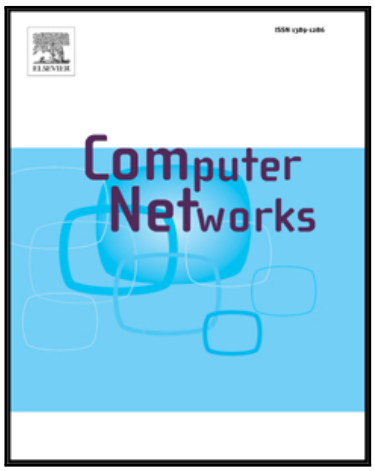

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Felipe S. Dantas Silva , Augusto Neto , Douglas Maciel , José Castillo-Lema , Flávio Silva , Pedro Frosi , Eduardo Cerqueira

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An Innovative Software-Defined WiNeMO Architecture for Advanced QoS-Guaranteed Mobile Service Transport

Felipe S. Dantas Silva[1], Augusto Neto[2], Douglas Maciel[2], José Castillo-Lema[3], Flávio Silva[4], Pedro Frosi[4], Eduardo Cerqueira[56]

1 Federal Institute of Education, Science and Technology of Rio Grande do Norte (LaTARC/IFRN) – Brazil
2 Department of Informatics and Applied Mathematics (DIMAp) – Federal University of Rio Grande do Norte (UFRN) – Brazil
3 Laboratory of Integrated Systems (LSI) - University of São Paulo (USP) - Brazil
4 Faculty of Computing (FACOM) – Federal University of Uberlândia (UFU) – Brazil
5 Federal University of Pará (UFPA) - Brazil
6 Centre for Informatics and Systems of the University of Coimbra (CISUC), Portugal

Abstract

The spread of wireless networks and the growing proliferation of mobile devices require the development of new mobility control mechanisms to support the different demands of traffic in different network conditions. A major obstacle to developing this kind of technology refers to the complexity involved in handling all the information about the large number of *Moving Objects* (MOs), as well as the total signaling overhead required to manage these procedures in the network. Several initiatives proposed by the scientific community to address this issue reveal weakness, particularly by relying on the MO for the responsibility in triggering the mobility process. Moreover, they are often only guided by wireless medium statistics, such as the *Received Signal Strength Indicator* (RSSI) of the candidate *Point of Attachment* (PoA). Thus, this work seeks to develop, evaluate and validate a high-level communication infrastructure for *Wireless Networking for Moving Objects* (WiNeMO) systems by making use of the flexibility provided by the *Software Defined Networking* (SDN) paradigm, where network functions are easily and efficiently deployed by integrating OpenFlow and IEEE 802.21 standards. The *Software-Defined WiNeMO (SDWiNeMO)* holistic framework is largely aimed at enabling the network infrastructure to provision service transport while guaranteeing *Quality of Service (QoS)* for multiple mobile applications, as well as providing seamless mobility for MOs always seeking the best connectivity to maintain good *Quality of Experience* (QoE) over time. Moreover, SDWiNeMO deploys a new mobility-based load balancing technique to increase MO admissions for situations involving PoA resource saturation. The feasibility and effectiveness of our proposal is assessed by prototyping and evaluating the SDWiNeMO architecture in a baseline two-part hybrid testbed comprising realistic networking conditions. For purposes of benchmarking, the analysis was conducted in the control and data plane aspects, which demonstrate that the SDWiNeMO proposal significantly outperforms typical QoS-capable *Internet Protocol* (IP)-based SDN configurations by allowing the network to handle the multimedia traffic with optimal QoS-guaranteed transport and acceptable QoE over time.

Keywords: mobility management, software-defined networking, quality of service, quality of experience, load balancing.

1. Introduction

The future of the Internet requires the adoption of a radically innovative approach consisting of large-scale converged networks that are capable of interconnecting a huge number of *Moving Objects* (MOs) ranging from cars, drones, boats and cyber-physical devices to the widely-used personal mobile devices (smartphones, smartwatches, body sensors, etc.). In this scenario, *Wireless Networking for Moving Objects* (WiNeMO) [1] is drawing considerable renown supported by the prospect of an innovative infrastructure that envisages maximizing Internet use in different ways and new patterns of behavior. In WiNeMO systems, MOs act as autonomous (or semi-autonomous) network nodes that move through various patterns and at different speeds while communicating. The MOs embed communication interfaces of different technologies such as IEEE 802.11 [2], 3GPP 3G [3]/4G [4] and SIGFOX [5], which can be used for simultaneous transmissions/receptions in multi-homing scenarios as a means of expanding the capabilities of the network system. As a result, it is expected that WiNeMO systems will incorporate a large number of autonomous MOs with different types of mobility, communication and patterns of behavior, while making use of multihoming capabilities to communicate ubiquitously.

In a WiNeMO system, MOs largely play a generalist role owing to their heterogeneity (kinds, platforms, technologies and patterns of behavior). This allows them to act in various ways and to carry out different