

The Puget Sound Amateur Radio TCP/IP Network

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Abstract

The Puget Sound Amateur Radio TCP/IP Network (also known as WETNET, the Washington Experimenter's Tcp/ip NETwork), centered in the Seattle, Washington metropolitan area, has built an extremely functional packet radio network based on TCP/IP networking and cellular RF techniques. The network encompasses more than eighteen separate Local Area Networks, an estimated 200 users, four 9600 baud bit regenerative repeaters, and a full time Internet gateway. This paper is intended to provide an overview of an operational Amateur Radio TCP/IP network.

A Frequently Asked Question is "Why TCP/IP? Can't you do everything with regular packet radio that you can do with TCP/IP?" The answer is... somewhat, but not really. A key feature about Amateur Radio implementations of TCP/IP is that its various capabilities are built in- you don't have to combine dissimilar systems to do mail forwarding, file transfers, provide Packet Bulletin Board System (PBBS) services, multi-connect chat sessions, multiple ports, etc.- "It's (all) in there". A typical TCP/IP station can do:

- file transfers (including binary files)
- 0 keyboard to keyboard (chat, telnet)
- finger (display short text files)
- operate as a very capable Packet Bulletin Board System
- 0 operate as a very capable Net/ROM, TheNET, XI J node, etc.
- accept multiple connections from AX.25, Net/ROM, and other TCP/IP stations
- 0 access multiple ports, including modem, RS-232, terminals, and Ethernet connections
- 0 electronic mail
- automatic routing
- ping (test link integrity)

These operations are simultaneous, since the TCP/IP software is written to multitask. The capabilities outlined above are only a subset of TCP/IP's capabilities.

Some Background on Amateur Radio TCP/IP

A complete discussion of all of the various TCP/IP utilities and capabilities is beyond the scope of this paper, but a few deserve some discussion. One of the most interesting capabilities of Amateur Radio TCP/IP is e-mail. Since each TCP/IP station can send and receive e-mail, there cannot be a “choke point” in the network for message traffic- each TCP/IP user has the ability to send e-mail to any other user from their station. This was a much appreciated feature after having been through “PBBS Forwarding Battles”, where certain PBBS Sysops wouldn’t forward to other PBBS Sysops. With the added capability of a mailing list- being able to forward a single message to multiple recipients, e-mail made PBBS’, and their problems, almost irrelevant. TCP/IP users have the capability to participate in PBBS forwarding, and can “translate” PBBS messages to e-mail messages, and vice-versa.

Being able to add multiple ports easily is liberating. TCP/IP users can gateway between multiple ports, and this capability is used to provide redundant routes, and to provide network access to remote Local Area Networks whose users cannot access other parts of the network directly.

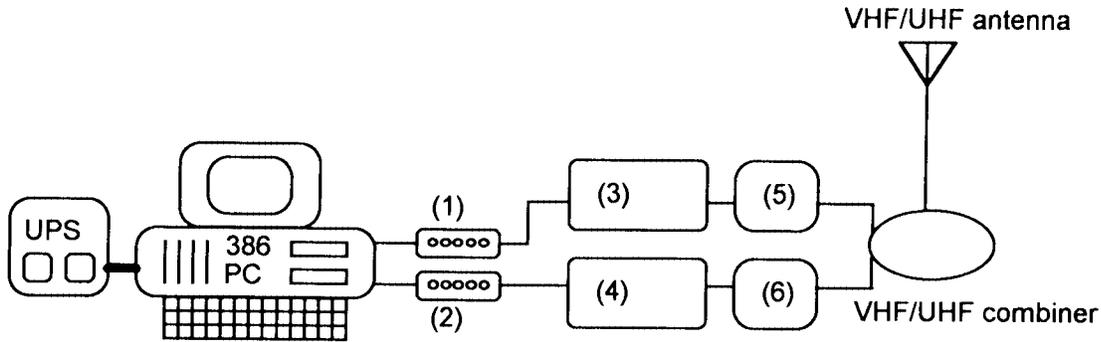
A TCP/IP station can effectively service AX.25 users by providing the capabilities of a PBBS, a network node, a “chat node” , and much more to AX.25 users.

Amateur Radio TCP/IP authors have traditionally (begun by Phil Karn KA9Q) made all source code, (written in C) freely available. If you want to add a new feature, or fix a bug, the source code is available, and several Puget Sound TCP/IP operators have made good use of this to add features and fix bugs, and contribute back to the code pool.

Network Operating System (NOS) was the name that KA9Q gave to his “second generation” of Amateur Radio TCP/IP software (the first was named NET). Since NOS was released, there have been numerous offshoots of NOS, including JNOS, TNOS, and others. In this paper, NOS is used interchangeably with the term “Amateur Radio TCP/IP Software”.

It is important to remember that “Amateur Radio” TCP/IP is completely interoperable with “commercial”, or “wired” TCP/IP. TCP/IP was enhanced to make use of Amateur Radio just as it was to make use of satellite links, other networking systems, and modems.

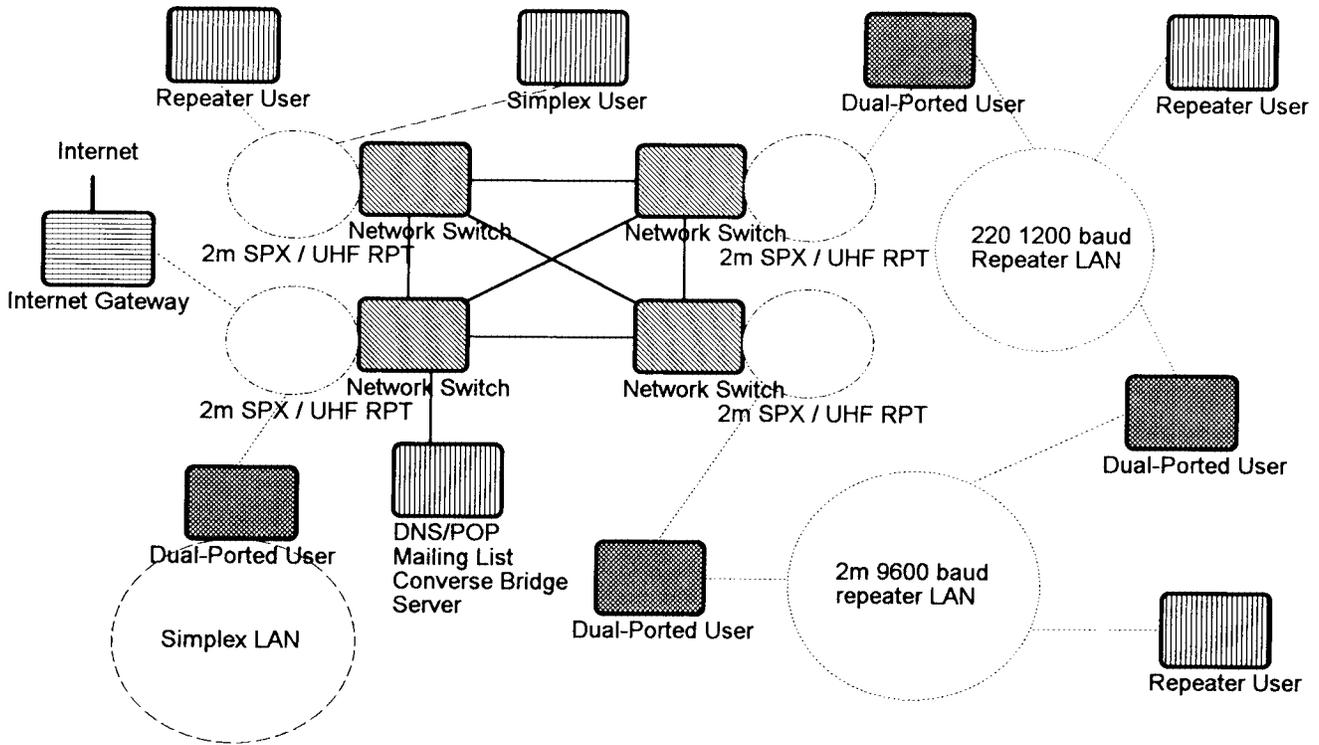
Networking



PC runs modified NOS or Linux

- (1) TNC w/TAPR 9600 modem w/bit regen (5) UHF duplexer
- (2) TNC w/1200 baud w/open squelch mod (6) VHF RF eqpt.
- (3) UHF land mobile radio, modified for repeater and 9600 baud
- (4) VHF land mobile, modified for 9600 baud (used for 1200)

Figure 1 - Diagram of a typical Puget Sound Network Switch site



- Simplex RF link
- - - Repeater User RF link
- Wire

**Figure 2 - Puget Sound Amateur Radio Network
Diagram of Potential Routes**

Typically, the Switches do not offer any “user functions” and only handle routing and other network functions. If a user function is enabled, it is typically routed to other systems in the network. This may change as the Switches are converted to Linux.

Several LANs have been formed by multi-ported stations that access a repeater and a 2m simplex frequency. Network users have gradually adopted the cellular telephone approach of using low power and a low RF profile, and thus are able to reuse frequencies.

Typically, the multi-ported station forms the center of a simplex LAN. Any stations joining the LAN are encouraged to be within good DCD range of the other stations on the LAN. This keeps overall performance on the LAN reasonably high, despite the inevitable collisions and hidden transmitters resulting from simplex operation.

The network is linked full time to the Internet through a Network Switch at the premises of one of the largest Internet Service Providers in the Seattle area. The primary use of the gateway is to allow participation in the global Converse Bridges. Amateur Radio TCP/IP users can also telnet, FTP, etc. to Internet hosts, as long as the user has a good connection to the network so the Internet system doesn't time-out from long delays.

The group makes extensive use of subnetting- the third “octet” of the Amateur Radio TCP/IP address is specific to a particular LAN. For example, 44.24.103 .xxx is an IP address for the 220 1200 baud repeater, and 44.24.101 .xxx is an IP address for the 147.60 simplex LAN. RIP (Routing Information Protocol) is used to propagate routes throughout the network.

Operational

A typical user station consists of a 386 PC using a Tekk KS-900 UHF radio with a beam, an AEA PK96 or MFJ1270 TNC with TAPR 9600 baud modem. The favored 2m 9600 baud radio is a modified GE MVP. The TCP/IP software of choice is the JNOS (WG7J). It is not uncommon to for the NOS PC to be configured as a “router” for other PC's in the household via serial or Ethernet connections to a second PC running “commercial” TCP/IP software, often with a graphical user interface- WindowsWinsock, OS/2 Warp, or Xwindows on Linux.

AX.25 users are welcome to connect to any TCP/IP station, both to browse around on that particular system or be routed to another system on the network. Some user stations and Switches actively encourage AX.25 and telnet connections by having numerous information files, binary files, and BBS areas available, . The group, at present, hasn't placed a high priority on interconnection between AX.25 PBBS forwarding and Net/ROM-type networking. There is limited connectivity between local PBBS systems and TCP/IP

users through a TCP/IP to PBBS gateway which transfers PBBS messages via e-mail. Personal PBBS messages are sent privately, and PBBS bulletins are sent via a mailing list.

Setup of TCP/IP for the first time has traditionally been a problem. The group has developed a JNOS setup disk, which includes all executable and configuration files necessary to get JNOS up and running. It includes a customized setup program which prompts the user for IP address, callsign, and other particulars, and then customizes the AUTOEXEC.NOS startup file, creates directories, and installs files as appropriate. From all accounts, the disk is working well in getting TCP/IP newcomers on the air.

The Puget Sound Amateur Radio TCP/IP Group

Early members of the group had been active in other area packet radio groups and had become burned out from the formal duties of a group, such as holding office, constitutions, dues, newsletters, etc. A deliberate, conscious decision was made that this group would remain informal in order to concentrate on technical and other innovative lack-of-management techniques. When funding has been needed for repairs or new equipment, money is donated by members of the group. This arrangement has worked relatively well, but the group did recently decide to get “slightly less disorganized” by requesting volunteers for *Keeper of the Notes*, *Keeper of the List of Projects*, and *Keeper of the Shekels*.

The group communicates primarily through a mailing list. Members of the group that wish to pose a question, comment on a previous posting, or share information send a single message to the list, and that message is automatically propagated. If a user’s connectivity is good, messages from the list can be delivered in minutes. Mailing list functions have been automated using Majordomo mailing list server software on a Linux system.

The group meets monthly on a weeknight evening. In keeping with its informal nature, meetings are “moderated” only to the point of “collision avoidance”. There is usually plenty to discuss, and formal presentations are rare. Any “burning issues” have typically been discussed on the mailing list prior to the meeting, and there are only a few “reports”. The group has a small advertisement in the local “Computer Paper” which draws in a few lapsed hams and technically curious non-hams.

An ongoing effort is to write effective documentation. Those involved in the documentation effort are enthusiastic about the potential of using the World Wide Web (WWW, or Web) to distribute information. Articles can be distributed as they are created, and updated individually. Web pages, being composed of ASCII text, can easily be distributed as e-mail, or printed from a Web browser. Using Web pages also enables other

groups worldwide to easily access the group's information. The group will support Web pages on the Internet gateway (typical graphically rich Web pages), and a well connected RF site in the network (primarily text Web pages). The group's current Internet Web page is located at:

<http://wetnet.wa.com/>

Future goals and projects

- Enhancing the reliability of the overall network is a high priority
- Expand high speed TCP/IP links to other areas in the Pacific Northwest, especially Vancouver and Victoria, British Columbia and Portland, Oregon.
- Implement several 56 KBPS and higher links
- Replace NOS with Linux at all Network Switches
- Increased use of Linux and other TCP/IP capable systems
- Contribute to the forthcoming TAPR TCP/IP book
- Sponsor a TAPR Annual Meeting and/or an ARRL Digital Communication Conference
- Accommodate increased use of PC's, Mats, Amigas, and Unix systems running their native implementations of TCP/IP
- Aggressively test and implement new radio-based routing techniques as they are developed

Conclusion

TCP/IP works very well for Amateur Radio networking. It has been a satisfying learning experience to get it running and keep it functioning. The results are well worth the effort expended.

The group would enjoy hearing from Amateur Radio TCP/IP users around the country and the globe that have implemented Internet access to their Amateur Radio Networks.

For those that are able, wouldn't it be more interesting to use our "radio" computers to participate in mailing list discussions such as NOSBBS, NETSIG, and others? There is no reason not to if your system has adequate connectivity to the Internet.

References

Steve Stroh N8GNJ, 206-481-5735, strohs@halcyon.com for questions on the Puget Sound Amateur Radio TCP/IP Group,

Ken Koster N7IPB, kenk@wetnet.wa.com for questions on the Puget Sound Amateur Radio TCP/IP Network,

Terry Conboy N6RY, 206-450-8388, tconboy@uswnvg.com for questions on the US West NewVector Amateur Radio Group and the Cellular Base Station systems.

The most complete book on Amateur Radio TCP/IP is NOSintro, subtitled TCP/IP of Packet Radio, An introduction to the KA9Q Network Operating System by Ian Wade G3NRW, copyright 1992 by Dowermain Ltd., ISBN 1-897649-00-2. NOSintro is available from the ARRL.

A good FTP site for downloading Amateur Radio TCP/IP software fi-om the Internet is:
`ftp.ucsd.edu/hamradio/packet/tcpip`

The mailing list for Puget Sound Amateur Radio TCP/IP Network users is:
`seatcp@algedi.ampr.org`

My thanks to the users and builders of the Puget Sound Amateur Radio TCP/IP Network- it's not a network without users to use it. It's been quite a ride, and we're "finally having fun yet". I'd especially like to thank N7IPB, KD7NM, WA7QFR, N7NKJ, and WA7FUS for inviting me into the group.