Demo Abstract: Commissioning of Low Power Embedded Devices with IPv6/CoAP

Berta Carballido Villaverde, Julien Oury, Dirk Pesch
Nimbus Centre for Embedded Systems Research
Cork Institute of Technology, Cork, Ireland
{berta.carballido, dirk.pesch}@cit.ie, julien.oury@mycit.ie

Rodolfo De Paz Alberola, Szymon Fedor
United Technologies Research Centre
Cork, Ireland
{depazar, fedors}@utrc.utc.com

Abstract

The commissioning of sensors and actuators within a building is often carried out by an operator who manually gathers and later inserts configuration data into the building management system. Data sets collected can easily reach hundreds which makes this manual process a slow complex operation which in turn is prone to errors. In this paper, we present a client-server architecture for a simple web based commissioning application, based on the Constrained Application Protocol (CoAP), that allows an operator to easily discover and browse through newly installed devices in order to perform commissioning configurations onsite.

Categories and Subject Descriptors

C.2.4 [**Computer-Communication Networks**]: Distributed Systems

General Terms

Management, Design

Keywords

CoAP, IPv6, Commissioning, Wireless Sensors, Web

1 Introduction

This demo uses a typical setting of a building automation system (BAS) to illustrate the benefits of the proposed approach to commissioning low power embedded devices. Figure 1 (A) describes the traditional commissioning process of a BAS [1]. After the physical installation of each device, the operator manually gathers ID and location of each device (step1) and later introduces these into the BAS system (step2). After this, the device ID and location can be mapped to its offered services (step3). Moreover, installing and configuring a protocol translation gateway is usually required (step4). The role of the gateway is to allow interaction between BAS standard protocols (i.e. ZigBee, BACnet, etc.)

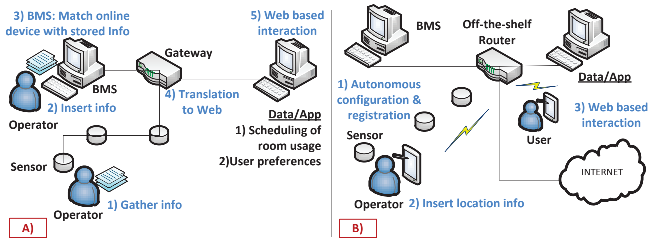

Figure 1. Commissioning process of sensors as currently carried out (A) and as envisioned utilising CoAP/IPv6 technology (B).

with other IT applications available within the building that usually communicate through Web services. For instance, in the case of a University, it is important to read information on the teaching schedules to efficiently manage the heating, lighting, etc. in the corresponding classrooms. Overall this commissioning process is slow (since configurations are done offsite), expensive (due to operator and gateway costs) and prone to errors (due to the large amounts of information that need to be manually collected and later stored offsite).

The IETF recently created the CoRE group whose first goal has been to develop a RESTful application layer protocol for communications within embedded wireless networks, the Constrained Application Protocol (CoAP) [4]. With CoAP existing Web technologies can also be applied in the constrained domain. This is highly attractive for the integration of sensors with any building system (without the need for special gateways) as well as to allow user/sensor interaction through popular Web technologies locally or remotely over the Internet. In this paper we propose an architecture, based on CoAP and IPv6, to simplify the commissioning process of wireless embedded devices for building automation applications. Figure 1 (B) depicts how we envision the commissioning process using CoAP and IPv6 within the sensing devices. With the proposed architecture, after physical installation of the device, the device obtains its address using IPv6 autoconfiguration capabilities and later registers with a service directory (such as a Resource Directory as described in [5]) (step 1). The operator, through a Web based application sees the RD contents and the newly installed device once it has finished its autoconfiguration. At

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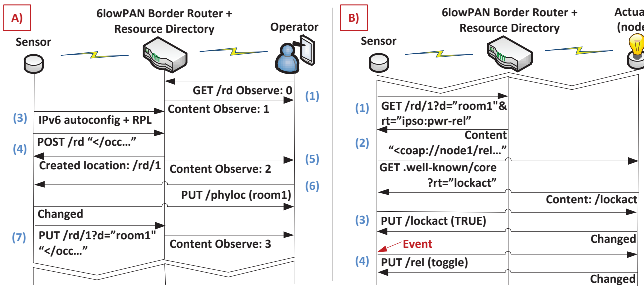

Figure 2. Detailed operation of the CoAP/IPv6 commissioning process (A) and the CoAP based distributed control application (B).

this point, and onsite, the operator easily supplies the physical location information to the device (step 2). Thus it is not necessary to manually gather and store any information offsite anymore. Moreover, since Web/IP technology is used all the way, gateways do not have to be installed. This way, a faster, cheaper and more reliable commissioning process is achieved.

This demo implements the proposed commissioning architecture and shows how the operator can easily discover and configure newly installed devices onsite through an application running on a mobile device. Moreover, this demo shows how autonomous plug-and-play devices can be created to perform distributed control tasks utilising CoAP discovery mechanisms, CoAP queries and the location information provided onsite by the operator.

2 The IPv6/CoAP Based Commissioning Architecture

The detailed operation of the CoAP/IPv6 commissioning process to be demonstrated is depicted in Figure 2 (A). (1) The Operator switches on a Tablet PC and observes the resource directory, hosted by the border router, using CoAP Observing feature as described in [2]. (2) The sensor or actuator is plugged in. (3) The device obtains its own address and route to the 6lowPAN border router using IPv6 autoconfiguration [6] and RPL [8]. (4) The device registers its resources with the resource directory (RD), using CoAP requests as described in [5]. (5) At this point, since the operator is observing the RD, the operator sees how the new device appears on its Tablet PC. (6) The Operator introduces the physical location to the device through the application (PUT request to ”/phyloc”). (7) Once the device receives the location information, it updates its registration at the resource directory to include this information in its resource descriptions (location information is translated into the resources parameter ”d” as proposed in [7]). (8) At this point, any application can search for devices hosting certain types of resources (i.e. light switch, luminance sensor), using CoAP queries, and establish relationships among them. Moreover, the application can search within a specific location using the parameter ”d” to filter resources by location among the resource descriptions available in the resource directory.

The Copper plugin for Firefox [3] was enhanced for this demo to enable resource directory/operator interaction with the Tablet PC. The new feature allows *observing* the content of the RD to see instantaneously if any device has joined or left the network, e.g. due to a failure. Moreover, the feature allows browsing and interacting directly with the devices and resources that have been discovered through the RD. Additionally, the RD was implemented in one of the constrained devices using Contiki CoAP implementation. Finally, an IPv6 router has been created in a linux machine to route traffic from the wireless sensor/actuator network to the Tablet and vice versa.

3 CoAP Based Distributed Lighting Application

In order to put to a test the service discovery capabilities provided by CoAP, an autonomous distributed lighting control application was implemented in the nodes. Its operation, to be demonstrated, is as follows (see Figure 2 (B)): (1) Once the occupancy sensor has received its physical location, as provided directly by the operator, it queries the RD to provide the resource description of an actuator located in the same area (i.e. CoAP query searching for resource type rt=ipso:pwr-rel, d=mylocation). (2) The RD responds to the sensor with the required information. (3) The sensor tries to lock the actuator to have sole control rights on the actuator by setting a resource (i.e. ”/lockact”) to *TRUE* (if the resource is already set to true the attempt to lock is rejected). (4) Once a sensor succeeds to lock the use of one actuator, it can start controlling it by writing *TRUE* or *FALSE* to the actuator resource previously discovered depending on occupancy. (5) If the sensor is moved to another location or loses connectivity and the actuator stops receiving commands, the actuator unlocks itself after a period of time (i.e. ”/lockact” is set to *FALSE*). Moreover, if the sensor stops receiving acknowledgements, it searches for another actuator within the same region. Finally, the sensor must *observe* the actuator location to stop actuating on it if moved to a different location but still within range. This application demonstrates that, with CoAP, autonomous plug-and-play devices can be created as they can discover and interact with one another using CoAP queries, service discovery capabilities and the location information supplied by the operator.

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