Web Pages on Packet Radio?

Yes, folks—it CAN be done! And better than that, it is BEING done in Wisconsin. Join us on a trip to "America's Dairyland" to learn how they're sending Web pages via packet, and how you can, too!

In my first "Digital Data Link" column (March, 1996, *CQ VHF*, p. 50), I wrote about delivering Web pages via packet. I didn't explain how to do it—I didn't know how—but I knew that some hams had done it, and I promised to find one who could tell the rest of us what to do.

That was nearly three years ago, and I might have forgotten it, except I remained quite eager to actually see it happen. You see, I believe that doing something like distributing HTML content via packet is a reasonable concept and that users will actually find it useful. No, they wouldn't find it overwhelmingly fast, especially at 1200 baud (1k2), but using it might just drive a desire for greater speed. HTML works well at 9k6, and a speed of 76k8 is not only reasonable, it is *way* faster than most of us are used to. Dreaming? I don't think so.

This month, we are graced with a guest columnist, Andy Nemec, KB9ALN. Andy wrote this article as editor of *The Wisconsin Packeteer*, the newsletter of the Wisconsin Amateur Packet Radio Association, and it is republished here with permission. The newsletter takes up a few pages of the August, 1998, issue of the *Badger State Smoke Signals*, a non-profit cooperative newspaper containing a number of different clubs' newsletters, along with information of general interest to hams in the upper midwest. Refer to the "Resources" box for further information. The article has been modified slightly for *CQ VHF*. Now, over to Andy.

Many hams are on the Internet these days and have become accustomed to the many conveniences and resources available there. One of the most popular Internet activities for hams and the general population is "Web surfing," or looking for information and/or entertainment on the World Wide Web. In fact, WWW has nearly become part of our language, and we see it in magazine advertisements and TV commercials. These days, "the Web is hot" is nearly an understatement.

How does packet radio fit into this? After all, you can't send Web pages over packet—or can you? The answer is, "Oh, yes you can," and I have done it.

We in Green Bay have been able to route TCP/IP packet radio as well as the more conventional AX.25 packet radio traffic for quite some time now. Many of us have been operating TCP/IP stations (known as *hosts* in Internet terms) and have been having quite a good time at it. For those of you who may not know, TCP/IP is the protocol set (the method computers use to talk among themselves) used on the Internet. It seemed logical to a number of folks that it should be possible to send Web pages out over the packet radio network using TCP/IP. I had heard that it has been done out in the eastern part of the country, so I set out to try it myself. That is the subject of this article: what was done and how it was done. For those of you who are less technically oriented, we'll look at it in general terms. For those who are more technically minded, we'll look at it in more depth as well, with an equipment and setup summary near the end of the article.

The Basics

Before we get all wrapped up in terminology, we should get acquainted with how the basic system of Web page distribution works on the Internet. In looking at the general layout of the system, we'll also explain some of the terminology used to describe it.

One important concept you will need to understand is that of a *client/server system*. You also need to understand the idea of *distributed resources*. Simply put, a *server* is a computer running a specific program that allows it to provide a service on behalf of a user or another computer. On the World Wide Web, a computer that stores and dispenses copies of Web pages is known as a *Web server*.

At the other end of the system is the *client*. Just as lawyers have clients, a Web server has clients, too. A client is a computer running software designed to collect and display (or store) information provided by the server. When you connect to the Internet and view Web pages, your computer is the "client." The software that allows your computer to become the client is your Web browser, plus the software that allows you to connect to the Internet.

When you use the client/server system, you are said to be on a network of *distributed resources*. The resources required to transfer and view Web pages (or other information) are distributed across many computers, not just a single computer. It is literally impossible to store every Internet Web page on a single computer—there is just too much data. Plus, it would take an incredible amount of network time to transfer that information to your computer. So, the client/server concept is really the only way to go, as it distributes resources across a wide network. In most cases it is the Internet. Of course, this same concept works in radio networking.

The chances are good that you already have been using a client/server system on packet, perhaps without realizing it. If

By Don Rotolo, N2IRZ (N2IRZ@compuserve.com)

For the "Techies"

Here are the specifics of what we're running on our packet "Web server" in Green Bay. If you understand this, we encourage you to try it on your own, make your own improvements, and then let all of us know how it's working!

Server Side: 486DX-33 computer running Caldera OpenLinux Lite, kernel 2.0.29; Apache Web server v. 1.1.1-11, with a 10-Mbps wired network port.

Server Side Radio Interface: 386SX-16 running MS-DOS 6.22; WNOS 4 (DAMA slave custom version, a variant of KA9Q NOS); 10-Mbps Ethernet wired network port; PacComm Tiny-2 TNC at 1200 bps; Motorola Moxie VHF radio, converted to the 2-meter amateur band.

The Client Side: 486DX-100 computer running Red hat 5.0 Linux; Lynx 2.4.2-4 Text-based Web browser; Pseudo-SLIP (UNIX "Pipe") connection to the radio interface program.

Client radio Interface: JNOS v1.11b (Linux) software, running on the above Client computer under Linux; Pseudo-SLIP (UNIX "Pipe") connection to the Linux-operated browser; PacComm Spirit-2 TNC at 9600 bps in KISS mode; Motorola Mitrek UHF radio converted to the 70-centimeter amateur band.

Radio Network Nodes: PacComm Tiny-2 1200-bps TNC running TheNET X1J firmware; Motorola Syntor-X VHF radio converted to 2 meters; PacComm Spirit-2 TNC at 9600 bps running TheNET X1J firmware; Motorola Mitrek UHF radio converted to 70 centimeters.

Notes: The "server side" may also be configured like our "client side" is configured, perhaps running a NOS program such as JNOS or TNOS. This would mean only one computer would be used, and it could be set up as both the server and the radio interface computer. We did not do it this way for convenience—the wired Ethernet network was already in place. As a side benefit, we are able to demonstrate the concept of distributed resources in a small network.

The same can be said of the 1200-bps "speed limit." At present, there is no 9600-bps capability at the server site (which just happens to be my house!). The 1200-bps system was already in place and is workable as a test bed when the LAN is not being used for other purposes. This is a limited-run test, and we do not wish to congest the LAN by offering this as a full-time service until a 9600-bps (or faster) TNC is installed.

you use a packet BBS, you are essentially using an e-mail server of sorts. When you connect to a BBS and read messages, your computer becomes the client. On the other hand, when someone connects to your TNC mailbox, your TNC (terminal node controller) becomes the server and the person connected to your mailbox becomes the client. This is an example of how the concept already applies to packet radio.

In the world of the Web, we need a server to store and distribute the Web pages on demand and suitable client software to interpret and display the pages. There is no commonly available Web server and Web client software (that I know of) written specifically for packet radio, but we can use other existing software to perform these functions. However, we do need a radio network capable of operating with this software.

Network Interconnection

In amateur packet radio, our computers communicate with each other using a standardized method known as the *AX.25 protocol*. Other protocols, such as TCP/IP and NetROM, may be sent via packet radio, but they must first be "wrapped up" or encapsulated into an AX.25 packet. (If you are unfamiliar with this concept, it is discussed, among other places, in the "Using the Wisconsin Network" series, parts 10, 23, and 24. If you have access to the World Wide Web, you can find these on the Wisconsin Amateur Packet Radio Association Web page. Again, see "Resources.")

Once we have the ability to send these TCP/IP packets, we must have the ability to carry the packets to their destination. When all of these pieces (server, radio interface, and radio network) are put together, we have something that looks like this on the "server" side of things:

Web Server Computer → Radio Interface → Radio Network (nodes, etc.)

When we add the client into the picture, the "other half" looks like this:

Radio Network → Radio Interface → Client Computer

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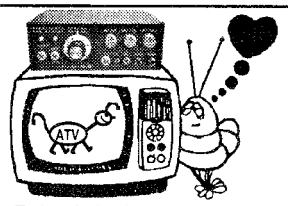

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The "Badger State Smoke Signals"

I have had the privilege of receiving the *Badger State Smoke Signals* newsletter for nearly 15 years now. As far as I know, this is a unique publication in the world of amateur radio: it combines statewide coverage of ham radio news stories and *is* the club newsletter for various radio clubs around Wisconsin.

Participating clubs submit monthly columns about their activities, meeting notices, etc., and all subscribers receive the *Smoke Signals*. This allows clubs not only to communicate with their own members, but with members of other clubs in the state as well. It also saves the individual clubs from the time and expense involved in laying out, printing, and mailing a newsletter each month. Expenses are shared and per club costs are no doubt lower, due to reduced duplication and economies of scale. Newsletter editors and publishers in other parts of the country could benefit from taking a look at the *Badger State Smoke Signals*, and perhaps it can serve as an inspiration to do something similar where you live.

—W2VU

The *radio interface* is one term that might be a little vague, because there's more than just a TNC and a radio required to couple a computer running TCP/IP to the AX.25 computer network. I mentioned earlier that we need to "wrap" (encapsulate) the TCP/IP packets in AX.25 packets, so the TNC can send them to the radio and out on the airwaves. We can use one of a couple of methods to do this:

1) We can have another computer intervene and perform this function. This computer sits between the server and the TNC and accepts incoming TCP/IP packets. It then wraps them in AX.25 packets and sends them out to the TNC, which in turn sends them to the radio and out into the packet network. This is another example of "distributed resources." This has its appeal for reasons I will not go into right now, but it also has the disadvantage of requiring more hardware—two computers instead of one—and a wire network connecting them together.

2) We could also program the server to do the "encapsulation." The Web server would not only serve up the pages, but would also do the encapsulation and hook to the TNC. This is a little tidier, but also requires the use of an operating system that will support multitasking.

Specifics of Our Test Setup

What we did to test our Web page server incorporated both of the concepts discussed above. The server uses *Linux* as an operating system (see "Using the Wisconsin Network"—Part 40). Linux is a multi-tasking system, and is able to run the Web server software as a program that runs in the background. It listens for incoming connection requests and accepts and processes them. This server computer connects to a wired network.

The radio interface computer serves the function of a gateway to the radio network. Aside from the Web server computer, this radio interface computer provides gateway service to the radio network for three other computers on the wired network. In a sense, it is a "radio interface server." It wraps the TCP/IP packets into AX.25 packets for any computer on the wire network that needs this service. This computer runs an amateur radio TCP/IP *NOS* (Network Operating System) program set up for this purpose.

The radio interface computer is also connected to a TNC running on VHF at 1200 bps. The local LAN (local area network) and "backbone" nodes are able to route the AX.25-encapsulated TCP/IP packets to the client computer. (*A packet "backbone" node is a high-speed link between user-accessible nodes, or connection points, on a packet network—ed.*) The server-side LAN node is a 1200-bps VHF node. It is on the same node stack as the client-side LAN node, which is on UHF at 9600 bps.

The client side uses the second "unified" approach, but without the server software running. It uses client software and is set up to do the radio interfacing with a conventional TCP/IP NOS program. Because we are using more than one program at a time, a multi-tasking operating system is again needed. Linux is used here as well, because it easily supports a Web browser as well as the radio NOS program.

The radio NOS program links the Web browser to the radio network. It runs on the same computer and sends the AX.25-wrapped TCP/IP packets to the TNC and then to the radio, where they are sent out to the radio network. Naturally, it also does the reverse, so that commands can be sent to the server.

The Web pages themselves are written in HTML (HyperText Markup Language), the language of the Web. They are simple text in content, with no graphics. The system operates just as usual—it supports linking to other pages and other sites. Our server side was not set up to link to other sites, but it does support this feature.

Graphics can be sent as well, but it was decided that the heavy download time needed would not be suitable for a radio path that is using 1200 bps in part of the radio link. As it was, this 1200 bps limiting factor did make itself known—those folks who are used to lightning-fast speeds will most certainly yawn while waiting for the full page to appear. However, a Web page with mostly text content would be far more practical even at 9600 bps.

Are There Other Ways to Do This?

Linux is the best choice for a server operating system, as it was born to do server work. Setting up a DOS-based server would be very difficult and probably would limit its utility. That is, assuming you could find something that can run effectively under DOS.

The client side is a little more flexible, however. There are two programs that have been written that will allow Windows 3.11 and Windows 95 to operate their TCP/IP systems with a TNC. What these programs do is wrap the TCP/IP packets from your browser into AX.25 packets and send them to your TNC through your serial port. You would need a TCP/IP address in order to use this system, but it is possible to use a specially configured Windows computer to see Web pages served over the amateur packet radio network. Both of these programs are available at the following Web site: <http://hambox1.cqu.edu/au>. The files also include setup instructions, and this site has a lot of other neat information on it as well.

The Future

We plan to offer this as a full-time service to users of the 9600-bps LAN on UHF here in Green Bay. Graphic content will be light, and other area hams will eventually be invited to have their own Web pages for all to see.

N2IRZ here again. Just a brief note to thank Andy for taking the time to write all that down in a form that is understandable for most everyone. Also, the usual note to encourage *you* to write down what you know and send it in—I'd like to hear about it, and I'm sure others would, too! Don't worry if you can't write well, that's what editors are for...*(gee, thanks, Don!—ed.)*

Next month, we'll have a look at higher speed and what we can do about it. Until then, get cracking on putting up that Web server!

—N2IRZ

There has been talk of implementing some system or Web server using solely the AX.25 protocol. It is possible to transfer at least text pages via AX.25. They are, after all, written in HTML, which is a text-based "programming language." So far, though, there are no firm plans to implement AX.25 Web serving—just ideas floating around. If it ever comes to pass, it will not be able to implement all of the features one will find with the Internet Web server implementation, but it may prove intriguing for those people with limited computer resources.

In closing, this was an especially fun project that I recommend to technically minded packeteers for duplication. I also recommend a good radio network for the task, and at least 9600-bps speed. It is also especially important to consider the content and size of the Web pages and the time of day you decide to test. Other users of the packet radio network in your area will be glad you did.

I welcome your questions and comments on this. Refer to the info below for this. If you do decide to undertake this test, good luck! ■

Resources

Wisconsin Amateur Packet Radio Association. Bob Gedemer, KA9JAC, 609 Wilson St., Neenah WI 54956. Web: <http://netnet.net/~ke9lz>. Membership is $20/year, or $15 without the *Smoke Signals* subscription. Write for details.

Badger State Smoke Signals, Kenneth A. Ebneter, K9EN, Chairman, 822 Wauona Trail, Portage WI 53901. A one-year subscription is $13.95, or included with WAPR membership (above).

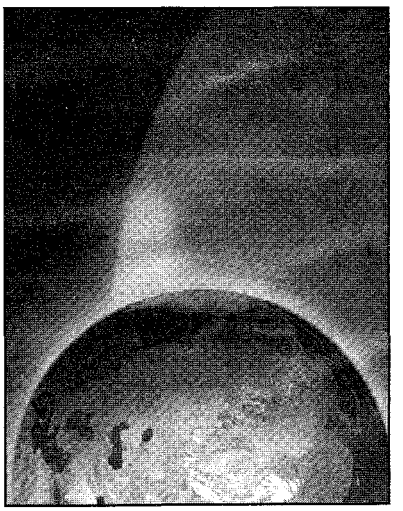
Andy Nemec, KB9ALN, 433 Cottage Grove Ave., Green Bay WI 54304. E-Mail <kb9aln@kb9byq.ampr.org>

Radio Science

Putting the Squeeze on Earth's Atmosphere

Researchers using NASA's Polar spacecraft have found the first direct evidence that bursts of energy from the sun can cause oxygen and other gases to gush from Earth's ionosphere into space, and that these gases then return to touch off auroras.

According to a NASA news release, scientists first saw this effect last September 24 and 25, when a storm from the sun hit the Earth. Using particle detectors on Polar, they found that the flow of "polar wind" out of Earth's upper atmosphere increased substantially when the storm hit. In effect, pressure from the solar ejection squeezed gas out of the ionosphere. But those same gases get caught in the Earth's "wake" and are pulled back into the atmosphere after being heated and excited by the solar wind, and it appears to be these supercharged gases that are responsible for causing aurora.



A two-way flow of gases at the poles. The "plasma fountain" seen in this NASA image is both spewing oxygen and other gases from the ionosphere into space and simultaneously pulling in plasma energy that causes auroras to form. (Courtesy NASA)

A Leaky Ionosphere

According to NASA, scientists have known since the early 1980s that the Earth's upper atmosphere leaks oxygen, helium, and hydrogen ions (atoms that have gained or lost an electron) into space from regions near the poles. But it was not until the Polar spacecraft actually flew through this fountain of ionized gas last September that scientists confirmed that the flow of ions was caused by solar activity.

On September 22, 1998, the sun ejected a mass of hot, ionized gas (known as plasma) toward Earth. NASA says this magnetic cloud of plasma (called a coronal mass ejection) increased the density and pressure of the solar wind and produced a shock wave similar to a sonic boom. When that shock wave arrived at the Earth late on September 24, it rammed into and compressed the Earth's magnetic shell in space (the magnetosphere). This shock to the magnetosphere excited the plasma trapped in Earth's ionosphere to a point where some ions gained enough energy to escape the planet's gravity and flow downwind of Earth. The amount of oxygen and other gases lost from the ionosphere amounted to a few hundred tons, roughly equivalent to the mass of oxygen inside the Louisiana Superdome.

"This is the supply of plasma that makes things interesting in space," said Dr. Thomas E. Moore of NASA's Goddard Space Flight Center, Greenbelt, Maryland, principal investigator for Polar's Thermal Ion Dynamics Experiment (TIDE). "Much of the gas ejected from the ionosphere is caught in Earth's wake. It then flows back toward the Earth while being heated and accelerated by the same processes that create auroral particles and the radiation belts."