Internet of Things

Technology, Communications and Computing

Giancarlo Fortino · Paolo Trunfio
Editors

Internet of Things Based on Smart Objects

Technology, Middleware and Applications

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Preface

The Internet of Things (IoT) usually refers to a worldwide network of interconnected heterogeneous objects (sensors, actuators, smart devices, smart objects, RFID, embedded computers, etc.) uniquely addressable, based on standard communication protocols.

Beyond such a definition, a new definition of IoT is emerging seen as a loosely coupled, decentralized system of cooperating Smart Objects (SOs). An SO is an autonomous, physical digital object augmented with sensing/actuating, processing, storing, and networking capabilities. SOs are able to sense/actuate, store, and interpret information created within themselves and around the neighboring external world where they are situated, act on their own, cooperate with each other, and exchange information with other kinds of electronic devices and human users. Their importance resides in the capabilities they have to make physical environments "smart" so as to provide novel cyber-physical services to people.

However, such SO-oriented IoT raises many "in-the-small" and "in-the-large" issues involving SO programming, IoT system architecture/middleware, and methods/methodologies for the development of SO-based applications.

This book focuses on exploring recent advances in architectures, systems, and applications for an IoT based on Smart Objects. The book specifically covers the following topics: (i) middleware for SOs; (ii) agent-oriented SOs; (iii) service-oriented SOs; (iv) Smart applications; (v) SOs indexing and discovery; (vi) IoT technologies for Smart Manufacturing; (vii) IoT technologies for Smart Grids; (viii) SOs trajectory mining for Smart City scenarios; (ix) Smart Health systems; and (x) Sensing platforms. The book is structured into ten authored chapters focused on the above-mentioned topics and provides novel and cutting-edge contributions for next-generation IoT systems. A brief introduction to the chapters is provided below.

"Middlewares for Smart Objects and Smart Environments: Overview and Comparison", by Giancarlo Fortino, Antonio Guerrieri, Wilma Russo, and Claudio Savaglio, presents an overview of middlewares for SOs and smart environments and compares them according to the most important general and specific requirements that have been identified in the literature so far. The chapter aims at providing a clear picture of the suitability of such middlewares to support the development of SO-based IoT systems.

"Mobile Agents-Based Smart Objects for the Internet of Things", by Teemu Leppänen, Jukka Riekki, Meirong Liu, Erkki Harjula, and Timo Ojala, proposes a method for the integration of mobile agents and SOs in order to facilitate cooperation and global intelligence. The chapter discusses SOs, agents, and systems requirements to enable cooperation, introduces a RESTful framework for agent creation, migration, and control, and presents an evaluation method to assist in system and agent composition design.

"Service-Oriented Middleware for the Cooperation of Smart Objects and Web Services", by Andrea Giordano and Giandomenico Spezzano, discusses how enterprise web services can be integrated with RESTful SOs by exploiting the concept of service choreography, undertaking the scalability and dynamicity issues of the IoT in order to extend the existing service composition mechanisms. The chapter shows that applications involving SO interaction can be seen as a particular case of event-driven composite services.

"CO-Based Outdoor Smart Lighting for Energy Aware Factory", by Anna Florea, Ahmed Farahat, Corina Postelnicu, Jose L. Martinez Lastra, and Francisco J. Azcondo Sánchez, describes an approach to the implementation of smart applications in a multi-purpose environment following the cooperating objects paradigm, aimed at increasing energy awareness, reducing power consumption, and enhancing user experience. As a use case, the chapter presents a smart lighting application for a multi-purpose outdoor environment.

"A Service-Oriented Discovery Framework for Cooperating Smart Objects", by Marco Lackovic and Paolo Trunfio, presents a service-oriented framework designed to support indexing, discovery, and selection of network-enabled SOs. The framework enables the dynamic discovery of distributed SOs and, specifically, their services and operations described through an ad hoc metadata model. The chapter presents the metadata model, the framework architecture and implementation, and the programming APIs.

"Smart Manufacturing Through Cloud-Based Smart Objects and SWE", by Pablo Giménez, Benjamín Molina, Carlos E. Palau, Manuel Esteve, and Jaime Calvo, discusses how IoT concepts can be applied to smart manufacturing, with smart entities that cooperate to achieve broader goals or to increase the overall knowledge in a factory through information sharing. The chapter shows that interoperability can be achieved by means of Sensor Web Enablement (SWE), while processing capabilities can be provided by virtualizing SOs on a Cloud-based datacenter.

"The Cloud of Things Empowered Smart Grid Cities", by Stamatis Karnouskos, discusses the impact that real-time monitoring and management capabilities offered by the IoT can have on the Smart Grid, and its applicability in Smart City scenarios. As an example case, the chapter highlights the efforts within the NOBEL project, which has prototyped an open service-based infrastructure for energy monitoring, management, and brokering, and points out some key aspects for the future Smart Grid City.

"Trajectory Data Analysis Over a Cloud-Based Framework for Smart City Analytics", by Eugenio Cesario, Carmela Comito, and Domenico Talia, proposes

a methodology and a Cloud-based framework for trajectory pattern mining, which can be used for analyzing the trajectories of SOs in large-scale environments, particularly in Smart City scenarios. The chapter provides an experimental evaluation showing that trajectory pattern mining can take advantage from a Cloud-based parallel execution environment.

"People-Centric Service for mHealth of Wheelchair Users in Smart Cities", by Lin Yang, Wenfeng Li, Yanhong Ge, Xiuwen Fu, Raffaele Gravina, and Giancarlo Fortino, presents a real-time health-driven model for a people-centric healthcare context, introduces a social-aware architecture to support SOs mapping to online social networks, then discusses discovering and interacting with shared SOs in a virtual community. The chapter presents also a prototype for validating the proposed model.

Finally, "Experiments With a Sensing Platform for High Visibility of the Data Center", by João Loureiro, Nuno Pereira, Pedro Santos, and Eduardo Tovar, presents a hardware sensing platform for collecting physical parameters in a data center, which can serve as an enabler to optimize energy consumption. The chapter includes an analysis of the delay to obtain data from sensor networks under different data center topologies, and discusses some capabilities of the system in a real deployment.

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