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Vertical Handoff Decision Algorithm to Reduce Unnecessary Handoff for Heterogeneous Wireless Networks

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***Abstract*—The next generation wireless networks provide heterogeneous wireless access. This heterogeneous network provides seamless connectivity and always best connected services. In this paper, Network parameters are used to filter the candidate network set. Sole fuzzy logic based handoff algorithm is compared with Proposed algorithm and the simulation results shows that the proposed algorithm's performance is enhanced by reducing unnecessary Handoffs. This paper also calculates on packet delay and packet delivery ratio in Ad-hoc On-Demand Distance Vector (AODV) routing protocol. The ns2 is used for simulation purpose.**

***Keywords*—Received signal strength (RSS), Bandwidth (B), Cost(C), delay (D), bit error rate (BER).**

I. INTRODUCTION

The future wireless network which consist of different wireless networks like WIFI, UMTS and WIMAX. In future generation seamless connectivity and Always Best Connected service are the main goals. Handoff is a Process of changing the mobile connection between different base stations or access points. Handoffs are of two types horizontal handoff (HHO) and vertical handoff (VHO) [1].When two Base station (BS) uses same access technology then it is called Horizontal Handoff which occurs in Homogenous wireless network. In Heterogeneous wireless network, vertical handoff happens between different access technologies, such as changing a connection between an Access point (AP) and a base station (BS).At present many of the handoff decision algorithms are proposed in the literature. Traditional algorithm uses only received signal strength (RSS) as a parameter. Multiple attribute decision making is method(MADM) which consider many attributes to select a target network from a set of user networks. SAW, TOPSIS, AHP and GRA are the most popular traditional MADM methods. In [2], a comparison done among Simple Additive Weighting (SAW) [3], Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) [4], Grey Relational Analysis (GRA) [5] and AHP (Analytic Hierarchy Process) for vertical handoff decision [6].In vertical handoff decision problem cannot solve by MADM methods efficiently. Fuzzy logic approach considers multiple parameters. Fuzzy logic overcome all the drawbacks of MADM methods. Our proposed algorithm overcomes the drawbacks of existing vertical handoff algorithms.

Vertical Handoff is divided into three steps. First, a mobile node finds a reachable networks. This step is called as Network Discovery. The next step is handoff decision, mobile node evaluates whether the connections should continue with current network or switch on to another network and last step is handoff execution ,it is used to select the network according to the handover decision phase.

Handoff decision phase is the most important phase because wrong handoff decision may break off the current communication and degrade the quality of service (QOS) of traffic [6].Handoff decision phase is the main focus of this paper.

1) Network discovery scheme introduces before handoff decision, which improves the update rate of the candidate networks set.

2) Pre-hand off decision method, which reduces the serious Ping-Pong effect and decreases the probability of call dropping and blocking.

3) The paper proposes fuzzy logic based vertical handoff decision algorithm.

The paper is divided as follows: Section II gives Network Discovery scheme and Pre handoff Decision. In Section III, Fuzzy logic based vertical handoff decision algorithm is proposed. Section IV, shows simulation results of proposed algorithm and Finally, section V gives conclusion.

II. PROPOSED TECHNIQUE

A. *Network Discovery Scheme*

Mobile terminal (MT) searches for reachable wireless networks during the network discovery process [7]. Vertical handoff algorithm uses speed adaptive scheme in network discovery phase which reduces the drawbacks of fixed and single network discovery method. Also it raises update rate of candidate network set and improves the network discovery time of high speed MT's. Now mobile terminal uses GPS (Global Positioning System) technology to get the instant velocity of MT at given time. We should compute the average velocity of the MT in fixed time duration because MT's movement is variable. First we get N samples of instant velocity of the MT in time duration Ts and then compute the average value.

$$V_o = \frac{1}{N}\sum_{i=1}^{N} V_i \quad (i=1.......N) \qquad (1)$$

$$p = \frac{V_o}{V_{max}} \quad (0 \le p \le 1)$$

$$\Delta T = (T_{max} - T_{min})\,(1-p)^n \qquad (2)$$

Where, V_o = Average velocity of MT
V_i= Instant velocity of the i'th sample
P = Adaptive factor
Vmax = maximum available velocity of the MT
ΔT= update time of the candidate network set
Tmax = maximum update time
Tmin = minimum update time
n = exponential factor that related to the service

When MT moves quickly, it increases update time of the candidate network set and also network discovery time.

B. Pre Decision Method

It is a method which can quickly filter the candidate networks set as per user priority and also evaluates the function [8]. A different combinations of parameters gives different services. Here, we consider five parameters: available bandwidth, RSS, monetary cost handoff time delay and bit error rate (BER)

$$F_i = F(B_i - B_{th}) \times F(RSS_i - RSS_{th}) \times \times F(C_{th} - C_i)$$
$$F(D_{th} - D_i) \times F(BER_{th} - BER_i) \qquad (4)$$

Where B_i, RSS_i, C_i , D_i, BER_i and B_{th}, RSS_{th}, C_{th}, D_{th}, BER_{th} represent the values of parameters and predefined thresholds of RSS, available bandwidth, time delay, BER and monetary cost of the requested service respectively. Threshold value of parameters can be decided by user. Unit step function F (*), whose value is zero for negative input and one for positive input. Minimum guarantee function F_i decides whether the MT can access to the candidate network i or not.This decision is taken only if output of minimum guarantee function has a value one. For this the condition is that the values of RSS and available bandwidth must be larger than their thresholds. While the values of time delay, BER, Monetary cost must be lower than their thresholds. Thus the network i with output value one will be added to the candidate network set, otherwise the related network i is not considered as a candidate network. Pre-handoff decision method is time saving because it is simple to calculate and also decreases the probability of call blocking, dropping and eliminates the serious Ping-Pong effect. Depend on size of candidate network set, there are three stages: a) MT stays connected to the current network if candidate network set is empty b) MT makes the handoff to the sole network when one candidate network is present in the set; c) decision algorithm is used to select the best network among them, when more than one candidate network is present in the set.

III. FUZZY LOGIC BASED VERTICAL HANDOFF DECISION ALGORITHM (VHD)

After the pre decision phase, candidate network set arrive at VHD algorithm. There are three sub procedures in the proposed algorithm: Normalization of input parameters , Membership function of input parameters and Handoff Decision[8]. We are taking RSS, B and C as input parameters. In VHD algorithm first input parameters processed by Normalization procedure. Then normalized input parameters go through Fuzzification procedure. Next step is Handoff Decision in which we calculate Performance evaluation value (PEV) for each candidate network. Handoff decision is taken from PEV of the current network and target network.

A. Normalization of Input parameters

Every parameter has different unit and need to be normalized in a common scale. Normalization of B,C and RSS [9] is given by (5):

$$N(B_n) = \frac{B_n - B_{min}}{B_{max} - B_{min}}, \quad N(C_n) = \frac{C_n - C_{min}}{C_{max} - C_{min}},$$
$$N(RSS_n) = \frac{RSS_n - RSS_{min}}{RSS_{max} - RSS_{min}} \qquad (5)$$

Normalized available bandwidth (B), monetary cost(C) and RSS are the inputs in the proposed algorithm. Available bandwidth is to measure networks performance, monetary cost is related to the users consideration and RSS is a crucial factor.

B. Membership Function of Input Parameters

Every normalized input parameter has three fuzzy sets low, medium and high according to their membership function [8][10].Using membership function of B,C and RSS. we can determine membership degrees of B,C and RSS which is given by *(6):*

$$[\mu_{i-L}^x, \mu_{i-M}^x, \mu_{i-H}^x] \qquad (6)$$

Where i = WiFi or WiMax, x = B,RSS,C.
Impact factor distributed to each parameter for the evaluation of membership values of RSS, *B* and C .impact factor is given by (7):

$$[I_{i-L}^x, I_{i-M}^x, I_{i-H}^x] = \left[\frac{F_{i(x)} - T_1^x}{T_2^x}, \frac{F_{i(x)} - T_1^x}{T_2^x - T_1^x}, \frac{F_{i(x)}}{T_2^x}\right] \qquad (7)$$

We can get the membership values of B, RSS and C from impact factors and the membership degrees. Membership evaluation value is given by (8):

$$MEV_i^x = [I_{i-L}^x, I_{i-M}^x, I_{i-H}^x] \times [\mu_{i-L}^x, \mu_{i-M}^x, \mu_{i-H}^x] \qquad (8)$$

Where x= B,RSS,C

C. *Handoff Decision*

Weight is given to every network parameter and weighting factor decides importance of each parameter. The larger the weight of a specific parameter, the more important that parameter to the user. Weights are in fractions and it ranges from $0 \leq w_B, w_{RSS}, , w_C \leq 1$

$$W=(w_B, w_{RSS}, w_C) \quad (9)$$

Where, $(w_B + w_{RSS} + w_C = 1)$

The performance evaluation value (PEV) of the i'th network can be obtained by combining the three membership values[10]. For the i'th candidate network, the PEV is:

$$PEV_i = W.MEV_i^T$$

$$PEV_i = [w_B, w_{RSS}, w_C] \times [MEV_i^B, MEV_i^{RSS}, MEV_i^C]^T \quad (10)$$

Where $MEV_i = (MEV_i^B, MEV_i^{RSS}, MEV_i^C)$ and i represents the i'th candidate network. In handoff decision mechanism we select the target network whose PEV is largest among the candidate networks and then compare the target network PEV to the current network PEV. The condition is that if $PEV_{target} - PEV_{current} > PEV_{th}$, then make handoff to the target network; otherwise, stay connecting with the current network.

IV. SIMULATION RESULT

The Simulation has been done for 40 nodes in network simulator 2.35[11].In this paper ,two sets of networks WIFI and WIMAX are considered for simulation. We used AODV as a routing protocol for transmission of packets [12][13]. The performance of packet delivery ratio and packet delay from AODV protocol are as follows:

A. *Evaluation Parameters*

1) Packet Delivery Ratio: Packet delivery ratio is defined as the ratio of data packets received by the destinations to those generated by the sources. Mathematically, it can be defined as [14]. Packet delivery ratio (PDR) in percentage

PDR = (No of packet receive / No of packet send)

2) *Packet Delay*: It is the difference between the packet received time and packet sent time.

PD = packet received time – packet sent time.

Packet delivery ratio and packet delay observed are 93.76% and 0.95.

It is important to reduce the number of handovers because frequent handovers would cause the wastage of resources of the network. A handover is considered to be extra overhead when a handover needed back to the original point of attachment within certain time duration, and such handovers should be minimized [10].We compare proposed algorithm to sole fuzzy algorithm. The simulation parameters used are mentioned in table 1.

TABLE I
SIMULATION PARAMETERS

1	Number of nodes	40
2	Routing protocol	AODV
3	Traffic source	TCP
4	Tool	NS-2.35
5	MAC Type	MAC/802_11
6	Queue Length	201 packets
7	Size of Packets	512
8	Bandwidth	$0 \leq B \leq 20$ Mbps
9	RSS_{max} , RSS_{min}	-80dbm ,-100dbm
10	C_{max} , C_{min}	12 cent ,2 cent

Red colour bars represents proposed system and green colour bars represents sole fuzzy system.

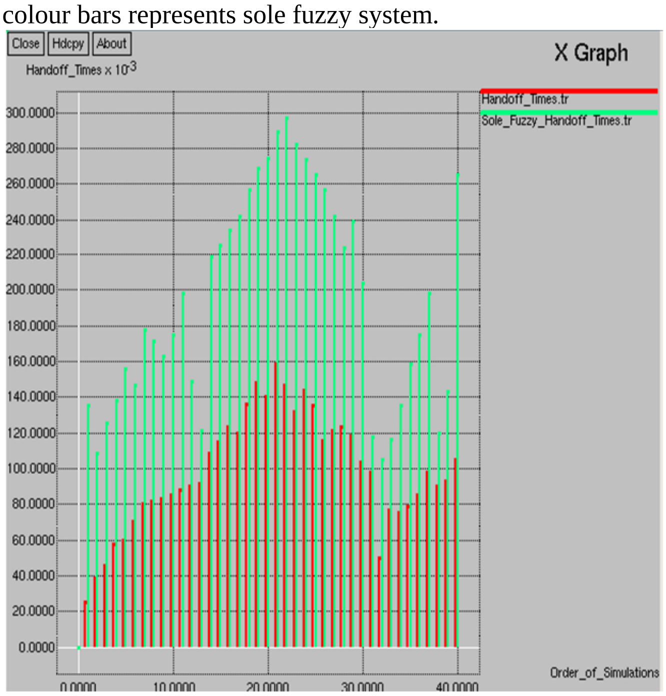

Fig 1: Comparison of Handoff Times

Figure 1 gives handoff time for different order of simulations. The results Shows that proposed algorithm reduces number of handoff times compared to sole fuzzy algorithm. Because the proposed algorithm considers many different parameters and adds the pre-handoff decision method which filters the candidate network set.

V. CONCLUSIONS

In this paper, we proposed Vertical handoff algorithm in heterogeneous wireless network. The algorithm is based on fuzzy logic which considers many parameters like RSS, monetary cost, bandwidth, time delay and BER. The simulation results shows that proposed scheme can provide higher performance, reduces unnecessary handoffs than the sole fuzzy logic based algorithm and also eliminates the serious ping-pong effect.

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