Enabling Cellular Device to Device Data Exchange on WISDOM 5G by Actuating Cooperative Communication Based on SMNAT

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ABSTRACT

The key attributes envisioned for LTE-Advanced pertaining to 5G Networks are ubiquitous presence, device convergence, massive machine connectivity, ultrahigh throughput and moderated carbon footprint of the network and the user equipment actuated by offloading cellular data traffic and by enabling device to device communication. The present method of mobility management and addressing as the authors have foreseen in LTE Advanced can solve some issues of cellular traffic backhaul towards the access and core network by actuating a local breakout and enabling communication directly between devices. But most of the approaches look forward towards an enhancement in the radio resource allocation process and prone to interference. Besides, most of these proposals delve in Device to Device (D2D) mode initiation from the device end, but no research has so far addressed the concept of a network initiated D2D process, which can optimise the channel utilisation and network operations further. In their attempt to knot these loose ends together, the authors furnish the concept of WISDOM (Wireless Innovative System for Dynamic Operating Mega communications) (Badoi Cornelia-I., Prasad N., Croitoru V., Prasad R., 2011) (Prasad R., June 2013) (Prasad R., December 2013) and SMNAT (Sanyal, R., Cianca, E. and Prasad, R., 2012a) (Sanyal, R., Cianca, E. and Prasad, R., 2012b) (Sanyal, R., Cianca, E. and Prasad, R., 2012c) (Sanyal, R., Cianca, E. and Prasad, R., 2012d) (Sanyal, R., Cianca, E. and Prasad, R. (2011a). Further, the authors explore how SMNAT (Smart Mobile Network Access Topology) can engage with WISDOM in cooperative communication to actuate D2D communication initiated by the device or the network. WISDOM is an architectural concept for 5G Networks based on cognitive radio approach. The cognition, sustained by adaptation techniques, is a way to provide communication, convergence, connectivity, co-operation, and content, anytime and anywhere. Though D2D communication using a dedicated spectrum in multi cell environment is possible through advanced network coding or by use of fractional frequency reuse, but physical proximity of the 2 devices is still a key requisite. In this paper the authors will discuss SMNAT which employs physical layer addressing to enable D2D communication agnostic to the spatial coordinates of the devices.

Keywords: Cognitive Radio, Cooperative Communication, D2D Server, Generalized Frequency Division Multiplexing (GFDM), IP Multimedia System, Mobility Management Entity (MME), Rich Communication Services (RCS), Service Centralisation and Continuity Application Server (SCCAS), SMNAT, WISDOM

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1. INTRODUCTION

Ubiquitous, instantaneous and always connected are some of the key prerequisites of a modern mobile device. It has been partly complied by LTE and some Network based applications based on the IMS framework like Rich Communication Suite (RCS) (GSM Association Official Document). The data requirement per user is facing an exponential growth with the high proliferation of the applications on the UEs available today. Fixed to Mobile convergence have been realised by ‘Over the top’ (OTT) applications or by network based applications like Service Centralisation and Continuity Application Server (SCCAS) (3GPP TS 24.294) V9.6.0. Machine to Machine applications (M2M) and Internet of Things (IoTs) today play an important role in shaping up the data traffic patterns which can be sporadic or distributed over time. In near future, we anticipate two primary requirements for the network:

1. As the new device technologies come up, the data throughput per user will increase. For example, smartphone and tablets with 3 Dimension (3D) screens and cameras may require double the bandwidth. Screen resolution will further increase leading to higher bandwidth requirements. Online multiplayer gaming applications running on 5G gaming consoles with 3D displays will require higher throughput both for the uplink and downlink. More dedicated data bearers will be required at the access and core to guarantee the Quality of Service (QoS) promised to the user. Ultra High Definition (UHD) voice and UHD video will be some of the fundamental requirements;

2. Due to the swarm of M2M and IoT devices in the network, the mobility management related processes will be more intense and will consume more network resources. The nano nature of the devices with limited RF power will imply additional small-cells/microcells which will increase the intricacy of the access and core network.

The telecom researchers are in a constant endeavour to make the network itself leaner and greener by improvising ways to trim down the signalling and data overhead. In this paper we attempt to contribute to this research by proposing an Access Technology termed as SMNAT to facilitate Device to Device (D2D) communication that can be initiated by the network. This can enable substantial traffic offload in cellular, thus boosting the capacity of the network. It will interoperate with WISDOM 5G based on cooperative communication as explained in the latter sections.

The rest of the paper is arranged as follows. First we present the 5G communication landscape and the work done so far. Then, in the next section, we briefly discuss the primary attributes of WISDOM based on cognitive radio. In the subsequent section, we focus on D2D communication where we discuss the state of the art. Following, we discuss D2D based on SMNAT. A Comparison matrix is also included in this section. Further, conclusions are drawn.

2. 5G COMMUNICATION LANDSCAPE

With the present day device capabilities, the mobile devices are in constant interaction with each other. The human centric Mobile device interacts with various wearable devices, like smart watches, wearable computers (e.g. Sixth Sense), SOS devices and health equipments. As we move around, these devices become more dynamic in nature. The devices, categorised as M2M or IoTs may be as below (though this is an example and not an exhaustive list):

1. Environment sensors;
2. Connected cars;
3. Smart objects and robots;
4. Health equipment;
5. Small cells not owned by the mobile operators.

According to the newly formed group called METIS (Mobile and wireless communications
Requirements Traceability within Model-Based Testing: Applying Path Fragments and Temporal Logic
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System Frame Erasure Rate and its Relationship to Perceived Call Quality in a Wireless Network: A Quantitative Investigation