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An Overview of the IoT Coordination Challenge

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ABSTRACT

The Internet of Thing has been identified as one of the emerging technologies in IT. It interconnects and integrates large numbers of digital and physical entities by capability of appropriate information and communication technologies, to enable building enormous useful and unimaginable services and applications. However, building new IoT services or applications is a fastidious task since it is faced to several challenges such as interoperability, context-awareness, discovery, availability, decision-making. In this article, the authors are interested in coordination challenges that are still open despite the efforts of international organizations and scientific research groups. In fact, the authors outline a recent literature review of existing IoT coordination approaches. In the literature, researchers tend to use orchestration or choreography as a way to meet this challenge. A classification and the vision on this topic are presented. The authors propose an approach that is more likely to respond to the co-ordination challenge.

KEYWORDS

Coordination Models, IoT, IoT Architectures, IoT Building Blocks, IoT Challenges, IoT Choreography, IoT Context-Driven Architecture, IoT Coordination, IoT Orchestration, IoT Requirements

1. INTRODUCTION

According to Gartner's IT, Internet of Things (IoT) has been identified as one of the emerging technologies in IT. It has tremendously evolved in the last few years and involves an increasing number of smart interconnected devices and sensors such as cameras, biometric and medical sensors, etc. It aims to integrate, collect information from-, and offer services to a large spectrum of physical things used in different domains. These "Things" permit to add capabilities to self-organize and communicate with other things without human intervention (Dobre & Cristea, 2013). As it is a paradigm, IoT applications are various and brought to several areas: health care, transportation, smart cities, etc. This means that the "things" are diverse and from different natures that make them heterogeneous in term of communication and networking technology. On one hand, this diversity is essential and useful, as for instance different services, applications and environments benefit from varying networking technology. Several studies have shown the enormous potential and opportunities of IoT (e.g. Internet of Healthcare Things, Smart mining coal, etc.). On the other hand, it makes the task of processing, integrating, and interpreting the real-world data a challenging task (Henson;

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Taylor; Barnaghi & Wang, 2012) in term of networking, software development, distributed systems, security, etc. Unfortunately, these challenges hinder the development of more suitable, scalable and advanced IoT services and applications. As described in the literature IoT can be realized in three paradigms: internet-oriented (middleware), things oriented (sensors) and semantic-oriented (knowledge) (Atzori, Iera, & Morabito, 2010) and should be seamlessly and smoothly integrated within the emerging integrated services delivery models, such as the Internet-of-Services (IoS) and their associated utility computing paradigms, where computing resources are offered as a metered service (Hauswirth & Soldatos, 2012). Therefore, IoT systems must cope with a large amount of sensor information, and they need to aggregate and integrate this information, distribute it to participants in different applications, and trigger the corresponding business process collaboration in a timely manner (Cheng; Zhu; Chen & Zhao, 2016)). To provide better and more resilient IoT services and applications it was identified that flexible and advanced IoT architectures are needed to address several challenges like easy-connectivity, interoperability, control, scalability, coordination, QoS, security, and so on. In this paper we are interested on coordination challenge that still represents an open issue despite the efforts of international organizations and scientific research groups. Coordination consists of organizing things, objects, information, tasks, functionalities, services, etc. in a network in order to enable them to work together efficiently to attain a required and desired objective. Research studies in literature have shown that coordination is the most complex challenge in distributed systems such as M2M, IoT, etc. To be addressed in its wholeness due to its dependence on other challenges like scalability, ubiquity, mobility, privacy, security, context awareness, etc. we noticed that researchers simply use service orchestration or service choreography as an approach for coordination, rather than encountering the complexity of the tasks coordination. So those proposed solutions are mainly focused on the studied application and therefore can't be used for general case studies requiring tasks coordination. This motivated us to propose in this paper a survey on IoT coordination. To organize this survey, we start with presenting IoT building blocks, IoT challenges and IoT architectures.

The paper is organized as follows. Section II introduces IoT background and our motivation by presenting IoT building blocks, IoT requirements and architectures. Section III identifies the more important contribution of IoT coordination. Section IV proposes a classification and a discussion of evoked reviews on coordination. Section V presents an overview of coordination models. Before concluding, Section VI highlights our vision on a suitable architecture that meets the coordination challenge.

2. IOT BACKGROUND AND MOTIVATION

2.1. Understanding IoT Blocks

To accomplish the vision of IoT that consists of connecting billions of things around the world, there's a need to identify the IoT elements or building blocks to more understand IoT behavior and real sense. The work in (Al-Fuqaha, Aledhari, Ayyash, Guizani, & Mohammadi, 2015) identified mainly six blocks required to deliver the functionality of IoT as depicted in Figure1.

Figure1. IoT blocks