Wireless Communications

What's It All About?

by Bill Boothe

One of the great mysteries of physics was solved more than 100 years ago when Marconi sent and received his first radio signal. As the "wireless age" has progressed forward, many variations on Marconi's initial achievements have made their way into our world: radio and television, satellite, cordless telephones, cell phones and pagers, and a host of gadgets that make our lives a bit easier (remote TV and sound system controls, remote car entry systems, and garage door openers) and more entertaining (radio control cars, boats and airplanes). All of these devices have one common thread — they are operated across open spaces with no visible connection.

Wireless technology has also invaded the computer world. In just the past five years, staggering advances have been made in the inevitable transition from a wired to a wireless society. Private clubs are just now discovering the advantages — and potential cost savings — that can be derived from wireless technology. But like most computer technologies, there's more than initially meets the eye. Let's dig a little deeper in our understanding of wireless communications.

Wireless - A Brief Overview

One thing is sure about wireless: it comes in lots of flavors. In this article we'll take a look at the top seven wireless platforms:

1. Wireless Fidelity (Wi-Fi)
2. Laser
3. Microwave
4. Cellular
5. Satellite
6. Infrared
7. Bluetooth

Not all of these technologies are practical for use in private clubs and some of them have both physical and financial parameters which limit their utility to a narrow niche of club facilities. Keep in mind throughout your reading of this article that there is some amount of capability overlap between these technologies, and that choosing the best solution for your club should involve professionals specializing in wireless technology for small businesses.

Wi-Fi

Wi-Fi is the popular acronym for Wireless Fidelity, the most widely used wireless method available today. Wi-Fi uses radio waves to transmit data from point to point. Industry standards address the way in which specific devices transmit and receive information. Standards facilitate integration of devices from different manufacturers, however our experience has been that not all manufacturers' equipment necessarily interoperate with other manufactures' equipment.

The most popular Wi-Fi standard for transmission speeds is up to 11 megabits per second (11Mbps). Also known as 802.11b, this standard is the one now shipping with today's new PCs. This data transmission speed is slightly faster than the older Ethernet (10Base-T) network hubs which are still operating in many private clubs today. The 802.11b standard oper-

ates on the same 2.4GHz bandwidth used by cordless phones and baby monitors. However, as this article is being written, 802.11b is being replaced by the 802.11g standard which also operates on the same 2.4GHz bandwidth, but allows throughput at speeds up to 54Mbps and is backward compatible with 802.11b.

Wi-Fi transmissions emanate from Access Points (APs), which connect directly to a network switch and serve as a "wireless hub" for up to a dozen or so devices (PCs and printers) that simultaneously access the network. Each PC and printer houses a wireless transmitter that serves the same function as a traditional network card/connector (NIC).

While APs using the 802.11b/g standard can accept connections from as far away as 300 feet, the realistic limit is 100 feet. That's because the "effective range" is reduced by physical structures between the AP and the PCs trying to connect.

"Hot Spot" Applications

Wi-Fi Internet connections are fast becoming a popular draw for customers visiting certain commercial establishments. The "hot spot" model for Wi-Fi is being used where people tend to congregate, such as cafés, restaurants, airports, and hotels. Patrons need have only a laptop equipped with a wireless card and a credit card to connect to the Internet.

Private clubs can use this same technique to create hot spots within the clubhouse for member use. Likely hot spot locations could be a terrace, a casual café, business meeting rooms, the library, or club overnight guest rooms (provided, of course that the club's culture is observed in the process). You can also use the Wi-Fi network to connect with mobile or hand-held POS devices used by your club's service staff.

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Wi-Fi Transmission Concerns

The effective range of a Wi-Fi transmission can be reduced by everything from the lead and other metals in old plaster to metal lathe in replacement plaster. Devices that use the 2.4GHz bandwidth, such as cordless phones and remote door openers, as well as devices using other bandwidth ranges, such as televisions, can also interfere with a Wi-Fi network. Before you go "live" with a Wi-Fi network, or even commit to purchasing equipment, you can and should do some very inexpensive testing for possible transmission issues in your club.

Testing is easy. Simply purchase a single AP device. Plug it into an outlet near the device's intended location, and walk around with a wireless laptop to see how far you can move away and still receive the AP signal. In this manner you can "map" the planned Wi-Fi areas of the club to assure adequate coverage and signal strength.

Throughput and Compatibility Issues

Today's software applications are being written with the premise that 100Mbps will be available in a "switched environment" (not using hubs) — the defacto standard with today's wired networks. Wi-Fi's 11Mbs is probably enough bandwidth for a smaller club with less than 15 PCs using straightforward accounting, POS, and desktop applications.

If you plan to use wireless with a large number of devices over an 802.11b network, you will want to consider "thin client" technology, which reduces the size and frequency of the communication between your terminals and the server.

You should also check with your application software providers to confirm that their solutions have been successfully tested with the wireless set-up you are contemplating.

Wi-Fi technology is continuing to evolve. A new standard was approved in June 2004, 802.11i. This is the long awaited security enhancement to all 802.11-based standards that adds the latest encryption technology and techniques to better ensure secure communications. This standard is expected to be available in Wi-Fi hardware and software around Fall 2004.Two new standards will be arriving soon, 802.11a (five times faster and more secure than 802.11, but more expensive and greater issues with distance and signal interference) and 802.11g (designed for home computing at faster speeds).

Security Concerns

While Wi-Fi offers unparalleled freedom to roam with your PC, it also offers outsiders an opportunity to compromise your club's network. Unlike copper or fiber optic cable that restrict access to only those users who can physically connect to the network, APs broadcast their signal in all directions for a significant distance. Wi-Fi has

opened the door to electronic intruders called "war drivers" who literally drive around in their automobiles with PCs looking for Wi-Fi signals, then publish the location of vulnerable equipment on the Internet.

To protect wireless networks from unauthorized access, manufacturers offer Wired Equivalent Privacy (WEP). WEP is available in almost all wireless AP equipment, but must be activated to work. WEP requires wireless cards to 'authenticate' using codes which you set before the AP will provide a connection. Because of flaws in WEP the 802.11i standard replaces WEP with the Wi-Fi Protected Access 2 (WPA2) security protocol.

What's the Cost of Wi-Fi?

Listed below are the typical components of a Wi-Fi solution:

Access Point (AP) "Wireless Hub" — $125 - $600

* Connects to a network switch;

* Effectively supports 6-12 active devices;

* Has an effective range of 100-300 feet;

* Uses WEP or WPA2 for security (should be included with the AP).

Wireless Card — $85 - $200

* Installed either internally or externally with each PC or printer;

* Seeks the AP by transmitting the proper identifiers, if WEP or WPA2 is enabled.

As you can see, the cost of Wi-Fi can be much less than the physical wiring of a building. Wi-Fi is also a good solution in situations where your building could be damaged by installing cable, or the locations where you need network access are difficult to reach (island bars, for example), outdoor locations, or for PCs that are in need of frequently moved relocation. You can also extend the effective range of an AP by having it communicate with another AP, eliminating, for example, the need for fiber optic cabling between the clubhouse and the pro shop.

Who Are the Major Wi-Fi Players?

Lots of companies are getting into the Wi-Fi business. It's important for you to make sure any provider considered by your club has deep experience with this specific technology, and has a strong track record for successful Wi-Fi installations. The following manufacturers are the top players in the industry (in alphabetical order):

- Avaya (formerly Lucent Technologies)
- Cisco Systems
- Hewlett Packard
- IBM
- Intel
- Linksys (now a Cisco subsidiary)
- Proxim (formerly Agere Systems)
- Symbol

Radio Frequency (RF)

The term "radio frequency" can be applied to any wireless technology that uses radio waves to communicate. By the 1980s, RF became synonymous with hand-held devices used in grocery stores and warehouses to take physical inventories by scanning bar codes. Today, that technology has moved on to use Wi-Fi.

However, RF technology has been enhanced over the years to become the premier wireless transmission platform for distances under 30 miles. Known as "long haul" RF, this technology is used by private parties to connect computer systems that are long distances apart. Private club examples could be:

- A main clubhouse with a second clubhouse several miles away;
- A main clubhouse with a realty/administration building several miles distant;
- A main clubhouse with a golf course maintenance facility a mile or two away.

Here's what RF requires:

Clear Line of Sight — Needed to allow the RF signal to travel between the two communication points. A few tree branches and leaves can be accommodated by the RF signal, but buildings, or natural barriers, such as hills, will block an RF signal.

Transmitters — Electronic "boxes" the size of a desktop PC, which contain the electronics needed to generate the RF signal. A transmitter is installed at each location, connected to a network switch or hub.

Antennae — Are installed on the exterior of the buildings to transmit and receive the RF signal.

Relay Stations — Connect RF signals for end points which have no direct line of sight with one another. Two antennas are needed to relay a signal — one to receive the signal and one to relay it to the final destination.

RF solutions come in different flavors, defined by transmission speed and distance limits. A minimum configuration will provide T-1 speed (1.544Mbps), which will handle 50-100 users with Internet access and e-mail, or 24 voice circuits (or a combination of voice and data), for up to over a five miles distance. Using T-1 speed might require the use of thin client technology to reduce bandwidth demand if software applications, such as accounting or POS, are transmitted. The average one time cost of a T-1 speed solution is about $6,000, inclusive of two transmitters, two antennas, installation, and configuration. Compare that to the average cost of a T-1 telephone circuit ($250 or more per month), and the cost advantage of RF is obvious.

For $12,000-$15,000 a more powerful 12Mbps RF solution can also be employed, providing about the same bandwidth as a traditional Ethernet LAN (still commonly used by many clubs as a 10BaseT network), for up to 20 miles distance. The real beauty of RF is low overall cost and high bandwidth, as compared to leasing telephone circuits. For most private clubs interested in connecting computers located miles apart, RF will be the wireless solution of choice.

The downside is that RF is susceptible to signal interference from a wide variety of sources, be it police radios, cell phones, or airport radar. Data, whether on hard wires or wireless, is transmitted in "packets" (think of a train of boxcars filled with scrambled information that is re-assembled in proper sequence when it reaches its destination). Interference corrupts packets, which will cause the RF system to re-transmit them and will slow data throughput. As with other wireless systems, RF is vulnerable to hacking and tight security must be exercised. While not entirely impermeable to hacking, the equipment required to

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perform a successful hack is so expensive and complicated that security of long haul RF is not as big an issue as with 802.11, but most organizations encrypt all wireless transmissions to be safe.

Microwave

Microwave communications have been in use by telephone companies for more than 50 years, primarily for telephone voice service. Microwave involves the transmission and receipt of high frequency radio waves (at a frequency of billions of hertz, or GHz) by special antennas. In effect, microwave is simply RF at a higher frequency. Microwave was originally designed to save telephone companies from stringing wires through difficult terrain such as mountains, valleys and forests, or where they could not obtain the necessary rights of way. But microwave communication can be greatly affected by adverse weather conditions such as heavy rain, snow, and fog.

Microwave is capable of handling thousands of simultaneous telephone calls and data transmissions, but is limited to line of sight and a maximum of 15-20 miles between antennas and signal repeaters. There are microwave solutions available that would be useful for private clubs, for direct distances up to 25 miles. Microwave can provide network speeds from 2Mbps to 155Mbps over that distance. Because microwave is simply high-frequency RF, the cautions and limitations discussed above with RF also apply to microwave.

Laser

Laser is widely recognized in telephony as the signal generator for fiber optic cable communications. However, lasers are also used to provide wireless voice and data communications at distances of up to one mile. Laser wireless is typically used to interconnect buildings in a campus environment. Transmission speed typically runs at T-1 (1.544Mbps) or better (maximum of 155Mbps), depending on distance, optics used, and other environmental factors. Laser transmitters look like security cameras mounted on the outside of the buildings, and must be pointed directly at each other, with an absolute clear line of sight.

The key problem with laser wireless is physical interference — if something comes between the transmitter and receiver (a flying bird, for example), the transmission is broken and has to be restarted. Inclement weather that decreases visibility can also impair or completely disrupt the transmission, particularly at the greater distances between the transmitters.

Conversely, laser is unaffected by competing wireless transmissions. Laser costs for equipment, installation, and configuration are about the same as an RF T-1 solution, but its effective distance is much shorter (one versus five miles). That makes laser a good choice for building-to-building connections where wireless interference is an issue.

Satellite

Satellite communication uses a ground station (dish) pointed at a communication satellite positioned approximately 22,300 miles above the earth's surface, in a geo-synchronous (stationary) orbit. Most dishes for satellite telecommunications are three meters in radius or larger. Satellite communication can be adversely affected by heavy clouds, fog, rain, and snow. And you must have clear access from the dish to the satellite position in the sky. Satellite communication suffers from transmission delays (latency) because of the time it takes a signal to travel from the ground to the satellite and back, which can create a problem with some computer applications.

Unlike RF and laser, the satellite would be best used by clubs for Internet access. If your club is located in an area with no ready access to high-speed Internet service (such as DSL, cable modem, or T-1 circuits), satellite service may be a viable alternative. The speed (bandwidth) of satellite communication is only limited by available transponder capacity on the satellite, and the amount you are willing to pay for that capacity. Typical pricing for 128Kbps service is about $100 per month — not cheap. So satellite may serve as a "last ditch" effort to secure basic Internet access and e-mail for your club. Hughes Electronics and MCI offer satellite-based Internet access in North America.

Infrared (IR)

Infrared (also known as IR or infrared light) was originally used in remote controls for television sets and other home appliances. These remote controls operate in diffuse

or "scatter" mode, which means that while the user has to be in the same room as the device being controlled, the remote does not have to be pointed directly at the device.

Infrared was adapted for use by computers in the early 1990s. These IR transmissions operate in "line of sight" or directed mode, meaning that the two communicating IR ports must point at each other to properly communicate. IR is currently used by wireless mice and keyboards, wireless connections to printers, and to transfer files between computers. IR transfers computer information at about 2Mbps between devices that cannot be more than about six feet from each other. It's designed to be a "convenience" factor in occasionally transferring files from one PC to another, and to operate devices remotely or having wireless access to a printer.

Bluetooth

Bluetooth is the Wi-Fi equivalent of IR and has the same transmission and reception characteristics, with the exception that Bluetooth can transmit through solid walls and is omni-directional. Bluetooth typically has a six to eight foot transmission range and operates in the 2.4GHz bandwidth, the same as 802.11b Wi-Fi. Because of the limited distance issues, Bluetooth is primarily used to wirelessly connect cellular telephones to PDA's, or wireless headsets and microphones to cellular phones, and generally to connect other devices that are used in close proximity to one another.

Cellular

Everyone is familiar with cell phones, but many people are not aware that cellular telephony is capable of computer communications. Most of today's digital cellular telephones have the capability of acting as a cellular modem for a PC. A special cable is used to connect the cell phone to the PC's USB or serial port. For older generation phones, an additional fee is charged for this service by the cell phone service provider. Or the fee is bundled into the voice/data service package with more advanced PDA-type phones.

The key problem with cellular wireless is speed. Most cellular systems run around 19.2Kbps. This is much slower than dialup access through a normal telephone line of 38Kbps to 56Kbps. Plus, signal strength dictates the actual transmission speed you can achieve (a weak signal reduces the transmission speed).

Cellular telephone providers are introducing newer digital services that raise the transmission rate to near hard-wire speeds (40 to 60Kbps). Future services are expected to increase speeds to the DSL equivalent of 1.44Mbps. While adding to the convenience of wireless connectivity, these higher communication speeds are also accompanied by significantly higher costs, which will likely limit such access to only those times when you urgently need wireless cellular access. In other words, cellular wireless is meant for "emergencies," or for the "truly mobile" person who is perpetually on the go and unable to stop to hook up to a land line telephone. The typical cost of wireless cellular Internet service is $100 per month or less in addition to voice service.

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Wireless — The Bottom Line

The rule of thumb on Wi-Fi wireless should be as follows: Whenever possible, PCs should be "wired" (copper or fiber) with a minimum of switched 100Mbps to the system. Wireless should only be used in situations where it's either not convenient to wire, or you can't wire. Today's wireless devices shouldn't be used as an overall replacement for wired devices in your club. There's a strong probability that that situation will change going forward.

RF, microwave, and laser wireless solutions offer clubs great alternatives to leased telephone circuits for connectivity over long distances. And for clubs located in areas with no available DSL, cable modem, or T-1 service, satellite offers a potential last ditch connectivity option. Infrared, Bluetooth ,and Cellular are interesting technologies, but have little impact on private club systems that require "long distance" connectivity. Keep in mind that all wireless solutions are sensitive to weather-related problems, and signal interference can cause outages. If the communications link must be available at all times, more traditional connectivity links may still be necessary.

The key to successful implementation of 'long-distance' wireless technology is engaging a knowledgeable wireless communications specialist (NOT your regular IT or network consultant) to determine the appropriate solution(s) that meet your communications requirements. Wireless communications

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specialists have the equipment to test signal strength and other variables, access to government databases to locate transmitting equipment that might interfere with your club's devices, and topology maps for use in antenna placement. If you're even considering a long-distance wireless solution, hire an expert — and do it right.

Bill Boothe is director of club/resort technology consulting for RSM McGladrey, Inc., one of the nation's largest business services providers. He has assisted more than 300 private clubs and resorts with the planning, evaluation, selection, and implementation of computer technology in all facets of their operations. Bill has published numerous articles, is a frequent speaker at hospitality conferences, and is the author of the national newsletter ***Private Club Technology Update****. He can be reached at bill.boothe@ rsmi.com, or at (561) 682-1638. Jeffrey B. Hall, CISSP, GSEC, CISM, Manager Director with the RSM McGladrey, Inc. Integrated Technology Solutions Group, was a contributing author for this article.*

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