International Journal of Management, IT & Engineering
Vol. 9 Issue 1, (Special Issue HICAAMMC- January 2019)
ISSN: 2249-0558 Impact Factor: 7.119
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

A Survey on Handover Mechanisms in Mobile Ad hoc Networks

N.Sivapriya
Research Scholar
Dept. of Computer Science
Periyar E.V.R. College
Trichy, India
nmsivapriya@gmail.com

Dr.T.N.Ravi
Assistant Professor
Dept. of Computer Science
Periyar E.V.R. College
Trichy, India
proftnravi@gmail.com

ABSTRACT

In modern years, mobile equipments are becoming the most primary platforms for many users who always around and access the mobile computing applications. The rapid growth and development of mobile communication network system has accelerated data transfer speed. Such technologies are expected for providing the various services such as voice, data, web browsing, video conferencing, video streaming and telemetry along with mobility of the end users. The mobility is provided by different handoff mechanisms for all types of services. However, the most challenging issues in wireless mobile communication networks are providing the seamless handover while mobile equipment moves between different access networks. Making a transition from one network to another and moving between heterogeneous networks are not the issues that worried scientific and mobile operators; the concern of Quality-of-Service (QoS) requirement is the most significant for handoff. The requirements such as capability of the network, network conditions, handoff latency, power consumption, network cost and user preferences should be considered during handoff. Hence, different adaptive mechanisms have been required for implementing the handoff mechanisms in wireless networks and producing an effective service for the user by considering different handover parameters. This paper covers a detailed study and analysis on different handover mechanism for transmitting the data in wireless networks technology. In addition, comparison analysis is also presented based on their merits, demerits and performance metrics. Hence, this study helps to reveal the requirement for a novel approach which satisfy the most essential requirements and reduce the handover failure probability and the number of unnecessary handover.

Keywords: Wireless Networks, Mobile computing, Handover, Mobility, Quality-of-Service.

I. INTRODUCTION

In wireless mobile telecommunications, handover is defined as the process of transferring an ongoing call or data session from one channel to the other channel which is connected to the access network. It is also referred as handoff which is mostly utilized within International and European organizations like ITU-T, IETF, ETSI and 3GPP, and standardized within European originated standards like GSM and UMTS [1]. The handover is used for the following purposes:

While the mobile is moving away from the coverage region by one cell and entering the coverage region by another cell, the call is transferred to the second cell for avoiding the call termination when mobile gets outside the range of the first cell.

When the channel utilized by the mobile becomes interfered by another mobile which uses the similar channel in the different cell, the call is transferred to the different channel in the same cell or to the different channel in another cell for avoiding the interference.

The most fundamental concept of handover is when the call in progress is redirected from its current cell named source to the new cell called target [2]. In terrestrial networks, the source and the target cells may be served from two different cell sites or from one and the same cell site. Such handover is known as inter-cell handover.

International Journal of Management, IT & Engineering
Vol. 9 Issue 1, (Special Issue HICAAMMC- January 2019)
ISSN: 2249-0558 Impact Factor: 7.119
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

The source and the target may be served from same cell sites and only the used channel is changed during handover is known as intra-cell handover. Moreover, handover is also classified into hard handover and soft handover.

Hard handover is one where the channel in the source cell is released and only then the channel in the target cell is engaged. Therefore, the connection to the source is broken before or as the connection to the target is made so such handovers are also called as break-before-make. These are intended to be instantaneous for minimizing the disruption to the call. When the mobile is between base stations, the mobile may switch with any of the base stations. Hence, the base stations bounce the connection with the mobile back and forth which is called as ping-ponging. Soft handover is one where the channel in the source cell is retained and used for a while in parallel along with the channel in the target cell. For this, the connection to the target is established before the connection to the source is broken so these are also called as make-before-break [3]. Handover may be classified based on the handover techniques used. Such classification includes three types like network controlled handover, mobile phone assisted handover and mobile controlled handover.

Furthermore, it is categorized as horizontal and vertical handoff according to the types of access networks. Handoff between homogeneous networks is called as horizontal handoff in which one type of network is considered. Alternatively, a handoff between different types of networks such as heterogeneous environment is known as vertical handoff. The horizontal handoff takes place between two cellular base stations whereas vertical handoff happens between an access points of a Wireless Local Area Network (WLAN) and a base station of a cellular base station. Vertical handoff is implemented across heterogeneous cells of access systems which may differ in various QoS parameters such as bandwidth, data rate, operation frequency, etc. Such various characteristics of the networks make vertical handoff more challenging as compared with horizontal handoff [4].

Generally, WLAN connections provide higher speeds when cellular technologies provide more ubiquitous coverage. Hence, the mobile equipments may require to use the WLAN connection whenever one is available and to fall over to the cellular connection when WLAN is unavailable. Therefore, vertical handover is used for automatic fall over from one technology to the other for maintaining the communication. This is different from the horizontal handover between various wireless access points which use the same technology in that a vertical handover involves the data link layer modification for accessing the network. However, several issues are observed in the implementation of handover mechanism in wireless technologies such as QoS, optimization, rerouting connection, etc. The primary objective of this article is to present the detailed survey on different handover mechanisms in wireless technologies and notice the issues during handover process using such mechanisms.

II. LITERATURE SURVEY

Context-aware load balancing in WiFi-WiMAX heterogeneous network environment [5] was proposed for deciding the handover points. Initially, the bandwidth management and admission control scheme were proposed for proper distribution of total network traffic over an integration of WiFi-WiMAX environment. The load-imbalance problem in WiFi base station was mitigated by distributing the traffic load among the overlapping access points in a WiFi hotspot. According to the bandwidth management mechanism, a handover policy was designed which instructs the users when to do a handover between WiFi and WiMAX interfaces other than normal handover performed due to mobility for maintaining QoS and Quality-of-Experience (QoE) of the end-users when preferring WiFi interface for communication.

A utility-based fuzzy TOPSIS method was proposed [6] for energy efficient network selection in heterogeneous wireless networks. A novel method was proposed which considers the user preferences, network conditions, QoS and energy consumption requirements for selecting the optimal network which achieves the best balance between performance and energy consumption. The utilization of parameterized utility functions was incorporated by the proposed network selection method for modeling the diverse QoS elasticity of different

International Journal of Management, IT & Engineering
Vol. 9 Issue 1, (Special Issue HICAAMMC- January 2019)
ISSN: 2249-0558 Impact Factor: 7.119
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

applications and adopting the different energy consumption metrics for real-time and non-real-time applications. User preferences were easily configured for different application and situation contexts through the utilization of linguistic assessments and their representation as triangular fuzzy numbers. The aggregation of multiple criteria for the determination of the overall rating of the networks was performed by using Fuzzy Set Representation TOPSIS method which is used for solving the inconsistency issues related to conflicting decision criteria. Moreover, the utility functions were employed for removing the ranking abnormality problem.

Energy and quality of service aware fuzzy technique [7] was proposed for heterogeneous wireless network. A novel energy efficient vertical handover decision algorithm was designed which is called as fuzzy technique for order preference by similarity to ideal solution (FUZZY-TOP). The proposed algorithm was obtained by combining a fuzzy-rule based mechanism including with the mechanism for order preference by similarity to ideal solution approach. Fine tuning of fuzzy membership values was performed by increasing the number of membership regions and also reduced the rule set. Moreover, the detailed evaluation of the proposed handover decision mechanism was investigated by using the generalized Markov chain.

An optimized seamless dual-link handover mechanism [8] was proposed for High-Speed Rail (HSR) with Long Term Evolution (LTE) technology. The seamless handover was performed based on the utilization of two antennas on the front and rear of the train respectively for proper handover and communication. A novel algorithm was considered for optimizing the handoff opportunity by investigating not only the hysteresis exceeding level but also the signal strength of both antennas. The parameter selection was analyzed according to the probability model. Moreover, a set of new handover mechanisms were introduced for optimizing the utilization of two antennas which reduce the overhead and improve the QoS of the users. Thus, the proposed algorithm was used for avoiding untimely and unstable handover and unnecessary bi-casting while train comes to the base station.

An adaptive membership function for handover decision mechanism [9] was proposed in wireless mobile network. The proposed approach was incorporated by self-tuning of fixed Fuzzy Membership Functions (FMF) which dynamically modifies the membership functions for matching the requirements of the service option requested. Therefore, a single FMF set was maintained. In the proposed dynamic FMF mechanism, the adaptive behavior of a fuzzy engine was realized by dynamically modifying its FMF sets. This may be accomplished by the FMF self-tuning process. The performance was compared with the static adaptive membership based handover decision algorithm.

A hybrid Network or Mobile Controlled Handover (N/M-CHO) [10] was proposed for heterogeneous wireless networks. Initially, soft or hard vertical handover mechanism was proposed by using the mathematical analysis model based on the six-dimension (6-D) Markov chain model. Then, a reward and cost model was defined according to the data rate and the bandwidth allocated to the incoming calls. This model was used by mobile users operating in MCHO mode for deciding whether perform a hard or soft handover or not. Moreover, a soft or hard handover decision mechanism was also defined which may work by using either MCHO or NCHO depending on the decision metric used. The performance was evaluated based on the handover gain, handover frequency.

An enhanced fast handover with seamless mobility support [11] was proposed for next generation wireless networks. The proposed handover protocol was named as enhanced Seamless Mobile IPv6 (e-SMIPv6). Bidirectional tunnels were established among access routers before actual handover accordingly mobile users may utilize their previous care-of-address within the new visiting network. The delay related to duplicate address detection was reduced by each access router which maintains the pool of duplicate-free addresses. Moreover, the packet loss was also minimized by access router which performs bicasting for roaming node. In addition, the mobility signaling during handoff was minimized by the proposed mechanism which is used for presenting an ideal solution for fast moving and ping-pong moving mobile users.

International Journal of Management, IT & Engineering
Vol. 9 Issue 1, (Special Issue HICAAMMC- January 2019)
ISSN: 2249-0558 Impact Factor: 7.119
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

A hybrid artificial intelligent based handover decision algorithm [12] was developed in wireless mobile communication. The developed model was based on the hybrid of Artificial Neural Network (ANN) based prediction model and fuzzy logic. Initially, the Received Signal Strength (RSS) was obtained over the time period during the network access to form a time series data. Then, the data was fed into the proposed k-step ahead ANN-based RSS prediction system for estimating the prediction model coefficients. The synaptic weights and adaptive coefficients of the trained ANN were used for computing k-step ahead ANN-based RSS prediction model coefficients. The predicted RSS value was codified as fuzzy sets and in conjunction with the other measured network parameters were fed into the fuzzy logic controller for finalizing the handover decision process. Thus, the proposed system was having the capability for reducing the ping-pong effect associated with other handover mechanisms.

An optimization performance was studied [13] for minimizing the impact of the handover for mobile users in WLAN. A performance model was developed for a set of networked 802.11 based WLAN access points which is based on the Mixed Integer Linear Program (MILP). The objective function was used simultaneously for maximizing the total system rate and also minimizing the number of handovers for a configurable handover signaling rate. Since, the conflicting behavior of the two objective functions such multi-objective optimization was complex for exploration. In addition, the weighted sum method for understanding the impact of higher weights on one of the two objective functions. Finally, the proposed approach was evaluated based on the different scenarios which consider different number of users and mobility parameters like user speed.

Handover management model was developed [14] for WiMAX point-to-multi-point networks. A distributed base station cooperation-based handover management mechanism was proposed for providing the quality of service to handover nodes. Furthermore, a delay reduction approach was proposed for reducing the packet delivery delays during handover process. Then, Call Admission Control (CAC) algorithm was introduced for handling handover calls of different service classes accurately based on their priorities. In addition, a bandwidth borrowing method was proposed for reducing the handover call dropping probabilities of different service classes when not starving the ongoing calls of lower priority service classes. Finally, a Markov model was developed for analyzing the proposed CAC method and obtaining the approximate handover call dropping probabilities of different service classes.

Simplified and improved multiple attributes alternate ranking method [15] was proposed for vertical handover decision in heterogeneous wireless networks. The proposed approach was referred as SI-MAAR for eliminating the attribute normalization and weight calculation methods so the rank reversal problem resulting in reliable network rank for seamless handover was solved. This may be achieved by a simple closeness index matrix which is computed based on the network's attributes and their expectations. Furthermore, new positive and negative ideal solutions were proposed based on the benefit and cost attributes for overcoming the rank reversal problem.

Application of renewal theory was proposed [16] for call handover counting and dynamic location management in cellular mobile networks. The three fundamental strategies such as distance-based, time-based and movement-based and their corresponding optimization cost were described for location management. Moreover, counting the number of wireless cell crossings or handovers occurring in the call duration time during the inter-call times was emphasized which is a basic issue for mobility management analysis. Finally, the renewal theory was developed for modeling the probabilistic structure of such optimization problems.

Guaranteed handover schemes were described [17] for a multilayer cellular system. In the proposed approach, two guaranteed handover schemes were designed in which overflow and take-back operations with geographical information were utilized for assisting in guaranteeing the handover. A system model was established for illustrating the proposed two schemes. In the system model, the cell layer with smaller sized cells (CL I) were overlaid by the Cell Layer with larger sized cells (CL II). The call blocking probability for the system with Time-based Channel Reservation Algorithm (TCRA) was reduced by the overflow operation. Moreover, by

International Journal of Management, IT & Engineering
Vol. 9 Issue 1, (Special Issue HICAAMMC- January 2019)
ISSN: 2249-0558 Impact Factor: 7.119
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

considering the overflowed traffic back to the CL I, the call blocking probability in the CL I can be further improved and the overflowed traffic may be reduced.

III. DISCUSSIONS

This section illustrates an overview of merits and demerits of different handover mechanisms whose functional scenarios are discussed in brief in literature survey. From the following Table 1, the most challenging issues in handover mechanisms are observed and an ideal solution is identified for overcoming such issues during handover process in wireless network scenarios.

Table.1 Comparison of Different Handover Mechanisms

Ref. No.	Merits	Demerits
[5]	Less communication cost, Improved network capacity	The total handover delay was increased
[6]	High QoS performance and Less energy consumption	Ping-pong effect was not removed and handover triggering was not examined
[7]	Improved availability and QoS requirements	Requires better optimization method for selecting fuzzy membership functions
[8]	Reduced handover failure probability and communication interruption probability	High complexity and Requires an effective approach for parameter selection and QoS requirements
[9]	Improved network selection	Performance of QoS requirements was not analyzed
[10]	Improved throughput, bandwidth saving percentage and handover latency	High handover latency for hard vertical handover method
[11]	Reduced total cost and packet losses	When router does not have enough buffer, the packet loss was high and QoS parameters were not analyzed
[12]	Improved handover decision and removed ping-pong effect	Requires optimization method for selecting the fuzzy input parameters
[13]	Reduced total download volume and handover failure probability	Requires robust optimization techniques for improving the performance
[14]	Reduced call dropping probability	The handover call dropping probability was increased due to increased call arrival rates
[15]	Reduced rank reversal problem and High network rank reliability	High complexity and Requires the analysis of handover delay and QoS parameters
[16]	Improved mobility management	Requires QoS parameter analysis
[17]	Reduced new call blocking probability and overflowed traffic	QoS parameters were not analyzed

IV. CONCLUSION

In this paper, a detailed survey on handover mechanisms in wireless and mobile computing technologies was encountered. It is obvious that all researches have tried in different handover mechanism under different network scenarios to achieve better results than the other handover mechanisms with different modifications based on the previous mechanisms. Even then, further improvement of handover mechanisms can make the estimation of QoS parameters based on the multiple services. Hence, the further research focus will be based on the reduction of handoff delay and QoS variability based on priority-based algorithm using location-aware adaptive applications.

REFERENCES

[1] Nisha, Kumar, S., & Bhatnagar, J., "Handoff strategies in cellular system", *International Journal of New Trends in Electronics and Communication, 1*(2), 22-28, 2013.

[2] Zekri, M., Jouaber, B., & Zeghlache, D., " A review on mobility management and vertical handover solutions over heterogeneous wireless networks", *Computer Communications, 35*(17), 2055-2068, 2012.

International Journal of Management, IT & Engineering
Vol. 9 Issue 1, (Special Issue HICAAMMC- January 2019)
ISSN: 2249-0558 Impact Factor: 7.119
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

[3] Paul, L. C., "Handoff/Handover Mechanism for Mobility Improvement in Wireless Communication", *Global Journal of Researches in Engineering, Electrical amd Electronics Engineering*, *13*(16), 2240-4596, 2013

[4] El Fachtali, I., Saadane, R., & Koutbi, M., "A survey of handovers decision algorithms for next generation wireless networks", *International Journal of Advanced Research in Computer and Communication Engineering*, *4*(1), 159-165, 2015.

[5] Sarma, A., Chakraborty, S., & Nandi, S., "Deciding Handover Points Based on Context-Aware Load Balancing in a WiFi-WiMAX Heterogeneous Network Environment", *IEEE Transactions on Vehicular Technology*, *65*(1), 348-357, 2016

[6] Kantubukta, V., Maheshwari, S., Mahapatra, S., & Kumar, C. S., "Energy and quality of service aware FUZZY-technique for order preference by similarity to ideal solution based vertical handover decision algorithm for heterogeneous wireless networks", *IET networks*, *2*(3), 103-114, 2013

[7] Chamodrakas, I., & Martakos, D., "A utility-based fuzzy TOPSIS method for energy efficient network selection in heterogeneous wireless networks", *Applied Soft Computing*, *12*(7), 1929-1938, 2012

[8] Yu, X., Luo, Y., & Chen, X., "An optimized seamless dual-link handover scheme for high-speed rail", *IEEE Transactions on Vehicular Technology*, *65*(10), 8658-8668, 2016

[9] Thumthawatworn, T., "Adaptive Membership Functions for Handover Decision System in Wireless Mobile Network", *Procedia Computer Science*, *86*, 31-34, 2016

[10] Vegni, A. M., & Natalizio, E., "A hybrid (N/M) CHO soft/hard vertical handover technique for heterogeneous wireless networks", *Ad Hoc Networks*, *14*, 51-70, 2014

[11] Zhang, L. J., & Pierre, S., "An enhanced fast handover with seamless mobility support for next-generation wireless networks", *Journal of Network and Computer Applications*, *46*, 322-335, 2014

[12] Aibinu, A. M., Onumanyi, A. J., Adedigba, A. P., Ipinyomi, M., Folorunso, T. A., & Salami, M. J. E., "Development of hybrid artificial intelligent based handover decision algorithm", *Engineering Science and Technology, an International Journal*, *20*(2), 381-390, 2017

[13] Zola, E., & Kassler, A. J., "Minimizing the impact of the handover for mobile users in WLAN: A study on performance optimization", *Computer Networks*, *107*, 292-303, 2016

[14] Lakshmi, L. R., Ribeiro, V. J., & Jain, B. N., "Handover management framework for WiMAX Point-to-Multi-Point networks", *Computers & Electrical Engineering*, 2015

[15] Chandavarkar, B. R., & Guddeti, R. M. R., "Simplified and improved multiple attributes alternate ranking method for vertical handover decision in heterogeneous wireless networks.*Computer Communications*, *83*, 81-97, 2016

[16] Rodríguez-Dagnino, R. M., & Takagi, H., "Application of renewal theory to call handover counting and dynamic location management in cellular mobile networks", *European Journal of Operational Research*, *204*(1), 1-13, 2010

[17] Li, S., Grace, D., Wei, J., & Ma, D., "Guaranteed handover schemes for a multilayer cellular system", In *Wireless Communication Systems (ISWCS)*, 300-304, 2010