SIMULATION OF RADIO RESOURCES MANAGEMENT IN UMTS SYSTEM

Petr Kejík
Doctoral Degree Programme (2), FEEC BUT
E-mail: xkejik00@stud.feec.vutbr.cz

Supervised by: Stanislav Hanus
E-mail: hanus@feec.vutbr.cz

ABSTRACT

This article deals with radio resources management in UMTS system, especially with admission control and congestion control. These functions are responsible for access to UMTS network and for ensuring QoS (Quality of Services) in UMTS. In this paper, a fuzzy logic based admission control is briefly described, studied and compared with load factor based admission control.

1 INTRODUCTION

This article deals with so-called RRM (Radio Resources Management) functions that play a very important role in UMTS system. These functions are responsible for supplying optimum coverage, ensuring efficient use of physical resources, keeping the desired QoS (Quality of Services) and providing the maximum planned capacity. An admission control (AC) and congestion control (CC) are considered there. Overloaded situations are solved by CC algorithm. AC solves system load and it decides if a new connection request will be accepted or rejected. There are many versions of AC algorithm, e.g.: interference based AC, throughput based AC, transmitted power based AC and some others. Some examples could be found in [1]-[4].

2 FUZZY CONTROLLER

A fuzzy logic, see [2], [3] and [5], becomes quite popular technique as it is able to deal with traffic uncertainty and measurement errors. A fuzzy controller (based on [3], [4] and [8] is considered there. Fig. 1 shows the main block structure. Input variables are: voice activity factor v_f, user mobility (speed) M and total uplink load factor η_{ul}. Membership function values for all input parameters are calculated (fuzzyfication process). The corresponding terms sets are: *low* and *high* for v_f; *low*, *medium* and *high* for M and η_{ul}. Term set for decision: *strongly accepted* (SA), *accepted* (A), *weakly accepted* (WA), *weakly rejected* (WR) and *rejected* (R). The application of fuzzy rules (see Tab. 1) follows. The final value is defuzzified to form the final decision (accepted or rejected).

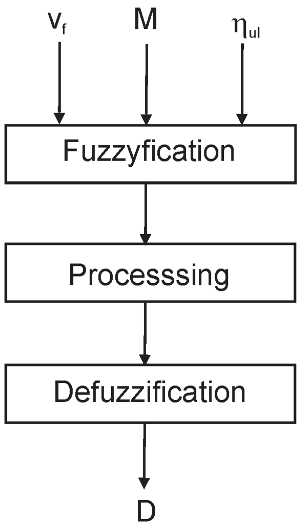

Figure 1: Fuzzy controller structure

3 SIMULATION

System model of UMTS has been created in MATLAB. This model contains 7 hexagonal cells of equal size. Diameter of each cell is 1 km. Each cell contains centrally located Node B with an omni directional antenna. Two traffic classes of users are considered (voice and video) with

Rule	v_f	M	η_{ul}	Decision
1	low	low	low	SA
2	low	low	medium	A
3	low	low	high	WA
4	low	medium	low	SA
5	low	medium	medium	WA
6	low	medium	high	WA
7	low	high	low	A
8	low	high	medium	WA
9	low	high	high	WR
10	high	low	low	SA
11	high	low	medium	A
12	high	low	high	WR
13	high	medium	low	A
14	high	medium	medium	WA
15	high	medium	high	WR
16	high	high	low	WA
17	high	high	medium	WA
18	high	high	high	R

Table 1: Fuzzy rules

voice activity factor 0.5 and 1 respectively. Session requests are generated according to Poisson process distribution with the arrival frequency from 150 up to 1200 session requests per hour (for each cell separately). All simulations last 60 minutes, call duration varies between 60 and 180 seconds. Users (sessions) have the same demands (except the voice activity factor): E_b/N_0 = 7.5 dB (energy per bit per noise spectral density), R = 12.2 kbit/s (desired bit rate), speed of users varies between 0 and 50 km/hour.

Fuzzy logic controller (denoted as AC-F), as described in section 2 and in [8], is compared with load factor based controller (denoted as AC-L). AC-L uses overall uplink load factor, which is compared with the decision threshold. According to [1], the total uplink η_{ul} load factor can be expressed as:

$$\eta_{ul} = (1+j) \cdot \sum_{i=1}^{K} \frac{1}{1 + \frac{W}{(E_b/N_0)_i \cdot R_i \cdot v_i}} \tag{1}$$

where j is the other cells to own cell interference ratio, K is the number of users in cell, W is the chip rate (3.84 Mchip/s), $(E_b/N_0)_i$ is required energy per bit per noise power spectral density, R_i is the required bit rate and v_i is the voice activity factor of the i^{th} user.

Two cases are considered there - with and without congestion control (CC). The congestion control averages total load factor for last 20 seconds. If it exceeds threshold level the last accepted user in that cell is dropped out. Blocking (BP) and dropping (DP) probabilities were chosen for algorithms evaluation. Blocking probability is the ratio of rejected users and call requests. Dropping probability is the ratio of dropped users and number of handover call requests.

Fig. 2 shows blocking (BP) and dropping (DP) probabilities of voice users. Two cases are considered there: without congestion control and with congestion control (CC). Fig. 2 shows that BP for AC-F (without CC) is worse than BP for AC-L. However DP for AC-F is significantly lower than for AC-L. This is quite important because of users perspective. Both

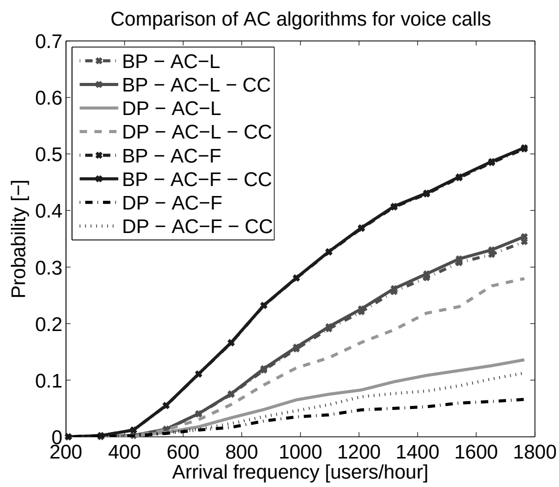

Figure 2: Comparison of AC algorithms for voice users

algorithms cause a occasional exceeding of allowed threshold level for uplink load factor. This is handled by congestion control. CC has minimal impact to the blocking probabilities of both algorithms (curves for BP are overlapping), but it has quite high influence to the dropping probabilities (it is partially caused by the way how it performs) of both algorithms. However it can be observed that BP of load factor based AC is increased more than in the AC-F case.

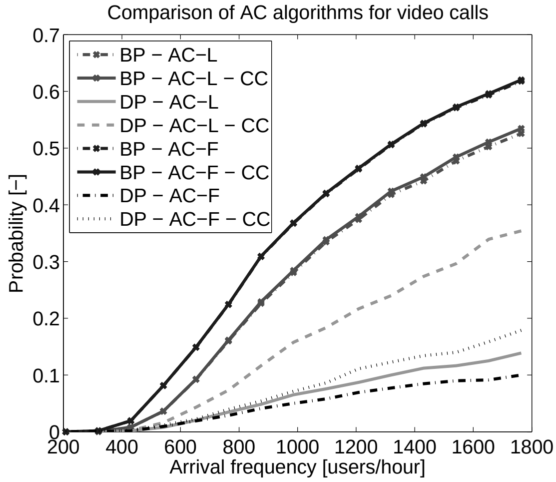

Figure 3: Comparison of AC algorithms for video users

Fig. 3 shows blocking (BP) and dropping (DP) probabilities of video users. Two cases are considered there again: without congestion control and with congestion control (CC). This figure corresponds to the Fig. 2. It could be observed that all values in Fig. 3 are lower than in Fig. 2. This is because the voice users have higher priority.

4 CONCLUSION

This article deals with admission and congestion control in UMTS system. A fuzzy logic based admission controller and a load factor based controller are compared via simulation. Fuzzy controller (a quite simple version) is able to decrease dropping probability. A simple congestion control is used and its influence is studied. It increases dropping probability of both algorithms, so more complex version (e.g.: it should decrease bit rates of already accepted users instead of dropping out users) should be used in the future.

ACKNOWLEDGEMENTS

This contribution has been supported by the research project of the GA CR (Czech Science Foundation) No. 102/07/1295 “Models of Mobile Networks and their Parts”, by the research program No. MSM 0021630513 “Advanced Electronic Communication Systems and Technologies” (ELCOM) and by the project of the GA CR No. 102/08/H027 “Advanced Methods, Structures and Components of Electronic Wireless Communication”.

REFERENCES

[1] Agusti, R., Sallent, O., Perez, J., Goria, P., Mangani, N., Vaillant, A.: First report on the evaluation of RRM algorithms by simulation. 2002, [online], [cit 2008-11-24]. Available: http://www.arrows-ist.upc.es/.

[2] Shen, S., Chang, C. J., Huang, C., Bi, Q.: Intelligent call admission control for wideband CDMA cellular systems. IEEE Transactions on Wireless Communications, Sep. 2004, vol. 3, no. 5.

[3] Malarkkan, S., Ravichandran, V.: Performance analysis of call admission control in WCDMA systems with adaptive multi class traffic based on fuzzy logic. IJCSNS International Journal of Computer Science and Network Security, Nov. 2006, vol. 6, no. 11.

[4] Chang, Ch., Kuo, L., Chen, Y., Schen, S.: Neural fuzzy call admission and rate controller for WCDMA cellular systems providing multirate services. In: Proceedings of the 2006 International Conference on Wireless Communications and Mobile Computing, Canada, p. 383-388. ISBN 1-59593-306-9.

[5] Nawrocki, M., Dohler, M., Aghvani, A.: Understanding UMTS radio network modelling, planning and automated optimisation. Chichester: J. Wiley & Sons, 2006. ISBN 0-470-01567-5.

[6] Holma, H., Toskala, A.: WCDMA for UMTS: Radio access for third generation mobile communications. 3rd ed. Chichester: J. Wiley & Sons, 2005. ISBN 978-470-87096-9.

[7] Hossain, F., Sohab, A.: Mathematical modelling of call admission control in WCDMA networks: Master's thesis. Blekinge Institute of Technology, 2007. 58 s.

[8] Kejík, P., Hanus, S.: The application of fuzzy logic for admission control in UMTS system. *Radioelektronika 2009*, in progress.