Chapter 24

Web, Wi-Fi, Wireless and PC Technology

With the Internet and the Personal Computer (PC) more commonplace in homes and ham shacks around the world, some fear it may actually destroy Amateur Radio! Their reasoning is that increasingly powerful PCs, coupled with access to the Internet or worldwide web (www), will primarily divert youth from the lure, mystique and magic of radio. Could an advancement in technology with the corresponding economies-of-scale actually deprive Amateur Radio of an influx of fresh, young operators and enthusiasts?

The PC and its Internet link to the world around us have surely changed many lifestyles — young and old and those in between. But far from destroying Amateur Radio as we know it, these technologies have greatly enhanced and improved the ham radio experience of countless operators! Many hams with an interest or passion in homebrewing, DXing, contesting, and the wide variety of other related areas of interest now take for granted nearly instantaneous access to information and interest-related Web sites. Computers and modems are sometimes used for the operation of various modes, and can also be a primary part of the actual ham radio equipment (e.g., a *transceiver* or *receiver*).

In this chapter, in addition to covering many of these exciting areas described above, 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 contributions from John J. Champa, K8OCL, Reed E. Fisher, W2CQH, Howard S. Huntington, K9KM, and Ronnie P. Milione, KB2UAN.

The World Wide Web (www) — The Internet

SEARCH ENGINES

The Internet encompasses millions and millions of pages of information. There is simply too much information on the subject of ham radio to find without properly using search engines. There are many related ham sites, but the most popular are listed in the sidebar *A Ham's Guide to Useful Internet Sites*. In any event, the most popular search engines are ***Google***, ***Yahoo***, ***Ask Jeeves***, ***Alta Vista***, ***Dogpile***, ***Look Smart***, ***Overture***, ***Teoma*** and ***Find What***.

The secret to a successful search is to be specific by limiting the results or *hits*. Simply typing "ham radio" as the topic of interest to you is not sufficient. A query on *ham* yielded links to Web sites mentioning ham radio, ham (the food) and other hits totaling over 7 million pages! A more specific search of *ham radio* reduced the page count to 1.7 million pages, still too numerous to be helpful. Narrowing and refining your search is as simple as adding

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

Since website URLs change so often, any attempt to present a comprehensive list here would be out of date by the time of publication. Accordingly, we have instead listed general ham-related sites that contain current links to many of the specific radio sites on the Web:

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 4500 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/Misc/adxo.html** 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/master.htm** Al, 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.david-taylor.pwp.blueyonder.co.uk/software/wxtrack.htm**

QSL Museum: **www.hamgallery.com/** In addition to one of the most complete online QSL collections, Tom (K8PX) has one of the more complete ham radio link sites on the web.

more words. This is called using keywords, and choosing them wisely will reduce the page count to manageable levels. *Ham radio software* reduces our search to 427,000 pages while *ham radio dsp software* reduces it to 18,600 pages; you can keep refining your search by adding keywords, and there is no need to include the word *and* between the words.

Another way to reduce hits on your search is to exclude categories. For instance, if you want to search for ham you can exclude the food ham by *ham –food*. If you want to search for an item but only want to search for it on a specific Web site, you can do that too. For instance, to look on the ARRLWeb you can do *license renewal site: www.arrl.org*.

Searching for specific part numbers for your do-it-yourself projects is similarly easy. In the *PC Technology* section of this chapter we discuss isolation transformers. A search for *273-1374* brings you right into the RadioShack catalog, as well as pages on how to build other projects with it. There is a fine line for being 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*.

VOICE OVER INTERNET PROTOCOL — VoIP

Like our airwaves, the Internet can carry our transmissions over great distances. Unlike ham radio, the Internet is only digital. If we are use voice or video over that medium 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 new publication titled *VoIP: Internet Linking for Radio Amateurs*. The book discusses in great detail the brief outline of the topic that follows.[1]

Echolink

Recognizing the growing use of the Internet by hams, 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 more than 120,000 registered users in 147 countries worldwide. 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 non-duplex; both stations cannot talk at once. The software is free (you must be licensed) 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 having a radio, IRLP takes a different approach to VoIP. David Cameron, VE7LTD, designed the Internet Radio Linking Project (IRLP). As he says on his Web site, he designed the software to provide a simple and easy system to link radio systems together using the Internet as the communications backbone.

IRLP users do not need to own computers. They simply access the network nodes using VHF or UHF FM transceivers.

The IRLP network is *Linux* based and requires a *Linux*-based Pentium PC at each node running *Speak Freely* software, an interface card (purchased inexpensively from VE7LTD), your radio and a sound card. The sound card takes the analog audio from the radio, converts it to compressed digital packets and sends short streams over the

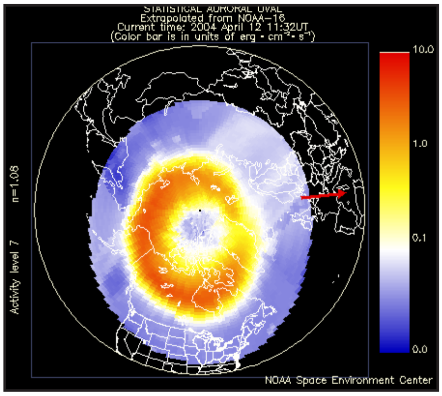

Fig 24.1 — NOAA North Pole map image of recent, real-time auroral activity.

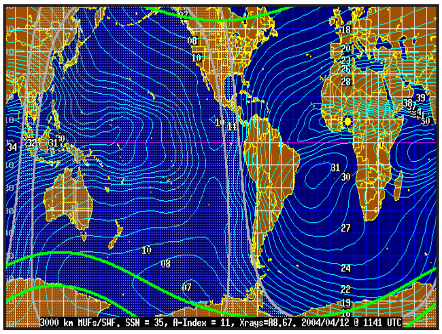

Fig 24.2 — Solar Terrestrial Dispatch graphic depicting frequency usability in real time.

Internet to the connected nodes via the interface card. The control software controls the packets along with continuous tone coded sub audible squelch signals (CTCSS) to start and stop the streams. CTCSS is also used by the transmitting user to pass commands to the nodes for the information as to which node a user wants 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 the IRLP website at **www.irlp.net**

PROPAGATION FORCASTING

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, etc. are all posted on various ham and government Web sites giving the Internet-connected ham useful tools to know where the best paths to the DX are. Current solar flux numbers are published by the Canadian Space Agency as monitored at its Penticton Observatory: **www.drao-ofr.hia-iha.nrc-cnrc.gc.ca/icarus/www/current_flux.shtml**

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/gif/pmapN.gif**. A recent North Pole image is shown in **Fig 24.1**.

Knowing which frequencies are usable in real time is also as handy a propagation tool as a ham could want. As shown in **Fig 24.2**, a real-time graphic can be found at the Solar Terrestrial Dispatch Web site: **www.spacew.com/www/realtime.html**.

VIRUS PROTECTION AND FIREWALLS

Lastly, 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. However, 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 is installing one of two types of firewalls. The first is an inexpensive software-based firewall from Norton or McAfee for under $50. They detect both internal and external attempts to compromise your personal computer (PC). The more expensive but more capable solution is a hardware-based device commonly 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.

Notes

[1]See *ARRLWeb* at **www.arrl.org/shop**; Order no. 9264.

Wi-Fi Glossary

Access Point (AP) — A wireless bridging device that connects 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 (FHSP) — 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 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 spectrum 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 re-locating 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 operate 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 Modulation Sources** 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 Dept. 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 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 — 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 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 eight 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 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 24.3** shows a typical seven-cell (n = 7) cluster. Each cell has a radius r, which may be up to eight miles in

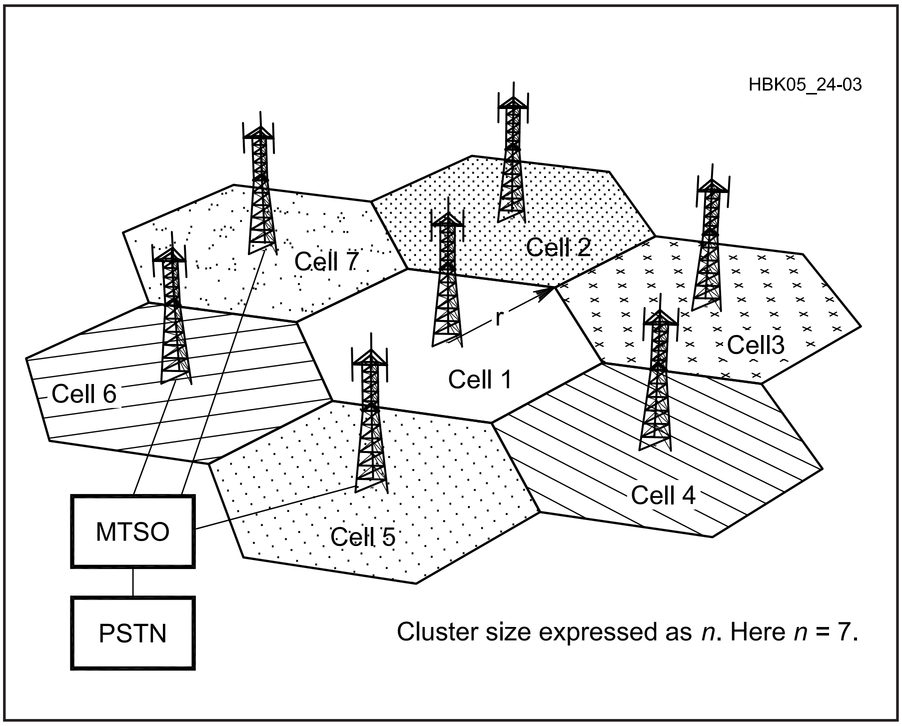

Fig 24.3 — A seven-cell cluster.

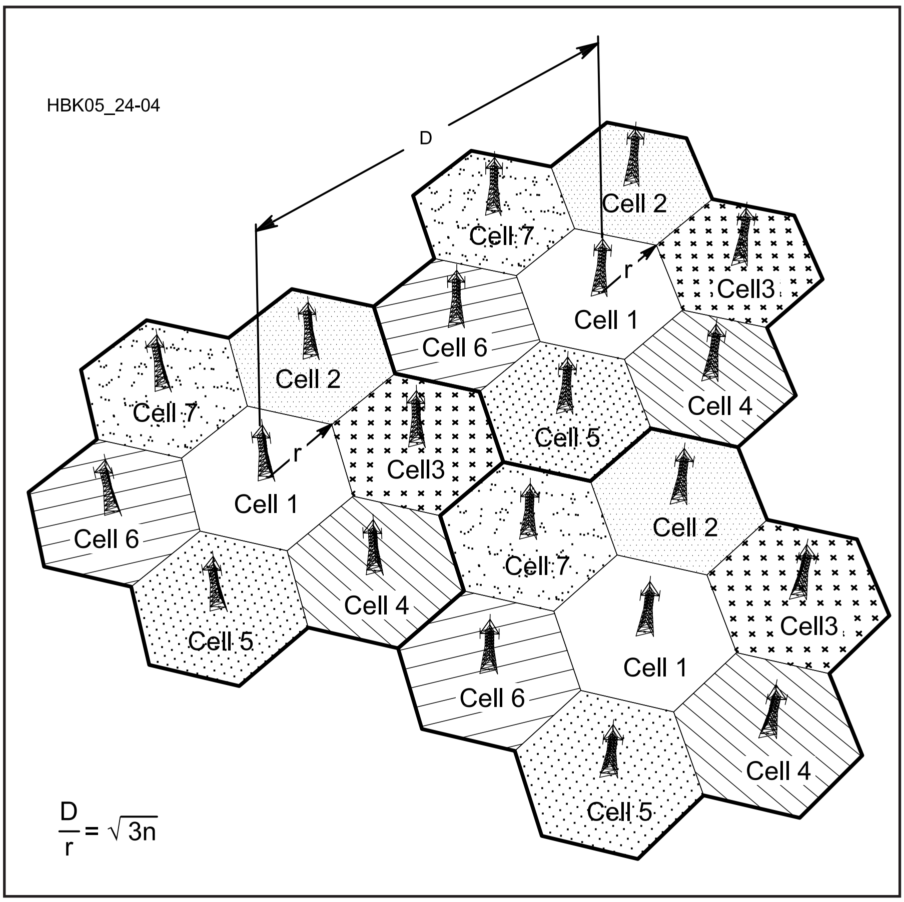

Fig 24.4 — Frequency reuse over an area to conserve spectrum.

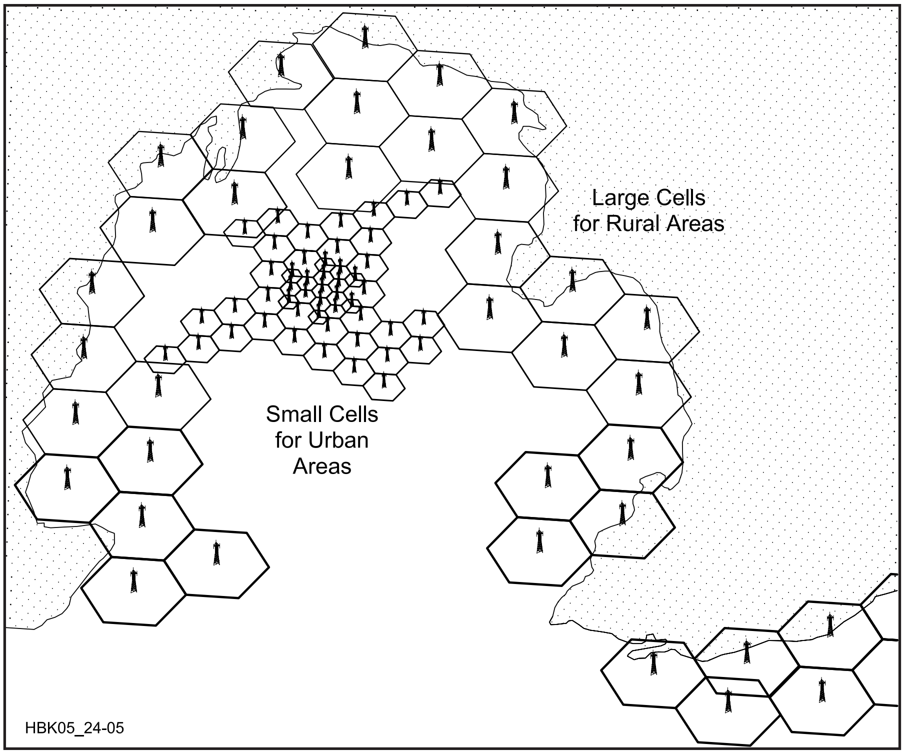

Fig 24.5 — Cell size corresponding to density of population and use.

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 24.4**. In this configuration, all cells with the same number use the same channel set. This condition 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. 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 24.5 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 proprietary 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. The four standards are:

• *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, e.g. 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, e.g. 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 48.3/3 = 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 un-interrupted trans-mission as the mobile station moves through the cell cluster. Handoff is accomplished by a "blank-and-burst" procedure. The down-link 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 section.

Virtual Private Network

A Virtual Private Network 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 (e.g., BellSouth Wireless Data Network, CDPD, Wireless LAN, Ethernet). Traditionally, IP network independence (roaming) is done over the same media access (e.g., 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)

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 watts, up from the previous limit of a single watt! However, stations that transmit more than one watt must utilize automatic power control to limit power output to the minimum necessary to communicate. For information on the rules change, see *ARRLWeb* at: **www.arrl.org/news/stories/1999/09/08/2/**. For the text of the rules, see Section 97.311 in *The ARRL FCC Rule Book*.

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.wow-com.com/**
Protocols.com Reference page: **www.protocols.com/pbook/cellular.htm**
FCC Cellular Services: **wireless.fcc.gov/services/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 (4kB) an audio tape drive and an imbedded *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 24.6** 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. In an extreme example, you can use it to download from the web the test questions to take your exam, learn the code, design your antennas, and even search ebay or QRZ.com to buy a 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 to compute which bands have propagation, use TELNET for packet spots to help find a DX station, provide software to log the QSO and keep track of award progress, and finally assist the operator in finding the QSL route to complete the process (or in the case of the new Logbook of The World (LoTW) upload the QSO to the ARRL site 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 desktop 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 in the shack.

HARDWARE

The computer itself should have a minimum of 256 MB of memory (more is better), hard drive with 40 GB minimum space, a rewritable CD, two serial ports, and a sound card. Serial ports are becoming a thing of the past; newer PCs have replaced them with USB ports. However, there are now many commercial USB-to-Serial Converter devices that allow you to still connect older DB9-serial devices to the newer PCs. If you are connecting your station 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 display to preserve maximum desk space — and be less of a heat source.

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.

Receiving computer-generated RF in your radios is often the result of poorly designed monitors or leakage from the monitor cables. Whenever adding new computer equipment into 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 are at fault. In many cases, the installation of toroids on the monitor cable and all cables (power, speaker, CAT, Keyboard or Microphone) that are a source of radiating will eliminate the problem.

Most modern radios have a CAT (Computer Access Terminal) port that is a serial 9 pin (MINIDIN9). Some older radios required a computer interface device that was usually RS232 based. Yet other radios use DIN6 or CI-V interface devices. Complicating the interface issue is the trend to USB ports instead of serial ports. Fortunately, the commercial ham market has kept up with the lack of standards with a host of good USB to Radio Port products. MicroHam is one such source (**www.microham.com**) covering just about all the USB wiring possibilities. The basic commands to control your radio are available from the radio manufacturer's Web sites. Third-party software applications all support these functions and are discussed in detail below.

Your computer sound card can act as a digital modem enabling you to operate FSK, PSK, SSTV, FAX and other digital modes. However, you also will find the need for a direct-controlled interface to key the transmitter in response to signals over the serial port's RTS or DTR pins. The interface should also include an attenuator to simplify the connection between the computer sound card and the transceiver microphone jack. This type of interface may also be used to connect your

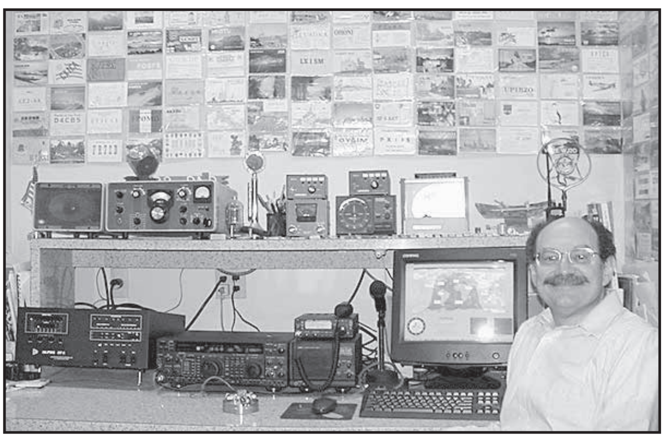

Fig 24.6 — Don, N1DG, and his computer-enriched operating station.

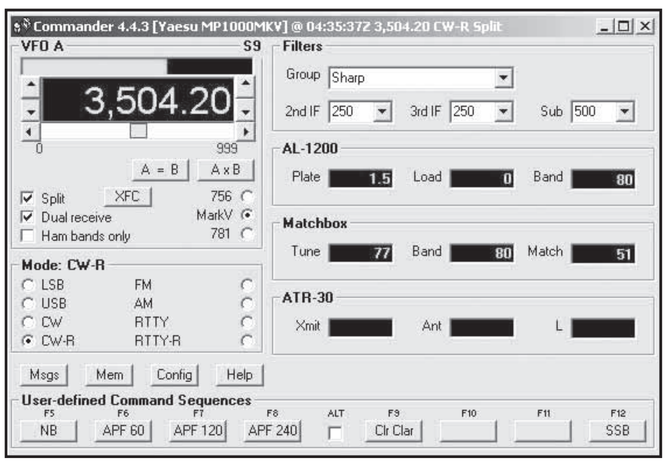

Fig 24.7 — The DXLAB *Commander* Control Panel.

computer to your radio for Echolink or IRLP operation. The RIGblaster from West Mountain Radio is one of several commercial products for this.

Lastly, most logging and contest software generates Morse code. Connecting the output of the radio to the input of the sound card is simple enough with a stereo cable. However, 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. The output from the PC to the radio can come either from a parallel or serial port. There are several commercial products available, the best for parallel ports being from Jack Shuster, W1WEF. Two suppliers of interfaces are N3JT (**n3jt@arrl.net**) and W1WEF (**w1wef@arrl.net**).

The recent 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 shareware programs — *Directio* and *Userport* — that will install drivers on your operating system to allow most ham logging and modem software to reach the ports. Both are free downloads at **www.embeddedtronics.com/design&ideas.html**.

SOFTWARE

Radio Control Software

One of the most popular free programs is *Commander*, (**www.qsl.net/civ_commander/**) by DXLab Software. It is one of many shareware modules by DXLabs and this specific program interfaces with the recent radios from Ten-Tec, ICOM, Kenwood and Yaesu.

Through its graphical interface shown in **Fig 24.7**, 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 setups. All the logging programs listed below have rig control as part of their logging features. However, most of the general logging programs do not have the ability to set filters and menu items as *Commander* does (see Fig 24.7). They are designed for other things.

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, K1EA introduced *CT*. Computerized logging enabled faster contacts, more accurate recording of those contacts, easy scoring and simple QSL management. Today's logging software not only logs, but it controls the radios, uses the sound card to send and decode digital mode transmissions, and even interfaces to packet-spotting networks via VHF packet or Internet nodes.

In 1996, the CEØZ and VKØHI expeditions took computer logging to the next level by posting their logs on their Web sites during the DXpeditions so hams could check their progress while the DXpeditions were still in progress. In order to standardize the format among the many logging programs that appeared over the last 15 years, 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 your logs without retyping everything.

The second format has been written and is used by contesters to submit their scores to the various organizations sponsoring the contests. This format is known as Cabrillo and is available on all contest software today. 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.

It is worth noting that both current general logging programs and contest software also handle both of these standards to make transferring the contest logs into the general logging programs for award tracking.

LoTW

No discussion of general logging and the award tracking can be complete without a discussion of the latest development in this area. In 2003, the ARRL launched a Web-based depository of QSO data called the Logbook of The World (LoTW). The purpose is to electronically verify QSLs and provide those certified QSLs for its award programs and eventually other ham-organization award programs. LoTW has its own Web site (**www.arrl.org/lotw/default**) that is password protected. Membership is free, but digital certificates and passwords are issued only after licensing, and user details are verified by mail to the address of the licensee. This assures that the data submitted is actually done so by the operator.

The free software to obtain your certificate (called *TQSL*), and instructions, are downloadable from **www.arrl.org/lotw/#download**. Once receiving a digital certificate, the Cabrillo or ADIF logs can be *signed* 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. In the first six months since the Web site went live, 7,000 users have uploaded over 40 million QSO records resulting in QSL matches of over 1.2 million records.

Today's leading software packages include:

• *WriteLog* (by W5XD) Web site: **www.writelog.com/**
Contest logging software for Win95/98, NT, Win2K $75

• *WinEQF* (by N3EQF) Web site: **www.eqf-software.com**
General logging Program for Win95/98, ME, NT, XP, or Win2K $60

• *VHF log* (by W3KM) Web site: **www.qsl.net/w3km/features.htm**
VHF contest logger With CW/PTT/DVK for Win98, ME, 2000 or XP $40

• *TR Log* (by F6DEX) Web site: **www.qth.com/tr/**
Contest logger for DOS $75

• *NA* (by K8CC) Web site: **www.datomonline.com/products.htm**
Contest logger for DOS $60

• *N1MM Logger* (by N1MM, AB5K, PA3CEF, G4UJS, N7ZFI, N2AMG)
Web site: **pages.cthome.net/n1mm/**
Contest logger for 95/98/ME/NT/2000/XP Freeware

• *SWISSLOG* (by HB9BJS) Web site: **www.informatix.li/English/Frame_EN.htm**
General logging software for Win95/98/ME/NT4/2000/XP $65

• *Dxbase* (by Scientific Solutions) Web site: **www.dxbase.com/proddxbw.htm**
General logging software for Win95/98 and Windows/NT/2000 $90

• *DX4WIN* (by KK4HD) Web site: **www.dx4win.com/**
General logging software for Win95/98/ME/XP/2000/NT $99

• *ProLog2K* (by W5VP) Web site: **www.prolog2k.com/**
General logging software for Win95/98/ME/2000/NT/XP $50

• *CT* (by K1EA) Web site: **www.k1ea.com**
Contest logger for DOS/Win85/98/2000 Freeware

This list is by no means complete, but it will give you a start to explore the products available based on your interests.

PacketCluster and AR Cluster

During the late 1980s, Dick Newell, AK1A, developed PacketCluster software to link PCs together via VHF radios to DX-related information. Now 15 years later, the software is still in use, but is slowly being replaced by Internet-based Telnet software such as *AR Cluster*, *DX Spider*, *CLX*, *DxNet*, *Clusse* and *WinCluster*.

These software servers enable users to announce and receive DX spots, general information announcements, and send personal talk messages and email. 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. A VHF-only user does not need to see HF spots. Spots outside of licensed frequencies can be ignored, etc. The *AR-Cluster* user manual can be read at **www.ab5k.net/ArcDocs/UserManual/ArcUserManual.htm**.

One of the best sources of Telnet Ham radio sites is maintained by K6PBT on his website **telnet.dxcluster.info/**.

Mode-Specific Software

The ability to use the sound card as a modem has enabled hams to operate many digital modes without additional equipment. Software has emerged that generates and decodes these modes, and in some cases, even log the contacts made. While some of the logging software listed earlier includes mode decoding routines, the most feature-rich software is mode specific. The most popular of this software is:

RTTY:

MMTTY (by JE3HHT) Web site:
www.qsl.net/mmhamsoft
Win9x Freeware

SSTV:

DIGTRX (by PY4ZBZ & KB9VAK) Web site: **planeta.terra.com.br/lazer/py4zbz/hdsstv/teste1.html#digtrx**
MMSSTV (JE3HHT Makoto Mori) Web site: **www.qsl.net/mmhamsoft/mmsstv/**
SSTV Win9x/WinNT/Win2k Freeware
Mscan (by PA3GPY) Web site:
whatasite.com/mscan/products.html

PSK31:

W1SQLpsk > (by W1SQL) Web site:
www.faria.net/w1sql/psk31.htm
Win9x/WinNT Freeware
DXPSK (by F6GQK) Web site:
dxfile.free.fr/dxpsk.htm
Win9x Freeware
WinPSKse Web site:
www.winpskse.com
Win9x Freeware
WinPSK Web site: **www.qsl.net/ae4jy**
Win9x Freeware

Multimode Web site:
www.blackcatsystems.com/software/multimode.html
Mac PowerPC $89

Meteor Scatter:

WSJT by (K1JT) Web site:
pulsar.princeton.edu/~joe/K1JT
JT44 mode for weak signals Win9X/ME/XP Freeware
WinMSDSP2000 (by 9A4GL) Web site:
www.qsl.net/w8wn/hscw/msdsp.html
Win9X Shareware

Hellschreiber:

Hellschreiber (by IZ8BLY) Web site:
iz8bly.sysonline.it/Hell/index.htm
Feldhell Win9x Freeware
Feldhell (by G3PPT) Web site:
members.xoom.com/ZL1BPU/software.html
Feld-Hell/MTHELL/SMTHEL8 MS-DOS Freeware