Chapter 1

IoT Resources and IoT Services

ABSTRACT

Although many IoT applications have been developed, a theoretical basis for interconnecting all things is still obscure. In order to establish a solid foundation for IoT applications, this chapter addresses three issues: how to model physical sensors and devices as IoT resources, how to introduce IoT resources into IoT services, and how to use distributed events to connect IoT resources and IoT services together to form an IoT service system. An IoT resource is defined by its static attributes and dynamic lifecycle; both of these are specified using semantic knowledge to enable automatic sharing and understanding. An IoT service is considered as a set of actions imposed on IoT resources to monitor and control the physical world. An example application is given in order to demonstrate a proof of concept for event-driven IoT services over IoT resources (streamlining events) to integrate IoT services.

INTRODUCTION

The primary aim of IoT services is to introduce physical entities in the physical world into the information world. Digital entities corresponding to physical entities are referred to as IoT resources. A resource provides functionalities allowing access to the physical entity’s properties and actuation of the physical entity. We treat this resource, also called a bottom-layer service or resource service, as a primary base for sharing, interaction, composition, and so on.

DOI: 10.4018/978-1-5225-7622-8.ch001
A resource is defined by its object model and its lifecycle model; its object model describes its attributes and the relations it has with other resources, while its lifecycle model describes the way in which it runs and its lifetime state transitions. The interface of the resource service allows access to its attributes and the states in its lifecycle. Business services operate on the resources, inducing state transitions or accessing the resource attributes. The operation of the service is carried out based on events, i.e., it uses an event-driven model.

Distributed events play a key role in communication between business services and underlying resources, driving all these system-building components to progress during operation. Upper-layer IoT services, i.e. business services, use events to access the attributes or actuation capabilities of resources. Each IoT service can obtain events locally, react to their occurrence, and publish its output as a distributed event for other IoT services to use locally. Each event is also required to be independent, meaning that each IoT service should be able to consume it without knowing its ‘from’ or ‘to’.

A hierarchical model is presented here to specify IoT services based on distributed events, including basic IoT services reacting to the occurrence of events, and multiple IoT services interacting via the distribution of events. Although events are independent within the service environment, each service has its own behaviour and interacts with other services. The behaviour and interactions of a service control how events are exchanged among service activities and the reactions to the occurrence of events; that is to say, there are dependency relationships between events in the service system. In order to fill this gap and to maintain consistency with an event-driven methodology, an information-centric session mechanism is proposed here to describe service behaviour and interactions based on distributed events, called an event session. An event session involves using the event itself to correlate the different service activities through which the activity relationship in a service behaviour can be defined.

To the best of the authors’ knowledge, there are no existing works that fully explore ways in which to use IoT resources as the basis for event-driven IoT services. The contributions made by this chapter are as follows:

1. First, a semantic method is used to specify physical sensors and actuators based on existing standards and specifications. In most existing works, the physical systems monitored by sensors and initiated by actuators are not comprehensively discussed; these physical systems are therefore modelled here, and together with sensor and actuator models become
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