Demo : TWIN Node, A Flexible Wireless Sensor Network Testbed

Idrees Zaman
ComNets
University of Bremen
iz@comnets.uni-bremen.de

Jens Dede
ComNets
University of Bremen
jd@comnets.uni-bremen.de

Anna Förster
ComNets
University of Bremen
afoerster@comnets.uni-bremen.de

Abstract

In recent years, there is substantial growth in research in the field of Wireless Sensor Networks (WSNs). The applications of WSNs include smart homes, smart grids, smart roads, intelligent buildings, assisted living etc. Recently, researchers have developed various testbeds for evaluating WSNs. However, they are typically very expensive, cannot be re-positioned easily and operate the sensor nodes on wall power. In this paper, we propose a new platform to support flexible WSN testbeds called TWIN. The TWIN Node testbed will allow researchers to analyze wireless sensor networks (WSNs) remotely with maximum flexibility.
Firstly, no wired back-channel is needed for TWIN Node that allows flexible re-positioning of the testbed. Secondly, the TWIN Node supports reliable wireless reprogramming of sensor nodes. The TWIN Node is the first testbed that supports monitoring of wireless sensor nodes operating on battery power.

Categories and Subject Descriptors

C.2.m [**COMPUTER COMMUNICATION NETWORKS**]: Wireless Sensor Networks; C.4 [**PERFORMANCE OF SYSTEMS**]: WSN Testbed

General Terms

Performance

Keywords

WSN, Testbed, TWIN Node

1 Introduction

The increased research in Wireless Sensor Networks (WSNs) has resulted in development of new standards and applications. Development of any new standard for WSNs requires extensive trial. Normally simulation tools are used for the evaluation of any new standard. Since WSNs can be deployed in any environment, modeling of such environments without valid assumptions leads to erroneous assessment of performance. For that reason WSN testbeds are extensively used for performance evaluation. WSN testbeds have allowed researchers to evaluate the performance of their protocols in real physical environment. Motivation behind the TWIN Node is to provide a flexible testbed that uses WiFi as back channel support and is free from the constraints of a wired testbed. Figure 1 shows an overview of the TWIN Node testbed.

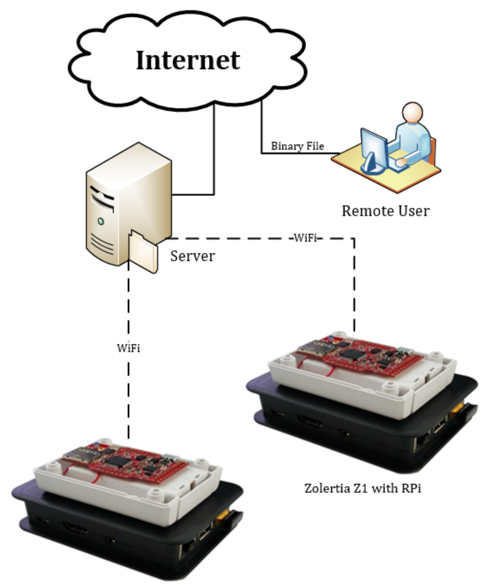

Figure 1. Wifi based back-channel support for TWIN Node testbed

The TWIN Node testbed has following features:

- Over the air (OTA) programming of wireless sensor node via a Raspberry Pi.
- WiFi based back channel that replaces active USB cables.
- Performance evaluation of battery and USB powered wireless sensor nodes.
- Remote programming and monitoring of wireless sensor nodes.

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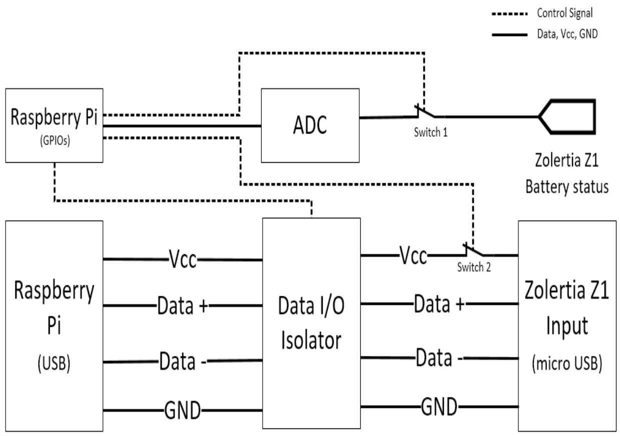

Figure 2. Data and power isolation block between Raspberry Pi and Zolertia Z1 sensor node

- Complete physical isolation of wireless sensor node from Raspberry Pi when operating over battery.
- Monitoring of power consumption for each individual wireless sensor node.
- Support for multiple operating systems and wireless sensor nodes.

MoteLab [4], Kansei [2], TWIST [3] and Indriya[1] WSN testbeds use wired back channel for programming wireless sensor nodes. Most of the existing low cost WSN testbeds i.e. Indriya and TWIST use active USB cables for programming wireless sensor nodes and data logging. The MoteLab testbed uses MIB-600 an ethernet port programmer for remote programming of wireless sensor nodes. Average deployment cost for each node in Indriya and TWIST is approximately US$158 [1] while this cost in MoteLab and Kansei is approximately US$548 [3]. The average cost per node in the TWIN Node with Zolertia Z1 sensor node is approximately US$200.

2 TWIN Node

The TWIN Node testbed uses Raspberry Pi as single board computer and Zolertia Z1 sensor nodes as main components of its initial setup. Communication between Zolertia Z1 sensor node and Raspberry Pi is carried out through normal USB cable and an isolation unit as shown in Figure 2. An Edimax WiFi adapter provides wireless connectivity to the Raspberry Pi. This wireless connectivity allows the user to program Z1 sensor nodes remotely. The Raspberry Pi used can be powered through any existing power sockets and does not require any additional infrastructural setup.

The Twin Node provides support for major operating systems in the WSN community, i.e. ContikiOS and TinyOS. The Raspberry Pi does not require the installation of a WSN OS. Source codes for different applications are compiled on the personal computer of the remote user, that generates a binary file. This locally generated binary file is then uploaded to the server that transfers them to the Raspberry Pi through WiFi. The Raspberry Pi uploads this binary file to the sensor node.

In most real world applications, wireless sensor nodes use battery power source while most testbeds power wireless sensor nodes through USB. Hence performance of a certain application cannot be properly imitated in such testbeds. The TWIN Node addresses this issue by providing multiple powering options. A wireless sensor node can either be powered through a battery or via the USB port from the Raspberry Pi. In order to measure true performance of the wireless sensor node over battery, it has to be completely isolated from the Raspberry Pi. Figure 2 shows the block diagram of the isolation system between the Raspberry Pi and Z1 sensor node. The "Data I/O Isolator" and "Switch 2" disconnect the data lines and power line respectively when Z1 sensor node is operating over battery. Similarly data lines and power line are connected for programming, data logging and USB power mode. In battery mode, the Raspberry Pi repeatedly monitors the battery of Z1 sensor node by connecting "Switch 1" to measure the voltage drop of the battery and thus derives the energy consumption.

Replacement of active USB cables with over the air (OTA) programming gives the TWIN Node flexibility for future enhancements without effecting the existing setup of the testbed. Hence, the TWIN Node solves multiple issues present in existing WSN testbeds with comparable deployment cost.

3 Future work

The number of nodes per single board computer will be increased in future to further reduce average cost per node in the testbed. The Twin Node will be deployed at multiple floors in NW1 building at the University of Bremen.

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