Abstract

The underlying concept of internet of things (IoT) envisions the ubiquitous connectivity of smart objects through the Internet as a global platform. Such a pervasive IoT network involves a large number of heterogeneous sensors that are expected to generate massive data. Consequently, the network should be flexible and programmable to manage the sensors and the generated data efficiently. However, the current best-effort networking technology suffers from increased capital and operational expenditures, while imposing different challenges in supporting emerging IoT applications, such as smart grid energy management and smart healthcare.

The software-defined networking (SDN) technology enables real-time programmability of network devices by decoupling control and data-planes. Thus, the complexity involved in managing networks is reduced significantly compared to that of the traditional networks. Although different SDN-based approaches exist in the literature, they are either focused on the traditional networking issues or are at their infancy to be integrated into fully programmable networks to provide differentiated service provisioning for IoT applications. In this dissertation, we focus on rule-placement and routing strategies to satisfy heterogeneous quality-of-service (QoS) requirements of traffic from sensors and network devices in SDN-enabled end-to-end IoT networks, such as smart grid and smart healthcare. A summary of the major studies reported in this dissertation are described as follows.

We start by focusing on designing a unified wireless sensor network (WSN) management system from the aspects of SDN. This design helps us to manage the devices equipped with heterogeneous sensors in IoT access networks in a unified manner. The efficacy of the designed system is tested by building a prototype of the system. The data generated from the sensors is received at IoT gateways. Consequently, we propose an adaptive rule placement technique for managing traffic at the IoT gateways. Further, the generated data is either processed at the IoT devices itself or offloaded to edge networks to minimize computation delay. To address the issues with offloading, we propose a QoS-aware computational data offloading scheme at IoT edge networks. The effectiveness of the proposed scheme for managing traffic at the IoT edge and access networks is evaluated through simulations. The IoT traffic is eventually carried through core networks to data centers for further processing and decision making. To provide differentiated QoS service provisioning at core networks, we propose adaptive flow-rule placement schemes at the switches in the network. Additionally, a QoS-aware routing scheme is also proposed to provide QoS-guaranteed end-to-end data delivery in the IoT network. The efficacy of the proposed schemes is evaluated through network emula-

tors, while injecting traffic generated from IoT applications, such as smart grid energy management and smart healthcare, into real network topologies.

The aforementioned solution approaches considered a single SDN controller in the network. It is observed that the use of a single controller may not be suitable to address the stringent QoS requirements of IoT traffic. Consequently, the impact of using multiple controllers in the network is investigated. Further, a dynamic controller association scheme is also proposed to minimize controller response time.

Keywords: Software-defined networks, Internet of things, Quality-of-service, Rule placement, Routing, Performance evaluation