

Chapter 24

Web, Wi-Fi, Wireless and PC Technology

The personal computer (PC) and Internet have surely changed many lifestyles — young and old and those in between. Hams have always embraced technology, and they have used the PC and Internet to greatly enhance and improve the ham radio experience in many ways! Hams with an interest or passion in virtually all interests (homebrewing, DXing, contesting, digital modes, satel-

lites are but a few examples) now take for granted nearly instantaneous access to information and specialized Web sites. Computers are routinely used for operating digital modes, logging contacts, tracking satellites, controlling stations locally or remotely, software defined radio and a host of other applications.

In this chapter, in addition to touching on how hams are using PCs and the

Internet, we will also review the personal/commercial *wireless* world around us that is extraneous to ham frequencies, equipment or operation. This chapter was written by Donald R. Greenbaum, N1DG, and Dana G. Reed, W1LC. It also includes additional contributions from John J. Champa, K8OCL, Reed E. Fisher, W2CQH, Howard S. Huntington, K9KM, and Ronnie P. Milione, KB2UAN.

The Internet and World Wide Web

SEARCH ENGINES

The Internet encompasses millions and millions of pages of information. Unless you know exactly what you are looking for, there is simply too much information on the subject of ham radio to find without properly using search engines. There are countless ham radio Web sites created by individuals, clubs, organizations and commercial vendors. The Web sites listed in the sidebar “A Ham’s Guide to Useful Internet Sites” offer just a small taste of what’s available.

In any event, the best way to locate ham radio Web sites for your particular interest is to use one of the popular search engines: *Google, Yahoo, Ask, Alta Vista, Dogpile* and *Look Smart* are among the more popular. The secret to a successful search is to be specific by limiting the results or *hits*.

Although most search engines are pretty good at ranking results in a useful order, simply typing *ham radio* as the topic of

Search Engines — Electronic Parts and Cross Referencing

A QRP list member was trying to search, or cross reference, a semiconductor in Google, but without success. He had probably only entered the exact part number. The part was described as possibly of one family of semiconductor, but apparently in Google he used the part number “IRF331A” which indeed comes up blank.

However, a knowledge of manufacturing prefixes or numbering systems used for semiconductors or other components can be very valuable. Originally, IRF was the prefix for International Semiconductor Parts. Entering that in Google.com, I came up with a Web page: **www.irf.com**. From there, I came to a search engine on the page that eventually led to their cross reference guide — and the fact that the IRF331A can possibly be replaced (depending on the application) by the IRF330. However, an upgraded part is the IRF440, or the 2N6760.

Knowing a general supplier of replacement semiconductors, my next stop — had this not worked out — would have been **www.NTE.com**. The main point here is to study distributors catalogs, for knowledge of part-numbering conventions for whatever electronics you might need. Get to know company logos that are applied to parts as these will shorten your searches if the company still exists, using that logo. For the totally unfamiliar part, a logo can be very helpful to focus your search.—*Stuart Rohre, K5KVH*

A HAM'S GUIDE TO USEFUL INTERNET SITES

The Web is all about change, so it's difficult to present a comprehensive list in an annual print publication. Here are a few general ham-related sites to get you started. Many more are linked from these sites. If you don't find what you're looking for, try your favorite search engine.

ARRL: www.arrl.org Where else would you go for ham radio news?

AC6V: www.ac6v.com/ Rod has links to over 6,000 other radio related sites covering all topics imaginable.

AA1V: www.goldtel.net/aa1v/ Don has the usual DX links plus some pretty good NASA links not found on other sites.

DX Zone: www.dxzone.com/ A good commercially-run site that is well laid out providing 7000 links to other commercial and private ham run sites.

425 DX News: www.425dxn.org/ Good Italian non-commercial site for DX News and links to DX-related sites.

K4UTE: www.nfdxa.com/K4UTE/K4UTE.HTML One of the best sources of QSL routes and links to other DX-related activities.

NG3K: www.ng3k.com/ Want to know who's going where and the link to their Web site? Since 1996, Bill has been keeping track of these things on this Web site and has everything archived for searching.

QSL.NET: www.qsl.net AI, K3TKJ, provides free hosting to thousands of hams for radio-related Web pages.

K1BV Awards Directory: www.dxawards.com/ Are you into wallpaper? Ted has one of the best sites for award information and links to those offering them.

MODS: www.mods.dk/ Modifying your radio? Find hundreds of links compiled over the last eight years by Erik, OZ2AEP.

Linux Ham Radio Software Directory: radio.linux.org.au/ Do you prefer Linux to Windows? This site lists Perl scripts ranging from modeling antennas to European Microwave Beacon propagation forecasting.

Satellite Tracking Software: www.satsignal.net

QSL Museum: www.hamgallery.com/ In addition to one of the most complete online QSL collections, Tom (K8CX) has one of the more complete ham radio link sites on the Web.

VOICE OVER INTERNET PROTOCOL — VOIP

Like our airwaves, the Internet can carry our transmissions over great distances. Unlike ham radio, the Internet offers only digital transmission. If we are using an analog mode like voice or video, those modes must be converted into that digital format before sending and converted back to analog upon receipt. Two software packages have emerged to allow hams to converse over the Internet in what is known as *Voice over Internet Protocol*, or *VoIP*. ARRL offers a publication titled *VoIP: Internet Linking for Radio Amateurs* by Jonathon Taylor, K1RFD (check with your favorite ham radio dealer or visit www.arrl.org/shop). The book discusses Amateur Radio VoIP operation in great detail.

EchoLink

Recognizing the growing use of the Internet by hams, Jonathon Taylor, K1RFD, wrote a software program called *EchoLink*. Now even antenna restricted hams can enjoy the fun with a computer, a microphone and an Internet connection. You can connect via EchoLink to other licensed hams on computers, mobiles transmitting through repeaters linked to the Internet via connected VHF repeaters, and even nodes connected via HF. There are well over 100,000 registered users worldwide using EchoLink. There are also conference nodes, some specific to other hobbies such as aviation. It is the ultimate party line encompassing computers, radio and the Internet. Like radio, it is not a duplex mode; both stations cannot talk at once. The software is free (you must have a ham radio license) and is downloadable from www.echolink.org. The software is very user friendly, and all control features are click-of-a-mouse enabled. The only requirement of your PC is a sound card and microphone.

IRLP

Unlike Echolink, which allows two hams to communicate without either having a radio, the *Internet Radio Linking Project (IRLP)* takes a different approach to VoIP. David Cameron, VE7LTD, designed the software to provide a simple and easy system to link radio systems together using the Internet as the communications backbone.

The system is Linux based and requires a Linux-based Pentium PC running *Speak Freely* software, an interface card (purchased inexpensively from VE7LTD), your radio and a sound card. Your sound card takes the analog audio from the radio, converts it to compressed digital packets and sends short streams over the Internet to the connected nodes via the interface card. The control software controls the packets

interest to you is not sufficient. For example, a query on *ham* yields links to Web sites mentioning ham radio, ham (the food) and other hits totaling more than 100 million pages! A more specific search of *ham radio* reduces the page count to 25 million pages. Narrowing and refining your search is as simple as adding more specific words, sometimes called *keywords*, and choosing them wisely will reduce the page count to manageable levels. *Ham radio software* reduces our search to 19 million pages while *ham radio dsp software* reduces it to 500,000 pages.

You can keep refining your search by adding keywords. Most search engines offer various options to help narrow your search. These are found in a section called something along the lines of *advanced search*. For example, searching for the exact phrase "*ham radio software*" returns 40,000 hits and "*ham radio dsp software*" brings it down to a handful.

Search engines are a great help for locating parts and component data for construction projects. For example, later in this chapter we discuss isolation transformers and specify a RadioShack part. A search for *radioshack 273-1374* brings you right into the RadioShack online catalog with information on ordering this part. It's possible to be too specific in searches. Sometimes the part number can be too exact, and adding either a manufacturer or looking up the description of *isolation transformers* are a broader alternative that will help if the specific part search comes up negative. See also the sidebar, "Search Engines — Electronic Parts and Cross Referencing."

Another way to find ham radio related Web sites is to browse one of the link sites. A number of good sites like the one shown in **Fig 24.1** are run by hams and dedicated to collecting thousands of links to Web sites of interest. They are usually arranged by topic as well as alphabetically by name.

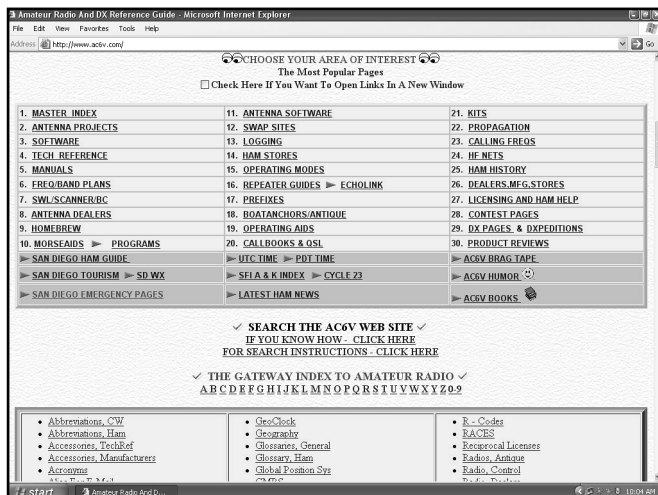


Fig 24.1 — AC6V's collection of links to thousands of ham radio Web sites can provide hours of exploration.

along with continuous tone coded subaudible squelch signals (CTCSS) to start and stop the streams. CTCSS is also used to pass commands that specify which node to connect to, start and stop the connection and a host of other settable parameters to control the process. Streams can be sent to one or many nodes.

The software, interface cards and all manuals are available from www.irlp.net (see Fig 24.2).

PROPAGATION FORECASTING

One of the most valuable pieces of information available on the Web is the various real time propagation statistics and tools. Current gray-line paths are vital to the LF operator. MUF values are helpful to HF operators. Current observed sunspot activity, solar storm indexes and other data are posted on various ham and government

Web sites. Current solar flux numbers are published by the Canadian Space Agency as monitored at its Penticton Observatory: www.drao-ofr.hia-ihh.nrc-cnrc.gc.ca/.

Since auroral activity is harmful to HF transmissions over the globe, NOAA provides both North and South Pole real time auroral maps: sec.noaa.gov/pmap/. Knowing which frequencies are usable in real time is also as handy a propagation tool as a ham could want. As shown in Fig 24.3, a real-time graphic can be found at the Solar Terrestrial Dispatch Web site, www.spacew.com/.

INTEREST GROUPS

No matter where your ham radio interests lie, there's likely one or more Web sites or discussion groups dedicated to your topic. Looking for a new rig? You'll find Web sites and discussion groups

where owners share opinions, tips and information on most current radios. Are you collecting or restoring vintage gear? The 'net has a wealth of information from individuals and clubs interested in similar radios (Fig 24.4). Sites devoted to DXing,

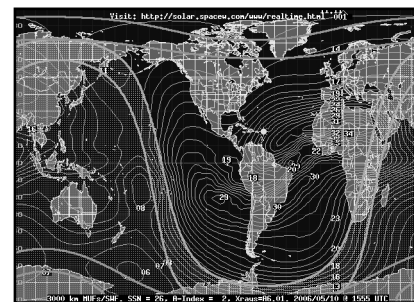


Fig 24.3 — Maps like this one from www.spacew.com display maximum usable frequency in real time.



Fig 24.4 — The Internet is home to the Web sites of countless clubs and organizations like the Collins Collectors Association.

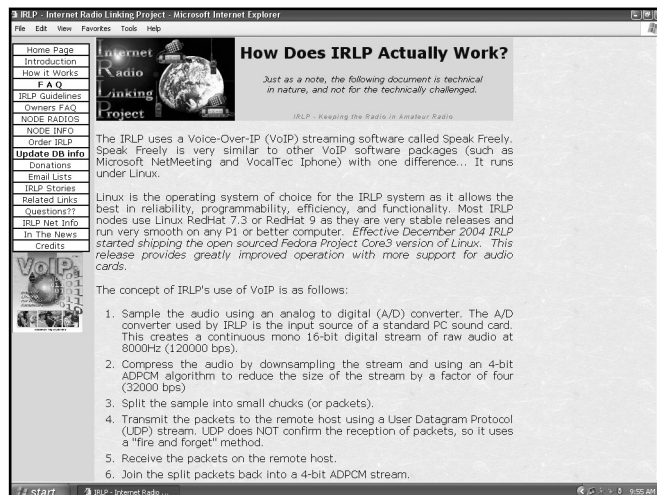


Fig 24.2 — IRLP links radio systems together via the Internet.

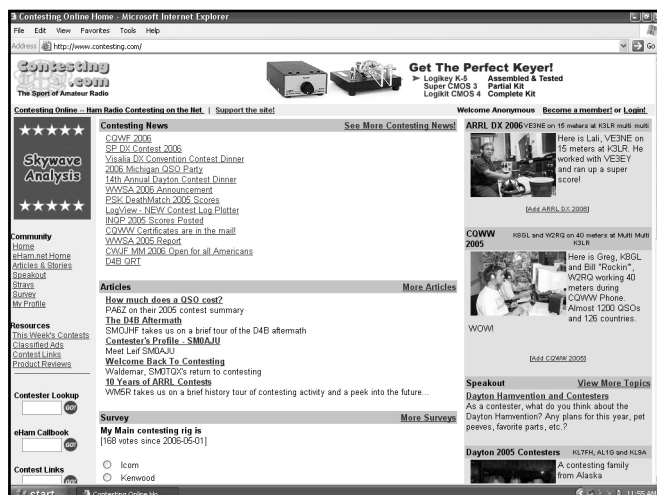


Fig 24.5 — Contesting.com is but one example of the many Web sites devoted to specific Amateur Radio modes and activities.

contesting (**Fig 24.5**), emergency communications, digital modes, QRP, AM, VHF/UHF, ATV and just about any other activity will help you get started or become more proficient. It's never been so easy to explore the many and varied ways that hams enjoy their hobby.

VIRUS PROTECTION AND FIREWALLS

No Internet user should be connecting to the Web without up-to-date virus protection. Norton Antivirus and McAfee are the two most popular commercial products. There are also some

shareware products available.

Virus protection alone does not offer full protection from intruders. Hams increase the risk of being infected by opening ports to allow IRLP, Telnet, Instant Messenger, VoIP or FTP applications. The solution here is installing a *firewall*. Firewall and other security features are built into later versions of *Windows XP* or you can choose third-party software from a number of vendors. They detect both internal and external attempts to compromise your personal computer (PC).

A more expensive but more capable solution is a hardware-based device com-

monly known as a *firewall appliance*. In addition to the simple intruder detection found in firewall software, they contain an intruder *prevention* system, the ability to connect multiple PCs (as a router or switch), monitor ability on all traffic in and out of the network, open secure ports (VPN) and automatically obtain updates to firmware.

No matter what virus protection and firewall you are running, it's very important to keep it current and effective with regular updates. In addition, it's important to regularly check for security updates for your operating system software.

Wi-Fi Glossary

Access Point (AP) — A wireless bridging device that connects IEEE 802.11 stations to shared resources and a wired network such as the Internet.

Ad Hoc — In wireless LAN (WLAN) networks this is a direct wireless connection between two laptop computers without the use of an AP.

AP — Access point.

Carrier Sense Multiple Access / Collision Avoidance (CSMA/CA) — The wireless method that tries to avoid simultaneous access or collisions by not transmitting, if another signal is detected on the same frequency channel.

Direct-Sequence Spread Spectrum (DSSS) — The type of modulation used in

802.11b that is capable of maximum half-duplex data speeds of 11 Mbps.

Frequency Hopping Spread Spectrum (FHSS) — A type of modulation used in early 802.11 devices that uses a time-varied narrow signal to spread the signal over a wide band. Maximum half-duplex data rate is 2 Mbps.

Institute of Electrical and Electronics Engineers (IEEE) — The professional standards setting organization for data networking devices.

Orthogonal Frequency Division Multiplexing (OFDM) — A type of modulation that splits a wide frequency band into many narrow frequency bands. Both 802.11a and 802.11g use OFDM.

Service Set Identity (SSID) — The identification for an AP. It is transmitted continuously in the form of a beacon.

Wired Equivalent Privacy (WEP) — A standard for providing minimal privacy of wireless LAN communication by encrypting individual data frames.

Wireless Fidelity (Wi-Fi) — The Wireless Ethernet Compatibility Alliance certification program to ensure that equipment claiming to be in compliance with IEEE 802.11 standards is truly interoperable. The term Wi-Fi5 is sometimes applied to 802.11a equipment that operates on the 5-GHz band.

Wireless Fidelity (Wi-Fi)

COMPUTER CONNECTIONS BY RADIO

Wireless local area networks (WLAN) using spread spectrum transmit in the 902-MHz range (802.11), in the 2.4-GHz frequency range (802.11b and 802.11g), and in the 5-GHz frequency range (802.11a). Combining spread spectrum transmission's characteristics with a low power output (30 to 100-mW range) means it is highly unlikely that one spread spectrum network user will interfere with another. Spread spectrum transmissions distribute or "spread" a radio signal over a broad frequency range. There are various techniques for doing this spreading.

The older WLAN systems operate in the 902-MHz range based on the IEEE 802.11 standard and use frequency hopping spread spectrum modulation, or FHSS. This modulation technique uses what is called a predetermined pseudo-random sequence to transmit data. This pseudo-random sequence is actually a predetermined digital signal pattern that places data on a combination of frequencies across the entire spread spec-

trum channel. The receiving station must know the specific signal pattern used by the transmitting station to decode the data. These early 802.11 systems generally operated with slightly higher power (250 mW) but at much slower data rates of typically 2 Mbps.

New-Generation WLAN

The first of the new generation of WLAN systems is based on the IEEE 802.11b standard and use a modulation technique known as direct-sequence spread spectrum, or DSSS. This modulation technique achieves higher data rates by using a different pseudo-random code known as a Complimentary Sequence. The 8-bit Complimentary Sequence can encode 2 bits of data for the 5.5 Mbps data rate or 6 bits of data for the 11 Mbps data rate. This is known as Complimentary Code Keying (CCK).

The latest generation of WLAN devices are based the same type of modulation, Orthogonal Frequency Division Multiplexing (OFDM) but operate on different

frequency bands. OFDM provides its spreading function by transmitting the data simultaneously on multiple carriers. 802.11g operating in the 2.4-GHz range and 802.11a operating in the 5-GHz range both specify 20-MHz wide channels with 52 carriers spaced every 312.5 kHz. OFDM radios can be used to transmit data rates of 6, 9, 12, 18, 24, 36, 48 and 54 Mbps.

The WLAN Advantage

The main advantage of WLAN systems is that the laptop PC users are not tied to an RJ-45 type of wall outlet. At home they can roam between the home office and the patio. At work, they can move with ease between an office and a conference room, for example.

There is a significant economic advantage for businesses relocating office areas. With the use of WLAN technology, it is not necessary to spend the time and money to rewire an entire floor or building. These small radio devices with their small antennas and low power can readily

transmit through several layers of drywall.

If more than one access point, or AP, is required to cover the business area, several AP devices can all be linked together by putting them in the same virtual LAN in the wired network. Consequently, rather than having to wire each individual office and conference room, only the various AP nodes need to be wired together. This can produce a huge savings in time and expense.

WLAN Security

Although the majority of WLAN oper-

ate in the open mode allowing anyone in the area convenient access the network, often a minimum level of information security is desirable. This can be provided by using a WLAN encryption protocol built into the equipment called Wired Equivalent Privacy, or WEP.

For those situations requiring a higher level of security, most commercial firms simply re-employ their virtual private network (VPN) or tunneling strategy commonly used to allow secure network remote access for mobile workers and teleworkers. However, in the case of

WLAN use, extra steps need to be taken to ensure that the VPN user ID and password are not being wirelessly transmitted in the clear without some form of encryption. A new WLAN security standard called IEEE 802.1x attempts to address this need but is currently plagued with interoperability issues.

Wi-Fi systems being used in Amateur Radio applications are typically referred to as High Speed Multimedia (HSMM), and these techniques are discussed in detail in the HSMM section of the **Modes and Systems** chapter of this *Handbook*.

Wireless Technology Glossary

AMPS (Advanced Mobile Phone Service) — First standardized cellular service in the world, released in 1983. Uses the 800-900 MHz frequency band.

Analog — A signal that can vary continuously between a maximum and minimum value. For example, the voice voltage waveform from the output of a microphone is analog. RF voltage waveforms (as those from AM, FM and SSB transmitters) are also analog.

Cap Code — A specific address encoded into both a data transmission and the intended receiving equipment so the receiving equipment can discriminate against unintended or unwanted messages.

CDMA (Code Division Multiple Access) — A digital radio system that separates users by digital codes.

Cellular — Characteristic of or pertaining to a system of wireless communication made up of many individual cell units. The term itself is derived from the typical geographic honeycomb shape of the areas into which a coverage region is divided.

CELP (Codebook Excited Linear Predictive coding) — A type of low-bit-rate voice coder that emulates a single human voice tract. Details can be found in Ref. 3 at the end of this chapter.

CSMA/CD (Carrier Sense Multiple Access / Collision Detection) — A set of rules that determine how network devices respond when two devices attempt to use a data channel simultaneously (called a *collision*). After detecting a collision, a device waits a random delay time and then attempts to re-transmit the message. If the device detects a collision again, it now waits twice as long to try to re-transmit the message.

DHCP (Dynamic Host Configuration Protocol) — An external assignment mechanism that provides a “care-of address” to a mobile client (see also *Foreign Agent*).

Digital — A signal that has only discrete values, usually two (logic 1 and logic

0), that changes at predetermined intervals. The value (e.g., voltage) present in a single time period is called a bit. The number of bits transferred per second is called the bit rate that has units of bits per second (bit/s), or kilobits per second (kbit/s), etc.

E-mail — Electronic mail sent and received via computers with modems. Transmission media can be existing telephone or other communication lines, wireless, or not uncommonly both.

Encode — The process whereby a transmission contains additional data or code added to facilitate proper routing of the transmission to the desired point or points.

Encryption — Technology used to form a secure channel between a wireless client and the server to support user authentication, data integrity, and data privacy.

ESN (Electronic Serial Number) — A manufacturer-assigned identity contained in a data transmission from a call placed to verify that the hardware used belongs to a valid cellular account.

Ethernet — A local-area network (LAN) protocol. Ethernet uses a bus or star topology and supports data transfer rates of 10 Mbit/s, 100 Mbit/s, 1 Gbit/s and 10 Gbit/s. Ethernet uses the CSMA/CD access method to handle simultaneous demands, and is one of the most widely implemented LAN standards.

FDMA (Frequency Division Multiple Access) — A radio system that separates user channels by frequency. Amateur Radio equipment presently uses FDMA.

Footprint — The coverage area of an individual cell.

Foreign Agent — A special “node” which is present on a foreign network and provides mobility services to visiting mobile nodes.

GPS (Global Positioning System) — A Department of Defense-developed, worldwide, satellite-based radio navigation system.

Handoff — Process whereby a mobile telephone network automatically transfers a call from cell to cell — possibly to another channel — as a mobile crosses adjacent cells.

Home Agent — A host on a mobile’s home network responsible for trapping its packets, and forwarding them to the mobile’s present location.

LAN (Local Area Network) — A computer network that spans a relatively small area. Most LANs are confined to a single building or group of buildings. However, one LAN can be connected to other LANs over any distance via telephone lines and radio waves. A system of LANs connected in this way is called a *wide-area network* (WAN). Most LANs connect workstations and personal computers. Each *node* (individual computer) in a LAN has its own central processing unit (CPU) with which it executes programs, but it is also able to access data and devices anywhere on the LAN. This means that many users can share expensive devices, such as laser printers, as well as data. Users can also use the LAN to communicate with each other, by sending e-mail or engaging in chat sessions.

Mobile Host — Also known as a “mobile node,” this addressed entity in the Mobile IP protocol roams between its home network and foreign networks.

Mobile IP — This mobile industry standard enhances the IP protocol to remedy problems associated with using the standard TCP/IP with a mobile entity. It allows for transparent routing of IP datagrams to mobile hosts (nodes) on the Internet.

Modem — A hardware device, either internally or externally connected to a computer that provides a connection from the computer and some of its programs to a landline (phone or communications line).

Network Independence — The ability to roam among networks (e.g., BellSouth Wireless Data Network, CDPD, Wireless

LAN, Ethernet), although traditionally accomplished using the same access media such as SLIP, PPP, etc.

Node — A unique host on a network such as a printer, computer device, handheld Personal Digital Assistant (PDA), or a mainframe.

PCMCIA (Personal Computer Memory Card International Association) — An organization consisting of some 500 companies that has developed a standard for small, credit card-sized devices called *PC Cards*, originally designed for adding memory to portable computers.

PDA (Personal Digital Assistant) — A handheld device that functions as a personal organizer. Many PDAs began as pen-based, i.e., using a writing stylus rather than a keyboard for input, thus utilizing handwriting recognition features. Some PDAs feature voice recognition technologies. At present, most PDAs offer either a stylus or keyboard version.

POS (Point of Service) — A new generation of narrowband digital, two-way, low-powered wireless services in the 800-900 MHz bands that will support confirmed delivery of message, full two-way data transfer, voice messaging and connectivity via the Internet.

PPP (Point-to-Point Protocol) — A method of connecting a computer to the Internet. PPP is more stable than the older SLIP protocol and provides error-checking features.

Remote Presence — The ability to establish remote network connections and still appear to be connected to the home network.

Security — The ability to create secure channels for user authentication, data integrity, and data privacy.

SLIP (Serial Line Internet Protocol) — An older method of connecting a computer to the Internet. A more commonly used method is PPP. SLIP is an older and simpler protocol, but from a practical perspective, there's not much difference between connecting to the Internet via SLIP or PPP. In general, service providers only offer one protocol, although some support both protocols.

TCP/IP (Transmission Control Protocol/Internet Protocol) — The suite of communications protocols used to connect hosts on the Internet. TCP/IP uses several protocols, the two main ones being TCP and IP. TCP/IP is built into the UNIX operating system and is used by the Internet, making it the *de facto* standard for transmitting data over networks. Even network operating systems that have their own protocols, such as *Netware*, also support TCP/IP.

TDMA (Time Division Multiple Access) — A digital radio system that separates users by time.

Third Party Mobile IP — An Internet technology solution that provides both wireless and wireline IP network and media roaming/communications to both Intranet and Internet services.

Throughput — The amount of data processed, or transferred from one place to another in a specified amount of time. Data transfer rates for disk drives and networks are measured in terms of

throughput. Typically, throughput is measured in kbit/s, Mbit/s, and Gbit/s.

TIA (Telecommunications Industry Association) — Telecommunications Industry Association, 2500 Wilson Blvd., Arlington, VA 22001. On the Web: www.tiaonline.org.

T1P1 — The wireless group in Committee T1. Alliance for Telecommunications Industry Solutions, 122 G St. NW, Suite 500, Washington, DC 20005. On the Web: www.atis.org.

Virtual Private Network (VPN) — Network created when a mobile user connects a data terminal to a foreign network and establishes a presence equivalent to a direct connection to the home network.

WAN (Wide Area Network) — A computer network that spans a relatively large geographical area. Typically, a WAN consists of two or more local-area networks (LANs). Computers connected to a wide-area network are often connected through public networks such as the telephone system. They can also be connected through leased lines or satellites. The largest WAN in existence is the Internet.

Windows OS — Microsoft *Windows* Operating System.

Wireless Data — Information or “intelligence,” sent or received by wireless transmission/reception without the direct aid of a landline.

WLAN (Wireless Local Area Network) — A local-area network that uses high frequency radio waves rather than wires to communicate between nodes.

Wireless Technology

Most of us hams have an interest in gadgets. In recent years, the public's use of radio waves to communicate on the telephone and via mobile computer networks has increased tremendously. This section of the chapter is written by Ron Milione, KB2UAN, and explains how these wireless systems work. Reed E. Fisher, W2CQH, also contributed to the cellular subsection.

Radio communications have been with us for a long time, with analog voice as the principal application. Today, tens of millions of people in the United States are using two-way radio for point-to-point or point-to-multipoint voice communications.

The past 25 years have seen an explosion in wireless communications and computer technology. The past 10 years have seen the explosion of the Internet. Standing at the center of this convergence is wireless data technology.

Wireless data gives you the freedom to

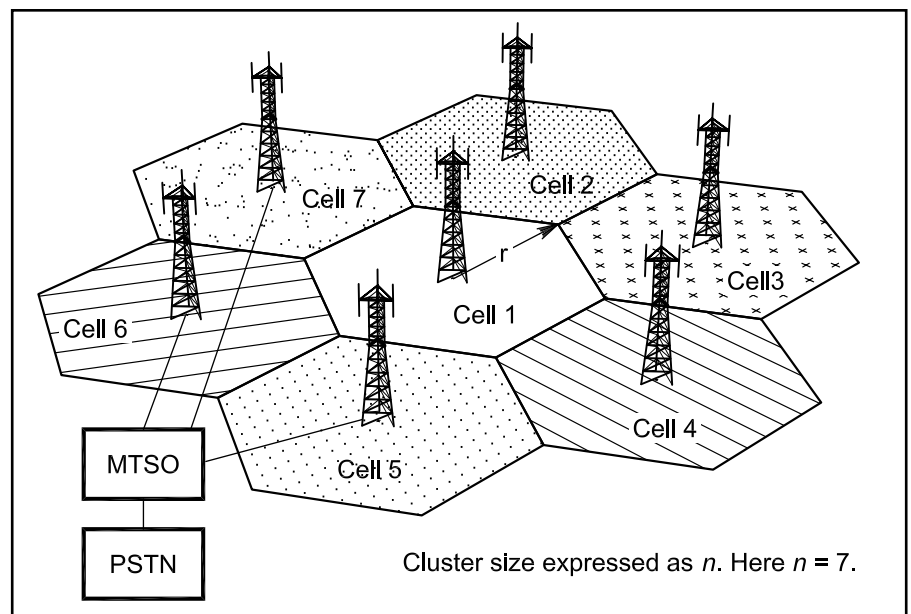


Fig 24.6 — A seven-cell cluster.

work from almost anywhere and gives you access to personal information when you are on the go. Whether the wireless system is accessing e-mail from an airport or receiving dispatch instructions in a taxi, maintaining a data connection with a remote network from almost anywhere can be realized.

Wire or fiber-based data communications span a wide range of *throughput* and distances — 56 kbps over a modem connection; 10/100 Mbps over an *Ethernet* segment; and gigabit speeds over fiber. Similarly, wireless connections span a wide range. The world of wireless data includes fixed microwave links, wireless Local Area Networks (LANs), data over cellular networks, wireless Wide Area Networks (WANs), satellite links, digital dispatch networks, one-way and two-way paging networks, diffuse infrared, laser-based communications, keyless car entry, the Global Positioning System (GPS) and more.

The benefits of wireless include communications when and where no other communication links are possible, connections at lower cost in many scenarios, faster connections, backups to landlines, networks that are much faster to install and data connections for mobile users.

FUNDAMENTAL CONCEPTS IN CELLULAR TECHNOLOGY

In a cellular radiotelephone system the desired radio coverage area is divided up into a number of smaller geographical areas called cells. **Fig 24.6** shows a typical seven-cell ($n = 7$) cluster. Each cell has a radius r , which may be up to eight miles in a startup system. Each cell uses a unique group of radio channels (channel set) that is different from the others. Thus, there is no interference between radio users within a cell cluster. At the center of each cell is located a base station (cell-site) with associated radio tower and antenna system. Mobile stations, located within the cell, communicate with the base station via two-way UHF radio links. The base stations are linked to an MTSO (Mobile Telephone Switching Office) by landline (usually wireline) transmission lines. The MTSO is connected to the PSTN (Public Switched Telephone Network) by additional links. Thus, radio mobile station users can communicate with wireline PSTN users.

Mobile station users can also communicate with other mobile station users, but only through the MTSO and PSTN. The MTSO has other important functions including location and handoff (handover). When a larger serving area is required, cell clusters are placed together as shown in **Fig 24.7**. In this configuration, all cells with the same number use the same channel set. This con-

dition is called frequency reuse, a prime feature of cellular systems. Co-channel interference now becomes important, for a mobile station in cell #1 may interfere with

other mobile stations in the surrounding #1 cells. In **Fig 24.4**, the distance between same-numbered cells is called D . The co-channel interference ratio is a function of D/r

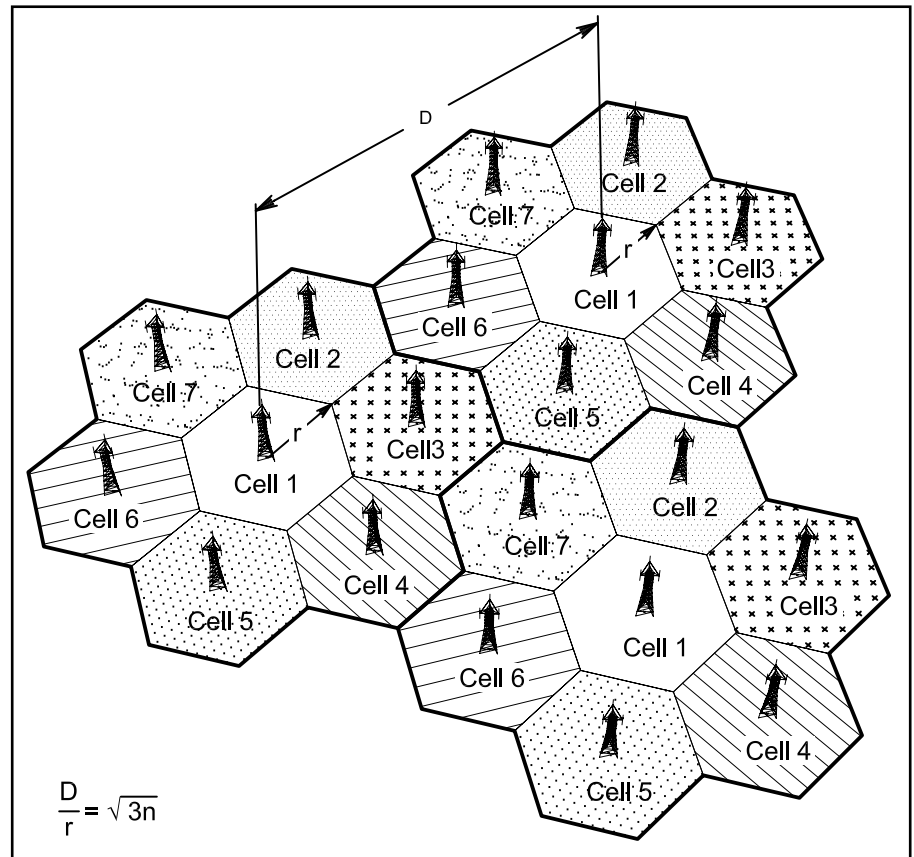


Fig 24.7 — Frequency reuse over an area to conserve spectrum.

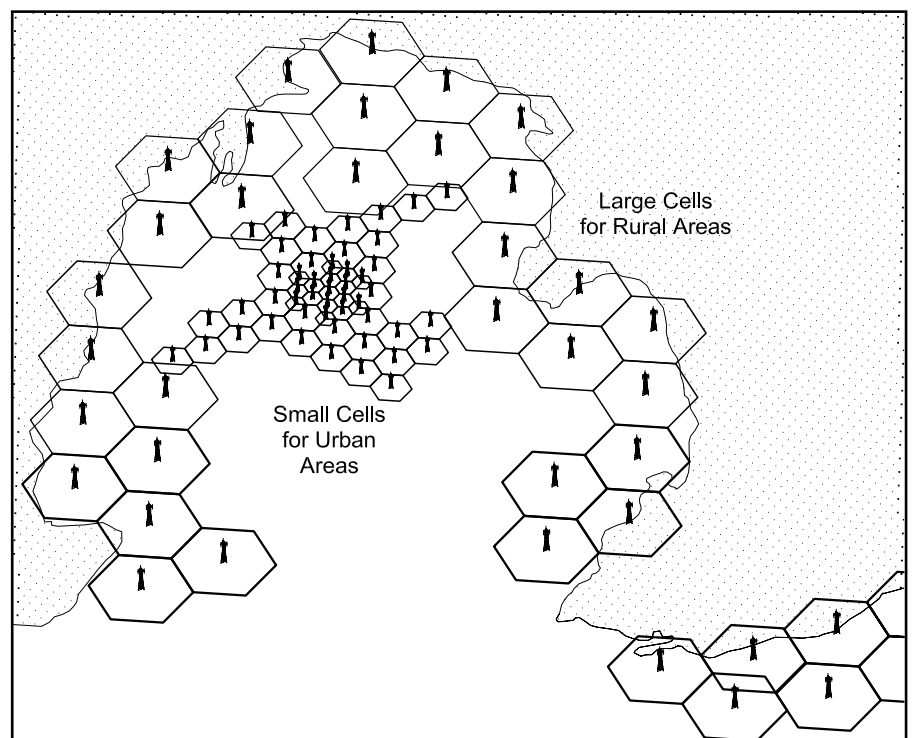


Fig 24.8 — Cell size corresponding to density of population and use.

r. In a hexagonal grid $D/r = \sqrt{3n}$. For $n = 7$, $D/r = \sqrt{21} = 4.58$. For ground-to-ground UHF radio propagation, the received carrier power (C) falls off with distance raised to the 4th power. The worst case C/I (carrier-to-interference ratio) is: $C/I = 40 \log (D/r)$. For $n = 7$, $C/I = 40 \log 4.58 = 26.4$ dB. A properly designed AMPS cellular system requires $C/I > 18$ dB in 95% of the coverage area and this value provides satisfactory voice transmission.

As the mobile station moves away from its serving base station, the mobile station's received carrier power (C) becomes smaller and eventually approaches the system noise floor (N). The cell radius r must be kept small enough to provide a satisfactory carrier-to-noise ratio (C/N). An AMPS system with $r = 8$ miles, serving mobile stations with roof-mounted antennas, is designed to provide $C/N > 18$ dB in 95% of the coverage area.

Fig 24.8 shows the concept of cell splitting, which is another feature of cellular systems. For example, in densely populated regions such as the center of a city, the cell radius can be reduced from eight miles to four miles. Since the C/I is a function of D/r, it is not reduced when D and r are both made small.

CELLULAR AND PCS FREQUENCY BANDS

The 850 MHz cellular frequency band was allocated by the FCC in 1974. Cellular radios operate in the FDD (Frequency Division Duplex) mode that means that both transmitter and receiver are active at the same time. The transmitter of the base station transmits on a forward (downlink) channel, while at the same time the transmitter of the mobile station transmits on a reverse (uplink) channel 45 MHz lower. The cellular uplink band is 824-849 MHz and the downlink band is 869-894 MHz. The bands are divided into two blocks for the two cellular service providers licensed in each coverage area. In 1995, the FCC allocated a new band for a new all-digital, cellular-like service called PCS (Personal Communications Service). The PCS uplink band is 1850-1910 MHz, and the downlink band is 1930-1990 MHz. PCS also uses FDD and the duplex frequency spacing is 80 MHz. The bands are divided into six blocks for the six PCS service providers licensed in each coverage area. There are currently more than 100 million cellular and PCS subscribers in the United States (US).

Cellular Air Interfaces

Air interfaces are the protocol standards used by phone companies to provide cellular voice and data service. The base station, mobile station and MTSO hardware and software are usually implemented with prop-

rietary equipment procured from manufacturers chosen by the cellular/PCS service providers. In contrast, the cellular air interfaces are documented in open (public) standards complying with FCC regulations.

Cellular/PCS standards in the US are generated by the TIA and T1P1, then finally approved by the American National Standards Institute (ANSI). Four standards provide most of the cellular service in the US. Three of the four standards operate in the 850-MHz cellular band. Three different standards operate in the 1.9-GHz PCS band. An obvious disadvantage of multiple air interface standards, and two frequency bands, is the difficulty encountered by "roaming" mobile stations when they enter non-home systems. This problem has necessitated the design of higher cost "dual-band, multi-mode" mobile stations.

AMPS (Advanced Mobile Phone Service)

AMPS was the first cellular system in the US. Service commenced in October 1983 in Chicago. AMPS was standardized by the TIA as IS-553. AMPS is an FDMA (Frequency Division Multiple Access) system that means that user channels are separated by frequency. (Amateur Radio currently uses FDMA.)

The channel spacing is 30 kHz, which allows 832 FDD channels in each 25-MHz band near 850 MHz. AMPS, is an analog/digital system. Voice uses analog PM (Phase Modulation) with a peak frequency deviation of ± 12 kHz. Digital system control, for example, call setup and handoff, uses 10 kbit/s binary FM (Frequency Modulation) with a peak frequency deviation of ± 7 kHz. There is no digital service provided to the users. A user-provided modem must be attached to the mobile station.

At this time, most US cellular customers still use AMPS. (See Ref. 1 at the end of this chapter for a description of a typical AMPS base station.) By 1986, there was already worry that AMPS service might soon become saturated in city centers. There was a competitive effort to design new cellular air interfaces with increased spectral efficiency — more user channels per MHz. It was decided that all future cellular systems must be digital.

There are many advantages to digital transmission above the obvious benefit to users requiring data transmission services. Unfortunately, there are a few disadvantages. Digital has a sharp threshold, so there are no "fringe" coverage areas. The received signal is either excellent, or absent. Digital requires the use of low-bit-rate voice coders and their associated artifacts.

Wireline digital transmission systems encode voice using 64 kbit/s PCM (Pulse Code Modulation) waveform coders that provide

nearly distortion-free coding. Since 64 kbit/s PCM cannot fit into the narrowband radio channels, a number of low rate (eg 8 kbit/s) coders have been devised. Most use the CELP principle that emulates a single human voice tract. Strange sounds may appear at the receiver when the CELP coder is driven by multiple voices, music or background noises. See Ref. 3 at the end of this chapter for a description of CELP and other voice coders.

TDMA (Time Division Multiple Access)

TDMA was the first all-digital US cellular system. TDMA service started in the late 1980s. It was standardized by the TIA as IS-54 and provided three times the traffic capacity of an AMPS system. It was designed to gradually replace AMPS.

The channel spacing was kept at 30 kHz so that TDMA channels could be mixed with AMPS channels. Within each 30 kHz frequency channel are placed three time-divided digital channels. Thus, "TDMA" is actually a hybrid TDMA/FDMA system. QPSK (Quadrature Phase Shift Keying) modulation is used which provides a "raw" channel bit rate of 48.6 kbit/s. The raw user bit rate is $48.6/3 = 16.1$ kbit/s. After bit error control techniques are applied, each user is provided an almost error free 8 kbit/s data service or 8 kbit/s VSELP (a version of CELP) voice coder service.

An upbanded version of TDMA, with enhanced features, operates in the 1.9 GHz PCS band. It is standardized as IS-136.

CDMA (Code Division Multiple Access)

By 1986, some in the cellular industry believed that CDMA techniques would provide more capacity than TDMA. In the US, CDMA was standardized by the TIA as IS-95. CDMA uses the same up and down bands as AMPS and TDMA, but channel spacing is 1.25 MHz. CDMA separates the user bit streams by digital codes. More than 40 users can occupy the same 1.25 MHz frequency channel at the same time.

The "raw" bit rate provided to each user is 28.8 kbit/s. After bit error control, each user is given a 9.6 kbit/s data channel or 13 kbit/s QCELP (a version of CELP) voice service. In this direct-sequence type of CDMA transmitter, the incoming user-generated bit stream (either digital voice or data) is multiplied (exclusive-OR) with a 1.2288 Mbit/s pseudo-random digital spreading code. Each user is given a unique code.

The 1.2288 Mbit/s multiplier output bit stream enters a QPSK modulator, and is then amplified and transmitted with a spreaded RF bandwidth near 1.25 MHz. In the CDMA receiver, the incoming mixed signal — received from all of the active

users — is multiplied by the desired user's unique code that is synchronized with the transmitter code (a challenging task). Only the desired user's de-spreaded 28.8 kbit/s bit stream will emerge from the multiplier. The other codes emerge as wideband noise that is eliminated by a low-pass filter.

Tight mobile station transmit-power control must be used for the CDMA system uplink to achieve its expected capacity. All mobile station transmissions received at the base station should be within a few dB of each other. To achieve this severe requirement, mobile station power output is updated 800 times per second by a base station-generated 800 bit/s power control data stream interspersed into the downlink 28.8 kbit/s data stream.

It is difficult to calculate the user capacity of a CDMA system. The per-channel spectral efficiency of CDMA (40 bit streams in 1.25 MHz) is comparable with AMPS (40 channels in 1.20 MHz). However, CDMA is so resistant to co-channel interference that all CDMA radio channels can be used in all cells ($n = 1$). Therefore, there is a traffic capacity increase of at least seven times that of a standard AMPS system.

An upbanded version of CDMA, with enhanced features, operates in the 1.9-GHz PCS band. It is standardized as IS-95A.

GSM/PCS-1900

GSM (Global System for Mobile Communications) was imported from Europe in the mid 1990s. In the US it operates only in the 1.9 GHz US PCS band. It was standardized by the T1P1 as J-STD-007. It is a TDMA/FDMA system. Frequency channel spacing is 200 kHz and the channel bit rate is 270 kbit/s.

GMSK (Gaussian Mean Shift Keying), a type of narrowband binary FM, is the modulation method. There are eight time slots in each RF channel, so the user raw bit rate is $270/8 = 33.75$ kbit/s. After bit error control, each user is provided a 9.6 kbit/s data channel or a 13 kbit/s RPE-LTP (Regular Pulse Excited-Long Term Prediction) voice coder for voice. The spectral efficiency of GSM (8 bit streams in 200 kHz) is only slightly better than AMPS (8 channels in 240 kHz). This weakness is mitigated by using $n = 4$, a layout tolerated by the more interference-resistant GSM digital transmission. Thus, GSM can handle about twice as much traffic capacity as AMPS.

Radio Link Operating Protocols

The AMPS system uses three protocols for system communication between the base station and the mobile station.

Paging

At least one channel in each cell is used

for paging mobiles with incoming calls from the MTSO. A downlink paging bit stream, the same in each cell, is continuously monitored by power-ON, non-active mobile stations. When a mobile station recognizes its user number, it responds on the uplink-paging channel. The paging stream then hands off the mobile station to a setup channel. Conversely, the mobile station originates a call by sending its request on the uplink-paging channel.

Setup

At least three channels are used in each cell for setup; the mobile station-base station link sets up and tears down calls. After the two-way setup procedure is finished, the mobile station is commanded to tune to its assigned voice channel. Mobile authentication is performed during setup. Each mobile station has a NAM (Numeric Address Module) and an ESN (Electronic Serial Number). The NAM contains the user's telephone number. The manufacturer-assigned ESN is unique. At setup, the MTSO verifies that the NAM and ESN numbers are valid.

Location and Handoff

While an active mobile station is linked to its serving base station, its radio signal strength is also being periodically monitored by the six surrounding base stations. When the averaged signal strength at a neighboring base station exceeds that measured at the serving station, the MTSO commands a handoff to the neighbor. This handoff procedure allows uninterrupted transmission as the mobile station moves through the cell cluster.

Handoff is accomplished by a "blank-and-burst" procedure. The downlink voice channel is interrupted, and a brief 10 kbit/s digital message commands the mobile to move to its newly assigned frequency channel. The mobile station acknowledges, via blank-and-burst on the uplink voice channel, then tunes to the newly assigned channel. If handoff fails, the call is terminated.

The TDMA, CDMA and GSM digital systems use similar procedures. DSP (digital signal processing) techniques provide better authentication and user privacy. Details are found in Ref. 2 at the end of this chapter.

Virtual Private Network

A Virtual Private Network (VPN) is created when a mobile user connects a data terminal to a foreign network, either via dial-in or public networks, and establishes a presence equivalent to a direct connection to the home network.

The Wireless Mobile IP solution is intended to enable the creation of Virtual Private Networks by using the Internet as the communications backbone to connect

mobile users. The following features characterize Virtual Private Networks:

Remote presence — the ability to establish remote network connections and still appear to be connected to the home network.

Network independence — the ability to roam among networks (for example, BellSouth Wireless Data Network, CDPD, Wireless LAN, Ethernet). Traditionally, IP network independence (roaming) is done over the same media access (for example, SLIP, PPP, Ethernet). Virtual Private Network implementation offers the ability to roam across not only single media IP networks, but across multiple wireless and wireline media *without user intervention*.

Security — the ability to help create secure channels for authentication, data integrity, and data privacy.

Third Party Mobile IP — this solution is unique in that it provides wireless and wireline IP network and media roaming/communications to both Intranet and Internet services.

The ability for mobile users to roam seamlessly and without intervention among radio frequency (RF) networks and wireline networks allows the system to operate at maximum system efficiency.

MOBILE COMPUTING

With the rapid growth and availability of wireless data networks, wireless communications tools and Internet standards, mobile workers are finding new ways to do business in today's competitive environment. The need for the mobile worker to access mission-critical information requires access to corporate databases and Internet/Intranet applications. In addition, convenient and reliable file transfer, integrated messaging, and personalized information delivery allow the mobile employee to work at peak productivity levels.

Successful communications between mobile workers and their corporate environment requires the right combination of technologies. From a business standpoint, these technologies must be cost-effective and easy to use. For long-term viability, they should be based on open system architectures and industry standard interfaces.

Virtual Private Networks have emerged to provide networking solutions to a growing mobile workforce. These networks allow businesses to provide their mobile employees with access to corporate information and applications by connecting them to the enterprise via the Internet. A Virtual Private Network provides a low cost extension to the enterprise while offering secure access to an open networking environment.

Mobile IP Security

Mobile IP is an Internet industry standard

that enhances the IP protocol to remedy these existing problems and allow the transparent routing of IP datagrams to mobile nodes on the Internet. Security is an integral part of building a Virtual Private Network solution. The Wireless Mobile IP Network Configuration utilizes Mobile IP encryption to form a secure channel between the Wireless client and server to support user authentication, data integrity, and data privacy in mobile environments.

Using the Wireless Mobile IP encryption, a secure channel is formed which allows various foreign networks to become extensions of the home network.

Mobile IP Benefits

The Wireless Mobile IP solution is intended to enable enterprises to create their own Virtual Private Networks, thus providing:

- 1) Low initial costs
- 2) Low operating costs
- 3) Solution flexibility
- 4) Significant productivity gains

By providing seamless network roaming and communications capabilities, Mobile IP provides a networking solution to bring enterprises into the 21st century.

Many of the spread spectrum devices on the market today are listed as FCC Part 15 devices. There are three frequency bands allocated to this service: 902-928

MHz (26-MHz bandwidth); 2400-2483.5 MHz (83.5-MHz bandwidth) and 5725-5850 MHz (125-MHz bandwidth).

Regulations

In 1999, the FCC greatly liberalized amateur spread spectrum rules, allowing spreading techniques not previously permitted. Amateurs are no longer limited to frequency hopping and direct sequence; any documented spreading code may now be utilized. Amateurs may now freely use SS devices designed under Part 15 of the Commission's rules for amateur applications as well, keeping in mind the identification requirements of the Amateur Service.

The maximum power allowed for an amateur SS emission is now 100 W, up from the previous limit of a single watt! However, stations that transmit more than 1 W must utilize automatic power control to limit power output to the minimum necessary to communicate. For information on the rules change, see Section 97.311 of the FCC rules.

KEEPING CURRENT WITH WIRELESS

Changes to the wireless communications industry have been dramatic since the first mobile phone systems were introduced. The high-tech, expanding nature of this fascinating area will continue to

drive new wireless communication developments. The following are some related Web sites where interested readers can keep up-to-date on this fast-paced technology:

Cellular Communications and Internet Association (CTIA): www.ctia.org

Protocols.com Reference page: www.protocols.com/pbook/cellular.htm

FCC Cellular Services: www.fcc.gov/wtb/cellular/

International Engineering Consortium: www.iec.org/online/tutorials/cell_comm/

Wireless Application Protocol (WAP): www.cellular.co.za/wap.htm

Waveguide, A brief history of Cellular: www.wave-guide.org/archives/waveguide_3/cellular-history.html

Mobile Cellular Technology Newsletter: www.mobilecomms-technology.com/

An overview of cellular technologies: www.ee.washington.edu/class/498/sp98/final/marsha/final.html

References

1. "Advanced Mobile Phone Service," *The Bell System Technical Journal*, Vol 58, No. 1, Jan 1979.

2. V.K. Garg and J.E. Wilkes, *Wireless and Personal Communications Systems*, Prentice Hall, 1996, ISBN 0-13-234626-5.

3. J. Bellamy, *Digital Telephony*, John Wiley, 1991. ISBN 0-471-62056-4.

PC Technology (Personal Computers in the Shack)

The Personal Computer debuted in 1980 with offerings by Commodore (PET), Tandy (TRS-80) and Apple (Apple II). Almost immediately, hams found them to be useful additions to the shack. These first computers were little more than a 4-MHz processor with a little RAM (4 kB), an audio tape drive and an embedded BASIC operating system. One of the first applications available for hams was an RTTY decoder. The age of digital modes for hams was about to expand exponentially.

As the photo in **Fig 24.9** indicates, today the PC is an important part of any radio station. In most cases, it is the control center of the various pieces of equipment we use. You can use it to download from the Web the test questions to study for your exam, learn the Morse code, design your antennas, and even research or buy a new or used radio. It can control the radio, provide various digital modes through the use of the sound card, connect to the Internet for solar flux numbers for propagation prediction, use TELNET for packet spots to help find a DX station, provide software to log QSOs, keep track of award progress and print QSL card labels. The computer can assist the operator

in finding the QSL route to complete the process, or in the case of ARRL's Logbook of The World (LoTW) upload the QSO to a database and perhaps have that confirmation in hours. What could be a more important tool to the operator?

ERGONOMICS

Since the computer will connect to most of your equipment it is usually found in the center of the operating arena. A tower unit on the floor will give it some distance from the RF generators and keep the desk-top free for equipment that you need to handle. A well-designed station will have the keyboard, mouse and keyer (assuming you are a CW op!) all within a 45-degree arc on either side of your operating chair. Use of an LCD monitor will preserve more space on your desk as well as produce less RF interference in the shack.

HARDWARE

The computer itself should be a Pentium class PC running *Windows* with a minimum of 256 MB of memory (more is better), hard drive with 40 GB minimum space, a rewritable CD-ROM drive, serial

or USB ports, and a sound card. Serial ports are becoming a thing of the past; newer PCs have replaced them with USB ports. Commercial USB-to-serial converter devices allow you to connect older DB9-equipped serial devices to the newer PCs. Some hams prefer Macintosh computers or the *Linux* operating system, and requirements are similar.

If you are connecting your radio to the Internet (recommended), you also need to consider a modem or Ethernet port depending on your Internet service provider. To save space on the operating table, locate your PC on the floor if possible (tower) and use an LCD flat panel monitor to preserve maximum desk space — and generate less heat and fewer "birdies" in your receiver.

One of the first things to consider is interference from the radio to the PC or from the PC to the radio. If your radio is properly grounded, your antennas at a proper distance from the shack, and you use well-shielded cables, the chance of RF getting into your PC is remote. It is also good practice to try to keep your radios and computer equipment on separate power circuits.

Computer-to-radio interference often re-



Fig 24.9 — Don, N1DG, keeps his station computer front and center in this neat shack.

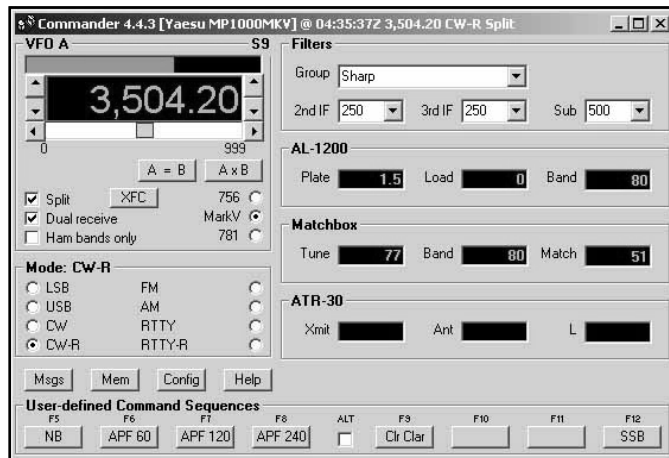


Fig 24.10 — The DXLAB Commander control panel.

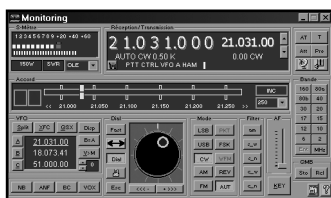


Fig 24.11 — TRX-Manager replicates the radio's front panel in software and supports many rig control functions.

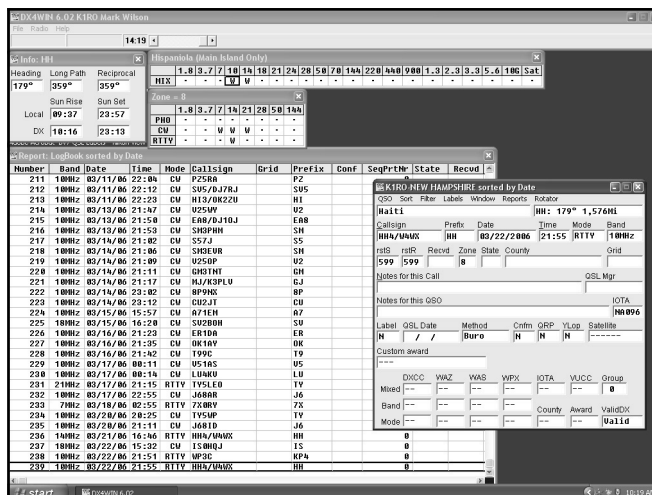


Fig 24.12 — Logging software such as DX4WIN not only logs QSOs but also tracks award credits, prints QSL labels, controls radios and rotators, and assists with a host of other ham shack functions.

sults from poorly designed monitors or leakage from the monitor cables. Whenever adding new computer equipment to the shack it is good to immediately scan the bands to find any new birdies or new noise. Should there be any, shutting off the monitor and then the computer will isolate which of the two pieces of equipment is at fault. In many cases, the installation of toroids on the monitor cable and power, speaker, radio control, keyboard or microphone cables will eliminate the problem.

Most modern radios have some provision for computer interface and control. Some radios are directly compatible, while others require some type of external computer interface device. Until recently, virtually all computer interfaces worked through an RS-232 serial port. Complicating the interface issue is the trend to USB ports instead of serial ports. Fortunately, the commercial ham market has developed good USB-based radio products. Check the ads in *QST* for vendors.

The basic commands to control your radio are available from the radio manufacturer's Web sites or from the instruction manual. You can write your own software or take advantage of the many good ham radio application programs that are available.

Your computer sound card can act as a digital modem enabling you to operate

FSK, PSK, SSTV, FAX and other digital modes. For receiving, connecting the output of the radio to the input of the sound card is simple enough with a stereo cable. Be sure to isolate the two devices with an isolation transformer in the cable (such as a RadioShack 273-1374) to prevent 60-Hz hum from arriving with the signal.

Transmitting is a bit more involved. Some modes (PSK31 or AFSK for example) require another audio cable between the sound card's output and transceiver's mic jack or auxiliary audio input. Once again this connection should utilize an isolation transformer and some type of attenuator to set the right audio level to avoid overdriving the transmitter. In addition, an interface is needed to key the transceiver's PTT line and, in some cases, its FSK RTTY jack. These signals are often generated through the computer serial port's RTS or DTR pins. This type of interface may also be used to connect your computer to your radio for Echolink or IRLP operation. Again, there are a number of commercial products to make sound

card interfacing easier and provide the needed interface to computer serial or USB ports.

Most logging and contest software generates Morse code. The CW keying output from the PC to the radio can come either from a parallel or serial port. Most logging software includes information on building a simple interface using a transistor or optoisolator. There are several commercial products available to solve this problem as well as solutions for computers that have only USB ports. Check the ads in *QST* or search the Web for more information on these devices.

The introduction of *Windows XP* further complicates the software output to serial or parallel ports. *WinXP* no longer allows programs direct access to them. However, there are two programs that will install drivers on your operating system to allow most ham logging and modem software to reach the ports. *Direct I/O* is shareware (www.direct-io.com). *UserPort* is available for free download at www.embeddedtronics.com/design&ideas.html.

SOFTWARE

Radio Control Software

One of the most popular programs is *Commander* by DXLab Software. It is one of many shareware modules by DXLab and this specific program interfaces with the recent radios from Ten Tec, ICOM, Kenwood and Yaesu. Another popular package with similar capabilities is *TRX-Manager*.

Through a graphical interface (**Fig 24.10** and **Fig 24.11**), a click of the mouse allows you to set filters, frequency ranges pursuant to your license class, memories for favorite frequencies and customization for the way you want your radio set up. Modern logging programs include basic rig control features, but for the most part they do not offer as much flexibility (for example, setting filter and menu items) as *TRX-Manager* or *Commander*.

Logging Software

In 1986, two logging programs appeared for MS-DOS based PCs that would inaugurate an easier way of keeping track of operating awards and contesting scoring. The first, the WB2DND *Log Database*, was built around *DBASE III* and became popular among DXers and DXpeditioners. At the same time, Ken Wolff, K1EA, introduced *CT*, optimized for contest operation.

Computerized logging enabled faster contacts, more accurate recording of those contacts, easy scoring and simple QSL management. In 1996, the CE0Z and VK0HI expeditions took computer logging to the next level. They uploaded logs to a Web site so hams could check to see if they were in the log while the DXpeditions were still in progress. Today hams are experimenting with real-time Internet display of QSOs as they are logged, as well as real-time streaming audio so you can listen to what other operators are hearing.

Today there are a number of good logging programs available for *Windows*, *MS-DOS* and *MacOS*. An example is shown in **Fig 24.12**. Today's logging software not only logs contacts, but serves as the station command and control center. The more sophisticated logging software also controls one or more radios and allows for automatic switching of antennas, filters and other accessories. It can drive antenna rotator control boxes for automatic pointing, and offer sunrise/sunset times and other information for predicting propagation. Some logging software uses the sound card to send and decode digital mode transmissions, and even interfaces to packet-spotting networks via VHF packet or Internet nodes. The capabilities improve every year.

In order to standardize the format

among the many logging programs available to hams, two standards emerged to allow for the easy use of the information being collected. General logging programs now allow you to export your data in a format known as *ADIF* (Amateur Data Interface Format), which allows you to use multiple programs and move data among them and share log data with friends or QSL managers. You never need to worry about obsolescence of your data. If your publisher goes out of business, or no longer supports new platforms, you can choose from a large selection of other programs that will load and use your log files without retyping everything.

The second format, *Cabrillo*, is used by contesters to submit their scores to the various organizations sponsoring the contests. By submitting all contest logs in a standard format, adjudicators can link the logs with a common database and quickly see errors for scoring adjustments. *Cabrillo* is available on all contest software today and is required by many contest sponsors.

It is worth noting that most general logging programs and contest programs can handle both *ADIF* and *Cabrillo* formats. This makes it easier to transfer the contest logs into the general logging programs for award tracking and other uses.

Logbook of The World (LoTW)

No discussion of general logging and award tracking can be complete without a discussion of ARRL's online log database and confirmation system called Logbook of The World (LoTW). ARRL launched LoTW to provide secure, electronic verification of QSOs and then submit those certified QSLs for award programs such as DXCC and WAS. LoTW has its own Web site (www.arrrl.org/lotw) that is password protected. Membership is free but digital certificates and passwords are issued only after ham radio license and user details are verified through a secure process. This assures that the data submitted is actually sent by the operator.

The free software to obtain your certificate (called *TQSLCert*), and instructions, are downloadable from www.arrrl.org/lotw. After receiving and installing a digital certificate, the *Cabrillo* or *ADIF* logs can be signed using the *TQSL* software and uploaded over the Web to the database. The software automatically matches your data to the database and shows your QSLs in a variety of formats. For a small fee, you can use the verified QSL credits toward DXCC or WAS using the tools available online.

PacketCluster and AR Cluster

During the late 1980s, Dick Newell, AK1A, developed *PacketCluster* software

to link PCs together via VHF radios to share DX-related information. The software is still in use, but is slowly being replaced by Internet-based Telnet software such as *AR-Cluster*, *DXSpider*, *CLX*, *DxNet* and *Clusse*.

These software servers enable users to announce and receive DX spots or general information announcements, as well as send personal talk messages and e-mail. Almost all logging software today has Telnet software built in to interface to the Internet nodes and retrieve Cluster spots.

AR-Cluster (developed by AB5K) allows the user to tailor the information he receives. Since it is an SQL database, the user can query that database in an almost unlimited way. SH/DX commands can be by call, band, mode, DX Country, State or Country of the spotter, the node the spot came from, DTS (Date/Time stamp), ITU or CQ Zone, or even from a comment associated with the spot. Further, the inquiry can be any one or all of the above parameters. Looking for the last 50 spots for a DXpedition is as simple as sh/dx/50 CALLSIGN. The user can also set specific filters for his use so that spots sent to him are set to the specific parameters he has set for his call. For example, a VHF-only user does not need to see HF spots.

The *AR-Cluster* user manual can be read at www.ab5k.net. One of the best sources of Telnet ham radio sites is maintained by K6PBT on his Web site telnet.dxcluster.info.

Mode-Specific Software

The proliferation of computer sound cards has enabled hams to operate many digital modes without additional equipment. Software has emerged to generate and decode these modes and in some cases even log the contacts made. While some logging software includes mode decoding routines, the most feature-rich software is mode specific.

Once the radio and sound card and computer are connected as described earlier in this chapter, changing modes is as easy as changing software. RTTY operators often use *MMTTY*. For SSTV, *DIGTRX*, *MMSSTV* and *Mscan* are popular. PSK31 operators have a number of choices, including *Digipan*, *DXPSK*, *WinPSK*, *WISQLpsk* and *Multimode*. *WSJT* and *JT44* make meteor scatter and EME contacts possible with far weaker signals than traditional CW or SSB. Software such as *RadioCom5* and *Skysweep* works on several modes.

Other sound card modes include Hellschreiber, MT63 and Throb. It seems that a new digital modes are constantly under development. Use your favorite Internet search engine to find out more about this ever-developing segment of Amateur Radio.

