Chapter 2
5G Networks:
A Holistic View of Enabling Technologies and Research Challenges

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ABSTRACT

Mobile communication witnesses a new generation after every 10 years. Following the same trend, the roll out of next generation called 5G network is anticipated by 2020. In this chapter, a critical review of enabling technologies and research issues of 5G network is provided. The novelty of the chapter lies in providing a holistic view of 5G networks spanning discussions on technologies and issues across all the layers of protocol stack. Specifically, the chapter talks about the higher-level research issues of 5G network. The chapter is primarily structured as follows: It starts with a brief overview of various generations of mobile communication. Then, the problems with existing generation of mobile communication are presented, thus providing the motivation for a new generation of mobile network. A survey of different enabling technologies of 5G network is provided afterwards. After having brief discussions on key enablers, the chapter presents various research issues of 5G network. The chapter concludes with highlighting current challenges and future research issues.

INTRODUCTION

The past few decades have witnessed the continuous emergence of mobile communication standards. Starting from first generation of mobile phones that provide voice services, a new standard has emerged after every ten years. A large number of standards are thus evolved that provide a variety of services such as audio-video, Internet access and fax. Based on the past trends, 5G mobile communication is anticipated as next generation of mobile phones that will provide advanced features beyond those provided by earlier generations. In recent past, a number of researches have appeared talking about the features

of this new generation. A survey of 5G architecture and emerging technologies have been presented in (Gupta & Jha, 2015). The author talks about MIMO technology, ultra dense network and full duplexing were highlighted. Issues such as interference management and spectrum sharing were discussed and a mmWave solution was proposed. Another survey on 5G network talks about technologies and issues such as dense network, handoff management, interference, QoS, load balancing, security and caching. An overview of 5G architecture, developments and a brief overview of technologies such as cloud computing and mmWave communication have been provided in (Mitra & Agrawal, 2015). (Andrews, Buzzi, Choi, Hanly, Lozano, & Anthony, 2014) highlighted major design issues of 5G as multiple access technologies, network virtualization and energy efficiency. The authors in (Boccardi, Jr., Lozano, Marzetta, & Popovski, 2014) discussed five disruptive technology directions for 5G network i.e. device-to-device communication, mmWave, massive MIMO, smarter devices and machine-to-machine communication. Various emerging technologies of 5G network has also been discussed in (Bojkovic, Bakmaz, & Bakmaz, 2015). An overview of various 5G research activities have been provided in (Pirinen, 2014). (Demestichas, Georgakopoulos, Karvounas, Tsagkaris, Stavroulaki, & Lu, 2013) provided a survey of 5G technology and highlighted intelligence as a key component for next generation network. (Le, Lau, Jorswieck, Dao, Haghighat, & Kim, 2015) discussed various enabling technologies and research issues of 5G network. An overview of device-to-device communication issues in 5G network is provided in (Tehrani, Uysal, & Yanikomeroglu, 2014).

However, a review of current surveys on 5G networks lead to the conclusion that most of the work on 5G network is on radio network. Understanding the higher level research issues and their impact is essential. In this direction, only few research surveys are available. (Fiorani, Skubic, Mårtensson, Valcarenghi, Castoldi, & Wosinska, 2015) provided a study on issues of designing transport protocol. A brief discussion on 5G security has been provided in (Horn & Schneider, 2015). An overview of various caching schemes of 5G network has been presented in (Islam, 2017).

Unlike the previous surveys, this paper provides a holistic view of properties, developments, enabling technologies and research issues of 5G network. Specifically, it deliberates on higher level research issues which have not been discussed thoroughly in literature so far. Rest of the sections are organized as follows. The next section presents an overview of earlier generations of mobile phones. Then, the properties, architecture, application models and various recent developments in 5G networking are presented. Afterwards, an overview of enabling technologies of 5G network is presented. The major contribution of 5G networks i.e. various higher level research issues of 5G network is presented afterwards. The paper concludes with summarizing the research issues of 5G network.

Generations of Mobile Communication

This section talks briefly about the various earlier generations of mobile communication. Before proceeding towards the discussion on 5th generation of mobile communication, it is essential to understand what earlier generation of mobile phones offer to end user and how various earlier generations progressed.

Introduction

The earliest mobile communication systems (0G) were mobile radiotelephone systems. These early mobile telephone systems were different from previous closed radiotelephone systems as these services were commercial and constituent of the public switched telephone network (PSTN). However, they

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