Journal of Green Engineering (JGE)

Volume-10, Issue-12, December 2020

Power Efficient Intelligent-Based Scheme of Vertical Handover Decision for Enhancing QoS in Vehicular Ad-Hoc Networks

[1]Fazli Azzali, [2]Osman Ghazali, [3]Mohd Hasbullah Omar, [4]Azizi Abas

[1,2,3,4]*Universiti Utara Malaysia, Sintok, Kedah, Malaysia.*
E-mail:[1]fazli@uum.edu.my,[2]osman@uum.edu.my,[3]mhomar@uum.edu.my,
[4]azizia@uum.edu.my

Abstract

The design of next Vehicular Ad-hoc Network (VANET) in various technologies will offer seamless connectivity across different coverage. However, VANET's vertical handover (VHO) decision in seamless connectivity is a huge challenge caused by the network topology complexity. Furthermore, the conventional scheme only uses a received signal strength as a metric value, which shows a lack of appropriate handover metrics that is more suitable in horizontal handover compared to VHO. This study aims to design an intelligent network to minimize the handover delay and latency, and packet loss in the heterogeneous Vehicle-to-Infrastructure (V2I) wireless networks. The proposed intelligent-based scheme uses Fuzzy Logic (FL) that generates multiple attributes parameters using the information context of vertical handover decision in the V2I heterogeneous wireless networks. This study uses a network simulator as the mobility traffic network and vehicular mobility traffic generator to perform a topology in a realistic VANET mobility scenario via Wi-Fi, WiMAX, and LTE networks technologies. The proposed intelligent scheme shows an improvement in the QoS handover over the conventional (RSS-based) scheme with an average QoS increased of 21%, 20%, and 13% in delay, latency and packet loss, while Media Independent Handover based (MIH-based) scheme with 12.2%, 11%, and 7% respectively. The proposed scheme assists the mobile user enhanced the QoS handover during the vehicles' movement without degrading the performance of ongoing applications.

Journal of Green Engineering, Vol. 10_12, 13606-13620.

Keywords: Vehicle-to-Infrastructure, Fuzzy logic, Received signal strength, Vertical handover decision, Media independent handover.

1 Introduction

The next-generation of the wireless technology was deployed in many countries. This technology provides more freedom to users in accessing the Internet and network applications with seamless communication through different wireless network technologies. The main intention is to allow a better connection with such applications, anywhere at any time without disconnection. Such enhanced connectivity is also referred to as “Always Best Connected (ABC)” network. On this context, this research proposes a strategy of VHO decision in heterogeneous VANET, which focuses on vehicle-to-infrastructure (V2I) communication technology.

Vertical handover (VHO) wireless networks will be leading in the future generation communication technology with the combination of different access wireless networks. Consequently, the presence of multiple networks in the VHO wireless network overlaps with each other in coverage areas which occurred the drop calling and unnecessary handover [1]. However, the RSS metric is not only a value of consideration in VHO decision making [2]. Therefore, implementing several metrics in VHO should be measured to attain the ideal decision which are the power requirements, bandwidth, user preference, monetary cost and service. Figure 1 illustrations the scenario of the complex issue that happens through various of radio access systems by using RSS-based algorithm through the aforementioned factors such as increased latency, delay, and packet loss ongoing application.

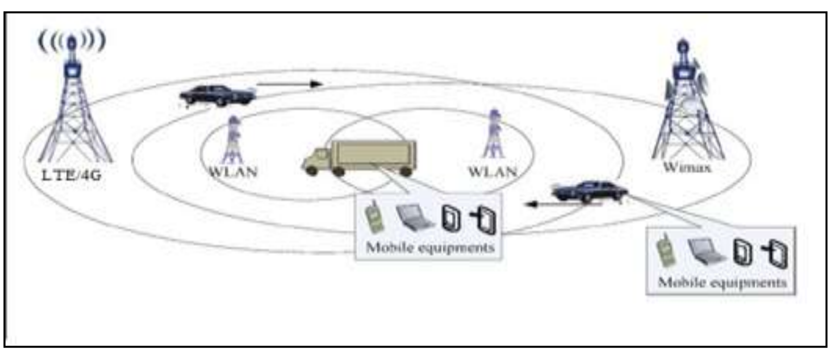

Figure 1 Vertical handover in Vehicular Ad-hoc Network

Multi-path fading, increased signal-to - noise ratio, and natural interference are another problem of interference in the various quality levels of the wireless network. [3].

2 Vehicular Ad-Hoc Network

Vehicular Ad-hoc Networks (VANETs) is subgroup of MANET, which represents networks-vehicles collaboration in a particular communication environment. VANETs can be classified into Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I). The V2V allows direct communication among available cars, while V2I is communication between vehicles and infrastructure (also known as a roadside unit- RSU). VANETs are also described as autonomous and self-configured ad-hoc networks. VANETs are the reliable establishment of vehicle networks used for communication purposes in highway or urban environments.

However, network switching and seamlessness are two important features of the VHO management in VANET need more studied. In preparation for a high technology improvement compared to horizontal handover, vertical handover is a key for the potential wireless network. This is due to the interrelated grouping of several technology networks that delivered mobile users broadband connectivity [4][5][6]. The VHO process can be divided into three phases: collection information, decision, and execution of handover [7, 8]. The first phase is known as the collection of information handover data, where the mobile terminal recognizes all the details of the data necessary to evaluate in the handover [9] [10]. The second phase is the handover decision, that most appropriate network access due to mobile terminal direction is noticed and predicted. This phase is also concerned with the communication of execution phase commands and is known as method selection.

There are different studies in the literature that describe the classification of VHO decision methods as stated in [11][12][13]. The final phase is the process of handover execution, where the mobile terminal has moved from its current network to the new network coverage. In addition, if the vertical handover decision is smart enough to select the appropriate different access networks by analyzing multiple criteria because of the complexities of the existing network design and technical development, smooth connected devices can be achieved [14][15][16][17]. VHO decision schemes can be classified into five groups based on current work[45-48]. The structures and methodologies used to process the decision on the handover are shown as Figure 2.

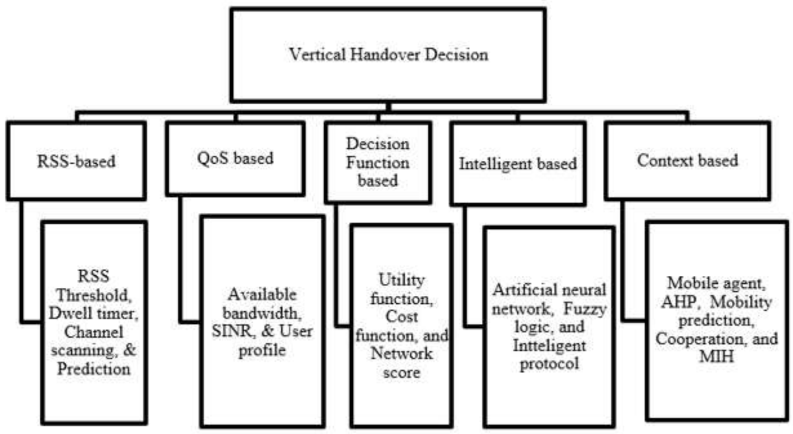

Figure 2 Categorization of VHO Decision Schemes [18]

Table 1 shown the comparative exisiting studied of VHO decision schemes as follows.

Table 1 Comparative of VHO decision schemes

Category of VHD Scheme	Description	Advantages	Drawbacks	Author
RSS-based Scheme	The decision of handover only based on RSS value and another metric assist for handover procedures but not directly involved in the handover decision making.	Reduced handover delay, reduced handover failure, reduced Ping-Pong effect.	Increased packet loss, increased signaling, higher handover delay in real time application, increased handover latency.	[12], [20], [21], [22], [23], [24], [25], [26]
QoS based Scheme	To maximize the QoS using the metrics of available bandwidth, user preferences and Signal-to-Interference and Noise Ratio (SINR) for making an optimal handover decision.	High throughput, decreased handover latency, less packet loss, reduced handover delay.	High Ping-Pong effect, not applicable for high speeds, higher resource consumption, inefficient bandwidth calculation.	[27], [28], [29], [30],[31]
Decision Function based Scheme	This handover decision making in order to select the best available networks becomes multi-criteria decision making (MCDM). The MCDM has included the cost, utility, score, and policy-based functions.	Cost effective, low handover blocking rate, reduced Ping-Pong effect, rank network selection.	Increased handover latency, unsuitable real-time application, high communication delay.	[32], [33], [13], [34], [16], [35], [11], [36]
Intelligent based Scheme	This scheme is used to overcome the issues of handover performance that irreversible in real-time data delivery in terms of handover latency, throughput, and unnecessary handovers.	Reduced handover delay, reduced latency, lower packet loss, successful handover, intelligent network selection, users satisfaction	High complexity, higher decision processing delays, high signaling overhead	[17], [18], [37], [38], [39], [40]
Context-based Scheme	The context is defined within any information that is relevant to the situation of an entity (person, place or object.). In other words, it is the distribution of correct and accurate information to the end users for making a decision.	Optimal network selection, reduced packet loss, high throughput,	Higher resource consumption, increased communication overhead, high signaling cost, security provision.	[41],[42],[43], [44],[45]

3 Experiment

The implemented Fuzzy Logic (FL) algorithm into Media independent handover (MIH) mechanism are divided into two subsections in this section. The simulation is conducted using VanetMobiSim and the National Institute of Standards and Technology (NIST) add-on module (NS2.29), which contains the IEEE 802.21 (MIH) library and is integrated with many packages. The experiments are described in detail as follows;

3.1 Fuzzy Logic Algorithm and Media Independent Handover (MIH)

The simulation scenario study of the proposed Fuzzy Logic in VHO and the IEEE 802.21 MIH mechanism is discussed in this subsection. The MIH protocol in the IEEE 802.21 standard deploys the sharing and exchange of data between peers to trigger handover. However, through the different media technologies, it also enables common information payload such as 802.3, 802.11, 802.16, and Cellular/UMTS/LTE [19][20]. Mostly, there are four link status services in the prediction algorithm definition of MIH: link up (LU), link coming up (LCU), link going down (LGD), and link down (LD) that signify the standard label used into MIH events. In this research, the crisp inputs received from Information service MIH were generated in fuzzy inference system. Afterward, the output of result is used by the MIH event service manager to obtain the link status as shown in Figure 3.

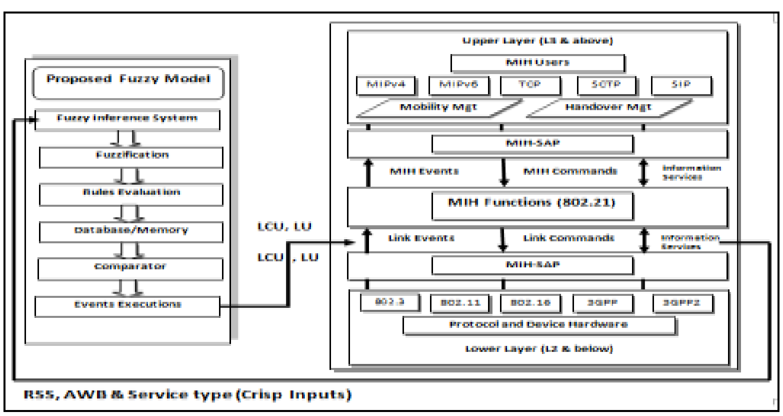

Figure 3 Fuzzy Logic model with MIH process

Based on Figure 3 shown the fuzzy inference system (FIS) started receive values of the crisp inputs from the MIH and examined via requirement of rules. The outcome is referred to the assessment regulation for defuzzied and event execution as crisp outputs. In addition, the fuzzifier with the rule calculation was improved to outfit the interest of the user, while the following sections will elaborate further descriptions of the fuzzy method. The fuzzification method contains a number of steps to transform the value into a member function (MF) classification for the linguistic provision of all parameters of fuzzy sets and delineated MFs as depicted in Table 2, Table 3, and Table 4. On the other hand, some MFs are being used in the operations for estimating the relation status of the MIH mechanism.

Table 2 Values of the Mfs

Membership Functions (mfs)	Weak	Medium	Strong	Available	Unavailable
Value	1	2	3	4	5

Table 3 Variables of the MFs

Variable	Weak	Medium	Strong
RSS (- dbm)	RSS<60	$60 \leq RSS < 90$	$RSS \geq 90$
ABW(Mbps)	ABW< 0.2	$0.2 < ABW < 0.37$	$ABW \geq 0.37$
Service type	**Unavailable (U)**	**Available (A)**	
		In our case assume all service is available	

3.2 Simulation and Parameters

Figure 4 demonstrates the simulation handover scenario used by three vary of radio technologies, such as Wi-Fi, WiMAX, and LTE, in VANET traffic light scenario. This study was used the CanuMobisim Spatial Model data traffic produced by the University of Stuttgart Informatik which implemented in the VanetMobiSim simulation. It also generated with macroscopic and microscopic model characteristics of VANET such as road topology, road characteristics, and choosing the motion pattern. Afterwards, the outcome from VanetMobiSim was extracted in Xml file and then incorporated into the network simulator (NS2.29) to measure the QoS.

Table 4 Possible Rules with Output Event Execution

		IF		THEN
Rule	**RSS**	**ABW**	**Service Type**	**Output Event**
1	1(Weak)	1(Weak)	5(U)	LD
2	1(Weak)	1(Weak)	4(A)	LD
3	1(Weak)	2(Medium)	5(U)	LD
4	1(Weak)	2(Medium)	4(A)	LD
5	1(Weak)	3(Strong)	5(U)	LD
6	1(Weak)	3(Strong)	4(A)	LD
7	2(Medium)	1(Weak)	5(U)	LD
8	2(Medium)	1(Weak)	4(A)	LD
9	2(Medium)	2(Medium)	5(U)	LD
10	2(Medium)	2(Medium)	4(A)	LGD
11	2(Medium)	3(Strong)	5(U)	LD
12	2(Medium)	3(Strong)	4(A)	LCU
13	3(Strong)	1(Weak)	5(U)	LD
14	3(Strong)	1(Weak)	4(A)	LD
15	3(Strong)	2(Medium)	5(U)	LD
16	3(Strong)	2(Medium)	4(A)	LCU
17	3(Strong)	3(Strong)	5(U)	LD
18	3(Strong)	3(Strong)	4(A)	LU

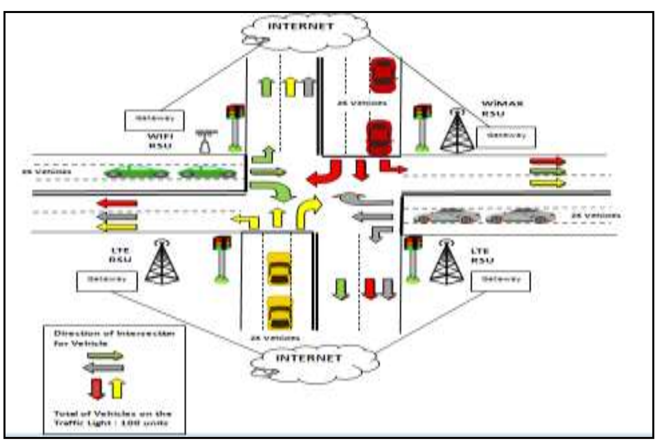

Figure 4 Simulation Traffic light Scenario

Table 5 Simulation Parameters

SIMULATION PARAMETERS	VALUES
Simulation range	2000m x 2000m
Simulation duration	300 s
Frequency bandwidth of 802.11	2.4 GHZ
Transmission radiuses of 802.11	20 m
Data rate of 802.11	11 Mbps
Propagation Model	TwoRayGround
Antenna	Omni antenna
Routing Protocol 802.11	DSDV
Max packet in if queue length 802.11	50
Frequency bandwidth of 802.16	3.5 GHZ
Transmission radiuses of IEEE 802.16	500m
802.16 channel bandwidth	10 MHz
Propagation Model	TwoRayGround
802.16 modulation and coding	OFDM 16QAM 3/4
MAC/802.16 UCD (uplink channel) interval	5 s
MAC/802.16 DCD (downlink channel) interval	5 s
UMTS/LTE uplink bandwidth	384 kbps
UMTS/LTE downlink bandwidth	384 kbps
Link data rate	100 Mb/s
UDP Max packet size (byte)	1,024
UDP header size (bytes)	8
Mobility protocol	MIPv6
Vehicle speed	1~100 / kmph

Table 5 indicates the set-up of simulation parameters in network simulator. The vehicles were assumed to move through the road topology in 300s with interactive platform in traffic classes for the simulation time. As in the actual traffic light situation, to imitate its function, the traffic light was lined up into 3 lanes. [46-48] The movement of the vehicle starts, crosses and leaves the traffic light connected to the adjacent access network coverage from the first lane of the road. Afterward, it is followed by the second lane on either side or proceeds to the third lane. The maximum interval time was set at 5 s.

4 Result and Discussion

This section uses the proposed fuzzy logic algorithm to evaluate QoS in VANET. It is compared with RSS-based and MIH-based algorithms using various vehicle speeds, such as 20, 40, 60, 80, and 100 km/h, in terms of latency, end-to-end delay, and packet loss.

4.1 Handover Latency

Figure 5 shows that Fuzzy Logic's average latency is much lower due to the RSS and MIH-based algorithms. The average latencies are 10.6, 11.90, and 13.2 milliseconds respectively for the FL, MIH-based, and RSS-Threshold algorithms. The handover latency was decreased by up to 20 percent as the velocity rose from 20 km/h to 100 km /h.

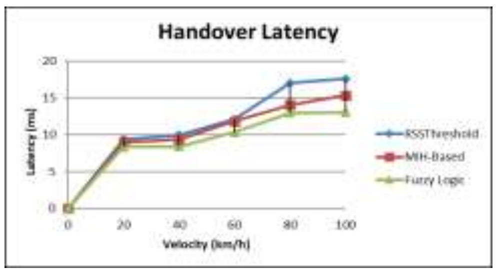

Figure 5 Handover Latency and Velocity

4.2 End-to-end Delay

The Fuzzy Logic algorithm is much good than others algorithms on RSS-Threshold and MIH which have a lower end-to-end average delay rate of around 21 and 12 percent, respectively as depicted in Figure 6. The result of proposed Fuzzy Logic also decreases rapidly to 29 milliseconds while speed increases from 20 km/h to 100 km/h.

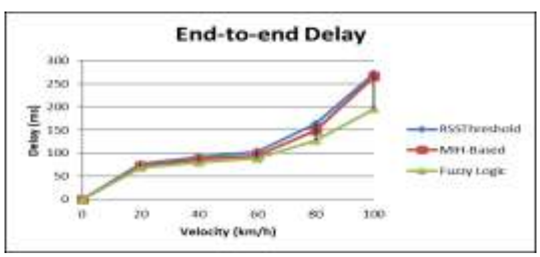

Figure 6 End-to-end and Velocity

4.3 Packet Loss

Generally, packet loss often lowers once handover latency reduces as illustrated in Figure 7. As a result, the average packet loss of Fuzzy Logic dropped by 13 and 7 percent, respectively when compared to the RSS-Threshold and MIH-based algorithms.

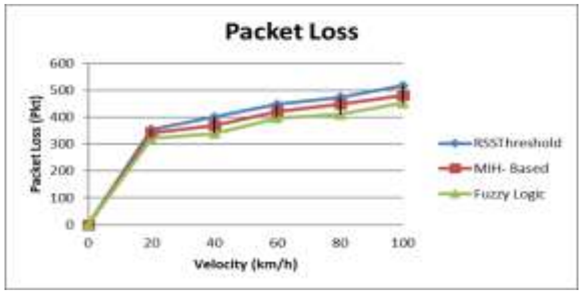

Figure 7 Packet loss and Velocity

5 Conclusion

Networking technology for VANET, network tracking and handover decision processes will perform key important role in achieving potential efficient mobility solutions for Internet connectivity. The outcome analysis is an improved QoS of the heterogeneous VANET mentioned in this study. The study of proposed algorithm improved QoS efficiency result in heterogeneous VANET compared to the RSS and MIH-based algorithms that reduced delay, latency, and packet loss from the experiment.

References

[1] Y. S. Hussein, B. M. Ali, P. Varahram, and A. Sali, "Enhanced Handover Mechanism in Long Term Evolution (LTE) Networks", Sci. Res. Essays, Vol. 6, no. 24, pp. 5138–5152, 2011.

[2] A. Aziz, S. Rizvi, and N. M. Saad, "Fuzzy Logic based Vertical Handover Algorithm between LTE and WLAN," International Conference on Intelligent and Advanced Systems, 2010,

[3] Narayanan, "An Intelligent Vertical Handover Decision Algorithm For Wireless Heterogeneous Networks, American Journal of Applied Sciences, Vol. 11, no.5, pp.732-739, 2014.

[4] Payaswini P, Manjaiah D H, "Simulation and Performance analysis of Vertical Handoff between WiFi and WiMAX using Media Independent Handover Services", International Journal of Computer Applications, Vol. 87, no.4, pp.14–20 2014.

[5] R. M. Abdullah, A. Z. Abualkishik, and A. A. Alwan, "Improved handover decision algorithm using multiple criteria," Procedia Computer Science, Vol. 141, pp.32-39, 2018.

[6] E. Obayiuwana and O. E. Falowo, "Network selection in heterogeneous wireless networks using multi-criteria decision-making algorithms: a review," Wirel. Networks, Vol. 23, no. 8, pp. 2617–2649, 2017.
[7] S. Mohanty and I. F. Akylidiz, "A cross-layer (layer 2 + 3) handoff management protocol for next generation wireless systems", IEEE Trans. Mob. Comput., Vol. 5, no. 10, pp. 1347–1360, 2006.
[8] X. Yan, Y. A. Sekercioglu, and S. Narayanan, "A survey of vertical handover decision algorithms in fourth generation heterogeneous wireless networks", Asian J. Inf. Technol., Vol. 13, no. 4, pp. 247–251, 2010.
[9] E. M. Malathy and V. Muthuswamy, "State of Art : Vertical Handover Decision Schemes in Next-Generation Wireless Network," J. Commun. Inf. Networks, Vol. 3, no. 1, pp. 43–52, 2018.
[10]M. Navale and S. Bhavani, "Comparative Analysis of Vertical Handover Algorithms," Int. J. Appl. Eng. Res., Vol. 13, no. 6, pp. 4583–4587, 2018.
[11]A. Kumar and H. Purohit, "A Comparative Study of Different Types of Handoff Strategies in Cellular Systems," Int. J. Adv. Res. Comput. Commun. Eng., Vol. 2, no. 11, pp. 4278–4287, 2013.
[12]I. Bisio, C. Braccini, S. Delucchi, F. Lavagetto, and M. Marchese, "Dynamic multi-attribute Network Selection algorithm for Vertical Handover procedures over mobile ad hoc networks," IEEE International Conference on Communications (ICC),pp. 342–347, 2014.
[13]Z. Hameed Mir and F. Filali, "LTE and IEEE 802.11p for vehicular networking: a performance evaluation," EURASIP Journal on Wireless Communications and Networking, Vol.1,no.89, pp. 1–15, 2014.
[14]E. M. Malathy and V. Muthuswamy, "Knapsack - TOPSIS technique for vertical handover in heterogeneous wireless network," PLoS One, Vol. 10, no. 8, pp. 1–16, 2015.
[15]S. T. Miri and S. Tabatabaei, "Improved Routing Vehicular Ad-Hoc Networks (VANETs) Based on Mobility and Bandwidth Available Criteria Using Fuzzy Logic," Wireless Personal Communications, Vol.113, no.8, pp. 1–16, 2020.
[16]G. Li, M. Ma, C. Liu, and Y. Shu, "Fuzzy Multiple Attribut Decision Routing in VANETs International Journal of Communication Systems, Vol. 30,no.4,2015.
[17]T. Bouali and S.-M. Senouci, "A Fuzzy Logic-Based Communication Medium Selection for QoS Preservation in Vehicular Networks," Proc. 5th ACM Symp. Dev. Anal. Intell. Veh. Networks Appl. - DIVANet '15, pp. 101–108, 2015.
[18]M. Drissi, M. Oumsis, and D. Aboutajdine, "A Fuzzy AHP Approach to Network Selection Improvement in Heterogeneous Wireless Networks", International Conference on Networked Systems, Vol.1, pp 169-182, 2016.

[19]I. Kustiawan and K. Chi, "Handoff Decision Using a Kalman Filter and Fuzzy Logic in Heterogeneous Wireless Networks," IEEE Commun. Lett., Vol. 19, no. 12, pp. 2258–2261, 2015.
[20]A. Ahmed, L. M. Boulahia, and D. Gaïti, "Enabling vertical handover decisions in heterogeneous wireless networks: A state-of-the-art and a classification", IEEE Commun. Surv. Tutorials, Vol. 16, no. 2, pp. 776–811, 2013.
[21]S. Park, J. P. Jeong, and C. S. Hong, "QoS-guaranteed Mobile IPTV service in heterogeneous access networks," ELSEVIER-Computer Networks, Vol. 69, pp. 66–81, 2014.
[22]D. Mu, X. Ge, and R. Chai, "Vertical handoff modeling and simulation in VANET scenarios", Int. Conf. Wirel. Commun. Signal Process., pp. 1–6, 2013.
[23]C. W. Lee, M. C. Chen, and Y. S. Sun, "Protocol and architecture supports for network mobility with QoS-handover for high-velocity vehicles," Springer -Wireless Networks, Vol. 19, no. 5, pp. 811–830, 2013.
[24]L. Sun, H. Tian, and P. Zhang, "Decision-making models for group vertical handover in vehicular communications," Springer-Telecommunication Syst., Vol. 50, no. 4, pp. 257–266, 2012.
[25]M. B. Patil, "Vertical Handoff in Future Heterogenous 4G Network", Int. J. Comput. Sci. Netw. Secur., Vol. 11, no. 10, pp. 201–206, 2011.
[26]S. K. Lee, K. Sriram, K. Kim, Y. H. Kim, and N. Golmie, "Vertical handoff decision algorithms for providing optimized performance in heterogeneous wireless networks", IEEE Trans. Veh. Technol., Vol. 58, no. 2, pp. 865–881, 2009.
[27]T. F. M. Hendrixen, "UMTS and LTE / SAE handover solutions and their comparison," 2009. Available online : https://www.semanticscholar.org/paper/UMTS-and-LTE%2FSAE-handover-solutions-and-their-Hendrixen/172529969f2488d3a620234b7d267b553a483509
[28]Y. K. Salih, O. H. See, R. W. Ibrahim, S. Yussof, and A. Iqbal, "A user-centric game selection model based on user preferences for the selection of the best heterogeneous wireless network", annals of telecommunications, Vol.70, pp. 239–248, 2014.
[29]P. Vetrivelan, P. Narayanasamy, B. Anitha, G. Anusha, T. A. Arvindan, and S. Ganesh, "A Mixed Game Theory and Ranking Approaches for Vertical Decision in 4G Heterogeneous VANETs," Int. J. Soft Comput., Vol. 8, no. 4, pp. 283–289, 2013.
[30]E. H. Ong and J. Y. Khan, "On optimal network selection in a dynamic multi-RAT environment," IEEE Commun. Lett., Vol. 14, no. 3, pp. 217–219, 2010.
[31]R. Libnik, A. Svigelj, and G. Kandus, "A novel SIP based procedure for congestion aware handover in heterogeneous networks," Computer Communications, Vol. 33, no. 18, pp. 2176–2184, 2010.
[32]H. L. Wang and S. J. Kao, "A Vertical Handover Scheme from WMAN to WLAN by Taking into Account the Maximum Available Resource,"

6th International Conference on Computer Science & Education (ICCSE),pp. 1373–1378, 2011.

[33]G. Mahardhika, M. Ismail, and R. Nordin, "Vertical Handover Decision Algorithm Using Multicriteria Metrics in Heterogeneous Wireless Network," J. Comput. Networks Commun., Vol. 2015, pp. 720–721, 2015.

[34]K. S. S. Anupama, S. S. Gowri, B. Prabhakararao, and P. Rajesh, "Application of MADM Algorithms to Network Selection," International Journal of Innovative Technology and Exploring Engineering, Vol. 3, no. 6, pp. 64–67, 2015.

[35]Z. Ning, Q. Song, Y. Liu, F. Wang, and X. Wu, "Markov-based vertical handoff decision algorithms in heterogeneous wireless networks", ELSEVIER-Computers Electr. Eng., Vol. 40, no. 2, pp. 456–472, 2014.

[36]C. Kathirvel and D. Loyd, "Optimized Hybrid Wireless Mesh Protocol Using Estimation of Packet Loss Rate Algorithm for Vanet," Int. J. Comput. Sci. Mob. Appl., Vol. 2, pp. 117–123, 2014.

[37]A. Mehbodniya, F. Kaleem, K. K. Yen, and F. Adachi, "A fuzzy MADM ranking approach for vertical mobility in next generation hybrid networks," Int. Congr. Ultra Mod. Telecommun. Control Syst. Work., pp. 262–267, 2012.

[38]V. Anantha Narayanan, A. Rajeswari, and V. Sureshkumar, "An intelligent vertical handover decision algorithm for wireless heterogeneous networks," Am. J. Appl. Sci., Vol. 11, no. 5, pp. 732–739, 2014.

[39]A. S. Sadiq, K. A. Bakar, K. Z. Ghafoor, J. Lloret, and R. Khokhar, "An intelligent vertical handover scheme for audio and video streaming in heterogeneous vehicular networks," Mob. Networks Appl., Vol. 18, no. 6, pp. 879–895, 2013.

[40]T. Sivakami and S. Shanmugavel, "Performance Analysis of Fuzzy Logic Based Vertical Handoff Decision Algorithm for Heterogeneous Networks," Asian J. Sci. Res., Vol. 6, no. 4, pp. 763–771, 2013.

[41]J. M. Kang, J. Strassner, S. S. Seo, and J. W. K. Hong, "Autonomic personalized handover decisions for mobile services in heterogeneous wireless networks," Computer Networks, Vol. 55, no. 7, pp. 1520–1532, 2011.

[42]M. Zekri, B. Jouaber, and D. Zeghlache, "Context aware vertical handover decision making in heterogeneous wireless networks," IEEE Local Comput. Netw. Conf., pp. 764–768, 2010.

[43]Y. Kim, S. Pack, C. G. Kang, and S. Park, "An enhanced information server for seamless vertical handover in IEEE 802.21 MIH networks," Computer Networks, Vol. 55, no. 1, pp. 147–158, 2011.

[44]J. J. J. Roy, V. Vaidehi, and M. S. Sricharan, "QoS guaranteed integration methodology for a WLAN-WiMAX heterogeneous network," Computers Electr. Eng., Vol. 37, no. 3, pp. 261–274, 2011,.

[45]P. Neves, J. Soares, S. Sargento, H. Pires, and F. Fontes, "Context-aware media independent information server for optimized seamless handover procedures," Computer Networks, Vol. 55, no. 7, pp. 1498–1519, 2011.

[46] C.Jothi Kumar R.Karthikeyan, "Improved Reputation System for Wireless Sensor Networks (WSNS)",International Journal Of Innovations In Scientific And Engineering Research (IJISER), Vol.1,no.3,pp.191-195,2014.

[47] Mai Navid And Nh Niloy, "Development Of Forecasting Model Using Back Propagation Neural Network For Predicting Vegetable Price", International Research Journal of Multidisciplinary Science & Technology (IRJMRS),Vol.2,no.1,pp.66-70,2017.

[48]Mallikarjuna Nandi and K.Anusha, "Evaluation of Energy Aware Routing Protocol for Mobile Adhoc Network", Vol.10, no.11, pp.10753-10766, 2020.

Biographies

Fazli Azzali, Universiti Utara Malaysia, Sintok, Kedah, Malaysia.

Osman Ghazali, Universiti Utara Malaysia, Sintok, Kedah, Malaysia.

Mohd Hasbullah Omar, Universiti Utara Malaysia, Sintok, Kedah, *Malaysia.*

Azizi Abas, Universiti Utara Malaysia, Sintok, Kedah, Malaysia.