

Chapter 8

Challenges of 5G Networking in Access and Core Networks

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ABSTRACT

The 5th Generation wireless and mobile communication is expected to provide ultrahigh data rates over wireless in the range of Gbps. But 5G will also be about providing consistency and supporting Quality of Experience in a personalized manner. We foresee an evolution in terms of physical layer enhancements to provide increased data rates, whereas a revolutionary step is required in terms of network orchestration and management to provide consistency and efficient utilization of the available resources at a minimum cost. In this chapter, key trends in wireless access technologies and thus-required network management strategies with respect to the core network are discussed. In the roadmap towards 5G networks, we envision an evolution of technologies for supporting Gbps wireless transmission, whereas a revolution would be required from the current modus operandi in the ways network orchestration and resource management is performed in these complex, hierarchical, heterogeneous and highly autonomous wireless networks.

1. INTRODUCTION AND BACKGROUND

The key challenge for mobile and wireless networks for the decade to come will undoubtedly be to support the anticipated thousand-fold mobile traffic increase, while at the same time efficiently support the ever increasing diverse set of requirements from different applications. With 4G technologies (LTE-A) not fully deployed yet (as of 2014) research and innovation efforts have com-

menced on the development of the next generation wireless systems. Generally referred to as 5G, it will need to encompass breakthrough technologies and architectures, which will be able to match the unprecedented rise in quantity and heterogeneity of wireless traffic. This has repercussions on both access and core networks, which will be the discussion point of this chapter. We will dwell on latest emerging design paradigms, notably network densification and split-architectures, distributed mobility support and network visualization. These

items are discussed bearing in mind the general requirements of wireless design, i.e. cost, scalability, robustness and availability, unprecedented delay allowing for control application, and peak rates aiming to match those of wired networks.

Prior to this, let us revise some of the lessons learned from prior cellular designs and deployments. 3G will be remembered as the first mobile network which was largely IP enabled, i.e. packet-switching technologies have been designed into the network. That was important for the exponential uptake of data-driven applications, which eventually would drive the smart phone revolution. On the downside, 3G will be remembered as performing relatively poorly in the Radio Access Technology (RAT) and Radio Access Network (RAN) side – contrary to all promises made on the ease of using a single-frequency network. A positive side-effect of the radio network management becoming so complex, however, was the emergence of self-organizing networking (SON) techniques which would pave the way for proper management of heterogeneous networks in 4G and now 5G networks. 3G was also the first system to introduce more advanced multi-antenna systems, such as space time coding, among others, and prove it would work in a commercial setting.

4G learned from the lessons of designing and rolling out 3G. Notably, the core was made lighter and flatter and was entirely packet-switched; the RAN was enjoying advanced concepts such as Coordinated Multipoint (CoMP) reception and carrier aggregation (CA); more SON features – mainly related to RAN management – appeared; and a much simpler yet powerful and scalable air interface was introduced in form of OFDMA. 4G engineers tried less to come even closer to the Shannon bounds, rather than building a cost efficient system able to meet capacity needs of the emerging smartphone revolution. Techniques such as CoMP for example seem to be complex for efficiently implementing them in real networks. Two major constituents in the design were the availability of more spectrum (leading to CA protocols)

and denser networks (leading to the first highly heterogeneous cellular networks). On the other hand, 4G networks can be considered as “islands” where sharing and innovation on the control and management plane are very much limited since all functions are based on proprietary hardware and software. This is a significant limiting factor to ensure network sustainability and integration of various different heterogeneous networks.

With above lessons in mind, the community is currently gauging the design requirements for 5G networks, where some trends are outlined in below sections of this book chapter. To this end, the rest of the chapter is organized as follows. In the next section, we discuss trends and opportunities related to 5G RAT/RAN designs, which includes mm-Wave, machine-type communication (MTC), phantom cells as well as decoupled up and downlinks. In the subsequent section, the emerging issue of softwarization of the end-to-end communication is introduced that includes both Software-defined Radio (SDR), Software-defined Networking (SDN) and Network Function Virtualization (NFV). This is followed by the emerging trend of network sharing via virtualization where recent works and challenges are discussed. The chapter is closed with a set of 5G design visions, hopefully enabling future avenues of research.

2. TOWARDS 5G: RAT EVOLUTION AND RAN REVOLUTION

In this section, we outline issues related to RAT and RAN designs. Notably, we outline some of the lessons learned from previous design efforts of 3G and 4G networks. Then, we discuss emerging trends and how they are reflected in the RAT and RAN designs.

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