Wireless Networking at Indiana University

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EDUCAUSE is a nonprofit association whose mission is to advance higher education by promoting the intelligent use of information technology.

The mission of the EDUCAUSE Center for Applied Research is to foster better decision making by conducting and disseminating research and analysis about the role and implications of information technology in higher education. ECAR will systematically address many of the challenges brought more sharply into focus by information technologies.

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Preface

The EDUCAUSE Center for Applied Research (ECAR) produces research to promote effective decisions regarding the selection, development, deployment, management, socialization, and use of information technology (IT) in higher education. ECAR research includes research bulletins, short summary analyses of key IT issues; research studies, in-depth applied research on complex and consequential technologies and practices; and case studies designed to exemplify important themes, trends, and experiences in the management of IT investments and activities.

ECAR has investigated the state of wireless networking in higher education and has issued “Wireless Networking in Higher Education.” This research was undertaken in three phases:

- an online survey of 391 EDUCAUSE members to establish the state of wireless networking in higher education and to understand its implementation characteristics;
- follow-up, in-depth telephone and on-site interviews, covering 17 selected institutions, with IT personnel and university members who are directly involved with the creation, operation, or use of wireless networks; and
- best practices cases studies with six higher education institutions about their wireless network implementations.

Between March and May 2002, ECAR and IDC began with a list of approximately 150 colleges and universities that had experience implementing wireless networks. From this list, 20 were interviewed extensively by telephone, and six were selected for either on-site visits or extensive telephone follow-up. On-site visits are rigorous and involve nearly two days of interviews and meetings with the widest variety of institutional representatives associated with—or affected by—the technologies or practices being investigated.

This case study was undertaken to draw on the direct experience of others to provide insights into what has—and, as appropriate, what hasn’t—worked in wireless implementations. It is assumed that readers of the case studies will also read the main report, which incorporates the findings of the case studies within the generalized context of the report.

ECAR wishes to thank the leadership of Indiana University for their time, assistance, and diligence in support of this research. We hope readers of this ECAR case study will learn from their experiences.
Introduction

Indiana University (IU) has eight campus locations; the largest are in Bloomington (IUB), Indianapolis (IUPUI), and Fort Wayne. The university offers four-year programs, advanced degree programs (professional, master’s and master’s degree equivalents, and doctoral), and associate’s and certificate degree programs. For the fall semester 2000–2001, IU’s all-campus enrollment was 93,775 students (graduate and undergraduate). With an annual operating budget of approximately $2.1 billion, IU employs 4,230 full-time and 1,901 part-time faculty and approximately 10,500 appointed staff. Established in 1820 in Bloomington, Indiana, IU boasts 116 academic programs ranked in the nation’s top 20.

IU’s central IT organization, UITS, is headed by Dr. Michael A. McRobbie, vice president for information technology. The UITS comprises four divisions:

- **Teaching and Learning Information Technologies** (TLIT) provides support services to faculty, students, staff, and computing support professionals on the IUPUI and IUB campuses. TLIT’s resources include student computing labs and the Knowledge Base FAQ database. A key mandate for the division is to partner with faculty in integrating technology into their teaching practices. Within the UITS organization, wireless has been the domain of the TLIT division.

- **Telecommunications** is responsible for the development and evolution of IU’s voice, data, and video communications infrastructure and devices.

- **University Information Systems** (UIS) develops, implements, and manages the enterprise information systems that support IU’s core business processes (including student, financial, human resources, procurement, facilities, research administration, instructional, library, and other systems). UIS also manages the computing infrastructure supporting these information systems.

- **Research and Academic Computing** (RAC) provides computing facilities, visualization facilities, support, and services for IU’s research community, including faculty researchers, clinicians, engineers, artists, and students.

Within the UITS organization, the Information Technology Policy Office (ITPO) coordinates the development, review, and management of policies for a wide array of IT issues. IT security issues are addressed by the Information Technology Security Office (ITSO), which is closely aligned with ITPO. According to its mission statement, ITSO is mandated “to provide proactive security analysis, development, education, and guidance related to Indiana University’s information asset and information technology environment. The overall objective is a safe and secure atmosphere for teaching and learning, research, service, and the conduct of university business.”

On the university’s Bloomington campus, most buildings are connected to the campus backbone using Ethernet data communications equipment and fiber-optic cabling (see Figure 1). Most connections are either Fast Ethernet (100 Mbps) or Gigabit Ethernet (1,000 Mbps). In the few, remote instances where campus fiber isn’t available, buildings are connected at a variety of speeds, depending on the applications at those places. Speeds range from T1 (1.54 Mbps) to DS3 (45 Mbps), with some locations using full 1-Gbps connections.
**Drivers of IU’s Wireless Deployment**

IU’s wireless network began with a series of pilot programs conducted at its Bloomington and Indianapolis campuses. The initial thrust of the wireless program was to provide coverage in common areas (meeting locations and student areas) as well as in classrooms. The most important driver behind IU’s wireless initiative was its “Information Technology Strategic Plan,” published in May 1998, which called for a converged telecom and networking infrastructure across the campus. In the context of the plan, wireless is seen as contributing to UITS’s broader strategic goal of creating a world-class infrastructure for teaching, learning, and research.

**Planning and Funding**

IU’s long-term wireless plan is driven by two basic principles that serve as the foundation for the institution’s overall IT planning. The first is that a wireless infrastructure is an integral part of its strategy of establishing itself in the top tier of institutions of public higher education. This entails the “creative use and application of information technology,” focusing specifically on “the design, development, and application of information technology in support of teaching and learning, research, service, and the conduct of university business.” The second principle is that funding for technology in general (and wireless in particular) must be done in a way that recognizes the full cost of technology, including ongoing replacement and support.
While the first principle firmly establishes wireless within IU’s overall technology plan, the second has implications for the eventual scope and timing of the infrastructure build-out. According to Brian Voss, associate vice president for telecommunications, the key to funding initiatives like wireless is to look at budgeting from a life-cycle perspective and to budget in the funding to maintain and upgrade the system.

“If we took the approach of using grant money to fund wireless, we’d probably be able to establish nearly ubiquitous coverage on campus,” said Voss, “but we would still be in a situation where we would be dependent on ‘miracle money’ (money left over in the budget) to maintain and upgrade the infrastructure as it ages and applications become more bandwidth intensive. In general, counting on future miracles is a bad strategy for funding over the long term.”

IU’s present approach to general technology funding shows how the process would likely proceed for wireless. The basic approach to establishing technology budgets involves collaboration between UITS and individual IU departments designed to flesh out the overall cost of an initiative over its projected life cycle. Once a cost has been established, UITS provides departments with a matching grant such that the cost is roughly split between individual departments and UITS.

Role and Policies of UITS

The broader role of UITS in wireless planning has been to guide departments in wireless technology acquisition. As Voss noted, the most important aim of these guidelines is to ensure that departments choose products and solutions that adhere to IU’s prevailing IT infrastructure standards. “The criteria we establish for departments is that the wireless technology is robust, reliable, and fits within our overall environment,” said Voss. “We essentially provide them with the checklist, but they are responsible for the procurement of the technology.” An example of the kinds of issues addressed by these recommendations is the appropriateness of frequency hopping versus direct sequencing in wireless infrastructure equipment, given IU’s security requirements.

While individual IU departments can sponsor wireless initiatives, wireless nonetheless remains under the policy jurisdiction of UITS. Following are examples of key policy statements issued by UITS:

- Wireless technology is not suitable for all locations and applications and is certainly not a strategic replacement for a wired infrastructure. An exception is deployment in places where fixed wiring is not an option because of building configuration, age, or location—that is, where installing traditional wiring is either not possible or not practical.
- UITS will manage all wireless hubs, except those that are mobile, temporary, or serially connected.
- All UITS-managed wireless hubs will be connected via the VPN-secured system, unless a specific exception is granted by the University Information Technology Policy Office.
- UITS will make a site visit to assist departmental staff in determining the optimal location of equipment. Where possible, hubs installed by departments must use IU’s central, VPN-secured system. Departments must contact the UITS Network Operations Center to have their wireless networks added to the VPN-secured system.
- If equipment installed by a department interferes with the wireless network maintained for the university by UITS, the configuration of that equipment will have to be changed to eliminate the conflict, or it will have to be removed.
Wireless Deployment Issues

Evolving standards, selection of areas for deployment, and the extent and type of wireless use were among the key issues requiring consideration.

Technology and Standards Selection

When IU began piloting wireless in 2000, the issue of wireless standards was not of immediate importance, given that the IEEE 802.11b standard represented the only major option at the time. However, with the impending availability of 802.11a and 802.11g, the issue of wireless standards has gained prominence. The university is almost certainly moving in the direction of 802.11a, with the key driver being improved bandwidth. However, as Voss explained, its general “newness” acts as a gating factor. “We will deploy 802.11a when we feel it has matured enough to be reliable, and the costs are such that we can reasonably replace the equipment on a standard three- or four-year life cycle.”

One factor that may accelerate 802.11a deployment is an interest within certain departments in moving more quickly toward its adoption. To ensure standardization, UITS acknowledges that it may be compelled to identify an 802.11a-compliant product earlier than it had originally planned.

Scope and Focus of Wireless Deployment

In the first phase of deployment, IU deployed wireless in “islands” across its campuses, largely because of its goal of providing the most coverage with the least amount of funding. The locations of these islands—a mixture of academic classrooms, meeting places, and student gathering areas—were influenced by individual departments, which also provided funding. On IU’s Bloomington campus, wireless is deployed in the following locations:

- Kelley School of Business
- Carmichael Center
- Creative Arts Building
- Law School
- Lilly Library
- Indiana Memorial Union
- Main Library
- Spea Library
- UITS

The Kelley School of Business was one of the earliest adopters of wireless on the Bloomington campus. One key to the success of this deployment was the mandated ownership of laptops for graduate business students, which encouraged adoption by providing a proportionately larger pool of potential wireless laptop users. Another was the high level of importance graduate business students attached to mobility—specifically the ability to move from room to room without having to unplug. The fact that many (if not most) graduate business students choose to use their wireless connections even when ample wired connections are available signifies how embedded wireless has become in their everyday collaboration.

Deployment of wireless in common areas was an especially important part of IU’s initial roll-out plan. The two most important such areas were the Indiana Memorial Union (where wireless is now fully deployed) and the main library. The goal of the library deployment was to provide greater mobility for students and researchers.

Primary Applications

For the university as a whole, Web browsing and messaging represent the dominant wireless applications. While there are relatively few examples of departments using wireless for highly specific applications, the Computer Science Department has been relatively aggressive in using wireless for collaboration and ex-
expanding access to its server resources. Similarly, the UITS organization uses wireless in the course of everyday departmental activities, explained Voss, a frequent user of wireless himself. “Wireless has been an indispensable tool in department meetings because it allows our staff to access and alter reports in real time,” he said. “This increases the overall productivity of the department.”

**Architecture and Security Profile**

IU’s wireless implementation employs a mix of Lucent 500 and 1,000 and Cisco Aironet wireless access points. The location of each access point was determined by a series of site studies conducted by UITS. During its site surveys, UITS determined the location and number of access points required to provide a given area with a throughput of at least 2 Mbps. For sites with a heightened probability of airwave congestion, UITS used dual-transmitter access points to double the number of simultaneous users.

IU’s wireless architecture places all users on a single subnet, with a net mask that supports 1,024 users. When simultaneous usage rates begin to exceed network capacity (not expected until mid-2003), UITS expects to split its wireless network into two domains of 1,024 users each.

IU’s wireless network is secured through a VPN that provides both end-user authentication (via a user name and password) and encryption. The UITS organization manages and maintains the VPN environment, which is designed to allow departments coming on line with wireless to simply “plug in.” The VPN solution has thus far delivered acceptable security and prevented significant security problems.

IU’s focus on security reflects the institution’s relatively high IT profile within the higher education community, a status that has made it a frequent target of network intruders. While UITS controls all aspects of the wired network (including security), the freedom of departments to add wireless infrastructure establishes a potential point of vulnerability in the area of network security. UITS addressed this by establishing a set of policies and standards, an important element of which is the requirement that departments plug into the VPN.

**Perceived Benefits of Wireless**

Brian Voss sees the primary benefits of a wireless infrastructure as wider and more convenient access to IU’s network resources, beyond the range of wired boundaries. “IU is already a top ‘most-wired’ institution, and we’d like to become a top ‘most-wireless’ as well,” he said. “We see the complementary combination of wired and wireless infrastructures as benefiting all constituencies at IU.”

While Voss sees such metrics as network usage as a gauge of success, he believes that the real value of wireless is seen in more nebulous—and far-reaching—measures. “UITS looks at the value of technology in terms of its potential for facilitating the teaching, learning, research, and service missions of the university. It’s less a question of metrics than of providing a fertile environment via technology.”

**Lessons Learned**

Although still in the early stages of its wireless deployment, IU has learned several key lessons, the most important of which concerning how wireless should be introduced. Brad Wheeler, associate dean in UITS’s Teaching and Learning Information Technologies Division, sees the value of rapid deployment (over an incremental approach) as an important lesson of IU’s experience. “With technology initiatives like wireless, it’s better to embrace it on a global scale,” said
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Wheeler, “changing not just the technology infrastructure but the processes and funding priorities as well.”

Brian Voss concurred and pointed to the need to match expectations with capabilities—as well as with the funding required to back them up. “Because Indiana is a leader in IT, there was an expectation that we were going to build a wireless infrastructure that would enable people to access from anywhere on campus,” noted Voss. “This shows we needed to better set expectations or define an adequate funding stream to enable ubiquitous deployment.”

IU’s wireless experience also uncovered and debunked widely held misconceptions about the respective roles of the wireless and wired infrastructure, and the funding implications that sprang from these misconceptions. The first of these was the simplistic assumption that the wireless infrastructure would ultimately replace large components of the wired infrastructure, enabling large portions of funding for the wired network to be channeled to wireless initiatives. “We should have understood from the outset that we were talking about an augmentation deployment, not a substitution deployment,” explained Voss. “It would have given us a more realistic funding plan earlier on.” The second (and a related) assumption that was proved wrong was that reductions in the cost of maintaining the wired infrastructure would free up funds from the existing budget to support a broader wireless deployment.

As IU expands its embrace of wireless, one of the challenges it faces is to adapt classroom testing practices—which often permit laptop use—to a wireless computing environment. The university’s short-term solution has been to require students to remove their wireless cards during a test. However, with more and more laptops shipping with wireless built into the motherboard, IU’s Wheeler sees the challenge escalating.

“While we’re still trying to work it out, we see two alternatives—technical solutions and behavioral solutions. I see technical solutions as inferior because it turns into a ‘radar and radar detector’ scenario. At the end of the day, behavioral solutions are the only answer.”

The Future of Wireless at Indiana University

Going forward, IU expects its wireless coverage to grow steadily and quickly. IU still plans to build increasingly larger islands of connectivity, which will eventually deliver campus-wide coverage. But, in step with Brad Wheeler’s comments, the intention is to do that over a fairly short period of time. The effort began in the summer of 2002 and will proceed rapidly in stages of deployment, culminating in a campus-wide solution for IU’s two core campuses, in Bloomington and Indianapolis, by fall 2003.

The key, said Voss, has been to find a funding model that can make broad-based wireless deployment a reality. “We started to think out of the box [on wireless funding],” he said. “We believe, now, we can reallocate both one-time and ongoing funds from other services and savings exercises—particularly low-speed campus network access via modems, which is rapidly giving way to high-speed, user-acquired access in the form of cable modems and DSL services.” This transition means that IU will be trading its investment in low-speed modem access for high-speed wireless access on the campuses. The shift corresponds with users’ migration, brought about by their own demands for developing their home connections.

How will IU’s continued deployment be carried out? Voss said UITS will quickly evaluate a number of alternatives. “We have an opportunity to do the best thing we can. [That may be] a continuation of our self-deployment/management strategy, such as
we use on our wired network, or going with an outsourced installation of access points and integration of that environment with our current network and security environment.” He added, “Or perhaps something in between. Whatever it turns out to be, we’ll be determining that very quickly over the next 60–90 days.”

On the technology front, IU continues to evaluate IEEE 802.11a, 802.11g, and even G3. But in the near term, as it moves to deploy wireless rapidly across its campuses, UITS believes it will follow the option of deploying 802.11b immediately. “802.11b certainly works, is well established, and is cost-effective, though it allows only a limited amount of bandwidth,” Voss explained. “With a limited number of machines—which describes the current situation—802.11b will be fine. But when more and more people are looking for wireless connectivity down the road, or when the next generation of high-bandwidth applications comes along, we’ll be straining that network’s ability to deliver adequate performance. Fortunately, it looks like the newer equipment will have fairly straightforward upgrade paths, at least within the 802.11x technology. So we believe we’ll be fine.”