INTERNATIONAL JOURNAL OF RESEARCHES IN BIOSCIENCES, AGRICULTURE AND TECHNOLOGY
© VISHWASHANTI MULTIPURPOSE SOCIETY (Global Peace Multipurpose Society) R. No. MH-659/13(N)
www.vmsindia.org

AN OVERVIEW OF MULTI ATTRIBUTE DECISION MAKING (MADM) METHODS FOR NETWORK SELECTION IN HETEROGENEOUS WIRELESS NETWORKS

Piyush K. Ingole[1] and M.V.Sarode[2]
[1]GHRCE, Department of CSE, Nagpur, India – 440016
[2]JCOET, Department of CSE, Yavatmal, India – 445105

Abstract:
In near future wireless services will be provided through heterogeneous network service providers, customer of any scribed network will be able to connect any another network if its QoS (Quality of Service) requirements are not fulfilled.. There will be a multi-access network environment where users will be able to select from various available networks the best suitable one to satisfy its need. Selection of the best suitable and efficient access network to meet QoS requirements has become a significant topic in heterogeneous wireless networking environment to enhance the QoS experienced by the user. Therefore, this paper focuses on the study of Multi Attribute Decision Making (MADM) techniques frequently used for the network selection problem, A case study on AHP (Analytical Hierarchical Process) is presented and results are drawn using MATLAB for better understanding of working of MADM.
Keywords: Multi attribute Decision making, network selection; quality of service.

Introduction

Today there are several wireless and mobile networking technologies such as Wireless Fidelity (Wi-Fi), Worldwide Interoperability for Microwave Access (Wi-MAX), Universal Mobile Telecommunication System (UMTS) , Code Division Multiple Access (CDMA), Bluetooth, Wireless LANs (WLANs), Universal Mobile Telecommunications System (UMTS), Cellular networks, Zigbee , Long Term Evaluation (LTE) etc. These networks are designed for specific service purpose and vary in terms of bandwidth, latency, cost, coverage, Network architecture, Quality of Service (QoS) it providing, mobility support, etc. However, none of the current technology can simultaneously satisfy all needs at a time, wireless communication scenario is changing rapidly, development of different wireless access technologies leads in overlapping coverage area, which opens the another era of networking for optimal use of spectrum and other resources and to provide better QoS to the end user, spectrum and resource sharing concepts are used which opens the door of heterogeneous wireless Networking, in HWN (Heterogeneous Wireless Networks) customer of any subscribed network can be connected to any other network if its QoS requirements are not satisfied.

The "optimally connected anywhere, anytime" vision was introduced by ITU in Recommendation ITU-R M.1645 [1] in June 2003. In Heterogeneous Wireless Networking, the concept of being always connected becomes *"always best connected"* (ABC). This refers to be connected to "best network in best way".

For transferring the ongoing call from one network to another the efficient and seamless handover mechanism has to be developed. Handover is the process of transferring user connections in such a way that ongoing connections are uninterrupted. Basically there are two types of handovers Horizontal handover (HO) and Vertical Handover Horizontal handover represents handover between same types of access technology, for example in a Global System for Mobile communications (GSM) network; The end device is connected to Base Station(BS) if user travels from one BS to another BS the connections has to be transfer likewise to keep the connection interrupted, Here the user is switching from one BS to another BS where both the Base stations are having same access technologies this type of handover is called as Horizontal Handover i.e handover between same access technologies.

On the other hand Vertical handover (VHO) [2] is the process of switching the connection between different wireless access technologies. In a horizontal handover the connection transfers from one base station to another within the same access technology. The vertical handover consists mainly in three phases: Network discovery, Making Handover Decision and Handover Execution. In the Network Discovery, the mobile terminal (MT) discovers all available networks in its vicinity. In the decision phase, the best suitable network is selected according to the specified criteria; in last i.e. the handover execution phase the new connection is established and previous connection is release according to the vertical handoff decision. Vertical handover (VHO) represents handover between different types of networks i.e. different access technologies.

The paper is organized as follows. Section: II summarizes different Multi Attribute Decision Making techniques. Section: III represents the case study on AHP. Section: IV results and discussion and Section: V presents conclusions and future work.

Multi Attribute Decision Making

Multiple attribute decision making (MADM). MADM is a branch of multiple criteria decision making (MCDM), in MADM decision is made by taking in consideration alternatives and multiple attributes.

The Simple Additive Weighting Method (SAW) [3] (also known as the weighted sum method) is one of the most widely used Multi Attribute Decision Making (MADM) methods used in the network selection. The basic concept of SAW is to obtain a weighted sum of the normalized form of each parameter over all alternative networks, in order to have a comparable scale among all parameters normalization is required Depending on the formulation of the problem, the network which has the highest/lowest score is selected as the target network. One of the main drawbacks with SAW is that a less efficient value for one parameter can be outweighed by a very good value for another parameter.The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) [4] is based on the concept that the selected network is the near most to the best possible solution. The best possible solution can be obtained by giving the best possible values to each parameter. The authors in [12] propose a network selection algorithm based on TOPSIS method, Study show that TOPSIS is sensitive to user preference and the parameter values. The Multiplicative Exponential Weighting Method (MEW) [4] uses multiplication for connecting network parameters ratings. For example, for each candidate network i a score is obtained The greater the score value the more preferred the candidate network. The Elimination and Choice Expressing Reality (ELECTRE) method [5] is based on a pair-wise comparison between the parameters of the candidate networks. The concepts of concordance and discordance are used in order to measure the satisfaction and dissatisfaction of the decision maker when comparing the candidate networks.

Case Study

Analytic Hierarchy Process (AHP) [6] and Grey Relational Analysis (GRA)

Analytic Hierarchy Process (AHP): The idea behind AHP is to decompose a complicate problem into a hierarchy of simple sub-problems. Results are translated into numerical values on a scale from 1 to 9 and presented in a square matrix, referred to as the AHP matrix by pair wise comparison - at each level the elements within the same parent compared with each other, the weights of the decision factors are computed by calculating the eigenvector of the AHP matrix. Grey Relational Analysis (GRA): The GRA method is used to rank candidate networks and select the one which has the highest rank. As different networks have different characteristics normalization is required. AHP is studied and results are drawn in MATLAB using following parameters

Number of alternatives = 3 (WiMax, WiFi, UMTS)

Number of Attributes= 7 (Bandwidth, Cost per byte, Security, Delay, N/W Condition, N/W Performance Power)

Normalization

Various network attributes (i.e., the criteria) have different characteristics. Network attributes such as cost, delay, and packet loss ratio belong to the smaller-the-better class, while other ones like available bandwidth and security are considered to be the larger-the-better category. Besides, different attributes have various dimensions. Taking into account the aforementioned difference among network attributes, normalization is a necessary process.

Construct AHP judgment matrix:

According to different scenarios and user preferences, the criteria are compared pair wise in the matter of their levels of importance. The comparison results are presented in a square matrix called AHP matrix as

Validation:

By taking Geometric mean as $(X_i) = (M_{11}* M_{12}* M_{13}* M_{14}* M_{15}* M_{16}* \text{--} M_{1m})^{1/n}$ Where m-Number of attributes & n- Dimension of matrix Weighted matrix A2 is found as :

W1	0.2286
W2	0.1576
W3	0.3366
W4	0.0209
W5	0.0517
W6	0.1177
W7	0.0868
Matrix A2	

Step I : A3=A1*A2

Step II: A4=A3/A2

Average of A4 = λmax

λmax= 7.5740

CI= (λmax – N)/(N-1) (Where N is A1 matrix dimension)

CI = (7.5740-7)/6

= 0.0957

CR = CI/RI

= 0.0957/1.32

CR = 0.0725 (Approximately 7 % Error)

Note: Value of RI is taken from Random Consistency Index

Result and Discussion

According to the problem specifies in table 1, by applying AHP with specified parameters the results are drawn in MATLAB, It can be seen in the results Alternative 1 has score 0.5558, Alternative 1 has score 0.5827 & Alternative 3 has score 0.7045, the alternative with highest score will rank as one and respectively. In this case study network 3 is ranked as 1 (One) as it satisfies the user needs.

Alternative	Score	Rank
1	0.5558	3
2	0.5827	2
3	0.7045	1

Table 1: Network Parameters

N/W	Bandwidth (Kbps)	Cost (Cent/Min)	Security	Delay (ms)	N/W Condition (%)	N/W Performance (%)	Power
WiMax	2000	3	1	30	50	80	3
WiFi	1000	2	2	20	60	90	2
UMTS	384	5	7	90	70	95	1

Table 2: Normalization

N/W	Bandwidth (Kbps)	Cost (Cent/Min)	Security	Delay (ms)	N/W Condition (%)	N/W Performance (%)	Power
WiMax	1	2/3	1/7	20/30	50/70	80/95	1/3
WiFi	1000/2000	1	2/7	1	60/70	90/95	1/2
UMTS	384/2000	2/5	1	20/90	1	1	1

Table 3

	Bandwidth	Cost	Security	Delay	N/W Condition	N/W Performance	Power
Bandwidth	1	3	1/3	9	3	3	3
Cost	1/3	1	1/3	9	3	3	2
Security	3	3	1	9	5	3	3
Delay	1/9	1/9	1/9	1	1/3	1/7	1/5
N/W Condition	1/3	1/3	1/5	3	1	1/3	1/3
N/W Performance	1/3	1/3	1/3	7	3	1	3
Power	1/3	1/2	1/3	5	3	1/3	1

Matrix A1 (Pair wise comparison of attributes)

1-Equally Important 3-Moderately Important 5-Strongly Important

7-Very Strongly Important 9-Extermely Important

Scale of relative importance (According to Saaty)

Conclusion

In this paper, we sum up different Multi Attribute Decision Making schemes, need of vertical handover and next generation of wireless Networks i.e Heterogeneous Wireless Networks, We presented a case study on AHP and results are drawn using MATLAB for better understanding of working of MADM.

References:

1. ITU,"Framework and overall objectives of the future development of IMT-2000 and systems beyond IMT-200," Switzerland, ITU-R M.1645,2003.
2. Lusheng Wang and Geng-Sheng (G.S.) Kuo "Mathematical Modeling for Network Selection in Heterogeneous Wireless Networks– A Tutorial" IEEE COMMUNICATIONS SURVEYS & TUTORIALS, VOL. 15, NO. 1, FIRST QUARTER 2013
3. C- H . Yeh, "A Problem - based Selection o f Multi- attribute Decision making Methods " International Trans actions in Operational Research , vol. 9, pp. 169-181, 2002.
4. E. Gustafsson and A. Jonsson, "Always best connected," IEEE Wireless Commun., vol. 10, no. 1, pp. 49–55, Feb. 2003.
5. J . Flp," I ntroduction to D ecis ion Making Methods ", Computer and Automation Institute, Hungarian Academy of Sciences , Budapest, 2005.
6. Bin Liu,Hui Tian,Bin Wang, Bo fan "AHP And Game theory based Approach for Network Selection in Heterogeneous Wireless Networks" 11 Annual IEEE CCNC, Wireless Communication Track, IEEE 2014.