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An Experimental Study of a Reliable IoT Gateway

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Abstract

The Internet of Things (IoT) will include new devices specifically designed for IoT compatibility and systems that are already in place today and operate outside of IoT networks. However, the path to creating cloud networks of interconnected devices requires a means for devices that are not IP-based to connect without having to bear the cost of a full Ethernet or WiFi interface with the accompanying protocol stack. This can be achieved through the use of IoT gateways that bridge these devices to the Internet in the context of real-world applications. In this paper, we introduce an experimental study of a reliable and self-configurable IoT gateway that is developed in a laboratory testbed by using the IoTivity framework.

Keywords: IoT, IoT gateway, Smart gateway, Reliability

1. Introduction

Many works have been carried out to advance Internet of Things (IoT) technology in business domains [1, 2] because of the value gained by connecting an endpoint device for system reliability, automation, and centralized management. Although developed for business applications, many of these advances are applicable to all types of smart systems, including wearables, mobile phones, healthcare equipment, security devices, and cloud and deep-learning systems [3, 4]. For engineers, the greatest challenge in designing the IoT is reliability [5, 6]. The implementation of robust and secure access to the Internet or a wide area network (WAN) is outside their range of experience. To make design even more difficult, developers need to support access to multiple devices that are limited in their processing capability. Reliability must also be added in a way that does not adversely impact the overall cost efficiency [7, 8, 9].

The diversity of endpoints that a gateway must support raises design concerns [10, 11] as well. The direct connection of a simple device such as a humidity sensor to the Internet can be complex and expensive, especially if the device does not have its own processor. In addition, different types of end equipment support varying interfaces. The collection and aggregation of data from a disparate set of nodes require a means for bridging devices with a range of processing capabilities and interfaces together in a consistent and reliable way [12, 13]. Gateways offer an elegant means for simplifying the networking of "things." They achieve this by supporting the different methods of device connection, whether this is a varying voltage from a raw sensor, a stream of data over I2C from an encoder, or periodic updates from an appliance via WiFi. Gateways effectively mitigate the great variety and diversity of devices by consolidating data from disparate sources and interfaces and bridging them to the Internet. The result is that individual nodes do not need to bear the complexity or cost of a high-speed Internet interface in order to be connected.

An IoT gateway is an intelligent component based on an IoT platform [14, 15]. It is typically employed between the network of the machine-to-machine (M2M) devices and the remote peers (e.g., clients) over the internet. The basic goal of the gateway is to settle the heterogeneity between different endpoint networks and the Internet, strengthen the management of the endpoint networks, and bridge the traditional Internet with endpoint networks. As state-of-the-art IoT gateways [16, 17] are designed to connect to mobile and wireless networks, they emphasize the provision of flexible connections among smart devices and a user's cloud to enable intelligent big data analysis and data-driven decision-making. Furthermore, they can be flexibly configured with different protocol-ready modules to communicate with end nodes or I/O devices.

However, current IoT gateways [14] operate passively or semi-automatically. This means that, when a user buys a new IoT device, he/she manually installs the device using the setup manual. After that, the IoT gateway asks the user whether a new device should be registered. To solve this problem, we propose a reliable IoT gateway for small-scale IoT environments in this paper. When a user brings a new device in their home, the IoT gateway automatically detects this new device and registers this device by itself. If the user discards old devices from his/her home, the smart IoT gateway automatically deletes that device from the device list. In our system, the user does not have to worry

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