

WIRELESS LANs

By Richard W. Boss

Interest in wireless local area networks (wireless LANs or WLANs) has been growing exponentially since the fourth quarter of 2001, including in libraries. At least 30 percent of public libraries and 70 percent of academic libraries had a wireless LAN in the fourth quarter of 2005. The widespread acceptance of the technology appears to be attributable to the fact that standards are now in place that address many of the shortcomings of earlier wireless technology.

Definition

A wireless LAN makes it possible for a desktop or notebook PC, or for a PDA, to access a local area network without being physically connected to it. It is rare for a wireless LAN to be deployed throughout an entire building; typically it is installed in an area that is difficult to wire or where a large number of mobile users with notebook computers or PDAs may be working.

The typical wireless LAN involves the installation of access points on the interior walls and/or in the ceilings of a building. Each access point, typically the size of a book, houses a transmitter, a receiver, an antenna, and a piece of equipment that acts as a bridge to an organization's wire-based network. A single access point can serve a number of users, but as more people connect, each person gets a smaller share of the bandwidth--which translates into a slower network connection.

A user who has a "wireless network card" (also known as a "wireless adapter") in his or her desktop, notebook PC, or PDA that is compatible with the access points in a building can be anywhere up to 300 hundred feet from an access point and remain connected to the network because the wireless radio signal carries through most walls, floors, and ceilings.

The major vendors of wireless LAN components are Avaya, Cisco, Intersil, Nokia, Symbol

Technologies, and 3Com. All maintain Web sites that are easily accessed by using Google or another search engine. .

Standards

Most of the installed wireless LANs are based on the IEEE (Institute of Electrical and Electronics Engineers) **802.11b** standard of 1999, a standard which specifies use of the 2.4 GHz band at 11 Mbps. The 802.11b standard replaced the now outdated 802.11 standard.

While a commercial success at \$3.5 billion per year in sales, products conforming to the IEEE 802.11b standard have been subject to interference from other applications using the 2.4 GHz band, and performance well below 11 Mbps. Among the products which interfere with 802.11b products are cordless telephones, cellular radios, wireless audio speakers, microwave ovens, wireless karaoke machines, and many remote controls--all common, especially in cities. In tests conducted in 2000 by Schneider National Labs in Green Bay, WI for Network Computing, a major networking journal, most wireless LANs based on the 802.11b standard performed at around 3.2 Mbps. Only one product topped out at more than 4.0 Mbps. Several major users have more recently reported that 2.0 Mbps is a more realistic figure when planning a wireless LAN.

Interoperability among products was a problem with the early versions of products based on the 802.11b standard. It was two years after the standard was adopted that 3Com, Aironet, Avaya, Intersil, Nokia, and Symbol Technologies formed a group called the Wireless Ethernet Compatibility Alliance (WECA). The group's aim is to give customers cast-iron guarantees that products from the participating vendors will work together perfectly. The group has extended its efforts to all other wireless LAN standards. WECA has applied the label "Wi-Fi" to products that conform to its interoperability requirements.

Security has also been an issue. Because radio frequencies are shared among users of the network, any information sent or received can be intercepted. Radio frequencies frequently "leak" out of buildings onto adjacent streets and parking lots, therefore, making it possible for those not affiliated with an organization to "listen in." However, there is now a solution if security is a

concern: encryption and/or patron authentication can be used. It is also possible to limit access to network cards that have been registered. Anecdotal evidence suggests that most libraries do not use encryption; they merely warn users that it is possible that the information sent and received may be intercepted by others.

Newer products based on the *802.11a* standard, which was adopted in November 2001, operate in the 5 GHz band at up to 54 Mbps. The use of the 5 GHz band dramatically reduces interference because the band is little used by other applications. Actual bandwidth using products based on the standard almost always exceeds 30 Mbps. That makes products that conform to this standard far better than those that conform to 802.11b not only for densely populated user environments, but also for video and large-image applications. However, the range at which 802.11a products operate is relatively short: 100 feet as against 300 feet for 802.11b products. It is, therefore, necessary to install a larger number of access points to cover a given area. That increases cost and the amount of time required for network maintenance.

. Cahners In-Stat Group, a market research firm, estimated in 2002 that the WLAN market would grow to \$4.6 billion by 2005 as the result of the 802.11a standard's adoption. It also predicted that the 802.11a standard would represent more than 60 percent of the market. The market did grow as predicted, but 802.11b products outsold 802.11a products by four to one in 2005 because prices for 802.11b products came down to half those for 802.11a. That, and the fact that the greater range of 802.11b access points means that fewer of them are required to cover an area, made the older standard far more cost effective.

While 802.11a products from WECA members are interoperable with other products which conform to the same standard, they are not compatible with products which conform to the 802.11b standard. However, there are access points that are dual-mode, supporting both standards. That is important for libraries that provide wireless access to patrons because some will have 802.11b network cards and some will have 802.11a network cards in their devices.

There is yet another option, IEEE *802.11g*, a standard which uses the 2.4 GHz band, but bumps bandwidth up to a potential 54 Mbps. The actual is probably 30 Mbps. It is compatible with 802.11b. Its main drawback is that, like 802.11b, it does not address the problem of interference. It

has particular appeal for home users and small organizations because of its relatively low implementation cost. While 802.11g has not been very successful, libraries that want to provide access to patrons regardless of the network card used should purchase multi-mode access points that support all three standards. These will be at least 30 to percent more expensive than dual-mode access points that support only 802.11b and 802.11a.

A fourth standard is in development, **802.11n**. The main benefit of this standard is that it will support bandwidths of 200 Mbps or more, with actual performance likely to be at least 100 Mbps. The standard will be backward compatible, with interoperability with 802.11a and 802.11g and coexistence with 802.11b. Range will be a minimum of 300 feet. The draft standard was adopted in March of 2006 and distributed for trial use. While the final version it is not expected to be adopted until 2007, some products that conform to the 802.11n draft standard had already reached the market at the time the draft was approved. Unless a manufacturer guarantees that it will bring its product into conformity with the standard when ratified at no additional cost, it is unwise to purchase 802.11n products.

All of the foregoing standards use the Ethernet protocol and CSMA/CA (carrier sense multiple access with collision avoidance) for path sharing.

Applications

Some libraries use wireless LANs solely in locations where pulling cable is difficult and expensive. Examples include single-story buildings on concrete slabs and multi-story buildings with no plenums (space between the floor and the ceiling of the floor below it. Another application is where the installation is intended to be temporary--thus making it possible to remove and relocate the wireless LAN at modest cost.

The vast majority of libraries use wireless LANs to accommodate network users who move around a facility with a notebook computer or a PDA. Now that airports, coffee houses, academic buildings and many other public places have wireless LANs, users expect to have that convenience

in libraries.

One of the most popular applications of wireless LANs in libraries has been the lending of laptops to patrons for their use throughout the building. That is not only an excellent way to increase the number of available PCs during busy periods without installing a large number of data jacks, but also gives the library the opportunity to configure the machines to best work with its automated library system and other electronic products and services. One library has learned that students studying as a group like to take several laptops into a group study room that has only one data jack so they can work collaboratively. Another--one with extensive book stacks-- has observed students using laptops on the floor in the classifications of interest to them. They can then search and retrieve very quickly.

Patrons, especially students, often bring their own 3.5 -inch diskettes so they can download information, therefore, most libraries which make laptops available do not disable the “a” drives. They do limit access to the hard drives, however.

Costs and Headaches

Each access point costs up to \$500 in equipment (\$180 to \$250 for a single mode; \$300 to \$400 for a dual mode, and \$400 or more for a multi-mode access point), plus another \$1,500 for design and installation--a figure which includes connection to the electrical supply and to the organization’s wired network. The network cards or adapters are under \$100 each, however, an increasing number of notebook PCs and PDAs come with a built-in wireless LAN card.

Libraries that require 50 or more access points in a facility should consider installing a wireless LAN switch. That obviates the need to have relatively expensive “intelligent” access points—access points that include considerable data communication and security software. The simpler access points costs at least 60 percent less to purchase and require less maintenance. The leading vendors of wireless LAN switches are Aruba and Trapeze.

Wireless LANs take more time and expertise to design and tune than wired networks. Very

thick concrete floors, a large number of metal desks and filing cabinets, densely filled book stacks, and a large number of people can all weaken the radio signal.

Carnegie Mellon University, an early adopter of wireless LANs, spent six years experimenting and redesigning to adjust to all of the constraints before deciding that it would deploy wireless LANs campus wide. Among the important discoveries it made was that for 802.11b wireless LANs to work optimally, the operating frequencies of the access points must be spaced out evenly among the eleven allotted sub-frequencies or “channels” in the 2.4 GHz range to prevent signal contention and performance degradation. The same is proving to be true with regard to 802.11g wireless LANs.

Larry Glover of the William F. Laman Public Library in North Little Rock, AK described the mistakes and missteps he experienced in the March 2001 issue of *Computers in Libraries*. He suggested measuring the building to get the spacing of access points right, computing bandwidth needs based on the potential number of users, and identifying potential obstructions to the radio signal before beginning the installation of the access points. The advice remains valid.

Although the libraries which have invested in laptops have generally purchased high-end machines, there have been a large number of maintenance headaches. Floppies often get stuck in the drives and drives are damaged in users’ frantic efforts to remove them. This often requires returning the entire unit to the manufacturer. The hinges, which attach a monitor to a chassis, also break regularly. The batteries also do not hold up under heavy use and constant charging and discharging. The general rule-of-thumb is that a laptop costs two to three times as much as a desktop PC, lasts one-third to one-half as long, and requires three to four times as much repair over its life than a desktop device.

Security Concerns

There has been increasing concern expressed about the security of wireless LANs. They are much less secure than wired LANs, but the level of security can be increased by using encryption and/or authentication. The Wi-Fi Alliance has developed a standard for encryption and authentication in a wireless environment known as WPA (Wi-Fi Protected Access). It is

participating in the development of an IEEE standard based on its work. The standard will be officially known as 802.11i, but is already being referred to as WPA2. A library can choose to use encryption on all of its own equipment, including not just PCs, but other devices including RFID readers and sensors; but it should not expect patrons to utilize encryption on the devices they bring into the library.

A library can protect its applications, including databases, against wireless users by requiring authentication of users for everything except its patron access catalog. The patron access catalog can be protected by using a proxy server so that the back-end database is not accessed directly.

What a library cannot do is to protect the devices patrons bring into the library. It should advise patrons of that fact. The warning can be included in the instructions for accessing a library's wireless LAN. The New York Public Library—Branches has a detailed set of wireless LAN instructions with a security disclaimer (www.nypl.org/branch/services/wifi.html/). Also worth consulting is the Internet use policy of the Jacksonville Public Library at <http://jpl.coj.net/Library/internetpolicy.html/>.

Prospects

Despite the enthusiasm about wireless LANs, they do not appear to pose an immediate threat to conventional wired LANs. While 30 to 54 Mbps may seem like a great deal of bandwidth, a significant number of libraries have upgrading their wired Ethernet LANs to 100 Mbps because they have found that the increasing use of graphics, audio, and motion video on LANs means that it must be possible to provide each user with up to 1 Mbps of bandwidth. A few are now moving to 1.0 Gbps wired LANs. A cluster of desktop machines or laptops in a small area can overwhelm a wireless LAN offering 54 Mbps or less of bandwidth.

Finally, the users will be the ones to determine whether they will use wireless LANs exclusively. Rensselaer Polytechnic Institute, which for several years has required each student to own a notebook computer, expected that requirement to reduce the demand for student computer

labs, but it has found that students often don't want to add a notebook to an already heavy book bag, or don't want to risk its theft. Students are also less inclined to upgrade memory and software on a regular basis than the institution; therefore, they may choose to use the more robust devices available in a library. That is probably true of non-students as well.

More Information

Libraries interested in pursuing wireless LANs should search online reference services under headings such as wireless LANs, WLANs, wireless local area networks, wireless communication systems, and 802.11.

One of the most useful sites for information about wireless LAN products can be found at www.wi-fi.org, the Web site of the Wi-Fi Alliance. Current news in 802.11n development can be found at <http://wifinetnews.com/>

When surfing the net, it is best to look for that which is dated 2004 or later because earlier information does not reflect the current state of wireless LAN technology.

Revised version prepared March 28, 2006