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Vertical Handover Decision Algorithms in Multi-Wireless Network Systems

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Abstract

The premise of having several network systems consists of different access technologies. Network correspondence happens when two wireless schemes exchange information over the network. A moving cell-phone device could achieve vertical handover operation when receiving signal strength (RSS) from network. Using one of wireless services may interrupt with other service and cause unbalanced network load, or it may cause incompetent vertical handover. This research improves vertical handover decision algorithm for multiple wireless network service. It is preceded with comparing three wireless communication interfaces, which are Wireless Local Area Network (WLAN), Worldwide Interoperability for Microwave Access (WiMAX), and Long-Term Evolution (LTE). The study base on three types of priority algorithms to make a vertical handover decision (VHD), they are: equal, mobile, and network priority. VHD algorithms are fundamental segments to the engineering of the anticipated Fourth Generation (4G) heterogeneous wireless networks. These algorithms should be intended to give the required Quality of Service (QoS) to a wide scope of uses while permitting consistent wandering through a host of access network fees. The results show that the proposed algorithm for handover decision calculation beats the customary network decision calculation as far as handover number likelihood and the handover disappointment likelihood. What's more, it is seen that the network need handover decision calculation creates better outcomes contrasted with equivalent need and mobile need handover decision calculation. Lastly, the simulation outcomes are approved using explanatory model.

Keywords: VHD algorithm, Handover information, Equal weight, Mobile weight, network weight, and network throughput.

I. INTRODUCTION

According to Alex [1] Provisioning, consistent administrations while traveling through heterogeneous wireless networks is a fundamental subject in the 4th era wireless Networks. An effective VHD making the calculation which considers administrations prerequisites clients inclinations and sureties consistent handover over heterogeneous advancements is necessary. In this study, it had been proposed a smart context-aware arrangement which reflects the two clients and administrations necessities. It depends on cutting edge decision methods such as fuzzy logic and scientific chain of importance forms [1].

According to Liang [2] with mobile working frameworks ending up progressively regular in vehicles, where vehicular requests for continuous access to internet until get a flood in near future. The vehicular impromptu network (VANET) offloading speaks to a promising answer for the staggering traffic issue charmed to cell networks. With a vehicular heterogeneous service shaped via a phone service and VANET, productive service choice is essential toward guaranteeing vehicles' nature of administration Quality of Service (QoS), maintaining a strategic distance from network clogs and other acts of corruption. To arrange this topic, it has been built up an insightful network get to framework utilizing the control hypothesis to give consistent vehicular correspondence. In particular, our framework includes two segments. The primary segment prescribes vehicles a proper network to access by utilizing a scientific structure that depends on traffic status, client inclinations, benefits users, and network status into the record. The secondary segment, a disseminated programmed access motor is created by using a learning strategy, which empowers singular vehicles to settle on access choices dependent on access endorser, nearby perception, and memorable data. Ultimately, reproductions demonstrate that our proposition can adequately choose the ideal service to guarantee the QoS of vehicles, and network asset is completely used without network clogs meanwhile [2].

According to Thiago Coqueiro [3], both of bandwidth and power-hungry applications are multiplying in cell-phone services at a fast pace. Be that as it may, cell-phone gadgets have been experiencing an absence of adequate battery limit with respect to the concentrated/nonstop utilization of these applications. What's more, the cell-phone biological system is at present heterogeneous and contains plenty of networks with various advances, for example, LTE, Wi-Fi, and WiMAX. Thus, a topic necessary to be routed to guarantee that nature of involvement Quality of Experience (QoE) is accommodated, the clients in this situation: a vitality productive technique that is intended to broaden the battery lifetime of cell-phone gadgets. The study offers engineering that provides a savvy decision-production emotionally supportive network dependent on Fuzzy Logic for sparing the vitality of cell-phone gadgets inside an incorporated LTE and Wi-Fi network. The mimicked trials demonstrate the advantages of the arrangement this engineering can give by utilizing QoE measurements [3].

As per Malathy [4], he has used a mix of sub-atomic electronic function with cutting edge silicon improvement. The process is to securing the single atoms at explicit parts on silicon sides.

As per Li [5], in cell-phone distributed computing, utilizing calculation offloading empowers cell-phone gadgets to

extensively enlarge their capacity in rising asset hungry applications. Be that as it may, contemplates on practical offloading handoff components are as yet inadequate. The present effort shows, a cross-layer association handoff mechanism Cross-layer Collaboration Handoff Mechanism Decision (CCHMD) is suggested to create sensible, powerful and productive handoff decisions by thinking about the regular development of astute terminals and the heterogeneity of wireless services. Cross-layer coordinated effort alludes to the participation among correspondence handoff and calculation handoff. A previous for the most part relies upon the acknowledged signal strength of cell-phone terminals, a base fairness factor with the base enhancement factor of all network traits. Paradoxically, the last relies on a few critical characteristics of competitor networks. To impartially assess the performance of every applicant network, required to apply the enhanced standardization and data Entropy Method (EM) to consequently figure the load estimation of each property, and utilize the enhanced multi-ascribe decision calculation to survey all hopeful networks. At that point of organize these networks in the diving request and choose the primary network as the ideal handoff network. Trial outcomes has demonstrated that CCHMD shows preferred flexibility and performance over EM, straightforward added substance weight and strategy for request inclination by comparability to perfect arrangement as far as a few pointers, for example, assignment execution time, handoff recurrence, vitality utilization, and errand execution proficiency [5].

There is study for broad-spectrum, that asset to calculate the interference from the 4G systems into FSS systems, when transmit power is unallocated to some sub-carriers cause handover to the band of the victim system [6].

With advances in wireless networks, Jain [7] came up with upcoming wireless networks are relied upon to be ultra-thick and heterogeneous not simply as far as the number and sort of base stations yet additionally as far as the client numbers and the application kinds get to. Like this network engineering will need versatility to the board components that adjust quickly to these profoundly unique network attributes. Specifically, the peak of the handover signalling inside these upcoming network models will be incredibly basic given their thickness and heterogeneity. This work shows, the peak is important for both of the aggregate sum of signalling made and the complete deferral per handover process.

II. HANDOVER WORKING IN DIFFERENT NETWORKS HETEROGGNEOUS NETWORKS

In the Universal Mobile Telephone system (UMTS), handover (HO) is performed if the signal level reaches a certain threshold value specified by the radio network controller (RNC) as shown in Fig.1. This can be applied for the uplink and downlink it can also be implemented if the cell traffic becomes too heavy. HO in UMTS still depends on the user's mobility, traffic distribution, bandwidth and change of service.

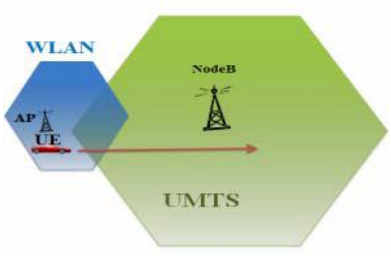

Fig. 1. Proposed interconnection architecture of WLAN and UMTS

The demand for exchange data with high rate and low traffic in cell-phone communication is becoming a main topic of the studies. For that, heterogeneous network has been presented to light up this demand. In a wireless network, mobility feature is vital due to the reason that cell-phone should be capable to roam throughout the network and able to link different radio access technologies. For that, the cell-phone considers the point of attachment relying on special standard called Received Signal Strength (RSS), the idea is to use simple algorithm to determine HO based on RSS [8]. However, varies RSS will lead to unreliable HO [9]. That due to each component of different network contains a different threshold of RHS, this will produce great packet delay, extreme handover, great handover miscarriage possibility, and decreases throughput in RSS-based algorithm (Fig. 2 and 3).

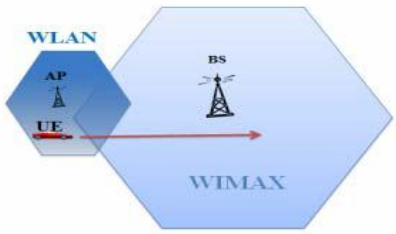

Fig. 2. Proposed interconnection architecture of WLAN and WiMax

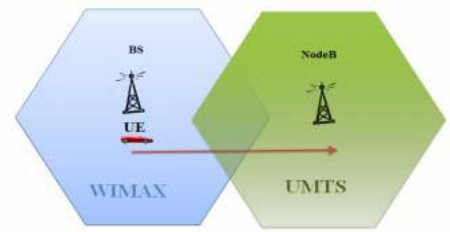

Fig. 3. Proposed interconnection architecture of WiMax and UMTS

Moreover, there are number of issues have been notes in VHD algorithm as follows:

1. Reliable algorithm: Incorrect VHD will cost network capitals (where the collective amount of all existing resources will be high cost).
2. Flexible algorithm: Can balance traffic loads network by properly service distribution to mobile.
3. Accurate algorithm: Should be able to recognize the required amount of data rate to be transfer to mobile devices on the network.

Approaching towards applying multi-wireless technique for the vertical handover algorithm, assist in providing a substitute network which would be the best network looking for. It is possible to classify VHDA into five methods as following:

i. Method based on RSS: where RSS used for triggering handover [10] also, to decide which are the main criteria of handover [11]. This method has been upgraded by using the RSS threshold [12] and enhanced after combined RSS threshold with the position and rate of the operator's [13]. For making the decision, using ether fuzzy logic method which called multi-attributes decision making (MADM), or use multi-criteria method [14].

ii. Multi-criteria method: with this method VHDA accomplished to lower power consumption [15].

iii. Context-aware method: It is an arrangement that considers the two clients and administrations necessities. It depends on cutting edge decision approaches like fuzzy logic and scientific series of significance forms [16]. It also may define as any data that can describe the entity status [17], or it may be a location, environment, identity, and time [18].

iv. Cost function method: There are two types of cost function for this method which are user-related and network-related cost functions [19]. For first type depends on time unit, monetary cost, and client bit rate [20, 21]. About second type used fuzzy logic strategy which include two steps the fuzzi-fication and weighting step and the decision making step [22].

v. Fuzzy logic method: The idea proposed by Ribeiro [23], it displayed as a strategy for handling information. FL is propelled by human thinking. The rule of its task resembles the manner in which individuals decide: we have the choice of picking yes or no. Similarly, fuzzy logic dependent on known data and a few principles picks a decision among genuine and false. In Boolean logic, genuine and false qualities are related to whole number numbers 1 and 0. In Fuzzy Logic (FL) and numbers somewhere in the range of 0 and 1 are utilized, the fuzzy procedure taking decisions between "total genuine" and "totally false" [24]. Current methodologies for network choices may moreover include either Fuzzy Logic-based plans or MADM plans. In the first, a gathering of fuzzy logic administers as Linguistic (IF-THEN) which identify model network steps. Anyway, like this standards must design based on client physically preceding determination and their multifaceted nature winds up overpowering high as the amount of qualities increments. In this manner, the adaptability of the fuzzy logic plans are very low, that confines the utilization in wireless networks determination. Regardless of adaptability matters, fuzzy logic plans might be connected to issue being referred to, as long the aim of parameter loads and characteristic qualities includes fuzziness [25].

There are a number of projects done on multi-criteria VHDA. multi-wireless technique is able to do the quantitative calculation on decision using multi-wireless technique between many users [22]. Making decision calculation in Multi-criteria introduced on the separation from the perfect arrangement idea, and can form the issues containing both fresh and fuzzy information. The causes of the planned making decision methodology are found in the multi-criteria decision instrument named Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). TOPSIS depends on the instinctive rule which is the favoured choice should have the summary removed from the best preparation and the most remote separation from the counter perfect arrangement [26]. For a Multiple Criteria Decision-Making (MCDM) strategy will choose the elective which contains base separation from the perfect option [27]. TOPSIS reflects both distances of ideal and anti-ideal, as long as ideal short distance alternatives might not have anti-ideal farthest distance or opposite case. The customary TOPSIS method utilizes Euclidean standard to standardize the first characteristic qualities, and the Euclidean separation to realize every elective separation from the perfect and against perfect arrangements. TOPSIS is a generally acknowledged MADM method because of its looks reasonable, concurrent thought and hostile to the perfect arrangement and effectively programmable calculation technique [28].

Assessing the act of a wireless network surmises the presence of satisfactory measurements which is a mirror to the network's genuine ability to fulfill its clients. The Fuzzy sets hypothesis, acquainted by Zadeh in 1965 with manage dubious, loose and questionable issues has been utilized as a demonstrating instrument for complex frameworks that can be constrained by people however are difficult to characterize accurately. The primary qualities of fluffiness are the gathering of people into a class that doesn't have pointedly characterized limits. The unsure correlation decision could be quelled with the Fuzzy number. To instance, a triangular fuzzy number is the extraordinary class of fuzzy numbers any members are characterized with three genuine numbers communicated like (i, m, u) where i is as far as possible esteem, m is the most encouraging worth and u is as far as the upper limit value [29].

III. HANDOVER DECISION ALGORITHM

Handover is the solution to keep up the congruity to the end clients as shown in Fig.4.

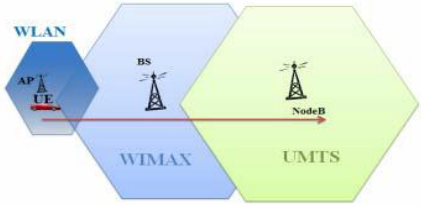

Fig. 4. HO decision based on RSS

Handover decision recommendations settle on the decision at a reasonable time to change to another network connection for vertical or even HO, to ensure the nature of administration to

end clients. A few number of customary approaches for settling on a HO decision dependent on various portability types, similar to proposition cost function, that built up the network determination calculation cost function models; and proposition bit mistake rate, to dissects the act on bit blunder rate and strength relative signal to settle on a handoff decision RSS proposition, that settling on a HO decision for the most part dependent on RSS [30].

IV. MULTIPLE CRITERIA HANDOVER DECISION ALGORITHM

In customary handover decision provider algorithms, to utilize decision algorithms that regularly edge. "Ping-Pong" impact could happen due to use of such algorithms. So, when parameters at the HO decision limit will happen over again. That would prompt the impact to low Quality of Experience (QoE). Utilize hysteresis esteems to form this problem. For this situation, a handover is started just if the estimation of measurement is adequately more grounded with hysteresis esteem instead of the current one. In a versatile handover, the calculation is created by powerfully deciding the hysteresis esteem. The HO algorithm relay on four criteria which are cost function, network availability, RSS, and cellphone speediness. So the man-made brainpower depends HO decision making calculation is planned for taking care of these issues [31].

This study takes in consideration two parameters: cost function and mobile speed. Where cost function consists of three types as listed below:

1. Gold Cost: The client has wide range of subscription which lets him use high level of Quality of Service (QoS). It comes with high cost role.
2. Silver Cost: The client has medium range of subscription which will balance between QoS requirements and cost function.
3. Bronze Cost: The client has low range of subscription; here the cost function is much more important than QoS parameters.

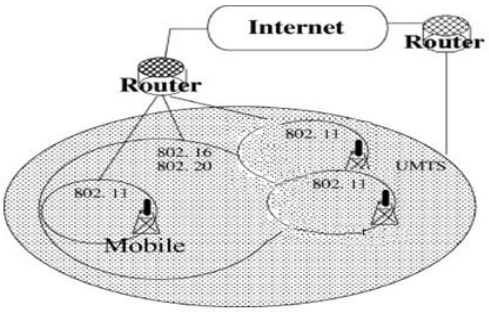

Fig. 5. Heterogeneous network overly

Above in Fig.5, is a combination of wireless access networks (WANs) to offer multi situation case of wireless access at the terminal devices with a number of network interfaces (Heterogeneous Network).

V. SYSTEM METHODOLOGY

Using the fuzzy TOPSIS method will help to know the priority weights of multi-wireless technique smoothly. Where three kinds of priority must be used in VHD which are: equal, mobile, and network priority. Priority technique will stress the mobile parameters (cost function and mobile speed); for the meantime, network priority will emphasize the network occupancy. The system flowchart methodology is shown in Fig. 6.

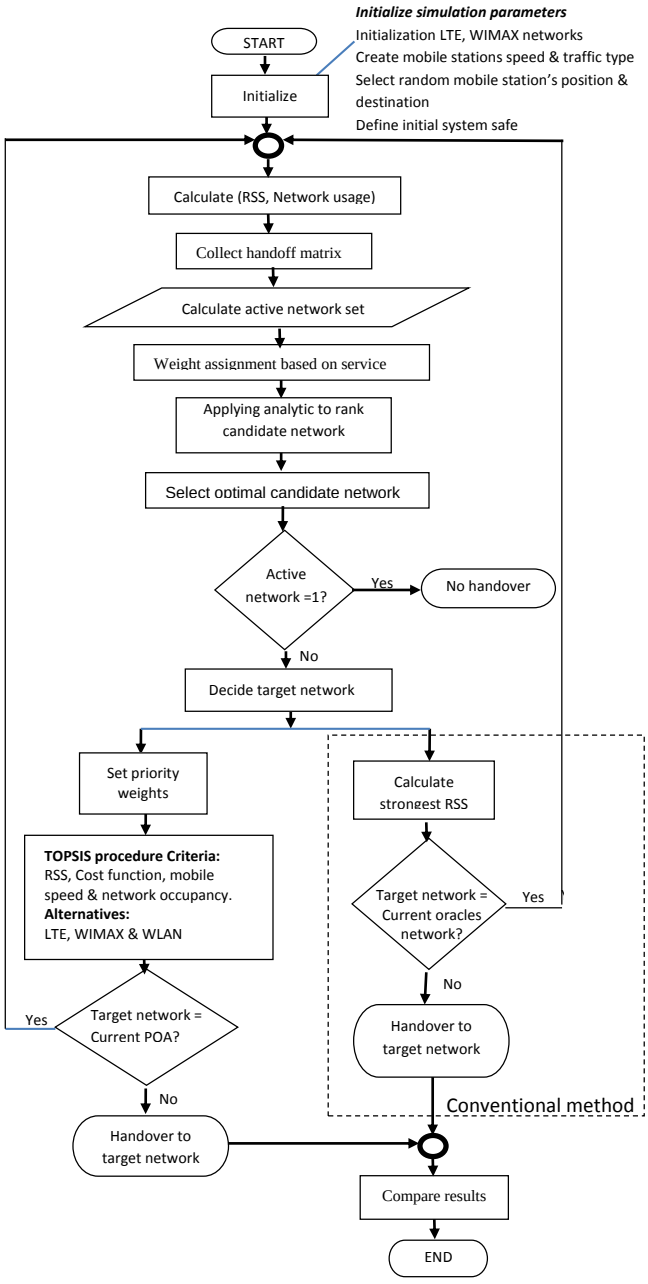

Fig. 6. System flowchart methodology

VI. HANDOVER NETWORK ALGORITHM

TOPSIS algorithm required an individual subjective input for decision calculation, the handover decision is compared in terms of four aspects: mobile speed, cost function, RSS, and

network occupancy. Where, mobile speed contains five speed values between 5m/s and 25m/s [33]. The algorithm determines in terms of three weights criteria which are mentioned earlier (equal, mobile, and network weights) as shown in table 1.

Table 1. The weight for each handover decision

Criteria	Equal priority	Mobile priority	Network priority
Mobile speed	0.25	0.4	0.1
Cost function	0.25	0.4	0.1
RSS	0.25	0.1	0.4
Network occupancy	0.25	0.1	0.4

VII. SYSTEM OUTPUT RESULTS

A case study had been created and analyzed all the vertical handover algorithms discussed in this paper. Consider a case of a cell phone terminal linked to a Wi-Fi cell presently and must make decision from six applicant networks A_1, A_2, A_3, A_4, A_5, and A_6. It is to be noted that the networks A_3 and A_4 are Wi-Fi cells and others are Wi-Max cells. Assume the VHD as delay, bandwidth, cost, and jitter, it had been presented notation for the criteria as X_1, X_2, X_3, and X_4. The decision (M) as shown in the matrix below:

$$M = \begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \\ A_4 \\ A_5 \\ A_6 \end{array} \begin{array}{c} \begin{array}{cccc} X_1 & X_2 & X_3 & X_4 \end{array} \\ \begin{bmatrix} 0.00062 & 7.5 & 9 & 0.422 \\ 0.00063 & 2 & 7.5 & 0.758 \\ 0.00062 & 12 & 12 & 0.057 \\ 0.00063 & 7 & 6 & 0.939 \\ 0.00062 & 11 & 10 & 0.103 \\ 0.00061 & 1 & 9 & 0.247 \end{bmatrix} \end{array}$$

Let us assume the running application is voice, the importance weight of each criterion as W = [w_1, w_2, w_3, w_4] = [0.3, 0.2, 0.2, 0.3].

From above matrix, the best network is A_4 which is the network because it processing minimum delay which connect community service with mobile terminal.

The system parameters in the HO information for wireless networks were recorded in table 2.

Table 2: Observed HO data for different wireless access networks

Network	RSSI (dBm)	Typical downlink Service		
		Mbps	Service cost	Mobility
GSM/GPRS	-45 to -115	9.6 to 144kb/s	High	High
UMTS	-45 to -115	3.14	High	High
Wi-Fi (802.11b)	-25 to -95	5	Low	Low
Wi-Fi (802.11g)	-25 to -95	20	Low	Low
Wi-Fi (802.11n)	-25 to -95	270	Low	Low
IEEE (802.20)	Not known	1 to 9Mb/s	High	Very high

As it is shown in table 1, the entire HO algorithm associated attributes. Network associated metric contains coverage, bandwidth (Bw), latency, link quality, carrier to interferences ratio (CIR), signal to interferences ratio (SIR), bit error rate (BER), monetary cost, and security level.

Based on the applicant profile and service, the importance to these attributes will vary. This part is done by collecting data for interface statistics, current radio environment information, application priority scores and user preferences. This information used to decide whether HO is required. These inputs are fed into decision engine for making HO decision as in Fig.7.

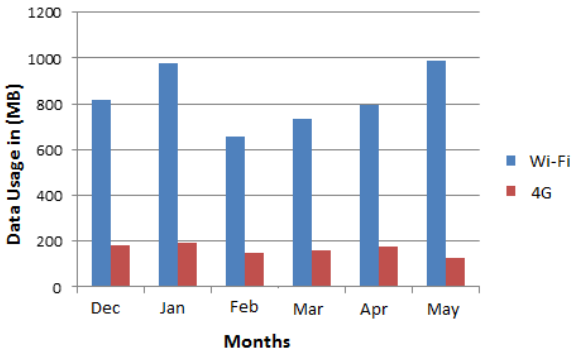

Fig. 7. Resources utilization in the cellphone

Apply the proposed method to obtain the measuring mechanism for the efficiency and effectiveness of the proposed algorithm.

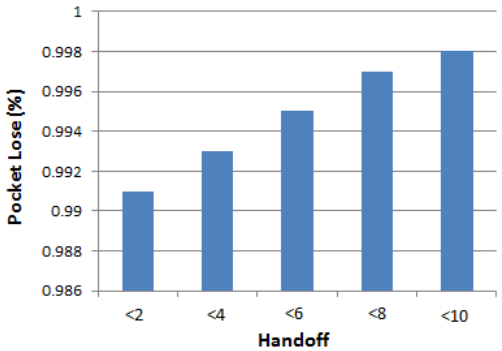

Fig. 8. Packet loss analysis of proposed algorithm

Fig.8 shows there is a positive relationship HO and packet loss, where increasing packet of loss will cause to increase the HO. That is because of the great signalling load. However, the

proposed algorithm continuous showing that high data rate (throughput) with less amount of packet loss.

When applied the algorithm in a mixed network setting for multiple handover decision: equal, mobile, and network weights. The performance where compared with RSS in terms of cost function, mobile speed, and network occupancy aspects. The handover distributions for 100 mobile users were tested the algorithm to each weight where as shown in figures from 9 to 11.

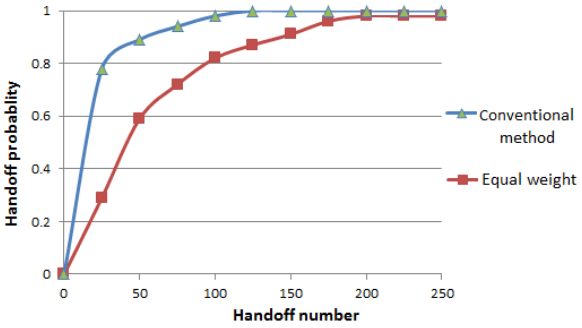

Fig. 9. Handover number probability to equal weight

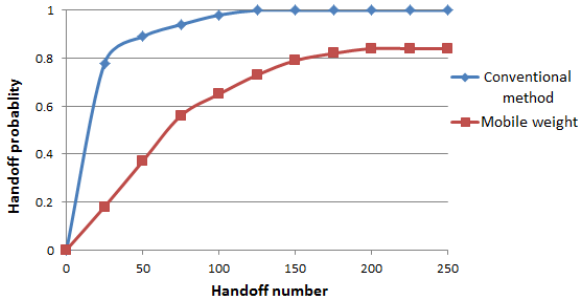

Fig. 10. Handover number probability to mobile weight

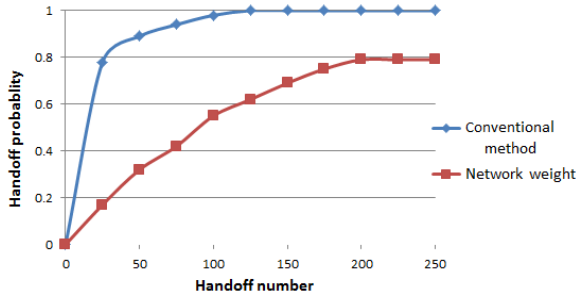

Fig. 11. Handover number probability to network weight

Fig.9 shows that, using equal weight had reduced the handover by 24.5%. While the mobile weight in Fig.10 has minimized the handover amount by 45.1%. On the other hand Fig.11 demonstrates that, the network weight had been enhanced by 61%. Based on above figures (9 – 11), by comparing between the conventional approach and proposed algorithm using equal weight, mobile and network, it is possible to notice that, the proposed approach has improved the network efficiency and increased the resource availability is, also offers higher mobile speed with lower cost function because the unwanted handover had been reduced. Whereas handover failure probability shown in figure 12 refers to a basic performance metric this indicates the capability of a network in serving incoming mobile users.

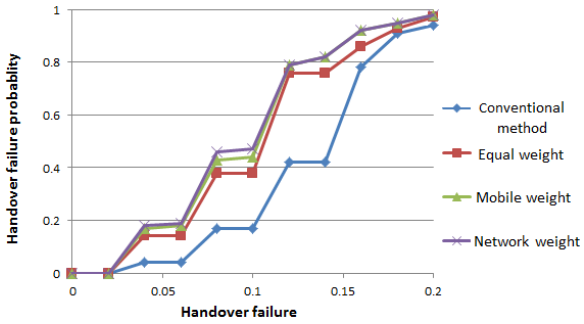

Fig. 12. Average handover failure probability in each method

Fig.12 demonstrates that, the average handover failure probability values have been enhanced in all other weight criteria than the conventional approach.

On the other hand, the efficiency of proposed algorithm had been tested under different Radio Frequency environmental conditions as shown in figure 13. The test was in terms of switching between 4G and Wi-Fi using calls dropping and blocking probability. There were a 1000 calls experimented during 48 hours, 210 seconds were holding time calls. It was found that total of 5 blocking calls and 3 dropped calls.

Drop call rate = (Number of dropped calls) / (No of call attempts)

Blocking Probability = (Number of lost calls)/ (Total number of offered calls)

Blocking Probability in busy hours = 5 / 988 = 0.0051

Drop call rate in busy hour= 3/1000 = 0.003

Blocking Probability in busy hours with handover = 5 / 988 = 0.0051

Drop call rate in busy hours with handover = 5/1000 = 0.005

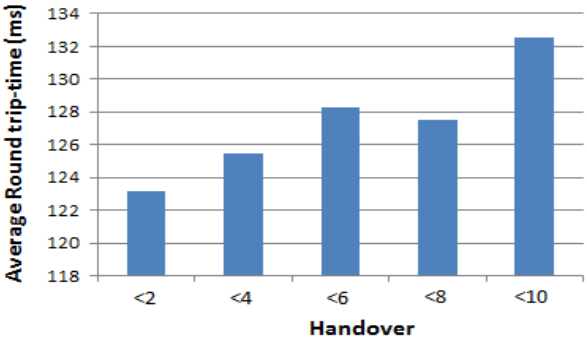

Fig. 13. Average Round-trip time (RTT) analysis of proposed algorithm

In Fig. 13, the Round-trip time (RTT) for network resources have been used for the decision algorithm efficiently, that's done via exchanging among 4G and Wi-Fi under various radio frequencies environmental circumstances, this to reach to the optimum connectivity with less service cost to the clients. It is found that it takes from 26 - 35 ms in the average of handover delay, it had been proposed to use smart decision algorithm and to minimizes, the call falling rate (<0.0051), call obstructive possibility (<0.0051), and avoidable HO in heterogeneous networks.

VIII. CONCLUSION

This study proposed algorithm to improve the probabilities of handovers, a comparison was made between the three types of the priority in terms of weight (equal, mobile, and network), VHDA has enhanced overall network performance in respects to the amount of HO, network balance, and average blocking possibility. The performance of the algorithm efficiently uses the network resources by exchanging between 4G and Wi-Fi with different RF to give best connectivity with minimal service cost to the clients. It is obtained that the average handover delay for the experiment takes about 30 ms and the proposed intelligent decision Algorithm minimize the dropping rate to (<0.005), and blocking probability (<0.0051) as well as unnecessary handover in heterogeneous networks.
The suggested algorithm will help to classify the required application resource to real time and non-real time, which will help to reduce the load on the decision engine by routing IP traffic base on applicant schedule.

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