Chapter 43
Processing IoT Data:
From Cloud to Fog—It's Time to Be Down to Earth

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ABSTRACT

This chapter describes how traditionally, Cloud Computing has been used for processing Internet of Things (IoT) data. This works fine for the analytical and batch processing jobs. But most of the IoT applications demand real-time response which cannot be achieved through Cloud Computing mainly because of inherent latency. Fog Computing solves this problem by offering cloud-like services at the edge of the network. The computationally powerful edge devices have enabled realising this idea. Witnessing the exponential rise of IoT applications, Fog Computing deserves an in-depth exploration. This chapter establishes the need for Fog Computing for processing IoT data. Readers will be able to gain a fair comprehension of the various aspects of Fog Computing. The benefits, challenges and applications of Fog Computing with respect to IoT have been mentioned elaboratively. An architecture for IoT data processing is presented. A thorough comparison between Cloud and Fog has been portrayed. Also, a detailed discussion has been depicted on how the IoT, Fog, and Cloud interact among them.

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INTRODUCTION

Typically, IoT devices are attributed to very limited computation and storage capacity. To get over this limitation, Cloud Computing has been the most favoured platform for processing IoT data, which provides on-demand and scalable resources for computing and storage. The sensor data are transported to the Cloud data centre, where they are processed, and the outcome is sent to the subscribed applications. Furthermore, the data centres may store the IoT data, if necessary, for analysis to extract further knowledge which helps in business decision making. The Cloud platform has become popular for IoT data processing mainly because of economic reason. By opting Cloud Computing, organisations have freed themselves from the hassle of establishing their own computing setup and maintenance. But as we are heading towards the smart world for a smart living, uses of sensors and wireless networks locally has been on the rise, and the data generated locally is increasingly consumed locally (Chiang, 2015). In other words, instead of at the remote centralised Cloud data centre, the data gravity is shifting more and more towards the neighbouring to the data source or, formally what we call, the edge of the network. For these applications, it is extremely crucial to be facilitated by low and predictable communication latency for real-time interaction, location awareness, and support for mobility and large-scale networks (Milunovich, Passi, & Roy, 2014). The traditional Cloud Computing architecture lacks in these aspects. IoT requires a different computing architecture that enables distributed processing of IoT data with mobility support and quick response whenever and wherever wanted. Fog Computing perfectly befits this scenario. Fog Computing is particularly suited for applications that demand real-time response with predictable and minimal latency (Milunovich, Passi, & Roy, 2014). The edge devices such as set-top-boxes, access points, routers, switches, base stations etc. are becoming ever more powerful in terms of computing, storage and networking. Hence, they are being considered as capable candidates to perform computational jobs. Considering that, Fog Computing can play a big role in processing the huge amount of data generated from billions of distributed IoT sensors. Fog Computing is not to replace the Cloud Computing rather it augments Cloud Computing by extending its services to the edge of the network. Principally, both Cloud and Fog serve the end users by providing data, computing resource, storage, and application services. But Fog is differentiated from the Cloud with respect to its proximity to the source and sink, its distribution irrespective of the geography and last but not the least its support for mobility (Mora, 2014). In the case of Cloud-based IoT data processing, every single bit of data would have to be shipped to the data centre. When the size of data to be processed grows enormously (and that is the exact case of IoT), it becomes very expensive to move them around. Since in Fog Computing data are being processed locally, the burden of transporting these data is lessened. The processed data are sent to the Cloud only if they are to be stored for further analysis and historical purposes. Also, since the data are processed very close to the source, the end-user service becomes very prompt which is very crucial for maintaining QoS in real-time and machine-to-machine (M2M) applications. Handling services in the Fog provide better user experience and more efficient and effective applications of IoT data. In this chapter, we have advocated for employing Fog Computing for IoT applications while discussing and comparing it with Cloud Computing in several aspects.

The rest of the chapter is organized as follows. A brief review of IoT and Cloud Computing is presented in section 2. The section 3 discusses how IoT data is processed in the Cloud, along with the advantages and issues. In section 4, we shall discuss the basics of Fog Computing including its characteristics and architecture. We shall identify the differences between Cloud and Fog in section 5. Section 6 addresses the processing of IoT data in the Fog. An architecture has been laid out for this. This section also discusses

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