Project Acronym: MEDIS

Project Title: A Methodology for the Formation of Highly Qualified Engineers at Masters Level in the Design and Development of Advanced Industrial Informatics Systems

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Context

WP 2	Design of the AIISM-PBL methodology
WPLeader	Universitat Politècnica deValència (UPV)
Task 2.3	Development of the AIISM teaching resources - Mobile and Cloud Computing Platforms
Task Leader	MDU
Dependencies	UPV, MDU, TUSofia, USTUTT, UP

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History

Version	**Date**	**Author**	**Comments**
0.1	01/03/2014	Radu Dobrin and Sasikumar Punnekkat	Initial draft
1.0	19/09/2014		Final version

Table of Contents

1 Executive summary

WP 2.3 details the learning materials of the Advanced Industrial Informatics Specialization Modules (AIISM) related to the Mobile and Cloud Computing Platforms.

The contents of this package follows the guidelines presented in the MDU's documentation of the WP 1 (Mobile and Cloud Computing Platforms)

- The PBL methodology was presented in WP 1.1
- The list of the module's chapters and the temporal scheduling in WP 1.2
- The required human and material resources in WP 1.3
- The evaluation in WP 1.4

The rest of the document is organized as follows: Section 2 introduces the course and the outlines. Section 3 details the lectures, divided in subsections for each chapter. Section 4 describes the labs. There is a special subsection for each chapter. Section 5 gives an overview to the seminars. Each seminar has its own subsection. Finally section 7 lists the bibliography and the references.

2 Introduction

This document describes the first chapter of the MEDIS module that MDU is developing. The first chapter presents an introduction of the fundamentals of remote monitoring and control.

3 Lectures

This chapter will give an introduction to the fundamentals of remote monitoring and control of embedded systems as well as the liquid tank system, which will be used throughout the course. There will be 2 lectures covering this chapter, consisting of remote monitoring and control, and an introduction to the liquid tank system, as well as the communication between them through wireless technology according to the table below:

	Distance up to	**Data Rates up to**	**Frequency Ranges**	**Power Consumption**
WiFi [802.11]	70 m (802.11n)	248 Mb/s (802.11n 2x2 MIMO)	2.4 GHz 5 GHz	Medium
Bluetooh [802.15.1]	100 m (for Class 1 devices)	1 Mb/s	2.4 GHz	Low
ZigBee [802.15.4]	10 m	250 kb/s	868 MHz (Europe only) 902 MHz 2.4 GHz	Ultra Low
Bluetooth LE	100 m	1 Mb/s	2.4 GHz	Ultra Low
NFC	10 cm	424 kb/s	13.56 MHz	Low
WiMedia [802.15.3]	10 m	55 Mb/s	2.4 GHz	

Table 1

3.1.1 WLAN

WiFi [802.11]

– Extends the 802.3 functionalities to create wireless connections between 2 or more devices

- Frequency ranges: 900MHz, 2.4GHz, 5GHz
- WLAN standards:
    - 802.11/a
    - Frequency range: 5.7GHz
    - Modulation: OFDM
    - Bitrate: up to 54Mbs
    - Pros:
        - Fast
        - Less prone to the interference
    - Cons:
        - High cost
        - Short range (up to 35m)
- 802.11/b
    - Frequency range: 2.4GHz
    - Modulation: DSSS
    - Bitrate: up to 11Mbs
    - Pros:
        - Low cost
    - Cons:
        - Slow
- 802.11/g
    - Frequency range: 2.4GHz
    - Modulation: DSSS/OFDM
    - Bitrate: 11Mbs (DSSS)/54Mbs (OFDM)
    - Pros:
        - Fast
        - Good Range
        - Not easy to obstruct
    - Cons:
        - Prone to interference
- 802.11/n
    - Frequency range: 2.4 GHz / 5 GHz
    - Modulation: MIMO-OFDM
    - Bitrate: up to 248Mbs (2x2 MIMO)
    - Pros:

        - Very good data rate
        - Range improved
- Distributed Coordination Function
    - CSMA/CA (using RTS/CTS messages)
- Network Topology
    - BSS: simplest topology (star topology)
    - IBSS: independent BSS for ad-hoc connections
    - ESS: used when a single BSS is not able to cover the entire connectivity area. Allow 2 or more BSS to work together as a single entity.
- Security
    - WEP
    - WPA
        - Using TKIP/MIC
    - WPA2
        - Using AES/CCMP

3.1.2 WPAN

Bluetooth[802.15.1]

- 2.4 GHz, 1Mb/s, distance up to 100m
- Topology: master/slave (Piconet)
- Devices/Networks: 8
- Pros:
    - High data rate
    - Long distance
    - Available for various platforms
    - Simple and instant network setup
- Cons:
    - High duty cycle
    - Requires a fairly defined line-of-site because of its low penetration qualities.
    - More power consumes compared to ZigBee
    - Low security

ZigBee [802.15.4]

- 868MHz (only Europe), 902MHz, 2.4GHz
- Data Rates up to 250kb/s
- Very low costs

- Reliable data transfer
- Distance: 10m
- Topology: star or p2p
- Devices/Networks: 216
- Pros:
    - Low power consumption
    - Don’t need a good line-of-site
    - Supports large networks
- Cons:
    - Low data rates
    - Low interoperability

Bluetooth LE

- Low energy consumption, great efficiency
- 2.4GHz, 1Mbit/s
- Distance: up to 100 m
- Topology: master/slave (Piconet)
- Pros:
    - Low power consumption
    - Comparable to ZigBee
- Cons:
    - "New" technology (not yet spread)

WiMedia [802.15.3]

- 2.4GHz, from 11 to 55Mb/s
- QoS
- 802.15.3a: Data Rates up to 110Mb/s at 10m, and 480Mb/s at less distances
- Topology: master/slave (Piconet)

According to the Table 2 there are many opportunities to build a communication channel between different devices. Here the case of study is very important. If the main concern is low power consumption, then the 802.15.4 or the Bluetooth LE technologies are the best choice, but develop an application that makes use of them is more difficult (and so it takes a lot of time). The NFC standard could be the best choice if we have phisical access to the system we are going to control or monitor, because it has a short range of action. In order to develop a mobile application, the NFC technology is easier to configure than ZigBee or Bluetooth LE.

WiMedia could be used if the case of study requires an high data rate WPAN and at the same time QoS and real time constraints. It is ideally suited for a home multimedia wireless network. Finally, the use of 802.11 is the easiest way in order to build a mobile application: it has the best performance in terms of data rate but it has also the highest power- consumption and, moreover, the 802.11 IBSS topology is not supported in some mobile OS (i.e Android).

At the end of the lecture, the students will be able to:

- Understand the different kinds of architectures that can be used for remote monitoring and control, such as
  - Direct communication
  - Communication through a web based application using a client-server approach
- Explain the working principles of the liquid tank system
- Understand the principles interfacing the liquid tank to a PC or a microcontroller board equipped with communication modules

  The two lectures are currently under preparation, as it should also include the introduction to the course, grading and other formalities, prerequisites etc.

4 Lab

The first lecture will implement 2 main laboratories that follow the structure of the lectures.

In the first lab, the students are required to write a 2 page description of the parts of the water tank controller and explain how the components work. They should also be able to describe the controller in terms of its size and complexity and investigate methods to interface the wáter tank controller with mobile devices over a communication infrastructure based on WI-FI.

They are provided with a document that introduces them to the world of Android.

The second lab involves testing the wáter tank controller. In this lab the students are expected to get a clearer understanding of the controller and be able to think of interfacing it with Android. Consideration of how to represent the pressure, the temperature and other components of the model is a must. The ideas should be discussed during the seminar. The students should also start with the initial steps such as installing Android Studio.

The students are provided with a document that introduces them to the world of Android.

5 Seminar

In the seminar the students are expected to discuss the working of the water tank controller and its different aspects. They are also expected to discuss how to modify the water tank controller to e.g., randomly skip values transmitted through wifi to simulate a faulty scenario.

6 Miniproject

The students are expected to read about the use of a water tank controller system as an example of a typical control system. They are expected to hand in a two page report that describes its basic principles associated with control theory, along with some real world examples.

7 References

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