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Fuzzy Logic based Call Admission Control for Next Generation Wireless Networks

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Abstract: There is rapid growth and changes occurring in the field of wireless communication network (WCN) in recent days. Due to which the management and control of this WCN without decreasing the quality of service (QoS) has become a great problem. One of the major reasons for the decrease of QoS in WCN is increase in the call blocking probability. A Fuzzy Logic (FL) based Call Admission Control (CAC) method is proposed to address this problem in the work carried out. In this scheme primarily, the total bandwidth is partitioned into three parts viz. platinum class, gold class and silver class. These divisions are mainly based on user preferences. So to cleverly keep the blocking probability as low as possible, a FL based CAC is being implemented in platinum class for the available bandwidth. Simulation results show that the proposed FL based CAC reduces the call blocking probability to a maximum extent.

Key words: CAC, FL, call blocking probability.

I. INTRODUTION

In current time wireless communication is changing and growing rapidly in this world. Due to its tremendous growth and complex nature, it has been difficult to manage its kind of vast networks. So to control and mange such a complex and immense network CAC is being used. The CAC is a mechanism whose main purpose is to decide, at the time of call arrival, whether or not a new call should be admitted into the network or not. A new call is accepted only if QoS constraints are fulfilled without affecting the QoS constraints of the existing calls in the network.

For example, if a call is requested and the network is in the condition like free, or slightly impeded, or fully impeded, then the inclusion or exclusion of the new call depends on CAC decision. This decision impacts the QoS of the already existing calls and the QoS of the new calls in the network. Therefore a new call is accepted if the network assures QoS or else it must be blocked. One of the main aims of CAC is to prevent the delivery of voice and multimedia communication from over using, through internet protocol. CAC can be achieved using different soft computing techniques. Soft computing is process of finding a solution to the problems whose solution is not inexact. It is a synergistic mixture of artificial intelligence methodologies and models to solve real world problems that are either unfeasible or too hard to model mathematically. Here the solution will be in an approximation form rather than the exact solution. The European Centre for Soft Computing defines it as “A set of computational techniques to solve problems by imitating nature’s approaches”. The major techniques or methodologies of soft computing techniques are FL, neural networks and genetic algorithm. In the proposed methodology FL is used for reducing the call blocking probability.

FL is a methodology for depicting unpredictable and indefinite knowledge. FL was developed by Zadeh in 1964 to address uncertainty and imprecision, which widely exist in the engineering problems. The word fuzzy means not certain or precise, in other words it means not the exact value. The idea of FL was first designed while making the computer to understand the natural language which cannot be easily translated into the absolute terms of 0 and 1. It is

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a simple, rule-based "if and then" approach for solving a complex problem. FL comes to picture mainly when results are not in the manner like true or false. For example if the results of a climatic temperature are to be recorded then the device accepting it can use fuzzy logic. Here the input values will not be an exact values like 0, 1 or 2, rather it will be in the form of raging from 0 to1 or 1 to 2. So the values which are not in exact form are also accepted. Later these results are aggregated and an appropriate result is produced.

FL is one of the methodologies which is widely used in the area of problem solving. In CAC the FL is applied when new calls are to be accepted or when calls are handoff from one cell to another. While accepting new calls into the network call blocking takes place due to the variation in the signal strength. This problem can be solved by applying FL in the process of CAC. Here the new incoming calls are classified into very high, high, low and very low based on the signal strength of the each calls. Later using FL calls having very high, high and low signal strength are accepted and calls having very low signal strength are rejected or blocked from entering the network. The fuzzy mainly works in the form of IF and THEN rules, here two or more input values are sent to fuzzifier and approximate result is derived from it. Based on these results the incoming calls are either accepted or rejected into the network. The main advantage of using FL during the call admission process is that, calls having even low signal strength are also accepted. So using FL the problem of call rejection or blocking can be reduced to certain extent. Therefore using FL an effective CAC can be achieved, by reducing the call blocking probability while admitting a new call into the network.

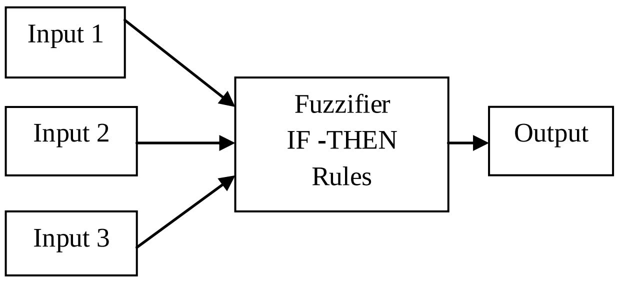

Figure 1: Basic Fuzzy Logic Model

II. RELATED WORKS

In [1] Petr proposes a CAC technique for UMTS. Four different algorithms based on FL have been presented like simple Algorithm (AC-F1), Algorithm with Simple Prediction of UEs Positions (AC-F2), Algorithm with Capacity Reservation (AC-F3) and Advanced Algorithm (AC-F4). The proposed AC-F3 and AC-F4 algorithms are compared with AC-F1 and AC-F2 algorithms which already exist. Comparison results show that AC-F4 has better performance compare to AC-F1 and AC-F2 and AC-F3 has comparable or slightly less performance than AC-F4. Simulations show that the novel advanced fuzzy algorithm outperforms the other simulated algorithms (in terms of blocking probability, dropping probability and the number of active UEs in cell) [1].

Renyong in [2] has described a fuzzy approached or controlled CAC for wireless or mobile networks. The method forecasts the future possible number of handoff dropping calls using auto regressive moving average model, but due to the complex system it is difficult to design control rules for it. To conquer this kind of difficulties a fuzzy control method has been introduced in the paper. In this scheme it monitors the state of cellular system at regular interval, number of handoff dropping calls and next possible handoff dropping calls. Based on the forecasted value and the measured handoff-dropping probability at each interval, the reservation threshold is updated using FL control to adaptively adjust the weighting factor [2]. The simulation result shows that proposed scheme enables us to attain a higher level of statistical multiplexing gain without decreasing the handoff-dropping probability.

Ray in [3] proposes a fuzzy traffic controller that controls both CAC and congestion control of the ATM network. The described fuzzy controller is an intellectual implementation that not only utilizes the mathematical formulation of classical control but also mimics the expert knowledge of traffic control [3]. The inputs to this method are linguistic variables of the traffic so that the controller

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performs in a closed loop with robust and stable operations. Later using clustering technique the data are collected from the conventional control methods and are used to set parameter to the membership function of the FL. The simulation results show that the described fuzzy CAC improves system utilization by a significant 11%, without decreasing the QoS when compared with conventional equivalent capacity method. The performance of the proposed fuzzy congestion control method is also 4% better than that of the conventional two-threshold congestion control method [3].

In [4] a novel CAC strategy founded on FL is described for UMTS by Roberto. Here a fuzzy set is defined using cell parameters like congestion state, total interference and available load. Later a fuzzy rule set is defined based on the CAC criterion rules. Its performance has been analyzed and compared with other well-known algorithms like Interference Admission Control and ARROWS Admission Control, by means of a UMTS radio access simulator [4]. Simulation results shows that it gives better results when compared with Interference Admission Control and ARROWS Admission Control in case of transfer delay for services accepted and dropping probability in that network.

In [5] the author proposes a FL partition-based CAC for efficient control and management of a mobile WiMAX network. The proposed method primarily partitions the total bandwidth into which corresponds to CBR, VBR and handover services. Based on the available bandwidth the proposed partition scheme is intelligently applied only to the HO portion to keep call dropping probability as low as possible. This proposed scheme is later compared with partition-based CAC and conventional bandwidth allocation CAC. Simulation results show that the proposed approach outperforms both partition-based CAC and conventional bandwidth allocation CAC in terms of total acceptance flow and low dropping probability. The described scheme provides better QoS in maintaining mobility for service flow in the network due to low dropping probability [5].

Jun Ye in [6] has proposed a FL based CAC for the reverse link transmission in CDMA wireless communications. At first the FL CAC estimates the bandwidth of the call from the MS. The user mobility information is estimated and predicted based on the measurements of the pilot signal power levels received at the MS [6]. Then makes a decision to accept or reject the call request based on the resource availability, where the handoff call have higher priority than the new calls which are entering into the network. Later the proposed scheme is compared with the received power-based CAC and non-predictive CAC. Simulation results shows that the proposed has better QoS in terms of the outage probability, lower handoff and new call dropping probability, higher resource and utilization efficiency, when compared to received power-based CAC and non-predictive CAC schemes.

III. SYSTEM MODEL

To reduce the complexity and easy understanding the proposed FL based CAC is sub-divided into different modules. This is mainly based on the data flow and data interaction with each module. The complete system design is divided into mainly 4 parts viz. Bandwidth Estimation, CAC module, FL module and Resource allocation. The CAC module mainly concentrates on division and allocation of the available bandwidth into different class of user. In resource allocation the available and required resources are allocated based on the priority and requirement. FL module is required mainly when the blocking of the call occurs in the network. The high level design of FL based CAC is shown in the figure below.

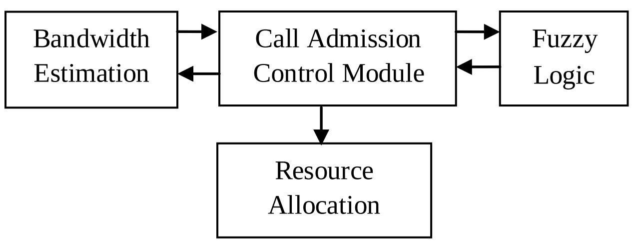

Figure 2: System Model

A. BANDWIDTH ESTIMATION MODULE

In bandwidth estimation module at first a request is received from the CAC module for updating the bandwidth available in network. So the initial process starts from fetching the list of all the available bandwidth in the network. This available bandwidth is put together to calculate total bandwidth availability. Later in bandwidth estimation process, the bandwidth is calculated by subtracting total bandwidth from current traffic rate. By this process the current available bandwidth will be known and can be allocated to new incoming calls in the network. As a reply to the request sent by CAC module the new bandwidth is updated and sent to it.

B. CAC MODULE

In the CAC module, the incoming calls are mainly divided into classes viz. Platinum, Gold and Silver. This classification is based on user preferences, it is mainly done using cost as parameter, where the platinum user will be charged more cost when compare to gold and silver. Gold users cost will be less than platinum but more than silver. The silver user cost is lowest when compared to platinum and gold users. The total bandwidth division is also dependent on the priority of the class. As the platinum users will have more priority the share in total bandwidth will also be more than other two classes. The gold having the next priority will have next high share of bandwidth to platinum but more than silver. The silver having least priority will have less bandwidth compared to platinum and gold. Each user based on their classes shares allocated bandwidth with respect to their priority.

If a new call arrives in the CAC module, then it is consider as incoming request. The call is validated and then the incoming call class is checked and classified into the platinum, gold and silver class based on the user who is initiating the call. When a new call occurs and the user belongs to platinum class then call is taken as platinum call and availability of the bandwidth in the particular class is checked. If the bandwidth is available, then the bandwidth is allocated from the available platinum class. Likewise if a gold or silver call occurs and required bandwidth is available, then the bandwidth is allocated from their respective classes.

The next scenario is if the available bandwidth is not present for the new incoming calls in their particular classes, then the calls automatically get blocked. To avoid this, FL is being used for the platinum class user calls. When a new call occurs in the network and if it is a platinum class call then by applying FL the bandwidth is adjusted. This adjustment is done by borrowing the available bandwidth from other two classes gold and silver respectively. The FL is applicable only to the platinum users so if any gold or silver call does not have available bandwidth it is just blocked from entering into the network.

C. FL MODULE

The FL module is mainly used to adjust the bandwidth of the platinum class, due to which blocking probability of new incoming call of the platinum class user reduces to a maximum extent. The fuzzy model first has fuzzifier, here input are given like available bandwidth of gold and silver class and the count of how many blocks are occurring currently in platinum class. These inputs are taken as suitable linguistic values or membership inputs which are needed by the inference engine.

The 5 membership functions which are being shaped are very small, small, medium, big and very big. There are total combinations of 25 membership functions, where each one is control by one IF-THEN rule. Hence the FL uses 25 IF-THEN rules, in which only one of the rules is triggered whenever there is a dropping of an existing service flow. Using this IF-THEN rule the inference engine makes decision on the output membership. This output membership is used by the defuzzifier to generate a non fuzzy control output. The non fuzzy control output is the amount of bandwidth to be added to the current platinum bandwidth [5]. Therefore using FL in CAC decision can be made such that call blocking probability in network is reduced to its maximum.

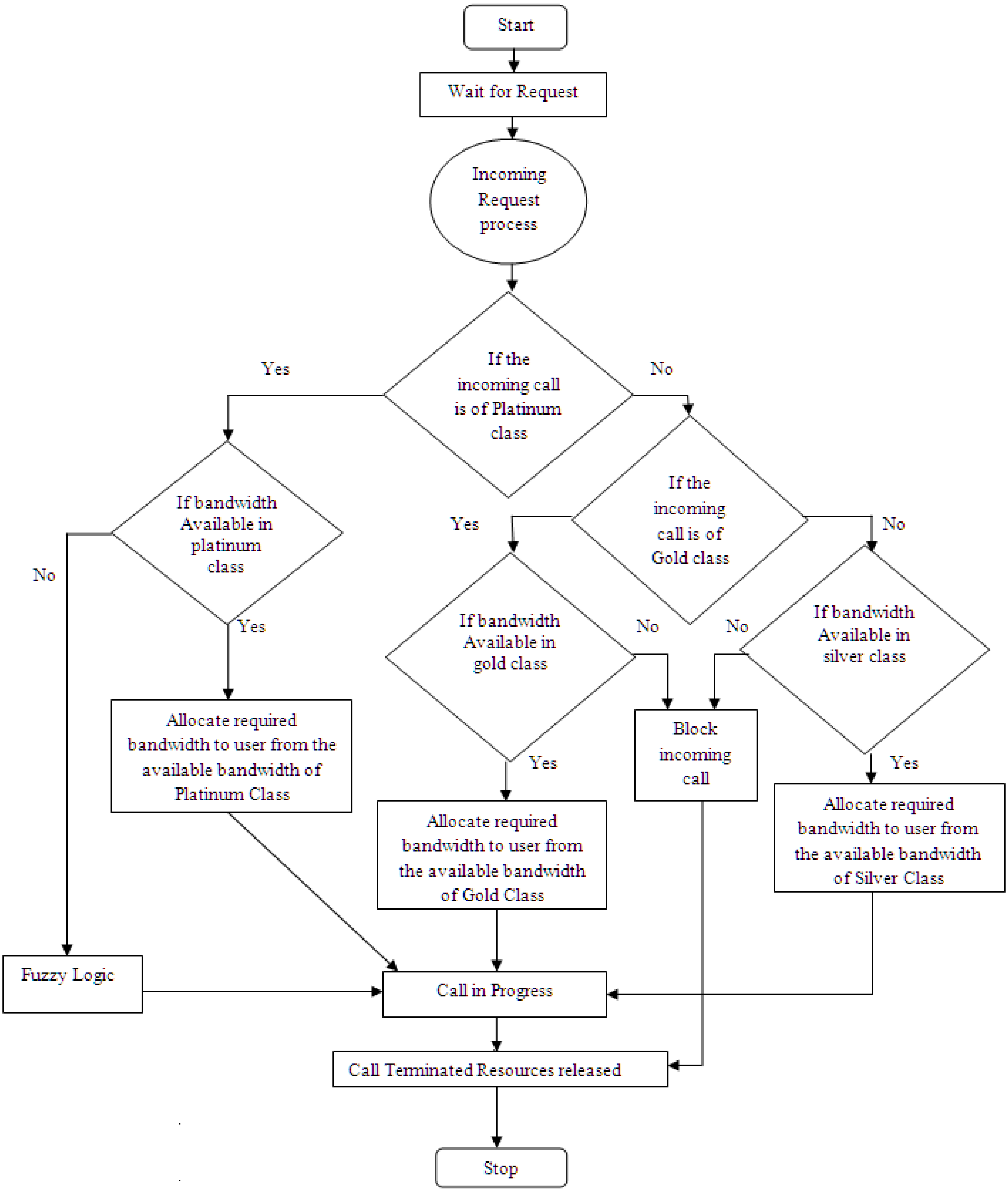

Figure 3: CAC Model

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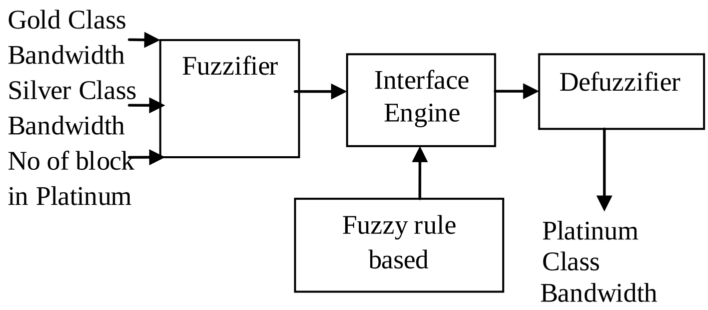

Figure 4: FL Module

S/N	Total call drop in platinum	Maximum bandwidth available	Bandwidth required to adjust
1	Very Small	Very Small	Zero
2	Very Small	Small	Very Small
3	Very Small	Medium	Very Small
4	Very Small	Big	Very Small
5	Very Small	Very Big	Very Small
6	Small	Very Small	Very Small
7	Small	Small	Very Small
8	Small	Medium	Small
9	Small	Big	Small
10	Small	Very Big	Small Medium
11	Medium	Very Small	Very Small
12	Medium	Small	Small
13	Medium	Medium	Small Medium
14	Medium	Big	Medium
15	Medium	Very Big	Big Medium
16	Big	Very Small	Very Small
17	Big	Small	Very Small
18	Big	Medium	Small
19	Big	Big	Medium
20	Big	Very Big	Big Medium
21	Very Big	Very Small	Very Small
22	Very Big	Small	Small
23	Very Big	Medium	Very Big
24	Very Big	Big	Very Big
25	Very Big	Very Big	Very Big

Table 1: Membership Functions

IV. SIMULATION RESULTS

The main aim of this research is to reduce the call blocking probability in the WCN. The utilization factor or λ/μ is defined as the call service time divided by call arrival time. Where λ is the call arrival time and μ is the call service time. Therefore for each 60 minutes simulation duration different λ and the μ are given as input and results have been obtained. The call blocking probability is derived by the dividing of total number of call arrived from the total number of call blocked. The call blocking of each class is as depicted in figure 5. From the figure 6, it can be observed that the call blocking probability keeps increasing as the utilization factor (λ/μ) increases. Figure 7 shows that the CAC with FL has less call blocking probability when compare to CAC without FL. Therefore it can be concluded that CAC with FL reduces call blocking probability to a maximum extent when compared to CAC without FL.

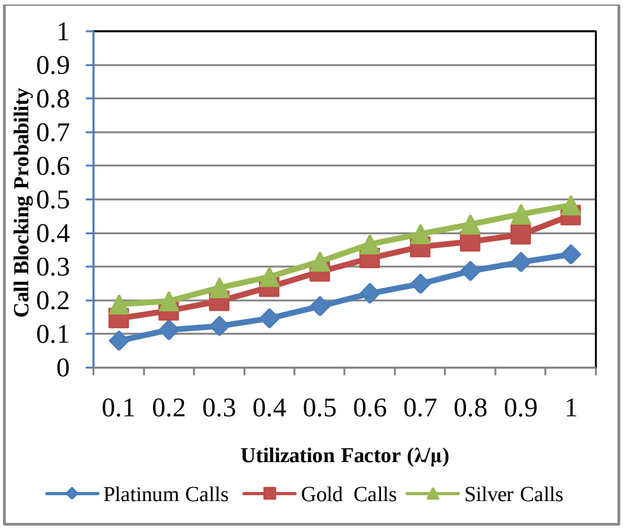

Figure 5: Call Blocking Probability of Different classes

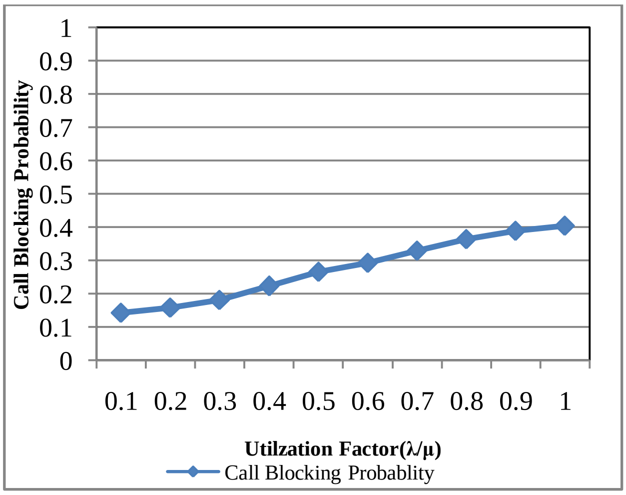

Figure 6: Call Blocking Probability

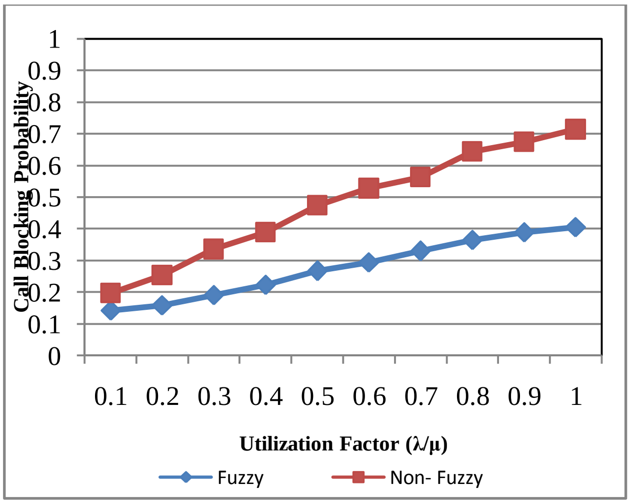

Figure 7: Call Blocking Probability with Fuzzy and Without Fuzzy comparison

V. CONCLUSION

In WCN QoS is still a major concern. The proposed scheme increases the QoS by decreasing the call blocking probability of the new incoming calls in the network. The proposed scheme is compared with non-FL CAC scheme. The proposed scheme performs better with respect to call blocking probability, when compared with non-FL scheme. Simulation results show that developed scheme improves QoS by reducing the call blocking probability to a maximum extent.

REFERENCES

[1] Kejik, Petr, Stanislav Hanus and Jirí Blumenstein, "Advanced Fuzzy Logic Based Admission Control for UMTS System", Radioengineering, vol 19, no 4, page no 673, 2010.
[2] Wu, Renyong and Guangxi Zhu "A Fuzzy-Control Approach to Call Admission Control for Wireless/Mobile Networks".
[3] Cheng, Ray-Guang and Chung-Ju Chang, "Design of a fuzzy traffic controller for ATM networks." Networking, IEEE/ACM Transactions, vol 4, on 3, page no: 460-469, 1993.
[4] Dini, Paolo and Roberto Cusani, "A Fuzzy Logic Approach to Solve Call Admission Control Issues in CDMA Systems", EUSFLAT Conf, page no 797-802, 2005.
[5] Shuaibu, D. S., S. K. Yusof, N. Fisal, S. H. S. Ariffin, R. A. Rashid, N. M. Latiff, and Y. S. Baguda, "Fuzzy logic partition-based call admission control for mobile WiMAX" ISRN Communications and Networking, no 16, 2011.
[6] Ye, Jun, Xuemin Shen, and Jon W. Mark, "Call admission control in wideband CDMA cellular networks by using fuzzy logic." Mobile Computing, IEEE Transactions on 4, no. 2, page: 129-141, 2005.
[7] Dini, Paolo and Roberto Cusani, "A Fuzzy Logic Approach to Solve Call Admission Control Issues in CDMA Systems" In EUSFLAT Conf., pp. 797-802. 2005.
[8] Ditze, Michael, and Matthias Grawinkel, "Fuzzy Logic Based Admission Control for Multimedia Streams in the UPnP QoS Architecture" In Advanced Information Networking and Applications Workshops, 2007, AINAW'07,21st International Conference on, vol. 1, pp. 970-976, IEEE, 2007.
[9] Todinca, Doru, Stefan Holban, Philip Perry and John Murphy, "Fuzzy logic based admission control for GPRS/EGPRS networks" Proc. of CONTI, 2004.
[10] Ghosh S, Razouqi Q, Schumacher H J and Celmins A, "A survey of recent advances in fuzzy logic in telecommunications networks and new challenges", Fuzzy Systems, IEEE Transactions, vol 6, no 3, page no 443-447, 1998.
[11] Ascia, G, Catania V, Ficili G, Palazzo S & Panno D, "A VLSI fuzzy expert system for real-time traffic control in ATM networks", Fuzzy Systems, IEEE Transactions, vol 5, on 1, page no: 20–31, 1997.
[12] Y. Ma, X. Hu, Y. Zhang and Y.Shi, "Intelligent call admission control using fuzzy logic in wireless networks," in proceedings of the 2005 American Control Conference , Jun. 2005.
[13] N. Mohan and T. Ravichandran, "A Fuzzy Logic Based Power Control for Wideband Code Division Multiple Access Wireless Networks", Journal of Computer Science 8 (8): 1372-1379, ISSN 1549-3636, Science Publications 2012.