digital connection

BY DON ROTOLO,* N2IRZ

Ham Radio and VoIP

Is it still amateur radio without the radio? Maybe, maybe not. On one hand, the communication is the key, regardless of medium. On the other hand, *radio* is at least half the equation, and the name. If we were to lose access to the "radio" part, how many of us would still be involved?

With that in mind, this month we will delve into the world of Voice over Internet Protocol, or VoIP, as used today in amateur radio. Some folks proclaim Internet linking as a death knell for amateur radio. I disagree. The same predictions of doom came about when people started linking packet nodes over wirelines (the Internet was not yet really a factor), but today we have a stronger VHF packet system, providing "last mile" data connections instead of trying to cover immense distances. In other words, we're making the best use of the technology.

So it will go with VoIP and other synergies between radio and wires. It doesn't make much sense to use (relatively) unreliable radio links for a job the Internet can do a zillion times better. It will not cause us to lose spectrum, or reduce the popularity of radio; instead, *more* will use it because it works so well. Do you think a major *radio* manufacturer (Yaesu) would develop a VoIP system (WIRES-II) if it thought it would make radio obsolete? Even if the Internet infrastructure is destroyed in an area due to a disaster, it is unlikely to disappear worldwide, and so radio will still serve best as the "last mile" (or last hundred miles) for critical communications. (If the Internet *did* somehow go down worldwide, there would be larger issues afoot than amateur radio, of course, although amateurs would most likely still be able to communicate.)

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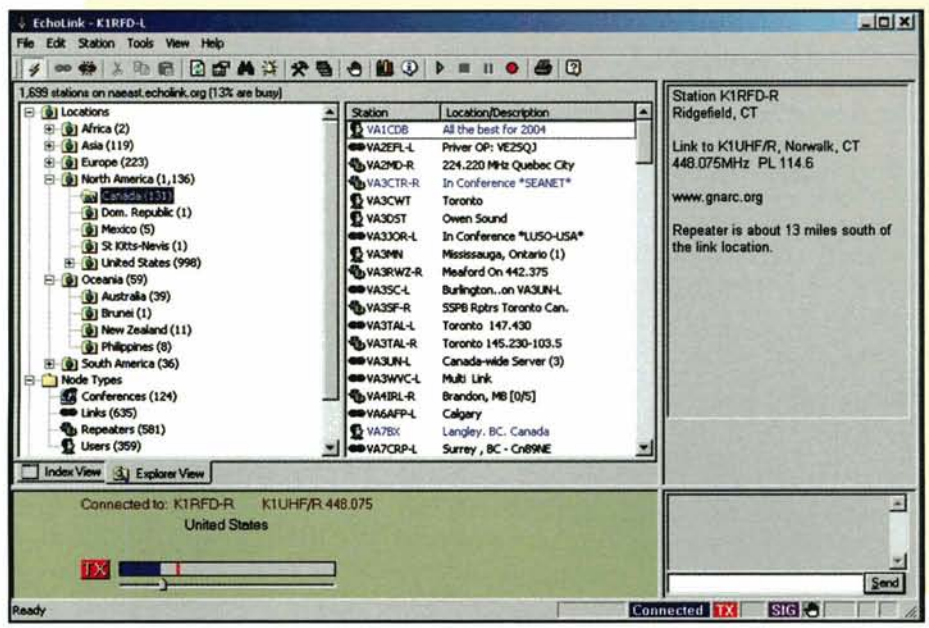
What Is It?

What exactly is VoIP and how does it work? I can only offer a very basic overview, as the topic would easily fill a textbook.

Voice over Internet Protocol is exactly that: Voice signals, as we often use for radio communications, being sent using the Internet protocol. Much like digital voice, we start by capturing a voice (or other sound) signal and "digitizing" it, turning the analog audio stream into a digital bit stream. How exactly we capture it, how many bits are needed to represent a particular sound, and just how faithful the reproduced sound will be to the original all are technical details. Hardware, software, and configuration settings control these finer points, but we do not have to even understand it in order to use it.

Virtually any computer with a sound card is able to record a voice signal and save it as a file. One could then e-mail that file to a friend, but that isn't really VoIP, since it is not being done in real time. The key to VoIP is not how you digitize the voice



A screen shot of an EchoLink QSO in progress, showing the K1RFD repeater linked to the K1UHF repeater. (Courtesy of K1RFD)

signal, but how you transport the data to another computer and then reconstruct it back into sound, in real time.

Early VoIP was used as a replacement for telephone calls. Any two people who could connect to the Internet could carry on a half-duplex (limited by the sound card) telephone conversation for as long as they like, with no cost above their access to the Internet. Voice quality was often less than toll-quality, a technical compromise to limit data bandwidth in the days of 28.8k dial-up, while dropouts and disconnections were not uncommon.

The transport mechanism is a little more complex. The Internet works much like a packet-radio network, in that data is sent as little packets of data, rather than a continuous bit stream (like PSK31 or RTTY). In order for VoIP to work, you need to get all the packets to the other end of the connection, in the right order, and do it fast, as nobody wants a 5- or 10-second delay in a communications channel. Because it is voice, a few missed packets or moments of silence are okay, as is a delay of about a second.

Moving from telephone calls to repeater linking wasn't a huge leap, but that's not to say it was easy to do. Much of the basic work—audio digitizing and decoding, the Internet and transport mechanisms, computer sound cards—was already there, but putting it all together, in a way that prevents non-amateurs from accessing a transmitter, and making it easy to install and configure . . . now that took some serious thinking and work.

EchoLink

Some time ago (September 2000), I wrote about the W7DXX Remote Base, a radio transceiver controlled over the Internet. VoIP is yet another way to get "on the air" without a radio, although its real value is its ability to link up widely separated radios. Two popular VoIP systems for amateur radio are IRLP (Internet Radio Linking Project, by Dave Cameron, VE7LTD) and the newer EchoLink (by Jonathan Taylor, K1RFD). I'll focus on EchoLink, since I am more familiar with it, but that shouldn't make you think any less of IRLP or any of the other VoIP systems out there (such as eQSO and WIRES-II).

As an over-the-air EchoLink user, you don't need any special equipment, just your regular radio. When it is linked in, it seems as if your local station just has wider coverage, although the "rest" of the coverage could be half a world away. You send DTMF tones (Table I) to control the link. If you know the EchoLink Node Number (address) of the other station you'd like to link in, you just enter it, but there's a search feature to help, and even a random mode. Search results are read over the air to you by a quasi-synthesized voice. Tune to the node or repeater input frequency and, using DTMF tones, build the link and have fun!

EchoLink can be very helpful for emergency communications by voice, much as WinLink 2000 can be for e-mail. While local EchoLink stations might be out of commission from a failure of equipment, power, or the Internet, distant stations with HF EchoLink gateways would still be there, as would the Internet. Once you get into the EchoLink system, you can go wherever you need. For example, in December 2002 a powerful typhoon struck Guam. Links to the island via HF were unsuccessful, but a voice channel was successfully established via EchoLink.

Setting It Up

Of course, as a Local Radio User (maybe just driving around in your car), you can set up a link between your local station and some distant one, and all you need is a radio. If you run the EchoLink software on your computer, however, you are either a Sysop or User.

As a Sysop (System Operator), you are expected to connect a radio to your computer, providing infrastructure for others to use. The Sysop can connect either a simplex radio or a repeater, but either way this role requires some commitment and funding, as well as a fast link to the Internet (and in some areas frequency coordination).

Many of us will work with EchoLink in the User mode. For this, all you need is a Windows® computer with a sound

Are WinLink 2000 and PacTOR the Enemy?

Just a short note about the controversy over the supposed "requirement" that WinLink 2000 (recently recommended by the ARRL for ARES work) will only operate with PacTOR. Let me state it plainly: **There is no such requirement.** WinLink 2000 will work with *any* data mode that is error-free. This includes Packet, PacTOR, and many other modes, but not "non-error-free" modes such as PSK31. The introduction of any error into an e-mail header obviously is a bad thing.

With that in mind, there is nothing out there that beats PacTOR III in performance or spectrum efficiency, with PacTOR II not far behind. Many are rankled by the "closed source" nature of PacTOR, but you can't blame the inventors for wanting to protect their intellectual property. Others get upset when the PacTOR "robots" come up on frequency and blow away all the PSK31 QSOs, something I experience regularly. While it is rude and maybe violates Part 97, we all need to work together to find a home for these operations instead of banning them altogether.

WinLink 2000 and PacTOR are valuable tools we have, so let's address the specific issues they bring up cooperatively instead of blindly condemning the good with the bad.

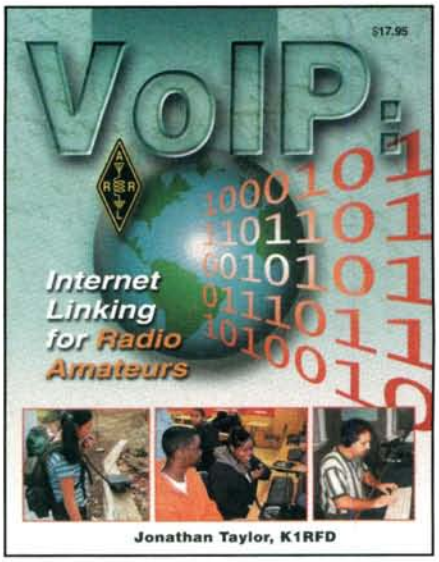
Command	Description	Default
Connect	Connects to a station on the Internet, based on its node number.	<num>
Connect by Call	Connects to a station on the Internet, based on its callsign.	**C**+call+**#**
Random Node	Selects an available node (of any type) at random, and tries to connect to it.	**00**
RandomFavNode	Selects an available node (of any type) at random from the Favorites List, and tries to connect to it.	**001**
Disconnect	Disconnects the station that is currently connected. If more than one station is connected, disconnects only the most recently connected station.	**#**
Status	Announces the callsign of each station currently connected.	**08**
Play Info	Plays a brief ID message.	*
Query by Call	Looks up a station by its callsign, and reads back its node number and status.	**07**+call+**#**

Table I– Some common DTMF commands in EchoLink. (Reproduced with permission)

card, speakers, microphone, and an Internet connection. Your PC replaces your radio, and you can link (and speak) to any other user, repeater, or simplex radio that's on the system and not busy. There's no RF path at your end.

The first step to getting onto the EchoLink system is to visit the EchoLink website at <http://www.echolink.org> and download the 2.3-MB self-extracting file to your hard drive. Mac users can use EchoMac by N9YTY, which is compatible with EchoLink (see the Installation FAQ on the EchoLink site for details). Running the installation program starts the easy installation process; just follow the on-screen prompts. Remember to select whether you planto be a Sysop or User (you can change later).

As the installation ends, the system will start the EchoLink program and find that you are not yet validated to the system and start that process automatically. Every user validation request is reviewed manually by volunteers, which may take "up to a day or less than an hour," so please be patient. Validation is a method used to verify that you are who you say you are, which helps prevent non-hams from accessing the system. After a few minutes I received an e-mail stating that N2IRZ appeared to be a valid callsign, and could I please verify my identity by sending in a clear copy of my amateur radio license, either by fax or by scanning and sending an e-mail. I chose to send the e-mail, since phone calls cost me a nickel a minute. About an hour later I received a message that my callsign was validated.



Jonathan Taylor, K1RFD's new book VoIP: Internet Linking for Radio Amateurs, *published by the ARRL, explains the detailed "nuts-n-bolts" of how radio amateurs are using VoIP technology today. Jonathan is also the developer of EchoLink.*

Once you've been validated, you should first try a connection to the Test Server, which is easily found on the "Station" menu and repeats everything back to you. This will help you spot and correct any problems before you go out into the real world. You'll probably find that you need to open up some UDP ports in your firewall and/or router; the EchoLink help feature that pops up the first time it happens explains this fairly well. It covers the most popular software firewalls and broadband routers. If necessary, there's even a troubleshooter utility you can download.

This was the trickiest part for me. I had to puzzle over this for a few hours until I figured out which setting was the key. With my LinkSys wired router, I decided to set up the router for Port Triggering, instructions for which I found on the LinkSys support site. The EchoLink help feature spoke about Port Forwarding, which require my router to use static IP routing (which I didn't want), but when I reviewed the instructions at LinkSys, they directed me to Port Triggering.

The issue, in a nutshell, is this: Your router and software firewalls (which, if you are a regular reader, you surely use) are set up to block all data from entering any "ports" on your computer that are not specifically opened. This helps prevent external attackers from accessing your system. EchoLink requires two ports, 5198 and 5199, to be open to incoming UDP data. Port Forwarding opens these ports and directs the incoming data to a specific computer on your LAN. That's why you need static IP addresses, so the router knows which computer is which. Port Triggering leaves these ports closed to incoming data until a program (such as Echolink) sends data *out* of those ports. Thus, until you start up EchoLink, the ports remain closed—a bit more secure.

If you have difficulty with this issue, I again urge you to read the troubleshooting documentation carefully; the solution really is in there. You just have to find it.

After you get it working, connect to the Test Server and set up your incoming and outgoing audio quality. There are a few settings on the Tools/Setup/ Audio menu, and you should try them all until you find the best combination for "on-the-air" sound quality for your station.

Getting on the air involves simply picking a station and connecting to it. From the Sysop side, you log into EchoLink and connect your radio or repeater to EchoLink, inviting others to use it. Local users use DTMF tones to connect and manage a QSO with another EchoLink station, or distant users connect into your system and their voice is transmitted on your radio. Some basic commands to connect to or find a specific EchoLink "node," or to connect to a random node, are included with the EchoLink application. Note that you really should be the operator of a repeater to link it into the system, or at least have permission and authorization from the repeater owner. A busy repeater is a poor candidate for linking. There are already too many users!

Before signing up as Sysop, I recommend becoming familiar with the system as a user, which is in itself a lot of fun. Some statistics on EchoLink: Currently (10/04) there are 137,573 validated, licensed users, 49% of which are in the U.S. They validate about 130 new users per day. The top 10 countries are USA, UK, Canada, Germany, Brazil, Japan, France, Italy, Australia, and Spain. Some 35% of the users are in a country where English is not the primary language.

If you want to learn more about the way VoIP works and is being used today by amateurs, pick up the book *VoIP: Internet Linking for Radio Amateurs* by Jonathan Taylor, K1RFD, who is also the author of EchoLink (ISBN 0-87259-926-4, $17.95, published by ARRL). It is a good book which explains the technology in a friendly, easy-to-read style and covers some of the finer points of setting up a station.

Holiday Wishes

That's all for this year. Next time I hope to take a close look at a few HF data modes, their performance and efficiency, as well as a new way of classifying the signal quality of PSK31 contacts using an "RSQ" report.

As is my custom this time of year, I wish you and your family & friends the very best for the holiday season, and hope you enjoy a happy, healthy, and prosperous New Year. This time of year causes the world to think more about peace, and regardless of your personal political and religious beliefs, I think most of us can agree that living in peace is one of the best ways to live.

73, Don, N2IRZ