Performance of Handover Management in 5G Network

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Abstract

As a result of femtocell technology, modern mobile networks may provide more robust and engaging communication services to their users. However, there are a few issues with this technology that need to be addressed. These include higher levels of interference and packet loss, more frequent handovers, and higher energy usage. Because of this variety, customers may choose the radio access technology that provides the optimum performance for their particular multimedia applications in terms of price, speed, and mobility. Maintaining an internet application's peak performance when switching between 5G networks is essential. That's why we're doing it, right there. In the study, we present a Multiple Attribute Decision Making (MADM)-based approach to handover management in a 5G network that is specified by software. The handover controller on the control plane is responsible for overseeing the handover procedures. The suggested handover management technique offers lower delay and handover failure percentages compared to baseline LTE1 in simulations.

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

1. INTRODUCTION

In response to rising expectations for high data rates and the difficulties in meeting those expectations, the fifth generation (5G) of mobile technologies has been created. 5G cellular technology intends to reduce penetration loss via building walls by isolating outdoor and interior settings, so it can offer large bandwidth and enable extremely high transmission speed. Through the use of hundreds of dispersed antenna arrays and enormous Multiple-Input and Multiple-Output (MIMO) systems, this is possible. Multiple networks, each corresponding to a different technology, will use the same infrastructure to create microcells, picocells, and femtocells that overlap by a picocell in the 5G design.

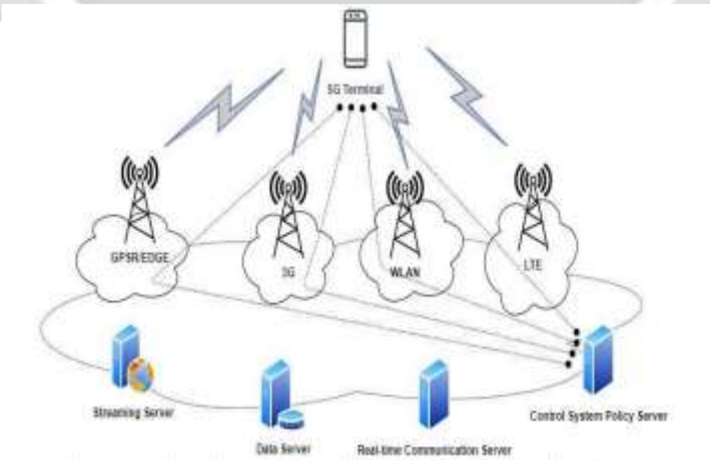

Figure.1 Functional architecture for 5G mobile networks.

Referring to Fig. 1, 5G's system architecture is wholly IP-based, consisting of a central mobile terminal and many decentralized Radio Access Network (RAN) technologies. Each of these radio technologies is handled much like an IP connection to the wider internet, most likely the cloud. The seamless incorporation of small-sized cells into the predominate macro-cellular network topology is now one of the most demanding topics in mobile communications. Femtocell was implemented as a solution because to its cheap price, power-saving potential, and ease of installation. Nonetheless, simple user mobility may cause an escape from a femtocell or approach the boundary of a microcell, necessitating a handover. The transition from one cell's coverage to another may be disruptive to service and connection, regardless of whether the two cells use the same network technology or not. Therefore, an efficient method of handover management is required to provide a smooth transition and continuous service for users while preserving network quality of service.

With the advent of femtocell technology, cellular networks may now provide more robust and responsive communication services to their users. These benefits come at the price of more interference, higher packet loss, more frequent handovers, longer handover delays and more changeover failures, as well as higher energy usage. These issues will worsen in congested urban centers and other urban settings, as well as in high-speed UE situations in interior settings. Therefore, sophisticated handover management methods are needed to compensate for femtocell shortcomings, reduce the number of unwanted handovers, and avoid the service deterioration that results from them . Different parameters, including network density, signal strength, and available resources, have been studied in many studies on handover management approaches. In, we find a comprehensive review of the methods used for handover management in 5G new radio (NR) and long-term evolution (LTE). Additionally, in we saw a survey of 4G and 5G Vertical Handover (VH) methods.

Whereas, this research revealed a handover strategy that was developed with network types and frequency mechanisms in mind, allowing for effortless integration across networks and improved QoS. In, a handoff algorithm was given that takes into account the Received Signal Strength Indicator (RSSI) by comparing the RSSI value to a predetermined RSSI threshold before deciding whether or not to execute a handover. This method has helped minimize the number of needless handovers. It's important to note that RSSI represents the strength of the signal that a user equipment (UE) has received from a serving or neighboring access point. Relatedly, in a method for making handover decisions in femtocell networks based on received signal strength indicator and user speed was developed. To further decrease needless handovers and packet loss, researchers in employed RSSI, user speed, cell radius, and distance between user and access point as a parameter to carry out smooth changeover. A handover decision was made using the Reference Signal Received Power (RSRP), user location, movement direction, and network capacity as described in [. The goal of this model was to improve the performance of LTE femtocell networks and optimize the handover process by improving the chance of a successful changeover. By considering a variety of network parameters including cell capacity, cell radius, bandwidth, number of users, capacity of microcell, and user speed demonstrated an improved handover algorithm that reduces both unwanted handover and the call blocking likelihood.

Using just the access points that are present alongside the user's mobility, the authors of offer a handover method that optimizes the list of possible femtocell access points. The authors employed a linear regression model, a machine learning predictor tool that takes into account the user's past behavior, to make predictions about future user behavior. After the list of available access points has been optimized, the algorithm chooses the one with the highest available capacity and the best received signal strength indication (RSSI). Mobile location and orientation were also studied in to lessen the number of needless handovers and boost network dependability. Using a Markov model to anticipate the user's next location, the system selects the most optimal access point to minimize the likelihood of disconnections. In , we see a second attempt at a handover management system that seeks to address the interference issue, lower noise ratios, and maximize the quality of the handover decision. Hand Over-driven Femtocell Interference Management was the name of the model used here (HO-FIM).

Rungrot Sukjaimuk (2018) The new Future Internet (FI) paradigm, Information-Centric Networking (ICN) is a plan for an architecture of the Internet that focuses on the flow of information rather than data. Despite the fact that ICN has numerous advantages over the current IP-based Internet architecture, it is still difficult to implement in practice, particularly when dealing with heavy traffic and low energy reserves in a sensor-enabled network designed for the Internet of Things (IoT). To achieve a full eco-friendly and efficient ICN-based sensor networking model, we present a smart congestion management technique to minimize network congestion rate, lower sensor power consumptions, and boost ICN network performance simultaneously. In order to reduce the total number of packet exchanges required by the proposed network architecture, data is aggregated into chunks based on the level of popularity of each individual chunk's content. To further improve power savings for the sensors, we further create the sensor power-based cache management method and an adaptive Markov-based sensor scheduling policy with selective sensing algorithm. By increasing the number of IoT sensors in an ICN, the evaluation results using ndn SIM (a popular ICN simulator) show that the proposed model can provide higher network performance efficiency with lower energy consumption for the future Internet. This is accomplished by increasing throughput, cache hit rate, and reducing the drop rate of Interest packets.

Rosilah Hassan (2019**)** One crucial part of the 4.0 industrial revolution is the widespread use of the Internet of Things (IoT). High power consumption and the requirement for a lot of room and equipment are two issues with modern computing. Therefore, it is important that the technology be compact and have a low power need. Researchers have looked at how IoT works in the context of UKM networks (or UKMNet). In addition, an Arduino Uno board is used to provide a test bed for the IoT hardware. iPerf is used to analyze the speed of data transmission between the Arduino board and the server. Accordingly, we conclude that Arduino Uno is an appropriate piece of Internet of Things (IoT) hardware for this application. The results of the performance tests show that the Arduino board can handle the data transfer rates needed for implementing the Internet of Things, which range from 3.48 Mbps to 3.563 Mbps. In addition to a packet loss rate of 0% to 0.59% during a period of 10 seconds, the jitter value for this connection is below 1.80 milliseconds to 1.85 milliseconds. In conclusion, the UKMNet may benefit from using Arduino Uno as its IoT hardware of choice.

2. MOBILITY MANAGEMENT OF DIVERSE 5G WIRELESS NETWORKS

Ubiquitous computing relies heavily on seamless roaming or mobility, which necessitates network management procedures to prevent degraded service. Mobility management includes both location management and handoff management. There are two steps involved in managing a location. This initial procedure, known as location registration or location update, occurs when the MT routinely communicates its current position to the network, prompting the latter to verify the user's identity and update the user's location profile in a database. Paging is the second method used for managing where people are. Mobility management encompasses several facets of user mobility and mobility support processes for wireless networks, one of the most important of which is handoff management. Horizontal handoff refers to the process of managing wireless terminals inside a single network, whereas vertical handoff refers to the process of managing wireless terminals across networks that may use various wireless access protocols.

A. Mobility Management Functions

Automatic roaming, authentication, and the handoff between systems are all aspects of mobility management. With automatic roaming, a subscriber may automatically connect to a new network when they go outside of their usual service provider's coverage region. These features operate mechanically and invisibly to the subscriber. The capabilities of autonomous roaming may be broken down into:

- Mobile station (MS) service qualification
- MS location management
- MS state management
- Home location register (HLR), and VLR fault recovery
- Authentication necessitates that each subscriber's identity be confirmed prior to granting access to the system.

B. Typical Requirements of Mobility Management

Some standard and essential criteria are listed below in order to offer smooth roaming across various wireless networks:

- Contact loss at an interface should trigger automated attempts to restore it.
- There are several potential causes for a handoff between network interfaces, including weak signal or a user's need for additional features.
- Especially for real-time uses, it is important to reduce handoff latency and packet loss.
- If the session is not maintained or is often disrupted by other network circumstances, it will be ended and re-initiated if the user wants to continue it using a different interface.

C. Handoff Across Diverse 5g Wireless Networks

One part of mobility management is handoff management, which keeps connections between mobile nodes operational even when they roam or transition to a new location. The handoff may be divided into two categories, horizontal and vertical, depending on the orientation of the connection. When transitioning from one attachment point to another, the mobile terminal will not alter the technology it is using to maintain its connection (horizontal handoff). Vertical handoffs, on the other hand, include a technology switch at the mobile terminal (MT) as it passes from one attachment point to another. There are three steps involved in a handoff identifying the network, deciding on a handoff, and putting it into action. On a regular basis, the system checks to see if there is a more suitable network to which the mobile terminal may be transferred. There are several factors to take into account during a handoff, and these factors vary based on the algorithms used and the handoff objectives. During "system discovery," a mobile device learns about available networks. Information on the data rates and Quality of Service (QoS) metrics provided by such networks may be publicized.

When deciding when to hand over, an algorithm takes into account a number of factors before making its final decision. The choice is highly critical and various different fascinating strategies were presented to handle the issue. Vertical handoff decision phase is when a mobile terminal decides whether or not to keep utilizing the present network for a connection. The choice may rely on numerous criteria or metrics including the nature of the application (e.g., conversational, streaming), minimum bandwidth and latency needed by the program, access cost, transmit power, and the user's preferences. Connections in the mobile terminal are seamlessly redirected from the old network to the new network during the vertical handoff execution phase. This step also involves the authentication, authorization, and transmission of a user's context information. Since different cells of access systems have different characteristics for example, bandwidth, data rate, frequency of operation, and improved QoS vertical handoffs are used.

3. MOBILITY REQUIREMENTS FOR PROPOSED SCHEME

We offer a modified version of an existing vertical handoff technique that makes use of adaptive lifespan and relative received signal algorithms to achieve smooth mobility. In this research, we assume that WLAN and Cellular networks are diverse and overlap. Two users, each having a mobile device and an IP address that supports Mobile IP for mobility management, are represented in a variety of situations that span both access networks. You can sum up the recommended criteria for vertical handoff in a heterogeneous 5G wireless network like this. Because of the layered design of heterogeneous networks, handoffs to embedded networks with low cell densities are prohibited during high-velocity transit. RSS, velocity, throughput, and user preferences are examples of the former, whereas network cost, power consumption, network security, and bandwidth capacity are examples of the latter. Both dynamic and static measurements are required for a well-rounded decision model of a handoff mechanism.

The analysis Handover Delay

The time taken for a handover to occur between the source eNB and the Target eNB is known as the handover delay. When evaluating the effectiveness of the handoff method, time is a crucial metric. A lower number will result in a quicker handover. The percentage of unsuccessful handoffs would go down as well. In conventional mobile communication standards, such as 3GPP, the source eNB bases its handover decision on the measurement reports sent by the UE. The handover request is then sent from the source eNB to the destination eNB. After a user equipment (UE) initiates a handover in LTE, the following steps must be taken before the UE may begin sending data through the target eNB:

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

In this case, TS U is the time it takes for UE to transmit packets like Measure Control and Measure Report to the Source eNB, and TCM is the time it takes for UE to measure the channel. The time at which packets like Handover Req and handover Ack are sent from the Source eNB to the Target eNB is denoted by TS T, whereas the time at which the UE changes its communication from the Source eNB to the Target eNB is denoted by TH. Time of eNB's handover decision, abbreviated THD. In the proposed method, the following steps must occur between the UE initiating handover and the packet being sent via the target eNB:

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

At the point in time Tupdate, the Controller's mobile-related data is refreshed. Furthermore, this is impacted by factors such as network traffic, Controller location, and others. Sending the Handover Req and Handover Acknowledgement packets between the UE and the Target eNB takes TU T. The rapid speeds, short delays, and large capacities that define 5G are no secret. Packet transmission takes just a small fraction of the total time involved in a changeover. Moreover, this issue would be exacerbated by the widespread installation of eNBs.

4. CONCLUSION

This research looks at the performance issues that arise in dense femtocell settings during handover. In order to increase the reliability of handover decisions, a novel method of handover management was introduced. Along with the BS RSS, we also used two additional criteria called user direction and BS capacity to determine whether or not to do a handover. By redefining the primary handover stages, the suggested method has enabled a more seamless integration of handover management into the femtocell setting. With the help of the visual C++ programming language, a new simulation tool has been created to showcase the massive rollout of 4G and 5G networks taking into account any and all environmental factors. The preceding section's findings reveal that the hybrid vertical handoff method keeps the resources of the heterogeneous network for users situated outside the WLAN, despite their growing reliance on the WLAN. When calculating the total number of handoffs, ASST value plays a crucial role. According to the suggested method, the handover controller handles all actions. Data plane devices are alerted through OpenFlow tables during the handoff process. From what we can see in the simulations, the recommended handover management technique is the most efficient in terms of reducing both delay and failure rates during handovers.

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