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# Channel Allocation Scheme for Cellular Network Using Fuzzy Logic

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***Abstract*** **- This paper, deals fuzzy call admission control scheme to the requirement of quality of service. Quality of service is very critical issue in mobile communication because of dearth of spectrum resource and mobility of consumer and the main parameter is call dropping probable condition which shows the possibility of the extant relation being refusable during mobility. When the consumer's call suddenly abolished in the term of the connection is more troubling than being obstructed likely on a new call try. Performance of channel allocation scheme is evaluated, using fuzzy control in terms of call dropping probability and channel utilization**
***Keywords:*** **Fuzzy rule, Call dropping probability, Traffic load**

## I. INTRODUCTION

A cellular system lies of a main switching system, likely mobile switching center and group of cells, every group with a fixed base station. Base stations directly communicate with all mobile stations around its half diameter of transmission. When the users move from one cell to another cell, handoff operation will come into the existence. Load network reallocate the channels, which is allocated to a network cells to balance and to avoid the overload of traffic. To handle the overload of traffic which varying from time to time through increases the capacity of system. It can be achieved by effective transferring channels from low loaded cells to heavy loaded cells.

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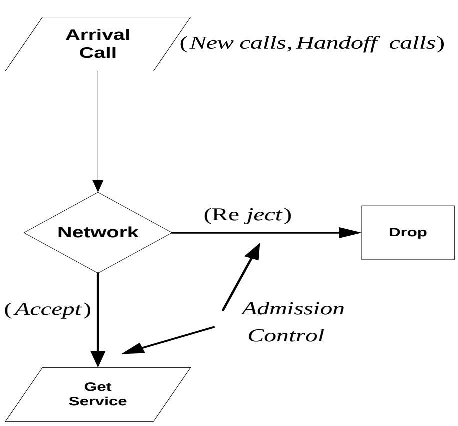


Fig. 1 Control systems for Call Admission

Recently fuzzy modeling is found to be very powerful tool for describe a real, complex and unknown process with nonlinear and time varying properties. Fuzzy rule is used for formulating fuzzy variables. A fuzzy rule is classified on cell to be poor, below average, average, above average. Collection of load information could be able to reflect its qualitative estimates of the current load on a cell. In a cellular system the arrival time of the calls may vary significantly as the call duration are uncertain and vague. Therefore fuzzy system can help us to obtain the best solution.

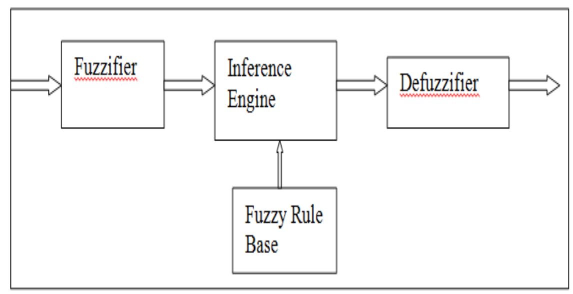


Fig. 2 Fuzzy Logic Controller

Several researches have been widely used fuzzy logic in different type of real world applications. Jiang and Rappaport [2] gave new channel assignment scheme which classified into fixed channel assignment, dynamic channel assignment and hybrid channel allocation. Ko and Cho [5] discussed adaptive handoff guard channel method using fuzzy logic. Dong and Lai [6] discussed conventional channel allocation approaches for cellular mobile with the classification of research and updation. Turksen et al [7] established fuzzy logic control rule for wireless cellular networks. Chong and Leung [8] proposed for fixed threshold values. Chen et al [9] proposed a fuzzy auto-regressive scheme to provide an effective and efficient traffic management for achieving high-speed networks.

Wang & Luoh [10] focused on defuzzification process when available computational capabilities are restricted by different parameters so in order to achieve a desired level of performance. Zhang and Lin [11] implemented and simulated an adaptive channel reservation scheme for wireless network. Wu et al [12] developed channel allocation algorithm for cellular networks. Wang and Shen [13] develop a policy to predicted the cell load and solve the channel borrowing scheme based on fuzzy logic. Ma et al [14] proposed fuzzy call admission control policy for getting requires quality of service. Sgore and Vergados [15] studied the detail survey of handoff prioritized channel assignment policy. Mallapur et al [16] considered buffer manager located at the base station using a fuzzy controller such as application priority, queue length and packet size for packet dropping in wireless cellular networks. Iancu

[17] established one of the most accepted centroid defuzzification method for computing the defuzzification. Jain and Mittal [18] investigated call admission control scheme by exploiting the soft handoff coverage area of cellular system.

## II. CELLULAR SYSTEM USING FUZZY BASED

Consider a cellular system, where numbers of cells are associated in hexagonal form and each served by the base station. Base station and the mobile host inform through the wireless links using channel. Every cell is allocated with a fixed group channels and common group of channels is reapplied by those identical cells. They are far from each other in order to avoid intervention. The intervention neighborhood of c, denoted by $IN(c) = \{c' \mid dist\ (c, c') < D_{\min}\}$,

where $D_{\min} = 3\sqrt{3R}$ and R is half diameter of compact shape of different channels. If $N_i$ indicate the number of cells in the ring i, and for the hexagonal geometry $N_i = 1\ if\ i = 0\ and\ N_i = 6i\ if\ i > 0$. The primary channels are denoted by $P_i\ (i = 0,1,2,......k-1)$ for the cells in $G_i$ and it is arranged in an ordered. Hence the cells in $G_i$ are primary cells of the channels in $P_i$ and secondary cells of the channels in $P_j\ (j \neq i)$ such group of cells construct the cell cluster. In this system, the arrival time of the call duration time and massage passing overhead among the cells are unclear and indecisive as discuss in figure 2.

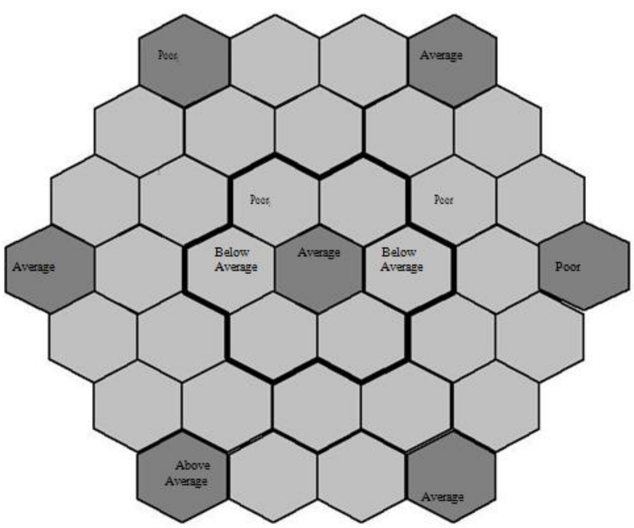


Fig. 3 Hexagonal Cellular Networks

## III. FUZZIFICATION MODULE

Employ the available channel and traffic load as the input variables for the fuzzy sets. Fuzzification function is introduced for each input variable to express the allied measurement uncertainty. The grade of membership function reflects unfolds an ordering of the objects in fuzzy set X. The support of a fuzzy set X is the crisp set of all x Є Φ such that $\Phi_x > 0$. i.e., $Sup\ (X) = \{x \epsilon\ \Phi, \Phi_x(x) > 0\}$. There are operations of different fuzzy set. They are used for operations like as union, intersection and complement, Zadel [15] described the fuzzy operations are as follows

1. Complement: Let a fuzzy set X is denoted by $\bar{X}$ and the membership function of $\bar{X}$ is $1 - \Phi_X(x)$, ∀ x Є X.
2. Intersection: Let fuzzy set X & Y is defined by $X \cap Y$ and the membership function of $X \cap Y$ is given by $X \cap Y = \min\{\Phi_X(x), \Phi_Y(x)\}$ ∀ x Є X.
3. Union: Let fuzzy set X & Y is defined by $X \cup Y$ and the membership function of $X \cup Y$ is given by $X \cup Y = \max\{\Phi_X(x), \Phi_Y(x)\}$ ∀ x Є X.

The following relation in the interval $x \in [a_0, a_5]$ and $y \in [b_0, b_2]$, are mentioned as:

$$\text{Poor} = \begin{cases} 1 & when\ x \le a_1 \\ \frac{(a_1 - x)}{(a_2 - a_1)} & when\ \ a_1 < x < a_2 \\ 0 & when\ x \ge a_2 \end{cases} \quad (1)$$

$$\text{Below Average} = \begin{cases} 1 & when\ a_1 \le x \\ \frac{(x - a_1)}{(a_2 - a_1)} & when\ \ a_1 < x < a_2 \\ 0 & when\ x = a_2 \end{cases} \quad (2)$$

$$\text{Average} = \begin{cases} 0 & when\ a_2 \le x \ge a_3 \\ \frac{(x - a_2)}{(a_3 - a_2)} & when\ \ a_2 < x < a_3 \\ 1 & when\ x = a_3 \end{cases} \quad (3)$$

$$\text{Above Average} = \begin{cases} 0 & when\ a_3 \le x \ge a_4 \\ \frac{(x - a_3)}{(a_4 - a_3)} & when\ \ a_3 < x < a_4 \\ 1 & when\ x = a_4 \end{cases} \quad (4)$$

$$\text{Low} = \begin{cases} 0 & when\ y \ge b_1 \\ \frac{(y - b_0)}{(b_1 - b_0)} & when\ \ b_0 < y < b_1 \\ 1 & when\ y = b_0 \end{cases} \quad (5)$$

$$\text{Medium} = \begin{cases} 0 & when\ either\ y = b_0\ or\ y = b_2 \\ \frac{(y - b_0)}{(b_1 - b_0)} & when\ \ b_0 < y < b_1 \\ \frac{(y - b_1)}{(b_2 - b_1)} & when\ b_1 < y < b_2,\ when\ y = b_1 \end{cases} \quad (6)$$

$$\text{High} = \begin{cases} 0 & when\ y \ge b_1 \\ \frac{(y - b_1)}{(b_2 - b_1)} & when\ b_1 < y < b_2, \\ 1 & when\ y = b_1 \end{cases} \quad (7)$$

Consider the $X = \int_{\phi} \frac{\phi_X(X)}{x}\ and\ Y = \int_{\phi} \frac{\phi_y(Y)}{y}$ where X is membership function and x is real input value for available channel and Y is membership function and y is real input value for traffic load. Let $a_i$ is lingual labels of available channel membership function for $0 \le i \le 5$ and $b_j$ is lingual labels of membership function for $0 \le j \le 2$. The status of X and Y are described for available channel and traffic load respectively.

### *A. Fuzzy Rule Base*

Fuzzy Rule Base is depicted as group of fuzzy IF-THEN rule in which the preconditions and resultant blend lingual variables. Such group of fuzzy control indicates the simple input-output relation of the system. There are 20 fuzzy rules used in the table. Fuzzy controller can obtain the tuning number of guard channels according to the call drop rate and current number of the guard channels. The output parameter can be converted into a crisp value by the maximum membership inference method.

TABLE I FUZZY CONTROL RULES

| Rule | IF (call drop rate) | AND (No. of Guard Channels) | THEN (Tuning No. of Guard Channels) |
|---|---|---|---|
| $R_1$ | Zero | Poor | Zero |
| R2 | Zero | Below Average | Zero |
| R3 | Zero | Average | Zero |
| R4 | Zero | Above Average | Zero |
| R5 | Poor | Poor | Zero |
| R6 | Poor | Below Average | Zero |
| R7 | Poor | Average | Below Average |
| R8 | Poor | Above Average | Average |
| R9 | Below Average | Poor | Below Average |
| R10 | Below Average | Below Average | Poor |
| R11 | Below Average | Average | Below Average |
| R12 | Below Average | Above Average | Average |
| R13 | Average | Poor | Below Average |
| R14 | Average | Below Average | Below Average |
| R15 | Average | Average | Average |
| R16 | Average | Above Average | Average |
| R17 | Above Average | Poor | Average |
| R18 | Above Average | Below Average | Average |
| R19 | Above Average | Average | Average |
| R20 | Above Average | Above Average | Zero |

In fig. 4-6 describe membership function for call dropping probability, guard channels and traffic load respectively.

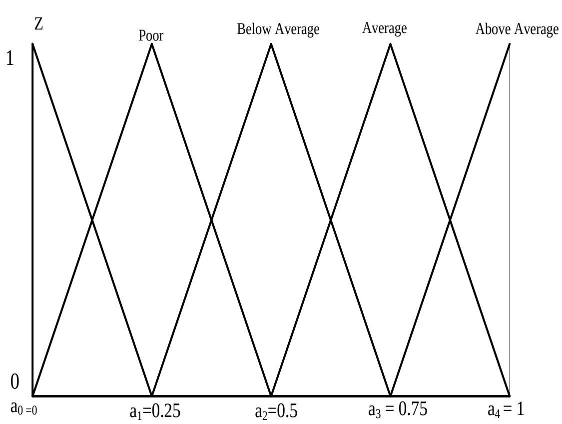


Fig. 4 Membership function for call dropping probability

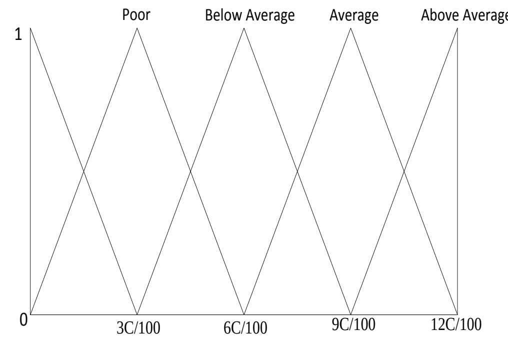


Fig. 5 Membership function for the guard channels

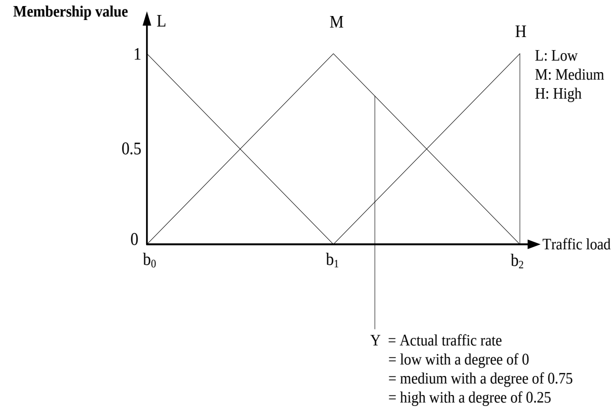


Fig. 6 Traffic Load

*B. Inference Engine*

Inference rule can be described in two ways. They are connectives by AND and ALSO may be interpreted as either union (U) or intersection (∩) for different definition of fuzzy implication and denoted by max(∨) –min (∧) composition operators. Consider the rule $R_i$ with fuzzy implication $R_c$, the conclusion $C'$ can be represented as the intersection of the individual conclusion of input linguistic state variables.

$$\phi_{c'}(z)=\bigcup_{x,y}\{[\phi_{X'}(x)\cap\phi_{Y'}(y)]\cap[\phi_{X_i}(x)\cap\phi_{Y_i}(y)\cap\phi_{Z_i}(z)]\}$$
$$=\bigcup_{x}\{[\phi_{X'}(x)\cap\phi_{X_i}(y)\cap\phi_{Z_i}(z)]\cap[\bigcup_{y}\{\phi_{Y'}(y)\cap\phi_{Y_i}(y)\cap\phi_{Z_i}(z)]\}$$
$$=\bigcup_{x}\{\phi_{X'}(x)\cap\phi_{X_i}(x)\cap\phi_{Z_i}(z)\cap\phi_{Y'}\circ R_c(Y_i;Z_i)(Z)\}$$

Where $R_c(X_i,Y_i,Z_i)=(X_i\ AND\ Y_i)\rightarrow Z_i$

i.e

$$Z'=(X',Y')\circ R_c(X_i,Y_{i,}Z_i)=[X'\circ R_c(X_i;Z_i)]\cap[Y'\circ R_c(Y_i;Z_i)]$$

If inputs are fuzzy singletons, $X'=x_0\ and\ Y'=y_0$ then the results $Z'$, obtained by employing minimum operation rule $R_c$ and product operation rule $R_p$ respectively.

$$R_c\ :\phi_{c'}(z)=\bigcup_{i=1}^{n}\alpha_i\cap\phi_{c_i}(z)=\bigcup_{i=1}^{n}[\phi_{X_i}(x_o)\cap\phi_{Y_i}(y_o)]\cap\phi_{Z_i}(z)$$

$$R_p\ :\phi_{c'}(z)=\bigcup_{i=1}^{n}\alpha_i\,.\phi_{c_i}(z)=\bigcup_{i=1}^{n}[\phi_{X_i}(x_o)\cap\phi_{Y_i}(y_o)]\phi_{Z_i}(z)$$

Where $\alpha_i$ is weight factor of the $i^{th}$ rule which is measured by $i^{th}$ rule to the fuzzy control action. Four load actions, have been used which are poor, below average, average, above average. This paper consists of 4x3 =12 possible rules. The possible 12 combination between available channel and traffic load is described in fig. 3.

TABLE II FUZZY CONTROL RULES FOR CHANNEL

| Traffic Load / Available channel | Low | Moderate | High |
|---|---|---|---|
| Poor | (1)Positive Small | (2)Positive Medium | (3)Stable Zero |
| Below Average | (4)Positive Small | (5)Positive Medium | (6)Positive Medium |
| Average | (7)Positive Medium | (8)Positive Large | (9)Positive Large |
| Above Average | (10)Stable Zero | (11)Positive Medium | (12)Positive Large |

*C. Defuzzification*

The process of defuzzification helps to control the problems in real life. It actually helps to control the action. Centroid technique for defuzzification is considered in obtaining a centre of gravity (COG) of the aggregated fuzzy set. A realistic estimate can be carried out by evaluating it over a sample of points.

$$COG = \frac{(0+10+20)\times 0.2+(30+40+50+60)\times 0.35+(70+80+90+100)\times 0.5}{0.2+0.2+0.2+0.35+0.35+0.35+0.35+0.5+0.5+0.5+0.5}$$

$$= \frac{6+63+170}{0.6+1.4+2} = \frac{239}{4} = 59.75$$

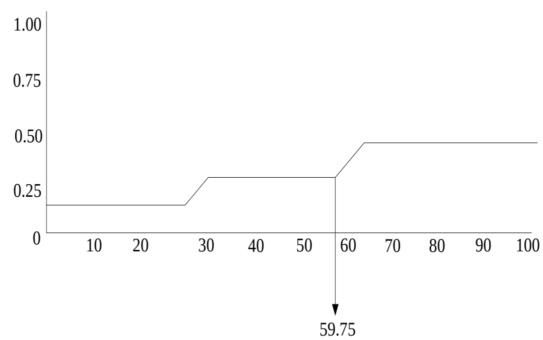


Fig. 7 Centre of Gravity

## IV. CONCLUSION

The present investigation highlights the call admission control scheme based on fuzzy logic. It believes that a fuzzy scheme is more capable to provide better control and management of cellular networks than the probabilistic approaches. Centroid defuzzification method provides a good performance. It also gives robust performance of the cellular networks like dropping rate, channel acquisition delay and messages complexity.

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