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Performance based user-centric dynamic mode switching and mobility management scheme for 5G networks

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ABSTRACT

User-centric communication in fifth generation (5G) network enables wireless peer-to-peer network interface between mobile users in order to improve the data rate and offload the traffic for improved QoE as compared to traditional legacy base station centric (network centric or eNB centric) architecture. In this paper, we introduce a user-centric performance based cooperative cellular communication architecture and device mobility management procedure for 5G networks. Due to the exponential growth of connected devices, the users are deployed very densely. It motivate the researcher for user-centric communication, and it is a feasible approach, where the user can communicate via a relay node with minimum network infrastructure support. The proposed approach is central to mode switching and supporting a high degree of user mobility during the communication. The mode switching techniques is depends on quality parameters (such as link utilization, delay, and energy consumption). When the network switches the communication link from traditional mode (network centric) to user-centric mode of communication, it resort to relays to sustained the quality parameters. The relay selection is a random process, the network selects an arbitrary node as a relay node without any negotiation on performance metrics and node mobility. In order to improve the network mobility management performance, a mobility management scheme is proposed, where the system computes the QoS/QoE and make a decision for mode switching between network-centric to user-centric or vice-versa. The proposed technique show better performance over the traditional cellular network and we compare our results with 4G/Long Term Evolution (LTE), with respect to link utilization, energy consumption, call-to-mobility ratio analysis and system scalability. The performance analysis and comparison demonstrates the superiority of proposed system in terms of QoE parameters as compared to LTE networks.

1. Introduction

The 5G is an emerging area of modern cellular networks, and expected to deploy by 2020. It is assumed to be the future of next generation wireless cellular systems with massive advantages over current communication technology (Andrews et al., 2014; Thompson et al., 2014; Agyapong et al., 2014; Zhang et al., 2015). It has many complex and challenging tasks associated with its real time deployment (Mishra et al., 2016a; Biswash and Kumar, 2010). Now the academia, industry, regulatory organizations, and the standardization bodies are anticipating its implementation, as the current cellular technologies cannot fulfill the communication needs of forthcoming user expectations (Ameigeiras et al., 2015). The authors of (Boccardi et al., 2014a) proposed "Big Five" features for 5G networks such as: Massive Multiple Input Multiple Output (M-MIMO), Device-centric Communication, Native support for heterogeneous communication, Millimeter wave, Smarter device-to-Smarter device, Native support for Machine-to-Machine communication system. The 5G and beyond network generations anticipate support for the concept of user-assistant green networking (Mishra et al., 2016b; Rowell et al., 2014). Resource allocation is an important challenge of 5G networks. The authors of (Mishra et al., 2016a; Hoang et al., 2016) show the importances of 5G networks and associate research challenges, including link efficiency, energy-efficiency, resource allocation etc. for performance enhancement. In this paper, we focus on performance improvement and QoE metrics analysis of user-assisted 5G networks. The network slicing is another a promising technology for 5G networks in order to provide services tailored for users' specific QoS issues (Zhang et al., 2017a). It is driven by the increased data traffic from different applications, efficient resource allocation schemes should be exploited to improve the flexibility of

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network resource allocation and capacity of 5G networks based on network slicing. In this work, we are consider delay, link utilization and energy consumption as a QoE metrics. The delay is associated with overall communication delay between source node and destination mobile user. The modern cellular network requires less communication delay, and consider it a performance metrics. We also considers the link utilization as a quality metric because, the cellular network has limited bandwidth, channel capacity and dynamic channel allocation for multiple users. The proposed work help to reduce traffic over the network, because the associated traffic does not move via the eNB and network. The cellular network consume 60% of energy in signalling energy. The high energy consumption lead to frequent device power discharge, and it refer as a poor performance. The proposed work helps to reduce the overall signalling energy. The Table 1 shows the list of abbreviations used for formulation purpos.

This paper is organized as follows: Section 2 provides the details of the domain specific literature survey. Section 3, presents the proposed mode switching procedure and mobility management. The complete system formulation is available in Section 4. The results and discussion are presented in Section 5 and followed by references.

2. Literature survey

In this section, we provide the overview of current state-of-art for cellular communication and consider the LTE as recent cellular technologies (Soltanmohammadi et al., 2016; Araniti et al., 2013).

2.1. LTE networks

The mobile network is upgraded to an LTE assists network. In the LTE network, mobile user have single-carrier frequency-division multiple access (SC-FDMA) for up-link and orthogonal frequency-division multiple access (OFDMA) for down-link channels (Soltanmohammadi et al., 2016). In the LTE network, the mobile system coverage interface facilitates Radio Access Networks (RAN) and support Host-to-Host (H2H) and Machine-to-Machine (M2M) communication and mobile devices referred to as user equipment (UE). The LTE network architecture is divided into the RAN and Core Network (CoN). Here, Enhanced Node B (eNB) is the base station (BS) component of the LTE network. It provides PHY and MAC layer services to the broadband users, and is an intelligent network (Chen et al., 2017). Fig. 1 shoes the LTE network architecture. The eNB and Mobility Management Entity (MME) is directly connected with the S1 links and all eNBs are commented with X2 links. The MME is responsible for mobility management, network access control, roaming management etc. The combination of X2 and S1 link supported by U-TRAN (Abu-Ali et al., 2014). In this paper we consider the LTE is base line cellular network architecture and it follows the eNB centric communication between the mobile nodes. Where, the all traffic goes via eNB and network has full control over it in order to provide the better user experience, it refer as network-centric communication system (Chen et al., 2017; Soltanmohammadi et al., 2016).

Table 1
List of abbreviations and symbols.

Notations	Descriptions
eNB	Enhanced Node B
UE	User Equipment
CN	Crossroading Node (Target Node)
n	Number of users within a cell
N	Number of active eNB within the service area
p	User movement-probability
A	Coverage area of service provider
R_c/R_u	Transmission rate in CM/UM
D	Power spectrum density
Bd_c/Bd_u	Bandwidth allocation for CM/UM
MC	Movement coefficient
H	Mobile user's movement directions
$\mathfrak{R}$	Network update energy
ξ	Hop Counts
$S_{req}/S_{\{rep\}}$	Request and Reply packet
η	Proportionality constant
ϕ	Liner coefficient for link utilization
w	Per unit association lookup cost
$T_{\{prop\}}$	Propagation time
$T_{\{pros\}}$	Processing time
CMR	Call-to-Mobility ratio
d	Straight line distance from current/origin position
$Bd(\cdot)$	Bandwidth function
$D(\cdot)$	Delay function
$S(\cdot)$	Signal Strength function
$P(\cdot)$	Performance function
U_T	Link round trip time between UE and eNB
C_T	Link round trip time between CN and eNB
v	The index for UE or CN
Z	Metric value between source and target using relay node

2.2. User-centric communication in 5G and beyond

The vision for the next generation 5G wireless networks lies in providing very high data rates (in Gbps order), extremely low latency, manifold increase in the eNB capacity, and a significant improvement in users' perceived quality of service (QoS) as compared to the current 4G/LTE networks (Agiwal et al., 2016). The 5G has the unique feature of Device-centric communication, and it supports minimum infrastructure utilization for mobile communication (Boccardi et al., 2014a). It is a promising area of research, with researchers working to design algorithms, protocols and systems design for device centric 5G networks (Agyapong et al., 2014; Costa-Perez et al., 2017; Schulz et al., 2017). Fig. 2 shows the user-centric communication system, where the mobile node (UE1) is communicating to target node (UE2) using relay node and UE1 can also communicate to UE3 without the relay node association. The user-centric communication is also shown in Fig. 7. The relay node selection is subject to network performance metrics. It is a prototype for user centric 5G network. The associated eNBs work as a intelligent network manager (NM) facilitator, it mange the MME and

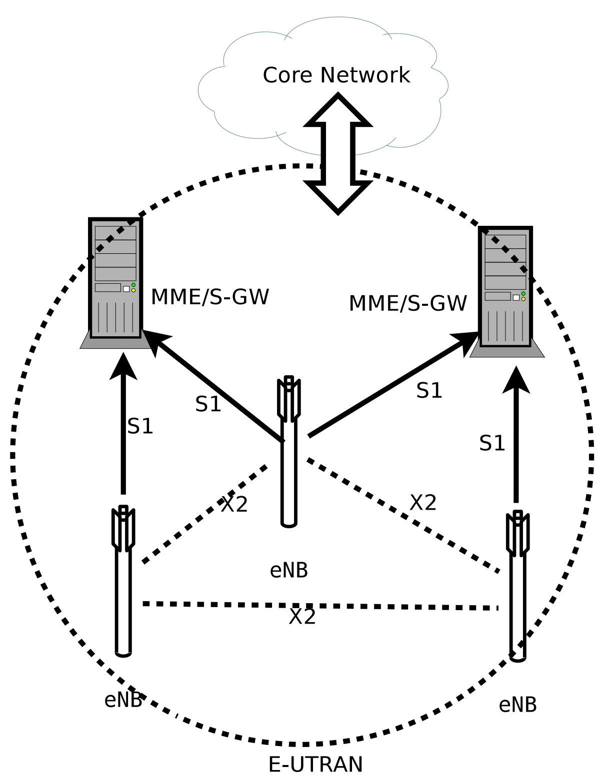

Fig. 1. LTE network architecture.