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HANDOVER PERFORMANCE IN 5G NETWORKS

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ABSTRACT

Femtocell technology has the potential to enhance the communication options available on today's mobile networks. But there are several problems with this technology that must be addressed. These include more frequent handovers, increased energy consumption, and increased levels of interference and packet loss. Customers may choose the radio access technology that meets their needs in terms of cost, speed, and portability for their specific multimedia applications. It is crucial that the performance of an online application remains stable while the user moves between 5G networks. That right there is the justification for our action. A software-defined solution to handover management in a 5G network is presented in the paper, and it is based on Multiple Attribute Decision Making (MADM). The handover processes must be monitored by the handover controller on the control plane. Simulations show that, compared to baseline LTE1, the proposed changeover management strategy reduces latency and handover failure percentages.

Keywords: 5G; femtocell; RSSI; handover; QoS.

INTRODUCTION

The fifth generation (5G) of mobile technologies was developed in response to the increasing demands for high data rates and the challenges of satisfying those demands. The goal of 5G cellular technology is to provide massive capacity and allow exceptionally high transmission speed while minimizing penetration loss across building walls. This is made feasible by massive deployments of Multiple-Input and Multiple-Output (MIMO) systems comprised of hundreds of individually deployed antenna arrays. In the 5G concept, many networks will use the same infrastructure to build microcells, picocells, and femtocells that overlap by a picocell.

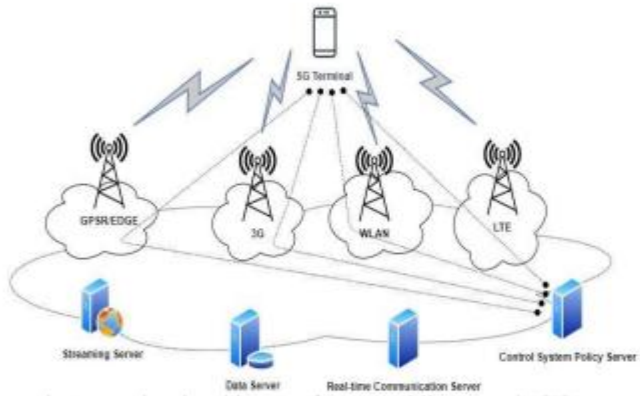

Figure.1 Functional architecture for 5G mobile networks.

As can be seen in Fig. 1, 5G relies entirely on IP-based technologies, with a centralized mobile terminal and several distributed Radio Access Network (RAN) technologies making up the system. All of these radio systems are managed similarly to an IP link to a larger network or the cloud. One of the most challenging issues in mobile communications nowadays is the smooth integration of small-sized cells into the prevailing macro-cellular network structure. Femtocell was adopted as a solution because to its low cost, potential for energy savings, and simple installation. However, a user's normal motions may force them to leave a femtocell or to go too close to the edge of a microcell, triggering a handover. Whether or whether the two cells use the same network technology, service and connection may be disrupted during the shift from one cell's coverage to another. Therefore, maintaining network quality of service necessitates an effective way of handover management to provide a seamless transition for users and uninterrupted service.

Femtocell technology has opened the door for cellular networks to offer consumers with faster and more reliable communication services. These advantages, however, come at the expense of increased interference, packet loss, handovers, handover delays, switch failures, and energy consumption. These problems will become much more severe in crowded cities and other metropolitan areas, as well as in high-velocity UE scenarios in rural areas. To make up for the limitations of femtocells, lessen the frequency of undesired handovers, and prevent the degradation of service that follows from them, advanced handover management techniques are required. Many studies have examined various methods of handover management, looking at factors including network density, signal strength, and available resources. The approaches utilized for handover management in 5G new radio (NR) and long-term evolution (LTE) are reviewed in detail in. In addition, a review of the various 4G and 5G Vertical Handover (VH) techniques was presented in.

Whereas, the results of this study show that a changeover approach tailored to different kinds of networks and different kinds of frequency mechanisms may be used to seamlessly integrate these networks and to improve quality of service. In, a method for performing a handoff was presented that takes the Received Signal Strength Indicator (RSSI) into consideration by comparing the

RSSI value to a fixed RSSI threshold. The amount of unnecessary handoffs has been reduced thanks to this technique. It's vital to remember that a UE's received signal strength indicator (RSSI) is a measure of the strength of the signal provided from an access point to the UE. Handover choices in femtocell networks were similarly formulated in based on a combination of received signal strength indication and user speed. In order to reduce unnecessary handovers and packet loss, researchers in used RSSI, user speed, cell radius, and user-to-access-point distance as parameters to implement seamless handoffs. The Reference Signal Received Power (RSRP), user position, user movement direction, and network capacity were all taken into account to arrive at a handover decision, as detailed in [. The purpose of this model was to maximize the likelihood of a smooth handover between cells in LTE femtocell networks. An enhanced handover algorithm was shown to decrease the probability of undesired handover and call blockage by taking into account a wide range of network factors such as cell capacity, cell radius, bandwidth, number of users, capacity of microcell, and user speed.

The authors provide a handover technique that optimizes the list of available femtocell access points using just the access points that are present alongside the user's mobility. The authors used a linear regression model, a machine learning predictor instrument that considers the user's prior behavior, to foretell the user's prospective actions. After all possible access points have been ranked in terms of capacity and received signal strength indication (RSSI), the algorithm selects the optimal one. Researchers looked into mobile devices' locations and orientations to find ways to improve network reliability and reduce the amount of unnecessary handovers. The system chooses the best available access point to reduce the possibility of user disconnection by using a Markov model to predict the user's future position. A second effort at a handover management system is presented in with the goals of fixing the interference problem, decreasing the noise ratio, and improving the quality of the handover choice. The model used in this case was known as HO-FIM (Hand Over-driven Femtocell Interference Management).

Sukjaimuk, Rungrot (2018) A proposed architecture for the Internet, Information-Centric Networking (ICN) lies at the heart of the new Future Internet (FI) paradigm. When dealing with high volumes of traffic and limited power resources in a sensor-enabled network built for the Internet of Things (IoT), practical implementation of ICN remains challenging despite its many benefits over the present IP-based Internet architecture. To realize a fully eco-friendly and efficient ICN-based sensor networking model, we provide a smart congestion management approach to concurrently reduce the rate of network congestion, the amount of power used by sensors, and the performance of the ICN. Data is aggregated into chunks depending on the popularity of each chunk's content in order to decrease the overall number of packet exchanges needed by the proposed network design. We also develop the sensor power-based cache management technique and the adaptive Markov-based sensor scheduling strategy with the selective sensing algorithm to further enhance power savings for the sensors. Evaluation findings using ndn SIM (a prominent ICN simulator) reveal that the suggested model may deliver improved network performance efficiency with reduced energy consumption for the future Internet by increasing the number of IoT sensors in an ICN. The throughput, cache hit rate, and Interest packet loss rate are all improved to achieve this goal.

Rosilah Hassan's (2019) The broad use of IoT is an important aspect of the 4.0 industrial revolution. One problem with current computers is their high power use, and another is the large amount of space and equipment needed. Therefore, the technology must be small and have a low power need. How IoT functions inside UKM networks (or UKMNet) has been studied by researchers. In addition, the IoT hardware is tested with the help of an Arduino Uno board. To measure how quickly information is sent between the Arduino board and the server, iPerf is employed. This leads us to believe that the Arduino Uno is the right Internet of Things (IoT) board for this project. The performance tests confirm that the Arduino board can manage the 3.48 Mbps to 3.563 Mbps data transmission speeds required to support the Internet of Things. The jitter value for this connection is below 1.80 ms to 1.85 ms, and the packet loss rate over a period of 10 seconds is between 0 and 0.59 percent. In conclusion, Arduino Uno might be a good solution for the UKMNet'sIoT hardware.

NourHindia, MHD (2019). The deployment of a relay node inside a cell not only enhances coverage but also improves spectral efficiency, making it one of the most competent and cost-effective solutions to the issue of coverage limitation for the future fifth-generation network. However, this method creates interferences from nearby base stations and relay nodes, reducing the signal-to-interference-plus-noise ratio and perhaps resulting in a garbled signal at the user's end. In this study, we use a stochastic geometrical approach to analyze a relay-based network at millimeter wave frequencies that is subject to interference. The success probability, ergodic capacity, and outage probability of the suggested Poisson point process model have all been estimated and compared to those of the ideal grid model and the traditional multiple-antenna ultra-dense network model. According to the results, the proposed model improves upon the status quo for high-density networks in terms of both success probability and ergodic capacity (3.5% and 2.3%, respectively). Analyzing the results at different multiple-input-multiple-output antenna configurations demonstrates that the model's capacity to improve network-wide performance holds water even if the number of antennas is increased.

FaizanQamar (2021) Early implementation of the 5G network has been the result of extensive research into how best to meet the demands of an increasing number of connected users who want ever-increasing throughput, bandwidth with Quality of Service (QoS), and latency. The traditional spectrum that has been used up to now is no longer a possibility due to the widespread saturation of the electromagnetic spectrum below 6 GHz. In light of this insufficient frequency spectrum, it is encouraging and extremely practical to acquire more frequency bands for next-generation mobile communications. The millimeter-wave (mm-Wave) has been the primary focus of research and development in this area since it is viewed as the most promising candidate for the frequency spectrum. The millimeter wave (mm Wave) frequency band may be able to accommodate these bandwidth requirements, but it has been demonstrated to have some disadvantages when compared to the more common sub-6 GHz range. The propagation channel in the millimeter Wave band must be improved if network operators are going to bring 5G into operation. Therefore, this study's goal is to investigate the outdoor channel characteristics of the 26, 28, 36, and 38 GHz frequency bands for use in the building's underground to rooftop communication infrastructure. The experimental campaign has compared the efficacy of several propagation route loss models from the top floor to the ground floor, for both line-of-sight (LOS) and non-line-of-sight (NLOS) scenarios. The field tests show that the CI propagation model is superior than the FI model in terms of performance thanks to its low learning curve, high accuracy, and fine-grained control.

MOBILITY MANAGEMENT OF DIVERSE 5G WIRELESS NETWORKS

In order to avoid poor service, ubiquitous computing depends on flawless roaming or mobility, which in turn requires network management processes. Mobility management encompasses both the administration of physical locations and the transition between them. There are two phases to effective location management. This first step, known as location registration or location update, takes place whenever an MT transmits its current location to the network, requiring the latter to authenticate the user and update the user's location profile in a database The second technique for keeping track of people's whereabouts is paging. One of the most crucial aspects of mobility management, which covers a wide range of procedures essential to the smooth operation of wireless networks, is handoff management. Wireless terminals may be managed in one of two ways: horizontally, inside a single network, or vertically, across networks that may use different wireless access protocols.

A. Mobility Management Functions

Mobility management includes features like automatic roaming, authentication, and system handoffs. When a user moves outside of their typical service provider's coverage area, automatic roaming may cause their device to connect to a different network. The functionality of these additions is automatic and transparent to the user. Autonomous roaming features may be divided down into:

- Mobile station (MS) service qualification
- MS location management
- MS state management
- Fixing problems with the HLR and the VLR home location register
- Each subscriber's identification must be verified before they are granted access to the system, a process known as authentication.

B. Typical Requirements of Mobility Management

The following are some of the most fundamental requirements for providing seamless roaming across different wireless networks:

- When an interface contact is lost, automatic restoration efforts must be made.

 Weak signal or the desire for extra functionality are two examples of situations in which a user could initiate a handoff between network interfaces.

 Handoff delay and packet loss must be minimized in particular for real-time applications.

 In the event that the session is lost or often interrupted by other network situations, the user will be required to terminate and restart the session before it may be resumed using a different interface.

C. Handoff Across Diverse 5g Wireless Networks

Handoff management is a subset of mobility management that ensures connections between mobile nodes remain functional while those nodes move or switch locations. Depending on the direction of the connection, the handoff may be classified as either horizontal or vertical. The mobile terminal's connection technology shall remain unchanged throughout the handoff from one attachment point to another (horizontal handoff). However, in vertical handoffs, the mobile terminal (MT) itself changes technologies as it moves from one attachment point to another. A handoff consists of three stages: discovering the network, selecting the handoff, and executing it. The system does periodic checks to see whether a better network exists to which the mobile terminal may be migrated. Several considerations must be made during a handoff, and these elements change depending on the algorithms used and the goals of the handoff. A mobile device does what's called "system discovery," which involves discovering what networks it can connect to. Quality of Service (QoS) indicators and data transfer rates offered by such networks might be made public.

An algorithm considers a variety of criteria before making a choice on whether to give over control. The decision is crucial, and many interesting options for resolving the problem have been proposed. The mobile device's choice on whether or not to continue using the current network occurs during the vertical handoff decision phase. The decision may be based on a wide variety of factors, such as the kind of application being used (conversational vs. streaming, for example), the required bandwidth and latency, the access cost, the transmit power, and the user's personal preferences. During the process of executing a vertical handoff, connections in the mobile terminal are switched from one network to another without any noticeable disruption. A user's context information must be authenticated, authorized, and sent at this phase. Access systems employ vertical handoffs because their cells have varying requirements in terms of bandwidth, data rate, operating frequency, and quality of service (QoS).

MOBILITY REQUIREMENTS FOR PROPOSED SCHEME

In order to achieve seamless movement, we provide a novel take on a previously proposed vertical handoff method by including algorithms for adaptive longevity and relative received signal. We assume heterogeneity and overlap between WLANs and cellular networks in this study. Two users are represented across both access networks, each with a mobile device and an IP address that supports Mobile IP for mobility management. The following is a concise summary of the conditions that should be met during a vertical handoff in a heterogeneous 5G wireless network. Heterogeneous networks' layered architecture prevents handoffs to embedded networks with low cell concentrations during high-velocity transit. The former include things like RSS, velocity, throughput, and user preferences, while the later include things like network cost, power consumption, network security, and bandwidth capacity. For a complete decision model of a handoff mechanism, it is necessary to collect both dynamic and static data.

The analysis Handover Delay

The handover delay is the time it takes for a handoff to occur between the original eNB and the destination eNB. Time is a critical factor in determining the handoff method's efficacy. If the number is low, the transition will happen more quickly. As a result, there would be a decrease in the number of botched passes. The source eNB uses the UE's provided measurement reports as the foundation for its handover decision in traditional mobile communication standards like 3GPP. The original eNB then communicates with the new eNB to request the handoff. In LTE, the following must happen before a UE may start delivering data across the target eNB once a handover has been initiated:

$$HDelay_1 = 3T_{S-U} + T_{CM} + T_{HD} + 2T_{S-T} + T_{U-T} + T_H$$

The time it takes for the UE to send packets like Measure Control and Measure Report to the Source eNB is denoted by TS U, whereas the time it takes for the UE to measure the channel is denoted by TCM. Time of eNB's handover decision, abbreviated THD, is the time at which packets like Handover Req and handover Ack are transmitted from the Source eNB to the Target eNB, and Time of UE's handover, abbreviated TH, is the time at which the UE switches its communication from the Source eNB to the Target eNB. Following UE handover initiation, the proposed technique requires the target eNB to do the following before sending the packet.

$$HDelay_2 = T_{U-C} + T_{HD} + 2T_{U-T} + T_H + 2T_{update}$$

The Controller's mobile-related data is updated at the moment Tupdate. Moreover, this is affected by variables such as network activity, the location of the Controller, and others. It takes TU T time for the UE and the Target eNB to exchange the Handover Req and Handover Acknowledgement packets. It's no secret that 5G is defined by lightning-fast speeds, negligible latency, and massive storage capabilities. The time it takes to send a packet is little in comparison to the whole switchover process. Furthermore, extensive deployment of eNBs would make this problem much worse.

CONCLUSION

The handover performance concerns in dense femtocell environments are the focus of this study. A new approach to handover management was developed to improve the trustworthiness of transitional choices. We considered the BS RSS and two other criteria—user direction and BS capacity—when deciding whether or not to perform a handover. The proposed approach has made it possible to more easily include handover management into the femtocell scenario by redefining the major handover phases. A novel simulation tool was developed using the visual C++ programming language to demonstrate the extensive deployment of 4G and 5G networks accounting for all possible environmental conditions. According to what we learned in the previous part, users located outside the WLAN may continue to make use of the heterogeneous network's resources thanks to the hybrid vertical handoff approach. The ASST value plays a significant impact in the final tally of handoffs. The proposed solution relies on the handover controller to perform all tasks. During a handoff, data plane devices are notified using OpenFlow tables. The simulation results show that the advised method of handover management effectively lowers the delay and failure rates of handovers.

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