Chapter 1
Edge-of-Things Computing-Based Smart Healthcare System

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ABSTRACT

Any delay introduced in healthcare applications could critically affect the health of patients. Edge computing paradigm has been introduced recently as an alternative to develop such applications, where a rapid response is necessary to ensure the immediate assistance of patients when they need help. In this chapter, the authors propose an edge-of-things computing-based architecture, which illustrates the benefits of the realization of IoT under edge computing approach. The proposed architecture offers significant advantages: 1) it reduces the latency time in the data transmission for processing and analysis; 2) it improves the response time of the delivery of notifications or emergency alerts; 3) it provides real-time processing and big data analysis in the proximity of data sources; 4) it enables interoperability between heterogeneous devices; and 5) it provides security and QoS in the data transmission. The usefulness and relevance of the proposed architecture is evaluated through the implementation of a smart healthcare system applied to a medical case study.

INTRODUCTION

The advancement and proliferation of communication technologies and the growing presence of a variety of wearable devices with communication, identification, sensing and actuating capabilities, have enabled the Internet of things (IoT) to rapidly gain ground as a key research theme both in the academic institutions and industrial organizations, notably in agriculture, logistic and healthcare fields. In this latter field, due to the fast-growing numbers of elderly persons over 65.

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According to the World Health Organization (WHO), by 2050, the current elderly population (8.5%) will increase, representing 20% of the world's population (He, Goodkind, & Kowal, 2016). On the basis of these trends, many countries are adopting healthy aging policies with the aim of helping the elderly to lead independent and active lives. In particular, ensuring active and healthy aging (AHA) of the elderly is one of the greatest challenges, but also a great opportunity for society in the upcoming decades. The notion of AHA has been lately characterized as a broad concept, which seeks to improve the quality of life (QoL) of the elderly people as they age, optimizing opportunities for health, participation and security (Bousquet, Kuh, Bewick, Standberg, & Farrell et al., 2015). In healthcare, the AHA brings with it some main concerns about the growth in social demand and financial feasibility of traditional healthcare systems. Therefore, pervasive solutions that enable the delivering patient-focused services of high quality is highly desired. To achieve these ends, new computing approaches have been developed.

Over the past few years, the integration of IoT and cloud computing often simply referred to as CloudIoT, which have contributed to the implementation of various application scenarios such as smart transportation, cities and communities, homes, logistic, environment and healthcare. The adoption of the CloudIoT paradigm in healthcare scenarios offer many opportunities, particularly in simplifying healthcare processes and enhancing the quality of the medical services by enabling the collaboration between the different entities engaged (Botta, de Donato, Persico, & Pescapé, 2014).

In particular, IoT enables the sensing and processing of biomedical signals and physiological parameters through a variety of devices, which are interconnected through the Internet with a view so they can work with other connected devices and share information between them. The interconnection of devices generates a large amount of data that require scalable computing infrastructure for further processing and analysis (Dastjerdi & Buyya, 2016). In such context, the adoption of cloud computing represents a promising solution for providing healthcare sensor data on-demand and scalable storage processing and analyzing services efficiently. However, cloud computing is not especially suited for data processing in latency-sensitive solutions, as in the case of healthcare solutions.

There are issues in the traditional CloudIoT- based architectures, which can have a direct negative impact on the health of patients with urgent needs, who need to be assisted on time. For example, in emergency situations, a delay in the latency caused by the transfer of data from the sensors to the cloud may produce fatal consequences for the patient. In addition, the processing and analysis of data in a server hosted in the cloud prevents the timely detection of unusual events in the health of patients, and the report of appropriate alerts to the professionals involved in their care (i.e., caregivers, health professionals, etc). Moreover, the majority of end nodes (i.e., sensors) are resource-constrained devices, i.e., class 0 devices. Class 0 devices are characterized by constraints in memory (10KiB of RAM and 100KiB of flash) and processing capabilities (Bormann, 2014). These devices have severe constraints to communicate with the Internet and send the data directly to the cloud or store records for a very long time in local memory, so they usually connect to gateway-like devices for internet communication.

The alternative approach proposes the use of an intermediate edge layer, able to process the data at the edge of the network, to improve the efficiency of CloudIoT- based architectures. An intelligent use of this layer can lead to a sufficient performance to meet the strict requirements of health care applications, without using a technological infrastructure of great features that are currently achieved in the cloud.

In this sense, we propose, edge-IoTA, an architecture based on IoT and edge to support remote health monitoring, in order to achieve:

- Reduce the latency in the transmission of data for processing and analysis.