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Handover Decision to Improve the Performance of the Communication System

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***Abstract*—** Wireless networks have been emerged as a great change to communication. Though handover plays a vital role when the network of communication changes. In order to achieve effective communication, there is a requirement of an effective handover with low latency. A significant number of researches have been performed to enhance the handover process (HO). These days, heterogeneous networks also become very popular and handover also plays an important role in communication. In this paper, an overview of different handover techniques used to perform effective operations for drones and other wireless devices so that efficient communication can be performed during changing of access point or base stations. This paper explains how handover can be used to attain better performance of the system by taking effective handover decision in terms of latency, and mobility and cost function.

***Keywords*—** Wireless Communication**,** Handover, Handover Process, Fuzzy Logic, Hard Handover, Soft Handover.

I. INTRODUCTION

Wireless Communication is the process of transmitting information from one location to another location without using any physical nodes. There are a huge number of wireless technologies that offers quality of services (QoS) to the customer and achieve customer satisfaction. However, these networks are different from each other, but their integration will provide better services to the customer which further boosts up the QoS. The next generation heterogeneous network has become chart topping in order to make this idea of 'Constantly Connected' a reality [1]. Therefore, enabling seamless communication in wireless network, a well-organized handoff between the various technologies plays a significant role. Handoff/Handover is referred to the process of forwarding a mobile station from a base station or channel to another. It can be defined as the process of shifting the communication channel associated with the present connection during an active call. In the handoff process, there are two phases: handoff initiation and handoff execution. The first stage is the initiation of the handoff, in this phase, the new base station or access point is chosen to which the mobile station has to be transferred. In the second phase- the execution of the handoff, formation of novel radio link takes place between the base station/ access point and mobile station. Along with this, allocation of resources is also performed in this phase.

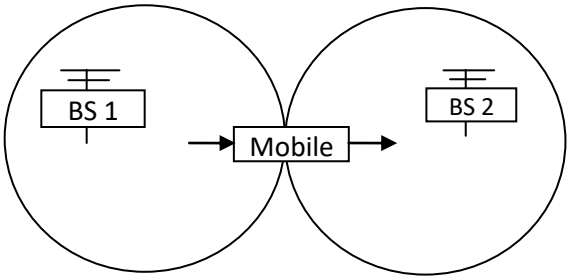

Figure 1: Handoff process between different base stations

Handover is classified into different categories such as: horizontal and vertical handoff, hard and soft handoff. A horizontal handover (HHO) is performed within the same network, between points of attachment, e.g. between two neighboring base stations of a cellular network (WLAN to WLAN) [2]. In contrast, the vertical handoff (VHO) takes place between the different network technologies, i.e. the points of attachment are from different networks. The example of a VHO is the handoff between a cellular network base station and an access point of IEEE 802.11. Figure 1 shows how handoff takes place between two base stations.

There are two types of handoffs in cellular communication systems [3].

Soft Handoff

In the soft handoff, firstly, the connection with the next cell is set up. After setting up the connection, the link with the last call broke. Soft handoff can be described as make before break handoff. The chances of dropping a call are less likely to occur as the first call is in connection with the next call, thus, it is considered as better handoff.

Hard Handoff

Hard handoff is opposite of soft handoff. It can be defined as break before make connection. Hard handoff breaks the connection that is already linked with the base station. After breaking the connection, the new connection is made with the next cell. It is the inter-cell or intra-cell handoff. In this type, call droppings are more than soft handoff as before making the connection, the connection with the last call is first broken.

Drones

Handover is performed in the heterogeneous networks. Meanwhile, Internet of things (IoT) has revolutionized significant handoff toward the researchers [3]. In the scenarios with the emergency, IoT act as a virtual technology where every individual and device engrosses the geographical locations, timestamps, and legible identity using Internet of things. IoT is being emerged as a popular field with the increased demand of unnamed aerial vehicles (UAVs). With the advancement in IoT, a significant number of application areas have been introduced [4, 5]. Drone is one of the applications that act as a promising solution to various problems such as in natural disasters, setting up the network on the ground is not feasible and drones come up with the solution to cope with such scenarios [6].

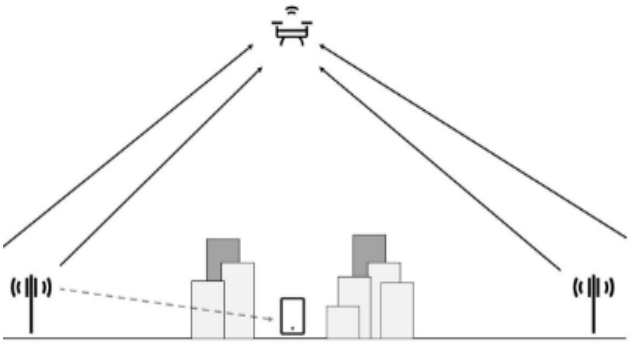

Figure 2: Coverage from base stations (BSs) to a terrestrial UE and a drone UE

However, in drones, handover is a critical concern. The communication at the ground may be difficult for users. Handover in drone is required to be so effective, thus many novel techniques have been introduced. Figure 2 illustrates the coverage of the drone to the base stations and terrestrial user equipment. Therefore, in this paper, the study of the different works performed by researchers in order to attain the better performance and better estimation of cost value by taking an effective handover decision is presented.

II. LITERATURE

This section gives the overview of the related work that has been performed by different authors. The overall literature is given on the heterogeneous networks such as aerial network, wireless network etc. Here, overview is categorized into two sections, the first one illustrates the handover techniques proposed for drones and the second demonstrates the handover processes for wireless systems. These categories are explained as:

(a) Handover in Drones

E. Lee et al [7] defined the parameters representing the features of drones that communicate between 3-D space by taking into account the limit of speed and coverage. A fuzzy inference system is proposed by giving these parameters as input to the fuzzy system. This system comprises of the sour sections in which first one is the analysis of terminal-related information for the selection of the factors affecting the handover decision of the drone. Secondly, the conversion of input data into membership functions (MFs) takes place. In the next step, to make the handover decision, fuzzy rules are created and applied to the system. Eventually, the decision of the handover is made by taking into account the present information. Author demonstrated that the parameters related to the terminal and the network gave a better impact to the make the handover decision.

A. Kumar and H. Purohit [8] presented the different techniques of the handoff along with their comparison handoff strategies. Author considered mobility as a crucial aspect that affects the effectiveness and the quality of the communication in a system. Handover plays a significant role in the efficiency of the call (call continuity) which decides the network quality. In the paper, the author also compared the techniques with respect to S/I ratio, execution time, Relative Signal strength, handoff made, call handling difficulty, and generation methods.

K.N. Park et al [9] projected an efficient mechanism of handoff for aerial networks in the 3-D space. In this scheme, the distances between the drones and their height can be adjusted. To examine the optimal coverage decision algorithm, author utilized the probability of seamless handover success and the false handover initiation. Author believed that this is the first method attempted to resolve the handover of net-drones in the 3-D space.

K.N. Park et al [10] had proposed an efficient coverage decision algorithm. The main objective of this algorithm is to

provide seamless handoff and establish an aerial network. In this paper the proposed author is examined by calculating the likelihood of the seamless handover success and the false handover initiation. The simulation results acquired by the author demonstrated that the developed method is better for the aerial network.

S. J. Yoo et al [11] proposed a RSSI-based predicative link trigger mechanism. There are chances of failure of the handover decisions because of too late or too early triggering. In this scheme, firstly the estimation of the required handover time is performed. Subsequently, the execution of the predicative link trigger mechanism takes place when predefined predication start threshold is more than filtered sample power. The estimation of the threshold is done by the required handover time. The handover process starts only when the value is less than the minimum power level.

(b) Handover in wireless system

B. A. Ammar et al [12] proposed an SINR based method which is similar to that mechanism developed by K. Yang et al [13]. In this mechanism the maximum achievable data rate for a given Signal to Interference and Noise Ratio SINR and carrier bandwidth is calculated by the Shannon capacity.

V. S. Pande et al [14] presented the advancements in the technology as the cause of fast changes in wireless communication systems. The enhancement is made in the offered services and the quality is also improved in order to make this technology ubiquitously accessible to the user. Author gave the novel handoff algorithm between CDMA 2000 cellular networks and WLAN. The delay time in handoff and throughput are used as the parameters to perform the effective and flawless handoff.

P. S. Jirapure and A. V. Vidhate [15] focused on mobility to analyze the effectiveness of the wireless networks. According to author, handoff is responsible for the mobility in the network. During handoff, there is a requirement to make some decisions for the transmission of the call such as choosing a network to maintain the continuity of the call. Author presented various techniques to make handoff decisions bay taking into account several parameters like Cost function Based, RSS Based, QoS Based, Processing Delay Based, Policy Based, Context-Aware Based etc.

A Receiver-Initiated MAC protocol (RIMAC) was developed by Q. Dong and W. Dargie [16]. The aim of developing this technique is the improvement of the associated latency. The poor link quality in the network is tackled by finding most stable link by using this mechanism. By doing this, data is transferred seamlessly over the network. The results of this scheme improve the handover latency from 0.006s to 0.026s.

T. Das and S. Roy [17] presented the mobile sensor nodes (MSNs) and their coordination when they have a common goal. In order to deal with this, author utilized a Game Theory Inspired Mobile Object Trapping System (GT-MOTS). This scheme is effective when MSNs trap the mobile object during exchanging the information. The neighbor nodes also get affected. By applying this method the collision frequency is reduced.

A vertical handover decision algorithm was presented by S. Lee et al [18] that increased the overall battery lifetime of the MS. Along with this, traffic load balancing over the networks is also maintained by this algorithm. M. A. K. Azad et al [19] believed that VHD function added for a region covering one or more base stations or access points during the implementation in a multiple VHD Controller (VHDC) available in the networks.

According to C. Hao et al [20] mobility plays an important role in wireless communication. Thus, an Adaptive Handover Scheme based on velocity for Mobile WiMAX was developed by this author. The usage of the resources was enhanced with threshold changes such as increased velocity avoids pointless handover.

Z. Abbass and M. Abakar [21] presented an algorithm for soft handover for the selection of base station. The effectiveness of the algorithm is examined by considering the bit error rate and time to transmit the mobile WiMAX using different modulation techniques such as BPSK, QPSK & 16QAM. It was observed by the author that seamless hand over can be achieved when speed of MS is 20 m/s and it has a extremely low latency but attaining the mobility of up to 120 km/h and latency less than 50ms with only 1% loss of related packets is still a challenging concern.

A technique was proposed by Nasser A. Hamad [22] for a cellular and a WiMAX with respect to the physical layer mode in order to attain for high mobility, high data rates, and reduced traffic congestion. Author takes traffic load, mobile terminal and signal quality by assuming the synchronization between the Wimax and cellular systems.

A. M. Vegni et al [23] presented a hybrid VHO technique in which parameters of both RSS and SINR are included in respect of both end users efficiency (cumulative received bits) and network performances. The results validated the effectiveness of the proposed scheme.

A policy-enabled handover algorithm was developed by H. J. Wang et al [24]. This mechanism allows the users to make the rules to determine the suitable network on the basis of dynamic and static parameters of the network which in turn shows the cost function. However, sophisticated configurations cannot be tackled by applying this algorithm.

F. Zhu, J. MacNair [25] developed a technique to solve the optimization problem in handoff decision. Author assigned a cost function every candidate network. The network with the lowest cost value should be selected. The cost value is estimated by considering the delay in handover, available bandwidth and power requirement.

S. M. Phemina, S. Sendhilnathan [26] presented a method to manage the mobility in 4G wireless networks by implementing fuzzy logic. Author takes five parameters as input to the fuzzy system. The parameters were RSS, BW, Monetary Cost, User Preference and UE Velocity. The output of this system is the handoff decision. According to the author, if more input is given to the fuzzy inference system, the netter handover decision can be achieved. Author also mentioned the issue in vertical handover decision such as overlay scenario with multi- criterion can be tackled by using soft computing techniques to increase the effectiveness.

X. Ji et al [27] developed a Fuzzy Logic Processing (FLP) amalgamated with AHP for UMTS and Wi-MAX overlay networks. Fuzzy inference analyzes the satisfaction of the user (US) by exploiting the parameters including RSS and BW. AHP is responsible for creating a decision by using service cost, network delay, battery consumption, and user preference. Eventually, the weighted value of the US and AHP makes the handoff decision for different types of traffic. This approach was able to mitigate the ping-pong effect and terminal power consumption in an efficient way.

C. Amali et al [28] presented the optimization between energy consumption, QoS, and cost. Authors verified the function by utilizing the user satisfaction degree based on Cobb Douglar. The selected networks offered the services and the average ratings of the network are computed and multi-criteria are aggregated with the help of FSR TOPSIS method presented by I. Chamodrakas, D. Martakos [29].

Y. N. Gyekye, J. Agbinya [30] presented the design and implementation of the algorithm of multi criteria vertical handoff decision. The algorithms of making decisions for vertical handover are presented in heterogeneous wireless wide area network i.e. WWAN and WLAN environment. This scheme was derived from the IP centric field workforce automation. The free movement is offered when connected with IP mode between networks and single device is being used on multiple networks. Author implemented fuzzy inference system for the efficient processing of the multi criteria vertical handoff decision metrics.

III. CONCLUSION

This paper presents a narrative review of the different techniques of handover process that are implemented to achieve better performance of heterogeneous networks in terms of latency and mobility. Many researchers have implemented fuzzy inference system to enhance the ability to take handover decision. This paper helps in understanding the several mechanisms opted to enhance the communication in the wireless network by performing effective handoff.

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