Network Selection in Heterogeneous Wireless Environment Using SAW Method

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Abstract - *Wireless network are now a days the most popular means of data communication. Selecting a network plays an important role in improving QoS and system performance. Selection of network in a heterogeneous wireless environment depends on several parameters with different relative importance such as the network, different applications and user preferences. In the proposed system network selection for heterogeneous wireless environment combines two Multi Attribute Decision Making methods (MADM), Analytic Hierarchy Process (AHP) and Simple Additive Weight (SAW). AHP method is used to assign the weights to QoS parameters and SAW method is used to rank the network for each application. Network is selected based on the requested application of the user by considering QoS parameters like Throughput, Delay, Jitter and Packet Loss. The aim is to provide the user with the best QoS network.*

Key terms - Heterogeneous wireless networks, MADM, AHP, SAW.

1. INTRODUCTION

Development of wireless technologies has totally revolutionized the world of communication. The coexistence of several wireless access technologies, such as WiFi and WiMAX, as broadband access networks and UMTS as cellular networks, gives rise to a heterogeneous wireless environment. Such environment provides mobile devices having sufficient access capabilities the opportunity to select a network. The overall goal for research on heterogeneous networks is to enable users to obtain and share necessary and timely information in right form over an integrated heterogeneous network that is scalable, evolvable and secure. An essential aspect of service delivery in a heterogeneous wireless environment is the selection of optimal network. Network selection in such environment is influenced by several factors, and there is no solution available to solve this problem. Non-optimal network selection can result in undesirable effects such as higher costs poor service experience. The network selection problem can be solved by using MADM methods.

MADM refers to making decision over the available alternative that are characterised by multiple attribute. MADM has been an active area of research since the 1970. Because of the deterministic nature and easy implementation MADM have found applications in a wide variety of problems, from social sciences to operational research. Different MADM methods are Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Analytic Hierarchy Process (AHP), Simple Additive Weighting (SAW), Weighed Product Model (WPM), Grey Relational Analysis (GRA). The network selection method depends on multiple criteria they are:

From terminal side: battery, velocity.

• From service side: QoS level, security level.

•From network side: provider's profile, current QoS parameters.

• From user side: users preferences, perceived QoS.

In the proposed system MADM approach has been used to select the network by considering QoS parameters like throughput, delay, jitter and packet loss. Network is selected based on the requested application of the user. AHP method is used to assign the weights to QoS parameters and SAW method is used to rank the network for each different application.

Section-2 of this paper reviews the related works.

Section-3 and 4 describes the introduction and the proposed network selection technique.

Finally, Section-5 and 6 shows the experimental results and conclusion of this paper respectively.

2. RELATED WORK

A number of researchers have proposed network selection algorithms in the literature. In [2], proposed system is based on a unique decision process, non-compensatory and compensatory MADM methods are used to select the

top candidate network. In [3], an improved network selection algorithm is presented by using group decision theory. In [4], simulation study is conducted to evaluate the QoS performance of WiMAX and UMTS for supporting VoIP traffic. In [5], presents the suitable network selection technique for heterogeneous wireless environment that is based on TOPSIS method when solving the multiple criteria decision making problems. In [6], reports a mobile agent based heterogeneous wireless network management system. Agent's decision focuses on multi parameter system, parameters like received signal strength, network delay, network latency and study of the collected information about adjoining network cells, accessible channel.

3. FUMDAMENTAL THEORY

In heterogeneous wireless environment, an important task for mobile terminals is to select the best network for various communications at any time anywhere, usually called as network selection.
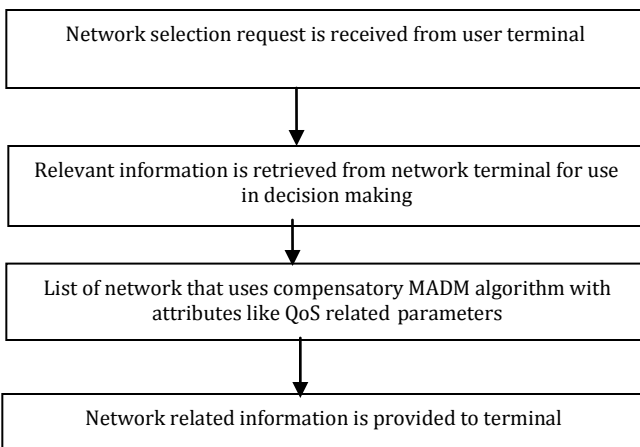
Network selection request is received from user terminal

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Relevant information is retrieved from network terminal for use in decision making

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List of network that uses compensatory MADM algorithm with attributes like QoS related parameters

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Network related information is provided to terminal

Fig-1: Decision making process in network selection

Decision process in network selection in a heterogeneous wireless environment is formulated as an MADM problem that deals with the evaluation of a set of alternatives using a set of attributes. The alternative represents different choice.

Table -1: List of attributes for network selection

Attribute	Abbreviation	Brief Explanation
Throughput	T	It is the rate of successful delivery of packets over a communication channel.

Packet Delay	D	It gives the average packet delay within the access system.
Packet Jitter	J	It is the measures of average delay variations within the access system.
Packet Loss	T	It measures the average packet loss rate within the access system.

4. PROPOSED NETWOR SELECTION TECHNIQUE

Heterogeneous wireless environment contains multiple networks, such as Universal mobile telecommunications system (UMTS), world-wide interoperability for Microwave access (WiMAX), wireless local area network (WLAN).This networks have various QoS parameters ,user have various preferences and applications have various QoS requirements. Therefore, it is difficult to determine the best network in the network selection issue because no network is better than others in all aspects. In order to always select a best network, various QoS parameters are considered.AHP method is used to assign the weight to parameters and SAW method is used to rank the network for each different application.

4.1 AHP Method

The Analytic Hierarchy Process (AHP) is a multi-attribute decision making method developed by Saaty. In network selection process AHP method is used to assign the weights to different criteria. The steps of AHP method are as follows.

Step1- Determination of the objective and the decision factors: In this step the final objective of the problem is analyzed as a number of decision factors, until the problem acquires a hierarchical structure, in the lowest level of which the alternative solutions of the problem are found.

Table-2: Scale of importance

Intensity of importance	Definition
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extreme importance
2,4,6,8	Intermediate values

Step 2- Determination of the relative importance of the decision factors with respect to the objective: In this step, in each level the decision factors are compared pair wise according to their levels of influence with respect to the

scale which is shown in Table 2. The comparison results are given in a square matrix $A=[a_{ij}]_{n*n}$ where n are the number of factors, and $a_{ii}=1$, $a_{ji} = 1/a_{ij}$, $a_{ij =!} 1$.

Step 3-Normalization and Calculation of the relative weights: In this step relative weights are calculated by finding the right eigenvector (w) corresponding to the largest eigenvalue (max), as

$$A_w = \lambda_{max} w \qquad (1)$$

Consistency Index (CI) is defined as

$$CI = \frac{(\lambda_{max} - n)}{n-1} \qquad (2)$$

The Consistency Ratio (CR) is calculated by dividing the CI by the Random consistency Index (RI), and it is given by

$$CR = \frac{CI}{RI} \qquad (3)$$

If the CR value is small or equal to 10%, the inconsistency is acceptable; otherwise the subjective judgment is revised.

4.2 SAW Method

Simple Additive Weighting (SAW) method is best known and it is most widely used MADM method. SAW method is also known as scoring method. The basic logic of the SAW method is to obtain a weighted sum of performance ratings of each alternative over all attributes. The steps of SAW method are as follows.

$$A=(a_1, a_2, a_3 \ldots\ldots a_n) \qquad (1)$$

Let $A= (a_1, a_2, a_3 \ldots.. a_n)$ be the set of alternatives.

$$C= (c_1, c_2, c_3 \ldots.c_n) \qquad (2)$$

Let $C= (c_1, c_2, c_3 \ldots.c_n)$ be the set of criteria.

Step 1: To Construct the decision matrix:

$$\begin{matrix} d_{11} & d_{12} & \cdots & d_{1n} \\ d_{21} & d_{22} & \cdots & d_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ d_{n1} & d_{n2} & \cdots & d_{nn} \end{matrix} \qquad (3)$$

Where d_{ij} is the rating of alternative A_i with respect to criterion C.

Step 2: To Construct the normalized decision matrix.

For beneficial attribute (criteria of benefit):

$$r_{ij} = \frac{d_{ij}}{d_{ij}^{max}} \qquad (4)$$

For non beneficial attribute (criteria of cost):

$$r_{ij} = \frac{d_{ij}^{min}}{d_{ij}} \qquad (5)$$

Step 3: To Construct the weighted normalized decision matrix.

$$v_{ij} = W_{ij} * r_{ij}, \sum_{i=1}^{n} W_i = 1 \qquad (6)$$

Step 5: To Select the best alternative.

$$BA_{saw} = \max_{i=1}^{n} S_i \qquad (7)$$

Where $BA\ saw$ is Best Alternative in SAW method and S_i is matrix score.

5. NUMERICAL RESULTS

We consider several different networks: A Universal Mobile Telecommunications System (UMTS) network, a Worldwide Interoperability for Microwave Access (WiMAX) network and Wireless Local Area Network (WLAN). Table 3 shows the network parameters of each network, that are determined at the time of network selection.   The decision for the network selection is affected by the requested application indicated by the user. We consider three applications, namely VoIP, media streaming and web browsing. AHP method is used to assign weights to QoS parameters. The results obtained from the computations based on the pair wise comparison matrices are given in chart 1.

Table-3: The candidate networks and their network parameters

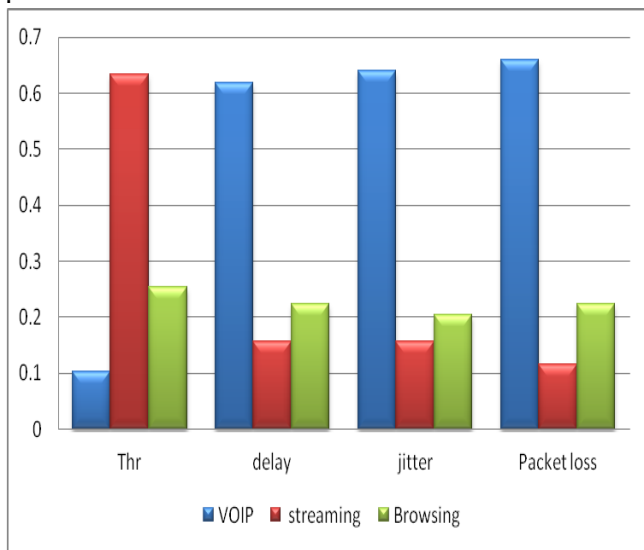| Networks	Throughput (Mbps)	Delay (ms)	Jitter (ms)	Packet Loss (%)
UMTS	2	35	20	0.08
WiMAX	50	30	20	0.09
WLAN	11	120	75	0.07

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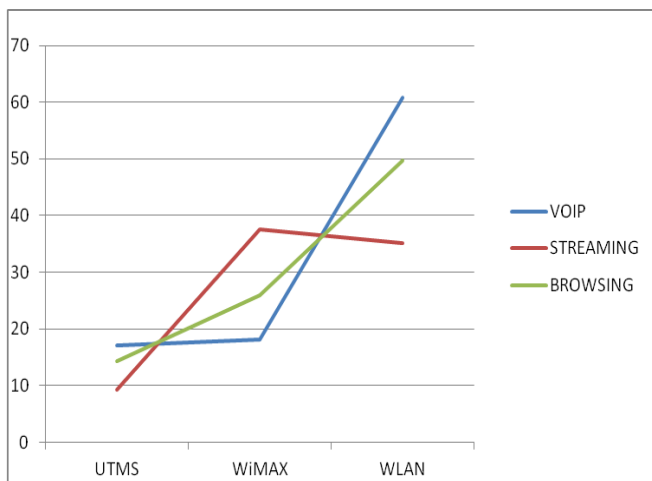**Chart-1:** Weights associated with parameters for different application.

Fig-2: Result of SAW method for each application

6. CONCLUSION

MADM method provides an effective framework for ranking the networks in a heterogeneous wireless environment by means of their ratings with respect to multiple attributes that combines AHP method to determine importance of Qos parameters and SAW method to rank the network for each application. Numerical results showed that this two methods are very effective for the network selection according to requirements of the application that the user wishes to use.

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