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Context and Movement Aware VIKOR MADM Based Vertical Handover Algorithm for Heterogeneous Networks

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ABSTRACT

Heterogeneous wireless networks comprise of variety of wireless technologies integrated to satisfy user's demand. Vertical handover algorithm is the need of present scenario to select optimum network among the available networks. Multiple attribute decision making based handover algorithm are capable to select optimum network having requisite set of context parameters. Context information related to quality of service parameters offered by networks varies with movement of mobile terminal. Thus, context and movement aware has been designed with vector normalized preferred performance based VIKOR method (CMV-VPP). The performance has been analyzed for conversational traffic and compared with other available normalization methods as MAX normalization based VIKOR (CMV-MAX) and Vector normalization based VIKOR (CMV-VEC) methods. Simulation results show that the proposed algorithm performs better in terms of network selection and number of handovers as compared with other methods used in this work.

Keywords : Heterogeneous, CMV-VPP, VIKOR, CMV-MAX, CMV-VEC

I. INTRODUCTION

Vertical handover is necessity of fourth generation and beyond 4G heterogeneous networks where different wireless technologies are incorporated and user has the choice to select suitable network from number of available wireless networks [3]. The decision of network selection with principle of "Always best connected" [1]should not rely solely on signal strength but context information of mobile device and networks needs to be included[9]. Different wireless networks offer varying quality of service and the user's demand may also vary with time. Further, to select optimum network among the networks available while on move is again a critical task. Thus a movement based context aware (MBCA) vertical handover technique is desirable in the present era of heterogeneous environment. The context information related to mobile user may involve battery status and application whereas wireless networks advertise information pertaining to signal strength, bandwidth, level of security, cost, network load etc. as context information. The handover technique should be able to incorporate maximum number of quality of service parameters along with signal strength at any point in the overlapping area of different wireless networks. Moreover the mobile device must have the interfaces inbuilt to connect to a suitable network which is able to satisfy his needs at particular instant of time. The wireless networks constituting heterogeneous environment present variable context information to user at different instant of time and selection of suitable network for his application is significant. Handover algorithm play important role in this task of optimum network selection. Several approaches such as Genetic algorithms, Fuzzy logic, Utility function and Multiple attribute decision making algorithms have been developed and suggested by researchers to provide ubiquitous access to user by means of vertical handover[4-8,10-11]. Among all the approaches, multiple attribute decision making algorithms are able to accumulate large number of context related attributes in network selection. In this work, Vector normalized preferred performance rating based Context and movement aware algorithm (CMV-VPP) has been proposed and applied to VIKOR multiple attribute decision making method for network selection. The performance of proposed algorithm has been compared with Max normalization based CMV-MAX and Vector normalization based CMV-VEC techniques applied to VIKOR method.

Rest of the paper is organized as follows: Following section presents the work done by various researchers in this area so as to appreciate and appraise their contributions made in this upcoming field, section 3 presents procedural details of proposed algorithm. Section4 describes the simulation set up used and compare the performance analysis with present. Section 5 provides results of simulation and section 6 conclude the work with final remarks.

II. RELATED WORK

In next generation wireless networks, different network technologies such as WLAN, UMTS etc. coexist and offer variety of quality of services to user. The information regarding network related context parameters like bandwidth, network load, coverage, security and many more has been advertised by different networks on control channels periodically. Traditional signal strength based algorithms lacks in suggesting suitable network for application based requisite quality of service in heterogeneous networks. Thus context aware vertical handover techniques are required to perform intelligent network selection in integrated wireless network. Q. Wei et.al [9] proposed a flexible and integrated approach for context management between mobile devices and networks. Programmable platforms, distributed context management components in network nodes and mobile devices were deployed in performing handover decision. Soft handoff procedure can be employed with vertical handoff allows multi connection between user and base stations/access points during handoff as compared with hard handoff. Kemeng Yang et.al[12] proposed a context-aware vertical soft handoff algorithm resulting in lower dropping probability, lower average cost and high throughput as compared with vertical hard handoff. Moreover location of mobile user play vital role in performing optimum handover among different networks. M. Ylianttila et.al[6] proposed a location aware architecture to support vertical roaming between WLAN hotspots and cellular networks. Power and dwell-timer based two handoff algorithms were used for moving-in and moving- out transitions between two networks. Several other approaches were also used in literature to design context aware vertical handover algorithms. Meriem Zekri et.al [15] proposed Fuzzy logic and Analytic hierarchy process based intelligent context-aware algorithm which considered both user's and service's requirements. Information regarding static (user's preference, cost) and dynamic context parameters(mobile terminal velocity, RSS etc.) was gathered and applied to Fuzzy inference system in handover initiation phase of vertical handover to check whether handover is required or not. Network selection is then performed by AHP. Due to multi-criteria nature of vertical handover,Multiple attribute decision making (MADM) algorithms are able to incorporate number of context attributes and provide compromising solution among conflicting criterion involved in complex vertical handover decision. Payman Talebi Ferd [16] proposed weighted product method based context-aware network selection algorithm for dynamic selection of best access network among available networks. In this work VIKOR MADM method has been used as baseline algorithm for performing context awareness based network selection in heterogeneous environment of three networks as WLAN, UMTS and WIMAX.

III. CONTEXT AND MOVEMENT AWARE VECTOR NORMALIZED PREFERRED PERFORMANCE BASED VIKOR METHOD (CMV-VPP)

In this work, VIKOR[1] Multiple attribute decision making method has been used as a baseline technique to develop Context and movement aware CMV-VPP algorithm for vertical handover in heterogeneous networks. The basic mechanism involved in proposed method for handover decision is shown in Fig. 2.

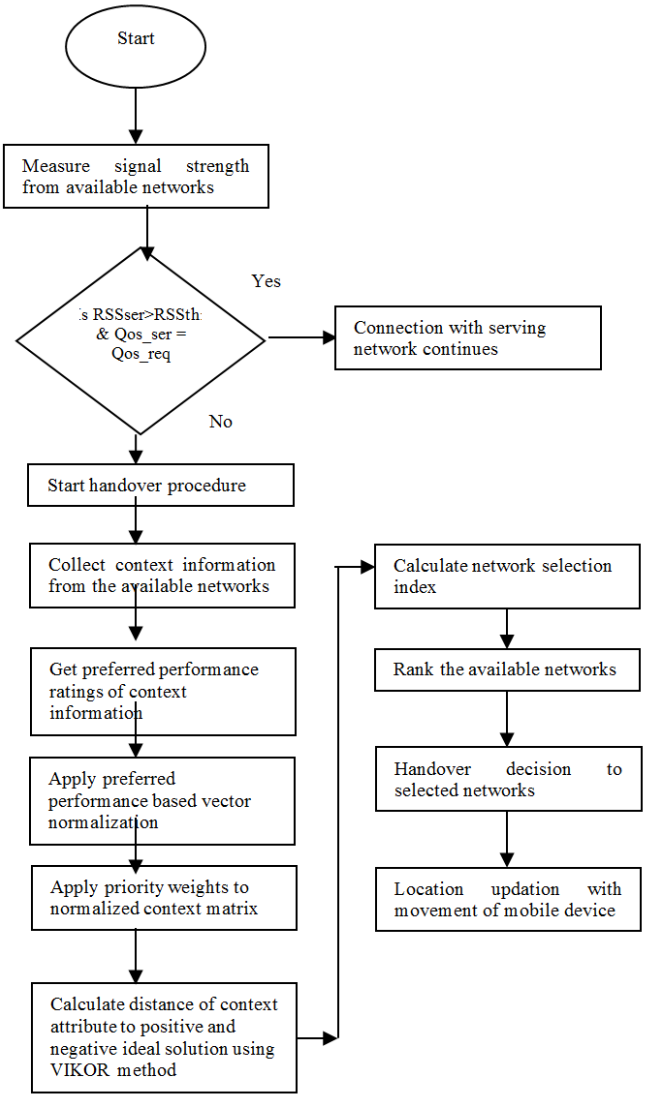

Figure 1 : Flow chart for mechanism of proposed method

RSS_{ser} and *RSS_{thr}* represent received signal strength from serving base station/ access point and threshold value respectively. *Qos_ser* and *Qos_req* represents quality of service provided by serving base station/access point and required quality of service as desired by user respectively. Normalized context attribute matrix is applied to VIKOR [1] multiple attribute decision making algorithm for selecting the optimum network from available networks. Application of VIKOR method to normalized matrix resulted in matrix containing network selection index (NSI) of all the available networks. The networks are arranged in decreasing value of NSI and the network having least value of NSI will be considered as optimum network. The other two techniques mentioned in this work differ with normalization method are MCV-MAX and MCV-VEC for max normalization and vector normalization respectively.

IV. SIMULATION SETUP

Three wireless networks considered for designing heterogeneous environment include WLAN, WIMAX and UMTS that are to be available uniformly throughout the region of interest with variable signal strength and other context parameters.

Five simulation scenarios have been designed using MATLAB platform for different context information to analyze the performance of the proposed MCV-VPP handover technique. In every scenario, velocity of mobile device is varied in equal intervals of 10 Kmph to analyze the movement based aspect of the handover technique.

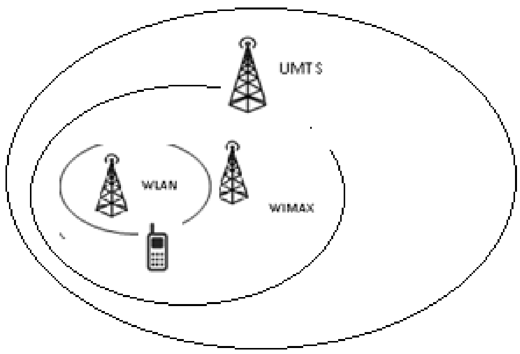

Figure 2 : Scenario for heterogeneous network

Fig. 2 presents the heterogeneous network considered in this work. Table I provides the overall simulation setup used whereas Table II explains the design of five scenarios on the basis of received signal strength.

TABLE I: SIMULATION SETUP

No. of networks	3 (WLAN,WIMAX and UMTS)
Traffic class/application preference	Conversational
Velocity of mobile device	10KMph- 100KMph(in 10 intervals)
Network load	100%
Context related parameters	Received signal strength, Delay, jitter, throughput, security, cost and packet loss,
Number of Vertical handoff Scenarios	5 (with different contribution of context information)

The values of other context parameters vary randomly in the range given in Table III. It is assumed that context related information is available in database of handover module attached with mobile user and updated with time. The quality Application preference (Conversational) of mobile user is used to assign priority values to different parameters. Analytical network process (ANP) is used to assign priority weights to all the parameters according to the characteristics of conversational traffic class. Packet delay and Jitter have assigned highest priority after Relative signal strength.

TABLE II: LEVEL OF SIGNAL STRENGTH FOR 3 NETWORKS IN 5 SCENARIOS

Scenario	**Network**		
	UMTS	**WLAN**	**WIMAX**
1	Low	Medium	High
2	Medium	High	Low
3	Max	Low	Medium
4	Comparable		
5	Low	Comparable	

In every scenario, the network selected by proposed handover algorithm will illustrate the optimal network selection feature of the handover algorithm. The performance of proposed technique is compared with two other techniques as described in section 3 on the bases of network selection as well as number of handovers. The performance of the proposed CMV-VPP (Context and Movement aware VPP based VIKOR) method has been analyzed on the basis of selected network and number of handovers for variation in velocity of mobile user. The performance is also compared with other normalization techniques namely CMV-MAX (Context and Movement aware Max normalization based VIKOR) method and CMV-VEC (Context and Movement aware vector normalization based VIKOR) method.

TABLE III: RANGE OF CONTEXT ATTRIBUTES FOR THREE NETWORKS[13]

Context attribute	**Network**		
	UMTS	**WLAN**	**WIMAX**
Delay(ms)	25-50	100-150	60-100
Jitter(ms)	5-10	10-20	3-10
Packet loss(per 10^6)	20-80	20-80	20-80
Throughput(Mbps)	0.1-3	50-150	20-100
Security (%)	70	50	60
Cost (%)	60	10	40

V. RESULTS AND DISCUSSION

As outlined in section 4, five scenarios have been constructed in the heterogeneous environment. In every scenario, the three wireless networks offer different context information to the user. The network selection will be done on the basis of values of network selection index (NSI) parameter of handover technique. The network having minimum value of NSI will be selected for given set of context parameters at any location in overlapping area of three networks. As the user is involved in conversation while on move then UMTS network will be the optimum choice as per the cost and other quality of service parameters required for conversational traffic and context information offered by UMTS network. Although received signal strength will be the trigger input in the decision but if UMTS network is available and signal strength received by mobile device is above threshold then it should be given priority in selection. The performance analysis of proposed CMV-VPP method is as follows:

A. *Scenario 1*:

At this point in heterogeneous network, WIMAX network offered highest signal strength among the three networks as depicted from Table II.

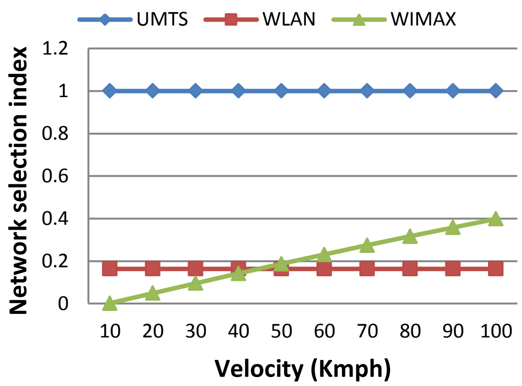

Figure 3 : (a) Network selection index and handover decision in scenario 1 for CMV-MAX method

Fig. 3(a-c) shows the variation in network selection index with velocity for the three handover techniques based on VIKOR method. As shown in Fig. 3(a), in CMV-MAX method, UMTS network has least priority among the three networks for all the time though it is the best choice for conversational traffic. Moreover handover occurred

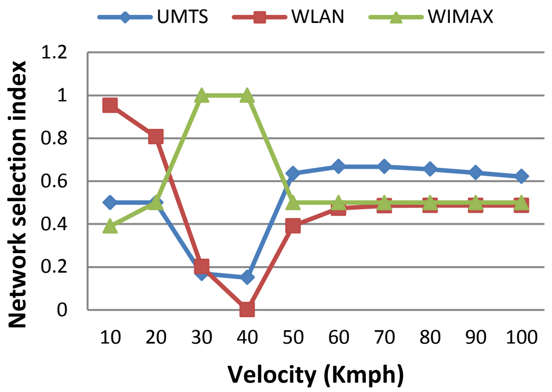

Figure 3 : (b) Network selection index and handover decision in scenario 1 for CMV-VEC method

between WLAN and WIMAX networks at velocity from 50-60Kmph.WIMAX network can be the reason for network selected on the basis of signal strength but this method selected WLAN for high velocity which is not the suitable choice. In the same manner, V-VEC method selected WLAN most of the time as can be seen from Fig. 3(b). This is again not the optimal choice for conversational traffic. Handover occurred at velocity of 30Kmph.

CMV-VPP method selected WIMAX network due to maximum signal strength and UMTS network is next choice which is justified. No handover occurred.

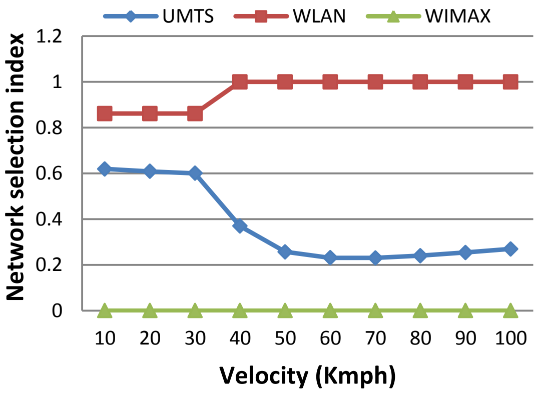

Figure 3 : (c) Network selection index and handover decision in scenario 1 for CMV-VPP method

B. Scenario 2

Here WLAN offered maximum signal strength among the three wireless networks. The performance of three normalization methods is shown in Table IV.

TABLE IV: Network selection by three methods

Velocity(Kmph)	**Normalization method**		
	CMV-MAX	**CMV-VEC**	**CMV-VPP**
10	WLAN	WIMAX	UMTS
20	WLAN	WIMAX	UMTS
30	WLAN	WLAN	UMTS
40	WLAN	WLAN	UMTS
50	WLAN	WLAN	UMTS
60	WLAN	WIMAX	UMTS
70	WLAN	WIMAX	UMTS
80	WLAN	WIMAX	UMTS
90	WLAN	WIMAX	UMTS
100	WLAN	WIMAX	UMTS

As shown in Table IV, V-MAX method selected WLAN network even though the velocity of mobile user increases. WIMAX network has lowest priority irrespective of signal strength. Priority of UMTS is next to WLAN but the difference between the NSI values is larger enough for continuous connection with WLAN network.

On the other hand CMV-VEC method resulted in handovers between WLAN and WIMAX networks; UMTS network has least priority in selection. CMV-VEC method selected UMTS network which is the optimal choice for conversational traffic.

C. *Scenario 3*

As given in Table II, here the signal strength received from UMTS network is largest as compared with other networks. Thus depending on signal strength and quality of service offered by UMTS network, mobile user should be connected with it. Fig. 4(a-c) presents NSI values provided by three normalization methods for three networks with variation in velocity of mobile user. CMV-MAX and CMV-VPP method suggested UMTS network to be selected for conversational traffic. CMV-VEC assigned least priority to UMTS network which is not acceptable. Moreover 2 handovers occurred.

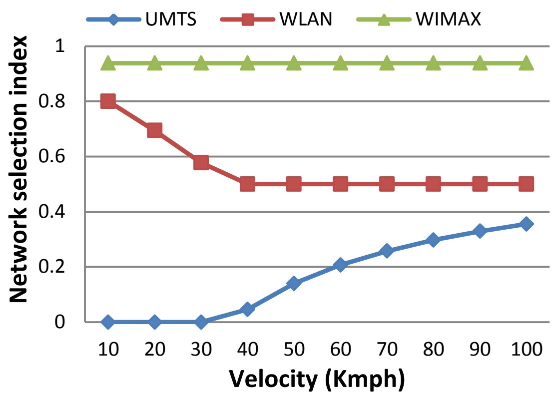

Figure 4 : (a) Network selection index and handover decision in scenario 3 for CMV-MAX method

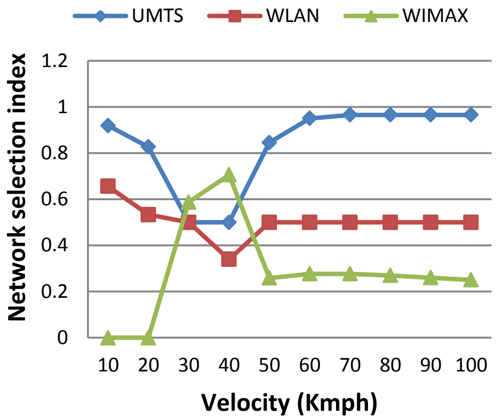

Figure 4 : (b) Network selection index and handover decision in scenario 3 for CMV-VEC method

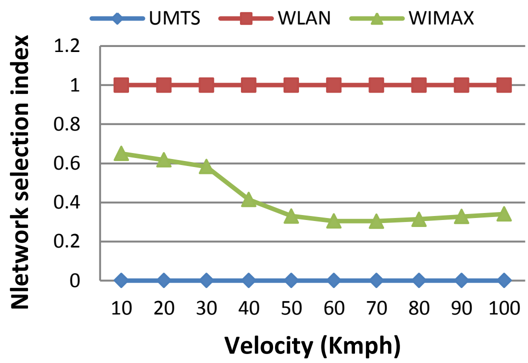

Figure 4 : (c) Network selection index and handover decision in scenario 3 for CMV-VEC method

D. *Scenario 4*

This is the critical location in the heterogeneous network as the signal strength received from the three networks is nearly equal. Thus the value of network selection index will highlight the effectiveness of normalization method regarding optimum network selection. Table V shows the performance of three normalization methods with variation in velocity of mobile device. Only CMV-VPP method selected desired UMTS network among the three methods. This indicates the context aware feature of vector normalized preferred performance normalization method. The other methods suggested WLAN network with 2 or 3 handovers which is not justified network selection.

TABLE V: Network selection by 3 normalization methods

Velocity(Kmph)	Normalization method		
	CMV-MAX	**CMV-VEC**	**CMV-VPP**
10	WLAN,WIMAX	WIMAX	UMTS
20	WLAN,WIMAX	WIMAX	UMTS
30	WLAN	WLAN	UMTS
40	WLAN	WLAN	UMTS
50	WLAN	WLAN	UMTS
60	WLAN	WLAN	UMTS
70	WLAN	WLAN	UMTS
80	WLAN	WLAN	UMTS
90	WLAN	WLAN	UMTS
100	WLAN	WLAN	UMTS

E. *Scenario 5*

In this scenario, the signal strength received from WLAN and WIMAX networks is almost equal and larger than UMTS. The signal strength received from UMTS network is adequate enough to maintain a call. Fig. 5(a-c) shows the network selection index values calculated by three normalization methods. Again CMV-VPP method recommended UMTS network as per the requirement of conversational matrix. WIMAX network is given priority next to UMTS which offers highest mobility among the three networks.

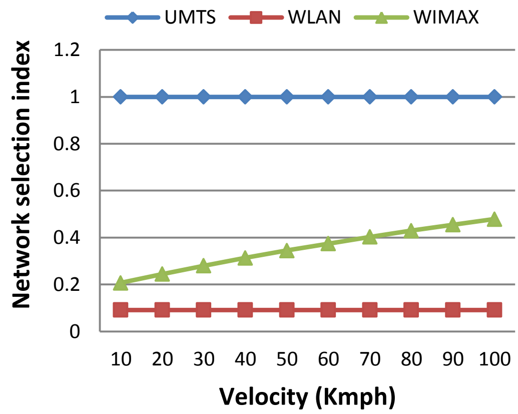

Figure 5 : (a) Network selection index and handover decision in scenario 5 for CMV-MAX method

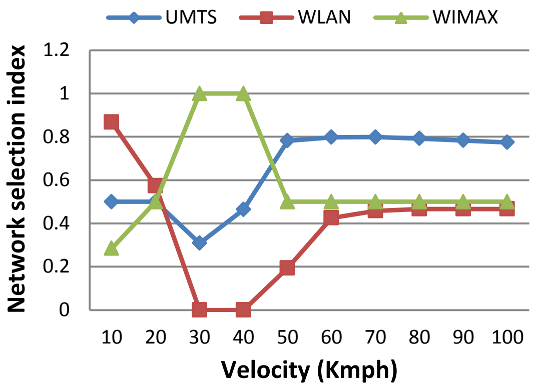

Figure 6 : (b) Network selection index and handover decision in scenario 5 for CMV-VEC method

VI. CONCLUSION

Context awareness is desired property for vertical handover in today's era of heterogeneous environment. Different kinds of networks offer variable network conditions in accordance with changing location of mobile user. The velocity of mobile terminal play important role in decision making phase of vertical handover. In view of these two factors, context and movement aware handover technique has been proposed and analyzed with five different scenarios to analyze robustness and effectiveness of proposed technique. Simulation results show that proposed technique select optimum network for conversational traffic with minimum number of handovers in five different situations defined by five scenarios. The proposed technique is also compared with two other techniques and showed better result in terms of optimum network selection.

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