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QoS in Mobile Traffic Management during Peak Hours

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Abstract: The process in which continuation of calls is facilitated when a mobile station travels across cell boundaries is called Handoff. The use of microcells to accommodate high density of calls results in the increased number of handoffs. The adequate resources to provide proper and timely handoff enable to accommodate more traffic. In this paper a bidirectional call overflow scheme between two layers of microcells and macrocells is presented, where handoffs or the originating calls are decided on the basis of traffic density and availability of channels in the target cell to receive the call. To ensure that the handoff calls are given high priorities, it is assumed that guard channels are assigned in both microcells and macrocells. The mobile station originating a call or already having ongoing call can have low or high speed, so depending upon the status of traffic density in target cell the call is either carried in the cell or transferred to overlaid macrocell. The calls are divided in four groups, high mobility/high load, low mobility/high load, low mobility/low load and high mobility/low load. Usually low mobility calls are directed to microcells whereas high mobility calls are directed to macrocells but during peak hours when the densely populated cell cannot hold much traffic the originating as well as handoff calls are directed to macrocells. These calls are then returned to another target microcell where resources are available and signal strength is acceptable. This will reduce the number of handoffs and result in enhanced quality of service by efficient traffic management system.

Keywords: Bidirectional Call Overflow, Handoffs, High Speed, Macrocell, Microcell, Prioritizing

I. INTRODUCTION

In wireless cellular network, a fixed number of channels are assigned to each cell depending upon population density. If a channel is occupied by a call, no other call can use this channel again in same cell at the same time till it is released for doing so. With the decrease in size of the cells, the system capacity increases because of the more efficient reuse the frequencies in a given area. However, there is also an increase in the number of cell boundaries that a mobile unit crosses. These boundary crossings stimulate handoff calls and location tracking operations, which are expensive in terms of time delay and communication bandwidth, hence limiting the call handling capacity of a cellular system. The forced termination of handoff call is less desirable than blocking an originating call. Handoff function is the most frequently encountered network function and has direct impact on the perceived quality of service [1, 2]. It provides continuation of calls as the mobile travels across cell boundaries. A mobile station can move around with different speeds, and based on the predefined threshold in speed, all the calls are divided in two broad groups; fast calls and slow calls (including originating calls and handoff calls). The management of fast and slow calls by macrocells and microcells respectively is described in [3, 4]. The early schemes introduced in [5, 6], for each individual call, the serving layer does not change at all, fast and slow calls are always served by macrolayer and microlayer respectively. Both the schemes does not allow overflow from one layer to another. The static allocation of calls in different layers is not desirable for high traffic loads. Imperfect calls assignment will result in some disadvantages, i.e. if the macrocell has no free channels, even though its overlaid microcell has many free channels, the fast calls will be terminated. Two strategies for traffic management are presented in [7]. Strategy 1, divided mobile station in two groups, based on their speed they are served by different layers to minimize the handoff rate. In strategy 2, the mobile station may enter either layer, regardless of their speed. More handoffs will cause more overhead and degrade the system performance.

Fuzzy logic control has been employed to improve the cellular system performance and has been presented in [8]. The approach used by Shum and Sung in [9] aims mainly at layer selection in hierarchical cellular systems, the fuzzy rules have been constructed to reduce handoff rate however another important element, handoff failure probability is ignored. An improved bidirectional call overflow scheme has been presented in [10]; the performance of this scheme is encouraging except for excessive handoffs between two tiers. Efficient handoffs between two layers using mobile velocity as an effective parameter have been presented by Mir et al [11], the inclusion of handoffs in speed of mobile station enables cell to retain control of call of mobile station if its velocity is within its threshold limit. This avoids excessive handoffs, thus reducing overhead processing. Techniques for enhancing handoffs between microcells due to efficient channel management system are presented in [12, 13]. The major contribution of our paper is the additional unconditional transfer of call from microcell to macrocell when the target microcell has no available channel to carry the call. So the exhaustion of channels in target cell has the highest priority over threshold in speed till channels are available for holding new calls. This will increase the traffic management at peak hours.

II. BIDIRECTIONAL CALL OVERFLOW SCHEME:

Mobiles cannot be presumed with fixed speeds; a mobile station can change speed from low to high and vice versa. Thus relying in one layer can hamper the performance of the system. Also if a mobile station speeds above and below a threshold level, the handoff triggering between two layers increases thereby increases the processing overhead. A threshold decides whether a call is slow or fast, if the speed of mobile originating a call is greater than the threshold, it is a fast call will be served by macrocell, otherwise it is a slow call and will be served by microcell during its lifetime. This is the unidirectional call overflow scheme in which calls can overflow in one direction only either from microcell to macrocell or vice versa and has been presented in [14, 15]. When a slow call originates and if the number of engaged channels in the current microcell is greater than the threshold value, this call will overflow into the corresponding macrocell. If all the channels in target macrocell and the microcell which the mobile is moving into are used, the slow handoff calls will be terminated. On the other hand the bidirectional call overflow scheme increases the channel utilization and reduces blocking probability and failure probability of handoff calls.

Figure 1 depicts the handoff of mobile station from microcell to macrocell and vice versa which is decided on the basis of two thresholds in speed of mobile station. A mobile station with live call at ‘A’ is accelerating and reaches threshold level ‘Th1’ the call is not handed over to macrocell layer till it reaches to second threshold value ‘Th2’ however the handoff within the same tier (microcell to microcell) can take place. The two thresholds will enable mobile station to retain the call in same tier provided channel is available in target cell to hold the handoff call. Similarly when a call is initiated at ‘B’ and mobile station is decelerating, the call is retained in macrocell till threshold level ‘Th1’ is reached. If the target cell has no free channel the call will be terminated. To further enhance the traffic management at peak hours the congested cell with no free channel is given the highest priority, this means that even if the mobile station is not fulfilling the speed threshold values call can still be transferred between two tiers. The threshold values have second priority and are in place if channels in the target cell are available. This will reduce call drops and enhance QoS.

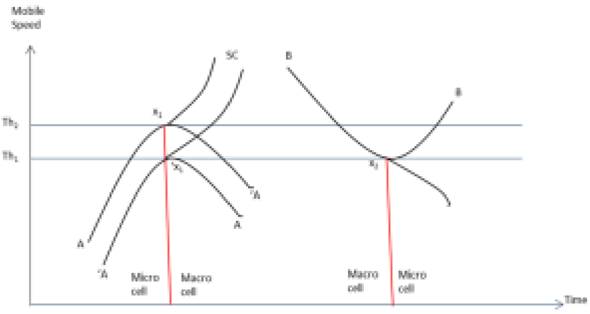

Figure1. Mobility of mobile station from Microcell to Macrocell and vice versa

III. EXECUTION OF HANDOFF ON THRESHOLD VALUES

Let Tin= Incoming mobile traffic to a cell
Tout= Outgoing mobile traffic of a cell
Tself= Self-contained mobile traffic of a cell
Tc = Total channels available in microcell for utilization (Fixed + Guard)
Tcp= Total channels presently engaged for traffic in the cell
Tinv= Total inflow traffic with velocity v
Then Tc-Tcp =Total channels available with the cell for handling extra traffic in the cell
Given the scenario of traffic inflation during peak hours in current and target cells the handoff algorithms during peak hours becomes

$$\text{Tinv} \begin{cases} v<Th2 \ \& \ (Tc-Tcp)>Th & \text{Call contained in microcell} \\ v<Th2 \ \& \ (Tc-Tcp)<Th & \text{Call shifted to macrocell} \end{cases}$$

IV. DISCUSSION

Handoff is the key operation in cellular mobile communication systems which is accomplished by the system and is imperceptible for the user. It is the means through which continuity of a call is maintained when mobile station moves from one cell area to another. The current trend of exponential growth in mobile communication sector is causing the industry to examine ways to use the available bandwidth more efficiently. The dimension of reduced microcells to meet the demand for increased capacity causes the number of handoffs to increase and thus the handoff decision must be significantly reduced. Although originating calls are important but the handoff calls are always given higher priorities because the termination of ongoing call is highly undesirable. In case of highly populated microcell because of some event like sports activity or some political event, it cannot accommodate further traffic irrespective of speed of mobile station. So the calls can be best managed by overlaid macrocells which can handle the additional mobile traffic. The thresholds in speed of mobile station will reduce the unnecessary handoff calls. If a mobile station with ongoing call is heading towards a microcell which has no free channel to take the call, the call is transferred to macrocell even if its speed qualifies for microcell. So the target cell which is fully congested is skipped and when the mobile station crosses target skipped cell, the call is returned back to adjacent microcell where mobile station has entered. Figure 2 depicts the movement of mobile station between microcells and macrocell by skipping a densely populated cell without terminating the call.

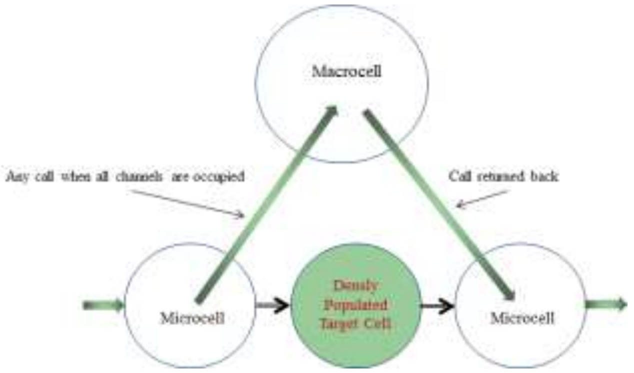

Figure2. Traffic management by skipping the occupied target cell

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V. FUZZY LOGIC APPROACH FOR HANDOFF

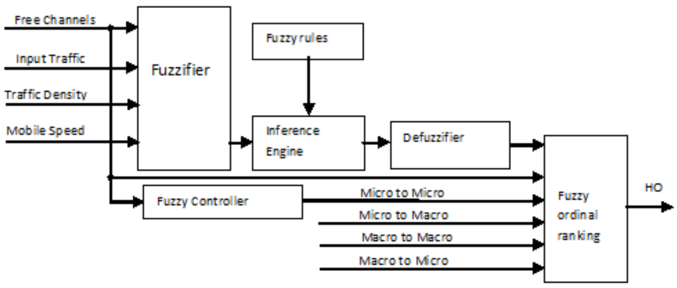

Figure3. Block diagram describing fuzzy control for handoff

VI. RESULTS

The simulation data obtained from Mamdani inference system is shown in table 1. The three dimensional view for handoffs obtained from simulation results using fuzzy logic approach giving the relationship between variables for better mobile traffic management is given in Figures 4,5,6&7. These give the insight view of mobility of mobile station for efficient channel utilization.

Table1. Membership values obtained from Mamdani Inference system

Input Traffic	Traffic Density	Mobile Speed	Microcell to Microcell	Microcell to Macrocell
0.25	0.25	0.25	0.837	0.411
0.25	0.25	0.67	0.639	0.455
0.25	0.25	0.791	0.589	0.5
0.25	0.5	0.5	0.838	0.5
0.25	0.5	0.79	0.612	0.563
0.25	0.5	0.75	0.589	0.589
0.25	0.5	0.811	0.586	0.63
0.25	0.7	0.5	0.562	0.467
0.25	0.7	0.4	0.564	0.559
0.25	0.7	0.679	0.641	0.544
0.25	0.7	0.74	0.599	0.582
0.25	0.7	0.842	0.586	0.669
0.5	0.403	0.209	0.845	0.366
0.5	0.403	0.444	0.863	0.5
0.5	0.403	0.75	0.589	0.589
0.5	0.403	0.872	0.51	0.781
0.747	0.505	0.73	0.599	0.576
0.747	0.75	0.73	0.502	0.587

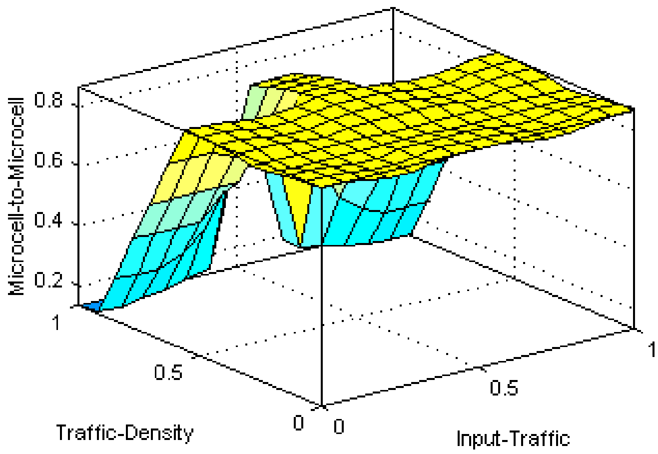

Figure4. Microcell to microcell handoff with Input traffic and Traffic density

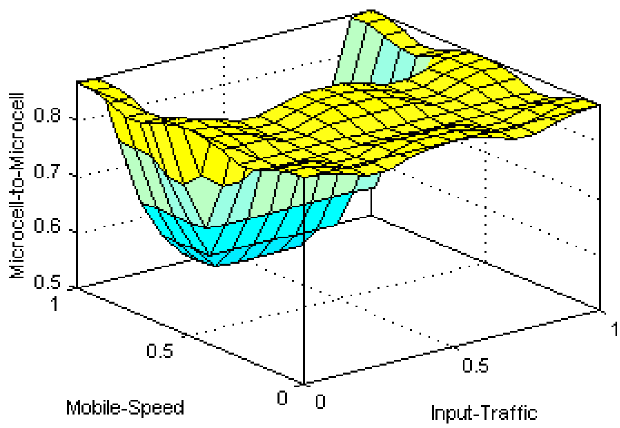

Figure5. Microcell to microcell handoff with Input traffic and Mobile speed

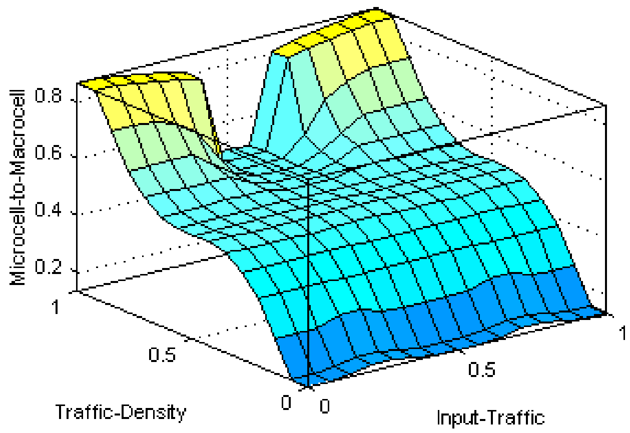

Figure6. Microcell to macrocell handoff with Input traffic and traffic density

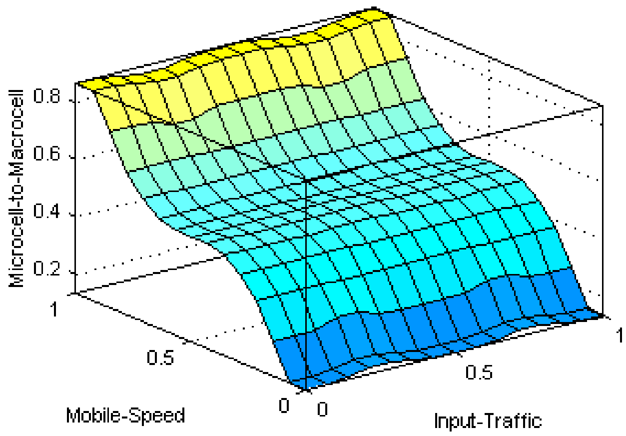

Figure7. Microcell to macrocell handoff with Input traffic and Mobile speed

VII. Conclusion

Fuzzy based handoff algorithm capable of responding to the fast changes that occur in mobile cellular environment is presented. Two threshold values in mobile stations speed results in lesser number of handoffs. The probability of call drop when mobile station moves between cells with no available channel to take the call has also been addressed, by transferring the call unconditionally to macrocellular layer for the time being till channel is available in microcellular layer. These results are to be expected because fuzzy algorithms are superior to conventional ones when working in areas of uncertainty. The flexibility in controlling handoff of mobile station for uninterrupted call carrying across cell layers is an added advantage for the system.

References

[1] M. D. Austin, G. L. Stuber, "Velocity Adaptive Handoff Algorithms for Microcellular Systems" IEEE Trans. Vehicular Technology, Vol 43, No. 3, pp 549-561, 1994.

[2] S. Shirvani Moghaddam, V. Tabataba Vakili, A. Falahati, "New Handoff Initiation Algorithm (Optimum Combination of Hysteresis and Threshold Based Methods)" Vehicular Technology Conference Vol. 4, pp 1567-1574, 2000.

[3] T.S. Rappaport, Wireless Communications Principles and practice Prentice Hall, 1996.

[4] V.R. Kolavennu and S.S. Rappaport, "Traffic Performance Characterization of a Personal Radio Communication System," IEEProc. Comm., vol. 133F, pp. 550-561, Oct. 1986.

[5] C.L. I, L.J. Greenstein, and R.D. Gitlin, "A Microcell/Macrocell CellularArchitecture for Low and High-Mobility Wireless User," IEEE J.Selected Areas Comm., vol. 11, pp. 885-891, Aug. 1993.

[6] M. Murata and E. Nakano, "Enhancing the Performance of MobileCommunications ystem," Proc. IEEE Int'l Conf. Universal PersonalComm. (ICUPC '93), pp. 732-736, 1993.

[7] W. Huang and V.K. Bhargava, "Effects of User Mobility on HandoffPerformance in a Hierarchical Cellular System," Proc. Canadian Conf.Electrical and Computer Eng. (CCECE '95), pp. 551-554, 1993.

[8] K.R. Lo, C.J. Chang, C. Chang, and C.B. Shung, "A QoS GuaranteedFuzzy Channel Allocation Controller for Hierarchical Cellular Systems,"IEEE Trans. Vehicular Technology, vol. 49, pp. 1588- 1597, Sept.2000.

[9] K. Shum and C.W. Sung, "Fuzzy Layer Selection Method inHierarchical Cellular Systems," IEEE Trans. Vehicular Technology,vol. 48, pp. 1840-1849, Nov. 1999.

[10] Wenhao Shan, Pingzhi Fan, and Yi Pan, "Performance Evaluation of aHierarchical Cellular System with Mobile Velocity-Based BidirectionalCall-Overflow Scheme IEEE Trans. on parallel and distributed systems,vol. 14, No. 1, pp 72-83, Jan 2003.

[11] G. M. Mir, Moinuddin, and N. A. Shah "Mobile Velocity Based Bidirectional Call Overflow Scheme in Hierarchical Cellular System" International Journal of Electrical, Computer, Energetic, Electronic and Communication Engineering Vol: 3, No: 10, 2009, pp 1864-1867.

[12] G. M. Mir, N. A. Shah and Moinuddin "Handoffs in Mobile Communication Using Path Codification Technique" J. Comp. & Math. Sci. Vol.4 (3), 135-141, 2013.

[13] G. M. Mir, N. A. Shah, Moinuddin "Variable Guard Channels for Efficient Traffic Management" International Journal of Electrical, Computer, Energetic, Electronic and Communication Engineering Vol: 4, No: 5, 2010, pp 808-812.

[14] S.S. Rappaport and L.R. Hu, "Microcellular Communication Systemswith Reneging and Dropping for Waiting New and Handoff Calls,"Proc. IEEE, vol. 82, pp. 1383-1397, Sept. 1994.

[15] S.S. Rappaport and L.R. Hu, "Personal Communication Systems UsingMultiple Hierarchical Cellular Overlays," IEEE J. Selected AreasComm., vol. 13, pp. 406-415, May 1995.

[16] Honey Soni1, Vaishali Sood2, Anu Sheetal3 Modelling of Fuzzy Based Handoff Decision Controller, "International Journal of Advanced Research in Computer and Communication Engineering" Vol. 4, Issue 5, May 2015.

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