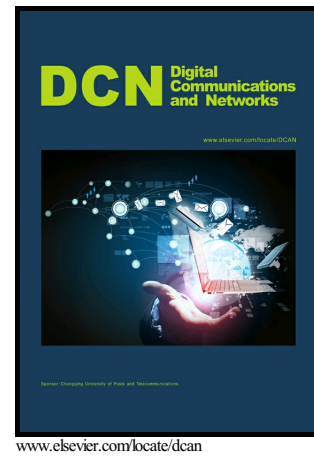


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Middleware Technologies for Cloud of Things - a survey

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Abstract

The next wave of communication and applications rely on the new services provided by Internet of Things which is becoming an important aspect in human and machines future. The IoT services are a key solution for providing smart environments in homes, buildings and cities. In the era of a massive number of connected things and objects with a high grow rate, several challenges have been raised such as management, aggregation and storage for big produced data. In order to tackle some of these issues, cloud computing emerged to IoT as Cloud of Things (CoT) which provides virtually unlimited cloud services to enhance the large scale IoT platforms. There are several factors to be considered in design and implementation of a CoT platform. One of the most important and challenging problems is the heterogeneity of different objects. This problem can be addressed by deploying suitable “Middleware”. Middleware sits between things and applications that make a reliable platform for communication among things with different interfaces, operating systems, and architectures. The main aim of this paper is to study the middleware technologies for CoT. Toward this end, we first present the main features and characteristics of middlewares. Next we study different architecture styles and service domains. Then we presents several middlewares that are suitable for CoT based platforms and lastly a list of current challenges and issues in design of CoT based middlewares is discussed.

Keywords: CoT, IoT, Middleware, Fog Computing, Cloud.

1. Introduction

The appearance of Internet of Things (IoT) concept is shaping and reshaping how future services are going to be define. The main idea behind this concept is to develop different type of communication network based on group of physical objects or simply “things”. The IoT objects embedded with electronic chips, software, sensors and internet connectivity to collect and process data from the environment

or affecting it by deploying actuators. IoT combines real-world data and computer processing to lower the costs and increase the efficiency and accuracy. Each thing can be recognized separately through its embedded computing system and is able to communicate with other things through Internet infrastructure. Recently the number of connected and embedded smart devices grows rapidly. According to Cisco IBSG [1], IoT world will includes more than 50 billion objects in 2020.

IoT is translated in different concepts or approach such as “Network-Oriented” or “Object-Oriented” or even, as it mentioned in ??[2], “Semantic Oriented”. These visions emerged because of different stakeholder ideas because different vendors and IT experts have their own vision of this technology. IoT semantically means “a worldwide network of interconnected objects uniquely addressable based on standard communication protocols” [3]. International Telecommu-

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