Chapter 13
Self-Organized Future Mobile Communication Networks: Vision and Key Challenges

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ABSTRACT

The chapter highlights the state of art and provides a comprehensive investigation of current research efforts in the field of SONs in the upcoming 5G mobile communication networks. It goes through SON functionalities and discusses their cyclic behavior. Moreover, the chapter investigates in detail the construction of a unified SON framework to self-organize future networks, which are expected to have a high degree of heterogeneity. A major contribution in this context is the study of how various SON activities can be coordinated to guarantee systems' stability and reliability in addition to performance optimization. Furthermore, the chapter handles SON use cases currently present and those expected to appear in 5G networks going through their goals, operation, proposed solutions and research challenges.

INTRODUCTION

Mobile communication technologies are significantly expanding in terms of increased complexity of applications as well as services, required capacities, heterogeneity in Radio Access Technologies (RATs) and involved mobile devices types, etc., see (RAS-FP7, 2013). The continuous evolution of consumer uptake of mobile broadband, which is expected to experience 33 times increase in 2020 compared with that of 2010 (UMTS Forum, 2011), is one of the main challenges of the upcoming version of mobile communication technologies, namely the 5G. Other challenges include a broad variation of requirements and service characteristics, reduced energy consumption, reduced costs, cognitive spectrum support, etc., see (RAS-FP7, 2013) and (Baldemair et al., 2013).

The increasing complexity of future mobile networks makes a cost-effective network operation an essential challenge to be faced. This challenge becomes more crucial when one also considers

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the additional cost resulting from the affordable operation of overlaid multi-standard networks (2G, 3G, 4G, etc.). Therefore, new solutions must be developed to keep network operators Operational Expenses (OPEX) minimized, while simultaneously simplifying the manageability and enhancing the performance of their networks (Ramiro & Hamied, 2012). It is worth mentioning that achieving the aforementioned goal is possible through implementing self-organized solutions in the infrastructure, see (Diab & Mitschele-Thiel, 2014).

The initial steps done to standardize mobile communication technologies with self-organization capabilities were achieved in the scope of the 3rd Generation Project Partnership (3GPP) (3GPP, 2014). The well-known standard with self-organized capabilities is termed Long Term Evolution-Advanced (LTE-Advanced) (Dahlman, Parkvall, & Skoeld, 2011). This standard aims at minimizing OPEX costs while maximizing resource usage, network capacity, etc. The key idea is simply a self-organized automation of tasks currently requiring significant efforts for planning and operation. To further contribute to Self-Organizing Networks (SONs), the Next Generation Mobile Networks (NGMN) alliance (NGMN, 2014) was also constructed. This alliance has addressed SONs requirements, use cases, possible solutions, etc. in LTE-Advanced systems, see (NGMN, 2008), (NGMN, 2008a) and (NGMN, 2006).

Due to the fact that the upcoming 5G mobile communication networks will consider heterogeneous RATs and both wired as well as wireless parts targeting a fully integrated solution (RAS-FP7, 2013), in addition to a continued evolution of present routines/services (e.g. network densification into ultra-dense networks and device-to-device communications), and development of new ones (e.g. moving networks, massive machine communications, etc.), auto-integration and self-management capabilities way beyond the today's SONs techniques are necessary. To address SONs activities in the upcoming mobile communication technologies, the NGMN alliance has currently announced the launch of a global initiative for 5G networks, see (NGMN, 2014). Many research communities have been initiated to contribute to these capabilities, see (iJOIN, 2014) and (SEMAFOUR, 2014).

This chapter focuses on the principles and activities of SONs in the upcoming 5G mobile communication networks. It provides in the second section a thorough overview of SONs principles as well as functionalities and presents their cyclic behavior. Following that, the chapter investigates in the third section the construction of a unified SON management framework to self-organize future networks, which are expected to have a high degree of heterogeneity. An important topic in this context is the investigation of how various SON activities can be coordinated to guarantee systems' stability and reliability in addition to performance optimization. Thereafter, the chapter handles in the fourth section various SON use cases currently present and expected to appear in 5G networks going through their goals, operation, proposed solutions and research challenges. Finally, the chapter concludes with the main results.

SON FUNCTIONALITIES

Major SON functionalities are categorized into five categories, namely self-planning, self-deployment, self-optimization, self-healing and SON enablers (Ramiro & Hamied, 2012), see figure 1 which summarizes these functionalities and shows the relations between them.

Self-planning functionalities include the routines that cover the derivation of new network nodes settings, the site location selection and hardware configuration including radio as well as transport parameters. Self-deployment functionalities cover all procedures necessary to bring new network nodes into commercial operation. These functionalities include the preparation,