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Modality of Multi-Attribute Decision Making for Network Selection in Heterogeneous Wireless Networks

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Abstract

Wireless communication systems are advancing rapidly to meet expanding client requests, advancement toward just a single particular innovation can't satisfy the client requests, the majority of the networks are deployed with overlapping coverage, forming the hybrid network, known as heterogeneous wireless networks (HWNs). Network selection in HWN plays a vital role in vertical handover decision (VHD) making, facilitating users to access desired services via a range of available radio access networks. This paper gives an exhaustive study of the VHD algorithms designed where the user is satisfied with the requirements and experiments for various Multi-attribute decision making (MADM) schemes for target network selection. Results show the ranking of various networks.

Introduction:

Over the last few years, telecommunication and internet technologies are evolving rapidly to meet user demands. Various advancements are developing all the while towards furnishing clients with top-notch services and seamless mobility, basically, several standards of communication are evolving in their respective directions, such as Wide Area Networks are evolved to GSM, UMTS etc, and on the other side Standards for Local area networks IEEE 802.11 evolve to IEEE 802.11a, IEEE 802.11b, etc., it changed the communication paradigm. Both types of networks i.e Wide and Local area networks are trying to fulfil user demands and to provide quality services to end-user, but evolution towards only one specific technology may not fulfil the user demands, most of the networks are deployed with overlapping coverage, forming the hybrid network, usually known as heterogeneous wireless networks (HWNs). What if users can operate between different network technologies? Heterogeneous wireless networking can be the answer. Current terminals such as cell phones are usually installed with multiple wireless interfaces to access different wireless access technologies. In current market basically two types of devices are available multi-mode and multi-homed, with the major issue of Mobility and seamlessness, in HWN the end-user of a network can be linked to any other network if its requirements are not satisfied without breaking the ongoing call, in June 2003 ITU recommended the vision "optimally connected anywhere, anytime" (ITU, 2014) states user should get optimum quality of service anywhere anytime. In HWN, the concept of being always connected becomes "always best connected" (ABC). This refers to being connected to the "best network in the best way".

Transferring the ongoing call seamlessly from one network to another the efficient handover mechanism has to be used. Handover is the process of transferring connections seamlessly. Basically, the handovers are differentiated into two types: the first is Horizontal handover (HO) and the other is Vertical Handover Horizontal handover specifies handover between similar types of access technology and the example can be the Global System for Mobile communications (GSM) network; The end device is linked with the Base Station (BS) if it travels from one BS to another BS the connections has to be transferred from previous to next base station here base stations have same access technologies this is known as Horizontal Handover.

However, Vertical handover (VHO) (Taha *et al.*, 2012) is the case of transferring an ongoing call from one network to another network, as networks are different accessing technologies also differs. Vertical handover (VHO) gives handover between different types of networks including different access technologies. The vertical handover is categorized into three parts handover inception, network selection, and handover execution (Khan *et al.*, 2017). The first two phases are highly important, it is shown in the research these two phases include 90% of the handover delay than the last phase. The study describes different

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techniques and challenges involved in VHO phases.

The rest of the paper is structured as Section 2 gives a brief literature review of the recent scheme used for similar purposes. Section 3 introduces multi-attribute decision making algorithms. Section 4 describes the use of MADM methods for decision making in VHD results are drawn and discussed for each scheme and section 5 gives the conclusion.

State of art literature

Numbers of studies have been published earlier on VHD algorithms. Kassar *et al.* (2008) studied VHO strategies and classified them into Decision function-based, user-centric, multi-attribute decision making, neural network-based, fuzzy logic, and context-aware VHO according to the authors' multi-attribute decision making is required. Dimitris *et al.* (2010) decomposed the network selection problem in four fundamental steps and comprehensively over viewed the network selection techniques according to the author's issue of stability should also be addressed. Trestian *et al.* (2012) present comprehensive classifications of the game theory approach, game theory applications in the selection of network, the survey gives state-of-art game theory solutions on the selection of network. However, computational complexity could not be defined (Bakmaz, 2013) uses entropy TOPSIS approach for network selection to find equilibrium between user preferences, service requirement and network condition. Kunarak & Suleesathira (2013) considered four parameters i.e., network condition, QoS level, security level and cost. To balance network conditions and user preferences applied RSS (Received Signal strength) and dwell time, where dwell-time value depends on user speed and moving pattern. The study has been carried out on UMTS, WLAN and WiMax but neglects vital VHO parameters such as handoff delay and throughput. Wang *et al.* (2013) give a systematic tutorial on mathematical studies used for network selection, it provides several important case studies on utility theory (cost function), Game theory and MARKOV chain model, MADM (Multi-attribute decision making), Fuzzy logic, a combination of multiple of these theories is explained in these studies and can be further investigated to get better VHO results. Tahir *et al.* (2014) Studied cost function based methods covering weight and cost factors. Weights are measured based on user preferences and mobile terminal power and the cost of performing handoff is also considered authors claim that the method increases the level of user satisfaction.

Multi-Attribute Decision Making Methods

Decision making in the availability of multiple conflicting criteria is referred to as Multiple criterion decision making (MCDM). In general, the problems are differentiated into two categories i.e., multiple objective decision making (MODM) and multiple attribute decision making (MADM) (Rao et al., 2017). multiple objective decision making (MODM) methods have decision variable values that are determined in a continuous or number domain, with a massive variety of selections, the best of which are thought to satisfy the choice maker's constraints and preference priorities. MADM methods, on the other hand, are usually separate, with a limited variety of preset alternatives. MADM is an approach used to resolve issues including choices within a finite variety of choices. The choice framework of MADM methods includes four key segments, to be specific: attributes, the weight of each attribute, alternatives, and the performance of alternatives.

Table-1 shows the decision matrix of MADM techniques wherein Ai are the set of alternatives, Tj are the set of attributes or features, Wj is weight of attribute Tj and Cij is the measure of performance of alternative Ai for corresponding attribute Tj. The role of the decision-maker is, to select the best alternative from the available set of alternatives.

Table 1 : Decision Matrix in Madm Techniques

Alternatives	Attributes (weights)					
	T1 (w1)	T2 (w2)	T3 (w3)	-	-	TM (wm)
A1	C11	C12	C13	-	-	C14
A2	C21	C22	C23	-	-	C24
A3	C31	C32	C33	-	-	C34
-	-	-	-	-	-	-
-	-	-	-	-	-	-
AN	Cn1	Cn2	Cn3	-	-	Cnm

The measures can be quantitative and qualitative, decision-maker can use any of the suggested eight scales to change the qualitative values into quantitative shown in Table-2.

Table-2: 11-point fuzzy scale

Linguistic term	Assigned crisp score	Linguistic term	Assigned crisp score
Exceptionally low	0.045	Extremely low	0.135
Very low	0.255	Low	0.335
Below medium	0.410	Medium	0.5
Above medium	0.590	High	0.665
Very high	0.745	Extremely high	0.865
Exceptionally high	0.955		

Many MADM techniques have been reported in the literature and few techniques have proven to be effective to solve decision-making problems. Some of the most widely used techniques such as SAW, WPM, AHP, TOPSIS and PROMETHEE are described in detail in this research work. The algorithmic details of these algorithms are as follows,

A. Simple Additive Weighing (SAW): it is considered to be one of the simplest methods based on a weighted sum. Alternatives are calculated with the attributes and the score of performance (composite) of the alternative is evaluated as per equation 1,

$$P_i=\text{å}_{j=1}^{M} W_j(c_{ij})_{normalized} \quad (1)$$

Where P_i is the composite score of alternative, w_j is the weight of attribute and $(c_{ij})_{normalized}$ is the normalized value of c_{ij}. The alternative having the highest value of P_i is selected to be the best alternative. An attribute can be considered as a beneficiary attribute and a non-beneficiary attribute. Beneficiary means higher values are desired and non-beneficiary means lower values are desired. For the beneficiary attribute, the $(c_{ij})_{normalized}$ is computed by using equation 2 and equation 3 for the non-beneficiary attribute.

$$(c_{ij})_{normalized} = \frac{(c_{ij})P}{(c_{ij})Q} \quad (2)$$

$$(c_{ij})_{normalized} = \frac{(c_{ij})R}{(c_{ij})P} \quad (3)$$

Where $(c_{ij})P$ is the measure of Pth alternative, $(c_{ij})Q$ is the alternative having highest measure and $(c_{ij})R$ is the alternative having the lowest measure.

B. Weighted Product Method (WPM): this method is similar to the SAW, the only difference is; that instead of addition, the model uses multiplication. The composite performance score of alternatives is calculated as follows;

$$Pi = \pi_{j=1}^{M} [(cij)\ wj\ i\ normalized]^{W_j} \quad (4)$$

The alternative having the highest value of P_i is considered to be the best alternative.

Analytical Hierarchy Processing (AHP): it is considered to be the most widely used analytical technique for solving complicated decision-making problems. developed this technique, which decomposes the problem into a system of hierarchies of criteria, objectives and alternatives. Objective and subjective problems can be handled by the AHP method very effectively. The main algorithm with the geometric mean method is as follows,

Step 1: formulate the decision matrix (Table-1)

Step 2: Compute the normalized matrix of measures by identifying beneficiary and non-beneficiary attributes (equations 2& 3).

Step 3: Evaluate the relative importance of several attributes mapping the objective

Prepare the pair-wise comparison matrix using Saaty's scale of relative importance. If an attribute is checked with itself representing, the value will be 1. The number 3 corresponds to 'moderately important', 5 correspond to 'strong important', 7 correspond to 'very strong important' and 9 corresponds to 'absolute importance'. 2, 4, 6 and 8 are used in case of compromise.

Let T_{MXM} be the pair-wise matrix, the $t_{ij=1}$ when $i=j$ and $t_{ij=}{}^{1/}t_{ij}$ Calculate the relative normalized weight (w_j) of every attribute by using geometric mean

$$G_j=[\tilde{O}^{M_{j=1}}\ t_{ij}]^{1/}{}_M \quad (5)$$

$$w_j=G_j/\tilde{O}^{M_{j=1}}\ G_j \quad (6)$$

Calculate the consistency ratio:

$$CR={}^{CI}/_{RI} \quad (7)$$

Where CI is the consistency index

$$CI=\frac{l_{\ max-1}}{M-1} \quad (8)$$

Table-3: Random Index Values

Attribute	3	4	5	6	7	8	9	10
RI	0.52	0.89	1.11	1.25	1.35	1.4	1.45	1.49

If the consistency ratio is below 0.1, then it is acceptable and weights obtained using equation (6) are appropriate.

Step 4: Evaluate the overall score of alternatives using equation (1) and the alternative having the highest performance score will be the best alternative.

D. Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS): it is the method that pic an alternative having minimum Euclidean distance from an ideal solution and outermost from a negative solution. In general, it finds a solution which is close to the hypothetically best solution and far away from the hypothetically worst solution.

Step 1: formulate the decision matrix (Table-1)

Step 2: Compute the normalized decision matrix R_{ij} as follows-

$$R_{ij}={}^{C}{}_{ij}/[\tilde{O}^{M_{j=1}} C^2{}_{ij}]^{0.5} \quad (9)$$

Step 3: Evaluate the relative importance of several attributes with respect to the objective Evaluate relative importance of several attributes with respect to the objective (step 3 of AHP)

Step 4: Evaluate the normalized weighted matrix. This is calculated by multiplying the normalized decision matrix of step 2 with the weight matrix acquired in step 3.

$$L_{ij}=w_{ij}R_{ij} \quad (10)$$

Step 5: Obtain the negative solution and best solution

$$L^+=\{L_1^+, L_2^+,........,L_M^+\} \quad (11)$$

$$V^-=\{L_1^-, L_2^-,........,L_M^-\} \quad (12)$$

L^+ indicate the best solution and this value is higher in the case of beneficiary attribute and lower for a non-beneficiary attribute. L^- indicate negative solution and this value is lower for the beneficiary attribute and higher for a non-beneficiary attribute.

Step 6: Calculate the separation of every alternative from the ideal/ best solution by using Euclidean distance

$$S_i^+ \quad \because \{i=1,2,...N\} \quad (13)$$

$$S_i^- \quad \because \{i=1,2,...N\} \quad (14)$$

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Step 7: Calculate the relative closeness of every alternative to ideal solution

$$Q_i = S_i^- / (S_i^+ + S_i^-) \qquad (15)$$

Alternative having highest Q_i value is considered to be the best alternative available.

E. Preference Ranking Organisation Method for Enrichment Evaluations (PROMETHEE): it is outranking method which begins with the pair-wise comparison of alternatives with respect to criteria, which will determine the binary relation indicating the strength of one alternative over another (Bchini *et al.*, 2010).
Step 1: formulate the decision matrix (table 1)
Step 2: Evaluate the relative importance of several attributes with respect to the objective (step 3 of AHP)
Step 3: Compare all alternatives with respect to every criterion. A difference obtained between the evaluations of two alternatives a_1 and a_2 is translated using the preference function P_i into preference degree which ranges from 0 to 1.

$$P_{i,a_1a_2} = F_i[t_i(a_1) - t_i(a_2)] \qquad (16)$$

Where F_i is non-decreasing function and t_i is the criteria. Let P_i be the preference function and w_i is the weight of the criteria t_i then the multiple criteria preference index is calculated as follows,

$$\Pi_{a_1a_2} = \sum_{j=1}^{M} W_i P_{i,a_1,a_2} \qquad (17)$$

It indicates the intensity of preference of one alternative over another and it is generally in range 0 to 1
Step 4: for PROMETHEE, incoming flow, net flow as well as leaving flow is calculated for every alternative and are defined as follows,

$$\Phi^-(a) = \sum_{x \in A} \Pi_{xa} \qquad (18)$$

$$\Phi^-(a) = \sum_{x \in A} \Pi_{ax} \qquad (19)$$

$$\Phi(a) = \Phi^+(a) - \Phi^-(a) \qquad (20)$$

Where $\Phi^-(a)$ is incoming flow, $\Phi^+(a)$ is leaving flow and $\Phi(a)$ is net flow. $\Phi(a)$ Indicates the outranking relationship between alternatives.

Vertical handover decision making using MADM

Making any decision is a very critical and important phase in the vertical handover process, for experimentation purposes, Wi-Fi, WiMAX, Zigbee, GPRS, EDGE, LTE and HSUPA+ networks are created in Matlab and Bandwidth, RSSI (Received Signal Strength Indicator), Cost/bit, SNR (Signal to Noise ratio), Congestion, Datarate, Security, Energy consumption, Packet Drop Ratio, Latency and Throughput parameters are considered as evaluation parameter for the network selection process. The Networks and formal parameter values for respective networks are specified in the tables.

As the network selection decision is to take place in the real-time context of the network for this purpose a snapshot of a system is taken at time instance t1 value of each parameter at time instance t1 is shown in Table-5.

Table-4: Networks and parameters

	1	2	3	4	5	6	7
Wifi 802.11	2.4	20 to 25	0 to-100	1 to 54	10 to 100	0 to 50	0.6
WiMax 802.16 m (Adv.)	2 to 6	10 to 20	0 to -100	1 to 100	0 to 50*	0 to 50	0.5
Zigbee	868 to 2.44	0.3 to 2	0 to-100	25	10 to 1000	0 to 50	0.5
GPRS	850 to 1.9	200	0 to -100	35 to 171	2 to 35*	0 to 50	0.3

1-Frequency (Ghz); 2-Bandwidth (MHz); 3-RSSI (db); 4-Data rate (mbps); 5-Range (m-km*); 6-SNR (db); 7-Cost/bit

As the network selection decision is to take place in real-time context of the network for this purpose a snap shot of a system is taken at time instance t1 value of each parameter at time instance t1 is shown in Table-5.

Table-5: A dynamic networks created at time instance t1

	1	2	3	4	5	6	7
Bandwidth	24.071	22.497	23.89	20.957	20.3466	24.0618	24.041
RSSI	-24.35	-23.637	-20.3	-21.0618	-21.847	-22.213	-20.1449
Data Rate	50.251	51.298	48.36	23	49.9856	53.1903	53.8633
SNR	39.83	37.686	23.47	40.704	41.8067	39.9935	35.493
Congestion	0.335	0.5	0.335	0.665	0.335	0.335	0.335
Cost/bit	0.3	0.3	0.4	0.5	0.3	0.4	0.6
Security	0.335	0.335	0.5	0.665	0.665	0.664	0.665
Energy consumption	120	150	160	160	170	170	100
Packet Drop Ratio	58.604	56.782	56.71	57.8152	57.2678	57.1414	56.3031
Latency	47.329	47.585	47.22	46.0542	47.6653	45.0648	47.6555
Throughput	91.166	91.395	91.43	74.3821	87.1898	91.1847	92.0952

1-Wifi 802.11; 2-WiMax 802.16; 3-Zigbee; 4-GPRS; 5-EDGE; 6-LTE; 7-HSUPA+

Decision making using SAW and WPM: for SAW and WPM methods, weights are estimated using a simple point method wherein let u_j be the user-defined weight of attribute and weight of individual attribute is obtained as follows,

$$W_i = \frac{u_j}{\sum_j^M u_j} \qquad (21)$$

The weight obtained for attribute are as follows: $w_{DT}=0.3462; w_{TD}=0.3846; w_{TT}=0.1154; w_{NI}=0.1538$

For the user preference weight of: $u_{DT}=45; u_{TD}=50; u_{TT}=15; w_{NI}=20$

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Table-6: Alternatives scores and rank for network selection problem using saw and wpm

	SAW		WPM	
Alternatives	Score	Rank	Score	Rank
Wifi 802.11	0.8514	3	0.830	4
WiMax 802.16 m (Advance)	0.8129	6	0.790	6
Zigbee	0.8509	4	0.838	3
GPRS	0.7301	7	0.703	7
EDGE	0.8601	2	0.841	2
LTE	0.8485	5	0.829	5
HSUPA+	0.8928	1	0.867	1

Decision making using AHP: the λ_{max} obtained for the pair-wise comparison matrix is 12.0614, the consistency index obtained is 0.1061 and the Consistency Ratio (CR) acquired is 0.0703 which is lower than 0.1 and hence can be accepted. The weights obtained for individual attributes are as follows: w_{BW}=0.00971; w_{RSSI}=0.0580; w_{DR}=0.1084; w_{SNR}=0.0825; w_{Cong}=0.0371; $w_{Cost/bit}$=0.1542; w_{Sec}=0.1288; w_{EC}=0.1703; w_{PDR}=0.0708; $w_{Latency}$=0.0347 and w_{TP}=0.0580 These weights are used in AHP, TOPSIS & PROMETHEE.

Table-7: Pair-wise comparison matrix of AHP

	1	2	3	4	5	6	7	8	9	10	11
1	1	2	1	2	3	2	⅓	½	⅓	3	2
2	½	1	1	½	1	⅓	½	⅓	1	2	1
3	1	1	1	3	3	½	1	½	2	3	2
4	½	2	⅓	1	3	1	½	⅓	2	2	2
5	⅓	1	⅓	⅓	1	⅓	?	⅓	½	1	½
6	½	3	2	1	3	1	2	3	2	4	3
7	3	2	1	2	5	½	1	⅓	2	3	3
8	2	3	2	3	3	⅓	3	1	3	4	3
9	3	1	½	½	2	½	½	⅓	1	2	1
10	⅓	½	⅓	½	1	¼	⅓	¼	½	1	⅓
11	½	1	½	½	2	⅓	⅓	⅓	1	3	1

1-BW; 2-RSSI; 3-DR; 4-SNR; 5-Cong.; 6-Cost/bit; 7-Security; 8-EC; 9-PDR; 10-Latency; 11-TP

The second step is to acquire the scores of composite performance for the alternatives where the relative normalized weight (*wj*) of each attribute (acquired by equation 6) is multiplied by its corresponding normalized weight value for each alternative acquired by equations 2 and 3) and after that taking sum of those attributes. The step can be seen in SAW Method. Table 11 gives the overall score of seven alternatives (route) using AHP method.

Table-8: Alternatives scores and rank for network selection problem using AHP

Alterna-tives	Wifi 802.11	WiMax 802.16 m	Zigbee	GPRS	EDG	ELTE	HSUPA+
Score	0.9870	1.0291	0.8508	0.5894	0.8692	0.5703	1.1631
Rank	3	2	5	6	4	7	1

Decision making using TOPSIS

Table-9: Normalized decision matrix

	Wifi 802.11	WiMax 802.16 m	Zigbee	GPRS	EDG	ELTE	HSUPA+
BW	0.6445	0.5275	0.0467	0.0054	0.0054	0.3637	0.4146
RSSI	-0.4507	-0.4760	-0.4641	-0.1270	-0.3762	-0.0601	-0.4400
DR	0.0443	0.2814	0.1434	0.0002	0.0019	0.0834	0.9441
SNR	0.3573	0.0802	0.4281	0.4652	0.2767	0.5422	0.3092
Cong.	0.2457	0.3667	0.4877	0.4877	0.3667	0.3667	0.2457
Cost/bit	0.4423	0.3686	0.3686	0.2212	0.2212	0.2949	0.5898
Sec.	0.2339	0.2339	0.3491	0.4643	0.4643	0.3491	0.4643
EC	0.3039	0.3799	0.4052	0.4052	0.4306	0.4306	0.2533
PDR	0.1993	0.6553	0.2807	0.2269	0.4625	0.4188	0.1068
Latency	0.3223	0.4669	0.3863	0.5600	0.4181	0.1319	0.1518
TP	0.4972	0.4982	0.0889	0.0179	0.3919	0.3901	0.4366

The weighted normalized decision matrix (Table-10) can be obtained for each element r_{ij} and its corresponding weight w_j is multiplied (Singh & Singh, 2014). Here weights are the same as calculated by the AHP method.

Table-10 :Weighted normalized decision matrix

	Wifi 802.11	WiMax 802.16 m	Zigbee	GPRS	EDG	ELTE	HSUPA+
BW	0.0626	0.0512	0.0045	0.0005	0.0005	0.0353	0.0402
RSSI	-0.0261	-0.0276	-0.0269	-0.0074	-0.0218	-0.0035	-0.0255
DR	0.0048	0.0305	0.0155	0.0000	0.0002	0.0090	0.1024
SNR	0.0295	0.0066	0.0353	0.0384	0.0228	0.0447	0.0255
Cong.	0.0091	0.0136	0.0181	0.0181	0.0136	0.0136	0.0091
Cost/bit	0.0682	0.0568	0.0568	0.0341	0.0341	0.0455	0.0909
Sec.	0.0301	0.0301	0.0450	0.0598	0.0598	0.0450	0.0598
EC	0.0518	0.0647	0.0690	0.0690	0.0733	0.0733	0.0431
PDR	0.0141	0.0464	0.0199	0.0161	0.0328	0.0297	0.0076
Latency	0.0112	0.0162	0.0134	0.0194	0.0145	0.0046	0.0053
TP	0.0288	0.0289	0.0052	0.0010	0.0227	0.0226	0.0253

This step can acquire the best and Worst solution. The best and the worst solution can be given as follows:

Table-11:The ideal (best) and negative ideal (worst) solutions

	V+	V -		V+	V -
BW	0.0626	0.0005	RSSI	-0.003	-0.027
DR	0.1024	0	SNR	0.0066	0.0447
Cong.	0.0091	0.0181	C0st/bit	0.0341	0.0909
Security	0.0598	0.0301	EC	0.0431	0.0733
PDR	0.0076	0.044	Latency	0.0046	0.0194
TP	0.0289	0.001			

Table-12 : Distance of each alternative from the ideal and the negative ideal solution

	Wifi 802.11	WiMax 802.16m	Zigbee	GPRS	EDGE	LTE	HSUPA+
S+	0.113	0.097	0.1207	0.131	0.1288	0.1128	0.0677
S-	0.084	0.0836	0.05	0.0742	0.0733	0.0717	0.1288

Here the relative closeness coefficient for each alternative Ai ($i = 1, 2, ...,$ m along its ideal soln can be expressed as

The list of best alternatives is maintained and the ranked keeping Pi value in descending order. Table 14 gives the overall score of seven alternatives (route) using TOPSIS method.

Table-13: The relative closeness coefficient of each alternative from the ideal solution

	Wifi 802.11	WiMax 802.16m	Zigbee	GPRS	EDGE	LTE	HSUPA+
P	0.4265	0.4631	0.2932	0.3614	0.3617	0.3889	0.555

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The list of best alternatives is maintained and the ranked keeping Pi value in descending order. Table-14 gives the overall score of seven alternatives (route) using TOPSIS method.

Table-14: Alternatives scores and rank for network selection problem using TOPSIS

	Wifi 802.11	WiMax 802.16m	Zigbee	GPRS	EDGE	LTE	HSUPA+
Score	0.4265	0.4631	0.2932	0.3614	0.3617	0.3889	0.6555
Rank	3	2	7	6	5	4	1

Decision making using PROMETHEE

Table-15: Incoming flow and leaving flow for every alternative

	Wifi 802.11	WiMax 802.16m	Zigbee	GPRS	EDGE	LTE	HSUPA+
? +	3.1373	2.9691	2.1321	2.2827	2.4275	2.33789	4.0964
? -	2.6967	2.6736	3.3775	3.0009	2.8189	3.2477	1.6088

Table-16: Alternatives scores and rank for network selection problem using PROMETHEE

	Wifi 802.11	WiMax 802.16m	Zigbee	GPRS	EDGE	LTE	HSUPA+
Score	0.4406	0.29556	-1.2454	-0.7181	-0.3914	-0.888	2.4876
Rank	2	3	7	5	4	6	1

Conclusion:

Target network selection is a vital phase in the vertical handover process, in this work several networks such as Wifi, wimax, zigbee, GPRS, EDGE, LTE and HSUPA+ are created, and Multi-attribute decision-making schemes are studied and implemented considering various parameters. Results show the ranking of various networks, the higher is the score higher will be the ranking. As wireless scenario changes rapidly a quick and less complex algorithm is needed for decision making, results for different decision-making techniques also differ in ranking the networks, and time and computational complexity VHO algorithms is also an area of research.

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