

A First Course in Wireless Networks and Telecommunication Systems

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Abstract

The telecommunications industry is rapidly implementing new technologies in order to provide high-bandwidth, high speed data transmission capabilities to the consumer. Wireless networks and telecommunication systems have recently shown rapid growth and these topics are now being introduced into the syllabus of Data Communications and Networking. This paper proposes a first course in Wireless Networks and Telecommunication systems. The paper examines the objectives and outcomes, methods for instruction and assessment strategies of such a course. An evaluation of such a course and future improvements to the course are then discussed.

1. Introduction

The study of computer networking concepts and administration is an essential part of the education of computer science and information systems students. Networking hardware and software are ever changing and new technologies are developed at a rapid rate. Wireless networks and telecommunication systems have recently taken the market by storm and these topics are now being introduced into the syllabus of Data Communication and Networking.

This paper describes a first course in Wireless Networks and Telecommunication Systems. The course is aimed at students in their final year undergraduate level, who have completed an introductory course in Data Communications and Networking. The course covers two basic wireless technologies, i.e. the wireless cellular technology and the technologies that produce wireless extensions to the wired IEEE 802.x data networks and wireless connectivity to the Internet. The paper firstly examines the objectives and outcomes of such a course. Methods for instruction and assessment strategies employed are then discussed. Finally, future improvements to the course are then discussed.

2. Course Objectives and Outcomes

The course described in this paper forms part of a B.Sc. degree in Computer Science. Students taking this course have completed an Introductory course in Data

Communications and Networking. The overall objectives of this course were defined as follows:

- Provide an introduction to Wireless Networks and Telecommunication Systems
- Examine the IEEE 802.11x technologies
- Examine Bluetooth technologies
- Examine the evolution and development of the Cellular Telephone System
- Examine the wireless network architecture and operations
- Examine the different cellular wireless network technologies.

Books by Barrett and King (2005), Mullett (2006) and Tanenbaum (2003) and papers on wireless networks and telecommunication systems were consulted when drawing up the syllabus for this course. A list of the overall syllabus follows:

Introduction

- Networking Standards and the OSI Model
- The Wireless Network
- Wireless LAN architecture
- Wireless Network Access Technologies

802.11x technologies

- Wi-Fi (802.11b)
- 802.11a
- 802.11g
- Infrared

Bluetooth technologies

- Aims of Bluetooth
- Applications of Bluetooth
- How Bluetooth works
- Creating a Piconet
- Creating a Scatternet
- Technical standards and performance levels
- Security

Evolution and Development of the Cellular Telephone System

- Different Generations of Wireless Cellular Networks
- 1G
- 2G
- 2.5G
- 3G
- 4G and beyond

Wireless network architecture and operations

- The Cellular concept
- Cell fundamentals
- Capacity Expansion Techniques
- Mobility Management
- Radio Resources and Power Management

Cellular wireless network technologies

- GSM
- TDMA
- CDMA
- GPRS and EDGE
- Evolution of GSM to 3G

The course also consisted of a practical component, where different aspects of Wireless Networks and Telecommunication Systems were tested. The aims of the practical component were to:

- Experiment with Bluetooth devices.
- Examine how Java MIDlets are created.
- Examine how WML and WML scripting works.

The practical components consisted of 6 practical sessions, one every second week. The duration of the course was one semester. The following section describes the teaching and assessment methods employed in order to attain the objectives of the course.

3. Methods of Instruction and Assessment

The course was aimed at assisting students to develop an understanding of wireless networks and telecommunication systems, focusing on the 802.11x technologies, Bluetooth technologies, and the Cellular Telephone System. The course was delivered over 13 weeks, with three lectures of forty-five minutes each week. The practical component was aimed at experimenting the exchanging of information using different wireless technologies. Practical sessions were run on a bi-weekly basis, with 6 sessions over the 13 weeks.

Practical assignments, theory tests and a three-hour examination were used to assess whether the students had acquired the necessary skills issued during the course. The practical assignments involve testing the Java-Bluetooth API, writing simple Java MIDlets, as well as writing WML and WML script code. The aim of the first assignment was to test the Bluetooth technology, using a few Bluetooth devices. The main aim of the second assignment was to investigate how Bluetooth worked, by studying the Java-Bluetooth API.

The third assignment focused on studying several Java MIDlet programs. This enabled the students to gain a better understanding of how Java MIDlet programs were written, and how a MIDlet operates on a Cellular device. The fourth assignment was to test the students understanding of the Java MIDlet, where students were asked to write a simple Java MIDlet program. The fifth and sixth assignment gave the students an understanding of how WML (wireless markup language) worked, and how WML scripting was used.

The two theory tests and the three-hour examination at the end of the semester assessed the students understanding of the material covered in the course, as well as their understanding of the practical component of the course. Examples of questions used in the tests and examination are listed in Figure 1.

Example 1

For each of the following standards, list their frequency range, maximum theoretical throughput and geographical range:

- Wi-Fi
- 802.11a
- Bluetooth version 2.0

Example 2

Explain what a scatternet is and how it is created.

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Example 3

Consider the following Java MIDlet code:

```
String[] stringArray = {
    "Exclusive",
    "Implicit",
    "Multiple"
};
mainList = new List("Choose type", Choice.IMPLICIT, stringArray,
    imageArray);
mainList.addCommand(CMD_EXIT);
mainList.setCommandListener(this);
display.setCurrent(mainList);
```

What will be displayed on the screen when this code is executed?

Figure 1: Example questions used for assessment

4. Course Evaluation

The course was evaluated by observing students during lectures and by interviews conducted with students at the end of the course. Students showed a great interest in the different technologies presented during the course, as most of these technologies were being used by the students in daily life, i.e. cellular technology and Bluetooth. Most of the students interviewed indicated that the course was very informative and that they gained a better understanding of the technology that they used every day. The students seemed to enjoy the practical sessions. Some comments made on the overall course included:

- “Now I know how my cell phone works.”
- “Subject was very interesting and very well presented.”
- “I loved the practical sessions. Now I can try making my own Java MIDlets for my cellular phone.”

5. Conclusion

This paper describes a first course in wireless networks and telecommunication systems, which forms part of the curriculum for a B.Sc. degree in Computer Science. The methods of instruction and assessment used in obtaining the objectives of the course were presented. All enrolled students successfully completed the course.

Future extensions to the course could include a study on broadband wireless technologies, including broadband satellite and microwave systems. Emerging wireless technologies could also be incorporated.

Reference:

Barrett, D., King, T. (2005). *Computer Networking illuminated*. USA: Jones and Bartlett Publishers.

Mullett, G. J. (2006). *Wireless Telecommunications Systems and Networks*. Canada: Thomson Delmar Learning.

Tanenbaum, A. S. (2003), *Computer Networks, Fourth Edition*. New Jersey: Pearson Education. Inc.