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Toward Service Aggregation for Edge Computing

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Abstract

Interoperability is one of crucial Internet-related research domains. Today, there is a shift in the architecture of the Internet and the traditional communication model; the human part in machine communication is blurring into a more sophisticated thing-to-thing communication model. In this model things search for other things and provide collaboration-base services, this way leading to more complex interaction issues. Especially, interoperability must transcend the use of protocols and include semantic to make the different building blocks of the Internet of Things (IoT) work together and exploit the maximum of it. Hence, we present our vision and concept of a multilayer model for IoT infrastructure to: abstract the data sources infrastructure, define filtering and formatting mechanisms, and to present pertinent data in the form of simple unitary or aggregation of multiple services.

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Keywords: IoT; fog computing; thing-to-thing communication; service composition;

1. Introduction

Since its appearance, there has been a debate among researchers about the concept of Internet of Things (IoT). A common aspect about the many proposed definitions is that they mutually state that IoT paves the road to a future where autonomous objects sense, actuate, communicate, interact and react to no-human interaction and automatically. Instead of human seeking information, there is currently a need to design network with a thing-to-thing based-communication infrastructure.

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Generally, sensors are used to collect data from their environment. The collected data are highly valuable when filtered, processed, analyzed, and presented properly. This data feeds the decision making process at the top level of the Internet: The Cloud. Indeed, recent trends in IoT are mostly toward a centralized Cloud-based architecture. However, such approach comes with drawbacks related to mobility support, distribution, and context-awareness[1]. In addition, the continuous torrent of heterogeneous and potentially irrelevant data comprises challenging tasks of filtration, unification, optimization and may decrease the speed of data analysis processes.

Prior to the decision making and the wisdom generation level, the IoT systems must come up with solutions to allow things to discover functionalities of other things, and to be able to use them efficiently, securely, and with minimal human intervention[2]. For instance, Flood Management is one of the crucial application domains where smart things may save human being lives. Sensors monitor water levels in rivers, precipitation, soil saturation and so forth. Sensors at the lower end of this system must be able to interact with each other to open floodgates at need. Such reaction does not require complex data analysis to be performed. A federation of Cloud-based approach and the ability of things to collaborate can leverage the gain from sensing activities and support highly heterogeneous systems[3]. However, this early thing-co-operation at the edge of the network increases even more the complexity of the thing-to-thing interaction model[4]. This increasing complexity is due to the huge number, the heterogeneous and the dynamic nature of the involved things, and to the different technologies of both provided and consumed services[5].

Our work focuses on the early interaction and collaboration of things. The goal of this paper is to model the aggregation of sensing activities at the edge of the network in order to support more advanced collaboration scenarios. The presented multilayer architecture abstracts IoT hardware, helps translate, describe and format data in order to deliver high-abstracted services.

In the rest of this paper, we define and describe a service aggregation model for the Internet of Things. The second section discusses related work. Section 3 describes the main layers of our model. To best exemplify the use of our model, section 4 illustrates and explains a generic simplified scenario of flood management. Section 5 expresses the future research lines and the conclusions of our work.

2. Related Work

There are mainly three approaches tackling the challenges of the Internet of Things. The traditional approaches, such as mobile cloud computing, in which both data storage and data analysis are moved to the centralized cloud[6]. In contrast, the mobile edge computing approach aims to run specific tasks and store data in a cloud-like server at the edge of the mobile network. For example, the edge-centric computing[7] merges the peer-to-peer and cloud computing paradigms to this end. The third approach is a combination of both mobile cloud and mobile edge concepts. Indeed, *Cisco System* presented Fog Computing[8], a new paradigm that allows to push computing to the edge of the network, to run generic applications and services directly on the edge resources. This new vision is motivated by the gain of low-latency data analysis and better support of mobility. TerraSwarm[9] is similar but more broad vision of the interaction between the cyber-physical network and the core Cloud. This system is an open model of interconnected graphs of applications designed to ensure a dynamic recombination of its components.

The main goal of this work is toward developing a collaboration system for IoT objects. On the one hand, by bringing service aggregation and composition to the edge of the network using fog computing. In the other hand by providing a middleware to abstract the underlying heterogeneity. In this same vein, *Mobile Fog* [5] presents a high-level programming model for the Internet of Things. This model is intended for latency-sensitive and on-demand scaling applications, but a more general approach is needed to deal with resources mobility. Similarly, by assuming that everything provides its functionality as a standard service, the presented composition model[10] uses artificial potential fields to deliver a decentralized service composition. In an attempt to tackle decentralized service composition, Rain4Service[11] models the behaviour of rain drops to achieve service composition. However, this framework is not intended for deployment at the edge of the network. Filtering and unifying data is a principal issue in order to provide a middleware in such environment[12]. Depending on the context of the service to provide, the use and presentation of data should adapt accordingly. The system[13] uses a goal-driven and context-aware filtering method. Though, in case of an aggregated or time-dependent sensing activity, issues like mobility support may rise. Sharing resources between devices at the edge of the network was the focus of Mobile Cloud[14]. The work proposed a framework to share resources in local cloud, the different measurements of resources are mapped into time.