Wireless Services in Libraries

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Abstract
The expansion of the wireless access offered by libraries has been driven by a number of factors, not the least of them being the tremendous growth in the numbers of devices capable of connecting to wireless networks and the parallel increases in the bandwidth available via wireless networks; and it has been constrained by insufficiently elastic budgets, confusion born of competing technologies and standards, and the other demands on the network bandwidth that is available to libraries.

From the perspective of academic libraries, the growth of wireless networking will continue to extend the reach of library services. However, academic librarians understand that educating and serving users whose primary contact with the library is through network interfaces is a major challenge, because it requires new approaches to instruction and service.

The critical issues for public libraries appear to be economic and managerial. Many public libraries cannot afford the bandwidth necessary to meet all of the demands of their users, and these libraries have commonly exacerbated the problem by diverting available bandwidth from wired connections to support wireless services. In many places, it appears that such tactics have caused the overall quality of Internet services to decline. Some improvements can be made through the more rational configuration of access to the Internet, but the only "real" solution in the foreseeable future appears to be assigning significantly higher financial priorities to Internet services.

INTRODUCTION

In recent years, wireless networking has become an important part of the continuing effort to extend access to library services through networked information technologies. The expansion of the wireless access offered by libraries has been driven by a number of factors, not the least of them being the tremendous growth in the numbers of devices capable of connecting to wireless networks and the parallel increases in the bandwidth available via wireless networks; and it has been constrained by insufficiently elastic budgets, confusion born of competing technologies and standards, and the other demands on the network bandwidth available to libraries.

Wireless connectivity is perhaps even more important in developing countries, where the physical infrastructure necessary for wired networking is lacking and constraints on financial resources argue against creating such facilities. An example is the One Laptop per Child project, known popularly as OLPC, which has been developed and led by Nicholas Negroponte, formerly the director of MIT's Media Lab. While the short-term effects of OLPC are unlikely to include libraries, it is reasonable to imagine libraries will become important focal points as distribution of the laptops and servers that the project provides goes forward. See http://laptop.org/.

The foremost benefit of wireless networking is its comparatively low cost. Because no physical lines or circuits are directly involved, the only ongoing cost usually incurred is associated with the maintenance of the wireless equipment, which is generally modest. A second benefit of wireless connectivity is the ease of implementation. Unlike wired networks, which often involve structural issues and the procurement of third-party services that delay implementation, wireless networks can often be installed in a matter of a few hours.

Wireless networking is also highly mobile. Access points and client devices may be moved with ease and at little cost, whereas the physical reconfiguration of wired networks tends to be costly and time consuming and commonly results in significant losses of productivity and/or service.

Wireless networks will also play an important role when the primary networks fail; in fact, NYCWireless.net, a nonprofit organization that works actively with businesses, government agencies, and other nonprofit organizations to help develop free wireless Internet access throughout the New York metropolitan area, played a key role in the aftermath of the World Trade Center disaster of September 11, 2001, because the access points which it had installed in Manhattan remained operational and accessible to emergency works.

WIRELESS NETWORKS IN PUBLIC LIBRARIES

For public libraries, the growth of wireless services has been substantial. According to the *2006 Public Libraries*

Encyclopedia of Library and Information Sciences, Third Edition DOI: 10.1081/E-ELIS3-120044404

and the Internet survey, 36.7% of public library branches offer wireless Internet access, up from 17.9% in 2004. The growth during 2006–2008 has been equally strong; as a result, more than 60% of the public libraries in the United States now offer wireless access.[1,2] However, the authors of the study speculated

> that this increase in wireless connectivity occurred in many instances without significant improvements in the library's basic connectivity from its provider – [. . . . . .] degrading overall quality and sufficiency of the library's connectivity. Or, if libraries augmented their bandwidth to accommodate the wireless service, libraries incurred additional costs to provide the service – at a time when library budgets largely stayed the same from previous years (thus, in effect, a cut due to personnel costs and inflation).[3]

Allowing users to bring in their own computers into the library and connect them via wireless networking presumably frees public-access workstations for use by patrons without the alternative of using their own computers, thus providing economic benefits that in many instances offset the problems noted in *Public Libraries and the Internet 2006: Study Results and Findings*.

Another area of speculation is the extent to which wireless access has increased the number of patrons of public libraries offering the service or the demand for library resources, particularly the commercially licensed databases and electronic publications now commonly available through larger public libraries and library consortia. Because the impact of wireless technologies on the use of the Internet has been great, there is a tendency to assume that the wireless access provided by public libraries has had an effect of substantial proportion. Today, however, this assumption cannot be tested on a significant scale, because the data available is inconsistent and insufficient.

The effects of computing and remote access to computing capabilities on the productivity of organizations has been and remains a matter of considerable debate, now focusing largely on the notion of information technology investments as commodity inputs—see works by Carr[4]—and for the relevance of context—see the work of Thatcher and Pingry.[5] In the domain of public libraries, there is almost no useful information on the subject of these effects available at this writing.

A follow-up report, *Libraries Connect Communities: Public Library Funding & Technology Access Study 2007–2008*, affirmed the continuing growth in the availability of wireless services offered by public libraries. However, because the report also indicated that growth in overall bandwidth had slowed considerably, the findings of the report reinforced the sense that the growth in the use of wireless networking is not wholly positive in its effects. Moreover, the report suggests that the expansion of wireless services may be exacerbating workflow and workload issues in many public libraries.[6]

The expansion of wireless services among public libraries varies by state and in terms of population density, with public libraries serving rural communities having lower speed connections to the Internet and fewer wireless access points for service. The leading states in adoption of wireless technology are concentrated in the Northeast and mid-Atlantic regions, while the public libraries with the lowest levels of wireless connectivity are located in the Southeast.[7] Based on the data presented in *2006 Public Libraries and the Internet*, it seems reasonable to conclude that the rates of adoption are governed largely by the size of operating budgets, and that in regions where public library funding is likely to remain low, the rate at which wireless networking is adopted will also remain comparatively low.

Outside of the United States, data about the use of wireless networking by public libraries is more difficult to obtain. For example, in the United Kingdom, the number of public libraries providing access to the Internet has more than doubled since 2001, but Loughborough University's *LISU Annual Library Statistics* for 2006 makes no specific reference to wireless networking.[8] Similarly, the *Canadian Public Library Statistics* for 2006 does not include data on wireless access.[9] In each instance, Web searches indicate that substantial numbers of public libraries in the United Kingdom and Canada do indeed provide wireless access to digital resources, but in neither case does there appear to be an empirical basis for general statements or comparisons to relevant conditions and trends in the United States. However, a report from the United Kingdom's Chartered Institute of Public Finance and Accountancy in 2005 indicating that public library visits are rising there at a significant rate (while circulation is declining) has been interpreted as an indication that wireless services are playing a critical role in increasing remote access to public library services.[10]

WIRELESS NETWORKS IN ACADEMIC LIBRARIES

In higher education, wireless networking has become an integral part of campus-wide networks. What is more important, the impact of wireless access in academic settings has clearly been remarkable in its breadth and depth, even if those effects are not yet fully understood. According to *The ECAR Study of Undergraduate Students and Information Technology, 2007*, approximately 75% of undergraduate students own laptop computers, with laptop ownership increasing by 23% between 2005 and 2007. Smartphone ownership is also rising rapidly, rising from slightly more than 1% in 2005 to 12% in 2007.[11]

The ECAR study indicates that more than 90% of college and university students have high-speed, wired access to the Internet, but wireless connectivity is gaining rapidly, having doubled (from 12 to 24%) between 2005

and 2007. Perhaps even more significant, where students have a choice between wired and wireless access, 21.8% of them use wireless networks as a first line of contact.[12] Students spend an average of 18.0 hr per week online, with the use of course management systems, online social networking, and music and video downloads all increasing at substantial rates. The report found that engineering students spend an average of 21.9 hr a week doing online activities. Students in the humanities spend less time online, at 18.7 hr, with education majors ranking lowest in this category, spending only 15.9 hr a week online.

A Swedish study of library users at three universities in Stockholm suggests, however, that the increasing reliance on remote access to library resources and services among students, but particularly undergraduate students, is a mixed blessing and may be a cause for concern. The findings of the study, which corroborate the findings of an earlier British study, indicate an almost reflexive reliance on Google, little direct contact with the physical library or its staff, and little understanding of the library staff's knowledge and skills or the relevance of that expertise.[13,14] Taken together, the British and Swedish studies suggest that remote access to academic library resources may be reinforcing an already troubling lack of awareness about how to deal effectively with information problems. Many colleges and universities are responding through the institution of information literacy programs, but it is not yet clear whether such programs are a sufficient remedy.

WIRELESS NETWORKING IN K-12 EDUCATION

In elementary and secondary education, data about the availability of wireless networking services is limited. The U.S. National Center for Educational Statistics reports that by 2005, 100% of the public schools in the United States had Internet access, and that 97% of the computers dedicated to instructional use could be connected to the Internet.[15] There is no evidence, however, to indicate how many of the computers in public schools are connecting to Internet via wireless connections, nor is it clear how many school libraries are providing wireless connections to the Internet. Similarly, neither the School Library Journal, a key professional journal for school librarians, nor the American Association of School Librarians (AASL) provide statistical data about the penetration of wireless networking in K-12 education. There is an abundance of anecdotal information in the library literature to suggest that school librarians are interested in wireless access, and that they are experimenting with personal digital assistants (PDAs) and other mobile devices, but it is not possible at this writing to offer any reliable sense of how important wireless networking is for school libraries serving elementary or secondary education in the United States.

WIRELESS NETWORKING IN SUPPORT OF SPECIALIZED LIBRARIES

In specialized library environments, there is evidence that wireless networks are increasingly common. According to the U.S. Institute of Museum and Library Services, 23.6% of large museums, 42.9% of medium-sized archives, and 42.5% of state library administrative agencies maintained wireless networks by 2006.[16] There is also evidence that wireless networks in specialized library environments yield significant benefits. For example, hospital libraries are experimenting with wireless access to the Internet for patients, in the belief that "Internet access can positively impact clinical outcomes indirectly, by enabling the patient to maintain contact with family and loved-ones and to exercise a level of control over personal and professional affairs, and directly by connecting the patient to relevant patient education materials."[17] In business and industry, the benefits of wireless networking are widely discussed (and would appear to be extensive), but it is not clear how many corporate libraries and information centers provide wireless access to resources and services, nor is it clear to what extent wireless access specifically benefits library and information centers users.

TYPES OF WIRELESS NETWORKS

Owing mainly to standardization, the technical framework in terms of which wireless networks function has remain stable since the mid-1990s, with specific changes and developments running by general agreement through the processes attending IEEE 802.11, the set of standards for wireless local area network (WLAN) computer communication, developed by the IEEE LAN/MAN Standards Committee (IEEE 802) in the 5 and 2.4 GHz public spectrum bands. (See IEEE Web Portal for information about the IEEE and the 802.11 standard.) (The IEEE name was originally an acronym for the Institute of Electrical and Electronics Engineers. Today, owing to the scope of the organizations interests, the acronym is the preferred name.)

There are two types of wireless networks. The first type is a so-called "*ad hoc*," or peer-to-peer network, consisting of two or more computers each equipped with a wireless networking interface card. Each computer may communicate directly with all of the other wireless-enabled computers on the peer-to-peer network. The computers on the network can share files and other resources, such as a printer, under this configuration, but they may not be able to access resources on a wired LAN, unless one of the computers in the peer-to-peer network also acts as a bridge to the wired LAN. A wireless network may also use a physical access point, commonly referred to as a base station. In this configuration, the access point acts as a network hub, providing connectivity for the wireless

computers. The main purpose of the access point is to provide a link (or "bridge") from a wireless LAN to a wired LAN, thus allowing wireless computer access to LAN resources, such as file servers or an existing Internet connection. This second type of network is the one used almost universally by public libraries offering wireless services.

There are two types of access points. The first and most commonly employed is the dedicated hardware access point. It is a wireless device that handles all the network traffic to and from its associated clients, usually within a range of about 300 ft and with the option of a coded radio frequency for secure transmissions. In the vast majority of installations, the hardware access point is connected to a traditional, "wired" Ethernet network, thereby acting as bridge between the wired and wireless networks. (Most hardware access points cannot communicate with each other on the basis of a wireless connection. Typically, an access point can communicate only with its wireless clients. The exception is the wireless repeater, a device that receives a signal and retransmits it at a higher level and/or higher power, or onto the other side of an obstruction, so that the signal can cover longer distances without degradation. What is more important, wireless access points cannot be used to bridge wireless LANs.) In many instances, because the wired LAN is connected to the Internet, shared access to the Internet is available to the clients connecting through the wireless access point. The second type of wireless access point is the software access point. A software access point is an application that runs on a computer equipped with a wireless network interface card configured for use in an *ad hoc* or peer-to-peer wireless network. Typically, the application is a software router that provides external connectivity through PPPoE (Point-to-Point Protocol over Ethernet).

The use of wireless devices that support the IEEE 802.11 specification is virtually universal. (The 802.11 family of standards specifies an over-the-air interface between a wireless client and a base station or between two wireless clients. The IEEE accepted the specification in 1997.) Of the devices supporting 802.11 standards, wireless adapters conforming to 802.11g, the third of the 802.11 modulation standards to be ratified are most commonly employed. The 802.11g standard operates in the 2.4 GHz, at a maximum physical layer bit rate of 54 Mbps, exclusive of forward error correction codes. However, 802.11n, whose ratification is expected by the end of 2009, is already supplanting 802.11g.[18] The new standard is much faster, building on previous 802.11 standards by adding multiple-input multiple-output (MIMO), 40 MHz channel bonding, and frame aggregation, to achieve a physical layer bit rate of 600 Mbps.

An increasing number of wireless devices also support a short-range data transfer technology known as Bluetooth. Bluetooth, a standard developed by a telecommunications industry consortium, is a so-called "WPAN (wireless personal area network) technology" that is designed to connect personal devices within a small area. Specifically, the purpose of Bluetooth is to develop and deploy a standardized, low-powered radio chip that may be used to connect devices within what the IEEE 802.15 Working Groups for WPANs (wireless personal area network) has defined Au1 personal operating space (POS) as being a space of up to 10 m extending in all directions and enveloping both stationary and mobile users. The Bluetooth chip is designed to replace cables by taking the information normally carried by cables to and from devices such as printers, keyboards, mice, andPDAs and transmitting it to a radio receiver. Even though Bluetooth has a much lower range and throughput than that of 802.11-compliant devices, its significantly lower power consumption means that it may eventually achieve a ubiquity equal to or greater than 802.11.

Today, Bluetooth chips are commonly placed in computers, printers, keyboards, and mice, replacing short-range cables. They are also found in a wide variety of other devices, including mobile phones. (The Bluetooth specification was originally conceived by Ericsson in 1998, before a number of other companies began to collaborate and eventually launched the Bluetooth Special Interest Group.) In recent years, the use of Bluetooth technology has expanded rapidly. (The latest Bluetooth standard, Core Specification v2.1 + EDR, which was approved in 2007, provides improved power consumption and security.) Although library technologists have been focused on 802.11-based networking technologies, it is reasonable to expect that Bluetooth-based devices may play a progressively larger role in the delivery of library services, including public library services.

TECHNICAL ISSUES

Standards issues have been characteristic of wireless networking since its inception. The Wi-Fi Alliance, which was organized in 1999 to perform testing, certify the interoperability of products, and to promote wireless technology, has played an important role in developing and maintaining standards within the framework of the IEEE 802.11 specification, but as the market for wireless networking services has grown and competition has intensified, maintaining the desired levels of inoperability has become increasingly problematic, as manufacturers brought new devices based on proposed rather than approved standards into the marketplace. (For information on the Wi-Fi Alliance, see http://www.wi-fi.org/index.php.)

An example of this problem is the proposed 802.11n standard. In 2007, the Wi-Fi Alliance began testing products for compliance with the second version of the draft standard, despite the fact that its members have not agreed to give formal approval to any version of the standard. (Approval of the proposed standard is not expected before the fourth quarter of 2009.) Meanwhile, compatible devices have been on the consumer market

and selling briskly since the second half of 2006, despite the fact that there is no guarantee that the devices purchased will be wholly compatible with the version of the standard that is eventually approved. (See Wi-Fi Alliance press release, June 25, 2007.)

802.11n builds upon previous 802.11 standards by adding MIMO. Multiple-input multiple-output uses multiple transmitter and receiver antennas to increase data throughput via spatial multiplexing and increased range by exploiting the spatial diversity, perhaps through various coding schemes. The typical data rate is expected to be approximately 75 Mbps, with a theoretical maximum of 248 Mbps.

Looking to the near future, it is anticipated that by 2015 mobile data traffic will be at least 10 times greater than it is today. Efforts mounted under the respective banners of the IEEE 802.16 Working Group on Broadband Wireless Access Standards and the IEEE 802.20 Mobile Broadband Wireless Access (MBWA) Working Group are aimed at developing new technologies capable of meeting the increasing demands for wireless capacity.

Approved in June 2008, the IEEE 802.20 standard is intended to foster the development of a functional architecture that will allow the creation of low-cost, always on, and highly mobile broadband wireless networks capable of supporting data traffic with peak rates in excess of one megabit. The IEEE 802-16e standard, commonly called "WiMAX" (from "Worldwide Interoperability for Microwave Access") standardizes two key aspects of the so-called "air interface," the physical layer and the media access control layer, and introduces a series of "quality of service" components.

At this writing, WiMAX appears to be the technology most likely to have a significant impact in the short term, owing to its bandwidth and range. Notwithstanding claims that multipoint WiMAX coverage could extend to a range of 30 mi, it is expected that the average cell ranges for most WiMAX networks will most likely be 4–5 mi, and that service ranges up to 10 mi are likely in line of sight applications. In terms of bandwidth, WiMAX has a theoretical maximum bandwidth of 75 Mbps; however, a more realistic appraisal based on actual performance testing suggests that first-generation system may be capable of delivering 40 Mbps, and over 300 Mbps with the next generation WiMAX standard. It is also anticipated that mobile network deployments will provide up to 30 Mbps of capacity within a typical cell radius of up to 3 km.[19] This bandwidth is enough to simultaneously support hundreds of businesses, thousands of residences, and thousands of mobile Internet users, and make WiMAX suitable for a range of applications, including connecting Wi-Fi hot spots with other parts of the Internet and providing various data and telecommunications services, such as a wireless alternative to cable and DSL, support for IT continuity plans, and portable connectivity.

The security of wireless systems remains problematic. That default configurations for many wireless networking access points are unsecured, and that those configurations are often unaltered in implementation remains a serious problem. The problem is serious enough that in 2006 Westchester County, New York enacted an ordinance that requires local businesses to secure wireless networks and also requires users to have firewalls or other security measures in place.[20] The Wi-Fi Alliance also points, in particular, to an exploitation scheme known as the "Evil Twin" or "W-Phishing." Under this scheme, a hacker sets up an access point in proximity to a public "hot spot." The access point mimics the characteristics of the network to which users expect to connect, and users unwittingly connect to the hacker's network instead of the intended network. The "Evil Twin" hijacks user data, such as user IDs, passwords, credit card numbers, etc., and then connects the user to the Internet as intended. More sophisticated versions of the scheme can control what Web site appears when the Internet is accessed, often mimicking the intended starting Web site, for the purposes of capturing the user's private information. (The Wi-Fi Alliance, in addition to certifying the Wired Equivalent Privacy (WEP) and Wi-Fi Protected Access (WPA) standards, now supports a series of nonproprietary, extensible authentication protocols. In addition, the Wi-Fi Alliance recommends that users limit connections to networks that use encryption with a list of trusted hotspots or virtual private networks.)

DEPLOYMENT OF WIRELESS NETWORKS IN PUBLIC LIBRARIES; RELATED POLICIES AND PRACTICES

The wireless networks that have been deployed in public libraries typically fall into one of three categories.

The first category consists of public libraries providing connectivity through an Internet service provider to registered borrowers. Hundreds of small-to-medium sized public libraries deploy two or more access points as a basis for wireless service, and a growing number of larger public library systems offer wireless access in all locations.

Most public libraries offer this service on the presumption that patrons will provide the laptop computer and wireless adapter necessary to exploit the wireless service, but a growing number of libraries also loan laptops and/or wireless adapters to patrons for use within the library.

In the second category, public libraries provide access for patrons through cooperative projects with other agencies in their respective communities. During the first generation of wireless services in libraries, such projects were common. In recent years, however, it appears that many, if most of these cooperative projects have been abandoned, in large part because broadband Internet service providers have typically added wireless services to the services they provide libraries, and bundled them at prices that have made the pursuit of other options largely pointless.

In the third category, computer networking, including wireless networking, is part of a strategy designed to offset geographical and socioeconomic limits on access to the Internet. In Maine, Maine InfoNet, a cooperative library automation project, and the Maine State Library provide the equipment and setup assistance necessary to enable and maintain free wireless Internet hot spots in more than 50 public libraries.[21]

Many installations are not secure, meaning that no form of authentication or encryption is in force, and the policy statements that these libraries place on their Web sites usually offer clear warnings. Even when some form of authentication and/or security is enabled, libraries tend to provide disclaimers on their respective Web site, warning wireless users that security cannot be guaranteed.

Many public libraries have devised laptop access policies that apply to wired as well as wireless connections provided within the library. Many policies of this type are general in nature, but owing to abuses of Internet usage, a growing number of them are now detailed and explicit.

At the Lakewood (Ohio) Public Library (LPL), compliance with specific sections of the Ohio Revised Code is noted, as well as compliance with The Ohio Public Information Network's policies concerning illegal and/or obscene materials and relevant policies of the Library's wireless Internet service provider.

In many places, public libraries offering wireless access do not provide services for users having difficulty contacting personal laptop computers to the library's wireless network. At the Juneau (Alaska) Public Libraries, the policy also stipulates that "the patron is the person responsible for setting up [wireless] equipment" and connections. The Boston Public Library in Massachusetts has a policy that is almost identical.

Wireless implementations in public libraries are also supported by various library organizations, most notably WebJunction. (WebJunction is an online community for library staff. It is hosted by OCLC and funded by the Bill and Melinda Gates Foundation. See http://www.webjunction.org/140 for more information about WebJunction's support of wireless networking.) WebJunction offers an array of services related to wireless networking, including a "How To," a wireless networking pathfinder, and guides to hardware, security and safety, training, and policy development. It has also assumed sponsorship of "Wireless Libraries," an influential Web site/blog that has been developed by Bill Drew, a librarian long associated with the State University of New York and currently working at the Tompkins Cortland (New York) Community College.

MUNICIPAL WIRELESS NETWORKS

In recent years, cities have begun setting up municipal wireless networks. Today, there are almost 200 municipalities in the United States that are running wireless networks or have definite plans to build one. Some of the networks provide high-speed Internet access to the public for free, or for a subsidized price substantially less than the price of other broadband services. In a number of instances, the networks are for the exclusive use of police and fire departments and/or other departments of municipal government.

Cities currently maintaining or proposing to build municipal wireless networks usually have several goals. They want to improve the productivity of the local workforce, make the city more attractive to business and industry, strengthen the local economy, and bridge the digital divide. While public libraries have generally played marginal roles in the development of municipal wireless networks, the development of these systems has commonly presumed that increased access to public library services would be one of the benefits of such networks.

Unlike the simple 802.11 networks that characterize virtually all public library installations, "municipal WiFi" networks are commonly based on wireless mesh networks. Whereas traditionally configured 802.11 networks rely on a small number of wired access points or wireless hotspots to connect users, a wireless mesh network typically entails dozens to hundreds of nodes "talk" to each other to share the network connection across a large area. Mesh nodes are small radio transmitters that provide access and route data traffic dynamically. The mesh nodes use the 802.11 standards as the basis of user connectivity and as format for communication among the nodes. Data moves across the network from node A to node Z, or somewhere in between, with the programmed nodes automatically identifying the quickest and safest route. The biggest advantage of wireless mesh networks is that they are truly wireless. In nonmesh wireless networks, access points are wired to the Internet. In a wireless mesh network, only one node needs to be wired to a network, with the wired note sharing the physical connection wirelessly with all other nodes in its vicinity. In turn, those nodes share the connection with the wireless nodes closest to them. The more the nodes, the further the connection spreads, creating a wireless "cloud of connectivity" that, in principal, can reach many users distributed over a wide area.

In reality, municipal wireless networks have been largely unsuccessful, and a significant number have failed, because the costs of providing services at acceptable levels have proven to be high and providers have commonly been unable or unwilling to deploy nodes in numbers commensurate with the demands for this service. These problems have been compounded by the growing demand for bandwidth among end users.

Recent research findings suggest that municipal wireless networks succeed at the enterprise level when subsidies are effectively combined with competitive pricing structures and mesh networks are configured on the basis of an understanding of how likely users are distributed

across a city.[22] Such findings suggests that public libraries, particularly urban public libraries, may yet play important roles in the development of municipal wireless networks, and that they may also prove to be beneficiaries of those initiatives.

DEPLOYMENT OF WIRELESS NETWORKS IN COLLEGES AND UNIVERSITIES; RELATED POLICIES AND PRACTICES

Wireless networks are now an important part of the systems that colleges and universities have built in order to provide access to both local and wide area networks. On many campuses, wireless coverage is expanding rapidly, because it represents the most efficient means of extending the reach of the existing infrastructure. Some schools require students to own a wireless-enabled laptop; other schools subsidize the purchase of wireless-enabled computers in order to ensure ubiquitous access to networked resources and services. (Examples of these policies include: Berklee College of Music Computer Requirements, http://www.berklee.edu/computers/6_faqs.html; and Laptop Computer Requirment, College of Education, University of Texas, http://www.edb.utexas.edu/education/programs/certification/life/about/faq/) In addition, there are a growing number of experimental programs aimed at developing the software and services necessary to bring mobile Internet devices, including smartphones, iPods, and PDAs, into widespread instructional use.[23]

At the policy level, colleges and universities are deeply concerned with the security of their computer networks. The use of firewalls and virtual private networks (VPNs) is common. So, too, is MAC (Media Access Control) authentication, a security scheme under which wireless adapters are registered by the identifier assigned to most network adapters or network interface cards (NICs); only those devices are granted access to the network. In some instances, institutions also route wireless traffic through off-campus security services to enhance local security measures.

There is, too, concern about the use of peer-to-peer and other file-sharing networks by students, particularly when such networks are used to distribute unauthorized copies of sound recordings, videos, and other materials. These concerns are the focus of the policies that colleges and universities have developed in order to regulate the use of their networks, including wireless networks. At Ohio University, for example, networking policy stipulates that (Ohio University announces changes in file-sharing policies, April 25, 2007. http://www.ohio.edu/students/file-sharing.cfm)

> Although P2P file sharing can sometimes be used for legitimate reasons, any use of P2P software on the campus network may result in Internet access being disabled under this new policy. In addition to consuming bandwidth and technological resources, P2P file sharing also exposes the university network to viruses, spyware and other attacks. It also is frequently used for illegally distributing copyrighted works.

Ohio University implemented this policy following a "crackdown" by the Recording Industry Association of America (RIAA) on illegal music downloading. The RIAA sent more than 1200 prelitigation letters to colleges and universities, including 100 to Ohio University, and initiated "John Doe" lawsuits against users of computers on Ohio University's network.

In addition, many colleges and universities, faced with demands for bandwidth that threaten to destabilize network infrastructures as well as IT budgets, are setting limits on its consumption. The caps vary in size, and the consequences of exceeding the cap, usually set on a monthly basis, range from temporary suspension of service to financial penalties.[24]

CONCLUSION

Wireless networking has become an important aspect of Internet connectivity, growing lately at dramatic rates. Moreover, if the possibilities of the technologies being developed in compliance with IEEE 802.16 and 802.20 are realized, wireless access could supplant wired connections as the primary means of access to the Internet.

In higher education, the demand for network bandwidth and related infrastructure costs are considered major issues, though there is evidence that bandwidth costs are dropping.[25] From the perspective of academic libraries, the growth of wireless networking will continue to extend the reach of library services. It is fair to say, however, that many academic libraries are in a conflicted position where remote access is concerned. On the one hand, increasing remote use of library resources and services is important, because it expands the user population and helps justify the investment in digital resources. On the other hand, librarians understand that educating and serving users whose primary contact with the library is through network interfaces is a major challenge, because it requires new approaches to instruction and service.

In the case of public libraries, Internet connectivity has already served to reinvigorate, if not redefine, the public library and restore its role as an advocate for access to information. Wireless technologies offer opportunities to continue this process of revitalization by allowing public libraries to extend their services to new cadres of users equipped with PDAs, laptops and tablet PCs with wireless network adapters, smartphones, and hybrid devices like the iPhone and the iPod Touch.

A large number of public libraries are meeting the connectivity needs of users through the provision of

wireless networking services, and there is ample reason to believe that the percentage of public libraries offering this service will continue to rise at a significant rate.

At this writing, however, the critical issues for public libraries appear to be economic and managerial. As *Libraries Connect Communities* documents, many public libraries cannot afford the bandwidth necessary to meet all of the demands of their users, and these libraries have commonly exacerbated the problem by diverting available bandwidth from wired connections to support wireless services. In many places, it appears that such stratagems have caused the overall quality of Internet services to decline.

The best solution to such problems is financial. As the authors of *Libraries Connect Communities* note, most public libraries need to allocate more money for Internet services in order to acquire the additional bandwidth that clients need and want. Some improvements can be made through the more rational configuration of access to the Internet, but the only "real" solution in the foreseeable future appears to be assigning significantly higher financial priorities to Internet services.

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