

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

## Survey on Vertical Handoff Decision

S.Swedaa<sup>1</sup>, I.Veronica Judith Joyce<sup>2</sup>, J.Jayakumar<sup>3</sup>

P.G. Student, Department of Electronics and Communication Engineering, St.Joseph's College of Engineering,  
Chennai, India<sup>1,2,3</sup>

**ABSTRACT:** A Vertical Handoff (VHO) or inter-system handoff is the process that occurs between attachment points supporting the different network technologies. Vertical handoff decision plays very important role in selection of best network. This paper provides a literature review on various vertical Handoff Algorithms such as RSS based algorithm, Cost function Based Algorithm, Bandwidth Based Algorithm, MADM algorithm etc.

**KEYWORDS:** Vertical Handoff; RSS; MADM; Bandwidth.

### I. INTRODUCTION

The wireless technologies during a heterogeneous wireless network are typically completely different from each other, from a technological purpose of view. Most of them typically disagree in terms of, however not restricted to, their offered bandwidths, operational frequencies, costs, coverage areas, and latencies. Currently, no single wireless technology provides efficient services, high bandwidths and low latencies to any or all mobile users during a massive coverage space. This can be wherever the requirement for well-organized Vertical Handoffs (VHO) between heterogeneous wireless technologies becomes necessary.

#### A. Vertical Handoff Process

The vertical handoff process [1] can be divided into three main steps, namely handoff initiation, handoff decision, and handoff execution

i) Handoff Initiation Phase - so as to trigger the handoff occasion, data to be gathered about the system from various layers like Link Layer, Transport Layer and Application Layer. These layers give the data, for example, RSS, transmission capacity, join speed, throughput, jitter, cost, power, client inclinations and system membership and so forth. In view of this data handoff will be started in a fitting time.

ii) Handoff Decision Phase - The cell phone chooses whether the association will be proceeded with current system or to be changed over to another. The choice might rely on upon different parameters which have been gathered amid handoff start stage.

iii) Handoff Execution Phase - Existing affiliations ought to be re-guided to the new framework consistently. This stage also joins the acceptance and endorsement, and the trading of customer's association information.

#### B. Vertical Handoff criteria and Metrics

In heterogeneous systems, Vertical handoffs can be started for comfort as opposed to network reasons. The decision may depend on various groups of parameters such as,

- (i) Network- Related Parameters - Bandwidth, Latency, Receiver signal strength (RSS), Cost, Security etc.
- (ii) Terminal Related Parameters - Velocity, Battery, power, Location Information etc.
- (iii) User-Related Parameters - user profile and preferences,
- (iv) Service Related Parameters - service capacities, QoS etc.

#### C. Classification of Vertical Handoff

(i) RSS based algorithms - RSS is used as the main handover decision criterion in this group. Various strategies have been developed to compare the RSS of the current point of attachment with that of the candidate point of attachment.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

(ii) Bandwidth based algorithms - Available bandwidth for a mobile terminal is the main criterion. In some algorithms, both bandwidth and RSS information are used 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.

(iii) Cost function based algorithms - This class of algorithms combine metrics such as monetary cost, security, bandwidth and power consumption in a cost function, and the handover decision is made by comparing the result of this function for the candidate networks .

(iv) Combination algorithms - These VHD algorithms attempt to use a richer set of inputs than the others for making handover decisions. When a large number of inputs are used, it is usually very difficult or impossible to develop analytical formulations of handover decision processes. Due to this reason, researchers apply machine learning techniques to formulate the processes.

(v) Multiple Attributes Decision Making Based Algorithms - The multiple attributes decision making based algorithm (MADMA) calculates the quantitative value of each normalized attribute and evaluates the target systems through the weighted function of the quantitative values, the final decision can then be made.

This report is organized as follows: Section II describes various Vertical Handoff Algorithm by different authors and finally conclusion is presented in section III.

## II. VERTICAL HANDOFF ALGORITHM

### A. RSS Based Algorithms

RSS is used as the main decision criterion in this group. A large number of studies have been conducted in this area. Some RSS based VHO algorithms are discussed below:

#### (i) An Adaptive Life Time Based Handoff Heuristic

Zahran et al (2006) [6] proposed an algorithm for handoff between 3G networks and WLANs by combining the RSS measurements either with an estimated lifetime (expected duration after which the mobile station will not be able to maintain its connection with the WLAN) or the available bandwidth of the WLAN candidate.

In the first scenario, when the MS moves away from the coverage area of a WLAN into a 3G cell, a handoff to the 3G network is initiated. The handoff is triggered under the conditions that (a) RSS average of the WLAN connection falls below a predefined threshold, and (b) the estimated lifetime is less than or equal to the handoff delay. The MS continuously calculates the average RSS using the moving average method

$$\overline{RSS(k)} = 1/W_{av} \sum_{i=0}^{W_{av}-1} RSS(k-i) \quad (2.1)$$

$\overline{RSS(k)}$  is the calculated average of RSS at time instant  $k$  .

$W_{av}$  is the window size of a slope estimator, a variable that changes with the velocity of the MS.

In the second scenario, when the MS moves towards a WLAN cell, the handoff to the WLAN is initiated if (a) the average RSS measurements of the WLAN is larger than a threshold and (b) the available bandwidth of the WLAN meets the bandwidth requirements of the application.

Since the lifetime metric and bandwidth are considered, the algorithm adapts to the application requirements and the user mobility and also the number of unnecessary handoffs is reduced. There is an improvement in throughput for the user, because of the MS's ability to remain connected to the WLAN as long as possible. However, Packet delays can be increased with an increase in the life time, due to the deterioration of the channel condition, as the MS moves towards the boundary of the WLAN. This issue can be critical for delay sensitive applications and degrade their performance.

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

(ii) *An RSS Threshold Based Dynamic Heuristic*

Mohanty & Akyildiz (2006) [5] proposed a handoff decision method from WLAN to 3G based on comparison of the current RSS and a dynamic RSS threshold ( $S_{dth}$ ) when the MS is connected to WLAN access point.  $S_{dth}$  (in dbm) is calculated as

$$S_{dth} = RSS_{\min} + 10\beta \log\left(\frac{d}{d - L_{BA}}\right) + \epsilon \quad (2.2)$$

Where  $RSS_{\min}$  is the minimum RSS required for the MS to communicate with an access point,  $\beta$  is the path loss coefficient,  $d$  is the side length of WLAN in meters,  $L_{BA}$  is the shortest distance between the point at which handoff is initiated and WLAN boundary and  $\epsilon$  is the zero-mean random variable with a standard deviation representing statistical variation in RSS caused by shadowing. The distance  $L_{BA}$  depends on desired handoff failure probability, velocity of the mobile station and WLAN to 3G handoff delay. The use of a dynamic RSS threshold helps to reduce the false handoff initiation and handoff failures. But this algorithm is not efficient when the MS's traveling time inside a WLAN is less than handoff delay. In such cases a handoff results in wastage of network resources.

### B. Bandwidth Based VHD Algorithms

Available bandwidth for a mobile station is the main criterion in this group. In some algorithms, both bandwidth and RSS information are used in the decision process. The algorithms are discussed below:

(i) *Bandwidth And Application Type Based Heuristic*

Lee et al (2005) [8] discussed an algorithm which takes residual bandwidth and application requirements into account in deciding whether to handoff from WLAN to WWAN and vice versa. When the MS is connected to a WLAN, the handoff is initiated if the measured RSS is less than RSS threshold. The handoff decision is based on the user application type. For delay sensitive applications, a handoff occurs only if the current serving WLAN is not able to provide necessary bandwidth. For delay insensitive applications, a handoff takes place if WWAN provides higher bandwidth than WLAN.

By considering the available bandwidth as the main VHD criterion, this algorithm is able to achieve high system throughput and by taking application types into account, lower handoff delay for delay sensitive applications is achieved. However, acquiring the available bandwidth information in a cellular network for handoff decision is difficult.

(ii) *A Signal-to-Interference and Noise Ratio (SINR) Based Heuristic*

Yang et al (2007) [7] presented an algorithm which involves handoff between WLAN and Wideband Code Division Multiple Access (WCDMA) network using Signal to Interference and Noise ratio. If  $SINR_{\text{target}} > SINR_{\text{current}}$ , then handoff is initiated. Based on bandwidth available, the handoff takes place.

SINR based handoffs provide higher throughput than RSS based handoff since the throughput directly depends on SINR. This algorithm provides balanced load between WLAN and WCDMA networks. This algorithm introduces excessive handoffs with the variation of SINR causing the MS to handoff back and forth between two networks.

(iii) *A Wrong Decision Probability (WDP) Prediction Based Heuristic*

In the work presented by Chi et al (2007), [8] the WDP is calculated by combining the probability of unnecessary and missing handoffs. Assume that there are two networks  $i$  and  $j$  with overlapping coverage, and  $b_i$  and  $b_j$  are their available bandwidths. An unnecessary handoff occurs when the MS is in network  $i$  and decides to handoff to  $j$ , but  $b_j$  is less than  $b_i$  after this decision. A missing handoff occurs when the MS decides to stay connected to network  $i$ , but  $b_i$  is less than  $b_j$  after this decision.

## International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

WDP algorithm avoids this kind of problem. A handoff from network  $i$  to network  $j$  is initiated if  $p < \rho \times l_0$  or  $b_j - b_i < L$ , where  $p$  is unnecessary handoff probability,  $\rho$  is traffic load of the network  $i$ ,  $l_0 = 0.001$  and  $L$  is a bandwidth threshold. Therefore, this algorithm reduces wrong decision probability and balances the traffic load. But RSS is not considered in this algorithm. A handoff to a target network with high bandwidth but weak received signal is not desirable as it results in connection breakdown.

### C. Multi Attribute Based Decision Algorithms

Multiple Attribute Decision Making algorithms are used for network ranking. They include Simple Additive Weighting (SAW), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Analytic Hierarchy Process and Grey Relational Analysis (AHP and GRA), Multiplicative Exponent Weighting (MEW) and Elimination and Choice Translating Priority (ELECTRE) as given in Zhang [6] (2004).

#### (i) SAW and TOPSIS

In SAW, the overall score function of a candidate network is determined by the weighted sum of all the parameter values. The score function of each candidate network  $i$  is obtained by adding the normalized contributions from each parameter  $r_{ij}$  multiplied by the importance weight assigned  $w_j$  of parameter  $j$ . The selected network  $A_{SAW}^*$  is:

$$A_{SAW}^* = \arg \left( \max_{i \in M} \sum_{j=1}^N w_j r_{ij} \right) \quad (2.6)$$

Where  $N$  is the number of parameters and  $M$  denotes the number of candidate networks.

In TOPSIS, the selected candidate network is the one which is the closest to the ideal solution. The ideal solution is obtained by using the best values for each parameter. Let  $C_i^*$  denote the relative closeness of the candidate network  $i$  to the ideal solution. The selected network  $A_{TOP}^*$  is:

$$A_{TOP}^* = \arg \left( \max_{i \in M} C_i^* \right) \quad (2.7)$$

#### (ii) GRA

The network selection is decided based on Analytic Hierarchy Process and Grey Relational Analysis. AHP decomposes the network selection problem into several problems and assigns a weight value for each sub-problem. GRA is then used to rank the candidate networks and selects the one with the highest ranking.

The ranking of GRA is performed by building grey relationships with a positive ideal network. A normalization process to deal with benefit and cost parameters is required and the Grey Relational Coefficient (GRC) of each network is calculated. The GRC is the score used to describe the similarity between each candidate network and the ideal network. The selected network is the one which has the highest similarity to the ideal network. The selected network  $A_{GRA}^*$  is:

$$A_{GRA}^* = \arg \left( \max_{i \in M} \Gamma 0, i \right) \quad (2.8)$$

Where  $\Gamma 0, i$  is the GRC of network  $i$ .

### D. Combined Algorithm

Combination algorithms are based on artificial neural networks or fuzzy logic, and combine various parameters in the handoff decision such as the ones used in the cost function algorithms. Many combination algorithms are proposed.

# International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

## (i) A Fuzzy Logic Based Heuristic

A Fuzzy MADM based numerical solution for vertical handoff decisions was first introduced by Zhang [6] (2004), where imprecise, or fuzzy data in terms of Linguistic Variables is used to specify network parameters and user preferences in the form of weights. These Linguistic Variables are first converted into crisp numbers using a fuzzy number conversion scale and then classical MADM methods like SAW and TOPSIS are applied to voice and Background traffic. The results indicate that TOPSIS is more sensitive to user-preferences and network-parameter values, and that SAW gives relative conservative ranking results.

## (ii) A Fuzzy Multiple Objective Decision Making Algorithm

In the paper published by Chan et al (2002), the authors demonstrate the use of fuzzy logic together with AHP. Fuzzy Logic is used to calculate the membership values of each parameter measured from different networks while AHP is used to determine the weights associated with these parameters (data rate, usage cost, battery, latency, etc.). These weights are used to evaluate the importance of each network parameter based on the network-provider's and the end-users' preferences. The objective of this scheme is to select a wireless network for a particular service that can satisfy end-users' preferences such as low cost, good RSS, optimum bandwidth, low network latency, high reliability, and long battery life.

## III. CONCLUSION

In this paper, various Vertical Handoff algorithm has been reviewed from the most recent published research work.

## IV. ACKNOWLEDGEMENT

we would like to express our gratitude to Head of the Department Mrs.B.Victoria Jancee M.E.,(Ph.D) who has been providing us encouragement for the successful completion of this project. we also very grateful to our Internal Guide Dr.S.Aghalya M.E., Ph.D.who has been providing us valuable guidance, ideas and encouragement for successful completion of this project.

## REFERENCES

- [1] Heterogeneous Wireless Networks:" Heterogeneous-Wireless-NetworksNetworking"-Protocol/dp/3836419270
- [2] W. Qadeer, T. Simunic, J.Ankorn, V. Krishnan and G. De Micheli, "Heterogeneous wireless network management", SpringerLink 2004.
- [3] Wei Shen and Qing-An Zeng, "A Novel Decision Strategy of Vertical Handoff in Overlay Wireless Networks", Fifth IEEE International Symposium on Network Computing and Applications, 2006.
- [4] Enrique Stevens-Navarro, Vincent W.S. Wong and Yuxia Lin, "A Vertical Handoff Decision Algorithm for Heterogeneous Wireless Networks", In Proc. of IEEE Wireless Communications and Networking Conference (WCNC'07), Hong Kong, China, March 2007.
- [5] S. Mohanty, I.F. Akyildiz, "A cross-layer (layer 2 + 3) handoff management protocol for next-generation wireless systems", IEEE Transactions on Mobile Computing 5 (10) (2006) 1347-1360.
- [6] A.H. Zahran, B. Liang, A. Saleh, "Signal threshold adaptation for vertical handoff in heterogeneous wireless networks", Mobile Networks and Applications 11 (4) (2006) 625-640.
- [7] K. Yang, I. Gondal, B. Qiu, L.S. Dooley, "Combined SINR based vertical handoff algorithm for next generation heterogeneous wireless networks", in: Proceedings of the 2007 IEEE Global Telecommunications Conference (GLOBECOM'07), Washington, DC, USA, November 2007, pp. 4483-4487.
- [8] C. Chi, X. Cai, R. Hao, F. Lee. "Modeling and analysis of handover algorithms", in: Proceedings of the 2007 IEEE Global Telecommunications Conference (GLOBECOM'07), Washington, DC, USA, November 2007, pp. 4473-4477.
- [9] Xiao,C, K.D.Mann and J.C.Olivier,2001, "Mobile speed estimation for TDMA-based hierarchical cellular systems", Proc.Trans. Veh.Technol,50, 981-991.
- [10] Juang,R.T, H.P.Lin and D.B.Lin,2005, "An improved location-based handover algorithm for GSM systems", Proc of wireless communications and networking conference, Mar.13-17, pp-1371- 1376.
- [11] Hasswa, N. Nasser, H. Hassanein, Tramcar: a context-"aware crosslayer architecture for next generation heterogeneous wireless networks", in: Proceedings of the 2006 IEEE International Conference on Communications (ICC'06), Istanbul, Turkey, June 2006, pp. 240-245.
- [12] R. Tawil, G. Pujolle, O. Salazar, "A vertical handoff decision scheme in heterogeneous wireless systems", in: Proceedings of the 67th Vehicular Technology Conference (VTC'08 - Spring), Marina Bay, Singapore, April 2008, pp. 2626-2630. X. Yan et al. / Computer Network.