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.

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 upadation. 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 $IN(c) = \{c' | \text{dist}(c, c') < D_{\min}\}$,

where $D_{\min} = 3\sqrt{3}R$ 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 ($i = 0, 1, 2, \dots, k-1$) 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 message 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 an ordering of the objects in fuzzy set X . The support of a fuzzy set X is the crisp set of all $x \in$

Φ such that $\Phi_x > 0$. i.e., $\text{Sup}(X) = \{x \in \Phi, \Phi_x(x) > 0\}$. There are operations of different fuzzy set. They are used for operations like as union, intersection and complement, Zadeh [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 $1 - \Phi_X(x)$, $\forall x \in X$.
2. Intersection: Let fuzzy set X & Y is defined by $X \cap Y$ and the membership function of $X \cap Y$ is given by $X \cap Y = \min\{\Phi_X(x), \Phi_Y(x)\}$ $\forall x \in X$.
3. Union: Let fuzzy set X & Y is defined by $X \cup Y$ and the membership function of $X \cup Y$ is given by $X \cup Y = \max\{\Phi_X(x), \Phi_Y(x)\}$ $\forall x \in X$.

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

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

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

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

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

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

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

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

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 $0 \leq i \leq 5$ and b_j is lingual labels of membership function for $0 \leq j \leq 2$. 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
R ₂	Zero	Below Average	Zero
R ₃	Zero	Average	Zero
R ₄	Zero	Above Average	Zero
R ₅	Poor	Poor	Zero
R ₆	Poor	Below Average	Zero
R ₇	Poor	Average	Below Average
R ₈	Poor	Above Average	Average
R ₉	Below Average	Poor	Below Average
R ₁₀	Below Average	Below Average	Poor
R ₁₁	Below Average	Average	Below Average
R ₁₂	Below Average	Above Average	Average
R ₁₃	Average	Poor	Below Average
R ₁₄	Average	Below Average	Below Average
R ₁₅	Average	Average	Average
R ₁₆	Average	Above Average	Average
R ₁₇	Above Average	Poor	Average
R ₁₈	Above Average	Below Average	Average
R ₁₉	Above Average	Average	Average
R ₂₀	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 ($\cap$) for different definition of fuzzy implication and denoted by $\max(\vee)$ – $\min(\wedge)$ 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.

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

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

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.

$$R_c : \phi_{c'}(z) = \bigcup_{i=1}^n \alpha_i \cap \phi_{c_i}(z) = \bigcup_{i=1}^n [\phi_{X_i}(x_0) \cap \phi_{Y_i}(y_0)] \cap \phi_{Z_i}(z)$$

$$R_p : \phi_{c'}(z) = \bigcup_{i=1}^n \alpha_i \cdot \phi_{c_i}(z) = \bigcup_{i=1}^n [\phi_{X_i}(x_0) \cap \phi_{Y_i}(y_0)] \phi_{Z_i}(z)$$

Where α_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 $4 \times 3 = 12$ 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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