An Information-Centric System for Building the Web of Things

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Abstract. In recent years, common-use devices has seen a leap transition in terms of equipped technology, introducing the so called “smart things” to the consumer market. This technological and societal revolution has underpinned the realization of the Internet of Things. To take full advantage of the opportunities arising from connectivity capabilities, smart things approached the application realm bringing the novel Web of Things vision to life. The Web, as a collaborative global space of information, is a critical asset to create value-added services. However, such a promising potential entails a number of challenges including data interoperability, data integration, information reuse and collaboration. This Ph.D. work focuses on a novel approach to take a smart thing to the Web, by representing it as graph of granular and individually addressable information called IDN-Document. IDN-Documents are simply structured web resources which can be aggregated, linked, reused and combined to build collaboration oriented, value-added services. IDN-Documents are managed by the InterDataNet middleware leveraging Linked Data and REST.

Keywords: Internet of Things, Web of Things, Information Modeling, Representational State Transfer, Linked Data, Information Reuse.

1 Introduction

The advances in electronics, informatics and communication sciences have paved the way for the widespread distribution of devices with considerable technological potential. Due to their capabilities, these objects are usually called “smart”. This scenario motivates the Internet of Things (IoT) concept which is a transformation of the Internet from a network of computers to a network of heterogeneous devices [1].

Leveraging the existing Web technologies and standards including HTTP [2], URIs [3], etc., smart things can also enter the application realm, giving rise to the Web of Things (WoT) vision. To take full advantage of the WoT opportunities is essential to address issues including interoperability, data integration,
information reuse and collaboration. These topics are definitely challenging because of the heterogeneity of smart things in a number of aspects such as device and application requirements, connection strategies, data representation, data management and many others.

This Ph.D. work proposes an approach to enable interoperability and data reuse between objects in the WoT. To this intent, I follow a two-steps methodology: first, a connection with the smart object is established via a dedicated adapter, and second the object is represented as a graph of granular, individually addressable data units called IDN-Document, leveraging an information model. Consequently, the object is put on the Web as an aggregation of information whose pieces can be dereferenced, consumed, reused, and managed with negligible effort. The smart object representation relies on the expressiveness and flexibility of the graph structure adopted by Linked Data [4], which has been chosen as the inspiring paradigm. In this work I refer to a more general interpretation of Linked Data, as the one provided by Wilde et al. [5], who define Linked Data as “the general concept of publishing interlinked data representations, without referring to the one specific way of implementing it that is often associated with that term as well”.

The implementation of the IDN-Document is delegated to a middleware called InterDataNet (IDN) [6–9] which exposes RESTful [10] HTTP APIs for its management. This Ph.D. work covered the study and design of the information model, the study, design and implementation of the whole IDN core architecture, and the study, design and implementation of several applications on top of IDN, for validation purposes.

2 Motivation of the Work

Although the WoT is very promising, many problems remain to be solved [1]. Data should be produced and consumed easily, without worrying about formats and custom representations. Moreover, security concerns must be addressed to support collaboration around data. To fully benefit from the WoT concept, the author argues that the Web of Data [11] vision would contribute to effectively put a “thing” on the Web. Indeed, not only data produced by a smart object, but also the object itself can be represented as a graph of structured information to be exposed in the global space, where applications can use it and other objects can connect to, building a richer and more informative object. Zeng et al. [1] made a survey on the WoT and their analysis highlights several points of interest, which validate the approach proposed in this paper. First, they make a comparison of the WS-* and REST architectural styles and conclude that REST is the best choice because of its low complexity and loose-coupling stateless interactions. These features are particularly desirable because they take into account resource constrained devices. Also Wilde in [12] states that REST has substantial advantages over applications, having better performances in terms of testing, scalability, and integration with other applications with respect to state-based paradigms. Second, search and discovery capabilities are critical for