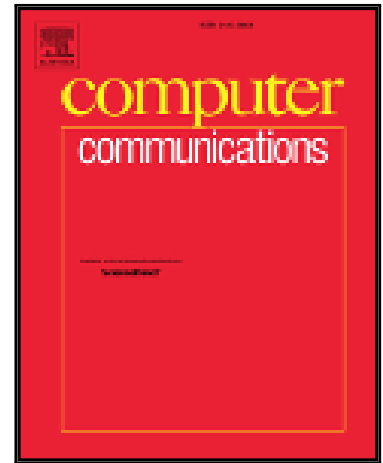


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A gap analysis of Internet-of-Things platforms

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Abstract

We are experiencing an abundance of Internet-of-Things (IoT) middleware solutions that provide connectivity for sensors and actuators to the Internet. To gain a widespread adoption, these middleware solutions, referred to as platforms, have to meet the expectations of different players in the IoT ecosystem, including device providers, application developers, and end-users, among others.

In this article, we evaluate a representative sample of these platforms, both proprietary and open-source, on the basis of their ability to meet the expectations of different IoT users. The evaluation is thus more focused on how ready and usable these platforms are for IoT ecosystem players, rather than on the peculiarities of the underlying technological layers. The evaluation is carried out as a gap analysis of the current IoT landscape with respect to (i) the support for heterogeneous sensing and actuating technologies, (ii) the data ownership and its implications for security and privacy, (iii) data processing and data sharing capabilities, (iv) the support offered to application developers, (v) the completeness of an IoT ecosystem, and (vi) the availability of dedicated IoT marketplaces. The gap analysis aims to highlight the deficiencies of today's solutions to improve their integration to tomorrow's ecosystems. In order to strengthen the finding of our analysis, we conducted a survey among the partners of the Finnish IoT program, counting over 350 experts, to evaluate the most critical issues for the development of future IoT platforms. Based on the results of our analysis and our survey, we conclude this article with a list of recommendations for extending these IoT platforms in order to fill in the gaps.

Keywords: Internet of Things, IoT platforms, IoT marketplace, gap analysis, IoT ecosystem.

1. Introduction

The Internet of Things (IoT) paradigm foresees the development of our current environment towards new enriched spaces, such as smart cities, smart homes, smart grid, digital health, and automated environmental pollution control [1, 2].

In recent years, an abundance of solutions has emerged to interconnect smart objects for systems with different scales and objectives. For instance, a lightweight platform can be deployed in one's home to orchestrate several connected objects, such as the fridge, the lights, and the heating system. On a broader scale, a smart city may benefit its development and management from new IoT solutions that can handle thousands of sensors, ease their maintenance, recalibration and, more importantly, analyze the data that they produce [3, 4].

In this article, we study today's IoT landscape with regard to the distribution of applications and services, as well

as the platforms that connect the devices to the Internet. For the purposes of this paper, an IoT platform is defined as the middleware and the infrastructure that enables the end-users to interact with smart objects, as depicted in Figure 1. We frame our study as a gap analysis of these platforms with regard to their capacities in meeting the challenges emerging from the current development of the IoT technologies. In order to evaluate the limitations of the current IoT platform landscape and identify the gaps that need to be filled, we consider the viewpoints of different players of the IoT platform ecosystem, including device vendors, application developers, providers of platforms and related services, and the end-users. In order to strengthen the findings of the gap analysis, we conducted a survey among the experts of the national Finnish IoT program [5] to highlight the most critical gaps for the development of future IoT platforms. As a result of this evaluation, we propose a set of recommendations aimed at filling in the identified gaps.

The remainder of this article is organized as follows: Section 2 presents the review of a representative list of IoT platforms. This is followed by a thorough gap analysis of the solutions in Section 3. In Section 4, we present the results of the survey and in Section 5, we enumerate our

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