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# Multi Attribute Vertical Handoff Algorithm for Heterogeneous Networks

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**Abstract:** *In a wireless heterogeneous network, the number of devices called mobiles is increasing rapidly. Therefore to provide finest service value, mobile phones are necessary to convey consistently handover. That's why in heterogeneous systems vertical handover is turning into intense research issue. The movement from one access technology to another is called vertical handover, which keeps a user's device associated with the internet and gives continuous communication without any hindrance. Many algorithms have been proposed to solve this crucial issue. In this paper, we proposed a New_CRI (New Composite Rule Inference) based logarithm for vertical handover between WLAN_UMTS (Wireless Local Area Network and Universal Mobile Telephone System) networks. This algorithm maps contents toward range somewhere around 1 and 0 in fuzzy controllers that enhance facts of vertical handover. Two different wireless technologies are compared with the thought of handover measurements. The technology with better handover metric is favored. Preferences and requirements as per users, relative signal quality, system conditions and expenses are a central point for the handover choice. Outcomes confirmed that calculation lessens needless handovers and enhances proficiency of handover*

**Keyword:** *Please provide four to Fuzzy Controller; New_CRI logarithm; Network selection; WLAN _ UMTS ;*

## 1. INTRODUCTION

There are different wireless technologies like WLAN, WiMAX, UMTS,and LTE etc. These were developed with different standards and they offer different services, different data rates and diverse area of coverage. Successfully connecting between end to end heterogeneous wireless technologies is one of the biggest challenges in network management [1]. Providing back-to-back relation between networks can be performed by handoff. Two types of handover existin wireless communication namely, vertical handover and horizontal handover. Horizontal handoff is performed between same types of systems like handover among WLANs. Received Signal Strength (RSS) is only one parameter that affects the above said handover. Another handover that exists between systems with unlike technologiesis a vertical handoff, like handover between 3G (UMTS) and WLAN networks.

Vertical handover process consists of three different stages namely, searching networks, settling handoff and developing handoff. During network searching phase, mobile points find networks to be used. Since there is much number of networks, the system has to make a decision as to which network to connect. Thus while finding the networks the parameters like quality of service (QoS) and encouraging data rates has to be satisfied.

Handoff settling phase is the most important phase in wireless heterogeneous networks to perform a vertical handoff. Here devices determine if those associations sought to keep on utilizing those existing systems or should switch to an alternate system. The decision depends on a range of parameters like minimum bandwidth, transmit power, delay, access cost, power supply, error rate, QoS and latency user's preferences.

## 2. RELATED WORKS

The wireless heterogeneous network is a network which is wireless that gives assistance through LAN. There are several benefits in heterogeneous wireless network compared to a homogeneous wireless network which includes increased reliability, improved spectrum efficiency,and increased coverage. The problems which are still to be solved in the heterogeneous wireless network include mobility, handover, determining the theoretical capacity of HWNs, interoperability of technology, and Quality of Service.

Several challenging types in research has been done related to the network selection during handoff mechanism for heterogeneous networks. The limitation in the traditional selection has been studied extensively

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in the past. The current trend is Self-Selection Decision [2, 3] for network selection and for efficient handoff. Cost function based algorithms [4] have been proposed to combine the metrics such as monetary cost, security, power consumption and bandwidth in the cost function. The handoff decision is made by comparing the result of the function for candidate networks. Different weights are assigned to different input metrics depending on the network conditions and user preferences.

A better and improved velocity and position based handover algorithm [5, 6] has been presented to decrease the number of unnecessary handoffs by using geographical position and velocity information estimated from GSM measurement data of distinct signal strengths at Mobile Station(MS) received from Base Station(BS).

A fuzzy based CRI algorithm is presented in paper [7]. This calculation maps contents towards range somewhere around 1 and 0 in fuzzy controllers that enhance knowledge of vertical handover. Outcomes demonstrated that calculation lessens needless handovers and enhances the proficiency of handover.

An algorithm based on fuzzy logic in WLAN-3G fusion atmosphere has been projected in a paper [8]. The algorithm settles on vertical handoff choices in view of fuzzy control, by considering SNR, the system transfer speed and the charge of service. Results of the simulation showed that projected algorithm settles exact handover choices as well as eliminates ping-pong effect compared with conventional algorithm.

An easy and strong vertical handover judgment calculation for HetNet is described in [9]. Here mobile points are sorted into asset reduced versatile hubs and asset loaded versatile hubs. Examination results verified that calculation presentation is very good in transmission capacity usage and handover reducing rate.

Another versatile handover decision making algorithm[10] in which fuzzy membership functions are optimized by method for a genetic calculation to adjust the state of fuzzy membership functions with a specific end goal to accomplish optimum handover performance. The outcomes demonstrated that contrasted with the few unique calculations, execution of the proposed approach with genetic calculation is altogether enhanced for both user and network as far as a number of handoffs while alternate necessities are still fulfilled.

A new vertical handover decision algorithm is illustrated in [11] in view of fuzzy judgment dynamic weights and gray theory adaptation. Four information parameters like QoS, RSS, accessible bandwidth and cost of candidate systems are considered here and diminish call reducing possibility. Results of simulation give an increasing presentation in heterogeneous and in addition homogeneous systems.

A mathematical model is created in [12] for vertical handoff decision issue and proposed a multi-objective optimization immune calculation based vertical handoff choice plan. Results demonstrated that the technique outperforms in aspects of total left over battery life and drop in the probability of handover data calls.

The issue of vertical handoff in heterogeneous systems for streaming data is clarified in [13, 14]. A new strategy is proposed for vertical handoff by utilizing clustering of systems (WLAN, WiMAX, and 3G) and packet delivery through tunneling in various clusters. The K-means algorithm is utilized for cluster development in various systems. Simulation results demonstrated that the technique performs satisfactorily for the back-to-back delay, packet release proportion and network output.

## 3. HANDOVER IN HETEROGENEOUS WIRELESS NETWORK

Providing end to end relation between networks can be performed by handoff. Two types of handover existin wireless communication namely, vertical handover and horizontal handover. Horizontal handoff is performed between same types of systems like handover among WLANs shown in Figure 1. Received Signal Strength (RSS) is only one parameter that affects theabove said handover. Another handover that exists between systems with unlike technologies is the vertical handoff, like handover between 3G (UMTS) and WLAN networks.

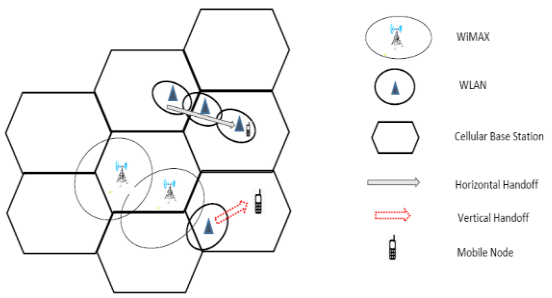


*Figure 1 Horizontal and Vertical Handover*

Vertical handoff process consists of three different stages namely; searching networks, settling handoff and developing handoff (see the Figure 2). Handoff settling phase is mainly important phase in wireless heterogeneous networks to perform a vertical handoff. Here devices determine if those associations ought to keep on utilizing those existing systems or should switch to an alternate system. Decision depends on a range of parameters like minimum bandwidth, transmit power, delay, access cost, power supply, error rate, QoS and latency user's preferences

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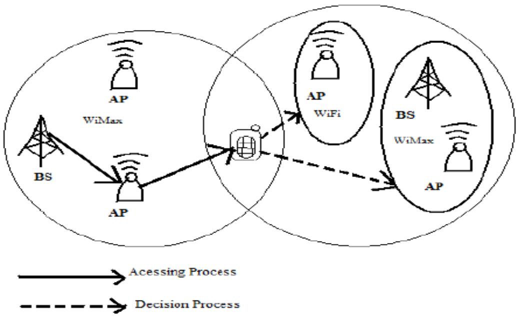


*Figure 2 Vertical Handover in Heterogeneous wireless network*

## 4. NEW CRI ALGORITHM AND METHODOLOGY

*Fuzzy Inference:* The fuzzy control basic is fuzzy inference. This system consists of fuzzifier, fuzzy rule base, inference engine and defuzzifier shown in Figure 3.

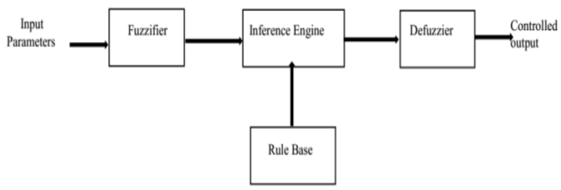


*Figure 3 A Fuzzy Controller*

Fuzzy inference engine depends on fuzzy sets. In fuzzifier, key in characters is fuzzified. Prior to fuzzy reaction, key in characters are handled in fuzzy inference machine. Fuzzy reaction ought to be defuzzified in defuzzifier to acquire correct output. Fuzzy rule base is used to direct as a part of fuzzy inference machine. The fuzzy rule base depends on specialists' skill, normally defined by a specific amount of "if…then" equations, which indicates "n" inference rules. Fuzzy inference procedure is of type (1).

$M_{11}$……., $M_{1m}$ → $N_1$
…………. …… …
$M_{n1}$……., $M_{nm}$ → $N_n$
Specified Set of Laws$M_{11}$……., $M_{1m}$ → $N_1$(1)
…………. …… …
$M_{n1}$……., $M_{nm}$ → $N_n$
Input $M^*_{1}$,…… $M^*_m$

Calculate N*

$M_1^*$, .., $M_m^*$ is unlike of inference rule provided in (1).

The approximate calculation of fuzzy inference step plays a key role and it is the most difficult. The Minkowski distance between fuzzy sets $M^*_1$,……. $M^*_m$ and $M_{j1},\cdots,M_{jm}$, j=1,⋯,n (computer using relation 3 below ), It is a non-negative real numbers sets and this set of real numbers by a minimum of rules determined by $M^*$activated $M_{i1},\cdots,M_{im}\rightarrow B_i$ I ∈{1,⋯,n}, then further uncertain reasoning are degraded after the relation (3)

$A_1(M_j,M^*)=\sum_{j=1}^{m}|A(xj)-A*(xj)|$,j=1,2,….,m(2) (3)

for given$M_{i1}$,……………$M_{im}\rightarrow B_i$…… major premise sets
input$A^*1,\cdots,A^*m$……..……… minor premise sets

Calculate B* (3)

Here, relation 1 used for fuzzy rule base, the predefined sets each rule by computing the product of fuzzy sets and from this fuzzy sets are converted into a single entity, that is, let

$$M_i=A_{i1}\times\cdots\times A_{im}$$

Then the input fuzzy sets multiplied, and even if

$$A^*=A^*_1\times\cdots\cdots\times A^*_m$$

The fuzzy sets on $X_1\times\cdots\cdots\times X_m$. obtain from a domain of $M_{ij}$,$M^*_j$, and these setsare represented as X.(j=1,2,⋯,m) . The values of $M_i$ and $M^*$ on the point $(x_1,\cdots\cdots,x_m)\in X_1\times\cdots\cdots\times X_m$ are computed from the relation 4

$$M_i(x_1,\cdots,x_m)=\min(M_{i1}(x_1),\cdots,M_{im}(x_m)),i=1,\cdots,n$$

$$M^*(x_1,\cdots\cdots x_m)=\min(M^*_1(x_1),\cdots,M^*_m(x_m))(4)$$

This reasoning relation (4) degenerated into the form of equation reasoning relation (5)

Given $M_i\rightarrow B_i$…….. Major premise sets
Known input$A^*$⋯⋯minor premise sets
Calculate $B^*$⋯conclusion ( 5)

The last step of making the decision is executed after defuzzification.

### 4.1 CRI Inference Algorithm

CRI algorithm **[7]** was projected by Zadeh, L.A in 1973. Below is CRI algorithm:

a. Consider $M(x) = M$, $M^*(x) = M^*$ otherwise $N(x) = N$, $N^*(x) = N^*$, where $M(x)$, $M^*(x)$, $N(y)$ and $N^*(y)$ are fuzzy sets under domain X and Y correspondingly.

b. Selecting implication $S$, transform $M\rightarrow N$ into fuzzy relationship $X\times Y$, represented by ($M(x)$, $N(y)$) or $M(x)\rightarrow N(y)$.

c. Compute N* with compositional operation between M*(x) and rule M(x) → N (y). $N^*(y) = \sup\{M^*(x))\wedge\rightarrow N(y))\}$, $y^*\in Y$ (6)

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### 4.2 System Model

Users in different systems may experience numerous WLAN. When the portable point enters WLAN, it is given services by WLAN, or an else user might not pick and will oppose to utilize first UMTS system. Then user moves and decides to depart WLAN and utilize UMTS, then the user needs to change into UMTS with a specific end goal to get services. As of now, the framework is worked as appeared in the Figure (4) underneath.

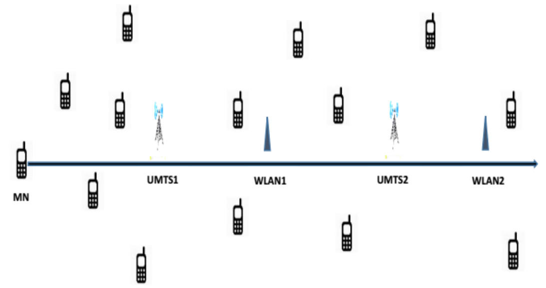


*Figure 4 Simulation Scenario*

## 5. MULTI-ATTRIBUTE VHOALGORITHM BASED ON FUZZY INFERENCE MACHINE

In heterogeneous network environment of WLAN and UMTS, we consider new-CRI based vertical handover calculation. Four parameters considered here are: Received Power (R), Bandwidth (W), Cost or Preference (C) and Delay (D). Memberships of the parameters are extended to [0, 1].

R: [0, ∞] → [0, 1] for any x ∈ [0, ∞].

Membership function is

$$R(x) = \begin{cases} 0\ , & r1 < x \\ \frac{\left[lg\left(\frac{x}{r1}\right)\right]}{\left[lg\left(\frac{rg}{r1}\right)\right]}, & r1 \le x \le rg \\ 1, & rg < x \end{cases} \quad (7)$$

Equation (7) mentions membership function for signal power R(x) mentions signal power in DB. When $x \ge r_l$, a receiver will extract the signal. When $x \ge r_g$, signal is decided to be a fine signal with the membership of R is to be 1.

Membership function for W: [0, ∞] → [0, 1], for any x ∈ [0, ∞], Equation (8) mentions bandwidth W membership function. $w_m$ is networked maximum bandwidth. Minimum bandwidth is $w_l$. The receiver extracts the signal when $x \ge w_l$. When a value of maximum bandwidth exceeds than the bandwidth given, membership becomes 1.

Preference parameters are determined by cost factors. Equation (5) describes membership function for preferences.

$$W(x) = \begin{cases} 0\ , & w1 < x \\ \frac{(x - w1)}{(wm - w1)}, & w1 \le x \le wm \\ 1, & wm < x \end{cases} \quad (8)$$

Membership function for C: [0, ∞] → [0, 1] for any x ∈[0, ∞]

$$C(x) = \begin{cases} 1\ , & c1 > x \\ e^{-(x-c1)^2}, & c1 \le x \end{cases} \quad (9)$$

If the cost is less than $c_l$ membership value is 1. If cost is greater than $c_l$, preference decreases gradually and becomes 0 as it reaches a particular value.

Membership function for D: [0, ∞] → [0, 1] for any x ∈[0, ∞]

$$D(x) = \begin{cases} 1\ , & D1 > x \\ e^{-(x-dy)}, & dy \le x \end{cases} \quad (10)$$

R, W, C, D fuzzy sets are shown in Figure 5,

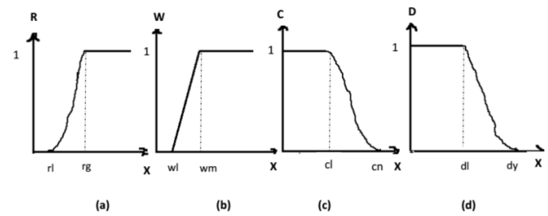


*Figure 5 Fuzzy membership function: (a) Received power (b) bandwidth (c) Cost (d) Delay*

From the classic indicators of the fuzzy controller, we calculate the final yield value. If yield value $y^* \ge 0.6$, we decide to switch or not.

TABLE 1 SPECIFICATIONS OF SIMULATION MODEL

| | |
|---|---|
| Simulator | Network Simulator 2 |
| Nodes | 40 |
| Channel | Wireless Channel |
| MAC Type | MAC/ 802.11 |
| Type of Queue | Queue/Drop tail |
| Length of Queue | 201 packets |
| Type of Antenna | Omni Antenna |
| Type of Propagation | Two Ray Ground |
| Packet Size | 512 bytes |

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### 5.1 Flowchart for New-CRI based algorithm

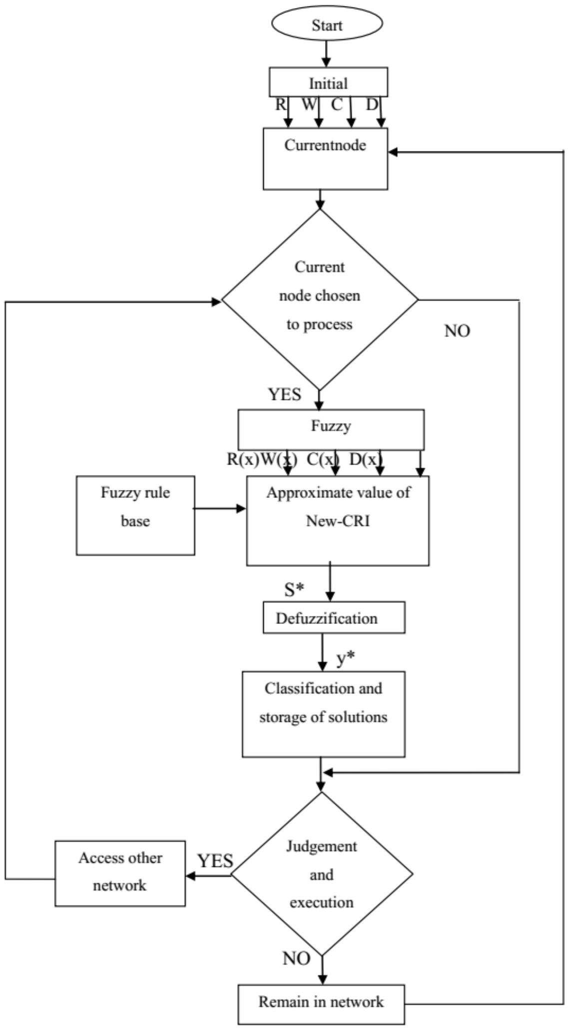


*Figure 6 Flowchart for CRI based vertical handoff algorithm*

## 6. PERFORMANCE COMPARISON OF PROPOSED ALGORITHM

Simulation for integrated WLAN-UMTS networks using New_CRI fuzzy based algorithm has been carried out using Network Simulator (NS2) in Linux platform for the specifications as shown in Table 1

In simulation environment, 40 nodes are created and these nodes group and configured with WLANs and UMTS networks. The performance parameters like delay, packet error rate and throughput of proposed algorithm show a significant improvement than others algorithms, which are shown in Figure 7, 8, 9.

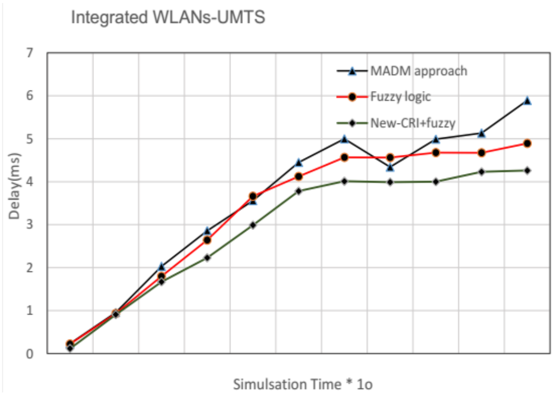


*Figure 7 A comparative Delay results of different algorithms*

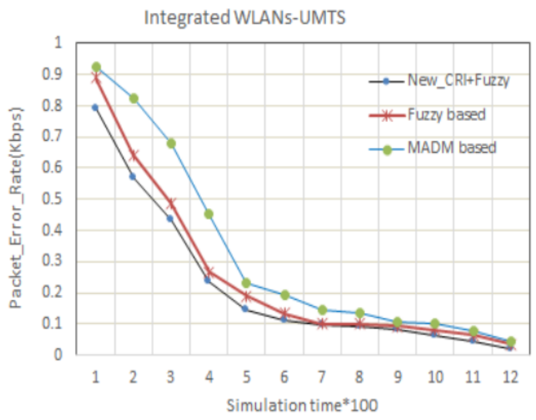


*Figure 8 A comparative Packet error rate results of different algorithms*

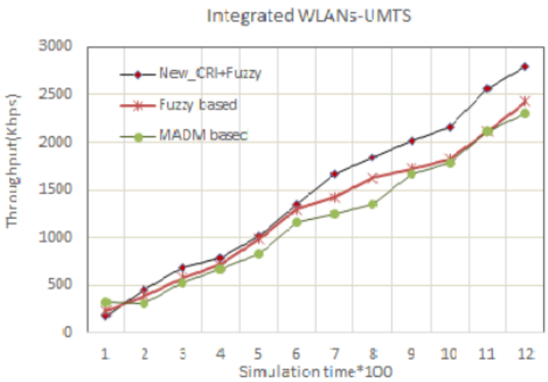


*Figure 9 A comparative Throughput results of different algorithms*

As shown in Figure 10. For 40 nodes networks, the proposed New_CRI fuzzy based algorithm performs better than other algorithms in order to reduce the number of handoffs need for the mobile nodes with QOS.

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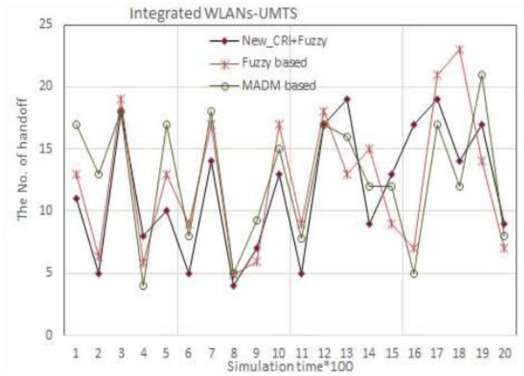


*Figure10 Number of handoffs of proposed New_CRI algorithm with other algorithms*

## 7. CONCLUSION

Heterogeneous networks require intelligent vertical handover process for seamless connectivity. In this paper,WLAN and UMTS networks are integrated. Vertical handover is performed using Fuzzy based multi attribute New_CRI algorithm. This algorithm reduces the number of handoffs to be performed and also reduces the Ping-Pong effect.The simulation results confirm that performance of New_CRI algorithm is better than remaining algorithms. The New_CRI calculation gives a clear idea as to which network to select for handover. From results, it is clear that this algorithm lessens needless handoffs. Also, this algorithm is more intelligent than other approaches.

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