h

$$L = \frac{\lambda_h}{\mu - \lambda_h} \qquad (i)$$

$$L_s = \frac{\lambda_h}{\mu} \qquad (ii)$$

$$L_q = \frac{\lambda_h^{\,2}}{\mu(\mu - \lambda_h)} \qquad (iii)$$

$$W = \frac{1}{\mu - \lambda_h} \qquad (iv)$$

$$w_q = \frac{\lambda_h}{\mu(\mu - \lambda_h)} \qquad (v)$$

$$w_s = \frac{1}{\mu} \qquad (vi)$$

Note – *The same sets of equation* (i) *to equation* (vi) *are also required for the new calls type with arrival rate of* λ_n

Performance Metrics:

$$\text{Call Blocking Rate} = \frac{\text{Total number of calls blocked}}{\text{Total number of new calls Initiated}} \qquad (vii)$$

$$\text{Call Dropping Rate} = \frac{\text{Total number of calls dropped}}{\text{Total number of handoff calls}} \qquad (viii)$$

3.4 Proposed Algorithm

The proposed algorithm as shown in Algorithms 1 & 2 for Threshold Adjustment and Call Admission Control respectively, takes into account the traffic intensity, the dropping probability and the blocking probability to adjust the guard and the shared channel. The algorithm therefore ensures that channels are not reserved for the handoff call and the new call when it is not necessary to do so. This is intended to reduce the dropping rate and the blocking rate in order to have an acceptable QoS for the handoff calls and the new calls.

Parameters used in the algorithm:

-arrivalRateNew = arrival rate for new call buffer
-serviceRateNew = service rate for new call buffer
-noOfCallsBufferNew = number calls in new call buffer
-arrivalRateHO = arrival rate for handoff call buffer
-serviceRateHO = service rate for handoff call buffer
-noOfCallsBufferHO = number calls in handof call buffer
-bufferStatNew = new call buffer statistics
-bufferStatHO = handoff call buffer statistics

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-blockRate = blocking rate of new call
-dropRate = dropping rate of handoff call

```
Algorithm1: Algorithm for Threshold adjustment
  Input: integerbufferLength, totalChannel
Output: integernoOfSharedChannel, noOfGuardChannel
Begin:
Step 0:   Initialize bufferLength, totalChannel, noOfSharedChannel, noOfGuardChannel,
               timeFrame, LOWFACTOR, MEDIUMFACTOR, HIGHFACTOR
Step 1:   do... while true
Step 2:             arrivalRateNew= noNewCalls / timeFrame
                    serviceRateNew = completedNewCalls / timeframe
               bufferRateNew = noNewCallsOut / timeFrame
                    noOfCallsBufferNew = totalNewCalls – basestationNewCalls
arrivalRateHO = noHOCalls / timeframe
serviceRateHO = completedHOCalls / timeframe
               bufferRateHO = noHOCallsOut / timeFrame
                    noOfCallsBufferHO = totalHOCalls - basestationHOCalls
Step 3:             bufferStatNew = store new call buffer statistics (arrivalRateNew,
                              serviceRateNew, noOfCallsBufferNew, bufferRateNew)
                    bufferStatHO = store handoff call buffer statistics (arrivalRateHO,
                              serviceRateHO, noOfCallsBufferHO, bufferRateHO)
Step 4:             thresholdMeasure = fuzzySystem(bufferStatNew, bufferStatHO, totalChannel)
Step 5:             if thresholdMeasure == LOW then
                         noOfSharedChannel = ceil(totalChannel / LOWFACTOR)
                         noOfGuardChannel = totalChannel – noOfSharedChannel
                    else ifthresholdMeasure == MEDIUM then
                         noOfSharedChannel = ceil(totalChannel / MEDIUMFACTOR)
                         noOfGuardChannel = totalChannel – noOfSharedChannel
                    else ifthresholdMeasure == HIGH then
                         noOfSharedChannel = ceil(totalChannel / HIGHFACTOR)
                         noOfGuardChannel = totalChannel – noOfSharedChannel
                    end if
          end do while
End
```

```
Algorithm 2:   CallAdmissionControlAlgorithm
Input: integernoOfCalls
Output: doubleblockRate, dropRate
Begin
Step 0: Initialization: CallcallType = {NEWCALL, HANDOFFCALL}, Call call[noOfCall],
                    Buffer bufferNC, bufferHOChannel sharedChannel, guardChannel
Step 1:   do... while true
Step 2:   For eachi = 1 to noOfCalls
Step 3:             If call[i] == callType.NEWCALLthen
Step 4:   IfsharedChannelIsAvailable() == true then
                    allocateChannel(call[i], sharedChannel);
                    updateChannel(sharedChannel)
Step 5:   else IfbufferIsFull(bufferNC) == false then
                    queueCall(call[i], bufferNC)
Step 6:   else
                    blockCall(call[i])
```

Step 7: end If
Step 8: else If call[i] == callType.HANDOFFCALLthen
Step 9: IfsharedChannelIsAvailable() == true then
allocateChannel(call[i], sharedChannel);
updateChannel(sharedChannel)
Step 10: else IfguardChannelIsAvailable() == true then
allocateChannel(call[i], guardChannel)
updateChannel(guardChannel)
else IfbufferIsFull(bufferHO) == false then
queueCall(call[i], bufferHO)
Step 11: else
dropCall(call[i])
Step 12: end If
Step 13: end For each
Step 14: end do while

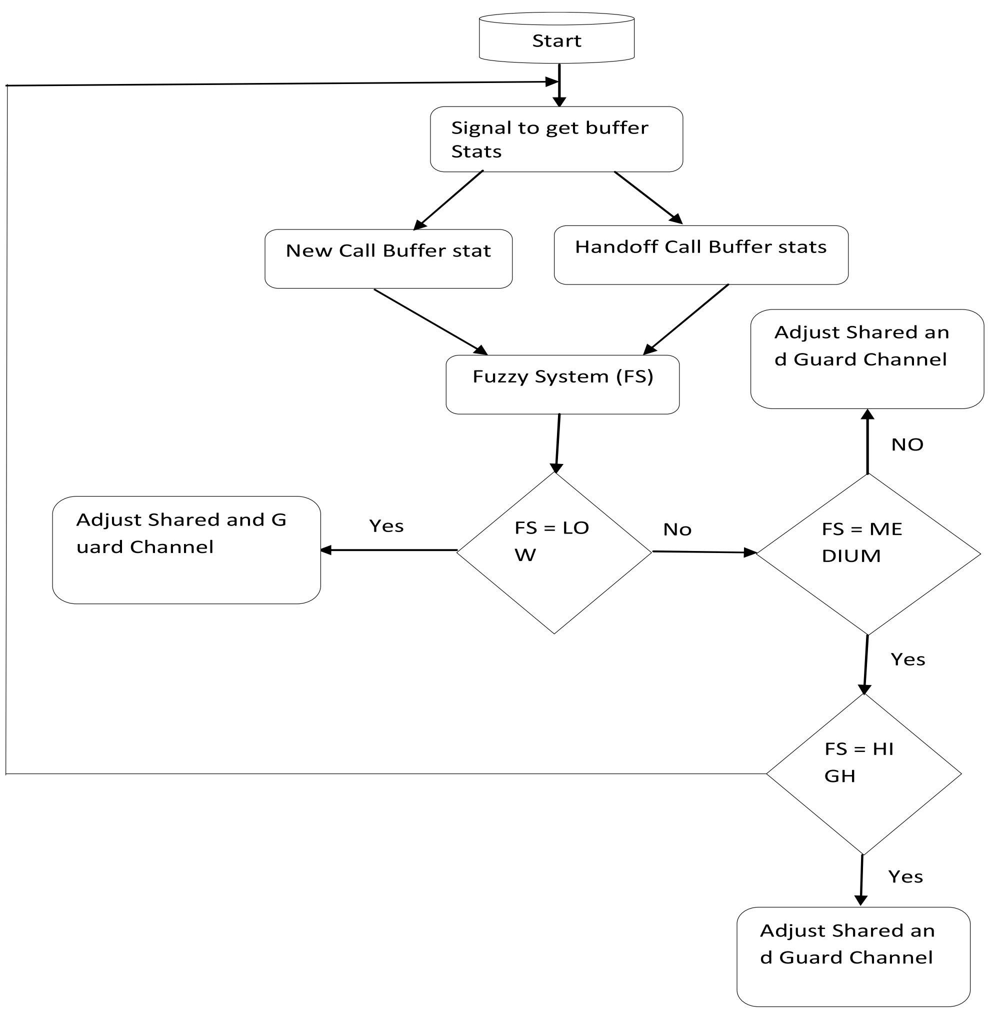

Figure 1: Proposed Threshold Adjuster Flow Chart

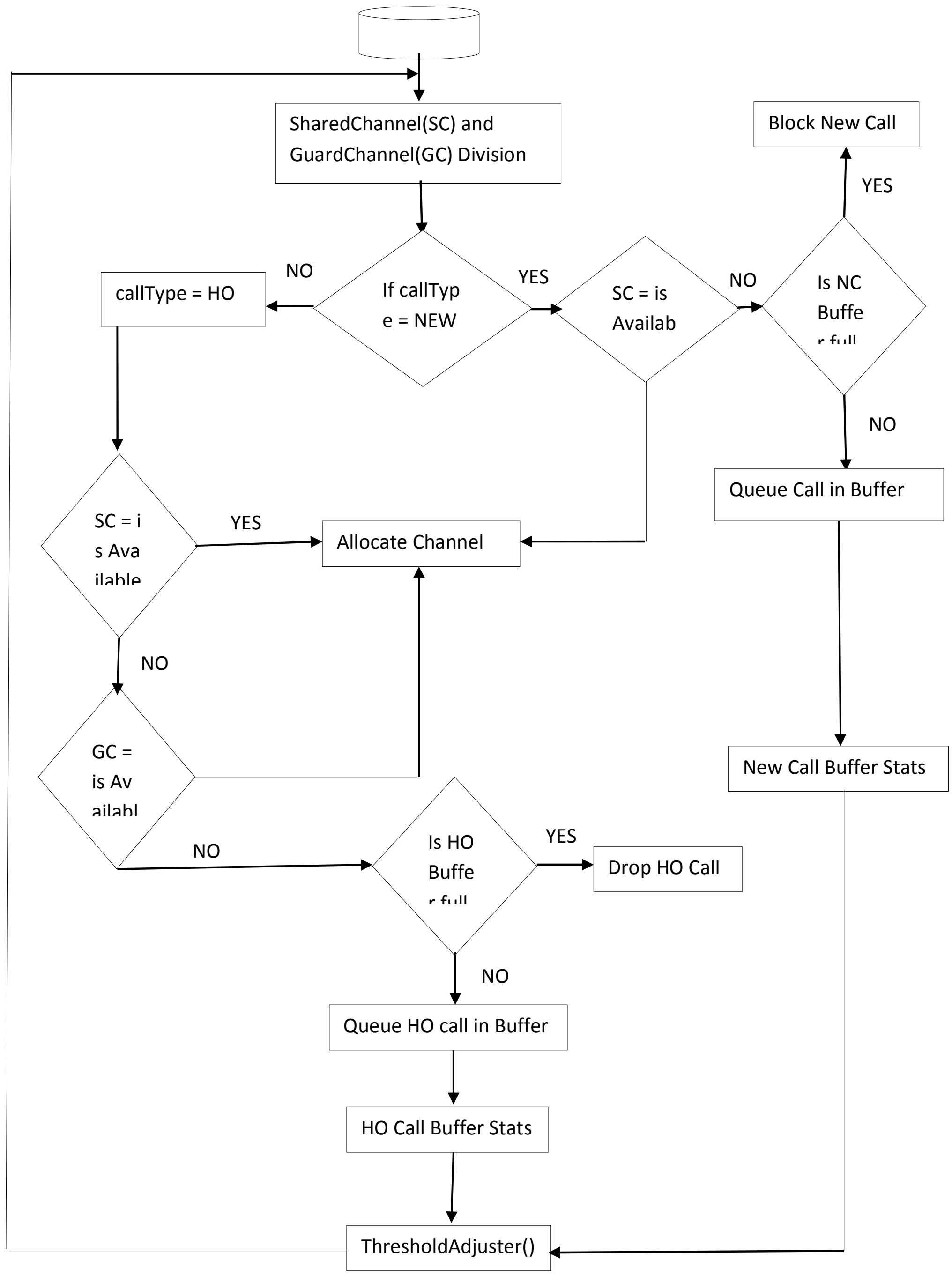

Figure 2: Proposed Call Admission Control Flowchart

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3.5 Proposed System Architecture

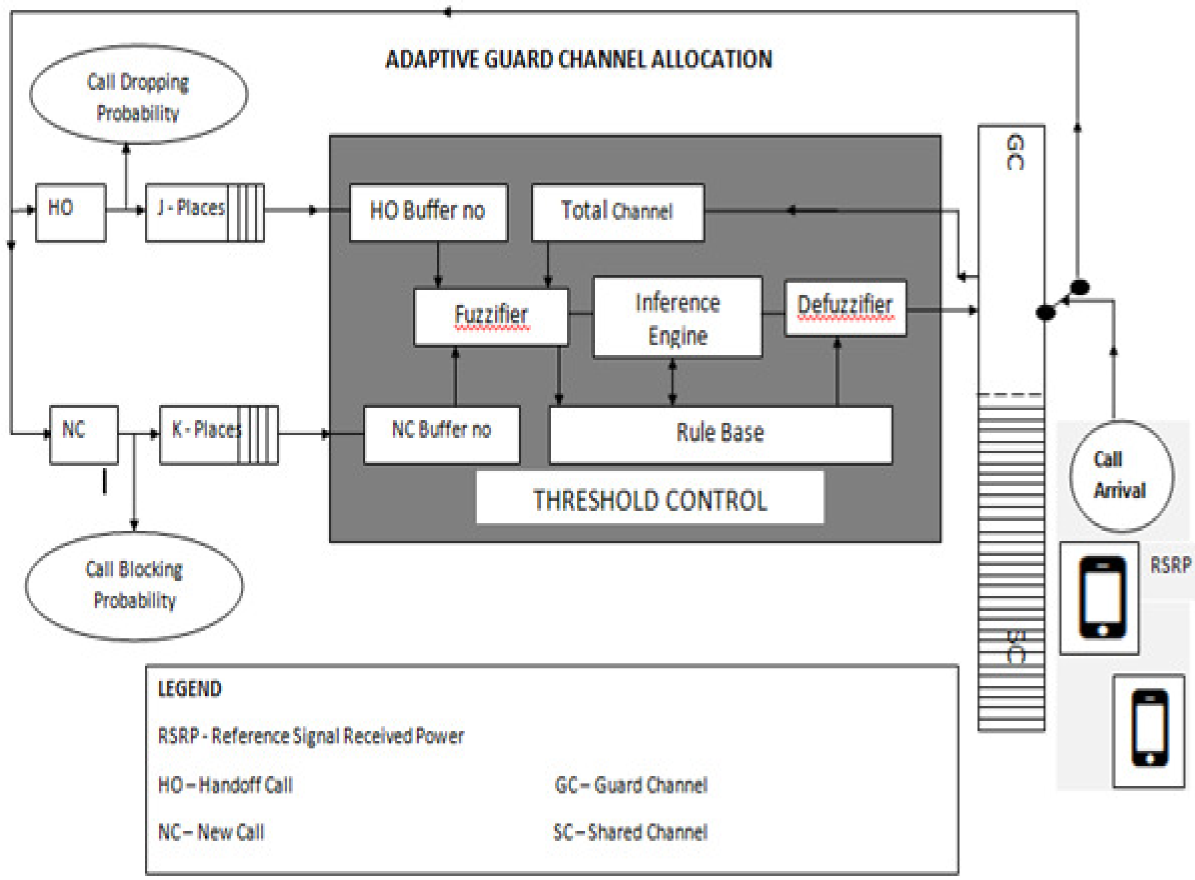

Figure 3: Proposed System Architecture

4. PROPOSED SYSTEM DESIGN

The proposed system architecture of an adaptive congestion control scheme will be modeled to meet an acceptable QoS for the users of a wireless communication system.The system model will be implemented in MATLAB using the following; MATLAB Optimization toolbox and MATLAB Fuzzy Logic toolbox.
The findings from our proposed solution to optimal channel allocation will be benchmarked with recent works by (Arun, 2015) and (Nayak et al, 2015).

4.1 Performance Metrics

The performance will be evaluated using the following metrics:
(i) Call Dropping Rate
(ii) Call Blocking Rate
(iii) Buffer Size
(iv) Time Spent in Buffer
(v) Total Service Time

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Table 1: Proposed Implementation Parameters

Total Channel	Handoff buffer length	New call buffer length	Threshold\Guard channel
H_c	H_{ho}	H_{nc}	H
H_c	H_{ho}	M_{nc}	H
H_c	H_{ho}	L_{nc}	H
H_c	M_{ho}	H_{nc}	M
H_c	M_{ho}	M_{nc}	M
H_c	M_{ho}	L_{nc}	M
H_c	L_{ho}	H_{nc}	M
H_c	L_{ho}	M_{nc}	M
H_c	L_{ho}	L_{nc}	M
M_c	H_{ho}	H_{nc}	M
M_c	H_{ho}	M_{nc}	M
M_c	H_{ho}	L_{nc}	M
M_c	M_{ho}	H_{nc}	M
MC	Mho	Mnc	M
MC	Mho	Lnc	M
MC	Lho	Hnc	L
MC	Lho	Mnc	L
MC	Lho	Lnc	L
LC	Hho	Hnc	L
LC	Hho	Mnc	L
LC	Hho	Lnc	L
LC	Mho	Hnc	L
LC	Mho	Mnc	L
LC	Mho	Lnc	L
LC	Lho	Hnc	L
LC	Lho	Mnc	L
LC	Lho	Lnc	L

TOTAL CHANNEL (HIGH = H_c, MEDIUM = M_c AND LOW = L_c)
HANDOFF BUFFER LENGTH (HIGH= H_{ho}, MEDIUM = M_{ho} AND LOW = L_{ho})
NEW CALL BUFFER LENGTH (HIGH =H_{nc}, MEDIUM = M_{nc} AND LOW = L_{nc})
THRESHOLD/GUARD CHANNEL (HIGH = H, MEDIUM = M AND LOW = L)

The system will be tested by analyzing the call dropping rate, the call blocking rate, the time spent in buffer and the total service time using various sizes of the buffer. The findings from the proposed solution to optimal channel allocation will be benchmarked with recent works by (Arun, 2015) and (Nayak et al, 2015).

5. CONCLUSSION

In adaptive congestion control scheme, the model is to integrate an adaptive guard channel assignment scheme with the queuing of hand off calls and the new calls in order to reduce the dropping rate and the blocking rate respectively. In addition to the adaptive guard channel allocation, the model is structured in order to consider the analysis of the queuing systems so as to address the need to optimize channel assignment. This study is expected to generate parameters for measuring the performance of the system such as the dropping probability of the hand off call, blocking probability of the new call, size of the buffer, time spent in the buffer and the total service time. The model is expected to employ fuzzy logic model to effectively estimate the threshold, which indicates the number of channels that would be allocated for handoff calls. The result from this research is expected to provide knowledge of how to combine the dynamic guard channel scheme with buffer management so as to control congestion in wireless mobile network.

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