

Wireless Communications and Networking Course: Does It Belong in the I. S. Curricula?

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Abstract

It is customary that most I.S. related degree programs include a course in data communications and networking. However, it is unusual to find a course in wireless communications. A course in wireless communications and networking should be considered to be a part of the I.S. and I.T. academic curricula. The purpose of this paper is to identify the relevance of wireless communications and examine the topics and the challenges associated with teaching wireless communications courses.

Keywords: Wireless communications, wireless networking, wireless LANs, curriculum development, data communications.

1. INTRODUCTION

Two decades ago, data communications and networking courses were not included in most Information Technology (I.T.) or Information Systems (I.S.) curricula. However, at the present time, data communications and networking courses can be found as part of most I.T. and I.S. curricula. The relevancy and the importance of teaching data communications concepts are very well documented. Data communications and networking courses can be found in most I.T. curricula. In the past decade or so, that was not the case. In the existing traditional data communications and networking courses a section with limited materials on the topic of *wireless communications can be found*.

To assess and ascertain how wireless communications and networking topics are viewed and taught by academic institutions that offer academic programs in information technology related areas, a review of over forty academic institutions was conducted.

A review of the selected academic institutions yielded that a small number of institutions offer a course in wireless communications and networking. These

institutions offered a wireless course as apart of engraining related degrees, area of specialization or a part of telecommunications program, but not as a part of an I.S. related program. This finding is consistent with the view of how a data communications and networking course was viewed in the past.

While the review is brief and lacked the depth and detailed analysis to make a definitive conclusion, it revealed that a course in the area of wireless communications and networking is not widely included in the curricula. Also, wireless communications and networking was offered in limited cases as an elective course. Reviewing the recent and most contemporary literature on the subject suggests that a wireless communications and networking course is essential, relevant and beneficial to students. An exposure and familiarity of wireless communications and networking concepts provide new I.T. graduates with much needed knowledge that can ameliorate their skills and help them be more competitive in the job market. As we all can attest, a consensus of opinion is very rare among information technology professionals and practitioners. Each one has his/her own opinion on which is the best hardware, software or computing platforms. However,

the one thing that most if not all information technology professionals and practitioners do agree on, is the relevancy, the importance of wireless communications and technology and the tremendous impact it will have on the field of information technology.

The widespread reliance on networking in business, and the rapid growth of the Internet and online services are strong evidence and indicators of the increased relevance and importance of wireless communications and networking. Without a doubt, the proliferation of the Internet has caused wireless communications and networking to gain significant prominence and popularity in businesses and among individuals. The changes, the applications of, and the breakthrough in technology have made wireless communications and networking secure its own discipline over the past decade. From cellular voice telephony to wireless access to the Internet and wireless home networking, wireless networks have profound impact on business enterprise, individuals' life styles, and society. Therefore, a conclusion can be reached to support a stand-alone course in wireless communications and networking as relevant and appropriate to be included in the curriculum.

2. BACKGROUND

Wireless communications is not a new technology; it has been around for at least 100 years. The early part of wireless communications can be found in the form of radio, which involved inducing a remote electrical current to a remote location via the propagation of the electromagnetic wave through space with the intent of communicating information.

It is very apparent that wireless communications and networking has emerged as its own discipline over the past decade. From cellular voice telephony, to wireless access to the Internet and wireless home networking, wireless networks have profoundly impacted the lifestyle. After a decade of exponential growth, today's wireless industry is one of the largest industries in the world.

The term *wireless* is used to describe all types of devices and technologies that are not connected by a wire. A garage door opener, a television remote control, a portable telephone, and a pager all can be called "wireless," since these devices do not have wires, but that is the extent of what they share in common. Because the term wireless today is sometimes used to refer to any device that has no wires, users tend to be puzzled about the exact meaning of wireless communications. Therefore it is important to establish a common definition that accurately defines wireless communications. Wireless communications can be defined as the transmission of

user data without the use of wires. "User data" may include e-mail messages, spreadsheets, and telephone voice messages. The early focus of wireless communications was on analog cellular systems. It is important to recognize that the complexity of wireless networks resides in the design of air-interface and support of mobility, which is not a significant issue in wired networks.

In the recent past, voice-oriented wireless networks have been the central focus of wireless systems. The third generation (3G) wide area cellular systems are designed to support several hundreds of kbps with comprehensive coverage and up to 2 Mbps for local selected zones. Even before the emergence of 3G services, mobile data networks such as the general packet radio service (GPRS) over TDMA systems and high-speed packet data over CDMA systems were becoming increasingly popular. At the same time, after the introduction of Bluetooth technology in 1998, local broadband and ad hoc wireless networks have attracted tremendous attention. This sector of the wireless networking industry includes the traditional wireless local area networks (WLANs) and the emerging wireless personal area networks (WPANs). Wireless broadband and ad hoc networking is expected to create a revolution in the future of Internet access, home networking, and wireless consumer products. While there is a plurality of standards and a differentiation between voice and data networks, the essential aspects of wireless systems remain the same.

3. WHY WIRELESS

The changes and advances in wireless technology have made adopting such technology very practical and cost effective. Examining the global marketplace, organizations of every size, from every industry, we found that they all are looking to extend their businesses into the wireless world. The ability to offer remote access to information and transaction-based systems via wireless handheld devices is rapidly becoming commonplace and cost effective.

The widespread reliance on information technology in businesses, the tremendous growth of the Internet, and on-line services are strong indications of the significance and the importance of wireless systems. Wireless communications and systems present significant opportunities and advantages that wired systems may not provide. This makes it very appealing and effective to use wireless systems. Wireless systems provide mobility and access to real time information anywhere and any time. This mobility supports business efforts to enhance productivity and service. The cost of installing and maintaining wireless systems is very effective. Wireless systems eliminate the need to pull cable through walls and ceilings. It also provides a high

level of flexibility. While wireless systems may require a larger initial investment in hardware than wired systems, the overall installation cost, maintenance expenses and life cycle is significantly less expensive. Long term cost benefits are greatest in dynamic environments requiring frequent moves and changes. Scalability of wireless systems is very effective. Wireless systems can be configured in a variety of models to meet a specific application or installation.

4. COURSE PURPOSE AND CONTENT

The major goal and purpose of the course should be to provide students with detailed knowledge, a solid foundation, and in-depth exposure to the principles and concepts of wireless communications and networking and other related security, legal and ethical implications. Included in these are wireless technology, applications, hardware, networking, security and legal implications of wireless communications. Students should have the opportunity to learn alternatives to wired communications systems and the issues that relate to migrating or implementing wireless systems. Students who complete this course should have knowledge of the theoretical and practical foundations of wireless systems. The course should also provide students with the experience to be able to differentiate between wireless communications systems and other types of communications. Also, the course should provide students with hand-on experience in setting-up, managing and maintaining wireless systems or networks.

The structure and sequence of material for this course should have a significant influence on students' understanding of the subject. Selecting the appropriate mix of topics to be included in any course is always a challenging task. Attempting to identify the appropriate topics to be included in a wireless communications and networking course is no exception. The content and the topic of the course should be carefully selected with the target audience (the students) in mind. The brief review that was conducted of the institutions that offer courses in wireless communications revealed that those courses are targeted toward students who are majoring in electrical, electronics or computer engineering. A review of the content of these courses indicated that these courses are very technical in nature, engineering and theory oriented. These courses lacked focus on applications, hardware, and other implications of wireless systems.

Examining the curriculum guidelines that were recently published by several professional associations indicated that there is no specific recommendation for a stand-alone course or curricula in the area of wireless communications and networking. However, the recommendations included a course in traditional data communications concepts. Reviewing the knowledge areas of the traditional data communications concepts course revealed that it includes a section on wireless communications.

Since the curriculum guidelines did not provide adequate general topical content for the course, another source needed to be identified. A meaningful and appropriate source used to identify and determine the content of a wireless communications and networking course were recently published books and reviews of the contemporary literatures in the field.

A review and examination of several recently published books in the field revealed that these books have different orientations. However, it was apparent that most of the reviewed books included similar topics notwithstanding the focus of the book. The titles of these books varied from emphasis on a survey of wireless or mobile communications and wireless networking, to designs of wireless systems. The reviewed books are: Wireless Communications and Networks by Stallings, Guide to Designing and Implementing Wireless LANs by Ciampa, Wireless Networks: The Definitive Guide by O'Reilly Networking, Wireless Communications: Principles and Practice by Rappaport, The Essential Guide to the Business of U.S. Mobile Wireless Communications by Burnham, The Essential Guide to Wireless Communications Applications by Dornan and Dornan, and Building Wireless Community Networks, by Flickenger.

Providing an overall organization for understanding both legacy voice-oriented and emerging data-oriented wireless networks for a diverse audience of students who need to understand this industry is very challenging. An in-depth presentation of specific topics related to the air-interface, such as channel modeling or modem design, will lead to losing the overall systems-engineering perception. Avoiding the details of air-interface, there will be no wireless content, as this forms the core of the difference between wireless and wired networks. While the selection of a specific book for the course will influence how the course in wireless communications will be presented, it should not be the only source or approach to presenting the course topics.

The approach to select the appropriate topics should not be driven by the selected book; rather, it should be a balanced approach between theory and practice. The approach to selecting the topics should be

striking a balance between intuitive understanding of the wireless medium and detailed aspects of the system. The topics of the course should be divided into four major categories: (1) technical background and overview, (2) wireless communications technology, (3) wireless networks, and (4) security and legal implications of wireless systems and networking.

The first category should include overview, comparative evaluation, transmission fundamentals, and logical classification of important standards. The second category should cover a detailed description of important wireless systems. It should also include topics such as antennas, propagation, signals, spread spectrum, coding, and error control. The third category should focus on the explanation of principles of design and analysis of wireless networks. It should also include topics such as satellite communications, cellular transmission, cordless systems, wireless local loop, mobile IP, and wireless access protocol. The last category should cover topics such as security, licensing issues, government regulations, and ethical and legal issues that may arise from wireless communications.

5. TECHNOLOGY RESOURCES

The Laboratory component is considered an essential component of this course. At minimum, a wireless local area networking lab should be utilized. The lab will provide students with the opportunity to have hands-on experience in installing and configuring wireless LANs utilizing different hardware devices.

Wireless LANs use electromagnetic airwaves (radio or infrared) to communicate information from one point to another without relying on any physical connection. In a typical wireless LAN configuration, a transmitter/receiver (transceiver) device, called an access point, connects to the wired network from a fixed location using standard cabling. At a minimum, the access point receives, buffers, and transmits data between the wireless LAN and the wired network infrastructure. A single access point can support a small group of machines and can function within a range of less than one hundred to several hundred feet. The access point (or the antenna attached to the access point) is usually mounted high but may be mounted essentially anywhere that is practical as long as the desired radio coverage is obtained. Wireless LAN laboratories can be simple or complex. However, the level of complexity, the number of hardware devices, and the lab configurations will depend on issues such as cost, spaces, and expertise. Figure 1, below presents a typical wireless LAN configuration.

6. CONCLUSION.

It is apparent that there is a major difference between the traditional data communications course and a wireless communications course. Requiring a course in wireless communications as a part of I.S or I.T. will present a challenge to I.S. educators. However, the importance, the relevance, and the significance of such a course is very obvious. Institutions selecting the appropriate mix of topics will present faculty who teach the course both a challenge and an opportunity. The challenge of teaching a course in wireless communications is to find the appropriate mix of topics meeting the focus and the orientation of the curriculum. The opportunity is to provide students with the needed experience and exposure to be more competitive in the job market. The proliferation of the Internet and the on-line services makes it imperative for students to be exposed to and to be familiar with wireless communications and networking.

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