



Contents lists available at ScienceDirect

Pervasive and Mobile Computing

journal homepage: www.elsevier.com/locate/pmc

A utility paradigm for IoT: The sensing Cloud

Salvatore Distefano^{a,b,*}, Giovanni Merlino^c, Antonio Puliafito^c^a Politecnico di Milano, Piazza L. Da Vinci 32, 20133 Milano, Italy^b Machine Cognition Lab, Higher Institute of Information Technologies and Information Systems Kazan Federal University, Kazan, Russia^c Università degli Studi di Messina, 98166 Messina, Italy

ARTICLE INFO

Article history:
Available online 16 October 2014

Keywords:
IoT
Reference architecture
Sensors and actuators
Cloud
Mobiles
Abstraction and virtualization

ABSTRACT

IoT is such a key trend in ICT that it is quickly becoming one of the most influential research and development topics. This popularity is spawning also lots of laudable initiatives, one of the most prominent being carried on by the IoT-A consortium, including influential blueprints such as its Reference Architecture (RA). Their main goal is to interconnect network-enabled devices and “things” through the Internet. This bottom-up view of IoT is lacking mechanisms for aggregating, managing and administrating groups of things. Such a perspective could be reverted to provide control and management facilities through specific framework and software, in line with new trends such as software defined networking.

In this paper we propose a top-down utility paradigm for IoT starting from the IoT-A reference architecture and the Sensing and Actuation as a Service (SAaaS) approach. It aims at implementing a sensing Cloud by enrolling and aggregating sensing resources from sensor networks and personal, mobile devices. We follow a device-driven approach, as adopted in IaaS Clouds: once collected, the physical (sensing) resources are abstracted and virtualized and then provided as a service to end users. A key point of the SAaaS is the abstraction of resources, i.e. providing a uniform way to access to and interact with the underlying physical nodes in compliance with IoT goals. The main contribution of the paper is the design and development of the sensing resource abstractions for SAaaS to demonstrate the feasibility of such an approach, providing details on theoretical and design aspects as well as technical ones. In particular, a preliminary implementation for mobiles is described, delving in platform-dependent details where needed. The facilities thus developed under the Android platform have been tested through a typical IoT application, in order to gauge the validity of the approach.

© 2014 Elsevier B.V. All rights reserved.

1. Introduction and motivations

The growing trends involving personal and mobile devices have made quite an impact on the current ICT scenario bringing about huge networks of more and more powerful smart devices. This state of affairs has spawned new ideas and paved the way for rethinking and reinterpreting foundational technologies such as Internet, driving efforts towards the Internet of Things (IoT), or service engineering at the basis of the Cloud computing and the Web 2.0.

Plenty of devices (tens of billions according to recent reports [1]), usually embedding a diverse range of sensing resources as well as extensive connectivity capabilities, populate and characterize the scenario, calling for adequate techniques and tools for their management in order to unlock their potential. IoT mainly aims at rationalizing this ecosystem of (more or

* Corresponding author. Tel.: +39 02 2399 2513.

E-mail addresses: salvatore.distefano@polimi.it (S. Distefano), gmerlino@unime.it (G. Merlino), apuliafito@unime.it (A. Puliafito).