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Design of a wireless intranet in the lab for enhancement of online teaching

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Abstract

The main purpose of this paper is to present the design and implementation of a wireless network system combined with the pre-existing wired intranet for use in both education and research in geomechanics and engineering mechanics. Applications using such a combined system include online learning or teaching, remote data transferring from triaxial devices, numerical simulations, and modeling. The wireless network will extend the reach of laboratory facilities, add convenience, and integrate with the wired network. In the present paper, the design of the wireless networking system is discussed from two perspectives: 1) the hardware necessary in wireless networking, 2) the software necessary in wireless networking. An effort is made in this paper to illustrate the utility of a wireless network in teaching engineering. It is clear that this convenient and powerful implement will aid teaching, research, as well as learning Geomechanics or Engineering Mechanics by removing previously restrictive boundaries of physically linked networks.

I. Introduction

With the advancement of computer technologies, the personal computer has become integrated into nearly ever aspect of our lives. This great surge in acceptance is due, in part, to the rapid progress in computational power, to the continuing miniaturization of electrical components, along with corresponding drops in prices. By incorporating computers into our lives, we have felt significant impact in the way we educate our children, communicate with each other, conduct business, and live our lives. Education is one field that has benefited the most from the modern computer revolution (1-8). This is evident in the exposure of students to the prevalent technology when compared to the general public. In the current Information Age, 83% of students have ventured onto the Internet. This is a significant figure, especially given that only 56% of the general public has been acquainted with the World Wide Web. Newly devised wireless protocols will take advantage of radio waves, which reduce our dependence on traditional physical media

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such as copper wiring. In achieving this newfound freedom, we can expand on our current networks where wired infrastructures are difficult to create or unrealistic to alter. Additionally, we can take networking to places where installing new copper wires or fiber optic wires for every connection is not plausible (e.g., a wired connection in a lecture hall would be prohibitive due to the numerous connections necessary). We have already witnessed the beneficial effect of wired networks in our schools; imagine what added freedom of wireless networking can produce. The increased flexibility in time, space, and other resources produced by such networks can only grow with the incorporation of wireless technology. Wireless networks will push computer networking to new heights by reducing clutter, increasing convenience, and increasing productivity in the research lab and in the classroom (Figures 3 and 4).

In this paper, the design and implementation of a wireless network in conjunction to a wired network are presented. At the School of Engineering, Morgan State University, this is a part of an ongoing effort to extend the ability for students and faculty members to communicate outside of resource and time limitations presented by lectures schedules and office hours. This is obviously beneficial to both parties involved. The teacher is able to better educate his or her students, while the student is better equipped to learn material presented by the educator. Like many other institutions such American University, University of California at San Diego, and University of Minnesota, Morgan State University (MSU) has recognized the importance of wireless networks and have integrated wireless networks into their campus-wide networks. School of Engineering at MSU has set up the wireless network that allow engineering students to access online courses conveniently via the wireless intranet for learning. The implementation of such a wireless network system is both affordable and practical, making it a viable option for both students and faculty members to gain access to the many computer-based data acquisition systems and portable laboratories utilized in Engineering Mechanics or Geomechanics fields.

The most important issue to consider when adopting new technology, such as a wireless network, is that of feasibility. When computing technology specifically is concerned, the main foci are on practicality and potential utilization. An impractical technology may be interesting but may not provide the utility that meets the needs of the users. Utilization is key also in determining the success of a technology. In wireless networking we find both a practical technology with a high potential for usage. The cost effectiveness and overall benefits of a wireless network will make this technology a staple for educational facilities in the future.

II. Hardware Requirements of the Wireless Network

Wireless network topography is similar to that of a wired network. In fact, the standards for communication in a wireless network are closely related to the communication protocols of a wired network. The most widely used wireless networking protocol is the international standard outlined in IEEE 802.11b. Due to the great similarities, the hardware components that are required to complete a wireless network closely parallel those necessary for the more familiar wired network. Wireless access points represent nodes that connect computers and compose the essence of a wireless network. Access points found on a wireless network may spawn from a wired connection to the greater network structure. This means that the access points themselves

may be physically connected to the wired network. The wired network counterpart is the hub, router, or switch. Like its counterpart, the access point serves to transmit, receive, and condition signals to and from various computers. The information may also be routed to a larger network infrastructure such as the Internet. A variety of wireless networking kits can be purchased at electronics stores as shown in Figure 2.

The client side hardware for the user requires a modest change to accommodate a wireless network. Instead of a physically connected Ethernet card, a wireless network card is required. A wireless Ethernet card is equipped with an internal or external antenna capable of transmission and reception with wireless access points within signal range. Many brands of commercial PC Card wireless cards for laptops are available. These cards fit in the PC Card slots that all new laptop computers are equipped with. Some manufacturers even include the wireless access hardware as a built-in feature in higher priced product models. Wireless networking on a laptop compliments the concept of portability by enabling computers and providing them with even greater roaming value and usefulness. Desktop computers can also participate in wireless networks. Often times, certain physical limitations may prohibit the use of a wired solution. Wireless networks are very simple, clutter free, and cost effective ways of overcoming such physical limitations. Commercial wireless solutions are also available for desktop computers. Hardware solutions for laptop computers and desktop computers can be found at an affordable price in any computer electronics store as seen in Table 1.

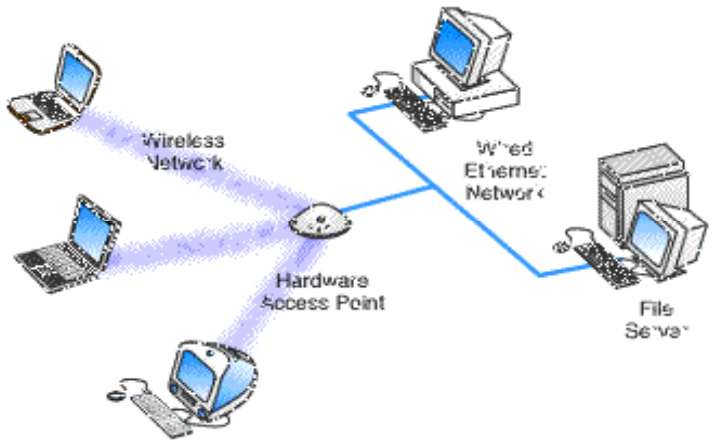

Figure 1. Combined wired and wireless network topology

Wireless Network Hardware Items	Retail Price
Linksys 2.4GHz Instant Wireless Access Point	$129.99
Linksys 2.4GHz Instant Wireless Notebook Card	$69.99
Linksys 2.4GHz Instant Wireless Desktop Card	$79.99

Table 1. Pricing for 802.11b compliant wireless networking hardware

Figure 2. Wireless access point, external USB wireless network card, and laptop PC wireless card for a wireless network (clockwise from top)

III. Software Requirements of the Wireless Network

As is the case for most computer technologies, there are software applications to manage the corresponding hardware components. In the case of wireless networking, the software is targeted toward the connection management and information flow between the computer and the rest of the network (i.e., through wireless access point). In most scenarios, the software is already available or even installed. If not pre-installed, management software can be installed in minutes.

As with hardware, there are two sides to software requirements: network and server requirements versus client software requirements. Server software such as UNIX, LINUX, Windows 2000 Server, and Windows NT Server operating systems already support the standard wireless networking protocol. Management software on the servers to configure and maintain the wireless appliances is easy to setup, especially when applied on a small scale (i.e., a research laboratory or a classroom). Once completely, no more intervention (other than routine maintenance) is required.

Client software requirements are simple as well. Computer operating systems such as Windows 9X, ME, 2000, and XP, Macintosh OSs, UNIX, and LINUX are all capable of wireless network accessibility. Additionally software installation will likely consist of installing driver components packaged with the hardware, configuration, and installing network management software on the server. In many managed networks situations such as educational institutions, the software changes for the client installation may be completely transparent to the user.

Figure 3. Geomechanics research lab at the Department of Civil Engineering utilizing a wireless network combined with a wired intranet

Figure 4. Online resources available over a wireless network to students and faculty members at the School of Engineering, Morgan State University

IV Applications of the Wireless Intranet at the Geotechnical Laboratory

Currently the designed wireless intranet is used for the following applications:

1. Online teaching or learning using materials available at the learning center. Engineering students, especially for those having notebooks, now can access the online learning center for teaching and learning materials. The online materials include online courses (more than thirty online graduate courses and three undergraduate courses), online seminars, online galleries, online presentations and online publications. Students can also conduct the online project using provided online software via this wireless network, such as online modeling, numerical simulation, analysis, etc.
2. Data transferring within the Lab for shear testing. The Geotechnical Laboratory is equipped with three multiple axes shear devices such as static triaxial shear device, dynamic triaxial device and soil resonant column. These not wired testing machine are used frequently for research projects and teaching in Geomechanics and Geotechnical Engineering. Using such wireless network, significant amount of shear testing data (5MB – 20MB) from these devices are now conveniently transferred to powerful workstations for further data processing and modeling.
3. Data exchanging and transferring for other applications. The data transferring and exchanging between independent workstations and wired intranet can be conducted for numerical simulation and modeling as well as other applications such as GIS applications in the laboratory. The powerful workstations are normally used for high performance of computation and image processing that cope with huge amount of data transferring.

V. Summary and Conclusion

In the present paper, a wireless network design and implementation used for the online teaching of engineering courses were discussed. The wireless network utilizes hardware and software that are readily available and are also affordable. The wireless network is able to accentuate the freedom that modern technology has provided to the students and teachers in engineering courses. Wireless networking alone offers new answers where wired networks fail. The largest problem facing wired networks is the physical limitations of the carrying media. Laying down cable is often impossible or undesirable due to building limitations. However, radio waves employed in wireless networking do not have such limitations as it bounces off walls. The result is a reliable network minus the annoyances of physical cabling. The portable computer systems frequently used in both the classroom and the research lab can take advantage of a wireless network by extending the capabilities of a single computer. Roaming freedom no longer comes at the expense of networking capabilities. This allows students to reach online teaching resources such as course web sites, educational sites, online modeling and simulations for teaching engineering, and other online informational databases from anywhere on campus without having to sacrifice portability.

The demand for a wireless network is undeniable. However, it offers even greater appeal when integrated with an established physical network infrastructure. Personal laboratories become more wide-reaching and laboratory equipment become more readily accessible from anywhere

within range of the wireless network. Using wireless networks, data acquisition can be completed while across campus and data analysis can be computed using networked computer resources. These liberties afforded to students, teachers, and researchers are invaluable. With universities recognizing the full utility of the personal computer and the greater potential of networked computers, the added independence of wireless networking is more desirable than ever before. Such wireless networks will serve to enhance our already existent information infrastructure to support online teaching in engineering.

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