COMBINED NEURO-FUZZY VERTICAL HANDOVER DECISION CRITERIA FOR LTE/LTE-A NETWORKS

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Abstract- Vertical handover advantage giant importance due to the upgrades in mobility models by way of the Fourth generation (4G) technology. A handover selection scheme in LTE networks both primarily based on unmarried or multiple standards. The range of standards is directly depending on the whole handover time. Similarly, the time required for deciding on a target network for the duration of handover is likewise elevated with the increase in some of parameters. Traditional handover choice procedures are specifically based totally at the single parameter. However, with the introduction of heterogeneous Wi-Fi networks, the performance of those single parameter choice schemes is distinctly decreased. Therefore, researchers introduce multi-standards handover selection schemes. The complexity and processing of multi-standards during handover is a complex activity and hence these schemes require excessive handover time which ultimately leads to the excessive packet loss or even breaking of connection. Moreover these improvements are confined to precise situations and for this reason do not offer help for conventional mobility. Similarly, various schemes are proposed based on these mobility fashions however most of them are suffered from the excessive packet loss, common handovers, too early and late handovers, beside the point community choice, and many others. To deal with these demanding situations, a normal vertical handover control scheme for heterogeneous Wi-Fi networks is proposed is needed.

Keywords:- Neuro-Fuzzy, LTE/LTE-A Networks, Handover.

1.0 Introduction

Wi-Fi networks, packages and gadgets had been undergoing a breathtaking evolution during the last decade. due to the complexity of the Wi-Fi surroundings, no single technology can be efficient to provide cell users with excessive information price and right first-rate of carrier (QoS) over all situations. Certainly, to meet the growing demand of cellular users, subsequent technology Wi-Fi structures are relaying on cooperative heterogeneous Wi-Fi technologies permitting the customers to be related at anytime and anywhere.

Heterogeneous wireless networks may additionally comprise exclusive radio access technology consisting of GSM, GPRS, HSPA, UMTS, WiFi, WiMAX or even LTE which is turning into the new 4G well known for wireless communication. The main promise of the interworking of those heterogeneous networks is to provide excessive performances by way of attaining excessive information price and assisting video telephony, streaming and multicasting with excessive QoS ranges. Numerous troubles related to the heterogeneity of such wireless environment need to be addressed, particularly, mobility and multi homing control, aid allocation, safety, excessive QoS help and seamless handover. Handover is the motion of transferring a mobile Terminal (MT) from one wireless cell/generation to some other.

2.0 Types of Handover

Traditionally, the handover manner has been studied among get entry to points (AP) or networks the use of the identical radio technology. This manner, denoted through the Horizontal Handover (HHO), is particularly primarily based at the Received Signal Strength (RSS) degrees. With the emergence of a multitude of overlapping Wi-Fi networks, MTs ought to switch their connections among extraordinary get admission to technologies with special skills and characteristics. In this example, the handover technique is greater complex and is denoted via Vertical Handover (VHO). Figure 1 indicates a class of the handover according three types:

2.1 Handover Based at the Community Worried

This form of handover may be characterized in ways:

2.1.1 Horizontal Handover

The horizontal transfer is the transfer manner precipitated during a alternate of the access point in the equal generation [1].

It is typically accomplished in homogeneous cell networks whilst a cell movements among two cells of the same access era.

This technique is usually required because of the mobility and the impossibility to keep connection. discern 2 indicates the trade of get admission to point. for instance UMTS to UMTS, WLAN to WLAN.

2.1.2 Vertical handover

The vertical handover is the switch technique between two networks of various technologies. For example: between WIFI to WiMAX or UMTS to LTE.

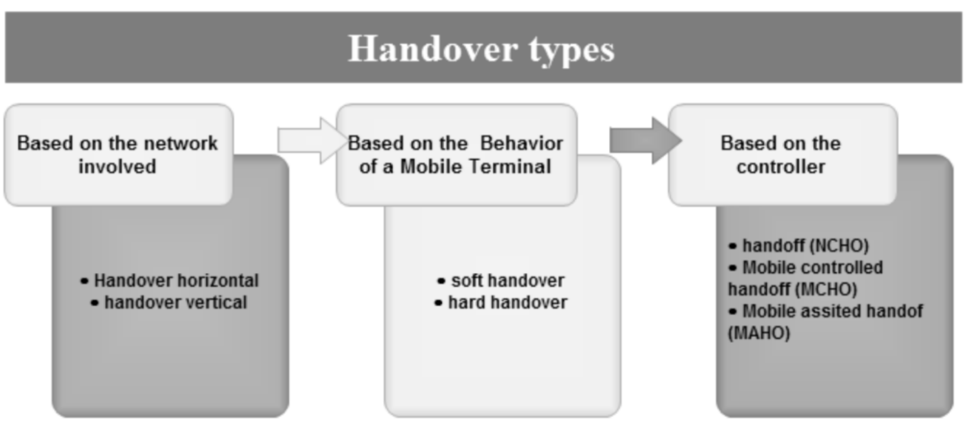

Figure 2.1: Classification of handover

This system is essential inside the field of heterogeneous networks. The usage of handover may stem from the desire of the person who seeks a higher best of connection, rather than connectivity problem. As an instance, the cellular terminal may additionally need to connect with another network for a better great of connection even supposing the connection to the old network is still possible. Figure 2 illustrates both horizontal and vertical handovers.

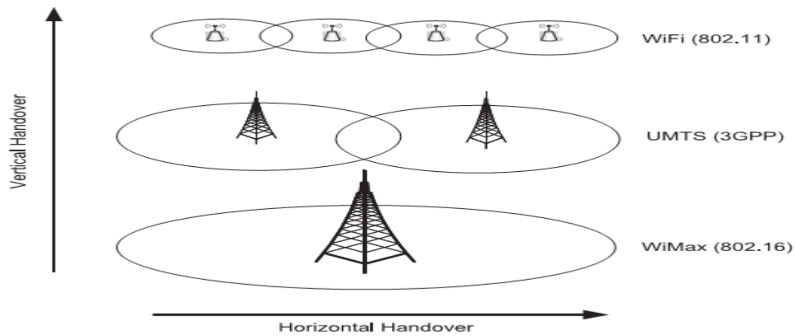

Figure 2.2: Horizontal and Vertical Handover

Vertical handover control is a imperative issue as it's far meant to make certain seamless roaming of customers from one Wi-Fi get entry to generation to any other. It requires mobility choice mechanisms and mobility protocols. Mobility decisions are based totally on vertical handover choice criteria and algorithms aiming to make sure automatic, short and proper selections for network choice. Mobility protocols tackle addressing and routing tactics together with the help of multi-homing permitting users to be simultaneously connected to a couple of Wi-Fi networks. Mobility selections and protocols are covered within the VHO control manner that consists in 3 steps, namely, system discovery, handover choice, and handover execution. At some stage in the system discovery segment, the data required to perceive the need for vertical handover is accumulated. Both Mobile Terminals (MT) and networks take part to accumulate that information. This information is then used all through the handover selection phase to evaluate the available networks and determine the maximum suitable one for every ongoing utility. Eventually, all through the handover execution step, a new connection is set up and old sources are launched. As soon as the new get entry to community is chosen, the communication classes should be transferred from the vintage radio interface to the new one. A brand new routing route is then set up.

2.2 Handover Primarily Based at the Conduct of a Cell Terminal

This kind of handover can be characterized in methods, illustrated in parent 3 inside the case of mobile networks:

2.2.1 Difficult Handover

Tough handover is largely a connection 'spoil before make ". The relationship to the bottom station is completed earlier than switch to some other get right of entry to point [2]. Accordingly the cellular communication undergoes an interruption at some stage in the transfer process among heterogeneous networks. Difficult handover is visible as an incident at some stage in a connection.

2.2.2 Tender Handover

Gentle handover is also referred to as handover led by means of the cellular. The supply get entry to point is retained and used for some time in parallel with the goal access factor. At some point of this segment, the connection to the goal is hooked up before the relationship to the supply is broken; this mode is known as "make-before break".

3.1. Handover Primarily Based at the Controller

Selection making and execution of the handover may be completely supported both through the operator or by way of the mobile. Such a handover may be declined in three modes:

3.1.1. Community-Managed Handoff (NCHO)

On this mode the selection is as much as the network. The handover may be initiated or assisted by means of the mobile (cellular initiated or mobile assisted). In the first case, handover is initiated by means of the cellular; the cell node detects a new get entry to point considered excellent (Handover Initiation), it then informs the community that accepts or rejects the handover. Within the second case, the network initiates the handover and the cellular node assists the process (cellular Assisted Handover, MAHO) with the aid of providing information needed for selection-making [3].

3.1.2. Cellular-Controlled Handoff (MCHO)

The cell node makes a decision the handover based on local information consisting of the signal electricity (Radio sign power, RSS), the interference at the radio channel (signal to Noise Interference Ratio, SINR), the blocking errors rate (BLER), the choices of the consumer, the rate of the cell, and many others.

The network that provides, in this example, some carrier nice parameters such as bandwidth and packet loss charge, may assist the handover managed by way of the cell. Those parameters can also be taken into account through the mobile node to determine the destination network.

3.1.3 Cell-assisted handoff (MAHO)

This approach is related to mobile technology in which the bottom station is assisted by using the mobile to make a switch with more potent signal and higher channel pleasant.

4.0 Vertical Handover manner

Vertical handover refers to all operations carried out to enable a cell terminal to transport from one network to some other without lack of connection.

As an instance, in a cell community handover mechanism allows roaming between cells or operators. Among the reasons that create a want for handover, we can mention [4]:

- The cell node leaves the coverage location of the present day mobile and communicates via a brand new cellular.
- The cellular node undergoes big interference at the current cell consequently the need to go on every other cellular (at the identical network or a one of a kind network), wherein there is less interference.
- The variety of cellular nodes in a mobile may be very huge leading to a saturation of bandwidth and thereby inflicting deterioration of the high-quality of provider. The mobile can pick to go in much less congested neighboring cells.

In general, the handover procedure is achieved in three most important steps:

4.1 Segment 1: Handover records collecting

In this degree of handover's coaching and initiation, the cell terminal detects available networks and their important characteristics consisting of the sign energy, the level of interference and the bit errors fee. Every other statistics will also be beneficial such the person's velocity, the overall performance's terminal, and battery's charging price.

Taking handover selection may be primarily based in this statistics. The scan this records can be both periodic or precipitated with the aid of events [5].

4.2 Phase 2: Handover choice

In the course of the handover, the transfer's choice is the most crucial step that could have an effect on the normal progress of the communication. Fallacious choice can degrade the first-class of service or even interrupt the communication in progress.

In well known, this step video display units the reference to the present day network, it allows evaluating the want for handover, choosing a brand new community and estimating the correct switch time.

Considering consumer options and traits of to be had networks, the followed choice method lets in every user to pick out the maximum appropriate network get right of entry to from those available. This step ends in the instructions vital for the implementation phase.

4.3 Section 3: Handover Execution

This segment is used to alternate channels closer to new get right of entry to factor or base station (AP or BS) via following instructions furnished inside the selection phase. This section takes region in three steps: hook up with the target network, launch the contemporary channel and use the desired authentication carrier. Once the exceptional get entry to network decided on and authentication performed, the conversation session will continue with the brand new community.

5.0 Vertical Handover Decision Criteriea

To ensure continuity of service, various parameters can orient the choice of a vertical handover.

Among the most important criteria, we quote:

- Signal strength (RSS).
- Bandwidth.
- Power.
- Security
- User Preference.
- Rapidity.
- Flow.
- Load.
- Jitter

Figure 3 illustrates the most important criteria that can be raised according to various points of view: user, terminal, service, or network.

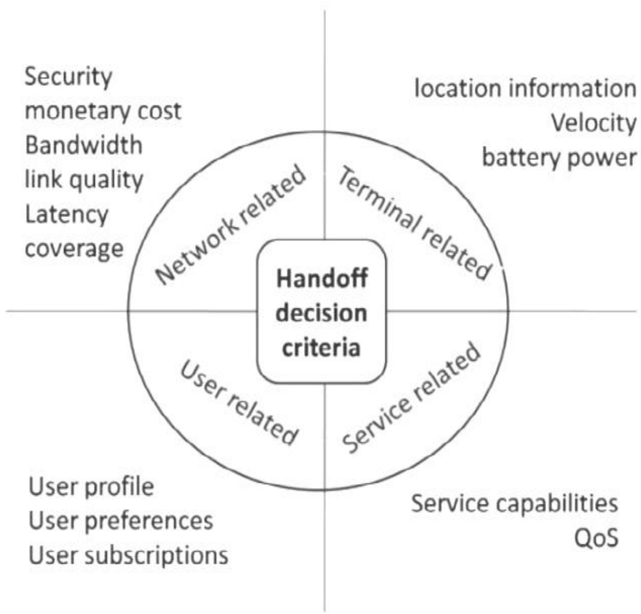

Figure 3.1: Handover decision criteria

6.0 Related Work

Sivasankaran V., et al. (2015) presented a upcoming world the communication among heterogeneous wireless networks is a challenging task. Since the access technologies of various networks are different and while interoperable operations, some technical issues may occur. Handoff is an important method can provide solution for making interoperability among heterogeneous networks. Handoff method is purely depends on the attributes of the network such as bandwidth, delay, signal quality, reliability, and energy, access cost and so on. Handoff decision can be obtained by investigating the attribute values and various MADM methods such as SAW, MEW, TOPSIS and GRA are proposed already. In this paper EMADM approach is proposed to choose the optimized attribute values for decision making using AIS. Performance is evaluated by analyzing and comparing the obtained performance metrics with the existing approaches [1]. After that **Jain A., et al. (2015**) presented the future generation of wireless system is expected to provide multimedia, multi class services any time anywhere with seamless mobility and Quality of service (QoS). In such environment, optimal vertical handoff is a challenging issue. Unnecessary handoff causes wastage of network resources and thus affects the QoS of network. In this paper, we have proposed the vertical handoff decision depends on coverage area of the network and the velocity of the mobile user. We have determined application-wise critical speed for particular coverage range of network during which handoff is beneficial. In our work, we have considered applications like HDTV, MPEG-4, and H.261 in heterogeneous network of UMTS (Universal Mobile Telecommunication System) and WLAN. The simulation is performed using Network Simulator NS-2 with NIST (National Institute of Standards and Technology) mobility module [2]. Then **Li W., et al. (2015)** told about mobility is the inherent cause of resource poverty and low connectivity in wireless environment, it also enables the opportunity for surrounding sensing, therefore providing mobility-augmented cloud service becomes the key challenge for the emerging paradigm of Mobile Cloud Computing (MCC). This article provides an overview of the mechanisms and open issues for mobility-augmented service provisioning in MCC. We first outline the concept, system architecture, and taxonomy of research issues. Then we introduce three key mechanisms with respect to mobility augmentation, heterogeneous network convergence and mobile service provisioning. Moreover, we discuss the open challenges to reveal the future direction of MCC [3]. Therefore **Bin M., et al. (2015)** solve the problem the existing vertical handoff algorithms of vehicle heterogeneous wireless network do not consider the diversification of network's status, an optimized vertical handoff algorithm based on markov process is proposed and discussed in this paper. This algorithm takes into account that the status transformation of available network will affect the quality of service (QoS) of vehicle terminal's communication service. Firstly, Markov process is used to predict the transformation of wireless network's status after the decision via transition probability. Then the weights of evaluating parameters will be determined by fuzzy logic method. Finally, by comparing the total incomes of each wireless network, including handoff decision incomes, handoff execution incomes and communication service incomes after handoff, the optimal network to handoff will be selected. Simulation results show that: the algorithm proposed, compared to the existing algorithm, is able to receive a higher level of load balancing and effectively improves the average blocking rate, packet loss rate and ping-pang effect [4]. After that **Srivastava A., et al. (2016)** worked on new generation of wireless mobile network is an integration of different radio access technologies. These radio access technologies can be 802 family such as Wi-Fi and WiMAX, and non-802 family such as UMTS and LTE. Integration of these technologies provides global seamless roaming across the diverse range of mobile access networks. Nowadays, mobile devices are coming with many interfaces. Most of cell phone models support Wi-Fi, WiMAX and 3G and 4G technologies. In this context, vertical handoff is a biggest challenge that allows a mobile node to transfer its traffic from one network interface to another. Integrating multiple heterogeneous technologies into a cell phone invokes many challenges regarding networks cooperation, QoS and service continuity guaranty. Various algorithms for handoff has been introduced to make the handoff seamless. This paper discusses about vertical handoff and its algorithms and parameters used for handoff [5]. Then **Chang W., et al. (2016)** presented the emerging hyper-dense heterogeneous network (HetNets) is an effective solution to building an easy-access wireless communication environment. In the hyper-dense HetNets, however, the inescapable handoff procedure is the key to its success. An effective handoff algorithm can not only achieve the goal of load-balancing but also enhance the overall system capacity. In this paper, we proposed an efficient load-aware vertical handoff (VHO) algorithm for HetNets. With the aid of the system load information from the neighboring cells, the computational complexity during the VHO procedure can be significantly reduced. Moreover, by effectively off-loading the cells with relatively light traffic loads (i.e. Non-worst conditioned cells), the dropping rate can be significantly reduced. Most importantly, the user and the overall system capacity can be greatly enhanced as well [6]. Then **Sateesh, S., et al. (2016)** worked on the increase in popularity of wireless networks, there is a need of combining various heterogeneous networks to provide global information access to the user. Vertical handoff is an exciting and a latest scheme that intends at combining different network interfaces. The most decisive parameter which plays an important role in certain mobile nodes is battery power. Due to the complexity of vertical handoff algorithms previously developed, the battery power of certain mobile nodes is almost exhausted at the end of execution of algorithm. Moreover, as mobile nodes operate with limited battery power, when battery level falls below a specific level, handing off to a network with low power consumption can provide extended usage time. Thus there is a necessity to develop a vertical handoff algorithm with minimum complexity. In this paper, a new vertical handoff algorithm is developed which aims at taking an optimal handoff decision using two simple steps. Unlike the previous developed algorithms, this algorithm discriminates resource rich and resource poor mobile stations during the execution of the algorithm. Due to the consideration of dynamic new call blocking probability during handoff decision, this algorithm helps in connecting to the optimal network in the vicinity of the mobile station [7]. Then **Van T. D., et al. (2016)** gave one considerable challenge in future heterogeneous wireless networks (HetNets) is vertical handover. Current vertical handover approaches almost focus on resolving two questions 1) when a Mobile Station (MS) needs to carry out a vertical handover (VHO) procedure; and 2) how a proper handover decision can be made in a HetNets environment. Actually, some approaches do not guarantee that MS can avoid handover flapping due to continuous changes in AP/BTS association. In addition, after MS joins in a new environment, many solutions do not care if VHO candidates meet requirements on QoS, such as fairness and throughput due to channel dynamicity. In this paper, we propose two algorithms: the VHO decision-making algorithm and proportional fair over HetNets algorithm. VHO decision-making algorithm and Proportional Fair over HetNets (PFoHN) determines the network selection based on the availability of the target network. After VHO process is finished, resource allocation is performed by the algorithm Proportional Fair over HetNets (PFoHN). In our study, the proposed approaches are developed with the support of Software-Defined Wireless Network technologies. Performance results show that Proportional Fair over HetNets (PFoHN) outperforms the Proportional Fair (PF) in terms of bandwidth and resource fairness, it also remarkably improves the overall system spectral efficiency [8]. After that **Khan M., et al (2017)** proposed scheme works in three phases. In the first phase, a handover triggering approach is designed to identify the appropriate place for initiating handover based on the estimated coverage area of a WLAN, Access point or cellular base station. In the second phase, fuzzy rule based system is designed to eliminate the inappropriate networks before deciding an optimal network for handover. In the third phase, a network selection scheme is developed based on the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) decision mechanism. Various parameters such as delay, jitter, Bit Error Rate (BER), packet loss, communication cost, response time, and network load are considered for selecting an optimal network. The proposed scheme is tested in a mobility scenario with different speeds of a mobile node ranging from very low to very high. The simulation results are compared with the existing decision models used for network selection and handover triggering approaches. The proposed scheme outperforms these schemes in terms of energy consumption, handover delay and time, packet loss, good put, etc [9].

7.0 Conclusion and Future Scope

A handover decision scheme is either based on single or multiple criteria. The number of criteria is directly depending on the total handover time. Similarly, the time required for selecting a target network during handover is also increased with the increase in a number of parameters. Traditional handover decision approaches are mainly based on the single parameter. But, with the introduction of heterogeneous wireless networks, the performance of these single parameter decision schemes is highly reduced. Therefore, researchers introduce multi-criteria handover decision schemes. The complexity and processing of multi-criteria during handover is a complex job and hence these schemes require high handover time which ultimately leads to the high packet loss and even breaking of connection. Moreover, the schemes provided in the literature are based on several logical interfaces and modification to the existing systems. The IP-based solutions are more favorable than any other infrastructure, but the research consists of vertical handover schemes that are mostly based on lower layer architecture. Finally, deploying these schemes in heterogeneous wireless networks consume high power and suffered from high packet loss and handover time. To cope with aforementioned constraints, we proposed a network selection model based on fuzzy based multi-criteria decision modeling. The decision of handover triggering is performed by computing the expected coverage area of the AP or BS. A multi-threshold mechanism is designed to trigger the handover at appropriate place and time. Moreover, the network selection is performed using fuzzy based TOPSIS with the MADM decision model incorporating several parameters such as delay, jitter, Bit Error Rate, packet loss, communication cost, response time, and network load. We consider only those parameters which are indirectly proportional with the QoS of a network. The ultimate goal of considering only indirect parameters is to avoid the imbalance created due to the two different types of parameters (directly and indirectly affecting). The proposed scheme is tested in different heterogeneous scenarios and the results are compared with different decision models and handover triggering techniques. The handover latency, the number of handovers, and packet loss is significantly reduced and the good put an ACT of the MN in a network are significantly increased due to the proposed handover triggering and network selection. The simulation results show that the proposed scheme perform superior to the schemes present in the current literature. In future, we will extend the work to more complex heterogeneous scenarios.

8.0 References

1. Sivasankaran V., Nagarajan V. and Senthil R., "Decision Making For Vertical Handoff In Heterogeneous Wireless System," In *ITC-CSCC: International Technical Conference on Circuits Systems, Computers and Communications*, pp. 203-206, 2015.
2. Jain A. and Tokekar S., "Application Based Vertical Handoff Decision in Heterogeneous Network," *Procedia Computer Science* 57, pp. 782-788, 2015.
3. Li W., Zhao Y., Lu S. and Chen D., "Mechanisms and challenges on mobility-augmented service provisioning for mobile cloud computing," IEEE Communications Magazine, Vol. 53(3), pp. 89-97, 2015
4. Bin M., Hong D., Xianzhong X. and Xiaofeng L.. "An optimized vertical handoff algorithm based on Markov process in vehicle heterogeneous network," China Communications, Vol. 12(4), pp. 106-116, 2015.
5. Srivastava A. and Misra A., "Exploration of Vertical Handoff between Heterogeneous Networks," Imperial Journal of Interdisciplinary Research, Vol. 2(9), pp. 1391-1396, 2016.
6. Chang W., Wu H. T., Lee Y. and Su S. L.. "Efficient load-aware vertical handoff for hetnet with poisson-point-process distributed traffics," In *Wireless Communications and Networking Conference (WCNC)*, pp. 1-6, 2016.
7. Sateesh S., Kumar M., Krishna M. B. and Laxmi V., "Handoff Probability Analysis of GSM Cellular Network," *Wireless Communication*, Vol. 8(3), pp. 117-122, 2016.
8. Van Tung D, Thanh N. H., Nam T. M., Hung N. T. and Dung N. X., "Joint Vertical Handoff and Resource Allocation in OFDMA/TDD Systems based on Software-Defined Wireless Network," In Proceedings of the 10th International Conference on Ubiquitous Information Management and Communication, pp. 22. ACM, 2016.
9. Khan M., Ahmad A., Khalid S., Ahmed S. H., Jabbar S. and Ahmad J., "Fuzzy based multi-criteria vertical handover decision modeling in heterogeneous wireless networks," Multimedia Tools and Applications, pp. 1-26, 2017.