OpenMobileNetwork: A Platform for Providing Estimated Semantic Network Topology Data

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ABSTRACT

Mobile network operators maintain data about their mobile network topology, which is mainly used for network provisioning and planning purposes restricting its full business potential. Utilizing this data in combination with the extensive pool of semantically modeled data in the Linking Open Data Cloud, innovative applications can be realized that would establish network operators as service providers and enablers in the highly competitive services market. In this article, the authors introduce the OpenMobileNetwork (available at http://www.openmobilenetwork.org/) as an open solution for providing approximated network topology data based on the principles of Linked Data along with a business concept for network operators to exploit their valuable asset. Since the quality of the estimated network topology is crucial when providing services on top of it, the authors further analyze and evaluate state-of-the-art approaches for estimating base station positions out of crowdsourced data and discuss the results in comparison to real base station locations.

Keywords: Context-Aware Services, Linked Data, Linking Open Data (LOD) Cloud, Location-Based Services, Mobile Networks, Network Topology, OpenMobileNetwork

INTRODUCTION

In the last decade, the World Wide Web became a global access point for information providing not only linked documents, but also an extensive pool of mashup services that require raw and structured data. The Linked Data (Heath & Bizer, 2011) paradigm has evolved over the time from the vision of the Semantic Web (Berners-Lee, Hendler, & Lassila, 2001) and took the driving force position in pushing the Web of Data. Taking the Web of Documents and its key standards as a basis, Linked Data describes an approach for publishing, sharing and linking structured data on the Web. Data resources are identified via dereferenceable HTTP Uniform Resource Identifiers (URIs) and are related to each other in the form of subject-predicate-object triples using the Resource Description Framework (RDF) (W3C, 2004a). This is done within a dataset as well as with resources from other datasets.

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Over the years, many researchers, institutes, libraries, etc., published their data according to those principles covering various content domains, such as Media, Life Sciences, Geographic Data or Government, all directly linked to each other building a huge graph of interlinked structured data, which is also known as the Linking Open Data (LOD) Cloud (see Figure 1). The number of datasets in this cloud has been increasing rapidly and has reached a total of 338 by April 2013. These datasets provide a huge pool of contextual information that can be exploited for new and innovative context-aware services.

In parallel to the developments in the Web, the emergence of smartphones and the roll-out of different wireless network technologies including GSM, UMTS, LTE and WiFi, revolutionized the mobile market and enabled the realization of mobile services that have a major impact on our daily life. In particular, location-based services (being a sub-group of context-aware services) have become very popular. According to Shen et al. (2011), the number of location-based service users was supposed to reach 1.4 billion by 2012.

A location-based service uses the location of a user (through his mobile device) in order to perform any kind of related action, such as recommending restaurants or points of interest in the vicinity. The position of the user can most accurately be determined by utilizing the Global Positioning System (GPS). Cell-ID and WiFi Positioning, on the other hand, are less accurate, but fast and energy-efficient alternatives. The basic working principle of these positioning methods is that the device sends a query to a cellular location provider (e.g., Google) including information about the radio cells and/or WiFi access points nearby. This information usually consists of a unique identifier for each cell, the received signal strength, and additional data. The cellular location provider uses a database containing network topology data to identify the position of the device and returns the location information.

In order to establish such a cellular database, companies like Google or Apple exploit the capabilities of smartphones via a crowdsourcing approach measuring cell data with which the network topology can be approximately derived. Since this data is quite valuable for them due to many reasons (Bareth, 2012), they do not provide them in an open-source environment. In addition, their APIs are quite restrictive and only provide WGS84 coordinates for a position request. In contrast to the aforementioned commercial cellular location providers, open databases, such as OpenCellID (8Motions, 2013) and OpenBMap (OpenBMap, 2013), allow access to the entire available dataset collected by their own, but much smaller crowdsourcing communities. These projects utilize various position estimation methods for deriving the position and coverage area of a base station out of a collection of single measurements.

Mobile network operators already possess the information about their network topology including base station positions and coverage areas, traffic, signaling as well as anonymized customer data. This data is considered as their asset and is therefore kept very secret. However, it is more or less only used for network provisioning, planning and maintenance issues, which is far away from its full business potential. Furthermore, the existing positioning approaches as mentioned above are mainly driven by geometric spatial data and do not take further information of the location into consideration, such as points of interest and events occurring in the vicinity, the relation to other neighboring locations or the special preferences of the target users.

Combining network topology data with the extensive pool of interlinked semantic data that is present in the LOD Cloud has the potential to enable the development of innovative and semantically enriched services that other service providers do not have in their portfolio. Mobile network operators will not only act as a bit pipe, but rather establish themselves as service providers and enablers regaining revenue in the services market. The main advantage that network operators have is the accuracy of their data, whereas other commercial providers only rely on estimations.
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