VERTICAL HANDOVER ALGORITHMS IN HETEROGENEOUS NETWORKS

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Abstract- Due to the integration of different wireless technologies in heterogeneous environment, demand of ubiquitous connectivity is increasing day by day. Vertical handover is the mechanism to support seamless connectivity any time anywhere. Various approaches have been proposed in literature for network selection in vertical handover. In this work, an approach for vertical handover is proposed to reduce call blocking probability and optimal network selection algorithm. Three networks CDMA, WIMAX and WLAN have been considered for performance evaluation of proposed approach for network selection**.** SAW (Simple additive weighting), MEW (Multiplicative exponent weighting) and TOPSIS (Technique for order of Preference by similarity to the Ideal Solution) multiple attributes decision making (MADM) algorithms have been used for the selection of suitable network.

Keywords: Heterogeneous, Vertical handover SAW, MEW, TOPSIS, and MADM

I. INTRODUCTION

Next generation wireless networks will offer services at high data rates and seamless mobility over heterogeneous environment of different network technologies. The main focus in next generation wireless network is on the selection of suitable network which will provide requisite service anywhere anytime seamlessly under the principal of always best connected [8]. For seamless mobility and roaming in wireless network, service continuity is required which can be served by handover. Handover handoff is the process of transferring an ongoing call from one wireless network to another without service interruption. Handover can be broadly classified into two categories as horizontal handover and vertical handover. Horizontal handover occurs between the same wireless technologies (eg. cellular to cellular). On the other hand, vertical handover is an asymmetric process in which handover occurs between different base stations which belong to different networks eg. from CDMA to WLAN. Handover process is implemented in three sequential phases as handover initiation, handover decision and handover execution [12]. In the first phase, the mobile terminal (MT) discovers available neighboring networks. During handover decision phase, mobile device or network decides whether the connection to be continued with current network or to be switched to another one. The decision may depend on various parameters including the available bandwidth, delay, security, bit error rate, cost, transmit power, current battery status of the mobile device, and the user's preferences [13]. During the handover execution phase, connections need to be re-routed from the existing network to the new network in a seamless manner. Among these three phases, handover decision is crucial phase as it may involve large number of network attributes which will participate in decision phase. So, in this work, the focus is to decide a suitable network from the available networks while considering number of decision attributes. In literature, various methods such as genetic algorithms, fuzzy logic, RSS algorithm, cost and context-aware MADM have been suggested to select the suitable network for requisite quality of service. Among these methods, MADM algorithms have shown their efficacy in selection of suitable network for large number of network attributes. So, three popular MADM algorithms SAW, MEW and TOPSIS have been considered for network selection in handover decision.

Rest of the paper is organized as follows: section 2 describes proposed approach for vertical handover followed by simulation setup and decision parameters in section 3. Section 4 provides simulation results and discussion. Section 4 concludes the work with future remarks.

II PROPOSED APPROACH

In this work SAW, MEW and TOPSIS multiple attributes decision making algorithms have been used for network selection in heterogeneous networks comprising of CDMA, WLAN and WIMAX networks depending upon power consumption, cost, traffic load and call blocking probability parameters. By using the proposed approach, power consumption and latency is calculated. Here three MADM (multi attribute decision making) methods have been used for network selection. Simple additive weighting (SAW), Multiplicative exponent weighting (MEW) and Technique for order of Preference by similarity to the Ideal Solution (TOPSIS) method is used to determine ranking of networks. The proposed algorithm reduces the handover call blocking probability and selects most optimal network according to the user preference. Two phases is used for decision function are:

2.1 Handover initiation phase: In this phase, value of any parameter is less than prescribed threshold values, that network is removed from the list of candidate networks for handover decision. If the values of available network are greater than predefined threshold value in this, calculate second phase. Vertical Handover to compare various parameters to reduce delay and choose the best network

$$Mi = F(bi - bth) \cdot F(RSSi - RSSth) \cdot F(Vi - Vth) \times F(Ti - Tth) \cdot F(Pi - Pth) \cdot F(Ci - Cth)$$

If the attributes values of available network are not greater than predefined threshold value in this, show the resource poor condition and mobile terminal stay in same network and consume less power.

2.2 Handover decision phase: Decision phase has two functions one is to reduce the call blocking probability and other is to select the optimal network. For network selection, MADM algorithms SAW, MEW and TOPSIS have been considered and reduce the traffic load on the network dynamic call blocking probability is used.

- **Dynamic new call blocking probability (DNCBP)**

DNCBP is depend upon the mean of request arrived by the network and mean no of call serviced by the network and it is used to balance the traffic load on the available network. In this, DNCBP is used with decision algorithm reduce the call blocking probability and select the optimal network for handover. DNCBP of network n, we just use bi to replace Bi in above Eq. (4). Thus, the priority to handover calls is obtained in a more dynamic manner. Denote hi as the DNCBP of network n according to the Erlang-B model, the following equation holds:

$$h_i = \frac{\left(\frac{\lambda i}{\mu i}\right)i}{b_i!}\left(\sum_{n=0}^{b_i}\frac{\left(\frac{\lambda i}{\mu i}\right)n}{n!}\right) - 1 \qquad (1)$$

- **SAW (Simple additive weighting):** SAW is the most widely used scoring method, the score of each candidate network 'i' is obtained by adding the contributions from each attribute rij multiplied by the weight factors wi. Then, the selected network [2, 3] is given by

$$EQ = arg\ max \sum_{i=1}^{N} wi * rij \qquad (2)$$

Where N=no of network, rij = parameters, wi is weight of the parameters with i networks.

- **MEW (Multiplicative exponent weighting):** MEW works similar to SAW algorithms. The MEW score the overall alternative, it uses the weighted product of all attributes. Then, the selected network [4, 5] is given by

$$EQ = arj\ max \sum_{i=1}^{N} rij^{Wi} \qquad (3)$$

Where, EQ= network selection index to score highest value

- **Technique for order preference by similarity to ideal solution (TOPSIS):** TOPSIS algorithms consider and ideal solution for performance comparison, considering as the best alternative. The basic principle of the TOPSIS method is to choose the shortest distance alternative from the positive ideal solution and the farthest distance from the negative ideal solution. Then, the network selected [6 7] EQ is

$$\mathrm{EQ} = \frac{\mathrm{Sj-}}{\mathrm{Sj*+Sj-,}}, \mathrm{j} = 1, \ldots \mathrm{n} \qquad (4)$$

EQ= Network selection

2.3 Priority Weights Assignment to Network Parameters

From network decision perspective, the users can specify their preferences by assigning priority weights to system attributes. Several methods for finding weights most of them can be categorized into two groups:

- Subjective weights are determined according to the preference decision makers.
- Objective weights these weights solving by mathematical models without any consideration of the decision maker's preferences.

Since the objective of proposed scheme is to maximize users satisfaction, and assigning higher weights to network parameters according to the user preference. These attributes are assigned different priority weight using subjective weighting assignment method. Table 3.1 provides weight assignment of different parameters are cost, security, power consumption, network condition and network performance are used in performance evaluation.

Table 1: Priority weight assignment of different parameters

	Priority weights				
Parameters	Cost	Security	Power consumption	Network condition	Network performance
Cost	0.7	0.075	0.075	0.075	0.075
Security	0.075	0.7	0.075	0.075	0.075
Power consumption	0.075	0.075	0.7	0.075	0.075
Network condition	0.075	0.075	0.075	0.7	0.075
Network performance	0.075	0.075	0.075	0.075	0.7

III. SIMULATION SETUP

In the simulation, we have considered a heterogeneous environment, having five candidate networks, and each network with five parameters and weight. The scenario consists of CDMA, two WLANS as WLAN1 and WLAN2, and two WIMAX networks as WIMAX1 and WIMAX2. We have considered five attributes associated in this heterogeneous environment. The attributes are: Cost (C), Security (S), Power consumption (pj), Network condition (D) and Network performance (Fj).MATLAB platform is used for creating simulating platform for our proposed vertical handover approach.

❖ **Performance parameters of vertical handover**

Vertical handover helps to decide whether the connection is to be continued with current network or to be switched over to another one. The decision of network selection may depend on various parameters as:

- **Power consumption:** It is required to handover to an attachment point which may consume lesser power and extends the battery life of mobile terminal.
- **Service cost:** A user may prefer to be connected through, the cheapest available access network in order to reduce service cost incurred. Service cost is usually measured in unit price per second for real-time services and unit price per KB for non-real-time services.
- **Security:** The security metric is used to select a network which offers higher security as compared to other available networks.

Table 2: Parameters Values for the Candidate networks

Parameters	Network values	Network values	Network values	Network values	Network values
	UMTS	WLAN1	WLAN2	Wimax1	Wimax2
Bandwidth (Mbps)	0-2	1-11	1-54	1-60	1-60
Received signal strength (dBm)	-70	-55	-60	-60	-65
Velocity (m/s)	40	40	40	45	40
Estimated Time (s)	12	8	8	10	10
Battery power (mAh)	3200	3200	3200	3200	3200
Cost	60	10	8	50	40
Security	70	60	50	80	80
Power dissipation (watts)	0.6915	0.7421	0.7404	0.6045	0.6045
Network performance (fj)	80	60	70	80	80
Mean no of request(lambda)	8	10	12	10	8
Mean no of call serviced(mu)	2	2	4	4	2

- **Network condition:** Network condition of any network is depends upon the available bandwidth and call blocking of the network.
- **Network performance:** Interference or unstable network connections discourage the handover decision; the network performance shows the interference.

IV RESULTS

The three algorithms are simulated with variation in weights and attributes values. The simulation is done with five attributes. The five attributes were cost per byte, security, power consumption, and network condition and performance.

A. **Call blocking of four networks (CDMA, WLAN1, WLAN2 and WIMAX):** As shown Fig.1 shows the Call blocking probability of five networks as CDMA, WLAN1, WLAN2 and WIMAX. The call drop of CDMA is higher as compare to other eligible networks due to traffic load and bandwidth.

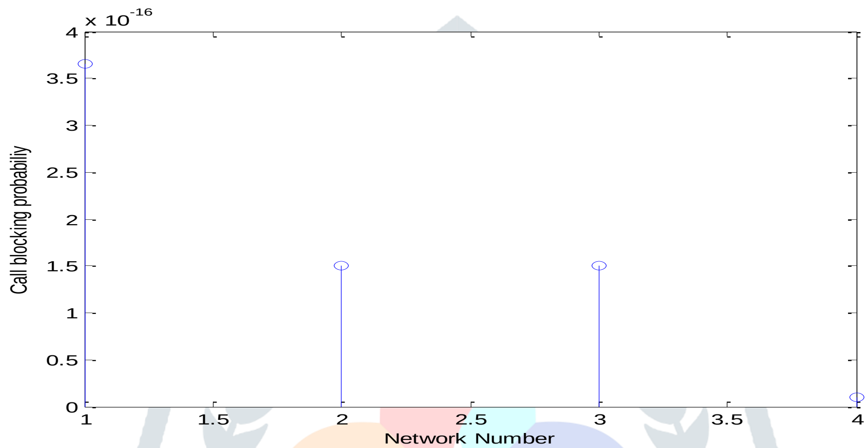


Fig1. Call blocking probability

B. Network selection: For network selection, three algorithms SAW, MEW and TOPSIS are used.

i. **With 4 networks:** In this section, performance of SAW, MEW and TOPSIS algorithms has been evaluated for four networks as CDMA and WLAN1, WLAN2 and WIMAX.

- **Cost parameter as highest priority:** In this, cost has given 70% more weightage as compared to the other parameters. From this table 3 to compare the values of 5 attributes the decision function select the best network for handover. TOPSIS selects the WLAN2 as best network while SAW and MEW selected WIMAX1 as network for handover. TOPSIS gives better result as compare to SAW and MEW.

Table 3: Network selection with cost as highest priority

Algorithms	Network selection index			
	CDMA	WLAN1	WLAN2	WIMAX1
SAW	0.32	0.28	0.28	0.43
MEW	3.65	3.74	3.73	4.09
TOPSIS	0.032	0.84	0.85	0.24

- **Security parameter as highest priority:** In this, security has given 70% more weightage as compared with other parameters. SAW, MEW and TOPSIS selected WIMAX1 as network for handover as shown in Table 4.

Table 4: Network selection for security as highest priority

Algorithms	Network selection index			
	CDMA	WLAN1	WLAN2	WIMAX1
SAW	0.76	0.70	0.63	0.93
MEW	4.35	4.49	4.46	4.87
TOPSIS	0.50	0.35	0.21	0.81

- **Power consumption parameter as highest priority:** In this, power consumption has given 70% more weightage as compared with other parameters. SAW, MEW and TOPSIS selected WIMAX1 as network for handover as shown in table 5.

Table 5: Network selection for power consumption as highest priority

Algorithms	Network selection index			
	CDMA	WLAN1	WLAN2	WIMAX1
SAW	0.76	0.74	0.75	0.93
MEW	4.41	4.54	4.74	4.87
TOPSIS	0.22	0.31	0.33	0.72

- **Network condition parameter as highest priority:** In this, network condition has given 70% more weightage as compared with other parameters. Shows that three algorithms are used to compare the network condition of available network. SAW, MEW and TOPSIS selected WIMAX1 as network for handover as shown in table 6.

Table 6: Network selection for network conditions as highest priority

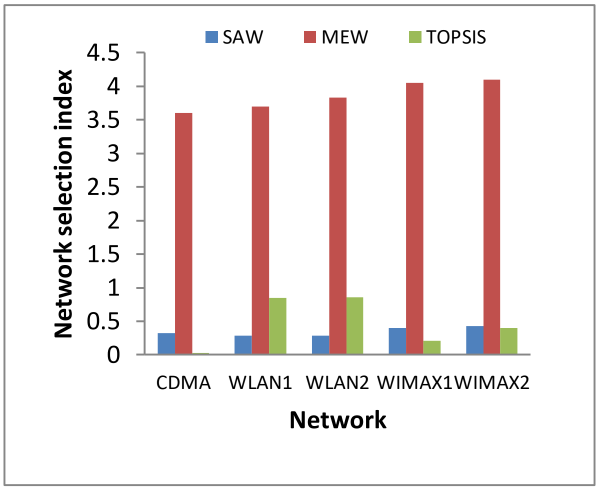
Algorithms	Network selection index			
	CDMA	WLAN1	WLAN2	WIMAX1
SAW	0.21	0.25	0.28	0.93
MEW	3.77	3.88	3.95	4.87
TOPSIS	0.022	0.068	0.089	0.94

- **Network performance parameter as highest priority:** In this, network performance has given 70% more weightage as compared with other parameters. Shows that three algorithms are used to compare the network condition of available network. SAW, MEW and TOPSIS selected WIMAX1 as network for handover as shown in table 7.

Table 7: Network selection network performance as highest priority

Algorithms	Network selection index			
	CDMA	WLAN1	WLAN2	WIMAX
SAW	0.84	0.70	0.71	0.93
MEW	4.39	4.41	4.56	4.87
TOPSIS	0.52	0.27	0.28	0.75

ii. **With 5 networks:** To compare the value 5 of attributes the decision function select the best network. Shows that SAW, MEW and TOPSIS compare the values provided by each network. The results are shown in Fig.2 the preferred network is different for all the algorithms. In this simulation, cost parameter has been assigned 70% importance and other attributes have been assigned equal weights. As shown in Fig. 2, SAW and MEW selected WIMAX2 as best network while TOPSIS, selected WLAN2 as network for handover. In Fig.3 and 4, security and power consumption have assigned 70% importance and other attributes had assigned equal weights such that SAW, MEW and TOPSIS selected WIMAX2. In Fig.5, network condition had assigned 70% importance and other attributes had assigned equal weights such that SAW, MEW and TOPSIS selected WLAN2. In Fig.6, network performance had assigned 70% importance and other attributes had assigned equal weights such that SAW and TOPSIS selected WIMAX2 as best network while MEW, selected WLAN2 as network for handover.



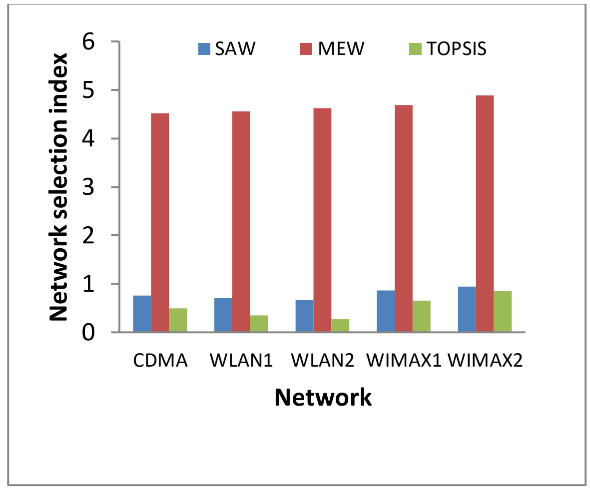
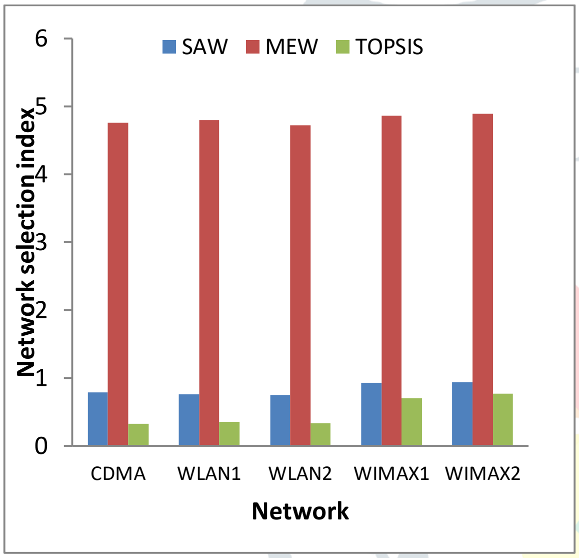


Fig.2 Cost as highest priority

Fig. 3 Security as highest priority



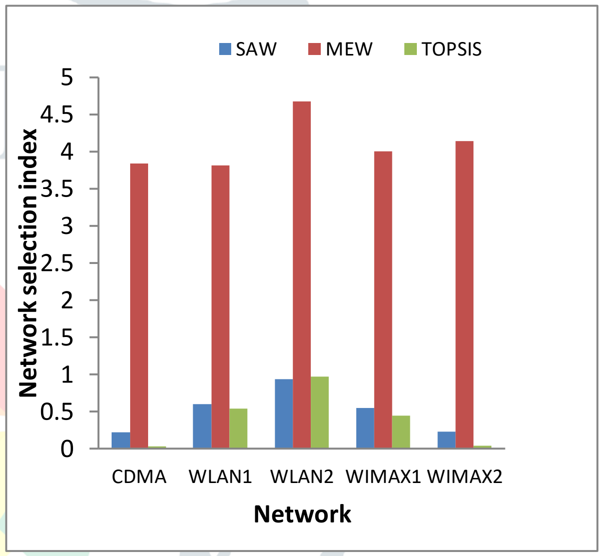


Fig. 4 Power consumption as highest priority

Fig. 5 Network condition as highest priority

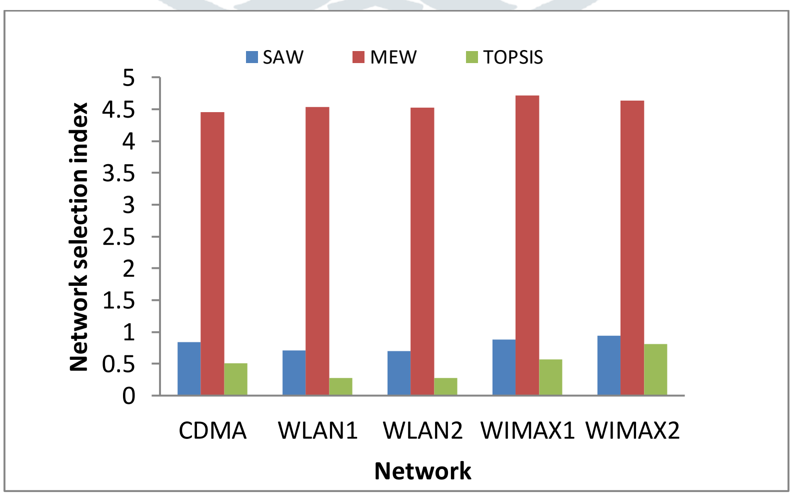


Fig. 5 Network performance as highest priority

V. CONCLUSION AND FUTURE WORK

In this work, we described the vertical handover algorithms in heterogeneous networks. Decision function algorithm is used with handover algorithm to reduce the call blocking probability and power consumption of the network. For network selection, we have compared the three algorithms as SAW, MEW and TOPSIS by variation in weights and parameters values to choose the optimal network. Optimal network is based upon the cost, security, power consumption, network conditions and network performance. On the bases of simulation results, it was concluded that TOPSIS gives better result as compared to SAW and MEW algorithms

The work can be extended by increasing the number of networks and different MADM technique such as ELECTRE and VIKOR.

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