Research on Handover Technologies in 5th Generation Wireless Communication System

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Abstract: The continuously increasing demand of wireless communications impels the fast development of the next generation wireless communication technology. The 5G communication technology, which scheduled to be realized in the year beyond 2020, is still on its researching stage. Aim at the novel handover problems in ultra-dense network deployments and high-band communications in 5G scenarios, the recent researches about handover were introduced and remarked in this paper. The improvements include handover decision algorithm, handover execution mechanism and handover schemes combined with novel network architecture and technology.
Key words: 5G; handover; overview; application scenario; development trend;

1. Introduction

In order to solve the explosive growth of mobile data and terminals, new emerging businesses and varieties of brand new services and scenarios, the fifth generation mobile communication network (5G) is proposed and generally becoming a hot topic in both academic and industrial field. Motivated by the high-speed development of the mobile Internet and the growing demand for business, 5G is supposed to be low-cost, low power consumption, safe and reliable. The transmission rate will increased 10 to 100 times, and the peak transmission rate can reach 10Gbit/s. The end-to-end delay will be reduced to ms level. Furthermore, the connection device density will be increase by 10 to 100 times and the traffic density will be increased by 1000 times. Also, the spectrum efficiency will be improved by 5 to 10 times, and the user experience can be guaranteed at a speed of 500 km/h [1]. In conclusion, 5G will make information communication break the constraints of time and space, and give the users excellent interactive experience, greatly shorten the distance between people and things, and quickly realize the connection among all people and things [2].

Handover is an important content of radio resource management. The processing and optimization of handover has a great effect on improving the effectiveness and reliability of the whole system, which plays an important role in modern wireless communication. In 5G mobile communication system, it is necessary to provide high bandwidth and high transmission rate service for different kinds of terminals in several scenarios. Handover technology is an important guarantee of communication continuity and service quality, and it is very important to the overall performance of the network.

As we move towards 5G filed, the environment becomes so complex that there are a number of new challenges in handover problem. The data rate in 5G is much higher than that in current 4G network, as a result the handover problem requires faster processing. Furthermore, as the number of Base Stations (BSs) and mobile devices sharply increases, the centralized control may not be

efficient [3]. Therefore more intelligent mobile terminals can play important roles in handover process. Moreover, increasingly serious data security problem reminds users do not share their private information with others. Thus, it is glad to see several new handover schemes in future 5G environments. Motivated by all above, we will focus on the different handover scenarios and schemes, and study the handover problem for 5G environments in this paper.

2. The handover in 5G scenarios

The handover is defined as the mobile terminal change the original communication link when the communication terminal is moving from the coverage of its serving base station to the coverage of the neighboring base station. Or the interference of the external environment causes the communication quality deteriorates during the continuous communication. Hence the terminal has to switch to other free channels to maintain a continuous communication process. If the switch fails, it will result in the interruption of communication and will seriously affect the quality of the network [4]. The basic handover model is shown in Figure 1.

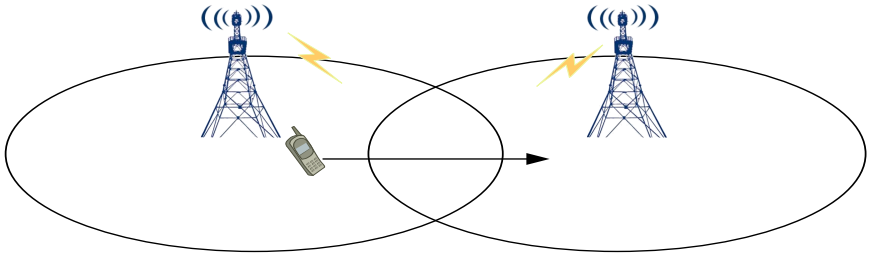

Figure 1. The basic handover model

In 5G scenarios, there are several proposed technologies such as UDN (Ultra Dense Network), massive MIMO, SON (Self-Organized Network), millimeter wave communication, etc.

UDN is designed to satisfy the demands that very high system capacity and end-user data rates of the order of 10 Gb/s. It is characterized as network switch very short inter-site distances capable of ensuring low interference levels during communications.

As for handover problems, next we will briefly introduce two of them which have strong effect on handover. UDN are expected to operate in the millimeter-wave band, where wide bandwidth signals needed for such high data rates can be designed. The basic framework of UDN is shown in the figure 2.

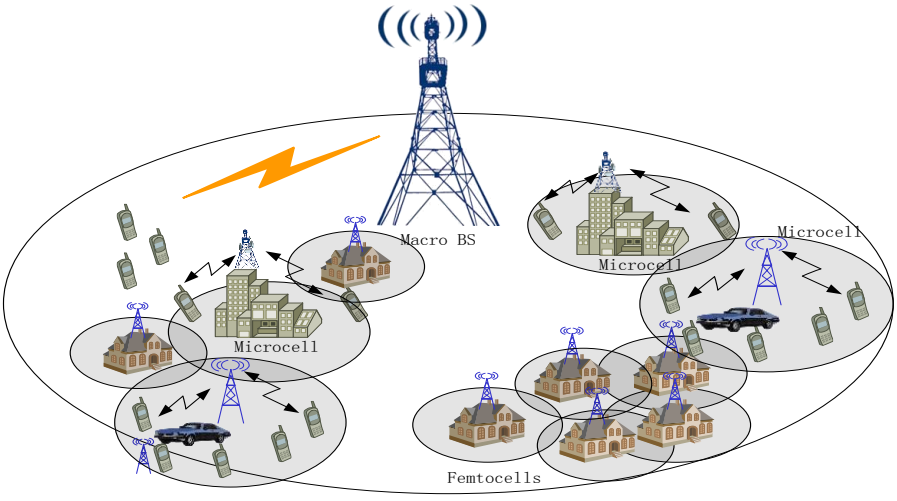

Figure 2. The basic framework of UDN

As a result of a variety of new technologies, there are many new problems in the mobility management of 5G communication system, which mainly includes the following aspects:

- Signal measurement are not precise: mm-wave communication develops a higher frequency band to communicate, which highly increases the capacity of the communication system. However, the high-band radio has strong path loss, atmospheric and rain absorption, low diffraction around obstacles, which makes it only be used in a small range [5]. Besides, after sharply fading, the measurement signal will have a certain error, and the error will result in a lower successful switching rate and unnecessary switching. These have seriously affected the user's communications experience.
- Frequent handover: In Ultra Dense Network architecture, the radius of the cell becomes much smaller than the current size. The time when the mobile terminal stays in each cell becomes short, which result in frequent handover [6]. Assuming that the moving speed of the mobile terminal is 10km/h and the cell radius is 25m and the overlap length is 5m. Then the mobile terminal needs to proceed handover every 12s and the time of staying in the overlap area is only about 4s.
- Different Network layers Switching: In conventional mobile communication system, handover is performed between two identical network layers. While in 5G, the handover will be proposed among LTE, WCDMA, WLAN and other different network technologies. So there will be the handover between the same network layer called horizontal handover and the vertical handover between the different network layers. In addition, in 5G system, the splitting of control plane and user plane also brings more handover problems [7].

In view of the above problems, this paper mainly discusses the measures to solve the above problems from the aspects of handover decision algorithm, handover execution mechanism and novel network architecture.

3. Handover decision algorithm and Handover execution mechanism

In view of the problem that the measurement signal is not accurate and the switching is frequent in the 5G environment, we can ensure the smooth completion of the switching by adjusting the base station parameter setting, improving the wireless coverage environment to reduce the switching rate. Besides, researchers focus on the research, in the handover decision algorithm and Handover execution mechanism.

Through the actual measurement and simulation we can found that most of the handover failure occurs in the state2 in which the original base station channel quality is so bad that HO CMD cannot be properly delivered. [8] proposes a scheme that prepare handover in advance to improve the correct sending of HO CMD. The base station configures two measurement events with the same length and the same threshold. After receiving the measurement of the TTT1 event, the base station starts the process of preparing the handover with the target base station. After the completion of the sending of the HO CMD to the terminal, the terminal starts to perform the handover after triggering the TTT2 event. If there is no TTT2, the terminal releases HO CMD. The original base station sends a signaling to the target base station to release the reserved

resource. This scheme sends the HO CMD earlier and improves the efficiency of the handover decision. The scheme is shown as figure 3.

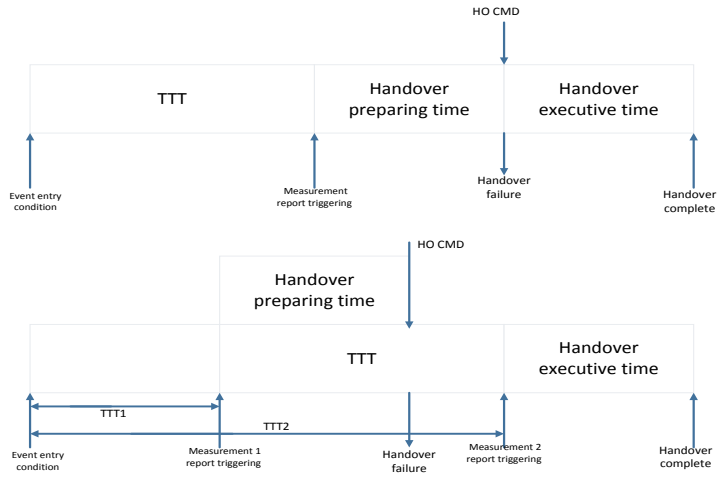

Figure 3. The prepare handover scheme

The existence of a large number of small cells in 5G intra-macrocell deployments enables high data rates and capacity, but on the other hand, they have posed some challenges from different aspects. The most obvious challenge is the unnecessary and frequent handovers causing packet losses, dropped and blocked calls in high rates. In view of this, [9] proposed a scheme using the position of UE and novel Target cell prediction algorithm. When UE detects that the distance between UE and its serving cell is larger than a predefined value, a prediction request message is sent to the network. Then the potential target handover cell is predicted by serving eNB, and handover preparation can be conducted before measurement report is sent. When the handover starts, if the predicted target handover cell is the same as the one that MR suggested, the delay caused by handover preparation can be saved. Moreover, in 5G intra-macrocell deployments, due to the control and data channel separation handover operation must be executed in two tiers. In [10], researchers present an optimal eNodeB selection approach for 5G intra-macrocell handovers by using spatiotemporal estimations to improve handover.

Moreover, the single decision algorithm determines whether the handover is triggered by comparing the decision criteria with the threshold value and the hysteresis tolerance value. The research mainly focuses on the selection and optimization of decision parameters. By means of strategy iteration, genetic algorithm, gray prediction and other methods we can get the optimal switching parameters, and further improve the handover efficiency. In [11], the author proposed a dynamic fuzzy Q-Learning algorithm based on fuzzy logic controller for MRO (Mobility robustness optimization) in Heterogeneous network. .they compared different UE speeds and TTT (time to trigger) in the algorithm. The simulation results show the Q-Learning algorithm can decrease the handover ratio while maintaining the call-dropping ratio at a low level.

4. Combined with novel network architecture and technology

The current architecture of the micro-base station ultra-dense deployment is distributed. And

in this architecture, it is difficult to execute the overall mobility management intensively, and it can't be avoided that handover will bring huge core network load. The solution to the problems in 5G mobile scenarios is to break through the constraints of the existing network architecture, and combine the emerging network technology. In [12], the author proposed a scheme named mobility anchor, which is suitable for microcell base stations deployment. This scheme introduces a logical entity called a mobility anchor whose function is to terminate the control plane and user plane of the S1 port, and to take charge of the location management and handover management in the local control area. In this way, the mobility anchor can receive and process the relevant signaling in the handover process, thus effectively reducing the signaling burden on the MME (Mobility Management Entity).

With the development of future 5G technology, along with data analysis, Internet and other technologies, more and more technologies can be brought in with the existing mobility scheme to further enhance the handover performance in ultra-dense network [13]. By introducing the interference coordination scheme, when sending the HO CMD, we can reduces the co-channel interference from the neighbor cell to the source cell , then the success rate of the HO CMD transmission is improved. In the 5G ultra-dense network architecture, we can use big data analysis. According to the users' behavior characteristics and other information, the users' behavior can be predicted, which includes the direction of movement, the destination and service situation. Then the handover resources can be prepared in advance. In this way, the handover delay can be further reduced and the user experience is improved.

5. Conclusion

Handover is the key technology in the research of the next generation of wireless mobile communication systems. It ensures the continuous connection of the communication when the communication terminal crosses the cell. Besides, handover can improve the validity and reliability of the whole communication system. In 5G application scenarios, the handover decision algorithm and handover executing mechanism are the key factors that affect the performance of handover technology. In view of the problems of 5G application scenarios caused by complex network structure, frequent handover and the network layers with different techniques, we introduce and summarize the handover decision algorithm, the handover execution mechanism and novel network architecture in this paper.

The handover technology in the current network has been widely studied and applied. However, how to combine the theoretical results with 5G network to meet the demand of the next generation of broadband mobile communication system is still a very attractive problem. At the same time, the application scenario of 5G network has a more intensive cell deployment and higher transmission frequency band, which will impose higher requirements on the handover decision algorithm and handover enforcement mechanism. Therefore, how to improve the handover decision algorithm and optimize the handover enforcement mechanism, so as to improve the handover performance and achieve the purpose of guaranteeing communication quality and service demand, has important practical significance.

6. References

[1]RAY S K, PAWLIKOWSKI K, SIRISENA H. Handover in mobile WiMAX networks: the state of art and research issues [J]. IEEE Communications Surveys & Tutorials, 2010, 12(3): 376-399

[2] Ni Shanjin, Zhao Junhui. Key Technologies in Physical Layer of 5G Wireless Communications Network [J]. Telecommunications Science. 2015, 31(12): 40-45.

[3] IMT-2020(5G) Promotion Group. 5G Vision and requirements, white paper [EB/OL]. [2014-05-28]http:/ /www.IMT-2020.cn.

[4] Qiang L, Li J, Touati C. A User Centered Multi-Objective Handoff Scheme for Hybrid 5G Environments [J]. IEEE Transactions on Emerging Topics in Computing, 2016.

[5]ZTE. R2-130957, HO performance improvement in hetnet [Z]. 3GPP RAN2 #81b, 2014.

[6]Andrews J G, Buzzi S, Choi W, et al. What will 5G be? [J]. IEEE Journal on selected areas in communications, 2014, 32(6): 1065-1082.

[7]opez-Perez D, Guvenc I, Chu X L. Mobility enhancements for heterogeneous networks through interference coordination. In: Proceedings of IEEE Wireless Communications and Networking Conference Workshops (WCNCW), 2012.69-74

[8]Song H, Fang X, Yan L. Handover scheme for 5G C/U plane split heterogeneous network in high-speed railway [J]. IEEE Transactions on Vehicular Technology, 2014, 63(9): 4633-4646.

[9]Fei M, Fan P. Position-assisted fast handover schemes for LTE-advanced network under high mobility scenarios [J]. Journal of Modern Transportation, 2012, 20(4): 268-273.

[10]Bilen T, Duong T Q, Canberk B. Optimal eNodeB Estimation for 5G Intra-Macrocell Handover Management[C]//Proceedings of the 12th ACM Symposium on QoS and Security for Wireless and Mobile Networks. ACM, 2016: 87-93.

[11]Wu J, Liu J, Huang Z, et al. Dynamic fuzzy Q-learning for handover parameters optimization in 5G multi-tier networks[C]//Wireless Communications & Signal Processing (WCSP), 2015 International Conference on. IEEE, 2015: 1-5.

[12]China Telecom, HUAWEI. R3-150016，Consideration on mobility anchor solution[Z]. 3GPP RAN3#87, 2015

[13]Peng Chen. 5G: Key Technology and System Evolution. Machinery Industry Press.2015.10

[14]Ni S, Zhao J, Ran R. Analysis of Channel Estimation in Large-Scale MIMO Aided OFDM Systems with Pilot Design[C]//Vehicular Technology Conference (VTC Spring), 2016 IEEE 83rd. IEEE, 2016: 1-5.