

Chapter 18

D2D– and DTN–Based Efficient Data Offloading Techniques for 5G Networks

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ABSTRACT

With the advancement of smart phone technologies cellular communication has come to a stage where user bandwidth has surpassed the available bandwidth. In addition, the well-organized but stubborn architecture of cellular networks sometimes creates hindrance to the optimal usage of the network resources. Due to this, a User Equipment (UE) experiencing a poor channel to the Base Station (BTS) or evolved NodeB (eNB) or any other Access Point (AP) retransmits the data. In such scenarios, Device-to-Device (D2D) communication and offload/relay underlying the cellular networks or the access networks provides a unique solution where the affected UE can find a close proximity offloader UE to relay its data to eNB. Delay Tolerant Networks (DTN) is another framework which has potential usage in low-connectivity zones like cell edge and/or remote locations in cellular networks. This chapter investigates various possibilities where D2D and DTN can be jointly used to improve teledensity as well delayed but guaranteed services to poor or no connectivity areas.

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INTRODUCTION

Today's generation is witnessing a continuous and exponential growth in cellular devices, applications, and data usage. In the future, mobile devices including surveillance cameras, smart-city/home/grid devices etc., are expected to increase by 10- to 100- to 1000- fold. This huge transition presents a formidable challenge in the field of wireless communications. Moreover, each one of us desires to stay connected all the time in a seamless manner through social networking, on-line gaming, and ubiquitous business framework, etc. With the demand in data usage increasing day-by-day and 5G knocking the doors, mobile operators are facing a major challenge in providing adequate services. In addition to this, with limited spectrum available and almost saturated channel capacity, supporting extra services becomes a nightmare for the operators. At present, the mobile operators are struggling to make significant profit on voice, message, and other services due to the advancement of Over-The-Top (OTT) services like instant messaging, multimedia services such as photo sharing, video calling and other popular mobile application based free services.

To match the above demand and to generate more revenue from their operations, operators need to increase the capacity of the cellular networks which means both the access capacity from the mobile to the Base Stations (BTSs) or Access Points (APs) and the backhaul capacity from the BTSs/APs to the core network has to be increased. This can be achieved in three different ways:

1. Add new BTSs/Aps,
2. Release new spectrum,
3. Increase the spectral efficiency of the technology used.

However, these are neither feasible nor scalable due to various reasons, and hence not viable for the operators to continue in making business. Moreover, as predicted by industry and academia, all the above techniques can only add 15-20 times capacity (even with LTE and LTE-Adv technologies that is expected to roll out by the year 2017-18). Therefore it is hard to find "*a solution*" or a "*class of solutions*" which can support more than 1,000 times traffic growth. Mobile operators need to evaluate alternate solutions or ways to handle this growth in a cost effective manner. The operators not only need to find-out cost effective solutions, but also look for solutions which are complementary in nature as "*one technology fits all*" will not be able to cater the traffic growth. The seamless integration of such complementary technologies with evolved 3G and 4G can bring a new consumer experience, enable a host of new services and can be called as the evolution towards 5G.

Technologies such as Wireless Fidelity (WiFi), Small Cells, Delay Tolerant Network (DTN) based Relays, and Device-to-Device (D2D) communications have emerged as some of the complimentary solutions to the cellular technology through simultaneous transmission or offloading. Many a times, although the mobile users are communicating (sharing files) in close proximity (in a stadium, club, office, homes, etc.), they require to follow the existing cellular transmission procedures, i.e., up link from the sender mobile to the base station (BTS or eNB) first, and then down link from eNB to the receiver mobile. This is not only complex, but also resource consuming. In such scenarios, Device-to-Device (D2D) communication can be used as an alternative; can be realized as a network assisted service in which eNB facilitates the peer to peer (P2P) or Device-to-Device connectivity. In addition, other technologies such as WiFi Direct and Bluetooth can also be used in such scenarios. Since there is a proximity involved, the transmission power required in such cases is significantly low. Therefore, D2D communication not

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