RESEARCH ARTICLE

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A Smart Decision Algorithm for Handover

Siddharth Goutam*, Srija Unnikrishnan, Aradhana Goutam

Department of Electronics Engineering, Fr. Conceicao Rodrigues College of Engineering, Fr. Agnel Ashram, Bandstand, Mumbai, Maharashtra, India

Fr. Conceicao Rodrigues College of Engineering, Fr. Agnel Ashram, Bandstand, Mumbai, Maharashtra, India

Department of Business Analytics, IES Management College & Research Centre, Mumbai, Maharashtra, India

Abstract

There has been a continuous demand, of smartphone users, for high bandwidth and the least usage cost of the network. The smart phone users require high bandwidth for the use of multiple mobile applications. Vertical handover (VHO) becomes necessary for hassle-free running of these mobile applications while smartphone users are traveling. In this research paper, we present an intelligent decision algorithm for vertical handover which decide the best network among the available candidate networks. The decision is based on the calculation of the score value of the networks. The parameters considered are the cost of the usage, bandwidth and battery consumption. We have considered two networks scenario i.e., 3G & wireless local area network (WLAN).

Keywords: Received Signal Strength, Vertical Handover, Vertical Handover Decision Algorithm.

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INTRODUCTION

With the current growth and development in the area of mobile computing, mobile handsets need to switch connectivity to the various Radio Access Technologies (RATs).[1,2] This results in an interesting issue of deciding the "best network" among the available candidate networks in the given area. The decision for the network selection is based on various parameters such as network usage cost, bandwidth and battery consumption.[3,4]

This research paper has been organized as follows: Section II provides Literature Review. Theoretical framework is explained in Section III. Section IV provides the design of the proposed system model. Section V gives the experimental scenario. Section VI provides Simulation & Results followed by Conclusion & future scope in Section VII.

LITERATURE REVIEW

The authors have reviewed the papers written by researchers in the area of Vertical Handover (VHO). In[5] a performance analysis of mobile IPv6 and proposed improvements is presented. The simulation has been performed using NS-2 network simulator. In[6] the author has presented a policy-enabled handover. The main aim of this proposed model is to check the possibility of balancing the load of bandwidth across various networks. In[7] the link capacity measurement considering queuing delay and packet loss is presented. The estimation of the link capacity is done using a technique called CAPPROBE. In[8] the authors have presented an architecture for creating cluster-based scalable networks. In[9] the authors have presented an evaluation of structures of the cost functions and the optimization of the decision process. In[10] the authors have proposed an architecture known as Transport Layer Mobility. In this architecture, the change of the point of attachment is allowed for the mobile user. In[11] the authors have presented a mobile handover approach that uses a combination of the hierarchical approach, fast approach, and software-based movement monitoring methods. In[12] the authors have developed an app which is able to deliver seamless music while the occurrence of vertical and horizontal handover. In[13], the authors have presented an approach for handover based on handover server and mobile node. In[14] the authors have implemented vertical handover among overlapping wireless networks. In[15] the authors have

Corresponding Author: Siddharth Goutam, Department of Electronics Engineering, Fr. Conceicao Rodrigues College of Engineering, Fr. Agnel Ashram, Bandstand, Mumbai, Maharashtra, India, E-mail: sgoutam07@gmail.com

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presented an algorithm for selecting the network for vertical handover. The algorithm uses the approach combining the Analytical Hierarchy Process (AHP) & fuzzy logic. The research papers have explored various techniques for seamless handover across networks[11][16-19] The classification for VHO can be divided into two approaches - network layer approach & upper layer approach. The network layer approach focuses on IP V6 or IP V4 standards[3] The main requirement is network layer approach requires deploying the various agents for the purpose of the redirection of the data to Mobile Host (MH).[3] While in the upper layer approach, a session layer is implemented over the transport layer to establish the connection changes in the layers below the application layer. [10][12]

The solutions for the handover, whether it is using a network layer or transport layer, involve complexity. The solutions have complexity in implementation as well as operation. While using the network layer solutions, the implementation refers to the up gradation of every router that does not have mobile IP features. There is a substantial cost associated with this approach and hence acts as a barrier in the implementation of the solution. In the approach using upper layer solutions, a new session layer needs the updation for all present applications, systems & ecosystems. This requires substantial cost which hinders the deployment. As a result, while there are solutions for handover which have reduced latency (delay) and packet loss, the implementation becomes difficult due to the cost associated with the solution. [3]

Considering the present scenario of the use of the various application by the smartphone users the need exists for a handover solution which does not change the existing telecom infrastructure.

Theoretical Framework

VHO – Parameters

The primary function of Vertical Handover (VHO) is to ensure that the mobile user is latched on the best network among the available candidate networks. Also the Quality of Service should be guaranteed. [20-22]

Vertical Handover Decision Algorithms (VHDAs) make the decision for VHO on the basis of the input parameters. [23-25]

Received Signal Strength (RSS) is considered one of the most important parameters for deciding handover. [26-32]

Score Value (SV)

The Score Value (SV) for each and every network is calculated and then the handover is performed to the network with the highest score value.

Let us consider

n: total number of networks

m: number of parameter being considered for making decision

Then the Score Value of the network is given by the following equation

$$SV_n = \sum_{i=1}^{m} w_i f_{i,n} \quad (1)$$

Where

$$0 < SV_n < 1 \quad (2)$$

And

$$\sum_{i=1}^{m} w_i = 1 \quad (3)$$

In the above equation

w_i denotes the weight of the parameter i

$f_{i,n}$ denotes the normalized value of network n for parameteri

The score value for the parameters is captured below as below :

$$SV_n = w_c f_{c,n} + w_d f_{d,n} + w_b f_{b,n} \quad (4)$$

Where

w_c denotes weight for usage cost for network n

w_d denotes weight for bandwidth for network n

w_b denotes weight for battery status for network n

The values of $f_{c,n}$, $f_{d,n}$ and $f_{b,n}$ are normalized between the values of 0 and 1.

The equations are represented as under:

$$f_{c,n} = \frac{1}{e^{x_n}} \quad (5)$$

Where

$$x_n \geq 0 \quad (6)$$

$$f_{d,n} = \frac{e^{y_n}}{e^{T}} \quad (7)$$

Where

$$T \geq y_n \geq 0 \quad (8)$$

T is the maximum bandwidth required by the mobile user

$$f_{b,n} = \frac{1}{e^{z_n}} \quad (9)$$

Where

$$z_n \geq 0 \quad (10)$$

The coefficients x_n, y_n and z_n are obtained through practical measurement. [3]

PROPOSED SYSTEM MODEL DESIGN

In this section, the authors have described the design of the proposed system model. The connection between the various RATs and upper layer applications is provided by Handover Control Center (HCC). Figure 1 denotes the system model.

As shown in Figure 1, the HCC comprises of the following four parts. Device Monitor (DM): It is a device monitor which is used for monitoring a device. The main function of the DM is to monitor and report the status of each and every network. The parameters like Received Signal Strength (RSS), bandwidth and cost are monitored.

System Monitor (SM): The main function is to monitor and report the information and details pertaining to the system. The parameters monitored by SM are the battery status of

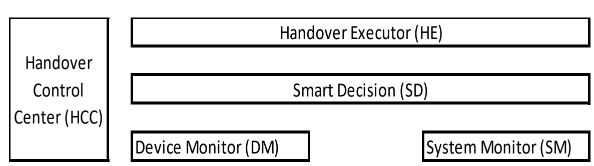

Figure 1: System Model

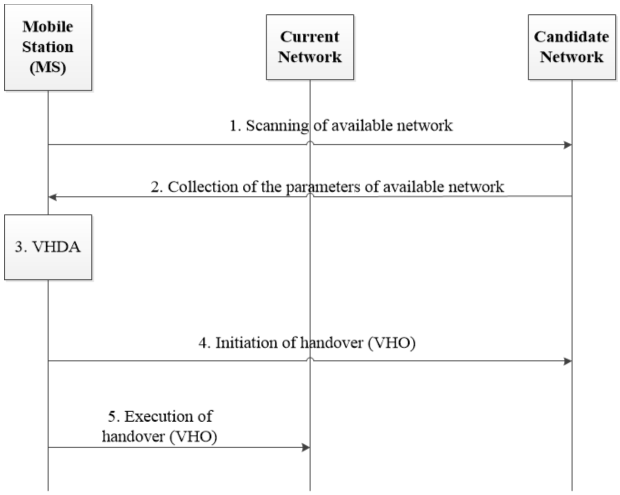

Figure 2: Handover process

Algorithm : Decision for Vertical Handover (VHO)
Input Data :
Received Signal Strength (RSS)
Bandwidth
Usage Cost
Battery Status
Calculated Data : Score Value (SV) of the Network
Output : Handover to the Network
Execution Steps:
1. Monitor the RSS of all the networks
2. If RSS of available network is greater than RSS of current network then go to step 3 else keeping monitoring the RSS
3. Capture the values of other parameters
4. Perform calculation of the Score Value (SV) for the network
5. Perform handover to the network with highest score value

Figure 3: Algorithm for Vertical Handover

the handset.

Smart Decision (SD): The main function of this component is to perform integration of the details provided by the components like DM, SM along with the user preferences for making the decision for vertical handover. The component named Smart Decision selects the network on the basis of the Score Value (SV) of the network.

Handover Executor (HE): The main function of the Handover Executor is to perform handover to the selected network. The handover is performed in case the selected network is different from the current network.

The RSS of all the available networks is monitored. Once RSS criteria is satisfied, the value of the other parameters is fed into the algorithm and the output obtained is the Score Value (SV) of the network. Figures 2 & 3 represent the handover process and vertical handover decision algorithm

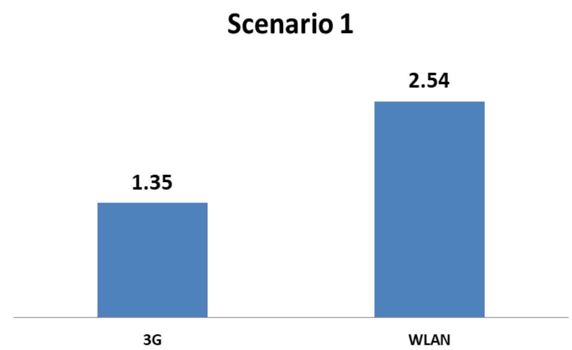

Figure 4: Score Value for Scenario 1

respectively.

EXPERIMENTAL SCENARIO

In this section, the authors have described the experimental scenario. The authors have considered a practical and real-life scenario in which a mobile user (3G) is entering a café. The café has its own Wireless Local Area Network (WLAN). The user has two options

- To continue on to 3G network
- To latch on to WLAN.

The authors have considered various scenarios with different weightage of the parameters. The RSS criterion is checked before calculating the score value for both the networks and making decision on the handover. Practical values of network parameters have been considered.

SIMULATION AND RESULTS

The simulation has been performed by considering two networks (3G & WLAN). The parameters for simulation are captured in table 1.

The cost of 3G has been taken as 0, since the mobile user has already subscribed for the monthly plan. For using WLAN of the café, the mobile user has to pay for the wifi Voucher (for using the WLAN deployed at cafe). The values of the cost for both the networks have been normalized on the scale of 0 to 1.

The maximum bandwidth available for 3G user is taken as 2 Mbps and the maximum bandwidth for WLAN is taken as around 4 Mbps. The available bandwidth for 3G is taken as 1 Mbps. The available bandwidth for WLAN is taken as 2 Mbps. The battery consumption in 3G will be less than WLAN. The battery of the mobile user is around 8 hours. The mobile battery will be available for 8 hours if user is latched on to 3G and the mobile battery will be available for 4 hours if the mobile user latches on WLAN. This is normalized on the scale of 0 to 1.

Scenario 1

$w_c = 0.3$

$w_d = 0.3$

$w_b = 0.4$

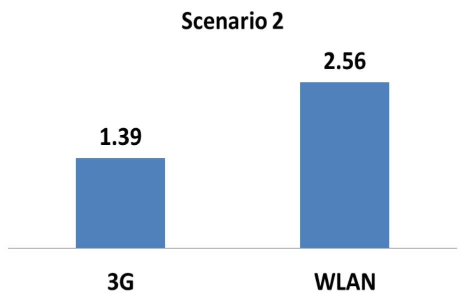

Figure 5: Score Value for Scenario 2

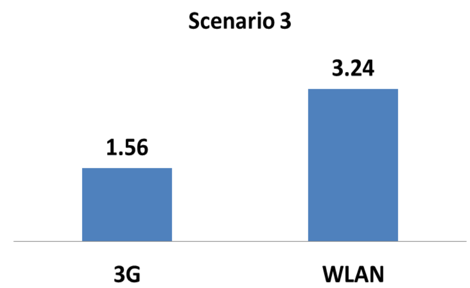

Figure 6: Score Value for Scenario 3

The values of simulation parameters are shown in table 1. Basis the values of the simulation parameters and weightages, the Score Values (SV) of both the networks is calculated. Figure 4 depicts the Score values for Scenario 1.

$SV_{3G} = 1.35$

$SV_{WLAN} = 2.54$

Observation from Figure 4 – The authors observe from above figure that the score value for WLAN is greater than 3G. Hence the handover should be performed to WLAN.

Remark: Perform handover to WLAN.

Scenario 2

$w_c = 0.4$

$w_d = 0.3$

$w_b = 0.3$

The values of simulation parameters are shown in table 1. Basis the values of the simulation parameters and weightages, the Score Value (SV) for both the networks is calculated. Figure 5 depicts the Score value for Scenario 2.

$SV_{3G} = 1.39$

$SV_{WLAN} = 2.56$

Observation from Figure 5 – The authors observe from above figure that the score value for WLAN is greater than 3G hence the handover should be performed to WLAN.

Remark: Perform handover to WLAN.

Scenario 3

$w_c = 0.3$

$w_d = 0.4$

$w_b = 0.3$

The values of simulation parameters are shown in table 1. Basis the values of the simulation parameters and weightages, the Score Value (SV) for both the networks is calculated. Figure 6 depicts the Score value for Scenario 3.

Table :1 Simulation parameters

Parameter	*Unit*	*3G*	*WLAN*
x (Usage Cost)	INR	0	0.5
y (Available Bandwidth)	Mbps	1	2
z (Battery Consumption)	hrs	0.5	1
T (Max. bandwidth required by user)	Mbps	2	4

$SV_{3G} = 1.56$

$SV_{WLAN} = 3.24$

Observation from Figure 6 – The authors observe from above figure that the score value for WLAN is greater than 3G hence the handover should be performed to WLAN.

Remark: Perform handover to WLAN.

CONCLUSION & FUTURE SCOPE

In this research paper, the authors have presented Vertical Handover Decision Algorithm (VHDA) which considers parameters like Received Signal Strength (RSS), bandwidth, usage cost and battery status. The authors have performed the implementation for a practical and real-life scenario. The VHDA is implemented using measured values of parameters on the field. The calculations of the score values for all the available networks have been performed. The selection of network for handover is performed on the basis of the calculated score values.

In future, the authors intend to design the algorithm for vertical handover using the Least Squares Weighting techniques. The authors also intend to establish the relationship between handover value and parameters using a polynomial regression model. The authors also intend to improve the algorithm for vertical handover by using more parameters like Quality of Service (QoS) and velocity of the user.

REFERENCES

[1] Siddharth Goutam and Srija Unnikrishnan, "QoS based Vertical Handover Decision Algorithm using Fuzzy Logic," in 2019 International Conference on Nascent Technologies in Engineering (ICNTE 2019), IEEE, Mumbai, 2019.

[2] Siddharth Goutam, Srija Unnikrishnan, Sundary Prabavathy, and Neel Kudu, "Prediction of Vertical Handover Using Multivariate Regression Model," International Journal of Innovative Technology and Exploring Engineering (IJITEE) (ISSN: 2278-3075), vol. 8, no. 10, pp. 2626-2633, August 2019.

[3] Ling- Jyh Chen, Tony Sun, Benny Chen, Venkatesh Rajendran, and Mario Gerla, "A Smart Decision Model for Vertical Handoff," in 4th ANWIRE Conference, 2004.

[4] Siddharth Goutam and Srija Unnikrishnan, "Algorithm for Vertical Handover Decision in Vehicular Environment," Journal of Information Technology Research, vol. 14, no. 1, January-March 2021.

[5] Xavier Perez Costa, Marc Torrent Moreno, and Hannes Hartenstein, "A Performance Comparison of Mobile IPv6,

Hierarchical Mobile IPV6, FAst Handovers for Mobile IPV6 and their Combination," Mobile Computing and Communications Review, vol. 7, no. 4, pp. 5-19, October 2003.

[6] Helen J. Wang, Randy H. Katz, and Jochen Giese, "Policy-enabled handoffs across heterogeneous wireless networks," in Proceedings WMCSA'99. Second IEEE Workshop on Mobile Computing Systems and Applications, IEEE, New Orleans, LA, USA, 25-26 Feb. 1999.

[7] Rohit Kapoor, Ling-Jyh Chen, M. Y. Sanadidi, and Mario Gerla, "CapProbe: A Simple and Accurate Technique to Measure Path Capacity," UCLA Computer Science Department , Technical Report CSD-TR No. 040001, 2004.

[8] Armando Fox, Steven D. Gribble, Yatin Chawathe, Eric A. Brewer, and Paul Gauthier, "Cluster-based scalable network services," in Proceedings of the Sixteenth ACM symposium on Operating systems principles, SOSP' 97, 1997, pp. 78-91.

[9] Angermann M. and Kammann J., "Cost Metrics for Decision Probelms in Wireless Ad Hoc Networking," in Proceedings of CAS 2002. IEEE CAS Workshop on Wireless Communications and Networking, IEEE, Pasadena, CA (USA), 2002.

[10] David A. Maltz and Pravin Bhagwat, "MSOCKS: an architecture for transport layer mobility," in Proceedings. IEEE INFOCOM '98, the Conference on Computer Communications. Seventeenth Annual Joint Conference of the IEEE Computer and Communications Societies. Gateway to the 21st Century (Cat. No.98), IEEE, San Francisco, CA, USA, p. 1998.

[11] Robert Hsieh, Zhe Guang Zhou, and Aruna Seneviratne, "S-MIP: a seamless handoff architecture for mobile IP," in IEEE INFOCOM 2003. Twenty-second Annual Joint Conference of the IEEE Computer and Communications Societies (IEEE Cat. No.03CH37428), IEEE, San Francisco, CA, USA, 2003.

[12] V. Ghini, G. Pau, M. Roccetti, P. Salamoni, and M. Gerla, "Smart download on the go: a wireless Internet application for music distribution over heterogeneous networks," in 2004 IEEE International Conference on Communications (IEEE Cat. No.04CH37577), IEEE, Paris, France, 2004.

[13] Ling-Jyh Chen, Tony Sun, Benjamin Cheung, Duke Nguyen, and Mario Gerla, "Universal Seamless Handoff Architecture in Wireless Overlay Networks," UCLA Computer Science Department, Technical Report CSD-TR No. 040012, 2004.

[14] Mark Stemm and Randy H. Katz, "Vertical handoffs in wireless overlay networks," Mobile Networks and Applications, vol. 3, pp. 335-350, January 1998.

[15] Imane Chattate, Mohamed El Khaili, and Jamila Bakkoury, "A Fuzzy-AHP based Approach for Enhancing Network Selection in Heterogeneous Networks Using Battery Energy Criterion," International Journal of Engineering & Technology, vol. 7, pp. 118-123, 2018.

[16] Siddharth Goutam and Srija Unnikrishnan, "Algorithm for handover decision in IEEE 802.11 WLAN Environment based on Fuzzy Logic," in International WIE Conference on Electrical and Computer Engineering (WIECON - ECE 2019), IEEE, Bangalore, 2019.

[17] Siddharth Goutam and Srija Unnikrishnan, "Analysis & Comparison of Decision Tree Algorithms for Vertical Handover in Wireless Networks," in Eighth International Conference on Advances in Electrical Measurements and Instrumentation Engineering - EMIE 2019, Cochin, 2019.

[18] Siddharth Goutam and Srija Unnikrishnan, "Handoff decision algorithm in wifi zone using Fuzzy Logic," in IEEE Xplore, 2019-Women Institute of Technology Conference On Electrical and Computer Engineering, WITCON ECE, Dehradun, 2019.

[19] Siddharth Goutam, Srija Unnikrishnan, and Aradhana Goutam, "Model for Vertical Handover Decision in Vehicular Networks," in IEEE, IEEE International Conference on Advances in Computing, Communication and Control (ICAC3'17) , Mumbai, 2017.

[20] Siddharth Goutam and Srija Unnikrishnan, "Decision for Vertical handover based on Naive Bayes Algorithm," in International Conference on Advances in Computing, Communication and Control (ICAC3'19), IEEE, Mumbai, 2019.

[21] Ali Calhan and Celal Ceken, "An optimum Vertical Handoff Decision Algorithm based on Adaptive Fuzzy Logic and Genetic Algorithm," Wireless Pers Communication, pp. 647 - 664, 2012.

[22] Xiaohuan Yan, Ahmet Sekercioglu, and Sathya Narayanan, "A survey of vertical handover decision algorithms in Fourth Generation heterogeneous wireless networks," Elsevier, Computer Networks, pp. 1848-1863, 2010.

[23] Maroua Drissi and Mohammed Oumsis, "Multi-criteria Vertical Handover comparison betweenWimax and Wifi," Information, vol. 6, pp. 399-410, 2015.

[24] Shidrokh Goudarzi, Wan Haslina Hassan, Mohammed Hossein Anisi, and Ahmad Soleymani, "A Comparative Review of Vertical Handover Decision-Making Mechanisms in Heterogeneous Wireless Networks," Indian Journal of Science & Technology, September 2015, Vol 8(23).

[25] Transforming Diagnostics Manufacturing at Cepheid: Migration from Paper-Based Processes to Digital Manufacturing using Opcenter MES. (2022). International Journal of Research and Applied Innovations, 5(1), 9451-9456. https://doi.org/10.15662/IJRAI.2022.0501005

[26] Y. N Gyekye and J. I. Agbinya, "Vertical Handoff Decision Algorithms Using Fuzzy Logic," in International Conference on Wireless Broadband and Ultra Wideband Communications, Sydney, January 2006.

[27] Siddharth Goutam and Srija Unnikrishnan, "A Geolocation based Algorithm for Vehicular Congestion Avoidance Using Fuzzy Logic," International Journal of Information Technology and Electrical Engineering (ITEE Journal), vol. 8, no. 6, pp. 68-73, December 2019.

[28] Venkata Krishna Bharadwaj Parasaram. (2021). Explainable Machine Learning Models for Improving Decision Making in Project Portfolio Management. Darpan International Research Analysis, 9(1), 12–21. https://doi.org/10.36676/dira.v9.i1.188

[29] Gamal Abdel Fadeel Mohamed Khalaf and Hesham Zarief Badr, "A comprehensive approach to vertical handoff in heteroegeneous wireless networks," Journal of King Saud University - Computer and Information Sciences, vol. 25, pp. 197-205, 2013.

[30] Mohamed Lahby and Abderrahim Sekkaki, "Optimal Vertical handover based on TOPSIS algorihm and Utility function In Heterogeneous Wireless Networks," in IEEE, 2017.

[31] Hongwei Liao, Ling Tie, and Zhao Du, "A Vertical Handover Decision Algorithm based on Fuzzy Control Theory ," in Proceedings of the First International Multi-Symposiums on Computer and Computational Sciences (IMSCCS'06),IEEE, 2006.

[32] Siddharth Goutam, Srija Unnikrishnan, Sundary Prabavathy, Neel Kudu, and Aradhana Goutam, "Assessment and Prediction of Quality of Service of Wireless Networks using Support Vector Machines," in 10th International Conference on Advances in Computing, Control and Telecommunication Technologies, ACT 2019, Cochin, 2019.

[33] Johann Marquez-Barja, Carlos T. Calafate, Juan-Carlos Cano, and Pietro Manzoni, "An overview of vertical handover techniques: Algorithms, protocols and tools," Elsevier, Computer Communications, pp. 985-997, 2011.

[34] K. Savitha and C. Chandrasekar, "Trusted Network Selection using SAW and TOPSIS Algorithms for Heterogeneous Wireless Networks," International Journal of Computer Applications, vol. 26, no. 8, pp. 22-29, 2011.