Chapter 43
SEMDPA:
A Semantic Web Crossroad Architecture for WSNs in the Internet of Things

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ABSTRACT

The Internet of Things (IoT) vision is to connect uniquely identifiable devices that surround us to the Internet, which is best described through ontologies. Thereby, new emerging technologies such as wireless sensor networks (WSN) are recognized as an essential enabling component of the IoT today. Hence, given the increasing interest to provide linked sensor data through the Web either following the Semantic Web Enablement (SWE) standard or the Linked Data approach, there is a need to also explore those data for potential hidden knowledge through data mining techniques utilized by a domain ontology. Following that rationale, a new lightweight IoT architecture SEMDPA has been developed. It supports linking sensors and other devices, as well as people via a single web by mean of a device-person-activity (DPA) crossroad ontology. The architecture is validated by mean of three rich-in-semantic services: contextual data mining over WSN, semantic WSN web enablement, and Linked WSN data. SEMDPA could be easily extensible to capture semantics of input sensor data from other domains as well.

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INTRODUCTION

Internet of Things (IoT) paradigm has been around since almost two decades but its meaning has undergone significant changes. Initially, the term was though as a way to link supply chain with radio frequency identification (RFID) (Ashton, 2009). Nowadays, IoT vision is to connect to the Internet not only computers, tablets or smartphones but also other physical objects and devices surrounding us, such as sensors, actuators, etc. – which, through unique identifiers are able to interact with each other to reach common goals in everyday life like in environmental monitoring, e-health, domotics, or in automation and industrial manufacturing just to mention few (Atzori, 2010), (Giusto, 2010).

That would set up a triangle device – person - activity with relations drawn between people and devices. It should be further explored in order to infer important knowledge like are activities of people but also their devices. All of that needs meaning interpretation, which can be obtained by semantics. Therefore, using ontologies to describe the conceptualization of this certain domain is necessary. Some researchers argue that sensor networks are the most essential components of the IoT, with most of the sensors today deployed as wireless (Perera, 2014). According to a recent BBC report, the global market for sensors is expected to grow fast to almost double by 2021, with wireless sensor devices[1] nearly triple its current market by 2021. Ericsson[2] on the other side predicts that IoT sensors and devices are expected to exceed mobile phones as the largest category of connected devices in 2018. Hence, new emerging technologies such as WSNs (wireless sensor networks) are an imperative in this domain conceptualization. That may implicate adding new ontological constructs and constraints on top of the existing ontologies.

There is a standard, the Sensor Web Enablement (SWE) (Lefort, 2011), (Bröring, 2012), conceived by the Open Geospatial Consortium[3] (OCG) that supports publication on the Web of (potentially heterogeneous) WSN related data following a single standard schema. WSN data may thus get accessed with ease via a single web, the so-called Web Enabled WSN (Rouached 2012) (Udayakumar, 2012), leading provisionally to lower cost and better-quality communication between sensors.

On the other side, there is an ever-growing vast amount of data from a diversity of domains being published as *Linked Data* (Bizer, 2009), (Lee, 2006), namely open semantically described and interlinked data that are made available for access through the Web. It may thus be easier and time effective to build applications using Linked Data. Moreover, applications may gain from new knowledge potentially derived from semantic descriptions including interlinks. As more open rich-in-semantics linked sensor data are published on the Web, best practices are evolving too, such as the proposed six step model to create and publish linked data (Hyland, 2011, Cygankia, 2014) and as well the best practices for publishing Linked Data published by World Wide Web Consortium (W3C)[4].

Finally, given the increasing interest to provide linked sensor data through the Web following either the SWE standard or the Linked Data approach, there is obviously also need to further explore such data in order to check for potentially new knowledge. Data mining techniques may aid in exploring massive datasets, especially if utilized by ontologies imposing certain modeling on data and their semantic annotations.

The work presented here is part of a major project InWaterSense[5] (Ahmedi, 2013), which consists of a wireless sensor network (WSN) deployed in a river in Kosovo for monitoring its water quality. WSN has two main components: static component – deployed in a specific location at the river, and the mobile component – used to measure in different locations throughout the river. Both components contain several sensors, which measure different quality parameters such as: pH, temperature, dissolved oxygen, etc. As an umbrella of the project, an environmental monitoring portal was introduced. The portal sup-