Hybrid Model for LTE Network-Assisted D2D Communications

Thouraya Toukabri Gunes¹, Steve Tsang Kwong U¹, and Hossam Afifi²

¹ Orange Labs, Issy-les-Moulineaux, France
{thouraya.toukabrigunes,steve.tsangkwongu}@orange.com
² Telecom SudParis, Evry, France
hossam.afifi@telecom-sudparis.eu

Abstract. In the evolution path towards the “Always-Connected” era and the trend for even more context-aware services, Device-to-Device communications (D2D) promise to be a key feature of the next-generation mobile networks. Despite remaining technical issues and uncertain business strategies, D2D-based services represent a new market opportunity for mobile operators that would manage to smoothly integrate these new technologies as a complement or even an efficient alternative to cellular communications. Existing research efforts on the integration of D2D technologies in cellular networks have mostly failed to meet user expectations for service simplicity and reliability along with operator requirements regarding lightweight deployment, control and manageability. This paper proposes a hybrid model for D2D communications assisted by mobile operators through the LTE network: it includes a lightweight D2D direct discovery phase and an optimized data communication establishment for proximity services. The proposed hybrid model is appraised against the existing solutions in literature and the current standardization effort on Proximity Services (ProSe) within the 3GPP.

Keywords: D2D communications, LTE networks, Proximity Services.

1 Introduction

Today’s mobile networking world facts are: the mobile industry is shipping more smartphones and tablets than PCs; success stories of social networking services like Facebook has become a social trend from which mobile users developed the need to be connected anywhere to their surroundings; statistics in [4] envision an exploding number of more than thousand billion wireless connections around the world in 2020. Meanwhile, revenues of mobile services have been growing at a much slower rate than the growth of mobile connections since 2011¹. The challenge for mobile operators, who struggle each quarter to turn a profit on voice and SMS services, is yet to face the threat of Over-The-Top (OTT) providers who have put their foot down at the mobile market with apps that supply instant messaging, multimedia services like photo sharing and video conferencing and other popular services for free. In this context,

¹ http://www.wwpi.com/
Device-to-Device communications have become the new driver in wireless networking and mobile market.

Defined as a short range direct communication between devices without the involvement of the network infrastructure, D2D communications have been proposed as an underlay to cellular networks. Such a solution will evolve cellular networks toward a layered topology in which multiple network layers (femto-network, D2D-network, Wifi-network…) would coexist with a main macro-cell layer.

With these new types of communications mainly based on context and proximity information, a new generation of user-centric mobile services will rise, offering at the same time the opportunity for operators to extend their mobile networks’ capacities and to alleviate the traffic in their core networks; for instance, smart cities services, real-time social discovery of nearby persons, targeted and personalized hyper-local services (advertising, couponing/ticketing, restaurant/hotels booking, content download, etc.). Besides, when including group communications and relay mechanisms, D2D communications could be a relevant fallback alternative for the public safety services (police, firefighters, emergency services, etc…) in disaster situations (earthquake, Fire, etc.): using a specific D2D-enabled Public safety device, an officer/agent can exchange data and transmit information to other devices through a D2D group communication. Moreover, in poor radio coverage areas, relay-based D2D mechanisms could be an efficient way to extend network connectivity.

Surfing on the wave of the successful worldwide launch of 4G LTE (Long Term Evolution) mobile networks, a new short range technology based on LTE (LTE Direct) has been developed by Qualcomm\(^2\). Envisioned to be the next trendy D2D technology that best meets the requirements of the above mentioned types of services and successfully tested in a recent research work\(^3\), 3GPP (3\(^{rd}\) Generation Partnership Project) has then initiated a standardization effort on the integration of LTE Direct in mobile networks [12]. If this effort first addresses Radio Access Network (RAN) requirements and technical issues for the support of D2D-based services, it comes also along with a feasibility study [5] and a technical specification on the architecture enhancements for the support of Proximity Services (ProSe) [6].

In literature, many research works have been done on D2D communications and their integration within LTE networks. The earliest ones addressed mainly the radio aspects such as D2D radio interference management with cellular communications, power control, radio resources allocation/sharing methods and spectrum regulatory aspects (use of a licensed or unlicensed band for D2D). Studies have also been made on D2D discovery and communication mechanisms. However, the few proposed solutions in these fields are still immature and don’t answer basic user concerns for simplicity, reliability and QoS when using D2D-based services. Otherwise, if these requirements have been answered by the recently standardized solutions proposed in 3GPP [6], the current specification is globally lacking from a more extensible and evolutionary vision of the D2D integration in current and next generation networks.

\(^2\) [http://www.qualcomm.com/solutions/wireless-networks/technologies/lte/lte-direct](http://www.qualcomm.com/solutions/wireless-networks/technologies/lte/lte-direct)

\(^3\) [http://english.etnews.com/internet/2909211_1299.html](http://english.etnews.com/internet/2909211_1299.html)