



Stack4Things: a sensing-and-actuation-as-a-service framework for IoT and cloud integration

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Abstract With the increasing adoption of embedded smart devices and their involvement in different application fields, complexity may quickly grow, thus making vertical ad hoc solutions ineffective. Recently, the Internet of Things (IoT) and Cloud integration seems to be one of the winning solutions in order to opportunely manage the proliferation of both data and devices. In this paper, following the idea to reuse as much tooling as possible, we propose, with regards to infrastructure management, to adopt a widely used and competitive framework for Infrastructure-as-a-Service such as OpenStack. Therefore, we describe approaches and architectures so far preliminary implemented for enabling Cloud-mediated interactions with droves of sensor- and actuator-hosting nodes by presenting Stack4Things, a framework for Sensing-and-Actuation-as-a-Service (SAaaS). In particular, starting from a detailed requirement analysis, in this work, we focus on the subsystems of Stack4Things devoted to resource control and management as well as on those related to the management and collection of sensing data. Several use cases are presented justifying how our proposed framework can be viewed as a concrete step toward the complete fulfillment of the SAaaS vision.

Keywords IoT · Cloud · OpenStack · WebSocket · WAMP · SAaaS

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1 Introduction

In the last years, the Internet of Things (IoT) has emerged as one of the hottest trend in ICT thanks to the proliferation of field-deployed, dispersed, and heterogeneous sensor- and actuator-hosting platforms. Recently, with the increasing development of powerful and flexible embedded systems characterized by reprogrammable behavior and ease of use, such *things* are gaining a “smart” labeling to indicate this evolution. This all-encompassing and much ambitious scenario calls for adequate technologies.

Several solutions are already present in the literature mainly focusing on lower (communication) layer and in particular on how to interconnect (among themselves and to the Internet) any network-enabled *thing* [1]. However, in order to realize the Sensing-and-Actuation-as-a-Service (SAaaS) vision [2], other aspects have to be also taken into account such as solutions for creating and managing a dynamic infrastructure of sensing and actuation resources. In fact, in order to effectively control devices, sensors, and things, several mechanisms are strongly needed, e.g., management, organization, and coordination. Then, a middleware devoted to management of both sensor- and actuator-hosting resources may help in the establishment of higher-level services.

In this direction, the integration between IoT and Cloud is one of the most effective solutions even if up to now efforts revolve around managing heterogeneous devices by resorting to legacy protocols and vertical solutions out of necessity, and integrating the whole ecosystem by means of ad-hoc approaches [3]. In our vision, the Cloud may play a role both as a paradigm, and as one or more ready-made solutions for a (virtual) infrastructure manager (VIM), to