Poster Abstract: SDN-based Handover Management in Enterprise Networked Femtocells with X2-Forwarding Scheme

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Presented in IEEE INFOCOM 2017, May 2017

***Abstract*—We propose an architecture that integrates the SDN paradigm into an X2-interface based mobility management scheme for local mobility handling in femtocell networks. We mathematically model and analyze the performance gain of the proposed architecture with handover decision taken at centralized SDN controller, which achieves a highly reduced handover signaling overhead.**

I. Introduction

With the introduction of smartphones in the mobile market, the last decade, there is an enormous growth in the number of mobile devices, applications and services offered. [1] describes that in 2015 more than half a billion mobile devices and connections were added causing a 74% increase in the mobile data traffic. It is expected that global mobile data traffic will continue to increase nearly eight fold between 2015 and 2020. Current radio access are not capable of handling the foreseen number of mobile devices and traffic volume and some 5G research activities have already begun to address these 3G/4G mobile network performance limitations.

The Deployment of HetNets has been recognized as a potential solution to face the explosive growth of mobile broadband usage in mobile networks. HetNets can boost spectral efficiency and enlarge the coverage area by allowing signal transmissions at high frequency bands and reducing coverage holes, respectively. One immediate challenge with HetNets deployment is to provide an optimized and seamless mobility management to handle the coordination, management complexity and increased signaling overhead they introduce.

Software Defined Networking (SDN) is recently proposed to address the coordination and management issues of future HetNets. The key concept of SDN is the decoupling of control and data plane, and centralizing the control plane into an SDN controller. It introduces flexibility and programmability into network and devices enabling network operators to easily integrate new service and requirements, while simplifying management, maintenance and operational costs [2]. Several use cases of SDN continue to emerge with different roles in different networks and applications, such as in data centers, LANs and WANs. Some practical implementations have also emerged by companies such as Google [3].

In this work, we show how local mobility management can be realized with a centralized SDN controller and 3GPP's X2-interface in an enterprise femtocell network. We also present some preliminary results to show the performance gains.

II. SDN-based Local Handover Management Scheme with X2 Interface

In this work we present a typical enterprise femtocell network scenario shown in Fig. 1, where we consider an SDN-based local mobility management approach with a centralized SDN controller and 3GPP supported direct X2-interface between femtocells (HeNBs) [4]. In this SDN-based scenario, the control plane is decoupled from the data plane and the central controller handles all the necessary connected-state handover signaling and manages the mobility of users within the femtocell network. Moreover, we assume the SDN controller can provide a common control protocol (e.g., OpenFlow) that manages multiple OpenFlow enabled HeNBs with a primary task of forwarding packets. Furthermore, the SDN controller includes the MME and SGW functionalities, and HeNBs can be an existing HeNB with an OpenFlow switch on top of it or future HeNB with an integrated open standard protocol stack.

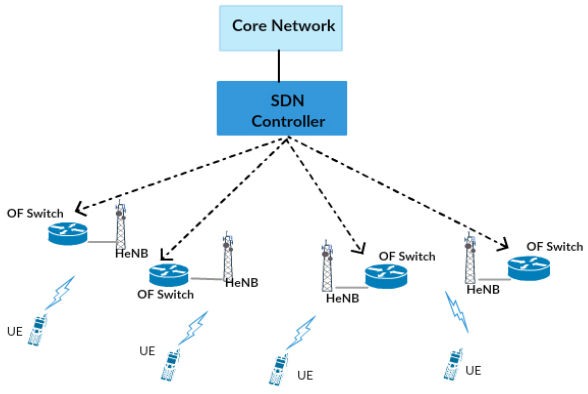

Fig. 1. Proposed SDN-based local handover management approach

The main feature of this approach lies on the centralization of network-status information and the capability of

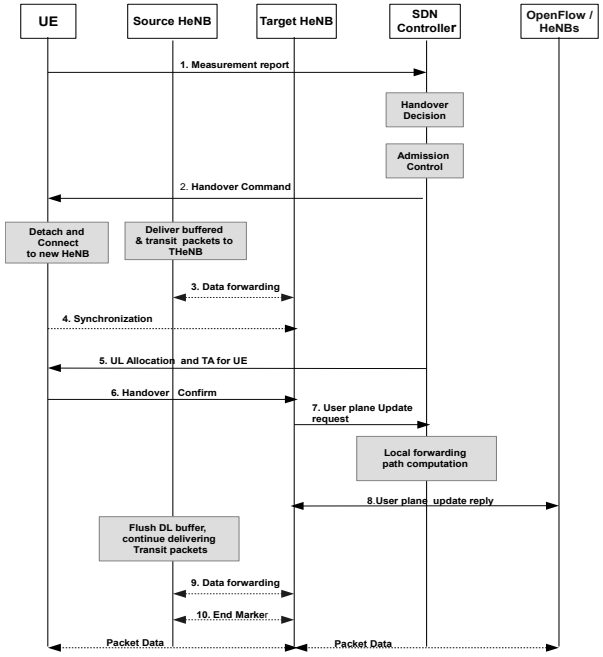

Fig. 2. Message sequence chart for SDN-based local handover management

SDN controller to control and manage network nodes. Fig. 2 depicts a simplified handover signaling sequence for a user moving within the femtocell network. It shows how SDN-based approach can reduce the number of handover management message exchanges as compared to the standard 3GPP X2 based handover management [4], more detail can be found in [5], [6]. In this scheme, the handover decision, admission control, and forwarding path computation functions, are centralized in the SDN-controller. For a fast and resource efficient handover within the enterprise network, the decision can be taken based on the measurement reports from the UEs and the overall network overview with respect to user location and mobility pattern. Location management and handover decision details are not considered in this work.

III. Preliminary Results and Future Work

To evaluate the performance of the SDN-based approach we analytically model a cluster of femtocells with a fluid-flow mobility model to represent the movement of users in the network. Based on the message sequence of Fig. 2 we produce a closed form expression for handover signaling cost in terms of signal transmission delay between nodes, packet processing cost at each node and packet delivery overhead. A key challenge in mobility management schemes is the reduction of the handover latency [7], [8].

In Fig. 3 and 4 we present preliminary numerical results to highlight the performance gains of the SDN-based local handover management approach. As shown in Fig. 3, with increasing user mobility rate the total handover signaling cost is significantly reduced by more than 50% with centralized handover decision as compared to the 3GPP standard where handover decision is taken in the source HeNB. Furthermore, Fig. 4 depicts how the total handover signaling cost is affected by increasing the number of HeNBs. We notice that the SDN-based approach is more scalable than the existing 3GPP solution, showing a two fold signaling cost reduction, which in turn decreases also the handover latency.

In the future, we plan to further analyse the results, extend the SDN-based local handover management to include location management and inter-domain mobility management aspects.

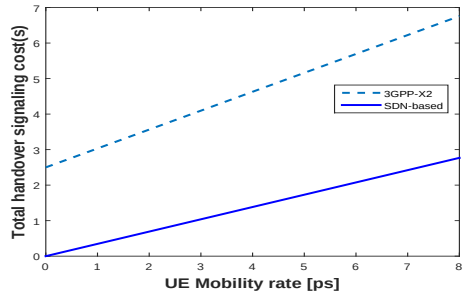

Fig. 3. Impact of user mobility rate on total handover signaling cost

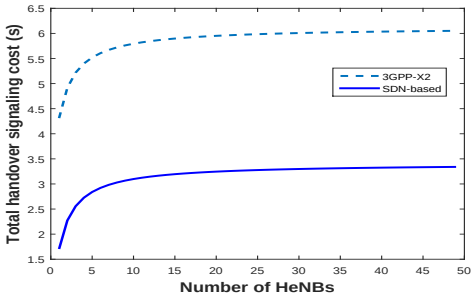

Fig. 4. Impact of network size on total handover signaling cost

IV. Acknowledgement

This work has received funding from the European Unions Seventh Framework Programme (FP7/2007-2013) under grant agreement no 324515 and from the European Unions Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 642743.

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