

# Chapter 5

## SMARC:

### Seamless Mobility Across RAN Carriers Using SDN

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#### ABSTRACT

*Next-generation network promises to integrate cross-domain carriers; thus, infrastructure can be provided as a service. 5G-PPP's vision is directed toward solving existing 4G LTE mobility challenges that congest core networks, disrupt multimedia and data transfer in high mobility situations such as trains or cars. This research adopts 5G methodology by using software-defined networking (SDN) to propose a novel mobile IP framework that facilitates seamless handover, ensures session continuity in standard and wide area coverage, and extends residential/enterprise indoor services across carriers under service level agreement while ensuring effective offload mechanism to avoid core network congestion. Performance excels existing protocols in setup and handover delays such as eliminating out-band signaling in bearer setup/release and isolating users' packets in virtual paths. Handover across cities in wide area motion becomes feasible with lower latency than LTE handover inside city. Extending indoor services across carriers becomes equivalent to LTE bearer setup inside a single carrier's PDN.*

#### INTRODUCTION

Next generation cellular system is expected to be a transformational shift in telecommunication. 5G aims to mobilize service cross-domain networks so carriers can provide their infrastructure on a need-for-service basis (5G Americas, 2016). Consistent user quality of experience across heterogeneous topologies becomes a real challenge hindering the applicability of wide range of Internet of Things (IoT) real time services (Abdulhussein et al., 2015). Tremendous innovation in smart homes, offices, remote health care, and multimedia streaming services raise an urgent need for continuous connectivity to real

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time indoor services. Effective solutions are required with optimal cost structures through the benefits gained by leveraging automation. This is to ensure seamless coverage with millisecond latencies and wire rate of transfer during motion in high speed vehicle crossing wide geographically separated areas with large population density under different administrative domains. 4G Long Term Evolution (LTE) exhausted several trials to provide an effective solution that guarantees session continuity in wide area motion with uninterrupted access to residential, enterprise, and internet services. Unluckily, existing solutions suffer dramatically from inefficient data forwarding that leads to the Evolved Packet Core (EPC) congestion and induces high latency in the services offered. LIMONET trials in 3GPP releases from 9 to 12 as well as the IETF Multipath TCP, discussed in the background section, highlight these problems (ETSI, 2016; Gupta & Rastogi, 2012; Hampel, Rana, & Klein, 2013; Wang, 2015).

This research proposes a novel network based Mobile IP (MIP) framework using SDN, called SMARC, which guarantees uninterrupted accessibility to indoor services with an effective offload mechanism inside and across carriers under service level agreement (SLA). SMARC is a successive research for SRMIP: Software-Defined RAN Mobile IP Framework for Real Time Applications in Wide Area Motion (Elsadek & Mikhail, 2016). SRMIP ensures session continuity in normal and challenging situations within a single carrier RAN. These researches target solving most mobility challenges that hinder services applicability in the next hyper interconnected IoT world (Elsadek, 2016). SMARC prototype is established to assess the feasibility of extending residential/enterprise indoor services inside and across carriers under SLA while ensuring seamless handover and wire speed forwarding of Mobile Node's (MN) packets without congesting core networks. Experimental results show that cross-carriers mobility setup delay is equivalent to existing LTE mobility setup delay inside single carrier's PDN. Strong improvements are achieved in mobility setup delay for standard and wide area motion inside single carrier over LTE total bearer setup time in Proxy Mobile IP (PMIP). Handover delay inside city becomes equivalent to L2 handover in Software-Defined Wireless Networks (SDWN) that is highly better than LTE. SMARC ensures session continuity during handover across cities that is currently unfeasible in LTE as of EPC congestion problem. The clue is replacing LTE bearer in PMIP and GPRS Tunneling Protocol (GTP) with OpenFlow virtual paths. Furthermore, LTE out-band signaling has been eliminated as of replacing the control messages associating bearer setup/release during MN's join/handover with a recursive procedure occurring in-line during the allocation of MN's IP address.

The research is organized as follows; the second section gives an overview on existing mobility protocols and highlights the performance degradation associating tunneling. In addition, it describes the inefficient data forwarding plan of existing mobility protocols that induces core congestion problem and limits session continuity in real deployments of wide area motion. The third section illustrates an overview over SDN principles, OpenFlow SDN-based architecture, the advantages gained from adopting such technology in LTE, and related research work. The fourth section presents SMARC framework, illustrates the key design concepts and states how the described problems are solved. The fifth section analyzes SMARC experimental results and compares them to SDWN and PMIP. The sixth and seventh sections provides the research summary and highlights the contributions respectively. The last two sections briefly conclude the research and present future research directions.

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