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A MCDM Based Technique in Wireless Networks

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Abstract: A MCDM based technique for smooth handover in wireless networks is presented in the paper. In the future, people have even more flexibility when true wireless internet and real-time multimedia are provided seamlessly over heterogeneous wireless network. Also, various applications demand different quality of service (QoS) parameters. The goal is to select the best network that can support the required service(s) and avoid excessive switching among different networks in order to minimize service interruptions and power consumption. The vertical handover scheme is proposed for conversational, streaming and interactive applications. In this multi- hierarchy decision making process the best suited Analytical Hierarchy Process(AHP) is applied for the decision making process in vertical handover. The proposed scheme of vertical handoff provides higher QoS than the earlier than the earlier algorithms. All the unnecessary vertical handover we controlled by proposed scheme. The results show that the proposed scheme provides low traffic applications and overall system throughput with a control of unnecessary handoffs for all kinds of services. Also, parameterized utility functions are used to model the different Quality of Service (QoS) attributes (data rate, delay, and jitter) and user preferences (cost) for three different types of applications. Finally, scores are calculated exclusively for each network by two MADM (Multiple Attribute Decision Making) methods, TOPSIS (The Technique for Order of Preference by Similarity to Ideal Solution) and AHP (Analytic hierarchy process).

Keywords: QoS, AHP, TOPSIS, MCDM, MADM

I. Introduction

Wireless communication has increased rapidly in recent years. Wireless technology has helped to simplify networking by enabling multiple computer uses to simultaneously share resources in a home or business with additional or intrusive wiring. Wireless networks allows you to access the internet while on the move; you can remain online while moving one area to another, without a disconnection or loss in coverage. So, user wants to connect to another network that provides better services. The process of switching from one network to another network is called handover. When this switching happens in same type of networks, it is called horizontal handover. When a mobile device roams in these heterogeneous environments, it undergoes vertical and horizontal handovers continuously. In order to provide Always Best Connected (ABC) property[1], an optimal Vertical Handover Decision (VHD) is required. This paper, Analytic Hierarchy Process (AHP)based network selection technique and The Technique for Order of Preference by Similarity to Ideal Solution(TOPSIS) is presented in heterogeneous wireless networks for conversational, interactive, and streaming applications.

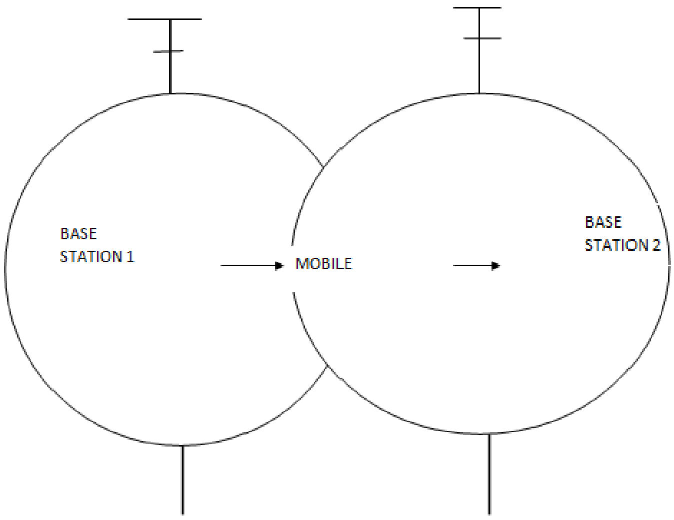

Fig 1. Handover Scenario

There may be different technologies available to the user for wireless connectivity and choosing the best alternative is the main objective of this paper. This selection procedure requires different parameters like data rate, delay, jitter, and the cost of network. The rest of the paper is organized as follows. Section 2 presents the related works.[1]The AHP technique for network selection is discussed in Sect. 3. Results of the approach are shown in Sect. 4. Finally, the conclusion is presented in Sect. 5.

II. RELATED WORKS

This section gives an overview of various multiple attribute decision-making (MADM) selection techniques used for network selection in heterogeneous networks. Many MADM techniques for decision making have been presented in .Various researchers have conducted various studies for applying MADM techniques for network selection. Raman Kumar Goyal and Sakshi Kaushal [1] have proposed analytic hierarchy process(AHP) method has been used for network selection in heterogeneous environments for moving vehicles. The method has been applied for various types of applications like conversational, streaming, interactive, and background applications. From the results, it has been found that WLAN's performance degrades significantly when the vehicles are moving at higher velocities while Universal Mobile Telecommunication Systems (UMTS) performs best for fast moving vehicles. Mohamed Lahby et al. [2] have proposed an enhanced TOPSIS method by calculating the relative closeness to the ideal solution by considering both the relative importance values of anti-ideal solution and ideal solution respectively. Madan Lal Taterwal et al. [3] in his paper the author state the advantages of wireless communication systems such as flexibility, mobility and scalability. Lots of researches have been done to reduce delays caused by handoffs. Author states that Handoff is more important in WLAN as compared to communication systems because of limited range of APs. Xiaohuan Yan et al (2012), [4] used both bandwidth and received signal strength (RSS) information in the decision process. Depending on whether RSS or bandwidth is the main criterion considered, an algorithm is classified either as RSS based or bandwidth based. This scheme is designed for both circular network and the satellite-based networks; it requires modifications in the base station. Joe et al [5] considered the case of heterogeneous wireless networks (CDMA, Wi Bro, WLAN), devised an algorithm predicting power consumption and expressed lifetime of the mobile terminal according to the current battery level and proposed a multiple criteria decision method of final network selection consisting of Analytic hierarchy process (AHP). Alkhawlani et al [6] proposed a VHO decision system, which integrates fuzzy logic and TOPSIS method. Network and user related criteria are each processed by parallel fuzzy logic control (FLC) subsystems, and consequently. Pollini et. Al. [7] has suggested various approaches to take Handover (HO) decision as RSS with threshold, RSS with threshold and hysteresis and future prediction of RSS. Inclusion of Threshold and Hysteresis Margin reduces Unnecessary HOs, but still a wrong decision HO may drop the call due to increase in HO delay. Especially hysteresis margin avoids ping-ponging effect. Prediction of the future RSS helps in reducing unnecessary HO as compared to threshold and hysteresis methods. But still RSS alone is not sufficient to take decision.

In this paper, we have demonstrated the affect of mobility in four three classes. Detailed network selection scheme is presented in Sect. 3.

III. Proposed AHP & TOPSIS Based Network Selection Method

AHP method was proposed by Saaty we have used AHP & TOPSIS for best network selection. The network selection is based on four attributes namely data rate, cost, delay and jitter. Three networks are considered for network selection, i.e., network 1, network 2 and network 3. Three types of applications are considered namely, conversational, interactive and streaming The AHP process for the network selection process is as follows.

Step 1: Determine the objective and evaluation parameters. Select the attributes and alternatives. In our problem following are the attribute values correspond to different types of networks as shown in Table 1.

Table.1: The Networks and their parameters

NETWORK	DATA RATE	COST	DELAY	JITTER
NETWORK 1	4	5	35	10
NETWORK 2	25	3	110	3
NETWORK 3	50	1	120	4

Obtain the normalized matrix by dividing with the value of beneficial attribute (data rate,) and dividing the non-beneficial attribute (cost, delay, and jitter) with the value of attribute.

Step 2: Construct a paired comparison matrix using a scale of relative importance. An attribute compared with itself is given a value of 1 and the values 3, 5,7 and 9 corresponds to moderate importance, strong importance, very strong importance and absolute importance. While, 2,4,6 and 8 compromise between these values. Relative importance matrices for different type of applications are shown in Tables.

Table 2: Relative importance of different attributes in conversational applications

Conversational	Data rate	Cost	Delay	Jitter
Data rate	1	½	½	1/2
Cost	2	1	1	2
Delay	2	1	1	2
Jitter	2	½	½	1

Table 3: Relative importance of different attributes in interactive applications

Interactive	Data rate	Cost	Delay	Jitter
Data rate	1	2	1/3	1/3
Cost	½	1	1/5	1/5
Delay	3	5	1	1
Jitter	3	5	1	1

Table 4: Relative importance of different attributes in streaming applications

Streaming	Data rate	Cost	Delay	Jitter
Data rate	1	2	3	3
Cost	½	1	1/3	1/4
Delay	1/3	3	1	1
Jitter	1/3	4	1	1

Step 3: Find the relative normalized weight for each attribute by calculating the geometric mean of the each row in the comparison matrix and normalize the geometric means of rows.

Step 4: Calculate the maximum Eigen value.

Step 5: Calculate the consistency index *CI*.

Step 6: Obtain the Random Index *(RI)* for the number of attributes used in decision making.
Step 7: Calculate the consistency ratio *CR= CI/RI*. A *CR* of 0.1 or less is acceptable.
Step 8: Calculate the overall AHP score by multiplying the normalized weight of the attribute.

TOPSIS (for the Technique for Order Preference by Similarly to Ideal Solution) was developed by Hwang and Yoon in 1980 as an alternative to the ELECTRE method and can be considered as one of its most widely accepted variants. TOPSIS method is a popular approach to MADM and has been widely used in the literature. TOPSIS simulation consider the distances to the ideal solution and negative ideal solution regarding each alternative and select the most relative closeness to the ideal solution as the best alternative. That is the best alternative is the nearest one to the ideal solution and the farthest one from the negative ideal solution. The TOPSIS method assumes that each criterion has a tendency of monotonically increasing or decreasing utility. Therefore, it is easy to define the ideal and negative-ideal solutions. TOPSIS is a practical and useful technique for ranking and selection of a number of alternatives determined through distance measures.
Generally A+ indicates the most preferable alternative or the ideal solution. Similarly, alternative A- indicates the least preferable alternative or the negative ideal solution. Further procedure can be described in 6 steps, as follows:

Step 1: Calculate the normalized decision matrix. The normalized value r_{ij} is calculated as follows:

$$r_{ij} = x_{ij} \sqrt{\sum_{i-1}^{m} x_{ij}^2} \quad \text{i =1, 2, ..., m and j = 1, 2, ..., n.}$$

Step 2: Calculate the weighted normalized decision matrix. The weighted normalized value v_{ij} is calculated as follows:

$$v_{ij} = r_{ij} \times w_j \quad \text{i =1, 2,..., m and j = 1, 2, ..., n.} \qquad (1)$$

where w_j is the weight of the j^{th} criterion or attribute and $\sum_{j=1}^{n} w_j = 1$.

Step 3: Determine the ideal (A^*) and negative ideal (A^-) solutions.

$$A^* = \{(\max_i v_{ij} \mid j \in C_b), (\min_i v_{ij} \mid j \in C_c)\} = \{v_j^* \mid j = 1,2,...,m\} \qquad (2)$$

$$A^- = \{(\min_i v_{ij} \mid j \in C_b), (\max_i v_{ij} \mid j \in C_c)\} = \{v_j^- \mid j = 1,2,...,m\} \qquad (3)$$

Step 4: Calculate the separation measures using the m-dimensional Euclidean distance. The separation measures of each alternative from the positive ideal solution and the negative ideal solution, respectively, are as follows:

$$S_i^* = \sqrt{\sum_{j=1}^{m} (v_{ij} - v_j^*)^2}, \; j = 1,2,...,m \qquad (4)$$

$$S_i^- = \sqrt{\sum_{j=1}^{m} (v_{ij} - v_j^-)^2}, \; j = 1,2,...,m \qquad (5)$$

Step 5: Calculate the relative closeness to the ideal solution. The relative closeness of the alternative A_i with respect to A^* is defined as follows:

$$RC_i^* = \frac{S_i^-}{S_i^* + S_i^-}, \; i = 1,2,...,m \qquad (6)$$

Step 6: Rank the preference order.

IV. RESULTS AND DISCUSSION

AHP score is calculated as discussed in Sect. 3. The performance of these networks for streaming, conversational and interactive applications of the basis of AHP, TOPSIS and is shown in Fig.2, Fig.3, Fig.4, Fig 5, Fig 6 and Fig 7, respectively. AHP-TOPSIS method is also applied for the same network selection problem. Based on the ratios obtained from AHP-TOPSIS method, handover decision is made. Results with TOPSIS method is almost same as with the AHP method. So, the results indicate that the large range networks are always the preferred choices as they can support higher mobility.

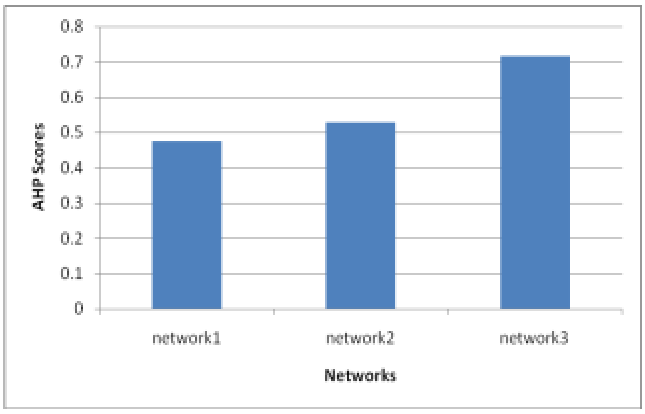

Fig. 2: AHP Scores of networks for conversational applications

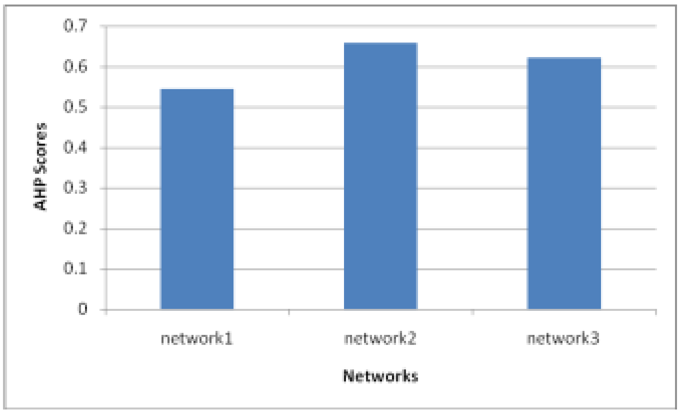

Fig.3: AHP Scores of networks for interactive applications

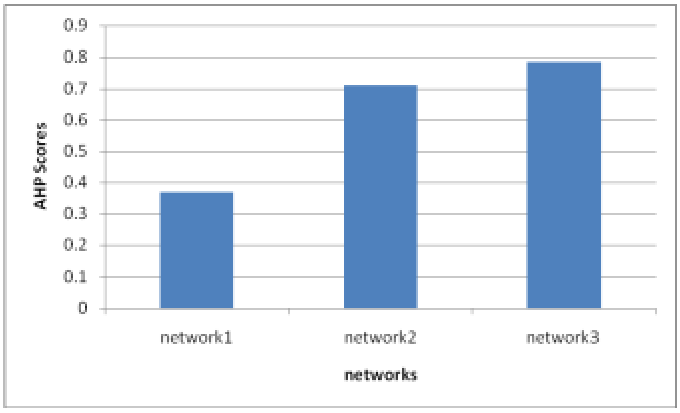

Fig.4: AHP Scores of networks for streaming applications

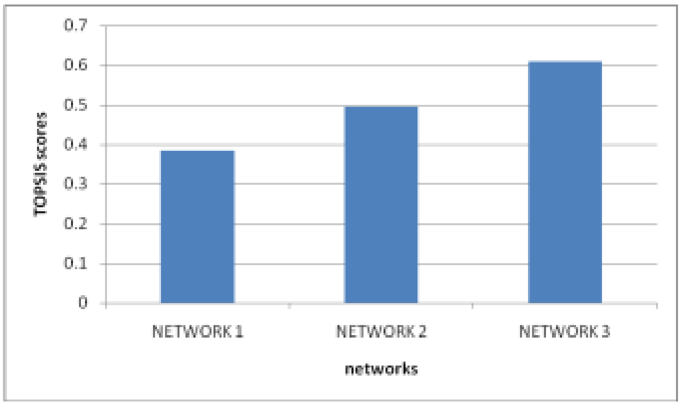

Fig.5: TOPSIS Scores of networks for conversational applications

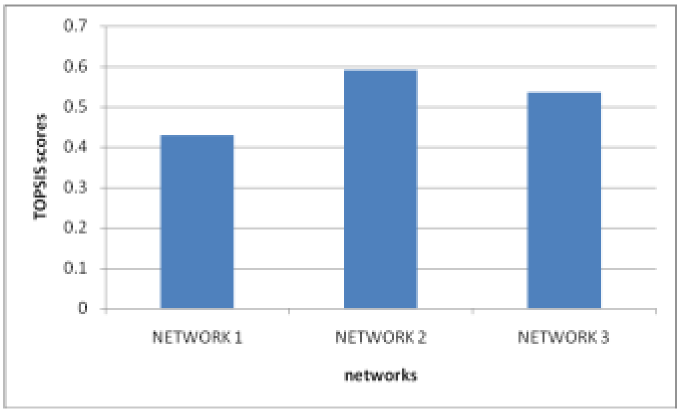

Fig.6: TOPSIS Scores of networks for interactive applications

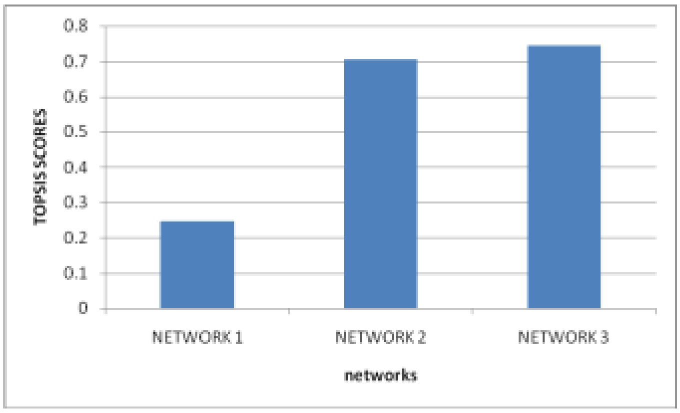

Fig.7: TOPSIS Scores of networks for streaming applications

V. CONCLUSION

The main objective of this paper to developed schemes is to minimize the number of unnecessary handoffs, while maximizing the time with a preferred network, resulting in increased end-user's satisfaction level. Network selection, the decision to select the best network among the available candidates, also plays an important role to maximize the end's user satisfaction levels. The scheme utilizes the parameters, such as, Data rate, Cost, Delay, Jitter, and Throughput of the network. Three types of applications: Conversational, Streaming, Interactive, are utilized in evaluating the performance of the proposed scheme. The network selection algorithm finds out the best available network that can support the continuity and quality of current service. It is observed that most of the research work deals with the target network selection, ignoring the handoff and necessity estimation, that are of equal importance, as handoff and its necessity estimation play a vital role in maximizing the end- user's satisfaction. This suggests that more work needs to be done in this area. This algorithm outperforms the other methods by providing less number of handoffs, a low handoff failure rate, the best network, and high network utilization.

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BIOGRAPHIES

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