A Novel Congestion based Approach for Vertical Handover

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Abstract - With the rise in demand for the mobile connection to the internet, the 4G heterogeneous technologies employed in cellular networks and WLANs faces major challenges in internetworking. Heterogeneity necessitates performing handoff of mobile nodes between networks of different technologies. This kind of handover is termed as vertical handover and handoff between similar systems is termed as horizontal handover. This paper proposes a new approach to perform vertical handover which uses fuzzy logic and neural networks. The approach considers congestion as the primary criteria in making handover decisions. If the congestion in the network is low, the mobile node is associated directly to a neighbouring network according to the user preferences. If the network is congested, then handover is made according to the fuzzy logic or neural network approaches. Choosing of fuzzy logic or neural network is made according to the handover parameters. The proposed approach works with reduced handoff latency and also the network experiences increased bandwidth availability than the pure fuzzy logic and neural networks based systems.

Keywords - 4G heterogeneous networks; vertical handover; fuzzy logic; neural networks.

I. INTRODUCTION

Wireless communications is one of the most active areas of technology development because it is considered as the medium for supporting voice telephony into a medium for supporting other services, such as the transmission of video, images, text, and data. Bandwidth and transmitter power are conventionally considered as the chief resources to avail the wireless services, where the radio band width depend upon restricted spectrum and the transmitter power depend on the battery power. As the demand for the wireless services grow, the resources are always limited. So, regarding this situation, the services which require the need of such resources can be provided by considering tradeoff between the demand criteria. For example WirelessLan,wimax, satellite systems, Bluetooth, Wi-Fi, UTRAN etc. are some of the wireless network technologies that are recognised everywhere. 4G is the next generation wireless technology [1] which aims to connect these wireless networks of different technologiesand ensures seamless connectivity.4G networks should take over both horizontal and vertical handovers. Horizontal handover is the handover of mobile nodes betweendifferent cells of networks with same technology. Vertical handover is the handover of mobile nodesbetweendifferent cellsbelonging to different networks of different technologies. A handover decision algorithm should always connect the mobile nodesflawlessly with the new network [6] and should consider all these strategies.This paper proposes a vertical handover algorithm which performs handover by considering congestion in the network as the primary criteria. The algorithm makes automatic handover if there is no congestion in the network. So, the node is connected to the nearby network. If the network is highly congested then the handover decision is taken according to fuzzy logic and neural network approaches. The selection of fuzzy logic and neural network is made according to the network condition. Thispaper concentrates on vertical handover even though the simulation supports all the above types of handovers. Handover decisions are taken by applying fuzzy logic and neural networks based logics in appropriate places. The algorithm handles the congestion in an intelligent way that calls the fuzzylogic or neural network logic only when the congestion goes above certain level. In low congested situations, the handover decision is taken automatically by connecting the node to the next nearby network with good signal strength.When the network is congested, the fuzzy logic or the neural networks modules to take handoff decision is made according to the network condition. The network condition is decided by the network parameters such as latency, bandwidth, load, cost and power. The performance study of the algorithm is made using MATLAB implementation for connecting 2G and 3G wireless networks

through 4G. The proposed logic performs handover with reduced latencyand increased available bandwidth. The comparisons are made with pure fuzzy logic and neural networks counterparts.

II. RELATED WORK

Numerous handover decision algorithms have been established recently. Also numerous papers have surveyed about diverse vertical handover algorithms. The vertical handoff algorithms generally take handoff decisions according to the network condition, battery power and user choices. Some of the proposals customs a vertical handoff decision function[7] which usages network constraints such as cost, power consumption, security and network performance in order to take handover verdict. Many proposals take the handover verdict according to the user requirements and choices[10]. Also,Somehandover problems convert network resources utilized by the connection and signal cost to take the handover decision into a Markova decision process in order to make the handover verdict. Route prediction server suggested in [5] uses load and round trip time to take handover verdict. Mobile Agents also support3] vertical handover verdict according to some papers.Prioritized hard handoff[2] ensures hard handoff at reduced rate of dropped calls. UMTS – WLAN integrated architecture suggested in [9]uses a dynamically updating database to tellabout network condition in order to take handoff verdict. Similarly, there are numerous papers suggests proposals towards the vertical handoff decision algorithms.

III. MOBILITY MANAGEMENT IN 4G

Mobility management is the mainproblem of 4G networks and some of such problems to be resolved are connectivity, location management, seamless connectivity, mobility context management, paging, network composition, terminal mobility, security, migration, personal mobility and etc. These mobility administration problems must be taken into account while creating a vertical handoveralgorithm. The proposed work considers all the above 4G problems while designing the latency reducing vertical handover decision algorithm.

IV. PROPOSED CONGESTION BASED ALGORITHM

This paper proposesansmart, handover mechanism for 4G heterogeneous networkswhich takes handover decision using congestion as the primary criteria. It uses six parameters namely signal strength, bandwidth, load, cost, congestion and power consumption. If the congestion around a mobile node is below a threshold value the vertical or horizontal handover decision is made only according to the signal strength. The node is associated to the neighbouring network which displaysdecent signal strength. Only when the congestion level rises above the threshold value the algorithm picks a fuzzy logic or neural network based function according to the network conditions decided by the parameters. The results show that the methodachieves better in terms of latency and bandwidth.

4.1. Fuzzy logic approach

Fuzzy logic is a multi-valued logic which produces fixed and exact results in reasoning. The proposed work in this work uses the fuzzy logic mechanism [4] to make the handover verdict when the congestion goes above the threshold value. The priority is given to fuzzy logic over the neural network method. Fuzzy methodmakes the verdict according to the input parameters. The structure of the fuzzy engine is shown in Figure. 1.

The four input parameters bandwidth, power, load and cost and the output parameter connection are individually connected with two number functions low and high. The functions are defined using the following equation.

$F(x : u, v, w) = \max(\min((x-u)/(b-v), (c-w)/(c-v)), 0)$

Where the values of a, b and c for the member function low are 0, 0.5 and 1. The values of a, b and c for the member function high are 0.5, 1 and 1.5. And the following fuzzy rule is set to the rule base.

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Rule = [ 1 1 1 1 1 (1) 1
         1 1 1 2 1 (1) 1
         1 1 2 1 1 (1) 1
         1 2 1 1 1 (1) 1
         1 2 1 2 2 (1) 1
         1 2 2 1 2 (1) 1
         1 2 2 2 2 (1) 1  ]
```

Each row in the rule matrix represents a separate rule. The four input parameters are defined in the first four columns. The weight associated with each rule is defined in the fifth column. The conjunction operation to be applied in between the input parameters is defined in the sixth column. In the sixth column an '1' indicates 'AND' operation and a '2' indicates 'OR' operation. In the first five columns an '1' indicates that the function low has to be used and a '2' indicates that the function high has to be used. All the parameter variables and member functions are fed to the fuzzy inference engine.

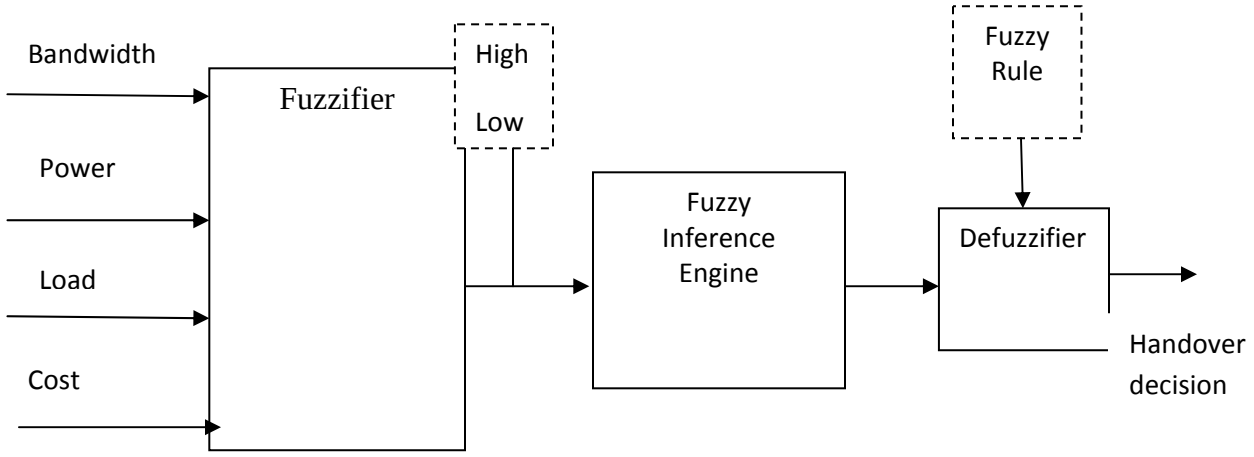

Figure.1. Fuzzy Engine for training the parameters

The bandwidth, power, load, cost, Max_bandwidth, Max_power, Max_cost, Max_load, Bandwidth_ threshold, Power_threshold, Load_Threshold and Cost_threshold are the parameters assumed and assigned the initial values.
Fuzzy fit are found for wifi, 3G and 4G networks using the trained values and the node is connected to the network with the highest fit value.

4.2. Neural network approach

As an alternate to the fuzzy logic approach the proposed handover uses the neural network approach [8] in high congestion situations. When the unknown values make the fuzzy logic approach unfit to make the handover verdict, the neural network approach comes to play the role.Neural network system is trained to withstand even in such kind of situations. The same variables assumed for fuzzy approach are also used here to train the neural network system.

V. EXPERIMENT AND RESULT

The test environment is created using the MATLAB tool as a model. We can feed the number of nodes, number of moving nodes, travelling time in terms of number of moves, the density as capacity and the speed of the moving nodes in seconds per move and hence we can change the values for these parameters during the run. The network environment is assumed to haveone 4G cell which consists of many 3G cells and each 3G cells contains many 2G(wifi) cells inside.If the congestion is below 5 (no. of nodes together) then the fore comingnodes are connected to the wifi network with the best RSS (Received Signal Strength). If the congestion is above 5 and below 5*9 then the fore coming nodes are associated with the 3G network. If the congestion is above 5*9 then the fore coming nodes are directly connected to the 4G network. The same process is carried out during handover circumstances also. In less congested circumstances the network is lightly loaded and hence most of the nodes are associated withthe wifi cells. In highly congested circumstances, the network is heavily loaded and hence many nodes are also connected to 3G and 4G networks. This is because of the test setup connects the further nodes to high order networks when lower networks become congested.
Automatic handover decision in low congestion results in low handover latency in the case of proposed logic than its pure fuzzy logic and neural network counter parts. This is shown in figure. 2.

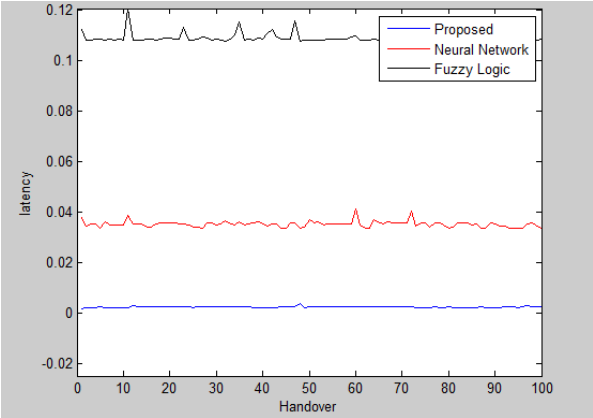

Figure.2. Better handover latency result from proposed logic

The proposed approach which considers congestion as the primary criteria and performs automatic handover in low congested situations consumes less control messages and hence gets more bandwidth measured in mbps for the proposed logic than the pure neural network and fuzzy logic counterparts. This is shown in Figure. 3.

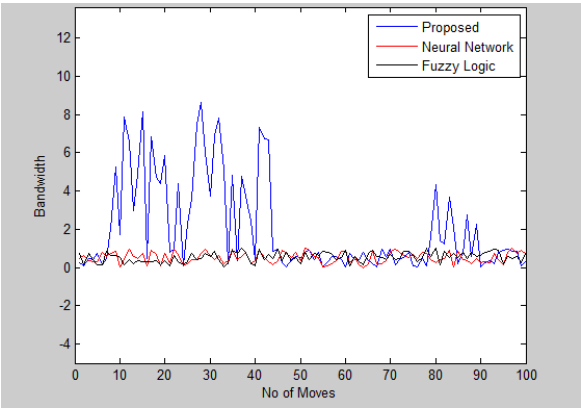

Figure.3. Better bandwidth result from proposed logic

VI. CONCLUSION

This paper proposes a vertical handover decision algorithm for the 4G wireless networks which makes handover verdict using congestion as the primary criteria. The algorithm performs direct handover in less congested situations and uses fuzzy logic and neural network based methods to take the handover decision when there is congestion in the network. The algorithm performs better with reduced latency and increased bandwidth in all situations. The future work of this paper will be implementing the 4G handover which is represented as a Markova process and comparing the performance with the new approaches.

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