Chapter 34
Evaluating Wireless Network Accessibility Performance via Clustering-Based Model: An Analytic Methodology

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ABSTRACT

Using the large amount of data collected by mobile operators to evaluate network performance and capacity is a promising approach developed in the recent last years. One of the challenge is to study network accessibility, based on statistical models and analytics. In particular, one aim is to identify when mobile network becomes congested, reducing accessibility performance for users. In this paper, a new analytic methodology to evaluate wireless network accessibility performance through traffic measurements is provided. The procedure is based on ensemble clustering of network cells and on regression models. It leads to identification of zones where the accessibility remains high. Numerical results show efficiency and relevance of the suggested methodology.

INTRODUCTION

The last few years have witnessed a quick development of wireless connections, together with a growth of smart devices consumers. Those induced a huge increase in the network flow of data. However, the network capacity is limited by infrastructure deployment. An heavy consumption leads to a deterioration of the network accessibility for users. Mobile operators have then to size correctly the network capacity. This capacity cannot be over-sized dues to infrastructure high price, but must be sufficiently large to avoid overloading.

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Data collected by mobile operators can be managed and understood to evaluate wireless network accessibility performance. In the traditional method, accessibility is only related to the number of subscribers. Nowadays, this method fails to render the high diversity of traffic patterns and user behaviors. Indeed, consumption of the services becomes more versatile: In addition with classic phone use, there are data-based services such as web browsing, video communication or streaming. Therefore, a critical needs is to dedicate novel methodologies to evaluate accessibility performance. This is done by understanding when the network begins to degrade and to be less accessible.

Relationships between accessibility, capacity management and network performance have been studied, mainly throug h simulations, both for 3G UMTS (Universal Mobile Telecommunications System) and LTE networks.

About network design, heuristic algorithms (Tsao & Lin, 2002; Szlovencsak, Godor, Harmatos, & Cinkler, 2002) are developed to provide network topologies which ensure a low traffic loss. Also, an analysis of capacity through uplink and downlink is performed in Navaie and Sharafat (2003), resulting in new approaches for network sizing. In Amzallag, Bar-Yehuda, Raz, and Scalosub (2013), an optimization for choosing cells maximizing their use in LTE networks leads to a better usage of network's capacity.

About accessibility, quality of experience prediction models is presented in Khan, Sun and Ifeachor (2012), based on encoded videos. They introduce an adaptation scheme when the accessibility begins to degrade. In Engels et al., (2013), autonomous adjustment of some optimization parameters through time are performed for LTE networks, depending of the network resources. In Ouyang and Fallah (2010) and Ouyang et al., (2014), traffic behavior are simulated through different scenarios to understand the throughput behavior, for both UMTS and LTE networks. In Ouyang, Yan, and Wang (2015), and Ouyang and Yan (2015), this methodology is used again through crowdsourcing-based analytics to evaluate voice or app accessibility. Finally, in Hu, Ouyang, Yao, Fallah and Lu (2014), a relational algorithm between LTE network resources and an wireless network KPI (Key Performance Indicator) is introduced to forecast network resource consumptions.

In this paper, we introduce a new wireless analytic methodology to evaluate accessibility performance. This methodology links network accessibility with traffic measurements performed by the mobile carrier. As in Hu et al., (2014), the network accessibility is depicted with a wireless network KPI, and traffic measurements by network resources. A challenge is then to detect when network starts to deteriorate and to be less accessible.

The first innovation of our procedure is to take into account the non-homogeneous behavior of cells of the network. Cells are not considered individually nor agglutinate, but clustered into groups. This allows to bring out cells which behave similarly. For example, some cells may be constrained to an higher pressure than others, or to a different consumption of the services.

The second innovation is to get an automatic procedure, where each step can be monitored. After selecting features of interest, the whole process is driven by data through machine learning algorithms. It is intended to provide robust and adaptive predictions. For this purpose, an ensemble clustering method is used and an appropriate regression algorithm to predict the KPI is selected.

Then, from selected clusters and obtained prediction functions, we infer when the network begins to degrade. A comfortable zone is deduced as a function of the network resources. This zone indicates when the accessibility performance remains sufficiently high.

This methodology is therefore tested, using data provided by China Mobile.

The paper is organized as follows. The section titled: Methodology to Evaluate Accessibility defines KPI and network resources retrieved and necessary to conduct our methodology. Then, the whole procedure