

Chapter 4

Interoperability in Wireless Sensor Networks Based on IEEE 1451 Standard

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ABSTRACT

The syntactic and semantic interoperability is a challenge of the Wireless Sensor Networks (WSN) with smart sensors in pervasive computing environments to increase their harmonization in a wide variety of applications. This chapter contains a detailed description of interoperability in heterogeneous WSN using the IEEE 1451 standard. This work focuses on personal area networks (PAN) with smart sensors and actuators. Also, technical, syntactic, and semantic levels of interoperability based on IEEE 1451 standardization are established with common control commands. In this architecture, each node includes a Transducer Electronic Datasheets (TEDS) and intelligent functions. The authors explore different options to apply the IEEE 1451 standard using SOAP or REST Web service style in order to test a common syntactical interoperability that could be predominant in future WSNs.

INTRODUCTION

In our days, the interoperability of Wireless Sensor Networks (WSN) is an attractive goal to share metadata information across heterogeneous WSN deployments, using an effective common model to

represent the information based on standardization rules. Nevertheless, in many cases different WSN based on smart sensors and actuators are inaccessible to extract the information in a common client application, because each network employs different data formats and their data cannot be accessed through a standard wireless interface. The challenge for this situation is the inclusion of a

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model based on levels of compliance with clear goals aimed to the harmonization of WSN, by introducing an open and global standard as IEEE 1451, which uses syntactic rules with metadata organized in a tuple structure. Also, it introduces different standard common commands to control efficiently each sensor node to share information with other heterogeneous devices. Motivated by this issue, our efforts are concentrated in standardized wireless physical transducer interfaces for smart sensors to encourage an efficient communication, allowing syntactic and semantic rules to exchange and to access metadata with accuracy and assurance.

The content of this chapter is organized into eight sections. In the related work section, a literature review on smart sensors and the IEEE 1451 standard is provided. Next, two sections provide an overview of smart sensor in WSN and the different interoperability levels, from technical level toward semantic level. Next, the family of IEEE 1451 standards in wired and wireless sensor networks is studied and a smart sensor model is defined based on the Network Capable Application Processor namely (NCAP) as coordinator node, and the sensor node as Wireless Transducer Interface Module (WTIM). Also, in this section is defined the Transducer Electronic Datasheet (TEDS) to store information related to each physical sensing channel, based on metadata information using a generalized tuple format. The subsequent section is dedicated to describe the main features of SOAP and REST Web Services for pervasive embedded devices that could be predominate in the future of WSNs. Finally, the chapter provides possible future research directions based on interoperable WSN.

RELATED WORK

The broad diversity of WSN hardware systems (Beutel, 2010) and the increase of different data formats raise the complexity in metadata represen-

tation for interoperable WSN. In effect, to share data information across heterogeneous network deployments requires an effective common model to represent the messages based on standardized rules. To address these problems, recent efforts are concentrated in standardized wireless physical interfaces (Gutierrez, Callaway & Barrett, 2003) to communicate and to process the information effectively allowing syntactic and semantic rules to exchange and to access metadata with accuracy and assurance.

Different initiatives toward interoperable sensor networks have been proposed in the past, for example, based on the Open Geospatial Consortium (OGC) standards to enable WSN for exchange and re-use the information in Service oriented architectures (SOA) as in (Klopper, 2005), to provide an unified formal model and framework for sensor networks as in (Gracanic, Eltoweissy, Wadaa & DaSilva, 2005), or using metadata elements and context rules to improve the network interoperability (Ballari, Wachowicz & Callejo, 2009). These proposals take in account a standardized Physical (PHY) and Medium Access Layer (MAC) related with low rate Personal Area Networks (IEEE Std. 802.15.4, 2006). Likewise, in the higher layers, as in application layer, sensor network schemes focus on a conceptual structures to describe and exchange ordered data information, using reusable syntactic metadata by including standard languages and meta-languages as XML (Bray, Paoli, Sperberg-McQueen, Maler & Yergeau, 2008) by enabling the exchange of structured information between different platforms, allowing compatibility to share information in a safe, easy and reliable arrangement.

In this context, a WSN can increase the interoperability by introducing metadata structures and standard physical interfaces using a set of rules to encode the information that could be used over Service Oriented Architectures (SOA) (Sleman & Moeller, 2008), integrating heterogeneous services that execute discrete transaction without depending on the state of other processes or func-

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